

L E S S O N 1 9

Bicycle Lanes

19.1 Purpose

The AASHTO *Guide for the Development of Bicycle Facilities* defines a bike lane as “a portion of a roadway which has been designated by striping, signing, and pavement markings for the preferential or exclusive use of bicyclists.” As levels of bicycling have increased in the United States, there has been a growing amount of support for bike lanes on urban and suburban roadways. Bike lanes are a preferred facility type in European countries, and in North America, nearly every major city has made an effort in recent years to install bicycle lanes, either as “pilot projects” (to test their success) or, in many cases, on larger networks of interconnecting roadways. Several small towns have led the way in establishing networks of bicycle lanes, particularly college towns where there are high levels of student bicycle commuters (e.g., University of California at Davis and University of Texas at Austin).

As a relatively new feature in the roadway cross-section, bike lane design has been the topic of much study in recent years. Bike lane design can be quite challenging in situations where the existing urban traffic patterns are complex and cross-sections are already constrained by heavy traffic

volumes. Designers throughout the country develop new and better solutions each year. This section includes excerpts from several sources, including Oregon’s *1995 Bicycle and Pedestrian Plan* and Philadelphia’s *Bicycle Network Plan*.

Note: The Europeans have pioneered innovative bike lane design solutions. Lesson 22 includes a description of European approaches that have been successful.

As with the other bicycle facility design issues covered in this manual, bike lane design is covered in



some detail by the AASHTO *Guide for the Development of Bicycle Facilities*. This text should be referenced for additional information.

19.2 Bicycle Lane Widths and Construction Standards

Bicycle lanes serve the needs of all types of cyclists in urban and suburban areas, providing them with their own travel lane on the street surface. The minimum width of a bike lane should be 1.5 meters (5 feet) against a curb or adjacent to a parking lane. On streets where the bike lane is adjacent to the curb and the curb includes a 1-foot to 2-foot gutter pan, bike lanes should be a minimum of 4 feet wide (width does not include the gutter pan, since bicyclists are typically unable to use this space).

Wider bike lanes are recommended on streets with higher motor vehicle speeds and traffic volumes, or where pedestrian traffic in the bike lane is anticipated. Width measurements are taken from the curb face to the bicycle lane stripe.

Since bicyclists usually tend to ride a distance of 0.8 meters to 1.1 meters (2.5 feet to 3.5 feet) from the curb face, it is very important that the pavement surface in this zone be smooth and free of structures. Drain inlets and manholes that extend into this area cause bicyclists to swerve, having the effect of reducing the usable width of the lane. Where these structures exist and the surface cannot be made smooth, bike



As a temporary solution, striping narrow lanes through intersections may be an option where space is limited.

lane width should be adjusted accordingly. Regular maintenance is critical for bike lanes (see text in this section).

Bike lanes should be constructed to normal full-depth pavement standards since motor vehicles will occasionally cross them, or may use them as a breakdown area.

19.3 Unmarked Lanes

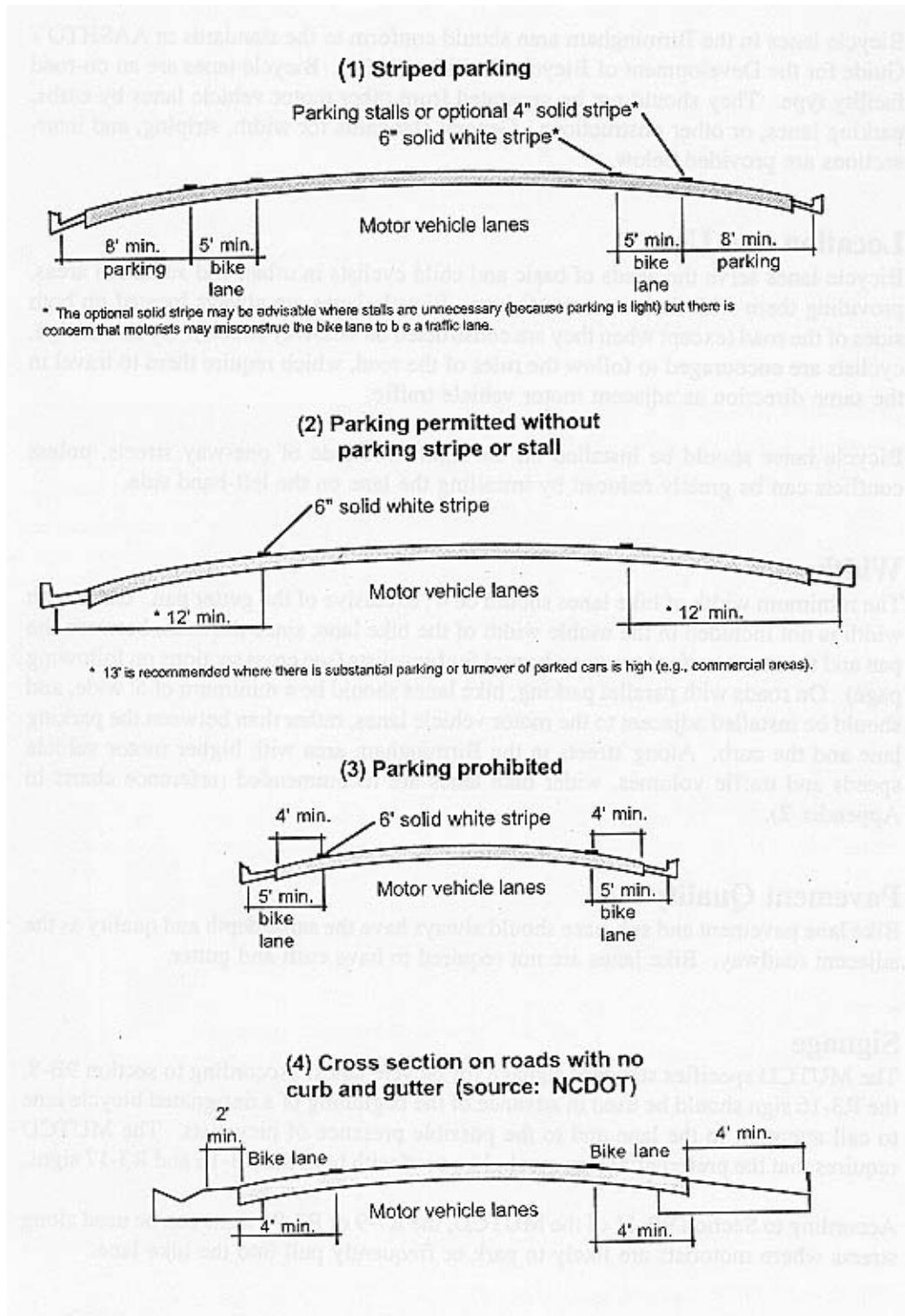
Where the minimum widths listed above cannot be met, it may be possible to provide an unmarked lane. Studies have shown that the bicyclist's perceived level of comfort is higher when a striped area is provided; therefore, this method can raise the bicycle level of service for the street. An unmarked lane is a striped area of 0.6 m (2 ft) wide or more that contains no markings or signing that would denote it as a bike lane. "Share the Road" signs may be used to caution motorists to be alert for bicyclists.

It is important to recognize that this is a temporary solution. Particularly on busy streets, narrow unmarked lanes will not adequately serve the needs of the majority of bicyclists.

19.4 Location Within the Street Cross-Section

Bicycle lanes are always located on both sides of the road on two-way streets. Since bicyclists must periodically merge with motor vehicle traffic, bike lanes should not be separated from other motor vehicle lanes by curbs, parking lanes, or other obstructions. Two-way bike lanes on one side of two-way streets create hazardous conditions for bicyclists and are not recommended.

On one-way streets, bicycle lanes should be installed on the right-hand side, unless conflicts can be greatly reduced by installing the lane on the left-hand side. Left-side bicycle lanes on one-way streets may also be considered where there are frequent bus or trolley stops, unusually high numbers of right-turning motor vehicles, or if there is a significant number of left-turning bicyclists.



Bicycle lanes provided under different types of conditions. Source: AASHTO Guide for the Development of Bicycle Facilities, 1991.

19.5 Practices To Be Avoided

Two-Way Bike Lane

This creates a dangerous condition for bicyclists. It encourages illegal riding against traffic, causing several problems:

- At intersections and driveways, wrong-way riders approach from a direction where they are not visible to motorists.
- Bicyclists closest to the motor vehicle lane have opposing motor vehicle traffic on one side and opposing bicycle traffic on the other.
- Bicyclists are put into awkward positions when transitioning back to standard bikeways.

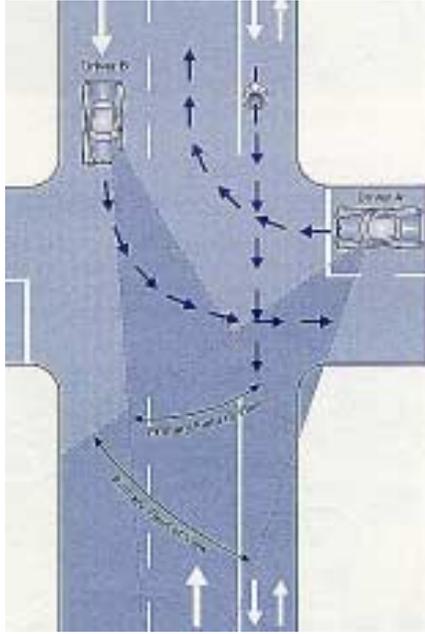
If constraints allow widening on only one side of the road, the centerline stripe may be shifted to allow for adequate travel lanes and bike lanes:

Continuous Right-Turn Lanes

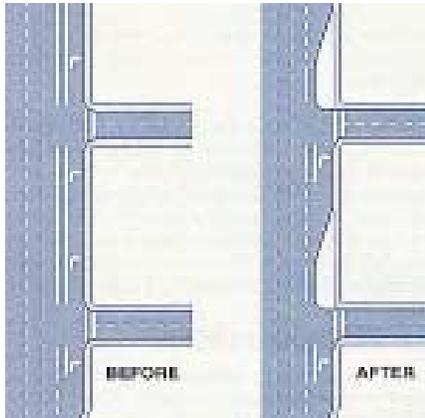
This configuration is difficult for cyclists: Riding on the right puts them in conflict with right-turning cars, but riding on the left puts them in conflict with cars merging into and out of the right-turn lane. The best solution is to eliminate the continuous right-turn lane, consolidate accesses, and create well-defined intersections.

19.6 Contra-Flow Bike Lanes

Contra-flow bike lanes on a one-way street are not usually recommended. They may encourage cyclists



In both cases above, a wrong-way bicyclist is not in the driver's main field of vision.



Continuous right-turn lane reconfigured to standard approaches.

to ride against traffic, which is contrary to the rules of the road and a leading cause of bicycle/motor vehicle crashes.

There are, however, special circumstances when this design may be advantageous:

- A contra-flow bike lane provides a substantial savings in out-of-direction travel.
- The contra-flow bike lane provides direct access to high-use destinations.
- Improved safety because of reduced conflicts on the longer route.
- There are few intersecting driveways, alleys, or streets on the side of the contra-flow lane.
- Bicyclists can safely and conveniently re-enter the traffic stream at either end of the section.
- A substantial number of cyclists are already using the street.
- There is sufficient street width to accommodate a bike lane.

A contra-flow bike lane may also be appropriate on a one-way residential street recently converted from a two-way street (especially where this change was made to calm traffic).

For a contra-flow bike lane to function well, these special features should be incorporated into the design:



Contra-flow bike lanes can provide direct access to high-use destinations.

- The contra-flow bike lane must be placed on the right side of the street (to motorists' left) and must be separated from oncoming traffic by a double yellow line. This indicates that the bicyclists are riding on the street legally, in a dedicated travel lane.
- Any intersecting alleys, major driveways, and streets must have signs indicating to motorists that they should expect two-way bicycle traffic.
- Existing traffic signals should be fitted with special signals for bicyclists; this can be achieved with either loop detectors or push buttons (these should be easily reached by bicyclists without having to dismount).

Note: Under no circumstances should a contra-flow bike lane be installed on a two-way street, even where the travel lanes are separated by a raised median.

19.7 Bike Lane Pavement Markings

The *Manual on Uniform Traffic Control Devices* (MUTCD) section 9C addresses standard bike lane markings. The stripe between the bicycle lane and the adjacent motor vehicle lane should be a 100-millimeter (4 inch) wide white line (minimum width). Six- to eight-inch-wide lines provide an even clearer division of space, and are highly recommended.

Where parking is allowed next to a bike lane, the parking area should be defined by parking space markings or a solid 100 millimeter (4 inch) wide stripe.

Care should be taken to use pavement striping that is durable, yet skid-resistant. Reflectors and raised markings in bike lanes can deflect a bicycle wheel, causing a bicyclist to lose control. If reflective pavement markers are needed for motorists, they should be installed on the motorist's side of the stripe, and have a beveled front edge.

While the 1988 edition of the MUTCD recommends the use of the diamond-

shaped preferential lane symbol in conjunction with bike lane signs, this symbol is often confusing for both the bicyclist and motorist. For this reason, subsequent editions of the MUTCD will probably eliminate the use of the diamond in bike lanes. The new standard pavement markings for bicycle lanes are the bicycle symbol (or the words BIKE LANE) and a directional arrow.

19.8 Bike Lane Signing

The *Manual on Uniform Traffic Control Devices* (MUTCD) section 9B addresses standard bike lane signing. According to section 9B-8, the R3-16 sign should be used in advance of the beginning of a



Bike lane signs should be replaced with bike lane stencils, with optional NO PARKING signs where needed.

designated bicycle lane to call attention to the lane and to the possible presence of bicyclists. In locations where bicycle lanes are ending, the same R3-16 sign should be used, with the word ENDS substituting for the word AHEAD. The R7-9 or R7-9a signs should be used along streets where motorists are likely to park or frequently pull into the bike lane.

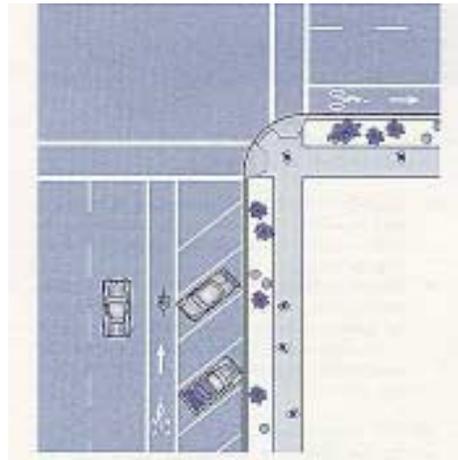
19.9 Diagonal Parking

Diagonal parking causes conflicts with bicycle travel: Drivers backing out have poor visibility of oncoming cyclists and parked vehicles obscure other vehicles backing out. These factors require cyclists to ride close to the center of a travel lane, which is intimidating to inexperienced riders.

Where possible on one-way streets, diagonal parking should be limited to the left side, even if the street has no bike lane; on one-way streets with bike lanes, the bike lane should be placed adjacent to parallel parking (preferably on the right).

Bike lanes are not usually placed next to diagonal parking. However, should diagonal parking be required on a street planned for bike lanes, the following recommendations can help decrease potential conflicts:

- The parking bays must be long enough to accommodate most vehicles.
- A 200-millimeter- (8-inch-) wide stripe should separate the parking area from the bike lane.
- Enforcement may be needed to cite or remove vehicles encroaching on the bike lane.



Bike lane next to diagonal parking, 8-inch stripe should separate the areas.

19.10 Bike Lane Design at Intersections

Intersections With Bus Stops

If there is a bus stop at the near side of the intersection, a broken line should extend the length of the bus stop (no less than 15 meters [50 feet]), and the solid white line should resume on the far side of the intersection, immediately after the crosswalk. If a bus stop is located on the far side of the intersection, the solid white

line on the far side of the intersection should be replaced with a broken line for a distance of at least 24 meters (80 feet) from the crosswalk (at this intersection, a broken line would still be required on the near side if there is right-turning traffic).

Intersections With Right-Turn Lanes

In general, right-turn lanes should be used only where warranted by a traffic study, as they present problems for both bicyclists and pedestrians:

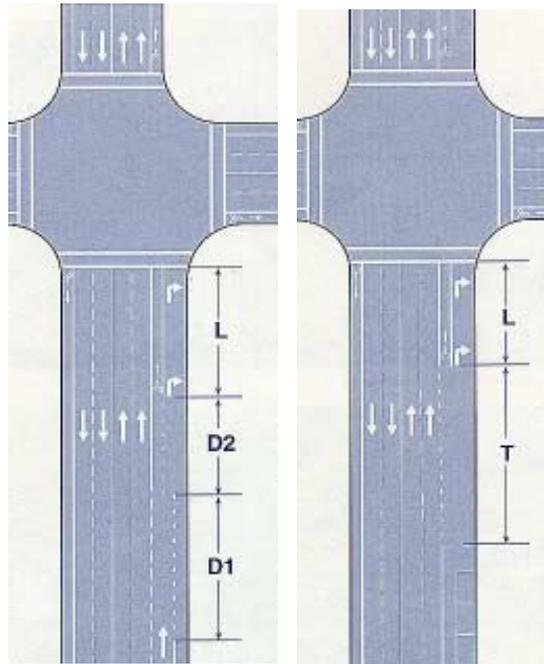
- If right-turning cars and through bicyclists must cross paths.
- If the additional lane width adds to the pedestrian crossing distance.
- If right-turn moves are made easier for motorists, which may cause inattentive drivers to not notice pedestrians on the right.

The through bike lane to the left of a right-turn lane should be striped with two 100-millimeter- (4-in-) wide stripes and connected to the preceding bike lane with 0.9-meter (3-foot) dashes and 2.7-meter (9-foot) spaces. This allows turning motorists to cross the bike lane. A legend must be placed at the beginning of the through bike lane. Sign R4-4, BEGIN RIGHT TURN LANE, YIELD TO BIKES, may be placed at the beginning of the taper in areas where a through bike lane may not be expected.

Not all intersections can be widened to provide a right-turn lane. A bike lane to the left of right-turning cars should still be provided. One common configuration occurs where a right-turn lane is developed by dropping parking (see figure at right).

Another configuration occurs where a lane is dropped and turns into a right-turn lane.

Note: This is a difficult movement for bicyclists as they must merge left and find a gap in the traffic stream:



Above left: Bike lane left of right-turn lane developed by dropping a travel lane. Above right: Bike lane left of right-turn lane developed by dropping parking.

Exception #1: Heavy Right Turns

If the major traffic movement at an intersection is to the right, and the straight through move leads to a minor side street, then the bike lane may be placed on the right and wrapped around the curve, assuming that the majority of cyclists will desire to turn right too. This often occurs where a highway is routed over local streets and the route is indirect.

Exception #2: Tee Intersections

At a Tee intersection, where the traffic split is approximately 50 percent turning right and 50 percent turning left, the bike lane should be dropped prior to the lane split to allow cyclists to position themselves in the correct lane. Where traffic volumes are very high, a left- and right-turning bike lane should be considered.

Offset Intersections

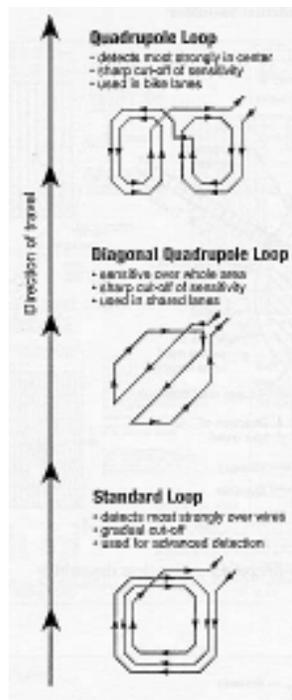
Care should be taken to ensure that motorists are not inadvertently encouraged to ride in the bike lane because of offset travel lanes. At intersections with offset lanes, dashed offset lane markings should continue through the intersection to direct traffic flow (MUTCD Section 3B-7).

Traffic Signal Actuation

It is highly recommended that new on-road bicycle facilities include traffic signals that detect bicycles for all actuated signal systems. *The Traffic Detector Handbook* (FHWA-IP-90-002) recommends several bicycle-sensitive loop configurations (loops are wires installed beneath the pavement surface that detect the presence of vehicles) that effectively detect bicycles. The quadrupole loop is the preferred solution for bike lanes, and the diagonal quadrupole loop is preferred for use in shared lanes.

One solution for existing intersection signals that do not respond to bicycles is to install a special pavement marking over the exact spot that a bicycle must stand in order to “trip” the signal.

Expressway Interchanges
Expressway interchanges often present barriers to bicycle circulation. Designs that encourage free-flowing motor vehicle traffic movements are the most difficult for pedestrians and bicyclists to negotiate.



Different loop configurations: The quadrupole loop is recommended for bike lanes.

At-Grade Crossings

Interchanges with access ramps connected to local streets at a right angle are easiest for bicyclists to negotiate. The intersection of the ramp and the street should follow established urban intersection designs. The main advantages are:

- The distance that pedestrians and bicyclists must cross at the ramps is minimized.
- Signalized intersections stop traffic.
- Visibility is enhanced.

If these configurations are unavoidable, mitigation measures should be sought. Special designs should be considered that allow pedestrians and bicyclists to cross ramps in locations with good visibility and where speeds are low.

Grade-Separated Crossings

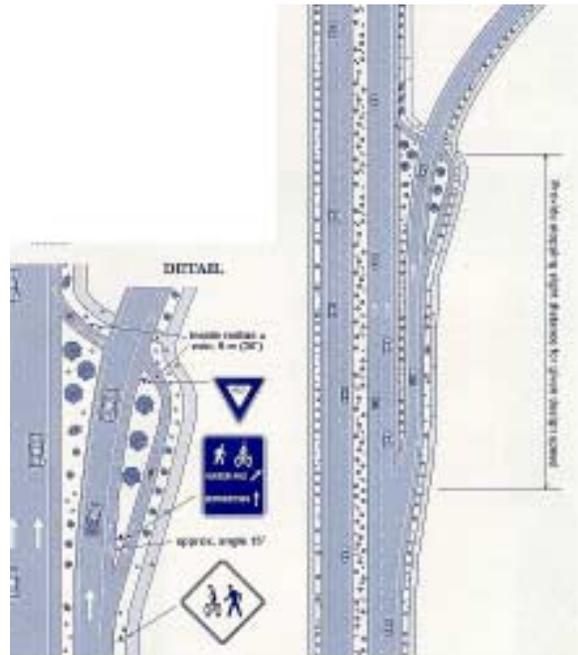
Where it is not possible to accommodate pedestrians and bicyclists with at-grade crossings, grade separation should be considered. Grade-separated facilities are expensive; they add out-of-direction travel and will not be used if the added distance is too great. This can create problems if pedestrians and bicyclists ignore the facility and try to negotiate the interchange at grade with no sidewalks, bike lanes, or crosswalks.

In some instances, a separate path can be provided on only one side of the interchange, which leads to awkward crossing movements. Some bicyclists will be riding on a path facing traffic, creating difficulties when they must cross back to a bike lane or shoulder (clear and easy-to-follow directions must be given to guide bicyclists' movements that are inconsistent with standard bicycle operation).

To ensure proper use by bicyclists, structures must be open, with good visibility (especially underpasses).

Other Innovative Designs

These concepts are presented as examples of innovative solutions to bike lane design at freeway interchanges and intersections.



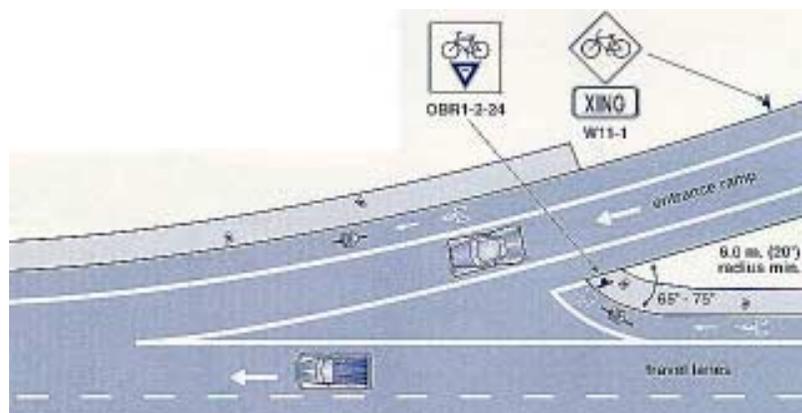
Exit ramp configuration for bike lane and sidewalks (urban design — not for use on limited-access freeways).

Traffic entering or exiting a roadway at high speeds creates difficulties for slower moving bicyclists. The following designs help alleviate these difficulties:

Right-Lane Merge

It is difficult for bicyclists to traverse the undefined area created by right-lane merge movements, because:

- The acute angle of the approach creates visibility problems.



Right-lane merge — bike lane and sidewalk configuration (urban design — not for use on limited-access freeways).

- Motor vehicles are often accelerating to merge into traffic.
- The speed differential between cyclists and motorists is high.

The following design guides bicyclists in a manner that provides:

- A short distance across the ramp at close to a right angle.
- Improved sight distances in an area where traffic speeds are slower than farther downstream.
- A crossing in an area where drivers' attention is not entirely focused on merging with traffic.

Exit Ramps

Exit ramps present difficulties for bicyclists because:

- Motor vehicles exit at fairly high speeds.
- The acute angle creates visibility problems.
- Exiting drivers often do not use their right-turn signal, confusing pedestrians and bicyclists seeking a gap in the traffic.

The exit ramp design on the previous page guides bicyclists in a manner that provides:

- A short distance across the ramp, at close to a right angle.
- Improved sight distances in an area where traffic speeds are slower than farther upstream.
- A crossing in an area where the driver's attention is not distracted by other motor vehicles.

Dual Right-Turn Lanes

This situation is particularly difficult for bicyclists. Warrants for dual turn lanes should be used to ensure that they are provided only if absolutely necessary.

The design for single right-turn lanes allows bicyclists and motorists to cross paths in a predictable manner, but the addition of a lane from which cars may also turn adds complexity: Some drivers make a last minute decision to turn right from the center lane without signaling, catching bicyclists and pedestrians unaware.

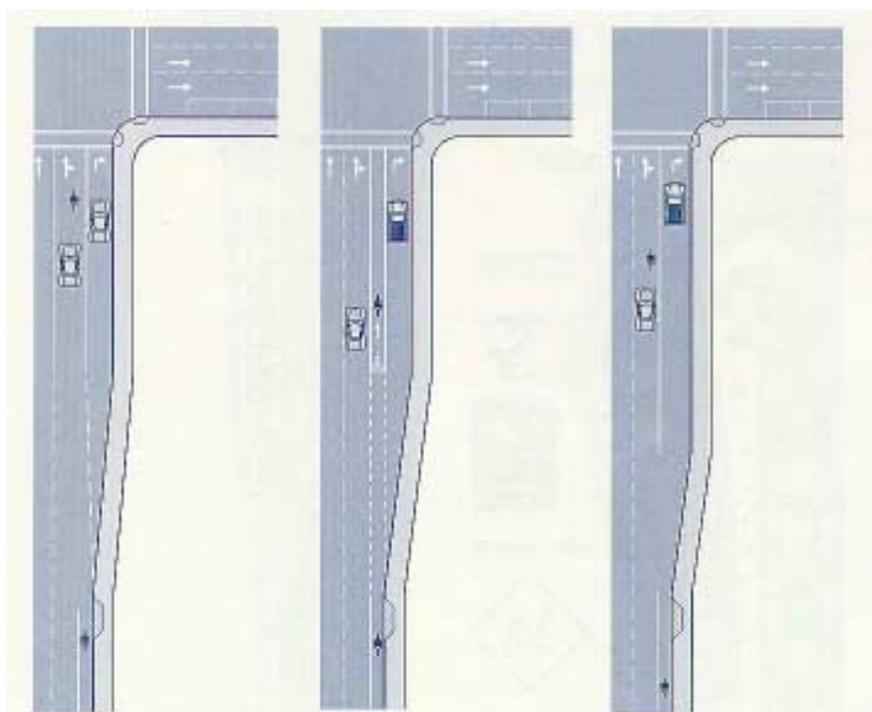
Bicyclists and motorists should be guided to areas where movements are more predictable, so bicyclists and motorists can handle one conflict at a time, in a predictable manner. A curb cut provides bicyclists with access to the sidewalk, for those who prefer to proceed as pedestrians.

- Design A (see Figure 19-13) encourages cyclists to share the optional through-right-turn lane with motorists.
- Design B guides cyclists up to the intersection in a dedicated bike lane.
- Design C allows cyclists to choose a path themselves (this design is the AASHTO recommendation—simply dropping the bike lane prior to the intersection).

A.

B.

C.



Bike lane through dual right-turn lanes.

A fourth design places an island between the right-turn lane and the optional through-right turn lane. This creates a more conventional intersection, separating the conflicts. This design is also better for pedestrians, as the island provides a refuge.

Engineering judgment should be used to determine which design is most appropriate for the situation.

Right-Turn Lane Without Room for a Bike Lane

On bike lane retrofit projects where there is insufficient room to mark a minimum 1.2-meter (4-foot) bike lane to the left of the right-turn lane, a right-turn lane may be marked and signed as a shared-use lane to encourage through-cyclists to occupy the left portion of the turn lane. This is most successful on slow-speed streets.

19.11 Exercise

Redesign a local intersection to include bike lanes. Choose an intersection with a moderate level of complexity, and assume that curb lines can be moved at will in order to achieve your design. Prepare a report and graphics that show existing conditions and recommended modifications. Signalization changes (if necessary) should also be explained, as well as any advance striping and signing needed on the intersection approaches.

19.12 References

Text and graphics in this lesson were derived from the following sources:

Oregon Department of Transportation, *Oregon Bicycle and Pedestrian Plan*, 1995.

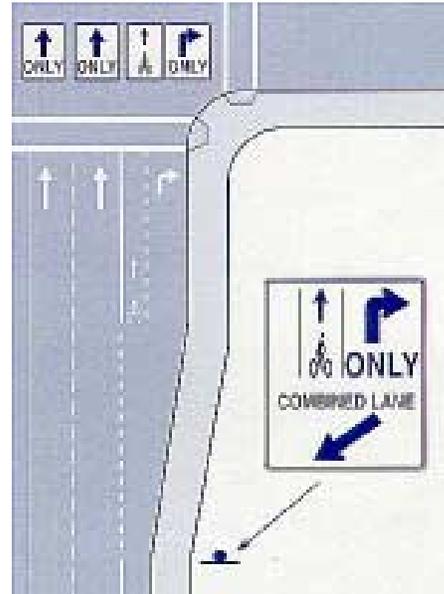
Philadelphia Department of Streets, *Philadelphia Bicycle Facility Design Guidelines*, 1998.

For more information on this topic, refer to:

AASHTO, *Guide for the Development of Bicycle Facilities*, latest edition.

ITE Technical Committee 6A-55, *Review of Planning and Design Standards for Bicycle Facilities*, 1997.

USDOT, *Manual on Uniform Traffic Control Devices*, Section 9, latest edition.



Joint use of a right-turn lane for through-bicyclist.