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CONTENTS

ROUNDABOUTS:

AN INFORMATIONAL GUIDE

U.S. Department of Transportation

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16. Abstract

The guidance supplied in this document, *Roundabouts: An Informational Guide,* is based on established international and U.S. practices and is supplemented by recent research. The guide is comprehensive in recognition of the diverse needs of transportation professionals and the public for introductory material through design detail, as well as the wide range of potential applications of roundabout intersections. The following topics are addressed: definition of a roundabout and what distinguishes roundabouts from traffic circles; public acceptance and legal issues associated with roundabouts; consideration of all user modes, including heavy vehicles, buses, transit, bicycles, and pedestrians; a methodology for identifying appropriate sites for roundabouts and the range of conditions for which roundabouts offer optimal performance; methodologies for estimating roundabout capacity, delays, and queues with reference to the *Highway Capacity Manual*; design principles and guidance on safety and geometric design, with reference to applicable national standards such as the *AASHTO Policy on Geometric Design of Highways and Streets*; guidelines for control features such as signing and pavement markings, with reference to the *Manual on Uniform Traffic Control Devices*; illumination; and landscaping.

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Foreword

Roundabouts are a form of intersection control in common use throughout the world. Until recently, many transportation professionals and agencies in the United States have been hesitant to recommend and install roundabouts, however, due to a lack of objective nationwide guidelines on planning, performance, and design of roundabouts. Prior to the development of this guide, transportation professionals who were interested in roundabouts had to rely on foreign roundabout design guides, consultants with roundabout experience, or in some States, statewide roundabout design guides. To facilitate safe, optimal operation and designs that are both consistent at a national level and consequential for driver expectation and safety, the Federal Highway Administration (FHWA) developed this informational guide on roundabouts.

The information supplied in this document, *Roundabouts: An Informational Guide,* is based on established international and U.S. practices and is supplemented by recent research. The guide is comprehensive in recognition of the diverse needs of transportation professionals and the public for introductory material through design detail, as well as the wide range of potential applications of roundabout intersections.

Roundabout operation and safety performance are particularly sensitive to geometric design elements. Uncertainty regarding evaluation procedures can result in over-design and less safety. The "design problem" is essentially one of determining a design that will accommodate the traffic demand while minimizing some combination of delay, crashes, and cost to all users, including motor vehicles, pedestrians, and bicyclists. Evaluation procedures are suggested, or information is provided, to quantify and cost how well a design achieves each of these aims.

Since there is no absolutely optimum design, this guide is not intended as an inflexible "rule book," but rather attempts to explain some principles of good design and indicate potential tradeoffs. In this respect, the "design space" consists of performance evaluation models and design principles such as those provided in this guide, combined with the expert heuristic knowledge of a designer. Adherence to these principles still does not ensure good design, which remains the responsibility of the designer.

Michael F. Trentacoste
Director, Office of Safety Research and Development

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Barry Crown: Exhibits 8-6, 8-7

Ken Courage: Exhibit 1-5 (g, Portland)

Lee Rodegerdts: Exhibits 1-5 (all except g, Portland), 1-6 (all except Fort Pierce), 2-4 (all except Fort Pierce), 3-3, 3-4, 6-23, 6-42, 7-10 (all), 7-11 (all), 7-14 (all), 7-16 (all), 7-22, 8-7, 8-8, 8-9, C-3 (a, d–i, k–n)

Paul Ryus: Exhibits 1-6 (Fort Pierce), 2-4 (Fort Pierce), C-3 (b, c, j)

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Chapter 1 Introduction

Circular intersections were first introduced in the U.S. in 1905.

Traffic circles have been part of the transportation system in the United States since 1905, when the Columbus Circle designed by William Phelps Eno opened in New York City. Subsequently, many large circles or rotaries were built in the United States. The prevailing designs enabled high-speed merging and weaving of vehicles. Priority was given to entering vehicles, facilitating high-speed entries. High crash experience and congestion in the circles led to rotaries falling out of favor in America after the mid-1950's. Internationally, the experience with traffic circles was equally negative, with many countries experiencing circles that locked up as traffic volumes increased.

The modern roundabout was developed in the United Kingdom in the 1960's.

The modern roundabout was developed in the United Kingdom to rectify problems associated with these traffic circles. In 1966, the United Kingdom adopted a mandatory "give-way" rule at all circular intersections, which required entering traffic to give way, or yield, to circulating traffic. This rule prevented circular intersections from locking up, by not allowing vehicles to enter the intersection until there were sufficient gaps in circulating traffic. In addition, smaller circular intersections were proposed that required adequate horizontal curvature of vehicle paths to achieve slower entry and circulating speeds.

Modern roundabouts provide substantially better operational and safety characteristics than older traffic circles and rotaries.

These changes improved the safety characteristics of the circular intersections by reducing the number and particularly the severity of collisions. Thus, the resultant modern roundabout is significantly different from the older style traffic circle both in how it operates and in how it is designed. The modern roundabout represents a substantial improvement, in terms of operations and safety, when compared with older rotaries and traffic circles (1, 2, 3). Therefore, many countries have adopted them as a common intersection form and some have developed extensive design guides and methods to evaluate the operational performance of modern roundabouts.

1.1 Scope of the Guide

This guide provides information and guidance on roundabouts, resulting in designs that are suitable for a variety of typical conditions in the United States. The scope of this guide is to provide general information, planning techniques, evaluation procedures for assessing operational and safety performance, and design guidelines for roundabouts.

International consensus has not been achieved on some aspects of roundabout design.

This guide has been developed with the input from transportation practitioners and researchers from around the world. In many cases, items from national and international practice and research indicate considerable consensus, and these items have been included in this guide. However, other items have generated considerable differences of opinion (e.g., methods of estimating capacity), and some practices vary considerably from country to country (e.g., marking of the circulatory roadway in multilane roundabouts). Where international consensus is not apparent, a reasoned approach is presented that the authors believe is currently most appropriate for the United States. As more roundabouts are built, the opportunity to conduct research to refine—or develop better—methods will enable future editions of this guide to improve.

Despite the comprehensive nature of this document, it cannot discuss every issue related to roundabouts. In particular, it does not represent the following topics:

Topics not discussed in this guide.

- *Nonmountable traffic calming circles.* These are small traffic circles with raised central islands. They are typically used on local streets for speed and volume control. They are typically not designed to accommodate large vehicles, and often left-turning traffic is required to turn left in front of the circle. Mini-roundabouts, which are presented, may be an appropriate substitute.
- *Specific legal or policy requirements and language.* The legal information that is provided in this guide is intended only to make the reader aware of potential issues. The reader is encouraged to consult with an attorney on specific legal issues before adopting any of the recommendations contained herein. Similarly, regarding policy information, the guide refers to or encompasses applicable policies, such as those of the American Association of State Highway and Transportation Officials (AASHTO) (4). It does not, however, establish any new policies.
- *Roundabouts with more than two entry lanes on an approach.* While acknowledging the existence and potential of such large roundabouts, the guide does not provide specific guidance on the analysis or design of such roundabouts. However, the design principles contained in this document are also applicable to larger roundabouts. The relative safety advantages of roundabout intersections diminish at high traffic flows, particularly with regard to pedestrians and bicyclists. The advantages of larger roundabouts are their higher capacities that may make them attractive alternatives at sites with high traffic volumes. More intricate design is required to ensure adequate operational and safety performance. Therefore, expert operations and design advice should be sought and roundabout analysis software should be utilized in such circumstances. As users and designers in the United States become more familiar with roundabouts, this experience may then be extended to such applications.

1.2 Organization of the Guide

This guide has been structured to address the needs of a variety of readers including the general public, policy-makers, transportation planners, operations and safety analysts, conceptual and detailed designers. This chapter distinguishes roundabouts from other traffic circles and defines the types of roundabouts addressed in the remainder of the guide. The remaining chapters in this guide generally increase in the level of detail provided.

Chapter 2—Policy Considerations: This chapter provides a broad overview of the performance characteristics of roundabouts. The costs associated with roundabouts versus other forms of intersections, legal issues, and public involvement techniques are discussed.

Chapter 3—Planning: This chapter discusses general guidelines for identifying appropriate intersection control options, given daily traffic volumes, and procedures for evaluating the feasibility of a roundabout at a given location. Chapters 2 and 3 provide sufficient detail to enable a transportation planner to decide under which circumstances roundabouts are likely to be appropriate, and how they compare to alternatives at a specific location.

Chapter 4—Operational Analysis: Methods are presented for analyzing the operational performance of each category of roundabout in terms of capacity, delay, and queuing.

Chapter 5—Safety: This chapter discusses the expected safety performance of roundabouts.

Chapter 6—Geometric Design: Specific geometric design principles for roundabouts are presented. The chapter then discusses each design element in detail, along with appropriate parameters to use for each type of roundabout.

Chapter 7—Traffic Design and Landscaping: This chapter discusses a number of traffic design aspects once the basic geometric design has been established. These include signs, pavement markings, and illumination. In addition, the chapter provides discussion on traffic maintenance during construction and landscaping.

Chapter 8—System Considerations: This chapter discusses specific issues and treatments that may arise from the systems context of a roundabout. The material may be of interest to transportation planners as well as operations and design engineers. Signal control at roundabouts is discussed. The chapter then considers the issue of rail crossings through the roundabout or in close proximity. Roundabouts in series with other roundabouts are discussed, including those at freeway interchanges and those in signalized arterial networks. Finally, the chapter presents simulation models as supplementary operational tools capable of evaluating roundabout performance within an overall roadway system.

Appendices: Three appendices are provided to expand upon topics in certain chapters. Appendix A provides information on the capacity models in Chapter 4. Appendix B provides design templates for each of the categories of roundabout described in Chapter 1, assuming four perpendicular legs. Appendix C provides information on the alternative signing and pavement marking in Chapter 7.

Margin notes have been used to highlight important points.

Several typographical devices have been used to enhance the readability of the guide. Margin notes, such as the note next to this paragraph, highlight important points or identify cross-references to other chapters of the guide. References have been listed at the end of each chapter and have been indicated in the text using numbers in parentheses, such as: (3). New terms are presented in *italics* and are defined in the glossary at the end of the document.

1.3 Defining Physical Features

A roundabout is a type of circular intersection, but not all circular intersections can be classified as roundabouts. In fact, there are at least three distinct types of circular intersections:

Types of circular intersections.

- *Rotaries* are old-style circular intersections common to the United States prior to the 1960's. Rotaries are characterized by a large diameter, often in excess of 100 m (300 ft). This large diameter typically results in travel speeds within the circulatory roadway that exceed 50 km/h (30 mph). They typically provide little or no horizontal deflection of the paths of through traffic and may even operate according to the traditional "yield-to-the-right" rule, i.e., circulating traffic yields to entering traffic.
- *Neighborhood traffic circles* are typically built at the intersections of local streets for reasons of traffic calming and/or aesthetics. The intersection approaches may be uncontrolled or stop-controlled. They do not typically include raised channelization to guide the approaching driver onto the circulatory roadway. At some traffic circles, left-turning movements are allowed to occur to the left of (clockwise around) the central island, potentially conflicting with other circulating traffic.
- *Roundabouts* are circular intersections with specific design and traffic control features. These features include yield control of all entering traffic, channelized approaches, and appropriate geometric curvature to ensure that travel speeds on the circulatory roadway are typically less than 50 km/h (30 mph). Thus, roundabouts are a subset of a wide range of circular intersection forms.

Key roundabout features include:

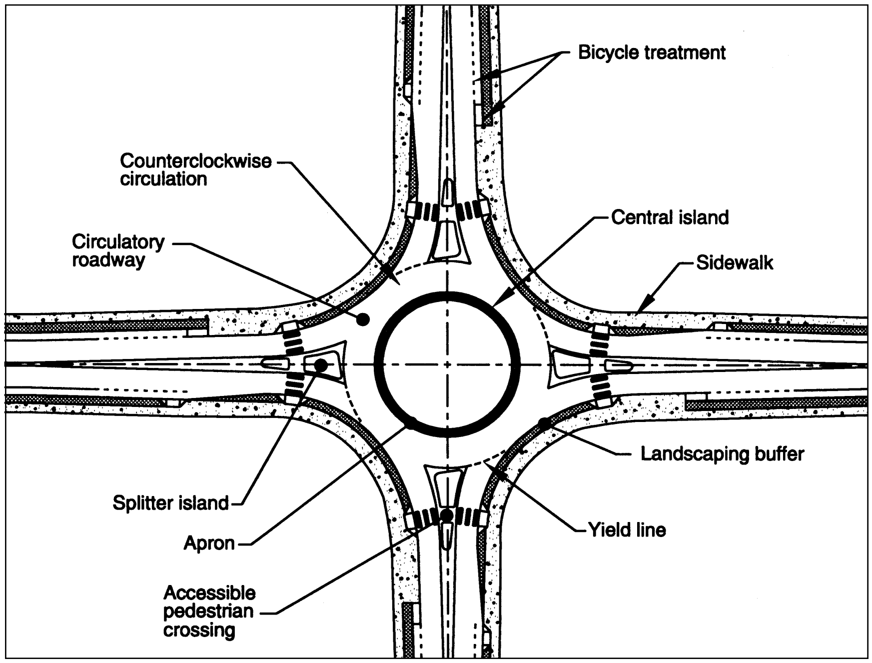
- **Yield control of entering traffic**
- **Channelized approaches**
- **Appropriate geometric curvature to slow speeds**

To more clearly identify the defining characteristics of a roundabout, consistent definitions for each of the key features, dimensions, and terms are used throughout this guide. Exhibit 1-1 is a drawing of a typical roundabout, annotated to identify the key features. Exhibit 1-2 provides a description of each of the key features.

1.4 Key Dimensions

For operational analysis and design purposes, it is useful to define a number of key dimensions. Exhibit 1-3 shows a number of key dimensions that are described in Exhibit 1-4. Note that these exhibits do not present all of the dimensions needed in the detailed analysis and design of roundabouts; these will be presented and defined in later chapters as needed.

Exhibit 1-1. Drawing of key roundabout features.



Splitter islands have multiple roles. They:

- **Separate entering and exiting traffic**
- **Deflect and slow entering traffic**
- **Provide a pedestrian refuge**

Exhibit 1-2. Description of key roundabout features.

Feature	Description
Central island	The *central island* is the raised area in the center of a roundabout around which traffic circulates.
Splitter island	A *splitter island* is a raised or painted area on an approach used to separate entering from exiting traffic, deflect and slow entering traffic, and provide storage space for pedestrians crossing the road in two stages.
Circulatory roadway	The *circulatory roadway* is the curved path used by vehicles to travel in a counter-clockwise fashion around the central island
Apron	If required on smaller roundabouts to accommodate the wheel tracking of large vehicles, an *apron* is the mountable portion of the central island adjacent to the circulatory roadway.
Yield line	A *yield line* is a pavement marking used to mark the point of entry from an approach into the circulatory roadway and is generally marked along the inscribed circle. Entering vehicles must yield to any circulating traffic coming from the left before crossing this line into the circulatory roadway.
Accessible pedestrian crossings	*Accessible pedestrian crossings* should be provided at all roundabouts. The crossing location is set back from the yield line, and the splitter island is cut to allow pedestrians, wheelchairs, strollers, and bicycles to pass through.
Bicycle treatments	*Bicycle treatments* at roundabouts provide bicyclists the option of traveling through the roundabout either as a vehicle or as a pedestrian, depending on the bicyclist's level of comfort.
Landscaping buffer	*Landscaping buffers* are provided at most roundabouts to separate vehicular and pedestrian traffic and to encourage pedestrians to cross only at the designated crossing locations. Landscaping buffers can also significantly improve the aesthetics of the intersection.

Exhibit 1-3. Drawing of key roundabout dimensions.

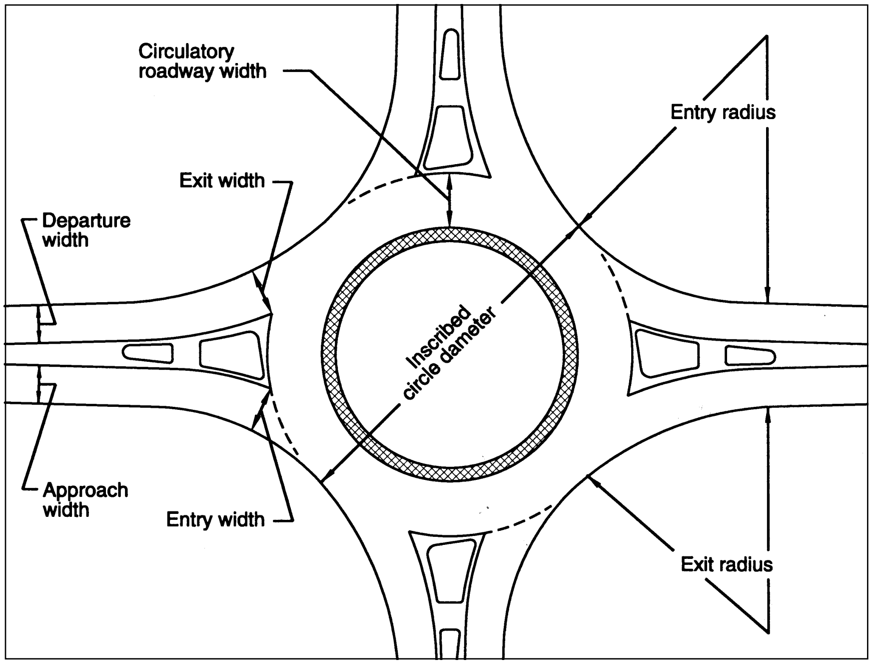


Exhibit 1-4. Description of key roundabout dimensions.

Dimension	Description
Inscribed circle diameter	The *inscribed circle diameter* is the basic parameter used to define the size of a roundabout. It is measured between the outer edges of the circulatory roadway.
Circulatory roadway width	The *circulatory roadway width* defines the roadway width for vehicle circulation around the central island. It is measured as the width between the outer edge of this roadway and the central island. It does not include the width of any mountable apron, which is defined to be part of the central island.
Approach width	The *approach width* is the width of the roadway used by approaching traffic upstream of any changes in width associated with the roundabout. The approach width is typically no more than half of the total width of the roadway.
Departure width	The *departure width* is the width of the roadway used by departing traffic downstream of any changes in width associated with the roundabout. The departure width is typically less than or equal to half of the total width of the roadway.
Entry width	The *entry width* defines the width of the entry where it meets the inscribed circle. It is measured perpendicularly from the right edge of the entry to the intersection point of the left edge line and the inscribed circle.
Exit width	The *exit width* defines the width of the exit where it meets the inscribed circle. It is measured perpendicularly from the right edge of the exit to the intersection point of the left edge line and the inscribed circle.
Entry radius	The *entry radius* is the minimum radius of curvature of the outside curb at the entry.
Exit radius	The *exit radius* is the minimum radius of curvature of the outside curb at the exit.

1.5 Distinguishing Roundabouts from Other Circular Intersections

Since the purpose of this guide is to assist in the planning, design, and performance evaluation of roundabouts, not other circular intersections, it is important to be able to distinguish between them. Since these distinctions may not always be obvious, the negative aspects of rotaries or neighborhood traffic circles (hereafter referred to as "*traffic circles*") may be mistaken by the public for a roundabout. Therefore, the ability to carefully distinguish roundabouts from traffic circles is important in terms of public understanding.

Circular intersections that do not conform to the characteristics of modern roundabouts are called "traffic circles" in this guide.

How then does one distinguish a roundabout from other forms of circular intersection? Exhibit 1-5 identifies some of the major characteristics of roundabouts and contrasts them with other traffic circles. Note that some of the traffic circles shown have many of the features associated with roundabouts but are deficient in one or more critical areas. Note also that these characteristics apply to yield-controlled roundabouts; signalized roundabouts are a special case discussed in Chapter 8.

Exhibit 1-5. Comparison of roundabouts with traffic circles.

Roundabouts must have all of the characteristics listed in the left column.

Chapter 8 discusses signalization at roundabouts.

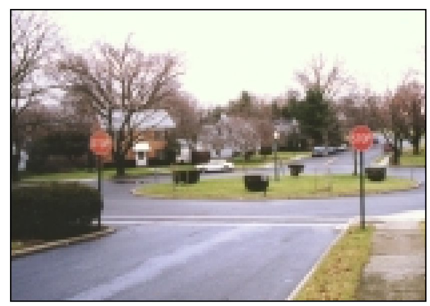
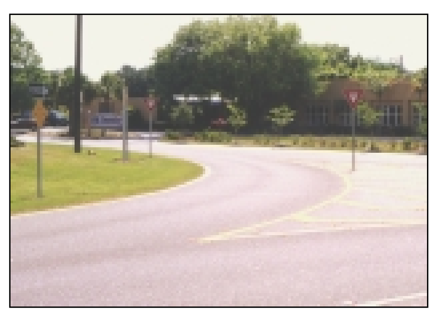
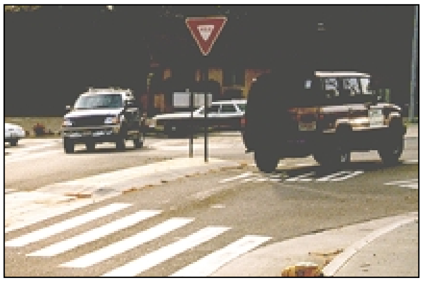
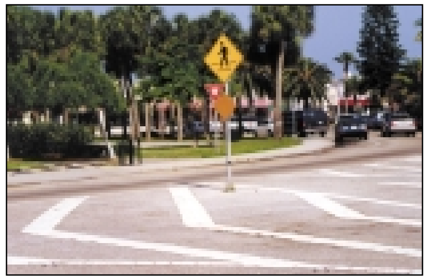
Roundabouts	Traffic Circles
	
(a) Traffic control Yield control is used on all entries. The circulatory roadway has no control. *Santa Barbara, CA*	Some traffic circles use stop control, or no control, on one or more entries. *Hagerstown, MD*
	
(b) Priority to circulating vehicles Circulating vehicles have the right-of-way. *Santa Barbara, CA*	Some traffic circles require circulating traffic to yield to entering traffic. *Sarasota, FL*

Exhibit 1-5. (continued). Comparison of roundabouts with traffic circles.

Roundabouts	Traffic Circles





(c) Pedestrian access
Pedestrian access is allowed only across the legs of the roundabout, behind the yield line. *Santa Barbara, CA*

Some traffic circles allow pedestrian access to the central island. *Sarasota, FL*

(d) Parking
No parking is allowed within the circulatory roadway or at the entries. *Avon, CO*

Some traffic circles allow parking within the circulatory roadway. *Sarasota, FL*

(e) Direction of circulation
All vehicles circulate counter-clockwise and pass to the right of the central island. *Naples, FL*

Some neighborhood traffic circles allow left-turning vehicles to pass to the left of the central island. *Portland, OR*

All traffic circulates counter-clockwise around a roundabouts central island.

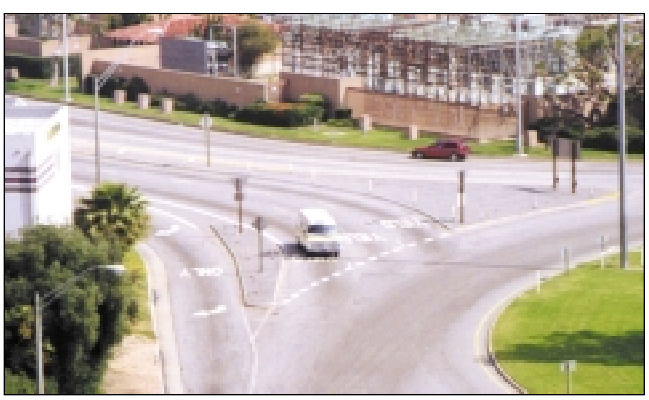
In addition to the design elements identified in Exhibit 1-5, roundabouts often include one or more additional design elements intended to enhance the safety and/or capacity of the intersection. However, their absence does not necessarily preclude an intersection from operating as a roundabout. These additional elements are identified in Exhibit 1-6.

Exhibit 1-6. Common design elements at roundabouts.

Roundabouts may have these additional design features.

Characteristic	Description
(a) Adequate speed reduction	 Good roundabout design requires entering vehicles to negotiate a small enough radius to slow speeds to no greater than 50 km/h (30 mph). Once within the circulatory roadway, vehicles' paths are further deflected by the central island. *West Boca Raton, FL*  Some roundabouts allow high-speed entries for major movements. This increases the risk for more severe collisions for vehicles, bicycles, and pedestrians. *Bradenton Beach, FL*

Exhibit 1-6 (continued). Common design elements at roundabouts.

Characteristic	Description
(b) Design vehicle	 Good roundabout design makes accommodation for the appropriate design vehicle. For small roundabouts, this may require the use of an apron. *Lothian, MD*
	 Some roundabouts are too small to accommodate large vehicles that periodically approach the intersection. *Naples, FL*
(c) Entry flare	 Flare on an entry to a roundabout is the widening of an approach to multiple lanes to provide additional capacity and storage at the yield line. *Long Beach, CA*

Aprons can be used in small roundabouts to accommodate the occasional large vehicle that may use the intersection.

Exhibit 1-6 (continued). Common design elements at roundabouts.

Characteristic	Description
(d) Splitter island	 All except mini-roundabouts have raised splitter islands. These are designed to separate traffic moving in opposite directions, deflect entering traffic, and to provide opportunities for pedestrians to cross in two stages. Mini-roundabouts may have splitter islands defined only by pavement markings. *Tavares, FL*
(e) Pedestrian crossing locations	 Pedestrian crossings are located at least one vehicle length upstream of the yield point. *Fort Pierce, FL*

1.6 Roundabout Categories

For the purposes of this guide, roundabouts have been categorized according to size and environment to facilitate discussion of specific performance or design issues. There are six basic categories based on environment, number of lanes, and size:

This guide uses six basic roundabout categories.

- Mini-roundabouts
- Urban compact roundabouts
- Urban single-lane roundabouts
- Urban double-lane roundabouts
- Rural single-lane roundabouts
- Rural double-lane roundabouts

Multilane roundabouts with more than two approach lanes are possible, but not explicitly covered in this guide.

Multilane roundabouts with more than two approach lanes are possible, but they are not covered explicitly by this guide, although many of the design principles contained in this guide would still apply. For example, the guide provides guidance on the design of flaring approaches from one to two lanes. Although not explicitly discussed, this guidance could be extended to the design of larger roundabout entries.

Note that separate categories have not been explicitly identified for suburban environments. Suburban settings may combine higher approach speeds common in rural areas with multimodal activity that is more similar to urban settings. Therefore, they should generally be designed as urban roundabouts, but with the high-speed approach treatments recommended for rural roundabouts.

Suburban roundabouts incorporate elements of both urban and rural roundabouts.

In most cases, designers should anticipate the needs of pedestrians, bicyclists, and large vehicles. Whenever a raised splitter island is provided, there should also be an at-grade pedestrian refuge. In this case, the pedestrian crossing facilitates two separate moves: curb-to-island and island-to-curb. The exit crossing will typically require more vigilance from the pedestrian and motorist than the entry crossing. Further, it is recommended that all urban crosswalks be marked. Under all urban design categories, special attention should be given to assist pedestrian users who are visually impaired or blind, through design elements. For example, these users typically attempt to maintain their approach alignment to continue across a street in the crosswalk, since the crosswalk is often a direct extension of the sidewalk. A roundabout requires deviation from that alignment, and attention needs to be given to providing appropriate informational cues to pedestrians regarding the location of the sidewalk and the crosswalk, even at mini-roundabouts. For example, appropriate landscaping is one method of providing some information. Another is to align the crosswalk ramps perpendicular to the pedestrian's line of travel through the pedestrian refuge.

Roundabout design should generally accommodate pedestrian, bicycle, and large vehicle use.

1.6.1 Comparison of roundabout categories

Exhibit 1-7 summarizes and compares some fundamental design and operational elements for each of the six roundabout categories developed for this guide. The following sections provide a qualitative discussion of each category.

Exhibit 1-7. Basic design characteristics for each of the six roundabout categories.

Design Element	Mini-Roundabout	Urban Compact	Urban Single-Lane	Urban Double-Lane	Rural Single-Lane	Rural Double-Lane
Recommended maximum entry design speed	25 km/h (15 mph)	25 km/h (15 mph)	35 km/h (20 mph)	40 km/h (25 mph)	40 km/h (25 mph)	50 km/h (30 mph)
Maximum number of entering lanes per approach	1	1	1	2	1	2
Typical inscribed circle diameter[1]	13 m to 25 m (45 ft to 80 ft)	25 to 30 m (80 to 100 ft)	30 to 40 m (100 to 130 ft)	45 to 55 m (150 to 180 ft)	35 to 40 m (115 to 130 ft)	55 to 60 m (180 to 200 ft)
Splitter island treatment	Raised if possible, crosswalk cut if raised	Raised, with crosswalk cut	Raised, with crosswalk cut	Raised, with crosswalk cut	Raised and extended, with crosswalk cut	Raised and extended, with crosswalk cut
Typical daily service volumes on 4-leg roundabout (veh/day)	10,000	15,000	20,000	Refer to Chapter 4 procedures	20,000	Refer to Chapter 4 procedures

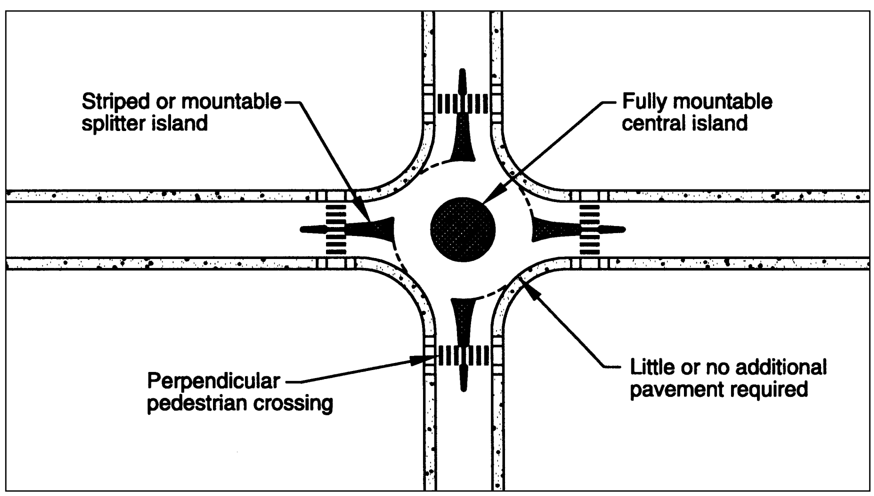
1. Assumes 90-degree entries and no more than four legs.

1.6.2 Mini-roundabouts

Mini-roundabouts can be useful in low-speed urban environments with right-of-way constraints.

Mini-roundabouts are small roundabouts used in low-speed urban environments, with average operating speeds of 60km/h (35mph) or less. Exhibit 1-8 provides an example of a typical mini-roundabout. They can be useful in low-speed urban environments in cases where conventional roundabout design is precluded by right-of-way constraints. In retrofit applications, mini-roundabouts are relatively inexpensive because they typically require minimal additional pavement at the intersecting roads-for example, minor widening at the corner curbs. They are mostly recommended when there is insufficient right-of-way for an urban compact roundabout. Because they are small, mini-roundabouts are perceived as pedestrian-friendly with short crossing distances and very low vehicle speeds on approaches and exits. The mini-roundabout is designed to accommodate passenger cars without requiring them to drive over the central island. To maintain its perceived compactness and low speed characteristics, the yield lines are positioned just outside of the swept path of the largest expected vehicle. However, the central island is mountable, and larger vehicles may cross over the central island, but not to the left of it. Speed control around the mountable central island should be provided in the design by requiring horizontal deflection. Capacity for this type of roundabout is expected to be similar to that of the compact urban roundabout. The recommended design of these roundabouts is based on the German method, with some influence from the United Kingdom.

Exhibit 1-8. Typical mini-roundabout.



1.6.3 Urban compact roundabouts

Like mini-roundabouts, urban compact roundabouts are intended to be pedestrian- and bicyclist-friendly because their perpendicular approach legs require very low vehicle speeds to make a distinct right turn into and out of the circulatory roadway. All legs have single-lane entries. However, the urban compact treatment meets all the design requirements of effective roundabouts. The principal objective of this design is to enable pedestrians to have safe and effective use of the intersection. Capacity should not be a critical issue for this type of roundabout to be considered. The geometric design includes raised splitter islands that incorporate at-grade pedestrian storage areas, and a nonmountable central island. There is usually an apron surrounding the nonmountable part of the compact central island to accommodate large vehicles. The recommended design of these roundabouts is similar to those in Germany and other northern European countries. Exhibit 1-9 provides an example of a typical urban compact roundabout.

Urban compact roundabouts are intended to be pedestrian-friendly; capacity should not be a critical issue when considering this type.

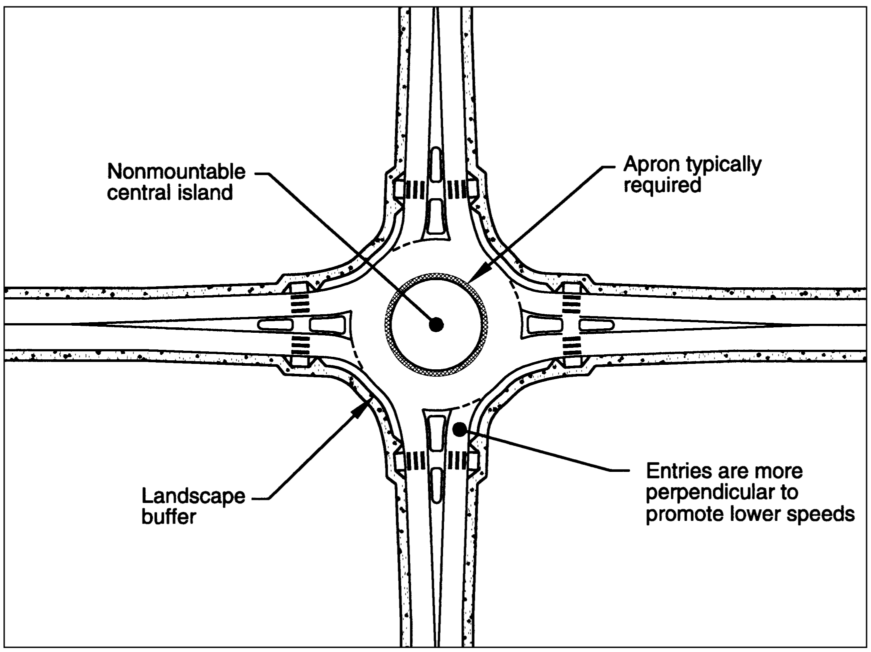


Exhibit 1-9. Typical urban compact roundabout.

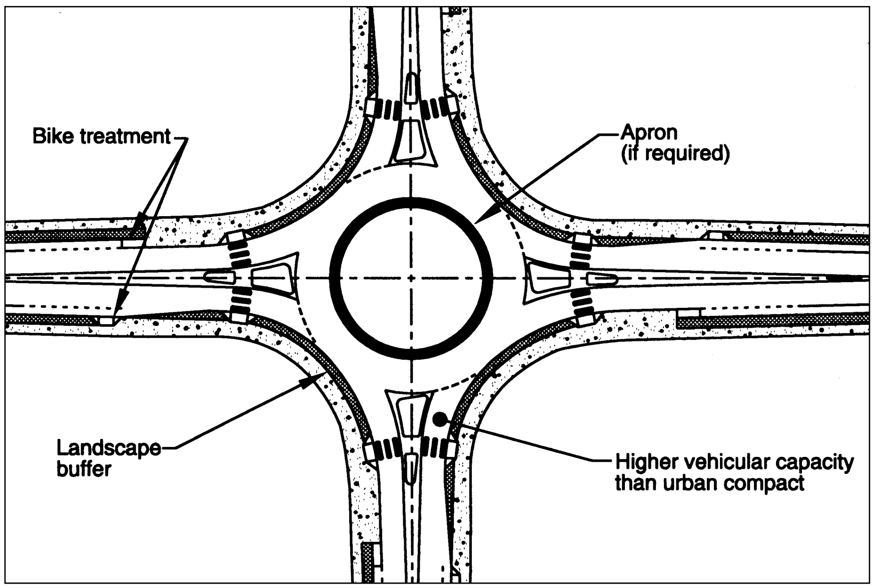
1.6.4 Urban single-lane roundabouts

Urban single-lane roundabouts have slightly higher speeds and capacities than urban compact roundabouts.

This type of roundabout is characterized as having a single lane entry at all legs and one circulatory lane. Exhibit 1-10 provides an example of a typical urban single-lane roundabout. They are distinguished from urban compact roundabouts by their larger inscribed circle diameters and more tangential entries and exits, resulting in higher capacities. Their design allows slightly higher speeds at the entry, on the circulatory roadway, and at the exit. Notwithstanding the larger inscribed circle diameters than compact roundabouts, the speed ranges recommended in this guide 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 nonmountable central island, and preferably, no apron. The design of these roundabouts is similar to those in Australia, France, and the United Kingdom.

The design focuses on consistent entering and exiting speeds.

Exhibit 1-10. Typical urban single-lane roundabout.



1.6.5 Urban double-lane roundabouts

Urban double-lane roundabouts include all roundabouts in urban areas that have at least one entry with two lanes. They include roundabouts with entries on one or more approaches that flare from one to two lanes. These require wider circulatory roadways to accommodate more than one vehicle traveling side by side. Exhibit 1-11 provides an example of a typical urban multilane roundabout. The speeds at the entry, on the circulatory roadway, and at the exit are similar to those for the urban single-lane roundabouts. Again, it is important that the vehicular speeds be consistent throughout the roundabout. The geometric design will include raised splitter islands, no truck apron, a nonmountable central island, and appropriate horizontal deflection.

The urban double-lane roundabout category includes roundabouts with one or more entries that flare from one to two lanes.

Alternate routes may be provided for bicyclists who choose to bypass the roundabout. Bicycle and pedestrian pathways must be clearly delineated with sidewalk construction and landscaping to direct users to the appropriate crossing locations and alignment. Urban double-lane roundabouts located in areas with high pedestrian or bicycle volumes may have special design recommendations such as those provided in Chapters 6 and 7. The design of these roundabouts is based on the methods used in the United Kingdom, with influences from Australia and France.

See Chapters 6 and 7 for special design considerations for pedestrians and bicycles.

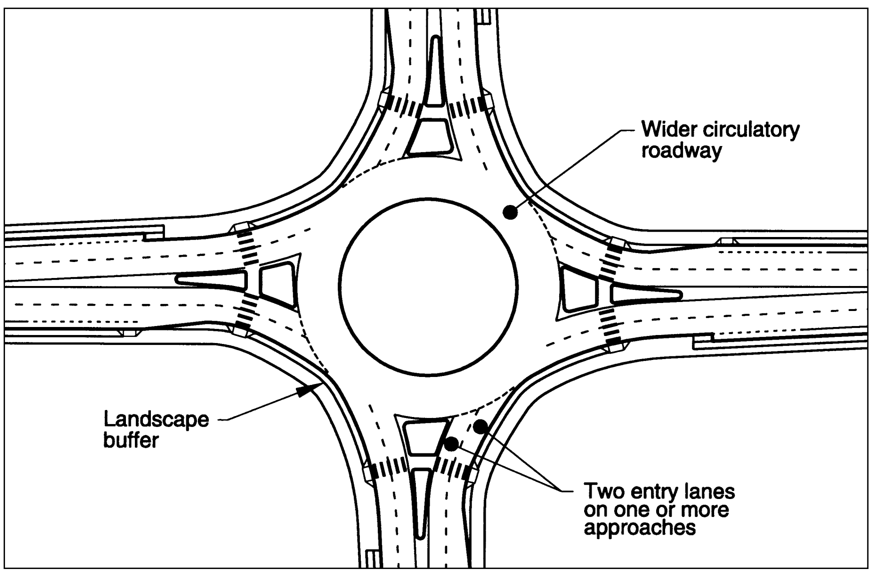


Exhibit 1-11. Typical urban double-lane roundabout.

1.6.6 Rural single-lane roundabouts

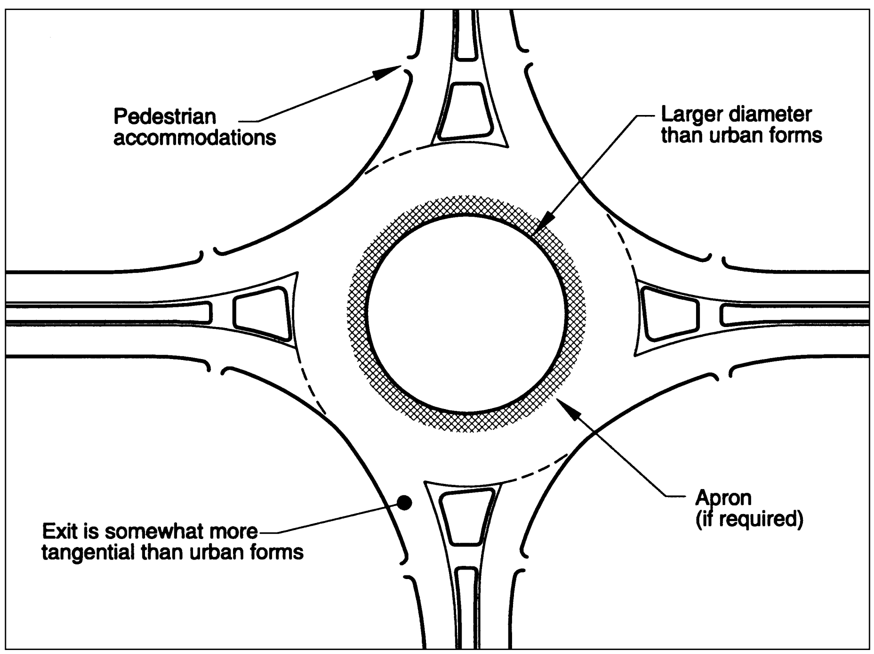
Because of their higher approach speeds, rural single-lane roundabouts require supplementary geometric and traffic control device treatments on the approaches.

Rural single-lane roundabouts generally have high average approach speeds in the range of 80 to 100 km/h (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 nonmountable central island, and adequate horizontal deflection. The design of these roundabouts is based primarily on the methods used by Australia, France, and the United Kingdom. Exhibit 1-12 provides an example of a typical rural single-lane roundabout.

Rural roundabouts that may become part of an urbanized area should include urban roundabout design features.

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.

Exhibit 1-12. Typical rural single-lane roundabout.



1.6.7 Rural double-lane roundabouts

Rural double-lane roundabouts have speed characteristics similar to rural single-lane roundabouts with average approach speeds in the range of 80 to 100 km/h (50 to 60 mph). They differ in having two entry lanes, or entries flared from one to two lanes, on one or more approaches. Consequently, many of the characteristics and design features of rural double-lane roundabouts mirror those of their urban counterparts. The main design differences are designs with higher entry speeds and larger diameters, and recommended supplementary approach treatments. The design of these roundabouts is based on the methods used by the United Kingdom, Australia, and France. Exhibit 1-13 provides an example of a typical rural double-lane roundabout. Rural roundabouts that may one day become part of an urbanized area should be designed for slower speeds, with design details that fully accommodate pedestrians and bicyclists. However, in the interim they should be designed with approach and entry features to achieve safe speed reduction.

Rural double-lane roundabouts have higher entry speeds and larger diameters than their urban counterparts.

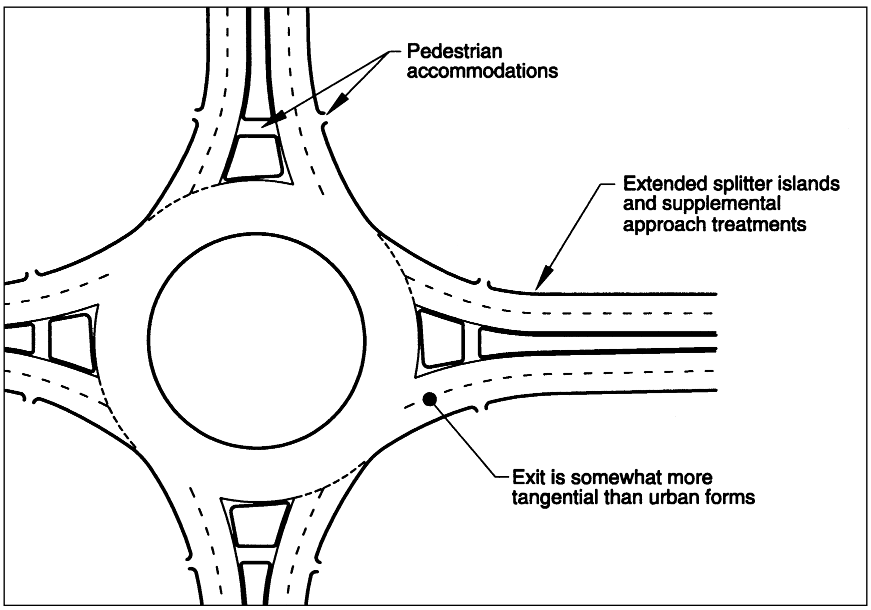


Exhibit 1-13. Typical rural double-lane roundabout.

1.7 References

1. Brown, M. *TRL State of the Art Review—The Design of Roundabouts.* London: HMSO, 1995.
2. Todd, K. "A history of roundabouts in Britain." *Transportation Quarterly,* Vol. 45, No. 1, January 1991.
3. Jacquemart, G. *Synthesis of Highway Practice 264: Modern Roundabout Practice in the United States.* National Cooperative Highway Research Program. Washington, D.C: National Academy Press, 1998.
4. American Association of State Highway and Transportation Officials (AASHTO). *A Policy on Geometric Design of Highways and Streets.* Washington, D.C.: AASHTO, 1994.