On-Street Bicycle Facilities

A. General

Cyclists have similar access and mobility needs as other transportation users. However, cyclists must use their own strength and energy to propel the bicycle, thus a bicyclist is generally slower than other vehicles that are operating on the roadway. Additionally, cyclists are more vulnerable to injury during a crash and are of any age group. With these factors in mind, it is imperative that designing bicycle facilities is done with great care.

The fourth edition (2012) of the AASHTO "Guide for the Development of Bicycle Facilities" (or *AASHTO Bike Guide*) was used as a reference for developing this section. References made to the *AASHTO Bike Guide* within this section are shown in parentheses, e.g. (AASHTO 4.2).

B. Elements of Design

Since cyclists usually have a higher eye height and are slower than the adjacent traffic, the roadway design elements for motor vehicles usually meet or exceed the minimum design elements required for cyclists.

Surface conditions affect cyclists more significantly than motor vehicles. Therefore, when establishing bicycle lanes and routes, it is important that the roadway surface is in good condition and is free of potholes, bumps, cracks, loose gravel, etc. If the roadway is not in good bicycle riding condition, it should be repaired either with resurfacing or reconstruction. Chip-sealed surfaces prove to create difficult riding conditions. (AASHTO 4.2).

C. Facilities

Except where prohibited, bicycles may be operated on all roadways. The following are the different types of bicycle facilities that are located on the roadway along with their design criteria.

1. **Shared Lanes:** Shared lanes already exist on local neighborhoods and city streets. However, these lanes can include design features that will make the lanes more bicycle friendly. This includes good pavement quality, adequate sight distance, lower speeds, bicycle-compatible drainage grates, bridge expansion joints, railroad crossings, etc. (AASHTO 4.3).

    a. **Major Roads (Wide Curb/Outside Lanes):** Lane widths should be 13 to 15 feet wide with 14 foot lanes as preferred. Lane widths of 14 feet and greater allow motorists to pass cyclists without encroaching into adjacent lanes; however, it is important to note that 15 foot lanes should be used only on appropriate sections with steep grades or sections where drainage grates, raised delineators, or on-street parking effectively reduces the usable width. The gutter should not be included in the measurement as usable width. Lanes 15 feet or wider could encourage faster vehicular movements or even two vehicles operating side by side in one lane. (AASHTO 4.3.1).

b. **Marked Shared Lanes:** In areas that need to provide enhanced guidance for cyclists, shared lanes may be marked with pavement marking symbols. This marking should be provided in locations where there are insufficient widths to provide bicycle lanes or shared use paths. This pavement marking not only lets the cyclists know where to be located within the lane but also the direction of travel.

Shared lane markings are not appropriate for paved shoulders or bicycle lanes, and should not be used on roadways that have a speed limit above 35 mph. Markings should be placed immediately after an intersection and spaced not greater than 250 foot intervals. Refer to both the MUTCD and AASHTO 4.4.

c. **Signs for Shared Roadways:** Along with pavement markings, signage is a very useful tool to communicate and inform both motorists and cyclists about shared roadways. It is important to note, that signs shall be used only when needed in order to prevent confusion, reduce clutter, and improve visibility. Refer to both the MUTCD and AASHTO 4.3.2.

Figure 12B-3.01: Share the Road Sign Assembly

Source: *AASHTO Bike Guide* Exhibit 4.1

2. **Paved Shoulders:** For higher speed and higher traffic roadways, adding or improving a paved shoulder can greatly improve cyclist accommodations on roadways. This will not only benefit the cyclists and motorists by giving the cyclists a place to ride that is located outside of the travel lane, but it also can extend the service life of roads by reducing edge deterioration.

It is important to note that paved shoulders should not be confused with bicycle lanes, as bicycle lanes are travel lanes and paved shoulders are not. Paved shoulders should have a minimum width of 4 feet wide with a preferred width of 5 feet. Also, they should be at least 5 feet in locations of guardrails, curbs, or other roadside barriers. Additionally, the width may be increased in areas where the speeds exceed 50 mph, areas of heavy truck traffic, or locations with static obstruction exist at the right side of the roadway.

It is preferred to have paved shoulders on both sides of a two-way roadway; however, in constrained locations and where pavement widths are limited, it may be preferable to provide a wider shoulder on one side of the roadway and a narrower shoulder on the other. This may be beneficial in uphill roadway sections to provide slow-moving cyclists additional maneuvering space and sections with vertical or horizontal curves that limit sight distance over crests and on the inside of horizontal curves.

In locations where unpaved driveways or roadways meet a paved shoulder, it is recommended to pave at least 10 feet of the driveway and 20 feet or to the right-of-way line, whichever is less, of the unpaved public road. This will help minimize loose gravel from spilling onto the travel way and affecting the cyclists. Additionally, raised pavement markers should not be used, unless they are beveled or have tapered edges.

Rumble strips may be used on paved shoulders that include the bicycle traffic; however, the minimum clear path should be 4 feet from the rumble strip to the outside edge of paved shoulder or 5 feet to the adjacent curb or other obstacle. Gaps at a minimum of 12 feet and a recommended distance of 40 to 60 feet for the rumble strips should also be provided in order to allow room for cyclists to leave or enter the shoulder without crossing the rumble strip. (AASHTO 4.5). Rumble strips should have the following design:

- Width: 5 inches
- Depth: 0.375 inches
- Spacing: 11 to 12 inches (may be reduced to 6 inches)

3. **Bicycle Lanes:** Bicycle lanes are a portion of the roadway that is designated for bicycle traffic. They are one-way facilities that typically carry bicycle traffic in the same direction as the adjacent motor vehicle traffic. They are appropriate and preferred on corridors located in both urban and suburban areas; however, they may be used on rural roadways. They are typically used when vehicle traffic exceeds 3,000 vehicles per day and vehicle speeds are greater than 30 mph. Frequent use of visible pavement markings is essential to identify the lane for use by bicycles only. Color may be added for increased visibility. The use of colored markings should be consistent throughout the corridor and community. Public information and education programs may be necessary when a specific type of bicycle lane is introduced into a community. Programs should include a focus for drivers, as well as for bicyclists. Paved shoulders can be designated as bicycle lanes by installing bicycle lane symbol markings, yet marked shoulders will still need to meet the criteria listed herein.

Bicycle lanes should have a smooth surface with utility and grate covers flush with the surface of the lane. Additionally, bicycle lanes should be free of ponding water, washouts, debris accumulation, and other potential hazards. (AASHTO 4.6). Designers need to be aware that pavement joints, especially near curb and gutter sections, could impact the usability of the bicycle lane.

There are three types of bicycle lanes:

- Conventional
- Buffered
- Separated

a. **Conventional:** Located between the travel lanes and the curb, road edge, or parking lane and generally flow in the same direction as motor vehicles. They are the most common bicycle facility in the United States.

1) **Two-way Streets:** It is recommended that bicycle lanes are provided on both sides of two-way streets as bicycle lanes on only one side may encourage wrong-way use. The exceptions are in cases of long downhill grades where bicyclists' speeds are similar to typical motor vehicle speeds. In this case, shared lane markings may be used in the downhill direction and a bicycle lane in the uphill direction.

2) **One-way Streets:** On one-way streets, the bicycle lane should be on the right-hand side of the roadway. A bicycle lane may be placed on the left side of the roadway if there are a significant number of left turn lanes, or if left-sided bicycle lanes will reduce conflicts with bus traffic, on-street parking, and/or heavy right-turn movements, etc.

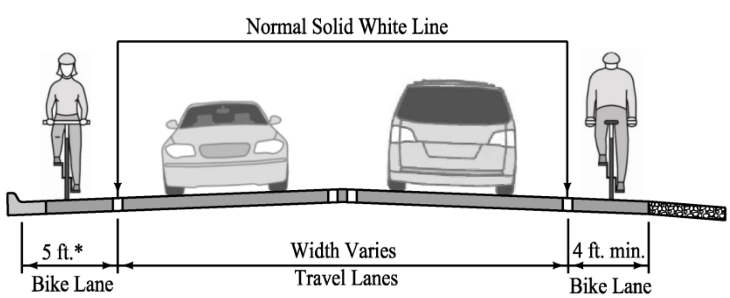
   Bicycle lanes should also be provided on both streets of a one-way couplet as to provide a more complete network and discourage wrong-way riding. If width constraints are in effect, shared lane markings should be considered.

   In some designated one-way streets, it may be preferred to provide bicyclists a contra-flow bicycle lane using markings and separated by a double yellow centerline. This design should be used where there are few intersecting driveways, alleys, and streets on the side of the street with the contra-flow lane. (AASHTO 4.6.3).

3) **Lane Widths:** The preferred operating width for bicycle lanes is 5 feet; however, 4 feet is the minimum in locations where there is an absence of on-street parking and a curb and gutter. In some instances, wider lanes may be more desirable. These instances are:
   - In locations with narrow parking lanes and high turnover. A wider bicycle lane of 6 to 7 feet will allow cyclists to ride out of the area of opening vehicle doors.
   - In areas with high bicycle use. A bicycle lane width of 6 to 8 feet will allow cyclist to pass each other or ride side-by-side.
   - In high-speed and high-volume roadways and/or high heavy vehicle traffic. A wider lane will provide an additional separation between cyclists and motorist, thus increasing safety and comfort of the cyclists.

   With wider bicycle lanes, appropriate signage and markings shall be used to delineate the bicycle lanes from the vehicle lanes.

Figure 12B-3.02: Conventional Bicycle Lane Cross-sections - Parking Prohibited

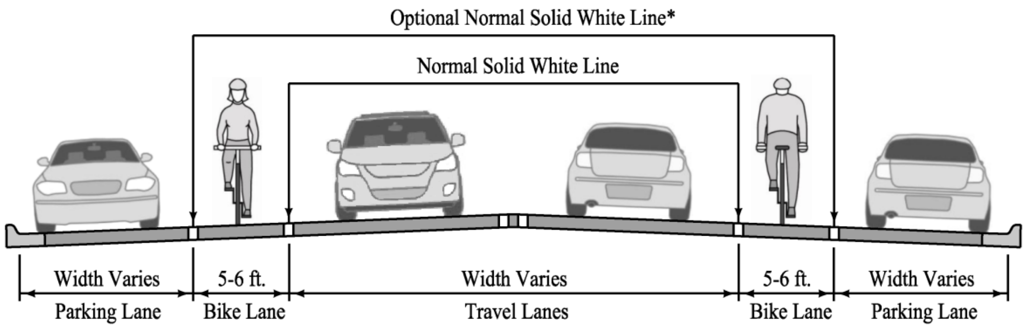


* On extremely constrained, low-speed roadways with curbs but no gutter, where the preferred bicycle lane width cannot be achieved despite narrowing all other travel lanes to their minimum widths, a 4 foot wide bicycle lane can be used.

Source: Adapted from *AASHTO Bike Guide* Exhibit 4.13

4) **Bicycle Lanes and On-street Parking:** With on-street parking facilities, bicycle lanes shall be located between the vehicle travel lane and the parking spot. For parallel on-street parking, the recommended width of a marked parking lane is 8 feet with a minimum of 7 feet. When the parking lane is not marked, the recommended width of the shared bicycle and parking lane is 13 feet with a 12 foot minimum. Any on-street diagonal parking that is adjacent to bicycle lanes shall be back-in parking as to prevent accidents due to poor visibility of bicyclists. (AASHTO 4.6.5).

Figure 12B-3.03: Conventional Bicycle Lane Cross-sections - On-street Parking

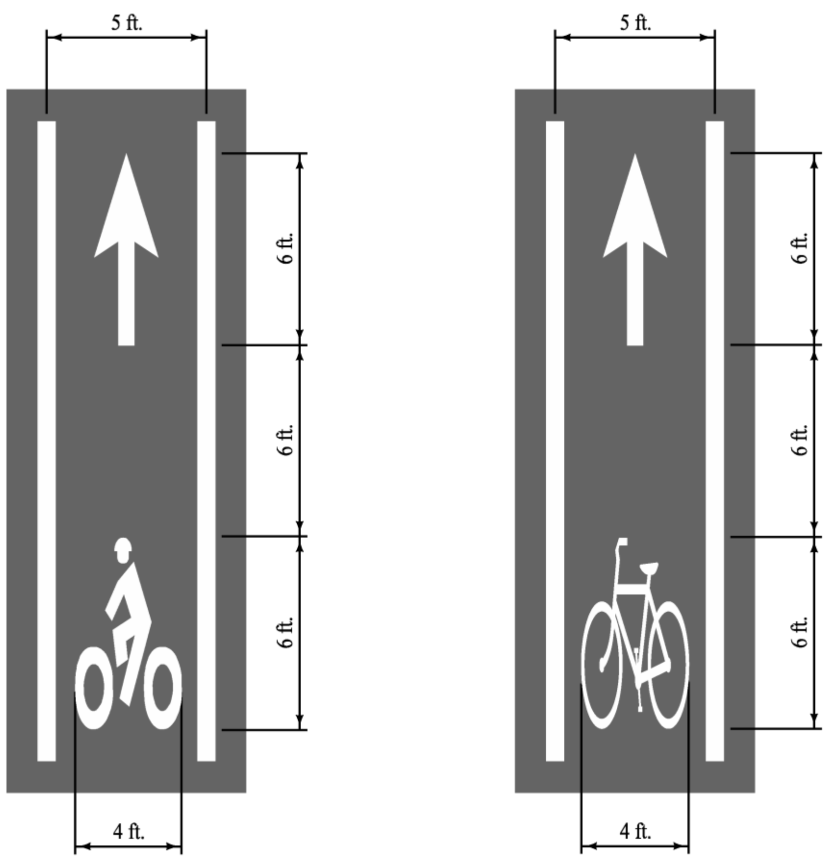


* The optional normal (4 to 6 inch) solid white line may be helpful even when no stalls are marked (because parking is light), to make the presence of a bicycle lane more evident. Parking stall markings may also be used.

Source: Adapted from *AASHTO Bike Guide* Exhibit 4.13

5) **Signs and Markings:** Bicycle lanes are designated for preferential use by bicyclists with a normal white line (4 to 6 inches wide) and one of the two standard bicycle lane symbols, which may be supplemented with a directional arrow marking. Pavement signs and non-raised pavement markings should be used instead of curbs, posts, raised pavement markings, or barriers. Raised devices are hazardous to cyclists and make it more difficult for cyclists to maintain riding in the bicycle lane. Refer to both the MUTCD and AASHTO 4.7.

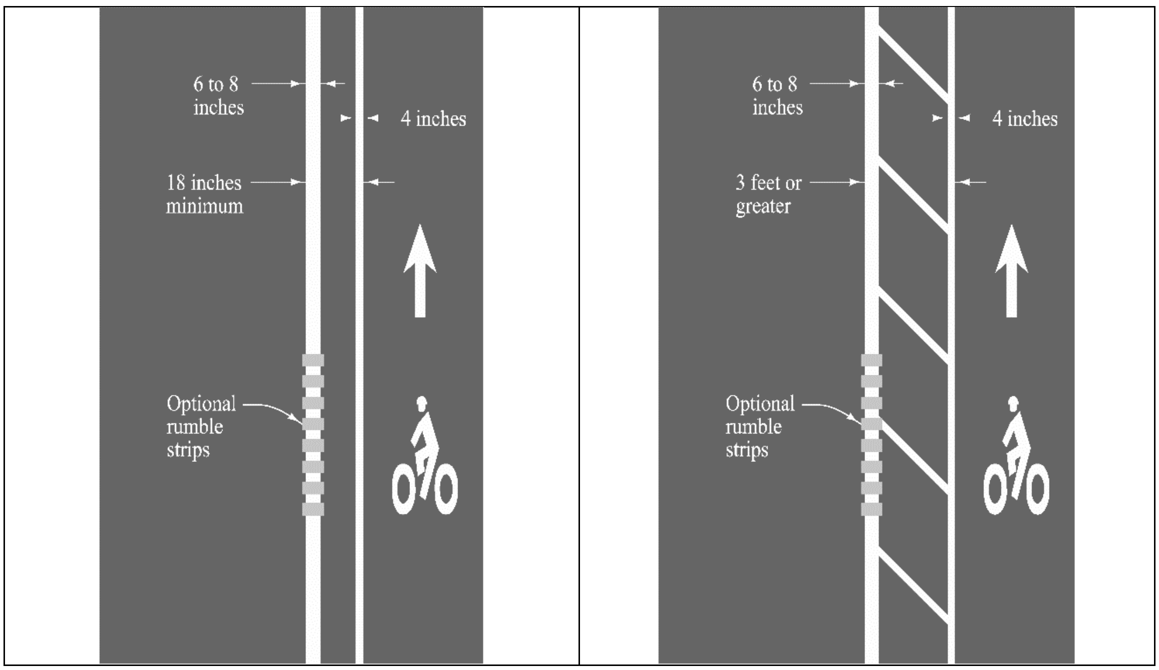
Figure 12B-3.04: Conventional Bicycle Lane Symbol Markings



Source: Adapted from *AASHTO Bike Guide* Exhibit 4.17

b. Buffered: Conventional bicycle lanes coupled with a designated buffer space separating the bicycle lane from adjacent motor vehicle lanes and/or a parking lane. They are generally used when traffic volumes include high percentages of trucks or buses and higher travel speeds. The lane widths are the same as for conventional bicycle lanes. The buffered bicycle lane provides a greater space for cycling without making the bicycle lane appear so wide that it might be mistaken for a travel or parking lane. The buffer should be a minimum of 18 inches wide and marked with two solid white lines with diagonal hatching or chevron markings if the width is 3 feet or greater. Colored markings may be used at the beginning of each block to discourage motorists from entering the buffered lane. The combined width of the buffer(s) and bicycle lane should be considered the "bicycle lane width." For buffered lanes between travel lanes and on-street parking, the bicycle lane should be a minimum of 7 feet wide (inclusive of buffer width) to encourage bicyclists to ride outside the door zone. Rumble strips may be added to the painted buffer area as an additional indicator for vehicles to remain clear of the bicycle lane. Placement of rumble strips should comply with Iowa DOT requirements.

Figure 12B-3.05: Buffered Bicycle Lane Markings



Source: Adapted from *Urban Bikeway Design Guide, NACTO*

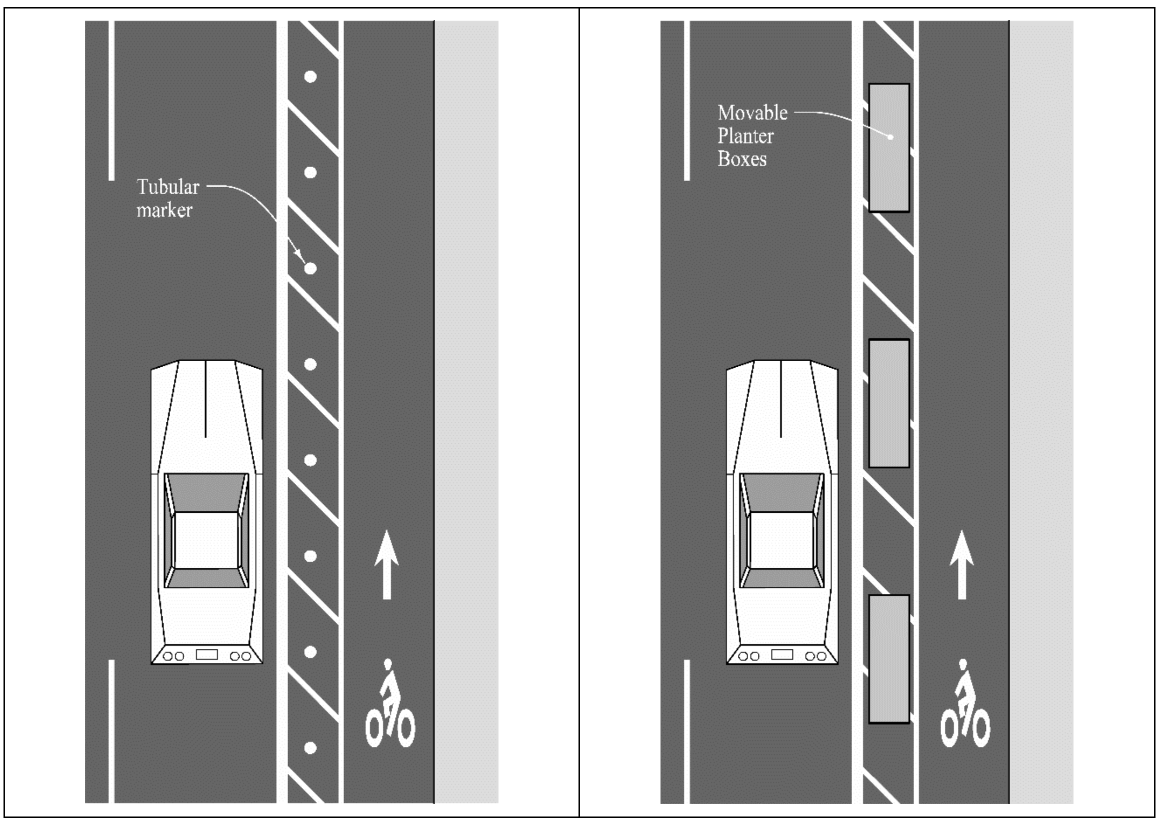
c. Separated: An exclusive facility for bicyclists that is physically separated from motor vehicle or parking lanes by a vertical element. Separated bicycle lanes are also sometimes called cycle tracks or protected bicycle lanes. Examples of vertical separation include delineators, bollards, curbs, medians, planters, concrete barriers, and on-street parking. Separated bicycle lanes can provide a safer, more comfortable experience for less-skilled bicycle riders and encourage more use of bicycles for travel if interconnected with other community bicycle facilities. Separated bicycle lanes typically include a painted buffer space that is used to locate the vertical element. Separated bicycle lanes are often implemented through the removal of a parking lane or by moving the parking lane between the separated bicycle lane and the travel lanes.

If the separated bicycle lane is parking protected, parking should be prohibited a minimum of 30 to 50 feet from the crosswalk of an intersection. Make sure to provide ADA access across the separated bicycle lane from parking spaces.

Separated bicycle lanes can operate as one-way or two-way facilities. Minimum width is 5 feet (exclusive of width for physical separation) for a one-way facility. Widths of 7 feet or greater are required for passing or side-by-side riding. Consideration should be given to the equipment that will be needed to perform sweeping and snow removal maintenance. Unobstructed widths of less than 8 feet will likely require specialized maintenance equipment. If a solid median is used as the means of vertical separation, drainage may also be impacted. Separation devices such as delineators or planters may be removed during the winter months to facilitate snow plowing and removal activities.

Interaction between transit stops and separated bicycle lanes can be difficult. When possible, the bicycle lane should be routed behind the bus platform. If bus traffic is infrequent (less than four buses per hour), bus stops can utilize the bicycle lane space. When buses are present, cyclists should merge left and pass the stopped bus.

Figure 12B-3.06: Separated Bicycle Lane

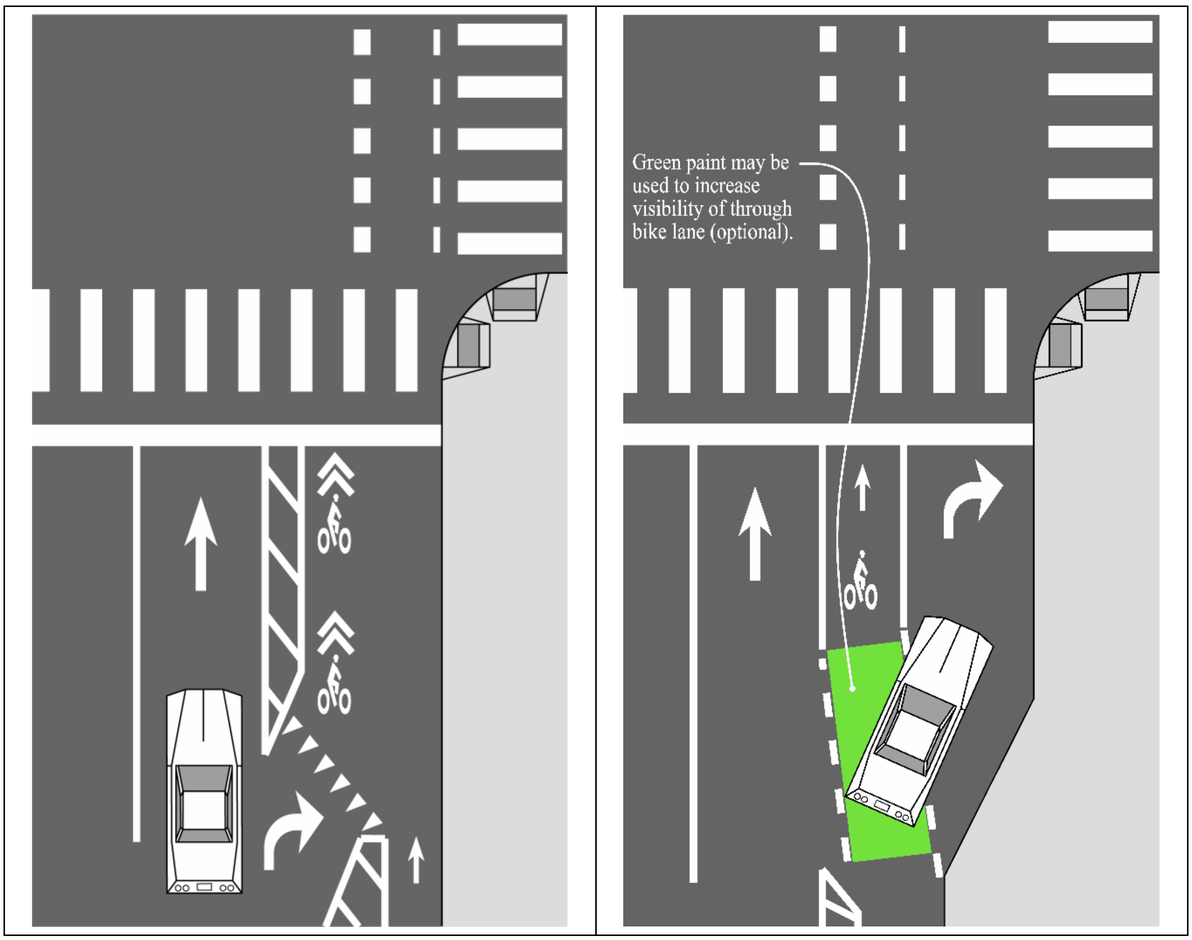


Source: Adapted from *Urban Bikeway Design Guide, NACTO*

d. Intersection Design: Most conflicts between motor vehicles and bicyclist occur at intersections and driveways. Due to the vulnerability of cyclists as well as the low visibility the cyclists have in relationship to the motorists, good intersection bicycle lane design and intersection pavement marking design is crucial to the success of an intersection that incorporates bicycle lanes. Refer to both the MUTCD and AASHTO 4.8 for additional information pertaining to intersection pavement marking and bicycle lane design.

Intersection design is critical since it is not possible to maintain physical separation between bicycles and vehicles where cross-street traffic and turning movements must cross the bicycle lane. One technique for intersections that do not have sufficient volumes for traffic signals is to use a mixing zone. The vertical element is discontinued about 100 feet from the intersection and the bicycle lane becomes a shared lane with the turning vehicles. Sharrow markings are used to guide the bicyclists to the left side of the right turning vehicles. The combined lane should be a minimum of 9 feet and a maximum of 13 feet wide. Another technique involves a lateral shift of the bicycle lane to a position to the left of the right turn lane (through bicycle lane). The transition involves a 30 feet long merge area without the vertical elements for vehicles to cross the bicycle lane and eliminate the conflict with right turning vehicles. The lateral shift also positions bicyclists to take advantage of a bicycle box that provides a space for bicycles to queue in front of vehicles during red signal indications.

Figure 12B-3.07: Mixing Zones and Through Bicycle Lane

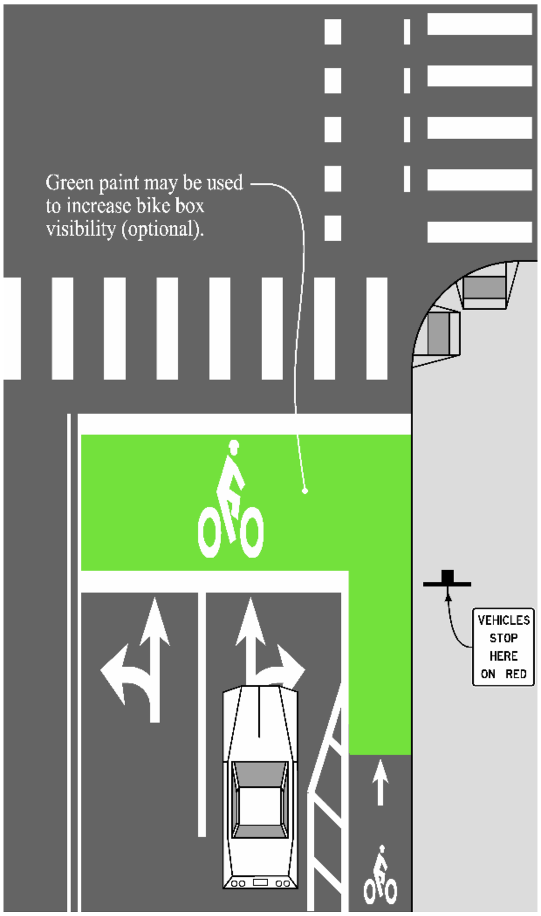


Source: Adapted from *Urban Bikeway Design Guide, NACTO*

The mixing zones and bicycle boxes may include an optional green pavement paint. If used, the green pavement paint must meet the MUTCD “Interim Approval for Optional Use of Green Colored Pavement for Bike Lanes (IA-14).”

Bicycle boxes, which have experimental status by the MUTCD, are placed between the vehicle stop line and the pedestrian crosswalk. Bicycle boxes increase the visibility of bicyclists and provide them with the ability to start up and enter the intersection in front of motor vehicles when the signal turns green. Bicycle boxes are used at signalized intersections with high volumes of bicycle left turns. The bicycle box should be a minimum of 10 feet deep and the combined width of the bicycle lane, the buffer space, and all of the adjacent same direction traffic lanes at the intersection. Bicycle boxes provide the opportunity for bicyclists to position for a left turn.

Figure 12B-3.08: Bicycle Box



Source: Adapted from *Urban Bikeway Design Guide, NACTO*

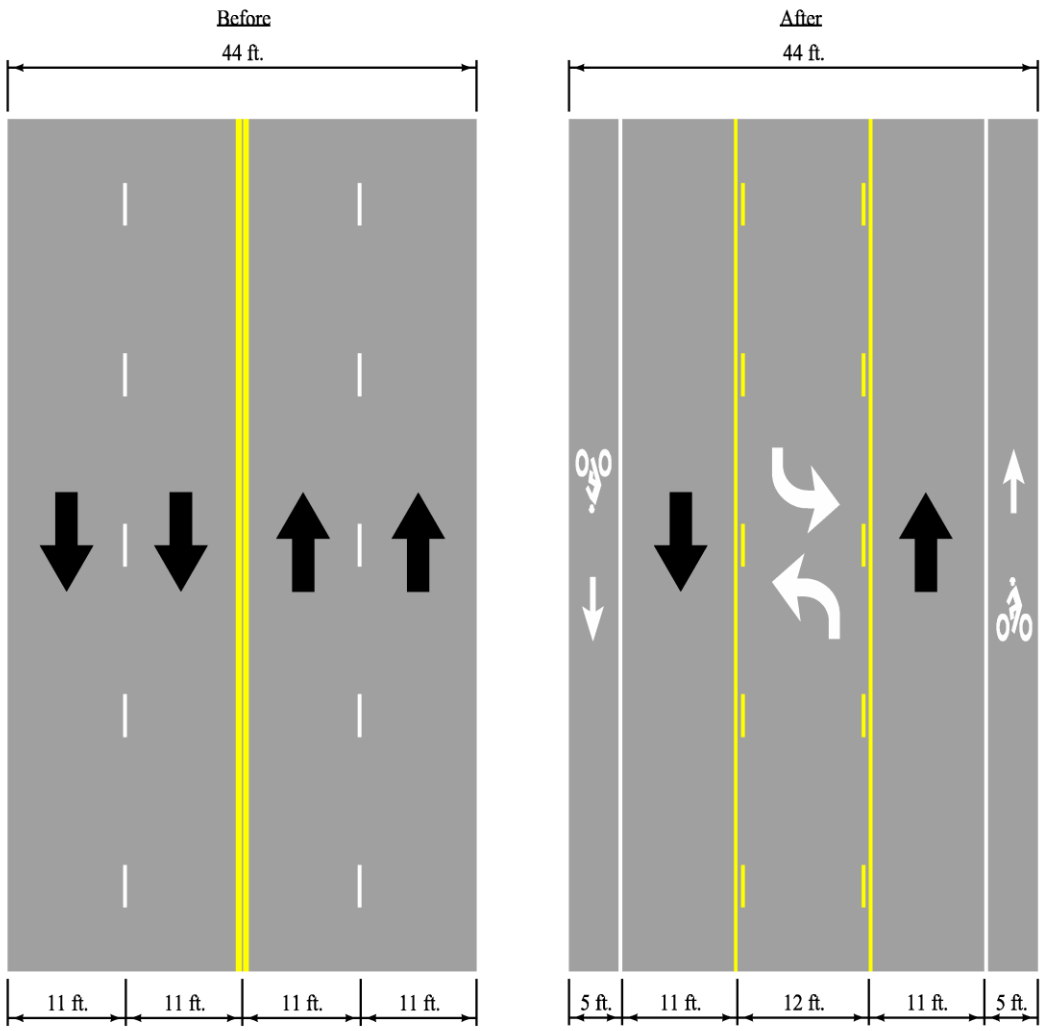
Bicycle signals may be used to separate bicycle through movements from vehicle movements for increased safety. They should only be used in combination with a conventional traffic signal. Bicycle signal heads use the traditional green, yellow, and red indications but have bicycle stenciled lenses. A supplemental "Bicycle Signal" plaque should be added below the bicycle signal head. A leading bicycle signal phase, which uses a bicycle signal lens to provide three to five seconds of green time before the corresponding vehicle green indication, can be used to increase the visibility and safety for bicyclists. Bicycle signal detection is critical to appropriate operation of a bicycle signal. There are four major types of bicycle detection including induction loop, video, push-button, and microwave.

Because drivers and bicyclists in Iowa are not familiar with the use of bicycle boxes and bicycle signals, it is critical to provide extensive educational information prior to implementing either of these strategies at urban intersections.

4. **Retrofitting Bicycle Facilities on Existing Roadways:** Existing streets and highways may be retrofitted to improve bicycle accommodations by either reconfiguring the travel lanes to accommodate bicycle lanes or by widening the roadway to accommodate bicycle lanes or paved

shoulders. These retrofits are best accomplished as either a reconstruction project or a repaving project as these projects will eliminate traces of old pavement markings. (AASHTO 4.9).

Figure 12B-3.09: Example of Road Diet



* Dimensions are illustrative

Source: Adapted from *AASHTO Bike Guide* Exhibit 4.23

5. **Bicycle Boulevards:** A bicycle boulevard is described as a local street or a series of contiguous street segments that have been modified to function as a through street for cyclists while discouraging through vehicle traffic. To be effective, bicycle boulevards should be long enough to provide continuity over a distance of between 2 and 5 miles.

   Due to the low traffic volumes and speeds, local streets naturally create a bicycle-friendly environment in which the cyclists share the roadway with the vehicles. However, many local streets are not continuous enough for long bicycle routes. Therefore, in order to create a bicycle boulevard, some short sections of paths or segments may need to be constructed between local streets in order to create the continuous route.

Some design elements that are involved in the design of bicycle boulevards are:

- Traffic diverters at key intersections that allow bicycle through traffic but reduce or deny vehicle traffic
- Two-way stop-controlled intersection that give the bicycle boulevard priority
- Neighborhood traffic circles or mini-roundabouts
- Traffic-calming features
- Wayfinding signs to guide bicyclists
- Shared lane markings where appropriate
- Bicycle-sensitive traffic signals at busy intersections
- Median refuges large enough for bicycles
- Curb extensions on crossed thoroughfare with on-street parking

It is important to note that before the design of a bicycle boulevards, an investigation of the proposed boulevards should be performed since many of the design elements listed may already be in use. (AASHTO 4.10).

D. Bicycle Guide Signs

Guide signs are an important element to all bicycle facilities as they help cyclists navigate to their destination. There are many guidelines and standards that go along with the type and placement of guide signs. See both the MUTCD and AASHTO 4.11.

E. Railroad Crossings for Bicycles

Where roadways or shared use paths cross railroad tracks on a diagonal, the designer should take care in the design of the crossing as to prevent steering difficulties for the cyclists. This includes:

- Increasing the skew angle between the tracks and the bicycle path to 60 degrees or greater so bicyclists can avoid catching their wheels in the flange of the tracks. This can be accomplished with reverse curves or with a widened shoulder.
- Creating a smooth crossing surface that will last over time and not be slippery when wet.
- Minimizing flange openings as much as possible. Under special rail conditions, rubber fillers products may be used. Contact the railroad company for approval prior to the design and installation of the fillers.

See both the MUTCD and AASHTO 4.12.1.

F. Obstruction Markings for Bicycle Lanes

The design of bicycle facilities should avoid obstruction and barriers as much as possible. However, in rare circumstance in which an obstruction or barrier cannot be avoided, signs, reflectors, and markings should be utilized to alert they cyclists. (AASHTO 4.12.2).

G. Traffic Signals for Bicycles

Traffic signals have traditionally been designed based off the operating characteristics of motor vehicles. However, at intersections with medium to high bicycle usage that incorporates shared lanes or bicycle lanes, traffic signal designers should include the characteristics of bicyclists to their traffic signals. The signal parameters that could be modified to accommodate bicyclists when appropriate are minimum green interval, all-red interval, and extension time. This information can be found in AASHTO 4.12.3 and 4.12.4 as well as the latest edition of the “Highway Capacity Manual.”

H. Bridges and Viaducts for Bicycles

Two considerations should be taken into account before the design of bicycle accommodations with bridges - the length of the bridge and the design of the approach roadway. If the bridge approach does not include bicycle accommodations, the bridge can still facilitate use by bicyclists by including a wide shoulder or bicycle lanes and include paved shoulder, shared lanes, or shared use path as part of the bridge project. Additionally, if the bridge is continuous and spans over a 1/2 mile in length with speed of excess of 45 mph, a concrete barrier separated shared use path on both sides of the bridge should be considered. By allowing paths on both sides of the bridge, wrong-way travel of the cyclists will be deterred. (AASHTO 4.12.5).

I. Traffic Calming and Management of Bicycles

There are many things that a designer can do to reduce the traffic speed of cyclists and to manage bicycles effectively. These things include narrowing streets to create a sense of enclosure; adding vertical deflections such as speed humps, speed tables, speed cushions, and raised sidewalks; adding curb extension or chokers; adding chicanes; installing traffic circles; and incorporating multi-way stops. (AASHTO 4.12.6 and 4.12.7).

J. Intake Grates and Manhole Castings for Bicycle Travel

It is important to have intake grate openings run perpendicular to the direction of travel as this will prevent bicycle wheels from dropping into the gaps and causing crashes. SUDAS Specifications Figure 6010.603, Type R and Type S, are intake grates that are appropriate for use on bicycle routes. Where it is not immediately feasible to replace existing grates, metal straps can be welded across slots perpendicular to the direction of travel at a maximum longitudinal spacing of 4 inches. Additionally, open-throat intakes can be used instead of grate intakes in order to eliminate the grate all together. The presence of the depressed throat of the intake should be taken into account.

Surface grates and manhole castings should be flush with the roadway surface. In the case of overlays, the grates and castings should be raised to within 1/4 inch of the new surface. If this is not possible or practical, the pavement must taper into drainage inlets so it does not have an abrupt edge at the inlet. Take care in the design of the taper of the pavement around inlets and castings so to avoid “birdbaths” or low spots that are not drainable in the pavement. (AASHTO 4.12.8).

K. Bicycles at Interchanges

When designing bicycle facilities at interchanges, it is important to consider both safety and convenience for the cyclists. This is best achieved by designing right-angle intersection or single lane roundabouts at the intersection between the local route and the ramps. These designs promote low speeds, minimize conflict areas, and increase visibility. Additionally, stop signs or signals are encouraged for motorists turning from the off ramp to the local route rather than allowing a free-flowing movement as this will increase the safety of the cyclists.

At complex interchanges that include high-speeds and free-flowing motor vehicle movements, a well signed and clearly directed grade-separated crossings may be necessary. These grade-separated facilities should still include good visibility, be convenient, and consist of adequate lighting. (AASHTO 4.12.9).

L. Bicycles at Roundabouts

In designing roundabouts for bicycle usage, single lane roundabouts are safer and easier to navigate for cyclists. Multi-lane roundabouts include too many conflict points due to bicycle weaving/changing lanes and motorist cutting off cyclists when exiting the roundabout.

In instances of bicycle lanes approaching a roundabout, the bicycle lane should be terminated at least 100 feet from the edge of the entry curve of the roundabout and prior to the crosswalk. Also, prior to the roundabout and after the termination of the bicycle lane, a tapering of the bicycle lane to the travel lane should be provided. This is done to achieve the appropriate entry width for the roundabout and the taper should be 7:1 for a 20 mph design speed or 40 feet for a 5 to 6 foot bicycle lane. Additionally, the bicycle lane line should be dotted 50 to 200 feet in advance of the taper to encourage cyclists to merge into traffic.

In rare circumstances, bicyclists should be given the option to merge with traffic prior to the roundabout or exit onto the adjacent sidewalk via a ramp. These instances include multi-lane roundabouts, high design speed roundabouts, and/or complex roundabouts. However, in some jurisdictions, cyclists riding on sidewalks may be prohibited. In designing bicycle ramps prior to a roundabout, the following criteria should be followed:

- Place bicycle ramps at the end of the full width bicycle lane and just before the taper of the bicycle lane.
- Where no bicycle lane is present on the approach to the roundabout, a bicycle ramp should be placed at least 50 feet prior to the crosswalk at the roundabout.
- Bicycle ramps should be placed at a 35 to 45 degree angle to the roadway.
- If the ramp is placed outside of the sidewalk, it can have up to a 20% slope; if the ramp is placed within the sidewalk, it should be designed in a manner to prevent a tripping hazard.
- If the ramp is placed outside the sidewalk, a detectable warning device should be placed at the top of the ramp; if the ramp is placed within the sidewalk, the detectable warning device should be placed at the bottom of the ramp.
- Bicycle ramps should be placed relatively far from the marked crosswalk as to prevent pedestrians from mistaking the ramp as a crosswalk.

Bicycle ramps at the exits of roundabouts should be built with the similar geometry and placement as the ramps that are designed at roundabout entries. Bicycle ramps at the exits of roundabouts should be placed at least 50 feet beyond the crosswalk of the roundabout. Refer to AASHTO 4.12.10 and the FHWA Roundabout Guide.

M. References

American Association of State Highway and Transportation Officials (AASHTO). *A Policy on Geometric Design of Highways and Streets* (“Green Book”). Washington, DC. 2004.

American Association of State Highway and Transportation Officials (AASHTO). *Guide for the Development of Bicycle Facilities*. Fourth Edition. Washington, DC. 2012.