7 BIKEWAYS ON MAJOR ROADS

Optimally, as stated in Chapter 3, all arterials should have bike lanes. However, options are needed for arterials that cannot be retrofitted to accommodate bike lanes. The standard Class 3 Bike Route designation defined in the HDM requires no special markings or treatments other than signage. It is a generic category which applies to roadways ranging from busy arterials with narrow lanes to quiet low-volume residential streets. To aid bicyclists, city staff and motorists in anticipating what type of roadway conditions to expect on a Class 3 Bike Route, this manual presents many options for accommodating bicycles on roadways without bike lanes. Those that apply to arterials, collectors and highways are presented after the bike lane discussion in this chapter. Those that apply to local roads are presented in Chapter 8. It is encouraged that cities use one or more of these categories in their planning documents and bikeway maps. See also Chapter 8 *Local Roads*.

IN THIS CHAPTER:

Local and National Practices

Many cities in Santa Clara County have adopted additional bikeway categories. Palo Alto has developed a bikeway called a Bicycle Boulevard. This is a residential street where unnecessary STOP signs have been removed to improve travel time for bicyclists, and traffic calming measures have been implemented to reduce its attractiveness to automobiles. The cities of Cupertino and Berkeley, California; and Portland, Oregon have followed Palo Alto's example and are developing a network of bicycle boulevards. Napa County has developed Class 3A and Class 3C to describe rural roads with four-foot minimum and two-foot minimum shoulders, respectively. Berkeley has included on its adopted bike network a category called Class 2.5, for arterials where bike lanes are preferred but widening would be prohibitively expensive. The cities of San Francisco, California; Portland, Oregon; and Charlotte, North Carolina have adopted roadways with wide outside lanes as a specific facility for bicyclists. The cities of Denver, San Francisco, and Oakland are using the Sharrow stencil on busy roadways with narrow outside lanes to identify them as roadways where the full travel lane needs to be shared by both motorists and bicyclists.

Bike Lane-Parking Permitted

Wide Curb Lane

Road with "Sharrow"

Wide Shoulder

NOTE

Separate bike paths paralleling the roadway do not substitute for bike lanes on the arterial.

TECH TIP

RETROFIT OPTIONS

To retrofit existing roadways to have 5 ft minimum bike lanes, consider the following options:

- *Reduce lane widths to 11 or 10 feet;*
- *Four-lane undivided roads can be redesigned as three lanes with bike lanes; see PTG Fig 2.31*
- *Remove parking on one side of the street*

7.1 BIKE LANES

7.1.1 Bike Lane Widths on Arterials/Collectors

Urban arterials and collectors carrying 2000 or more vehicles per day per lane (vpdpl) (e.g. 4000 vpd for a two-lane roadway) should have bike lanes (See also Section 7.4 for discussion on the use of shoulders in lieu of bike lanes e.g. on County Expressways and state highways). Optimally, the width of bike lanes should increase as motor vehicle travel speed increases as discussed below.

The following provides guidance for three ranges of posted speeds.

With Posted Speeds Less Than or Equal to 30 mph

The optimum width for a bike lane on an arterial/collector with no on-street parking with speeds of 30 mph or less is five feet. The optimal minimum width to the longitudinal joint with the gutter pan is four feet. [When retrofitting bicycle lanes on existing streets, the minimum width per HDM is 3.0 feet from the gutter lip]. If there is on-street parallel parking, an additional eight feet should be provided. (See Section 7.1.2 for striping options of the parking lane).

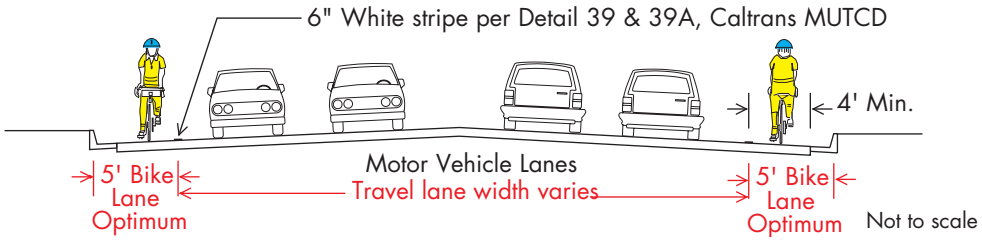


Figure 7-1a:
Bike Lane Width - 30 mph or less Posted Speed

With Posted Speeds between 35 and 40 mph

The optimal width for a bike lane on an arterial/collector with no on-street parking with posted speeds of 35 mph to 40 mph, is six feet. The optimal minimum width to the longitudinal joint with the gutter pan is five feet. If there is on-street parallel parking, an additional eight feet should be provided.

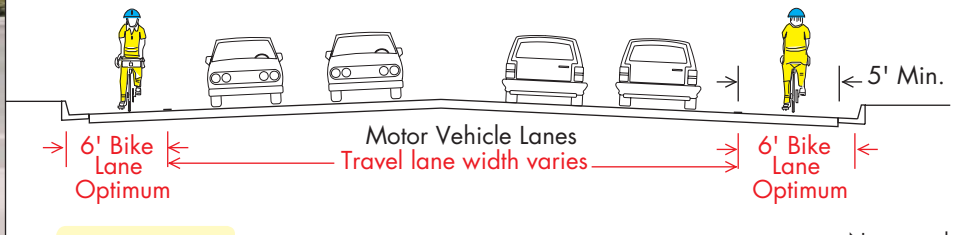


Figure 7-1b:
Bike Lane Width - 35-40 mph Posted Speed

With Posted Speeds of 45 mph or more

The optimum width for a bike lane on an arterial/collector with no on-street parking with posted speeds of 45 mph or more is eight feet. The optimal minimum width to the longitudinal joint with the gutter pan is seven feet. If there is on-street parallel parking, an additional eight feet should be provided.

Bike lane-parking prohibited.

Not to scale

Figure 7-1c:
Bike Lane Width - 45 mph or more Posted Speed

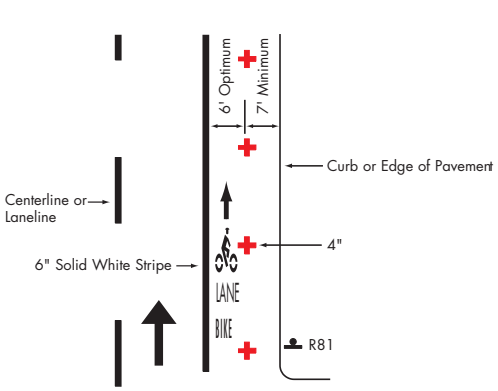
NOTE

On-street parallel parking presents the possibility of drivers illegally opening doors into the path of oncoming bicyclists. Wider bike lanes would allow bicyclists to ride outside of this "door zone."

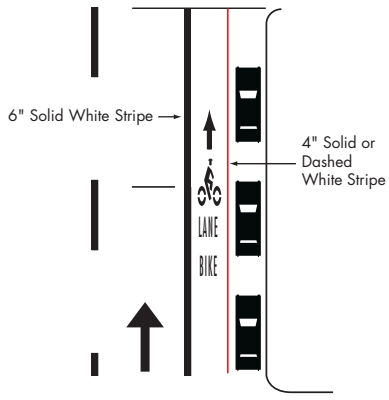
7.1.2 Striping with and without a Parking Lane

The bike lane stripe shall be a 6-inch white stripe per MUTCD-CA Detail 39. When the bike lane is next to a parking lane, optimally add 8 feet to the widths presented in Section 7.1

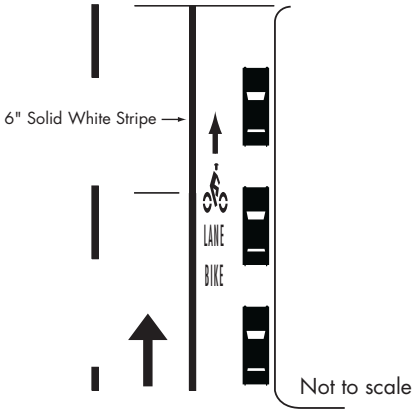
There are three ways to delineate the parking spaces from the bike lane using a 4-inch white line:



A. With metered parking, parking crosses are recommended: these are 24 inches by 24 inches and the center of the cross is placed 7 feet from the curb face;



B. Solid stripe or dashed stripe, where individual parking spaces are not marked;



C. No stripe-where turnover is low but parking occupancy is high, then no stripe or marking may be necessary.

Figure 7-2:
Bike Lane Striping Options with On-street Parking

LOCAL PRACTICE

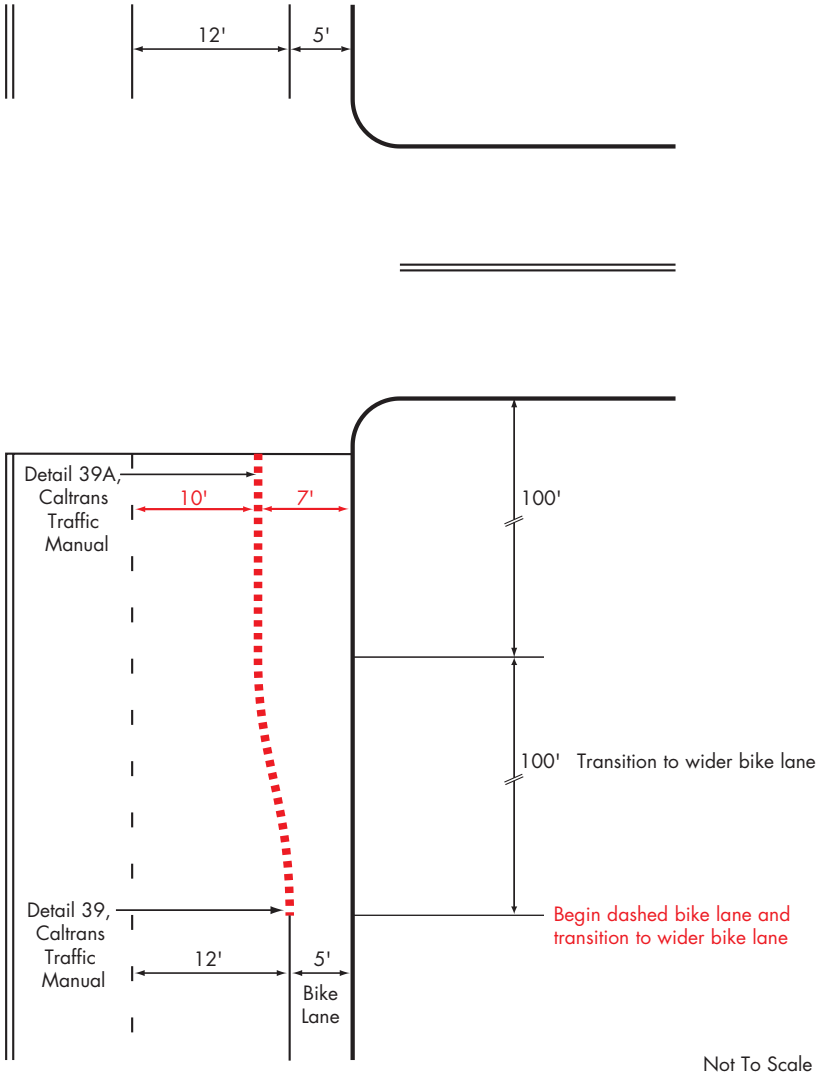
An option used in Cupertino at intersections without right-turn lanes is to dash and widen the bike lane for the last 200 feet by narrowing the travel lane. The City found that by narrowing the through lane and widening the bike lane, motorists were more likely to enter the bike lane to make their right-turn. (See Figure 7-3).

7.1.3 Bike Lanes Approaching Intersections

Caltrans Standard

Bike lanes approaching intersections should dash the solid bike lane line for the last 100 to 200 feet in advance of the intersection. This encourages the right-turn vehicle to enter the bike lane prior to the turn per CVC 21717.

Bike lanes approaching angled freeway ramps should drop the bike lane line for the last 200 feet in advance of the ramp angle point. This is depicted in HDM Figure 1003.2D which is reproduced in Chapter 5, Figure 5-7.



SOURCE: City of Cupertino Standard Detail 39AC.

Figure 7-3:
Bike Lane Striping Option at Intersection Approach

7.1.4 Bike Lanes and Exclusive Turn Lanes

Caltrans Standard

The bike lane shall be provided to the left of the right-turn only lane (see Figures 7-4 and 7-5) per HDM and the AASHTO Guide.

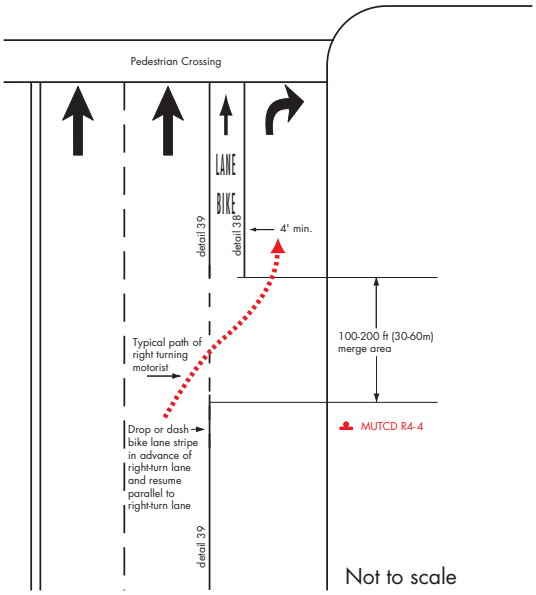


Figure 7-4:
Bike Lane Striping at Right-turn Only Lane

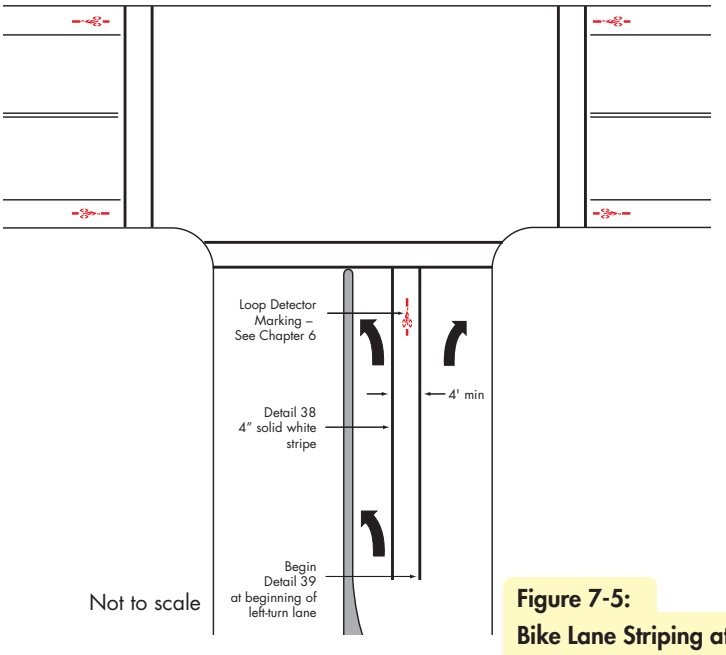


Figure 7-5:
Bike Lane Striping at T-intersection with Right-Turn and Left-Turn lanes

Caltrans Standard

Similarly, when a left-turn bike lane is provided it shall be provided to the right of the right-most left-turn only lane (see Figure 7-6) per HDM and the AASHTO Guide.

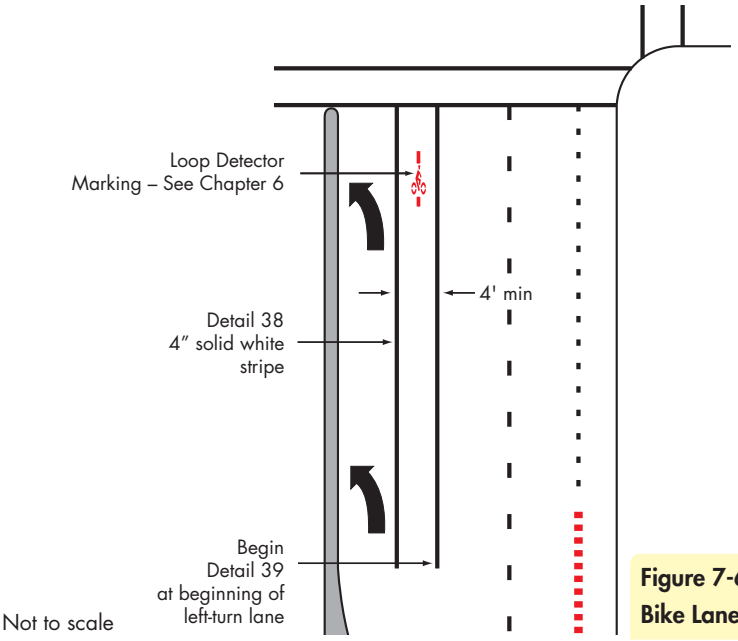


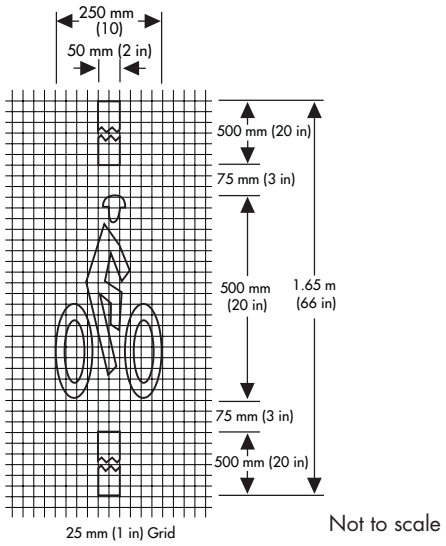
Figure 7-6:
Bike Lane Striping at Left-turn Only Lane

VTA Best Practice

A left-turn only bike lane should be considered when an average of two bikes per signal cycle are present during the peak hour.

7.1.5 Bike Lanes Approaching Signalized Intersections

Bike lanes approaching signalized intersections should drop the solid bike lane line and provide a dashed line for the last 200 feet leading to the intersection. Dashing is preferable to dropping the bike lane stripe because it alerts bicyclists and right-turning motorist of the weave. Also, if there are loop detectors in the bike lane, the dashed bike lane stripe encourages bicyclists to wait in the proper to be detected. Type Q loop detectors, adjusted to detect bicycles, should be placed near the limit line in the bike lanes and Type D should be used in motor vehicle travel lanes including the left-turn lanes (See Figure 7-7). The pavement marking as depicted in Standard Plans A24C shall be used to inform bicyclists where to wait to trigger the signal (Figure 7-8). More discussion is presented in Chapter 6.2. Alternative detection technology is acceptable as long as it reliably detects bicycles (see Chapter 6.2.3).



BICYCLE DETECTOR SYMBOL

Figure 7-8:
Loop Detector Pavement Marking

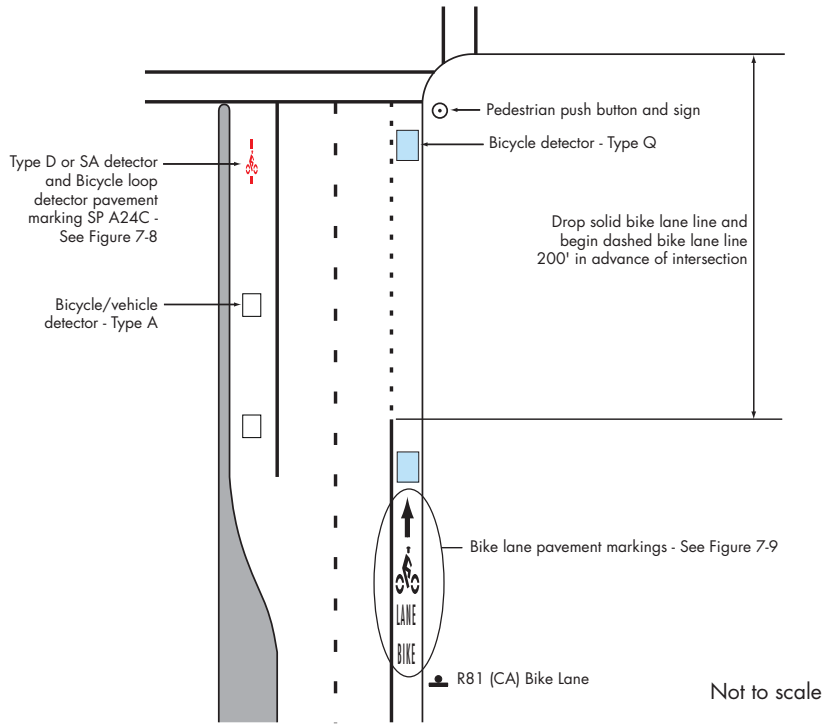


Figure 7-7:
Bike Lane Striping and Detector Layout at Signalized Intersection Approach

7.1.6 Pavement Markings and Signage in Bike Lanes

Markings:

Caltrans Standard

Bike lanes are marked with a bike lane pavement marking; the MUTCD-CA contains three options: the words BIKE LANE, the Bike symbol and the Bike Rider symbol. The bike lane symbol may also be used in conjunction with the word legends. The trend toward using symbols in lieu of words is favored by many cities, including San Jose. See MUTCD Figure 9C-6 and 9C-6(CA) for specifications. A typical marking is depicted in Figure 7-9.

Figure 7-9:
Typical Bike Lane Pavement Markings

VTA Best Practice

Include a straight directional arrow, to reinforce the one-way travel flow of the bike lane. The arrow is placed after the bike lane pavement markings.

Signs:

MUTCD-CA

Bike Lane (MUTCD R81 (CA))-The Bike Lane sign shall be placed at the beginning of each designated bike lane, after every arterial street intersection and at maximum half-mile intervals. No Parking signs may be integrated with the Bike Lane sign where parking is prohibited.

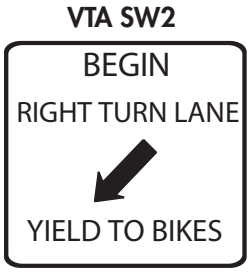
Wrong–Way signing (MUTCD R5-1b)-"Wrong-Way" signs may be posted on the back of the R81(CA) bike lane signs to educate bicyclists that bike lanes are intended for one-way travel. The Cities of Cupertino and Santa Clara currently do so.

Begin Right-Turn Lane Yield to Bikes (MUTCD R4-4)-This sign is used to reinforce to motorists entering a right-turn lane that the through bicyclist has the right of way.

VTA Best Practice

Bike Lane (through) at Forced Right-Turn Lane (VTA SW-5)-This sign is used at intersections with a bike lane and a trap right-turn lane where cars must turn right but bicyclists may proceed straight.

Right-turning Vehicles Enter Bike Lane When Clear (VTA SR-4)-This sign is used at locations where right-turning motorists are not complying with CVC Section 21717 to enter the bike lane prior to making their turn. This prevents turning motorists from cutting off a through bicyclist and helps ensure that the bicyclist will pass the motorist on the left. A variation of this sign is currently used in Lafayette, California.



VTA SW5

VTA SR-4

7.1.7 Bike Lanes at Bus Stops

Bike lanes on streets with bus routes present challenges in designing the bus stops or pullouts vis à vis the bike lanes. In general, for near side bus stops, it is recommended to drop the bike lane stripe adjacent to the bus stop while for farside bus stops, the bike lane stripe is only recommend if the cyclist can remain in the bike lane while passing a bus in the stop. (See Figure 7-10).

Discussion

The weave that must take place between through bicyclists and buses pulling over to load and unload passengers is a concern whether or not bike lanes are striped on a roadway. The presence of bus routes on a roadway should not prevent the provision of bike lanes on that roadway.

Concrete bus pad on N. First Street, San Jose.

Concrete Bus Pads

Portland cement concrete (PCC) pavement at all bus stops is preferred; asphalt pavement tends to ripple and crack over time. Figure 26 from VTA Bus Stop & Facility Standards indicates a structural section of 8.5 inch thick PCC over 8.5 inch thick aggregate base. Typical size of the pad is 10 feet wide by 55 feet in length for a standard 40' long coach.

Bike Lanes Next to BRT or HOV lanes

To reduce the weaving between bikes and buses, bike lanes should be provided to the left of bus High Occupancy Vehicle (HOV) and Bus Rapid Transit (BRT) lanes. If there is no bike lane or wide shoulder, bicycles should be explicitly permitted to ride in the HOV lane.

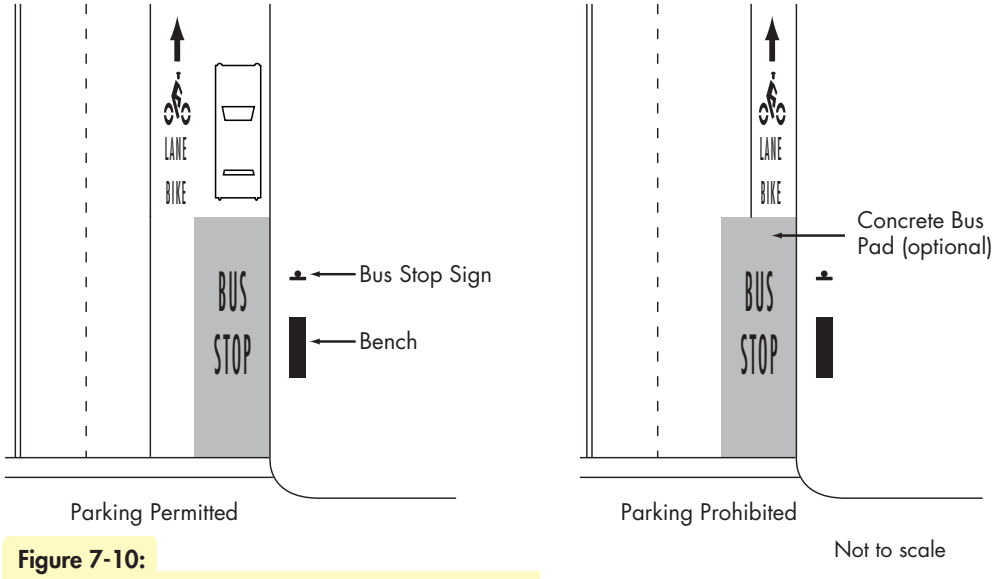


Figure 7-10:
Bike Lanes on Bus Routes (Farside Bus Stop)

7.1.8 Bike Lanes on Steep Grades

Bicycle lanes are generally not recommended on downhill grades greater than 5% unless a minimum of 8 feet can be provided because descending bicycles generally travel at motor vehicle speeds and should be able to merge with motor vehicles traffic in the outer lane.

On steep grades (5% or greater) where pavement widening potential is limited and extra lane width or a bike lane can only be provided on one side of the road, the bike lane or extra width should be provided in the uphill direction. Downhill bicyclists typically can travel nearer to or at the prevailing speed of traffic and can take the lane.

7.2 WIDE CURB LANES

Optimally, as stated in Chapter 3.1, an arterial or a collector roadway with 5,000 vehicles per day or more should have bike lanes. However, when bike lanes are not provided, the curb lane (outside through lane) should have an optimum width of 15 feet as illustrated in Figure 7-11.

See also AASHTO "A Policy on Geometric Design of Highways and Streets" 2001, Chapter 7 Urban Arterials- Lane Widths pp 476-477

Wide curb lanes also help trucks and buses, which predominantly use the curb lane. Such a curb lane of 15 feet (assuming no parking) is wide enough for most motor vehicles to pass a bicyclist without changing lanes. Curb lanes of thirteen feet or less are very intimidating and dangerous to bicyclists because it is difficult for motor vehicles (especially trucks and buses) to safely pass a bicyclist without straddling the lane line. This is compounded by the presence of a wide gutter pan as discussed in Chapter 3.2

To implement wide outside lanes on multi-lane roadways where roadway pavement widening is not practicable, it is recommended to narrow the

NOTE

A separate bike path paralleling the roadway does not substitute for providing wide curb lanes on the arterial.

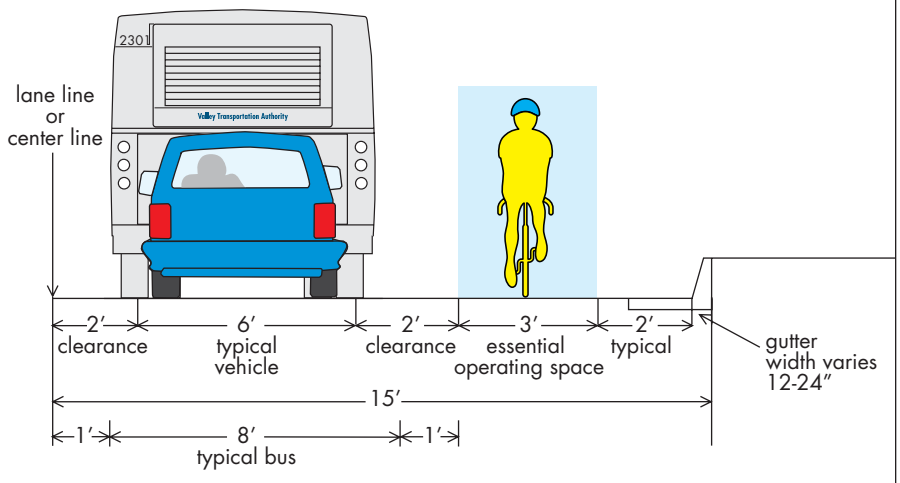
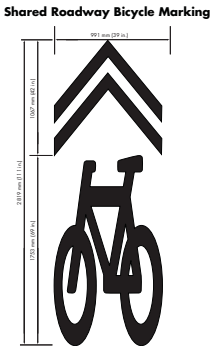


Figure 7-11:
Bicycle Operating Space in Typical Travel Lane

Not to scale

inner lanes and/or left-turn lanes and/or median in order to provide more width in the outer lane. Many cities have narrowed inner travel lanes to eleven or even ten feet (and left-turn lanes even narrower); AASHTO supports reducing travel lanes to eleven feet on arterials, (and to nine feet on residential streets), which allows for greater width in the outer through lane.



MUTCD Figure 9C-104 (CA)

7.3 SHARED ROADWAY BICYCLE MARKING (SHARROW)

The "Sharrow" is used to inform both motorists and bicyclists of the safe positioning of the bicycle on a roadway without bike lanes or shoulders. It is intended to reduce the chance of drivers opening doors of parked vehicles in the path of bicyclists and to alert road users within a narrow traveled way of the lateral location where bicyclists ride. They have been shown to reduce wrong-way riding and sidewalk riding, which are associated with increased risk of collisions.

A typical layout is depicted in Figure 7-12.

7.3.1 Roadway Characteristics

Caltrans Standard MUTCD 9C.103 (CA)

Caltrans permits Sharrows on state highways only in urban areas.

Per MUTCD-CA, sharrows may be used where the roadway has the following characteristics:

- No bike lanes or shoulders
- Speed limit < 40 mph
- Roadway with parallel parking

VTA Best Practice

In addition to the above, VTA recommends that the roadway:

- Be a designated bike route
- Have an ADT > 4,000 for a two-lane road or
- ADT > 12,000 for a four-lane road

For roadways with no on-street parking, VTA recommends that the outside lane be 14 feet (4.2 m) or less.

7.3.2 Placement

Caltrans Standard

- Lateral placement: centerline of symbol should be 11 ft min. (3.3 m) from edge of curb where there is on-street parking.
- Longitudinal placement: immediately after an intersection and every 250 feet (75 m).

MUTCD-CA states that the lateral distance may be increased as needed for roadway and traffic conditions.

VTA Best Practice

VTA recommends that the lateral placement be 12 feet (3.6 m) based on the findings of a City of San Francisco study.

For roadways with no parking, centerline of symbol should be 2.5 ft min. (0.8 m) from the curb face or 2.0 ft min. (0.6 m) from gutter lip.

W11-1

7.3.3 Signage

VTA Best Practice

Urban-Install Bike Route G93 or G series per Chapter 8.

W16-1

Caltrans Option

Rural-the Share the Road Sign installation (W16-1 & W11-1) may be used to supplement the Shared Roadway Bicycle Marking. Share the Road signs should be installed after every major intersection and at one-half mile intervals.

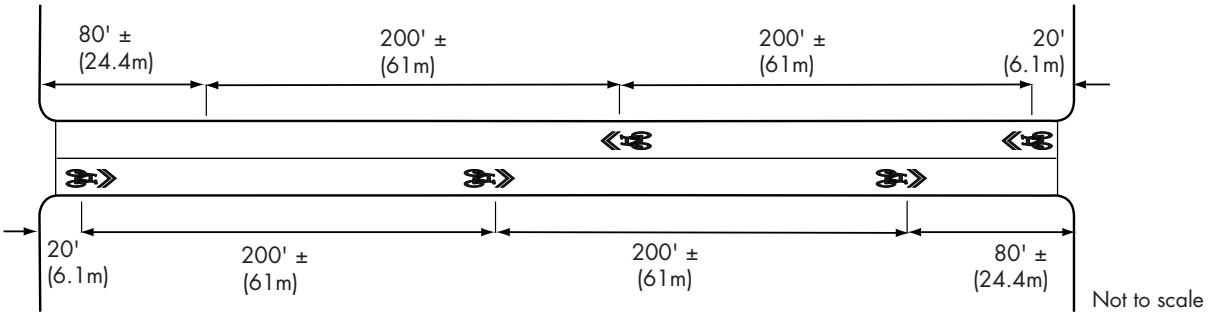


Figure 7-12:
Typical Sharrow Pavement Marking Installation

TECH TIP

Shoulder rumble strips are 19 mm (0.75 in) or less in height if raised 25 mm (1 in) in depth for rolled-in indentations and 8.5 mm (0.33 in) +/- 1.5 mm (0.06 in) for ground-in indentations that extend along the highway shoulder. The maximum width of shoulder rumble strips is 300 mm (12 in) for both rolled-in and ground-in indentations.

Guidance: Where bicycles are permitted, shoulder rumble strips should not be used unless approximately 1.5 m (5 ft) of clear shoulder width for bicycle use is available between the rumble strips and the outer edge of the shoulder.

Standard: Ground-in rumble strip treatments that are greater than 8.5 mm (0.33 in) +/- 1.5 mm (0.06 in) depth shall not be installed on shoulders where bicyclists are allowed.

Source: MUTCD-CA Section 3B.106 and Standard Plans A40.

7.4 SHOULDERS ON RURAL ROADS AND STATE HIGHWAYS

Shoulders are appropriate and preferable to bike lanes in rural areas if they are paved and maintained. They are also appropriate on County Expressways where the intersections are widely spaced. Given that there are legal differences (e.g. motor vehicles' use of shoulders) and practical differences (e.g. signing and marking requirements) between shoulders and bike lanes, the engineer must consider all factors before deciding to implement one versus the other.

7.4.1 Shoulder Rumble Strips

On shoulders, rumble strips are typically depressed grooves rather than raised pavement markers. Such rumble strips are typically needed only on highways with few interchanges and long tangents to reduce drift-off-road accidents. If a location is experiencing such accidents and rumble strips are being considered, shoulder rumble strips shall be placed adjacent to the fog line with a minimum of five feet of usable shoulder width available to the right of the grooves. (See Figure 7-13 and Standard Plans A40.)

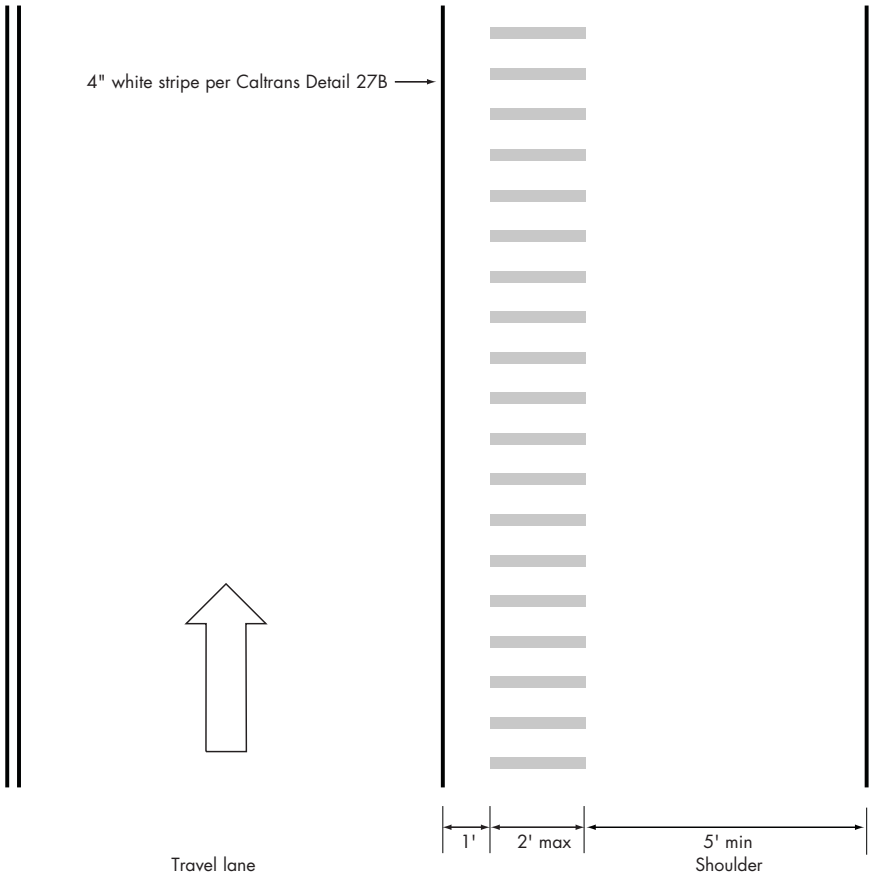


Figure 7-13:
Shoulder Rumble Strip Details

Not to scale

7.4.2 Design Issues

Issues that should be addressed when roadway shoulders are on a designated Bike Route include the following: [1] see Figure 7-14.

Width
The shoulder width should increase with the 85th percentile speed, similar to bike lane widths. The shoulder width should be 6 feet for speeds of 40 mph or less, and 8 feet for speeds greater than or equal to 45 mph. For low-volume highways, (under 2,000 vpd) lane/shoulder widths should comply with the guidelines set forth in Table 4-1 on pp. 54 of AASHTO's *Highway Safety Design and Operations Guide, 1997.*

Parking
When a designated bike route has shoulders, No Parking signs should be installed if traffic volumes exceed 4000 vpd and parking in the shoulder would otherwise be expected.

Intersections
On roads with significant bicycle traffic, the shoulder stripe should be dropped in 100 feet in advance of the intersection, just as a bike lane stripe is. [2]

Right-Turn Lanes
While right-turn lanes are not common in the settings where shoulders are used, there may be instances where a roadway with a shoulder also has a dedicated right-turn only lane. In these cases, the shoulder stripe should terminate in advance of the right-turn lane so that bicyclists are not tempted to proceed straight through the intersection from the shoulder area. They should merge left into the through lane, according to the rules of the road. Providing a bike lane-type treatment between the through lane and the right-turn lane is recommended.

[1] *See also: AASHTO's Greenbook, Chapter IV, Shoulder Stability, pp. 342.*

[2] *See also: Countywide Expressway Bicycle Accommodation Guidelines, Santa Clara County Roads and Airports Department, August 2003*

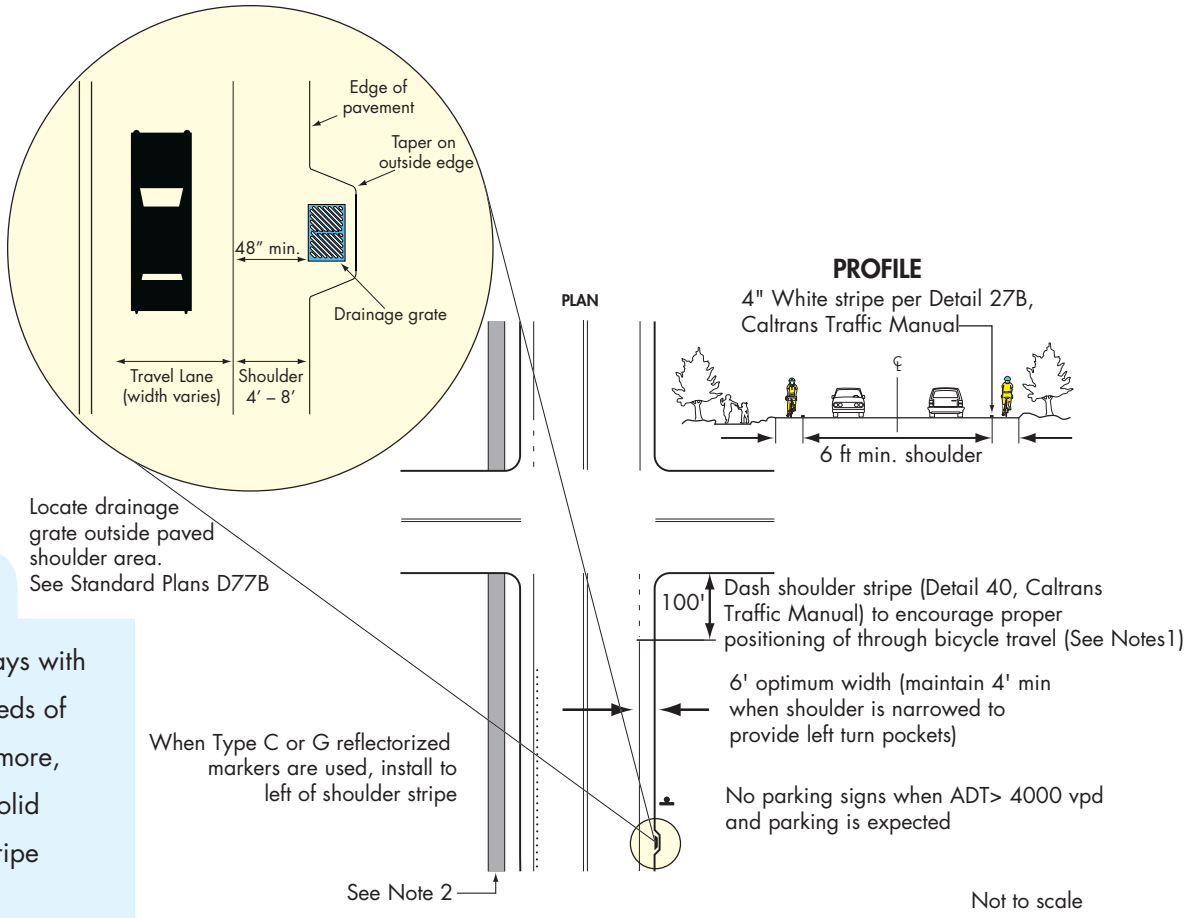
Pedestrians
If there is a reasonable expectation that there will be pedestrian activity, an all-weather pedestrian pathway should be provided so that bicyclists and pedestrians do not share the shoulder.

Left-Turn Lanes
Where left-turn lanes are provided at intersections or driveways by narrowing the roadway shoulders, the shoulder width should not be reduced to less than 48 inches.

Longitudinal Joints
The joint between the shoulder and the travel lane should be smooth. [1] The City of Portland's Design Guidelines also provide guidance on how to maintain a smooth joint when the shoulder is widened to accommodate bicyclists.

This drainage grate located off of the shoulder will not force cyclists into the travel lane in order to avoid it.

Drainage Grates
Grates should be placed outside the paved shoulder area. Bicyclists should not be expected to ride over drainage grates. If the grate



NOTES

1. For roadways with posted speeds of 45mph or more, terminate solid shoulder stripe 200 feet in advance of intersection.
2. When there is a localized increase in the number of pedestrians, provide a pathway so pedestrians do not walk on Shoulder.
3 For roadways <2000 vpd, see Table 4-1 of AASHTO's *Highway Safety Design and Operations Guide, 1997.*

Figure 7-14:
Wide Shoulders - Bicycle Friendly Details

encroaches on the shoulder, there shall be a minimum of 48 inches of clear asphalt. See also: TDMG Policy UD-4.13.

Asphalt Berms

When asphalt berms are constructed on roadway shoulders to divert storm water into catch basins, they should be constructed in a manner that would not obstruct bicyclists from using the shoulder or transitioning between the shoulder and the travel lane.

Driveway Aprons

Unpaved driveways should be paved for first 15 feet from the roadway to minimize dirt and gravel migration onto the shoulder.

8 LOCAL ROADS AS BIKEWAYS

Residential roadways can make excellent bike routes particularly if they are designed and/or retrofitted for speeds of less than 25 mph. The street design should balance cyclists' needs for wider lanes with the trend for narrower cross-sections to discourage speeding. For traffic volumes less than 2,000 vpd, a roadway width of 30 feet maximum will reinforce slow speeds while bicyclists can comfortably share the full lane due to the low traffic volumes. Curb radii should be 15 feet maximum to discourage fast right-turns.

Roadway and neighborhood design features should be incorporated that support bicycling and walking. These include pathways to neighborhood schools; connections between abutting cul-de-sacs, and other integrated well-lit short-cuts and pathways for non-motorized users to access adjacent neighborhoods, parks, retail areas, shopping centers, and commercial districts.

This chapter describes Caltrans guidance for bike routes; recommended practices for planning and implementing bike routes as well as bicycle boulevards and bicycle-compatible traffic calming devices.

IN THIS CHAPTER:

See VTA's PTG Section 3.1A and Figure 3.4 for more guidance on curb rodii.

Typical residential street in Mountain View.

8.1 BIKE ROUTES AND SIGNED SHARED ROADWAYS

8.1.1 Terminology

The AASHTO Bike Guide discontinued the use of the term "Bike Route" in its 1999 revision. It now refers to this type of bikeway as a "Signed Shared Roadway" since all roadways are shared roadways but only some are signed as a designated bike route. Caltrans HDM uses the terms "Class 3" and "Bike Route". The BTG will use the term Signed Bike Route.

8.1.2 Features of a Signed Bike Route

Caltrans Standard

As discussed in HDM 1003.3(1), it is recommended that a signed bike route have some advantage for bicyclists over other streets that they might choose. A signed Bike Route should either:

- provide continuity in the overall bikeway network, or
- identify a route which is somehow preferable to immediately adjacent streets. ▷

▷ An appropriate application would be a street that has all the design features described in Chapters 3-6 rather than a parallel arterial that has few of those features.

Examples of the latter include a road that is maintained to a higher standard, has wide curb lanes or wide shoulders, has traffic-calming and/or directly serves major destinations, is less circuitous, or provides direct access to a bike bridge.

VTA Best Practice

If local streets are signed bike routes, they should meet as many of the conditions below as possible:

- ADT < 2,000
- Standard street lighting
- Directional signing (see Section 8.1.3)

NOTE: With two additional design features, it is essentially a "bike boulevard" which is described more fully in Section 8.2. These design features are:

- STOP signs positioned to give right-of-way to travel on the bike route
- Aids to cross arterials (e.g. traffic signals, median refuge, in roadway lighted crosswalks)

See Section 7.1 for guidance on arterials and collectors as signed bike routes.

8.1.3 Guide Signs for Bike Routes

Caltrans Standard

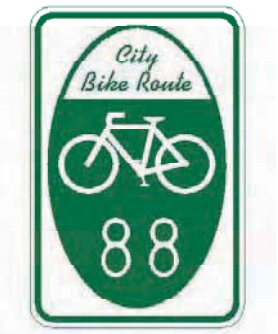
Signed Bike Routes are marked with the D11-1 sign or the SG 45 (CA) sign described below.

The following are options for alternative and additional signage for bike routes and destinations from MUTCD-CA. Optimally, destination signage for bicyclists would be included, particularly on trails where bicyclists do not have the use of motorist information signage.

D11-1

VTA Best Practice

Numbered Bike Route Sign (SG-45 (CA) Numbering bike routes such as Bike Route sign SG-45 (CA) helps cyclists follow a signed bike route, particularly those that turn and jog onto other roads, bike bridges or paths. The SG-45 (CA) sign is designed so that local jurisdictions can insert a custom logo.



SG 45 (CA)

Numbered bike route signs should be used to identify the cross-county bicycle corridors. In certain applications, particularly trails, a name can be used instead of a number (e.g. the San Tomas Aquino trail through Santa Clara, Cupertino and Campbell). A distinctive logo for the County should be designed for the SG-45 (CA) sign. If a route is given a name or number by a Member Agency, it should be consistent with the countywide route numbering or naming system.

SG45 (CA)

Destination signing (MUTCD D-1 series) should be used on trails, bike lanes and bike routes. Indicating the distances to these destinations is recommended where appropriate as both education and encouragement to cyclists and the general public.

Three options for bike guide signing are:

- Supplementary placard on the D11-1 or SG 45 sign (or R81(CA) bike lane sign) indicating the destination and distance;
- Inserting direction, destination, and/or route name in place of the "BIKE ROUTE" wording on the D11-1 sign
- Use of the guide sign series D1-2 in MUTCD 2008

D11-1C

MUTCD guidance for the D1 sign series states:

Bike symbol: The bicycle symbol should be to the left of the destination legend and placed next to each destination or group of destinations.

Distance: The distance figures, if used, shall be placed to the right of the destination names.

D1-2C

Arrows: The directional arrows should be horizontal or vertical unless a sloping arrow will convey a clearer indication of the direction to be followed. If an arrow is at the extreme left, the bicycle symbol shall be placed to the right of the respective arrow.

8.2 BIKE BOULEVARDS

A bicycle boulevard is a typical residential street where bicycle traffic is given the right-of-way wherever feasible. Palo Alto created the County's (and the country's) first bike boulevard by removing unnecessary STOP signs along Bryant Street, which dramatically improved the travel time for bicyclists. To prevent automobile traffic from diverting to the bike boulevard, traffic calming measures can be installed to restrict or discourage motorized traffic. See Figure 8-1.

Residential streets meeting the following conditions are optimum locations for bicycle boulevards:

- Existing low vehicle volumes;
- Very little commercial frontage;
- Roadway is parallel to a major arterial or a high-traffic collector street (within approximately 0.25 mile);
- Not a transit or truck route;
- Roadway is reasonably continuous, i.e. it extends over at least two miles; it should have few jogs with main segments at least 0.5 miles long.

W4-4p

AT TWO-WAY STOP SIGN CONTROLLED INTERSECTION

Cross-Traffic Does Not Stop (W4-4p) -These signs may be used to supplement standard markings at intersections which have been converted from 4-way stop to 2-way stop, or when 2-way stop signs have been rotated as in the implementation of a bicycle boulevard. Generally, they are used for a limited time until the traffic is used to the change.

Typically, the following treatments are needed to fully create a full functioning bike boulevard:

1. Whenever possible, STOP signs are positioned so that the bike boulevard has the right of way.
2. Installing traffic control devices so that bicyclists on bike routes can easily cross major streets and arterials.
3. If necessary, installing traffic calming measures, such as traffic circles or semi-diverters, in selected locations to ensure that motor vehicles do not divert to the bicycle boulevard. See Figures 8.2 and 8.3.

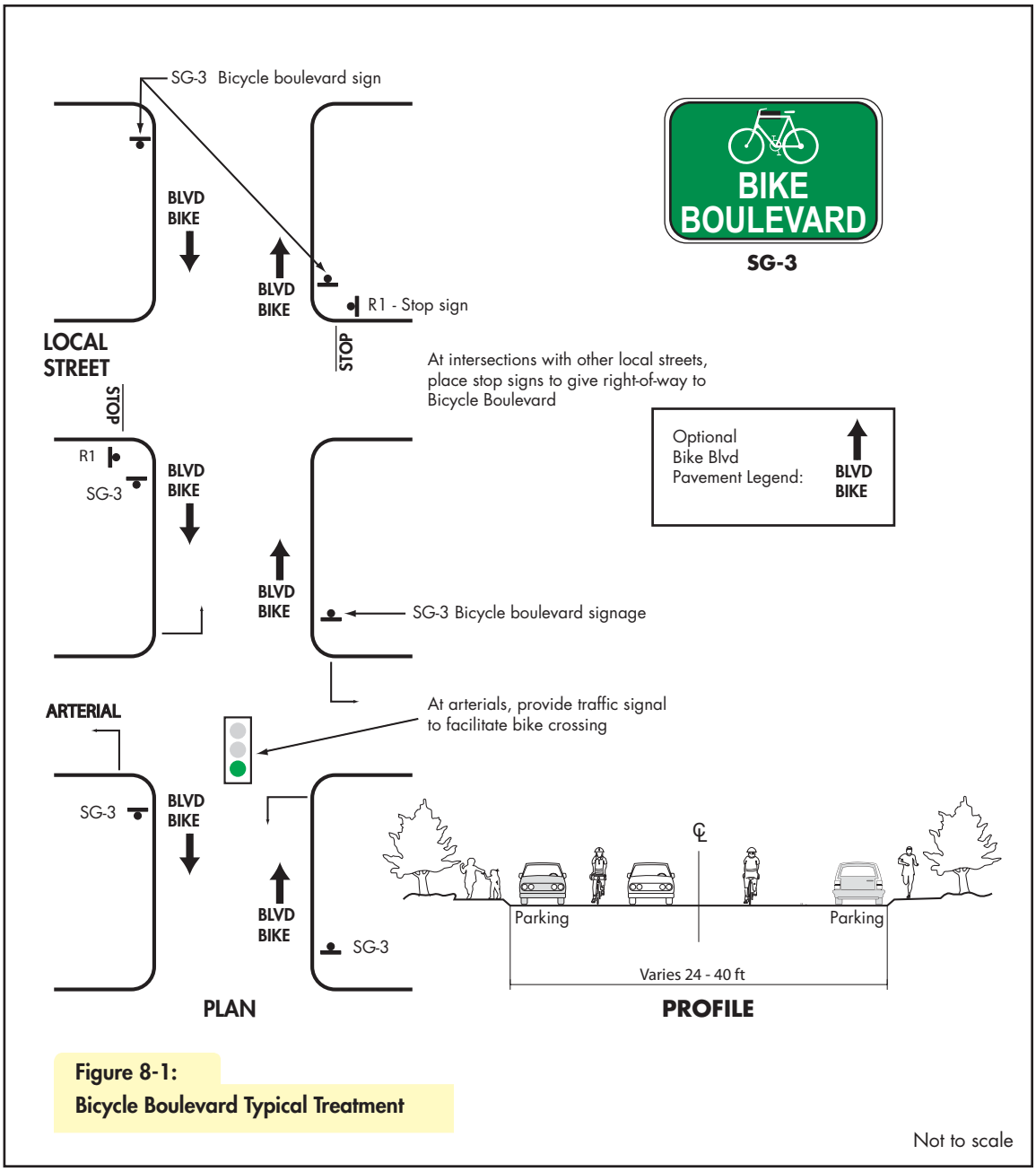


Figure 8-1:
Bicycle Boulevard Typical Treatment

Bryant Street at Embarcadero Road in Palo Alto, where bikes may proceed straight but motor vehicles must turn right.

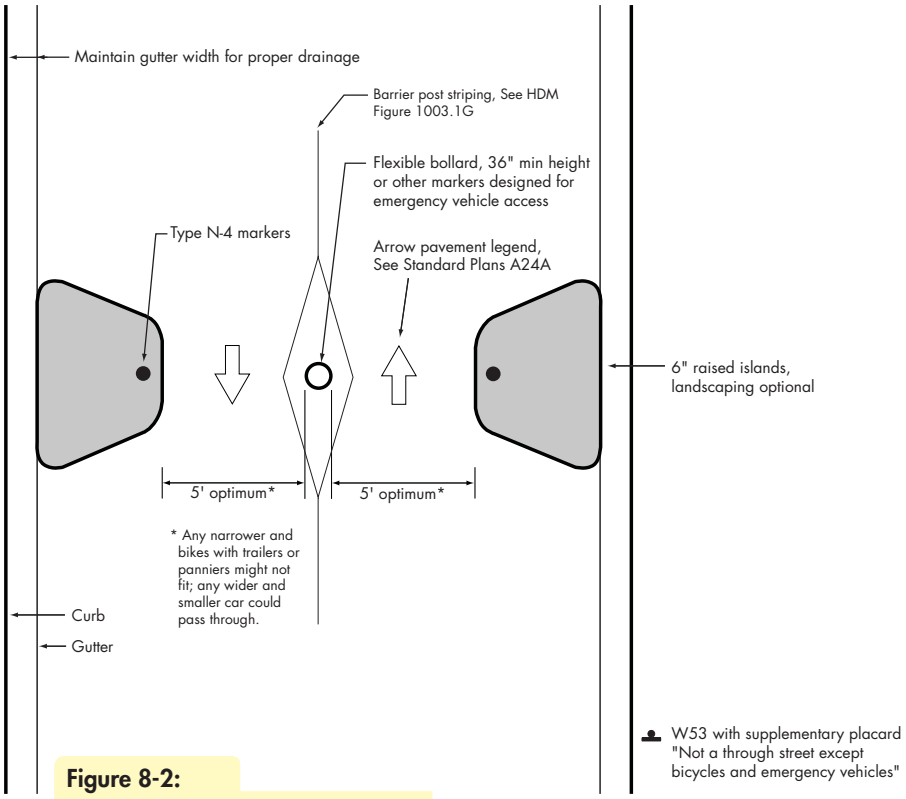


Figure 8-2:
Barrier Design: Bicycle Boulevard

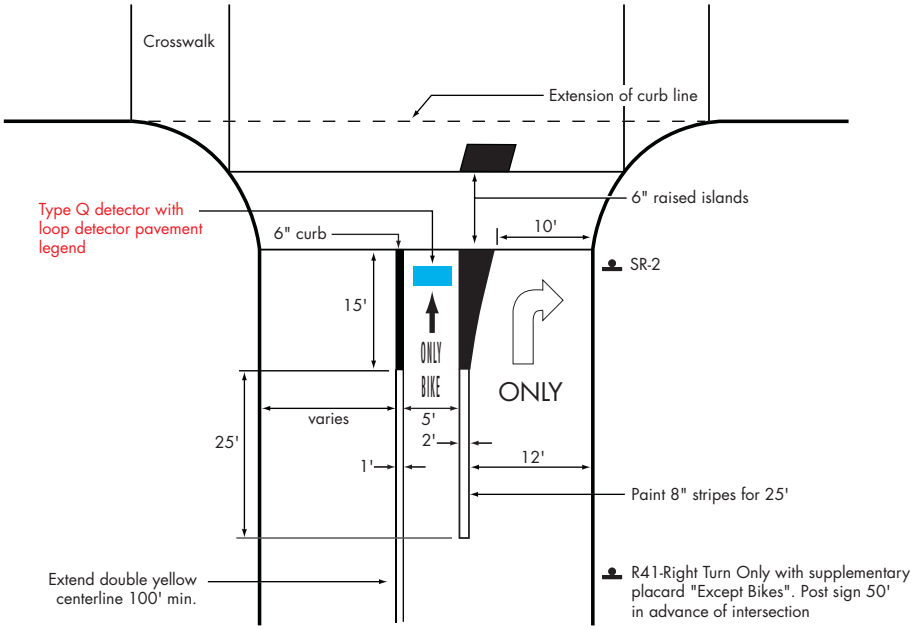


Figure 8-3:
Forced Right-Turn Channelization

8.3 BICYCLE-FRIENDLY TRAFFIC CALMING

Traffic Calming techniques provide many benefits for bicyclists, not the least of which is slowing traffic, which reduces the incidence and severity of injuries. However, the specific design of individual strategies can make the difference between being beneficial or innocuous to bicycles and being an obstruction or deterrent to bicycling.

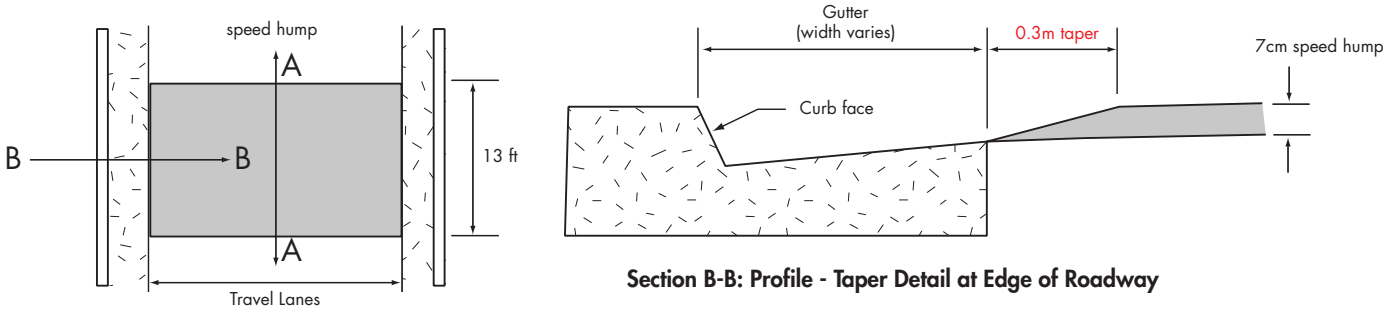
Also see "Traffic Calming in Practice" Institute of Transportation Engineers.

8.3.1 Speed Humps

Sinusoidal speed humps (see Figure 8-4) have been shown to cause the least discomfort to bicyclists while still providing the traffic calming benefits to motorists. The design shown in Figure 8-4, from Toronto, Ontario, is designed to slow auto travel to 18 mpg. Molded rubber speed humps have shown promise in Portland, Oregon; they have advantages in that they can be quickly removed and relocated.

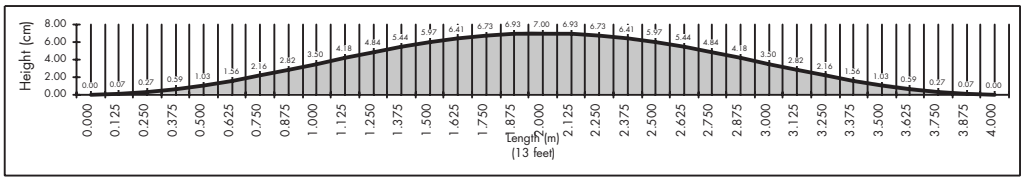
8.3.2 Speed Lumps

Speed lumps are like speed humps but with gaps for the wheels of emergency vehicle to travel through. The idea is that larger vehicles like



Plan view of roadway

Section B-B: Profile - Taper Detail at Edge of Roadway



Section A-A: Profile of Speed Hump Cross Section

Not to scale

Figure 8-4: Sinusoidal Speed Hump

fire trucks are able to straddle the humps and are not adversely impacted whereas passenger cars must still pass over the hump with at least one wheel. Bicyclists can also benefit by using the gap in the Lumps.

8.3.3 Medians

Center raised medians have been used to improve safety, aesthetics, and also to provide some measure of traffic calming. When designing roadways with medians, bike lanes should be included or the curb-to-curb width should be 15 feet to enable motorists to safely pass bicyclists. Fire Departments may also have their own minimum standards. Also, curb-cuts should be considered to facilitate bicycle crossings where there is no median break.

Residential traffic circles at two intersections.

8.3.4 Bulb-outs

Bulb-outs should be designed such that 14 feet of lane width remains, so that bicycles and cars can both safely pass through the narrowed opening.

8.3.5 Traffic Circles

Traffic circles on bike routes should be implemented in consultation with the local Bicycle Advisory Committee. They should be designed such that there is 14 feet of clear roadway for motorists and bicycles to share through the intersection. At a standard four-way intersection, two approaches should be controlled by STOP signs; otherwise, the circle should be designed as a full Modern Roundabout (see below).

8.3.6 Roundabout

At intersections of neighborhood street with volumes at or approaching the need for 4-way stop sign control, consider use of a Roundabout instead. Modern Roundabouts have YIELD on entry control and deflection for entering vehicles.

TECH TIP

See also TECH TIP in Section 5.3.1 for the use of roundabouts at freeway ramp intersections and in Section 9.2.2 for use of roundabouts at the intersection of two bike paths.

8.3.7 Forced Right-Turns

Forced right-turns are one of the strategies that can be used on bicycle boulevards or other locations to discourage non-local motor vehicle traffic from using the roadway in question. (See Figure 8-3).