

Appendix E: **Bicycle Facility** **Design Standards**



To: Suzanne Engelke, City of Roseville
From: Mauricio Hernandez, Alta Planning + Design
Date: March 4, 2025
Re: Roseville Active Transportation Plan – Bicycle Facility Design Guidelines

Overview

This Bicycle Design Guide has been developed to complement the City of Roseville Active Transportation Plan. The document has been informed by various state and federal design guidance focusing on improving comfort and safety for people biking. This memo presents a toolbox of current engineering standards and design approaches to implement bicycle and trail crossing enhancements. The guidance provides context-sensitive options from current best practices and established state and national guidance. The following local, state, federal, and industry guidelines and standards were referenced in the development of these guidelines:

- City of Roseville [Design & Construction Standards](#) (2023)
- City of Roseville [Community Design Guidelines](#) (2008)
- Caltrans [Design Information Bulletin \(DIB\) Number 94 – Complete Streets Contextual Design Guidance](#) (2024)
- Caltrans [Design Information Bulletin \(DIB\) Number 89-02 – Class IV Bikeway Guidance](#) (2022)
- Caltrans [Traffic Calming Guide](#) (2023)
- Caltrans [Traffic Safety Bulletin 21-01 - Leading Pedestrian Interval \(LPI\) Implementation Guidelines](#) (2021)
- Caltrans 7th Edition Highway Design Manual (HDM) – [Chapter 1000 Bicycle Transportation Design](#) (2023)
- Caltrans [California Manual on Uniform Traffic Control Devices, Revision 8](#) (2024)
- FHWA STEP: [Improving Visibility at Trail Crossings](#) (2021)
- FHWA [Bikeway Selection Guide](#) (2019)
- FHWA [Small Town and Rural Multimodal Networks](#) (2016)
- FHWA [Safe Transportation for Every Pedestrian \(STEP\)](#)
- FHWA [Proven Safety Countermeasures](#)
- NACTO [Don't Give Up at the Intersection](#) (2019)
- NACTO [Designing for All Ages & Abilities](#) (2017)

Contextualizing Facility Design

Future roadway planning, engineering, design, and construction should continue to strive for a balanced transportation system that includes a seamless, accessible, active transportation network and encourages active transportation wherever possible.

Supporting active modes allows users to make decisions between transportation modes, whether to make trips entirely by walking or bicycling or to access public transit. Convenient non-motorized travel provides many benefits, including reduced traffic congestion, economic savings, increased economic development, and a healthier environment. Safe and well-connected active transportation facilities do more than help those who already ride a bicycle or walk; they encourage greater use of non-motorized transportation and make the street safer for everyone.

The design guidelines and recommendations in this document are for use in Roseville. Projects must not only be planned for their physical aspects as facilities serving specific transportation objectives; they must also consider effects on the aesthetic, social, economic, and environmental values, needs, constraints, and opportunities in a larger community setting. This is known as Context Sensitive Design and should be employed when determining which standard applies in each scenario.

When applicable, all bicycle design guidelines in this document meet or exceed the minimums set by the Americans with Disabilities Act Accessible Design, such as along Class I multi-use trails and at crossing locations. All traffic control devices, signs, and pavement markings used and identified in this document must conform to the California Manual on Uniform Traffic Control Devices (CA MUTCD) as supplemented and adopted by Caltrans and the Caltrans Design Manual. Whenever possible and appropriate, Roseville's Design & Construction Standards and the guidance included in this document should be considered for the construction of bicycle facilities. There are situations where standards cannot be achieved due to geometric or environmental constraints or may not be appropriate due to a unique situation. Engineering judgment may determine that the dimensions may be reduced for specific conditions.

Bicycle Design Principles

Shared-use Paths (Class I)

Shared-use Paths (Class I), or multi-use trails as the City of Roseville generally refers to these facilities, are off-street facilities that can provide a desirable transportation and recreation connection for users of all skill levels who prefer separation from traffic. They often provide low-stress connections to local and regional attractions that may be difficult or not be possible on the street network.



Class I Multi-Use Trail in Roseville

Typical Application

- Can be developed in various linear corridors, open spaces, or adjacent to roadways where sufficient separation exists.

Design Features

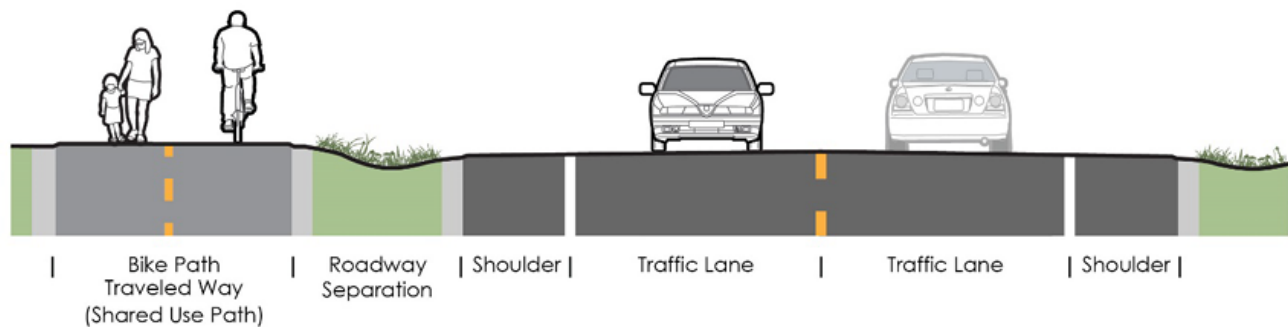
- 10 to 12 feet is the minimum width allowed for two-way travel (with 2-foot shoulders) and is only recommended for constrained situations (**Caltrans DIB-94 and HDM**).
 - 12 to 15 feet is recommended (but not required) for heavy-use situations OR situations with high concentrations of multiple user types (people walking, bicycling, rolling, etc.) (**Caltrans DIB-94**). Wider facilities can more comfortably accommodate side-by-side riding and encourage more social use of trails while reducing conflicts. One-way bike paths in these settings should have a minimum width of 7 feet.
 - If there is a desire to separate people walking and bicycling, wider facilities should be provided. A separate track (5-foot minimum) can be provided for pedestrian use but is not required.

Table 1. Standard Bicycle Traveled Way Widths (Class I)

Bicycle Facility Placement	Minimum (feet)	Preferred (feet)	Practical Maximum (feet)
One Way	6 to 7	7	8
Two Way	10 to 12	10 to 12	12 to 15
On structures between railings and in tunnels (one way or two way)	10 to 14	10 to 14	15
At sidewalk level*	12 to 16	12 to 16	20

Source: Caltrans DIB-94, 2024

*Refers to on-street multi-use trails versus off-street trails



Source: Caltrans DIB-94 Figure 5-B

Further Considerations

Lateral Clearance

- Caltrans HDM requires that a minimum 2-foot-wide shoulder, composed of the same pavement material as the bike path or all-weather surface material (ex. decomposed granite) free of vegetation, be provided adjacent to the traveled way of the path when not on a structure. The CA MUTCD requires an additional foot of lateral clearance (total of 3 feet) to install signage or other furnishings. A 5-foot minimum clearance is required if the pathway is adjacent to a roadway.
- If bollards are used at intersections and access points, they should be colored brightly and/or supplemented with reflective materials to be visible at night. Other design alternatives are preferred over bollards.

Overhead Clearance

- The vertical clearance to obstructions across the clear width of the bike path shall be a minimum of 12 feet when Fire Department access is required; otherwise, it shall be nine (9) feet, including bike paths placed beneath bridge structures (**City of Roseville Design Standards Section 13-4.B**).

Striping

- When striping is desired, it is recommended that a 4-inch dashed yellow centerline stripe be used.
- Solid centerlines can be provided (but are not required) on tight corners or where sight distance is limited and on the approaches to roadway crossings.
- 4-inch solid white edge lines are optional but will narrow the effective width of the facility.

Materials and Maintenance

- Must be regularly maintained to be free of potholes, cracks, root damage, and debris. Signage and lighting should also be regularly maintained to ensure multi-use trail users feel comfortable, especially where visibility is limited.
- Adjacent landscaping should be regularly pruned to allow adequate sightlines, daylight, and pedestrian-scale lighting and not obstruct trail users' travel paths.

NOTE: Roseville also has an additional classification for Class I bikeways. Class IA Bike Paths are paths that have been developed as parallel widened (8'–12') sidewalk routes along major roadways and are separated from the roadway by a landscape strip. These paths are for the use of pedestrians and beginning bicyclists. Caltrans does not consider sidewalk facilities to be Class I facilities and does not recommend that they be signed as bike routes. However, the Class IA facilities are desirable, particularly for bicyclists of lower skill levels, such as children, as well as others who are hesitant to use on-street routes. Class IA bike paths are intended to supplement, not replace on-street bike lanes, but there may be occasions where they are used in lieu of on-street bike lanes.

Bicycle Lanes (Class II)

On-street bicycle lanes (Class II) are a portion of the roadway that has been designated by striping, signage, and pavement markings for the preferential or exclusive use of bicyclists. The bike lane is located directly adjacent to motor vehicle travel lanes and is used in the same direction as motor vehicle traffic. Bike lanes are typically on the right side of the street, between the adjacent travel lane and curb, road edge, or parking lane. Bike lanes enable bicyclists to ride at their preferred speed without interference from prevailing traffic conditions and facilitate predictable behavior and movements between bicyclists and motorists.



Example of Class II Bicycle Lane in Roseville

Typical Application

- Bike lanes may be used on streets with adequate space but are most appropriate and effective on streets with moderate traffic volumes of 3,000 to 6,000 and low to moderate speeds of 25 mph to 35 mph.
- Appropriate for skilled adult riders on most streets.
- They may be considered low-stress when on a street with one lane in each direction, a speed limit of 25 mph or less, and traffic volumes of fewer than 3,000 vehicles a day.

Design Features

- Mark the edge of the bike lane with a 6-inch white stripe.
 - When next to vehicle parking, mark a 4 to 6-inch parking lane line or "Ts" (**CA MUTCD 9C-102**).
- Bicycle lane markings must be included at the beginning of blocks (**MUTCD 9C-3**) and at regular intervals along the route based on engineering judgment (**MUTCD 9C.04**). Bicycle lanes require standard signing and pavement markings as shown in CA MUTCD Figure 9C-102.
- 6 to 7 feet width is the preferred bike lane width adjacent to on-street parking, with 5 to 7-feet as the minimum requirement (center of stripe to center of stripe).
- 6 to 7 feet is the preferred bike lane width adjacent to curb and gutter (5 to 7 feet is the minimum requirement) or 3 to 4 feet minimum/ 4 to 5 feet preferred wider than the gutter pan width (center of stripe to center of stripe).

Table 2. One Way Standard Bicycle Lane Widths* (Class II, Class II buffered [next section])

Bicycle Facility Placement	Minimum (feet)	Preferred (feet)	Practical Maximum (feet)
Adjacent to edge of pavement	5 to 7	6 to 7	8
Adjacent to curb	5 to 7	6 to 7	8
Between through lanes and turn lanes	5 to 7	6 to 7	8
Adjacent to buffers	4 to 7	5 to 7	8
Adjacent to parking	5 to 7	6 to 7	8

Source: Caltrans DIB-94, 2024

Further Considerations

- On high-speed streets (greater than 35 mph), it is recommended but not required that the minimum width for a bike lane should be 6 feet.
- It may be desirable (but not required) to reduce the width of vehicle travel lanes to add or widen bicycle lanes or calm traffic next to the bike lane.
- Green color may be used (but is not required) within the lane to discourage motorists from entering the lane.
 - Green paint may also be used in more limited instances, like at the entry and exit points of bike lanes on each block.
 - Dashed green bike lane markings are recommended at conflict points like intersections, major driveways, or the beginning of turn pockets.
- On multi-lane and/or streets with speeds greater than 35 mph, the most appropriate bicycle facility for user comfort may be [Class IIB buffered bicycle lanes](#), or [Class IV separated bicycle bikeways](#).



Manhole Covers and Grates

- Maintenance hole surfaces should be manufactured with a shallow surface texture in the form of a tight, nonlinear pattern.
- If maintenance holes or other utility access boxes cannot be avoided in bike lanes within 50 feet of intersections or within 20 feet of driveways or other bicycle access points, specially manufactured permanent nonstick surfaces are required to ensure a controlled travel surface for bicyclists breaking or turning.
- Maintenance holes, drainage grates, or other obstacles should be set flush with the paved roadway. Roadway surface inconsistencies pose a threat to safe riding conditions for bicyclists. Maintenance holes, access panels, or other drainage elements will be constructed with no variation in the surface. The maximum allowable tolerance in vertical roadway surface will be 1/4 of an inch. Drainage grates must include elements that are perpendicular to the bicyclist's travel direction.

Materials and Maintenance

- Bike lane striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway.
- Bike lanes should also be maintained so that there are no potholes, cracks, uneven surfaces, or debris.

Bike Lanes (Class II) Adjacent to Right-Turn Lanes

Where right turn lanes are introduced at intersections, it is recommended that bike lanes be placed between the right turn lane and the right-most through lane or, where right-of-way is insufficient, to use a shared bike lane/turn lane. The design to the right also features striping and signage to indicate that motorists should yield to bicyclists through the conflict area.

Typical Application

- Locations where vehicular traffic must cross over dedicated bike facilities to enter a right-turn lane.
- At auxiliary right turn-only lanes or where a through lane becomes a right-turn-only lane.

Design Features

- Continue existing bike lane width; standard width of 5 to 6 feet or 4 feet in constrained locations.
- Signage should be used to indicate that motorists should yield to bicyclists through the conflict area.
- Consider (but not require) the use of colored conflict areas to promote the visibility of the mixing zone.
- In some instances, especially where bike lane alignment shifts, shared lane markings may be appropriate at conflict zones.

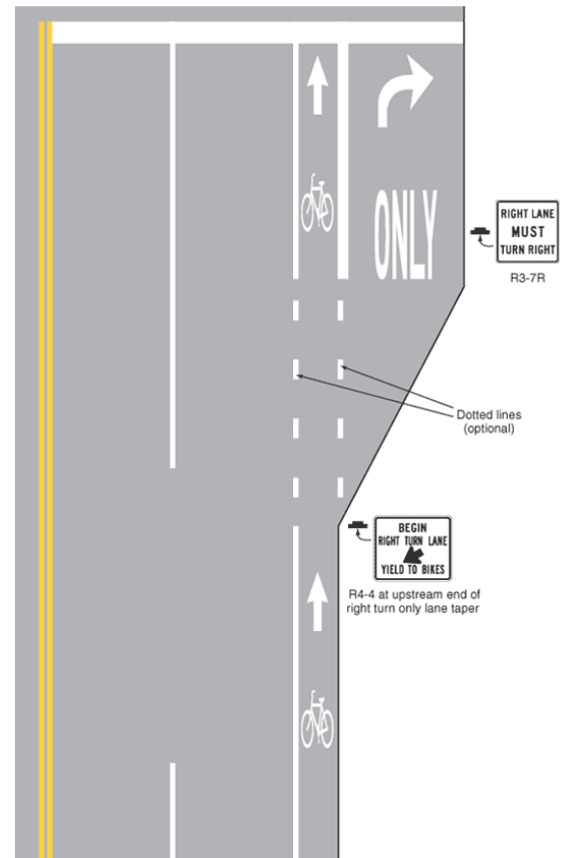


Figure 9C-04, MUTCD

Further Considerations

- The bicycle lane maintains a straight path, and drivers must weave across, providing clear right-of-way priority to bicyclists.
- Maintaining a straight bicycle path reinforces the priority of bicyclists over turning motorists. Drivers must yield to bicyclists before crossing the bike lane to enter the turn lane.
- Through lanes that become turn-only lanes can be difficult for bicyclists to navigate and should be avoided unless at signalized intersections that have appropriate phasing for bicycles.
- The use of dual right-turn-only lanes should be avoided on streets with bike lanes (AASHTO, 2013). Where there are dual right-turn-only lanes, the bike lane should be placed to the left of both right-turn lanes. Keeping the bike lane to the right of the turn lanes is possible if a bicycle signal phase is implemented to separate bicyclists from right-turning vehicles.

Materials and Maintenance

- Because the effectiveness of markings depends entirely on their visibility, maintaining the visibility of markings should be a high priority. Special consideration should be given to pavement markings on concrete that can have different application methods and different durability.

Combined Bike Lanes (Class II)/Turn Lanes

Where there is not room for a conventional bicycle lane and turn lane, a combined bike lane/turn lane creates a shared lane where bicyclists can ride and turning motor vehicles yield to through traveling bicyclists. The combined bicycle lane/turn lane places shared lane markings within a right turn-only lane.



Example Combined Bicycle Lane/Turn Lane in Eugene, OR

Typical Application

- Most appropriate in areas with lower posted speeds (25 MPH or less) and lower traffic volumes (10,000 ADT or less).
- Not be appropriate for high-speed arterials, intersections with long right-turn lanes, or intersections with large percentages of right-turning vehicles.
- This treatment is recommended (but not required) at intersections lacking sufficient space to accommodate a standard through bike lane and a right turn lane.

Design Features

- The maximum shared turn lane width is 13 feet; narrower is preferable (NACTO, 2012).
- Shared Lane Markings should indicate the preferred positioning of bicyclists within the combined lane.
- A "Right Lane Must Turn Right" (CA MUTCD R3-7R) sign with an "EXCEPT BIKES" plaque may be needed to permit through bicyclists to use a right turn lane.

- "Begin Right Turn Lane Yield to Bikes" signage (CA MUTCD R4-4) is recommended to indicate that motorists should yield to bicyclists through the conflict area.
 - There should be a receiving bicycle lane or shoulder on the far side of the intersection.

Further Considerations

- Combined bike lane/turn lane creates safety and comfort benefits by negotiating conflicts upstream of the intersection area.

Materials and Maintenance

- Because the effectiveness of markings depends entirely on their visibility, maintaining the visibility of markings should be a high priority.

Buffered Bicycle Lanes (Class IIB)

Buffered bike lanes (often referred to as Class II buffered) are conventional bicycle lanes paired with a designated striped buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane.

Typical Application

- Anywhere a conventional bike lane is being considered.
- On streets with extra lane width.
- Appropriate for skilled adult riders on most streets.



Example Class II Buffered Bicycle Lane in Roseville

Design Features

- The desired minimum bicycle travel area (not including buffer) is 5 feet wide, while the absolute minimum width is 4 feet (CA MUTCD).

- Buffered area width must be at least 18 inches wide but should be at least two feet wide. If the buffered area is 4 feet or wider, white chevron or diagonal markings should be used (CA MUTCD 9C-104).
 - For clarity at driveways or minor street crossings, a dotted line should be considered to identify the bicycle travel path, but it is not required.
 - Whether the buffer is provided on the parking side, the travel side, or a combination of both is dependent upon how much right-of-way is available and where the highest risk for bicyclists is, higher-speed moving traffic or high-turnover parking.
 - The use of pavement markings delineates space for bicyclists to ride and buffer area to create a more comfortable facility.
 - Green paint at the entry and exit points near intersections can also increase driver awareness of the presence of bicycles.

Further Considerations

- Color may be used but is not required within the lane to discourage motorists from entering the buffered lane.
- On multi-lane streets with high vehicle speeds, the most appropriate bicycle facility for user comfort may be separated bikeways.
- A study of buffered bicycle lanes found that to make the facilities successful, there needs to also be driver education, improved signage, and proper pavement markings.¹

Materials and Maintenance

- Bike lane striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway.
- Bike lanes should be maintained so that there are no potholes, cracks, uneven surfaces, or debris.

¹ Monsere, C.; McNeil, N.; and Dill, J., "Evaluation of Innovative Bicycle Facilities: SW Broadway Cycle Track and SW Stark/Oak Street Buffered Bike Lanes. Final Report" (2011). *Urban Studies and Planning Faculty Publications and Presentations*.

Bicycle Routes (Class III)

Bike routes are shared facilities designated for bicycle travel. Bike routes can be either in-road facilities (where bicyclists share the travel lane with vehicles) or visually separated facilities (where bicyclists ride on paved shoulders adjacent to vehicular traffic). Signs and appropriate markings should accompany bike routes to notify all road users. According to the FHWA Bikeway Selection Guide, "in shared lanes, bicyclists ride in mixed traffic, therefore, their comfort and safety varies widely based on traffic operating speeds and volumes. Shared lanes can be a positive and affordable solution when designed correctly and used in the correct context; however, most bike/car crashes in the U.S. occur in shared lanes that are applied to inappropriate contexts and environments." As most bicyclists (current or potential) may not feel comfortable on multi-lane or higher-speed roadways with shared lane markings, the CA MUTCD and Caltrans DIB-94 suggest these markings be restricted to roadways with operating speeds of 35 miles per hour or less. Please note that SB 1216 would "prohibit, on and after January 1, 2025, an agency responsible for the development or operation of bikeways or highways where bicycle travel is permitted from installing a new sharrow on a highway that has a posted speed limit greater than 30 miles per hour."² The bill would also "prohibit, on and after January 1, 2026, the [California Transportation] commission from adding a project that creates a Class III bikeway or a sharrow to the program of projects, except as specified."

Bicycle Boulevards with additional traffic calming measures are the preferred treatment.

Typical Application

- Low-volume roadways with limited roadway width and few intersections

Design Features

Shared Lane

- Shared lane markings serve several purposes, including making motorists aware of the shared route and showing bicyclists the direction of travel and their preferred positioning within the lane.
- Markings should be placed to indicate bicyclist positioning in the roadway. When placed next to parking, markings should be placed outside of the door zone. In constrained areas, center the marking in the lane. Minimum placement is 13-feet from the face of the curb (CA MUTCD 9C-07).
- Markings should be placed immediately after intersections and spaced at intervals not greater than 250 feet thereafter (CA MUTCD 9C-07).



² Senate Bill 1216 https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240SB1216

Paved Shoulder Bike Route

- A paved shoulder should provide 4 to 6 feet for bicyclists. The absolute minimum allowable width is 2 feet when no obstructions are present.
- While not required, consider using contrasting paving materials between the paved shoulder and adjacent travel lanes to differentiate between the two clearly.

Further Considerations

Markings

- [Shared lane] A green background can be applied further to increase the visibility of the shared lane markings.
- [Shoulders] Wide solid white lines or buffer areas enhances the visual separation between shoulder and travel lane.
- [Shoulders] While not required, if rumble strips are installed in the roadway, consider installing bicycle-friendly rumble strips. Ideal spacing should include 12-inch spacing (center-to-center), 6-8 inches long (perpendicular to the roadway), 6 inches wide (measured parallel to the roadway), and 3/8-inch deep, according to **FHWA Technical Advisory 5040.39**.

Signs

It is recommended that signs be used to alert road users of the designation of the shoulder or shared in-road facility as a shared bicycle facility.

- Bike Route Guide (**D11-1c**) signs are used to indicate to bicyclists that they are on a designated bikeway and alert motorists of the bike route.

Bicycle Boulevards (Class IIIB)

Bicycle boulevards (Class III, often referred to as Class IIIB³) are low-volume, low-speed streets modified to prioritize and enhance bicyclist comfort by using treatments such as signage, pavement markings, traffic calming, traffic reduction/diversion, and special designs to ease major street crossings. These treatments prioritize through movements of bicyclists while discouraging (and in some cases limiting) similar through-trips by non-local motorized traffic (while still allowing emergency vehicle access).

Typical Application

- Parallel with and near major thoroughfares (1/4-mile or less) or in residential areas to connect to community destinations and the larger bicycle network.
- Streets with travel speeds of 25 mph or less (20 mph recommended) and traffic volumes of below 1,500 vehicles per day. Utilize traffic calming to maintain or establish low volumes and discourage vehicle cut-through / speeding.

³ Not an official Caltrans classification. HDM considers bicycle routes and bicycle boulevards as Class III.



Example Class III B Bicycle Boulevard in Palo Alto, CA

- Along corridors that create a sufficient network density of routes suitable for all ages and abilities.
- Avoid alignments with excessive zigzag or circuitous routing. The bikeway should strive to have less than 10 percent out-of-direction travel compared to the shortest path along the primary corridor.

Design Features

- Signs and pavement markings are the minimum treatments necessary to designate a street as a bicycle boulevard.
- Implement volume control treatments, such as traffic diverters, based on the context of the bicycle boulevard, using engineering judgment. Target motor vehicle volumes should not exceed 1,500 vehicles per day.
- Intersection crossings should be designed to enhance comfort and minimize delay for bicyclists of diverse skills and abilities.

Further Considerations

- Bike Boulevards are established on streets that improve connectivity to key destinations and provide a direct, low-stress route for bicyclists, with low motorized traffic volumes and speeds, designated and designed to give bicycle travel priority over other modes.
- Bicycle boulevards are typically located on streets without existing signalized accommodation at collector and arterial roadway crossings. Without treatments for bicyclists (and pedestrians), these intersections can become major barriers along the bicycle boulevard.
 - Crossing aids such as rectangular rapid flashing beacons (RRFBs), pedestrian signals, and refuge islands are some of the treatments that can improve the crossing experience and increase driver awareness at uncontrolled locations.
- Traffic calming can lower motorized vehicle speeds along bicycle boulevards and deter motorists from driving on that street. Anticipate and monitor vehicle volumes on adjacent streets to determine whether traffic

calming results in inappropriate volumes or diversions. Traffic calming can be implemented on a trial basis using quick build or temporary materials.

Materials and Maintenance

- Bike Boulevards require few additional maintenance requirements compared to local roadways. Signage, signals, and other traffic calming elements should be inspected and maintained according to local standards.

Separated Bikeways (Class IV)

One-Way Separated Bikeway

One-way separated bikeways, also known as protected bikeways or cycle tracks, are on-street bikeway facilities that are separated from vehicle traffic. Physical separation is provided with a vertical barrier between the bikeway and the vehicular travel lane. These barriers can include flexible posts, bollards, planter strips, various types of concrete or rubber curbs, or on-street parking. Separated bikeways using these barrier elements typically share the same elevation as adjacent travel lanes, but the bikeway could also be raised above street level, either matching sidewalk level or at an intermediate height between the sidewalk and roadway surface.



Example Class IV One-Way Separated Bikeway in Davis, CA

Typical Application

- Along streets on which conventional bicycle lanes can cause many bicyclists to feel stress because of factors such as multiple lanes, high bicycle volumes, high motor traffic volumes (9,000-30,000 ADT), higher traffic speeds (35+ mph), high incidence of double parking, higher truck traffic (10% of total ADT) and high parking turnover.
- Along streets for which conflicts at intersections can be effectively mitigated using parking lane setbacks, bicycle markings through the intersection, and other signalized intersection treatments.

Design Features

- Pavement markings, symbols and/or arrow markings must be placed at the beginning of the separated bikeway and at intervals along the facility based on engineering judgment to define the bike direction. (CA MUTCD 9C.04)
- 7-foot width preferred in areas with high bicycle volumes or uphill sections to facilitate safe passing behavior (5-foot minimum). (HDM 1003.1(1))
- 3-foot minimum buffer width adjacent to parking lines (2-foot minimum when adjacent to travel lanes), marked with 4-inch solid white line (DIB 89).



Example Class IV Two-Way Separated Bikeway in San Diego, CA

Table 3. One Way Standard Bicycle Traveled Way Widths (Class IV)*

Bicycle Facility Placement	Minimum (feet)	Preferred (feet)	Practical Maximum (feet)
Between curbs if a raised island is the separation	6 to 9	7 to 9	10
Between curb and buffer	5 to 8	6 to 8	9
Between curb and parking buffer	5 to 8	6 to 8	9
Between edge of pavement and buffer, curb, or parking buffer	4 to 7	5 to 7	8
Between through traffic lane and right turn lane	4 to 7	5 to 7	8

Source: Caltrans DIB-94, 2024

*Exclusive of the gutter

Further Considerations

- Separated bikeway buffers and barriers are covered in the CA MUTCD as preferential lane markings (**Section 9C-102**) and channelizing devices (**Section 3H.01**). If the buffer area is 4 feet or wider, white chevron or diagonal markings should be used (**Section 9C.04**). Curbs may be used as a channeling device, see the section on islands (**Section 3I.01**). Grade-separation provides an enhanced level of separation in addition to buffers and other barrier types.
- Where possible, physical barriers such as removable curbs should be oriented towards the travel lane edge of the buffer to provide as much extra width as possible for bicycle use.
- A retrofit separated bikeway has a relatively low implementation cost compared to road reconstruction by making use of existing pavement and drainage and using a parking lane as a barrier.
- Gutters, drainage structures, and utility covers should be designed and configured so as not to impact bicycle travel.
- For clarity at major or minor street crossings, consider a dotted line (**CA MUTCD Detail 39A - Bike Lane Intersection Line**) for the buffer boundary where cars are expected to cross.
- Special consideration should be given at transit stops to manage bicycle and pedestrian interactions.
 - Pavement markings and signage should clarify expectations among users. The bikeway could also ramp up to sidewalk level at this crossing to reduce bicycle speeds and enhance ADA access to the stop.
 - Pavement markings on the bikeway should define the bicycle path of travel to minimize intrusion by pedestrians, except at designated crossings.

Materials and Maintenance

- Bikeway striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway. Green conflict striping (if used) will also generally require higher maintenance due to vehicle wear.
- Bikeways should be maintained so that there are no potholes, cracks, uneven surfaces, or debris.
- Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway.

Two-Way Separated Bikeway

Two-way separated bikeways are bicycle facilities that allow bicycle movement in both directions on one side of the road. Two-way separated bikeways share some of the same design characteristics as one-way separated bikeways but often require additional considerations at driveways and side-street crossings, major intersections, and intersections with other bikeways.

Typical Application

- Streets with high motor vehicle volumes and/or speeds.
- Streets with high bicycle volumes.
- Streets with a high incidence of wrong-way bicycle riding.
- Streets with few conflicts, such as driveways or cross-streets on one side of the street.
- Streets that connect to Class I Multi-use Trails.

Design Features

- 12 to 14-foot operating width preferred (10 to 14-foot minimum) for two-way facility.
 - In constrained locations, such as approaching intersections or at accessible parking or a raised bus stop island, an 8-foot minimum operating width for short distances may be considered (**DIB-89**).
- Adjacent to on-street parking a 3-foot minimum width channelized buffer or island shall be provided to accommodate opening doors (**NACTO, 2012**) (**CA MUTCD 3H.01, 3I.01**).
 - Additional signalization and signs may be necessary to manage conflicts.

Table 4. Two Way Standard Bicycle Traveled Way Widths* (Class IV)

Bicycle Facility Placement	Minimum (feet)	Preferred (feet)	Practical Maximum (feet)
Between curbs	10 to 14	12 to 14	16
Between curb and buffer	9 to 12	10 to 12	14
Between curb and parking buffer	9 to 14	10 to 14	16
Between edge of pavement and buffer, curb, or parking buffer	8 to 11	9 to 11	14

Source: Caltrans DIB-94, 2024

*Exclusive of the gutter

Further Considerations

- On-street bikeway buffers and barriers are covered in the CA MUTCD as preferential lane markings (**Section 9C-102**) and channelizing devices, including flexible delineators (**Section 3H.01**). Curbs may be used as a channeling device; see the section on islands (**Section 3I.01**).
- A two-way separated bikeway on one-way street is typically located on the left side, but requires engineering judgement.
- A two-way separated bikeway may be configured at street level or as a raised separated bikeway with vertical separation from the adjacent travel lane.
- Two-way separated bikeways should ideally be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles.
- See Caltrans Design Information Bulletin No. 89 for more details.

Materials and Maintenance

- Bikeway striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained roadway segments. Green conflict striping (if used) will also generally require higher maintenance due to vehicle wear.
- Bikeways should be maintained so that there are no potholes, cracks, uneven surfaces, or debris.
- Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway.

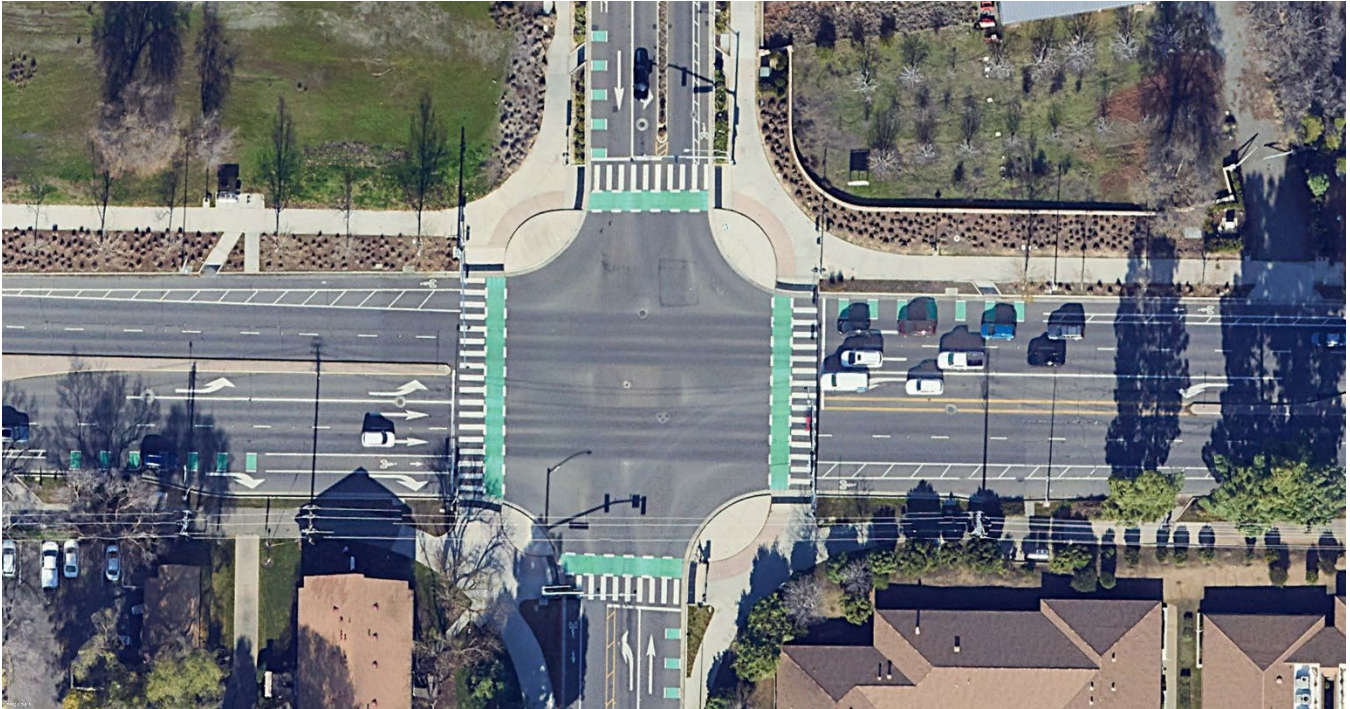


Example Class IV Two-Way Separated Bikeway in San Diego, CA

Bicycle Intersection Treatments

Protected Intersection

A protected intersection uses a collection of intersection design elements to maximize user comfort within the intersection and promote a high rate of motorist yielding to bicyclists. Protected intersections may be physically protected and/or protected using signal timing. The design maintains a physical separation within the intersection to define the turning paths of motor vehicles, slow vehicle turning speed, and offer a comfortable place for bicyclists to wait at a red signal. Time-based separation applications (e.g., bicycle-only signal phases) may also be used to reduce bicycle-motor vehicle conflicts.



Example Protected Intersection in Davis, CA

Typical Application

- Streets with separated bicycle lanes protected by wide buffer or on-street parking.
- Where two separated bicycle lanes intersect, and two-stage left-turn movements can be provided for bicycle riders.
- Helps reduce conflicts between right-turning motorists and bicycle riders by reducing turning speeds and providing a forward stop bar for bicycles.

Design Features

- Setback bicycle crossing of 19.5-feet allows for one passenger car to queue while yielding. Smaller setback distance is possible in slow-speed, space-constrained conditions.
- Corner safety island with a 15–20-foot corner radius slows motor vehicle speeds. Larger radius designs may be possible when paired with a deeper setback, a protected signal phase, or small mountable aprons. Two-stage turning boxes are provided for queuing bicyclists adjacent to corner islands.
- Use intersection crossing markings.

Further Considerations

- Wayfinding and directional signage should be provided to help bicycle riders navigate through the intersection.
- Colored pavement may be used within the corner refuge area to clarify use by people bicycling and discourage use by people walking or driving.
- Intersection approaches with high volumes of right-turning vehicles should provide a dedicated right-turn-only lane paired with a protected signal phase. Protected signal phasing may allow for different design dimensions than those described here.
- At signalized intersections, time-based separation may take the form of bicycle-only signal phases or a "leading bicycle interval." These applications typically necessitate additional features, including bicycle-specific signals (with bicycle signal heads) and supplemental signage aimed at bicyclists (e.g., "Bike Signal") and motorists (e.g., "No Turn on Red").

Materials and Maintenance

- Green conflict striping (if used) will also generally require higher maintenance due to vehicle wear.
- Bikeways should be maintained so there are no potholes, cracks, uneven surfaces, or debris.
- Bikeways protected by concrete islands or other permanent physical separation can be swept by street sweeper vehicles with narrow widths.

Bikeway Intersection Markings

Bicycle pavement markings through intersections ("cross bikes") guide bicyclists on a safe and direct path through the intersection and provide a clear boundary between the paths of through bicyclists and vehicles in the adjacent lane.



Example of bicycle intersection markings in San Diego, CA

Typical Application

- Streets with Class II conventional, Class IIB buffered, or Class IV separated bike lanes.
- Across signalized intersections, particularly through wide or complex intersections where the bicycle path may be unclear.
- Where potential conflicts exist between through bicyclists and adjacent motor vehicle traffic.

Design Features

- Intersection markings should be the same width and in line with leading bike lane.
- Dotted lines shall be on either side of the bicycle crossing space (**CA MUTCD 3B.08**). Dotted lines should be a minimum of 6 inches wide and 4 feet long, spaced every 12 feet.
 - All markings should be white, skid resistant and retro reflective (**CA MUTCD 9C.02.02**).

Further Considerations

- Green pavement markings may also be used for increased visibility within conflict areas or across entire intersections.

Materials and Maintenance

- Routine roadway/utility maintenance.
- Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority.

Bike Box

A bike box provides bicyclists with a safe and visible space to get in front of queuing traffic during the red signal phase. Motor vehicles must queue behind the white stop line at the rear of the bike box. On a green signal, bicyclists can clear the intersection.



Example Bike Box in Olympia, WA

Typical Application

- At potential areas of conflict between bicyclists and turning vehicles, such as right or left turn locations.
- At signalized intersections with high bicycle volumes.
- At signalized intersections with high vehicle volumes.
- Not to be used on downhill approaches to minimize the right hook threat potential during the extended green signal phase.

Design Features

- 14-foot minimum depth from back of crosswalk to motor vehicle stop bar.
- A "No Turn on Red" (CA MUTCD R10-11) or "No Right Turn on Red" (CA MUTCD R13A) sign shall be installed overhead to prevent vehicles from entering the bike box (Refer to CVC 22101 for the signage). A "Stop Here on Red" (CA MUTCD R10-6) sign should be post-mounted at the stop line to reinforce observance of the stop line.
- A 50-foot ingress lane should be used to provide access to the box.
 - The use of green-colored pavement is optional.

Further Considerations

- This treatment positions bicyclists together, and on a green signal, bicyclists can clear the intersection, minimizing conflict and delay to transit or other traffic.

- Pedestrians also benefit from bike boxes, as they experience reduced vehicle encroachment into the crosswalk.

Materials and Maintenance

- Bike boxes are subject to high vehicle wear, especially turning passenger vehicles, buses, and heavy trucks. As a result, bike boxes with green coloring will require more frequent replacement over time. The life of the green coloring will depend on vehicle volumes and turning movements, but thermoplastic is generally a more durable material than paint.

Bicycle Signal Phasing

Protected Bicycle Signal Phase

Protected bicycle lane crossings of signalized intersections can be accomplished with a bicycle signal phase, which reduces conflicts with motor vehicles by separating bicycle movements from any conflicting motor vehicle movements. Bicycle signals are traditional three-lens signal heads with green, yellow, and red bicycle-stenciled lenses.

Typical Application

- Two-way protected bike lanes with contraflow bicycle movement or at locations with increased conflict points that warrant protected operation.
- Bicyclists moving on a green or yellow signal indication in a bicycle signal shall not conflict with any simultaneous motor vehicle movement at the signalized location.
- Right (or left) turns on red must be prohibited in locations where such operation would conflict with a green bicycle signal indication.

Design Features

- An additional "Bicycle Signal" sign should be installed on the bicycle signal head.
- Designs for bicycles at signalized crossings should allow bicyclists to either actively or passively actuate signals and safely maneuver the crossing.
- On bikeways, signal timing and actuation shall be reviewed and adjusted to consider the needs of bicyclists. (CA MUTCD 9D.02)

Further Considerations

- A bicycle signal should be considered for use only when the volume/collision or volume/geometric warrants have been met. (CA MUTCD 4C.102)
- Bicyclists typically need more time to travel through an intersection than motor vehicles. Green phase durations should be determined using the bicycle crossing time for standing bicycles.



Bicycle signal at Junction Boulevard and Park Regency Drive in Roseville

- Bicycle detection and actuation systems include user-activated buttons that face the bike lane, loop detectors that trigger a change in the traffic signal when a bicycle is detected, and video detection cameras that use digital image processing to detect a difference in the image at a location.

Leading Bicycle Interval

Vehicle conflicts can occur when drivers performing turning movements do not see or yield to bicyclists who have the right-of-way. Bicycle traffic signal enhancements can be made to provide bicyclists with a head start in front of turning vehicles, called a Leading Bicycle Interval (LBI).

Typical Application

- LBIs provide bicyclists with a priority head start across the intersection.
- LBIs are used to reduce right-turn and permissive left-turn vehicle and bicycle conflicts.
- At locations where increased bicyclist stop compliance is needed.
- Where it is determined that there is a higher than expected collision rate (based on Caltrans thresholds) between users of a crosswalk (includes bicyclists using the crosswalk) and conflicting turning vehicles (**City of Roseville LPI Policy**).
- Can be paired with [Leading Pedestrian Intervals](#), except at trail crossings.

Further Considerations

- These signal enhancements facilitate safer, more predictable, and conspicuous crossing conditions. The LBI provides additional time for bicyclists who may need more time to cross the street, such as the elderly and children.
- Leading Bicycle Intervals are considered a successful application of bike signals as approved under the current **FHWA Interim Approval for Optional Use of Bicycle Signal Faces (IA-16)**.
- There is no official guidance on interval length, but typically, 3 to 7 second "head start" is recommended.
- See [Traffic Signal Detection and Actuation](#) for more information on detection and actuation devices.

Traffic Signal Detection and Actuation

At fully signalized intersections, bicycle crossings are typically accomplished using a standard green signal indication for Class II and III bikeways. Several traffic signal enhancements can be made to improve detection and actuation and better accommodate bicyclists. An exclusive bicycle phase provided by bicycle signals offers the highest level of service and protection, especially for Class I and IV bikeways, but features the same detection and actuation methods used at intersections with standard traffic signals. See Protected Bicycle Signal Phase (above) for more information on bicycle signals.

Typical Application

- Bicycle detection and actuation are used to alert the signal controller of bicycle crossing demand on a particular approach. Proper bicycle detection should meet at least two primary criteria: 1) accurately detect bicyclists, and 2) provide clear guidance to bicyclists on how to actuate detection (e.g., what button to push or where to stand). Additionally, new technologies are being developed to provide feedback to bicyclists once they have been detected to increase the likelihood of stop compliance.
- Detection mechanisms can also provide bicyclists with an extended green time before the signal turns yellow so that bicyclists of all abilities can reach the far side of the intersection.

- All new or modified traffic signals in California must be equipped for bicyclist detection or be placed on permanent recall or fixed time operation. (**Caltrans Traffic Operations Policy Directive 09-06**).
- Detection shall be placed where bicyclists are intended to travel and/or wait.
- On bicycle priority corridors with on-street bike lanes or separated bikeways, consider the use of advance detection placed 100-200' upstream of the intersection to provide an early trigger to the signal system and reduce bicyclist delay.

Design Features

- Bicycle detection and actuation systems include user-activated buttons mounted on a pole facing the street, In-pavement loop detectors that trigger a change in the traffic signal when a bicycle is detected, video detection cameras that use digital image processing to detect a change in the image at a location, and/or Remote Traffic Microwave Sensor Detection (RTMS) which uses frequency modulated continuous wave radio signals to detect objects in the roadway.

Further Considerations

- The location of push-buttons should not require bicyclists to dismount or be rerouted out of the way or onto the sidewalk to activate the phase. Signage should supplement the signal to alert bicyclists of the required activation to prompt the green phase.
- In-pavement Type D Loop detectors are induction circuits installed within the roadway surface to detect bicyclists as they wait for the signal. This allows the bicyclists to stay within the lane of travel. Loop detectors should be sufficiently sensitive to detect bicyclists and be marked with pavement markings instructing bicyclists on where to stand. CA MUTCD provides guidance on stencil markings and signage related to loop detectors.
- Remote Traffic Microwave Sensor Detection (RTMS) is unaffected by temperature and lighting, which can affect standard video detection.
- Bicyclists typically need more time to travel through an intersection than motor vehicles. Green light times should be determined using the bicycle crossing time for standing bicycles. See Leading Bicycle Interval for more information on extending the green phase with bicycle signals.

Trail Crossing Improvements

Class I Shared-use paths (multi-use trails) attract people of all ages and abilities, some of whom may not have experience finding adequate gaps in traffic or may need additional time to cross roadways. There are a variety of countermeasures that can be implemented to improve traffic control, reduce vehicle speeds, and increase trail user visibility. For more information on specific countermeasures, see the [Multi-Use Trail Crossing Treatments](#) section.



Example multi-use trail crossing, Oak Ridge Drive, Roseville

Typical Application

- At different types of multi-use trail crossings:
 - Mid-block trail crossings occur outside of an intersection, regardless of distance from the closest intersection.
 - Adjacent trail crossings occur where the trail or sidepath runs parallel and close to a roadway, crossing another roadway (or driveway).
 - Complex intersection trail crossings include trail crossings that occur at signalized, skewed, or multi-lane uncontrolled intersections. Often involve multistage phases for bicycle or pedestrian travel, indirect routes, or multi-lane crossings.
 - Trailhead access crossings occur where a trailhead or trail access point is across a roadway from a destination, such as a parking lot, school, store, transit stop, etc.

Design Features

- The following types of treatments can be used to improve safety and visibility at multi-use trail crossings:
 - [Marked crossings](#)
 - [Raised crosswalks](#)
 - [Median refuge islands](#)
 - [Curb extensions](#)
 - [Pedestrian and bicycle signals and beacons](#)
 - [Leading Pedestrian Intervals, Leading Bicycle Intervals](#)
 - [Lighting](#)

Traffic Calming Strategies

Traffic calming may include elements intended to reduce the speeds of motor vehicle traffic to be closer to bicyclist travel speeds or may consist of design elements that discourage drivers from using Class IIIB bicycle boulevard corridors for through travel. Traffic calming treatments can cause drivers to slow down by constricting the roadway space or requiring careful maneuvering. Such measures may reduce the design speed of a street and can be used in conjunction with reduced speed limits to reinforce the expectation of lowered speeds. They can also lower vehicle volumes by physically or operationally reconfiguring corridors and intersections along the route.

Typical Application

- Locations where vehicle speed will negatively impact non-motorized modes of travel, such as along roadway segments with a history of speed-related collisions.
- Locations where it is desired to bring traffic volumes down to 1,500 – 3,000 cars per day maximum. Neighborhood bikeways with daily volumes above this limit should be considered for traffic calming measures.
- Locations that generate high concentrations of bicyclists and pedestrians.

Design Features

Speed Reduction

- [Median refuge islands](#) create a pinch point for traffic in the center of the roadway and offer shorter crossing distances for pedestrians when used in tandem with a marked crossing. Depending on the degree of lane narrowing and volume of traffic, they can slow vehicle speeds by up to 8 mph (**Caltrans Traffic Calming Guide, page 60**).
- Chicanes are a series of narrowing or curb extensions that alternate from one side of the street to the other, forming an S-shaped, curvilinear roadway alignment. Chicanes slow drivers by requiring vehicles to shift laterally through narrowed lanes and reducing what would otherwise be uninterrupted sightlines. They can slow vehicle speeds by up to 9 mph (**Caltrans Traffic Calming Guide, page 84**).
- Pinch points and chokers reduce speeds by up to 5 mph on local streets by narrowing the roadway (**Caltrans Traffic Calming Guide, page 50**).
- [Curb extensions](#) have a traffic-calming effect because they require more attention from drivers while inducing a speed reduction due to the larger turning maneuvers required (**Caltrans Traffic Calming Guide, page 53**).
- Street trees and landscaping can reduce vehicle speeds due to a perceived narrowing of the roadway, a sense of rhythm and human scale created by framing the street, and the perception that the driver is in a place where they are more likely to encounter pedestrians, bicyclists, and cross-traffic (**Caltrans Traffic Calming Guide, page 87**).
- Maintain a minimum clear width of 14 feet with a constricted length of at least 20 feet in the direction of travel.



Example of chicanes in Austin, TX

Wayfinding

Sign Types

The ability to navigate through an area is informed by landmarks, natural features, and other visual cues. Signs throughout the city should indicate to bicyclists the direction of travel, the locations of destinations, and the travel time/distance to those destinations. A bicycle wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bicycle routes.

Typical Application

- There are many potential applications for wayfinding signage in a citywide bicycle network. Overall, signs can increase users' comfort with and accessibility to the bicycle network and achieve the following:
 - Help users identify the best routes to destinations
 - Help address misconceptions about time and distance
 - Help overcome a "barrier to entry" for people who are not frequent bicyclists (e.g., interested but concerned bicyclists).



D11-1c



D1-1



D11-1/D1-3A

Design Features

- A.** Confirmation signs indicate to bicyclists that they are on a designated bikeway, make motorists aware of the bicycle route, can include destinations and distance/time but do not include arrows.
- B.** Turn signs indicate where a bikeway turns from one street onto another street or from one trail to another. These can be used with pavement markings and include destinations and arrows.
- C.** Decision signs inform bicyclists of the designated bike route to access key destinations. These include destinations, arrows, and distances. Travel times are optional.



Wayfinding signs can include a local community identification logo, Oakland, CA.



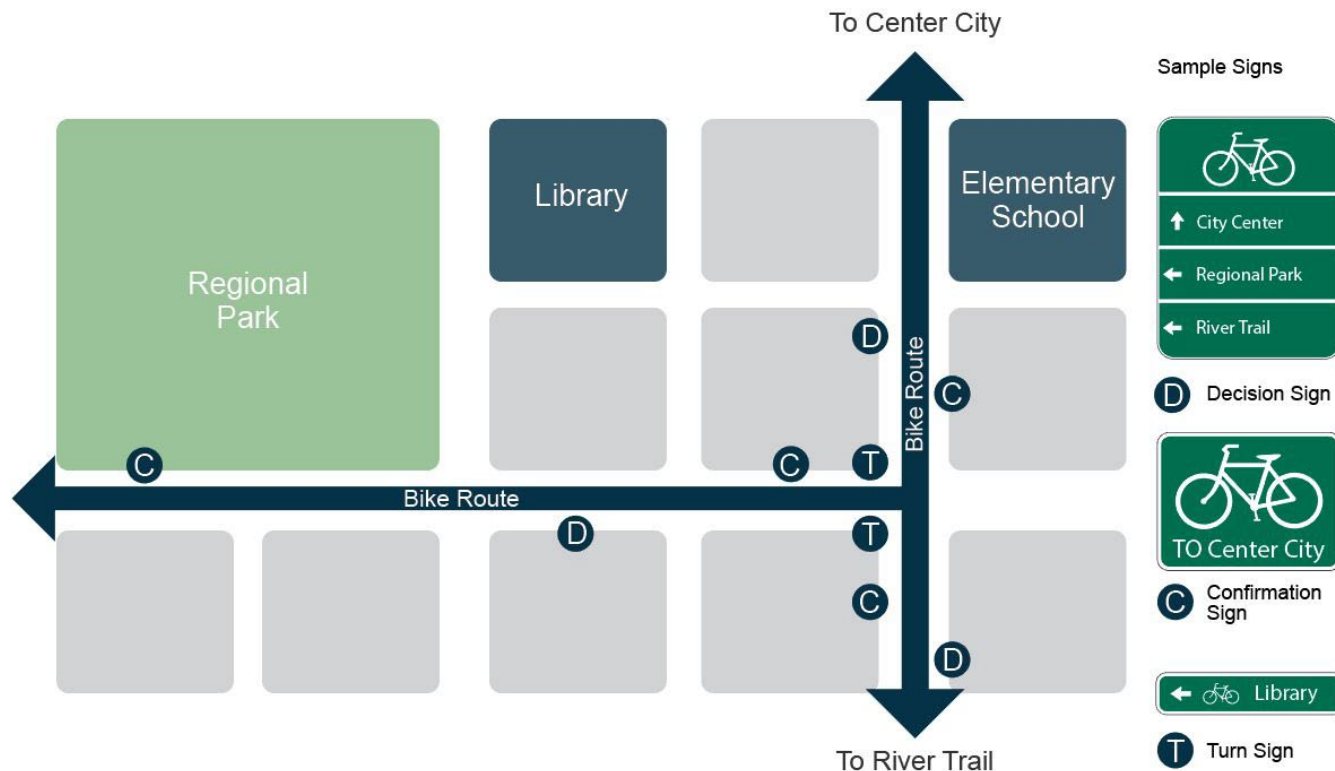
Custom street signs can also act as a type of confirmation sign to let all users know the street is prioritized for bicyclists, Berkeley, CA.

Further Considerations

- Bicycle wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution. Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes.
- Too many road signs tend to clutter the right-of-way. It is recommended that provided the sign location satisfies established signage standards, the signs be posted at a level most visible to bicyclists rather than per vehicle signage standards.
- A citywide bicycle wayfinding signage plan would identify:
 - Sign locations
 - Sign type – what type of sign should be used based on its intended function.
 - Destinations to be highlighted on each sign – key destinations for bicyclists
 - Approximate distance and travel time to each destination
- Green is the color used for directional guidance and is the most common color of bicycle wayfinding signage in the U.S., including those in the MUTCD.
- Check wayfinding signage along bikeways for signs of vandalism, graffiti, or normal wear, and replace signage along the bikeway network as needed.
- Language presented in **MUTCD Section 2D.50** provides some flexibility on logos and colors, which may be integrated into a comprehensive system that reflects the local identity and integrates with pedestrian and vehicular wayfinding signage.

Sign Placement

Signs are placed at decision points along bicycle routes – typically at the intersection of two or more bikeways and at other key locations leading to and along bicycle routes. The graphic below provides example placements for each sign type.



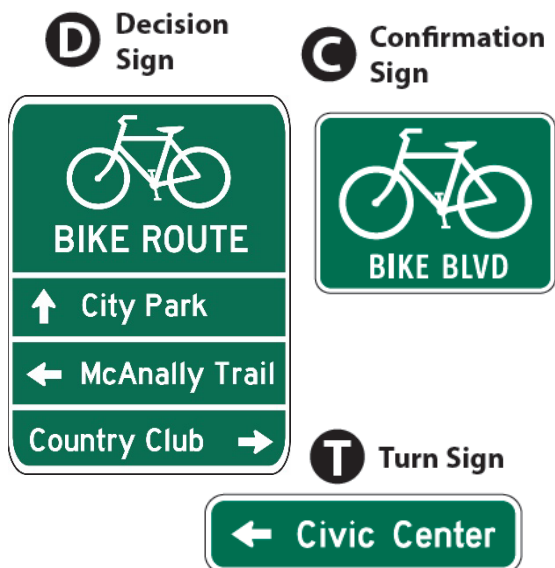
Typical Application

Confirmation Signs

- Placed every ¼ to ½ mile on off-street facilities and every 2 to 3 blocks along on-street bicycle facilities unless another type of sign is used (e.g., within 150 feet of a turn or decision sign).
- Should be placed soon after turns to confirm destination(s). Pavement markings can also act as confirmation that a bicyclist is on a preferred route.

Turn Signs

- Near-side of intersections where bike routes turn (e.g., where the street ceases to be a bicycle route or does not go through).
- Pavement markings can also indicate the need to turn to the bicyclist.



Decision Signs

- Near-side of intersections in advance of a junction with another bicycle route.
- Along a route to indicate a nearby destination.

Design Features

- MUTCD guidelines must be followed for wayfinding sign placement, including mounting height and lateral placement from the path's edge or roadway.
- Pavement markings can be used to reinforce routes and directional signage.

Further Considerations

It can be helpful to classify a list of destinations for inclusion on the signs based on their relative importance to users throughout the area. A particular destination's ranking in the hierarchy can be used to determine the physical distance from which the locations are signed. For example, primary destinations (such as the downtown area) may be included on signage up to 5 miles away. Secondary destinations (such as a transit station) may be included on signage up to two miles away. Tertiary destinations (such as a park or school) may be included on signage up to one mile away.

Multi-Use Trail Crossing Treatments

Marked Crossings

High-Visibility Crosswalks

High-visibility crosswalks signal to motorists that they must stop for people crossing the street and encourage people to cross at designated locations. At mid-block locations, crosswalks can be marked where there is a demand for crossing and no nearby marked crosswalks. Information about bicycle crossing and intersection improvements can be found in this guide's Bicycle Intersection Treatments section.



Example High-Visibility Crosswalk and Lighting at a trail crossing in Danville, CA

Typical Application

- Crossings with high pedestrian use or where vulnerable pedestrians are expected, including school crossings, across arterial streets for pedestrian-only signals, and at intersections where there is expected high pedestrian use and the crossing is not controlled by signals or stop signs.
- At unsignalized intersections, crosswalks may be marked under the following conditions:
 - At a complex intersection, to orient people crossing the street in finding their way across.
 - At an offset intersection, to show people walking or biking the shortest route across traffic with the least exposure to vehicular traffic and traffic conflicts.
 - At an intersection with visibility constraints, to position people walking and biking where they can best be seen by oncoming traffic.
 - At an intersection within a school zone on a walking and biking route.

Design Features

- The crosswalk should be located to align as closely as possible with the through pedestrian zone of the sidewalk corridor and should include ADA-compliant curb ramps at either end.

Further Considerations

Materials and Maintenance

- Routine roadway/utility maintenance.
- Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority.
 - Thermoplastic markings offer increased durability than conventional paint.

Raised Crosswalks

A raised crossing is a speed table elevated above the street which also includes a marked pedestrian crosswalk, bicycle lane crossing, or multi-use trail crossing spanning the entire width of the street.



Example Raised Crosswalk along the Iron Horse Trail in Danville, CA

Typical Application

- At controlled or uncontrolled crossings to address safety issues related to motorist speeds and failure to yield.
- Recommended only where vehicular speeds are 35 mph or lower, traffic volumes less than 20,000 vehicles per day, and there are no more than 2 lanes of through traffic in each direction (4 total).
- Intersection or midblock locations which have direct access to schools, hospitals, senior housing, community centers, parks, transit stations, and multi-use trail crossings.
- Where there are sight distance constraints or a pattern of collisions between pedestrians and motorists.
- Where highly-utilized multi-use trails cross minor streets.
- Not on designated emergency vehicle or truck routes.

Design Features

- Raised crossing creates vertical deflection that slows drivers and prepares them to yield to path users, while high-visibility crosswalk markings establish a legal crosswalk away from intersections.
- Path priority signing (**MUTCD R1-5 or R1-2**) and stop or yield markings are placed 20 feet in advance of the crossing and function best when path user volumes are high.
- A raised crosswalk marking (chevron) should be used to mark the approach and departure ramps for each lane of travel at all raised crosswalks.
- Advance speed hump markings shall be placed 100 feet to 250 feet in advance of the raised crossing, where possible.
 - At channelized right turns, it may not be possible to use advanced pavement markings.
- The crosswalk marking width should match the width of the top of the raised crossing. Where a Class IV separated bike lane is located parallel with the pedestrian crossing, the bike lane may be marked with green pavement markings supplemented by white edge lines to differentiate the pedestrian and bicyclist crossing areas within the crossing.

Further Considerations

- Geometric design should promote a high degree of yielding to path users through raised crossings, horizontal deflection, signing, and striping.
- The approach to designing path crossings of streets depends on an evaluation of vehicular traffic, line of sight, pathway traffic, use patterns, vehicle speed, road type, road width, and other safety issues such as proximity to major attractions.
- Advisory speed signs may be used to indicate the required slow crossing speed.
- A median refuge island would allow path users to cross one lane of traffic at a time. The bicycle waiting area should 8 feet wide or wider to allow for a variety of bicycle types.
- Considered part of an accessible route for people with disabilities and therefore, the surface must be smooth, stable, slip-resistant, and meet ADA guidelines.

Materials and Maintenance

- Raised crosswalks should be inspected regularly for deformations and pavement marking visibility.
- Due to the importance of warning motorists of the raised crosswalk, it is important for the pavement markings and signs be maintained to maintain the conspicuity of the devices. Integrating color throughout the raised crosswalk material or surface can be an effective strategy to increase its conspicuity to the adjacent street and minimize the need to rely on pavement markings.

Median Refuge Islands

Median refuge islands provide protected space in the center of the street to facilitate pedestrian and bicycle crossings, particularly when there are multiple lanes of traffic. They can simplify the crossing, by allowing people crossing the street to focus on one direction of traffic at a time, which may be useful at locations where gaps in motor vehicle traffic are limited, particularly when assessing a single crossing as one continuous movement across both directions of traffic.



Example Median Refuge Island in Ukiah, CA

Typical Application

- Typically provided at intersections, but they can also be implemented at midblock locations where high pedestrian activity is observed or anticipated. The presence of the island provides motorists visual cues that people may be crossing at those locations.
- At signalized and unsignalized locations with higher pedestrian volumes such as locations near schools, hospitals, senior housing, community centers, parks, transit stations, and multi-use trail crossings.
- At marked, uncontrolled crossings where the posted speed limit is 35 mph or higher, traffic volumes (AADT) are greater than 9,000, or there are 3 or more traffic lanes.

Design Features

- Must be a minimum of 6 feet in width to be considered a median refuge island.
 - Where pedestrian volumes are high, where people with mobility devices cross, or where bicyclists will cross (e.g., multi-use trail crossings), depths between 8 and 10 feet are preferred.
- To maximize accessibility for people with mobility challenges, the cut-through opening of the refuge area should match the width of the crosswalk. Detectable warning surfaces are required at each entrance into the street to alert visually impaired pedestrians that they are entering the street when the crossing island is 6 feet or more in width.

Further Considerations

- A minimal elevation change for pedestrians within the median refuge island is preferable to decrease the effort required for people with disabilities to navigate curb ramps, while ensuring a level surface free from water ponding within the refuge
- Median refuge islands can be used in conjunction with other traffic calming elements such as curb extensions to increase traffic calming effectiveness.
- At uncontrolled crossings, it is recommended that median refuge islands be paired with pavement markings, signage, advanced yield markings, and other treatments to increase visibility.
 - At multi-lane crossings, a flashing beacon or signalized pedestrian or bicycle crossing may be used as supplemental treatments to increase motorist yielding rates.

Materials and Maintenance

- The refuge area will require regular sweeping to dispose of dirt and debris.
- Plantings, trees, street furniture, signs, or other obstructions within the median refuge island must not inhibit intersection sight distances.

Curb Extensions

Curb extensions minimize pedestrian exposure during crossing by shortening crossing distance and giving pedestrians a better chance to see and be seen before committing to crossing.



Example Curb Extensions in Richmond, CA

Typical Application

- Extending between parking stalls within parking lanes at midblock locations or at intersections where it is desirable to shorten the crossing distance and there is a parking lane adjacent to the curb.
- Where a Class I multi-use trail intersects a street and it is desired to increase the queuing area or to shorten the crossing distance of the street.
- At crossings where pedestrians must cross 4 or more lanes of moving traffic (2 or more lanes per direction).

- At crossings with high volumes of people walking and biking, near schools, parks, or at unsignalized crossings
- At crossings where collisions or near misses occur between turning motorists and pedestrians or bicyclists.

Design Features

- Curb extensions should usually extend the full width of a parking lane, typically 8 feet from the curb, but not less than 6 feet from the curb.
 - Curb extensions should not extend into bicycle lanes or other travel lanes to provide a typical one-foot shy distance. The gutter pan, if present, should be outside of the bicycle lane.
 - When a bike lane is present, the curb extensions should terminate one foot short of the parking lane width to maximize bicyclist safety.
- Curb extension installation on both sides of a crossing is preferred, but where curb extension installation on one side is infeasible or inappropriate (i.e. no full-time parking), this should not preclude installation on the opposite side.
- Planted curb extensions may be designed as a bioswale for stormwater management but plantings should be low-profile and not inhibit driver ability to see pedestrians.

Further Considerations

- Can require larger vehicles (i.e. buses, delivery/garbage/construction trucks, street sweepers, and emergency vehicles) to encroach into other lanes to negotiate the corner.
- Curb ramp design should consider the slope within the bottom curb ramp landing area. In many cases, a curb extension will allow the installation of directional curb ramps. This may require additional regrading of the street to adjust the existing cross slope to meet ADA accessibility guidelines.
- There may be potential parking removal near crossings.
- Drainage must be evaluated as part of the design to determine if the curb extension will significantly alter the drainage characteristics of a street.

Materials and Maintenance

- Any plantings, street furniture, and other utilities on curb extensions may require periodic maintenance to maintain required clearances and sight lines.
- Debris clean-out from gutters, culverts, and ramps.

Bicycle and Pedestrian Signals and Beacons

Bicycle and pedestrian signals and beacons are used to warn and control traffic at multi-use trail crossings to assist people walking and biking in crossing a street at a marked crossing. See the [Bicycle Signal Phasing](#) section for more information about bicycle signal options. See the FHWA STEP [Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations](#) for more information.

Typical Application

- At multi-use trail crossings, both at intersections and mid-block.
- Mid-block crossings where there are 3 or more travel lanes, traffic volumes greater than 9,000, and posted speed limits 35 mph or greater.



Example signalized crosswalk in Pasadena, CA

Design Features

- Bicycle signals consist of three-section signal heads with green, yellow, and red bicycle stenciled lenses that can be employed at standard signalized intersections.
- Flashing amber warning beacons may be utilized at unsignalized intersection crossings.
- A conventional traffic control signal operation with a standard signal face displaying green, yellow, and red (steady and/or flashing red) indications, can be used at a mid-block trail crossing as an alternative to a pedestrian hybrid beacon (CA MUTCD 4F.01).
- Push buttons (or other actuation), signage, and pavement markings are required for these facilities for bicyclists, pedestrians, and motorists.
- Bicycle and pedestrian beacons should remain dark (not illuminated) during periods between actuations.
- Pedestrian countdown signals tell crossing pedestrians and bicyclists how much time they have to cross the street. It is recommended that pedestrian countdown signals be used at all new and reconstructed signalized intersections.

Further Considerations

- It is required that signage and pavement markings be used in conjunction with bicycle and pedestrian signals to warn and control traffic at locations where people enter or cross the street.
- AB 1909 allows bicyclists to cross the intersection on red, if a pedestrian control signal displays an approved "walking person" symbol, unless otherwise directed by a bicycle control device.
- The installation of pedestrian and bicycle signals or beacons at uncontrolled intersections or mid-block should also include public education and enforcement campaigns to ensure proper use and compliance.

Materials and Maintenance

- Bicycle and pedestrian signals and beacons require the same maintenance as standard traffic signal heads, such as replacing LEDs and responding to power outages.

Leading Pedestrian Intervals

A leading pedestrian interval (LPI) is a signal timing tool shown effective in reducing vehicle-pedestrian conflicts. LPIs allow pedestrians to enter an intersection 3 to 7 seconds before vehicles are given a green indication. With this head start, pedestrians can better establish their presence in the crosswalk before motorists have permission to turn. LPIs provide the benefits of increased visibility of crossing pedestrians, reduced conflicts between pedestrians and drivers, and increased likelihood of motorists yielding to pedestrians. See [Leading Bicycle Interval](#) section for more information about applications for bicyclists.

Typical Application

- At locations where, for at least one hour of the day, there are a minimum of 10 pedestrian activations for any given phase (direction) and at least 60 conflicting turning (left and right) vehicles for the same hour (**City of Roseville LPI Policy**).
- If it is determined that there is a higher than expected collision rate (based on Caltrans thresholds) between users of a crosswalk (includes bicyclists using the crosswalk) and conflicting turning vehicles (**City of Roseville LPI Policy**).
- If the visibility of pedestrians waiting to cross is limited for drivers making a conflicting turning movement due to roadway geometry or fixed objects (physical structures, landscaping, etc.) (**City of Roseville LPI Policy**).
- Intersections where frequent turning vehicle movements make pedestrian crossing movements difficult.

Design Features

- The minimum duration of an LPI is defined by the **CA MUTCD 4E.06** as at least 3 seconds. Typically, 3 to 7 second pedestrian "head start" is used while vehicles continue to receive a red indication.
 - Intervals of up to 10 seconds may be appropriate where pedestrian volumes are high and/or the crossing distance is long.
- LPIs may also only be active during certain times of the day, based on pedestrian traffic volumes.

Further Considerations

- LPIs typically require adjustments to existing signal timing that are relatively low-cost compared to other treatments.
- Right Turn on Red prohibitions have been shown to contribute significantly to the effectiveness of LPIs but regular enforcement is needed to ensure that right-turning motorists held at the red signal are not entering the pedestrian right-of-way during the LPI phase.

Lighting

Overhead lighting in advance of and at multi-use trail crossings and other crosswalks can increase the visibility of and for people walking and biking across the street.

Design Features

- Overhead lighting is placed in advance of marked crosswalks on both sides of the street to illuminate the front of the pedestrian and the crosswalk.
 - Provide lighting 10-15 ft in advance of the crosswalk on both sides of the street and both approaches.
- Design lighting to reduce "dark spots" between lit areas and shadows on the pedestrian.
- Design to avoid conflict with other vertical amenities such as signage, traffic lights, and parking meters. Signage and lighting can be integrated to conserve space.

Further Considerations

- Nearby residential facilities should be considered for excessive light pollution.
- New lighting features can serve as an opportunity for more sustainable solar infrastructure.



Example of Intersection Lighting