Chapter 4: On-Road Bikeways

4-1.0 Introduction

This chapter provides guidelines to help select and design safe on-road bikeways. On-road bikeways include bicycle lanes, shared lanes, shoulders, and wide outside lanes (bikeways that are off the roadway are not covered in this chapter; for off-road bikeways see Chapter 5, Shared-Use Paths).

Section 4-2 provides a framework for considering factors that affect bikeway selection and design, and Section 4-2.2 includes Bikeway Design Selection Tables to assist designers in selecting an appropriate type of on-road bikeway. Section 4-3 provides detailed information about design and construction of specific on-road bikeway configurations, while Section 4-4 provides information for design of bikeways at intersections. Section 4-5 and 4-6 cover retrofitting existing roadways to better accommodate bicycles, and other considerations for on-road bikeways.

On-road bikeways must be considered at the same time as other elements of the roadway in all projects during scoping, preliminary design and final design.

Many of the same factors that are used to determine appropriate roadway design in new construction, reconstruction and rehabilitation are also used to determine appropriate bikeway design. Decisions regarding bikeways will potentially affect major project elements including roadway cross section, grading, drainage, right-of-way requirements, signs, striping, traffic barriers, lighting and signals, as well as operation and maintenance.

Existing roadways that are not being reconstructed provide many opportunities to improve safety for bicyclists and other users. Bikeways should be considered in all projects, including pavement surface overlay projects, signal replacement, re-striping or pavement maintenance. Bikeways can be retrofitted onto existing streets and roads without construction by making reasonable changes with signs, striping, lighting, traffic signals, operation, and maintenance.

Figure 4-1: Children in a Bicycle Lane
The following four basic types of on-road bikeways are discussed in this chapter:

**Bicycle Lane (Bike Lane):**
A bike lane is a portion of the roadway or shoulder designated for exclusive or preferential use by people using bicycles. Bicycle lanes are distinguished from the portion of the roadway or shoulder used for motor vehicle traffic by striping, marking, or other similar techniques.

**Paved Shoulder:**
The shoulder is the edge or border of a roadway that is contiguous with, and on the same level as, the regularly traveled lanes. Bicyclists require a paved surface for operation. Any unpaved shoulder width does not accommodate bicycles. The width of a shoulder bikeway and separation from the travel lane depend primarily on roadway motor vehicle speed and traffic volume.

**Shared Lane:**
On any roadway where a bicycle may legally be operated, bicycles may need to share a travel lane with motor vehicles if the road does not have a bike lane, a paved shoulder or a separate shared-use path. A shared travel lane may be an appropriate bikeway on some low-speed, low-volume streets or roads. Where a shared lane is intended to be part of a bike route, it should be signed as a bikeway to direct bicyclists and inform motorists. Standard travel lanes are typically 3.3 – 3.6 m (11 – 12 ft) wide, but may vary.

**Wide Outside Lane:**
A wide outside lane (the right-most through traffic lane) is shared by bicyclists and motorists but designed with extra width to accommodate bicycles. A wide outside lane should be no less than 4.2 m (14 ft) and no more than 4.8 m (16 ft) wide.

### 4-2.0 Selecting a Bikeway Design
For new designs as well as retrofitting, there are a few key factors that are used to determine appropriate bikeway design.

For a given type of roadway cross section, motor vehicle speed and average daily traffic volume are the first factors to look at in the process of selecting a bikeway design treatment. However, bikeway design is influenced by other geometric and operational factors including the following:

- On-street parking
- Intersections and driveways
- Right-of-way constraints
- Vehicle turn lane configuration
- Number of traffic lanes
- Topography, grades, sight distances and sight lines
- Traffic composition, especially volume of large trucks
● Bus routes
● Peak-hour vehicle traffic volume
● Average daily and peak-hour bicycle traffic volume
● Bicyclist characteristics

Answers to the following questions will assist in developing the appropriate design:
● What current and anticipated traffic operations will affect the choice of a bicycle design treatment? Accurate traffic data will assist designers in selecting appropriate on-road design treatments.
● Are there right-of-way limitations?
● What kind of bicyclist is the route intended to serve? Bicyclists have different needs based on their skill and comfort in riding a bicycle. (Refer to Chapter 3 for definitions and specific needs of different types of cyclists.)

4-2.1 Consideration of Geometric and Operation Factors
The factors that affect bikeway selection and design are discussed below along with the ranges of values used to differentiate levels of need.

Traffic Volume

Average daily traffic (ADT) volume is the most readily available measure of motor vehicle traffic volume. Peak-hour volume is another commonly reported measure. These are reported from observed counts, automated counts or computer modeling. Higher motor vehicle traffic volume increases risk for bicyclists and increases the required width and separation of the bikeway. The values in Tables 4-1 and 4-2 refer to motor vehicle ADT in terms of two-way ADT.

Figure 4-2: Mixing of Bicycle and Vehicular Traffic
Motor Vehicle Speed

Higher motor vehicle speed has a negative impact on bicyclist risk and comfort unless mitigated by design treatments. Posted speed is recommended as the motor vehicle speed to use when selecting a bikeway design treatment, but consideration may be given to operating speed and design speed where they are known.

A note on motor vehicle speed

Posted speed is the maximum legal operating speed. Actual operating speed is measured by observation of traffic and is generally reported as a statistic, such as average operating speed or 85th percentile operating speed (85 percent of motorists drive at or below this speed). Design speed is defined by AASHTO as “a selected speed used to determine the various geometric design features of the roadway.” Designers are accustomed to thinking in terms of the design speed selected to determine geometric characteristics of the facility, including allowable curvature and sight distances. Posted speed and operating speed after construction may or may not be the same as the selected design speed. Posted speed in many situations is determined by policy, statute or ordinance, rather than by design speed. Observation in many settings indicates that traffic often operates at a speed greater than posted, and these observations have been confirmed by data. However, observation also indicates that many motorists reduce their speed when they see that bicyclists are present on the roadway. All roads have a posted speed, but operating speed and design speed may not be readily known. On existing roads the advisory posted speeds may be based on sight lines and other geometric factors that were achievable, given the topography and construction practices used. These considerations lead to the conclusion that posted speed should be the primary factor when selecting a bikeway design treatment, but consideration may be given to operating speed and design speed where they are known.

Roadway Cross Section

The two basic types of roadway cross section for selecting a bikeway design in this chapter are urban (curb and gutter) cross section and rural (shoulder and ditch) cross section. The rural and urban cross section highway terminology are a convention based on the presence or absence of curbing, and have nothing to do with the land use adjacent to the road. The roadway cross section, in general, includes travel lanes, turn lanes, bikeways, sidewalks, shared-use paths, drainage features (curb and gutter or shoulder and drainage ditch), medians, traffic barriers, frontage roads and other features.

Road Functional Classifications

The two major considerations in classifying the functions of highway and street networks are mobility and access. Mobility refers to the ability to travel at higher speeds over longer distances, while access refers to connections between the transportation system and adjacent land uses. There are three major functional classes: Arterial roads provide good mobility but have limited access to adjacent property, local roads provide access to each property but may
have restricted mobility, and collector roads connect local roads with arterial roads, providing both mobility and access. Functional classification is based upon traffic volume, speed, traffic composition and access. However, Mn/DOT classifies roads on the State Trunk Highway System as principal arterials, minor arterials and collectors, with local roads in that context meaning all roads of any size or function that are operated and maintained by a city or county. Therefore the Mn/DOT Road Design Manual provides design guidelines only for arterial and collector roads, but arterials and collectors are divided into low speed roads, which have a design speed less than or equal to 70 km/h (40 mph), and high speed roads, which have a design speed greater than or equal to 75 km/h (45 mph).

**On-Street Parking**

The presence of on-street parking increases the width needed in an adjacent bike lane for cyclists to maneuver around motorists entering and exiting cars in the bicycle travel path, thus bike lane width should be increased by 0.3 m (1 ft) over the width listed in Table 4-1. This is primarily a concern on streets and highways with an urban (curb and gutter) cross section. On-street parking is not allowed on high speed streets or roads (i.e. those with a design speed 75 km/h (45 mph) or greater) on the State Trunk Highway System.

**Intersections and Driveways**

Intersections and driveways are roadway features that require extra consideration and care as they relate to bikeways, and provide opportunities as well as potential difficulties for designers of bikeways. Since bicyclists generally want to reach the same destinations as motorists, these features provide access to those destinations. They also present potential locations for conflicts between motor vehicles and bicycles. Most bicycle crashes with motor vehicles occur at intersections.

**Right-of-Way Constraints**

Right-of-way needs and constraints related to bikeways should be considered throughout project planning and design. Where limited right-of-way does not accommodate a standard bikeway treatment, creative bikeway design solutions may be worked out in consultation with the Mn/DOT Bikeways and Pedestrians Section or other appropriate resource. On alignments where bicycles cannot be safely accommodated due to right-of-way constraints, the project may need to include funding of a bikeway on a parallel road or other alignment in order to meet the project purpose and need pertaining to the bicycle transportation mode.

**Vehicle Turn Lane Configuration**

Since bicyclists typically operate to the right of motorized traffic, vehicle right turn lanes are roadway features that require extra consideration and care as they relate to bikeways. Traffic flow and safety can be improved by signing and striping bike lanes as well as providing informational signs for motorists stating the rules of interaction at points where vehicle right-turn lanes cross bike lanes.
**Number of Traffic Lanes**

Intersection design treatment may depend on the number of lanes that a bicyclist or pedestrian must cross.

**Topography, Grades, Sight Distance And Sight Lines**

Additional bikeway width or separation from the roadway is needed on roads with hills or curves, as determined through a case-by-case analysis. A higher level of bicycle accommodation than indicated in Tables 4-1 and 4-2 is necessary in most cases in rough terrain, and should be considered in rolling terrain. Adequate sight distance is required when a motorist overtaking a bicycle needs to either change lane positions or slow to the bicyclist’s speed. Motorists tend to encroach on the shoulder on the inside of curves where the curve advisory speed is less than the main route speed. Inadequate sight distance and obstructed sight lines may be due to restrictive roadway geometry and/or visual obstructions such as vegetation. Bicyclist speed is strongly influenced by topography and grades. On long, steep downhills, bicyclists may approach motor vehicle speeds and may have reduced ability to stop. On uphill sections, bicyclists may need to stand up to pedal, leading to a wider bicycle track in the bikeway.

**Traffic Composition**

The regular presence of heavy vehicles (trucks, buses, and/or recreation vehicles) may decrease safety and comfort for bicyclists unless special design treatments are provided. If the percentage of trucks or other large vehicles is greater than 10 percent or greater than 250 per peak-hour, a higher level of bikeway accommodation should be used on designated bike routes by increasing the bike lane width, providing an off-road bikeway (shared-use path) or increasing the separation between the roadway and bikeway.

At speeds greater than 75 km/h (45 mph) the windblast from large vehicles may create a serious risk for bicyclists. Even at lower operating speeds, they are not compatible with bicyclists.
using a shared lane. All types of bicyclists prefer extra roadway width or separate facilities to allow greater separation from large vehicles. Many bicyclists will choose a different route or not ride at all where there is a regular presence of large-vehicle traffic unless they are able to move several meters away from them.

**Bus Routes**

Bus routes may be compatible with bikeways, or they may present unsafe conditions for bicyclists, depending on bus operation and lane configuration. On streets where buses make frequent stops, they may operate at a similar average speed as bicycles, but because the bicyclist’s speed is relatively constant while the bus makes frequent stops at the curb, they may have to pass each other many times, creating a potentially unsafe condition. Dedicated busways or transitways may provide good opportunities for bikeways.

**Peak-hour Traffic Volume**

Peak-hour volume of motor vehicles should be considered in addition to ADT, especially in regard to high-volume turning movements and at intersections where queuing of vehicles may obstruct bikeways.

**Average Daily Bicycle Volume and Peak-Hour Bicycle Volume**

These measures are not routinely reported, in part because they are difficult to obtain using automated equipment and because they are likely to be significantly higher after a bikeway is added to a street or road that does not currently have appropriate bicycle accommodations. Estimates of bicycle traffic volume may be determined by video recording a road or intersection, or a facility that is similar to the one under design, observing the tape and manually logging the data. Qualitative data may be obtained by simply observing similar facilities.

**Bicyclist Characteristics**

The types of bicyclists expected to use the bikeway may be an important consideration in some cases (see Chapter 3 for additional information). Most bikeways are designed to accommodate basic bicyclists, but advanced bicyclists and children bicyclists may have additional needs. Advanced bicyclists and bicycle commuters may have low tolerance for bikeways that require frequent stops or detours away from the road, and may choose to occupy a traffic lane instead of an inconvenient bikeway. Children bicyclists are likely to have limited bicycling ability and limited understanding of traffic rules and drivers’ perception, and they may need additional accommodation near schools and playgrounds, and at busy intersections or other locations.

**4-2.2 On-Road Bikeway Design Selection Tables**

Use Table 4-1 or Table 4-2 to select an appropriate bikeway type and width for roadways with either an urban (curb and gutter) cross section or rural (shoulder and ditch) cross section, based on expected motor vehicle speed and traffic volume. The bikeway widths and types determined from the tables should be modified by consideration of the additional geometric and operation factors discussed in Section 4-2.1.
Refer to Section 4-2.1 for additional geometric and operation factors.

### Table 4-1: Bikeway Design Selection for Urban (Curb and Gutter) Cross Section – English Units

<table>
<thead>
<tr>
<th>Motor Vehicle ADT (2 Lane)</th>
<th>&lt;500</th>
<th>500-1,000</th>
<th>1,000-2,000</th>
<th>2,000-5,000</th>
<th>5,000-10,000</th>
<th>&gt;10,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Vehicle ADT (4 Lane)</td>
<td>N/A</td>
<td>N/A</td>
<td>2,000-4,000</td>
<td>4,000-10,000</td>
<td>10,000-20,000</td>
<td>&gt;20,000</td>
</tr>
<tr>
<td><strong>Motor Vehicle Speed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 mph</td>
<td>SL</td>
<td>WOL</td>
<td>WOL</td>
<td>WOL</td>
<td>BL = 5 ft</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>30 mph</td>
<td>SL with sign</td>
<td>WOL</td>
<td>BL = 5 ft</td>
<td>BL = 5 ft</td>
<td>BL = 6 ft</td>
<td>BL = 6 ft</td>
</tr>
<tr>
<td>35 - 40 mph</td>
<td>WOL</td>
<td>BL = 5 ft</td>
<td>BL = 5 ft</td>
<td>BL = 6 ft</td>
<td>BL = 6 ft</td>
<td>BL = 6 ft or PS = 8 ft</td>
</tr>
<tr>
<td>45 mph and greater</td>
<td>BL = 5 ft</td>
<td>BL = 5 ft</td>
<td>BL = 6 ft</td>
<td>BL = 6 ft</td>
<td>BL = 6 ft or PS = 8 ft</td>
<td>SUP or PS = 10 ft</td>
</tr>
</tbody>
</table>

BL = Bicycle Lane, SL = Shared Lane, WOL = Wide Outside Lane, SUP = Shared-Use Path, PS = Paved Shoulder

### Table 4-2: Bikeway Design Selection for Rural (Shoulder and Ditch) Cross Section – English Units

<table>
<thead>
<tr>
<th>Motor Vehicle ADT (2 Lane)</th>
<th>&lt;500</th>
<th>500-1,000</th>
<th>1,000-2,000</th>
<th>2,000-5,000</th>
<th>5,000-10,000</th>
<th>&gt;10,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Vehicle ADT (4 Lane)</td>
<td>N/A</td>
<td>N/A</td>
<td>2,000-4,000</td>
<td>4,000-10,000</td>
<td>10,000-20,000</td>
<td>&gt;20,000</td>
</tr>
<tr>
<td><strong>Motor Vehicle Speed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 mph</td>
<td>PS = 4 ft* or SL</td>
<td>PS = 4 ft* or SL</td>
<td>PS = 4 ft* or WOL</td>
<td>PS = 4 ft*</td>
<td>PS = 4 ft*</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>30 mph</td>
<td>PS = 4 ft* or SL</td>
<td>PS = 4 ft* or WOL</td>
<td>PS = 4 ft*</td>
<td>PS = 4 ft*</td>
<td>PS = 6 ft</td>
<td>PS = 6 ft</td>
</tr>
<tr>
<td>35 - 40 mph</td>
<td>PS = 4 ft* or SL</td>
<td>PS = 4 ft* or WOL</td>
<td>PS = 6 ft</td>
<td>PS = 6 ft</td>
<td>PS = 6 ft</td>
<td>PS = 8 ft</td>
</tr>
<tr>
<td>45 mph and greater</td>
<td>PS = 4 ft*</td>
<td>PS = 4 ft*</td>
<td>PS = 6 ft</td>
<td>PS = 8 ft</td>
<td>PS = 8 ft</td>
<td>SUP or PS = 10 ft</td>
</tr>
</tbody>
</table>

* See discussion in Section 4-3.1 regarding rumble strips on 4-foot shoulders.
PS = Paved Shoulder, SL = Shared Lane, SUP = Shared-Use Path, WOL = Wide Outside Lane

Refer to Section 4-2.1 for additional geometric and operation factors.
4-3.0 On-Road Bikeway Design Guidelines

Several types of bikeway treatments can be used to accommodate bicycles on roadways, including the following:

- Shoulders
- Traffic barrier-protected shoulders
- Standard bicycle lanes
- Combination bus/bicycle lanes
- Wide outside lanes
- Shared lanes

These and other design treatments are discussed in the following sections.

4-3.1 Shoulders

The shoulder is the edge or border of a roadway that is contiguous with, and on the same level as, the regularly traveled lanes. Bicycles can be accommodated on paved shoulders of appropriate width, but unpaved shoulders do not accommodate bicycles. By law, bicyclists may use roadway shoulders, with the exception that bicycles are not permitted on shoulders or travel lanes of the Interstate freeway system and certain other restricted-access expressways. The appropriate width of the shoulder is determined by design speed, ADT, bicyclist needs, and other factors. Bicyclists need at least 4 feet of smooth, rideable paved shoulder width.

Shoulder Rumble Strips

Shoulder rumble strips are typically 0.3 m (1 ft) wide and are typically located on the right shoulder beginning 0.15 to 0.3 m (0.5 ft to 1 ft) from the edge of the travel lane, but sometimes are wider and/or farther from the edge of travel lane. For compatibility with bicycle transportation, rumble strips should be no wider than 0.4 m (1.33 ft), and should be installed in an alternating on/off pattern within 0.15 m (0.5 ft) of the edge of travel lane or fog line, with a minimum 1.2 m (4 ft) width of smooth pavement for bicycles on the shoulder.

Figure 4-4:
Shoulders as a Bikeway Facility
Shoulder widths of 1.2 m (4 ft) or less with standard rumble strips will not adequately accommodate bicycles. Therefore, in accordance with the Mn/DOT Road Design Manual, rumble strips should not be placed on these roadway sections unless there is a documented serious ROR (run-off-the-road) crash history, and little or no bicycle traffic is expected. Where a rumble strip is necessary on a 4 ft shoulder, designers can consider the option of placing a 0.3 m (1 ft) wide rumble strip on the edge line of the roadway with the edge stripe painted over the rumble strip. See Figures 4-4 and 4-5. For more information on rumble strips, see Section 4-6.1 of this manual, and Chapter 4 of the Mn/DOT Road Design Manual.

**Shoulder as a Bikeway Facility**

Figure 4-5 illustrates signing and striping of the roadway shoulder as a bikeway. The appropriate shoulder width ranges from 1.2 m to 3 m (4 ft to 10 ft) as provided in Table 4-2.

The minimum paved shoulder width to accommodate bicyclists is 1.2 m (4 ft), with a minimum 1.5 m (5 ft) distance from the right edge of the rumble strip to any guardrail, curb or other roadside barrier.
Design Requirements:

- Shoulder width ranges from 1.2 m - 3 m (4 ft - 10 ft) (See Table 4-2)
- Minimum 1.5 m (5 ft) from right edge of rumble strip to the face of a guardrail, curb or other roadside barrier.
- Shoulders should be wider where higher volumes of bicyclists are expected.

Optional:
Sign shoulders as a bikeway on designated bicycle routes and/or popular bicycling roadways when ADT > 2,000, average vehicle speeds > 56 km/h (35 mph), and when there is inadequate sight distance (e.g. corners and hills).

** Note:** Check current MN MUTCD for any changes to signs and striping configurations.

**Figure 4-5:**
Shoulder as a Bikeway Facility
4-3.2 Traffic Barrier-Protected Shoulders

Although additional shoulder width can accommodate bicyclists on roads with relatively high traffic speeds and/or volumes, not all types of riders will feel safe. Some high-volume, high-speed roadways may warrant a physical separation of bikes from traffic lanes. This can be accomplished by partitioning shoulders with a concrete traffic barrier.

Traffic barrier-protected shoulders are also recommended in highway construction zones where vehicle travel lanes and shoulders have been shifted or eliminated. Connections should be well marked with signage, especially in construction/detour zones.

A bikeway created through the construction of a concrete barrier-protected shoulder is pictured in Figure 4-6 and illustrated in Figure 4-7.

When concrete barriers are installed on a shoulder, 0.6 m (2 ft) (minimum) should be left for emergency or distressed vehicles on the motor vehicle side and 1.8 m (6 ft) on the other side for one-way bicycle travel. Any two-way bicycle facility along a roadway must be designed in accordance with the guidelines of Chapter 5 of this manual.

Figure 4-6:
Bikeway with a Concrete Traffic Barrier-Protected Shoulder, Seattle
Picture courtesy of www.pedbikeimages.org / Dan Burden
Note: Check current MN MUTCD for any changes to signs and striping configurations.

Figure 4-7: Traffic Barrier-Protected Shoulders
4-3.3 **Standard Bicycle Lanes**

The designs in this section provide designers with flexibility in a variety of conditions, including limited right of way. Designs that specifically address accommodating bicycles where there is constrained right of way include share the road options and reducing lane widths and parking lane widths to accommodate a bike lane. When looking at these options designers must pay particular attention to site specific factors such as vehicle speed and traffic volume while balancing the needs of maintaining network continuity for bicyclists and safety for all road users. It is also important for the designer to choose a solution that maintains the proper design standards for the roadway’s classification.

A bicycle lane is a portion of a roadway designated by striping, signing, and pavement markings for the preferential or exclusive use of bicycles. These one-way bicycle facilities are appropriate for roads with an urban (curb and gutter) cross section. Bicycle lanes carry bicycle traffic in the same direction as adjacent motor vehicle traffic.

Bicycle lanes provide separation from traffic and accommodate bicycles better than shared lanes or wide outside lanes. Research indicates that bicycle lanes have a strong channelizing effect on motor vehicles and bicycles. Bicycle lane stripes remind motorists to expect bicycles and can increase bicyclists' confidence that motorists will not stray into their path of travel. Designers should refer to Chapter 9 of the *MN MUTCD*, which provides standards for bike lane signs, striping and pavement markings.

Bicycle lanes usually have a width of 1.5 m (5 ft) or 1.8 m (6 ft) as provided in Table 4-1, depending on the factors discussed in Section 4-2.1. Bicycle lanes wider than 1.8 m (6 ft) may be misinterpreted by some drivers as a travel lane or right-turn lane. Where additional width is available on the roadway, additional clearance between vehicles and the bike lane can be provided by increasing the widths of the parking lane and/or travel lane. Where the roadway width is restrictive, striping and marking a non-standard 1.2 m (4 ft) bike lane may provide safer channelization than a wide curb lane.

Figure 4-8 illustrates recommended standard bike lane widths for several typical roadway conditions. Additional bike lane design guidelines are provided in Sections 4-3.3.1, 4-3.3.2, 4-3.3.3 and 4-3.3.4.
Figure 4-8:
Typical Roadways with Bike Lanes
4-3.3.1 Bicycle Lanes, Road with Gutter Pan

The longitudinal joint between the gutter pan (the curb and gutter) and roadway surface can be hazardous to a cyclist. Where a standard gutter pan is present, and the longitudinal seam or joint is within the bike lane, the minimum bicycle lane width should be 1.5 m (5 ft) from the face of the curb to the bike lane stripe, with a minimum continuous width of 0.9 m (3 ft), and preferably 1.2 m (4 ft) or greater, of smooth rideable surface provided. In locations with greater than 10 percent truck traffic, and at higher traffic speeds and traffic volumes as indicated in Table 4-1, a minimum bicycle lane width of 1.8 m (6 ft) is preferred, with a minimum width 1.5 m (5 ft) of smooth, rideable surface provided.

Figure 4-10 illustrates design of a bike lane on a roadway with a standard gutter pan, where parking is prohibited.

Figure 4-9:
Bicycle Lane on a Roadway with Curb and Gutter
1.2 m (4 ft) bike lane
3.6 m (12 ft) travel lane (typical)

0.3 m (1 ft) CL
Curb & Gutter
Bike Lane Stripe

* See Table 4-1 for bicycle lane width

** Not to Scale **

Note:
Application of MN MUTCD Series R7-9 or R7-9a “NO PARKING BIKE LANE” signage may be used. Check current MN MUTCD for any changes to signs and striping configurations.

Figure 4-10:
Bicycle Lane with No Parking and Standard Gutter Pan
4-3.3.2 Bicycle Lanes, Road with Curb but No Gutter Pan

For a curbed section that has pavement to the curb, with no longitudinal gutter seam, the minimum width for a bicycle lane is 1.5 m (5 ft) from the face of the curb to the bike lane stripe, with a minimum width 1.2 m (4 ft) of smooth, rideable surface. In locations with greater than 10 percent truck traffic, and at higher traffic speeds and traffic volumes as indicated in Table 4-1, a minimum bicycle lane width of 1.8 m (6 ft) is preferred, with a minimum width 1.5 m (5 ft) of smooth, rideable surface provided. See Figure 4-11. Bicycle lanes on roadways with no gutter pan seams are illustrated in Figure 4-12.
Bike Lane Stripe
Pavement marking line 100 mm (4 in) wide solid white

Bike Lane Symbol & Arrow
Pre-cut plastic or stencil pavement markings

** Not to Scale **
Install #R3-17 signs and pavement symbols at periodic intervals along the bicycle lane

Note:
Application of MN MUTCD Series R7-9 or R7-9a “NO PARKING BIKE LANE” signage may also be used. Check current MN MUTCD for any changes to signs and striping configurations.

Figure 4-12:
Bicycle Lane with No Gutter Pan Seam within the Bicycle Lane
4-3.3.3 Bicycle Lanes with On-Street Parking Allowed

On streets with a parking lane, the bicycle lane shall be located between the vehicle travel lane and the parking lane. Parking movements and car doors opening potentially cause bicycle crashes. Design bicycle lanes and parking lanes to minimize these conflicts. A 1.8 m (6 ft) bicycle lane is preferred adjacent to a parking lane. The right side of the bike lane should be marked with a parking lane stripe, especially where there is high parking turnover. Where space is available, additional clearance from opening car doors can be provided by increasing the width of the parking lane, and additional emergency maneuvering space can be provided by increasing the width of the travel lane.

It is important for bicyclist safety to periodically maintain and repaint the bike lane stripes and pavement markings.

Bicycle lanes on a roadway with on-street parking is pictured in Figure 4-13 and the design is illustrated in Figure 4-14. See also Section 4-2.1 for additional discussion of on-street parking.

Decisions to designate bicycle lanes adjacent to angled parking should be accompanied by a full engineering review. Angled parking spaces with a “back in” configuration may increase the visibility of bicyclists to motorists. Width of the parking lane depends on parking angle.
Design Requirements

Bike Lane Stripe
Pavement marking line
100 mm (4 in) wide solid white

Parking Stripe
Pavement marking line
100 mm (4 in) wide solid white

Bike Lane Symbol & Arrow
Pre-cut plastic or stencil pavement markings

Note: Check current MN MUTCD for any changes to signs and striping configurations.

* See Table 4-1 for bicycle lane width

Figure 4-14:
Bicycle Lane with On-Street Parking Allowed
4-3.3.4  **Left-Side Bicycle Lane on a One-Way Street**

Bike lanes on the left side of one-way streets are unfamiliar and unexpected for most motorists. They should only be considered when they would substantially decrease the number of conflicts, such as those caused by parked cars, bus traffic, or unusually heavy vehicle turning movements to the right, or where there are a significant number of left-turning bicyclists. See Figure 4-16 for an illustration of left-side bike lane design.

A bicycle lane on the left side of the street is designed according to the same guidelines as standard right side bicycle lanes. It is best if there is no on-street parking on the left side of the roadway, and a full engineering review should accompany any planning or decision making process for this configuration.

Contra-flow bike lanes (those in the opposite direction of the normal traffic flow) are not recommended. Since they route bicyclists in a direction motorists do not expect, these facilities create an unpredictable environment that may create conflict.

Application of Series R7-9 and/or R7-9a “No Parking Bike Lane” signage, in accordance with Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD), may also be appropriate.

4-3.4  **Combination Bus/Bike Lanes**

Bus/bicycle lanes are usually intended for the exclusive use of buses, bicycles, and right-turning vehicles. Because bicycles generally travel at slow speeds and buses make frequent stops, these lanes can often function without impeding traffic flow. Generally, the bicyclist should overtake a stopped bus on the left, since passing on the right invites conflict with boarding and exiting bus passengers. Depending on traffic conditions, bus/bicycle lanes are sometimes closed to other traffic during peak hours and opened in those hours when fewer bicyclists and buses are present. Right-turning vehicles are often allowed in the lane only within 25 m (82 ft) of an intersection.

Mixing bicycle and bus traffic in a designated lane is most acceptable if bus speeds are low, preferably less than 30 km/h (20 mph). Where the posted speed is greater than 50 km/h (30 mph), employing combination bus/bicycle lanes is not desirable. A bike route may not be safe on streets with high peak hour traffic volume where buses make frequent stops. In this case, buses and bicycles may have similar average speeds, but have to pass each other repeatedly, with bicyclists required to share a busy adjacent travel lane to pass.
** Figure 4-16:**
Left Side Bike Lane on a One-Way Street

**Note:** Check current MN MUTCD for any changes to signs and striping configurations.
4-3.5  Bike Lane on Constrained Right-of-Way with Parking

Creating a bicycle lane on a constrained-width roadway that includes parking is a design that can be accomplished by narrowing parking and travel lanes, and designating a portion of the roadway for bicycle use by striping, signing, and using pavement markings. The recommended reduced widths of the travel and parking lanes are described below for cases where the existing roadway width in one direction of travel is 24 feet, and for cases where it is 22 feet.

Case A (48-foot Right-of-Way)

Creating a constrained bike lane via striping, signing, and pavement marking as illustrated in Figure 4-17 is appropriate when the following conditions exist:

- Traffic lane plus parking lane = 7.2 m (24 ft) wide
- Traffic lane = 4.5 m (15 ft) wide
- Posted vehicle speeds = 48 km/h (30 mph) or less
**Not to Scale**

**Note:** Check current MN MUTCD for any changes to signs and striping configurations.

Figure 4-17: Constrained R.O.W. with Parking Case A (48-Foot Right-of-Way)
Bike Lane on Constrained Right-of-Way with Parking

**Case B (44-foot Right-of-Way)**

Creating a constrained bike lane via striping, signing, and pavement marking as illustrated in Figure 4-18 is appropriate when the following conditions exist:

- Traffic lane plus parking lane = 6.7 m (22 ft) wide
- Traffic lane = 4.2 m (14 ft) wide
- Posted vehicle speeds = 48 km/h (30 mph) or less

Designating a 1.5 m (5 ft) bicycle lane in this narrow right-of-way is possible because in low-speed residential areas, the combination of narrow parallel parking and travel lanes [2.1 to 2.4 m (7 to 8 ft) parking and 3.0 m (10 ft) travel] are acceptable. For additional information on minimum lane widths, see *A Policy on the Geometric Design of Highways and Streets* (AASHTO; 2004) or *Local State-Aid Route Standards* (Minnesota Rules Chapter 8820).
Install #R3-17 signs and pavement symbols at periodic intervals along the bicycle lane.

**Note:** Check current MN MUTCD for any changes to signs and striping configurations.

**Figure 4-18:**
Constrained R.O.W. with Parking Case B (44-Foot Right-of-Way)
4-3.6 Wide Outside Lanes

Wide outside lanes accommodate bicycles and motorists in the same lane with a lane width of 4.2 – 4.8 m (14 – 16 ft). For accommodating bicyclists, the wide outside lane dimension should not include the gutter pan. In most cases, motorists will not need to change lanes to pass a bicyclist, minimizing conflicts. Wide outside lanes also provide bicyclists more maneuvering room at driveways, in places with limited sight lines, and on steep grades. Wide outside lanes can accommodate advanced bicyclists who ride comfortably and safely in areas with high traffic volumes. However, for basic bicyclists, wide outside lanes generally do not provide the same degree of comfort and safety as designated bicycle lanes.

Wide outside lanes may be considered where there is insufficient width to provide striped bicycle lanes. The following wide outside lane widths are recommended:

- A wide outside lane with 4.2 m (14 ft) width is appropriate where vehicle speeds are 56 km/h (35 mph) or less.
- A wide outside lane with 4.5 – 4.8 m (15 – 16 ft) width is appropriate where vehicle speeds are 64 km/h (40 mph) or greater, or where bicyclists need extra maneuvering room.
- Wide outside lanes greater than 4.8 m (16 ft) are not recommended, because drivers may try to form two travel lanes, where striping a bike lane may provide better channelization of vehicles and bicycles.

Caution should be used when designating wide outside lanes because they may encourage increased traffic speeds, contrary to the goals of traffic calming and pedestrian safety. On popular bicycling streets, it may be appropriate to mark wide outside lanes with shared-lane marking. Pavement marking should be placed at least 0.9 m (3 ft) from the edge of the rideable surface. Figure 4-19 illustrates urban roadway cross sections with a wide outside lane, which are discussed further in Sections 4-3.6.1 and 4-3.6.2. Wide outside lanes may also be appropriate on roadways without curbs (see Table 4-2).
Figure 4-19:
Typical Roadways with Wide Outside Lanes
4-3.6.1 Wide Outside Lane with No Parking

Most practitioners agree that on urban streets without parking, the minimum space necessary to allow a bicyclist and motorist to share the same lane, is 4.2 m (14 ft), measured from the lane stripe to the edge of the gutter pan, rather than to the curb face. This width allows a shared lane without creating conflicts, necessitating lane changes, or reducing the motor vehicle capacity of the lane. See Figure 4-20. Application of \textit{MN MUTCD} Series R7-9 or R7-9a “NO PARKING BIKE LANE” signs may be appropriate.
Design Requirements

- *4.5 m (15 ft)* of usable width is desirable on sections of roadway where bicyclists need more maneuvering room (e.g., steep grades, limited sight distance)

- If traffic speeds exceed 64 km/h (40 mph), 4.5 - 4.8 m (15 - 16 ft) wide curb lanes are desirable

Optional:

- Install Share the Road signs to warn drivers to watch for bicyclists traveling along urban streets with wide outside lanes of 4.2 m (14 ft) or greater, but no bicycle lane.

- Space signs approximately every 0.8 km (0.5 mi) on urban routes frequently used by bicyclists.

Note: Check current MN MUTCD for any changes to signs and striping configurations.

Figure 4-20:
Wide Outside Lane with No Parking
4-3.6.2 **Wide Outside Lane with On-Street Parking**

Since an open car door takes up extra space, a wide outside lane of 4.5 m (15 ft) minimum width is recommended adjacent to the parking lane to allow bikes extra space for maneuvering to keep clear of on-street parking. See Figure 4-21.

If on-street parking is provided along with the wide outside travel lane, the parking lane should be at least standard width. Narrowing a parking lane to provide the space for bicyclists may or may not encourage motorists to park closer to the curb.
4.8 m (16 ft) of usable width is desirable on sections of roadway where bicyclists need more maneuvering room (e.g., steep grades, limited sight distance).

If traffic speeds exceed 64 km/h (40 mph) 4.8 m (16 ft) wide outside lanes are desirable.

Bike Lane Stripe
Pavement marking line
100 mm (4 in) wide solid white

Optional:
Install Share the Road signs to warn drivers to watch for bicyclists traveling along urban streets with wide outside lanes of 4.2 m (14 ft) or greater, but no bicycle lane.
Space signs approximately every 0.8 km (0.5 mi) on urban routes frequently used by bicyclists.

Note: Check current MN MUTCD for any changes to signs and striping configurations.

Figure 4-21: Wide Outside Lane with On-Street Parking
Shared Lanes

Shared lanes are streets and highways with no special provision on the roadway for bicyclists, as shown in Figure 4-22. Shared lanes often feature 3.6 m (12 ft) lane widths or less with no shoulders, allowing cars to pass bicyclists only by crossing the centerline or moving into another traffic lane. In residential areas with low motor vehicle traffic volumes and posted speeds of less than or equal to 48 km/h (30 mph), shared lanes are normally adequate for bicyclists to use. With higher speeds and traffic volumes, shared lanes become less attractive to basic bicyclists.

Shared lanes are not typically signed as bicycle routes. Signage may be needed when specific destinations or potential alternate routes for bicyclists need to be shown, or on roads that bridge a gap between two designated bike routes. Application of MN MUTCD Series R7 and/or R8 “No Parking” signage may also be appropriate. Figure 4-23 illustrates shared lanes on three typical roadway types. Figure 4-24 illustrates a shared lane on an urban (curb and gutter) cross section roadway with no on-street parking.

![Figure 4-22: Non-Marked Shared Lane](image)

![Figure 4-23: Typical Roadways with Shared Lanes](image)
Optional:

- Install Share the Road signs to warn drivers to watch for bicyclists traveling along the road in rural situations where there is no paved shoulder and a large number of bicycles use the roadway.

- Space signs every 1.6 - 3.2 km (1 - 2 mi) and/or on corners, hills, or other places with limited sight distances.

Note:
Application of MN MUTCD Series R7 and/or R8 “NO PARKING” signage may also be appropriate. Check current MN MUTCD for any changes to signs and striping configurations.

Figure 4-24:
Shared Lane, Urban Cross Section with No Parking
4-3.7.1 Shared Lane, Urban (Curb and Gutter) Cross Section with Parking

Where a shared lane is used adjacent to a parking lane, striping the parking lane to indicate a 4.2 m (14 ft) shared lane is recommended. This provides some extra clearance and allow bicyclists to avoid potential collisions in the "open door zone" of parked vehicles. In addition, signage can clarify bicyclists’ right to share the road and alert motorists to bicyclists. See Figure 4-25.
3.6 - 4.2 m (12 - 14 ft) travel lane
2.4 - 3.0 m (8 - 10 ft) parking lane

Optional:
Install Bike Route signs with destination plaques if street is needed to connect specific destinations, establish a potential alternate route, or provide a link between other bicycle facilities.

Install signs at every major intersection, intersections with other bicycle routes, confusing junctions, or every 300 m (1000 ft).

Note: Check current MN MUTCD for any changes to signs and striping configurations.

Figure 4-25: Shared Lane, Urban Cross Section with Parking Lane
4-3.7.2 Shared Lane, Rural (Shoulder and Ditch) Cross Section with No Parking

On a road with no curb and no parking, the width for a shared lane should be 3.6 - 4.2 m (12 - 14 ft) wide. Motorists may have to cross the centerline of the road to pass bicyclists, which is acceptable on low-volume roads.

Installing “Share the Road” signage to increase driver awareness of bicyclists is optional.

Figure 4-26 illustrates shared lane design on a rural (shoulder and ditch) cross section roadway with no parking.
Optional:

- Install Share the Road signs to warn drivers to watch for bicyclists traveling along the road in rural situations where there is no paved shoulder and a large number of bicycles use the roadway.

- Space signs every 1.6 - 3.2 km (1 - 2 mi) and/or on corners, hills, or other places with limited sight distances.

Note:

Application of MN MUTCD Series R7-9 or R7-9a “NO PARKING BIKE LANE” signage may also be used. Check current MN MUTCD for any changes to signs and striping configurations.

Figure 4-26:
Shared Lane, Rural Cross Section (No Parking, No Curb & Gutter)
4-4.0 On-Road Bikeways at Intersections

In urban areas, more than three-fourths of all car/bike crashes occur at intersections. The causes of these crashes are numerous; no single measure will provide a solution to the intersection problem. Almost one-fifth of all car/bike collisions are caused when a bicyclist runs a stop sign or red light. In addition, motor vehicle drivers in both left and right turning situations have a tendency to overlook bicyclists riding (improperly) against the normal flow of traffic. Safety at intersections depends on the functions of the roads and bikeways, motor vehicle and bicycle traffic volumes and speeds, crossing distances, and the amount of space available at the crossing.

The following guidelines will help achieve safe, workable intersections.

Safety

- Ensure that bicyclists and motor vehicles are able to easily see each other
- Create intersection designs that avoid the need for complex maneuvers
- Use the design guidelines in this section and Section 5-4
- Allow sufficient maneuvering or waiting space

Bicycle Delay

- Minimize bicyclist waiting times at crossings on bike routes
- Maximize the possibility to cross without delay
- Give main bicycle routes priority over local motor vehicle routes

Convenience

- Provide bicyclists clearly marked routes across the intersection
- Make curb cuts and transitions flush with the road and as wide as the approaching facility
- Pay special attention to bicyclist turning movements (primarily left-turning bicycles)

4-4.1 Intersection Crossing Distance

More than three lanes to cross at a time may be difficult for bicyclists. A raised pedestrian refuge island should be installed where the crossing distance is greater than 23 m (75 ft). See Section 5-4.3 of this manual for guidance on the design of pedestrian refuge islands.

4-4.2 Signalized Intersections

At intersections with traffic signals, detection loops should be adjusted, when possible, to detect bicycles. Installation of bicycle-sensitive loops within the bicycle lane is desirable, and is particularly important where signals are vehicle-actuated and may not change for a bicycle unless a car is present, or unless the bicyclist leaves the lane to trip the signal within the traffic lane. If push button activators are used, they should be installed in a location to allow the bicyclist to remain mounted and in the designated bike lane.
Where bicycle lanes are heavily used, a separate bikes-only green phase may be included. This allows bicyclists to cross the street and make turns without having to contend with motor-vehicle traffic. Where bicyclists tend to become “stranded” while crossing multi-lane streets, consideration should be given to the clearance intervals. A common solution is an all-red clearance interval.

### 4-4.3 Bikeways at Right-Turn-Only Lanes

Minnesota law requires the bicyclist to keep as close as practicable to the right edge of the roadway. Therefore, many bicyclists tend to move to the right edge of the right-turn lane, which is not a desirable position if the bicyclist is intending to go straight through the intersection. On roadways with right turn lanes, providing a through bicycle lane to the left of the right-turn lane at the intersection can minimize conflicts, as shown in Figure 4-27. The designer should review traffic volumes and speeds in determining appropriate actions. It should be recognized that if the roadway carries enough traffic to warrant a right-turn lane, bicycle lanes are likely to be appropriate for the entire section of the roadway.

In some cases it will be desirable to replace the standard “Right-Turn Lane” sign (R3-X1) with “Begin Right-Turn Lane; Yield to Bikes” (R4-4).

**Right Turn on Red**

On-road bikeways can complicate turning movements at intersections. Where right turn on red is permitted, right-turning motorists focus more intently on cross traffic approaching from the left. Bicyclists stopped for the red light may find that vehicles turning right on red infringe on the area where the bicyclist is waiting, unless the bike lane is located to the left of the right turn lane.

While right-turning motor vehicles may infringe less if the intersection curve radius is relatively small, designers should consider prohibiting “right turn on red” on some bikeways where there is not a right-turn-only lane.

**Bicyclist and Right-Turning Motorist Positioning**

Conflicts with right-turning cars account for about one tenth of all car/bike collisions in urban settings. Right-turning motorists approaching an intersection often infringe on the bike lane. Operating space and expected behavior near intersections can be communicated to bicyclists and motorists by using clear pavement symbol markings, striping and signs.

Right turns on green by motorists may be hazardous because both the driver and the through-bicyclist may perceive they have the right of way. Every effort should be made to encourage right-turning motorists to slow down and observe bicycle traffic, before reaching the intersection and turning right. The most effective solution is to place a through bicycle lane to the left of the right turn lane, with dotted lines indicating where right-turning vehicles may cross the bike lane. This will ensure that vehicles can move to the right of bicycles in advance of the intersection, and both bicyclist and motorists are correctly positioned to proceed without conflict. Weaving of motor vehicles and bicycles is not desirable if the intersection approach or exit is on a curve.
Some bicyclists use right-turn-only lanes when traveling straight through an intersection. This causes difficulties because motorists expect the bicyclist to turn right. At right-turn only lanes, bicyclists traveling straight through an intersection should be encouraged to merge to the left side of the lane to complete the weave maneuver. However, this is often difficult for bicyclists to do. In lanes that allow both through traffic and right-turns, it may be difficult for the motorist and bicyclist to recognize each other’s intent. At intersections where there is a history of bicycle crashes, designers should specify signage and pavement markings that clarify who is responsible for yielding. As an additional safety measure, parking may be prohibited for a minimum of 30 m (100 ft) or more from the intersection.

### 4-4.3.1 Bicycle Lane Parallel to Right-Turn-Only Lane

Right-turn lanes have always posed a challenge for bike lane designers. Moving the bicycle lane to the left of the right-turn lane, however, allows designers to create a merging area ahead of the intersection. This gives bicyclists and right-turning motorists the opportunity to negotiate to the proper position before reaching the intersection.

At the point where a right-turn only lane starts, the bike lane left stripe should continue across with a dotted line. The length of the dotted line will be determined by the length of the right-turn storage area and the taper. A second dotted line may be used to delineate the right side of the bicycle lane. See Figure 4-27.

For more information on standard design of right-turn lanes, see Chapter 5 of the *Mn/DOT Road Design Manual*. 
**Not to Scale**

**Design Requirement**
- Place bicycle lane symbol and sign immediately after but not closer than 20 m (65 ft) from the crossroad.
- Install #R3-17 signs and pavement symbols at periodic intervals along the bicycle lane.

**Bike Lane Skip Dashing**
- Dotted lines through merge areas are recommended.
- 100 mm (4 in) wide white stripe 0.6 m (2 ft) long with 1.8 m (6 ft) space between.

**Note:** Check current MN MUTCD for any changes to signs and striping configurations.

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**Figure 4-27:**
Bike Lane Parallel to Right-Turn Only Lane
4-4.3.2 Bicycle Lane Parallel to Double Right-Turn Lane

Where a double right-turn lane starts, it may be necessary to discontinue the bicycle lane through the intersection. However, safe bicyclist movements can be accommodated via a wide outside lane with extra width carried thorough the intersection in the right-most through lane and the rights of bicyclists clearly delineated through signage. MN MUTCD sign #R4-4 indicates that motorists must yield to bicyclists approaching the intersection. The bicyclist-motorist merging area is based on standard right-turn lane designs detailed in the Mn/DOT Road Design Manual.

A bike lane at a double right-turn lane is illustrated in Figure 4-28.
Design Requirement

- Place bicycle lane symbol and sign immediately after but not closer than 20 m (65 ft) from the crossroad.
- Install #R3-17 signs and pavement symbols at periodic intervals along the bicycle lane.

Bicyclist Position

Cyclist merges to assume position in the right-hand side of the right most through travel lane.

Note: Check current MN MUTCD for any changes to signs and striping configurations.

Figure 4-28:
Bike Lane Parallel to Double Right-Turn Lane
4-4.3.3 Parking Lane Becomes Right-Turn-Only Lane with Bicycle Lane

On a street with a bike lane, if a parking lane becomes a right-turn-only lane, the bicycle lane left edge stripe should be continued to the crosswalk or to the extension of adjacent property line if there is no crosswalk. The parking lane markings should be dropped at an appropriate distance from the intersection to allow proper sight distances, and a dotted line may be used to delineate the right edge of the bicycle lane continuing to the crosswalk. This type of intersection is illustrated in Figure 4-29.
**Design Requirement**

- Place bicycle lane symbol and sign immediately after but not closer than 20 m (65 ft) from the crossroad.
- Install #R3-17 signs and pavement symbols at periodic intervals along the bicycle lane.

**Bike Lane Skip Dashing**

- Dotted lines through merge areas are recommended.
- 100 mm (4 in) wide white stripe 0.6 m (2 ft) long with 1.8 m (6 ft) space between.

**Note:** Check current MN MUTCD for any changes to signs and striping configurations.

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**Figure 4-29:**
Parking Lane Becomes Right-Turn Only Lane with Bicycle Lanes
4-4.4 Bikeways and Left-Turn Movements

On-road bikeways encourage bicyclists to keep right and motorists to keep left, regardless of their turning intentions. Bicyclists changing lanes to the left from a bicycle lane or shared lane to make a left turn are maneuvering contrary to the usual rules of the road. Operating space and expected behavior near intersections can be communicated to bicyclists and motorists by using clear pavement symbol markings, striping and signs.

Bicyclists use a variety of maneuvers to make left turns, depending on road conditions, traffic and bicyclist skill level. These bicyclist maneuvers include a 2-stage left turn by staying to the right in the crosswalks, left turn from a vehicle left turn-only lane, left turn from left through lane, left turn from right through lane, or left turn stopping at a pedestrian refuge or median island.

Bicyclists may follow the same maneuver that motor vehicles use, and make the necessary lane-changing movements to make a left turn from the left lane. The tendency for bicyclists to ride alongside turning vehicles, rather than follow them, may create opportunity for sideswipes.

4-4.4.1 Left-Turning Motorist and Oncoming Bicyclist

Conflicts with left-turning motorists account for almost one-fourth of all crashes involving a motor vehicle and a bicycle in urban settings. This type of collision typically occurs because the left-turning motorist either does not see oncoming bicyclists or the motorist underestimates the bicyclist’s speed. While a bicycle traveling in the roadway is usually within a motorist’s field of view, the pressure on the motorist to clear the intersection in the face of oncoming traffic may cause the left-turning motorist to fail to yield to the oncoming bicycle. This type of “panic” turn by motorists can be eliminated by installing a protected left-turn phase at signalized intersections. Bicycle lanes located farther from the curb at the intersection can also make bicyclists easier to see.

4-4.4.2 Bicycle Lanes and Left-Turning Bicycle Traffic

At busy intersections, pavement marking options may improve safety and comfort for left-turning bicyclists. When left-turn bicycle volumes are significant, a left-turn bicycle lane painted next to the right edge of a left-turn lane may be appropriate. This option is recommended at signalized intersections and stop-controlled intersections without right turn on red. Double left turns lanes are discouraged on streets with bikeways.

4-4.5 Bikeways at Roundabouts

Bicycles can be accommodated through roundabouts either in mixed flow with vehicular traffic or on a separate path outside the roundabout. Mn/DOT roundabout design policy is to generally provide off-road paths around the roundabout circumference, where feasible. On roundabouts with two or more lanes in the circulatory roadway, mixing bicycles and vehicles is not recommended due to potentially higher vehicle speeds, and a separate off-road path should be provided. These concepts are discussed below. For additional information, see Roundabouts: An Informational Guide (FHWA; 2000), Publication No. FHWA-RD-00-067.
Bicyclists are vulnerable users of roundabouts and consideration should be given for their accommodation. A majority of bike crashes at roundabouts involve entering vehicles and circulating bicycles, reinforcing the need to reduce entering speeds by providing ample deflection, to maintain good visibility for entering traffic and to enforce yield conditions for entering traffic. All crosswalks must be designed as accessible pedestrian crossings, with the splitter island cut to allow pedestrians, wheelchairs, strollers and bicycles to pass through. Pedestrian access is allowed only across the legs of the roundabout, and not to the central island.

Where a road with a bicycle lane approaches a roundabout, the bike lane striping shall not be carried on the roadway through the roundabout, and bike lanes within the circulatory roadway should never be used. Bicycle lanes should be terminated before the splitter island, and bicyclists should either be accommodated in mixed traffic in the roundabout or preferably on a separate pathway outside the roundabout.

Urban compact roundabouts and mini-roundabouts are characterized by vehicle approach speeds less than 60 km/h (35 mph) and low speed on the circulatory roadway. At these types of roundabouts, bicycle traffic may proceed through the roundabout in a shared lane with motor vehicles after termination of the bicycle lane. However, child bicyclists may need to be accommodated as pedestrians.

Urban single-lane roundabouts and urban double-lane roundabouts are characterized by slightly higher approach speeds than compact roundabouts, with circulatory speeds 35 – 40 km/h (20 – 25 mph). Alternative bicycle pathways should be provided and must be clearly delineated with path construction and landscaping to direct bicyclists to the appropriate crossing locations and alignment. On the approach to these roundabouts, dotted white 200 mm (8 in) striping is used to indicate that the bicycle lane ends, and pavement markings should route bicycle traffic onto an off-road bike path or shared-use path via a curb-cut ramp. The ramp up and ramp down for bicycles is in addition to the curb-cut ramp at the crosswalk, and the designer should exercise care in locating and designing the bicycle ramps so that they are not misinterpreted by pedestrians as an unmarked pedestrian crossing. See Chapter 5 for description of curb-cut ramp requirements. The off-road path continues to the roundabout crosswalk and also to a continuation of the bicycle lane on departing legs of the roundabout, or to a shared-use path adjacent to the departing legs.

Rural single-lane roundabouts and rural double-lane roundabouts are characterized by high average approach speeds in the range of 80 – 100 km/h (50 – 60 mph), with circulatory speeds of 40 – 50 km/h (25 – 30 mph). Mixing bicycle and vehicle traffic on these types of roundabouts is not recommended. The approach roads will typically have paved shoulders, but the highway shoulder is eliminated from the cross section in advance of the roundabout and the shoulder is not carried through the roundabout circulatory roadway. To accommodate bicyclists, an off-road shared-use path should be included in the design from the point where the shoulder is terminated. This must be identified early in project planning and scoping because it may require acquisition of additional right-of-way beyond the limits of an existing intersection.
4-4.6 Bikeways at Interchanges

Bikeway treatments at interchanges and on bridges are discussed in Chapter 6, Bridges and Grade Separations.

4-4.7 Painted Refuge Islands for Bicyclists

Where traffic is relatively light, painting a refuge island on the corner provides a comfort zone for bicyclists. Allowing right turn on red is not recommended with painted refuge islands. Where traffic volumes are relatively high, refuge space can be provided by a raised free right turn island that is easily reached by left-turning bicyclists who are using a two-step left turn maneuver.

4-4.8 Advanced Stop Lines

Creating an advanced stop line (ASL) makes it possible for bicyclists to position themselves in front of waiting motorized traffic and cross the intersection first on the green light or, when turning left, on a separate green phase. Twenty-five bicycles or more per peak hour and good enforcement of stopping behavior are needed for effective use of ASLs. The ASL helps bicyclists turning left where there is one lane for motorized traffic. ASLs may also be applied on approaching road sections with no more than two lanes.

A separate ASL, inclusive of an approaching bicycle lane, is best introduced when there is a left-turn lane. If traffic turning left has a separate green phase, a separate ASL is necessary. If this is not the case, one ASL may suffice, however, bicyclists may choose to weave to the left turn lane anyway. For increased visibility and recognition, complete the ASL and a part of the approaching bicycle lane in a different color pavement, preferably red. Bicycle sensitive vehicle detectors (pavement loops or other devices) are desirable when using ASLs.

Figure 4-30:
Bicycle Lane Continuation at T-Intersection (See Section 4-4.9)
4-4.9 **Bicycle Lane Continuation at T-Intersections**

It is preferred that bicycle traffic be allowed uninterrupted through-movement at T-intersections. Continuing the bicycle lane through the intersection as shown in Figure 4-30 is recommended. Even where there are no bicycle lanes, lane continuation could be added to the intersection if it is stop-sign controlled.

4-4.10 **Railroad Crossing Intersections**

Special care should be taken wherever a bikeway crosses railroad tracks at grade. The bicyclist should be able to approach the tracks at an angle of 60 to 90 degrees. Wherever practical, the bicyclist traveling straight ahead should be allowed a level crossing at right angles to the rails. If the road does not cross the tracks at a right angle, the bikeway may swing away from the roadway to allow the bicyclist to approach the tracks at 60 to 90 degrees, or the shoulder, bike lane or wide curb lane may be widened in the approach area to allow the bicyclist to swing wide.
for a better approach. The more the crossing deviates from 90 degrees, the greater is the potential for a bicyclist’s front wheel to be diverted by the flangeway (the gap on either side of the rail) or even by the rail, particularly when wet. Crossing rails at angles of 30 degrees or less is considered hazardous. See Figure 4-31, which illustrates bicycle-safe rail crossings.

The crossing should be at least as wide as the bikeway approach. The surface between rails should be based on the planned uses of the roadway. Hot mix asphalt and rubber surfaces are generally acceptable for at-grade crossings. Wood surfaces are suited to limited use; they are very slippery when wet and tend to wear faster than other surfaces. Abandoned tracks should be removed, but only as authorized by the owner of the track.

Most tracks and rail crossings are governed by Federal Railroad Administration (FRAG) rules, but tracks and crossings on light rail transit (LRT) lines such as the Hiawatha LRT line and proposed Central Corridor LRT line are governed by Federal Transit Administration (FTA) rules. The proposed Northstar Corridor Commuter Rail would run on existing freight railroad tracks and may be regulated by both FTA and FRAG. Designers should refer to the applicable agencies and rules for guidance.

The flangeway poses potential hazards to all non-motorized users, but particularly those who rely on wheeled forms of mobility. A 90-degree crossing angle reduces the risk, but flangeways at any angle can be a safety concern and should be minimized. The gap on the outside of the rail, or the “field flangeway,” is easy to reduce. Fillers made of rubber or polymer can be installed to eliminate the field flangeway almost entirely and provide a level surface. The “gauge flangeway,” the gap on the inside of the rails where the train wheel’s flange must travel, must be kept open. Federal regulations require public crossings to have at least a 65 mm (2.5 in) gauge flangeway. Products are available to fill the gauge flangeway, but these may only be used in low-speed applications, such as on freight yard or manufacturing plant track, with authorization from the owner of the tracks. At higher speeds, the filler will not compress and can derail the train.

Special construction and materials should be considered to keep the flangeway depth and width to a minimum. Currently there are no design treatments that can completely eliminate the flangeway gap for high-speed freight trains. Where train speeds are low, commercially available compressible flangeway fillers may be used, and additional treatments may be allowable for light-rail trains.

- Approaches to the track and the area between the tracks should be at the same elevation as the top of the rail. Approaches to the track should be ramped with minimal grades and should be flat for a distance of 5 feet on either side of the tracks, free from obstacles, and have a firm and stable surface
- A surface material that will not buckle, expand or contract significantly should be used.
- Pavement should be maintained so ridge buildup, a potential hazard to bicyclists, does not occur next to the rails.
- Timber plank crossings may be used, but tend to be slippery when wet.
- Signs and pavement markings should be installed in accordance with Section 9B of the MN MUTCD to inform and warn bicyclists of tracks
- Signals with flashers, bells and/or gates should be considered
It should be noted that the design of crossings and other facilities in the railroad right-of-way are generally subject to review and approval by the owner of the tracks.

Roadways, paths, and bicycle lanes should have signage and pavement markings installed in accordance with *MN MUTCD*. Consider sign and signal visibility and installation when widening the approach bikeway. “Pedestrian arms” and signals with bells may also be appropriate.

### 4-5.0 Design of Retrofits for Bicycle Accommodation

There are a number of ways to efficiently use an existing road right-of-way to upgrade bicycle accommodation as discussed in the following paragraphs. Finding the best alternative requires careful consideration of the operating characteristics of the road space, the context of the area, and types of cyclists using the bicycle facility.

#### 4-5.1 Changing Vehicular Travel Lane Widths

In lower speed zones, motor vehicle lane widths can be reduced to create space for a bikeway within the existing roadway. This treatment is often used in urban settings where the roadway width cannot be widened. Refer to AASHTO guidelines, State Aid rules and other applicable standards to determine acceptable minimum travel lane width based on vehicle speed and ADT. The following lane widths may be acceptable:

- Where the posted speed is 40 km/h *(25 mph)*, a travel lane width of 3.0 m *(10 ft)* may be acceptable.
- Where the posted speed is 50 – 60 km/h *(30 – 40 mph)*, a travel lane width of 3.2 m *(10.5 ft)* and center turn lane width of 3.6 m *(12 ft)* may be acceptable.
- Where posted speed is 70 km/h *(45 mph)* or greater, a travel lane width of 3.6 m *(12 ft)* and center turn lane width of 4.2 m *(14 ft)* are desirable.

#### 4-5.2 Changing the Number of Travel Lanes

There are opportunities to create or improve bicycle accommodations on streets and roads by changing two-way streets to one-way couplets, or changing four-lane undivided roadways to a 3-lane configuration that includes a center two-way turn lane.

#### 4-5.2.1 Two-Way Streets to One-Way Couplet

The conversion of parallel two-way streets to one-way couplets may result in greater motor vehicle capacity and more travel lanes than are needed. For example, a pair of two-way streets with parking on each side may be changed to a couplet of one-way streets. These one-way streets provide better opportunities for a bike lane or wide curb lane than the original two-way streets because there are fewer vehicle turning movements to contend with.
4-5.2.2 **Four-Lane Road Converted to Three-Lane Road with Two-Way Left-Turn Lane**

Four-lane undivided roads can be converted to a three-lane configuration that includes one travel lane in each direction and a center two-way left-turn lane. This is a common treatment that creates space for bike lanes or wide curb lanes in each direction on the roadway. Safety and traffic flow may be improved for motorists as well as bicyclists, especially if there is a significant number of vehicle left-turn movements. In many cases, this approach can be implemented by striping and pavement markings and without significant changes to signals.

4-5.3 **Removing Obstructions**

Paved or landscaped traffic islands often reduce available roadway space. If not needed for access control, traffic calming, or as refuges, raised islands may be eliminated, narrowed, or replaced with pavement markings, to increase usable width. Relocating utility poles and light standards, parking meters, signs, guardrails, and other obstructions away from the edge of the roadway may also increase usable width.

4-5.4 **Changing Parking Needs or Arrangements**

Parking should be closely evaluated prior to designating bicycle facilities, as parking may be rearranged, reduced, or eliminated on one or both sides of the street to allow space for bicycle facilities. Shared parking between businesses and residences may alleviate the need for on-street parking. Removing parking does not always improve safety, however, and in some locations doing so may actually decrease safety. Conduct a careful study of existing businesses and residences and associated parking before making changes.

When it is determined unacceptable to remove all on-street parking, other options may be pursued. These include narrowing parking lanes to a non-standard minimum of 2.1 m (7 ft) in areas with low truck parking and low parking turnover. Changing the parking direction from diagonal to parallel parking requires less pavement width to accommodate a parking stall, and allows for additional space for bicycle facilities. Removing parking from one side of the roadway to provide space for bicycle facilities is appropriate when businesses and residences only need parking on one side. Prohibiting parking by employees can also increase the number of available spaces for customers and allow parking spaces to be reduced.

4-5.5 **Traffic Calming**

Traffic calming is a series of design tools to increase overall traffic safety and improve the quality of the street environment by employing methods that cause vehicular traffic to slow down. On streets with restricted space and appropriate traffic operation factors, traffic calming techniques by themselves or combined with other alternatives may be an effective option to improve safety for bicyclists and pedestrians. See Section 4-6.6 for a discussion of traffic calming techniques.
4-6.0 Other Design Considerations

To promote a consistent and safe bicycling environment, the following additional factors may be considered in the design phase of on-street bikeway facilities:

- Rumble strips
- Drainage and drainage grates
- Bypass lanes
- Climbing lanes
- Lighting
- Traffic calming
- Alternate bike routes

4-6.1 Rumble Strips

Rumble strips are bands of raised material or indentations formed or grooved in the pavement that transmit sound and vibration through the vehicle, alerting inattentive drivers. Research has documented that use of rumble strips along the shoulders of rural freeways and expressways has reduced the number of run-off-the-road (ROR) accidents by 40 to 70 percent. In-lane rumble strips across the travel lane are sometimes used to provide advanced audible warning of a stop sign at an intersection.

Provisions should be made for bicyclists to safely traverse through or around rumble strips, regardless of their location. Rumble strips are a rough surface that causes instability and unsafe operating conditions for bicyclists. Potential for mishap arises when the bicyclist contacts rumble strips or attempts to avoid them by weaving. Care must be taken to ensure a stable riding surface. Sand and debris tend to gather along the outside edge of the shoulder, effectively reducing the available bicycling space. Brooming of shoulders may become necessary to remove debris.

Where shoulder rumble strips are used on the right shoulder, there shall be 1.2 m (4 ft) minimum width of smooth pavement between the outside edge of the rumble strip and the outside edge of the paved shoulder, and a minimum distance of 1.5 m (5 ft) from the outside edge of the rumble strip to a guardrail, curb or other obstacle adjacent to the shoulder. See Section 4-3.1 of this manual for a discussion of rumble strips on 4-foot shoulders. All rumble strips should be placed using an

Figure 4-32: Bicycle-Safe Rumble Strips
intermittent pattern, alternating on and off in 3 m (10 ft) lengths, which allows maneuverability of bicyclists onto the shoulder area. See Chapter 4 of the Mn/DOT Road Design Manual for additional design specifications for rumble strips.

4-6.2 Drainage and Drainage Grates

For bicycle travel, existing roadway drainage is normally adequate. However, on curb and gutter sections, ponding depths should be checked when a problem is identified and corrective action taken if depths are significant. This may entail improved drainage grates or wider lanes. Pavement overlays are troublesome where the surface material tapers into drainage outlets and manhole covers. In the years following the overlay, these tapers often loosen around inlets and manholes, leaving an unacceptable ridge that can be hazardous for cyclists. The existing pavement should be scarified or the inlets and manholes raised prior to the overlay.

When a new roadway is designed, all drainage grates and manhole covers should be kept out of the bicyclists’ expected path. Curb inlets are preferable to surface type inlets.

Drainage inlet grates on roadways must have openings narrow enough and short enough to prevent bicycle tires from dropping into the grates, regardless of the direction of bicycle travel. Grates with bars parallel to the direction of bicycle travel should be replaced with bicycle-safe, hydraulically efficient grates. Vane type grates are preferable surface type grates. Pavement marking to identify and warn cyclists about unsafe grates may be a temporary solution in some situations. However, parallel bar grates must be replaced or physically corrected as soon as practicable. See Mn/DOT Standard Plates 4151 and 4152 for acceptable designs of grates. Where it is not immediately feasible to replace existing grates with standard grates designed for bicycles, 25 mm by 6 mm (1 in by 1/4 in) steel cross straps should be welded to the grates at a spacing of 150 mm to 200 mm (6 in to 8 in) on center to reduce the size of the opening. This should be considered a temporary correction, as snowplows can often scrape off such straps.

See the Mn/DOT Drainage Manual and Chapter 8 of the Mn/DOT Road Design Manual for further design information.

4-6.3 Left-Turn Bypass Lanes

A bypass lane allows a vehicle to move to the right on the roadway and pass another vehicle that has slowed or stopped in the travel lane to make a left turn. They are typically found at “T” intersections on two-lane roads where there is no left-turn lane. A combination right-turn and bypass lane may be used at four-legged intersections. Cars overtaking left-turning vehicles move to their right, often without slowing, traveling in the shoulder area typically used by bicycles. On designated bike routes, at least 1.2 m (4 ft) of smooth paved shoulder should be added to the right of the bypass lane to provide space for bicyclists, where practical, and even greater additional shoulder width is desirable if the percentage of heavy vehicles (trucks, buses and recreational vehicles) is high.

The bypass lane should be clearly striped so that the motorist does not drift into the bicyclist’s path. Refer to Chapter 5 of the Mn/DOT Road Design Manual for left-turn bypass lane design information.
4-6.4  Truck-Climbing Lanes and Passing Lanes

A truck-climbing lane is an additional uphill lane that allows vehicles to pass those that are unable to maintain satisfactory speeds. Passing lanes are an additional lane added on a two-lane road for a limited distance to allow slow-moving vehicles to move to the right and be passed. On designated bike routes, the shoulder should include a minimum 1.2 m (4 ft) smooth paved width adjacent to the truck-climbing lane or passing lane and through the lane drop area. Chapter 3 of the Mn/DOT Road Design Manual contains design information for truck-climbing lanes and passing lanes.

Climbing lanes should be indicated with appropriate signage. The shoulder edge as well as the climbing lane must be clearly marked to ensure that motorists do not move into the bicycle path.

4-6.5  Lighting

On shared roadways and those with bicycle lanes, the area normally reserved for bicyclists may be illuminated in accordance with recommended design values in AASHTO’s An International Guide for Roadway Lighting and ANSI/IES Recommended Practices and the Mn/DOT Roadway Lighting Design Manual. The lighting system as a whole should provide adequate illumination along the entire length and width of the bikeway, without variations in luminous intensity (bright and dark spots) to which bicyclists and motor vehicle drivers might experience difficulty adjusting.

All preliminary roadway lighting designs should be checked for conformance with luminance requirements prescribed for walkways adjacent to roadways and bicycle lanes. Additional information regarding bikeway lighting can be found in Section 5-8 of this manual.

4-6.6  Traffic-Calmed Roadways

Traffic calming employs a variety of techniques, including grade changes, curb extensions, and pedestrian refuges, to reduce the dominance and speed of motor vehicles. In areas of traffic calming, it is rare to see special facilities for bicyclists because many of the benefits of traffic calming (slower vehicle speeds, better driver discipline, less traffic, and environmental improvements) directly benefit bicyclists. For these reasons, traffic-calmed roadways are often used as routes in bicycle and pedestrian networks.

Benefits attributed to traffic calming include an average one-third reduction in crashes, a greater feeling of security among vulnerable road users, and aesthetic improvements through landscaping and reduced presence of motor vehicles. In addition to making traffic-calmed roads safer, slower vehicle speeds may create better driver discipline and reduce fuel consumption, vehicle emissions, and noise levels.

Traffic calming is typically used on residential streets, but may apply to other roads depending on their functional classification and use. Techniques applicable to main urban thoroughfares generally differ from those employed in minor residential streets. A greater variety of traffic calming features has been developed for minor roads where stricter speed controls and reduced capacity will not create undue delay.
Some traffic calming treatments may be detrimental to bicyclists, who are susceptible to changes in surface height and texture or unexpected road narrowing. A design balance should be maintained so that bicyclists traveling through traffic-calmed areas are able to maintain their momentum without endangering other users.

General design guidelines to accommodate bicycles on roadways with traffic calming are listed below:

- Provide bicyclists with alternative paths [minimum width 1.2 m (4 ft)] around physical obstacles such as ramps and through barriers such as cul-de-sacs.
- Where roads are narrowed as a speed control measure, consider how bicyclists and motorists can share the remaining space.
- Surface materials should have good skid resistance. Textured areas should not be so rough as to create instability for bicyclists.
- Smooth transitions on entry and exit slopes adjacent to raised surfaces, with clear indication and transition gradients of no more than 6:1.
- Consider overall gradients, noting that bicyclists are likely to approach grade changes at different speeds uphill and downhill.
- Combine appropriate signing with public awareness campaigns to remind drivers about traffic-calmed areas.

4-6.6.1 Curb Extensions

Narrowing the roadway by extending the curb reduces the crossing distance for pedestrians. When placed near an intersection, curb extensions tend to tighten the vehicle turning radius and reduce vehicle speeds, and prevent vehicles from parking too close to the intersection. They also help shelter parked vehicles and ensure that a pedestrian’s view of approaching vehicles and bicyclists is not obstructed. To prevent curb extensions from causing a safety hazard by protruding into the bicyclists’ path they should not extend beyond the width of the parking lane.

4-6.6.2 Pedestrian Refuge Islands

Refuge islands allow pedestrians to cross fewer lanes at a time and assess conflicts differently. Pedestrian refuge islands should be 2.4 m (8 ft) wide, where practical, to allow bicycles with trailers to use the island to cross the street. There are no impacts to on-street bicycle facilities unless the lanes are narrowed to provide space for the island.

4-6.7 Alternate Bicycle Route

Whenever possible, bike facilities should be constructed to accommodate the entire range of cyclists with one facility. However, in some instances, it may be necessary to create an alternate, parallel bicycle route, as when a route along an arterial roadway may be acceptable to advanced bicyclists, but inappropriate for basic bicyclists and children bicyclists. A lower-volume roadway that parallels a high-volume arterial can provide a pleasant alternative for “through” bicyclists, as well as a higher level of mobility and safety. Figure 4-33 illustrates an alternative bicycle route.
Alternate routes are most appropriate under the following conditions:

- The alternate route is within 400 m (0.25 mi) of the arterial
- The arterial has on-street parking and/or multiple driveways and/or turning conflicts
- Average daily traffic on the arterial road is greater than 10,000;
- Average vehicle speeds exceed 50 km/h (30 mph)
- The arterial lacks sufficient right-of-way to allow a striped bicycle lane

Designating an alternate bicycle route does not remove the need to improve the safety of the primary route for those bicyclists who still need to use the arterial, especially when commercial or other public destinations exist along that arterial. However, the alternate route should decrease bicycle traffic on the arterial substantially.

To succeed, an alternate bicycle route needs to be very convenient and legible. That is, creating a strong mental image in the minds of the bicyclists expected to use it. Alternate routes are most successful when they connect destination points, such as trails, schools, parks, churches, historical sites, downtown areas, and other points of interest.

To implement alternate routes, AASHTO recommends that directional and informational signs should be posted every 500 m (0.3 mi) and at every turn to both mark upcoming turns and confirm that riders have made the correct turns. Limit stop signs and signals to the greatest extent practical, except where they are needed to cross busy streets. Traffic-calming techniques should be used to enhance attractiveness and safety for bicyclists.

It is inappropriate to designate a sidewalk as an alternate route or designated bike route. To do so would prohibit bicyclists from using an alternate facility that might better serve their needs and prevent conflicts with pedestrians or motorists.
Figure 4-33:
Alternate Bicycle Route