



Safety Auditing of Roundabouts: In-service or at Design



Design Principles:

- Effective Geometry
- Entry Deflection & Speed Consistency
- Design Vehicle
- Forward Visibility
- Signs and Markings
- Needs of Non-Motorized Users (VRU's)
- Lighting

• Composition based on principles is what determines the functionality

• If you only focus on the components the final assembly may be totally overlooked



Principles Based Safety Evaluation

Demands of Safe Intersection

Design:

1. Clarity of the situation for approaching drivers
2. Visibility between road users
3. Comprehensibility of traffic operations
4. Space for the largest permitted vehicles

Design Elements:

1. geometric layout; lateral and forward visibility
2. lateral and forward visibility
3. geometric layout; pedestrians; cyclists; signs and lighting
4. geometric layout

Common Problems With Roundabouts

| <u>PROBLEM</u> | <u>PERCENTAGE</u> |
|-----------------------|-------------------|
| Signs | 15% |
| New Markings | 9% |
| Cyclists | 7% |
| Inadequate Deflection | 7% |
| Delineation | 6% |
| Lane Configuration | 6% |
| Pedestrians | 6% |
| Visibility | 6% |
| Sight Lines | 6% |
| Pole Location | 5% |
| Lighting | 5% |

Traffic Design Group for Transfund New Zealand, The Ins and Outs of Roundabouts - Safety Auditors' Perspective, 2002



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Effective Geometry

Geometric Parameters in the Predictive Relationship:

- Entry Path Curvature
- Entry Width
- Approach lane(s) width
- Angle between arms
- Inscribed Circle Diameter/Central Island Diameter

• (U.K. Research TRL Report LR 1120)

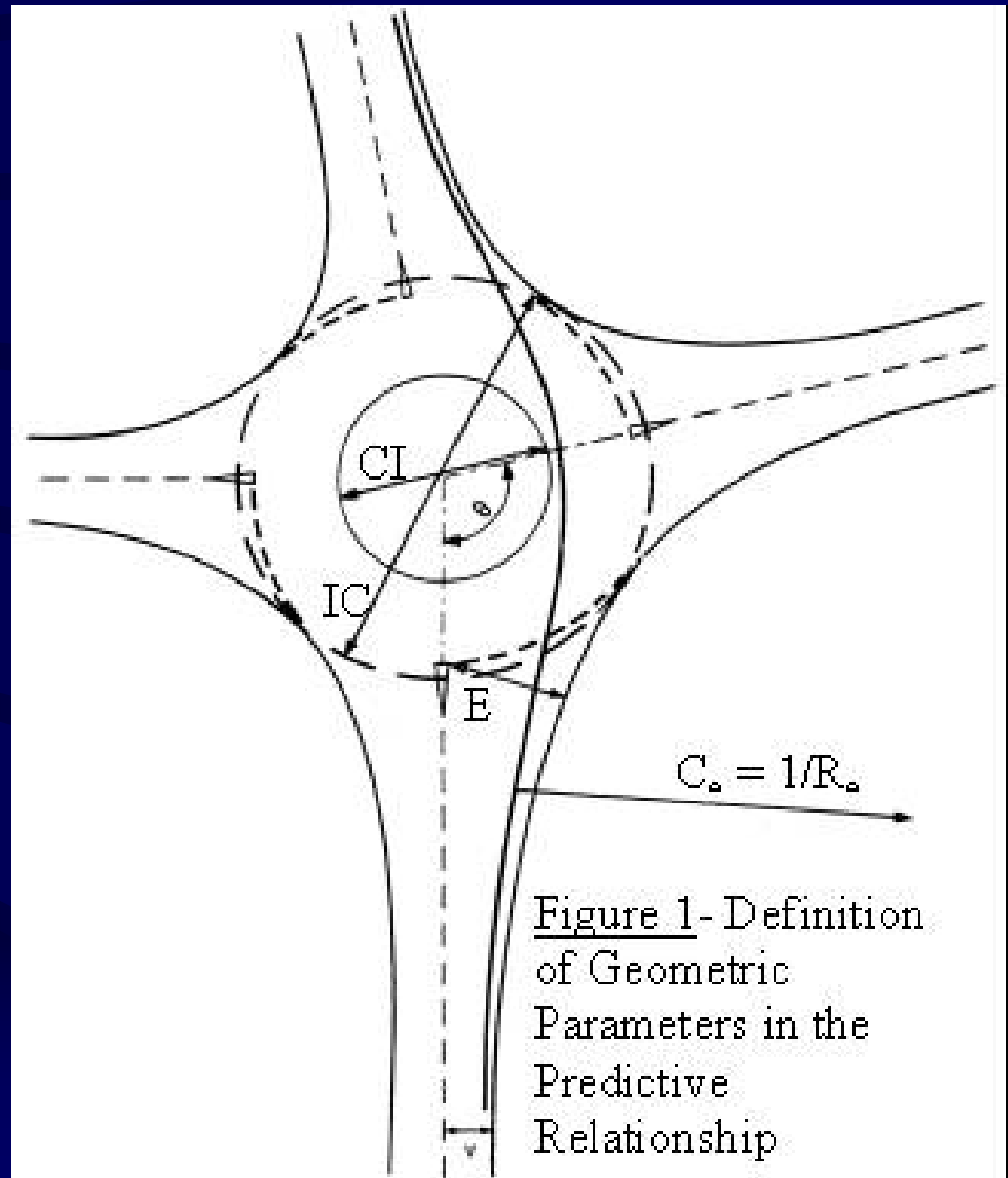


Figure 1- Definition of Geometric Parameters in the Predictive Relationship



Safety Issue: Inadequate Deflection

CAUSE/RESULTS:

- Speed of entry too fast
- Impacts pedestrian safety
- Entry circulating crashes
- SMV crashes

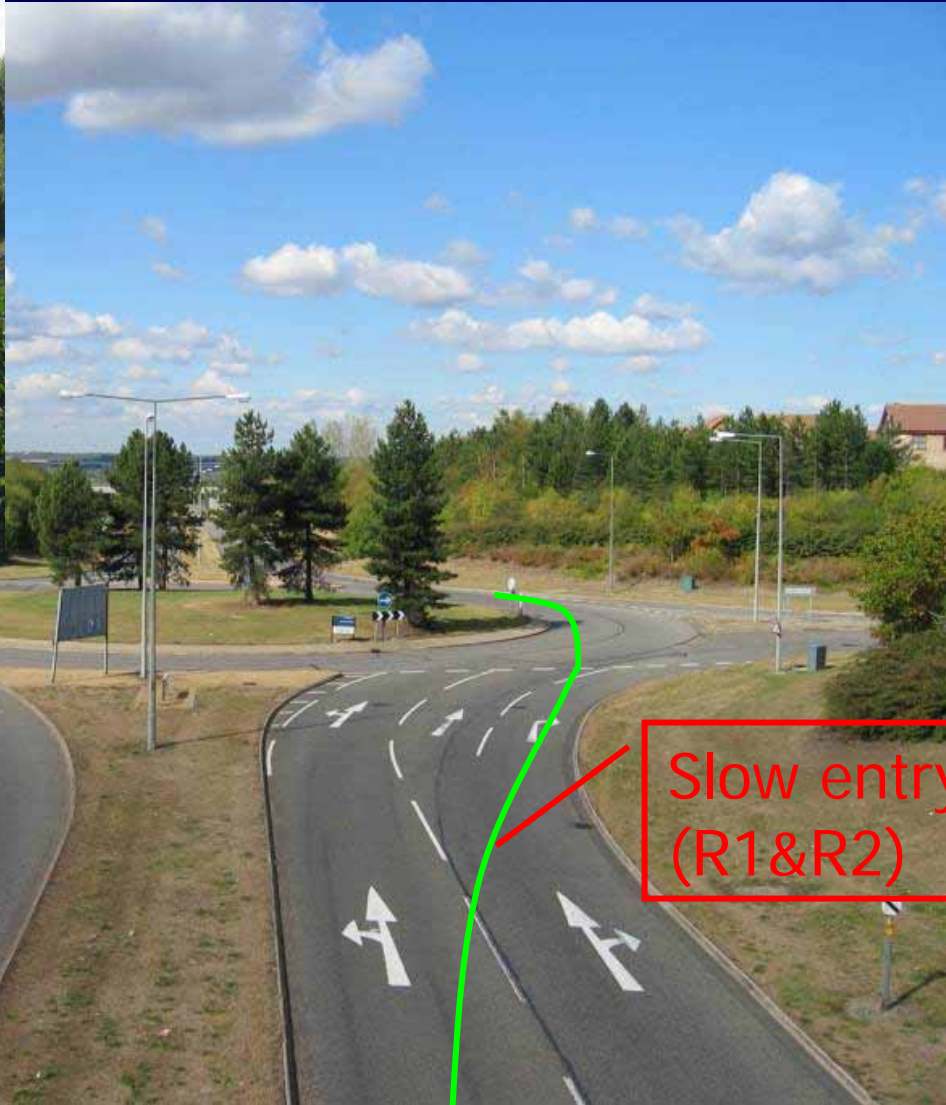
SOLUTIONS:

- Adjust ICD size
- Adjust entry radius
- Offset entry alignment
- Apply EPC based on traffic flows - ACCIDENT CHANGE IS A NET EFFECT



Courtesy of M. Johnson

Good EPC = Deflection





Safety Issue: Entry/Exit Path Overlap

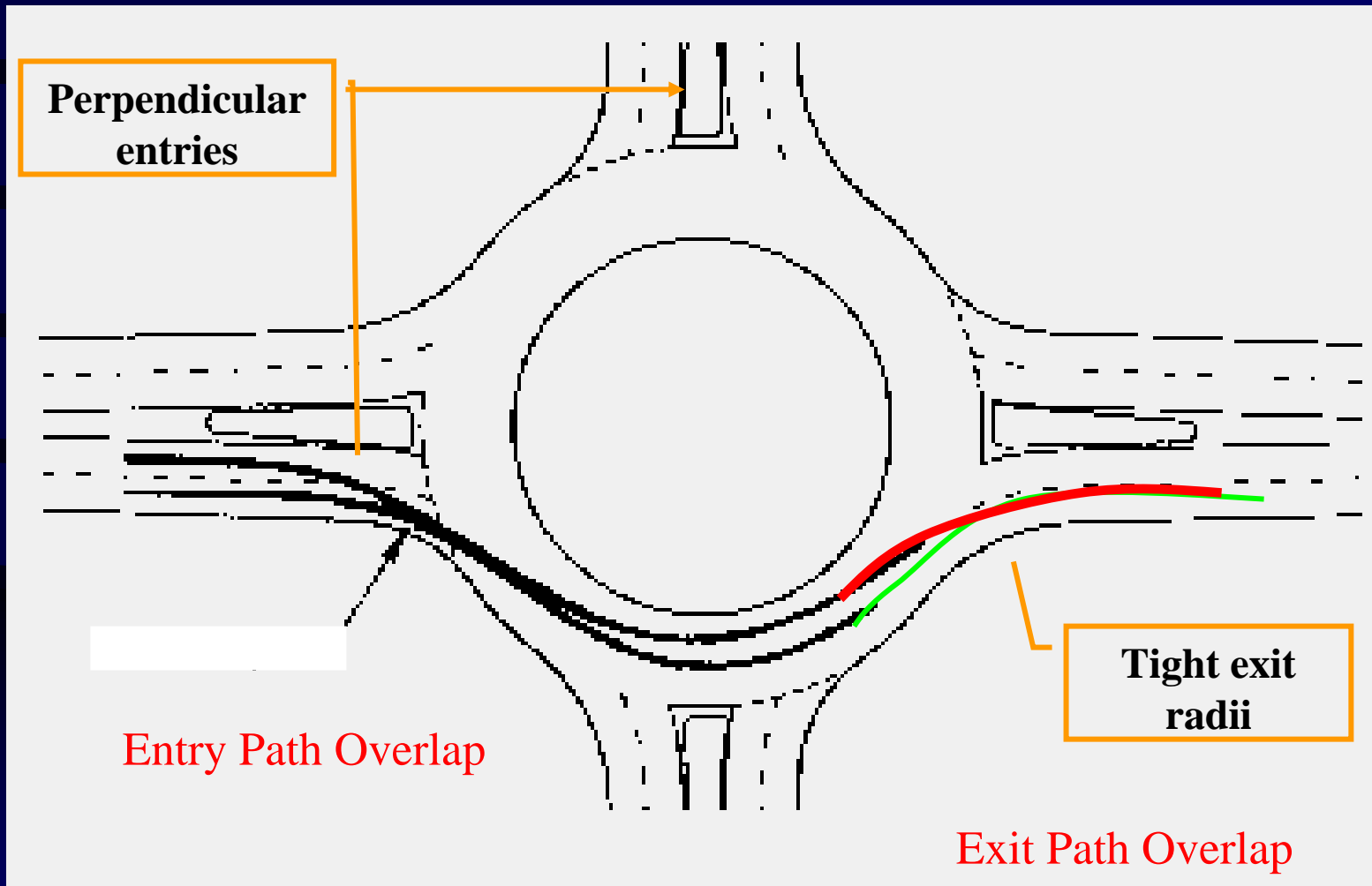
CAUSE/RESULTS:

- Unnatural vehicle paths
- Sideswipe or rear-end entry-entry or exiting crashes (lane change)

SOLUTIONS:

- Increasing entry and/or exit radii
- Modify entry angle (compound radii and tangential entry/exit)
- Road markings (exit striping)

Safety Issue: Entry/Exit Path Overlap



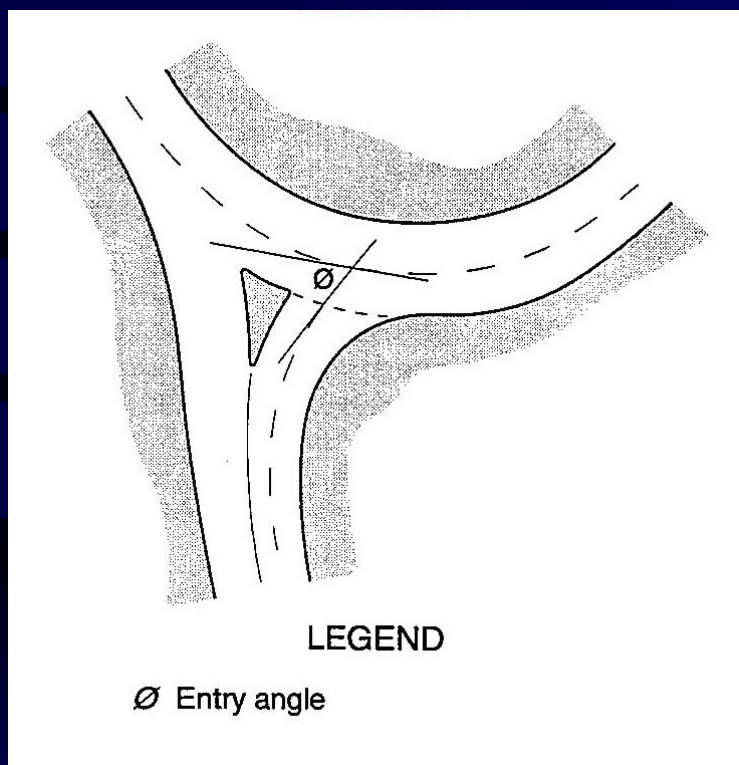
Non-Tangent Exit Path Design



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Entry Angle & Entry Radius

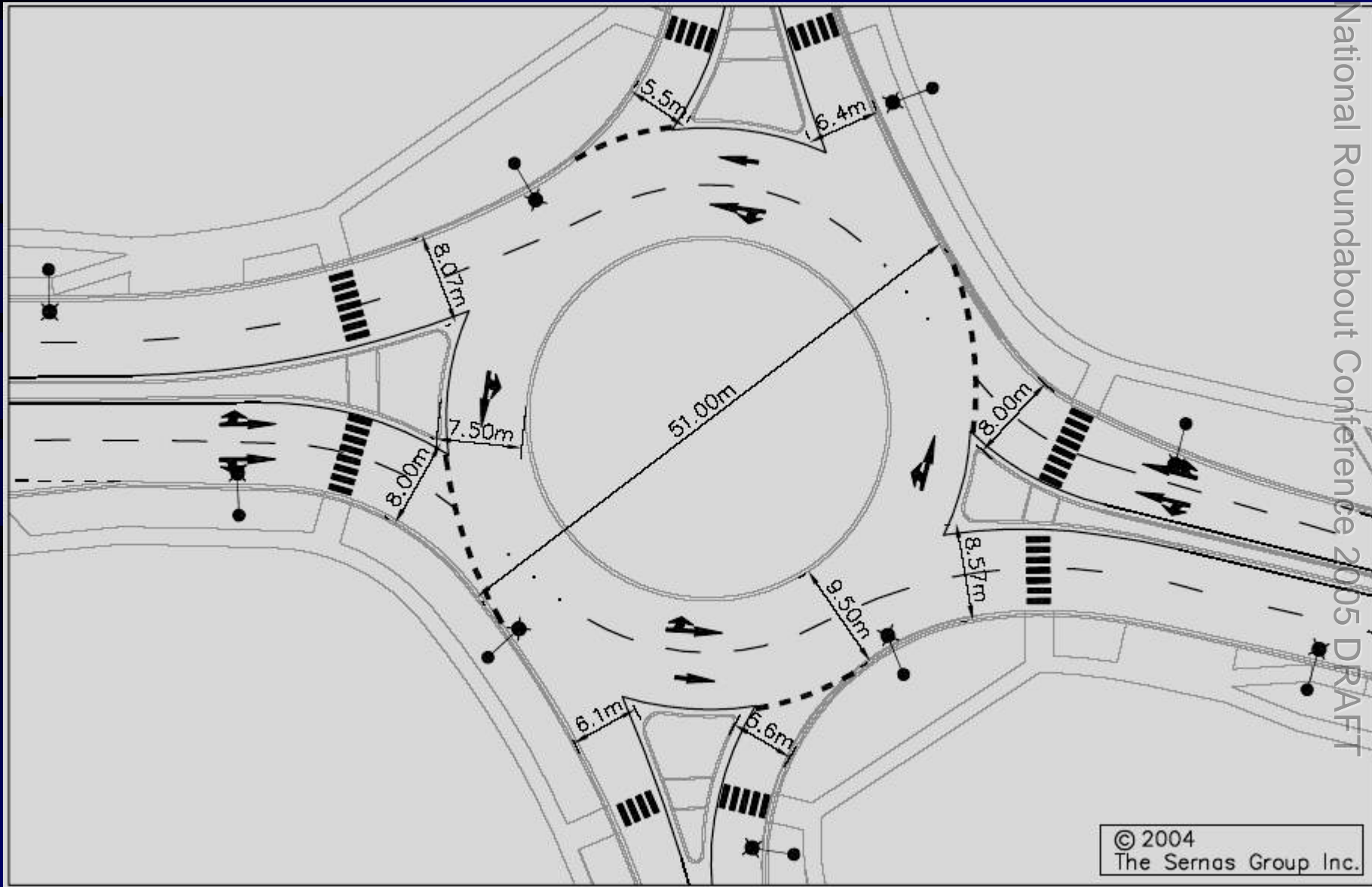


- Perpendicular approaches:
 - Large entry angle
 - Small entry radius
 - Lots of deflection

Combined Net Effect:

- Low capacity
- Abrupt braking at entries and potential for rear-end crashes (especially in high-speed locations)

Safety Issue: Avoiding or repairing Entry/Exit Path Overlap



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Safety Issue: Markings





Safety Issue: Markings

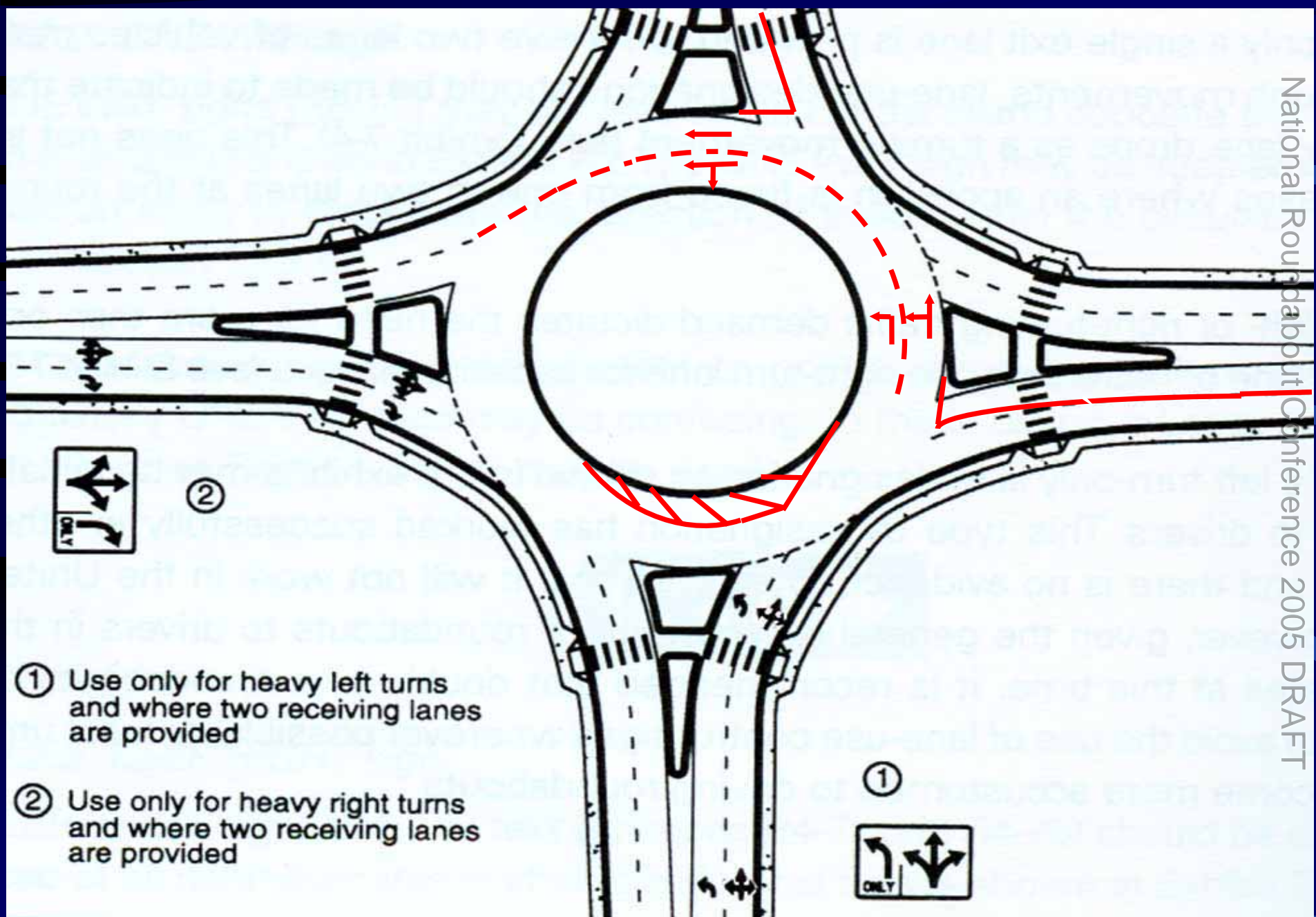
CAUSE/RESULTS:

- Violation of regulatory traffic circulation
- Incorrect lane choice – exit crashes (sideswipe)
- Sudden lane changes
- Improper left turns
- Navigational and way-finding errors

SOLUTIONS:

- Lane arrows on circulatory opposite splitter islands
- Use lane designation arrows
- Use of exit stripes
- Use of spiral marking
- Design the geometry & markings

FWHA Guide gets arrows / stripes wrong





Safety Issue: Signage

CAUSE/RESULTS:

- Violation of regulatory traffic circulation
- Incorrect lane choice – exit crashes (sideswipe)
- Single motor vehicle crashes
- Poor guidance – warning of hazards – fixed objects e.g. splitter island
- Poor spacing of signs
- Improper left turns
- Navigational and way-finding errors

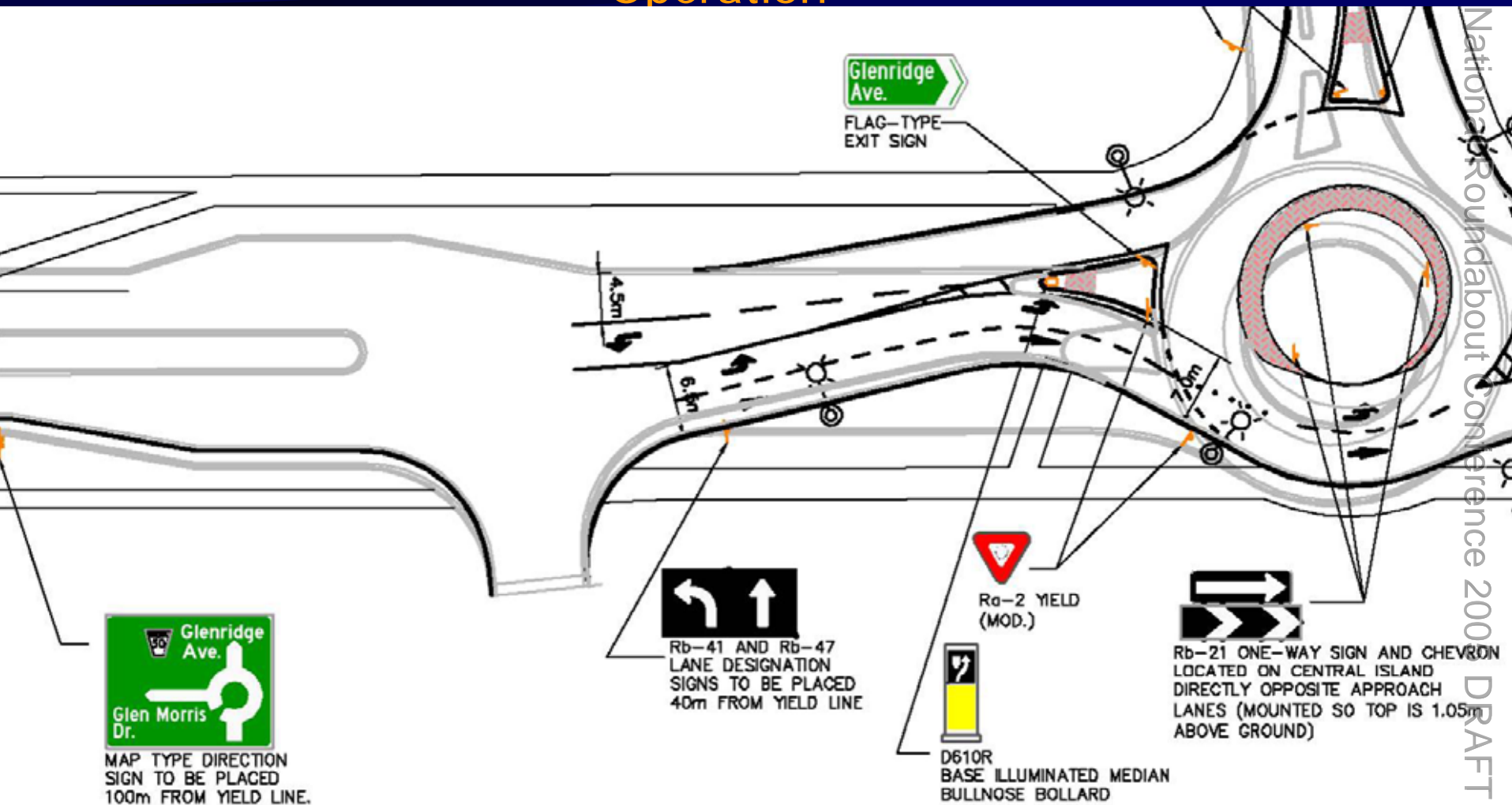
SOLUTIONS:

- Enlarge central island chevrons
- Use lane designation signs
- Use of illuminated signs
- Use of map-type guide signs

Safety Issue: Signage



Combined Signs and Markings – Promotes Holistic Operation

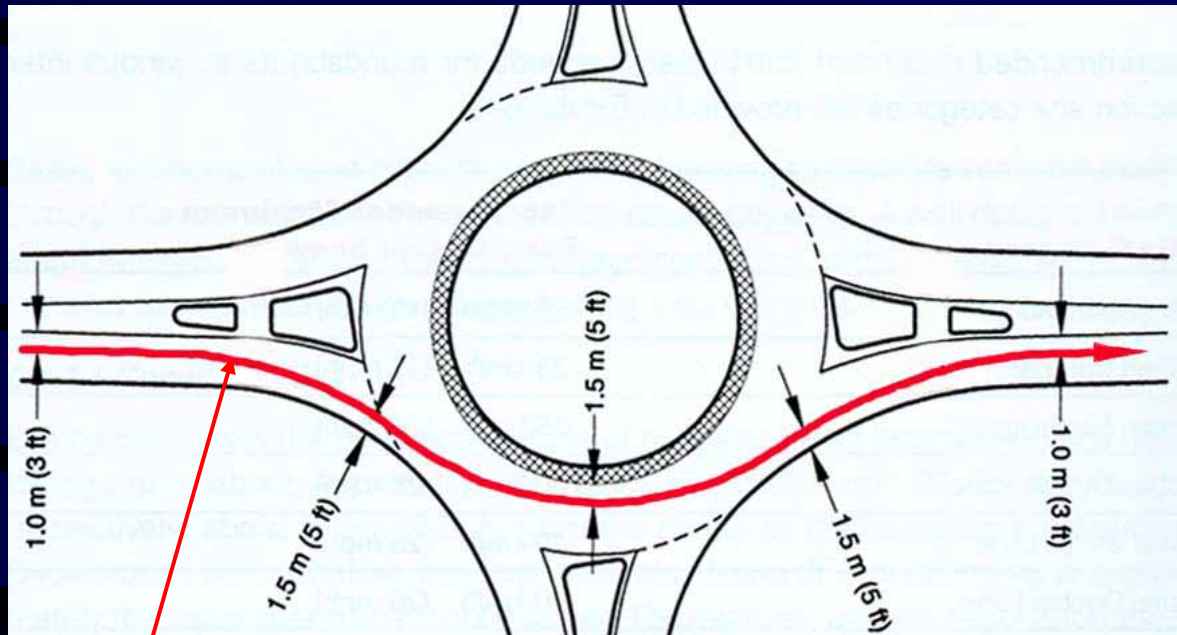


Yellow Bar Markings





APPLYING ENTRY PATH CURVATURE



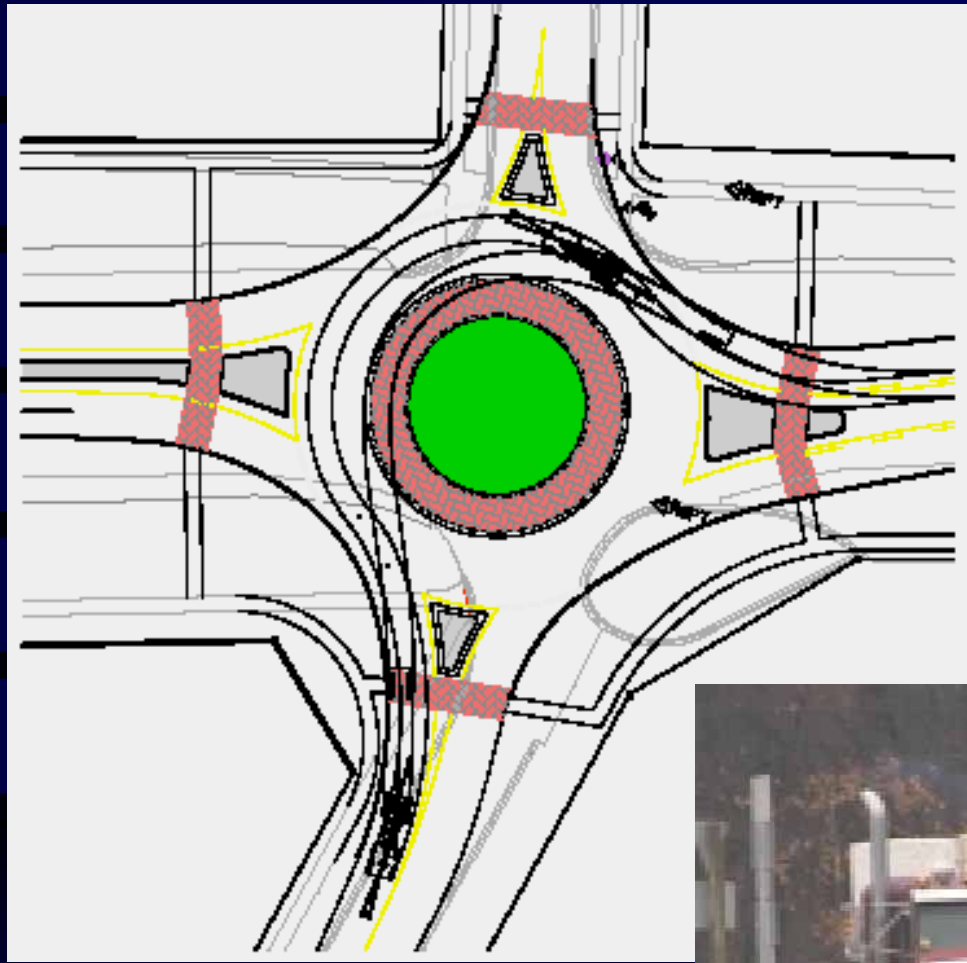
- Reduces Entry Circulating Accidents
- Increases Approach Accidents
- Increases Single Vehicle Accidents
- ACCIDENT CHANGE IS A NET EFFECT
 - Depends on traffic flows

EPC: $R1 < 70m$ for Single Lane Entries

$R1 < 100m$ for Multi-lane Entries

Safety Issue: Failure to Accommodate Large Vehicles

ACCOMMODATION OF LARGE VEHICLES

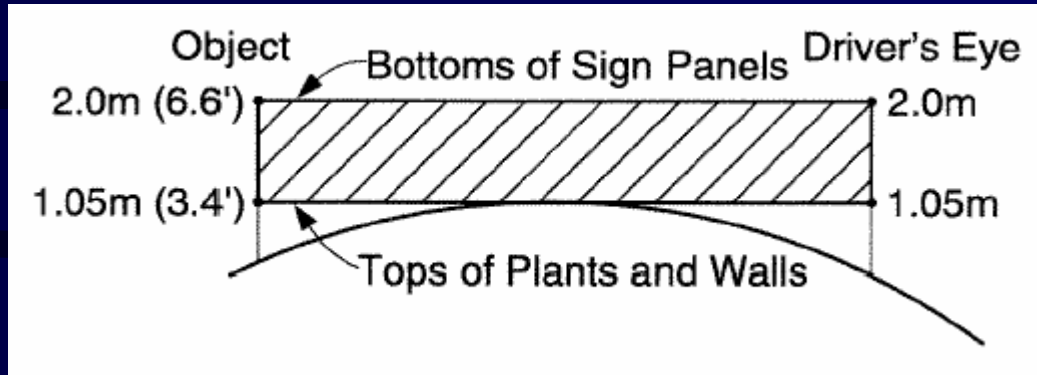


Safety Issue: Visibility

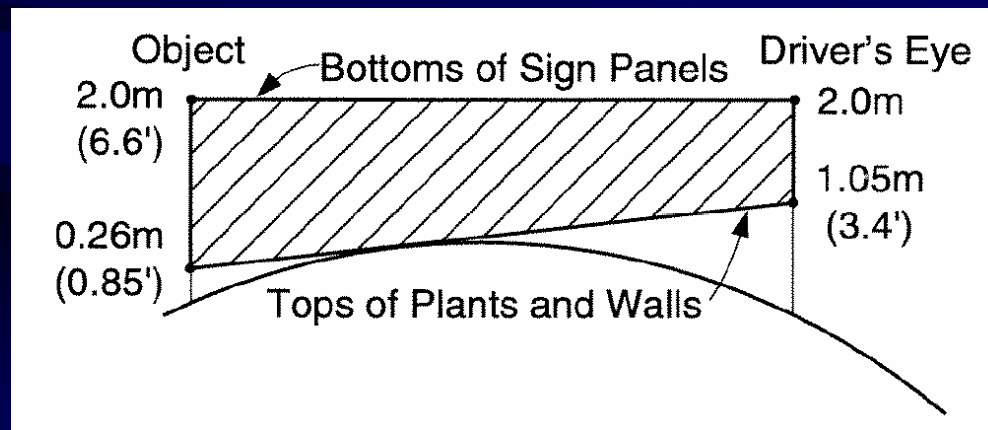
Sight Distance Check



VERTICAL SIGHT CLEARANCE REQUIREMENTS



Visibility to the left at entry



All other visibility



Safety Issue: Central Island and Splitter Island Conspicuity

CAUSE/RESULTS:

- Inconspicuous central island or splitter islands
- Poor guidance – surprise condition
- Single motor vehicle crashes
- Improper left turns

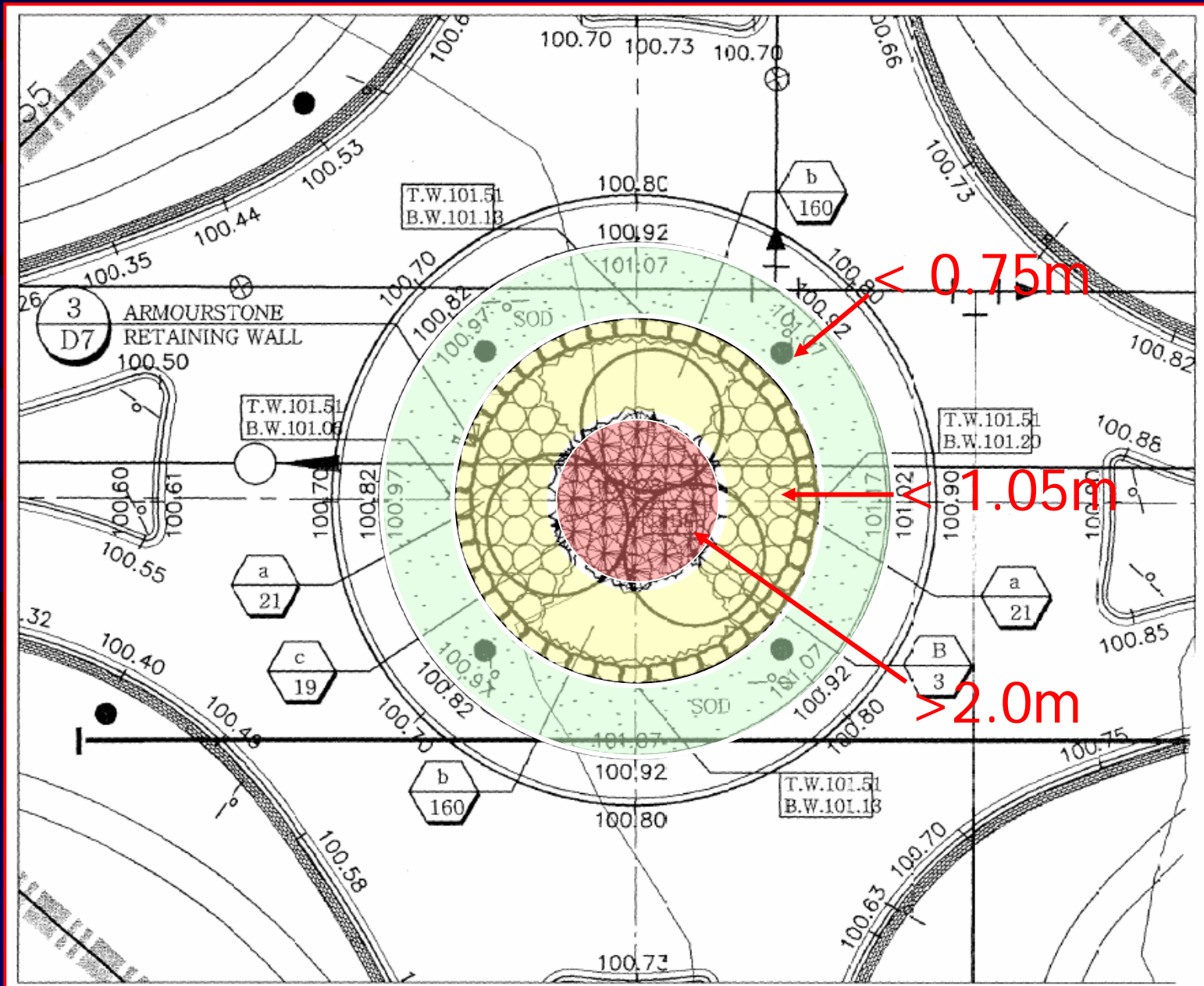
SOLUTIONS:

- Increasing height of central island through grading and or planting
- Signage

Central Island Conspicuity



Use Scale and Definition of Plantings



Central Island Delineation



Cross-Section – Splitter Island Visibility





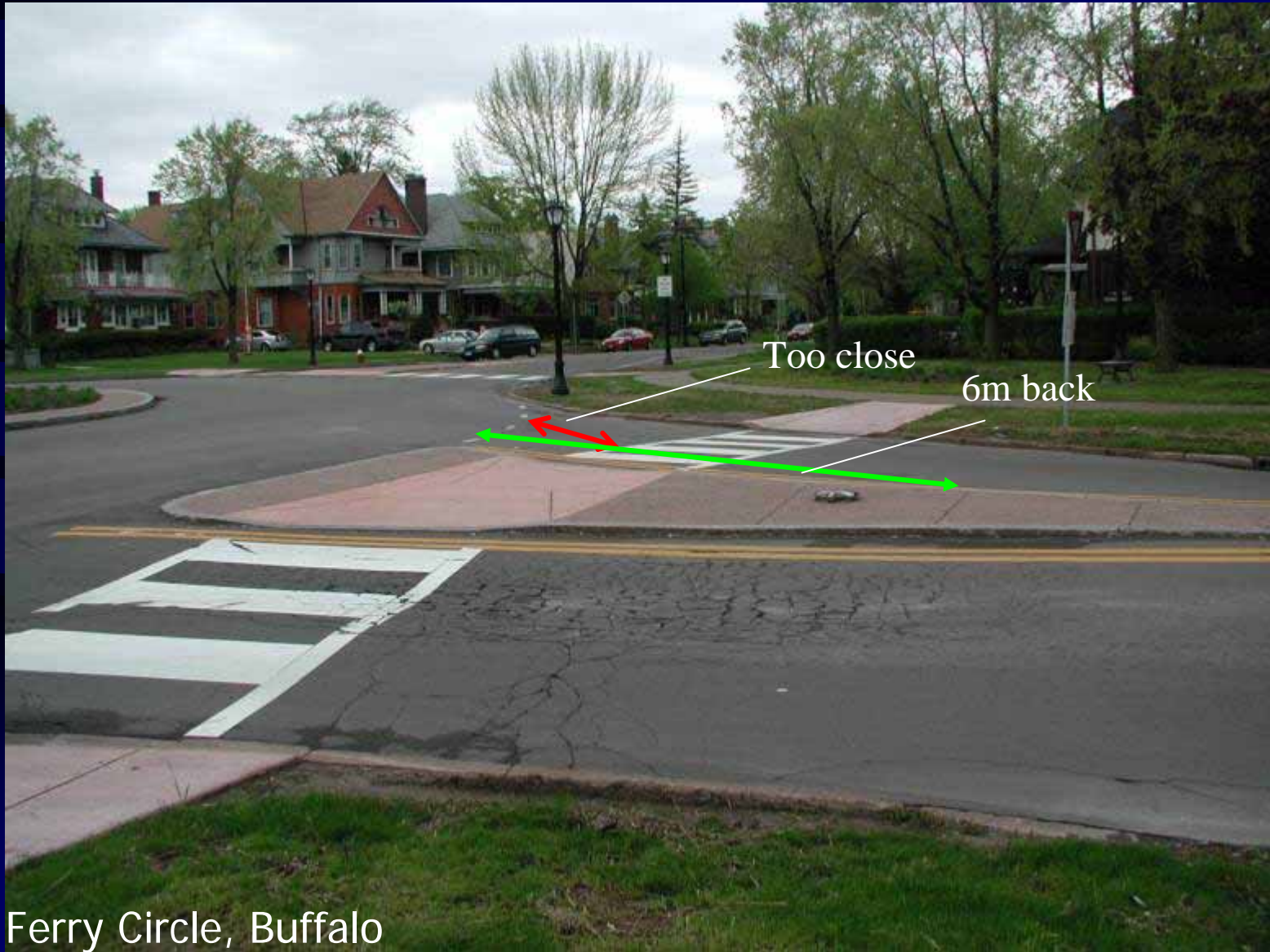
Safety Issue: Non-motorized Users



Pedestrian Safety Considerations

- Provide adequate deflection to reduce entry speed
- Provide splitter islands as large as the site allows.
- Provide clearly defined splitter island crossings.
- Prohibit parking on approaches
- Assure street lighting illuminates the pedestrian from the drivers view – not shadow back lighted
- Locate signs so users perceive an easily recognizable intersection layout.

Cross Walk Location



Ferry Circle, Buffalo

Accommodating Visually Impaired



Signalized Split Crosswalk



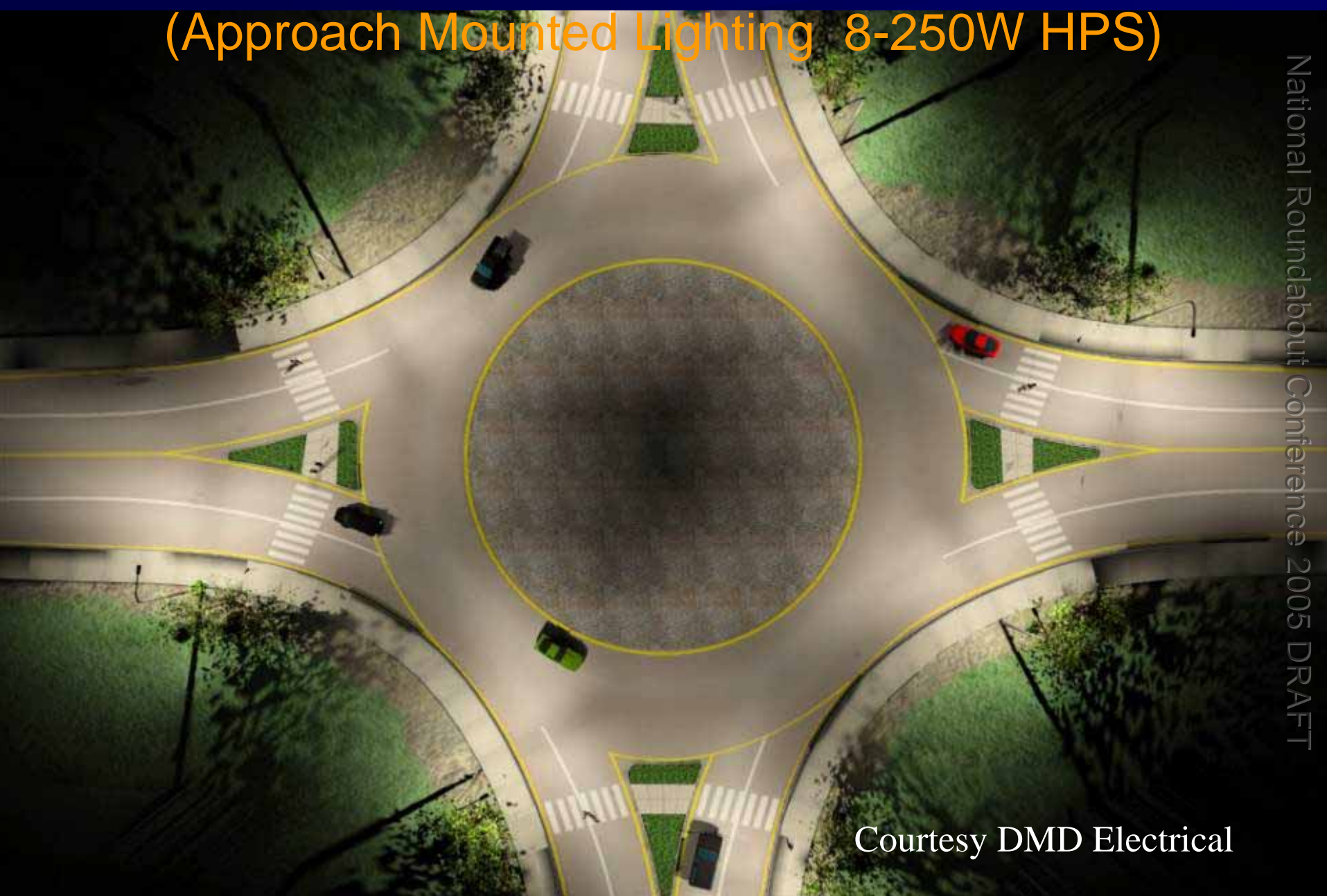
Tactile Crossing Areas and Angled Crossings



Truncated Domes
U.S. Access Board
Approved



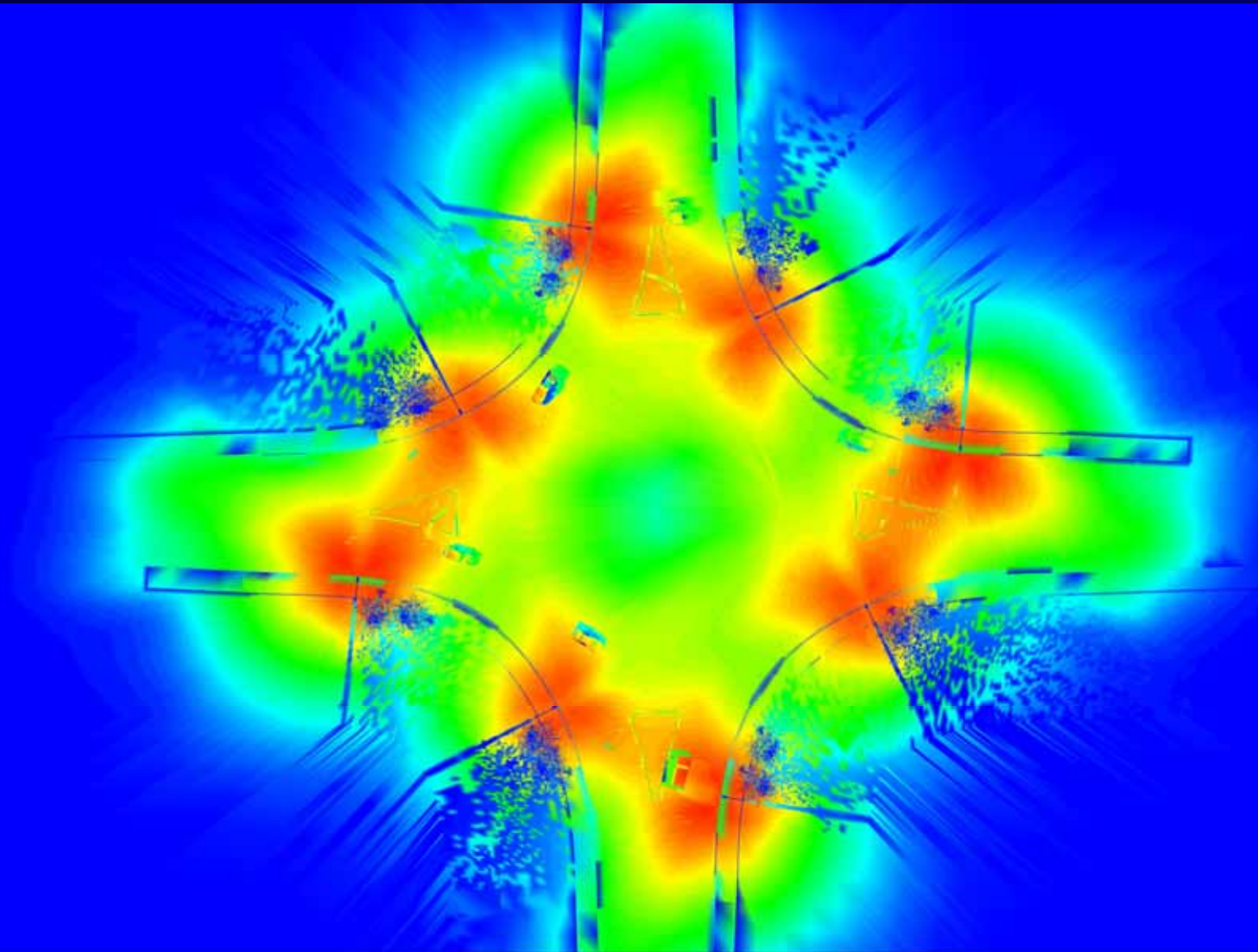
Contrast Lighting and Vertical Illumination (Approach Mounted Lighting 8-250W HPS)



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Courtesy DMD Electrical

Approach Mounted Lighting 8-250W HPS



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Center Lighting



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Approach Lighting



Courtesy of
DMD Electrical
Consultants

may.03

CONFLICT & TRADE-OFF

- Often the aims conflict
- Trade-offs are needed
- Optimisation required
- No Finish Line (Design Domain)

