

Design Guidelines for On-street Bicycle Facilities

The 2008 Lawton Metropolitan Bicycle and Pedestrian Plan (LMBPP) provided design guidelines for the implementation of the comprehensive network of bicycle routes proposed in the Plan. These guidelines were intended to help establish a clear, continuous, uniform, and safe circulation network that will encourage people to walk and ride bicycles throughout the City. The construction of new bikeways, however, pose unique planning and design challenges because the bicycle is not compatible with either automobiles or pedestrians, the automobile being a hazard to the bicyclist and the bicycle presenting dangers to the pedestrian. As the City reviewed possible implementation of the Phase I on-street priority routes, they determined that a need for additional or expanded design standards were needed to deal with the issues arising on these Phase I routes.

To this end, the following guidelines are offered as expanded or additional guidelines to the principles contained in the LMBPP and are not intended to void those standards that have been approved by the City as a part of the LMBPP. In general, the standards contained in this section include guidelines related to:

1. Recommended Rules for Bikeway Facility types by Road Classification;
2. Recommended Guidelines for Intersections with Bikeway Facilities; and
3. Design Standards for Shared Roadways and Bike Lanes for various road types

Ultimately, the final design of individual bikeway facilities at specific locations depends almost entirely on the unique and current conditions along the specific route. These design guidelines address the various factors for bikeway design, including levels of separation from roadways and walkways, widths and clearances, merging distances, signage and street crossings, but in all instances, these standards are not intended to replace or supplant sound engineering design and judgment. Each case should be reviewed, planned, designed and constructed with these standards in mind, but specific site conditions should dictate ultimate final design decisions.

Bikeway Facilities by Road Classifications

Bikeways should be planned and designed according to classifications that define the level of separation they maintain from roadways and walkways. The ideal solution for the development of bikeways is to physically separate them from both roadways and walkways, but in many instances this ideal solution is not feasible. The LMBPP's Phase I implementation plan was to prioritize on-street facilities in order to hasten bikeway development in the City at the most economical costs, but a field review and engineering analysis of the Phase I routes indicated that some of these proposed facilities were not appropriate for the roadway type on which they were occurring.

The following chart provides additional guidance for future bike route planning and design in terms of the roadway type being targeted for the future facility. All other design issues and conditions being equal, this chart should be used as the "rules" for determining which type bike facility is most appropriate for each roadway classification.

Table 4.1 Recommendations for On-Street bicycle facilities by Roadway Classification

Classification	Volume	Speed	Lanes	Recommendations
Local	Below 5,000 ADT	25 mph	2	Shared Roadway
Collector	Below 20,000 ADT	Below 35 mph	2-3	Shared Roadway
Collector	10,000 to 20,000 ADT	Below 35 mph	4	Convert to Three Lanes (w/ designated bike lanes) or Shared Roadway
Arterial	Below 20,000 ADT	35 mph	4	Designated Bike Lanes (both directions)
Arterial	Below 20,000 ADT	Above 35 mph	4-5	Bike Lanes or Off-street Shared Use Path
Arterial	Above 20,000 ADT	Above 35 mph	4+	Bike Lanes or Off-street Shared Use Path

Roadway Classification Definitions:

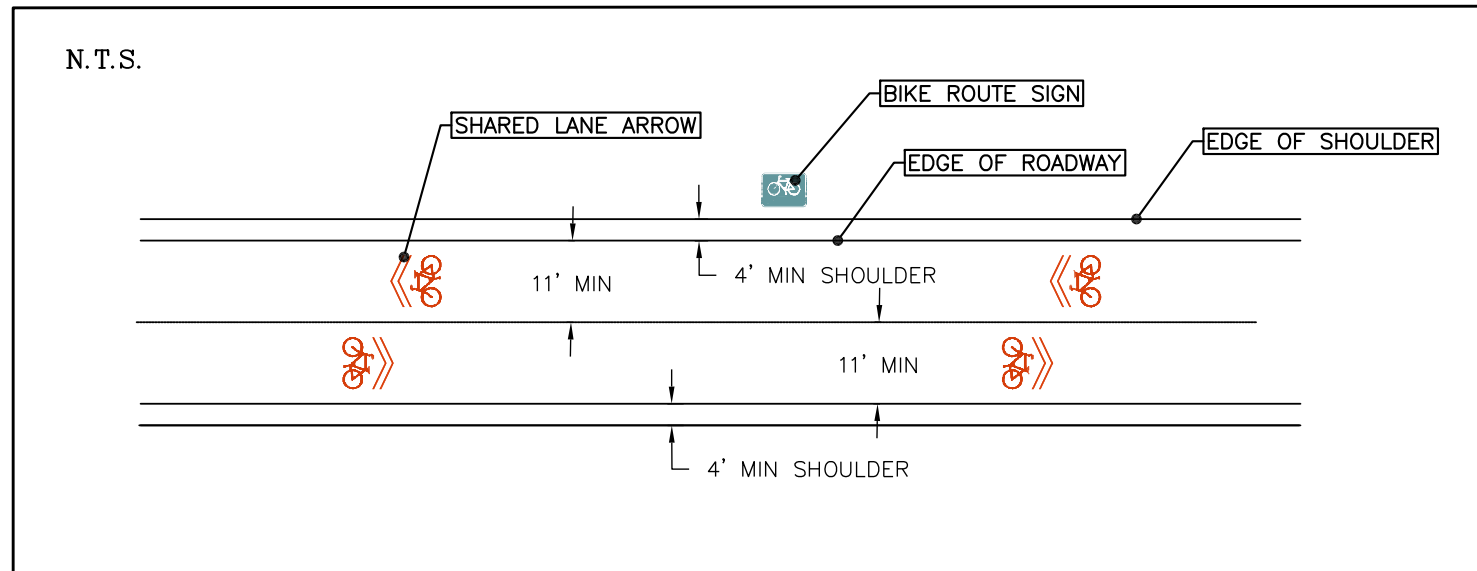
- **Local:** A street which is primarily residential and is used primarily by residents of a neighborhood.
- **Collector:** Relatively low-speed (25-35 mph), relatively low-volume (5,000-20,000 average daily trips) street that provides circulation within and between neighborhoods. Collectors usually serve short trips and are intended for collecting trips from local streets and distributing them to the arterial network.
- **Arterial:** Medium-speed (35-45 mph), medium-capacity (10,000-35,000 average daily trips) roadway that provides intra-community travel and access to the county-wide highway system. Access to community arterials should be provided at collector roads and local streets, but direct access from parcels to existing arterials is common.

In general, the Lawton Bicycle and Pedestrian Master Plan and this Feasibility Study recommend that on-street shared lanes (sharrow) be utilized as the preferred bicycle facility type for local and low volume collector roadways within the City. The City should evaluate the standard cross sections for each of these roadway types and determine if reduced lane widths for segments which are proposed to contain on-street bike routes can be accommodated.

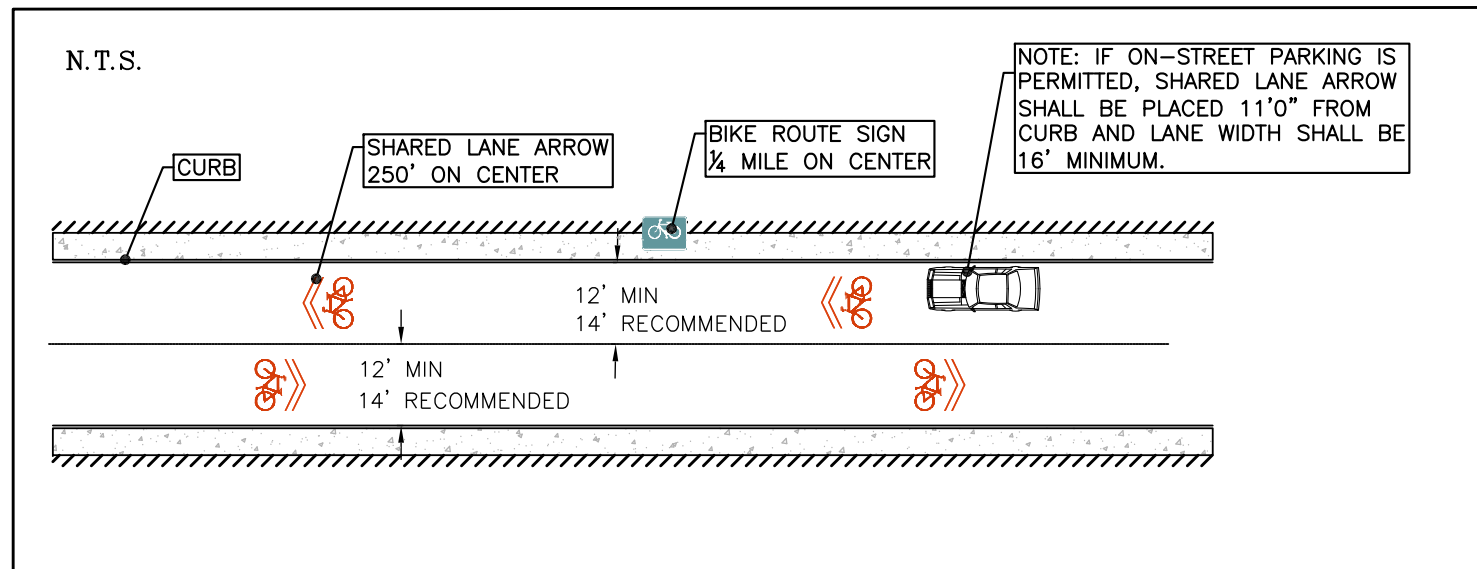
In addition, Exhibit 4-1 (on next page) provides some design guidelines for on-street bicycle facilities, including shared lane and designated bike lanes.



SHARED ROADWAY

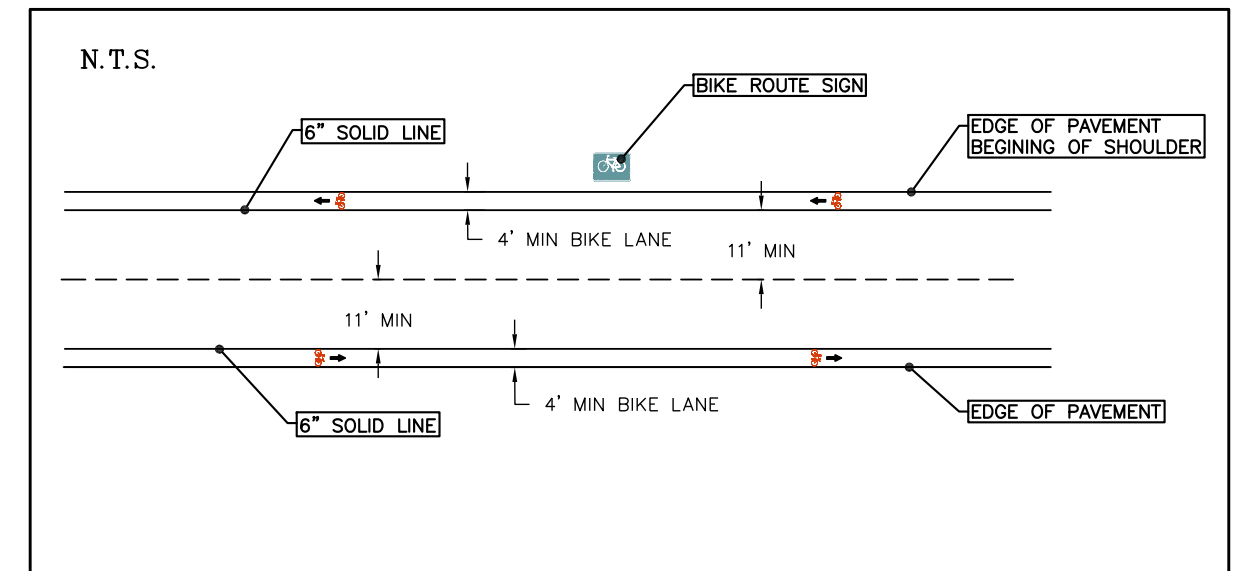


SHARED ROADWAY WITH PAVED SHOULDERS

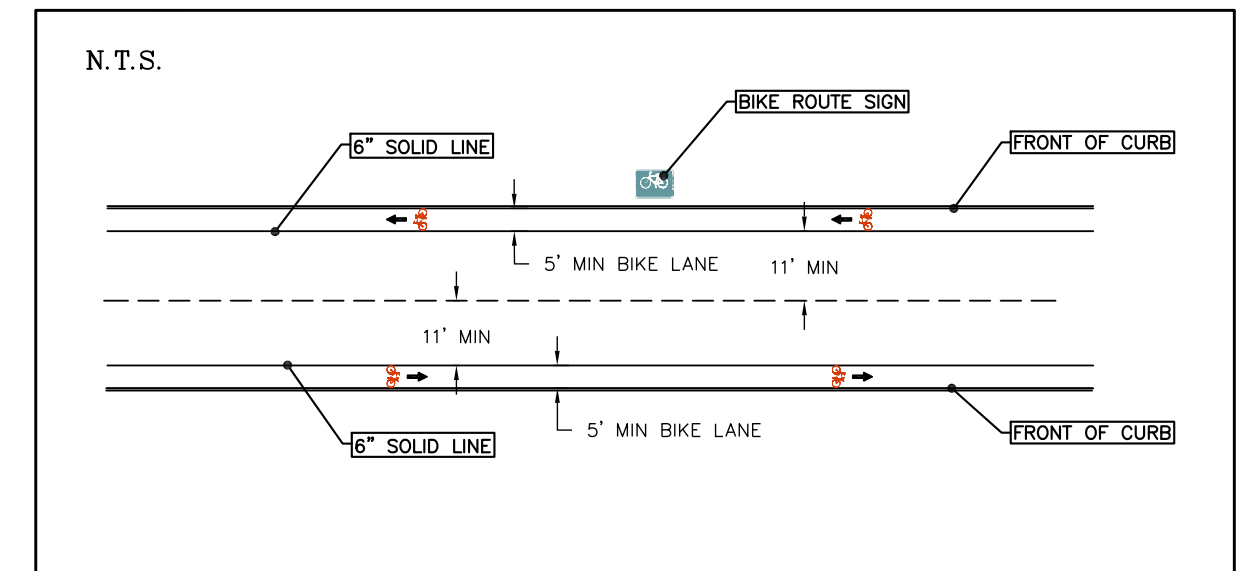


SHARED ROADWAY WITH CURBS

BIKE LANE



BIKE LANE WITH SHOULDER



BIKE LANE WITH CURB AND GUTTER

GENERAL NOTES:

- 1) SIGNAGE AND MARKING OF ROUTES TO BE IN ACCORDANCE WITH MUTCD
- 2) IF THE LONGITUDINAL JOINT BETWEEN THE GUTTER PAN AND PAVEMENT SURFACE IS NOT SMOOTH, 4 FT. OF RIDE ABLE SURFACE SHOULD BE PROVIDED.
- 3) BIKE LANE MARKING SHALL BE PAINTED ON THE FAR SIDE OF EACH INTERSECTION. ADDITIONAL STENCILS MAY BE PLACED ON LONG, UNINTERRUPTED SECTIONS OF ROADWAY.



Bicycle Facilities at Intersections

As stated in the Lawton Metropolitan Bicycle and Pedestrian Plan (LMBPP),

“Intersections represent one of the primary collision points for bicyclists and pedestrians. Generally, the larger the intersection, the more difficult it is for bicyclists and pedestrians to cross. On-coming vehicles from multiple directions and increased turning movements sometimes may make difficult for motorists to see non-motorized travelers. Most intersections do not provide a designated place for bicyclists. Bike lanes and pavement markings often end before intersections, causing confusion for bicyclists. Loop and other traffic signal detectors, such as video, often do not detect bicycles. Bicyclists wanting to make a left turn can face quite a challenge. Bicyclists must either choose to behave like motorists by crossing travel lanes and seeking refuge in a left-turn lane, or they may act as pedestrians and dismount their bikes, push the pedestrian walk button located on the sidewalk, and then cross the street the crosswalk. In some situations bicyclists traveling straight may have difficulty maneuvering from the far right lane, across a right turn lane, to a through lane of travel. Furthermore, motorists often do not know which bicyclist movement to expect.”

Based on an analysis of the proposed LMBPP Master Plan routes and a review of existing conditions at the major intersections along the Phase I routes, the number and type of intersection configurations present across the City are too many and too varied to permit the development of intersection design standards for ‘typical’ intersection types. Detailed design and traffic analysis (particularly a review of existing turning movements and volumes) of each intersection along each route will be required to adequately determine the safest route for bicyclists. Improvements to these complex crossings must be considered on a detailed, case-by-case basis, understanding the unique conditions at the site and utilizing sound engineering judgment.

Figure 4.1 (see this page) provides a graphic depiction of the typical bike and automobile movements at major intersections. This graphic clearly indicates the multiple variations that could be encountered if a bike lane striping and signage plan for a “typical” intersection was attempted. This exhibit was generated by AASHTO and suggests that: (1) designated bike lanes should be provided on major roadways as the cyclist approaches major intersections; and (2) because there is no clear method to determine which direction a cyclist may take at the crossing, the preferred method to deal with intersections is to permit the cyclist to “act” as a vehicle and merge with the appropriate vehicle lane to achieve their intended turning movements or directions.

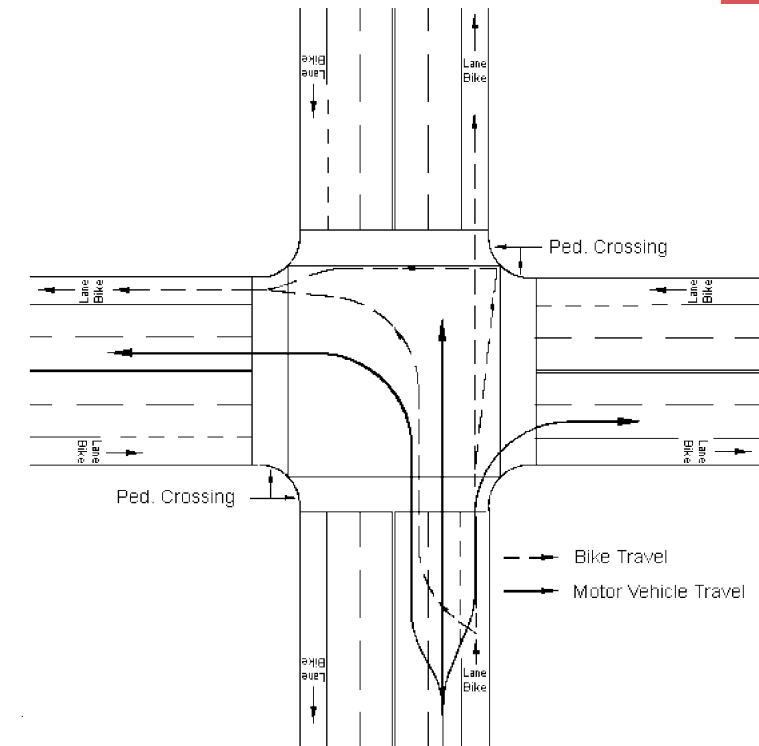


Figure 4.1 Typical Bike and Auto Movements at Major Intersections (AASHTO)

Intersection Guidelines/Rules

As a general rule, however, the City should consider adopting some type of design standards for bike routes through intersections in order to provide a consistent approach for both cars and bicyclists. To this end, the following intersection treatments should be evaluated as minimum standards that govern bicycle facility design at intersections across the City:

- **Four-Way-Stops on Local Roadways:** Where local streets, with shared roadway bicycle facilities, intersect other local streets, the minimum intersection treatment and bicycle route facilitator should be stop sign placement on intersecting streets in order to prioritize the bike route as having the right-of-way and to coordinate the flow of traffic and to protect bicyclists from moving vehicles. Surprisingly, there are several locations along the proposed bike routes in the residential areas of the City do not have stop signs at any single leg of these four way intersections.
- **Signal Modifications at Intersections:** In many instances, bicycle detection loops and signal cycle timing should be adjusted to accommodate bicycle travel through signalized intersections. The extent of adjustment required should be reviewed on a case-by-case basis and in consultation and coordination with the City’s public works and engineering departments. In most instances, larger intersections may require additional green time for the bike route phase to facilitate safe travel through the



- Separate Bike Lanes at Major Intersections:** To promote safety at major intersections where potential car and bicycle conflicts can occur, separate bike lanes are recommended. Primarily at collector and arterial streets, when left-turn or right-turn demand exceeds the available vehicle storage area within the available turn lanes at signalized intersections OR when two or more lanes (in one direction) exist on the bike route leg of the intersection, separate bike lanes are recommended to protect bicyclists from potential conflicts with vehicle movements. Figure 4.2 (see this page) provides a graphic depiction of possible bike lane configurations and striping at an individual “leg” of an intersection as developed by AASHTO. Because the difficulty, geometry and traffic conditions at each intersection throughout the City is different, these guidelines provide typical treatments that should be evaluated as the bike route approaches an intersection. More detailed analysis of the intersection is warranted as the specific bike route is being designed and constructed, and this analysis should be coordinated with the City Engineer.

Intersection Types in Lawton

In many instances, the City can and should adopt design standards for bike routes through various intersection types in order to provide a consistent approach for both cars and bicyclists throughout the City. To this end, the following intersection “types” have been identified as typical across the Lawton community and they warrant some level of design guidelines as provided on the following pages. In particular, many of these intersections are encountered in Phase I.

Intersection Type 1: Local Streets

Roadway Class of Bike Route:	Local street
Intersected Roadway:	Local street
Traffic control at Intersection:	Four Way Stop Sign
Posted Speed on Bike route:	Below 35 MPH
Intersection Geometry/Alignment:	Aligned

Recommended Treatment/Rule:

Route Type:	Shared Roadways through Intersection
Treatments/Rules:	All streets to be marked & signed as four way stops

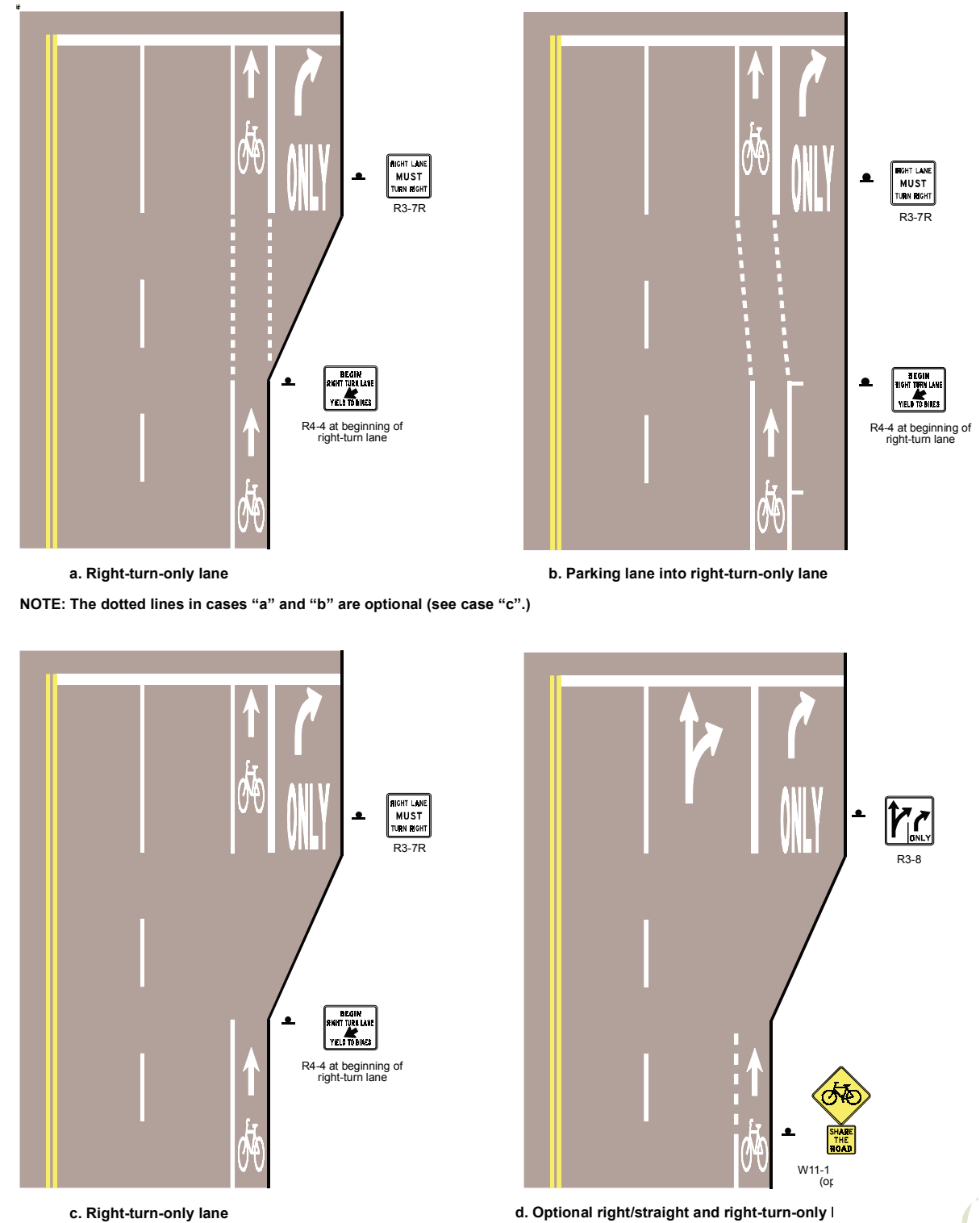


Figure 4.2: Potential Bike Lane Striping/Signage at Intersections



Intersection Type 2: Locals and Collectors

Roadway Class of Bike Route:	Local street
Intersected Roadway:	Collector street
Traffic control at Intersection:	Signalized
Posted Speed on Bike route:	Below 35 MPH
Intersection Geometry/Alignment:	Aligned

Recommended Treatment/Rule:

1. If no bike route (planned or built) on intersecting street:

Route Type:	Shared Roadway through Intersection
Treatments/Rules:	May require modified signal timing and detection loops to permit safe bicycle movements to and through intersection
2. If bike route is planned or built on intersecting street:

Route Type:	Transition from shared roadway to separate bike lanes at intersection on both streets
Treatments/Rules:	- May require modified signal timing and detection loops to permit safe bicycle movements to and through intersection - Bike lane positioning should be determined on the volume of turning movements at each leg of intersection (See Figure 4.2 for potential striping solutions)

Intersection Type 3: Collectors/Arterials

Roadway Class of Bike Route:	Collector street
Intersected Roadway:	Collector or Arterial street
Traffic control at Intersection:	Signalized
Posted Speed on Bike route:	Greater than 35 MPH
Intersection Geometry/Alignment:	Aligned

Recommended Treatment/Rule:

1. If no bike route (planned or built) on intersecting street:

Route Type:	Bike Lanes through Intersection
Treatments/Rules:	- May require modified signal timing and detection loops to permit safe bicycle movements to and through intersection - If 2 or more lanes (in one direction) are present along bike route, provide separate bike lane at intersection that provides separation for bicyclists and minimizes potential turning conflicts with vehicles based on analysis of turning movements/volumes (See Figure 4.2 for potential striping solutions)

Intersection Type 3: Collectors/Arterials (continued)

2. If bike route is planned or built on intersecting street:

Route Type:	Bike Lanes through Intersection
Treatments/Rules:	- May require modified signal timing (i.e. add pedestrian phase) and detection loops to permit safe bicycle movements to and through intersection - If 2 or more lanes (in one direction) are present along all bike routes, provide separate bike lane at intersection legs that provides separation for bicyclists and minimizes potential turning conflicts with vehicles based on analysis of turning movements/volumes (See Figure 4.2 for potential striping solutions) - Install Refuge islands or similar measures to permit a two step crossing function for bicyclists across the intersecting street if the needed signal timing modifications adversely impact traffic flow or levels of service at the intersection or if the signal timing modifications are not possible

Intersection Type 4: Off-set or Misaligned Intersections

Roadway Class of Bike Route:	Local or Collector street
Intersected Roadway:	Arterial street
Traffic control at Intersection:	Signalized or unsignalized
Posted Speed on Bike route:	Greater than 35 MPH
Intersection Geometry/Alignment:	Off-set or misaligned

Recommended Treatment/Rule:

1. If intervening arterial street does not have a traffic signal:

Treatments/Rules:	AVOID THIS INTERSECTION AND FIND ALTERNATIVE ROUTE
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Intersection Type 4: Off-set or Misaligned Intersections (continued)

2. If intervening arterial street has one or more signal(s) at bike route and can not be avoided:

Route Type: Off-street shared use paths along intersecting Arterial and transition to shared use path on lower classified street at the intersections

Treatments/Rules: - Bicyclists should be required to dismount & walk bike across intersection on pedestrian crossing. Modified signal timing may be required to provide sufficient time for crossing.
- Off-street paths should begin a minimum of 100 feet from intersection and, to the maximum extent feasible, should be available on both sides of street and provide full access to and through the intersections (i.e. crosswalks at both intersections and paths on both sides of lower classified street)
See Exhibit 4-4 on the following pages for graphic depiction.
- Off-street shared use path should be provided along entire length of arterial and should be minimum twelve feet (12') in width and be separated from nearest travel lane by a minimum of two feet (2').
- Install Refuge islands or similar measures to permit a two step crossing function for bicyclists across the intersecting street if the needed signal timing modifications adversely impact traffic flow or levels of service at the intersection or if the signal timing modifications are not possible.

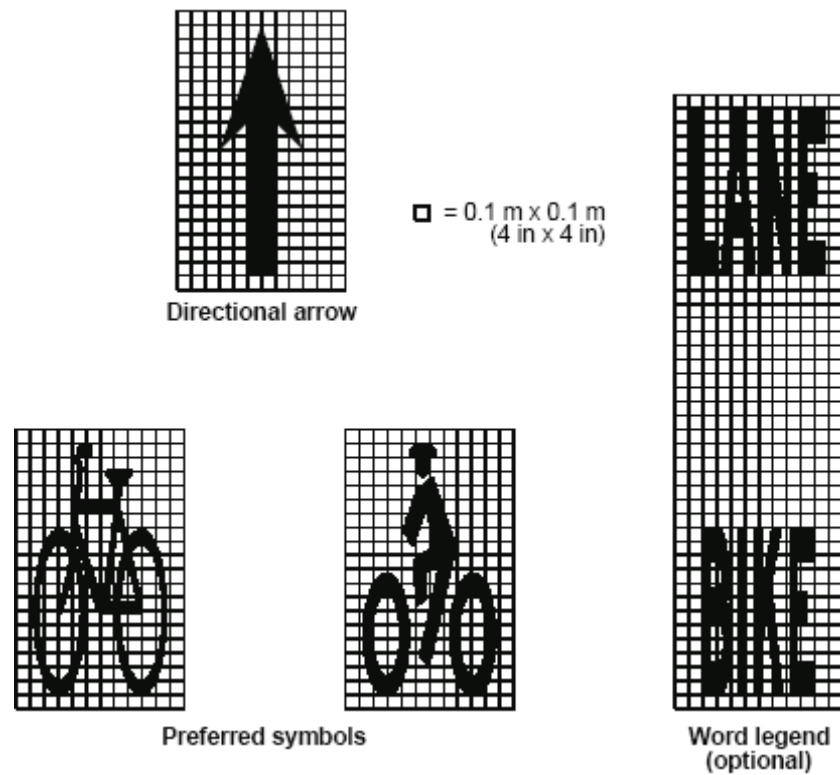


Bicycle Lane Markings and Signage

Bike Lane Markings

A bike lane should be painted with standard pavement symbols to inform bicyclists and motorists of the presence of the bike lane. The standard pavement symbols are one of two bicycle symbols (or the words "BIKE LANE") and a directional arrow. These symbols should be painted on the far side of each intersection. Additional stencils may be placed on long, uninterrupted sections of roadway. All pavement markings are to be white and reflectorized. Additional bicycle facility marking size, shape, and material shall be based upon the typical markings shown below.

Typical Bike Lane Markings

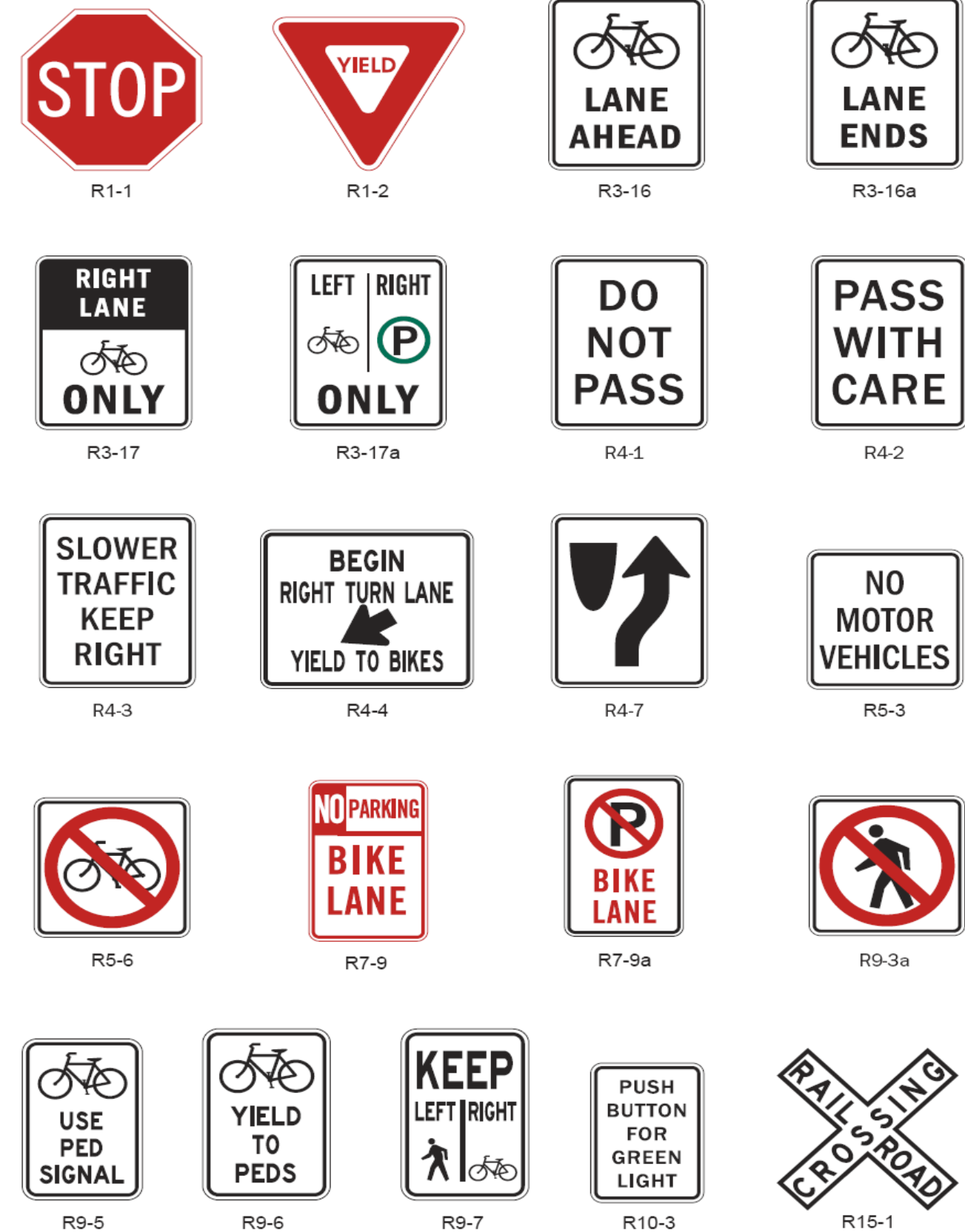


Bike Signs

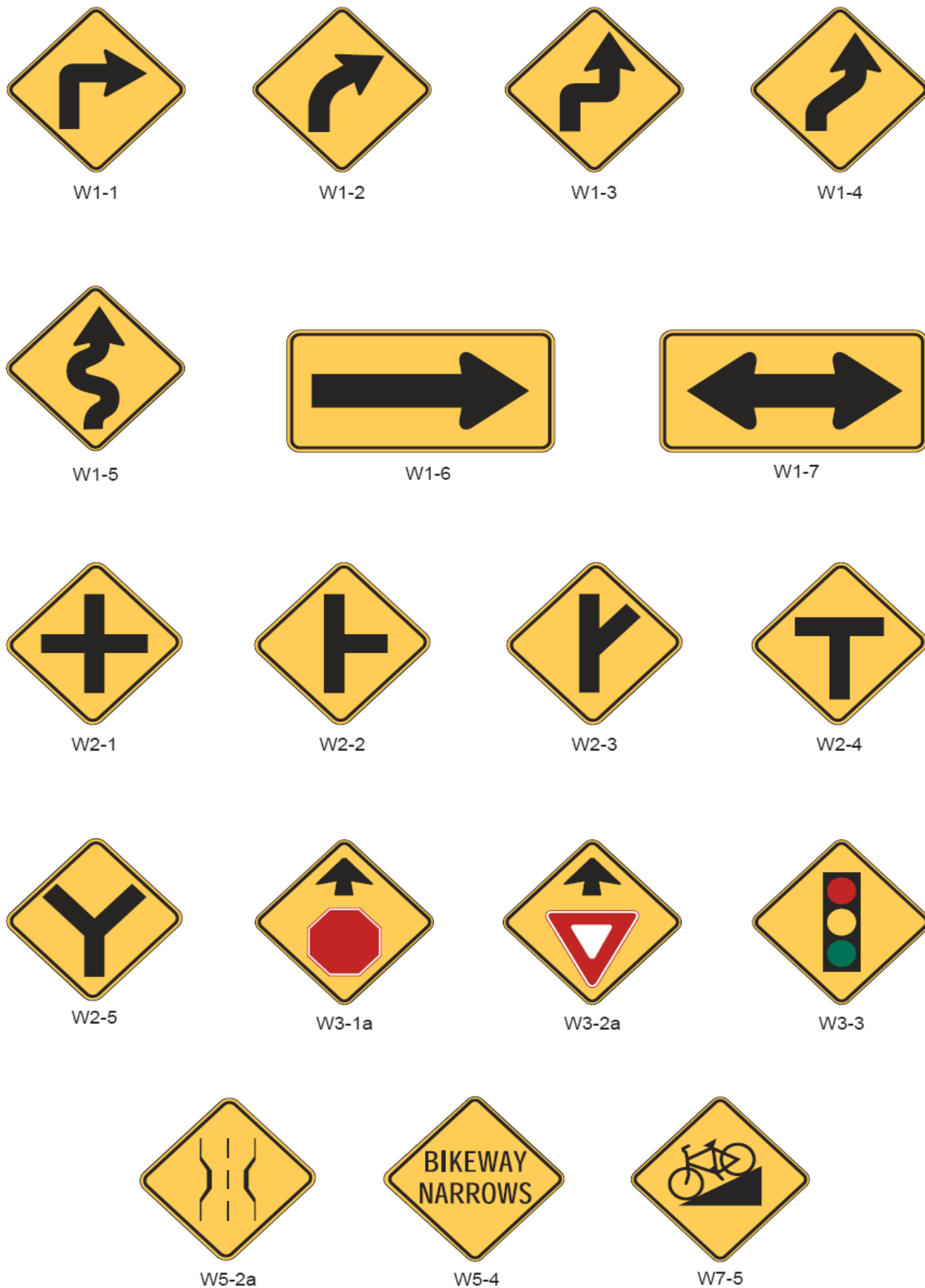
Bicycle signs shall be standard in shape, legend, and color. All signs shall be retroreflectorized for use on bikeways, including shared-use paths and bicycle lane facilities. Where signs serve both bicyclists and other road users, vertical mounting height and lateral placement shall be as specified in part 2 of MUTCD. On shared-use paths, lateral sign clearance shall be a minimum of 0.9 m (3 ft) and a maximum of 1.8m(6 ft) from the near edge of the sign to the near edge of the path. Mounting height for ground-mounted signs on shared-use paths shall be a minimum of 1.2 m (4 ft) and a maximum of 1.5 m (5 ft), measured from the bottom edge of the sign to the near edge of the path surface. When overhead signs are used on shared-use paths, the clearance from the bottom edge of the sign to the path surface directly under the sign shall be a minimum of 2.4 m (8ft).

A representative sampling of bicycle facility signs are shown on subsequent pages. All signs should be consistent with the requirements of MUTCD, 2009 edition.

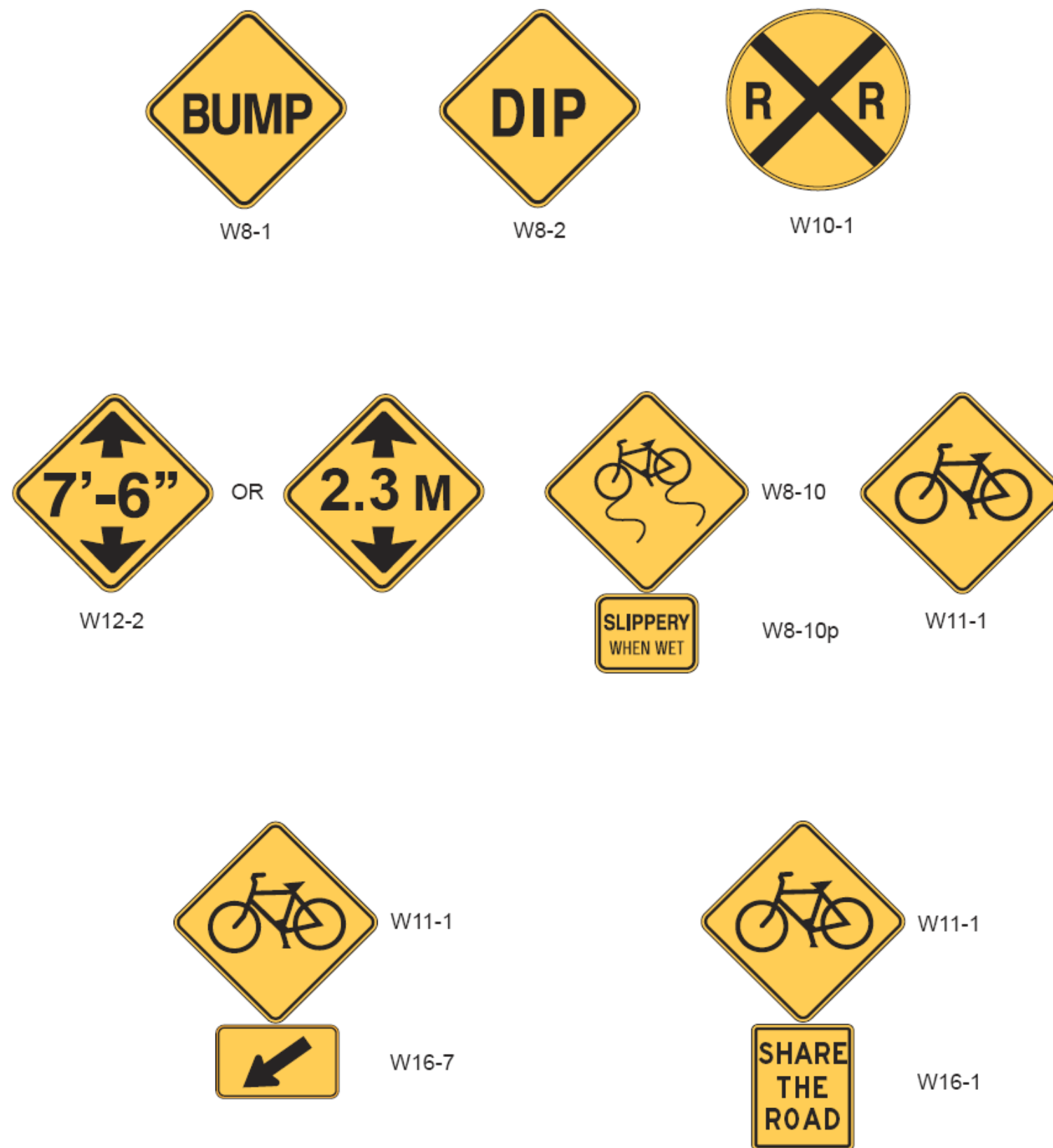
Bicycle Lane Signs



Other Regulatory Signs



Other Regulatory Signs



Bicycle Route Guide Signs



D11-1



M1-8



M1-9



D1-1b(L)



M4-11



D1-1b(R)



M4-12



D1-1c



M4-13



M7-1



M7-2



M7-3



M7-4



M7-5



M7-6



M7-7



D4-3

