213 Modern Roundabouts

213.1 General

This chapter provides design criteria for the geometric layout of modern roundabouts. The criteria contained in the FDM are supplemented by guidance provided in the National Cooperative Highway Research Program (NCHRP) Report 672, Roundabouts: An Informational Guide.

Only single-lane and two-lane modern roundabouts are to be constructed on the SHS. Partial three-lane roundabouts may be acceptable under certain conditions.

Exhibit 213-1 illustrates the elements of a modern roundabout that are discussed in this chapter.

213.1.1 Roundabout Evaluation

The Department is committed to installing modern roundabouts on the SHS where it makes sense to do so. A roundabout alternative must be evaluated in accordance with ***FDM 116*** when:

- New signalization is proposed
- Major reconstruction of an existing signalized intersection is proposed
- A change in an un-signalized intersection control is required

An evaluation is not required for minor operational improvements such as changes to signal phasing, or for signal replacement projects where the primary purpose is to upgrade deficient equipment and installations.

To construct a modern roundabout on the SHS, one of the following must be met:

(1) ***MUTCD*** traffic signal warrants 1 or 2 is met,

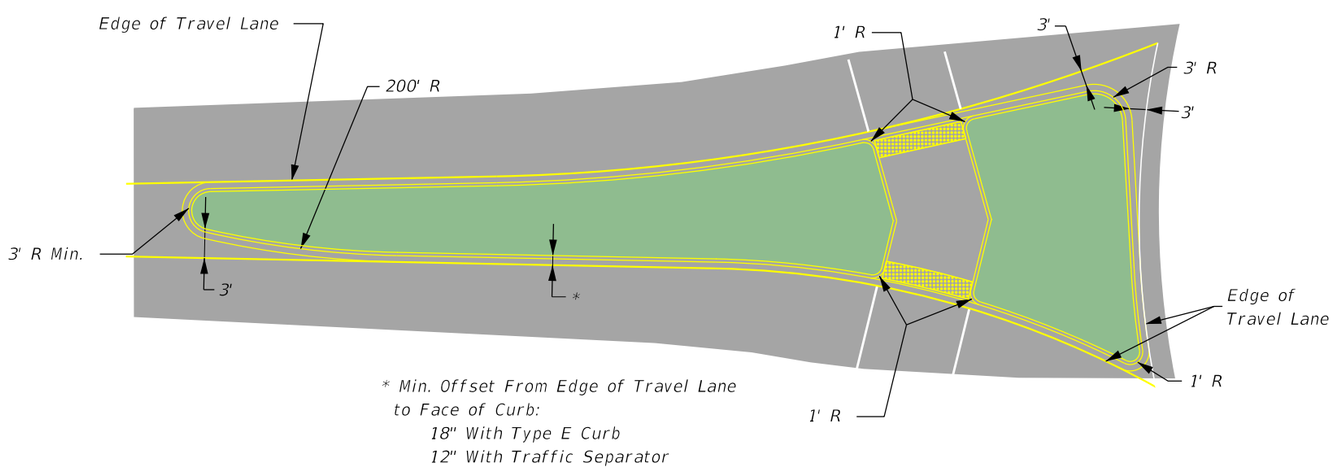
(2) Documented high frequency of severe crashes,

(3) Context appropriate operational improvement on low-speed facilities, or

(4) Need for speed management when transitioning from a high-speed context classification to a lower-speed context classification.

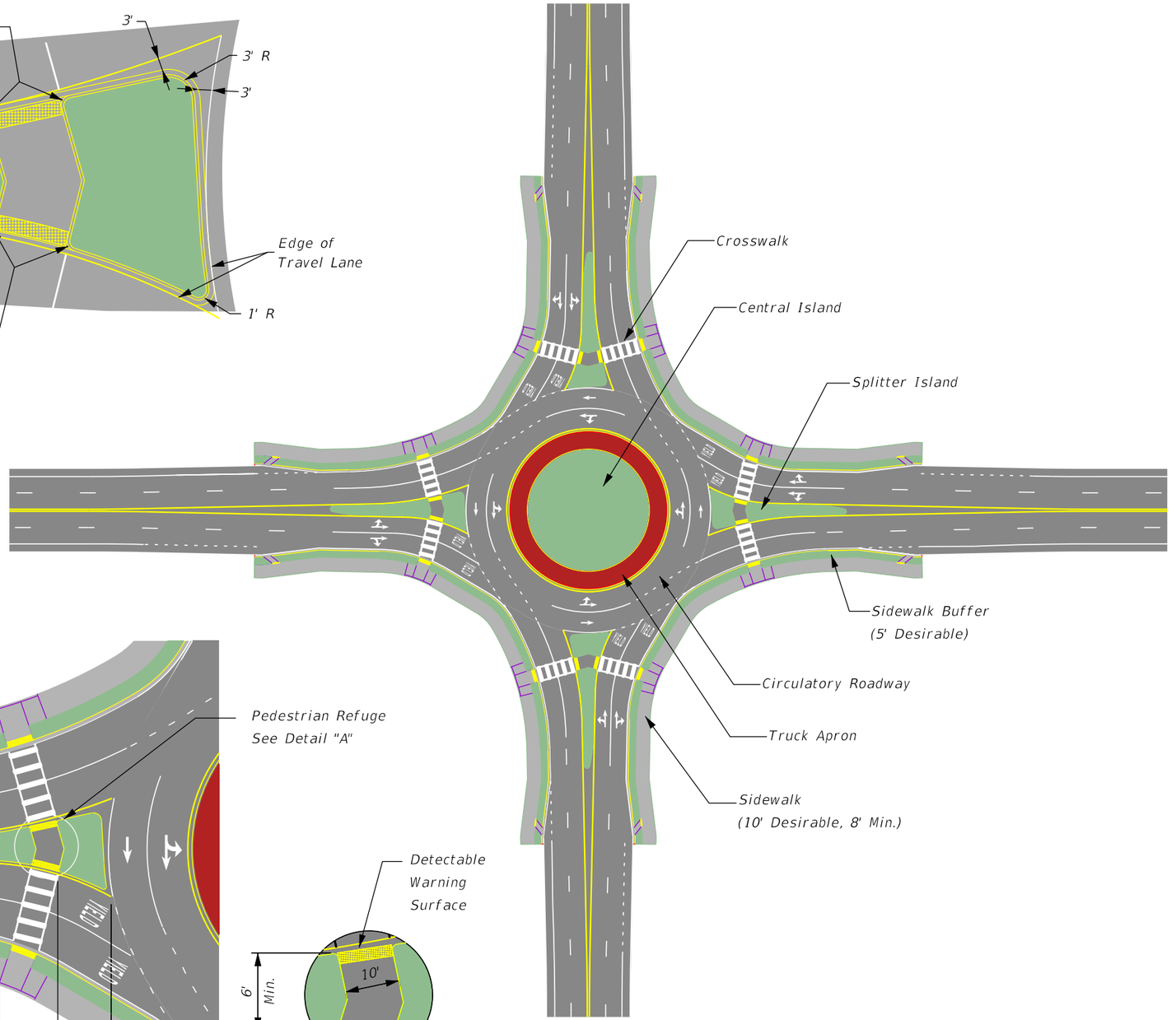
While roundabouts may provide a community enhancement, they are not to be constructed on SHS solely for this purpose.

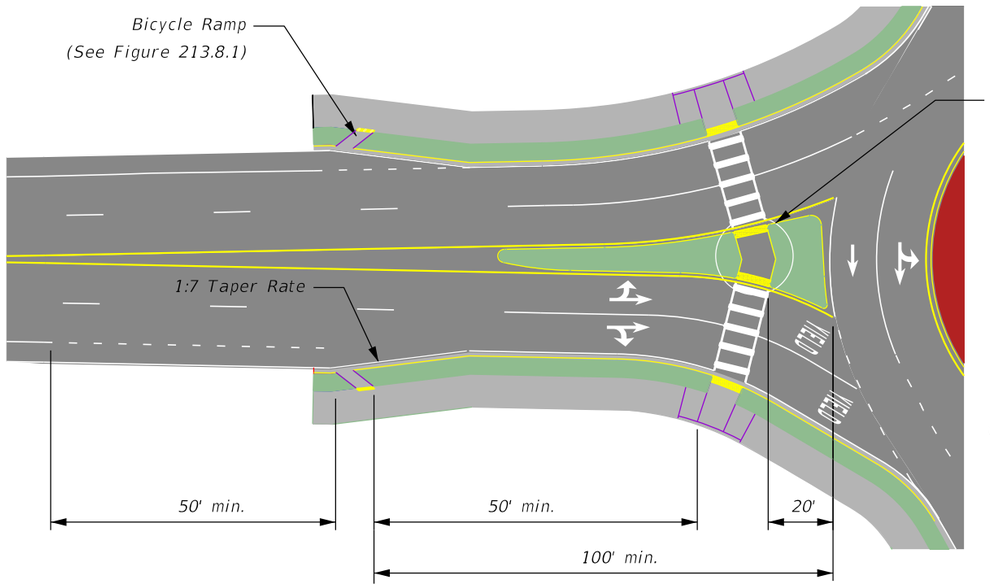
MODERN ROUNDABOUT DETAILS



* Min. Offset From Edge of Travel Lane to Face of Curb:
18" With Type E Curb
12" With Traffic Separator

SPLITTER ISLAND DETAIL





BICYCLE AND PEDESTRIAN DETAIL

DETAIL "A"

NOT TO SCALE

EXHIBIT 213-1
01/01/2019

213.1.2 Central Office Review and Approval

Submit roundabout designs to the Central Office for review as early as practical, but no later than Phase II design submittal. See ***FDM 301.4*** for the roundabout review submittal requirements. Concept designs developed during the PD&E process should be submitted to Central Office for review and comment.

The design for a roundabout on the SHS requires the approval of the State Roadway Design Engineer.

213.2 Operational Analysis

HCS 7 and SIDRA are software packages that are often used to determine performance measures of roundabouts in compliance with the ***Highway Capacity Manual***. The preferred software for evaluation and design of roundabouts on the SHS is HCS 7.

To optimize safety and operation performance, provide only the lanes that are warranted through the traffic operational analysis. Inclusion of unwarranted approach, circulatory or by-pass lanes increases complexity and conflict points. Provide roundabout designs that are simplistic and have pavement widths based on necessity.

Use 20-year design traffic volumes for roundabout evaluation and design.

213.2.1 Stage Construction

Consider stage construction when traffic operational analysis indicates that a multi-lane roundabout will be required in the design year (20-year design life), but a single-lane roundabout would provide acceptable service for 10 to 15 years (1st resurfacing cycle). Having more lanes than what is warranted in the early years will have a negative effect on safety and operational performance.

When it is determined that staged construction will be utilized, develop the ultimate design first to assure all right-of-way needs for the ultimate project are identified. Then develop the initial design that allows for expansion in the future with minimal “throw-away” work. Both the interim and ultimate designs require Central Office approval.

213.3 Geometric Design

It is important to develop roadway geometry that encourages drivers to gradually slow down as they approach the roundabout. Roundabout design features that influence vehicular approach speeds include:

(1) Prominent landscaping in the central island serves to increase visibility of the central island and provides a visual queue to approaching drivers that they are entering a low-speed environment. Roadway approach geometry should work with the landscaping to limit line of sight beyond what is necessary to meet intersection sight distance requirements. See ***NCHRP Report 672, 6.7.3*** for additional information.

(2) Raised splitter islands and roadside curb provide visual ques to establish a speed transition zone. Lengthening this transition zone on high-speed facilities can be an effective strategy for slowing down traffic prior to entering a roundabout.

(3) Geometric features (e.g., inscribed circle diameter, lane width, entry width, curb locations) introduce deflection and curvature into the driver's path and is the most effective way to slow vehicles down to a safe entry speed.

A chicane is a series of curves that requires the driver to turn slightly right and then slightly left while approaching the roundabout entry. Chicaning should not be excessive, but used only to the extent necessary to establish the splitter island, and create an offset left alignment.

Tangent segments between reverse curves:

- Provides a smooth natural path for drivers
- Improves the alignment of the approach with the receiving circulatory roadway
- Aids and assists truck drivers in navigating the roundabout

Tangent segments between reverse curves are required for high-speed approaches as discussed in the ***FDM 213.3.1***. A minimum 25-foot tangent segment between reverse curves on low speed approaches should be provided; i.e., avoid back to back reverse curves.

213.3.1 High-Speed Approach Geometry

Exhibit 213-2 illustrates the Department's desired geometry for a high-speed two-lane undivided highway approaching a single-lane roundabout. High-speed approach geometry uses a series of three curves upstream of the roundabout with successively

smaller radii separated by tangent segments. The general approach demonstrated can be applied to high-speed two-lane roundabouts as well.

The approach roadway alignment contains three curves labeled AR1, AR2, and AR3. The Department criteria for minimum curve length on open roadway (400 feet) does not apply within the functional area of the intersection. See ***FDM 212.4*** for more information on intersection functional area.

AR1

The first curve encountered by the driver as they approach the roundabout is AR1. This curve to the right has the largest radius of the three and is intended to alert the driver that they are approaching a roundabout and need to slow down. This curve also initiates separation between the opposing traffic lanes allowing for the development of the splitter island. The PC of AR1 demarks the area of influence of the intersection. The radius of AR1 is based on the design speed of the approach leg and is determined by using ***AASHTO Greenbook 2011 Equation 3-8***. Assuming normal crown, the superelevation rate (e_{max}) is 2%. Side friction factors are dependent on speed and are determined using ***AASHTO Greenbook 2011 Figure 3-6***.

AR1 is typically not necessary for divided highway approaches because separation between opposing traffic lanes is already established.

AR2

The second curve approaching the roundabout is AR2. This curve to the left aligns the approach roadway centerline to the left of the roundabout center (offset left). An offset left design allows for proper deflection and speed control. When entering AR2, it is assumed that the driver has decelerated 15-20 mph from the vehicle's approach speed.

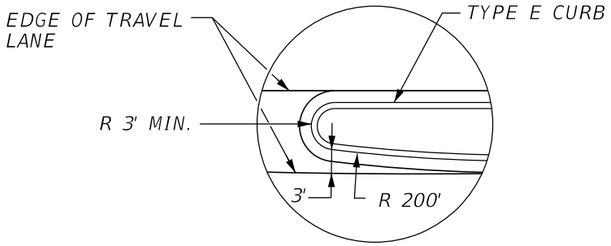
Since the curve is to the left and the roadway cross slope is normal crown, the superelevation rate used to calculate AR2 is -2%.

AR3

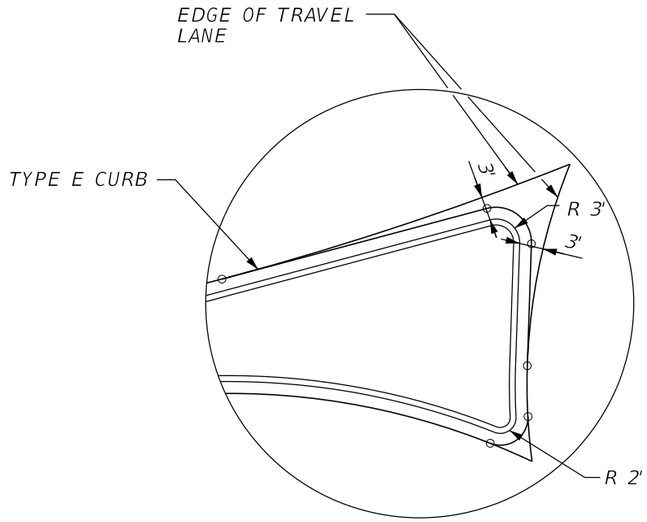
The final curve entering the roundabout is AR3. This curve to the right guides the driver into the circulatory roadway. AR3 radius is typically between 75 and 100 feet and is determined through the fastest path analysis. At this point it is assumed that the driver has decelerated to an operating speed between 20 and 25 mph.

Tangent Segments

Provide a tangent segment between AR1 and AR2 not less than 100 feet. Provide a tangent segment between AR2 and AR3 not less than 50 feet.

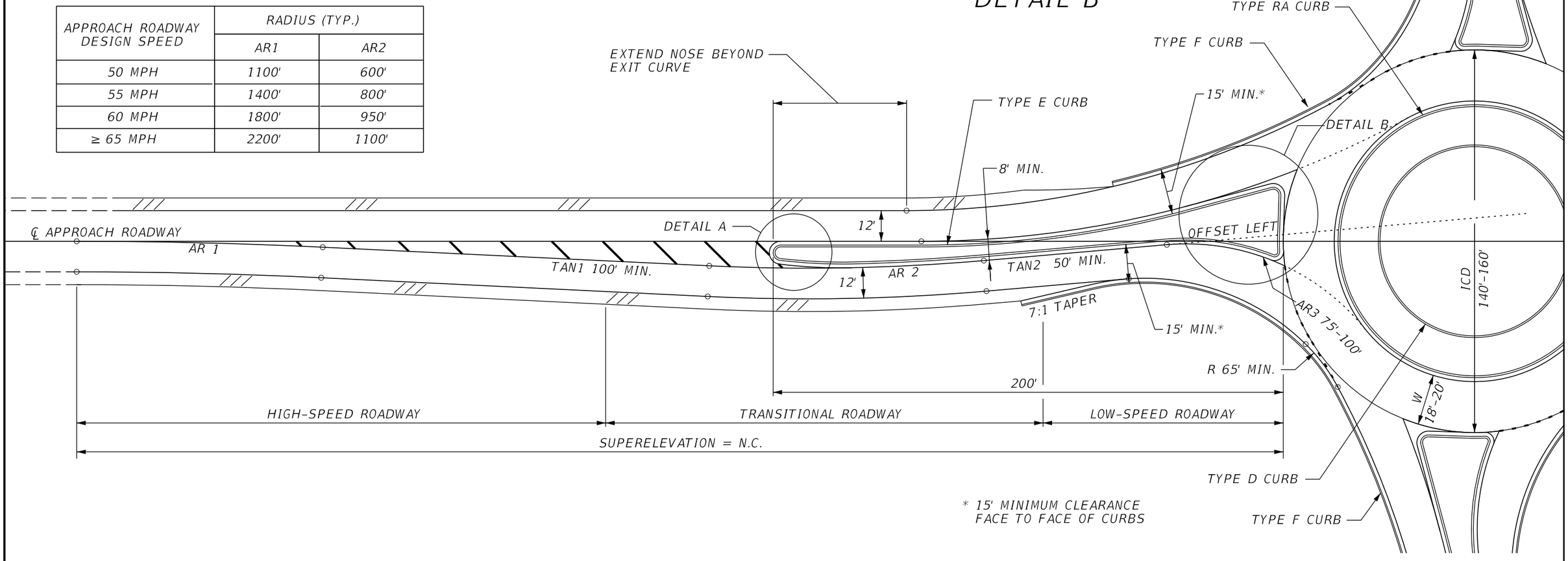


DETAIL A



DETAIL B

APPROACH ROADWAY DESIGN SPEED	RADIUS (TYP.)	
	AR1	AR2
50 MPH	1100'	600'
55 MPH	1400'	800'
60 MPH	1800'	950'
≥ 65 MPH	2200'	1100'



NOT TO SCALE

ROUNDABOUT HIGH SPEED APPROACH DETAILS

EXHIBIT 213-2
01/01/2019

213.3.2 Alignment of Approach Lane

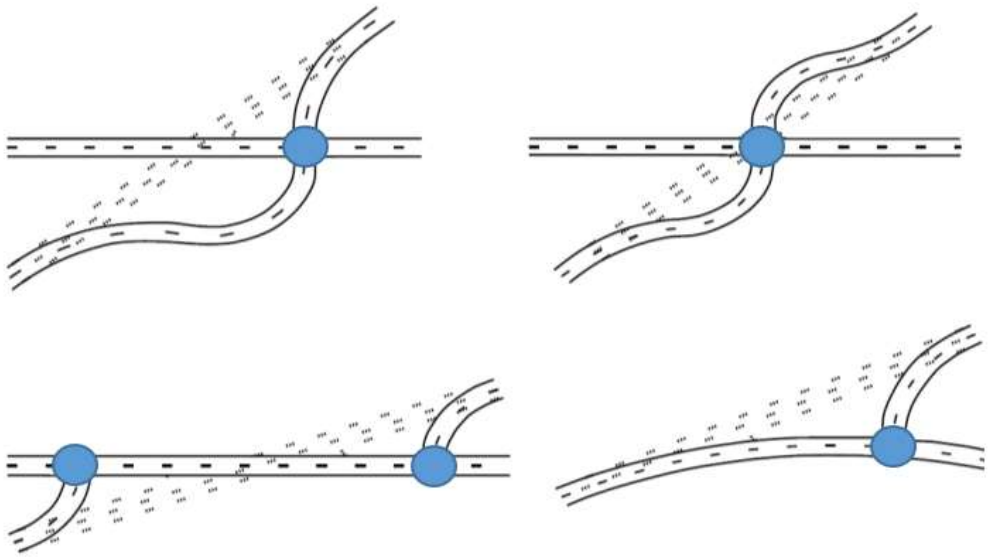
The alignment of the approach affects the amount of deflection (speed control) that is achieved, the ability to accommodate the design vehicle, and the visibility angles to adjacent legs. The optimal alignment is generally governed by the size and position of the roundabout relative to its approaches.

An offset left alignment is typically preferred as it increases the deflection achieved at the entry to improve speed control and is easier to remove path overlap for multilane entries.

213.3.3 Angle Between Approach Legs

The intersection angle between two roadways has a significant influence on the geometrics and operation of a roundabout. Intersection angles are to be as close to 90 degrees as practical. Consider realigning the approach legs of minor roads when the intersection angle is greater than 75 degrees; ***Figure 213.3.1*** illustrates realignment configurations.

Figure 213.3.1 Realignment Configurations



213.3.4 Roadway Profiles

The profile grade of the roadways carried through the influence area of the intersection should be as flat as practical to allow the circulatory roadway pavement to slope to the outside. See ***FDM 213.3.7*** for cross slope requirements.

213.3.5 Splitter Islands

Splitter islands generally extend upstream of the yield line to the point at which entering drivers are expected to begin decelerating comfortably. ***Exhibit 213-1*** provides details for splitter islands. Splitter islands are to use Type E curb or Type I traffic separator.

Minimum width for the raised splitter island at crosswalks is 6-foot (between curb faces). The minimum crosswalk width in the splitter island is 10-feet. Locate the crosswalk approximately 20-feet upstream from the yield line.

Minimum length of the splitter island is based on the design speed of the approach leg, as follows;

- 50-foot for design speed 35 mph or less; 100-foot desirable
- 100-foot for design speed 45 mph or less
- 200-foot for design speed 50 mph or greater

Extend the splitter island beyond the PT of the exit curve to discourage exiting traffic from crossing into the path of approaching traffic.

213.3.6 Roadway Width

The width of the roadway at locations with curb on both sides needs to accommodate the design vehicle and be a minimum 15-feet face to face.

213.3.7 Circulatory Roadway

The width of the circulatory roadway is determined from the number of entry lanes and the turning requirements of the design vehicle. Provide only the minimum width necessary to serve the required lane configuration. Typically accommodate a bus without use of the truck apron.

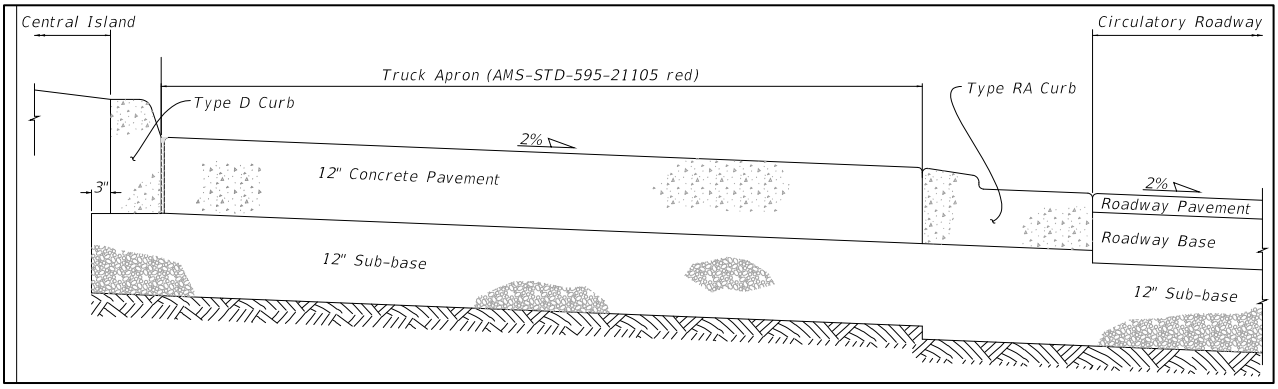
Circulatory roadway lane widths of multilane roundabout do not need to be consistent and typically range from 12-feet to 18-feet. The outside lane is typically larger to provide additional space for the design vehicle and reduce entry and exit path overlap.

Slope the circulatory roadway away from the central island at 2%, 1% minimum.

213.3.8 Truck Apron

Use the standard truck apron design illustrated in ***Figure 213.3.2***. Indicate in the plans that the roundabout truck apron is to be red in color that closely matches AMS-STD-595-21105 red.

Figure 213.3.2 Standard Truck Apron Design



213.4 Path Overlap

The natural path of a vehicle is the path it will take based on the speed and orientation imposed by the roundabout geometry. Path overlap occurs when the natural paths of vehicles in adjacent lanes overlap or cross one another; i.e., geometry leads vehicles into the wrong lane. It occurs at entries where the geometry of the right-hand lane tends to lead vehicles into the left-hand circulatory lane. Aligning the approach lanes with the receiving lanes in the circulatory roadway helps drivers maintain their natural trajectory upon entry and significantly reduces potential for path overlap.

Path overlap can also occur at exits where the geometry or pavement marking tends to lead vehicles from the left-hand circulatory lane into the right-hand exit lane. Flattening the exit radius helps drivers maintain their natural trajectory upon existing and significantly reduces potential for path overlap. The potential for increased speeds associated with a flatter exit radius should be taken into consideration.

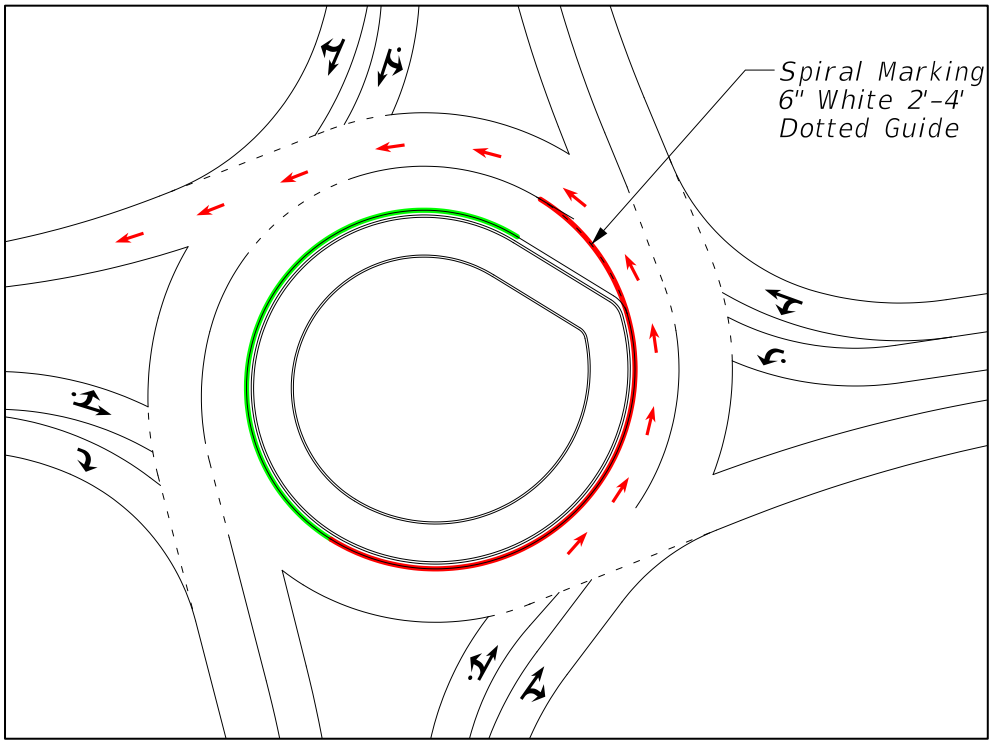
213.5 Spiral Transitions

A spiral transition is used to guide drivers into the appropriate lane for their desired exit. Drivers that enter the roundabout on the inside lane are pushed to the outside lane within the circulatory roadway to exit; avoiding potential lane changing within the circulatory roadway. Inclusion of left turn only lanes and transition spirals complicate the design and should only be provided if warranted through traffic operational analysis.

Figure 213.5.1 illustrates the inclusion of a spiral transition with a lane configuration that includes two circulatory lanes and a single exit lane. The spiral geometry is developed by connecting two semi-circles with different diameters as indicated by the green and red arcs. The smaller diameter (green) represents the inside edge of travel lane adjacent to the truck apron and the larger diameter (red) is equal to smaller diameter plus the width of the inside travel lane. The spiral transition allows for the left turning movement as indicated by the red arrows. Also shown in the figure is the required spiral transition pavement marking.

The central island should be developed (shaped) using curb to enforce the spiral geometry. Use of striping to create the spiral geometry should be avoided.

Figure 213.5.1 Spiral Transition

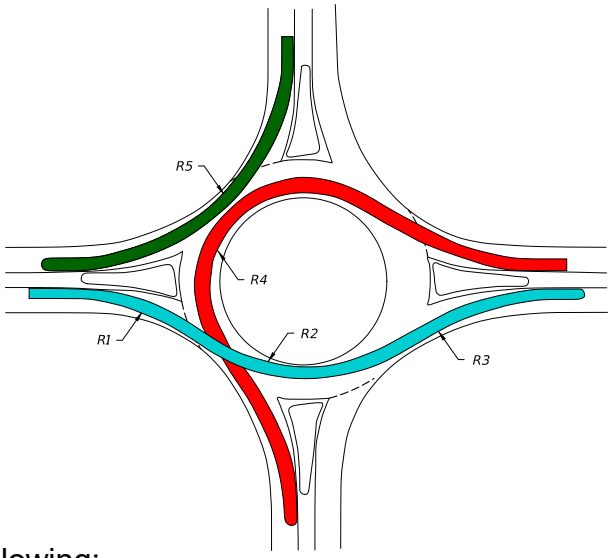


213.6 Fastest Path

Controlling speeds for vehicles entering and traveling through roundabouts is a critical design objective that significantly impacts the safety and comfort of all users. A well-designed roundabout reduces vehicle speeds upon entry and encourages consistency in the relative speeds between conflicting traffic streams. The effectiveness of speed control within a roundabout can be determined by conducting a fastest path performance check.

The fastest path is defined as the radius (R1, R2, R3, R4 and R5) that provides the smoothest and flattest path possible for a single vehicle (assumed 6 feet wide) traversing the roundabout. The fastest path does not consider lane markings when determining the vehicles path; i.e., drivers will run over striping and use all available pavement. Fastest path movements are as follows:

- R1 – Entry Radius
- R2 – Circulating Radius
- R3 – Exit Radius
- R4 – Left Turn Radius
- R5 – Right Turn Radius



Fastest path speeds must adhere to the following;

- R1 and R5 entry speeds are not to exceed 25 mph for single-lane entries and 30 mph for multi-lane entries.
- R2 and R4 circulating speeds should be no more than 15 mph less than the entry speed.
- R3 exit speeds requires engineering judgement to balance the competing objectives of accommodating the design vehicle and providing a safe environment for pedestrians using the crosswalk.

The fastest path for the through movement (R1, R2, and R3) is illustrated in ***Figure 213.6.1***. The fastest path for the right turn movement (R5) is illustrated in ***Figure 213.6.2***. Centerline of vehicle path is drawn with a 5-foot offset from face of curb, or a 3-foot offset from the painted edge line

Figure 213.6.1 Fastest Path for Through Movement

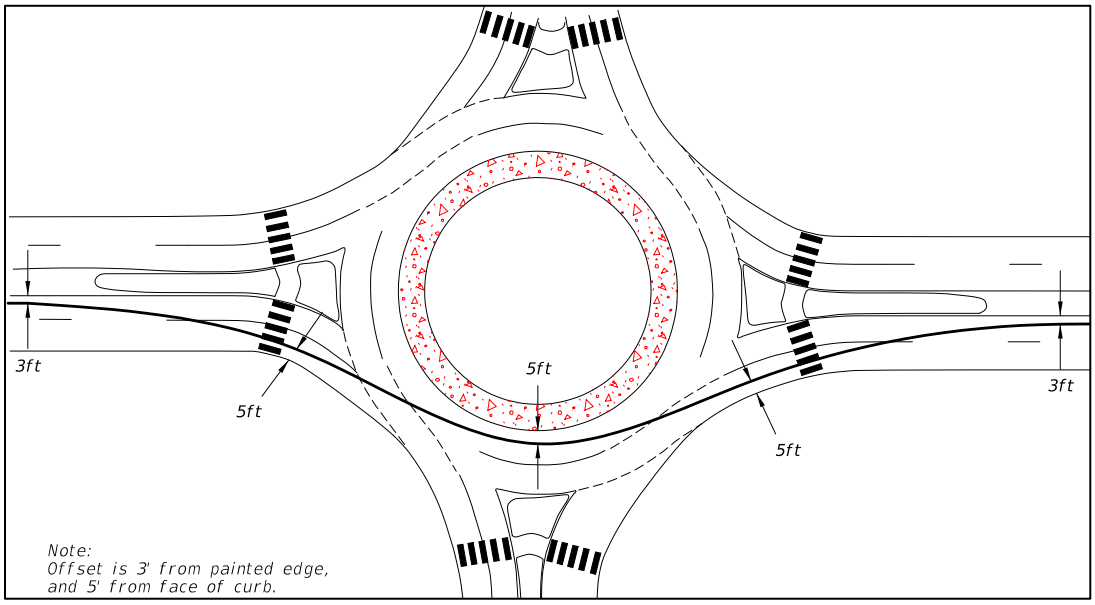
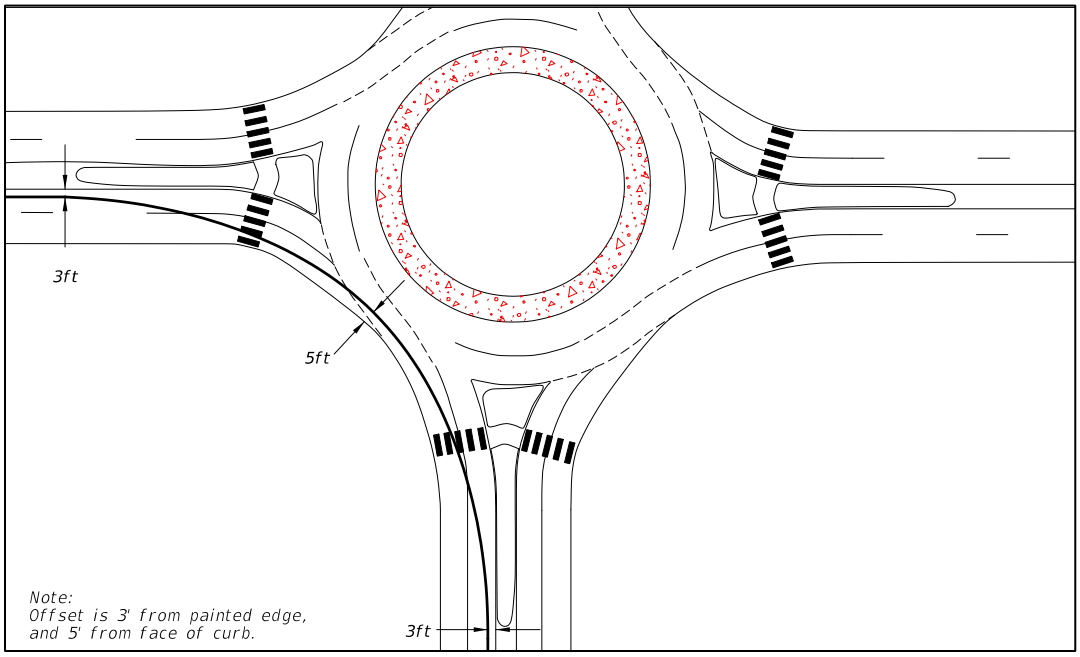


Figure 213.6.2 Fastest Path for Right Turn Movement



213.6.1 Fastest Path Methodology

A CADD-based procedure for conducting fastest path analysis has been adopted by the Department and can be downloaded from the ***FDM*** web page. For consistency, this step-by-step procedure should be followed when determining R1, R2, R3, R4, and R5.

Calculated speeds for R1, R3 and R5 are based on NCHRP 672 equation 6-1 with a pavement slope of +2%.

Calculated speeds for R2 and R4 are based on NCHRP 672 equation 6-2 with a pavement slope of -2%.

A spread sheet has been developed to assist with these calculations and can be downloaded from the ***FDM*** web page.

213.7 Design Vehicle Accommodation (Swept Path)

Roundabouts typically accommodate a WB-62FL design vehicle for the through movements on the SHS. A smaller design vehicle may be appropriate for turning movements connecting off-system roads. See ***FDM 201.5*** for additional information on design vehicle.

Swept path diagrams assure that there is adequate pavement to accommodate the maneuvers of the design vehicle through the roundabout without over-tracking the curb. AUTOTURN is a CADD-based vehicle turning path program that is often used to determine the swept path of the design vehicle.

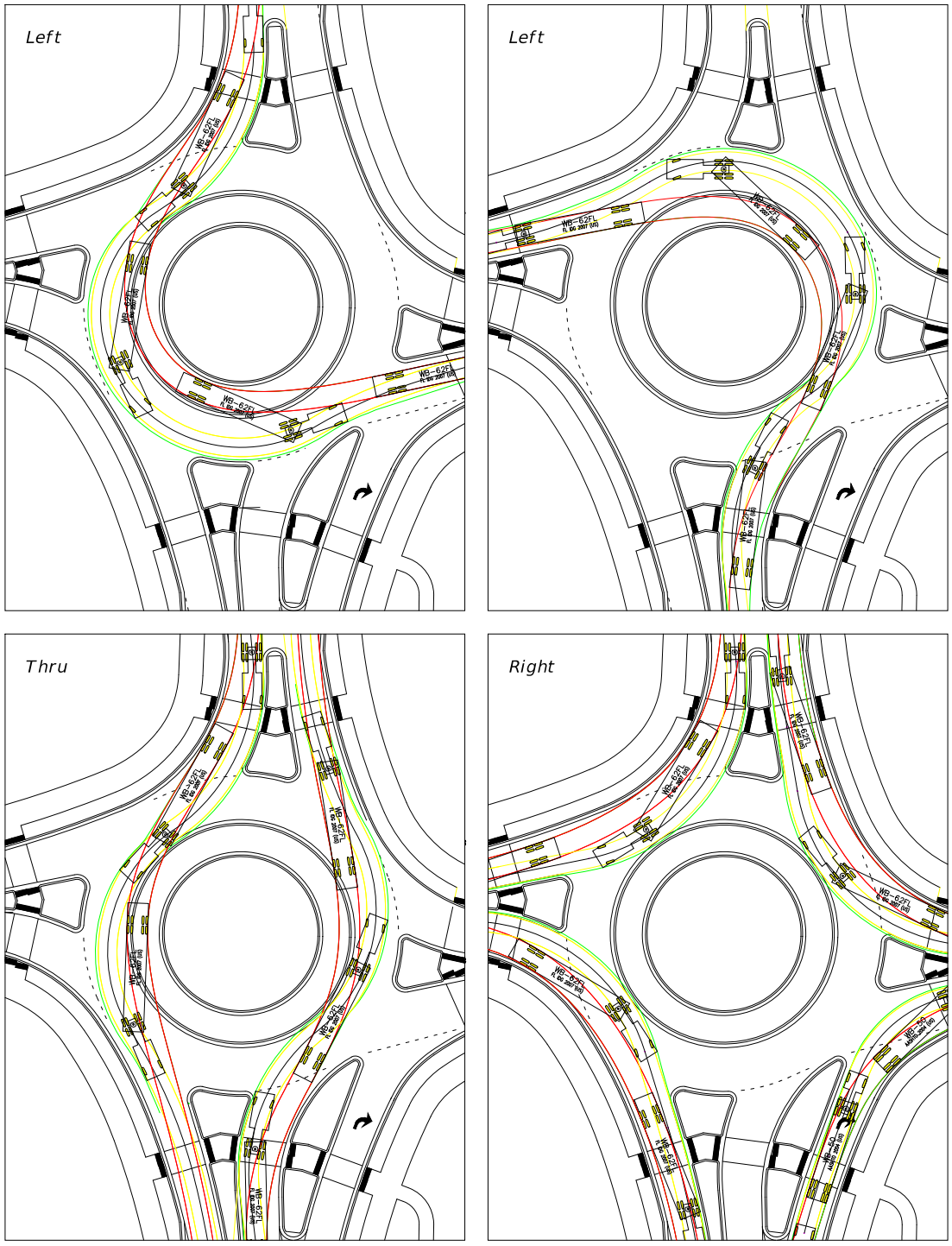
Provide swept path diagrams for the design vehicle for all turning movements. Develop travel paths using continuous smooth spline curve alignments representative of travel paths experienced in the field.

Provide a minimum 1.5-foot offset from the face of curb to the design vehicle's tire track.

213.7.1 Single-Lane Roundabout

The swept path design vehicle is required to stay within the travel lane and is prohibited from encroaching onto the splitter island, central island, or outside gutter pans. The truck trailer is permitted to mount the RA curb and use the truck apron. ***Figure 213.7.1*** illustrates a WB-62FL design vehicle swept paths for a single-lane roundabout.

Figure 213.7.1 WB-62FL Swept Paths: Single Lane Roundabout



213.7.2 Two-lane Roundabout

Provide adequate pavement area for the simultaneous passage of the design vehicle and a passenger vehicle through the roundabout and for turning movements. The design vehicle must stay within the travel lanes without encroaching onto the inside or outside gutters. The truck trailer is permitted to mount the RA curb and use the truck apron. Develop swept path diagrams for all turning movements in the following combinations:

- Design vehicle in the outside lane and passenger vehicle in the inside lane
- Design vehicle in the inside lane and passenger vehicle in the outside lane

It is acceptable for the design vehicle path to encroach into the adjacent travel lane within the circulatory roadway when there is sufficient space for the passenger vehicle plus two feet of clearance between the two vehicles.

Use a painted gore when providing in lane truck accommodates on multilane entries. Typical lane widths range from 11 to 12-feet with a 4 to 6-foot painted gore.

When truck volume is very low, consider allowing the truck-trailer to command both lanes to complete the maneuver.

213.7.3 Exit Radius

An exit radius of 300 to 400 feet should be provided to create a smoother vehicular path and better truck accommodation. Use engineering judgement to balance the competing objectives of accommodating the design vehicle and providing a safe environment for pedestrians. Provide flat exit geometry when no pedestrian facilities are present.

213.8 Bicycle and Pedestrian Accommodation

Exhibit 213-1 provides standard details for pedestrian and bicycle facilities.

213.8.1 Pedestrian Facilities

When there are existing or planned pedestrian facilities on the approach roadways, the following requirements apply:

(1) Provide sidewalk widths in accordance with ***FDM 222,*** or consistent with approach sidewalk widths. When bicycle ramps are provided, the desired sidewalk width is 10 feet, but not be less than 8 feet.

(2) A 5 foot set-back from back of curb to sidewalk is desired; typically not less than 2 feet.

(3) Provide crosswalks at every approach leg.

(a) Provide curb ramps and detectable warning surfaces consistent with ***FDM 222*** and ***Standard Plans, Index 522-002***.

(b) Orient crosswalks perpendicular to the roadway to minimize pedestrian crossing distance.

(c) At each crosswalk location provide a minimum 6-foot wide and 10-foot long pedestrian refuge area within the splitter island. Locate the pedestrian refuge area approximately 20 feet from the outside edge of the circulatory roadway.

(d) Provide pedestrian crosswalk lighting in accordance with ***FDM 231***.

213.8.2 Bicycle Facilities

Do not carry bicycle lanes through the roundabout.

Inclusion of bicycle ramps is required for multi-lane roundabouts and is optional for single-lane roundabouts. Terminate bicycle lanes or shoulders as illustrated in ***Exhibit 213-1***.

Figure 213.8.1 illustrates the geometrics for a bicycle ramp when a utility strip of at least 3-feet is present. The desired angle between the ramp and the roadway ranges from 20 to 25 degrees; however, angle is not to exceed 35 degrees.

Figure 213.8.2 illustrates the geometrics for a bicycle ramp when sidewalk on the approach leg is adjacent to, or very near the back of curb.

Place directional indicator at the top of the bicycle ramp to provide a tactile cue for visually impaired pedestrians to continue down the sidewalk. Do not place detectable warning surfaces on the bicycle ramp.

Figure 213.8.1 Angled Bicycle Ramp

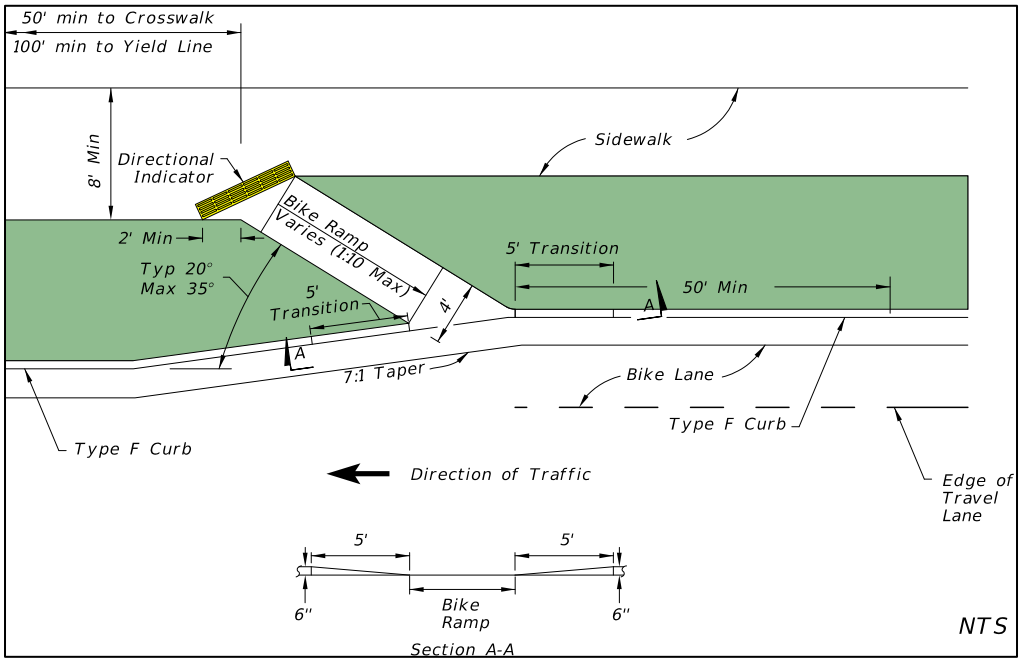
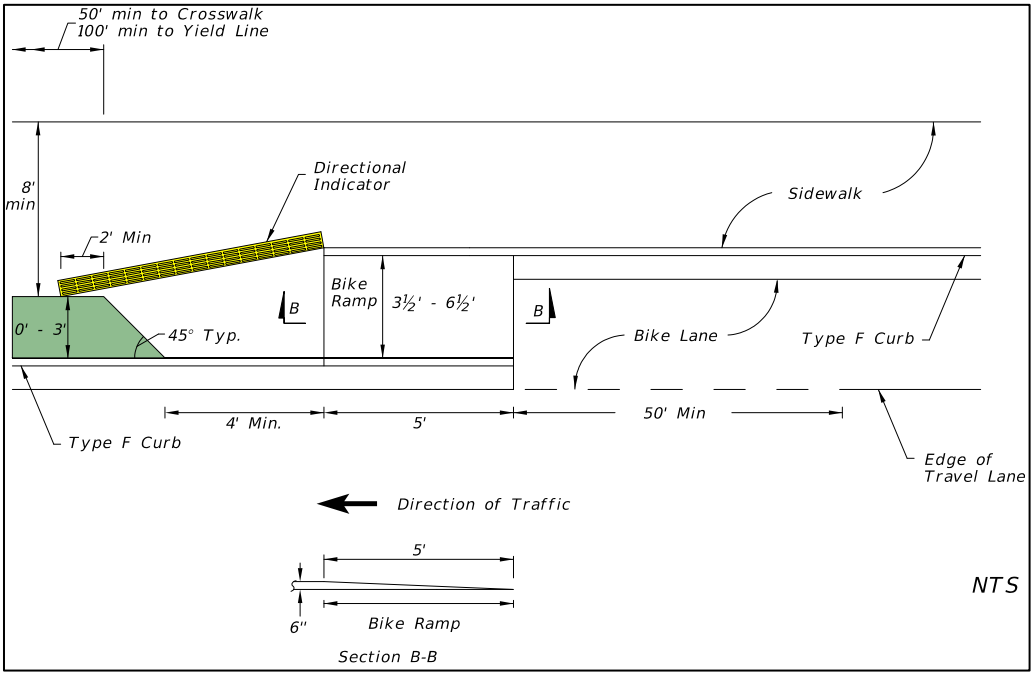


Figure 213.8.2 Straight Bicycle Ramp



213.9 Landscaping

Create a mounded central island that slopes upward from the truck apron using a slope no flatter than 1:10 and no steeper than 1:6. Provide varying height trees and plants in the central island to enhance driver recognition of the roundabout upon approach. On large roundabout center islands, varying heights, and uneven slopes can increase visual awareness of the roundabout and enhance aesthetics.

Provide quality space above and below ground for trees and other desirable vegetation to grow. Do not construct roundabout center islands on existing road pavement and base. Assure that the soil conditions will support the health and growth of selected trees and plants. Place trees and palms near the center of the central island, and not less than 6 feet from the face of Type D curb. Place shrubs in a simple arrangement to help increase visual awareness of the roundabout.

Coordinate the landscape design in the early stages of plans development to assure that landscaping will be fully integrated into the roundabout design.

Additional information regarding roundabout landscaping is in Chapter 9 of ***NCHRP 672***.

213.9.1 Plant Selection

Select a diverse, low maintenance mix of ***Florida Friendly*** plant species. Select trees 6-foot in height or taller when installed; palm trees 12-foot or taller. The use of native tree species is encouraged. Select shrubs that will recover or regenerate naturally after mechanical damage. Select trees and plants with a variety of height, color, form, and texture. Select trees that will continue to grow in value, after establishment, without routine irrigation.

Plants placed in splitter islands must not exceed 18-inches in height, at full maturity; i.e., do not encroach on sight distance requirements.

If more decorative plantings are requested by local agency or groups, a maintenance agreement should be obtained.

213.10 Signing and Pavement Markings

Well-designed signing and pavement markings will enhance safety and traffic operations by clarifying the rules of the road and proper lane assignments to drivers as they navigate through the roundabout.

Follow the details presented in ***Exhibits 213-3, 213-4,*** and ***213-5*** when developing roundabout signing and pavement marking plans to promote consistency throughout the state.

Use the standard left-turn arrow with a circular dot on the left-most lane of the approach to multi-lane roundabouts as shown in ***Standard Plans, Index 711-001***. Use standard arrows within the circulatory roadway.

R6-4a (A)

R3-8 (B)

R3-17 BIKE LANE / R3-17bP ENDS (C)

W2-6 / 25 MPH W13-1P (D)

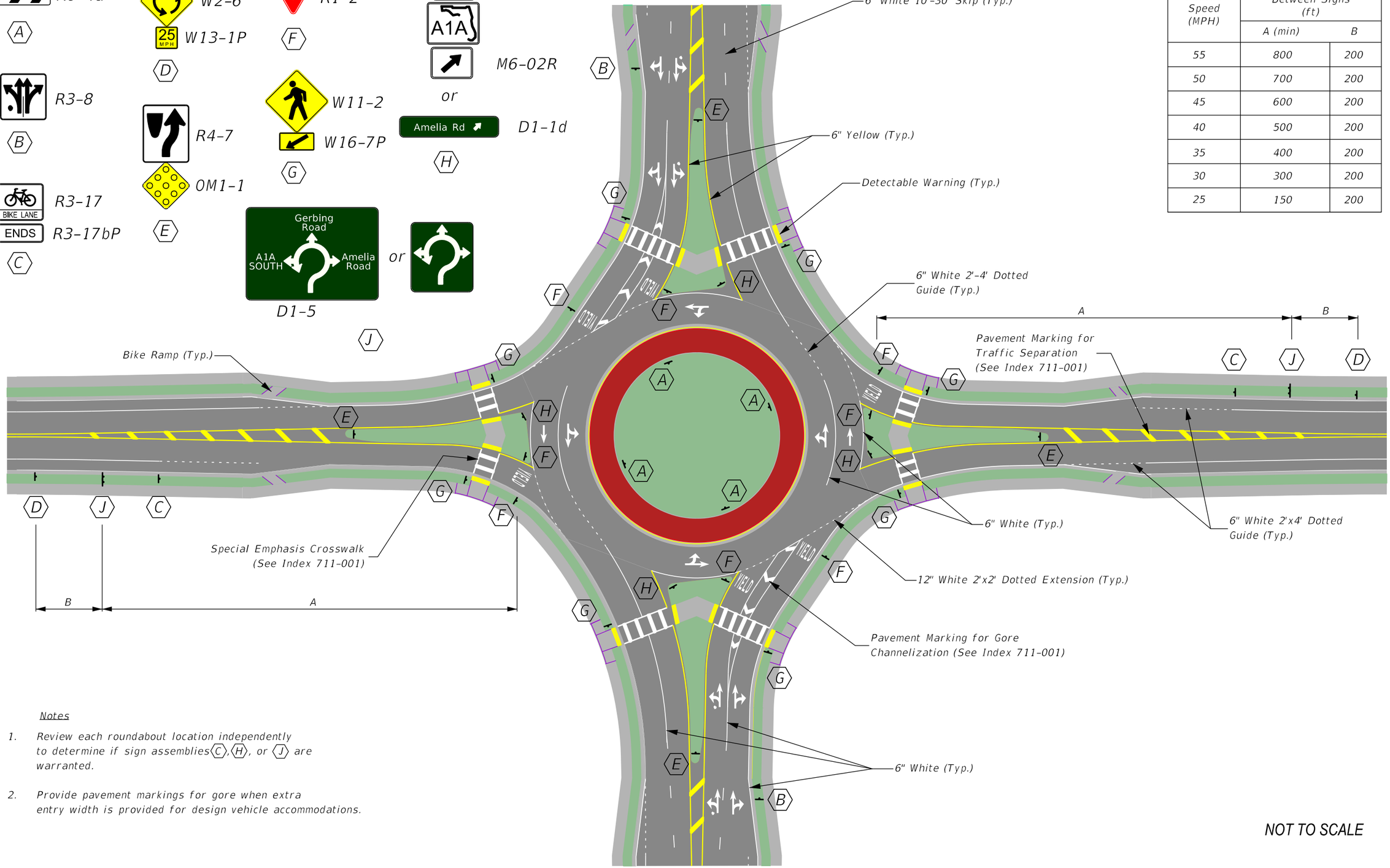
R4-7 / OM1-1 (E)

R1-2 (F)

W11-2 / W16-7P (G)

SOUTH / A1A / M6-02R or Amelia Rd D1-1d (H)

Gerbing Road / A1A SOUTH / Amelia Road D1-5 or (J)



Typical Sign Location

Posted Speed (MPH)	Distance Between Signs (ft)	
	A (min)	B
55	800	200
50	700	200
45	600	200
40	500	200
35	400	200
30	300	200
25	150	200

Notes

1. Review each roundabout location independently to determine if sign assemblies (C), (H), or (J) are warranted.
2. Provide pavement markings for gore when extra entry width is provided for design vehicle accommodations.

NOT TO SCALE

1x2 ROUNDABOUT SIGNING AND PAVEMENT MARKINGS

EXHIBIT 213-3
01/01/2019

R6-4

A

R4-7

OM1-1

E

R3-17

BIKE LANE

ENDS

R3-17bP

C

W11-2

W16-7P

G

Gerbing Road

A1A SOUTH

Amelia Road

D1-5

or

J

R1-2

F

W2-6

25 MPH

W13-1P

D

SOUTH

A1A

M3-03

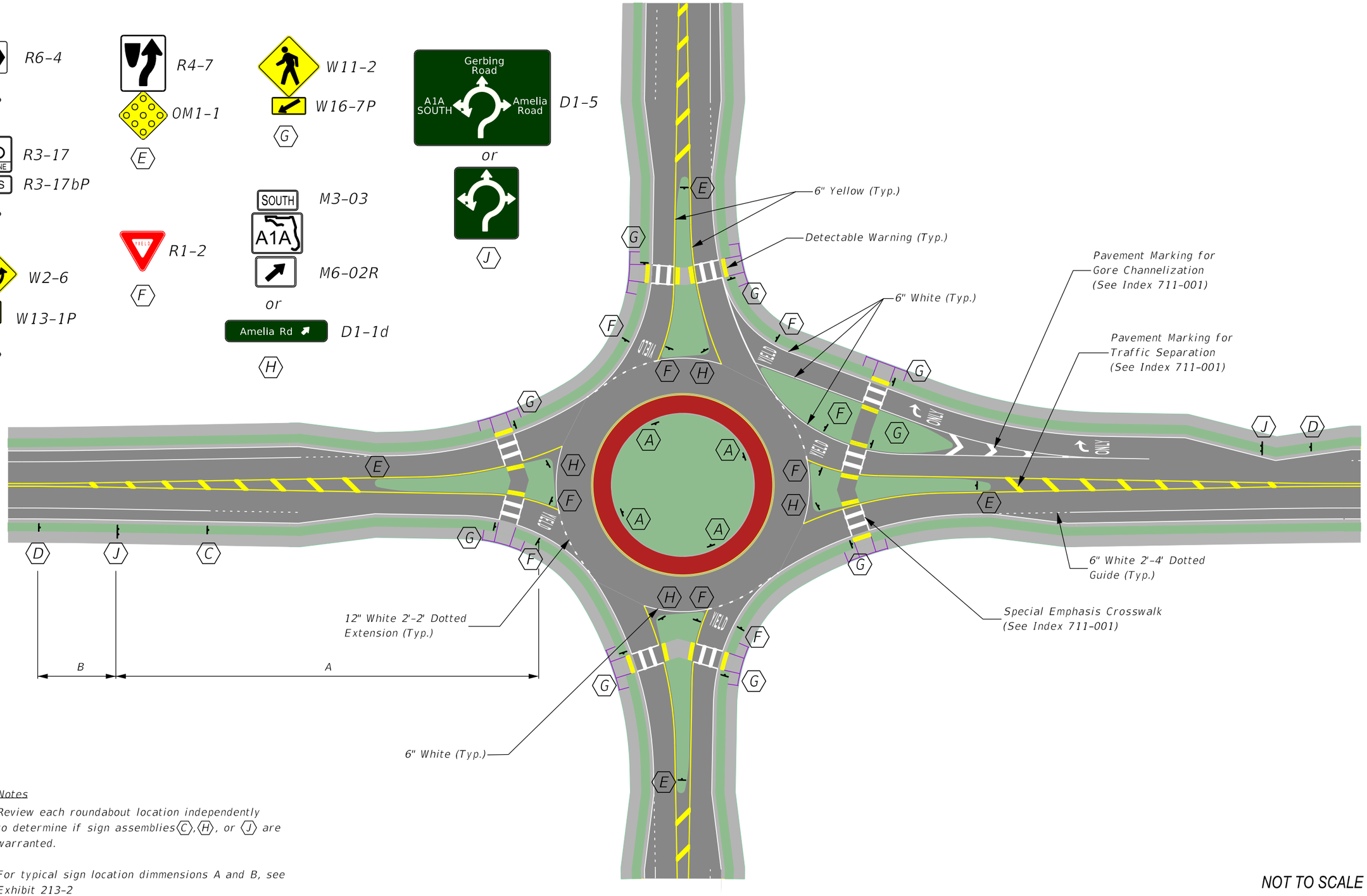
M6-02R

or

Amelia Rd

D1-1d

H



Notes

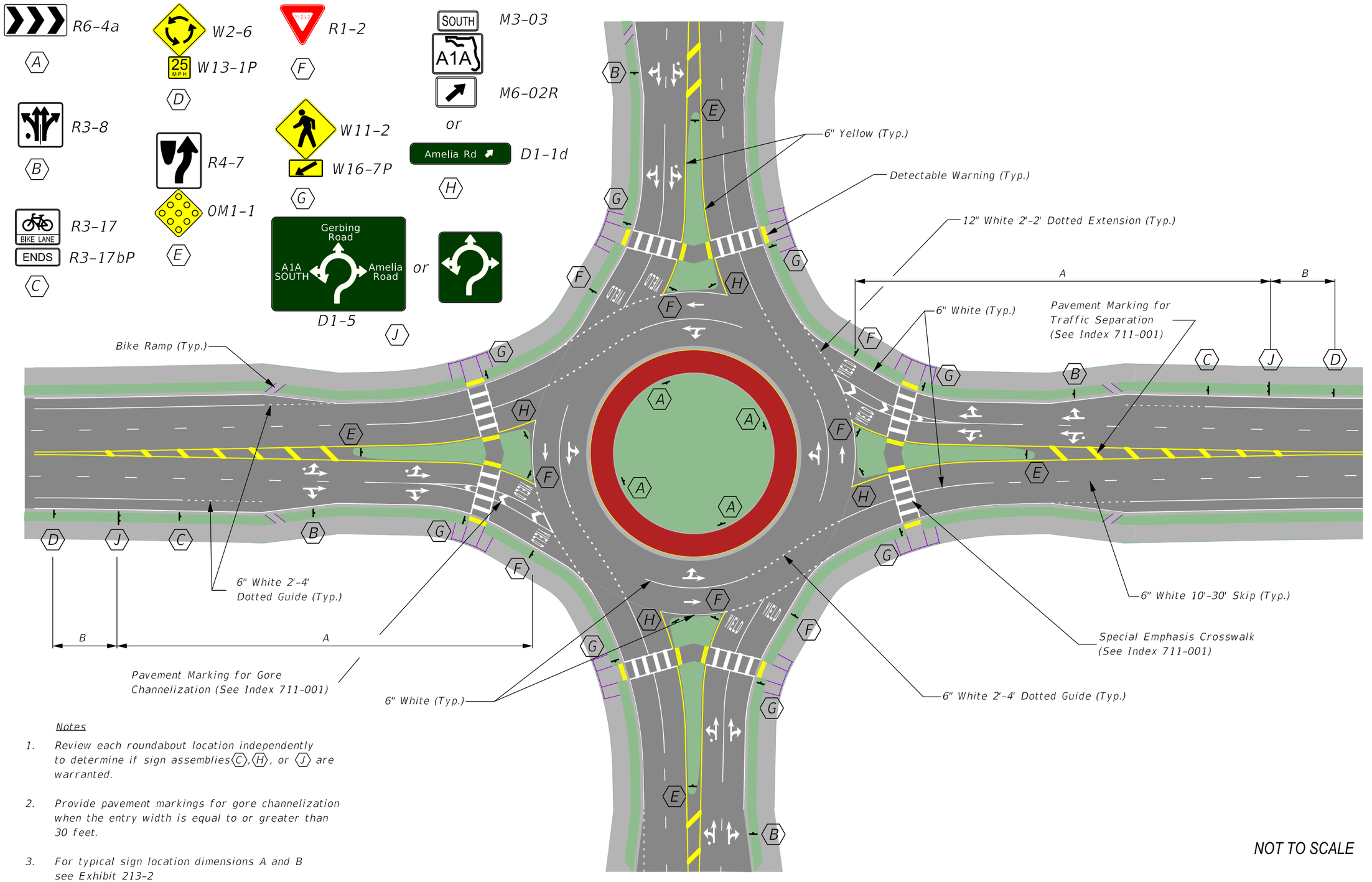
1. Review each roundabout location independently to determine if sign assemblies (C), (H), or (J) are warranted.

2. For typical sign location dimmensions A and B, see Exhibit 213-2

NOT TO SCALE

1X1 ROUNDABOUT WITH BYPASS LANE
TYPICAL SIGNING AND PAVEMENT MARKINGS

EXHIBIT 213-4
01/01/2019



Notes

1. Review each roundabout location independently to determine if sign assemblies (C), (H), or (J) are warranted.

2. Provide pavement markings for gore channelization when the entry width is equal to or greater than 30 feet.

3. For typical sign location dimensions A and B see Exhibit 213-2

NOT TO SCALE

2X2 ROUNDABOUT SIGNING AND PAVEMENT MARKINGS

EXHIBIT 213-5
01/01/2019

213.11 Lighting

Nighttime illumination of roundabouts is required. Provide a minimum 1.5 foot-candles on the roadway surface within the circulatory roadway and at least 200 feet in advance of the splitter islands.

See ***FDM 231.3.3*** for additional lighting requirements when pedestrian facilities are provided.

213.12 Community Aesthetic Features

Communities commonly desire to place public art or other large aesthetic objects within the central island; e.g., statues, monuments, gateway features. These types of features are acceptable provided that:

- Objects are located outside the required sight triangles,
- Not less than 6 feet from the inside edge of the truck apron, and
- Approval is granted through the process outlined in ***FDM 127***.

Fountains, or other water spraying features are not permitted.