Why are Roundabouts Important

June 24, 2008

Philip Demosthenes
Parametrix, Denver

Parametrix

Roadways are the Most Dangerous Public Facilities on the Face of the Earth

- In the US, over 830 people were killed each **week** in 2005
- 17,500 Crashes each **day**
- 7,400 Injuries each **day**

- The leading cause of death of a child between the ages of 4 and 14 is a traffic crash.

If two jumbo jets crashed weekly Something would be done about it.

California Recent Rates

- Since 1999, fatal rates are up
  - 1999 1.19 per 100 mvm (record low)
  - 2003 1.30 4215
  - 2004 1.25 4126
  - 2005 1.31 4329 292,798 injured
  - 2006 1.29 4236 {over 11 per day}
    - Best state is 0.78, US rate is 1.41,
- About 250 children die annually
- Economic loss, over $20 billion yr.

Intersection Crash Statistics (nationally)

- 27.3 % of all reported crashes
- Almost 25% of all traffic fatalities
- Almost 50% of all traffic injuries
- About 55% of all crashes are related to Access
- Traffic Signals increase crash frequency

Are Traffic Signals Obsolete?

Old Golden Rd before

Dan Hartman (303) 384-8150 dhartman@ci.golden.co.us

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Old Golden Rd rehab

netrix

Crash reductions - Golden CO

- 4 Signals changed to RBTS
- 60% drop in Crashes (mvm)
- 94% drop in injuries
  - 31 in 3 yrs before
  - Only 1 in 5 yrs following
    - A median opening left turn
- No Pedestrian accidents
- Single lane RBT has best record

South Glens Falls – elliptical single lane

courtesy of Howard McCulloch, NE Roundabouts

Michigan, Lee at Green Oak

Courtesy of Mark Johnson, MTJ Engineering

Evolution of the Circular Intersection

Arc de Triomphe, Paris

Circulation Yields to Entry

Old Circle Operations

- Need large circles to provide long weaving distances
- Large curves = higher speeds
- High speeds = lower capacity
- Higher speed = more severe crashes

Modern Circular Intersection

- Motorists entering yield (reverse priority).
- Occurred in England in 1963
- Allowed several design and operational changes to evolve.

Rotary to Roundabout (Ulster, NY) Old circles and rotaries are generally 300 to over 600 ft in diameter

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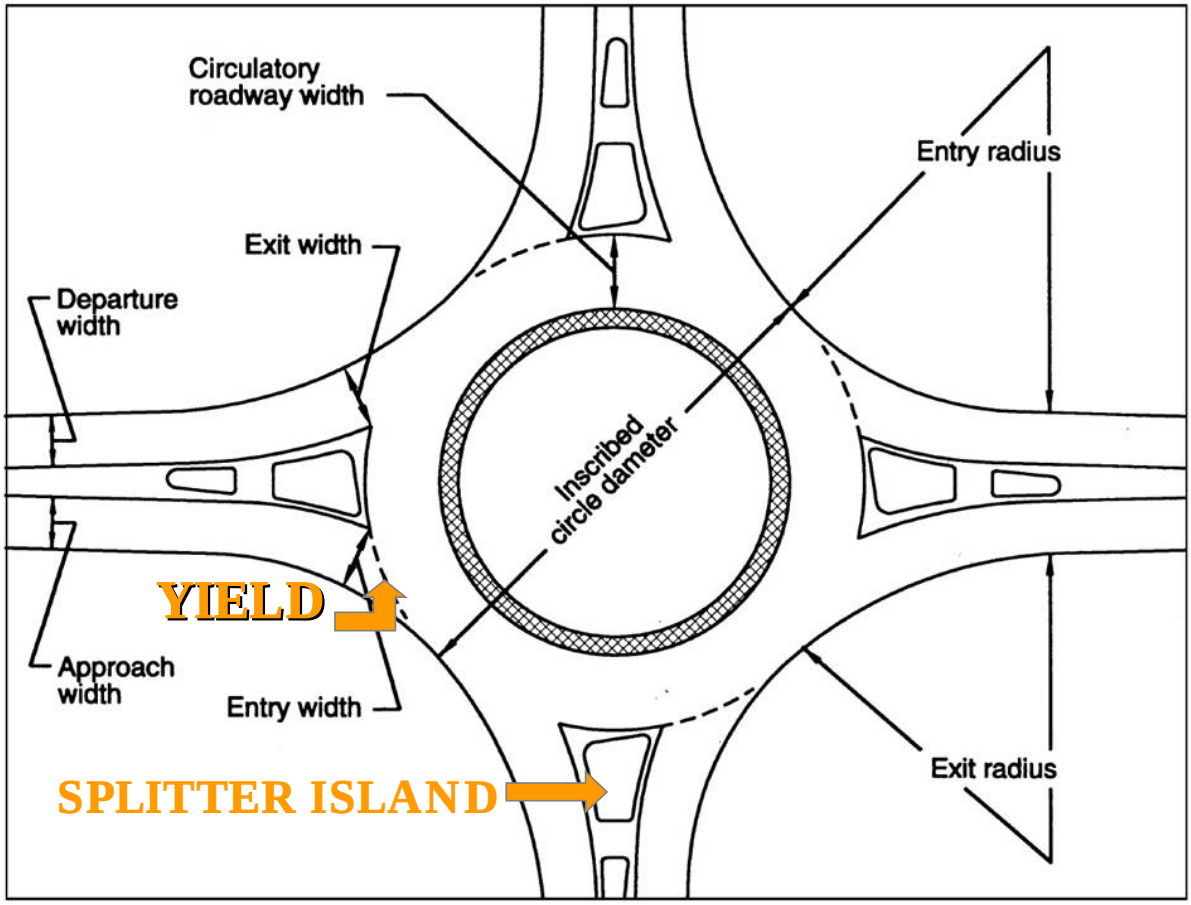


Disadvantages of Roundabouts

- ROW required for good outside diameter
- Grade on entries and the profile must be less than 4%.
- Platooned traffic flow is impacted in signal coordinated networks
- Pedestrian crossing traffic signals may be required by new ADA rules
- Rapidly goes from LOS D to LOS F

Benefits of Roundabouts

- Reduced crash frequency and severity for all users
- Very safe on high speed roads
- Pedestrians crossing distances are shorter and require looking in one direction only
- Drivers only make right turns
- Vehicle emissions are reduced through reduced stops and delays
- Small carbon footprint

Benefits

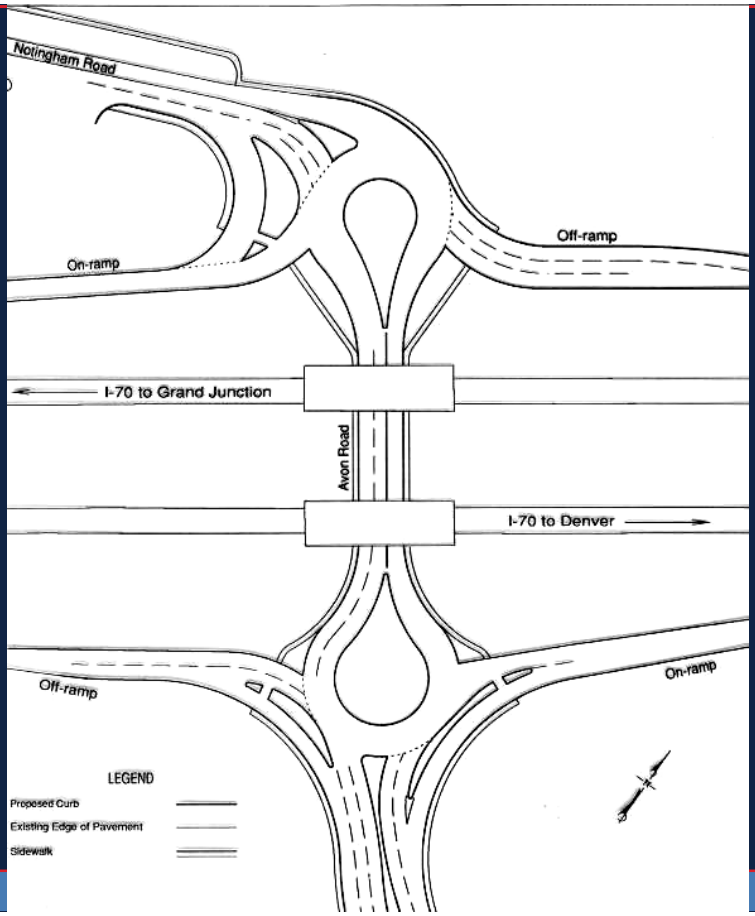
- Will typically outperform a traffic signal in terms of delays and queues
- Suitable for lowest to highest traffic volumes
- Change in Speed – Rural to Urban delimiter
- Suitable when turning volumes are unbalanced
- Suitable for almost all locations

Why Roundabouts

- Unique geometric flexibility
- Fit almost anywhere (Minis to Interchanges)
- Flexible - easy to modify
- Provide better turning radii for trucks
- Require very small sight distances
- Simple for traffic -Yield to the LEFT

Roundabouts - Aesthetics

Narrow underpass



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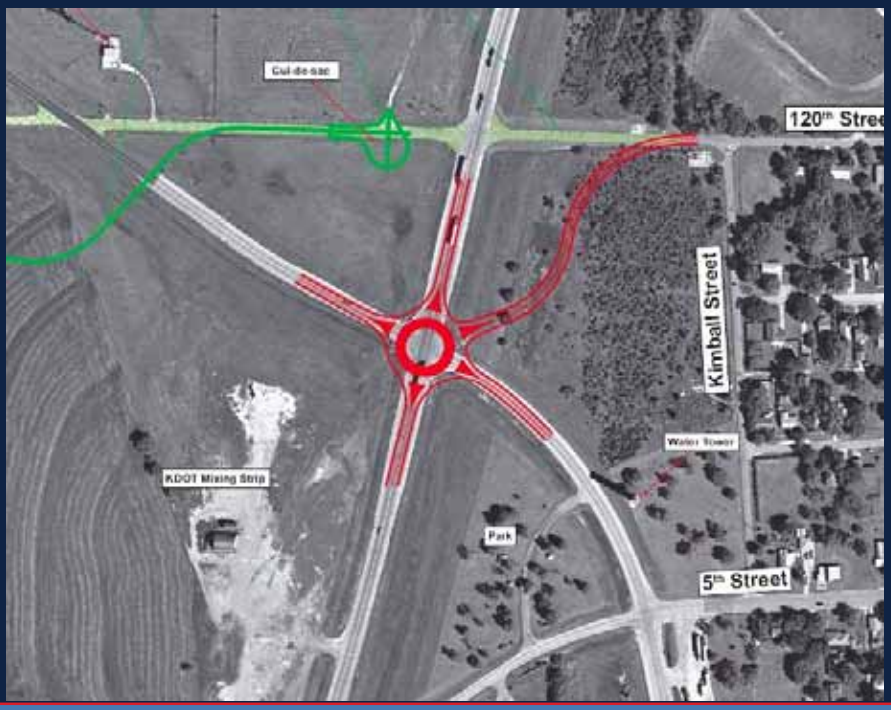
West Vail

Rapids Wisconsin, Challenging Geometry Mark Johnson, MTJ Engineering, WI

Utah

Courtesy of Bill Baranowski, Jordon Utah

Provides new alternatives (Kansas)



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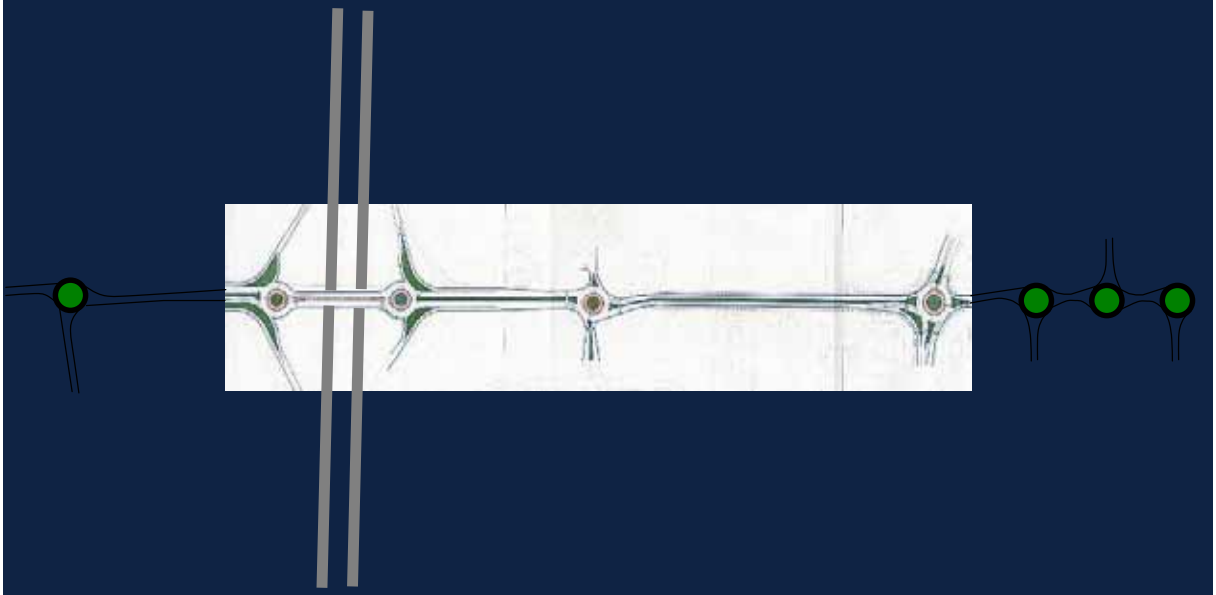
Roundabouts in Series

I-87 Exit 12 – Malta New York Roundabout corridor



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First Four Completed in Malta NY

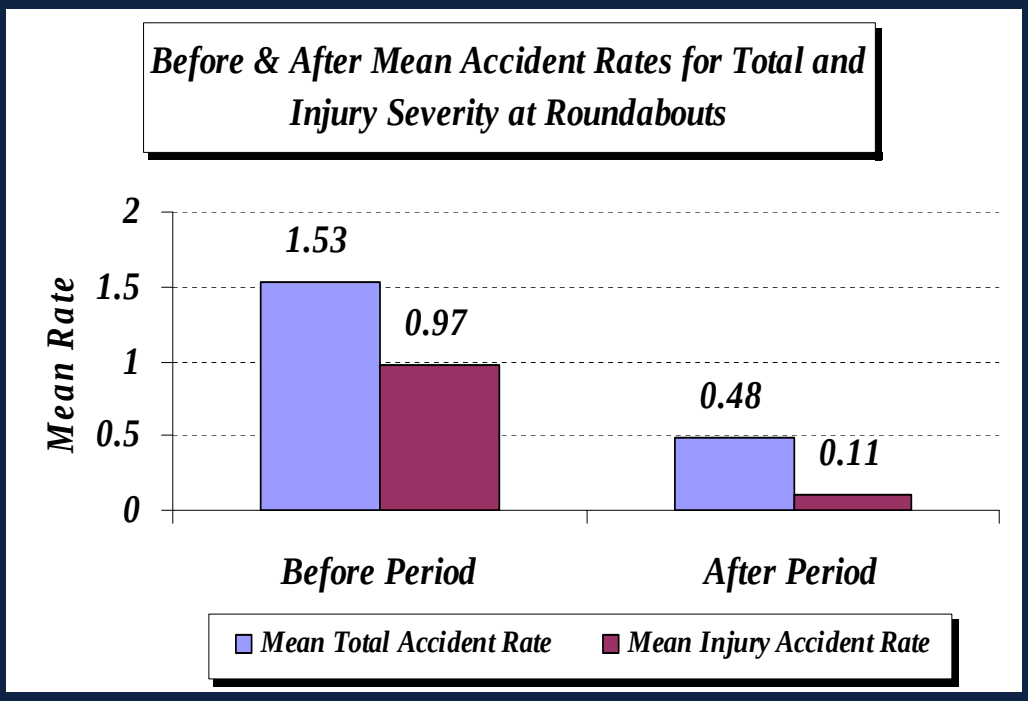
From NYS DOT

Roundabouts at the High Volume Intersections

Signals at the Low Volume Intersections

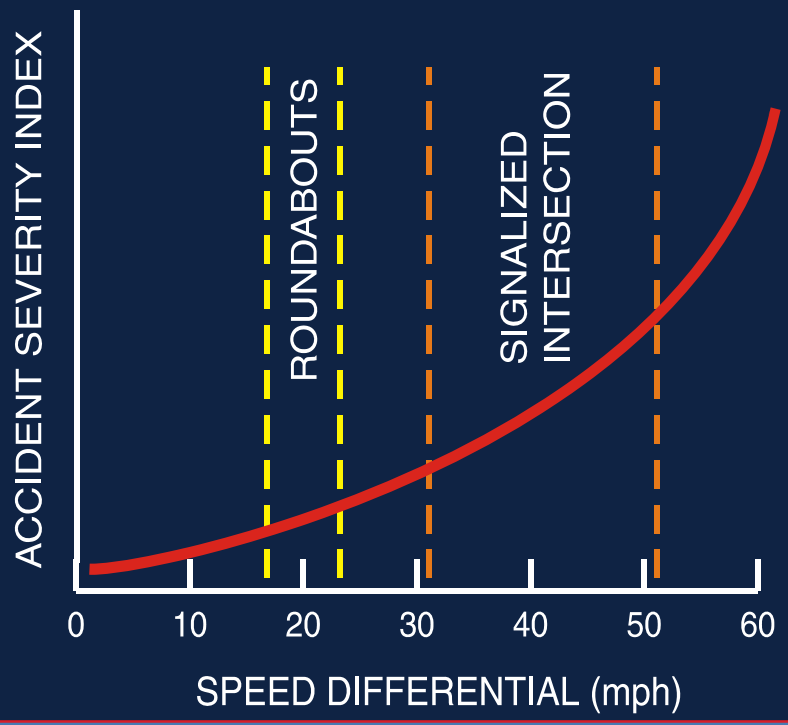
...in Grid

Maryland, 2001



Port Orchard WA
ICD: 160 feet
Design Speed: 15-20 mph
Entering Traffic: 2,690 vph
Designed for future two-lane function

Why Fewer Injuries



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Crash types in circular roadway

Crash Type	Single-Lane	Dual-Lane
Run-off-road	82 %	21 %
Rear-end	14 %	16 %
Side-swipe	0 %	58 %
Other	5 %	5 %

Crash Reductions, EUP, AU, US

All Crashes	37 to 61 %
Injury Crashes	25 to 87 %
Serious Injury And Fatal Crashes	81 to 90 %

Roundabouts Internationally

- Over 30,000 in France
- Over 18,000 in United Kingdom
- Found world wide
- Nine countries were represented at the TRB National Roundabout Conference in Vail in May 2005

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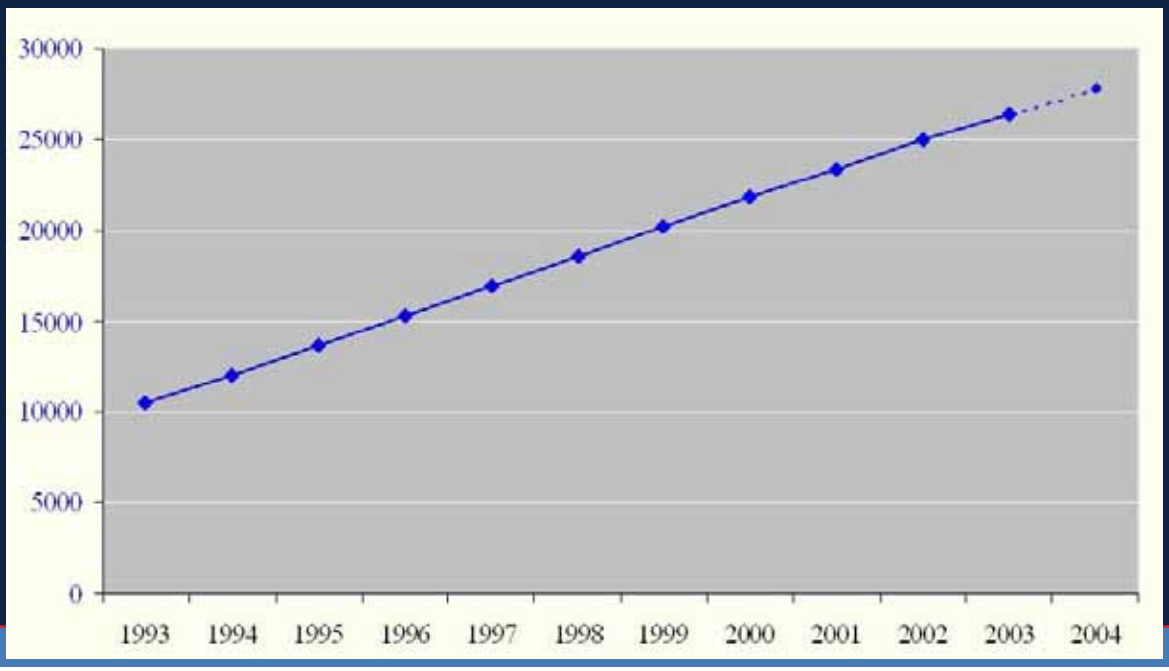
Roundabouts in France: 30,000

Building over 1,000 roundabouts per year

From '93-'03, Total Crashes drop 36%, per RBT drop by 58%



City of Colorado Springs

- Population over 460,000
- 42 roundabouts (late 2007)
- 4 More in progress
- Roundabout Preferred Policy

Tort Liability and Negligence

- If a hospital only uses technology that is more than 40 years old, would they still be in business?
- If a local or state highway agency uses a traffic signal technology that is more than 40 years old, and has a serious injury and fatal rate 9 times higher than new technology, is there a liability?

NEW YORK STATE

Department Of Transportation

- NYDOT- "Signal Policy"
- "When the analysis shows that a roundabout is feasible, it should be considered the Department's preferred alternative due to the proven substantial safety benefits and other operational benefits."

Washington State DOT

915 **Roundabouts**

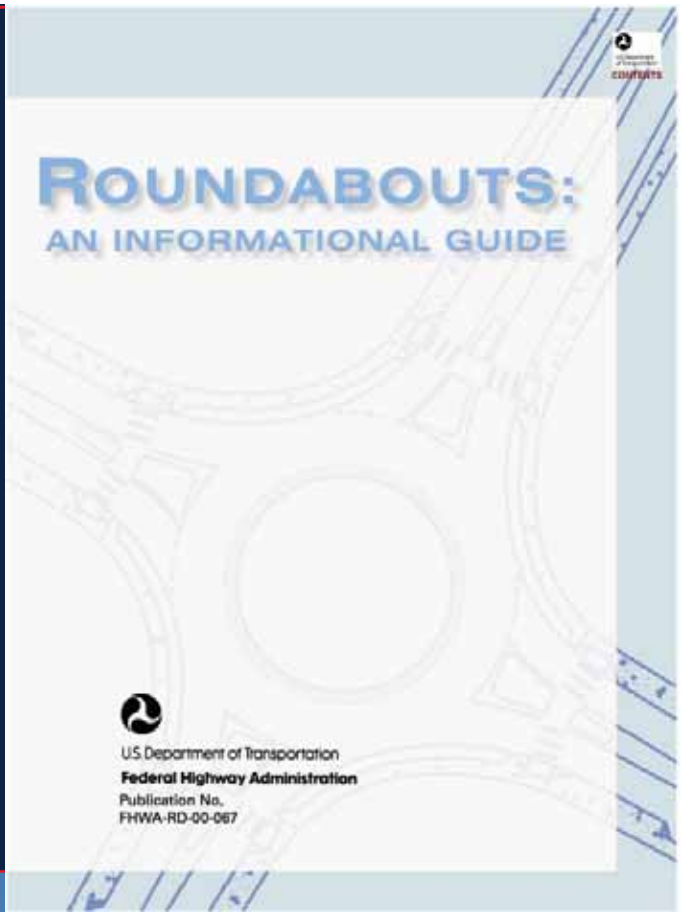
915.01 General
915.02 References
915.03 Definitions
915.04 Roundabout Categories
915.05 Capacity Analysis
915.06 Geometric Design
915.07 Pedestrians
915.08 Bicycles
915.09 Signing and Pavement Markings
915.10 Illumination
915.11 Access, Parking, and Transit Facilities
915.12 Procedures
915.13 Documentation

Old rotaries and traffic circles are characterized by a large diameter, often in excess of 300 ft. This large diameter typically results in travel speeds within the circulating roadway that exceed 30 mph. They typically provide little or no horizontal deflection of the paths of through traffic. These large diameters also create weaving areas that increase accidents in the circulating roadway. At times, traffic control was imposed on the circulating traffic, such as yield or stop signs that required circulating traffic to yield to entering traffic. In some cases, each entry was controlled with a traffic signal. Circular intersections with any of these features are not an approved intersection type.

Division of Design

DESIGN INFORMATION BULLETIN NUMBER 80-01
ROUNDABOUTS

Federal Highway Administration, June 2000



Insurance Institute for Highway Safety

Nov 19, 2005

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Most Cyclists Use the Road Taking the Inside Lane

etrix

Elderly Drivers and Left Turns

- Elderly drivers find left turns the most difficult.
- Difficulty judging approaching speeds and gaps. (about twice AASHTO gap value)
- FHWA study. Left turn countermeasures reduced all crashes by 45%, but reduced elderly crashes by 53%.
- Suggested that roundabouts have an even larger safety benefit for elderly drivers
- French study. Elderly injury rate at roundabouts lower than all other intersection types (4000 RBTs studied)

Clearwater Beach, FL

- *32% of residents are aged 65 +*
- *2.6 x the national average*

Utah (light rail)

Courtesy of Bill Baranowski, Jordon Utah

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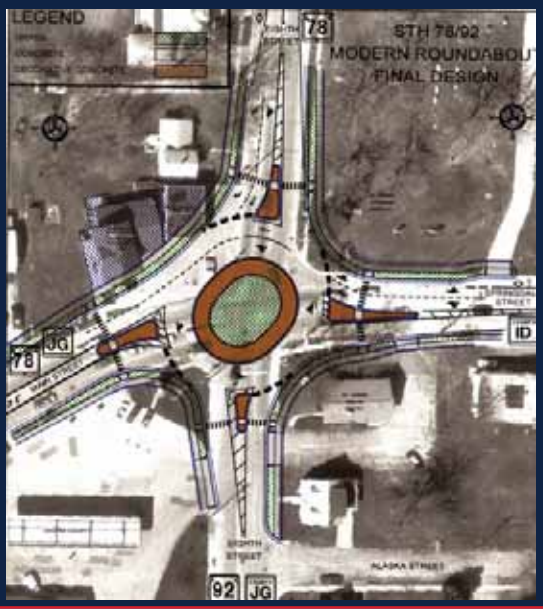
Nashville, Tennessee (music mode)

ROW differences, Horeb WI (Mark Johnson MTJ Engineering)



Completed RBT

(Mark Johnson MTJ Engineering)

In the Ball Park – Typical Max Entry Volume to Size

- **Not** to be used to make a decision
- ≈ 2,000 VPH single lane
- ≈ 4,000 VPH multi-lane
- ≈ 6,000 VPH three-lanes
- ≈ 8,000 VPH four-lanes
- This will vary significantly depending on individual entry and left turn volumes.

Primary Models Used in US for Roundabout Analysis

- RODEL – Empirical, **RO**undabout **DEL**ay
  - ARCADY (**A**ssessment of **R**oundabout **CA**pacity and **D**ela**Y**)
- aaSIDRA – Analytical (gap theory)
- VISSIM, Paramics – Simulation (gap theory)

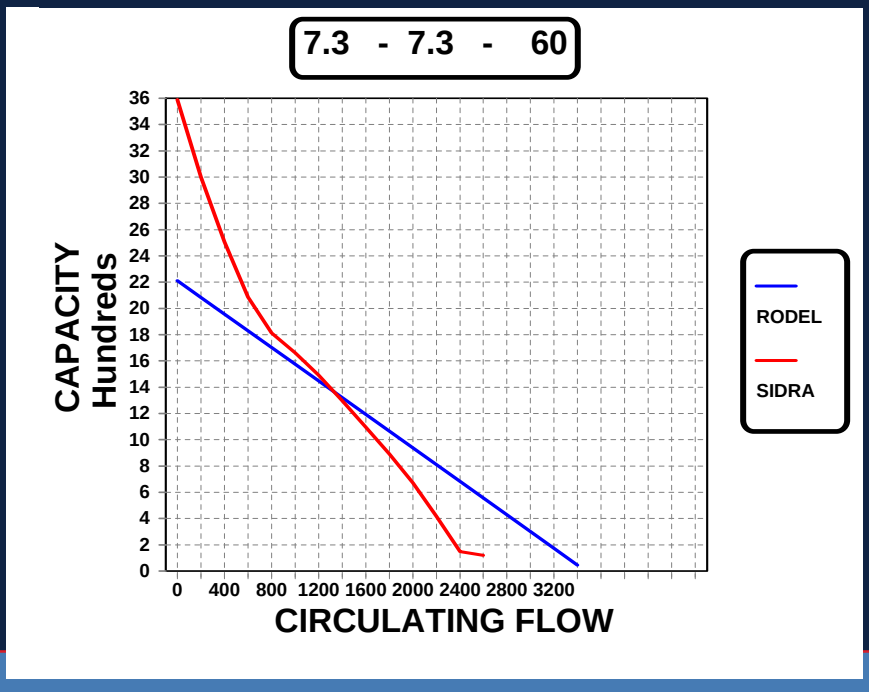
- Each is different, results vary significantly
- Each is useful, none are perfect
- None are all-encompassing
- No one agrees as to which is most accurate

Model Differences

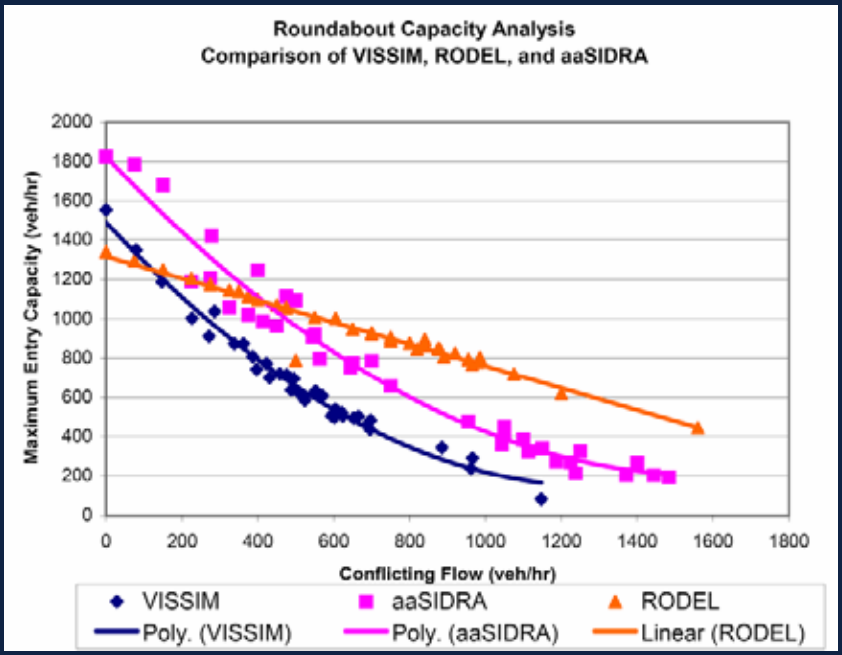
- GAP THEORY
  - Uses a single roundabout capacity mechanism
  - Availability of gaps in the circulating traffic
- EMPIRICAL (field studies)
  - Empirical Method captures all capacity mechanisms (gap, design, drivers)
  - Five significant capacity mechanisms
  - Field data collected from roundabouts operating at capacity limits

RODEL and aaSIDRA

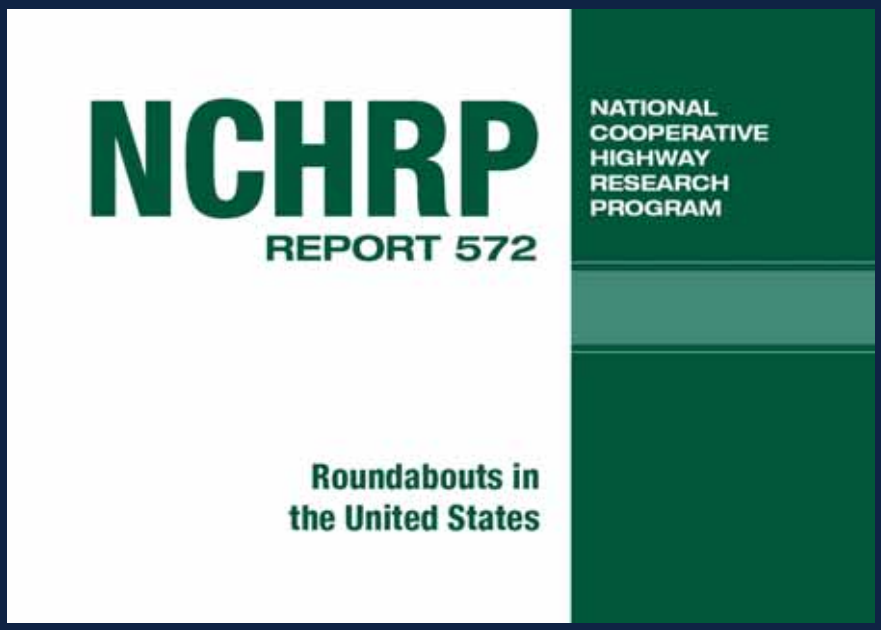
7.3 Entry 60m ICD



Single Lane Comparison Plots



Joe G. Bared, FHWA
Praveen K. Edara, Civil and Environmental Engineering,
Virginia Polytechnic Institute and State University



Comparing Models on Computer

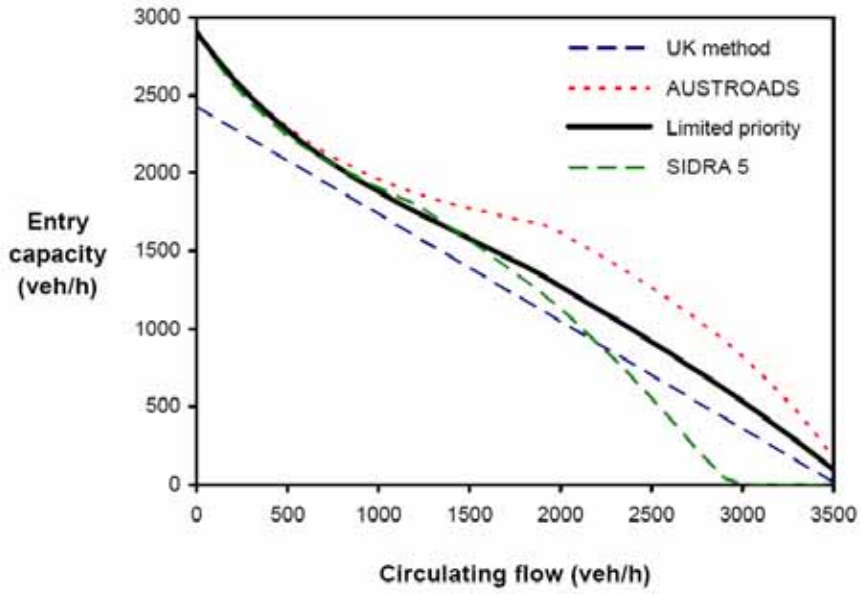
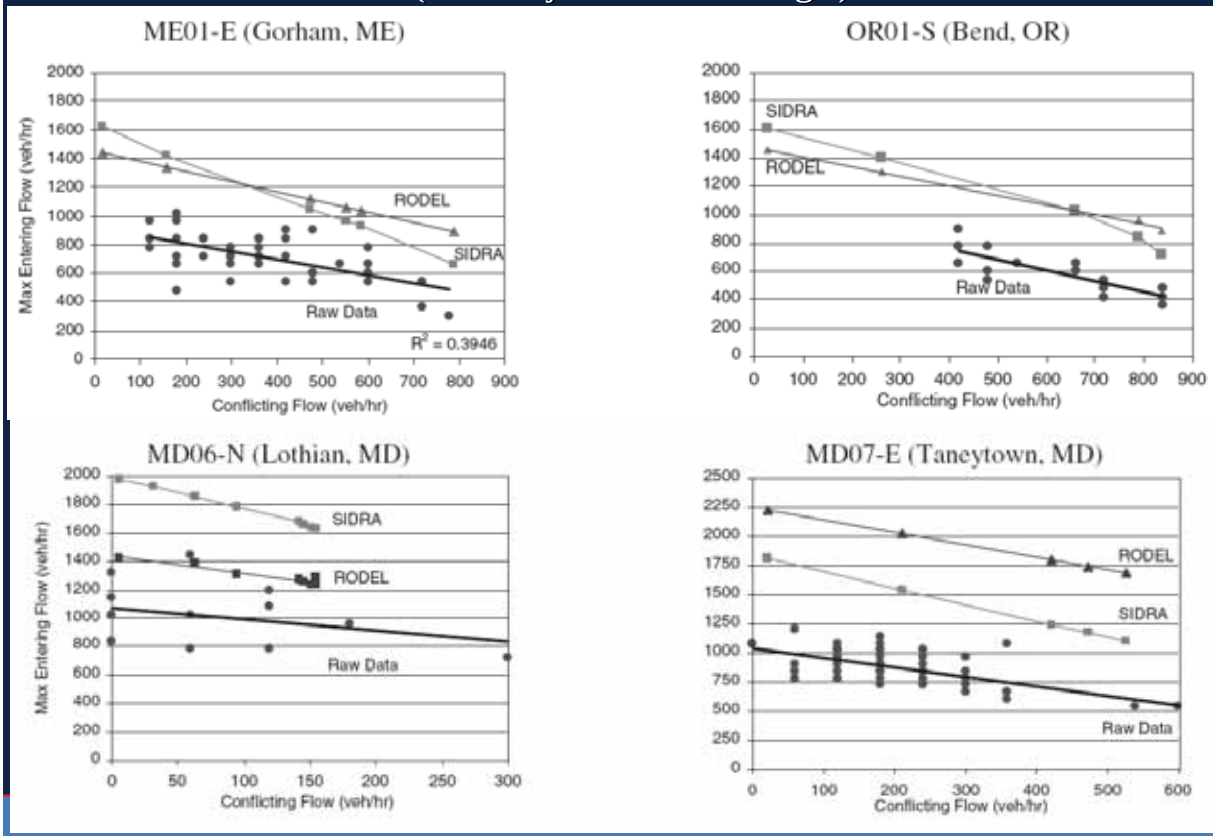


Figure B-29. Entry Capacity Against the Circulating Flow for a 60-m Diameter Roundabout with Two 4-m Entry Lanes and Two Circulatory Lanes

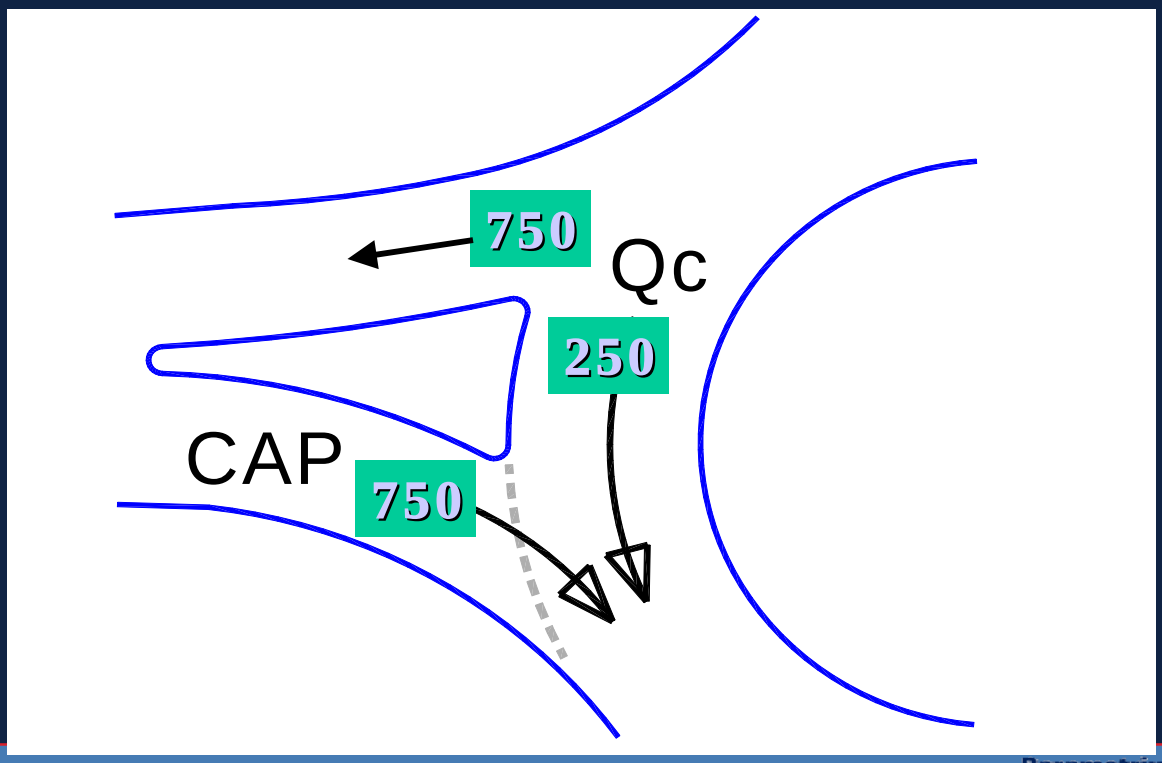
572 field studies. (Not adjusted for design)



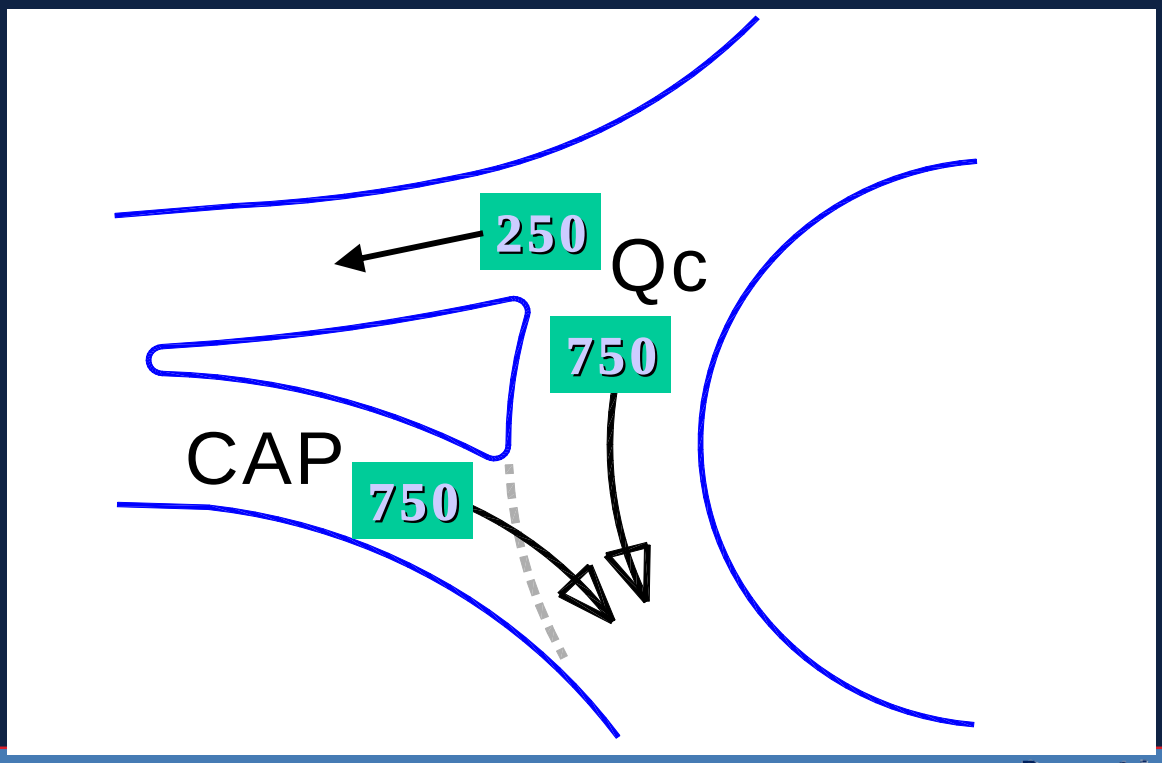
Entry capacity depends on:

- The GEOMETRY of the entry
- The CIRCULATING volumes passing the entry
- Capacity is VERY sensitive to geometry

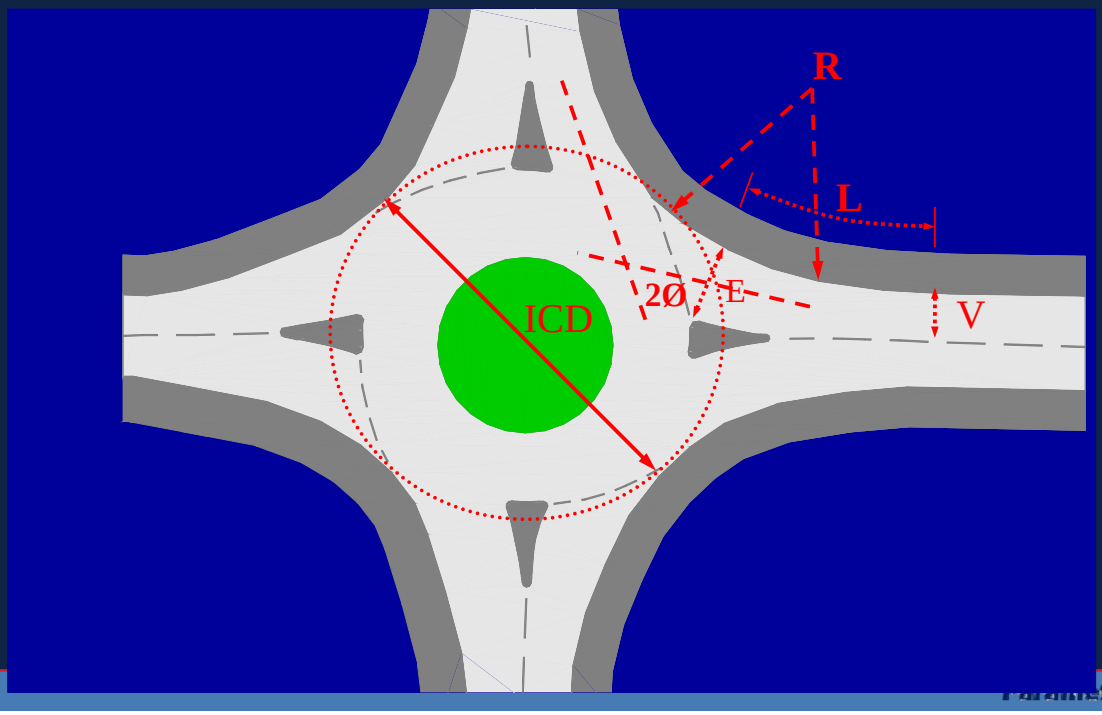
Capacity of an Approach



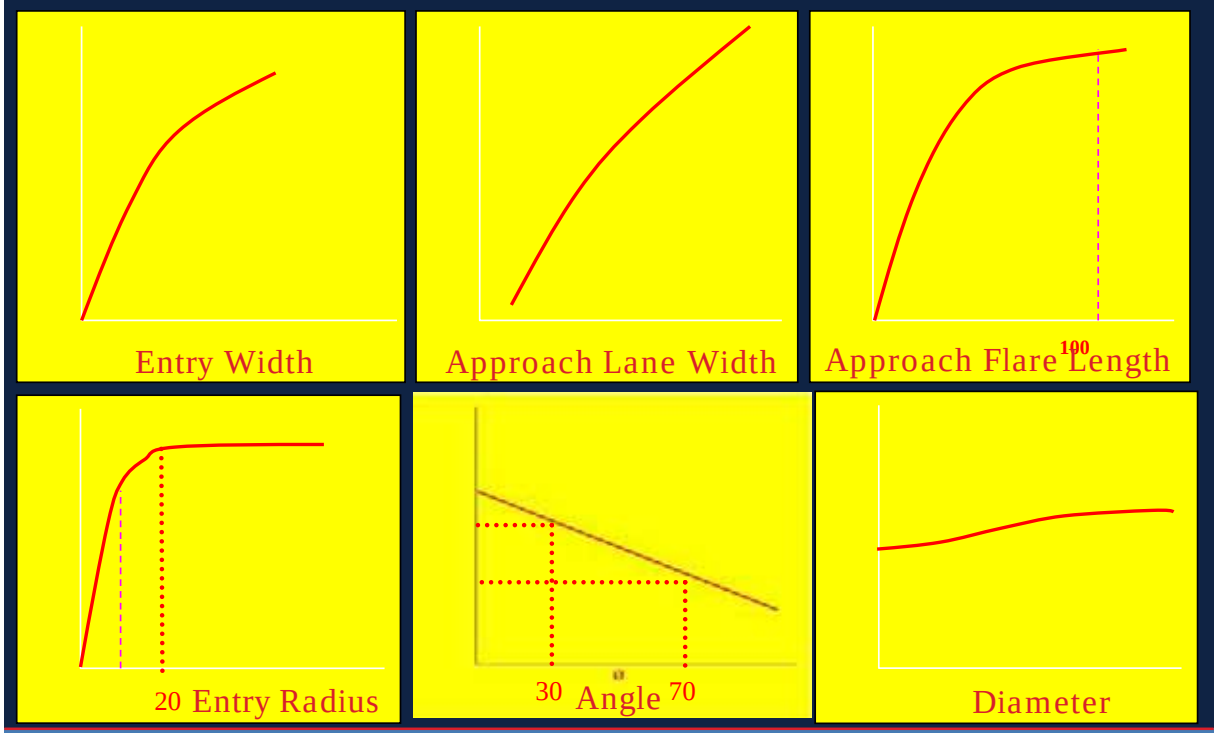
Capacity of an Approach

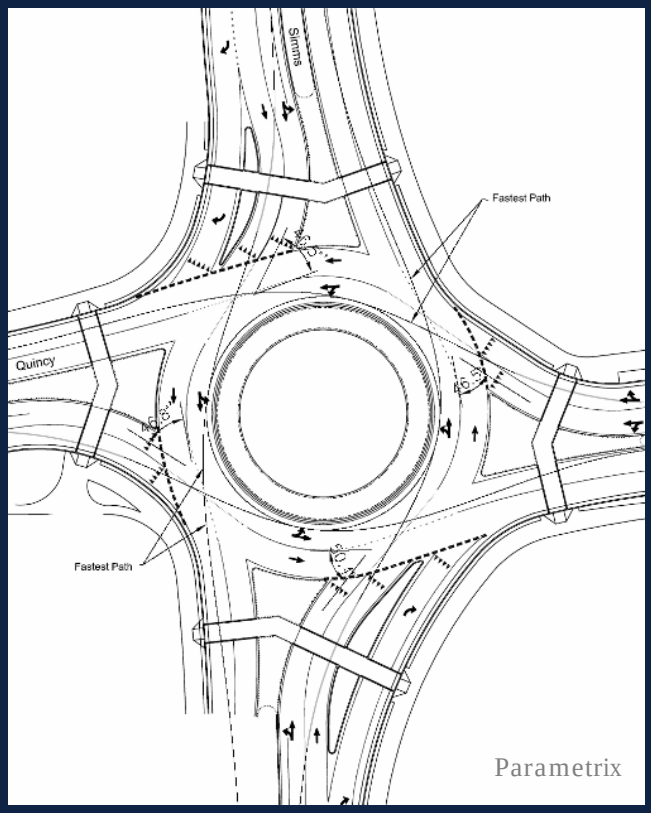


Geometric Parameters



Design Related Capacity Curves





Some Design Issues

The Design Problem

- SLR easiest – few trade-offs necessary.
  - Low Flows, few delays, small size, little vehicle conflict
- Multilane roundabouts 10 times more difficult.
  - Have challenging internal geometric conflicts and trade-off decisions
- Every design element is a trade-off in Multi's
  - High Flows, delays higher, large size, ROW issues
  - Higher crash risk
- MLRs Can get very complex on some designs

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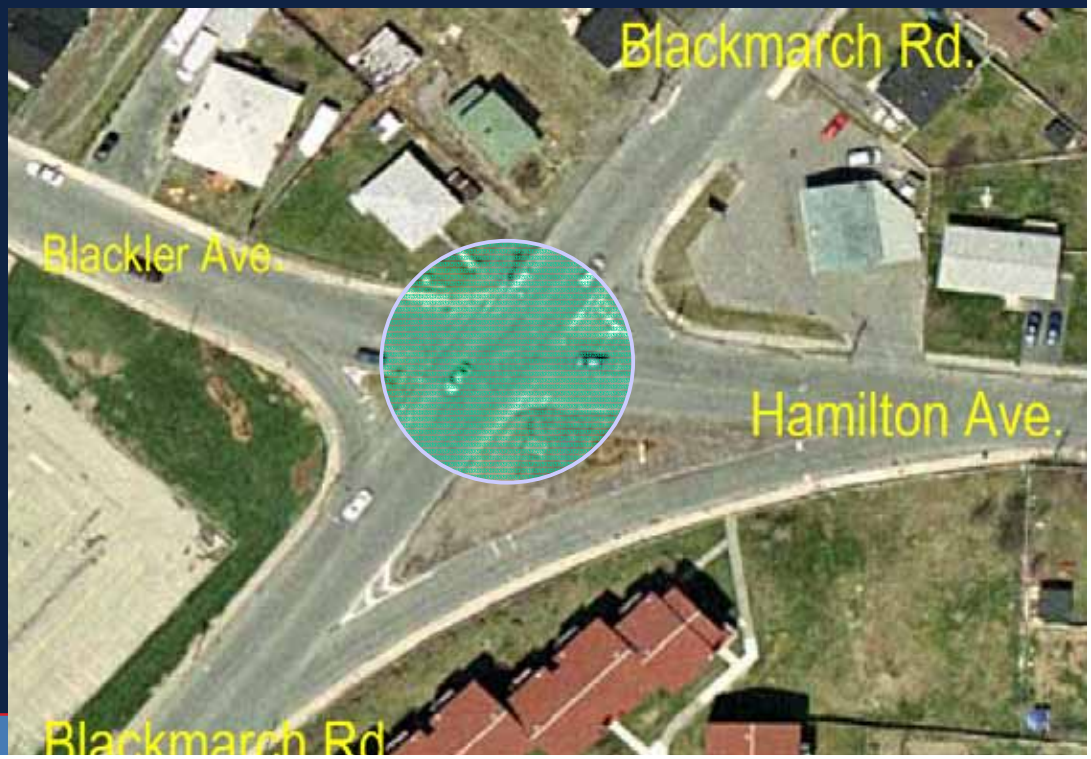
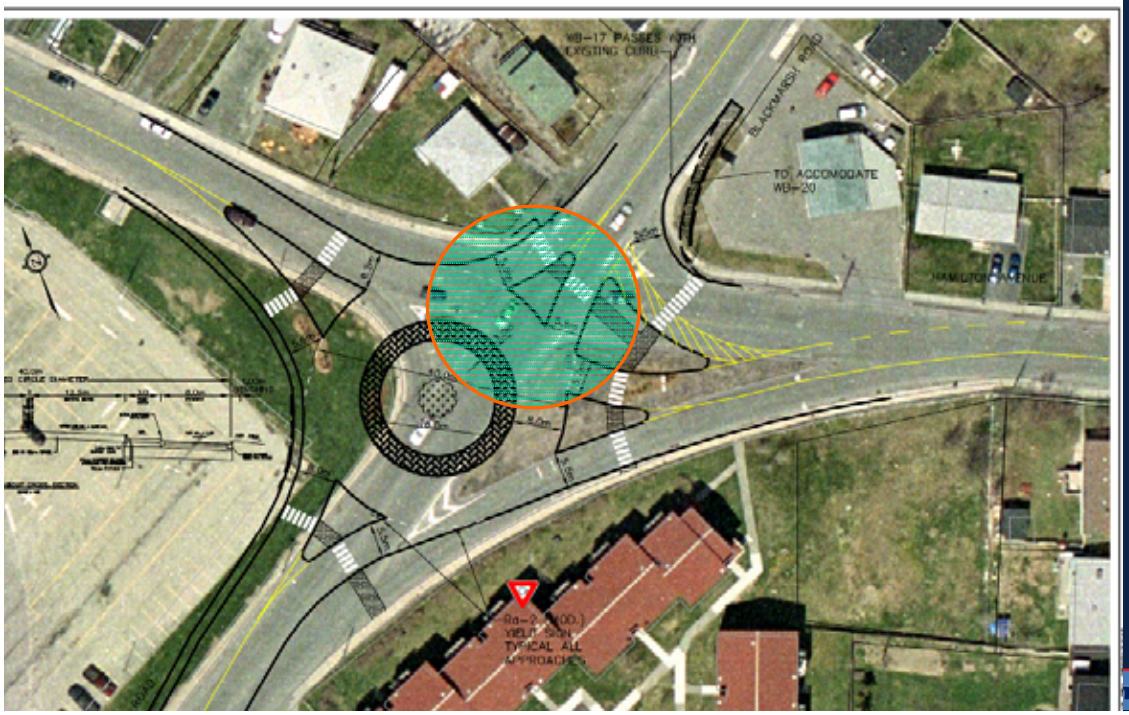
Selecting the Circle center

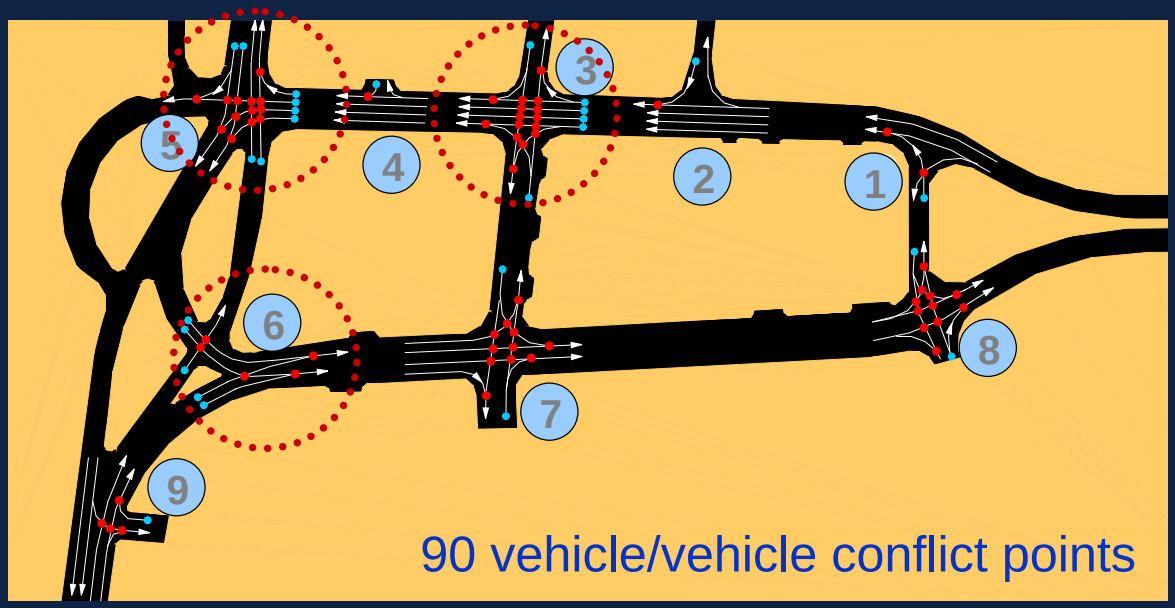


Getting the circle in the right place.
ROW avoidance and good entry curves
City of St. John's, Newfoundland by SRM Roundabouts CA



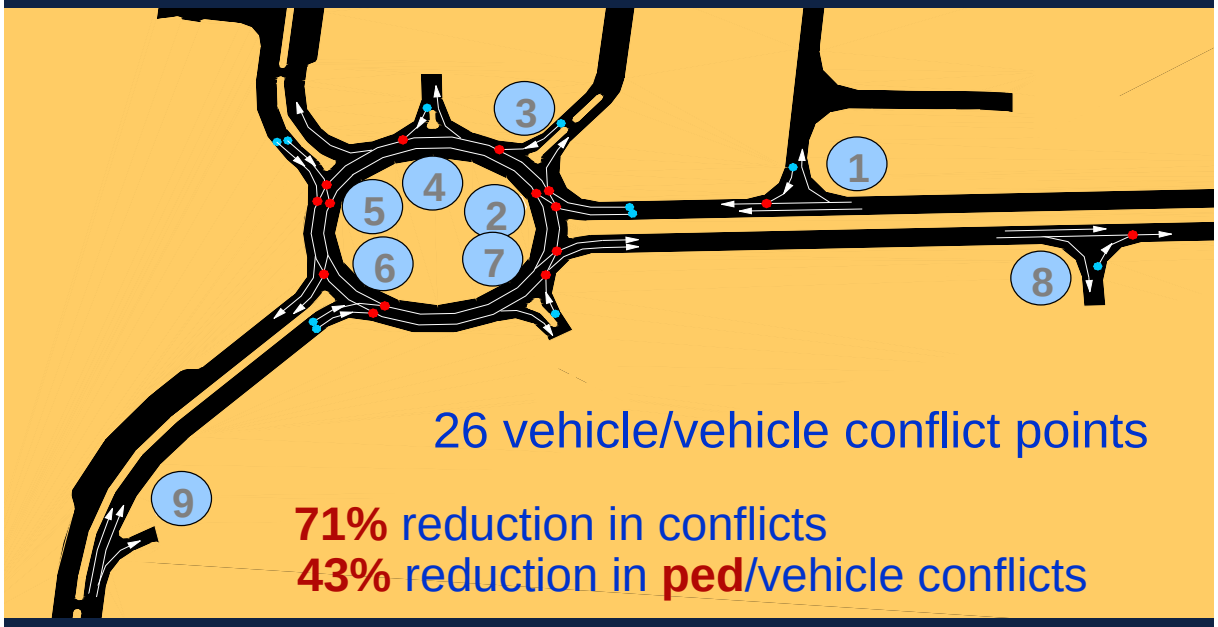
The Infamous Clearwater Florida Roundabout

Before Construction



90 vehicle/vehicle conflict points

Completed Entryway Roundabout



26 vehicle/vehicle conflict points

71% reduction in conflicts
43% reduction in **ped**/vehicle conflicts

way Roundabout

Alignment and arrangement at approach legs

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Over 260 crashes in 6 months
10 per week
Previous signal system had 1 per 2 wks

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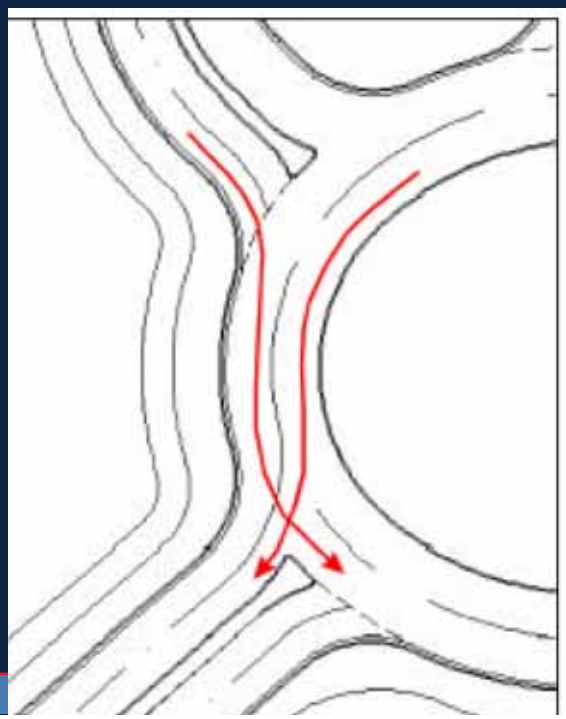
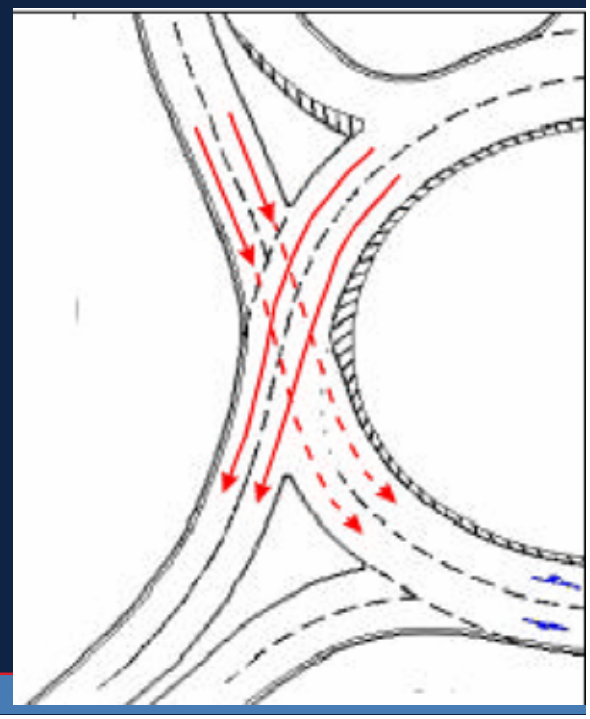
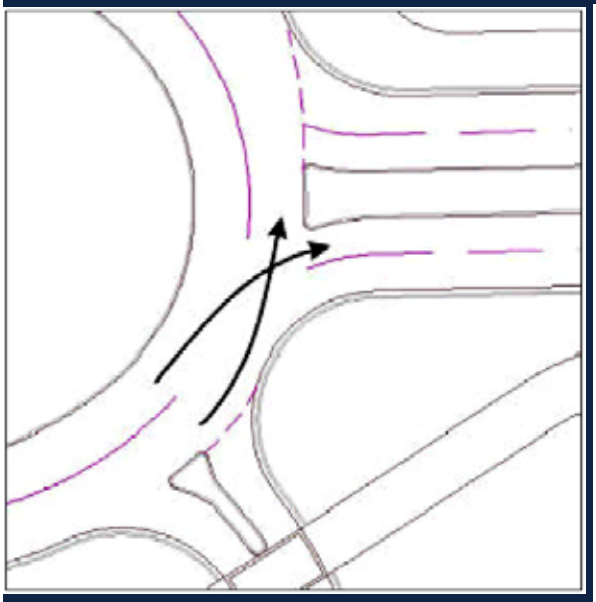
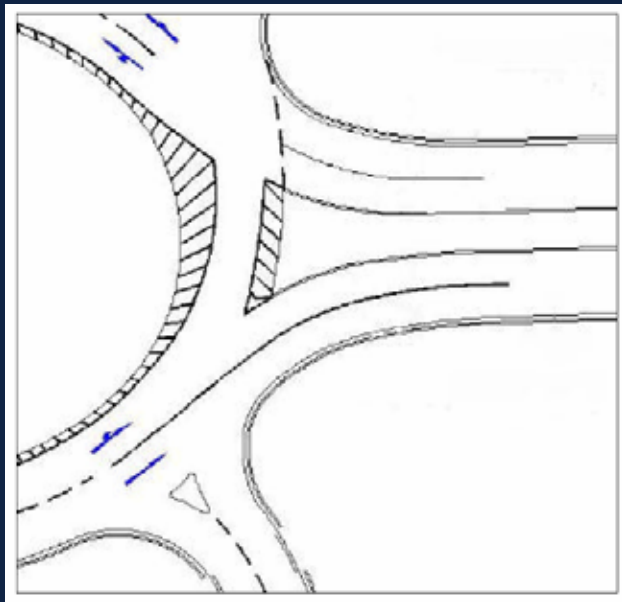
Hard objects in the central island and minimum sight distance

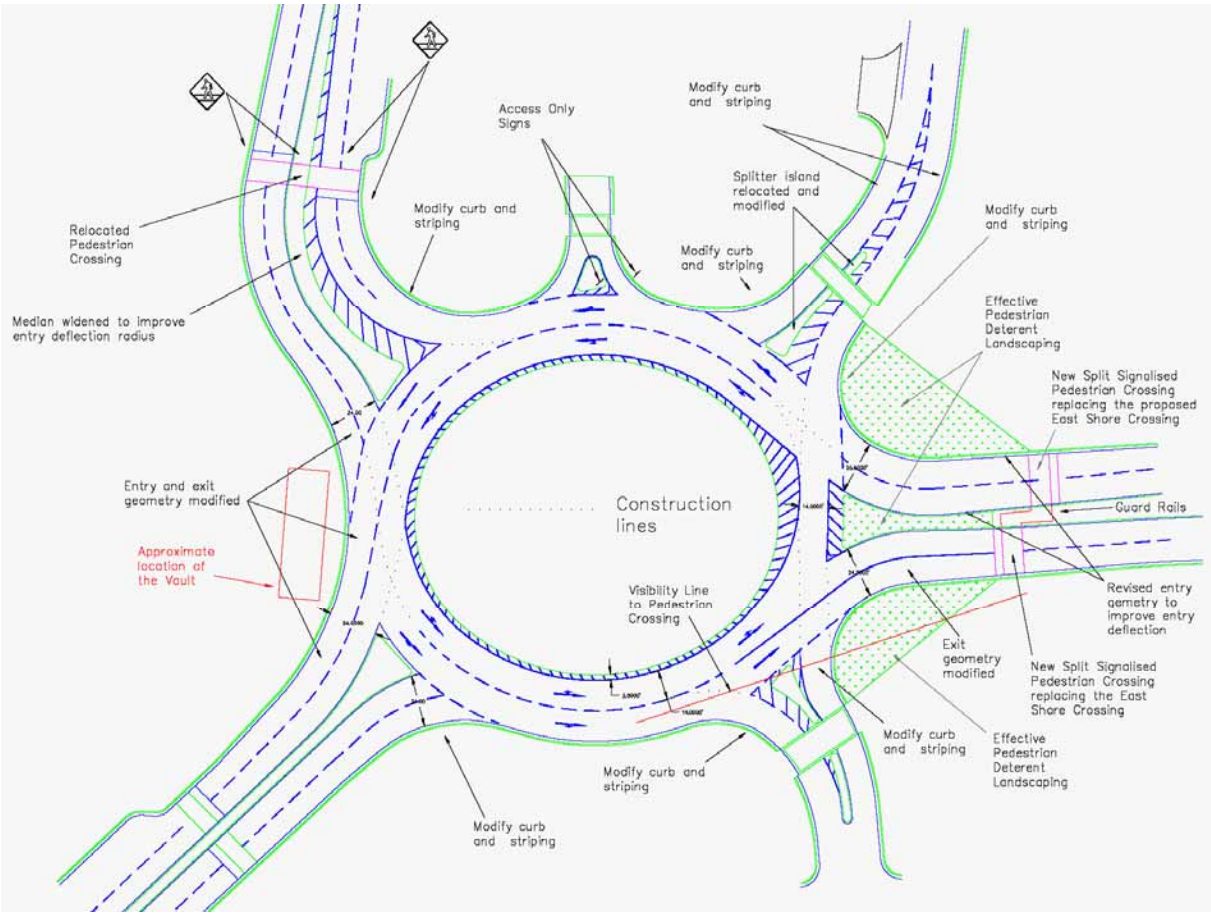
Tight Exit – and over taking turns











Clearwater 3 (02-3), Shape Changes
3 crashes in 18 months

Exit Overlap
"curve straightening"

Ineffective deflection

Ineffective Splitter; Low visibility; Little face of curb value; Little approach speed control prior to yield; Inadequate approach design considerations for left turn;. See-through island visibility; Tight exit radius on left; poor night visibility.

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Large Phi. If on the left, would you follow the curve? Would you over-lap?

Parametrix

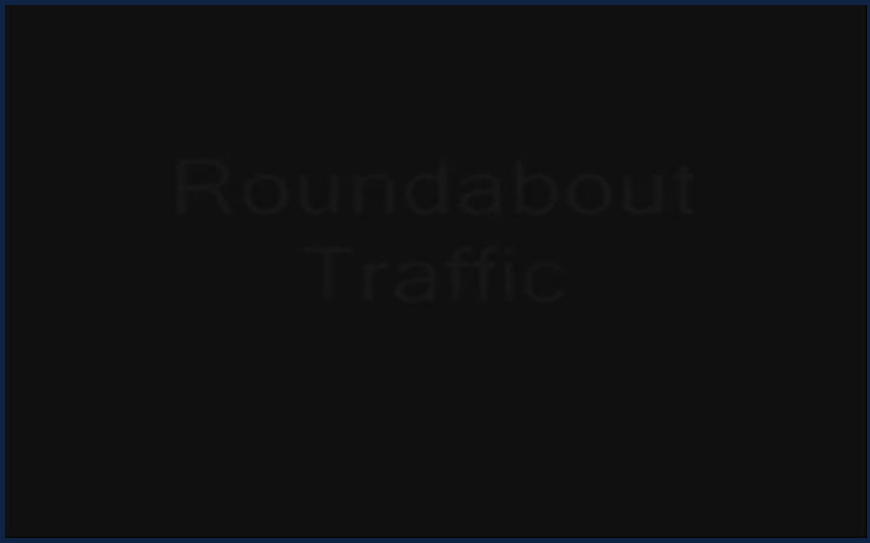
Neither of these sight distance restrictions would have been easily evident on the design plans.

Residential errors: Lg Phi, 6” apron, narrow road. Slow but unfriendly. Also- blocked sign

Movie – La Jolla buses

Movie. US 6, Post Road

Movie: SR 203 - Wash DOT
The fastest path for a truck



Movie: Modular Home, left turn

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