SUDAS Revision Submittal Form

Status Date:	As of 5/12/2017	**Topic:**	Buffered and separated bicycle lanes
Manual:	Design	**Manual Location:**	Sections 5M-1, C, 8 and 12B-3, C, 3

Requested Revision:

Section 5M-1 (Complete Streets), C (Design Elements)

8. **Bicycle Facilities:** Bicycle facilities provide opportunities for a range of users and are a fundamental element of complete streets design. In Iowa, bicycles are legally considered a vehicle and thus have legal rights to use any street facility unless specifically prohibited. They also have legal responsibilities to obey all traffic regulations as a vehicle. Bicycle facilities generally are one of the following three types:

   a. **Shared Use Paths:** Separate travel ways for non-motorized uses. Bicycles, pedestrians, skaters, and others use these paths for commuting and recreation. Generally used by less experienced bicyclists.

   b. **Shared Lanes:** These are lanes shared by vehicles and bicycles without sufficient width or demand for separate bicycles lanes. They made be marked or unmarked. Low speed, low volume residential streets generally will not have pavement markings. For higher speed or higher volume facilities, sharrow pavement markings and signage are used to remind drivers of the presence of bicyclists in the travel lane. Placing the sharrow markings between vehicle wheel tracks increases the life of the marking. These types of shares lanes are used more for commuting than recreation.

   c. **Bicycle Lanes:** ~~Dedicated lanes used on higher speed, higher volume streets separated from vehicle lanes or on-street parking spaces by pavement markings. No specific standards for when to use bike lanes exist, but conflicts between bikes and vehicles in shared lanes generally become problematic when vehicular volumes exceed 3,000 to 5,000 ADT and operating speeds are 30 mph or greater. Bicycle lanes should be a minimum of 5 feet wide on curbed pavements and 4 feet wide on rural cross-sections. If possible, a buffer zone of 3 feet should be provided between the bike lane and the on-street parking area to minimize conflicts with bikes and opening vehicle doors. These lanes are generally used by experienced bicyclists for commuting.~~ Dedicated bicycle lanes are used to separate higher speed vehicles from bicyclists to improve safety. Conflicts in shared lanes generally becomes problematic when vehicular volumes exceed 3,000 vehicles per day and operating speeds are 30 mph or greater. Use of bicycle lanes will influence the capacity of the roadway unless widening is possible. The mobility and potential safety benefits of the bicycle lanes need to be evaluated against the capacity impacts. There are generally three types of bicycle lanes:
      1) **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.
      2) **Buffered:** Conventional bicycle lanes coupled with a designated buffer space separating the bicycle lane from adjacent motor vehicle lanes and/or a parking lane.
      3) **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 called cycle tracks or protected bicycle lanes.

   Design information for each bicycle facility type is detailed in Sections 12B-1 through 12B-3. Bicycle parking facilities at destination points will assist in encouraging bicycle usage.

Snow and ice control activities impact vehicular lanes and bicycle lanes differently. Generally plows will leave some snow on the pavement. Vehicles are able to travel through this material but bicyclists may have more difficulty. In addition, the material may refreeze and make bicycle use more treacherous.

~~Design information for each bicycle facility type is detailed in Sections 12B-1 through 12B-3. Bicycle parking facilities at destination points will assist in encouraging bike usage.~~

Section 12B-3 (On-Street Bicycle Facilities), C (Facilities)

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.
      ~~a.~~**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.
      ~~b.~~**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.

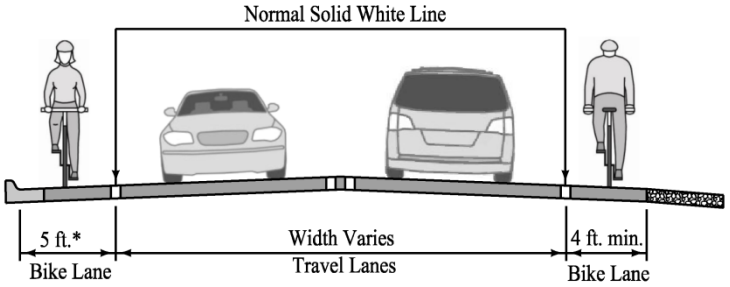
In some designated one-way streets, it may be preferred to provide bicyclists a contra-flow bicycle lane using markings and separated by a double yellow centerline. This design should be used where there are few intersecting driveways, alleys, and streets on the side of the street with the contra-flow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

~~c.~~**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: ~~Typical~~ Conventional Bicycle Lane Cross-sections - Parking Prohibited

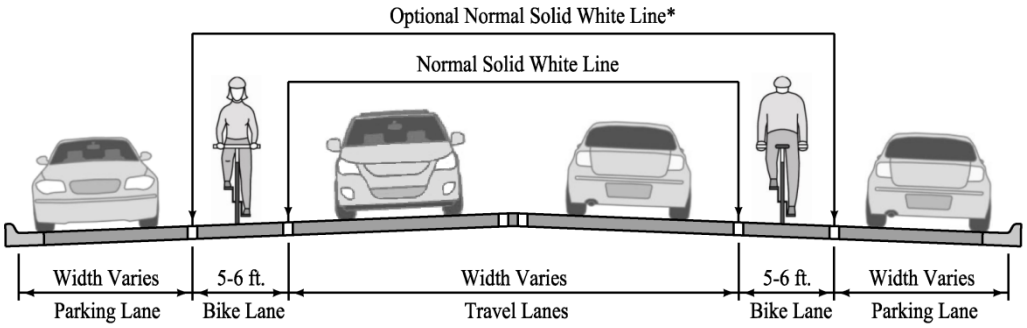


* On extremely constrained, low-speed roadways with curbs but no gutter, where the preferred bicycle lane width cannot be achieved despite narrowing all other travel lanes to their minimum widths, a 4 foot wide bicycle lane can be used.

Source: Adapted from *AASHTO Bike Guide* Exhibit 4.13

~~d.~~**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: ~~Typical~~ Conventional Bicycle Lane Cross-sections - On-street Parking

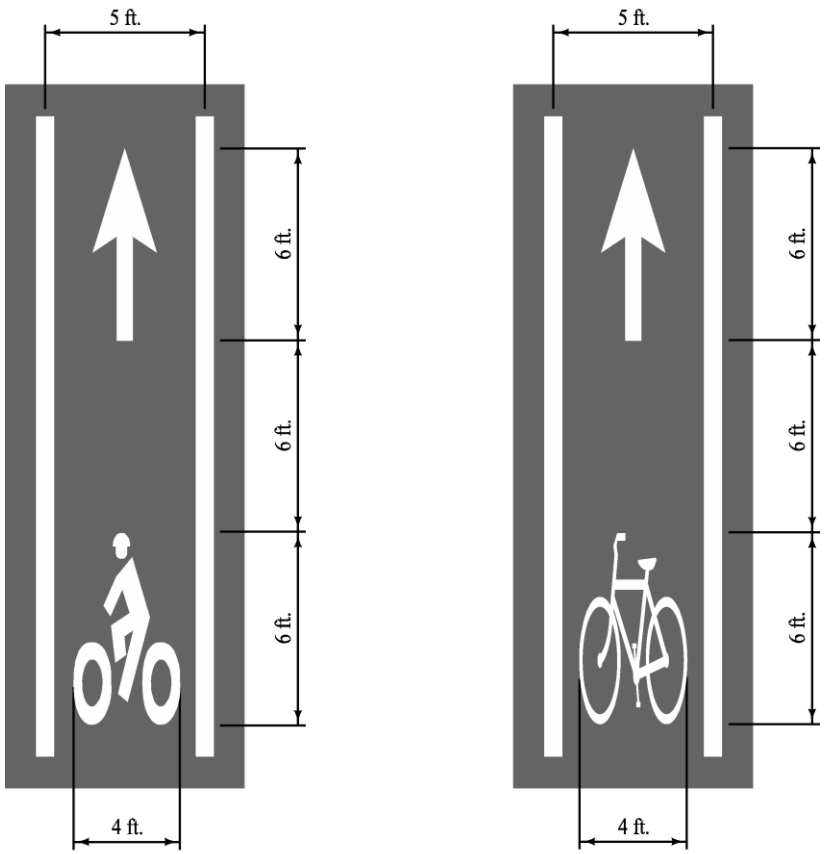


* The optional normal (4 to 6 inch) solid white line may be helpful even when no stalls are marked (because parking is light), to make the presence of a bicycle lane more evident. Parking stall markings may also be used.

Source: Adapted from *AASHTO Bike Guide* Exhibit 4.13

~~e.~~**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.

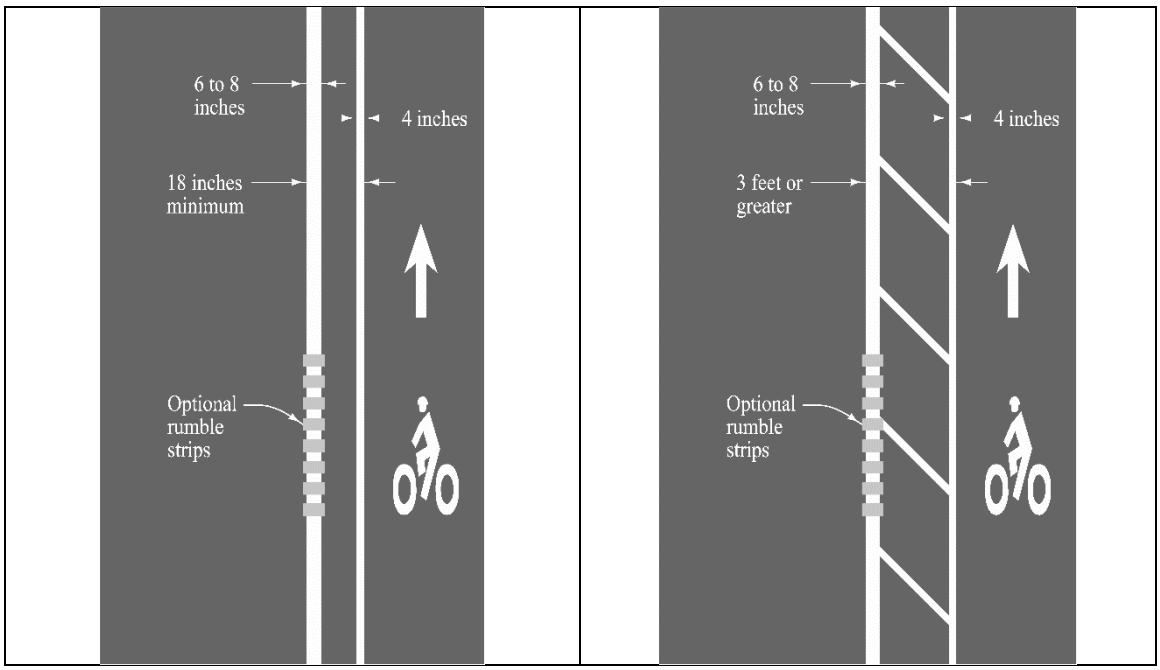
Figure 12B-3.04: Conventional Bicycle Lane Symbol Markings



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 bike lane. Placement of rumble strips should be in accordance with Iowa DOT requirements.

Figure 12B-3.05: Buffered Bicycle Lane Markings



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

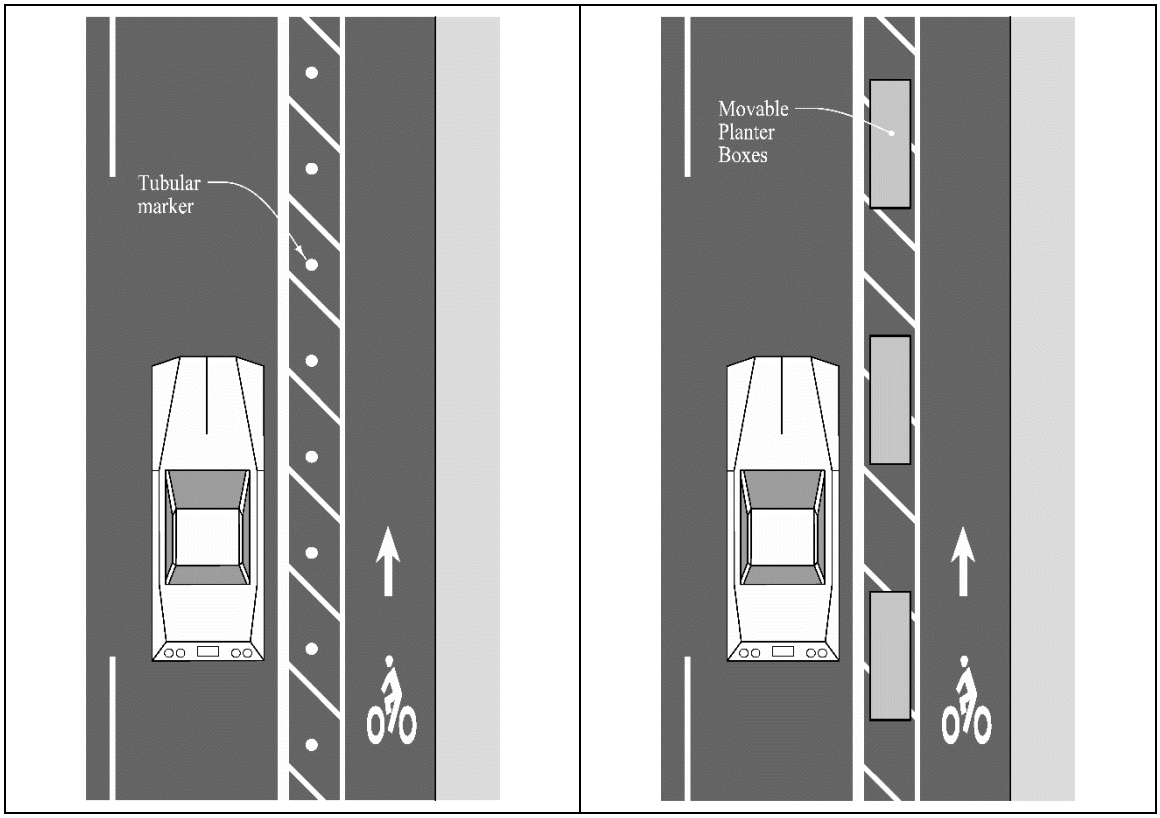
c. Separated: An exclusive facility for bicyclists that is physically separated from motor vehicle or parking lanes by a vertical element. Separated bicycle lanes are also sometimes called cycle tracks or protected bicycle lanes. Examples of vertical separation include delineators, bollards, curbs, medians, 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



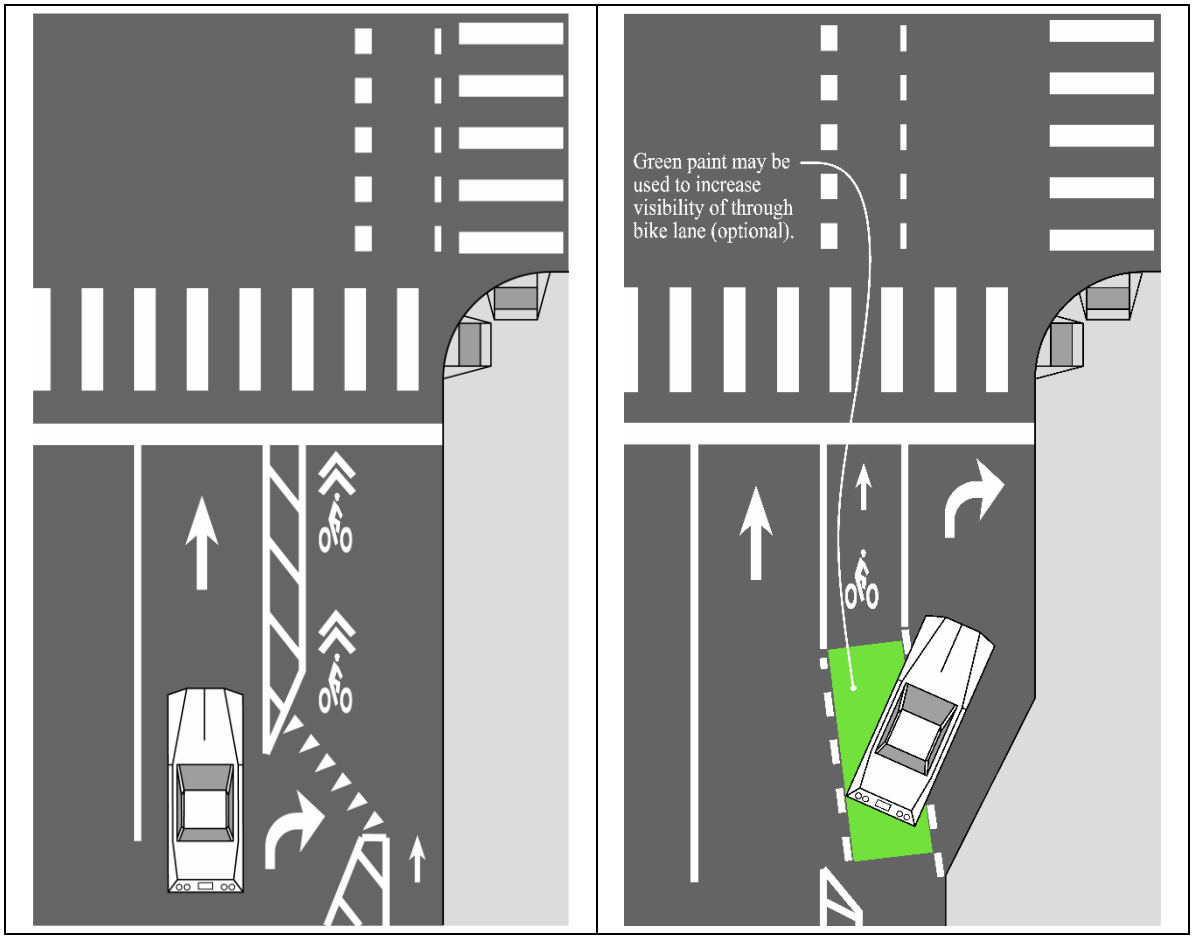
Source: Adapted from *Urban Bikeway Design Guide, NACTO*

fd. Intersection Design: Most conflicts between motor vehicles and bicyclists 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

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

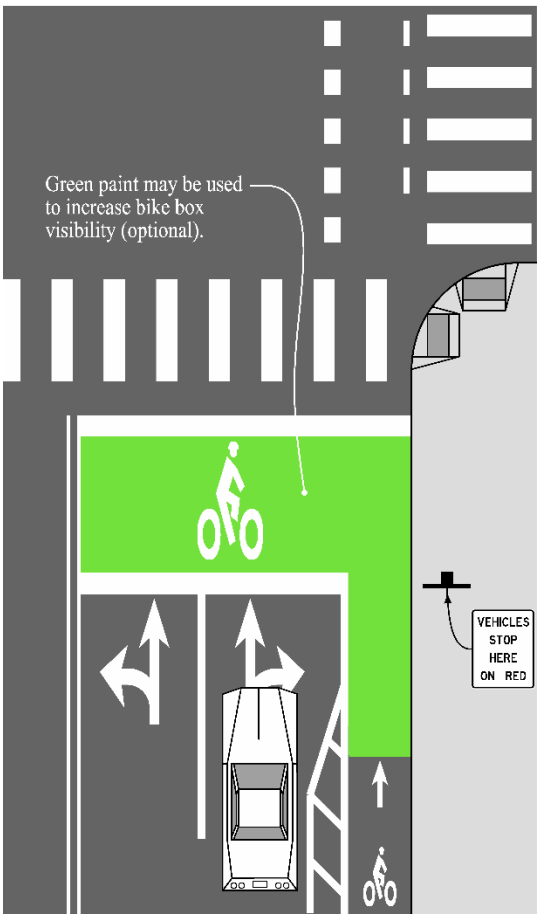


Source: Adapted from *Urban Bikeway Design Guide, NACTO*

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 bike boxes and bicycle signals, it is critical to provide extensive educational information prior to implementing either of these strategies at urban intersections.

Reason for Revision: Provide additional information about design of buffered and separated bicycle lanes.

Comments: None.

District:	☐ 1 ☐ 2 ☐ 3 ☒ 4 ☐ 5 ☐ 6
Initial Comments:	None.
Final Comments:	None.
Action:	☐ Deferred ☐ Not Approved ☒ Approved

District:	☐ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6
Initial Comments:	None.
Final Comments:	Add rumble strips in the buffer area as a reminder to the driver to not drive into the bicycle lane. *Note - done.*
Action:	☐ Deferred ☐ Not Approved ☒ Approved

District:	☒ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
Initial Comments:	None.
Final Comments:	Maybe need to add guidance on rumble strips (how to handle in jointed pavement) in the PCC section of the Design Manual. Show radius at corners. *Note - done.*
Action:	☐ Deferred ☐ Not Approved ☒ Approved

District:	☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
Initial Comments:	None.
Final Comments:	None.
Action:	☐ Deferred ☐ Not Approved ☒ Approved

District:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☒ 6
Initial Comments:	Change Figures 12B-3.02 and 12B-3.03 to "Conventional" rather than "Typical" in the title. *Note - done.*
Final Comments:	The arrow heads on multiple figures are too small and hard to see; make them all uniform. *Note - done.*
Action:	☐ Deferred ☐ Not Approved ☒ Approved

District:	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☒ 5 ☐ 6
Initial Comments:	This district is concerned about educating the public about what these pavement markings and information mean - similar to the flashing yellow arrow. In general, this district was very concerned about the safety in some of these scenarios. *Note - a statement was added to advise the designer about educating the public.*
Final Comments:	None.
Action:	☐ Deferred ☐ Not Approved ☒ Approved

Final District Action Summary: All 6 districts approved; see comments above.

Board of Directors Action: In Section 5M-1, C, 8, b, add "or higher volume" to the 4th sentence. Add some color to the figures. In Section 12B-3, C, b, make the language consistent 3 feet or greater vs. greater than 3 feet. Approved with changes. *Note - done.*