Draft Minnesota State Aid Roundabout Guide

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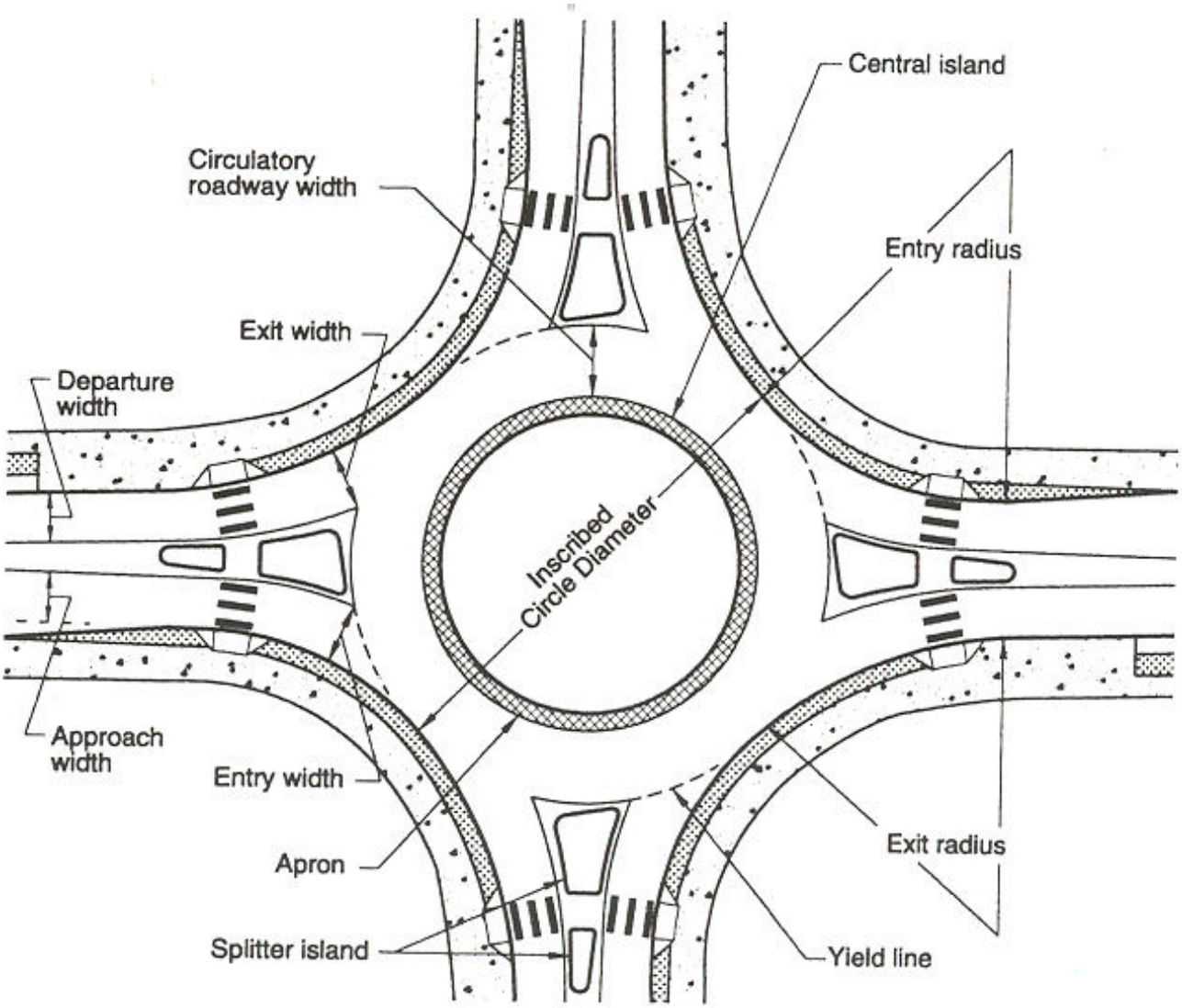


COMMENT DRAFT

Draft Minnesota State Aid Roundabout Guide

For Consideration by Minnesota Cities and Counties

GENERAL:

This document is based on the Federal Highway Administration's (FHWA's) publication FHWA-RD-00-067 Roundabouts: An Informational Guide, hereinafter referred to as the FHWA Guide. Basically it captures only the most essential design elements of the FHWA Guide. Designers should not use this Draft Minnesota State Aid Roundabout Guide as their only design reference, but should become familiar with the full understanding of the roundabout design elements as provided in the FHWA Guide and/or other sources. References to FHWA Guide Sections [for example: (1.6.4, p.16)] and Exhibits are used throughout this document.

The policies stated in this Draft Minnesota State Aid Roundabout Guide are to be considered for city or county intersections on their State Aid system and, if desired by the road authority, these policies may be used for appropriate intersection on their non-state aid segments. These policies are not intended to apply to Minnesota's trunk highway system. Italics indicate state Aid policy.

It is hoped that the guide will help develop public acceptance of roundabouts by defining the appropriate usage of roundabouts, consistency of the driver's experience, and by achieving design/maintenance success by updating the draft guide in response to user feedback. The guide will help communities understand which situations are not appropriate for roundabouts on the state aid system.

Note that state law may conflict with some of the basic premises of roundabout operation (yield to right, overtaking, etc.). The information in this Draft Minnesota State Aid Roundabout Guide does not constitute legal opinion; rather each jurisdiction should consult with its attorneys on specific legal issues.

A copy of the FHWA Guide can be obtained by calling the FHWA Report Center at (301) 577-0818 or downloaded from http://www.tfhrc.gov/safety/00068.htm.

PURPOSE:

At this time roundabout use is rarely considered in Minnesota, but their use is expected to increase. Minnesota's transportation customers and providers have a lot to learn about roundabout use and design. This Draft Minnesota State Aid Roundabout Guide is not currently intended to constrain transportation professionals in any way, but should be considered by designers during their design process to develop some uniformity so as to

enhance driver expectation, thereby enhancing public acceptability and safety. This document is a draft design guide that may develop into a design standard for Minnesota roundabouts through practical feedback from design, construction, and maintenance personnel, cooperation with adjoining states, or through other refinements.

The FHWA Guide defines six categories of intersection control treatments: the Mini-roundabout, Urban Compact, Urban Single-Lane, Urban Double-Lane, Rural Single-Lane, and Rural Double-Lane. *Only Urban Single-lane Roundabouts and Rural Single–lane Roundabouts as defined below are allowed on the state aid system at this time. Double lane roundabouts are not permitted on state aid routes at this time because typical Minnesota drivers are not familiar with roundabout function. Mini-roundabouts and compact urban roundabouts are also not permitted on state aid routes.* This Draft Minnesota State Aid Roundabout Guide focuses on two of those classifications as defined below:

Urban single-lane roundabouts (1.6.4, p.16): This type of roundabout is characterized as having a single lane entry at all legs and one circulatory lane. Their design allows slightly higher speeds at the entry, on the circulatory roadway, and at the exit. Speed ranges recommended are somewhat lower than those used in other countries in order to enhance safety for bicycles and pedestrians. The roundabout design is focused on achieving consistent entering and circulating vehicle speeds. The geometric design includes raised splitter islands, a non-mountable central island, and preferably, no apron (mountable portion of center island).

Rural single-lane roundabouts (1.6.6, p.18): Rural single-lane roundabouts generally have high average approach speeds in the range of 50 to 60 mph. They require supplementary geometric and traffic control device treatments on approaches to encourage drivers to slow to an appropriate speed before entering the roundabout. Rural roundabouts may have larger diameters than urban roundabouts to allow slightly higher speeds at the entries, on the circulatory roadway, and at the exits. This is possible if few pedestrians are expected at these intersections, currently and in future. There is preferably no apron because their larger diameters should accommodate larger vehicles. Supplemental geometric design elements include extended and raised splitter islands, a non-mountable central island, and adequate horizontal deflection. Rural roundabouts that may one day become part of an urbanized area should be designed as urban roundabouts, with slower speeds and pedestrian treatments. However in the interim they should be designed with supplementary approach and entry features to achieve safe speed reduction.

LEGAL CONSIDERATIONS (2.4, p.37):

State law governs how roundabouts function. For Minnesota, the following will apply:

1. *A roundabout should be considered as a single intersection treatment, not as separate "T" intersections*.

2. Law gives right of way to vehicles to the right. Roundabouts give vehicles within the roundabout, which approach from the left of entering vehicles, the right-of-way. Signage and stripping in accordance with the MnMUTCD shall be provided.
3. *Two lane roundabouts are not allowed at this time because of the issue of ambiguous rights of way within the circulatory roadway for multi-lane roundabouts such as overtaking and exiting.*
4. American with Disabilities Act (ADA) laws must be applied to roundabouts.
5. *An agency shall restrict parking and erect appropriate no parking signage within the roundabout and 20 feet before each crosswalk (6.3.14, p.169).*
6. The design shall not encourage pedestrians to cross to the center island. No restrictive signing is required. Crosswalks shall be provided to indicate where pedestrians are to the cross approach roadways.

ROUNDABOUT JUSTIFICATION REPORT (3.1 p. 52):

Where roundabouts are proposed on the state aid system, a Roundabout Justification Report (similar to a Signal Justification Report) shall be prepared and submitted for review to the District State Aid Engineer (DSAE), who shall in turn submit the report to the State Aid Engineer for final approval. The report shall include a description of all intersection control devices considered, and provide the reasons for selecting the roundabout option. The report shall also include many other considerations that are relevant such as overall cost, maintenance considerations, R/W limitations, public acceptance/desirability, or landscaping maintenance.

Page 52 of the FHWA Guide provides further guidance as to the contents of a roundabout justification report, specifically it shall:

1) identify current or projected traffic control or safety problems at the intersection if the roundabout is proposed as a solution to these problems;
2) provide design data which justifies the proposed configuration (note: two lane roundabouts are not allowed at this time);
3) identify all potential complicating factors, assess their relevance to the location, and identify any mitigation efforts that might be required.
4) identify the impacts to bicyclists and pedestrians.

Additional information in the justification report may include:

1) demonstrated institutional and community support;
2) detailed performance comparisons of the roundabout with alternative control modes;
3) an economic analysis indicating that a roundabout compared favorably with alternative control modes from a benefit/cost perspective;
4) traffic volume data, signal, or all-way stop control warrant analysis, etc.;
5) demonstrate that the proposed configuration can be implemented feasibly and that it will provide adequate capacity on all approaches.

A layout shall be provided showing a plan view, grades, profiles, each with relevant dimensions. The layout shall show all design vehicle paths (offsets and radii), large vehicle

paths (using truck apron if necessary), curb radii, parking restrictions, and typical section through roundabout (showing curb, cross-slopes, truck apron curb, apron slope, center island features, etc.). Design speed for each movement shall also be indicated.

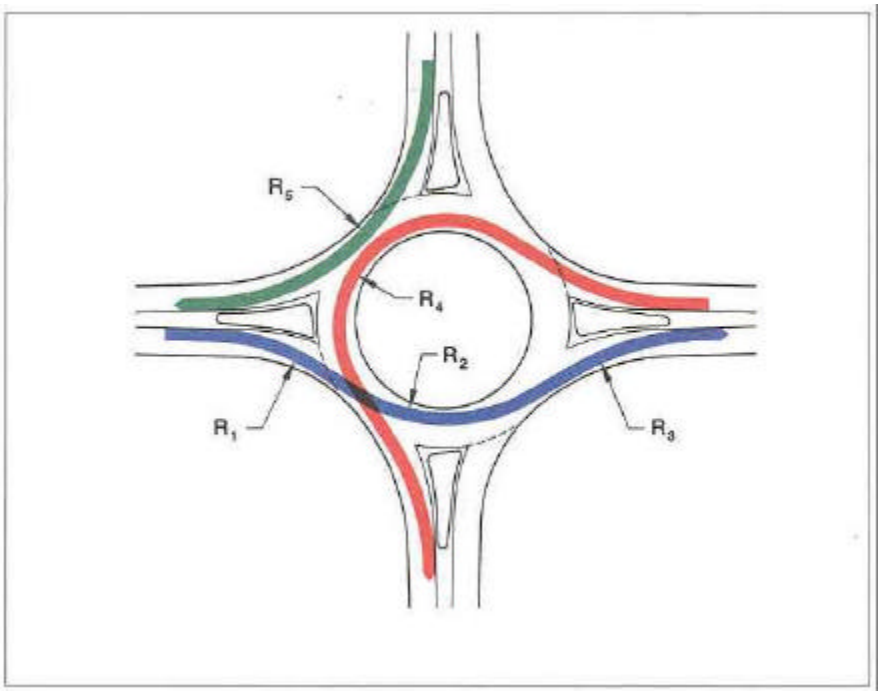
DESIGN PROCEDURE:

Design Process (6.1.2 p. 130):

Roundabout design is an iterative process, iteration bringing the design closer to an optimal design for the particular situation (Exhibit 6-2).

The design speed within the roundabout is based on the smoothest, flattest path allowed, without other traffic with in the roundabout and ignoring lane markings, of a vehicle path traversing through the entry, around the central island, and out the opposite exit (unless right turn is faster). The vehicle path is measured 5 feet from a concrete curb, 5 feet from a roadway centerline, and 3 feet from a painted edge line (Exhibit 6-5). Use Exhibit 6-11 to determine radii. Superelevation is generally +0.02 for entry/exit curves and –0.02 for curves around the central island.

The relative speeds between consecutive geometric elements should be minimized and the relative speed between conflicting traffic streams should be minimized to help reduce crash rates and severity. The five critical paths must be checked for speed consistency (exhibit 6-12). It is preferred that R1 < R2 < R3 for any path. If necessary, the design speed for R1 may be larger than R2, but preferably by no more than 6 mph, and never by more than 12 mph. Also, the design speed for R4 shall not have more than a 12 mph difference from the conflicting R1 and R5. *R5 shall be no more than the maximum design speed of the roundabout and less than 12 mph greater than the conflicting R4.*



GEOMETRIC DESIGN ELEMENTS:

Speed Profiles (6.2.1.1 p. 132):
See Exhibit 6-3

Design Speed (6.2.1.2 p. 132):
For an urban single lane roundabout, the maximum entry design speed is 20 mph. For a rural single lane roundabout, the maximum entry design speed is 25 mph (Exhibit 6-4, p. 133).

Design Vehicle (6.2.2, p. 142):
Urban or rural single-lane roundabouts must be designed to accommodate as a minimum the following design vehicles:

1. *if any of the legs is an Interstate ramp use WB-62.*
2. *if any of the legs is a Trunk Highway, use WB-62.*
3. *if any of the legs is a State Aid route, use WB-50 (bus).*
4. *If all legs are local roads, use WB-50 (bus).*
5. *Regardless of jurisdiction, if anticipated truck volume on any leg is greater than 10%, use WB-62.*

Roundabouts shall be designed able to accommodate the largest expected vehicle by using truck aprons, minimal speeds, and curb offsets as necessary.

Non-motorized Design Users (6.2.3, p. 144):
Use key dimensions shown in Exhibit 6-17 (p. 144).

Alignment of Approaches and Entries (6.2.4, p. 144):
The minimum inscribed circle diameter will be sized to accommodate the design vehicle (6.2.4 p.146). The circulatory roadway must be as wide as the widest entry (6.3.2, p.147).

Alignment of Approaches and Entries (6.2.4, p. 144):
The approach centerline shall be aligned through the center or slightly to the left of the inscribed circle (Exhibit 6-18). Alignment to the right of center is not allowed in Minnesota until drivers have become more accustomed to roundabout operation.

Additionally, it is desirable to equally space the angles between entries. This provides optimal separation between successive entries and exits. The optimal angle spacing is 90 degrees for four-leg roundabouts, 72 degrees for five-leg roundabouts, and so on.

Inscribed Diameter (6.3.1, p. 145):
For single lane roundabouts, the inscribed diameter is largely dependent on the turning requirements of the design vehicle. The diameter must be large enough to accommodate the design vehicle while maintaining an adequate deflection curvature to ensure safe travel speeds for smaller vehicles.

Exhibit 6-19 (p. 146) shows inscribed circle diameter ranges. The exhibit shows that for urban single lane roundabouts the inscribed circle diameter range is 100 to 130 feet, and for rural single lane roundabouts the inscribed circle diameter range is 115 to 130 feet.

Entry Width (6.3.2, p. 147):
Entry width is the largest determinant of a roundabout's capacity. Determine the number of approach entry lanes required as described in chapter 4 *(note: at this time, for purposes of public acceptance, double lane roundabouts are not allowed)*. Section 4.3 Capacity (page 86) suggests that roundabouts be designed to operate at no more than 85% of their estimated capacity. Exhibit 4-3 page 87 shows approach capacity for single lane Rb's with 80 – 180 foot inscribed circles. Additional sections of chapter 4 show effects of short flared lanes and pedestrians. The entry width should be kept to a minimum while maintaining capacity. Entry widths shall accommodate turning requirements for the design vehicle. Where future traffic volumes may require a wider entry, but the entry width is too wide for current traffic volumes, a two-phase construction solution may be appropriate so that the entry width can be initially constructed for current traffic but easily modified to accommodate future traffic volumes.

Circulatory Roadway Width (6.3.3, p. 149):
The circulatory roadway should be at least as wide (up to 120%) of the widest entry. The circulatory roadway *shall provide 2 feet* between the outside edge of the design vehicle's tire and the curb line. The circulatory roadway width should just accommodate the design vehicle. Truck aprons should be used only when there is no other means of providing adequate deflection for passenger vehicles while accommodating the larger design vehicle. If a mountable truck apron is necessary, use of a *"D" style curb with a minimum 2-inch height* should be considered between the traffic lane and the mountable truck apron.

Central Island (6.3.4, p.150):
It is important to provide visibility of the central island, especially in rural areas. Islands shall be raised and non-traversable. Island diameter is determined by subtracting the required circulatory roadway width from the required inscribed circle diameter. If the fastest vehicle path is too fast, increase the central island diameter to increase path deflection thereby slowing vehicles (the circulatory roadway width will remain the same while the inscribed circle will increase). Other adjustments as described on FHWA Guide page 151 may alternatively reduce speeds. Mountable aprons *shall have colored and/or textured surfaces* with cross slopes of 3-4% and *shall be raised 1-2 inches above the circulatory roadway surface*. The central island should not be designed to encourage pedestrian traffic.

Entry Curves (6.3.5, p. 152):
Entry curves are measured along the right edge of pavement. The entry radius has a significant impact on capacity and safety, i.e. larger entry radii provide faster entry speeds but generally result in higher crash rates. Entry curves are designed curvilinearly tangential to the outside edge of the circulatory roadway, and the projection of the inside (left) edge of the entry roadway should be curvilinearly tangential to the central island. As shown in FHWA Guide Exhibit 6-24, entry curves are designed to meet speed objectives. They

should also be designed so that the entry path radius is less than or equal to the circulating path radii. Entry radii at urban single-lane roundabouts typically range from 30 to 100 feet, but may be smaller for local streets. Larger radii may be used but should not result in excessive entry speed. The FHWA Guide suggests the use of approach curves or some other speed reduction measure at rural or suburban locations where the approach roadway speed is more than 12 mph greater than the entry speed.

Exit Curves (6.3.6, p. 154):
The right exit curve is designed curvilinearly tangential to the outside edge of the circulatory roadway, and the projection of the inside (left) edge of the exit roadway should be curvilinearly tangential to the central island. As shown in Exhibit 6-25 of the FHWA Guide, the exit curve radii should be equal to or larger than the circulating path radius, yet not so large as to allow an accelerating vehicle to become a hazard to pedestrian traffic (in urban and suburban areas). Width is based on capacity requirements and design vehicle requirements. In urban environments exit speed should be less than 25 mph and the exit radii generally should not be less than 50 feet.

Pedestrian Crossings and Treatments (6.3.7, p. 155):
Pedestrian crossings should be located at least one vehicle length (25 feet) before the yield line but more distance may be necessary based on exit queuing situations. *A minimum 6' wide median pedestrian refuge should be flush with the street surface*. *A physically and visually detectable warning surface in accordance with Americans with Disabilities Act Accessibility Guidelines (ADAAG) or MnDOT design practice shall be considered for the median pedestrian refuge.*

Transportation engineers and planners should make every effort in the design, construction, and operation of roundabouts to accommodate persons who are blind and visually impaired, and as research identifies best practices concerning roundabouts and blind pedestrians, incorporate those practices. (Included per Resolution 2000-05 of the Association of Education and Rehabilitation of the Blind and Visually Impaired (AER))

Splitter Islands (6.3.8, p. 157):
A minimum 50-foot long, raised splitter island shall be provided on all two-way legs of urban and rural roundabouts. They should extend beyond the end of the exit curve. *Curb style shall be vertical ("B" style).* Nose radii and offsets shall be as shown in Exhibit 6-27. Standard American Association of State Highway and Transportation Officials (AASHTO) guidelines for divider islands design should be followed. The island should meet the AASHTO recommendations for required braking distance with an alert driver to determine the ideal splitter island length (painted portion).

Stopping Sight Distance (6.3.9, p. 159):
Stopping Sight Distance (SSD) shall be provided at every point within a roundabout and on each entering and exiting approach. Formulas shown in the most current AASHTO design guide (Green Book) may be used to determine SSD to the entrance crosswalk, to the yield line, on the circulatory roadway, and to the exit crosswalk (see Exhibit 6-29, p. 160).

Intersection Sight Distance (6.3.10, p. 161):
Sufficient Intersection Sight Distance (ISD) shall be provided such that drivers at each entry yield line can see and react to conflicting vehicles in the circulatory roadway. Sufficient ISD shall also be provided such that drivers at each entry stop bar can see and react to objects in the pedestrian crossing. The height of eye and height of object shall be in accordance with the most current AASHTO design guide (Green Book).

Length of Approach Leg of Sight Triangle (6.3.10.1, p. 162):
So that vehicles slow down to focus on the pedestrian crossing prior to entry, the length of the approach leg of the sight triangle should be limited to 50 feet. For longer approach legs, provide landscaping to restrict sight distances.

Length of Conflicting Leg of Sight Triangle (6.3.10.2, p. 162):
Determine the length of the conflicting leg by using Equation 6-3. Check the entering (immediate upstream entry) and circulating (entered prior to immediate upstream entry) traffic streams. The critical gap used in the equation is based on the amount of time required for a vehicle to turn right while requiring the conflicting stream vehicles to slow no less than 70 percent. Alternatively, Exhibit 6-33 lists sight distances for different approach speeds or the most current AASHTO design guide (Green Book) may be used. In general, it is recommended to provide no more than the minimum required intersection sight distance on each approach. Landscaping may be used to restrict excessive sight distances.

The central island shall not include objects that obscure required sight distances nor have grades that endanger an errant vehicle (see chapter 7).

Vertical Considerations (6.3.11, p. 164):
Normal super-elevation should be 2% sloping away from the central island. Roundabouts are not desirable where grades through the intersection or on approach roadways are greater than 4%.

Adequate visibility of roundabouts located at vertical crests shall be provided. If adequate visibility cannot be provided, some other intersection treatment shall be used.

Bicycle Provisions (6.3.12, p. 167):
It is recommended that on-road bicycle lanes be terminated at least 100 feet in advance of the yield line*. Bicycle access shall be provided to shared bike/pedestrian or separate bike facilities in advance of the roundabout*. See Exhibit 6-39 (p. 168).

Sidewalk Treatments (6.3.13, p. 168):
Crossings must be ADA consistent. Sidewalks should be set back 5 feet from roadway where possible to discourage pedestrians from crossing to the central island*. A minimum 2-foot wide setback between the sidewalk and the back of outer circulatory roadway curb shall be provided.*

Parking Considerations and Bus Stop Locations (6.3.14, p. 169):
No parking or bus stops shall be permitted within the circulatory roadway or within 20 feet of the crosswalk.

Double Lane Roundabouts (6.4, p. 172):
Double lane roundabouts are not permitted at this time because typical Minnesota drivers are not familiar with roundabout function.

Rural Roundabouts - Additional Considerations (6.5 p. 176):

Visibility (6.5.1, p. 177):
Adequate visibility is the most important element affecting safety at a rural intersection (not unlike rural intersection with stop signs or signals*). Approaches to rural roundabout shall include text signs placed below the advance pictorial roundabout sign required by the Minnesota Manual on Uniform Traffic Control Devices (MUTCD).* Advance destination guide signs should be used in all rural locations (7.1.4.1, p 191).

Splitter Islands (6.5.3, p. 177):
The AASHTO recommendations for required braking distance with an alert driver should be applied to determine the ideal splitter island length for rural roundabout approaches (Per Exhibit 3-1 of the AASHTO green book, minimum length is 200 feet). Landscaping may be provided to reduce excessive sight distances but shall not obstruct required sight distances.

Approach Curves (6.5.4, p. 178):
At rural and suburban locations, consideration should be given to the speed differential between the approach and entry speeds. If the difference is greater that 12 mph, it is desirable to introduce approach curves or some other speed reduction measure to reduce the speed of approaching traffic prior to the entry curve.

END

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