

## PART 3. MARKINGS

### CHAPTER 3A. GENERAL

#### **Section 3A.01 Functions and Limitations**

Support:

01 Markings on highways and on private roads open to public travel have important functions in providing guidance and information for the road user. Major marking types include pavement and curb markings, delineators, colored pavements, channelizing devices and islands. In some cases, markings are used to supplement other traffic control devices such as signs, signals and other markings. In other instances, markings are used alone to effectively convey regulations, guidance, or warnings in ways not obtainable by the use of other devices.

02 Markings have limitations. Visibility of the markings can be limited by snow, debris, and water on or adjacent to the markings. Marking durability is affected by material characteristics, traffic volumes, weather, and location. However, under most highway conditions, markings provide important information while allowing minimal diversion of attention from the roadway.

#### **Section 3A.02 Standardization of Application**

Standard:

01 **Each standard marking shall be used only to convey the meaning prescribed for that marking in this Manual. When used for applications not described in this Manual, markings shall conform in all respects to the principles and standards set forth in this Manual.**

*Guidance:*

02 *Before any new highway, private road open to public travel (see definition in Section 1A.13), paved detour, or temporary route is opened to public travel, all necessary markings should be in place.*

Standard:

03 **Markings that must be visible at night shall be retroreflective unless ambient illumination assures that the markings are adequately visible. All markings on Interstate highways shall be retroreflective.**

04 **Markings that are no longer applicable for roadway conditions or restrictions and that might cause confusion for the road user shall be removed or obliterated to be unidentifiable as a marking as soon as practical.**

Option:

05 Until they can be removed or obliterated, markings may be temporarily masked with tape that is approximately the same color as the pavement.

#### **Section 3A.03 Maintaining Minimum Pavement Marking Retroreflectivity**

01 (This section is reserved for future text based on FHWA rulemaking.)

#### **Section 3A.04 Materials**

Support:

01 Pavement and curb markings are commonly placed by using paints or thermoplastics; however, other suitable marking materials, including raised pavement markers and colored pavements, are also used. Delineators and channelizing devices are visibly placed in a vertical position similar to signs above the roadway.

02 Some marking systems consist of clumps or droplets of material with visible open spaces of bare pavement between the material droplets. These marking systems can function in a manner that is similar to the marking systems that completely cover the pavement surface and are suitable for use as pavement markings if they meet the other pavement marking requirements of the highway agency.

*Guidance:*

03 *The materials used for markings should provide the specified color throughout their useful life.*

04 *Consideration should be given to selecting pavement marking materials that will minimize tripping or*  
*loss of traction for road users, including pedestrians, bicyclists, and motorcyclists.*

05 *Delineators should not present a vertical or horizontal clearance obstacle for pedestrians.*

### **Section 3A.05 Colors**

#### **Standard:**

01 **Markings shall be yellow, white, red, blue, or purple. The colors for markings shall conform to the**  
**standard highway colors. Black in conjunction with one of the colors mentioned in the first sentence of**  
**this paragraph shall be a usable color.**

02 **When used, white markings for longitudinal lines shall delineate:**

- A. **The separation of traffic flows in the same direction, or**
- B. **The right-hand edge of the roadway.**

03 **When used, yellow markings for longitudinal lines shall delineate:**

- A. **The separation of traffic traveling in opposite directions,**
- B. **The left-hand edge of the roadways of divided highways and one-way streets or ramps, or**
- C. **The separation of two-way left turn lanes and reversible lanes from other lanes.**

04 **When used, red raised pavement markers or delineators shall delineate:**

- A. **Truck escape ramps, or**
- B. **One-way roadways, ramps, or travel lanes that shall not be entered or used in the direction**  
**from which the markers are visible.**

05 **When used, blue markings shall supplement white markings for parking spaces for persons with**  
**disabilities.**

06 **When used, purple markings shall supplement lane line or edge line markings for toll plaza**  
**approach lanes that are restricted to use only by vehicles with registered electronic toll collection**  
**accounts.**

#### **Option:**

07 Colors used for official route shield signs (see Section 2D.11) may be used as colors of symbol markings  
to simulate route shields on the pavement (see Section 3B.20).

08 Black may be used in combination with the colors mentioned in the first sentence of Paragraph 1 where a  
light-colored pavement does not provide sufficient contrast with the markings.

#### **Support:**

09 When used in combination with other colors, black is not considered a marking color, but only a  
contrast-enhancing system for the markings.

### **Section 3A.06 Functions, Widths and Patterns of Longitudinal Pavement Markings**

#### **Standard:**

01 **The general functions of longitudinal lines shall be:**

- A. **A double line indicates maximum or special restrictions,**
- B. **A solid line discourages or prohibits crossing (depending on the specific application),**
- C. **A broken line indicates a permissive condition, and**
- D. **A dotted line provides guidance or warning of a downstream change in lane function.**

02 **The widths and patterns of longitudinal lines shall be as follows:**

- A. **Normal line—4 to 6 inches wide.**
- B. **Wide line—at least twice the width of a normal line.**
- C. **Double line—two parallel lines separated by a discernible space.**
- D. **Broken line—normal line segments separated by gaps.**
- E. **Dotted line—noticeably shorter line segments separated by shorter gaps than used for a**  
**broken line. The width of a dotted line extension shall be at least the same as the width of the**  
**line it extends.**

**Support:**

- 03 The width of the line indicates the degree of emphasis.

**Guidance:**

- 04 *Broken lines should consist of 10-foot line segments and 30-foot gaps, or dimensions in a similar ratio of line segments to gaps as appropriate for traffic speeds and need for delineation.*

**Support:**

- 05 Patterns for dotted lines depend on the application (see Sections 3B.04 and 3B.08).

**Guidance:**

- 06 *A dotted line for line extensions within an intersection or taper area should consist of 2-foot line segments and 2- to 6-foot gaps. A dotted line used as a lane line should consist of a 3-foot line segments and 9 foot gaps.*

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## CHAPTER 3B. PAVEMENT AND CURB MARKINGS

### Section 3B.01 Yellow Center line Pavement Markings and Warrants

**Standard:**

01 **Center line pavement markings, when used, shall be the pavement markings used to delineate the separation of traffic lanes that have opposite directions of travel on a roadway and shall be yellow.**

Option:

02 Center line pavement markings may be placed at a location that is not the geometric center of the roadway.

03 On roadways without continuous center line pavement markings, short sections may be marked with center line pavement markings to control the position of traffic at specific locations, such as around curves, over hills, on approaches to grade crossings, at grade crossings, and at bridges.

**Standard:**

04 **The center line markings on two-lane, two-way roadways shall be one of the following as shown in Figure 3B-1:**

- A. **Two-direction passing zone markings consisting of a normal broken yellow line where crossing the center line markings for passing with care is permitted for traffic traveling in either direction;**
- B. **One-direction no-passing zone markings consisting of a double yellow line, one of which is a normal broken yellow line and the other is a normal solid yellow line where crossing the center line markings for passing with care is permitted for the traffic traveling adjacent to the broken line, but is prohibited for traffic traveling adjacent to the solid line; or**
- C. **Two-direction no-passing zone markings consisting of two normal solid yellow lines where crossing the center line markings for passing is prohibited for traffic traveling in either direction.**

05 **A single solid yellow line shall not be used as a center line marking on a two-way roadway.**

06 **The center line markings on undivided two-way roadways with four or more lanes for moving motor vehicle traffic always available shall be the two-direction no-passing zone markings consisting of a solid double yellow line as shown in Figure 3B-2.**

*Guidance:*

07 *Center line markings should not be applied within 150 feet of a one-lane bridge.*

08 *On two-way roadways with three through lanes for moving motor vehicle traffic, two lanes should be designated for traffic in one direction by using one- or two-direction no-passing zone markings as shown in Figure 3B-3.*

**Support:**

09 In Ohio, Sections 4511.25, 4511.33, and 4511.35 of the Ohio Revised Code (ORC) address left turns across center line no-passing zone markings and paved medians. Sections 11-301(c) and 11-311(c) of the "Uniform Vehicle Code (UVC)" also contain information regarding left turns across center line no-passing zone markings and paved medians, respectively. The UVC can be obtained from the National Committee on Uniform Traffic Laws and Ordinances at the address shown in the Preface.

**Standard:**

10 **Center line markings shall be placed on all paved urban arterials and collectors that have a traveled way of 20 feet or more in width and an ADT of 6,000 vehicles per day or greater. Center line markings shall also be placed on all paved two-way streets or highways that have three or more lanes for moving motor vehicle traffic.**

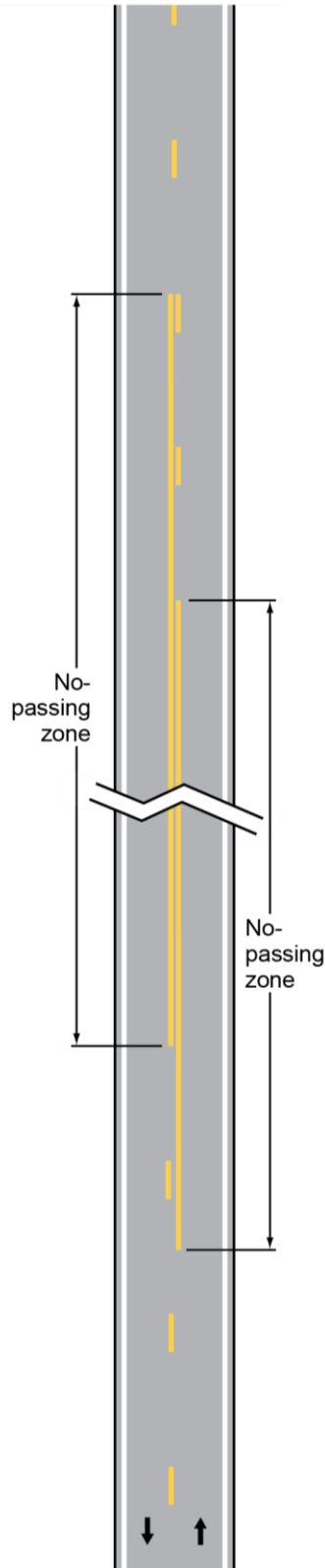
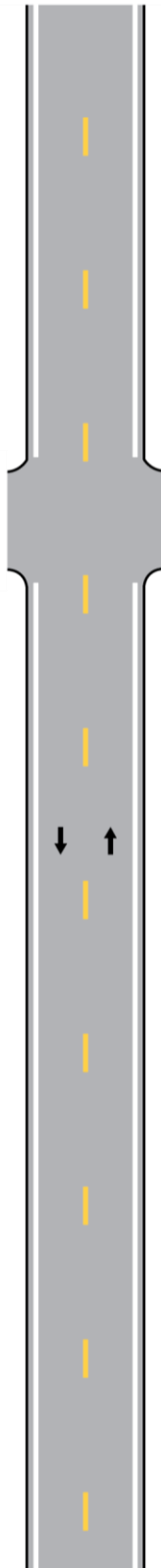
*Guidance:*

11 *Center line markings should be placed on paved urban arterials and collectors that have a traveled way of 20 feet or more in width and an ADT of 4,000 vehicles per day or greater. Center line markings should also be placed on all rural arterials and collectors that have a traveled way of 18 feet or more in width and*

### Figure 3B-1. Examples of Two-Lane, Two-Way Marking Applications

A - Typical two-lane, two-way marking with passing permitted in both directions

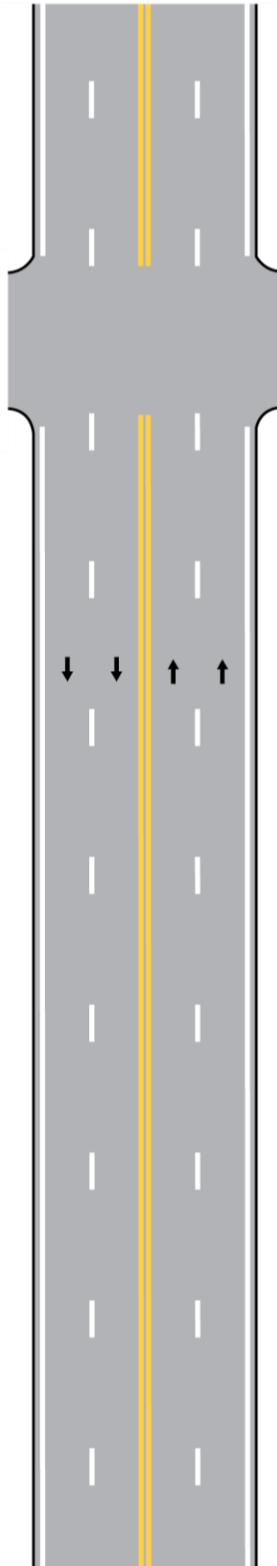
B - Typical two-lane, two-way marking with no-passing zones



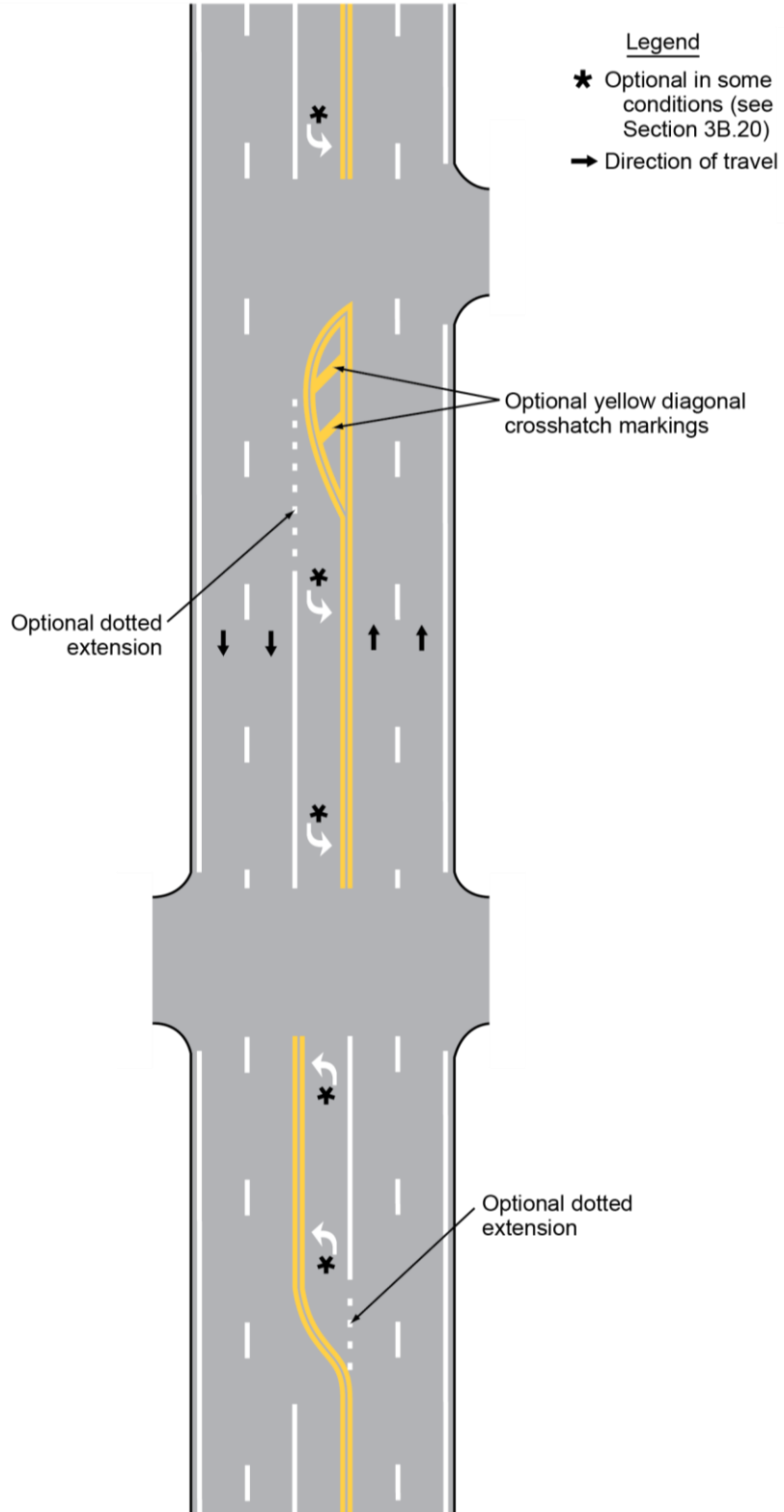
Legend  
→ Direction of travel

**Figure 3B-2. Examples of Four-or-More Lane, Two-Way Marking Applications**

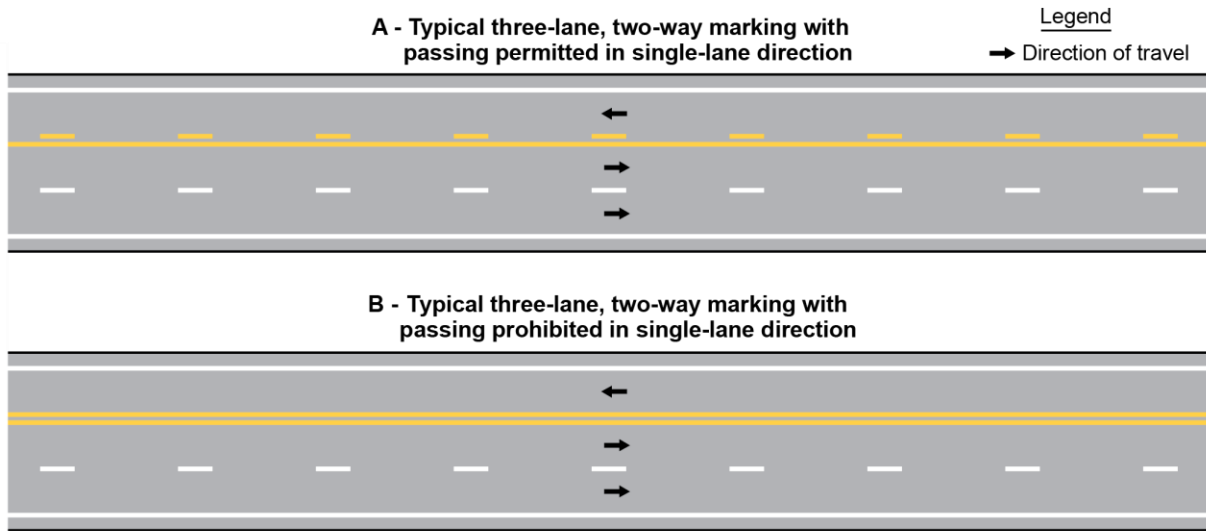
**A - Typical multi-lane, two-way marking**



**B - Typical multi-lane, two-way marking with single lane left turn channelization**



**Figure 3B-3. Examples of Three-Lane, Two-Way Marking Applications**



an ADT of 3,000 vehicles per day or greater. Center line markings should also be placed on other traveled ways where an engineering study indicates such a need.

- 12 Engineering judgment should be used in determining whether to place center line markings on traveled ways that are less than 16 feet wide because of the potential for traffic encroaching on the pavement edges, traffic being affected by parked vehicles, and traffic encroaching into the opposing traffic lane.

Option:

- 13 Center line markings may be placed on other paved two-way traveled ways that are 16 feet or more in width.
- 14 If a traffic count is not available, the ADTs described in this Section may be estimates that are based on engineering judgment.

**Section 3B.02 No-Passing Zone Pavement Markings and Warrants**

**Standard:**

- 01 No-passing zones shall be marked by either the one direction no-passing zone pavement markings or the two-direction no-passing zone pavement markings described in Section 3B.01 and shown in Figures 3B-1, 3B-2 and 3B-3.

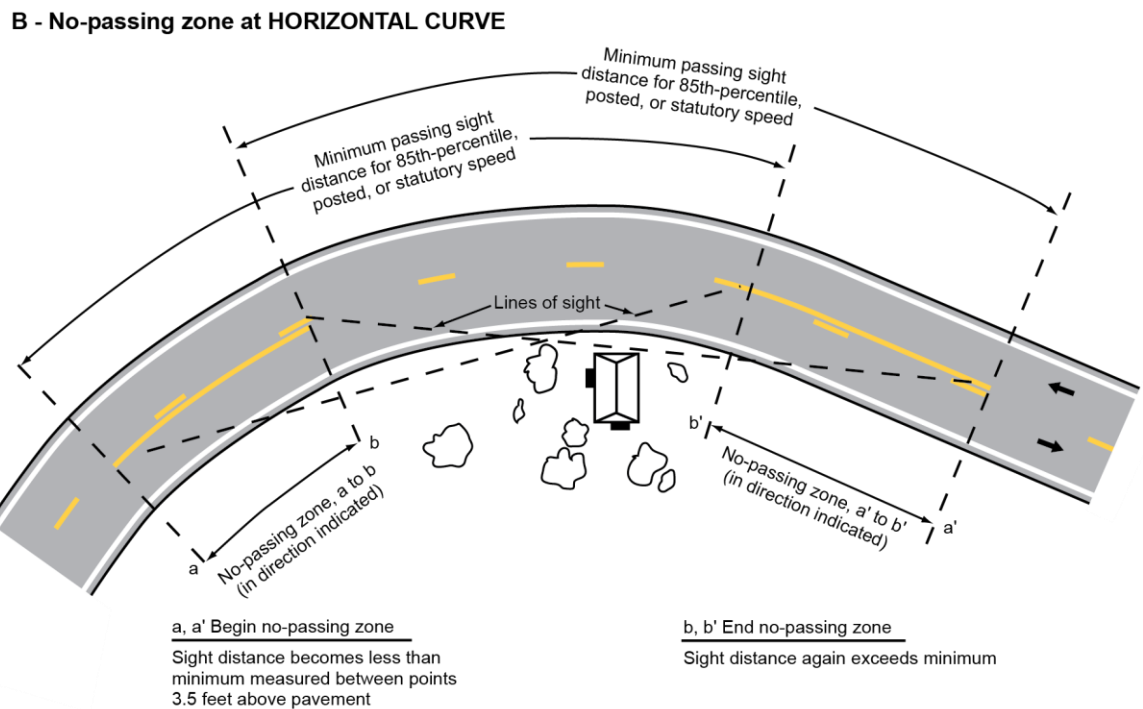
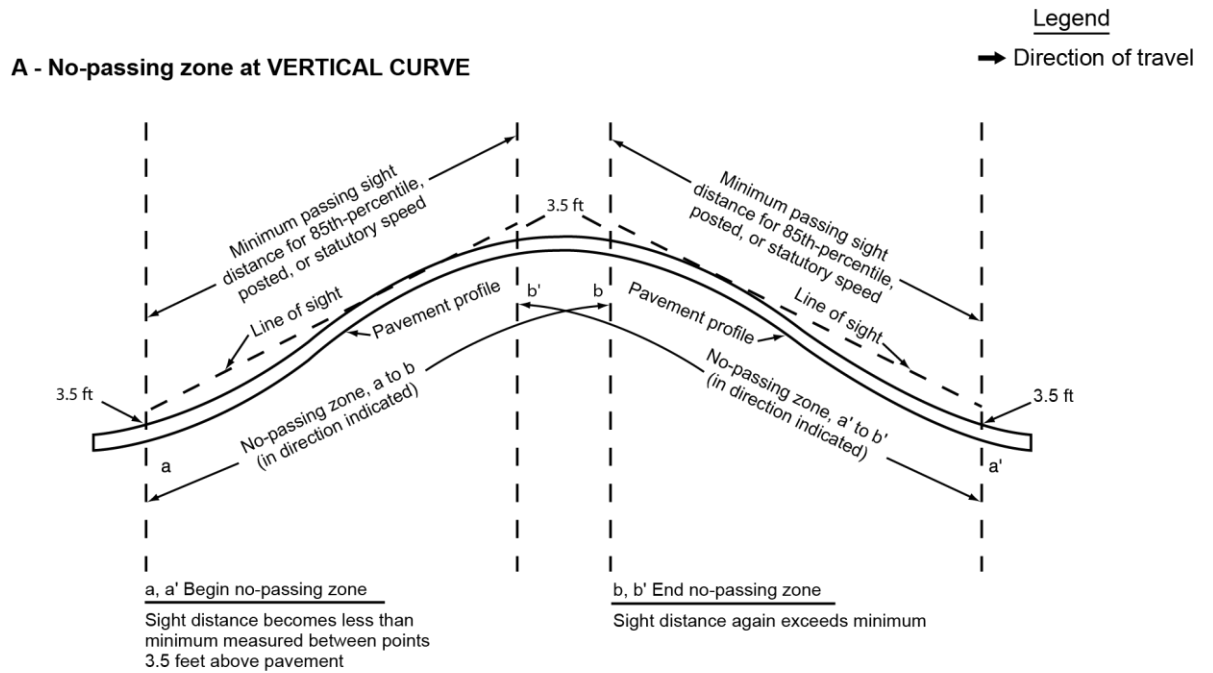
- 02 When center line markings are used, no-passing zone markings shall be used on two-way roadways at lane reduction transitions (see Section 3B.09) and on approaches to obstructions that must be passed on the right (see Section 3B.10).

- 03 On two-way, two- or three-lane roadways where center line markings are installed, no-passing

**Table 3B-1. Minimum Passing Sight Distances for No-Passing Zone Markings**

85th-Percentile or Posted or Statutory Speed Limit	Minimum Passing Sight Distance
25 mph	450 feet
30 mph	500 feet
35 mph	550 feet
40 mph	600 feet
45 mph	700 feet
50 mph	800 feet
55 mph	900 feet
60 mph	1,000 feet
65 mph	1,100 feet
70 mph	1,200 feet

**Figure 3B-4. Method of Locating and Determining the Limits of No-Passing Zones at Curves**



zones shall be established at vertical and horizontal curves and other locations where an engineering study indicates that passing must be prohibited because of inadequate sight distances or other special conditions.

04 **On roadways with center line markings, no-passing zone markings shall be used at horizontal or vertical curves where the passing sight distance is less than the minimum shown in Table 3B-1 for the 85th-percentile speed or the posted or statutory speed limit. The passing sight distance on a vertical curve is the distance at which an object 3.5 feet above the pavement surface can be seen from a point 3.5 feet above the pavement (see Figure 3B-4). Similarly, the passing sight distance on a horizontal curve is the distance measured along the center line (or right-hand lane line of a three-lane roadway) between two points 3.5 feet above the pavement on a line tangent to the embankment or other obstruction that cuts off the view on the inside of the curve (see Figure 3B-4).**

05 **There is explicitly no requirement under this Manual that no-passing zones shall be marked at intersections, notwithstanding the provisions of any other section of this Manual.**

Option:

06 No-passing zones may be marked at rural and urban intersections when engineering judgment so dictates.

Support:

07 The upstream end of a no-passing zone at point “a” in Figure 3B-4 is that point where the sight distance first becomes less than that specified in Table 3B-1. The downstream end of the no-passing zone at point “b” in Figure 3B-4 is that point at which the sight distance again becomes greater than the minimum specified.

08 The values of the minimum passing sight distances that are shown in Table 3B-1 are for operational use in marking no-passing zones and are less than the values that are suggested for geometric design by the AASHTO Policy on Geometric Design of Streets and Highways (see Section 1A.11).

Guidance:

09 *The decision as to whether or not a no-passing zone should be marked at intersections is a matter of engineering judgment. When used, the no-passing zone should start at least 100 feet in advance of the intersection.*

10 *The no-passing zone marking should not be less than 500 feet in length, except in advance of an intersection, or as a result of a special engineering study. If the actual no-passing zone distance is less than 500 feet, an additional length of marking should be added at the beginning of the zone. The distance between successive no-passing zones should be no more than 400 feet for speeds less than 50 mph and no more than 600 feet for speeds 50 mph or greater. When the distances are less than these, the single or double no-passing lines should be extended to connect the zones.*

11 *No-passing markings should be used on approaches to other locations where passing should be prohibited.*

**Standard:**

12 **In locations where there are dips or undulations in the profile of the pavement which create areas where the actual pavement surface is more than 3.5 feet below the line of sight, the no-passing line shall be extended as required.**

13 **Where center line markings are used, no-passing zone markings shall be used on approaches to grade crossings in compliance with Section 8B.27.**

Option:

14 In addition to pavement markings, no-passing zone signs (see Sections 2B.28, 2B.29, and 2C.45) may be used to emphasize the existence and extent of a no-passing zone.

**Support:**

15 **In Ohio, Sections 4511.25, 4511.26, 4511.27, 4511.29, 4511.30, and 4511.33 of the Ohio Revised Code (ORC) address no-passing zone markings and paved medians.**

**Standard:**

16 **On three-lane roadways where the direction of travel in the center lane transitions from one direction to the other, a no-passing buffer zone shall be provided in the center lane as shown in Figure 3B-5. A lane-reduction transition (see Section 3B.09) shall be provided at each end of the buffer zone.**

17 **The buffer zone shall be a flush median island formed by two sets of double yellow center line markings that is at least 50 feet in length.**

*Option:*

18 Yellow diagonal crosshatch markings (see Section 3B.24) may be placed in the flush median area between the two sets of no-passing zone markings as shown in Figure 3B-5.

*Guidance:*

19 *For three-lane roadways having a posted or statutory speed limit of 45 mph or greater, the lane transition taper length should be computed by the formula  $L = WS$ . For roadways where the posted or statutory speed limit is less than 45 mph, the formula  $L = WS^2/60$  should be used to compute taper length.*

*Support:*

20 Under both formulas, L equals the taper length in feet, W equals the width of the center lane or offset distance in feet, and S equals the 85th-percentile speed or the posted or statutory speed limit, whichever is higher.

*Guidance:*

21 *The minimum lane transition taper length should be 100 feet in urban areas and 200 feet in rural areas.*

**Section 3B.03 Other Yellow Longitudinal Pavement Markings**

**Standard:**

01 **If reversible lanes are used, the lane line pavement markings on each side of reversible lanes shall consist of a normal broken double yellow line to delineate the edge of a lane in which the direction of travel is reversed from time to time, such that each of these markings serve as the center line markings of the roadway during some period (see Figure 3B-6).**

02 **Signs (see Section 2B.26), lane-use control signals (see Chapter 4M), or both shall be used to supplement reversible lane pavement markings.**

03 **If a two-way left-turn lane that is never operated as a reversible lane is used, the lane line pavement markings on each side of the two-way left-turn lane shall consist of a normal broken yellow line and a normal solid yellow line to delineate the edges of a lane that can be used by traffic in either direction as part of a left-turn maneuver. These markings shall be placed with the broken line toward the two-way left-turn lane and the solid line toward the adjacent traffic lane as shown in Figure 3B-7.**

*Guidance:*

04 *White two-way left-turn lane-use arrows (see Figure 3B-7), should be used in conjunction with the longitudinal two-way left-turn markings at the locations described in Section 3B.20.*

05 *Signs should be used in conjunction with the two-way left-turn markings (see Section 2B.24).*

**Standard:**

06 **If a continuous flush median island formed by pavement markings separating travel in opposite directions is used, two sets of solid double yellow lines shall be used to form the island as shown in Figures 3B-2 and 3B-5. Other markings in the median island area shall also be yellow, except crosswalk markings which shall be white (see Section 3B.18).**

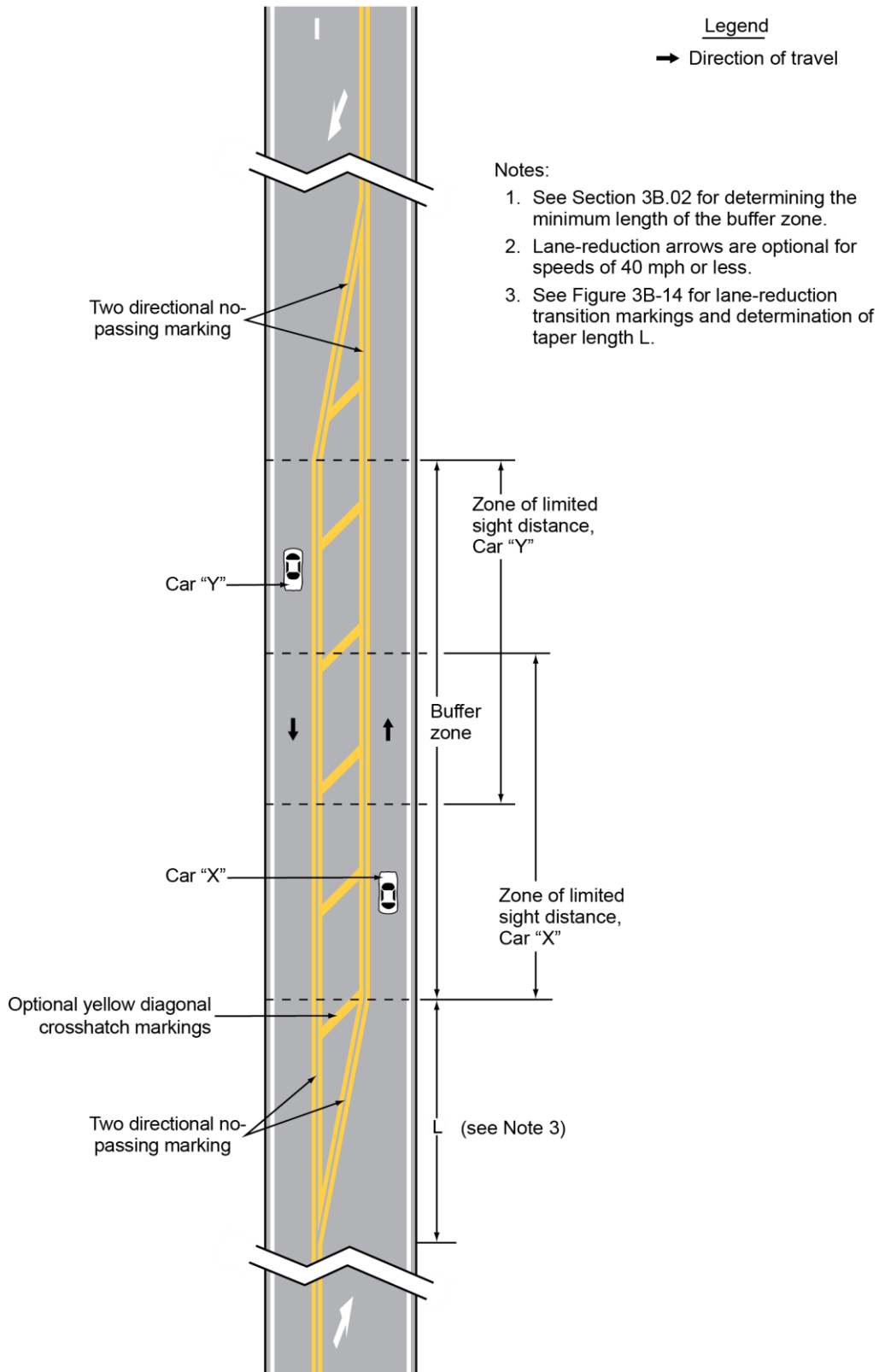
**Section 3B.04 White Lane Line Pavement Markings and Warrants**

**Standard:**

01 **When used, lane line pavement markings delineating the separation of traffic lanes that have the same direction of travel shall be white.**

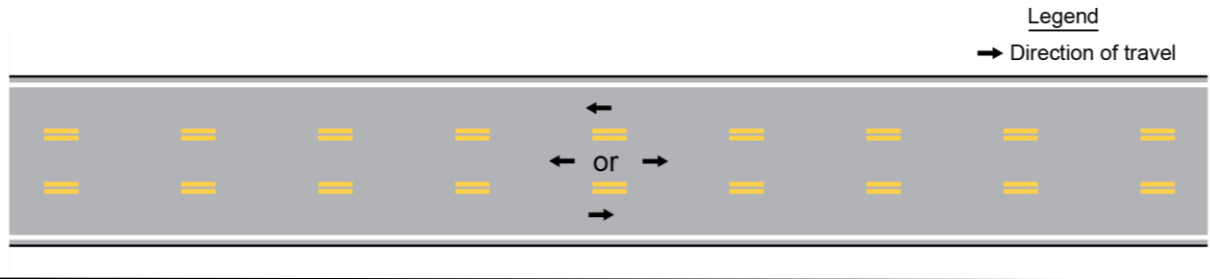
02 **Lane line markings shall be used on all freeways and Interstate highways.**

**Figure 3B-5. Example of Three-Lane, Two-Way Marking for Changing Direction of the Center Lane**





**Figure 3B-6. Example of Reversible Lane Marking Application**



*Guidance:*

03 Lane line markings should be used on all roadways that are intended to operate with two or more adjacent traffic lanes in the same direction of travel, except as otherwise required for reversible lanes. Lane line markings should also be used at congested locations where the roadway will accommodate more traffic lanes with lane line markings than without the markings.

Support:

04 Examples of lane line markings are shown in Figures 3B-2, 3B-3, and 3B-7 through 3B-13.

**Standard:**

05 Except as provided in Paragraph 6, where crossing the lane line markings with care is permitted, the lane line markings shall consist of a normal broken white line.

06 A dotted white line marking shall be used as the lane line to separate a through lane that continues beyond the interchange or intersection from an adjacent lane for any of the following conditions:

- A. A deceleration or acceleration lane,
- B. A through lane that becomes a mandatory exit or turn lane,
- C. An auxiliary lane 2 miles or less in length between an entrance ramp and an exit ramp, or
- D. An auxiliary lane 1 mile or less in length between two adjacent intersections.

07 For exit ramps with a parallel deceleration lane, a normal width dotted white lane line shall be installed from the upstream end of the full-width deceleration lane to the theoretical gore or to the upstream end of a solid white lane line, if used, that extends upstream from the theoretical gore as shown in Drawings A and C of Figure 3B-8.

Option:

08 For exit ramps with a parallel deceleration lane, a normal width dotted white line extension may be installed in the taper area upstream from the full-width deceleration lane as shown in Drawings A and C of Figure 3B-8.

09 For an exit ramp with a tapered deceleration lane, a normal width dotted white line extension may be installed from the theoretical gore through the taper area such that it meets the edge line at the upstream end of the taper as shown in Drawing B of Figure 3B-8.

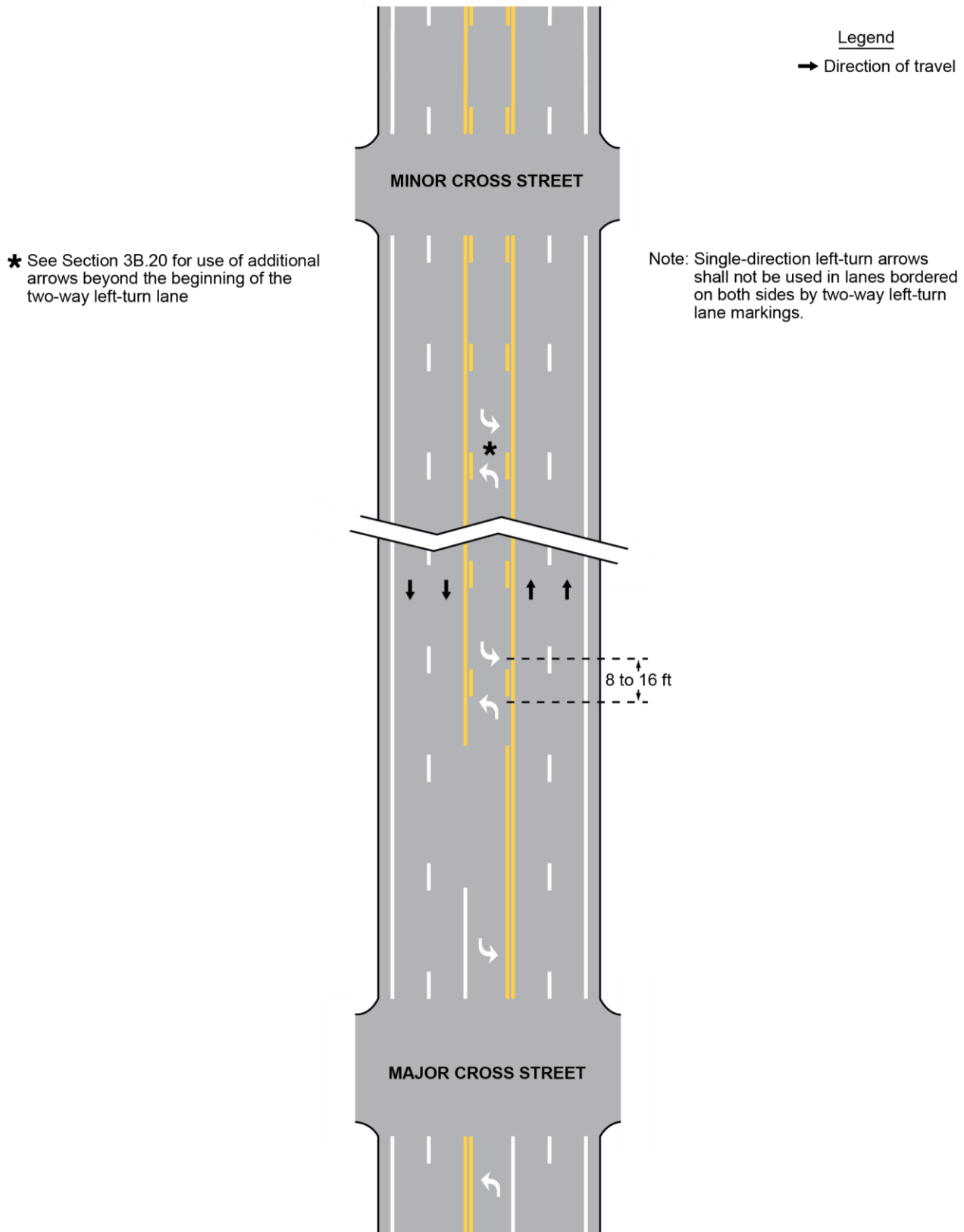
**Standard:**

10 For entrance ramps with a parallel acceleration lane, a normal width dotted white lane line shall be installed from the theoretical gore or from the downstream end of a solid white lane line, if used, that extends downstream from the theoretical gore, to a point at least one-half the distance from the theoretical gore to the downstream end of the acceleration taper, as shown in Drawing A of Figure 3B-9.

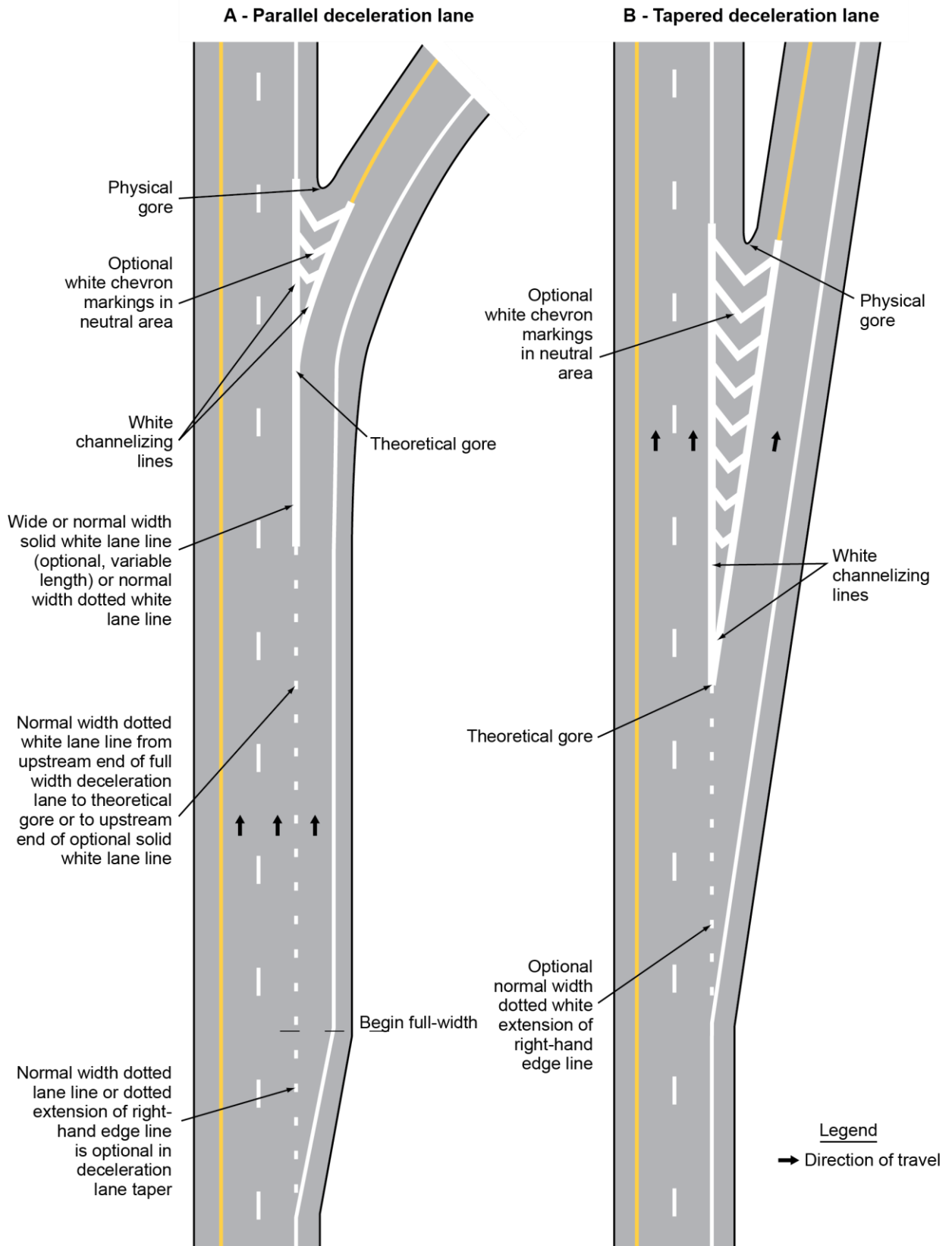
Option:

11 For entrance ramps with a parallel acceleration lane, a normal width dotted white line extension may be installed from the downstream end of the dotted white lane line to the downstream end of the acceleration taper, as shown in Drawing A of Figure 3B-9.

**Figure 3B-7. Example of Two-Way Left-Turn Lane Marking Applications**

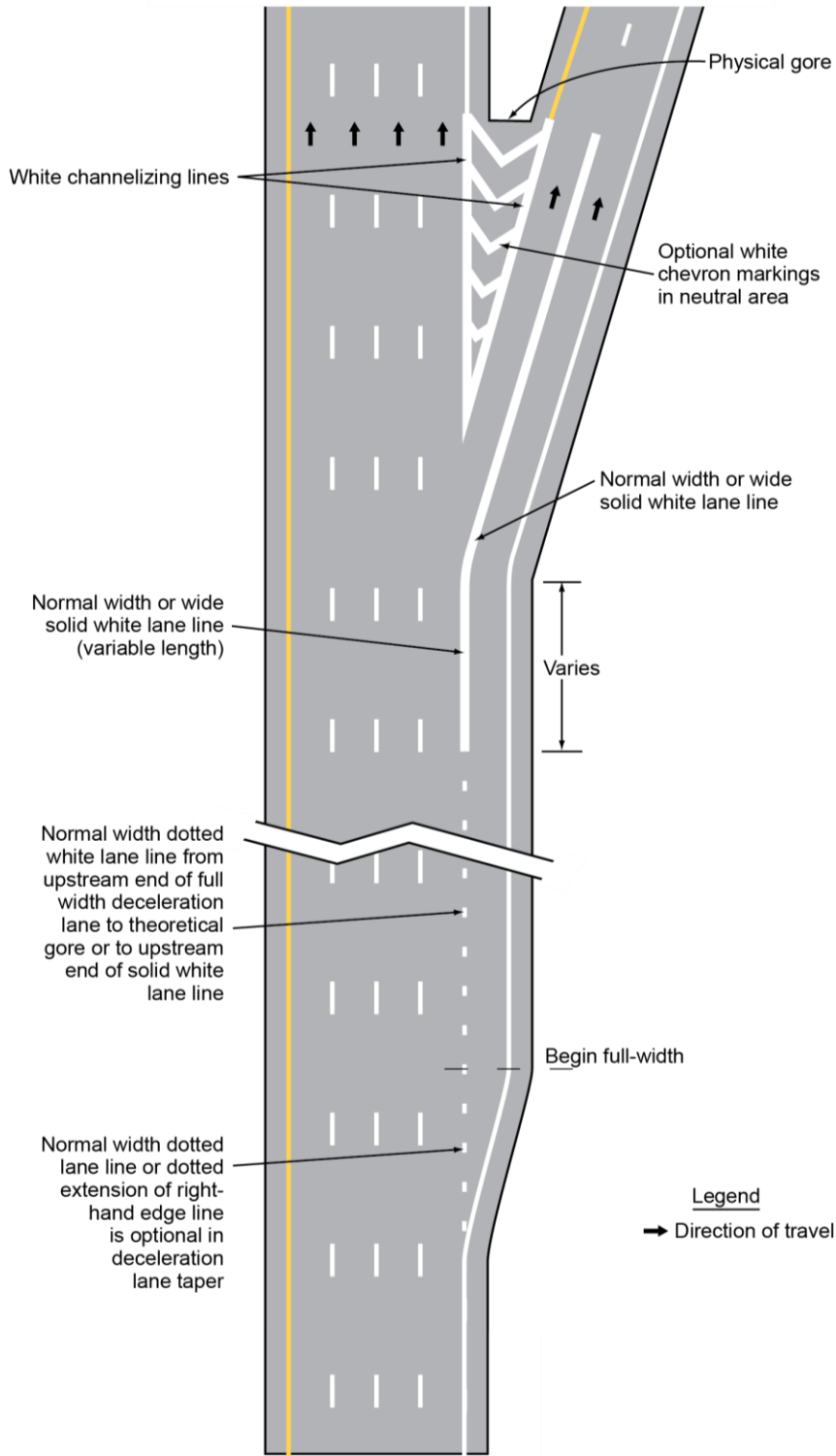


**Figure 3B-8. Examples of Dotted Line and Channelizing Line Applications for Exit Ramp Markings (Sheet 1 of 2)**

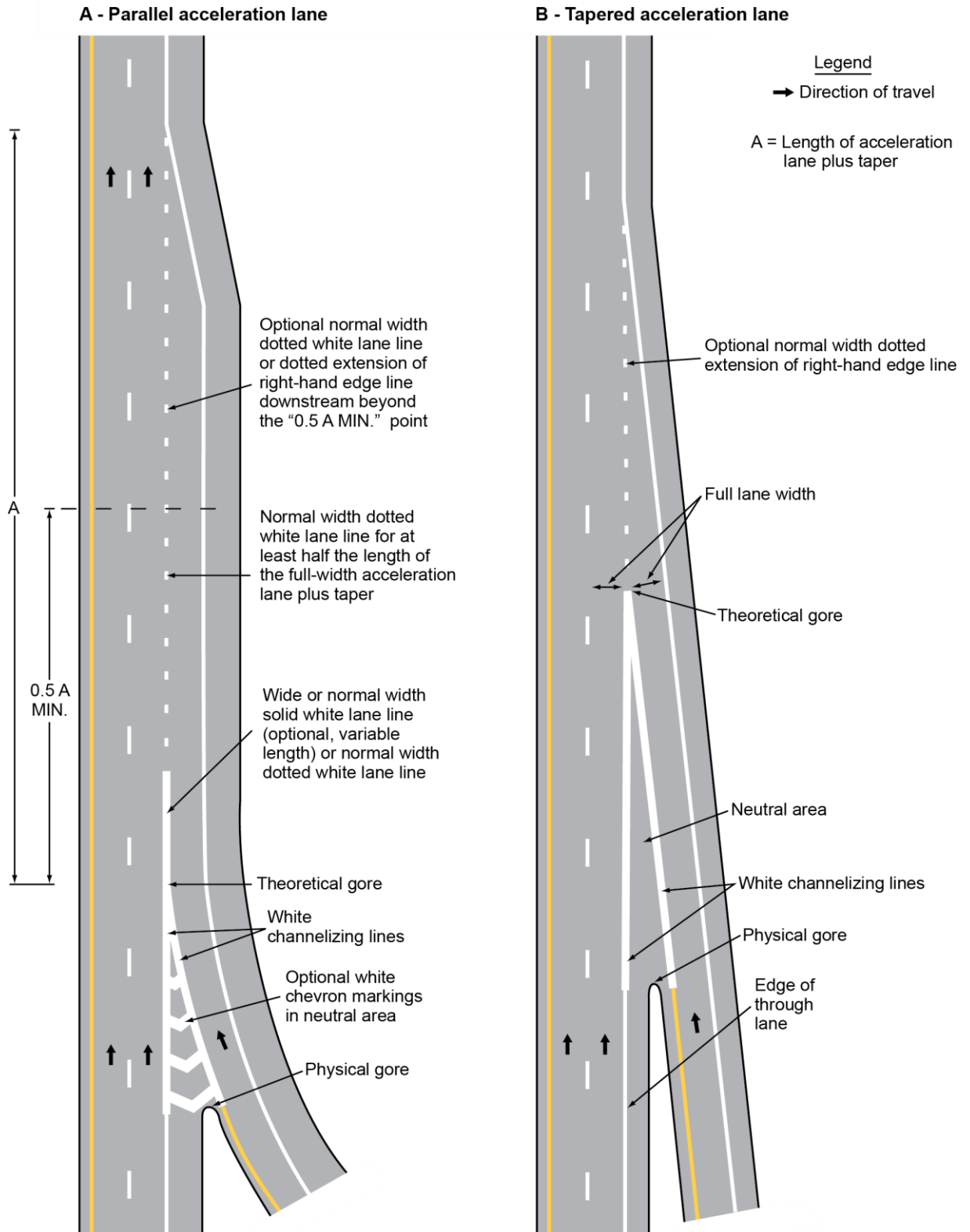


**Figure 3B-8. Examples of Dotted and Channelizing Line Applications for Exit Ramp Markings (Sheet 2 of 2)**

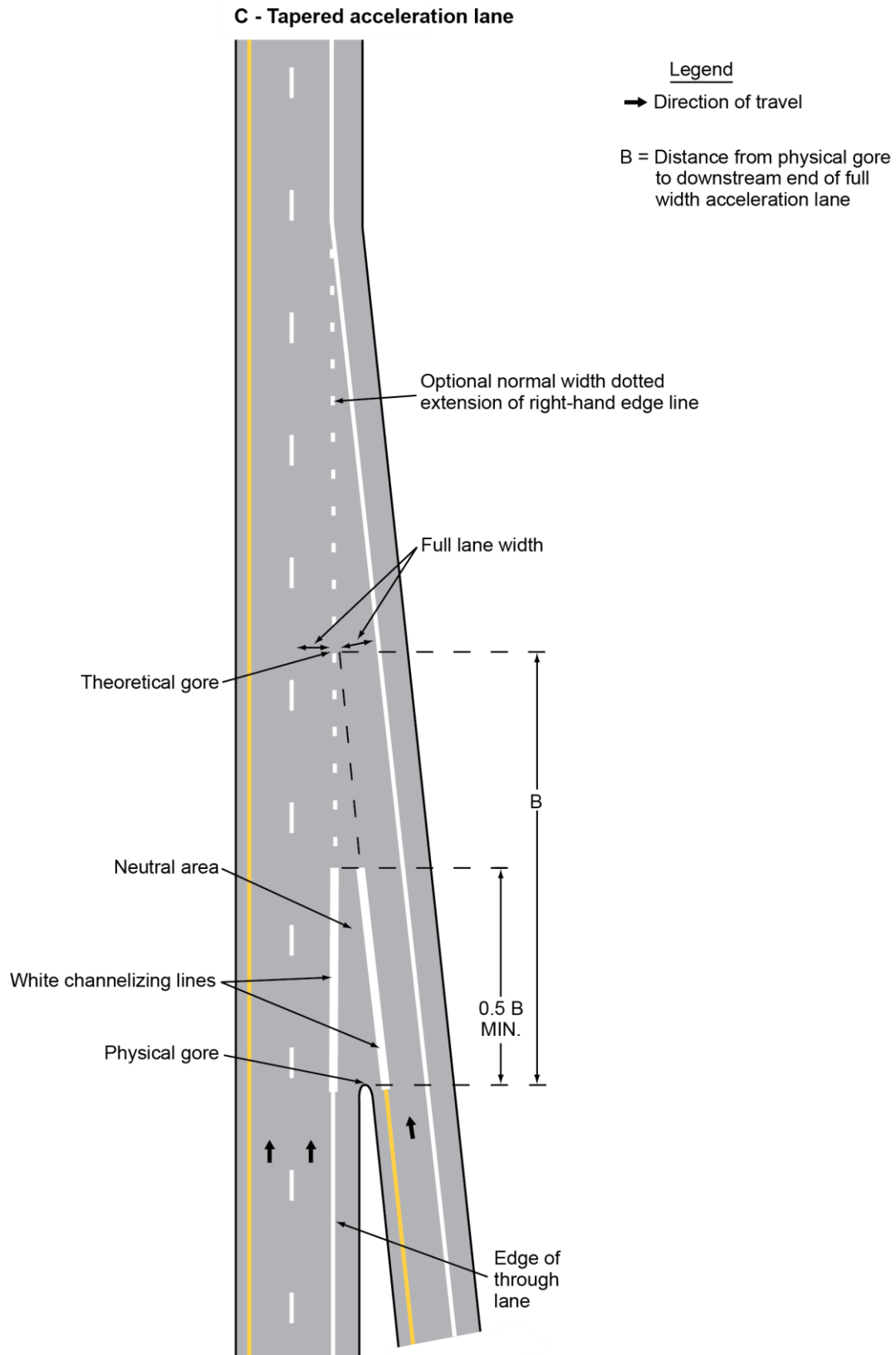
**C – Parallel deceleration lane at a multi-lane exit ramp having an optional exit lane that also carries the through route**



**Figure 3B-9. Examples of Dotted Line and Channelizing Line Applications for Entrance Ramp Markings (Sheet 1 of 2)**



**Figure 3B-9. Examples of Dotted Line and Channelizing Line Applications for Entrance Ramp Markings (Sheet 2 of 2)**



- 12 For entrance ramps with a tapered acceleration lane, a normal width dotted white line extension may be installed from the downstream end of the channelizing line adjacent to the through lane to the downstream end of the acceleration taper, as shown in Drawings B and C of Figure 3B-9.

**Standard:**

- 13 **A wide dotted white lane line shall be used:**
- A. As a lane drop marking in advance of lane drops at exit ramps to distinguish a lane drop from a normal exit ramp (see Drawings A, B, and C of Figure 3B-10),
  - B. In advance of freeway route splits with dedicated lanes (see Drawing D of Figure 3B-10),
  - C. To separate a through lane that continues beyond an interchange from an adjacent auxiliary lane between an entrance ramp and an exit ramp (see Drawing E of Figure 3B-10),
  - D. As a lane drop marking in advance of lane drops at intersections to distinguish a lane drop from an intersection through lane (see Drawing A of Figure 3B-11), and
  - E. To separate a through lane that continues beyond an intersection from an adjacent auxiliary lane between two intersections (see Drawing B of Figure 3B-11).

*Guidance:*

- 14 *Lane drop markings used in advance of lane drops at freeway and expressway exit ramps should begin at least 1/2 mile in advance of the theoretical gore.*
- 15 *On the approach to a multi-lane exit ramp having an optional exit lane that also carries through traffic, lane line markings should be used as illustrated in Drawing B of Figure 3B-10. In this case, if the right-most exit lane is an added lane such as a parallel deceleration lane, the lane drop marking should begin at the upstream end of the full-width deceleration lane, as shown in Drawing C of Figure 3B-8.*
- 16 *Lane drop markings used in advance of lane drops at intersections should begin a distance in advance of the intersection that is determined by engineering judgment as suitable to enable drivers who do not desire to make the mandatory turn to move out of the lane being dropped prior to reaching the queue of vehicles that are waiting to make the turn. The lane drop marking should begin no closer to the intersection than the most upstream regulatory or warning sign associated with the lane drop.*
- 17 *The dotted white lane lines that are used for lane drop markings and that are used as lane line separating through lanes from auxiliary lanes should consist of line segments that are 3 feet in length separated by 9-foot gaps.*

**Support:**

- 18 Section 3B.20 contains information regarding other markings that are associated with lane drops, such as lane-use arrow markings and ONLY word markings.
- 19 Section 3B.09 contains information about the lane line markings that are to be used for transition areas where the number of through lanes is reduced.

**Standard:**

- 20 **Where crossing the lane line markings is discouraged, the lane line markings shall consist of a normal or wide solid white line.**

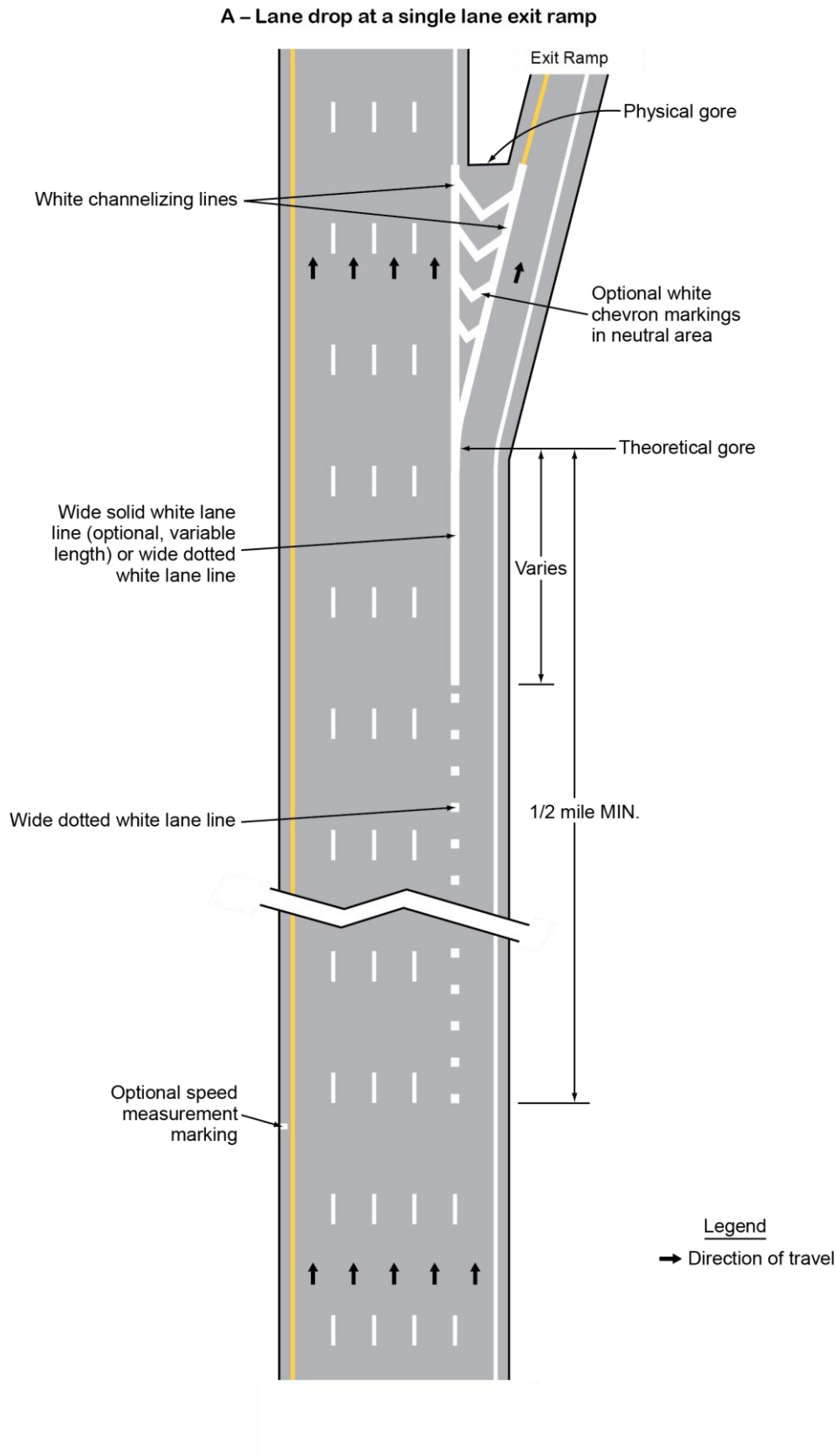
**Option:**

- 21 Where it is intended to discourage lane changing on the approach to an exit ramp, a wide solid white lane line may extend upstream from the theoretical gore or, for multi-lane exits, as shown in Drawing B of Figure 3B-10, for a distance that is determined by engineering judgment.
- 22 Where lane changes might cause conflicts, a wide or normal solid white lane line may extend upstream from an intersection.
- 23 In the case of a lane drop at an exit ramp or intersection, such a solid white line may replace a portion, but not all of the length of the wide dotted white lane line.

*Guidance:*

- 24 *On approaches to intersections, a solid white lane line marking should be used to separate a through lane from an added mandatory turn lane.*

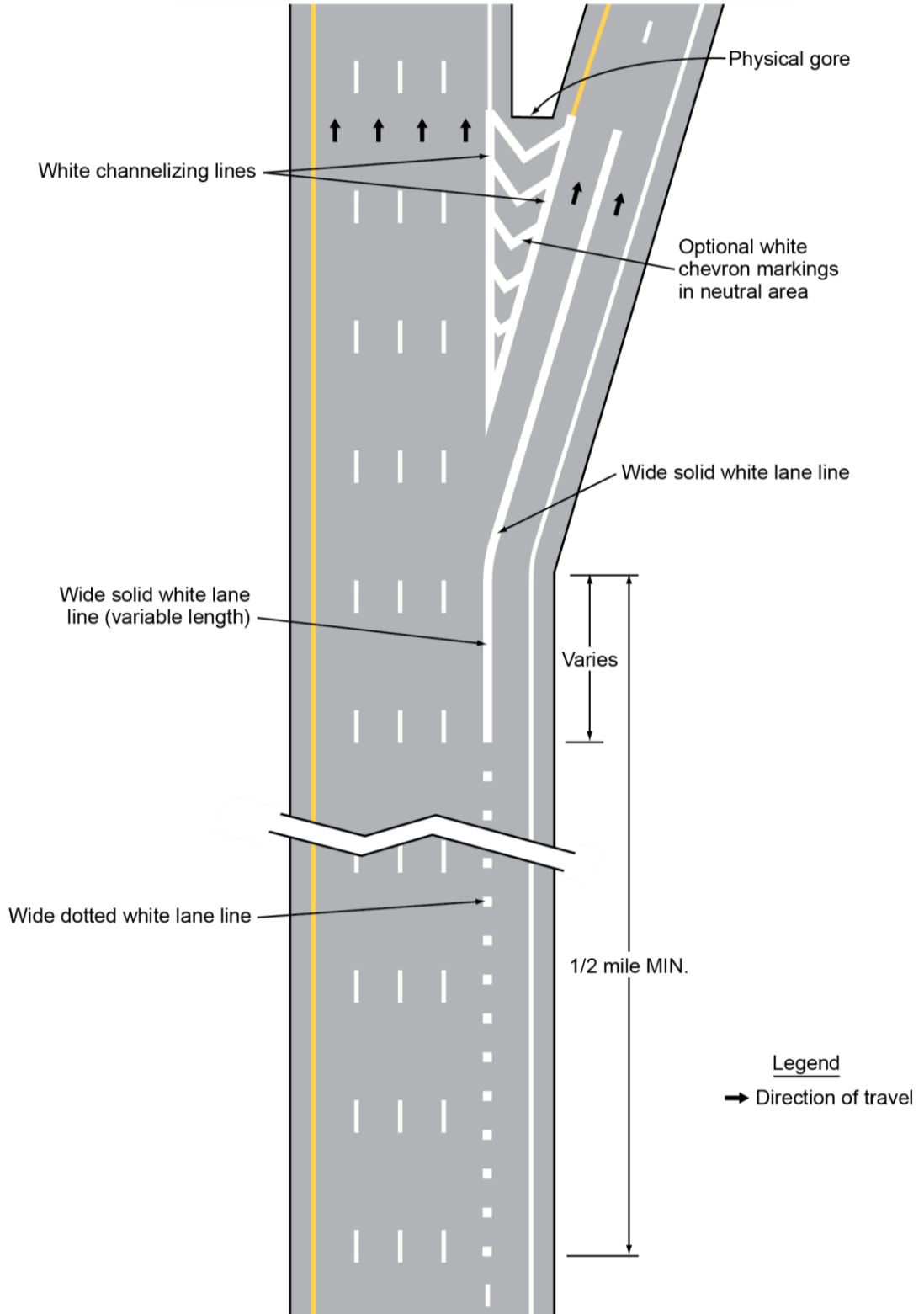
**Figure 3B-10. Example of Applications of Freeway and Expressway Lane Drop Markings (Sheet 1 of 5)**



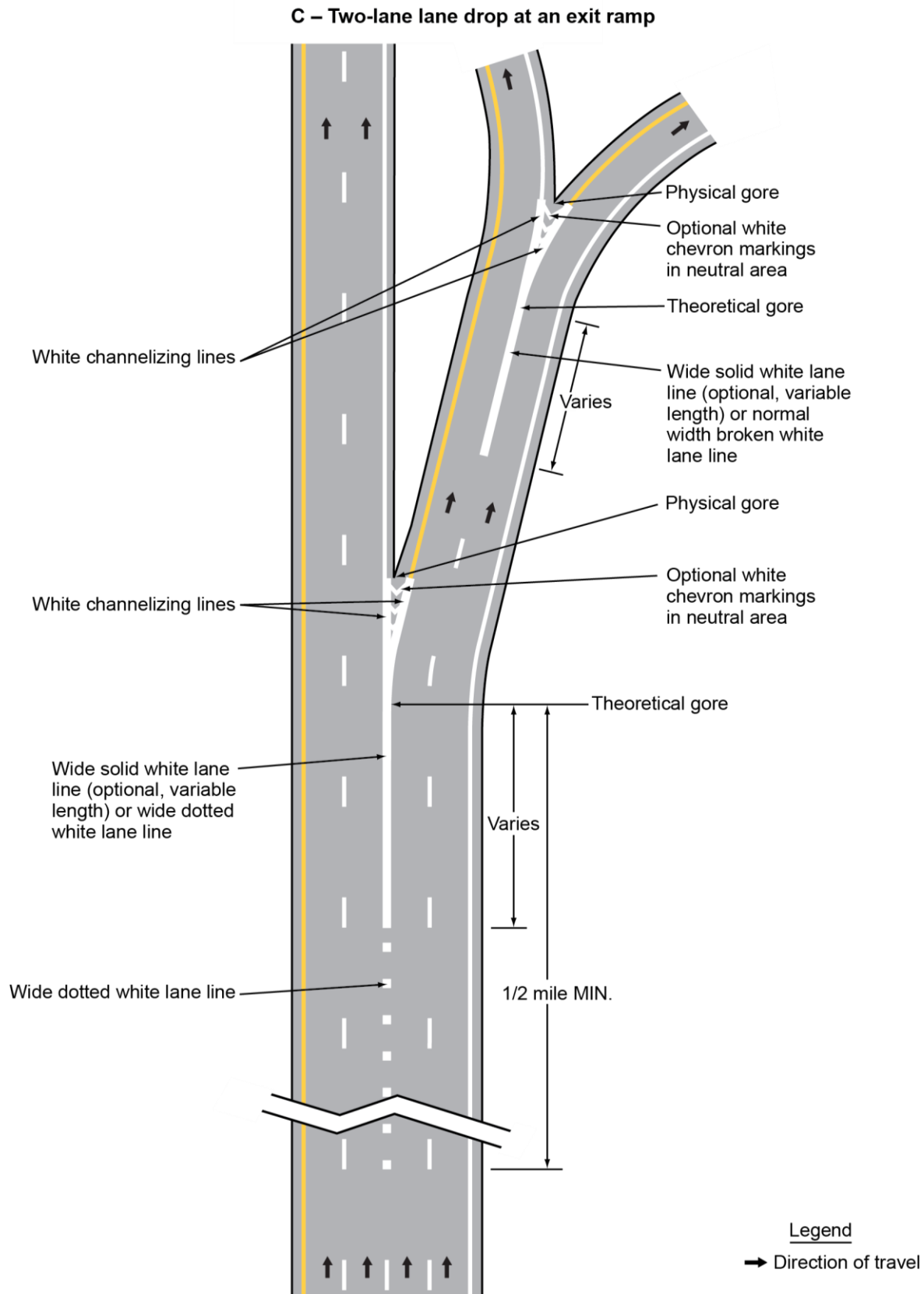


**Figure 3B-10. Example of Applications of Freeway and Expressway Lane Drop Markings (Sheet 2 of 5)**

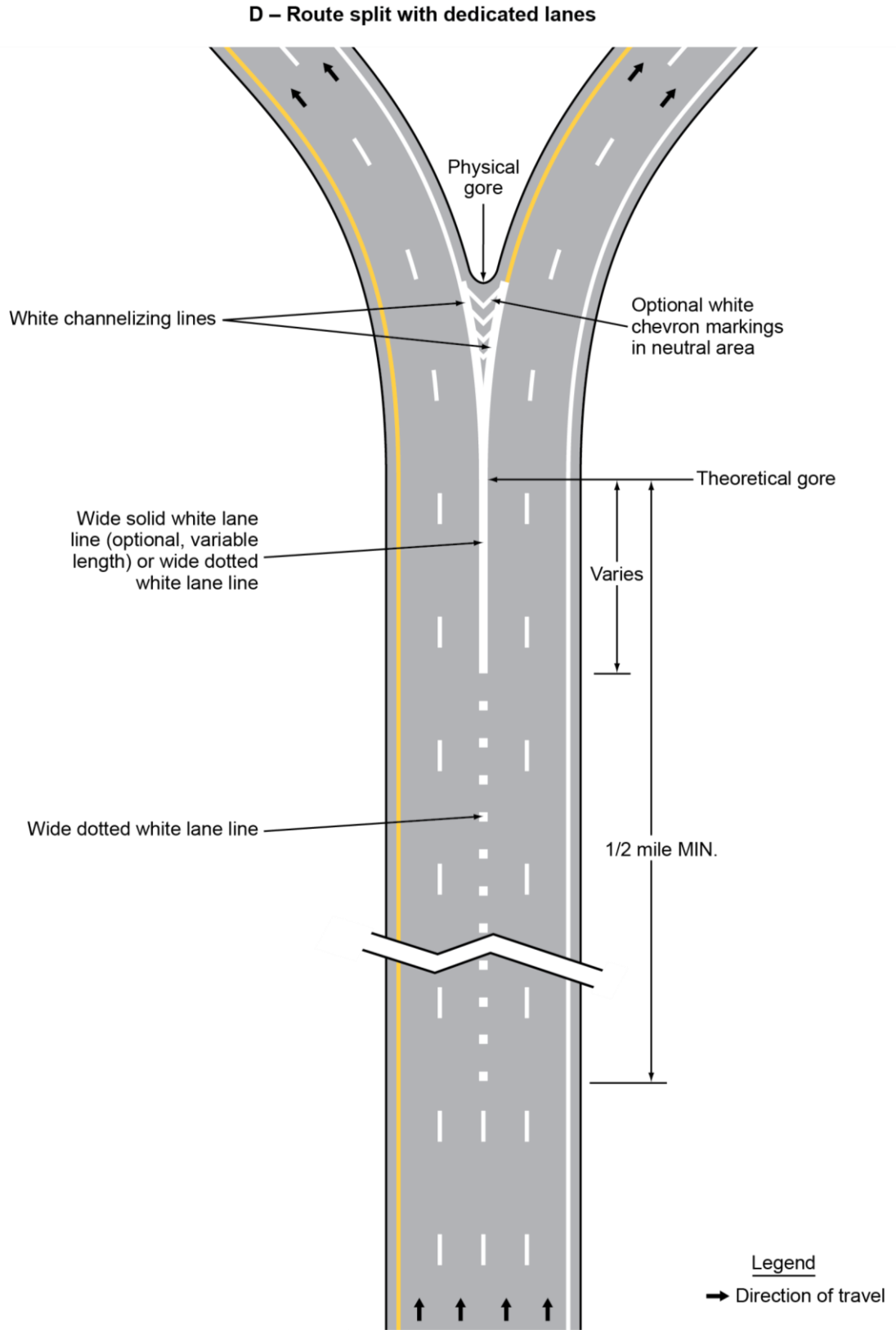
**B – Lane drop at a multi-lane exit ramp having an optional exit lane that also carries the through route**



**Figure 3B-10. Example of Applications of Freeway and Expressway Lane Drop Markings (Sheet 3 of 5)**

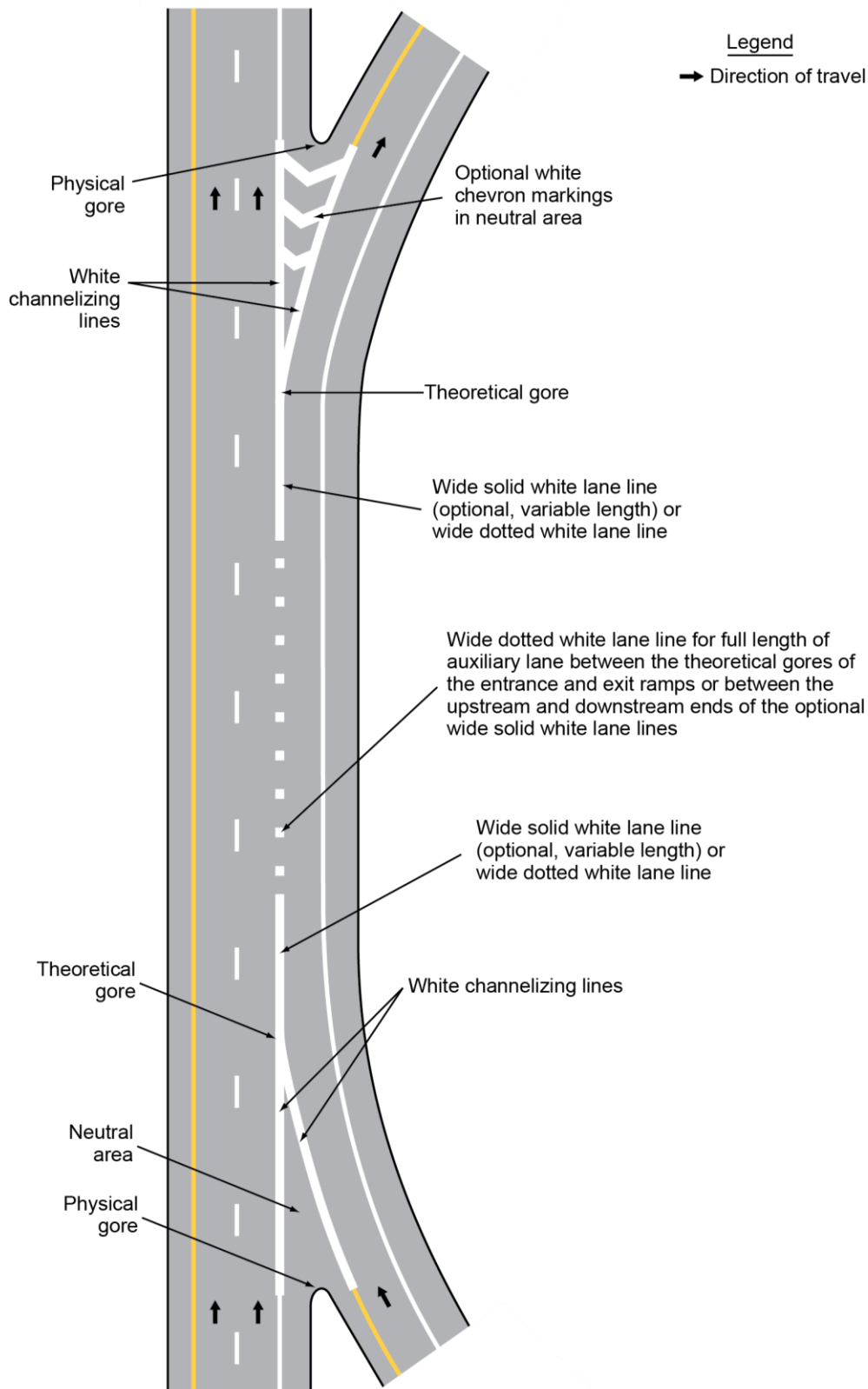


**Figure 3B-10. Example of Applications of Freeway and Expressway Lane Drop Markings (Sheet 4 of 5)**

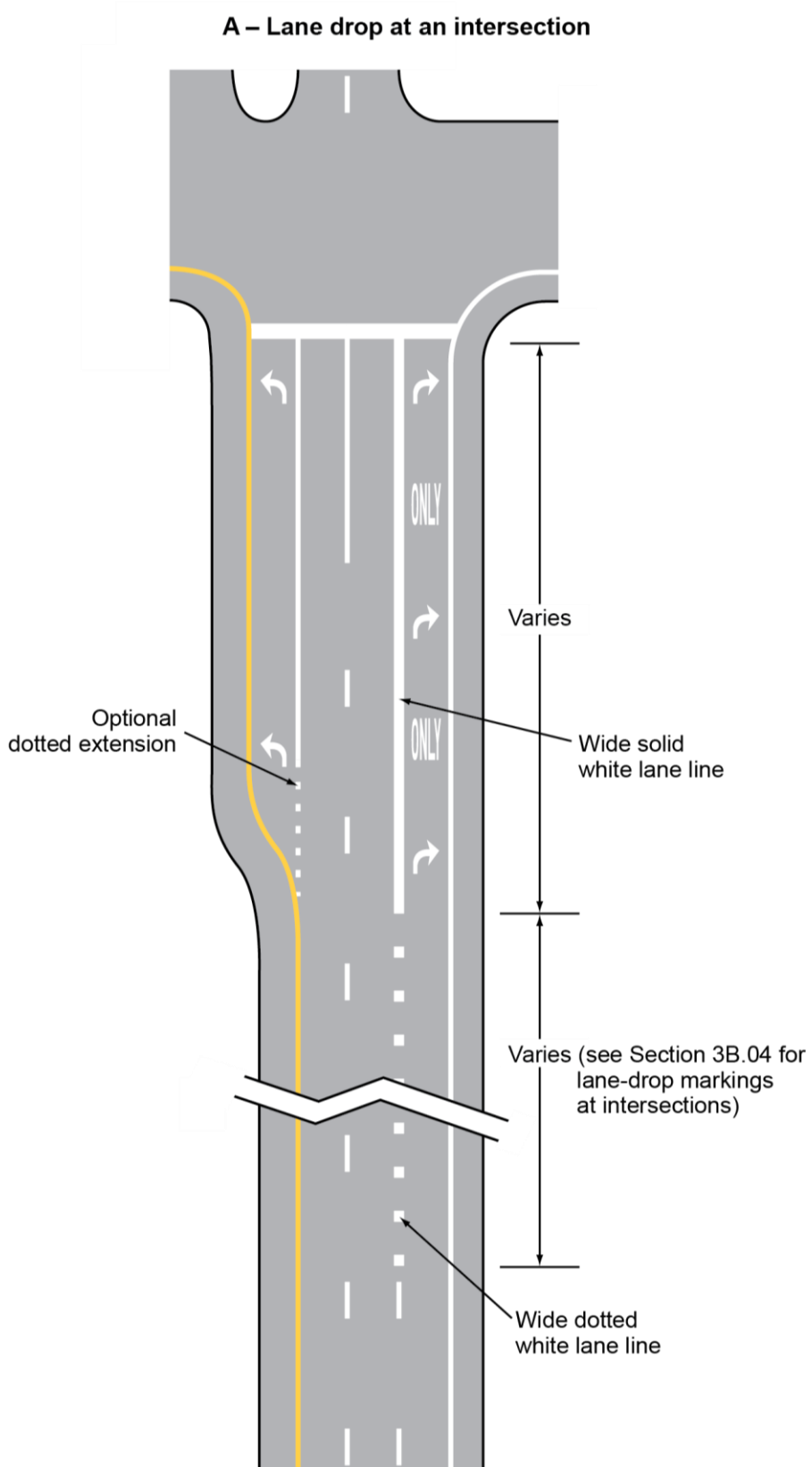


**Figure 3B-10. Example of Applications of Freeway and Expressway Lane Drop Markings (Sheet 5 of 5)**

**E – Auxiliary lane, such as at a cloverleaf interchange or closely spaced interchanges.**

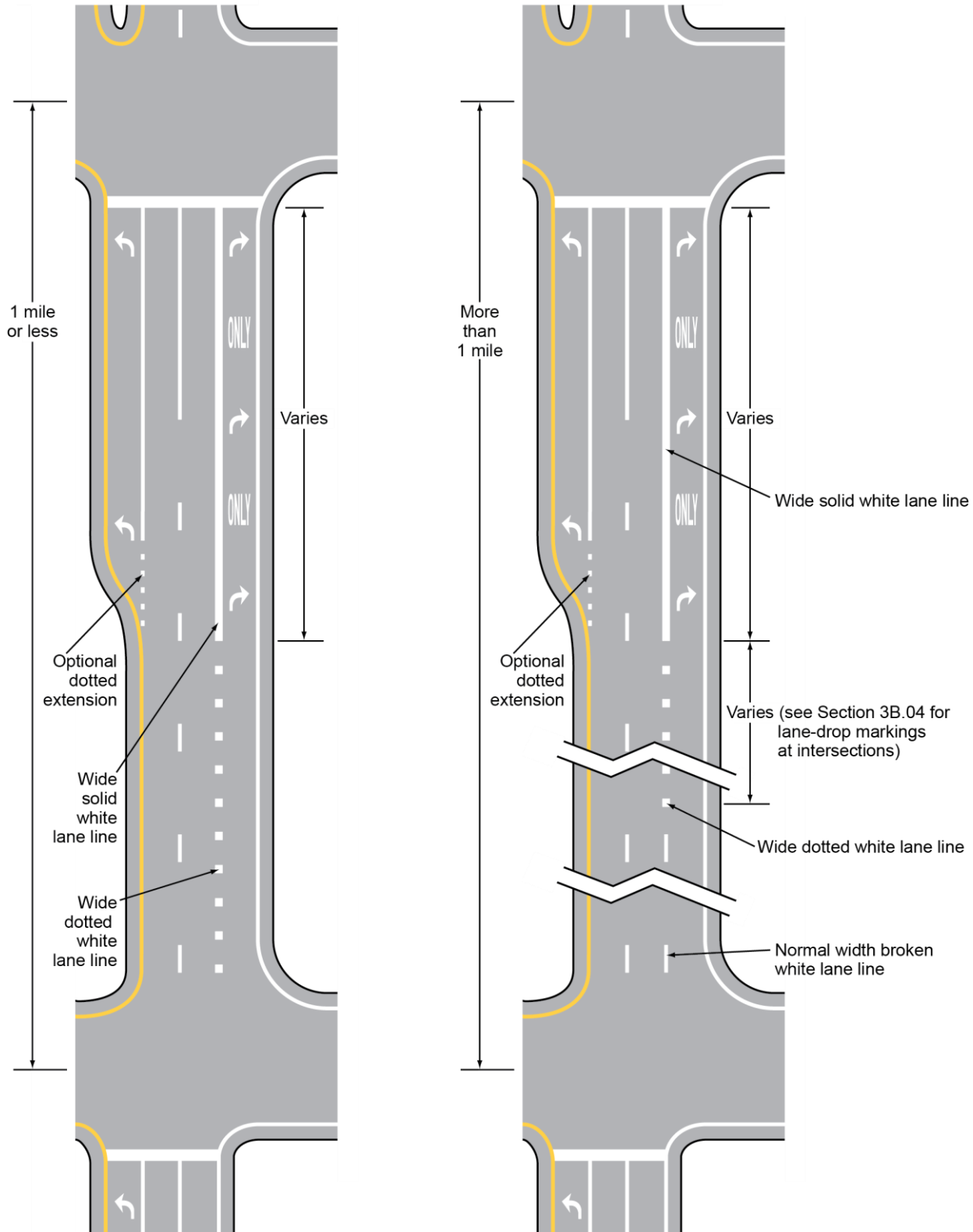


**Figure 3B-11. Examples of Applications of Conventional Road Lane-Drop Markings (Sheet 1 of 2)**



**Figure 3B-11. Examples of Applications of Conventional Road Lane-Drop Markings (Sheet 2 of 2)**

**B – Auxiliary lane between intersections**



Option:

- 25 On approaches to intersections, solid white lane line markings may be used to separate adjacent through lanes or adjacent mandatory turn lanes from each other.
- 26 Where the median width allows the left-turn lanes to be separated from the through lanes to give drivers on opposing approaches a less obstructed view of opposing through traffic, white pavement markings may be used to form channelizing islands as shown in Figure 2B-17.
- 27 Solid white lane line markings may be used to separate through traffic lanes from auxiliary lanes, such as an added uphill truck lane or a preferential lane (see Section 3D.02).
- 28 Wide solid white lane line markings may be used for greater emphasis.

**Standard:**

- 29 Where crossing the lane line markings is prohibited, the lane line markings shall consist of a solid double white line (see Figure 3B.12).

**Section 3B.05 Other White Longitudinal Pavement Markings**

**Standard:**

- 01 A channelizing line shall be a wide or double solid white line.

Option:

- 02 Channelizing lines may be used to form channelizing islands where traffic traveling in the same direction is permitted on both sides of the island.

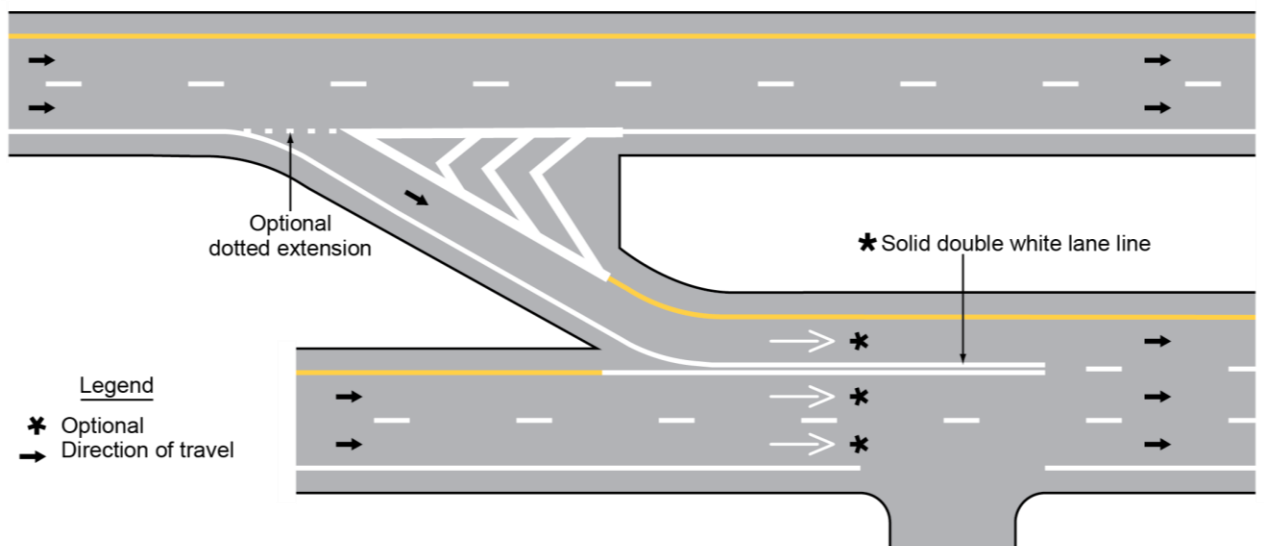
**Standard:**

- 03 Other pavement markings in the channelizing island area shall be white.

Support:

- 04 Examples of channelizing line applications are shown in Figures 3B-8, 3B-9, and 3B-10, and in Drawing C of Figure 3B-15.
- 05 Channelizing lines at exit ramps as shown in Figures 3B-8 and 3B-10 define the neutral area, direct exiting traffic at the proper angle for smooth divergence from the main lanes into the ramp, and reduce the probability of colliding with objects adjacent to the roadway.

**Figure 3B-12. Example of Solid Double White Lines Used to Prohibit Lane Changing**



06 **Channelizing lines at entrance ramps as shown in Figures 3B-9 and 3B-10 promote orderly and efficient merging with the through traffic.**

**Standard:**

07 **For all exit ramps and for entrance ramps with parallel acceleration lanes, channelizing lines shall be placed on both sides of the neutral area (see Figures 3B-8 and 3B-10 and Drawing A of Figure 3B-9).**

08 **For entrance ramps with tapered acceleration lanes, channelizing lines shall be placed along both sides of the neutral area to a point at least one-half of the distance to the theoretical gore (see Drawing C of Figure 3B-9).**

**Option:**

09 For entrance ramps with tapered acceleration lanes, the channelizing lines may extend to the theoretical gore as shown in Drawing B of Figure 3B-9.

10 White chevron crosshatch markings (see Section 3B.24) may be placed in the neutral area of exit ramp and entrance ramp gores for special emphasis as shown in Figure 3B-8 and 3B-10 and Drawing A of Figure 3B-9. The channelizing lines and the optional chevron crosshatch markings at exit ramp and entrance ramp gores may be supplemented with white retroreflective or internally illuminated raised pavement markers (see Sections 3B.11 and 3B.13) for enhanced nighttime visibility.

**Section 3B.06 Edge Line Pavement Markings**

**Standard:**

01 **If used, edge line pavement markings shall delineate the right or left edges of a roadway.**

02 **Except for dotted edge line extensions (see Section 3B.08), edge line markings shall not be continued through intersections or major driveways.**

03 **If used on the roadways of divided highways or one-way streets, or on any ramp in the direction of travel, left edge line pavement markings shall consist of a normal solid yellow line to delineate the left-hand edge of a roadway or to indicate driving or passing restrictions left of these markings.**

04 **If used, right edge line pavement markings shall consist of a normal solid white line to delineate the right-hand edge of the roadway.**

*Guidance:*

05 *Edge line markings should not be broken for minor driveways. Support:*

06 Edge line markings have unique value as visual references to guide road users during adverse weather and visibility conditions.

**Option:**

07 Wide solid edge line markings may be used for greater emphasis.

**Section 3B.07 Warrants for Use of Edge Lines**

**Standard:**

01 **Edge line markings shall be placed on paved streets or highways with the following characteristics:**

- A. Freeways,**
- B. Expressways, and**
- C. Rural arterials with a traveled way of 20 feet or more in width and an ADT of 6,000 vehicles per day or greater.**

*Guidance:*

02 Edge line markings should be placed on paved streets or highways with the following characteristics:

- A. Rural arterials and collectors with a traveled way of 20 feet or more in width and an ADT of 3,000 vehicles per day or greater.
- B. On other paved streets and highways where an engineering study indicates a need for edge line markings.



- 03 Edge line markings should not be placed where an engineering study or engineering judgment indicates that providing them is likely to decrease safety.

Option:

- 04 Edge line markings may be placed on streets and highways with or without center line markings.
- 05 Edge line markings may be excluded, based on engineering judgment, for reasons such as if the traveled way edges are delineated by curbs, parking, or other markings.
- 06 If a bicycle lane is marked on the outside portion of the traveled way, the edge line that would mark the outside edge of the bicycle lane may be omitted.
- 07 Edge line markings may be used where edge delineation is desirable to minimize unnecessary driving on paved shoulders or on refuge areas that have lesser structural pavement strength than the adjacent roadway.

### **Section 3B.08 Extensions Through Intersections or Interchanges**

**Standard:**

- 01 **Except as provided in Paragraph 2, pavement markings extended into or continued through an intersection or interchange area shall be the same color and at least the same width as the line markings they extend (see Figure 3B-13).**

Option:

- 02 A normal line may be used to extend a wide line through an intersection.

*Guidance:*

- 03 *Where highway design or reduced visibility conditions make it desirable to provide control or to guide vehicles through an intersection or interchange, such as at offset, skewed, complex, or multi-legged intersections, on curved roadways, where multiple turn lanes are used, or where offset left turn lanes might cause driver confusion, dotted line extension markings consisting of 2-foot line segments and 2- to 6-foot gaps should be used to extend longitudinal line markings through an intersection or interchange area.*

Option:

- 04 Dotted edge line extensions may be placed through intersections or major driveways.

*Guidance:*

- 05 *Where greater restriction is required, solid lane lines or channelizing lines should be extended into or continued through intersections or major driveways.*

**Standard:**

- 06 **Solid lines shall not be used to extend edge lines into or through intersections or major driveways.**

*Guidance:*

- 07 *Where a double line is extended through an intersection, a single line of equal width to one of the lines of the double line should be used.*
- 08 *To the extent possible, pavement marking extensions through intersections should be designed in a manner that minimizes potential confusion for drivers in adjacent or opposing lanes.*

### **Section 3B.09 Lane-Reduction Transition Markings**

Support:

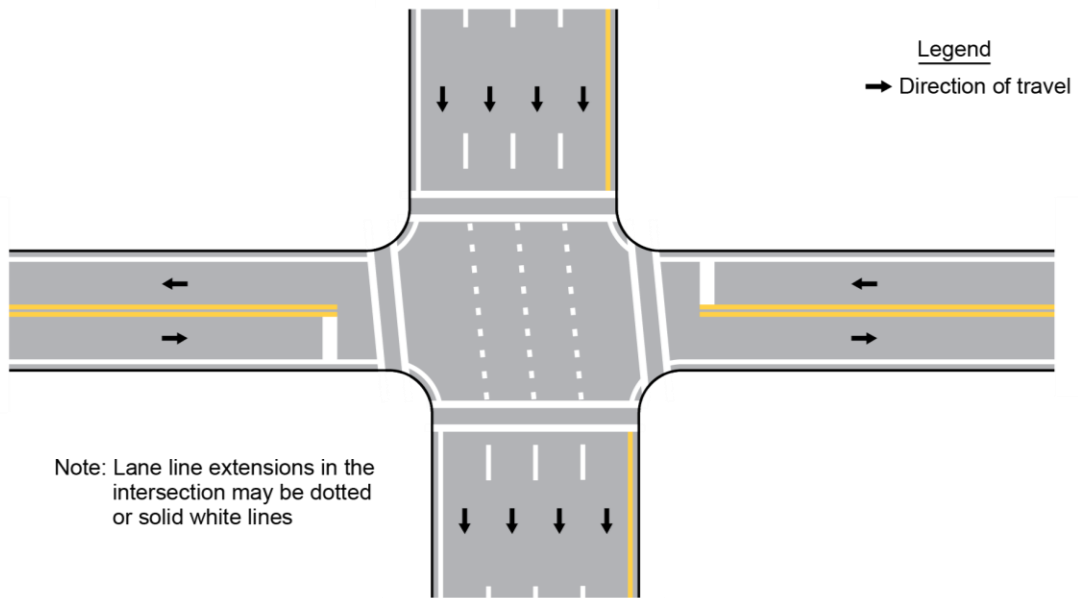
- 01 Lane-reduction transition markings are used where the number of through lanes is reduced because of narrowing of the roadway or because of a section of on-street parking in what would otherwise be a through lane. Lane-reduction transition markings are not used for lane drops.

**Standard:**

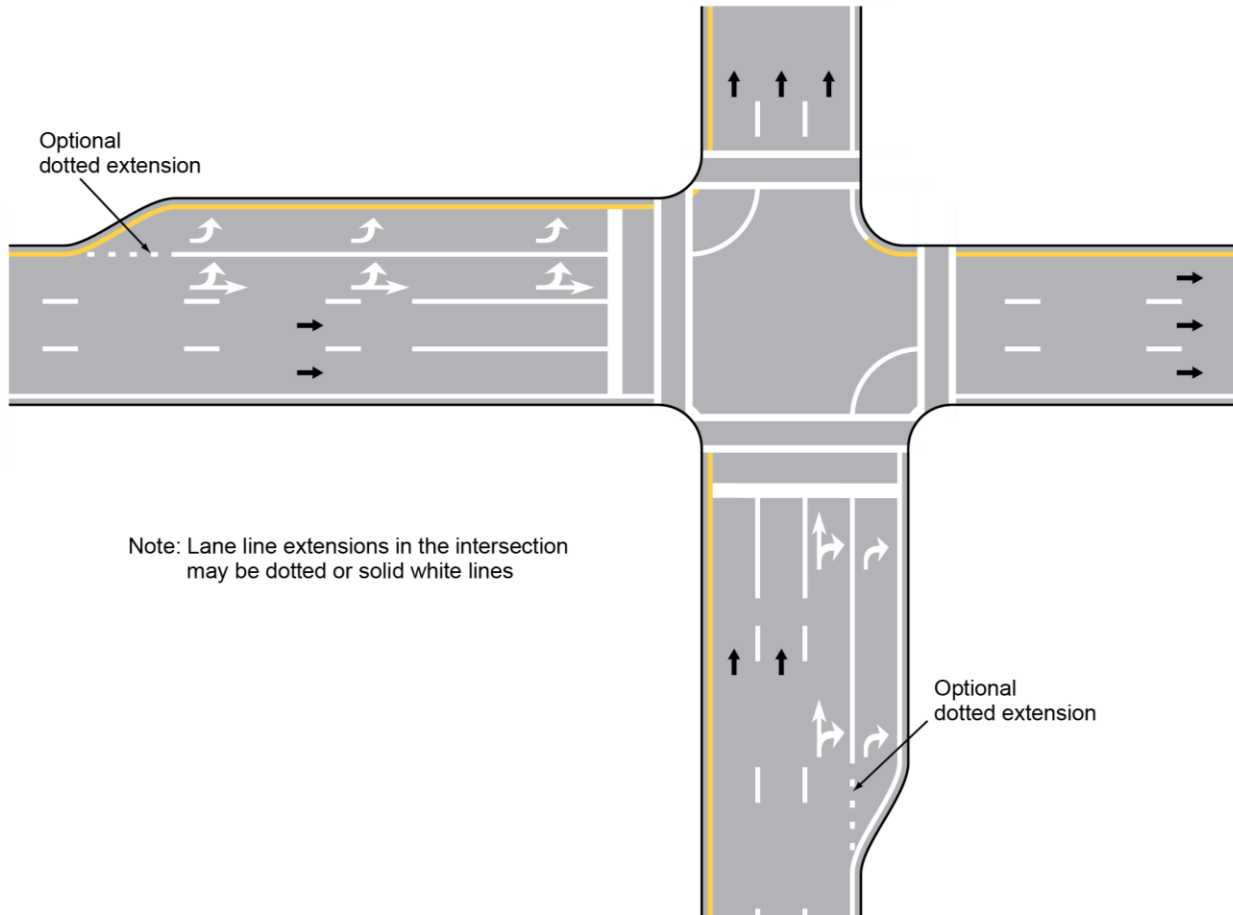
- 02 **Except as provided in Paragraph 3, where pavement markings are used, lane reduction transition markings shall be used to guide traffic through transition areas where the number of through lanes is reduced, as shown in Figure 3B-14. On two-way roadways, no-passing zone markings shall be used to prohibit passing in the direction of the convergence, and shall continue through the transition area.**

**Figure 3B-13. Examples of Line Extensions through Intersections**  
(Sheet 1 of 2)

**A - Typical pavement markings with offset lane lines continued through the intersection and optional crosswalk lines and stop lines**

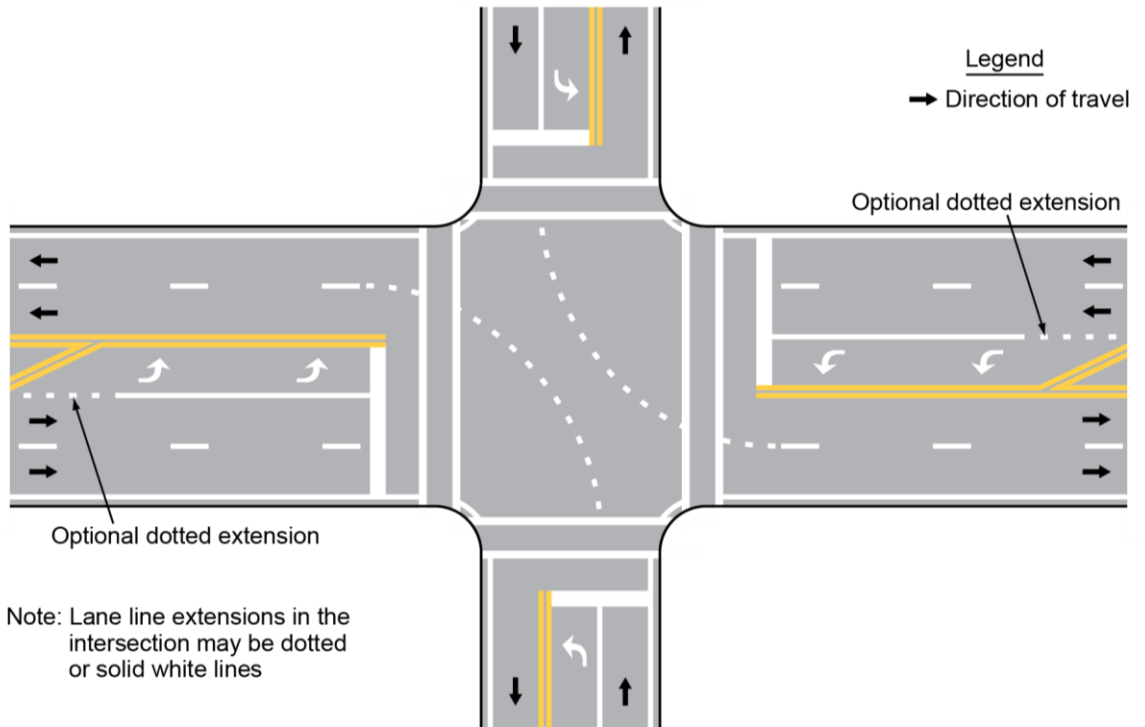


**B - Typical pavement markings with double-turn lanes, lane-use turn arrows, and optional crosswalk lines, stop lines, and line extensions into intersection for double turns**

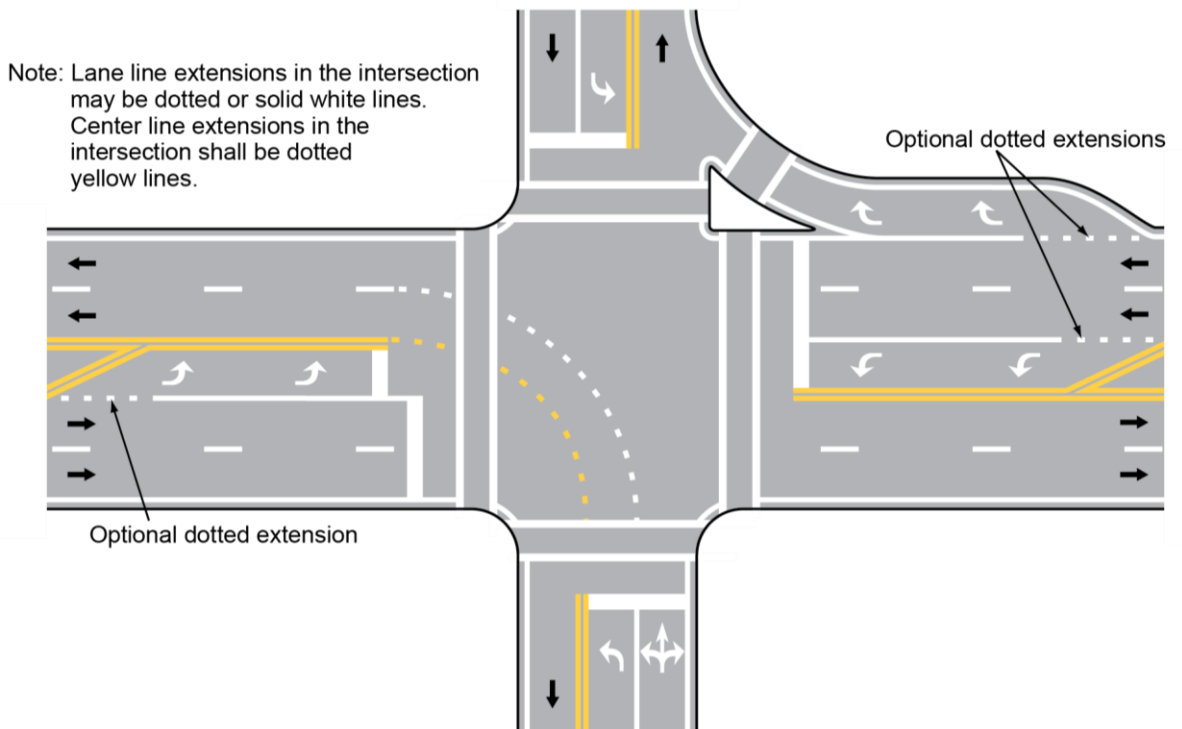


**Figure 3B-13. Examples of Line Extensions through Intersections**  
(Sheet 2 of 2)

**C - Typical dotted line markings to extend lane line markings into the intersection**



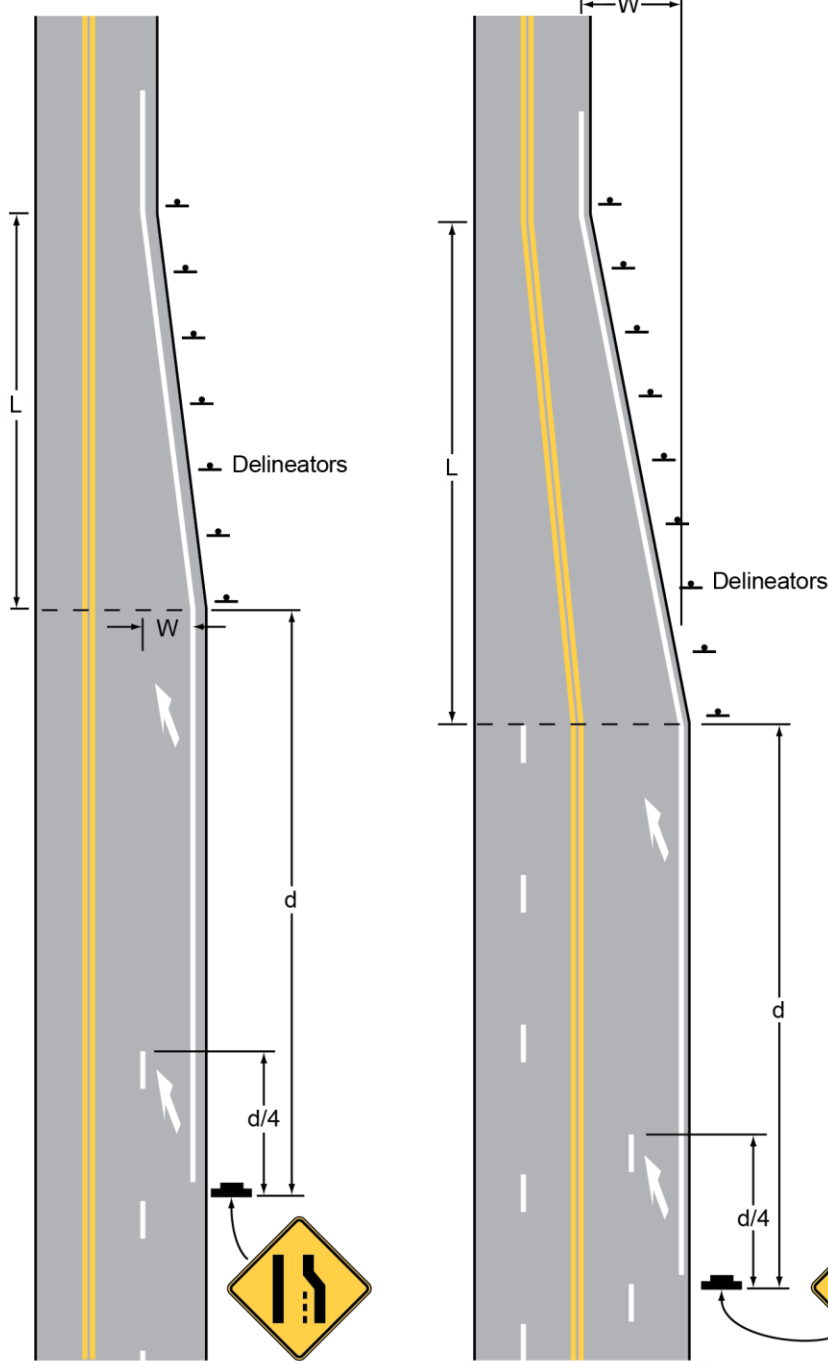
**D - Typical dotted line markings to extend center line and lane line markings into the intersection**



**Figure 3B-14. Examples of Applications of Lane-Reduction Transition Markings**

**A – Lane reduction**

**B – Lane reduction with lateral shift to the left**



Notes:

1. For use of lane-reduction arrows in this situation see Section 3B.20 (paragraph 34).
2. The delineators are optional. See Section 3F.04 for delineator spacing.
3.  $L = WS$  for speeds of 45 mph or greater and  $L = WS^2/60$  for speeds of less than 45 mph, where:  
 $L$  = Length of taper in feet  
 $S$  = Posted, 85th-percentile, or statutory speed in mph  
 $W$  = Offset in feet
4.  $d$  = Advance warning distance (see Section 2C.05).

Option:

- 03 On low-speed urban roadways where curbs clearly define the roadway edge in the lane-reduction transition, or where a through lane becomes a parking lane, the edge line and/or delineators shown in Figure 3B-14 may be omitted as determined by engineering judgment.

*Guidance:*

- 04 *For roadways having a posted or statutory speed limit of 45 mph or greater, the transition taper length for a lane reduction transition should be computed by the formula  $L = WS$ . For roadways where the posted or statutory speed limit is less than 45 mph, the formula  $L = WS^2/60$  should be used to compute taper length.*

Support:

- 05 Under both formulas, L equals the taper length in feet, W equals the width of the offset distance in feet, and S equals the 85th-percentile speed or the posted or statutory speed limit, whichever is higher.

*Guidance:*

- 06 *Where observed speeds exceed posted or statutory speed limits, longer tapers should be used.*

Option:

- 07 On new construction, where no posted or statutory speed limit has been established, the design speed may be used in the transition taper length formula.

*Guidance:*

- 08 *Lane line markings should be discontinued one-quarter of the distance between the Lane Ends sign (see Section 2C.42) and the point where the transition taper begins.*

- 09 *Except as provided in Paragraph 3 for low-speed urban roadways, the edge line markings shown in Figure 3B-14 should be installed from the location of the Lane Ends warning sign to beyond the beginning of the narrower roadway.*

Support:

- 10 Pavement markings at lane reduction transitions supplement the standard signs. See Section 3B.20 for provisions regarding use of lane-reduction arrows.

### **Section 3B.10 Approach Markings for Obstructions**

**Standard:**

- 01 **Pavement markings shall be used to guide traffic away from fixed obstructions within a paved roadway. Approach markings for bridge supports, refuge islands, median islands, toll plaza islands, and raised channelization islands shall consist of a tapered line or lines extending from the center line or the lane line to a point 1 to 2 feet to the right-hand side, or to both sides, of the approach end of the obstruction (see Figure 3B-15).**

Support:

- 02 See Chapter 3E for additional information on approach markings for toll plaza islands.

*Guidance:*

- 03 *For roadways having a posted or statutory speed limit of 45 mph or greater, the taper length of the tapered line markings should be computed by the formula  $L = WS$ . For roadways where the posted or statutory speed limit is less than 45 mph, the formula  $L = WS^2/60$  should be used to compute taper length.*

Support:

- 04 Under both formulas, L equals the taper length in feet, W equals the width of the offset distance in feet, and S equals the 85th-percentile speed or the posted or statutory speed limit, whichever is higher.

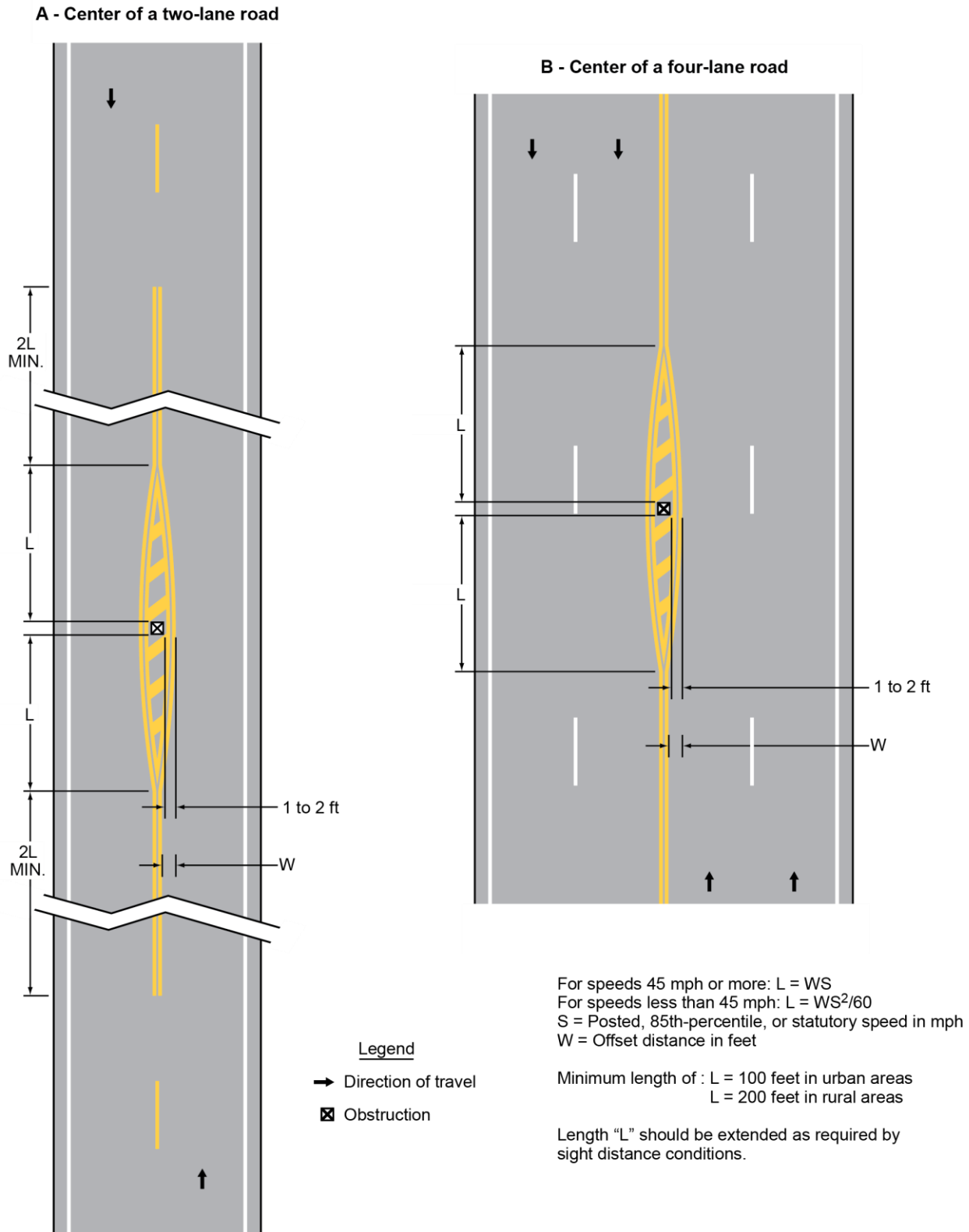
*Guidance:*

- 05 *The minimum taper length should be 100 feet in urban areas and 200 feet in rural areas.*

Support:

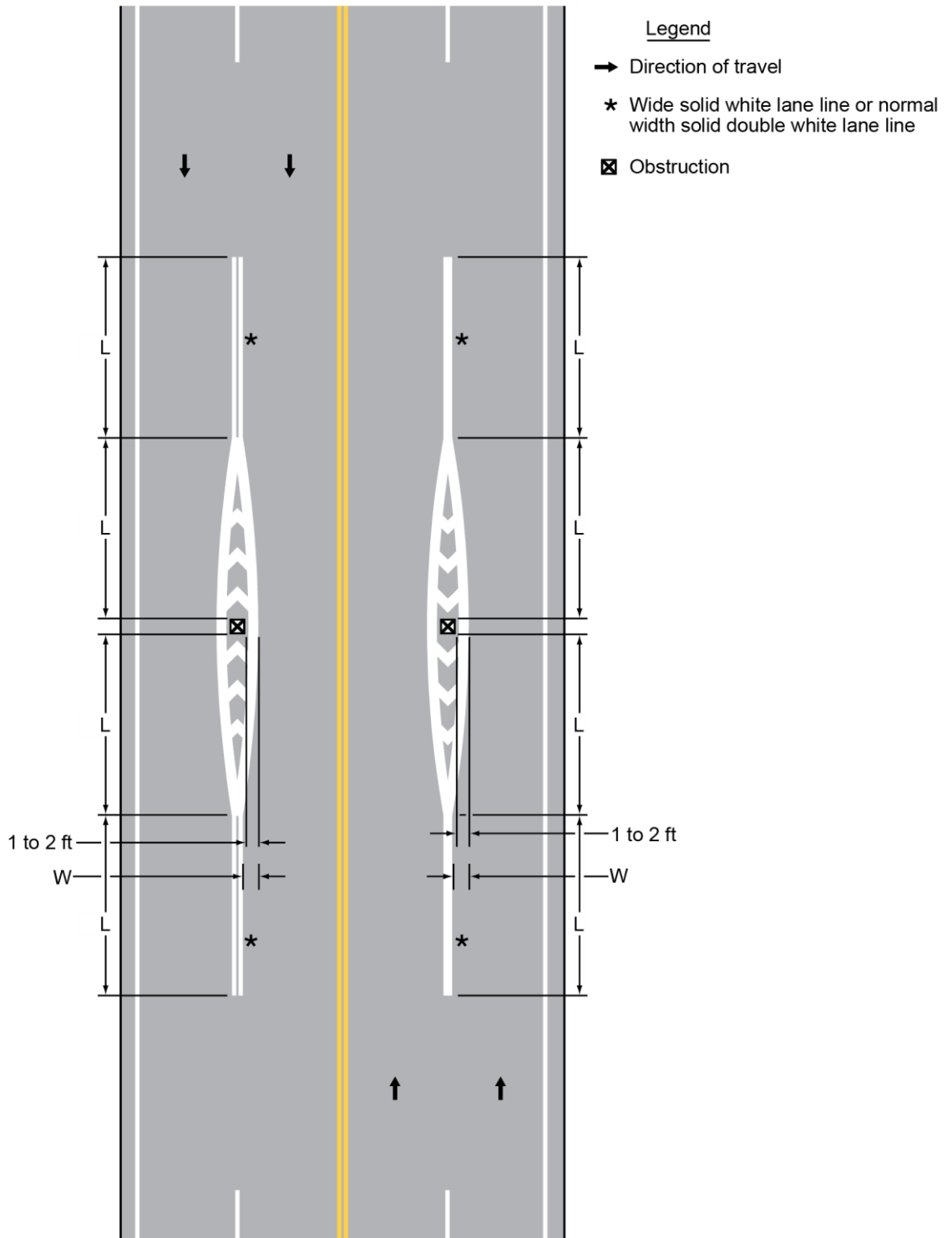
- 06 Examples of approach markings for obstructions in the roadway are shown in Figure 3B-15.

**Figure 3B-15. Examples of Applications of Markings for Obstructions in the Roadway (Sheet 1 of 2)**



**Figure 3B-15. Examples of Applications of Markings for Obstructions in the Roadway (Sheet 2 of 2)**

**C - Traffic passing in the same direction on both sides of an obstruction**



For speeds of 45 mph or more:  $L = WS$   
 For speeds of less than 45 mph:  $L = WS^2/60$   
 S = Posted, 85th-percentile, or statutory speed in mph  
 W = Offset distance in feet

Minimum length of: L = 100 feet in urban areas  
 L = 200 feet in rural areas

Length "L" should be extended as required by sight distance conditions.

**Standard:**

07 **If traffic is required to pass only to the right of the obstruction, the markings shall consist of a two-direction no-passing zone marking at least twice the length of the diagonal portion as determined by the appropriate taper formula (see Drawing A of Figure 3B-15).**

## Option:

08 If traffic is required to pass only to the right of the obstruction, yellow diagonal crosshatch markings (see Section 3B.24) may be placed in the flush median area between the no-passing zone markings as shown in Drawings A and B of Figure 3B-15. Other markings, such as yellow delineators, yellow channelizing devices, yellow raised pavement markers, and white crosswalk pavement markings, may also be placed in the flush median area.

**Standard:**

09 **If traffic can pass either to the right or left of the obstruction, the markings shall consist of two channelizing lines diverging from the lane line, one to each side of the obstruction. In advance of the point of divergence, a wide solid white line or normal solid double white line shall be extended in place of the broken lane line for a distance equal to the length of the diverging lines (see Drawing C of Figure 3B-15).**

## Option:

10 If traffic can pass either to the right or left of the obstruction, additional white chevron crosshatch markings (see Section 3B.24) may be placed in the flush median area between the channelizing lines as shown in Drawing C of Figure 3B-15. Other markings, such as white delineators, white channelizing devices, white raised pavement markers, and white crosswalk markings may also be placed in the flush median area.

**Section 3B.11 Raised Pavement Markers – General****Standard:**

01 **The color of raised pavement markers under both daylight and nighttime conditions shall conform to the color of the marking for which they serve as a positioning guide, or for which they supplement or substitute.**

## Support:

02 Retroreflective and internally illuminated raised pavement markers are available in mono-directional and bidirectional configurations. The bidirectional marker is capable of displaying the applicable color for each direction of travel.

## Option:

03 Raised pavement markers may be used to warn traffic proceeding in the wrong direction.

## Standard:

04 When used to warn traffic proceeding in the wrong direction, the side of the raised pavement marker facing the wrong way traffic shall be red (see Section 3A.05).

## Option:

05 Retroreflective or internally illuminated raised pavement markers may be used in the roadway immediately adjacent to curbed approach ends of raised medians and curbs of islands, or on top of such curbs (see Section 3B.23).

## Support:

06 Blue raised pavement markers are sometimes used in the roadway to help emergency personnel locate fire hydrants.

**Standard:**

07 **When used, internally illuminated raised pavement markers shall be steadily illuminated and shall not be flashed.**

## Support:

08 Flashing raised pavement markers are considered to be In-Roadway Lights (see Chapter 4N).



*Guidance:*

- 09 *Non-retroreflective raised pavement markers should not be used alone, without supplemental retroreflective or internally illuminated markers, as a substitute for other types of pavement markings.*
- 10 *Directional configurations should be used to maximize correct information and to minimize confusing information provided to the road user. Directional configurations also should be used to avoid confusion resulting from visibility of markers that do not apply to the road user.*
- 11 *The spacing of raised pavement markers used to supplement or substitute for other types of longitudinal markings should correspond with the pattern of broken lines for which the markers supplement or substitute.*

**Standard:**

- 12 **The value of N cited in Sections 3B.12 through 3B.14 for the spacing of raised pavement markers shall equal the length of one line segment plus one gap of the broken lines used on the highway.**

*Option:*

- 13 For additional emphasis, retroreflective raised pavement markers may be spaced closer than described in Sections 3B.12 through 3B.14, as determined by engineering judgment or engineering study.

*Support:*

- 14 Figures 9-20 through 9-22 in the “Traffic Control Devices Handbook” (see Section 1A.11) contain additional information regarding the spacing of raised pavement markers on longitudinal markings.

**Section 3B.12 Raised Pavement Markers as Vehicle Positioning Guides with Other Longitudinal Markings**

*Option:*

- 01 Retroreflective or internally illuminated raised pavement markers may be used as positioning guides with longitudinal line markings without necessarily conveying information to the road user about passing or lane-use restrictions. In such applications, markers may be positioned in line with or immediately adjacent to a single line marking, or positioned between the two lines of a double center line or double lane line marking.

*Guidance:*

- 02 *The spacing for such applications should be 2N, where N equals the length of one line segment plus one gap (see Section 3B.11).*

*Option:*

- 03 Where it is desired to alert the road user to changes in the travel path, such as on sharp curves or on transitions that reduce the number of lanes or that shift traffic laterally, the spacing may be reduced to N or less.
- 04 On freeways and expressways, the spacing may be increased to 3N for relatively straight and level roadway segments where engineering judgment indicates that such spacing will provide adequate delineation under wet night conditions.

**Section 3B.13 Raised Pavement Markers Supplementing Other Markings**

*Guidance:*

- 01 *The use of retroreflective or internally illuminated raised pavement markers for supplementing longitudinal line markings should comply with the following:*
- A. *Lateral Positioning*
1. *When supplementing double line markings, pairs of raised pavement markers placed laterally in line with or immediately outside of the two lines should be used.*
  2. *When supplementing wide line markings, pairs of raised pavement markers placed laterally adjacent to each other should be used.*
- B. *Longitudinal Spacing*
1. *When supplementing solid line markings, raised pavement markers at a spacing no greater than N (see Section 3B.11) should be used, except that when supplementing channelizing lines or edge line markings, a spacing of no greater than N/2 should be used.*

2. *When supplementing broken line markings, a spacing no greater than 3N should be used. However, when supplementing broken line markings identifying reversible lanes, a spacing of no greater than N should be used.*
3. *When supplementing dotted lane line markings, a spacing appropriate for the application should be used.*
4. *When supplementing longitudinal line extension markings through at-grade intersections, one raised pavement marker for each short line segment should be used.*
5. *When supplementing line extensions through freeway interchanges, a spacing of no greater than N should be used.*

02 *Raised pavement markers should not supplement right-hand edge lines unless an engineering study or engineering judgment indicates the benefits of enhanced delineation of a curve or other location would outweigh possible impacts on bicycles using the shoulder, and the spacing of raised pavement markers on the right-hand edge is close enough to avoid misinterpretation as a broken line during wet night conditions.*

Option:

03 Raised pavement markers also may be used to supplement other markings such as channelizing islands, gore areas, approaches to obstructions, or wrong-way arrows.

04 To improve the visibility of horizontal curves, center lines may be supplemented with retroreflective or internally illuminated raised pavement markers for the entire curved section as well as for a distance in advance of the curve that approximates 5 seconds of travel time.

### **Section 3B.14 Raised Pavement Markers Substituting for Pavement Markings**

Option:

01 Retroreflective or internally illuminated raised pavement markers, or non-retroreflective raised pavement markers supplemented by retroreflective or internally illuminated markers, may be substituted for markings of other types.

Guidance:

02 If used, the pattern of the raised pavement markers should simulate the pattern of the markings for which they substitute.

**Standard:**

03 **If raised pavement markers are used to substitute for broken line markings, a group of three to five markers equally spaced at a distance no greater than N/8 (see Section 3B.11) shall be used. If N is other than 40 feet, the markers shall be equally spaced over the line segment length (at 1/2 points for three markers, at 1/3 points for four markers, and at 1/4 points for five markers). At least one retroreflective or internally illuminated marker per group shall be used or a retroreflective or internally illuminated marker shall be installed midway in each gap between successive groups of non-retroreflective markers.**

04 **When raised pavement markers substitute for solid line markings, the markers shall be equally spaced at no greater than N/4 with retroreflective or internally illuminated units at a spacing no greater than N/2.**

Guidance:

05 *Raised pavement markers should not substitute for right-hand edge line markings unless an engineering study or engineering judgment indicates the benefits of enhanced delineation of a curve or other location would outweigh possible impacts on bicycles using the shoulder, and the spacing of raised pavement markers on the right-hand edge line is close enough to avoid misinterpretation as a broken line during wet night conditions.*

**Standard:**

06 **When raised pavement markers substitute for dotted lines, they shall be spaced at no greater than N/4, with not less than one raised pavement marker per dotted line segment. At least one raised marker every N shall be retroreflective or internally illuminated.**

Option:

- 07 When substituting for wide lines, raised pavement markers may be placed laterally adjacent to each other to simulate the width of the line.

### **Section 3B.15 Transverse Markings**

**Standard:**

- 01 **Transverse markings, which include shoulder markings, word and symbol markings, arrows, stop lines, yield lines, crosswalk lines, speed measurement markings, speed reduction markings, speed hump markings, parking space markings, and others, shall be white unless otherwise provided in this Manual.**

**Guidance:**

- 02 *Because of the low approach angle at which pavement markings are viewed, transverse lines should be proportioned to provide visibility at least equal to that of longitudinal lines.*

### **Section 3B.16 Stop and Yield Lines**

**Guidance:**

- 01 *Stop lines should be used to indicate the point behind which vehicles are required to stop, in compliance with a traffic control signal.*

Option:

- 02 Stop lines may be used to indicate the point behind which vehicles are required to stop, in compliance with a STOP (R1-1) sign, or some other traffic control device that requires vehicles to stop, except YIELD signs that are not associated with passive grade crossings.

- 03 Yield lines may be used to indicate the point behind which vehicles are required to yield in compliance with a YIELD (R1-2) sign or a Yield Here to Pedestrians (R1-5 or R1-5a) sign.

**Standard:**

- 04 **Except as provided in Section 8B.28, stop lines shall not be used at locations where drivers are required to yield in compliance with a YIELD (R1-2) sign or a Yield Here To Pedestrians (R1-5 or R1-5a) sign or at locations on uncontrolled approaches where drivers are required by State law to yield to pedestrians.**

- 05 **Yield lines shall not be used at locations where drivers are required to stop in compliance with a STOP (R1-1) sign, a traffic control signal, or some other traffic control device.**

- 06 **Stop lines shall consist of solid white lines extending across approach lanes to indicate the point at which the stop is intended or required to be made.**

- 07 **Yield lines (see Figure 3B-16) shall consist of a row of solid white isosceles triangles pointing toward approaching vehicles extending across approach lanes to indicate the point at which the yield is intended or required to be made.**

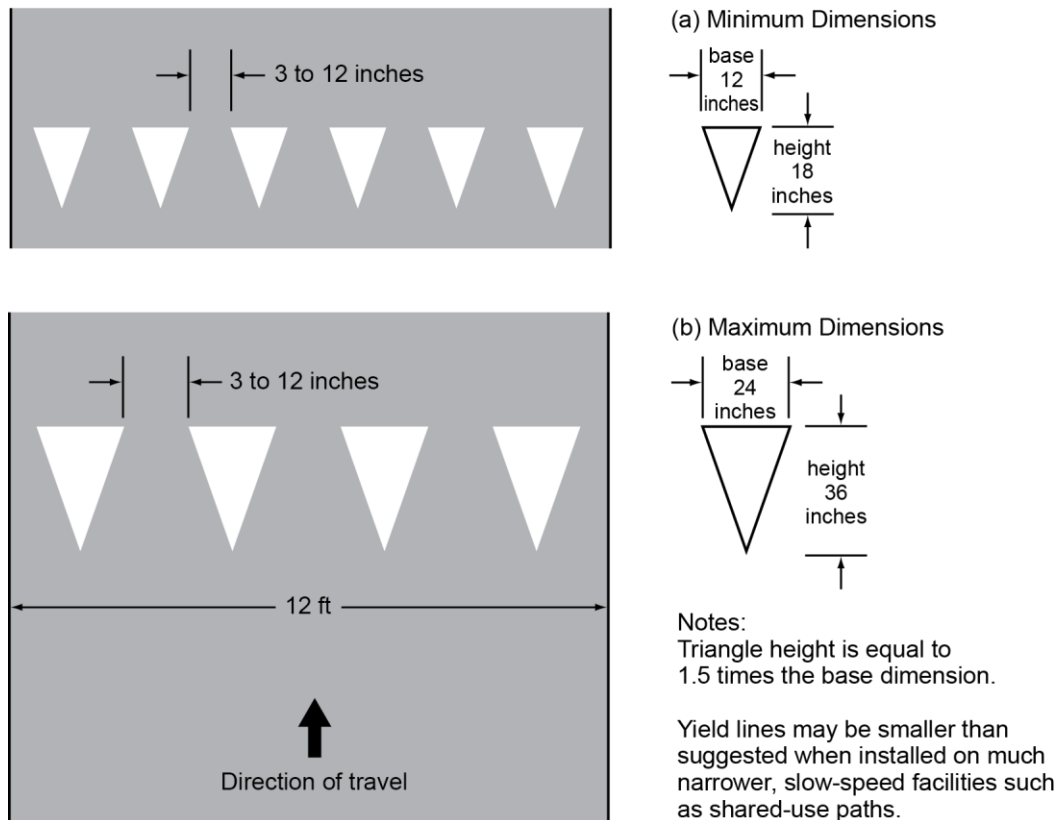
**Guidance:**

- 08 *Stop lines should be 12 to 24 inches wide.*

- 09 *The individual triangles comprising the yield line should have a base of 12 to 24 inches wide and a height equal to 1.5 times the base. The space between the triangles should be 3 to 12 inches.*

- 10 *If used, stop and yield lines should be placed a minimum of 4 feet in advance of the nearest crosswalk line at controlled intersections, except for yield lines at roundabouts as provided for in Section 3C.04 and at midblock crosswalks. In the absence of a marked crosswalk, the stop line or yield line should be placed at the desired stopping or yielding point, but should not be placed more than 30 feet or less than 4 feet from the nearest edge of the intersecting traveled way.*

- 11 *Stop lines at midblock signalized locations should be placed at least 40 feet in advance of the nearest signal indication (see Section 4D.14).*

**Figure 3B-16. Recommended Yield Line Layouts**

- 12 *If yield or stop lines are used at a crosswalk that crosses an uncontrolled multi-lane approach, the yield lines or stop lines should be placed 20 to 50 feet in advance of the nearest crosswalk line, and parking should be prohibited in the area between the yield or stop line and the crosswalk (see Figure 3B-17).*

**Standard:**

- 13 **If yield lines are used at a crosswalk that crosses an uncontrolled multi-lane approach, Yield Here To Pedestrians (R1-5 or R1-5a) signs (see Section 2B.11) shall be used.**

*Guidance:*

- 14 *Yield lines and Yield Here To Pedestrians signs should not be used in advance of crosswalks that cross an approach to or departure from a roundabout.*

**Support:**

- 15 When drivers yield or stop too close to crosswalks that cross uncontrolled multi-lane approaches, they place pedestrians at risk by blocking other drivers' views of pedestrians and by blocking pedestrians' views of vehicles approaching in the other lanes.

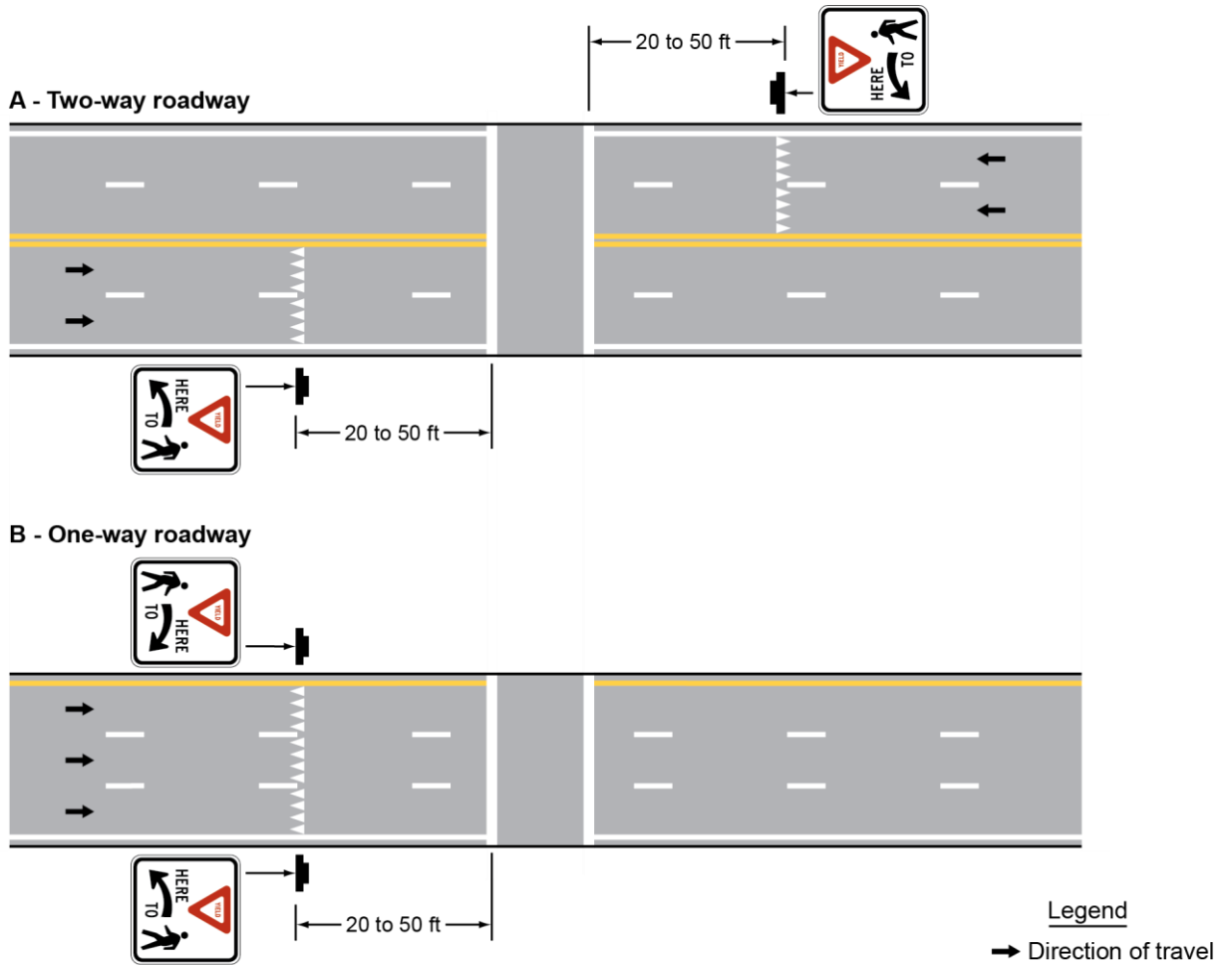
**Option:**

- 16 Stop and yield lines may be staggered longitudinally on a lane-by-lane basis (see Drawing D of Figure 3B-13).

**Support:**

- 17 Staggered stop lines and staggered yield lines can improve the driver's view of pedestrians, provide better sight distance for turning vehicles, and increase the turning radius for left-turning vehicles.
- 18 Section 8B.28 contains information regarding the use of stop lines and yield lines at grade crossings.

**Figure 3B-17. Examples of Yield Lines at Unsignalized Midblock Crosswalks**



**Section 3B.17 Do Not Block Intersection Markings**

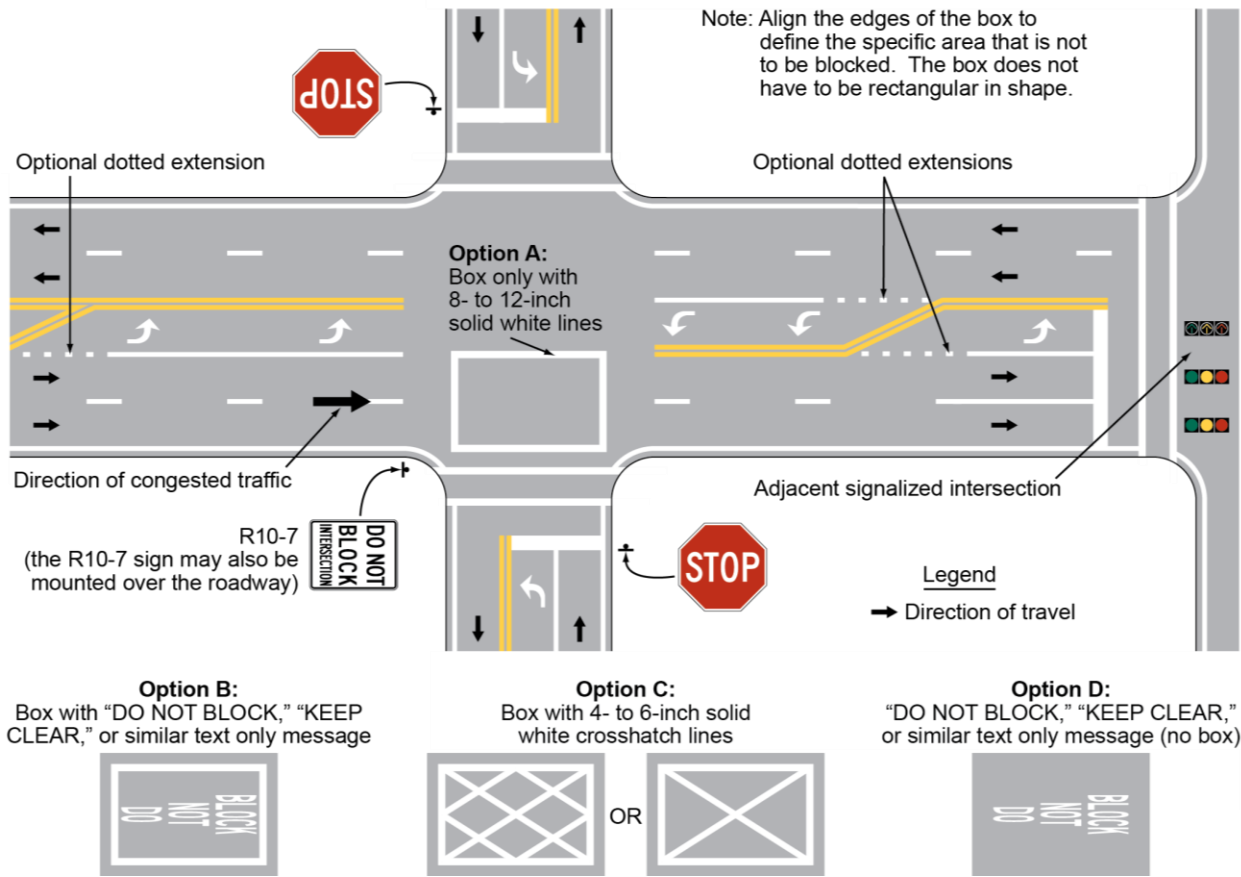
Option:

- 01 Do Not Block Intersection markings may be used to mark the edges of an intersection area that is in close proximity to a signalized intersection, railroad crossing, or other nearby traffic control that might cause vehicles to stop within the intersection and impede other traffic entering the intersection. If authorized by law, Do Not Block Intersection markings with appropriate signs may also be used at other locations.

**Standard:**

- 02 **If used, Do Not Block Intersection markings (see Figure 3B-18) shall consist of one of the following alternatives:**
  - A. Wide solid white lines that outline the intersection area that vehicles must not block;
  - B. Wide solid white lines that outline the intersection area that vehicles must not block and a white word message such as DO NOT BLOCK or KEEP CLEAR;
  - C. Wide solid white lines that outline the intersection area that vehicles must not block and white cross-hatching within the intersection area; or
  - D. A white word message, such as DO NOT BLOCK or KEEP CLEAR, within the intersection area that vehicles must not block.
- 03 **Do Not Block Intersection markings shall be accompanied by one or more DO NOT BLOCK INTERSECTION (DRIVEWAY) (CROSSING) (R10-7) signs (see Section 2B.53), one or more DO NOT STOP ON TRACKS (R8-8) signs (see Section 8B.09), or one or more similar signs.**

**Figure 3B-18. Do Not Block Intersection Markings**



**Section 3B.18 Crosswalk Markings**

Support:

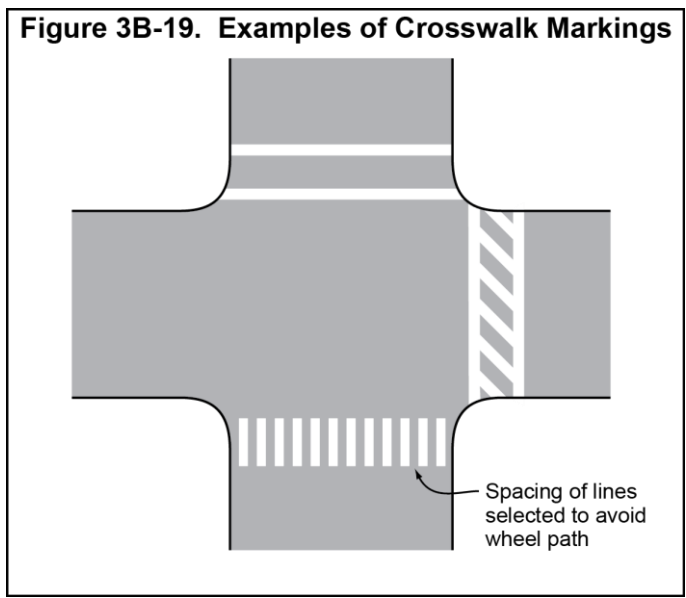
01 Crosswalk markings provide guidance for pedestrians who are crossing roadways by defining and delineating paths on approaches to and within signalized intersections, and on approaches to other intersections where traffic stops.

02 In conjunction with signs and other measures, crosswalk markings help to alert road users of a designated pedestrian crossing point across roadways at locations that are not controlled by traffic control signals or STOP or YIELD signs.

03 At non-intersection locations, crosswalk markings legally establish the crosswalk.

**Standard:**

04 **When crosswalk lines are used, they shall consist of solid white lines that mark the crosswalk. They shall be not less than 6 inches or greater than 24 inches in width.**



*Guidance:*

- 05 *If transverse lines are used to mark a crosswalk, the gap between the lines should not be less than 6 feet. If diagonal or longitudinal lines are used without transverse lines to mark a crosswalk, the crosswalk should be not less than 6 feet wide.*
- 06 *Crosswalk lines, if used on both sides of the crosswalk, should extend across the full width of pavement or to the edge of the intersecting crosswalk to discourage diagonal walking between crosswalks (see Figures 3B-17 and 3B-19).*
- 07 *At locations controlled by traffic control signals or on approaches controlled by STOP or YIELD signs, crosswalk lines should be installed where engineering judgment indicates they are needed to direct pedestrians to the proper crossing path(s).*
- 08 *Crosswalk lines should not be used indiscriminately. An engineering study should be performed before a marked crosswalk is installed at a location away from a traffic control signal or an approach controlled by a STOP or YIELD sign. The engineering study should consider the number of lanes, the presence of a median, the distance from adjacent signalized intersections, the pedestrian volumes and delays, the average daily traffic (ADT), the posted or statutory speed limit or 85th-percentile speed, the geometry of the location, the possible consolidation of multiple crossing points, the availability of street lighting, and other appropriate factors.*
- 09 *New marked crosswalks alone, without other measures designed to reduce traffic speeds, shorten crossing distances, enhance driver awareness of the crossing, and/or provide active warning of pedestrian presence, should not be installed across uncontrolled roadways where the speed limit exceeds 40 mph and either:*
- A. *The roadway has four or more lanes of travel without a raised median or pedestrian refuge island and an ADT of 12,000 vehicles per day or greater; or*
  - B. *The roadway has four or more lanes of travel with a raised median or pedestrian refuge island and an ADT of 15,000 vehicles per day or greater.*

*Support:*

- 10 Chapter 4F contains information on Pedestrian Hybrid Beacons. Section 4L.03 contains information regarding Warning Beacons to provide active warning of a pedestrian's presence. Section 4N.02 contains information regarding In-Roadway Warning Lights at crosswalks. Chapter 7D contains information regarding school crossing supervision.

*Guidance:*

- 11 Because non-intersection pedestrian crossings are generally unexpected by the road user, warning signs (see Section 2C.50) should be installed for all marked crosswalks at non-intersection locations and adequate visibility should be provided by parking prohibitions.

*Support:*

- 12 Section 3B.16 contains information regarding placement of stop line markings near crosswalk markings.

*Option:*

- 13 For added visibility, the area of the crosswalk may be marked with white diagonal lines at a 45-degree angle to the line of the crosswalk or with white longitudinal lines parallel to traffic flow as shown in Figure 3B-19.
- 14 When diagonal or longitudinal lines are used to mark a crosswalk, the transverse crosswalk lines may be omitted. This type of marking may be used at locations where substantial numbers of pedestrians cross without any other traffic control device, at locations where physical conditions are such that added visibility of the crosswalk is desired, or at places where a pedestrian crosswalk might not be expected.

*Guidance:*

- 15 *If used, the diagonal or longitudinal lines should be 10 to 24 inches wide and separated by gaps of 12 to 60 inches. The design of the lines and gaps should avoid the wheel paths if possible, and the gap between the lines should not exceed 2.5 times the width of the diagonal or longitudinal lines.*

**Option:**

- 16 When an exclusive pedestrian phase that permits diagonal crossing of an intersection is provided at a traffic control signal, a marking as shown in Figure 3B-20 may be used for the crosswalk.

**Guidance:**

- 17 *Crosswalk markings should be located so that the curb ramps are within the extension of the crosswalk markings.*

**Support:**

- 18 Detectable warning surfaces mark boundaries between pedestrian and vehicular ways where there is no raised curb.

Detectable warning surfaces are required by 49 CFR, Part 37 and by the Americans with Disabilities Act (ADA) where curb ramps are constructed at the junction of sidewalks and the roadway, for marked and unmarked crosswalks. Detectable warning surfaces

contrast visually with adjacent walking surfaces, either light-on-dark, or dark-on-light. The “Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)” (see Section 1A.11) contains specifications for design and placement of detectable warning surfaces.

**Section 3B.19 Parking Space Markings****Support:**

- 01 Marking of parking space boundaries encourages more orderly and efficient use of parking spaces where parking turnover is substantial. Parking space markings tend to prevent encroachment into fire hydrant zones, bus stops, loading zones, approaches to intersections, curb ramps, and clearance spaces for islands and other zones where parking is restricted. Examples of parking space markings are shown in Figure 3B-21.

**Standard:**

- 02 **Parking space markings shall be white and not less than 4 inches, nor more than 6 inches wide.**

**Guidance:**

- 03 *Where angle parking is permitted under Section 4511.69 of the Ohio Revised Code (see Appendix B2), the stalls should be marked with a series of solid lines spaced not less than 8.5 feet apart and placed at the desired angle.*

**Option:**

- 04 Blue lines may supplement white parking space markings of each parking space designated for use only by persons with disabilities.

**Support:**

- 05 Additional parking space markings for the purpose of designating spaces for use only by persons with disabilities are discussed in Section 3B.20 and illustrated in Figure 3B-22. The design and layout of accessible parking spaces for persons with disabilities is provided in the “Americans with Disabilities Act Accessibility Guidelines (ADAAG)” (see Section 1A.11).

**Section 3B.20 Pavement Word, Symbol, and Arrow Markings****Support:**

- 01 Word, symbol, and arrow markings on the pavement are used for the purpose of guiding, warning, or regulating traffic. These pavement markings can be helpful to road users in some locations by supplementing signs and providing additional emphasis for important regulatory, warning, or guidance messages, because

**Figure 3B-20. Example of Crosswalk Markings for an Exclusive Pedestrian Phase that Permits Diagonal Crossing**

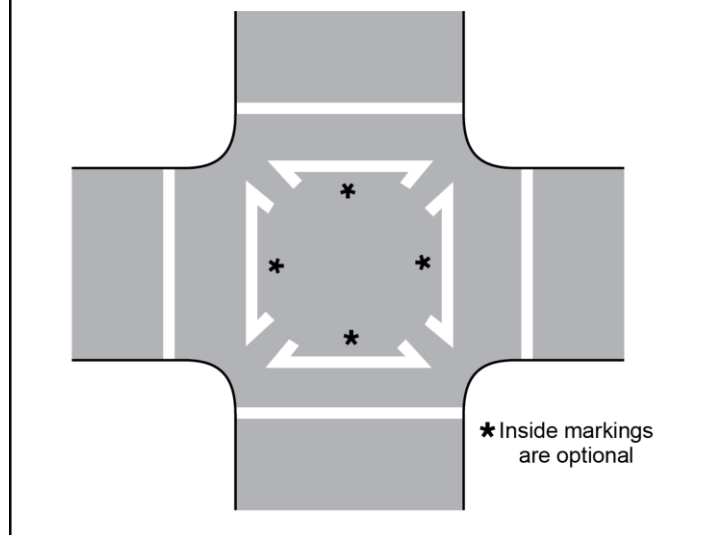
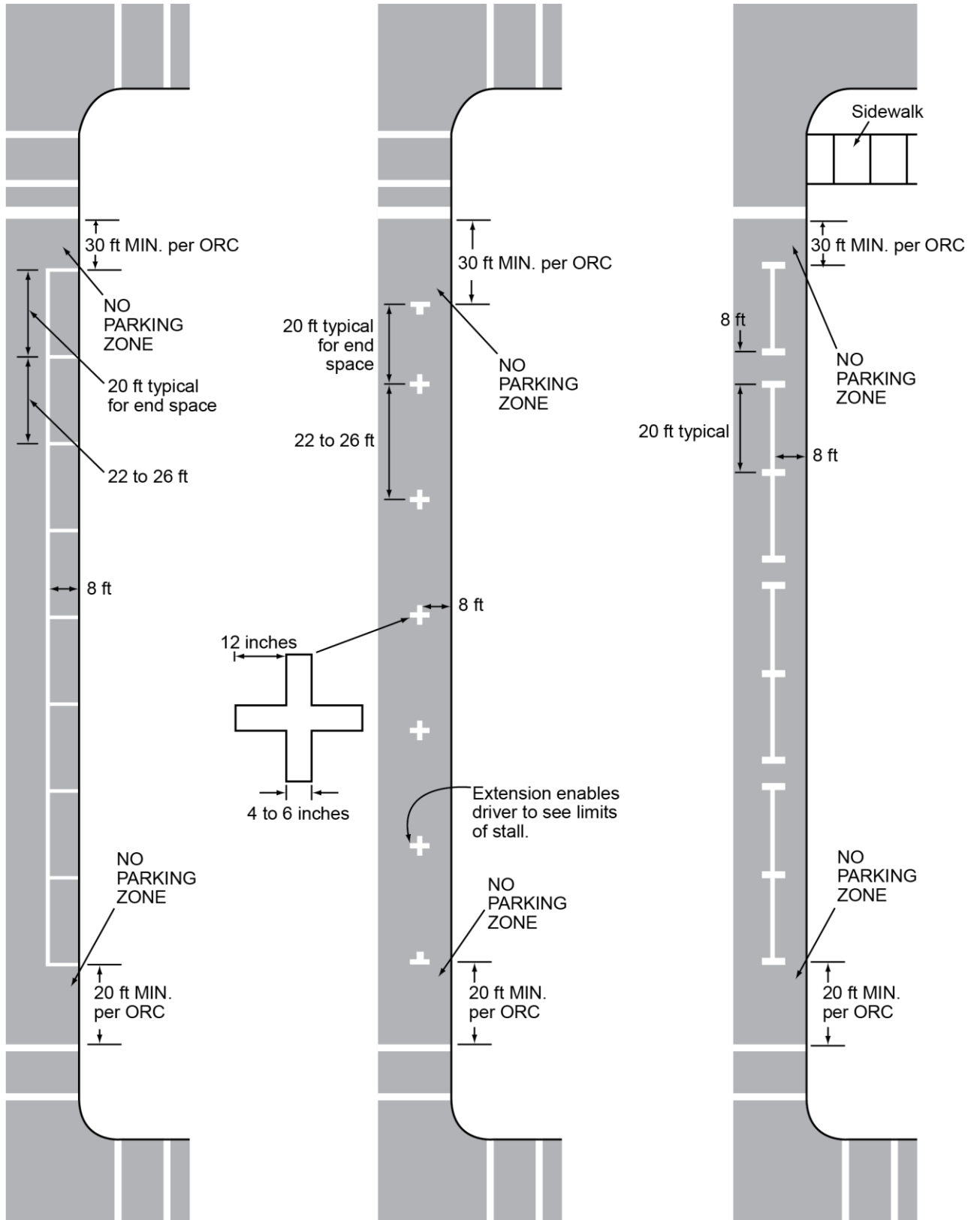




Figure 3B-21. Examples of Parking Space Markings



the markings do not require diversion of the road user's attention from the roadway surface. Symbol messages are preferable to word messages. Examples of standard word and arrow pavement markings are shown in Figures 3B-23 and 3B-24.

Option:

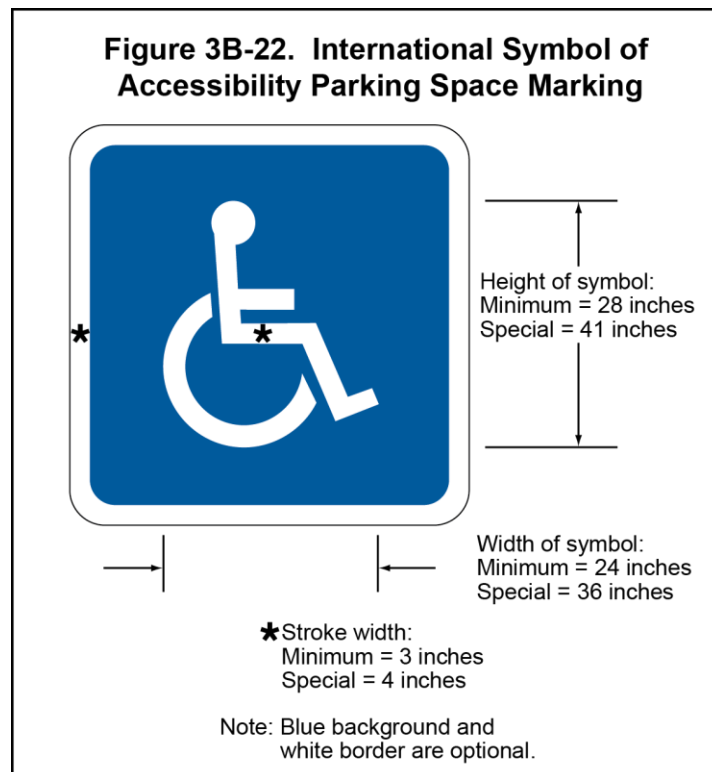
- 02 Word, symbol, and arrow markings, including those contained in the "Sign Designs and Markings Manual" (SDMM) (see Section 1A.11), may be used as determined by engineering judgment to supplement signs and/or to provide additional emphasis for regulatory, warning, or guidance messages. Among the word, symbol, and arrow markings that may be used are the following.
- A. Regulatory:
    1. STOP
    2. YIELD
    3. RIGHT (LEFT) TURN ONLY
    4. 25 MPH
    5. Lane-use and wrong-way arrows
    6. Diamond symbol for HOV lanes
    7. Other preferential lane word markings
  - B. Warning:
    1. STOP AHEAD
    2. YIELD AHEAD
    3. YIELD AHEAD Triangle Symbol
    4. SCHOOL XING
    5. SIGNAL AHEAD
    6. PED XING
    7. SCHOOL
    8. R X R
    9. BUMP
    10. HUMP
    11. Lane-reduction arrows
  - C. Guide:
    1. Route numbers (route shield pavement marking symbols and/or words such as I-81, US 40, STATE 135, or ROUTE 10)
    2. Cardinal directions (NORTH, SOUTH, EAST, or WEST)
    3. TO
    4. Destination names or abbreviations thereof

**Standard:**

- 03 **Word, symbol, and arrow markings shall be white, except as otherwise provided in this Section.**
- 04 **Pavement marking letters, numerals, symbols, and arrows shall be installed in accordance with the design details in the Pavement Markings chapter of the "Sign Designs and Markings Manual" (SDMM) (see Section 1A.11).**

*Guidance:*

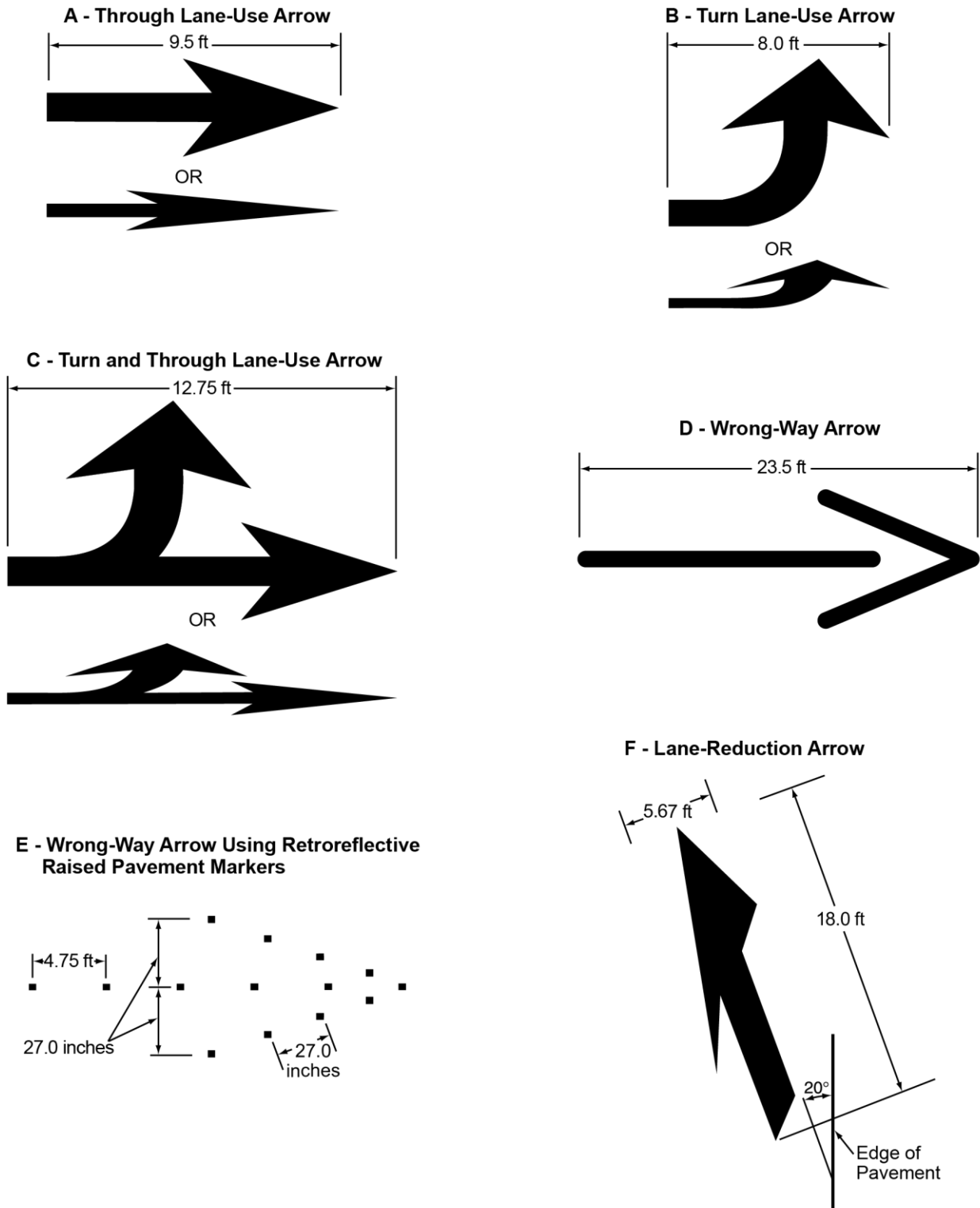
- 05 *Letters and numerals should be 6 feet or more in height.*
- 06 *Word and symbol markings should not exceed three lines of information.*



**Figure 3B-23. Example of Elongated Letters for Word Pavement Markings**

- 07 *If a pavement marking word message consists of more than one line of information, it should read in the direction of travel. The first word of the message should be nearest to the road user.*
- 08 *Except for the two opposing arrows of a two-way left-turn lane marking (see Figure 3B-7), the longitudinal space between word or symbol message markings, including arrow markings, should be at least four times the height of the characters for low-speed roads, but not more than ten times the height of the characters under any conditions.*
- 09 *The number of different word and symbol markings used should be minimized to provide effective guidance and avoid misunderstanding.*
- 10 *Except for the SCHOOL word marking (see Section 7C.03), pavement word, symbol, and arrow markings should be no more than one lane in width.*
- 11 *Pavement word, symbol, and arrow markings should be proportionally scaled to fit within the width of the facility upon which they are applied.*
- Option:
- 12 *On narrow, low-speed shared-use paths, the pavement words, symbols, and arrows may be smaller than suggested, but to the relative scale.*
- 13 *Pavement markings simulating Interstate, U.S., State, and other official highway route shield signs (see Figure 2D-3) with appropriate route numbers, but elongated for proper proportioning when viewed as a marking, may be used to guide road users to their destinations (see Figure 3B-25).*
- Standard:**
- 14 **Except at the ends of aisles in parking lots, the word STOP shall not be used on the pavement unless accompanied by a stop line (see Section 3B.16) and STOP sign (see Section 2B.05). At the ends of aisles in parking lots, the word STOP shall not be used on the pavement unless accompanied by a stop line.**
- 15 **The word STOP shall not be placed on the pavement in advance of a stop line, unless every vehicle is required to stop at all times.**
- Option:
- 16 *A yield-ahead triangle symbol (see Figure 3B-26) or YIELD AHEAD word pavement marking may be used on approaches to intersections where the approaching traffic will encounter a YIELD sign at the intersection.*

**Figure 3B-24. Examples of Standard Arrows for Pavement Markings**



**Notes:**

1. Typical sizes for normal installation; sizes may be reduced approximately one-third for low-speed urban conditions; larger sizes may be needed for freeways, above average speeds, and other critical locations.
2. The narrow elongated arrow designs shown in Drawings A, B, and C are optional.
3. For proper proportion, see the Pavement Markings information in the "Sign Designs and Markings Manual" (SDMM) (see Section 1A.11).

**Standard:**

- 17 **The yield-ahead triangle symbol or YIELD AHEAD word pavement marking shall not be used unless a YIELD sign (see Section 2B.08) is in place at the intersection. The yield-ahead symbol marking shall be as shown in Figure 3B-26.**

*Guidance:*

- 18 *The International Symbol of Accessibility parking space marking (see Figure 3B-22) should be placed in each parking space designated for use by persons with disabilities.*

*Option:*

- 19 A blue background with white border may supplement the wheelchair symbol as shown in Figure 3B-22.

*Support:*

- 20 Lane-use arrow markings (see Figure 3B-24) are used to indicate the mandatory or permissible movements in certain lanes (see Figure 3B-27) and in two-way left-turn lanes (see Figure 3B-7).

*Guidance:*

- 21 *Lane-use arrow markings (see Figure 3B-24) should be used in lanes designated for the exclusive use of a turning movement, including turn bays, except where engineering judgment determines that physical conditions or other markings (such as a dotted extension of the lane line through the taper into the turn bay) clearly discourage unintentional use of a turn bay by through vehicles. Lane-use arrow markings should also be used in lanes from which movements are allowed that are contrary to the normal rules of the road (see Drawing B of Figure 3B-13). When used in turn lanes, at least two arrows should be used, one at or near the upstream end of the full-width turn lane and one an appropriate distance upstream from the stop line or intersection (see Drawing A of Figure 3B-11).*

*Option:*

- 22 An additional arrow or arrows may be used in a turn lane. When arrows are used for a short turn lane, the second (downstream) arrow may be omitted based on engineering judgment.

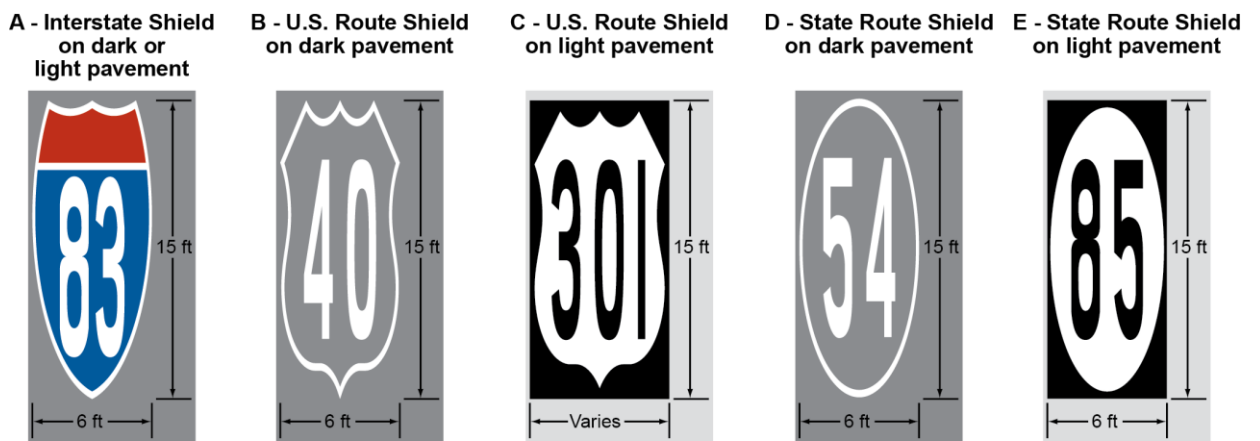
*Guidance:*

- 23 *Where opposing offset channelized left-turn lanes exist, lane-use arrow markings should be placed near the downstream terminus of the offset left-turn lanes to reduce wrong-way movements (see Figure 2B-17).*

*Support:*

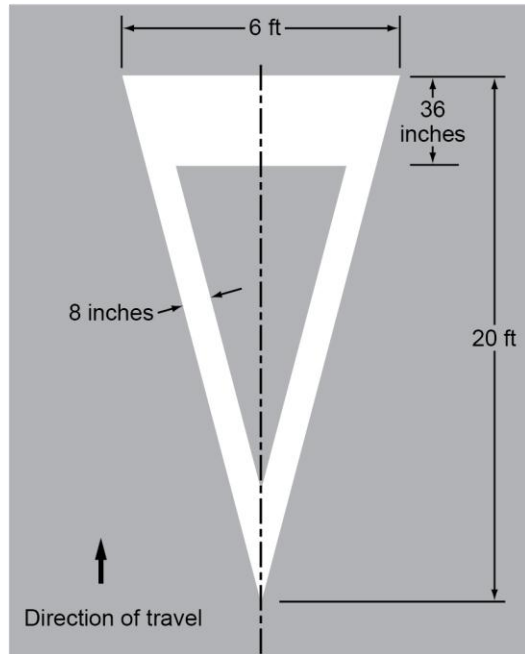
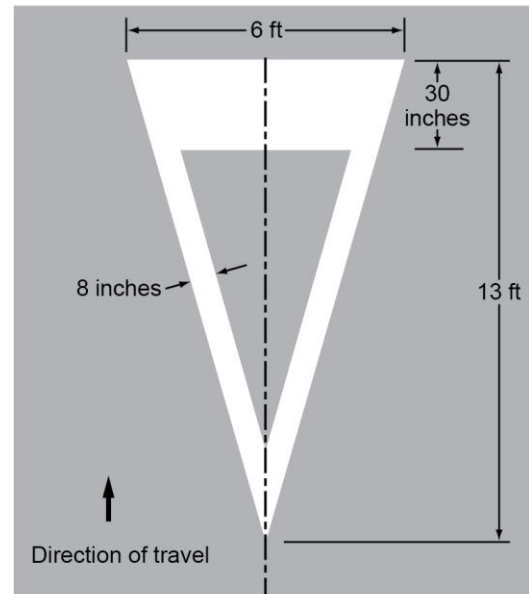
- 24 An arrow at the downstream end of a turn lane can help to prevent wrong way movements.

**Figure 3B-25. Examples of Elongated Route Shields for Pavement Markings**



**Notes:**

1. See the "Sign Designs and Markings Manual" (SDMM) (see Section 1A.11) for other sizes and details.
2. Colors and elongated shapes simulating State route shield signs may be used for route shield pavement markings where appropriate.

**Figure 3B-26. Yield Ahead Triangle Symbols****A - Posted or Statutory Speed Limit of 45 mph or greater****B - Posted or Statutory Speed Limit of less than 45 mph****Standard:**

- 25 **Where through lanes approaching an intersection become mandatory turn lanes, lane-use arrow markings (see Figure 3B-24) shall be used and shall be accompanied by standard signs.**

*Guidance:*

- 26 *Where through lanes approaching an intersection become mandatory turn lanes, ONLY word markings (see Figure 3B-23) should be used in addition to the required lane-use arrow markings and signs (see Sections 2B.19 and 2B.20). These markings and signs should be placed well in advance of the turn and should be repeated as necessary to prevent entrapment and to help the road user select the appropriate lane in advance of reaching a queue of waiting vehicles (see Drawing A of Figure 3B-11).*

**Option:**

- 27 On freeways or expressways where a through lane becomes a mandatory exit lane, lane-use arrow markings may be used on the approach to the exit in the dropped lane and in an adjacent optional through-or-exit lane if one exists.

*Guidance:*

- 28 *A two-way left-turn lane-use arrow pavement marking, with opposing arrows spaced as shown in Figure 3B-7, should be used at or just downstream from the beginning of a two-way left-turn lane.*

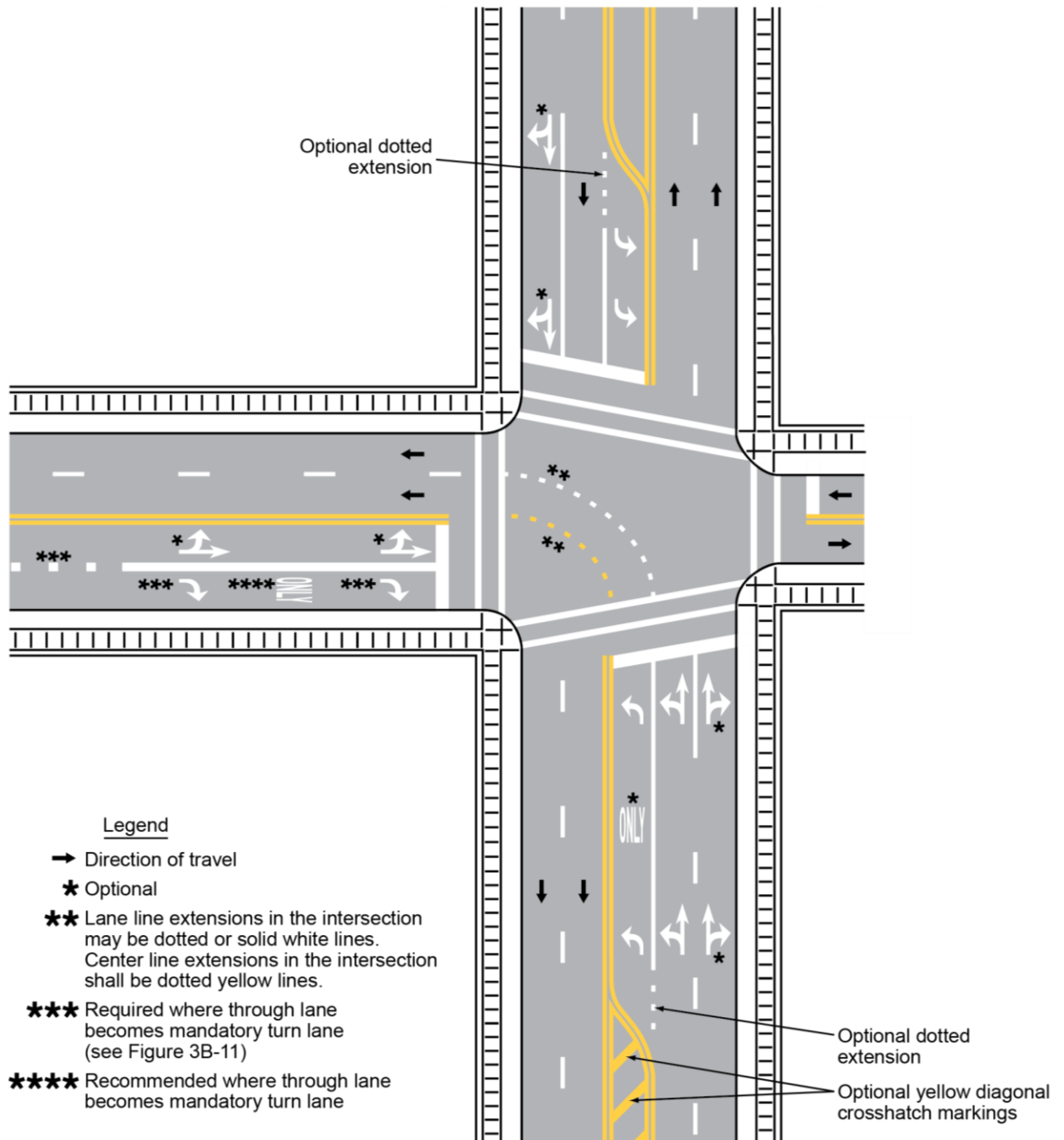
**Option:**

- 29 Additional two-way left-turn lane-use arrow markings may be used at other locations along a two-way left-turn lane where engineering judgment determines that such additional markings are needed to emphasize the proper use of the lane.

**Standard:**

- 30 **A single-direction lane-use arrow shall not be used in a lane bordered on both sides by yellow two-way left-turn lane longitudinal markings.**
- 31 **Lane-use, lane-reduction, and wrong-way arrow markings shall be designed as shown in Figure 3B-24 and in the “Sign Designs and Markings Manual” (SDMM) (see Section 1A.11).**

**Figure 3B-27. Examples of Lane Use Control Word and Symbol Markings**



**Option:**

32 The ONLY word marking (see Figure 3B-23) may be used to supplement the lane-use arrow markings in lanes that are designated for the exclusive use of a single movement (see Figure 3B-27) or to supplement a preferential lane word or symbol marking (see Section 3D.01).

**Standard:**

33 **The ONLY word marking shall not be used in a lane that is shared by more than one movement.**

**Guidance:**

34 Where a lane reduction transition occurs on a roadway with a speed limit of 45 mph or more, the lane reduction arrow markings (Drawing F in Figure 3B-24) should be used (see Figure 3B-14). Except for

*acceleration lanes, where a lane-reduction transition occurs on a roadway with a speed limit of less than 45 mph, lane-reduction arrow markings should be used if determined to be appropriate based on engineering judgment.*

Option:

35 Lane-reduction arrow markings may be used in long acceleration lanes based on engineering judgment.

Guidance:

36 *Where crossroad channelization or ramp geometrics do not make wrong-way movements difficult, the appropriate lane-use arrow should be placed in each lane of an exit ramp near the crossroad terminal where it will be clearly visible to a potential wrong-way road user (see Figure 2B-18).*

Option:

37 The wrong-way arrow markings shown in Drawing D in Figure 3B-24 may be placed near the downstream terminus of a ramp as shown in Figures 2B-18 and 2B-19, or at other locations where lane-use arrows are not appropriate, to indicate the correct direction of traffic flow and to discourage drivers from traveling in the wrong direction.

### **Section 3B.21 Speed Measurement Markings**

Support:

01 A speed measurement marking is a transverse marking placed on the roadway to assist the enforcement of speed regulations.

**Standard:**

02 **Speed measurement markings, if used, shall be white, and shall not be greater than 24 inches in width.**

Option:

03 Speed measurement markings may extend 24 inches on either side of the center line or 24 inches on either side of edge line markings at 1/4 mile intervals over a 1-mile length of roadway. When paved shoulders of sufficient width are available, the speed measurement markings may be placed entirely on these shoulders (see Drawing A of Figure 3B-10). Advisory signs such as SPEED ENFORCED BY AIRCRAFT (R2-H15) may be used in conjunction with these markings.

### **Section 3B.22 Speed Reduction Markings**

Support:

01 Speed reduction markings (see Figure 3B-28) are transverse markings that are placed on the roadway within a lane (along both edges of the lane) in a pattern of progressively reduced spacing to give drivers the impression that their speed is increasing. These markings might be placed in advance of an unexpectedly severe horizontal or vertical curve or other roadway feature where drivers need to decelerate prior to reaching the feature and where the desired reduction in speeds has not been achieved by the installation of warning signs and/or other traffic control devices.

Guidance:

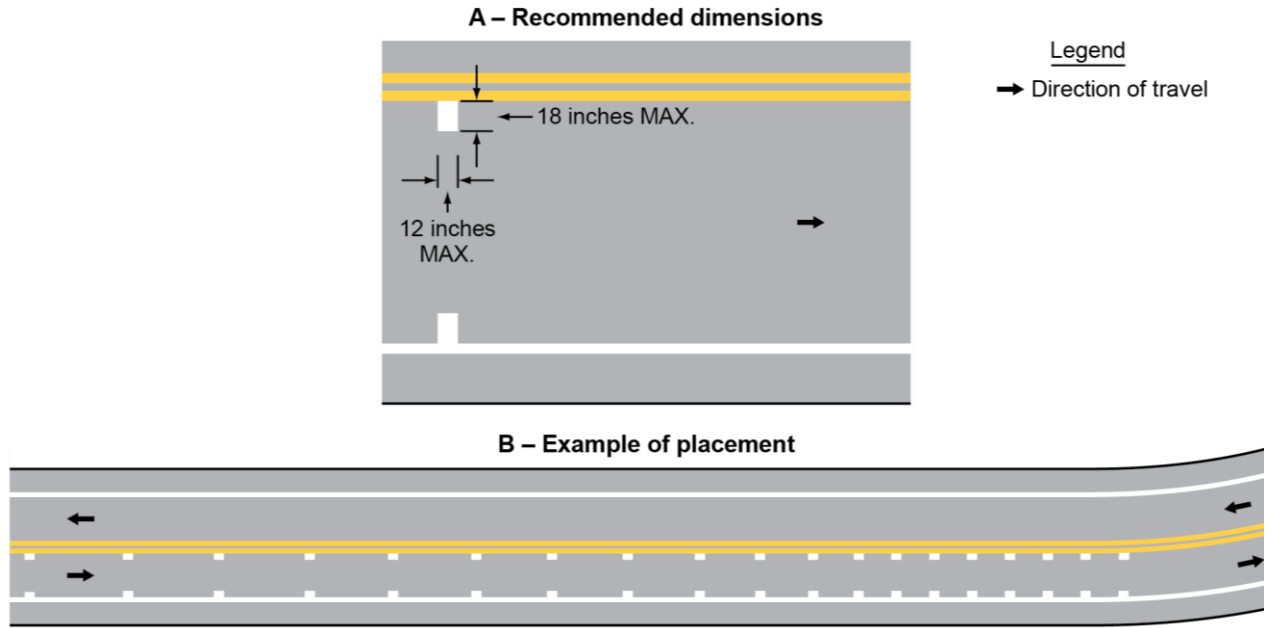
02 *If used, speed reduction markings should be reserved for unexpected curves and should not be used on long tangent sections of roadway or in areas frequented mainly by local or familiar drivers, (e.g., school zones). If used, speed reduction markings should supplement the appropriate warning signs and other traffic control devices and should not substitute for these devices.*

**Standard:**

03 **If used, speed reduction markings shall be a series of white transverse lines on both sides of the lane that are perpendicular to the center line, edge line, or lane line. The longitudinal spacing between the markings shall be progressively reduced from the upstream to the downstream end of the marked portion of the lane.**



**Figure 3B-28. Example of the Application of Speed Reduction Markings**



*Guidance:*

- 04 *Speed reduction markings should not be greater than 12 inches in width, and should not extend more than 18 inches into the lane.*

**Standard:**

- 05 **Speed reduction markings shall not be used in lanes that do not have a longitudinal line (center line, edge line, or lane line) on both sides of the lane.**

**Section 3B.23 Curb Markings**

*Support:*

- 01 Curb markings are most often used to indicate parking regulations or to delineate the curb.

**Standard:**

- 02 **Where curbs are marked to convey parking regulations in areas where curb markings are frequently obscured by snow and ice accumulation, signs shall be used with the curb markings except as provided in Paragraph 4.**

*Guidance:*

- 03 *Except as provided in Paragraph 4, when curb markings are used without signs to convey parking regulations, a legible word marking regarding the regulation (such as “No Parking” or “No Standing”) should be placed on the curb.*

*Option:*

- 04 Curb markings without word markings or signs may be used to convey a general prohibition by statute of parking within a specified distance of a STOP sign, YIELD sign, driveway, fire hydrant, or crosswalk.
- 05 Local highway agencies may prescribe special colors for curb markings to supplement standard signs for parking regulation.

*Support:*

- 06 Since yellow and white curb markings are frequently used for curb delineation and visibility, it is advisable to establish parking regulations through the installation of standard signs (see Sections 2B.46 through 2B.48).

**Standard:**

- 07 **Where curbs are marked for delineation or visibility purposes, the colors shall comply with the general principles of markings (see Section 3A.05).**

*Guidance:*

- 08 *Retroreflective solid yellow markings should be placed on the approach ends of raised medians and curbs of islands that are located in the line of traffic flow where the curb serves to channel traffic to the right of the obstruction.*

- 09 *Retroreflective solid white markings should be used when traffic is permitted to pass on either side of the island.*

**Support:**

- 10 Where the curbs of the islands become parallel to the direction of traffic flow, it is not necessary to mark the curbs unless an engineering study indicates the need for this type of delineation.

- 11 Curbs at openings in a continuous median island need not be marked unless an engineering study indicates the need for this type of marking.

**Option:**

- 12 Retroreflective or internally illuminated raised pavement markers of the appropriate color may be placed on the pavement in front of the curb and/or on the top of curbed noses of raised medians and curbs of islands, as a supplement to or substitute for retroreflective curb markings used for delineation.

**Section 3B.24 Chevron and Diagonal Crosshatch Markings****Option:**

- 01 Chevron and diagonal crosshatch markings may be used to discourage travel on certain paved areas, such as shoulders, gore areas, flush median areas between solid double yellow center line markings or between white channelizing lines approaching obstructions in the roadway (see Section 3B.10 and Figure 3B-15), between solid double yellow center line markings forming flush medians or channelized travel paths at intersections (see Figures 3B-2 and 3B-5), buffer spaces between preferential lanes and general-purpose lanes (see Figures 3D-2 and 3D-4), and at grade crossings (see Part 8).

**Standard:**

- 02 **When crosshatch markings are used in paved areas that separate traffic flows in the same general direction, they shall be white and they shall be shaped as chevron markings, with the point of each chevron facing toward approaching traffic, as shown in Figure 3B-8, Drawing A of Figure 3B-9, Figure 3B-10, and Drawing C of Figure 3B-15.**

- 03 **When crosshatch markings are used in paved areas that separate opposing directions of traffic, they shall be yellow diagonal markings that slant away from traffic in the adjacent travel lanes, as shown in Figures 3B-2 and 3B-5 and Drawings A and B of Figure 3B-15.**

- 04 **When crosshatch markings are used on paved shoulders, they shall be diagonal markings that slant away from traffic in the adjacent travel lane. The diagonal markings shall be yellow when used on the left-hand shoulders of the roadways of divided highways and on the left-hand shoulders of one-way streets or ramps. The diagonal markings shall be white when used on right-hand shoulders.**

*Guidance:*

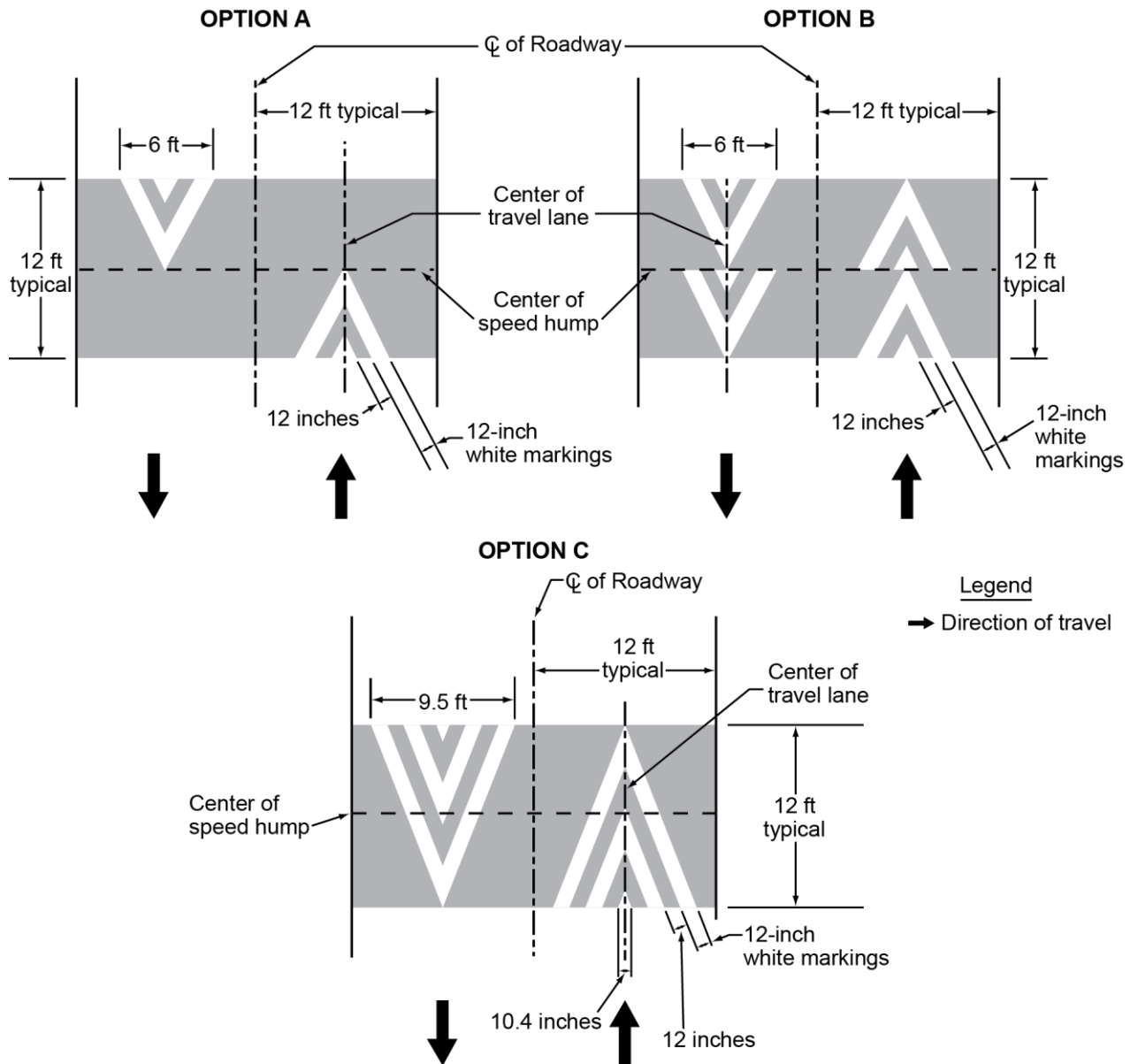
- 05 *The chevrons and diagonal lines used for crosshatch markings should be at least 12 inches wide for roadways having a posted or statutory speed limit of 45 mph or greater, and at least 8 inches wide for roadways having posted or statutory speed limit of less than 45 mph. The longitudinal spacing of the chevrons or diagonal lines should be determined by engineering judgment considering factors such as speeds and desired visual impacts. The chevrons and diagonal lines should form an angle of approximately 30 to 45 degrees with the longitudinal lines that they intersect.*

**Section 3B.25 Speed Hump Markings**

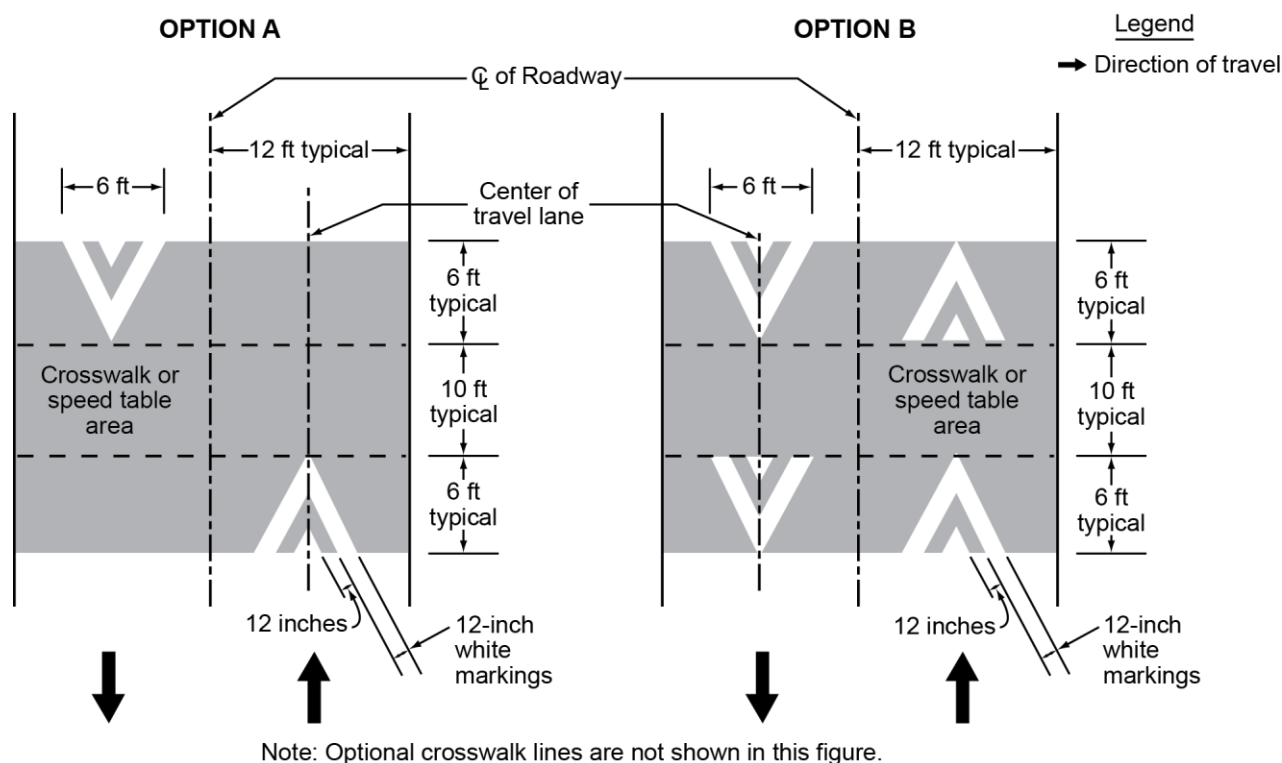
**Standard:**

- 01 If speed hump markings are used, they shall be a series of white markings placed on a speed hump to identify its location. If markings are used for a speed hump that does not also function as a crosswalk or speed table, the markings shall comply with Option A, B, or C shown in Figure 3B-29. If markings are used for a speed hump that also functions as a crosswalk or speed table, the markings shall comply with Option A or B shown in Figure 3B-30.

**Figure 3B-29. Pavement Markings for Speed Humps without Crosswalks**



**Figure 3B-30. Pavement Markings for Speed Tables or Speed Humps with Crosswalks**



### Section 3B.26 Advance Speed Hump Markings

Option:

- 01 Advance speed hump markings (see Figure 3B-31) may be used in advance of speed humps or other engineered vertical roadway deflections such as dips where added visibility is desired or where such deflection is not expected.
- 02 Advance pavement wording such as BUMP or HUMP (see Section 3B.20) may be used on the approach to a speed hump either alone or in conjunction with advance speed hump markings. Appropriate advance warning signs may be used in compliance with Section 2C. 29.

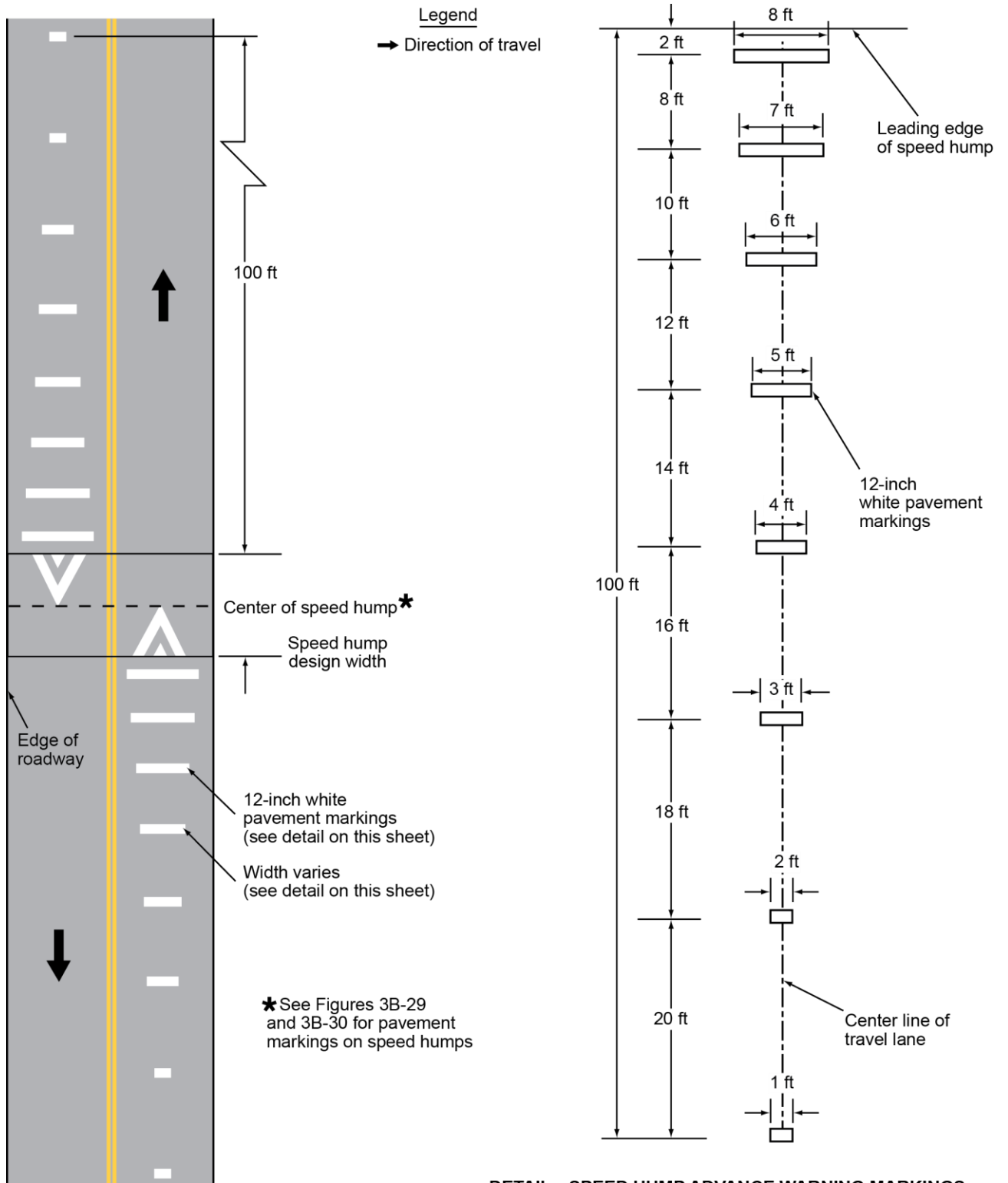
**Standard:**

- 03 **If advance speed hump markings are used, they shall be a series of eight white 12-inch transverse lines that become longer and are spaced closer together as the vehicle approaches the speed hump or other deflection. If advance markings are used, they shall comply with the detailed design shown in Figure 3B-31.**

*Guidance:*

- 04 *If used, advance speed hump markings should be installed in each approach lane.*

**Figure 3B-31. Advance Warning Markings for Speed Humps**





## CHAPTER 3C. ROUNDABOUT MARKINGS

### Section 3C.01 General

#### Support:

- 01 A roundabout (see definition in Section 1A.13) is a specific type of circular intersection designed to control speeds and having specific traffic control features.

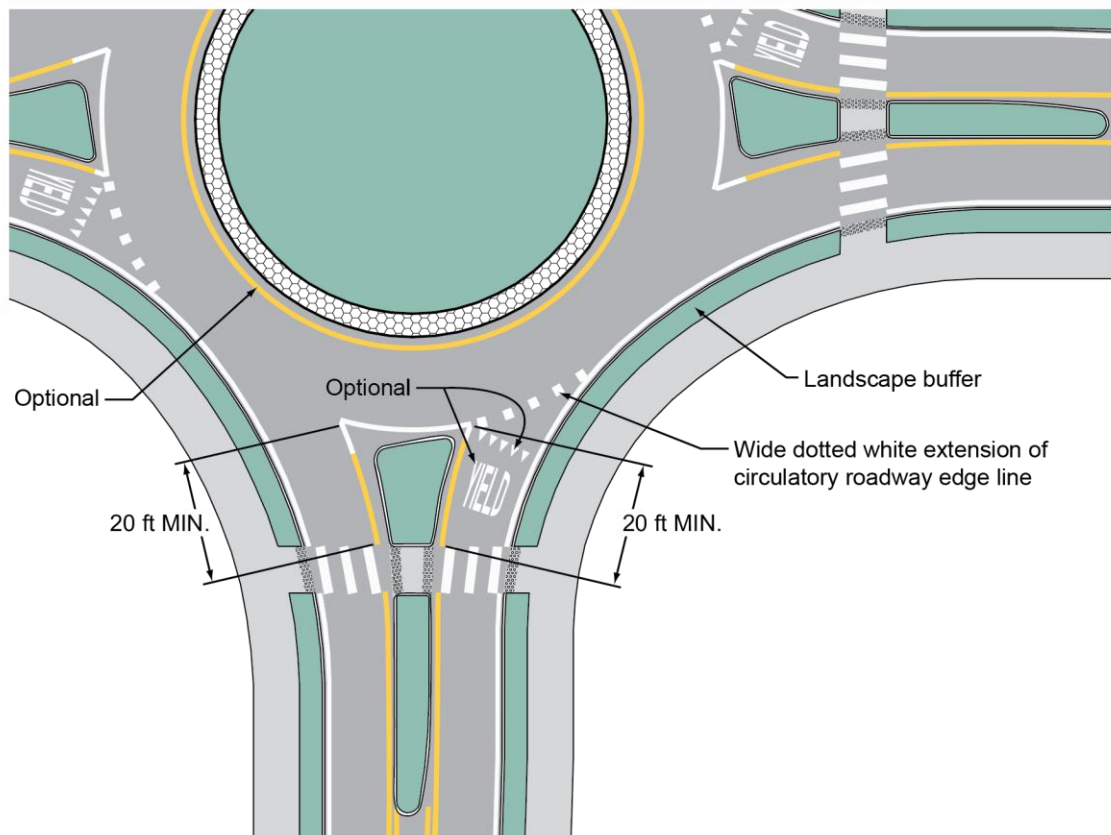
#### Guidance:

- 02 *Pavement markings and signing for a roundabout should be integrally designed to correspond to the geometric design and intended lane use of a roundabout.*
- 03 *Markings on the approaches to a roundabout and on the circular roadway should be compatible with each other to provide a consistent message to road users and should facilitate movement through the roundabout such that vehicles do not have to change lanes within the circulatory roadway in order to exit the roundabout in a given direction.*

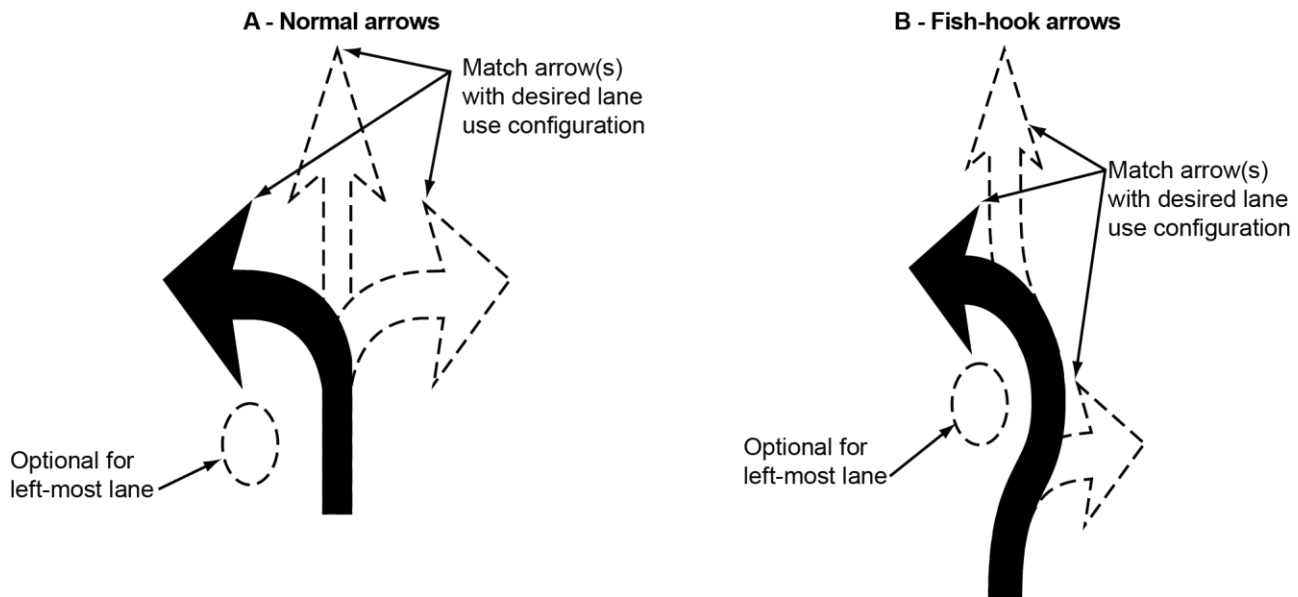
#### Support:

- 04 Figure 3C-1 provides an example of the pavement markings for approach and circulatory roadways at a roundabout. Figure 3C-2 shows the options that are available for lane-use pavement marking arrows on approaches to roundabouts. Figures 3C-3 through 3C-14 illustrate examples of markings for roundabouts of various geometric and lane-use configurations.
- 05 Traffic control signals or pedestrian hybrid beacons (see Part 4) are sometimes used at roundabouts to facilitate the crossing of pedestrians or to meter traffic.
- 06 Section 8C.12 contains information about roundabouts that contain or are in close proximity to grade crossings.

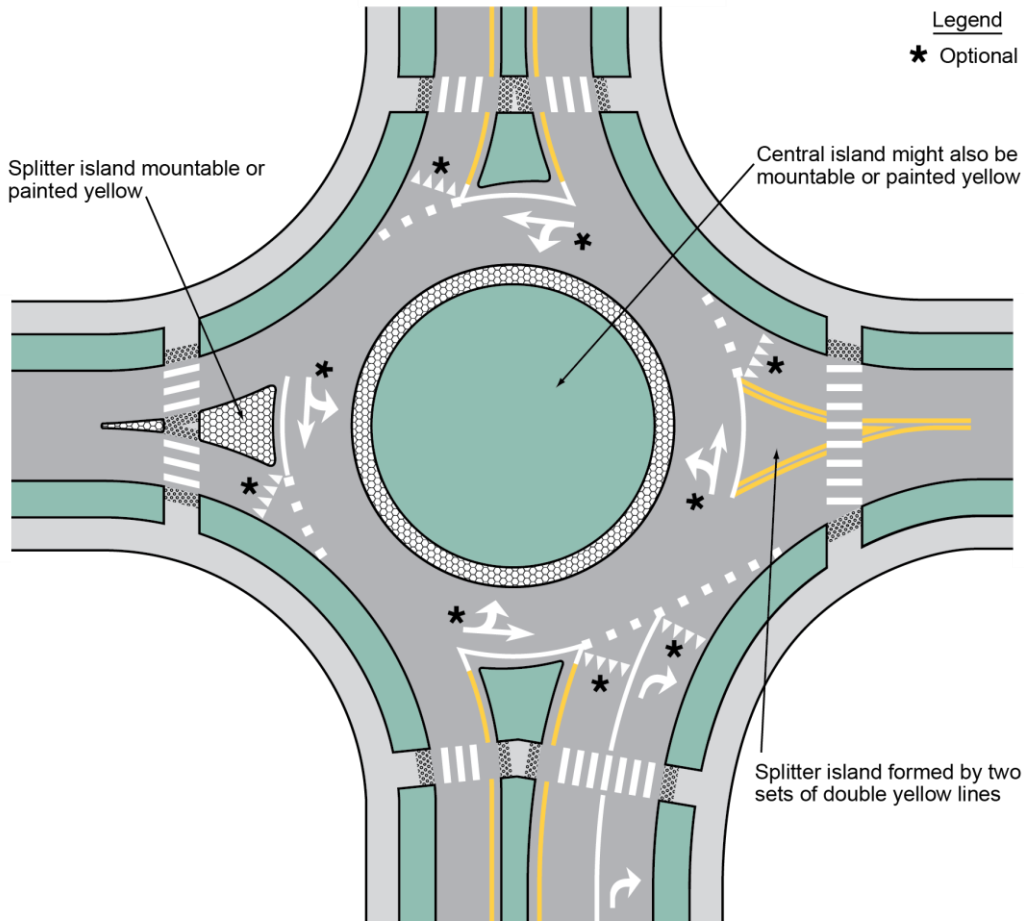
**Figure 3C-1. Example of Markings for Approach and Circulatory Roadways at a Roundabout**



**Figure 3C-2. Lane-Use Arrow Pavement Marking Options for Roundabout Approaches**

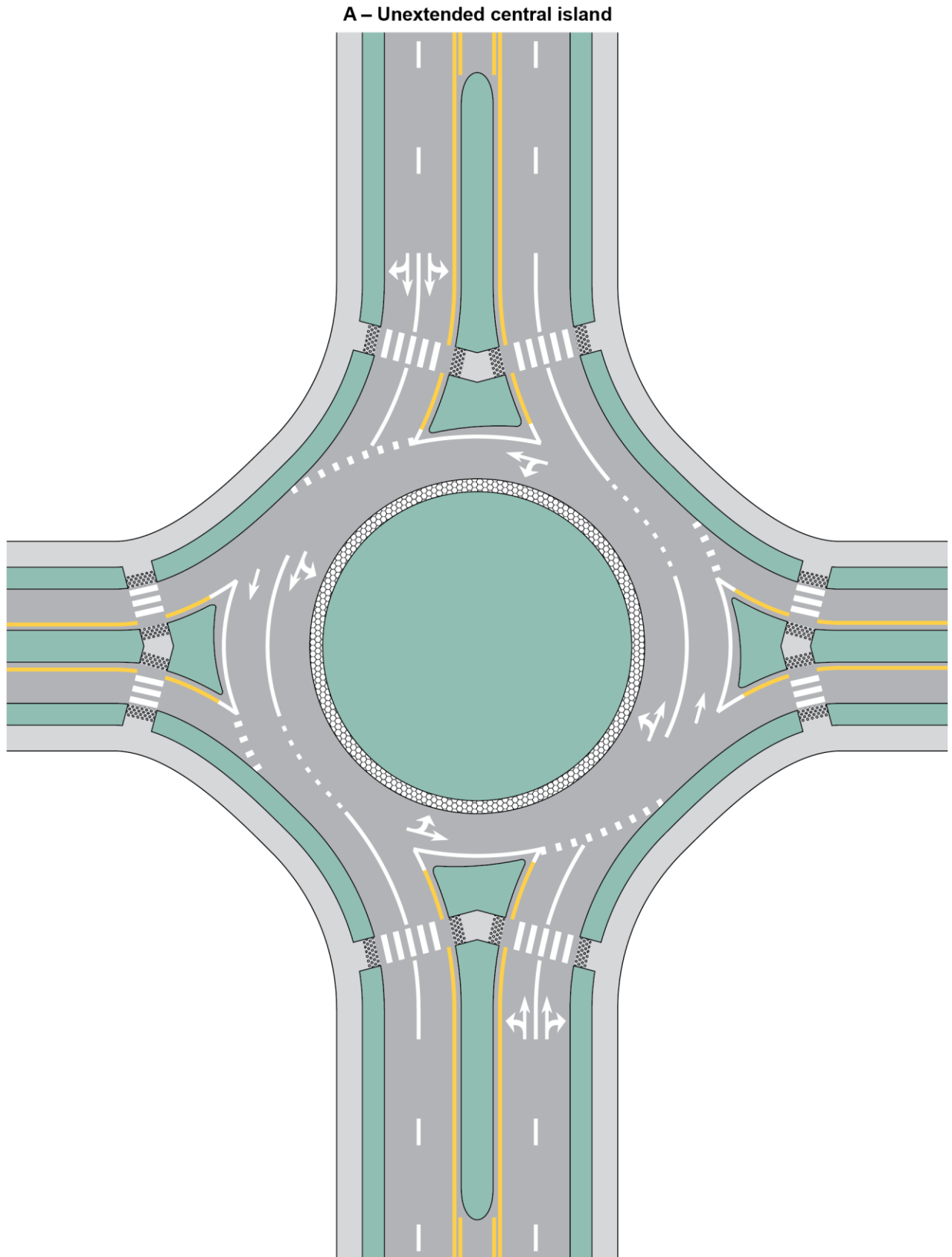


**Figure 3C-3. Example of Markings for a One-Lane Roundabout**



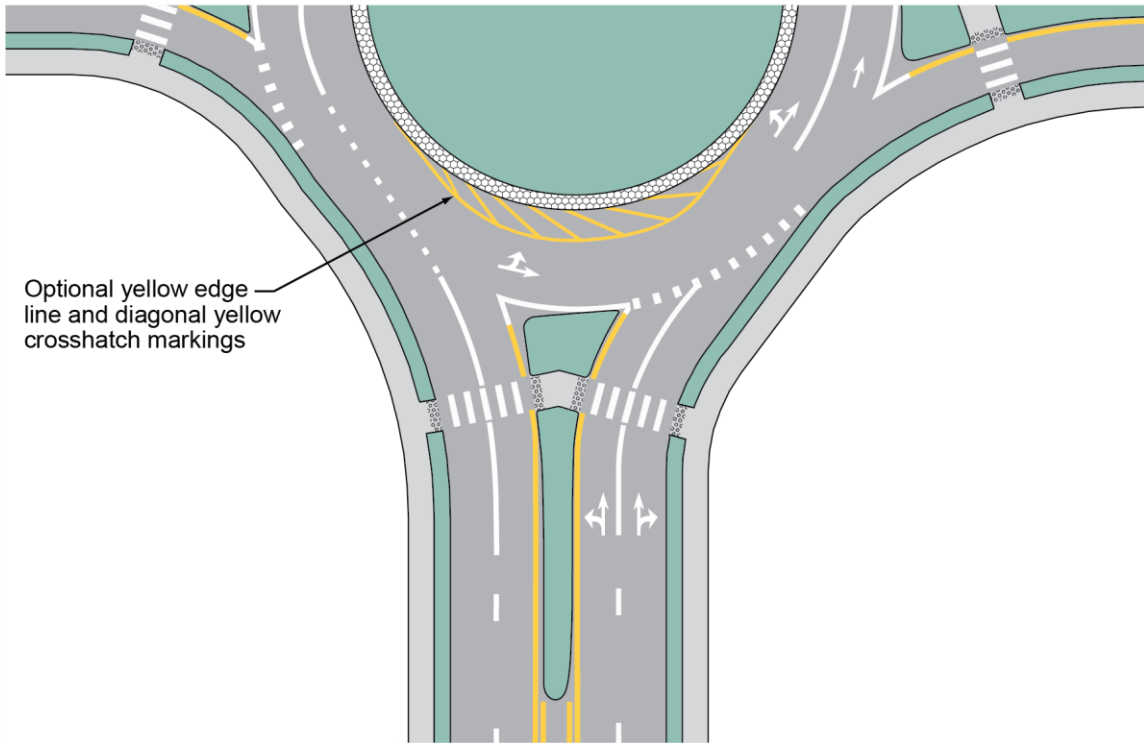


**Figure 3C-4. Example of Markings for a Two-Lane Roundabout with One- and Two-Lane Approaches (Sheet 1 of 2)**

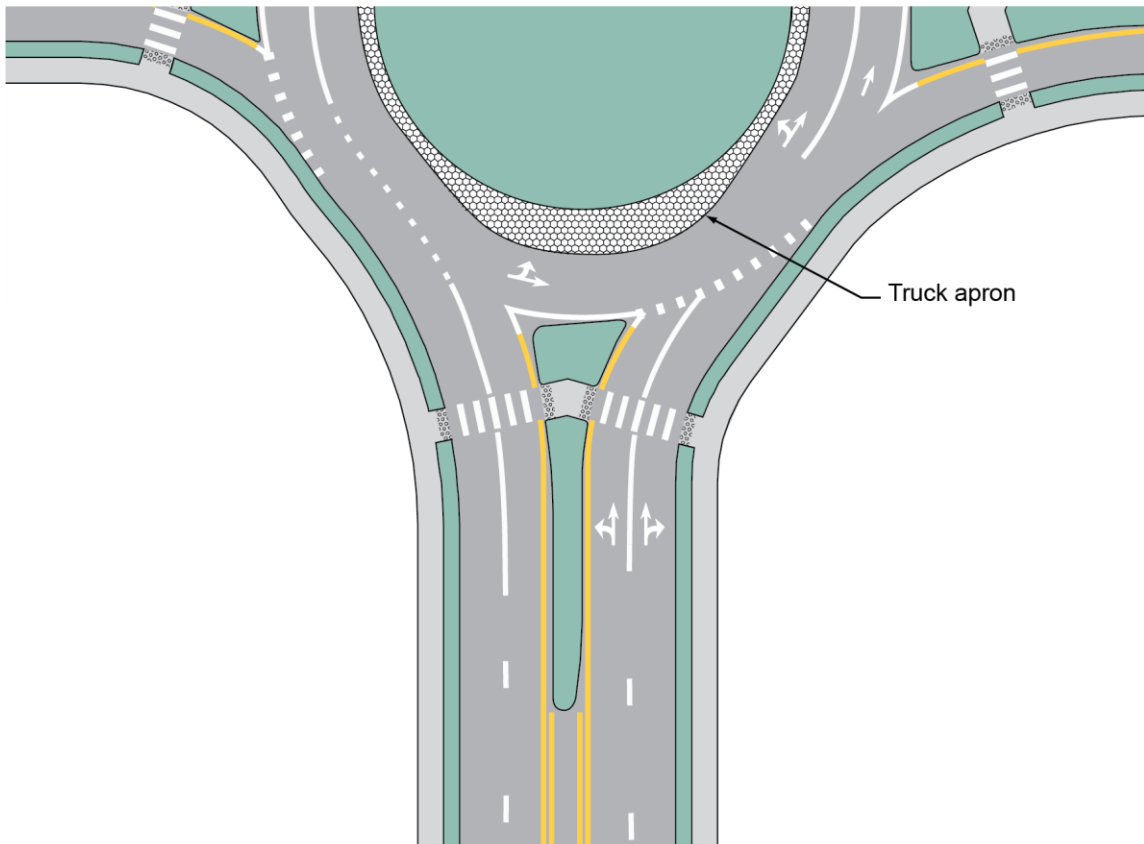


**Figure 3C-4. Example of Markings for a Two-Lane Roundabout with One- and Two-Lane Approaches (Sheet 2 of 2)**

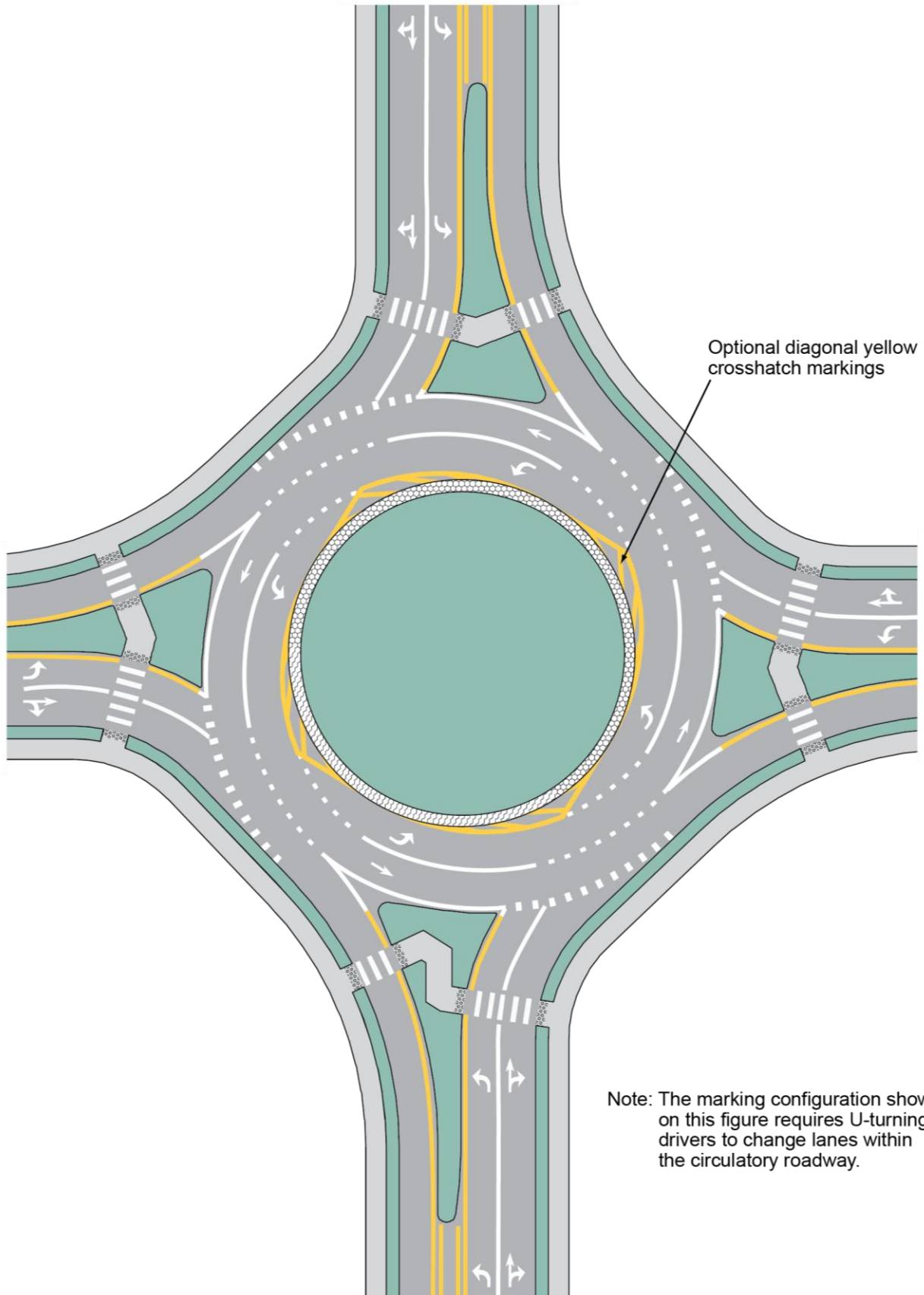
**B – Central island extended by pavement markings**



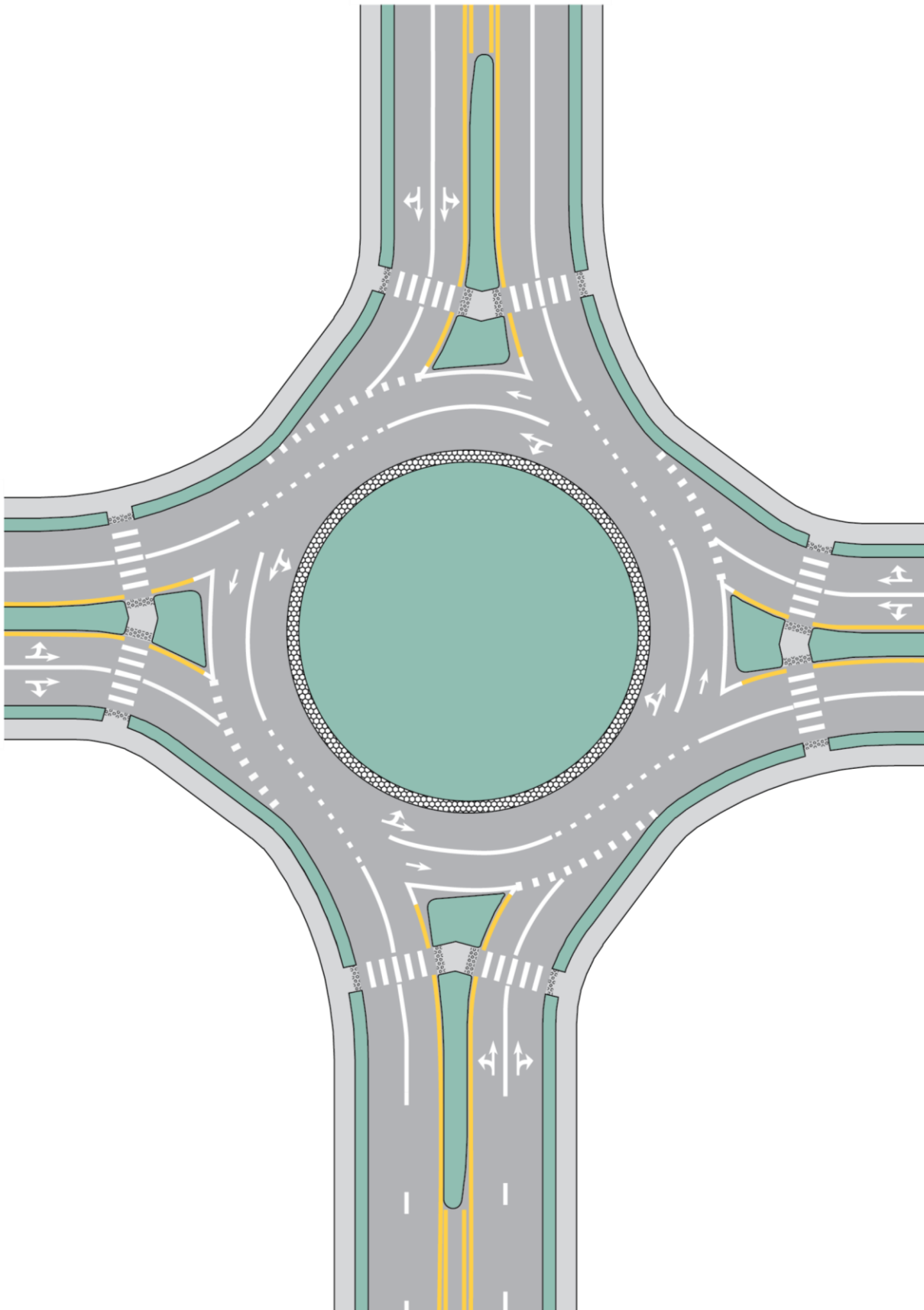
**C – Central island extended by a truck apron**



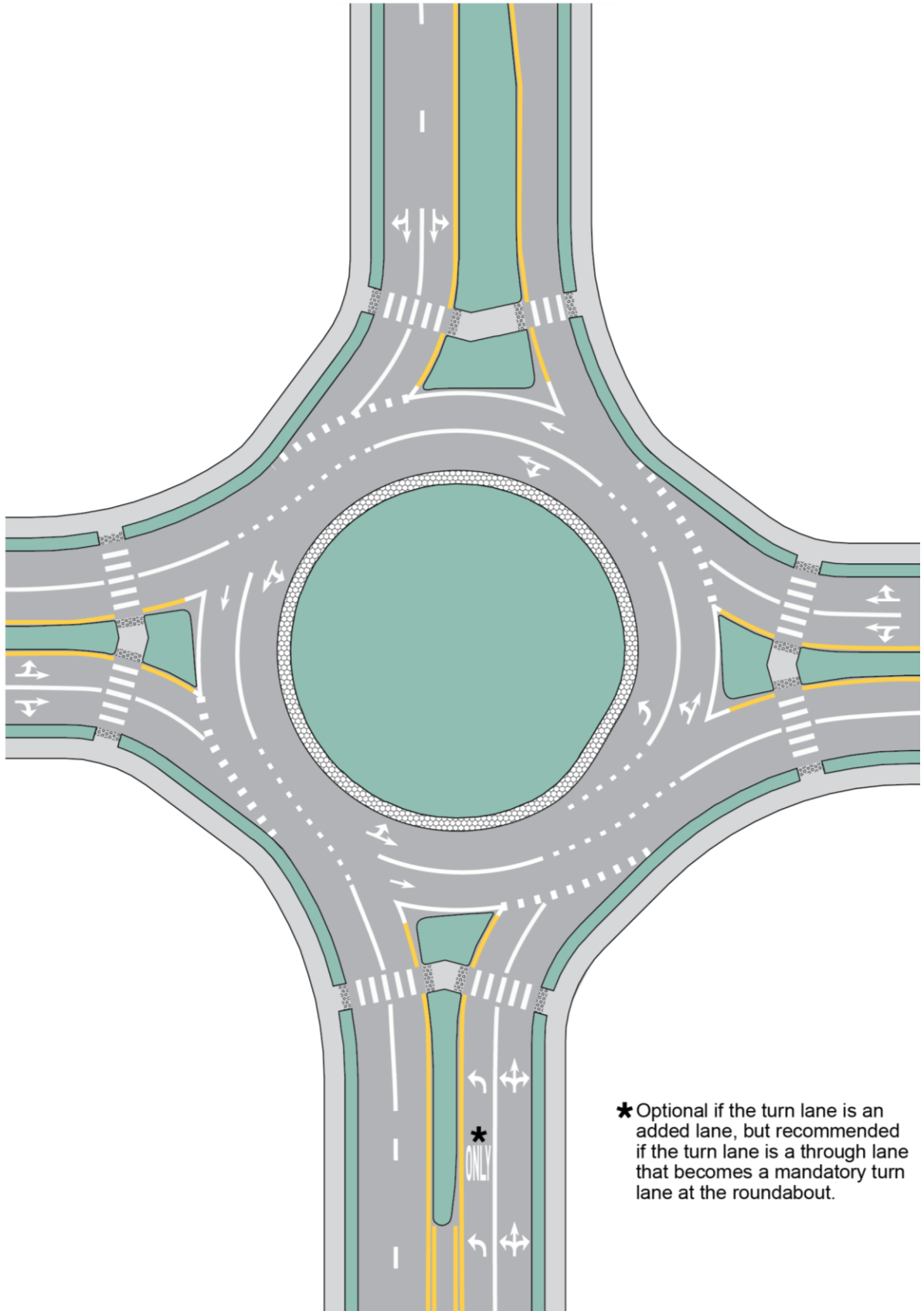
**Figure 3C-5. Example of Markings for a Two-Lane Roundabout with One-Lane Exits**



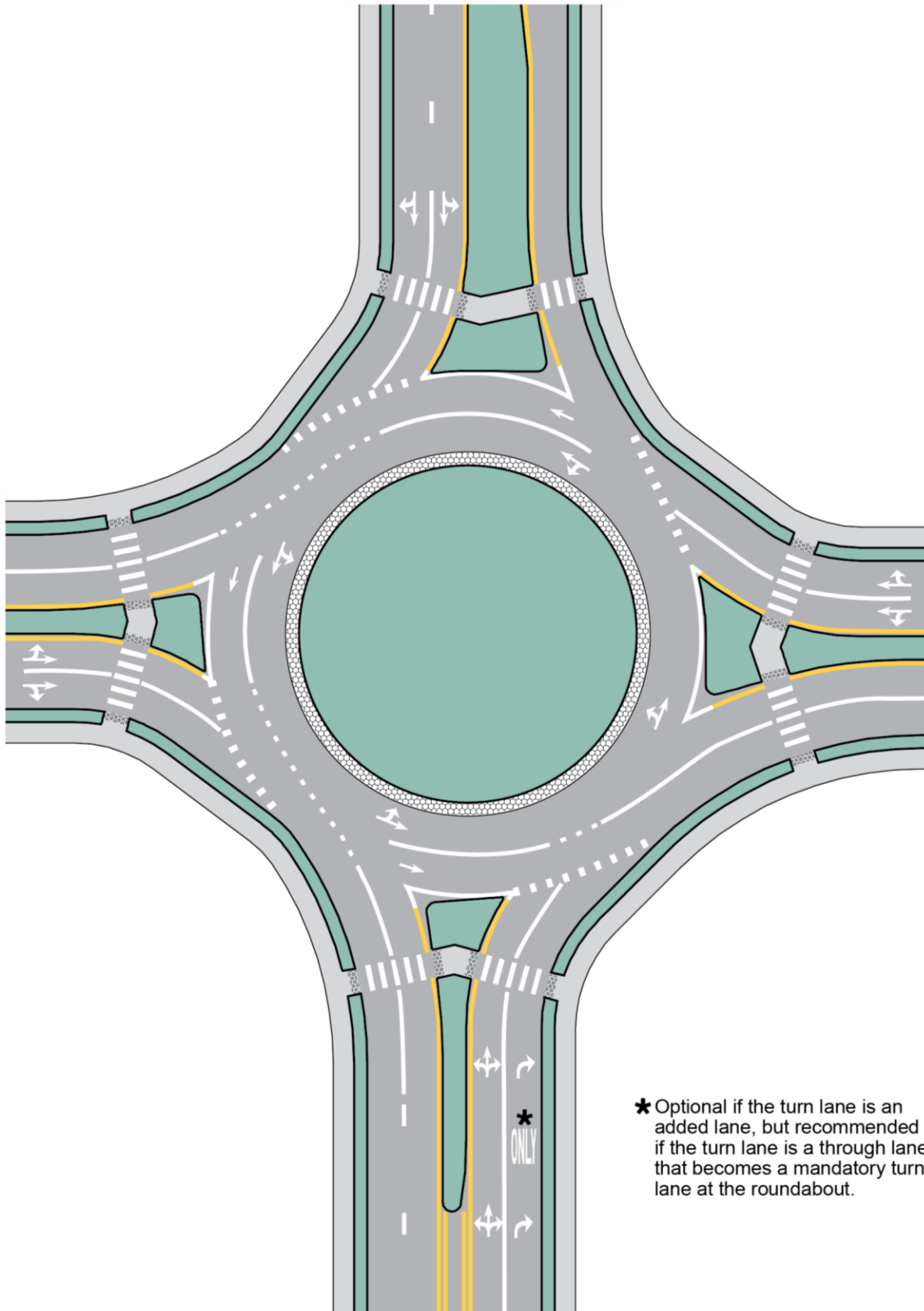
**Figure 3C-6. Example of Markings for a Two-Lane Roundabout with Two-Lane Exits**



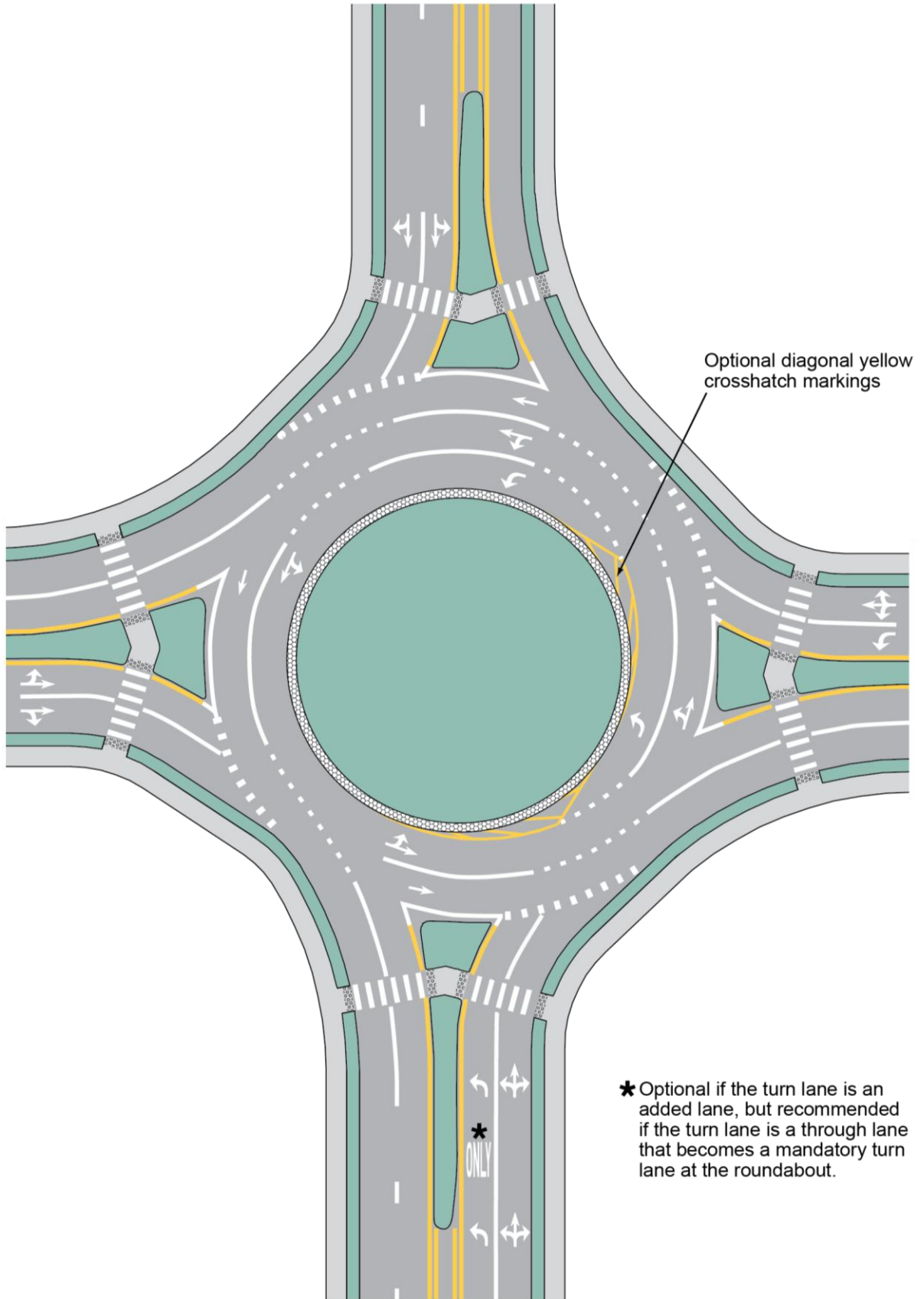
**Figure 3C-7. Example of Markings for a Two-Lane Roundabout with a Double Left Turn**



**Figure 3C-8. Example of Markings for a Two-Lane Roundabout with a Double Right Turn**

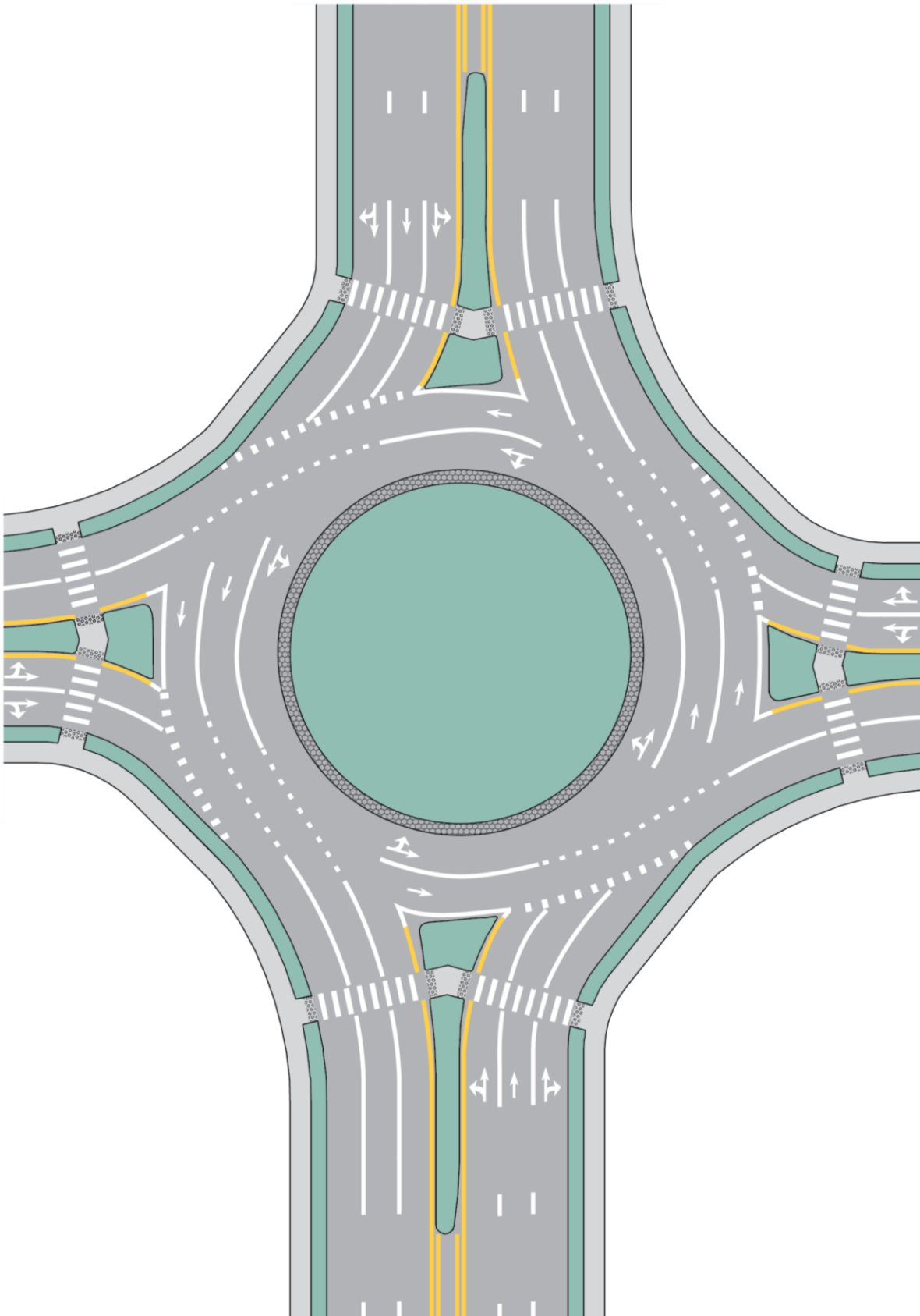


**Figure 3C-9. Example of Markings for a Two-Lane Roundabout with Consecutive Double Left Turns**



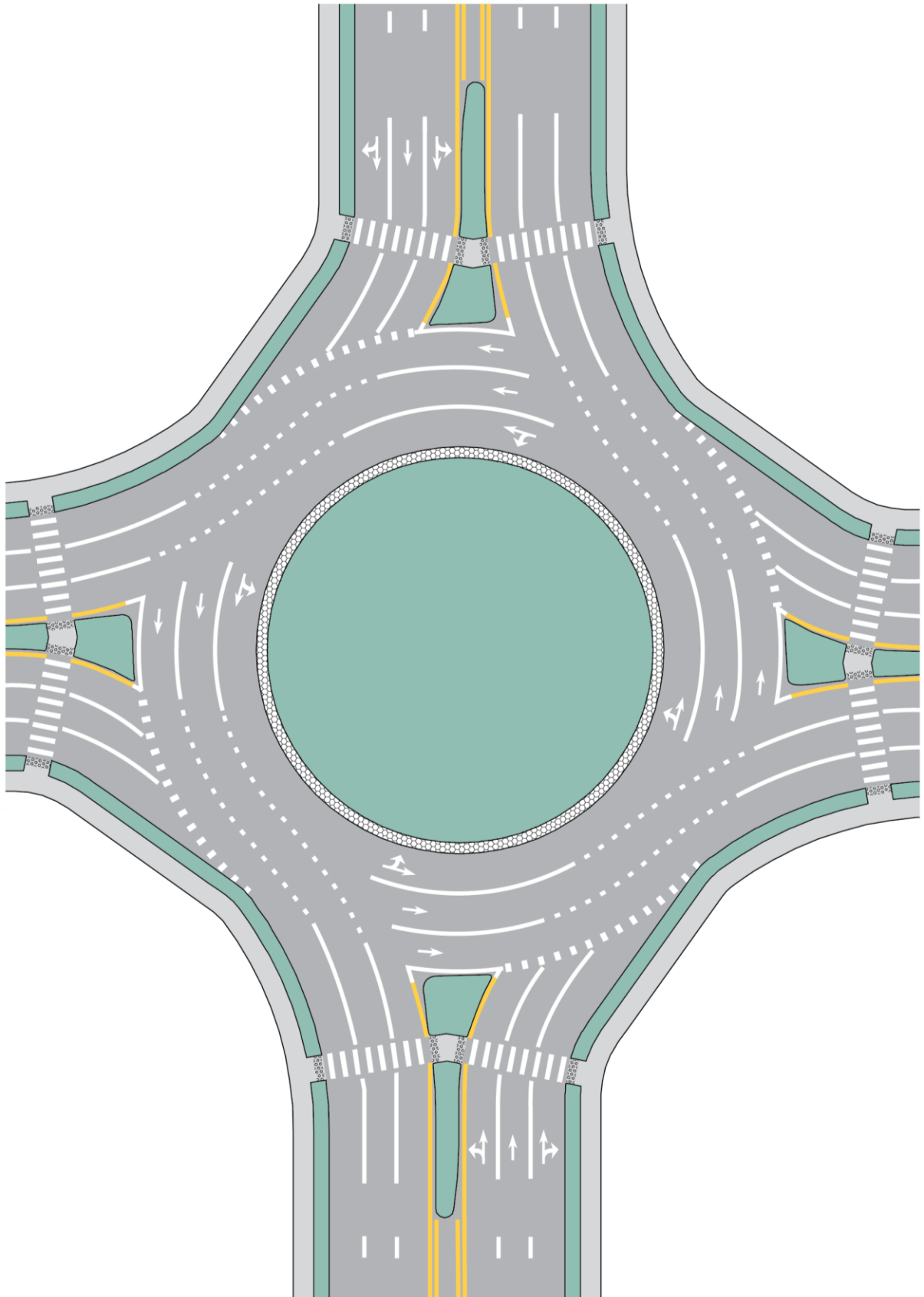


**Figure 3C-10. Example of Markings for a Three-Lane Roundabout with Two- and Three-Lane Approaches**

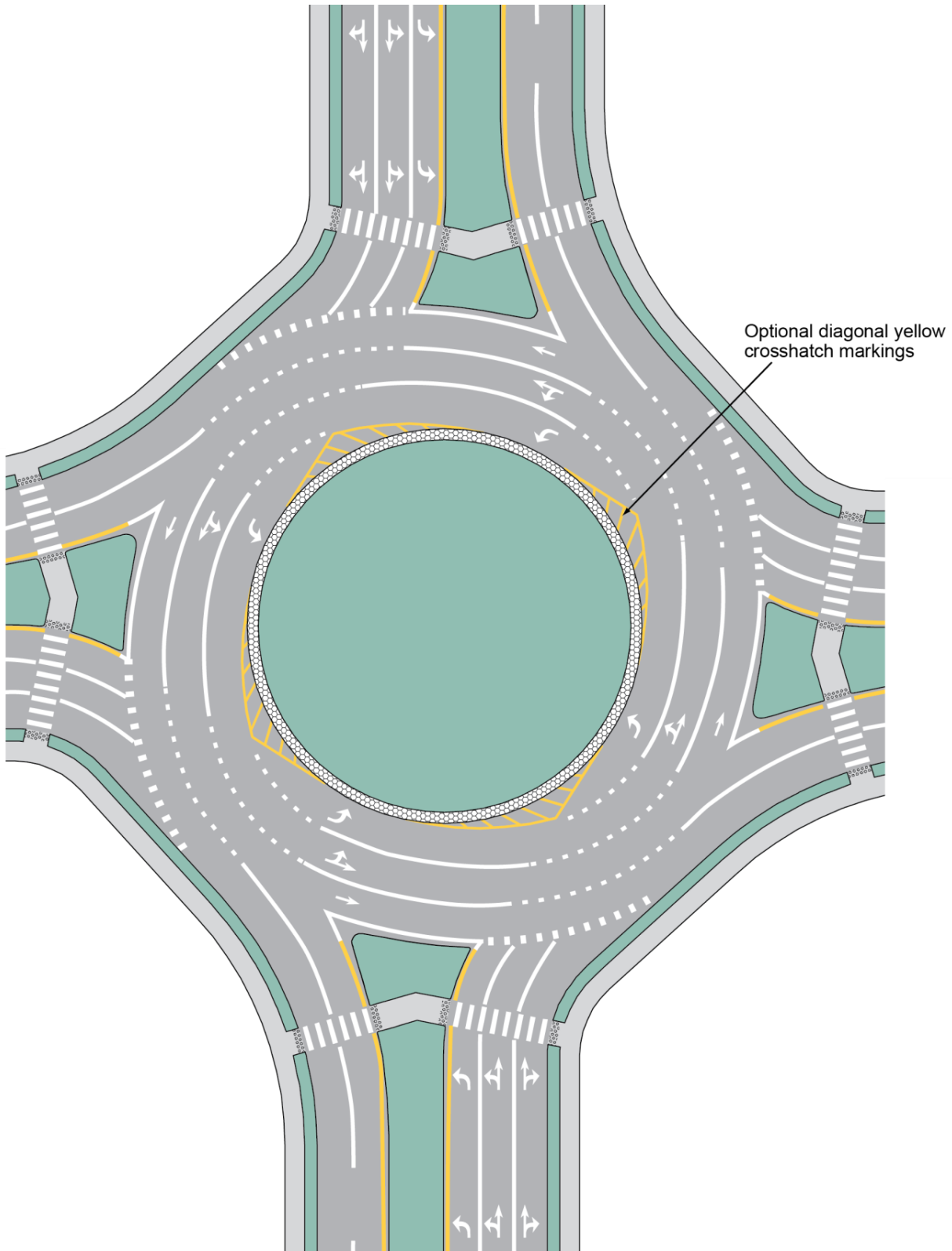




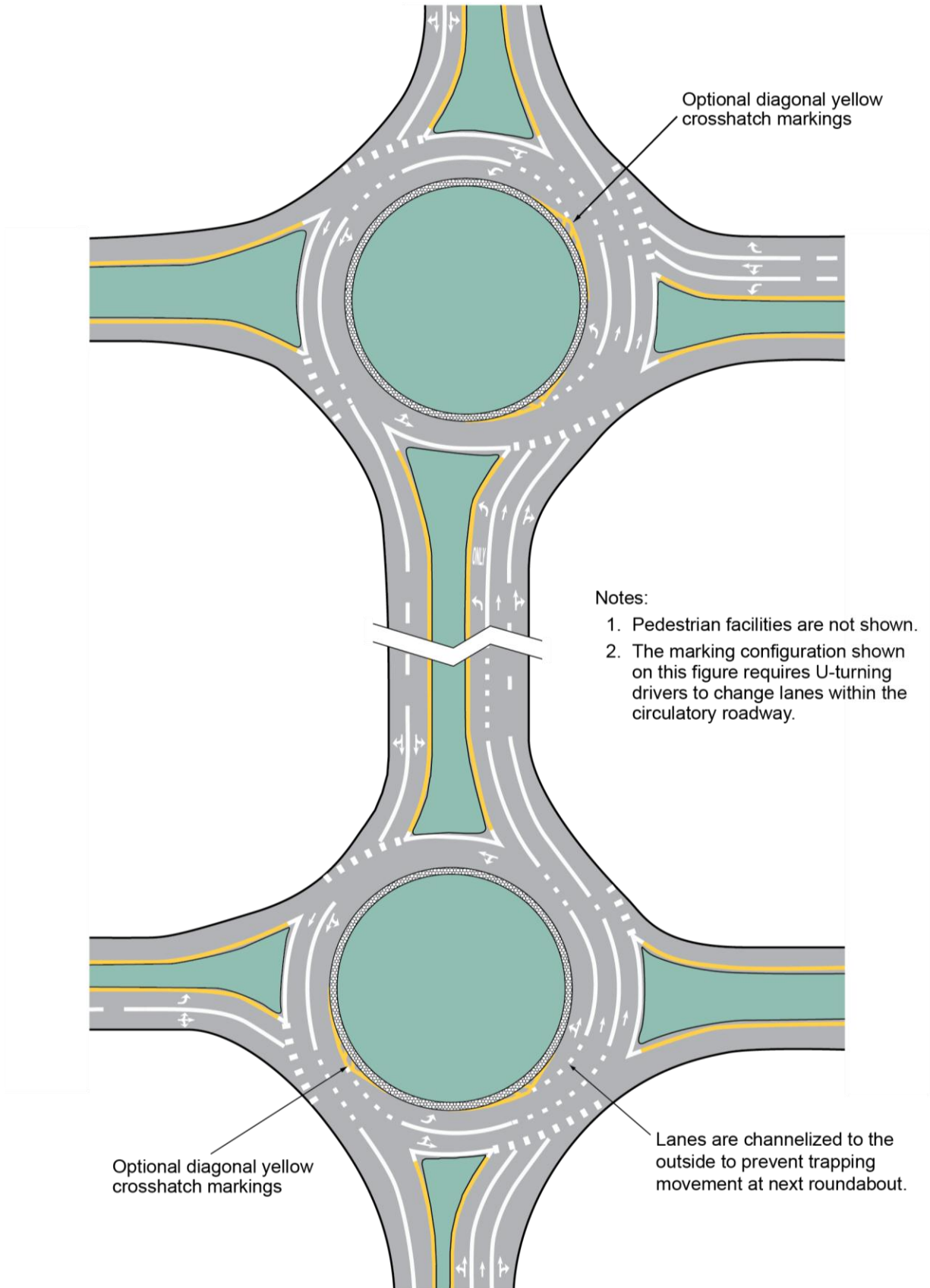
**Figure 3C-11. Example of Markings for a Three-Lane Roundabout with Three-Lane Approaches**



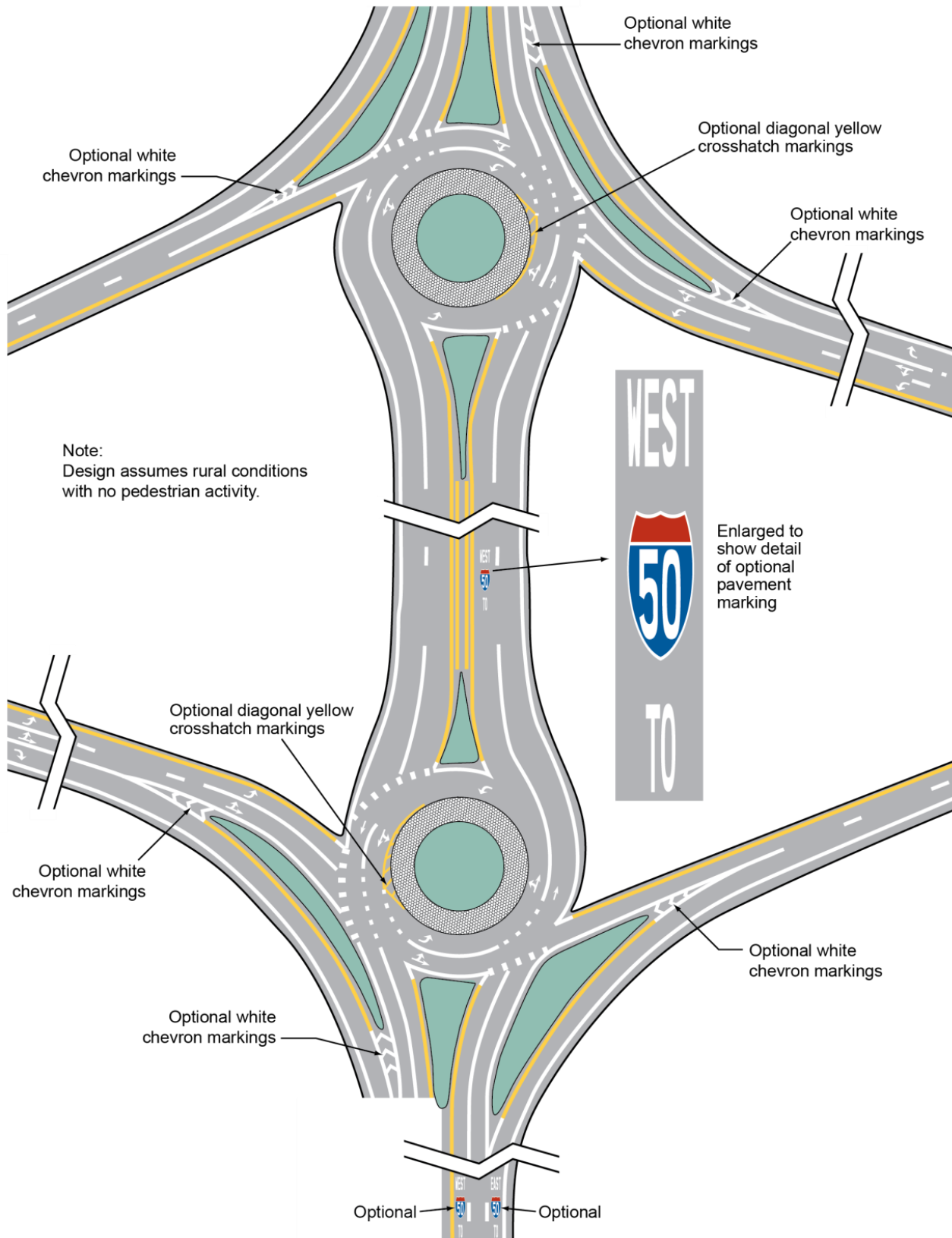
**Figure 3C-12. Example of Markings for a Three-Lane Roundabout with Two-Lane Exits**



**Figure 3C-13. Example of Markings for Two Linked Roundabouts**



**Figure 3C-14. Example of Markings for a Diamond Interchange with Two Circular-Shaped Roundabout Ramp Terminals**



**Section 3C.02 White Lane Line Pavement Markings for Roundabouts**

**Standard:**

01 **Multi-lane approaches to roundabouts shall have lane lines.**

02 **A through lane on a roadway that becomes a dropped lane (mandatory turn lane) at a roundabout shall be marked with a dotted white lane line as described in Section 3B.04.**

*Guidance:*

03 *Multi-lane roundabouts should have lane line markings within the circulatory roadway to channelize traffic to the appropriate exit lane.*

**Standard:**

04 **Continuous concentric lane lines shall not be used within the circulatory roadway of roundabouts.**

*Support:*

05 Section 9C.04 contains information regarding bicycle lane markings at roundabouts.

**Section 3C.03 Edge Line Pavement Markings for Roundabout Circulatory Roadways**

*Guidance:*

01 *A white edge line should be used on the outer (right-hand) side of the circulatory roadway.*

02 *Where a white edge line is used for the circulatory roadway, it should be as follows (see Figure 3C-1):*

*A. A solid line adjacent to the splitter island, and*

*B. A wide dotted line across the lane(s) entering the roundabout.*

**Standard:**

03 **Edge lines and edge line extensions shall not be placed across the exits from the circulatory roadway at roundabouts.**

*Option:*

04 A yellow edge line may be placed around the inner (left-hand) edge of the circulatory roadway (see Figure 3C-1) and may be used to channelize traffic (see Drawing B of Figure 3C-4).

**Section 3C.04 Yield Lines for Roundabouts**

*Option:*

01 A yield line (see Section 3B.16) may be used to indicate the point behind which vehicles are required to yield at the entrance to a roundabout (see Figure 3C-1).

**Section 3C.05 Crosswalk Markings at Roundabouts**

**Standard:**

01 **Pedestrian crosswalks shall not be marked to or from the central island of roundabouts.**

*Guidance:*

02 *If pedestrian facilities are provided, crosswalks (see Section 3B.18) should be marked across roundabout entrances and exits to indicate where pedestrians are intended to cross.*

03 *Crosswalks should be a minimum of 20 feet from the edge of the circulatory roadway.*

*Support:*

04 Various arrangements of crosswalks at roundabouts are illustrated in the figures in this Chapter.

**Section 3C.06 Word, Symbol, and Arrow Pavement Markings for Roundabouts**

*Option:*

01 Lane-use arrows may be used on any approach to and within the circulatory roadway of any roundabout.

02 YIELD (word) and YIELD AHEAD (symbol or word) pavement markings (see Figure 3C-1) may be used on approaches to roundabouts.

03 Word and/or route shield pavement markings may be used on an approach to or within the circulatory roadway of a roundabout to provide route and/or destination guidance information to road users (see Figure 3C-14).

*Guidance:*

04        *Within the circulatory roadway of multi-lane roundabouts, normal lane-use arrows (see Section 3B.20 and Figure 3B-24) should be used.*

05        *On multi-lane approaches with double left-turn and/or double right-turn lanes, lane-use arrows as shown in Figures 3C-7 and 3C-8 should be used.*

*Option:*

06        If used on approaches to a roundabout, lane-use arrows may be either normal or fish-hook arrows, either with or without an oval symbolizing the central island, as shown in Figure 3C-2.

**Section 3C.07 Markings for Other Circular Intersections***Support:*

01        Other circular intersections include, but are not limited to, rotaries, traffic circles, and residential traffic calming designs.

*Option:*

02        The markings shown in this Chapter may be used at other circular intersections if engineering judgment indicates that their presence will benefit drivers, pedestrians, or other road users.

## CHAPTER 3D. MARKINGS FOR PREFERENTIAL LANES

### Section 3D.01 Preferential Lane Word and Symbol Markings

#### Support:

- 01 Preferential lanes are established for one or more of a wide variety of special uses, including, but not limited to, high-occupancy vehicle (HOV) lanes, **Electronic Toll Collection (ETC)** lanes, high-occupancy toll (HOT) lanes, bicycle lanes, bus only lanes, taxi only lanes, and light rail transit only lanes.

#### Standard:

- 02 **When a lane is assigned full or part time to a particular class or classes of vehicles, the preferential lane word and symbol markings described in this Section and the preferential lane longitudinal markings described in Section 3D.02 shall be used.**
- 03 **All longitudinal pavement markings, as well as word and symbol pavement markings, associated with a preferential lane shall end where the Preferential Lane Ends (R3-12a or R3-12c) sign (see Section 2G.07) designating the downstream end of the preferential only lane restriction is installed.**
- 04 **Static or changeable message regulatory signs (see Sections 2G.03 to 2G.07) shall be used with preferential lane word or symbol markings.**
- 05 **All preferential lane word and symbol markings shall be white and shall be positioned laterally in the center of the preferential lane.**
- 06 **Where a preferential lane use exists contiguous to a general-purpose lane or is separated from a general-purpose lane by a flush buffered space that can be traversed by motor vehicles, the preferential lane shall be marked with one or more of the following symbol or word markings for the preferential lane use specified:**
- A. **HOV lane**—the preferential lane use marking for high-occupancy vehicle lanes shall consist of white lines formed in a diamond shape symbol or the word message HOV. The diamond shall be at least 2.5 feet wide and 12 feet in length. The lines shall be at least 6 inches in width.
  - B. **HOT lane or ETC Account-Only lane**—except as provided in Paragraph 8, the preferential lane-use marking for a HOT lane or an ETC Account-Only lane shall consist of a word marking using the name of the ETC payment system required for use of the lane, such as E-Z PASS ONLY.
  - C. **Bicycle lane**—the preferential lane use marking for a bicycle lane shall consist of a bicycle symbol or the word marking BIKE LANE (see Chapter 9C and Figures 9C-1 and 9C-3 through 9C-6).
  - D. **Bus only lane**—the preferential lane use marking for a bus only lane shall consist of the word marking BUS ONLY.
  - E. **Taxi only lane**—the preferential lane use marking for a taxi only lane shall consist of the word marking TAXI ONLY.
  - F. **Light rail transit lane**—the preferential lane use marking for a light rail transit lane shall consist of the word marking LRT ONLY.
  - G. **Other type of preferential lane**—the preferential lane use markings shall consist of a word marking appropriate to the restriction.
- 07 **If two or more preferential lane uses are permitted in a single lane, the symbol or word marking for each preferential lane use shall be installed.**

#### Option:

- 08 Preferential lane-use symbol or word markings may be omitted at toll plazas where physical conditions preclude the use of the markings (see Section 3E.01).

#### Guidance:

- 09 *The spacing of the markings should be based on engineering judgment that considers the prevailing speed, block lengths, distance from intersections, and other factors that affect clear communication to the road user.*

**Support:**

- 10 Markings spaced as close as 80 feet apart might be appropriate on city streets, while markings spaced as far as 1,000 feet apart might be appropriate for freeways.

*Guidance:*

- 11 *In addition to a regular spacing interval, the preferential lane marking should be placed at strategic locations such as major decision points, direct exit ramp departures from the preferential lane, and along access openings to and from adjacent general-purpose lanes. At decision points, the preferential lane marking should be placed on all applicable lanes and should be visible to approaching traffic for all available departures. At direct exits from preferential lanes where extra emphasis is needed, the use of word markings (such as “EXIT” or “EXIT ONLY”) in the deceleration lane for the direct exit and/or on the direct exit ramp itself just beyond the exit gore should be considered.*

**Option:**

- 12 A numeral indicating the vehicle occupancy requirements established for a high-occupancy vehicle lane may be included in sequence after the diamond symbol or HOV word message

*Guidance:*

- 13 *Engineering judgment should determine the need for supplemental devices such as tubular markers, traffic cones, or other channelizing devices (see Chapter 3H).*

**Section 3D.02 Preferential Lane Longitudinal Markings for Motor Vehicles****Support:**

- 01 Preferential lanes can take many forms depending on the level of usage and the design of the facility. They might be barrier-separated or buffer-separated from the adjacent general-purpose lanes, or they might be contiguous with the adjacent general-purpose lanes. Barrier-separated preferential lanes might be operated in a constant direction or be operated as reversible lanes. Some reversible preferential lanes on a divided highway might be operated counter-flow to the direction of traffic on the immediately adjacent general-purpose lanes. See Section 1A.13 for definitions of terms.

- 02 Preferential lanes might be operated full-time (24 hours per day on all days), for extended periods of the day, part-time (restricted usage during specific hours on specified days), or on a variable basis (such as a strategy for a managed lane).

**Standard:**

- 03 **Longitudinal pavement markings for preferential lanes shall be as follows (these same requirements are presented in tabular form in Table 3D-1):**

- A. **Barrier-separated, nonreversible preferential lane—the longitudinal pavement markings for preferential lanes that are physically separated from the other travel lanes by a barrier or median shall consist of a normal solid single yellow line at the left-hand edge of the travel lane(s), and a normal solid single white line at the right-hand edge of the travel lane(s) (see Drawing A in Figure 3D-1).**
- B. **Barrier-separated, reversible preferential lane—the longitudinal pavement markings for reversible preferential lanes that are physically separated from the other travel lanes by a barrier or median shall consist of a normal solid single white line at both edges of the travel lane(s) (see Drawing B in Figure 3D-1).**
- C. **Buffer-separated (left-hand side) preferential lane—the longitudinal pavement markings for a full-time or part-time preferential lane on the left-hand side of and separated from the other travel lanes by a neutral buffer space shall consist of a normal solid single yellow line at the left-hand edge of the preferential travel lane(s) and one of the following at the right-hand edge of the preferential travel lane(s):**
  1. **A wide solid double white line along both edges of the buffer space where crossing the buffer space is prohibited (see Drawing A in Figure 3D-2).**
  2. **A wide solid single white line along both edges of the buffer space where crossing the buffer space is discouraged (see Drawing B in Figure 3D-2).**



**Table 3D-1. Standard Edge Line and Lane Line Markings for Preferential Lanes**

Type of Preferential Lane	Left-Hand Edge Line	Right-Hand Edge Line
Barrier-Separated, Non-reversible	A normal solid yellow line	A normal solid single white line (see Drawing A of Figure 3D-1)
Barrier-Separated, Reversible	A normal solid white line	A normal solid single white line (see Drawing B of Figure 3D-1)
Buffer-Separated, Left-Hand Side	A normal solid single yellow line	<p>A wide solid double white line along both edges of the buffer space where crossing is prohibited (see Drawing A of Figure 3D-2)</p> <p>A wide solid single white line along both edges of the buffer space where crossing is discouraged (see Drawing B of Figure 3D-2)</p> <p>A wide broken single white line along both edges of the buffer space, or a wide broken single white line within the buffer space (resulting in wider lanes), where crossing is permitted (see Drawing C of Figure 3D-2)</p>
Buffer-Separated, Right-Hand Side	<p>A wide solid double white line along both edges of the buffer space where crossing is prohibited (see Figure 3D-2)</p> <p>A wide solid single white line along both edges of the buffer space where crossing is discouraged (see Figure 3D-2)</p> <p>A wide broken single white line along both edges of the buffer space, or a wide broken single white line within the buffer space (resulting in wider lanes), where crossing is permitted (see Figure 3D-2)</p> <p>A wide dotted single white line within the buffer space (resulting in wider lanes) where crossing is permitted for any vehicle to perform a right-turn maneuver (see Figure 3D-2)</p>	A normal solid single white line (if warranted)
Contiguous, Left-Hand Side	A normal solid single yellow line	<p>A wide solid double white line where crossing is prohibited (see Drawing A of Figure 3D-3)</p> <p>A wide solid single white line where crossing is discouraged (see Drawing B of Figure 3D-3)</p> <p>A wide broken single white line where crossing is permitted (see Drawing C of Figure 3D-3)</p>
Contiguous, Right-Hand Side	<p>A wide solid double white line where crossing is prohibited (see Figure 3D-3)</p> <p>A wide solid single white line where crossing is discouraged (see Figure 3D-3)</p> <p>A wide broken single white line where crossing is permitted (see Figure 3D-3)</p> <p>A wide dotted single white line where crossing is permitted for any vehicle to perform a right- turn maneuver (see Figure 3D-3)</p>	A normal solid single white line

Notes:

1. If there are two or more preferential lanes, the lane lines between the preferential lanes shall be normal broken white lines.
2. The standard lane markings listed in this table are provided in a tabular format for reference.
3. This information is also described in Paragraph 3 of Section 3D.02.

3. A wide broken single white line along both edges of the buffer space, or a wide broken single white lane line within the allocated buffer space (resulting in wider lanes), where crossing the buffer space is permitted (see Drawing C in Figure 3D-2).
- D. Buffer-separated (right-hand side) preferential lane**—the longitudinal pavement markings for a full-time or part-time preferential lane on the right-hand side of and separated from the other travel lanes by a neutral buffer space shall consist of a normal solid single white line at the right-hand edge of the preferential travel lane(s) if warranted (see Section 3B.07) and one of the following at the left-hand edge of the preferential travel lane(s) (see Drawing D in Figure 3D-2):
1. A wide solid double white line along both edges of the buffer space where crossing the buffer space is prohibited.
  2. A wide solid single white line along both edges of the buffer space where crossing of the buffer space is discouraged.
  3. A wide broken single white line along both edges of the buffer space, or a wide broken single white line within the allocated buffer space (resulting in wider lanes), where crossing the buffer space is permitted.
  4. A wide dotted single white lane line within the allocated buffer space (resulting in wider lanes) where crossing the buffer space is permitted for any vehicle to perform a right-turn maneuver.
- E. Contiguous (left-hand side) preferential lane**—the longitudinal pavement markings for a full-time or part-time preferential lane on the left-hand side of and contiguous to the other traveled lanes shall consist of a normal solid single yellow line at the left-hand edge of the preferential travel lane(s) and one of the following at the right-hand edge of the preferential travel lane(s):
1. A wide solid double white lane line where crossing is prohibited (see Drawing A in Figure 3D-3).
  2. A wide solid single white lane line where crossing is discouraged (see Drawing B in Figure 3D-3).
  3. A wide broken single white lane line where crossing is permitted (see Drawing C in Figure 3D-3).
- F. Contiguous (right-hand side) preferential lane**—the longitudinal pavement markings for a full-time or part-time preferential lane on the right-hand side of and contiguous to the other travel lanes shall consist of a normal solid single white line at the right-hand edge of the preferential travel lane(s) if warranted (see Section 3B.07) and one of the following at the left-hand edge of the preferential travel lane(s) (see Drawing D in Figure 3D-3):
1. A wide solid double white lane line where crossing is prohibited.
  2. A wide solid single white lane line where crossing is discouraged.
  3. A wide broken single white lane line where crossing is permitted.
  4. A wide dotted single white lane line where crossing is permitted for any vehicle to perform a right-turn maneuver.

*Guidance:*

- 04 Where preferential lanes and other travel lanes are separated by a buffer space wider than 4 feet and crossing the buffer space is prohibited, chevron markings (see Section 3B.24) should be placed in the buffer area (see Drawing A in Figure 3D-2). The chevron spacing should be 100 feet or greater.

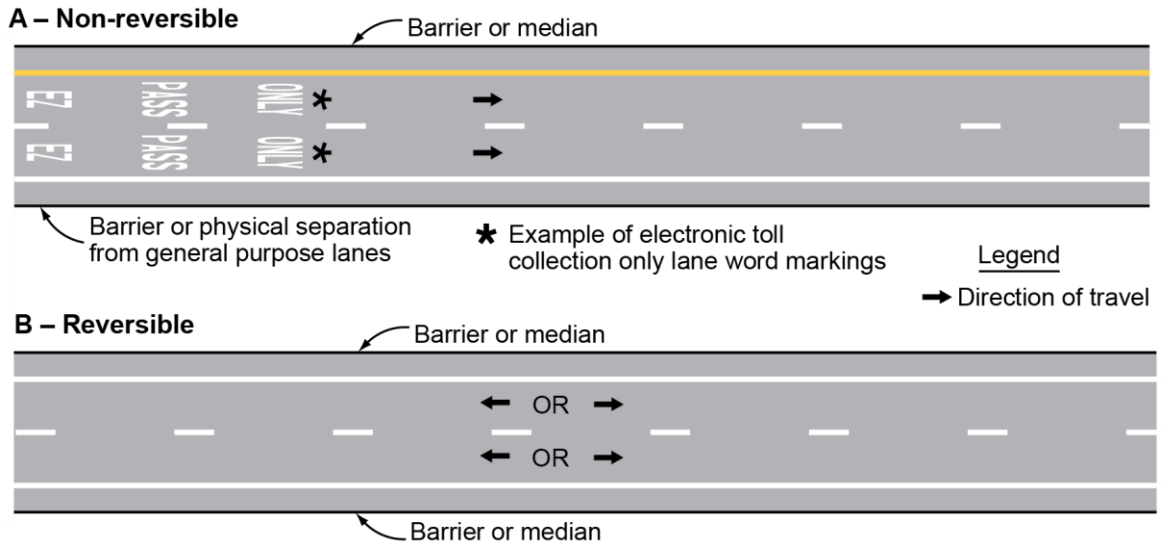
*Option:*

- 05 If a full-time or part-time contiguous preferential lane is separated from the other travel lanes by a wide broken single white line (see Drawing C in Figure 3D-3), the spacing or skip pattern of the line may be reduced and the width of the line may be increased.

**Standard:**

- 06 If there are two or more preferential lanes for traffic moving in the same direction, the lane lines between the preferential lanes shall be normal broken white lines.

**Figure 3D-1. Markings for Barrier-Separated Preferential Lanes**



**Figure 3D-2. Markings for Buffer-Separated Preferential Lanes (Sheet 1 of 2)**

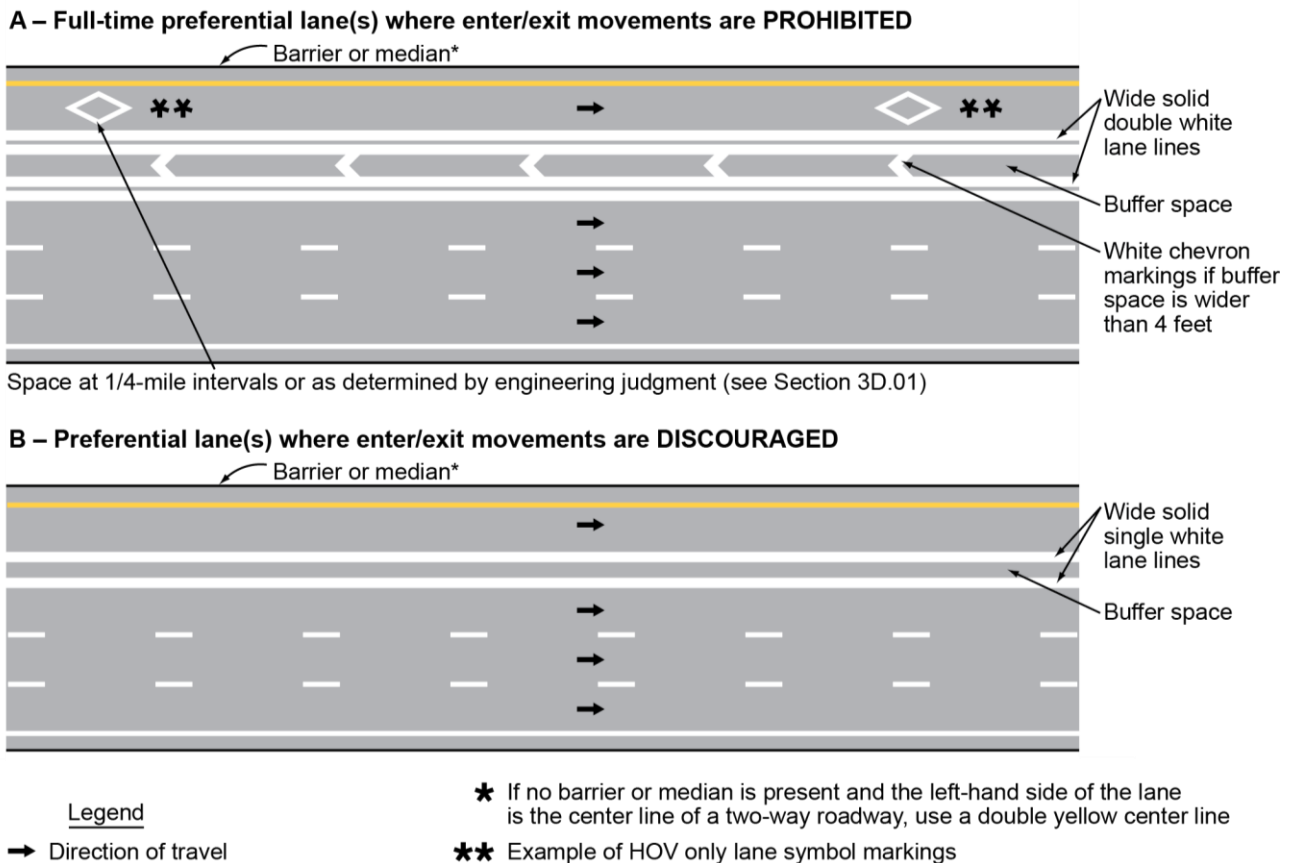
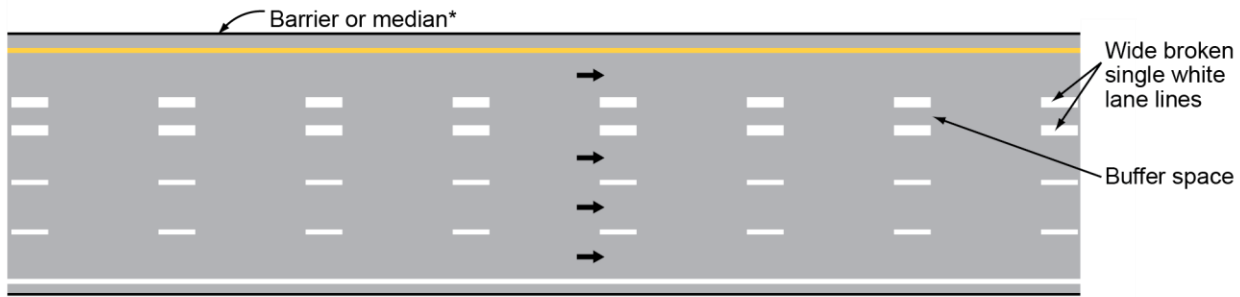
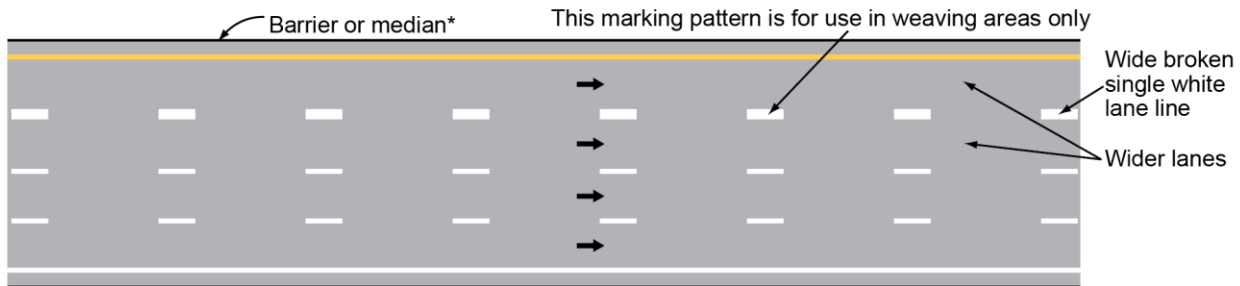


Figure 3D-2. Markings for Buffer-Separated Preferential Lanes (Sheet 2 of 2)

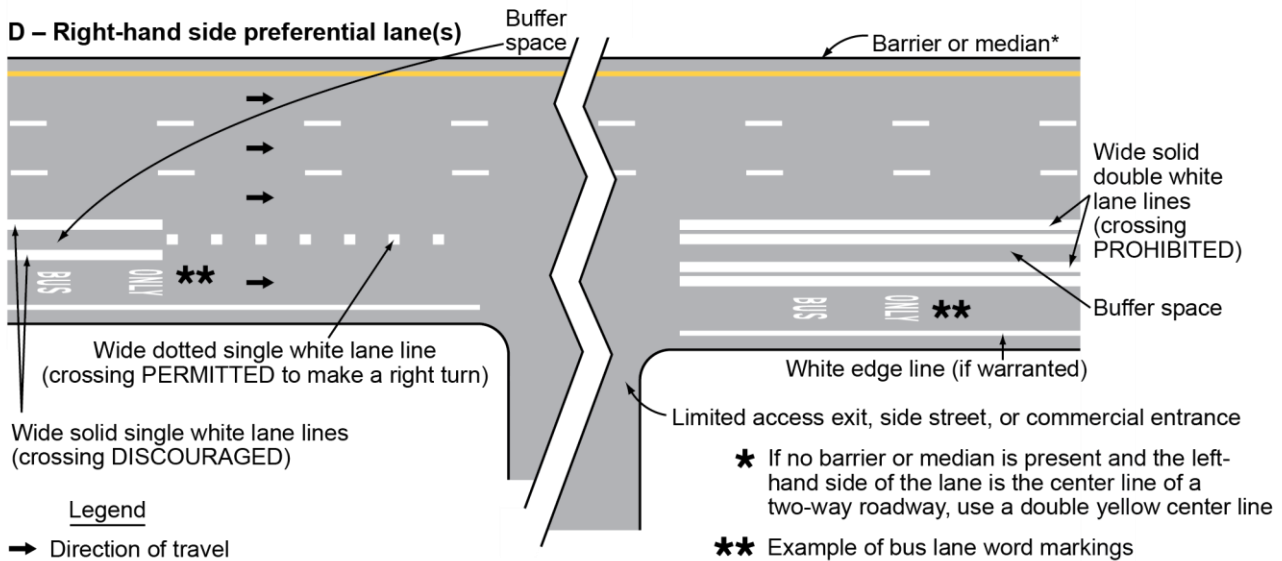
C – Preferential lane(s) where enter/exit movements are PERMITTED



OR

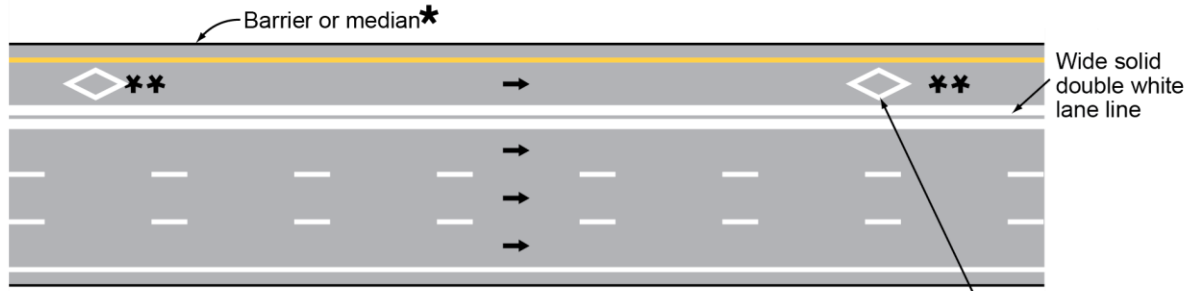


D – Right-hand side preferential lane(s)

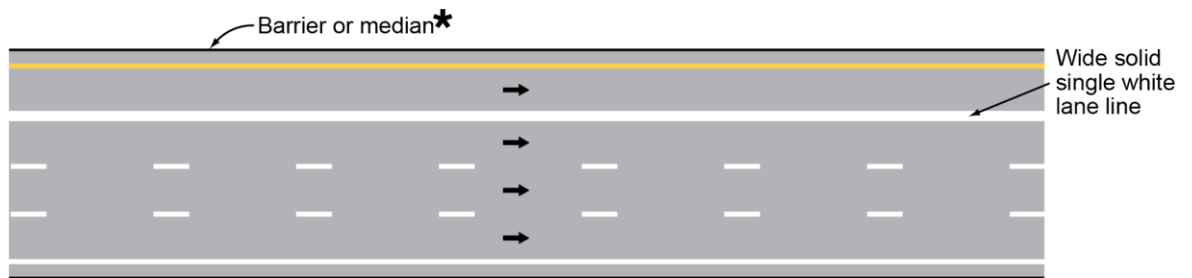


**Figure 3D-3. Markings for Contiguous Preferential Lanes**

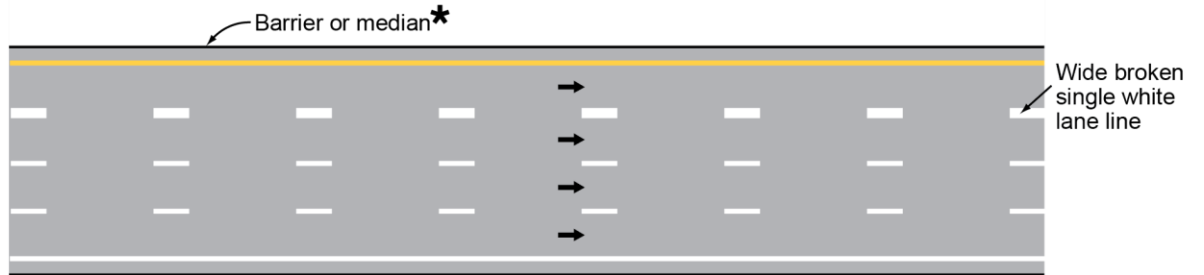
**A – Full-time preferential lane(s) where enter/exit movements are PROHIBITED**



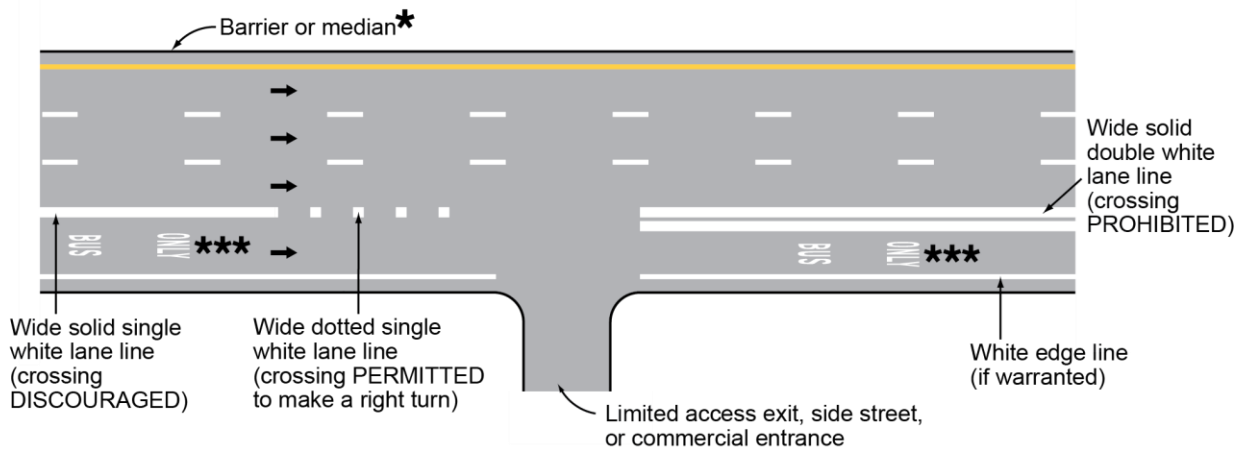
**B – Preferential lane(s) where enter/exit movements are DISCOURAGED** Space at 1/4-mile intervals



**C – Preferential lane(s) where enter/exit movements are PERMITTED**



**D – Right-hand side preferential lane(s)**



Legend

➔ Direction of travel

\* If no barrier or median is present and the left-hand side of the lane is the center line of a two-way roadway, use a double yellow center line.

\*\* Example of HOV only lane symbol markings

\*\*\* Example of bus lane word markings

- 07 **Preferential lanes for motor vehicles shall also be marked with the appropriate word or symbol pavement markings in accordance with Section 3D.01 and shall have appropriate regulatory signs in accordance with Sections 2G.03 through 2G.07.**

*Guidance:*

- 08 *At direct exits from a preferential lane, dotted white line markings should be used to separate the tapered or parallel deceleration lane for the direct exit (including the taper) from the adjacent continuing preferential through lane, to reduce the chance of unintended exit maneuvers.*

**Standard:**

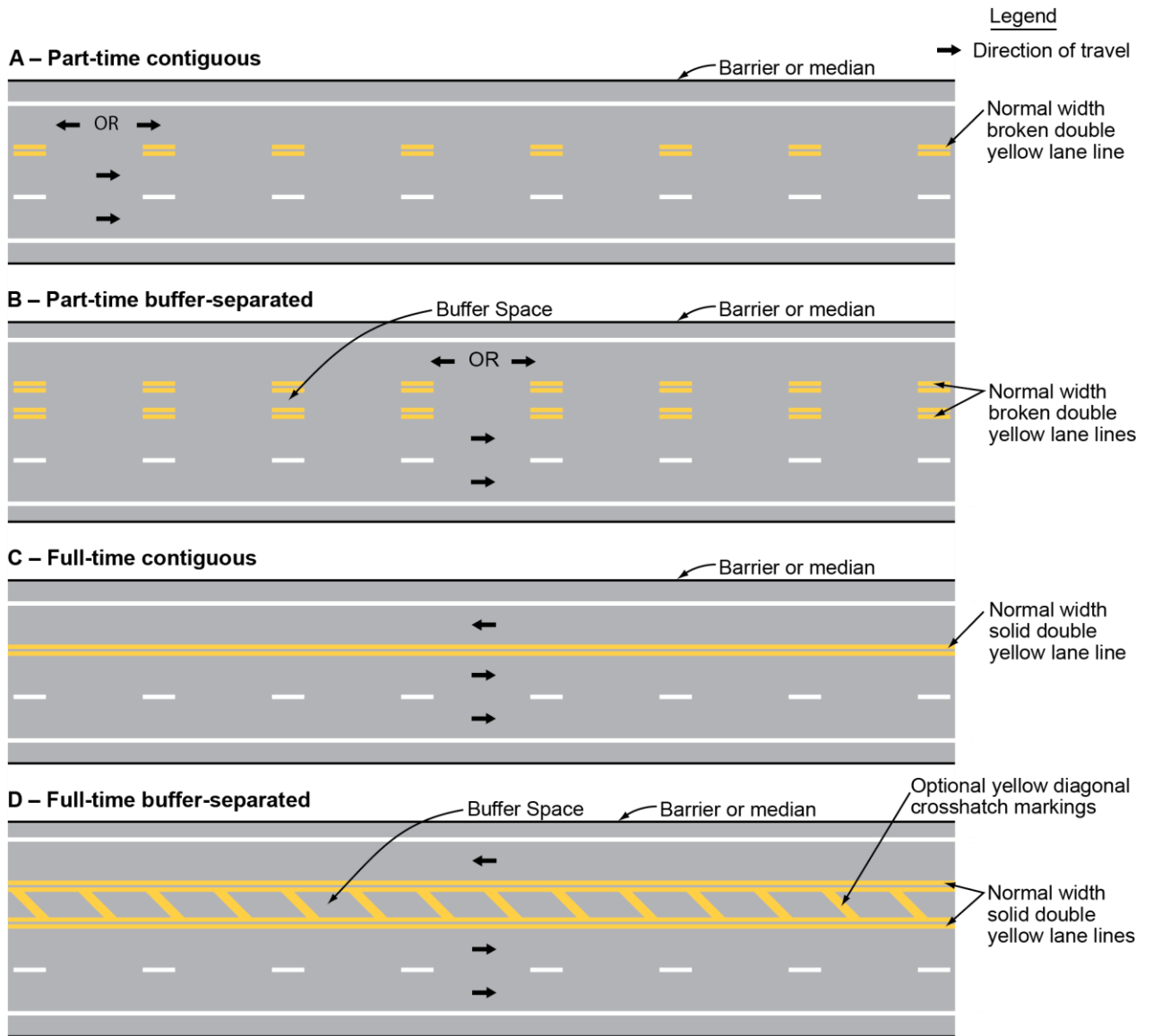
- 09 **On a divided highway, a part-time counter-flow preferential lane that is contiguous to the travel lanes in the opposing direction shall be separated from the opposing direction lanes by the standard reversible lane longitudinal marking, a normal width broken double yellow line (see Section 3B.03 and Drawing A of Figure 3D-4). If a buffer space is provided between the part-time counter-flow preferential lane and the opposing direction lanes, a normal width broken double yellow line shall be placed along both edges of the buffer space (see Drawing B of Figure 3D-4). Signs (see Section 2B.26), lane-use control signals (see Chapter 4M), or both shall be used to supplement the reversible lane markings.**

- 10 **On a divided highway, a full-time counter-flow preferential lane that is contiguous to the travel lanes in the opposing direction shall be separated from the opposing direction lanes by a solid double yellow center line marking (see Drawing C of Figure 3D-4). If a buffer space is provided between the full-time counter-flow preferential lane and the opposing direction lanes, a normal width solid double yellow line shall be placed along both edges of the buffer space (see Drawing D of Figure 3D-4).**

*Option:*

- 11 **Cones, tubular markers, or other channelizing devices (see Chapter 3H) may also be used to separate the opposing lanes when a counter-flow preferential lane operation is in effect.**

**Figure 3D-4. Markings for Counter-Flow Preferential Lanes on Divided Highways**



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## CHAPTER 3E. MARKINGS FOR TOLL PLAZAS

### Section 3E.01 Markings for Toll Plazas

Support:

- 01 At toll plazas, pavement markings help road users identify the proper lane(s) to use for the type of toll payment they plan to use, to channelize movements into the various lanes, and to delineate obstructions in the roadway.

**Standard:**

- 02 **When a lane on the approach to a toll plaza is restricted to use only by vehicles with registered Electronic Toll Collection (ETC) accounts, the ETC Account-Only lane word markings described in Section 3D.01 and the preferential lane longitudinal markings described in Section 3D.02 shall be used. When one or more ORT lanes that are restricted to use only by vehicles with registered ETC accounts bypass a mainline toll plaza on a separate alignment, these word markings and longitudinal markings shall be used on the approach to the point where the ORT lanes diverge from the lanes destined for the mainline toll plaza.**

Option:

- 03 Preferential lane-use symbol or word markings may be omitted at toll plazas where physical conditions preclude the use of the markings.

*Guidance:*

- 04 *If an ORT lane that is immediately adjacent to a mainline toll plaza is not separated from adjacent cash payment toll plaza lanes by a curb or barrier, then channelizing devices (see Section 3H.01), and/or longitudinal pavement markings that discourage or prohibit lane changing should be used to separate the ORT lane from the adjacent cash payment lane. This separation should begin on the approach to the mainline toll plaza at approximately the point where the vehicle speeds in the adjacent cash lanes drop below 30 mph during off-peak periods and should extend downstream beyond the toll plaza approximately to the point where the vehicles departing the toll plaza in the adjacent cash lanes have accelerated to 30 mph.*

Option:

- 05 For a toll plaza approach lane that is restricted to use only by vehicles with registered ETC accounts, the solid white lane line or edge line on the right-hand side of the ETC Account-Only lane and the solid white lane line or solid yellow edge line on the left-hand side of the ETC Account-Only lane may be supplemented with purple solid longitudinal markings placed contiguous to the inside edges of the lines defining the lane.

**Standard:**

- 06 **If used, the purple solid longitudinal marking described in the previous paragraph shall be a minimum of 3 inches in width and a maximum width equal to the width of the line it supplements, and ETC Account-Only preferential lane word markings (see Section 3D.01) shall be installed within the lane.**

- 07 **Toll booths and the islands on which they are located are considered to be obstructions in the roadway and they shall be provided with markings that comply with the provisions of Section 3B.10 and Chapter 3I.**

Option:

- 08 Longitudinal pavement markings may be omitted alongside toll booth islands between the approach markings and any departure markings.

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## CHAPTER 3F. DELINEATORS

### **Section 3F.01 Delineators**

Support:

- 01 Delineators are particularly beneficial at locations where the alignment might be confusing or unexpected, such as at lane reduction transitions and curves. Delineators are effective guidance devices at night and during adverse weather. An important advantage of delineators in certain locations is that they remain visible when the roadway is wet or snow covered.
- 02 Delineators are considered guidance devices rather than warning devices.

Option:

- 03 Delineators may be used on long continuous sections of highway or through short stretches where there are changes in horizontal alignment.

### **Section 3F.02 Delineator Design**

**Standard:**

- 01 **Delineators shall consist of retroreflective devices that are capable of clearly retroreflecting light under normal atmospheric conditions from a distance of 1,000 feet when illuminated by the high beams of standard automobile lights.**
- 02 **Retroreflective elements for delineators shall have a minimum dimension of 3 inches.**

Support:

- 03 Within a series of delineators along a roadway, delineators for a given direction of travel at a specific location are referred to as single delineators if they have one retroreflective element for that direction, double delineators if they have two identical retroreflective elements for that direction mounted together, or vertically elongated delineators if they have a single retroreflective element with an elongated vertical dimension to approximate the vertical dimension of two separate single delineators.

Option:

- 04 A vertically elongated delineator of appropriate size may be used in place of a double delineator.

### **Section 3F.03 Delineator Application**

**Standard:**

- 01 **The color of delineators shall comply with the color of edge lines stipulated in Section 3B.06.**
- 02 **A series of single delineators shall be provided on the right-hand side of freeways and expressways and on at least one side of interchange ramps, except when either Condition A or condition B is met, as follows:**
- A. On tangent sections of freeways and expressways when both of the following conditions are met:**
- 1. Raised pavement markers are used continuously on lane lines throughout all curves and on all tangents to supplement pavement markings, and**
- 2. Roadside delineators are used to lead into all curves.**
- B. On sections of roadways where continuous lighting is in operation between interchanges.**

Option:

- 03 Delineators may be provided on other classes of roads. A series of single delineators may be provided on the left-hand side of roadways.

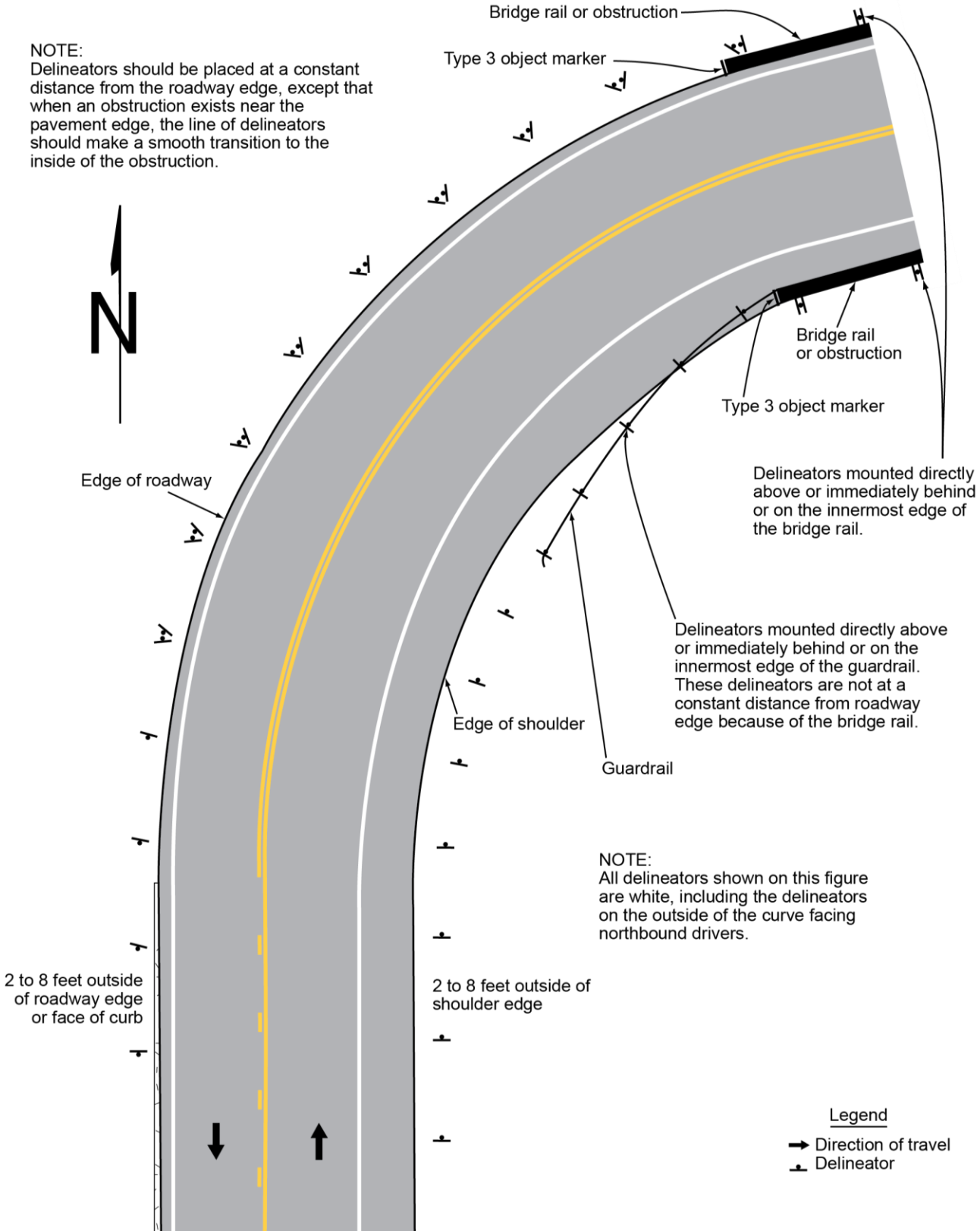
**Standard:**

- 04 **Delineators on the left-hand side of a two-way roadway shall be white (see Figure 3F-1).**

*Guidance:*

- 05 *A series of single delineators should be provided on the outside of curves on interchange ramps.*
- 06 *Where median crossovers are provided for official or emergency use on divided highways and where these crossovers are to be marked, a double yellow delineator should be placed on the left-hand side of the through roadway on the far side of the crossover for each roadway.*

Figure 3F-1. Examples of Delineator Placement



07 *Double or vertically elongated delineators should be installed at 100-foot intervals along acceleration and deceleration lanes.*

08 *A series of delineators should be used wherever guardrail or other longitudinal barriers are present along a roadway or ramp.*

Option:

09 *Red delineators may be used on the reverse side of any delineator where it would be viewed by a road user traveling in the wrong direction on that particular ramp or roadway.*

10 *Delineators of the appropriate color may be used to indicate a lane reduction transition where either an outside or inside lane merges into an adjacent lane.*

Guidance:

11 *When used for lane reduction transitions, the delineators should be installed adjacent to the lane or lanes reduced for the full length of the transition and should be so placed and spaced to show the reduction (see Figure 3B-14).*

Support:

12 *Delineators are not necessary for traffic moving in the direction of a wider pavement or on the side of the roadway where the alignment is not affected by the lane reduction transition.*

Guidance:

13 *On a highway with continuous delineation on either or both sides, delineators should be carried through transitions.*

Option:

14 *On a highway with continuous delineation on either or both sides, the spacing between a series of delineators may be closer.*

**Standard:**

15 **When used on a truck escape ramp, delineators shall be red.**

Guidance:

16 *Red delineators should be placed on both sides of truck escape ramps. The delineators should be spaced at 50-foot intervals for a distance sufficient to identify the ramp entrance. Delineator spacing beyond the ramp entrance should be adequate for guidance according to the length and design of the escape ramp.*

### **Section 3F.04 Delineator Placement and Spacing**

Guidance:

01 *Delineators should be mounted on suitable supports at a mounting height, measured vertically from the bottom of the the lowest retroreflective device to the elevation of the near edge of the roadway, of approximately 4 feet.*

Option:

02 *When mounted on the face of or on top of guardrails or other longitudinal barriers, delineators may be mounted at a lower elevation than the normal delineator height recommended in Paragraph 1.*

Guidance:

03 *Delineators should be placed 2 to 8 feet outside the outer edge of the shoulder, or if appropriate, in line with the roadside barrier that is 8 feet or less outside the outer edge of the shoulder.*

04 *Delineators should be placed at a constant distance from the edge of the roadway, except that where an obstruction intrudes into the space between the pavement edge and the extension of the line of the delineators, the delineators should be transitioned to be in line with or inside the innermost edge of the obstruction. If the obstruction is a guardrail or other longitudinal barrier, the delineators should be transitioned to be just behind, directly above (in line with), or on the innermost edge of the guardrail or longitudinal barrier.*

05 *Delineators should be spaced 200 to 530 feet apart on mainline tangent sections. Delineators should be spaced 100 feet apart on ramp tangent sections.*

06 Examples of delineator installations are shown in Figure 3F-1.

Option:

07 When uniform spacing is interrupted by such features as driveways and intersections, delineators which would ordinarily be located within the features may be relocated in either direction for a distance not exceeding one quarter of the uniform spacing. Delineators still falling within such features may be eliminated.

08 Delineators may be transitioned in advance of a lane transition or obstruction as a guide for oncoming traffic.

Guidance:

09 *The spacing of delineators should be adjusted on approaches to and throughout horizontal curves so that several delineators are always simultaneously visible to the road user. The approximate spacing shown in Table 3F-1 should be used.*

Option:

10 When needed for special conditions, delineators of the appropriate color may be mounted in a closely-spaced manner on the face of or on top of guardrails or other longitudinal barriers to form a continuous or nearly continuous “ribbon” of delineation.

**Table 3F-1. Approximate Spacing for Delineators on Horizontal Curves**

Radius (R) of Curve	Approximate Spacing (S) on Curve
50 feet	20 feet
115 feet	25 feet
180 feet	35 feet
250 feet	40 feet
300 feet	50 feet
400 feet	55 feet
500 feet	65 feet
600 feet	70 feet
700 feet	75 feet
800 feet	80 feet
900 feet	85 feet
1,000 feet	90 feet

Notes:

- Spacing for specific radii may be interpolated from table.
- The minimum spacing should be 20 feet.
- The spacing on curves should not exceed 300 feet.
- In advance of or beyond a curve, and proceeding away from the end of the curve, the spacing of the first delineator is 2S, the second 3S, and the third 6S but not to exceed 300 feet.
- S refers to the delineator spacing for specific radii computed from the formula  $S=3\sqrt{R-50}$ .
- The distances for S shown in the table above were rounded to the nearest 5 feet.

**CHAPTER 3G. COLORED PAVEMENTS****Section 3G.01 General****Support:**

- 01 Colored pavements consist of differently colored road paving materials, such as colored asphalt or concrete, or paint or other marking materials applied to the surface of a road or island to simulate a colored pavement.
- 02 If non-retroreflective colored pavement, including bricks and other types of patterned surfaces, is used as a purely aesthetic treatment and is not intended to communicate a regulatory, warning, or guidance message to road users, the colored pavement is not considered to be a traffic control device, even if it is located between the lines of a crosswalk.

**Standard:**

- 03 **If colored pavement is used within the traveled way, on flush or raised islands, or on shoulders to regulate, warn, or guide traffic or if retroreflective colored pavement is used, the colored pavement is considered to be a traffic control device and shall be limited to the following colors and applications:**
- A. **Yellow pavement color shall be used only for flush or raised median islands separating traffic flows in opposite directions or for left-hand shoulders of roadways of divided highways or one-way streets or ramps.**
  - B. **White pavement color shall be used for flush or raised channelizing islands where traffic passes on both sides in the same general direction or for right-hand shoulders.**
- 04 **Colored pavements shall not be used as a traffic control device, unless the device is applicable at all times.**

*Guidance:*

- 05 *Colored pavements used as traffic control devices should be used only where they contrast significantly with adjoining paved areas.*
- 06 *Colored pavement located between crosswalk lines should not use colors or patterns that degrade the contrast of white crosswalk lines, or that might be mistaken by road users as a traffic control application.*

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

### Section 3H.01 Channelizing Devices

#### Option:

- 01 Channelizing devices, as described in Sections 6F.63 through 6F.73, and 6F.75, and as shown in Figure 6F-7, such as cones, tubular markers, vertical panels, drums, lane separators, and raised islands, may be used for general traffic control purposes such as adding emphasis to reversible lane delineation, channelizing lines, or islands. Channelizing devices may also be used along a center line to preclude turns or along lane lines to preclude lane changing, as determined by engineering judgment.

#### Standard:

- 02 **Except for color, the design of channelizing devices, including but not limited to retroreflectivity, minimum dimensions, and mounting height, shall comply with the provisions of Chapter 6F.**
- 03 **The color of channelizing devices used outside of temporary traffic control zones shall be either orange or the same color as the pavement marking that they supplement, or for which they are substituted.**
- 04 **For nighttime use, channelizing devices shall be retroreflective (as described in Part 6) or internally illuminated. On channelizing devices used outside of temporary traffic control zones, retroreflective sheeting or bands shall be white if the devices separate traffic flows in the same direction and shall be yellow if the devices separate traffic flows in the opposite direction or are placed along the left-hand edge line of a one-way roadway or ramp.**

#### Guidance:

- 05 *Channelizing devices should be kept clean and bright to maximize target value.*

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## CHAPTER 3I. ISLANDS

### **Section 3I.01 General**

Support:

- 01 This Chapter addresses the characteristics of islands (see definition in Section 1A.13) as traffic-control devices. Criteria for the design of islands are set forth in “A Policy on Geometric Design of Highways and Streets” (see Section 1A.11).

Option:

- 02 An island may be designated by curbs, pavement edges, pavement markings, channelizing devices, or other devices.

### **Section 3I.02 Approach-End Treatment**

*Guidance:*

- 01 *The ends of islands first approached by traffic should be preceded by diverging longitudinal pavement markings on the roadway surface, to guide vehicles into desired paths of travel along the island edge.*

Support:

- 02 The neutral area between approach-end markings that can be readily crossed even at considerable speed sometimes contains slightly raised (usually less than 1 inch high) sections of coarse aggregate or other suitable materials to create rumble sections that provide increased visibility of the marked areas and that produce an audible warning to road users traveling across them. For additional discouragement to driving in the neutral area, bars or buttons projecting 1 to 3 inches above the pavement surface are sometimes placed in the neutral area. These bars or buttons are designed so that any wheel encroachment within the area will be obvious to the vehicle operator, but will result in only minimal effects on control of the vehicle. Such bars or buttons are sometimes preceded by rumble sections or their height is gradually increased as approached by traffic.

*Guidance:*

- 03 *When raised bars or buttons are used in these neutral areas, they should be marked with white or yellow retroreflective materials, as determined by the direction or directions of travel they separate.*

**Standard:**

- 04 **Channelizing devices, when used in advance of islands having raised curbs, shall not be placed in such a manner as to constitute an unexpected obstacle.**

Option:

- 05 Pavement markings may be used with raised bars to better designate the island area.

### **Section 3I.03 Island Marking Application**

**Standard:**

- 01 **Markings, as related to islands, shall consist only of pavement and curb markings, channelizing devices, and delineators.**

Option:

- 02 Pavement markings as described in Section 3B.10 for the approach to an obstruction may be omitted on the approach to a particular island based on engineering judgment.

### **Section 3I.04 Island Marking Colors**

*Guidance:*

- 01 *Islands outlined by curbs or pavement markings should be marked with retroreflective white or yellow material as determined by the direction or directions of travel they separate (see Section 3A.05).*
- 02 *The retroreflective area should be of sufficient length to denote the general alignment of the edge of the island along which vehicles travel, including the approach end, when viewed from the approach to the island.*

## Option:

- 03 On long islands, curb retroreflection may be discontinued such that it does not extend for the entire length of the curb, especially if the island is illuminated or marked with delineators or edge lines.

**Section 3I.05 Island Delineation****Standard:**

- 01 **Delineators installed on islands shall be the same colors as the related edge lines except that, when facing wrong-way traffic, they shall be red (see Section 3F.03).**
- 02 **Each roadway through an intersection shall be considered separately in positioning delineators to assure maximum effectiveness.**

## Option:

- 03 Retroreflective or internally illuminated raised pavement markers of the appropriate color may be placed on the pavement in front of the curb and/or on the top of curbed approach ends of raised medians and curbs of islands, as a supplement to or as a substitute for retroreflective curb markings.

**Section 3I.06 Pedestrian Islands and Medians****Support:**

- 01 Raised islands or medians of sufficient width that are placed in the center area of a street or highway can serve as a place of refuge for pedestrians who are attempting to cross at a midblock or intersection location. Center islands or medians allow pedestrians to find an adequate gap in one direction of traffic at a time, as the pedestrians are able to stop, if necessary, in the center island or median area and wait for an adequate gap in the other direction of traffic before crossing the second half of the street or highway. The minimum widths for accessible refuge islands and for design and placement of detectable warning surfaces are provided in the “Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)” (see Section 1A.11).

## CHAPTER 3J. RUMBLE STRIP MARKINGS

### Section 3J.01 Longitudinal Rumble Strip Markings

Support:

01 Longitudinal rumble strips consist of a series of rough-textured or slightly raised or depressed road surfaces intended to alert inattentive drivers through vibration and sound that their vehicle has left the travel lane. Shoulder rumble strips are typically installed along the shoulder near the travel lane. On divided highways, rumble strips are sometimes installed on the median side (left-hand side) shoulder as well as on the outside (right-hand side) shoulder. On two-way roadways, rumble strips are sometimes installed along the center line.

02 This Manual contains no provisions regarding the design and placement of longitudinal rumble strips. The provisions in this Manual address the use of markings in combination with a longitudinal rumble strip.  
Option:

03 An edge line or center line may be located over a longitudinal rumble strip to create a rumble stripe.

**Standard:**

04 **The color of an edge line or center line associated with a longitudinal rumble stripe shall be in accordance with Section 3A.05.**

05 **An edge line shall not be used in addition to a rumble stripe that is located along a shoulder.**

Support:

06 Figure 3J-1 illustrates markings used with or near longitudinal rumble strips.

### Section 3J.02 Transverse Rumble Strip Markings

Support:

01 Transverse rumble strips consist of intermittent narrow, transverse areas of rough-textured or slightly raised or depressed road surface that extend across the travel lanes to alert drivers to unusual vehicular traffic conditions. Through noise and vibration, they attract the attention of road users to features such as unexpected changes in alignment and conditions requiring a reduction in speed or a stop.

02 This Manual contains no provisions regarding the design and placement of transverse rumble strips that approximate the color of the pavement. The provisions in this Manual address the use of markings in combination with a transverse rumble strip.

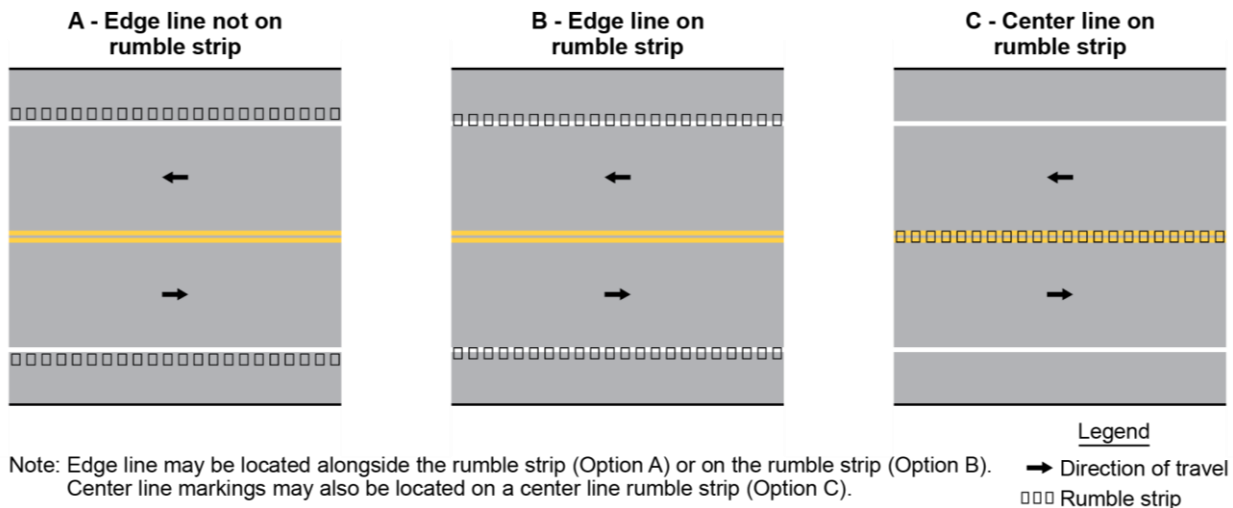
**Standard:**

03 **Except as otherwise provided in Section 6F.87 for TTC zones, if the color of a transverse rumble strip used within a travel lane is not the color of the pavement, the color of the transverse rumble strip shall be either black or white.**

*Guidance:*

04 *White transverse rumble strips used in a travel lane should not be placed in locations where they could be confused with other transverse markings such as stop lines or crosswalks.*

**Figure 3J-1. Examples of Longitudinal Rumble Strip Markings**



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**PART 4. HIGHWAY TRAFFIC SIGNALS****CHAPTER 4A. GENERAL****Section 4A.01 Types**

Support:

- 01 The following types and uses of highway traffic signals are discussed in Part 4: traffic control signals; pedestrian signals; hybrid beacons; emergency-vehicle signals; traffic control signals for one-lane, two-way facilities; traffic control signals for freeway entrance ramps; traffic control signals for movable bridges; toll plaza traffic signals; flashing beacons; lane-use control signals; and in-roadway lights.

**Section 4A.02 Definitions Relating to Highway Traffic Signals**

Support:

- 01 Definitions and acronyms pertaining to Part 4 are provided in Section 1A.13 and 1A.14.

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## CHAPTER 4B. TRAFFIC CONTROL SIGNALS—GENERAL

### Section 4B.01 General

Support:

- 01 Words such as pedestrians and bicyclists are used redundantly in selected sections of Part 4 to encourage sensitivity to these elements of “traffic.”
- 02 Standards for traffic control signals are important because traffic control signals need to attract the attention of a variety of road users, including those who are older, those with impaired vision, as well as those who are fatigued or distracted, or who are not expecting to encounter a signal at a particular location.

### Section 4B.02 Basis of Installation or Removal of Traffic Control Signals

*Guidance:*

- 01 *The selection and use of traffic control signals should be based on an engineering study of roadway, traffic, and other conditions.*

Support:

- 02 A careful analysis of traffic operations, pedestrian and bicyclist needs, and other factors at a large number of signalized and unsignalized locations, coupled with engineering judgment, has provided a series of signal warrants, described in Chapter 4C, that define the minimum conditions under which installing traffic control signals might be justified.

*Guidance:*

- 03 *Engineering judgment should be applied in the review of operating traffic control signals to determine whether the type of installation and the timing program meet the current requirements of all forms of traffic.*
- 04 *If changes in traffic patterns eliminate the need for a traffic control signal, consideration should be given to removing it and replacing it with appropriate alternative traffic control devices, if any are needed.*
- 05 *If the engineering study indicates that the traffic control signal is no longer justified, and a decision is made to remove the signal, removal should be accomplished using the following steps:*
- A. *Determine the appropriate traffic control to be used after removal of the signal.*
  - B. *Remove any sight-distance restrictions as necessary.*
  - C. *Inform the public of the removal study.*
  - D. *Flash or cover the signal heads for a minimum of 90 days, and install the appropriate stop control or other traffic control devices.*
  - E. *Remove the signal if the engineering data collected during the removal study period confirms that the signal is no longer needed.*

Option:

- 06 Because Items C, D, and E in Paragraph 5 are not relevant when a temporary traffic control signal (see Section 4D.32) is removed, a temporary traffic control signal may be removed immediately after Items A and B are completed.
- 07 Instead of total removal of the traffic control signal, the poles, controller cabinet, and cables may remain in place after removal of the signal heads for continued analysis.

Support:

- 08 Various methods are available for informing the public of the removal study, including a media campaign, and/or an informational sign (or signs) such as the SIGNAL UNDER STUDY FOR REMOVAL (W3-H12) sign installed at the signalized location in a position where it is visible to all road users (see Appendix C).

### Section 4B.03 Advantages and Disadvantages of Traffic Control Signals

Support:

- 01 When properly used, traffic control signals are valuable devices for the control of vehicular and pedestrian traffic. They assign the right-of-way to the various traffic movements and thereby profoundly influence traffic flow.
- 02 Traffic control signals that are properly designed, located, operated, and maintained will have one or more of the following advantages:

- A. They provide for the orderly movement of traffic.
- B. They increase the traffic-handling capacity of the intersection if:
  1. Proper physical layouts and control measures are used, and
  2. The signal operational parameters are reviewed and updated (if needed) on a regular basis (as engineering judgment determines that significant traffic flow and/or land use changes have occurred) to maximize the ability of the traffic control signal to satisfy current traffic demands.
- C. They reduce the frequency and severity of certain types of crashes, especially right-angle collisions.
- D. They are coordinated to provide for continuous or nearly continuous movement of traffic at a definite speed along a given route under favorable conditions.
- E. They are used to interrupt heavy traffic at intervals to permit other traffic, vehicular or pedestrian, to cross.

03 Traffic control signals are often considered a panacea for all traffic problems at intersections. This belief has led to traffic control signals being installed at many locations where they are not needed, adversely affecting the safety and efficiency of vehicular, bicycle, and pedestrian traffic.

04 Traffic control signals, even when justified by traffic and roadway conditions, can be ill-designed, ineffectively placed, improperly operated, or poorly maintained. Improper or unjustified traffic control signals can result in one or more of the following disadvantages:

- A. Excessive delay,
- B. Excessive disobedience of the signal indications,
- C. Increased use of less adequate routes as road users attempt to avoid the traffic control signals, and
- D. Significant increases in the frequency of collisions (especially rear-end collisions).

#### **Section 4B.04 Alternatives to Traffic Control Signals**

##### *Guidance:*

01 *Since vehicular delay and the frequency of some types of crashes are sometimes greater under traffic signal control than under STOP sign control, consideration should be given to providing alternatives to traffic control signals even if one or more of the signal warrants has been satisfied.*

##### *Option:*

02 These alternatives may include, but are not limited to, the following:

- A. Installing signs along the major street to warn road users approaching the intersection;
- B. Relocating the stop line(s) and making other changes to improve the sight distance at the intersection;
- C. Installing measures designed to reduce speeds on the approaches;
- D. Installing a flashing beacon at the intersection to supplement STOP sign control;
- E. Installing flashing beacons on warning signs in advance of a STOP sign controlled intersection on major- and/or minor-street approaches;
- F. Adding one or more lanes on a minor-street approach to reduce the number of vehicles per lane on the approach;
- G. Revising the geometrics at the intersection to channelize vehicular movements and reduce the time required for a vehicle to complete a movement, which could also assist pedestrians;
- H. Revising the geometrics at the intersection to add pedestrian median refuge islands and/or curb extensions;
- I. Installing roadway lighting if a disproportionate number of crashes occur at night;
- J. Restricting one or more turning movements, perhaps on a time-of-day basis, if alternate routes are available;
- K. If the warrant is satisfied, installing multi-way STOP sign control;
- L. Installing a pedestrian hybrid beacon (see Chapter 4F) or In-Roadway Warning Lights (see Chapter 4N) if pedestrian safety is the major concern;
- M. Installing a roundabout; and
- N. Employing other alternatives, depending on conditions at the intersection.

### **Section 4B.05 Adequate Roadway Capacity**

#### **Support:**

- 01 The delays inherent in the alternating assignment of right-of-way at intersections controlled by traffic control signals can frequently be reduced by widening the major roadway, the minor roadway, or both roadways. Widening the minor roadway often benefits the operations on the major roadway, because it reduces the green time that must be assigned to minor-roadway traffic. In urban areas, the effect of widening can be achieved by eliminating parking on intersection approaches. It is desirable to have at least two lanes for moving traffic on each approach to a signalized location. Additional width on the departure side of the intersection, as well as on the approach side, will sometimes be needed to clear traffic through the intersection effectively.

#### *Guidance:*

- 02 *Adequate roadway capacity should be provided at a signalized location. Before an intersection is widened, the additional green time pedestrians need to cross the widened roadways should be considered to determine if it will exceed the green time saved through improved vehicular flow.*
- 03 *Other methods of increasing the roadway capacity at signalized locations that do not involve roadway widening, such as revisions to the pavement markings and the careful evaluation of proper lane-use assignments (including varying the lane use by time of day), should be considered where appropriate. Such consideration should include evaluation of any impacts that changes to pavement markings and lane assignments will have on bicycle travel.*

### **Section 4B.06 Traffic Signals on State Highway Extensions in Villages**

#### **Standard:**

- 01 **As noted in Section 4511.11(C) of the Ohio Revised Code (ORC) (see Appendix B2): “No village shall place or maintain any traffic control signal upon an extension of the state highway system within the village without first obtaining the permission of the director.”**

#### **Support:**

- 02 Section 4511.11(C) of the ORC also states that “the director may revoke the permission and may require to be removed any traffic control signal that has been erected without the director’s permission on an extension of a state highway within a village, or that, if erected under a permit granted by the director, does not conform to the state manual and specifications, or that is not operated in accordance with the terms of the permit.”

#### *Guidance:*

- 03 *Requests from village authorities for permission to install and operate traffic control signals on state highway extensions within villages (village signal permits) should be submitted to the ODOT District Deputy Director in accordance with the procedures, and using the forms, in Part 4 of the ODOT “Traffic Engineering Manual” (TEM) (see Section 1A.11).*

#### **Support:**

- 04 The instructions and forms for submitting village signal permit requests are also available from each ODOT District Office.
- 05 Traffic control signal needs studies are discussed in Chapter 4C of this Manual. Additional information about preparing traffic studies is available in various traffic engineering publications, including the ODOT TEM (see Section 1A.11).

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## CHAPTER 4C. TRAFFIC CONTROL SIGNAL NEEDS STUDIES

### Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

#### Standard:

- 01 **An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.**
- 02 **The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants:**
- Warrant 1, Eight-Hour Vehicular Volume**
  - Warrant 2, Four-Hour Vehicular Volume**
  - Warrant 3, Peak Hour**
  - Warrant 4, Pedestrian Volume**
  - Warrant 5, School Crossing**
  - Warrant 6, Coordinated Signal System**
  - Warrant 7, Crash Experience**
  - Warrant 8, Roadway Network**
  - Warrant 9, Intersection Near a Grade Crossing**

- 03 **The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.**

#### Support:

- 04 Sections 8C.09 and 8C.10 contain information regarding the use of traffic control signals instead of gates and/or flashing light signals at highway-rail grade crossings and highway-light rail transit grade crossings, respectively.

#### Guidance:

- 05 *A traffic control signal should not be installed unless one or more of the factors described in this Chapter are met.*
- 06 *A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.*
- 07 *A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.*
- 08 *The study should consider the effects of the right-turn vehicles from the minor-street approaches. Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the signal warrants listed in Paragraph 2.*
- 09 *Engineering judgment should also be used in applying various traffic signal warrants to cases where approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic characteristics should dictate whether an approach is considered as one lane or two lanes. For example, for an approach with one lane for through and right-turning traffic plus a left-turn lane, if engineering judgment indicates that it should be considered a one-lane approach because the traffic using the left-turn lane is minor, the total traffic volume approaching the intersection should be applied against the signal warrants as a one-lane approach. The approach should be considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane is of sufficient length to accommodate all left-turn vehicles.*
- 10 *Similar engineering judgment and rationale should be applied to a street approach with one through/left-turn lane plus a right-turn lane. In this case, the degree of conflict of minor-street right-turn traffic with traffic on the major street should be considered. Thus, right-turn traffic should not be included in the minor-street volume if the movement enters the major street with minimal conflict. The approach should be evaluated as a one-lane approach with only the traffic volume in the through/left-turn lane considered.*
- 11 *At a location that is under development or construction and where it is not possible to obtain a traffic count that would represent future traffic conditions, hourly volumes should be estimated as part of an engineering study for comparison with traffic signal warrants. Except for locations where the engineering*

*study uses the satisfaction of Warrant 8 to justify a signal, a traffic control signal installed under projected conditions should have an engineering study done within 1 year of putting the signal into stop-and-go operation to determine if the signal is justified. If not justified, the signal should be taken out of stop-and-go operation or removed.*

- 12 For signal warrant analysis, a location with a wide median, even if the median width is greater than 30 feet, should be considered as one intersection.

Option:

- 13 At an intersection with a high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the “minor-street” volume and the corresponding single direction of opposing traffic on the major street as the “major-street” volume.

- 14 For signal warrants requiring conditions to be present for a certain number of hours in order to be satisfied, any four sequential 15-minute periods may be considered as 1 hour if the separate 1-hour periods used in the warrant analysis do not overlap each other and both the major-street volume and the minor-street volume are for the same specific one-hour periods.

- 15 For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians.

Support:

- 16 When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually counted as pedestrians.

Option:

- 17 Engineering study data may include the following:

- A. The number of vehicles entering the intersection in each hour from each approach during 12 hours of an average day. It is desirable that the hours selected contain the greatest percentage of the 24-hour traffic volume.
- B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations, bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the afternoon during which total traffic entering the intersection is greatest.
- C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in Item B and during hours of highest pedestrian volume. Where young, elderly, and/or persons with physical or visual disabilities need special consideration, the pedestrians and their crossing times may be classified by general observation.
- D. Information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities, including requests from persons with disabilities for accessible crossing improvements at the location under study. These persons might not be adequately reflected in the pedestrian volume count if the absence of a signal restrains their mobility.
- E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to the location.
- F. A condition diagram showing details of the physical layout, including such features as intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and routes, parking conditions, pavement markings, roadway lighting, driveways, nearby railroad crossings, distance to nearest traffic control signals, utility poles and fixtures, and adjacent land use.
- G. A collision diagram showing crash experience by type, location, direction of movement, severity, weather, time of day, date, and day of week for at least 1 year.

- 18 The following data, which are desirable for a more precise understanding of the operation of the intersection, may be obtained during the periods described in Item B of Paragraph 17:

- A. Vehicle-hours of stopped time delay determined separately for each approach.
- B. The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.
- C. The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.

- D. Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.
- E. Queue length on stop-controlled approaches.

### **Section 4C.02 Warrant 1, Eight-Hour Vehicular Volume**

#### **Support:**

- 01 The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.
- 02 The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.
- 03 It is intended that Warrant 1 be treated as a single warrant. If Condition A is satisfied, then Warrant 1 is satisfied and analysis of Condition B and the combination of Conditions A and B are not needed. Similarly, if Condition B is satisfied, then Warrant 1 is satisfied and an analysis of the combination of Conditions A and B is not needed.

#### **Standard:**

- 04 **The need for a traffic control signal shall be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:**
  - A. **The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or**
  - B. **The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.**

**In applying each condition the major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of these 8 hours.**

#### **Option:**

- 05 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 70 percent columns in Table 4C-1 may be used in place of the 100 percent columns.

#### **Guidance:**

- 06 *The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied, and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.*

#### **Standard:**

- 07 **The need for a traffic control signal shall be considered if an engineering study finds that both of the following conditions exist for each of any 8 hours of an average day:**
  - A. **The vehicles per hour given in both of the 80 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; and**
  - B. **The vehicles per hour given in both of the 80 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.**

**These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied in Condition B. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.**

**Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume****Condition A—Minimum Vehicular Volume**

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% <sup>a</sup>	80% <sup>b</sup>	70% <sup>c</sup>	56% <sup>d</sup>	100% <sup>a</sup>	80% <sup>b</sup>	70% <sup>c</sup>	56% <sup>d</sup>
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

**Condition B—Interruption of Continuous Traffic**

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% <sup>a</sup>	80% <sup>b</sup>	70% <sup>c</sup>	56% <sup>d</sup>	100% <sup>a</sup>	80% <sup>b</sup>	70% <sup>c</sup>	56% <sup>d</sup>
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

<sup>a</sup> Basic minimum hourly volume.

<sup>b</sup> Used for combination of Conditions A and B after adequate trial of other remedial measures.

<sup>c</sup> May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000.

<sup>d</sup> May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000.

**Option:**

- 08 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

**Section 4C.03 Warrant 2, Four-Hour Vehicular Volume****Support:**

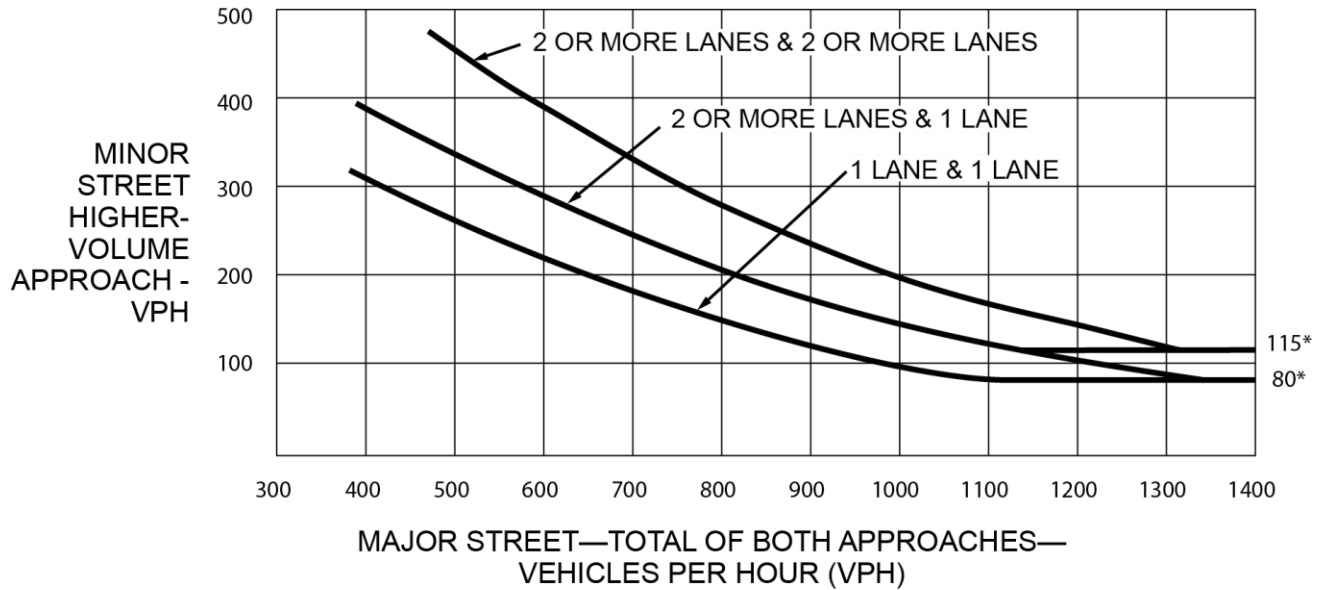
- 01 The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

**Standard:**

- 02 **The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.**

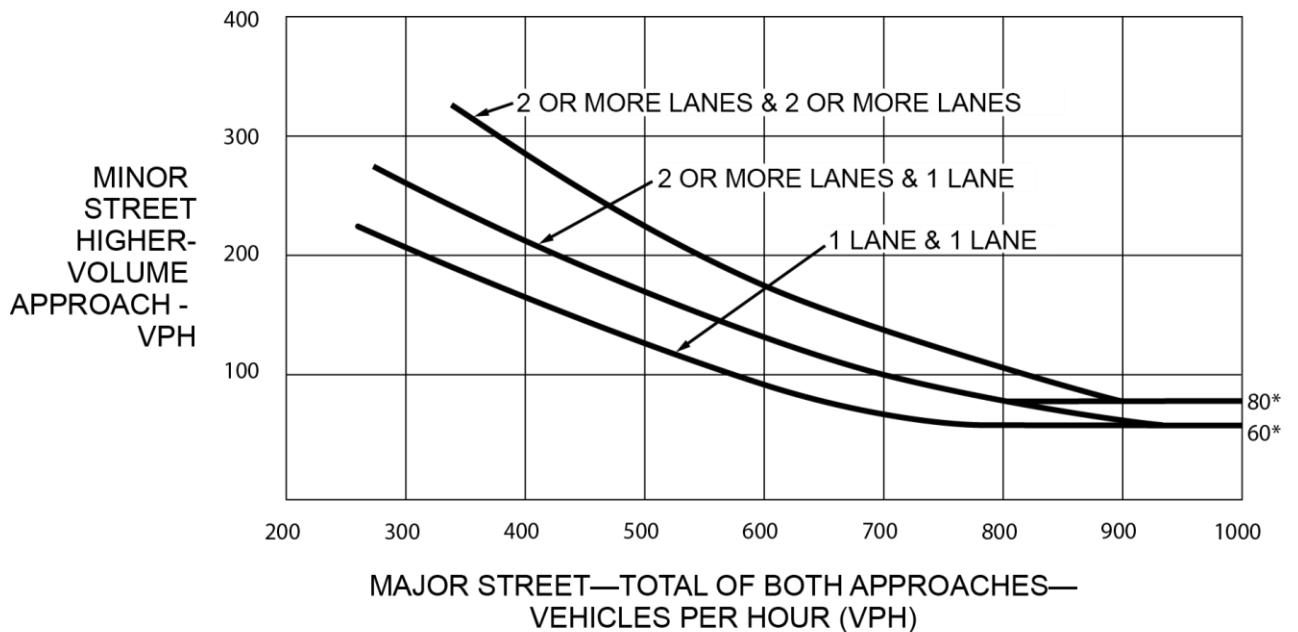


**Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume**



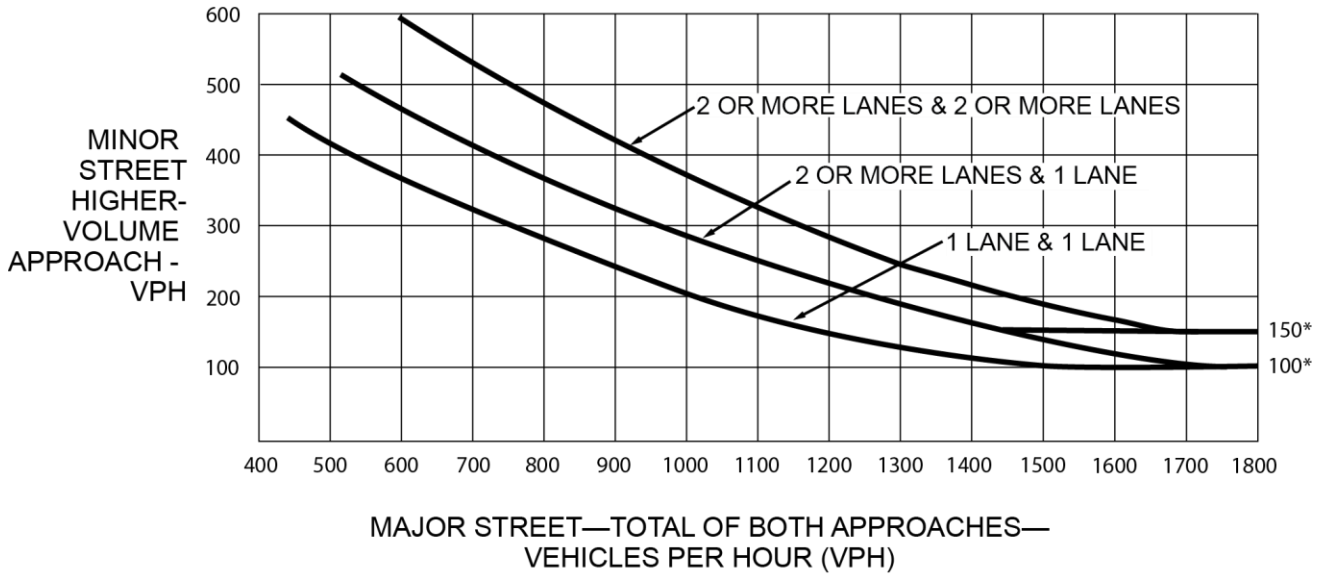
\*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

**Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)**  
(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 mph ON MAJOR STREET)



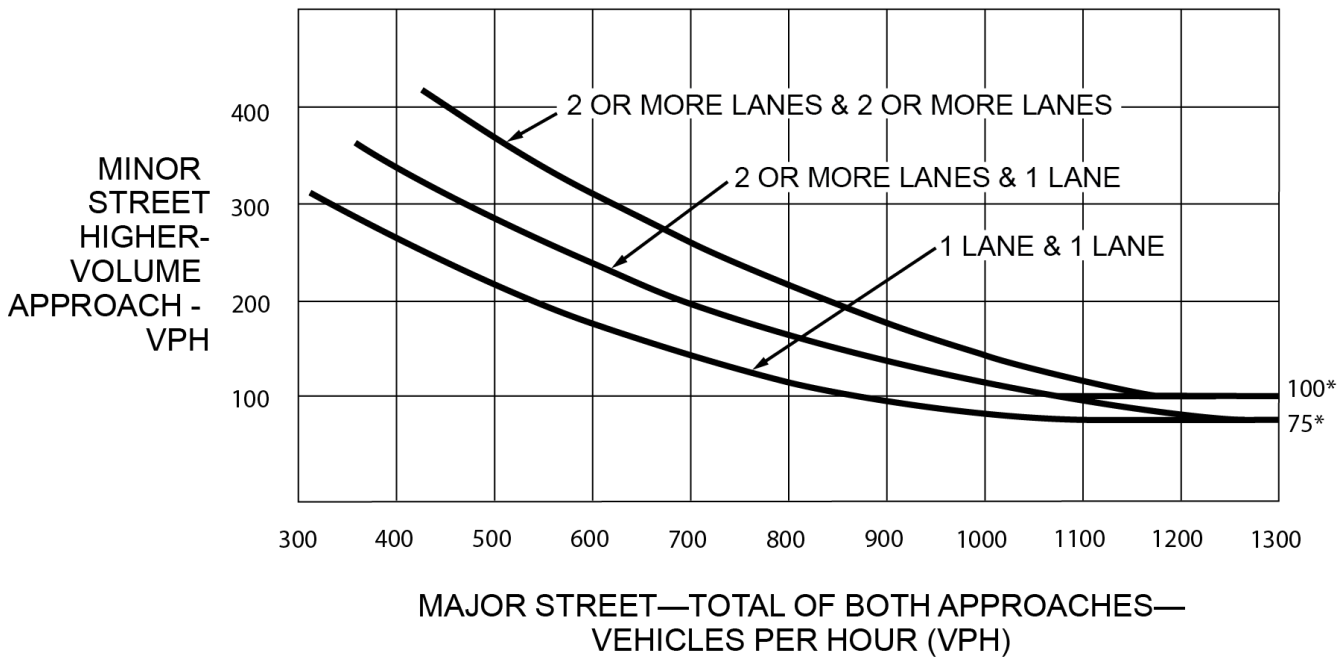
\*Note: 80 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor-street approach with one lane.

**Figure 4C-3. Warrant 3, Peak Hour**



\*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

**Figure 4C-4. Warrant 3, Peak Hour (70% Factor)**  
(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 mph ON MAJOR STREET)



\*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

- 03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-2 may be used in place of Figure 4C-1.

#### **Section 4C.04 Warrant 3, Peak Hour**

Support:

- 01 The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

**Standard:**

- 02 **This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.**
- 03 **The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:**
- A. **If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:**
    - 1. **The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach; or 5 vehicle-hours for a two-lane approach; and**
    - 2. **The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and**
    - 3. **The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.**
  - B. **The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3 for the existing combination of approach lanes.**

Option:

- 04 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-4 may be used in place of Figure 4C-3 to evaluate the criteria in the second category of the Standard.

- 05 If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal may be operated in the flashing mode during the hours that the volume criteria of this warrant are not met.

*Guidance:*

- 06 *If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal should be traffic-actuated.*

#### **Section 4C.05 Warrant 4, Pedestrian Volume**

Support:

- 01 The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

**Standard:**

- 02 **The need for a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that one of the following criteria is met:**
- A. **For each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) all fall above the curve in Figure 4C-5; or**
  - B. **For 1 hour (any four consecutive 15-minute periods) of an average day, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) falls above the curve in Figure 4C-7.**

## Option:

- 03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 35 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-6 may be used in place of Figure 4C-5 to evaluate Criterion A in Paragraph 2, and Figure 4C-8 may be used in place of Figure 4C-7 to evaluate Criterion B in Paragraph 2.

**Standard:**

- 04 **The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal or STOP sign controlling the street that pedestrians desire to cross is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.**
- 05 **If this warrant is met and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads complying with the provisions set forth in Chapter 4E.**

*Guidance:*

- 06 *If this warrant is met and a traffic control signal is justified by an engineering study, then:*
- A. *If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.*
  - B. *If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.*
  - C. *Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.*

## Option:

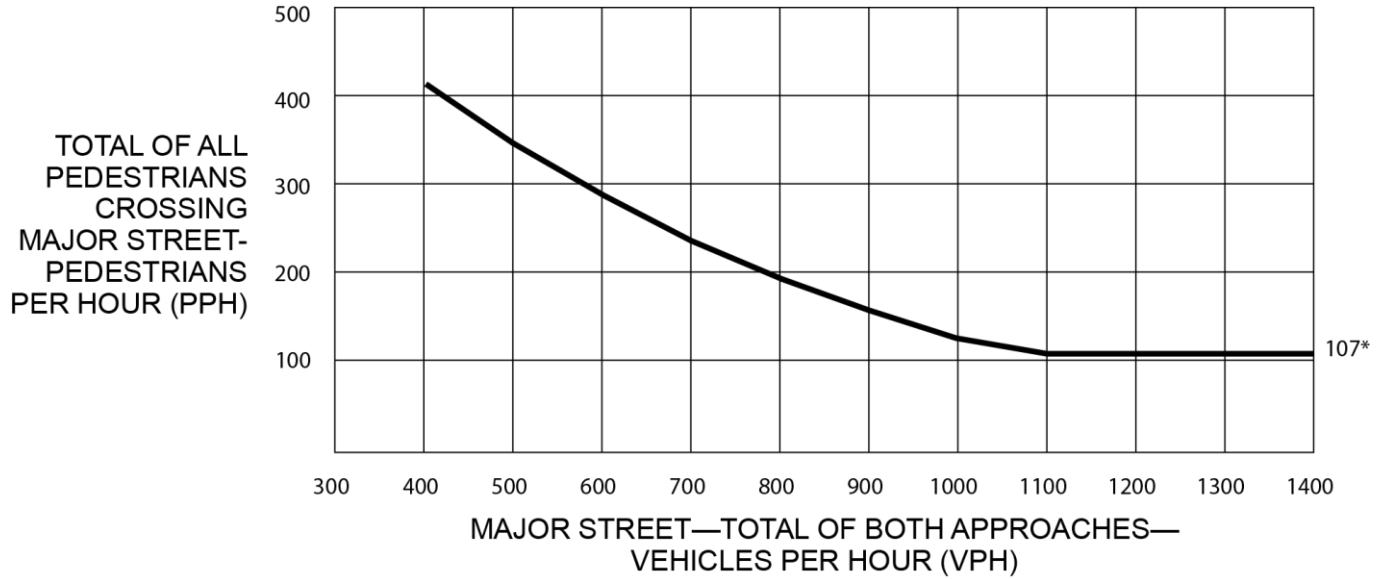
- 07 The criterion for the pedestrian volume crossing the major street may be reduced as much as 50 percent if the 15th-percentile crossing speed of pedestrians is less than 3.5 feet per second.
- 08 A traffic control signal may not be needed at the study location if adjacent coordinated traffic control signals consistently provide gaps of adequate length for pedestrians to cross the street.

**Section 4C.06 Warrant 5, School Crossing**

## Support:

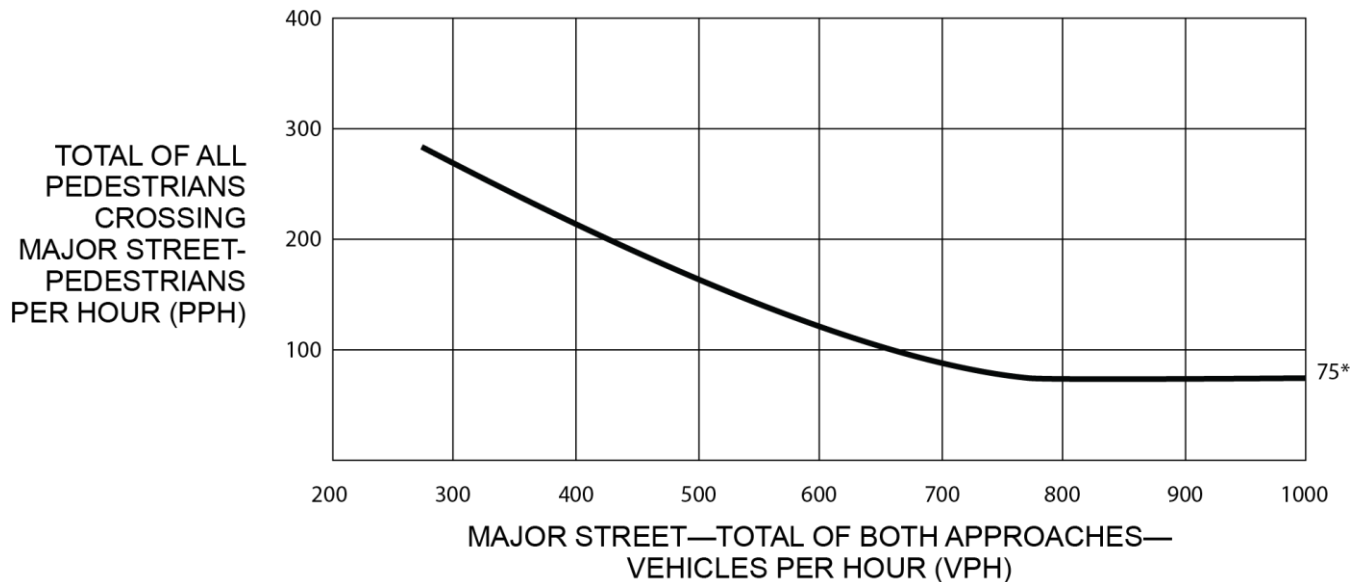
- 01 The School Crossing signal warrant is intended for application where the fact that schoolchildren cross the major street is the principal reason to consider installing a traffic control signal. For the purposes of this warrant, the word “schoolchildren” includes elementary through high school students.

**Figure 4C-5. Warrant 4, Pedestrian Four-Hour Volume**



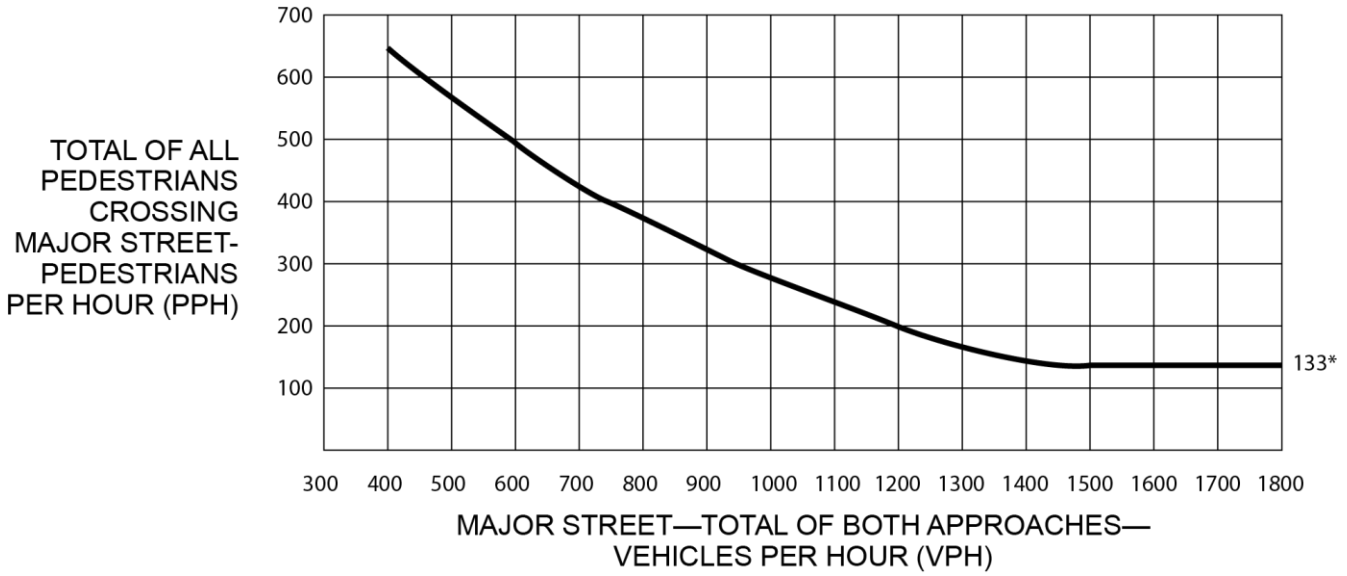
\*Note: 107 pph applies as the lower threshold volume.

**Figure 4C-6. Warrant 4, Pedestrian Four-Hour Volume (70% Factor)**



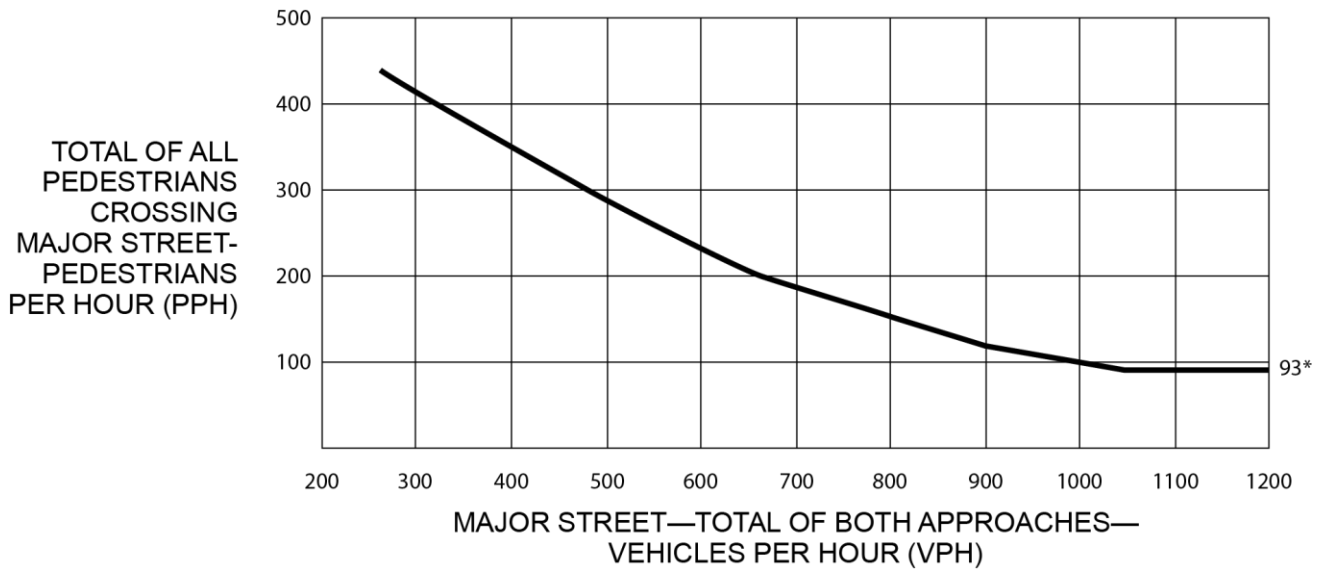
\*Note: 75 pph applies as the lower threshold volume.

**Figure 4C-7. Warrant 4, Pedestrian Peak Hour**



\*Note: 133 pph applies as the lower threshold volume.

**Figure 4C-8. Warrant 4, Pedestrian Peak Hour (70% Factor)**



\*Note: 93 pph applies as the lower threshold volume.

**Standard:**

02 **The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of schoolchildren at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the schoolchildren are using the crossing is less than the number of minutes in the same period (see Section 7A.03) and there are a minimum of 20 schoolchildren during the highest crossing hour.**

03 **Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.**

04 **The School Crossing signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.**

*Guidance:*

05 *If this warrant is met and a traffic control signal is justified by an engineering study, then:*

- A. *If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.*
- B. *If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.*
- C. *Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.*

**Section 4C.07 Warrant 6, Coordinated Signal System****Support:**

01 Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles.

**Standard:**

02 **The need for a traffic control signal shall be considered if an engineering study finds that one of the following criteria is met:**

- A. **On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.**
- B. **On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.**

*Guidance:*

03 *The Coordinated Signal System signal warrant should not be applied where the resultant spacing of traffic control signals would be less than 1,000 feet.*

**Section 4C.08 Warrant 7, Crash Experience****Support:**

01 The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

**Standard:**

02 **The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:**

- A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and
- B. Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and
- C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1 (see Section 4C.02), or the vph in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

**Option:**

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

**Section 4C.09 Warrant 8, Roadway Network****Support:**

01 Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network.

**Standard:**

02 **The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:**

- A. The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an average weekday; or
- B. The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).

03 **A major route as used in this signal warrant shall have at least one of the following characteristics:**

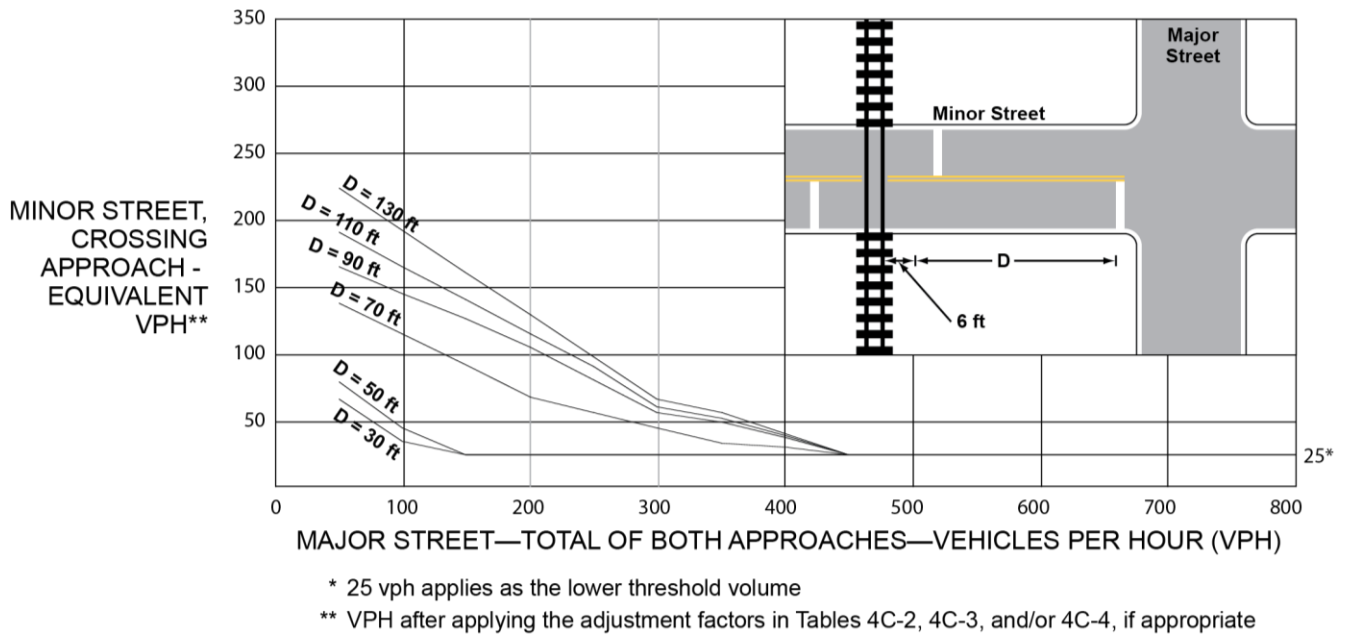
- A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow,
- B. It includes rural or suburban highways outside, entering, or traversing a city,
- C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

**Section 4C.10 Warrant 9, Intersection Near a Grade Crossing****Support:**

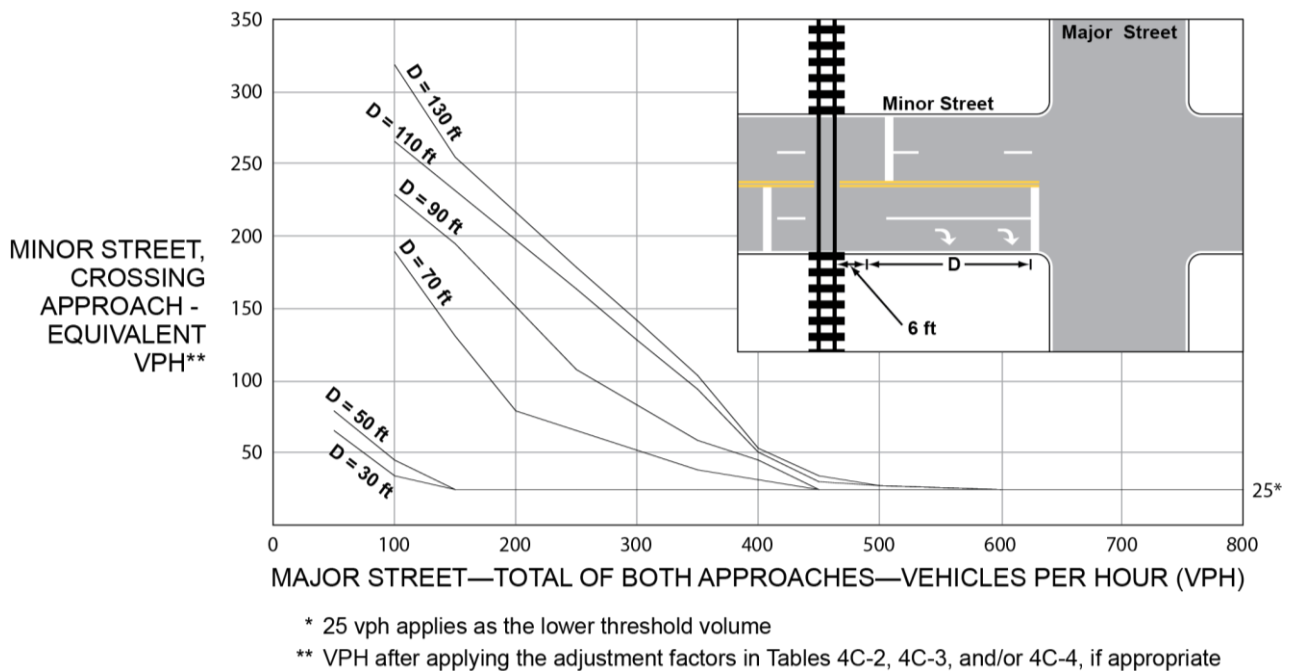
01 The Intersection Near a Grade Crossing signal warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.



**Figure 4C-9. Warrant 9, Intersection Near a Grade Crossing (One Approach Lane at the Track Crossing)**



**Figure 4C-10. Warrant 9, Intersection Near a Grade Crossing (Two or More Approach Lanes at the Track Crossing)**



*Guidance:*

02 *This signal warrant should be applied only after adequate consideration has been given to other alternatives or after a trial of an alternative has failed to alleviate the safety concerns associated with the grade crossing. Among the alternatives that should be considered or tried are:*

- A. *Providing additional pavement that would enable vehicles to clear the track or that would provide space for an evasive maneuver, or*
- B. *Reassigning the stop controls at the intersection to make the approach across the track a non-stopping approach.*

**Standard:**

03 **The need for a traffic control signal shall be considered if an engineering study finds that both of the following criteria are met:**

- A. **A grade crossing exists on an approach controlled by a STOP or YIELD sign and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach; and**
- B. **During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the minor-street approach that crosses the track (one direction only, approaching the intersection) falls above the applicable curve in Figure 4C-9 or 4C-10 for the existing combination of approach lanes over the track and the distance D, which is the clear storage distance as defined in Section 1A.13.**

*Guidance:*

04 *The following considerations apply when plotting the traffic volume data on Figure 4C-9 or 4C-10:*

- A. *Figure 4C-9 should be used if there is only one lane approaching the intersection at the track crossing location and Figure 4C-10 should be used if there are two or more lanes approaching the intersection at the track crossing location.*
- B. *After determining the actual distance D, the curve for the distance D that is nearest to the actual distance D should be used. For example, if the actual distance D is 95 feet, the plotted point should be compared to the curve for D = 90 feet.*
- C. *If the rail traffic arrival times are unknown, the highest traffic volume hour of the day should be used.*

**Option:**

05 The minor-street approach volume may be multiplied by up to three adjustment factors as provided in Paragraphs 6 through 8.

06 Because the curves are based on an average of four occurrences of rail traffic per day, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-2 for the appropriate number of occurrences of rail traffic per day.

07 Because the curves are based on typical vehicle occupancy, if at least 2 percent of the vehicles crossing the track are buses carrying at least 20 people, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-3 for the appropriate percentage of high-occupancy buses.

08 Because the curves are based on tractor-trailer trucks comprising 10 percent of the vehicles crossing the track, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-4 for the appropriate distance and percentage of tractor-trailer trucks.

**Table 4C-2, Warrant 9, Adjustment Factor for Daily Frequency of Rail Traffic**

Rail Traffic per Day	Adjustment Factor
1	0.67
2	0.91
3 to 5	1.00
6 to 8	1.18
9 to 11	1.25
12 or more	1.33

**Standard:**

- 09 **If this warrant is met and a traffic control signal at the intersection is justified by an engineering study, then:**
- A. **The traffic control signal shall have actuation on the minor street;**
  - B. **Preemption control shall be provided in accordance with Sections 4D.27, 8C.09, and 8C.10; and**
  - C. **The grade crossing shall have flashing-light signals (see Chapter 8C).**

*Guidance:*

- 10 *If this warrant is met and a traffic control signal at the intersection is justified by an engineering study, the grade crossing should have automatic gates (see Chapter 8C).*

**Table 4C-3, Warrant 9, Adjustment Factor for Percentage of High-Occupancy Buses**

% of High-Occupancy Buses* on Minor-Street Approach	Adjustment Factor
0%	1.00
2%	1.09
4%	1.19
6% or more	1.32

\* A high-occupancy bus is defines as a bus occupied by at least 20 people.

**Table 4C-4, Warrant 9, Adjustment Factor for Percentage of Tractor-Trailer Trucks**

% of Tractor-Trailer Trucks on Minor-Street Approach	Adjustment Factor	
	D less than 70 feet	D of 70 feet or more
0% to 2.5%	0.50	0.50
2.6% to 7.5%	0.75	0.75
7.7% to 12.5%	1.00	1.00
12.6% to 17.5%	2.30	1.15
17.6% to 22.5%	2.70	1.35
22.6% to 27.5%	3.28	1.64
More than 27.5%	4.18	2.09

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## CHAPTER 4D. TRAFFIC CONTROL SIGNAL FEATURES

### Section 4D.01 General

#### Support:

01 The features of traffic control signals of interest to road users are the location, design, and meaning of the signal indications. Uniformity in the design features that affect the traffic to be controlled, as set forth in this Manual, is especially important for the safety and efficiency of operations.

02 Traffic control signals can be operated in pretimed, semi-actuated, or full-actuated modes. For isolated (non-interconnected) signalized locations on rural high-speed highways, full-actuated mode with advance vehicle detection on the high-speed approaches is typically used. These features are designed to reduce the frequency with which the onset of the yellow change interval is displayed when high-speed approaching vehicles are in the “dilemma zone” such that the drivers of these high-speed vehicles find it difficult to decide whether to stop or proceed.

#### Standard:

03 **When a traffic control signal is not in operation, such as before it is placed in service, during seasonal shutdowns, or when it is not desirable to operate the traffic control signal, the signal faces shall be covered, turned, or taken down to clearly indicate that the traffic control signal is not in operation.**

#### Support:

04 Seasonal shutdown is a condition in which a permanent traffic signal is turned off or otherwise made non-operational during a particular season when its operation is not justified. This might be applied in a community where tourist traffic during most of the year justifies the permanent signalization, but a seasonal shutdown of the signal during an annual period of lower tourist traffic would reduce delays; or where a major traffic generator, such as a large factory, justifies the permanent signalization, but the large factory is shut down for an annual factory vacation for a few weeks in the summer.

#### Standard:

05 **A traffic control signal shall control traffic only at the intersection or midblock location where the signal faces are placed.**

06 **Midblock crosswalks shall not be signalized if they are located within 300 feet from the nearest traffic control signal, unless the proposed traffic control signal will not restrict the progressive movement of traffic.**

#### Guidance:

07 *A midblock crosswalk location should not be controlled by a traffic control signal if the crosswalk is located within 100 feet from side streets or driveways that are controlled by STOP signs or YIELD signs.*

08 *Engineering judgment should be used to determine the proper phasing and timing for a traffic control signal. Since traffic flows and patterns change, phasing and timing should be reevaluated regularly and updated if needed.*

09 *Traffic control signals within 1/2 mile of one another along a major route or in a network of intersecting major routes should be coordinated, preferably with interconnected controller units. Where traffic control signals that are within 1/2 mile of one another along a major route have a jurisdictional boundary or a boundary between different signal systems between them, coordination across the boundary should be considered.*

#### Support:

10 Signal coordination need not be maintained between control sections that operate on different cycle lengths.

11 For coordination with grade crossing signals and movable bridge signals, see Sections 4D.27, 4J.03, 8C.09, and 8C.10.

## **Section 4D.02 Responsibility for Operation and Maintenance**

### *Guidance:*

- 01 *Prior to installing any traffic control signal, the responsibility for the maintenance of the signal and all of the appurtenances, hardware, software, and the timing plan(s) should be clearly established. The responsible agency should provide for the maintenance of the traffic control signal and all of its appurtenances in a competent manner.*
- 02 *To this end the agency should:*
- A. *Keep every controller assembly in effective operation in accordance with its predetermined timing schedule; check the operation of the controller assembly frequently enough to verify that it is operating in accordance with the predetermined timing schedule; and establish a policy to maintain a record of all timing changes and that only authorized persons are permitted to make timing changes;*
  - B. *Clean the optical system of the signal sections and replace the light sources as frequently as experience proves necessary;*
  - C. *Clean and service equipment and other appurtenances as frequently as experience proves necessary;*
  - D. *Provide for alternate operation of the traffic control signal during a period of failure, using flashing mode or manual control, or manual traffic direction by proper authorities as might be required by traffic volumes or congestion, or by erecting other traffic control devices;*
  - E. *Have properly skilled maintenance personnel available without undue delay for all signal malfunctions and signal indication failures;*
  - F. *Provide spare equipment to minimize the interruption of traffic control signal operation as a result of equipment failure;*
  - G. *Provide for the availability of properly skilled maintenance personnel for the repair of all components; and*
  - H. *Maintain the appearance of the signal displays and equipment.*

## **Section 4D.03 Provisions for Pedestrians**

### *Support:*

- 01 *Chapter 4E contains additional information regarding pedestrian signals and Chapter 4F contains additional information regarding pedestrian hybrid beacons.*

### **Standard:**

- 02 **The design and operation of traffic control signals shall take into consideration the needs of pedestrian as well as vehicular traffic.**
- 03 **If engineering judgment indicates the need for provisions for a given pedestrian movement, signal faces conveniently visible to pedestrians shall be provided by pedestrian signal heads (see Chapter 4E) or a vehicular signal face(s) for adjacent concurrent vehicular movement.**

### *Guidance:*

- 04 *Accessible pedestrian signals (see Sections 4E.09 through 4E.13) that provide information in non-visual formats (such as audible tones, speech messages, and/or vibrating surfaces) should be provided where determined appropriate by engineering judgment.*
- 05 *Where pedestrian movements regularly occur, pedestrians should be provided with sufficient time to cross the roadway by adjusting the traffic control signal operation and timing to provide sufficient crossing time every cycle or by providing pedestrian detectors.*
- 06 *If it is necessary or desirable to prohibit certain pedestrian movements at a traffic control signal location, No Pedestrian Crossing (R9-3) signs (see Section 2B.51) should be used if it is not practical to provide a barrier or other physical feature to physically prevent the pedestrian movement.*

## **Section 4D.04 Meaning of Vehicular Signal Indications**

### **Support:**

- 01 The “Ohio Revised Code” is the primary source for the standards for the meaning of vehicular signal indications to both vehicle operators and pedestrians as in this Section, and the standards for the meaning of separate pedestrian signal head indications as provided in Section 4E.02.
- 02 The physical area that is defined as being “within the intersection” is dependent upon the conditions that are described in the definition of intersection in Section 1A.13.

### **Standard:**

- 03 **As specified in 4511.13 of the Ohio Revised Code, highway traffic signal indications for vehicles and pedestrians shall have the following meanings, except those for pedestrian signal indications described in Section 4E.02 and Lane-Use Control Signals (see Section 4J.02):**

#### **“(A) Steady green signal indication:**

- (1) (a) Vehicular traffic, streetcars, and trackless trolleys facing a circular green signal indication are permitted to proceed straight through or turn right or left or make a u-turn movement except as such movement is modified by a lane-use sign, turn prohibition sign, lane marking, roadway design, separate turn signal indication, or other traffic control devices. Such vehicular traffic, including vehicles turning right or left or making a u-turn movement, shall yield the right-of-way to both of the following:
- (i) Pedestrians lawfully within an associated crosswalk;
  - (ii) Other vehicles lawfully within the intersection.
- (b) In addition, vehicular traffic turning left or making a u-turn movement to the left shall yield the right-of-way to other vehicles approaching from the opposite direction so closely as to constitute an immediate hazard during the time when such turning vehicle is moving across or within the intersection.
- (2) Vehicular traffic, streetcars, and trackless trolleys facing a green arrow signal indication displayed alone or in combination with another signal indication, are permitted to cautiously enter the intersection only to make the movement indicated by such arrow, or such other movement as is permitted by other indications displayed at the same time. Such vehicular traffic, streetcars, and trackless trolleys, including vehicles turning right or left or making a u-turn movement, shall yield the right-of-way to both of the following:
- (a) Pedestrians lawfully within an associated crosswalk;
  - (b) Other traffic lawfully using the intersection.
- (3) (a) Unless otherwise directed by a pedestrian signal indication, as provided in section 4511.14 of the Revised Code, pedestrians facing a circular green signal indication are permitted to proceed across the roadway within any marked or unmarked associated crosswalk. The pedestrian shall yield the right-of-way to vehicles lawfully within the intersection or so close as to create an immediate hazard at the time that the green signal indication is first displayed.
- (b) Pedestrians facing a green arrow signal indication, unless otherwise directed by a pedestrian signal indication or other traffic control device, shall not cross the roadway.

#### **(B) Steady yellow signal indication:**

- (1) Vehicular traffic, streetcars, and trackless trolleys facing a steady circular yellow signal indication are thereby warned that the related green movement or the related flashing arrow movement is being terminated or that a steady red signal indication will be exhibited immediately thereafter when vehicular traffic, streetcars, and trackless trolleys shall not enter the intersection. The provisions governing vehicular operation under the movement being terminated shall continue to apply while the steady circular yellow signal indication is displayed.
- (2) Vehicular traffic facing a steady yellow arrow signal indication is thereby warned that the related green arrow movement or the related flashing arrow movement is being terminated. The provisions governing vehicular operation under the movement being terminated shall continue to apply while the steady yellow arrow signal indication is displayed.

- (3) **Pedestrians facing a steady circular yellow or yellow arrow signal indication, unless otherwise directed by a pedestrian signal indication as provided in section 4511.14 of the Revised Code or other traffic control device, shall not start to cross the roadway.**
- (C) Steady red signal indication:**
- (1) (a) **Vehicular traffic, streetcars, and trackless trolleys facing a steady circular red signal indication, unless entering the intersection to make another movement permitted by another signal indication, shall stop at a clearly marked stop line; but if there is no stop line, traffic shall stop before entering the crosswalk on the near side of the intersection; or if there is no crosswalk, then before entering the intersection; and shall remain stopped until a signal indication to proceed is displayed except as provided in divisions (C)(1), (2), and (3) of this section.**
- (b) **Except when a traffic control device is in place prohibiting a turn on red or a steady red arrow signal indication is displayed, vehicular traffic facing a steady circular red signal indication is permitted to enter the intersection to turn right, or to turn left from a one-way street, after stopping. The right to proceed with the turn shall be subject to the provisions that are applicable after making a stop at a stop sign.**
- (2) (a) **Vehicular traffic, streetcars, and trackless trolleys facing a steady red arrow signal indication shall not enter the intersection to make the movement indicated by the arrow and, unless entering the intersection to make another movement permitted by another signal indication, shall stop at a clearly marked stop line; but if there is no stop line, before entering the crosswalk on the near side of the intersection; or if there is no crosswalk, then before entering the intersection; and shall remain stopped until a signal indication or other traffic control device permitting the movement indicated by such red arrow is displayed.**
- (b) **When a traffic control device is in place permitting a turn on a steady red arrow signal indication, vehicular traffic facing a steady red arrow indication is permitted to enter the intersection to make the movement indicated by the arrow signal indication, after stopping. The right to proceed with the turn shall be limited to the direction indicated by the arrow and shall be subject to the provisions that are applicable after making a stop at a stop sign.**
- (3) **Unless otherwise directed by a pedestrian signal indication as provided in section 4511.14 of the Revised Code or other traffic control device, pedestrians facing a steady circular red or steady red arrow signal indication shall not enter the roadway.**
- (4) **Local authorities by ordinance, or the director of transportation on state highways, may prohibit a right or a left turn against a steady red signal at any intersection, which shall be effective when signs giving notice thereof are posted at the intersection.**
- (D) A flashing green signal indication has no meaning and shall not be used.**
- (E) Flashing yellow signal indication:**
- (1) (a) **Vehicular traffic, on an approach to an intersection, facing a flashing circular yellow signal indication, is permitted to cautiously enter the intersection to proceed straight through or turn right or left or make a u-turn movement except as such movement is modified by lane-use signs, turn prohibition signs, lane markings, roadway design, separate turn signal indications, or other traffic control devices. Such vehicular traffic, including vehicles turning right or left or making a u-turn movement, shall yield the right-of-way to both of the following:**
- (i) **Pedestrians lawfully within an associated crosswalk;**
- (ii) **Other vehicles lawfully within the intersection.**
- (b) **In addition, vehicular traffic turning left or making a u-turn to the left shall yield the right-of-way to other vehicles approaching from the opposite direction so closely as to constitute an immediate hazard during the time when such turning vehicle is moving across or within the intersection.**
- (2) (a) **Vehicular traffic, on an approach to an intersection, facing a flashing yellow arrow signal indication, displayed alone or in combination with another signal indication, is permitted to cautiously enter the intersection only to make the movement indicated by such arrow, or other such movement as is permitted by other signal indications displayed at the same time. Such vehicular traffic, including vehicles turning right or left or making a u-turn, shall yield the right-of-way to both of the following:**
- (i) **Pedestrians lawfully within an associated crosswalk;**



- (ii) **Other vehicles lawfully within the intersection.**
- (b) **In addition, vehicular traffic turning left or making a u-turn to the left shall yield the right-of-way to other vehicles approaching from the opposite direction so closely as to constitute an immediate hazard during the time when such turning vehicle is moving across or within the intersection.**
- (3) **Pedestrians facing any flashing yellow signal indication at an intersection, unless otherwise directed by a pedestrian signal indication or other traffic control device, are permitted to proceed across the roadway within any marked or unmarked associated crosswalk. Pedestrians shall yield the right-of-way to vehicles lawfully within the intersection at the time that the flashing yellow signal indication is first displayed.**
- (4) **When a flashing circular yellow signal indication is displayed as a beacon to supplement another traffic control device, road users are notified that there is a need to pay extra attention to the message contained thereon or that the regulatory or warning requirements of the other traffic control device, which might not be applicable at all times, are currently applicable.**
- (F) **Flashing red signal indication:**
  - (1) **Vehicular traffic, on an approach to an intersection, facing a flashing circular red signal indication, shall stop at a clearly marked stop line; but if there is no stop line, before entering the crosswalk on the near side of the intersection; or if there is no crosswalk, at the point nearest the intersecting roadway where the driver has a view of approaching traffic on the intersecting roadway before entering the intersection. The right to proceed shall be subject to the provisions that are applicable after making a stop at a stop sign.**
  - (2) **Pedestrians facing any flashing red signal indication at an intersection, unless otherwise directed by a pedestrian signal indication or other traffic control device, are permitted to proceed across the roadway within any marked or unmarked associated crosswalk. Pedestrians shall yield the right-of-way to vehicles lawfully within the intersection at the time that the flashing red signal indication is first displayed.**
  - (3) **When a flashing circular red signal indication is displayed as a beacon to supplement another traffic control device, road users are notified that there is a need to pay additional attention to the message contained thereon or that the regulatory requirements of the other traffic control device, which might not be applicable at all times, are currently applicable. Use of this signal indication shall be limited to supplementing stop, do not enter, or wrong way signs, and to applications where compliance with the supplemented traffic control device requires a stop at a designated point.**
- (G) **In the event an official traffic-control signal is erected and maintained at a place other than an intersection, the provisions of this section shall be applicable except as to those provisions which by their nature can have no application. Any stop required shall be made at a sign or marking on the pavement indicating where the stop shall be made, but in the absence of any such sign or marking the stop shall be made at the signal.**
- (H) **This section does not apply at railroad grade crossing. Conduct of drivers of vehicles, trackless trolleys, and streetcars approaching railroad grade crossings shall be governed by sections 4511.61 and 4511.62 of the Revised Code.”**

#### **Section 4D.05 Application of Steady Signal Indications**

##### **Standard:**

- 01 **When a traffic control signal is being operated in a steady (stop-and-go) mode, at least one indication in each signal face shall be displayed at any given time.**
- 02 **A signal face(s) that controls a particular vehicular movement during any interval of a cycle shall control that same movement during all intervals of the cycle.**
- 03 **Steady signal indications shall be applied as follows:**
  - A. **A steady CIRCULAR RED signal indication:**
    - 1. **Shall be displayed when it is intended to prohibit traffic, except pedestrians directed by a pedestrian signal head, from entering the intersection or other controlled area. Turning after stopping is permitted as stated ORC Section 4511.13(C)(1) (see Section 4D.04).**

2. Shall be displayed with the appropriate GREEN ARROW signal indications when it is intended to permit traffic to make a specified turn or turns, and to prohibit traffic from proceeding straight ahead through the intersection or other controlled area, except in protected only mode operation (see Sections 4D.19 and 4D.23), or in protected/permissive mode operation with separate turn signal faces (see Sections 4D.20 and 4D.24).
- B. A steady CIRCULAR YELLOW signal indication:**
1. Shall be displayed following a CIRCULAR GREEN or straight-through GREEN ARROW signal indication in the same signal face.
  2. Shall not be displayed in conjunction with the change from the CIRCULAR RED signal indication to the CIRCULAR GREEN signal indication.
  3. Shall be followed by a CIRCULAR RED signal indication except that, when entering preemption operation, the return to the previous CIRCULAR GREEN signal indication shall be permitted following a steady CIRCULAR YELLOW signal indication (see Section 4D.27).
  4. Shall not be displayed to an approach from which drivers are turning left permissively or making a U-turn to the left permissively unless one of the following conditions exists:
    - (a) A steady CIRCULAR YELLOW signal indication is also simultaneously being displayed to the opposing approach;
    - (b) An engineering study has determined that, because of unique intersection conditions, the condition described in item (a) cannot reasonably be implemented without causing significant operational or safety problems and that the volume of impacted left-turning or U-turning traffic is relatively low, and those left-turning or U-turning drivers are advised that a steady CIRCULAR YELLOW signal indication is not simultaneously being displayed to the opposing traffic if this operation occurs continuously by the installation near the left-most signal head of a W25-1 sign (see Section 2C.48) with the legend ONCOMING TRAFFIC HAS EXTENDED GREEN; or
    - (c) Drivers are advised of the operation if it occurs only occasionally, such as during a preemption sequence, by the installation near the left-most signal head of a W25-2 sign (see Section 2C.48) with the legend ONCOMING TRAFFIC MAY HAVE EXTENDED GREEN.
- C. A steady CIRCULAR GREEN signal indication shall be displayed only when it is intended to permit traffic to proceed in any direction that is lawful and practical.**
- D. A steady RED ARROW signal indication shall be displayed when it is intended to prohibit traffic, except pedestrians directed by a pedestrian signal head, from entering the intersection or other controlled area to make the indicated turn.**
- E. A steady YELLOW ARROW signal indication:**
1. Shall be displayed in the same direction as a GREEN ARROW signal indication following a GREEN ARROW signal indication in the same signal face, unless:
    - (a) The GREEN ARROW signal indication and a CIRCULAR GREEN (or straight-through GREEN ARROW) signal indication terminate simultaneously in the same signal face, or
    - (b) The green arrow is a straight-through GREEN ARROW (see Item B.1).
  2. Shall be displayed in the same direction as a flashing YELLOW ARROW signal indication in the same signal face, when the flashing yellow arrow indication is displayed as part of a steady mode operation, if the signal face will subsequently display a steady red signal indication.
  3. Shall not be displayed in conjunction with the change from a steady RED ARROW or flashing YELLOW ARROW signal indication to a GREEN ARROW signal indication, except when entering preemption operation as provided in Item 5(a).
  4. Shall not be displayed when any conflicting vehicular movement has a green or yellow signal indication (except for the situation regarding U-turns to the left provided in Paragraph 4) or any conflicting pedestrian movement has a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbolizing DONT WALK) signal indication, except that a steady left-turn (or U-turn to the left) YELLOW ARROW signal indication, except that a steady left-turn (or U-turn to the left) YELLOW ARROW signal indication used to terminate a flashing left-turn (or U-turn to the left) YELLOW ARROW

signal indication in a signal face controlling a permissive left-turn (or U-turn to the left) movement as described in Sections 4D.18 and 4D.20 shall be permitted to be displayed when a CIRCULAR YELLOW signal indication is displayed for the opposing through movement. Vehicles departing in the same direction shall not be considered in conflict if, for each turn lane with moving traffic, there is a separate departing lane, and pavement markings or raised channelization clearly indicate which departure lane to use.

5. Shall not be displayed to terminate a flashing arrow signal indication on an approach from which drivers are turning left permissively or making a U-turn to the left permissively unless one of the following conditions exists:
    - (a) A steady CIRCULAR YELLOW signal indication is also simultaneously being displayed to the opposing approach;
    - (b) An engineering study has determined that, because of unique intersection conditions, the condition described in Item (a) cannot reasonably be implemented without causing significant operational or safety problems and that the volume of impacted left-turning or U-turning traffic is relatively low, and those left-turning or U-turning drivers are advised that a steady CIRCULAR YELLOW signal indication is not simultaneously being displayed to the opposing traffic if this operation occurs continuously by the installation near the left-most signal head of a W25-1 sign (see Section 2C.48) with the legend ONCOMING TRAFFIC HAS EXTENDED GREEN; or
    - (c) Drivers are advised of the operation if it occurs only occasionally, such as during a preemption sequence, by the installation near the left-most signal head of a W25-2 sign (see Section 2C.48) with the legend ONCOMING TRAFFIC MAY HAVE EXTENDED GREEN.
  6. Shall be terminated by a steady RED ARROW signal indication for the same direction or a CIRCULAR RED signal indication except:
    - (a) When entering preemption operation, the display of a GREEN ARROW signal indication or a flashing arrow signal indication shall be permitted following a steady YELLOW ARROW signal indication.
    - (b) When the movement controlled by the arrow is to continue on a permissive mode basis during an immediately following CIRCULAR GREEN or flashing YELLOW ARROW signal indication.
- F. A steady GREEN ARROW signal indication:
1. Shall be displayed only to allow vehicular movements, in the direction indicated, that are not in conflict with other vehicles moving on a green or yellow signal indication and are not in conflict with pedestrians crossing in compliance with a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbolizing DONT WALK) signal indication. Vehicles departing in the same direction shall not be considered in conflict if, for each turn lane with moving traffic, there is a separate departing lane, and raised channelization clearly indicate which departure lane to use.
  2. Shall be displayed on a signal face that controls a left-turn movement when said movement is not in conflict with other vehicles moving on a green or yellow signal indication (except for the situation regarding U-turns provided in Paragraph 4) and is not in conflict with pedestrians crossing in compliance with a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbolizing DONT WALK) signal indication. Vehicles departing in the same direction shall not be considered in conflict if, for each turn lane with moving traffic, there is a separate departing lane, and pavement markings or raised channelization clearly indicate which departure lane to use.
  3. Shall not be required on the stem of T-intersections or for turns from one-way streets.

Option:

- 04 If U-turns are permitted from the approach and a right-turn GREEN ARROW signal indication is simultaneously being displayed to road users making a right turn from the conflicting approach to the left, road users making a U-turn may be advised of the operation by the installation near the left-turn signal face of a U-TURN YIELD TO RIGHT TURN (R10-16) sign (see Section 2B.53).
- 05 If U-turns are permitted from an approach and a steady circular red signal indication is simultaneously being displayed to road users making a right turn from the conflicting approach to the left, road users making

a right turn on red may be advised of the operation by the installation near the right-turn signal face of a NO TURN ON RED (R10-11b), a RIGHT TURN ON RED MUST YIELD TO U-TURN (R10-30) or a NO TURN ON RED blank-out sign active during the U-Turn phase (see Section 2B.54).

06 If not otherwise prohibited, a steady straight-through GREEN ARROW signal indication may be used instead of a CIRCULAR GREEN signal indication in a signal face on an approach intersecting a one-way street to discourage wrong-way turns.

07 If not otherwise prohibited, steady red, yellow, and green turn arrow signal indications may be used instead of steady circular red, yellow, and green signal indications in a signal face on an approach where all traffic is required to turn or where the straight-through movement is not physically possible.

Support:

08 Section 4D.25 contains information regarding the signalization of approaches that have a shared left-turn/right-turn lane and no through movement.

**Standard:**

09 **If supplemental signal faces are used, the following limitations shall apply:**

- A. **Left-turn arrows and U-turn arrows to the left shall not be used in near-right signal faces.**
- B. **Right-turn arrows and U-turn arrows to the right shall not be used in far-left signal faces. A far-side median-mounted signal face shall be considered a far-left signal for this application.**

10 **A straight-through RED ARROW signal indication or a straight-through YELLOW ARROW signal indication shall not be displayed on any signal face, either alone or in combination with any other signal indication.**

11 **The following combinations of signal indications shall not be simultaneously displayed on any one signal face:**

- A. **CIRCULAR RED with CIRCULAR YELLOW;**
- B. **CIRCULAR GREEN with CIRCULAR RED; or**
- C. **Straight-through GREEN ARROW with CIRCULAR RED.**

12 **Additionally, the above combinations shall not be simultaneously displayed on an approach as a result of the combination of displays from multiple signal faces unless the display is created by a signal face(s) devoted exclusively to the control of a right-turning movement and:**

- A. **The signal face(s) controlling the right-turning movement is visibility-limited from the adjacent through movement or positioned to minimize potential confusion to approaching road users, or**
- B. **A RIGHT TURN SIGNAL sign (R10-10) (see Sections 4D.21 through 4D.24) is mounted adjacent to the signal face(s) controlling the right-turning movement.**

13 **The following combinations of signal indications shall not be simultaneously displayed on any one signal face or as a result of the combination of displays from multiple signal faces on an approach:**

- A. **CIRCULAR GREEN with CIRCULAR YELLOW;**
- B. **Straight-through GREEN ARROW with CIRCULAR YELLOW;**
- C. **GREEN ARROW with YELLOW ARROW pointing in the same direction;**
- D. **RED ARROW with YELLOW ARROW pointing in the same direction; or**
- E. **GREEN ARROW with RED ARROW pointing in the same direction.**

14 **Except as otherwise provided in Sections 4F.03 and 4G.04, the same signal section shall not be used to display both a flashing yellow and a steady yellow indication during steady mode operation.**

*Guidance:*

15 *No movement that creates an unexpected crossing of pathways of moving vehicles or pedestrians should be allowed during any green or yellow interval, except when all three of the following conditions are met:*

- A. *The movement involves only slight conflict, and*
- B. *Serious traffic delays are substantially reduced by permitting the conflicting movement, and*
- C. *Drivers and pedestrians subjected to the unexpected conflict are effectively warned thereof by a sign.*

## Section 4D.06 Signal Indications – Design, Illumination, Color, and Shape

### Standard:

- 01 Each signal indication, except those used for pedestrian signal heads and lane-use control signals, shall be circular or arrow.
- 02 Letters or numbers (including those associated with countdown displays) shall not be displayed as part of a vehicular signal indication.
- 03 Strobes shall not be used within or adjacent to any signal indication.
- 04 Except for the flashing signal indications and the pre-emption confirmation lights that are expressly allowed by the provisions of this Chapter, flashing displays shall not be used within or adjacent to any signal indications.
- 05 Each circular signal indication shall emit a single color: red, yellow, or green.
- 06 Each arrow signal indication shall emit a single color: red, yellow or green except that the alternate display (dual-arrow signal section) of a GREEN ARROW and a YELLOW ARROW signal indication, both pointing in the same direction, shall be permitted, provided that they are not displayed simultaneously.
- 07 The arrow, which shall show only one direction, shall be the only illuminated part of an arrow signal indication.
- 08 Arrows shall be pointed:
- A. Vertically upward to indicate a straight-through movement, or
  - B. Horizontally in the direction of the turn to indicate a turn at approximately or greater than a right angle, or
  - C. Upward with a slope at an angle approximately equal to that of the turn if the angle of the turn is substantially less than a right angle, or
  - D. In a manner that directs the driver through the turn if a U-turn arrow is used (see Figure 4D-1).
- 09 Except as provided in Paragraph 10, the requirements of the publication titled “Vehicle Traffic Control Signal Heads” (see Section 1A.11) that pertain to the aspects of the signal head design that affect the display of the signal indications shall be met.

### Guidance:

- 10 *The intensity and distribution of light from each illuminated signal lens should comply with the publications entitled “Vehicle Traffic Control Signal Heads” and “Traffic Signal Lamps” (see Section 1A.11).*

### Standard:

- 11 References to signal lenses in this section shall not be used to limit signal optical units to incandescent lamps within optical assemblies that include lenses.

### Support:

- 12 Research has resulted in signal optical units that are not lenses, such as, but not limited to, light-emitting diode (LED) traffic signal modules. Some units are practical for all signal indications, and some are practical for specific types such as visibility-limited signal indications.

### Guidance:

- 13 *If a signal indication is so bright that it causes excessive glare during nighttime conditions, some form of automatic dimming should be used to reduce the brilliance of the signal indication.*

## Section 4D.07 Size of Vehicular Signal Indications

### Standard:

- 01 There shall be two nominal diameter sizes for vehicular signal indications: 8 inches and 12 inches.

**Figure 4D-1. Example of U-Turn Signal Face**



02 **Except as provided in Paragraph 3 below, 12-inch signal indications shall be used for all signal sections in all new signal faces.**

Option:

03 Eight-inch circular signal indications may be used in new signal faces only for:

- A. The green or flashing yellow signal indications in an emergency-vehicle traffic control signal (see Section 4G.02);
- B. The circular indications in signal faces controlling the approach to the downstream location where two adjacent signalized locations are close to each other and it is not practical because of factors such as high approach speeds, horizontal or vertical curves, or other geometric factors to install visibility-limited signal faces for the downstream approach;
- C. The circular indications in a signal face that is located less than 120 feet from the stop line on a roadway with a posted or statutory speed limit of 30 mph or less;
- D. The circular indications in a supplemental near-side signal face;
- E. The circular indications in a supplemental signal face installed for the sole purpose of controlling pedestrian movements (see Section 4D.03) rather than vehicular movements; and
- F. The circular indications in a signal face installed for the sole purpose of controlling a bikeway or a bicycle movement.

04 Existing 8-inch circular signal indications that are not included in Items A through F in Paragraph 3 may be retained for the remainder of their useful service life.

#### **Section 4D.08 Positions of Signal Indications Within a Signal Face – General**

Support:

01 Standardization of the number and arrangements of signal sections in vehicular traffic control signal faces enables road users who are color vision deficient to identify the illuminated color by its position relative to other signal sections.

**Standard:**

02 **Unless otherwise provided in this Manual for a particular application, each signal face at a signalized location shall have three, four, or five signal sections. Unless otherwise provided in this Manual for a particular application, if a vertical signal face includes a cluster (see Section 4D.09), the signal face shall have at least three vertical positions.**

03 **A single-section signal face shall be permitted at a traffic control signal if it consists of a continuously-displayed GREEN ARROW signal indication that is being used to indicate a continuous movement.**

04 **The signal sections in a signal face shall be arranged in a vertical or horizontal straight line, except as otherwise provided in Section 4D.09.**

05 **The arrangement of adjacent signal sections in a signal face shall follow the relative positions listed in Sections 4D.09 or 4D.10, as applicable.**

06 **If a signal section that displays a CIRCULAR YELLOW signal indication is used, it shall be located between the signal section that displays the red signal indication and all other signal sections.**

07 **If a U-turn arrow signal section is used in a signal face for a U-turn to the left, its position in the signal face shall be the same as stated in Sections 4D.09 and 4D.10 for a left-turn arrow signal section of the same color. If a U-turn arrow signal section is used in a signal face for a U-turn to the right, its position in the signal face shall be the same as stated in Sections 4D.09 and 4D.10 for a right-turn arrow signal section of the same color.**

08 **A U-turn arrow signal indication pointing to the left shall not be used in a signal face that also contains a left-turn arrow signal indication. A U-turn arrow signal indication pointing to the right shall not be used in a signal face that also contains a right-turn arrow signal indication.**

Option:

09 Within a signal face, two identical CIRCULAR RED or RED ARROW signal indications may be displayed immediately horizontally adjacent to each other in a vertical or horizontal signal face (see Figure 4D-2) for emphasis.

10 Horizontally-arranged and vertically-arranged signal faces may be used on the same approach provided they are separated to meet the lateral separation spacing required in Section 4D.13.

Support:

11 Figure 4D-2 illustrates some of the typical arrangements of signal sections in signal faces that do not control separate turning movements. Figures 4D-6 through 4D-12 illustrate the typical arrangements of signal sections in left-turn signal faces. Figures 4D-13 through 4D-19 illustrate the typical arrangements of signal sections in right-turn signal faces.

**Section 4D.09 Positions of Signal Indications Within a Vertical Signal Face**

**Standard:**

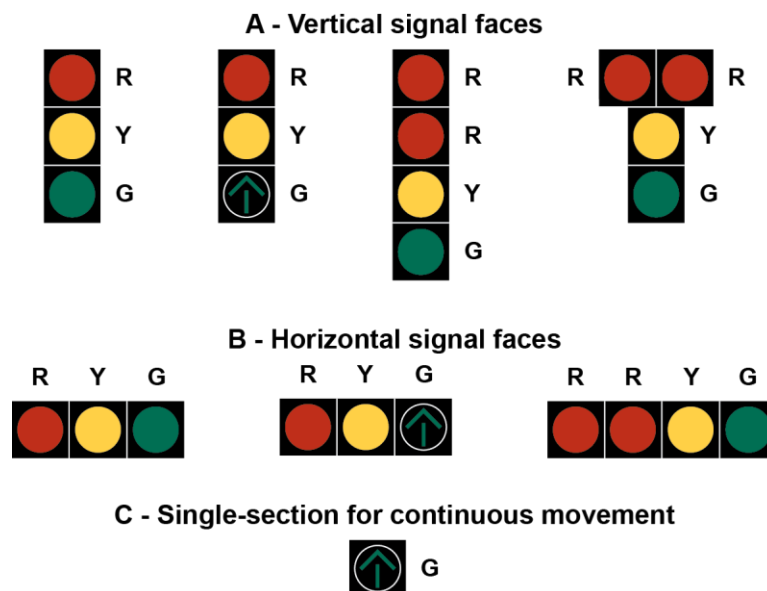
01 In each vertically-arranged signal face, all signal sections that display red signal indications shall be located above all signal sections that display yellow and green signal indications.

02 In vertically arranged signal faces, each signal section that displays a YELLOW ARROW signal indication shall be located above the signal section that displays the GREEN ARROW signal indication to which it applies.

03 The relative positions of signal sections in a vertically-arranged signal face, from top to bottom, shall be as follows:

- CIRCULAR RED
- Steady left-turn RED ARROW
- Steady right-turn RED ARROW
- CIRCULAR YELLOW
- CIRCULAR GREEN
- Straight-through GREEN ARROW
- Steady left-turn YELLOW ARROW
- Flashing left-turn YELLOW ARROW
- Left-turn GREEN ARROW
- Steady right-turn YELLOW ARROW
- Flashing right-turn YELLOW ARROW
- Right-turn GREEN ARROW

**Figure 4D-2. Typical Arrangements of Signal Sections in Signal Faces That Do Not Control Turning Movements**



04 **If a dual-arrow signal section (capable of alternating between the display of a GREEN ARROW and a YELLOW ARROW signal indication) is used in a vertically-arranged signal face, the dual-arrow signal section shall occupy the same position relative to the other sections as the signal section that displays the GREEN ARROW signal indication in a vertically arranged signal face would occupy.**

Option:

05 In a vertically arranged signal face, signal sections that display signal indications of the same color may be arranged horizontally adjacent to each other at right angles to the basic straight line arrangement to form a clustered signal face (see Figures 4D-2, 4D-8, 4D-9, 4D-11, 4D-16, 4D-18, and 4D-20).

**Standard:**

06 **Such clusters shall be limited to the following:**

- A. Two identical signal sections,
- B. Two or three different signal sections that display signal indications of the same color, or
- C. For only the specific case described in Section 4D.25 (see Drawing B of Figure 4D-20), two signal sections, one of which displays a GREEN ARROW signal indication and the other of which displays a flashing YELLOW ARROW signal indication.

07 **The signal section that displays a flashing yellow signal indication during steady mode operation:**

- A. Shall not be placed in the same vertical position as the signal section that displays a steady yellow signal indication, and
- B. Shall be placed below the signal section that displays a steady yellow signal indication.

Support:

08 Sections 4F.02 and 4G.04 contain exceptions to the provisions of this Section that are applicable to hybrid beacons.

#### **Section 4D.10 Positions of Signal Indication Within a Horizontal Signal Face**

**Standard:**

01 **In each horizontally-arranged signal face, all signal sections that display red signal indications shall be located to the left of all signal sections that display yellow and green signal indications.**

02 **In horizontally-arranged signal faces, each signal section that displays a YELLOW ARROW signal indication shall be located to the left of the signal section that displays the GREEN ARROW signal indication to which it applies.**

03 **The relative positions of signal sections in a horizontally-arranged signal face, from left to right, shall be as follows:**

**CIRCULAR RED**

**Steady left-turn RED ARROW**

**Steady right-turn RED ARROW**

**CIRCULAR YELLOW**

**Steady left-turn YELLOW ARROW**

**Flashing left-turn YELLOW ARROW**

**Left-turn GREEN ARROW**

**CIRCULAR GREEN**

**Straight-through GREEN ARROW**

**Steady right-turn YELLOW ARROW**

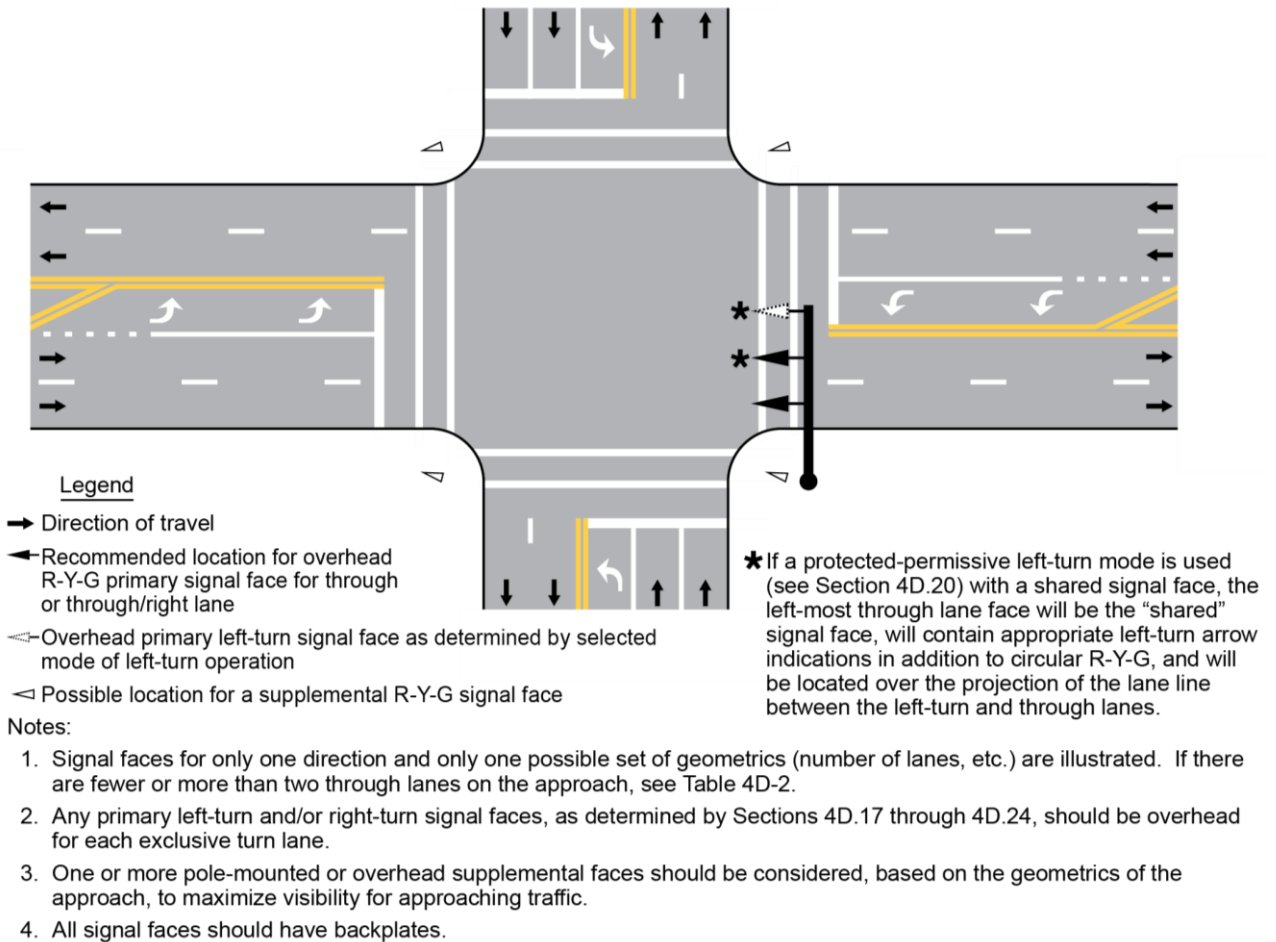
**Flashing right-turn YELLOW ARROW**

**Right-turn GREEN ARROW**

04 **If a dual-arrow signal section (capable of alternating between the display of a GREEN ARROW and a YELLOW ARROW signal indication) is used in a horizontally-arranged signal face, the signal section that displays the dual left-turn arrow signal indication shall be located immediately to the right of the signal section that displays the CIRCULAR YELLOW signal indication, the signal section that displays the straight-through GREEN ARROW signal indication shall be located immediately to the right of the signal section that displays the CIRCULAR GREEN signal indication, and the signal**



**Figure 4D-3. Recommended Vehicular Signal Faces for Approaches with Posted, Statutory, or 85<sup>th</sup>-Percentile Speed of 45 mph or Higher**



section that displays the dual right-turn arrow signal indication shall be located to the right of all other signal sections.

- 05 The signal section that displays a flashing yellow signal indication during steady mode operation:
- A. Shall not be placed in the same horizontal position as the signal section that displays a steady yellow signal indication, and
  - B. Shall be placed to the right of the signal section that displays a steady yellow signal indication.

**Section 4D.11 Number of Signal Faces on an Approach**

**Standard:**

- 01 The signal faces for each approach to an intersection or a midblock location shall be provided as follows:
- A. If a signalized through movement exists on an approach, a minimum of two primary signal faces shall be provided for the through movement. If a signalized through movement does not exist on an approach, a minimum of two primary signal faces shall be provided for the signalized turning movement that is considered to be the major movement from the approach (also see Section 4D.25).
  - B. See Sections 4D.17 through 4D.20 for left-turn (and U-turn to the left) signal faces.
  - C. See Sections 4D.21 and 4D.24 for right-turn (and U-turn to the right) signal faces.

**Table 4D-1. Recommended Minimum Number of Primary Signal Faces for Through Traffic on Approaches with Posted, Statutory, or 85th-percentile Speed of 45 mph or Higher**

Number of Through Lanes on Approach	Total Number of Primary Through Signal Faces for Approach*	Minimum Number of Overhead-Mounted Primary Through Signal Faces for Approach
1	2	1
2	2	1
3	3	2**
4 or more	4 or more	3**

Notes: \* A minimum of two through signal faces is always required (see Section 4D.11). These recommended numbers of through signal faces may be exceeded. Also, see cone of vision requirements otherwise indicated in Section 4D.13.

\*\* If practical, all of the recommended number of primary through signal faces should be located overhead.

**Option:**

- 02 Where a movement (or a certain lane or lanes) at the intersection never conflicts with any other signalized vehicular or pedestrian movement, a continuously-displayed single-section GREEN ARROW signal indication may be used to inform road users that the movement is free-flow and does not need to stop.

**Support:**

- 03 In some circumstances where the through movement never conflicts with any other signalized vehicular or pedestrian movement at the intersection, such as at T-intersections with appropriate geometrics and/or pavement markings and signing, an engineering study might determine that the through movement (or certain lanes of the through movement) can be free-flow and not signalized.

**Guidance:**

- 04 *If two or more left-turn lanes are provided for a separately controlled protected only mode left-turn movement, or if a left-turn movement represents the major movement from an approach, two or more primary left-turn signal faces should be provided.*

- 05 *If two or more right-turn lanes are provided for a separately controlled right-turn movement, or if a right-turn movement represents the major movement from an approach, two or more primary right-turn signal faces should be provided.*

**Support:**

- 06 Locating primary signal faces overhead on the far side of the intersection has been shown to provide safer operation by reducing intersection entries late in the yellow interval and by reducing red signal violations, as compared to post-mounting signal faces at the roadside or locating signal faces overhead within the intersection on a diagonally-oriented mast arm or span wire. On approaches with two or more lanes for the through movement, one signal face per through lane, centered over each through lane, has also been shown to provide safer operation.

**Guidance:**

- 07 *If the posted or statutory speed limit or the 85th-percentile speed on an approach to a signalized location is 45 mph or higher, signal faces should be provided as follows for all new or reconstructed signal installations (see Figure 4D-3):*

- A. *The minimum number and location of primary (non-supplemental) signal faces for through traffic should be provided in accordance with Table 4D-1.*
- B. *If the number of overhead primary signal faces for through traffic is equal to the number of through lanes on an approach, one overhead signal face should be located approximately over the center of each through lane.*

- C. *Except for shared left-turn and right-turn signal faces, any primary signal face required by Sections 4D.17 through 4D.25 for an exclusive turn lane should be located overhead approximately over the center of each exclusive turn lane.*
  - D. *All primary signal faces should be located on the far side of the intersection.*
  - E. *In addition to the primary signal faces, one or more supplemental pole-mounted or overhead signal faces should be considered to provide added visibility for approaching traffic that is traveling behind large vehicles.*
  - F. *All signal faces should have backplates.*
- 08 *This layout of signal faces should also be considered for any major urban or suburban arterial street with four or more lanes and for other approaches with speeds of less than 45 mph.*

**Section 4D.12 Visibility, Aiming, and Shielding of Signal Faces**

**Standard:**

01 **The primary consideration in signal face placement, aiming, and adjustment shall be to optimize the visibility of signal indications to approaching traffic.**

02 **Road users approaching a signalized intersection or other signalized area, such as a midblock crosswalk, shall be given a clear and unmistakable indication of their right-of-way assignment.**

03 **The geometry of each intersection to be signalized, including vertical grades, horizontal curves, and obstructions as well as the lateral and vertical angles of sight toward a signal face, as determined by typical driver-eye position, shall be considered in determining the vertical, longitudinal, and lateral position of the signal face.**

**Table 4D-2. Minimum Sight Distance for Signal Visibility**

85th-Percentile Speed	Minimum Sight Distance
20 mph	175 feet
25 mph	215 feet
30 mph	270 feet
35 mph	325 feet
40 mph	390 feet
45 mph	460 feet
50 mph	540 feet
55 mph	625 feet
60 mph	715 feet

Note: Distances in this table are derived from stopping sight distance plus an assumed queue length for shorter cycle lengths (60 to 75 seconds).

*Guidance:*

04 *The two primary signal faces required as a minimum for each approach should be continuously visible to traffic approaching the traffic control signal, from a point at least the minimum sight distance provided in Table 4D-2 in advance of and measured to the stop line. This range of continuous visibility should be provided unless precluded by a physical obstruction or unless another signalized location is within this range.*

*Support:*

05 Section 4511.16 of the Ohio Revised Code (see Appendix B2) prohibits the display of, and authorizes removal of, “any unauthorized sign, signal, marking or device which ... interferes with the effectiveness of any traffic control device...”

*Guidance:*

06 *At signalized midblock crosswalks, at least one of the signal faces should be over the traveled way for each approach.*

**Standard:**

07 **If approaching traffic does not have a continuous view of at least two signal faces for at least the minimum sight distance shown in Table 4D-2, a sign (see Section 2C.36) shall be installed to warn approaching traffic of the traffic control signal.**

## Option:

08 If a sign is installed to warn approaching road users of the traffic control signal, the sign may be supplemented by a Warning Beacon (see Section 4L.03).

09 A Warning Beacon used in this manner may be interconnected with the traffic signal controller assembly in such a manner as to flash yellow during the period when road users passing this beacon at the legal speed for the roadway might encounter a red signal indication (or a queue resulting from the display of the red signal indication) upon arrival at the signalized location.

10 If the sight distance to the signal faces for an approach is limited by horizontal or vertical alignment, supplemental signal faces aimed at a point on the approach at which the signal indications first become visible may be used.

*Guidance:*

11 *Supplemental signal faces should be used if engineering judgment has shown that they are needed to achieve intersection visibility both in advance and immediately before the signalized location.*

12 *If supplemental signal faces are used, they should be located to provide optimum visibility for the movement to be controlled.*

**Standard:**

13 **In cases where irregular street design necessitates placing signal faces for different street approaches with a comparatively small angle between their respective signal indications, each signal indication shall, to the extent practical, be visibility-limited by signal visors, signal louvers, or other means so that an approaching road user's view of the signal indication(s) controlling movements on other approaches is minimized.**

14 **Signal visors exceeding 12 inches in length shall not be used on free-swinging signal faces.**

*Guidance:*

15 *Signal visors should be used on signal faces to aid in directing the signal indication specifically to approaching traffic, as well as to reduce "sun phantom," which can result when external light enters the lens.*

16 *The use of signal visors, or the use of signal faces or devices that direct the light without a reduction in intensity, should be considered as an alternative to signal louvers because of the reduction in light output caused by signal louvers.*

## Option:

17 Special signal faces, such as visibility-limited signal faces, may be used such that the road users do not see signal indications intended for other approaches before seeing the signal indications for their own approach, if simultaneous viewing of both signal indications could cause the road users to be misdirected.

*Guidance:*

18 *If the posted or statutory speed limit or the 85th-percentile speed on an approach to a signalized location is 45 mph or higher, signal backplates should be used on all of the signal faces that face the approach. Signal backplates should also be considered for use on signal faces on approaches with posted or statutory speed limits or 85th-percentile speeds of less than 45 mph where sun glare, bright sky, and/or complex or confusing backgrounds indicate a need for enhanced signal face target value.*

## Support:

19 The use of backplates enhances the contrast between the traffic signal indications and their surroundings for both day and night conditions, which is also helpful to older drivers.

**Standard:**

20 **The inside of signal visors (hoods), the entire surface of louvers and fins, and the front surface of backplates shall have a dull black finish to minimize light reflection and to increase contrast between the signal indication and its background.**

## Option:

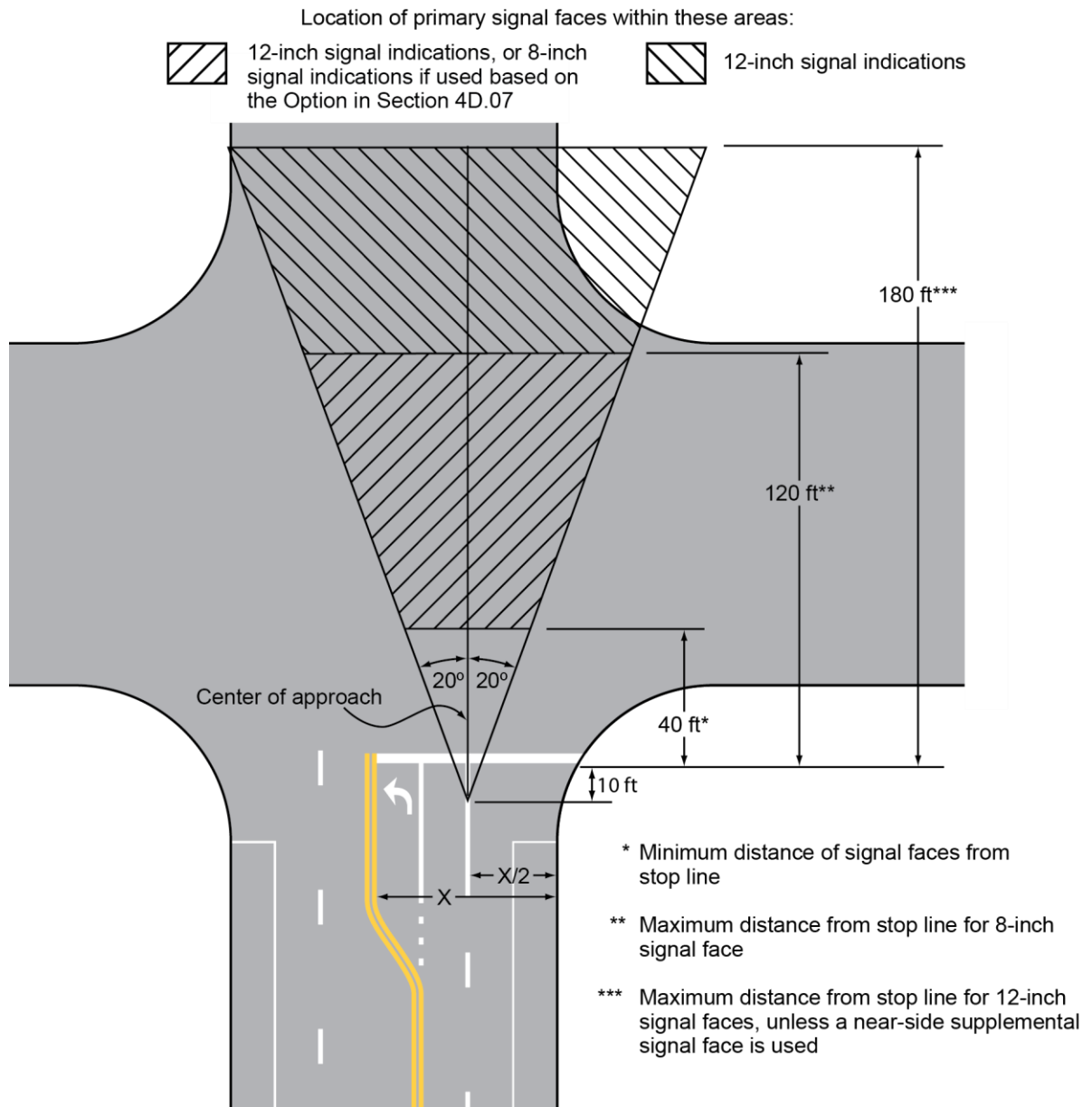
21 A yellow retroreflective strip with a minimum width of 1 inch and a maximum width of 3 inches may be placed along the perimeter of the face of a signal backplate to project a rectangular appearance at night.

**Section 4D.13 Lateral Positioning of Signal Faces**

**Standard:**

01 At least one and preferably both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach shall be located between two lines intersecting with the center of the approach at a point 10 feet behind the stop line, one making an angle of approximately 20 degrees to the right of the center of the approach extended, and the other making an angle of approximately 20 degrees to the left of the center of the approach extended. The signal face that satisfies this requirement shall simultaneously satisfy the longitudinal placement requirement described in Section 4D.14 (see Figure 4D-4).

**Figure 4D-4. Lateral and Longitudinal Location of Primary Signal Faces**



**Notes:**

1. See Section 4D.11 for approaches with posted, statutory, or 85th-percentile speeds of 45 mph or higher.
2. See Section 4D.13 regarding location of signal faces that display a CIRCULAR GREEN signal indication for a permissive left-turn movement on approaches with an exclusive left-turn lane or lanes.

02 **If both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach are post-mounted, they shall both be on the far side of the intersection, one on the right and one on the left of the approach lane(s).**

03 **The required signal faces for through traffic on an approach shall be located not less than 8 feet apart measured horizontally perpendicular to the approach between the centers of the signal faces.**

04 **If more than one separate turn signal face is provided for a turning movement and if one or both of the separate turn signal faces are located over the roadway, the signal faces shall be located not less than 8 feet apart measured horizontally perpendicular to the approach between the centers of the signal faces.**

*Guidance:*

05 *If a signal face controls a specific lane or lanes of an approach, its position should make it readily visible to road users making that movement.*

Support:

06 Section 4D.11 contains additional provisions regarding lateral positioning of signal faces for approaches having a posted or statutory speed limit or an 85th-percentile speed of 45 mph or higher.

**Standard:**

07 **If an exclusive left-turn, right-turn, or U-turn lane is present on an approach and if a primary separate turn signal face controlling that lane is mounted over the roadway, the primary separate turn signal face shall not be positioned any further to the right than the extension of the right-hand edge of the exclusive turn lane or any further to the left than the extension of the left-hand edge of the exclusive turn lane.**

08 **Supplemental turn signal faces mounted over the roadway shall not be subject to the positioning requirements in the previous paragraph.**

*Guidance:*

09 *For new or reconstructed signal installations, on an approach with an exclusive turn lane(s) for a left-turn (or U-turn to the left) movement and with opposing vehicular traffic, signal faces that display a CIRCULAR GREEN signal indication should not be post-mounted on the far-side median or mounted overhead above the exclusive turn lane(s) or the extension of the lane(s).*

**Standard:**

10 **If supplemental signal faces are used, the following limitations shall apply:**

- A. **Left-turn arrows and U-turn arrows to the left shall not be used in near-right signal faces.**
- B. **Right-turn arrows and U-turn arrows to the right shall not be used in far-left signal faces. A far-side median-mounted signal face shall be considered a far-left signal for this application.**

#### **Section 4D.14 Longitudinal Positioning of Signal Faces**

**Standard:**

01 **Except where the width of an intersecting roadway or other conditions make it physically impractical, the signal faces for each approach to an intersection or a midblock location shall be provided as follows:**

- A. **A signal face installed to satisfy the requirements for primary left-turn signal faces (see Section 4D.17 through 4D.20) and primary right-turn signal faces (see Section 4D.21 through 4D.24), and at least one and preferably both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach shall be located:**
  - 1. **No less than 40 feet beyond the stop line,**
  - 2. **No more than 180 feet beyond the stop line unless a supplemental near side signal face is provided, and**
  - 3. **As near as practical to the line of the driver's normal view, if mounted over the roadway. The primary signal face that satisfies this requirement shall simultaneously satisfy the lateral placement requirement described in Section 4D.13 (see Figure 4D-4).**

**B. Where the nearest signal face is located between 150 and 180 feet beyond the stop line, engineering judgment of the conditions, including the worst-case visibility conditions, shall be used to determine if the provision of a supplemental near side signal face would be beneficial.**

Support:

02 Section 4D.11 contains additional provisions regarding longitudinal positioning of signal faces for approaches having a posted or 85th-percentile speed of 45 mph or higher.

Guidance:

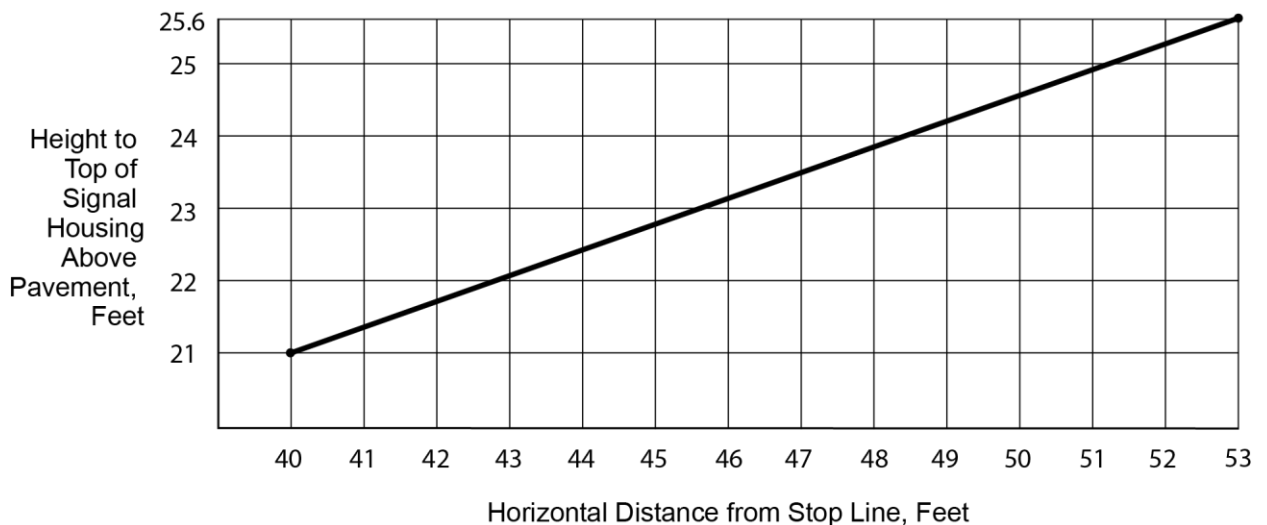
03 *Supplemental near-side signal faces should be located as near as practical to the stop line.*

**Section 4D.15 Mounting Height of Signal Faces**

Standard:

- 01 The top of the signal housing of a vehicular signal face located over any portion of a highway that can be used by motor vehicles shall not be more than 25.6 feet above the pavement.
- 02 For viewing distances between 40 and 53 feet from the stop line, the maximum mounting height to the top of the signal housing shall be as shown on Figure 4D-5.
- 03 The bottom of the signal housing and any related attachments to a vehicular signal face located over any portion of a highway that can be used by motor vehicles shall be at least 15 feet above the pavement.
- 04 The bottom of the signal housing (including brackets) of a vehicular signal face that is vertically arranged and not located over a roadway:
  - A. Shall be a minimum of 8 feet and a maximum of 19 feet above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.
  - B. Shall be a minimum of 4.5 feet and a maximum of 19 feet above the median island grade of a center median island if located on the near side of the intersection.
- 05 The bottom of the signal housing (including brackets) of a vehicular signal face that is horizontally arranged and not located over a roadway:
  - A. Shall be a minimum of 8 feet and a maximum of 22 feet above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.
  - B. Shall be a minimum of 4.5 feet and a maximum of 22 feet above the median island grade of a center median island if located on the near side of the intersection.

**Figure 4D-5. Maximum Mounting Height of Signal Faces Located Between 40 Feet and 53 Feet from Stop Line**



### **Section 4D.16 Lateral Offset (Clearance) of Signal Faces**

#### **Standard:**

- 01 **Signal faces mounted at the side of a roadway with curbs at less than 15 feet from the bottom of the housing and any related attachments shall have a horizontal offset of not less than 2 feet from the face of a vertical curb, or if there is no curb, not less than 2 feet from the edge of a shoulder.**

### **Section 4D.17 Signal Indications for Left-Turn Movements – General**

#### **Standard:**

- 01 **In Sections 4D.17 through 4D.20, provisions applicable to left-turn movements and left-turn lanes shall also apply to signal indications for U-turns to the left that are provided at locations where left turns are prohibited or not geometrically possible.**

#### **Support:**

- 02 **Left-turning traffic is controlled by one of four modes as follows:**
- A. **Permissive Only Mode**—turns made on a CIRCULAR GREEN signal indication or a flashing left-turn YELLOW ARROW signal indication, after yielding to pedestrians, if any, and/or opposing traffic, if any.
  - B. **Protected Only Mode**—turns made only when a left-turn GREEN ARROW signal indication is displayed.
  - C. **Protected/Permissive Mode**—both modes can occur on an approach during the same cycle.
  - D. **Variable Left-Turn Mode**—the operating mode changes among the protected only mode and/or the protected/permissive mode and/or the permissive only mode during different periods of the day or as traffic conditions change.

#### **Option:**

- 03 **In areas having a high percentage of older drivers, special consideration may be given to the use of protected only mode left-turn phasing, when appropriate.**

#### **Standard:**

- 04 **During a permissive left-turn movement, the signal faces for through traffic on the opposing approach shall simultaneously display green or steady yellow signal indications. If pedestrians crossing the lane or lanes used by the permissive left-turn movement to depart the intersection are controlled by pedestrian signal heads, the signal indications displayed by those pedestrian signal heads shall not be limited to any particular display during the permissive left-turn movement.**

- 05 **During a protected left-turn movement, the signal faces for through traffic on the opposing approach shall simultaneously display steady CIRCULAR RED signal indications. If pedestrians crossing the lane or lanes used by the protected left-turn movement to depart the intersection are controlled by pedestrian signal heads, the pedestrian signal heads shall display a steady UPRAISED HAND (symbolizing DONT WALK) signal indication during the protected left-turn movement.**

- 06 **A protected only mode left-turn movement that does not begin and terminate at the same time as the adjacent through movement shall not be provided on an approach unless an exclusive left-turn lane exists.**

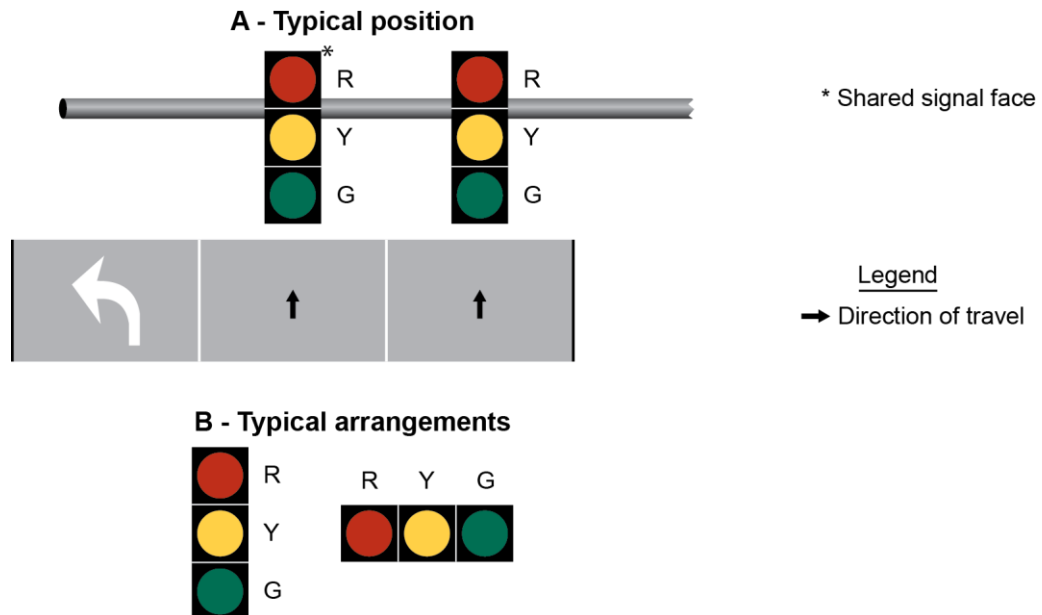
- 07 **A yellow change interval for the left-turn movement shall not be displayed when the status of the left-turn operation is changing from permissive to protected within any given signal sequence.**

- 08 **If the operating mode changes among the protected only mode and/or the protected/permissive mode and/or the permissive only mode during different periods of the day or as traffic conditions change, the requirements in Sections 4D.18 through 4D.20 that are appropriate to that mode of operation shall be met, subject to the following:**

- A. **The CIRCULAR GREEN and CIRCULAR YELLOW signal indications shall not be displayed when operating in the protected only mode.**
- B. **The left-turn GREEN ARROW and left-turn YELLOW ARROW signal indications shall not be displayed when operating in the permissive only mode.**



### Figure 4D-6. Typical Position and Arrangements of Shared Signal Faces for Permissive Only Mode Left Turns



#### Option:

- 09 Additional static signs or changeable message signs may be used to meet the requirements for the variable left-turn mode or to inform drivers that left-turn green arrows will not be available during certain times of the day.

#### Support:

- 10 Sections 4D.17 through 4D.20 describe the use of the following two types of signal faces for controlling left-turn movements:

- A. Shared signal face – This type of signal face controls both the left-turn movement and the adjacent movement (usually the through movement) and can serve as one of the two required primary signal faces for the adjacent movement. A shared signal face always displays the same color of circular indication that is displayed by the signal face or faces for the adjacent movement. If a shared signal face that provides protected/permissive mode left turns is mounted overhead at the intersection, it is usually positioned over or slightly to the right of the extension of the lane line separating the left-turn lane from the adjacent lane.
- B. Separate left-turn signal face – This type of signal face controls only the left-turn movement and cannot serve as one of the two required primary signal faces for the adjacent movement (usually the through movement) because it displays signal indications that are applicable only to the left-turn movement. If a separate left-turn signal face is mounted overhead at the intersection, it is positioned over the extension of the left-turn lane. In a separate left-turn signal face, a flashing left-turn YELLOW ARROW signal indication is used to control permissive left-turning movements.

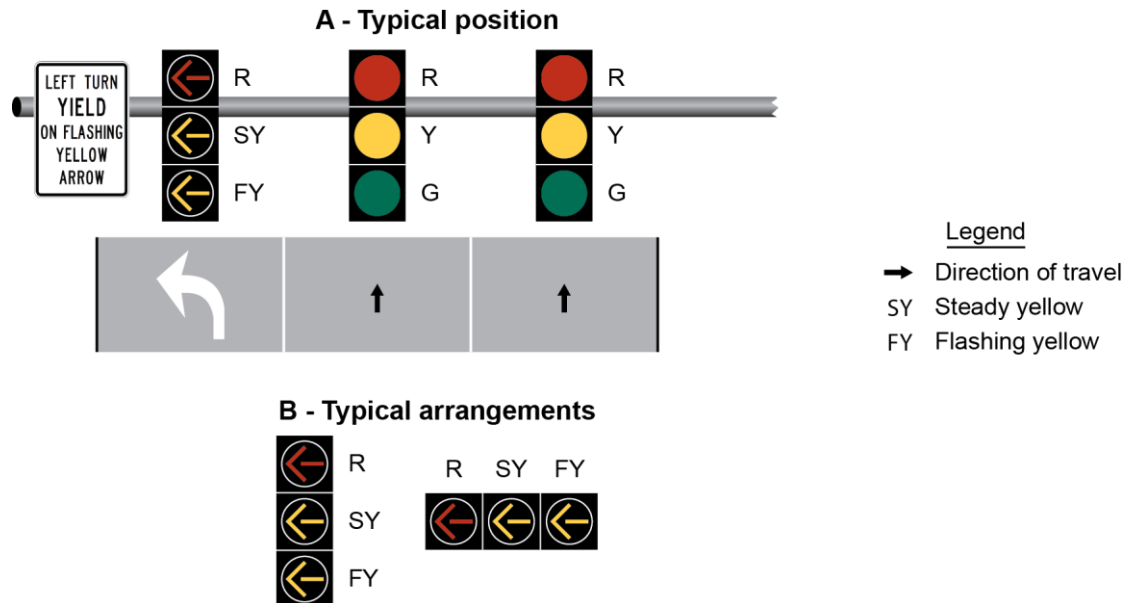
- 11 Section 4D.13 contains provisions regarding the lateral positioning of signal faces that control left-turn movements.

- 12 It is not necessary that the same mode of left-turn operation or same type of left-turn signal face be used on every approach to a signalized location. Selecting different modes and types of left-turn signal faces for the various approaches to the same signalized location is acceptable.

#### Option:

- 13 A signal face that is shared by left-turning and right-turning traffic may be provided for a shared left-turn/right-turn lane on an approach that has no through traffic (see Section 4D.25).

**Figure 4D-7. Typical Position and Arrangements of Separate Signal Faces with Flashing Yellow Arrow for Permissive Only Mode Left Turns**



#### Section 4D.18 Signal Indications for Permissive Only Mode Left-Turn Movements

##### Standard:

- 01 If a shared signal face is provided for a permissive only mode left turn, it shall meet the following requirements (see Figure 4D-6):
- A. It shall be capable of displaying the following signal indications; steady CIRCULAR RED, steady CIRCULAR YELLOW, and CIRCULAR GREEN. Only one of the three indications shall be displayed at any given time.
  - B. During the permissive left-turn movement, a CIRCULAR GREEN signal indication shall be displayed.
  - C. A permissive-only shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
  - D. If the permissive only mode is not the only left-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permissive mode (see Section 4D.20) except that the left-turn GREEN ARROW and left-turn YELLOW ARROW signal indications shall not be displayed when operating in the permissive only mode.
- 02 If a separate left-turn signal face is being operated in a permissive only left-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.
- 03 If a separate left-turn signal face is being operated in a permissive only left-turn mode and a flashing left-turn YELLOW ARROW signal indication is provided, it shall meet the following requirements (see Figure 4D-7):
- A. It shall be capable of displaying the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, and flashing left-turn YELLOW ARROW. Only one of the three indications shall be displayed at any given time.
  - B. During the permissive left-turn movement, a flashing left-turn YELLOW ARROW signal indication shall be displayed.
  - C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn YELLOW ARROW signal indication.

- D. It shall be permitted to display a flashing left-turn YELLOW ARROW signal indication for a permissive left-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications and the opposing left-turn signal faces display left-turn GREEN ARROW signal indications for a protected left-turn movement.
- E. During steady mode (stop-and-go) operation, the signal section that displays the steady left-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing left-turn YELLOW ARROW signal indication for permissive left turns.
- F. During flashing mode operation (see Section 4D.30), the display of a flashing left-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady left-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.
- G. If the permissive only mode is not the only left-turn mode used for the approach, the signal face shall be the same separate left-turn signal face with a flashing YELLOW ARROW signal indication that is used for the protected/permissive mode (see Section 4D.20) except that the left-turn GREEN ARROW signal indication shall not be displayed when operating in the permissive only mode.

Support:

- 02 Research and field experience with the flashing left-turn YELLOW ARROW signal indication has found that most road users recognize the meaning of this application. However, it has also been noted that an educational campaign in advance of installation, and supplemental signing during implementation aids in comprehension.

Guidance:

- 03 *A public information campaign should be used in advance of projects introducing this device in an area to make road users aware of the planned introduction of the new signal display type and its meaning.. Once the flashing left-turn YELLOW ARROW signal indication has been in use within an area for a while, public information campaigns should not be needed.*
- 04 *For consistency, when installing a flashing left-turn YELLOW ARROW signal indication for protected/permitted operation at a new location, the same treatment should be considered for nearby signal installations with a similar operation.*

Standard:

- 05 **The LEFT TURN YIELD ON FLASHING YELLOW ARROW (R10-H12c) sign (see Figure 4D-7) shall be used with the installation of each flashing left-turn YELLOW ARROW signal indication within a jurisdiction for at least five years.**

#### **Section 4D.19 Signal Indications for Protected Only Mode Left-Turn Movements**

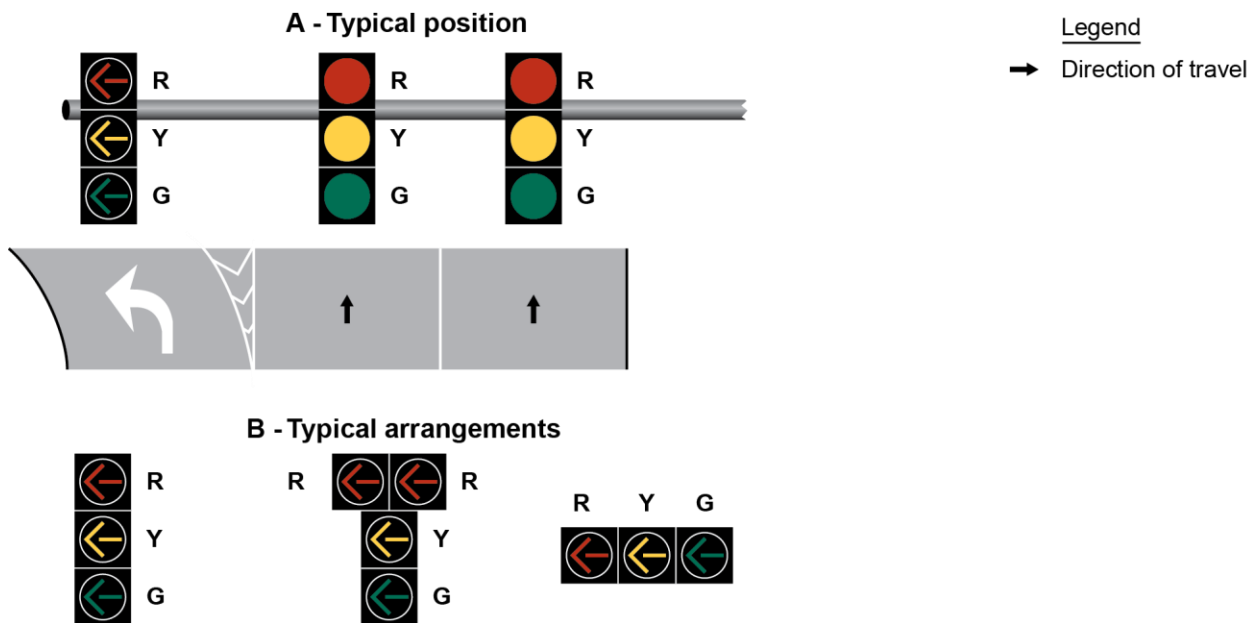
Standard:

- 01 **A shared signal face shall not be used for protected only mode left turns unless the CIRCULAR GREEN and left-turn GREEN ARROW signal indications always begin and terminate together. If a shared signal face is provided for a protected only mode left turn, it shall meet the following requirements (see Figure 4D-9):**
- A. **It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR GREEN, and left-turn GREEN ARROW. Only one of the three colors shall be displayed at any given time.**
  - B. **During the protected left-turn movement, the shared signal face shall simultaneously display both a CIRCULAR GREEN signal indication and a left-turn GREEN ARROW signal indication.**
  - C. **The shared signal face shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.**
  - D. **If the protected only mode is not the only left-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permissive mode (see Section 4D.20).**

Option:

- 02 A straight-through GREEN ARROW signal indication may be used instead of the CIRCULAR GREEN signal indication in Items A and B in Paragraph 1 on an approach where right turns are prohibited and a

**Figure 4D-8. Typical Position and Arrangements of Separate Signal Faces with Red Arrow for Protected Only Mode Left Turns**



straight-through GREEN ARROW signal indication is also used instead of a CIRCULAR GREEN signal indication in the other signal face(s) for through traffic.

**Standard:**

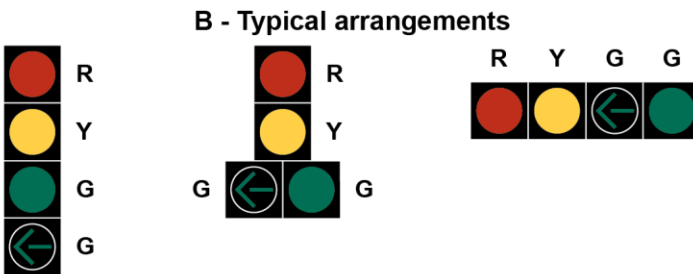
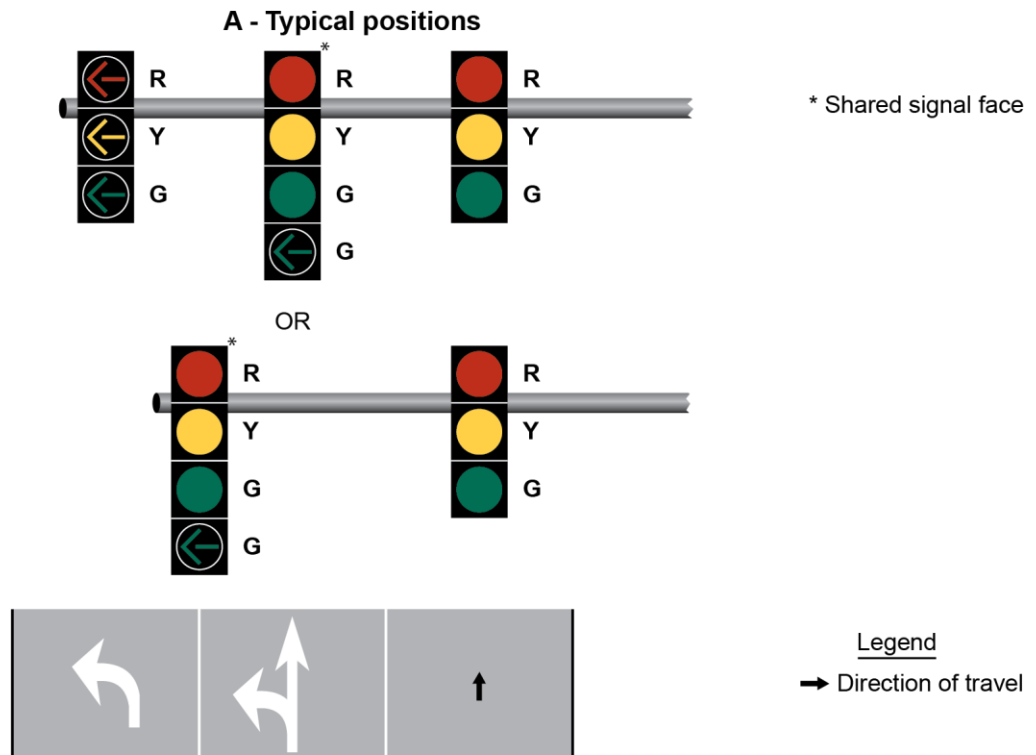
- 03 **If a separate left-turn signal face is provided for a protected only mode left turn, it shall meet the following requirements (see Figure 4D-10):**
- It shall be capable of displaying the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time. A signal instruction sign shall not be required with this set of signal indications. If used, it shall be a LEFT ON GREEN ARROW ONLY (R10-5) sign (see Figure 2B-27).**
  - During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.**
  - A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication.**
  - If the protected only mode is not the only left-turn mode used for the approach, the signal face shall be the same separate left-turn signal face that is used for the protected/permissive mode (see Section 4D.20 and Figure 4D-12) except that the flashing left-turn YELLOW ARROW signal indication shall not be displayed when operating in the protected only mode.**

**Section 4D.20 Signal Indications for Protected/Permissive Mode Left-Turn Movements**

**Standard:**

- 01 **If a shared signal face is provided for a protected/permissive mode left turn, it shall meet the following requirements (see Figure 4D-11):**
- It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR GREEN, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three circular indications shall be displayed at any given time. Only one of the two arrow indications shall be displayed at any given time. If the left-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are always terminated together, the steady left-turn YELLOW ARROW signal indication shall not be required.**

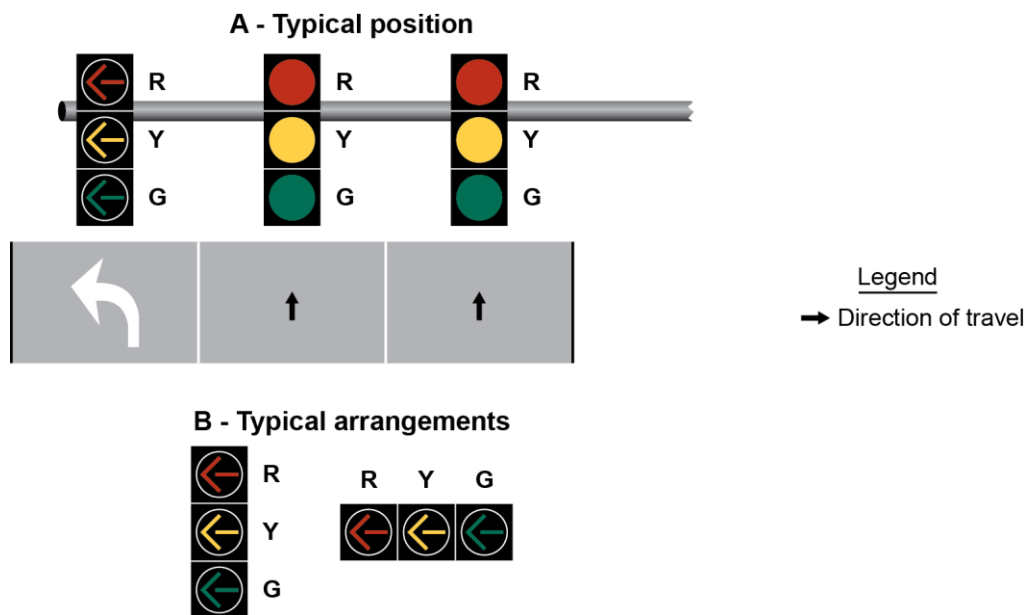
**Figure 4D-9. Typical Positions and Arrangements of Shared Signal Faces for Protected Only Mode Left Turns**



Note: Shared signal faces shall only be used for a protected-only mode left turn if the circular green and green left-turn arrow indications always begin and terminate together

- B. During the protected left-turn movement, the shared signal face shall simultaneously display a left-turn GREEN ARROW signal indication and a circular signal indication that is the same color as the signal indication for the adjacent through lane on the same approach as the protected left turn.**
- C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication, unless the left-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are being terminated together. When the left-turn GREEN ARROW and CIRCULAR GREEN signal indications are being terminated together, the required display following the left-turn GREEN ARROW signal indication shall be either the display of a CIRCULAR YELLOW signal indication alone or the simultaneous display of the CIRCULAR YELLOW and left-turn YELLOW ARROW signal indications.**
- D. During the permissive left-turn movement, the shared signal face shall display only a CIRCULAR GREEN signal indication.**

**Figure 4D-10. Typical Position and Arrangements of Separate Signal Faces for Protected Only Mode Left Turns**



E. A protected/permissive shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular signal indication that the adjacent through signal face or faces display.

F. A supplementary sign shall not be required. If used, it shall be a LEFT TURN YIELD ON GREEN (symbolic circular green) (R10-12) sign (see Figure 2B-27).

02 If a separate left-turn signal face is being operated in a protected/permissive left-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.

03 If a separate left-turn signal face is being operated in a protected/permissive left-turn mode and a flashing left-turn YELLOW ARROW signal indication is provided, it shall meet the following requirements (see Figure 4D-12):

A. It shall be capable of displaying the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, flashing left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the four indications shall be displayed at any given time.

B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.

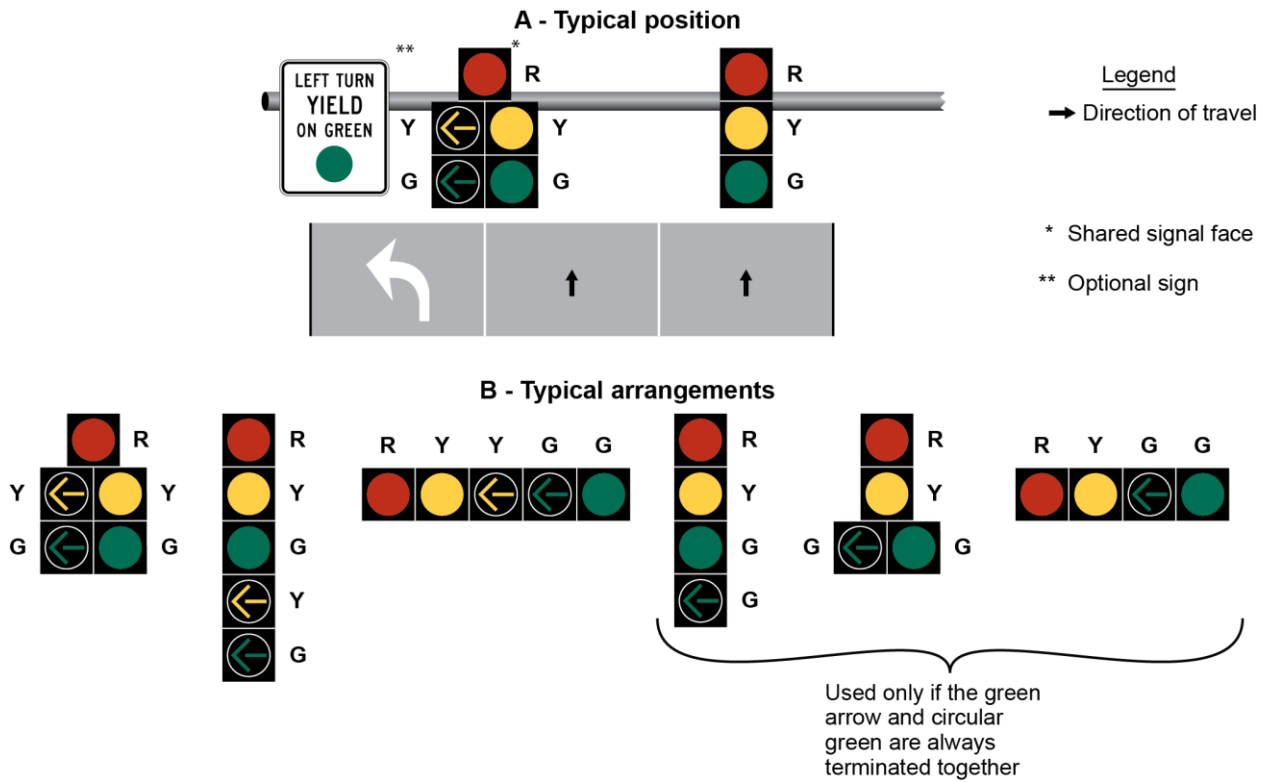
C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication.

D. During the permissive left-turn movement, a flashing left-turn YELLOW ARROW signal indication shall be displayed.

E. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn YELLOW ARROW signal indication if the permissive left-turn movement is being terminated and the separate left-turn signal face will subsequently display a steady left-turn RED ARROW indication.

F. It shall be permitted to display a flashing left-turn YELLOW ARROW signal indication for a permissive left-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications and the opposing left-turn signal faces display left-turn GREEN ARROW signal indications for a protected left-turn movement.

**Figure 4D-11. Typical Position and Arrangements of Shared Signal Faces for Protected/Permissive Mode Left Turns**



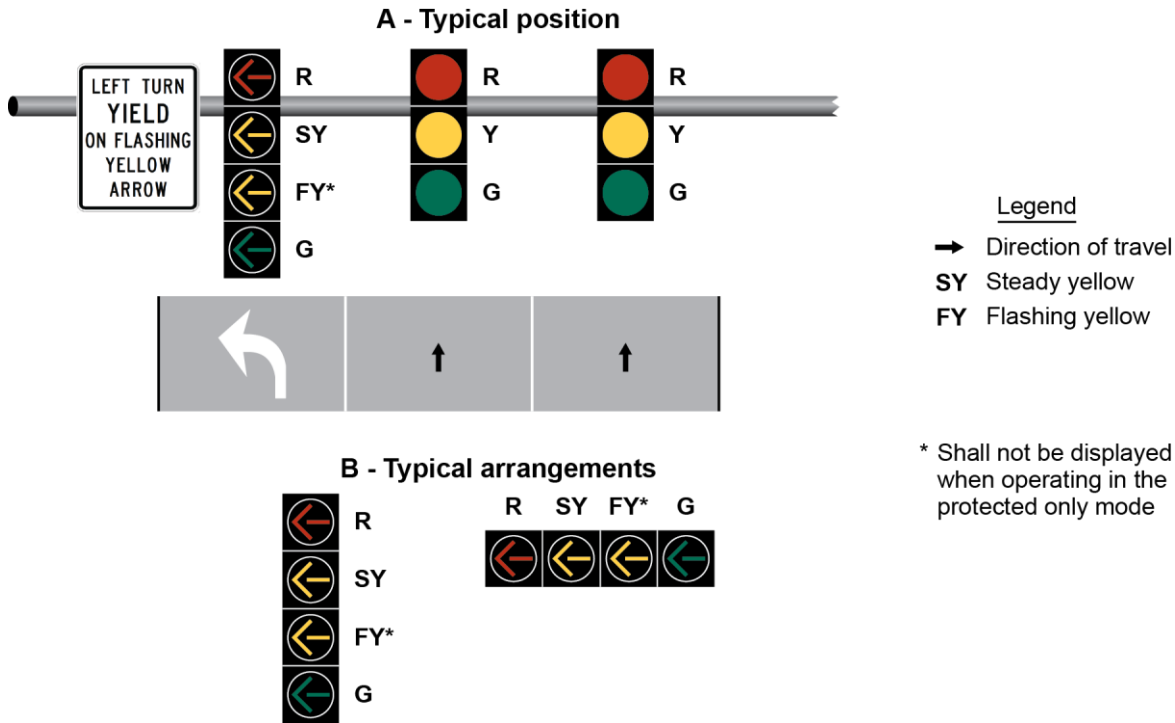
- G. When a permissive left-turn movement is changing to a protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed immediately upon the termination of the flashing left-turn YELLOW ARROW signal indication. A steady left-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing left-turn YELLOW ARROW signal indication and the display of the steady left-turn GREEN ARROW signal indication.
- H. The display shall be a four-section signal face except that a three-section signal face containing a dual-arrow signal section shall be permitted where signal head height limitations (or lateral positioning limitations for a horizontally-mounted signal face) will not permit the use of a four-section signal face. The dual-arrow signal section, where used, shall display a GREEN ARROW for the protected left-turn movement and a flashing YELLOW ARROW for the permissive left-turn movement.
- I. During steady mode (stop-and-go) operation, the signal section that displays the steady left-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing left-turn YELLOW ARROW signal indication for permissive left turns.
- J. During flashing mode operation (see Section 4D.30), the display of a flashing left-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady left-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.

**Standard:**

- 04 The LEFT TURN YIELD ON FLASHING YELLOW ARROW (R-10-H12c) sign (see Figure 4D-12) shall be used with the installation of each flashing left-turn YELLOW ARROW signal indication within a jurisdiction for at least five years (see Section 4D.18).



**Figure 4D-12. Typical Position and Arrangements of Separate Signal Faces with Flashing Yellow Arrow for Protected/Permissive Mode and Protected Only Mode Left Turns**



**Section 4D.21 Signal Indications for Right-Turn Movements – General**

**Standard:**

01 In Sections 4D.21 through 4D.24, provisions applicable to right-turn movements and right-turn lanes shall also apply to signal indications for U-turns to the right that are provided at locations where right turns are prohibited or not geometrically possible.

Support:

- 02 Right-turning traffic is controlled by one of four modes as follows:
- A. Permissive Only Mode—turns made on a CIRCULAR GREEN signal indication or a flashing right-turn YELLOW ARROW signal indication, after yielding to pedestrians.
  - B. Protected Only Mode—turns made only when a right-turn GREEN ARROW signal indication is displayed.
  - C. Protected/Permissive Mode—both modes occur on an approach during the same cycle.
  - D. Variable Right-Turn Mode—the operating mode changes among the protected only mode and/or the protected/permissive mode and/or the permissive only mode during different periods of the day or as traffic conditions change.

**Standard:**

03 During a permissive right-turn movement, the signal faces, if any, that exclusively control U-turn traffic that conflicts with the permissive right-turn movement (see Item F.1 in Section 4D.05) shall simultaneously display steady U-turn RED ARROW signal indications. If pedestrians crossing the lane or lanes used by the permissive right-turn movement to depart the intersection are controlled by pedestrian signal heads, the signal indications displayed by those pedestrian signal heads shall not be limited to any particular display during the permissive right-turn movement.

04 During a protected right-turn movement, the signal faces for left-turn traffic, if any, on the opposing approach shall not simultaneously display a steady left-turn GREEN ARROW or steady left-turn YELLOW ARROW signal indication, and signal faces, if any, that exclusively control U-turn traffic that conflicts with the protected right-turn movement (see Item F.1 in Section 4D.05) shall



**simultaneously display steady U-turn RED ARROW signal indications. If pedestrians crossing the lane or lanes used by the protected right-turn movement to depart the intersection are controlled by pedestrian signal heads, the pedestrian signal heads shall display a steady UPRAISED HAND (symbolizing DONT WALK) signal indication during the protected right-turn movement.**

05 **A protected only mode right-turn movement that does not begin and terminate at the same time as the adjacent through movement shall not be provided on an approach unless an exclusive right-turn lane exists.**

06 **A yellow change interval for the right-turn movement shall not be displayed when the status of the right-turn operation is changing from permissive to protected within any given signal sequence.**

07 **If the operating mode changes among the protected only mode and/or the protected/permissive mode and/or the permissive only mode during different periods of the day or as traffic conditions change, the requirements in Section 4D.22 through 4D.24 that are appropriate to that mode of operation shall be met subject to the following:**

**A. The CIRCULAR GREEN and CIRCULAR YELLOW signal indications shall not be displayed when operating in the protected only mode.**

**B. The right-turn GREEN ARROW and right-turn YELLOW ARROW signal indications shall not be displayed when operating in the permissive only mode.**

Option:

09 Additional static signs or changeable message signs may be used to meet the requirements for the variable right-turn mode or to inform drivers that right-turn green arrows will not be available during certain times of the day.

Support:

10 Sections 4D.21 through 4D.24 describe the use of the following two types of signal faces for controlling right-turn movements:

A. Shared signal face – This type of signal face controls both the right-turn movement and the adjacent movement (usually the through movement) and can serve as one of the two required primary signal faces for the adjacent movement. A shared signal face always displays the same color of circular indication that is displayed by the signal face or faces for the adjacent movement.

B. Separate right-turn signal face – This type of signal face controls only the right-turn movement and cannot serve as one of the two required primary signal faces for the adjacent movement (usually the through movement) because it displays signal indications that are applicable only to the right-turn movement. If a separate right-turn signal face is mounted overhead at the intersection, it is positioned over the extension of the right-turn lane. In a separate right-turn signal face, a flashing right-turn YELLOW ARROW signal indication is used to control permissive right-turning movements.

11 Section 4D.13 contains provisions regarding the lateral positioning of signal faces that control right-turn movements.

12 It is not necessary that the same mode of right-turn operation or same type of right-turn signal face be used on every approach to a signalized location. Selecting different modes and types of right-turn signal faces for the various approaches to the same signalized location is acceptable.

Option:

13 A signal face that is shared by left-turning and right-turning traffic may be provided for a shared left-turn/right-turn lane on an approach that has no through traffic (see Section 4D.25).

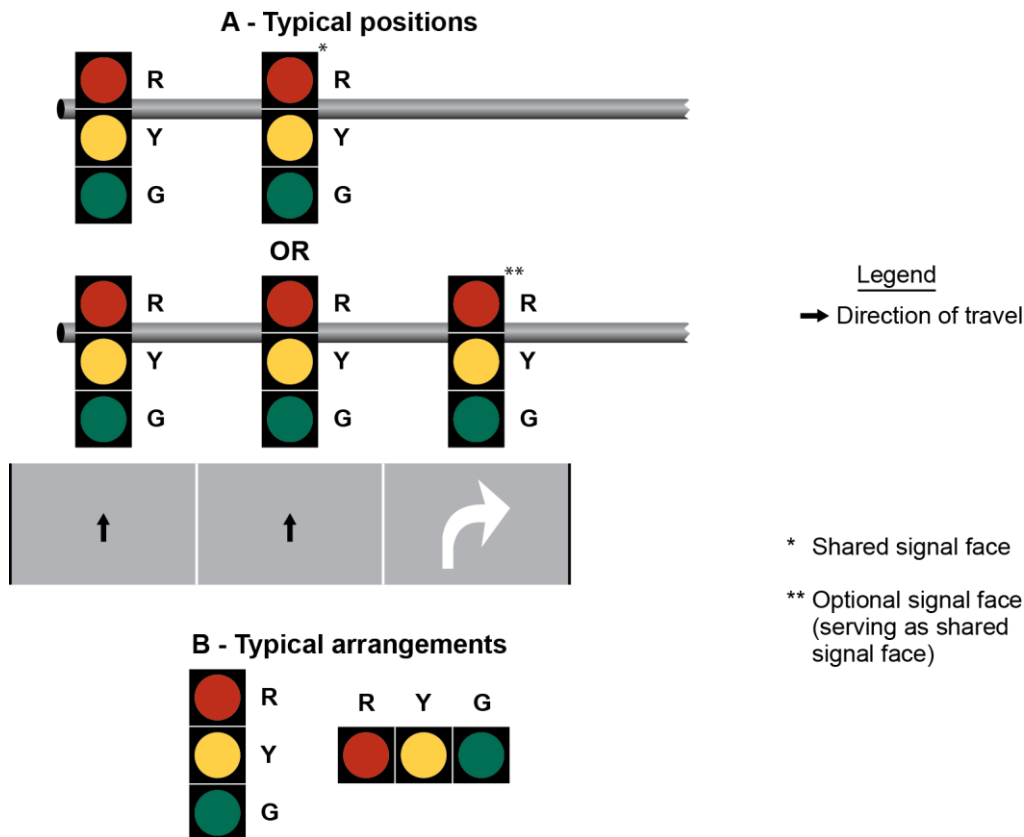
#### **Section 4D.22 Signal Indications for Permissive Only Mode Right-Turn Movements**

**Standard:**

01 **If a shared signal face is provided for a permissive only mode right turn, it shall meet the following requirements (see Figure 4D-13):**

**A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, and CIRCULAR GREEN. Only one of the three indications shall be displayed at any given time.**

**Figure 4D-13. Typical Positions and Arrangements of Shared Signal Faces for Permissive Only Mode Right Turns**



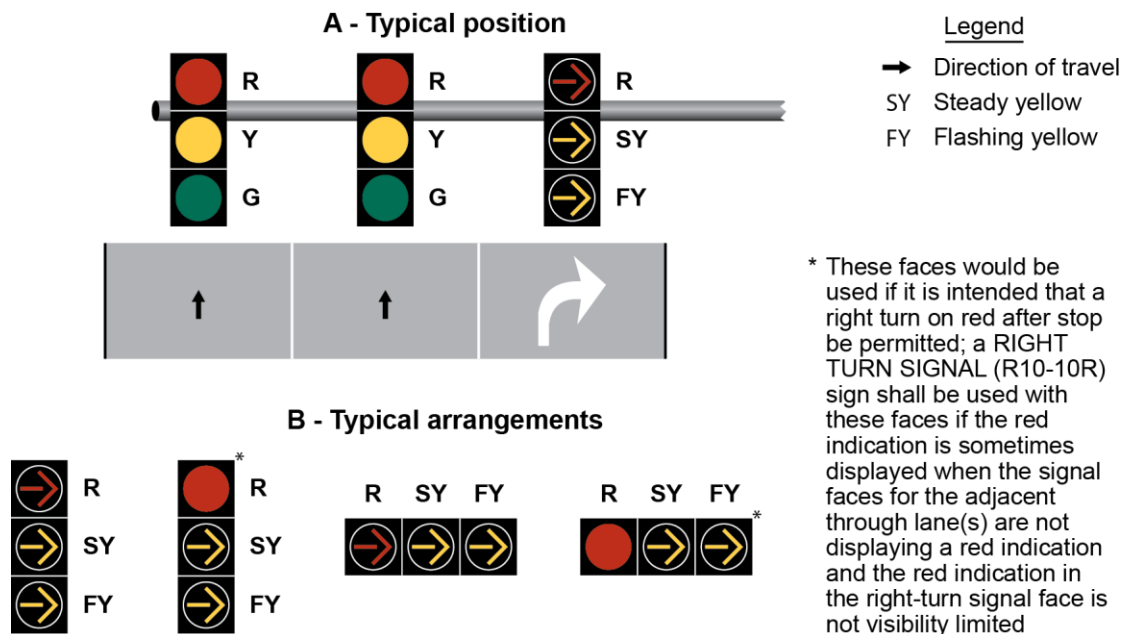
- B.** During the permissive right-turn movement, a **CIRCULAR GREEN** signal indication shall be displayed.
- C.** A permissive only shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
- D.** If the permissive only mode is not the only right-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permissive mode (see Section 4D.24) except that the right-turn **GREEN ARROW** and right-turn **YELLOW ARROW** signal indications shall not be displayed when operating in the permissive only mode.

02 If a separate right-turn signal face is being operated in a permissive only right-turn mode, a **CIRCULAR GREEN** signal indication shall not be used in that face.

03 If a separate right-turn signal face is being operated in a permissive only right-turn mode and a flashing right-turn **YELLOW ARROW** signal indication is provided, it shall meet the following requirements (see Figure 4D-14):

- A.** It shall be capable of displaying one of the following sets of signal indications:
1. Steady right-turn **RED ARROW**, steady right-turn **YELLOW ARROW**, and flashing right-turn **YELLOW ARROW**. Only one of the three indications shall be displayed at any given time.
  2. Steady **CIRCULAR RED**, steady right-turn **YELLOW ARROW**, and flashing right-turn **YELLOW ARROW**. Only one of the three indications shall be displayed at any given time. If the **CIRCULAR RED** signal indication is sometimes displayed when the signal faces for the adjacent through lane(s) are not displaying a **CIRCULAR RED** signal indication, a **RIGHT TURN SIGNAL (R10-10R)** sign (see Figure 2B-27) shall be used unless the

**Figure 4D-14. Typical Positions and Arrangements of Separate Signal Faces with Flashing Yellow Arrow for Permissive Only Mode Right Turns**

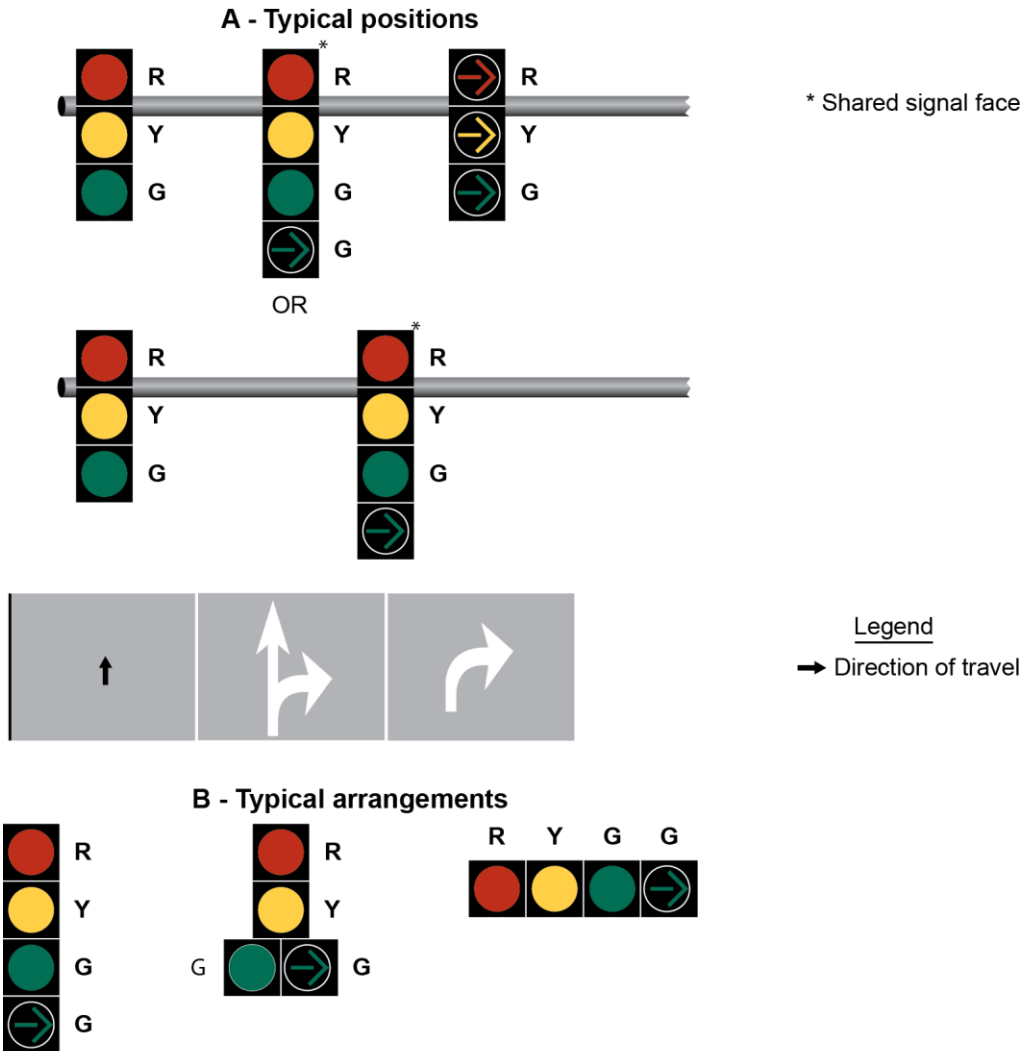


**CIRCULAR RED** signal indication in the separate right-turn signal face is shielded, hooded, louvered, positioned, or designed such that it is not readily visible to drivers in the through lane(s).

- B. During the permissive right-turn movement, a flashing right-turn **YELLOW ARROW** signal indication shall be displayed.
- C. A steady right-turn **YELLOW ARROW** signal indication shall be displayed following the flashing right-turn **YELLOW ARROW** signal indication.
- D. When the separate right-turn signal face is providing a message to stop and remain stopped, a steady right-turn **RED ARROW** signal indication shall be displayed if it is intended that right turns on red not be permitted (except when a traffic control device is in place permitting a turn on a steady **RED ARROW** signal indication) or a steady **CIRCULAR RED** signal indication shall be displayed if it is intended that right turns on red be permitted.
- E. It shall be permitted to display a flashing right-turn **YELLOW ARROW** signal indication for a permissive right-turn movement while the signal faces for the adjacent through movement display steady **CIRCULAR RED** signal indications.
- F. During steady mode (stop-and-go) operation, the signal section that displays the steady right-turn **YELLOW ARROW** signal indication during change intervals shall not be used to display the flashing right-turn **YELLOW ARROW** signal indication for permissive right turns.
- G. During flashing mode operation (see Section 4D.30), the display of a flashing right-turn **YELLOW ARROW** signal indication shall be only from the signal section that displays a steady right-turn **YELLOW ARROW** signal indication during steady mode (stop-and-go) operation.
- H. If the permissive only mode is not the only right-turn mode used for the approach, the signal face shall be the same separate right-turn signal face with a flashing **YELLOW ARROW** signal indication that is used for the protected/permissive mode (see Section 4D.24) except that the right-turn **GREEN ARROW** signal indication shall not be displayed when operating in the permissive only mode.

Figure 4D-15. Reserved for Future Use

Figure 4D-16. Typical Positions and Arrangements of Shared Signal Faces for Protected Only Mode Right Turns



Note: Shared signal faces shall only be used for a protected-only mode right turn if the circular green and green right-turn arrow indications always begin and terminate together.

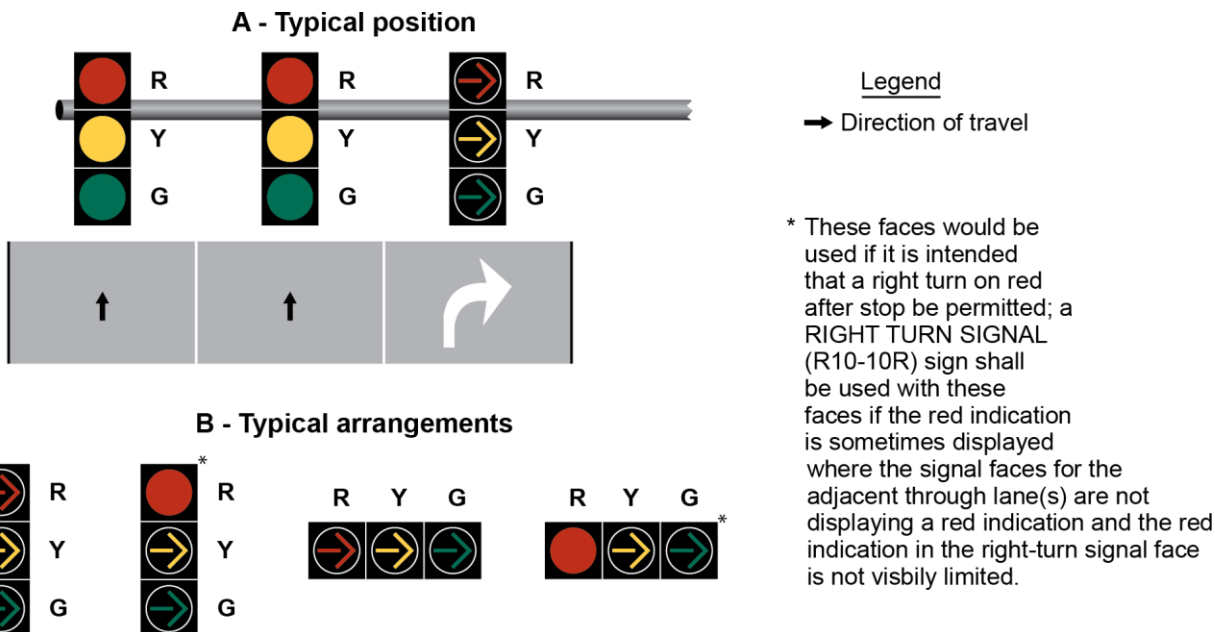
**Section 4D.23 Signal Indications for Protected Only Mode Right-Turn Movements**

**Standard:**

01 A shared signal face shall not be used for protected only mode right turns unless the **CIRCULAR GREEN** and **right-turn GREEN ARROW** signal indications always begin and terminate together. If a shared signal face is provided for a protected only right turn, it shall meet the following requirements (see Figure 4D-16):

- A. It shall be capable of displaying the following signal indications: steady **CIRCULAR RED**, steady **CIRCULAR YELLOW**, **CIRCULAR GREEN**, and **right-turn GREEN ARROW**. Only one of the three colors shall be displayed at any given time.
- B. During the protected right-turn movement, the shared signal face shall simultaneously display both a **CIRCULAR GREEN** signal indication and a **right-turn GREEN ARROW** signal indication.

**Figure 4D-17. Typical Positions and Arrangements of Separate Signal Faces for Protected Only Mode Right Turns**



- C. The shared signal face shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
- D. If the protected only mode is not the only right-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permissive mode (see Section 4D.24).

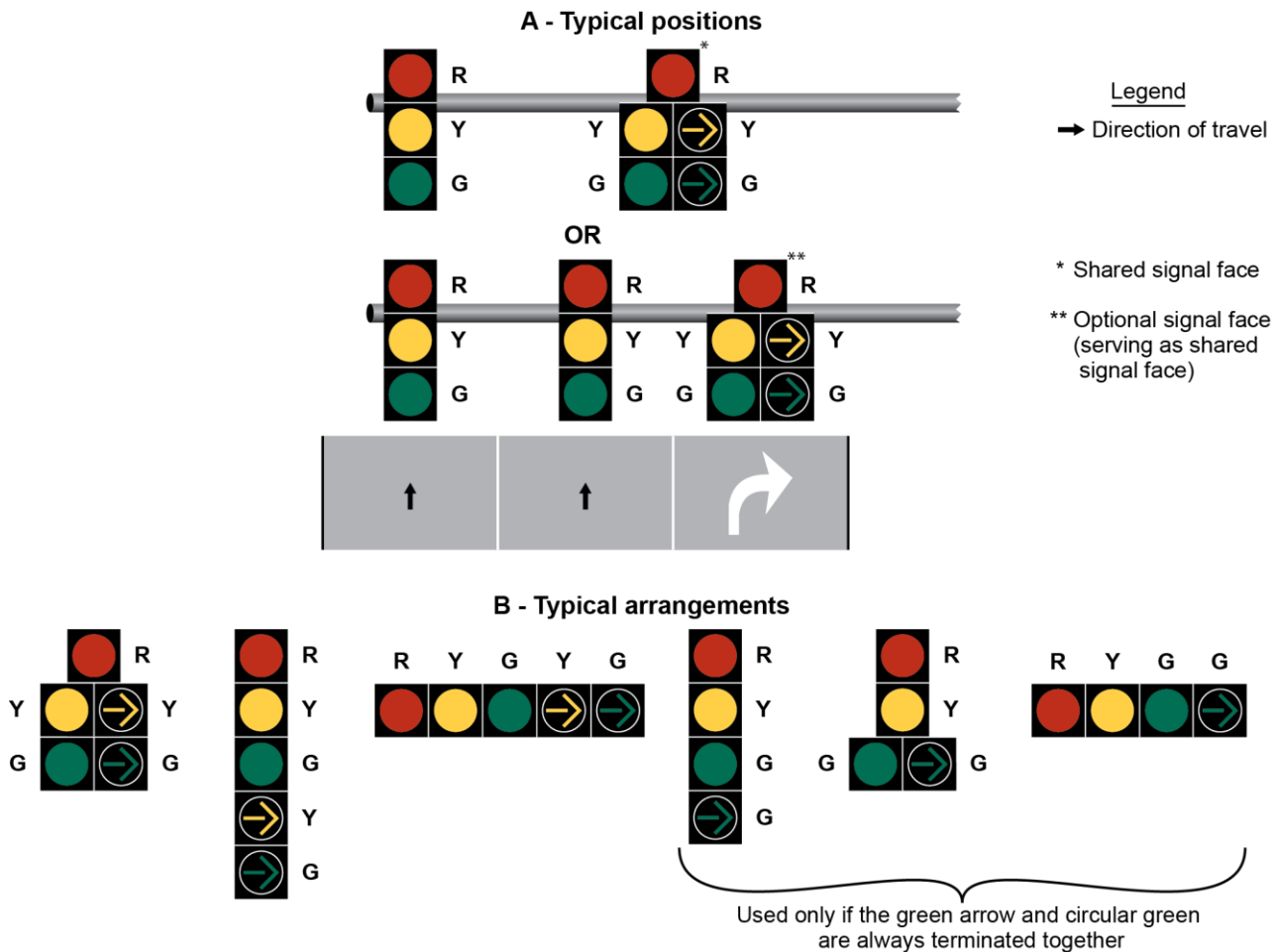
Option:

- 02 A straight-through GREEN ARROW signal indication may be used instead of the CIRCULAR GREEN signal indication in Items A and B in Paragraph 1 on an approach where left turns are prohibited and a straight-through GREEN ARROW signal indication is also used instead of a CIRCULAR GREEN signal indication in the other signal face(s) for through traffic.

**Standard:**

- 03 **If a separate right-turn signal face is provided for a protected only mode right turn, it shall meet the following requirements (see Figure 4D-17):**
  - A. It shall be capable of displaying one of the following sets of signal indications:
    1. Steady right-turn RED ARROW, steady right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time. A signal instruction sign shall not be required with this set of signal indications. If used, it shall be a RIGHT ON GREEN ARROW ONLY (R10-5R) sign (see Figure 2B-27).
    2. Steady CIRCULAR RED, steady right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of three indications shall be displayed at any given time. If the CIRCULAR RED signal indication is sometimes displayed when the signal faces for the adjacent through lane(s) are not displaying a CIRCULAR RED signal indication, a RIGHT TURN SIGNAL (R10-10R) sign (see Figure 2B-27) shall be used unless the CIRCULAR RED signal indication is shielded, hooded, louvered, positioned, or designed such that it is not readily visible to drivers in the through lane(s).
  - B. During the protected right-turn movement, a right-turn GREEN ARROW signal indication shall be displayed.
  - C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the right-turn GREEN ARROW signal indication.

**Figure 4D-18. Typical Positions and Arrangements of Shared Signal Faces for Protected/Permissive Mode Right Turns**



- D. When the separate signal face is providing a message to stop and remain stopped, a steady right-turn RED ARROW signal indication shall be displayed if it is intended that right turns on red not be permitted (except when a traffic control device is in place permitting a turn on a steady RED ARROW signal indication) or a steady CIRCULAR RED signal indication shall be displayed if it is intended that right turns on red be permitted.
- E. If the protected only mode is not the only right-turn mode used for the approach, the signal face shall be the same separate right-turn signal face that is used for the protected/permissive mode (see Section 4D.24 and Figure 4D-19) except that a flashing right-turn YELLOW ARROW signal indication shall not be displayed when operating in the protected only mode.

**Section 4D.24 Signal Indications for Protected/Permissive Mode Right-Turn Movements**

**Standard:**

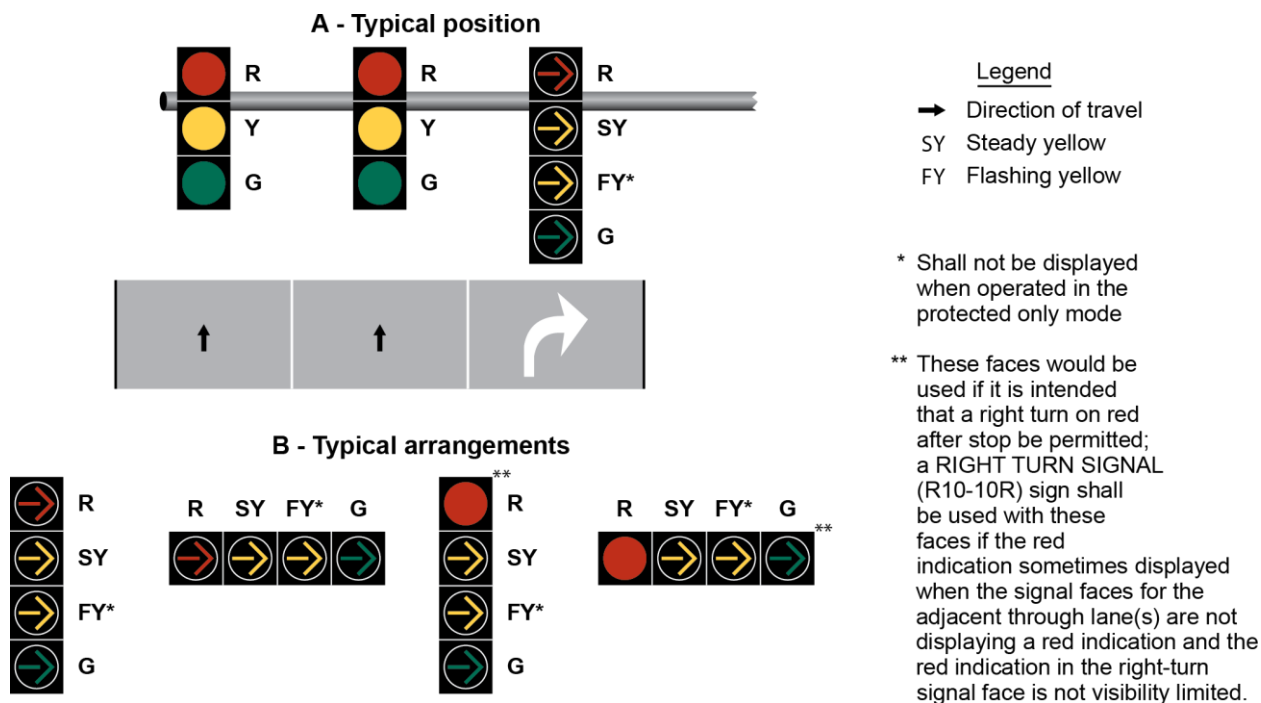
01 If a shared signal face is provided for a protected/permissive mode right turn, it shall meet the following requirements (see Figure 4D-18):

- A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR GREEN, steady right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of the three circular indications shall be displayed at any given time. Only one of the two arrow indications shall be displayed at any given time. If the right-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are always terminated together, the steady right-turn YELLOW ARROW signal indication shall not be required.

- B. During the protected right-turn movement, the shared signal face shall simultaneously display a right-turn GREEN ARROW signal indication and a circular signal indication that is the same color as the signal indication for the adjacent through lane on the same approach as the protected right turn.
  - C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the right-turn GREEN ARROW signal indication, unless the right-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are being terminated together. When the right-turn GREEN ARROW and CIRCULAR GREEN signal indications are being terminated together, the required display following the right-turn GREEN ARROW signal indication shall be either the display of a CIRCULAR YELLOW signal indication alone or the simultaneous display of the CIRCULAR YELLOW and right-turn YELLOW ARROW signal indications.
  - D. During the permissive right-turn movement, the shared signal face shall display only a CIRCULAR GREEN signal indication.
  - E. A protected/permissive shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
- 02 If a separate right-turn signal face is being operated in a protected/permissive right-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.
- 03 If a separate right-turn signal face is being operated in a protected/permissive right-turn mode and a flashing right-turn YELLOW ARROW signal indication is provided, it shall meet the following requirements (see Figure 4D-19):
- A. It shall be capable of displaying one of the following sets of signal indications:
    1. Steady right-turn RED ARROW, steady right-turn YELLOW ARROW, flashing right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of the four indications shall be displayed at any given time.
    2. Steady CIRCULAR RED, steady right-turn YELLOW ARROW, flashing right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of the four indications shall be displayed at any given time. If the CIRCULAR RED signal indication is sometimes displayed when the signal faces for the adjacent through lane(s) are not displaying a CIRCULAR RED signal indication, a RIGHT TURN SIGNAL (R10-10R) sign (see Figure 2B-27) shall be used unless the CIRCULAR RED signal indication in the separate right-turn signal face is shielded, hooded, louvered, positioned, or designed such that it is not readily visible to drivers in the through lane(s).
  - B. During the protected right-turn movement, a right-turn GREEN ARROW signal indication shall be displayed.
  - C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the right-turn GREEN ARROW signal indication.
  - D. During the permissive right-turn movement, a flashing right-turn YELLOW ARROW signal indication shall be displayed.
  - E. A steady right-turn YELLOW ARROW signal indication shall be displayed following the flashing right-turn YELLOW ARROW signal indication if the permissive right-turn movement is being terminated and the separate right-turn signal face will subsequently display a steady red indication.
  - F. When a permissive right-turn movement is changing to a protected right-turn movement, a right-turn GREEN ARROW signal indication shall be displayed immediately upon the termination of the flashing right-turn YELLOW ARROW signal indication. A steady right-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing right-turn YELLOW ARROW signal indication and the display of the steady right-turn GREEN ARROW signal indication.
  - G. When the separate right-turn signal face is providing a message to stop and remain stopped, a steady right-turn RED ARROW signal indication shall be displayed if it is intended that right turns on red not be permitted (except when a traffic control device is in place permitting a turn on a steady RED ARROW signal indication) or a steady CIRCULAR RED signal indication shall be displayed if it is intended that right turns on red be permitted.



**Figure 4D-19. Typical Position and Arrangements of Separate Signal Faces with Flashing Yellow Arrow for Protected/Permissive Mode and Protected Only Mode Right Turns**



- H. It shall be permitted to display a flashing right-turn YELLOW ARROW signal indication for a permissive right-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications.
- I. A signal face containing a dual-arrow signal section in place of separate flashing right-turn YELLOW ARROW and right-turn GREEN ARROW signal sections shall be permitted where signal head height limitations (or lateral positioning limitations for a horizontally-mounted signal face) are a concern. The dual-arrow signal section, where used, shall display a GREEN ARROW for the protected right-turn movement and a flashing YELLOW ARROW for the permissive right-turn movement.
- J. During steady mode (stop-and-go) operation, the signal section that displays the steady right-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing right-turn YELLOW ARROW signal indication for permissive right turns.
- K. During flashing mode operation (see Section 4D.30), the display of a flashing right-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady right-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.

**Section 4D.25 Signal Indications for Approaches With Shared Left-Turn/Right-Turn Lanes and No Through Movement**

Support:

- 01 A lane that is shared by left-turn and right-turn movements is sometimes provided on an approach that has no through movement, such as the stem of a T-intersection or where the opposite approach is a one-way roadway in the opposing direction.

Standard:

- 02 When a shared left-turn/right-turn lane exists on a signalized approach, the left-turn and right-turn movements shall start and terminate simultaneously and the red signal indication used in each of the signal faces on the approach shall be a CIRCULAR RED.



- 03 This requirement for the use of CIRCULAR RED signal indications in signal faces for approaches having a shared lane for left-turn and right-turn movements is a specific exception to other provisions in this Chapter that would otherwise require the use of RED ARROW signal indications.

**Standard:**

- 04 **The signal faces provided for an approach with a shared left-turn/right-turn lane and no through movement shall be one of the following:**
- A. **Two or more signal faces, each capable of displaying CIRCULAR RED, CIRCULAR YELLOW, and CIRCULAR GREEN signal indications, shall be provided for the approach. This display shall be permissible regardless of number of exclusive left-turn and/or right-turn lanes that exist on the approach in addition to the shared left-turn/right-turn lane and regardless of whether or not there are pedestrian or opposing vehicular movements that conflict with the left-turn or right-turn movements. However, if there is an opposing approach and the signal phasing protects the left-turn movement on the approach with the shared left-turn/right-turn lane from conflicts with the opposing vehicular movements and any signalized pedestrian movements, a left-turn GREEN ARROW signal indication shall also be included in the left-most signal face and shall be displayed simultaneously with the CIRCULAR GREEN signal indication.**
  - B. **If the approach has one or more exclusive turn lanes in addition to the shared left-turn/right-turn lane and there is no conflict with a signalized vehicular or pedestrian movement, and GREEN ARROW signal indications are used in place of CIRCULAR GREEN signal indications on the approach, the signal faces for the approach shall be:**
    - 1. **A signal face(s) capable of displaying CIRCULAR RED, YELLOW ARROW, and GREEN ARROW signal indications for the exclusive turn lane(s), with the arrows pointing in the direction of the turn, and**
    - 2. **A shared left-turn/right-turn signal face capable of displaying CIRCULAR RED, left-turn YELLOW ARROW, left-turn GREEN ARROW, right-turn YELLOW ARROW, and right-turn GREEN ARROW signal indications, in an arrangement of signal sections that complies with the provisions of Section 4D.09 or 4D.10.**
  - C. **If the approach has one or more exclusive turn lanes in addition to the shared left-turn/right-turn lane and there is a conflict with a signalized vehicular or pedestrian movement, and flashing YELLOW ARROW signal indications are used in place of CIRCULAR GREEN signal indications on the approach, the signal faces for the approach shall be as described in Items B.1 and B.2, except that flashing YELLOW ARROW signal indications shall be used in place of the GREEN ARROW signal indications for the turning movement(s) that conflicts with the signalized vehicular or pedestrian movement.**

Support:

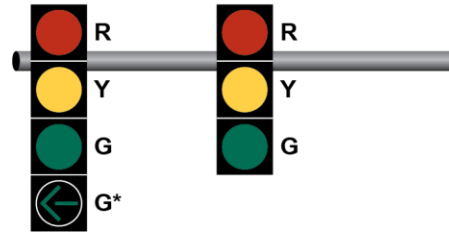
- 05 Figure 4D-20 illustrates application of these Standards on approaches that have only a shared left-turn/right-turn lane, and on approaches that have one or more exclusive turn lanes in addition to the shared left-turn/right-turn lane.

Option:

- 06 If the lane-use regulations on an approach are variable such that at certain times all of the lanes on the approach are designated as exclusive turn lanes and no lane is designated as a shared left-turn/right-turn lane:
- A. **During the times that no lane is designated as a shared left-turn/right-turn lane, the left-turn and right-turn movements may start and terminate independently, and the left-turn and right-turn movements may be operated in one or more of the modes of operation as described in Sections 4D.17 through 4D.24; and**
  - B. **If a protected-permissive mode is used, the shared left-turn/right-turn signal face provided in Paragraph 4 may be modified to include a dual-arrow signal section capable of displaying both a GREEN ARROW signal indication and a flashing YELLOW ARROW signal indication for a turn movement(s) in order to not exceed the maximum of five sections per signal face provided in Section 4D.08.**

### Figure 4D-20. Signal Indications for Approaches with a Shared Left-Turn/Right-Turn Lane and No Through Movement (Sheet 1 of 3)

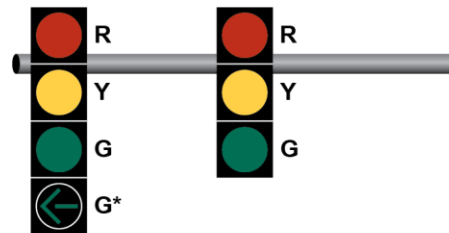
#### A - No conflicting vehicular or pedestrian movements



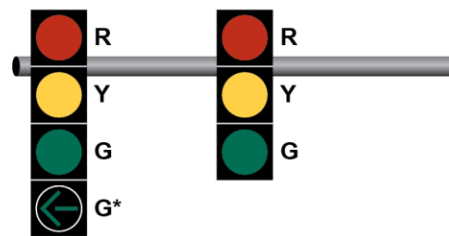
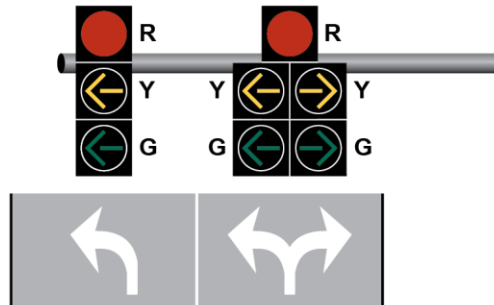
\* Left-turn GREEN ARROW section shall be included if there is an opposing one-way approach and the signal phasing eliminates conflicts.

Notes:

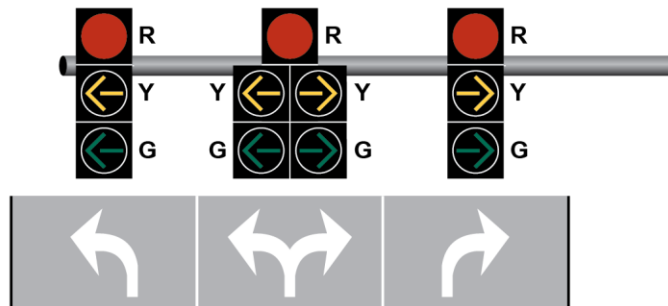
- 1. Horizontally-aligned signal faces may also be used.
- 2. Shared signal faces may also be 5 sections in a vertical straight line instead of a cluster.



OR

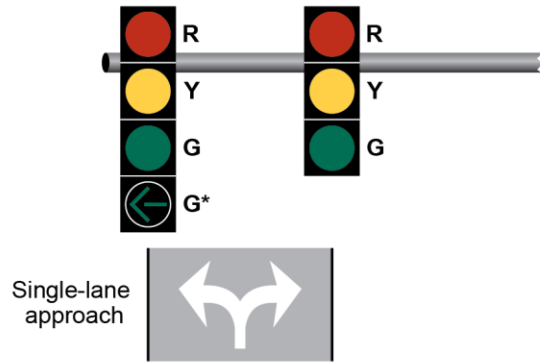


OR



**Figure 4D-20. Signal Indications for Approaches with a Shared Left-Turn/Right-Turn Lane and No Through Movement (Sheet 2 of 3)**

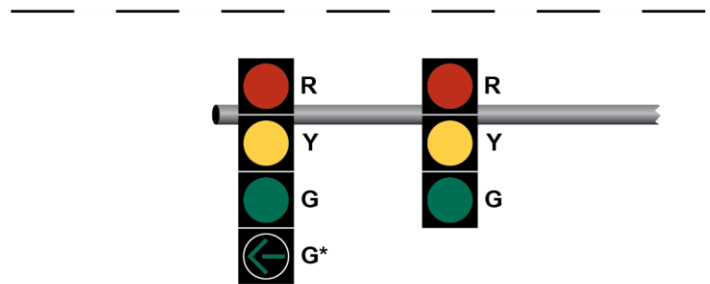
**B - Pedestrian or vehicular conflict with one turn movement**



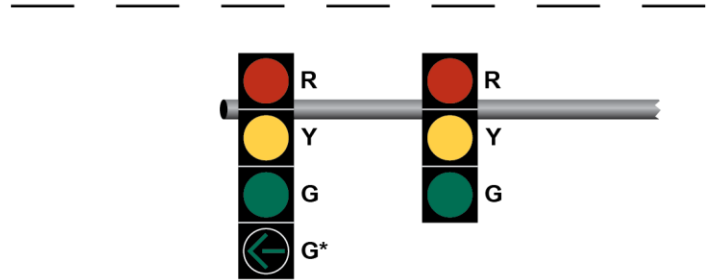
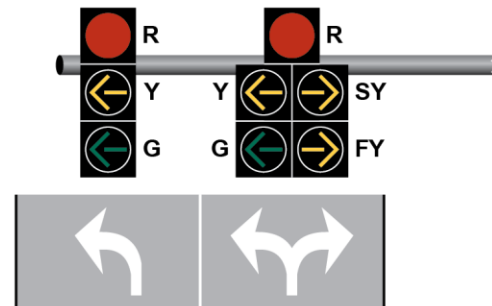
\* Left-turn GREEN ARROW section shall be included if there is an opposing one-way approach and the signal phasing eliminates conflicts.

Notes:

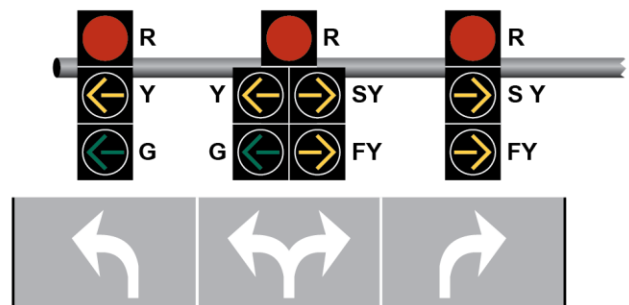
1. A conflict with the right-turn movement is illustrated.
2. Horizontally-aligned signal faces may also be used.
3. Shared signal faces may also be 5 sections in a vertical straight line instead of a cluster.



OR

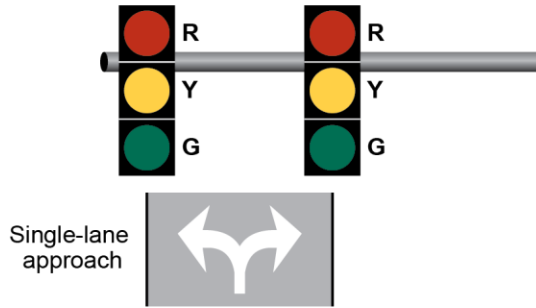


OR



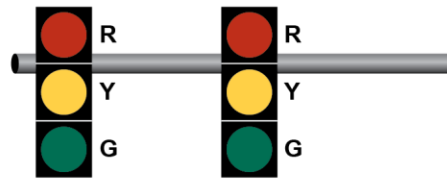
### Figure 4D-20. Signal Indications for Approaches with a Shared Left-Turn/Right-Turn Lane and No Through Movement (Sheet 3 of 3)

#### C - Pedestrian or vehicular conflicts with both turn movements

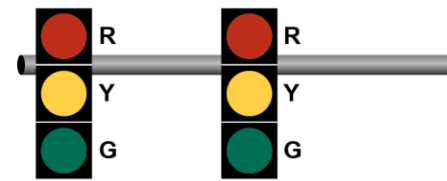
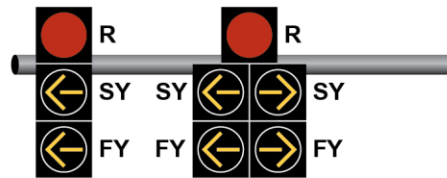


Notes:

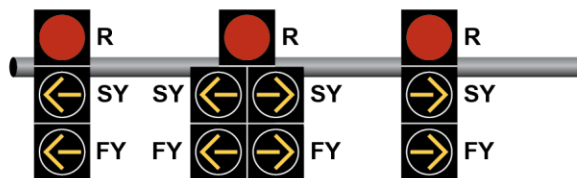
- 1. Horizontally-aligned signal faces may also be used.
- 2. Shared signal faces may also be 5 sections in a vertical straight line instead of a cluster.



OR



OR



## **Section 4D.26 Yellow Change and Red Clearance Intervals**

### **Standard:**

01 **A steady yellow signal indication shall be displayed following every CIRCULAR GREEN or GREEN ARROW signal indication and following every flashing YELLOW ARROW signal indication displayed as a part of a steady mode operation. This requirement shall not apply when a CIRCULAR GREEN or a flashing YELLOW ARROW signal indication is followed immediately by a GREEN ARROW signal indication.**

02 **The exclusive function of the yellow change interval shall be to warn traffic of an impending change in the right-of-way assignment.**

03 **The duration of the yellow change interval shall be determined using engineering practices.**

### Support:

04 Section 4D.05 contains provisions regarding the display of steady CIRCULAR YELLOW signal indications to approaches from which drivers are allowed to make permissive left turns.

### Guidance:

05 *When indicated by the application of engineering practices, the yellow change interval should be followed by a red clearance interval to provide additional time before conflicting traffic movements, including pedestrians, are released.*

### **Standard:**

06 **When used, the duration of the red clearance interval shall be determined using engineering practices.**

### Support:

07 Engineering practices for determining the duration of yellow change and red clearance intervals can be found in ITE's "Traffic Control Devices Handbook" and in ITE's "Manual of Traffic Signal Design" (see Section 1A.11).

### **Standard:**

08 **The durations of yellow change intervals and red clearance intervals shall be consistent with the determined values within the technical capabilities of the controller unit.**

09 **The duration of a yellow change interval shall not vary on a cycle-by-cycle basis within the same signal timing plan.**

10 **Except as provided in Paragraph 12, the duration of a red clearance interval shall not be decreased or omitted on a cycle-by-cycle basis within the same signal timing plan.**

### Option:

11 The duration of a red clearance interval may be extended from its predetermined value for a given cycle based upon the detection of a vehicle that is predicted to violate the red signal indication.

12 When an actuated signal sequence includes a signal phase for permissive/protected (lagging) left-turn movements in both directions, the red clearance interval may be shown during those cycles when the lagging left-turn signal phase is skipped and may be omitted during those cycles when the lagging left-turn signal phase is shown.

13 The duration of a yellow change interval or a red clearance interval may be different in different signal timing plans for the same controller unit.

### Guidance:

14 *A yellow change interval should have a minimum duration of 3 seconds and a maximum duration of 6 seconds. The longer intervals should be reserved for use on approaches with higher speeds.*

15 *Except when clearing a one-lane, two-way facility (see Section 4H.02) or when clearing an exceptionally wide intersection, a red clearance interval should have a duration not exceeding 6 seconds.*

### **Standard:**

16 **Except for warning beacons mounted on advance warning signs on the approach to a signalized location (see Section 2C.36), signal displays that are intended to provide a "pre-yellow warning"**

**interval, such as flashing green signal indications, vehicular countdown displays, or other similar displays, shall not be used at a signalized location.**

Support:

- 17 The use of signal displays (other than warning beacons mounted on advance warning signs) that convey a “pre-yellow warning” have been found by research to increase the frequency of crashes.

#### **Section 4D.27 Preemption and Priority Control of Traffic Control Signals**

Option:

- 01 Traffic control signals may be designed and operated to respond to certain classes of approaching vehicles by altering the normal signal timing and phasing plan(s) during the approach and passage of those vehicles. The alternative plan(s) may be as simple as extending a currently displayed green interval or as complex as replacing the entire set of signal phases and timing.

Support:

- 02 Preemption control (see definition in Section 1A.13) is typically given to trains, boats, emergency vehicles and light rail transit.

- 03 Examples of preemption control include the following:

- A. The prompt displaying of green signal indications at signalized locations ahead of fire vehicles, law enforcement vehicles, ambulances, and other official emergency vehicles;
- B. A special sequence of signal phases and timing to expedite and/or provide additional clearance time for vehicles to clear the tracks prior to the arrival of rail traffic; and
- C. A special sequence of signal phases to display a steady red indication to prohibit turning movements towards the tracks during the approach or passage of rail traffic.

- 04 Priority control (see definition in Section 1A.13) is typically given to certain non-emergency vehicles such as light-rail transit vehicles operating in a mixed-use alignment and buses.

- 05 Examples of priority control include the following:

- A. The displaying of early or extended green signal indications at an intersection to assist public transit vehicles in remaining on schedule, and
- B. Special phasing to assist public transit vehicles in entering the travel stream ahead of the platoon of traffic.

- 06 Some types or classes of vehicles supersede others when a traffic control signal responds to more than one type or class. In general, a vehicle that is more difficult to control supersedes a vehicle that is easier to control.

Option:

- 07 Preemption or priority control of traffic control signals may also be a means of assigning priority right-of-way to specified classes of vehicles at certain non-intersection locations such as on approaches to one-lane bridges and tunnels, movable bridges, highway maintenance and construction activities, metered freeway entrance ramps, and transit operations.

**Standard:**

- 08 **During the transition into preemption control:**

- A. The yellow change interval, and any red clearance interval that follows, shall not be shortened or omitted.**
- B. The shortening or omission of any pedestrian walk interval and/or pedestrian change interval shall be permitted.**
- C. The return to the previous green signal indication shall be permitted following a steady yellow signal indication in the same signal face, omitting the red clearance interval, if any.**

- 09 **During preemption control and during the transition out of preemption control:**

- A. The shortening or omission of any yellow change interval, and of any red clearance interval that follows, shall not be permitted.**
- B. A signal indication sequence from a steady yellow signal indication to a green signal indication shall not be permitted.**

- 10 **During priority control and during the transition into or out of priority control:**
- A. **The shortening or omission of any yellow change interval, and of any red clearance interval that follows, shall not be permitted.**
  - B. **The shortening of any pedestrian walk interval below that time described in Section 4E.06 shall not be permitted.**
  - C. **The omission of a pedestrian walk interval and its associated change interval shall not be permitted unless the associated vehicular phase is also omitted or the pedestrian phase is exclusive.**
  - D. **The shortening or omission of any pedestrian change interval shall not be permitted.**
  - E. **A signal indication sequence from a steady yellow signal indication to a green signal indication shall not be permitted.**

*Guidance:*

- 11 *Except for traffic control signals interconnected with light rail transit systems, traffic control signals with railroad preemption or coordinated with flashing-light signal systems should be provided with a back-up power supply.*
- 12 *When a traffic control signal that is returning to a steady mode from a dark mode (typically upon restoration from a power failure) receives a preemption or priority request, care should be exercised to minimize the possibility of vehicles or pedestrians being misdirected into a conflict with the vehicle making the request.*

*Option:*

- 13 During the change from a dark mode to a steady mode under a preemption or priority request, the display of signal indications that could misdirect road users may be prevented by one or more of the following methods:
- A. Having the traffic control signal remain in the dark mode,
  - B. Having the traffic control signal remain in the flashing mode,
  - C. Altering the flashing mode,
  - D. Executing the normal start-up routine before responding, or
  - E. Responding directly to initial or dwell period.

*Guidance:*

- 14 *If a traffic control signal is installed near or within a grade crossing or if a grade crossing with active traffic control devices is within or near a signalized highway intersection, Chapter 8C should be consulted.*
- 15 *Traffic control signals operating under preemption control or under priority control should be operated in a manner designed to keep traffic moving.*
- 16 *Traffic control signals that are designed to respond under preemption or priority control to more than one type or class of vehicle should be designed to respond in the relative order of importance or difficulty in stopping the type or class of vehicle. The order of priority should be: train, boat, heavy vehicle (fire vehicle, emergency medical service), light vehicle (law enforcement), light rail transit, rubber-tired transit.*

*Option:*

- 17 A distinctive indication may be provided at the intersection to show that an emergency vehicle has been given control of the traffic control signal. In order to assist in the understanding of the control of the traffic signal, a common distinctive indication may be used where drivers from different agencies travel through the same intersection when responding to emergencies.
- 18 If engineering judgment indicates that light rail transit signal indications would reduce road user confusion that might otherwise occur if standard traffic signal indications were used to control these movements, light rail transit signal indications complying with Section 8C.11 and as illustrated in Figure 8C-3 may be used for preemption or priority control of the following exclusive movements at signalized intersections:
- A. Public transit buses in “queue jumper” lanes, and
  - B. Bus rapid transit in semi-exclusive or mixed-use alignments.

## **Section 4D.28 Flashing Operation of Traffic Control Signals – General**

### **Standard:**

01 The light source of a flashing signal indication shall be flashed continuously at a rate of not less than 50 or more than 60 times per minute.

02 The displayed period of each flash shall be a minimum of 1/2 and a maximum of 2/3 of the total flash cycle.

03 Flashing signal indications shall comply with the requirements of other Sections of this Manual regarding visibility-limiting or positioning of conflicting signal indications, except that flashing yellow signal indications for through traffic shall not be required to be visibility-limited or positioned to minimize visual conflict for road users in separately controlled turn lanes.

04 Each traffic control signal shall be provided with an independent flasher mechanism that operates in compliance with this Section.

05 The flashing operation shall not be terminated by removal or turn off of the controller unit or of the conflict monitor (malfunction management unit) or both.

06 A manual switch, a conflict monitor (malfunction management unit) circuit, and, if appropriate, automatic means shall be provided to initiate the flashing mode.

### **Option:**

07 Based on engineering study or engineering judgment, traffic control signals may be operated in the flashing mode on a scheduled basis during one or more periods of the day rather than operated continuously in the steady (stop-and-go) mode.

### **Support:**

08 Sections 4E.06 and 4E.09 contain information regarding the operation of pedestrian signal heads and accessible pedestrian signal detector pushbutton locator tones, respectively, during flashing operation.

## **Section 4D.29 Flashing Operation – Transition Into Flashing Mode**

### **Standard:**

01 The transition from steady (stop-and-go) mode to flashing mode, if initiated by a conflict monitor (malfunction management unit) or by a manual switch, shall be permitted to be made at any time.

02 Programmed changes from steady (stop-and-go) mode to flashing mode shall be made under either of the following circumstances:

A. At the end of the common major-street red interval (such as just prior to the start of the green in both directions on the major street), or

B. Directly from a CIRCULAR GREEN signal indication to a flashing CIRCULAR YELLOW signal indication, or from a GREEN ARROW signal indication to a flashing YELLOW ARROW signal indication, or from a flashing YELLOW ARROW signal indication (see Sections 4D.17 to 4D.24) to a flashing YELLOW ARROW signal indication in a different signal section.

03 During programmed changes into flashing mode, no green signal indication or flashing yellow signal indication shall be terminated and immediately followed by a steady red or flashing red signal indication without first displaying the steady yellow signal indication.

## **Section 4D.30 Flashing Operation – Signal Indications During Flashing Mode**

### **Guidance:**

01 When a traffic control signal is operated in the flashing mode, a flashing yellow signal indication should be used for the major street and a flashing red signal indication should be used for the other approaches unless flashing red signal indications are used on all approaches.

02 If a traffic control signal with left-turn signal face is operated in flashing mode during off-peak hours, the supplementary sign LEFT TURN YIELD ON FLASHING RED ARROW AFTER STOP (R10-27) (see Figure 2B-27) should be used.



**Standard:**

03 When a traffic control signal is operated in the flashing mode, all of the green signal indications at the signalized location shall be dark (non-illuminated) and shall not be displayed in either a steady or flashing manner, except for single-section GREEN ARROW signal indications as provided elsewhere in this Section.

04 Flashing yellow signal indications shall be used on more than one approach to a signalized location only if those approaches do not conflict with each other.

05 Except as provided in Paragraph 6, when a traffic control signal is operated in the flashing mode, one and only one signal indication in every signal face at the signalized location shall be flashed.

## Option:

06 If a signal face has two identical CIRCULAR RED or RED ARROW signal indications (see Section 4D.08), both of those identical signal indications may be flashed simultaneously.

**Standard:**

07 No steady indications, other than a single-section signal face consisting of a continuously-displayed GREEN ARROW signal indication that is used alone to indicate a continuous movement in the steady (stop-and-go) mode, shall be displayed at the signalized location during the flashing mode. A single-section GREEN ARROW signal indication shall remain continuously displayed when the traffic control signal is operated in the flashing mode.

08 If a signal face includes both circular and arrow signal indications of the color that is to be flashed, only the circular signal indication shall be flashed.

09 All signal faces that are flashed on an approach shall flash the same color, either yellow or red, except that separate turn signal faces (see Sections 4D.17 and 4D.21) shall be permitted to flash a RED ARROW signal indication when the adjacent through movement signal indications are flashed yellow. Shared signal faces (see Sections 4D.17 and 4D.21) for turn movements shall not be permitted to flash a CIRCULAR RED signal indication when the adjacent through movement signal indications are flashed yellow.

10 The appropriate RED ARROW or YELLOW ARROW signal indication shall be flashed when a signal face consists entirely of arrow indications. A signal face that consists entirely of arrow indications and that provides a protected only turn movement during the steady (stop-and-go) mode or that provides a flashing YELLOW ARROW signal indication for a permissive turn movement during the steady (stop-and-go) mode shall be permitted to flash the YELLOW ARROW signal indication during the flashing mode if the adjacent through movement signal indications are flashed yellow and if it is intended that a permissive turn movement not requiring a full stop by each turning vehicle be provided during the flashing mode.

**Section 4D.31 Flashing Operation – Transition Out of Flashing Mode****Standard:**

01 All changes from flashing mode to steady (stop-and-go) mode shall be made under one of the following procedures:

- A. **Yellow-red flashing mode:** Changes from flashing mode to steady (stop-and-go) mode shall be made at the beginning of the major-street green interval (when a green signal indication is displayed to through traffic in both directions on the major street), or if there is no common major-street green interval, at the beginning of the green interval for the major traffic movement on the major street.
- B. **Red-red flashing mode:** Changes from flashing mode to steady (stop-and-go) mode shall be made by changing the flashing red indications to steady red indications followed by appropriate green indications to begin the steady mode cycle. These green indications shall be the beginning of the major-street green interval (when a green signal indication is displayed to through traffic in both directions on the major street) or if there is no common major-street green interval, at the beginning of the green interval for the major traffic movement on the major street.

*Guidance:*

02 *The steady red clearance interval provided during the change from red-red flashing mode to steady (stop-and-go) mode should have a duration of 6 seconds.*

03 *When changing from the yellow-red flashing mode to steady (stop-and-go) mode, if there is no common major-street green interval, the provision of a steady red clearance interval for the other approaches before changing from a flashing yellow or a flashing red signal indication to a green signal indication on the major approach should be considered.*

**Standard:**

04 **During programmed changes out of flashing mode, no flashing yellow signal indication shall be terminated and immediately followed by a steady red or flashing red signal indication without first displaying the steady yellow signal indication.**

*Option:*

05 Because special midblock signals that rest in flashing circular yellow in the position normally occupied by the green signal indication do not have a green signal indication in the signal face, these signals may go directly from flashing circular yellow (in the position normally occupied by the green signal indication) to steady yellow without going first to a green signal indication.

**Section 4D.32 Temporary and Portable Traffic Control Signals***Support:*

01 A temporary traffic control signal is generally installed using methods that minimize the costs of installation, relocation, and/or removal. Typical temporary traffic control signals are for specific purposes, such as for one-lane, two-way facilities in temporary traffic control zones (see Chapter 4H), for a haul-road intersection, or for access to a site that will have a permanent access point developed at another location in the near future.

**Standard:**

02 **Advance signing shall be used when employing a temporary traffic control signal.**

03 **A temporary traffic control signal shall:**

- A. **Meet the physical display and operational requirements of a conventional traffic control signal.**
- B. **Be removed when no longer needed.**
- C. **Be placed in the flashing mode when not being used if it will be operated in the steady mode within 5 working days; otherwise, it shall be removed.**
- D. **Be placed in the flashing mode during periods when it is not desirable to operate the signal, or the signal heads shall be covered, turned, or taken down to indicate that the signal is not in operation.**

*Guidance:*

04 *A temporary traffic control signal should be used only if engineering judgment indicates that installing the signal will improve the overall safety and/or operation of the location.*

05 *The use of temporary traffic control signals by a work crew on a regular basis in their work area should be subject to the approval of the jurisdiction having authority over the roadway.*

06 *A temporary traffic control signal should not operate longer than 30 days unless associated with a longer-term temporary traffic control zone project.*

07 *For use of temporary traffic control signals in temporary traffic control zones, reference should be made to Section 6F.84.*

**Section 4D.33 Lateral Offset of Signal Supports and Cabinets***Guidance:*

01 *The following items should be considered when placing signal supports and cabinets:*

- A. *Reference should be made to the American Association of State Highway and Transportation Officials (AASHTO) "Roadside Design Guide" (see Section 1A.11) and to the "Americans with*

*Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)” (see Section 1A.11).*

- B. Signal supports should be placed as far as practical from the edge of the traveled way without adversely affecting the visibility of the signal indications.*
- C. Where supports cannot be located based on the recommended AASHTO clearances, consideration should be given to the use of appropriate safety devices.*
- D. No part of a concrete base for a signal support should extend more than 4 inches above the ground level at any point. This limitation does not apply to the concrete base for a rigid support.*
- E. In order to minimize hindrance to the passage of persons with physical disabilities, a signal support or controller cabinet should not obstruct the sidewalk, or access from the sidewalk to the crosswalk.*
- F. Controller cabinets should be located as far as practical from the edge of the roadway.*
- G. On medians, the minimum clearances provided in Items A through E for signal supports should be obtained if practical.*

#### **Section 4D.34 Use of Signs at Signalized Locations**

Support:

- 01 Traffic signal signs are sometimes used at highway traffic signal locations to instruct or guide pedestrians, bicyclists, or motorists. Among the signs typically used at or on the approaches to signalized locations are movement prohibition signs (see Section 2B.18), lane control signs (see Sections 2B.19 to 2B.22), pedestrian crossing signs (see Section 2B.51), pedestrian actuation signs (see Section 2B.52), traffic signal signs (see Sections 2B.53 and 2C.48), Signal Ahead warning signs (see Section 2C.36), Street Name signs (see Section 2D.43), and Advance Street Name signs (see Section 2D.44).

*Guidance:*

- 02 *Regulatory, warning, and guide signs should be used at traffic control signal locations as provided in Part 2 and as specifically provided elsewhere in Part 4.*
- 03 *Traffic signal signs should be located adjacent to the signal face to which they apply.*

Support:

- 04 Section 2B.19 contains information regarding the use of overhead lane control signs on signalized approaches where lane drops, multiple-lane turns involving shared through-and-turn lanes, or other lane-use regulations that would be unexpected by unfamiliar road users are present.

**Standard:**

- 05 **If used, illuminated traffic signal signs shall be designed and mounted in such a manner as to avoid glare and reflections that seriously detract from the signal indications. Traffic control signal faces shall be given dominant position and brightness to maximize their priority in the overall display.**
- 06 **The minimum vertical clearance and horizontal offset of the total assembly of traffic signal signs (see Section 2B.53) shall comply with the provisions of Sections 4D.15 and 4D.16.**
- 07 **STOP signs shall not be used in conjunction with any traffic control signal operation, except in either of the following cases:**
- A. If the signal indication for an approach is a flashing red at all times, or**
  - B. If a minor street or driveway is located within or adjacent to the area controlled by the traffic control signal, but does not require separate traffic signal control because an extremely low potential for conflict exists.**

#### **Section 4D.35 Use of Pavement Markings at Signalized Locations**

Support:

- 01 Pavement markings (see Part 3) that clearly communicate the operational plan of an intersection to road users play an important role in the effective operation of traffic control signals. By designating the number of lanes, the use of each lane, the length of additional lanes on the approach to an intersection, and the proper stopping points, the engineer can design the signal phasing and timing to best match the goals of the operational plan.

*Guidance:*

- 02 *Pavement markings should be used at traffic control signal locations as provided in Part 3. If the road surface will not retain pavement markings, signs should be installed to provide the needed road user information.*

## CHAPTER 4E. PEDESTRIAN CONTROL FEATURES

### Section 4E.01 Pedestrian Signal Heads

Support:

- 01 Pedestrian signal heads provide special types of traffic signal indications exclusively intended for controlling pedestrian traffic. These signal indications consist of the illuminated symbols of a WALKING PERSON (symbolizing WALK) and an UPRaised HAND (symbolizing DONT WALK).

*Guidance:*

- 02 *Engineering judgment should determine the need for separate pedestrian signal heads (see Section 4D.03) and accessible pedestrian signals (see Section 4E.09).*

Support:

- 03 Chapter 4F contains information regarding the use of pedestrian hybrid beacons and Chapter 4N contains information regarding the use of In-Roadway Warning Lights at unsignalized marked crosswalks.

### Section 4E.02 Meaning of Pedestrian Signal Head Indications

Standard:

- 01 **As specified in 4511.14 of the Ohio Revised Code, pedestrian signal head indications shall have the following meanings**
- “(A) A steady walking person signal indication, which symbolizes “walk,” means that a pedestrian facing the signal indication is permitted to start to cross the roadway in the direction of the signal indication, possibly in conflict with turning vehicles. The pedestrian shall yield the right-of-way to vehicles lawfully within the intersection at the time that the walking person signal indication is first shown.**
  - (B) A flashing upraised hand signal indication, which symbolizes “don’t walk,” means that a pedestrian shall not start to cross the roadway in the direction of the signal indication, but that any pedestrian who has already started to cross on a steady walking person signal indication shall proceed to the far side of the traveled way of the street or highway, unless otherwise directed by a traffic control device to proceed only to the median of a divided highway or only to some other island or pedestrian refuge area.**
  - (C) A steady upraised hand signal indication means that a pedestrian shall not enter the roadway in the direction of the signal indication.**
  - (D) Nothing in this section shall be construed to invalidate the continued use of pedestrian control signals utilizing the word “wait” if those signals were installed prior to March 28, 1985.**
  - (E) A flashing walking person signal indication has no meaning and shall not be used.”**

### Section 4E.03 Application of Pedestrian Signal Heads

Standard:

- 01 **Pedestrian signal heads shall be used in conjunction with vehicular traffic control signals under any of the following conditions:**
- A. If a traffic control signal is justified by an engineering study and meets either Warrant 4, Pedestrian Volume or Warrant 5, School Crossing (see Chapter 4C);**
  - B. If an exclusive signal phase is provided or made available for pedestrian movements in one or more directions, with all conflicting vehicular movements being stopped;**
  - C. At an established school crossing at any signalized location; and/or**
  - D. Where engineering judgment determines that multi-phase signal indications (as with split-phase timing) would tend to confuse or cause conflicts with pedestrians using a crosswalk guided only by vehicular signal indications.**

*Guidance:*

- 02 *Pedestrian signal heads should be used under any of the following conditions:*
- A. If it is necessary to assist pedestrians in deciding when to begin crossing the roadway in the chosen direction or if engineering judgment determines that pedestrian signal heads are justified to minimize vehicle-pedestrian conflicts;*

- B. *If pedestrians are permitted to cross a portion of a street, such as to or from a median of sufficient width for pedestrians to wait, during a particular interval but are not permitted to cross the remainder of the street during any part of the same interval; and/or*
- C. *If no vehicular signal indications are visible to pedestrians, or if the vehicular signal indications that are visible to pedestrians starting a crossing provide insufficient guidance for them to decide when to begin crossing the roadway in the chosen direction, such as on one-way streets, at T-intersections, or at multi-phase signal operations.*

Option:

- 03 Pedestrian signal heads may be used under other conditions based on engineering judgment.

#### **Section 4E.04 Size, Design, and Illumination of Pedestrian Signal Head Indications**

**Standard:**

- 01 **All new pedestrian signal head indications shall be displayed within a rectangular background and shall consist of symbolized messages (see Figure 4E-1), except that existing pedestrian signal head indications with lettered or outline style symbol messages shall be permitted to be retained for the remainder of their useful service life. The symbol designs that are set forth in the “Sign Designs and Markings Manual” (SDMM) (see Section 1A.11) shall be used. Each pedestrian signal head indication shall be independently displayed and emit a single color.**

- 02 **If a two-section pedestrian signal head is used, the UPRAISED HAND (symbolizing DONT WALK) signal section shall be mounted directly above the WALKING PERSON (symbolizing WALK) signal section. If a one-section pedestrian signal head is used, the symbols shall be either overlaid upon each other or arranged side-by-side with the UPRAISED HAND symbol to the left of the WALKING PERSON symbol, and a light source that can display each symbol independently shall be used.**

- 03 **The WALKING PERSON (symbolizing WALK) signal indication shall be white, conforming to the publication entitled “Pedestrian Traffic Control Signal Indications” (see Section 1A.11), with all except the symbol obscured by an opaque material.**

- 04 **The UPRAISED HAND (symbolizing DONT WALK) signal indication shall be Portland orange, conforming to the publication entitled “Pedestrian Traffic Control Signal Indications” (see Section 1A.11), with all except the symbol obscured by an opaque material.**

- 05 **When not illuminated, the WALKING PERSON (symbolizing WALK) and UPRAISED HAND (symbolizing DONT WALK) symbols shall not be readily visible to pedestrians at the far end of the crosswalk that the pedestrian signal head indications control.**

- 06 **For pedestrian signal head indications, the symbols shall be at least 6 inches high.**

- 07 **The light source of a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication shall be flashed continuously at a rate of not less than 50 or more than 60 times per minute. The displayed period of each flash shall be a minimum 1/2 and a maximum of 2/3 of the total flash cycle.**

*Guidance:*

- 08 *Pedestrian signal head indications should be conspicuous and recognizable to pedestrians at all distances from the beginning of the controlled crosswalk to a point 10 feet from the end of the controlled crosswalk during both day and night.*

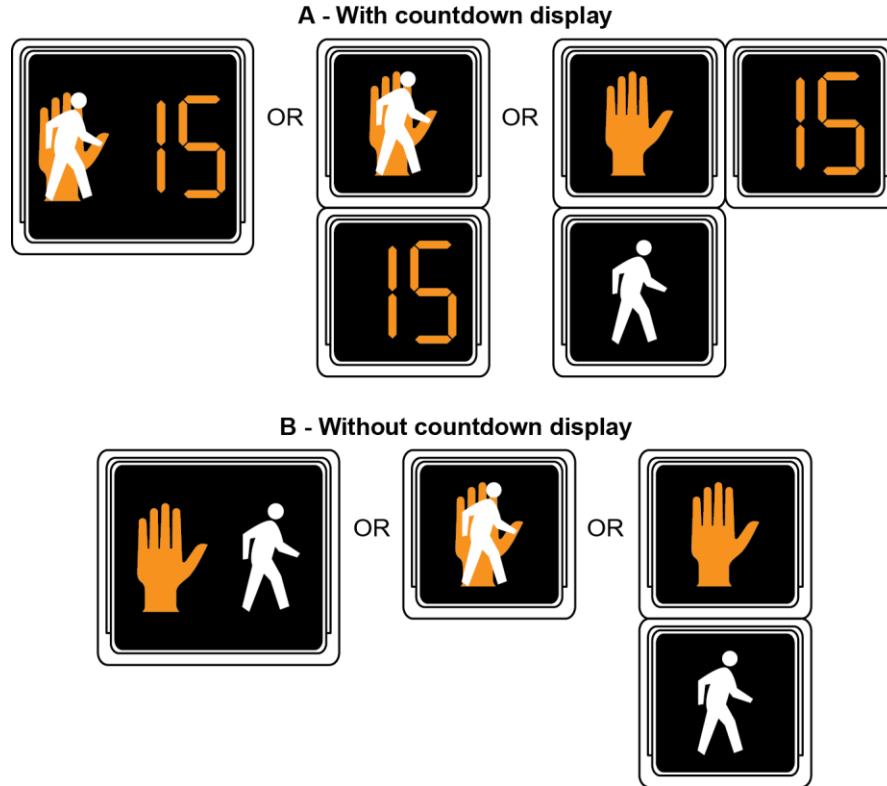
- 09 *For crosswalks where the pedestrian enters the crosswalk more than 100 feet from the pedestrian signal head indications, the symbols should be at least 9 inches high.*

- 10 *If the pedestrian signal indication is so bright that it causes excessive glare in nighttime conditions, some form of automatic dimming should be used to reduce the brilliance of the signal indication.*

Option:

- 11 **An animated eyes symbol may be added to a pedestrian signal head in order to prompt pedestrians to look for vehicles in the intersection during the time that the WALKING PERSON (symbolizing WALK) signal indication is displayed.**

**Figure 4E-1. Typical Pedestrian Signal Indications**



**Standard:**

- 12 If used, the animated eyes symbol shall consist of an outline of a pair of white steadily-illuminated eyes with white eyeballs that scan from side to side at a rate of approximately once per second. The animated eyes symbol shall be at least 12 inches wide with each eye having a width of at least 5 inches and a height of at least 2.5 inches. The animated eyes symbol shall be illuminated at the start of the walk interval and shall terminate at the end of the walk interval.

**Section 4E.05 Location and Height of Pedestrian Signal Heads**

**Standard:**

- 01 Pedestrian signal heads shall be mounted with the bottom of the signal housing including brackets not less than 7 feet or more than 10 feet above sidewalk level, and shall be positioned and adjusted to provide maximum visibility at the beginning of the controlled crosswalk.
- 02 If pedestrian signal heads are mounted on the same support as vehicular signal heads, there shall be a physical separation between them.

**Section 4E.06 Pedestrian Intervals and Signal Phases**

**Standard:**

- 01 At intersections equipped with pedestrian signal heads, the pedestrian signal indications shall be displayed except when the vehicular traffic control signal is being operated in the flashing mode. At those times, the pedestrian signal indications shall not be displayed.
- 02 When the pedestrian signal heads associated with a crosswalk are displaying either a steady WALKING PERSON (symbolizing WALK) or a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication, a steady or a flashing red signal indication shall be shown to any conflicting vehicular movement that is approaching the intersection or midblock location perpendicular or nearly perpendicular to the crosswalk.

03 **When pedestrian signal heads are used, a WALKING PERSON (symbolizing WALK) signal indication shall be displayed only when pedestrians are permitted to leave the curb or shoulder.**

04 **A pedestrian change interval consisting of a flashing UPRAISED HAND (symbolizing DON'T WALK) signal indication shall begin immediately following the WALKING PERSON (symbolizing WALK) signal indication. Following the pedestrian change interval, a buffer interval consisting of a steady UPRAISED HAND (symbolizing DONT WALK) signal indication shall be displayed for at least 3 seconds prior to the release of any conflicting vehicular movement. The sum of the time of the pedestrian change interval and the buffer interval shall not be less than the calculated pedestrian clearance time (see Paragraphs 7 through 16). The buffer interval shall not begin later than the beginning of the red clearance interval, if used.**

Option:

05 During the yellow change interval, the UPRAISED HAND (symbolizing DON'T WALK) signal indication may be displayed as either a flashing indication, a steady indication, or a flashing indication for an initial portion of the yellow change interval and a steady indication for the remainder of the interval.

Support:

06 Figure 4E-2 illustrates the pedestrian intervals and their possible relationships with associated vehicular signal phase intervals.

*Guidance:*

07 *Except as provided in Paragraph 8, the pedestrian clearance time should be sufficient to allow a pedestrian crossing in the crosswalk who left the curb or shoulder at the end of the WALKING PERSON (symbolizing WALK) signal indication to travel at a walking speed of 3.5 feet per second, to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait.*

Option:

08 A walking speed of up to 4 feet per second may be used to evaluate the sufficiency of the pedestrian clearance time at locations where an extended pushbutton press function has been installed to provide slower pedestrians an opportunity to request and receive a longer pedestrian clearance time. Passive pedestrian detection may also be used to automatically adjust the pedestrian clearance time based on the pedestrian's actual walking speed or actual clearance of the crosswalk.

09 The additional time provided by an extended pushbutton press to satisfy pedestrian clearance time needs may be added to either the walk interval or the pedestrian change interval.

*Guidance:*

10 *Where pedestrians who walk slower than 3.5 feet per second, or pedestrians who use wheelchairs, routinely use the crosswalk, a walking speed of less than 3.5 feet per second should be considered in determining the pedestrian clearance time.*

11 *Except as provided in Paragraph 12, the walk interval should be at least 7 seconds in length so that pedestrians will have adequate opportunity to leave the curb or shoulder before the pedestrian clearance time begins.*

Option:

12 If pedestrian volumes and characteristics do not require a 7-second walk interval, walk intervals as short as 4 seconds may be used.

Support:

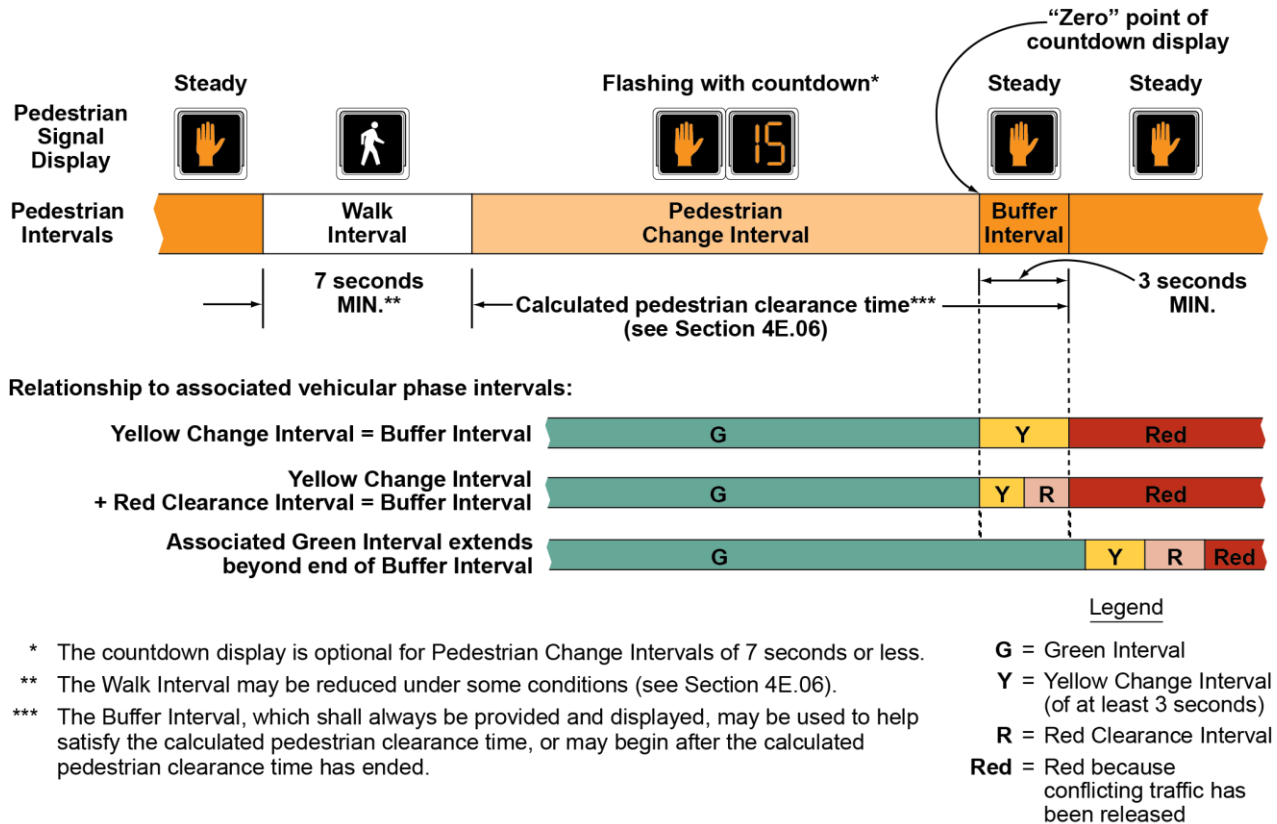
13 The walk interval is intended for pedestrians to start their crossing. The pedestrian clearance time is intended to allow pedestrians who started crossing during the walk interval to complete their crossing. Longer walk intervals are often used when the duration of the vehicular green phase associated with the pedestrian crossing is long enough to allow it.

*Guidance:*

14 *The total of the walk interval and pedestrian clearance time should be sufficient to allow a pedestrian crossing in the crosswalk who left the pedestrian detector (or, if no pedestrian detector is present, a location 6 feet from the face of the curb or from the edge of the pavement) at the beginning of the WALKING PERSON (symbolizing WALK) signal indication to travel at a walking speed of 3 feet per second to the far side of the traveled way being crossed or to the median if a two-stage pedestrian crossing sequence is used.*



**Figure 4E-2. Pedestrian Intervals**



Any additional time that is required to satisfy the conditions of this paragraph should be added to the walk interval.

Option:

- 15 On a street with a median of sufficient width for pedestrians to wait, a pedestrian clearance time that allows the pedestrian to cross only from the curb or shoulder to the median may be provided.

**Standard:**

- 16 **Where the pedestrian clearance time is sufficient only for crossing from the curb or shoulder to a median of sufficient width for pedestrians to wait, median-mounted pedestrian signals (with pedestrian detectors if actuated operation is used) shall be provided (see Sections 4E.08 and 4E.09) and signing such as the R10-3d sign (see Section 2B.52) shall be provided to notify pedestrians to cross only to the median to await the next WALKING PERSON (symbolizing WALK) signal indication.**

*Guidance:*

- 17 *Where median-mounted pedestrian signals and detectors are provided, the use of accessible pedestrian signals (see Sections 4E.09 through 4E.13) should be considered.*

Option:

- 18 During the transition into preemption, the walk interval and the pedestrian change interval may be shortened or omitted as described in Section 4D.27.
- 19 At intersections with high pedestrian volumes and high conflicting turning vehicle volumes, a brief leading pedestrian interval, during which an advance WALKING PERSON (symbolizing WALK) indication is displayed for the crosswalk while red indications continue to be displayed to parallel through and/or turning traffic, may be used to reduce conflicts between pedestrians and turning vehicles.

*Guidance:*

- 20 *If a leading pedestrian interval is used, the use of accessible pedestrian signals (see Sections 4E.09 through 4E.13) should be considered.*

## Support:

- 21 If a leading pedestrian interval is used without accessible features, pedestrians who are visually impaired can be expected to begin crossing at the onset of the vehicular movement when drivers are not expecting them to begin crossing.

*Guidance:*

- 22 *If a leading pedestrian interval is used, it should be at least 3 seconds in duration and should be timed to allow pedestrians to cross at least one lane of traffic or, in the case of a large corner radius, to travel far enough for pedestrians to establish their position ahead of the turning traffic before the turning traffic is released.*
- 23 *If a leading pedestrian interval is used, consideration should be given to prohibiting turns across the crosswalk during the leading pedestrian interval.*

## Support:

- 24 At intersections with pedestrian volumes that are so high that drivers have difficulty finding an opportunity to turn across the crosswalk, the duration of the green interval for a parallel concurrent vehicular movement is sometimes intentionally set to extend beyond the pedestrian clearance time to provide turning drivers additional green time to make their turns while the pedestrian signal head is displaying a steady UPRAISED HAND (symbolizing DONT WALK) signal indication after pedestrians have had time to complete their crossings.

**Section 4E.07 Countdown Pedestrian Signals****Standard:**

- 01 **All pedestrian signal heads used at crosswalks where the pedestrian change interval is more than 7 second shall include a pedestrian change interval countdown display in order to inform pedestrians of the number of seconds remaining in the pedestrian change interval.**

## Option:

- 02 Pedestrian signal heads used at crosswalks where the pedestrian change interval is 7 seconds or less may include a pedestrian change interval countdown display in order to inform pedestrians of the number of seconds remaining in the pedestrian change interval.

**Standard:**

- 03 **Where countdown pedestrian signals are used, the countdown shall always be displayed simultaneously with the flashing UPRAISED HAND (symbolizing DONT WALK) signal indication displayed for that crosswalk.**

- 04 **Countdown pedestrian signals shall consist of Portland orange numbers that are at least 6 inches in height on a black opaque background. The countdown pedestrian signal shall be located immediately adjacent to the associated UPRAISED HAND (symbolizing DONT WALK) pedestrian signal head indication (see Figure 4E-1).**

- 05 **The display of the number of remaining seconds shall begin only at the beginning of the pedestrian change interval (flashing UPRAISED HAND). After the countdown displays zero, the display shall remain dark until the beginning of the next countdown.**

- 06 **The countdown pedestrian signal shall display the number of seconds remaining until the termination of the pedestrian change interval (flashing UPRAISED HAND). Countdown displays shall not be used during the walk interval or during the red clearance interval of a concurrent vehicular phase.**

*Guidance:*

- 07 *If used with a pedestrian signal head that does not have a concurrent vehicular phase, the pedestrian change interval (flashing UPRAISED HAND) should be set to be approximately 4 seconds less than the required pedestrian clearance time (see Section 4E.06) and an additional clearance interval (during which a steady UPRAISED HAND is displayed) should be provided prior to the start of the conflicting vehicular phase.*

- 08 *For crosswalks where the pedestrian enters the crosswalk more than 100 feet from the countdown pedestrian signal display, the numbers should be at least 9 inches in height.*

09 *Because some technology includes the countdown pedestrian signal logic in a separate timing device that is independent of the timing in the traffic signal controller, care should be exercised by the engineer when timing changes are made to pedestrian change intervals.*

10 *If the pedestrian change interval is interrupted or shortened as a part of a transition into a preemption sequence (see Section 4E.06), the countdown pedestrian signal display should be discontinued and go dark immediately upon activation of the preemption transition.*

### **Section 4E.08 Pedestrian Detectors**

Option:

01 Pedestrian detectors may be pushbuttons or passive detection devices.

Support:

02 Passive detection devices register the presence of a pedestrian in a position indicative of a desire to cross, without requiring the pedestrian to push a button. Some passive detection devices are capable of tracking the progress of a pedestrian as the pedestrian crosses the roadway for the purpose of extending or shortening the duration of certain pedestrian timing intervals.

03 The provisions in this Section place pedestrian pushbuttons within easy reach of pedestrians who are intending to cross each crosswalk and make it obvious which pushbutton is associated with each crosswalk. These provisions also position pushbutton poles in optimal locations for installation of accessible pedestrian signals (see Sections 4E.09 through 4E.13). Information regarding reach ranges can be found in the “Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)” (see Section 1A.11).

Guidance:

04 *If pedestrian pushbuttons are used, they should be capable of easy activation and conveniently located near each end of the crosswalks. Except as provided in Paragraphs 5 and 6, pedestrian pushbuttons should be located to meet all of the following criteria (see Figure 4E-3):*

- A. *Unobstructed and adjacent to a level all-weather surface to provide access from a wheelchair;*
- B. *Where there is an all-weather surface, a wheelchair accessible route from the pushbutton to the ramp;*
- C. *Between the edge of the crosswalk line (extended) farthest from the center of the intersection and the side of a curb ramp (if present), but not greater than 5 feet from said crosswalk line;*
- D. *Between 1.5 and 6 feet from the edge of the curb, shoulder, or pavement;*
- E. *With the face of the pushbutton parallel to the crosswalk to be used; and*
- F. *At a mounting height of approximately 3.5 feet, but no more than 4 feet, above the sidewalk.*

05 *Where there are physical constraints that make it impractical to place the pedestrian pushbutton adjacent to a level all-weather surface, the surface should be as level as feasible.*

06 *Where there are physical constraints that make it impractical to place the pedestrian pushbutton between 1.5 and 6 feet from the edge of the curb, shoulder, or pavement, it should not be farther than 10 feet from the edge of curb, shoulder, or pavement.*

07 *Except as provided in Paragraph 8, where two pedestrian pushbuttons are provided on the same corner of a signalized location, the pushbuttons should be separated by a distance of at least 10 feet.*

Option:

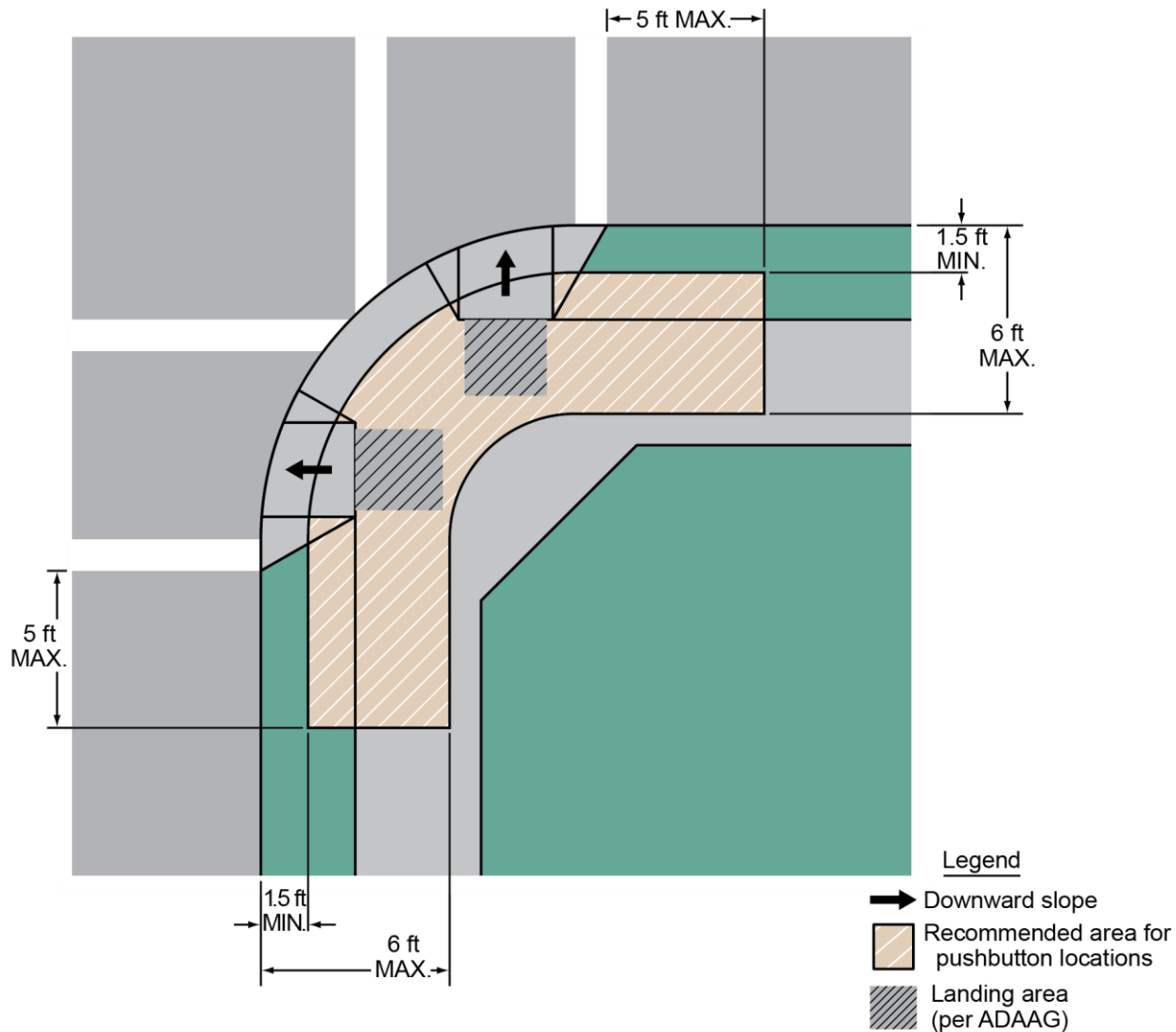
08 Where there are physical constraints on a particular corner that make it impractical to provide the 10-foot separation between the two pedestrian pushbuttons, the pushbuttons may be placed closer together or on the same pole.

Support:

09 Figure 4E-4 shows typical pedestrian pushbutton locations for a variety of situations.

**Standard:**

10 **Signs (see Section 2B.52) shall be mounted adjacent to or integral with pedestrian pushbuttons, explaining their purpose and use.**

**Figure 4E-3. Pushbutton Locations Area****Notes:**

1. Where there are constraints that make it impractical to place the pedestrian pushbutton between 1.5 feet and 6 feet from the edge of the curb, shoulder, or pavement, it should not be further than 10 feet from the edge of curb, shoulder, or pavement.
2. Two pedestrian pushbuttons on a corner should be separated by 10 feet.
3. This figure is not drawn to scale.
4. Figure 4E-4 shows typical pushbutton locations.

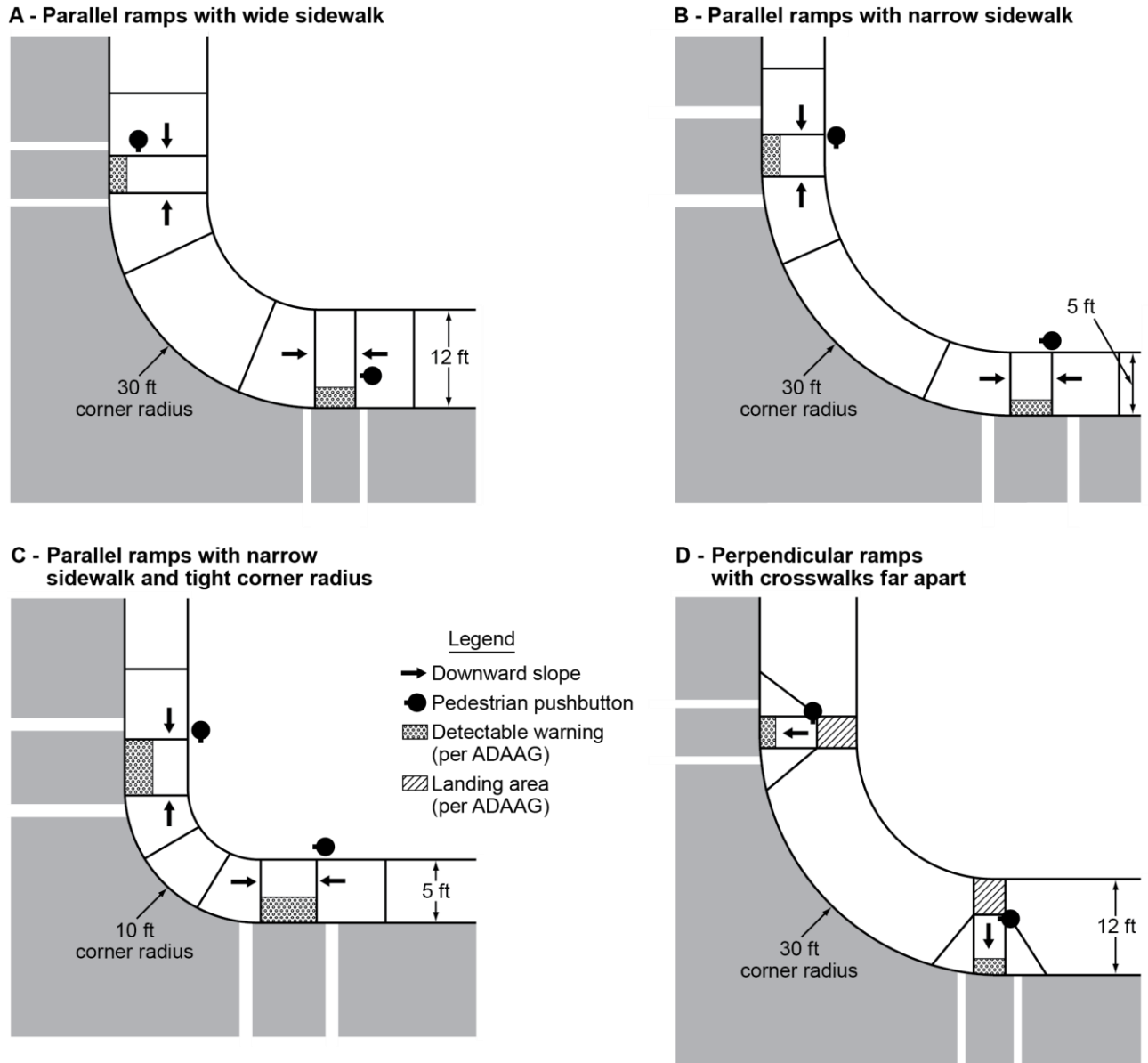
**Option:**

- 11 At certain locations, a supplemental sign in a more visible location may be used to call attention to the pedestrian pushbutton.

**Standard:**

- 12 **The positioning of pedestrian pushbuttons and the legends on the pedestrian pushbutton signs shall clearly indicate which crosswalk signal is actuated by each pedestrian pushbutton.**
- 13 **If the pedestrian clearance time is sufficient only to cross from the curb or shoulder to a median of sufficient width for pedestrians to wait and the signals are pedestrian actuated, an additional pedestrian detector shall be provided in the median.**

**Figure 4E-4. Typical Pushbutton Locations (Sheet 1 of 2)**



**Notes:**

1. This figure is not drawn to scale.
2. These drawings are intended to describe the typical locations for pedestrian pushbutton installations. They are not intended to be a guide for the design of curb cut ramps.
3. Figure 4E-3 shows the recommended area for pushbutton locations.

**Guidance:**

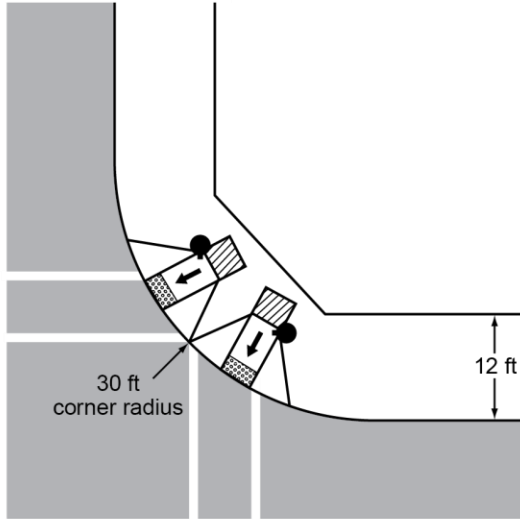
- 14 *The use of additional pedestrian detectors on islands or medians where a pedestrian might become stranded should be considered.*
- 15 If used, special purpose pushbuttons (to be operated only by authorized persons) should include a housing capable of being locked to prevent access by the general public and do not need an instructional sign.

**Standard:**

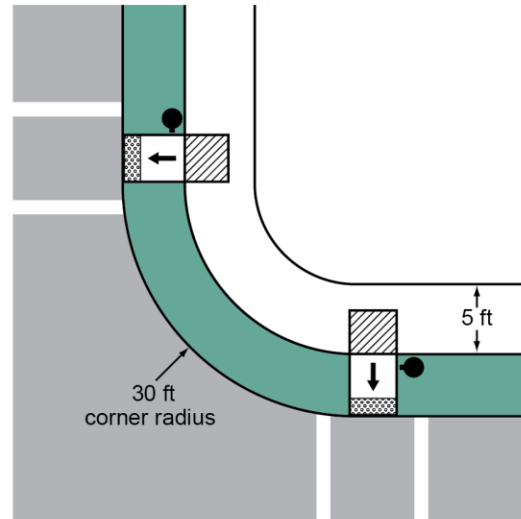
- 16 **If used, a pilot light or other means of indication installed with a pedestrian pushbutton shall not be illuminated until actuation. Once it is actuated, the pilot light shall remain illuminated until the pedestrian's green or WALKING PERSON (symbolizing WALK) signal indication is displayed.**

**Figure 4E-4. Typical Pushbutton Locations (Sheet 2 of 2)**

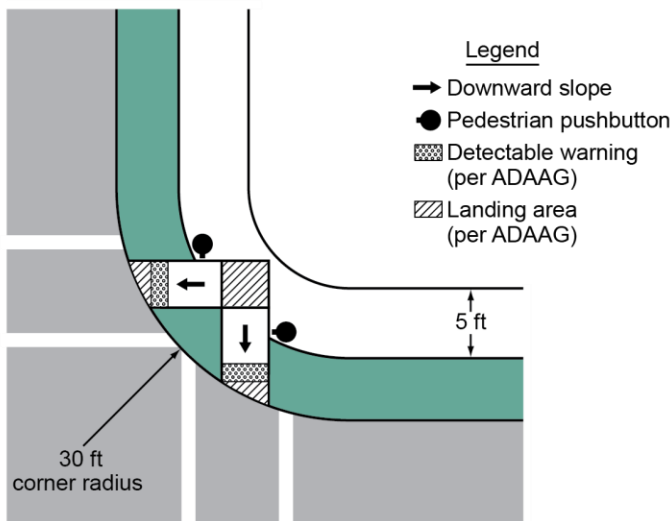
**E - Perpendicular ramps with crosswalks close together**



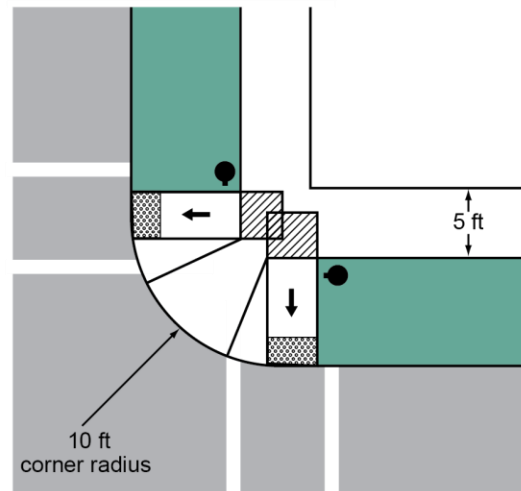
**F - Perpendicular ramps with sidewalk set back from road with crosswalks far apart**



**G - Perpendicular ramps with sidewalk set back from road with crosswalks close together**



**H - Perpendicular ramps with sidewalk set back from road with continuous sidewalk between ramps**



**Notes:**

1. This figure is not drawn to scale.
2. These drawings are intended to describe the typical locations for pedestrian pushbutton installations. They are not intended to be a guide for the design of curb cut ramps.
3. Figure 4E-3 shows the recommended area for pushbutton locations.

17 **If a pilot light is used at an accessible pedestrian signal location (see Sections 4E.09 through 4E.13), each actuation shall be accompanied by the speech message “wait.”**

Option:

18 At signalized locations with a demonstrated need and subject to equipment capabilities, pedestrians with special needs may be provided with additional crossing time by means of an extended pushbutton press.

**Standard:**

19 **If additional crossing time is provided by means of an extended pushbutton press, a PUSH BUTTON FOR 2 SECONDS FOR EXTRA CROSSING TIME (R10-32P) plaque (see Figure 2B-26) shall be mounted adjacent to or integral with the pedestrian pushbutton.**

## Section 4E.09 Accessible Pedestrian Signals and Detectors - General

### Support:

- 01 Accessible pedestrian signals and detectors provide information in non-visual formats (such as audible tones, speech messages, and/or vibrating surfaces).
- 02 The primary technique that pedestrians who have visual disabilities use to cross streets at signalized locations is to initiate their crossing when they hear the traffic in front of them stop and the traffic alongside them begin to move, which often corresponds to the onset of the green interval. The existing environment is often not sufficient to provide the information that pedestrians who have visual disabilities need to cross a roadway at a signalized location.

### Guidance:

- 03 *If a particular signalized location presents difficulties for pedestrians who have visual disabilities to cross the roadway, an engineering study should be conducted that considers the needs of pedestrians in general, as well as the information needs of pedestrians with visual disabilities. The engineering study should consider the following factors:*
- A. *Potential demand for accessible pedestrian signals;*
  - B. *A request for accessible pedestrian signals;*
  - C. *Traffic volumes during times when pedestrians might be present, including periods of low traffic volumes or high turn-on-red volumes;*
  - D. *The complexity of traffic signal phasing (such as split phases, protected turn phases, leading pedestrian intervals, and exclusive pedestrian phases); and*
  - E. *The complexity of intersection geometry.*

### Support:

- 04 The factors that make crossing at a signalized location difficult for pedestrians who have visual disabilities include: increasingly quiet cars, right turn on red (which masks the beginning of the through phase), continuous right-turn movements, complex signal operations, traffic circles, and wide streets. Furthermore, low traffic volumes might make it difficult for pedestrians who have visual disabilities to discern signal phase changes.
- 05 Local organizations, providing support services to pedestrians who have visual and/or hearing disabilities, can often act as important advisors to the traffic engineer when consideration is being given to the installation of devices to assist such pedestrians. Additionally, orientation and mobility specialists or similar staff also might be able to provide a wide range of advice. The U.S. Access Board ([www.access-board.gov](http://www.access-board.gov)) provides technical assistance for making pedestrian signal information available to persons with visual disabilities (see the Preface for the address for the U.S. Access Board).

### Standard:

- 06 **When used, accessible pedestrian signals shall be used in combination with pedestrian signal timing. The information provided by an accessible pedestrian signal shall clearly indicate which pedestrian crossing is served by each device.**
- 07 **Under stop-and-go operation, accessible pedestrian signals shall not be limited in operation by the time of day or day of week.**

### Option:

- 08 Accessible pedestrian signal detectors may be pushbuttons or passive detection devices.
- 09 At locations with pretimed traffic control signals or non-actuated approaches, pedestrian pushbuttons may be used to activate the accessible pedestrian signals.

### Support:

- 10 Accessible pedestrian signals are typically integrated into the pedestrian detector (pushbutton), so the audible tones and/or messages come from the pushbutton housing. They have a pushbutton locator tone and tactile arrow, and can include audible beaconing and other special features.

### Option:

- 11 The name of the street to be crossed may also be provided in accessible format, such as Braille or raised print. Tactile maps of crosswalks may also be provided.

12 Specifications regarding the use of Braille or raised print for traffic control devices can be found in the “Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)” (see Section 1A.11).

**Standard:**

13 **At accessible pedestrian signal locations where pedestrian pushbuttons are used, each pushbutton shall activate both the walk interval and the accessible pedestrian signals.**

**Section 4E.10 Accessible Pedestrian Signals and Detectors – Location**

Support:

01 Accessible pedestrian signals that are located as close as possible to pedestrians waiting to cross the street provide the clearest and least ambiguous indication of which pedestrian crossing is served by a device.

*Guidance:*

02 *Pushbuttons for accessible pedestrian signals should be located in accordance with the provisions of Section 4E.08 and should be located as close as possible to the crosswalk line furthest from the center of the intersection and as close as possible to the curb ramp.*

**Standard:**

03 **If two accessible pedestrian pushbuttons are placed less than 10 feet apart or on the same pole, each accessible pedestrian pushbutton shall be provided with the following features (see Sections 4E.11 through 4E.13):**

- A. A pushbutton locator tone,
- B. A tactile arrow,
- C. A speech walk message for the WALKING PERSON (symbolizing WALK) indication, and
- D. A speech pushbutton information message.

04 **If the pedestrian clearance time is sufficient only to cross from the curb or shoulder to a median of sufficient width for pedestrians to wait and accessible pedestrian detectors are used, an additional accessible pedestrian detector shall be provided in the median.**

**Section 4E.11 Accessible Pedestrian Signals and Detectors – Walk Indications**

Support:

01 Technology that provides different sounds for each non-concurrent signal phase has frequently been found to provide ambiguous information. Research indicates that a rapid tick tone for each crossing coming from accessible pedestrian signal devices on separated poles located close to each crosswalk provides unambiguous information to pedestrians who are blind or visually impaired. Vibrotactile indications provide information to pedestrians who are blind and deaf and are also used by pedestrians who are blind or who have low vision to confirm the walk signal in noisy situations.

**Standard:**

02 **Accessible pedestrian signals shall have both audible and vibrotactile walk indications.**

03 **Vibrotactile walk indications shall be provided by a tactile arrow on the pushbutton (see Section 4E.12) that vibrates during the walk interval.**

04 **Accessible pedestrian signals shall have an audible walk indication during the walk interval only. The audible walk indication shall be audible from the beginning of the associated crosswalk.**

05 **The accessible walk indication shall have the same duration as the pedestrian walk signal except when the pedestrian signal rests in walk.**

*Guidance:*

06 *If the pedestrian signal rests in walk, the accessible walk indication should be limited to the first 7 seconds of the walk interval. The accessible walk indication should be recalled by a button press during the walk interval provided that the crossing time remaining is greater than the pedestrian change interval.*

**Standard:**

07 **Where two accessible pedestrian signals are separated by a distance of at least 10 feet, the audible walk indication shall be a percussive tone. Where two accessible pedestrian signals on one corner are**



**not separated by a distance of at least 10 feet, the audible walk indication shall be a speech walk message.**

- 08 **Audible tone walk indications shall repeat at eight to ten ticks per second. Audible tones used as walk indications shall consist of multiple frequencies with a dominant component at 880 Hz.**

*Guidance:*

- 09 *The volume of audible walk indications and pushbutton locator tones (see Section 4E.12) should be set to be a maximum of 5 dBA louder than ambient sound, except when audible beaconing is provided in response to an extended pushbutton press.*

**Standard:**

- 10 **Automatic volume adjustment in response to ambient traffic sound level shall be provided up to a maximum volume of 100 dBA.**

*Guidance:*

- 11 *The sound level of audible walk indications and pushbutton locator tones should be adjusted to be low enough to avoid misleading pedestrians who have visual disabilities when the following conditions exist:*
- A. *Where there is an island that allows unsignalized right turns across a crosswalk between the island and the sidewalk.*
  - B. *Where multi-leg approaches or complex signal phasing require more than two pedestrian phases, such that it might be unclear which crosswalk is served by each audible tone.*
  - C. *At intersections where a diagonal pedestrian crossing is allowed, or where one street receives a WALKING PERSON (symbolizing WALK) signal indication simultaneously with another street.*

*Option:*

- 12 An alert tone, which is a very brief burst of high-frequency sound at the beginning of the audible walk indication that rapidly decays to the frequency of the walk tone, may be used to alert pedestrians to the beginning of the walk interval.

*Support:*

- 13 An alert tone can be particularly useful if the walk tone is not easily audible in some traffic conditions.
- 14 Speech walk messages communicate to pedestrians which street has the walk interval. Speech messages might be either directly audible or transmitted, requiring a personal receiver to hear the message. To be a useful system, the words and their meaning need to be correctly understood by all users in the context of the street environment where they are used. Because of this, tones are the preferred means of providing audible walk indications except where two accessible pedestrian signals on one corner are not separated by a distance of at least 10 feet.
- 15 If speech walk messages are used, pedestrians have to know the names of the streets that they are crossing in order for the speech walk messages to be unambiguous. In getting directions to travel to a new location, pedestrians with visual disabilities do not always get the name of each street to be crossed. Therefore, it is desirable to give users of accessible pedestrian signals the name of the street controlled by the pushbutton. This can be done by means of a speech pushbutton information message (see Section 4E.13) during the flashing or steady UPRAISED HAND intervals, or by raised print and Braille labels on the pushbutton housing.
- 16 By combining the information from the pushbutton message or Braille label, the tactile arrow aligned in the direction of travel on the relevant crosswalk, and the speech walk message, pedestrians with visual disabilities are able to correctly respond to speech walk messages even if there are two pushbuttons on the same pole.

**Standard:**

- 17 **If speech walk messages are used to communicate the walk interval, they shall provide a clear message that the walk interval is in effect, as well as to which crossing it applies. Speech walk messages shall be used only at intersections where it is technically infeasible to install two accessible pedestrian signals at one corner separated by a distance of at least 10 feet.**
- 18 **Speech walk messages that are used at intersections having pedestrian phasing that is concurrent with vehicular phasing shall be patterned after the model: “Broadway. Walk sign is on to cross Broadway.”**

19 **Speech walk messages that are used at intersections having exclusive pedestrian phasing shall be patterned after the model: “Walk sign is on for all crossings.”**

20 **Speech walk messages shall not contain any additional information, except they shall include designations such as “Street” or “Avenue” where this information is necessary to avoid ambiguity at a particular location.**

*Guidance:*

21 *Speech walk messages should not state or imply a command to the pedestrian, such as “Cross Broadway now.” Speech walk messages should not tell pedestrians that it is “safe to cross,” because it is always the pedestrian’s responsibility to check actual traffic conditions.*

**Standard:**

22 **A speech walk message is not required at times when the walk interval is not timing, but, if provided:**

**A. It shall begin with the term “wait.”**

**B. It need not be repeated for the entire time that the walk interval is not timing.**

23 **If a pilot light (see Section 4E.08) is used at an accessible pedestrian signal location, each actuation shall be accompanied by the speech message “wait.”**

*Option:*

24 Accessible pedestrian signals that provide speech walk messages may provide similar messages in languages other than English, if needed, except for the terms “walk sign” and “wait.”

**Standard:**

25 **Following the audible walk indication, accessible pedestrian signals shall revert to the pushbutton locator tone (see Section 4E.12) during the pedestrian change interval.**

**Section 4E.12 Accessible Pedestrian Signals and Detectors – Tactile Arrows and Locator Tones**

**Standard:**

01 **To enable pedestrians who have visual disabilities to distinguish and locate the appropriate pushbutton at an accessible pedestrian signal location, pushbuttons shall clearly indicate by means of tactile arrows which crosswalk signal is actuated by each pushbutton. Tactile arrows shall be located on the pushbutton, have high visual contrast (light on dark or dark on light), and shall be aligned parallel to the direction of travel on the associated crosswalk.**

02 **An accessible pedestrian pushbutton shall incorporate a locator tone.**

*Support:*

03 A pushbutton locator tone is a repeating sound that informs approaching pedestrians that a pushbutton to actuate pedestrian timing or receive additional information exists, and that enables pedestrians with visual disabilities to locate the pushbutton.

**Standard:**

04 **Pushbutton locator tones shall have a duration of 0.15 seconds or less and shall repeat at 1-second intervals.**

05 **Pushbutton locator tones shall be deactivated when the traffic control signal is operating in a flashing mode. This requirement shall not apply to traffic control signals or pedestrian hybrid beacons that are activated from a flashing or dark mode to a stop-and-go mode by pedestrian actuations.**

06 **Pushbutton locator tones shall be intensity responsive to ambient sound, and be audible 6 to 12 feet from the pushbutton, or to the building line, whichever is less.**

*Support:*

07 Section 4E.11 contains additional provisions regarding the volume and sound level of pushbutton locator tones.

### **Section 4E.13 Accessible Pedestrian Signals and Detectors – Extended Pushbutton Press Features**

Option:

- 01 Pedestrians may be provided with additional features such as increased crossing time, audible beaoning, or a speech pushbutton information message as a result of an extended pushbutton press.

**Standard:**

- 02 **If an extended pushbutton press is used to provide any additional feature(s), a pushbutton press of less than one second shall actuate only the pedestrian timing and any associated accessible walk indication, and a pushbutton press of one second or more shall actuate the pedestrian timing, any associated accessible walk indication, and any additional feature(s).**

- 03 **If additional crossing time is provided by means of an extended pushbutton press, a PUSH BUTTON FOR 2 SECONDS FOR EXTRA CROSSING TIME (R10-32P) plaque (see Figure 2B-26) shall be mounted adjacent to or integral with the pedestrian pushbutton.**

Support:

- 04 Audible beaoning is the use of an audible signal in such a way that pedestrians with visual disabilities can home in on the signal that is located on the far end of the crosswalk as they cross the street.

- 05 Not all crosswalks at an intersection need audible beaoning; audible beaoning can actually cause confusion if used at all crosswalks at some intersections. Audible beaoning is not appropriate at locations with channelized turns or split phasing, because of the possibility of confusion.

*Guidance:*

- 06 *Audible beaoning should only be considered following an engineering study at:*
- A. *Crosswalks longer than 70 feet, unless they are divided by a median that has another accessible pedestrian signal with a locator tone;*
  - B. *Crosswalks that are skewed;*
  - C. *Intersections with irregular geometry, such as more than four legs;*
  - D. *Crosswalks where audible beaoning is requested by an individual with visual disabilities; or*
  - E. *Other locations where a study indicates audible beaoning would be beneficial.*

Option:

- 07 Audible beaoning may be provided in several ways, any of which are initiated by an extended pushbutton press.

**Standard:**

- 08 **If audible beaoning is used, the volume of the pushbutton locator tone during the pedestrian change interval of the called pedestrian phase shall be increased and operated in one of the following ways:**

- A. **The louder audible walk indication and louder locator tone comes from the far end of the crosswalk, as pedestrians cross the street,**
- B. **The louder locator tone comes from both ends of the crosswalk, or**
- C. **The louder locator tone comes from an additional speaker that is aimed at the center of the crosswalk and that is mounted on a pedestrian signal head.**

Option:

- 09 Speech pushbutton information messages may provide intersection identification, as well as information about unusual intersection signalization and geometry, such as notification regarding exclusive pedestrian phasing, leading pedestrian intervals, split phasing, diagonal crosswalks, and medians or islands.

**Standard:**

- 10 **If speech pushbutton information messages are made available by actuating the accessible pedestrian signal detector, they shall only be actuated when the walk interval is not timing. They shall begin with the term “Wait,” followed by intersection identification information modeled after: “Wait to cross Broadway at Grand.” If information on intersection signalization or geometry is also given, it shall follow the intersection identification information.**

*Guidance:*

- 11 *Speech pushbutton information messages should not be used to provide landmark information or to inform pedestrians with visual disabilities about detours or temporary traffic control situations.*

**Support:**

- 12 Additional information on the structure and wording of speech pushbutton information messages is included in ITE's "Electronic Toolbox for Making Intersections More Accessible for Pedestrians Who Are Blind or Visually Impaired," which is available at ITE's website (see the Preface).

## CHAPTER 4F. PEDESTRIAN HYBRID BEACONS

### **Section 4F.01 Application of Pedestrian Hybrid Beacons**

#### **Support:**

- 01 A pedestrian hybrid beacon is a special type of hybrid beacon used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk.

#### **Option:**

- 02 A pedestrian hybrid beacon may be considered for installation to facilitate pedestrian crossings at a location that does not meet traffic signal warrants (see Chapter 4C), or at a location that meets traffic signal warrants under Sections 4C.05 and/or 4C.06 but a decision is made to not install a traffic control signal.

#### **Standard:**

- 03 **If used, pedestrian hybrid beacons shall be used in conjunction with signs and pavement markings to warn and control traffic at locations where pedestrians enter or cross a street or highway. A pedestrian hybrid beacon shall only be installed at a marked crosswalk.**

#### **Guidance:**

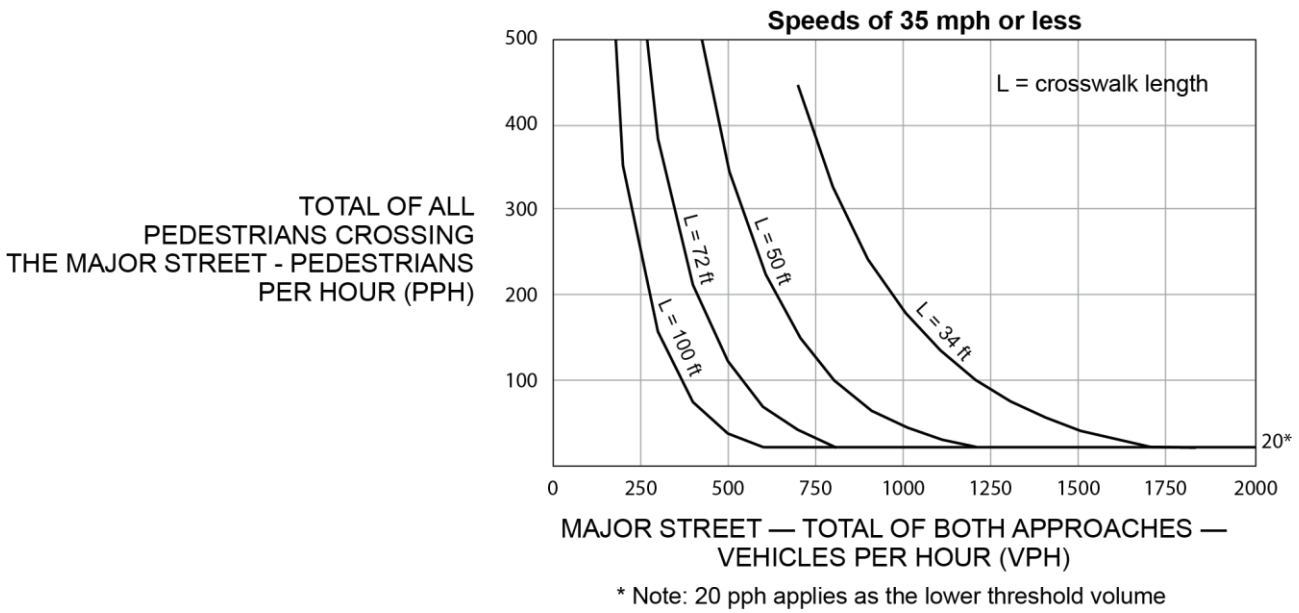
- 04 *If one of the signal warrants of Chapter 4C is met and a traffic control signal is justified by an engineering study, and if a decision is made to install a traffic control signal, it should be installed based upon the provisions of Chapters 4D and 4E.*
- 05 *If a traffic control signal is not justified under the signal warrants of Chapter 4C and if gaps in traffic are not adequate to permit pedestrians to cross, or if the speed for vehicles approaching on the major street is too high to permit pedestrians to cross, or if pedestrian delay is excessive, the need for a pedestrian hybrid beacon should be considered on the basis of an engineering study that considers major-street volumes, speeds, widths, and gaps in conjunction with pedestrian volumes, walking speeds, and delay.*
- 06 *For a major street where the posted or statutory speed limit or the 85th-percentile speed is 35 mph or less, the need for a pedestrian hybrid beacon should be considered if the engineering study finds that the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding total of all pedestrians crossing the major street for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4F-1 for the length of the crosswalk.*
- 07 *For a major street where the posted or statutory speed limit or the 85th-percentile speed exceeds 35 mph, the need for a pedestrian hybrid beacon should be considered if the engineering study finds that the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding total of all pedestrians crossing the major street for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4F-2 for the length of the crosswalk.*
- 08 *For crosswalks that have lengths other than the four that are specifically shown in Figures 4F-1 and 4F-2, the values should be interpolated between the curves.*

### **Section 4F.02 Design of Pedestrian Hybrid Beacons**

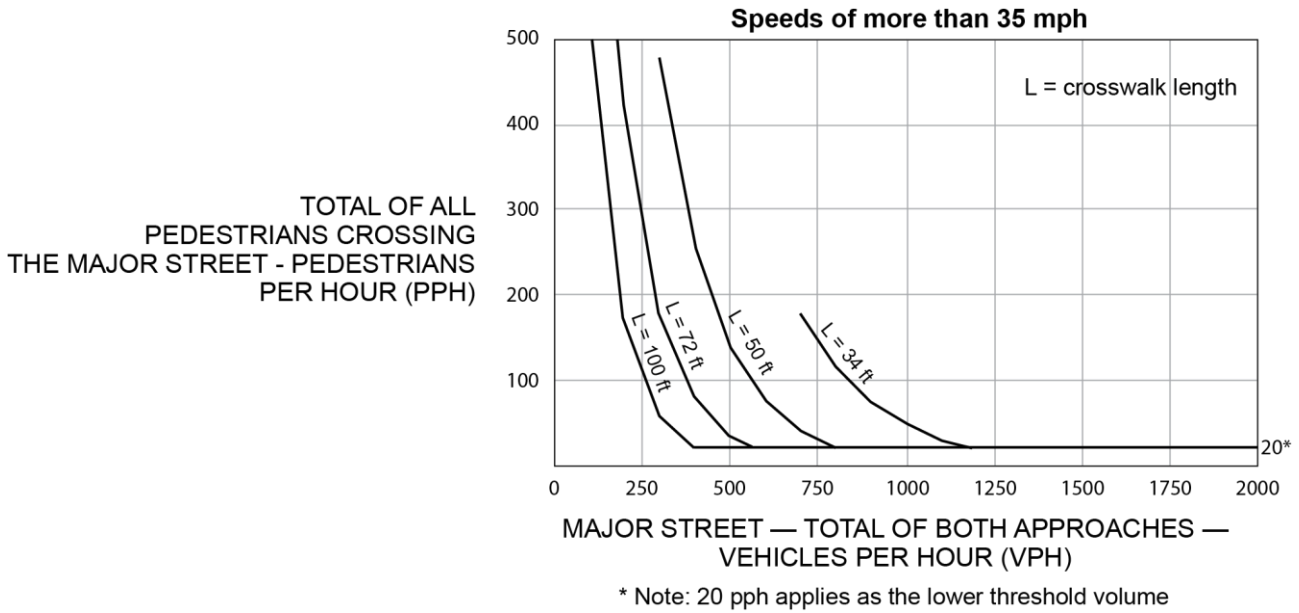
#### **Standard:**

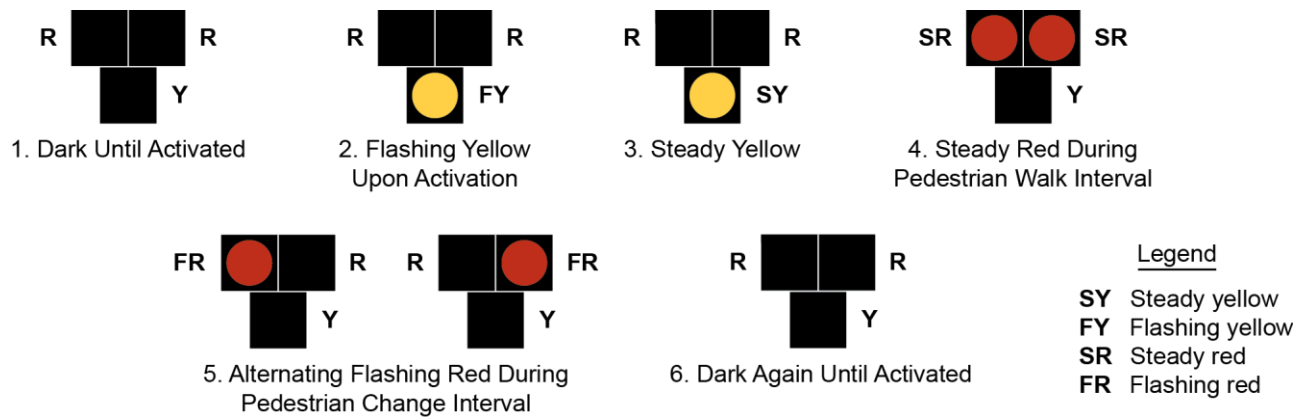
- 01 **Except as otherwise provided in this Section, a pedestrian hybrid beacon shall meet the provisions of Chapters 4D and 4E.**
- 02 **A pedestrian hybrid beacon face shall consist of three signal sections, with a CIRCULAR YELLOW signal indication centered below two horizontally aligned CIRCULAR RED signal indications (see Figure 4F-3).**
- 03 **When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then:**
- A. **At least two pedestrian hybrid beacon faces shall be installed for each approach of the major street,**
  - B. **A stop line shall be installed for each approach to the crosswalk,**
  - C. **A pedestrian signal head conforming to the provisions set forth in Chapter 4E shall be installed at each end of the marked crosswalk, and**
  - D. **The pedestrian hybrid beacon shall be pedestrian actuated.**

**Figure 4F-1. Guidelines for the Installation of Pedestrian Hybrid Beacons on Low-Speed Roadways**



**Figure 4F-2. Guidelines for the Installation of Pedestrian Hybrid Beacons on High-Speed Roadways**



**Figure 4F-3. Sequence for a Pedestrian Hybrid Beacon****Guidance:**

- 04 When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then:
- The pedestrian hybrid beacon should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs,
  - Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk, or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance,
  - The installation should include suitable standard signs and pavement markings, and
  - If installed within a signal system, the pedestrian hybrid beacon should be coordinated.
- 05 On approaches having posted or statutory speed limits or 85th-percentile speeds in excess of 35 mph and on approaches having traffic or operating conditions that would tend to obscure visibility of roadside hybrid beacon face locations, both of the minimum of two pedestrian hybrid beacon faces should be installed over the roadway.
- 06 On multi-lane approaches having a posted or statutory speed limits or 85th-percentile speeds of 35 mph or less, either a pedestrian hybrid beacon face should be installed on each side of the approach (if a median of sufficient width exists) or at least one of the pedestrian hybrid beacon faces should be installed over the roadway.
- 07 A pedestrian hybrid beacon should comply with the signal face location provisions described in Sections 4D.11 through 4D.16.

**Standard:**

- 08 **A CROSSWALK STOP ON RED (symbolic circular red) (R10-23) sign (see Section 2B.53) shall be mounted adjacent to a pedestrian hybrid beacon face on each major street approach. If an overhead pedestrian hybrid beacon face is provided, the sign shall be mounted adjacent to the overhead signal face.**

**Option:**

- 09 A Pedestrian (W11-2) warning sign (see Section 2C.50) with an AHEAD (W16-9P) supplemental plaque may be placed in advance of a pedestrian hybrid beacon. A warning beacon may be installed to supplement the W11-2 sign.

**Guidance:**

- 10 If a warning beacon supplements a W11-2 sign in advance of a pedestrian hybrid beacon, it should be programmed to flash only when the pedestrian hybrid beacon is not in the dark mode.

**Standard:**

- 11 **If a warning beacon is installed to supplement the W11-2 sign, the design and location of the warning beacon shall comply with the provisions of Sections 4L.01 and 4L.03.**

**Section 4F.03 Operation of Pedestrian Hybrid Beacons****Standard:**

01 Pedestrian hybrid beacon indications shall be dark (not illuminated) during periods between  
actuations.

02 Upon actuation by a pedestrian, a pedestrian hybrid beacon face shall display a flashing  
CIRCULAR YELLOW signal indication, followed by a steady CIRCULAR YELLOW signal  
indication, followed by both steady CIRCULAR RED signal indications during the pedestrian walk  
interval, followed by alternating flashing CIRCULAR RED signal indications during the pedestrian  
change interval (see Figure 4F-3). Upon termination of the pedestrian change interval, the pedestrian  
hybrid beacon faces shall revert to a dark (not illuminated) condition.

03 Except as provided in Paragraph 4, the pedestrian signal heads shall continue to display a steady  
UPRAISED HAND (symbolizing DONT WALK) signal indication when the pedestrian hybrid beacon  
faces are either dark or displaying flashing or steady CIRCULAR YELLOW signal indications. The  
pedestrian signal heads shall display a WALKING PERSON (symbolizing WALK) signal indication  
when the pedestrian hybrid beacon faces are displaying steady CIRCULAR RED signal indications.  
The pedestrian signal heads shall display a flashing UPRAISED HAND (symbolizing DONT WALK)  
signal indication when the pedestrian hybrid beacon faces are displaying alternating flashing  
CIRCULAR RED signal indications. Upon termination of the pedestrian change interval, the  
pedestrian signal heads shall revert to a steady UPRAISED HAND (symbolizing DONT WALK)  
signal indication.

**Option:**

04 Where the pedestrian hybrid beacon is installed adjacent to a roundabout to facilitate crossings by  
pedestrians with visual disabilities and an engineering study determines that pedestrians without visual  
disabilities can be allowed to cross the roadway without actuating the pedestrian hybrid beacon, the  
pedestrian signal heads may be dark (not illuminated) when the pedestrian hybrid beacon faces are dark.

**Guidance:**

05 *The duration of the flashing yellow interval should be determined by engineering judgment.*

**Standard:**

06 **The duration of the steady yellow change interval shall be determined using engineering practices.**

**Guidance:**

07 *The steady yellow interval should have a minimum duration of 3 seconds and a maximum duration of 6  
seconds (see Section 4D.26). The longer intervals should be reserved for use on approaches with higher  
speeds.*



## CHAPTER 4G. TRAFFIC CONTROL SIGNALS AND HYBRID BEACONS FOR EMERGENCY VEHICLE ACCESS

### **Section 4G.01 Applications of Emergency-Vehicle Traffic Control Signals and Hybrid Beacons**

Support:

- 01 An emergency-vehicle traffic control signal is a special traffic control signal that assigns the right-of-way to an authorized emergency vehicle.

Option:

- 02 An emergency-vehicle traffic control signal may be installed at a location that does not meet other traffic signal warrants such as at an intersection or other location to permit direct access from a building housing the emergency vehicle.

- 03 An emergency-vehicle hybrid beacon may be installed instead of an emergency-vehicle traffic control signal under conditions described in Section 4G.04.

*Guidance:*

- 04 *If a traffic control signal is not justified under the signal warrants of Chapter 4C and if gaps in traffic are not adequate to permit the timely entrance of emergency vehicles, or the stopping sight distance for vehicles approaching on the major street is insufficient for emergency vehicles, installing an emergency-vehicle traffic control signal should be considered. If one of the signal warrants of Chapter 4C is met and a traffic control signal is justified by an engineering study, and if a decision is made to install a traffic control signal, it should be based upon the provisions of Chapter 4D.*

- 05 *The sight distance determination should be based on the location of the visibility obstruction for the critical approach lane for each street or drive and the posted or statutory speed limit or 85th-percentile speed on the major street, whichever is higher.*

### **Section 4G.02 Design of Emergency-Vehicle Traffic Control Signals**

**Standard:**

- 01 **Except as otherwise provided in this Section, an emergency-vehicle traffic control signal shall meet the requirements of this Manual.**

- 02 **An Emergency Vehicle (W11-8) sign (see Section 2C.49) with an EMERGENCY SIGNAL AHEAD (W11-12P) supplemental plaque shall be placed in advance of all emergency-vehicle traffic control signals. If a warning beacon is installed to supplement the W11-8 sign, the design and location of the beacon shall comply with the Standards of Sections 4L.01 and 4L.03.**

*Guidance:*

- 03 *At least one of the two signal faces for each approach on the major street should be located over the roadway.*

- 04 *The following size signal indications should be used for emergency-vehicle traffic control signals: 12-inch diameter for steady red and steady yellow circular signal indications and any arrow indications, and 8-inch diameter for green or flashing yellow circular signal indications.*

**Standard:**

- 05 **An EMERGENCY SIGNAL (R10-13) sign shall be mounted adjacent to a signal face on each major street approach (see Section 2B.53). If an overhead signal face is provided, the EMERGENCY SIGNAL sign shall be mounted adjacent to the overhead signal face.**

Option:

- 06 An approach that only serves emergency vehicles may be provided with only one signal face consisting of one or more signal sections.

- 07 Besides using an 8-inch diameter signal indication, other appropriate means to reduce the flashing yellow light output may be used.

### **Section 4G.03 Operation of Emergency-Vehicle Traffic Control Signals**

#### **Standard:**

- 01 **Right-of-way for emergency vehicles at signalized locations operating in the steady (stop-and-go) mode shall be obtained as provided in Section 4D.27.**
- 02 **As a minimum, the signal indications, sequence, and manner of operation of an emergency-vehicle traffic control signal installed at a midblock location shall be as follows:**
- A. **The signal indication, between emergency-vehicle actuations, shall be either green or flashing yellow. If the flashing yellow signal indication is used instead of the green signal indication, it shall be displayed in the normal position of the green signal indication, while the steady red and steady yellow signal indications shall be displayed in their normal positions.**
  - B. **When an emergency vehicle actuation occurs, a steady yellow change interval followed by a steady red interval shall be displayed to traffic on the major street.**
  - C. **A yellow change interval is not required following the green interval for the emergency-vehicle driveway.**
- 03 **Emergency-vehicle traffic control signals located at intersections shall either be operated in the flashing mode between emergency-vehicle actuations (see Sections 4D.28 and 4D.30) or be full-actuated or semi-actuated to accommodate normal vehicular and pedestrian traffic on the streets.**
- 04 **Warning beacons, if used with an emergency-vehicle traffic control signal, shall be flashed only:**
- A. **For an appropriate time in advance of and during the steady yellow change interval for the major street; and**
  - B. **During the steady red interval for the major street.**

#### *Guidance:*

- 05 *The duration of the steady red interval for traffic on the major street should be determined by on-site test-run time studies, but should not exceed 1.5 times the time required for the emergency vehicle to clear the path of conflicting vehicles.*

#### *Option:*

- 06 *An emergency-vehicle traffic control signal sequence may be initiated manually from a local control point such as a fire station or law enforcement headquarters or from an emergency vehicle equipped for remote operation of the signal.*

### **Section 4G.04 Emergency-Vehicle Hybrid Beacons**

#### **Standard:**

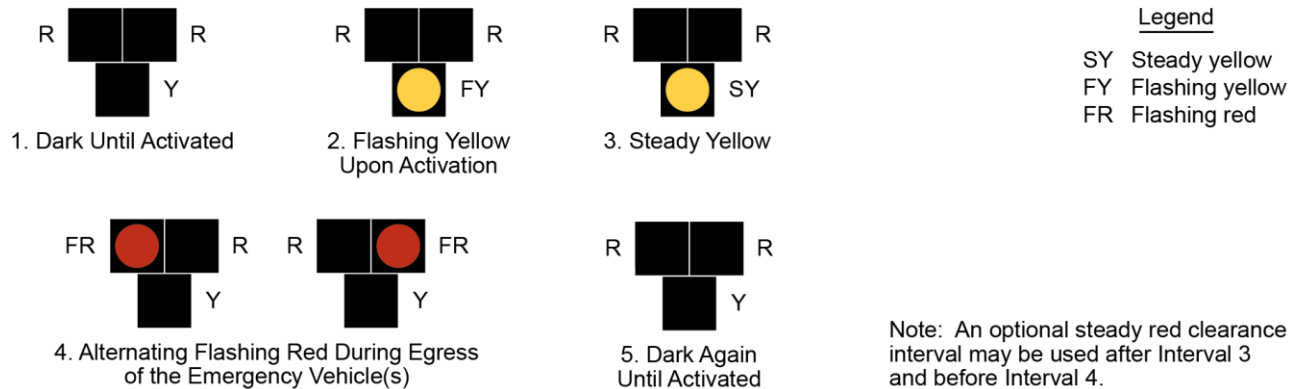
- 01 **Emergency-vehicle hybrid beacons shall be used only in conjunction with signs to warn and control traffic at an unsignalized location where emergency vehicles enter or cross a street or highway. Emergency-vehicle hybrid beacons shall be actuated only by authorized emergency or maintenance personnel.**

#### *Guidance:*

- 02 *Emergency-vehicle hybrid beacons should only be used when all of the following criteria are satisfied:*
- A. *The conditions justifying an emergency-vehicle traffic control signal (see Section 4G.01) are met; and*
  - B. *An engineering study, considering the road width, approach speeds, and other pertinent factors, determines that emergency-vehicle hybrid beacons can be designed and located in compliance with the requirements contained in this Section and in Section 4L.01, such that they effectively warn and control traffic at the location; and*
  - C. *The location is not at or within 100 feet from an intersection or driveway where the side road or driveway is controlled by a STOP or YIELD sign.*

#### **Standard:**

- 03 **Except as otherwise provided in this Section, an emergency-vehicle hybrid beacon shall meet the requirements of this Manual.**

**Figure 4G-1. Sequence for an Emergency-Vehicle Hybrid Beacon**

04 **An emergency-vehicle hybrid beacon face shall consist of three signal sections, with a CIRCULAR YELLOW signal indication centered below two horizontally aligned CIRCULAR RED signal indications (see Figure 4G-1).**

05 **Emergency-vehicle hybrid beacons shall be placed in a dark mode (no indications displayed) during periods between actuations.**

06 **Upon actuation by authorized emergency personnel, the emergency-vehicle hybrid beacon faces shall each display a flashing yellow signal indication, followed by a steady yellow change interval, prior to displaying two CIRCULAR RED signal indications in an alternating flashing array for a duration of time adequate for egress of the emergency vehicles. The alternating flashing red signal indications shall only be displayed when it is required that drivers on the major street stop and then proceed subject to the rules applicable after making a stop at a STOP sign. Upon termination of the flashing red signal indications, the emergency-vehicle hybrid beacons shall revert to a dark mode (no indications displayed) condition.**

*Guidance:*

07 *The duration of the flashing yellow interval should be determined by engineering judgment.*

**Standard:**

08 **The duration of the steady yellow change interval shall be determined using engineering practices.**

*Guidance:*

09 *The steady yellow change interval should have a minimum duration of 3 seconds and a maximum duration of 6 seconds (see Section 4D.26). The longer intervals should be reserved for use on approaches with higher speeds.*

*Option:*

10 A steady red clearance interval may be used after the steady yellow change interval.

11 Emergency-vehicle hybrid beacons may be equipped with a light or other display visible to the operator of the egressing emergency vehicle to provide confirmation that the beacons are operating.

12 Emergency-vehicle hybrid beacons may be supplemented with an advance warning sign, which may also be supplemented with a Warning Beacon (see Section 4L.03).

*Guidance:*

13 *If a Warning Beacon is used to supplement the advance warning sign, it should be programmed to flash only when the emergency-vehicle hybrid beacon is not in the dark mode.*

**Standard:**

14 **At least two emergency-vehicle hybrid beacon faces shall be installed for each approach of the major street and a stop line shall be installed for each approach of the major street.**

*Guidance:*

- 15 *On approaches having posted or statutory speed limits or 85th-percentile speeds in excess of 40 mph, and on approaches having traffic or operating conditions that would tend to obscure visibility of roadside beacon faces, both of the minimum of two emergency-vehicle hybrid beacon faces should be installed over the roadway.*
- 16 *On multi-lane approaches having posted or statutory speed limits or 85th-percentile speeds of 40 mph or less, either an emergency-vehicle hybrid beacon face should be installed on each side of the approach (if a median of sufficient width exists) or at least one of the emergency-vehicle hybrid beacon faces should be installed over the roadway.*
- 17 *An emergency-vehicle hybrid beacon should comply with the signal face location provisions described in Sections 4D.11 through 4D.16.*

**Standard:**

- 18 **Stop lines and EMERGENCY SIGNAL—STOP WHEN FLASHING RED (R10-14 or R10-14a) signs (see Figure 2B-27) shall be used with emergency-vehicle hybrid beacons.**

**Option:**

- 19 If needed for extra emphasis, a STOP HERE ON FLASHING RED (R10-14b) sign (see Section 2B.53) may be installed with an emergency-vehicle hybrid beacon.

## CHAPTER 4H. TRAFFIC CONTROL SIGNALS FOR ONE-LANE, TWO-WAY FACILITIES

### **Section 4H.01 Application of Traffic Control Signals for One-Lane, Two-Way Facilities**

Support:

- 01 A traffic control signal at a narrow bridge, tunnel, or roadway section is a special signal that assigns the right-of-way for vehicles passing over a bridge or through a tunnel or roadway section that is not of sufficient width for two opposing vehicles to pass.
- 02 Temporary traffic control signals (see Sections 4D.32 and 6F.84) are the most frequent application of one-lane, two-way facilities.

*Guidance:*

- 03 *Sight distance across or through the one-lane, two-way facility should be considered as well as the approach speed and sight distance approaching the facility when determining whether traffic control signals should be installed.*

Option:

- 04 At a narrow bridge, tunnel, or roadway section where a traffic control signal is not justified under the conditions of Chapter 4C, a traffic control signal may be used if gaps in opposing traffic do not permit the flow of traffic through the one-lane section of roadway.

### **Section 4H.02 Design of Traffic Control Signals for One-Lane, Two-Way Facilities**

**Standard:**

- 01 **The provisions of Chapter 4D shall apply to traffic control signals for one-lane, two-way facilities, except that:**
- A. Durations of red clearance intervals shall be adequate to clear the one-lane section of conflicting vehicles.**
  - B. Adequate means, such as interconnection, shall be provided to prevent conflicting signal indications, such as green and green, at opposite ends of the section.**

### **Section 4H.03 Operation of Traffic Control Signals for One-Lane, Two-Way Facilities**

**Standard:**

- 01 **Traffic control signals at one-lane, two-way facilities shall operate in a manner consistent with traffic requirements.**
- 02 **When in the flashing mode, the signal indications shall flash red.**

*Guidance:*

- 03 *Adequate time should be provided to allow traffic to clear the narrow facility before opposing traffic is allowed to move. Engineering judgment should be used to determine the proper timing for the signal.*

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## CHAPTER 4I. TRAFFIC CONTROL SIGNALS FOR FREEWAY ENTRANCE RAMPS

### **Section 4I.01 Application of Freeway Entrance Ramp Control Signals**

Support:

- 01 Ramp control signals are traffic control signals that control the flow of traffic entering the freeway facility. This is often referred to as “ramp metering.”
- 02 Freeway entrance ramp control signals are sometimes used if controlling traffic entering the freeway could reduce the total expected delay to traffic in the freeway corridor, including freeway ramps and local streets

*Guidance:*

- 03 *The installation of ramp control signals should be preceded by an engineering study of the physical and traffic conditions on the highway facilities likely to be affected. The study should include the ramps and ramp connections and the surface streets that would be affected by the ramp control, as well as the freeway section concerned.*

Support:

- 04 Information on conditions that might justify freeway entrance ramp control signals, factors to be evaluated in traffic engineering studies for ramp control signals, design of ramp control signals, and operation of ramp control signals can be found in the FHWA’s “Ramp Management and Control Handbook” (see Section 1A.11).

### **Section 4I.02 Design of Freeway Entrance Ramp Control Signals**

**Standard:**

- 01 **Ramp control signals shall meet all of the standard design specifications for traffic control signals, except as otherwise provided in this Section:**
- 02 **The signal face for freeway entrance ramp control signals shall be either a two section signal face containing red and green signal indications or a three section signal face containing red, yellow, and green signal indications.**
- 03 **If only one lane is present on an entrance ramp or if more than one lane is present on an entrance ramp and the ramp control signals are operated such that green signal indications are always displayed simultaneously to all of the lanes on the ramp, then a minimum of two signal faces per ramp shall face entering traffic.**
- 04 **If more than one lane is present on an entrance ramp and the ramp control signals are operated such that green signal indications are not always displayed simultaneously to all of the lanes on the ramp, then one signal face shall be provided over the approximate center of each separately-controlled lane.**

*Guidance:*

- 05 *Additional side-mounted signal faces should be considered for ramps with two or more separately-controlled lanes.*

**Standard:**

- 06 **Ramp control signals shall be located and designed to minimize their viewing by mainline freeway traffic.**

Option:

- 07 Ramp control signals may be placed in the dark mode (no indications displayed) when not in use.
- 08 Ramp control signals may be used to control some, but not all, lanes on a ramp, such as when non-metered HOV bypass lanes are provided on a ramp.
- 09 The required signal faces, if located at the side of the ramp roadway, may be mounted such that the height above the pavement grade at the center of the ramp roadway to the bottom of the signal housing of the lowest signal face is between 4.5 feet and 6 feet.
- 10 For entrance ramps with only one controlled lane, the two required signal faces may both be mounted at the side of the roadway on a single pole, with one face at the normal mounting height and one face mounted

lower as provided in Paragraph 9, as a specific exception to the normal 8-foot minimum lateral separation of signal faces required by Section 4D.13.

*Guidance:*

- 11 *Regulatory signs with legends appropriate to the control, such as XX VEHICLE(S) PER GREEN or XX VEHICLE(S) PER GREEN EACH LANE (see Section 2B.56), should be installed adjacent to the ramp control signal faces. When ramp control signals are installed on a freeway-to-freeway ramp, special consideration should be given to assuring adequate visibility of the ramp control signals, and multiple advance warning signs with flashing warning beacons should be installed to warn road users of the metered operation.*

**Section 4I.03 Operation of Freeway Entrance Ramp Control Signals**

*Guidance:*

- 01 *Operational strategies for ramp control signals, such as periods of operation, metering rates and algorithms, and queue management, should be determined by the operating agency prior to the installation of the ramp control signals and should be closely monitored and adjusted as needed thereafter.*
- 02 *When the ramp control signals are operated only during certain periods of the day, a RAMP METERED WHEN FLASHING (W3-8) sign (see Section 2C.37) should be installed in advance of the ramp control signal near the entrance to the ramp, or on the arterial on the approach to the ramp, to alert road users to the presence and operation of ramp meters.*

**Standard:**

- 03 **The RAMP METERED WHEN FLASHING sign shall be supplemented with a warning beacon (see Section 4L.03) that flashes when the ramp control signal is in operation.**



## CHAPTER 4J. TRAFFIC CONTROL FOR MOVABLE BRIDGES

### **Section 4J.01 Application of Traffic Control for Movable Bridges**

Support:

- 01 Traffic control signals for movable bridges are a special type of highway traffic signal installed at movable bridges to notify road users to stop because of a road closure rather than alternately giving the right-of-way to conflicting traffic movements. The signals are operated in coordination with the opening and closing of the movable bridge, and with the operation of movable bridge warning and resistance gates, or other devices and features used to warn, control, and stop traffic.
- 02 Movable bridge warning gates installed at movable bridges decrease the likelihood of vehicles and pedestrians passing the stop line and entering an area where potential hazards exist because of bridge operations.
- 03 A movable bridge resistance gate is sometimes used at movable bridges and located downstream of the movable bridge warning gate. A movable bridge resistance gate provides a physical deterrent to road users when placed in the appropriate position. The movable bridge resistance gates are considered a design feature and not a traffic control device; requirements for them are contained in AASHTO's "Standard Specifications for Movable Highway Bridges" (see the Preface for AASHTO's address).

**Standard:**

- 04 **Traffic control at movable bridges shall include both signals and gates, except in the following cases:**
- A. **Neither is required if other traffic control devices or measures considered appropriate are used under either of the following conditions:**
    1. **On low-volume roads (roads of less than 400 vehicles average daily traffic); or**
    2. **At manually operated bridges if electric power is not available.**
  - B. **Only signals are required in urban areas if intersecting streets or driveways make gates ineffective.**
  - C. **Only movable bridge warning gates are required if a traffic control signal that is controlled as part of the bridge operations exists within 500 feet of the movable bridge resistance gates and no intervening traffic entrances exist.**

### **Section 4J.02 Design and Location of Movable Bridge Signals and Gates**

**Standard:**

- 01 **The signal faces and mountings of movable bridge signals shall comply with the provisions of Chapter 4D except as provided in this Section.**
- 02 **Signal faces with 12-inch diameter signal indications shall be used for all new movable bridge signals.**

Option:

- 03 Existing signal faces with 8-inch diameter lenses may be retained for the remainder of their useful service life.

**Standard:**

- 04 **Since movable bridge operations cover a variable range of time periods between openings, the signal faces shall be one of the following types:**
- A. **Three-section signal faces with red, yellow, and green signal indications; or**
  - B. **Two one-section signal faces with red signal indications in a vertical array separated by a STOP HERE ON RED (R10-6) sign (see Section 2B.53).**
- 05 **Regardless of which signal type is selected, at least two signal faces shall be provided for each approach to the movable span and a stop line (see Section 3B.16) shall be installed to indicate the point behind which vehicles are required to stop.**

*Guidance:*

- 06 *If movable bridge operation is frequent, the use of three-section signal faces should be considered.*

07 *Insofar as practical, the height and lateral placement of signal faces should comply with the requirements for other traffic control signals in accordance with Chapter 4D. They should be located no more than 50 feet in advance of the movable bridge warning gate.*

Option:

08 Movable bridge signals may be supplemented with audible warning devices to provide additional warning to drivers and pedestrians.

**Standard:**

09 **A DRAW BRIDGE (W3-6) sign (see Section 2C.39) shall be used in advance of movable bridge signals and gates to give warning to road users, except in urban conditions where such signing would not be practical.**

10 **If physical conditions prevent a road user from having a continuous view of at least two signal indications for the distance specified in Table 4D-2, an auxiliary device (either a supplemental signal face or the mandatory DRAW BRIDGE (W3-6) sign to which has been added a warning beacon that is interconnected with the movable bridge controller unit) shall be provided in advance of movable bridge signals and gates.**

Option:

11 The DRAW BRIDGE (W3-6) sign may be supplemented by a Warning Beacon (see Section 4L.03).

**Standard:**

12 **If two sets of gates (both a warning and a resistance gate) are used for a single direction, highway traffic signals shall not be required to accompany the resistance gate nearest the span opening.**

13 **Movable bridge warning gates, if used, shall be at least standard railroad size, striped with 16-inch alternate vertical, fully reflectorized red and white stripes. Flashing red lights in accordance with the Standards for those on railroad gates (see Section 8C.04) shall be included on the gate arm and they shall only be operated if the gate is closed or in the process of being opened or closed. In the horizontal position, the top of the gate shall be approximately 4 feet above the pavement.**

*Guidance:*

14 *Movable bridge warning gates should be of lightweight construction. In its normal upright position, the gate arm should provide adequate lateral clearance.*

Option:

15 The movable bridge resistance gates may be delineated, if practical, in a manner similar to the movable bridge warning gate.

**Standard:**

16 **Movable bridge warning gates, if used, shall extend at least across the full width of the approach lanes if movable bridge resistance gates are used. On divided highways in which the roadways are separated by a barrier median, movable bridge warning gates, if used, shall extend across all roadway lanes approaching the span openings.**

*Guidance:*

17 *If movable bridge resistance gates are not used on undivided highways, movable bridge warning gates, if used, should extend across the full width of the roadway.*

Option:

18 A single full-width gate or two half-width gates may be used.

Support:

19 The locations of movable bridge signals and gates are determined by the location of the movable bridge resistance gate (if used) rather than by the location of the movable spans. The movable bridge resistance gates for high-speed highways are preferably located 50 feet or more from the span opening except for bascule and lift bridges, where they are often attached to, or are a part of, the structure.

**Standard:**

20 **Except where physical conditions make it impractical, movable bridge warning gates shall be located 100 feet or more from the movable bridge resistance gates or, if movable bridge resistance gates are not used, 100 feet or more from the movable span.**

*Guidance:*

- 21 *On bridges or causeways that cross a long reach of water and that might be hit by large marine vessels, within the limits of practicality, traffic should not be halted on a section of the bridge or causeway that is subject to impact.*
- 22 *In cases where it is not practical to halt traffic on a span that is not subject to impact, traffic should be halted at least one span from the opening. If traffic is halted by signals and gates more than 330 feet from the movable bridge warning gates (or from the span opening if movable bridge warning gates are not used), a second set of gates should be installed approximately 100 feet from the gate or span opening.*
- 23 *If the movable bridge is close to a grade crossing and traffic might possibly be stopped on the crossing as a result of the bridge opening, a traffic control device should notify the road users to not stop on the railroad tracks.*

**Section 4J.03 Operation of Movable Bridge Signals and Gates****Standard:**

- 01 **Traffic control devices at movable bridges shall be coordinated with the movable spans, so that the signals, gates, and movable spans are controlled by the bridge tender through an interlocked control.**
- 02 **If the three-section type of signal face is used, the green signal indication shall be displayed at all times between bridge openings, except that if the bridge is not expected to open during continuous periods in excess of 5 hours, a flashing yellow signal indication shall be permitted to be used. The signal shall display a steady red signal indication when traffic is required to stop. The duration of the yellow change interval between the display of the green and steady red signal indications, or flashing yellow and steady red signal indications, shall be determined using engineering practices (see Section 4D.26).**
- 03 **If the vertical array of red signal indications is the type of signal face selected, the red signal indications shall flash alternately only when traffic is required to stop.**

*Guidance:*

- 04 *The yellow change interval should have a minimum duration of 3 and a maximum duration of 6 seconds. The longer intervals should be reserved for use on approaches with higher speeds.*
- 05 *Traffic control signals on adjacent streets and highways should be interconnected with the drawbridge control if indicated by engineering judgment. When such interconnection is provided, the traffic control signal at adjacent intersections should be preempted by the operation of the movable bridge in the manner described in Section 4D.27.*

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## CHAPTER 4K. HIGHWAY TRAFFIC SIGNALS AT TOLL PLAZAS

### Section 4K.01 Traffic Signals at Toll Plazas

#### Standard:

- 01 Traffic control signals or devices that closely resemble traffic control signals that use red or green circular indications shall not be used at toll plazas to indicate the open or closed status of the toll plaza lanes.

#### Guidance:

- 02 Traffic control signals or devices that closely resemble traffic control signals that use red or green circular indications should not be used for new or reconstructed installations at toll plazas to indicate the success or failure of electronic toll payments or to alternately direct drivers making cash toll payments to stop and then proceed.

### Section 4K.02 Lane-Use Control Signals at or Near Toll Plazas

#### Standard:

- 01 Lane-use control signals used at toll plazas shall comply with the provisions of Chapter 4M except as otherwise provided in this Section.

- 02 At toll plazas with multiple lanes where one or more lanes is sometimes closed to traffic, a lane-use control signal shall be installed above the center of each toll plaza lane to indicate the open or closed status of the controlled lane.

#### Option:

- 03 The bottom of the signal housing of a lane-use control signal above a toll plaza lane having a canopy may be mounted lower than 15 feet above the pavement, but not lower than the vertical clearance of the canopy structure.

- 04 Lane-use control signals may also be used to indicate the open or closed status of an Open-Road ETC lane as a supplement to other devices used for the temporary closure of a lane (see Part 6).

### Section 4K.03 Warning Beacons at Toll Plazas

#### Standard:

- 01 Warning Beacons used at toll plazas shall comply with the provisions of Chapter 4L except as otherwise provided in this Section.

#### Guidance:

- 02 Warning Beacons, if used with a toll plaza canopy sign (see Section 2F.16) to assist drivers of such vehicles in locating the dedicated ETC Account-Only lane(s), should be installed in a manner such that the beacons are distinctly separate from the lane-use control signals (see Section 4M.01) for the toll plaza lane.

#### Option:

- 03 Warning Beacons that are mounted on toll plaza islands, behind impact attenuators in front of toll plaza islands, and/or on toll booth pylons (ramparts) to identify them as objects in the roadway may be mounted at a height that is appropriate for viewing in a toll plaza context, even if that height is lower than the normal minimum of 8 feet above the pavement.

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## CHAPTER 4L. FLASHING BEACONS

### **Section 4L.01 General Design and Operation of Flashing Beacons**

Support:

01 A Flashing Beacon is a highway traffic signal with one or more signal sections that operates in a flashing mode. It can provide traffic control when used as an intersection control beacon (see Section 4L.02) or it can provide warning when used in other applications (see Sections 4L.03, 4L.04, and 4L.05).

02 The meaning of flashing circular yellow and red signal indications are addressed in ORC Section 4511.13(E)(4) and (F)(3) (see Section 4D.04 and Appendix B2).

**Standard:**

03 **Flashing Beacon units and their mountings shall comply with the provisions of Chapter 4D, except as otherwise provided in this Chapter.**

04 **Beacons shall be flashed at a rate of not less than 50 or more than 60 times per minute. The illuminated period of each flash shall be a minimum of 1/2 and a maximum of 2/3 of the total cycle.**

05 **A beacon shall not be included within the border of a sign except for SCHOOL SPEED LIMIT sign beacons (see Sections 4L.04 and 7B.10).**

*Guidance:*

06 *If used to supplement a warning or regulatory sign, the edge of the beacon signal housing should normally be located no closer than 12 inches outside of the nearest edge of the sign.*

*Option:*

07 An automatic dimming device may be used to reduce the brilliance of flashing yellow signal indications during night operation.

### **Section 4L.02 Intersection Control Beacon**

**Standard:**

01 **An Intersection Control Beacon shall consist of one or more signal faces directed toward each approach to an intersection. Each signal face shall consist of one or more signal sections of a standard traffic signal face, with flashing CIRCULAR YELLOW or CIRCULAR RED signal indications in each signal face. They shall be installed and used only at an intersection to control two or more directions of travel.**

02 **Application of Intersection Control Beacon signal indications shall be limited to the following:**

- A. **Yellow on one route (normally the major street) and red for the remaining approaches; and**
- B. **Red for all approaches (if the warrant described in Section 2B.07 for a multi-way stop is satisfied).**

03 **Flashing yellow signal indications shall not face conflicting vehicular approaches.**

04 **A STOP sign shall be used on approaches to which a flashing red signal indication is displayed on an Intersection Control Beacon (see Section 2B.04).**

05 **If two horizontally aligned red signal indications are used on an approach for an Intersection Control Beacon, they shall be flashed simultaneously to avoid being confused with grade crossing flashing-light signals. If two vertically aligned red signal indications are used on an approach for an Intersection Control Beacon, they shall be flashed alternately.**

*Guidance:*

06 *An Intersection Control Beacon should not be mounted on a pedestal in the roadway unless the pedestal is within the confines of a traffic or pedestrian island.*

*Option:*

07 Supplemental signal indications may be used on one or more approaches in order to provide adequate visibility to approaching road users.

08 Intersection Control Beacons may be used at intersections where traffic or physical conditions do not justify conventional traffic control signals but crash rates indicate the possibility of a special need.

09 An Intersection Control Beacon is generally located over the center of an intersection; however, it may  
be used at other suitable locations.

### **Section 4L.03 Warning Beacon**

Support:

- 01 Typical applications of Warning Beacons include the following:
- A. At obstructions in or immediately adjacent to the roadway;
  - B. As supplemental emphasis to warning signs;
  - C. As emphasis for midblock crosswalks;
  - D. As supplemental emphasis to regulatory signs, except STOP, DO NOT ENTER, WRONG WAY, and SPEED LIMIT signs; and
  - E. In conjunction with a regulatory or warning sign that includes the phrase WHEN FLASHING in its legend to indicate that the regulation is in effect or that the condition is present only at certain times.

**Standard:**

02 **A Warning Beacon shall consist of one or more signal sections of a standard traffic signal face with a flashing CIRCULAR YELLOW signal indication in each signal section.**

03 **A Warning Beacon shall be used only to supplement an appropriate warning or regulatory sign or marker.**

04 **Warning Beacons, if used at intersections, shall not face conflicting vehicular approaches.**

05 **If a Warning Beacon is suspended over the roadway, the clearance above the pavement shall be a minimum of 15 feet and a maximum of 19 feet.**

*Guidance:*

06 *The condition or regulation justifying Warning Beacons should largely govern their location with respect to the roadway.*

07 *If an obstruction is in or adjacent to the roadway, illumination of the lower portion or the beginning of the obstruction or a sign on or in front of the obstruction, in addition to the beacon, should be considered.*

08 *Warning Beacons should be operated only during those periods of times when the condition or regulation exists.*

*Option:*

09 Warning Beacons that are actuated by pedestrians, bicyclists, or other road users may be used as appropriate to provide additional warning to vehicles approaching a crossing or other location.

10 If Warning Beacons have more than one signal section, they may be flashed either alternately or simultaneously.

11 A flashing yellow beacon interconnected with a traffic signal controller assembly may be used with a traffic signal warning sign (see Section 2C.36).

### **Section 4L.04 Speed Limit Sign Beacon**

**Standard:**

01 **A Speed Limit Sign Beacon shall be used only to supplement a Speed Limit sign.**

02 **A Speed Limit Sign Beacon shall consist of one or more signal sections of a standard traffic control signal face, with a flashing CIRCULAR YELLOW signal indication in each signal section. The signal indications shall have a nominal diameter of not less than 8 inches. If two signal indications are used, they shall be vertically aligned, except that they shall be permitted to be horizontally aligned if the Speed Limit (R2-1) sign is longer horizontally than vertically. If two signal indications are used, they shall be alternately flashed.**

*Option:*

03 A Speed Limit Sign Beacon may be used with a fixed or variable Speed Limit sign. If applicable, a flashing Speed Limit Sign Beacon (with an appropriate accompanying sign) may be used to indicate that the displayed speed limit is in effect.

04 A Speed Limit Sign Beacon may be included within the border of a School Speed Limit (S5-1) sign (see Section 7B.10).



**Section 4L.05 Stop Beacon****Standard:**

- 01        **A Stop Beacon shall be used only to supplement a STOP sign, a DO NOT ENTER sign, or a WRONG WAY sign.**
- 02        **A Stop Beacon shall consist of one or more signal sections of a standard traffic signal face with a flashing CIRCULAR RED signal indication in each signal section. If two horizontally aligned signal indications are used for a Stop Beacon, they shall be flashed simultaneously to avoid being confused with grade crossing flashing-light signals. If two vertically aligned signal indications are used for a Stop Beacon, they shall be flashed alternately.**
- 03        **The bottom of the signal housing of a Stop Beacon shall be not less than 12 inches or more than 24 inches above the top of a STOP sign, a DO NOT ENTER sign, or a WRONG WAY sign.**

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## CHAPTER 4M. LANE-USE CONTROL SIGNALS

### **Section 4M.01 Application of Lane-Use Control Signals**

Support:

01 Lane-use control signals are special overhead signals that permit or prohibit the use of specific lanes of a street or highway or that indicate the impending prohibition of their use. Lane-use control signals are distinguished by placement of special signal faces over a certain lane or lanes of the roadway and by their distinctive shapes and symbols. Supplementary signs are sometimes used to explain their meaning and intent.

02 Lane-use control signals are most commonly used for reversible-lane control, but are also used in nonreversible lane applications and for toll plaza lanes (see Section 4K.02).

*Guidance:*

03 *An engineering study should be conducted to determine whether a reversible-lane operation can be controlled satisfactorily by static signs (see Section 2B.2) or whether lane-use control signals are necessary. Lane-use control signals should be used to control reversible-lane operations if any of the following conditions are present:*

- A. *More than one lane is reversed in direction;*
- B. *Two-way or one-way left turns are allowed during peak-period reversible operations, but those turns are from a different lane than used during off-peak periods;*
- C. *Other unusual or complex operations are included in the reversible-lane pattern;*
- D. *Demonstrated crash experience occurring with reversible-lane operation controlled by static signs that can be corrected by using lane-use control signals at the times of transition between peak and off-peak patterns; and/or*
- E. *An engineering study indicates that the safety and efficiency of the traffic operations of a reversible-lane system would be improved by lane-use control signals.*

**Standard:**

04 **Pavement markings (see Section 3B.03) shall be used in conjunction with reversible-lane control signals.**

Option:

05 Lane-use control signals may also be used if there is no intent or need to reverse lanes, but there is a need to indicate the open or closed status of one or more lanes, such as:

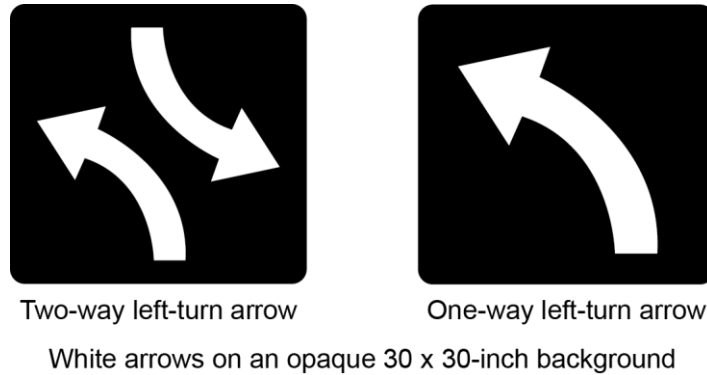
- A. On a freeway, if it is desired to close certain lanes at certain hours to facilitate the merging of traffic from a ramp or other freeway;
- B. On a freeway, near its terminus, to indicate a lane that ends;
- C. On a freeway or long bridge, to indicate that a lane may be temporarily blocked by a crash, breakdown, construction or maintenance activities, or similar temporary conditions; and
- D. On a conventional road or driveway, at access or egress points to or from a facility, such as a parking garage, where one or more lanes of the access or egress are opened or closed at various times.

### **Section 4M.02 Meaning of Lane-Use Control Signal Indications**

**Standard:**

01 **As specified in 4511.131 of the Ohio Revised Code the meanings of lane-use control signal indications shall be as follows:**

- “(A) A steady downward green arrow: A road user is permitted to drive in the lane over which the arrow signal indication is located.**
- (B) A steady yellow “X”: A road user is to prepare to vacate the lane over which the signal indication is located because a lane control change is being made to a steady red “X” signal indication.**
- (C) A steady white two-way left-turn arrow: A road user is permitted to use a lane over which the signal indication is located for a left turn, but not for through travel, with the understanding that common use of the lane by oncoming road users for left turns is also permitted. [See Figure 4M-1.]**

**Figure 4M-1. Left-Turn Lane-Use Control Signals**

- (D) A steady white one way left-turn arrow: A road user is permitted to use a lane over which the signal indication is located for a left turn, without opposing turns in the same lane, but not for through travel. [See Figure 4M-1.]
- (E) A steady red “X”: A road user is not permitted to use the lane over which the signal indication is located and that this signal indication shall modify accordingly the meaning of other traffic controls present.”

### Section 4M.03 Design of Lane-Use Control Signals

#### Standard:

- 01 All lane-use control signal indications shall be in units with rectangular signal faces and shall have opaque backgrounds. Nominal minimum height and width of each DOWNWARD GREEN ARROW, YELLOW X, and RED X signal face shall be 18 inches for typical applications. The WHITE TWO-WAY LEFT-TURN ARROW and WHITE ONE WAY LEFT-TURN ARROW signal faces shall have a nominal minimum height and width of 30 inches.
- 02 Each lane to be reversed or closed shall have signal faces with a DOWNWARD GREEN ARROW and a RED X symbol.
- 03 Each reversible lane that also operates as a two-way or one-way left-turn lane during certain periods shall have signal faces that also include the applicable WHITE TWO-WAY LEFT-TURN ARROW or WHITE ONE WAY LEFT-TURN ARROW symbol.
- 04 Each non-reversible lane immediately adjacent to a reversible lane shall have signal indications that display a DOWNWARD GREEN ARROW to traffic traveling in the permitted direction and a RED X to traffic traveling in the opposite direction.
- 05 If in separate signal sections, the relative positions, from left to right, of the signal indications shall be RED X, YELLOW X, DOWNWARD GREEN ARROW, WHITE TWO-WAY LEFT-TURN ARROW, WHITE ONE WAY LEFT-TURN ARROW.
- 06 The color of lane-use control signal indications shall be clearly visible for 2,300 feet at all times under normal atmospheric conditions, unless otherwise physically obstructed.
- 07 Lane-use control signal faces shall be located approximately over the center of the lane controlled.
- 08 If the area to be controlled is more than 2,300 feet in length, or if the vertical or horizontal alignment is curved, intermediate lane-use control signal faces shall be located over each controlled lane at frequent intervals. This location shall be such that road users will at all times be able to see at least one signal indication and preferably two along the roadway, and will have a definite indication of the lanes specifically reserved for their use.
- 09 All lane-use control signal faces shall be located in a straight line across the roadway approximately at right angles to the roadway alignment.
- 10 On roadways having intersections controlled by traffic control signals, the lane-use control signal face shall be located sufficiently far in advance of or beyond such traffic control signals to prevent them from being misconstrued as traffic control signals.

11 **Except as provided in Paragraph 12, the bottom of the signal housing of any lane-use control signal face shall be a minimum of 15 feet and a maximum of 19 feet above the pavement grade.**

Option:

12 The bottom of a lane-use control signal housing may be lower than 15 feet above the pavement if it is mounted on a canopy or other structure over the pavement, but not lower than the vertical clearance of the structure.

13 Except for lane-use control signals at toll plazas (see Section 4K.02), in areas with minimal visual clutter and with speeds of less than 40 mph, lane-use control signal faces with nominal height and width of 12 inches may be used for the DOWNWARD GREEN ARROW, YELLOW X, and RED X signal faces, and lane-use control signal faces with nominal height and width of 18 inches may be used for the WHITE TWO-WAY LEFT-TURN ARROW and WHITE ONE-WAY LEFT-TURN ARROW signal faces.

14 Other sizes of lane-use control signal faces larger than 18 inches with message recognition distances appropriate to signal spacing may be used for the DOWNWARD GREEN ARROW, YELLOW X, and RED X signal faces.

15 Non-reversible lanes not immediately adjacent to a reversible lane on any street so controlled may also be provided with signal indications that display a DOWNWARD GREEN ARROW to traffic traveling in the permitted direction and a RED X to traffic traveling in the opposite direction.

16 The signal indications provided for each lane may be in separate signal sections or may be superimposed in the same signal section.

#### **Section 4M.04 Operation of Lane-Use Control Signals**

**Standard:**

01 **All lane-use control signals shall be coordinated so that all the signal indications along the controlled section of roadway are operated uniformly and consistently. The lane-use control signal system shall be designed to reliably guard against showing any prohibited combination of signal indications to any traffic at any point in the controlled lanes.**

02 **For reversible-lane control signals, the following combination of signal indications shall not be simultaneously displayed over the same lane to both directions of travel:**

- A. **DOWNWARD GREEN ARROW in both directions,**
- B. **YELLOW X in both directions,**
- C. **WHITE ONE WAY LEFT-TURN ARROW in both directions,**
- D. **DOWNWARD GREEN ARROW in one direction and YELLOW X in the other direction,**
- E. **WHITE TWO-WAY LEFT-TURN ARROW or WHITE ONE WAY LEFT-TURN ARROW in one direction and DOWNWARD GREEN ARROW in the other direction,**
- F. **WHITE TWO-WAY LEFT-TURN ARROW in one direction and WHITE ONE WAY LEFT-TURN ARROW in the other direction, and**
- G. **WHITE ONE WAY LEFT-TURN ARROW in one direction and YELLOW X in the other direction.**

03 **A moving condition in one direction shall be terminated either by the immediate display of a RED X signal indication or by a YELLOW X signal indication followed by a RED X signal indication. In either case, the duration of the RED X signal indication shall be sufficient to allow clearance of the lane before any moving condition is allowed in the opposing direction.**

04 **Whenever a DOWNWARD GREEN ARROW signal indication is changed to a WHITE TWO-WAY LEFT-TURN ARROW signal indication, the RED X signal indication shall continue to be displayed to the opposite direction of travel for an appropriate duration to allow traffic time to vacate the lane being converted to a two-way left-turn lane.**

05 **If an automatic control system is used, a manual control to override the automatic control shall be provided.**

*Guidance:*

06 *The type of control provided for reversible-lane operation should be such as to permit either automatic or manual operation of the lane-use control signals.*

**Standard:**

- 07 **If used, lane-use control signals shall be operated continuously, except that lane-use control signals that are used only for special events or other infrequent occurrences and lane-use control signals on non-reversible freeway lanes shall be permitted to be darkened when not in operation. The change from normal operation to non-operation shall occur only when the lane-use control signals display signal indications that are appropriate for the lane use that applies when the signals are not operated. The lane-use control signals shall display signal indications that are appropriate for the existing lane use when changed from non-operation to normal operations. Also, traffic control devices shall clearly indicate the proper lane use when the lane control signals are not in operation.**

## Support:

- 08 Section 2B.26 contains additional information concerning considerations involving left-turn prohibitions in conjunction with reversible-lane operations.

## CHAPTER 4N. IN-ROADWAY LIGHTS

### Section 4N.01 Application of In-Roadway Lights

Support:

- 01 In-Roadway Lights are special types of highway traffic signals installed in the roadway surface to warn road users that they are approaching a condition on or adjacent to the roadway that might not be readily apparent and might require the road users to slow down and/or come to a stop. This includes situations warning of marked school crosswalks, marked midblock crosswalks, marked crosswalks on uncontrolled approaches, marked crosswalks in advance of roundabouts as described in Chapter 3C, and other roadway situations involving pedestrian crossings.

**Standard:**

- 02 **In-Roadway Lights shall not be used for any application that is not described in this Chapter.**  
 03 **If used, In-Roadway Lights shall not exceed a height of 3/4 inch above the roadway surface.**  
 04 **When used, In-Roadway Lights shall be flashed and shall not be steadily illuminated.**

Support:

- 05 Steadily illuminated lights installed in the roadway surface are considered to be internally illuminated raised pavement markers (see Section 3B.11).

Option:

- 06 In-Roadway Lights may be flashed in a manner that includes a continuous flash of varying intensity and time duration that is repeated to provide a flickering effect (see Section 4N.02).

### Section 4N.02 In-Roadway Warning Lights at Crosswalks

Option:

- 01 In-Roadway Warning Lights may be installed at certain marked crosswalks, based on an engineering study or engineering judgment, to provide additional warning to road users.

**Standard:**

- 02 **If used, In-Roadway Warning Lights at crosswalks shall be installed only at marked crosswalks with applicable warning signs. They shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic control signals.**
- 03 **If In-Roadway Warning Lights are used at a crosswalk, the following requirements shall apply:**
- A. **Except as provided in Paragraphs 7 and 8, they shall be installed along both sides of the crosswalk and shall span its entire length.**
  - B. **They shall initiate operation based on pedestrian actuation and shall cease operation at a predetermined time after the pedestrian actuation or, with passive detection, after the pedestrian clears the crosswalk.**
  - C. **They shall display a flashing yellow light when actuated. The flash rate shall be at least 50, but no more than 60, flash periods per minute. If they are flashed in a manner that includes a continuous flash of varying intensity and time duration that is repeated to provide a flickering effect, the flickers or pulses shall not repeat at a rate that is between 5 and 30 per second to avoid frequencies that might cause seizures.**
  - D. **They shall be installed in the area between the outside edge of the crosswalk line and 10 feet from the outside edge of the crosswalk.**
  - E. **They shall face away from the crosswalk if unidirectional, or shall face away from and across the crosswalk if bidirectional.**
- 04 **If used on one-lane, one-way roadways, a minimum of two In-Roadway Warning Lights shall be installed on the approach side of the crosswalk. If used on two-lane roadways, a minimum of three In-Roadway Warning Lights shall be installed along both sides of the crosswalk. If used on roadways with more than two lanes, a minimum of one In-Roadway Warning Light per lane shall be installed along both sides of the crosswalk.**

*Guidance:*

05 *If used, In-Roadway Warning Lights should be installed in the center of each travel lane, at the center*  
*line of the roadway, at each edge of the roadway or parking lanes, or at other suitable locations away from*  
*the normal tire track paths.*

06 *The location of the In-Roadway Warning Lights within the lanes should be based on engineering*  
*judgment.*

*Option:*

07 On one-way streets, In-Roadway Warning Lights may be omitted on the departure side of the crosswalk.

08 Based on engineering judgment, the In-Roadway Warning Lights on the departure side of the crosswalk  
on the left side of a median may be omitted.

09 Unidirectional In-Roadway Warning Lights installed at crosswalk locations may have an optional,  
additional yellow light indication in each unit that is visible to pedestrians in the crosswalk to indicate to  
pedestrians in the crosswalk that the In-Roadway Warning Lights are in fact flashing as they cross the street.  
These yellow lights may flash with and at the same flash rate as the light module in which each is installed.

*Guidance:*

10 *If used, the period of operation of the In-Roadway Warning Lights following each actuation should be*  
*sufficient to allow a pedestrian crossing in the crosswalk to leave the curb or shoulder and travel at a*  
*walking speed of 3.5 feet per second to at least the far side of the traveled way or to a median of sufficient*  
*width for pedestrians to wait. Where pedestrians who walk slower than 3.5 feet per seconds, or pedestrians*  
*who use wheelchairs, routinely use the crosswalk, a walking speed of less than 3.5 feet per second should be*  
*considered in determining the period of operation.*

**Standard:**

11 **If pedestrian pushbuttons are used to actuate the In-Roadway Warning Lights, a PUSH BUTTON**  
**TO TURN ON WARNING LIGHTS (with pushbutton symbol) (R10-25) sign (see Figure 2B-26) shall**  
**be mounted adjacent to or integral with each pedestrian pushbutton.**

12 **Where the period of operation is sufficient only for crossing from a curb or shoulder to a median**  
**of sufficient width for pedestrians to wait, median-mounted pedestrian actuators shall be provided.**