
Roundabout Traffic Design and Landscaping

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Credit: 3 PDH

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Traffic Design and Landscaping

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Chapter 7 **Traffic Design and Landscaping**

This chapter presents guidelines on the design of traffic elements, illumination, and landscaping associated with roundabouts. The design of these elements is critical in achieving the desired operational and safety features of a roundabout, as well as the desired visibility and aesthetics. This chapter is divided into the following sections:

- Signing;
- Pavement Markings;
- Illumination;
- Work Zone Traffic Control; and
- Landscaping.

Signing, striping, illumination, and landscaping are the critical finishing touches for an effectively functioning roundabout.

7.1 Signing

The overall concept for roundabout signing is similar to general intersection signing. Proper regulatory control, advance warning, and directional guidance are required to avoid driver expectancy related problems. Signs should be located where they have maximum visibility for road users but a minimal likelihood of even momentarily obscuring pedestrians as well as motorcyclists and bicyclists, who are the most vulnerable of all roundabout users. Signing needs are different for urban and rural applications and for different categories of roundabouts.

7.1.1 Relationship with the *Manual on Uniform Traffic Control Devices*

The *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) (1) and *Standard Highway Signs* (2), as well as local applicable standards, govern the design and placement of signs. To the extent possible, this guide has been prepared in accordance with the 1988 edition of the MUTCD. However, roundabouts present a number of new signing issues that are not addressed in the 1988 edition. For this reason, a number of new signs or uses for existing signs have been introduced that are under consideration for inclusion in the next edition of the MUTCD. Until such signs or uses are formally adopted, these recommendations should be considered provisional and are subject to MUTCD Section 1A-6, "Manual Changes, Interpretations and Authority to Experiment."

The following signs and applications recommended below are subject to these conditions:

- Use of YIELD signs on more than one approach to an intersection (Section 7.1.2.1);
- Long chevron plate (Section 7.1.2.2);
- Roundabout Ahead sign (Section 7.1.3.1);
- Advance diagrammatic guide signs (Section 7.1.4.1); and
- Exit guide signs (Section 7.1.4.2).

7.1.2 Regulatory signs

A number of regulatory signs are appropriate for roundabouts and are described below.

7.1.2.1 YIELD sign

YIELD signs are required on all approaches.

A YIELD sign (R1-2), shown in Exhibit 7-1, is required at the entrance to the roundabout. For single-lane approaches, one YIELD sign placed on the right side is sufficient, although a second YIELD sign mounted in the splitter island on the left side of the approach may be used. For approaches with more than one lane, the designer should place YIELD signs on both the left and right sides of the approach. This practice is consistent with the recommendations of the MUTCD on the location of STOP and YIELD signs on single-lane and multilane approaches (MUTCD, §2B-9). To prevent circulating vehicles from yielding unnecessarily, the face of the yield sign should not be visible from the circulatory roadway. YIELD signs may also be used at the entrance to crosswalks on both the entry and exit legs of an approach. However, the designer should not use both YIELD signs and Pedestrian Crossing signs (see Section 7.1.3.5) to mark a pedestrian crossing, as the yield signs at the roundabout entrance may be obscured.

Exhibit 7-1. YIELD sign (R1-2).



7.1.2.2 ONE WAY sign

ONE WAY signs establish the direction of traffic flow within the roundabout.

ONE WAY signs (R6-1R) may be used in the central island opposite the entrances. An example is shown in Exhibit 7-2. The ONE WAY sign may be supplemented with chevron signs to emphasize the direction of travel within the circulatory roadway (see Section 7.1.3.4).

At roundabouts with one-way streets on one or more approaches, the use of a regulatory ONE WAY sign may be confusing. In these cases, a Large Arrow warning sign (see Section 7.1.3.3) may be used.

Exhibit 7-2. ONE WAY sign (R6-1R).



7.1.2.3 KEEP RIGHT sign

KEEP RIGHT signs (R4-7 or text variations R4-7a and R4-7b) should be used at the nose of all nonmountable splitter islands. This sign is shown in Exhibit 7-3.

For small splitter islands, a Type 1 object marker may be substituted for the KEEP RIGHT sign. This may reduce sign clutter and improve the visibility of the YIELD sign.

Exhibit 7-3. KEEP RIGHT sign (R4-7).



7.1.2.4 Lane-use control signs

For roundabouts with multiple entry lanes, it can often be confusing for unfamiliar drivers to know which lanes to use for the various left, through, and right movements. There is no international consensus on the effectiveness of lane-use signs and/or pavement markings.

Lane-use control signs are generally not recommended.

The designation of lanes on entry to a roundabout is directly related to a number of factors:

- *Traffic volume balance.* Roundabouts with especially heavy left- or right-turning traffic may require more than one lane to handle the expected demand (see Chapter 4).
- *Exit lane requirements.* In general, the number of exit lanes provided should be the minimum required to handle the expected exit volume. This may not correspond with the number of entry lanes on the opposite side of the roundabout that would use the exit as through vehicles (see Chapter 4).
- *The rules of the road.* Drivers have a reasonable expectation that multiple through lanes entering a roundabout will have an equal number of receiving lanes on exit on the far side of the roundabout (see Chapter 2).

Lane-use control signs are generally not required where the number of receiving lanes for through vehicles on exit matches the number of entry lanes, as shown in Exhibit 7-4. Lane-use control signs should be used only for the following conditions:

- Where only a single exit lane is provided to receive two lanes of vehicles making through movements, lane-use designations should be made to indicate that an entry lane drops as a turning movement (see Exhibit 7-4). This does not include cases where an approach is flared from one to two lanes at the roundabout.
- Where left- or right-turning traffic demand dictates the need for more than one left-turn lane or more than one right-turn lane for capacity reasons (see Exhibit 7-5).

The use of a left-turn-only lane designation as shown in the exhibits may be initially confusing to drivers. This type of designation has worked successfully in other countries, and there is no evidence to suggest that it will not work in the United States. However, given the general unfamiliarity of roundabouts to drivers in the United States at this time, it is recommended that double-lane roundabouts be designed to avoid the use of lane-use control signs wherever possible, at least until drivers become more accustomed to driving roundabouts.

Exhibit 7-4. Lane-use control signing for roundabouts with double-lane entries.

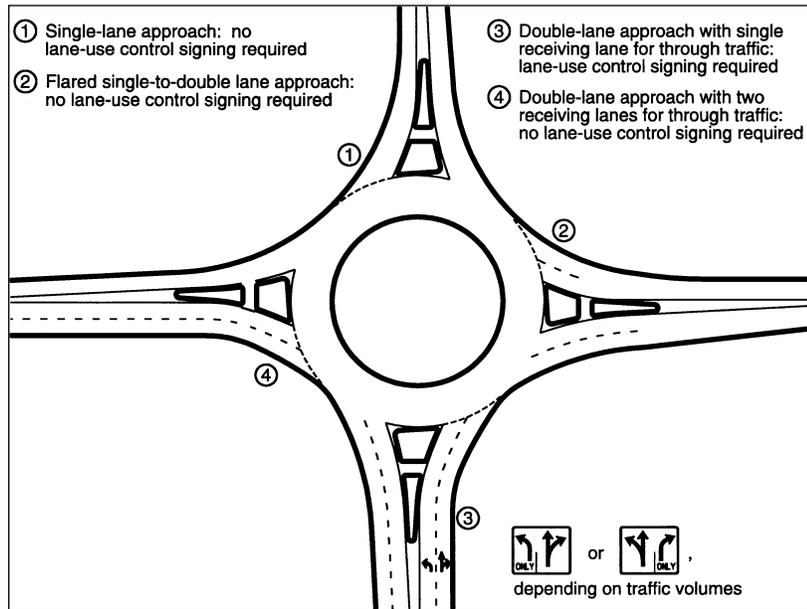
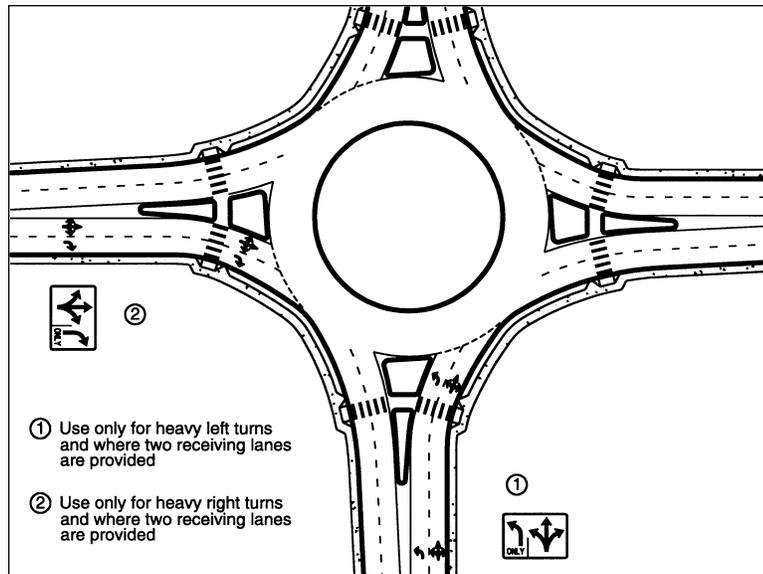


Exhibit 7-5. Lane-use control signing for roundabouts with heavy turning traffic.



7.1.3 Warning signs

A number of warning signs are appropriate for roundabouts and are described below. The amount of warning a motorist needs is related to the intersection setting and the vehicular speeds on approach roadways. The specific placement of warning signs is governed by the applicable sections of the MUTCD.

7.1.3.1 Circular Intersection sign

A Circular Intersection sign (W2-6) may be installed on each approach in advance of the roundabout. This sign, given in Exhibit 7-6, is proposed as part of the next edition of the MUTCD. When used, it is recommended that this sign be modified to reflect the number and alignment of approaches.



Exhibit 7-6. Circular Intersection sign (W2-6).

It is also recommended that an advisory speed plate (W13-1) be used with this sign, as shown in Exhibit 7-7. The speed given on the advisory speed plate should be no higher than the design speed of the circulatory roadway, as determined in Chapter 6.



Exhibit 7-7. Advisory speed plate (W13-1).

An alternative to the Circular Intersection sign, called a Roundabout Ahead sign, has been proposed and is shown in Exhibit 7-8. The rationale for this sign is given in Appendix C. At a minimum it is recommended that the Roundabout Ahead sign be used in place of the Circular Intersection sign at mini-roundabouts (see Section 7.1.7).



Exhibit 7-8. Roundabout Ahead sign.

7.1.3.2 YIELD AHEAD sign

A YIELD AHEAD sign (W3-2 or W3-2a) should be used on all approaches to a roundabout in advance of the yield sign. These signs provide drivers with advance warning that a YIELD sign is approaching. The preferred symbolic form of this sign is shown in Exhibit 7-9.

YIELD AHEAD signs warn drivers of the upcoming YIELD sign.



Exhibit 7-9. YIELD AHEAD sign (W3-2a).

71.3.3 Large Arrow sign

A Large Arrow sign with a single arrow pointing to the right (W1-6) should be used in the central island opposite the entrances, unless a regulatory ONE-WAY sign has been used. The Large Arrow sign is shown in Exhibit 7-10.

Exhibit 7-10. Large Arrow sign (W1-6).



71.3.4 Chevron Plate

Chevron plates can be especially useful for nighttime visibility for sites without illumination.

The Large Arrow may be supplemented or replaced by a long chevron board (W1-8a), as proposed in the next edition of the MUTCD) to emphasize the direction of travel within the circulatory roadway.

Exhibit 7-11. Chevron plate (W1-8a).



71.3.5 Pedestrian Crossing

Pedestrian Crossing signs (W11-2a) may be used at pedestrian crossings within a roundabout at both entries and exits. Pedestrian Crossing signs should be used at all pedestrian crossings at double-lane entries, double-lane exits, and right-turn bypass lanes. This sign is shown in Exhibit 7-12.

The use of Pedestrian Crossing signs is dependent on the specific laws of the governing state. If the crosswalk at a roundabout is not considered to be part of the intersection and is instead considered a marked midblock crossing, Pedestrian Crossing signs are required. Where installed, Pedestrian Crossing signs should be located in such a way to not obstruct view of the YIELD sign.

Exhibit 7-12. Pedestrian Crossing sign (W11-2a).



7.1.4 Guide signs

Guide signs are important in providing drivers with proper navigational information. This is especially true at roundabouts where out-of-direction travel may disorient unfamiliar drivers. A number of guide signs are appropriate for roundabouts and are described below.

7.1.4.1 Advance destination guide signs

Advance destination guide signs should be used in all rural locations and in urban/suburban areas where appropriate. The sign should be either a destination sign using text (D1-3) or using diagrams. Examples of both are shown in Exhibit 7-13. Diagrammatic signs are preferred because they reinforce the form and shape of the approaching intersection and make it clear to the driver how they are expected to navigate the intersection. Advance destination guide signs are not necessary at local street roundabouts or in urban settings where the majority of traffic tends to be familiar with the site.

The circular shape in a diagrammatic sign provides an important visual cue to all users of the roundabout.



Leeds, MD



Taneytown, MD



Lothian, MD



Long Beach, CA

Exhibit 7-13. Examples of advance destination guide signs.

Diagrammatic Style (Preferred)

Exit guide signs reduce the potential for disorientation.

7.1.4.2 Exit guide signs

Exit guide signs (D1-1) are recommended to designate the destinations of each exit from the roundabout. These signs are conventional intersection direction signs or directional route marker assemblies and can be placed either on the right-hand side of the roundabout exit or in the splitter island. An example is shown in Exhibit 7-14.

Exhibit 7-14. Exit guide sign (D1-1).



7.1.4.3 Route confirmation signs

For roundabouts involving the intersection of one or more numbered routes, route confirmation assemblies should be installed directly after the roundabout exit. These provide drivers with reassurance that they have selected the correct exit at the roundabout. These assemblies should be located no more than 30 m (100 ft) beyond the intersection in urban areas and 60 m (200 ft) beyond the intersection in rural areas.

7.1.5 Urban signing considerations

The designer needs to balance the need for adequate signing with the tendency to use too many signs.

The amount of signing required at individual locations is largely based on engineering judgment. However, in practice, the designer can usually use fewer and smaller signs in urban settings than in rural settings. This is true because drivers are generally traveling at lower vehicular speeds and have higher levels of familiarity at urban intersections. Therefore, in many urban settings the advance destination guide signs can be eliminated. However, some indication of street names should be included in the form of exit guide signs or standard street name signs. Another consideration in urban settings is the use of minimum amounts of signing to avoid sign clutter. A sample signing plan for an urban application is shown in Exhibit 7-15.

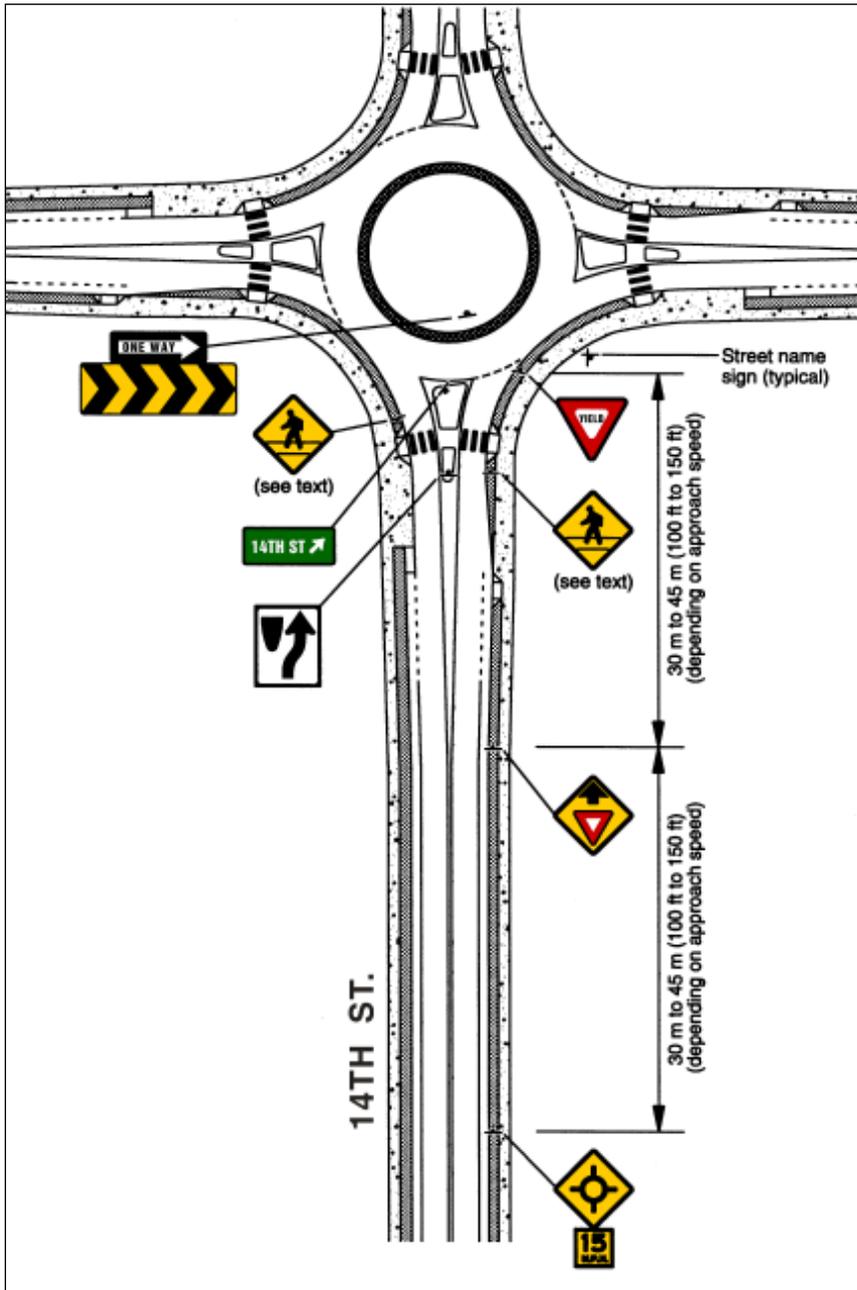


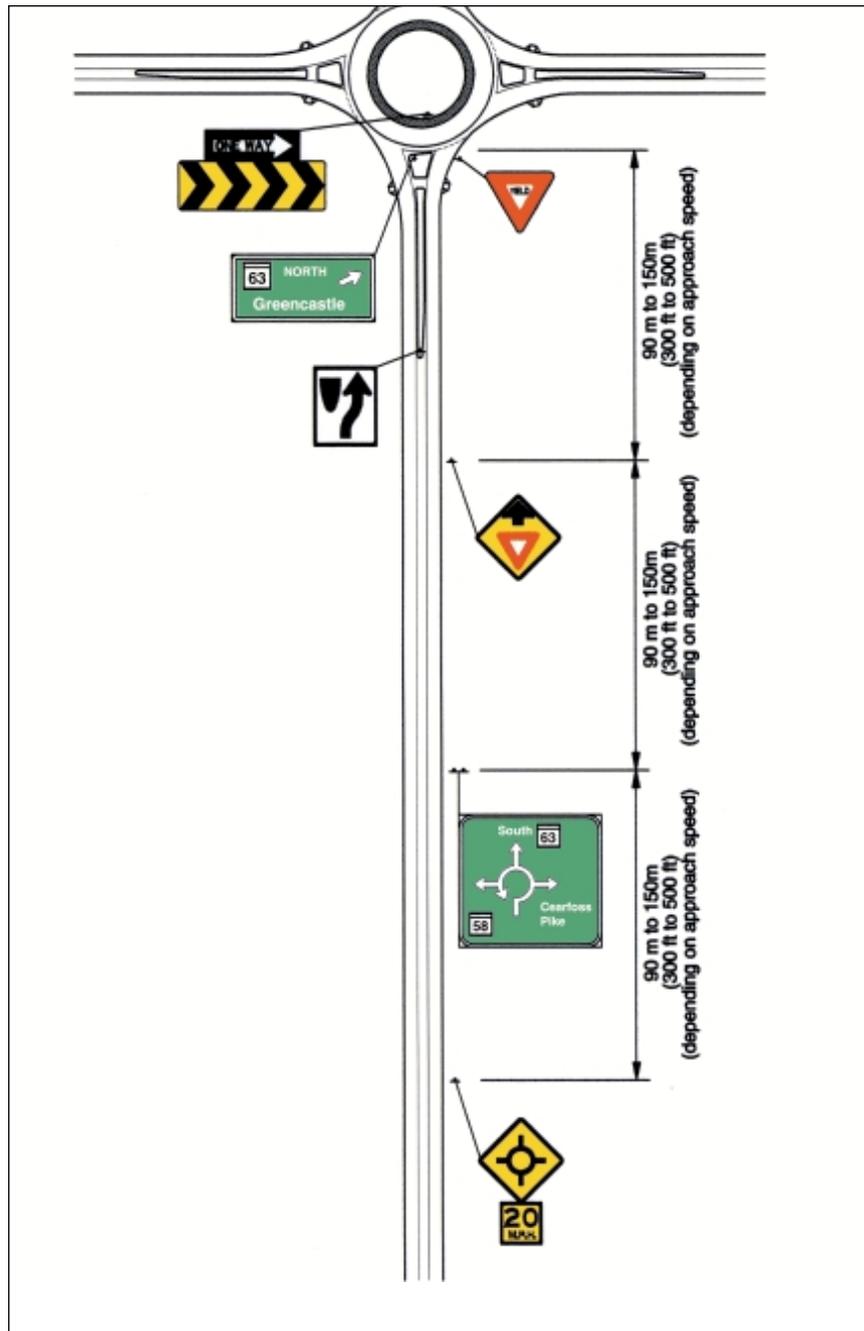
Exhibit 7-15. Sample signing plan for an urban roundabout.

7.1.6 Rural and suburban signing considerations

Rural signing needs to be more conspicuous than urban signing due to higher approach speeds.

Rural and suburban conditions are characterized by higher approach speeds. Route guidance tends to be focused more on destinations and numbered routes rather than street names. A sample signing plan for a rural application is shown in Exhibit 7-16.

Exhibit 7-16. Sample signing plan for a rural roundabout.



In cases where high speeds are expected (in excess of 80 km/h [50 mph]) and the normal signage and geometric features are not expected to produce the desired reduction in vehicle speeds, the following measures may also be considered (examples of some of these treatments are given in Exhibit 7-17):

- Large advance warning signs;
- Addition of hazard identification beacons to approach signing;
- Use of rumble strips in advance of the roundabout;
- Pavement marking across pavement; and
- Use of speed warning signs. These can be triggered by speeds exceeding an acceptable threshold.



Warning beacons. Leeds, MD



Rumble strips. Cearfoss, MD



Speed warning signs. Leeds, MD

These speed reduction treatments can apply to all intersection types, not just roundabouts.

Exhibit 7-17. Examples of speed reduction treatments.

7.1.7 Mini-roundabout signing considerations

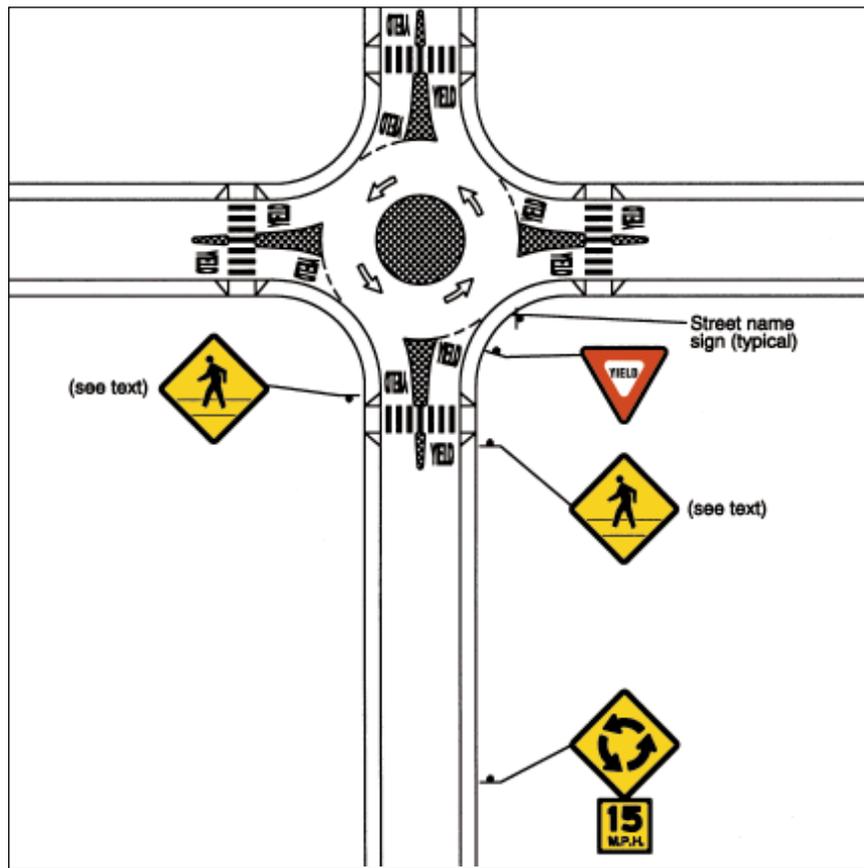
Due to their small size and unique features, mini-roundabouts require a somewhat different signing treatment than the larger urban roundabouts. The principal differences in signing at mini-roundabouts as compared to other urban roundabouts are the following:

- The central island is fully mountable. Therefore, no ONE WAY signs, Large Arrow signs, or chevrons can be located there. It is recommended that the direction of circulation be positively indicated through the use of pavement markings, as discussed in Section 7.2.4.
- The splitter islands are either painted or are fully mountable. Therefore, KEEP RIGHT signs are not appropriate for mini-roundabouts.

- Typically, advance directional guide signs and exit guide signs are unnecessary, given the size of the mini-roundabout and the nature of the approach roadways (generally low-speed local streets). However, standard street name signs (D3) should be used.
- The Roundabout Ahead warning sign discussed in Section 7.1.3.1 should be used on each approach in advance of the YIELD sign. The Circular Intersection warning gives no indication of the direction of circulation required at the mini-roundabout.

Exhibit 7-18 gives a sample signing plan for a mini-roundabout.

Exhibit 7-18. Sample signing plan for a mini-roundabout.



7.2 Pavement Markings

Typical pavement markings for roundabouts consist of delineating the entries and the circulatory roadway.

7.2.1 Relationship with the *Manual on Uniform Traffic Control Devices*

As with signing, the MUTCD (1) and applicable local standards govern the design and placement of pavement markings. Roundabouts present a number of new pavement marking issues that are not addressed in the 1988 edition of the MUTCD. For this reason, a number of new pavement markings or uses for existing pavement markings have been introduced that are under consideration for inclusion in the next edition of the MUTCD. Until such pavement markings or uses are formally adopted, these recommendations should be considered provisional and are subject to MUTCD Section 1A-6, “Manual Changes, Interpretations and Authority to Experiment.”

The following pavement markings and applications recommended below are subject to these conditions:

- YIELD lines (Section 7.2.2.1); and
- Symbolic YIELD legend (Section 7.2.2.2).

7.2.2 Approach and entry pavement markings

Approach and entry pavement markings consist of yield lines, pavement word and symbol markings, and channelization markings. In addition, multilane approaches require special attention to pavement markings. The following sections discuss these in more detail.

7.2.2.1 Yield lines

Yield lines should be used to demarcate the entry approach from the circulatory roadway. Yield lines should be located along the inscribed circle at all roundabouts except mini-roundabouts (see Section 7.2.4). No yield lines should be placed to demarcate the exit from the circulatory roadway.

The MUTCD currently provides no standard for yield lines. The recommended yield line pavement marking is a broken line treatment consisting of 400-mm (16-in) wide stripes with 1-m (3-ft) segments and 1-m (3-ft) gaps. This type of yield line is the simplest to install.

Alternatively, several European countries use a yield line marking consisting of a series of white triangles (known as “shark’s teeth”). These markings tend to be more visible to approaching drivers. Exhibit 7-19 presents examples of broken line and “shark’s teeth” yield line applications. The “shark’s teeth” ahead of the broken line has been recommended for adoption in the next edition of the MUTCD.

Yield lines provide a visual separation between the approach and the circulatory roadway.

“Shark’s teeth” provide more visual “punch” but require a new template for installation.

Exhibit 7-19. Examples of yield lines.



Broken line. *Leeds, MD*



"Shark's teeth." *Lothian, MD*

Pavement word markings are less effective in rainy or especially snowy climates.

7.2.2.2 Pavement word and symbol markings

In some cases, the designer may want to consider pavement word or symbol markings to supplement the signing and yield line marking. This typically consists of the word YIELD painted on the entrance to the roundabout immediately prior to the yield line. These markings should conform to the standards given in the appropriate section of the MUTCD (§3B-20).

Alternatively, some European countries paint a symbolic yield sign upstream of the yield line. This treatment has the advantage of being symbolic; however, such a treatment has not seen widespread use in the United States to date.

7.2.2.3 Lane-use control markings

If lane-use control signing has been used to designate specific lane use on an approach with more than one lane, it is recommended that corresponding arrow legends be used within each lane. See Section 7.1.2.4 for more discussion of the use of lane-use controls.

7.2.2.4 Approach markings

Typically, pavement markings are provided around raised splitter islands and right-turn bypass islands to enhance driver recognition of the changing roadway. Channelization markings shall be yellow when to the left of the traffic stream and white when to the right of the traffic stream. For a roundabout splitter island, pavement markings shall be yellow adjacent to the entry and exit and white adjacent to the circulatory roadway. Exhibit 7-20 presents a recommended pavement marking plan for the channelization on a typical single-lane approach to a roundabout. Optionally, edge stripes may end at the points of the splitter islands, allowing the curbs themselves to provide edge delineation.

Raised pavement markers are useful supplements to pavement markings.

Raised pavement markers are generally recommended for supplementing pavement markings. These have the benefit of additional visibility at night and in inclement weather. However, they increase maintenance costs and can be troublesome in areas requiring frequent snow removal. In addition, raised pavement markers should not be used in the path of travel of bicycles.

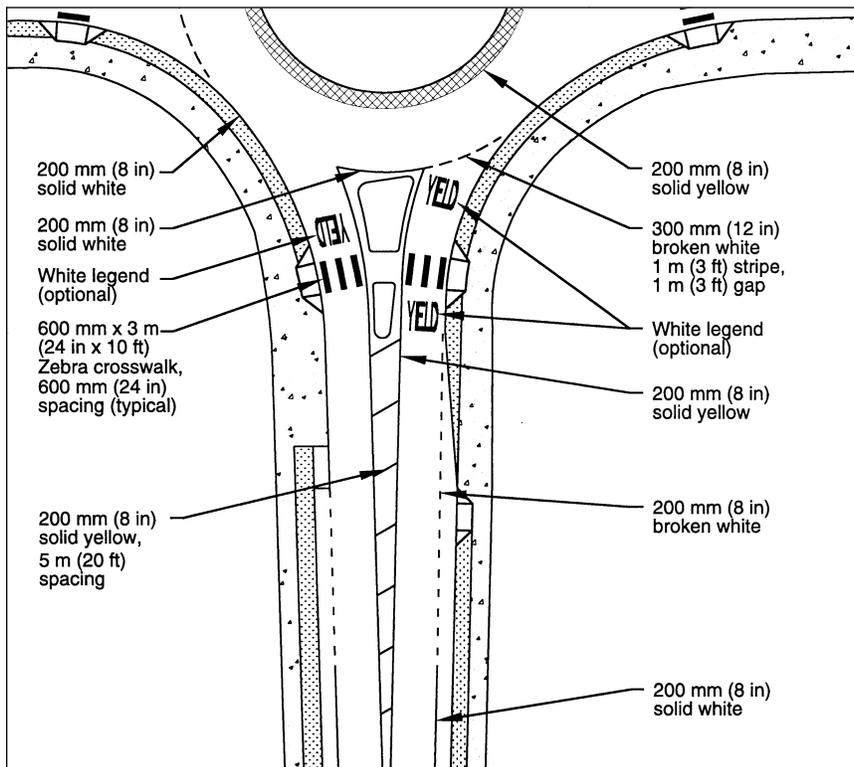


Exhibit 7-20. Approach pavement markings.

For small splitter islands (in area less than 7 m² [75 ft²]), the island may consist of pavement markings only. However, where possible, curbed splitter islands should be used.

7.2.2.5 Pedestrian crosswalk markings

Pedestrian crosswalk markings should generally be installed at all pedestrian crossing locations within roundabouts in urban locations. Because the crosswalk at a roundabout is located away from the yield line, it is important to channelize pedestrians to the appropriate crossing location. These markings should not be construed as a safety device, as data from other countries suggest that the presence of markings has no appreciable effect on pedestrian safety. Rather, markings provide guidance for pedestrians in navigating a roundabout and provide a visual cue to drivers of where pedestrians may be within the roadway. The use of crosswalk markings in this manner is consistent with published recommendations (3). Marked crosswalks are generally not needed at locations where the crosswalk is distinguished from the roadway by visually contrasting pavement colors and textures.

A crosswalk marking using a series of lines parallel to the flow of traffic (known as a “zebra crosswalk”) is recommended. These lines should be approximately 0.3 m to 0.6 m (12 in to 24 in) wide, spaced 0.3 m to 1.0 m (12 in to 36 in) apart, and span the width of the crosswalk (similar to the recommendations in MUTCD §3B-18). Crosswalk markings should be installed across both the entrance and exit of each leg and across any right turn bypass lanes. The crosswalk should be aligned with

Zebra crosswalks provide an important visual cue for drivers and pedestrians.

the ramps and pedestrian refuge in the splitter island and have markings that are generally perpendicular to the flow of vehicular traffic.

The zebra crosswalk has a number of advantages over the traditional transverse crosswalk marking in roundabout applications:

- Because the crosswalk at a roundabout is set back from the yield line, the zebra crosswalk provides a higher degree of visibility.
- The zebra crosswalk is distinct from traditional transverse crosswalk markings typically used at signalized intersections, thus alerting both drivers and pedestrians that this intersection is different from a signalized intersection.
- The zebra crosswalk is also less likely to be confused with the yield line than a transverse crosswalk.
- Although the initial cost is somewhat higher, the zebra crossing may require less maintenance due to the ability to space the markings to avoid vehicle tire tracks.

In rural locations where pedestrian activity is expected to be minimal, pedestrian crosswalk markings are optional. Pedestrian crosswalk markings should not be used at roundabouts without illumination (see Section 7.3 for an identification of these cases) because the headlights of vehicles may not be sufficient to illuminate a pedestrian in time to avoid a collision (4). Regardless of whether the crosswalk is marked, all roundabouts with any reasonable possibility of pedestrian activity should have geometric features to accommodate pedestrians as described in Chapter 6.

In addition to pavement markings, flashing warning lights mounted in the pavement and activated by a pedestrian push button or other method may be considered. These are not part of the current MUTCD and thus must be treated as an experimental traffic control device (see Section 7.2.1).

7.2.2.6 *Bike lane markings*

Bicycle striping treatments should be used when an existing (or proposed) bike lane is part of the roadway facility. Exhibit 7-20 shows a recommended treatment for bike lanes on an approach to a roundabout.

7.2.3 **Circulatory roadway pavement markings**

Circulatory pavement markings are generally not recommended.

In general, lane lines should not be striped within the circulatory roadway, regardless of the width of the circulatory roadway. Circulatory lane lines can be misleading in that they may provide drivers a false sense of security.

Bike lanes within the roundabout are not recommended.

In addition, bike lane markings within the circulatory roadway are not recommended. The additional width of a bike lane within the circulatory roadway increases vehicular speed and increases the probability of motor vehicle-cyclist crashes. Bicyclists should circulate with other vehicles, travel through the roundabout as a pedestrian on the sidewalk, or use a separate shared-use pedestrian and bicycle facility where provided.

7.2.4 Mini-roundabout pavement markings

Mini-roundabouts require pavement marking treatments that are somewhat different from other urban roundabouts. The following pavement marking treatments are recommended for mini-roundabouts.

- Pavement marking arrows should be provided in the circulatory roadway in front of each entry to indicate the direction of circulation. As noted in the discussion of signing treatments (Section 7.1.7), no signs can be placed in the fully mountable central island.
- At a minimum, the edges of the mountable central island and splitter islands should be painted to improve their visibility.

A sample pavement marking plan for a mini-roundabout is given in Exhibit 7-21.

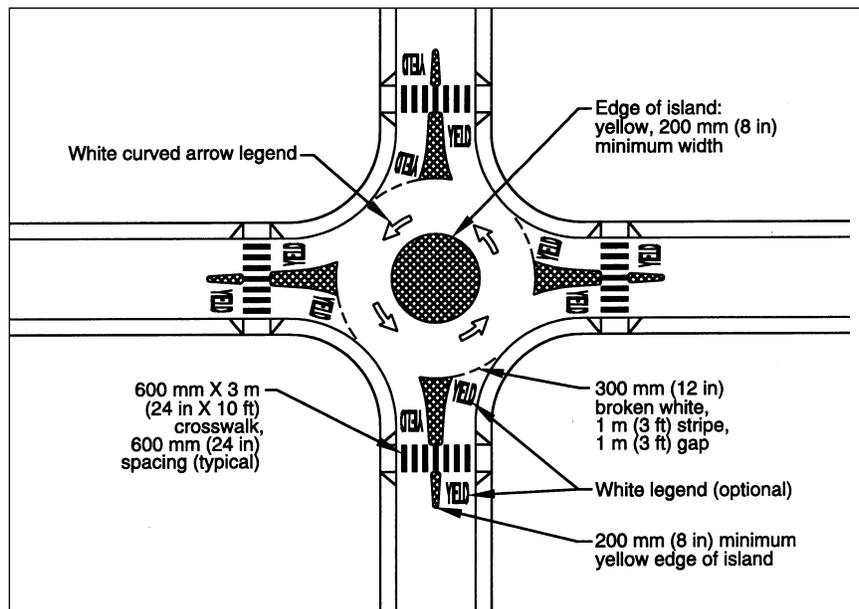


Exhibit 7-21. Sample pavement marking plan for a mini-roundabout.

7.3 Illumination

For a roundabout to operate satisfactorily, a driver must be able to enter the roundabout, move through the circulating traffic, and separate from the circulating stream in a safe and efficient manner. To accomplish this, a driver must be able to perceive the general layout and operation of the intersection in time to make the appropriate maneuvers. Adequate lighting should therefore be provided at all roundabouts. Exhibit 7-22 shows an example of an illuminated roundabout at night.

Exhibit 7-22. Illumination of a roundabout.



Loveland, CO

7.3.1 Need for illumination

The need for illumination varies somewhat based on the location in which the roundabout is located.

7.3.1.1 Urban conditions

In urban settings, illumination should be provided for the following reasons:

- Most if not all approaches are typically illuminated.
- Illumination is necessary to improve the visibility of pedestrians and bicyclists.

7.3.1.2 Suburban conditions

For roundabouts in suburban settings, illumination is recommended. For safety reasons, illumination is necessary when:

- One or more approaches are illuminated.
- An illuminated area in the vicinity can distract the driver's view.
- Heavy nighttime traffic is anticipated.

Continuity of illumination must be provided between illuminated areas and the roundabout itself (5). An unlit roundabout with one or more illuminated approaches is dangerous. This is because a driver approaching on an unlit approach will be attracted to the illuminated area(s) and may not see the roundabout.

7.3.1.3 Rural conditions

For rural roundabouts, illumination is recommended but not mandatory. If there is no power supply in the vicinity of the intersection, the provision of illumination can be costly. When lighting is not provided, the intersection should be well signed and marked so that it can be correctly perceived by day and night. The use of reflective pavement markers and retroreflective signs (including chevrons supplementing the ONE-WAY signs) should be used when lighting cannot be installed in a cost-effective manner.

Where illumination can be provided, any raised channelization or curbing should be illuminated. In general, a gradual illumination transition zone of approximately 80 m (260 ft) should be provided beyond the final trajectory changes at each exit (5). This helps drivers adapt their vision from the illuminated environment of the roundabout back into the dark environment of the exiting roadway, which takes approximately 1 to 2 seconds. In addition, no short-distance dark areas should be allowed between two consecutive illuminated areas (5).

7.3.2 Standards and recommended practices

The following standards and recommended practices should be consulted in completing the lighting plan:

- AASHTO, *An Information Guide for Roadway Lighting* (6). This is the basic guide for highway lighting. It includes information on warranting conditions and design criteria.
- AASHTO, *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* (7). This specification contains the strength requirements of the poles and bracket arms for various wind loads, as well as the frangibility requirements. All luminaire supports, poles, and bracket arms must comply with these specifications.
- IES RP-8: *The American National Standard Practice for Roadway Lighting* (8). This Recommended Practice, published by the Illuminating Engineering Society, provides standards for average-maintained illuminance, luminance, and small target visibility, as well as uniformity of lighting. Recommended illumination levels for streets with various classifications and in various areas are given in Exhibit 7-23.

Exhibit 7-23. Recommended street illumination levels.

Street Classification	Area Classification	Average Maintained Illuminance Values	Illuminance Uniformity Ratio (Average to Minimum)
Arterial	Commercial	17 lx (1.7 fc)	3 to 1
	Intermediate	13 lx (1.3 fc)	
	Residential	9 lx (0.9 fc)	
Collector	Commercial	12 lx (1.2 fc)	4 to 1
	Intermediate	9 lx (0.9 fc)	
	Residential	6 lx (0.6 fc)	
Local	Commercial	9 lx (0.9 fc)	6 to 1
	Intermediate	7 lx (0.7 fc)	
	Residential	4 lx (0.4 fc)	

Definitions:

- Commercial A business area of a municipality where ordinarily there are many pedestrians during night hours. This definition applies to densely developed business areas outside, as well as within, the central part of a municipality. The area contains land use which attracts a relatively heavy volume of nighttime vehicular and/or pedestrian traffic on a frequent basis.
- Intermediate Those areas of a municipality often with moderately heavy nighttime pedestrian activity such as in blocks having libraries, community recreation centers, large apartment buildings, industrial buildings, or neighborhood retail stores.
- Residential A residential development, or a mixture of residential and small commercial establishments, with few pedestrians at night.

Note: Values in table assume typical asphalt roadway surface (pavement classification R2 or R3). Consult the IES document for other pavement surfaces.

Source: Illuminating Engineering Society RP-8 (8)

7.3.3 General recommendations

The primary goal of illumination is to ensure perception of the approach and mutual visibility among the various categories of users. To achieve this, the following features are recommended:

- The overall illumination of the roundabout should be approximately equal to the sum of the illumination levels of the intersecting roadways. If the approaching roadways have been designed to the illumination levels given in Exhibit 7-23, this may result in illumination levels at the roundabout ranging from 9 lx (0.8 fc) for roundabouts at the intersection of local streets in residential areas to 36 lx (3.4 fc) for roundabouts at the intersection of arterials in commercial areas. Local illumination standards should also be considered when establishing the illumination at the roundabout to ensure that the lighting is consistent.
- Good illumination should be provided on the approach nose of the splitter islands, at all conflict areas where traffic is entering the circulating stream, and at all places where the traffic streams separate to exit the roundabout.
- It is preferable to light the roundabout from the outside in towards the center. This improves the visibility of the central island and the visibility of circulating vehicles to vehicles approaching to the roundabout. Ground-level lighting within the central island that shines upwards towards objects in the central island can improve their visibility.

Lighting from the central island causes vehicles to be backlit and thus less visible.

- Special consideration should be given to lighting pedestrian crossing and bicycle merging areas.

7.3.4 Clear zone requirements

As discussed in Chapter 5, the proportion of single-vehicle crashes at roundabouts is high compared to other intersection types. This is because roundabouts consist of a number of relatively small-radii horizontal curves for each traveled path through the roundabout. Drivers travel on these curves with quite high values of side friction, particularly at roundabouts in higher speed areas. Single-vehicle crashes, which predominantly involve out-of-control vehicles, increase with an increased amount of side friction.

Because of the relatively high number of out-of-control vehicles, it is desirable to have adequate amounts of clear zone where there are no roadside hazards on each side of the roadway. Lighting supports and other poles should not be placed within small splitter islands or on the right-hand perimeter just downstream of an exit point. Lighting poles should be avoided in central islands when the island diameter is less than 20 m (65 ft).

The reader should refer to the AASHTO *Roadside Design Guide* for a more detailed discussion of clear zone requirements (9).

7.4 Work Zone Traffic Control

During the construction of a roundabout it is essential that the intended travel path be clearly identified. This may be accomplished through pavement markings, signing, delineation, channelizing devices, and guidance from police and/or construction personnel, depending on the size and complexity of the roundabout. Care should be taken to minimize the channelizing devices so that the motorist, bicyclist, and pedestrian has a clear indication of the required travel path. Each installation should be evaluated separately, as a definitive guideline for the installation of roundabouts is beyond the scope of this guide. Refer to Part 6 of the MUTCD for requirements regarding work zone traffic control.

7.4.1 Pavement markings

The pavement markings used in work zones should be the same layout and dimension as those used for the final installation. Because of the confusion of a work area and the change in traffic patterns, additional pavement markings may be used to clearly show the intended direction of travel. In some cases when pavement markings cannot be placed, channelizing devices should be used to establish the travel path.

7.4.2 Signing

The signing in work zones should consist of all necessary signing for the efficient movement of traffic through the work area, preconstruction signing advising the pub-

Construction signing for a roundabout should follow the MUTCD standard.

lic of the planned construction, and any regulatory and warning signs necessary for the movement of traffic outside of the immediate work area. The permanent roundabout signing should be installed where practicable during the first construction stage so that it is available when the roundabout is operable. Permanent signing that cannot be installed initially should be placed on temporary supports in the proposed location until permanent installation can be completed.

7.4.3 Lighting

Permanent lighting, as described in Section 7.3, should be used to light the work area. If lighting will not be used, pavement markings, as described in Section 7.2, should be used.

7.4.4 Construction staging

Construction staging should be considered during the siting of the roundabout, especially if it must be built under traffic.

As is the case with any construction project, before any work can begin, all traffic control devices should be installed as indicated in the traffic control plan or recommended typical details. This traffic control shall remain in place as long as it applies and then be removed when the message no longer applies to the condition.

Prior to work that would change the traffic patterns to that of a roundabout, certain peripheral items may be completed. This would include permanent signing (covered), lighting, and some pavement markings. These items, if installed prior to the construction of the central island and splitter islands, would expedite the opening of the roundabout and provide additional safety during construction.

When work has commenced on the installation of the roundabout, it is desirable that it be completed as soon as possible to minimize the time the public is faced with an unfinished layout or where the traffic priority may not be obvious. If possible, all work, including the installation of splitter islands and striping, should be done before the roundabout is open to traffic.

If it is necessary to leave a roundabout in an uncompleted state overnight, the splitter islands should be constructed before the central island. Any portion of the roundabout that is not completed should be marked, delineated, and signed in such a way as to clearly outline the intended travel path. Pavement markings that do not conform to the intended travel path should be removed.

It is highly desirable to detour traffic for construction of a roundabout. This will significantly reduce the construction time and cost and will increase the safety of the construction personnel. If it is not possible to detour all approaches, detour as many approaches as possible and stage the remainder of the construction as follows:

1. Install and cover proposed signing.
2. Construct outside widening if applicable.
3. Reconstruct approaches if applicable.

4. Construct splitter islands and delineate the central island. At this point the signs should be uncovered and the intersection should operate as a roundabout.
5. Finish construction of the central island.

7.4.5 Public education

It is important to educate the public whenever there is a change in traffic patterns. It is especially important for a roundabout because a roundabout will be new to most motorists. The techniques discussed in Chapter 2 can be applied during the construction period. The following are some specific suggestions to help alleviate initial driver confusion.

- Hold public meetings prior to construction;
- Prepare news releases/handouts detailing what the motorist can expect before, during, and after construction;
- Install variable message signs before and during construction;
- Use Travelers Advisory Radio immediately prior to and during construction to disseminate information on “How to drive,” etc.; and
- Install signing during and after construction that warns of changed traffic patterns.

7.5 Landscaping

This section provides an overview of the use of landscaping in the design of a roundabout.

7.5.1 Advantages

Landscaping in the central island, in splitter islands (where appropriate), and along the approaches can benefit both public safety and community enhancement.

The landscaping of the roundabout and approaches should:

- Make the central island more conspicuous;
- Improve the aesthetics of the area while complementing surrounding streetscapes as much as possible;
- Minimize introducing hazards to the intersection, such as trees, poles, walls, guide rail, statues, or large rocks;
- Avoid obscuring the form of the roundabout or the signing to the driver;
- Maintain adequate sight distances, as discussed in Chapter 6;
- Clearly indicate to the driver that they cannot pass straight through the intersection;
- Discourage pedestrian traffic through the central island; and
- Help blind and visually impaired pedestrians locate sidewalks and crosswalks.

Public education during construction is as important as the public education effort during the planning process.

Landscaping is one of the distinguishing features that gives roundabouts an aesthetic advantage over traditional intersections.

7.5.2 Central island landscaping

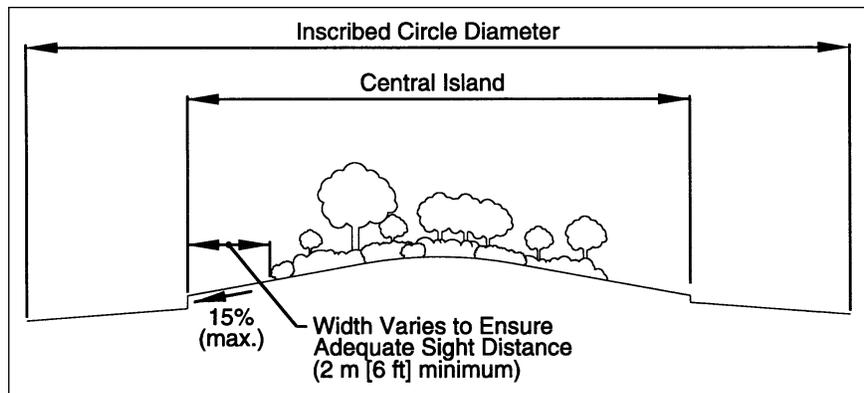
The central island landscaping can enhance the safety of the intersection by making the intersection a focal point and by lowering speeds. Plant material should be selected so that sight distance (discussed in Chapter 6) is maintained, including consideration of future maintenance requirements to ensure adequate sight distance for the life of the project. Large, fixed landscaping (trees, rocks, etc.) should be avoided in areas vulnerable to vehicle runoff. In northern areas, the salt tolerance of any plant material should be considered, as well as snow storage and removal practices. In addition, landscaping that requires watering may increase the likelihood of wet and potentially slippery pavement. Exhibit 7-24 shows the recommended placement of landscaping within the central island.

The slope of the central island should not exceed 6:1 per the requirements of the AASHTO *Roadside Design Guide* (9).

Avoid items in the central island that might tempt people to take a closer look.

Where truck aprons are used in conjunction with a streetscape project, the pavement should be consistent with other streetscape elements. However, the material used for the apron should be different than the material used for the sidewalks so that pedestrians are not encouraged to cross the circulatory roadway. Street furniture that may attract pedestrian traffic to the central island, such as benches or monuments with small text, must be avoided. If fountains or monuments are being considered for the central island, they must be designed in a way that will enable proper viewing from the perimeter of the roundabout. In addition, they must be located and designed to minimize the possibility of impact from an errant vehicle.

Exhibit 7-24. Landscaping of the central island.



7.5.3 Splitter island and approach landscaping

In general, unless the splitter islands are very large or long, they should not contain trees, planters, or light poles. Care must be taken with the landscaping to avoid obstructing sight distance, as the splitter islands are usually located within the critical sight triangles (see Chapter 6).

Landscaping on the approaches to the roundabout can enhance safety by making the intersection a focal point and by reducing the perception of a high-speed through traffic movement. Plant material in the splitter islands (where appropriate) and on the right and left side of the approaches can help to create a funneling effect and induce a decrease in speeds approaching the roundabout. Landscaping in the corner radii will help to channelize pedestrians to the crosswalk areas and discourage pedestrians from crossing to the central island.

7.5.4 Maintenance

A realistic maintenance program should be considered in the design of the landscape features of a roundabout. It may be unrealistic to expect a typical highway agency to maintain a complex planting plan. Formal agreements may be struck with local civic groups and garden clubs for maintenance where possible. Liability issues should be considered in writing these agreements. Where there is no interest in maintaining the proposed enhancements, the landscape design should consist of simple plant materials or hardscape items that require little or no maintenance.

Ensure that whatever landscaping is installed, it will be maintained.

7.6 References

1. Federal Highway Administration (FHWA). *Manual on Uniform Traffic Control Devices*. Washington, D.C.: FHWA, 1988.
2. Federal Highway Administration (FHWA). *Standard Highway Signs*. Washington, D.C.: FHWA, 1979.
3. Smith, S.A., and R.L. Knoblauch. "Guidelines for the Installation of Crosswalk Markings." In *Transportation Research Record 1141*. Transportation Research Board, National Research Council, Washington, D.C., 1987.
4. Herms, B.F. "Some Visual Aspects of Pedestrian Crosswalks." In *Proceedings, 22nd California Street and Highway Conference*, Institute of Transportation and Traffic Engineering, University of California, Los Angeles, January 1970.
5. Centre d'Etudes sur les Réseaux les Transports, l'Urbanisme et les constructions publiques (CERTU). *L'Éclairage des Carrefours à Sens Giratoire (The Illumination of Roundabout Intersections)*. Lyon, France: CERTU, 1991.
6. American Association of State Highway and Transportation Officials (AASHTO). *An Information Guide for Roadway Lighting*. Washington, D.C.: AASHTO, 1985.
7. American Association of State Highway and Transportation Officials (AASHTO). *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*. Washington, D.C.: AASHTO, 1994.
8. Illuminating Engineering Society (IES). *American National Standard Practice for Roadway Lighting*. Standard RP-8. December 1982.
9. American Association of State Highway and Transportation Officials (AASHTO). *Roadside Design Guide*. Washington, D.C.: AASHTO, 1989.