ROUNDABOUT EVALUATION AND DESIGN WORKSHOP

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Prepared for:
Texas Department of Transportation
July 12, 2011

WELCOME

Robert van der Hilst/CORBIS

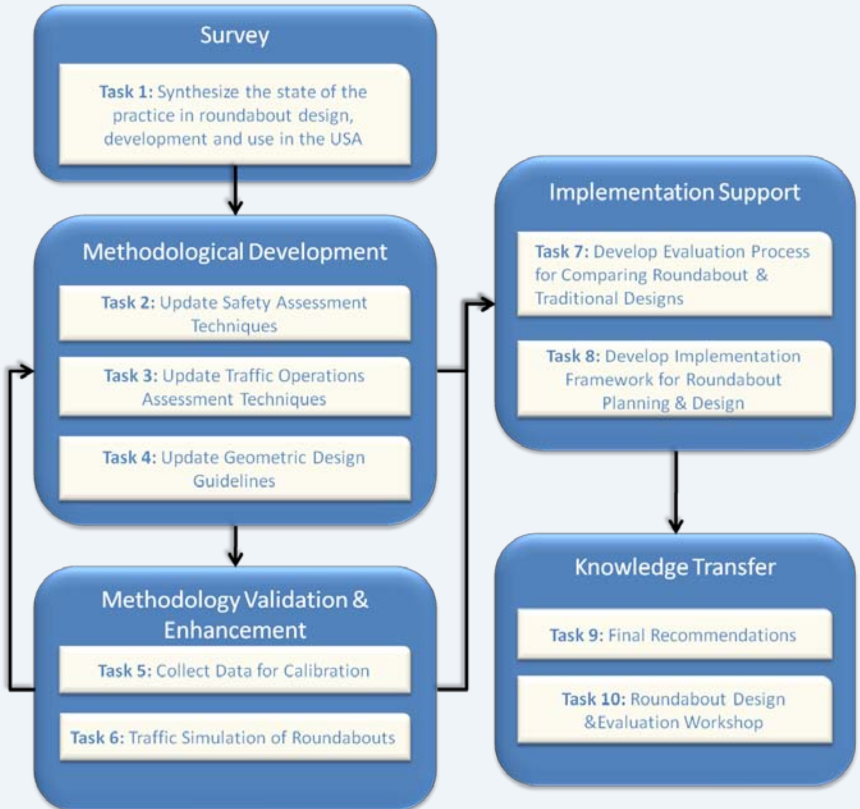
1975 Roundabout in Saigon, Vietnam

WELCOME

- Introductions
- **Course objectives:**
  - Introduction to roundabout design and operations guidelines for the state of Texas
  - Basic ideology and principles of roundabouts
  - Informational sources for designing, evaluating, and implementing roundabouts

PROJECT OVERVIEW

- **Purpose:** Develop roundabout guidelines for Texas that incorporate successful practices, recent U.S. research, and Texas specific conditions.
- Key Project Components:
  - Synthesis
  - Methodological Development
  - Validation and Enhancement
  - Implementation and Support
  - Knowledge Transfer



PROJECT OVERVIEW

Work Plan

Task 1: Survey the State of the Practice

Task 2: Update Safety Assessment Techniques

Task 3: Update Traffic Operations Assessment Techniques

Task 4: Update Geometric Design Guidelines

Task 5: Collect Data for Calibration

Task 6: Traffic Simulation of Roundabouts

Task 7: Develop Evaluation Process for Comparing Roundabouts and Traditional Intersection Forms

Task 8: Develop Implementation Framework for Roundabout Planning and Design

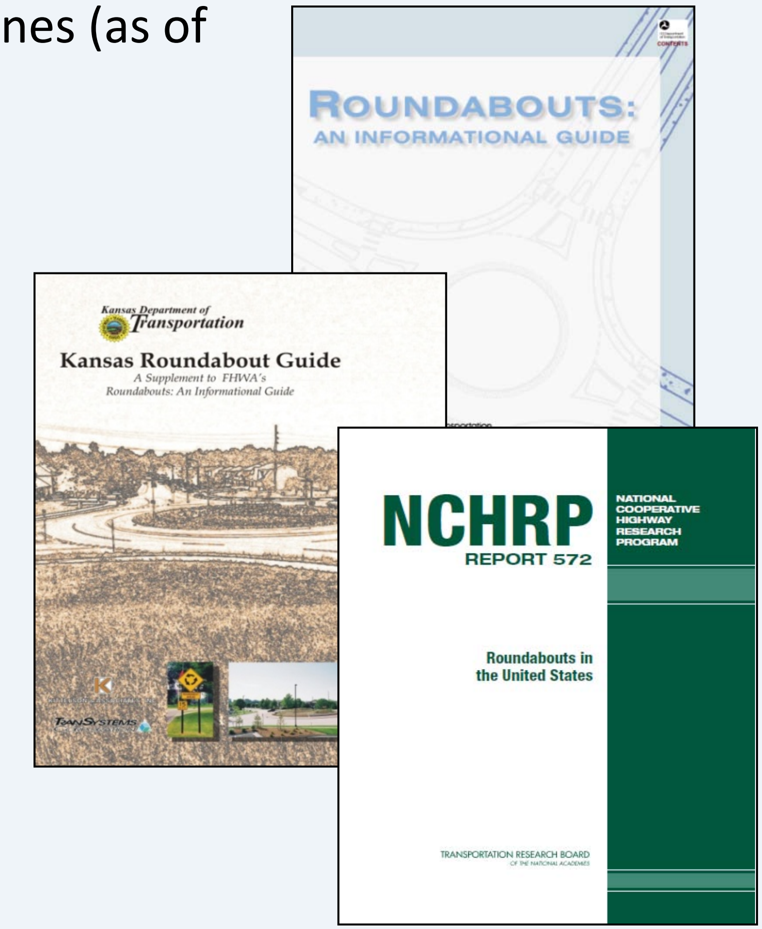
Task 9: Pilot Roundabout Design and Evaluation Workshop

Task 10: Final Recommendations

PROJECT OVERVIEW

Task 1 Survey the State of the Practice

- Reviewed Existing Roundabout Guidelines (as of Jan 2010)
  - 2000 FHWA Guidance
  - Other U.S. State's Standards and Supplementary Materials
  - Recent Research Materials
  - Input from Agencies Regarding Current Practices
- Recently Released
  - NCHRP 672
  - Highway Safety Manual 2010



PROJECT OVERVIEW

Task 2 Update Safety Assessment Techniques

- **Elements discussed in safety assessment technical memorandum…**
  - Recent developments in safety prediction and evaluation
  - Connection between recent safety assessment techniques and roundabouts
  - Guidance on applying approach-level and intersection-level safety prediction models

PROJECT OVERVIEW

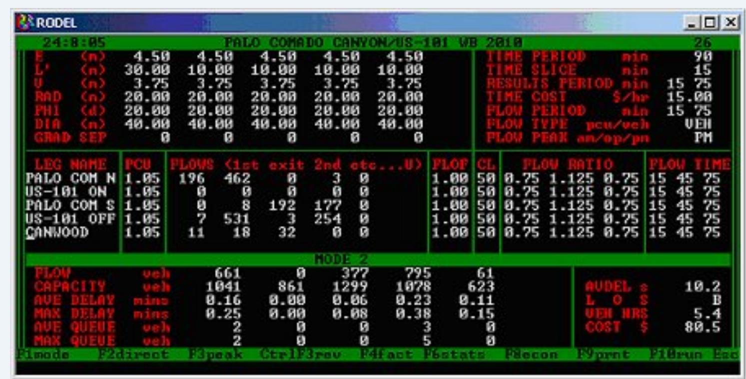
Task 2 Update Safety Assessment Techniques

- Intersection level safety prediction models
  - Equations (available for 11 geometries) that are functions of AADT
- Approach level safety prediction models
  - Equations for entering-circulating, exiting-circulating, and the approach (functions of AADT and geometric parameters)
  - Useful to gage the relative impact of a design change, not to estimate intersection-level safety

PROJECT OVERVIEW

Task 3 Update Traffic Operations Assessment Techniques

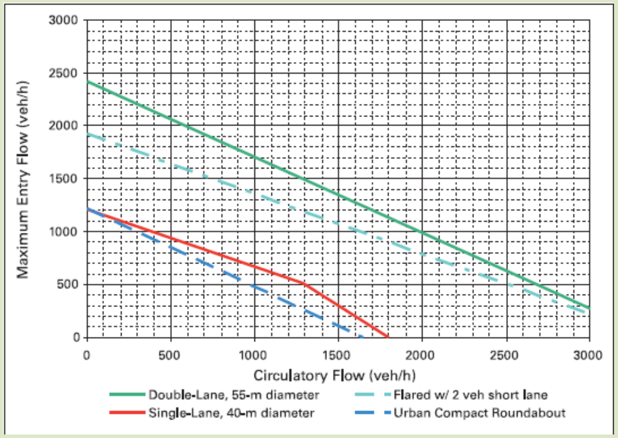
- Provided updated…
  - Entry capacity models based on most recent U.S. research
  - Delay and queue length models based on most recent U.S. research
  - (All models will be calibrated to Texas data.)
- Considered potential software packages for roundabout traffic operations analysis
  - SIDRA, ARCADY 7 and RODEL



PROJECT OVERVIEW

Task 3 Update Traffic Operations Assessment Techniques

- Focus is to recommend methodologies to predict…
  - Roundabout Capacity
  - Delay
  - Queue Lengths

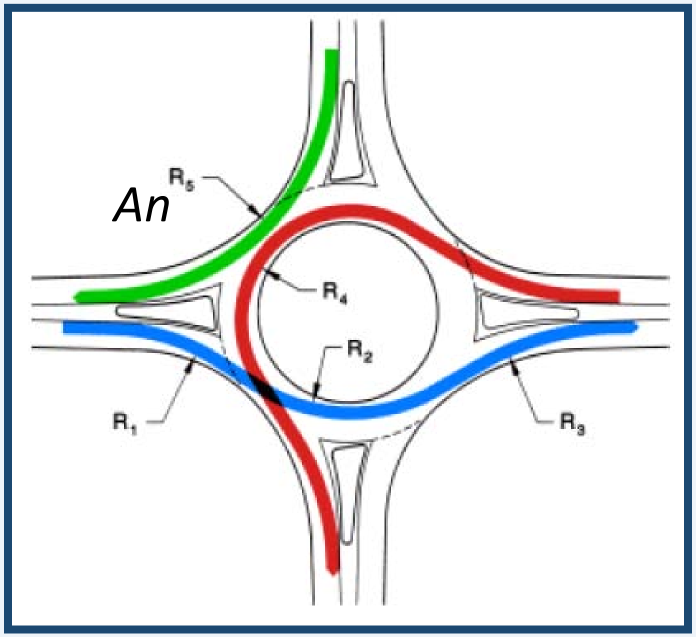


- **Preliminary recommendation is SIDRA**
- Final recommendations will seek a balance between accuracy, ease of use, and model complexity.

PROJECT OVERVIEW

Task 4 Update Geometric Design Guidelines

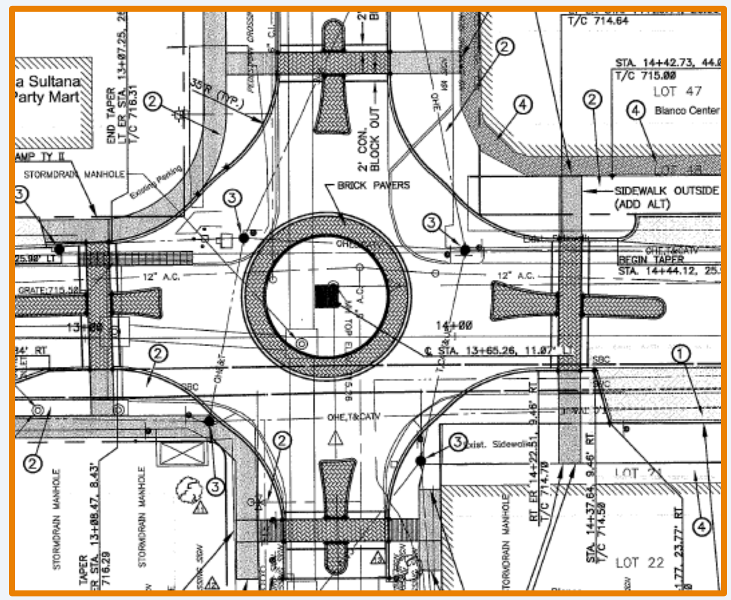
- Plays a significant role in how well a roundabout operates….
  - Speed control and consistency
  - Reducing and eliminating conflicts
  - Reducing delay for travelers
  - Serving pedestrians and bicyclists
  - Accommodating larger vehicles
- NCHRP 672, *Roundabouts: Informational Guide – 2nd Edition*



PROJECT OVERVIEW

Task 5 Collect Data for Calibration

- Pilot Data Collection (completed June 2010)
  - Approximately 13 roundabouts considered
- Final Data Collection (completed Aug 2010)
  - 5 roundabouts selected based on geometric features and traffic volume
    - On Site (TAMUK):
      - Speed readings
      - Video footage
        - 1 hour per approach
          - Peak period
    - Off Site:
      - Geometric design
      - Crash statistics

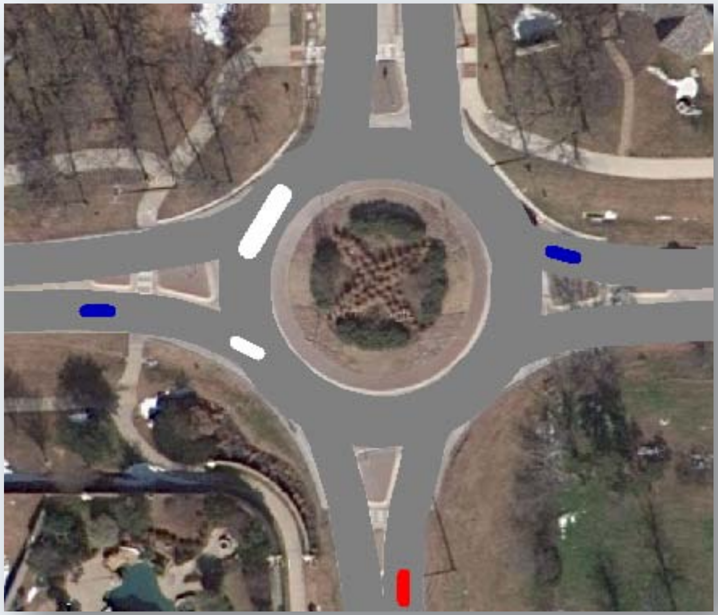


Blanco Rd/Fulton Ave, San Antonio

PROJECT OVERVIEW

Task 6 Traffic Simulation of Roundabouts

- Objectives…
  - Confirm recommendations made in Tasks 2, 3, and 4; and
  - Enhance guidelines for evaluating roundabouts using intersection based software
- Completed Work:
  - Validation of VISSIM roundabout models
  - Capacity analysis using **VISSIM** & **SIDRA**



PROJECT OVERVIEW

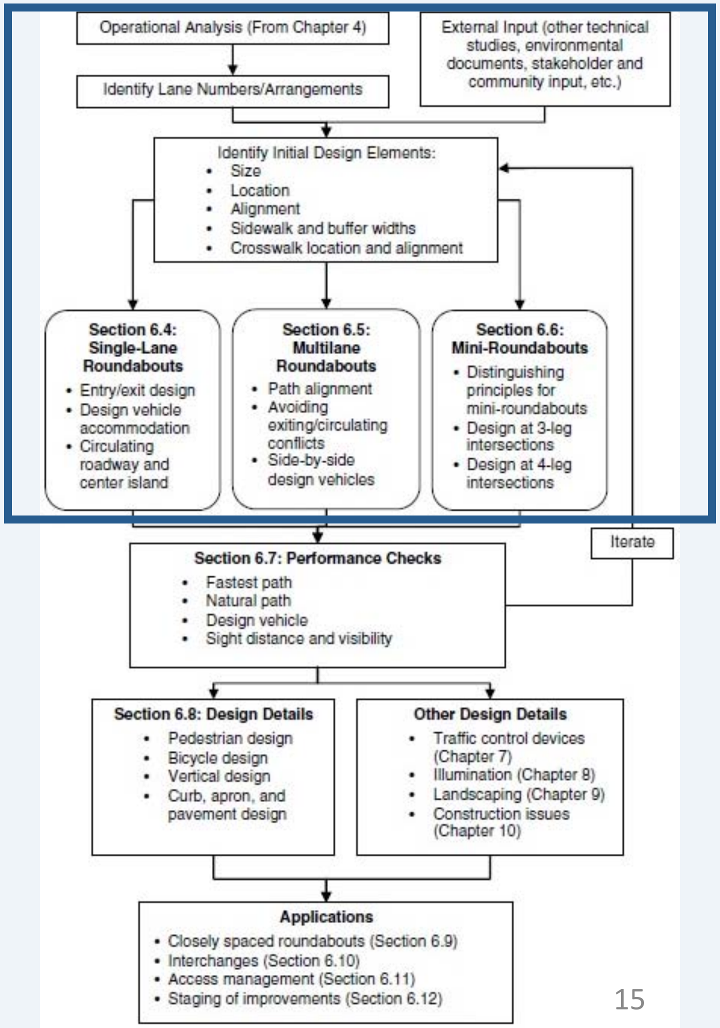
Task 7 Develop Intersection Evaluation Process

- Spreadsheet based evaluation process.
- Purpose…
  - Develop a process for alternatives comparison.
    - Roundabout vs. Traffic Signal
    - Roundabout vs. Two-Way Stop or All-Way Stop
    - Single Lane Roundabout vs. Multilane Roundabout
  - Provide screening level guidance for identifying promising sites as well as a quantitative procedure for comparing alternatives.

PROJECT OVERVIEW

Task 8 Develop Implementation Framework

- The workbook will . .
  - Introduce the modern roundabout
  - Provide a "how-to" for using the spreadsheet (Task 7) and other available resources to evaluate candidate designs
  - Emphasize the importance of feedback and refinement
  - Present Texas-specific considerations



PROJECT OVERVIEW

Task 9 Pilot Roundabout Design and Evaluation Workshop

Task 10 Final Recommendations

- The final report and recommendations will document….
  - Research project activities;
  - Methodologies;
  - Assumptions;
  - Resources; and
  - Final Recommendations.
- Final report will be provided in printed and electronic form.

INTRODUCTION
National Guidelines and Research

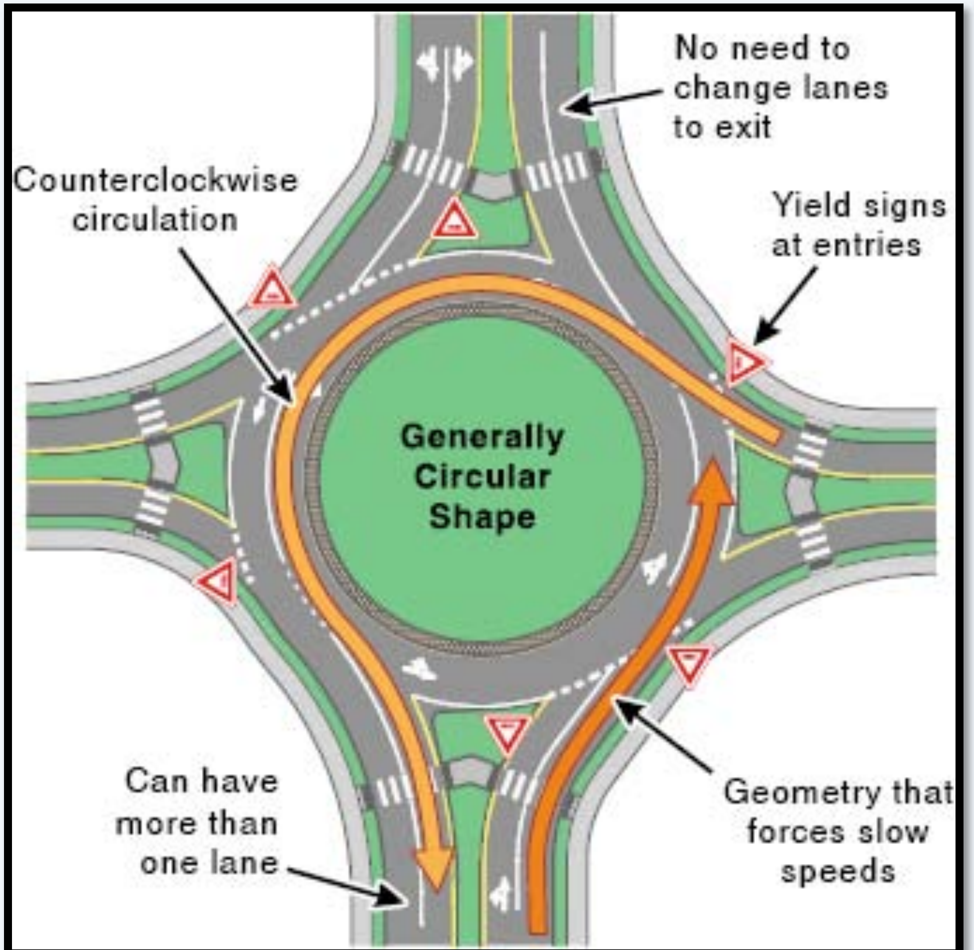
INTRODUCTION

What is a roundabout?


East Continental Blvd. and South Carroll Ave. in Southlake, Texas
(Source: Google maps)

INTRODUCTION

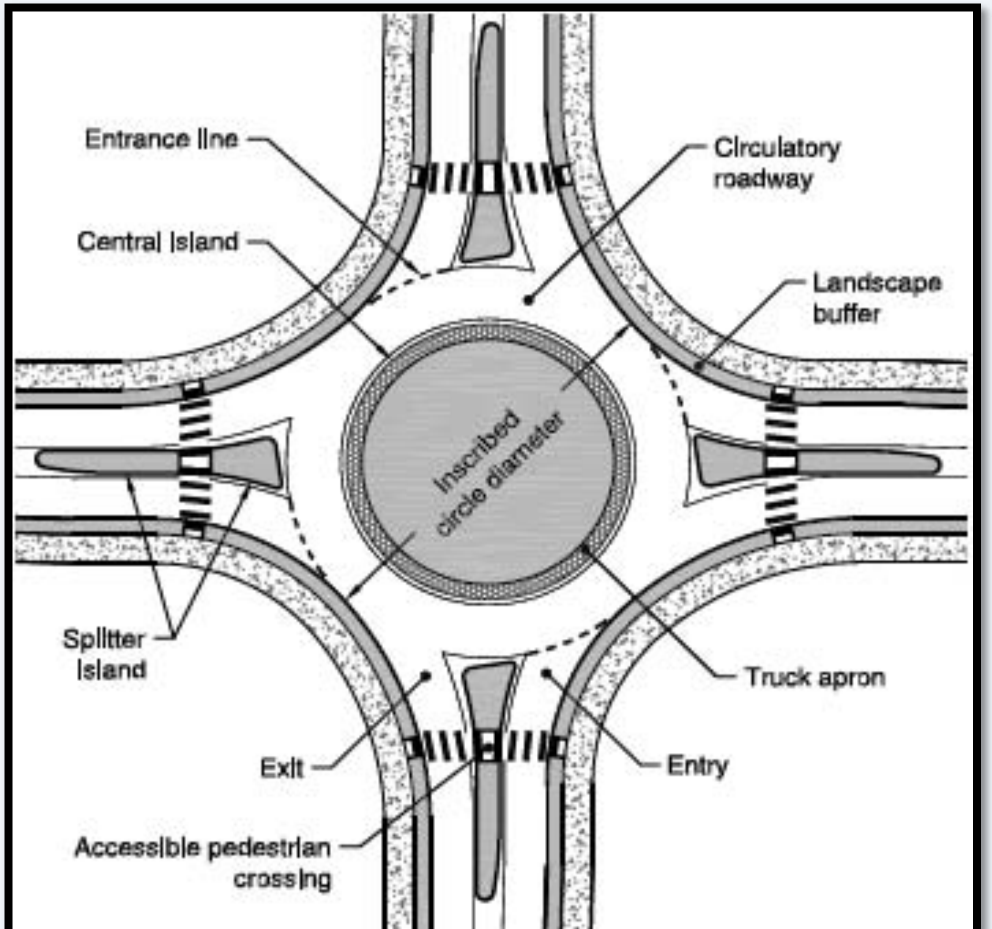
Roundabout Characteristics



(Source: NCHRP 672)

INTRODUCTION

Design Features



(Source: NCHRP 672)

INTRODUCTION

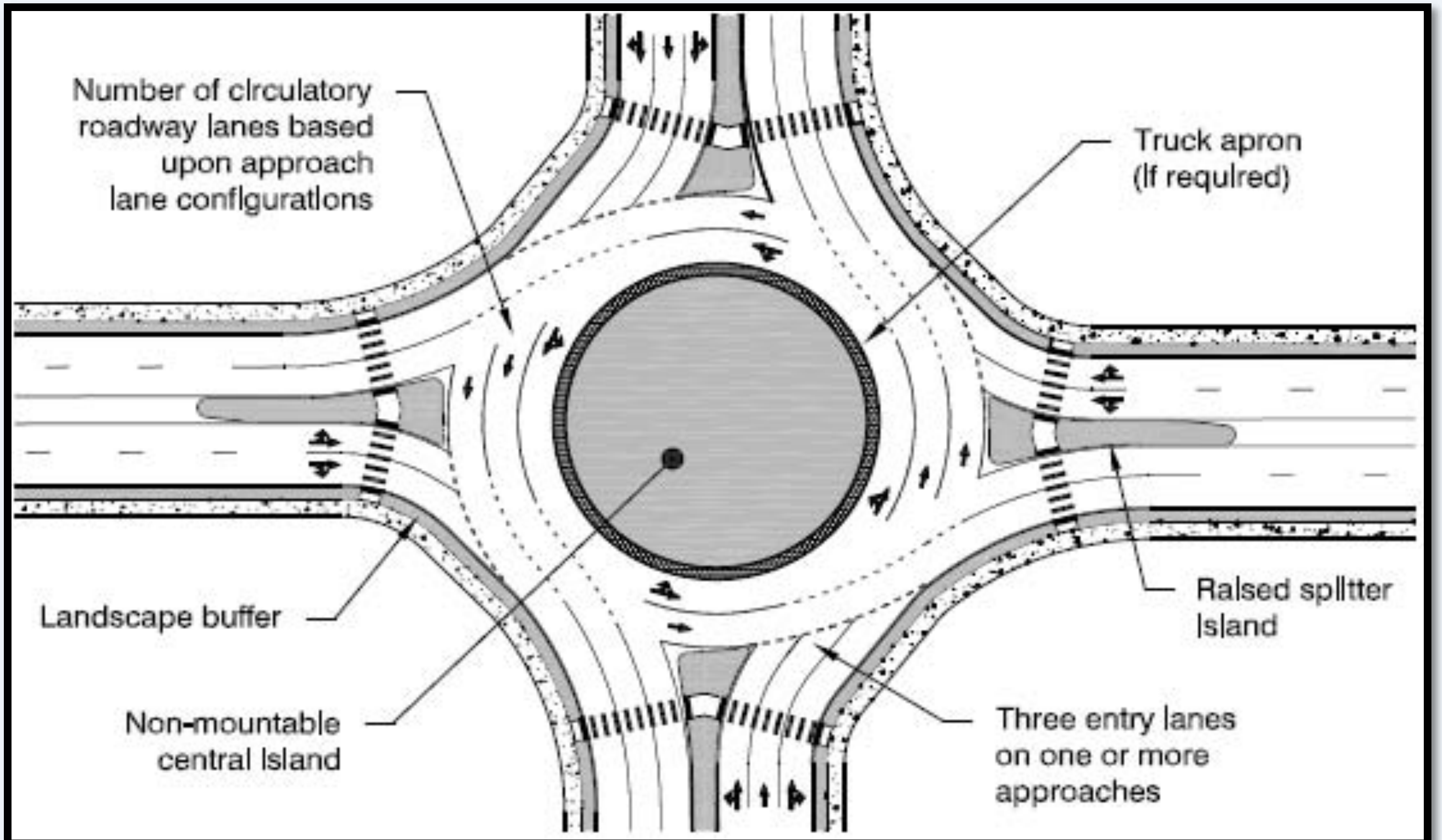
Categories

Single Lane Roundabout, source: NCHRP 672

Miniature Roundabout

INTRODUCTION

Categories



Multilane Roundabout, source: NCHRP 672

INTRODUCTION

Circular Intersections

Signalized Traffic Circle– Hollywood, CA, source: NCHRP 672

INTRODUCTION

Circular Intersections

Rotary – Fort Worth, TX, source: NCHRP 672

INTRODUCTION

Circular Intersections

Traffic circle – Portland, OR, source: NCHRP 672

INTRODUCTION

Roundabout vs. Signalized Intersection: Safety Improvements

- Eliminates right-angle and left-turn conflicts
- Provides speed control by geometric features

INTRODUCTION

Roundabout vs. Signalized Intersection: Safety Improvements

- Safety Benefits:
  - Drivers have more time to:
  - Judge when to enter into the circulating traffic and
  - Detect and correct for their mistakes or mistakes of others
- Sight triangles are smaller so users can see one another easier
- Drivers are more likely to yield to pedestrians
- Crashes are less frequent and less severe

INTRODUCTION

Roundabout vs. Signalized Intersection: Safety Improvements

- For Single-Lane Roundabouts:
  - Drivers do not have lane use decisions to make
  - Pedestrians only cross one lane of traffic at a time
  - Roadway speeds are low enough for bicycles to travel alongside vehicles

INTRODUCTION

Roundabout vs. Signalized Intersection: Safety Improvements

- For Multi-Lane Roundabouts:
  - Drivers have to select the proper lane to use
  - Pedestrians cross more than one lane of traffic at a time, which increases the chance of conflicts with vehicles
  - Bicyclists traveling as vehicles must select the proper lane to use

INTRODUCTION

Roundabout vs. Signalized Intersection: Decision Making

Drivers

- Select appropriate lane and
- Yield to those with right-of-way

Pedestrians

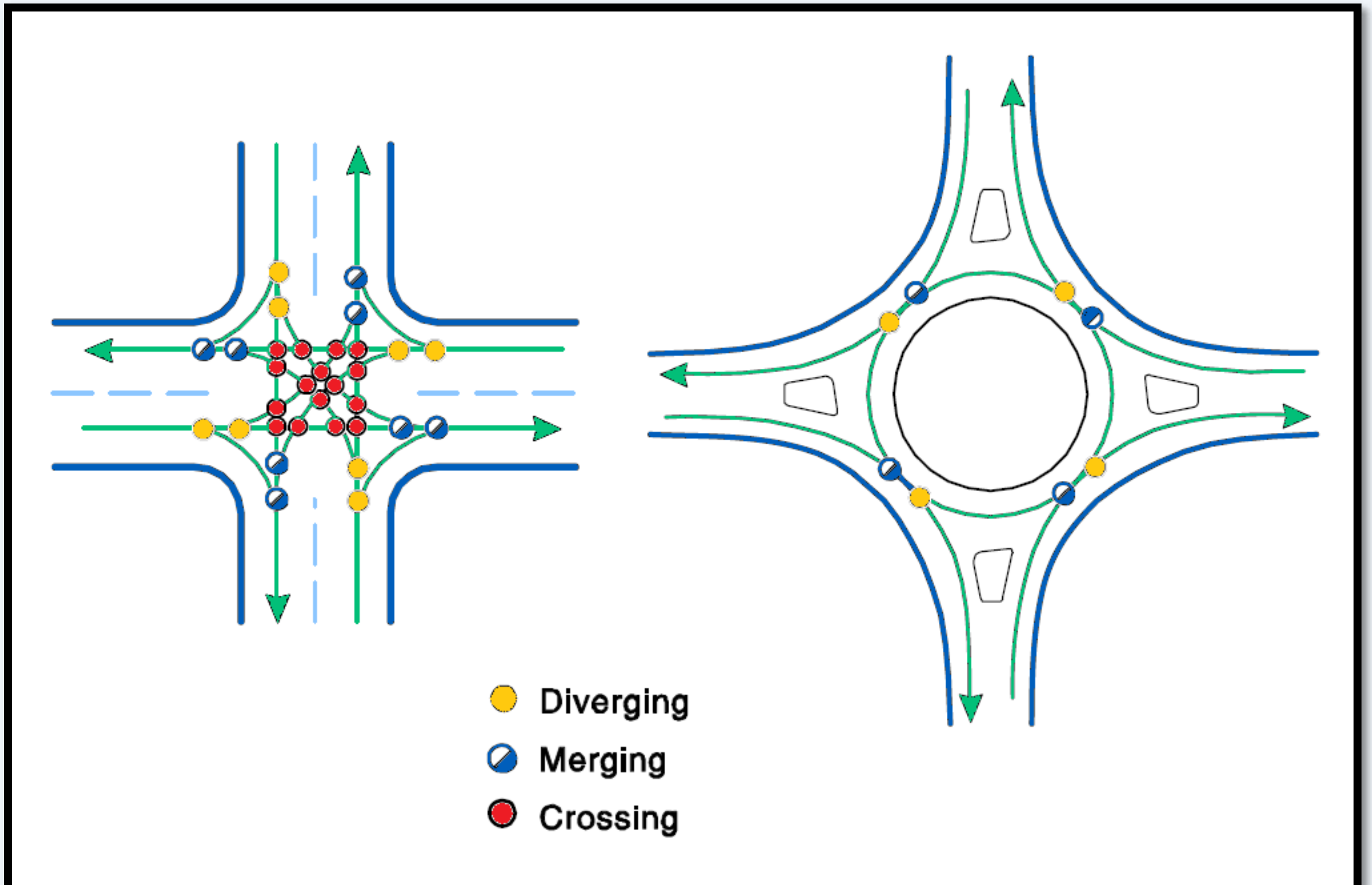
- Choose the appropriate time to cross each leg of the roundabout.

Bicyclists

- Travel as a vehicle or
- Travel as pedestrian

INTRODUCTION

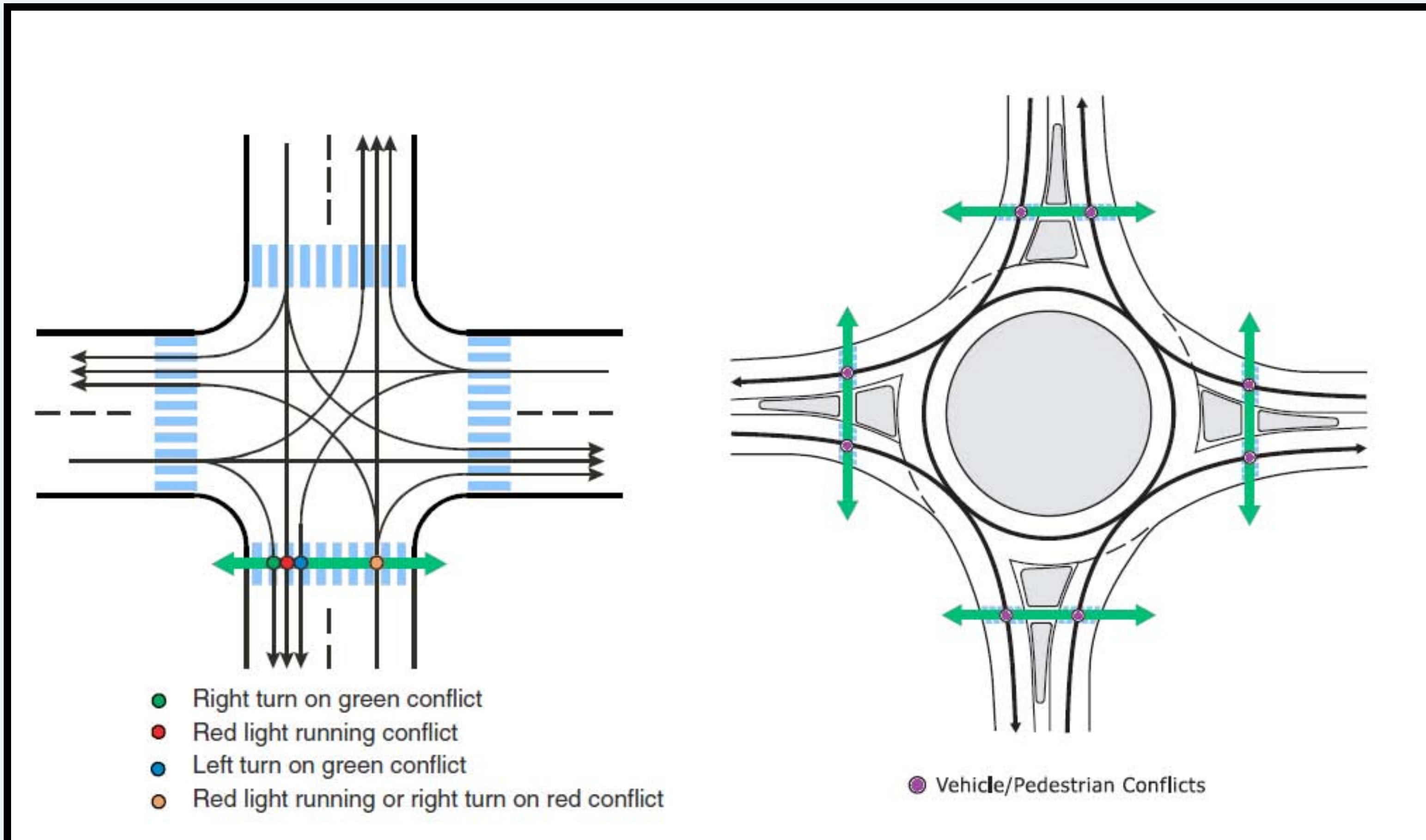
Roundabout vs. Signalized Intersection: Conflict Points



Vehicle – vehicle conflict points, source: NCHRP 672

INTRODUCTION

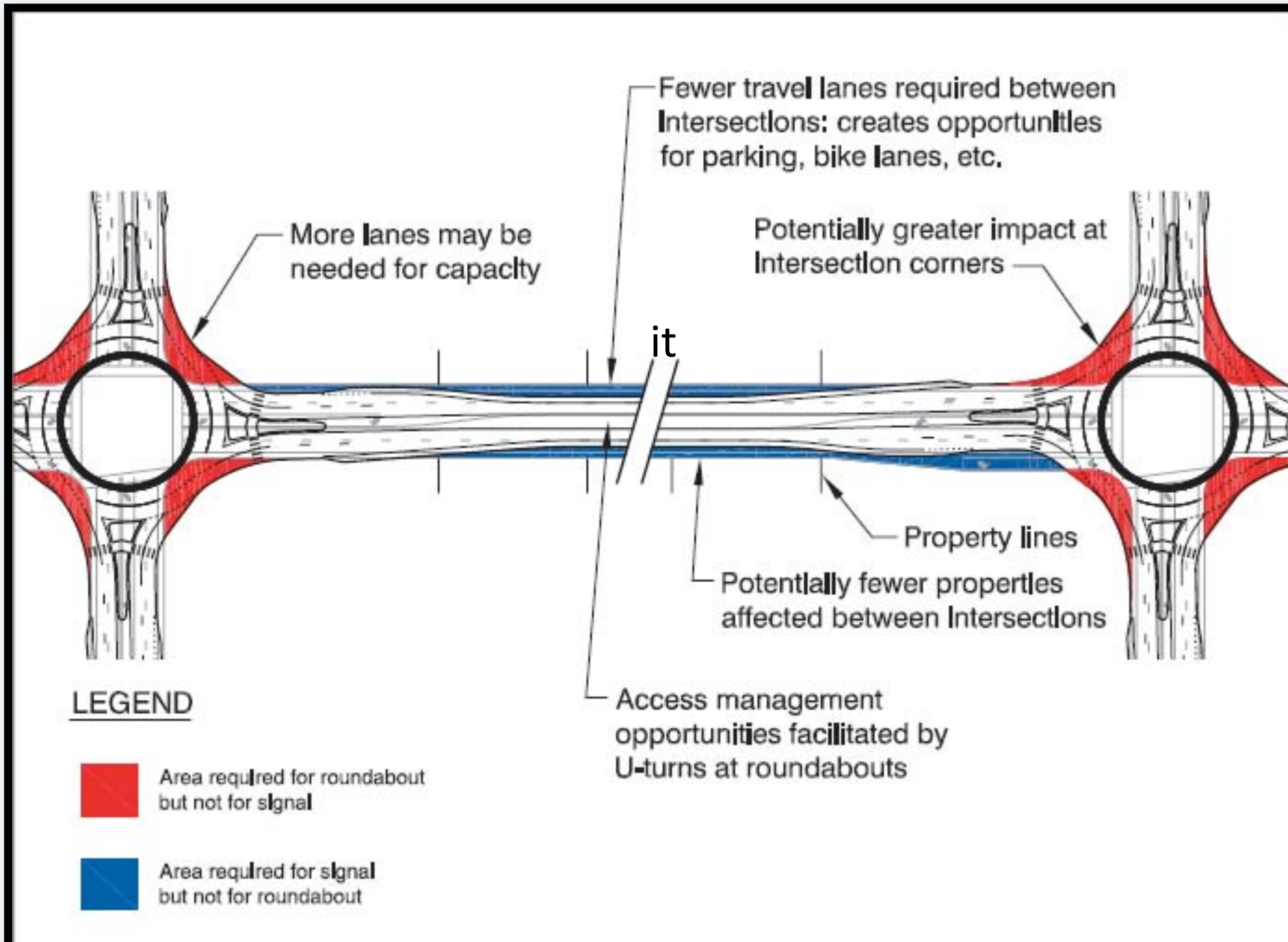
Roundabout vs. Signalized Intersection: Conflict Points



Pedestrian-vehicle conflict points, source: NCHRP 672

INTRODUCTION

Roundabout vs. Signalized Intersection: Spatial Requirements

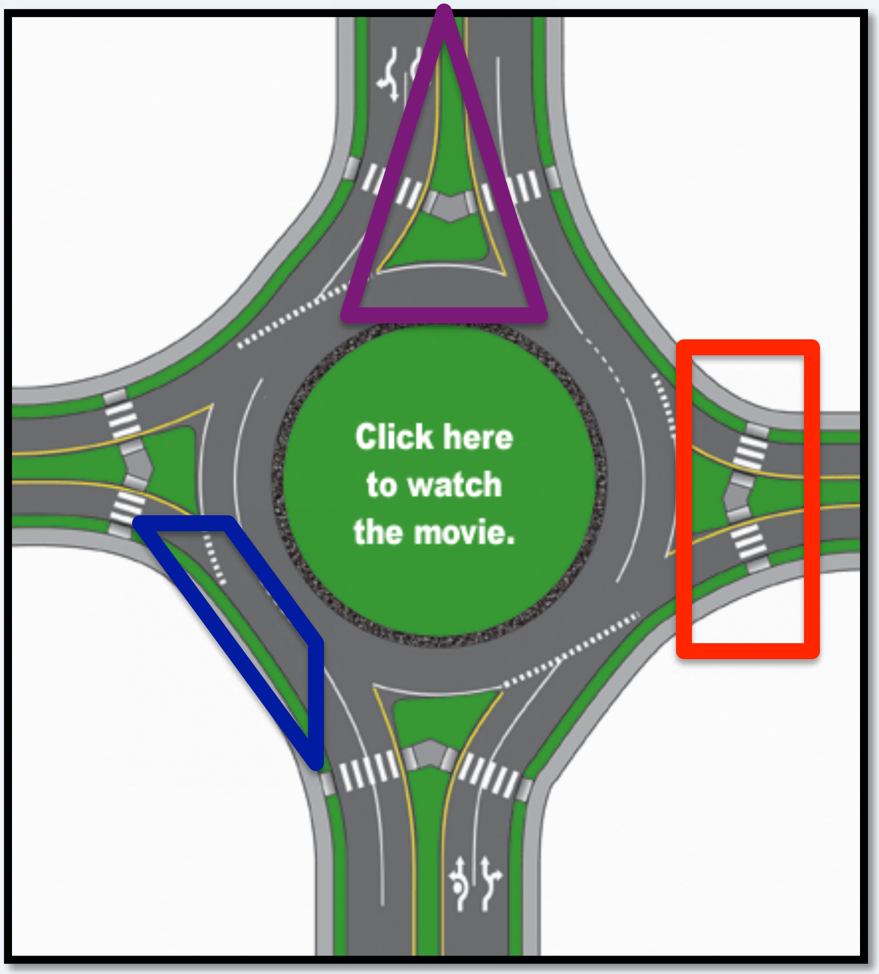


Wide Nodes, Narrow Roads Concept, source: NCHRP 672

INTRODUCTION

Roundabout vs. Signalized Intersection: Pedestrian Considerations

- Crosswalk is located around the perimeter of the roundabout and set back from the yield line.
- Splitter island provides space for pedestrians to pause.
- Landscape buffers prevent pedestrians from crossing to the central island.



(Source: http://cae2k.com/photos-de-studio-0/roundabout-pictures.html)

INTRODUCTION

Roundabout vs. Signalized Intersection: Pedestrian Considerations

Roundabouts	Signalized Intersections
❑ Pedestrians only have one direction of conflicting traffic. ❑ Pedestrians are required to judge when to cross the intersection. ❑ Speed-constrained environment results in less severe crashes.	❑ Pedestrians are vulnerable to unprotected right-turn and left-turn movements. ❑ Signal indication prompts pedestrians to cross the intersection. ❑ High-speed crashes occur when vehicles run through red light.

INTRODUCTION

Roundabout vs. Signalized Intersection: Operation and Maintenance Costs

Roundabouts	Signalized Intersections
❑ Higher illumination power and maintenance costs ❑ Higher signing and pavement marking maintenance costs ❑ Additional landscape maintenance costs ❑ Service life of 25 years	❑ Additional traffic signal power and maintenance costs ❑ Additional signal timing maintenance ❑ Service life of 10 years

INTRODUCTION

Roundabout vs. Signalized Intersection: Safer for Emergency Vehicles

- Drivers should not enter a roundabout when an emergency vehicle is approaching on another leg.
- Vehicles should clear out of the circulatory roadway when an emergency vehicle is traveling on it.
- Lower vehicle speeds makes it safer.
- Elimination of through vehicles unexpected running a signalized intersection and hitting the emergency vehicle

INTRODUCTION

Roundabout vs. Signalized Intersection: Comparing Performance

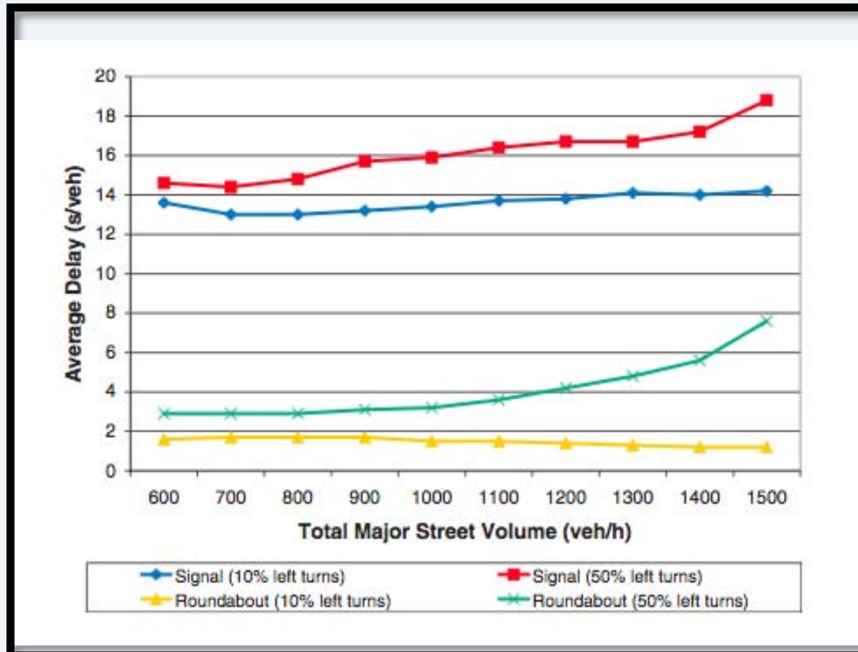
- Roundabouts do not have lower overall delays than TWSC intersections.
- At TWSC intersections that were converted to roundabouts, U.S. research identified average reductions of 44.2% for all crashes and 81.8% for injury crashes.
- Roundabouts reduce queues for left-turning vehicles yielding to opposing traffic.

INTRODUCTION

Roundabout vs. Signalized Intersection: Comparing Performance

- Roundabouts provide operational benefit during off-peak periods
- Roundabouts provide lower overall delays than signalized intersections.
- U.S. research identified average reductions of 47.8% for all crashes and 77.7% for injury crashes.

Average Control Delay Per Vehicle

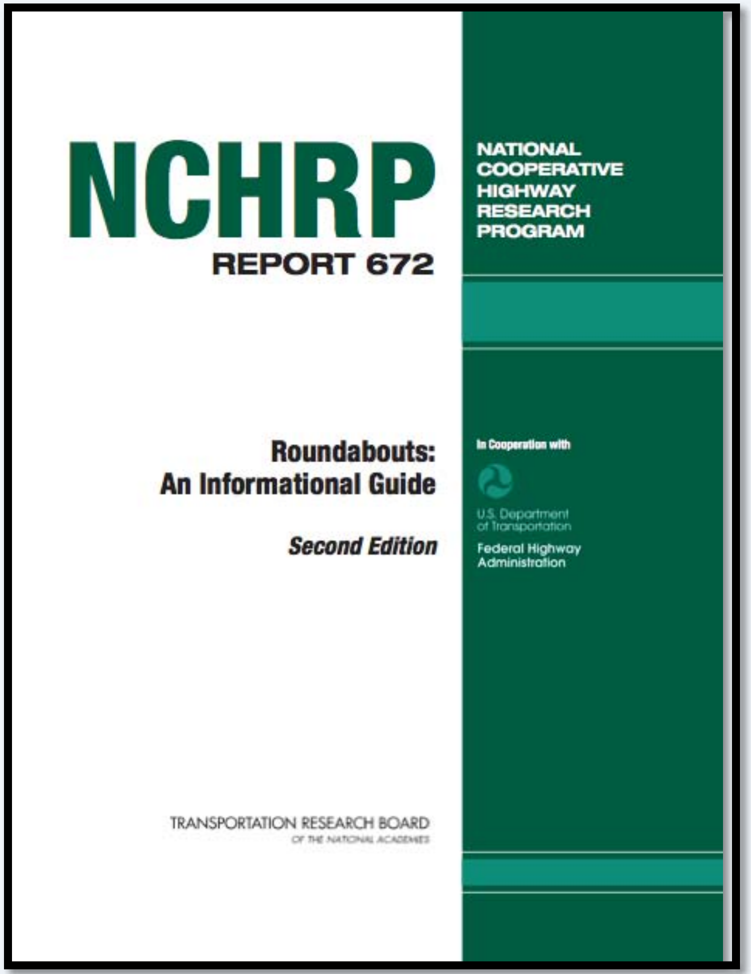


Source: NCHRP 672

INTRODUCTION

Roundabout vs. Signalized Intersection: Information Resources

- NCHRP 672, Roundabouts: An Informational Guide – 2nd edition
  - Current national guidance document regarding roundabouts
  - Covers operations analysis, safety, geometric design, traffic design, and system considerations



INTRODUCTION

Roundabout vs. Signalized Intersection: Information Resources

- Supplemental State Roundabout Design and Implementation Guides
  - Most are based on 1st edition of FHWA Roundabout Guide
  - Some are influenced by British practices
  - Contains state-specific information related to planning considerations, design attributes, or signing and pavement markings

INTRODUCTION

Roundabout vs. Signalized Intersection: Information Resources

- Roundabout Research Findings
  - Influences the guidelines developed for analysis, design, and implementation of roundabouts
  - Contains the most recent U.S. research related to roundabout safety, operations, and geometry

Roundabout Applications

Part I

APPLICATIONS PART I

Roundabouts Near Schools

- **Considerations**
  - *Sharp, often simultaneous peaks in pedestrians & traffic*
  - *Design vehicle (school bus, emergency vehicles)*
  - *Right-of-way*
  - *User education & outreach*
  - *If crossing guards are used, the distance between crosswalks may require two crossing guards instead of one.*

APPLICATIONS PART I

Roundabouts Near Schools

- **Benefits**
  - Lower vehicle speeds in and around intersection
  - Improved pedestrian and vehicle safety
  - Landscaping and gateway treatment

APPLICATIONS PART I

Roundabouts Near Schools

- Wider sidewalks/pathways near roundabout to allow for children walking side-by-side, bicycles, etc.
- Greater concentration of distracted drivers & pedestrians
- Educate & enforce pedestrians to not cross circulatory roadway
- Central island is not a "playground"
  - Be mindful of objects/landscape within circulatory roadway
- Bus and passenger drop-off circulation
  - Avoid use of roundabout as element in circulation plan, but consider it's impacts

APPLICATIONS PART I

Roundabouts in Rural, High-Speed Locations

- Historical safety of rural roundabouts:
  – Overall reduction in accidents
  – Increase in single vehicle accidents

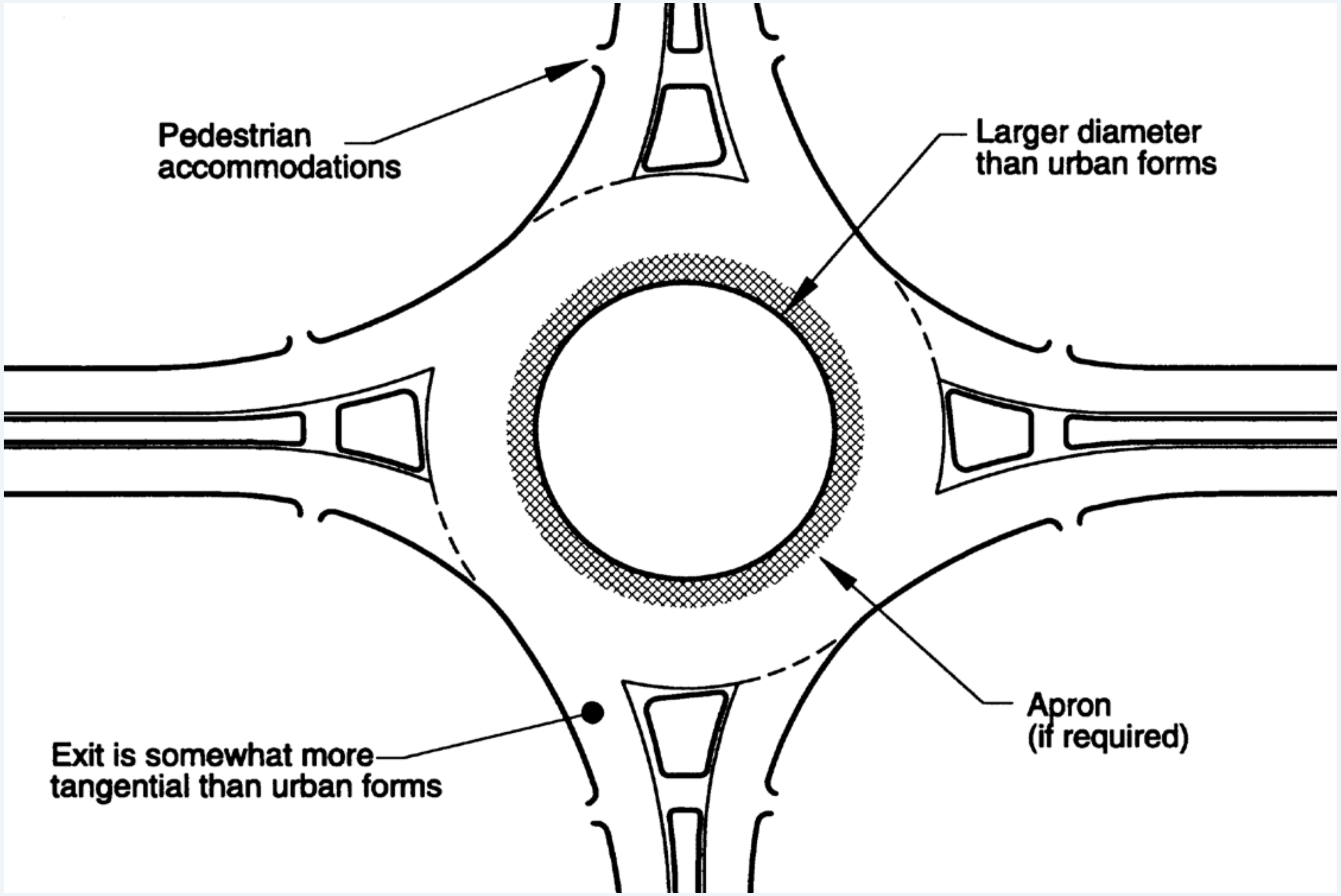
Photo: Lee Rodegerdts

High-Speed, Rural Roadway - Paola, KS

- Specific design guidance:
  – Maximize visibility of the central island
  – Add changes in cross section or alignment to alert drivers on approaches

APPLICATIONS PART I

Rural Roundabouts



APPLICATIONS PART I

Rural Roundabouts

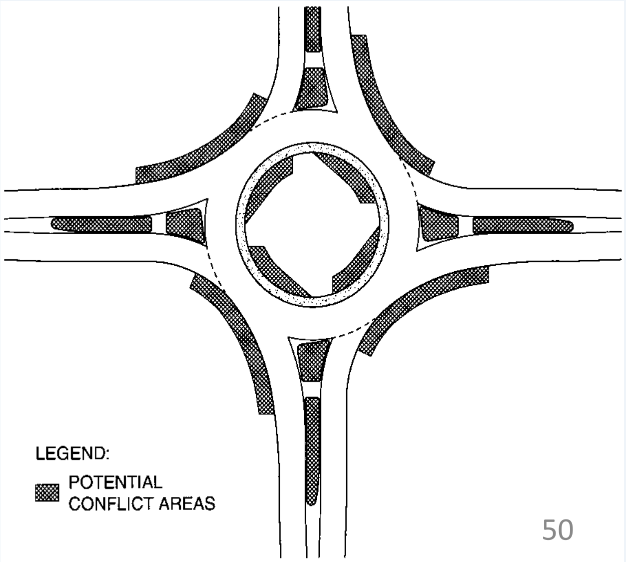
- Design objective is to raise awareness
  - Visibility
    - Terminal vista
    - Illumination
  - Curbing
  - Splitter islands
  - Approach curves

APPLICATIONS PART I

Rural Roundabouts - Visibility

- Illumination
  - Some roundabouts are rural today but will be developing into urban/suburban areas
  - Recommend using urban illumination levels based on expected traffic volume and pedestrian activity (design year)
  - For unlit approaches, use illuminance of approx. half the intersection value at the nose of the splitter islands to provide transition zone

- Advance warning
  - If necessary



APPLICATIONS PART I

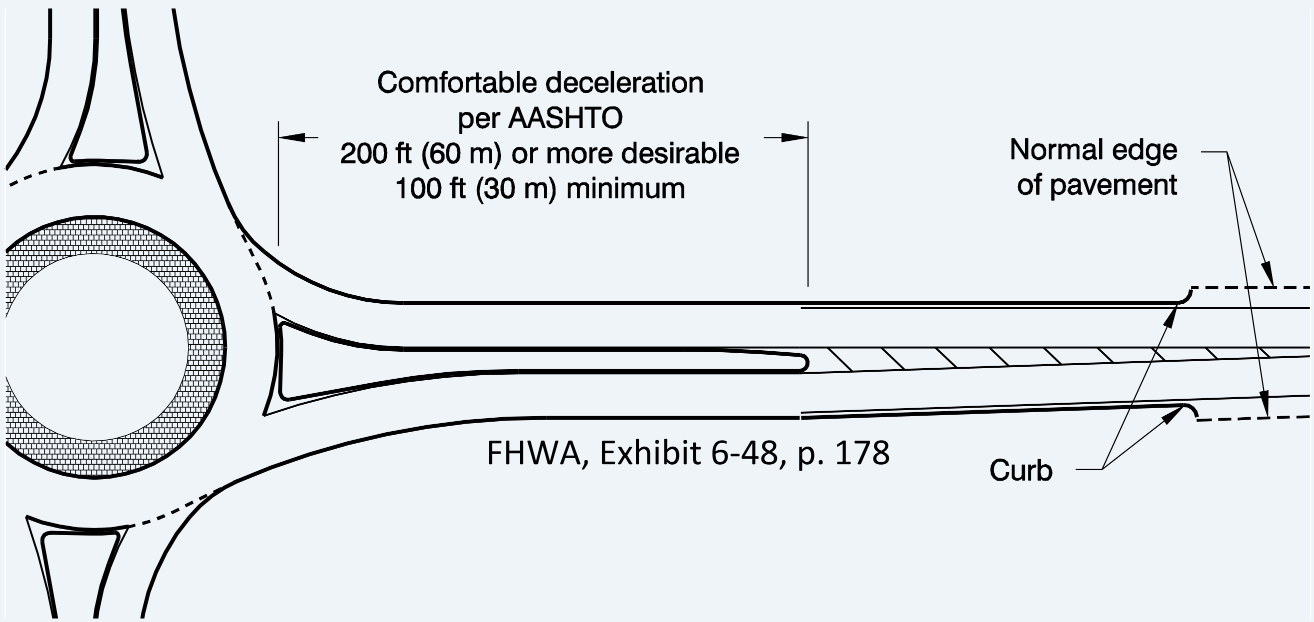
Rural Roundabouts - Curbing

- Change in cross section alerts driver of upcoming intersection
- Creates "funneling" effects, along with extended splitter islands

APPLICATIONS PART I

Rural Roundabouts

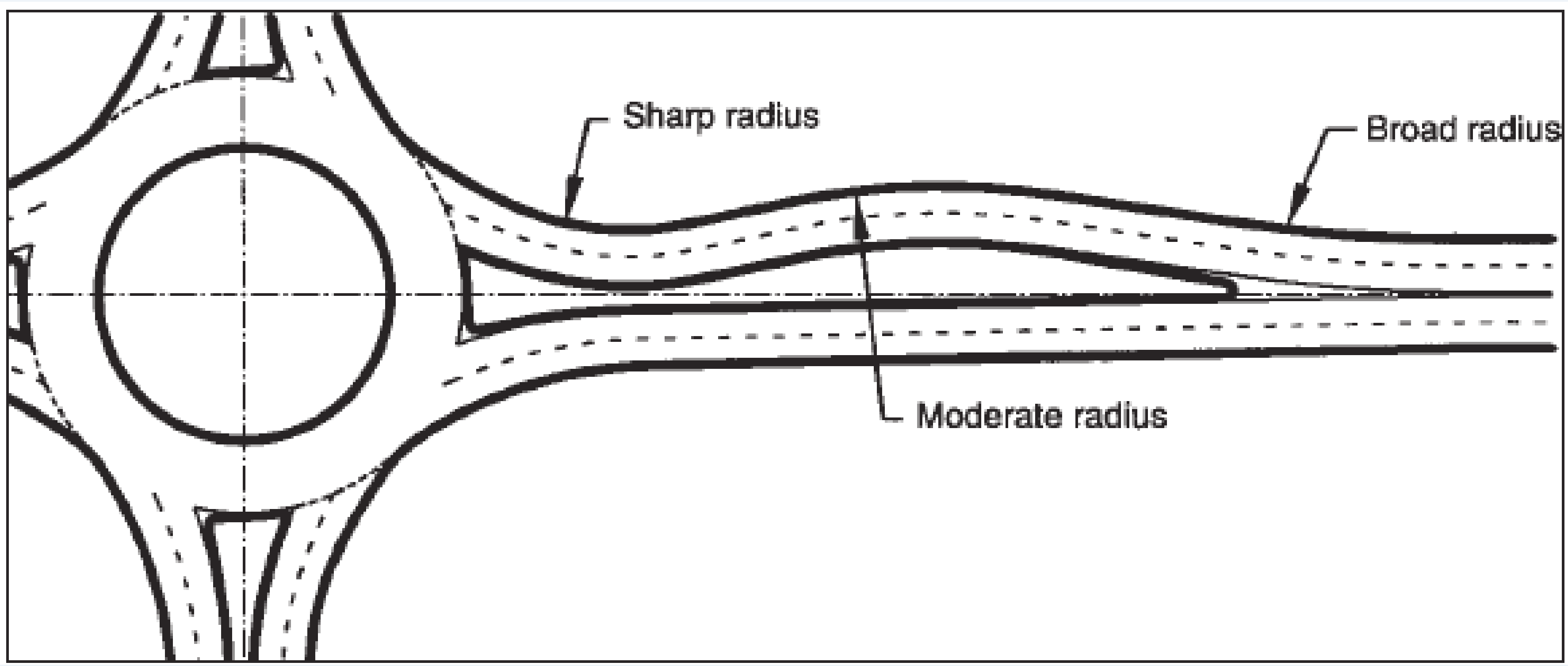
- AASHTO Exhibit 10-73 – Deceleration lengths
  - Design speed = 65 mph
  - Target speed = 25 mph
  - Desired deceleration length = 500 - 570’



FHWA, Exhibit 6-48, p. 178

APPLICATIONS PART I

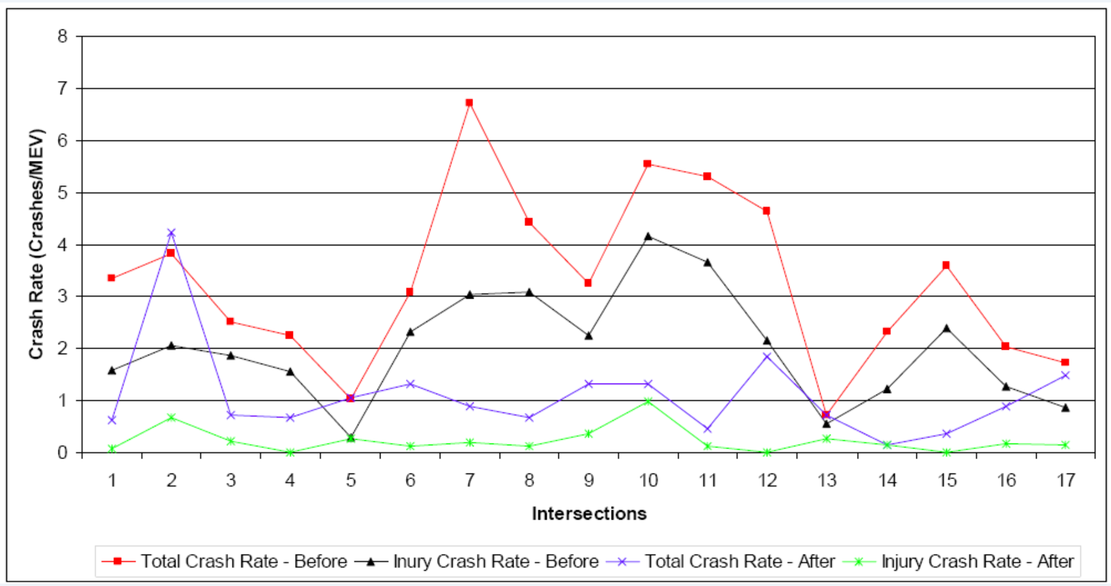
Rural Roundabouts – Approach Curves



APPLICATIONS PART I

Rural Roundabouts – Safety Performance

- Study by Isebrands, 2008
  - Seventeen roundabouts
  - Approach speeds of 40 to 65 mph
  - Crash Rate Reduction
    - Total – 67%
    - Injury – 89%
    - Fatal – 100%



Isebrands, TRB 2008

APPLICATIONS PART I

Rural Roundabouts – User Types

- Pedestrians/Cyclists?
- Emergency vehicles
- Oversized design vehicle
- Snow plows
- Farm equipment
  - Combine
  - Large tractor

APPLICATIONS PART I

Rural Roundabouts - Myths

- Reduction in approach speed
- Driver expectation
- Unbalanced flows results in poor operational performance
- Can't accommodate large design vehicle, farm equipment

APPLICATIONS PART I

Rural Roundabouts – Example: Kittitas County, WA
High-Speed Approach Treatments

Consider using:

- Longer splitter islands
- Advance approach curves

Photo: W&H Pacific, Inc.

APPLICATIONS PART I

Rural Roundabouts – Example: Verboort Road, Washington County

High-Speed Approach Treatments

APPLICATIONS PART I

Rural Roundabouts – Summary

- Roundabouts in rural locations have proven safety benefits
- Other state DOTs have successfully implemented rural roundabouts
- Rural locations have unique context to consider
- Cost effective solution to localized peak conditions
- Multiple applications on a corridor enhance the overall effectiveness

TRAFFIC ANALYSIS

- Recommended traffic analysis methods from the most comprehensive and recent research on traffic operations analysis for roundabouts in the U.S
- Information comes from **NHCRP 572 - Roundabouts in the United States** and **NCHRP 672 – Roundabouts: An Informational Guide Second Edition**
- Methods:
  - Planning level method
  - Highway Capacity Manual method
  - Deterministic software
  - Simulation

TRAFFIC ANALYSIS

Selection of Analysis Tool

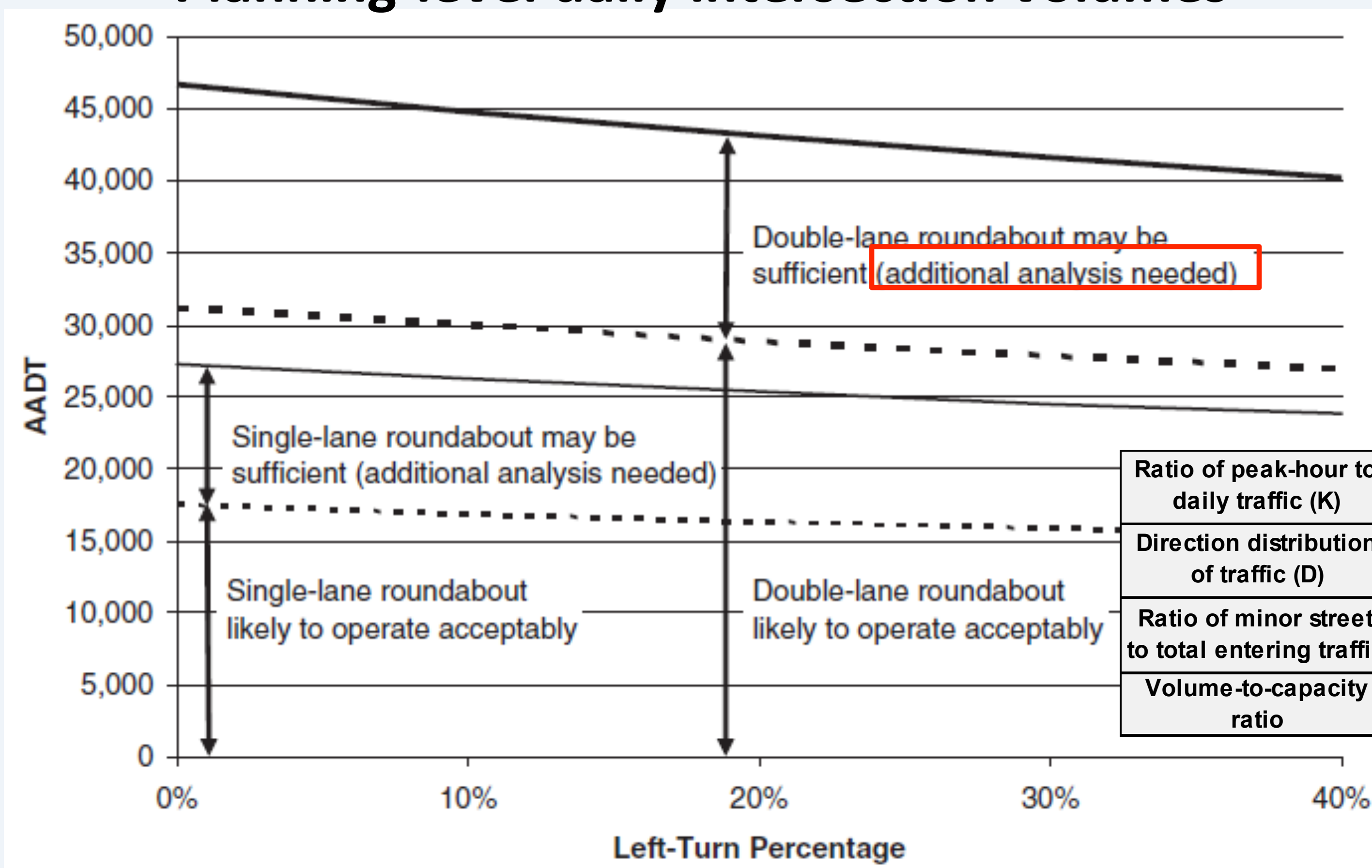
Application	Typical Outcome Desired	Input Data Available	Potential Analysis Tool
Planning-level sizing	Number of lanes	Traffic volumes	Section 3.3 of this guide, HCM, deterministic software
Preliminary design of roundabouts with up to two lanes	Detailed lane configuration	Traffic volumes, geometry	HCM, 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
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

Source: NCHRP 672

TRAFFIC ANALYSIS

Planning-level Method

Planning-level daily intersection volumes



Ratio of peak-hour to daily traffic (K)	0.09 to 0.10
Direction distribution of traffic (D)	0.52 to 0.58
Ratio of minor street to total entering traffic	0.33 to 0.50
Volume-to-capacity ratio	0.85 to 1.00

(Source: NCHRP 672)

TRAFFIC ANALYSIS

Planning-level Method

- **Capacity** is directly affected by the amount of vehicles on the circulatory roadway (conflicting traffic)

(Source: VISSIM)

TRAFFIC ANALYSIS

Planning-level Method

- **Capacity** is directly affected by the amount of vehicles on the circulatory roadway (conflicting traffic)

Volume range (sum of entering and conflicting volumes	Number of Lanes Required
0 to 1,000 veh/h	• Single-lane entry likely to be sufficient
1,000 to 1300 veh/h	• Two-lane entry may be needed • Single-lane entry may be sufficient based upon more detailed analysis.
1,300 to 1,800 veh/h	• Two-lane entry likely to be sufficient
Above 1,800 veh/h	• More than two entering lanes may be required • A more detailed capacity evaluation should be conducted to verify lane numbers and arrangements

(Source: NCHRP 672)

TRAFFIC ANALYSIS

2010 Highway Capacity Manual Method

Capacity estimation

$$c_{e,pce} = 1{,}130e^{(-1.0\times10^{-3})v_{c,pce}}$$

$c_{e,pce}$ = lane capacity (pc/h)
↑ adjusted for heavy vehicles
$v_{c,pce}$ = conflicting flow (pc/h)

(Source: NCHRP 672)

Bend, Oregon (Source: Flickr.com)

TRAFFIC ANALYSIS

Delay and Queue Length Models

CONTROL DELAY

$$d = \frac{3600}{c} + 900T * \left[\frac{v}{c} - 1 + \sqrt{\left(\frac{v}{c} - 1\right)^2 + \frac{\left(\frac{3600}{c}\right)\frac{v}{c}}{450T}} \right] + 5 * \min\left[\frac{v}{c}, 1\right]$$

d = average control delay (s)

c = entry capacity (veh/hr)

T = time period (hrs)

v = vehicle flow (veh/hr)

TRAFFIC ANALYSIS

Delay and Queue Length Models

GEOMETRIC DELAY

WDOT Roundabout (Source: Flickr)

TRAFFIC ANALYSIS

Delay and Queue Length Models

QUEUE LENGTH

$$Q_{95} \approx 900T * \left[\frac{v}{c} - 1 + \sqrt{\left(1 - \frac{v}{c}\right)^2 + \frac{\left(\frac{3600}{c}\right)\frac{v}{c}}{150T}} \right] * \left(\frac{c}{3600} \right)$$

Q_{95} = 95th percentile queue length in # vehs

c = entry capacity (veh/hr)

T = time period (hrs)

v = vehicle flow (veh/hr)

TRAFFIC ANALYSIS

Delay and Queue Length Models

- Other factors effecting performance…
  - Pedestrians
  - Exiting vehicles
  - Changes in effective priority
  - Capacity constraint
  - Origin-destination patterns
  - Geometry

TRAFFIC ANALYSIS

Deterministic Software Method

- Model vehicle flows as flow rates
- Sensitive to **various flow** and **geometric features** of a roundabout (i.e. number of lanes, arrangement of lanes, entry width, and inscribed circle diameter)
- The most common deterministic model used in the U.S. is based on British and Australian research and practice.
  - British research correlates capacity to geometry
  - Australian research correlates capacity to traffic flow
- NCHRP 672 discusses calibration of driver behavior, lane use, and geometry for deterministic software models.

TRAFFIC ANALYSIS

Traffic Operations Software Tools

- Most commonly used: RODEL and SIDRA
    - Based on information in NCHRP 572 and the questionnaire distributed to U.S. agencies by this research team
- Task 3 considered these as well as ARCADY
    - ARCADY7 and RODEL model capacity, delay, and queue length using empirical questions developed from British roundabout data
- Preliminary recommendation: SIDRA

TRAFFIC ANALYSIS

Traffic Operations Software Tools

- ARCADY7 and RODEL
  - Model capacity, delay, and queue length using empirical questions developed from British roundabout data.
  - Roundabout capacity is linked to roundabout geometry including precise geometric details without directly incorporating gap acceptance theory
  - Require detailed input for geometry
- ARCADY7 provides a calibration process to incorporate findings presented in NCHRP Report 572
  - Unclear if RODEL can do the same

TRAFFIC ANALYSIS

Traffic Operations Software Tools

- SIDRA
  - Also, models capacity, delay, and queue length
  - Incorporates gap acceptance theory and basic geometric features
    - attractive for modeling U.S. roundabouts because key parameters such as critical headway and follow-up headway are common between the two approaches
  - Models are consistent with NCHRP 572 findings
    - Variations in driver behavior and aggregate geometry have more influence then geometric design

TRAFFIC ANALYSIS

Traffic Operations Software Tools

- SIDRA (continued)
  - Parameters can be modified by users to reflect local driving conditions
  - Use of “environmental factor” reflects tentative nature of U.S. drivers.
  - Reasonably approximates calculations achieved with the capacity, delay and queue models recommended in NCHRP Report 572.
  - Follow-up headway and critical headway can be modified

TRAFFIC ANALYSIS

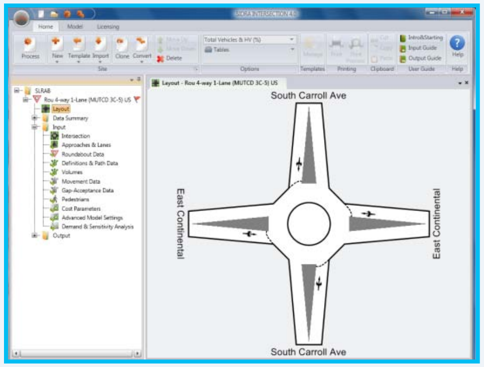
Simulation

- Models transportation networks
- Sensitive to individual vehicle behaviors (e.g., car-following behavior, lane-changing behavior, and decision-making behavior)
- The most commonly used simulation method in the U.S. is based on U.S., British, and German research and practice.
- **NCHRP 672** discusses the necessary driver behavior and traffic volume calibrations that must be applied when using the simulation model.
- **FHWA Traffic Analysis Toolbox**
- Examples of Simulation Software: VISSIM

TRAFFIC ANALYSIS

Capacity Analysis of Texas Roundabouts Using SIDRA and VISSIM

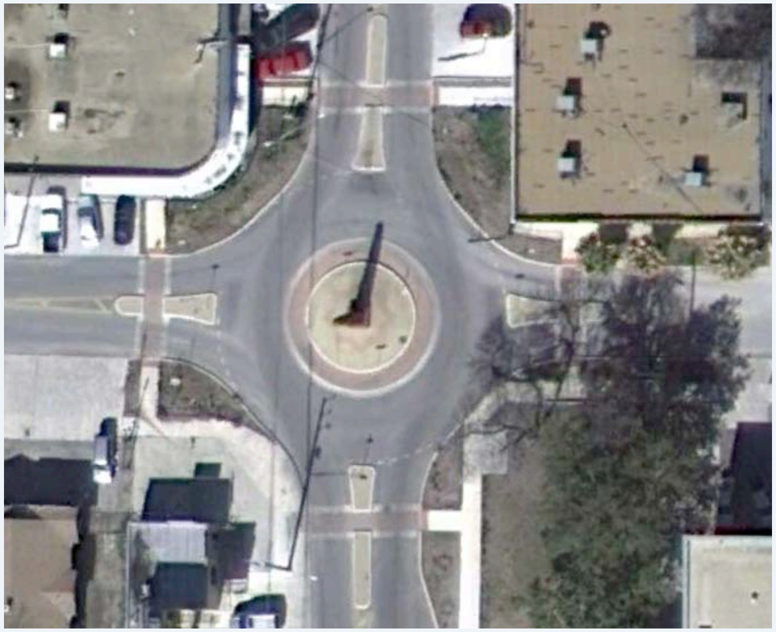
- Validation and enhancement phase of developing Texas-specific roundabout guidelines
- Objectives:
  - Confirm roundabout design criteria based on reasonability of results.
  - Use microsimulation results to enhance current guidelines for evaluating roundabout operations.



TRAFFIC ANALYSIS

Capacity Analysis of Texas Roundabouts Using SIDRA and VISSIM

East Continental Blvd. and South Carroll Ave., Southlake, TX



Fulton Ave. and Blanco Rd., San Antonio, TX

TRAFFIC ANALYSIS

Capacity Analysis of Texas Roundabouts Using SIDRA and VISSIM

- Results from VISSIM models were validated using data collected in the field
  - Southlake (PM) and San Antonio modeled trajectory, speed, and entry decision accurately so they were concluded to be the best models overall.
- Using the calibrated models the effect exiting flow, origin-destination patterns, and mean speed have on capacity were evaluated separately
- VISSIM **entry lane capacity** results compared to SIDRA results and the 2010 HCM entry lane capacity curve.

TRAFFIC ANALYSIS

Spreadsheet Evaluation Tool

- Evaluation of possible conversion of two-way stop to a roundabout

Source: Google Maps, 2011

TRAFFIC ANALYSIS

Spreadsheet Evaluation Tool

- **Step 1: Check for Roundabout Feasibility**

  Is there space available for the roundabout?

Source: Google Maps, 2011

Maximum inscribed diameter = 50’

Design vehicle = single unit truck

TRAFFIC ANALYSIS

Spreadsheet Evaluation Tool

- **Step 1: Check for Roundabout Feasibility**

  Can it handle the traffic demand?

Source: Google Maps, 2011

AADT = 13,000 veh/day

9% Left Turns

3% Cross Traffic

TRAFFIC ANALYSIS

Spreadsheet Evaluation Tool

- **Step 2: Enter Intersection Data**

  How many lanes are needed on each approach?

Source: Google Maps, 2011

Approach	1	2	3	4	5
1		30	700	30	
2	30		35	30	
3	300	35		30	
4	30	20	30		
5					

Peak Hour Factor = 0.97

2% Heavy Vehicles

TRAFFIC ANALYSIS

Spreadsheet Evaluation Tool

- **Step 2: Enter Intersection Data**

  Optional data entry for crash prediction

Source: Google Maps, 2011

Approach	Entering AADT	Exiting AADT	Circulating AADT
1	7600	3600	13000
2	950	850	
3	3650	7650	
4	800	900	
5	0	0	

*Assumed peak hour counts are 10% of daily counts

TRAFFIC ANALYSIS

Spreadsheet Evaluation Tool

- **Step 2: Inputs for Roundabout Alternative**

  Data needed to calculate performance measures

Source: Google Maps, 2011

	# Lanes	RT Bypass Lane? (Y or N)	# Exit Lanes	Entry Width [ft]	Angle to Next Leg [deg]
Approach 1				11	90
Approach 2				11	90
Approach 3				11	90
Approach 4				11	90
Approach 5				11	90

Roundabout Alternative:	
Number of Approaches	
# Lanes in Circle	
Mini-roundabout? (Y or N)	
Inscribed Circle Diameter [ft]	
Circulatory Width [ft]	11

TRAFFIC ANALYSIS

Spreadsheet Evaluation Tool

- **Step 3: Inputs for Roundabout Alternative**

  Option manual entry of performance measures

Source: Google Maps, 2011

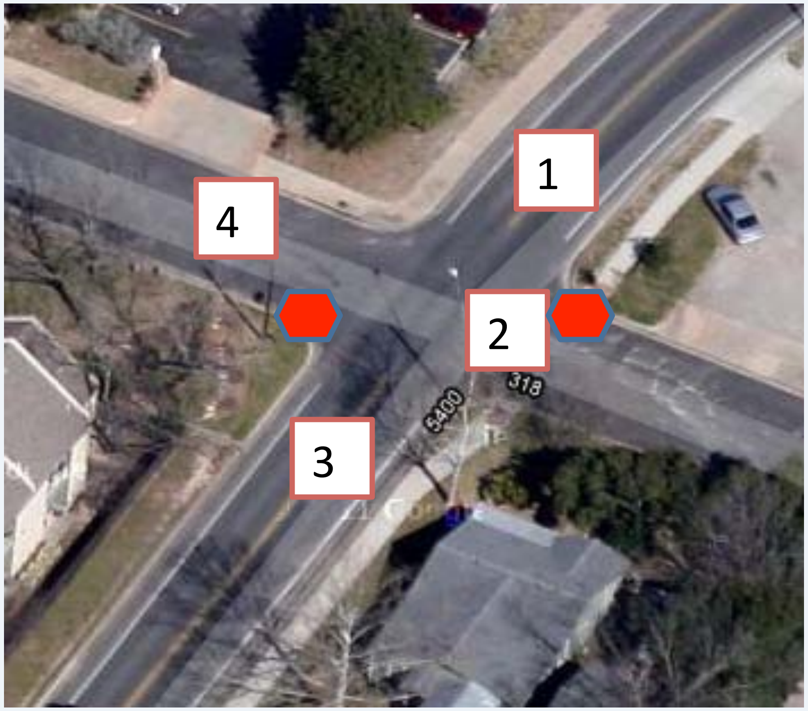
Vehicle Conflict Points	
Pedestrian Conflict Points	
Construction Cost	
Operation & Maintenance Cost	

TRAFFIC ANALYSIS

Spreadsheet Evaluation Tool

- **Step 4: Inputs for Non-Roundabout Alternative**

  Option manual entry of non-roundabout alternative characteristics



Source: Google Maps, 2011

Non-Roundabout Alternative:	
New or Existing?	
Number of Approaches	

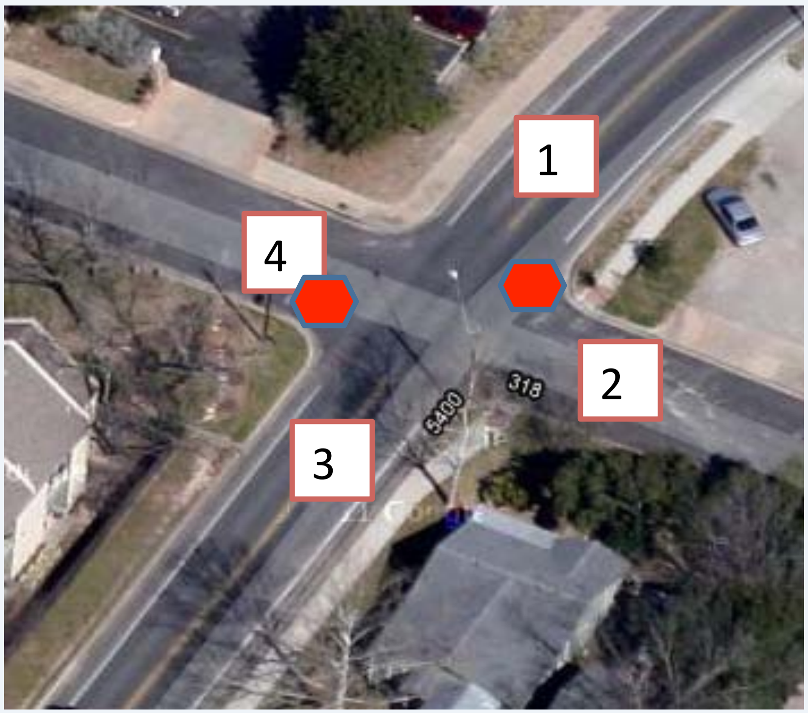
Approach	# Lanes
1	
2	
3	
4	
5	

TRAFFIC ANALYSIS

Spreadsheet Evaluation Tool

- **Step 4: Inputs for Non-Roundabout Alternative**

  Option manual entry performance measures



Vehicle Conflict Points	
Pedestrian Conflict Points	
Intersection Total Crash Prediction [crashes/year]	
Intersection Injury Crash Prediction [crashes/year]	
Average Speed [mph]	
Volume-to-capacity ratio	
Average delay [sec/veh]	
Level of Service	
95th Percentile Queue Length [vehicles]	
Construction Cost [$]	
Operation & Maintenance Cost [$]	

TRAFFIC ANALYSIS

Spreadsheet Evaluation Tool

- Compare Performance (see “Comparison” tab)

Source: Google Maps, 2011

Geometric Design

GEOMETRIC DESIGN

Introduction

- Applications Part 1
  - Roundabouts near schools
  - High speed rural intersections
- Geometric Design: Fundamental Principles
  - Single lane considerations
  - Multi-lane considerations
- Applications Part 2
  - Access management considerations
  - Traffic control during construction
- Peer Review Overview

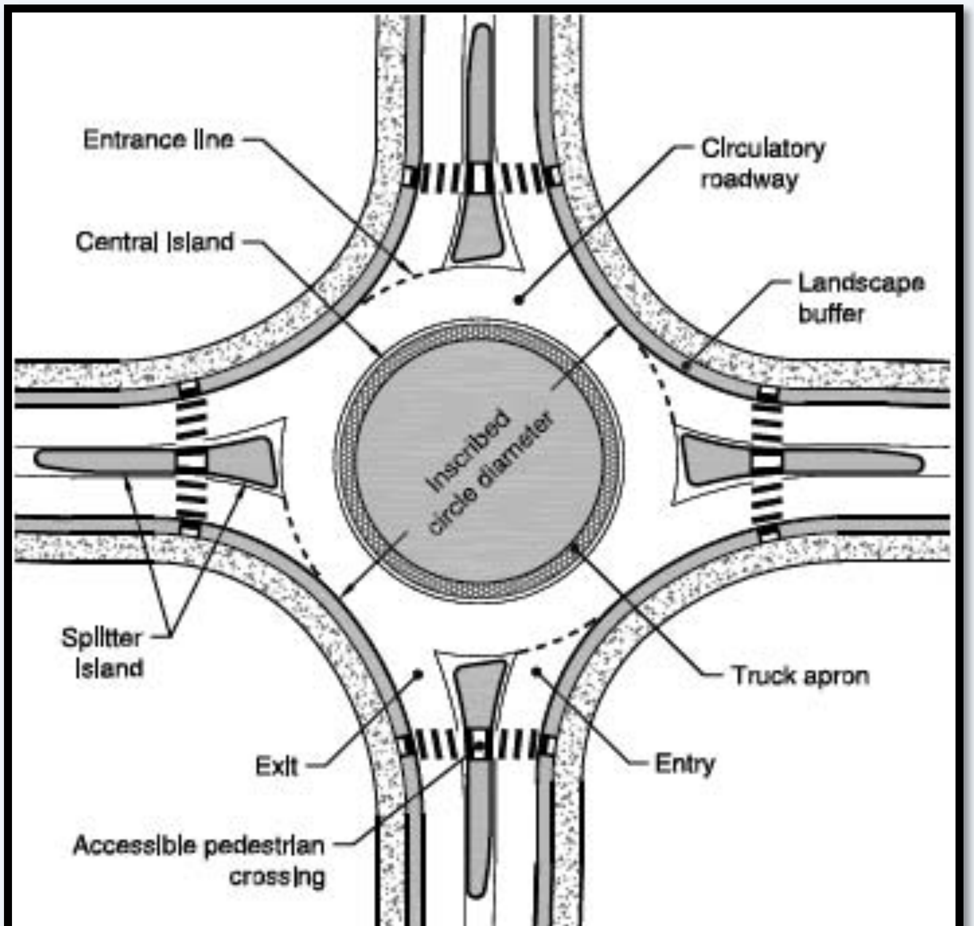
GEOMETRIC DESIGN

Introduction

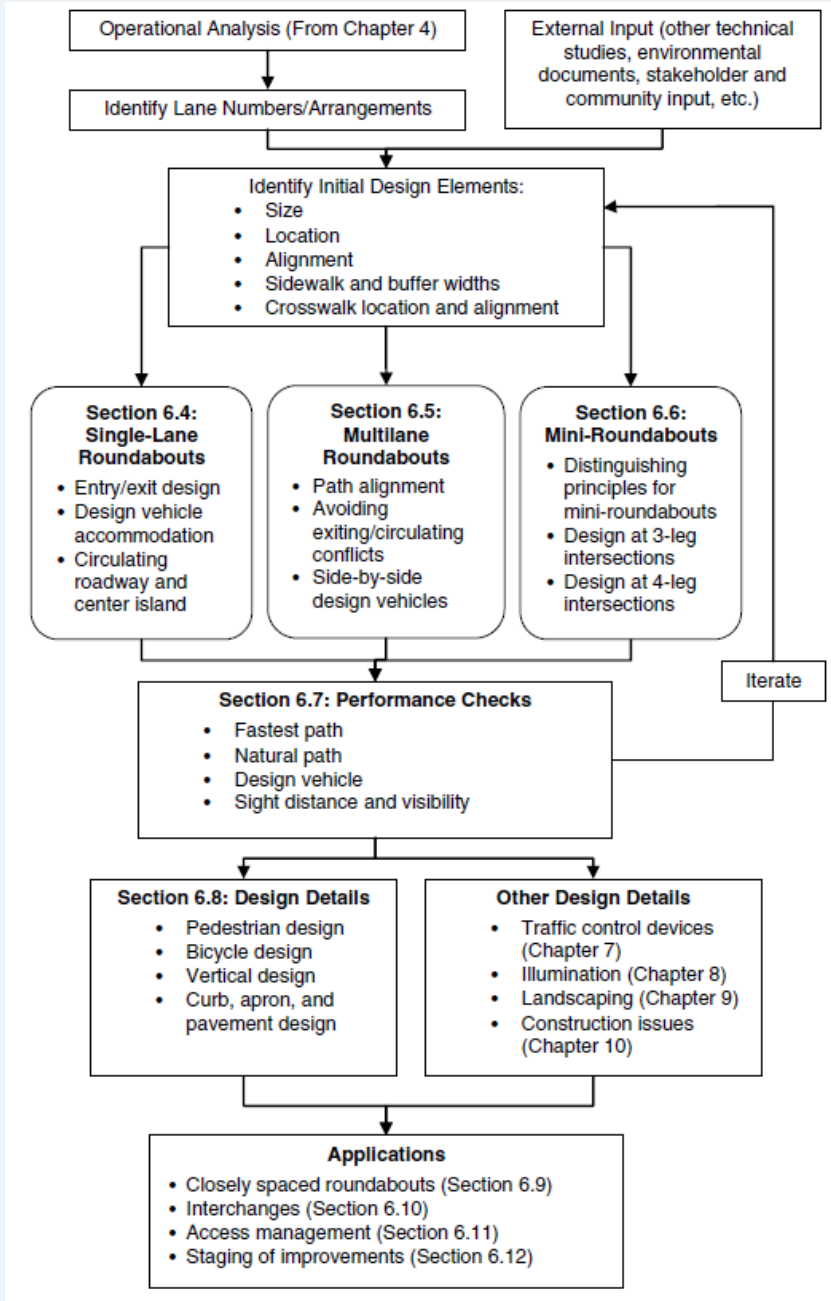
- Balancing of competing design forces
- <u>Slow speeds</u> create a safer environment
- Geometric parameters governed by maneuvering requirements of the design vehicle
- Design objectives are different for roundabouts in rural versus urban areas.

GEOMETRIC DESIGN

Introduction



(Source: NCHRP 672)



Outline for Design Process

(Source: NCHRP 672)

GEOMETRIC DESIGN

Principles and Objectives

- Principles from NCHRP 672 [6.2]:
  - Using deflection, facilitate slow entry speeds and consistent speeds on and out of the circulatory roadway
  - Number of lanes and lane assignment should result in desired capacity, lane volume balance, and lane continuity.
  - Smooth channelization that makes it obvious to drivers where they should be.
  - Sufficient accommodation of design vehicle
  - Keep all users in mind by meeting the needs of pedestrians and cyclists
  - Create ample sight distance and visibility for driver recognition of intersection and conflicting users.

GEOMETRIC DESIGN

Single Lane Roundabouts

- Size, location, and alignment
- Horizontal details
- How to sketch a roundabout from scratch

GEOMETRIC DESIGN

Inscribed Circle Diameter

- **Typical ranges for categories and design vehicles**

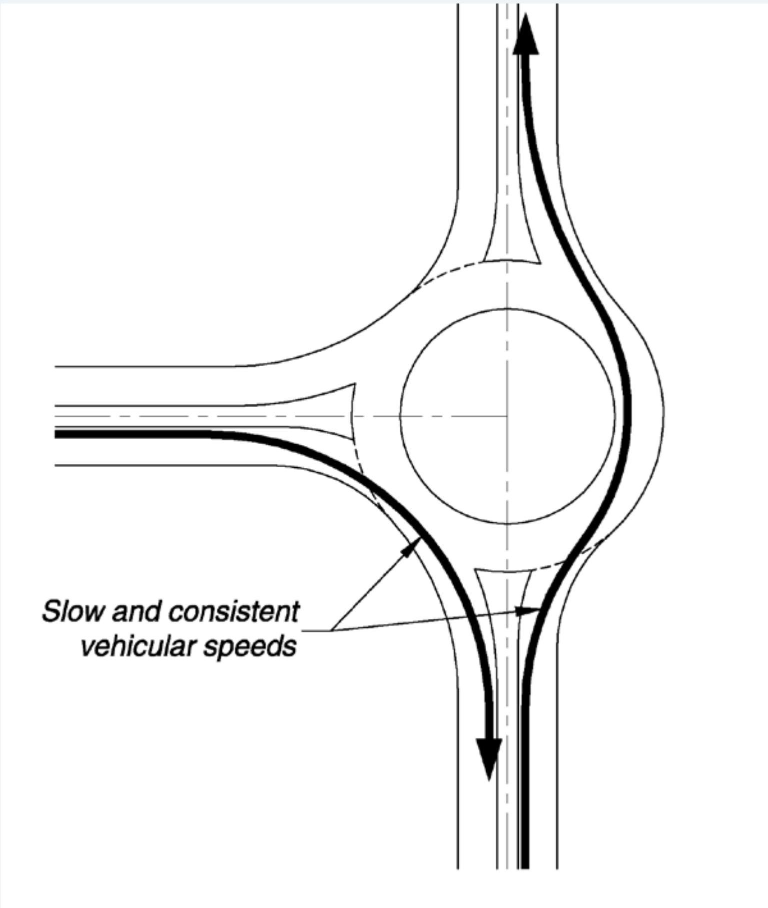
Roundabout Configuration	Typical Design Vehicle	Common Inscribed Circle Diameter Range*	
Mini-Roundabout	SU-30 (SU-9)	45 to 90 ft	(14 to 27 m)
Single-Lane Roundabout	B-40 (B-12)	90 to 150 ft	(27 to 46 m)
	WB-50 (WB-15)	105 to 150 ft	(32 to 46 m)
	WB-67 (WB-20)	130 to 180 ft	(40 to 55 m)
Multilane Roundabout (2 lanes)	WB-50 (WB-15)	150 to 220 ft	(46 to 67 m)
	WB-67 (WB-20)	165 to 220 ft	(50 to 67 m)
Multilane Roundabout (3 lanes)	WB-50 (WB-15)	200 to 250 ft	(61 to 76 m)
	WB-67 (WB-20)	220 to 300 ft	(67 to 91 m)

* Assumes 90-degree angles between entries and no more than four legs. List of possible design vehicles not all-inclusive.

NCHRP Report 672 Exhibit 6-9

GEOMETRIC DESIGN

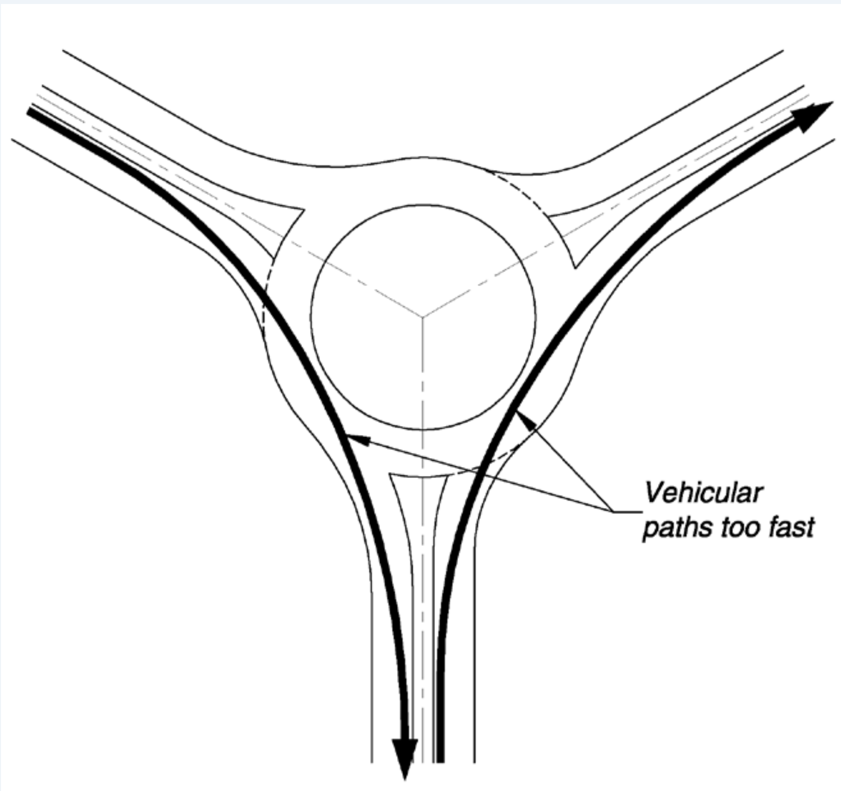
Approach Angles



- Perpendicular approaches often are more amenable to achieving desired speeds.
- However, perpendicular approaches are not a design requirement.
- If approaches skewed, make corresponding adjustments to other design components.

GEOMETRIC DESIGN

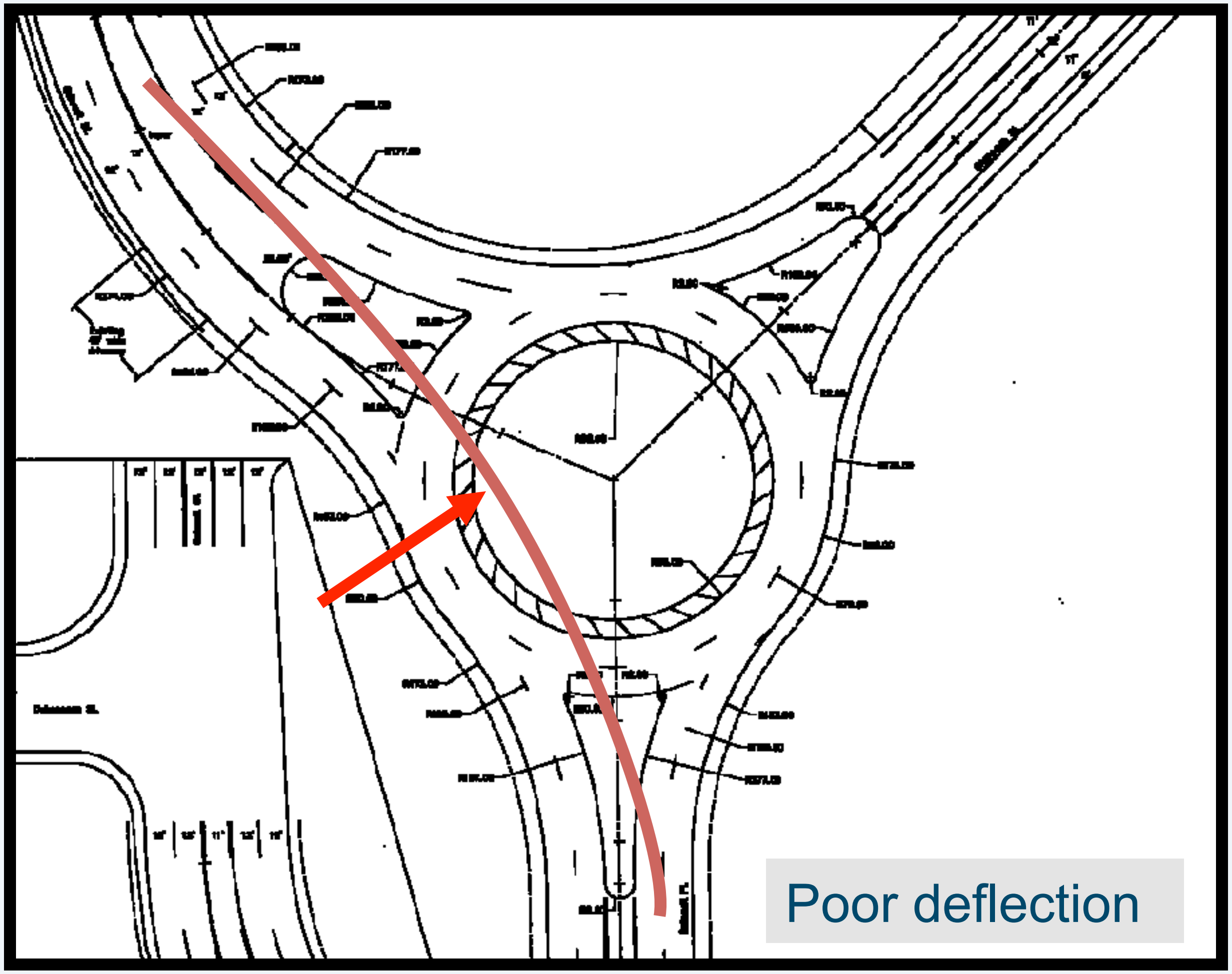
Approach Angles



- Possible remedies:
  - Changing the inscribed circle diameter
  - Offsetting the approach centerline to the left of the center of the roundabout
  - Reducing entry widths and entry radii

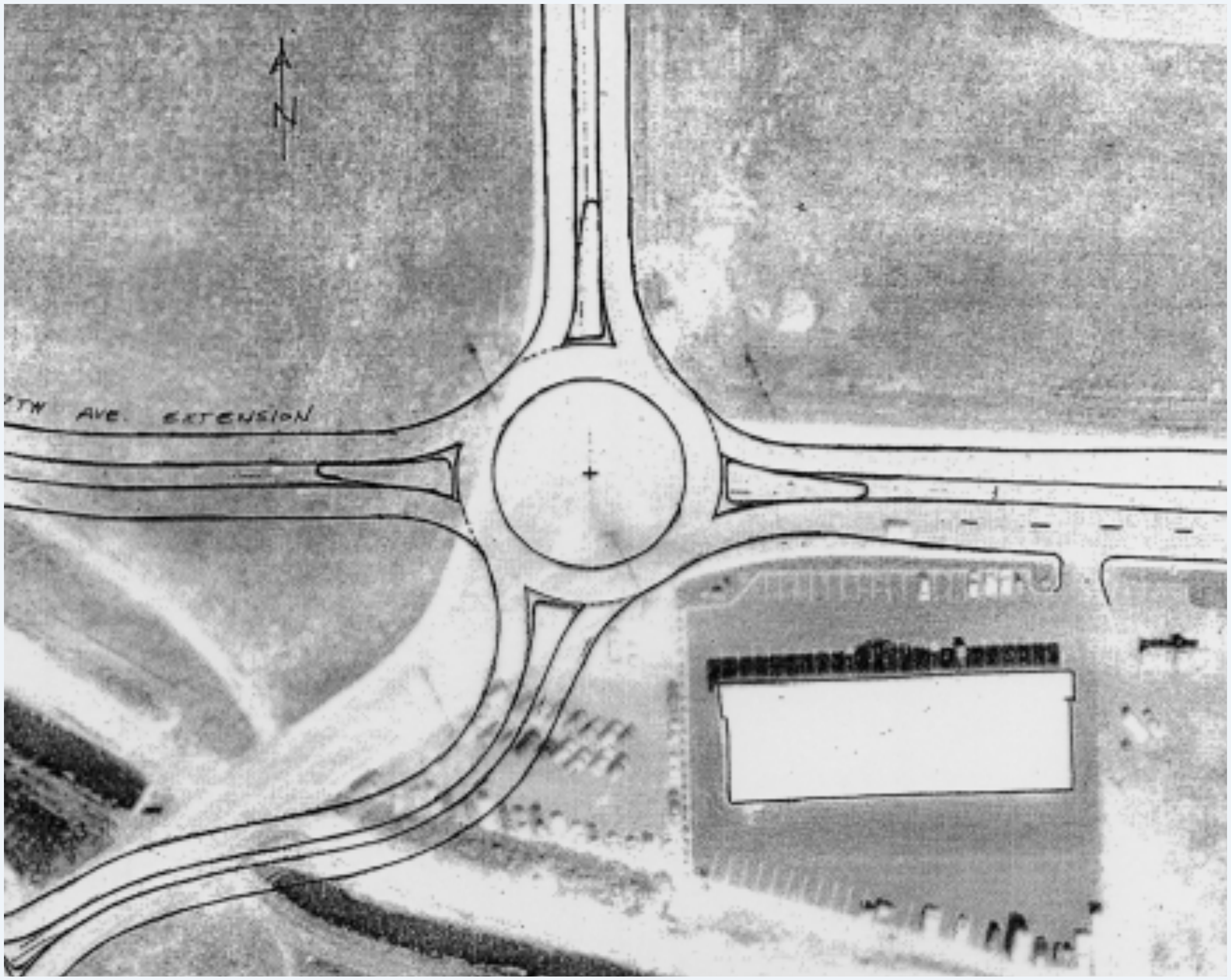
GEOMETRIC DESIGN

Approach Angles: Example



GEOMETRIC DESIGN

Approach Angles: Example – Kennewick, WA



(Source: Kittelson & Associates, Inc.)

GEOMETRIC DESIGN

Approach Angles: Example – Kennewick, WA

- Size, location, and alignment
- Horizontal details
- How to sketch a roundabout from scratch

GEOMETRIC DESIGN

Horizontal Geometry Details

- Entry design
- Exit design
- Circulatory width
- Central island design
- Splitter island design

GEOMETRIC DESIGN

Entry Width

- Largest determinant of a roundabout's capacity
- Dependent upon the number of lanes and the design vehicle
- Typical single-lane entry width: 13 - 18 ft (4.0 – 5.5 m)
- Typical single-lane circulatory width: 16 – 20 ft (4.8 – 6.0 m)

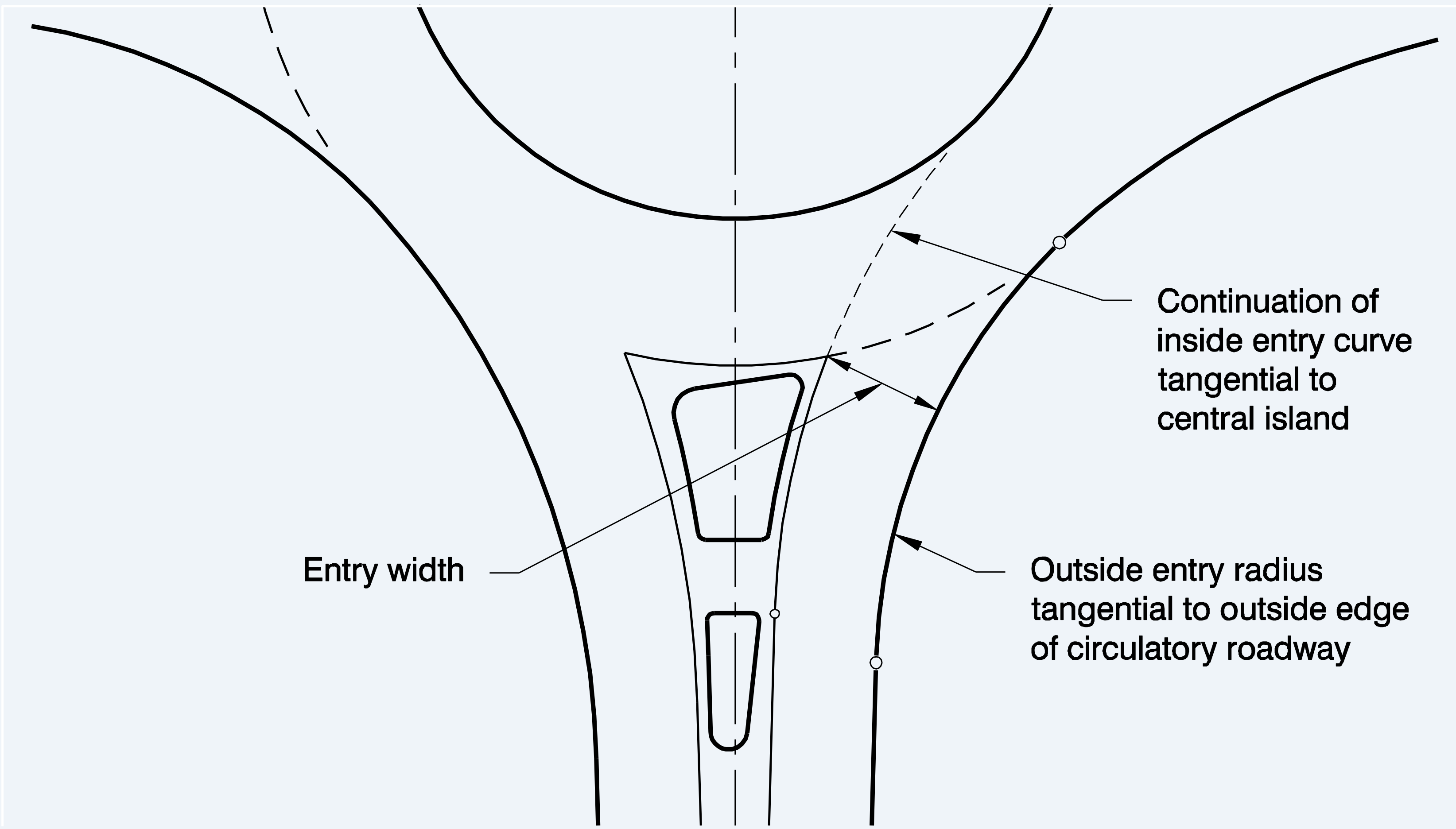
GEOMETRIC DESIGN

Entry Curves: Single Lane Roundabouts

- Range from 35 ft to 100 ft (10 - 30 m)
- Radii should be balanced against entry speeds and design vehicle needs
- Roundabouts with lower speeds and smaller design vehicles may have smaller radii

GEOMETRIC DESIGN

Entry Curves: Single Lane Roundabouts



NCHRP Report 672 Exhibit 6-14

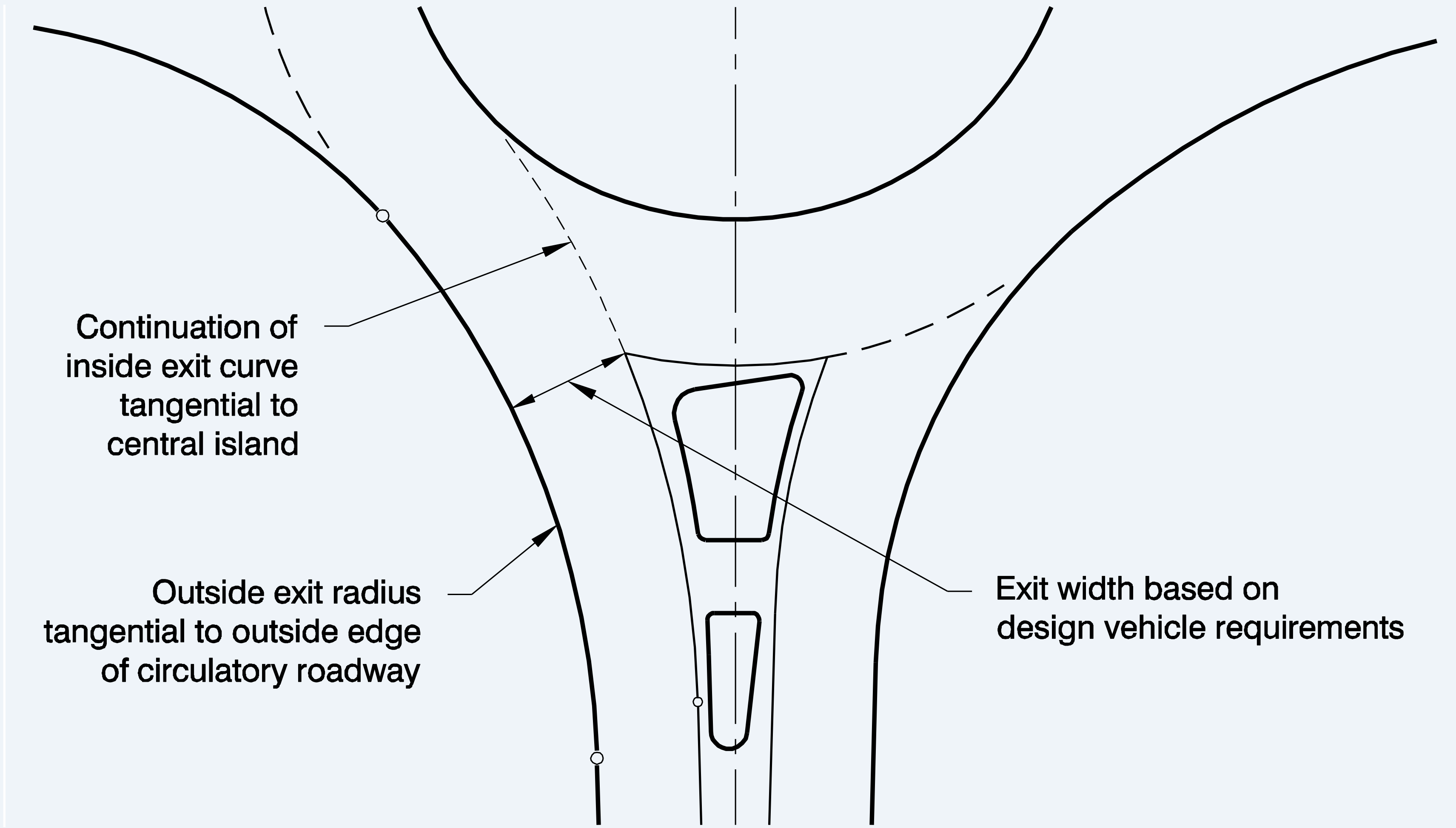
GEOMETRIC DESIGN

Exit Geometry

- Designed to enforce a curved exit path
- Consider pedestrians
- Can be larger at rural locations

GEOMETRIC DESIGN

Exit Curves: Single Lane Roundabouts



NCHRP Report 672 Exhibit 6-15

GEOMETRIC DESIGN

Differing Exit Design Philosophies

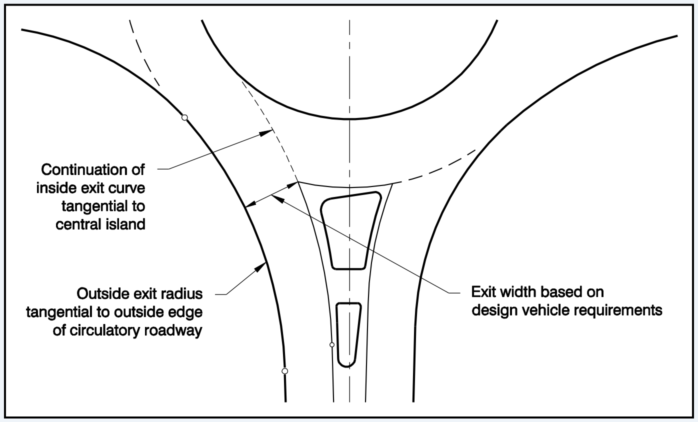
Tangential exit design

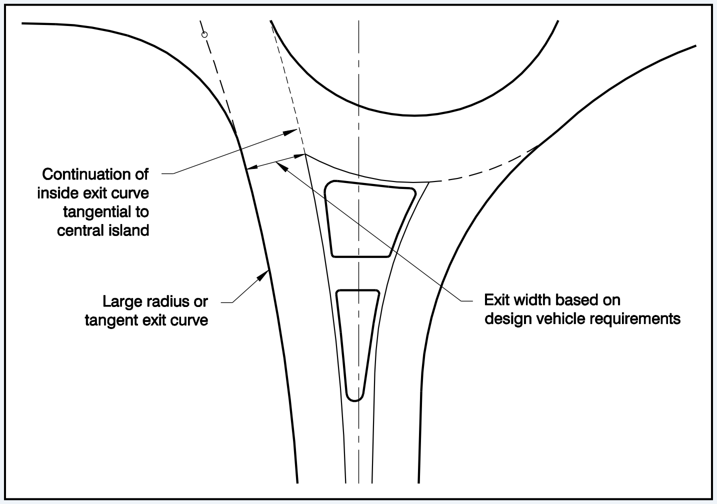
Curved exit design

GEOMETRIC DESIGN

Exit Curvature

- Radial alignments with smaller exit radii and offset-left alignments with larger exit radii each have their place
- Each circumstance requires its own solution, with principles determining tradeoffs





NCHRP Report 672 Exhibit 6-15, 6-16

GEOMETRIC DESIGN

Circulatory Roadway Width: Single Lane Roundabouts

- Width should be comfortable for passenger cars
- Width should accommodate transit vehicle without using apron
- A truck apron can be used to minimize the width while accommodating trucks

GEOMETRIC DESIGN

Central Island

- Includes both raised non-traversable area and truck apron area
- Can be landscaped → consider maintenance
- Central island should not attract pedestrians

GEOMETRIC DESIGN

Central Island Example: Santa Barbara, CA

Photo: Lee Rodegerdts

GEOMETRIC DESIGN

Central Island Example: Bend, OR

Photo: Oregon DOT

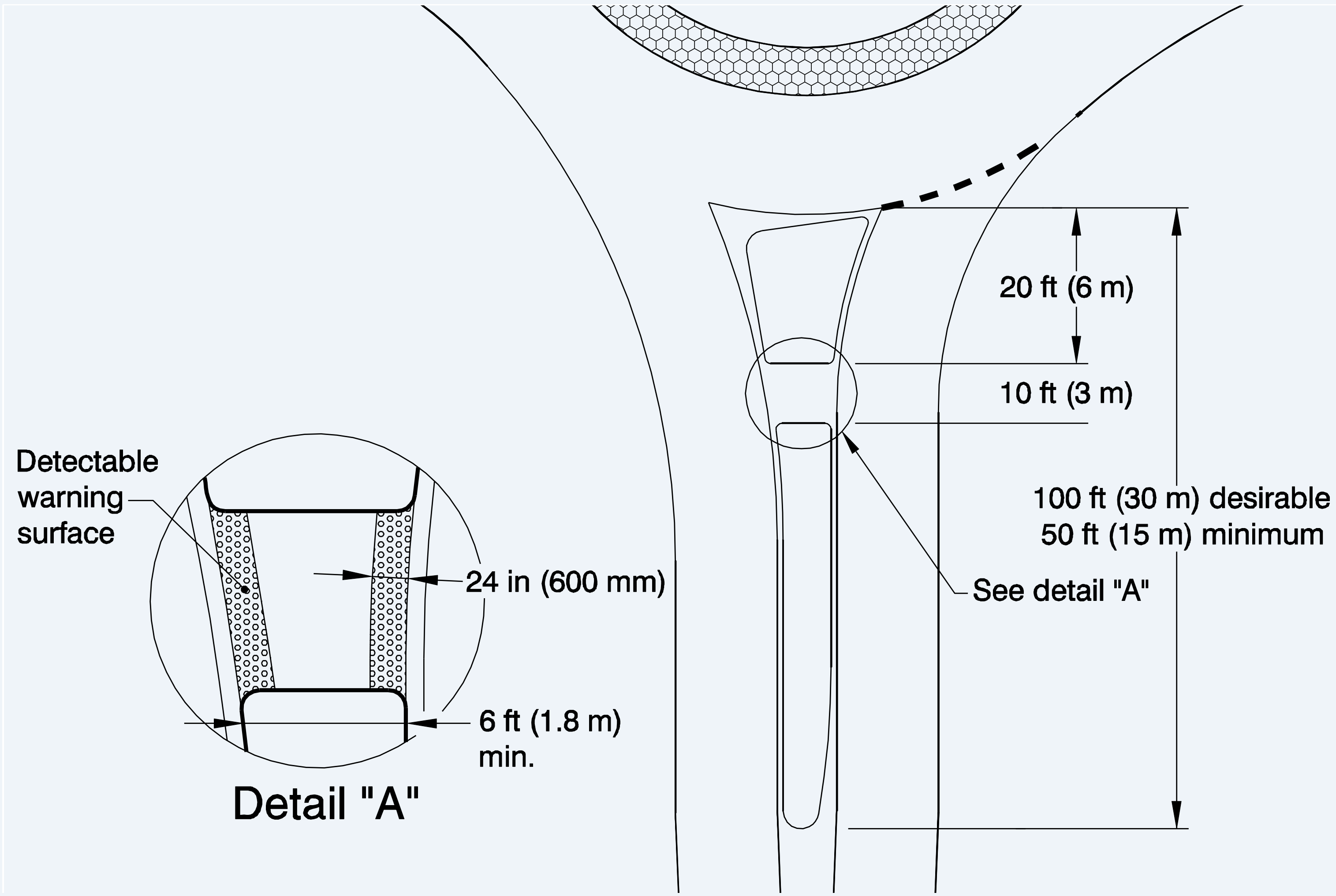
GEOMETRIC DESIGN

Splitter Islands

- Should be provided on all but the very small roundabouts
- Purpose is:
  - provide shelter for peds
  - assist in controlling speeds
  - positive guidance
  - physically separate entering and exiting traffic streams
  - deter wrong way movements
  - placement of signs
- Larger splitter islands can enhance safety by separating entering and exiting traffic streams

GEOMETRIC DESIGN

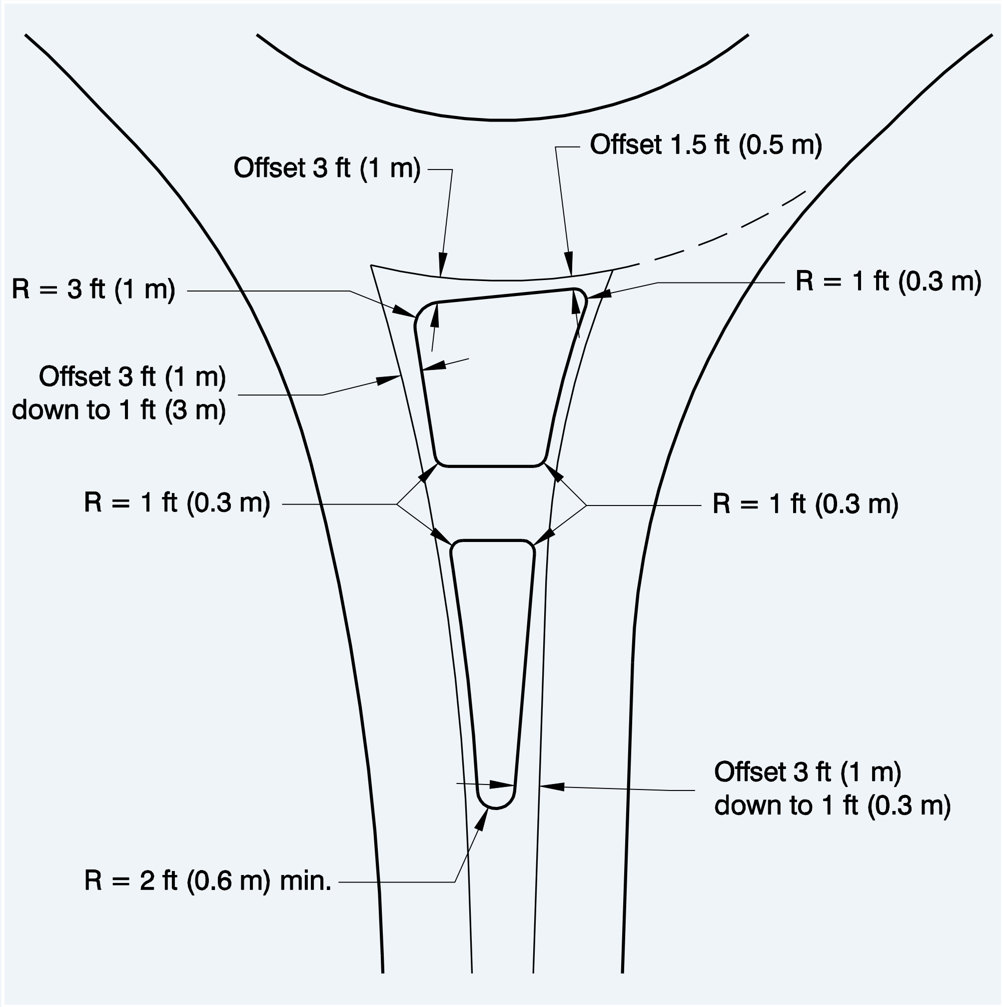
Pedestrian Crossing Detail



NCHRP Report 672 Exhibit 6-12

GEOMETRIC DESIGN

Splitter Island Details



NCHRP Report 672 Exhibit 6-13

GEOMETRIC DESIGN

Channelization Example: Kennewick, WA

Photo: Lee Rodegerdts

GEOMETRIC DESIGN

Single Lane Roundabouts

- Size, location, and alignment
- Horizontal details
- How to sketch a roundabout from scratch

GEOMETRIC DESIGN

Single Lane Roundabouts

- Size, location, and alignment
- Horizontal details
- How to sketch a roundabout from scratch

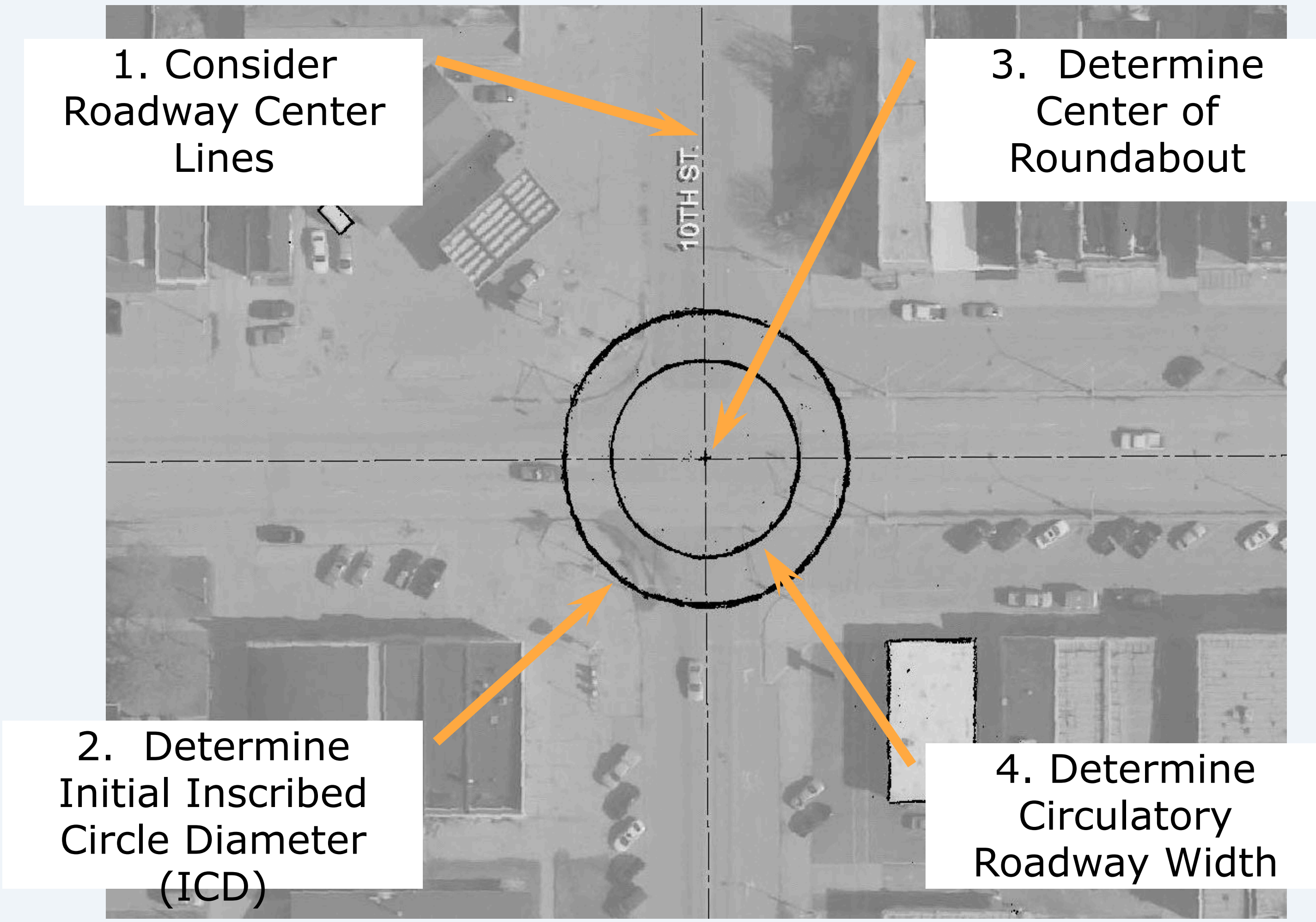
GEOMETRIC DESIGN

How to Sketch a Roundabout from Scratch

- There is no one correct way to design a roundabout – each designer develops their own methods
- Keeps principles in mind when developing a sketch
- Test sketch after completion
- Iterate as needed to balance objectives
- The following method is but one way to sketch a single-lane roundabout
- Other techniques needed for multilane

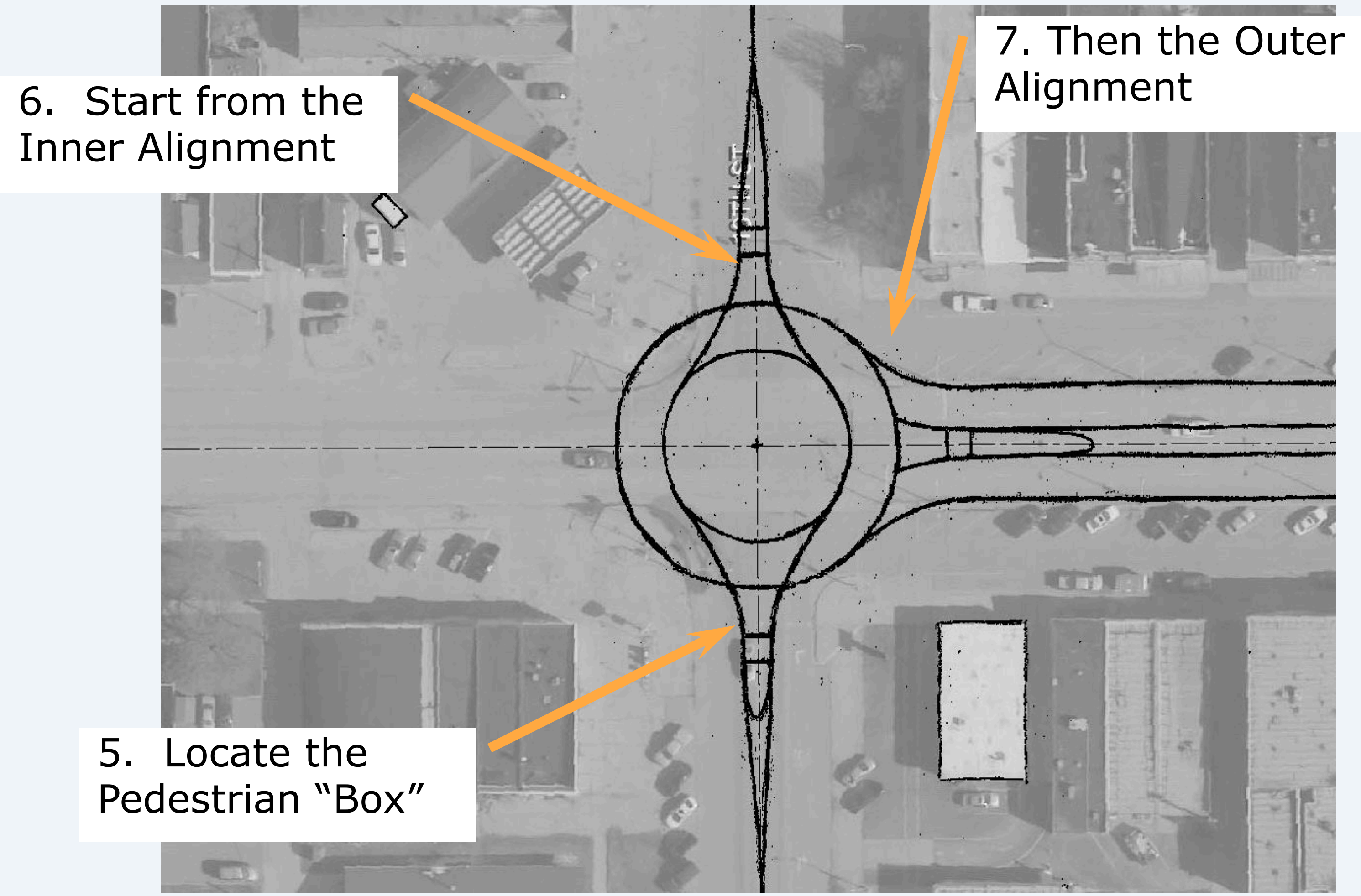
GEOMETRIC DESIGN

Starting Up: Size and Locate Circle



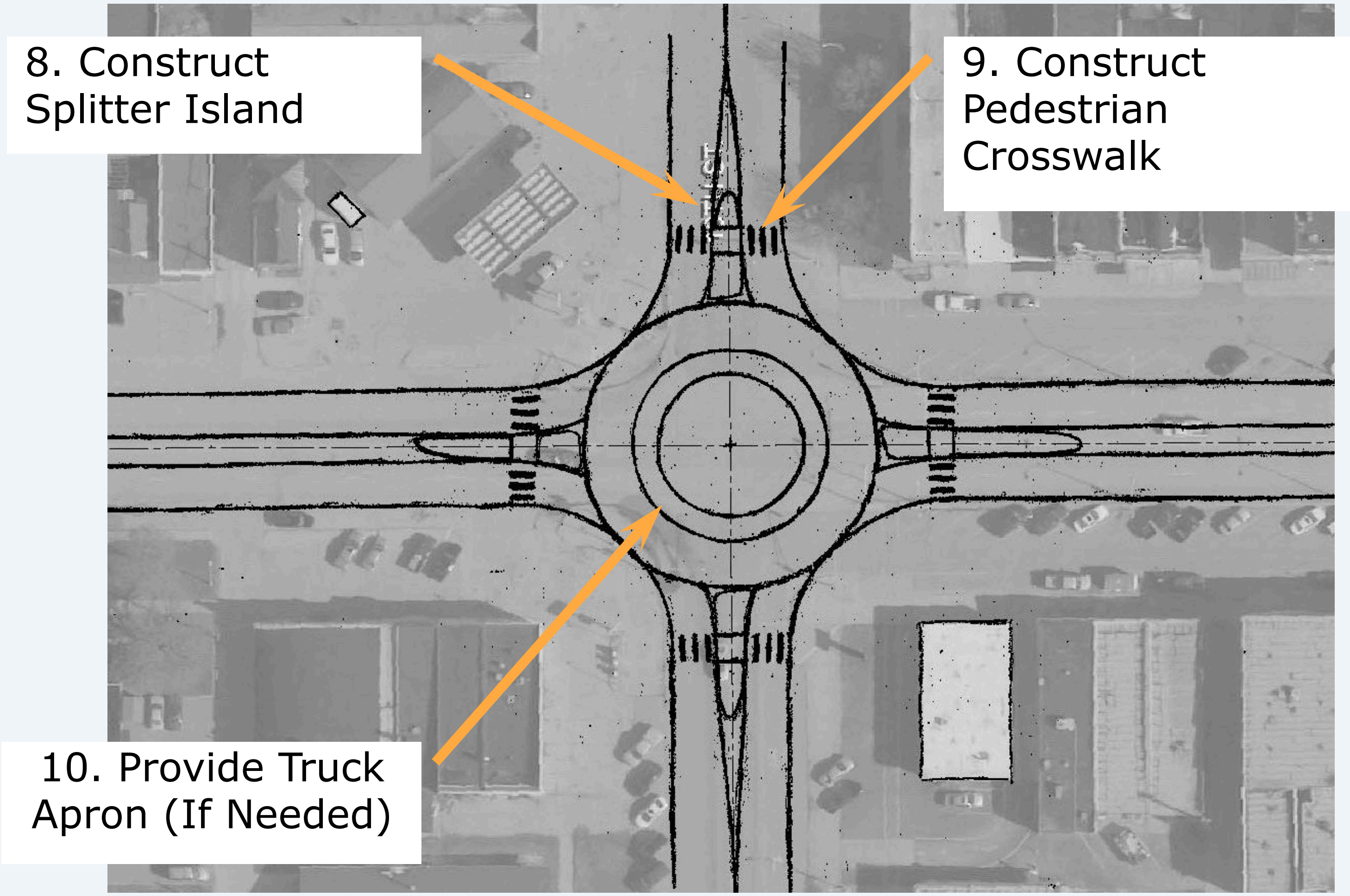
GEOMETRIC DESIGN

Sketching a Roundabout: Construct Entries and Exits



GEOMETRIC DESIGN

Sketching a Roundabout: Add Details

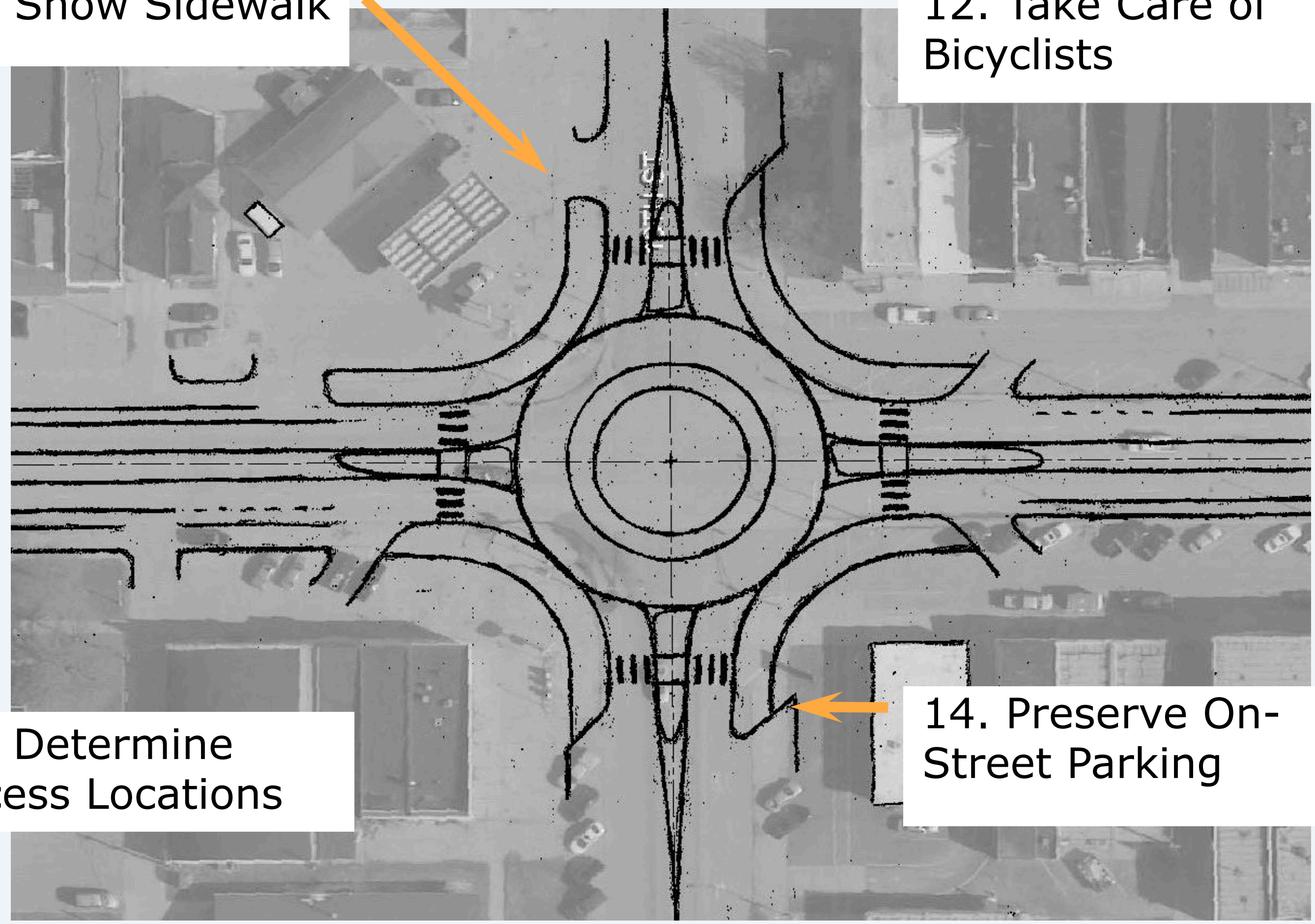


GEOMETRIC DESIGN

Sketching a Roundabout: Complete Remaining Details

11. Show Sidewalk

12. Take Care of Bicyclists

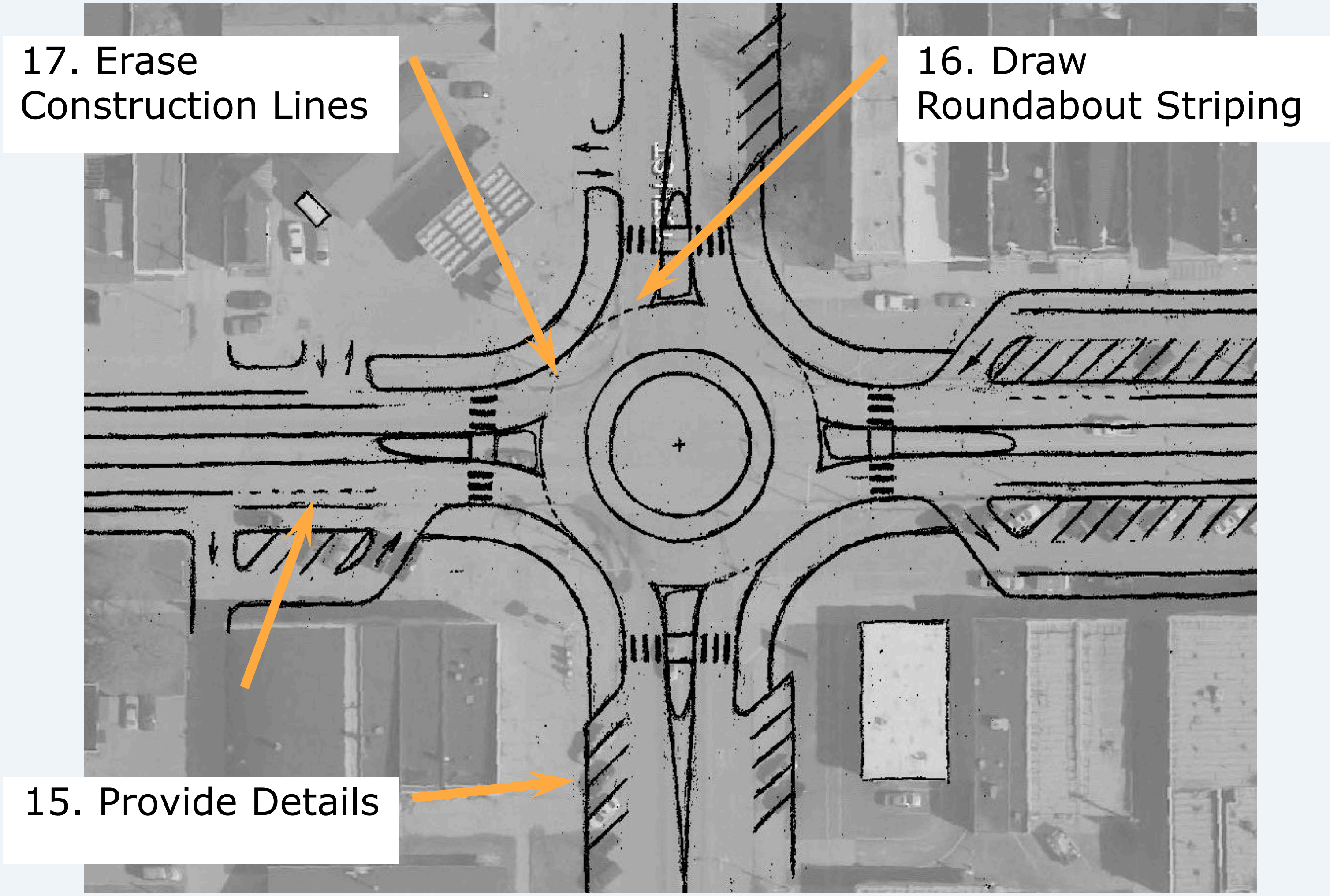


13. Determine Access Locations

14. Preserve On-Street Parking

GEOMETRIC DESIGN

Sketching a Roundabout: Clean Up to "Presentation" Quality



GEOMETRIC DESIGN

Multilane Roundabouts

- All of the principles of the single-lane roundabout apply
- Additional considerations:
  - Lane numbers and assignments
  - Natural vehicle paths
  - Crossing versus merging/diverging paths
- Techniques that work for single-lanes may not work for multilanes
- Order of magnitude more complicated – care needed to produce good designs

GEOMETRIC DESIGN

Multilane Roundabouts: Elements

- Lane numbers and assignments
- Conflict area management
- Accommodating side-by-side vehicles
- Designing for future expansion
- Treatment of wide medians on divided highways

GEOMETRIC DESIGN

Multilane Roundabouts: Lane Numbers and Assignments

- Each entry, exit, and section of circulatory roadway should have the appropriate number of lanes, properly assigned
- Geometric design, signing/striping, and operational analysis need to agree
- OK to have mixture of single- and multilane entries

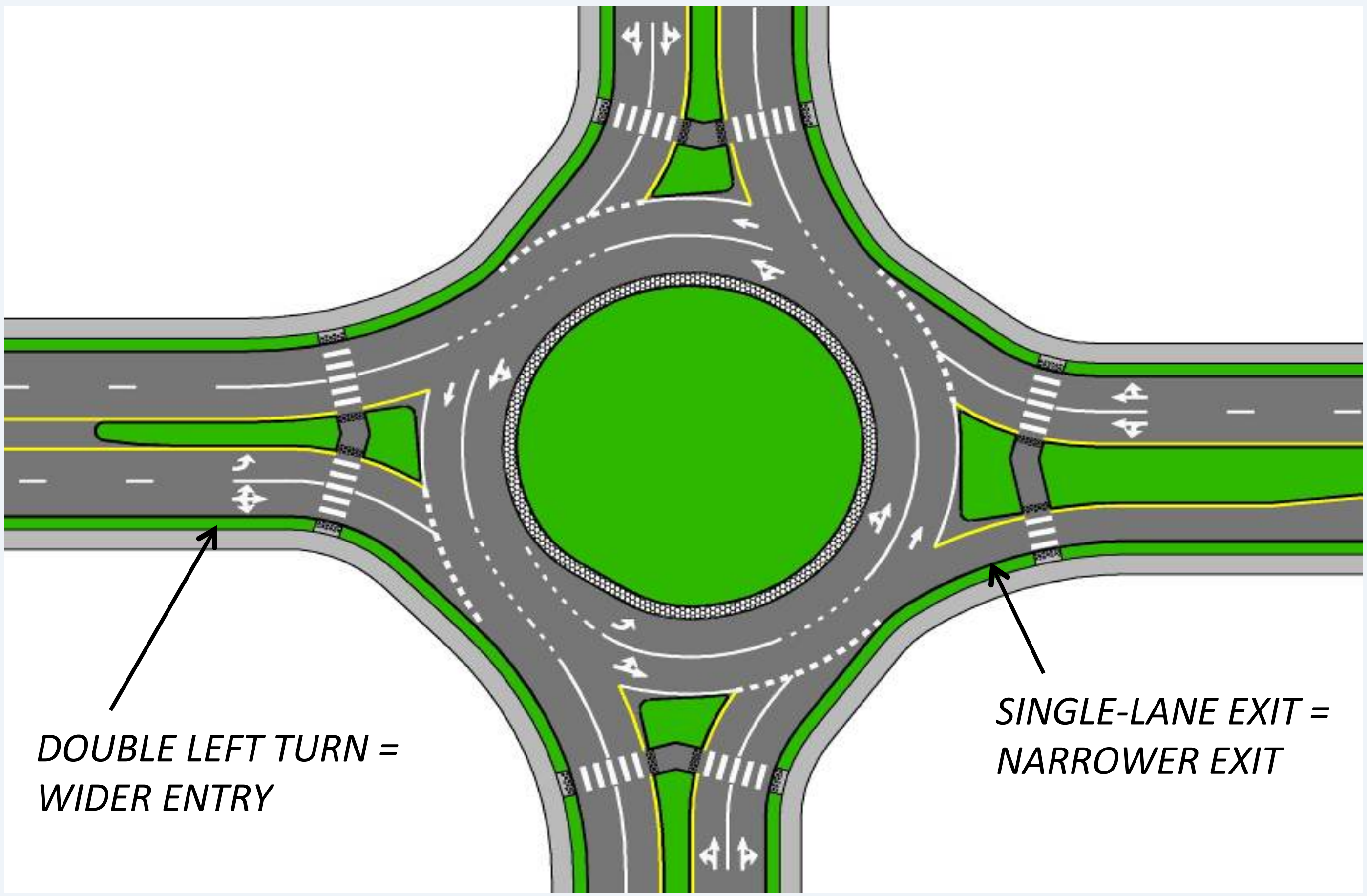
GEOMETRIC DESIGN

Multilane Roundabouts: Number of Lanes

- Use operational analysis to determine appropriate lane assignment
- Provide only as many lanes as needed for existing or anticipated demand
  - Wider entries and exits tend to be less safe for all modes
  - Consider building for near-term volumes and planning for future expansion

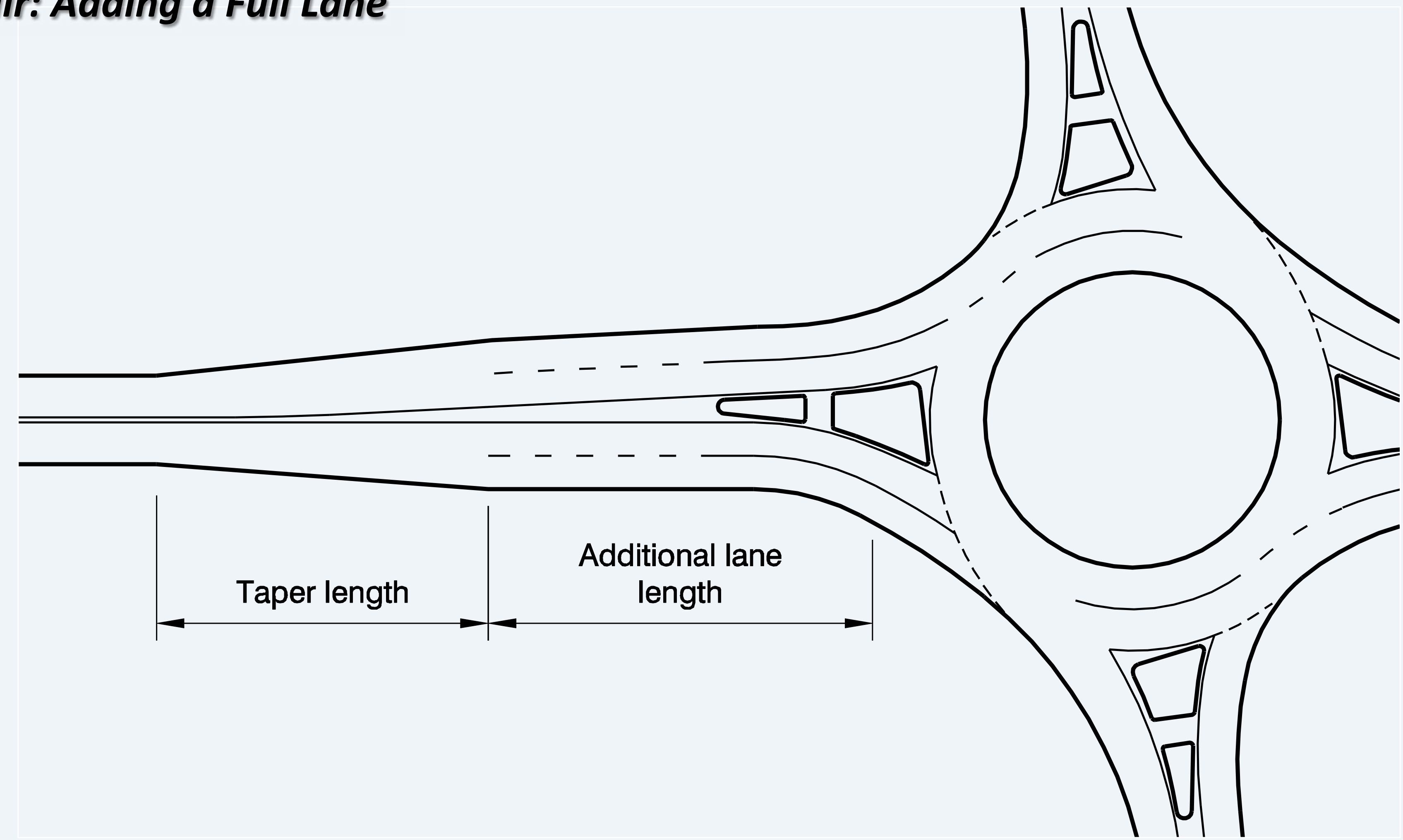
GEOMETRIC DESIGN

Match Geometric Design to Anticipated Lane Assignment



GEOMETRIC DESIGN

Flair: Adding a Full Lane



NCHRP Report 672 Exhibit 6-24

GEOMETRIC DESIGN

Multilane Roundabout Design Elements

- Lane numbers and assignments
- Conflict area management
- Accommodating side-by-side vehicles
- Designing for future expansion
- Treatment of wide medians on divided highways

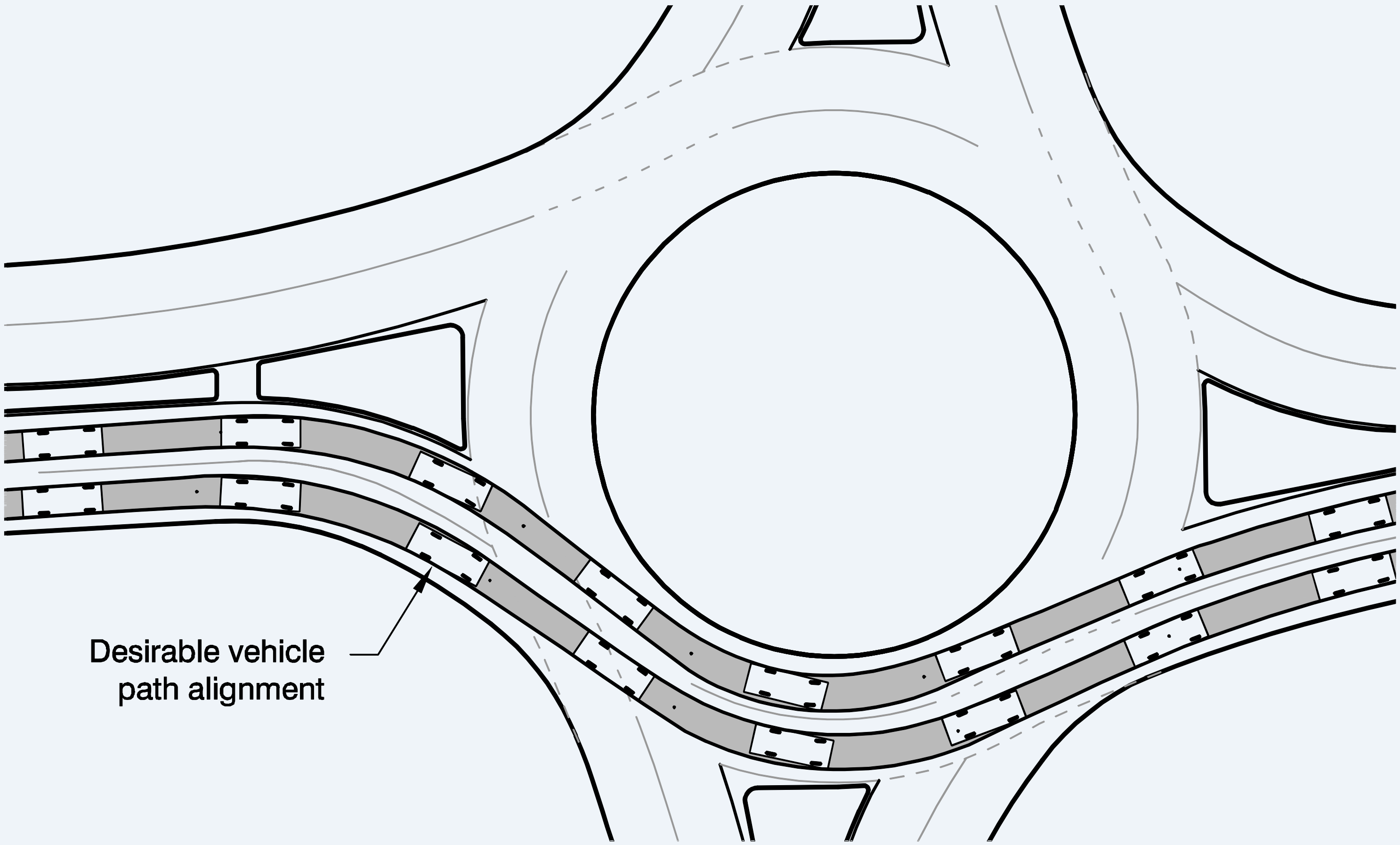
GEOMETRIC DESIGN

Conflict Area Management

- Path overlap conflicts
- Exit-circulating conflicts

GEOMETRIC DESIGN

Natural Vehicle Path



NCHRP Report 672 Exhibit 6-29

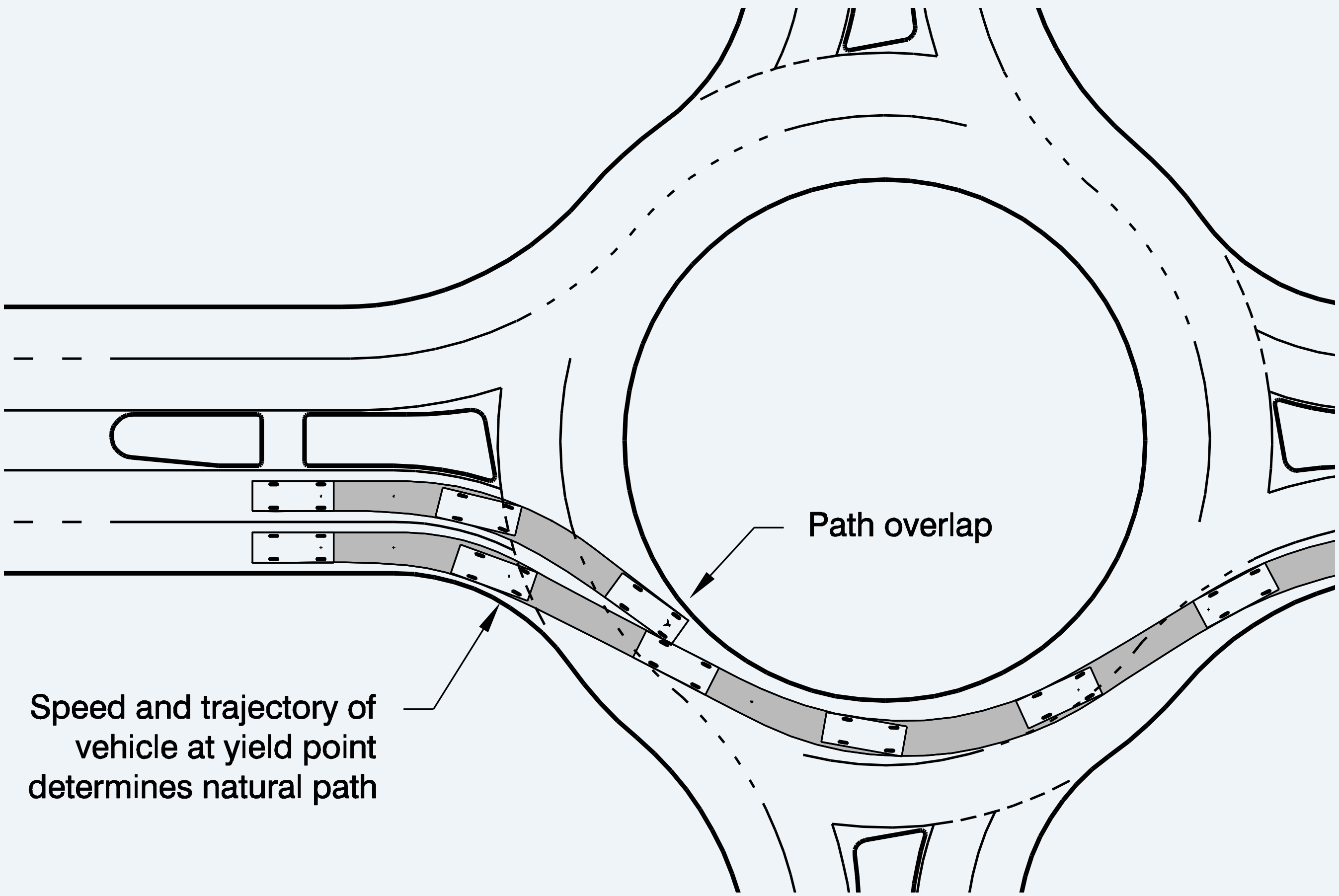
GEOMETRIC DESIGN

Natural Vehicle Path

- Path an approaching vehicle will take assuming there is traffic in all lanes
- Speed and orientation of vehicle at the yield line determines the natural path
- Natural path does not have sudden changes in curvature
- Consecutive curves should be of a similar radius
- If paths overlap, safety or capacity may be affected

GEOMETRIC DESIGN

Vehicle Path Overlap



NCHRP Report 672 Exhibit 6-28

GEOMETRIC DESIGN

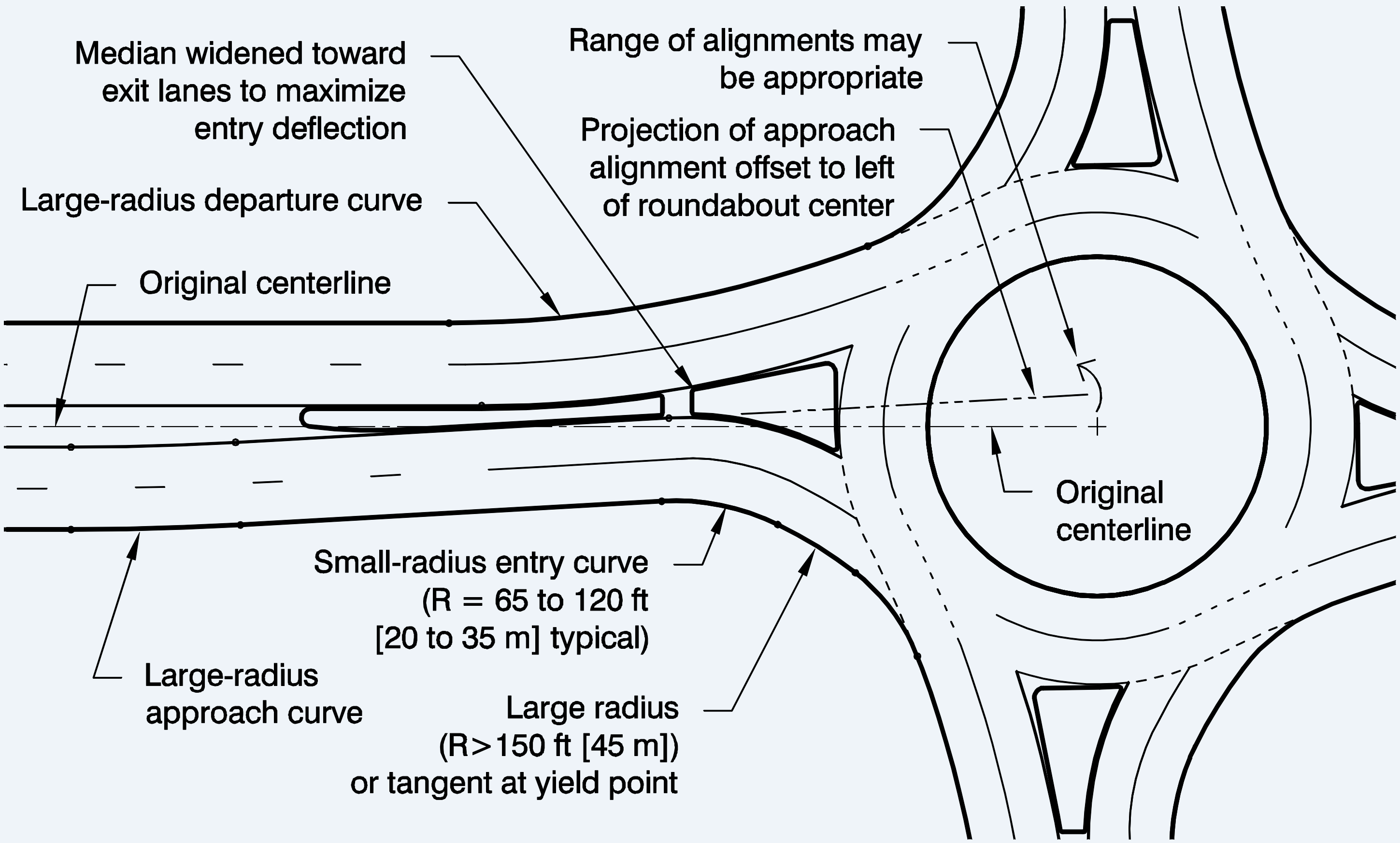
Capacity Problem Due to Entry Path Overlap

- Note poor lane utilization

Photo: Barry Crown

GEOMETRIC DESIGN

Design Techniques to Avoid Path Overlap



NCHRP Report 672 Exhibit 6-30

GEOMETRIC DESIGN

Multilane Roundabout Case Study: Clearwater, FL

Photo: Bruce Robinson

GEOMETRIC DESIGN

Multilane Roundabout Case Study: Clearwater, FL

Photo: Barry Crown

GEOMETRIC DESIGN

Multilane Roundabout Case Study: Clearwater, FL

Photo: Lee Rodegerdts

GEOMETRIC DESIGN

Multilane Roundabout Case Study: Clearwater, FL

Photo: Bruce Robinson

Before (2001)

Photo: Lee Rodegerdts

After (2005)

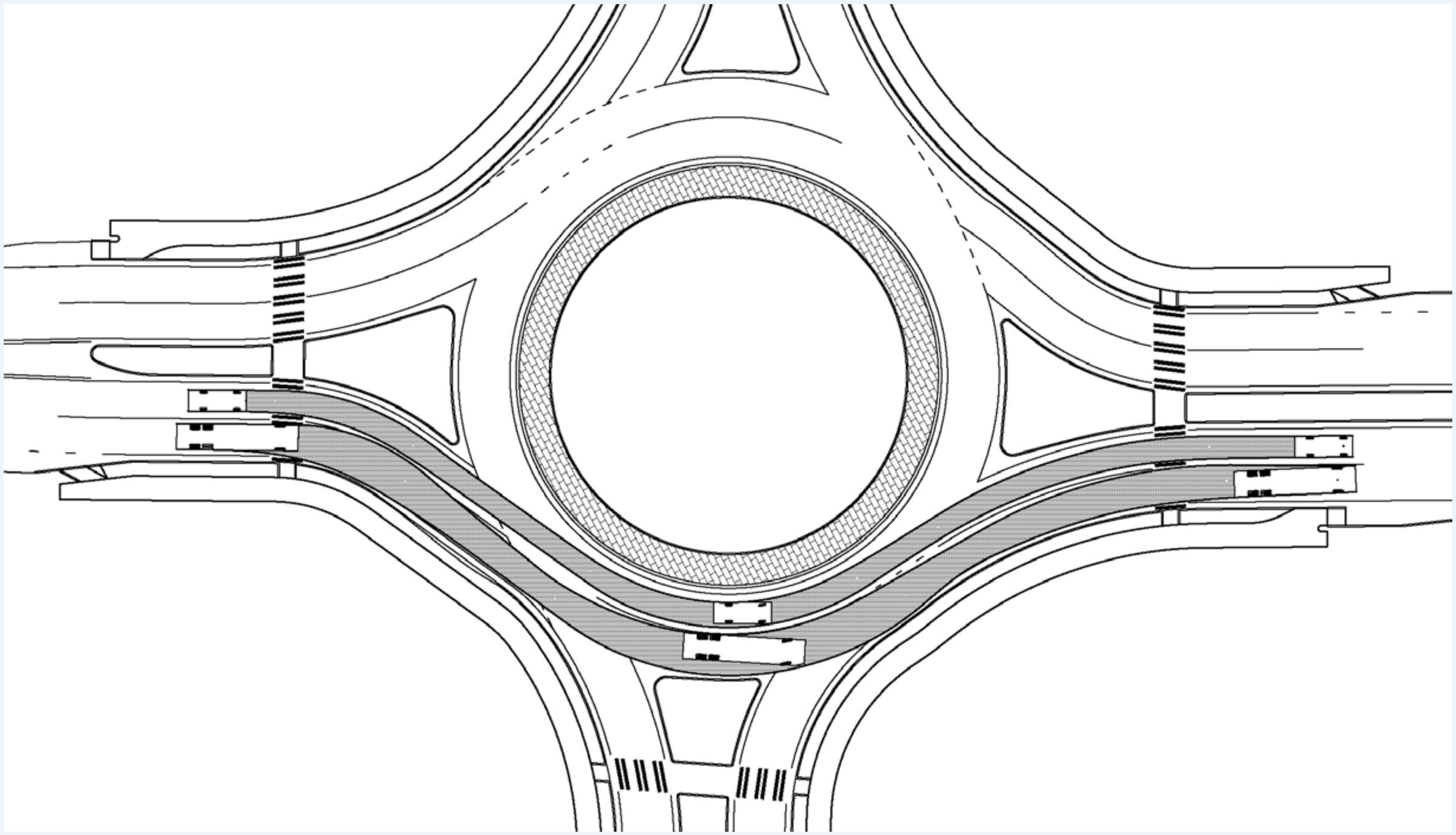
GEOMETRIC DESIGN

Multilane Design Elements

- Lane numbers and assignments
- Conflict area management
- <u>Accommodating side-by-side vehicles</u>
- Designing for future expansion
- Treatment of wide medians on divided highways

GEOMETRIC DESIGN

Circulatory Roadway Width: Double-Lane Example



NCHRP Report 672 Exhibit 6-36

GEOMETRIC DESIGN

Accommodating Trucks

- Truck occupying entire circulatory roadway
  - Common design approach for roundabouts with relatively few trucks
- Truck next to passenger car
  - Commonly a prudent design solution to provide a possible escape for a passenger car driver who pulls next to truck
- Truck next to truck
  - Likely rare occurrence, since truck drivers not likely to pull next to each other
  - May be needed at locations with high truck volumes

GEOMETRIC DESIGN

Accommodating Trucks

- Ongoing research in this area
  - Study by Wisconsin and Minnesota DOTs (primarily focused on treatments of normal design vehicles)
  - Pooled fund study led by Kansas DOT (primarily focused on oversized trucks)

GEOMETRIC DESIGN

Multilane Roundabouts Design Elements

- Lane numbers and assignments
- Conflict area management
- Accommodating side-by-side vehicles
- Designing for future expansion
- Treatment of wide medians on divided highways

GEOMETRIC DESIGN

Phased Construction Plan

Consider when:

- Multilane required for long-term traffic demand.
- Single-lane provides adequate capacity for near term traffic demand (5+ years).
- Single-lane offers safety benefits for near term.

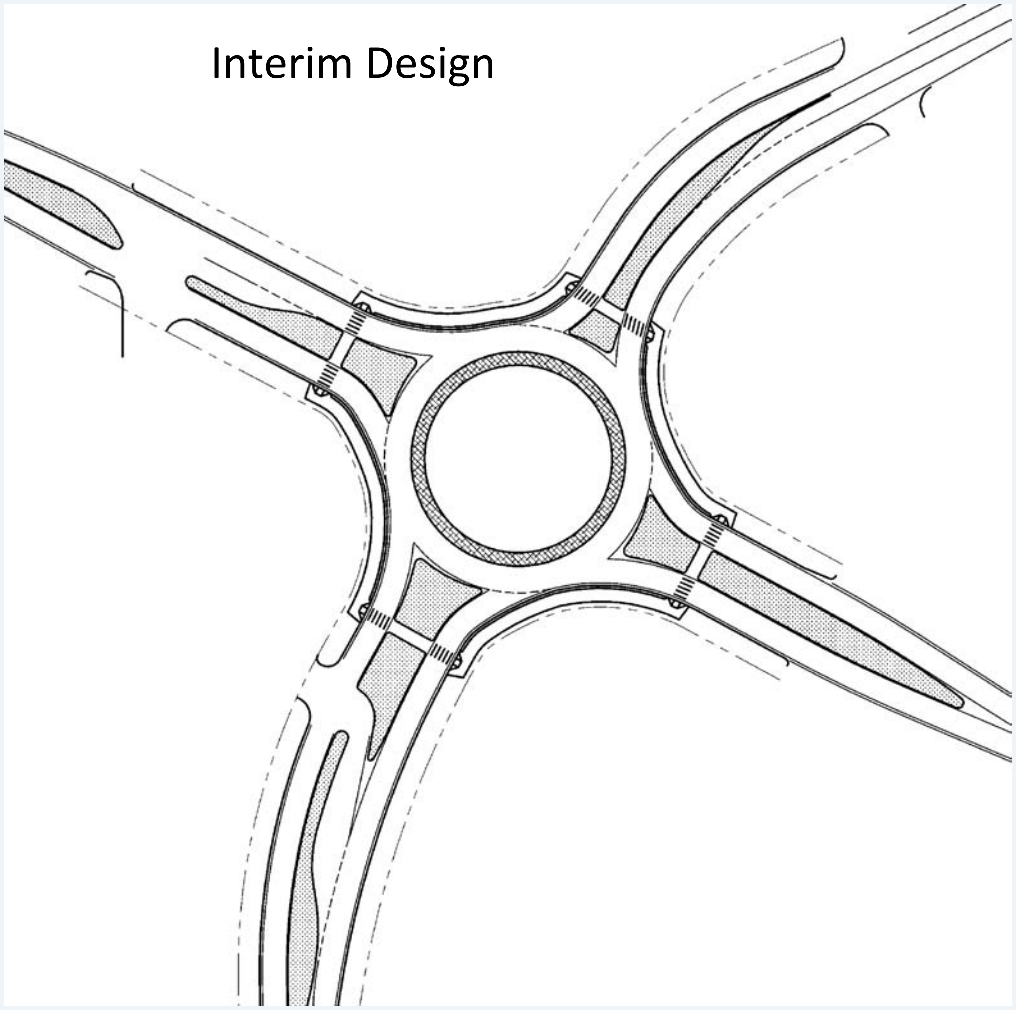
Typical Design Approach:

- Design ultimate (multilane) geometry first.
- Then establish interim geometric plan.

GEOMETRIC DESIGN

Phased Multilane Construction Example

Interim Design



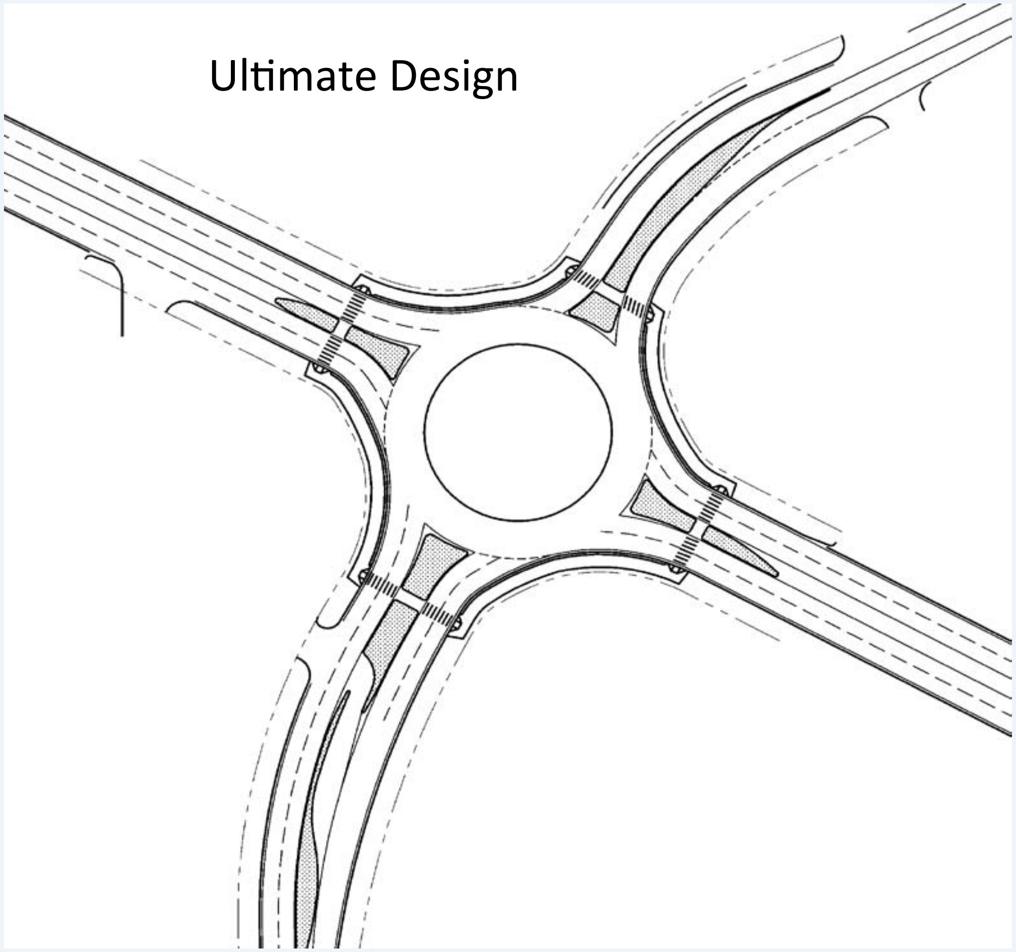
Outside curbs in ultimate location.

Wide median & splitter islands.

Truck apron in central island.

GEOMETRIC DESIGN

Phased Multilane Construction Example



Narrowed splitter islands.

Remove truck apron.

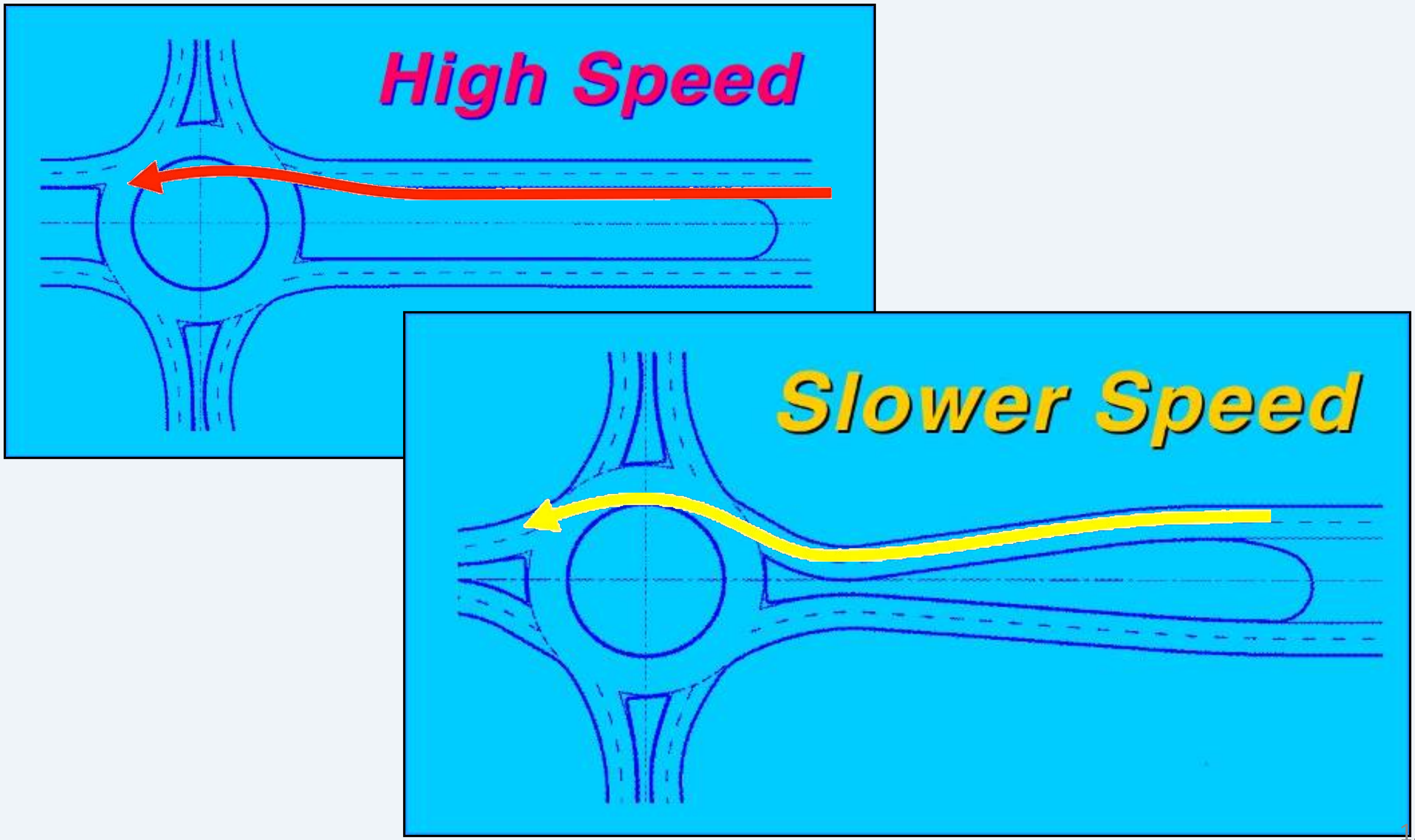
GEOMETRIC DESIGN

Multilane Roundabouts Sample Design

- Lane numbers and assignments
- Conflict area management
- Accommodating side-by-side vehicles
- Designing for future expansion
- <u>Treatment of wide medians on divided highways</u>

GEOMETRIC DESIGN

Treatment of Wide Medians on Divided Highways



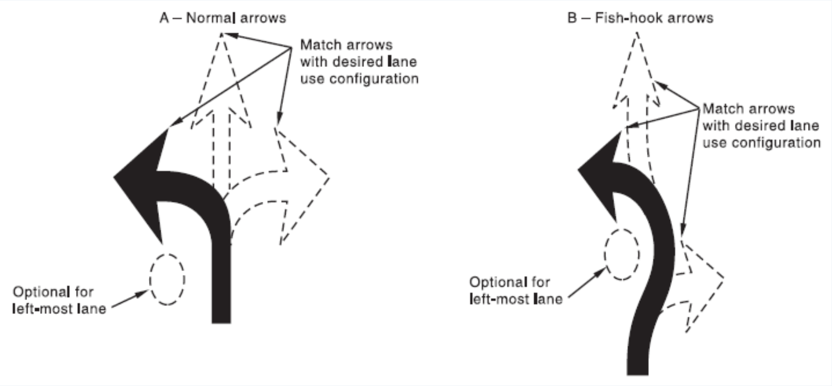
GEOMETRIC DESIGN

Treatment of Wide Medians Example: Dublin, OH

Traffic Design

TRAFFIC DESIGN

- Resources:
  - *Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)*
  - *NCHRP 672*



(Source: NCHRP 672)

TRAFFIC DESIGN

Principles

- Principles from NCHRP 672 [7.2], Markings and Signs…
  - are an integral aspect of design (especially for multilane roundabouts) and should be included in early design stages.
  - are meant to make clear to users how to navigate through a roundabout but don't provide safety as geometric features do.
  - should be used in such a way that they work with one another to clearly convey there message.
  - should guide vehicles to their appropriate lane on approach (providing sufficient time and distance to do so) and eliminate the need to change lanes within the circulatory roadway in order to get to their destination.

TRAFFIC DESIGN

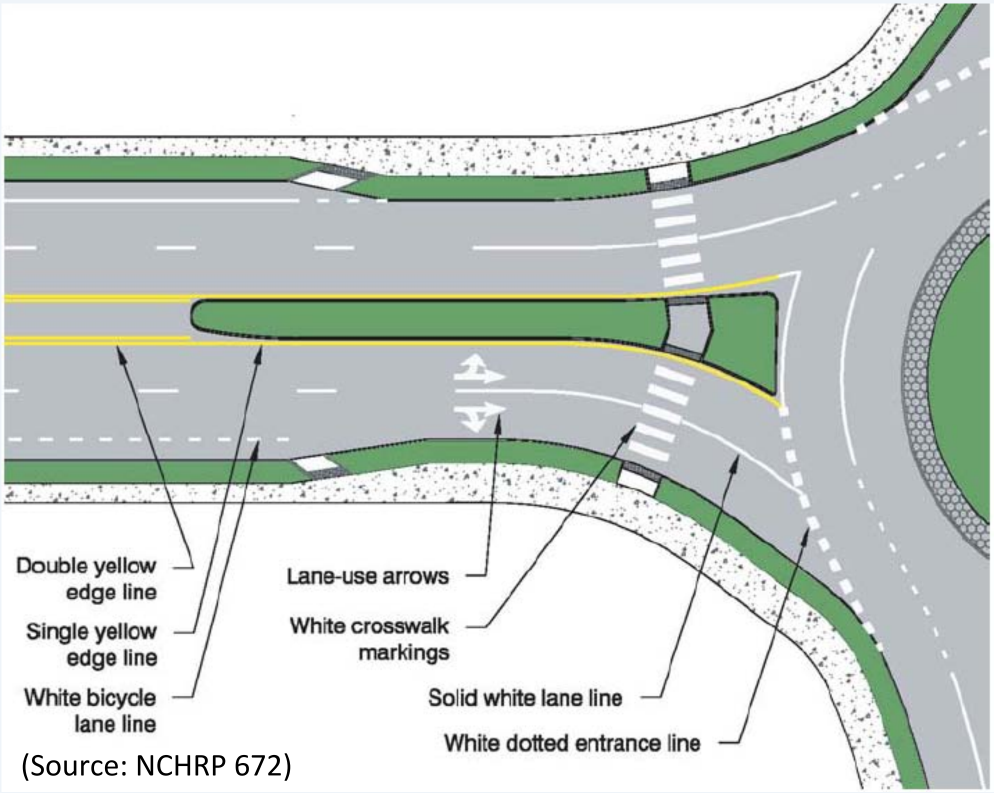
Designation of Lanes

- These principles also apply to designation of lanes on approaches to roundabouts
  - Traffic volume considerations and roundabout operations
  - Balance lane use
  - Exit lane requirements

TRAFFIC DESIGN

Pavement Markings

- Approach and Departure Pavement Markings
  - Lane lines, edge lines, lane-use arrows, other pavement work and symbol markings, yield lines, and crosswalk markings

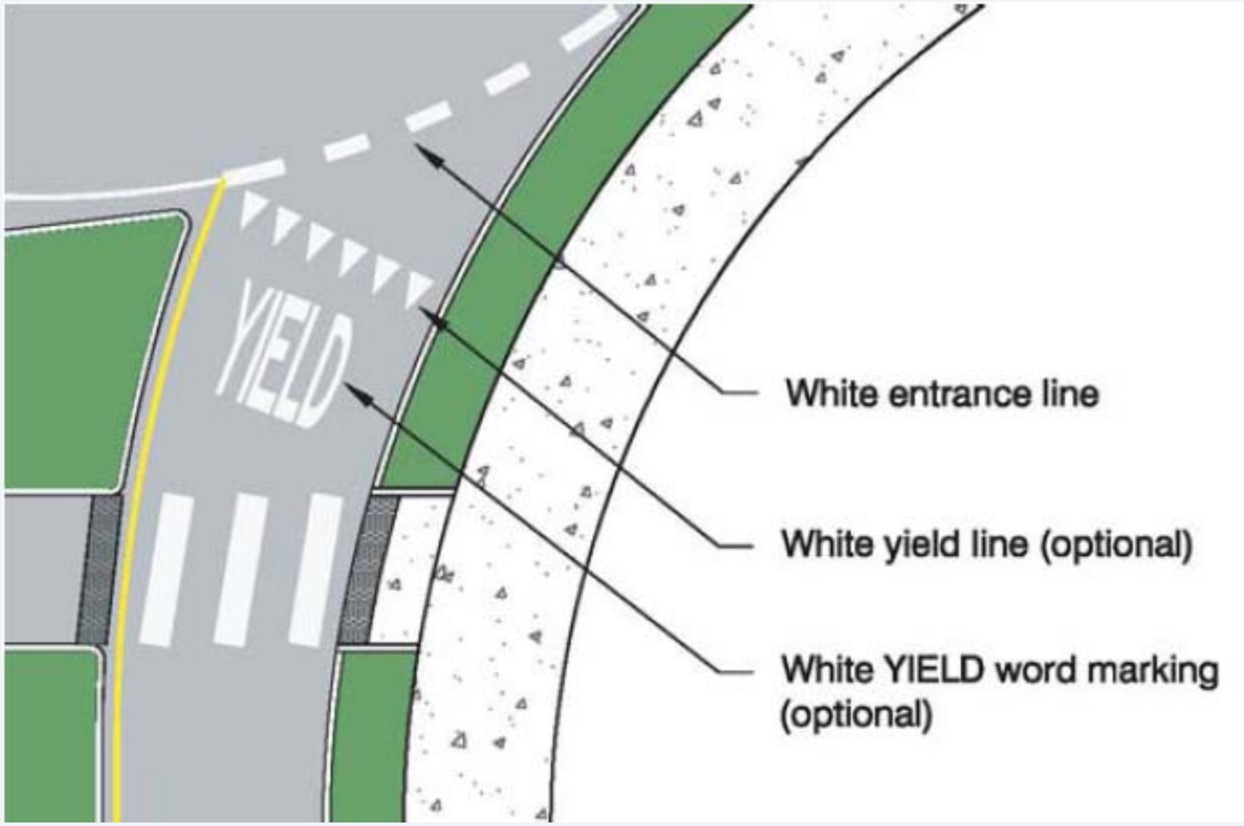


(Source: NCHRP 672)

TRAFFIC DESIGN

Pavement Markings

- Entrance and Yield Lines

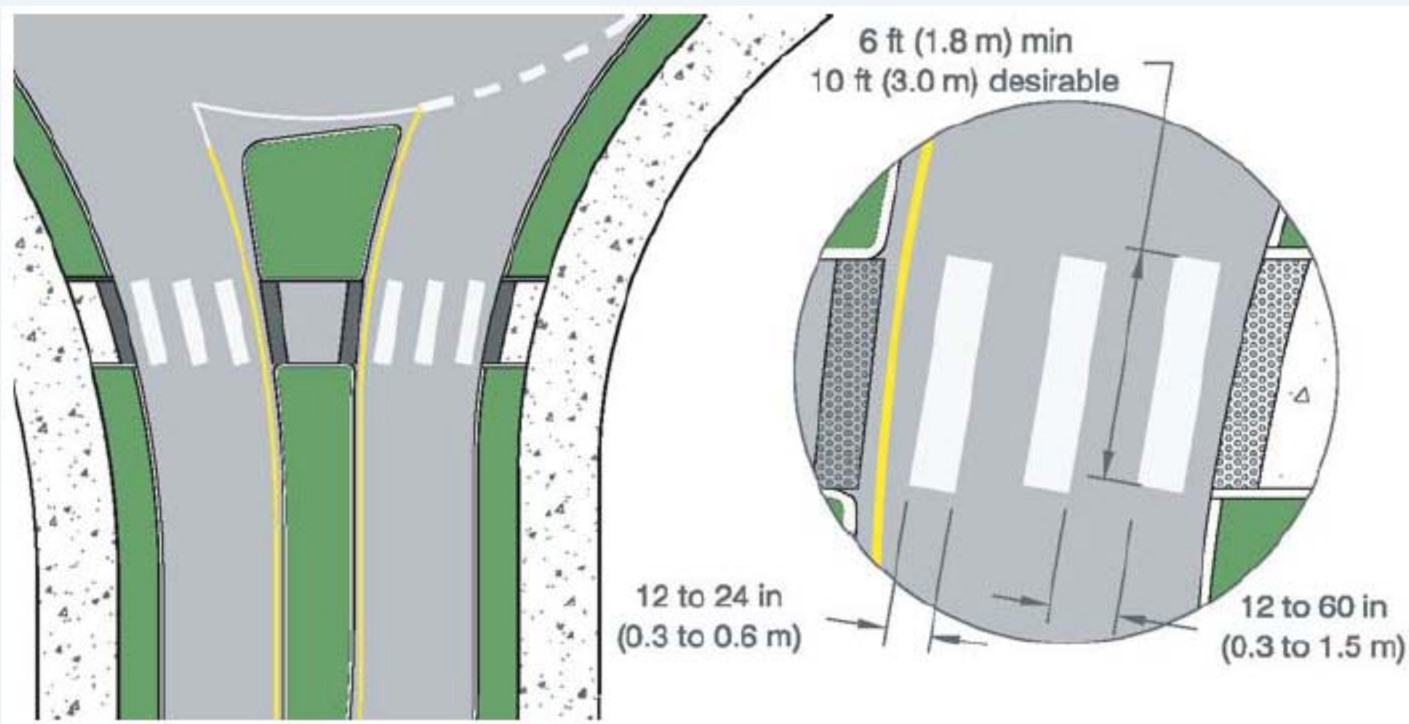


(Source: NCHRP 672)

TRAFFIC DESIGN

Pavement Markings

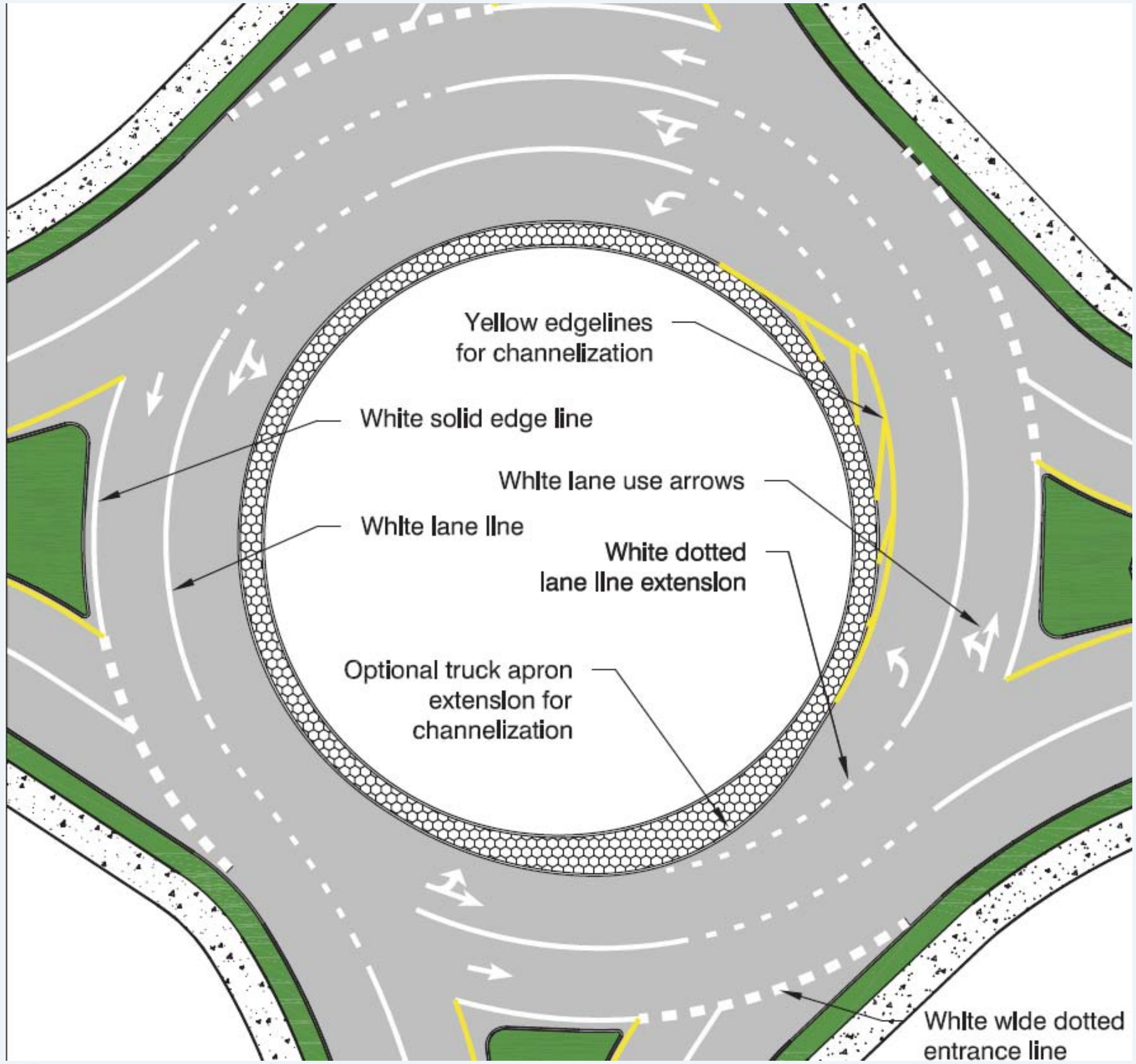
- Pedestrian Crosswalk Markings



(Source: NCHRP 672)

TRAFFIC DESIGN

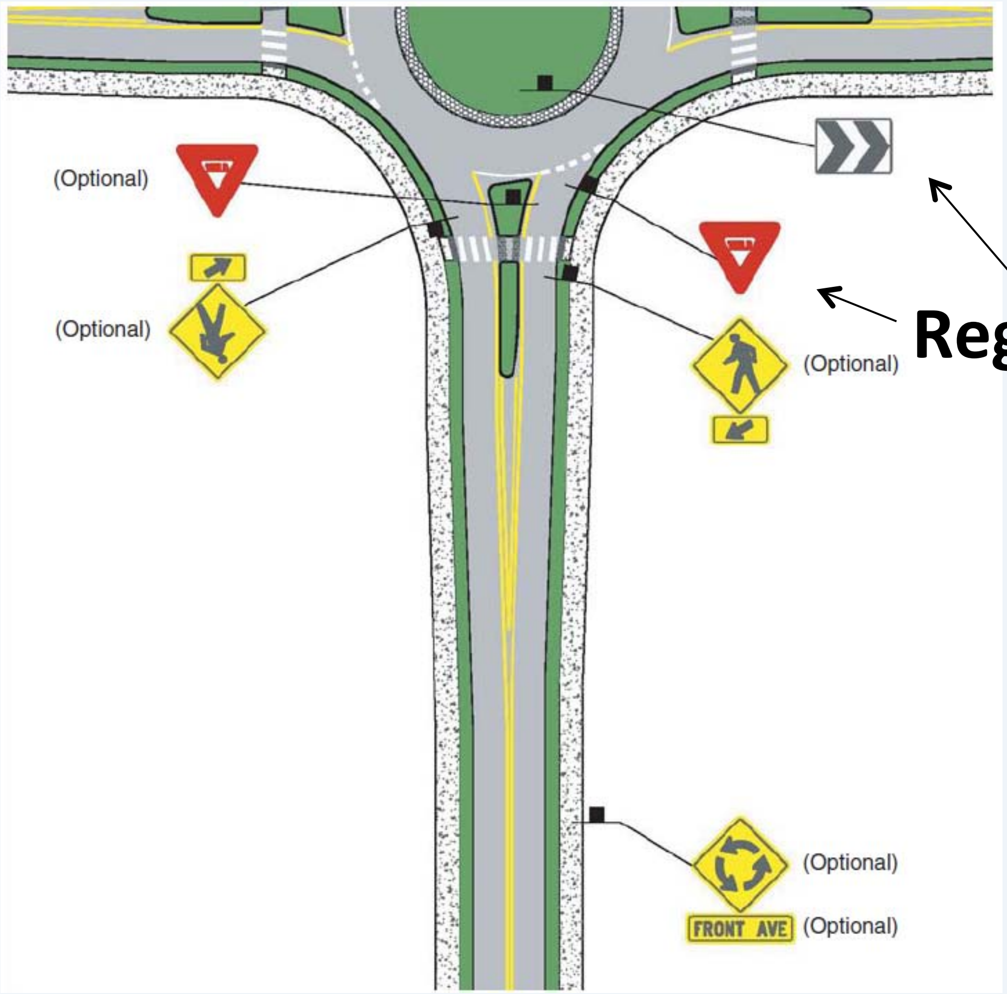
Signing



(Source: NCHRP 672)

TRAFFIC DESIGN

Signing



Regulatory Signs

(Source: MUTCD 2009)

TRAFFIC DESIGN

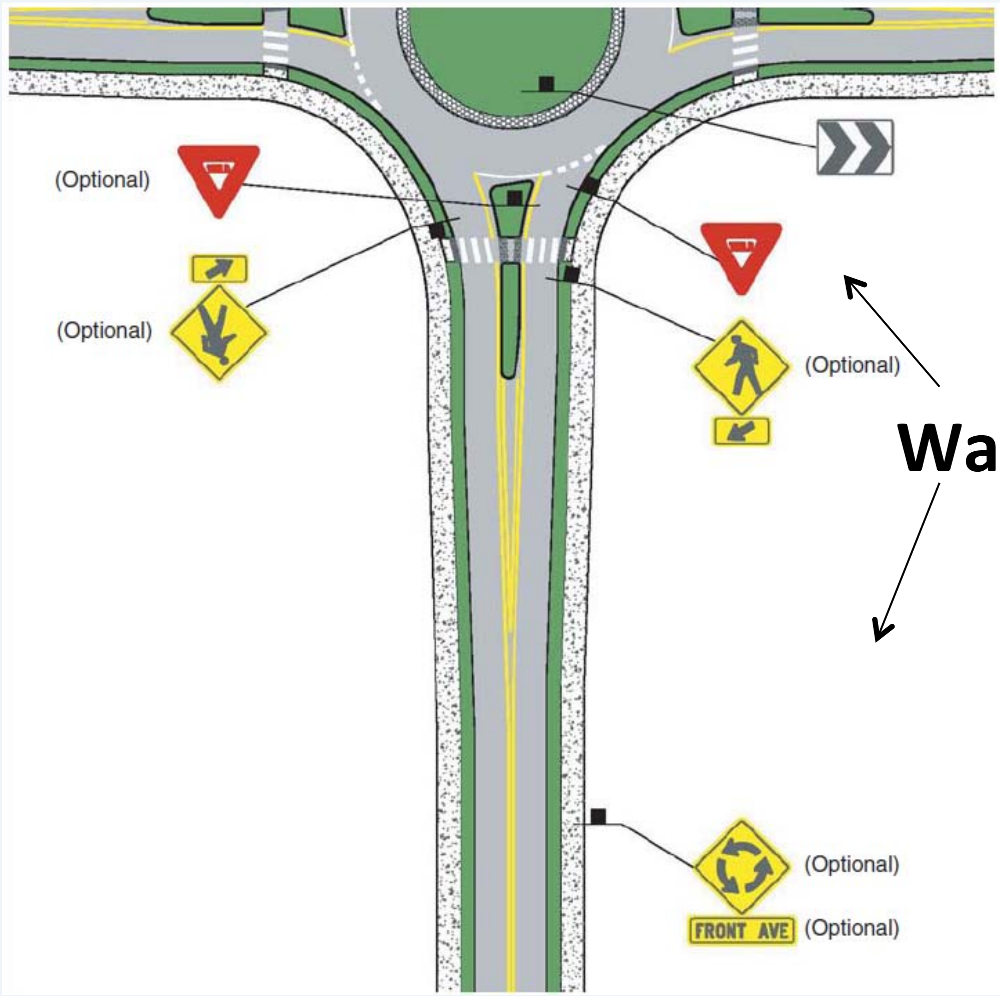
Signing

(Source: NCHRP 672)

- Other Regulatory Signs:
- Yield Here to Pedestrians and Stop Here for Pedestrians signs
- No-Left-Turn and No-U-Turn signs

TRAFFIC DESIGN

Signing



Warning Signs

(Source: MUTCD 2009)

Other Warning Signs:

- Object Markers
- Yield Ahead Sign
- Advance Pedestrian Crossing sign

APPLICATIONS PART II

Agenda

- Applications Part 1
  - Roundabouts near schools
  - High speed rural intersections
- Geometric Design: Fundamental Principles
  - Single lane considerations
  - Multi-lane considerations
- Applications Part 2
  - Access management considerations
  - Traffic control during construction
- Peer Review Overview

APPLICATIONS PART II

Access Management in the Vicinity of Roundabouts

- Considerations
  - Flows downstream from roundabout are more randomly distributed than downstream from a signal
  - Space available between access point and roundabout?
  - Speed transition area near roundabout = more difficult for minor street drivers to judge gaps (particularly in higher speed locations)
  - Consider use of frontage roads, cul-de-sacs, cross-access agreements, etc.
  - Roundabouts provide safe u-turn opportunities
- What to do with driveways?
- Three typical cases
  - Driveways entering roundabout
  - Driveways near roundabout
  - Midblock driveways between roundabouts

APPLICATIONS PART II

Access Management: Driveways Entering a Roundabout

- Generally should avoid
- High-volume driveways should be designed as regular approach

Photo: Lee Rodegerdts

Five Points Roundabout, Santa Barbara, CA

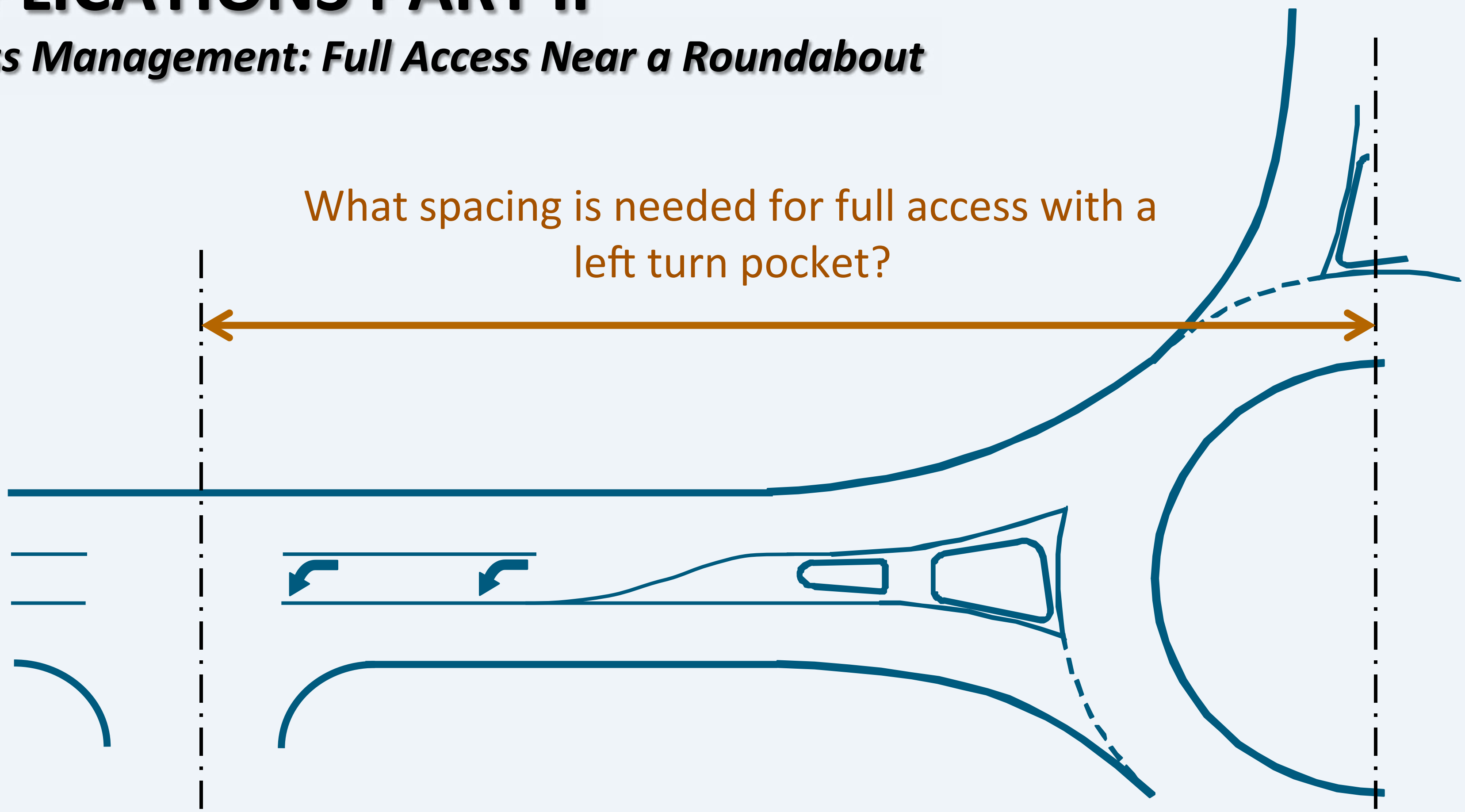
APPLICATIONS PART II

Access Management: Driveways Near a Roundabout

- In general, same principles as for driveways near signalized intersections
- Driveways blocked by splitter island restricted to right-in/right-out
- Should avoid driveways between pedestrian crossing and yield line

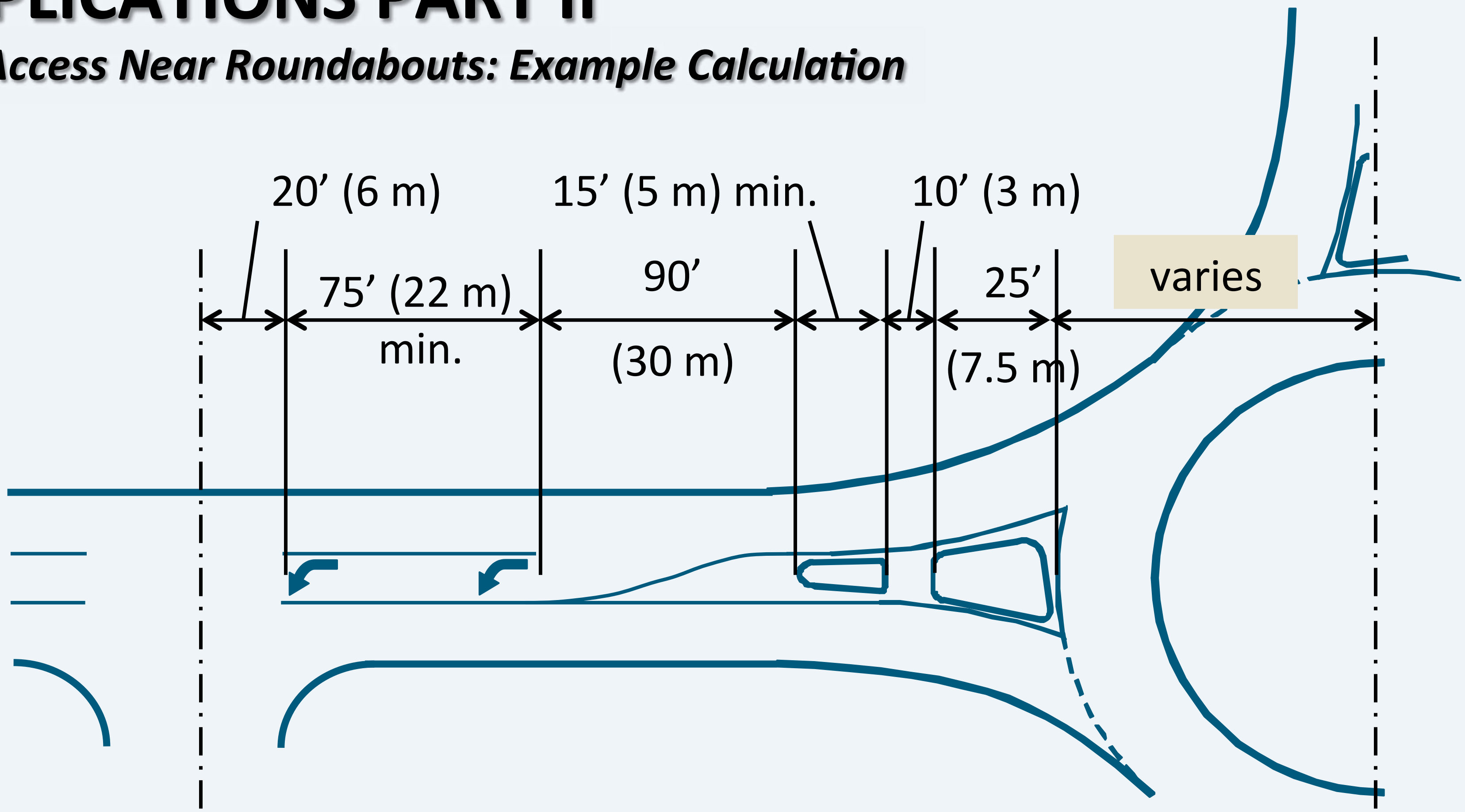
APPLICATIONS PART II

Access Management: Full Access Near a Roundabout



APPLICATIONS PART II

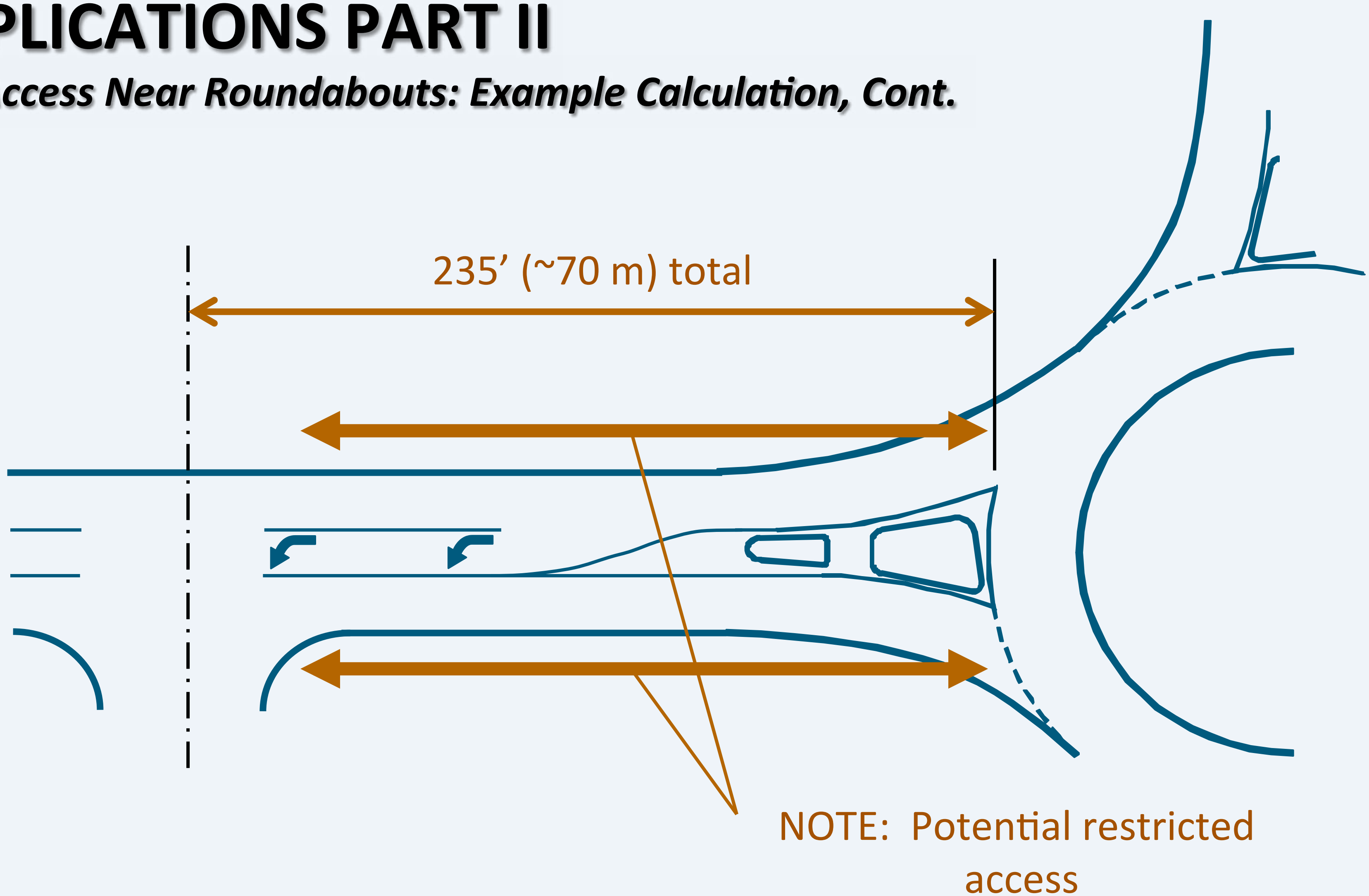
Full Access Near Roundabouts: Example Calculation



IMPORTANT: Adjust to local standards.

APPLICATIONS PART II

Full Access Near Roundabouts: Example Calculation, Cont.



APPLICATIONS PART II

Traffic Maintenance During Roundabout Construction

- Considerations
  - Public education – prior to, during, following construction
  - Phased construction?
  - Traffic conditions during construction
  - Work zone traffic control measures
    - Pavement markings and/or channelization devices place in same layout as final dimensions wherever possible
    - Signing – permanent signing should be installed where possible during first construction stage
    - Lighting
  - Contractor, designer, utility coordination
  - Maintenance after opening
    - Landscaping – Low maintenance, pullouts in central island for maintenance vehicles?

APPLICATIONS PART II

Traffic Maintenance: Phased Construction Plan

Consider when:

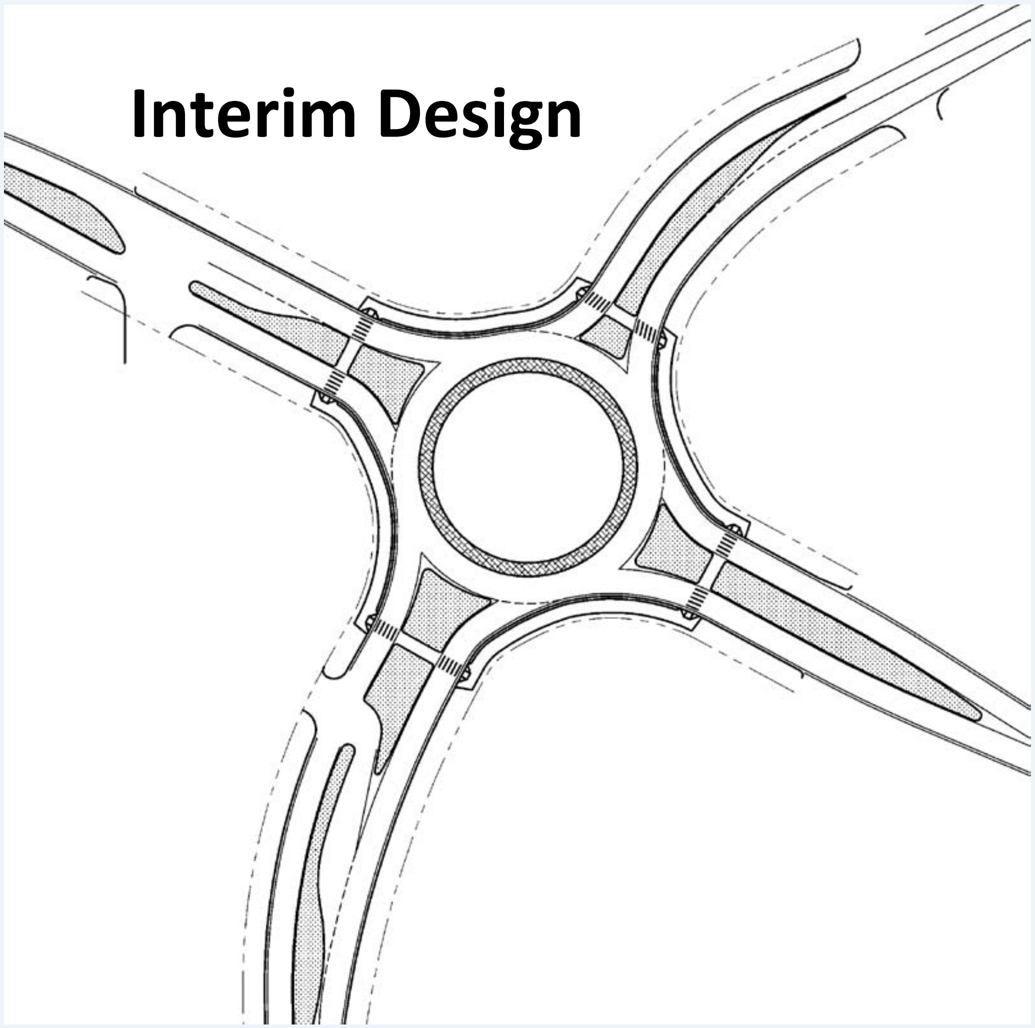
- Multilane required for long-term traffic demand
- Single-lane provides adequate capacity for near term traffic demand (5+ years)
- Single-lane offers safety benefits for near term

Design Approach:

- Design ultimate (multilane) geometry first
- Then establish interim geometric plan

APPLICATIONS PART II

Traffic Maintenance: Phased Multilane Construction Example



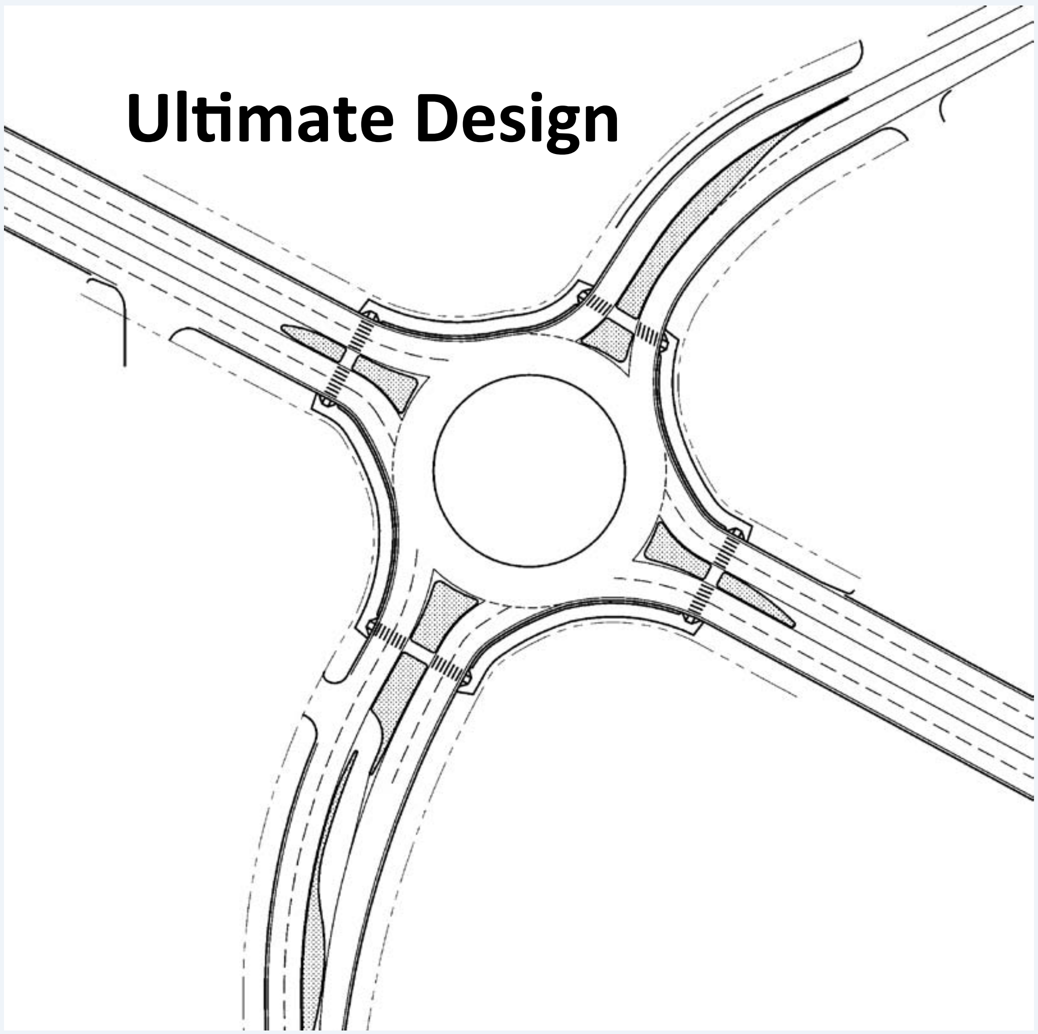
Outside curbs in ultimate location.

Wide median & splitter islands.

Truck apron in central island.

APPLICATIONS PART II

Traffic Maintenance: Phased Multilane Construction Example, Cont.



Narrowed splitter islands.

Remove truck apron.

APPLICATIONS PART II

Traffic Maintenance: Construction Traffic Control

- How to stage construction?

Photo: Lee Rodegerdts

APPLICATIONS PART II

Traffic Maintenance: Construction Staging

- Best: Detour all legs
- Ok: Detour two legs
- Possible staged construction sequence
  - install signing & lighting
  - construct widening
  - reconstruct or resurface approaches
  - construct splitter islands & delineate central island
  - construct central island

APPLICATIONS PART II

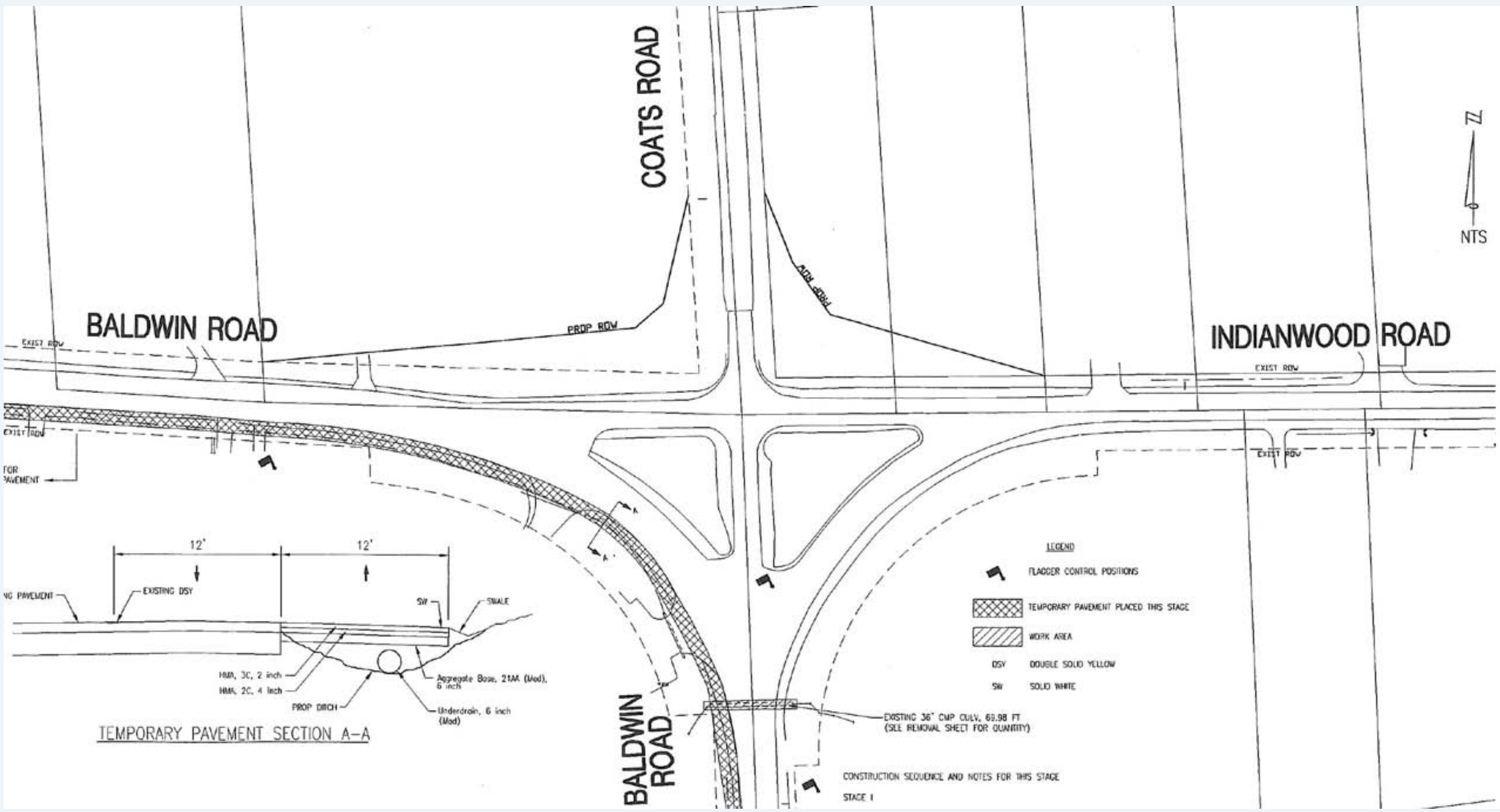
Construction Staging Example: Towson, MD

Photo: Ed Myers

APPLICATIONS PART II

Construction Staging Plan Examples

- ***Stage 1*** Temporary roadway construction

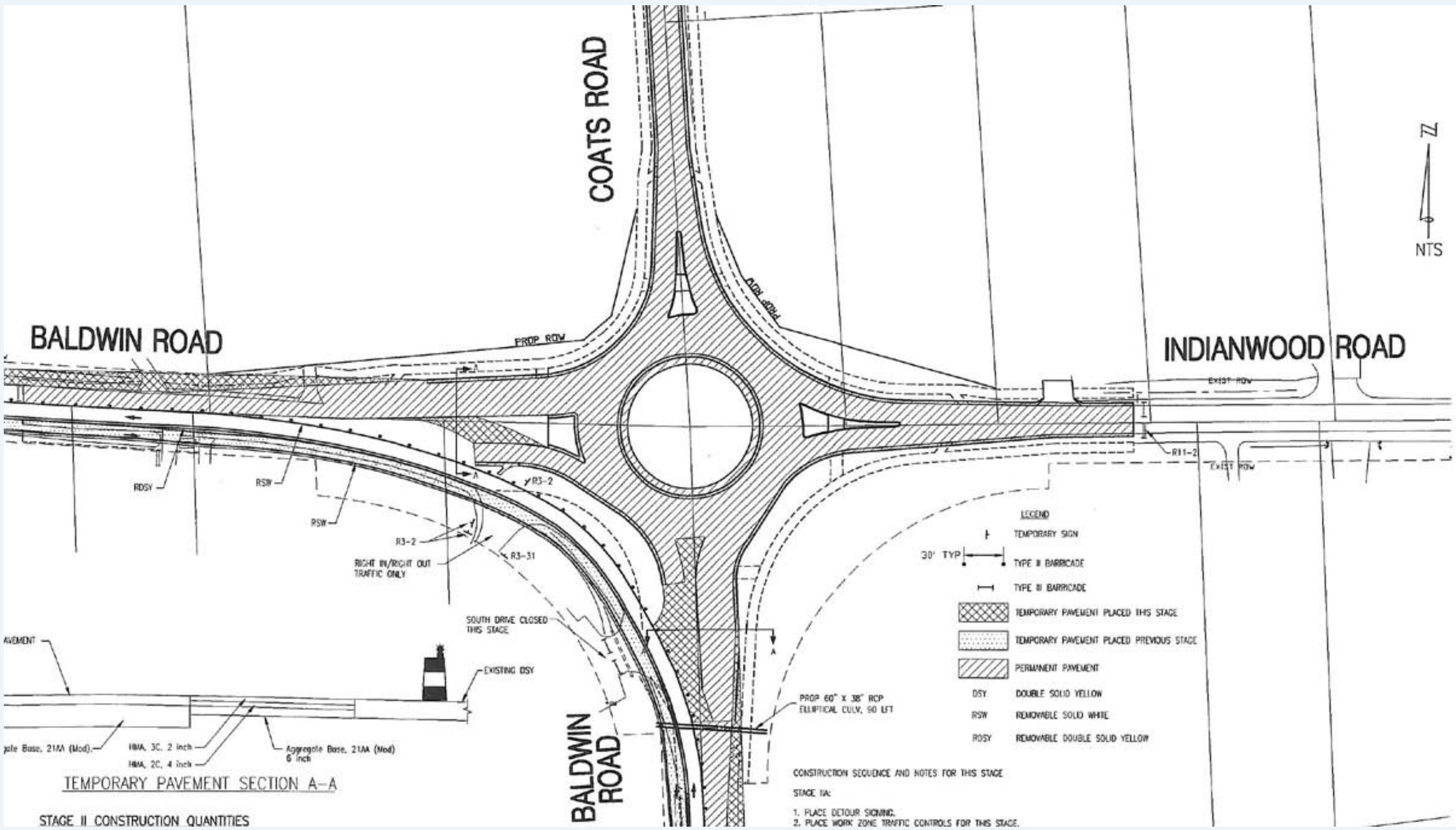


NCHRP Report 672 Exhibit 10-3

APPLICATIONS PART II

Construction Staging Plan Example: Oakland County, MI

- ***Stage 2*** Primary roundabout construction

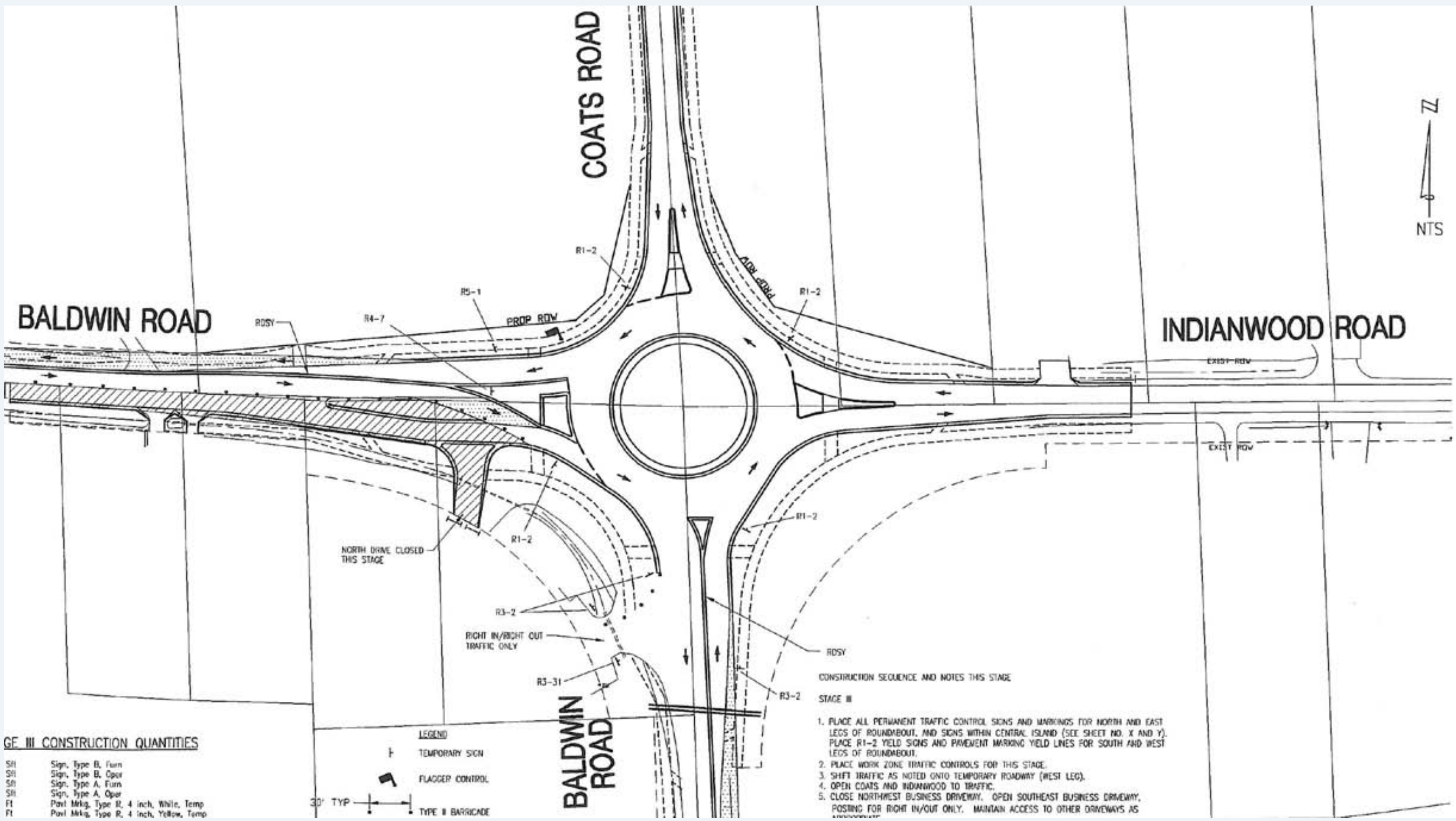


NCHRP Report 672 Exhibit 10-3

APPLICATIONS PART II

Construction Staging Plan Example: Oakland County, MI

- ***Stage 3*** West approach construction

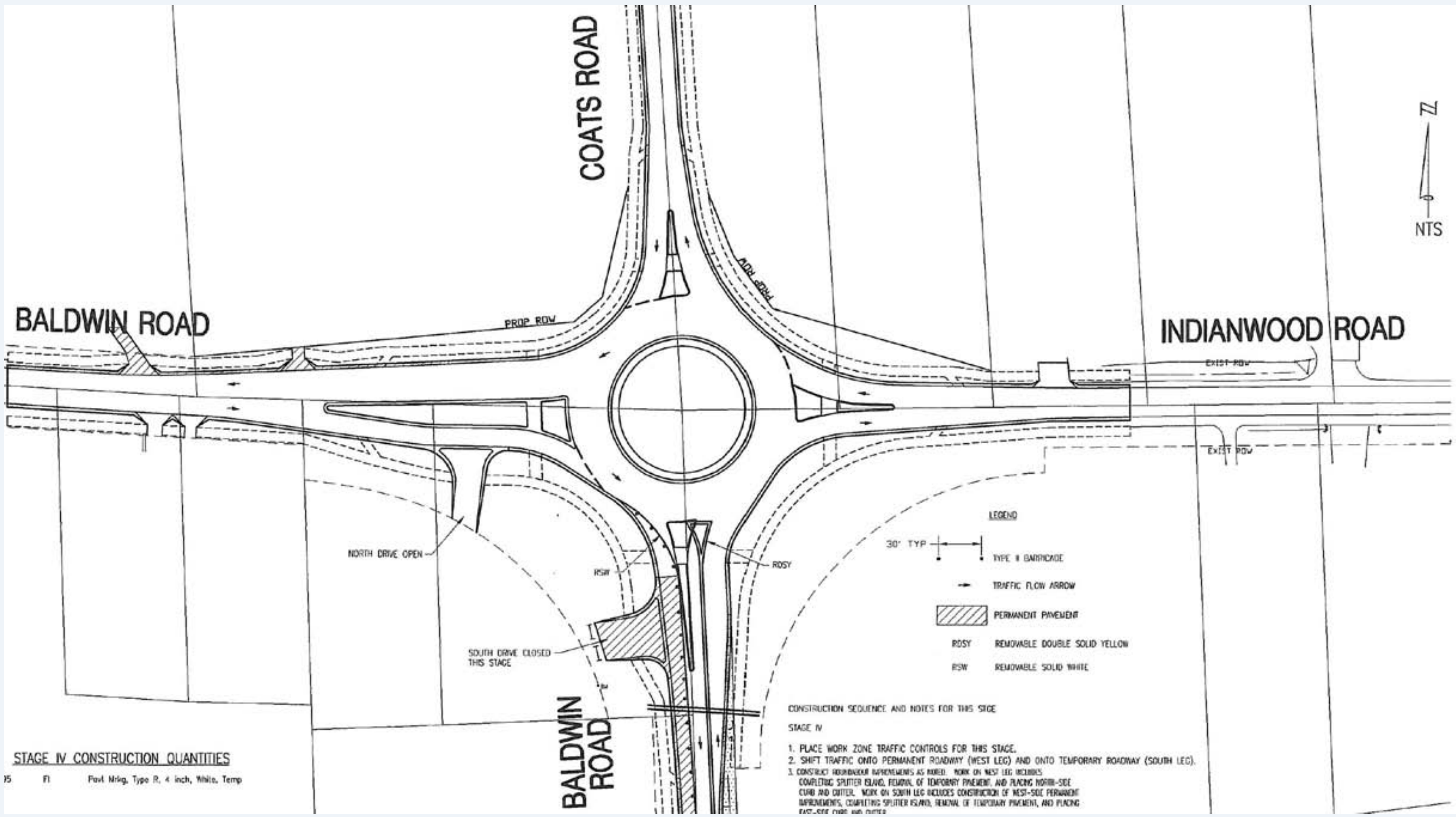


NCHRP Report 672 Exhibit 10-3

APPLICATIONS PART II

Construction Staging Plan Example: Oakland County, MI

- ***Stage 4*** South approach construction



NCHRP Report 672 Exhibit 10-3

PEER REVIEW

Agenda

- Applications Part 1
  - Roundabouts near schools
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  - Single lane considerations
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- Peer Review Overview

PEER REVIEW

Introduction

- A review by a 3rd party to evaluate a design and/or supporting information.
  - Can be conducted at any time during the feasibility or design process.
    - An earlier peer review (such as at the field check level of plan preparation) can identify design flaws and allows time for correction.
    - A later peer review (such as at the 60% or 80% plan level) will focus more on signing, striping, lighting, and plan preparation issues.
- TXDOT: You should encourage and support reviews
  - Internally: Between TXDOT staff
  - Externally: Reviewing work completed by consultants
- Iowa DOT Transportation Safety Assistance Program
  - IADOT pays for any roundabout review requested

PEER REVIEW

Introduction

- A peer review can cover a single issue or be broad in scope.
- Two main types of peer reviews
  - Feasibility level
  - Geometric design

PEER REVIEW

Introduction

- Traffic operations
- Lane configurations
- Preliminary design layout – fatal flaws
  - Speed check
  - Natural paths
- Is a roundabout an appropriate treatment?

PEER REVIEW

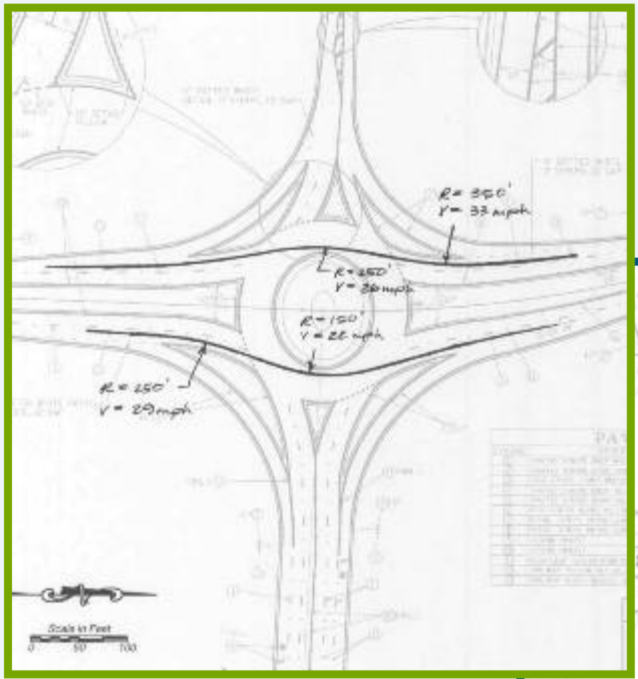
Elements of Design

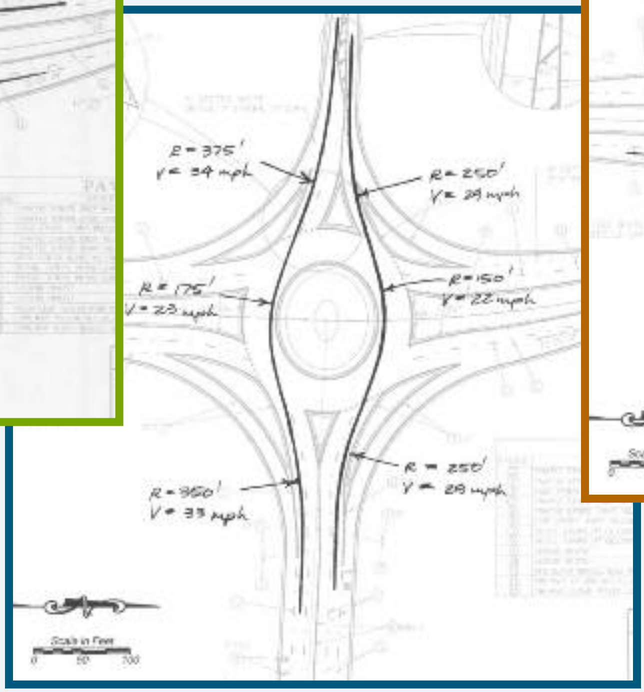
- Horizontal layout
- Vertical layout
- Pedestrian/bicycle accommodations
- Sight distance
- Signing/pavement marking
- Sight Distances
- Lighting

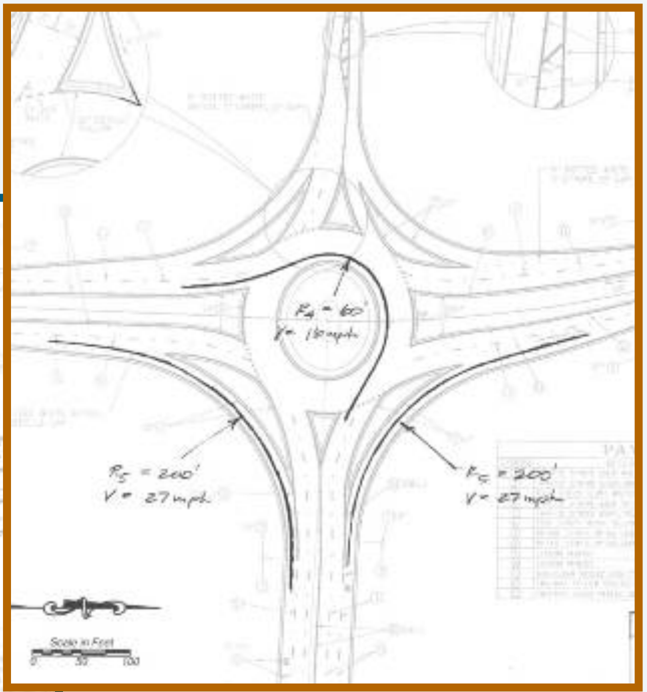
PEER REVIEW

Elements of Design: Horizontal Layout

- Fastest path vehicle speeds



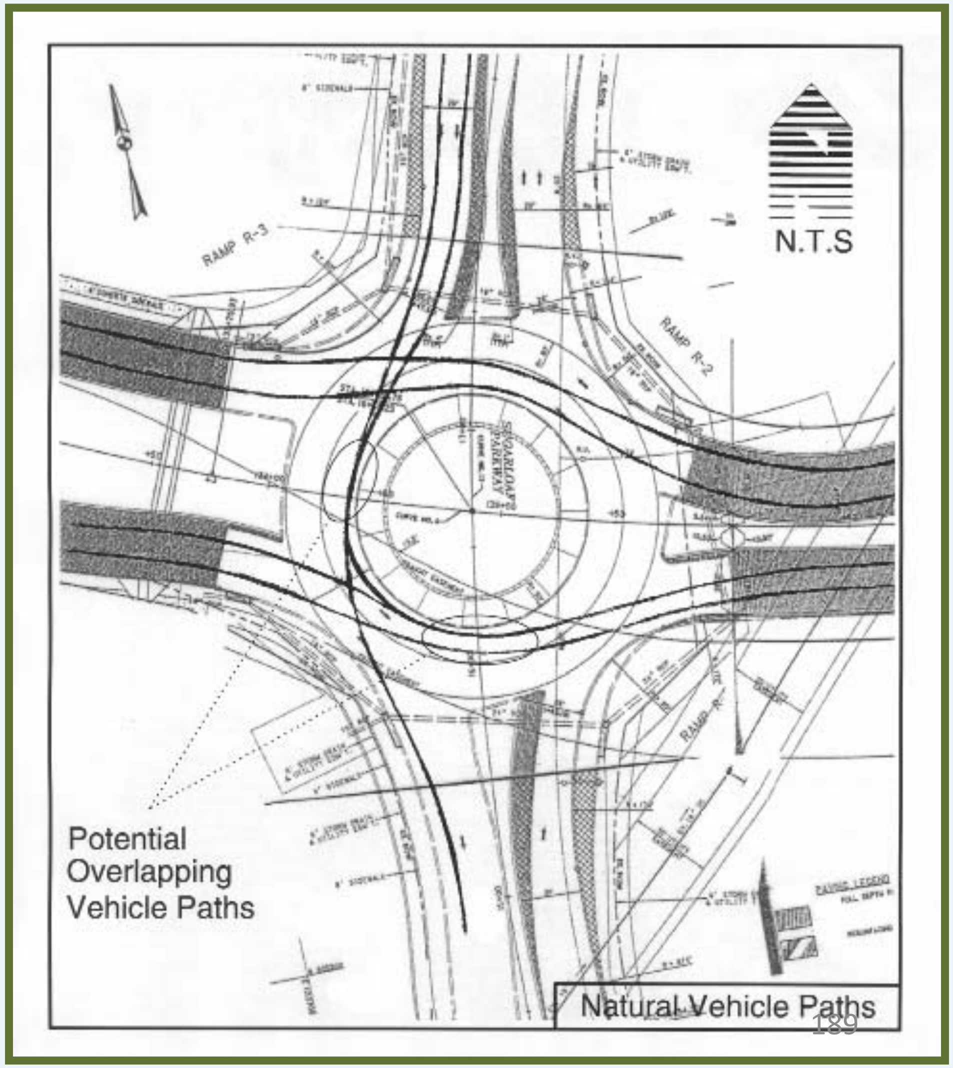




PEER REVIEW

Elements of Design: Horizontal Layout

- Natural Vehicle Paths



PEER REVIEW

Elements of Design: Vertical Layout

- Approach grades
- Drainage
- Central island profile

PEER REVIEW

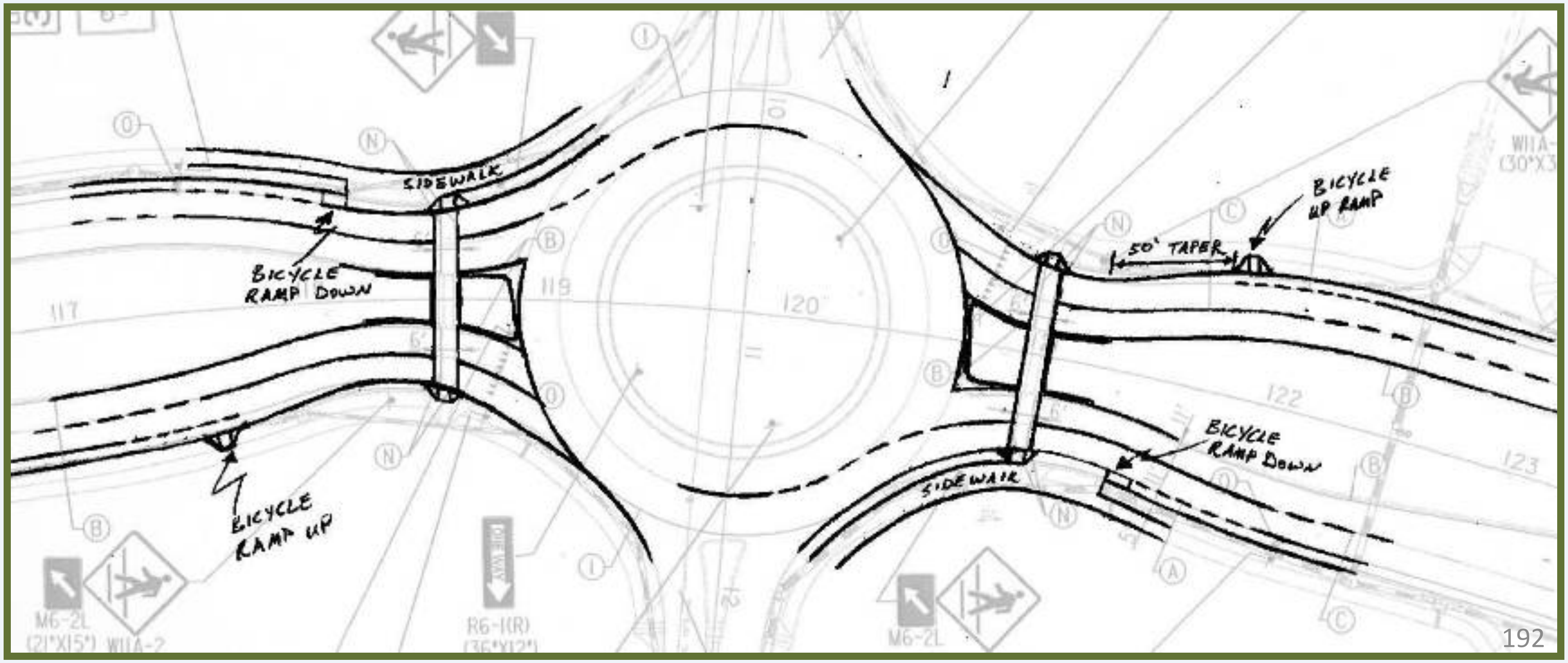
Elements of Design: Pedestrian/Bicycle Accommodations

- Pedestrian accommodations
  - Location of pedestrian crossing
  - Pedestrian crossing alignment
  - Design of pedestrian refuge
  - Presence of detectable warning surfaces

PEER REVIEW

Elements of Design: Pedestrian/Bicycle Accommodations

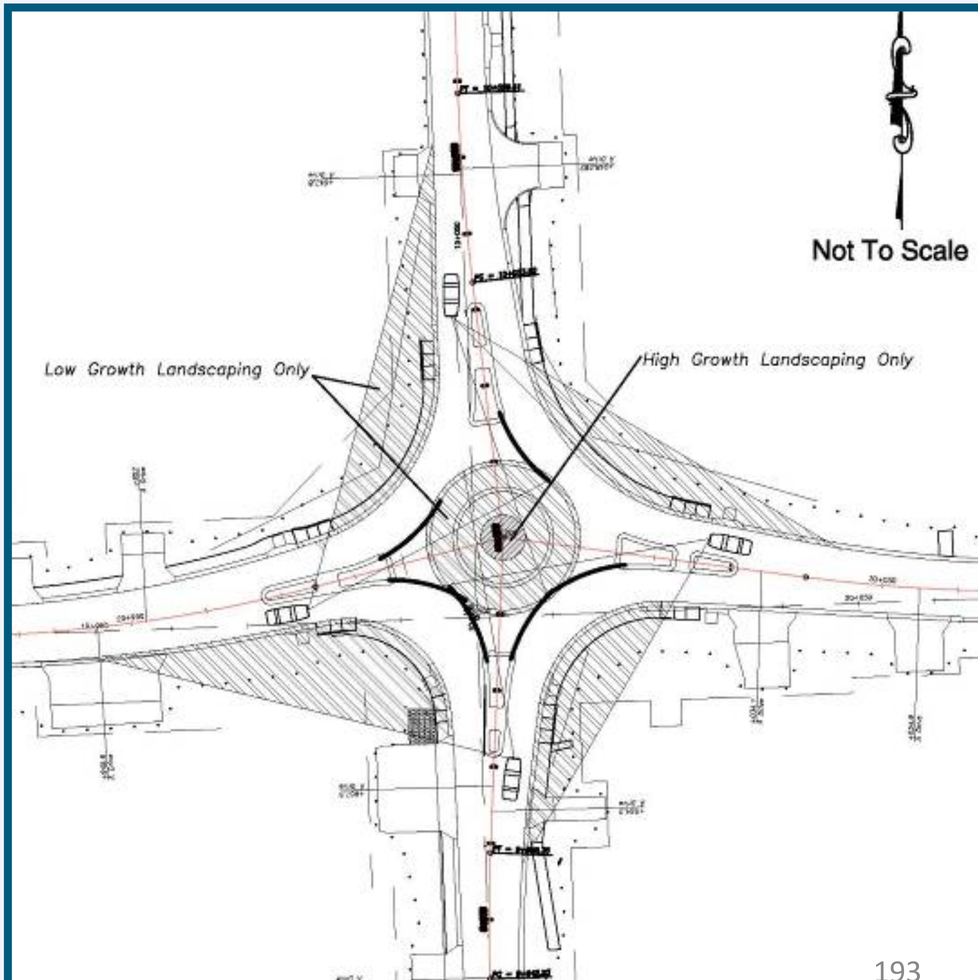
- Bicycle accommodations
  - Bike lane widths
  - Bike ramps off/on roadway



PEER REVIEW

Elements of Design: Sight Distance

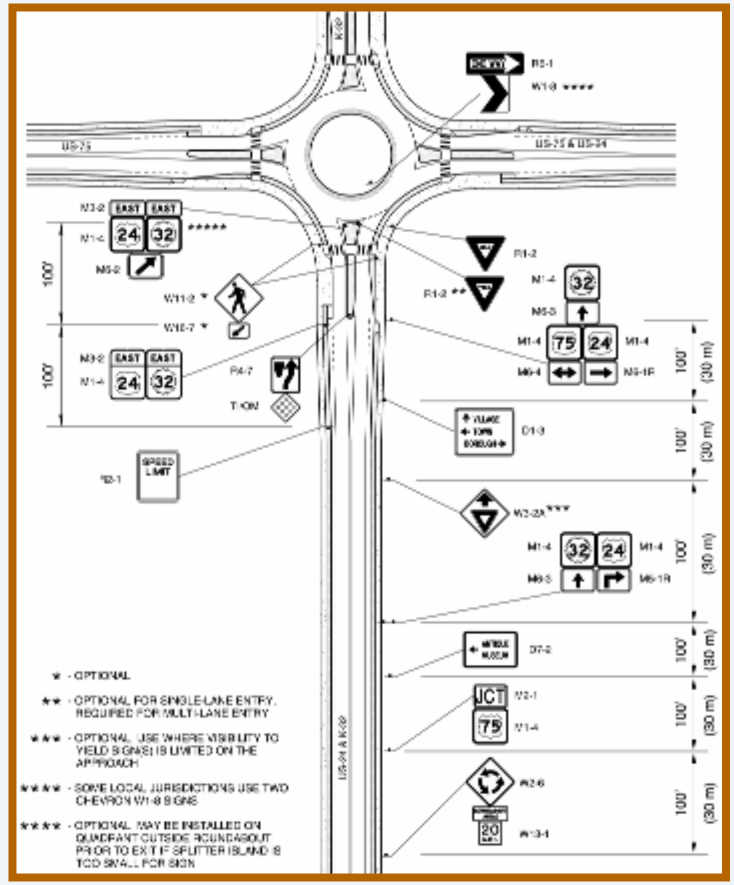
- Stopping sight distance
  - Approach sight distance
  - Sight distance on circulatory roadway
  - Sight distance to Crosswalk on exit
- Intersection sight distance



PEER REVIEW

Elements of Design: Signing and Pavement Markings

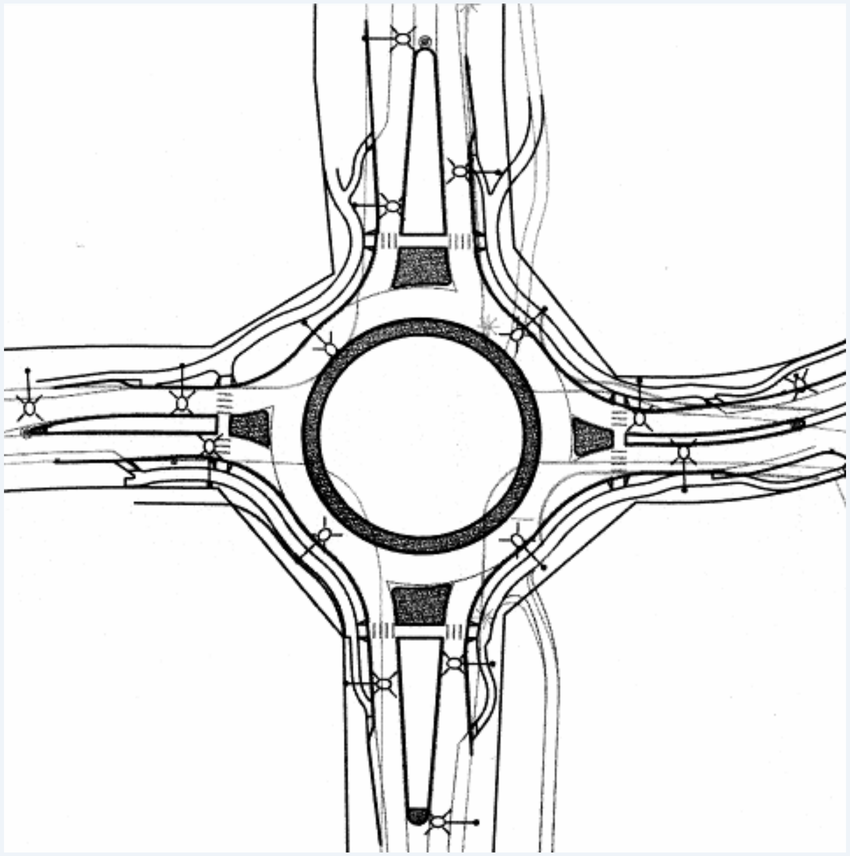
- Signing
  - Sign selection and placement
  - Intersection context
  - Use of diagrammatic signs
  - Lane usage signs
- Pavement markings
  - Within the circulatory roadway
  - Pavement legends
  - Striping at the yield line
  - Pedestrian crossing markings



PEER REVIEW

Elements of Design: Lighting

- Location of lighting equipment
- Illumination level appropriate for location?



PEER REVIEW

Elements of Design: Experiences

- Intersections having issues that make it difficult for a conventional form will be difficult with a roundabout.
- Solutions can be preconceived. Perform "intersection design studies," versus "roundabout design studies."

PEER REVIEW

Elements of Design: Experiences

- Be sure you know the problem (operations and safety) before you create the solution.
- Roundabouts are based on sound design PRINCIPLES, not standards—one size does not fit all.

PEER REVIEW

Elements of Design: Experiences

- Designers are often reluctant to make significant changes. The initial plan keeps getting tweaked with the same end result.
- Teams often underestimate the time needed for public awareness.
- Teams take risks with roundabouts in locations where they would not take risks for conventional roadway solutions.

PEER REVIEW

Elements of Design: Experiences

- People are surprised by how large (or small) roundabouts can be.
- People underestimate the impacts of trucks: WB-50 (WB-15) versus WB-67 (WB-20).

PEER REVIEW

Elements of Design: Test Your Understanding

- The following slides are photos of roundabouts from around the world
- Identify things that appear to be consistent with the roundabout principles shared and what you would change in an ideal world

PEER REVIEW

Test Your Understanding: Urban Single Lane Roundabout –Tallahassee, FL

Photo: Aimee Flannery

PEER REVIEW

Test Your Understanding: Urban Single Lane Roundabout –Truckee, CA

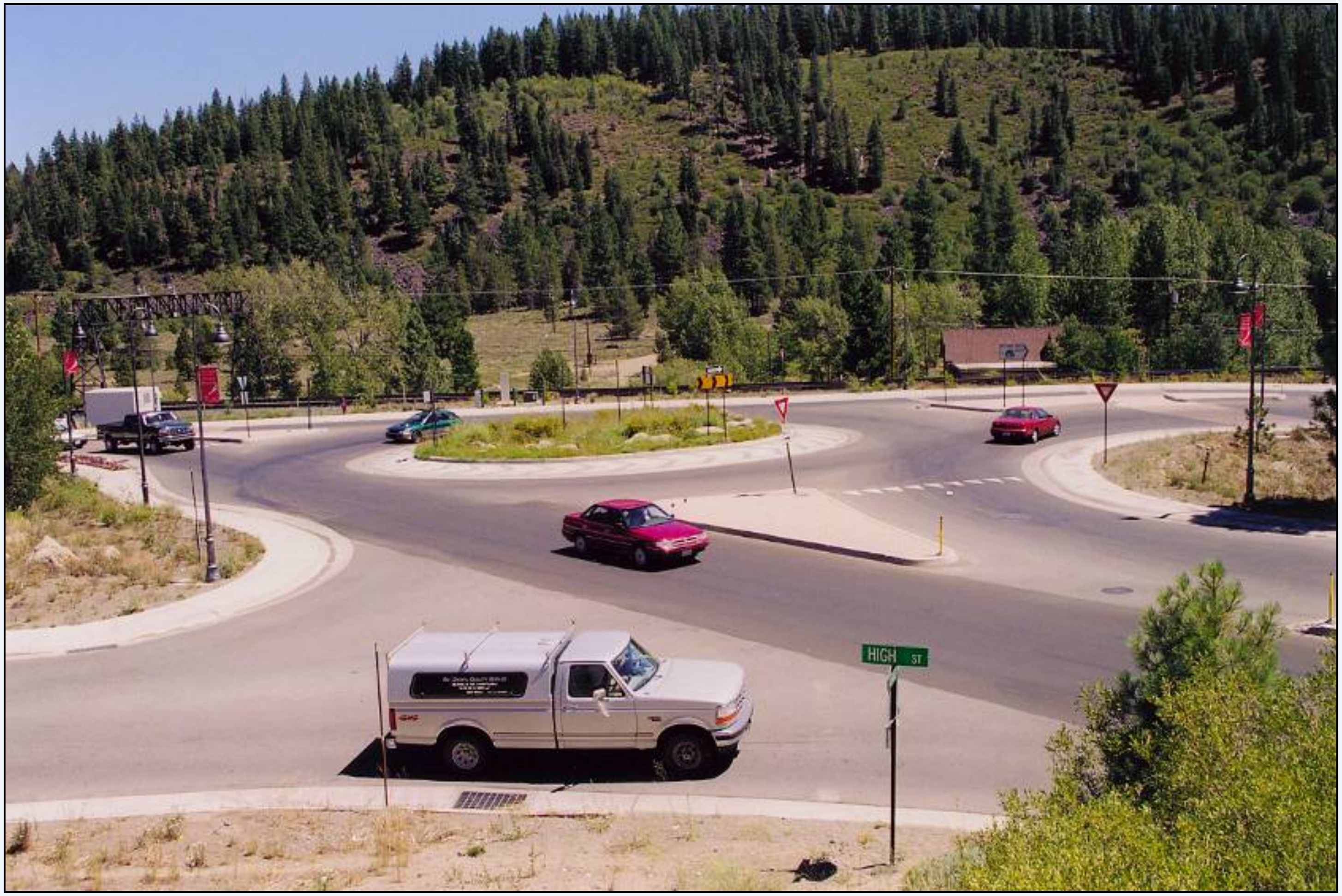


Photo: Lee Rodegerdts

PEER REVIEW

Test Your Understanding: Traffic Calming Roundabout - Naples, FL

Photo: Lee Rodegerdts

PEER REVIEW

Test Your Understanding: Urban Compact Roundabout –Bradenton, FL

Photo: Lee Rodegerdts

PEER REVIEW

Test Your Understanding: Urban Single Lane Roundabout –Germany

Photo: Werner Brilon

PEER REVIEW

Test Your Understanding: Urban Compact Roundabout –Gainsville, FL

Photo: Lee Rodegerdts

PEER REVIEW

Test Your Understanding: Urban Double Lane Roundabout –Towson, MD

Photo: Ed Myers

PEER REVIEW

Test Your Understanding: Urban Double Lane Roundabout –Santa Barbara, CA

Photo: Lee Rodegerdts

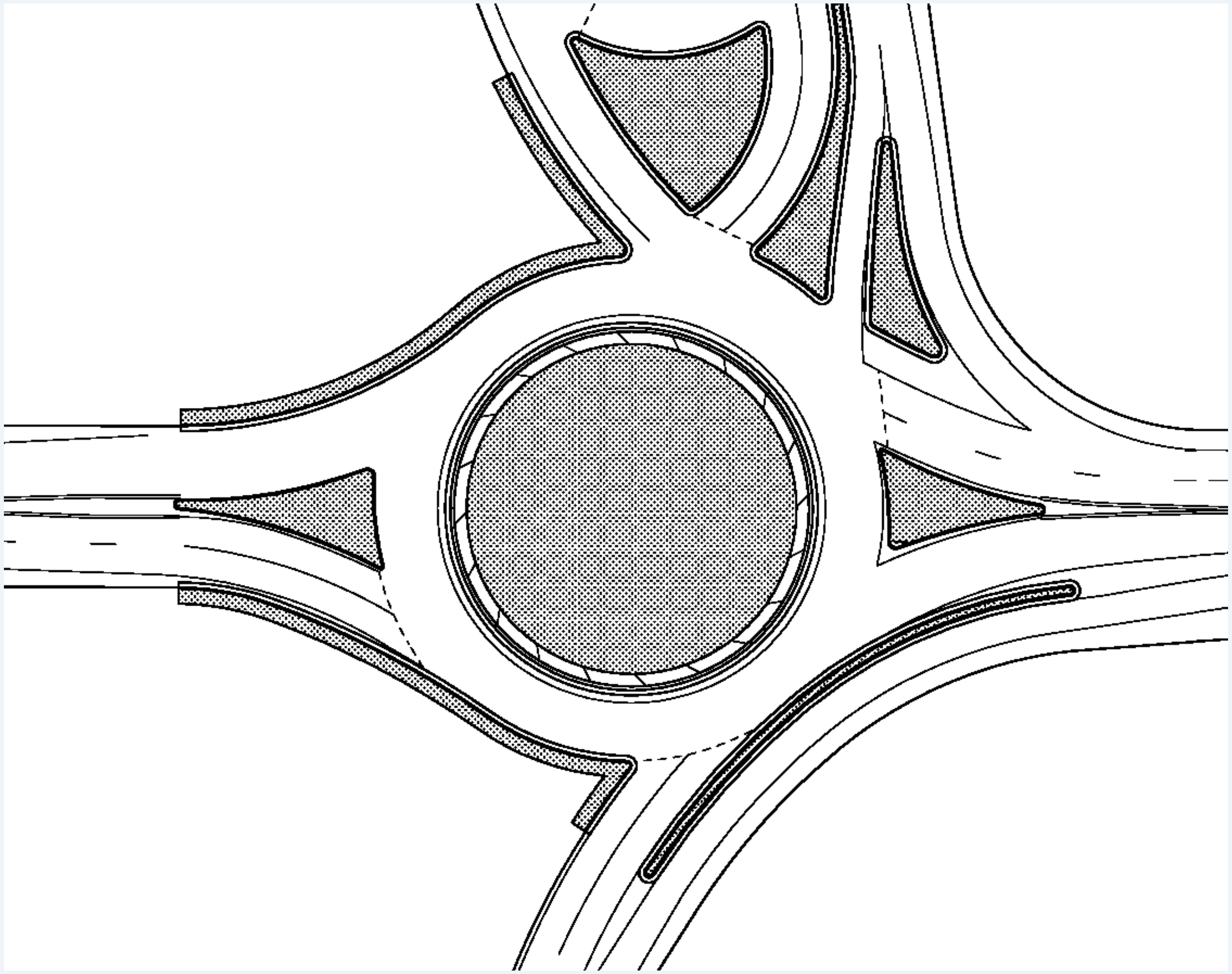
PEER REVIEW

Test Your Understanding: Rural SingleLane Roundabout –Switzerland

Photo: Paul Ryus

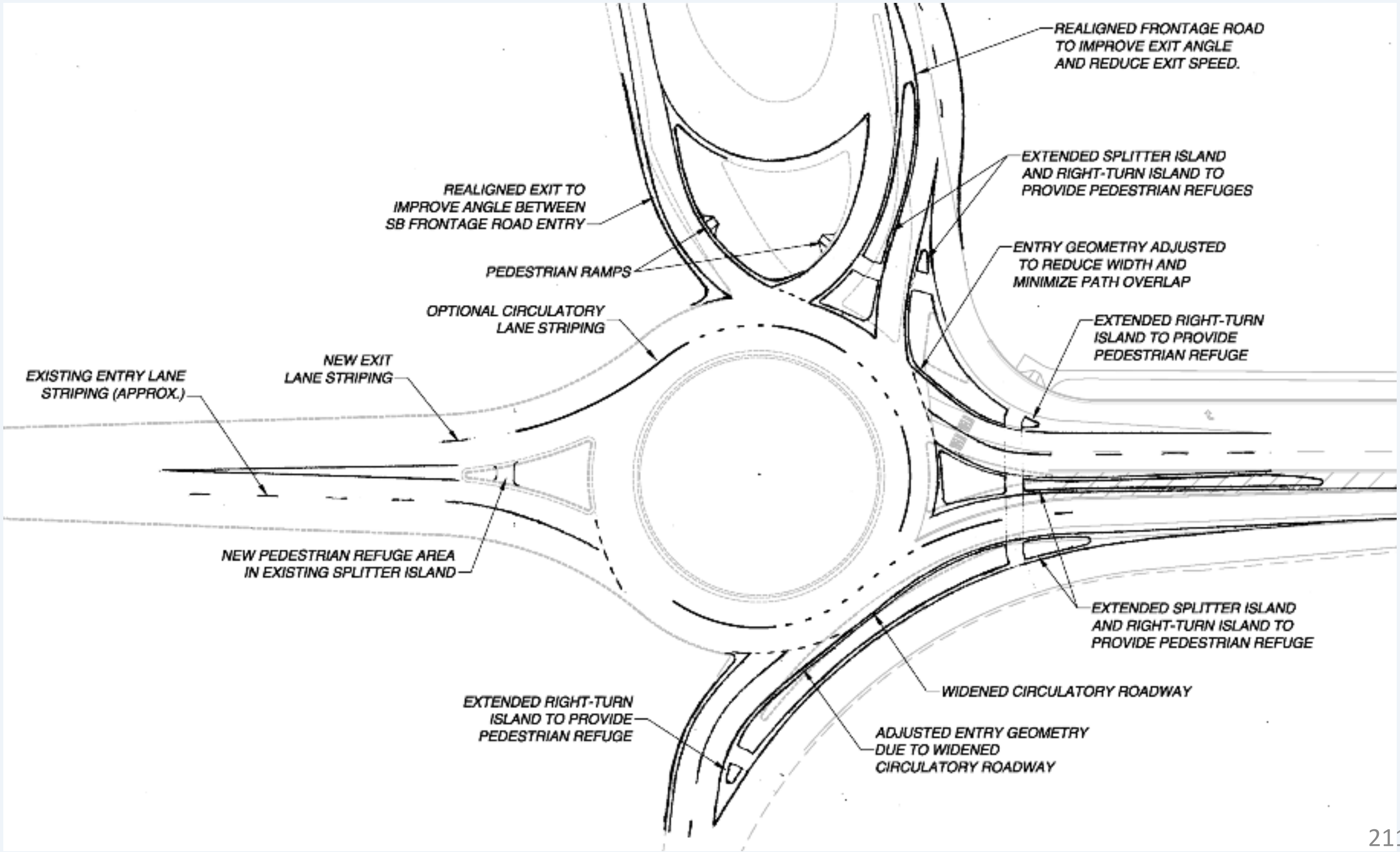
PEER REVIEW

Test Your Understanding: Urban Double Lane Roundabout –Phoenix, AZ



PEER REVIEW

Recommended Geometric Revisions



PEER REVIEW

Test Your Understanding: Urban Roundabout –Nashville, TN

PEER REVIEW

Test Your Understanding: Urban Single Lane Roundabout –Florida

Photo: Justin Bansen

CONCLUSION

CONCLUSION

- Is a roundabout a candidate?
- What makes a roundabout different from other intersections?
- Resources:
  - NCHRP 672, Roundabouts: An Informational Guide – 2nd edition
  - 2010 Highway Capacity Manual – Volume 3
  - 2009 MUTCD (Markings and Signage)
  - Implementation Workbook (Texas Roundabout Guidelines)