Bicycle and Pedestrian Facilities Toolkit

UNINCORPORATED SAN MATEO COUNTY
ACTIVE TRANSPORTATION PLAN

OFFICE OF SUSTAINABILITY
COUNTY OF SAN MATEO

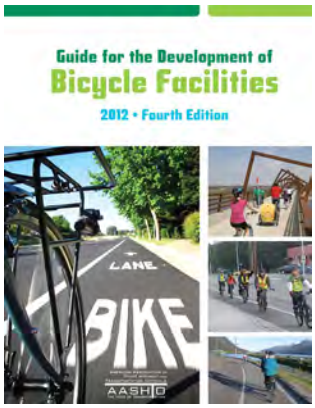
TOOLE DESIGN

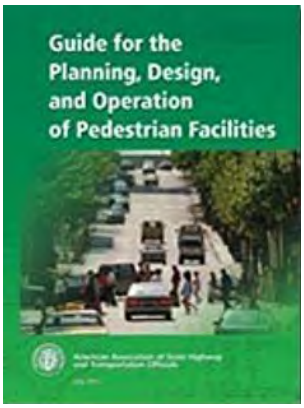
October 2020

TABLE OF CONTENTS

NATIONAL STANDARDS AND RESOURCES

The publications listed here are excellent resources for planning and design guidance in implementing safe, comfortable accommodations for pedestrians and bicyclists in a variety of environments. Many of these resources are available on-line at no cost.





American Association of State Highway and Transportation Officials (AASHTO)

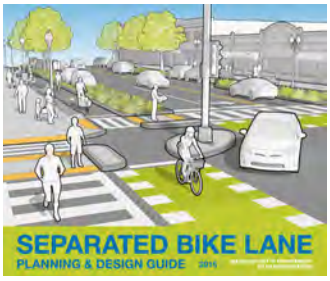
+ Guide for the Development of Bicycle Facilities (2012) (Updated anticipated in 2020)
+ Guide for the Planning, Design, and Operation of Pedestrian Facilities (2004)
+ A Policy on Geometric Design of Highways and Streets, 6th Edition (2011)

Federal Highway Administration (FHWA)

+ Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts (2016)
+ Separated Bike Lane Planning and Design Guide (2015)
+ Bikeway Selection Guide (2019)

National Association of City Transportation Officials (NACTO)

+ Urban Street Design Guide (2013)
+ Transit Street Design Guide (2016)
+ Urban Bikeway Design Guide (2014)



Massachusetts Department of Transportation (MassDOT)

+ Separated Bike Lane Planning & Design Guide (2015)

California Department of Transportation (Caltrans)

+ California Manual on Uniform Traffic Control Devices (CAMUTCD) (2014)

PEDESTRIAN FACILITIES

ELEMENTS OF A STREETSCAPE

Sidewalks play a critical role in the character, function, enjoyment, and accessibility of neighborhoods, main streets, and other community destinations. In addition to providing space for pedestrians separated from motor vehicles, the space between property lines and curbs also accommodates street trees and other plantings, stormwater infrastructure, street lights, and bicycle racks. This section defines those zones and provides considerations for better activating the streetscape to enhance peoples' experiences.

ZONES

Frontage Zone:

The Frontage Zone is the area of sidewalk that immediately abuts buildings along the street. In residential areas, the Frontage Zone may be occupied by front porches, stoops, lawns, or other landscape elements that extend from the front door to the sidewalk edge. The Frontage Zone of commercial properties may include architectural features, outdoor displays, café seating, awnings, signage, etc. Frontage Zones may vary widely in width from just a few feet to several yards.

Pedestrian Zone:

Also known as the "walking zone," the Pedestrian Zone is the portion of the sidewalk space used for active travel. For it to function, it must be kept clear of any obstacles and be wide enough to comfortably accommodate expected pedestrian volumes (as anticipated by density and adjacent land use) including those using mobility assistance devices, pushing strollers, or pulling carts.

Amenity Zone:

The Amenity Zone, or "landscape zone," lies between the curb and the Pedestrian Zone. This area is occupied by fixtures such as street lights, trees, bicycle racks, parking meters, signposts, signal boxes, benches, trash and recycling receptacles, and other amenities. In commercial areas, it is typical for this zone to be hardscape pavement, pavers, or tree grates. In residential, or lower intensity areas, it is commonly a planted strip.

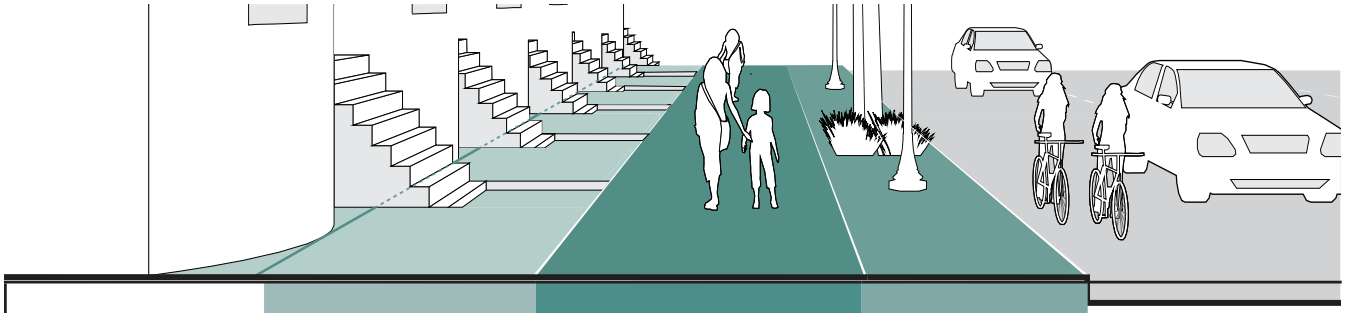
Frontage, Pedestrian and Amenity Zones

CONSIDERATIONS

+ Vibrant street walls with active uses adjacent to the sidewalk are particularly valuable and are essential to Main Street contexts. Where an active use adjacent to the sidewalk is not feasible, visually engaging walls should be provided adjacent to the street.
+ Outdoor dining opportunities contribute to a lively street environment and add economic value by enabling private commercial activity to spill into the public environment of the street. Sidewalk cafés are encouraged in Main Street contexts and other areas with commercial activity.
+ Planting in the public right-of-way typically occurs in the Amenity Zone; however, this is not the only place that can accommodate planting. Wherever there is an opportunity for landscape features, street or development projects should also look for opportunities to incorporate best management practices (BMPs), such as rain gardens. The preferred BMPs for use in the right-of-way are above-grade systems located within the sidewalk that treat stormwater runoff from adjacent roads and sidewalks.
+ While there are some exceptions, most street furniture is installed in the Amenity Zone. For example, bicycle parking may occasionally be installed in the frontage zone if it is sufficiently wide enough to accommodate it. Regardless, street furniture should not impede movement in the Pedestrian Zone.
+ Seating is most commonly located in the Amenity Zone of the street, but may also be placed in the Frontage Zone. Seating in the Amenity Zone should generally face away from the street and toward the sidewalk or be aligned perpendicular to the curb. Seating in the Frontage Zone should face the street.
+ Placement of micromobility devices such as bikeshare and scooters should not obstruct the pedestrian zone. These uses are best placed in the amenity zone.

SIDEWALK ZONE PREFERRED WIDTHS

The width of the various sidewalk zones will vary given the street type, the available right-of-way, scale of the adjoining buildings and the intensity and type of uses expected along a particular street segment. A balanced approach for determining the sidewalk width should consider the character of the surrounding area and the anticipated pedestrian activities. For example, is the street lined with retail that encourages window shopping or does it connect a residential neighborhood to a commercial area where pedestrians frequently need to pass one another? Does the scale of the buildings and the character of the street indicate a need for a wider sidewalk?



Street Type	Frontage Zone door swings, awnings, café seating, retail signage and displays, building projections	Pedestrian Zone zone should be clear of any and all fixed obstacles; clear space for pedestrian travel only.	Amenity Zone street lights and utility poles, street trees, bicycle racks, parking meters, transit stops, stormwater facilities, street furniture and signage	Preferred Total Width
Transit Station Areas	2 to 5 feet	6 to 15 feet	6 to 10 feet	14 to 30 feet
School Zones	2 to 6 feet	6 to 10 feet	6 to 10 feet	14 to 22 feet
Downtown/Urban Centers/Main Streets	2 to 6 feet	6 to 18 feet	6 to 10 feet	14 to 30 feet
Suburban Commercial	2 to 6 feet	6 to 8 feet	6 to 7 feet	14 to 17 feet
Suburban Areas/Residential Developments	2 to 6 feet	6 feet	5 to 7 feet	11 to 13 feet
Rural Areas	N/A	6 to 10 feet	5 to 10 feet	11 to 20 feet

CONSIDERATIONS

+ In locations with severely constrained rights-of-way, it is possible to provide a narrower Frontage Zone and Pedestrian Zone. Sidewalk width is based on local context. For example, 5-foot sidewalks may be adequate in a retrofit location where no development is occurring and existing buildings are anticipated to remain.
+ Frontage Zones used for sidewalk cafés are a special condition and should generally be no less than 6 feet in width.
+ Where on-street parking is not present, the wider dimensions in the above table should be provided.
+ The provision of tree wells or landscape strip within the Amenity Zone will be based on the existing or planned character of the neighborhood.
+ Tree plantings in the amenity zone should consider sufficient space for root growth, as well as location of existing utilities.
+ Sidewalk stormwater facilities (including rain gardens) require a minimum of 7 feet of width for the Amenity Zone. The final dimensions will be established based on the context of each landscape area. Where stormwater facilities are not provided in the Amenity Zone, this area may be at the lower end of the range.
+ Some rural areas may not have a dedicated pedestrian zone or amenity zone. When possible, a pedestrian zone should always be provided. The preferred total widths are often not feasible, particularly on County roads. However, these widths should be used as targets for design.

REFERENCES

NACTO Urban Street Design Guide (2013)

Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG) (2011)

CURB RAMPS

The transition for pedestrians from the sidewalk to the street is provided by a curb ramp. The designs of curb ramps are critical for all pedestrians, but particularly for people with disabilities. The ADA Standards require all pedestrian crossings be accessible to people with disabilities by providing curb ramps at intersections and midblock crossings as well as other locations where pedestrians can be expected to enter the street. Curb ramps also benefit people pushing strollers, grocery carts, suitcases, or bicycles.

CONSIDERATIONS

Amenity zones (the space between the curb and sidewalk) of 7' of width provide just enough space at intersections for curb ramps to gain sufficient elevation to a sidewalk.

Separate curb ramps should be provided for each crosswalk at an intersection rather than a single ramp at a corner for both crosswalks. The separate curb ramps improve orientation for visually impaired pedestrians by directing them toward the correct crosswalk.

Curb ramps are required to have landings. Landings provide a level area with a cross slope of 2% or less in any direction for wheelchair users to wait, maneuver into or out of a ramp, or bypass the ramp altogether. Landings should be 5' by 5' and shall, at a minimum, be 4' by 4'.

Consider providing wider curb ramps in areas of high pedestrian volumes and crossing activities.

Flares are required when the surface adjacent to the ramp's sides is walkable, however, they are unnecessary when this space is occupied by a landscaped buffer. Excluding flares can also increase the overall capacity of a ramp in high-pedestrian areas.

GUIDANCE

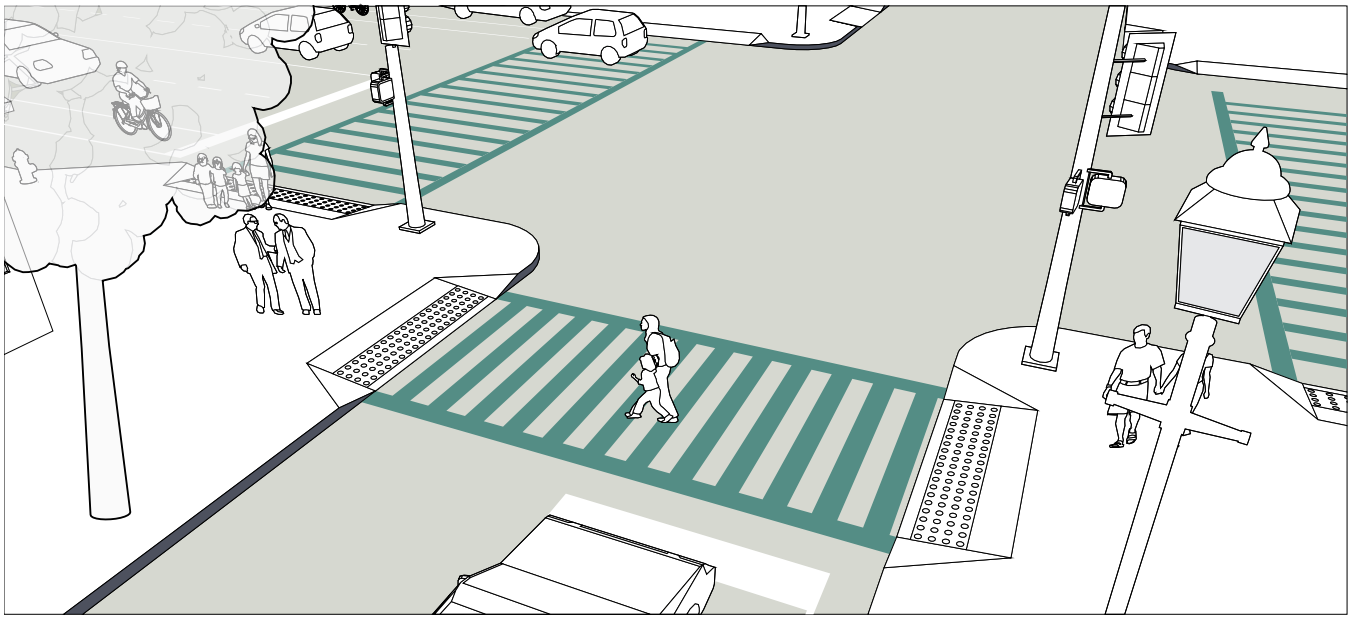
- Maximum slope: 1:12 (8.33%).
- Maximum slope of side flares: 1:10 (10%).
- Maximum cross-slope: 2% (1–2% with tight tolerances recommended).
- Should direct pedestrians into the crosswalk. The bottom of the ramp should lie within the area of the crosswalk.
- Truncated domes (the only permitted detectable warning device) must be installed on all new curb ramps to alert pedestrians to the sidewalk and street edge.

REFERENCES

Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG). 2011.

MARKED CROSSWALKS

Legal crosswalks exist at all locations where sidewalks meet the roadway, regardless of whether pavement markings are present. Drivers are legally required to yield to pedestrians at intersections, even when there are no pavement markings. Providing marked crosswalks communicates to drivers that pedestrians may be present, and helps guide pedestrians to locations where they should cross the street. In addition to pavement markings, crosswalks may include signals/beacons, warning signs, and raised platforms.



CONSIDERATIONS

- There are different styles of crosswalk striping with varying levels of effectiveness. High-visibility crosswalks with continental markings are recommended for increased visibility.
- Signal phasing is very important. Pedestrian signal phases must be timed based on the length of the crossing. If pedestrians are forced to wait longer than 30 seconds, non-compliance is more likely.
- Raised crossings can calm traffic and increase the visibility of pedestrians.
- Curb extensions, also known as bulb-outs or bump-outs, reduce the distance pedestrians have to cross and calm traffic.

GUIDANCE

- Place crosswalks on all legs of signalized intersections, in school zones, and across streets with more than minimal levels of traffic.
- Crosswalks should be at least 10 feet wide or the width of the approaching sidewalk if it is greater. In areas of heavy pedestrian volumes (such as transit station areas, school zones, and main streets) crosswalks can be up to 25 feet wide.
- Stop lines at stop-controlled and signalized intersection approaches should be striped no less than 4 feet and no more than 30 feet from the edge of crosswalks.
- For enhanced crossing treatments, refer to the section of this guide addressing Rectangular Rapid Flashing Beacons and Pedestrian Hybrid Beacons.
- Crosswalks should be oriented perpendicular to streets, minimizing crossing distances and therefore limiting the time that pedestrians are exposed.

REFERENCES

NACTO Urban Street Design Guide (2013)

ADA Accessibility Guidelines (2004)

California Manual on Uniform Traffic Control Devices (2014)

Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG) (2011)

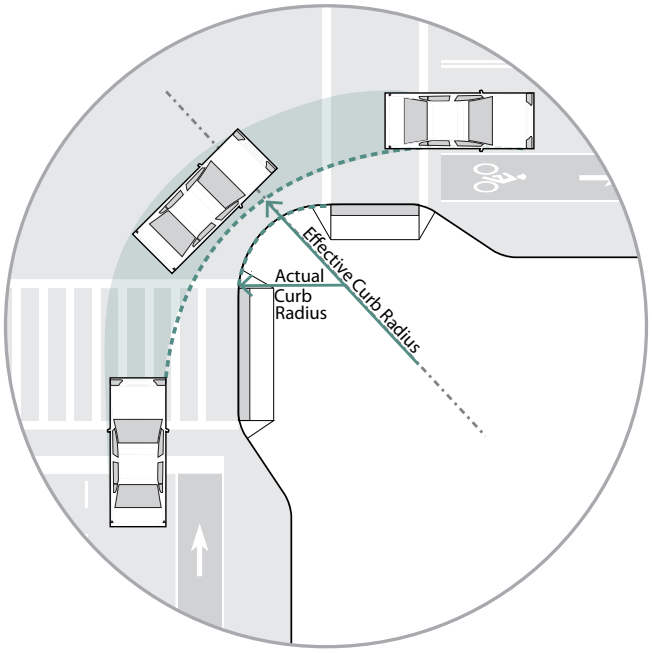
Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines (2005)

CORNERS AND CURB RADII

Pedestrian safety and comfort is enhanced by smaller curb radii, which shorten crossing distances for pedestrians and reduce turning vehicle speeds. However, streets must accommodate large turning vehicles, including school buses and transit vehicles. One of the most challenging aspects of intersection design is to determine methods of accommodating large vehicles while keeping intersections as compact as possible. This requires a great deal of design flexibility and engineering judgment, as each intersection is unique in terms of the angles of the approach and departure, the number of travel lanes, the presence of a median, and a number of other features that fundamentally impact corner design.

CONSIDERATIONS

- On-street parking and bicycle lanes may provide larger effective radii to accommodate the appropriate design vehicle.
- At signalized intersections where additional space is needed to accommodate turning vehicles, consideration can be given to recessing the stop bar on the receiving street to enable the vehicle to use the entire width of the receiving roadway (encroaching on the opposing travel lane).
- A compound curve can be used to vary the actual curb radius over the length of the turn so that the radius is smaller as vehicles approach a crosswalk and larger when making the turn.
- In some cases where there are alternative access routes, it may be possible to restrict turning movements by large vehicles (via signage) at certain intersections and driveways to enable tighter curb radii. Turn restrictions and alternate access routes should be properly signed and locally approved.
- On low-volume (less than 1,500 vehicles per day), two-lane streets, corner design should assume that a large vehicle will use the entire width of the departing and receiving travel lanes, including the oncoming traffic lane.
- At signalized intersections, corner design should assume that a large vehicle will use the entire width of the receiving lanes on the intersecting street.
- In some cases, it may be possible to allow a large turning vehicle to encroach on the adjacent travel lane on the departure side (on multi-lane roads) to make the turn.
- For truck routes, bus routes, garbage routes, and emergency routes, consider the inner turning radius of larger vehicles. To make turns at its tightest radius, the vehicle must slow significantly. This can cause run-time delays for buses, especially if turns are frequent along a route.
- Mountable truck aprons can be used to deter passenger vehicles from making higher-speed turns, but accommodate the occasional large vehicle without encroachment or off-tracking into pedestrian areas. Mountable truck aprons should be visually distinct from the adjacent travel lane and sidewalk.



GUIDANCE

- The design vehicle should be selected according to the types of vehicles using the intersection with considerations to relative volumes and frequencies. In most cases, the curb radii are based on a Single Unit vehicle with a 42-foot turning radius. If accommodations are needed for a larger design vehicle, a radius evaluation based on this larger vehicle would be required. Examples of typical turning templates would include SU-30, WB-40, WB-50, WB-60 and WB-62.
- Intersection design should strive for the minimum curb radius that accommodates a frequent design vehicle. The maximum curb radii are shown below.

Functional Classification	Local	Collector	Arterial
Local	20 feet	30 feet	30 feet
Collector	30 feet	40 feet	40 feet
Arterial	30 feet	40 feet	50 feet

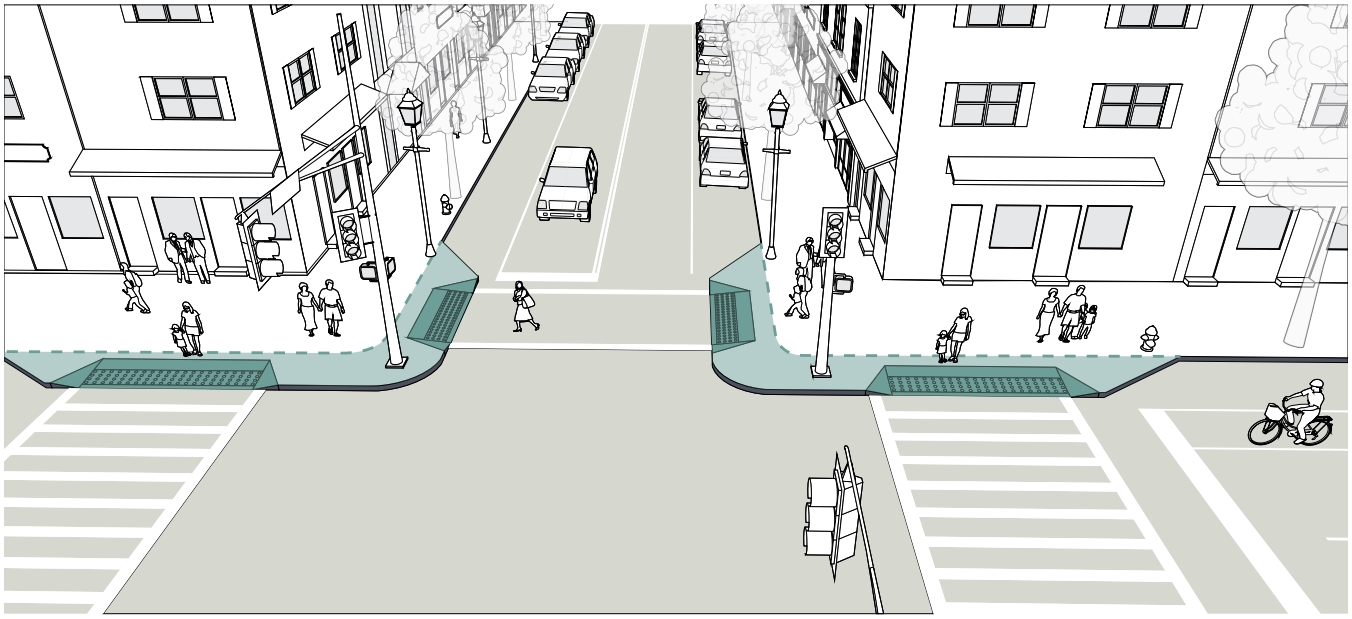
REFERENCES

NACTO Urban Streets Design Guide (2013)

NACTO Transit Street Design Guide (2016)

CURB EXTENSIONS

Curb extensions, also known as bulb-outs or bump-outs, are created by extending the sidewalk at intersections or mid-block. Curb extensions are intended to increase safety, calm traffic, and provide extra space along sidewalks for users and amenities. In addition to shortening crossing distances, curb extensions can be used to change the geometry of intersections resulting in smaller corner radii and slowing turning motor vehicles.



CONSIDERATIONS

- The turning needs of emergency and larger vehicles should be considered in curb extension design.
- Care should be taken to maintain direct routes across intersections by aligning pedestrian desire lines on either side of the sidewalk. Curb extensions often make this possible as they provide extra space for grade transitions.
- Consider providing a 20' long curb extension to restrict parking within 20' of an intersection to enhance visibility.
- When curb extensions conflict with turning movements, reducing the width and/or length of the curb extension should be prioritized over elimination.
- Emergency access is often improved through the use of curb extensions because intersections are kept clear of parked cars.

GUIDANCE

- Curb extensions should be considered only where parking is present or where motor vehicle traffic deflection is provided through other curbside uses such as bicycle share stations or parklets.
- Curb extensions are particularly valuable in locations with high volumes of pedestrian traffic, near schools, at unsignalized pedestrian crossings, or where there are demonstrated pedestrian safety issues.
- A typical curb extension extends approximately the width of a parked car (or about 6' from the curb).
- The minimum length of a curb extension is the width of the crosswalk, allowing the curvature of the curb extension to start after the crosswalk, which should deter parking; NO STOPPING signs should also be used to discourage parking. The length of a curb extension can vary depending on the intended use (i.e., stormwater management, transit stop waiting areas, parking restrictions).
- Curb extensions should not reduce a travel lane or a bicycle lane below minimum design width.
- Low-cost, quick-build "curb extensions" can be constructed with paint and vertical elements like posts or planters.

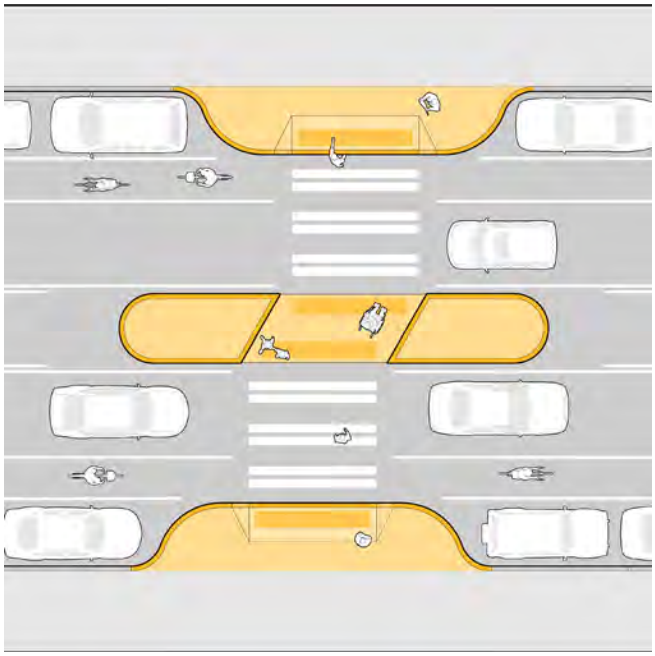
REFERENCES

AASHTO Guide for the Development of Bicycle Facilities (2012)

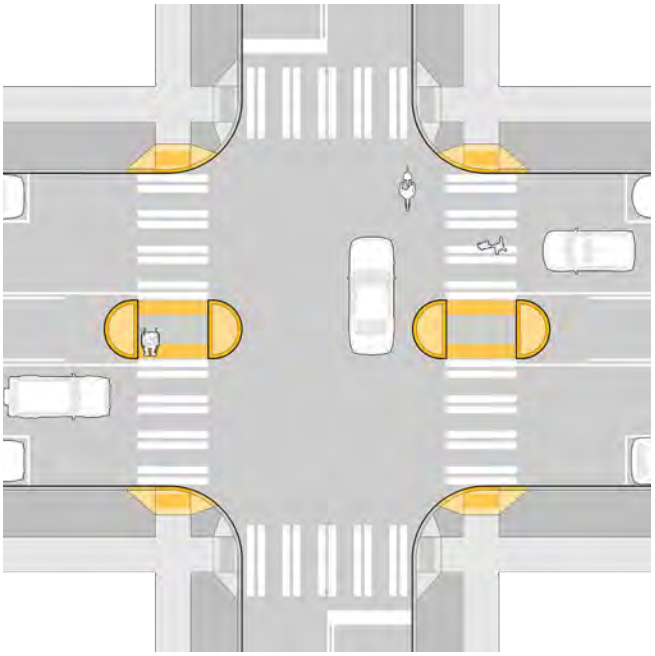
NACTO Urban Street Design Guide (2013) - Curb Extensions

CROSSING ISLANDS

Crossing islands are raised islands that provide a pedestrian refuge and allow multi-stage crossings of wide streets. They can be located mid-block or at intersections and along the centerline of a street, as roundabout splitter islands, or as "pork chop" islands where right-turn slip lanes are present.



Mid-block Crossing Island with Curb Extensions



Intersection Crossing Islands (Left Turns Prohibited)

CONSIDERATIONS

- There are two primary types of crossing islands. The first type provides a cut-through of the island, keeping pedestrians at street-grade. The second type ramps pedestrians up above street grade and may present challenges to constructing accessible curb ramps unless they are more than 17' wide (accommodating for ramp width and landing area).
- Crossing islands should be considered where crossing distances are greater than 50 feet or traffic volumes exceed 15,000 vehicles per day. For long distances, islands can allow multi-stage crossings, which in turn allow shorter signal phases.
- Crossing islands can be coupled with other traffic calming features, such as partial diverters and curb extensions at mid-block and intersection locations.
- At mid-block crossings where width is available, islands should be designed with a stagger, or in a "Z" pattern, encouraging pedestrians within the median to face oncoming traffic before crossing.

GUIDANCE

- Minimum width: 6 feet
- Preferred Width: 10 feet (to accommodate bicyclists with trailers and wheelchair users)
- Cut-through openings should equal the width of the crosswalk. Cut-throughs may be wider in order to allow the clearing of debris and snow, but should not encourage motor vehicles to use the space for U-turns.
- Curb ramps with truncated dome detectable warnings and 5-foot by 5-foot landing areas are required when the pedestrians are taken above the street level. When pedestrians remain at street level but the crossing island is 6 feet or wider, two 2' by 5' truncated dome detectable warnings must be provided on each end of the refuge area.
- A "nose" that extends past the crosswalk is not required, but is recommended to protect people waiting on the crossing island and to slow turning drivers.
- Vegetation and other aesthetic treatments may be incorporated, but must not obscure visibility.

REFERENCES

NACTO Urban Street Design Guide (2013)

California Manual on Uniform Traffic Control Devices (2014)

PEDESTRIAN SIGNALS

Pedestrian signal heads display the three intervals of the pedestrian phase: (1) The Walk Interval, signified by the WALK indication (or the walking person symbol) alerts pedestrians to begin crossing the street. (2) The Pedestrian Change Interval, signified by the flashing DON'T WALK indication (or the flashing hand symbol accompanied by a countdown display) alerts pedestrians approaching the crosswalk that they should not begin crossing the street. (3) The Don't Walk Interval, signified by a steady DON'T WALK indication (or the steady upraised hand symbol) alerts pedestrians that they should not cross the street.

CONSIDERATIONS

One of primary challenges for traffic signal design is to minimize conflicts between motor vehicle and pedestrian movements. Intersection geometry and traffic controls should encourage turning vehicles to yield the right-of-way to pedestrians. Traffic movements should be analyzed at intersections in order to utilize non-conflicting phases to implement one or more WALK intervals per cycle.

Signal design should minimize the time that pedestrians must wait. Requiring pedestrians to wait for extended periods can encourage crossing against the signal. The 2010 Highway Capacity Manual states that pedestrians have an increased likelihood of risk-taking behavior (crossing against the signal) after waiting longer than 30 seconds for a WALK indication.

Free-flowing right-turn lanes are discouraged at signalized intersections. Where they are present, the pedestrian signal and pushbutton should be located on the channelization ("pork chop") island. A yield or crosswalk warning sign should then be placed in advance of the crosswalk.

GUIDANCE: TIMING & ACTIVATION

- Pedestrian signals should allocate enough time for pedestrians of all abilities to safely cross the roadway. The MUTCD specifies a pedestrian walking speed of 3.5 feet per second to account for an aging population. The pedestrian clearance time, which is the total time for the pedestrian change interval plus the buffer interval, is calculated using the pedestrian walking speed and the distance a pedestrian has to cross the street.
- Countdown pedestrian displays inform pedestrians of the amount of time in seconds that is available to safely cross during the flashing DON'T WALK (or upraised hand) interval. All new pedestrian signal heads should contain a countdown display provided with the DON'T WALK (or upraised hand) indication.
- In areas with higher pedestrian activity, such as near transit stations, main streets, and school zones, push button actuators may not be appropriate. People should expect to get a pedestrian cycle on every signal cycle, rather than having to push a button to call for a pedestrian phase.
- Where especially long crossing distances exist, particularly near locations with a large population of people using mobility devices, elderly people, or school children, consider putting push buttons in pedestrian refuge islands.

GUIDANCE: ACCESSIBLE PEDESTRIAN SIGNALS (APS)

Accessible pedestrian signals and accessible detectors are devices that communicate information in non-visual formats about the pedestrian phase to pedestrians with visual and/or hearing disabilities. APS and detectors may include features such as audible tones, speech messages, detectable arrow indications and/or vibrating surfaces.

- Pushbutton locator tones are used for locating the pedestrian pushbutton needed to actuate the WALK interval. Detectable arrows should be located on pushbuttons to point in the same direction as the crosswalk. At corners of signalized locations where two pushbuttons are present, they should be separated by at least 10'.
- Audible walk indications should have the same duration as the pedestrian walk indication unless the pedestrian signal rests-in-walk (the parallel vehicle phase remains green until a vehicle approaching a conflicting movement is detected), in which case the audible indication should be provided in the first seven seconds of the Walk interval.
- For automatically-called pedestrian phases, pushbuttons can be used to activate accessible pedestrian signal features such as detectable arrow indications and/or speech messages.
- When new pedestrian signals are installed, APS with pushbuttons are required. For existing pedestrian signals, the APS and pedestrian pushbuttons should be provided when the signal controller and software are altered, or the signal head is replaced.

GUIDANCE: LEADING PEDESTRIAN INTERVAL (LPI)

The Leading Pedestrian Interval initiates the pedestrian WALK indication three to seven seconds before motor vehicles traveling in the same direction are given the green indication. This signal timing technique allows pedestrians to enter the intersection prior to turning vehicles, increasing visibility between all modes.

- The LPI should be used at intersections with high volumes of pedestrians and conflicting turning vehicles or at locations with a large population of people using mobility devices, elderly people, or school children, who tend to walk slower.
- A lagging protected left arrow for vehicles should be provided to accommodate the LPI.

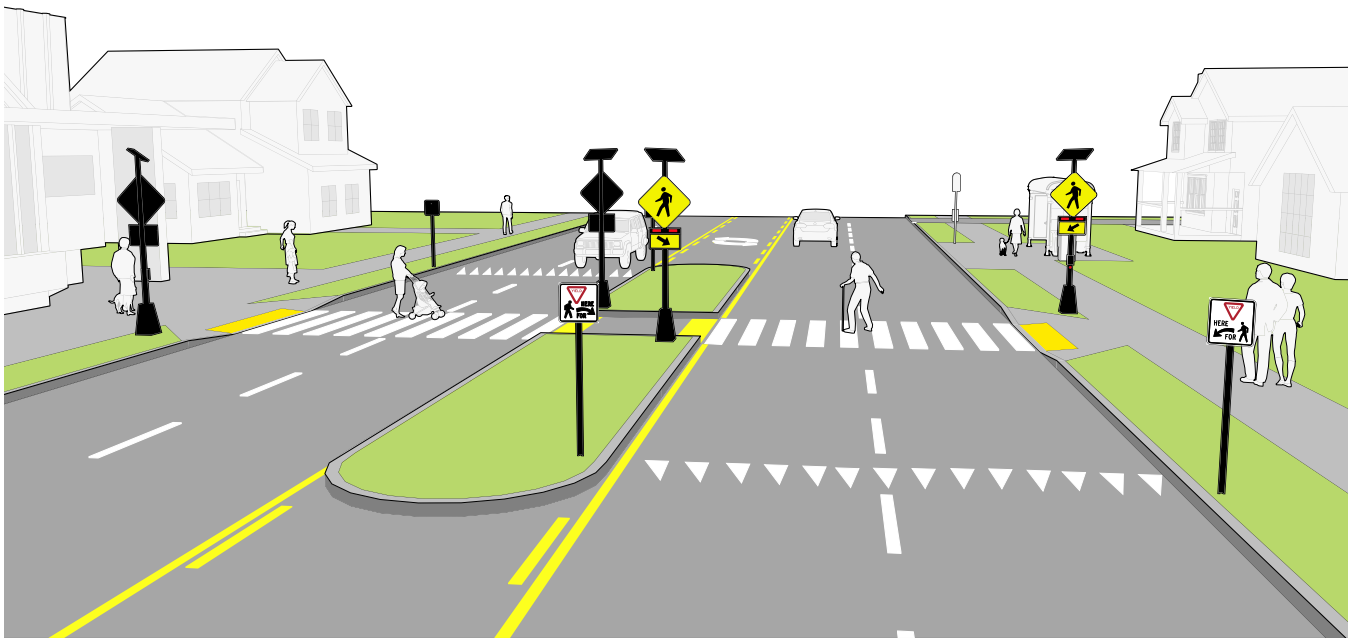
REFERENCES

NACTO Urban Street Design Guide (2013)

California Manual on Uniform Traffic Control Devices (2014)

RECTANGULAR RAPID FLASHING BEACON

At some uncontrolled crossings, particularly those with four or more lanes, it can be difficult to achieve compliance with laws that require motorists to yield to pedestrians. Vehicle speeds and poor pedestrian visibility combine to create conditions in which very few drivers are compelled to yield. One type of traffic control device proven to be successful in improving yielding compliance at these locations is the Rectangular Rapid Flash Beacon (RRFB). RRFBs combine a pedestrian crossing sign with a bright flashing beacon that is activated only when a pedestrian is present.



CONSIDERATIONS

- RRFBs are usually implemented at high-volume pedestrian crossings, but may also be considered for priority bicycle route crossings or locations where bike facilities cross roads at mid-block locations.
- RRFBs should be limited to locations with critical safety concerns, and should not be installed in locations with sight distance constraints that limit the driver's ability to view pedestrians on the approach to the crosswalk.
- RRFBs can be used when a signal is not warranted at an unsignalized crossing. They are not appropriate at intersections with signals or STOP signs.
- RRFBs are considerably less expensive to install than mast arm-mounted signals. They can also be installed with solar power panels to eliminate the need for an external power source.
- RRFBs can be more effective and have less impact on street maintenance than in-ground flashing systems.

GUIDANCE

- The design of RRFBs should be in accordance with FHWA's Interim Approval 21 for Operational Use of Pedestrian-Actuated Rectangular Rapid-Flashing Beacons at Uncontrolled Marked Crosswalks.
- RRFBs should be used in conjunction with advance yield markings and "Yield Here to Pedestrians" signs.
- RRFBs are installed on both sides of the roadway at the edge of the crosswalk. If there is a pedestrian refuge or other type of median on roadways with multi-lane approaches, an additional beacon should be installed in the median.
- See FHWA's *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* and the *Manual of Uniform Traffic Control Devices* to determine warrants for traffic control at midblock crossings.

REFERENCES

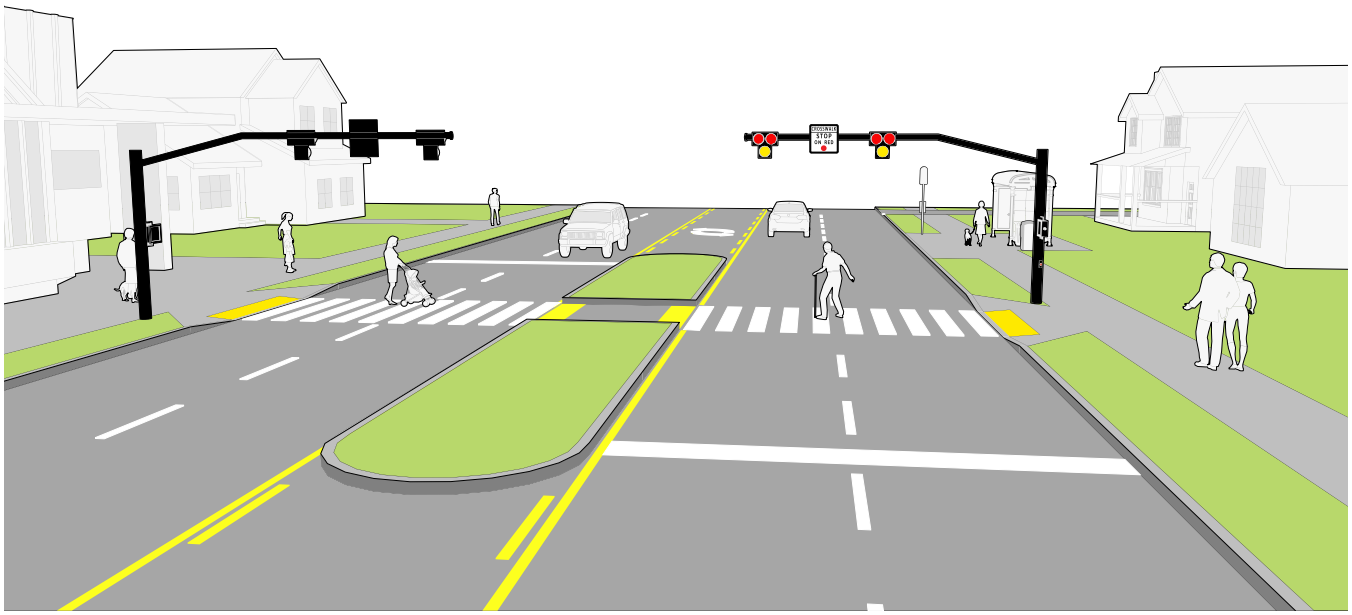
NACTO Urban Street Design Guide (2013)

California Manual on Uniform Traffic Control Devices (2014)

FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (2018)

PEDESTRIAN HYBRID BEACON

Pedestrian hybrid beacons, including the High-intensity Activated Crosswalk Beacon (HAWK), are a type of traffic control device intended to allow pedestrians and bicyclists to stop traffic to cross high-volume arterial streets. This type of signal may be used when warrants are met as provided in the California MUTCD. The California MUTCD provides that "A conventional traffic control signal operation with a standard signal face displaying green, yellow and red (steady and/or flashing red) indications, at a mid-block crosswalk is an alternative to the pedestrian hybrid beacon."



CONSIDERATIONS

- While this type of device is intended for pedestrians, it may also benefit bicyclists.
- This type of device should be considered for all arterial crossings in a bicycle network and for path crossings if other engineering measures are found inadequate to create safe crossings.

GUIDANCE

- The MUTCD recommends minimum volumes of 20 pedestrians or bicyclists an hour for major arterial crossings (volumes exceeding 2,000 vehicles/hour).
- Push button actuators should respond immediately when pressed, be placed in convenient locations for all users, and abide by other ADA standards. Passive signal activation, such as video or infrared detection, may also be considered.
- See FHWA's *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* and the *Manual of Uniform Traffic Control Devices* to determine warrants for traffic control at midblock crossings.

REFERENCES

NACTO Urban Street Design Guide (2013)

California Manual on Uniform Traffic Control Devices (2014)

FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (2018)

TRANSIT STOPS

Any marked or signed location where transit vehicles stop and service passenger boarding and alighting is a transit stop. The most basic transit stops have only a pole-mounted "header" sign indicating the transit provider and route(s). High frequency routes and higher volume stops generally have more passenger amenities such as benches, shelters, traveler information, trash receptacles, bicycle parking, and other features.

CONSIDERATIONS

Transit stops on urban streets are typically located at the natural curb line or on a bus bulb or transit island. Dedicated transit facilities may use medians. Transit operations, curbside uses, posted speed limits, traffic volumes, transit frequency and typical bus dwell time all influence location decisions for transit stops. See Transit Accommodations at Intersections for bus bulb design guidance.

Transit stops may be located on the near-side of an intersection before a signal or cross street, on the far-side after a bus has passed through an intersection, or at a mid-block location between intersections.

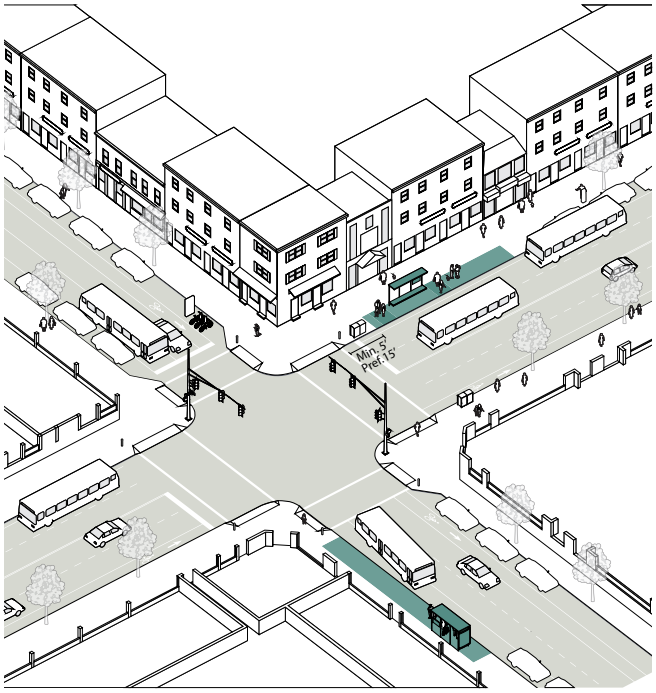
Transit stop locations are determined based on a number of factors including intersection operations, bus routing, curbside conditions, transfer points, intersection geometry and sightlines, consideration of other street users, and major generators or destinations. The location of a transit stop can affect transit travel time, passenger safety, and roadway operations.

Generally, transit agencies prefer far-side stops when traffic flows are heavy, where there are sight distance problems, and where buses turn left. Near-side located bus stops may be appropriate where traffic flow is lower or where transit riders can more easily transfer without crossing the street. Stops can also be placed mid-block where there are major passenger generators or where space next to an intersection is insufficient.

Regardless of location, all transit stops must be ADA compliant, and should be safe, convenient, well-illuminated, and clearly visible. Transit stops should be connected to the larger pedestrian network with continuous sidewalks, curb ramps, and safe pedestrian crossings. Mid-block stops should provide access to mid-block crosswalks.

Bus bulbs may be considered where additional pedestrian space is needed or where it is challenging for transit vehicles to re-enter traffic.

Seating at or near transit stops can improve passenger comfort, as can shade in the form of street trees or awnings. Seating need not be a unique and dedicated element, but may include leaning rails, planters, ledges, or other street elements.



GUIDANCE

- The landing zone at each transit vehicle door should be a clear zone 5 feet long (parallel to the curb) by 8 feet deep (beginning immediately adjacent to the curb). Newly constructed sidewalks should have a 10-foot by 8-foot landing zone to provide an accessible space for loading and unloading. If the sidewalk is not wide enough to support an 8-foot landing zone and on-street parking is present, a curb extension (bus bulb) should be built to accommodate the minimum width. Bus bulbs should extend to within 1 to 2 feet of the edge of the travel lane.
- Landing zones should be provided at all doors of the transit vehicle. For articulated buses, the distance between the front and rear landing zones is 18'. Buses can vary in length and will have different door configurations. Landing zones should be designed in coordination with all transit providers.

REFERENCES

NACTO Urban Street Design Guide (2013)

AASHTO Guide for Geometric Design of Transit Facilities on Highways and Streets (2014)

ALTERNATIVE WALKWAYS

Often, traditional sidewalks are either not feasible or may be undesirable, particularly in rural communities. In these cases, people are frequently left walking on the side of the road with little to no protection from fast moving vehicles. Alternative walkways aim to provide a more comfortable space for people walking and rolling where a sidewalk may not be feasible. These walkways typically cost less money to construct and preserve the rural character of a street.

CONSIDERATIONS

- The method of separation should depend on motor vehicle speeds and volumes. For speeds below 25 mph, and volumes below 2,000 ADT, a striped edge line can be sufficient. For roadways with higher vehicle speeds and volumes, vertical elements such as wood, concrete, or asphalt curbing or flexible posts should be used to separate people walking and rolling from vehicle traffic.
- Provide traffic calming elements to slow vehicle speeds when speed and volume thresholds cannot be met.
- On streets where there are no bicycle facilities, bicyclists may be inclined to use the pedestrian walkway. Where bicyclists are expected to use the facility, provide wider walkways to accommodate people passing one another.
- Consider drainage when constructing alternative walkways to ensure pooling doesn't occur within the path of the walkway.

GUIDANCE

- Alternative walkways should be a minimum of 6 feet in width, with a preferred width of 8 feet. Facilities anticipated to be used by bicyclists should be a minimum or 8 feet, with a preferred width of 10 feet.
- Walkways should be designed to be accessible for people using mobility devices, following guidance in the ADA Accessibility Guidelines and PROWAG. Paved surfaces with accessible slopes are preferred whenever possible.
- If located adjacent to parallel parking, provide intermittent gaps in vertical barriers to provide unobstructed access for pedestrians.
- Provide tactile warning indicators at all crossing locations to ensure that people with low or no vision can detect that they are about to enter the roadway.
- On streets with vehicle speeds below 25mph and volumes below 2,000 ADT, bicyclists should be expected to travel in the roadway with vehicles. Shared lane markings should be provided to encourage bicyclists to ride outside of the walkway area.
- Signage and pavement markings should be used to prohibit vehicles from parking in the walkway.

REFERENCES

ADA Accessibility Guidelines (2004)

California Manual on Uniform Traffic Control Devices (2014)

Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG) (2011)

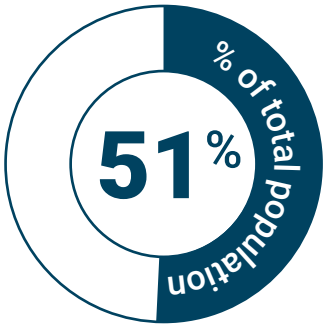
BICYCLE FACILITIES

POTENTIAL BICYCLE USERS

TYPES OF CYCLISTS

The figure below illustrates a typical range of cyclists, ranging from least to most comfortable sharing the road with motor vehicles. It is important to understand which type of cyclist is most likely or most desired to use any given facility, as this will affect the design and degree of separation from vehicle traffic necessary. See the Bikeway Facilities Selection Chart to determine which facility types best serve the different types of cyclists. All Ages and Abilities bikeway facilities are designed so all bicyclists, even the Interested but Concerned, can safely and comfortably travel in a given bikeway. Note that 37% of the population is either unwilling or unable to ride a bicycle.

Interested but Concerned



Who are they?

A mother and daughter who enjoy Saturday rides to the park along the trail that runs near their house. Concern over crossing a busy road prevents them from riding together to elementary school during the week.

Who are they?

A 45-year-old father of two who was just diagnosed with pre-diabetes. His doctor encouraged him to be more active, so he's been thinking about commuting to work by bike. As a motorist, he feels uncomfortable passing bicyclists, so he isn't sure he'd feel comfortable as a bicyclist sharing the road with cars.

Who are they?

A worker who just started a new job. He enjoys riding as long as he stays on quiet streets or the sidewalk. He'd like to be able to ride to more destinations, but he's uncomfortable crossing busy roads and intersections along the way.

LOWER STRESS TOLERANCE

POTENTIAL BICYCLE USERS

Enthusiastic and Confident

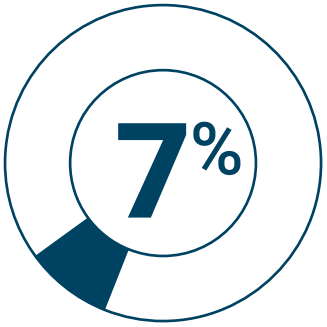
Who are they?

A North Fair Oaks resident who rides her bike in downtown Redwood City every morning to run errands. She prefers to ride on neighborhood streets, but doesn't mind riding a few blocks on a busy street since there's a bike lane.

Who are they?

A lower-income resident who rides a bicycle to save money for other household expenses. He's comfortable riding on streets as long as they have bike lanes.

Strong and Fearless



Who are they?

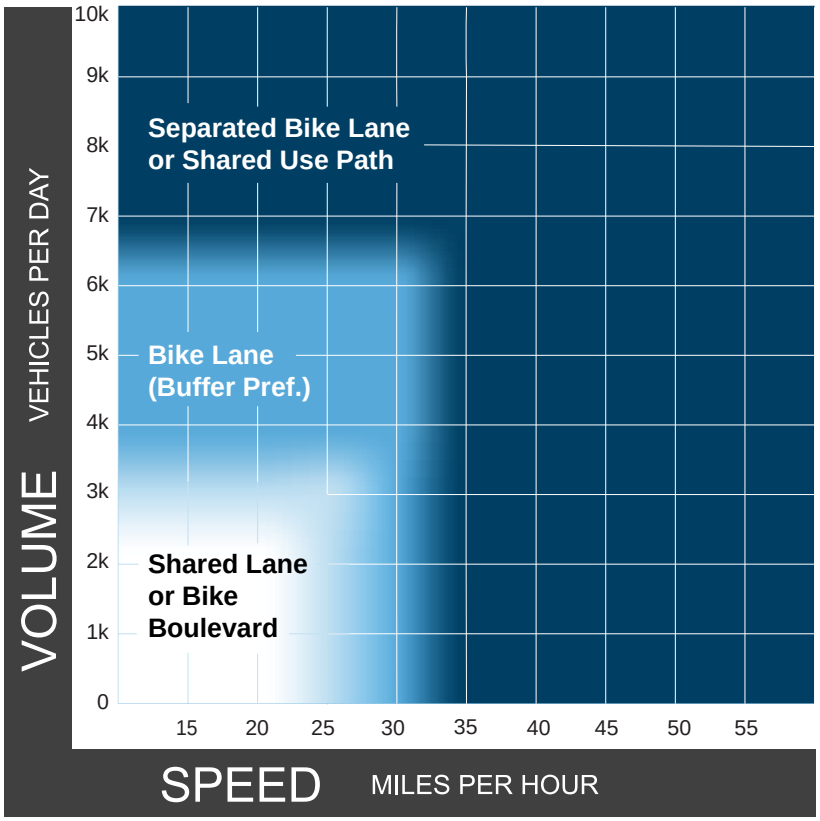
A recent Cal State East Bay grad who can't wait to hit the road this weekend for a 100-mile ride on his brand new road bike. He helped pay his way through college as a bike messenger, and loves the rush that he gets from racing.

HIGHER STRESS TOLERANCE

BICYCLE FACILITY SELECTION

Designing for Interested but Concerned and Enthusiastic and Confident Bicyclists

"Interested but Concerned" bicyclists prefer physical separation as traffic volumes and speeds increase. The bikeway facility selection chart below identifies bikeway facilities that improve the operating environment for this bicyclist type at different roadway speeds and traffic volumes. The "enthusiastic and confident" bicyclist will also prefer bikeway treatments noted in this chart. If a community's goal is to attract new users to bicycling, it is appropriate to select facility types based on this chart.



Notes

1 *Chart assumes operating speeds are similar to posted speeds. If they differ, use operating speed rather than posted speed.*

2 *Advisory bike lanes may be an option where traffic volume is <3K ADT.*

Source: 2019 FHWA Bikeway Selection Guide

FACILITY DETAILS

Physically separated facility:

+ Separated bike lane or shared-use path, separated from traffic by parking, posts, curb, etc.
+ For two-way facility: 10 to 12 ft preferred, 8 ft minimum

Bike lane: 5 to 7 ft

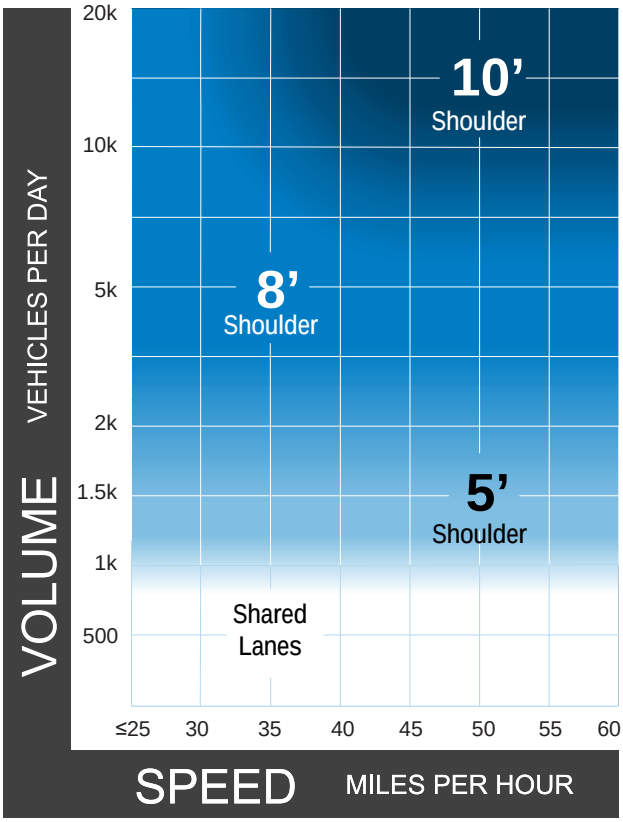
Buffered bike lane: 8 to 9 ft total

To determine whether to provide a shared-use path, separated bike lane, or buffered bike lane, consider pedestrian and bicycle volumes or, in the absence of volume, consider land use.

RURAL BICYCLE FACILITY SELECTION

Shoulder Widths for Rural Roadways

Often, the needs and constraints of rural roadways are very different from those of a more urban facility. Rural roadways most typically serve strong and confident riders, who can adequately be accommodated with narrower shoulders. Providing shoulders of the recommended width, and placing intermittent rumble strips between the travel lane and shoulder, helps accommodate less confident bicyclists. When selecting a minimum shoulder width to accommodate bicyclists, the decision should be based on traffic volumes and posted speeds in the rural context. For the purposes of determining the appropriate shoulder width, it is assumed that posted speeds are approximately the same as operating speeds. If operating speeds differ from posted speeds, then operating speed should be used instead of posted speed.



Notes

1 *This chart assumes the project involves reconstruction or retrofit in constrained conditions. For new construction, follow recommended shoulder widths in the AASHTO Green Book.*

2 *A separated shared use pathway is a suitable alternative to providing paved shoulders.*

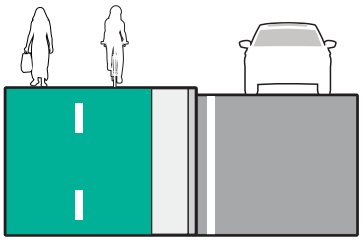
3 *Chart assumes operating speeds are similar to posted speeds. If they differ, use operating speed rather than posted speed.*

4 *If the percentage of heavy vehicles is greater than 10%, consider providing a wider shoulder or a separated pathway.*

Source: 2019 FHWA Bikeway Selection Guide

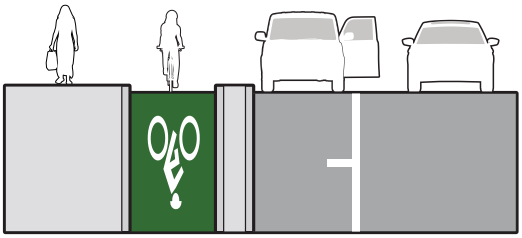
BICYCLE FACILITY OVERVIEW

Multi-Use Path Class I — MUP

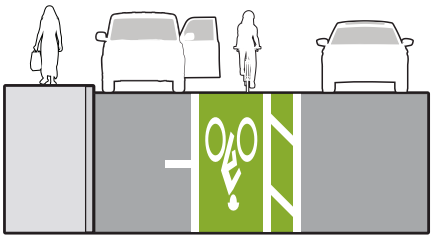


MOST SEPARATED

Separated Bike Lane Class IV — SBL



Buffered Bike Lane Class II — BBL



TYPICAL APPLICATION

Multi-use paths will generally be considered on any road with one or more of the following characteristics:

- Total traffic lanes: 3 lanes or greater
- Posted speed limit: 30 mph or greater
- Average Daily Traffic: 9,000 vehicles or greater
- Parking turnover: varies
- Bike lane obstruction: likely to be frequent
- Streets that are designated as truck or bus routes

Multi-use paths are shared with pedestrians and may be preferable to separated bike lanes in low density areas where pedestrians volumes are anticipated to be fewer than 200 people per hour on the path.

Separated bike lanes will generally be considered on any road with one or more of the following characteristics:

- Total traffic lanes: 3 lanes or greater
- Posted speed limit: 30 mph or more
- Average Daily Traffic: 9,000 vehicles or greater
- Parking turnover: frequent
- Bike lane obstruction: likely to be frequent
- Streets that are designated as truck or bus routes

Preferred in higher density areas, adjacent to commercial and mixed-use development, and near major transit stations or locations where observed or anticipated pedestrian volumes will be higher.

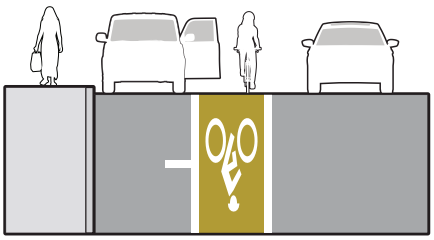
Buffered bike lanes will generally be considered on any road with one or more of the following characteristics:

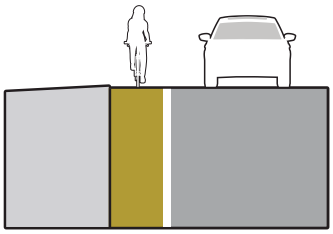
- Total traffic lanes: 3 lanes or fewer
- Posted speed limit: 30 mph or lower
- Average Daily Traffic: 9,000 vehicles or fewer
- Parking turnover: infrequent.
- Bike lane obstruction: likely to be infrequent
- Where a separated bike lane or sidepath is infeasible or not desirable

BICYCLE FACILITY OVERVIEW

Bike Lane
Class II

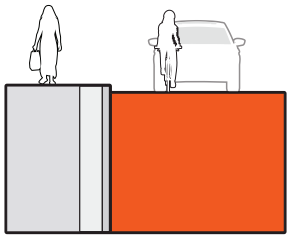
BL





Bicycle Route
Class III

SR



LEAST SEPARATED

TYPICAL APPLICATION

Conventional bike lanes will generally be considered on any road with one or more of the following characteristics:

+ Total traffic lanes: 3 lanes or fewer
+ Posted speed limit: 30 mph or lower
+ Average Daily Traffic: 9,000 vehicles or fewer
+ Parking turnover: infrequent
+ Bike lane obstruction: likely to be infrequent
+ Where a separated bike lane or sidepath is infeasible or not desirable

Bicycle routes will generally be considered on any road with one or more of the following characteristics:

+ Total traffic lanes: 2 lanes or fewer
+ Posted speed limit 25 mph or lower
+ Average Daily Traffic: 3,000 vehicles or fewer
+ Parking turnover: very infrequent
+ Bike Lane Obstruction: N/A

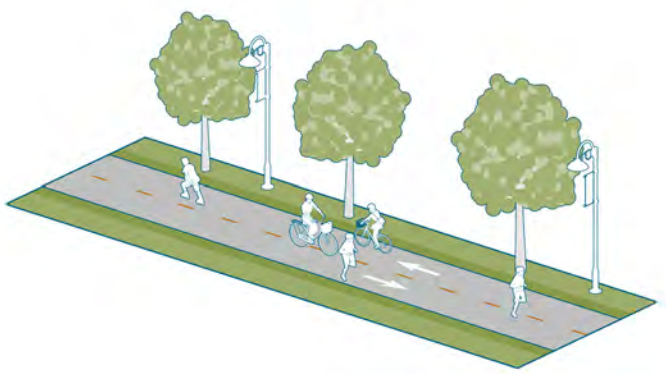
When paired with traffic calming measures this facility type is known as a bicycle boulevard and can provide a low stress environment.

MULTI-USE PATHS (CLASS I)

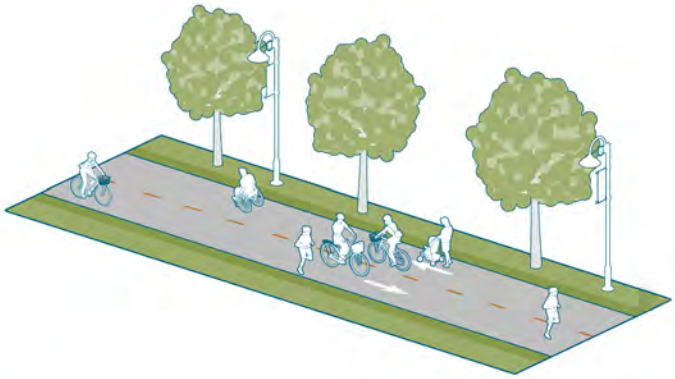
A multi-use path is a two-way facility physically separated from motor vehicle traffic and used by bicyclists, pedestrians, and other non-motorized users. Multi-use paths are often located in an independent alignment, such as a greenbelt or abandoned railroad. However, they are also regularly constructed along roadways; often bicyclists and pedestrians will have increased interactions with motor vehicles at driveways and intersections on these multi-use paths.

CONSIDERATIONS

- According to the AASHTO, "multi-use paths should not be used to preclude on-road bicycle facilities, but rather to supplement a network of on-road bike lanes, bicycle boulevards, and paved shoulders." In other words, in some situations it may be appropriate to provide an on-road bikeway in addition to a multi-use path along the same roadway.
- Many people express a strong preference for the separation between bicycle and motor vehicle traffic provided by paths when compared to on-street bikeways. Multi-use paths may be desirable along high-volume or high-speed roadways, where accommodating the targeted type of bicyclist within the roadway in a safe and comfortable way is impractical. However, multi-use paths may present increased conflicts between path users and motor vehicles at intersections and driveway crossings. Conflicts can be reduced by minimizing the number of driveway and street crossings present along a path and otherwise providing high-visibility crossing treatments.
- Paths typically have a lower design speed for bicyclists than on-street facilities and may not provide appropriate accommodation for more confident bicyclists who desire to travel at higher speeds. In addition, greater numbers of driveways or intersections along a multi-use path corridor can decrease bicycle travel speeds and traffic signals can increase delay for bicyclists on off-street paths compared to cyclists using in-street bicycle facilities such as bike lanes. Therefore, paths should not be considered a substitute to accommodating more confident bicyclists within the roadway.



Path Width for One-way Passing



Path Width for Two-way Passing

REFERENCES

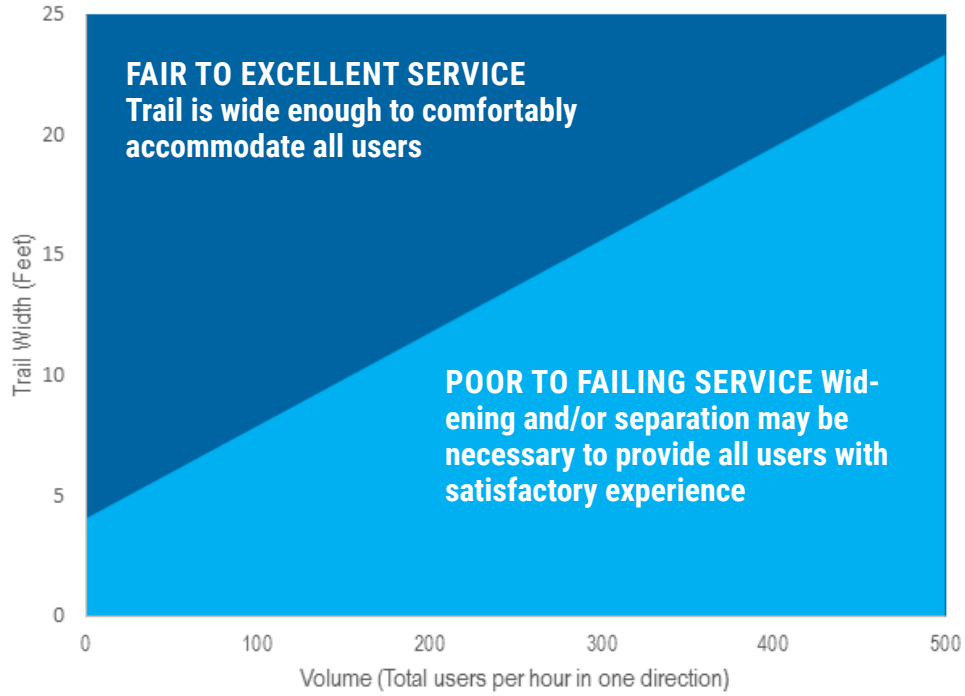
AASHTO Guide for the Development of Bicycle Facilities (2012)

FHWA Shared-Use Path Level of Service Calculator (2006)

California Manual on Uniform Traffic Control Devices (2014)

PATH WIDTH CONSIDERATION

Path width should be determined based on three main characteristics: the number of users, the types of users, and the differences in their speeds. For example, on a path that is used by higher-speed bicyclists and children walking to school, users may experience conflicts due to their speed differences. By widening the path to provide space to accommodate passing movements, conflicts can be reduced.



CONSIDERATIONS

- Typical path width is 12 feet wide with 3 foot shoulders on each side. This width allows users to pass one another with minimal conflict.
- Widths as narrow as 8 or 10 feet are acceptable for short distances under physical constraint or where volume is expected to be low.
- If there is frequent conflict between bicyclists and other users, separate bicyclists from pedestrians by constructing separate paths for each mode. The separate facilities may include two hard surface paths, or one hard surface path and one soft surface path.
- See above chart for path width recommendations based on volume. Soft surface paths are also preferred by some users, such as runners or equestrians.
- MUTCD warning signs showing the path narrowing should be considered at locations where the path narrows.

GUIDANCE

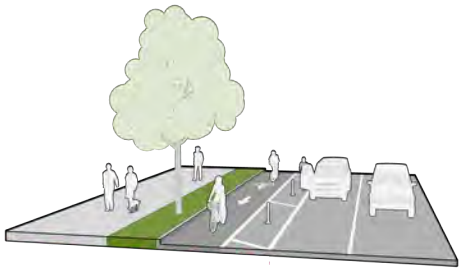
- Multi-use paths should be designed according to state and national standards. This process includes establishing a design speed (typically 18 mph) and designing path geometry accordingly.

Minimizing user conflicts:

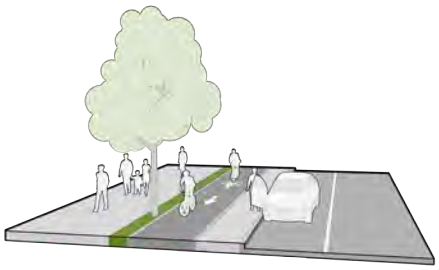
- Vertical objects close to the path edge can endanger users and reduce the comfortable usable width of the path. Vertical objects should be set back at least three feet from the edge of the path, for a height of 8 feet.
- 3 foot wide (minimum) shoulders provide space for users who step off the path to rest or to allow users to pass one another.
- Equestrian users and bicyclists may be integrated on the same multi-use path route. Ideally, a separate bridle path is desirable as horses prefer a soft surface to walk on and the horizontal separation keeps the horse from being startled by bicyclists.
- Include signage that dictates yielding responsibilities reduces conflict between equestrian users and other users.

SEPARATED BIKE LANES (CLASS IV)

Separated Bike Lanes are an exclusive bikeway facility type that combines the user experience of a multi-use path with the on-street infrastructure of a conventional bike lane. They are physically separated from motor vehicle traffic and distinct from the sidewalk. Two-way separated bike lanes are sometimes referred to as "cycle tracks".



One-way street level with Flexible Delineator posts



One-way Raised with buffer

Two-way Street level with raised buffer

Two-way Raised with buffer

CONSIDERATIONS

Separated bike lanes are more attractive to a wider range of bicyclists than striped bikeways on higher volume and higher speed roads. They eliminate the risk of a bicyclist being hit by an opening car door and prevent motor vehicles from driving, stopping or waiting in the bikeway. They also provide greater comfort to pedestrians by separating them from bicyclists riding at higher speeds.

Separated bike lanes can provide different levels of separation:

+ Separated bike lanes with flexible delineator posts ("flex posts") alone offer the least separation from traffic and are appropriate as an interim solution.
+ Separated bike lanes that are raised with a wider buffer from traffic provide the greatest level of separation from traffic, but will often require road reconstruction.
+ Separated bike lanes that are protected from traffic by a row of on-street parking offer a high-degree of separation.

GUIDANCE

Separated bike lanes can generally be considered on any road with one or more of the following characteristics:

+ Traffic lanes: 3 lanes or greater
+ Posted speed limit: 30 mph or more
+ Traffic: 9,000 vehicles per day or greater
+ On-street parking turnover: frequent
+ Bike lane obstruction: likely to be frequent
+ Streets that are designated as truck or bus routes

Separated bike lanes are preferred over multi-use paths in higher density areas, commercial and mixed-use development, and near major transit stations or locations where pedestrian volumes are anticipated to exceed 200 people per hour on a multi-use path. Parking removal may be required to construct separated bike lanes.

REFERENCES

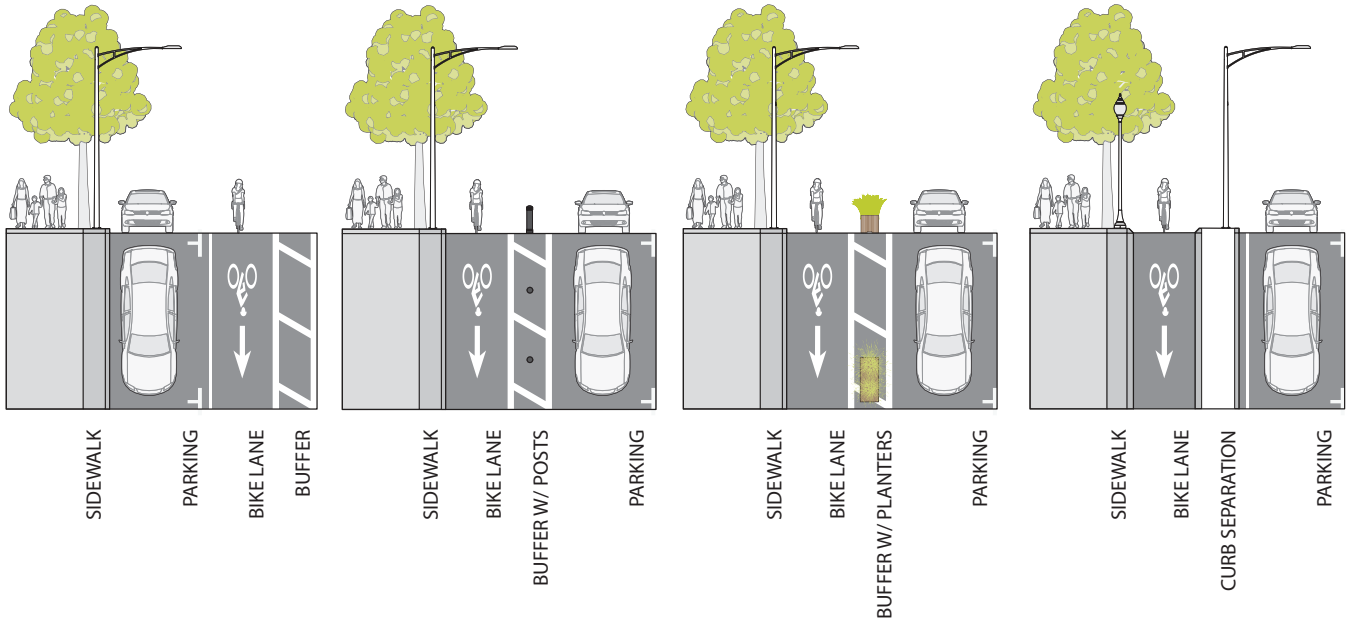
NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015

Caltrans. Class IV Bikeway Guidance (Separated Bikeways/Cycle Tracks). 2015.

LIFE OF A SEPARATED BIKE LANE

Separated bike lanes have been implemented in many cases as low-cost retrofit projects (e.g. using flex posts and paint within the existing right-of-way). More permanent forms of separation, such as curb-separated bike lanes, cost more and are less flexible once implemented. A phased implementation approach, where "pilot" projects transition to permanent separated bike lanes may solve both of these problems, by implementing the facility slowly and troubleshooting before permanent materials and high costs are necessary.



Progression from pilot project to separated bike lane

CONSIDERATIONS

Lower-cost retrofits or demonstration projects allow for quick implementation, responsiveness to public perception and ongoing evaluation. Separation types for short-term separated bike lane designs often include non-permanent separation, such as flexible delineator posts, planters or parking stops. Pilot projects allow the agency to:

+ Test the separated bike lane configuration for bicyclists and traffic operations
+ Evaluate public reaction, design performance, and safety effectiveness
+ Make changes if necessary
+ Transition to permanent design

GUIDANCE

+ Permanent separation designs provide a high level of protection and often have greater potential for placemaking, quality aesthetics, and integration with features such as green stormwater infrastructure.
+ Agencies often implement permanent separation designs by leveraging private development (potentially through developer contribution), major capital construction, and including separated bike lanes in roadway reconstruction designs.
+ Examples of permanent separation materials include rigid bollards, raised medians and grade-separated bike lanes at an intermediate or sidewalk level.

REFERENCES

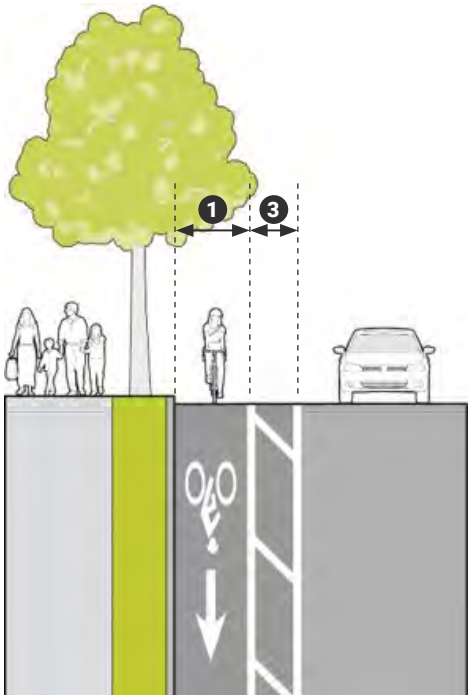
NACTO Urban Street Design Guide. 2013.

FHWA Protected Bike Lane Planning and Design Guide. 2015.

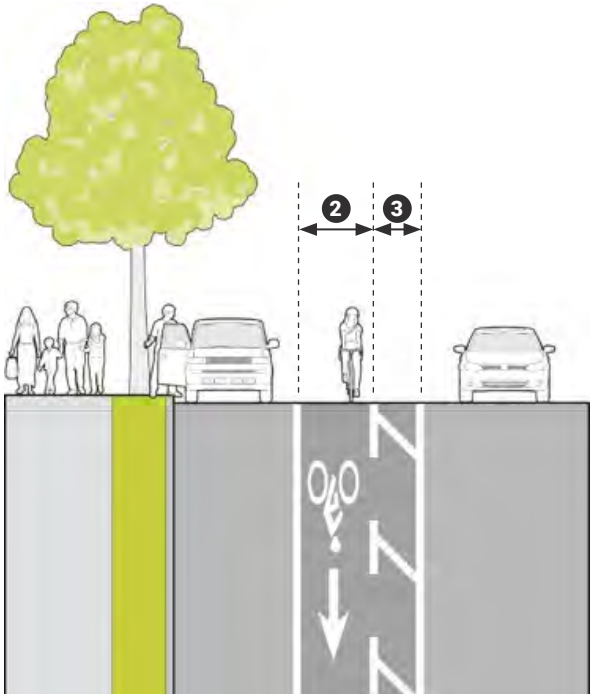
Caltrans. Class IV Bikeway Guidance (Separated Bikeways/Cycle Tracks). 2015.

BUFFERED BIKE LANES (CLASS II)

Buffered bicycle lanes are created by painting or otherwise creating a flush buffer zone between a bicycle lane and the adjacent travel lane. While buffers are typically used between bicycle lanes and motor vehicle travel lanes to increase bicyclists' comfort, they can also be provided between bicycle lanes and parking lanes in locations with high parking turnover to discourage bicyclists from riding too close to parked vehicles.



Buffered Bike Lane Adjacent to a Curb



Buffered Bike Lane Adjacent to Parking

CONSIDERATIONS

+ Preferable to a conventional bicycle lane when used as a contra-flow bike lane on one-way streets.
+ Typically installed by reallocating existing street space.
+ Can be used on one-way or two-way streets.
+ Consider placing buffer next to parking lane where there is commercial or metered parking.
+ Consider placing buffer next to travel lane where speeds are 30 mph or greater or when traffic volume exceeds 6,000 vehicles per day.
+ Where there is 7 feet of roadway width available for a bicycle lane, a buffered bike lane should be installed instead of a conventional bike lane.
+ Buffered bike lanes allow bicyclists to ride side by side or to pass slower moving bicyclists.
+ Research has documented buffered bicycle lanes increase the perception of safety.

GUIDANCE

1. The minimum width of a buffered bike lane adjacent to parking is 5 feet, a desirable width is 6 feet.
2. Buffers are to be broken where curbside parking is present to allow cars to cross the bike lane.
3. The minimum buffer width is 18 inches. There is no maximum. For buffers less than two feet in width, no cross hatching should be used. For buffers between 2 and 4 feet in width, diagonal cross hatching should be used. For buffers over 4 feet in width, chevron cross hatching should be used.

REFERENCES

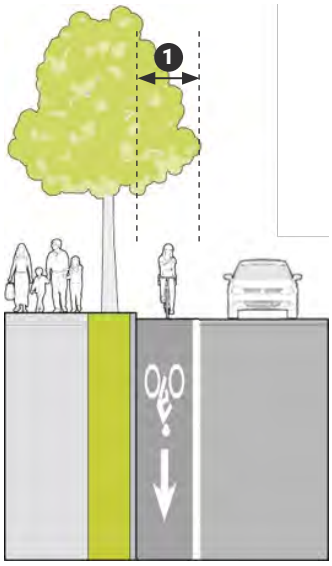
AASHTO. Guide for the Development of Bicycle Facilities. 2012.

NACTO. *Urban Bikeway Design Guide.* 2nd Edition.

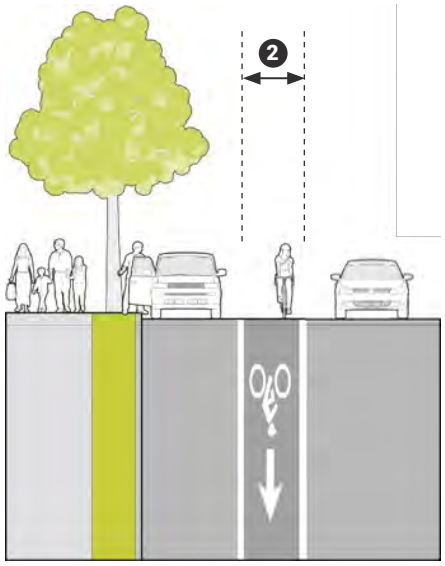
Portland State University, Center for Transportation Studies. *Evaluation of Innovative Bicycle Facilities: SW Broadway Cycle Track & SW Stark/Oak Street Buffered Bike Lanes FINAL REPORT.* 2011.

BIKE LANES (CLASS II)

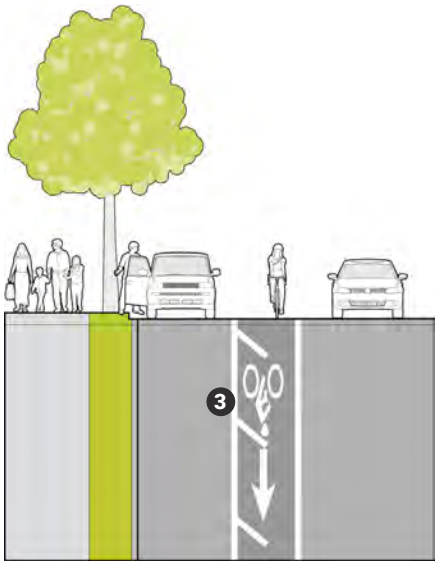
Bicycle lanes provide an exclusive space for bicyclists in the roadway. Bicycle lanes are established through the use of lines and symbols on the roadway surface. Bicycle lanes are for one-way travel and are normally provided in both directions on two-way streets and/or on one side of a one-way street. Bicyclists are not required to remain in a bicycle lane when traveling on a street and may leave the bicycle lane as necessary to make turns, pass other bicyclists, or to properly position themselves for other necessary movements. Bicycle lanes may only be used temporarily by vehicles accessing parking spaces and entering and exiting driveways and alleys. Stopping, standing and parking in bike lanes is prohibited.



Bike Lane Adjacent to Parking



Bike Lane Adjacent to a Curb



Bike Lane with Door Zone Marking

CONSIDERATIONS

+ Typically installed by reallocating existing street space.
+ Can be used on one-way or two-way streets.
+ Contra-flow bicycle lanes may be used to allow two-way bicycle travel on streets designated for one-way travel for motorists to improve bicycle network connectivity.
+ Stopping, standing and parking in bike lanes may be problematic in areas of high parking demand and deliveries, especially in commercial areas.
+ Wider bike lanes or buffered bike lanes are preferable at locations with high parking turnover.

GUIDANCE

1. The minimum width of a bike lane adjacent to a curb is 5 feet exclusive of a gutter; a desirable width is 6 feet.
2. The minimum width of a bike lane adjacent to parking is 5 feet; a desirable width is 6 feet.
3. Parking T's or hatch marks can highlight the door zone on constrained corridors with high parking turnover to guide bicyclists away from doors.

REFERENCES

AASHTO. Guide for the Development of Bicycle Facilities. 2012.

NACTO. Urban Bikeway Design Guide. 2nd Edition.

California Manual on Uniform Traffic Control Devices (2014)

BICYCLE BOULEVARD (CLASS III)

Bicycle boulevards are applied on quiet streets, often through residential neighborhoods. These treatments are designed to prioritize bicycle through-travel, while calming motor vehicle traffic and maintaining relatively low motor vehicle speeds. Treatments vary depending on context, but often include elements of traffic calming, including traffic diverters, speed attenuators such as speed humps or chicanes, pavement markings, and signs.

TREATMENT	VOLUME MANAGEMENT	SPEED MANAGEMENT
HORIZONTAL DEFLECTION		
Curb Extension	—	○
One-Lane Pinch Points	◒	◒
Chicanes	○	◒
Neighborhood Traffic Circles	—	◒
Median Islands	—	◒
VERTICAL DEFLECTION		
Speed Humps/Cushions	◒	●
Raised Crosswalks	◒	●
TRAFFIC DIVERTERS		
Signs and Markings	○	—
Diagonal Diverter	●	◒
Major Street Refuge Island	●	—
Forced Turn	●	◒

POTENTIAL EFFECTIVENESS

- ● High
- ◒ Medium
- ○ Low
- — None

Effectiveness of Bicycle Boulevard Treatments

CONSIDERATIONS

Many cities already have signed bike routes along neighborhood streets that provide an alternative to traveling on high-volume, high-speed arterials. Bicycle boulevard treatments make these streets more suitable for bicyclists of all abilities and can reduce crashes.

Stop signs or traffic signals should be placed along the bicycle boulevard to prioritize the bicycle movement, minimizing stops for bicyclists whenever possible.

Bicycle boulevard treatments include traffic calming measures such as street trees, traffic circles, chicanes, and speed humps. Traffic management devices such as diverters or semi-diverters can redirect cut-through vehicle traffic and reduce traffic volume while still enabling local access to the street.

Communities should begin by implementing bicycle boulevard treatments on one pilot corridor to measure the impacts and gain community support. The pilot program should include before-and-after crash studies, motor vehicle counts, and bicyclist counts on both the bicycle boulevard and parallel streets. Findings from the pilot program can be used to justify bicycle boulevard treatments on other neighborhood streets.

Additional treatments for major street crossings may be needed, such as median refuge islands, rectangular rapid flashing beacons, bicycle signals, and HAWK or half signals.

GUIDANCE

Bicycle boulevards can generally be considered on any road with one or more of the following characteristics:

- Maximum Average Daily Traffic (ADT): 3,000
- Preferred ADT: up to 1,000
- Target speeds for motor vehicle traffic are typically around 20 mph; there should be a maximum < 15 mph speed differential between bicyclists and vehicles.

REFERENCES

AASHTO Guide for the Development of Bicycle Facilities. 2012.

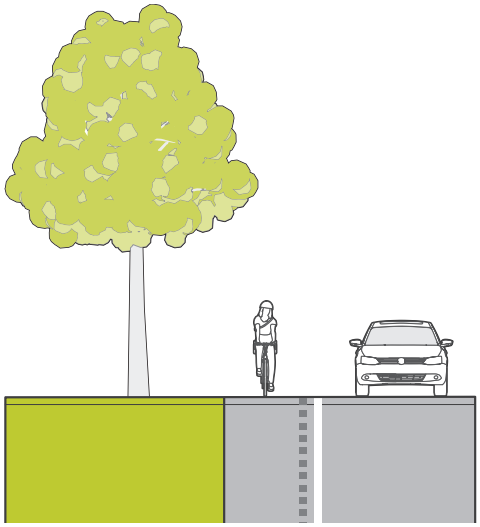
NACTO Urban Bikeway Design Guide. 2012.

Manual on Uniform Traffic Control Devices. 2009.

Fundamentals of Bicycle Boulevard Planning & Design. 2009.

RURAL BICYCLE ROUTE (CLASS III)

Paved shoulders are often the recommended bicycle facility on rural routes, except on low-volume streets where shared streets may be recommended. See the Rural Route Selection Chart for additional guidance. Paved shoulders provide a range of benefits: they reduce motor vehicle crashes, reduce long-term roadway maintenance, ease short-term maintenance such as snow plowing, and provide space for bicyclists and pedestrians (although paved shoulders typically do not meet accessibility requirements for pedestrians).



CONSIDERATIONS

- For roads that are unable to provide consistent and standard size bikeable shoulders in both directions, prioritize:
  - The uphill direction on hilly roads to reduce conflicts between slow-moving bicyclists and fast-moving motor vehicles.
  - The inside of a horizontal curve and/or the downgrade of a vertical curve where sight distance is restricted.
- Paved shoulders should be considered on roadways popular with recreational bicyclists that have significant motor vehicle traffic during periods when recreational bicycling is known to occur.
- Bicyclists will not use a shoulder if it is covered in gravel, glass and other road debris, so regular street sweeping is important.
- In rural areas, paved shoulders can also provide space for pedestrians on roadways without sidewalks. In situations where a shoulder is intended for pedestrian use, it must meet Americans with Disabilities Act requirements to the maximum extent possible.

GUIDANCE

- Shoulder width should be at least 4 feet if the roadway is curbless and there are no vertical obstructions. If curbs or vertical obstructions are present, shoulder width should be 5 feet minimum exclusive of the gutter if present. See Rural Route Selection Chart for additional guidance.
- Shoulders should be wider on roads with high levels of bicycle traffic to accommodate bicyclist passing and facilitate side-by-side bicycling.
- When posted speed limits or 85th percentile speeds exceed 50 mph and/or if heavy vehicles frequently use the road, shoulders should exceed minimum widths to enhance bicyclist comfort.
- Edge line rumble strips can provide additional bicyclist space on paved shoulders. The width of a shoulder with rumble strips should be measured from the rightmost side of the rumble strip to the edge of the roadway. Where rumble strips are present, gaps of at least 12' should be provided every 40-60'.

REFERENCES

AASHTO Guide for the Development of Bicycle Facilities (2012)

FHWA. Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts (2016)

Photo: Castro Valley, CA

BICYCLE INTERSECTION DESIGN AND SPOT TREATMENTS

CROSSING TREATMENTS

While the street segments of a bicycle boulevard or other traffic-calmed street may be generally comfortable for bicyclists without significant improvement, major street crossings must be addressed to provide safe, convenient and comfortable travel along the entire route. Treatments provide waiting space for bicyclists, control cross traffic, or ease bicyclist use by removing traffic control for travel along the bicycle boulevard route.

Median Diverter

Bicycle Box with Lead-In Bike Lane

Pedestrian Hybrid Beacon

Offset Crossing Left Turn Box with Lead-In Bike Lane

CONSIDERATIONS

- Adjustments to traffic control such as a Pedestrian Hybrid beacon or stop sign adjustments may necessitate a traffic study.
- Median islands may be constructed to require right-in/right-out turns by motor vehicles while still allowing left turns by bicyclists at off-set intersections.
- Numerous treatments exist to accommodate offset intersection crossings for bicyclists, and the full range of design treatments should be considered in these situations. These treatments include left turn queue boxes, two-way center left turn lanes (optionally designed solely for bicyclists), median left turn pockets and short sidepath segments.

GUIDANCE

Medians should be a minimum of 6 feet in width, though 8 feet is desirable to allow adequate space for a bicycle.

Intersections along a bicycle boulevard route may need treatment in the following situations:

- Unsignalized crossings of arterial or collector streets with high traffic volumes and speeds.
- Offset intersections where the bike route makes two turns in short succession.

REFERENCES

Fundamentals of Bicycle Boulevard Planning & Design (2009)

NACTO Urban Bikeway Design Guide (2014)

Portland's Neighborhood Greenway Assessment Report (2015)

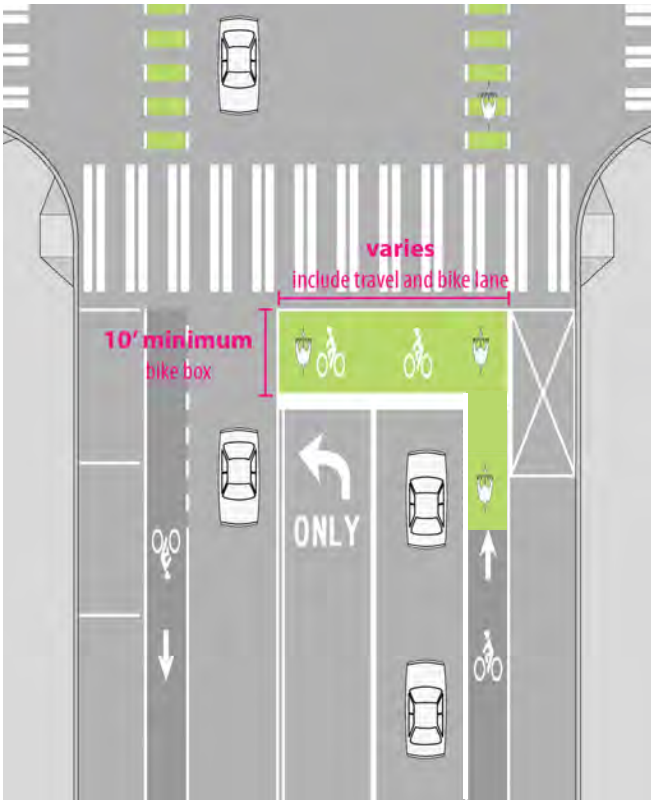
BIKE BOXES

A bicycle box provides dedicated space between the crosswalk and vehicle stop line where bicyclists can wait during the red light at signalized intersections. The bicycle box allows a bicyclist to take a position in front of motor vehicles at the intersection, which improves visibility and motorist awareness, and allows bicyclists to "claim the lane" if desired. Bike boxes aid bicyclists in making turning maneuvers at the intersection, and provide more queuing space for multiple bicyclists than that provided by a typical bicycle lane.

CONSIDERATIONS

In locations with high volumes of turning movements by bicyclists, a bicycle box should be used to allow bicyclists to shift towards the desired side of the travel way. Depending on the position of the bicycle lane, bicyclists can shift sides of the street to align themselves with vehicles making the same movement through the intersection.

In locations where motor vehicles can continue straight or cross through a right-side bicycle lane while turning right, the bicycle box allows bicyclists to move to the front of the traffic queue and make their movement first, minimizing conflicts with the turning vehicles. When a bicycle box is implemented in front of a vehicle lane that previously allowed right turn on red, the right turn on red movement must be restricted using signage and enforcement following installation of the bike box.



GUIDANCE

- Bicycle boxes are typically painted green and are a minimum of 10 feet in depth and are the width of the entire travel lane(s).
- Bicycle box design should be supplemented with appropriate signage according to the latest version of the California MUTCD.
- Bicycle box design should include appropriate signalization adjustment in determining the minimum green time if needed.
- Where right-turn lanes for motor vehicles exist, bicycle lanes should be designed to the left of the turn lane. If right turns on red are permitted, consider ending the bicycle box at the edge of the bicycle lane to allow motor vehicles to make this turning movement.

REFERENCES

NACTO Urban Bikeway Design Guide - Bike Boxes (2014)

FHWA Separated Bike Lane Planning and Design Guide (2015)

MassDOT Separated Bike Lane Planning & Design Guide (2015)

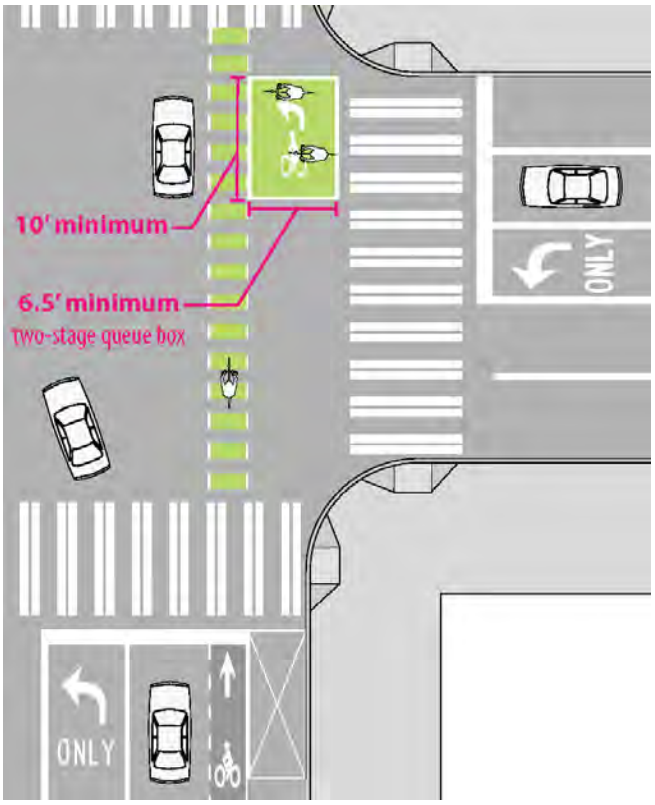
TWO-STAGE TURN QUEUE BOX

A two-stage turn queue box should be considered where bike lanes are continued up to an intersection and a protected intersection is not provided. The two-stage turn queue box designates a space for bicyclists to wait while performing a two-stage turn across a street at a location outside the path of traffic.

CONSIDERATIONS

FHWA granted interim approval to two-stage turn queue boxes on July 13, 2017.

Two-stage turn queue box dimensions will vary based on the street operating conditions, the presence or absence of a parking lane, traffic volumes and speeds, and available street space. The turn box may be placed in a variety of locations including in front of the pedestrian crossing (the crosswalk location may need to be adjusted), in a 'jug-handle' configuration within a sidewalk, or at the tail end of a parking lane or a median island.



GUIDANCE

- A minimum width of 10 feet is recommended.
- A minimum depth of 6.5 feet is recommended.
- Dashed bike lane extension markings may be used to indicate the path of travel across the intersection.
- NO TURN ON RED (R10-11) restrictions should be used to prevent vehicles from entering the queuing area.
- The use of a supplemental sign instructing bicyclists how to use the box is optional.
- The box should consist of a green box outlined with solid white lines supplemented with a bicycle symbol and a turn arrow to emphasize the crossing direction.
- Two-stage turn queue boxes should only be used at signalized intersections.

REFERENCES

NACTO Urban Bikeway Design Guide (2014)

MassDOT Separated Bike Lane Planning and Design Guide (2015)

FHWA Separated Bike Lane Planning and Design Guide (2015)

FHWA Bicycle Facilities and the Manual on Uniform Traffic Control Devices - Two-Stage Turn Box (2015)

MIXING ZONES

A mixing zone requires turning motorists to merge across a separated bike lane at a defined location in advance of an intersection. Unlike a standard bike lane, where a motorist can merge across at any point, a mixing zone design limits bicyclists' exposure to motor vehicles by defining a limited merge area for the turning motorist. Mixing zones are compatible only with one-way separated bike lanes.

CONSIDERATIONS

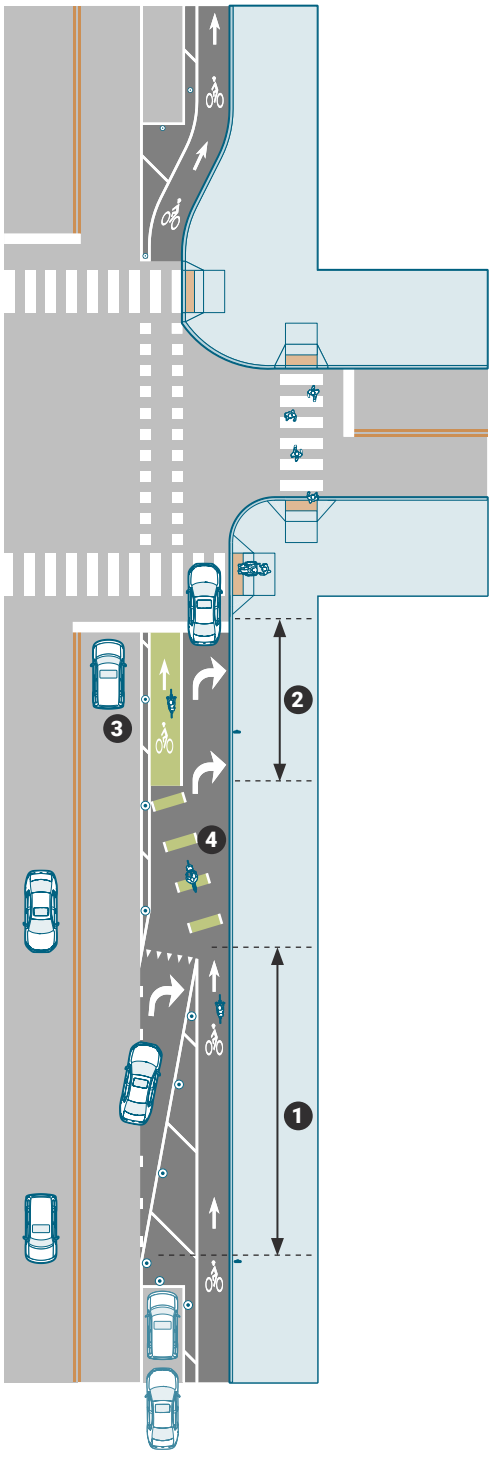
Protected intersections are preferable to mixing zones. Mixing zones are generally appropriate as an interim solution or in situations where severe right-of-way constraints make it infeasible to provide a protected intersection.

Mixing zones are only appropriate on street segments with one-way separated bike lanes. They are not appropriate for two-way separated bike lanes due to the contra-flow bicycle movement.

GUIDANCE

1. Locate merge points where the entering speeds of motor vehicles will be 20 mph or less by minimizing the length of the merge area and locating the merge point as close as practical to the intersection.
2. Minimize the length of the storage portion of the turn lane.
3. Provide a buffer and physical separation (e.g. flexible delineator posts) from the adjacent through lane after the merge area, if feasible.
4. Highlight the conflict area with green surface coloring and dashed bike lane markings, as necessary, or shared lane markings placed on a green box.

+ Provide a "Begin right (or left) turn lane yield to bikes" sign (R4-4) at the beginning of the merge area.
+ Restrict parking within the merge area.
+ At locations where raised separated bike lanes approach the intersection, the bike lane should transition to street elevation at the point where parking terminates.
+ Where posted speeds are 35 mph or higher, or at locations where it is necessary to provide storage for queued vehicles, it may be necessary to provide a deceleration/ storage lane in advance of the merge point.



REFERENCES

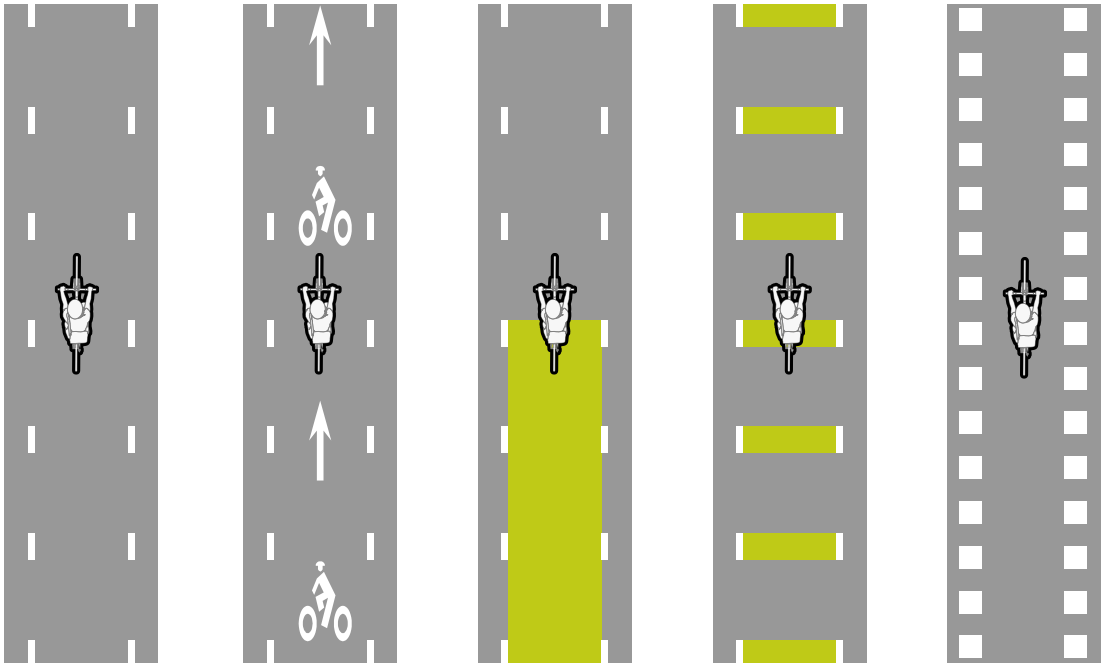
NACTO. *Urban Bikeway Design Guide. 2012.*

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

CONFLICT AREA MARKING

Conflict area markings are intersection pavement markings designed to improve visibility, alert all roadway users of expected behaviors, and to reduce conflicts with turning vehicles.



Dotted Line Extensions | **Line Extension w/ Markings** | **Colored Conflict Area** | **Colored Dash** | **Wide Dotted Line Extensions**

CONSIDERATIONS

+ The appropriate treatment for conflict areas can depend on the desired emphasis and visibility. Dotted lane lines may be sufficient for guiding bicyclists through intersections; however, consider providing enhanced markings with green pavement and/or symbols at complex intersections or at intersections with safety concerns.
+ Symbol placement within intersections should consider vehicle wheel paths and minimize maintenance needs associated with wheel wear.
+ Driveways with higher volumes may require additional pavement markings and signage.
+ Consideration should be given to using intersection conflict markings as spot treatments or standard intersection treatments. A corridor-wide treatment can maintain consistency; however, spot treatments can be used to highlight conflict locations.

GUIDANCE

+ The width of conflict area markings should be as wide as the bike lanes on either side of the intersection.
+ Dotted white lane lanes should conform to the latest edition of the California MUTCD. These markings can be used through different types of intersections based on engineering judgment.
+ Green pavement markings can be used along the length of a corridor or in select conflict locations. FHWA granted interim approval for green colored pavement for bike lanes in April of 2011.

REFERENCES

AASHTO Guide for the Development of Bicycle Facilities (2012)

NACTO Urban Bikeway Design Guide (2014)

California Manual on Uniform Traffic Control Devices (2014)

SEPARATED BIKE LANES AT INTERSECTIONS

Separated bicycle lanes provide an exclusive travel way for bicyclists alongside roadways that is separate from motor vehicle travel lanes, parking lanes, and sidewalks. Separated bike lane designs at intersections should manage conflicts with turning vehicles and increase visibility for all users.

CONSIDERATIONS

Separated bicycle lane designs at intersections should give consideration to signal operation and phasing in order to manage conflicts between turning vehicles and bicyclists. Bicycle signal heads also should be considered to separate conflicts.

Shared lane markings and/or colored pavement can supplement short dashed lines to demark the separated bike lane through intersections, where engineering judgment deems appropriate.

At non-signalized intersections, design treatments to increase visibility and safety include:

- Warning signs
- Raised intersections
- Special pavement markings (including colored surface treatment)
- Removal of parking prior to the intersection

GUIDANCE

- It is preferable to maintain the separation of the bike lane through the intersection rather than introduce the bicyclist into the street with a merge lane. Where this is not possible, see guidance on Mixing Zones.
- Increasing visibility and awareness are two key design goals for separated bike lanes at intersections. In some cases, parking restrictions between 20' to 40' are needed to ensure the visibility of bicyclists at intersections.
- Separated bike lanes should typically be routed behind transit stops (i.e., the transit stop should be between the bike lane and motor vehicle travel lanes). If this is not feasible, the separated bike lane should be designed to include treatments such as signage and pavement markings to alert the bicyclist to stop for buses and pedestrians accessing transit stops.
- Markings and signage should be used at intersections to give priority to separated bicycle lanes.
- For guidance regarding separated bike lanes at transit stops, refer to the AC Transit Multimodal Corridor Design Guidelines.

REFERENCES

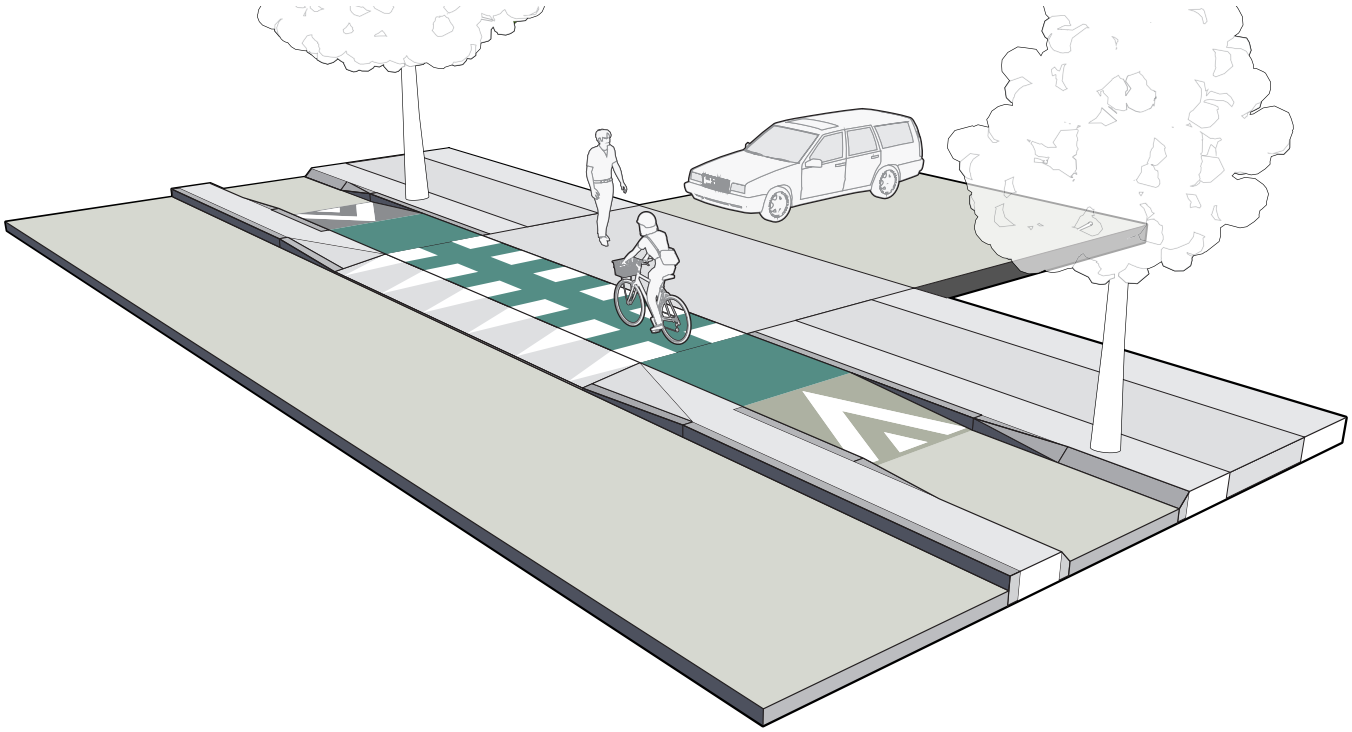
Bicycle Facilities and the Manual on Uniform Traffic Control Devices

NACTO Urban Bikeway Design Guide. 2012.

FHWA Separated Bike Lane Planning and Design Guide. 2015.

SEPARATED BIKE LANES AT DRIVEWAYS

Most bicycle facilities will need to cross streets, driveways, or alleys at multiple locations along a corridor. At these locations, the crossings should be designed to 1) delineate a preferred path for people bicycling through the intersection with the driveway and 2) to encourage driver yielding behavior, where applicable. Bicycle crossings may be supplemented with green pavement, yield lines, and/or regulatory signs.



CONSIDERATIONS

- Supplemental yield lines, otherwise known as shark's teeth, can be used to indicate priority for people bicycling and may be used in advance of unsignalized crossings at driveways, at signalized intersections where motorists may turn across a bicycle crossing during a concurrent phase, and in advance of bicycle crossings located within roundabouts.
- Raised bicycle crossings further promote driver yielding behavior by slowing their speed before the crossing and increasing visibility of people bicycling.

GUIDANCE

- The bicycle crossing may be bounded by 12-inch (perpendicular) and 24-inch (parallel) white pavement dashes, otherwise known as elephant's feet. Spacing for these markings should be coordinated with zebra, continental, or ladder striping of the adjacent crosswalk.
- The bicycle crossing should be at least 6 feet wide for one-way travel and at least 10 feet wide for two-way travel, as measured from the outer edge of the elephant's feet. Bicycle lane symbol markings should be avoided in bicycle crossings. Directional arrows are preferred within two-way bicycle crossings.
- Dashed green colored pavement may be utilized within the bicycle crossing to increase the conspicuity of the crossing where permitted conflicts occur. Green color may be desirable at crossings where concurrent vehicle crossing movements are allowed and where sightlines are constrained, or where motor vehicle turning speeds exceed 10 mph.

REFERENCES

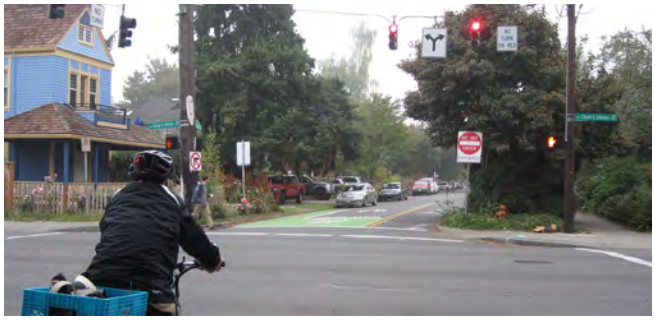
MassDOT Separated Bike Lane Planning and Design Guide (2015)

FHWA Separated Bike Lane Planning and Design Guide (2015)

ENHANCEMENTS AND SUPPORTING TREATMENTS FOR BICYCLE FACILITIES

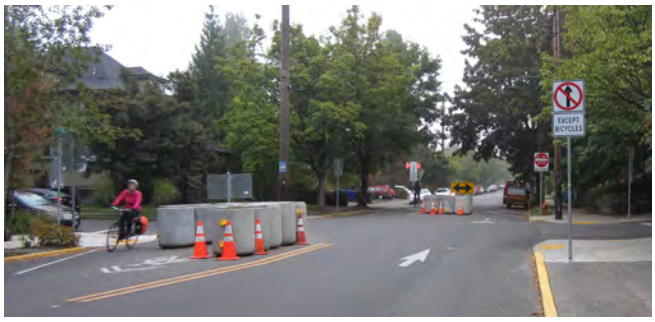
TRAFFIC DIVERSION

Traffic diversion strategies are part of traffic calming and are used to reroute traffic from a bicycle boulevard or other intentionally low-traffic streets onto other adjacent streets by installing design treatments that allow access by bicyclists and pedestrians but restrict motorized traffic from passing through.



Partial closure - permanent, signalized

Diagonal diverter



Partial closure - interim, stop-control

Full closure

CONSIDERATIONS

- Diverting motor vehicle traffic onto adjacent streets requires considering and addressing potential changes in traffic volume on other local streets during the planning, design and evaluation process.
- Other traffic calming tools should be explored for their effectiveness before implementing traffic diversion measures. In suburban contexts and other neighborhoods where the street network is not a traditional grid, the impacts of diversion to the larger street network will be greater, due to the inability of traffic to easily disperse and find alternate routes.
- Temporary materials may be used to test diversion impacts before permanent, curbed diverters are installed.
- Consultation with emergency services will be necessary to understand their routing needs.
- Traffic diversion requires community support from the surrounding neighborhood.

GUIDANCE

- Preferred motor vehicle volumes for bicycle boulevards are in the range of 1,000 to 1,500 per day, while up to 3,000 automobiles is acceptable.
- Diversion devices must be designed to provide a minimum clear width of 6 feet for a bicyclist to pass through.
- Some treatments may require a separate pedestrian accommodation.

REFERENCES

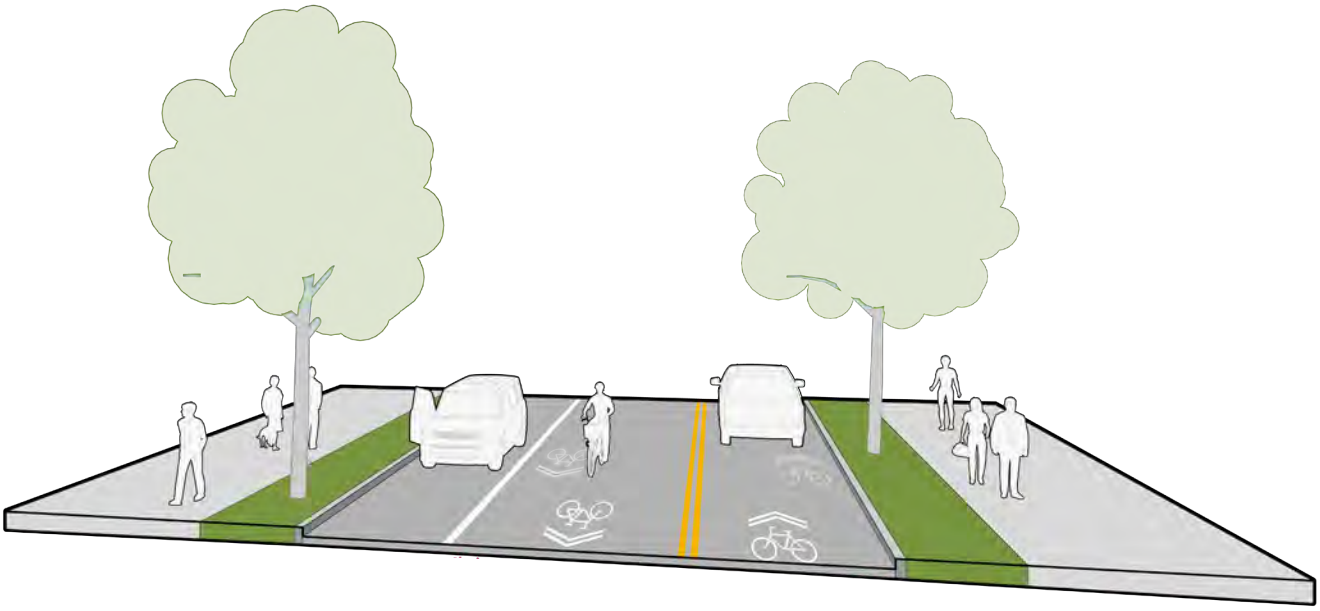
Fundamentals of Bicycle Boulevard Planning & Design (2009)

NACTO Urban Bikeway Design Guide (2014)

Portland's Neighborhood Greenway Assessment Report (2015)

SHARED LANE MARKINGS

Shared lane markings (or "sharrows") are pavement markings that denote shared bicycle and motor vehicle travel lanes. The markings are two chevrons positioned above a bicycle symbol, placed where the bicyclist is anticipated to operate. In general, this is a design solution that should only be used in locations with low traffic speeds and volumes as part of a signed route or bicycle boulevard. Shared lane markings are sometimes used as a temporary solution on constrained, higher-traffic streets (up to 10,000 vehicles per day) until additional right-of-way can be acquired, but should not be considered a permanent solution in these contexts.



CONSIDERATIONS

- Typically used on local, collector, or minor arterial streets with low traffic volumes. Commonly used on bicycle boulevards to reinforce the priority for bicyclists.
- Typically feasible within existing right-of-way and pavement width even in constrained situations that preclude dedicated facilities.
- May be used as interim treatments to fill gaps between bike lanes or other dedicated facilities for short segments where there are space constraints.
- May be used for downhill bicycle travel in conjunction with climbing lanes intended for uphill travel.
- Typically supplemented by signs, especially Bikes May Use Full Lane (R4-11).

GUIDANCE

- Intended for use only on streets with posted speed limits of up to 25 mph and traffic volumes of less than 4,000 vehicles per day. Maximum posted speed of street: 35 mph.
- May be used as a temporary solution on constrained streets with up to 10,000 vehicles per day until a more appropriate bikeway facility can be implemented. Maximum posted speed of street: 35 mph.
- Intended for use on lanes up to 14 feet wide (up to 13 feet preferred). For lanes 15 feet wide or greater, stripe a 4-foot bike lane instead of using shared lane markings.
- The marking's centerline must be at least 4 feet from curb or edge of pavement where parking is prohibited.
- The marking's centerline must be at least 11 feet from curb where parking is permitted, so that it is outside the door zone of parked vehicles.
- For narrow lanes (11 feet or less), it may be desirable to center shared lane markings along the centerline of the outside travel lane.

REFERENCES

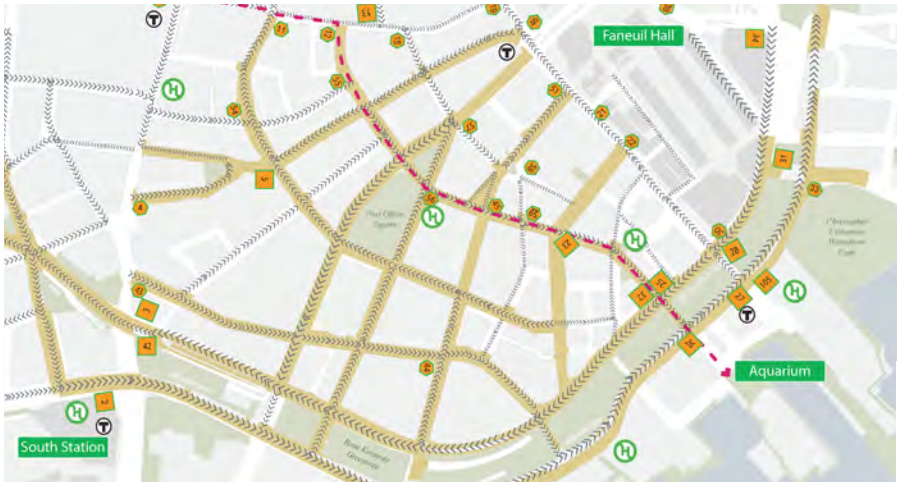
AASHTO Guide for the Development of Bicycle Facilities (2012)

NACTO Urban Bikeway Design Guide (2014)

California Manual on Uniform Traffic Control Devices (2014)

BICYCLE ROUTING / WAYFINDING

Wayfinding is a highly visible way to improve bicycling in an area because it helps identify the best routes to destinations, helps people overcome a barrier of not knowing where to ride, and reminds motorists to anticipate the presence of bicyclists. A wayfinding system typically combines signage and pavement markings to guide bicyclists along preferred routes to destinations across the community, county, or region. The routes may or may not be numbered, named, or color-coded. Signs may also indicate distances or travel time to destinations. Similar wayfinding systems can be devised for pedestrian travel.



D11-1

D1-3c

CONSIDERATIONS

A bicycle wayfinding protocol should coordinate with bicycle route maps and provide three general forms of guidance:

- Decision assemblies, which consist of Bike Route identification and optional destination fingerboards, placed at decision points where routes intersect or on the approaches to a designated bike route.
- Decision signs, which consist of Bike Route panels and arrow plaques, placed where a designated bike route turns from one street to another.
- Confirmation assemblies, which consist of Bike Route panels and optional destination fingerboards, placed on the far side of intersections to confirm route choice and the distance (and optionally, time) to destinations.

Sign design can be customized to add distinct community branding, but the clarity and accuracy of the information must be the top priority.

GUIDANCE

- Basic bicycle route signs consist of a MUTCD-style "Bike Route" sign (D11-1 shown above) placed every half mile on a major bike route and on the approach to major bike routes at decision points. Unique numbered routes can be designated and can incorporate a route name or agency logos.
- Bike route signs can be supplemented with "fingerboard" panels showing destinations, directions, and distances (MUTCD D1 series).
- Place directional signs on the near side of intersections and confirmation signs on the far side of intersections.

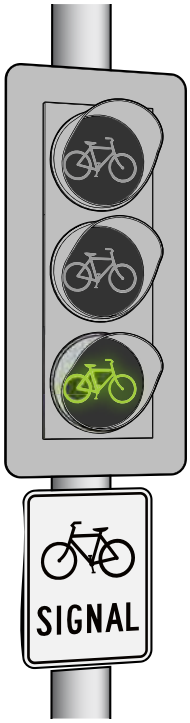
REFERENCES

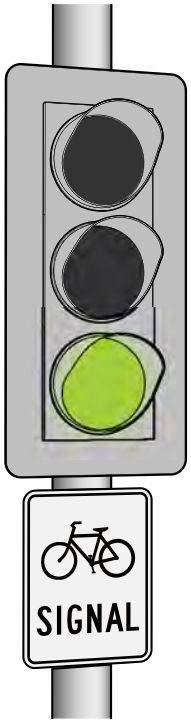
NACTO Urban Bikeway Design Guide (2014)

California Manual on Uniform Traffic Control Devices (2014)

BICYCLE SIGNALS, DETECTION, ACTUATION

Bicyclists have unique needs at signalized intersections. Bicycle movements may be controlled by the same indications that control motor vehicle movements, by pedestrian signals, or by bicycle-specific traffic signals. The introduction of separated bike lanes creates situations that may require leading or protected phases for bicycle traffic, or place bicyclists outside the cone of vision of existing signal equipment. In these situations, provision of signals for bicycle traffic will be required.





CONSIDERATIONS

- Bicycle-specific signals may be appropriate to provide additional guidance or separate phasing for bicyclists per the 2012 AASHTO Guide for the Development of Bicycle Facilities.
- It may be desirable to install advanced bicycle detection on the intersection approach to extend the phase, or to prompt the phase and allow for continuous bicycle through movements.
- Video detection, microwave and infrared detection can be an alternate to loop detectors.
- Another strategy in signal timing is coordinating signals to provide a "green wave", such that bicycles will receive a green indication and not be required to stop. Several cities including Portland, OR and San Francisco, CA have implemented "green waves" for bicycles.

GUIDANCE

- A stationary, or "standing", cyclist entering the intersection at the beginning of the green indication can typically be accommodated by increasing the minimum green time on an approach per the 2012 AASHTO Guide for the Development of Bicycle Facilities.
- A moving, or "rolling", bicyclist approaching the intersection towards the end of the phase can typically be accommodated by increases to the red times (change and clearance intervals) per the 2012 AASHTO Guide for the Development of Bicycle Facilities.
- Set loop detectors to the highest sensitivity level possible without detecting vehicles in adjacent lanes and field check. Type D and type Q loops are preferred for detecting bicyclists.
- Install bicycle detector pavement markings and signs per the MUTCD, 2012 AASHTO Guide for the Development of Bicycle Facilities, and the NACTO Urban Bikeway Design Guide.
- FHWA granted interim approval for bicycle signal faces in December of 2013.

REFERENCES

AASHTO Guide for the Development of Bicycle Facilities. 2012.

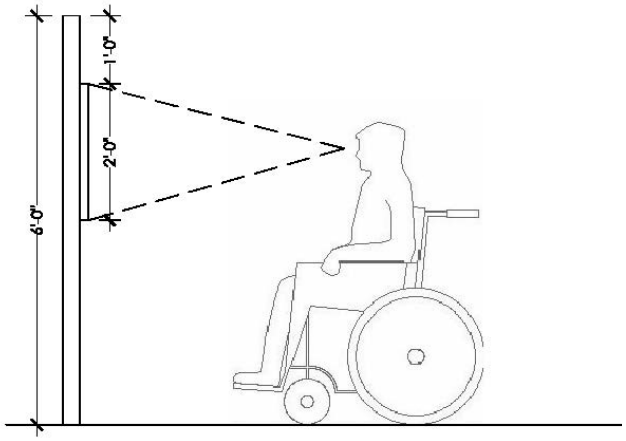
NACTO Urban Bikeway Design Guide. 2012.

Manual on Uniform Traffic Control Devices. 2009.

TRAILHEADS

Trailheads, parking areas, and rest stops provide access to the bikeway network, encourage more use of the paths and bikeways, and provide meeting and parking locations for groups. The number and type of amenities provided at a trailhead, parking area, or rest stop should be based on the number of users of the path or bikeway and the relative ease of finding services nearby.

Arapahoe Road Trailhead with amenities



Provide kiosk information at an appropriate height for all users

CONSIDERATIONS

- The number and types of amenities provided depends on the number of users of the facility, amenities and services available nearby, and the type of user.
- Trailheads located in a county, regional, or state park should provide a higher number of amenities because they serve more than just path users.
- Trailheads are best located adjacent to a main roadway system.
- They should also be spaced along a major trail to pick up users and traffic from various surrounding communities as well as connect users to other facilities and amenities through the trail system.
- Trailhead amenities may include: restroom (either plumbed, vault, or San-o-let), potable water (for people and dogs), bike racks, a DIY bike service station, picnic tables, benches, small playground, and parking area. Based on the type of user and the volume of use at each trailhead, consider any or all of the above amenities.

GUIDANCE

- All rest stops should be designed for accessibility according to the ADA.
- At a minimum, provide a trailhead at each path terminus.
- Preferred trailhead frequency would include all path intersections with major roadways or other major paths, where the path traverses a business district, or every 10 miles.
- The number of users at each trailhead will lead to decisions about including restrooms, potable water, picnic areas, and parking.
- Consider installing a counter to determine the volume of trail traffic at various days and times.
- Plan for expansion at trailheads. Design that allows for future expansion allows for easy modifications without detriment to the existing facilities.
- Map kiosks should be sited and placed so that the information is visible to someone in a wheelchair.
- Place map kiosks and seating areas a minimum of 5 feet off the path, to prevent people from blocking the path.

REST STOPS

Rest stops along major trails improve the comfort of the trail for users. In particular, active adults (65 and older) and families with young children need frequent breaks during their trail experience. Ideal locations for a rest stop include: landmarks, areas with good views, areas with substantial shade, areas at the top of a steep incline, or areas where users access other amenities.

Rest stop along Richmil Ranch Trail

Rest stop along the Centennial Link Trail at East Caley Avenue and South Steele Street with benches, shade, and trash receptacles

CONSIDERATIONS

- All rest stops should be designed for accessibility according to the current ADA.
- Active adults (65 years and older) need at least 2 hours and 30 minutes of moderate intensity aerobic activity a week (like brisk walking) according to the Centers for Disease Control and Prevention. Path networks provide an easy opportunity to achieve this requirement.
- Multi-use paths that provide regular rest stops and other amenities increase the likelihood of frequent use.
- Amenities at rest stops may include one or more benches, picnic tables with shade, trash receptacles, restrooms, access to interpretive or wayfinding signage, waste receptacles, and/or potable water. The site, the path route, and existing adjacent amenities all may be factors when deciding which amenities to include.
- Trailheads, parking areas, and especially rest stops are great opportunities for corporate sponsorship, donations, and "adoption" by clubs or other organizations. Public agencies would likely acquire the land and oversee construction, whereas businesses and non-profits could donate funds to purchase the amenities.

GUIDANCE

- At a minimum, locate rest stops on paths at parks and at intersections with major roadways or other paths.
- Preferred placement of rest stops would include intermediate locations along paths and on-road bikeways as well.
- In areas with more pedestrians or high use by active adults or families with young children, rest stops can be provided every 1 to 2 miles.
- In more remote areas on paths or on-road bikeways, they can be spaced at 3 to 5 miles.

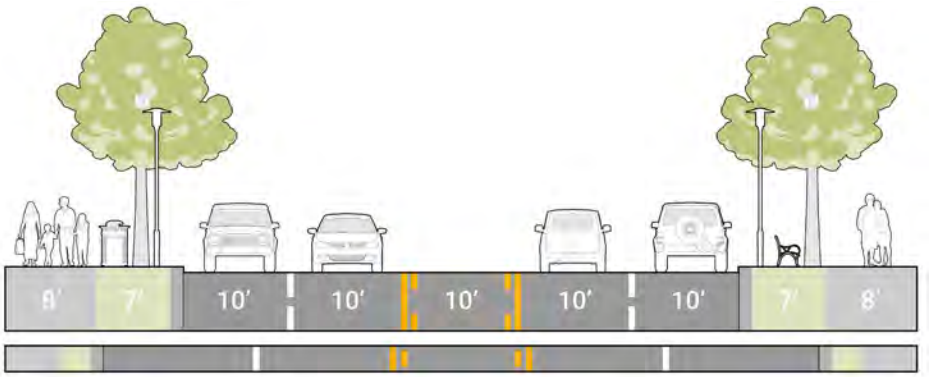
ADDITIONAL CONSIDERATIONS

LANE NARROWING

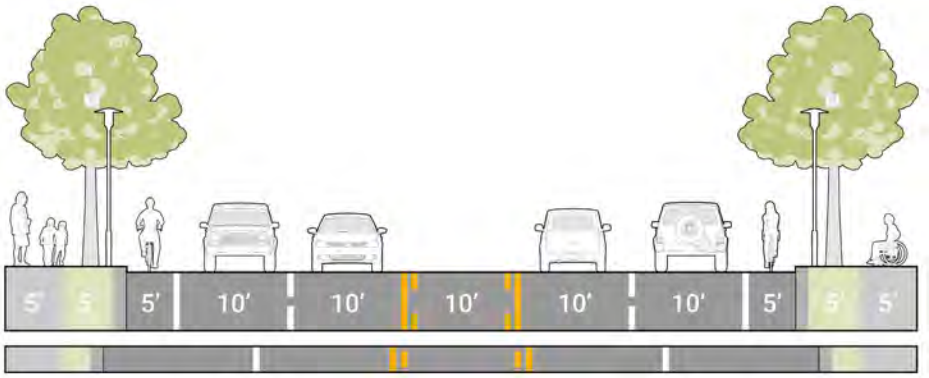
Lane narrowing can improve comfort and safety for vulnerable road users. Narrowing lanes creates space that can be reallocated to other modes, in the form of wider shoulders, sidewalks, bike lanes, and buffers between cyclists, pedestrians and motor vehicles. Space can also be dedicated to plantings and amenity zones, and reduces crossing distances at intersections.

Roadway Before Narrowing

Narrowing Motor Vehicle Lanes to increase Sidewalk and Amenity Zones



Narrowing Motor Vehicle Lanes to increase Amenity Zone and add Bicycle Lanes



CONSIDERATIONS

+ Narrowing existing motor vehicle lanes may result in enough space to create separated bicycle lanes, widened shoulders, sidewalks, and buffers, or a combination of on-street bike lanes and enhancements to the pedestrian corridor.
+ Narrower lanes can contribute to lower operating speeds along the roadway, which may be appropriate in dense, walkable corridors.
+ Ensure support from local emergency service providers before narrowing lanes

GUIDANCE

+ Motor vehicle travel lanes as narrow as 10 feet are allowed in low-speed environments (45 mph or less) according to the AASHTO Green Book.
+ 10-foot travel lanes are not appropriate on 4-lane undivided arterial roadways.

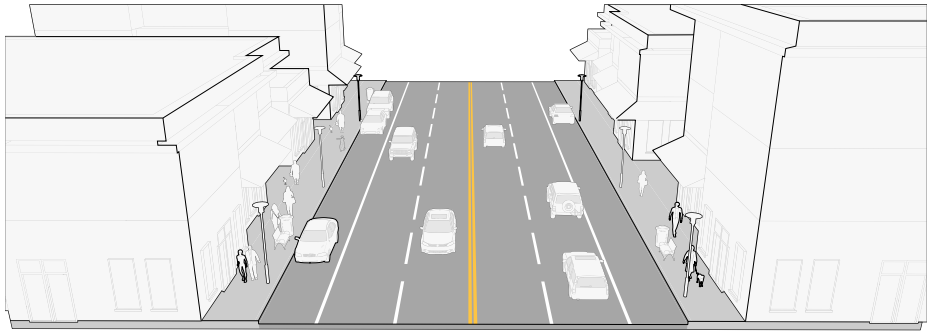
REFERENCES

FHWA Achieving Multi-modal Networks: Applying Design Flexibility and Reducing Conflicts. 2016.

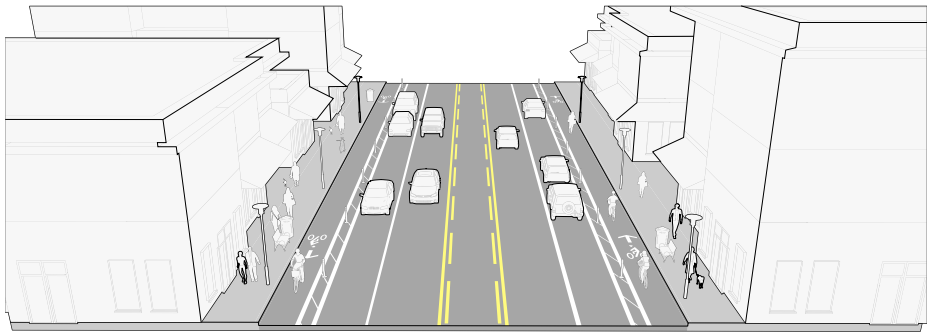
AASHTO Green Book. 2011.

LANE RECONFIGURATION

The reconfiguration of one or more travel lanes to calm traffic and provide space for bicycle lanes, turn lanes, streetscapes, wider sidewalks, and other purposes is called a road diet. Four- to three-lane conversions are the most common type of road diet, however, there are numerous types (e.g., three- to two-lanes, or five- to three-lanes).



Typical 4-lane road with on-street parking



Three-lane road diet (with center two-way left-turn lane), with on-street parking and separated bicycle lanes

CONSIDERATIONS

Lane reconfigurations are a great tool for reducing collisions and injuries, improving pedestrian crossings and providing designated space for bicyclists. They can improve safety and efficiency for people driving, bicycling, and walking, as they reduce conflict points and lead to fewer and less severe collisions.

Lane reconfigurations are possible under the following capacities:

- 3 lane road (one through lane in each direction with a center turn lane): 15,000 or fewer ADT
- 3 lane road (one through lane in each direction with a center turn lane): 20,000 or fewer ADT, traffic study suggested
- 5 lane road (two through lanes in each direction with a center turn lane): 35,000 or fewer ADT, traffic study suggested
- 7 lane road (three through lanes in each direction with a center turn lane): 50,000 or fewer ADT, traffic study suggested

GUIDANCE

Lanes greater than 11 feet in width should not be used as they may encourage higher speeds.

The following lane widths are recommended for each lane type:

- 10 foot wide travel lanes (11 feet for the curb lane is acceptable when on a designated truck or bus route)
- 7-9 foot wide parking lanes

REFERENCES

FHWA Road Diet Guide. 2014.

NACTO Urban Street Design Guide .2013.

Dr. Ata M. Kahn, P.E., ITE Journal, Washington, D.C.

MAINTENANCE OF MULTI-USE PATHS

Once constructed, multi-use paths require regular maintenance to ensure a safe and usable experience for the life of the path system.

CONSIDERATIONS

- The width of the path should allow maintenance vehicles to travel along and provide areas where they may turn around.
- The pavement section should also provide enough stability to prevent substantial wear and cracking with regular maintenance vehicle traffic. Typically, 6-inch thick concrete or asphalt provides stability to withstand maintenance traffic.
- Regular sweeping and trash removal of multi-use paths enhance the user experience and minimize opportunities for conflict or injury.
- Provide surface repairs such as crack repair, concrete stone replacement, and/or joint sealing as soon as the issue is identified. These problems grow worse over time and can continue to provide opportunity for conflict or injury.
- Cut back vegetation that is encroaching on multi-use paths. Cut back tree roots and/or install root barriers where appropriate.
- Cut back vegetation that is encroaching on signage along the path systems.
- Inspect signs and markings regularly, replacing and repairing them as soon as possible. Consider upgrading old signs or markings with newer materials, if available.
- Ensure drainage swales and structures are kept free of silt and debris and are functioning appropriately.
- For any construction project that may impact an existing multi-use path, an appropriate detour and signage plan should be proposed by the contractor to ensure continuous and safe service of the multi-use paths.
- Check, repair, and maintain all lights and lighting systems, particularly underpass lighting.
- Natural surface paths may need regrading, weeding, or the repair of ruts.

Mown shoulders

High Line Canal Trail - a crusher fines path free of ruts and weeds

MAINTENANCE OF SEPARATED BIKE LANES

Separated bike lanes require routine maintenance to ensure they provide safe bicycling conditions. Because of their location on the edge of the roadway, separated bike lanes are more likely to accumulate debris. As bicyclists are typically inhibited from exiting separated bike lanes, they may have no opportunity to avoid obstacles such as debris, obstructions, slippery surfaces, and pavement damage and defects.

CONSIDERATIONS

A separated bike lane should be maintained in a similar manner as the adjacent roadway, regardless of whether the separated bike lane is at street level or sidewalk level. Maintenance of separated bike lanes is therefore the responsibility of the public or private agency that is responsible for maintaining the adjacent roadway. This practice may contrast with responsibility for maintaining the adjacent sidewalk, which in some cases will be that of the abutting landowner.

Generally, separated bike lane widths of 8 feet or more are compatible with smaller sweepers, but responsible parties may have larger and incompatible maintenance fleets. Narrower sweepers (approximately 4 feet to 5 feet minimum operating width) may be required to clear one-way separated bike lanes.

Trash Collection

Where separated bike lanes are introduced, the general public, public works staff and contractors should be trained to place garbage bins in the street buffer zone to avoid obstructing the bike lane. Sidewalk buffers may be used to store bins where street buffers are too narrow. Special consideration may be required in separated bike lane design for access to large dumpsters which require the use of automated arms. This may require spot restrictions of on-street parking or curb cuts to dumpster storage in order to accommodate access.

Sweeping and Debris Removal

For street-level separated bike lanes without raised medians, debris can collect in the street buffer area between vertical objects and can migrate into the bike lane if not routinely collected. Landscaped areas, including green stormwater infrastructure, can also collect debris and require regular attention. Fine debris can settle into permeable pavement and inhibit surface infiltration unless vacuumed on a routine basis. At a minimum, permeable pavement should be vacuumed several times per year, depending on material type.

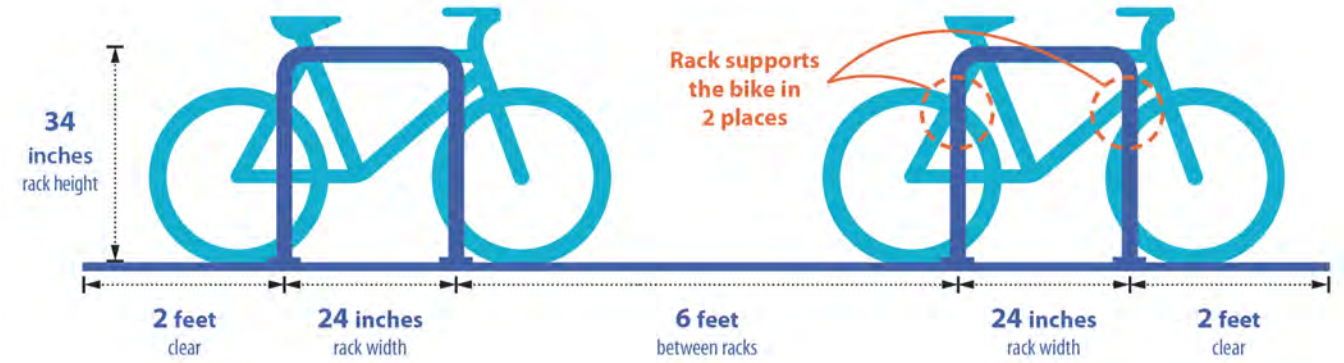
REFERENCES

NACTO Urban Street Design Guide (2013)

MassDOT Separated Bicycle Lane Planning & Design (2015)

SHORT-TERM BICYCLE PARKING

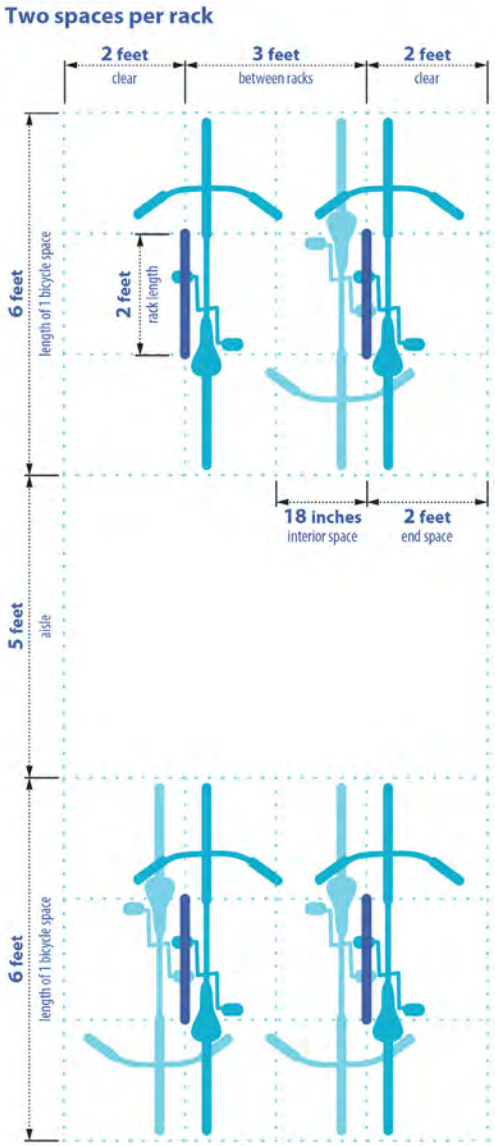
Bicycle parking enhances the effectiveness of bicycle networks by providing locations for the secure storage of bicycles during a trip. Bicycle parking enables bicyclists to secure their bicycles while patronizing businesses, recreating, and going to work. Bicycle parking requires far less space than automobile parking-- in fact, 10 bicycles can typically park in the area needed for a single car.



CONSIDERATIONS

Bicycle parking consists of a rack that supports the bicycle upright and provides a secure place for locking. Bicycle racks should be permanently affixed to a paved surface. Movable bicycle racks are only appropriate for temporary use, such as at major community gatherings.

On-street bicycle parking is intended for short term use.



GUIDANCE

- Bicycle parking facility should not obstruct pedestrian traffic or interfering with the use of the pedestrian areas.
- Each parked bicycle should be accessible without moving another bicycle.
- Any sidewalk rack that is parallel to the curb should be located 2 feet from the curb face.
- Any sidewalk rack aligned perpendicular to the curb should be located so that the nearest vertical component of the rack is a minimum of 4 feet from the curb.

REFERENCES

NACTO Urban Street Design Guide. 2013.

Manual on Uniform Traffic Control Devices. 2009.

LONG-TERM BICYCLE PARKING

Long-term bicycle parking is intended to provide sheltered and secure bicycle storage for residents, employees and long-term visitors who are leaving their bicycles in a residential or commercial building for several hours or longer and therefore need their bicycles to be protected from vandalism, theft and the elements.

CONSIDERATIONS

A bicycle locker is a secure, locked box that stores a single bicycle and provides:

+ Highly secure bicycle storage in an enclosed box.
+ Direct or indirect access to the street or sidewalk depending on whether it is located in a parking garage or at street level.
+ Varying amount of conflict with automobiles depending on whether it is located in a parking garage or at street level.
+ Electronic bicycle lockers allow for greater capacity and perforated lockers are preferred as they provide greater safety and security.

GUIDANCE

Lockers should be:

+ Clearly marked as a long-term bicycle parking space
+ Located no lower than the first complete parking level below grade, and no higher than the first complete parking level above grade
+ Available and accessible to all building tenants during the buildings hours of operation and at all times for residents in residential contexts
+ Located in a well-lit, visible location near the main entrance or elevators
+ Separated from vehicle parking by a barrier that minimizes the possibility of a parked bicycle being hit by a car
+ Securely anchored
+ Well-maintained and well-lit

REFERENCES

NACTO Urban Street Design Guide. 2013.

Manual on Uniform Traffic Control Devices. 2009.

TOOLE
DESIGN