

MUTCD Webinar #5

Bikes:

Overview of Part 9 & Bike Signals

This meeting will be recorded



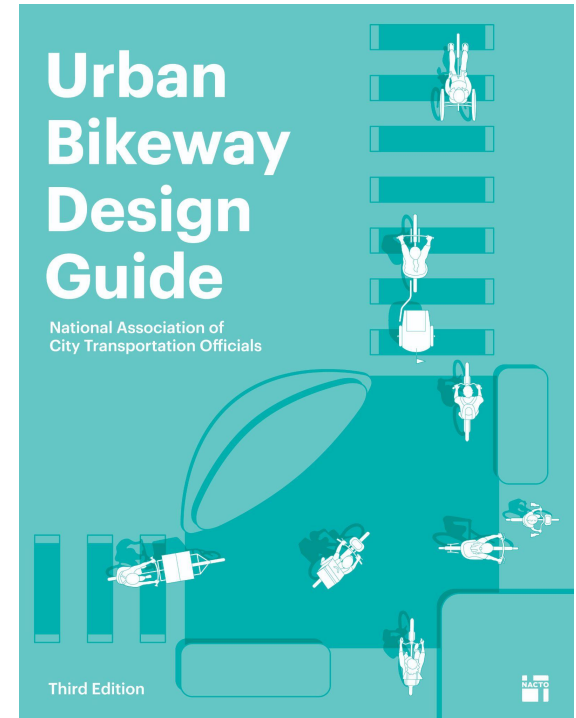
- A recording and copy of the slides will be shared with NACTO members and those registered for today's meeting.
- If you don't want to be on the recording, please keep your camera off.

It's almost here!



Urban Bikeway Design Guide, third edition

- Comprehensive update, 400+ pages of guidance and drawings
- Available in January 2025
 - nacto.org/bike-guide
 - 20% off pre-orders with code UBDG3



Post-Webinar:



- All questions will be documented and answers will be sent as a follow up.
- Receive AICP credit for attending today's session
 - planning.org/events/eventsingle/9298960/
- NACTO is unable to provide specialized accreditation for specific licenses and degrees.
 - Email events@nacto.org for a certificate of participation
- Sign up for Forj, NACTO's community discussion forum to join conversations about bikeway design, federal policy, street safety, and more!
 - <https://community.nacto.org/network-groups>

- February 27 - MUTCD 11th Edition Overview
- April 24 - *City Limits* and Speed Limit Changes
- June 26 - City Approaches to Setting Speed Limits
- August 29 - Crosswalks
- **October 30 - Part 9: Bikes & Bike Signals**
 - City Bike Examples - *to be scheduled*

Goals for today's webinar?



After today you should:

- Know what to look for (and what not to) in the MUTCD when designing bikeways or updating design standards
- Build confidence in applying engineering judgement

Today's Agenda



- How to use the MUTCD
- Bikeways
 - How to mark shared lanes
 - How to mark bike lanes
 - How to separate separated bike lanes
- Intersections
 - Bike lane approach
 - Crossbike markings
 - Bike signals
- Add-ons
 - Two stage left turn boxes
 - Bike Boxes
 - Pavement markings for obstructions

A short, solid blue horizontal line is positioned to the left of the main title.

How to use the MUTCD

Use of the MUTCD

Four headings used throughout the manual (1C.01.1)

- **Standard (shall/shall not) - these are requirements or prohibitions**
- *Guidance (should) - recommended practice with deviations allowed based on engineering judgement or engineering study*
- Option (may) - permissive condition
- Support - informational statement only

Thus, while this Manual provides Standards, Guidance, and Options for design and application of traffic control devices, **this Manual should not be considered a substitute for engineering judgment** (1D.03.5)

Engineering Judgment as defined in the MUTCD

The evaluation of available pertinent information including, but not limited to, the safety and operational efficiency of all road users, and the application of appropriate principles, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding upon the design (see Section 1D.03), use, installation, or operation of a traffic control device.

Engineering judgment shall be exercised by a professional engineer (see definition in this Section) with appropriate traffic engineering expertise, or by an individual working under the supervision of such an engineer, through the application of procedures and criteria established by the engineer.

Documentation of engineering judgment is not required

- 
- Bikeways: How to...**
- ...mark shared lanes**
 - ...mark bike lanes
 - ...protect separated lanes

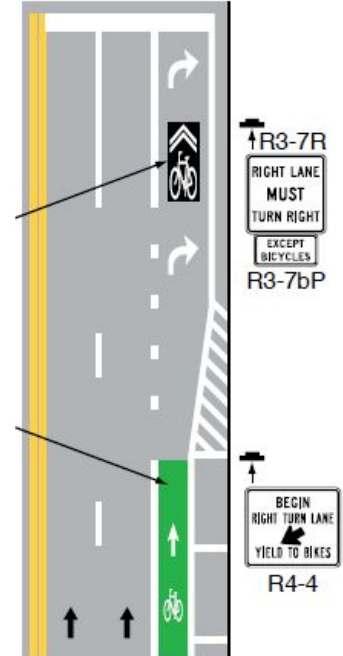
Shared lane markings

- Placement prohibition - shall not be used (9E.09.4)
 - In bike lanes nor bike lane extensions (across intersections nor turn lane weaving areas)
 - In light-rail travel lanes
 - Two-stage turn boxes nor bike boxes
 - Shared-use paths
 - Separated bikeways
- Marking
 - Shall not be green-backed, but may use a **black background** (9E.09.5-6)

Spacing and positioning guidance are suggestions not standards requirements. *Look to design guidance for recommendations*



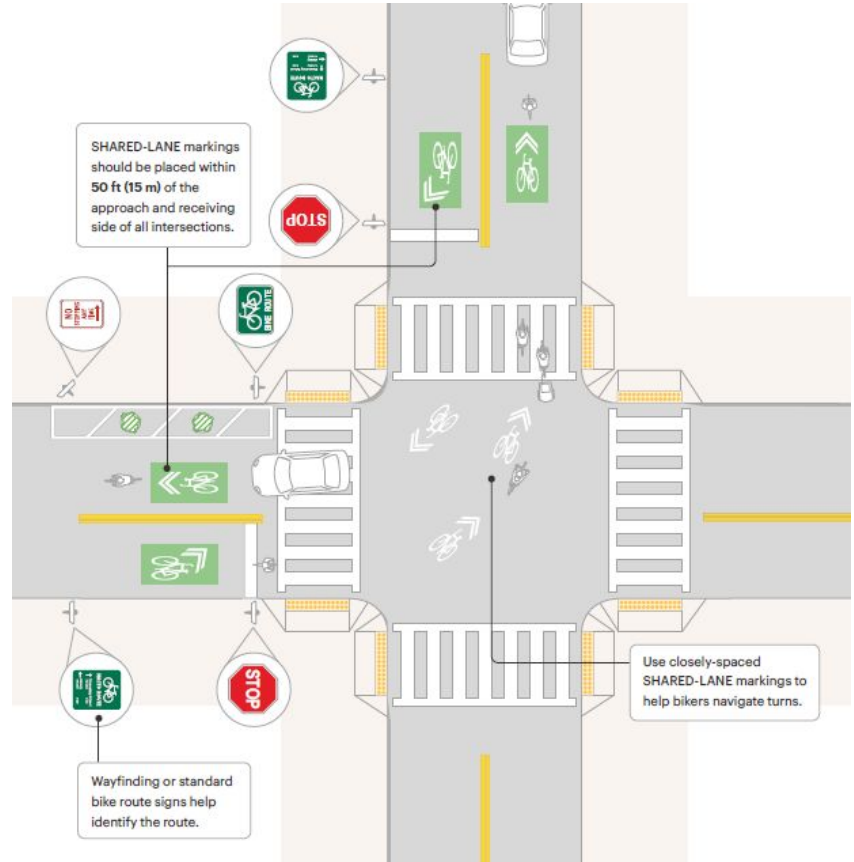
Figure 9E-9C



Shared lane markings

NACTO bike boulevard guidance

SHARED-LANE MARKINGS MINIMUM OFFSET DISTANCE FROM CURB					
Lane Width		Adjacent to Parking		Adjacent to Curb	
9 ft	2.7 m	11 ft	3.3 m	4 ft	1.2 m
10 ft	3 m	12 ft	3.6 m	5 ft	1.5 m
11 ft or more	3.3 m or more	13 ft	3.9 m	6 ft	1.8 m



—
Bikeways: How to...
 ...mark shared lanes
...mark bike lanes
 ...protect separated lanes

How to mark a bike lane

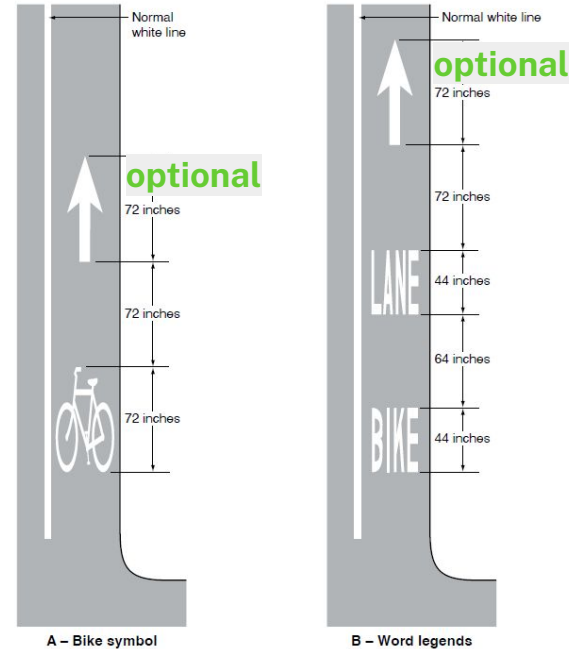
Bike lane pavement markings

- **Linear markings with bike lane symbol or word** markings pavement markings define a bike lane (9E.01.2) .
 - **Only bike symbol or word are required**
- Arrow markings may be used in conjunction with the bike lane symbol or word marking, placed downstream from the symbol or word (9E.01.4)
 - **Arrow marking is 'optional'**
- Symbol or word should be placed at the beginning of the bike lane and after major intersections. (9E.01.3)
 - **Frequency of bike lane markings is not prescribed**

Bike lane signs

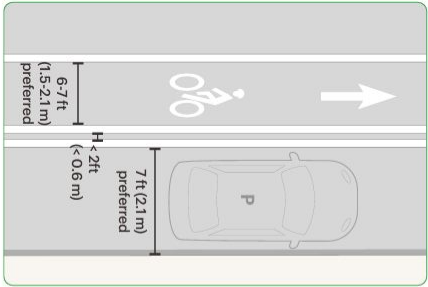
- Bike lane sign including AHEAD and ENDS plaques are optional (R3-17, R3-5hB, R3-17aP, R3-17bP; 9B.04.01). If used - “should” be at beginning and before the end of a bike lane and “may” be used at periodic intervals (9B.04.02-03)
 - **Bike lane signs are not required**

Figure 9E-1. Word, Symbol, and Arrow Pavement Markings for Bicycle Lanes

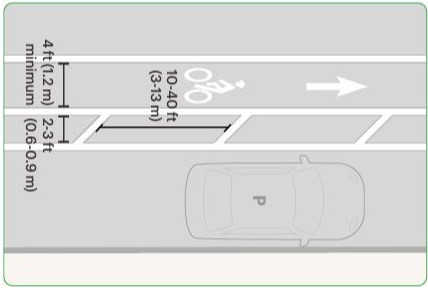


How to mark a bike lane

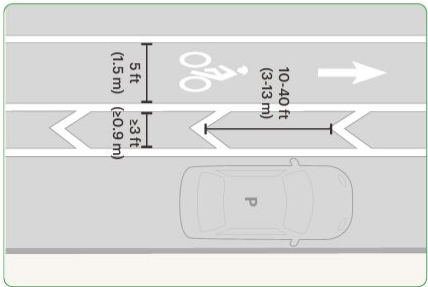
	Buffer markings requirements vary by buffer widths (distance between two longitudinal lines)		
	<2 ft	2-3 ft	>3 ft
Buffered (9E.06.14)	No requirement <i>should use diagonal or no markings</i>	No requirement <i>should use diagonal or chevron markings</i>	Shall use diagonal or chevron markings
Separated (9E.07.15)	No requirement	Shall use diagonal or chevron markings <i>unless physical separation occupies the "majority" of the buffer space</i>	
No spacing requirement, <i>chevrons or diagonal markings should be 10ft or more apart</i> (Buffered: 9E.06.12 and Separated: 9E.07.16)			



No buffer markings



Diagonal markings



Chevron markings

How to mark a bike lane

	Buffer markings requirements vary by buffer widths (distance between two longitudinal lines)		
	<2 ft	2-3 ft	>3 ft
Buffered (9E.06.14)	No requirement <i>should use diagonal or no markings</i>	No requirement <i>should use diagonal or chevron markings</i>	Shall use diagonal or chevron markings
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Buffer markings not required when physical separation occupies the "majority" of the buffer space

How to mark a bike lane

Edge line and lane line colors shall conform with requirements in Chapter 3A (see Figure 9E-7)

- 3A.03.03 - Yellow markings are used for
 - Separation of traffic traveling in opposite directions
 - Left hand side of the roadway of one-way streets
- 3A.03.04 - White markings are used for
 - Separation of traffic flows in the same direction
 - The right-hand edge of the roadway
- On-street parking space markings shall be white (3B.27.01)



White buffer markings separating bikes traveling in the **same direction** as motor vehicles



Yellow buffer markings separating bikes traveling in the **opposite directions**

How to mark a bike lane - counter-flow bike lanes

- Shall use double yellow centerline marking, painted median island (this is a buffer), raised median island, or some form of physical separation (9E.08.04) Need more than a double yellow line if speed limit is ≥ 35 mph (9E.08.05)
 - **If no buffer or separation, use double yellow centerline markings**
 - **Include more separation at higher speeds - see other design guidance**
- Shall place appropriate signage and signals facing counter-flow bikes (9E.08.11-12)
 - Use movement prohibition signs and DO NOT ENTER (R5-1) signs with EXCEPT BICYCLES (R3-7bP) plaque (9E.08.09-10)
 - **Use except bikes plaque as needed**
 - Where signs are used to regulate turns, one-way signs shall not be used
 - **Use Do not Enter signs instead of the One-way sign**
 -



How to mark a bike lane - counter-flow bike lanes

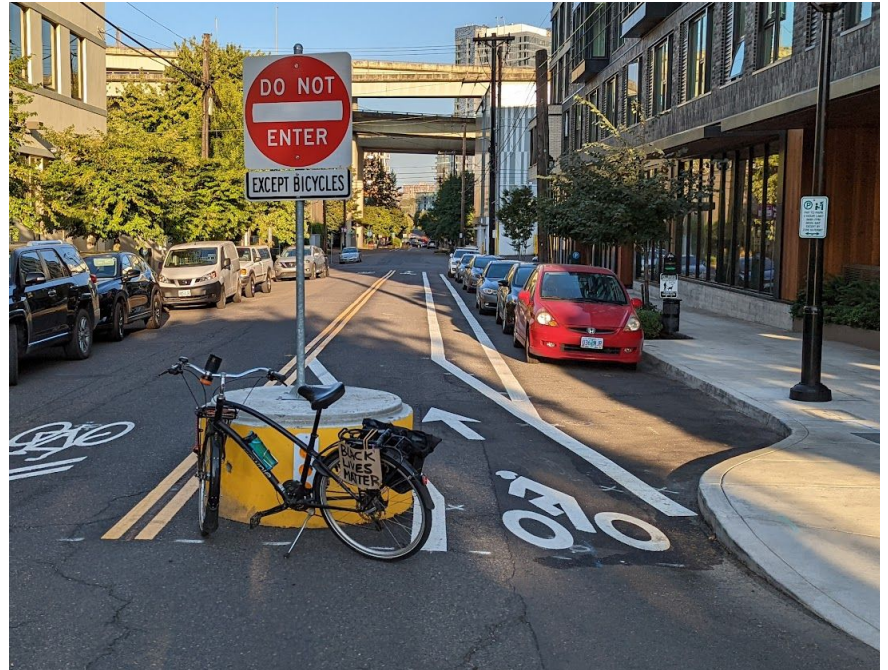
Use engineering judgement to design context sensitive counter-flow bike lanes

9E.08.3 - Where used, a counter-flow bicycle lane should be marked such that bicycles in the counter-flow lane travel on their right-hand side of the road in accordance with normal rules of the road, with opposing traffic on the left.

- **Can be on the left- or right-hand side of a one-way street**

9E.08.7 - Counter-flow bicycle lanes should not be used between a general-purpose lane and an on-street parallel parking lane for motor vehicles.

- **Can be on either side of on-street parking**



Bikeways: How to...
...mark shared lanes
...mark bike lanes
**...protect separated
lanes**

Separated bike lanes means of separation

- **Section 9E.07 Separated Bicycle Lanes**
 - **Vertical elements** used to provide physical separation between bike lanes and general-purpose lanes may include, but are not limited to **tubular markers**, raised islands, or parked vehicles (9E.07.03)
- **Section 9E.17 Raised Devices**
 - **Channelizing devices** used to emphasize the pavement marking patterns of bicycle facilities
 - shall not incorporate the color green into either the device or its retroreflective element to supplement the presence of green-colored pavement (9E.17.7)
 - **Shall not be or incorporate green**
 - Should be tubular markers (9E.17.4)
 - **No raised device requirement**
 - Should be placed in the buffer and at least 1 foot from the longitudinal bike lane markings (9E.17.8)
 - **No placement requirement within the buffer**



Separated bike lanes means of separation

CHAPTER 3I. CHANNELIZING DEVICES USED FOR EMPHASIS OF PAVEMENT MARKING PATTERNS

- Channelizing devices such as cones, tubular markers, vertical panels, lane separators, drums, and barricades may be used for general traffic purposes such as adding emphasis to reversible lane delineation, channelizing lines, islands, pedestrian facilities, or bicycle facilities (3I.01.01)
 - **Channelizing device may “add emphasis to bike facilities”**
- Channelizing devices shall be the same color as the pavement marking that they supplement (3I.01.04) with white or yellow retroreflectivity (3I.01.07) Exception: Temporary devices may be orange (3I.01.05)
 - **Note this is not specific to bike lanes which shall not use green devices even if supplementing green markings**
- **Tubular marker** shall be a minimum of 28 inches tall and 2 inches wide (3I.02.1)



Intersections

...**Bike lane approach**

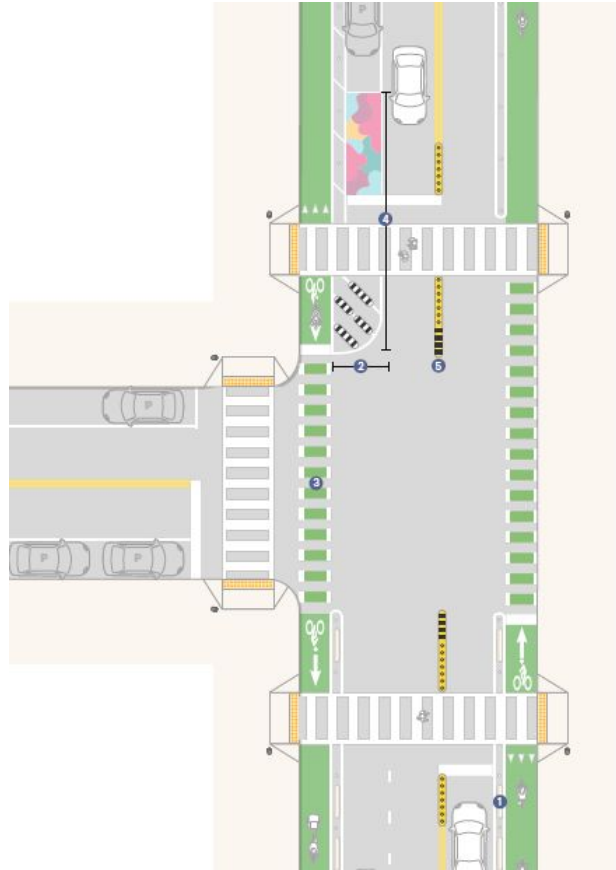
...Crossbike markings

...Bike signals

Intersections

Common practices are allowed

1. Do not need to dash or dot bike lanes as it approaches an intersection
 - (9E.02.11: “**should** be dotted...where turning vehicles cross the path of [bikes]”)
2. Buffer-separated or separated bike lanes may shift toward or away from MV lanes
 - (9E.02.14)
3. Bike stop lines can be staggered to improve visibility
 - (9E.02.17)



Intersections

Restrictive design guidance:

- A through bicycle lane **shall not be to the right of a right-turn lane** (or left of a left-turn lane) - **Unless phase separating** bike and turn movements (9E.02.1-2 and 9E.06.6-7)



Bike lanes and curbside turn lanes - Mixing Zones

- Where there is a through bike lane between MV lanes it shall include a bike lane marking (9E.02.06)
- Where the MV turn lane has a dedicated phase that coincides with a red for through bikes, the bike **shall not** share the turn lane. (9E.02.09)
 - If bikes can always continue through when the MV turn lane has a green, then they can share the lane
- Configurations and markings (9E.02.19-21)
 - Shall only be used with one-way bike lanes in the **same direction** as MV travel
 - Shall include **yield markings** where there is a “yielding area” for MV to yield to bikes
 - Shall include **shared lane markings** and **turn lane markings** where they share a lane



Video Screenshot: Example of bicyclists in a Mixing Zone weaving through or behind turning vehicles

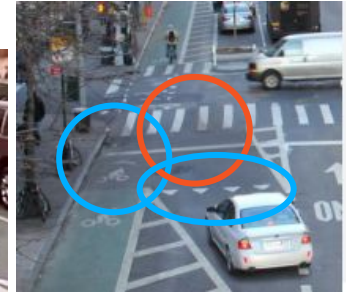
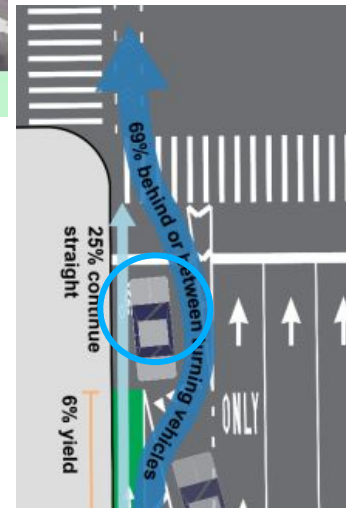
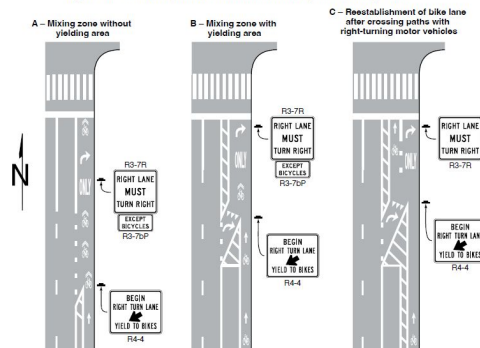


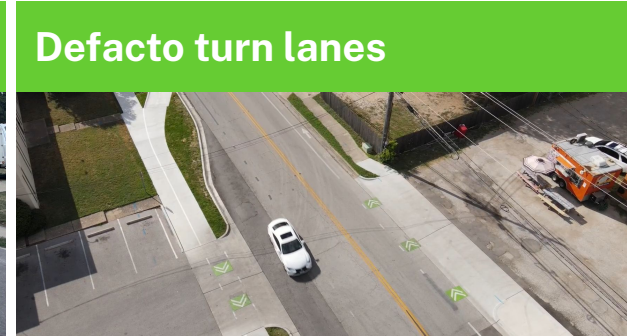
Figure 9E-5. Examples of Pavement Markings for Mixing Zones



Bike lanes and curbside turn lanes - other alternatives

A through bicycle lane shall not be to the right of a right-turn lane (or left of a left-turn lane) - **Unless phase separating** bike and turn movements

- Bike lane (9E.02.1-2)
- Buffered (9E.06.6-7)



Intersections

...Bike lane approach

...Crossbike markings

...**Bike signals**

Bike Signal Use

A bicycle signal may be used to provide separate control of a bike movement for various situations including:

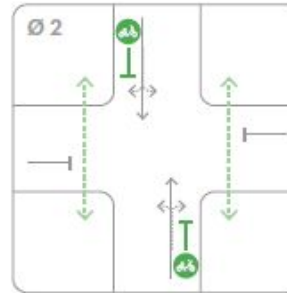
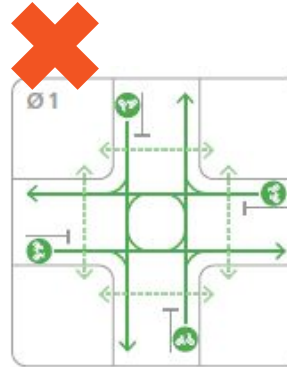
- To provide a protected bike signal phase or **leading or lagging bicycle interval**
- To continue a through bike lane on the right-hand side of a mandatory right-turn lane (or left) that would otherwise be non-compliant with 9E.02.1 or 9E.06.7
- To provide interval for counter-flow bikeway
- To provide for unusual or unexpected arrangements of bike movements through complex intersections



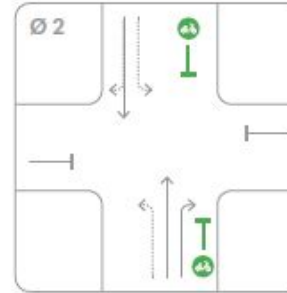
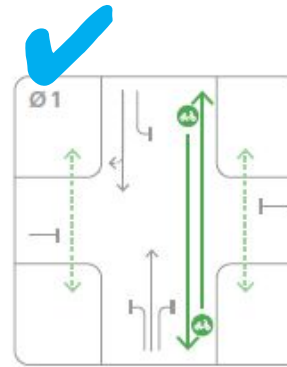
Bike Signals - phasing

- On bikeways, signal timing and actuation shall be reviewed and adjusted to consider the needs of bicyclists (9F.03.2) Minimum yellow change should be 3 seconds (4H.11.2)
 - Leverage this to make bike/ped friendly timing upgrades**
- If bike signal used - there shall be no potential conflicts from turning vehicles (4H.01.9)
 - Prohibits LBI**
- Shall not control “conflicting bicyclist movements form perpendicular or nearly perpendicular directions” (4H.02.1)
 - Prohibits bike scramble**

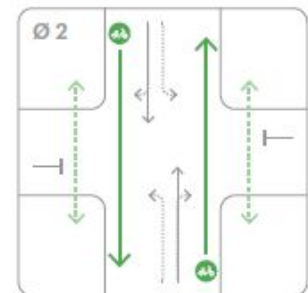
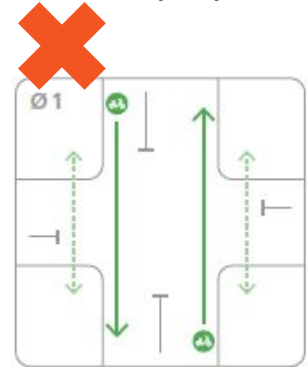
Bike scramble



Protected turns



Leading bike interval (LBI)



Bike Signal Use

- Use of Bicycle Signal faces shall not be used if lane is shared (only bike lane or shared use path) (4H.01.8 and 4H.02.2)
 - **Need to make bike lane approach along bike blvds to use bike signal**
- 4H.02.3 - Shall not be used with hybrid beacon
 - **Prohibits bike signal at PHB**
- May be used at a mid-block traffic control signal where there are no motor vehicle movements parallel to the bicycle crossing (4H.01.2)
 - **May be used at a mid-block signal**



Bike Signal signs

New, untested signs intended to:

- Inform road users that the signals are for bikes (4H.03.1)
- Inform bicyclists which specific bike movements are controlled by the bike signal face (4H.03.1)
- Signs shall do one of the following (9B.22.3)
 - Shall require bicycles to turn
 - Shall permit turns where such turns would otherwise not be allowed
 - Shall require a bicycle to stay in the same lane and proceed straight
 - Shall indicate allowed movements when a GREEN bike signal

Sign placement

- Bicycle signal sign SHALL be used immediately adjacent to (next to, above, or below) every bike signal face. (4H.03.2)
- Signs may be omitted from 4inch near side supplemental bike signals (4H.03.3)

Sign size

- Overhead-mounted bike signal signs shall be 24inx36in minimum
- Post-mounted bike signals signs shall be 12inx21in minimum



R10-40



R10-40a



R10-41



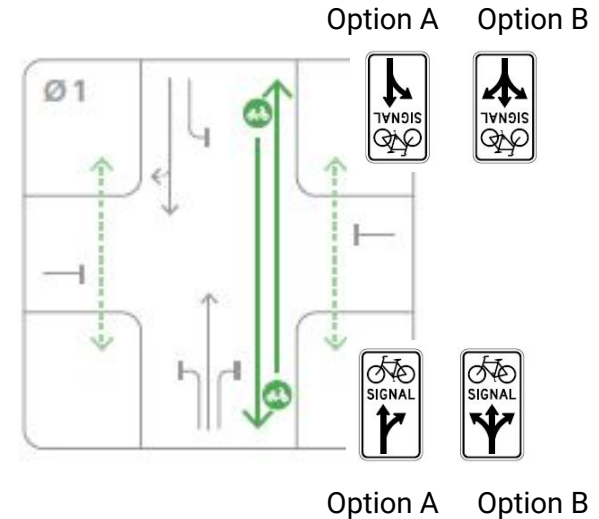
R10-41a



R10-41b



R10-41c



Bike Signals - detection and activation

- Bicycle Detector Symbol
 - May be placed on the pavement indicating the optimal position to actuate the signal (9E.15.1)
 - May use green colored-pavement as a background (3H.06.2F)
 - Symbols may be accompanied by:
 - words “WAIT HERE FOR GREEN” (9E.15.3)
 - R10-22 sign (9E.15.4)
- Bicycle Push Buttons
 - When used, bike push buttons shall use sign to explain the purpose (4H.12.4)



R10-4



R10-24

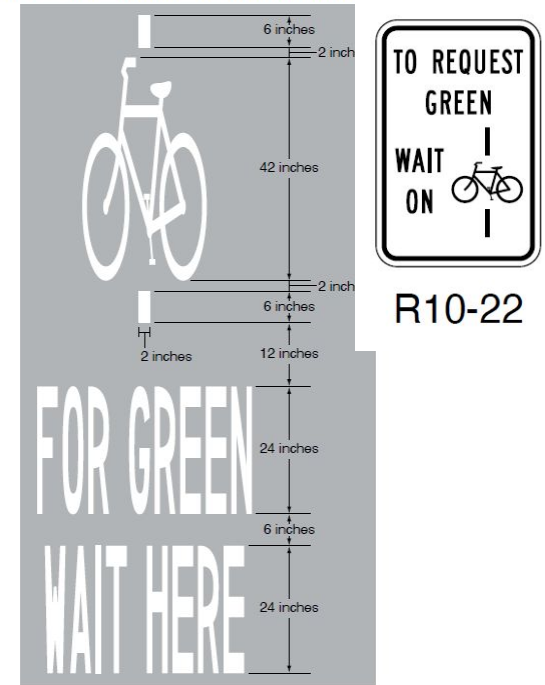


R10-25



R10-26

Figure 9E-16. Bicycle Detector Pavement Marking



Note: The word pavement markings are optional.

Intersections

...Bike lane approach

...**Crossbike
markings**

...Bike signals

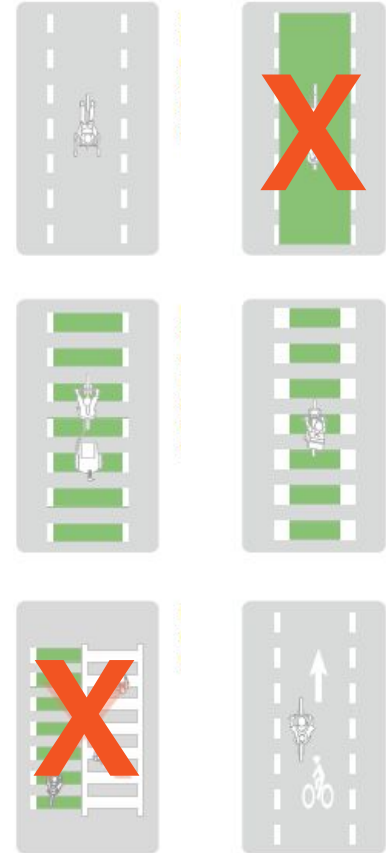
Cross bikes at intersections

Extensions of bike lanes across intersections

- May include any combination of the bike symbol, arrow, or word marking (9E.03.04)
 - **Note: don't need to use the bike symbol AND the arrow which can take up quite a bit of space**
- If provided, shall use dotted line patterns (9E.03.7)
 - **OK if use only one dotted line** ('should' use two lines defining edges of the bike lane, 9E.03.10)
- If used, green shall fill the area between the dotted white lines only (Section 3E.03.5, 3H.06.4)

What's not allowed

- **Joint cross-bike-walk** markings or any green incorporated into crosswalks - The edge of the crosswalk shall to be used to demarcate the edge of the crossbike (9E.03.11)
- Shall not use **chevron** markings in bike lanes or bike lane extensions (9E.03.07)
- **Solid green** bike lane extensions (Section 3E.03.5, 3H.06.4)



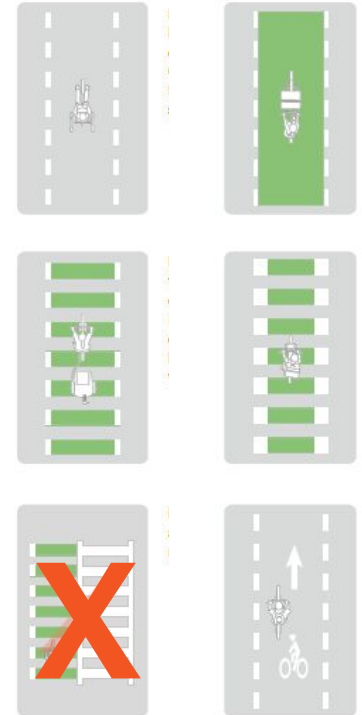
Cross bikes at driveways

Extensions of bike lanes across driveways

- May include any combination of the bike symbol, arrow, or word marking (9E.04.03)
 - **Note: don't need to use the bike symbol AND the arrow which can take up quite a bit of space**
- May be continued through a driveway using solid or dotted longitudinal lines (9E.04.02)
 - **OK if use dotted line, solid line, or no line**
- May use green to “enhance the conspicuity of the bicycle symbol” across driveways (9E.04.04)
 - **Ok to use solid green, bars of green, or no green**

What's not allowed

- **Joint cross-bike-walk** markings or any green incorporated into crosswalks - The edge of the crosswalk shall to be used to demarcate the edge of the crossbike (9E.03.11)
- Shall not use **chevron** markings in bike lanes or bike lane extensions (9E.03.6-7)





Add ons -

...Two-stage turn boxes

...Bike boxes

...Marking obstructions

Two-stage bicycle turn boxes

Placement (9E.11.04) shall be either:

- Between the bike lane and the through motor vehicle lane
- Between the bike lane and the crosswalk (marked or unmarked)

Bikes shall not cross the crosswalk (marked or unmarked) to access the two-stage bicycle turn box as that would make it a standard bike box

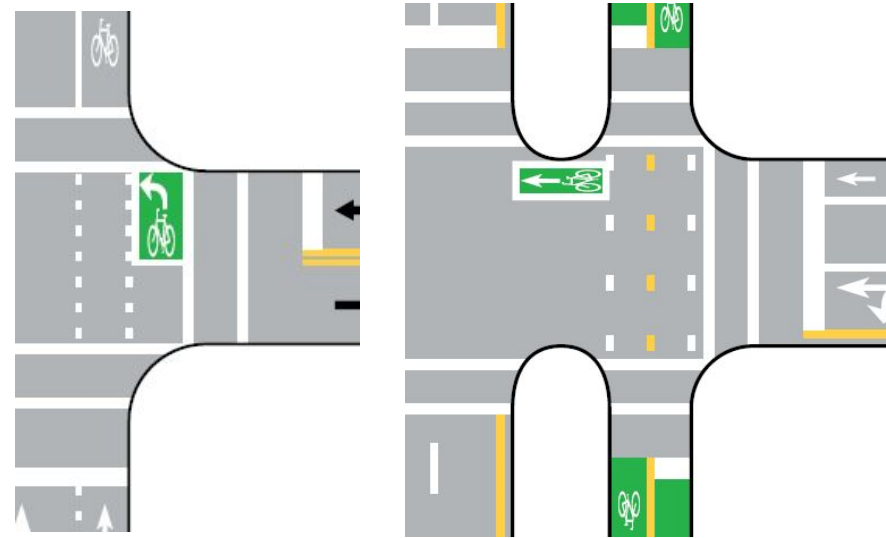


Two-stage bicycle turn boxes

Markings shall include

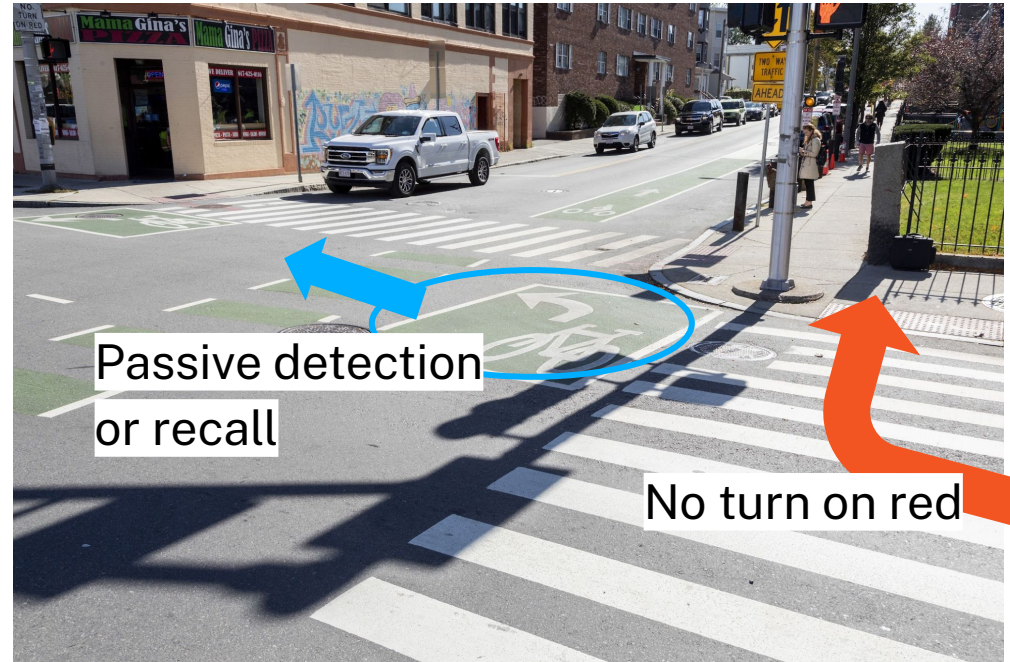
- At least one bike symbol (9E.11.5)
- At least one arrow (9E.11.5)
 - Along 2-way bike lanes, a through arrow (9E.11.6)
 - Along 1-way bikeways, a turn arrow and the bike symbol shall precede the pavement marking turn arrow (9E.11.8)
- White edge line on all sides (9E.11.7)

Markings may include green paint; if used, shall encompass the entire turn box (9E.11.11-12)



Two-stage bicycle turn boxes

- **Passive detection** shall be provided if the signal phase to enter the second stage is actuated (9E.11.09)
- **No turn on red** - shall be implemented if drivers would need to pass through the turn box (9E.11.13)



Two-stage bicycle turn boxes

Where two-stage box is physically or legally required - **regulatory signs shall be used** (9B.18.3)

At least one sign shall be posted in advance of the intersection (R9-23 or R9-23a) (9B.13.4)

At least one sign shall be posted at the intersection (if R9-23b post on the near side; if R9-23c post on the far side) (9B.13.4-5)

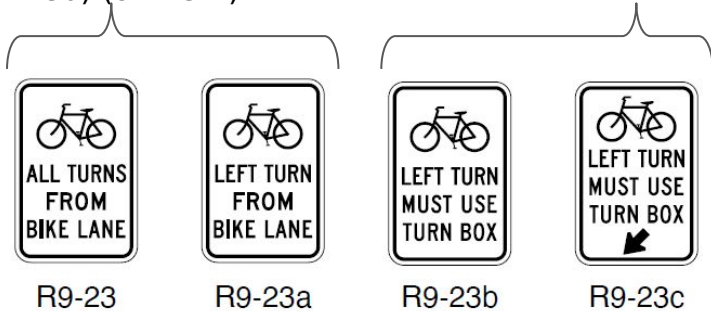
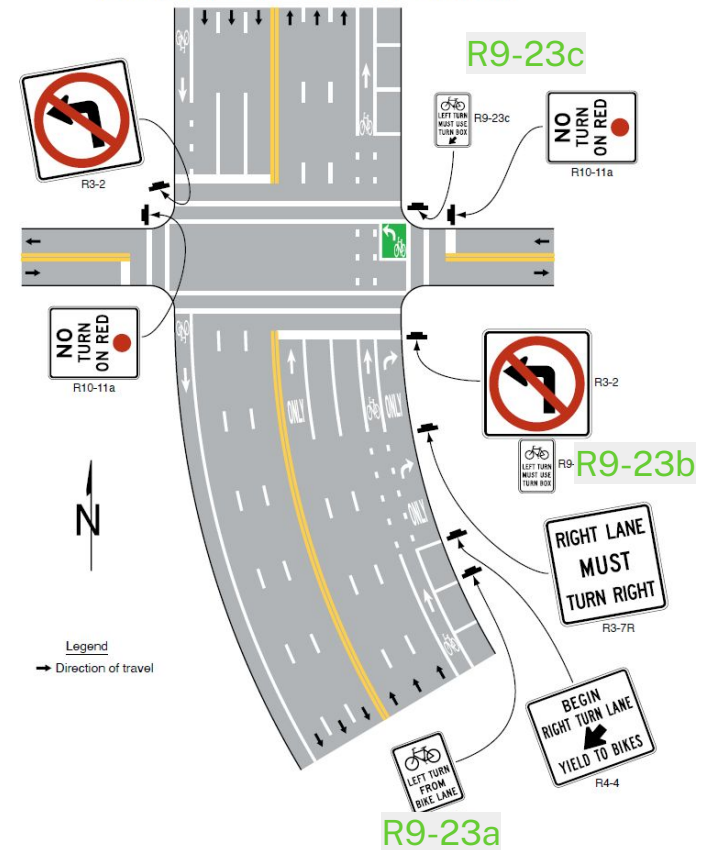


Figure 9B-5. Example of Two-Stage Bicycle Turn Box when Use is Mandatory



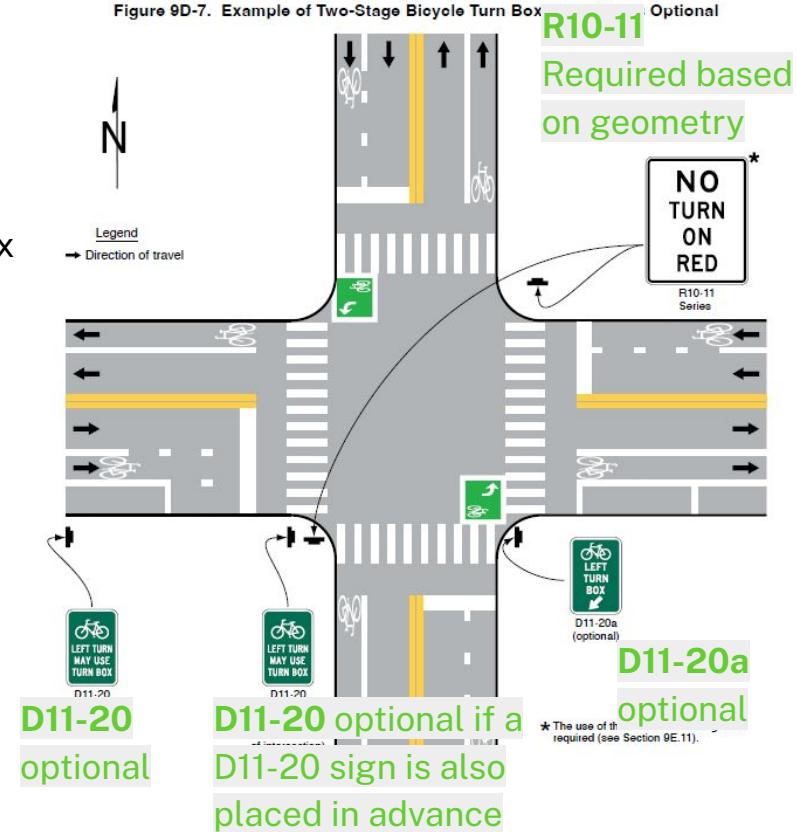
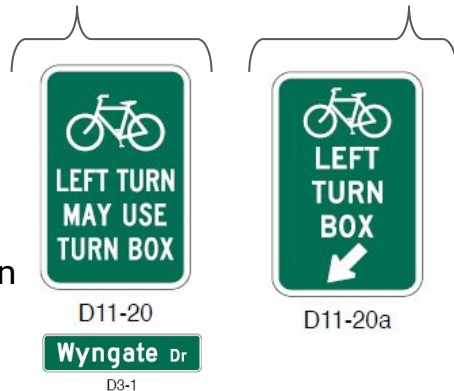
Two-stage bicycle turn boxes

Where two-stage box is not required - no sign is required but **guide signs may be used** (9D.13.4)

Where used, the advanced guide sign shall be posted in advance of the intersection (D11-20) (9D.13.5). A second D11-20 sign may be used on the near side (9D.13.7)

Where used, the turn box guide sign (D11-20a) shall be mounted on the far side of the intersection (9D.13.6)

Appropriately sized street name sign (D3-1) may be placed below the D11-20 sign (9D.13.8)





Add ons -

...Two-stage turn boxes

...**Bike boxes**

...Marking obstructions

Bike boxes

Bike boxes shall

- be at least 10ft deep (between bike and MV stop lines) (9E.12.6)
- include at least one bike symbol (9E.12.6)

Green paint, if used, shall encompass the entire turn box (9E.12.12-13)

No turn on red shall be implemented for any lane with a bike box (9E.12.9)



Bike boxes

Configuration (9E.12 paragraph 04-06)

- Bike box should be used where there is a bicycle lane (9E.12.4)
 - **OK if no bike lane** on the approach
- Bike box should not be contiguous with a crosswalk (9E.12.5)
 - **OK to share line with crosswalk**
- Bike box should use bike stop line (9E.12.5)
 - **Ok to not have bike stop line**



Bike boxes

Signal operations

- For bike boxes that extend across multiple lanes - Shall include a **pedestrian countdown signal** without the need for actuation on the street crossing the bike lane street (9E.12.8) - *This is to facilitate bikes entering the bike box*
- When motor vehicle stop line is moved, shall **recalculate** yellow change and red clearance times (9E.12.7)





Add ons -

...Two-stage turn boxes

...Bike boxes

...**Marking obstructions**

Pavement markings for obstructions

Pavement markings used at locations of obstructions should be used to guide bicyclists around the condition (9E.16.1-2)

Taper lengths (for bikes and motor vehicles) are not standards - use engineering judgement to determine appropriate tapers in low speed, urban environments



A short, solid blue horizontal line positioned above the word "Takeaways".

Takeaways

Takeaways

- Know what to look for (and what not to) in the MUTCD when designing bikeways or updating design standards
 - **Identify where typical practices are supported**
 - e.g. Separated bike lanes, protected intersections, contraflow bike lanes
 - **Use engineering judgment to determine where to update standards**
 - e.g. Crossbike markings, turn box markings, bike signal signs, buffer markings, bike lane symbol
 - **Explore opportunities for research where common, preferred, and best practices are non-compliant**
 - e.g. Bike signals without signs; Leading bike intervals, bike scrambles, and other non-exclusive phasing; Green-backed shared lane markings
- Build confidence in applying engineering judgement

Thank you!

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