The National Academies of
SCIENCES · ENGINEERING · MEDICINE

TRANSPORTATION RESEARCH BOARD

Designing Multimodal Roundabouts: Making Them Safe and Efficient for All

Monday, September 11, 2017
2:00-4:00 PM ET

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.

RCEP

REGISTERED CONTINUING EDUCATION PROGRAM

Purpose

Discuss state-of-the-art roundabout design procedures that make roundabouts safe and efficient for all modes of travel, including transit, trucks, bicycles, and pedestrians.

Learning Objectives

At the end of this webinar, you will be able to:

- Describe specific principles of designing safe and efficient roundabouts for pedestrians, bikes, transit, trucks and access
- Discuss state-of-the-art methods to design roundabouts for pedestrians and vulnerable users
- Describe state-of-the-art design practices to make roundabouts safe and efficient for bicycles

Welcome to another TRB webinar brought to you by the TRB Standing Committee on Roundabouts (ANB75)

Committee Webpage: http://trbroundabouts.com/

To become a friend of the committee go to:
www.mytrb.org/Committees/SelfNominationAsFriend.aspx

You can join the Roundabout Listserv by emailing
geno@ksu.edu or danita@ksu.edu

Upcoming Roundabout Webinars

Next Monday 9/18: "Downtown and Suburban Revitalization": Examples to revitalize a downtown area, enhance a community's sense of place, and provide a safer and more efficient traffic flow in urban and suburban areas.

Analyzing Crashes on Multi-Lane Roundabouts: Monday, October 2. Key aspects of driver errors and geometric issues on roundabouts that lead to crashes. Presenters will describe some possible geometric solutions and driver education programs that may mitigate crashes on multi-lane roundabouts.

And there will be more in 2018

TRB Roundabout Committee has national conferences every three years.

Proceedings for 5th International Conference on Roundabouts, our 2017 conference in Wisconsin.
http://teachamerica.com/RAB17/
Prior conferences: http://teachamerica.com/

Access to NCHRP Reports

http://www.trb.org/Publications/PubsNCHRPPublications.aspx

Example
http://www.trb.org/Publications/Blurbs/175586.aspx

Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities

Don't Miss the FHWA/Safety page

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- Conventional Intersections
- Rural & Local
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Program Contact

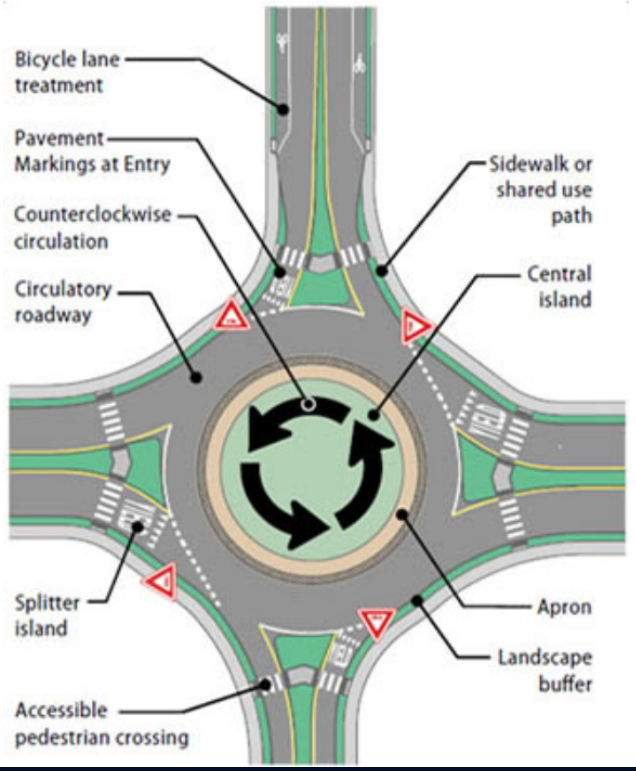
Jeffrey Shaw
jeffrey.shaw@dot.gov

Roundabouts and Mini Roundabouts

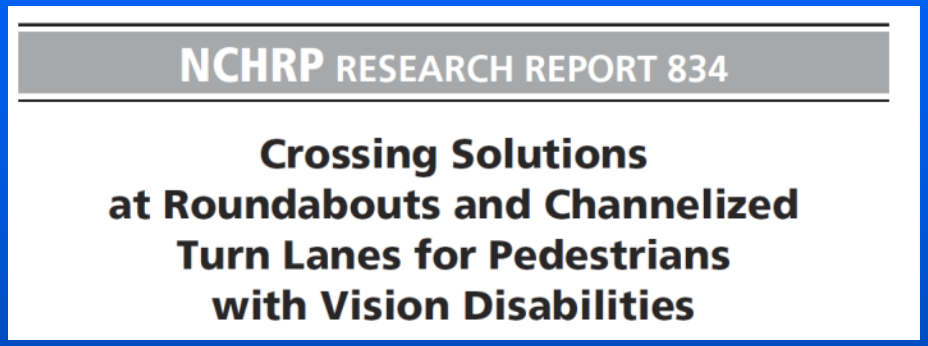
Outreach & Education
Technical Materials
Other Resources
State & Federal Research
National Partners

A roundabout is a type of circular intersection, but is quite unlike a neighborhood traffic circle or large rotary. Roundabouts have been proven safer and more efficient than other types of circular intersections.

Roundabouts have certain distinguishing features and characteristics (as shown in the adjacent diagram). While these noted features are common to many roundabouts, they are not always present, as roundabouts are adapted to the context of the location. In fact, roundabouts don't even need to be perfectly circular! Successful roundabouts come in all shapes and sizes. Some are oval-, teardrop-, peanut- and dogbone- shaped. Some have as few as three legs and others as many as six. There are small, simple mini roundabouts, and larger, more complex multilane roundabouts. However, regardless of size, circular shape, or number of legs, the fundamental and essential characteristics of all roundabouts include:



Research is frequent, and not always labeled 'Roundabout'.



Late 2016

20 mentions of roundabouts (4/2017)

New Research Report
Evaluation of Safety and Mobility of Two-Lane Roundabouts
Principal Investigator:
Gordon Parikh, John Hourdos
July 2017, MnDOT 2017-30

The TRB E-newsletter
http://www.trb.org/Publications/PubsTRBENewsletter.aspx

Transportation Research Information Services (TRIS)

- Includes the TRB Library and the TRB Databases which are free.
- TRID, largest & most comprehensive bibliographic source on transportation information. It contains more than 1.1 million records
- Research in Progress (RiP) contains more than 14,000 current or recently completed transportation research projects,
- Research Needs Statements (RNS) Database TRB committees identify, develop, and disseminate research need statements (RNS) for use by practitioners, researchers, and others.
- TRB Publications Index contains bibliographic information on more than 70,000 papers, articles, and reports.
- Practice Ready Papers (PRP) Database contains papers that are defined as those in which the research results presented and discussed make a contribution to the solution of current or future problems or issues for practitioners. effort.

Research Needs Listing https://rns.trb.org/

Design for Multi-Modal Roundabouts Making them Safe and Efficient for All

Part 1: Design for Peds, Bikes, Transit, Trucks, (Cars) & Access to Business.

Part 2: Pedestrians and Vulnerable Users at Roundabouts

Part 3: Bicycle facilities at Roundabouts

Mark T. Johnson, P.E.
MTJ Roundabout Engineering

TRB Webinar Sept 8th 2017

Multi-Modal Roundabout Innovation

Presentation Outline:

1. Overview of Design Principles for **Safety** (10 mins)
2. Review Operational **Characteristics that promote Flexibility** to meet Competing Goals and Objectives (5 mins)
3. Summary of Projects that Illustrate Safety and Flexibility leading to the Achievement of multi-**Transportation Solutions** for all users (15 mins)

Multi-Modal Roundabout Innovation

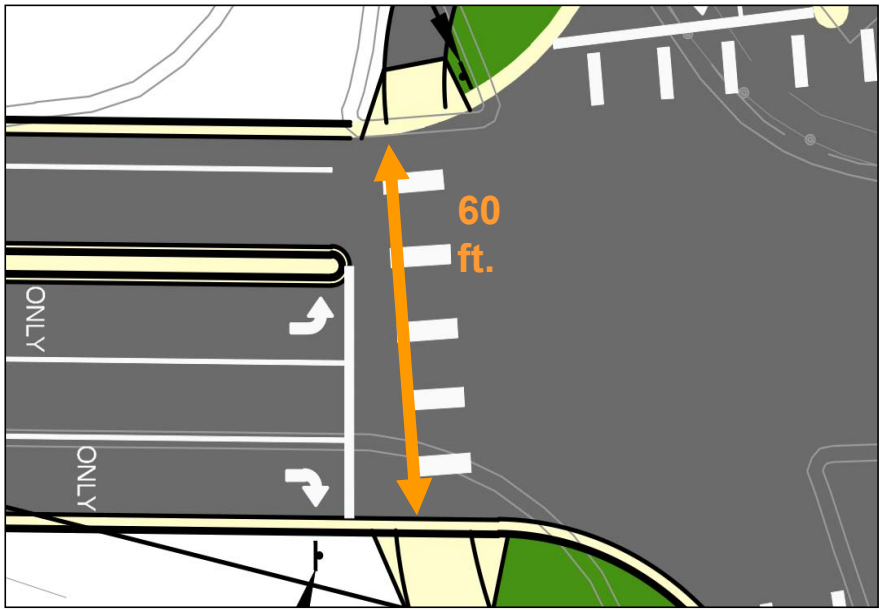
Many Competing Objectives:

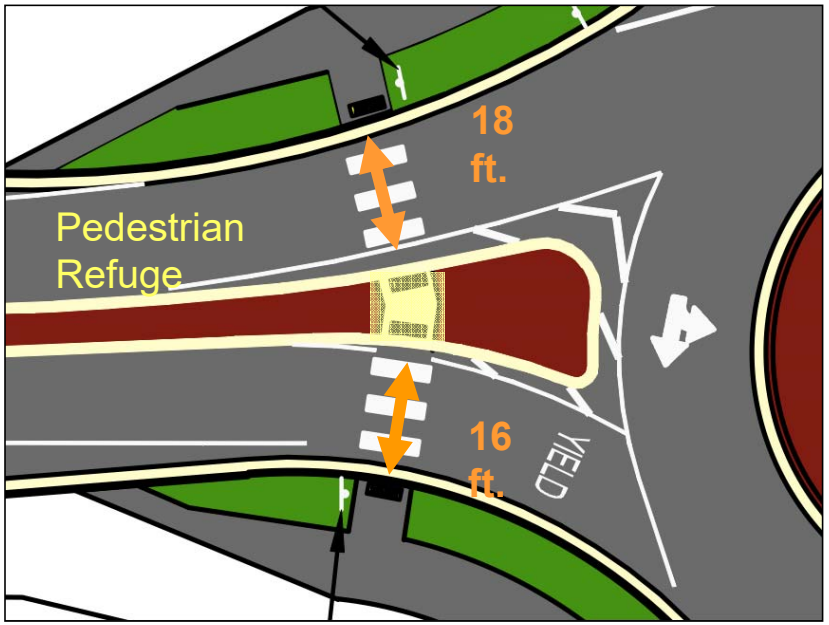
- Multi-modal - Complete Streets
- Business Access – Truckss / Freight
- Community Goals - Sensitive to Context
- Operations & Safety Performance
- Costs / Impacts

cars,
pedestrians, cyclists,
truck/freight,
transit (bus, rail)
&
Business Access

Roundabouts provide many advantages to meet these Competing Objectives

Multi-modal Roundabouts





Multi-modal Roundabouts

» Low speeds (15-25mph)

» Fewer Ped/Veh conflict points

» Shorter crossing distances

» Cross one direction of travel at a time

» Less Delay

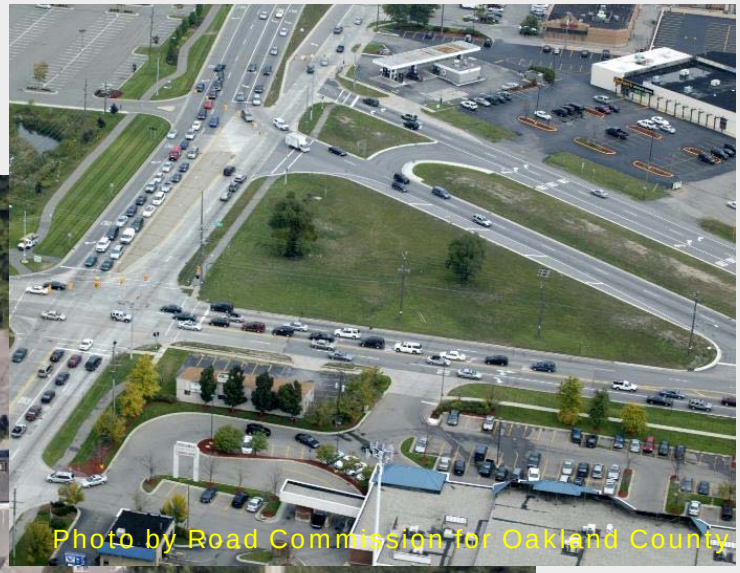
60s Delay for Ped w/ Signal

18s Delay for Ped at Roundabout

Multi-modal Roundabouts

Less roadway widths = bike/ped facilities w/i avail ROW

Northwestern Connector
Orchard Lake Rd. at 14 Mile Rd.

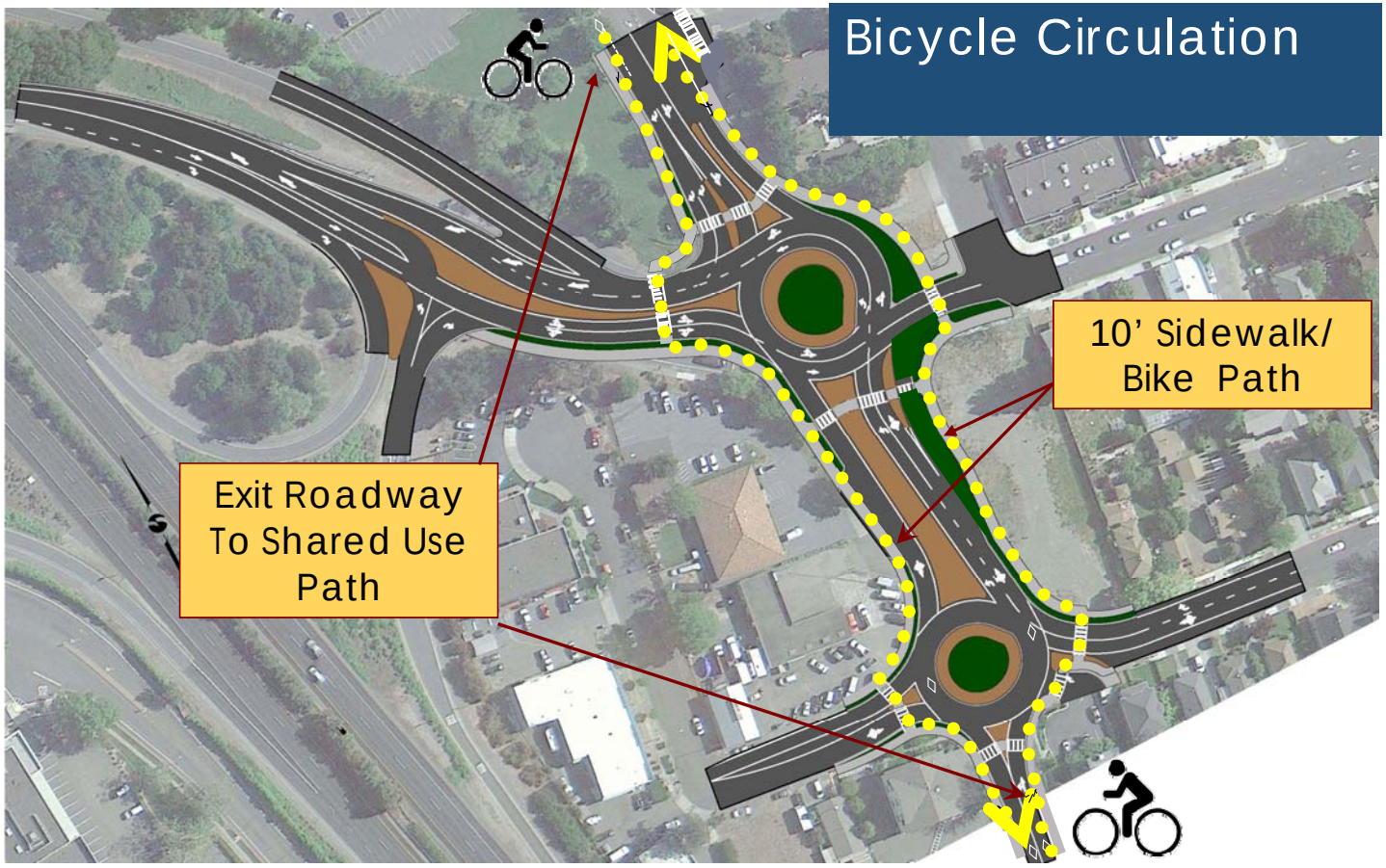


Northwestern Connector Triangle

Multi-modal Roundabouts

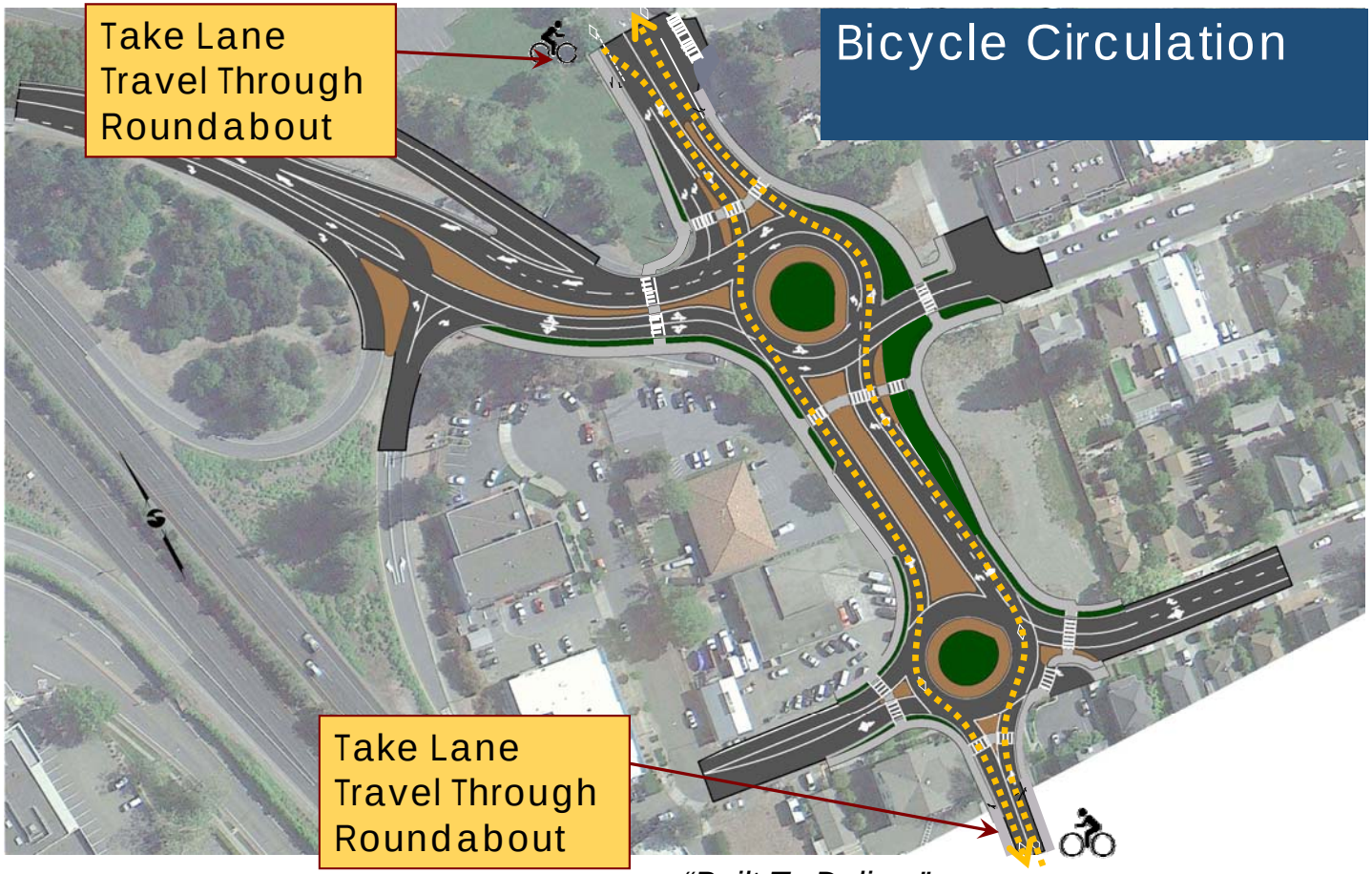
Multi-modal Roundabouts

Slower Safer Crossings



Multi-modal Roundabouts

Slower Consistent Vehicular Speeds - Safer



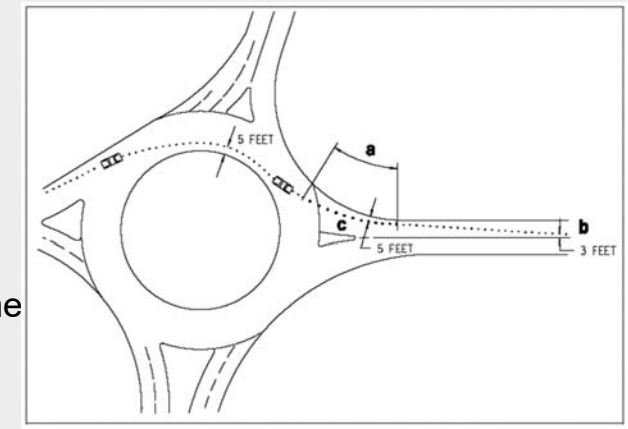
1. Design Principles for Safety

Design Principles for Safety and Operations

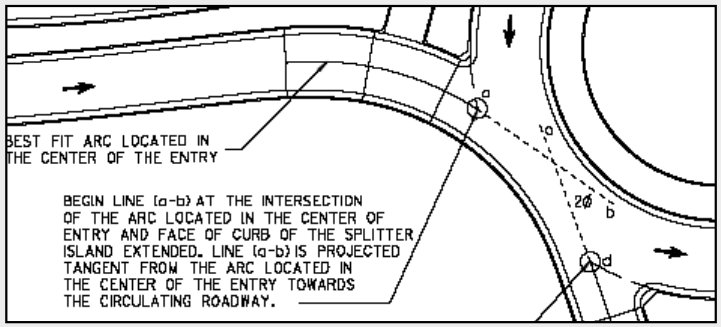
Roundabout Safety Principles:

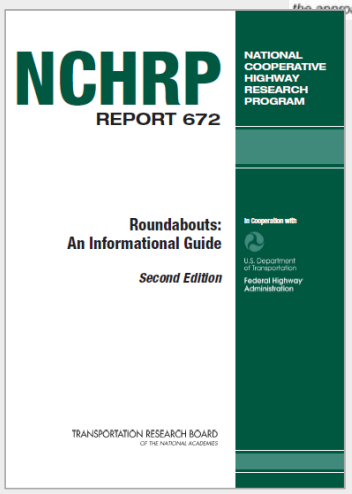
- Angle between arms
- Speed Control (“fast path”)
- Entry (PHI) Angles
- View angle to left - avoid severe neck turning
- Limit unnecessary sight distance (speed control)
- Avoid sign clutter – provide clarity in signing and pavme markings

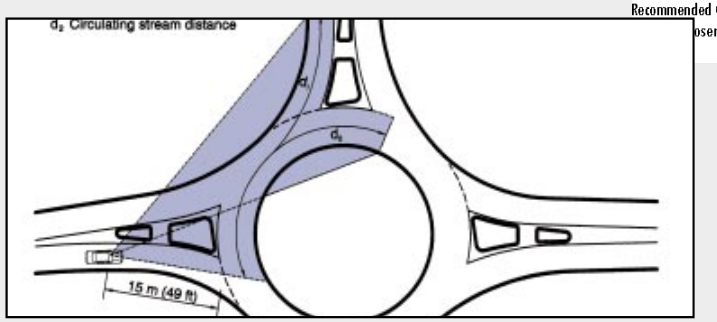
Sources: Maycock/Hall 1984 LR 1180
WisDOT Guide, NCHRP 672

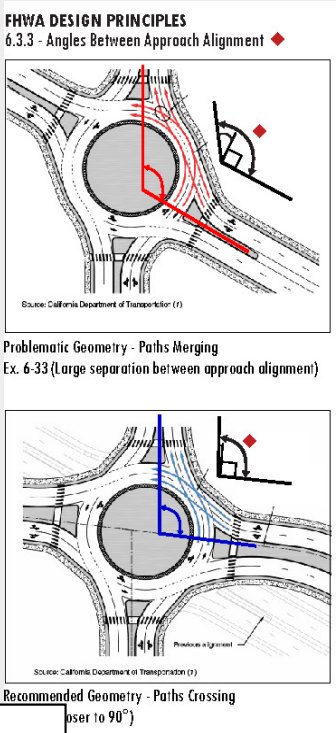


a - The radius should be measured over a distance of 65 to 80 feet. It is the minimum that occurs along the approach entry path near the yield point but not more than 165 feet in advance of it.





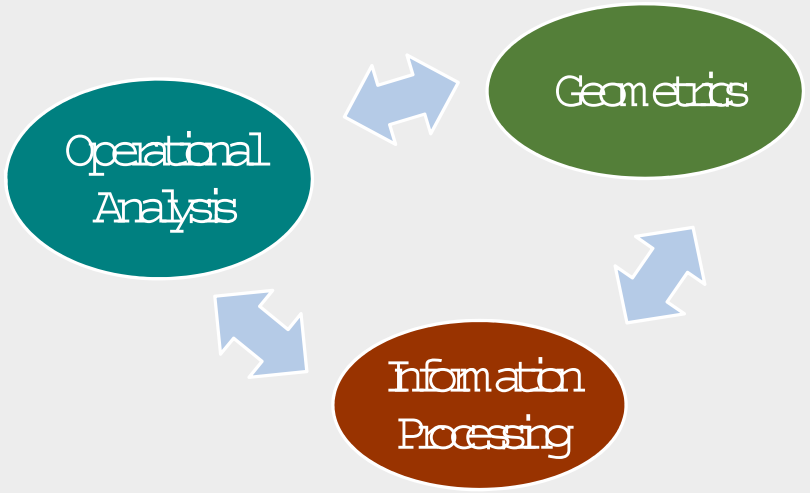




Roundabout Design for Safety and Operations

- Safety and performance attributed to multiple design elements:
- Adhere to Principles - Not prescribed methods
  i. Offset left , radial, lane widths, ICD must = X'
  ii. Use design flexibility to meet Safety Principles

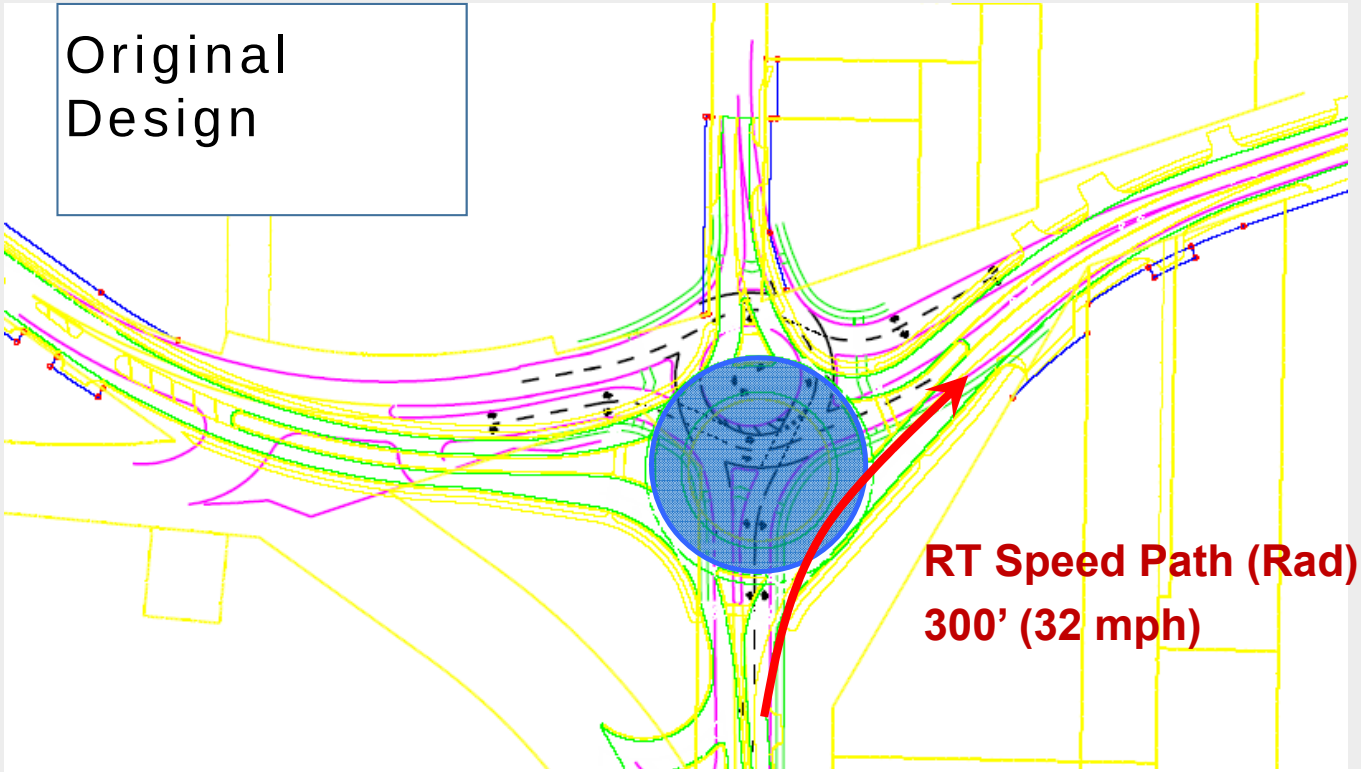
The Composition of Design:



Safety Examples

Geometry

Use design flexibility to meet Safety Principles

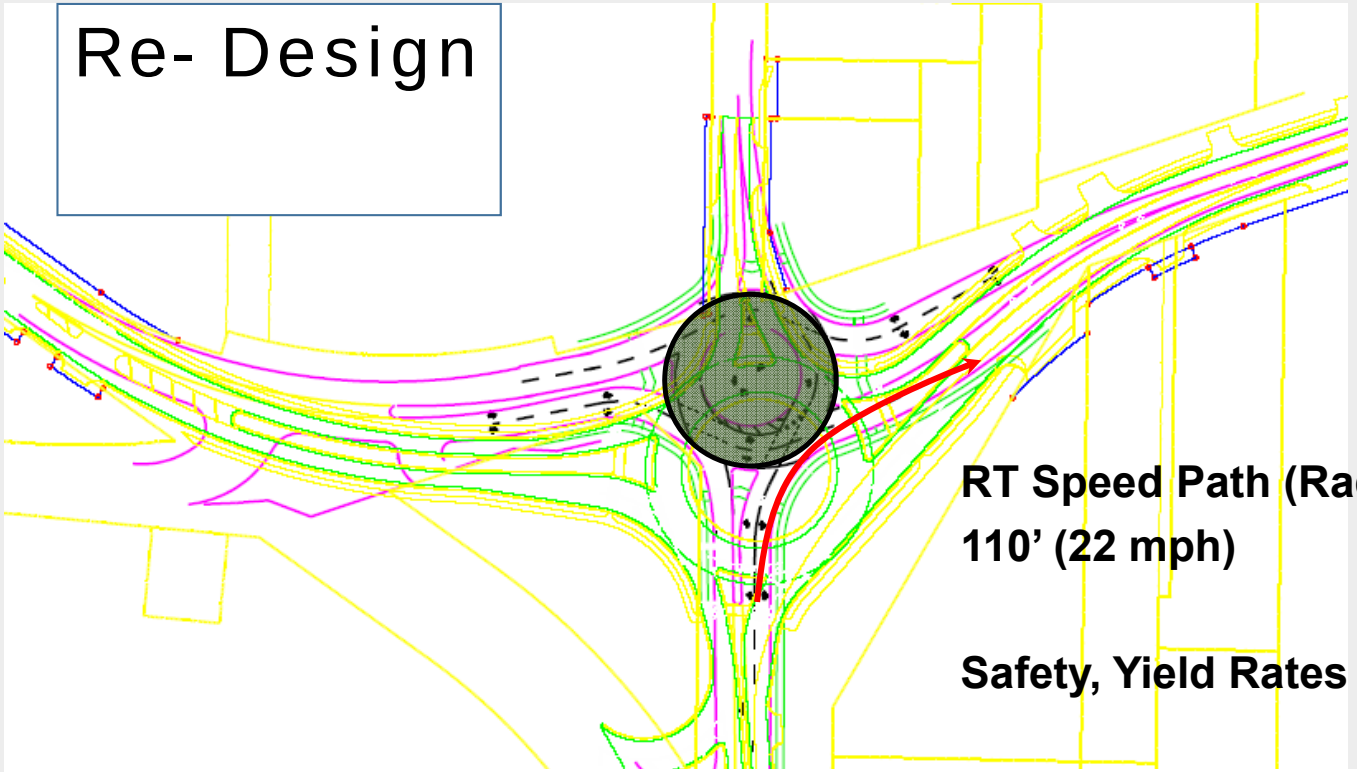


NB RT (R5) Fast Path	Radii (ft)	Speed (mph)
ORIGINAL DESIGN	300’	32
REVISED DESIGN	110’	22
PERCENT REDUCTION		31%

Source: MTJ

Geometry

Use design flexibility to meet Safety Principles



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ORIGINAL DESIGN	300’	32
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PERCENT REDUCTION		31%

Source: MTJ

Safety Examples

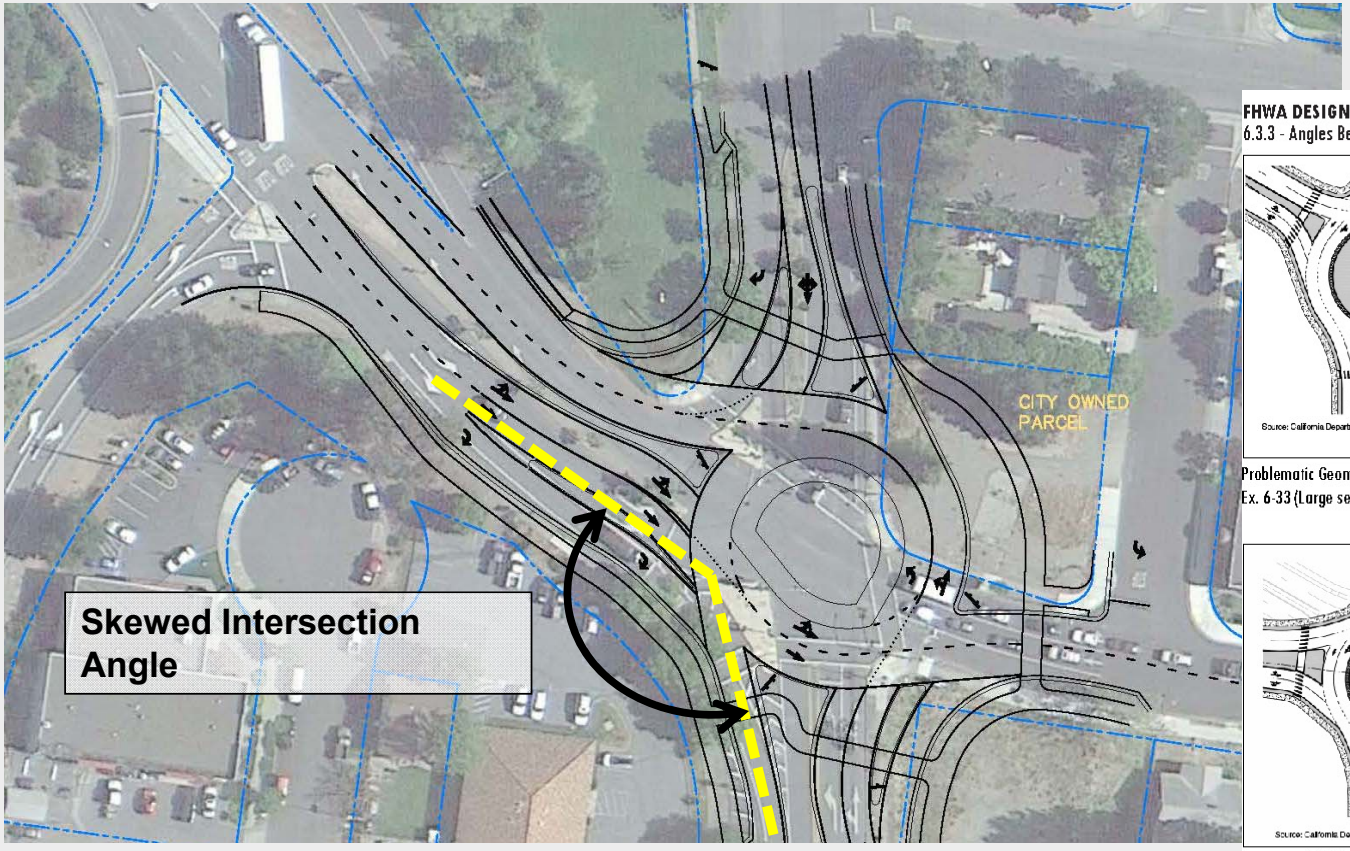
Roundabout Design/Optimization Example

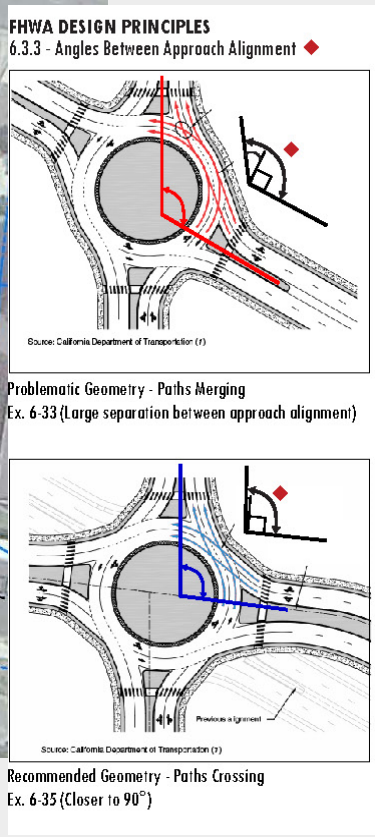
Initial Concept

Design Principles:

- Speed control
- Entry/View angles
- Intersection angles

These effect safety for all modes



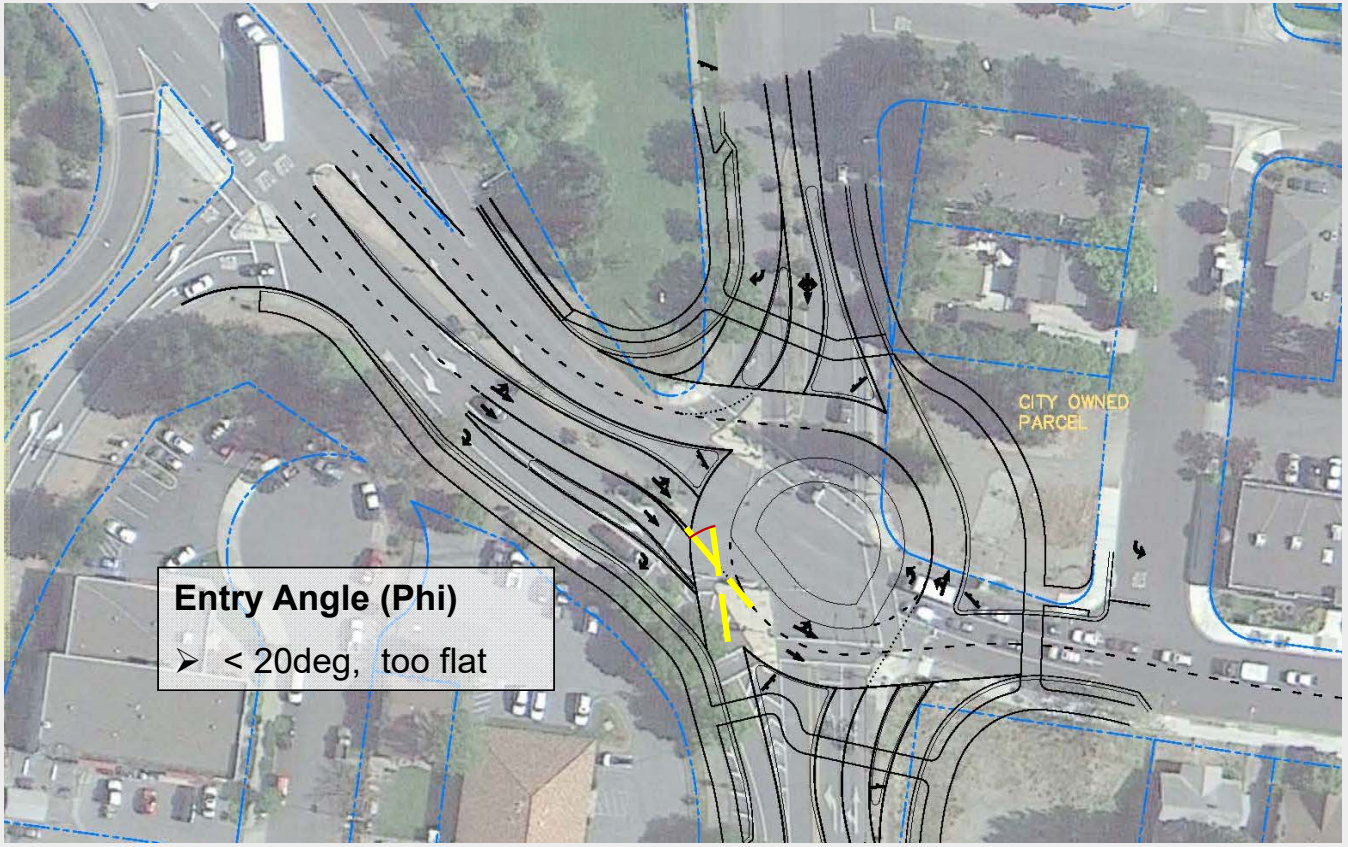


Roundabout Design/Optimization Example

Design Principles

- Entry (Phi) Angle
- View Angle
- Fast Path

Initial Concept

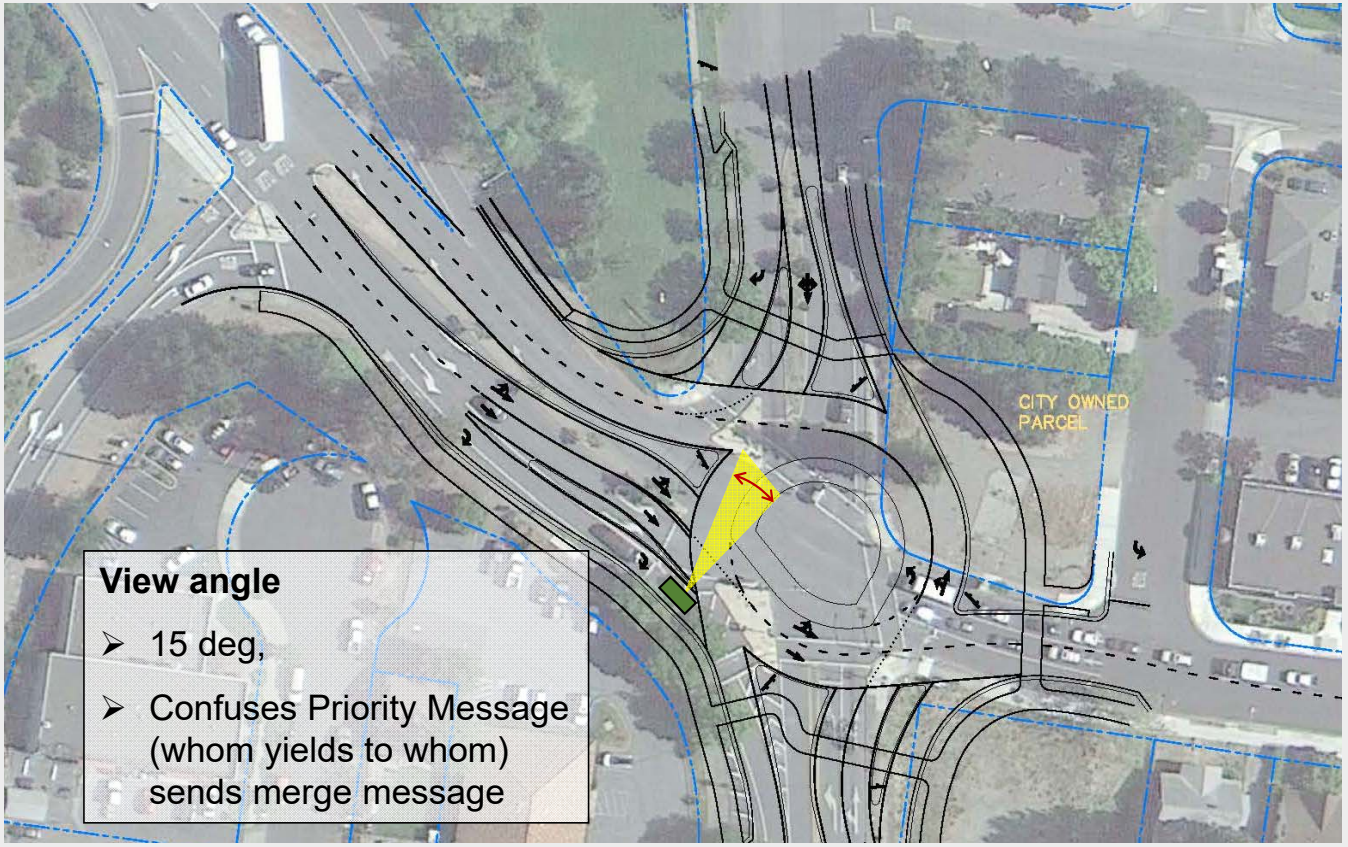


Roundabout Design/Optimization Example

Design Principles

- Entry Phi Angle
- View Angle
- Fast Path

Initial Concept

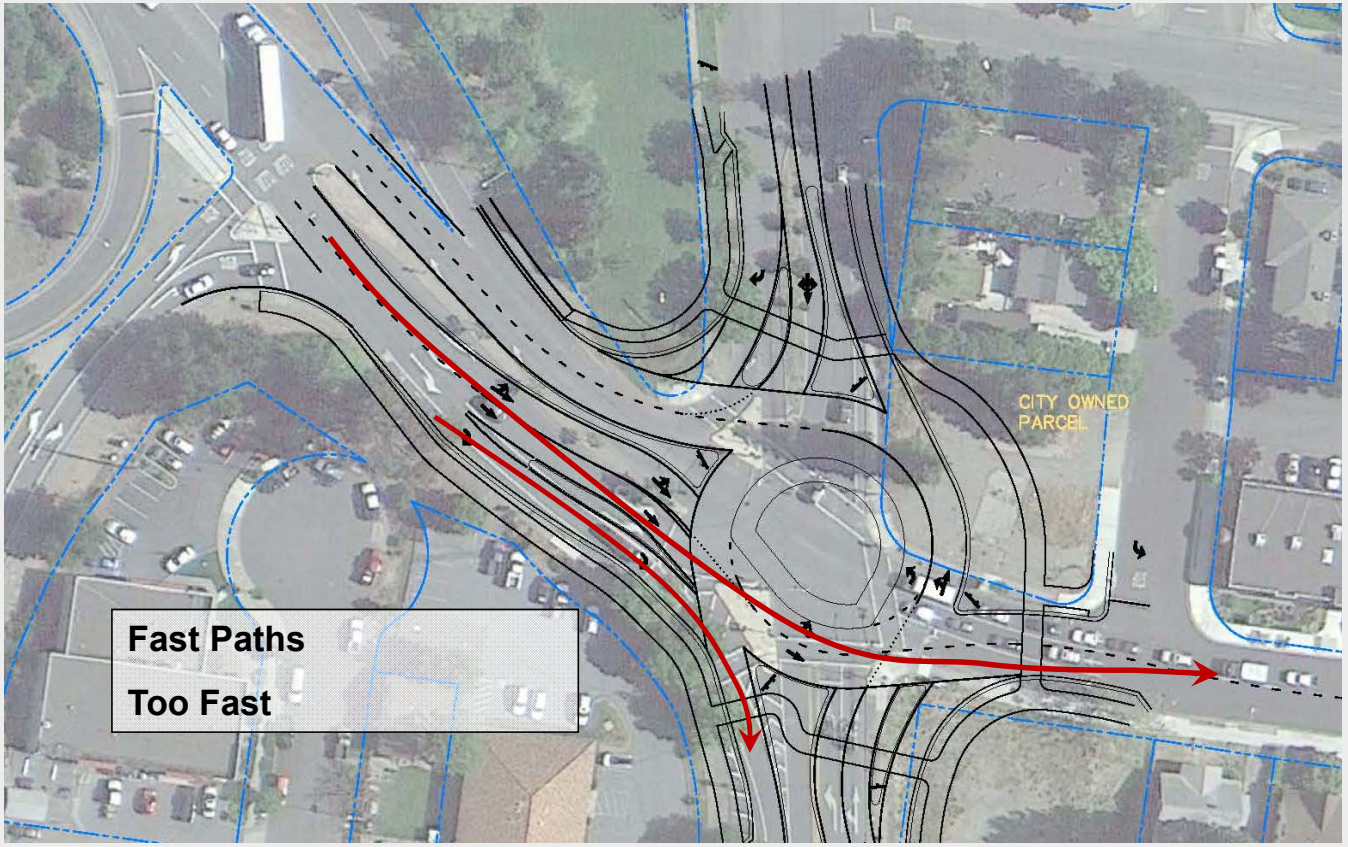


Roundabout Design/Optimization Example

Design Principles

- Entry Phi Angle
- View Angle
- Fast Path

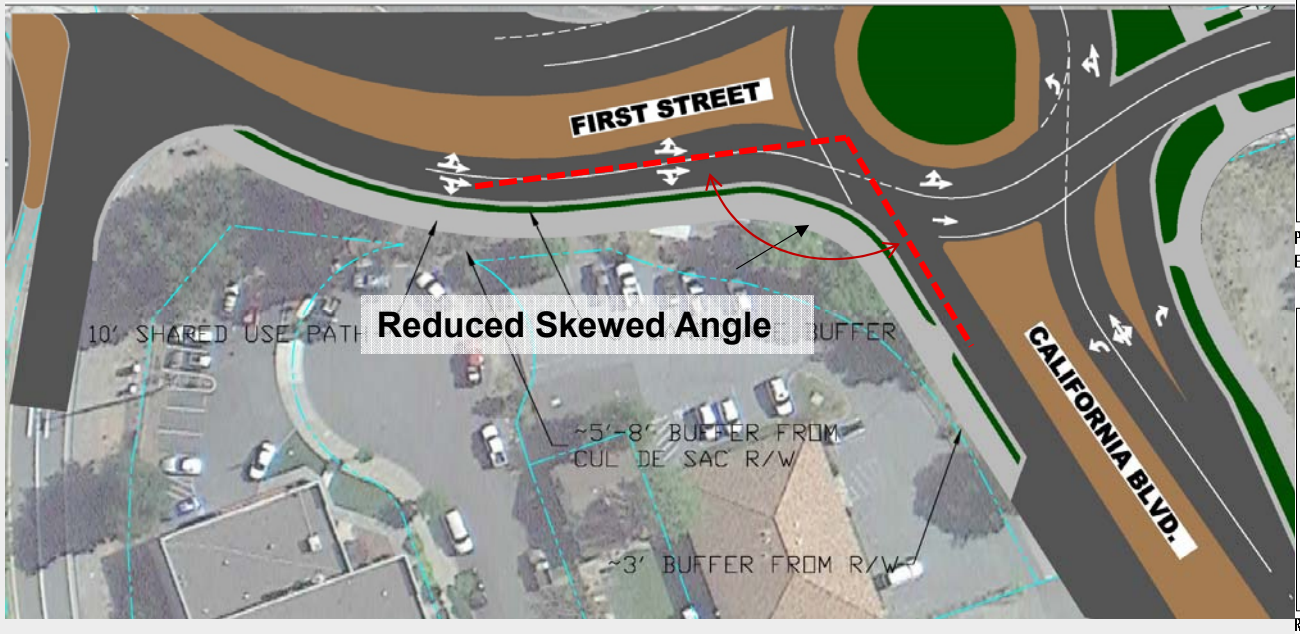
Initial Concept



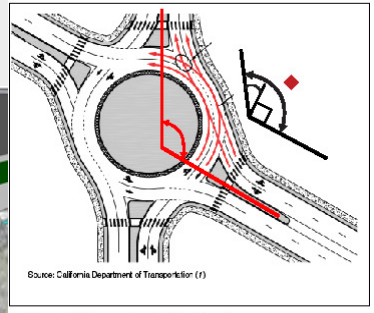
Roundabout Design/Optimization Example

SAFETY: Pedestrians – Bicycles – Vehicular

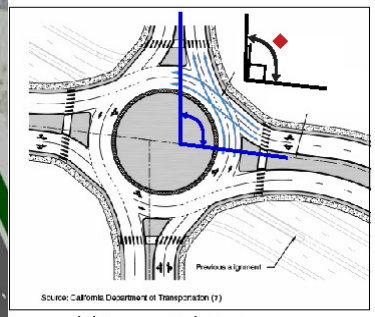
Re-Design Concept



FHWA DESIGN PRINCIPLES
6.3.3 - Angles Between Approach Alignment ◆



Problematic Geometry - Paths Merging
Ex. 6-33 (Large separation between approach alignment)

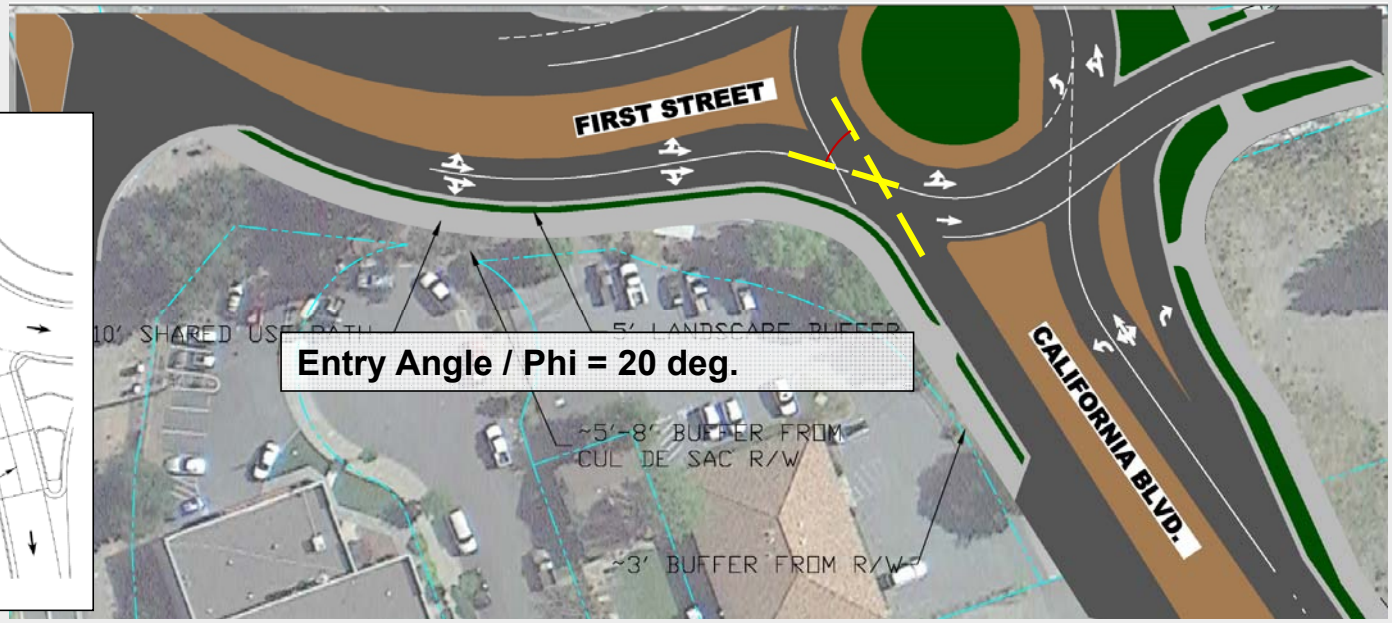


Recommended Geometry - Paths Crossing
Ex. 6-35 (Closer to 90°)

Roundabout Design/Optimization Example

SAFETY: Pedestrians – Bicycles – Vehicular

Re-Design Concept



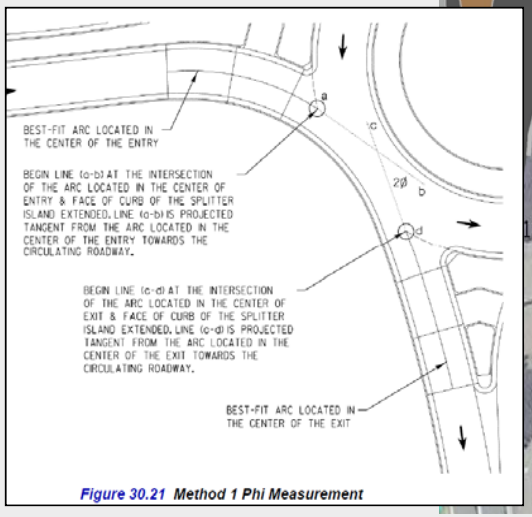


Figure 30.21 Method 1 Phi Measurement

Roundabout Design/Optimization Example

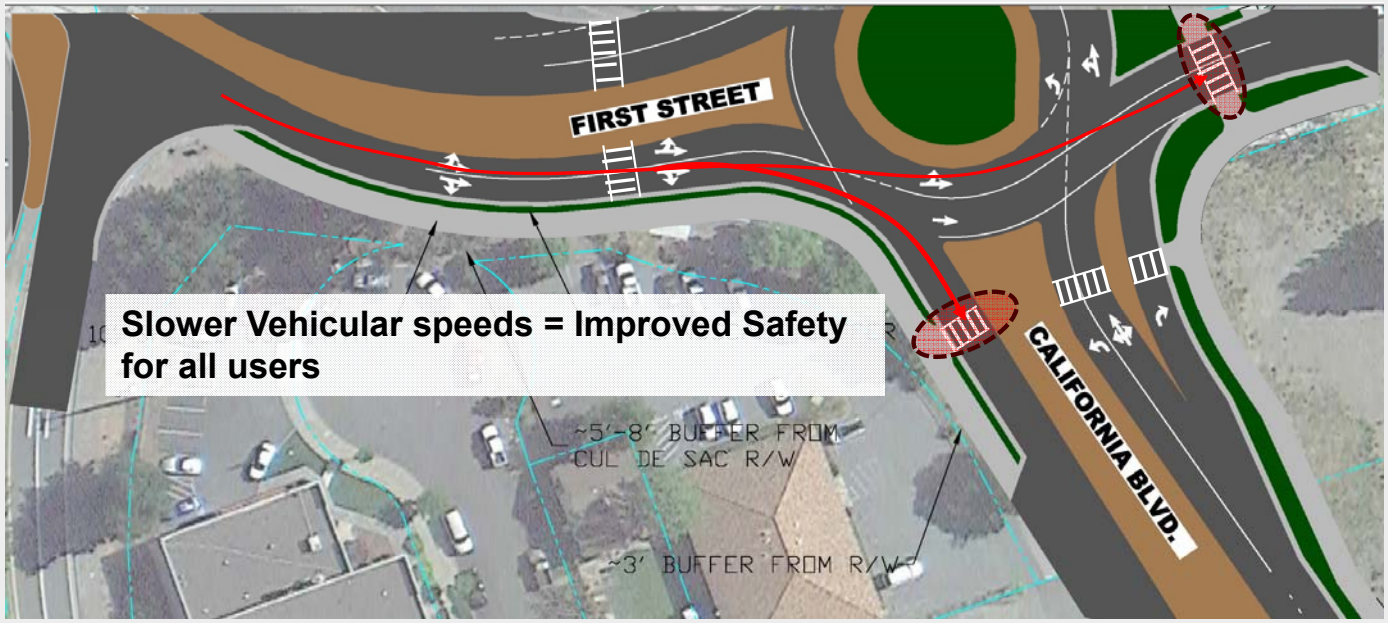
SAFETY: Pedestrians – Bicycles – Vehicular

Re-Design Concept

Roundabout Design/Optimization Example

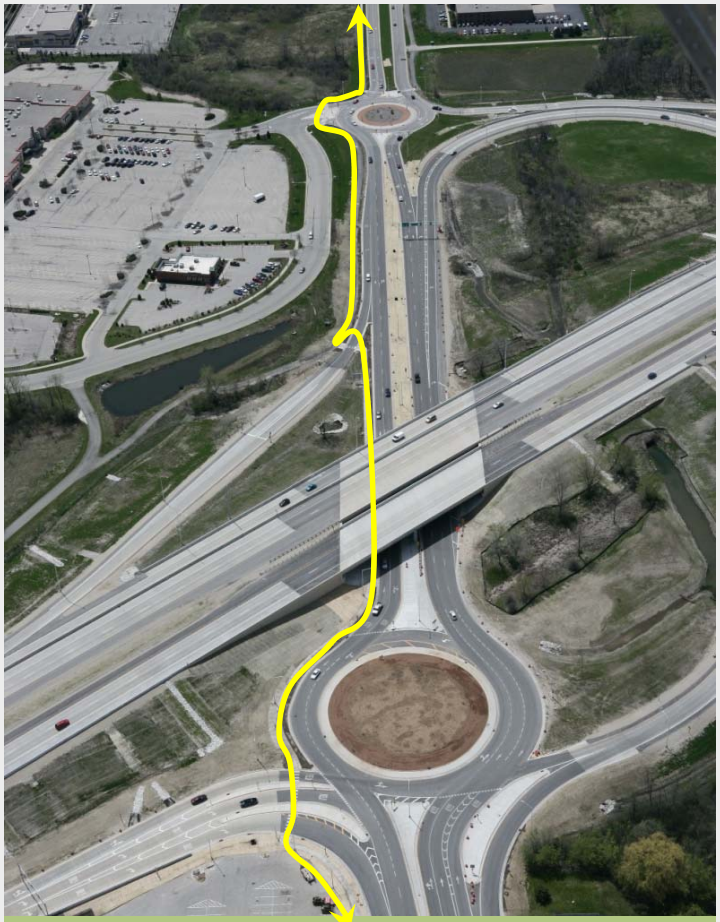
SAFETY: Pedestrians – Bicycles – Vehicular

Re-Design Concept



Safety

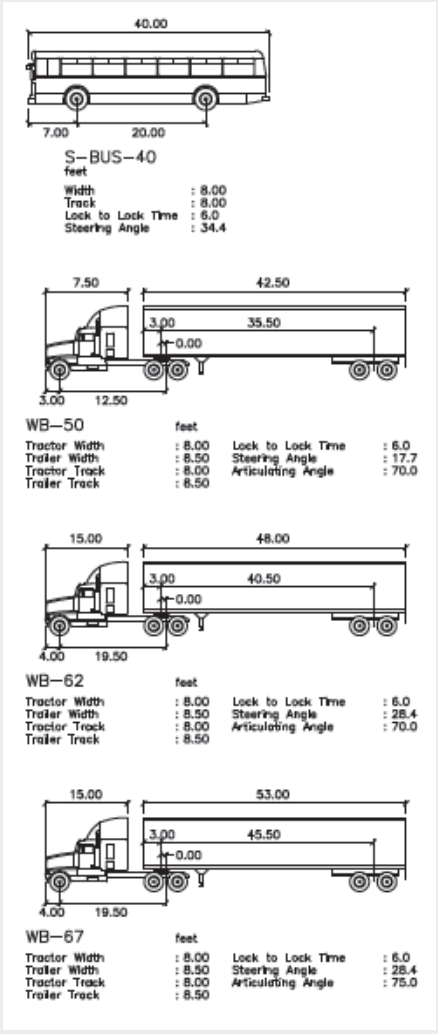
Roundabout Design/Optimization Example- Geometric Selection

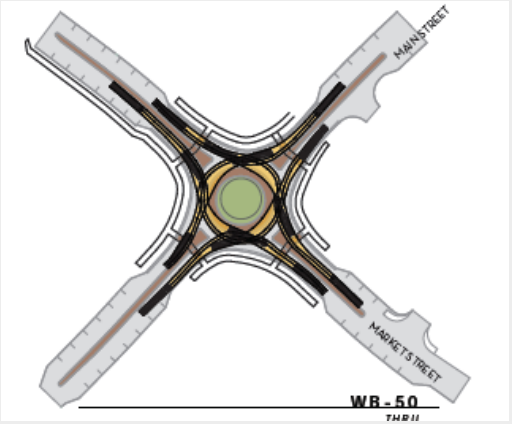


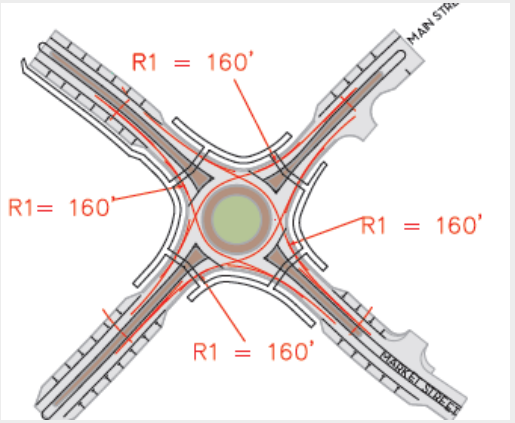
Three-Lane Entry:

Ave annual PDO crashes ~ 15 crashes per year (over 5 year period). 40k ADT

Freight, Trucks, Design Vehicles, OS/OW







Freight, Trucks, Design Vehicles, OS/OW

pedestrian safety enhancements

- Landscape features for way finding
- Bollards to promote visual awareness / way finding
- Colorized Pavement Surfaces

Accommodate Freight - Trucks

Vertical Design Elements:
- Cross Sections
- Profiles
- Curb Details
  - Mountable
  - Low profile
  - aprons

2. Flexibility

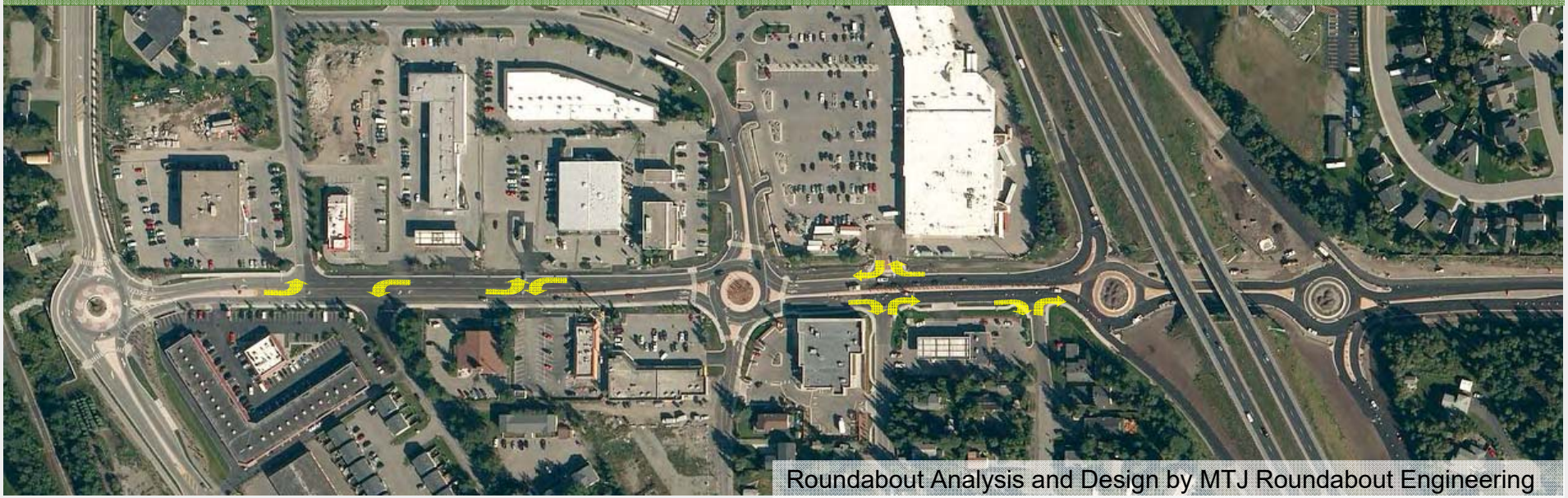
traffic/roadway planning/access

Multi-modal Roundabouts

Operational Characteristics of Roundabouts:

- Slower / Consistent Speeds & Less Q' in Functional areas
- No Signal Progression = Intersection/Access Spacing Versatility
- Less roadway widths = Opportunities for adding bike/ped facilities w/i avail ROW

Huffman Road Corridor, Anchorage, AK

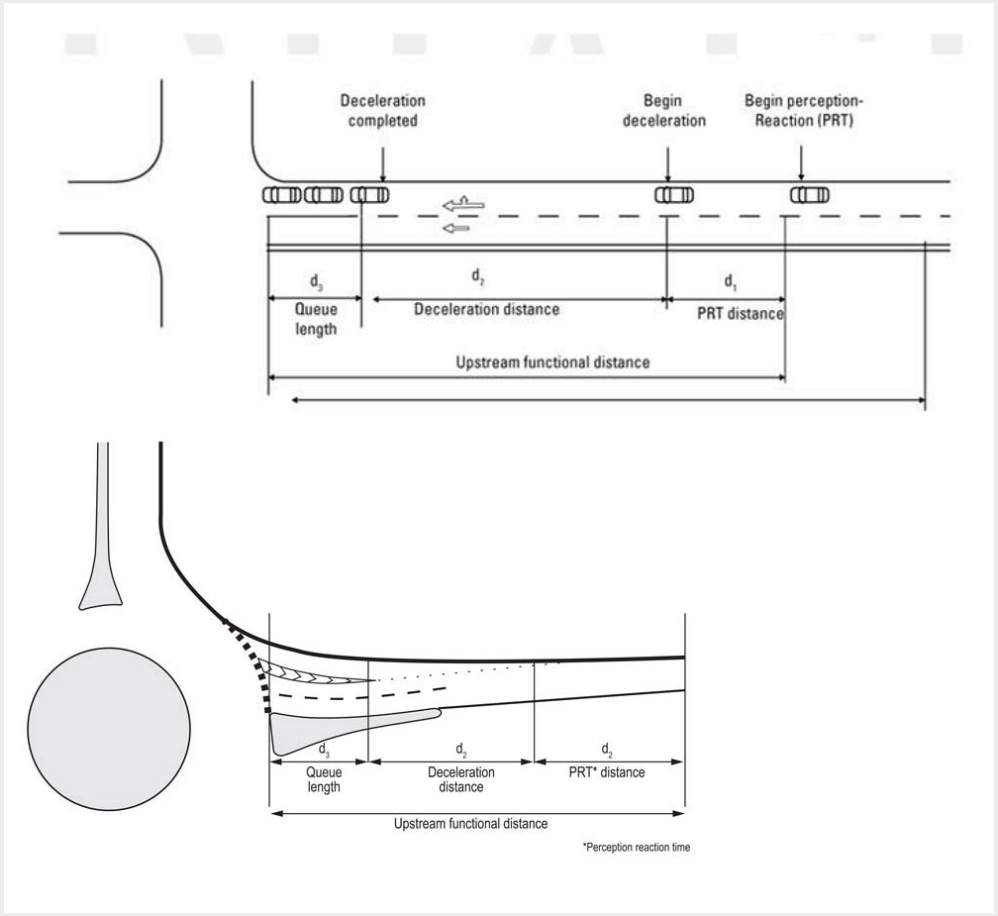


Roundabout Analysis and Design by MTJ Roundabout Engineering

Access Management Principles

Differing Functional Area and Speeds

Effects Driveway Locations



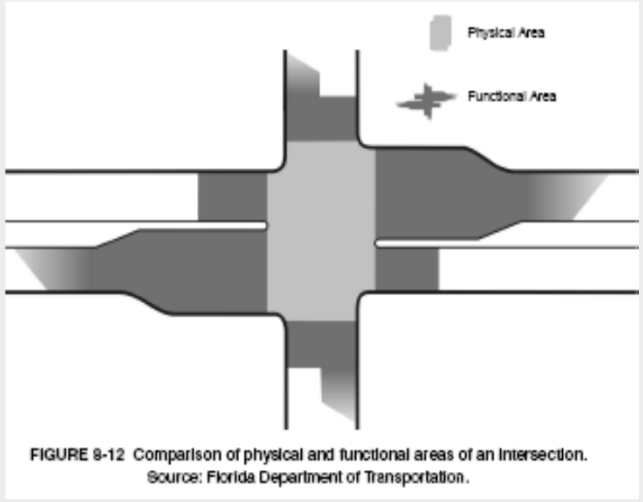


FIGURE 9-12 Comparison of physical and functional areas of an intersection.
Source: Florida Department of Transportation.

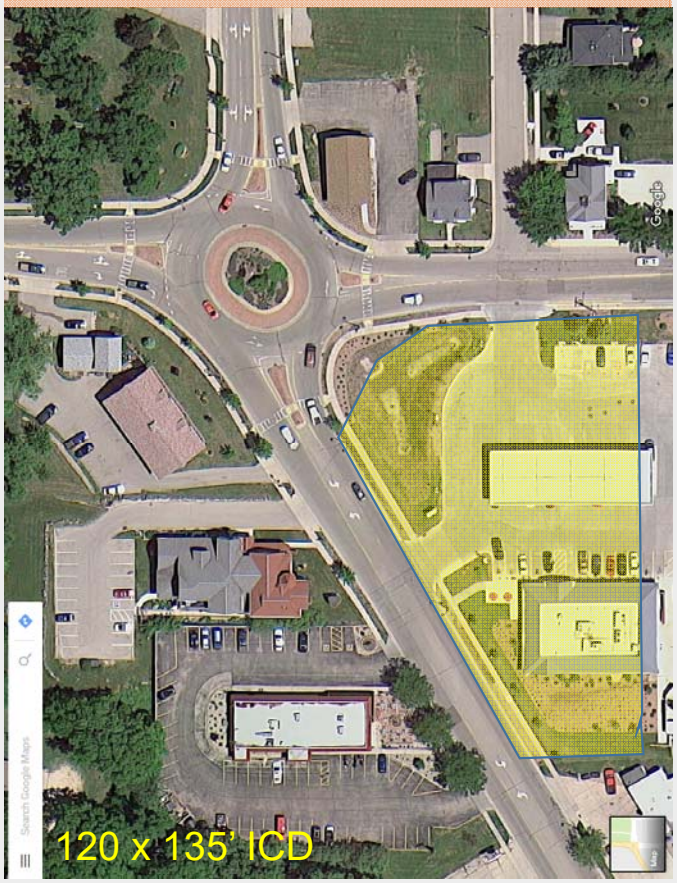
Flexibility
Example #1

Business Access and Roundabouts

Operational Characteristics promote access goals/objectives for Agency and Business owners

Safe & Efficient ingress/egress.

Slower / Consistent Speeds & Less Q' in Functional areas



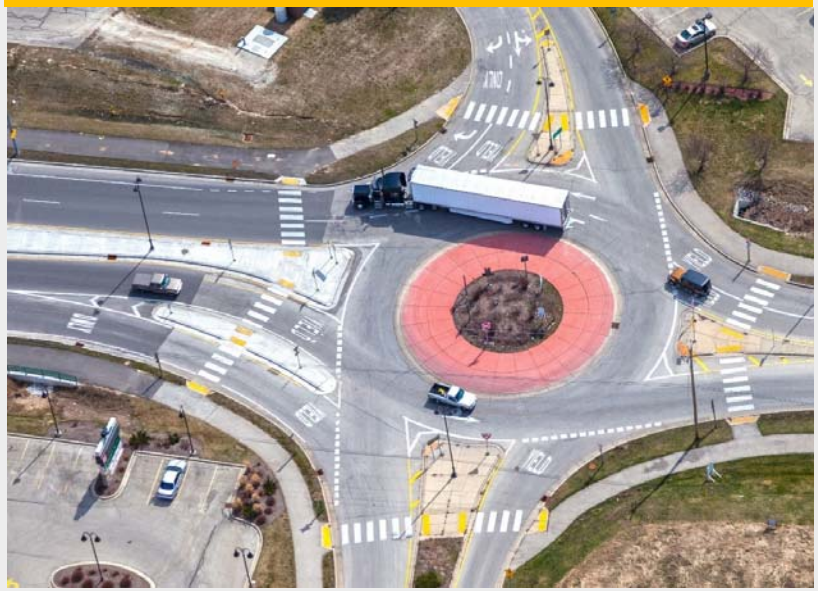
Flexibility
Example #2

Multi-modal Roundabouts

Business Access

Multi-modal Roundabouts

- 125’ ICD - Hybrid
- Flared Entry
- OS/OW Loads

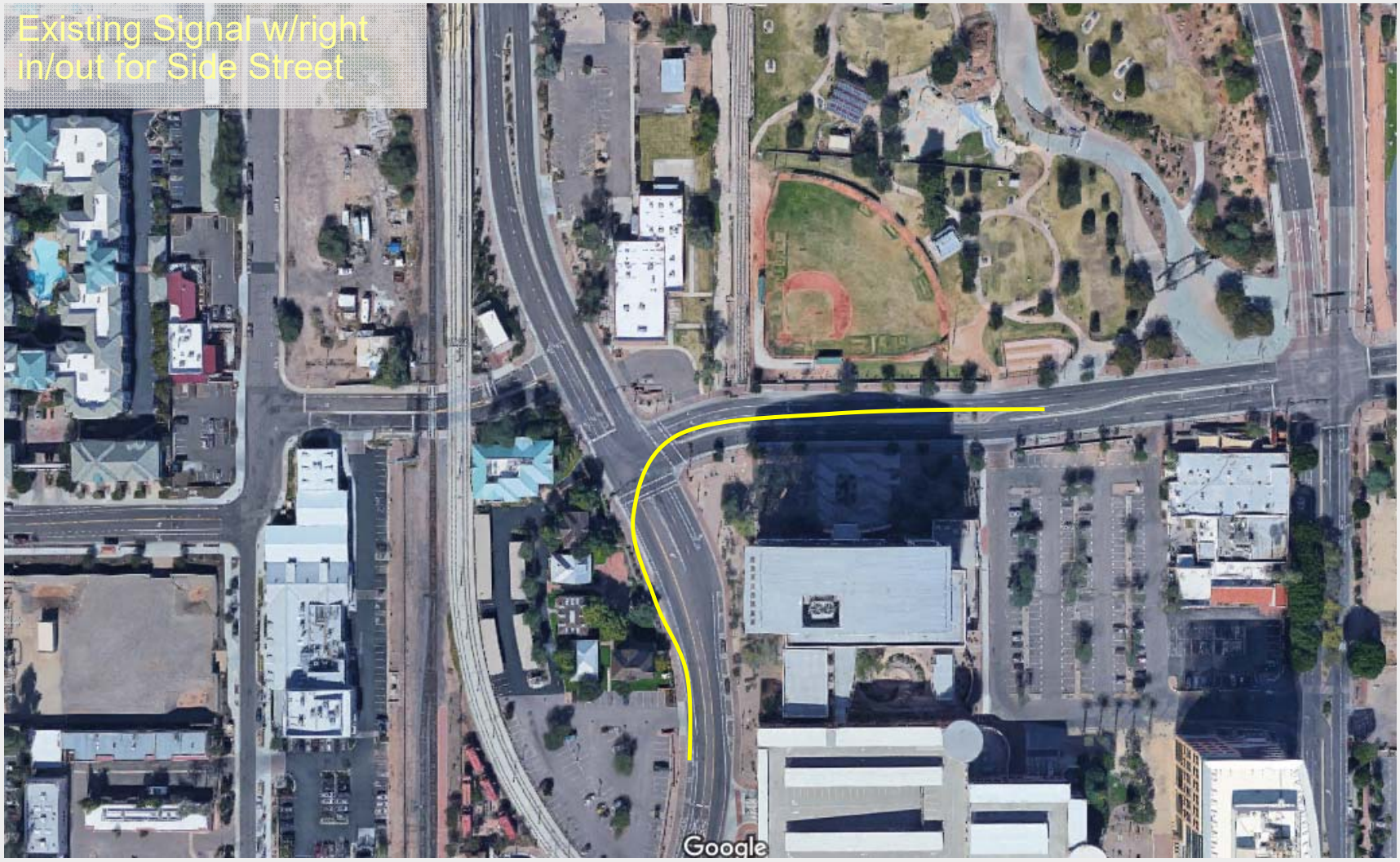


US 18/Blackwood Dr., Waukesha City, WI

- 155’ ICD 2x2
- Designed for OS/OW Loads

STH 83/USH 18., Waukesha City, WI

Flexibility
Example #3

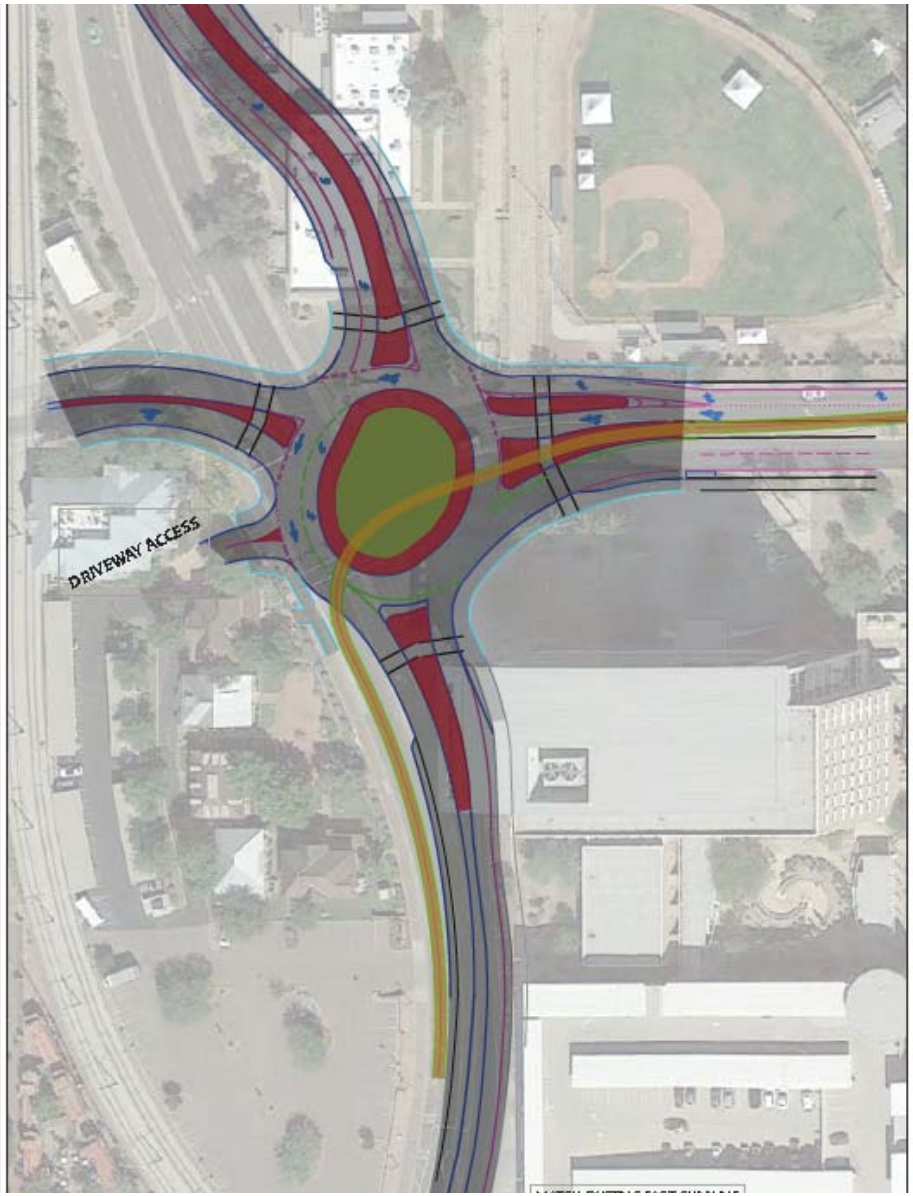

Existing Signal w/right in/out for Side Street
Google

5 Leg

Direct Access to Side street

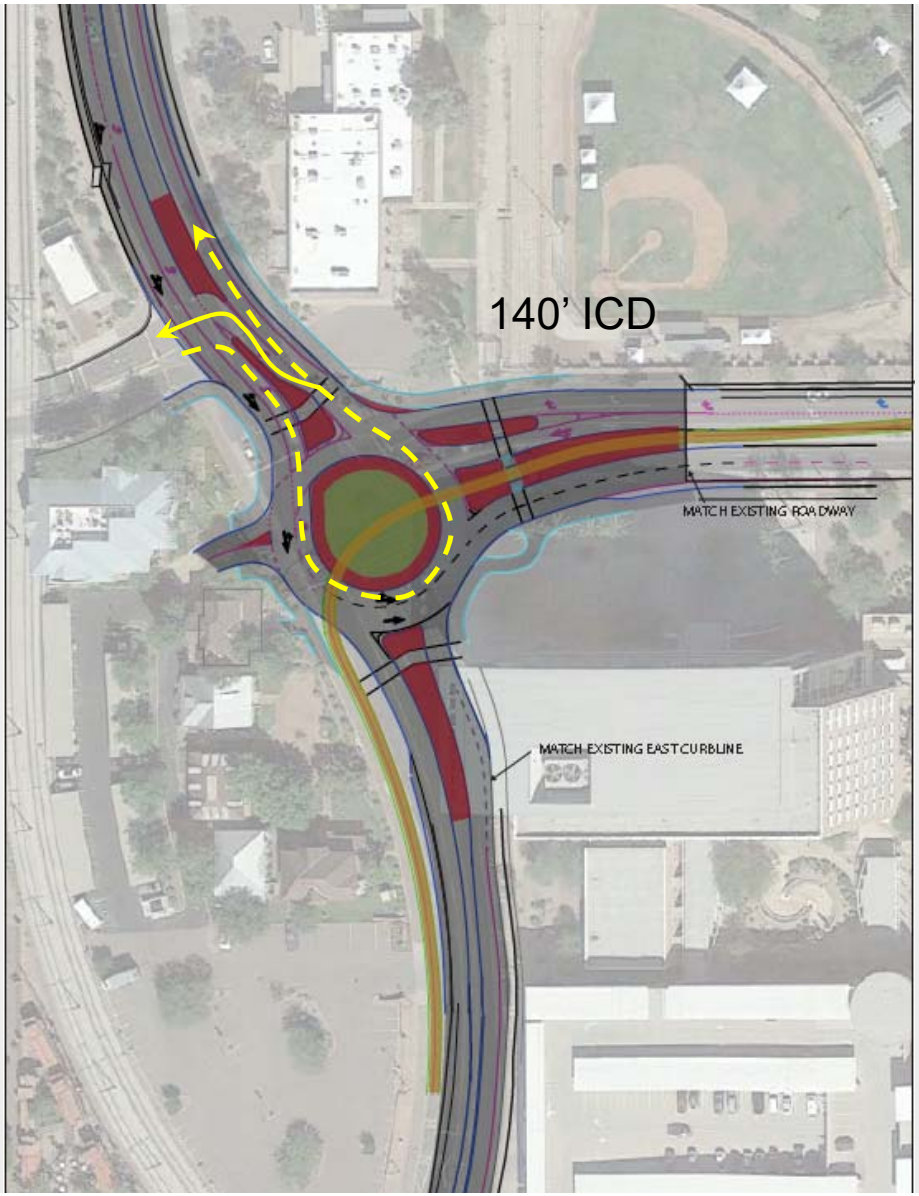
& Streetcar

Greater Impacts



4 Leg
3/4 access + u-turn = good side street circulation

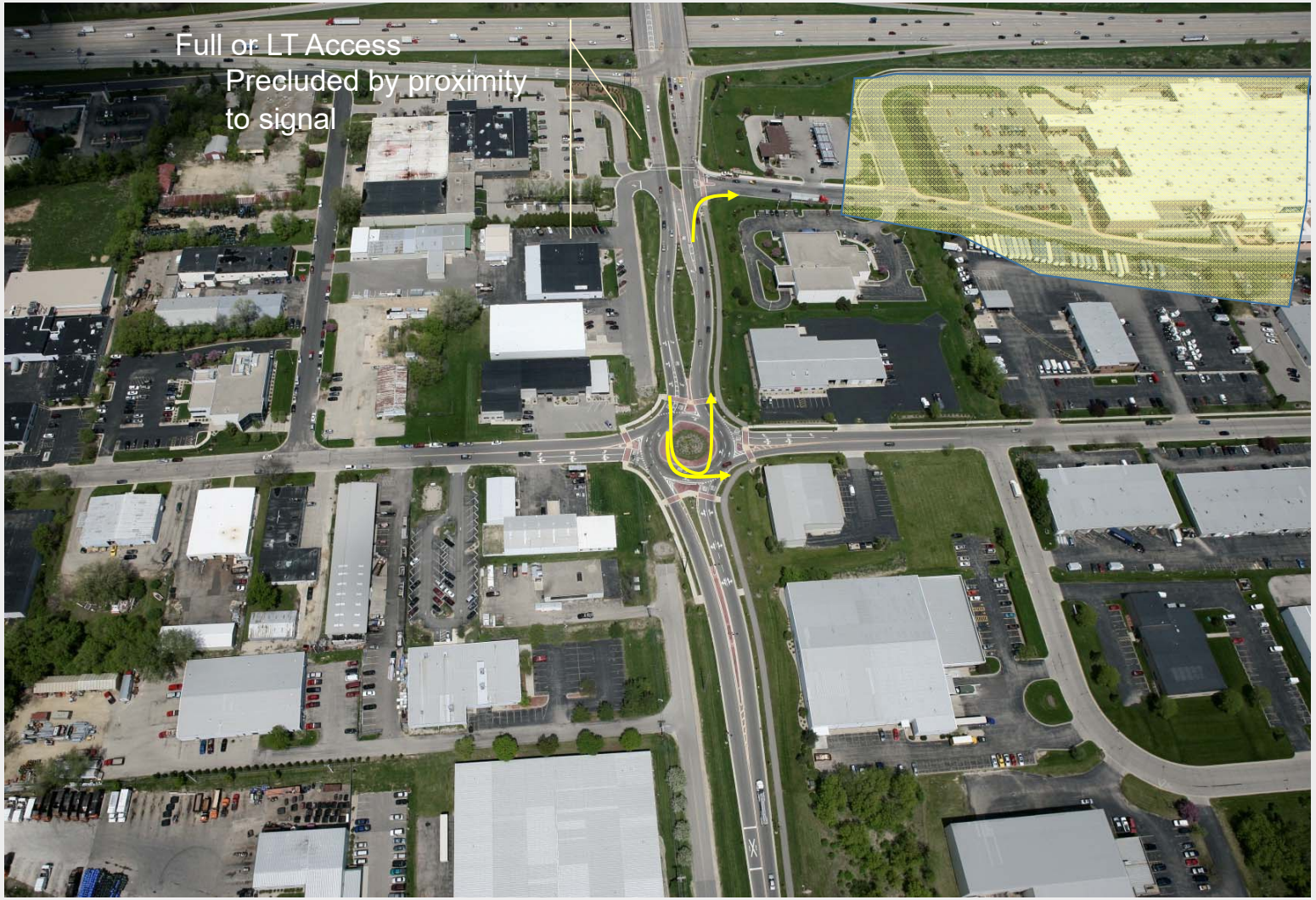
& Streetcar Line



3. Projects Illustrating achievement of **Transportation Solutions** for all users

Project #1

System Effects



System Effects

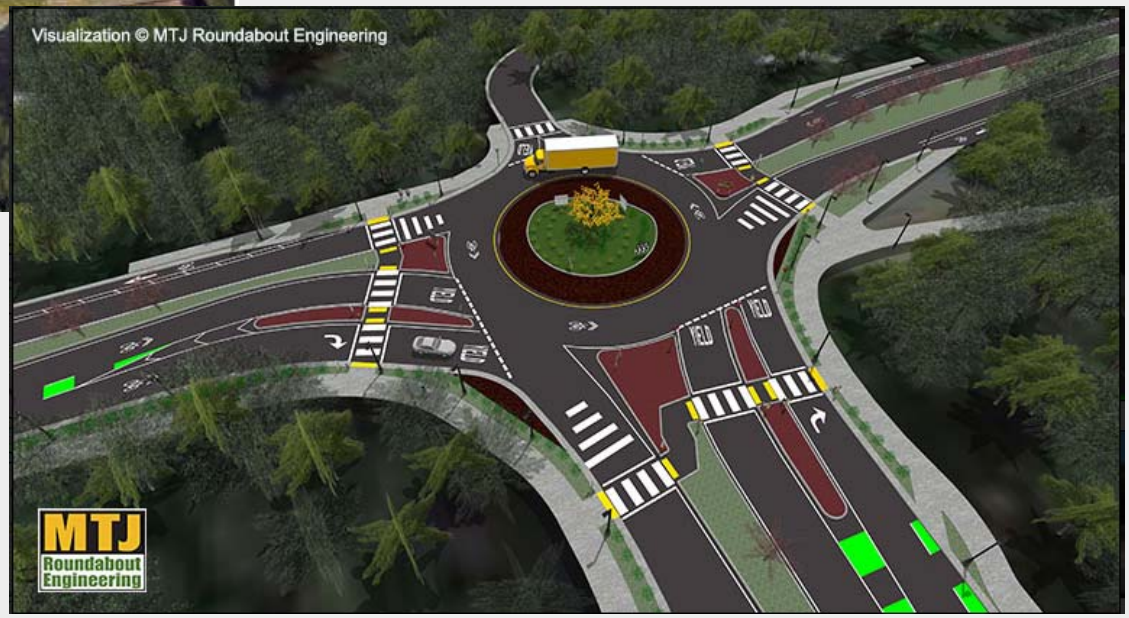
Ave annual PDO crashes ~ 8 crashes per year (over 8 year period). 28k ADT

Project #2

City of Lafayette CA

108’ ICD

Existing Ped/Bike Lanes, and Path



http://www.mtjengineering.com/project/pleasant-hill-olympic-blvd-lafayette-ca/

City of Lafayette CA

108’ ICD

Existing Ped/Bike Lanes, and Path

- Multi-Modal Peds, Bikes, Transit, Trucks, Cars
- Operational and safety improvement
- Reduced overall costs and impacts

http://www.mtjengineering.com/project/pleasant-hill-olympic-blvd-lafayette-ca/

Project #3

City of Monterey CA / Pebble Beach

SR 1 and Holman Hwy

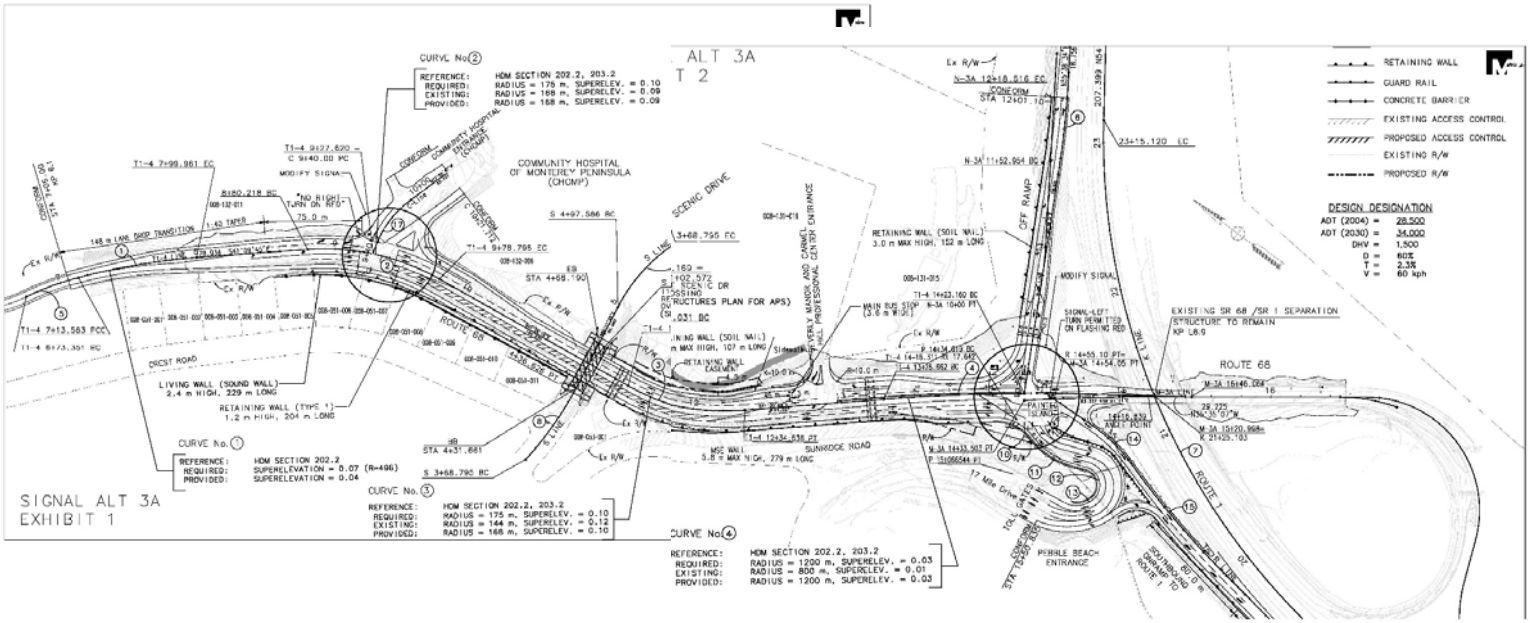
Highly Constrained

Existing Sever Congestion

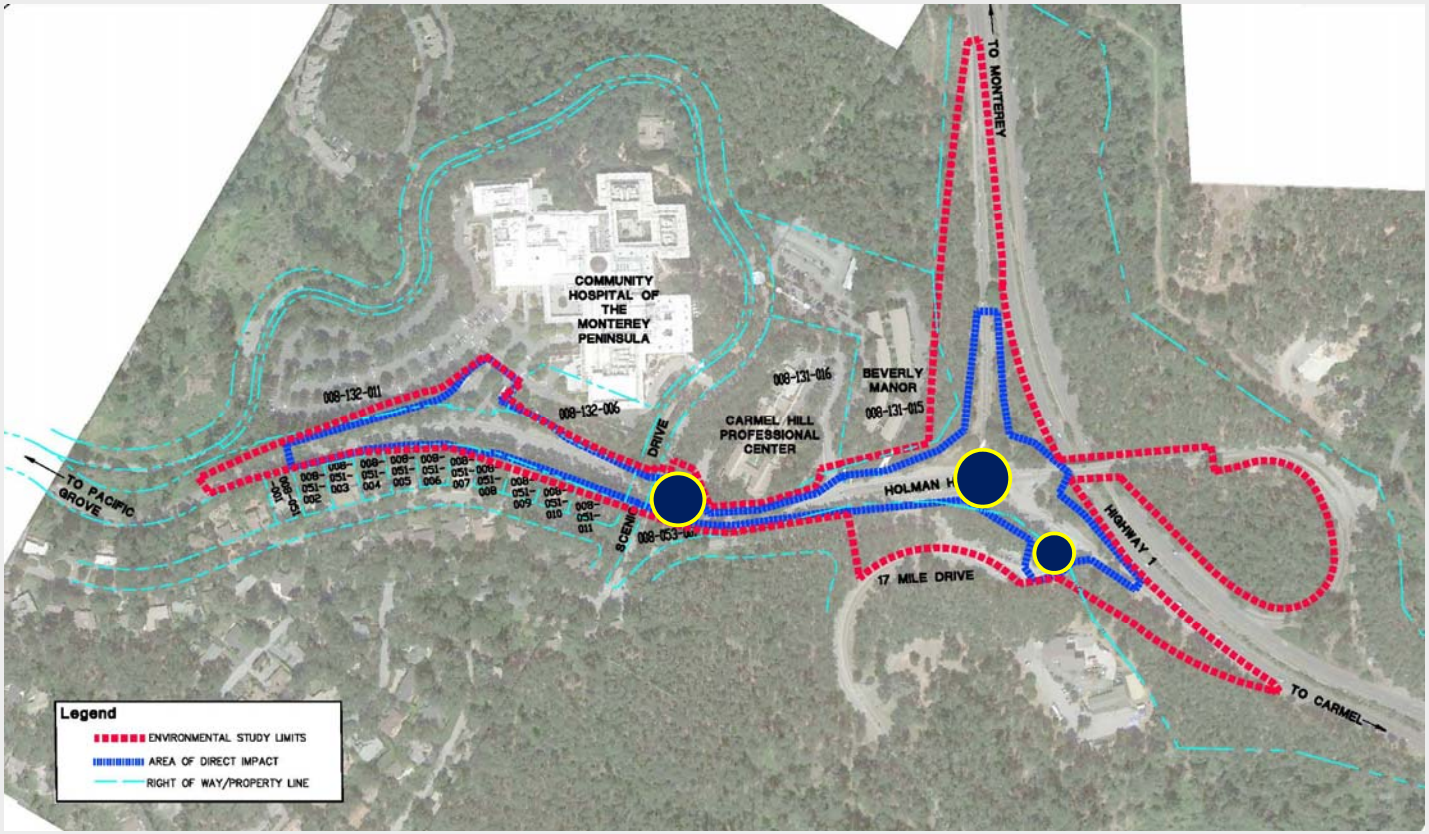
Emergency Response Issues with Hospital Nearby

Primary Access to the Monterey Peninsula

http://www.mtjengineering.com/project/holman-highway-68highway-1-roundabout/



Conventional Signal and widening
Total Estimated Cost = $25,170,000



- **Roundabouts = No Roadway/Structure Widening**
- **Much Less Env. Impacts**
- **Total Estimated Cost = $10,000,000**

City of Monterey CA, Pebble Beach
“Practical Design”

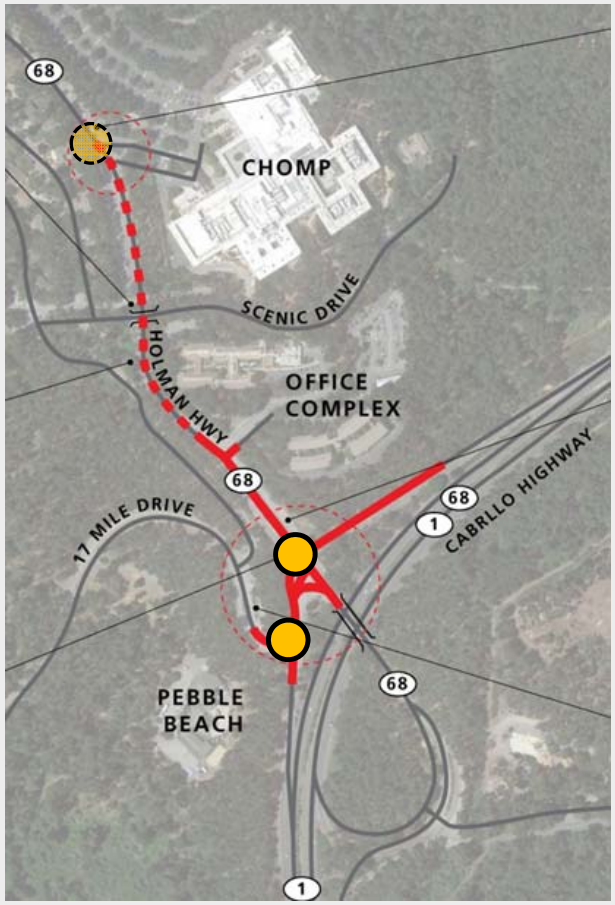
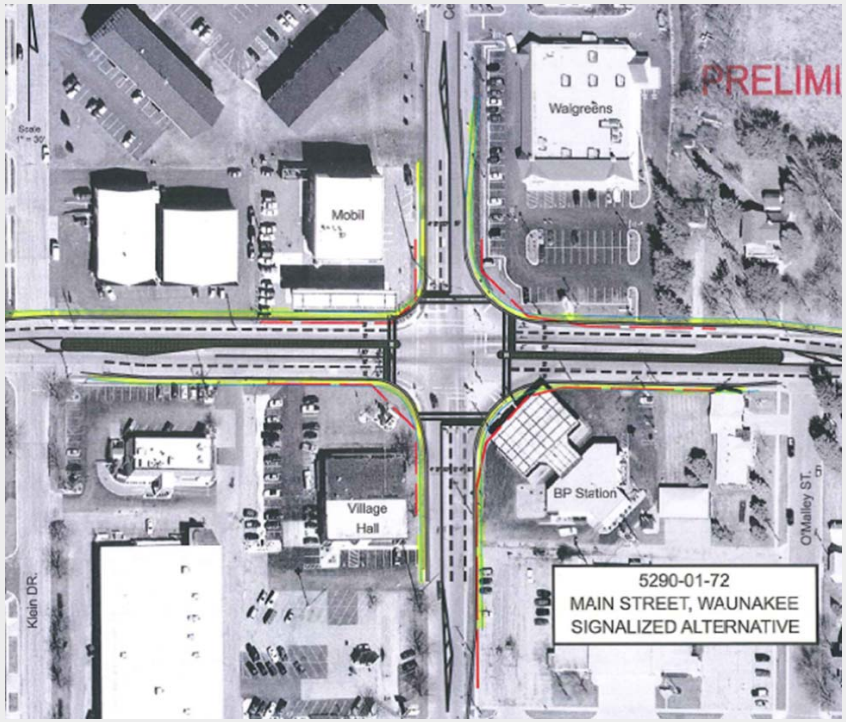


Photo Courtesy of Rich Deal, City of Monterey Traffic Engineer

Project #4

Alternatives Evaluation

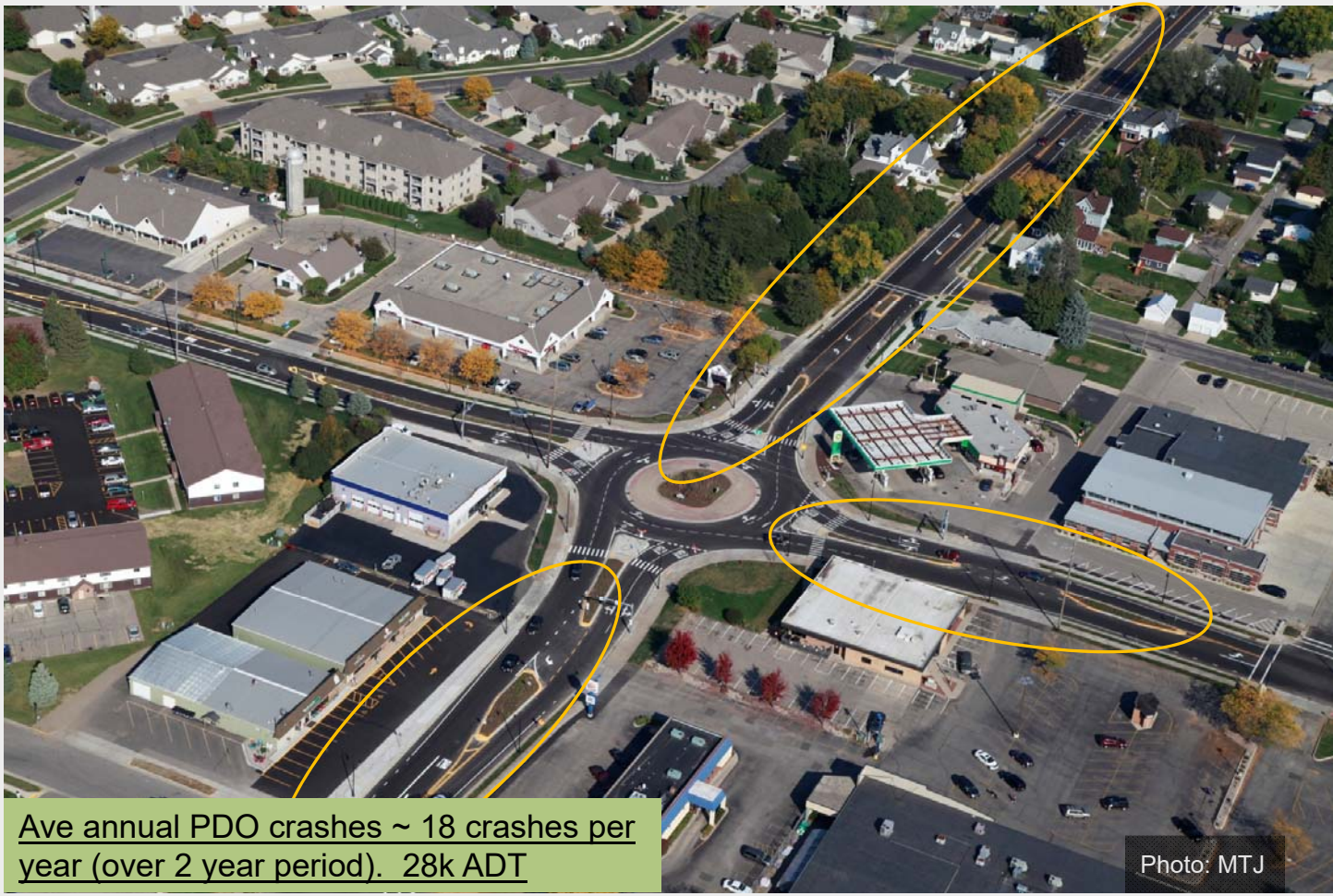
- 4-Lane Widening - Signal



- 3-Lane section with 2-Lane Flared Entry Roundabout

Multi-modal Roundabouts

- **Reduced Congestion**
- **3 Lane Section**
- **Fewer impacts**
- **Access and business vitality**

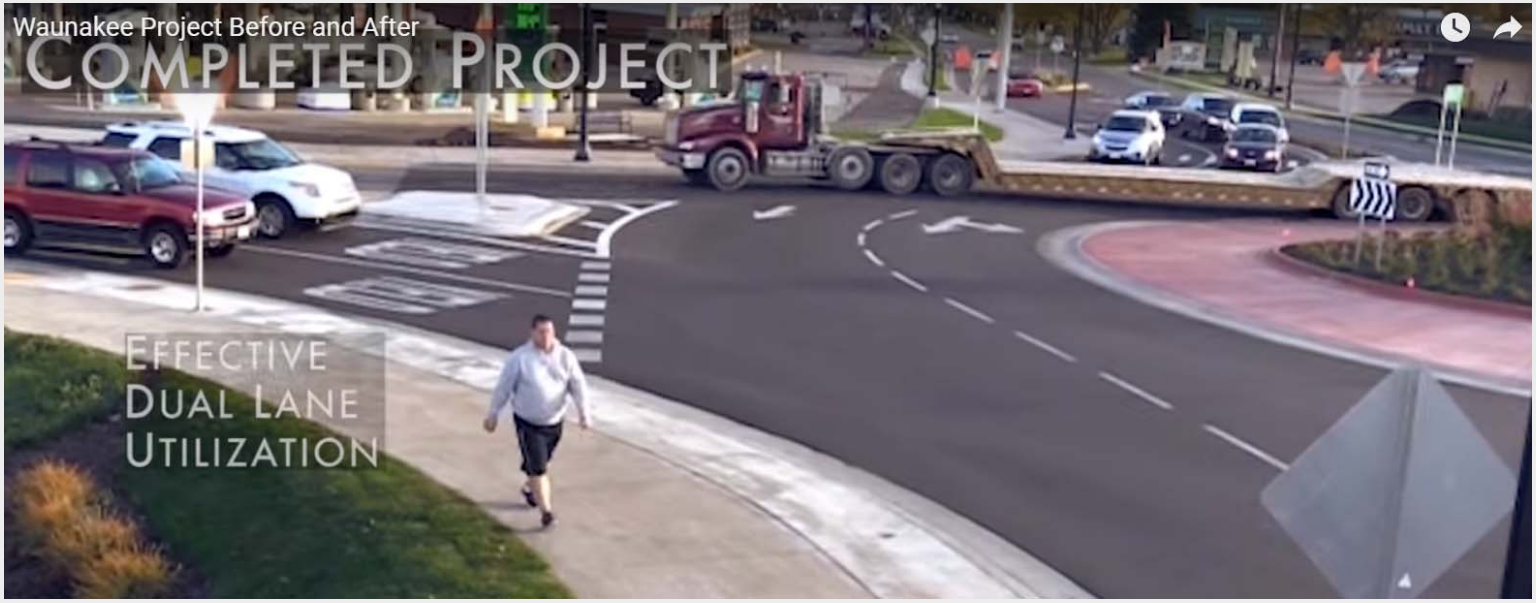


Ave annual PDO crashes ~ 18 crashes per year (over 2 year period). 28k ADT

Photo: MTJ

Multi-modal Roundabouts

All Modes



http://www.mtjengineering.com/project/main-st-and-century-ave-waunakee-wi/

Photo: MTJ

Project **#5**

Multi-modal Roundabouts

Bus Rapid Transit

Side Street Access

Pedestrians

Bikes

Multi-modal Roundabouts

Bus Rapid Transit Design

Multi-modal Roundabouts

Summary

Roundabouts:

- Meet Community Objectives
- Provide Multi-Modal Safety
- Operational and Safety Performance
- Reduce Costs / Impacts
  - Reduced Roadway Widening
  - Intersection Spacing Versatility
  - Access Control Opportunities

Thank You/ Questions

References Available:
http://www.mtjengineering.com/

Trending Operational Analysis, Design and Safety Issue Summaries by Mark T. Johnson of MTJ Roundabout Engineering

Please see these technical publications from our recently published papers/posters.

Traffic Planning Implications of the Operational Characteristics of Roundabouts	Solving Complex Traffic Issues with Unique Roundabout Applications
A Critical Review of TOPR34 (HCM 2016 Update)	Pedestrian/Vulnerable User Safety and Design Implementation
Synthesis of Roundabout Design and Operations with Multi-Lane Flared Entries	Roundabout Geometric Capacity Measurement: Calibration and Validation of U.S. Field Measurements
Application of Safety Design Principles for Urban Multi-lane Roundabouts	Public Outreach and Roundabout Implementation: Overcoming Challenges

Mark T. Johnson, P.E.
MTJ Roundabout Engineering

- *Key Contributor to WIDOT Roundabout Design Program 2001 - 2005*
- *Co-Author of FHWA 2010 Roundabout Guide*
- *FHWA Authorized P2P Reviewer*

Roundabouts and Bikes

Alek Pochowski

Overview

Who's riding bikes, and what's stopping them?

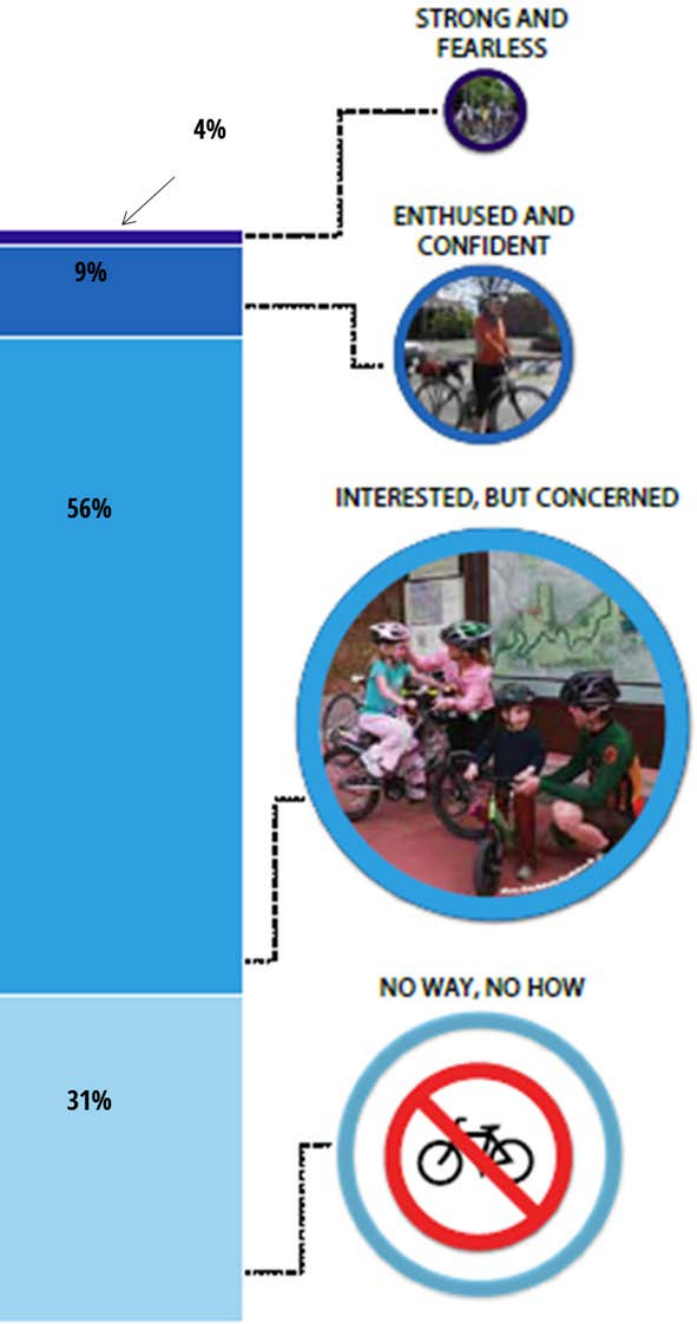
- Recent bicycle practice in the United States
- Intersection bicycle design principles

Bicycle options at roundabouts

- As a vehicle in the circulatory roadway
- In a bike lane in the circulatory roadway
- With pedestrians in a shared-use path
- Separate from pedestrians in a separated bike lane
- Grade separated

Recommended practice

- Current U.S. and international guidance



Who's Riding Bikes, and What's Stopping Them?

- Almost 70% of people are interested in riding a bike
- Only 13% of people feel confident and comfortable riding their bikes to get around, under current conditions
- The largest user group (interested but concerned) prefers greater levels of protection and separation, especially on higher speed and higher volume streets

Source: Jennifer Dill and Nathan McNeil. "Four Types of Cyclists? Testing a Typology to Better Understand Bicycling Behavior and Potential." Portland State University OTREC. August 2012.

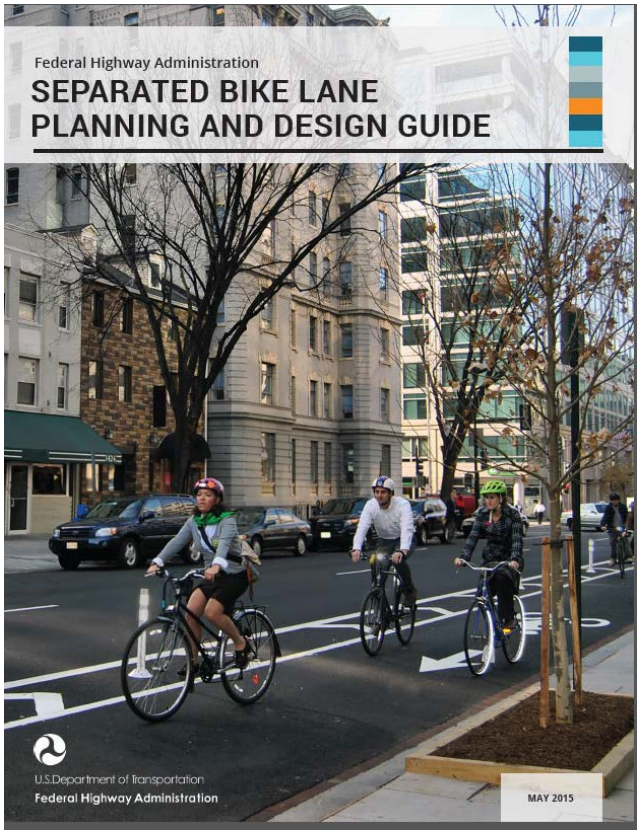


Photo: Conor Semler

Photo: Alek Pochowski

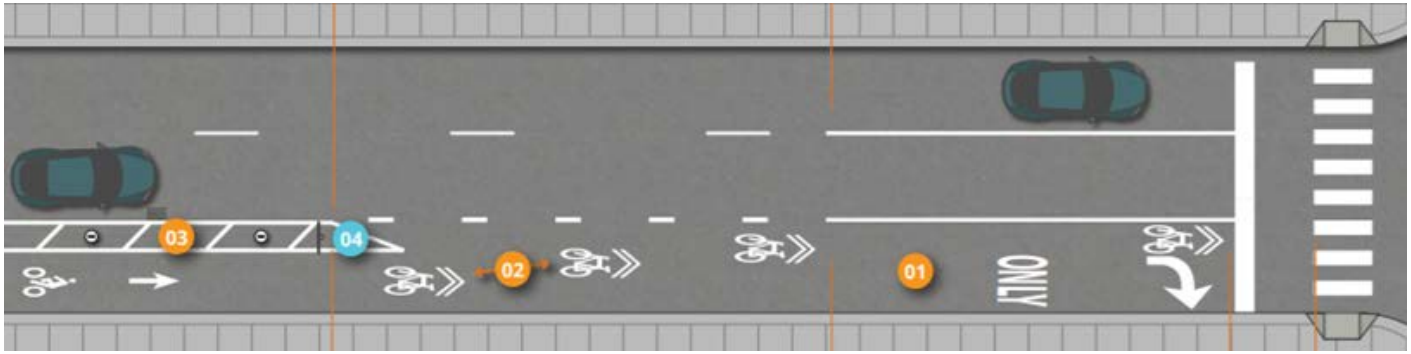
Recent Industry-Wide Bicycle Practice

Intersection Bicycle Design Principles

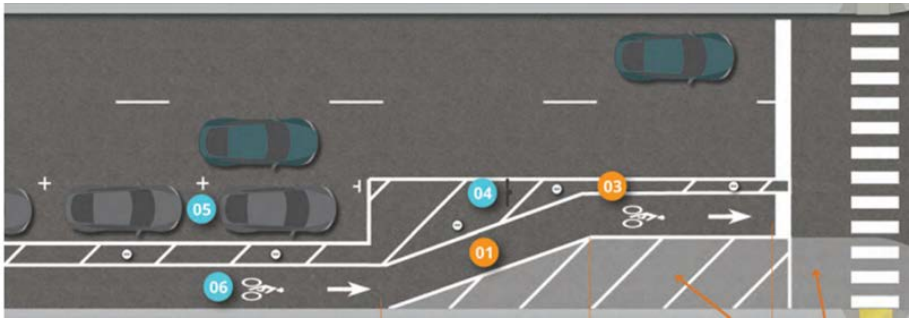
- Provide space for bicyclists
- Reduce conflict points
- Maximize bicyclist visibility
- Reduce speed differential
- Provide predictable and direct navigation
- Minimize stop-start maneuvers

Roundabouts are compatible with all of these principles!

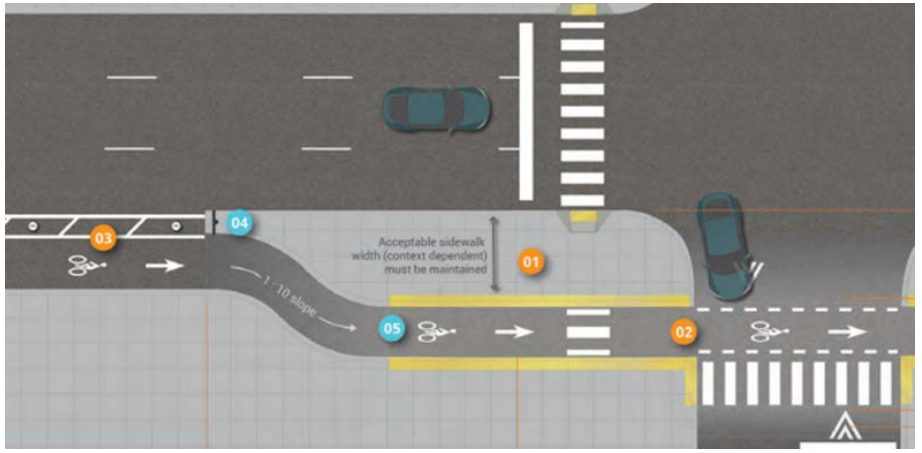
Photo: Alek Pochowski



Mixing Zone



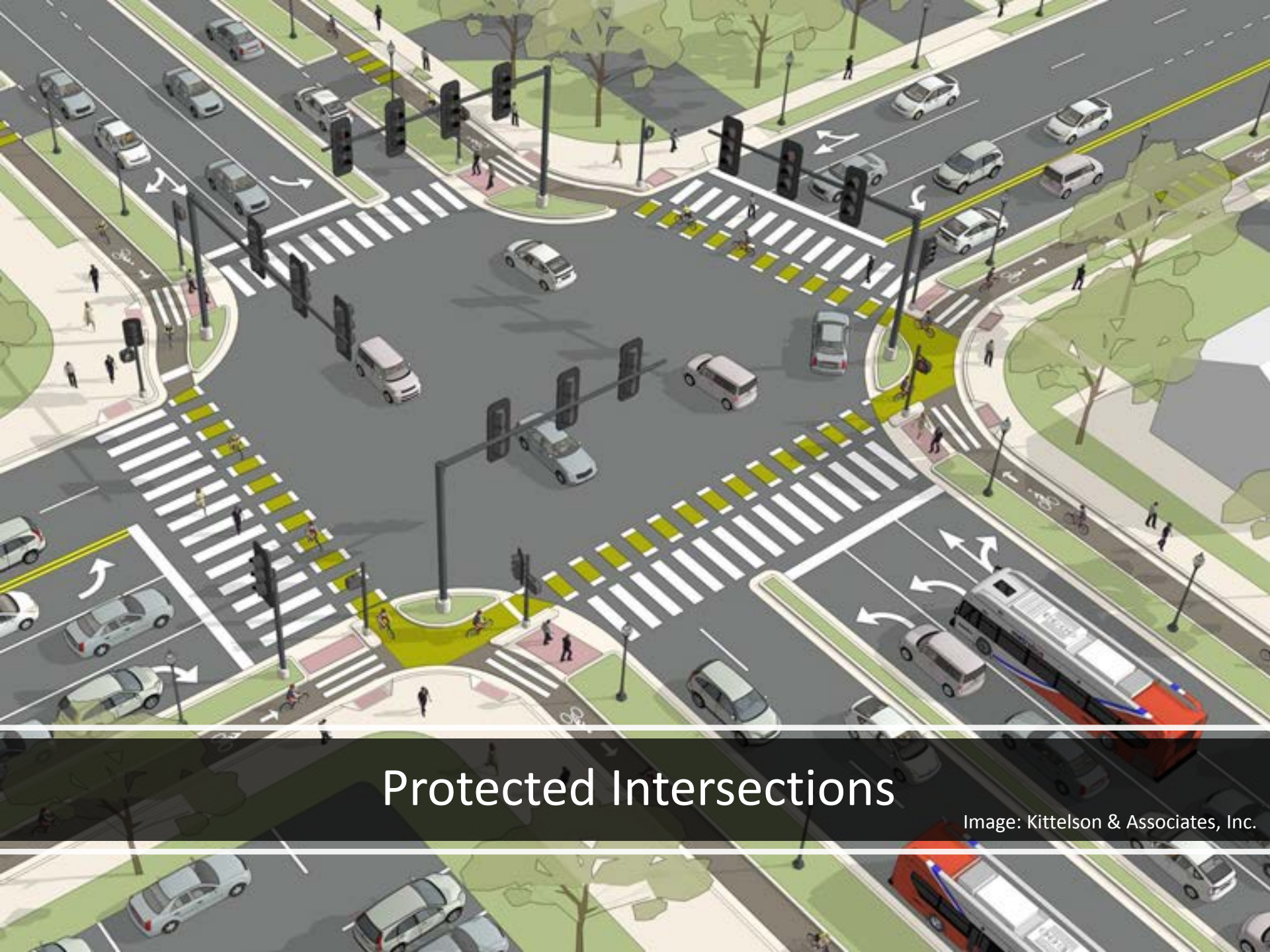
Bend-In



Bend-Out

Treating Bikes at Intersections

Images from: *Federal Highway Administration Separated Bike Lane Planning and Design Guide*



Protected Intersections

Image: Kittelson & Associates, Inc.

Requested by
ASSEMBLY CONCURRENT RESOLUTION NO. 26
1971 REGULAR SESSION

STATE OF CALIFORNIA
BUSINESS AND TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

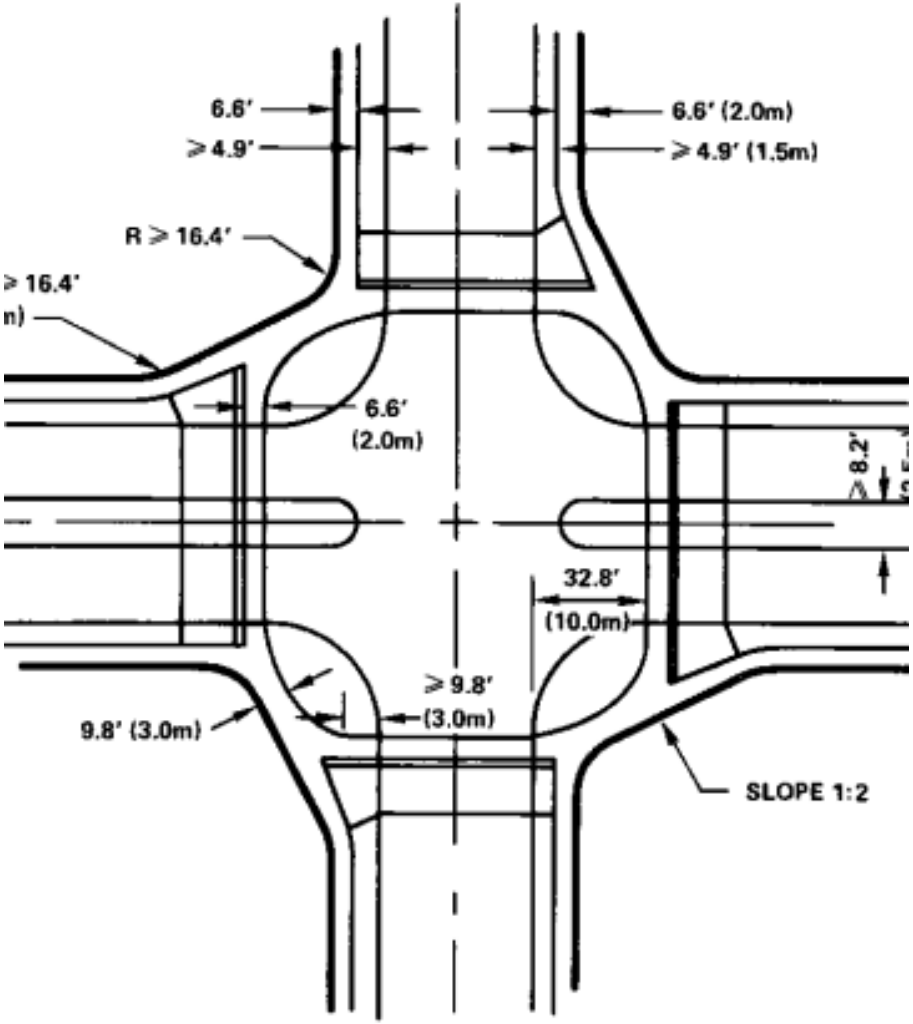
BIKEWAY PLANNING CRITERIA AND GUIDELINES

April 1972

Prepared by
INSTITUTE OF TRANSPORTATION
AND
TRAFFIC ENGINEERING

SCHOOL OF ENGINEERING AND APPLIED SCIENCE
UNIVERSITY OF CALIFORNIA, LOS ANGELES
UCLA-ENG-7224

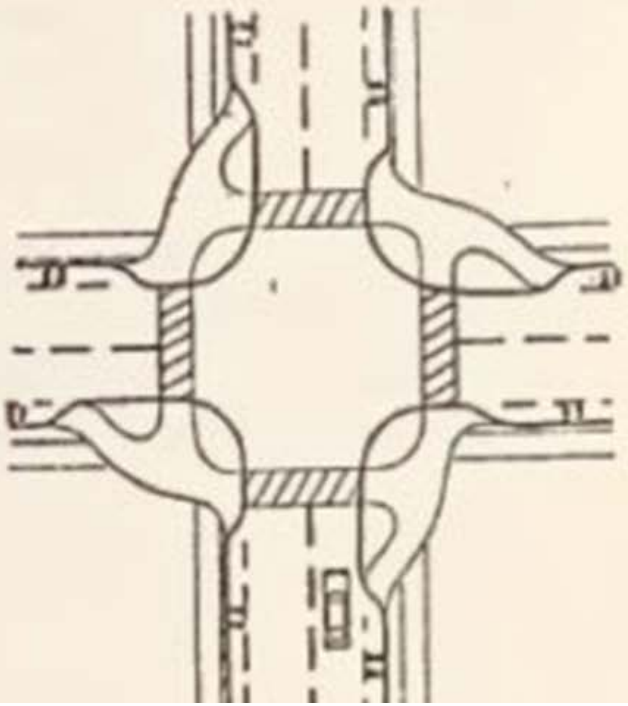
Reprinted November 1972 by the Federal Highway Administration, U. S. Department of Transportation, Washington, D. C.



.14. Recommended Intersection Design for Intersecting Arterial Roads with Bike
Each Road. Intersection is Asymmetrically Designed to Provide Bicycle Que
at the Entrance to the Crossings. (Reference 26, p. 23)

1976 FHWA "Safety and Location Criteria for Bicycle Facilities"

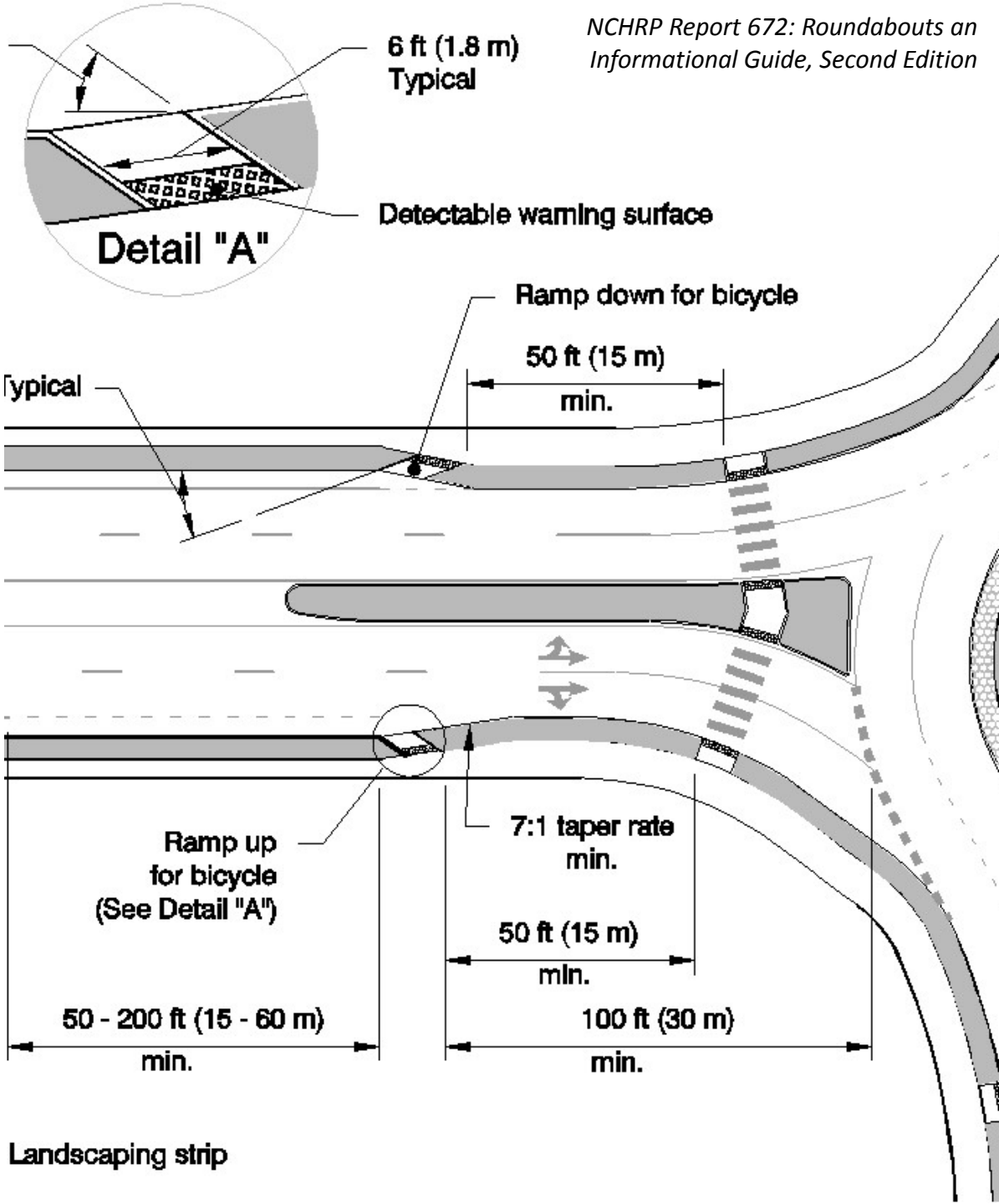
Offset Crossings -- Bicyclists are channeled onto the sidewalk area and to crossings of the intersecting streets just outside (farther from the center of the intersection) the normal pedestrian crosswalk area. In effect, a bikeway ring around the intersection is created.



Bicycles and Roundabouts: Current Practice

- Low-volume: encourage bicycles to circulate with vehicles
- High-volume: provide separate bicycle path with bike ramps
- Give bicyclists option of either being vehicle or pedestrian

First Protected Intersections in the United States!?



NCHRP Report 672: Roundabouts an Informational Guide, Second Edition

Bicycles and Roundabouts: Current Practice

Wisconsin Department of Transportation Facilities Development Manual

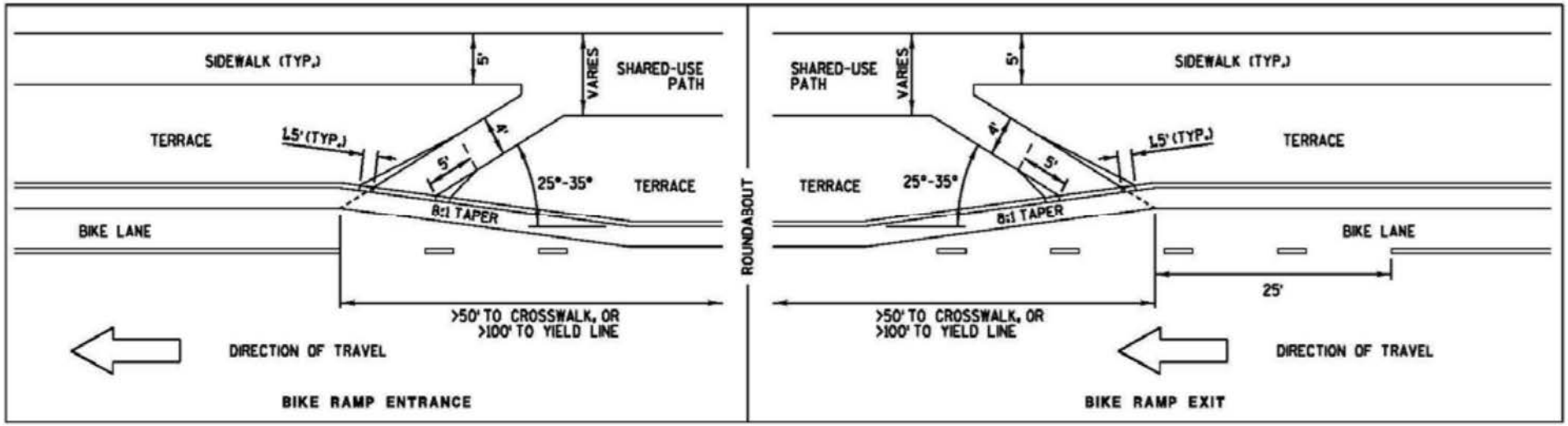
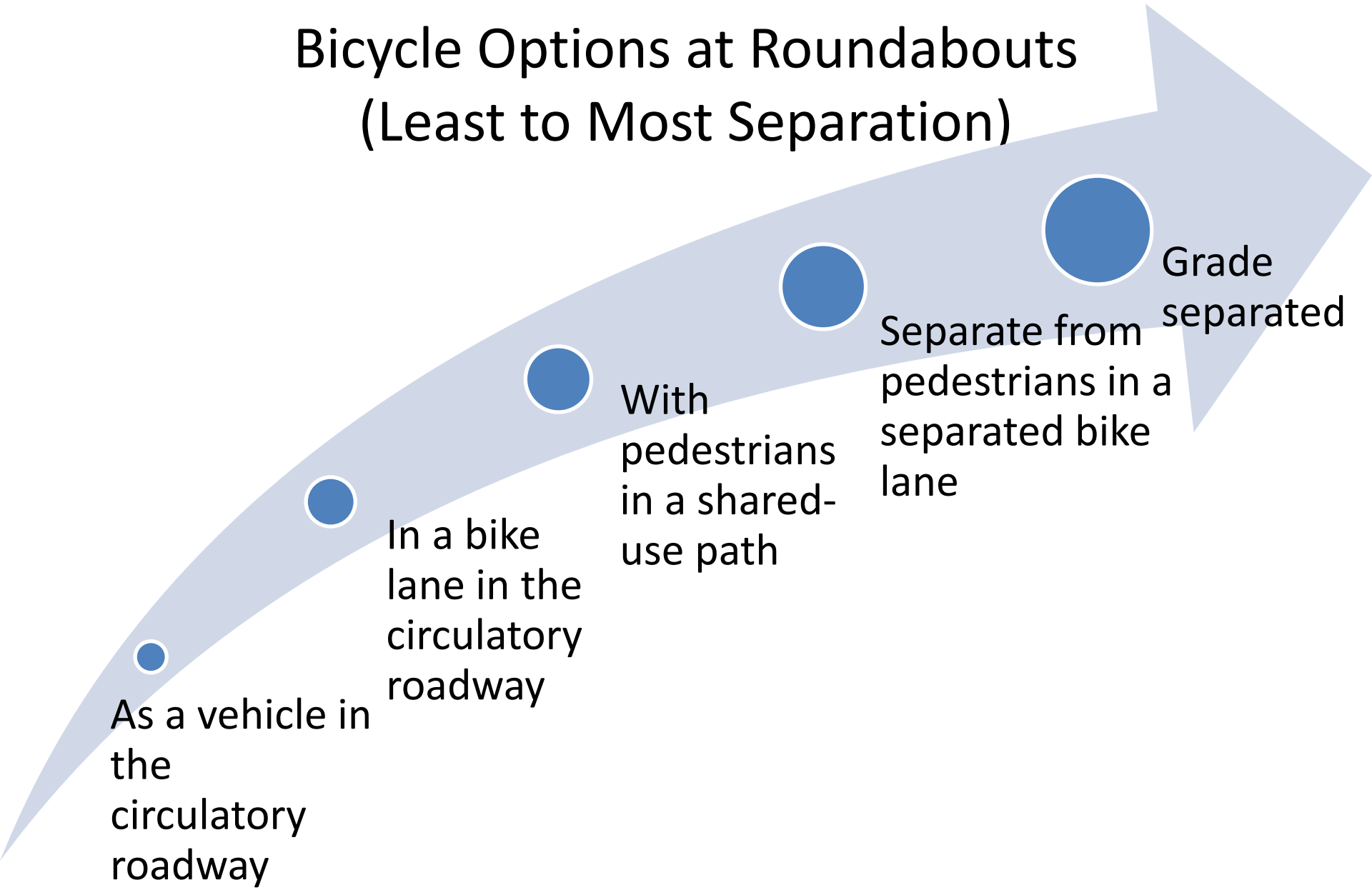


Figure 30.11 Bike Ramp Entrance and Exit

Image: Kittelson & Associates, Inc.

Bicycle Options at Roundabouts (Least to Most Separation)



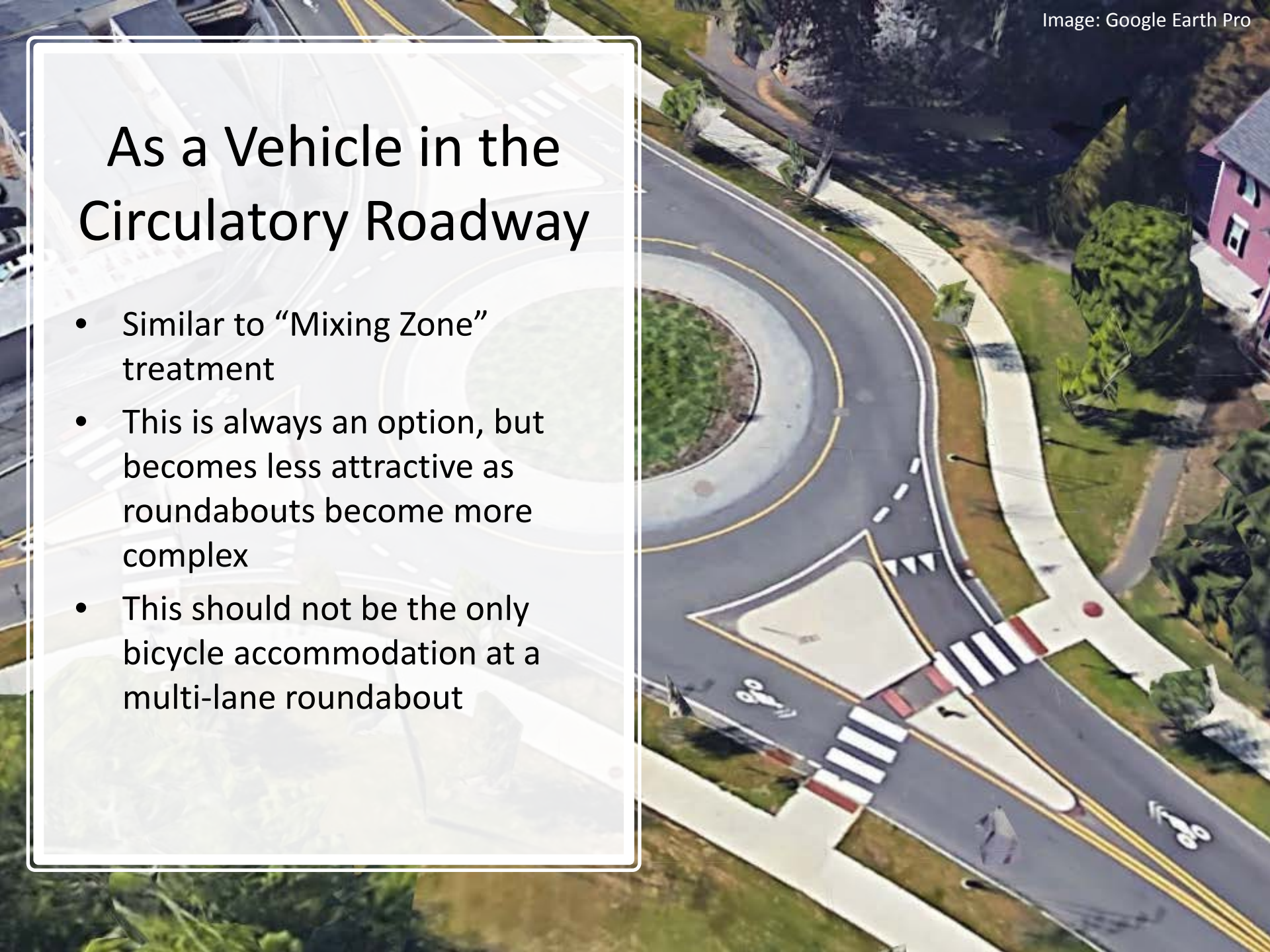
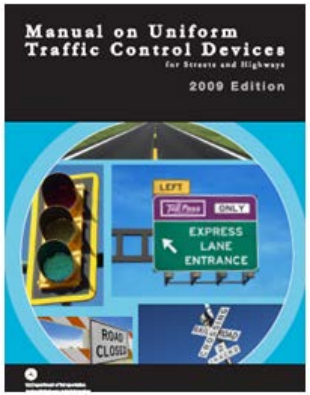


Image: Google Earth Pro

As a Vehicle in the Circulatory Roadway

- Similar to “Mixing Zone” treatment
- This is always an option, but becomes less attractive as roundabouts become more complex
- This should not be the only bicycle accommodation at a multi-lane roundabout

Bicycle Lanes in the Roundabout



MUTCD 9C.04 Markings for Bicycle Lanes:

Standard: Bicycle lanes shall not be provided on the circular roadway of a roundabout

https://viastrada.nz/pub/bicycle-lanes-roundabouts

(Image "mirrored" for right-hand driving)

Bicycle Lanes in a Traffic Circle

Image: Google Earth Pro

Bicycle Lanes in a “Roundabout”

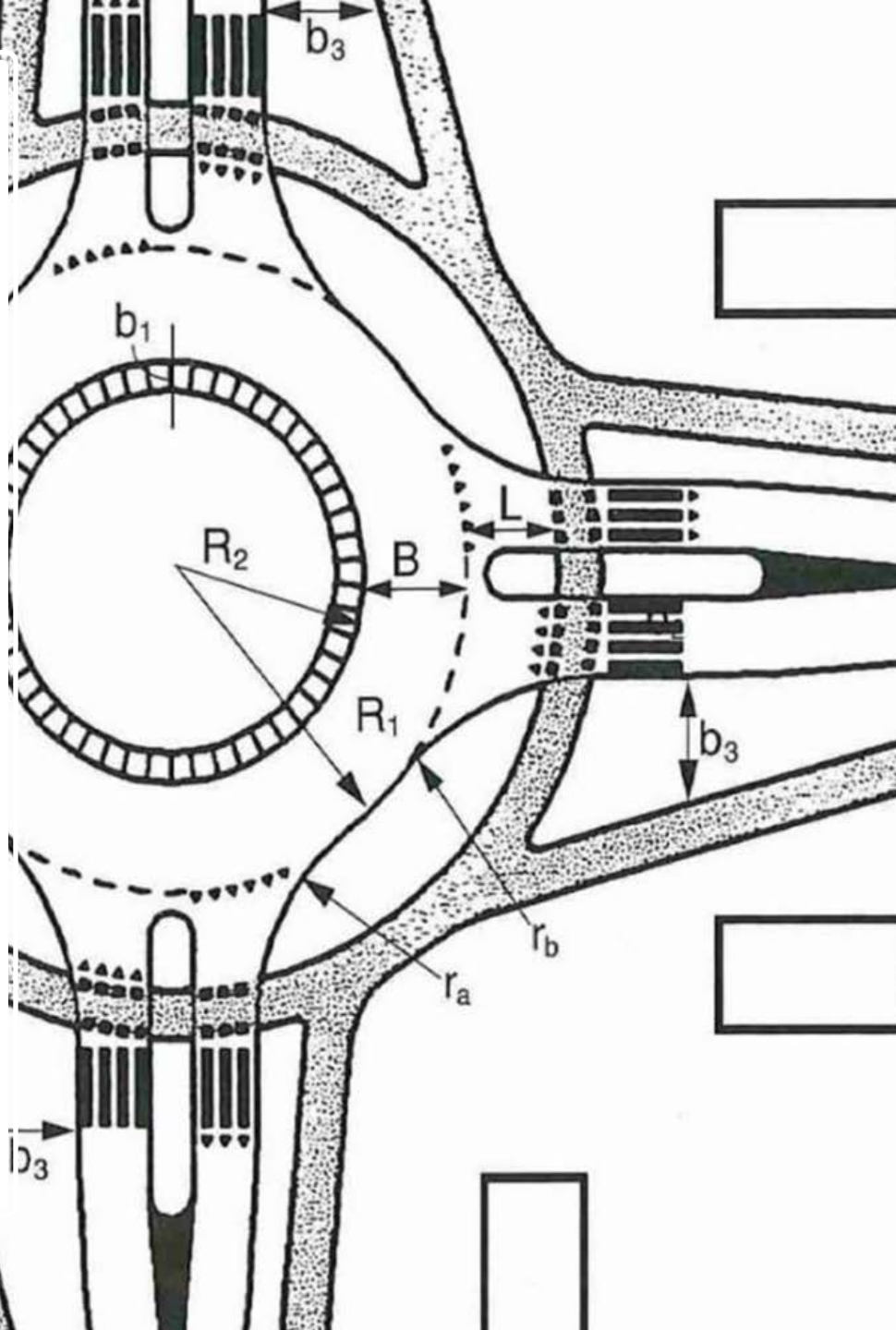
Image: Google Earth Pro

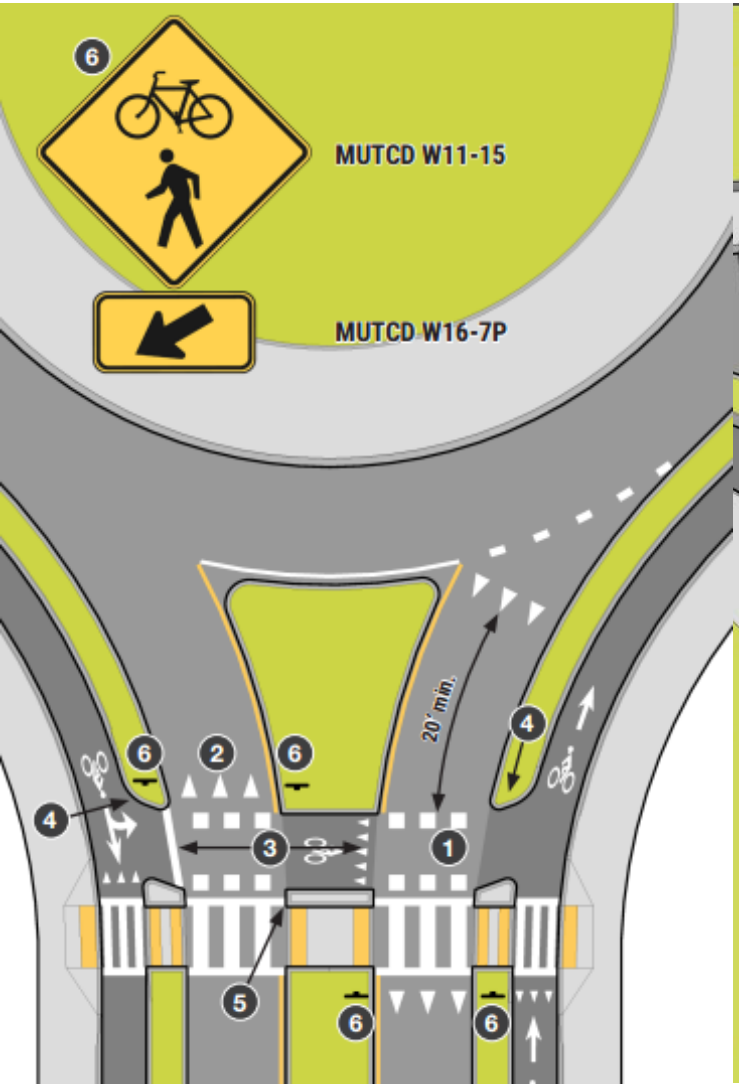

Video: Alek Pochowski

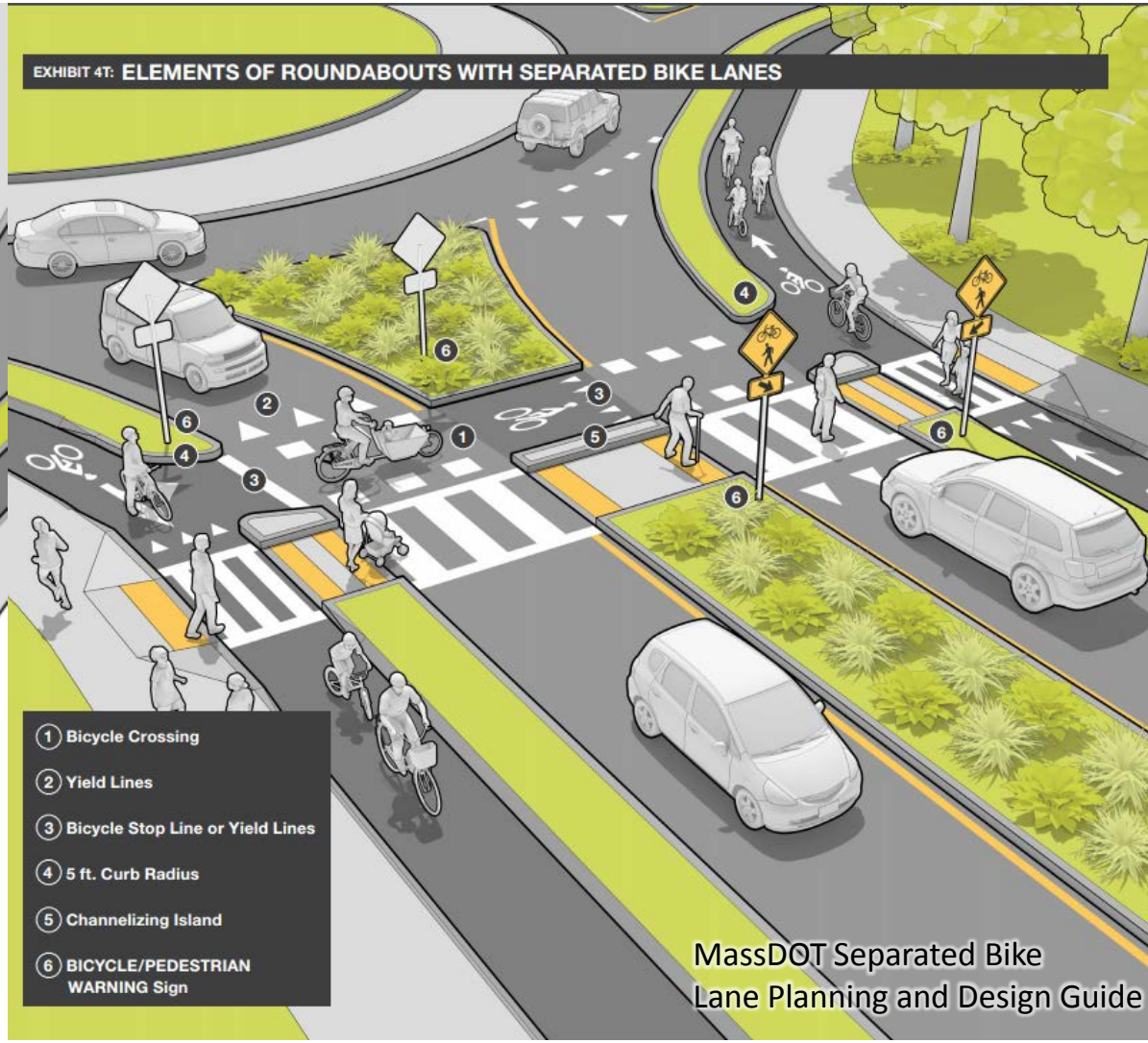
Dutch CROW Manual

Implementation:

- Bicycle crossing provided with block markings and shark's teeth to emphasize bicycle right-of-way
- Continue marked cycle path at the roundabout crossings, parallel to the roadway
- Use a concentric circle and/or "gentle cambers" for increased visibility



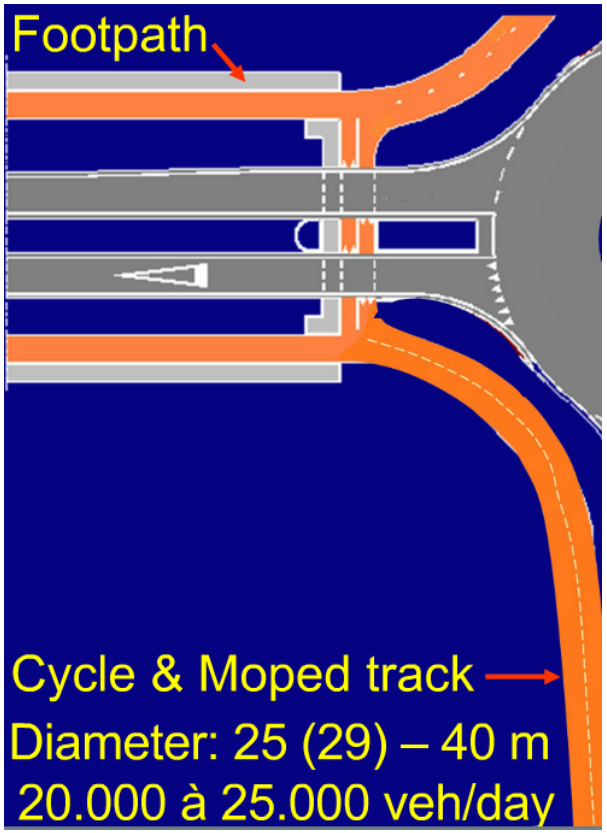




MassDOT Separated Bike Lane Planning and Design Guide

Image: Kittelson & Associates, Inc.

Image: Kittelson & Associates, Inc.



Bertus Fortujin

Two-Way Cycle Track

Two-Way Cycle Track

Photo: Alek Pochowski

Two-Way Cycle Track

Photo: Bill Schultheiss

Grade-Separated

Photo: Alek Pochowski

https://bicycledutch.files.wordpress.com/2012/08/stavanger1.jpg

Resources

- NCHRP Report 672: Roundabouts an Informational Guide, Second Edition
- FHWA Separated Bike Lane Planning and Design Guide
- MassDOT Separated Bike Lane Planning & Design Guide
- CROW Design Manual for Bicycle Traffic

Summary

- Roundabouts and bikes are compatible
- Design for all cyclists, not just those currently using the facility
- Bicycle facilities through the roundabout should be designed at similar “stress levels” as facilities on the approaches
- Innovation and creativity are great! Just make sure the design follows the principles of roundabout and bicycle design.

Recent Research on Pedestrians at Roundabouts

Pete Jenior

Photo: Lee Rodegerdts

Overview

- Focus remains on blind pedestrian accessibility (NCHRP Project 3-78a, b, and c)
  - Resulting in improved design guidance for all pedestrians
- Pedestrian crashes at roundabouts remain rare
  - No known pedestrian fatalities at US roundabouts
  - NCHRP Project 17-70
    - 355 roundabouts with 2088 “roundabout years” of data
    - 25 pedestrian crashes

Roundabout Accessibility Challenges

- The crossing task for blind Pedestrians
  - Finding the crosswalk
  - Aligning to cross
  - Deciding when it is safe to cross
  - Maintaining alignment during crossing
- Confounding challenges
  - Uninterrupted flow (no signal)
  - Potentially high speeds
  - Ambient noise at crosswalk
  - Non-straight geometry
  - Low driver yield compliance
- Treatments are available and can help

US Access Board Position

- Proposed Guidelines for Public Rights-of-Way - DRAFT
  - Pedestrian crossing easily located for wayfinding
  - Signalization Requirement for Two-Lane Approaches
  - http://www.access-board.gov/prowac/
- Research focused on identifying “equivalent facilitation”

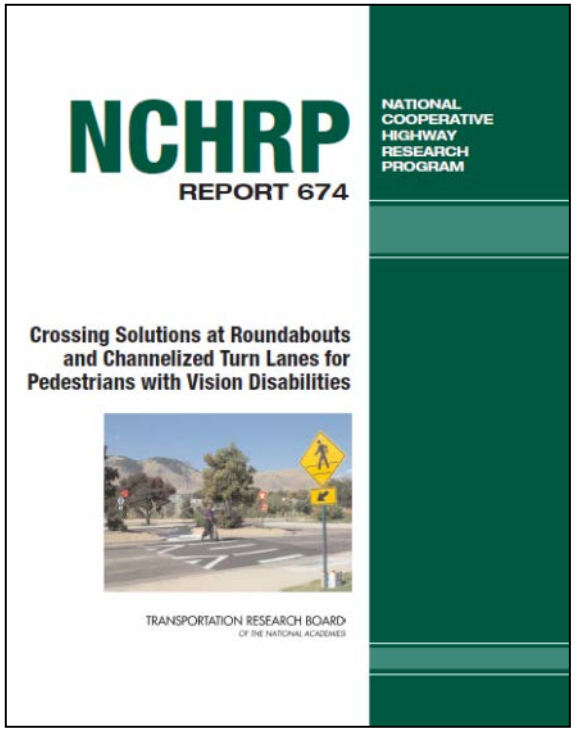
Roundabouts without Pedestrian Facilities

US23, Livingston County, MI

I-17 Phoenix, AZ

Kansas 68, Miami County, KS

Research and Literature on Roundabout Accessibility



Road Commission for Oakland County – HAWK and RRFB Study

NCHRP Report 834- Goals and Objectives

- Provide useful and implementable guidance
- Define feasible range of geometric and traffic operational conditions
- Target planning and preliminary design stage
- Supported by empirical data and modeling
- Useful for a broad audience
- Decision-support tool for practicing engineers

Photo: Janet Barlow

PHB in Oakland County, MI

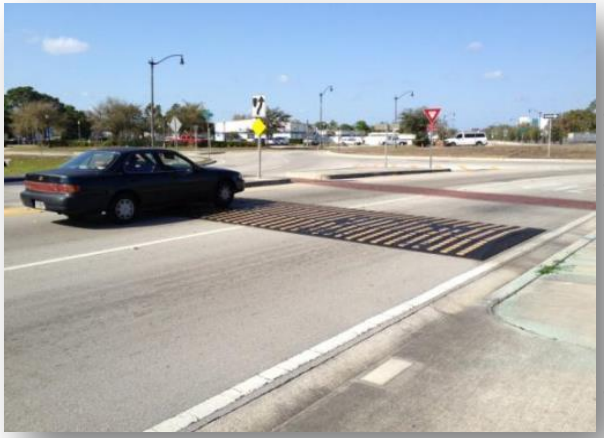
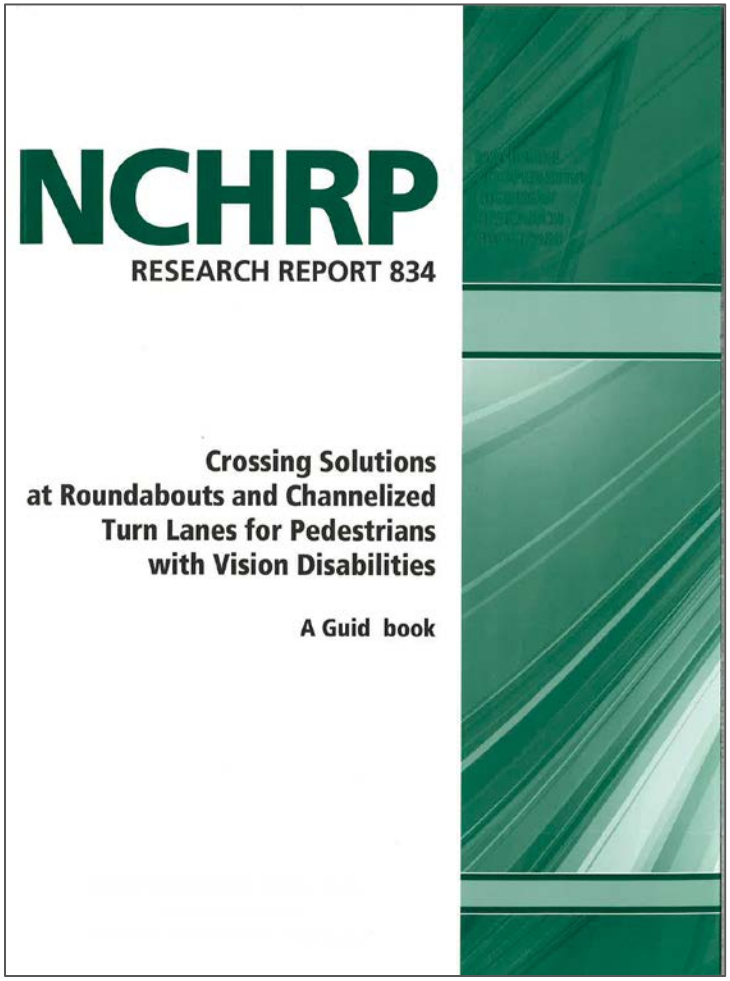
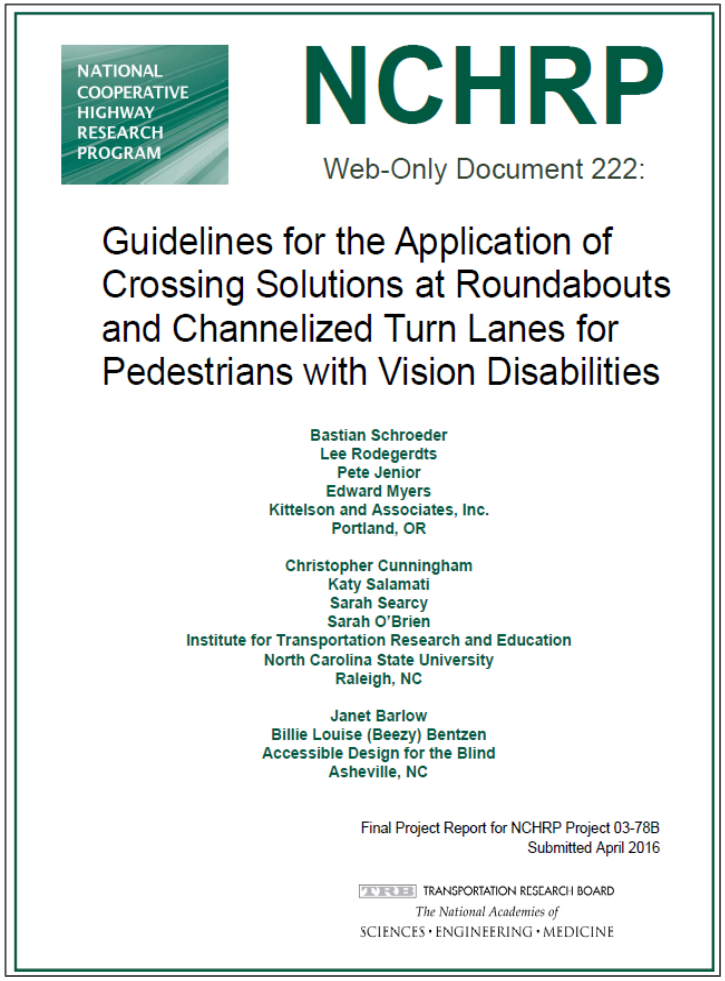


Photo: Bastian Schroeder

Speed Hump in Kissimmee, FL

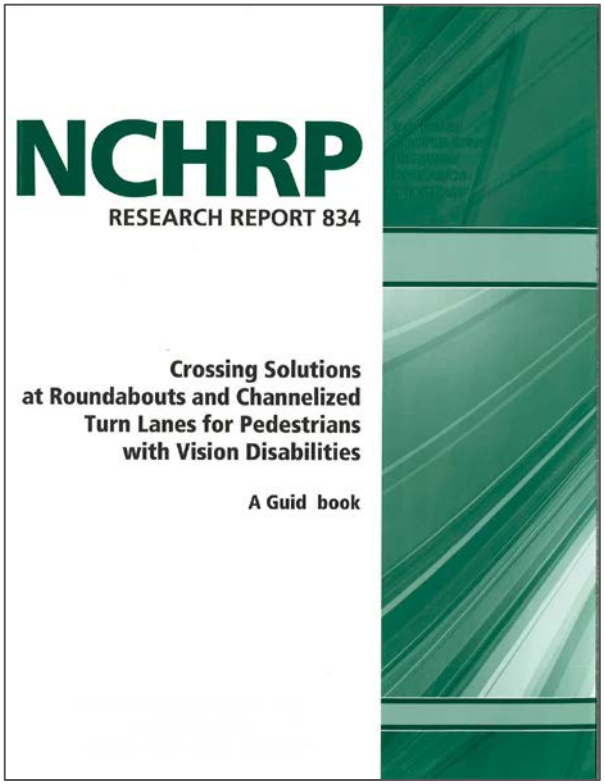
NCHRP Report 834 and Web-Only Document 222 (Published Jan 2017)



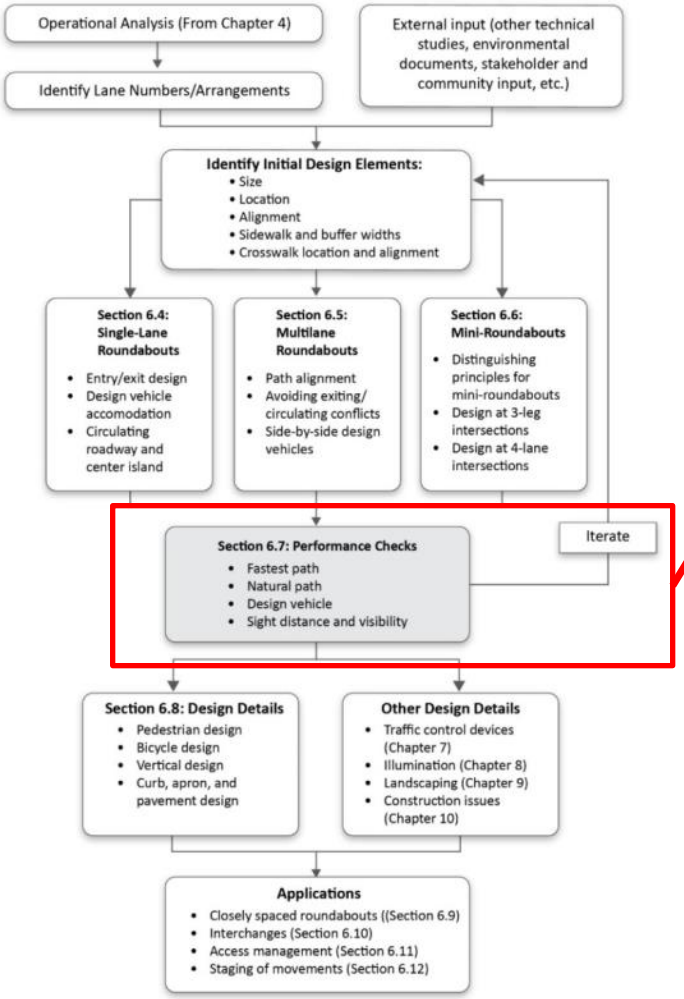


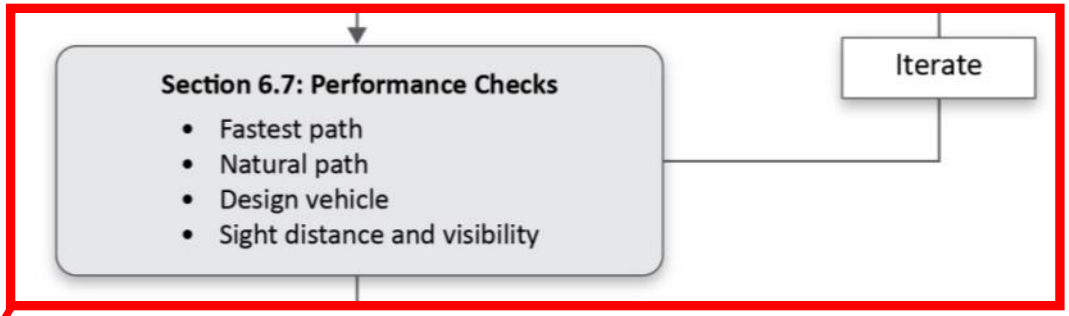
NCHRP Report 834 - Outline

1. Introduction
2. Design Process
3. General Principles for Pedestrian Wayfinding and Crossing tasks
4. Design Principles for Pedestrian Access at Roundabouts
5. Design Principles for Pedestrian Access at Channelized Turn Lanes
6. Wayfinding Assessment
7. Crossing Assessment
8. References
9. Appendix A – Discussion of Audible Environment and Noise Effects
10. Appendix B – Summary of Crossing Treatments



Tying into Existing Roundabout Design Process (NCHRP Report 672 – FHWA Roundabout Guide)





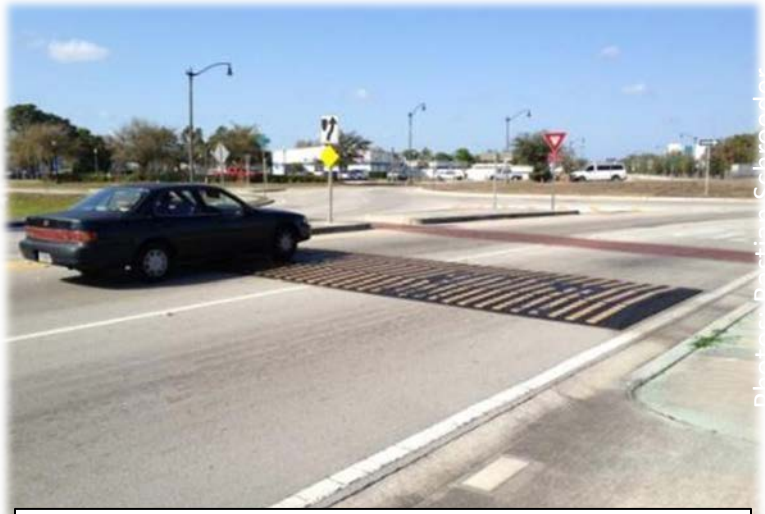
- New Performance Checks for
  - Wayfinding Assessment
  - Crossing Assessment
  - Pedestrian Sight Distance and Visibility

NCHRP Report 834 – Guidelines Development

- Provide useful and implementable guidance
- Define feasible range of geometric and traffic operational conditions
- Target planning and preliminary design stage
- Supported by empirical data and modeling
- Useful for a broad audience
- Decision-support tool for practicing engineers

PHB in Oakland County, MI

Photo: Janet Barlow



Speed Hump in Kissimmee, FL

Photo: Bastian Schroeder

Key Finding - Geometry Matters

- Larger Radii contribute to greater vehicle speeds, and more risky crossing environment

Key Finding - Speed Matters

- Faster Speeds linked to reduced yielding and increased risk
- Prior research also linking higher speeds to greater injury risk and reduced driver attentiveness to pedestrians

Key Finding - Sight Distance and Visibility Matter

- Open sight lines and good visibility can contribute to increased driver awareness and yielding
- Limited sight lines impact gap acceptance and yielding propensity
- Limited sight lines also impact audible information available at the crosswalk

Key Finding - Traffic Volume Matters

- Higher traffic volume can contribute to more yielding (vehicles slow and already delayed)
- But higher traffic are also linked to higher likelihood of multiple-threat events (at multi-lane crossings)
- And, higher traffic volume can also increase the ambient noise level

Photo: Bastian Schroeder

Photo: Janet Barlow

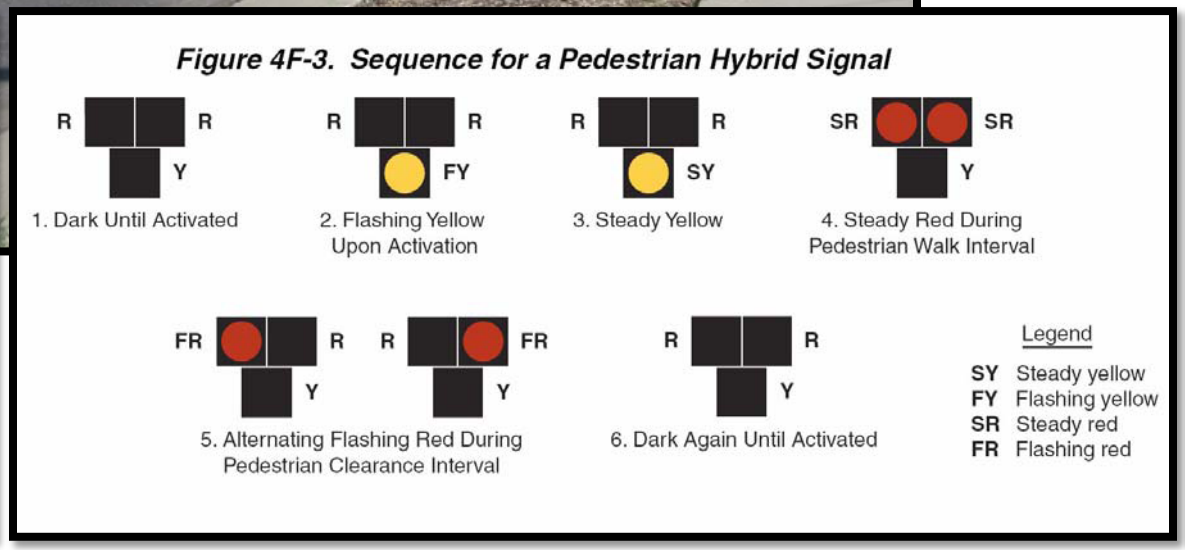
Treatments can enhance (crossing) accessibility

1. Treatments geared at reducing vehicle speeds through geometric modifications,
   - includes speed humps, raised crosswalk, or geometric changes;
2. Treatments geared at enhancing the visibility of the crosswalk and alerting drivers,
   - includes RRFBs and other beacons;
3. Treatments geared at providing additional audible information to blind pedestrians,
   - includes sound and rumble strips
4. Treatments geared at stopping traffic and creating crossing opportunities,
   - includes pedestrian hybrid beacons and other pedestrian signals.

Raised Crosswalk

Rectangular Rapid Flashing Beacon (RRFB)

Pedestrian Hybrid Beacon



Testing of Treatments

- Thousands of field studies
  - Blind pedestrian attempted to cross
  - Orientation and Mobility Specialist on-site to observe and stop pedestrian if they felt a risky crossing was about to occur (intervention)
- Several measures of effectiveness
  - Interventions most important
  - NCHRP Report 834 provides procedure to compute performance measure values
    - Being revised through NCHRP Project 3-78c

Effectiveness of Treatments

- Pedestrian Hybrid Beacons
  - Lowest intervention rate, presumed “equivalent” to traffic signal
- Raised Crosswalks
  - Lowers speed, which can improve accessibility
  - Not appropriate on all roadways
  - Potentially reduces capacity
- Rectangular Rapid Flash Beacon
  - Highly variable intervention rates

Wayfinding Provisions Matter

- Deciding when to cross is only one of four tasks at roundabouts; others are
  - Finding the crosswalk
  - Aligning to cross
  - Maintaining alignment during crossing
- Landscaping, fencing, tactile surfaces, and audible beacons have proven effective to

Wayfinding: Curb Ramp Alignment

- Direction of ramp slope and curb line affected direction of travel

Wayfinding: Detectable Warnings

- Detectable warning surface needs to extend the full width of area that is level with the

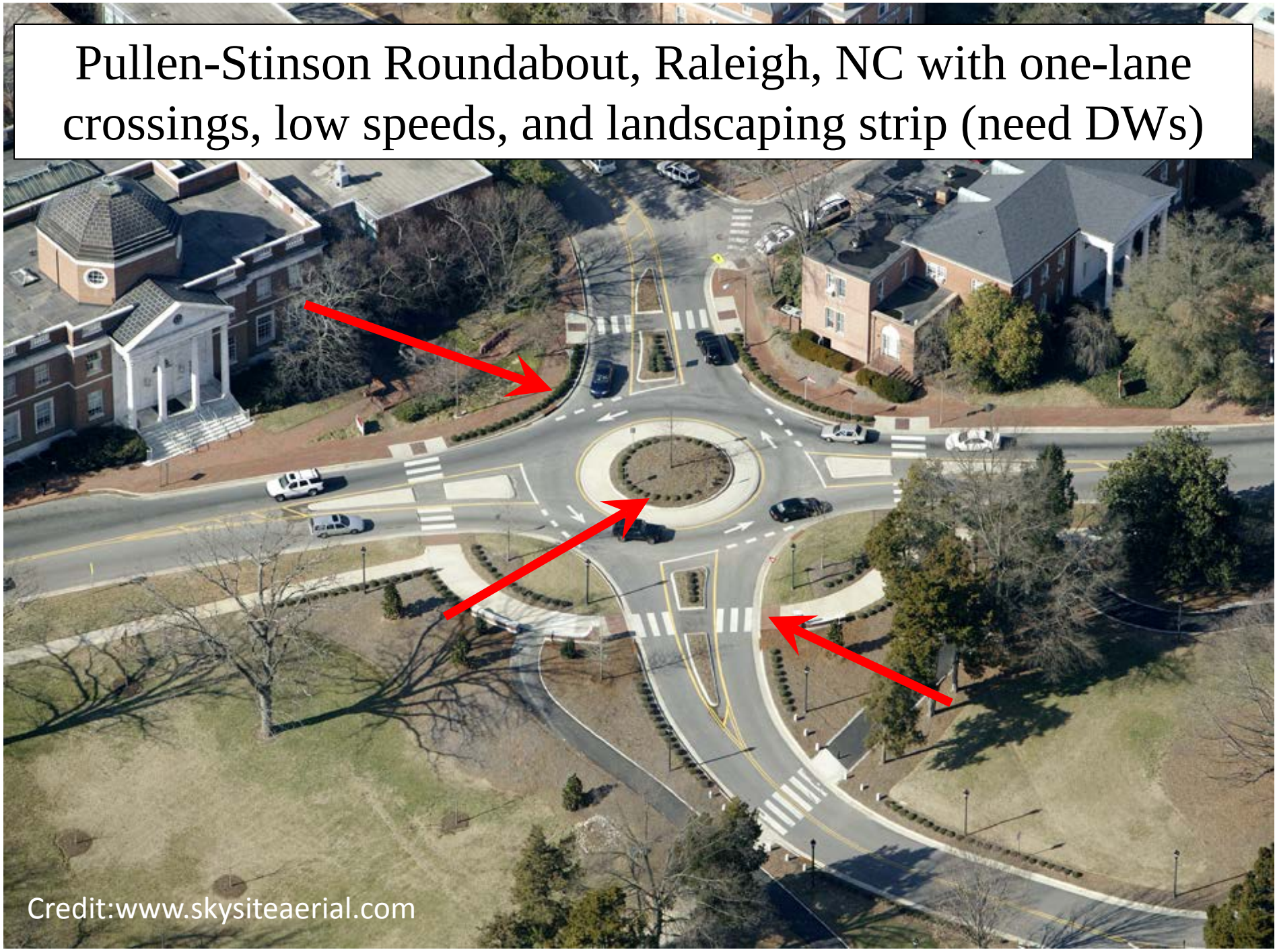
Wayfinding: Guidance Through Islands

- Lack of detectable warnings on splitter islands
- No real delineation of island

Wayfinding: Guidance Through Islands (cont.)

- Participants sometimes mistook the cut-through area for curb of street

Pullen-Stinson Roundabout, Raleigh, NC with one-lane crossings, low speeds, and landscaping strip (need DWs)



Two-lane roundabout in Gatineau, Canada with *zig-zag* signalized crossing and landscaping that guides to crosswalk (**need DWs!**)


Multi-Lane Roundabout in Bad Aibling, Germany with ped./bike underpass and *distal* crosswalks (need DWs)

Want to learn more

- **NCHRP 3-78c one-day workshops: intersectionaccess.org**
  - A dozen more to be offered

RRFB in Olympia, WA

Upcoming Roundabout Webinars

- Modern Roundabouts: Downtown and suburban revitalization
  - Monday September 18, 2:00-4:00PM ET
- Analyzing Crashes on Multilane Roundabouts: Driver Error or Geometrics?
  - Monday, October 2, 1:00-3:00PM ET

Today's Participants

- Phil Demosthenes, *Chair of Research for ANB75,* phil@pdemos.com
- Mark Johnson, *MTJ Roundabout Engineering,* mark@mtjengineering.com
- Alek Pochowski, *Kittelson & Associates, Inc.,* apochowski@kittelson.com
- Pete Jenior, *Kittelson & Associates, Inc.,* pjenior@kittelson.com

Get Involved with TRB

- Getting involved is free!
- Join a Standing Committee (http://bit.ly/2jYRrF6)
  - Committee on Roundabouts, ANB75
- Become a Friend of a Committee (http://bit.ly/TRBcommittees)
  - Networking opportunities
  - May provide a path to become a Standing Committee member
- For more information: www.mytrb.org
  - Create your account
  - Update your profile

97th TRB Annual Meeting: January 7-11, 2018

Take Part in the *Careers in Motion* Networking Fair

http://bit.ly/CareersInMotionFair