Appendix B – Design Standards for Class I, II, and III Bikeways

Introduction

The bicycle design guidelines presented in this section are intended to provide guidance to staff, policy makers, developers, and the public for the development, retrofit, and maintenance of bicycle facilities in Napa County. The guidelines are a combination of the minimum bicycle facility standards defined in Chapter 1000 of the Caltrans *Highway Design Manual* (HDM) and the *California Manual on Uniform Traffic Control Devices* (CA MUTCD), along with recommended standards contained in the American Association of State Highway and Transportation Officials' (AASHTO) *Guide for the Development of Bicycle Facilities*. Standards and guidelines from these resources have been assembled to improve the quality of consistency of Napa's countywide bikeway system. In addition to the standardized treatments, there are several creative solutions drawn from 'best practices' used in other locations throughout the state and nation that provide promising results, but remain experimental at this time. While 'best practice' or non-standard features have been identified at the request of the BAC, it should be noted that implementation of non-standard treatments should be done under the guidance and permission of State and Federal authorities.

The following resources, which provide detailed design guidance for the development of bikeways and bicycle parking facilities, are recommended to supplement the design information presented below.

- *NACTO Urban Bikeway Design Guide*, National Association of City Transportation Officials, 2011 http://nacto.org/cities-for-cycling/design-guide/

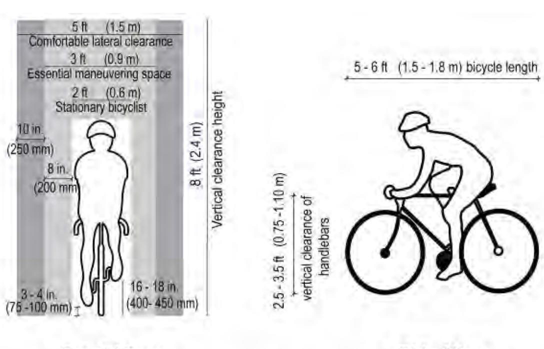
- *APBP Bicycle Parking Guidelines*, 2nd Edition, Association of Pedestrian and Bicycle Professionals, 2010 http://www.apbp.org/?page=Publications

Bicycle Characteristics

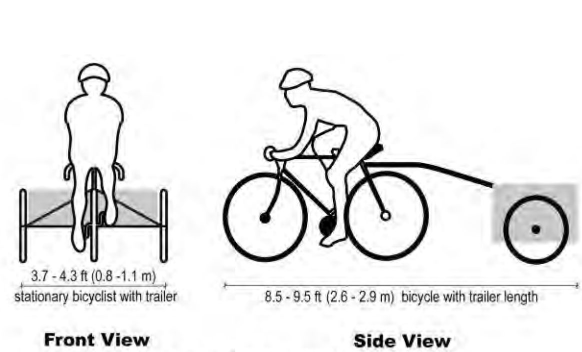
To understand the needs of bicyclists, and help encourage and accommodate safe bicycling within the plan area, it is important to have an understanding of the dimensions of typical bicycles as well as the operational characteristics of bicyclists. These design factors are critical in planning and designing both on-road and off-road bicycle facilities.

Horizontal Clearance

The images below show the dimensions and operating space of a typical bicyclist. The width of a stationary bicyclist is approximately 2.0 feet, and a moving bicyclist generally requires a 3.0-foot operating envelope in order to maintain their balance. To ride comfortably and avoid fixed objects (curbs, potholes, debris, automobiles, etc.) as well as other facility users including bicyclists, pedestrians, strollers, or in-line skaters, a bicyclist requires an operating envelope of five feet. If space is restricted, such as in a tunnel or on a bridge,



Source: Minnesota Department of Transportation



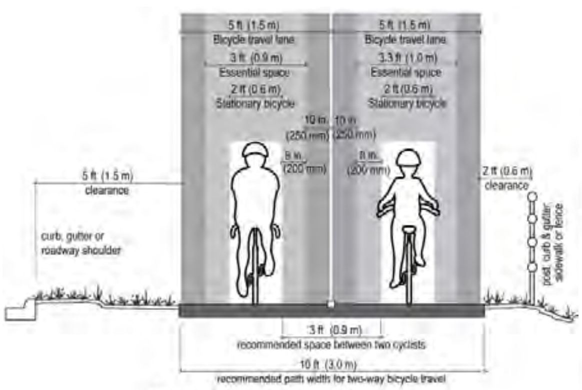
Source: Minnesota Department of Transportation ten feet of horizontal clearance is recommended to allow two opposing bicyclists enough space to pass each other comfortably. On pathways, more width may be needed to allow bicyclists to react to unexpected maneuvers of another bicyclist or other user types such as in-line skaters, persons with pets, etc. Given the popularity of multi-use pathways, other users and their dimensions and operational characteristics should be considered in addition to typical bicyclists when designing these facilities.

Vertical Clearance

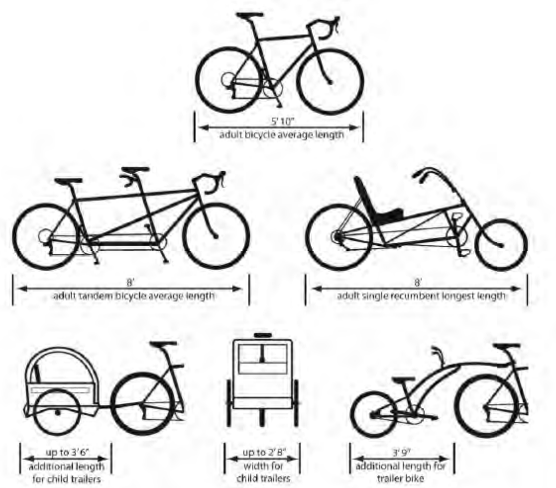
A bicyclist's vertical design height is eight feet. While even the tallest bicyclists would not be expected to reach this height when riding a bicycle; however, vertical clearance is essential to allow sufficient space for bicyclists pedaling upright or passing under an overpass. To accommodate maintenance and/or emergency vehicles in underpasses and tunnels, and to allow for overhead signing vertical clearance should be a minimum of ten feet.

Travel Speeds

An average bicyclist travels at a rate of speed between 12 and 19 mph. Advanced bicyclists and can maintain speeds of 20 mph or better on flat terrain in windless conditions. On descents, bicyclists can reach speeds 30 mph or greater.



Source: Minnesota Department of Transportation



Bicycle Facility Design Standards

According to Caltrans, the term "bikeway" encompasses all facilities that provide primarily for bicycle travel. The three standard classes include:

- Class I Bike Path
- Class II Bike Lanes
- Class III Bike Routes

Class I Bikeway

The following section includes recommended design standards and best practice information for Class I bikeways:

- Rails with Trails
- Rails-to-trails
- Under-crossings

- Rivers with Trails
- Mid-block Crossing

Typically called a "bike path" or "multi-use path," a Class I bikeway provides for bicycle travel on a paved right-of-way completely separated from any street or highway. The recommended design width of a Class I path is dependent upon anticipated usage:

- 8 feet (2.4 m) is the minimum width for Class I facilities;
- 10 feet (3.0 m) is the recommended minimum width for a typical two-way Class I path; and
- 12 feet (3.6 m) is the preferred minimum width, if heavy mixed bicycle and pedestrian use is anticipated

Typically, 25 feet of right-of-way is preferred to accommodate a Class I bikeway, including the pathway surface, required shoulders, signage, amenities, landscaping, and offsets. However, pathway implementation can be achieved in constrained corridors of 15 feet or less where necessary.

Guidelines:

1. Paths should be constructed with adequate sub grade compaction to minimize cracking and sinking (stabilization fabric is recommended), and should be designed to accommodate appropriate loadings, including maintenance trucks and emergency vehicles.

2. A minimum 2-foot wide graded area must be provided adjacent to the path to provide clearance from trees, poles, walls, guardrails, etc. Wider shoulders on one or both sides of the path are recommended where feasible to accommodate pedestrians and help reduce pathway conflicts.

3. A 2% cross slope shall be provided to ensure proper drainage.

4. A yellow centerline stripe is recommended to separate travel in opposite directions.

5. Pathway lighting should be provided where commuters will be expected during dark or nighttime hours.

6. Pathway/roadway intersections require engineering review to ensure appropriate safety features are incorporated. Pathways that cross roadways with average traffic volumes of 20,000 vehicles per day or greater generally require signalization or grade separation.

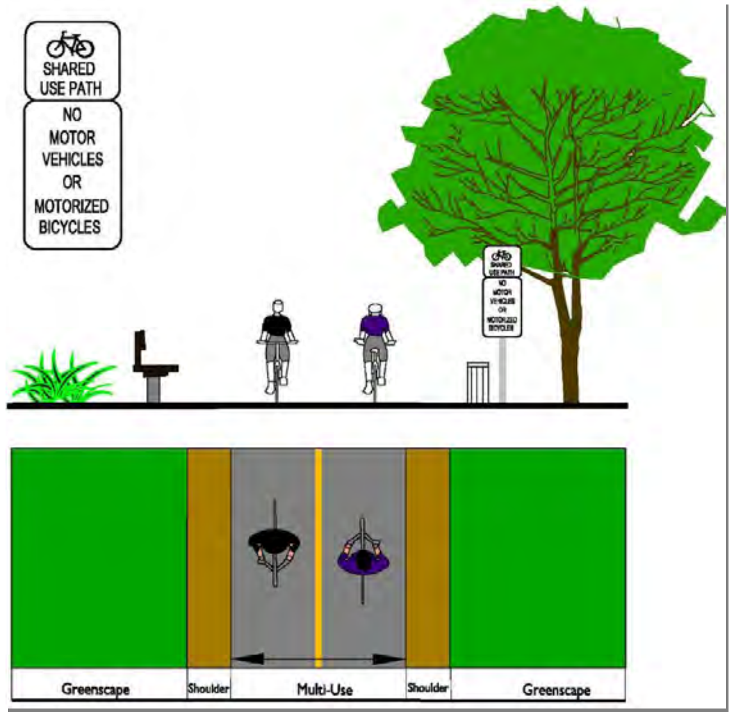
7. Landscaping should generally be low water consuming native vegetation. Vegetation that produces minimal debris is recommended to reduce maintenance needs.

8. Barriers at pathway entrances (bollards, gates, etc.) should be clearly marked with reflectors and be ADA accessible (minimum five feet clearance).

9. Bridges and/or other structures should be designed to accommodate appropriate vehicle loadings. The width of structures should be the same as the approaching trail width, plus minimum two-foot wide clear areas.

10. To minimize potential conflicts, pedestrian traffic should be directed to the right side of pathway with signing and/or stenciling.

11. Staging areas and/or trailhead parking including restrooms, drinking fountains, and secure bicycle parking should be provided at appropriate locations.



<u>Class I Bike Path: Rail-with-Trail</u>

Rail with trail (RWT) describes any shared use path or trail located on or directly adjacent to an active railroad corridor. No national standards or guidelines dictate RWT facility design. Therefore design guidance is pieced together from existing standards for Class I bikeways, railroad requirements, and pedestrian, road and highway design resources. In order to achieve safe and attractive designs, it is important for trail designers to work closely with railroad planning, operations, and maintenance staff.

General Design Guidelines:

1. RWT designers should maximize the setback between any RWT and active railroad track. The setback distance between a track centerline and the closest edge of the RWT should correlate to the type, speed, and frequency of train operations, as well as the topographic conditions and separation techniques.

2. Subject to railroad and State and Federal guidelines and the advice of engineering and safety experts, exceptions to the recommended setbacks may include:

   a. Constrained areas (bridges, cut and fill areas)
   b. Low speed and low frequency train operations

   In these cases and in areas with a history of extensive trespassing, fencing or other separation technique is recommended.

3. When on railroad property, RWT planners should adhere to the request or requirements for fencing by the railroad company. Fencing and/or other separation techniques should be a part of all RWT projects.

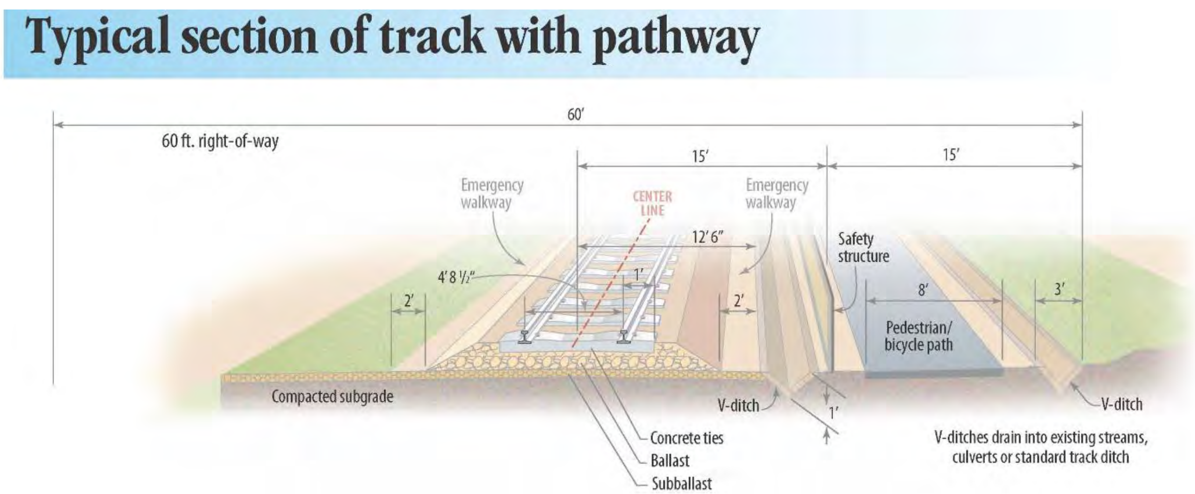
4. Trail planners should minimize the number of at-grade crossings, examine all reasonable alternatives to new at-grade track crossings, and seek to close existing at grade crossings as part of the project.

5. RWT proposals should include a full review and incorporation of relevant utility requirements for existing and potential utilities in the railroad corridor.

6. Trails should divert around railroad tunnels; if they need to go through a single-track railroad tunnel, they likely are not feasible due to extremely high cost.

For a comprehensive understanding of Rail-with-Trail issues, design guidelines, and recommendations, refer to FHWA's "Rails-with-Trails: Lessons Learned."

Source: *Rails-with-Trails: Lessons Learned*, Federal Highway Administration; *Pedestrian and Bicycle Facilities in California – Technical Reference and Technology Transfer Synthesis*, California Department of Transportation



Source: Sonoma Marin Area Rail Transit

<u>Class I Bike Path Mid-Block Crossing</u>

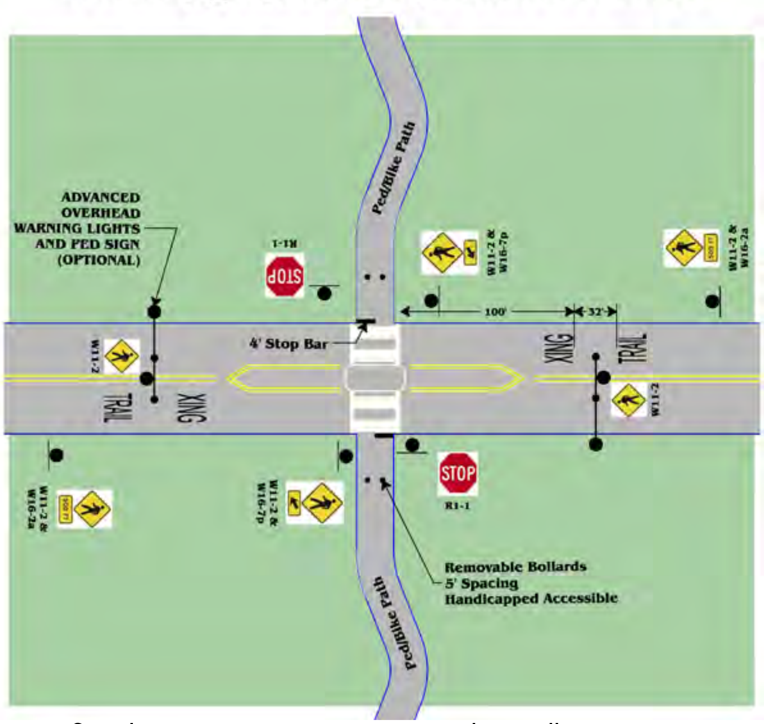
At-grade path crossings with streets, highways, or driveways should be limited to the maximum extent possible. To ensure safety, the design of at-grade crossings should feature traffic calming and crossing improvements such as: curb extensions, marked crosswalks, pedestrian refuge medians, and traffic control or warning devices. Stop or yield controls should be used for either trail users or street traffic or both, depending on right-of-way, traffic volumes and other safety issues.

Guidelines:

1. Pathways should intersect roadways as close to 90 degrees as possible.

2. Warning and stop or yield signage should be installed along pathway to alert users to impending roadway intersection.

3. Midblock crossings should not be installed close to intersections. If a pathway emerges within 300 feet or less of an intersection, consideration should be given to re-routing the path to the intersection for crossing.



Sample crossing treatment on a two-lane collector street

<u>Class II Bikeway – Bike Lanes</u>

The following section includes recommended design standards and best practice information for Class II bikeways:

- On-Street Parking
- Right turn lanes
- Left turn lanes
- Railroad tracks

A Bike Lane is defined as a portion of the roadway or highway that has been designated by striping, signage, and pavement markings for the preferential or exclusive use of bicyclists. Bike lanes enable bicyclists to ride along a roadway or highway without interference from prevailing traffic conditions. Bike lanes increase safety by facilitating predictable behavior and movements between bicyclists and motorists. Bike lanes typically run in the same direction of traffic, although they may be configured in a contra-flow direction along one-way streets for system connectivity where necessary.

Guidelines:

Class II bike lanes shall be one-way facilities, running with the direction of traffic. (Contra-flow bike lanes may be installed on one-way streets where necessary.)

Where on-street parking is allowed, Class II bike lanes must be striped between the parking area and the travel lanes.

The width of the bike lanes vary according to parking and street conditions:

- 4' minimum if no gutter exists, measured from edge of pavement;
- 5'minimum with normal gutter, measured from curb face; or 3' measured from the gutter pan seam;
- 5' minimum when parking stalls are marked; and

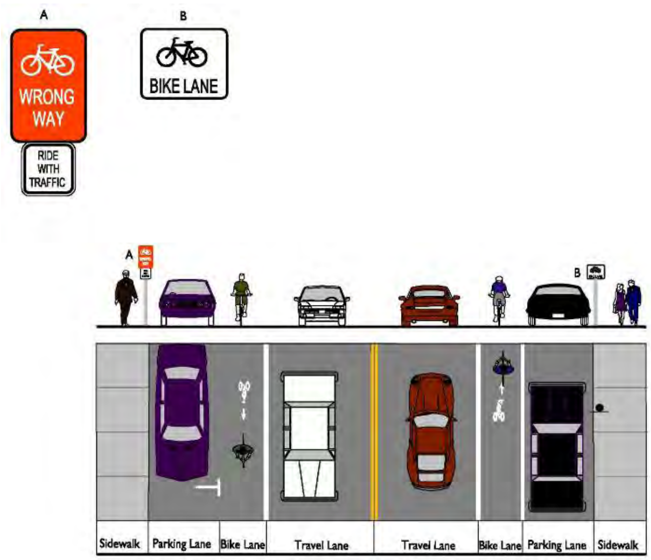
- 11’ minimum for a shared bike/parking lane where parking is permitted but not marked on streets without curbs or 12’ for a shared lane adjacent to a curb face.

Bike Lane striping standards:

- Bicycle lanes shall be comprised of a 6 inch solid white stripe on the outside of the lane, and a 4 inch solid white stripe on the inside of the lane.
- The inside 4 inch stripe of the bicycle lane should be dropped 90-180 feet prior to any intersection where right turns are permitted, and the outside 6 inch stripe should be dashed in this location.
- Bicycle lanes shall never be striped to the right of a right-hand turn lane

Bicycle lane signage standards:

- The R81 bicycle lane sign shall be placed at the beginning of all bicycle lanes, on the far side of arterial street intersections, at all changes in direction and at a maximum of 0.6 mile intervals, however, reassurance signs may be placed at 200 to 500 foot intervals.
- Standard signage is shown in Chapter 9 of the 2010 edition of the CA MUTCD.



<u>Class II Bike Lanes with On-Street Parking</u>

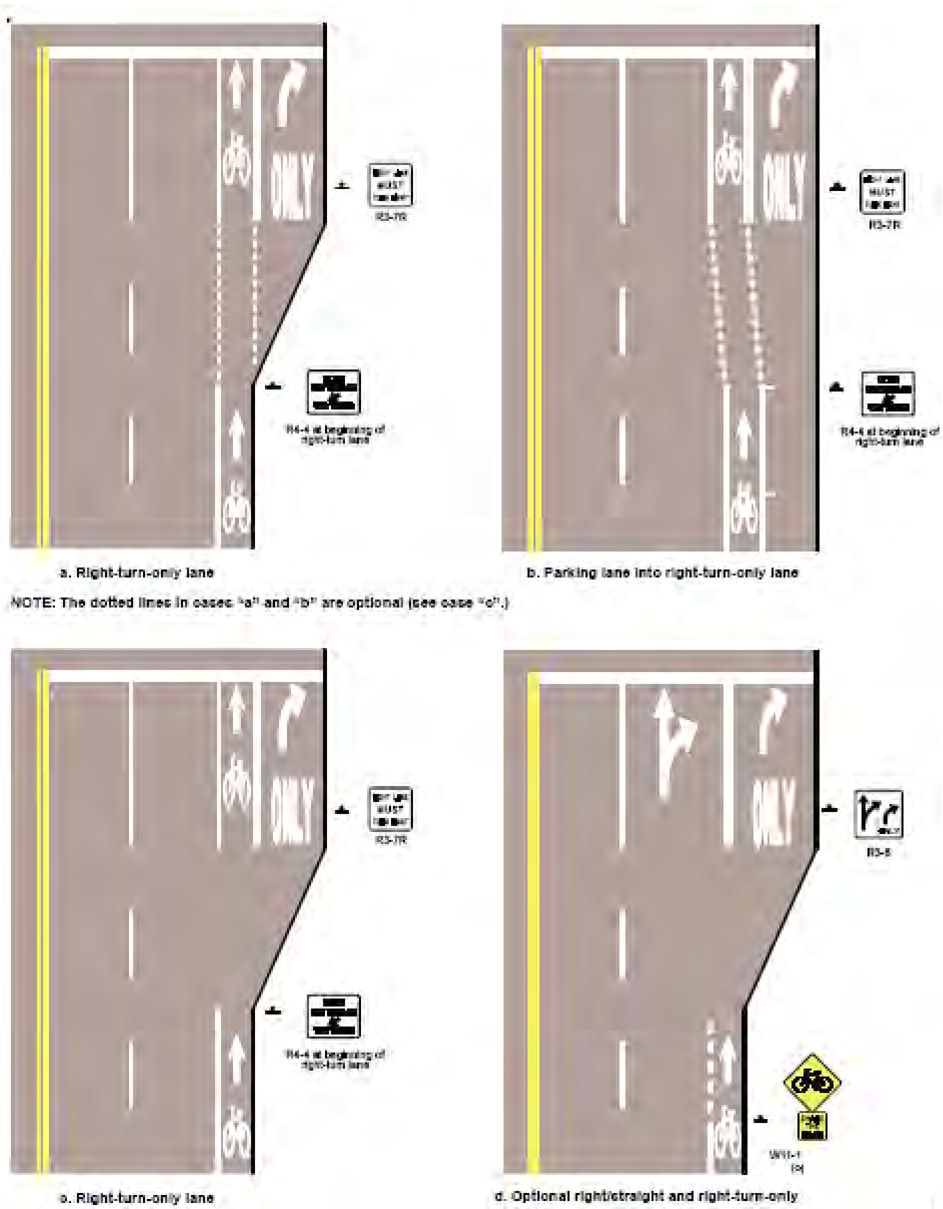
Parked vehicles can pose a serious hazard to bicyclists. Conflicts can occur during parking maneuvers and bicyclists are especially vulnerable to being hit by an opening door. On streets with parked vehicles, experienced bicyclists will generally ride three or four feet away from parked vehicles even if it means riding in a travel lane. To help maximize separation between bicyclists and parked vehicles, the following techniques may be employed:

- Minimize the parking lane width. This technique may be used in conjunction with widening the bike lane. Research suggests that the narrower the parking lane, the closer vehicles park to the curb. The traditional eight-feet wide parking lane can be reduced to seven feet or narrower where acceptable to help achieve this result.
- Parking stall markings. Marked parking spaces with cross hatches indicating the parking lane limits may help guide drivers closer to the curb.
- Angled parking should be avoided in areas of high bike traffic. If angled parking is used a four-foot buffer is recommended to provide maneuvering space for bicyclists, and/or reverse angle parking should be considered so that drivers back into spaces, which provides drivers greater visibility of bicyclists when entering and leaving the space.

<u>Class II Bike Lanes Approaching Intersections</u>

Right Turn Lanes

Bike lanes approaching intersections should dash the solid bike lane line for the last 100 to 200 feet in advance of the intersection. Dashing is preferable to dropping the bike lane stripe because it alerts bicyclists and right-turning motorist of the weave. Further, the treatment encourages bicyclists to wait in the proper location to be detected when signal detection is provided.

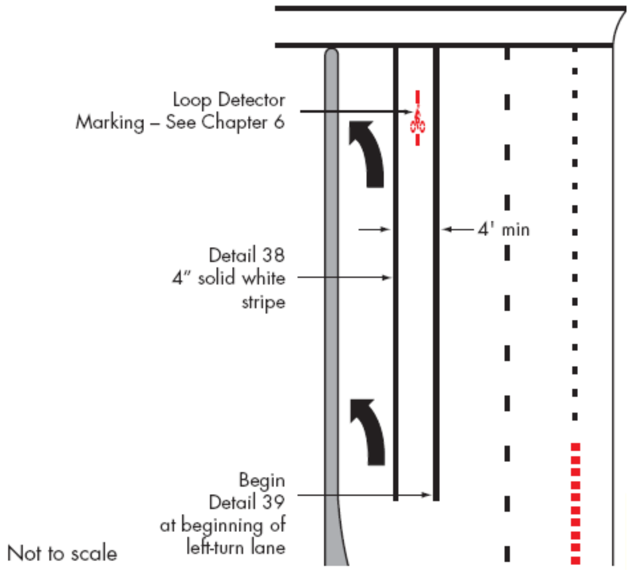


Bike Lanes approaching Right-Turn Only Lanes
Source: *Guide for the Development of Bicycle Facilities*, AASHTO

Left Turn Lanes

Left turns at intersections present difficulty to bicyclists in two ways: conflicts with left-turning motorists and the difficulty experienced by a bicyclist in executing a left turn. Improper left turns by motorist are often one of the chief causes of collisions at intersections. Often motorists are concentrating on finding a gap in vehicular traffic that they fail to notice oncoming bicycle traffic. Potential counter measures include:

- Provide left-turn pockets
- Provide protected left-turn signal phasing



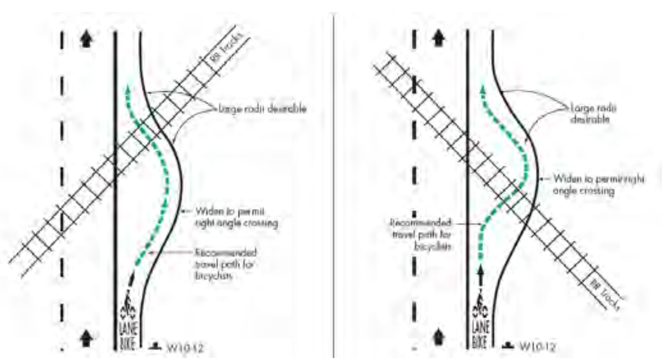
Bike Lane Striping at a Left-Turn Only Lane
Source: *VTA Bicycle Technical Guidelines*

<u>Class II Bike Lanes: Railroad Tracks</u>

All railroad crossings should be made as bicycle-safe as possible. Optimizing bicycle safety at railroad crossings involves three issues:

1. *The Angle of the Crossing*

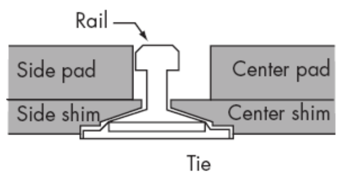
   Where the angle of the tracks is not 90 degrees, additional pavement shall be provided so that bicyclists can approach the crossing at 90 degrees as depicted in Figure 1003.6A of the Highway Design Manual. Warning signs should be installed at skewed railroad crossings.



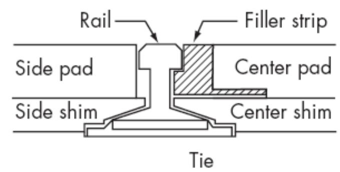
Bikeway Crossing Skewed Railroad Tracks

2. *The Smoothness of the Crossing*

   The surface of the crossing should be designed such that the rails are as flush as possible with the surrounding pavement with minimal gaps between the roadway and the flangeway. Rubber or concrete crossing materials last longer than wood or asphalt and accordingly require less maintenance.



Cross section of rubberized railroad crossing for rough perpendicular crossings



Cross section of rubberized railroad crossing with flangeway filler strip for low-speed skewed crossings

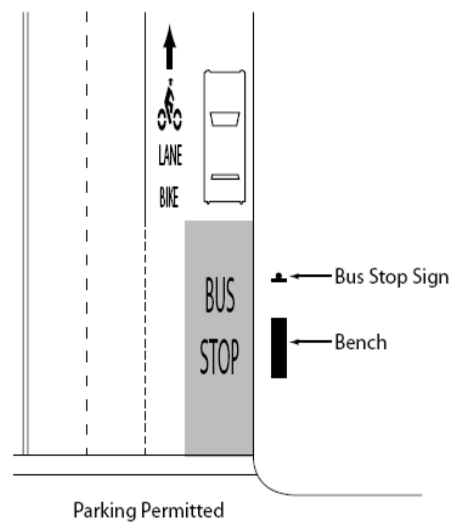
3. *The Gap Between the Flangeway and Roadway*

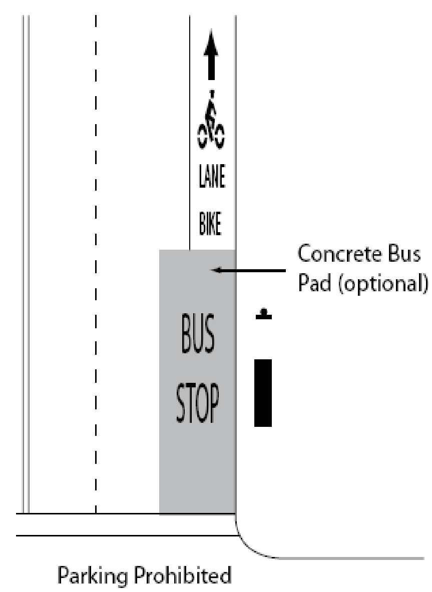
   On low-speed lightly traveled railroad tracks, commercially available flangeway fillers can eliminate the gap next to the rail.

<u>Bike Lane Treatments at Bus Stops and Pullouts</u>

Currently, no formal standard exists for the bike lane treatments at bus stops and pullouts. Therefore, the design is up to the local agency. The most common practice allows buses to cross through the bike lane to reach the curb. Treatments for this type of practice include bike lanes where both the inside and outside lanes are broken, or lanes where only the inside lane exists and it too is broken. Another alternative eliminates the bike lane completely, and then starts it again downstream of the bus stop.

The purpose of each of these alternatives is to let bikes know to expect vehicles crossing their lane, let cars know to expect buses, and let buses know to look out for bikes. Using a dashed or dotted line may be an attempt to tell motorists that cyclists may be leaving the bike lane to pass a bus, or to make it legal for the bus to encroach on the dedicated lane. The dashed lines in the bike lanes also inform the bicyclist that motor vehicles may be crossing the bike lane and to use extra caution.





Bike Lane Treatments at Bus Stops
(Far Side Stop)

<u>Class III Bikeway – Bike Route</u>

The following section includes recommended design standards and best practice information for Class III bikeways:

- Wide Curb Lane
- Bicycle pavement markings "Sharrow" Lanes
- Bicycle Boulevard

Referred to as a "bike route," a Class III bikeway provides a route for bicyclists, which is identified by signing. On-street Class III bikeways are shared with motorists, may provide a designated route through areas not served by Class I or II facilities, or connect discontinuous segments of a bikeway. Class III facilities can be shared with pedestrians on a sidewalk; however, this practice is not recommended.

The *Highway Design Manual* does not provide recommended minimum widths for Class III bikeways, however, when encouraging bicyclists to travel along selected routes, traffic speed and volume, parking, traffic control devices, and surface quality should be acceptable for bicycle travel. A wide outside traffic lane (14-15') is preferable to enable cars to safely pass bicyclists without crossing the centerline.

Class III Bike Route: Wide Curb Lane

On all streets, but especially where shoulder bikeways or bike lanes are warranted but cannot be provided due to severe physical constraints, a wide outside lane may be provided to accommodate bicycle travel. A wide lane usually allows an average size motor vehicle to pass a bicyclist without crossing over into the adjacent lane. Wide curb lanes are generally appropriate to accommodate bicyclists, whether or not the street is considered a bikeway.

Bike lanes should resume where the restriction ends. It is important that every effort be made to ensure bike lane continuity. Practices such as directing bicyclists onto sidewalks or other streets for short distances should be avoided, as they may introduce unsafe conditions. For curb lanes 16 ft or wider, the edge line should be striped.

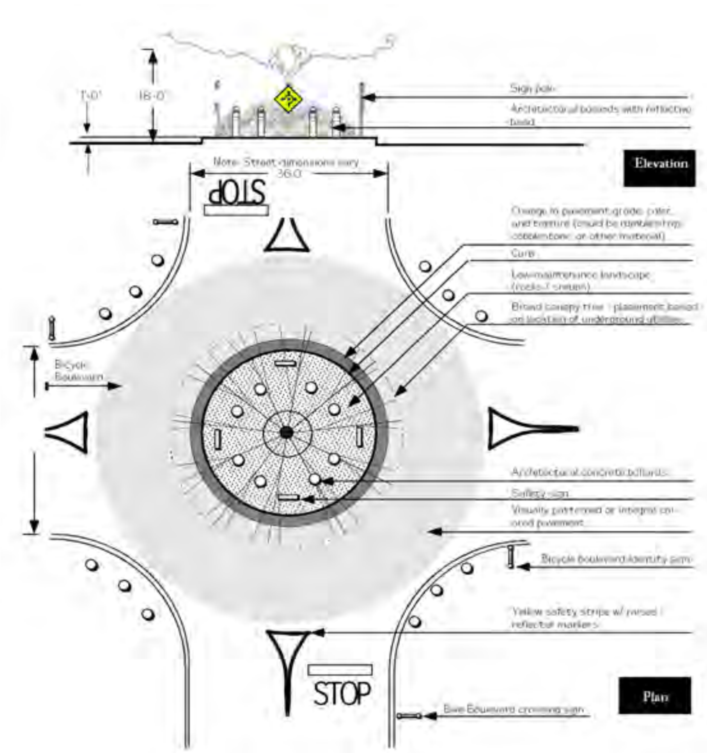
12' is the minimum width on State Highways without obtaining a Design Exception.

Class III Bike Route: Bicycle Boulevards

A variation of the Class III bike route known as a 'Bicycle Boulevard' has gained significant interest in California in recent years. Bicycle boulevards are generally comprised of low-volume residential streets that parallel major streets. Bicycle Boulevards are designed to give priority to bicyclists through various design techniques that reduce through traffic volumes and provide crossing enhancements for bicyclists at major intersections. Generally, bicycle boulevards include one or more of the following criteria:

- Low traffic volumes;
- Traffic calming devices to discourage non-local motor vehicle traffic;
- Priority for bicycles by assigning right-of-way to the bicycle boulevard at intersections wherever possible;

- Traffic control to help bicycles cross major streets (i.e. bicycle sensitive detectors at signals);
- Distinct "look" to alert bicyclists and motorists that the route is a priority for bicyclists (special signs, pavement markings, etc.); and
- By emphasizing bicycle use over automobiles, the walking environment for pedestrians along bicycle boulevards is also improved.



Sample Bicycle Boulevard treatments from Berkeley, CA

<u>Class III Bike Route: Shared Lane Markings "Sharrows"</u>

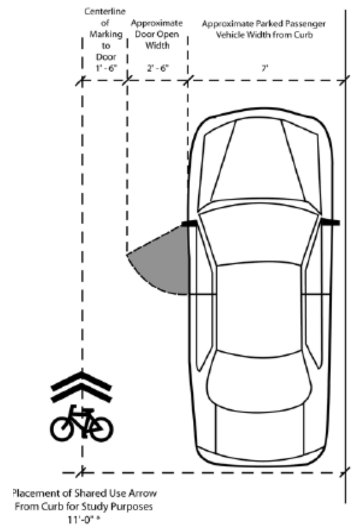
Shared Lane Marking

The SLM consists of a standard bicycle symbol combined with chevron arrows.

The shared lane marking (SLM), known as "shared roadway bicycle marking" in the MUTCD, and as "sharrows" by the bicycling public, is a pavement legend which may be placed in the travel lane adjacent to on-street parking. The purpose of the marking is to provide positional guidance to bicyclists on roadways that are too narrow to be striped with bike lanes. Unlike bike lanes, a SLM does not designate a particular part of the street for the exclusive use of bicyclists. It is simply an informational marking to guide bicyclists to the best place to ride on the road to avoid the "door swing" of parked cars, and to help motorists expect to see and share the lane with bicyclists. The marking gives bicyclists freedom to move further to the left within a travel lane rather than brave the door zone, squeezed between moving and parked cars. The marking is usually repeated every several hundred feet. Without such markings, bicyclists might seek refuge on the sidewalk, ride in a serpentine pattern between parked vehicles, or travel in the wrong direction. Perhaps the most important benefit of SLM is that they send a message to cyclists and drivers alike that bikes belong on the road.

Shared Lane Markings were approved for use in California in 2007 after device testing was performed by the City of San Francisco. While the version of the 2010 MUTCD adopted by California specifies that the device is to be used only where there is existing on-street parallel parking (Section 9C.103), the national MUTCD provides for use of the device on streets without on-street parking. Further, jurisdictions around the nation are recognizing the benefit of utilizing the device in locations where it may not be obvious where cyclists should be riding, such as at intersections with multiple turn lanes, as a guide marking through intersections (similar to skip lines), and as a guide-marking between bikeways.

Positional Layout of Shared Lane Markings



Source: *San Francisco Bicycle Design Guidelines*

Marking Placement

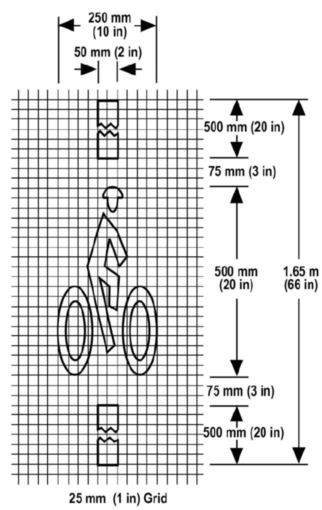
Laterally – According to the California MUTCD guidelines, SLM shall be placed so that the centers of the markings are a minimum of 11 feet from the curb face or edge of paved shoulders, and the distance may be increased beyond 11 feet. According to the National MUTCD, if SLM are used on a street without parking, the markings should be placed far enough from the curb to direct cyclists away from gutters, seams, and other obstacles, or near the center of the lane if the lane is less than 14 feet wide.

Longitudinally – SLM should be placed immediately after intersections and spaced at intervals of 250 feet. The longitudinal spacing of the markings may be increased or decreased as needed for roadway and traffic conditions (Source: 2010 CA MUTCD).

<u>Signalized Intersections</u>

Signal Detection

Actuated traffic signals pose a significant barrier to bicyclists when the detectors do not sense the presence of a bicycle. Bicyclists are then forced to wait for a vehicle to actuate the signal, dismount and use the intersection as a pedestrian, or proceed against the red light. A variety of signal detection technologies are currently available including inductive loop detectors which utilize an electromagnetic field to sense the presence of vehicles, video detection which senses the presence of vehicles optically, and a new technology – magnetometers – which uses magnetic anomaly detection.



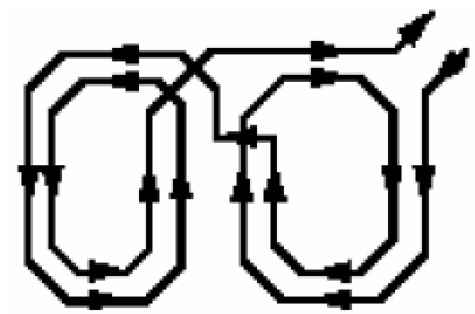
BICYCLE DETECTOR SYMBOL

R10-22

Each of these technologies is suitable for the detection of bicycles, and bicycle detection should be provided at all traffic signal installations. Efforts need to be made to ensure that signal detection devices are capable of detecting a bicycle and detectors need to be located in the bicyclist's expected path, including left-turn lanes and shoulders. Marking the road surface to indicate the optimum location for bicycle detection is helpful to the bicyclist so that they may position themselves properly to trigger the traffic signal.

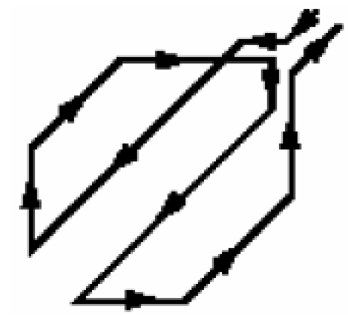
Inductive loops are still the most common technology employed. Two types of inductive loop detectors are typically used; the Diagonal Quadrupole Loop – Type "D" is typically used in vehicle lanes, and the Quadrupole Loop – Type "C" is typically used in bike lanes. The bicycle detection symbol may be used to show a bicyclist where to stop in a bike lane or traffic lane to be detected.

Quadrupole Loop
Type "C"



Used in bike lane. Detects strongly in center.
Sharp cut-off sensitivity

Quadrupole Loop
Type "D"



Used in vehicle & "shared lanes"
Sensitive over whole area
Sharp cut-off sensitivity

Bike Boxes

Bike boxes provide a reservoir for bicyclists in front of vehicle traffic at intersections. Cars wait behind the box, allowing bikes to come to the front of vehicular traffic and position themselves for turning and through movements. Bike boxes give bicyclists greater visibility, a head start through intersections, and help to reduce conflicts between turning bicycles and vehicles by clearly delineating the location for movements to occur. Bike boxes or "advanced stop lines" also provide a buffer between vehicles and pedestrians or bicycles crossing the street. Using colored surfacing for bike boxes should make them more prominent and thus making encroachment by motor vehicles less likely.

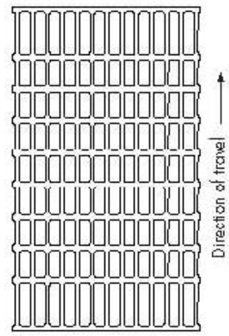
Source: Portland Office of Transportation

Photo: New York City, NY

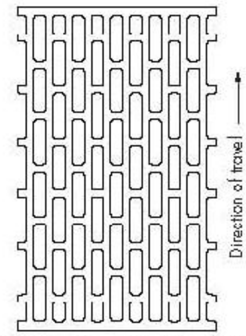
Design Elements

Drainage Grates

The function of drainage grates is to drain storm water quickly from the roadway and to provide access to the storm water system. Gutters are sloped to direct water flow into the inlet. This keeps water from ponding at the longitudinal joint and undermining the pavement. Improperly designed drainage grates can catch bicycle tires and cause bicyclists to lose control of their bicycle. Because of this, cyclists may veer into traffic lanes to avoid grates and utility covers. Properly designed grates and utility covers allow cyclists to maintain their direction of travel without catching tires or being forced into travel lanes.

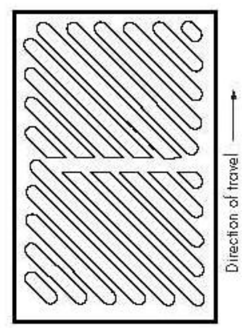


TYPE 18-10 or 24-13 GRATE
(METRIC: TYPE 450-10 or 600-13)



TYPE 18-8C or 24-106 GRATE
(METRIC: TYPE 450-8C or 600-10C)

Optimally the roadway should be designed so that the bicyclist does not have to traverse the grate per HDM Section 837.2. On roadways with curb and gutter, the grate should not be wider than the gutter pan. If the gutter pan needs to be widened to accommodate a large drainage grate, the taper should be on the outside edge.



OTHER BICYCLE PROOF GRATE

On roads with bike lanes, the roadway shall be designed such that the minimum asphalt concrete pavement width of 48 inches is maintained between the bike lane stripe and the edge of the gutter lip. If 48 inches of asphalt cannot be maintained, then a curb face inlet design for the drainage grate should be considered (see Section 3.2.1).

On roadways with shoulders, the grate should be placed outside the travel path of the bicyclist, i.e. 48 inches of clear pavement should be maintained between the shoulder stripe and the left edge of the drainage grate. If 48 inches cannot be provided within the existing shoulder width, the shoulder can be widened to accommodate the grate, with the taper on the outside edge, or a narrower grate should be selected. See also Section 7.4.2 and Figure 7-13.

Only drainage grates depicted in Caltrans Standard Plans D77B-Bicycle- Proof Grate Details or otherwise known to be bicycle-safe may be used on all roadways per HDM 837.2. Regardless of type of roadway or placement on the roadway, all grates on the roadway should be bicycle-proof.

Pavement Marking Materials

Paint is the least recommended marking material due to its low reflectivity and low skid resistance, plus it needs to be reapplied every 12 to 24 months, increasing maintenance costs. Durable pavement markings are preferred. They should be reflectorized and be capable of maintaining an appropriate skid resistance under rainy or wet conditions to maximize safety for bicyclists. The minimum coefficient of friction should be 0.30 as measured with California Test 342 to test surface skid resistance. Pavement marking tape or thermoplastic is recommended.

Pavement Marking Tape

Type I Tape such as 3M Stamark TM tape Series 380I and Series 420 is the least slippery (and most long-lasting) pavement marking. Type I tape is cost-effective when placed after resurfacing, since it lasts as long as (or longer than) the pavement itself. The skid resistance of 3M Stamark TM Series 420 tape is 55 BPN with a retained value of 45 BPN; the equivalent coefficient of friction is not available.

Thermoplastic

Thermoplastic is optimized when the composition has been modified with crushed glass to increase the coefficient of friction and the maximum thickness is 100 mils (2.5 mm).

Pavement Markers

Pavement markers, whether raised reflective markers (Type C, D, G or H) or non-reflective ceramic pavement markers (Type A or AY, otherwise known as Bott's dots) present a vertical obstruction to bicyclists, and shall not be used as bike lane stripes. When necessary as a fog line or adjacent to the edge line, the Type C or G reflective markers should be placed to the left of the line outside the shoulder area, and ideally the shoulder should be at least 4 feet wide. Where raised markers cross a bike lane or extensions thereof through intersections a gap of 4 feet should be provided as a clear zone for bicyclists. At gore areas (e.g. Standard Plan A20C) and other locations with channelizing lines, (e.g. Standard Plan A20D) if raised reflective markers are used to supplement the striping, extra lane width shall be provided in the areas where bicycles travel to provide bicyclists with more latitude to avoid the markers. (See also Section 7.2).

<u>Roadway Surface Obstacles</u>

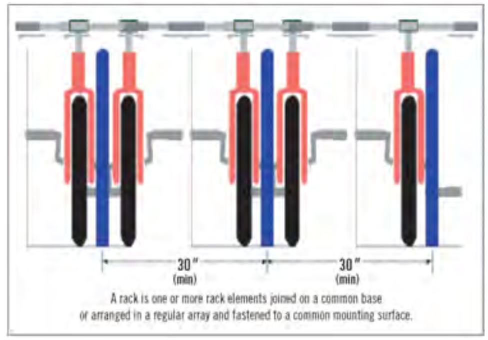
Manhole covers and utility plates present obstacles to bicyclists due to their slipperiness and change in surface elevation with the surrounding pavement. While covers and plates can be replaced with less slippery designs, as discussed below, to minimize their adverse impacts on bicyclists, it is best to design the roadway so that they are not located within the typical path of bicyclists riding on the roadway. Therefore, new construction should not place manhole and other utility plates and covers where bicyclists typically ride i.e. within the six feet adjacent to the curb (or between 8 and 13 feet from curb if parking is permitted).

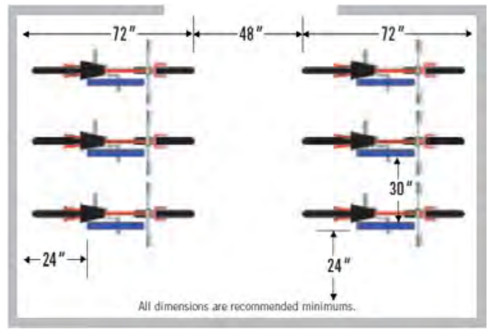
Wet utility covers and construction plate materials can be very slippery. Plain steel plates have a coefficient of friction of 0.012, which is unacceptably slippery and should never be used on the roadway. The coefficient of friction on all utility covers and steel plates placed on a roadway or highway or shoulder should be a minimum of 0.35. An example of an effective method for covers and plates (both steel or concrete) to have acceptable skid resistance is for the manufacturer to imprint waffle shaped patterns or right-angle undulations on the surface. The maximum vertical deviation within the pattern should be 0.25 inch (6 mm).

<u>Bike Parking</u>

As bicycle use becomes more prevalent in throughout the Plan Area, there will be more demand for adequate bicycle parking. Bicycle parking can be typified as either short- or long-term. Short-term parking generally consists of bicycle racks located conveniently to destinations such as at shopping centers, civic destinations, and schools. Long-term parking is designed to accommodate those who are expected to park for more that two hours. Long-term parking provides security and weather protection. It typically includes covered parking areas, bike lockers and/or bike lids, storage rooms, or secure areas such as "cages" or "corrals" that can only be accessed by bicyclists.

Bicycle parking should be provided at all public destinations, including transit centers and bus stops, community centers, parks, schools, downtown areas, and civic buildings. All bicycle parking should be in a safe, secure, covered area (if possible), conveniently located to the main building entrance.





Source: APBP Bike Parking Guidelines

Bicycle Parking Placement – Type and Location

- *Visibility* – bicycle racks and lockers should be located in a highly visible location near building entrances so cyclists can spot them immediately. Bicyclists and motorists alike appreciate the convenience of a parking space located right in front of a destination. A visible location also discourages the theft and vandalism of bicycles. Preferably, racks will be located as close as or closer than the nearest automobile parking spaces to the building entrance.

- *Security* – properly designed bicycle racks and lockers that are well anchored to the ground are the first measure to help avoid vandalism and theft. In some cases, added measures, which may include lighting and/or surveillance, are essential for the security of bicycles and their users. The rack element (part of the rack that supports the bike) must keep the bike upright by supporting the frame in two places allowing one or both wheels to be secured. Inverted "U," "A," and post and loop racks are recommended designs. Wave type racks that are found in many locations throughout the County are not recommended because they require excessive space and are so often used improperly.

- *Weather Protection* – is especially important. A portion of all bicycle parking should be protected from the rain and the sun. Various methods can be employed including the use of building awnings and overhangs, newly constructed covers, weatherproof bicycle lockers or lids, or indoor storage areas. Long-term parking should always be protected.

- *Clearance* – adequate clearance is an essential component of rack placement. Clearance is required between racks to allow for the parking of multiple bicycles and around racks to give bicyclists room to maneuver and too prevent conflicts with others. If it becomes too difficult for a bicyclist to easily lock their bicycle, they may park it elsewhere and the bicycle capacity is lowered. Racks should be placed in a position where they do not block access to and from building entrances, stairways, or fire hydrants. Empty racks must not pose a tripping hazard for visually impaired pedestrians. Position racks out of the walkway's clear zone (space reserved for walking). Likewise, bicycle racks placed along a sidewalk should be oriented parallel with the street, so parked bicycles do not intrude into the walkway's clear zone. A row of inverted "U" racks should be situated on 30" minimum centers. Ideally, racks should be located immediately adjacent to the entrance to the building it serves, but not in a spot that may impede upon pedestrian flow in and out of the building.