2014 Design Training Expo

Source of Images: Isebrands, Google Earth, Isebrands

Modern Roundabouts: A Safe & Robust Intersection Alternative

Lake Buena Vista, FL ▪ June 11, 2014

FDOT Florida Department of TRANSPORTATION

U.S. Department of Transportation Federal Highway Administration

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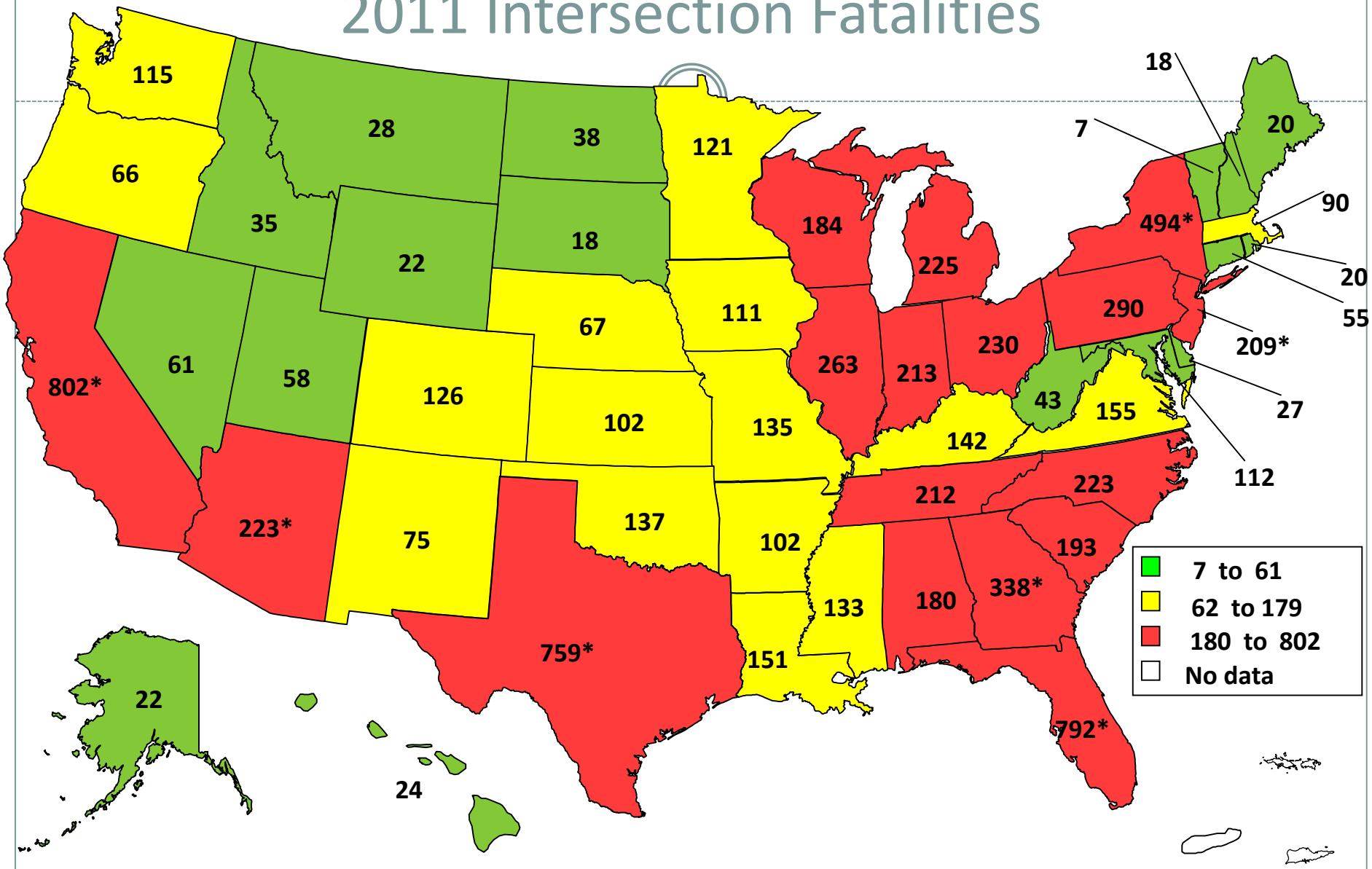
FHWA Resource Center, Safety & Design Technical Service Team ▪ Lakewood, CO

Topics for Discussion

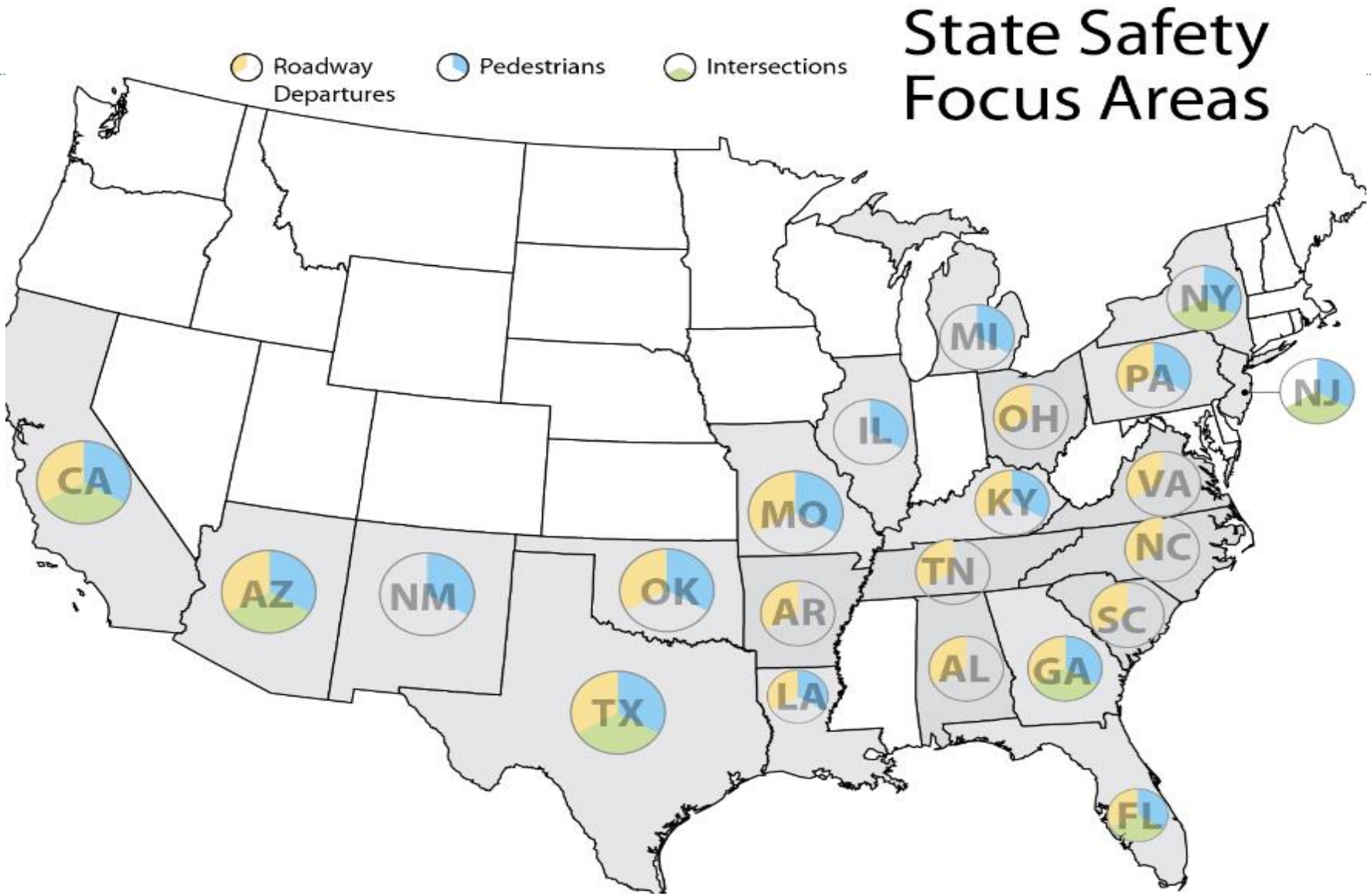
- Intersection Safety Facts
- Roundabout Guidance and Policy
- Roundabout Safety Facts
- Design and Operational Guidance
- Examples
- Summary
- Questions/Discussion

Photo Source: Isebrands

2011 Intersection Fatalities



FHWA Focused Approach to Safety



FHWA Pedestrian Safety Focus States and Cities

Intersection Safety Facts

- About half of all severe crashes occur at intersections
- Angle crashes account for over 40% of fatal crashes at intersections
- Left turn crashes account for over 20% of fatal crashes at intersections
- Ped/Bike crashes account for 25% of fatal crashes at signalized intersections

Source Isebrands, FHWA

Key Areas for Improving Intersection Safety

- Increase awareness of intersections
- Increase visibility of intersections and traffic control devices
- Improve the design of intersections to reduce conflicts
- Improve driver navigation to reduce confusion
- Improve the operations of intersections
- Improve sight distance at intersections
- Improve driver compliance with traffic control devices

FHWA Proven Safety Countermeasures

Roundabouts

Corridor Access Management

Backplates with Retroreflective Borders

Longitudinal Rumble Strips and Stripes on Two-Lane Roads

Enhanced Delineation and Friction for Horizontal Curves

Safety Edge$_{SM}$

Medians and Pedestrian Crossing Islands in Urban and Suburban Areas

Pedestrian Hybrid Beacon

Road Diet

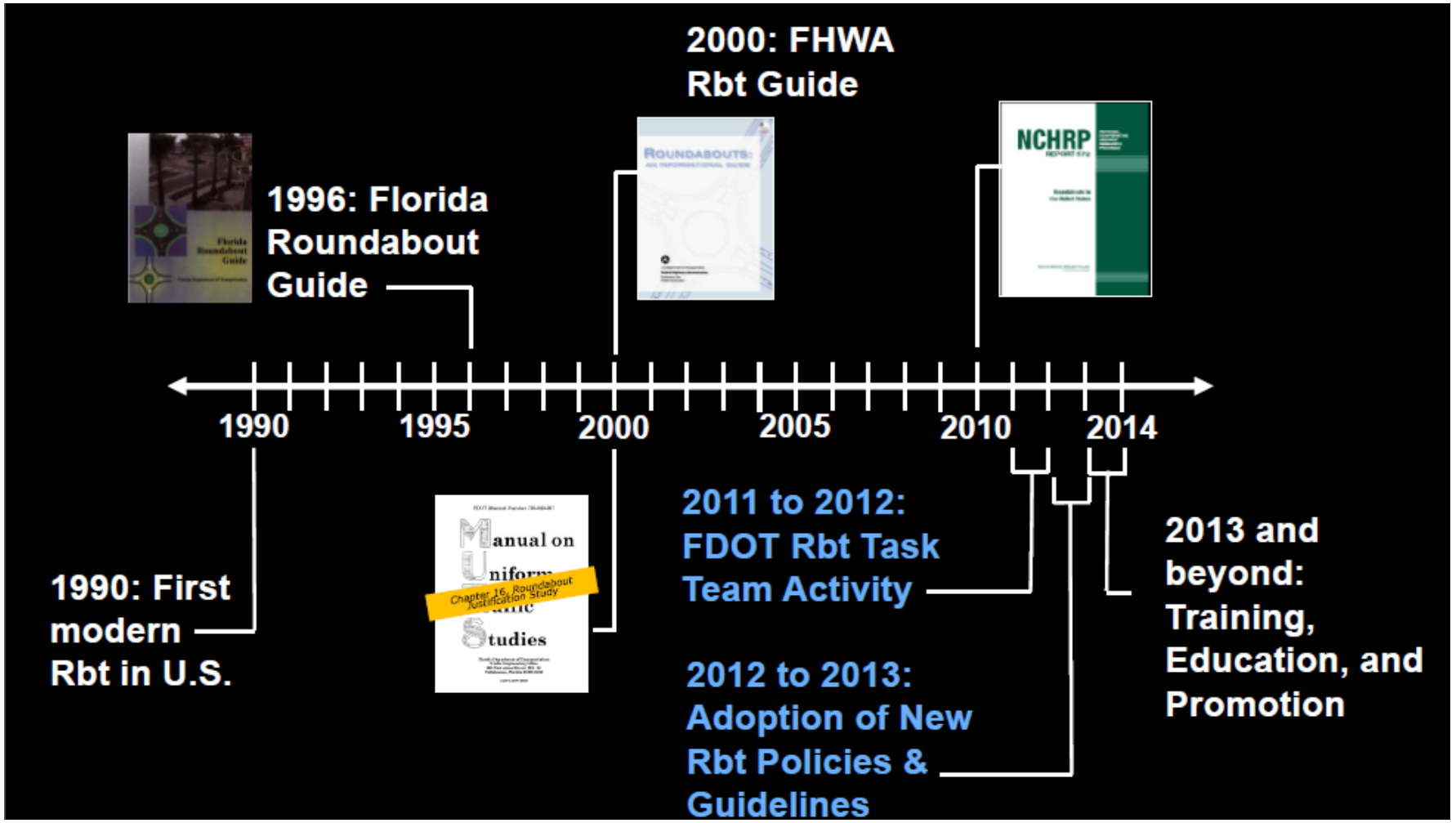
FHWA Roundabout Guidance

Roundabouts are the preferred safety alternative for a wide range of intersections. Although they may not be appropriate in all circumstances, they should be considered as an alternative for all proposed new intersections on Federally-funded highway projects, particularly those with major road volumes less than 90 percent of the total entering volume. Roundabouts should also be considered for all existing intersections that have been identified as needing major safety or operational improvements. This would include freeway interchange ramp terminals and rural intersections. (2008 Memo, FHWA Office of Safety)

Why Support Roundabout Implementation?

- Safety
  - Reduction in speeds for ALL vehicles (15-25 mph)
  - Less severe crashes (significantly reduces occurrence of angle crashes caused by running a stop sign or a red light)
- Operations
  - Reduction in delays (Less time at the intersection 24hrs/day)
  - Suitable for traffic volumes over 60,000 vehicles/day
- Environment
  - Potential reduction in emissions (starts and stops, idling)
  - Less pavement, more green space on approaches
    - Opportunities for landscaping in the center island
    - Wide nodes and narrow roads (keep corridors narrow and no left turn lanes)

Florida Roundabout Timeline



Source: Bansen & Sullivan

FDOT Roundabout Design Guidance

- Adopted by FDOT as the current roundabout design guidance document
- Vetted by FDOT Roundabout Task Team
- Supplemented in Florida by:
  - *FDOT Plans Preparation Manual*
  - *FDOT Intersection Design Guide*
  - *Florida Greenbook*
  - *Project Development & Environmental Manual*

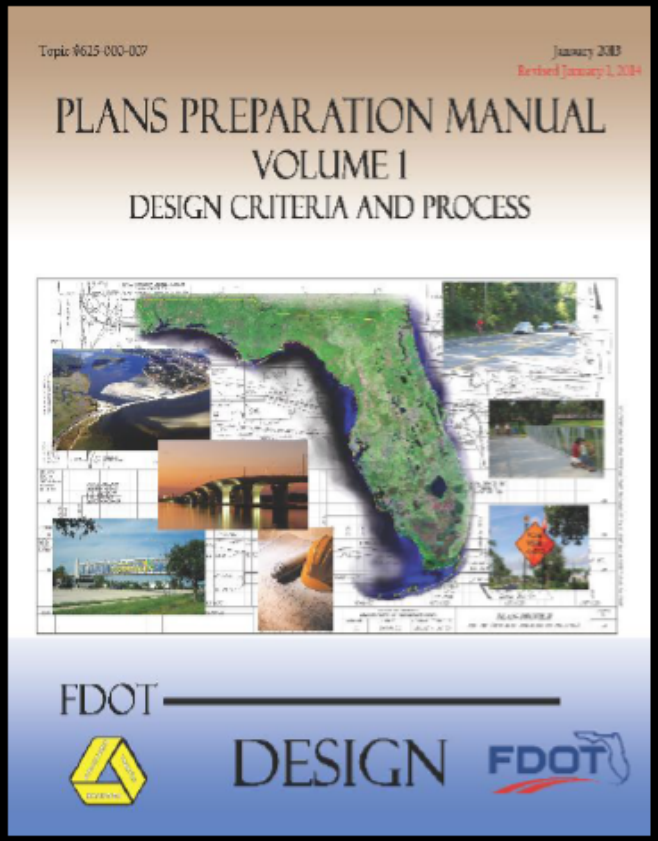
Source: Bansen & Sullivan

FDOT Roundabout Policy

- Plans Preparation Manual, Volume 1, Chapter 2

  Section 2.13 - Intersections

  *"Roundabouts **shall** be evaluated on new construction, reconstruction and safety improvement projects, as well as anytime there are proposed changes in intersection control that will be more restrictive than the existing conditions."*



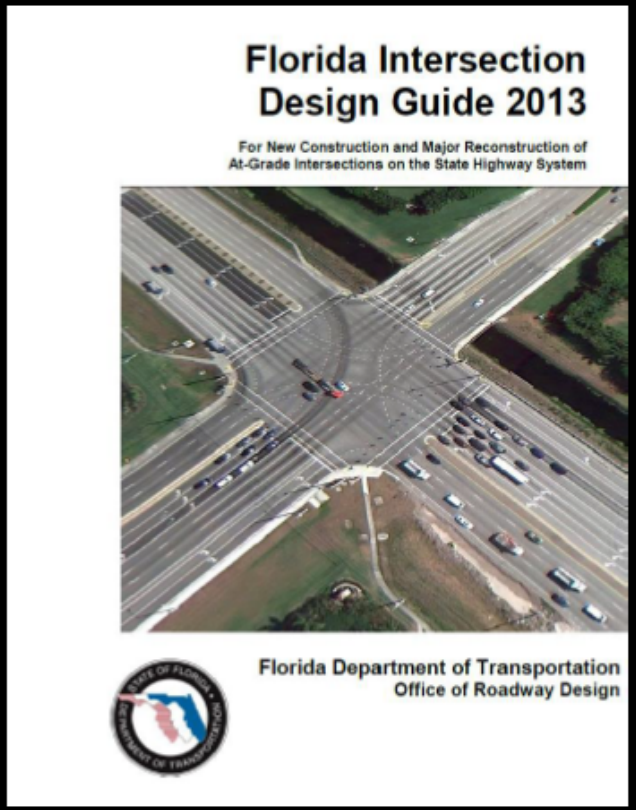
Source: Bansen & Sullivan

FDOT Roundabout Policy

- Florida Intersection Design Guide (2013 Edition)

  Section 2.2.3 – Traffic Control Modes

  "Due to substantial safety characteristics, and potentially significant operational and capacity advantages, the modern Roundabout is a preferred traffic control mode for any new road or reconstruction project. Roundabouts should be considered as an alternative to all the other traffic control modes…"



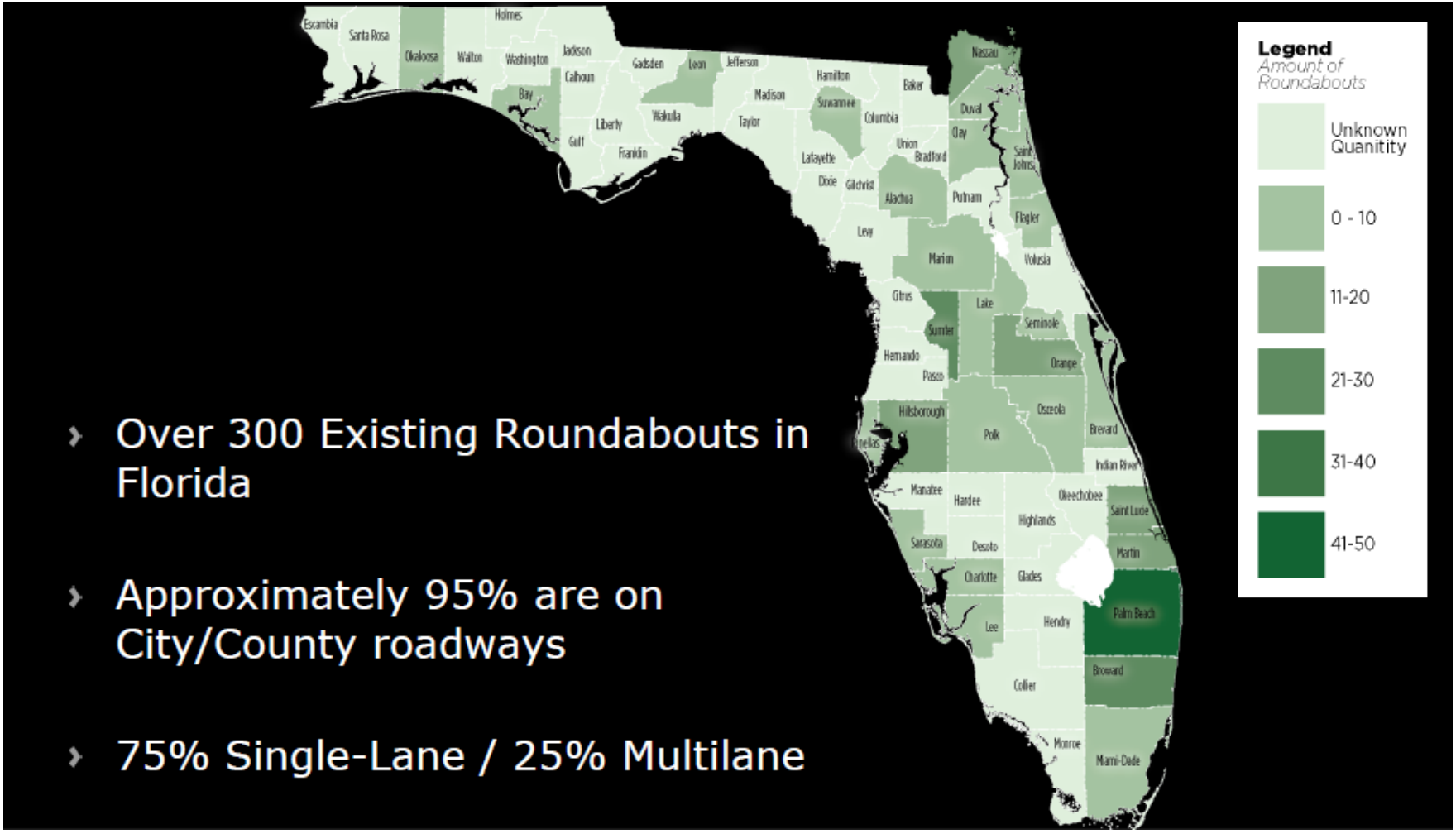
Source: Bansen & Sullivan

FDOT Roundabout Policy

- Roundabout Screening now conducted for:
  - *Any New Construction*
  - *Reconstruction*
  - *Isolated Intersection Improvements*
    - Operational Improvements
    - Safety Improvements
  - *New Interchanges or Interchange Modifications*
  - *PD&E Studies*
  - *Complete Streets Projects*
  - *Etc.*

Source: Bansen & Sullivan

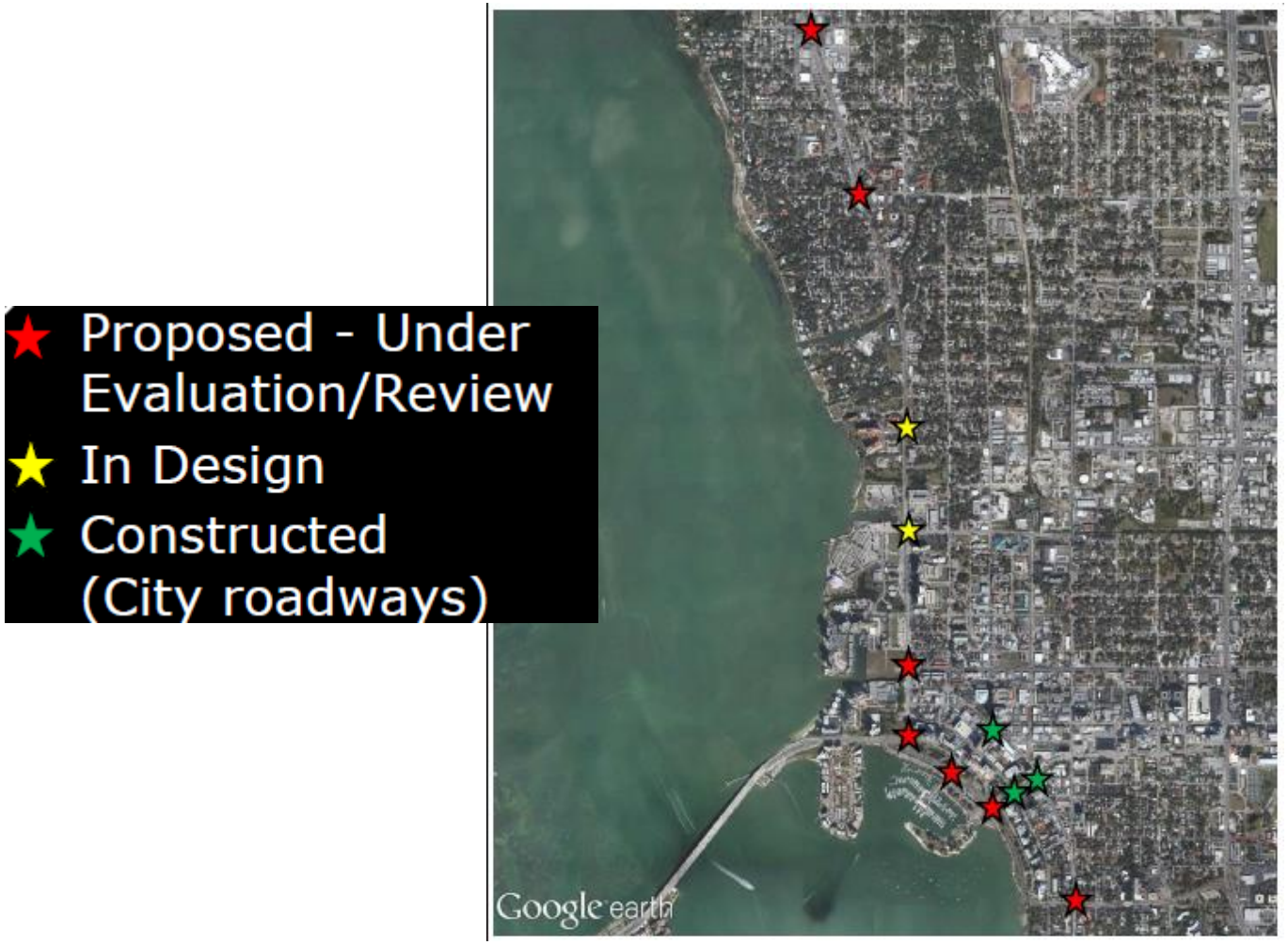
Current FL Roundabout Implementation



- Over 300 Existing Roundabouts in Florida
- Approximately 95% are on City/County roadways
- 75% Single-Lane / 25% Multilane

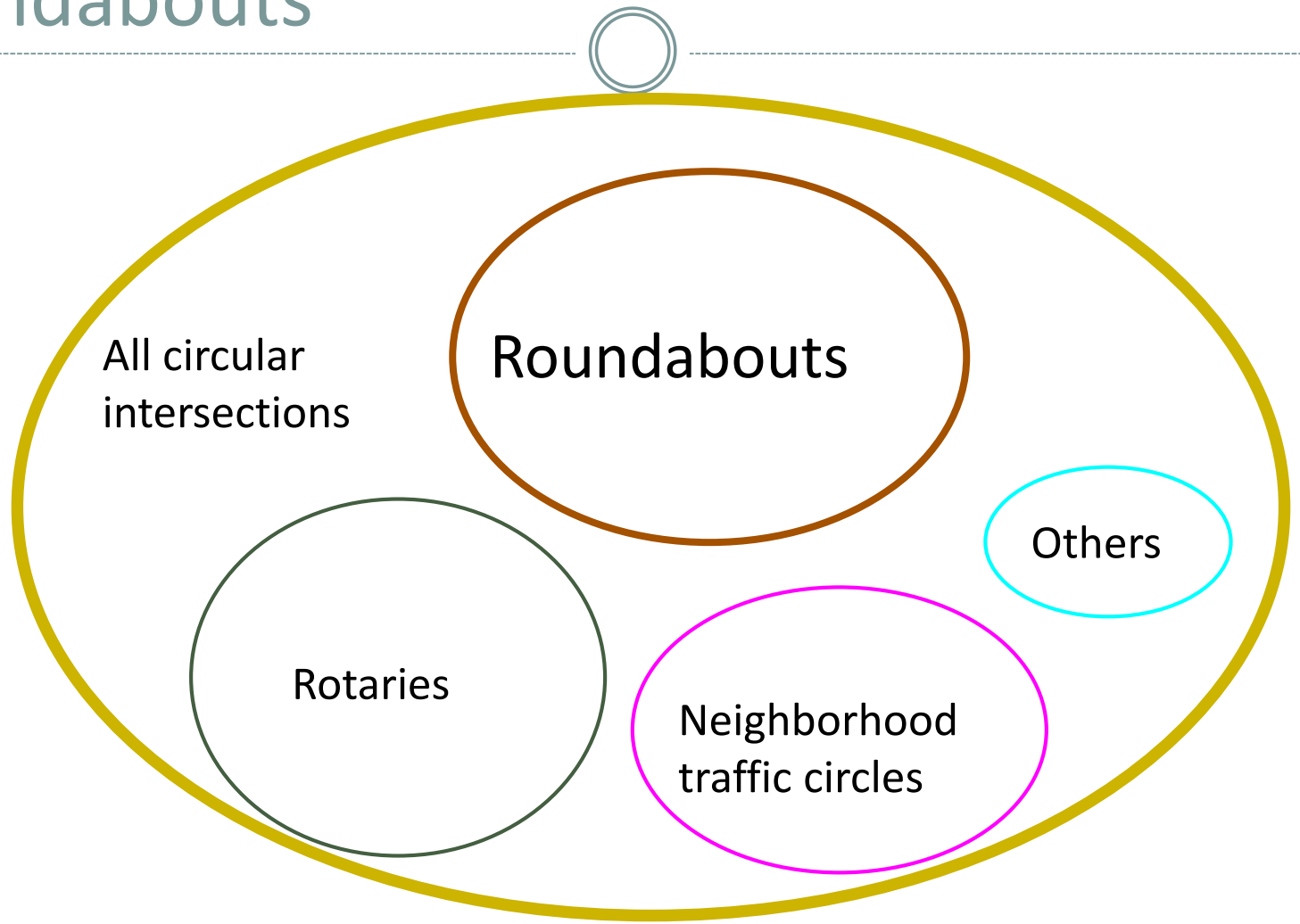
Source: Bansen & Sullivan

US 41 in Sarasota



Source: Bansen & Sullivan

Not All Circular Intersections Are Roundabouts



Traffic Circle to Roundabout Retrofit

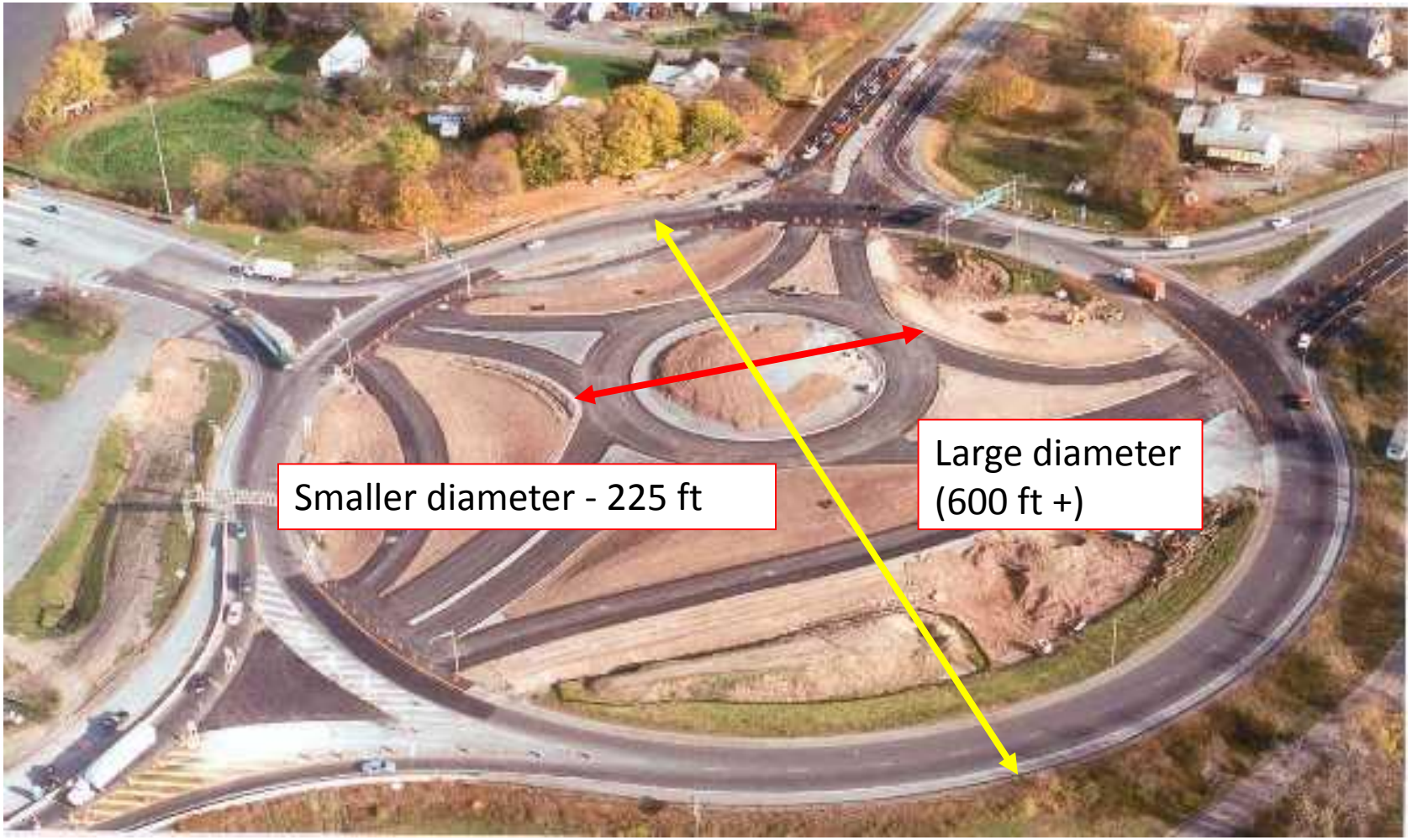
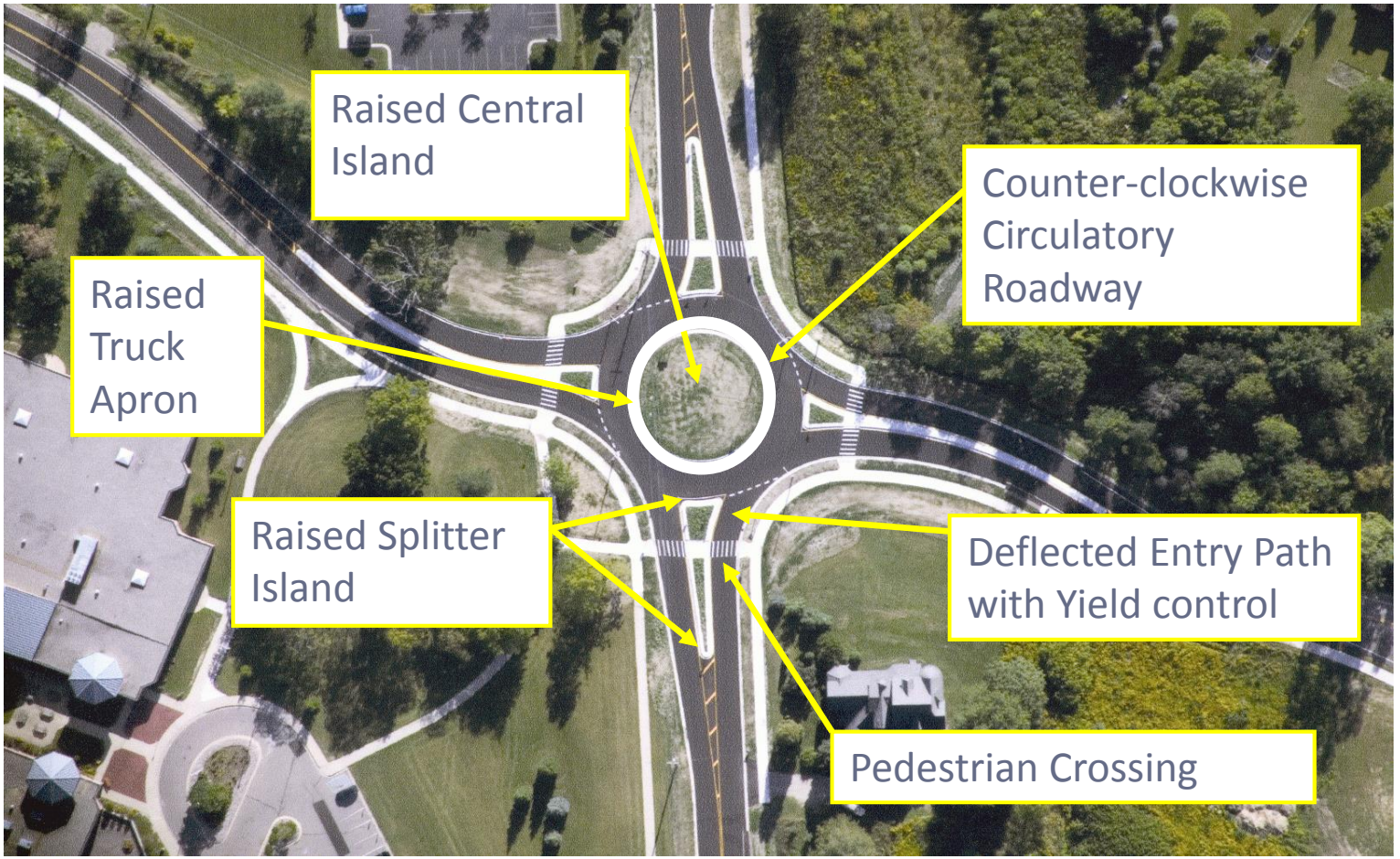


Photo Source: NYSDOT

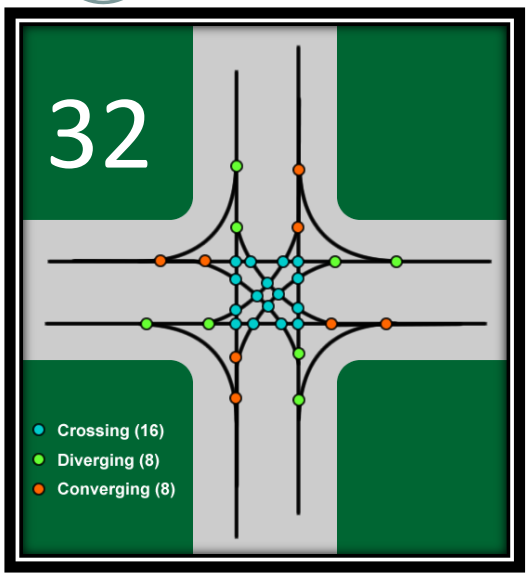
Traffic Circle to Roundabout Retrofit

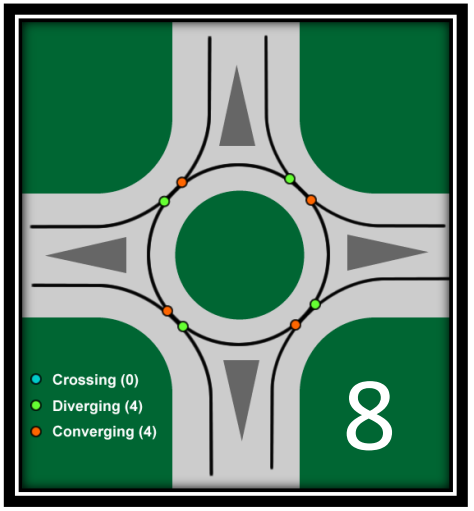
Physical Features of a Modern Roundabout



Roundabout Safety Experience

- Fatal and injury crashes reduced significantly
- The number of conflict points is ¼ of traditional intersection
- Changes in the types of crashes
- Slow speeds for all vehicles





Roundabout Safety Experience

- 35% Reduction in All Crashes
- 76% Reduction in Injury/Fatal Crashes
- 89% Reduction in Injury/Fatal Crashes in Rural Environments

Florence, KS
Photo credits: Isebrands

Source: NCHRP 572 (2007); Isebrands TRR 2096, 2009; Isebrands Dissertation 2011

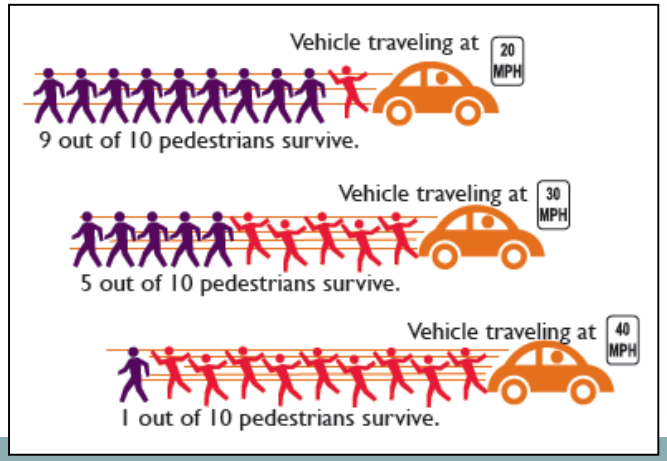
AASHTO Highway Safety Manual

Table 14-4. Potential Crash Effects of Converting a Stop-Controlled Intersections into a Modern Roundabout (29)

Setting (Intersection Type)	Traffic Volume	Crash Type (Severity)	CMF	Std. Error
All settings (One or two lanes)		All types (All severities)	**0.56**	**0.05**
		All types (Injury)	**0.18**	**0.04**
Rural (One lane)		All types (All severities)	**0.29**	**0.04**
		All types (Injury)	**0.13**	**0.04**

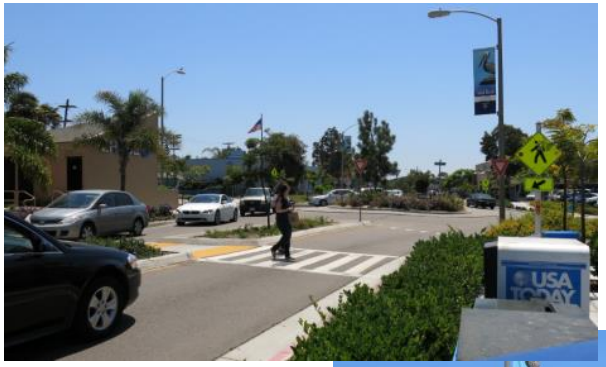
Pedestrians Roundabout Experience

- Low speeds (15-25mph)
- Fewer conflict points (16 to 8 ped-veh)
- Shorter crossing distances
- Cross only one direction of travel at a time

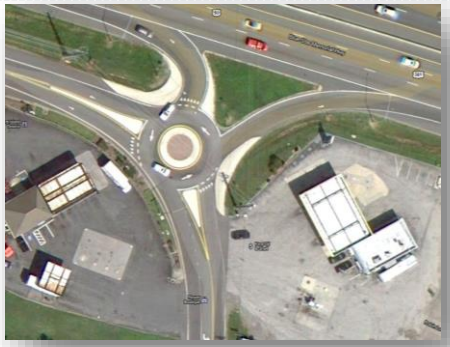


Source of Images: Seattle DOT and Asheville, NC

Designing Roundabouts



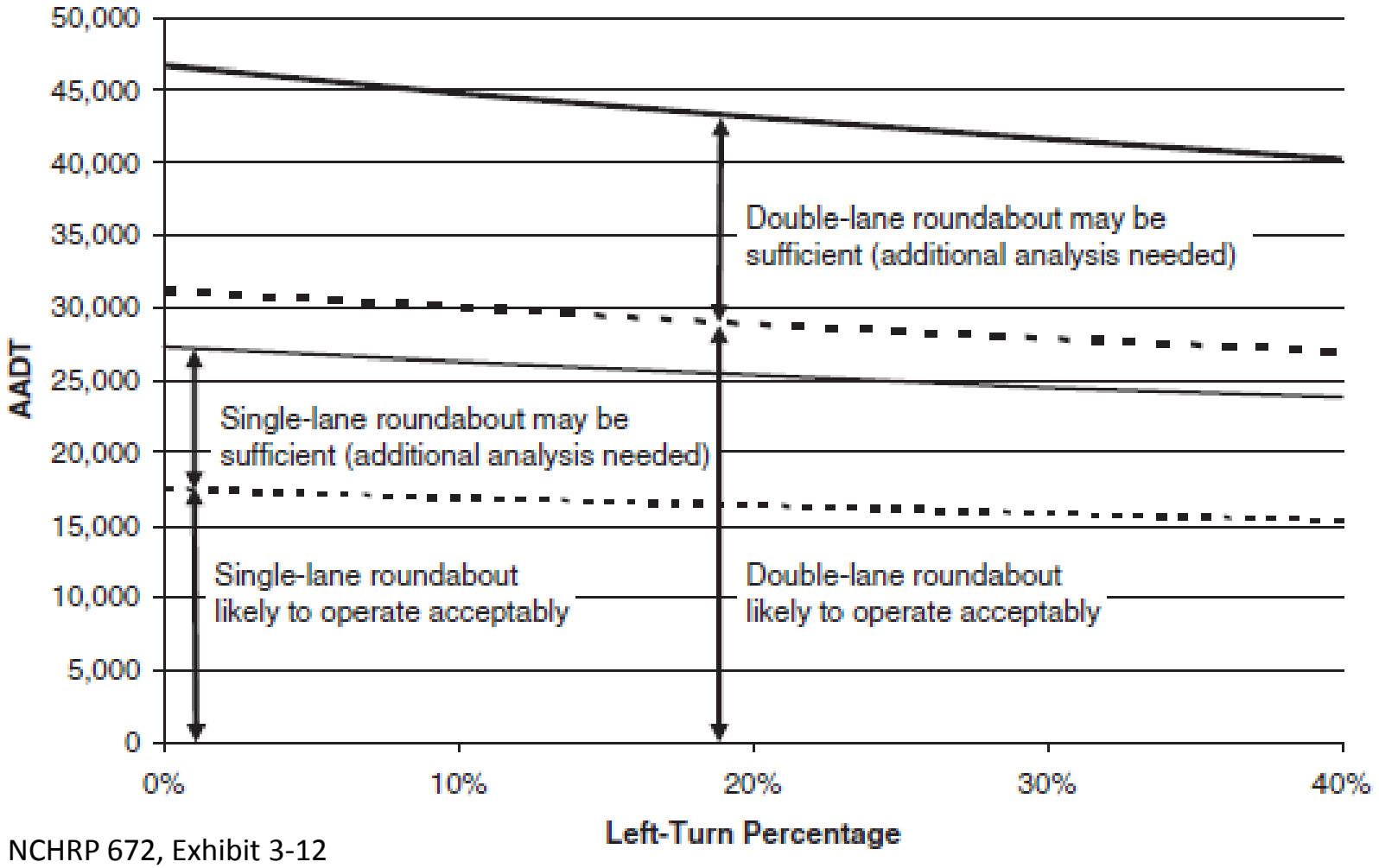
Roundabout Categories & Typical Footprint



- Mini-roundabouts
  - 45 to 90 ft diameter
  - Mountable center island
- Single-Lane Roundabouts
  - 90 to 180 ft diameter
  - Low to high approach speeds
- Multilane Roundabout
  - 150 to 300 ft diameter
  - Hybrid designs common

Source of Images: Google Earth

Planning Level Capacity - AADT



Source: NCHRP 672, Exhibit 3-12

Planning Level Capacity - VPH

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 1,300 veh/h	▪ Two-lane entry may be needed ▪ Single-lane 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: New York State Department of Transportation

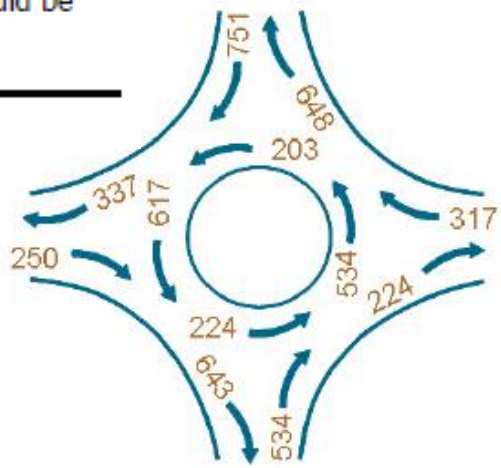
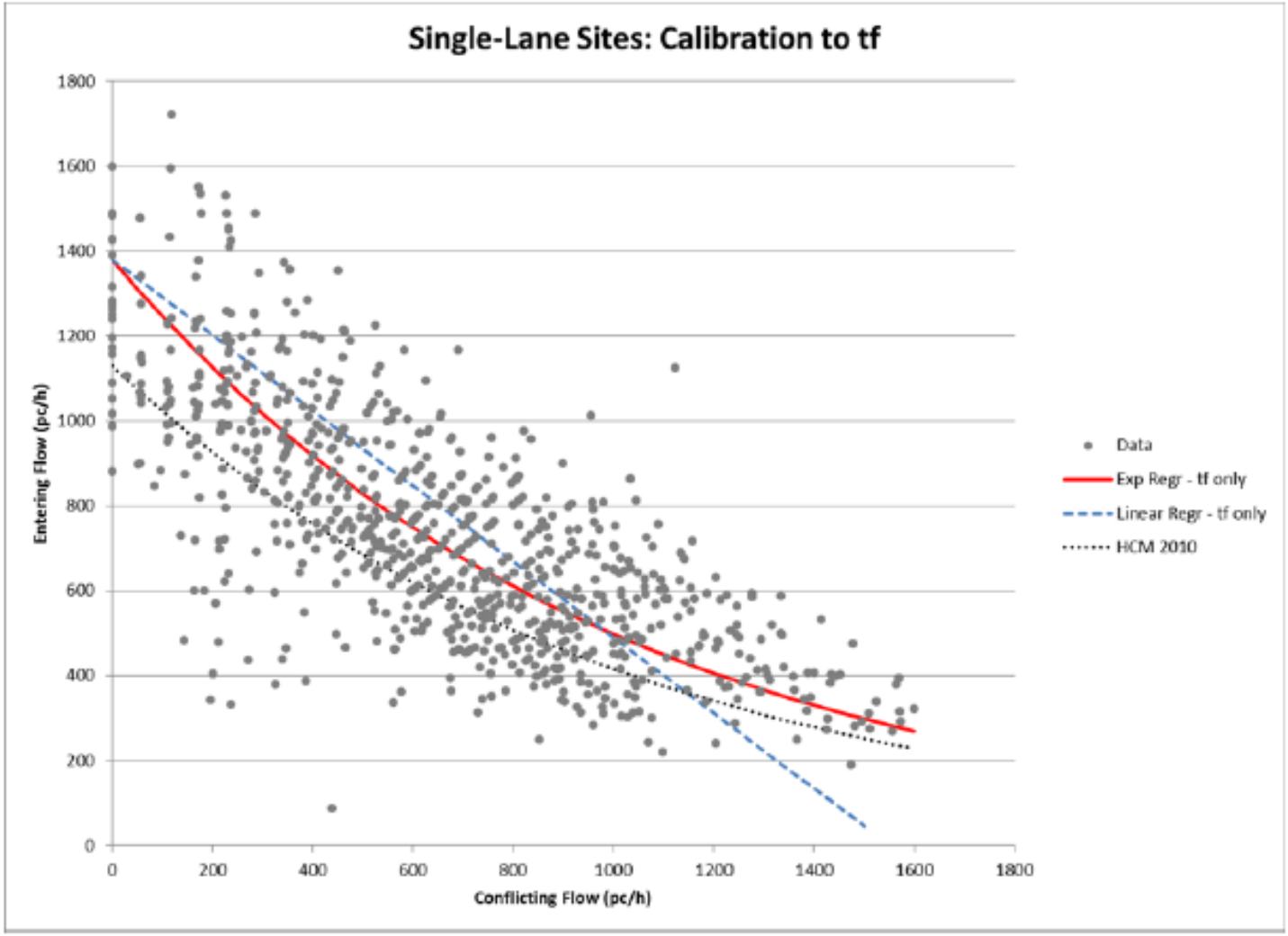


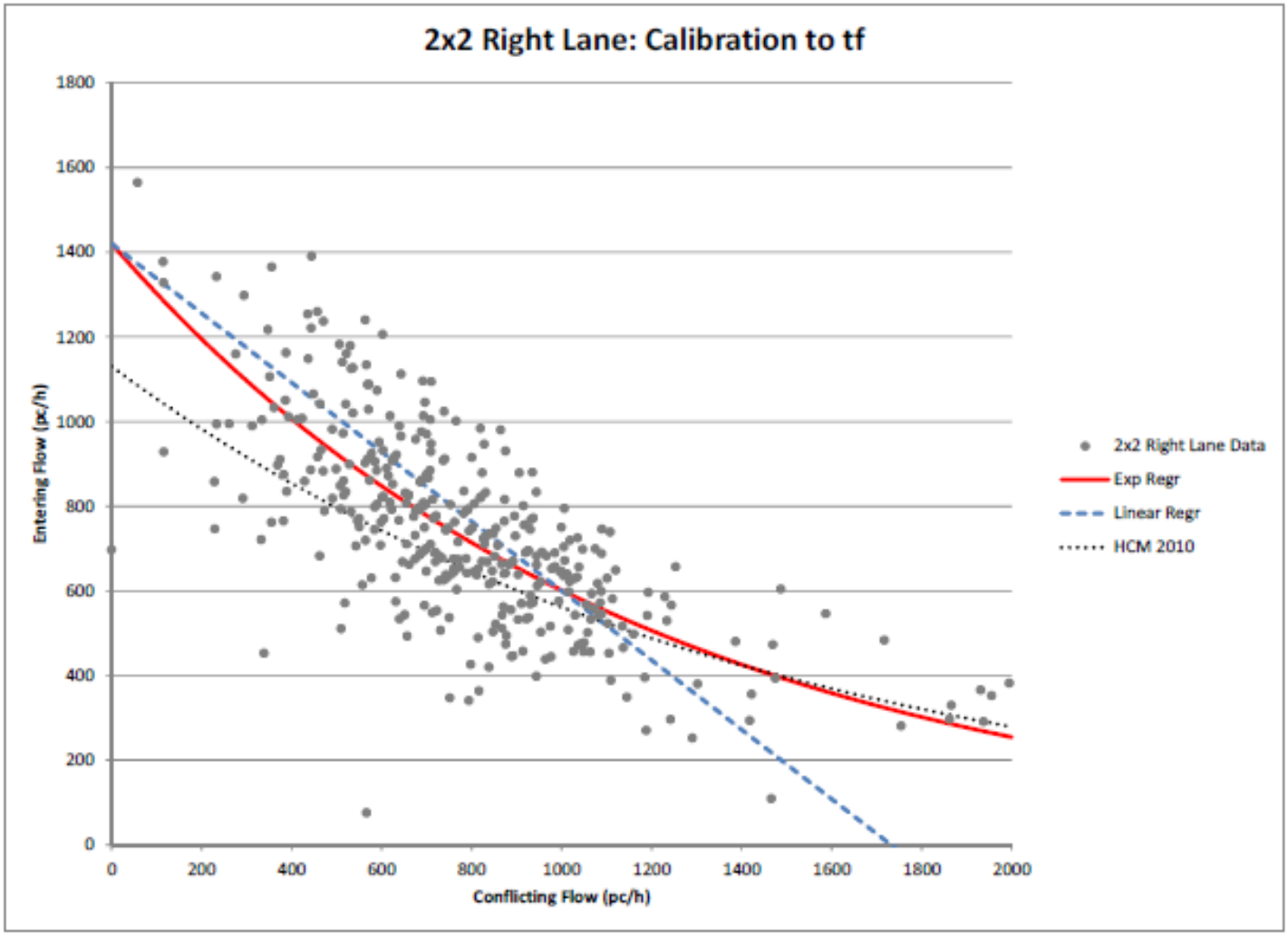
Table Source: NCHRP 672

FHWA DRAFT Calibrated Capacity Model - SLR



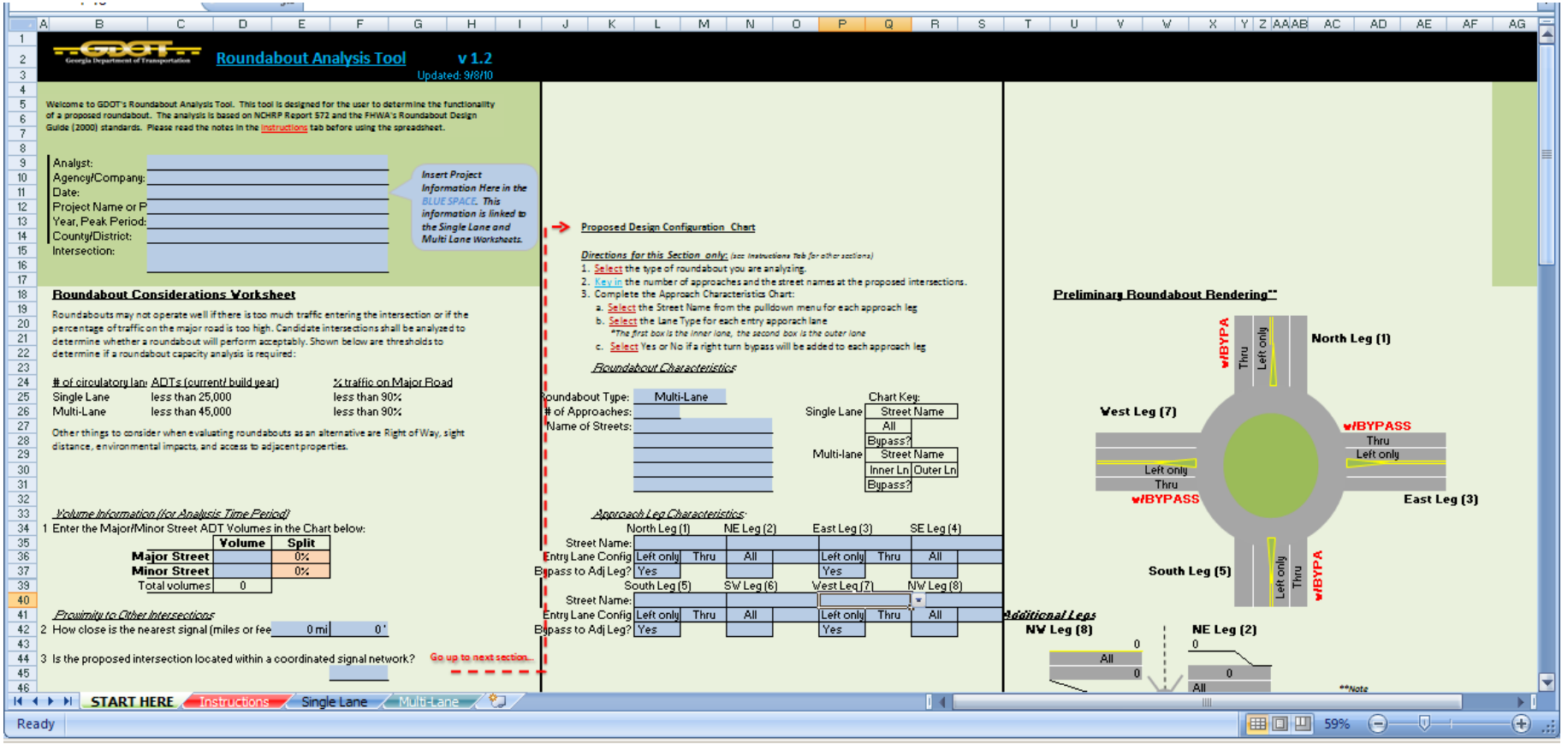
Source: FHWA

FHWA DRAFT Calibrated Capacity Model – MLR (Rt)



Source: FHWA

Georgia DOT Capacity Analysis Tool



Size, Position, Alignment

(a) Centered on Existing Intersection

(b) Center Shifted to the South

(c) Center Shifted to the East

Source: NCHRP 672, Exhibit 6-8

Fastest Path Speeds

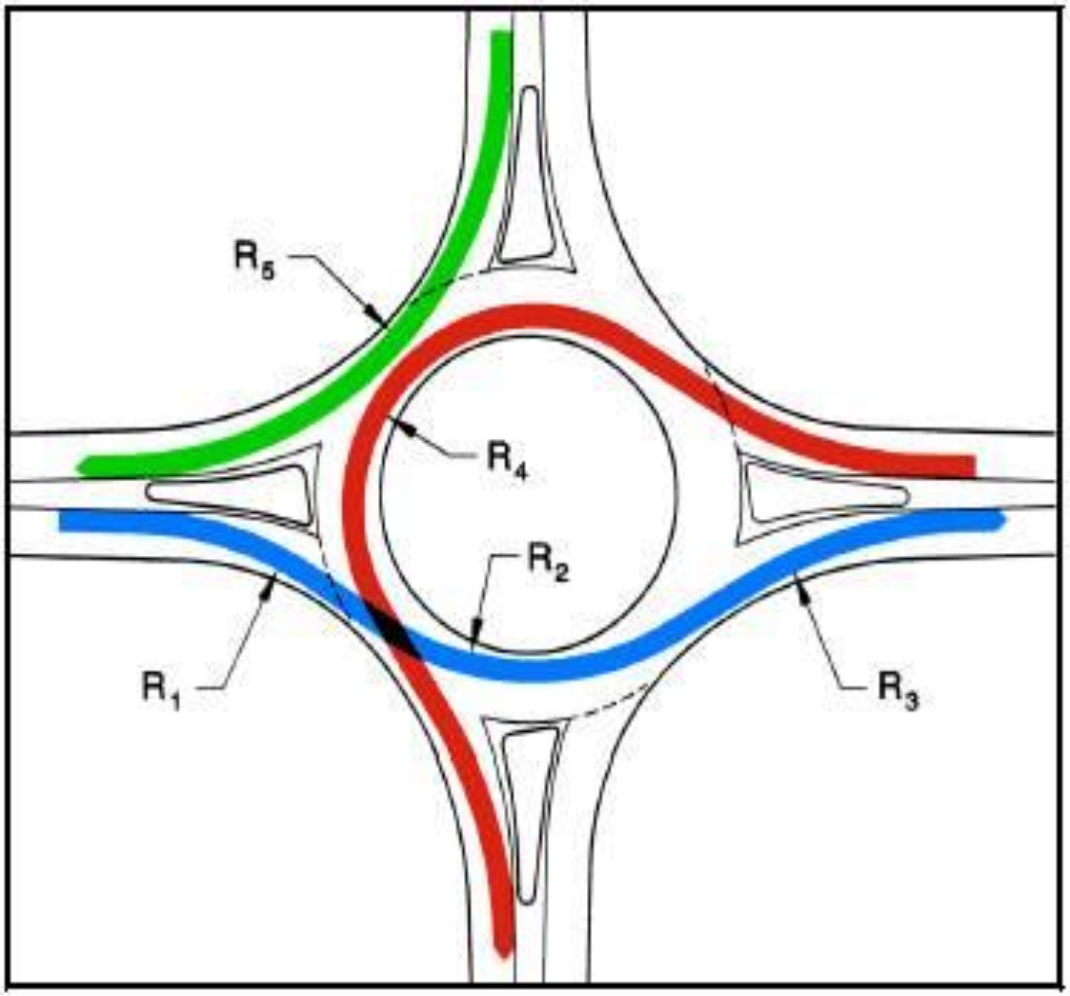
R1: entry path radius · Deflection

R2: circulating radius

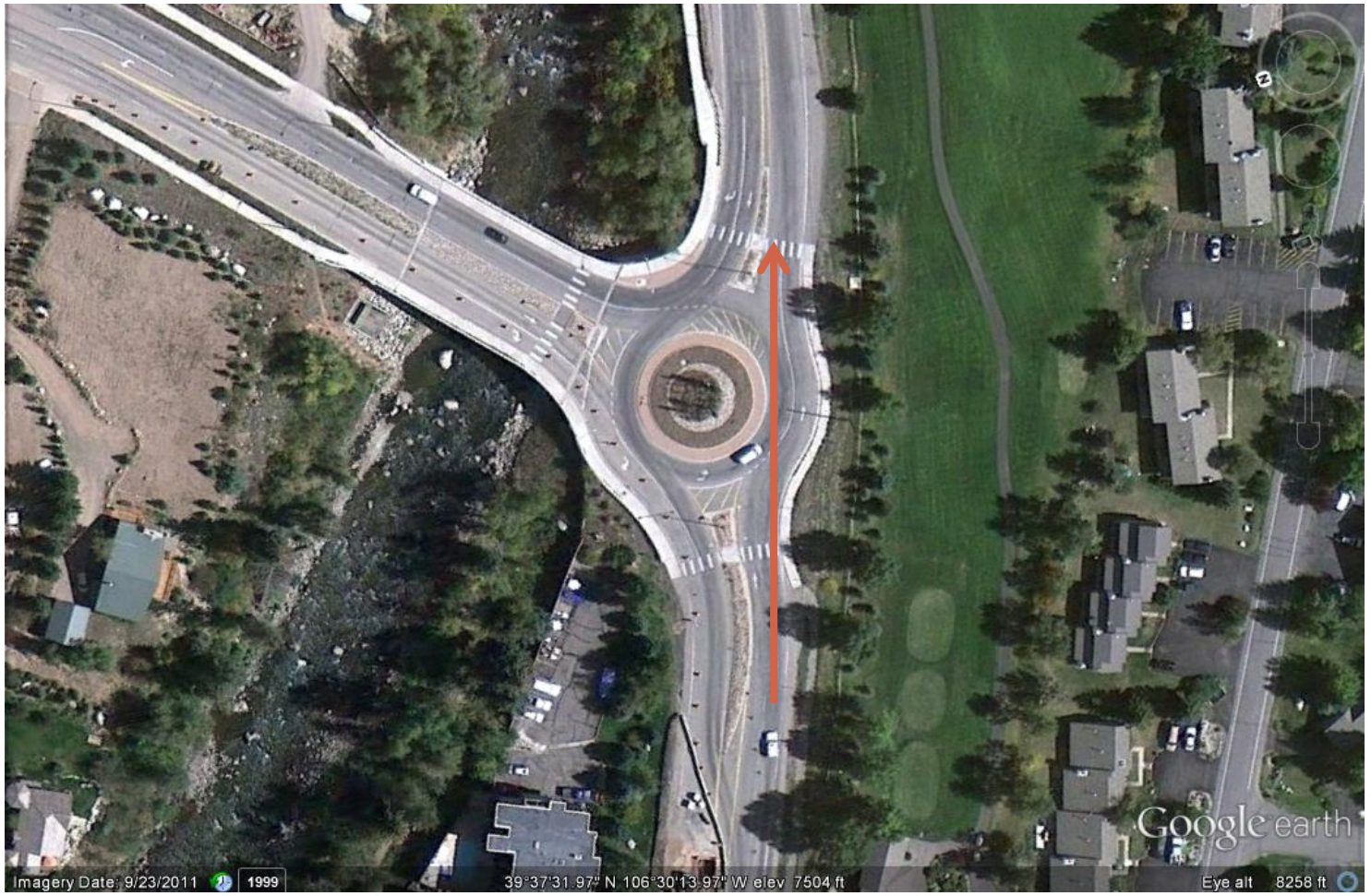
R3: exit path radius

R4: left turn radius

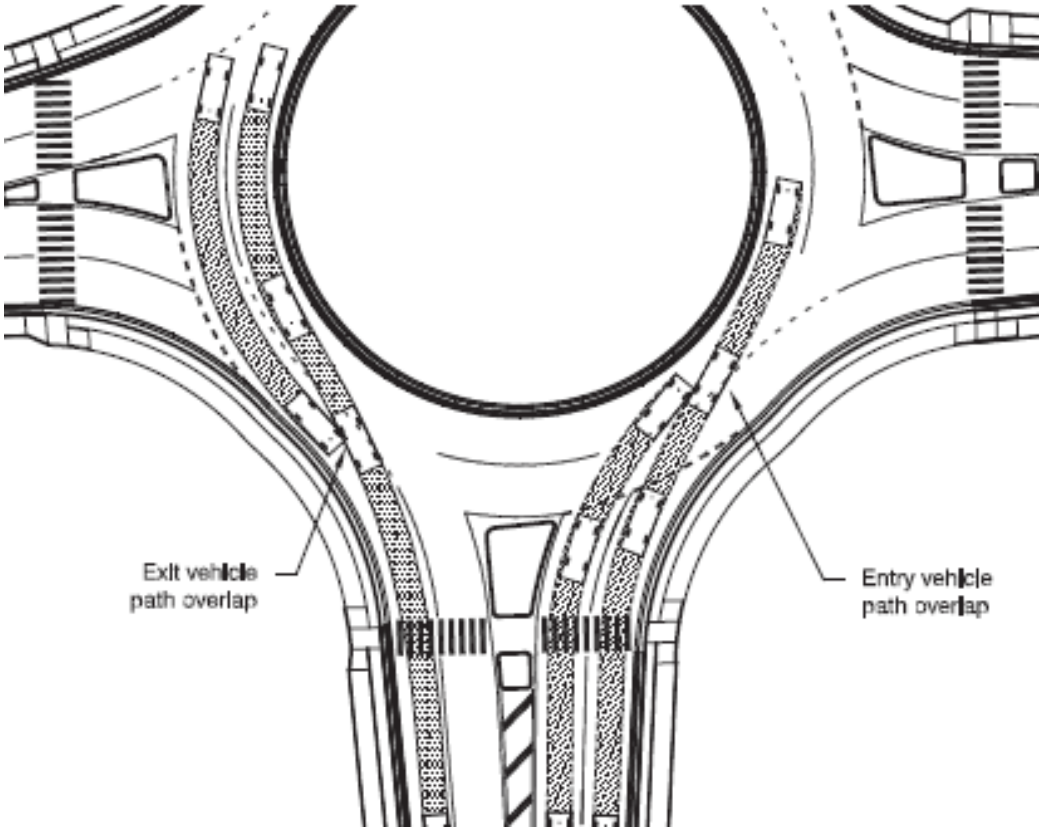
R5: right turn radius



Lack of Speed Control/Vehicle Path Overlap



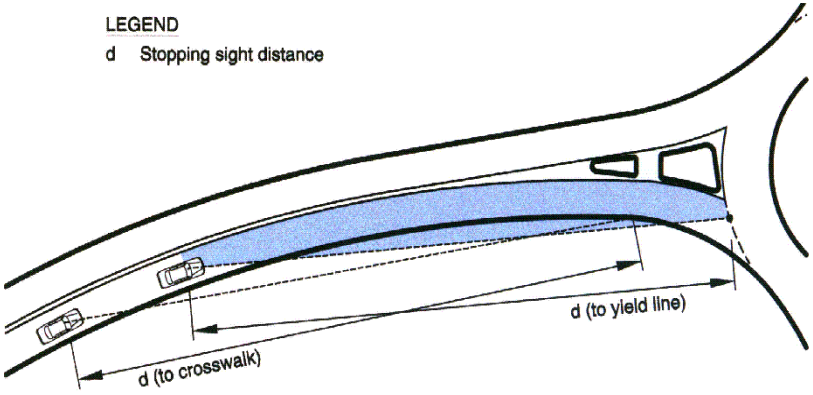
Multi-lane Designs – Vehicle Path Overlap

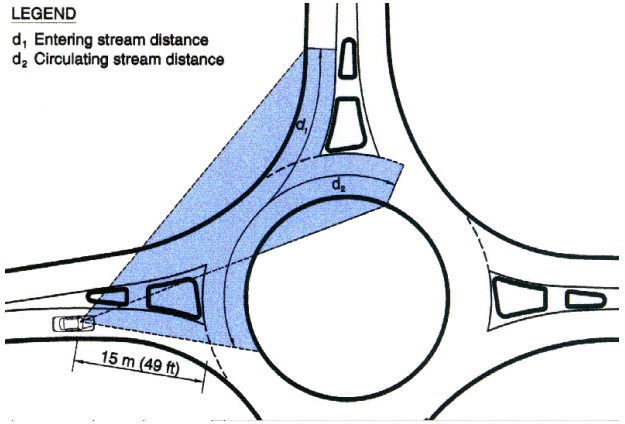


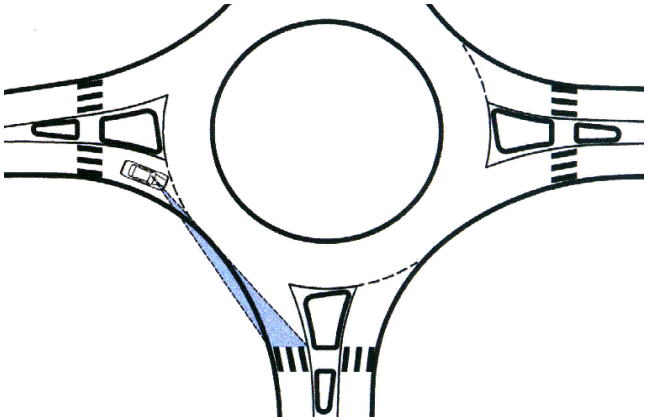
- Common error for first time designers
- Techniques available to correct
- Design and markings must complement each other

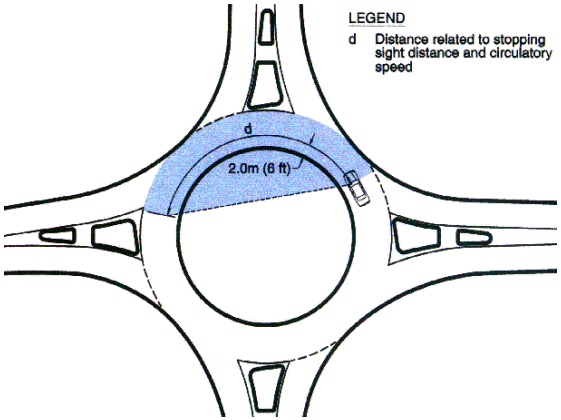
Source: NCHRP 672

Sight Distance







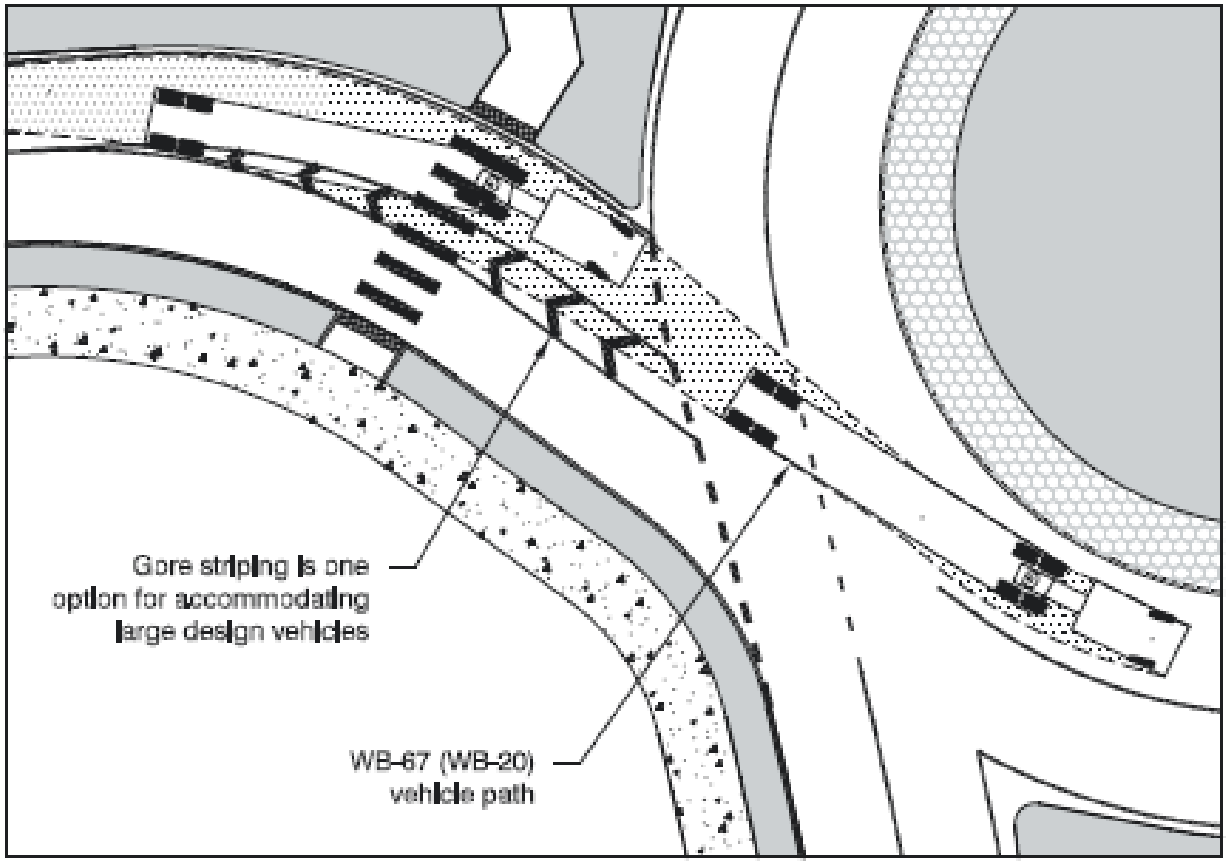


Large Vehicles

Source: Isebrands

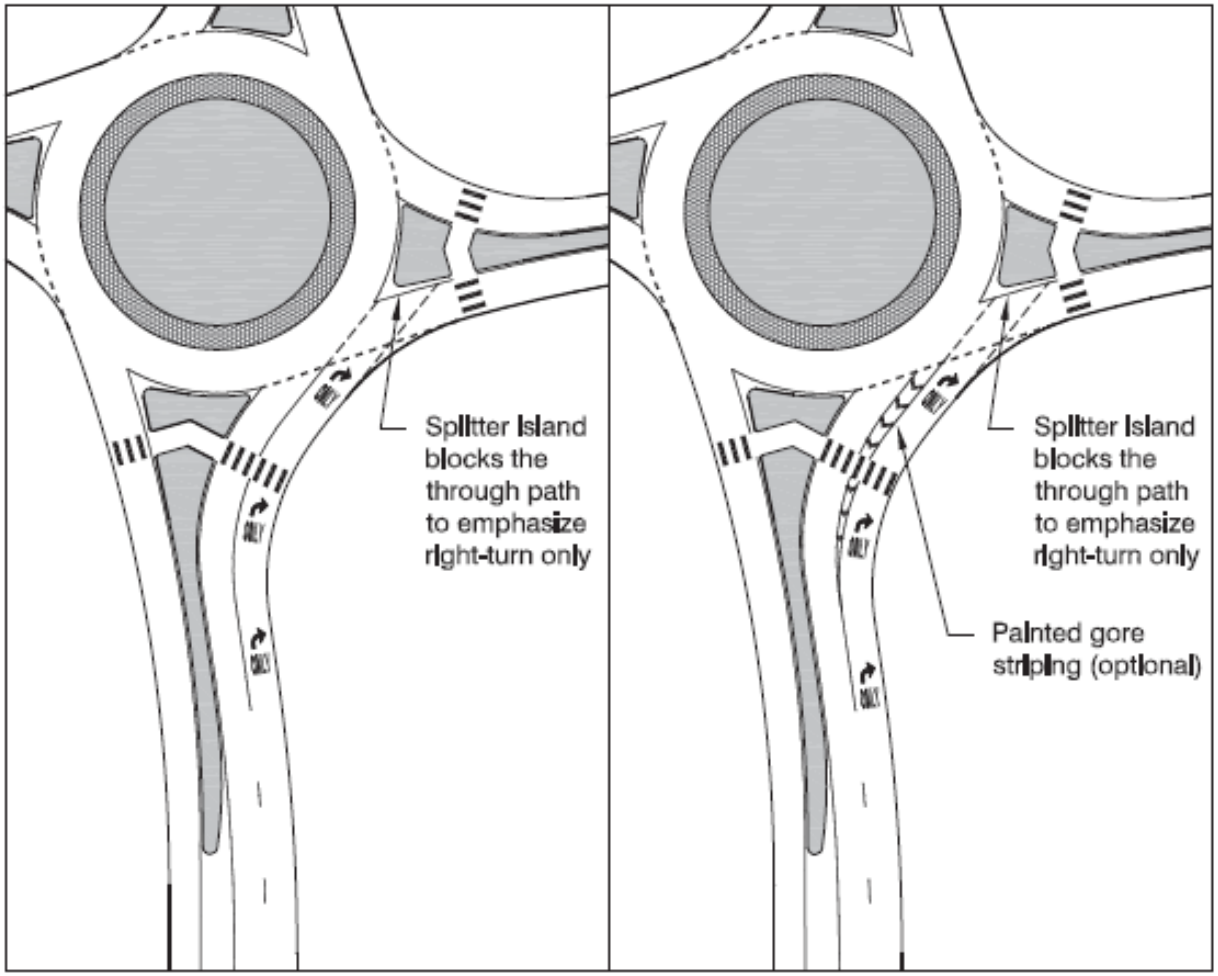
Source: City of Richfield, MN

Gore Striping



Source: New York State Department of Transportation (*11*)

Exclusive Right Turn Lanes

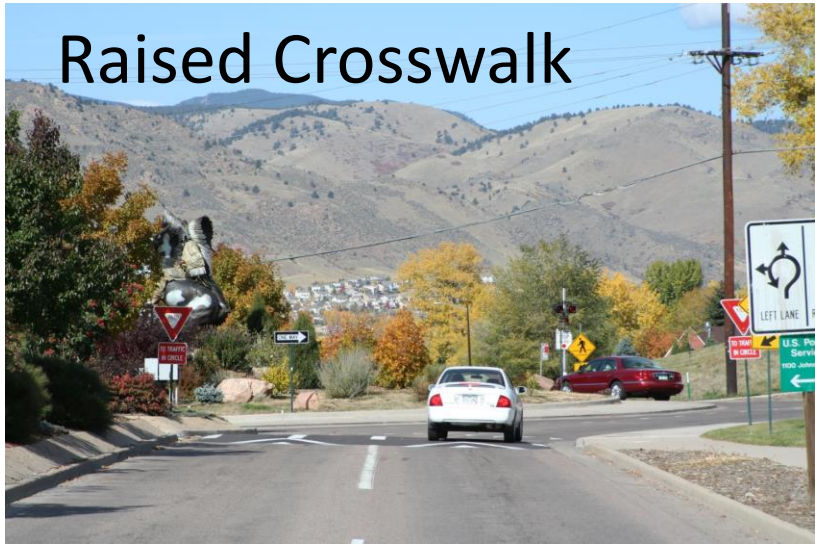


Source: NCHRP 672

Bikes at Modern Roundabouts

Photo credits: Isebrands

Accessibility at Modern Roundabouts



Rectangular Rapid Flash Beacon

Photo credits: Isebrands, FHWA

A Design Lessons Learned Case Study

Photo Courtesy: Hillary Isebrands

A Design Lessons Learned Case Study

Before

Photo Courtesy: Bruce Robinson

A Design Lessons Learned Case Study

After

Photo Courtesy: Hillary Isebrands

A Safety Case Study- The Problem

Photo Courtesy: Kansas DOT

A Safety Case Study – The Evidence

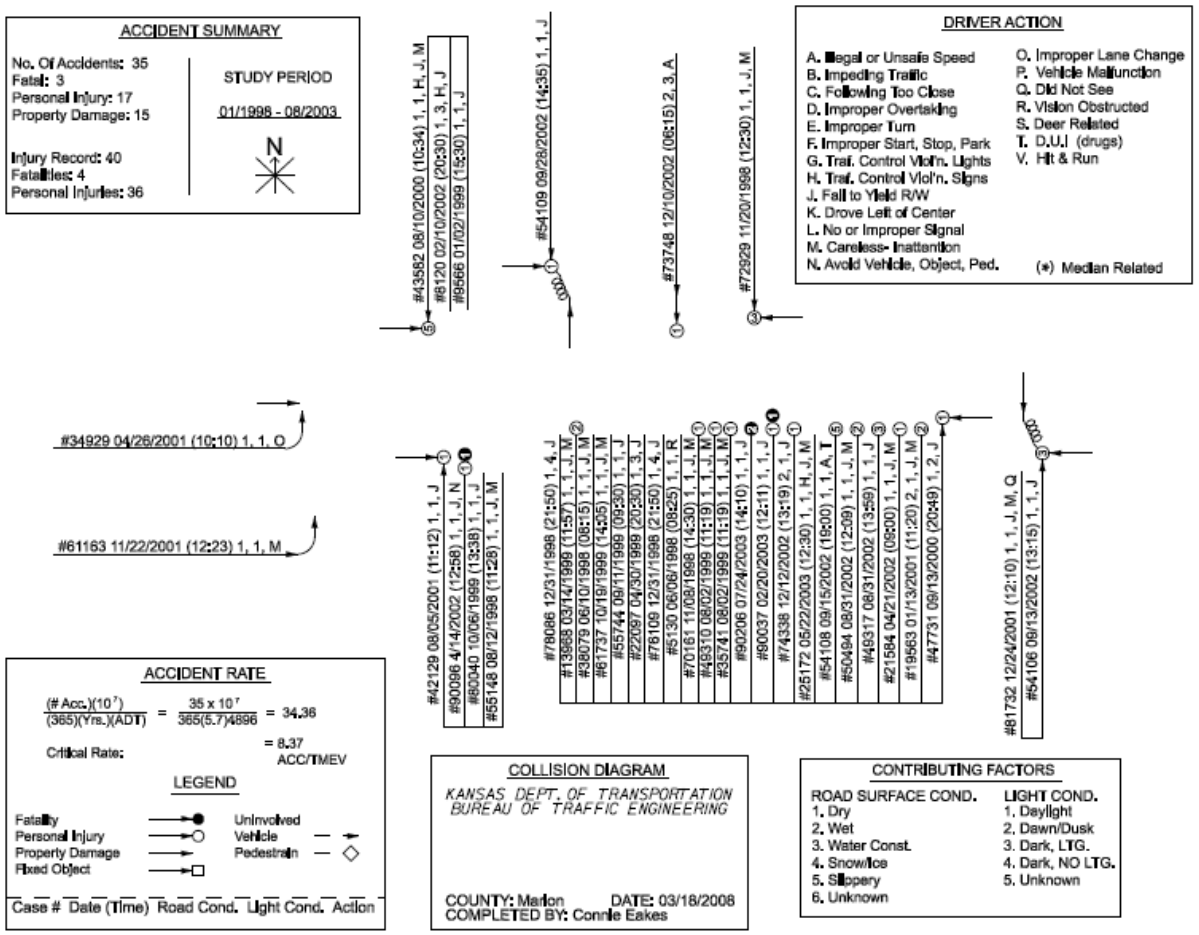


Photo Courtesy: Kansas DOT

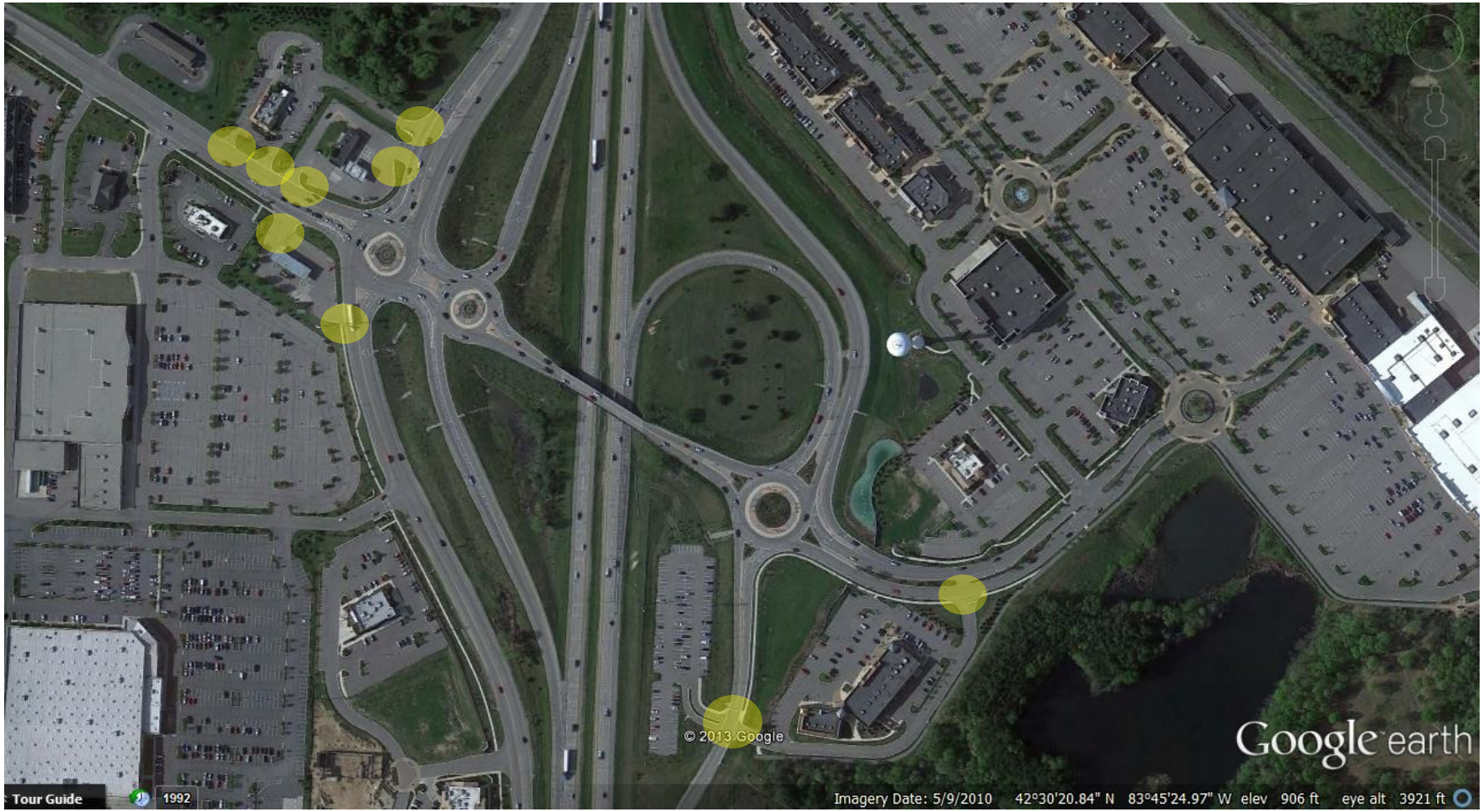
A Safety Case Study – The Solution


Source: Kansas DOT


Source: Isebrands


Source: Isebrands

US 23 and Lee Rd, Livingston County, MI



WisDOT – High Speed 4 Lane Divided Highway

WashDOT SR 539 – 4 lane Divided Hwy

I-70 and Pecos St – Denver, CO

Before

After

Photo Source: Google Earth


430 ft
590 ft
I-70
370ft
1150 ft
Avon, CO
US 6
Google earth
Imagery Date: 9/23/2011
1999
39°38'05.83" N 106°31'30.09" W elev 7458 ft
Eye alt 11474 ft

Design Review Checklist (1 of 2)

U.S. Department of Transportation
Federal Highway Administration

- Is the diameter appropriate for context? What are the Fastest Path Speeds?
  - Design Speeds for R1, R2, R3, R4, R5
  - Relationship between radiuses (max 12mph difference)
- Is alignment appropriate?
- Is there enough deflection?
- What is the design vehicle?
  - How often does design vehicle use intersection?
- Multi-lane roundabout
  - Potential for vehicle path overlap?
  - How robust are traffic projections?
  - Should it really be constructed as a SLR?

Design Review Checklist (2 of 2)

U.S. Department of Transportation
Federal Highway Administration

- Are the splitter island lengths appropriate?
  - High speed approaches
  - Driveways/Access
- Pedestrian and bicycle features
  - Landscaping buffer for way finding
  - Width of crosswalk/refuge area sufficient
  - Bike ramp
- Is there a truck apron? (check height, width)
- Is there curb and gutter on the outside?
- Is the lighting design appropriate?
- Does the signing and marking complement the design?
- Were any analysis for design tools used?

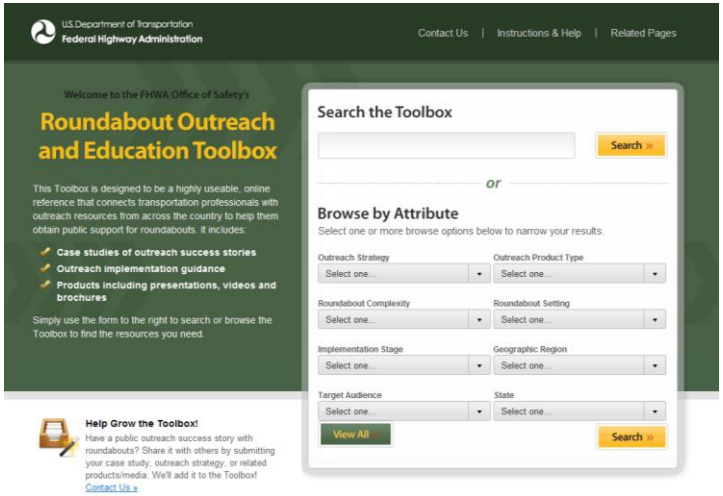
Peer Reviews

U.S. Department of Transportation
Federal Highway Administration

- Why are they important?
  - Roundabouts are still fairly “new”
  - Roundabout design not in academic curriculum
  - Not every agency has a roundabout expert on board (and that is okay)
  - An unbiased opinion almost always adds value
  - You can learn a lot from a peer review – it makes you a better designer
- On-call contract or pre-qualified designer until in-house expertise are developed (Iowa DOT, Kansas DOT, GDOT)

Education – Videos and Websites

- Brief decision makers about roundabouts before you have a project on the table
- Provide decision makers and public will Q&A briefing sheet including FAQ



http://www.youtube.com/watch?v=OvoFjirrgYA

Current Publications and Research

- NCHRP 672 – Roundabouts: An Informational Report, Second Edition
- NCHRP 674 - Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities
- NCHRP 03-100: Evaluating the Performance of Corridors with Roundabouts (In Publication)
- FHWA - Mini Roundabout Safety and Operational Study (On-going)
- FHWA - Accelerating Roundabout Implementation in the United States: Evaluations to Address Key Issues (On-going)
- NCHRP 03-110: Life Cycle Cost Analysis of Intersections (New)

Summary

- Safe
  - Most vehicles average 15 to 25 mph thru intersection
  - Fewer conflict points
  - Reduce probability of right angle, injury type crashes
  - Reduces fatal and injury crashes on average by 80%
- Efficient
  - All movements (LT, TH, RT) have equal priority
  - 24 hours a day (little stopping during off peak)
- Smart
  - Game changing design in terms of safety and operations
  - Provides flexibility where none may have existed before

2014 Design Training Expo

Source of Images: Isebrands, Google Earth, Isebrands

Thank You ▪ Questions and Discussion

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