Roundabouts
(Be Brave and Be Careful!)

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BURGESS & NIPLE
Engineers ■ Architects ■ Planners

Presenter Background

- B.S. and M.S. Civil Engineering
- 16-years experience in Transportation and Traffic engineering and planning
- Roundabout Convert!
- ITE Roundabout Taskforce Member

Presentation Overview

- Part 1 - Basics
  - Definitions / history
  - Benefits / concerns
  - Key design features
- Part 2 – Case Studies
  - Wide range of situations where roundabouts provide an excellent intersection solution
  - Lessons learned

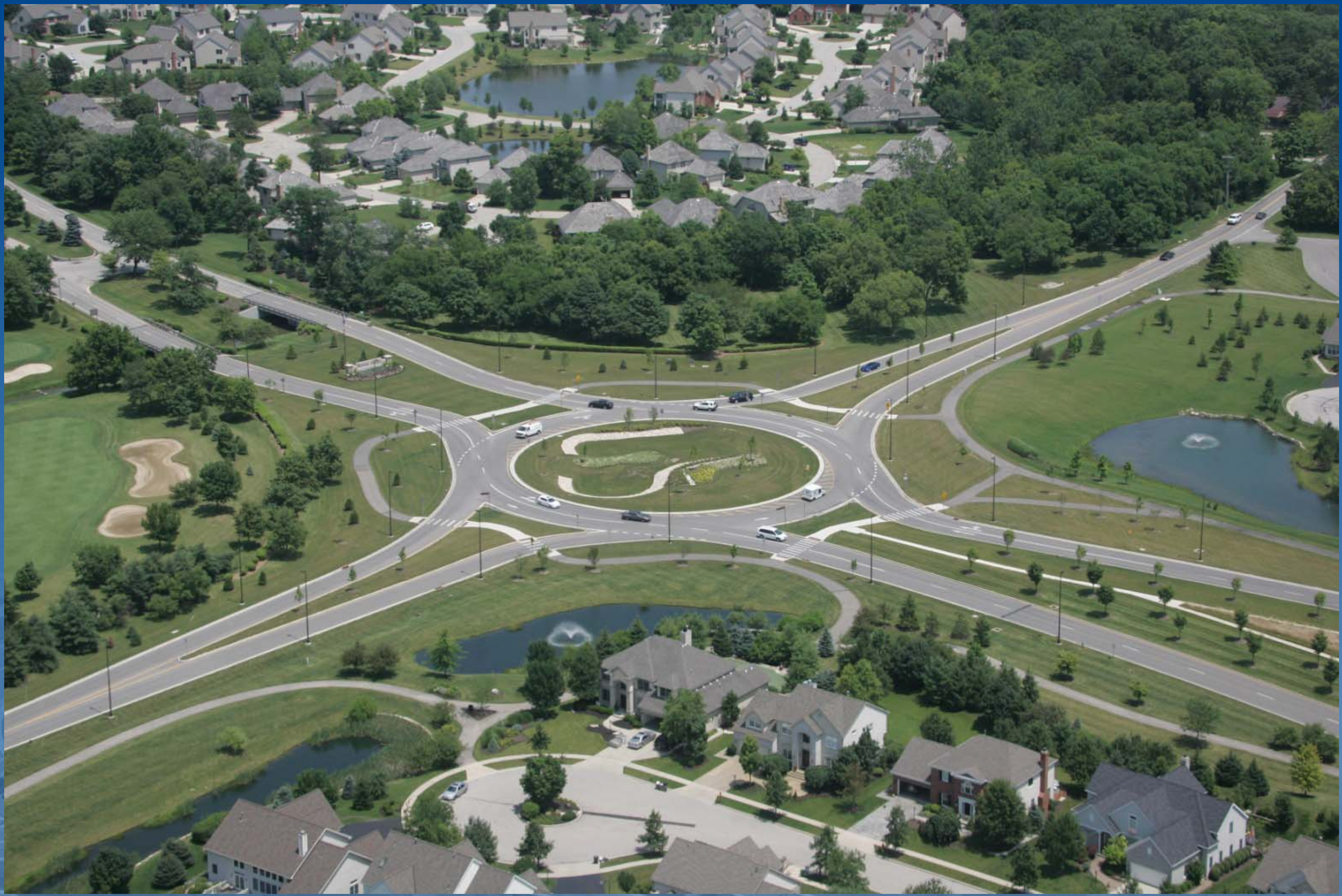
Part 1A: What is a roundabout?

- Examples
- Other circular intersections (what is not a roundabout)
- Key definitions/features

A Roundabout…

- … is an intersection with a generally circular shape.
- … requires all entering traffic to yield to circulating traffic.
- … has appropriate geometric features to ensure slow entering and circulating speeds.

The Modern Roundabout

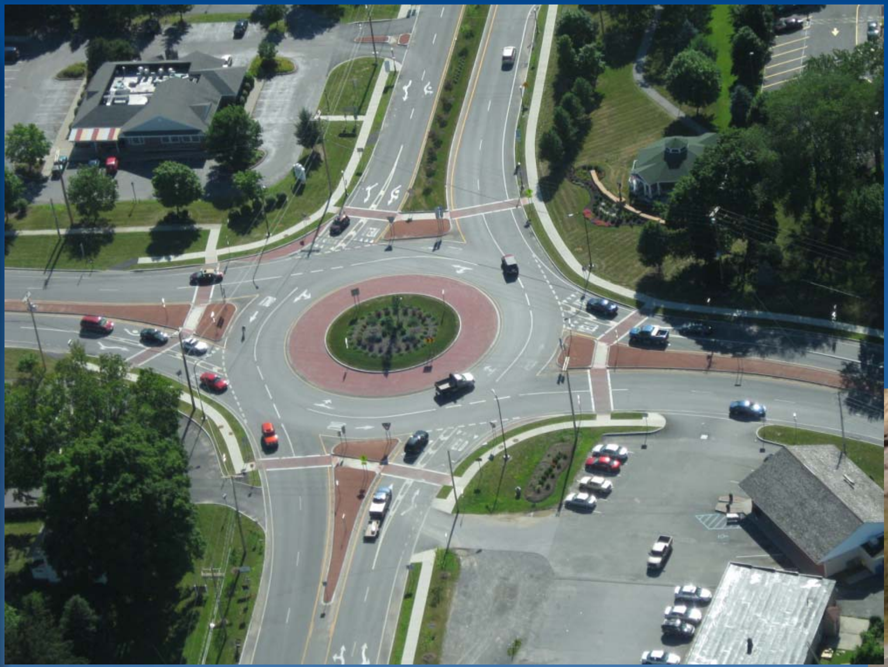


Examples

Examples

PHOTOGRAPHY SOURCE: Lee Rodegerdts

Examples



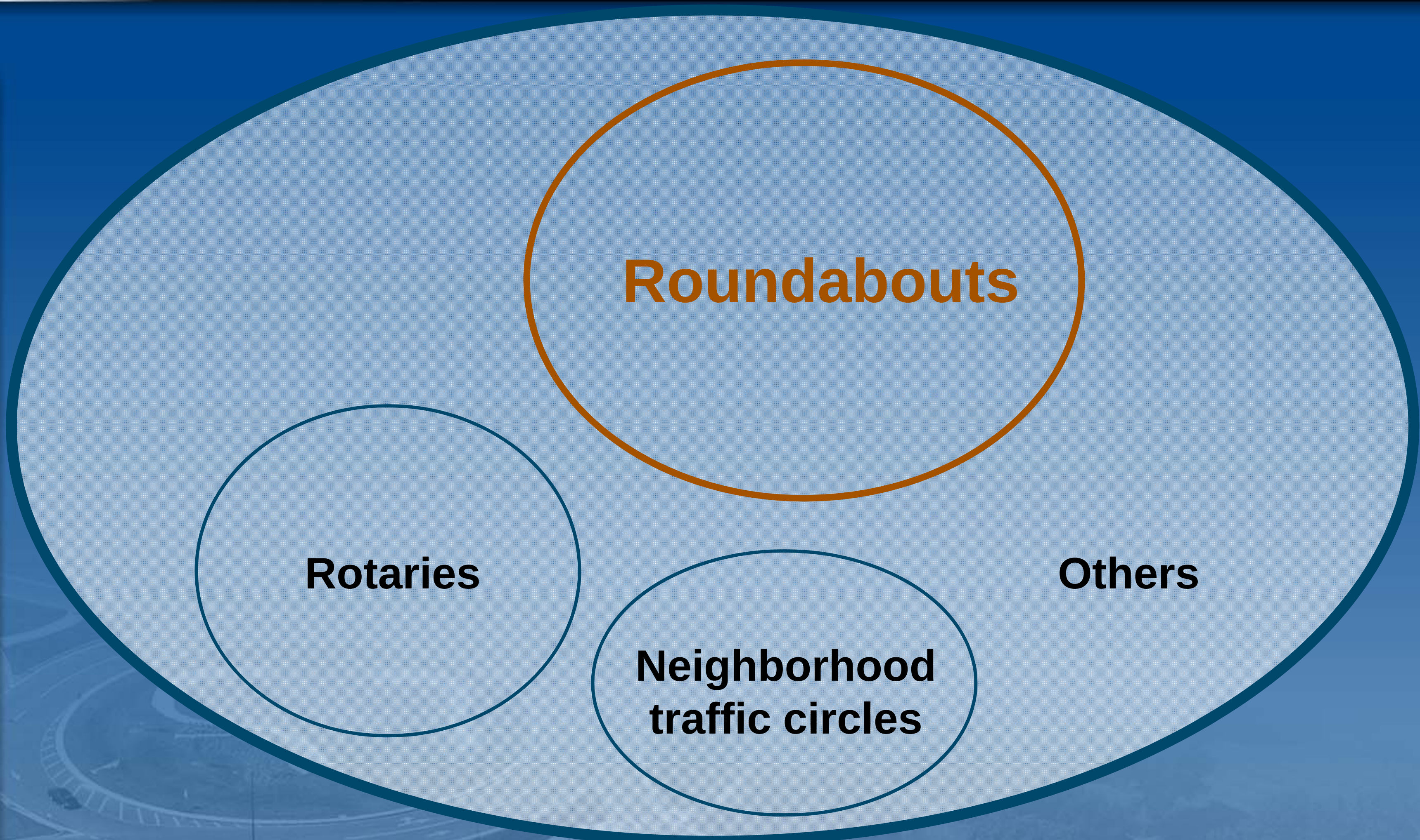
Examples

Example Roundabout(s)

PHOTOGRAPHY SOURCE: Lee Rodegerdts

Example Roundabout(s)

Roundabouts are a subset of circular intersections…



Other Circular Roadway Designs

- The Neighborhood Traffic Circle

PHOTOGRAPHY SOURCE: Lee Rodegerdts

Other Circular Intersection Designs

- The Rotary

PHOTOGRAPHY SOURCE: Unknown

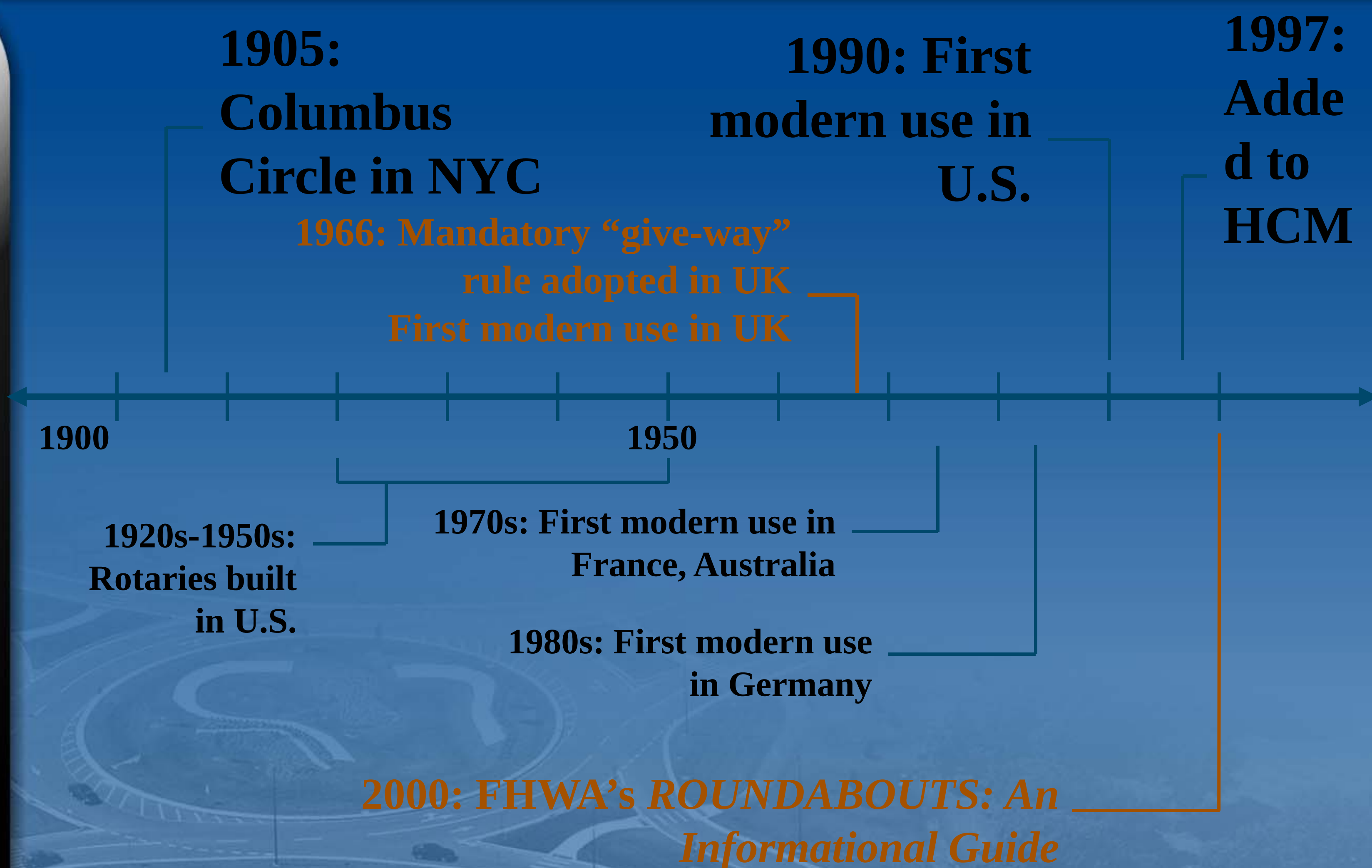
Other Traffic Circles: Fort Worth, TX

Photo: City of Fort Worth, TX

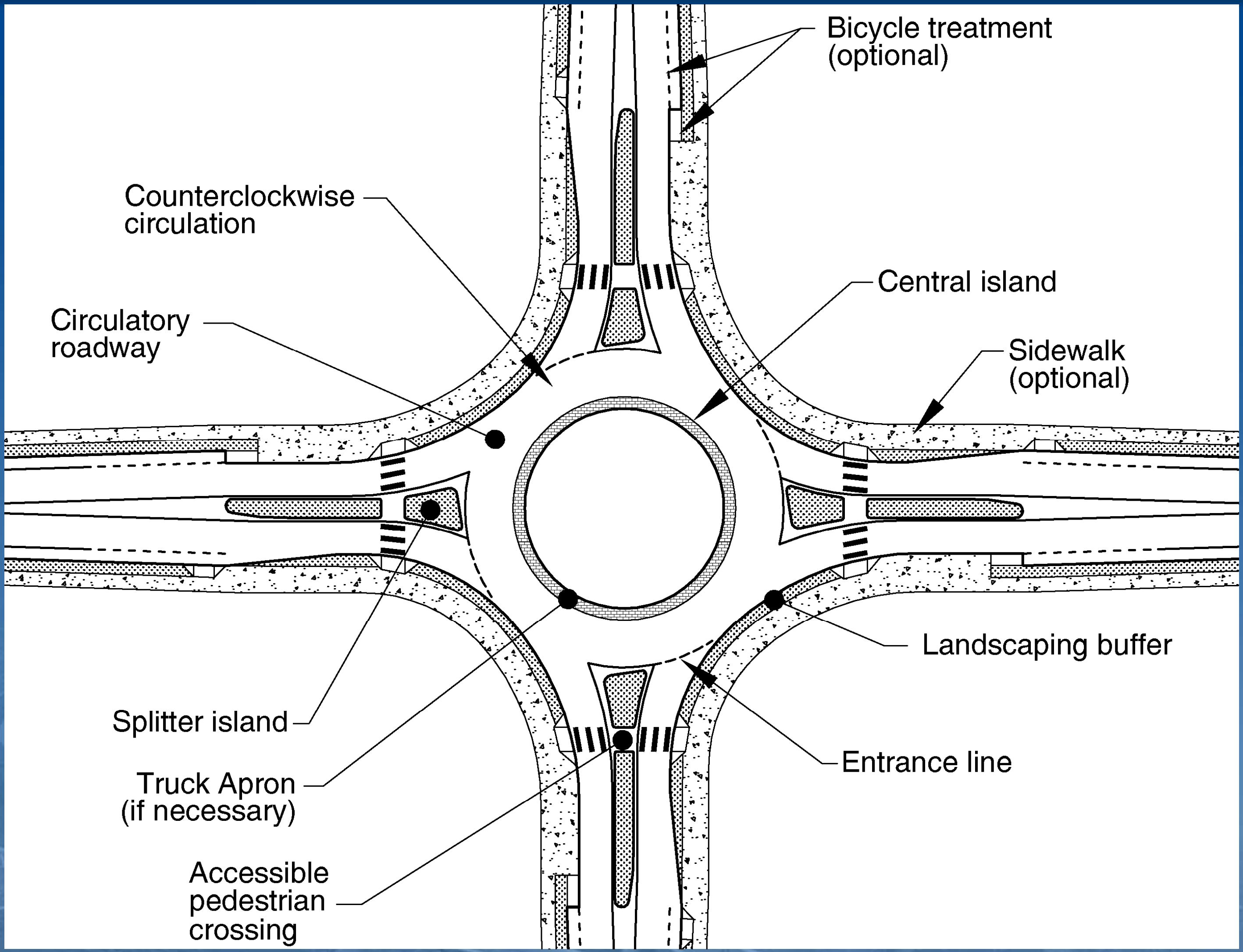
Conversion of Rotary to Roundabout: Kingston, NY

Photo: New York State DOT

A brief history of roundabouts

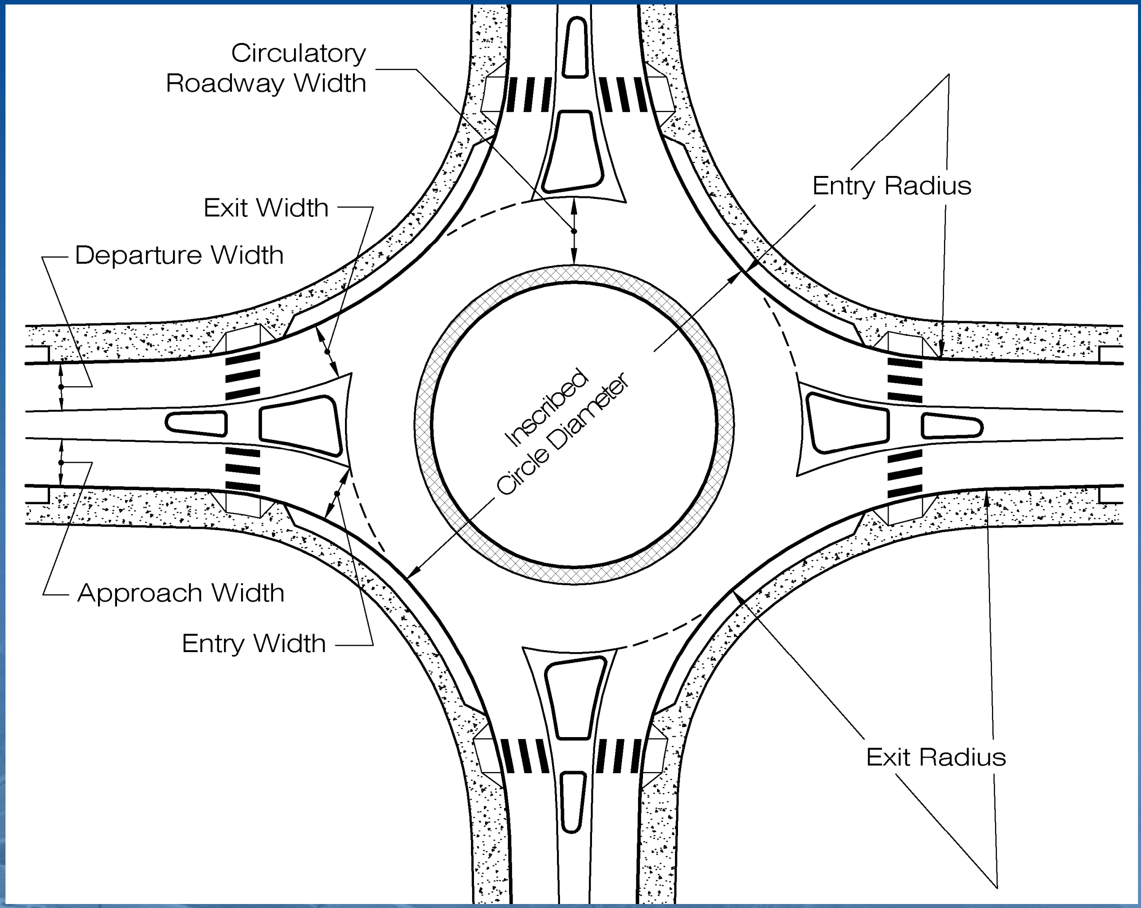


Key Roundabout Features



Key Dimensions

- Typical ICD
  - Single Lane 110-130’
  - Double Lane 150-180’



Part 1B: Why choose a Roundabout?

- Benefits
- Considerations

Why Roundabouts (vs. signals)?

- Much safer
- More efficient (less delay)
- More aesthetic design opportunities
- Reduced noise
- Reduced vehicle emissions – greener!
- Lower operating costs (and less energy consumption)
- Access management
- Less R/W required for approach lanes

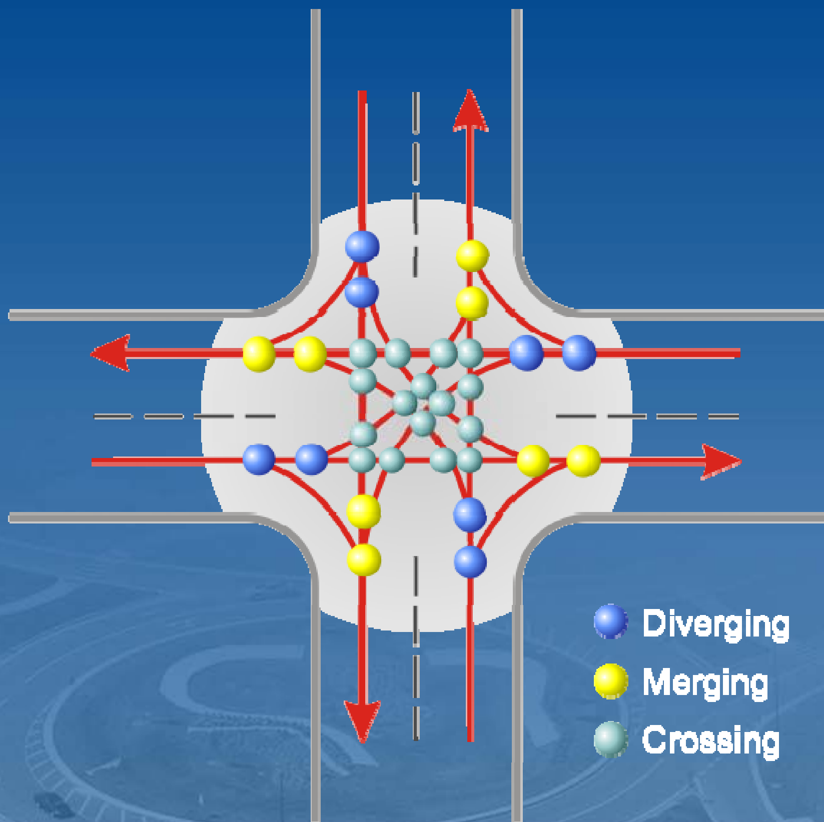
Roundabouts are Safer

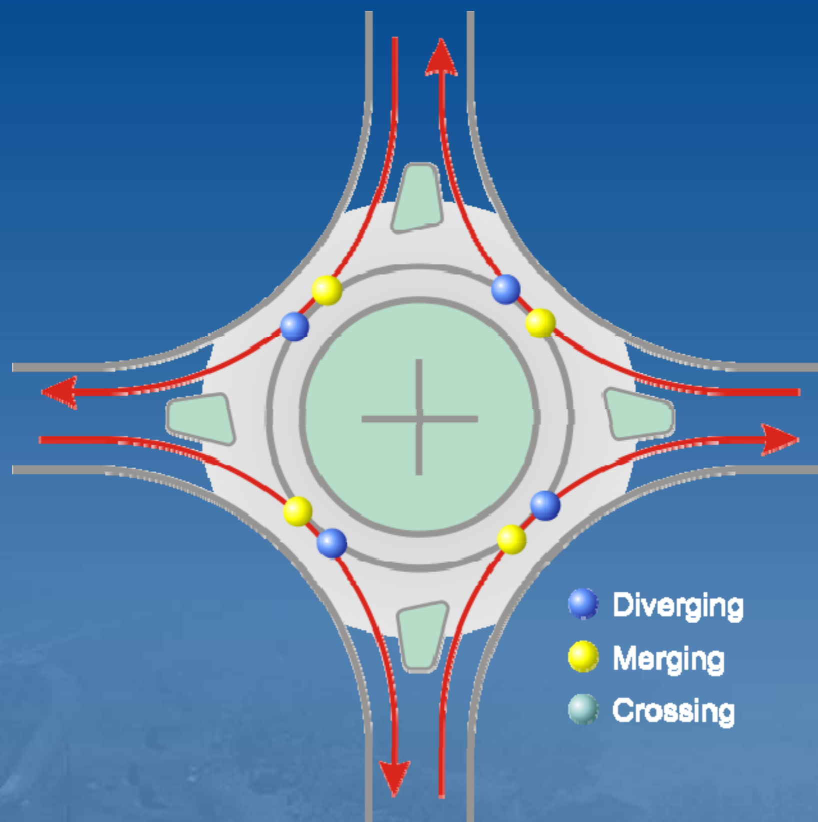
Intersection Type	Change in Total Crashes after Conversion	Change in Severe Injury after Conversion
All Four-Way Intersections	-35%	-76%
Signalized urban	TOO FEW	-60%
Signalized Suburban	-67%	TOO FEW
All-Way Stop Controlled	SIMILAR	SIMILAR
Two-Way Stop Controlled Urban	-72%	-87%
Two-Way Stop Controlled Suburban	-32%	-71%
Two-Way Stop Controlled Rural	-29%	-81%

Source: NCHRP 572

Fewer Conflict Points

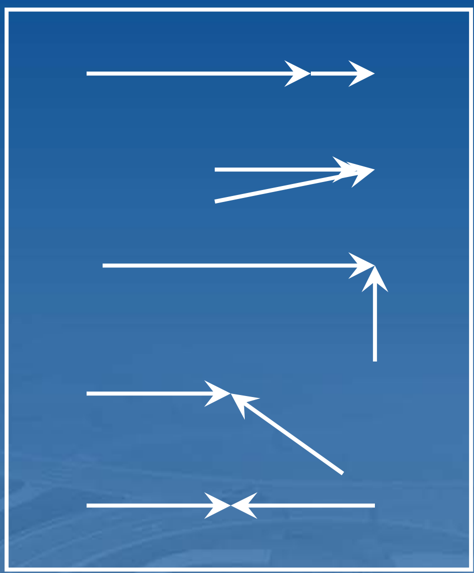
- Reduces number of conflict points from 32 to 8





Reduced Severity of Conflicts

- Severity related to relative velocities of conflicting streams



Rear-end
Sideswipe
Angle
Angle
Head-on

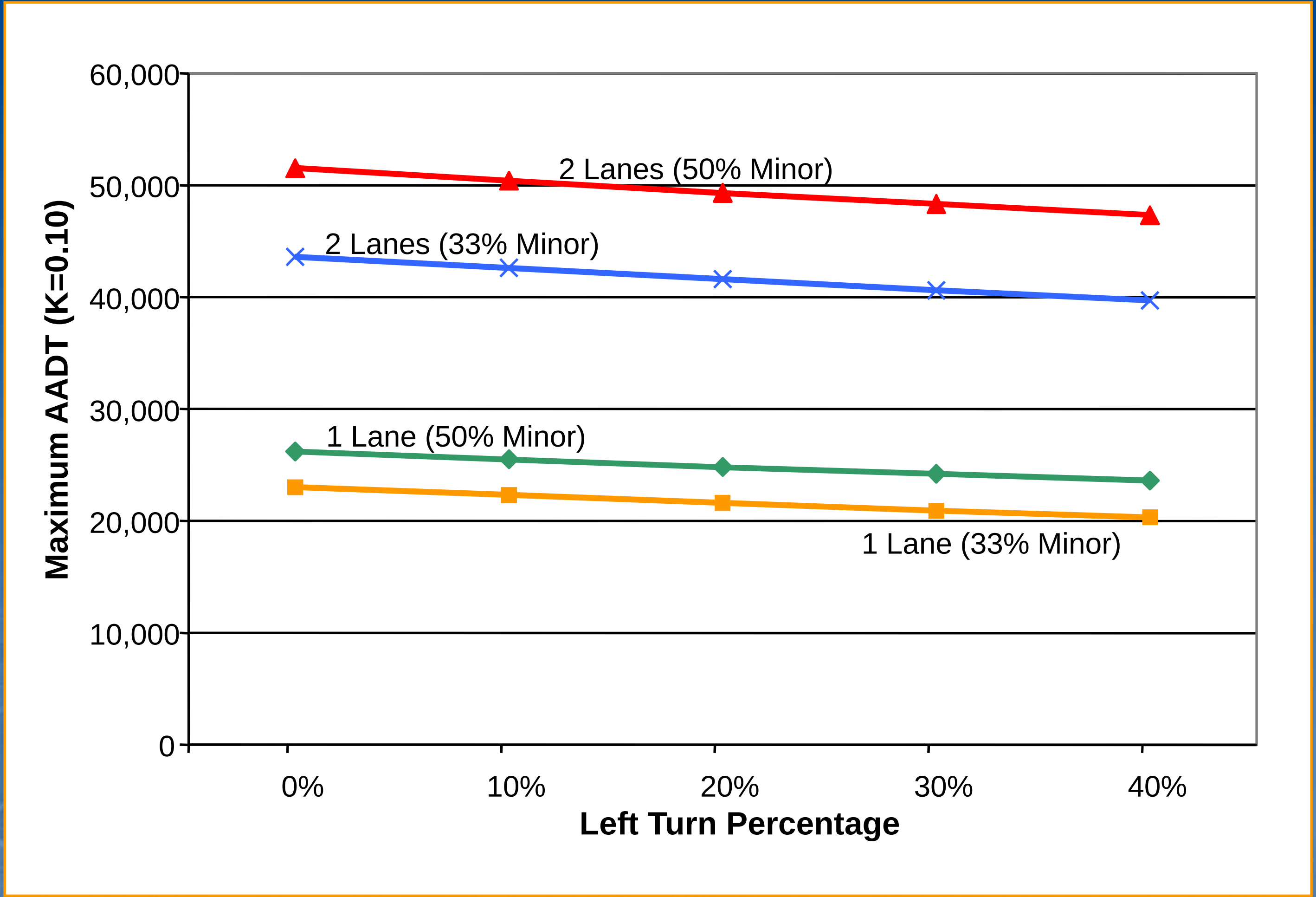
Least severe

Most severe

Roundabouts are Usually More Efficient

- Roundabout gives higher capacity and lower delays than All-Way Stop Control under same conditions
- Roundabout likely to have higher delays than Two-Way Stop Control if TWSC is operating without problems
- Roundabout within capacity will generally produce lower delays than signal under same conditions
  - Generally design for maximum 0.85 of capacity each approach

Maximum ADT (4-leg intersection)



Source: Roundabouts: An Informational Guide

Pedestrian Crash Statistics

- British study
- Shows that all three main classifications of roundabouts produce lower pedestrian crash rates

Intersection Type	Pedestrian Crashes per Million Trips
Mini-roundabout	0.31
Conventional roundabout	0.45
Flared roundabout	0.33
Signals	0.67

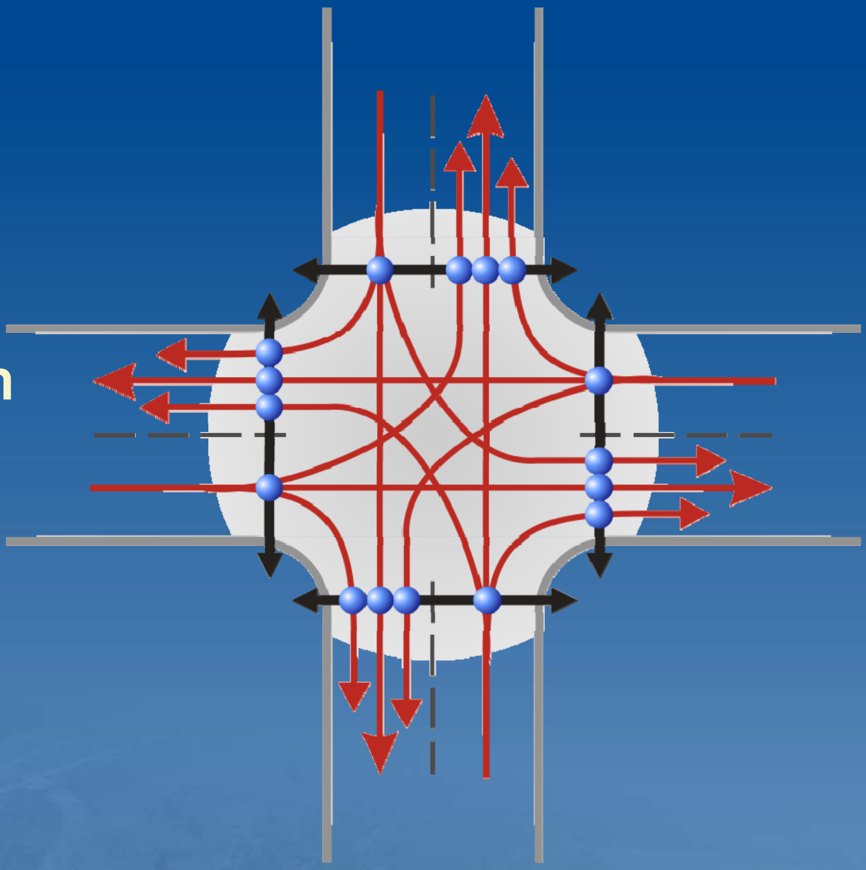
Source: (1, 15)

- Dutch Study
- Shows reductions in crash rates after intersections where changes from signalized to roundabouts
- 89% reduction in pedestrian injury crashes

Mode	All Crashes	Injury Crashes
Passenger car	63%	95%
Moped	34%	63%
Bicycle	8%	30%
Pedestrian	73%	89%
Total	51%	72%

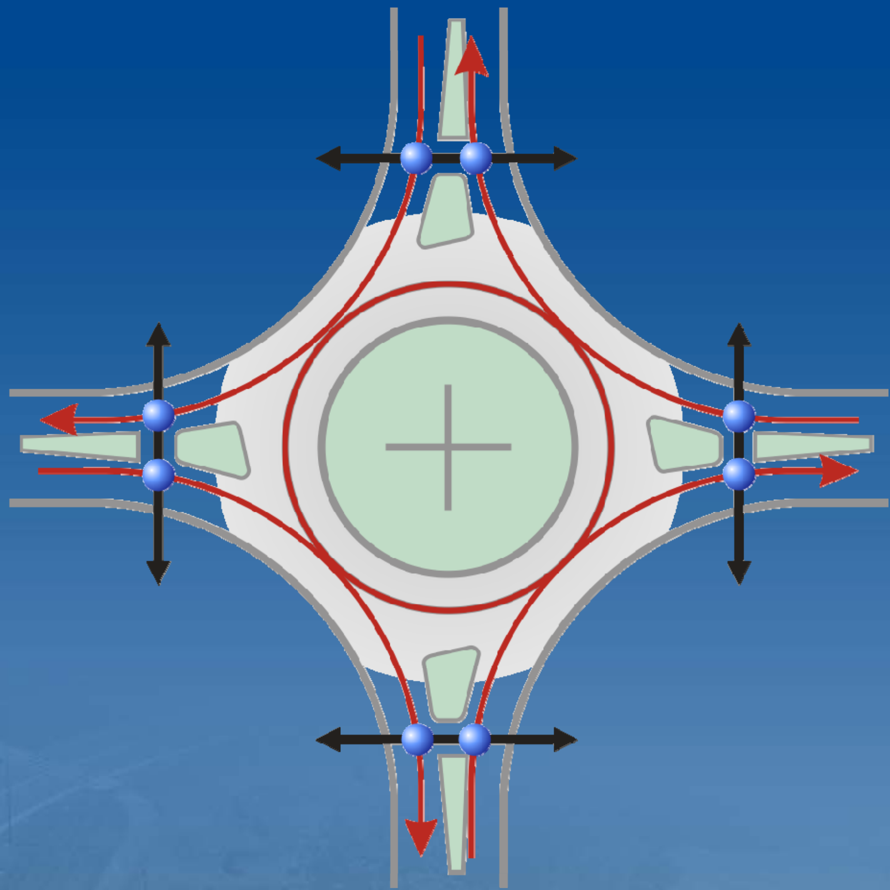
Signalized Intersections Safe for Peds?

- 4 vehicle/pedestrian conflicts for each leg:
  - Right turns on green (legal)
  - Crossing movements on red (high-speed, illegal)
  - Left on green (legal for permitted phasing)
  - Right on red (typically legal)

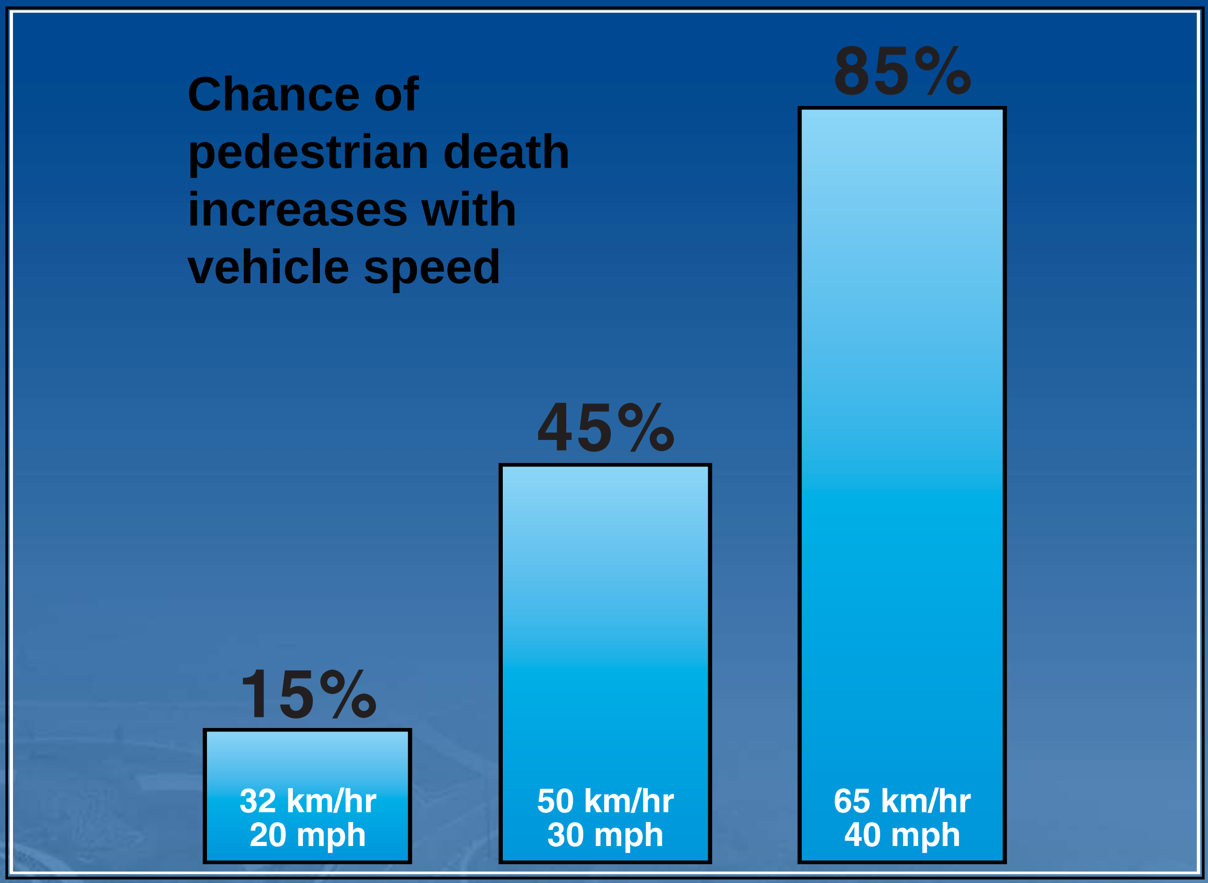


Pedestrian Crashes at Roundabouts

- 2 conflicts exist for each crossing
  1. Conflict with entering vehicles
  2. Conflict with exiting vehicles

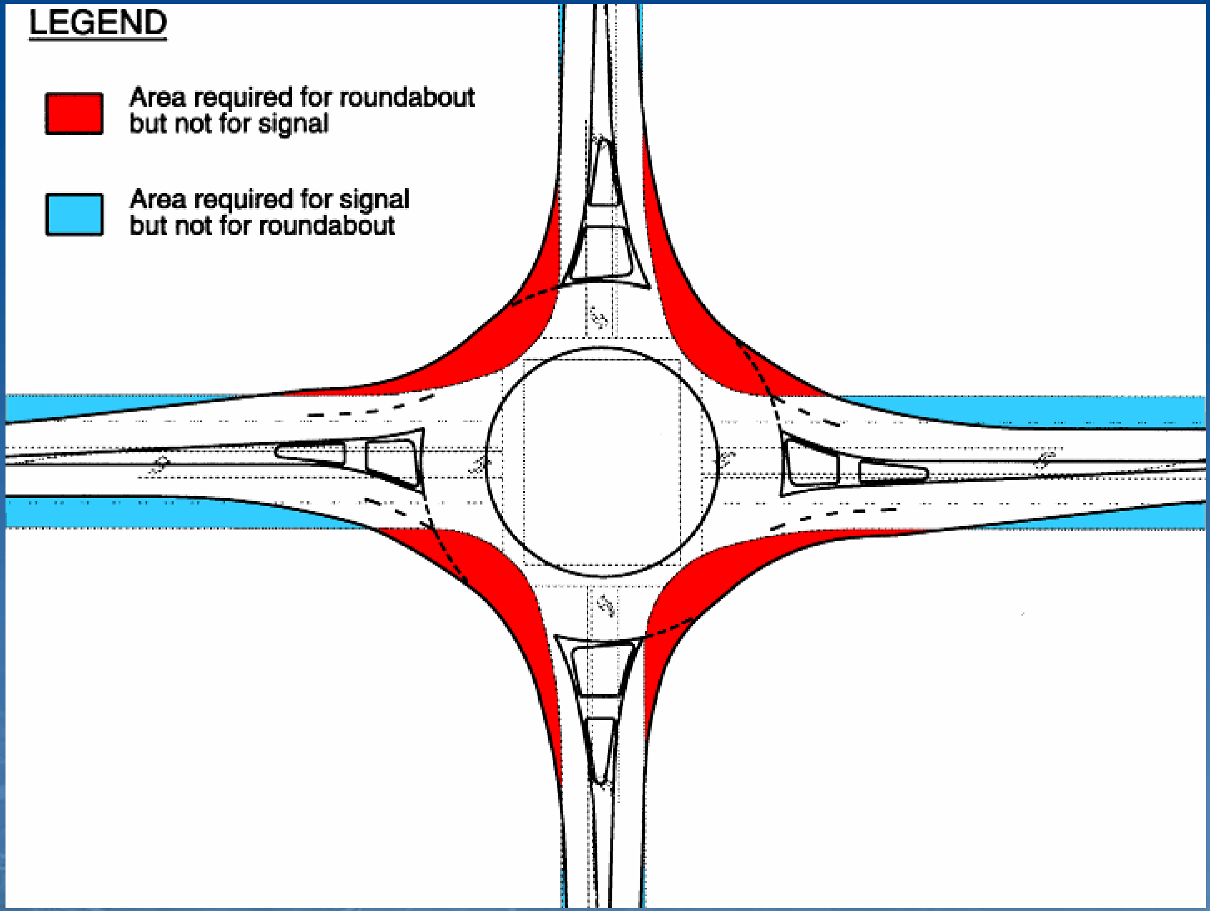


Lower speed is safer for pedestrians



Source: United Kingdom

Space Requirements

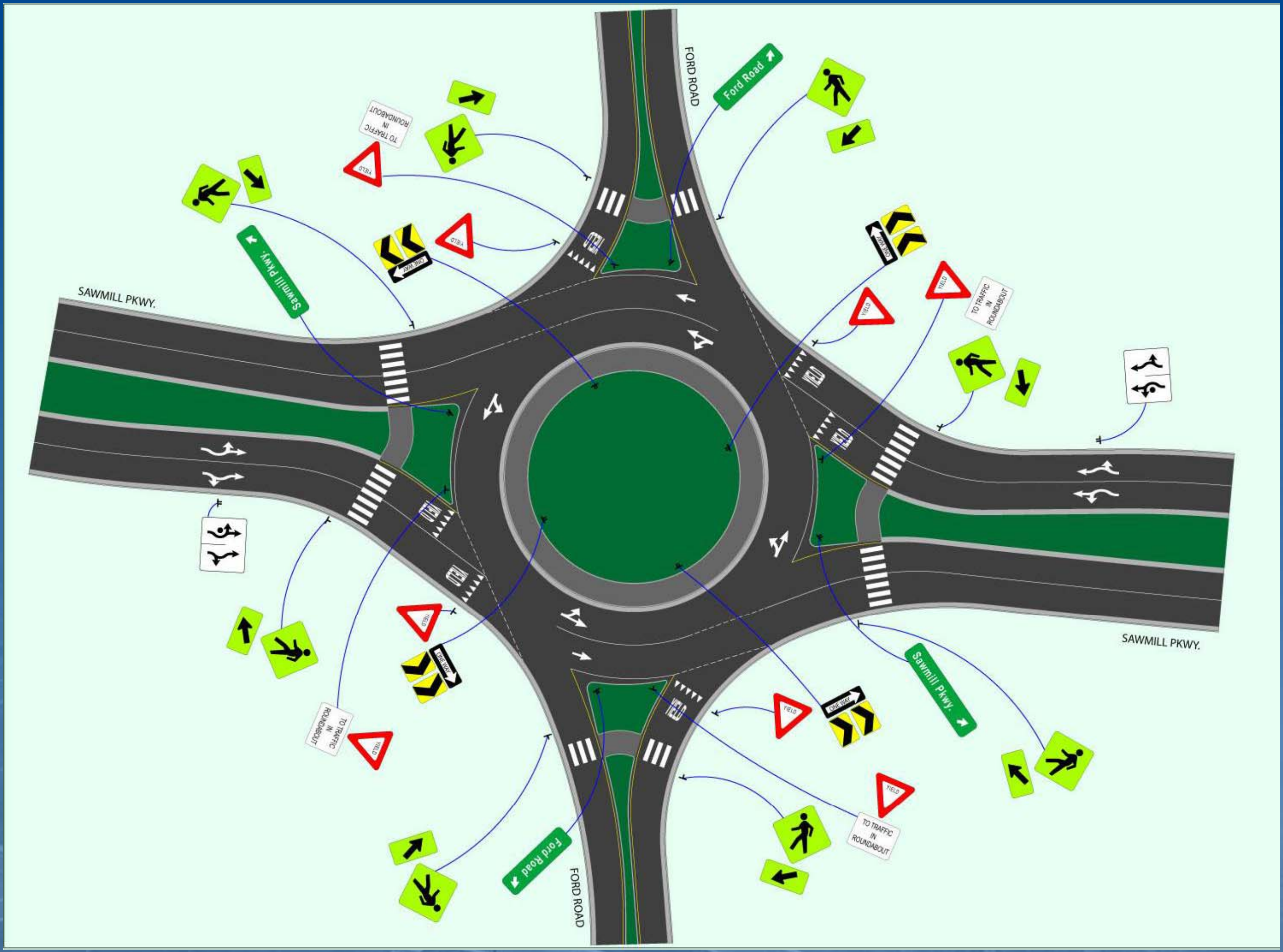


Source: NCHRP 572

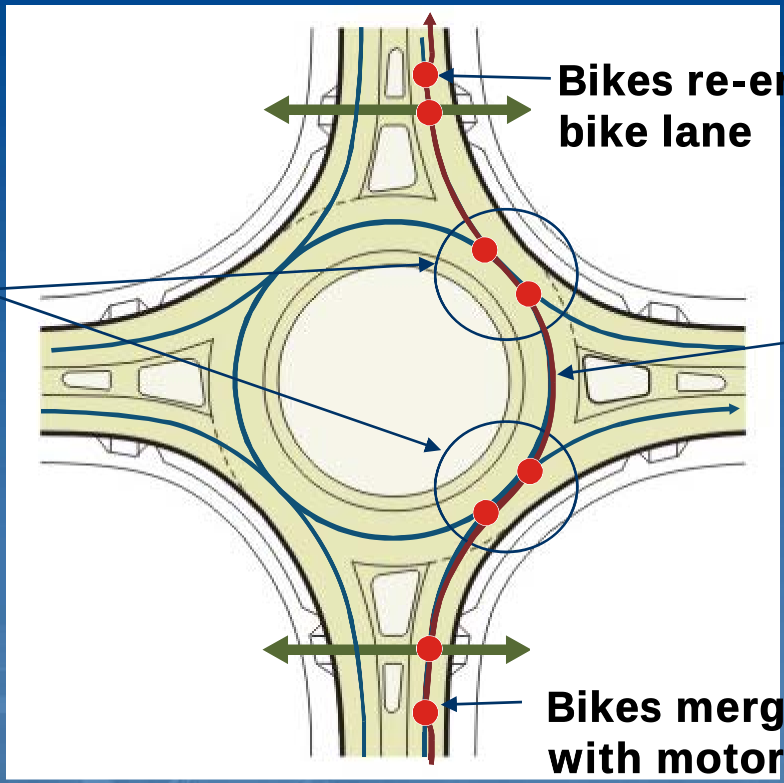
Exercise Care When

- Buildings or expensive property on corners
- Other traffic control devices are close by
- Bottlenecks are close
- There are steep grades and unfavorable topography
- There are heavy pedestrian and/or bicycle movements
- Located within a coordinated signal network

Part 1C: Key Design Considerations

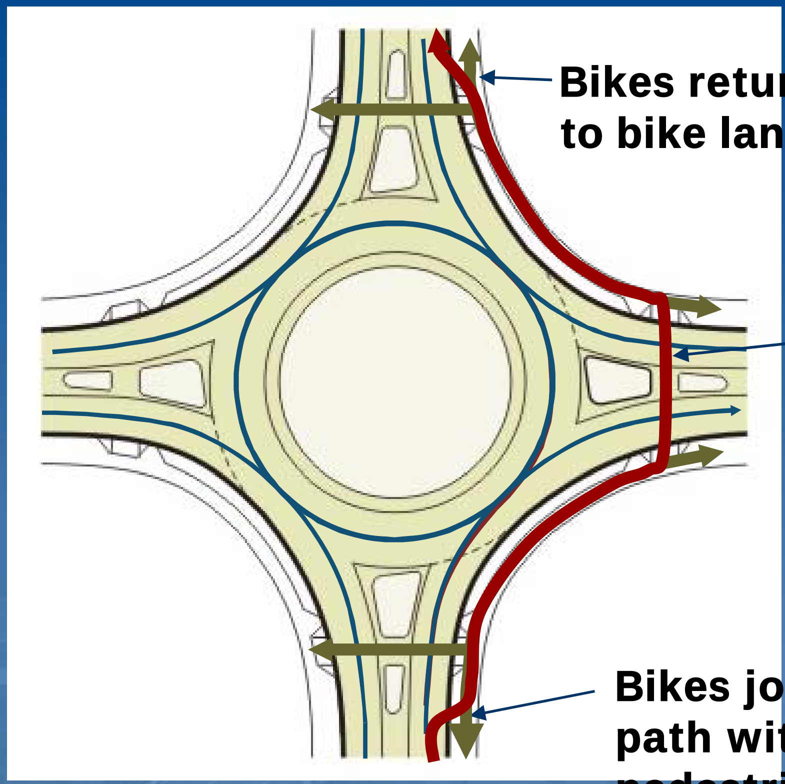


Cyclist Movements at Roundabouts – Circulating as a Vehicle



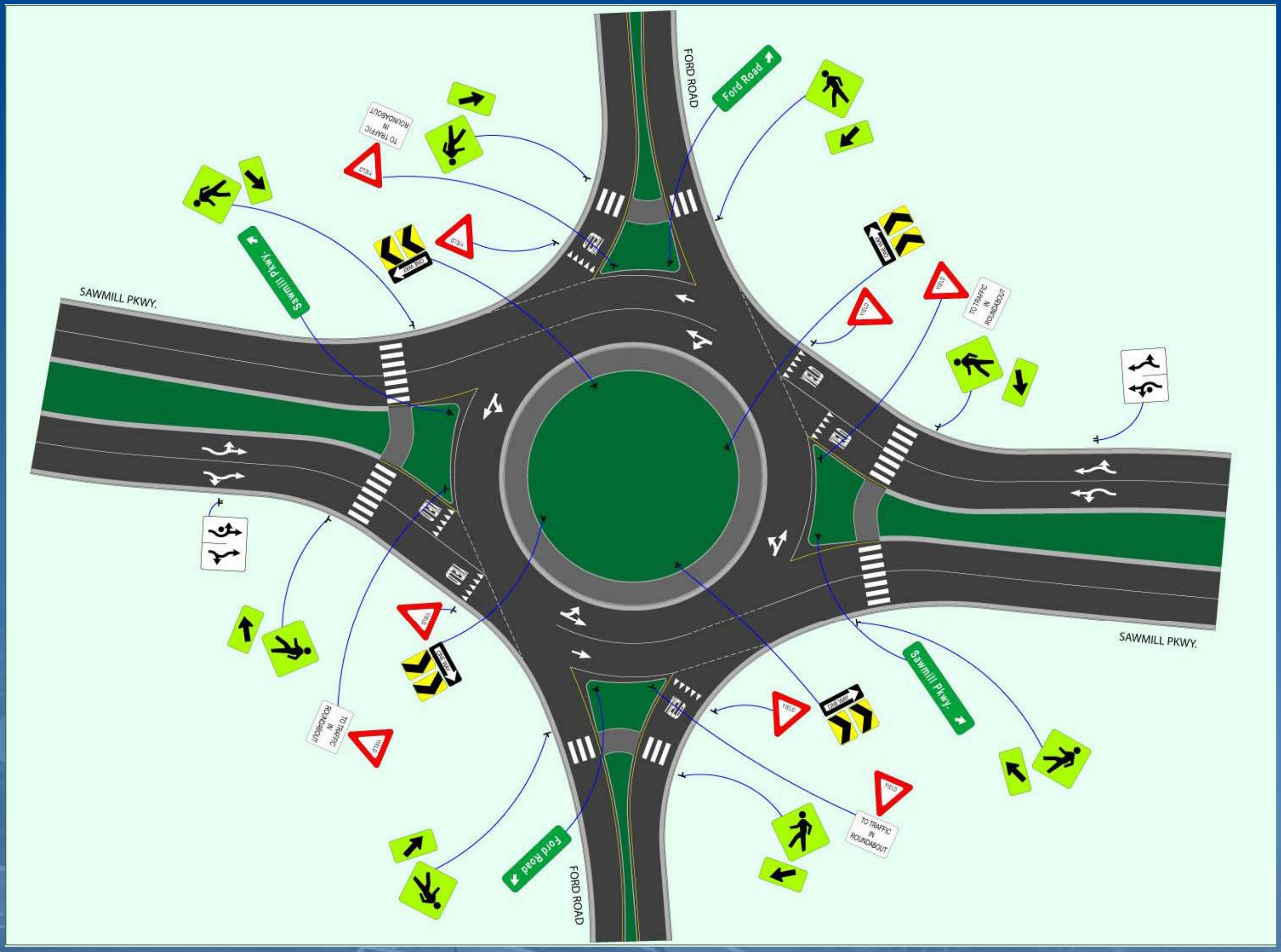
Source: NCHRP 572

Cyclist Movements at Roundabouts – Circulating as a Pedestrian



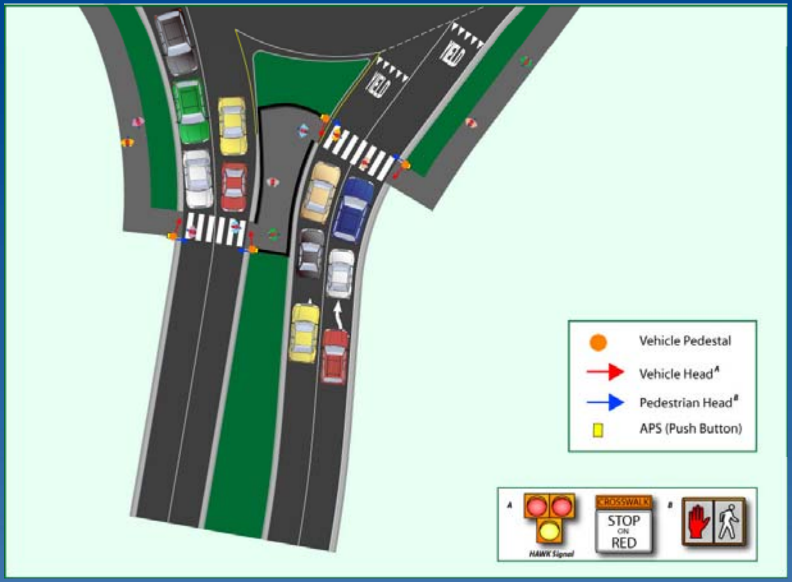
Source: NCHRP 572

Pedestrians



ADA - Access Board Ruling

- Revised Draft Guidelines for Accessible Public Rights-of-Way
- *R305.6.2 Signals. At roundabouts with multi-lane crossings, a pedestrian activated signal complying with R306 shall be provided for each segment of each crosswalk, including the splitter island.*
- YOU MAY WANT TO PLAN FOR THIS!
- NCHRP 3-78
- Oakland County, MI Lawsuit

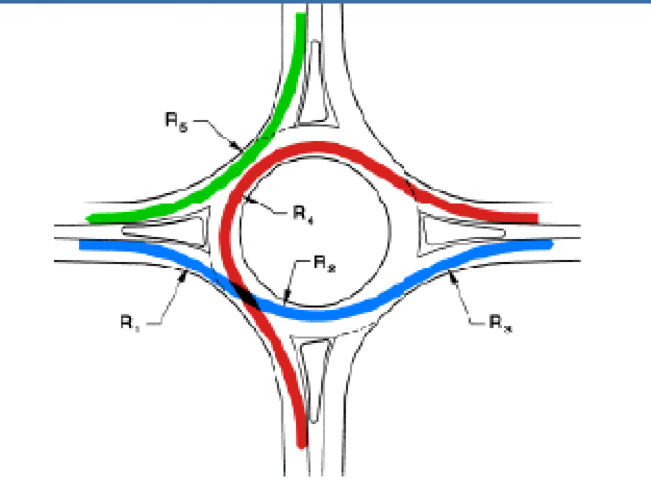


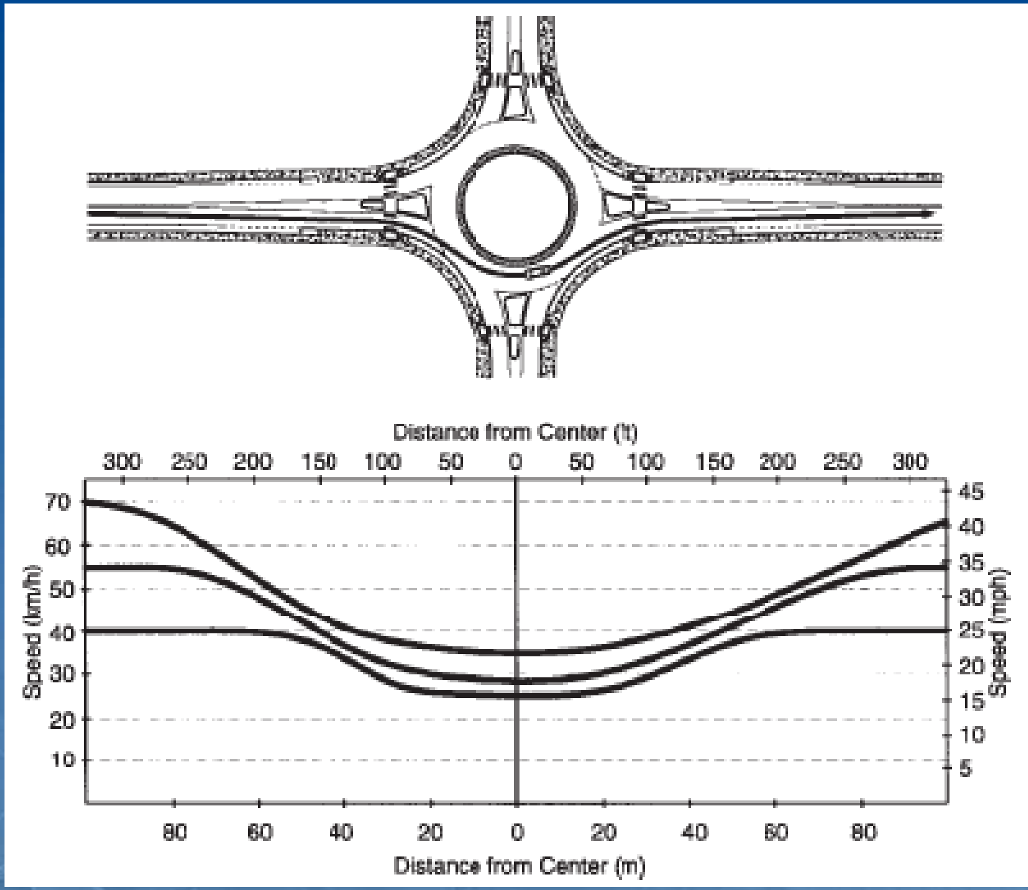
Critical Design Features

- Speed profiles
- Path overlap
- Phi Angle
- Truck design
- Sight distance (Landscaping)
- Lighting

Speed Profiles

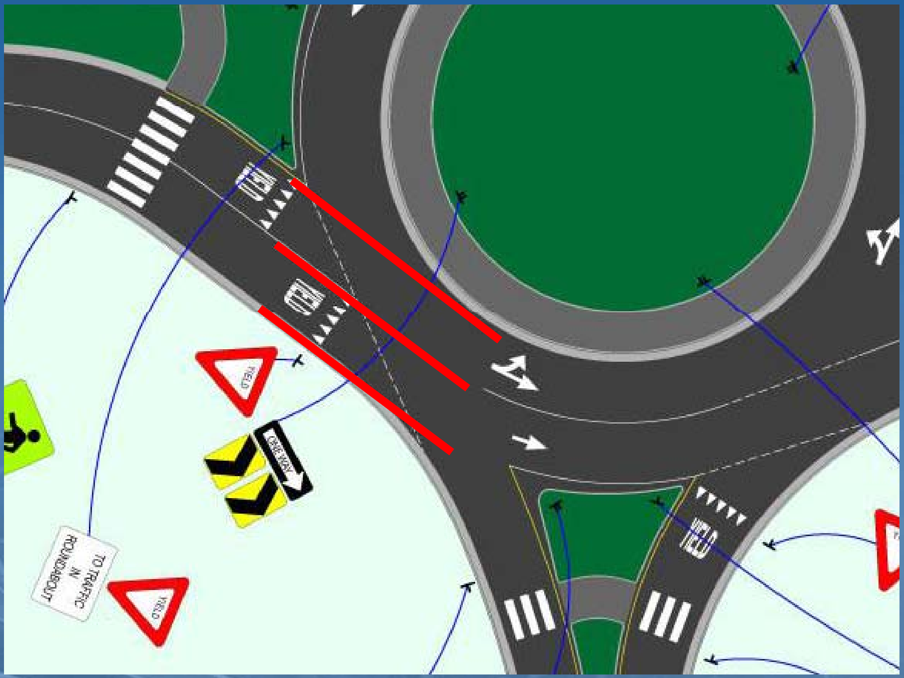
- Design to slow traffic
- Smooth transitions - relative "R" speed differences should be less than 12-mph, preferably less than 6-mph





Path Overlap

- On multi-lane roundabouts
- Guide drivers into proper lane
- Can cause and above average # of crashes



Phi Angle

- 20-40 degrees preferred

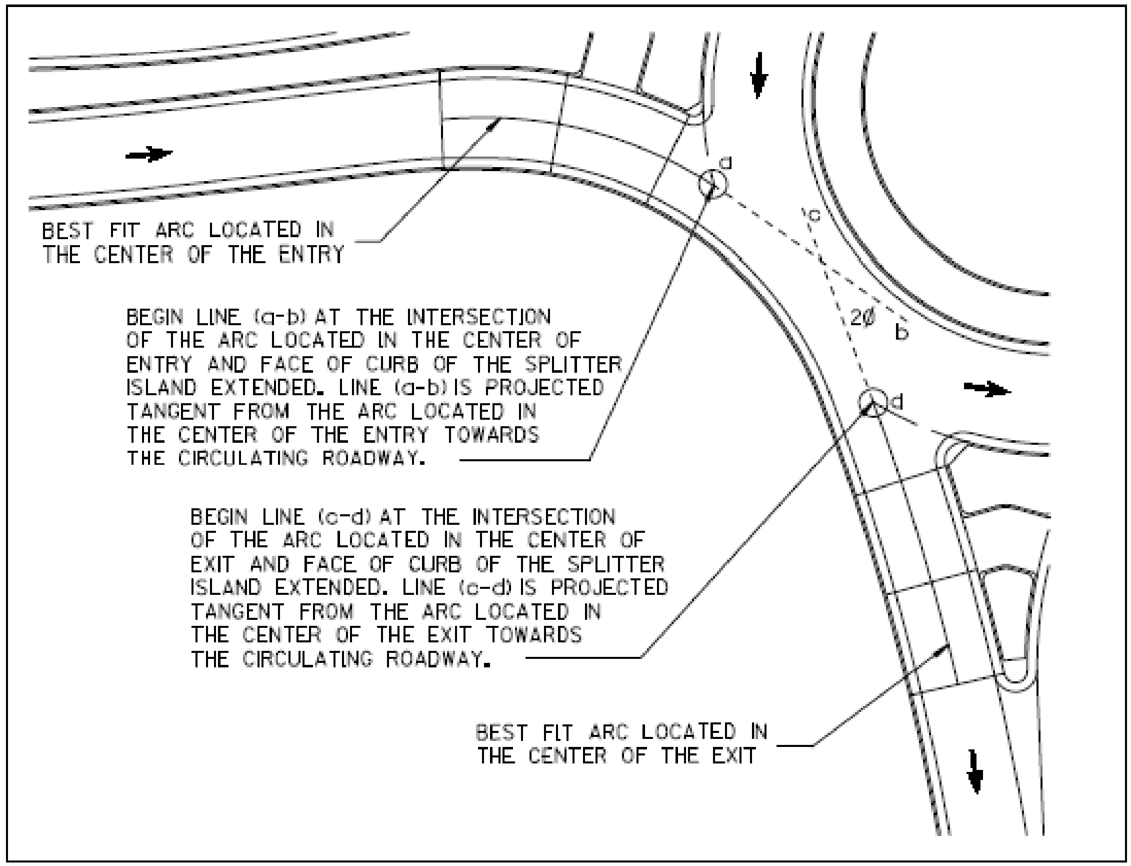


Figure 14. Method 1 Phi Measurement

Source: Wisconsin DOT

Truck Paths

PHOTOGRAPHY SOURCE: Lee Rodegerdts

Sight Distance (Landscaping)

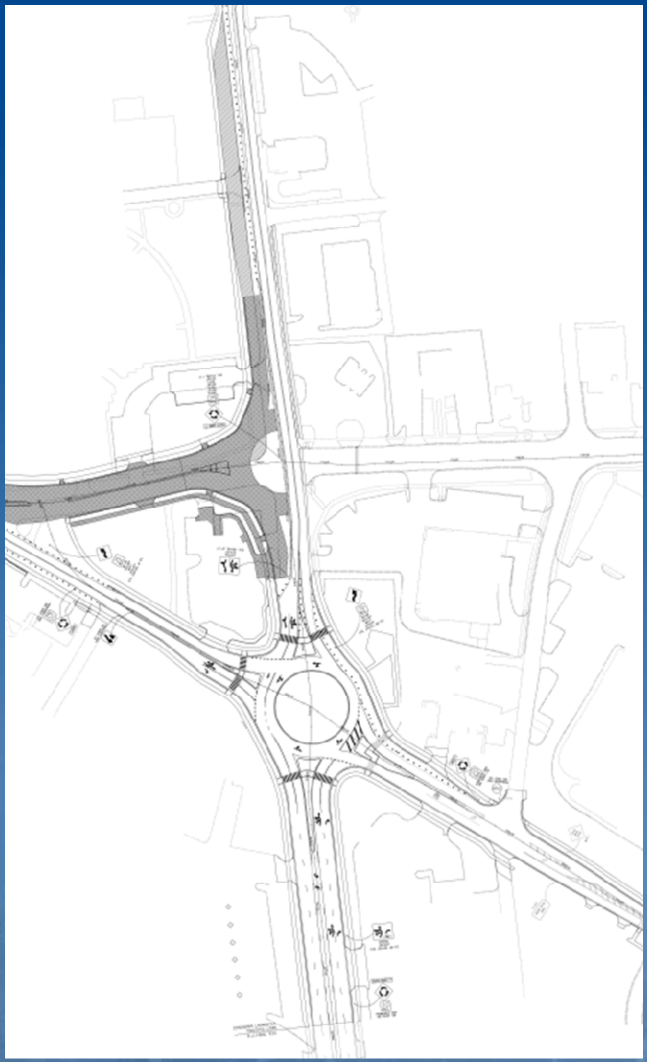
- Don't block critical sight distances
- Reducing sight distance will help to reduce traffic speeds
- Use landscaping to make roundabout apparent

Lighting

- Illuminate pedestrians and bicyclists
- Illuminate curbs and vehicle path
- Make driver aware of approaching roundabout

Maintaining Traffic During Construction

- Keep it as simple as possible
- Use closures and detours where possible
- Identify critical movements and seasonal factors
- Minimize constructing in "pieces"



MOT (continued)

- Wider roundabout footprint can be an advantage
- Be careful using "temporary" roundabouts
  - Safety
  - Use full pavement markings & signing
- Lighting should be operational
- Public perception (first impression!)

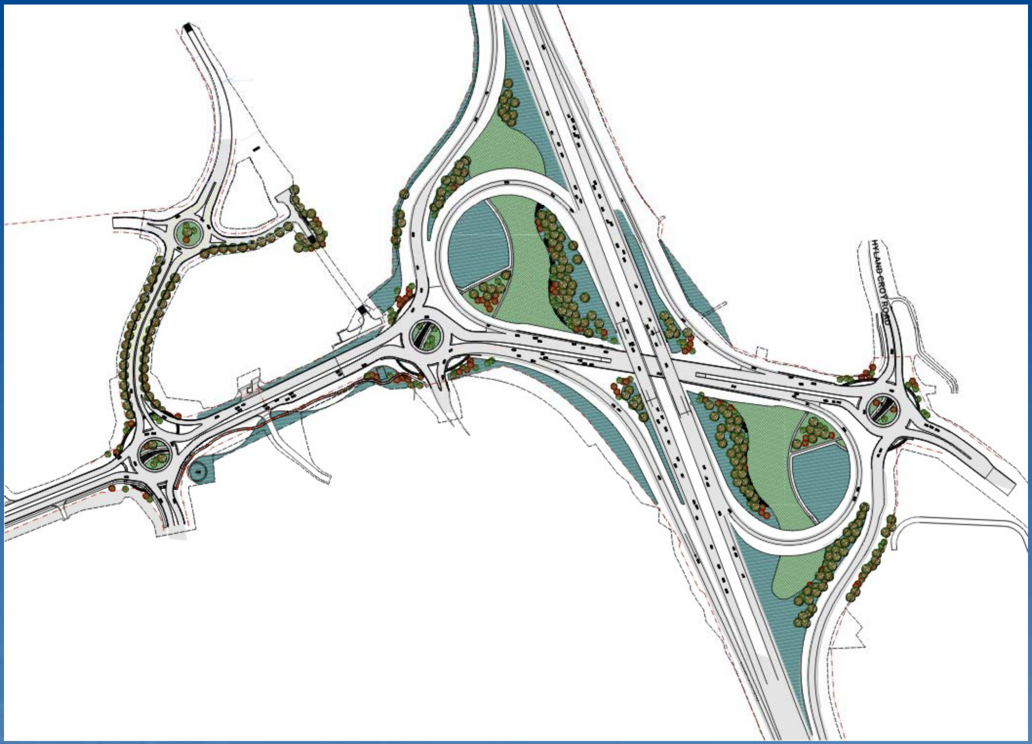
QUESTIONS?

Part B: Case Studies

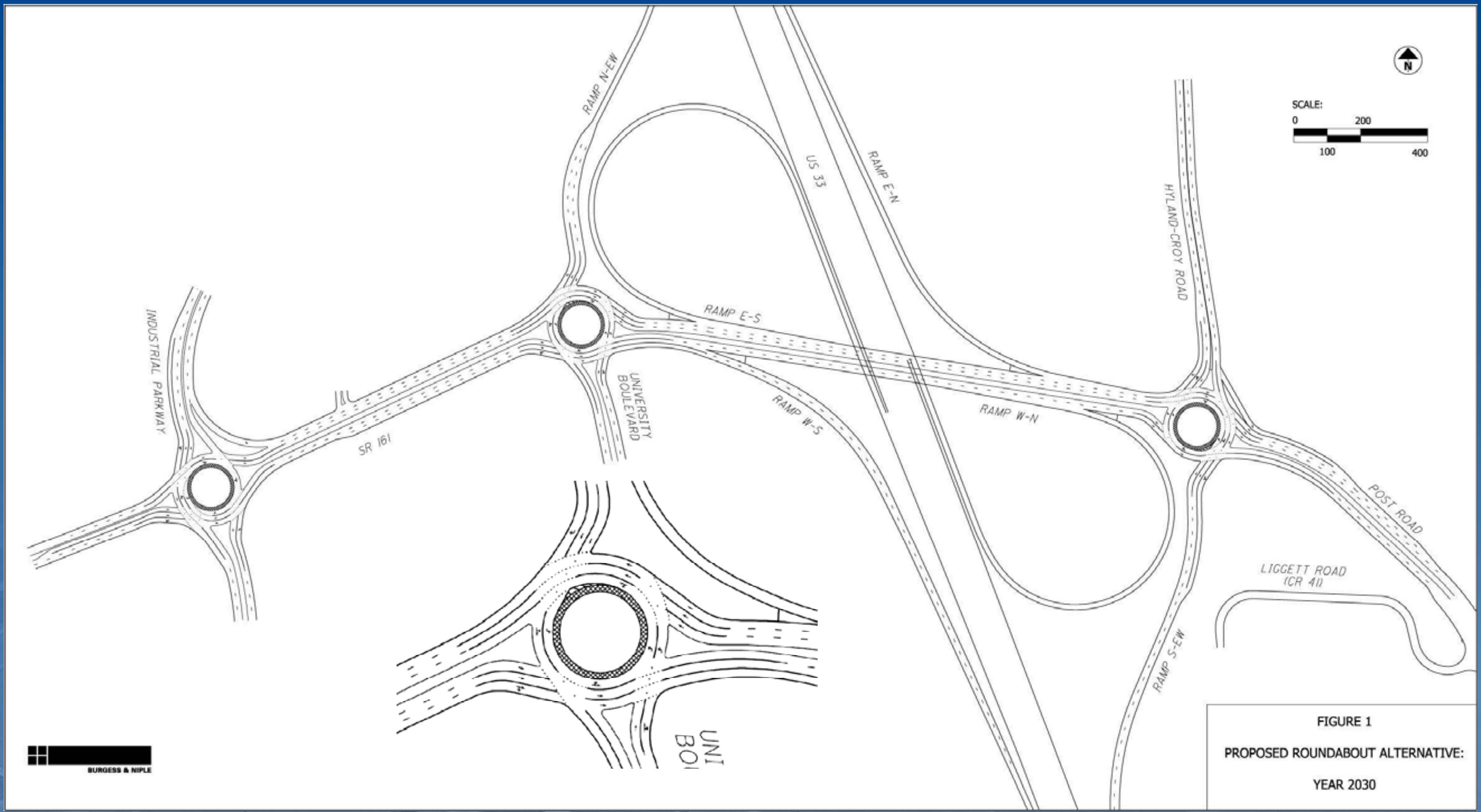
- Wide range of applications
- Key issues/characteristics
- Lessons learned

U.S. 33 and S.R. 161/Post Road Interchange - Dublin, Ohio

- Diamond Interchange
- Three-lane roundabouts at the exit ramp terminals
- Three-lane roundabout at an adjacent intersection
- 2010 Construction



ODOT & FHWA Approval



Operational Benefits

2030 Delay and LOS for East Ramp Terminal Intersection

Intersection Leg	LOS and Average Vehicle Delay (seconds)											
	RODEL (Roundabout)				aaSIDRA* (Roundabout)				HCS** (Signalized)			
	2030 AM		2030 PM		2030 AM		2030 PM		2030 AM		2030 PM	
North Leg (Off-Ramp)	A	3.0	A	3.6	B	14.0	B	16.3	D	53.2	D	43.0
West Leg (SR 161)	A	3.6	A	3.0	A	9.4	A	6.4	D	53.9	D	48.0
South Leg (University)	A	4.8	A	6.6	B	19.0	C	25.5	D	47.1	D	48.7
East Leg (SR 161)	A	1.8	A	2.4	A	4.6	A	4.4	C	20.7	D	39.4

2030 Delay and LOS for West Ramp Terminal Intersection

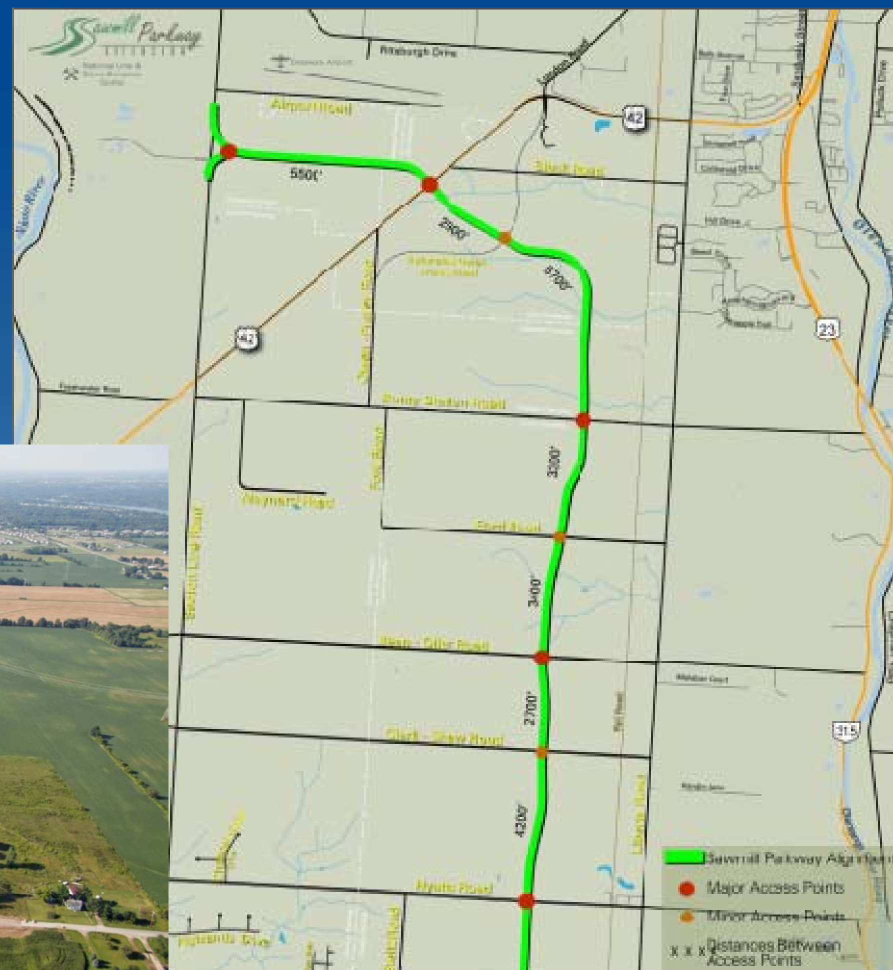
Intersection Leg	LOS and Average Vehicle Delay (seconds)											
	RODEL (Roundabout)				aaSIDRA* (Roundabout)				HCS** (Signalized)			
	2030 AM		2030 PM		2030 AM		2030 PM		2030 AM		2030 PM	
North Leg (Hyland Croy)	A	3.0	A	3.0	B	19.7	C	20.8	D	39.9	D	48.1
West Leg (SR 161)	A	3.0	A	2.4	A	7.5	A	6.5	D	35.2	C	32.7
South Leg (Off-Ramp)	A	2.4	A	2.4	B	17.3	B	14.5	D	47.4	D	47.0
East Leg (SR 161)	A	2.4	A	2.4	B	14.6	B	18.6	D	45.8	D	47.3

Issues

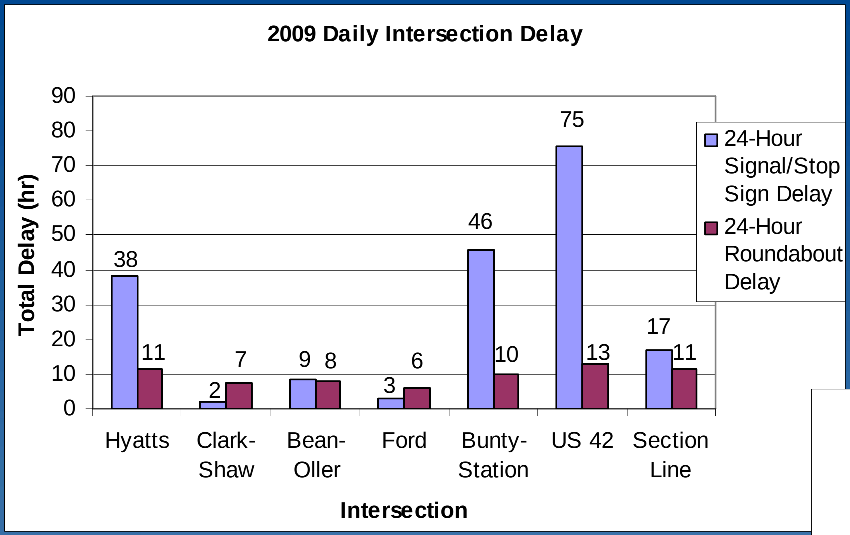
- Ramp metering
- Speed vs. truck design
- 2-lanes vs. 3-lanes

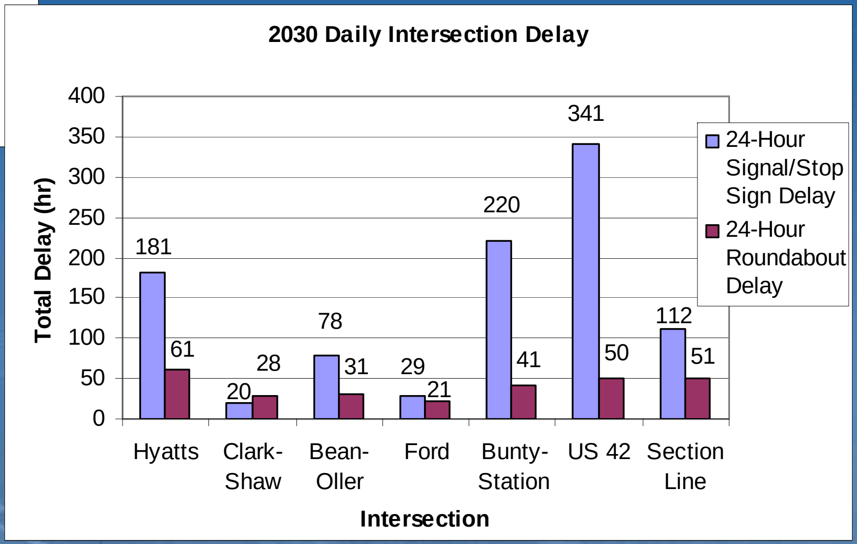
Sawmill Parkway Extension
Delaware County, Ohio

- 6.5 miles
- 6 proposed roundabouts
- Roundabout study requested by public
- Detailed study performed
- 2009 -2011 Construction



24 – Hour Delay Comparison



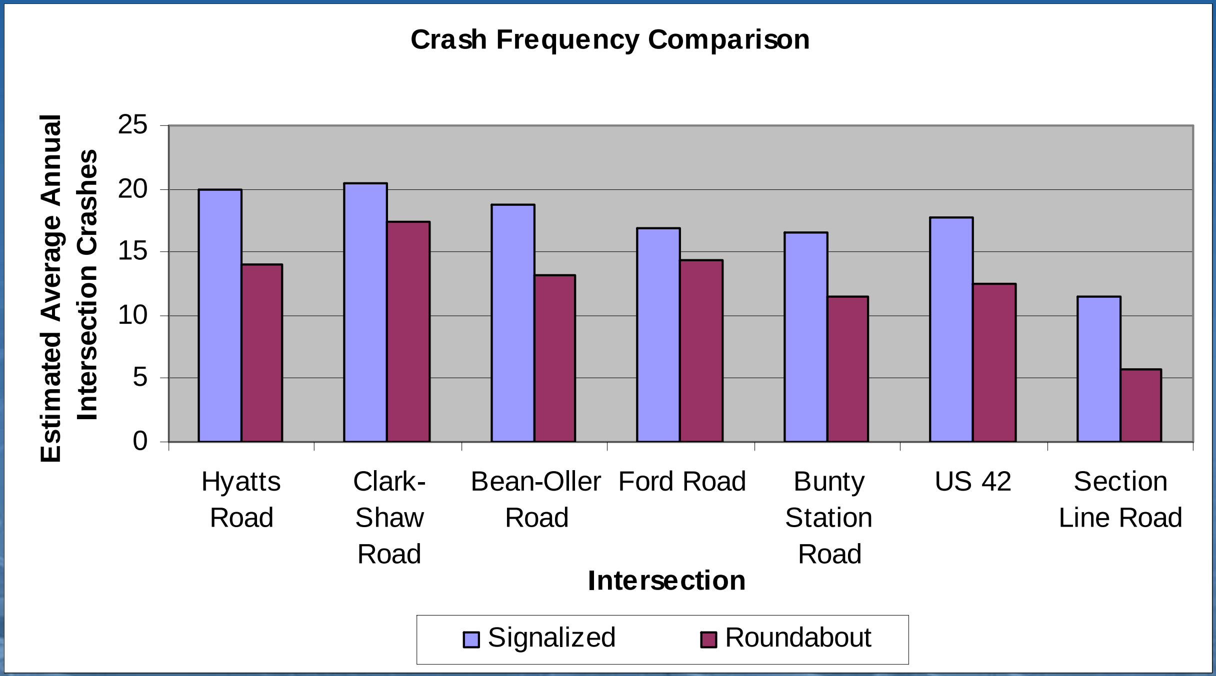


Peak Hour Travel Time Comparison

Intersection Scenario	Sawmill Parkway Extension Travel Time in Minutes							
	2009 AM		2009 PM		2030 AM		2030 PM	
	NB	SB	NB	SB	NB	SB	NB	SB
All signals and/or stop signs	9.10	9.16	9.23	9.05	10.78	10.95	10.74	10.19
All roundabouts except stop sign at Ford, Clark-Shaw, Owen-Fraley/Slack relocated	8.55	8.56	8.57	8.56	8.70	8.76	8.91	8.75
All roundabouts except Owen-Fraley/Slack relocated	8.61	8.62	8.63	8.62	8.78	8.87	9.04	8.83

Crash Reduction

- **Assumptions:**
  - Two-lane 30% fewer crashes
  - Single-lane 50% fewer crashes
  - 1.0 crashes/MEV non-roundabout

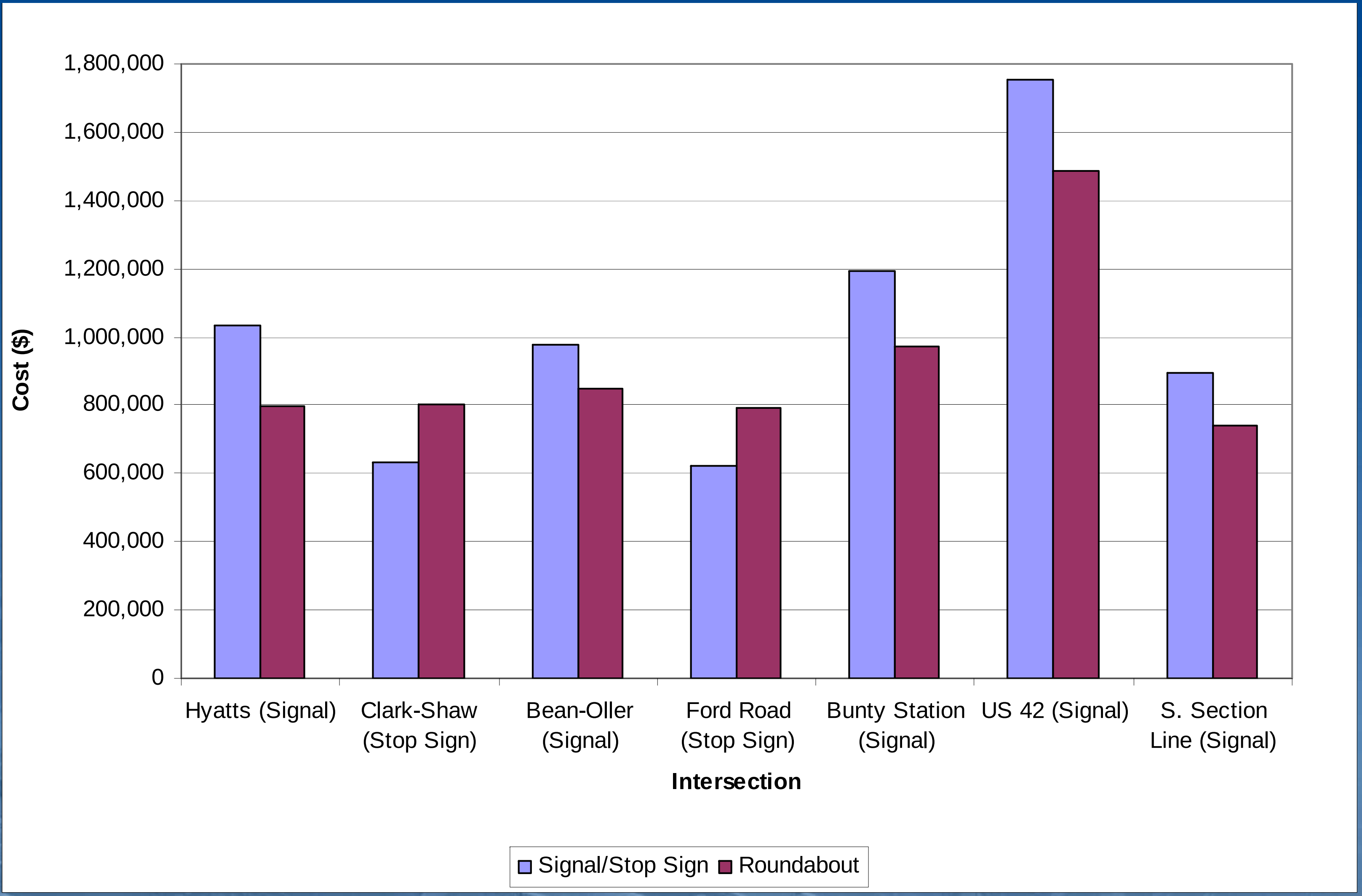


Average annual crash frequencies at 11 U.S. intersections converted to roundabouts.

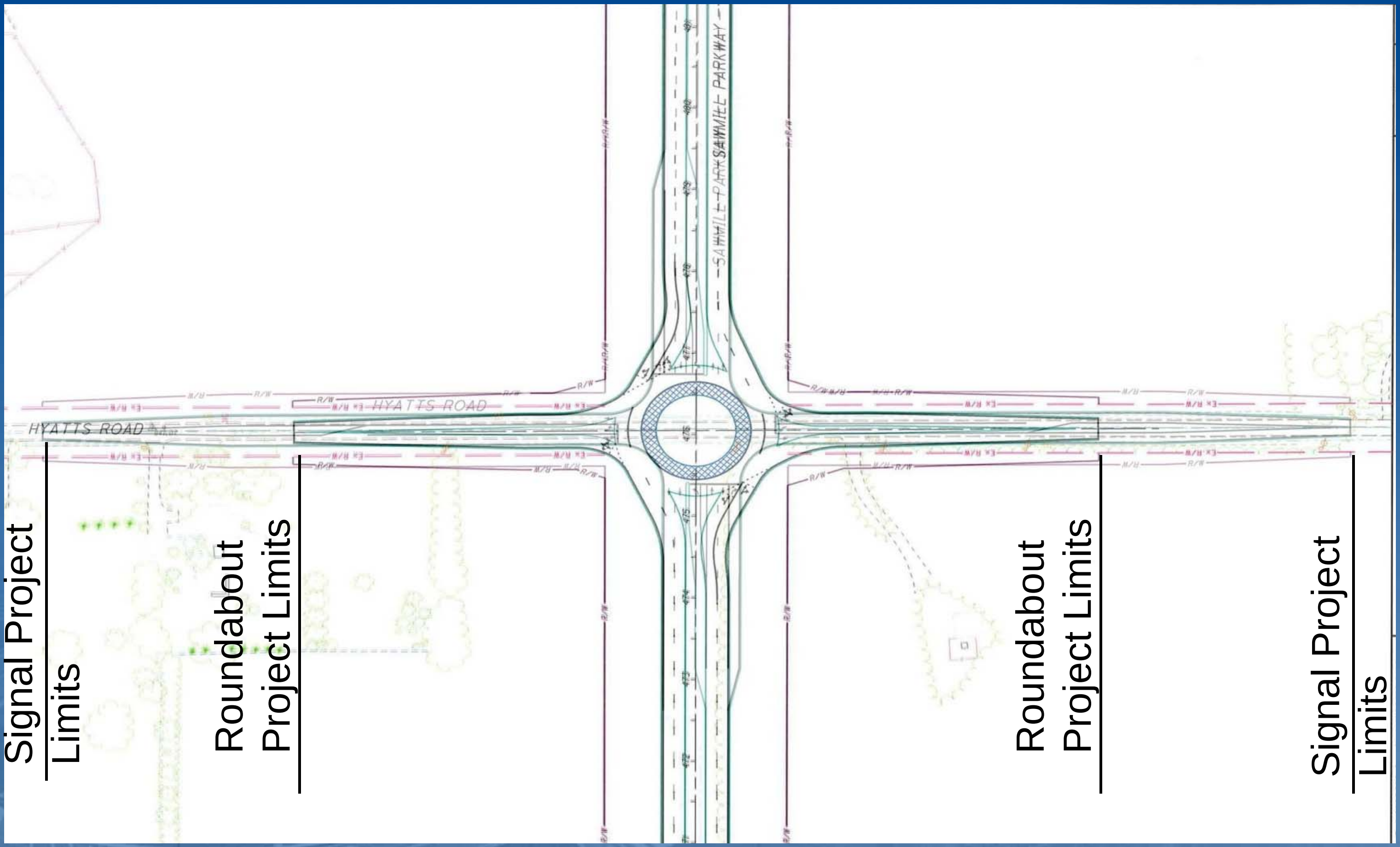
Type of Roundabout	Sites	Percent Change		
		Total	Injury	PDO
Single-Lane	8	-51%	-73%	-32%
Multi-Lane	3	-29%	-31%	-10%
Total	11	-37%	-51	-29%

Source: Jacquemart, G. *Synthesis of Highway Practice 264:* Modern Roundabout Practice in the United States. National Cooperative Highway Research Program. Washington, D.C.: National Academy Press, 1998.

Construction Cost

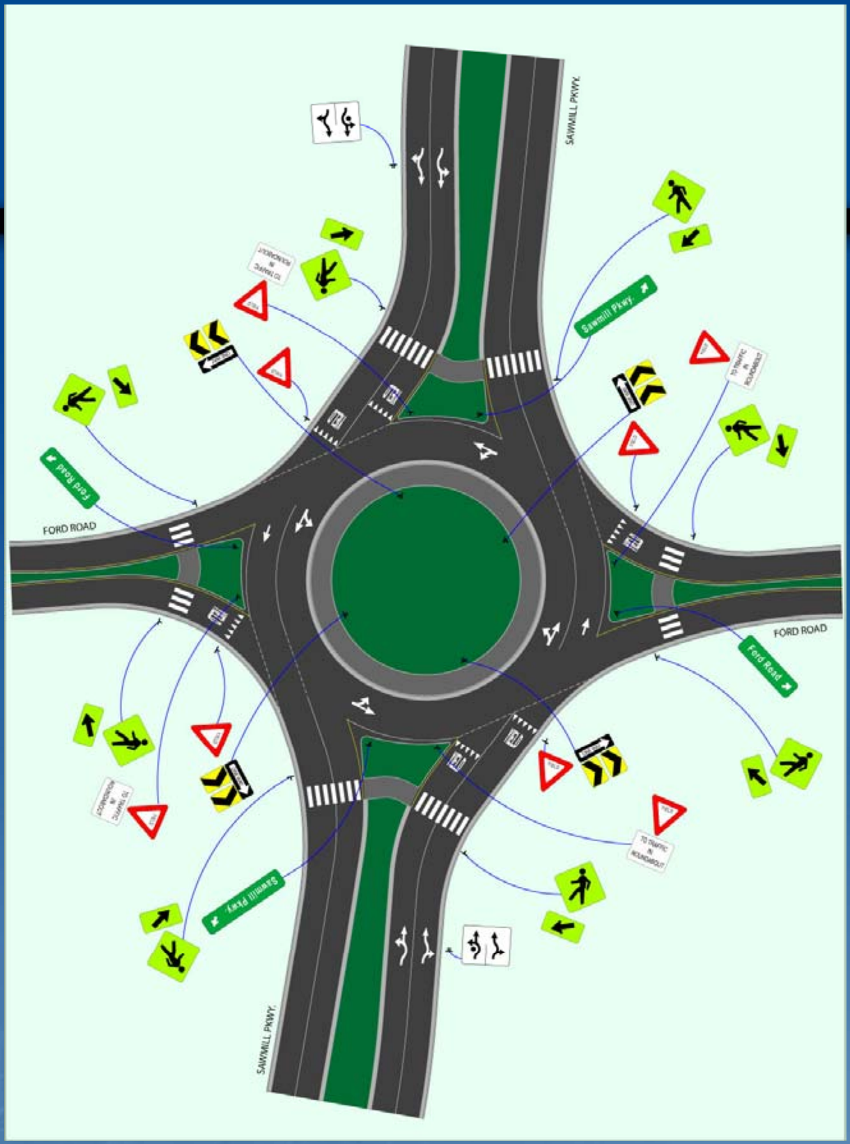


Right-of-Way Comparison



Issues

- Trucks
- Farm Equipment
- Unfamiliarity
- City/ODOT preference for signal at U.S. 42



Triangle Project - Hilliard, Ohio

- 2 closely spaced urban roundabouts
- Schools/pedestrians
- High traffic volumes
- 2010 planned construction

Signalized Alternative

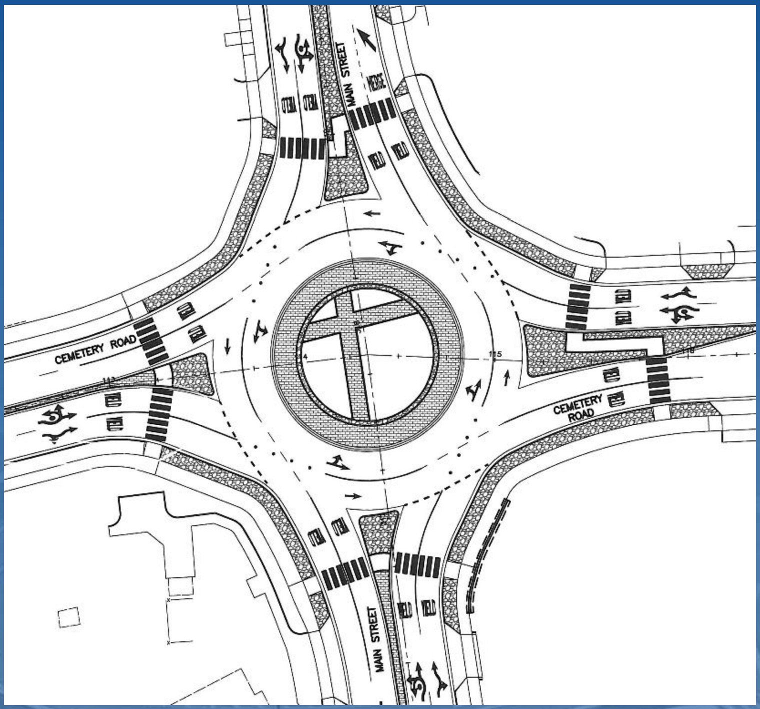
- Multiple turn lanes
- Turn restrictions
- Businesses

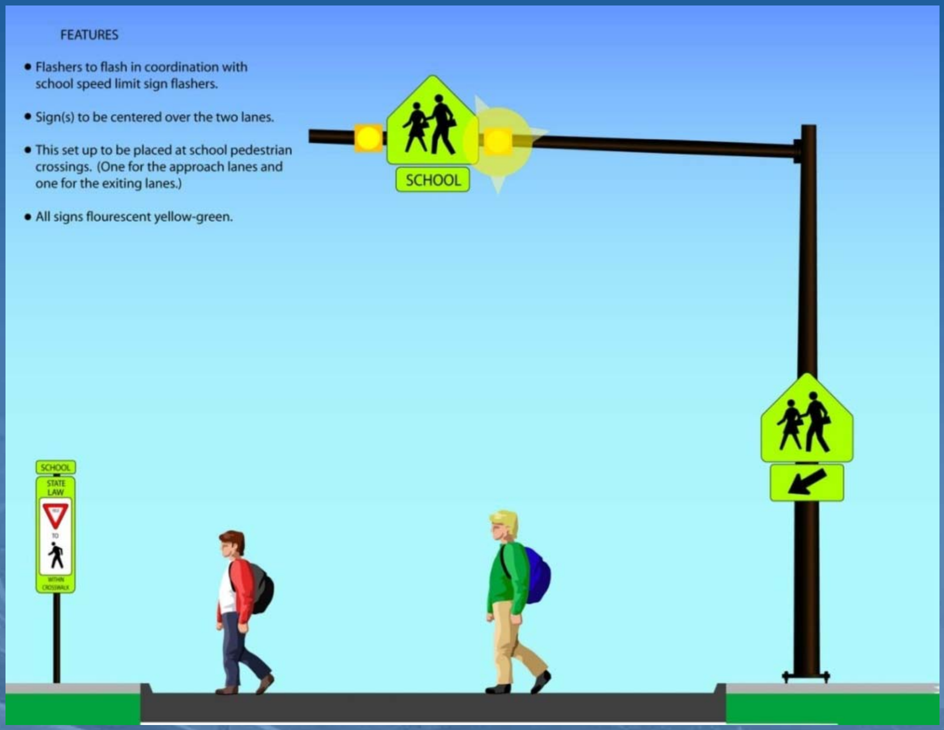
Roundabout Alternative

- All traffic movements maintained w/ good access management
- Right-of-way benefits

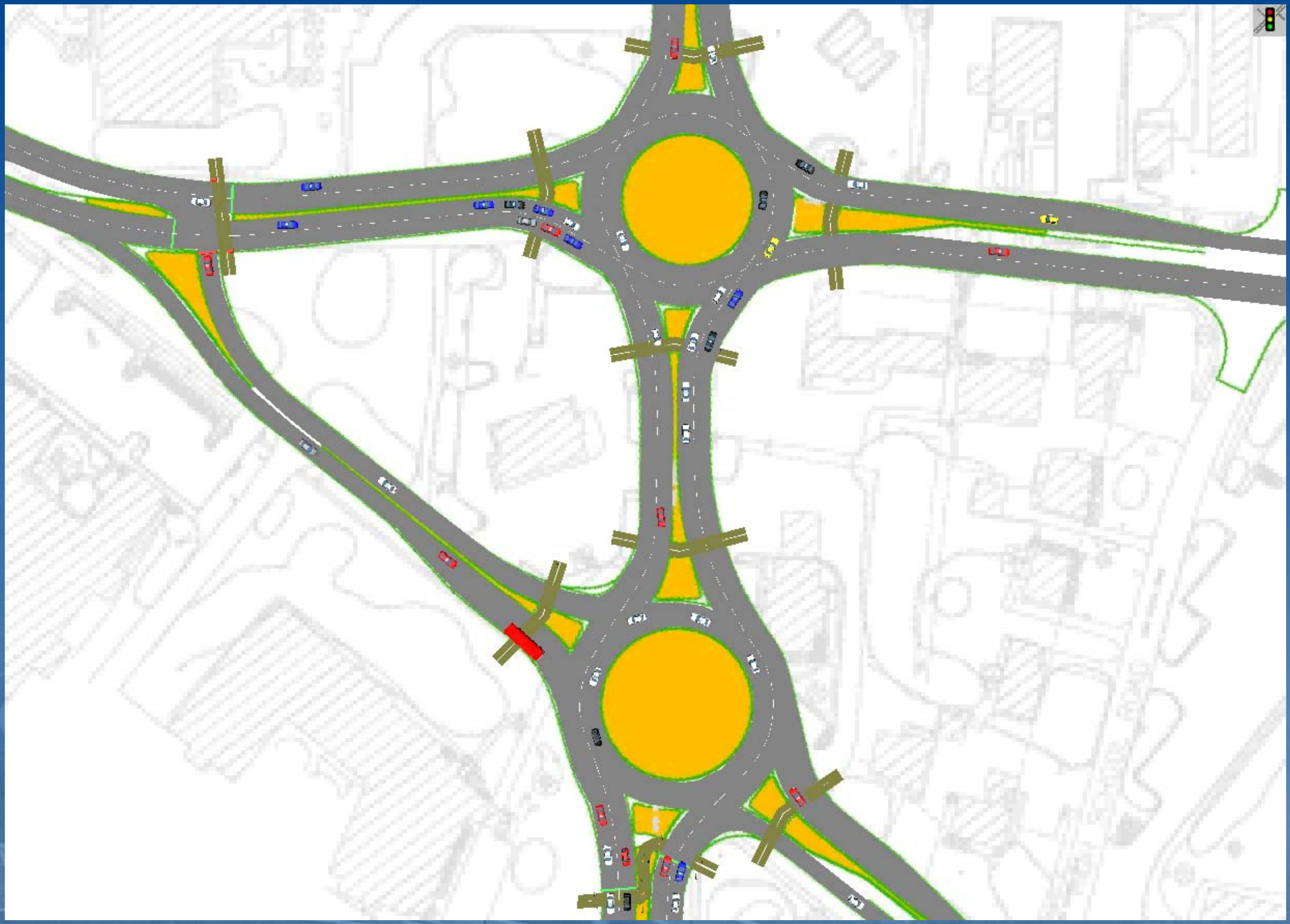
Public Concerns

- School Children
- Offset Crosswalk / Pedestrian signal?





Micro-simulation (VISSIM)

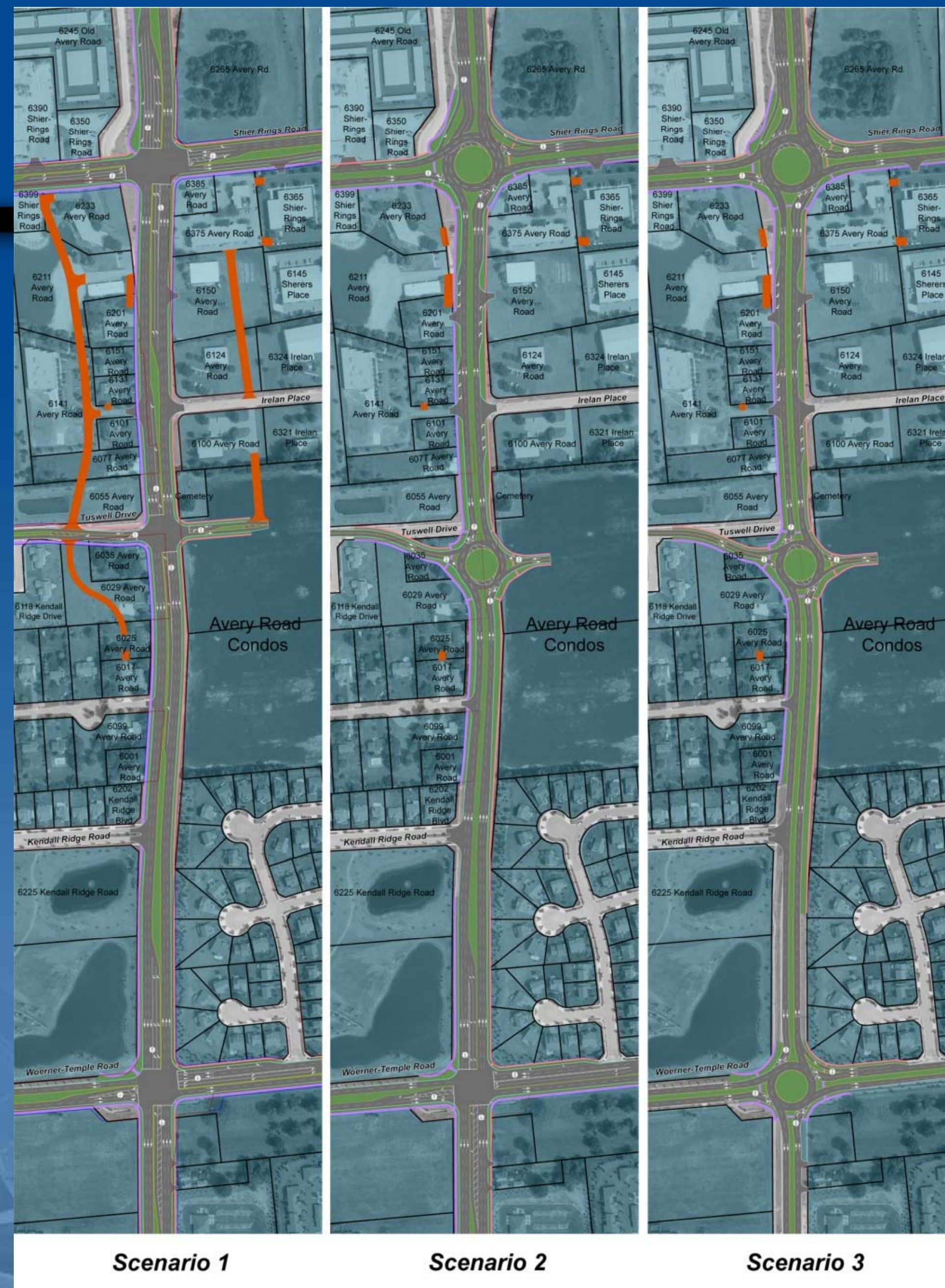


Avery Road South Corridor Study Dublin, Ohio

- 2/3 mile roadway widening for future volumes
- Redevelopment
- Access management needs

Three Scenarios Evaluated

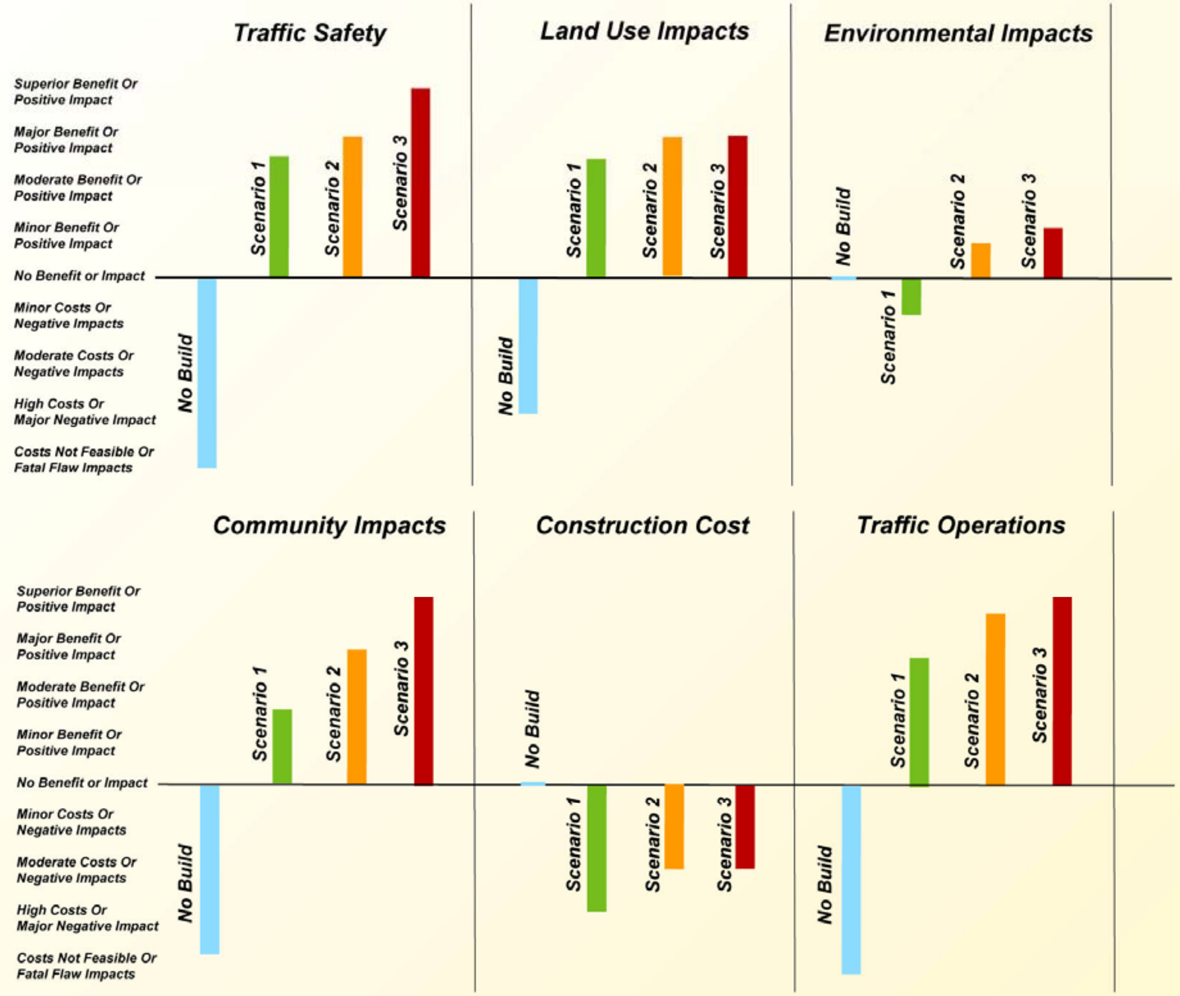
- Common Features:
  - Major intersection locations
  - Median
  - Access consolidation
- Varying Features:
  - Roundabouts and Signals
  - Service Roads



Alternate Left Turn Access

Alternate Left Turn Access

Scenarios Evaluation Sheet



BURGESS & NIPLE

10/11/2005

Issues

- Young pedestrians
- Trucks

- Middle roundabout constructed 2007

Richland Avenue

- Ohio University Campus
- Safety and Bridge Deck
- City wanted to investigate roundabout
  - Safety
  - Aesthetic Gateway
  - No “sea” of asphalt
  - Avoid bridge widening
  - Better pedestrian facility
- 2010 Construction

Traffic Operations

Signalized SR 682 / Richland

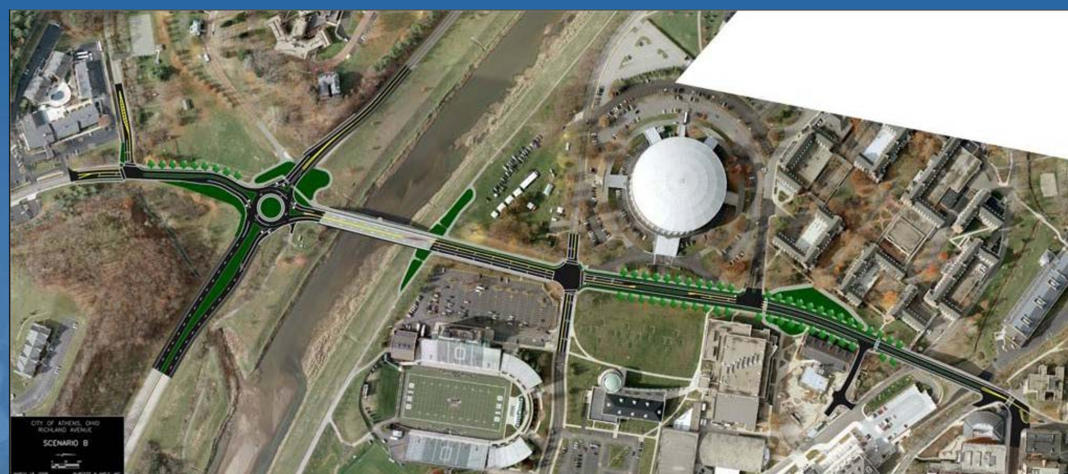
Approach	LOS and Average Vehicle Delay (sec)				Maximum Approach V/C		95th Percentile Queue Length (ft)	
	2030 AM		2030 PM		2030 AM	2030 PM	2030 AM	2030 PM
Eastbound	D	35.3	D	37.9	0.60	0.70	78	112
Westbound	C	26.0	C	32.5	0.59	0.49	168	167
Northbound	C	27.3	C	26.4	0.79	0.59	184	170
Southbound	D	35.1	C	30.8	0.89	0.90	25	277

Roundabout SR 682 / Richland

Approach	LOS and Average Vehicle Delay (sec)				Maximum Approach V/C		95th Percentile Queue Length (ft)	
	2030 AM		2030 PM		2030 AM	2030 PM	2030 AM	2030 PM
Eastbound	B	12.8	C	22.4	0.178	0.659	29	146
Westbound	B	18.8	B	15.4	0.696	0.409	182	79
Northbound	A	4.9	C	23.6	0.307	0.744	66	307
Southbound	B	10.3	B	18.6	0.178	0.850	39	471

Public Meetings

- Side-by-side exhibits with VISSIM simulation
- Matrix evaluation
- Educational materials



Evaluation Matrix

Alternatives Evaluation

Legend

\+ Meets this Criteria

++ Exceeds this Criteria

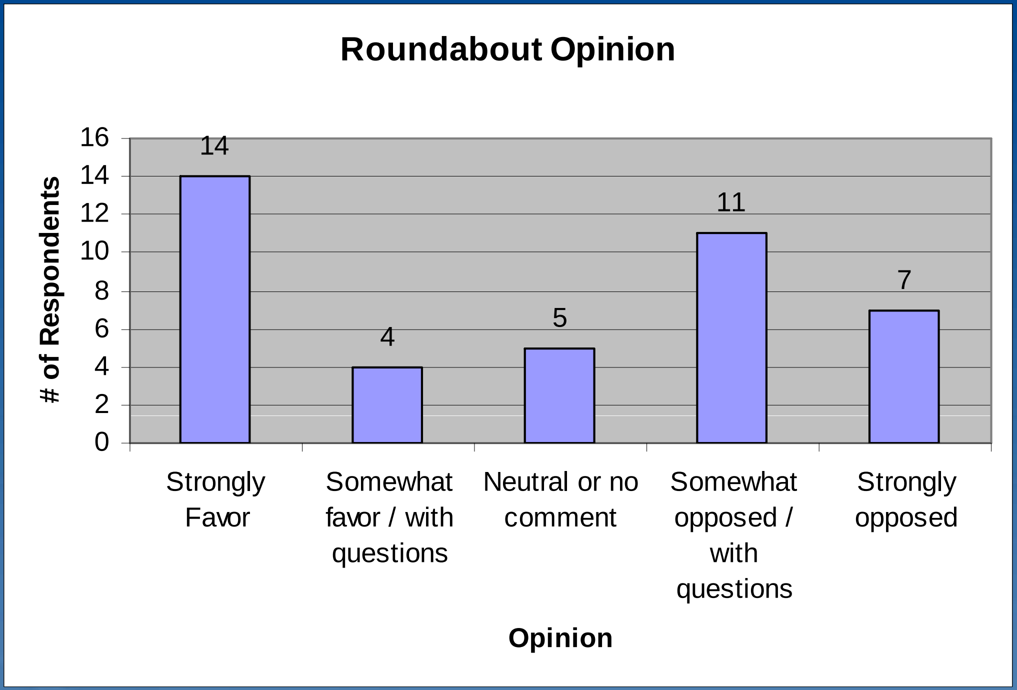
?+ Likely meets this Criteria - further information needed.

? May not meet Criteria

Evaluation Criteria	Alternative 1 with Bridge Option 1	Alternative 1 with Bridge Option 2	Alternative 2
1. Improve safety at the intersection of Richland Avenue and SR 682 by eliminating geometric and other design deficiencies and reducing congestion related crashes (Need Element).	+	+	++
2. Provide for acceptable side street traffic operations at Dairy Lane / Richland Avenue intersection (Need Element).	+	+	?-
3. Improve deck and perform other needed maintenance items for Richland Avenue Bridge over the Hocking River (Need Element).	+	+	+
4. The project should safely accommodate pedestrians & bicycle traffic through the intersection of SR 682 and Richland Avenue and through the project area, providing connections to existing and future locally planned improvements in the corridor (Project Goal and Objective from P&N).	+	++	+-
5. Include excellent urban aesthetic design elements where feasible in the corridor.	+	+	+-
6. Limit project costs to the available ODOT funding; 20% City matching funds, and contributions from Ohio University.	?	?	?+
7. Avoid negative environmental impacts, especially in the parkland and the Hocking River.	?	?	?+
8. Reduce vehicular speeds on SR 682 and Richland Avenue while not significantly reducing capacity.	+	+	+
9. Adequately accommodate and enhance public transit service.	+	+	+
10. Support special event traffic (vehicles and pedestrians).	+	++	+?
11. Maintain Richland Avenue as a critical fire response route both during and after construction.	+	+	+
12. Maintain service road to Ohio University Golf Course.	+	+	+

Public Feedback

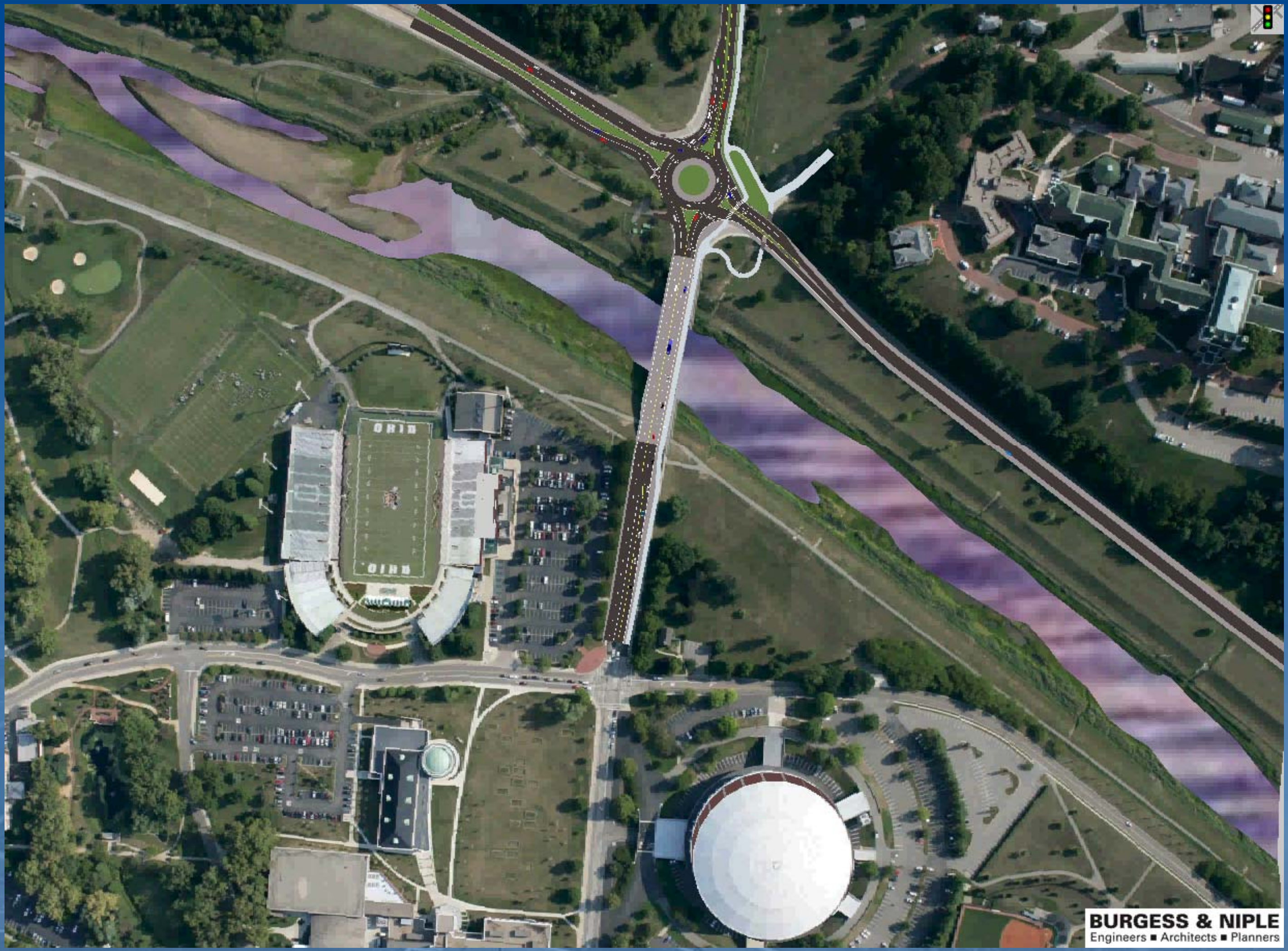
- People liked:
  - Slower traffic
  - Traffic safety
  - Pedestrian / bike safety
  - Efficiency/capacity
  - Aesthetics - Gateway
  - Less fuel consumption
- Concerns:
  - Confusing for locals at first
  - Confusing to elderly, visitors, freshmen
  - Pedestrian / bike safety
  - Efficiency/capacity
  - Education
  - Crossing at grade for blind



Issues / Considerations

- Bridge is very close to intersection
  - Could not meet all preferred design criteria (but are close)
- Steady volume of pedestrians (college students)
  - Dual crossing system – tunnel and at-grade
  - Pedestrians forced to one side (because of bridge)
- Special Events

VISSIM Model



Summary

- Roundabouts are a great solution for a wide variety of locations
- There are some critical design features
- Be brave!
- But be careful!

Questions & Comments

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