

# KANSAS ROUNDABOUT GUIDE SECOND EDITION 2014

A COMPANION TO  
**NCHRP REPORT 672**  
**ROUNDABOUTS: AN INFORMATIONAL GUIDE**  
SECOND EDITION



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## CONTENTS

<b>Chapter 1</b>	<b>Introduction</b>
<b>Chapter 2</b>	<b>Roundabout Considerations</b>
<b>Chapter 3</b>	<b>Planning</b>
<b>Chapter 4</b>	<b>Operational Analysis</b>
<b>Chapter 5</b>	<b>Safety</b>
<b>Chapter 6</b>	<b>Geometric Design</b>
<b>Chapter 7</b>	<b>Application of Traffic Control Devices</b>
<b>Chapter 8</b>	<b>Illumination</b>
<b>Chapter 9</b>	<b>Landscaping</b>
<b>Chapter 10</b>	<b>Construction and Maintenance</b>
<b>Appendix A</b>	<b>Public Meeting Material</b>
<b>Appendix B</b>	<b>Shoofly Bypass Examples</b>
<b>Appendix C</b>	<b>Example Joint Layouts</b>
<b>Appendix D</b>	<b>Example Signing Plans</b>
<b>Appendix E</b>	<b>US-77/US-166 Roundabout</b>
<b>Appendix F</b>	<b>US-400/K-47 Roundabout</b>
<b>Appendix G</b>	<b>US-75/K-31/K-268 Roundabout</b>
<b>Appendix H</b>	<b>K-7/Johnson Drive/55<sup>th</sup> Street Interchange Roundabout</b>
<b>Appendix I</b>	<b>K-18/Scenic Drive Roundabout</b>

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# **Chapter 1**

## **Introduction**

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**CHAPTER 1  
INTRODUCTION**

**CONTENTS**

**Chapter 1 Introduction ..... 1**

1.1 Purpose and Scope of the Guide ..... 1

1.2 Organization of the Guide..... 1

1.3 Roundabout Design Features..... 3

    1.3.1 Other Types of Circular Intersections..... 4

    1.3.2 Categories of Roundabouts..... 7

        1.3.2.1 Mini Roundabouts..... 7

        1.3.2.2 Single-Lane Roundabouts..... 8

        1.3.2.3 Multilane Roundabouts..... 9

1.4 Roundabout Settings ..... 9

1.5 Considerations for Roundabout Design..... 12

1.6 References ..... 14

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**LIST OF EXHIBITS**

Exhibit 1-1 Key Roundabout Features shown at the East Sheridan Street/  
South Rogers Road intersection in Olathe, Kansas..... 3

Exhibit 1-2 Description of Key Roundabout Features..... 4

Exhibit 1-3 Meyer Circle located on Ward Parkway in Kansas City, Missouri .... 5

Exhibit 1-4 DuPont Circle in Washington, DC is an example of a signalized  
traffic circle ..... 6

Exhibit 1-5 Neighborhood traffic circles at the intersections of Goldfield  
Street/Eldridge Street (top) and Goldfield Street/Prescott Drive  
(bottom) in Lawrence, Kansas ..... 6

Exhibit 1-6 Roundabout Category Comparison ..... 7

Exhibit 1-7 Mini Roundabout at the intersection of Creyts Road/East Road in  
Dimondale, Michigan..... 8

Exhibit 1-8 Single-lane roundabout at the intersection of Santa Fe  
Drive/Conser Street in Overland Park, Kansas ..... 8

Exhibit 1-9 Multi-lane roundabout at the intersection of SW 21st Street/SW  
Urish Road in Topeka, Kansas..... 9

Exhibit 1-10 Rural roundabout at the intersection of K-68/Old Kansas City  
Road/Hedge Lane in Paola, Kansas..... 10

Exhibit 1-11 Teardrop shaped roundabout interchange rendering at K-10/  
Lone Elm Road in Lenexa, Kansas ..... 10

Exhibit 1-12 Roundabout in a suburban setting at the intersection of Sheridan  
Street/Ridgeview Road in Olathe, Kansas ..... 11

Exhibit 1-13 Roundabouts adjacent to a commercial development in Olathe,  
Kansas ..... 11

Exhibit 1-14 Urban roundabout at the intersection of Sycamore Street/West  
Douglas Avenue in Wichita, Kansas ..... 12

Exhibit 1-15 Roundabout Considerations ..... 13

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## CHAPTER 1 INTRODUCTION

A modern roundabout, herein referred to as a roundabout, is a circular intersection in which traffic travels counterclockwise around a central island and entering traffic must yield to circulating traffic. Roundabouts should include appropriate geometric features to promote slow and consistent speeds for all movements.

Although roundabouts have been in widespread use in other countries for many years, they have only recently been used within the United States. Kansas' first roundabout opened in Manhattan in 1997. As of 2013, over 100 roundabouts are in place across the state. These roundabouts are in locations ranging from rural high-speed roadways to suburban arterials and urban locations. Roundabouts may offer several advantages over signalized and stop controlled alternatives, including better overall safety performance, lower delays, shorter queues (particularly during off-peak periods), better management of speeds, and opportunities for community enhancement features. In some cases, roundabouts can avoid or delay the need for expensive widening of an intersection approach that would otherwise be necessary for signalization.

### 1.1 PURPOSE AND SCOPE OF THE GUIDE

This guide is intended to provide practitioners and the general public with information and guidance related to roundabouts in the state of Kansas and serve as a companion to NCHRP Report 672: *Roundabouts: An Informational Guide*, 2nd Edition (hereafter referred to as NCHRP Report 672). For more discussion and details related to roundabouts, readers are encouraged to review NCHRP Report 672 (1). This guide has been developed with input from the Kansas Department of Transportation (KDOT) and from transportation practitioners and researchers from around the world. Where this guide provides information that overlaps with NCHRP Report 672, the guide attempts to provide a summary of the relevant information and directs the reader to NCHRP Report 672 for a more detailed explanation.

### 1.2 ORGANIZATION OF THE GUIDE

This guide has been structured to address the needs of the state of Kansas with regard to roundabouts and is aimed at a variety of readers, including the general public, policy makers, transportation planners, operations and safety analysts, and conceptual and detailed designers. The chapter structure matches that of NCHRP Report 672 to enable cross-referencing.

**Chapter 1 — Introduction:** This chapter distinguishes roundabouts from other circular intersections and defines the settings of roundabouts addressed in the remainder of the guide. The remaining chapters in this guide increase in the level of detail provided.

**Chapter 2 — Roundabout Considerations:** This chapter provides a broad overview of the performance characteristics of roundabouts and discusses the

various tradeoffs with installing roundabouts versus other types of intersections. Legal issues and public involvement techniques are also discussed.

**Chapter 3 — Planning:** This chapter provides guidelines for identifying appropriate intersection control options given daily traffic volumes and identifies procedures for evaluating the feasibility of a roundabout at a given location. Public involvement tools and techniques are also discussed in this chapter.

**Chapter 4 — Operational Analysis:** This chapter identifies methods 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 and methods for analyzing safety performance.

**Chapter 6 — Geometric Design:** This chapter presents geometric design principles, design elements for each category of roundabout, and design applications.

**Chapter 7 — Application of Traffic Control Devices:** This chapter discusses a number of traffic design aspects, including pavement markings, signing, and traffic signals.

**Chapter 8 — Illumination:** This chapter discusses principles and recommendations regarding illumination, along with recommended lighting levels and potential equipment types.

**Chapter 9 — Landscaping:** This chapter presents recommendations for landscaping at roundabouts. Discussions include the relationship to visibility and sight distance requirements, types of landscaping and fixed objects appropriate for the central island and external areas, and other relevant items. A brief discussion of the use of art and other aesthetics in the vicinity of roundabouts is also provided.

**Chapter 10 — Construction and Maintenance:** This chapter focuses on constructability and maintenance of a roundabout.

**Appendices:** Appendices are provided to expand upon topics in certain chapters.

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 italic numbers in parentheses, such as: (1).

*Margin notes have been used to highlight important points.*

### 1.3 ROUNDABOUT DESIGN FEATURES

Exhibit 1-1 identifies key roundabout features, and Exhibit 1-2 describes how each contributes to the functionality of the roundabout. Refer to Chapter 6 of this guide for further discussion related to each of the design features and dimensions.



Google Earth, © 2012 Google

Exhibit 1-1  
Key Roundabout Features shown  
at the East Sheridan Street/South  
Rogers Road intersection in  
Olathe, Kansas

**Exhibit 1-2  
Description of Key  
Roundabout Features**

*Key roundabout features include a generally circular shape, yield control of entering traffic, and geometric curvature and features to induce desirable vehicular speeds.*

Feature	Description
<b>Central Island</b>	The central island is the raised area in the center of a roundabout around which traffic circulates. The central island does not necessarily need to be circular in shape. In the case of mini roundabouts, the central island is traversable.
<b>Splitter Island</b>	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 allow pedestrians to cross the road in two stages.
<b>Circulatory Roadway</b>	The circulatory roadway is the curved path used by vehicles to travel in a counterclockwise fashion around the central island.
<b>Apron</b>	An apron is the traversable portion of the central island adjacent to the circulatory roadway that may be needed to accommodate the wheel tracking of large vehicles. An apron is sometimes provided on the outside of the circulatory roadway.
<b>Entrance line</b>	The entrance line marks the point of entry into the circulatory roadway. This line is physically an extension of the circulatory roadway edge line but functions as a yield line in the absence of a separate yield line. Entering vehicles must yield to any circulating traffic coming from the left before crossing this line into the circulatory roadway.
<b>Accessible pedestrian crossings</b>	For roundabouts designed with pedestrian pathways, the crossing location is typically set back from the entrance line, and the splitter island is typically cut to allow pedestrians, wheelchairs, strollers, and others to pass through. The pedestrian crossings must be accessible with detectable warnings and appropriate slopes in accordance with ADA requirements.
<b>Landscape strip</b>	Landscape strips separate vehicular and pedestrian traffic and assist with guiding pedestrians to the designated crossing locations. This feature is particularly important as a wayfinding cue for individuals who are visually impaired. Landscape strips can also improve the aesthetics of the intersection.

Adapted from NCHRP 672 (1)

**1.3.1 Other Types of Circular Intersections**

Roundabouts are one of the four distinct types of circular intersections. It should be noted that, with the exception of this section, the scope of this guide only includes roundabouts and does not include information on the other types of circular intersections.

- *Roundabouts* have specific design and traffic control features, including yield control on entry, geometric features to control vehicular speeds, and channelized approaches.
- *Rotaries* are generally large diameter circular intersections that fell out of favor in the United States in the 1950s due to safety and operational concerns. Those rotaries that are still in operation in the United States are predominantly located in the northeast, though some—like Meyer Circle located in Kansas City, Missouri and displayed in Exhibit 1-3—are located in other areas.



**Exhibit 1-3**  
**Meyer Circle located on Ward Parkway in Kansas City, Missouri**

Google maps © 2012

- *Signalized traffic circles* are traffic circles with traffic signals used to control one or more access points, resulting in distinctly different operational characteristics from roundabouts. These characteristics include queue storage in the circulatory roadway and the required progression of signals if more than one approach is signalized. In some cases, signalizing or metering one or more approach can improve the performance or extend the operational life of a roundabout. Signalized traffic circles are distinct from roundabouts with pedestrian signals, as the entry-circulating point at a roundabout with pedestrian signals is still governed by a yield sign. Dupont Circle in Washington, DC and displayed in Exhibit 1-4 is an example of a signalized traffic circle.

**Exhibit 1-4**  
DuPont Circle in Washington, DC is an example of a signalized traffic circle



Bing Maps, © 2012 Microsoft Corporation; Pictometry Bird's Eye, © 2012 Pictometry International Corp

- *Neighborhood traffic circles* are common in residential neighborhoods and provide traffic calming and aesthetics benefits. Unlike roundabouts, neighborhood traffic circles do not necessarily provide raised channelization, may be uncontrolled or stop-controlled, and left-turning movements for larger vehicles may be allowed in front of the central island. Exhibit 1-5 displays two neighborhood traffic circles in Lawrence, Kansas.

**Exhibit 1-5**  
Neighborhood traffic circles at the intersections of Goldfield Street/Eldridge Street (top) and Goldfield Street/Prescott Drive (bottom) in Lawrence, Kansas



Bing Maps, © 2012 Nokia; © 2012 Microsoft Corporation

### 1.3.2 Categories of Roundabouts

Consistent with NCHRP Report 672 (1), roundabouts are separated into three basic categories:

1. Mini roundabouts
2. Single-lane roundabouts
3. Multilane roundabouts

While separate categories are not explicitly identified for rural, suburban, or urban areas, the design of the roundabout may need to be adjusted to account for the amount of right-of-way available, the design vehicle, and potential pedestrian and bicycle accommodations. Exhibit 1-6 summarizes and compares some fundamental design and operational elements for each of the three roundabout categories.

Design Element	Mini Roundabout	Single-Lane Roundabout	Multilane Roundabout
Desirable maximum entry speed	15 to 20 mph	20 to 25 mph	25 to 30 mph
Maximum number of entering lanes per approach	1	1	2+
Typical inscribed circle diameter	45 to 90 feet	90 to 180 feet	150 to 300 feet
Central Island Treatment	Full traversable	Raised with traversable truck apron	Raised with traversable truck apron
Typical daily service volumes on 4-leg roundabout below which may be expected to operate without requiring a detailed capacity analysis (veh/day)*	Up to approximately 15,000	Up to approximately 25,000	Up to approximately 45,000 for two-lane roundabout

\*Operational analysis needed to verify upper limit for specific applications or for roundabouts with more than two lanes or four legs.  
NCHRP 672, Exhibit 1-9 (1)

Section 3.1.1, Use of Single and Multilane Roundabouts provides planning-level guidance related to the capacity of different types of roundabouts. The impact of roundabout size and environment on operations, safety, and design are discussed throughout chapters 4, 5 and 6, respectively. The following section briefly describes each of the three categories.

#### 1.3.2.1 Mini Roundabouts

Mini roundabouts are small roundabouts, typically used in environments with insufficient right-of-way to accommodate the design vehicle with a traditional single-lane roundabout. Because of their small size, the central island is fully mountable, and they are perceived as pedestrian-friendly due to their short crossing distances and low vehicle speeds on approaches and exits. The fully traversable central island allows large vehicles to cross over it, while the entry is designed to guide all other drivers around, rather than over or in front of, the central island. Exhibit 1-7 displays an image of a mini roundabout.

Exhibit 1-6  
Roundabout Category  
Comparison

**Exhibit 1-7**  
**Mini Roundabout at the**  
**intersection of Creyts**  
**Road/East Road in**  
**Dimondale, Michigan**



Courtesy of Lee Rodegerdts

### 1.3.2.2 *Single-Lane Roundabouts*

Single-lane roundabouts have a single-lane entry at all legs and one circulatory lane. They are distinguished from mini roundabouts by their larger inscribed circle diameter and non-fully traversable central islands. Their design allows slightly higher speeds at the entry, on the circulatory roadway, and at the exit. The geometric design includes raised splitter islands, a non-mountable central island, and a truck apron. The size of a single-lane roundabout is largely influenced by the choice of design vehicle and available right-of-way (1). Exhibit 1-8 displays a single-lane roundabout in Overland Park, Kansas.

**Exhibit 1-8**  
**Single-lane roundabout at the**  
**intersection of Santa Fe**  
**Drive/Conser Street in**  
**Overland Park, Kansas**



Courtesy of the City of Overland Park

### 1.3.2.3 Multilane Roundabouts

Multilane roundabouts have at least one entry with two or more lanes, and may have a different number of lanes on one or more approaches. Multilane roundabouts require wide circulatory roadways to accommodate vehicles traveling side-by-side through the roundabout, and thus have larger inscribed circle diameters. The speeds at the entry, on the circulatory roadway, and at the exit are similar or may be slightly higher than those for single-lane roundabouts. Again, it is important that the vehicular speeds be consistent throughout the roundabout. The geometric design will include raised splitter islands, a non-mountable central island, truck apron, and appropriate path deflection. Exhibit 1-9 displays a multilane roundabout in Topeka, Kansas.



Google Earth, © 2013 Google

**Exhibit 1-9**  
Multi-lane roundabout at the  
intersection of SW 21st  
Street/SW Urish Road in  
Topeka, Kansas

## 1.4 ROUNDABOUT SETTINGS

Roundabouts have been built in a variety of settings across Kansas, mirroring the variety of settings found across the United States. Examples of this variety are shown below to emphasize the flexibility and variety of situations in which a roundabout can be the appropriate solution. Roundabouts in additional settings are shown in various figures throughout this guide.

**Exhibit 1-10**  
Rural roundabout at the  
intersection of K-68/Old  
Kansas City Road/Hedge Lane  
in Paola, Kansas



Kansas Department of Transportation

**Exhibit 1-11**  
Teardrop shaped  
roundabout interchange  
rendering at K-10/Lone Elm  
Road in Lenexa, Kansas



Kansas Department of Transportation



Courtesy of the City of Olathe

**Exhibit 1-12**  
Roundabout in a suburban setting at the intersection of Sheridan Street/Ridgeview Road in Olathe, Kansas



Courtesy of the City of Overland Park

**Exhibit 1-13**  
Roundabouts adjacent to a commercial development in Olathe, Kansas

**Exhibit 1-14**  
**Urban roundabout at the**  
**intersection of Sycamore**  
**Street/West Douglas Avenue**  
**in Wichita, Kansas**



Bing Maps, © 2013 Microsoft Corporation Pictometry Bird's Eye © 2012 Pictometry International Corp.

## **1.5 CONSIDERATIONS FOR ROUNDABOUT DESIGN**

The following section provides general advice for planners and designers considering roundabouts. All of the considerations presented are items that factor into the evaluation of any intersection control device, and do not necessarily reflect every situation a planner or designer may encounter. More detailed information regarding each of these topics can be found in later chapters of this guide, as well as in NCHRP Report 672 (1). Exhibit 1-15 displays the roundabout considerations.

**Exhibit 1-15  
Roundabout Considerations**

<b>Considerations</b>	
<p><b>Compare alternatives:</b></p> <ul style="list-style-type: none"> <li>▪ Consider the full range of feasible alternatives at an intersection. This allows the designer to show the public that other alternatives have been examined and to understand why the selected alternative is recommended. The resulting information sharing can help to build community support for the project.</li> <li>▪ Start the planning process by creating several concept designs. This allows the designer to quickly compare and evaluate several different design concepts, capable of being altered with little effort.</li> <li>▪ It is usually better to wait on detailed design until other design options or intersection configurations have been explored. A sketch layout will often be sufficient at the beginning of the process to select an intersection configuration.</li> </ul>	<p><b>Understand the history of roundabouts in the area:</b></p> <ul style="list-style-type: none"> <li>▪ Consider whether local drivers are familiar with roundabouts. It may be helpful to start small when introducing roundabouts in a new geographic area. A single-lane roundabout will be more easily understood than multilane roundabouts, and will help the driving population become more comfortable with navigating a roundabout.</li> <li>▪ Include adequate time for public awareness. Roundabouts introduced into new areas may require additional effort to inform the general public about roundabouts and the proper way to use them. Public education efforts such as public awareness announcements, pamphlets, and other materials for public distribution may assist the public in becoming more comfortable in using roundabouts.</li> </ul>
<p><b>Understand the site environment:</b></p> <ul style="list-style-type: none"> <li>▪ Be aware of any constraints (including right-of-way, utilities, structures, environmental, etc.) that may impact the space available for a roundabout. Roundabouts often require more property at the corners of existing intersections; however, they can result in less widening of approach roadways than signalized intersections.</li> <li>▪ Consider the roundabout location and user population. Is the intersection in a rural or urban environment? Will the roundabout have frequent pedestrian and/or bicycle activity? The roundabout design should support all intended modes of travel.</li> <li>▪ Intersections having issues that make it difficult for other types of traffic control (e.g., more than four legs, acute angles, challenging vertical profiles) can also be difficult with a roundabout.</li> </ul>	<p><b>Design the roundabout with the principles of roundabout design in mind:</b></p> <ul style="list-style-type: none"> <li>▪ Check roundabout designs to confirm that the proposed geometry provides appropriate fastest path speeds. It is important that speeds are checked in preliminary and final designs alike so that the intended performance is maintained throughout the design process and into the field.</li> <li>▪ Provide accommodations for the largest motorized vehicle likely to use the intersection. OSOW vehicles have become more common at Kansas roundabouts in recent years. Despite the relatively low frequency of OSOW vehicles, it can be necessary to design roundabouts to accommodate OSOW vehicles that have design requirements beyond the typical WB-67 design vehicle. Roundabouts not properly designed for trucks can receive premature wear with maintenance concerns due to trucks driving over the top of curbs and tracking through the central island.</li> <li>▪ Be careful when using a roundabout that is too small for the operating conditions in an attempt to stay within the existing right of way. The resulting design may have unacceptably high speeds or be unable to accommodate the design vehicle.</li> </ul>

Considerations	
	<ul style="list-style-type: none"><li>▪ Check multilane roundabout designs to confirm that appropriate natural vehicle paths can be achieved. Vehicle paths through the roundabout should not “overlap” each other. Designs with overlapping natural paths may experience poor operational or safety performance.</li><li>▪ Be careful when designing a roundabout to accommodate a vehicle size that is unlikely to traverse the intersection. Designing a roundabout with geometry larger than necessary for its intended use can create operational and safety issues due to a lack of speed control, in addition to needing more right-of-way and costing more to construct.</li><li>▪ A roundabout design that works at one intersection location may not work as well at another. Roundabouts are based on sound design principles and performance outcomes, not standardized input dimensions; one size is not best for all conditions.</li></ul>

## 1.6 REFERENCES

1. Rodegerdts, L., J. Bansen, C. Tiesler, J. Knudsen, E. Myers, M. Johnson, M. Moule, B. Persaud, C. Lyon, S. Hallmark, H. Isebrands, R. B. Crown, B. Guichet, and A. O’Brien. *NCHRP Report 672: Roundabouts: An Informational Guide, 2nd ed.* Transportation Research Board of the National Academies, Washington, D.C., 2010.
2. Zhang, W., J. Bared, R. Jagannathan. *They’re Small but Powerful.* Federal Highway Administration. Found at: <http://www.fhwa.dot.gov/publications/publicroads/13novdec/03.cfm> November/December 2012.

## **Chapter 2**

# **Roundabout Considerations**

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**CHAPTER 2  
ROUNDBOUT CONSIDERATIONS**

**CONTENTS**

**Chapter 2 Roundabout Considerations ..... 1**

2.1 Roundabout Selection Guidance ..... 1

    2.1.1 Spatial Requirements ..... 1

    2.1.2 Access Management ..... 2

    2.1.3 Site-Specific Conditions ..... 3

        2.1.3.1 Sites Where Roundabouts Are Often Advantageous ..... 3

        2.1.3.2 Sites at Which Caution Should Be Exercised With  
                Roundabouts..... 4

    2.1.4 Transportation Network Considerations..... 4

    2.1.5 Advantages and Disadvantages..... 5

2.2 User Considerations..... 6

    2.2.1 Pedestrians ..... 6

    2.2.2 Bicyclists ..... 7

    2.2.3 Older Drivers..... 7

    2.2.4 Large Vehicles..... 8

    2.2.5 Transit Vehicles ..... 8

    2.2.6 Emergency Vehicles..... 9

2.3 Policy and Legal Issues..... 9

    2.3.1 Decision-Making Process..... 9

    2.3.2 Rules of the Road ..... 9

2.4 References ..... 10

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**LIST OF EXHIBITS**

Exhibit 2-1 “Wide Nodes, Narrow Roads” ..... 2

Exhibit 2-2 Access near roundabout at the intersection of Loula  
Street/Ridgeview Road in Olathe, Kansas ..... 3

Exhibit 2-3 Summary of Roundabout Advantages and Disadvantages ..... 5

Exhibit 2-4 Pedestrian accommodations at a roundabout; Lenexa, Kansas ..... 7

Exhibit 2-5 Rural roundabout with significant truck usage in Florence, Kansas .. 8

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## CHAPTER 2 ROUNDABOUT CONSIDERATIONS

This chapter has two purposes: 1) Highlight items that need to be evaluated when considering installing a roundabout at an intersection, and 2) Identify considerations for all the different groups likely to use the roundabout. Understanding the advantages and disadvantages of roundabouts allows designers, policy makers, and the public to understand the trade-offs with this type of intersection treatment.

While general information about roundabouts can be found in this chapter, the reader is encouraged to refer to later, more detailed chapters on the specifics associated with planning, operation, safety, and design of roundabouts.

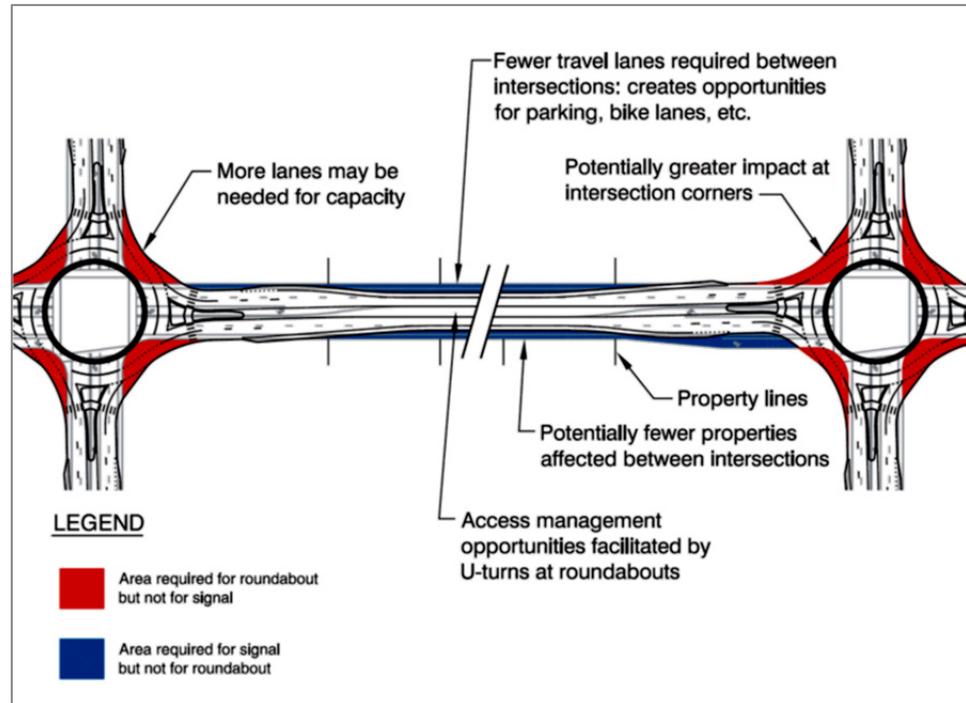
### 2.1 ROUNDABOUT SELECTION GUIDANCE

This section covers general issues that should be considered when evaluating a roundabout for a location. These issues are specific to the site and surrounding transportation network. The considerations outlined in this section relate to the environment (built or otherwise), as opposed to driver behavior. Safety and operations are discussed in later sections.

#### 2.1.1 Spatial Requirements

As discussed in NCHRP Report 672, “Roundabouts often require more space in the immediate vicinity of the intersection than comparable stop-controlled or signalized intersections” (1, p.2-7). This space requirement is dictated by factors that include the size and shape of the roundabout (e.g., circular versus noncircular). However, roundabouts may require reduced space between intersections, which may offset the additional space needed in the vicinity of the roundabout. A roundabout may require less queue storage space on the approach legs due to reduced delay and thus shorter queues. Additionally, roundabouts produce efficiency through a gap acceptance process where drivers can accept gaps as they appear rather than waiting for their time in the cycle (as with signalized intersections). This concept is sometimes referred to as a “wide nodes, narrow roads” concept and is illustrated in Exhibit 2-1. In some cases, a roundabout may be constructed in phases to accommodate current users’ needs while still providing an opportunity for expansion to serve projected future traffic volume growth. This strategy is further discussed in Chapter 3, Section 3.1.

Exhibit 2-1  
 “Wide Nodes, Narrow Roads”



NCHRP Report 672 (1)

### 2.1.2 Access Management

Access management is the proactive management of vehicular access points to land parcels adjacent to roadways. Good access management promotes safe and efficient use of the transportation network. Roundabouts can be used at key public and private intersections to facilitate major movements and enhance access management. Splitter islands restrict turning movements to right-in/right-out movements only, providing a form of access management. Minor public and private access points between roundabouts can be accommodated by partially or fully restricted two-way stop-controlled intersections, with the roundabouts providing U-turn opportunities. Access management at roundabouts follows many of the principles used for access management at conventional intersections. KDOT restricts accesses directly at a roundabout, but allows accesses near a roundabout that meet certain criteria.

The *KDOT Access Management Policy (2)* provides guidance on access management at roundabouts, including access spacing criteria. The required distance from a roundabout intersection to an access point on the highway is consistent with KDOT’s unsignalized access spacing. This distance should be measured from the end of the splitter island leaving the roundabout. The document also provides guidance on the factors that govern the ability to provide an access point with full movement access near a roundabout, including the capacity of the access point, left-turn storage needs, and sight-distance.



Courtesy of the City of Overland Park

**Exhibit 2-2**  
Access near roundabout at  
the intersection of Loula  
Street/Ridgeview Road in  
Olathe, Kansas

### 2.1.3 Site-Specific Conditions

Within the context of evaluating intersection alternatives, each individual location has its own unique characteristics, issues, and objectives for improvement that influence the choice between traffic control alternatives. Roundabouts offer benefits under many circumstances; however, they may also be more complicated to implement in comparison to other control types. The site-specific characteristics of a given intersection should be considered when assessing the feasibility of a roundabout. This section lists sites where roundabouts are often advantageous, and sites at which caution should be exercised with roundabouts. *Section 3.4 Potential Applications* of NCHRP Report 672 (1) discusses numerous potential applications for roundabouts, including near residential subdivisions, urban centers, and rural settings. It lists benefits and considerations with each application.

#### 2.1.3.1 Sites Where Roundabouts Are Often Advantageous

Roundabouts are often advantageous over other traffic control at the following locations and conditions:

- Intersections with historical safety problems.
- Intersections with relatively balanced traffic volumes.
- Intersections with a high percentage of turning movements, particularly left turns.
- Intersections with high traffic volumes at peak hours but relatively low traffic volumes during non-peak hours.
- Existing two-way stop-controlled intersections with high side-street delays (particularly those that do not satisfy signal warrants).
- Intersections that must accommodate U-turns.

- Intersections at a gateway or entry point to a campus, neighborhood, commercial development, or urban area.
- Intersections where a community enhancement may be desirable.
- Intersections or corridors where traffic calming is a desired outcome of the project.
- Intersections where widening the approaches may be difficult or cost-prohibitive, such as at bridge terminals.
- Intersections where traffic growth is expected to be high and future traffic patterns are uncertain.
- Locations where the speed environment of the road changes (for instance, at the fringe of an urban environment).
- Locations with a need to provide a transition between land use environments (such as between residential and commercial uses).
- Roads with a historical problem of excessive speeds.

#### 2.1.3.2 Sites at Which Caution Should Be Exercised With Roundabouts

There are a number of locations and site conditions that often present complications or difficulties for installing roundabouts. Some of these locations can also be difficult or problematic for other intersection alternatives. Therefore, these site conditions should not necessarily preclude a roundabout from consideration. However, extra caution should be exercised when considering roundabouts at these locations:

- Intersections in close proximity to a signalized intersection where queues may spill back into the roundabout.
- Intersections located within a coordinated arterial signal system.
- Intersections with a heavy flow of through traffic on the major street opposed by relatively light traffic on the minor street.
- Intersections with a heavy concentration of any mode, including vehicles, pedestrians, and bicyclists.
- Intersections that regularly serve oversize-overweight (OSOW) vehicles.
- Locations with steep grades and unfavorable topography that may limit visibility and complicate construction.

#### 2.1.4 Transportation Network Considerations

The surrounding transportation network should be considered when assessing the feasibility of a roundabout at an intersection. Due to the close spacing of intersections in many urban and suburban areas, the influence of nearby unsignalized intersections, signalized intersections, railroad crossings, and parking areas affects the placement, design, and operation of a roundabout. Chapter 4 of this guide discusses queuing at a roundabout and potential interactions with intersections in close proximity, and provides guidance to determine if the location of the roundabout is likely to disrupt the operations of

*Some of these locations can also be difficult or problematic for other intersection alternatives. Therefore, these site conditions should not necessarily preclude a roundabout from consideration.*

other intersections. This section discusses the application of roundabouts at interchanges and in a series.

### 2.1.5 Advantages and Disadvantages

Exhibit 2-3 provides an overview of the primary advantages and disadvantages of roundabouts for users, policy makers, designers, and planners to understand when considering this type of intersection.

Advantages	Disadvantages
<b>Non-Motorized Users</b>	
<ul style="list-style-type: none"> <li>• Pedestrians must consider only one direction of conflicting traffic at a time</li> <li>• Bicyclists have options for negotiating roundabouts, depending on their skill and comfort level</li> </ul>	<ul style="list-style-type: none"> <li>• Pedestrians with vision impairments may have trouble finding crosswalks and determining when/if vehicles have yielded at crosswalks, and if there are sufficient gaps in traffic</li> <li>• Bicycle ramps at roundabouts have the potential to be confused with pedestrian ramps</li> </ul>
<b>Safety</b>	
<ul style="list-style-type: none"> <li>• Reduce crash severity for all users, allow safer merges into circulating traffic, and provide more time for all users to detect and correct for their mistakes or mistakes of others due to lower vehicle speeds</li> <li>• Fewer number of overall conflict points and no left-turn conflicts</li> </ul>	<ul style="list-style-type: none"> <li>• Increase in single-vehicle and fixed-object crashes compared to other intersection treatments</li> </ul> <p>Multilane roundabouts present more difficulties for individuals with blindness or low vision due to challenges in detecting gaps and determining that vehicles have yielded at crosswalks</p>
<b>Operations</b>	
<ul style="list-style-type: none"> <li>• May have lower delays and queues than other forms of intersection control</li> <li>• Can reduce lane requirements between intersections, including bridges between interchange ramp terminals</li> <li>• Creates possibility for adjacent signals to operate with more efficient cycle lengths where the roundabout replaces a signal that is setting the controlling cycle length</li> </ul>	<ul style="list-style-type: none"> <li>• Equal priority for all approaches can reduce the progression for high volume approaches</li> <li>• Cannot provide explicit priority to specific users (e.g., trains, emergency vehicles, transit, pedestrians) unless supplemental traffic control devices are provided</li> </ul>
<b>Access Management</b>	
<ul style="list-style-type: none"> <li>• Facilitate U-turns that can substitute for more difficult midblock left turns</li> </ul>	<ul style="list-style-type: none"> <li>• May reduce the number of available gaps for mid-block unsignalized intersections and driveways</li> </ul>
<b>Environmental Factors</b>	
<ul style="list-style-type: none"> <li>• Noise, air quality impacts, and fuel consumption may be reduced</li> <li>• Little stopping during off-peak periods</li> </ul>	<ul style="list-style-type: none"> <li>• Possible impacts to natural and cultural resources due to greater spatial requirements at intersections</li> </ul>
<b>Traffic Calming</b>	
<ul style="list-style-type: none"> <li>• Reduced vehicular speeds</li> <li>• Beneficial in transition areas by reinforcing the notion of a significant change in the driving environment</li> </ul>	<ul style="list-style-type: none"> <li>• More expensive than other traffic calming treatments</li> </ul>

**Exhibit 2-3**  
**Summary of Roundabout**  
**Advantages and Disadvantages**

Advantages	Disadvantages
<b>Space</b>	
<ul style="list-style-type: none"> <li>• Often require less queue storage space on intersection approaches – can allow for closer intersection and access spacing</li> <li>• Reduce the need for additional right-of-way between links of intersection</li> <li>• More feasibility to accommodate parking, wider sidewalks, planter strips, wider outside lanes and/or bicycle lanes on the approaches</li> </ul>	<ul style="list-style-type: none"> <li>• Often requires more space at the intersection itself than other intersection treatments</li> </ul>
<b>Operation &amp; Maintenance</b>	
<ul style="list-style-type: none"> <li>• No signal hardware or equipment maintenance</li> </ul>	<ul style="list-style-type: none"> <li>• May require landscape maintenance</li> </ul>
<b>Aesthetics</b>	
<ul style="list-style-type: none"> <li>• Provide attractive entries or centerpieces to communities</li> <li>• Used in tourist or shopping areas to separate commercial uses from residential areas</li> <li>• Provide opportunity for landscaping and/or gateway feature to enhance the community</li> </ul>	<ul style="list-style-type: none"> <li>• May create a safety concern if hard objects are placed in the central island directly facing the entries</li> </ul>

Adapted from NCHRP Report 672, Exhibit 2-5 (1)

## 2.2 USER CONSIDERATIONS

As with any intersection design, each transportation mode present requires careful consideration. This section offers some of the issues associated with each mode; additional detail on mode-specific safety and design issues is provided in subsequent chapters.

### 2.2.1 Pedestrians

Pedestrian facilities should be provided at all roundabouts that connect to an existing or planned pedestrian network. If pedestrian facilities are provided, they must be made accessible to and usable by pedestrians of all abilities. Striped crossings may be omitted at rural roundabouts where pedestrian activity is nonexistent and not anticipated. Where used, the crossing location is set back from the entrance line, and the splitter island is cut to allow pedestrians, wheelchairs, strollers, and others to pass through, as shown in Exhibit 2-4.

In many cases, a roundabout can offer a safer environment for pedestrians than a traffic signal because the pedestrian crossing at a roundabout is reduced to two simple crossings of one-way traffic moving at slow speeds. In contrast, a pedestrian crossing at a traffic signal needs to contend with vehicles turning right or left on green, vehicles turning right on red, and vehicles running the red light. The latter of these potential conflicts may result in injuries or fatalities to pedestrians. On the other hand, pedestrians (particularly those with visual impairments) may have more difficulty crossing the unsignalized crosswalks at a high-volume, multilane roundabout than at a signalized intersection. Section 6.4.1 of this guide provides design guidance for accommodating pedestrians at a roundabout.



Courtesy of the City of Overland Park

**Exhibit 2-4**  
**Pedestrian accommodations at a roundabout; Lenexa, Kansas**

### 2.2.2 Bicyclists

As reported in NCHRP Report 672, “Recent research of roundabouts in the United States has not found any substantial safety problems for bicyclists, as indicated by few crashes being reported in detailed crash reports” (1, p. 2-17). Given that drivers should be traveling at about 15 to 20 mph, a single-lane roundabout should not present much difficulty to bicyclists. Multilane roundabouts may require cyclists to change lanes to make left-turn movements or otherwise select the appropriate lane for their direction of travel, and thus may be more difficult for bicyclists to ride through the roundabout like a car. Bicycle riders uncomfortable with riding through the roundabout may choose to dismount and circulate around the roundabout as a pedestrian using the provided sidewalks and crossings. To accommodate bicyclists who prefer not to use the circulatory roadway, a widened sidewalk or shared bicycle/pedestrian path may be used provided it is physically separated from the circulatory roadway. Further guidance on bicycle treatments at roundabouts is provided in Chapter 6.

### 2.2.3 Older Drivers

Roundabouts may be advantageous for older drivers, given that they slow traffic speeds. The potential benefits of slower approach speeds include reduced crash severity, safer merges, and more opportunities to correctly judge and enter gaps (1). It is important that older drivers understand how to navigate a roundabout, which can be accomplished through targeted driver education and the proper use of roundabout advance warning signs and directional signs. Designers should consider the presence of older drivers and pedestrians at a roundabout. The Federal Highway Administration (FHWA) *Highway Design Handbook for Older Drivers and Pedestrians* (3) presents considerations for understanding the needs of older drivers and pedestrians. In addition, *Section 2.3.4 Older Drivers* of NCHRP Report 672 (1) provides guidance on considerations associated with older drivers.

### 2.2.4 Large Vehicles

The presence of large vehicles on a corridor does not preclude the use of roundabouts, but may require special design treatments. Details on treatments for large vehicles at a single-lane roundabout can be found in *Section 6.4.7 Design Vehicle Considerations* of NCHRP Report 672 (1). *Section 6.5 Oversize-Overweight Load Accommodations* of this guide provides guidance on designing for and accommodating oversize/overweight (OSOW) vehicles. In order to accommodate larger vehicles at a single-lane roundabout, a larger-diameter may be required. A traversable truck apron can be used to accommodate large vehicles while minimizing other roundabout dimensions.

*Section 6.5.7 Design Vehicle Considerations* of NCHRP Report 672 provides guidance on the movement of large vehicles through multilane roundabouts and discusses treatments to accommodate the design vehicle within the circulatory roadway (1). The accommodation of side-by-side large vehicles at multilane roundabouts should be made on a case-by-case basis. *Section 6.5* of this guide presents guidance on oversize-overweight load accommodations. Exhibit 2-5 shows a roundabout with significant truck usage.

**Exhibit 2-5**  
Rural roundabout with  
significant truck usage in  
Florence, Kansas



Kansas Department of Transportation

### 2.2.5 Transit Vehicles

Transit vehicles can be accommodated at a roundabout through the selection of an appropriate design vehicle. It is strongly desired for buses to be able to navigate the roundabout without using the truck apron to minimize passenger discomfort. Therefore, roundabouts should be designed so that buses and other fixed-chassis vehicles do not have to use the truck apron. Bus stop locations should be planned to prevent the potential for vehicle queues to spill back into the circulatory roadway. Bus stops on the far side of the roundabout should have pullouts or be further downstream than the splitter island. *Section 6.8.4 Bus Stop Locations* of NCHRP Report 672 provides design guidance related to the location of nearside and farside bus stops in the vicinity of a roundabout (1).

### 2.2.6 Emergency Vehicles

Roundabouts should be designed to accommodate emergency vehicles, like other large vehicles. As discussed in NCHRP 672, “Roundabouts provide emergency vehicles the benefit of lower vehicle speeds, which may make roundabouts safer for them to negotiate than signalized crossings. Unlike at signalized intersections, emergency vehicle drivers are not faced with through vehicles unexpectedly running the intersection and hitting them at high speed” (1, p. 2-20). Drivers are directed to not enter a roundabout when an emergency vehicle is approaching on another leg. Drivers already in the roundabout should clear out of the circulatory roadway if possible or proceed to beyond the splitter island before pulling over.

## 2.3 POLICY AND LEGAL ISSUES

Policy plays an important role in the implementation of roundabouts, particularly at the state level. There are two key aspects to policy implementations:

- Decision-making process
- Legal issues, including rules of the road

### 2.3.1 Decision-Making Process

While KDOT does not have a formal policy at this time dictating the use of roundabouts, KDOT prefers that roundabouts be considered as an intersection alternative for potential operational and safety improvement.

### 2.3.2 Rules of the Road

The legal environment in which roundabouts operate is an important area for jurisdictions to consider when developing a roundabout program or set of guidelines. The rules of the road that govern the operation of motor vehicles in a given state can have a significant influence on the way a roundabout operates and on how legal issues, such as crashes involving roundabouts, are handled. Local jurisdictions that are building roundabouts should be aware of the governing state regulations in effect.

The *Kansas Driving Handbook (4)* provides guidance for driving through roundabouts. It advises drivers to yield to vehicles and bicyclists within the circulating roadway when approaching a roundabout. Drivers should always enter the roundabout to the right and proceed to the right side of the central island. It advises drivers to not try and pass bicyclists within the roundabout, as vehicular and bicycle speeds should be nearly equal. At multilane roundabouts, vehicles should yield to vehicles turning in front of them from the inside lane to exit the roundabout. The following general rules apply (unless signs or pavement markings indicate otherwise):

- If you intend to exit the roundabout less than halfway around it, use the right lane.
- If you intend to exit the roundabout more than halfway around it, use the left lane.

Additionally, the handbook advises drivers to watch for pedestrians in or approaching the crosswalk and stop for them. Drivers should not enter the roundabout when an emergency vehicle is approaching and, if already in the roundabout, should proceed beyond the splitter island and pull over.

## **2.4 REFERENCES**

1. Rodegerdts, L., J. Bansen, C. Tiesler, J. Knudsen, E. Myers, M. Johnson, M. Moule, B. Persaud, C. Lyon, S. Hallmark, H. Isebrands, R. B. Crown, B. Guichet, and A. O'Brien. *NCHRP Report 672: Roundabouts: An Informational Guide*, 2nd ed. Transportation Research Board of the National Academies, Washington, D.C., 2010.
2. Kansas Department of Transportation. *Access Management Policy*. January 2013.
3. Staplin, L., K. Lococo, S. Byington, and D. Harkey. *Highway Design Handbook for Older Drivers and Pedestrians*. Publication No. FHWA-RD-01-103. FHWA, Washington, D.C., May 2001.
4. Driver's License Examining Bureau. *Kansas Driving Handbook*.

# **Chapter 3**

## **Planning**

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**CHAPTER 3  
PLANNING**

**CONTENTS**

**Chapter 3 Planning.....1**

- 3.1 Planning ..... 1
  - 3.1.1 Use of Single and Multilane Roundabouts ..... 1
  - 3.1.2 Roundabouts in a Series ..... 3
  - 3.1.3 Designing for Future Conditions..... 4
  - 3.1.4 Cost..... 6
- 3.2 Public Involvement ..... 6
  - 3.2.1 Public Meeting Guidance ..... 6
  - 3.2.2 Education of Transportation Professionals and Elected Officials..... 8
  - 3.2.3 User Education ..... 8
    - 3.2.3.1 Drivers ..... 8
    - 3.2.3.2 Truck Drivers ..... 10
    - 3.2.3.3 Pedestrians ..... 11
    - 3.2.3.4 Bicyclists ..... 12
- 3.3 References ..... 12

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**LIST OF EXHIBITS**

Exhibit 3-1 Roundabout Category Comparison ..... 2

Exhibit 3-2 Volume Thresholds for Determining the Number of Entry Lanes  
Required..... 2

Exhibit 3-3 Roundabouts in a series on Renner Boulevard in Lenexa, Kansas ... 3

Exhibit 3-4 Example – Staged Multilane Roundabout Construction ..... 5

Exhibit 3-5 Roundabout Brochure from KDOT website ..... 7

Exhibit 3-6 Lane Use Sign at the intersection of Renner Boulevard/West Bass  
Pro Drive in Olathe, Kansas..... 9

Exhibit 3-7 Driving Straight Through a Roundabout..... 10

Exhibit 3-8 Truck Apron Example (Hutchinson, KS) ..... 11

Exhibit 3-9 Pedestrian Crosswalk Example (Lenexa, KS)..... 12

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## CHAPTER 3 PLANNING

This chapter provides high-level guidance on considerations associated with planning a roundabout, including the use of single and multilane roundabouts, sizing a roundabout for existing and future conditions, and cost. Public involvement is also addressed, including public meeting guidance and the education of users, transportation professionals, and elected officials.

### 3.1 PLANNING

This section provides guidance for the early stages of roundabout planning related to assessing the size of roundabout needed, design year, and approximate cost. Additional guidance for operational analysis at a roundabout is provided in Chapter 4, and design guidance is available in Chapter 6.

#### 3.1.1 Use of Single and Multilane Roundabouts

One of the first steps in examining the feasibility of a roundabout is determining the preliminary configuration of the proposed roundabout. At a planning level, this is determined based on the number of entry lanes needed on each approach to serve the design year traffic volumes. The number of circulatory lanes required for a roundabout is then set to accommodate the entry lanes. Roundabouts are typically identified in terms of the number of circulatory lanes (i.e. single-lane, double-lane, etc.).

Planning-level guidance related to the capacity of different types of roundabouts is provided in Exhibit 3-1. This guidance is intended to aid in the early stages of the decision making process to select or reject a roundabout as a viable improvement option prior to proceeding to detailed analysis and design. *Section 3.5 Planning-Level Sizing and Space Requirements* of NCHRP Report 672 provides additional planning-level techniques to determine the capacity and size required for a roundabout (1). The section includes volume thresholds for determining the number of entry lanes required and a discussion of the capacity of mini-roundabouts.

Exhibit 3-1 also provides a range of inscribed circle diameters for each category to assist in estimating the size of the roundabout footprint and aid in creating a preliminary assessment of right-of-way impacts.

**Exhibit 3-1  
Roundabout Category  
Comparison**

Design Element	Mini-Roundabout	Single-Lane Roundabout	Multilane Roundabout
Desirable maximum entry design speed	15 to 20 mph	20 to 25 mph	25 to 30 mph
Maximum number of entering lanes per approach	1	1	2+
Typical inscribed circle diameter	45 to 90 ft	90 to 180 ft	150 to 300 ft
Central island treatment	Fully traversable	Raised (may have traversable apron)	Raised (may have traversable apron)
Typical daily service volumes on 4-leg roundabout below which may be expected to operate without requiring a detailed capacity analysis (veh/day)*	Up to approximately 15,000	Up to approximately 25,000	Up to approximately 45,000 for two-lane roundabout

\* Operational analysis needed to verify upper limit for specific applications or for roundabouts with more than two lanes or four legs.  
NCHRP Report 672 (1)

Exhibit 3-2 provides additional planning-level lane requirements for ranges of entering and conflicting volumes.

**Exhibit 3-2  
Volume Thresholds for  
Determining the Number of  
Entry Lanes Required**

Volume Range (sum of entering and conflicting volumes)	Number of Lanes Required
0 to 1,000 veh/h	<ul style="list-style-type: none"> <li>Single-lane entry likely to be sufficient</li> </ul>
1,000 to 1,300 veh/h	<ul style="list-style-type: none"> <li>Two-lane entry may be needed</li> <li>Single-lane may be sufficient based upon more detailed analysis.</li> </ul>
1,300 to 1,800 veh/h	<ul style="list-style-type: none"> <li>Two-lane entry likely to be sufficient</li> </ul>
Above 1,800 veh/h	<ul style="list-style-type: none"> <li>More than two entering lanes may be required</li> <li>A more detailed capacity evaluation should be conducted to verify lane numbers and arrangements.</li> </ul>

\* Operational analysis needed to verify upper limit for specific applications or for roundabouts with more than two lanes or four legs.  
NCHRP Report 672 (1)

In addition to providing different amounts of capacity, there are other notable differences between single-lane and multilane roundabouts. Multilane roundabouts introduce additional conflict types (primarily due to side-by-side travel and lane use decisions, as discussed in Chapter 5) that may limit their ability to achieve the same level of crash reduction as their single-lane counterparts. Section 5.2.1 of this guide provides examples of additional vehicle conflicts possible at multilane roundabouts not present at single-lane roundabouts. Nevertheless, even with an expected lower overall crash

reduction, multilane roundabouts should still result in fewer serious injuries and fatalities as compared to signalized intersections. Chapter 5 provides additional information related to roundabout safety.

### 3.1.2 Roundabouts in a Series

Roundabouts may be installed in a series along a corridor, as shown in Exhibit 3-3. This can create a number of opportunities, including:

- Roundabouts facilitate U-turns between intersections. Driveways with restricted access can often be served more efficiently when located between roundabouts than between traffic signals due to more efficient U-turn movements. This may support an overall access management policy for the corridor.
- Roundabouts may forestall the need to widen the roadway between roundabouts (the “wide nodes, narrow roads” concept).

However, these opportunities may come with a number of challenges:

- Driveways between roundabouts will likely operate with a lower capacity and higher delay due to the higher degree of randomness in headways along the major street. Downstream of a traffic signal, platooned discharge creates periods between platoons where gaps are more plentiful. Therefore, it may be necessary to restrict some driveway movements and rely on U-turns at the roundabouts to achieve acceptable operations.
- Signal preemption and priority is not possible with a series of roundabouts unless additional signal treatments are provided.
- Delay may be higher for through traffic due to the inability to provide platoon progression as with coordinated traffic signals.



Courtesy George Butler Associates, Inc.

**Exhibit 3-3**  
**Roundabouts in a series on**  
**Renner Boulevard in**  
**Lenexa, Kansas**

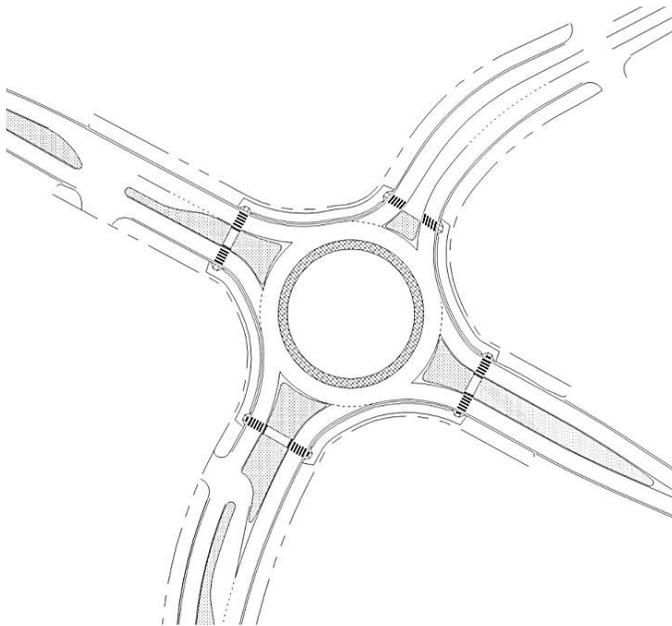
### 3.1.3 Designing for Future Conditions

When projected traffic volumes indicate a multilane roundabout is required for future year conditions, designers should evaluate how long an interim configuration (such as a single-lane roundabout) will operate acceptably before requiring additional lanes. When a single-lane roundabout will provide sufficient capacity for much of its design life, designers should consider constructing and operating the roundabout in a single-lane configuration until traffic volumes dictate the need for ultimate expansion to a multilane roundabout.

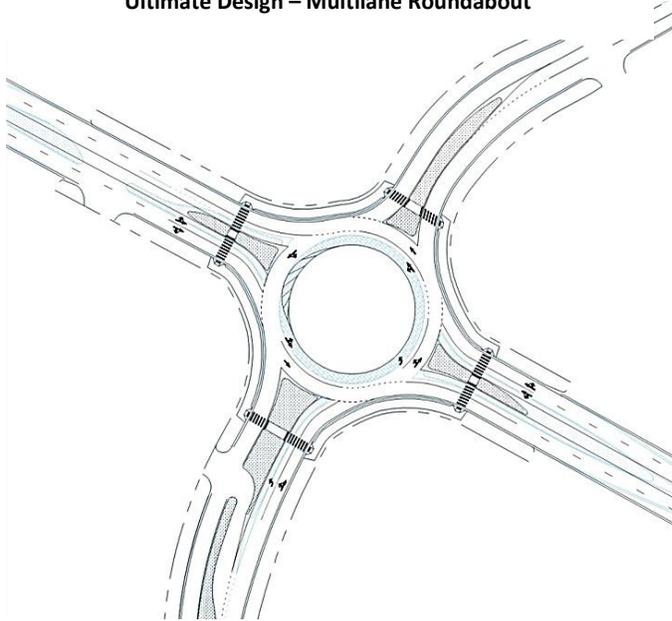
When considering an interim single-lane roundabout, the designer should evaluate the right-of-way and geometric needs for both the single-lane and ultimate multilane configurations. Consideration should also be given to the future construction staging for the additional lanes. There are generally two ways to expand from a single-lane to a multilane roundabout:

- **Construct additional entering, circulating, and exiting lanes on the outside of the single-lane roundabout (expansion to the outside).** Under this option, it may be easier for construction to occur while maintaining traffic flow. However, when using this option, care should be taken to provide adequate geometric design, including that of each entry and splitter island, so that speed reduction and good path alignment will be provided at ultimate build-out. In preparing for this type of construction staging, it is advised to initially design the roundabout for the ultimate multilane condition to provide adequate geometry and then remove the outside lanes from the design to form the initial single-lane roundabout. It is also helpful to evaluate the ultimate roundabout footprint to reserve right-of-way to accommodate the future widening.
- **Construct the additional entering, circulating, and exiting lanes on the inside of the single-lane roundabout (expansion to the inside).** Under this option, the initial single-lane roundabout is designed to occupy the same inscribed circle diameter as the ultimate multilane roundabout. This allows the designer to set the outer limits of the intersection during the initial construction. This limits the future construction impacts to surrounding properties during widening, as sidewalks, outer curb lines, drainage features, and illumination will not typically require adjustment. In this case, the roundabout is again initially designed for the ultimate multilane configuration. However, the modification from a single-lane design is done by providing wide splitter islands and an enlarged central island that occupies the space required for the inside travel lanes. Future expansion to the multilane roundabout is accomplished by reducing the width of the splitter islands and widening on the inside of the existing travel lanes. Typically, the splitter islands, central-island curbing, and truck apron would require replacement. This type of expansion is illustrated in Exhibit 3-4.

**Interim Design – Single-Lane Roundabout**



**Ultimate Design – Multilane Roundabout**



Adapted from NCHRP Report 672 (1)

Exhibit 3-4 shows a sample multilane roundabout design where staged construction allows a single-lane roundabout in the interim years until traffic volumes dictate the need for additional lanes. Note that the footprint of the roundabout and the approaches does not change between the interim and ultimate design. Narrowing the splitter islands and reducing the diameter of the central island to accommodate the additional travel lanes allows the conversion to a multilane roundabout. The ultimate roundabout design was established and refined first, then the interim design was produced by modifying the ultimate design to provide single entering, circulatory, and exiting lanes. This provides

**Exhibit 3-4  
Example – Staged Multilane  
Roundabout Construction**

appropriate geometric features for the ultimate multilane design at the time the roundabout is first constructed. This also helps to identify the potential right-of-way and environmental impacts so they can be addressed with the initial construction.

### **3.1.4 Cost**

The cost of a roundabout varies greatly depending on a wide variety of factors, including the setting (urban/suburban/rural), complexity of improvements, roundabout footprint, approach work needed, maintenance of traffic, and landscaping. Costs are typically higher when a substantial amount of realignment, grading, or drainage work is required (1). Other significant costs may include large amounts of landscaping, extensive signing and lighting, and curbing on all outside pavement edges. Maintenance of traffic under construction often contributes as much as a third of the total construction cost due to difficulties associated with the construction of the central island while maintaining traffic in all directions.

At some existing unsignalized intersections, a traffic signal can be installed without significant modifications to the intersection's geometry, whereas a roundabout may require more costly changes. However, at new sites and intersections that require widening, a roundabout can be comparable to a signal or even less expensive. As noted in Section 2.1 of this guide, roundabouts typically require more pavement area at the intersection, but may require less pavement width on approaches and exits if multiple turn lanes can be avoided. The cost savings of reduced approach roadway width is particularly significant at interchange ramp terminals or locations with bridge structures.

Operating and lifecycle costs for a roundabout should be considered in addition to construction costs. Operating costs for a roundabout are typically more than for an unsignalized intersection but less than for a signalized intersection (which consumes electricity and requires periodic service). Roundabout operating costs usually include lighting, re-striping and re-paving as necessary, snow removal, and landscape maintenance (which in many cases are also required for signalized intersections). Roundabouts also provide additional safety, operational, and environmental benefits, and a life-cycle cost analysis will often favor the construction of a roundabout over other alternatives due to these benefits. *Section 3.7 Economic Evaluation* of NCHRP Report 672 provides additional discussion on the costs associated with a roundabout, including a method for estimating the benefits of a roundabout (1).

## **3.2 PUBLIC INVOLVEMENT**

This section explains how to involve the public when considering constructing a roundabout and provides guidance for both public meetings and user education.

### **3.2.1 PUBLIC MEETING GUIDANCE**

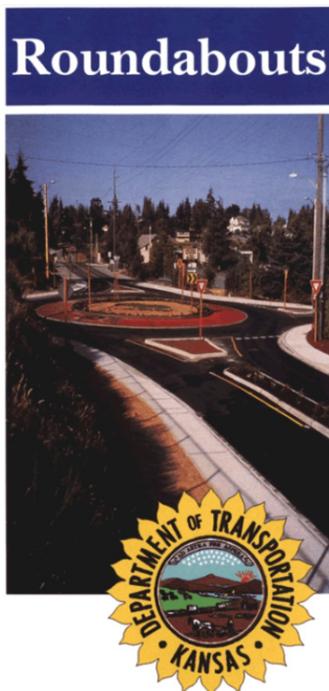
Public meetings can be an important tool for gaining acceptance of a roundabout in a community as well as providing a forum for educating the public on the new form of traffic control. This forum allows the public to

become involved in the design process to identify problems and preferred alternatives. This step in the design process may be especially important for the introduction of a roundabout into a new area that exhibits public opposition. The public meeting provides an opportunity to dispel any misnomers about roundabout design and operation, as well as to showcase the operational and safety benefits.

To gain the most benefit from a public meeting, it may be helpful to think about the following questions:

- Who are the advocates and opponents of the roundabout project?
- Why are people advocating or opposing the roundabout?
- What information does the public need to know to understand why a roundabout is being considered?
- What role can the public play in providing input and guidance?

Including visualizations to show how a roundabout works can be helpful for engaging the public. A simulation model can also be a useful tool, particularly for communities that may be new to roundabouts. KDOT has developed several materials for roundabout education, available on their website (<http://www.ksdot.org>). An example information brochure with roundabout basics is shown in Exhibit 3-5. The full brochure and sample materials from a public information meeting in Lyndon, Kansas are provided in Appendix A.



Kansas Roundabout Guide for Everybody (2)

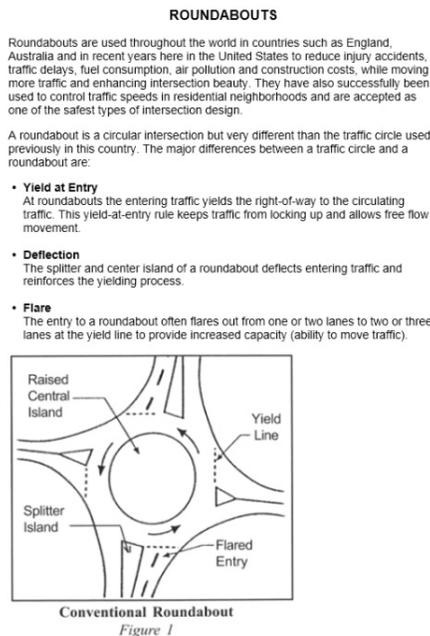


Exhibit 3-5  
Roundabout Brochure from  
KDOT website

### 3.2.2 EDUCATION OF TRANSPORTATION PROFESSIONALS AND ELECTED OFFICIALS

Education is not only an issue for the public but also for the agency staff implementing roundabouts to support elected officials in the decision-making process. An agency should have enough expertise available within its ranks to have an understanding of roundabouts and be able to review roundabout designs and operational analyses. This will help produce quality designs and encourage the continuation of the use of roundabouts as a feasible intersection alternative (3). Additionally, the negative perception of roundabouts held by some drivers and elected officials continue to be the principal impediment to the construction of roundabouts (4). Education of key decision-makers in particular allows the focus to be on objective criteria rather than myths and negative public perception when alternatives are being considered.

### 3.2.3 USER EDUCATION

An important component in educating the public about roundabouts is providing guidance on how to navigate a roundabout. While the yield form of traffic control has been around for several decades, surveys have shown that drivers tend to oppose roundabouts because they are perceived as “confusing” or “unsafe,” both of which could be attributed to a lack of familiarity with navigating a roundabout. As roundabouts become more and more common in Kansas and throughout the United States, users will likely become more comfortable driving, biking, or walking through roundabouts.

This section provides guidance on navigating a roundabout for the various modes of users. Brochures, videos, web-based guidance, or other presentation types may also be useful media for distributing this information. The *Kansas Driving Handbook* (5) provides detailed steps for navigating a roundabout and considering all users and vehicle types. Roundabout education could also be incorporated into driver’s education programs to reach more of the public. The following, based on KDOT’s *Roundabout Guide for Everybody* (2), provides guidance to drivers, truck drivers, pedestrians and bicyclists on how to navigate a roundabout.

#### 3.2.3.1 Drivers

The following provides step-by-step guidance to motorists on how to drive through a roundabout.

#### Approaching the Roundabout

- When you approach a roundabout, slow down and decide as early as possible which exit you want to take. At a multilane roundabout, the lane-use signs, shown in Exhibit 3-6, will guide you into the correct lane.
  - For a two-lane roundabout, use the left lane for making a left turn or for going straight when allowed by the roundabout lane configuration.
  - Use the right lane for a right turn or for going straight when allowed by the roundabout lane configuration.



Courtesy of the City of Overland Park

**Exhibit 3-6**  
Lane Use Sign at the intersection  
of Renner Boulevard/West Bass  
Pro Drive in Olathe, Kansas

- For a three-lane roundabout, note how the center lane is assigned on the lane-use signs. It might be limited to going straight, or it might be used for a left or right turn.
- Keep to the right of the splitter island and yield to pedestrians using the crosswalk.
  - You should allow bicyclists to use the roundabout as if they were driving a motorized vehicle.

#### **Yield When Entering the Roundabout**

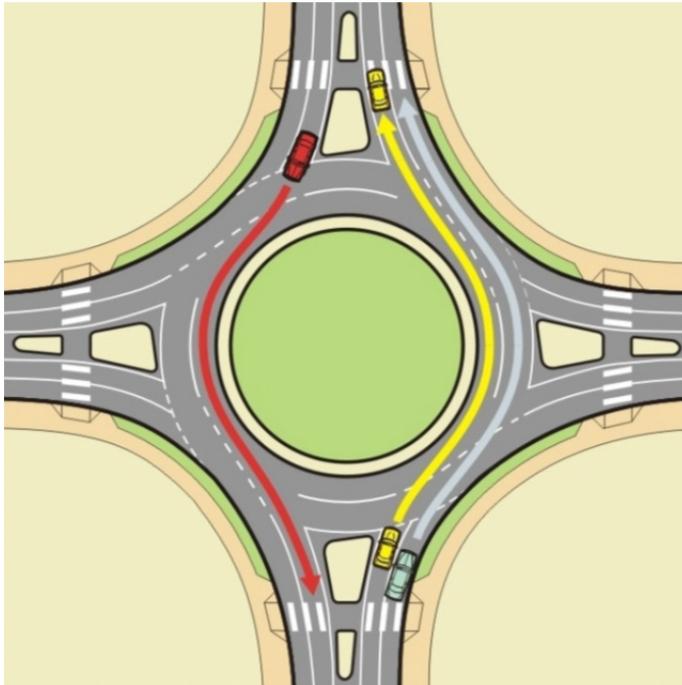
- Yield at the yield line to traffic coming from the left. Don't enter next to vehicles in the roundabout, i.e., the inner lane of a two-lane roundabout, since they may use the next exit. Always keep to the right of the central island.
- If an emergency vehicle is approaching on another leg, wait for the emergency vehicle to use the roundabout before entering.

#### **Driving in the Roundabout**

- Don't stop in the roundabout except to avoid a collision. You have the right-of-way over entering traffic. Stay to the right of the central island, keep moving, and travel in a counter-clockwise direction. Follow the lane lines and stay in your lane. [Exhibit 3-7] illustrates vehicles driving straight through a roundabout.
- Don't pass other vehicles in the roundabout and watch out for traffic crossing in front of you.
- Caution should be exercised when entering and driving adjacent to large trucks.

**Exhibit 3-7  
Driving Straight Through a  
Roundabout**

- If an emergency vehicle approaches from behind or at an entrance, you should drive to your exit and pull to the right past the splitter island at your exit.



Kansas Roundabout Guide for Everybody (2)

**Exiting the Roundabout**

- Signal your intention to exit using your right-turn signal. Watch for vehicles to your right, and stay in your lane. Watch for and yield to pedestrians at the crosswalk on the exit leg. Maintain a slow speed as you exit and accelerate when you are beyond the splitter island.

**3.2.3.2 Truck Drivers**

Roundabouts on the state highway system are generally designed to accommodate large vehicles. When large trucks with wide turning needs are expected to use the intersection, the roundabout will have a truck apron with a low curb around the center island. It might be colored red or some other color to set it off from the island. The apron allows truck drivers to roll the trailer's rear wheels over the low curb as they drive through the roundabout. The low curb discourages other drivers from using the apron, helping to keep their speeds slow and consistent. An illustration of a truck apron at a roundabout is provided in Exhibit 3-8. A more detailed discussion of the truck apron design is provided in Chapter 6 of this guide.

Trucks with a trailer should stay close to the left side of the entry as they approach the roundabout. As trucks pass through the roundabout, the rear trailer may roll over the truck apron. As trucks exit, they should stay close to the left side of the exit.

Depending on the design of the multilane roundabout, trucks may need to occupy the entire circular roadway to make the turn.



Courtesy of Lee Rodegerdts

**Exhibit 3-8**  
**Truck Apron Example**  
**(Hutchinson, KS)**

### 3.2.3.3 Pedestrians

In Kansas, pedestrians have the right-of-way within crosswalks at non-signalized intersections, including roundabouts. However, pedestrians must not suddenly leave a curb or other safe waiting place and walk into the path of a vehicle if the vehicle is too close. The following provides additional guidance for pedestrians:

- **Do not cross the roundabout to the central-island or walk in the circulatory lanes.** The central island is not intended or designed for pedestrian activity.
- **Use the crosswalks on the legs of the roundabout,** shown in Exhibit 3-9. If there is no crosswalk marked on a leg of the roundabout, cross the leg about one vehicle-length away from the circular roadway of the roundabout.
- **Look and listen for approaching traffic.** Choose a safe time to cross from the curb to the median opening in the splitter island. Although you have the right-of-way, if approaching vehicles are present, be sure drivers recognize you are there and that you intend to cross. When crossing an entry or exit with more than one lane, be sure that oncoming vehicles in all lanes recognize that you are crossing before proceeding.
- **Use the splitter island, if available.** It allows you to cross one direction of traffic at a time.

Exhibit 3-9  
Pedestrian Crosswalk Example  
(Lenexa, KS)



Courtesy of City of Overland Park

#### 3.2.3.4 Bicyclists

Roundabouts provide bicyclists three options for navigating the intersection: riding through the roundabout, using their bicycle on the sidewalk when allowed, or using a shared path (when provided). Guidance for each of these three options is provided below:

- **Ride like a car.** If you are comfortable riding in traffic, ride on the circular roadway of the roundabout like a car. Obey all of the same driving instructions as for cars. Watch out for vehicles crossing your path to leave or join the roundabout. Watch out for large vehicles on the roundabout, as they need more space to maneuver. On the approach to the entry, signal your intentions and merge into traffic. Keep in mind that drivers should be traveling at about 15 to 20 mph — close to the speed you ride your bicycle.
- **Walk like a pedestrian.** If you are uncomfortable riding in traffic in the roundabout, exit the approach lane before the splitter island, and move to the sidewalk. Once on the sidewalk, use your bicycle, yielding to pedestrians and following rules for pedestrians.
- **Use a shared bicycle-pedestrian path.** Some roundabouts have a widened sidewalk or a shared bicycle-pedestrian path that runs around the roundabout outside of the circular roadway.

### 3.3 REFERENCES

1. Rodegerdts, L., J. Bansen, C. Tiesler, J. Knudsen, E. Myers, M. Johnson, M. Moule, B. Persaud, C. Lyon, S. Hallmark, H. Isebrands, R. B. Crown, B. Guichet, and A. O'Brien. NCHRP Report 672: *Roundabouts: An Informational Guide, 2nd ed.* Transportation Research Board of the National Academies, Washington, D.C., 2010.

2. Kansas Department of Transportation. *Kansas Roundabout Guide for Everybody*. <http://www.ksdot.org>.
3. Pochowski, Alek and Myers, Edward J. *A Review of Statewide Roundabout Programs*. Washington, DC: Transportation Research Record, 2009.
4. Insurance Institute for Highway Safety. Q&As: Roundabouts. Insurance Institute for Highway Safety, Highway Loss Data Institute. <http://www.iihs.org/iihs/topics/t/roundabouts/qanda>.
5. Kansas Department of Revenue. *Kansas Driving Handbook*.

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# **Chapter 4**

## **Operational Analysis**

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**CHAPTER 4  
OPERATIONAL ANALYSIS**

**CONTENTS**

**Chapter 4 Operational Analysis ..... ii**

- 4.1 Roundabout Operations ..... 1
  - 4.1.1 Analysis Techniques..... 1
  - 4.1.2 Operational Performance Measures and Guidelines ..... 2
  - 4.1.3 Operational Analysis Tools ..... 3
  - 4.1.4 Simulation..... 3
- 4.2 Network Considerations ..... 4
  - 4.2.1 Network Queuing ..... 4
  - 4.2.2 Unsignalized Intersections ..... 5
  - 4.2.3 Signalized Intersections..... 5
  - 4.2.4 Rail Crossings..... 6
  - 4.2.5 Parking..... 6
- 4.3 References ..... 6

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**LIST OF EXHIBITS**

Exhibit 4-1 Selection of Analysis Tool ..... 1  
Exhibit 4-2 VISSIM Simulation..... 4  
Exhibit 4-3 Roundabout near signalized intersection in Basehor, KS ..... 5

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## CHAPTER 4 OPERATIONAL ANALYSIS

This chapter presents methods for analyzing the operations of a roundabout and assessing potential interactions with the surrounding transportation network.

### 4.1 ROUNDABOUT OPERATIONS

For KDOT projects, an operational analysis is required for each proposed roundabout configuration to estimate the capacity and operational performance. This allows the analyst to make comparisons to other intersection treatments.

#### 4.1.1 ANALYSIS TECHNIQUES

There are a variety of methodologies and tools that can be used to analyze the performance of a roundabout. As stated in NCHRP Report 672, “all are approximations, and the responsibility is with the analyst to use the appropriate tool for conducting the analysis” (1, p. 4-10). In order to determine the appropriate tool, the analyst should consider what data is available and what outcome is desired. Exhibit 4-1 presents a summary of common applications of operational analysis tools ranging from simple planning-level tools to *Highway Capacity Manual 2010* (HCM 2010) procedures to simulation models.

Application	Typical Outcome Desired	Input Data Available	Potential Analysis Tool
Planning-level sizing	Number of lanes	Traffic volumes	Chapter 3 NCHRP Report 672, HCM, deterministic software (e.g., SIDRA, RODEL)
Preliminary design of roundabouts with up to two lanes	Detailed lane configuration	Traffic volumes, geometry	HCM, deterministic software
Preliminary design of roundabouts with three lanes and/or with short lanes/flared designs	Detailed lane configuration	Traffic volumes, geometry	Deterministic software
Analysis of pedestrian treatments	Vehicular delay, vehicular queuing, pedestrian delay	Vehicular traffic and pedestrian volumes, crosswalk design	HCM, deterministic software, simulation (e.g., VISSIM)
System analysis	Travel time, delays and queues between intersections	Traffic volumes, geometry	HCM, simulation
Public involvement	Animation of no-build conditions and proposed alternatives	Traffic volumes, geometry	Simulation

NCHRP Report 672, Exhibit 4-4 (1)

Exhibit 4-1  
Selection of Analysis Tool

Typically, the level of detail desired in the analysis increases as a roundabout study progresses. Initially, only a rough analysis using the planning-level techniques in Section 3.1 Planning of this guide may be necessary to determine the type of roundabout (number of lanes) needed at an intersection. If a roundabout continues to be a feasible alternative, more detailed analysis using deterministic software may be performed to determine operational performance. The following sections discuss performance measures and guidelines for operations at a roundabout, as well as analysis tools.

#### 4.1.2 OPERATIONAL PERFORMANCE MEASURES AND GUIDELINES

Three key performance measures used to evaluate the operating performance for a particular roundabout design include:

- Volume-to-capacity ratio (degree of saturation)
- Delay
- Queue length

These three performance measures should be assessed for each lane, approach, and the intersection as a whole during all relevant analysis periods. The results can be used to compare two or more roundabout configuration options or additional intersection control treatments. When selecting a roundabout design or intersection treatment, operational performance should be considered in addition to others such as safety, cost, right-of-way impacts, and environmental impacts and benefits.

The **volume-to-capacity ratio** reflects the degree of saturation of a movement or intersection. The volume-to-capacity ratio is calculated by dividing the flow of traffic in a given lane by the measured or estimated capacity of that lane. A volume-to-capacity ratio of 1.0 indicates a lane that is operating at capacity. A volume-to-capacity ratio over 1.0 indicates the capacity of the lane is exceeded. For design purposes, KDOT preference is to use a maximum volume-to-capacity ratio of 0.85 under existing or near-term conditions. A higher volume-to-capacity ratio of up to 0.95 is acceptable for future operations, provided that the delays and queues described below are acceptable and the impacts of mitigating the higher volume-to-capacity ratio are unacceptable.

**Delay** is a standard parameter used to measure the performance of an intersection. Control delay is the standard measure used in the HCM to represent the delay component of a roundabout performance, as it is the same measure used to represent the delay for other types of intersections. Level of service (LOS) is determined from the control delay estimate. The HCM 2010 includes a method for calculating control delay at a given lane of a roundabout based on the lane's capacity and volume-to-capacity ratio (2). It also includes a method for calculating the average control delay for each approach to the roundabout and for the intersection as a whole. These can be used to make comparisons between operations at a roundabout and other intersection types.

**Queue length** is important for assessing the adequacy of the geometric design of the roundabout approaches and potential interactions with adjacent intersections. The 95th-percentile queue length is determined to estimate the design queue for a given lane. The HCM 2010 includes a method for calculating the 95th-percentile queue length for a given lane of an approach based on the

*KDOT preference is to use a maximum volume-to-capacity ratio of 0.85 under existing or near-term conditions.*

volume-to-capacity ratio and capacity of the given lane (2). The queue length should be checked against available storage to assess potential interactions with adjacent lanes.

#### 4.1.3 OPERATIONAL ANALYSIS TOOLS

The HCM 2010 provides an analytic method for assessing the operations of a roundabout (2). This method is a major update from the method presented in the 2000 edition and is largely based on a study of 31 sites in the United States. The method is applicable to existing or planned one-lane or two-lane roundabouts given traffic-demand levels.

While KDOT does not have a preferred analysis tool, analysis should be consistent with the methodologies described in the HCM 2010, either by implementing the HCM method directly or by calibration to the field data underlying the HCM method. At this time, KDOT accepts the following software methods for conducting performance analysis at roundabouts:

- Highway Capacity Software (HCS) 2010 software package
- SIDRA software package (US HCM 2010 model)
- RODEL software package (calibrated to latest US data from FHWA or Highway Capacity Committee)
- Various spreadsheet tools incorporating the HCM 2010
- Traffic simulation software packages (calibrated to latest US data from FHWA or Highway Capacity Committee)

There are advantages and considerations associated with each analysis tool that should be considered when selecting the appropriate model to use. For example, the HCS 2010 software package only allows analysis for up to four approaches with two entry lanes and therefore may not be appropriate for locations with more than four legs or with one or more approaches with more than two lanes. The SIDRA software package incorporates the HCM 2010 model, but with SIDRA extensions that introduce differences with the HCM methodology. Therefore, the onus is on the analyst to select the appropriate tool and show compliance with HCM methodologies. Discussions with KDOT on a case-by-case basis can help guide this selection.

#### 4.1.4 SIMULATION

A variety of simulation software packages are available for modeling transportation networks, several of which are capable of modeling roundabouts. Simulation models are sensitive to factors at an individual vehicle level, such as car-following behavior and gap acceptance. Therefore, care should be taken to apply the simulation model appropriately. If simulation is used, the preferred model for KDOT is VISSIM.

Simulation can be particularly beneficial for public presentations or when analyzing complex, congested, or unusual situations. Simulation provides a greater level of complexity to an analysis, but also requires a great deal of expertise and effort spent calibrating and validating the model. The model should be calibrated to local conditions and carefully analyzed.

*All analysis should be consistent with the methodologies described in the HCM 2010.*

**Exhibit 4-2  
VISSIM Simulation**



Courtesy of Kittelson & Associates, Inc.

## **4.2 NETWORK CONSIDERATIONS**

As noted in Chapter 2, the surrounding transportation network should be considered when assessing the feasibility of a roundabout at an intersection. The operations of a roundabout can influence or be influenced by nearby unsignalized intersections, signalized intersections, railroad crossings, and parking areas. This section provides a brief discussion of queuing at intersections in close proximity to roundabouts, followed by a discussion about nearby unsignalized and signalized intersections, rail crossings, and parking.

### **4.2.1 NETWORK QUEUING**

A downstream queue that extends into a roundabout impedes circulating flow during the queued period. As circulating flow is impeded, exits upstream of the impeded exit become blocked, further increasing the queuing within the circulatory roadway. In theory, an entire roundabout could become jammed if an exit is blocked for a sufficient period of time. In addition, queue spillback into a roundabout reduces the overall capacity of each approach that is blocked. Therefore, it is generally preferred to avoid having downstream queues caused by other intersection forms back up into a roundabout for any significant period of time.

The principal measure to determine how close a roundabout should be located to other intersections is the amount of queuing expected at each intersection. In general, it is desirable for the 95th-percentile queue to be completely accommodated within the space between the two intersections. More discussion on the impacts of queues at unsignalized and signalized intersections is provided below.

*It is desirable for the 95th-percentile queue to be completely accommodated within the space between the two intersections*

### 4.2.2 UNSIGNALIZED INTERSECTIONS

A roundabout located in close proximity to another unsignalized intersection may be influenced by the adjacent intersection queues. This is most common for an all-way stop-controlled intersection, although queues from a nearby two-way stop controlled-intersection could be an issue if the roundabout is located on the minor (stop-controlled) roadway. Downstream queue storage from a stop-controlled intersection should end short of the crosswalk area of a roundabout to avoid creating additional potential driver distractions that may compromise pedestrian safety.

### 4.2.3 SIGNALIZED INTERSECTIONS

Signalized intersections can influence a roundabout in several ways:

- **Queuing effects.** At nearby signalized intersections, 95th-percentile queues should not back up into the roundabout. However, because such backups are infrequent and momentary, it may be acceptable in highly constrained locations to allow momentary backups into the roundabout. This should only be done in areas where the downstream signal is operating below capacity and can reliably flush out queues during a single signal cycle, and where the unblocked capacity of the roundabout is sufficient to accommodate the loss of capacity during these blocked periods. In these situations queue detectors should be considered to allow the signal phase to change when queues begin to back up toward the roundabout.
- **Platooned arrival patterns.** Signalized intersections create platooned arrival patterns at a roundabout. The platooned arrivals from a nearby signal at a roundabout can increase a roundabout's capacity due to a regular pattern of gaps in traffic that can be used efficiently.
- **Signal preemption and priority.** A roundabout cannot be preempted or give priority to certain intersection users without additional signal treatments. If a traffic signal is preempted frequently, queues from the signal backing towards the roundabout may be larger than estimated using the above procedures.



Courtesy of the City of Overland Park

**Exhibit 4-3**  
Roundabout near signalized  
intersection in Basehor, KS

#### 4.2.4 RAIL CROSSINGS

In general, locating any intersection near an at-grade rail crossing is discouraged. However, when an intersection is necessary near an at-grade rail crossing, a key consideration is the accommodation of vehicle queues at the roundabout to avoid queuing across the tracks. *Section 7.6 At-Grade Rail Crossings* of NCHRP Report 672 discusses potential interactions between rails and roundabouts, issues to consider when designing a rail crossing, and the use of gated rail crossings (1). Exhibits 7-34 through 7-36 in the report illustrate three common scenarios:

1. Rail crosses one leg of the intersection
2. Rail crossing through center of the roundabout
3. Rail running down roadway median

NCHRP Report 672 presents considerations for each scenario in regards to providing gates at the roundabout (1). The 2009 *Manual on Uniform Traffic Control Devices (MUTCD)* (3) provides guidance on circular intersections near rail crossings in Section 8C.12: “Where circular intersections include or are within 200 feet of a grade crossing, an engineering study shall be conducted to determine if queuing could impact the grade crossing. If traffic queues impact the grade crossing, provisions shall be made to clear highway traffic from the grade crossing prior to the arrival of rail traffic.”

#### 4.2.5 PARKING

Parking maneuvers near a roundabout can create momentary congestion. At a minimum, parking spaces should be located no closer than 30 feet from the crosswalk to allow parking to take place without affecting pedestrian circulation. If traffic volume on the street is high and/or parking turnover is frequent, an analysis could be conducted to determine how often parking conflicts would occur, how long traffic is disrupted during each parking maneuver, and what length of queue will form. The proximity of parking to the roundabout could then be adjusted further away from the roundabout if closer proximity creates undesirable queuing conditions.

#### 4.3 REFERENCES

1. Rodegerdts, L., J. Bansen, C. Tiesler, J. Knudsen, E. Myers, M. Johnson, M. Moule, B. Persaud, C. Lyon, S. Hallmark, H. Isebrands, R. B. Crown, B. Guichet, and A. O’Brien. *NCHRP Report 672: Roundabouts: An Informational Guide, 2nd ed.* Transportation Research Board of the National Academies, Washington, D.C., 2010.
2. Transportation Research Board. *Highway Capacity Manual 2010.* Transportation Research Board of the National Academies, Washington, D.C., 2010.
3. Federal Highway Administration, *Manual on Uniform Traffic Control Devices.* 2009.

# **Chapter 5**

## **Safety**

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**CHAPTER 5  
SAFETY**

**CONTENTS**

**Chapter 5 Safety ..... 1**

- 5.1 Quantifying Roundabout Safety ..... 1
  - 5.1.1 Comparison to Other Intersection Treatments..... 2
  - 5.1.2 Crash Prediction Models ..... 3
  - 5.1.3 Crash Modification Factors..... 3
  - 5.1.4 Estimating Cost Savings from Safety Benefits ..... 5
  - 5.1.5 Roundabouts as a Safety Tool ..... 5
- 5.2 Designing for Safe Roundabouts..... 6
  - 5.2.1 Vehicular Conflicts at Multilane Roundabouts..... 6
  - 5.2.2 Additional Safety Recommendations ..... 9
- 5.3 References ..... 9

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**LIST OF EXHIBITS**

Exhibit 5-1 Crash Type Comparison for Intersections with Single-Lane Approaches ..... 1

Exhibit 5-2 Comparisons to Previous Intersection Treatments in the United States ..... 2

Exhibit 5-3 Crash Types at US Roundabouts ..... 3

Exhibit 5-4 CMFs for Conversion of a Stop Controlled Intersection to a Modern Roundabout ..... 4

Exhibit 5-5 CMFs for Conversion of a Signalized Intersection to a Modern Roundabout ..... 5

Exhibit 5-6 Failing to Maintain Lane Position at Multilane Roundabout ..... 7

Exhibit 5-7 Entering Next to an Exiting Vehicle at a Multilane Roundabout ..... 8

Exhibit 5-8 Improper Turn Conflicts at Multilane Roundabout ..... 8

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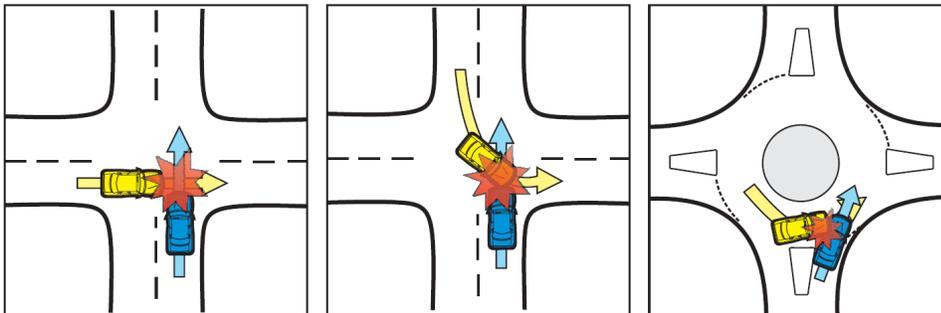
## CHAPTER 5 SAFETY

This chapter provides guidance on: 1) understanding and quantifying the safety benefits of roundabouts, and 2) designing roundabouts to optimize safety performance.

### 5.1 QUANTIFYING ROUNDABOUT SAFETY

Roundabouts improve intersection safety by eliminating or altering conflict types, reducing crash severity, and slowing vehicular speeds. Many studies have supported the safety benefits of roundabouts and worked to quantify these benefits. Being able to quantify the safety benefits of a roundabout can help inform the selection of an appropriate intersection treatment and gain public support for a roundabout. The primary reasons roundabouts provide safety benefits are the following (1):

- Roundabouts have fewer vehicular conflict points and less potential for high-severity conflicts, such as right-angle, left-turn, and head-on crashes. As shown in Exhibit 5-1, the shape of the roundabout eliminates the more severe crossing conflicts.
- Roundabouts slow vehicular speeds, which provides drivers more time to react to potential conflicts and reduces crash severities.
- Roundabouts generally reduce the speed differential between vehicles traveling through the intersection, which reduces crash severity.
- Pedestrians only have to cross one direction of traffic at a time at a roundabout and contend with slower moving vehicles. However, multilane roundabouts provide challenges for visually impaired pedestrians, including locating the crosswalk and detecting either a gap in traffic or a yielding driver.



Courtesy of Kittelson & Associates, Inc.

**Exhibit 5-1**  
Crash Type Comparison  
for Intersections with  
Single-Lane Approaches

### 5.1.1 COMPARISON TO OTHER INTERSECTION TREATMENTS

Chapter 3 Safety Findings of NCHRP Report 572 summarizes available data on the safety performance of roundabouts in the United States (2). It includes data that estimates the percent reduction in crashes with the installation of a roundabout, compared to previous intersection treatments. The results are shown in Exhibit 5-2.

Exhibit 5-2  
Comparisons to Previous  
Intersection Treatments in  
the United States

Control Before	Sites	Setting	Lanes	Estimate of the Percent Reduction in Crashes (and Standard Error)	
				All	Injury + Fatal
All sites	55	All	All	35.4% (3.4)	75.8% (3.2)
Signalized	9	All	All	47.8% (4.9)	77.7% (6.0)
	4	Suburban	2	66.7% (4.4)	Sample too small to analyze
	5	Urban	All	Effects insignificant	60.1% (11.6)
All-way stop	10	All	All	Effects insignificant	Effects insignificant
Two-way stop	36	All	All	44.2% (3.8)	81.8% (3.2)
	9	Rural	1	71.5% (4.0)	87.3% (3.4)
	17	Urban	All	29.0% (9.0)	81.2% (7.9)
	12		1	39.8% (10.1)	80.3% (10.0)
	5		2	Sample too small to analyze	Sample too small to analyze
	10	Suburban	All	31.8% (6.7)	71.0% (8.3)
	4		1	78.2% (5.7)	77.6% (10.4)
	6		2	19.3% (9.1)	68.0% (11.6)
	27	Urban/ Suburban	All	30.8% (5.5)	74.4% (6.0)
	16		1	56.3% (6.0)	77.7% (7.4)
	11		2	17.9% (8.2)	71.8% (9.3)

NCHRP Report 572, Table 28 (2)

The report makes the following conclusions from the data:

- **Control type before:** The most significant safety improvements were observed at intersections converted from a signal or two-way stop control to a roundabout. No statistically significant safety effect was apparent for the conversion from all-way stop control.
- **Number of lanes:** The safety improvement from prior control was greater for single-lane roundabouts than for multilane roundabouts.
- **Setting:** The safety improvement from conversion from a two-way stop to a roundabout in rural settings was greater than for urban and suburban settings.

- **Volume:** The relative safety improvement of roundabouts compared to other types of control appears to decrease with increasing AADT.

NCHRP Report 572 provides data related to crash types observed at roundabouts (2). The main crash types observed in an analysis of 39 roundabouts in the United States are shown in Exhibit 5-3.

Crash Type	Percent
Entering-Circulating	23
Exiting-Circulating	31
Rear-End on Leg	31
Loss of Control on Leg	13
Pedestrian	1
Bicycle	1

NCHRP Report 572, Table 13 (2)

NCHRP Report 572 also discusses available data related to pedestrian and bicycle safety at roundabouts. It concludes that roundabouts provide substantial safety benefits for both pedestrians and bicycles due to slower vehicle speeds and a reduced number of conflict points, but that accessibility issues may be present (2).

### 5.1.2 CRASH PREDICTION MODELS

*Section 5.4 Intersection-Level Crash Prediction Methodology* of NCHRP Report 672 provides an overview of intersection-level crash prediction models, and *Section 5.5 Approach-Level Crash Methodology* describes models used for predicting crashes at an approach level. The intent of both of these model types is to combine model predictions and observed crash frequencies into a single estimate of the expected crash frequency at an intersection. This allows an existing roundabout to be used in a “network screening process to examine the performance of that roundabout in relation to other roundabouts or other intersections” (1). An analyst could then conclude that the safety performance of a given roundabout is better or worse than similar roundabouts. In addition, the expected safety benefit of installing a roundabout at an intersection could be assessed using crash modification factors (CMFs), which are further described in Section 5.1.3 of this guide.

The approach level models can also be used to make design decisions at the approach level and assess the expected impact of a design change. At the approach level, models are used to separately predict three crash types (entering-circulating, exiting-circulating, and approach crashes). NCHRP Report 572 provides guidance on applying both model types (2).

### 5.1.3 CRASH MODIFICATION FACTORS

Part C of the *Highway Safety Manual* (HSM) provides safety performance functions for calculating the expected annual number of crashes at an intersection using roadway, crash, and volume data (3). The expected annual

**Exhibit 5-3**  
**Crash Types at US Roundabouts**

number of crashes is the long-term yearly average number of crashes anticipated to occur at the intersection based on the location’s physical characteristics, previous crash frequency, and current traffic volumes. The HSM does not currently include safety performance functions for roundabouts, but it does provide Crash Modification Factors (CMFs). Part D of the HSM includes CMFs for a variety of treatments intended to reduce the crash frequency and severity at roadways and intersections. CMFs can be used to “estimate the potential change in expected crash frequency or severity plus or minus a standard error due to implementing a particular action” (3).

The Federal Highway Administration (FHWA) maintains an online clearinghouse (<http://www.cmfclearinghouse.org>) of all documented CMFs (4). The HSM has stricter inclusion criteria, so the FHWA clearinghouse includes CMFs beyond those published in the HSM. Exhibit 5-4 presents CMFs from the FHWA clearinghouse for converting a stop-controlled intersection to a roundabout, and Exhibit 5-5 presents CMFs for converting a signalized intersection to a roundabout (the source of each CMF is noted in the table).

**Exhibit 5-4  
CMFs for Conversion of a Stop  
Controlled Intersection to a  
Modern Roundabout**

Treatment	Setting	Crash Type		Source
		All	Injury	
TWSC to single-lane roundabout	Rural	<b>0.29</b>	<b>0.13</b>	HSM (3)
	Suburban	<b>0.22</b>	<b>0.22</b>	HSM (3)
	Urban	<b>0.61</b>	<b>0.22</b>	HSM (3)
TWSC to two-lane roundabout	Suburban	<b>0.81</b>	<b>0.32</b>	HSM (3)
	Urban	0.88	-	HSM (3)
TWSC to single or two-lane roundabout	Suburban	<b>0.68</b>	<b>0.29</b>	HSM (3)
	Urban	<b>0.71</b>	<b>0.19</b>	HSM (3)
	All	<b>0.56</b>	<b>0.18</b>	HSM (3)
AWSC to single or two-lane roundabout	All	1.03	-	HSM (3)

**Bold** text indicates the most reliable CMFs, with standard error of 0.1 or less  
 TWSC = Two-way-stop-control  
 AWSC = All-way-stop-control

Treatment	Setting	Crash Type		Source
		All	Injury	
Signal to single-lane roundabout	All	0.74	0.45	Gross et al. (5)
Signal to two-lane roundabout	Suburban	<b>0.33</b>	-	HSM (3)
	All	0.81	0.29	Gross et al. (5)
Signal to single or two-lane roundabout	Suburban	0.58	<b>0.26</b>	Gross et al. (5)
	Urban	<b>0.99</b>	<b>0.4</b>	HSM (3)
	Urban	1.15	0.45	Gross et al. (5)
	3-approach	1.07	0.37	Gross et al. (5)
	4-approach	0.76	0.34	Gross et al. (5)
	All	<b>0.52*</b>	<b>0.22*</b>	HSM (3)
	All	0.79*	0.34*	Gross et al. (5)

**Bold** text indicates the most reliable CMFs, with standard error of 0.1 or less

\* Only includes suburban and urban sites (no rural sites)

**Exhibit 5-5  
CMFs for Conversion of a  
Signalized Intersection to a  
Modern Roundabout**

Further instructions for calculating the expected number of crashes at a site and applying CMFs are provided in the HSM.

### 5.1.4 ESTIMATING COST SAVINGS FROM SAFETY BENEFITS

The safety benefits associated with a roundabout can be translated to cost savings in order to better assess the cost of converting an intersection to a roundabout or constructing a new roundabout intersection. The safety benefits are assumed savings to the public due to the reduction in crashes associated with the installation of a roundabout. Once the anticipated reduction in crash frequency has been calculated, the total estimated number of prevented crashes of each severity can be calculated for each year or over the lifetime of the project. The safety benefit can then be calculated by multiplying the expected reduction in the number of each type of crash by the average cost of each crash. Within the state of Kansas, the economic costs per crash are calculated annually based on the crash severity. KDOT can provide the most up-to-date costs.

### 5.1.5 ROUNDABOUTS AS A SAFETY TOOL

In some cases, a roundabout may be selected at an intersection primarily for the safety benefits it is expected to provide. As noted in NCHRP Report 672, “the decision to install a roundabout as a safety improvement should be based on a demonstrated safety problem of the type susceptible to correction by a roundabout. A review of crash reports and the type of crashes occurring is essential” (1). NCHRP Report 672 lists the following as safety problems that are potentially correctable by roundabouts:

- High rates of crashes involving right angle, head-on, left/through, and U-turn conflicts
- High crash severity (injury or fatality crashes)
- Sight distance or visibility problems that reduce the effectiveness of stop sign control (in this case, landscaping of the roundabout needs to be carefully considered)
- Inadequate separation of movements, especially on single-lane approaches

In addition, a roundabout may be appropriate as a traffic calming measure when the following conditions are present:

- Documented observations of speeding, high traffic volumes, or careless driving activities
- Inadequate space for roadside activities, or a need to provide slower, safer conditions for both vehicular and non-automobile users
- New construction (road opening, traffic signal, new road, etc.) that would potentially increase the volumes of “cut-through” traffic

## **5.2 DESIGNING FOR SAFE ROUNDABOUTS**

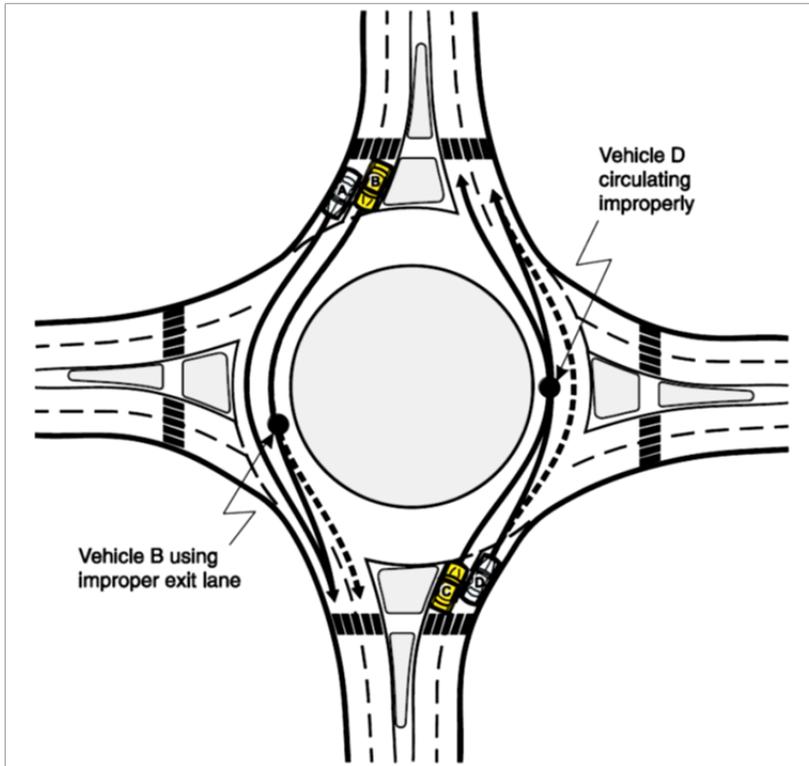
An understanding of the safety principles relevant to roundabouts can assist designers in examining the safety for vehicle occupants, pedestrians, and bicyclists at a roundabout. This section discusses the basic roundabout design principles related to safety performance of a roundabout.

### **5.2.1 VEHICULAR CONFLICTS AT MULTILANE ROUNDABOUTS**

*Section 5.2.2 Vehicular Conflicts at Multilane Roundabouts* of NCHRP 672 discusses the additional conflict points at a multilane roundabout that are not present in a single-lane roundabout (1). These conflicts can be divided into three categories:

#### **1. Drivers Fail to Maintain Lane Position**

As seen in Exhibit 5-6, a conflict may arise if a vehicle circulates improperly or attempts to exit the roundabout from an incorrect lane. This conflict can arise from improper roundabout geometry. Overly small entry and exit radii can lead to path overlap on the roundabout entries and exits. Larger curve radii can promote better path alignment, but also increase vehicle speeds. Therefore, the design should balance the needs to maintain low speeds and good path alignment. Further guidance for providing appropriate path alignment is provided in Section 6.3.3 of this guide and *Section 6.5 Multilane Roundabouts* of NCHRP Report 672 (1). Proper driver education can also help minimize the potential for this conflict.



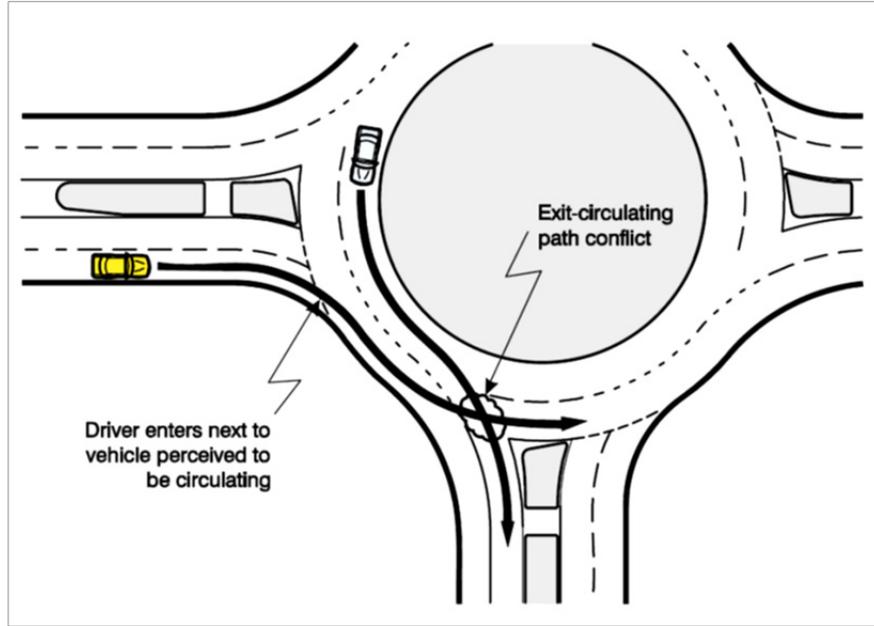
NCHRP Report 672, Exhibit 5-4 (1)

**Exhibit 5-6**  
**Failing to Maintain Lane Position**  
**at Multilane Roundabout**

## 2. Drivers Enter Next to an Exiting Vehicle

Exhibit 5-7 illustrates the potential conflict that can arise when a driver enters next to an exiting vehicle at a multilane roundabout. Again, the potential for this conflict can be reduced through good geometric design and driver education. Section 6.3.3 discusses design techniques that can help minimize conflicts between exiting and circulating vehicles.

**Exhibit 5-7**  
**Entering Next to an Exiting**  
**Vehicle at a Multilane**  
**Roundabout**

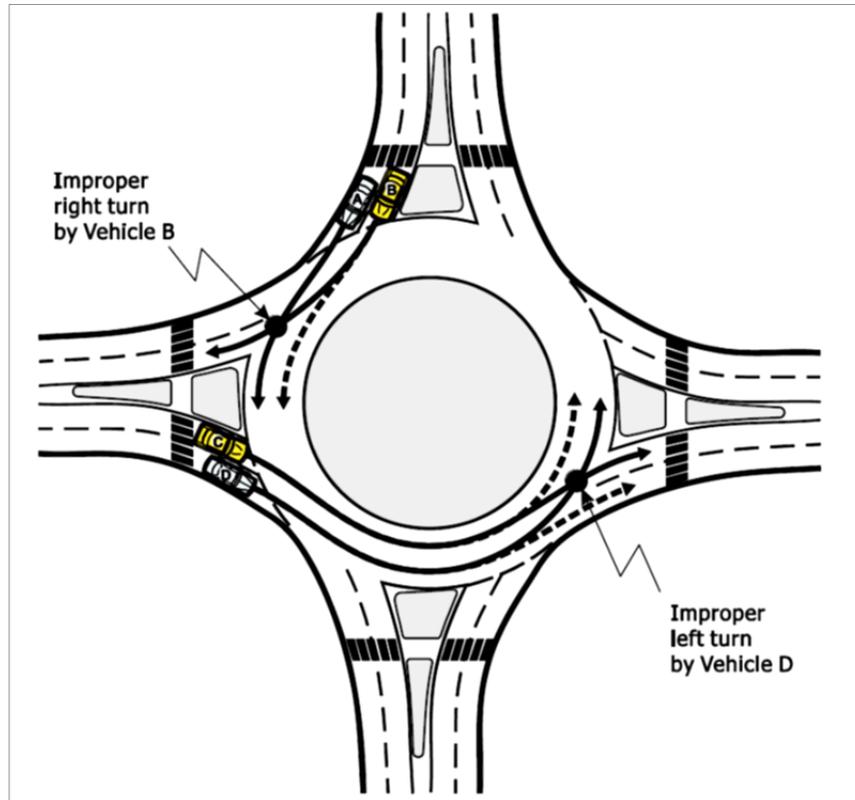


NCHRP Report 672, Exhibit 5-5 (1)

### 3. Drivers Turn From the Incorrect Lane

Exhibit 5-8 illustrates conflicts that can arise when drivers turn from the incorrect lane of a roundabout. Providing good directional signage and driver education can help reduce the potential of this conflict.

**Exhibit 5-8**  
**Improper Turn Conflicts at**  
**Multilane Roundabout**



NCHRP Report 672, Exhibit 5-6 (1)

It should be noted that “although the number of conflicts increases at multilane roundabouts when compared to single-lane roundabouts, the overall severity (and often number) of conflicts is typically less than other intersection alternatives” (1). The potential for conflicts can be reduced with good design geometry, signage, and driver education.

### 5.2.2 ADDITIONAL SAFETY RECOMMENDATIONS

Additional recommendations to improve the safety performance of a roundabout include:

- Design for appropriate entry, circulating, and exit speeds (see Section 6.3.1 Speed Management)
- Provide appropriate stopping and intersection sight distance (see Section 6.3.5 Sight Distance and Visibility)
- Consider potential pedestrian and bicyclist needs at the roundabout, such as providing sufficient width at splitter islands for pedestrians to cross in two stages (see Section 6.4.1 Pedestrians and Section 6.4.2 Bicyclists)
- Provide for the appropriate design vehicle (see Section 6.3.4 Design Vehicle)
- Provide appropriate cross slopes through the circulatory roadway (see Section 6.4.5 Vertical Considerations)

### 5.3 REFERENCES

1. Rodegerdts, L., J. Bansen, C. Tiesler, J. Knudsen, E. Myers, M. Johnson, M. Moule, B. Persaud, C. Lyon, S. Hallmark, H. Isebrands, R. B. Crown, B. Guichet, and A. O'Brien. *NCHRP Report 672: Roundabouts: An Informational Guide, 2nd ed.* Transportation Research Board of the National Academies, Washington, D.C., 2010.
2. Rodegerdts, L., M. Blogg, E. Wemple, E. Myers, M. Kyte, M. Dixon, G. List, A. Flannery, R. Troutbeck, W. Brilon, N. Wu, B. Persaud, C. Lyon, D. Harkey, and D. Carter. *NCHRP Report 572: Roundabouts in the United States.* Transportation Research Board of the National Academies, Washington, D.C., 2007.
3. American Association of State Highway and Transportation Officials (AASHTO). *Highway Safety Manual, First Edition.* AASHTO, Washington, D.C., 2010.
4. Federal Highway Administration. *Crash Modification Clearinghouse.* Available at: <http://www.cmfclearinghouse.org>.
5. Gross, F., C. Lyon, B. Persaud, and R. Srinivasan. “Safety Effectiveness of Converting Signalized Intersections to Roundabouts.” Paper Submitted for Presentation and Publication to the 91<sup>st</sup> Annual Meeting of the Transportation Research Board, Washington, D.C., 2012.

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# **Chapter 6**

## **Geometric Design**

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**CHAPTER 6  
GEOMETRIC DESIGN**

**CONTENTS**

**Chapter 6 Geometric Design ..... 1**

6.1 Introduction ..... 1

6.2 Roundabout Design Process ..... 1

6.3 Principles..... 3

6.3.1 Speed Management ..... 3

6.3.1.1 Drawing Fastest Paths ..... 3

6.3.1.2 Reducing Vehicle Speeds..... 9

6.3.1.3 Exit Design ..... 10

6.3.2 Lane Arrangements ..... 10

6.3.3 Appropriate Path Alignment ..... 12

6.3.4 Design Vehicle ..... 13

6.3.5 Sight Distance and Visibility..... 15

6.3.5.1 Stopping Sight Distance..... 15

6.3.5.2 Intersection Sight Distance..... 16

6.3.5.3 Sight Distance Checks..... 17

6.3.5.4 Visibility ..... 18

6.4 Design Details..... 19

6.4.1 Pedestrians ..... 19

6.4.1.1 Accessible Pedestrian Treatments ..... 21

6.4.1.2 Pedestrian Beacons and Signals ..... 22

6.4.1.3 Detectable Warning Surfaces..... 24

6.4.2 Bicyclists ..... 24

6.4.2.1 Bicyclists Riding Through a Roundabout ..... 24

6.4.2.2 Bicyclists Traversing Roundabout as a Pedestrian ..... 24

6.4.3 Roundabouts in High-Speed, Rural Environments ..... 25

6.4.4 Right-Turn Bypass Lanes..... 27

6.4.5 Vertical Considerations ..... 29

6.4.6 Roundabouts at Three-Legged Intersections ..... 30

6.4.7 Interchanges ..... 32

6.5 Oversize-Overweight Load Accommodations..... 34

6.5.1 Accommodating OSOW Vehicles..... 34

6.5.1.1 Vehicle Characteristics ..... 34

6.5.2	Design Modifications.....	35
6.5.2.1	Potential OSOW Design Modifications.....	35
6.5.3	OSOW Design Checks .....	42
6.6	Pavement Jointing .....	42
6.6.1	Asphalt Concrete versus Portland Cement Concrete.....	42
6.6.2	Jointing Patterns.....	42
6.6.2.1	Jointing Patterns and Roundabout Expansion .....	44
6.7	Curbing.....	44
6.8	References .....	46

## LIST OF EXHIBITS

Exhibit 6-1	Typical Roundabout Design Sequence.....	2
Exhibit 6-2	Fastest Path Radii Shown at the East 1st Street/Centennial Drive Roundabout in McPherson, Kansas.....	4
Exhibit 6-3	Fastest Path at Single-Lane Roundabout.....	4
Exhibit 6-4	Through Movement Theoretical Fastest Path Procedure in CAD.....	5
Exhibit 6-5	Speed-Radius Relationship .....	8
Exhibit 6-6	Fastest Path Example at the Intersection of US 50/Connector Road in Emporia, Kansas.....	9
Exhibit 6-7	Offset Left Alignment.....	10
Exhibit 6-8	Lane Configuration Example .....	11
Exhibit 6-9	Roundabout at SW 37th Street/SW Wanamaker Road in Topeka, Kanas with Varying Circulating Lanes .....	11
Exhibit 6-10	Path Overlap at a Multilane Roundabout.....	12
Exhibit 6-11	Example Minor Approach Offset to Increase Entry Deflection .....	13
Exhibit 6-12	Typical Design Vehicle for Various Roadway Types in Kansas.....	14
Exhibit 6-13	Turning Movement Swept Paths of WB-67 Vehicle .....	14
Exhibit 6-14	Stopping Sight Distance on the Approach .....	15
Exhibit 6-15	Stopping Sight Distance on the Circulatory Roadway .....	16
Exhibit 6-16	Sight Distance to Crosswalk on Exit .....	16
Exhibit 6-17	Intersection Sight Distance .....	17
Exhibit 6-18	Example Sight Distance Checks, Proposed Roundabout at West 165th Street/Lowell Street in Overland Park, Kansas.....	18
Exhibit 6-19	Example Angle of Visibility Check at proposed roundabout at West 165th Street/Lowell Street in Overland Park, Kansas .....	19
Exhibit 6-20	Minimum Splitter Island Dimensions.....	20
Exhibit 6-21	Pedestrian Accommodations at a Roundabout at 133rd Street/Lamar Avenue in Overland Park, Kansas.....	20
Exhibit 6-22	Traditional Traffic Signal Pedestrian Crossing at Superior Street/ N 14th Street Roundabout in Lincoln, Nebraska .....	23
Exhibit 6-23	Possible Treatments for Bicyclists .....	25
Exhibit 6-24	Rural High-Speed Roundabout at the Intersection of US 50/US 77/West 8th Street in Florence, Kansas .....	26
Exhibit 6-25	Configuration of Right-turn Bypass Lane with Acceleration Lane ..	28

Exhibit 6-26	Configuration of Right-turn Bypass Lane with Yield at Exit Lane ...	28
Exhibit 6-27	Continuous Right-Turn Bypass Lane at the Intersection of 155 <sup>th</sup> Street/Pinehurst Drive/Briar Road in Basehor, Kansas .....	29
Exhibit 6-28	Adjustment of the Vertical Profile to Achieve a More Desirable Grade through the Roundabout .....	30
Exhibit 6-29	Three-Legged roundabouts at the intersections of North Kasold Drive/Grand Vista Drive (Left) and North Kasold Drive/Tillerman Drive (Right) in Lawrence, Kansas .....	30
Exhibit 6-30	Angle between Approach Legs of Three-Legged Intersection .....	31
Exhibit 6-31	Lack of Deflection at Three-Legged Intersection.....	31
Exhibit 6-32	Conceptual diamond interchange with roundabouts at the ramp-node terminals.....	32
Exhibit 6-33	I-70/SE Rice Road folded diamond interchange with roundabouts at ramp-node terminals in Topeka, Kansas .....	32
Exhibit 6-34	Conceptual single-point roundabout diamond interchange .....	33
Exhibit 6-35	K-7/Johnson Drive oval split diamond single-point interchange roundabout in Shawnee, Kansas .....	33
Exhibit 6-36	OSOW Vehicle in Kansas with Low Ground Clearance Carrying a Wind Turbine Tower Section .....	35
Exhibit 6-37	Marion County, Kansas “Roundabout in a Box” OSOW Bypass Lanes.....	36
Exhibit 6-38	OSOW Bypass Lane at the intersection of N207/N460 outside of Alphen aan den Rijn, Netherlands .....	36
Exhibit 6-39	Advanced Left-Turn Movement at the intersection of Goudsestraatweg (N459)/A12 in Reeuwijk-Brug, Netherlands.....	37
Exhibit 6-40	Advanced Left-Turn Movement at the intersection of Goudsestraatweg (N459)/A12 in Reeuwijk-Brug, Netherlands.....	38
Exhibit 6-41	United Kingdom Roundabout with OSOW Truck Accommodation through the Central Island. (Mirrored Image).....	38
Exhibit 6-42	Central Island Cut-Through in the Netherlands.....	39
Exhibit 6-43	Central Island Cut-Through in Abu Dhabi .....	39
Exhibit 6-44	Central Island Cut-Through.....	39
Exhibit 6-45	Central-Island Cut-Through with Removable Guidance Signs (Top) and Folding Signs Blocking the Cut-Through Lane (Bottom) (Mirrored Image) .....	40
Exhibit 6-46	Removable Sign in Use in Washington State.....	40
Exhibit 6-47	Increased Width of Central Truck Apron and Outside Truck Apron .....	41

Exhibit 6-48	Striped Outside Truck Apron at the Intersection of I-70/S East Street/E Chestnut Street/E Ash Street in Junction City, Kansas .....	41
Exhibit 6-49	Pavement Jointing Plan Sheet at the Intersection of US-75/K-31/K-268 in Osage County, Kansas.....	43
Exhibit 6-50	Outside Curbing Shown at the West 161st Terrace/West 163rd Street/Flint Street Roundabout in Overland Park, Kansas .....	45
Exhibit 6-51	Truck Apron Curbing at the Intersection of Renner Boulevard/Bass Pro Drive in Olathe, Kansas.....	45
Exhibit 6-52	KDOT Truck Apron Curbing Design .....	45

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## **CHAPTER 6 GEOMETRIC DESIGN**

This chapter covers the basic principles of roundabout geometric design and provides guidance to facilitate the roundabout design process; it is organized to first discuss general design principles and then design details.

### **6.1 INTRODUCTION**

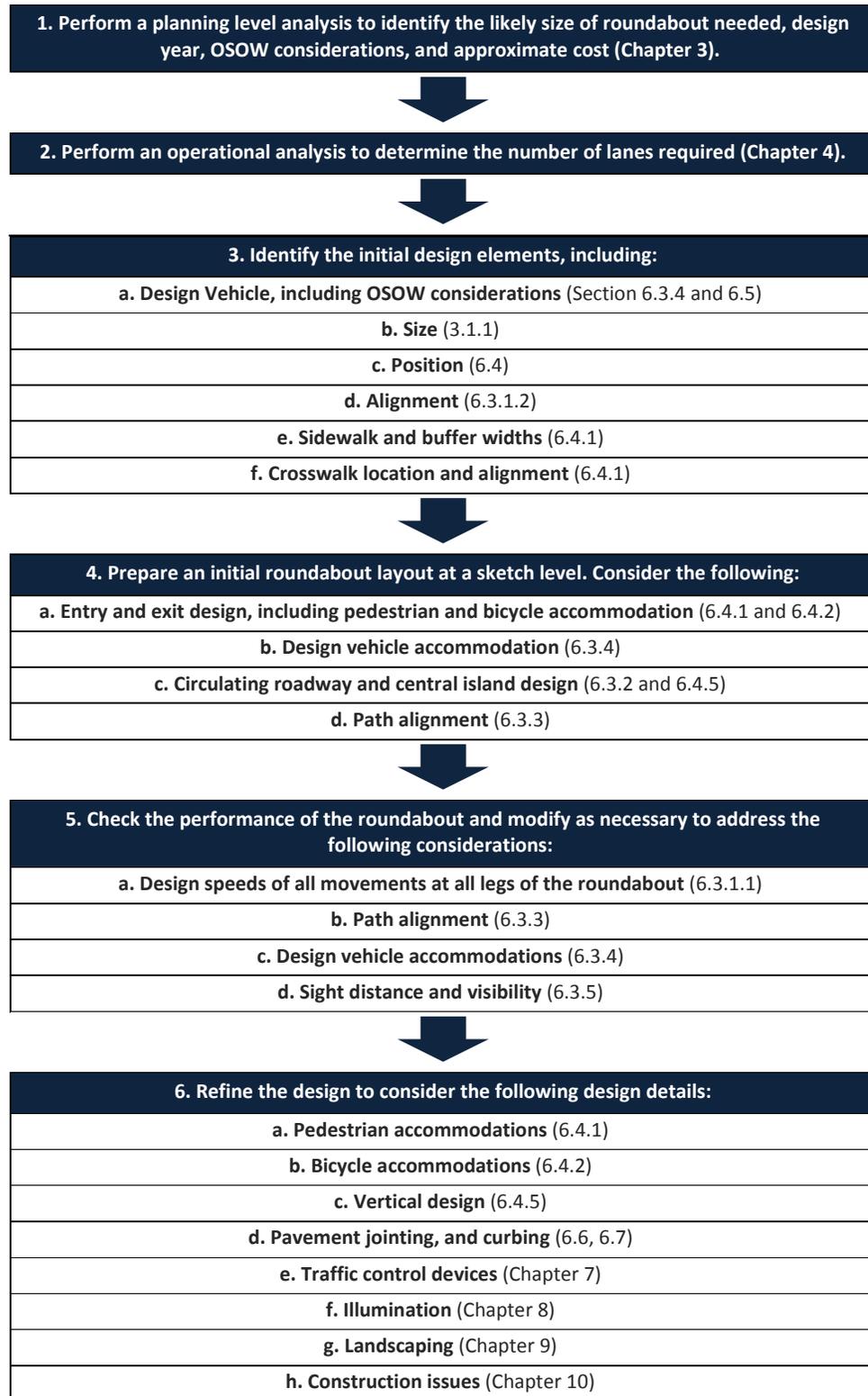
The contents of this chapter are intended to serve as guidance and should not be interpreted as absolute standards or rules. Roundabout design is an iterative process that requires balancing multiple objectives. While there are general principles that apply to all roundabouts, many of the specific design details and features are dependent on the location of the intersection. The designer should take care throughout the design process to apply the principles described in this section rather than relying on a standard design template.

### **6.2 ROUNDABOUT DESIGN PROCESS**

This section provides a brief overview of the design process that typically follows the early planning steps and operational analysis and carries the roundabout through to final design. Guidance for the early stages of roundabout planning is provided in Chapter 3, while Chapter 4 details the operational analysis that helps to identify the appropriate roundabout sizing and lane configuration. During this process, a feasibility study may be conducted to develop a conceptual roundabout design based on the anticipated traffic volumes and location and to determine whether a roundabout is a feasible option.

Roundabouts are typically designed using a performance-based analysis process whereby the ultimate goals of the design—operational and safety performance, impacts, costs, etc.—are kept in focus when choosing and fine-tuning project features and dimensions. In other words, a given set of design variables (such as inscribed circle diameter, position of the central island, alignment of the approaches, and entry widths) will be evaluated for their impact upon operational, safety, and other performance measures to determine whether they result in an acceptable level of performance. During the design process, trade-offs between outcomes (e.g., capacity versus cost) are reviewed to determine whether additional adjustments are needed. This process necessitates that design goes through a number of iterations before settling on a final design that best serves the particular intersection. A typical roundabout design sequence is displayed in Exhibit 6-1.

Exhibit 6-1  
Typical Roundabout Design  
Sequence



## 6.3 PRINCIPLES

Fundamentally, the principles of roundabout design are the same as other roadways and intersection types. The designer must consider the context of the project and provide suitable geometry and traffic control devices according to established engineering principles. The following principles should guide the development of all roundabout designs (1):

- Provide slow entry speeds and consistent speeds through the roundabout by using deflection.
- Provide the appropriate number of lanes and lane assignment to achieve adequate capacity, lane volume balance, and lane continuity.
- Provide smooth channelization that is intuitive to drivers and results in vehicles naturally using the intended lanes.
- Provide adequate accommodation for the design vehicles.
- Provide appropriate sight distance and visibility for driver recognition of the intersection and conflicting users.
- Design to meet the needs of pedestrians and cyclists.

The following sections provide design guidance to help achieve these principles and balance potentially competing objectives inherent in roundabout design. Guidance for assessing performance in the form of design checks is also provided.

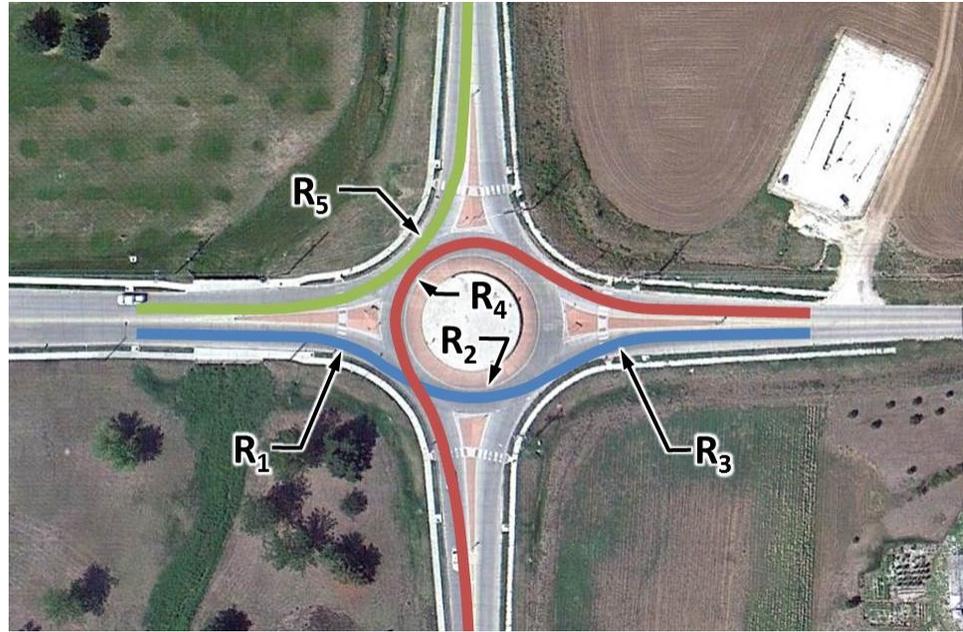
### 6.3.1 Speed Management

The most critical design objective is to maintain low and consistent speeds through the roundabout. Roundabouts operate most safely and effectively when their geometry forces traffic to enter, circulate, and exit at slow speeds. Maximum theoretical entry speeds of 25 mph are recommended for single-lane approaches and 30 mph for multilane approaches. These speeds assume a fastest path alignment that occupies the entire travel space regardless of lane lines, as described in the next section.

#### 6.3.1.1 Drawing Fastest Paths

The fastest path is drawn for a vehicle traversing through the entry, around the central island, and out the exit. This is the smoothest, flattest path possible for a single vehicle, in the absence of other traffic and ignoring all lane markings. The fastest paths should be measured for all approaches and all movements, including left-turn movements (which generally represent the slowest of the fastest paths) and right-turn movements (which may be faster than the through movement paths at some roundabouts), as shown in Exhibit 6-2.

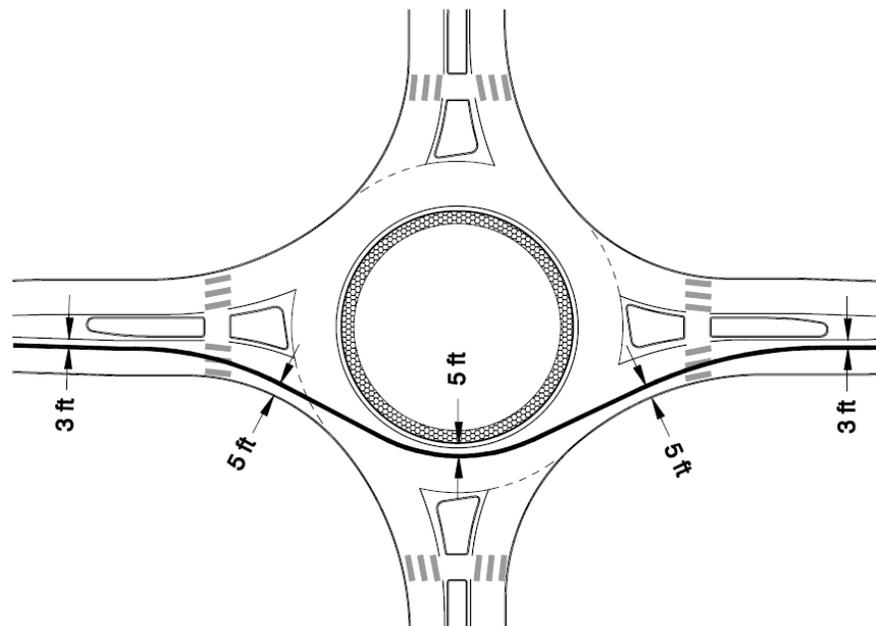
**Exhibit 6-2**  
**Fastest Path Radii Shown at**  
**the East 1st Street/Centennial**  
**Drive Roundabout in**  
**McPherson, Kansas**



Courtesy of Kittelson & Associates, Inc.

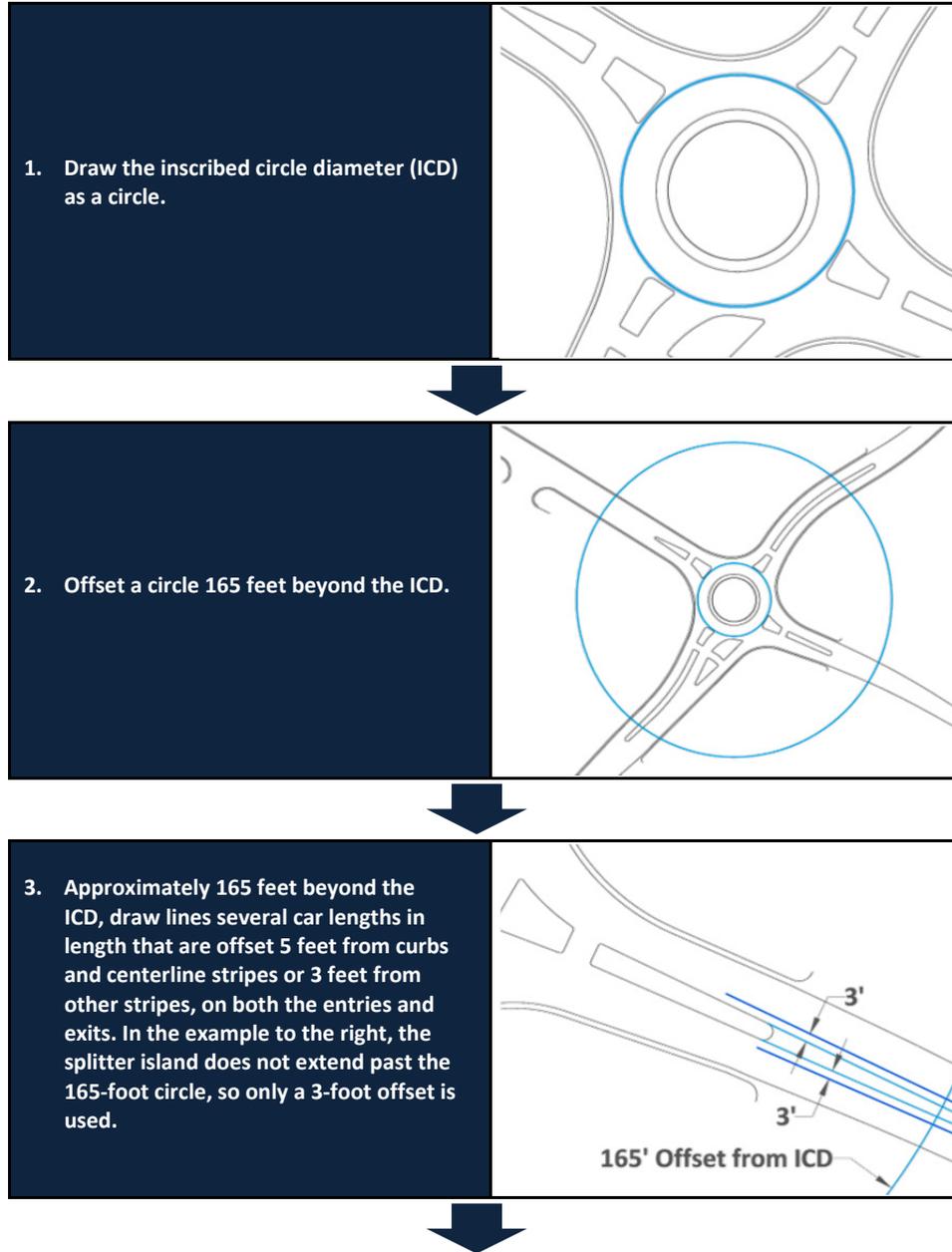
Section 6.7.1 *Fastest Path* of NCHRP Report 672 provides detailed instructions for drawing the fastest vehicle paths for all movements at a roundabout, including guidance on where to draw paths in relation to curbs and paint lines. In general, fastest paths should be drawn with an offset of 5 feet from curbs and centerline stripes and an offset of 3 feet from other stripes (such as those marking a striped median area). Exhibit 6-3 shows the fastest vehicle path through a single-lane roundabout. As seen in the exhibit, the fastest path is drawn to maintain the appropriate offsets from curbs and striping and includes short lengths of tangents between consecutive curbs to account for the time it takes a driver to turn the steering wheel (1).

**Exhibit 6-3**  
**Fastest Path at Single-Lane**  
**Roundabout**



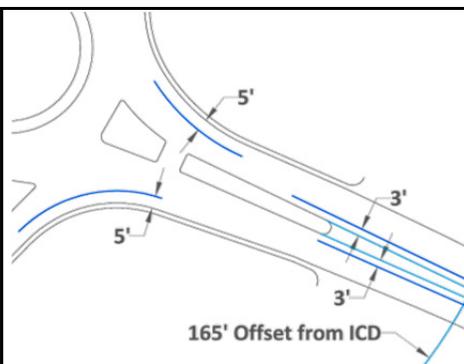
Adapted from NCHRP Report 672, Exhibit 6-48 (1)

There are many ways to draw fastest paths, including both hand-drawn and CAD methods, and there is no one absolutely correct method. Exhibit 6-4 provides suggested step-by-step guidance for creating the through movement theoretical fastest paths at a single-lane roundabout using CAD.

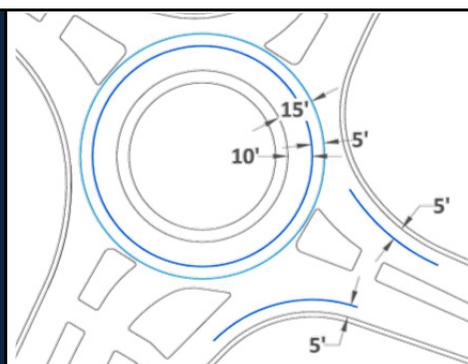


**Exhibit 6-4**  
Through Movement Theoretical  
Fastest Path Procedure in CAD

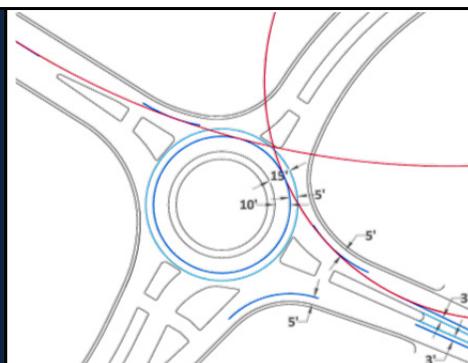
4. Draw an arc that is offset 5 feet from the outside entry- and exit-curve curbs.



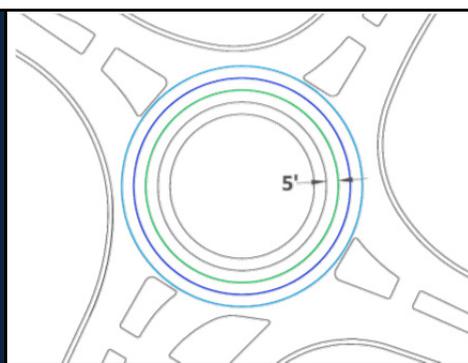
5. Within the circulatory roadway, draw a circle that is approximately two thirds of the distance from the inside edge of the circulatory roadway to the outside edge. For example, if the circulatory roadway is 15 feet wide, the circle would be offset 10 feet from the truck apron/inside of circulatory roadway and 5 feet from the outside of the circulatory roadway or ICD.

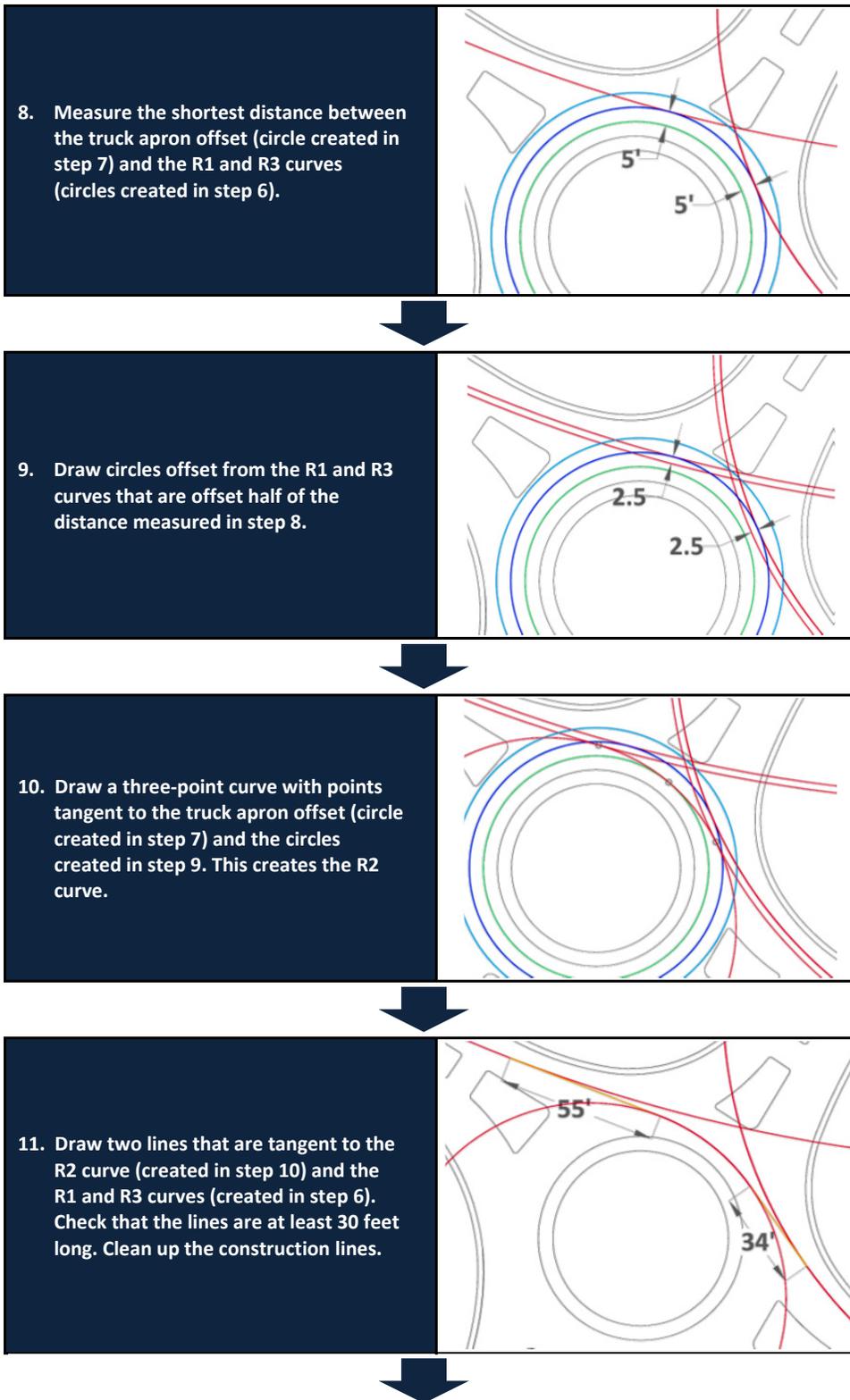


6. For both the entry and exit, draw a three-point circle. The three points are tangent to the lines created in steps 3, 4, and 5. This creates the R1 and R3 curves.



7. Draw a circle that is offset 5 feet beyond the truck apron.







12. Trim the R1, R2 and R3 curves and measure the R1, R2 and R3 radii

The correlation between the radii of horizontal curvature and travel speed is documented in the AASHTO “Green Book” (2). “Both superelevation and the side friction factor affect the speed of a vehicle. Side friction varies with vehicle speed and can be determined in accordance with AASHTO guidelines. The most common superelevation values encountered are +0.02 and -0.02, corresponding to a 2% cross slope” (1). Equation 6-1 and Equation 6-2 provide a simplified relationship between speed and radius for these two common superelevation rates that incorporates the AASHTO relationship and side friction factors. The speed-radius relationship is displayed graphically in Exhibit 6-5. This graph can be used to determine the speed associated with the theoretical fastest paths through the roundabout.

Equation 6-1

$$V = 3.4415R^{0.3861}, \quad \text{for } e = +0.02$$

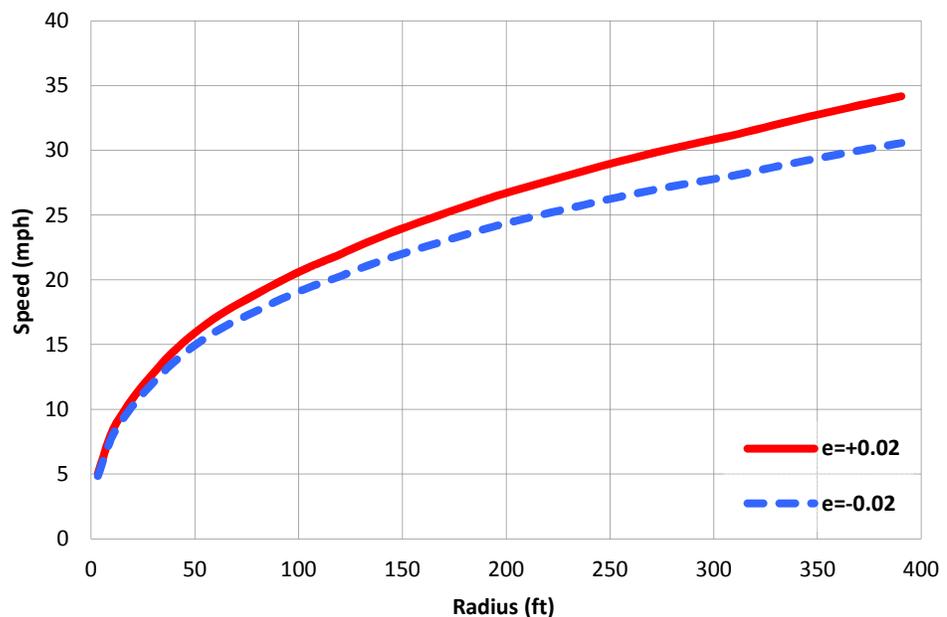
Equation 6-2

$$V = 3.4614R^{0.3673}, \quad \text{for } e = -0.02$$

Where

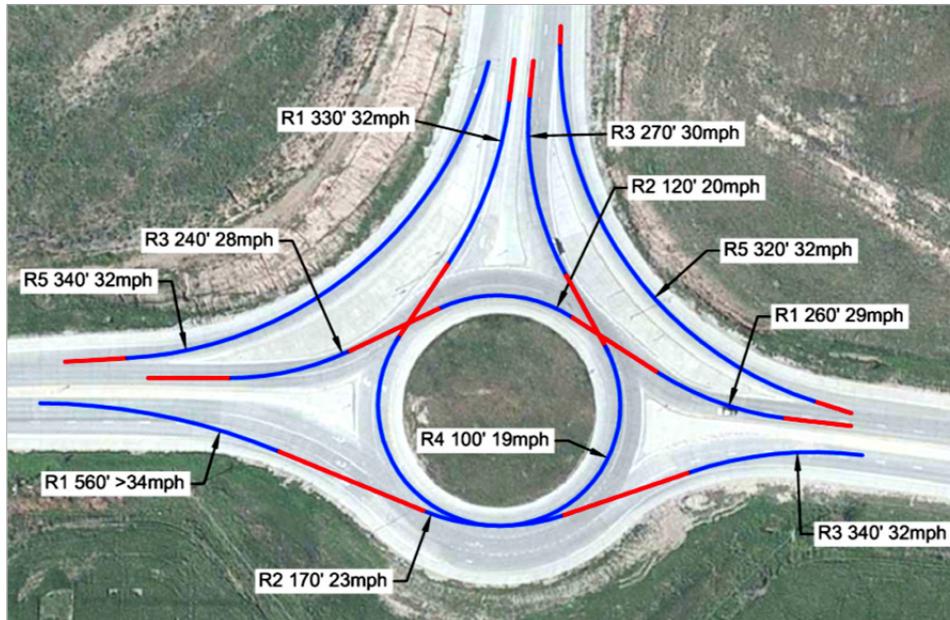
$V$  = predicted speed, mph;  
 $R$  = radius of curve, ft; and  
 $e$  = superelevation, ft/ft.

Exhibit 6-5  
 Speed-Radius  
 Relationship



Adapted from NCHRP Report 672, Exhibit 6-52 (1)

The method for constructing fastest paths shown in Exhibit 6-4 was used to create the example in Exhibit 6-6, which demonstrates the theoretical fastest paths, radii, and resulting speeds at a roundabout.



Courtesy of Kittelson & Associates, Inc.

Exhibit 6-6  
Fastest Path Example  
at the Intersection of  
US 50/ Connector Road in  
Emporia, Kansas

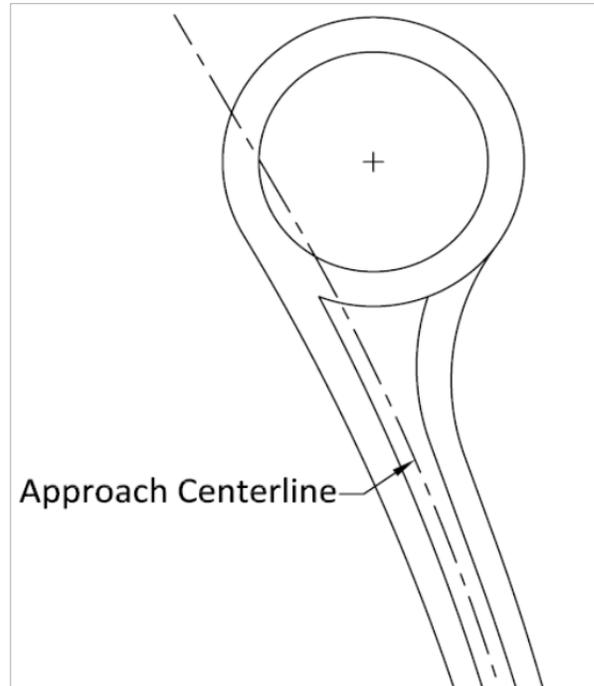
### 6.3.1.2 Reducing Vehicle Speeds

In the case that vehicle speeds are too high, several steps can be taken to lower speeds. *Section 6.7.1.4 Improving Fastest Path Vehicle Speeds* of NCHRP Report 672 provides guidance on this topic (1). Potential strategies, each of which may have trade-offs, include:

- Offsetting the alignment of the approach to the left, as shown in Exhibit 6-7
- Increasing the size of the ICD to provide better approach geometry and deflection to slow entering vehicles
- Adjusting the entry width and/or radii
- Providing a more perpendicular approach
- Adjusting the curvature of the approach upstream of the entry

Trade-offs exist for these potential strategies. For example, increasing the ICD to slow entering vehicles may increase right-turn speeds. Often, attempting to reduce speeds can produce other design problems, such as poor path alignments or lack of design vehicle accommodation. Therefore, balance across the various design principles is needed.

**Exhibit 6-7**  
**Offset Left Alignment**



Courtesy of Kittelson & Associates, Inc.

### **6.3.1.3 Exit Design**

Exit design is a challenging topic that currently lacks uniform consensus within the national practice. Some design philosophies have recommended relaxing the design speed guidelines for roundabout exits based on the principle that if entry and circulatory speeds are sufficiently low, vehicles will not be able to accelerate significantly on the exit, thus not compromising pedestrian safety. Large radii or even tangential geometry at exits helps to reduce vehicle-to-vehicle conflicts and ease the flow of traffic departing from the circulatory roadway. Larger exit radii may also help to achieve greater speed reduction on the adjacent roundabout entry by allowing for an offset-left design, as seen in Exhibit 6-6. In addition, larger exit radii may allow for greater visibility of the exit-side crosswalk by vehicles exiting the roundabout.

### **6.3.2 Lane Arrangements**

Chapter 4 provides guidance on conducting an operational analysis at a roundabout to determine the number of entry lanes needed at each approach to produce a desired operational performance. When designing the geometry of the roundabout, care must be taken to provide the appropriate number of circulating and exit lanes to match the desired entry lane configurations. In cases where the number of circulating or exit lanes are not consistent throughout the roundabout, the shape of the central island, ICD, or splitter islands may need to be adjusted. For example, the roundabout shown in Exhibit 6-8 has been designed to accommodate an exclusive left-lane and shared left/through/right-lane on the eastbound approach, resulting in a central island that is not perfectly circular. The designer should seek to create paths that are as natural as possible and consider path alignment, as described in the following section.

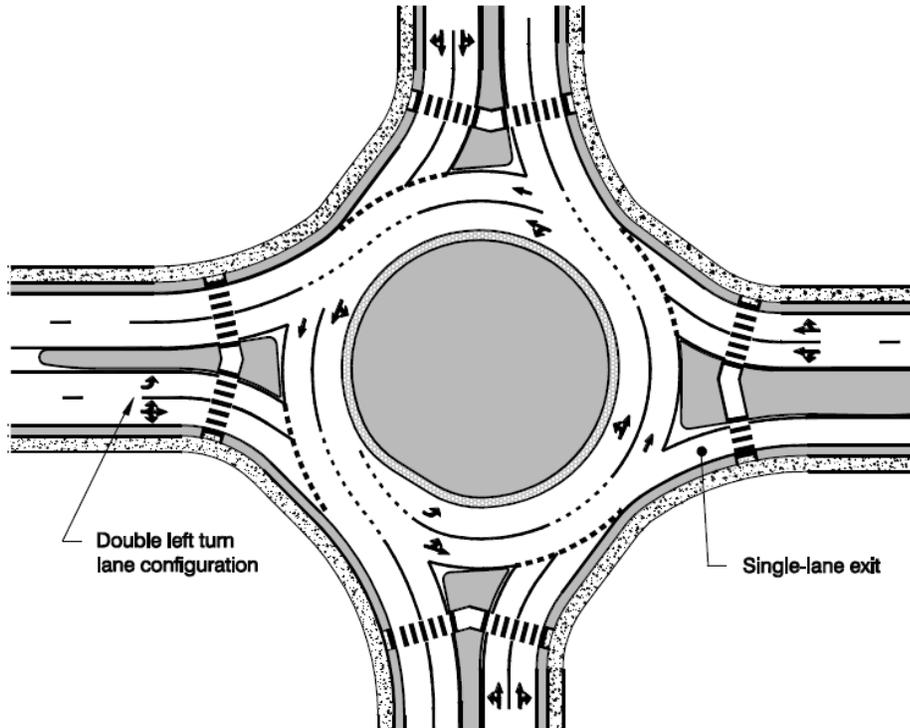


Exhibit 6-8  
Lane Configuration  
Example

NCHRP Report 672, Exhibit 6-4, (1)

Exhibit 6-9 provides an example of a roundabout with two circulating lanes in some places and one circulating lane in others to match the entry lane configurations. In this case, the central island is kept circular and the ICD is adjusted to accommodate the circulating lanes.

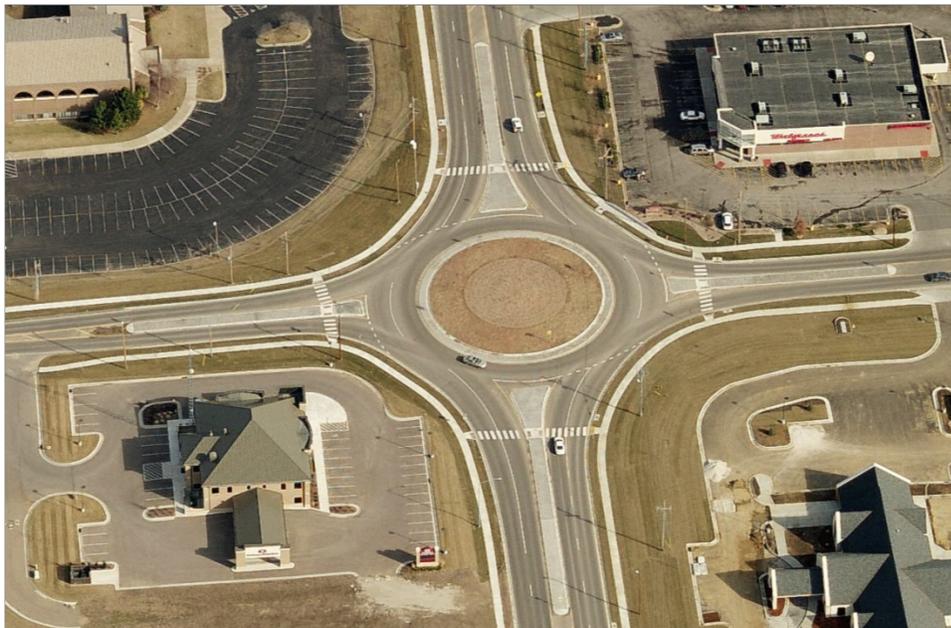


Exhibit 6-9  
Roundabout at SW 37th  
Street/SW Wanamaker Road in  
Topeka, Kansas with Varying  
Circulating Lanes

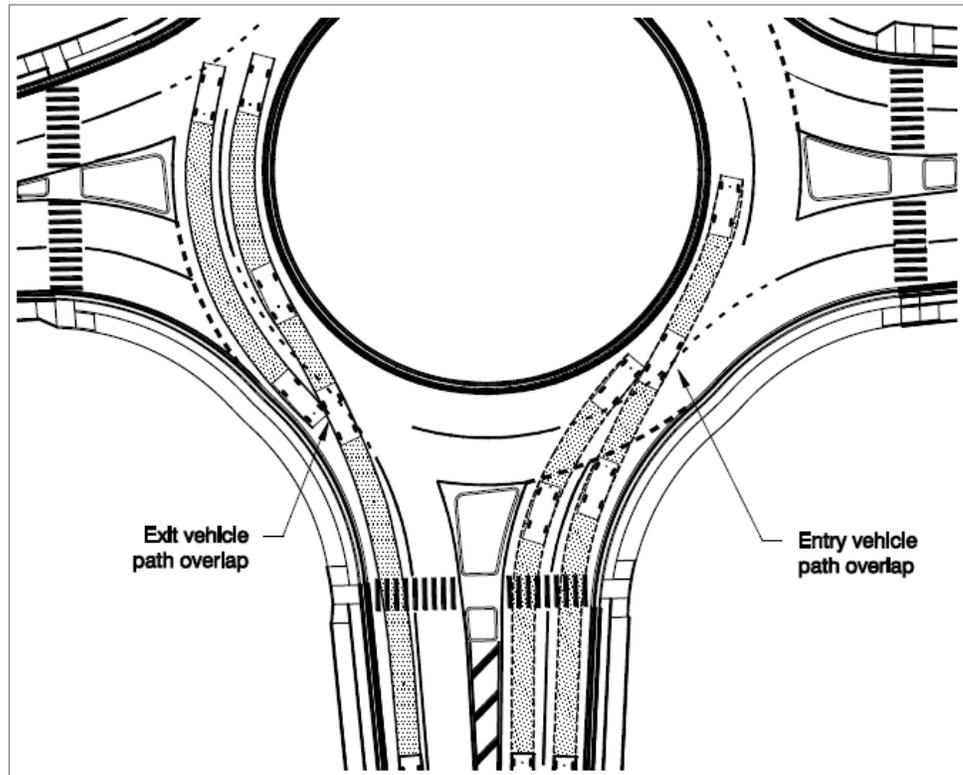
Bing maps © 2013 Microsoft Corporation, © 2012 Pictometry International Corp

### 6.3.3 Appropriate Path Alignment

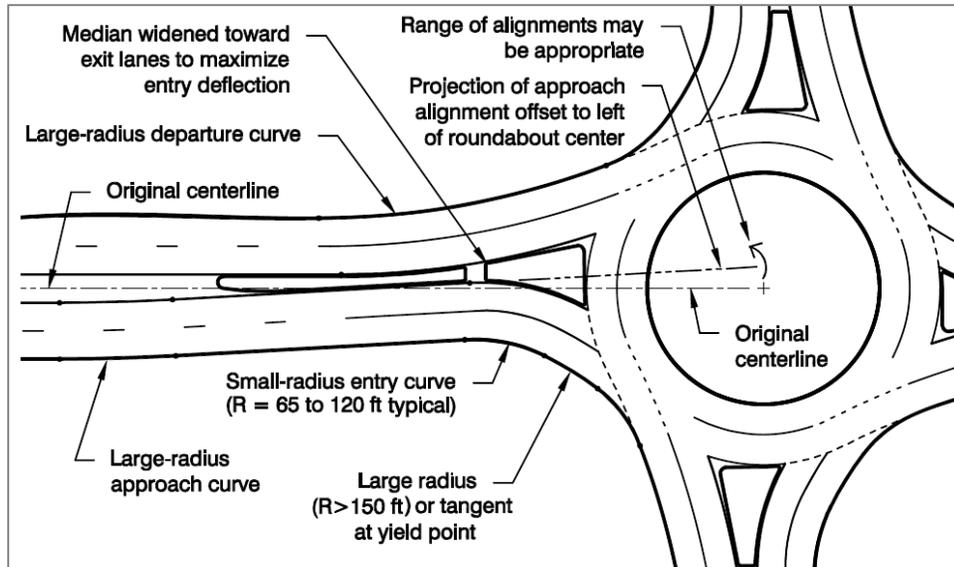
The geometry of the roundabout, particularly at the entries, will affect the path that vehicles take when circulating through and exiting the roundabout. Vehicles are guided by lane markings up to the entrance line of a roundabout. At this point, vehicles will continue along their natural trajectory into the circulatory roadway, based on their speed and orientation (1). At a multilane roundabout, if the path of one vehicle overlaps with another in an adjacent lane, there is the potential for inefficient operations or conflict. Vehicle path overlap occurs most commonly at entries where the geometry of the outside lane tends to lead vehicles into the inner circulatory lane. Overly small entry radii can produce path overlap. The geometry of the exits also affects the path of vehicles, and overly small exit radii may result in overlapping vehicle paths. Exhibit 6-10 displays an example of entry and exit vehicle path overlap.

The entries and exits of multilane roundabouts should be designed to align vehicles into the appropriate lanes within the circulatory roadway. Radii should be sufficiently large to avoid path overlap and care should be taken to maintain desirable vehicle path alignment through the roundabout. The techniques used to provide appropriate path alignment significantly depend on site-specific conditions, so it may not be possible to specify a single method for doing so. *Section 6.5.4 Entry Geometry and Approach Alignment* of NCHRP Report 672 provides one technique for promoting good path alignment using a compound curve or tangent along the outside curb to direct vehicles in to the correct lane, as shown in Exhibit 6-11 (1).

Exhibit 6-10  
Path Overlap at a  
Multilane Roundabout



NCHRP Report 672, Exhibit 6-5 (1)



NCHRP Report 672, Exhibit 6-30 (1)

Exhibit 6-11  
Example Minor Approach  
Offset to Increase Entry  
Deflection

### 6.3.4 Design Vehicle

The roundabout should be designed to accommodate the largest vehicle reasonably anticipated to use the intersection. There are three general categories of design vehicles to consider at roundabouts:

1. **Large vehicles without trailers**, including single-unit trucks, fire trucks without turntable ladders, transit vehicles (buses), and school buses. In general, roundabouts should be designed to allow these vehicles to navigate the roundabout without the use of the truck apron.
2. **Large vehicles with trailers**, including trucks with trailers and fire trucks with turntable ladders. Roundabouts should be designed to allow these vehicles' rear trailer to use the provided truck apron. In general, it should not be necessary for the cab of the truck to use the truck apron, as this behavior may not be expected by the truck driver.
3. **Oversize/Overweight (OSOW) vehicles** discussed in Section 6.5. Typically, special accommodations are needed beyond those provided for the two categories of design vehicles described above to allow OSOW vehicles to navigate the roundabout.

The design vehicle is selected by considering the types of roadways in the area where the intersection is located and the types and volume of vehicles using the intersection. For intersections in a residential environment, the design vehicle is often a school bus or fire truck. At urban arterial intersections, freeway ramp terminals, and other intersections on Kansas state highway routes, the design vehicle is a WB-67. Considerations for accommodating OSOW vehicles are presented in Section 6.5.

Typical design vehicles for various roadway types are given in Exhibit 6-12. The appropriate staff from KDOT and/or the governing local agencies should be consulted early in the design process to identify the design vehicle at each project location. Consideration should be given to the actual vehicle

**Exhibit 6-12**  
**Typical Design Vehicle for**  
**Various Roadway Types in**  
**Kansas**

classification mix in addition to the adjacent land uses and facility classifications for the near term and future design years.

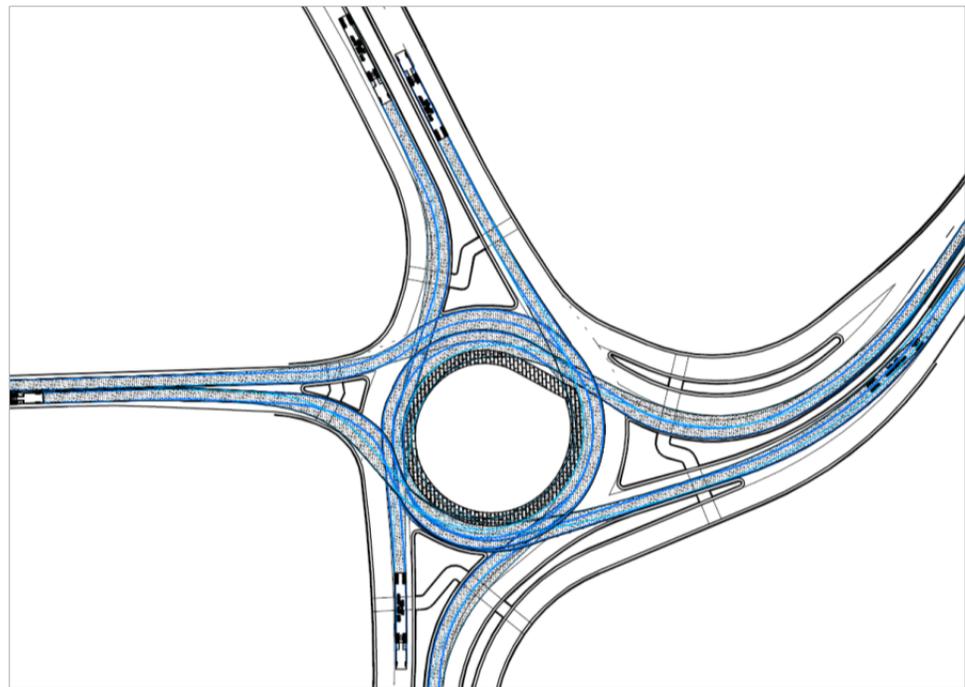
Intersection Type	Design Vehicle
State Highway Routes	WB-67
Ramp Terminal	WB-67
Other Rural	WB-67
Urban Major Streets <sup>1</sup>	WB-67
Other Urban <sup>1</sup>	Bus or Single Unit Truck

<sup>1</sup>Local design criteria may vary

The size and turning path requirements of the design vehicle will influence many of the roundabout’s dimensions. At single-lane roundabouts, the design vehicle is typically the controlling factor for the ICD, entry width, entry radius, and circulatory roadway width. At multilane roundabouts, design-vehicle requirements influence many of the roundabout dimensions. To balance design-vehicle requirements with appropriate speed management, multilane circulatory roadway lane widths typically range from 14 to 16 feet. Use of these values usually results in a total circulating width of 28 to 32 feet for two-lane circulatory roadways.

Vehicle turning path templates or CAD-based vehicle turning path simulation software should be used during the design process to establish the turning path requirements of the design vehicle. Exhibit 6-13 provides an example of a vehicle-design checks conducted using a WB-67 truck template. Section 6.5 provides further guidance on accommodating oversize-overweight vehicles.

**Exhibit 6-13**  
**Turning Movement Swept**  
**Paths of WB-67 Vehicle**



Courtesy of Kittelson & Associates, Inc.

### 6.3.5 Sight Distance and Visibility

As with all roadways, stopping sight distance must be provided within the roundabout and on the approaches to provide adequate time to perceive and react to non-motorized users, objects, and other vehicles in the road. Intersection sight distance must also be provided at the entries to enable drivers to identify vehicles from other approaches and safely enter the roundabout. The design speeds from the fastest path evaluation are used in the calculation of stopping sight distance and intersection sight distance requirements. International evidence suggests that it is advantageous to provide “no more than the minimum required intersection sight distance on each approach” (1). Excessive sight distance can lead to higher vehicle speeds, which creates safety and operational concerns.

*Intersection sight distance must also be provided at the entries to enable drivers to identify vehicles from other approaches and safely enter the roundabout*

#### 6.3.5.1 Stopping Sight Distance

Stopping sight distance is the “distance along a roadway required for a driver to perceive and react to an object in the roadway and to brake to a complete stop before reaching the object” (2). Equation 6-3 provides the formula to calculate stopping sight distance, based on AASHTO’s “Green Book,” (2):

$$d = (1.47)(t)(V) + 1.075 \frac{V^2}{a}$$

Equation 6-3

Where

- $d$  = stopping sight distance, ft;
- $t$  = perception–brake reaction time, assumed to be 2.5 s;
- $V$  = initial speed, mph; and
- $a$  = driver deceleration, assumed to be 11.2 ft/s<sup>2</sup>.

In accordance with AASHTO’s “Green Book,” stopping sight distance should be measured using an assumed height of 3.5 feet for a driver’s eye and an assumed height of 2 feet for an object (2). Adequate stopping sight distance should be provided at the following:

1. On the roundabout approaches
2. Within the roundabout circulatory roadway
3. To the crosswalk on the exits

Exhibits 6-14, 6-15, and 6-16 illustrate each type of stopping sight distance.

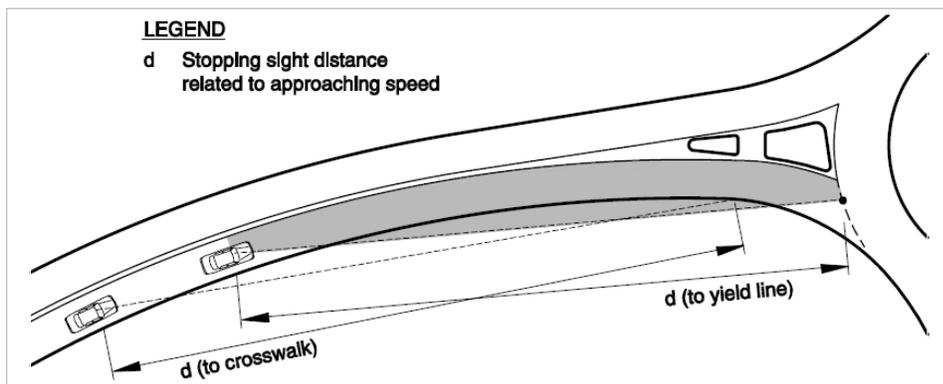
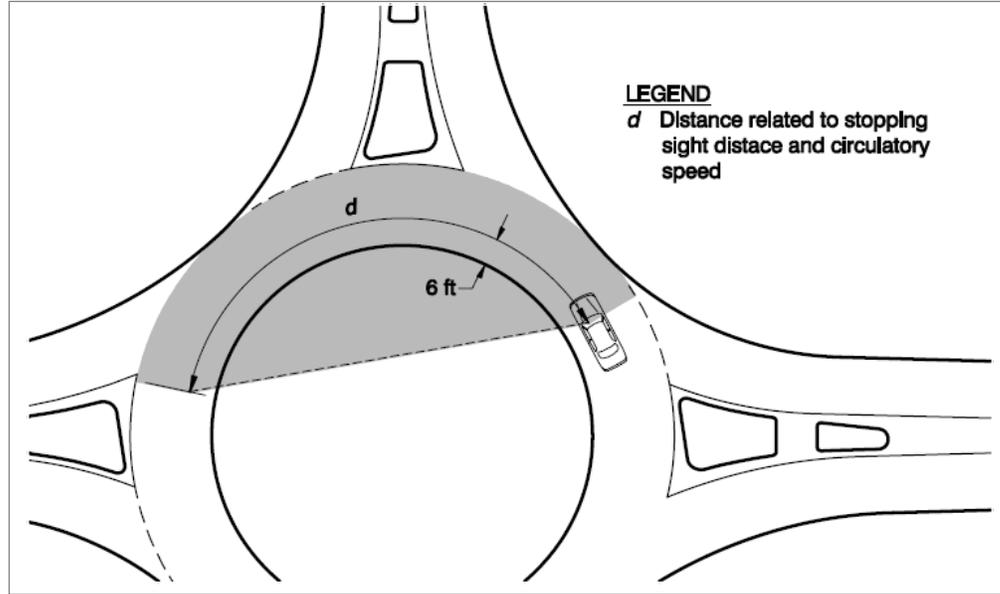


Exhibit 6-14  
 Stopping Sight Distance on the Approach

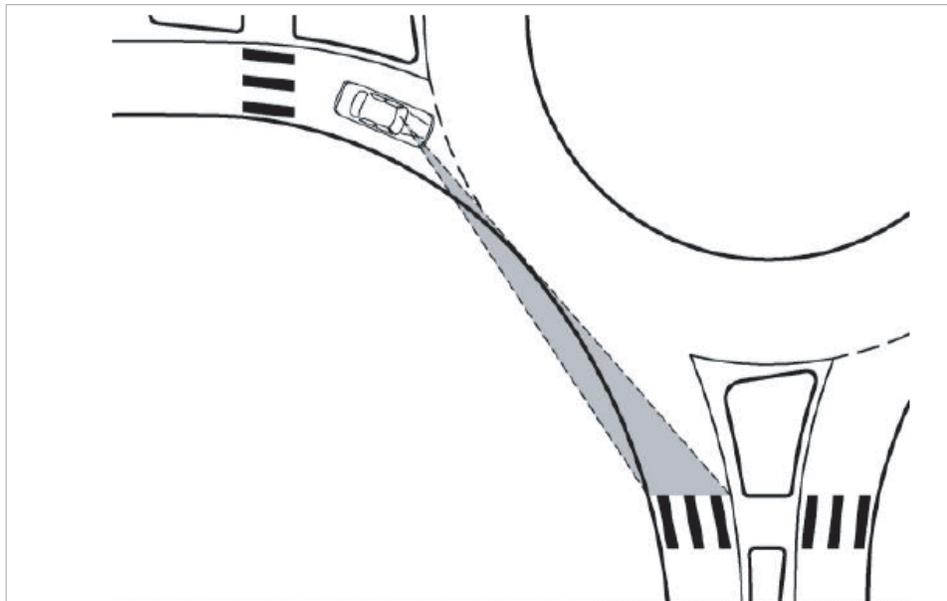
NCHRP Report 672, Exhibit 6-55 (1)

Exhibit 6-15  
Stopping Sight Distance on  
the Circulatory Roadway



Adapted from NCHRP Report 672, Exhibit 6-56 (1)

Exhibit 6-16  
Sight Distance to  
Crosswalk on Exit

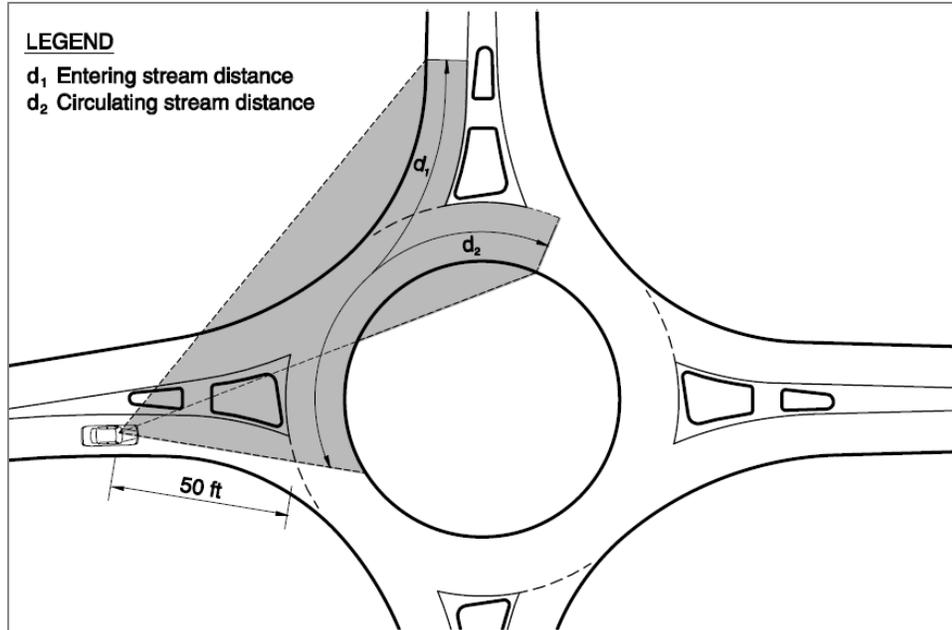


NCHRP Report 672, Exhibit 6-57 (1)

### 6.3.5.2 Intersection Sight Distance

Intersection sight distance is the “distance required for a driver without the right-of-way to perceive and react to the presence of conflicting vehicles” (2). It is typically measured by establishing sight triangles that define the space a driver should be able to see and safely react to potentially conflicting vehicles. At a roundabout, intersection sight distance should be provided on the entries. The sight triangle is bounded by a length of roadway defining a “limit away from the intersection on each of the two conflicting approaches and by a line connecting these two limits” (1). The legs of the sight triangle should follow the curvature of the roadway.

In accordance with AASHTO’s “Green Book,” intersection sight distance should be measured using an assumed height of 3.5 feet for a driver’s eye and an assumed height of 3.5 feet for an object (2). As shown in Exhibit 6-17, intersection sight distance should be checked by measuring the sight triangle to entering and circulating streams of traffic.



Adapted from NCHRP Report 672, Exhibit 6-58 (1)

Exhibit 6-17  
Intersection Sight  
Distance

The length of the approach leg of the sight distance triangle, as shown in Exhibit 6-17, is 50 feet (1). The entering stream distance and circulating stream distance are calculated according to Equation 6-4 and Equation 6-5:

$$d_1 = (1.47)(V_{major,entering})(t_c)$$

Equation 6-4

$$d_2 = (1.47)(V_{major,circulating})(t_c)$$

Equation 6-5

Where

$d_1$  = length of entering leg of sight triangle, ft;

$d_2$  = length of circulating leg of sight triangle, ft;

$V_{major}$  = design speed of conflicting movement, mph, discussed below; and

$t_c$  = critical headway for entering the major road, s, assumed to be 5.0 s.

The design speed of the entering stream of traffic can be approximated by taking the average of the theoretical entering speed and the circulating speed. The design speed of the circulating stream of traffic can be approximated by taking the speed of left-turning vehicles, based on the fastest paths (See Section 6.3.1.1) (1).

### 6.3.5.3 Sight Distance Checks

Roundabouts should be checked during design and review to confirm adequate stopping and intersection sight distance is provided, and each of the checks described above can be overlaid onto a single drawing. Exhibit 6-18 provides an example of a sight-distance check performed at a proposed single-lane roundabout. Areas within the minimum required sight distance area,

**Exhibit 6-18**  
**Example Sight Distance**  
**Checks, Proposed Roundabout**  
**at West 165th Street/Lowell**  
**Street in Overland Park,**  
**Kansas**

denoted in red in the exhibit, should be clear of large obstructions that may hinder visibility. Taller landscaping may be used in the green areas, which can serve to break the forward view for vehicles and reduce speeds.

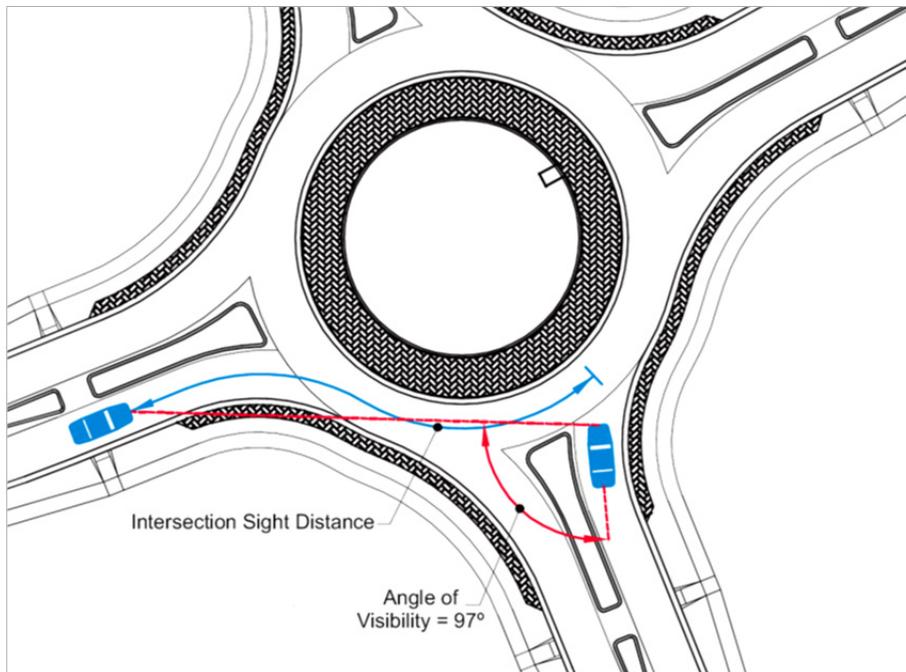


Courtesy of Kittelson & Associates, Inc.

#### 6.3.5.4 Visibility

The geometry of the roundabout should allow drivers to comfortably turn their heads to the left to view oncoming traffic. Guidance in designing for drivers recommends using 75 degrees as a minimum intersection angle (1). If the angle is too severe, the approach may need to be realigned to provide better visibility. This is a problem that can occur at roundabouts with entries less than 90 degrees apart, roundabouts with more than four legs, and roundabouts with consecutive entries (such as at freeway ramp terminals). Exhibit 6-19 provides an example of an angle of visibility check at a roundabout.

*Guidance in designing for drivers recommends using 75 degrees as a minimum intersection angle.*



Courtesy of Kittelson & Associates, Inc.

**Exhibit 6-19**  
**Example Angle of Visibility Check**  
**at proposed roundabout at West**  
**165th Street/Lowell Street in**  
**Overland Park, Kansas**

## 6.4 DESIGN DETAILS

The development of the roundabout design involves adjusting design details to balance the design principles described in Section 6.3 (1). Early in the design process, design elements such as the size of the ICD, the position of the roundabout, and the alignment of the approach legs are adjusted based upon constraints associated with the project site, and the ability of the roundabout design to meet the design principles. Adjustments to these elements have tradeoffs, and may require additional design iterations (1). For instance, if the position of the roundabout is shifted from the center of the intersection, the approach alignments will also require adjustment to provide appropriate speed control and design vehicle accommodations. Design guidance related to the size, position and alignment of approaches is provided in *Section 6.3* of NCHRP Report 672 (1).

This section provides discussion on a variety of design details including pedestrian and bicycle accommodations, vertical considerations, three-leg roundabouts, high-speed rural roundabouts, and right-turn bypass lanes.

### 6.4.1 Pedestrians

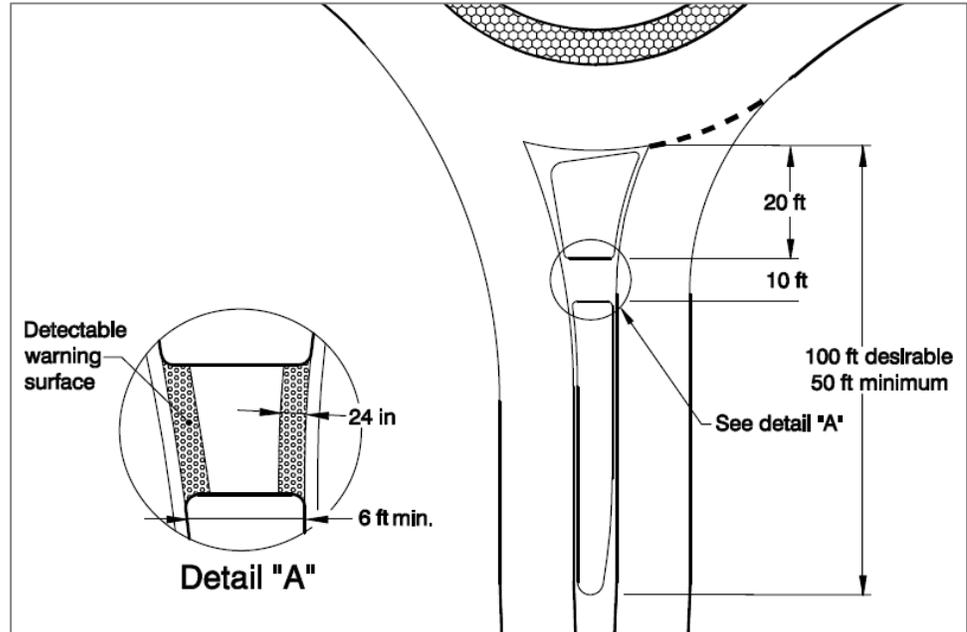
There are several design considerations that affect pedestrians, including the location of pedestrian crossings, sidewalk treatments, and ramp treatments. Connectivity should be a priority, meaning that pedestrian facilities at a roundabout should connect to a broader pedestrian network and coordinate with the community's master plan.

Pedestrian crossings should be provided at all roundabouts where there is current or planned pedestrian activity. If pedestrian activity is anticipated in the future, splitter islands should be designed so that marked pedestrian crossings including accommodations through the splitter islands can be installed in the

future. Where used, the crossing location should be set back from the entrance line at least 20 feet, and the splitter island should be cut to allow pedestrians, wheelchairs, strollers, and other users to pass through.

Exhibit 6-20 illustrates the minimum splitter island dimensions, including those for pedestrian accommodations. Exhibit 6-21 provides an example of pedestrian accommodations at a roundabout, including the crosswalk, sidewalk treatment, and signage. Design guidance related to sidewalks and crosswalks is provided in *Section 6.8.1 Pedestrian Design Considerations* of NCHRP Report 672 (1). Further guidance related to pedestrian signals and accessibility is provided below.

Exhibit 6-20  
Minimum Splitter Island  
Dimensions



Adapted from NCHRP Report 672, Exhibit 6-12 (1)

Exhibit 6-21  
Pedestrian Accommodations  
at a Roundabout at 133<sup>rd</sup>  
Street/Lamar Avenue in  
Overland Park, Kansas



Courtesy of the City of Overland Park

#### 6.4.1.1 Accessible Pedestrian Treatments

Roundabout accessibility features include sidewalks and crosswalks, sidewalk ramps and curb cuts with detectable warning surfaces connecting to the sidewalks and crosswalks, and detectable edge treatments that guide pedestrians to crosswalks (1). At roundabouts and other intersections, pedestrians with visual impairments are presented with travel challenges that are not experienced by sighted pedestrians. These challenges can be broken down into two general categories: wayfinding and alignment, and gap and yield detection.

- **Wayfinding and Alignment.** Detectable warning surfaces are placed at the bottom of sidewalk ramps and at the edges of raised median cuts. Detectable warning surfaces function essentially as detectable stop bars, and are used to help visually impaired pedestrians identify the beginning and end of the areas where vehicular traffic may be crossing their path. Section 6.4.1.3 provides more information on detectable warning surfaces.

Curb ramps should be provided at each end of the crosswalk to connect the crosswalk to the sidewalk and other crosswalks around the roundabout. Curb ramps should be aligned with the crossing to guide pedestrians in the proper direction. The pedestrian crossing should provide a straight continuous alignment across the intersection approach. Crossings that curve or change alignment within the pedestrian refuge area of the splitter island should be avoided unless a distinct angle point within the splitter island is provided. A straight alignment allows a visually impaired pedestrian to cross the approach and find the opposite curb ramp without the need to change direction.

Maintaining a consistent alignment of the pedestrian ramp and the crosswalk across the entire approach can help visually impaired pedestrians establish directional alignment for the crossing while monitoring traffic movements when crossing the active traffic stream.

Pedestrian refuge areas within the splitter island should be designed at street level, rather than elevated to the height of the splitter island. This eliminates the need for ramps within the refuge area. Install detectable warning surfaces to provide tactile indication when the pedestrian reaches and exits the splitter island.

- **Gap and yield detection.** Pedestrians with visual impairments initiate their crossings by listening for gaps in the active traffic stream and/or listening for yielding by drivers. At roundabouts, deciding when to initiate the crossing is more complex, as it requires a visually impaired pedestrian to distinguish between the traffic at the crosswalk of interest and background traffic that generates potentially conflicting noise.

Section 2.3.2 *Pedestrians with Disabilities* of NCHRP Report 672 provides additional details about the problems roundabouts pose in each of these areas (1).

#### 6.4.1.1.1 Guidelines

Title II of the Americans with Disabilities Act (ADA) requires that new and altered facilities constructed by, on behalf of, or for the use of state and local government entities be designed and constructed to be readily accessible to and usable by individuals with disabilities (28 CFR 35.151) (3).

The United States Access Board has developed the draft Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG), which are under review at the time of this writing. A full version of the proposed guidelines is available on the Access Board website (<http://www.access-board.gov>). Section R306.3 of the draft document provides guidelines for accessible pedestrian facilities at a roundabout, including the following (4):

- **R306.3.1 Separation.** Where sidewalks are flush against the curb and pedestrian street crossing is not intended, a continuous and detectable edge treatment shall be provided along the street side of the sidewalk. Detectable warning surfaces shall not be used for edge treatment. Where chains, fencing, or railings are used for edge treatment, they shall have a bottom edge 15 inches maximum above the sidewalk.
- **R306.3.2 Pedestrian Activated Signals.** At roundabouts with multilane pedestrian street crossings, a pedestrian activated signal complying with R209 shall be provided for each multilane segment of each pedestrian street crossing, including the splitter island. Signals shall clearly identify which pedestrian street crossing segment the signal serves.
- **R306.4 Channelized Turn Lanes at Roundabouts.** At roundabouts with pedestrian street crossings, pedestrian activated signals complying with R209 shall be provided at pedestrian street crossings at multilane channelized turn lanes.

Ongoing research is being conducted to improve accessibility for visually impaired pedestrians at roundabouts. This research is required to develop the information necessary for jurisdictions to determine where roundabouts may be appropriate and what design features are required for people with disabilities. Although PROWAG is not final as of the printing of this document, KDOT encourages the use of the draft guidelines and accommodating all road users.

#### 6.4.1.2 Pedestrian Beacons and Signals

In addition to complying with draft PROWAG guidelines, in some situations, it may be beneficial to install a pedestrian-activated beacon or signal at a roundabout. These devices may be beneficial at a roundabout crossing with any of the following conditions (1):

- High vehicular volumes;
- High pedestrian volumes; and/or
- Multilane crossings.

When pedestrian signals or beacons are used, Accessible Pedestrian Signals (APS) features should also be used. APS provides information in non-visual formats (e.g., locator tone, vibrating surfaces, audible tones, etc.). Section 4E.09

to 4E.13 in the 2009 MUTCD (5) provides additional information on Accessible Pedestrian Signals.

Although the draft PROWAG mandates signals at multilane pedestrian crossings, the Access Board has not specified a specific signalization system. To satisfy the requirements (i.e., yield rates of vehicular traffic and providing a clear walk indication), two systems have had the most consideration:

- **Traditional traffic signals** display red, yellow, and green indications to drivers. These are typically designed to be pedestrian-actuated. Traditional signals can be outfitted with APS and pedestrian signals, and additional driver and pedestrian education is often not necessary to accommodate their use. Exhibit 6-22 displays traditional traffic signals at a roundabout crossing in Lincoln, Nebraska.



Adapted from: <http://lincoln.ne.gov/city/pworks/engine/roundabout/projects.htm>

- **Pedestrian Hybrid Beacons** were developed as an alternative to traditional pedestrian signals. The beacon is dark until activated by a pedestrian, at which point the beacon displays a flashing yellow, followed by solid yellow, followed by solid red. The pedestrians are then provided a Walk indication. During the pedestrian clearance interval (Flashing Don't Walk), drivers are displayed an alternating red indication, allowing a stopped vehicle to proceed with caution through the crosswalk after yielding to pedestrians. Chapter 4F in the 2009 MUTCD (5) provides more information about the hybrid beacons. Research shows that drivers more frequently yield for pedestrians at hybrid beacons than at crosswalks without beacons (6), and Pedestrian Hybrid Beacons may cost less than a full traffic signal.

In addition to traffic signals and hybrid beacons, Rectangular Rapid Flashing Beacons (RRFBs) are being reviewed for use at roundabouts. RRFBs are yellow LEDs that supplement pedestrian crossing warning signs at unsignalized

Exhibit 6-22  
Traditional Traffic Signal  
Pedestrian Crossing at Superior  
Street/N 14th Street Roundabout  
in Lincoln, Nebraska

intersections or midblock crossings with the use of an irregular flash pattern to raise driver awareness. RRFBs are activated by a pedestrian push button. Unlike traditional traffic signals or pedestrian hybrid beacon, drivers never see a red indication. Research sponsored by the Transportation Research Board indicates that RRFBs are more effective at increasing driver yielding rates to pedestrians than traditional overhead beacons (6).

KDOT encourages the use of treatments that provide appropriate accessibility to all users. These treatments may involve signalization, or other accepted devices that provide appropriate stop/yield rates and indication to pedestrians that vehicles are stopping/yielding. The system used should be based on the project location and the expected vehicular and pedestrian volume.

*Section 7.5.2 Pedestrians Signals at Roundabouts* in NCHRP Report 672 provides further guidance on situations where a signal may be appropriate, types of pedestrian signals, and warning beacons at pedestrian crossings (1).

#### **6.4.1.3 Detectable Warning Surfaces**

Install detectable warning surfaces including raised truncated domes, as required by accessibility guidelines, to the sidewalk ramps and along the full width of the cut-through walkway within the splitter island (1). KDOT's standard drawings provide specifications for truncated domes.

### **6.4.2 Bicyclists**

Roundabout design details should consider the usability of the roundabout for bicyclists. As noted in Chapter 2, bicyclists may either choose to ride through the roundabout as a vehicle or circulate through the roundabout as a pedestrian. Design guidance for each of these options is provided.

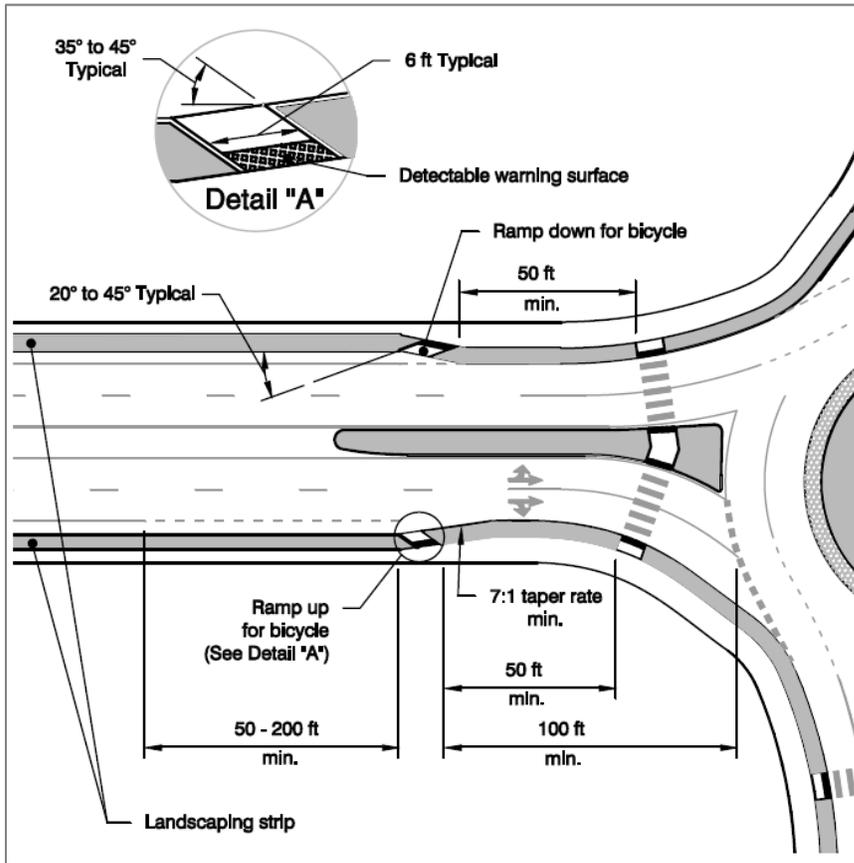
#### **6.4.2.1 Bicyclists Riding Through a Roundabout**

In Kansas, bicyclists have the option of navigating through the roundabout as a vehicle or as a pedestrian on an adjoining sidewalk. Where used, bike lanes should be terminated in advance of a roundabout to encourage cyclists to mix with vehicle traffic and navigate the roundabout as a vehicle. Consistent with the language of the 2009 MUTCD, bike lanes shall not be used within a roundabout (5). It is recommended that bike lanes end 100 feet upstream of the entrance line to allow for merging with vehicles. Multilane roundabouts may require cyclists to change lanes to make left turn movements or otherwise select the appropriate lane for their direction of travel.

#### **6.4.2.2 Bicyclists Traversing Roundabout as a Pedestrian**

Bicycle riders uncomfortable with riding through the roundabout may choose to circulate through the roundabout as a pedestrian using the provided sidewalks and crossings. To accommodate bicyclists who prefer not to use the circulatory roadway, a widened sidewalk or shared bicycle/pedestrian path may be provided that is physically separated from the circulatory roadway. Sidewalk ramps, bicycle ramps, or other suitable connections can be provided between the sidewalk or path and the bike lanes, shoulder, or road surface on the approaching and departing roadways as shown in Exhibit 6-23.

Care should be taken when locating and designing bicycle ramps so that they are not misconstrued as an unmarked pedestrian crossing. The AASHTO *Guide for Development of Bicycle Facilities* (7) provides further guidance on the design requirements for bicycle and shared-use path design. In addition, *Section 6.8.2 Bicycle Design Considerations* of NCHRP Report 672 provides more specific guidance on designing for bicyclists at a roundabout, including design options for providing bicycle ramps on the approaches to the roundabout (1).



Adapted from NCHRP Report 672, Exhibit 6-67 (1)

Exhibit 6-23  
Possible Treatments for Bicyclists

### 6.4.3 Roundabouts in High-Speed, Rural Environments

For roundabouts in high-speed, rural environments, special design considerations may be needed to sufficiently reduce vehicle speeds before entering the roundabout. The principles common to the design of all roundabouts remain in effect when applied to high-speed, rural environments. Especially important are the objectives to retain slow entry speeds, accommodate the design vehicle, and provide visibility. These principles and associated potential design strategies are listed below.

- Slow Entry Speeds:** The most critical design objective for all roundabouts is to maintain low and consistent speeds through the roundabout. Strategies, which may have trade-offs, to transition drivers from a high-speed environment on the approach to a low-speed environment at the roundabout entry include the following:

Exhibit 6-24  
Rural High-Speed  
Roundabout at the  
Intersection of US 50/US  
77/West 8<sup>th</sup> Street in  
Florence, Kansas



Bing Maps © 2014 Microsoft Corporation, Pictometry Bird's Eye ©2012 Pictometry International Corp.

- *Larger Inscribed Circle Diameters:* “In a higher-speed rural location, a larger diameter roundabout may have a larger footprint required to accommodate large trucks while providing increased visibility and speed control” (1). Exhibit 6-24 displays a single-lane roundabout in Florence, Kansas with a large ICD.
- *Extended Splitter Islands:* The length of the splitter island on high-speed approaches should be equivalent to the length necessary for vehicles to comfortably decelerate from the approach speed to the roundabout entry design speed. At high-speed approaches, the raised median portion of splitter islands should extend several hundred feet, with additional channelization provided by curbing or pavement markings.
- *Approach Alignment:* Offsetting the approach alignment to the left of center, as seen in Exhibit 6-7, increases the deflection and can allow for slower entry speeds. An offset left approach also can be beneficial for accommodating large trucks when increasing the size of the ICD is not possible; the offset approach allows for a larger entry radius while maintaining deflection and speed control. When adjusting the approach alignment, the designer should be aware of the design vehicle requirements, along with visibility and speed control tradeoffs associated with the roundabout entry angle.
- *Curbing:* Curbs should be provided at all rural roundabouts to alert drivers of the change in roadway character. This indicates to drivers that they are entering a more controlled environment and encourages them to slow down. In addition, curbs improve delineation, prevent corner cutting, and confine vehicles to the intended design path. All likely design vehicles, including farm equipment or OSOW vehicles should be considered when setting curb locations. Curbing may be extended the length of the required deceleration distance to

the roundabout, and will generally be extended beyond the length of the splitter island.

- *Approach curves:* Approach curves that are successively smaller in radii may be used on high-speed roundabout approaches to reduce vehicle speeds.
- **Design Vehicle Accommodation:** The roundabout should be designed for the largest vehicle reasonably expected to use the intersection. OSOW vehicles have become more common at Kansas roundabouts in recent years. As previously discussed in Section 6.3.4, the three categories of design vehicles (large vehicles without trailers, large vehicles with trailers, and OSOW vehicles) each have different design requirements. Despite the relatively low frequency of OSOW vehicles, it can be necessary to design roundabouts to accommodate OSOW vehicles that have design requirements beyond the typical WB-67 design vehicle. Additional information on OSOW accommodations can be found in Section 6.5.
- **Visibility:** Roundabout visibility is particularly important at rural intersections to make users aware of the roundabout and provide them sufficient time to react. “The geometric alignment of approach roadways should be constructed... [for] the visibility of the central island and the shape of the roundabout” (1). Increasing the size of the ICD, along with the use of lighting and landscaping, can further increase the available visibility. If visibility is an issue, signing, pavement markings, advanced warning beacons, and transverse rumble strips may also be used.

#### 6.4.4 Right-Turn Bypass Lanes

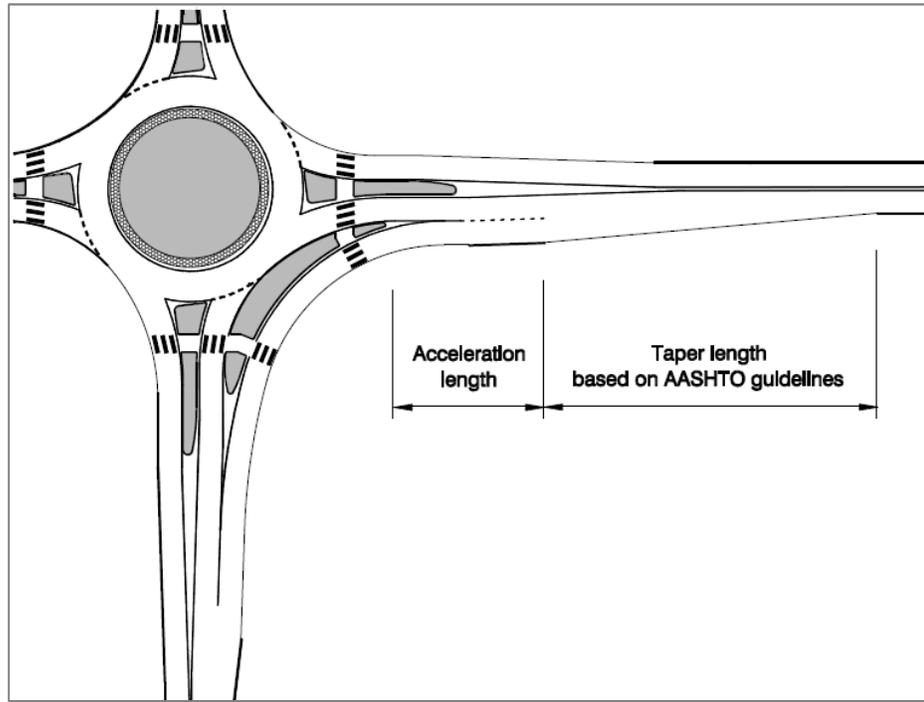
Right-turn bypass lanes can improve operations at locations with a high volume of right-turning traffic. They can be used to improve capacity at a roundabout and may allow a single-lane roundabout to continue to function acceptably to avoid upgrading to a multilane roundabout. They are most effective for approaches where a significant proportion of traffic is turning right. The capacity analysis described in Chapter 4 should be used to determine if a right-turn bypass lane should be used. Right-turn bypass lanes can also be beneficial in locations where the geometry is too tight to allow trucks to make right-turns within the roundabout (1). However, they can also increase conflicts with pedestrians and bicycles and with merging on the downstream leg. Bypass lanes typically have higher speeds and drivers have a lower expectation of stopping, which may increase the risk of collisions with pedestrians.

There are two common design options for right-turn bypass lanes:

1. Carry the bypass lane parallel to the adjacent exit roadway and then merge into the main exit (according to AASHTO guidelines). The bypass lane should be carried a sufficient distance to allow vehicles exiting the roundabout to accelerate to comparable speeds (1). An example of this configuration is shown in Exhibit 6-25.
2. Provide a yield controlled entrance onto the adjacent exit roadway (partial bypass). While this option does not provide as great of

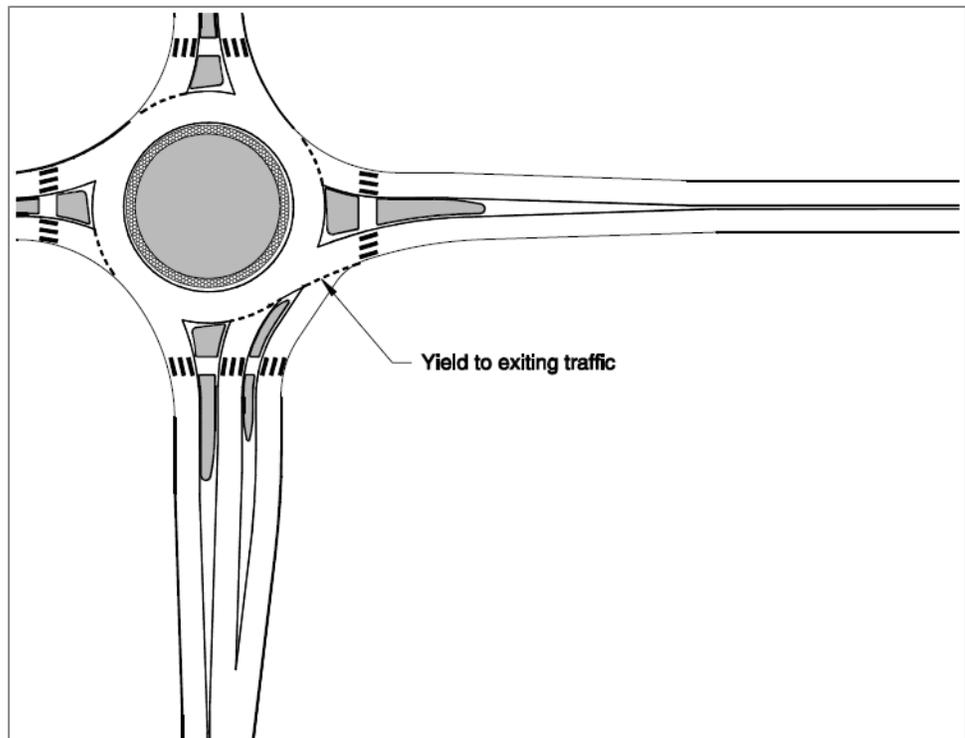
operational benefits, it generally requires less construction and right-of-way. It is recommended in areas where bicyclists and pedestrians are prevalent. An example of this configuration is shown in Exhibit 6-26.

Exhibit 6-25  
Configuration of Right-turn  
Bypass Lane with Acceleration  
Lane



NCHRP Report 672, Exhibit 6-72 (1)

Exhibit 6-26  
Configuration of Right-turn  
Bypass Lane with Yield at Exit  
Lane



NCHRP Report 672, Exhibit 6-73 (1)

The radius of the bypass lane should not be significantly larger than the radius of the roundabout. This will keep vehicle speeds on the bypass lane similar to those of vehicles traveling through the roundabout. Exhibit 6-27 displays a continuous right-turn bypass lane.



Courtesy of the City of Overland Park

*The radius of the bypass lane should not be significantly larger than the radius of the roundabout.*

**Exhibit 6-27**  
**Continuous Right-Turn Bypass Lane at the Intersection of 155<sup>th</sup> Street/Pinehurst Drive/Briar Road in Basehor, Kansas**

#### 6.4.5 Vertical Considerations

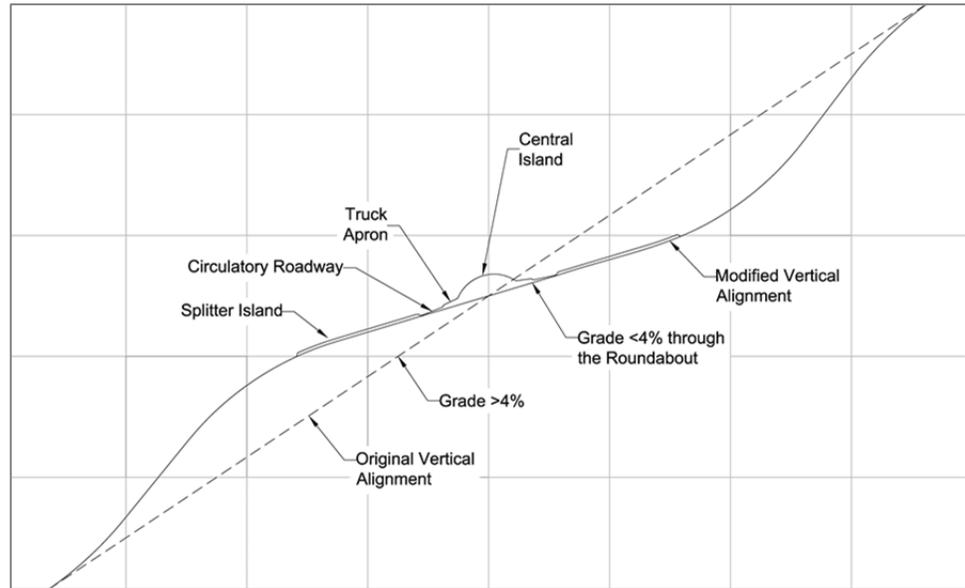
In order to provide proper drainage, and to reduce the likelihood of large trucks from overturning or load shifting, it is also important to consider the vertical alignment of the roundabout. These vertical considerations include profiles, superelevation, approach grades, and drainage. *Section 6.8.7 Vertical Considerations* of NCHRP Report 672 provides design guidance on each of these topics, which can be referenced to supplement the direction provided in this guide (1).

The development of the approach roadway and central island profiles is an iterative process. The intent is to smoothly tie the elevations of the approach roadway profiles into a smooth profile around the central island. Each approach profile should be designed to the point where it intersects with the central island (1). The central island profile is then developed from these points and the approach roadway profiles adjusted as necessary to meet the central island profile.

In general, a negative superelevation of 2% should be used for the circulatory roadway at single-lane roundabouts. This outward sloping design is recommended to improve visibility, promote lower circulating speeds, help drain surface water to the outside of the roundabout, and minimize breaks in the cross slopes of the entrance and exit lanes (1). In this design, the circulatory roadway is graded independently of the rest of each approach, and a grade of approximately 2% is used to provide drainage away from the central island. The slope of the truck apron, if used, should be no more than 2%. Truck aprons are typically sloped toward the outside of the roundabout. Sufficient clearance should be provided for low-boy-type trailers. At multilane roundabouts, while an outward sloping design is the most common, there are a variety of other styles that can be used. For example, the circulatory roadway can be crowned with approximately two-thirds of the width sloping toward the central island and one-third sloping outward (1).

In locations where the existing terrain has a grade greater than 4%, it is typically desirable to adjust the vertical profile so that roadway grades through the roundabout do not exceed 4%. “On approach roadways with grades steeper than -4%, it is more difficult for entering drivers to slow or stop on the approach” (1). Additional consideration is needed when designing roundabouts on steep grades to provide appropriate speeds and sight distance. *Section 6.8.7.5 Locating Roundabouts on Grades* of NCHRP Report 672 provides additional guidance for designing a roundabout on a significant grade (1).

**Exhibit 6-28**  
Adjustment of the Vertical Profile to Achieve a More Desirable Grade through the Roundabout



Courtesy of Kittelson & Associates, Inc.

### 6.4.6 Roundabouts at Three-Legged Intersections

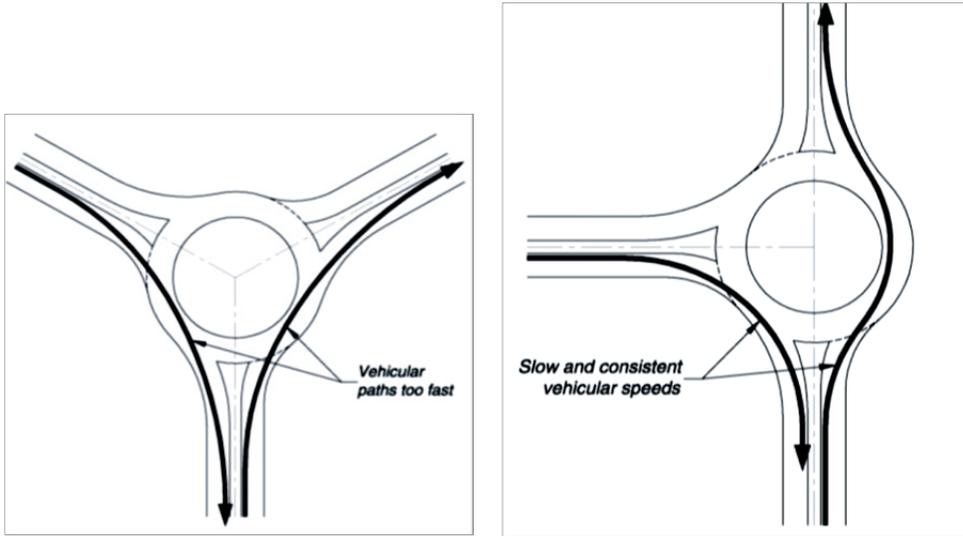
While a roundabout at a three-legged intersection follows most of the same design principles as at a conventional four-legged intersection, three-legged roundabouts can present challenges to achieving proper speed control. These challenges are particularly apparent when the approach legs are not perpendicular, or in locations with minimal right-of-way where it can be difficult to achieve proper deflection. These situations are discussed in more detail below.

**Exhibit 6-29**  
Three-Legged roundabouts at the intersections of North Kasold Drive/Grand Vista Drive (Left) and North Kasold Drive/Tillerman Drive (Right) in Lawrence, Kansas



Bing Maps. ©2013 Microsoft Corporation. Pictometry Bird's Eye ©2012 Pictometry International Corp.

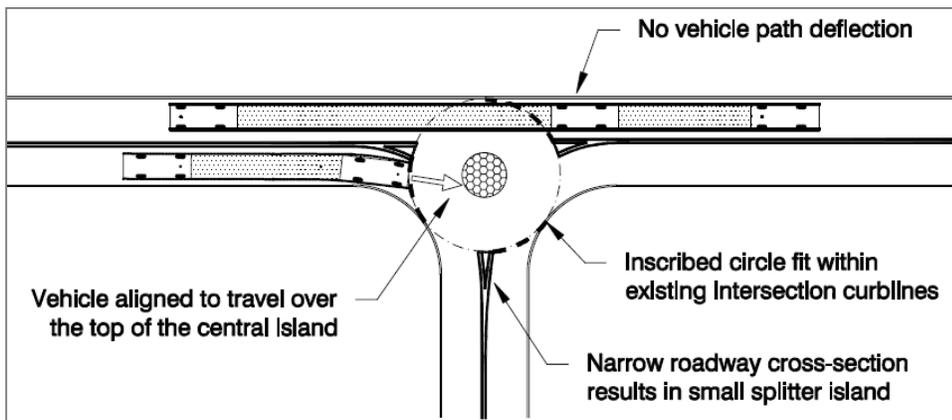
1. **Angle between approach legs:** Keeping the approach angle close to 90 degrees helps maintain slow and consistent speeds when used in combination with other appropriately sized design features. Angles greater than 90 degrees can result in excessive right-turn speeds, as seen in Exhibit 6-30. If the angles are less than 90 degrees, it may be difficult for trucks or other large design vehicles to navigate the roundabout.



NCHRP Report 672, Exhibit 6-11 (1)

Exhibit 6-30  
Angle between Approach Legs of Three-Legged Intersection

2. **Deflection:** At locations with minimal right-of-way, it may be difficult to achieve sufficient deflection within the available space, as seen in Exhibit 6-31. *Section 6.6.2 Design Considerations for Mini-Roundabouts at Three-Leg Intersections* of NCHRP Report 672 discusses this issue and provides potential solutions to create deflection on the approach, which include increasing the ICD, shifting the ICD along the minor street axis, and adjusting the alignment of the approach (1). These methods are also applicable at conventional roundabouts.



NCHRP Report 672, Exhibit 6-42 (1)

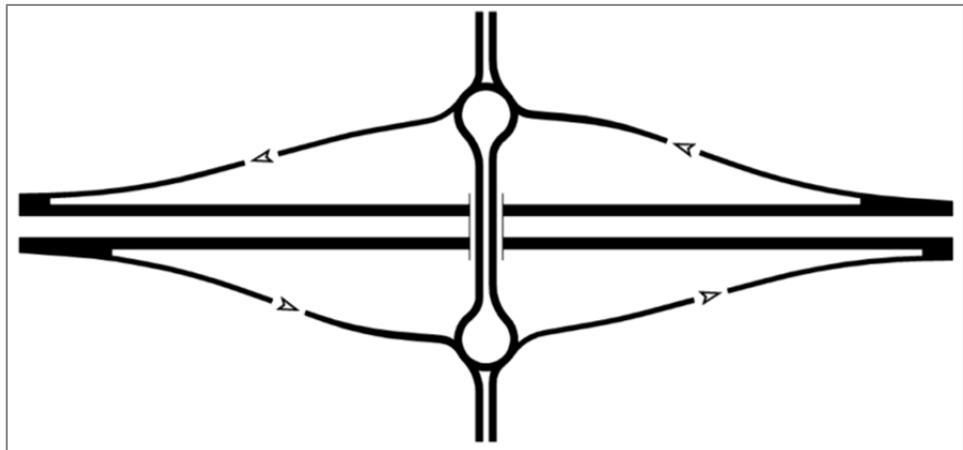
Exhibit 6-31  
Lack of Deflection at Three-Legged Intersection

### 6.4.7 Interchanges

Roundabouts can be acceptable and, in some locations, advantageous solutions for ramp terminal intersections within freeway service interchanges. Roundabouts may require a narrower bridge cross section, providing a significant cost benefit. If the interchange has a high proportion of left-turn flows from the off-ramps and to the on-ramps during peak periods, a roundabout may be particularly advantageous for the interchange.

Most commonly, roundabouts are used at diamond interchanges. There are two variations of diamond interchanges that can be used with roundabouts. The more common form, shown in Exhibits 6-32 and 6-33, consists of two roundabouts, one on each side of the freeway. There is typically a single bridge structure (or, in some cases, two structures if the freeway crosses over the cross street) between roundabouts. For these interchanges, it is best if the ramp terminal intersections are spread far enough apart to avoid the need for widening of the bridge structure and prevent queues from spilling back between intersections. In some cases, the central islands may be raindrop-shaped with no yielding required for traffic between the two roundabouts. If the intersections consist of frontage roads or need to accommodate U-turns, raindrop-shaped central islands should not be used.

Exhibit 6-32  
Conceptual diamond  
interchange with roundabouts  
at the ramp-node terminals



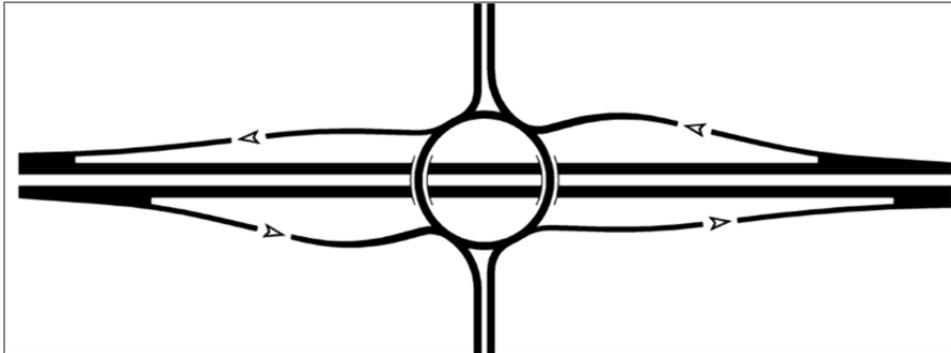
NCHRP Report 672 (1)

Exhibit 6-33  
I-70/SE Rice Road folded  
diamond interchange with  
roundabouts at ramp-node  
terminals in Topeka, Kansas



Bing Maps © 2012 Nokia, © 2013 Microsoft Corporation

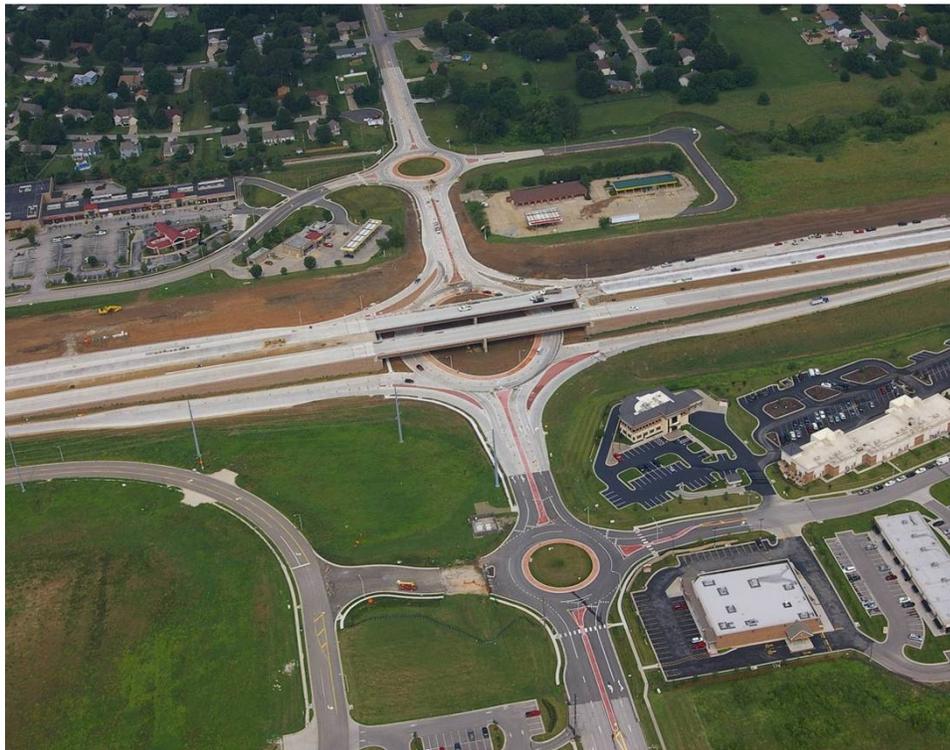
Another variation of the diamond interchange with roundabouts consists of a single-point interchange with one roundabout centered over or under the freeway. Exhibit 6-34 illustrates this interchange form. This interchange form can be likened to a typical single-point diamond interchange, where turning traffic from the freeway interchanges with arterial traffic at a single (albeit large) intersection. The single-point roundabout interchange form often is more expensive to build initially and more expensive to maintain in the long term, so designers should take care when using this type of interchange.



NCHRP Report 672 (1)

**Exhibit 6-34**  
Conceptual single-point roundabout diamond interchange

This single-point roundabout interchange requires two bridges. If the freeway goes over the roundabout, then four shorter bridges or two longer bridges may be required, as shown in Exhibit 6-35. Due to the structural support needed for the bridges, care should be taken to verify adequate sight distance is provided. Further, due to the large size of this roundabout, care should be taken to verify adequate entry curvature is achieved to control speeds.



Courtesy of the Kansas Aggregate Producers Association and the Kansas Ready Mix Concrete Association

**Exhibit 6-35**  
K-7/Johnson Drive oval split diamond single-point interchange roundabout in Shawnee, Kansas

## 6.5 OVERSIZE-OVERWEIGHT LOAD ACCOMMODATIONS

OSOW vehicles have become more common at Kansas roundabouts in recent years as the number of roundabouts on rural highways has increased, due in large part to the emerging wind-energy industry in Kansas. The typical and most commonly occurring design vehicle at many rural Kansas roundabouts is a WB-67 design vehicle, which consists of a truck-tractor-semi-trailer combination that may be used to transport loads anywhere in the state of Kansas without a permit. Despite the relatively low frequency of OSOW vehicles, it can be necessary to design roundabouts to accommodate OSOW vehicles that have design requirements beyond the typical WB-67 design vehicle. The specific needs and requirements of OSOW vehicles vary, as OSOW vehicles include a large range of vehicle types and sizes.

There are a variety of design modifications that can be made to accommodate OSOW vehicles, each with its own advantages and disadvantages. A decision about the proper modifications and treatments to employ should be made on a project by project basis and in consultation with KDOT, taking into account the OSOW vehicle configurations, vehicle paths through the intersection, and the location of the roundabout. This section is intended to describe some of the potential treatments that can be used for OSOW vehicles and serve as a starting point for identifying the potential needs and accommodations for OSOW vehicles at a roundabout. Regardless of the design modifications made, it is important that the principles of good roundabout design are maintained throughout the process.

### 6.5.1 Accommodating OSOW Vehicles

The primary concerns for OSOW vehicles in relation to roundabouts are the length, width, ground clearance of the load, and the swept path of the vehicle and load. The design of a roundabout that accommodates an OSOW vehicle needs to reach a balance between the needs of the OSOW vehicle and the basic roundabout design principles of controlling fastest path speeds and path alignment.

#### 6.5.1.1 Vehicle Characteristics

While the design modifications identified in this section focus on accommodating the additional length and width of OSOW vehicles compared to the typical WB-67 design vehicle, many OSOW vehicles have low ground clearance that also needs to be accommodated. During the evaluation of a roundabout to accommodate an OSOW vehicle, the distance between the load and the roadway surface should be reviewed to confirm that the low clearance of the load does not encroach on the truck apron or curbs at the roundabout (8). While some OSOW vehicles have a clearance as low as 3 inches, 6 to 12 inches is more common. Exhibit 6-36 displays an OSOW vehicle in Kansas with low ground clearance.



Courtesy of Phil Demosthenes

**Exhibit 6-36**  
**OSOW Vehicle in Kansas with**  
**Low Ground Clearance Carrying a**  
**Wind Turbine Tower Section**

## 6.5.2 Design Modifications

This section outlines alternatives for accommodating OSOW vehicles, which were identified through discussions with international roundabout experts and are listed in approximate order of the easiest to most difficult strategies to implement.

A variety of strategies are available for successfully accommodating OSOW vehicles at roundabouts. In all cases, the local context and the particular design vehicle will need to be taken into account to determine what approach is most practical and prudent. Furthermore, regardless of the strategy chosen, all of the design principles for roundabouts—maintaining appropriate vehicular speeds and alignment, accommodation of all modes, sight distance and visibility, and others—need to be balanced with the accommodation of OSOW vehicles.

Not all modifications described in this section can be used due to existing state and local laws and regulations. The inclusion of a modification here does not necessarily imply KDOT's endorsement or its appropriateness in all situations. The strategies discussed herein are included for discussion only and serve as a starting point for selecting the most appropriate treatment(s) to accommodate OSOW vehicles.

### 6.5.2.1 Potential OSOW Design Modifications

There are a number of typical strategies for accommodating larger design vehicles, including a larger ICD, wider approach widths, wider circulatory roadway, and larger entry radii (1). Additional strategies specific to OSOW vehicles have been grouped into four different treatment types:

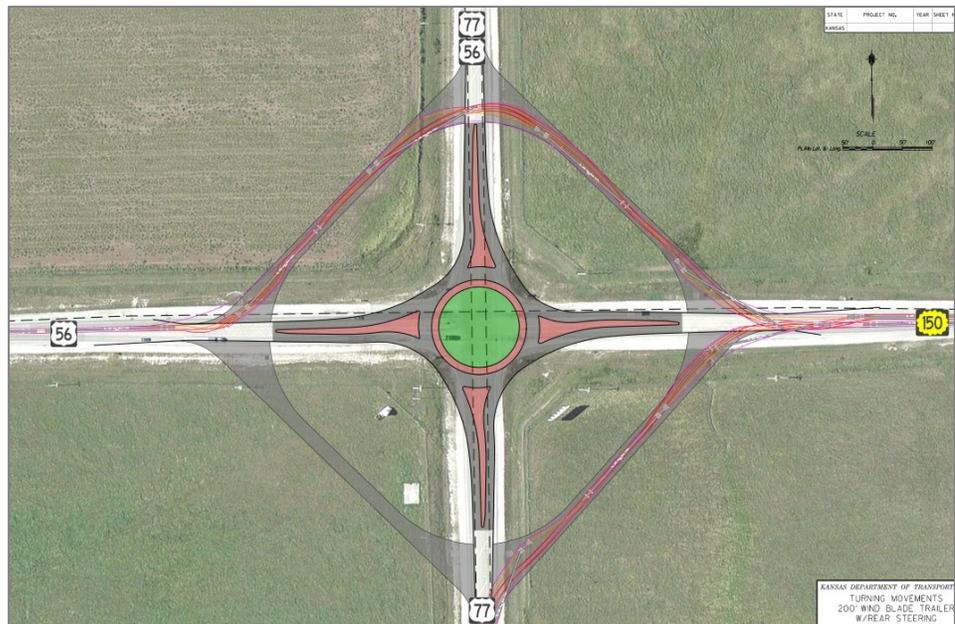
- Bypass treatments
- Traffic control device treatments
- Central island treatments
- Approach treatments

6.5.2.1.1 Bypass Treatments

There are several types of bypass treatments that can be used to accommodate OSOW vehicles, many of which are described below.

- Bypass Approach** A method for accommodating OSOW vehicles is to provide a bypass at the roundabout so OSOW vehicles can avoid the roundabout altogether. At the intersection of K-150/US-77/US-56 in Marion County, Kansas, as seen in Exhibit 6-37, a “Roundabout in a Box” design is used to provide bypass lanes for OSOW vehicles around the roundabout. As seen in Exhibit 6-38, a gated bypass is used to restrict vehicles from the bypass when OSOW vehicles are not present.

Exhibit 6-37  
Marion County, Kansas  
“Roundabout in a Box” OSOW  
Bypass Lanes



Kansas Department of Transportation

Exhibit 6-38  
OSOW Bypass Lane at the  
intersection of N207/N460  
outside of Alphen aan den  
Rijn, Netherlands



Courtesy of Bertus Fortuijn

- **Shoofly Bypass** If a shoofly, or temporary roadway, is needed during construction staging, it may be possible to design the shoofly to remain as a permanent feature to accommodate OSOW vehicles. Gates, landscaping, signs, or other measures can be used to prevent drivers from using the shoofly as shown in Exhibits 6-38, 6-39 and 6-40, which provide international examples. In some cases, a roundabout is designed in conjunction with realignment to the existing roadway, allowing traffic to use the existing roadway during construction of the roundabout. In these cases, it may be possible to keep the pavement from the existing roadway in place to accommodate OSOW vehicles in the future. Appendix B shows a proposed roundabout at the intersection of US-400/K-66/Beasley Road in Cherokee County, Kansas, which was designed to realign the US-400 approaches by locating the roundabout to the south of the existing intersection. This roundabout was opened to traffic in December 2008. At this location, it was possible to use the previous roadway alignment to accommodate OSOW vehicles.
- **Advanced Left-Turn Bypass** In cases where OSOW vehicles are projected to regularly make a left-turn movement at a roundabout, an advanced left-turn bypass can be used, as shown in Exhibits 6-39 and 6-40. As seen by the line superimposed on the images in the exhibits, OSOW vehicles making a left-turn movement are able to avoid navigating around the central island by turning in advance of the roundabout under flagging or similar temporary traffic control conditions. Further, the sign placement has been completed in a manner that does not require the removal or relocation of signs while an OSOW vehicle is navigating the roundabout.



Bing Maps. Image courtesy of Simmons ©2013 Microsoft Corporation

Exhibit 6-39  
Advanced Left-Turn Movement  
at the intersection of  
Goudsestraatweg (N459)/A12 in  
Reeuwijk-Brug, Netherlands

Exhibit 6-40  
Advanced Left-Turn  
Movement at the intersection  
of Goudsestraatweg  
(N459)/A12 in Reeuwijk-Brug,  
Netherlands



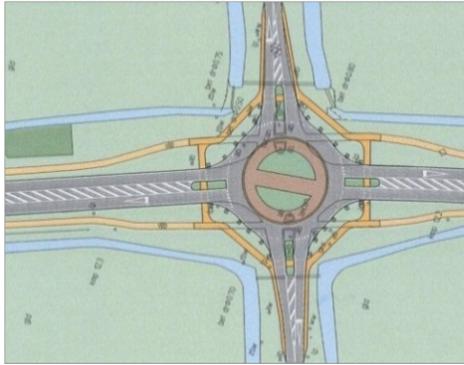
Courtesy of Bertus Fortuijn

- **Central Island Cut-Through Bypass** In situations where OSOW vehicles are expected to make regular through movements at a roundabout, a central island cut-through bypass can be used to accommodate the vehicles. Exhibits 6-41 through 6-44 show examples of cut-through bypasses at roundabouts. In all cases, removable or foldable traffic signs, landscaping, or some other visual element has been used to block the cut-through. In some cases, OSOW vehicles use the cut-through bypass by entering the roundabout on the exit side of the approach and exit directly to the exit on the opposite side of the roundabout. This directs non-OSOW vehicles away from the cut-through bypass as they approach the roundabout.

Exhibit 6-41  
United Kingdom  
Roundabout with OSOW  
Truck Accommodation  
through the Central Island.  
(Mirrored Image)



Courtesy of Steven Diebol



Courtesy of Bertus Fortuijn



Exhibit 6-42  
Central Island Cut-Through in the Netherlands



Courtesy of Phil Demosthenes



Exhibit 6-43  
Central Island Cut-Through in Abu Dhabi



Courtesy of Uroš Brumec and Brilon Werner

Exhibit 6-44  
Central Island Cut-Through

- Roundabouts with a cut-through bypass can be equipped with signs that can fold down, as shown in Exhibit 6-45, so that they do not need to be removed when an OSOW vehicle uses the cut-through bypass.

Exhibit 6-45  
Central-Island Cut-Through  
with Removable Guidance  
Signs (Top) and Folding  
Signs Blocking the Cut-Through Lane  
(Bottom) (Mirrored Image)



Courtesy of Uroš Brumec

#### 6.5.2.1.2 Traffic Control Device Treatments – Removable Signs

It is often necessary to remove permanent objects at the roundabout to accommodate OSOW vehicles. To prevent the costly removal and replacement of signs at roundabouts, signs and sign supports have been designed to be easily moved and put back into place, as shown in Exhibit 6-46.

Exhibit 6-46  
Removable Sign in Use in  
Washington State



Courtesy of Brian Walsh, Washington State Department of Transportation

#### 6.5.2.1.3 Central Island Treatments – Truck Apron Size

One strategy for accommodating OSOW vehicles is to increase the width of the central truck apron, as shown in Exhibit 6-47. When increasing the width of the truck apron, attention should be paid to verify that drivers are still able to see the central island as they approach the roundabout and that proper deflection and speed control are maintained. In addition, as at all truck aprons, the material or pattern used for the surface of the apron should be different from that used for the sidewalk so that pedestrians do not perceive that the truck apron is a sidewalk and thus are not encouraged to cross the circulatory roadway. Additional truck apron design information is discussed in sections 6.6 and 6.7 of this document.

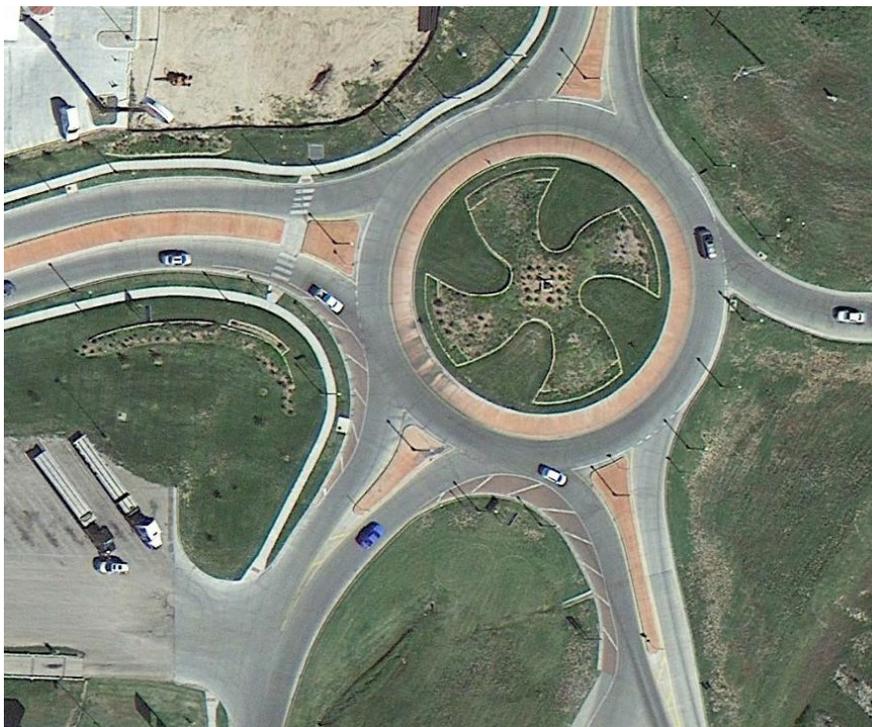


Courtesy of Kelli Owen (10)

**Exhibit 6-47**  
Increased Width of Central Truck Apron and Outside Truck Apron

#### 6.5.2.1.4 Approach Treatments - Outside Truck Apron/Mountable Splitter Islands

The use of an outside truck apron and/or a mountable splitter island can be used in circumstances where other design modifications are unable to accommodate larger design vehicles. Exhibit 6-48 displays a striped outside truck apron used to accommodate the swept path of entering vehicles. Similar to the discussion regarding increasing the size of the central truck apron, attention should be paid to maintain deflection and speed control with the use of an outside truck apron and/or mountable splitter island. The impact on pedestrian and bicycle facilities, as well as vertical clearance for vehicles, should also be assessed.



Google Maps Imagery © 2013 DigitalGlobe

**Exhibit 6-48**  
Striped Outside Truck Apron at the Intersection of I-70/S East Street/E Chestnut Street/E Ash Street in Junction City, Kansas

### **6.5.3 OSOW Design Checks**

Additional design vehicle checks may be necessary at roundabouts expected to serve OSOW vehicles. Simulations of these design vehicles can help identify the removable sign area or where an outside truck apron is required. A designer should be aware of surrounding industries and perform additional OSOW design checks as deemed appropriate. In addition, while a WB-67 is not an OSOW, it is a necessary check vehicle on statewide truck freight routes.

## **6.6 PAVEMENT JOINTING**

This section discusses the selection of appropriate paving materials and techniques at a roundabout. Joint plans are an important design feature when Portland cement concrete pavement is used at a roundabout. Joint lines can be mistaken as lane lines, so it is important that a jointing plan is carefully considered and developed.

### **6.6.1 Asphalt Concrete versus Portland Cement Concrete**

Two material types are commonly used for the top surface of approach and circulatory roadways at roundabouts: asphalt concrete and Portland Cement Concrete Pavement (PCCP). The decision of whether to use asphalt concrete or PCCP may depend on local preferences and the pavement type of the approach roadways.

In general, PCCP has a longer design life and may hold up better under truck traffic but is more difficult to install under traffic. PCCP may not require rehabilitation, such as overlays, as frequently as asphalt does. Drainage characteristics may also be better preserved over time with PCCP because it is less prone to rutting, shoving, and potholing. PCCP also provides good skid resistance. Concrete mixtures can also be colored and textured to differentiate traffic patterns and distinct areas of the intersection or for aesthetic reasons.

On the other hand, asphalt concrete provides better contrast for pavement markings, is easier to stage in construction, and provides visible distinction to PCCP commonly used for truck aprons. Also, few agencies to date have reported problems with rutting on asphalt pavement at roundabouts.

### **6.6.2 Jointing Patterns**

In general, the best joint patterns are those that are concentric and radial to the circulatory roadway within the roundabout. On single-lane roundabouts, jointing should not split the circulatory roadway, as this can give the illusion of a two-lane roundabout. This can be particularly problematic at night and in wet conditions when vehicles may drive along the joints, introducing the potential for side-by-side movements. On multilane roundabouts, circumferential joints within the circulatory roadway should follow pavement markings to the extent practical. Cracking in some PCCP roundabouts has been a problem, particularly around the outside of the circulatory roadway near outside curbs or splitter islands.

This issue may be solved by isolating the circulatory roadway portion with an expansion joint and constructing special monolithic sections in key areas on the approaches and around splitter islands. By laying out the joints



3. In the circulatory roadway, add “transverse” joints radiating out from the center of the circle. Extend these joints through the back of the curb and gutter.
4. On the approaches, add transverse joints at all locations where a width change occurs in the pavement (at bullnose of splitter islands, beginning ending of curves, tapers, tangents, curb returns, etc.). Extend these joints through the back of the curb and gutter.
5. Add transverse joints beyond and between those added in Step 4. Space joints out evenly between other joints, making sure to not violate maximum joint spacing.
6. Make adjustments for in-pavement objects and fixtures, and to eliminate L-shapes, small triangular slabs, etc.

The ACPA recommends consideration of the following when preparing a jointing plan for a roundabout:

- Match existing joints/cracks wherever possible
- Place joints to meet in-pavement structures
- Remember maximum joint spacing:
  - 24 times concrete thickness (on unstabilized base)
  - 21 times concrete thickness (on stabilized base)
  - Maximum of 15 feet for streets and highways
- Understand that practical adjustments can be made to joint locations

Similarly, the ACPA recommends avoiding the following:

- Slabs less than 1 foot wide
- Slabs greater than 15 feet wide
- Angles less than 60 degrees (~90 degrees is best) – do this by dog-legging joints through curve radius points
- Creating interior corners (L-shaped slabs)
- Odd shapes (keep slabs square or pie-shaped)

#### *6.6.2.1 Jointing Patterns and Roundabout Expansion*

As noted in Chapter 3, a roundabout may be built as a single-lane roundabout with plans for expansion in the future, if appropriate based on projected traffic volumes. However, because concrete jointing can be mistaken for striping, the jointing plans established for the opening-year roundabout should be reasonably compatible with plans for the ultimate roundabout configuration.

## **6.7 CURBING**

Curbing should be provided on the outside edge of all roundabouts and approach legs. These outside curbs should be KDOT’s standard 6-inch curb, as seen in Exhibit 6-50. Outside curbing provides positive guidance, tightens entry speeds, and prevents parking in the roundabout. The vertical clearance for

vehicles should be analyzed to so that the curbing design can accommodate vehicles expected to use the roundabout.

The truck apron should be a 3-inch curb with a radius, and the central island may be a 6-inch or 8-inch curb, as seen in Exhibit 6-51. The preferred curbing design for the roundabout truck apron is provided in Exhibit 6-52.



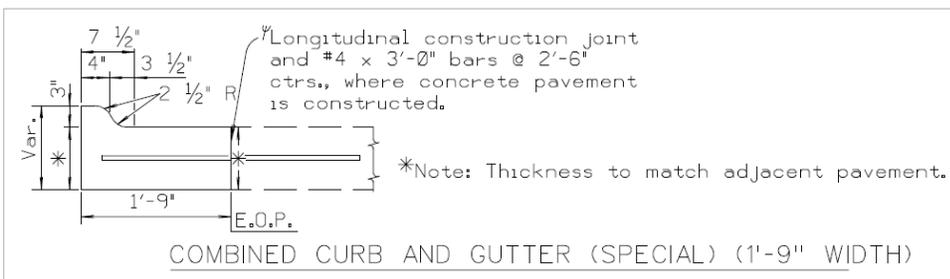
Courtesy of the City of Overland Park

**Exhibit 6-50**  
**Outside Curbing Shown at the**  
**West 161st Terrace/West 163rd**  
**Street/Flint Street Roundabout in**  
**Overland Park, Kansas**



Courtesy of the City of Overland Park

**Exhibit 6-51**  
**Truck Apron Curbing at the**  
**Intersection of Renner**  
**Boulevard/Bass Pro Drive in**  
**Olathe, Kansas**



Kansas Department of Transportation

**Exhibit 6-52**  
**KDOT Truck Apron**  
**Curbing Design**

## 6.8 REFERENCES

1. Rodegerdts, L., J. Bansen, C. Tiesler, J. Knudsen, E. Myers, M. Johnson, M. Moule, B. Persaud, C. Lyon, S. Hallmark, H. Isebrands, R. B. Crown, B. Guichet, and A. O'Brien. *NCHRP Report 672: Roundabouts: An Informational Guide, 2nd ed.* Transportation Research Board of the National Academies, Washington, D.C., 2010.
2. American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets, 6th Edition.* American Association of State Highway and Transportation Officials, Washington D.C., 2011.
3. Department of Justice. "2010 ADA Standards for Accessible Design." <http://www.ada.gov>.
4. United States Access Board. "Part 1190 –Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way." <http://www.access-board.gov>.
5. Federal Highway Administration. *Manual on Uniform Traffic Control Devices.* 2009.
6. Schroeder, B., R. Hughes, N. Roupail, C. Cunningham, K. Salamti, R. Long, D. Guth, R. W. Emerson, D. Kim, J. Barlow, B. L. Bentzen, L. Rodegerdts, and E. Myers. *NCHRP Report 674: Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities.* Transportation Research Board of the National Academies, Washington, D.C., 2011.
7. American Association of State Highway and Transportation Officials. *Guide for Development of Bicycle Facilities.* Washington, D.C., 1991.
8. <http://www.ksdot.org/burtrafficing/ktc/information/SuperloadAnalysisInformation.asp>. Accessed December 2011.
9. Anderson, Carla P., and Thalmann, Todd, W. "Roundabouts – Do you want to Supersize that?" Kansas Department of Transportation and TranSystems. July 2012.
10. Owen, Kelli. "A Roundabout's 11th hour surprise – a 112 ft – 12 Axle Lowboy." Reid Middleton. 2011 TRB Roundabout Conference. May 19, 2011
11. American Concrete Paving Association. Research & Technology Update No. 6.03: Concrete Roundabouts 6.03

# **Chapter 7**

## **Application of Traffic Control Devices**

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**CHAPTER 7**  
**APPLICATION OF TRAFFIC CONTROL DEVICES**

**CONTENTS**

**Chapter 7 Application of Traffic Control Devices ..... 1**

7.1 Pavement Markings ..... 1

    7.1.1 Roundabout Approach ..... 1

    7.1.2 Multilane Considerations ..... 2

    7.1.3 Lane-Use Arrow Pavement Markings ..... 2

7.2 Signing ..... 3

    7.2.1 Roundabout Ahead Sign ..... 4

    7.2.2 Diagrammatic Sign ..... 5

7.3 References ..... 5

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**LIST OF EXHIBITS**

Exhibit 7-1 Pavement Markings for Typical Approach ..... 1

Exhibit 7-2 Typical Two-Lane Roundabout Markings ..... 2

Exhibit 7-3 Fish Hook Lane Use Arrow Pavement Markings ..... 3

Exhibit 7-4 Roundabout Signing Plan at the Intersection of US-75/K-31/K-268  
in Osage County, Kansas..... 4

Exhibit 7-5 Roundabout Assembly Signage ..... 4

Exhibit 7-6 Roundabout Diagrammatic Sign at the Intersection of Old Kansas  
City Road/Hedge Lane/K-68 in Paola, KS..... 5

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## CHAPTER 7 APPLICATION OF TRAFFIC CONTROL DEVICES

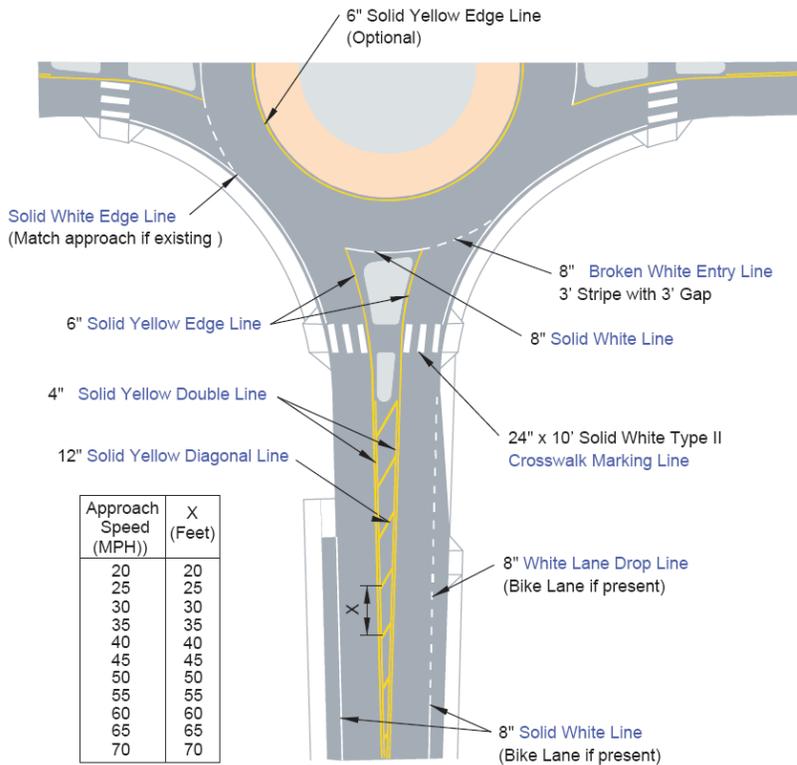
This chapter provides guidance on traffic control devices unique to Kansas roundabouts. It is intended to supplement guidance in Chapter 7 of NCHRP Report 672 (1) and the 2009 *Manual on Uniform Traffic Control Devices* (MUTCD) (2). Specific guidance on Kansas practices for signing and striping can be obtained from KDOT. The guidance in this chapter reflects the requirements and best guidance at the time of publication.

### 7.1 PAVEMENT MARKINGS

This section provides guidance on the appropriate pavement markings to be used at roundabouts. While KDOT has its own pavement marking standards for roundabouts, for the most part, KDOT’s standards follow the guidance provided in Chapter 3C of the MUTCD (2). Additional Kansas specific guidance is provided below.

#### 7.1.1 Roundabout Approach

Exhibit 7-1 displays an example of typical markings for approach roadways at a roundabout. In general, markings are consistent with the MUTCD. However, yield lines (see MUTCD Section 3B.16) are not used by KDOT on the Kansas State Highway System, although they are found at roundabouts in local jurisdictions. Wide-dotted, white lane line extensions of circulatory roadway edge lines should be used at all roundabout entries. These should be 12 inches wide with a 3-ft stripe and a 3-ft gap.



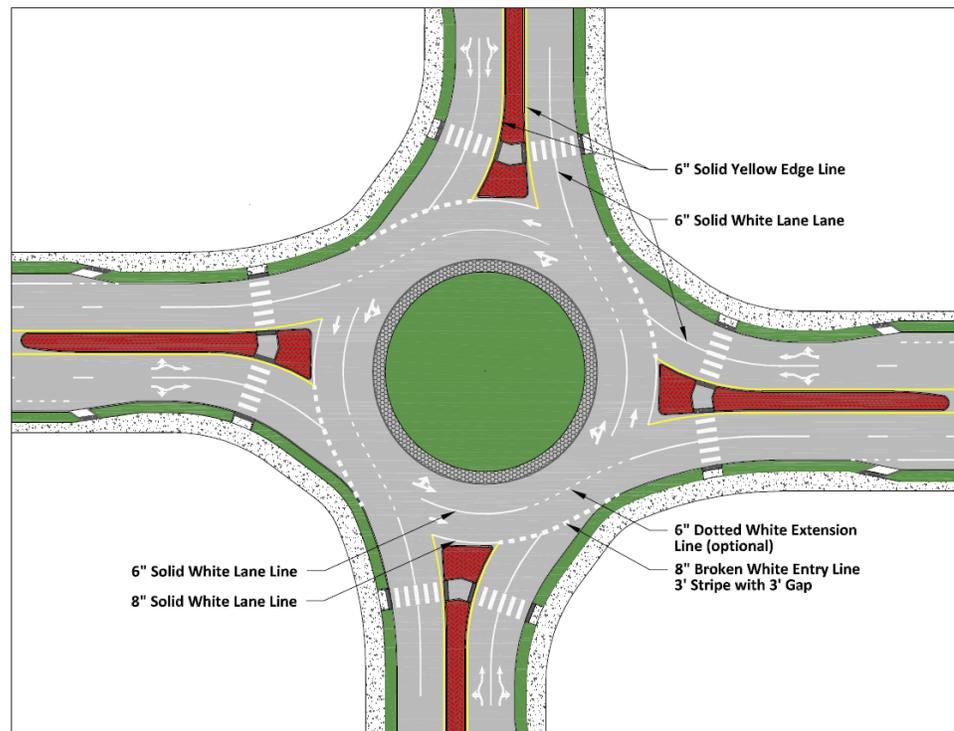
Kansas Department of Transportation

**Exhibit 7-1  
Pavement Markings for Typical Approach**

### 7.1.2 Multilane Considerations

As stated in the MUTCD, “markings on the approaches to a roundabout and on the circular roadway should be compatible with each other to provide a consistent message to road users and should facilitate movement through the roundabout such that vehicles do not have to change lanes within the circulatory roadway in order to exit the roundabout in a given direction” (2). Multilane roundabouts should have lane line markings within the circulatory roadway to channelize traffic to the appropriate exit lane. A dotted lane line should be provided at locations where entering vehicles cross a circulatory roadway lane line. Exhibit 7-2 displays the typical roadway markings used on two-lane Kansas roundabouts. In addition to the markings shown, turn arrows should also be provided on the circulatory roadway.

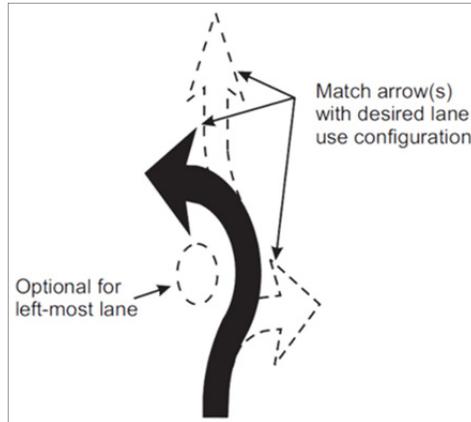
**Exhibit 7-2**  
**Typical Two-Lane Roundabout**  
**Markings**



Adaptation by Kittelson & Associates, Inc. of KDOT Figure

### 7.1.3 Lane-Use Arrow Pavement Markings

Where lane use arrow pavement markings are used at roundabout approaches, KDOT prefers the use of the fish hook arrow, as seen in Exhibit 7-3.



Source: MUTCD, Figure 3C-2 (2)

**Exhibit 7-3**  
**Fish Hook Lane Use Arrow**  
**Pavement Markings**

## 7.2 SIGNING

Similar to other intersection control types, signage at roundabouts is intended to “enhance and support driver expectations” (1). Signs should be visible to drivers without obstructing other users (i.e. pedestrians or bicyclists). KDOT provides guidance on appropriate signing for the following scenarios:

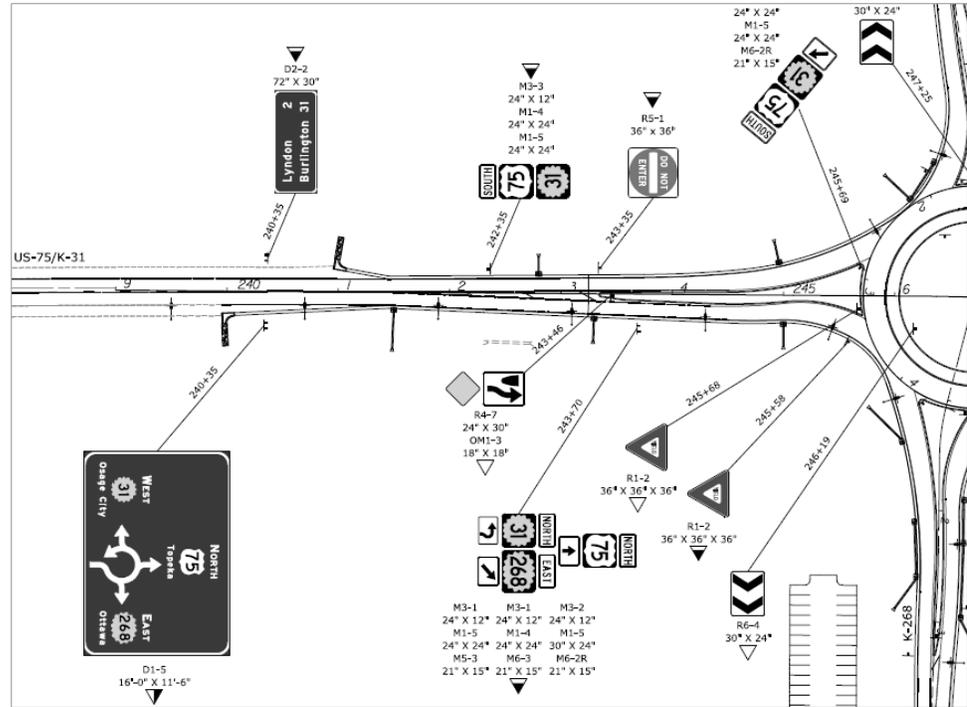
- Sign placement at typical roundabout
- Typical sign placement at splitter island
- Typical sign placement at central island
- Installation details for transverse rumble strips on roundabout approach
- Roundabout at highway/local road intersection
- Supplemental destination signage
- Signage at highway junction

In addition, Chapter 2 of the MUTCD provides guidance on the size and placement of roundabout signs. Some specific KDOT recommendations not found in the MUTCD include:

- Yield signs should be provided on both sides of the approaches (typically, yield signs will be used on both sides of a multilane entry approach, and only one side of a single-lane entry approach).
- A Do Not Enter (R5-1) sign should be placed downstream of the roundabout on the exit approach to alert approach traffic not to enter. In addition, a Two Way Traffic (W6-3) sign should be provided for exiting traffic.
- A diagonal up arrow (M6-2R) instead of a right turn bent arrow (M5-1R) should be used to indicate a right-turn movement for an approach.

Signing plans from a proposed roundabout in Lyndon, Kansas at the intersection of US-75/K-268/K-31 are provided in Appendix D and shown in Exhibit 7-4 as an example of appropriate signage for a rural roundabout. Additional Kansas specific guidance for roundabout signage is provided in the following sections.

**Exhibit 7-4**  
**Roundabout Signing Plan at the**  
**Intersection of US-75/K-31/K-268**  
**in Osage County, Kansas**

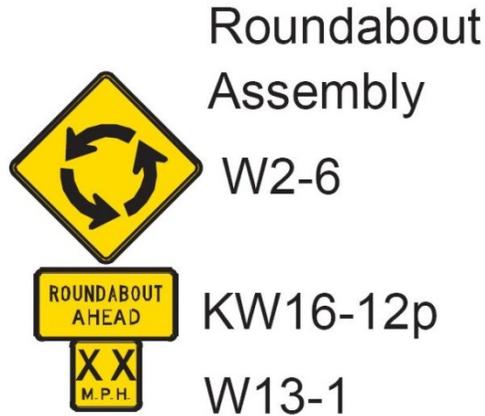


Kansas Department of Transportation

**7.2.1 Roundabout Ahead Sign**

The Circular Intersection (W2-6) symbol sign may be installed in advance of a roundabout. An educational plaque with the label “ROUNDABOUT AHEAD” (KW16-12P) and an advisory speed plaque (W13-1), as seen in Exhibit 7-5, should be mounted below the Circular Intersection symbol sign. The signs should be used on approaches with statutory or posted speed limits of 40 mph or higher.

**Exhibit 7-5**  
**Roundabout Assembly Signage**



Kansas Department of Transportation

### 7.2.2 Diagrammatic Sign

A diagrammatic sign, as shown in Exhibit 7-6, may be used at rural roundabouts with sufficient right of way to indicate the upcoming roundabout and to provide directional guidance. In general, diagrammatic signs are not necessary for urban roundabouts. However, a diagrammatic sign may be appropriate at an urban intersection with any of the following conditions:

- The intersection is the junction of two major highway routes.
- The signed highway route makes a bend through the roundabout.
- The intersection layout or signed route configuration is potentially confusing to unfamiliar drivers.
- Sufficient right-of-way is available to appropriately locate the sign without intruding on pedestrian spaces.
- The sign can be located in a way that does not significantly add to sign clutter.



Courtesy of the City of Overland Park

**Exhibit 7-6**  
**Roundabout Diagrammatic Sign**  
 at the Intersection of Old Kansas  
 City Road/Hedge Lane/K-68 in  
 Paola, KS

The diagrammatic sign serves as a guide sign, and therefore a Roundabout Ahead sign and Yield Ahead (where needed) sign should be provided in addition to the diagrammatic sign.

### 7.3 REFERENCES

1. Rodegerdts, L., J. Bansen, C. Tiesler, J. Knudsen, E. Myers, M. Johnson, M. Moule, B. Persaud, C. Lyon, S. Hallmark, H. Isebrands, R. B. Crown, B. Guichet, and A. O'Brien. NCHRP Report 672: *Roundabouts: An Informational Guide, 2nd ed.* Transportation Research Board of the National Academies, Washington, D.C., 2010.
2. Federal Highway Administration. *Manual on Uniform Traffic Control Devices.* 2009.

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# **Chapter 8**

## **Illumination**

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**CHAPTER 8  
ILLUMINATION**

**CONTENTS**

**Chapter 8 Illumination ..... 1**

    8.1 General Requirements ..... 1

    8.2 Lighting Levels ..... 1

    8.3 Equipment Type and Location ..... 3

    8.4 Temporary Lighting ..... 5

    8.5 References ..... 5

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**LIST OF EXHIBITS**

Exhibit 8-1 Recommended Illuminance for the Intersection of Continuously Lighted Urban and Suburban Streets..... 2

Exhibit 8-2 Recommended Illuminance for the Intersection of Unlit Rural Roadways..... 3

Exhibit 8-3 Roundabout Illuminated at Night at the Intersection of 110th Street/Lamar Avenue in Overland Park, Kansas..... 3

Exhibit 8-4 Critical Conflict Areas Affecting Pole Placement ..... 4

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## CHAPTER 8 ILLUMINATION

Adequate lighting should be provided at all roundabouts to help users identify the layout and operations of the roundabout and safely proceed through the intersection. The recommended type, placement, and layout of lighting vary based on the location and roadway characteristics of the roundabout. This section provides guidance primarily from Chapter 8 *Illumination* of NCHRP Report 672 (1), which is based heavily on the *Design Guide for Roundabout Lighting*, published by the Illuminating Engineering Society (IES) (2). The AASHTO publication *Roadway Lighting Design Guide* (3) also provides guidance on roundabout lighting.

### 8.1 GENERAL REQUIREMENTS

Lighting should be provided at all roundabouts, whether in rural or urban settings, and shall be provided for all roundabouts on the Kansas state highway system. The purpose of roundabout lighting, according to NCHRP Report 672, is to both “provide visibility from a distance for users approaching the roundabout” and “provide visibility of the key conflict areas to improve users’ perception of the layout and visibility of other users within the roundabout” (1). Adequate lighting is particularly important at roundabouts compared to more conventional intersection types because roundabouts introduce geometry and channelization a driver might not expect. In addition, the effectiveness of most vehicular headlights at a roundabout is limited due to the constrained curve radius (1).

KDOT prefers lighting along the perimeter of the roundabout to emphasize the circular aspects of the roundabout. *Section 8.2 General Considerations* of NCHRP Report 672 lists additional recommended features for roundabout lighting (1).

### 8.2 LIGHTING LEVELS

Kansas does not have its own guidelines for illuminance levels, but recommends the IES guide be used for both urban and rural roundabouts. The basic principle behind the lighting of roundabouts in urban and suburban areas is that the amount of light on the intersection should be proportional to the functional classification of the intersecting streets and equal to the sum of the values used for each separate street. In other words, if Street A is illuminated at a level of  $x$  and Street B is illuminated at a level of  $y$ , the intersection should be illuminated at a level of  $x + y$ . In addition, the IES guide specifies that if an intersecting roadway is illuminated above the recommended value, then the intersection illuminance value should be proportionately increased. Therefore, the illumination design for a roundabout in an urban or suburban area should be designed to properly illuminate the roundabout while being compatible with the illumination levels on approaching roadways.

Exhibit 8-1 presents the recommended illuminance for roundabouts located on continuously illuminated streets. Separate values have been provided for Portland cement concrete road surfaces (Road Surface Classification R1) and

typical asphalt road surfaces (Road Surface Classification R2/R3). Note that the predominant surface type should be used for illumination calculations; for example, a roundabout with an asphalt concrete circulatory roadway and Portland cement concrete truck apron should be designed using a surface type of R2/R3.

**Exhibit 8-1**  
**Recommended Illuminance for**  
**the Intersection of**  
**Continuously Lighted Urban**  
**and Suburban Streets**

Pavement Classification	Functional Classification	Maintained Average Horizontal Illuminance on the Pavement Based on Pedestrian Area Classification			E <sub>avg</sub> /E <sub>min</sub>
		High	Medium	Low	
R1	Major/Major	3.4 fc (34.0 lux)	2.6 fc (26.0 lux)	1.8 fc (18.0 lux)	3:1
	Major/Collector	2.9 fc (29.0 lux)	2.2 fc (22.0 lux)	1.5 fc (15.0 lux)	3:1
	Major/Local	2.6 fc (26.0 lux)	2.0 fc (20.0 lux)	1.3 fc (13.0 lux)	3:1
	Collector/Collector	2.4 fc (24.0 lux)	1.8 fc (18.0 lux)	1.2 fc (12.0 lux)	4:1
	Collector/Local	2.1 fc (21.0 lux)	1.6 fc (16.0 lux)	1.0 fc (10.0 lux)	4:1
	Local/Local	1.8 fc (18.0 lux)	1.4 fc (14.0 lux)	0.8 fc (8.0 lux)	6:1
R2/R3	Major/Major	3.4 fc (34.0 lux)	2.6 fc (26.0 lux)	1.8 fc (18.0 lux)	3:1
	Major/Collector	2.9 fc (29.0 lux)	2.2 fc (22.0 lux)	1.5 fc (15.0 lux)	3:1
	Major/Local	2.6 fc (26.0 lux)	2.0 fc (20.0 lux)	1.3 fc (13.0 lux)	3:1
	Collector/Collector	2.4 fc (24.0 lux)	1.8 fc (18.0 lux)	1.2 fc (12.0 lux)	4:1
	Collector/Local	2.1 fc (21.0 lux)	1.6 fc (16.0 lux)	1.0 fc (10.0 lux)	4:1
	Local/Local	1.8 fc (18.0 lux)	1.4 fc (14.0 lux)	0.8 fc (8.0 lux)	6:1

**Major** = Roadway system that serves as the principal network for through traffic flow.

**Collector** = Roadway servicing traffic between major and local streets.

**Local** = Streets primarily for direct access to residential, commercial, industrial, and other abutting property.

**High** = Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the streets during the hours of darkness. Over 100 pedestrians during the average annual peak hour of darkness, typically 18:00 to 19:00 hours.

**Medium** = Areas where lesser numbers of pedestrians use the streets at night. Between 11 and 100 pedestrians during the average annual peak hour of darkness, typically 18:00 to 19:00 hours.

**Low** = Areas with low volumes of nighttime pedestrian usage. Less than 11 pedestrians during the average annual peak hour of darkness, typically 18:00 to 19:00 hours.

**Note:** Use values for local/local functional classification if roundabout is located on roadway without continuous lighting.

Adapted from IES *Design Guide for Roundabout Lighting (2)*

Exhibit 8-2 provides recommended illuminance levels for rural isolated intersections with unlit approaches.

Pavement Classification	Average Maintained Illuminance at Pavement	Uniformity Ratio (Eavg/Emin)	Veiling Luminance Ratio (Lvmax/Lavg)
R1	0.6 fc (6.0 lux)	4.0	0.3
R2/R3	0.9 fc (9.0 lux)	4.0	0.3

IES American National Standard Practice for Roadway Lighting

**Exhibit 8-2**  
Recommended Illuminance for the Intersection of Unlit Rural Roadways

### 8.3 EQUIPMENT TYPE AND LOCATION

A photometric analysis is required to determine the appropriate lighting equipment and pole locations. *Section 8.4 Equipment Type and Location* of NCHRP Report 672 provides guidance on different types of illumination equipment and pole locations and provides examples of illumination plans that demonstrate the various types of lighting assemblies. The advantages and disadvantage associated with perimeter and central illumination are detailed in *Section 8.4.2 Pole Locations* of NCHRP Report 672 (1). The IES guide recommends that lighting be placed around the perimeter of the roundabout and on the approach side of the crosswalks to provide the most visibility within the key conflict areas (2). Exhibit 8-3 shows a roundabout with perimeter lighting.



Courtesy of the City of Overland Park

**Exhibit 8-3**  
Roundabout Illuminated at Night at the Intersection of 110th Street/Lamar Avenue in Overland Park, Kansas

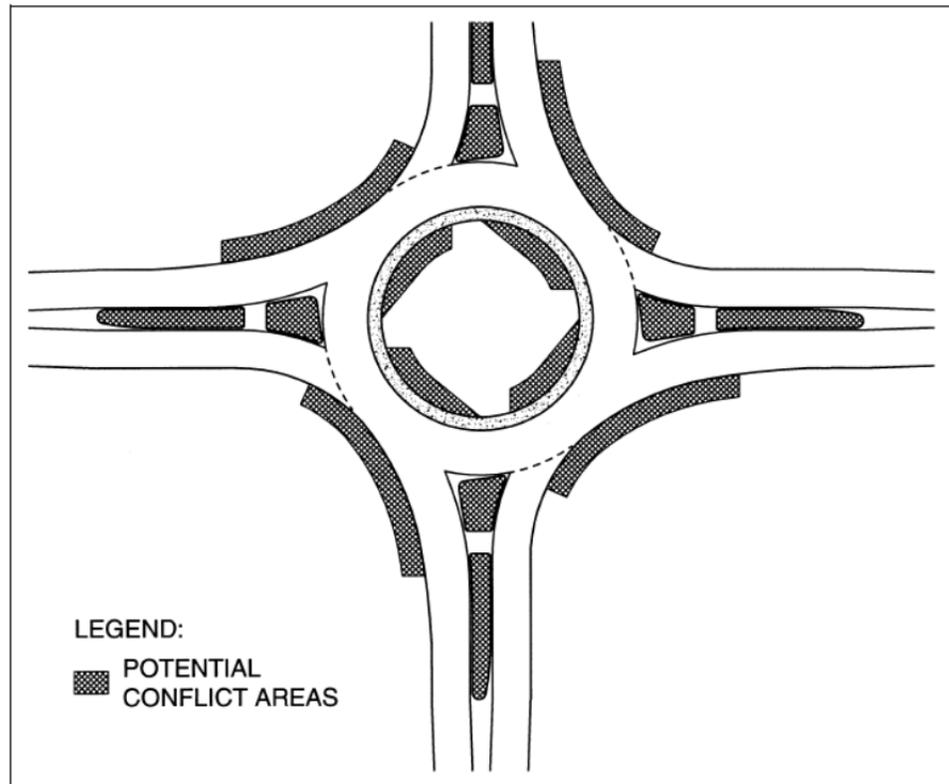
The position of lighting poles relative to the curbs at a roundabout is governed in part by the speed environment in which the roundabout is located and the potential speeds of errant vehicles that can be reasonably expected. In rural areas, KDOT prefers locating light poles at least 2 feet from the edge of the shoulder, or at least 8 feet from the edge of pavement in the absence of a shoulder. A generous setback may be preferred in cases where large loads are

expected. Additional guidance is provided in the AASHTO *Roadside Design Guide* (5).

For installations on urban arterials, collectors, and local streets where curbs are used, the clearance between the curb face and lighting pole should be a minimum of 2 feet, with additional separation desirable. KDOT prefers poles to be 6 to 8 feet behind the curb in urban areas. Although the lighting poles shown in Exhibit 8-3 meet this clearance, it would be preferable to place the poles farther from the curb face (i.e., set behind the sidewalk). For areas within or on the approach to a roundabout where the overhang of a turning truck could strike a lighting pole, a minimum offset distance of 3 feet should be provided (6).

Exhibit 8-4 suggests critical conflict areas where run-off-the-road crashes are most prevalent at roundabouts. In these areas, lighting poles should be placed as far back from the curb face as practical. In rural areas where pedestrian activity is low, breakaway pole bases are required for poles located in these critical areas.

**Exhibit 8-4**  
**Critical Conflict Areas Affecting**  
**Pole Placement**



Kansas Department of Transportation

The KDOT Utility Accommodation Policy (7) provides requirements pertaining to the placement of lighting facilities within the public right-of-way. This policy applies to the location, construction, maintenance, removal, and relocation of all private, public, and cooperatively owned utilities within the highway rights-of-way under the jurisdiction of the Secretary of the Kansas Department of Transportation.

## 8.4 TEMPORARY LIGHTING

Lighting should be installed and operational before the roundabout is open to traffic. If permanent lighting cannot be installed to meet construction schedules, temporary lighting will be allowed by KDOT. If any portion of the roundabout is opened to traffic during any stage of construction, lighting (either temporary or permanent) must be installed and operational prior to allowing traffic through the roundabout.

## 8.5 REFERENCES

1. Rodegerdts, L., J. Bansen, C. Tiesler, J. Knudsen, E. Myers, M. Johnson, M. Moule, B. Persaud, C. Lyon, S. Hallmark, H. Isebrands, R. B. Crown, B. Guichet, and A. O'Brien. NCHRP Report 672: *Roundabouts: An Informational Guide, 2nd ed.* Transportation Research Board of the National Academies, Washington, D.C., 2010.
2. Illuminating Engineering Society (IES). *Design Guide for Roundabout Lighting*. Publication IES DG-19-08. Illuminating Engineering Society of North America, New York, February 2008.
3. American Association of State Highway and Transportation Officials. *Roadway Lighting Design Guide*. Washington, D.C.: AASHTO, 2005.
4. IES. *American National Standard Practice for Roadway Lighting*. Standard RP-8-00. New York, 2005.
5. American Association of State Highway and Transportation Officials. *Roadside Design Guide*. Washington, D.C., 2011.
6. American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets*. Washington, D.C., 2011.
7. KDOT Utility Accommodation Policy. 2007.

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# **Chapter 9**

## **Landscaping**

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**CHAPTER 9  
LANDSCAPING**

**CONTENTS**

**Chapter 9 Landscaping.....1**

    9.1 Central Island Landscaping ..... 1

    9.2 Central island Art ..... 3

    9.3 Splitter Island and Approach Landscaping..... 4

    9.4 Gateway Treatments ..... 5

    9.5 Maintenance ..... 6

    9.6 References ..... 6

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**LIST OF EXHIBITS**

Exhibit 9-1 Central Island Landscaping Visible from the Roundabout Approach at the Intersection of 133<sup>rd</sup> Street/Lamar Avenue in Overland Park, Kansas..... 1

Exhibit 9-2 Central Island Landscaping; Profile ..... 2

Exhibit 9-3 Example Sight Distance Diagram..... 2

Exhibit 9-4 Central Island Landscaping at the Intersection of Prairie Star Parkway/ Monticello Road in Lenexa, Kansas..... 3

Exhibit 9-5 Roundabout with Public Art in the Central Island at the Intersection of West 141st Street/Bluejacket Street in Overland Park, Kansas..... 4

Exhibit 9-6 Splitter Island with Colored Concrete at the Intersection of East Kansas City Road/ North Nelson Road/North Church Street in Olathe, Kansas ..... 4

Exhibit 9-7 Splitter Island with Low Plant Growth at the Intersection of Prairie Star Parkway/ Monticello Road in Lenexa, Kansas..... 5

Exhibit 9-8 Roundabout as Gateway Treatment for the Overland Park Convention Center at the Intersection of Lamar Avenue/West 110<sup>th</sup> Street in Overland Park, Kansas ..... 6

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## CHAPTER 9 LANDSCAPING

The use of landscaping at a roundabout is one of the distinguishing features that give roundabouts an aesthetic advantage over traditional intersections. The type and quantity of landscaping plantings or other material incorporated into the roundabout design may be dependent on both the site location and level of care available for maintenance. This section discusses various landscaping opportunities at a roundabout and provides guidance on appropriate design and maintenance.

### 9.1 CENTRAL ISLAND LANDSCAPING

Landscaping within the central island provides both safety and aesthetic enhancements for the intersection. The inner portion of the central island may be planted with trees, bushes, and other large items. These plantings help to make the central island more conspicuous by creating a terminal vista in which the line of sight straight through the roundabout is partially obscured, as seen in Exhibit 9-1. This clearly indicates to the driver that they cannot pass straight through the intersection and helps to make the central island more visible at night when the vehicle headlights illuminate the landscaping.

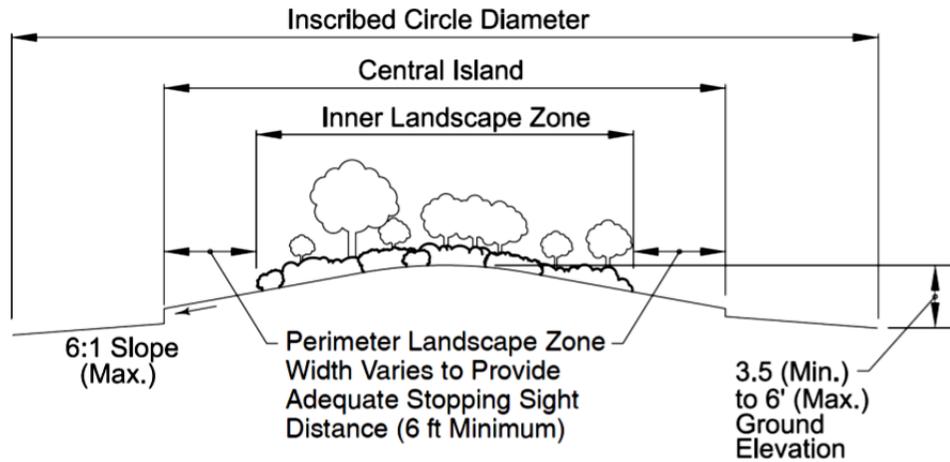


Courtesy of the City of Overland Park

As seen in Exhibit 9-2, there are two potential landscape zones in the central island: the perimeter landscape zone and the inner landscape zone. Each is described below.

**Exhibit 9-1**  
**Central Island Landscaping**  
**Visible from the Roundabout**  
**Approach at the Intersection of**  
**133<sup>rd</sup> Street/Lamar Avenue in**  
**Overland Park, Kansas**

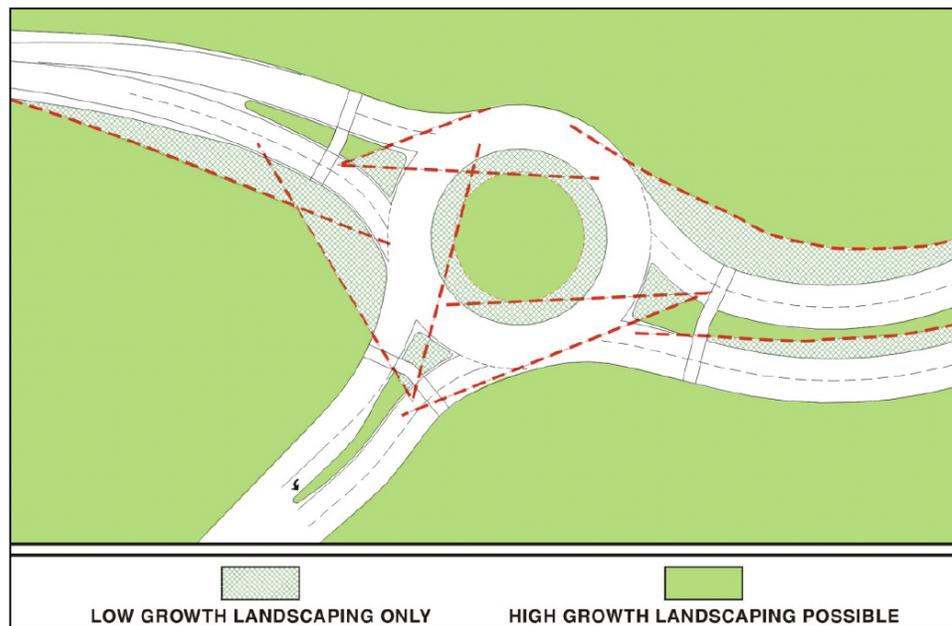
**Exhibit 9-2**  
Central Island Landscaping;  
Profile



Adapted from NCHRP Report 672

Exhibit 9-3 shows an example of how sight distance dictates the types of landscaping recommended at a roundabout. The perimeter of the central island should be landscaped with low-lying shrubs, grass, or groundcover so that stopping sight distance requirements, as discussed in Chapter 6, are maintained for vehicles within the circulatory roadway. This width may vary with the size of the roundabout. Many of the existing Kansas roundabouts have used bark, small rocks, and low growing plants to provide groundcover around the perimeter of the central island and maintain appropriate sight distance. Large, fixed landscaping objects such as trees, poles, large rocks (e.g., boulders), statues, or walls should be avoided in these areas.

**Exhibit 9-3**  
Example Sight Distance  
Diagram



NCHRP Report 672, Exhibit 6-60, (1)

Within the inner landscape zone, shrubs and columnar-growing species of trees may be appropriate. Consideration should be given to the size and shape of the mature plants so as not to block sight lines in the future. Trees with large canopies should be avoided within the central island. In addition, creating a domed or mounded central island can help increase the visibility of the

intersection on the approach (1). If the central island is domed or mounded, it is not as essential to provide or maintain landscaping. In all instances, the slope of the central island should not exceed 6:1 per the requirements of the AASHTO *Roadside Design Guide* (2).

Landscaping within the central island should discourage pedestrian traffic to and through the central island. As such, the design of the central island should avoid use of street furniture such as benches or monuments with small text. A landscape buffer between the sidewalk and the circulatory roadway can be used to provide critical wayfinding boundaries for pedestrians with vision disabilities and help prevent pedestrians from mistakenly crossing to the central island.



Courtesy of the City of Overland Park

*Section 9.3 Central Island Landscaping* of NCHRP Report 672 provides further guidance, including considerations associated with roundabout diameter and the trade-offs associated with landscaping related to aesthetics, operations, and design (1).

## 9.2 CENTRAL ISLAND ART

As an element of landscaping in the central island, art can provide aesthetic and safety benefits. To supplement shrubbery, large objects such as statues, fountains, monuments, and other art can often be desirable features. In some areas, art in the central island can help define the community or acknowledge a local artist. Art should be located outside the sight triangles and in areas unlikely to be struck by errant vehicles. In addition, as noted in NCHRP Report 672, feature such as fountains can generate water spray in windy areas that impact drivers' visibility (1). Exhibit 9-5 provides an example of central island art.

**Exhibit 9-4**  
Central Island Landscaping at the  
Intersection of Prairie Star  
Parkway/ Monticello Road in  
Lenexa, Kansas

**Exhibit 9-5**  
**Roundabout with Public Art in**  
**the Central Island at the**  
**Intersection of West 141st**  
**Street/Bluejacket Street in**  
**Overland Park, Kansas**



Courtesy of the City of Overland Park

### 9.3 SPLITTER ISLAND AND APPROACH LANDSCAPING

When designing landscaping for the splitter islands and along the outside edges of the approach, care should be taken to avoid obstructing sight distance, as splitter islands are usually located within the critical sight triangles (as discussed in Section 6.3.5 of this guide). Landscaping should avoid obscuring the basic shape of the roundabout, or the signing to an approaching driver.

Landscaping on each side of the approaches (where appropriate) can help create a funneling effect and causing a reduction in speeds as vehicles approach the roundabout. Landscaping on the outer edges of the approach and in the corner radii provide sidewalk setbacks that help to channelize pedestrians to the crosswalk areas and discourage pedestrians from crossing to the central island. Landscaping or other detectable treatments between the sidewalk and circulatory roadway provide key wayfinding guidance for pedestrians with vision disabilities.

At existing Kansas roundabouts, splitter islands have often been constructed with either low growth plant material or have simply used a patterned and/or colored concrete or concrete paver surface, as seen in Exhibit 9-6.

**Exhibit 9-6**  
**Splitter Island with Colored**  
**Concrete at the Intersection of**  
**East Kansas City Road/ North**  
**Nelson Road/North Church**  
**Street in Olathe, Kansas**



Courtesy of the City of Overland Park

Where plants are used in the splitter island, low growth plants are preferred, and trees or other tall foliage should not be used. The size of the splitter island and location of the roundabout are several factors to consider in assessing whether or not to provide landscaping within the splitter islands. Exhibit 9-7 illustrates a wide splitter island with patterned concrete and low plant growth.



Courtesy of the City of Overland Park

**Exhibit 9-7**  
**Splitter Island with Low Plant**  
**Growth at the Intersection of**  
**Prairie Star Parkway/ Monticello**  
**Road in Lenexa, Kansas**

At many existing roundabouts in Kansas, grass has typically been used along the outer edge of the roadway and within the corner radii between adjacent legs of the roundabout. Although other plants species may be used, grass typically blends in well with the surrounding streetscapes and requires little or no watering. The main maintenance requirement for planting grass is mowing. In such cases, dwarfed varieties such as “buffalo grass” may have an advantage with their shorter height and less frequent maintenance.

#### **9.4 GATEWAY TREATMENTS**

While most roundabouts address a capacity or safety problem, they can also be used as a part of community enhancement projects. Many communities have recognized this benefit and are using landscaped roundabouts to not only improve intersection performance but to also provide a “gateway” into their community. Such projects are often located in commercial and civic districts as a gateway treatment to convey a change of environment and to encourage traffic to slow down. Exhibit 9-8 shows a roundabout in the City of Overland Park that serves as a gateway to the Overland Park Convention Center.

Roundabouts proposed as gateway treatments often require a less rigorous analysis as a traffic control device. When studying an area where a roundabout is proposed as a gateway treatment, or for aesthetic benefits, the focus should be to demonstrate that the roundabout would not introduce traffic problems that do not currently exist. Particular attention should be paid to complications

**Exhibit 9-8**  
**Roundabout as Gateway**  
**Treatment for the Overland**  
**Park Convention Center at the**  
**Intersection of Lamar**  
**Avenue/West 110<sup>th</sup> Street in**  
**Overland Park, Kansas**

that could induce operational or safety problems. Fixed objects (i.e. trees, poles, walls, statues) can induce safety concerns for errant vehicles. As noted in NCHRP Report 672, the use of fixed objects should be minimized and, if used, “preferably be placed in a location where the geometry of the roundabout deflects approaching vehicles away from the object” (1).



Courtesy of the City of Overland Park

## 9.5 MAINTENANCE

The use of landscaping is preferable in order to enhance operations of the roundabout and provide aesthetic benefits. However, landscaping requires maintenance and upkeep, including watering and drainage, which should be considered in the design of the landscape features. The agency or group responsible for maintaining the landscaping at a roundabout should be identified and a maintenance agreement reached. Agreements may be reached with local civic groups or garden clubs to maintain the roundabout. As suggested in NCHRP Report 672, “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” (1). The use of native plants should be encouraged, where possible.

Additionally, an appropriate water supply and drainage system should be provided for any landscaping features requiring watering. If a sprinkler system is necessary, watering systems with a mist-type spray should be avoided to prevent spray on to windshields.

## 9.6 REFERENCES

1. Rodegerdts, L., J. Bansen, C. Tiesler, J. Knudsen, E. Myers, M. Johnson, M. Moule, B. Persaud, C. Lyon, S. Hallmark, H. Isebrands, R. B. Crown, B. Guichet, and A. O’Brien. NCHRP Report 672: *Roundabouts: An Informational Guide, 2nd ed.* Transportation Research Board of the National Academies, Washington, D.C., 2010.
2. American Association of State Highway and Transportation Officials. *Roadside Design Guide.* Washington, D.C.: AASHTO, 2011.

# **Chapter 10**

## **Construction and Maintenance**

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**CHAPTER 10  
CONSTRUCTION AND MAINTENANCE**

**CONTENTS**

**Chapter 10 Construction and Maintenance .....1**

10.1 General Considerations ..... 1

10.2 Construction Sequencing ..... 1

    10.2.1 No Traffic ..... 2

    10.2.2 Partial Traffic ..... 2

    10.2.3 Full Traffic ..... 3

    10.2.4 Additional Construction Staging Examples..... 4

10.3 Maintenance ..... 5

10.4 References ..... 5

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**LIST OF EXHIBITS**

Exhibit 10-1 Example Temporary Traffic Signal at the Intersection of C Avenue/  
40th Street in Maryville, Iowa..... 3

Exhibit 10-2 Maintenance of Traffic on a Roundabout on Renner Boulevard in  
Lenexa, Kansas ..... 4

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## CHAPTER 10 CONSTRUCTION AND MAINTENANCE

This chapter provides an overview of guidance particular to Kansas on the construction and maintenance of new and existing roundabouts.

### 10.1 GENERAL CONSIDERATIONS

When either constructing a new roundabout or altering an existing roundabout, the following should be considered:

- **Public Education.** Appropriate public education is important to notify the public about changes in traffic patterns and inform them how to respond. *Section 10.2 Public Education* of NCHRP Report 672 provides guidance on techniques for alleviating driver confusion during roundabout construction and provides examples of educational materials (1).
- **Pavement Markings.** Pavement markings used during construction should be the same layout and dimensions as planned for the final design to avoid driver confusion, where possible.
- **Signing.** Permanent roundabout signing should be installed prior to the roundabout becoming operational.
- **Lighting.** As noted in Chapter 8, lighting should be installed and operational before the roundabout is open to traffic. If permanent lighting cannot be installed to meet construction schedules, temporary lighting will be allowed by KDOT. If any portion of the roundabout is opened to traffic during any stage of construction, KDOT requires lighting (either temporary or permanent) be installed and operational prior to allowing traffic through the roundabout.
- **Coordination.** Proper coordination between the designer, inspector, and construction team enables a roundabout to be built as intended; any deviations from the plans are fully discussed and understood. Additionally, coordination with the local utility company can identify equipment needs and potential conflicts with existing utilities.
- **Construction Sequencing.** Proper staging of construction can minimize driver confusion, construction time, and costs. This is discussed further in the following section.

### 10.2 CONSTRUCTION SEQUENCING

Traffic control plans for roundabout construction or maintenance are likely to vary based on the surrounding conditions. Availability of viable detour routes, the scope and magnitude of the construction or maintenance, costs, and local context will be key considerations for determining what approach is most practical and prudent. In general, minimizing staging and limiting traffic at the roundabout site during construction and maintenance will improve worker safety and minimize construction time and costs. These benefits must be balanced against the inconvenience to the traveling public and the duration and

distance of potential detours. Each situation has different circumstances and limitations, and a one-size-fits-all approach should therefore be avoided.

A roundabout traffic control plan for the maintenance and protection of traffic during construction can be conducted under three types of conditions:

- Under no traffic (full detour)
- Under partial traffic (detour minor street)
- Under full traffic

The following sections discuss each scenario and provide examples of construction staging plans.

### **10.2.1 NO TRAFFIC**

Conducting certain roundabout maintenance and construction with no traffic is highly desirable given the significant reductions in costs, duration of construction, and increased safety for workers. A single temporary detour condition can also be less confusing to the driving public than a multi-stage approach. In addition, constructing a roundabout under no traffic can often result in a better finished product.

One option for detouring traffic is a shoofly, or temporary roadway. The shoofly can be designed to remain as a permanent feature after the roundabout is open to accommodate OSOW vehicles, as described in Section 6.5.2.1.1. Once the roundabout is reopened to traffic, measures such as gates, landscaping, or signs can be used to prevent drivers from using the shoofly. The roundabout at US-400/K-66 used a shoofly diversion in order to construct the roundabout in a single phase. Traffic control plans for the roundabout are provided in Appendix B.

### **10.2.2 PARTIAL TRAFFIC**

It is often infeasible to close all approaches to an intersection during construction of a roundabout. This is true in at least two cases: (1) the surrounding transportation system does not lend itself well to one or more viable detour routes, and (2) the duration or complexity of the required maintenance or rehabilitation will require too much time to be considered reasonable. The function of the approaching roadways themselves may also restrict the ability to close a particular route to traffic (emergency route, major arterial, etc.). Even under partial traffic detours, it may be necessary to detour truck traffic to allow construction of features such as truck aprons.

Exhibit 10-1 shows a picture of a roundabout approach in Maryville, Iowa, (intersection of C Avenue and 40<sup>th</sup> Street) where half of a roundabout was closed to retrofit curbs. Temporary signals were used to control traffic through the roundabout.



Courtesy of the Iowa Department of Transportation

**Exhibit 10-1**  
**Example Temporary Traffic Signal**  
**at the Intersection of C Avenue/  
40th Street in Maryville, Iowa**

Exhibit 10-3 of NCHRP Report 672 also provides an example of roundabout construction under partial traffic that maintained traffic flow on the major roadway with the use of temporary roadways (1). Construction of temporary roadways may not be cost effective unless the amount of maintenance/rehabilitation being performed is sizable and other approaches (full closure to traffic or maintaining full traffic) is even costlier.

### **10.2.3 FULL TRAFFIC**

Construction or maintenance of a roundabout under full traffic requires additional consideration of intersection conflicts. Certain intersection conflicts may require flagging or other labor-intensive monitoring or control. Traffic should not be allowed to run contraflow during a construction phase, if at all possible. Allowing drivers to drive opposite the final direction of travel may instill poor driving habits. In general, temporary signing and striping costs that accompany this approach may also be higher. Consideration must also be given to the work zone area itself and how traffic will operate during nighttime hours when active construction or traffic control (such as flaggers) are not present. In addition, detouring of truck traffic may be necessary even if no legs can be restricted to automobile traffic. Exhibit 10-2 shows a roundabout undergoing reconstruction while traffic is maintained.

**Exhibit 10-2**  
**Maintenance of Traffic on a**  
**Roundabout on Renner**  
**Boulevard in Lenexa, Kansas**



Courtesy of the City of Overland Park

#### **10.2.4 ADDITIONAL CONSTRUCTION STAGING EXAMPLES**

Exhibit 10-3 of NCHRP Report 672 (1) provides an example of roundabout construction under partial traffic. Additional examples of traffic control plans for construction illustrating a range of approaches and methods are provided in the appendices. Each example is briefly summarized below.

- A. US-77/US-166 Roundabout – Arkansas City, Kansas.** This roundabout was constructed in a single phase using detours to close the subject intersection entirely to traffic. The availability of reasonable detour routes in the immediate vicinity of the roundabout location supported this approach. Appendix E contains the traffic control plans for this roundabout.
- B. US-400/K-47 Roundabout – Fredonia, Kansas.** This roundabout was constructed in several phases while maintaining full traffic on the roadways. Offsetting the roundabout from the existing intersection location facilitated this approach and also provided the opportunity to create geometric deflection and speed control on the roundabout approaches. Appendix F contains the traffic control plans for this roundabout.
- C. US-75/K-31/K-268 Roundabout – Osage County, Kansas.** This proposed single-lane roundabout was constructed in four phases, with shoo-fly bypass roads constructed in the first phase that allowed the maintenance of full traffic on the roadways while the roundabout was constructed. Appendix G contains the traffic control plans for this roundabout.
- D. K-7/Johnson Drive/55<sup>th</sup> Street Interchange Roundabout – Shawnee, Kansas.** This multilane interchange roundabout was constructed in several phases with partial closures and sequenced detour routes put in place to allow property access. Appendix H contains the traffic control plans for this roundabout.

- E. **K-18/Scenic Drive Roundabout – Riley County, Kansas.** This roundabout interchange project used a combination of lane reductions, shoo-fly bypass roads, and detours during construction. Appendix I contains the traffic control plans for this roundabout.

### 10.3 MAINTENANCE

As noted in Chapter 3 of this guide, the maintenance costs associated with a roundabout are typically more than that of a stop-controlled intersection but less than for a signal. Maintenance requirements for a roundabout include landscaping maintenance (as discussed in Chapter 9), snow removal, and routine pavement maintenance.

Snow needs to be removed from the roundabout truck apron and circulatory roadway. As identified in NCHRP Report 672, one of the biggest problems associated with snow removal at roundabouts is locating the raised truck apron and other curb locations after a heavy snowfall (1). The apron and curbs can be damaged if care is not taken to identify their locations. One common method for snow removal is for one truck to start on the truck apron and plow around the roundabout to the outside while a second truck plows each entry and exit, pushing snow to the outside. Consideration should also be given to where the removed snow is stored, so as not to create sight obstructions or affect pedestrian access. In addition, pavement should be maintained at roundabouts like at other intersections.

### 10.4 REFERENCES

1. Rodegerdts, L., J. Bansen, C. Tiesler, J. Knudsen, E. Myers, M. Johnson, M. Moule, B. Persaud, C. Lyon, S. Hallmark, H. Isebrands, R. B. Crown, B. Guichet, and A. O'Brien. NCHRP Report 672: *Roundabouts: An Informational Guide*, 2nd ed. Transportation Research Board of the National Academies, Washington, D.C., 2010.



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