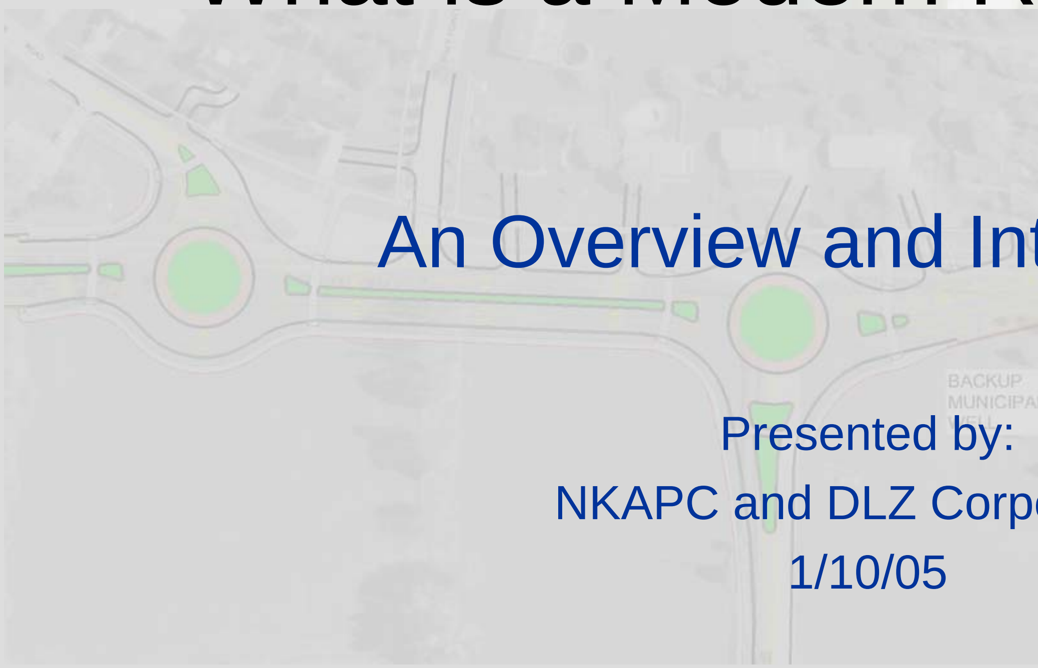
What is a Modern Roundabout?



An Overview and Introduction

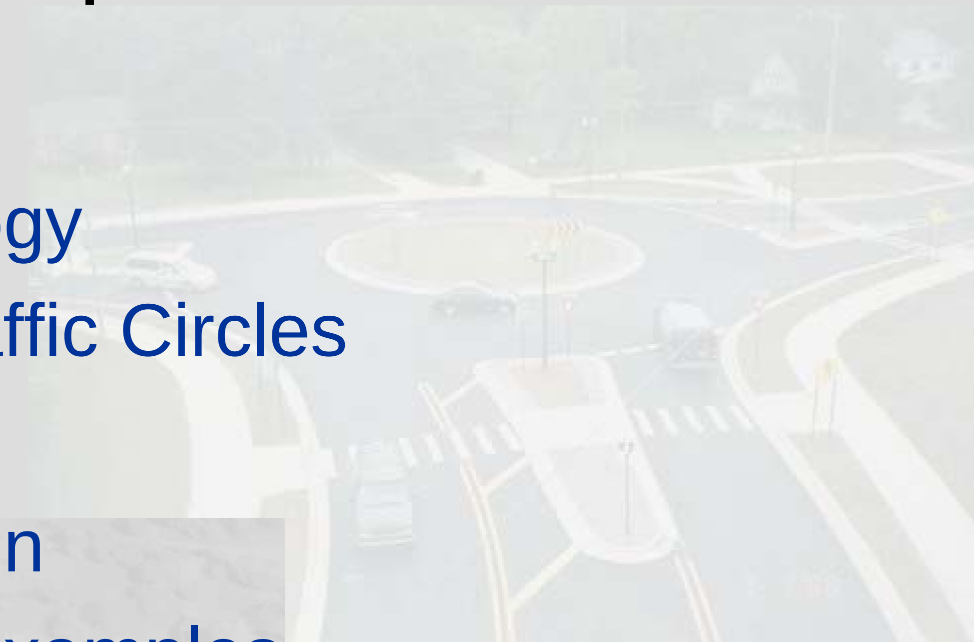
Presented by:

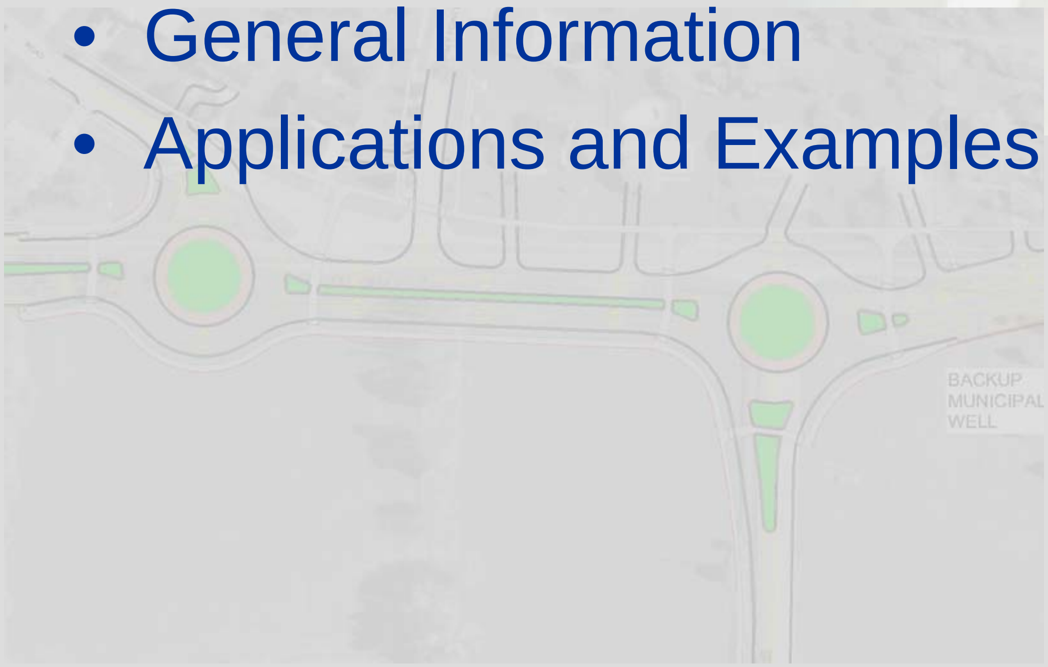
NKAPC and DLZ Corporation

1/10/05

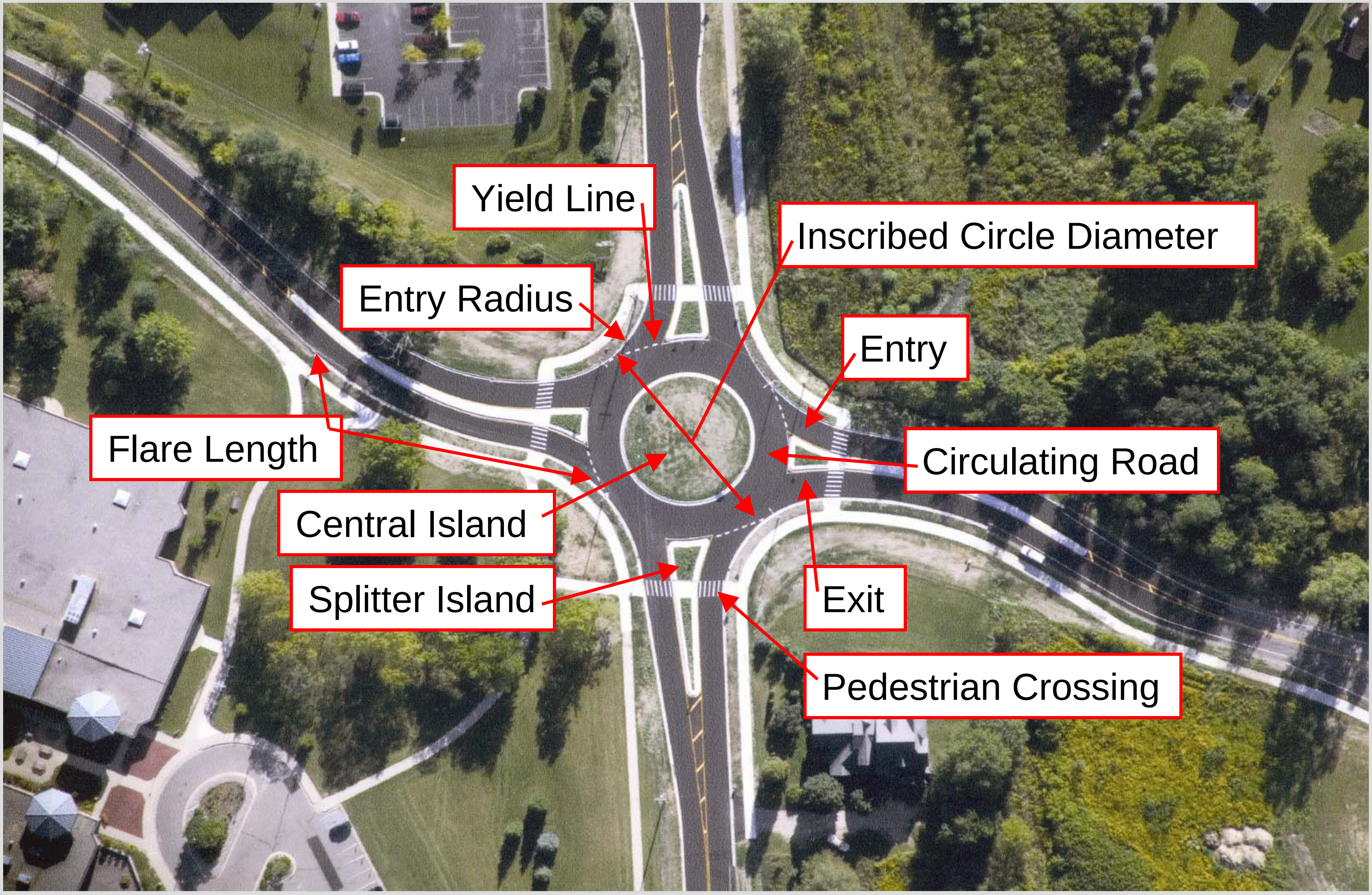
Topics

- General Terminology
- Comparison to Traffic Circles
- Video Clips
- General Information
- Applications and Examples





Roundabout Terminology



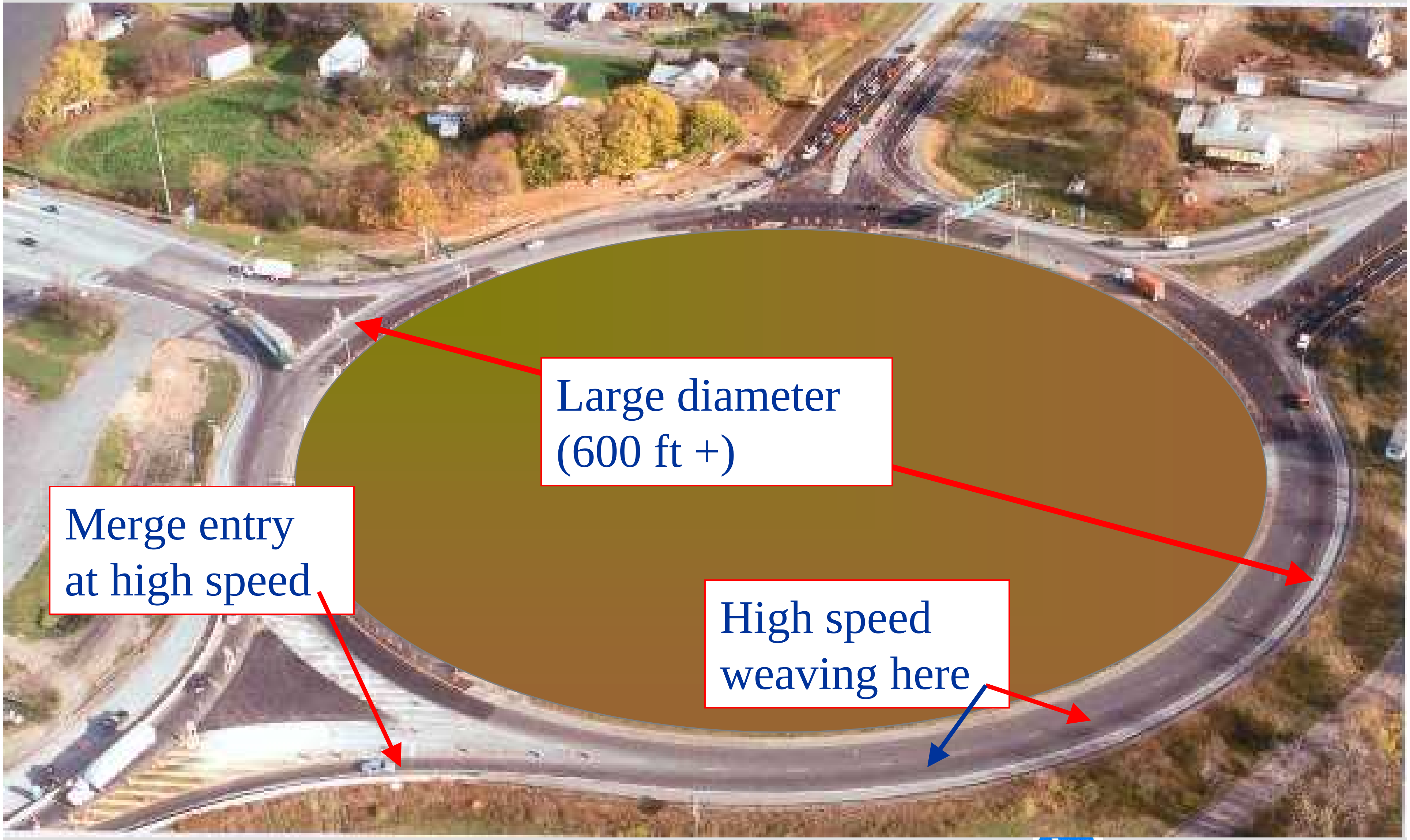
What is a Modern Roundabout?

- Many misperceptions
- Not simply a circular intersection
- All **<u>true</u>** roundabouts include:
  - Circular roadway
  - Yield at entry
  - Low speeds due to curvature
  - Precisely designed based on local peak hour traffic volumes
- Great variety
- **<u>Not the same as traffic circles</u>**

What are the Differences?

- Classic Traffic Circle ("Rotary")
  - Large diameter - high circulating speeds
  - Shallow angle entry merge - high entry speeds
  - High speed weaving to exit
- Modern Roundabout
  - Small diameter - low circulating speeds
  - Larger entry angle with yield - lower entry speeds
  - No weaving/lane changing
- Hybrid
  - Many U.S. traffic circles

Kingston, NY – Traffic Circle



Kingston, NY – Traffic Circle Conversion to Roundabout

Example of Modern Roundabout

Practical Differences

- Traffic Circles:
  - More crashes when volumes increase – can exceed signal
  - Congestion (capacity determined by weave/merge)
  - Gridlock
- Roundabouts:
  - Opposite of traffic circles
  - Low crashes
  - No congestion (capacity determined by geometry)
  - Promising at many intersections

Marsh - Hamilton Roundabout

Colorado Roundabout

Please Note:

- 2 lanes
- Downstream gaps available
- Low speeds – real time
- Minimal delays/backups
- Signal platoon arrival
- Aesthetic enhancements

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Traffic Circle Video Clip

General Information

Type of Roundabout	Typical ICD	Typical Maximum Volume	Comments
Mini	< 95 feet	Varies	•Very high capacity for size •Only where speeds < 30 mph •Traversable central island •1-3 lanes
Compact Urban	< 130 feet	Varies	•Only where speeds < 30 mph •Central island not traversable •1-2 lanes
Conventional Medium and Large	> 130 feet	Varies	•Speeds up to 70 mph •Flared or parallel approaches •1-3 lanes, 4 lanes possible
Single Lane	100 – 160 feet	Up to 2,000 vph	•Most common in U.S. •Relatively simple to design
Two Lane	150 – 210 feet	Up to 4,000 vph	•Moderately to very complex
Three Lane	210 – 250 feet	4,000+ vph	•Very complex
Four Lane	210 – 250 feet	4,000+ vph	•Usually just one entry

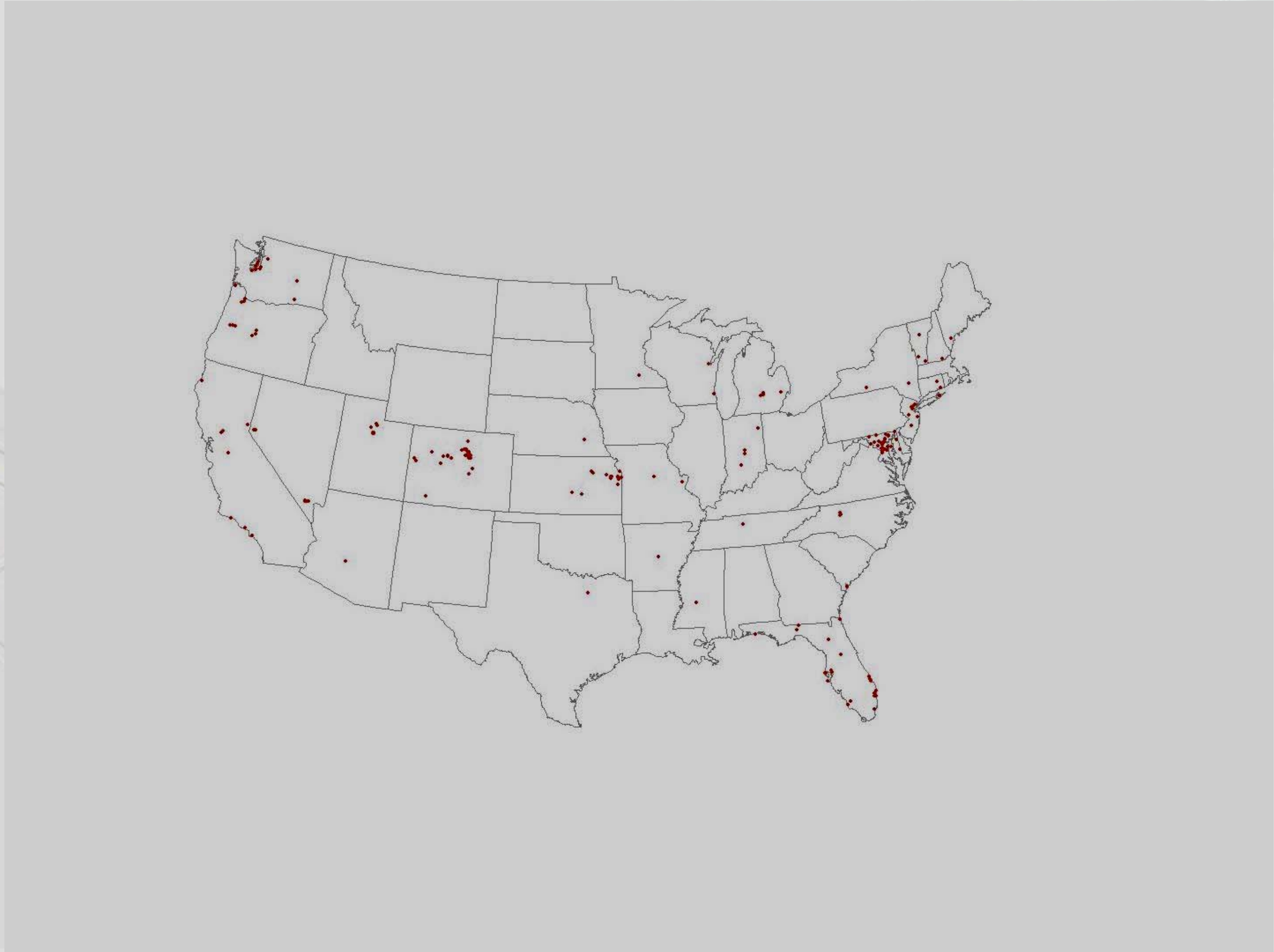
Roundabouts: Pros and Cons

- Pros
  - Good traffic operations/low delays
  - Very safe when designed properly
  - Look attractive
  - Slows all traffic - calming effect
  - Low maintenance cost
  - Easily modified
  - Construction cost (no need to widen approach roads)
- Cons
  - Bicyclists should not circulate in roundabout
  - Blind pedestrians have expressed concern
  - Construction cost/ROW requirements at intersection
  - Learning curve for drivers – uncertainty
  - Improper design can cause problems

Other General Information

- Hundreds of roundabouts constructed over last 10 years in U.S.
- One, two, and three lane entries (complexity varies)
- Drivers have quickly adapted where constructed elsewhere in U.S. (including older drivers)
- Can be designed to accommodate large trucks
- U.S./international studies have shown when signals/stop control replaced with roundabouts:
  - Reduction in overall crashes
  - Large reduction in injury crashes
  - Large reduction in serious injury/fatality crashes

Roundabout Locations



Useful Applications

- Safety problems
- Capacity problems
- Closely spaced intersections
- Unusual geometry
- Residential areas – traffic calming
- Locations where signal would require bridge widening/lengthening – Interchanges and rail
- Locations where sight triangles are obscured for signals
- Context sensitive applications

High Speed Rural Locations
Maryland Roundabout Tour

- **MD 213 at Leeds Road**
- **AADT 8,125 (1997)**
- **Complete in Aug 1995 - first roundabout**
- **High speed rural**
- **Single Lane**
- **Landscape maintained by father of child killed before roundabout**

High Speed Rural - Kansas

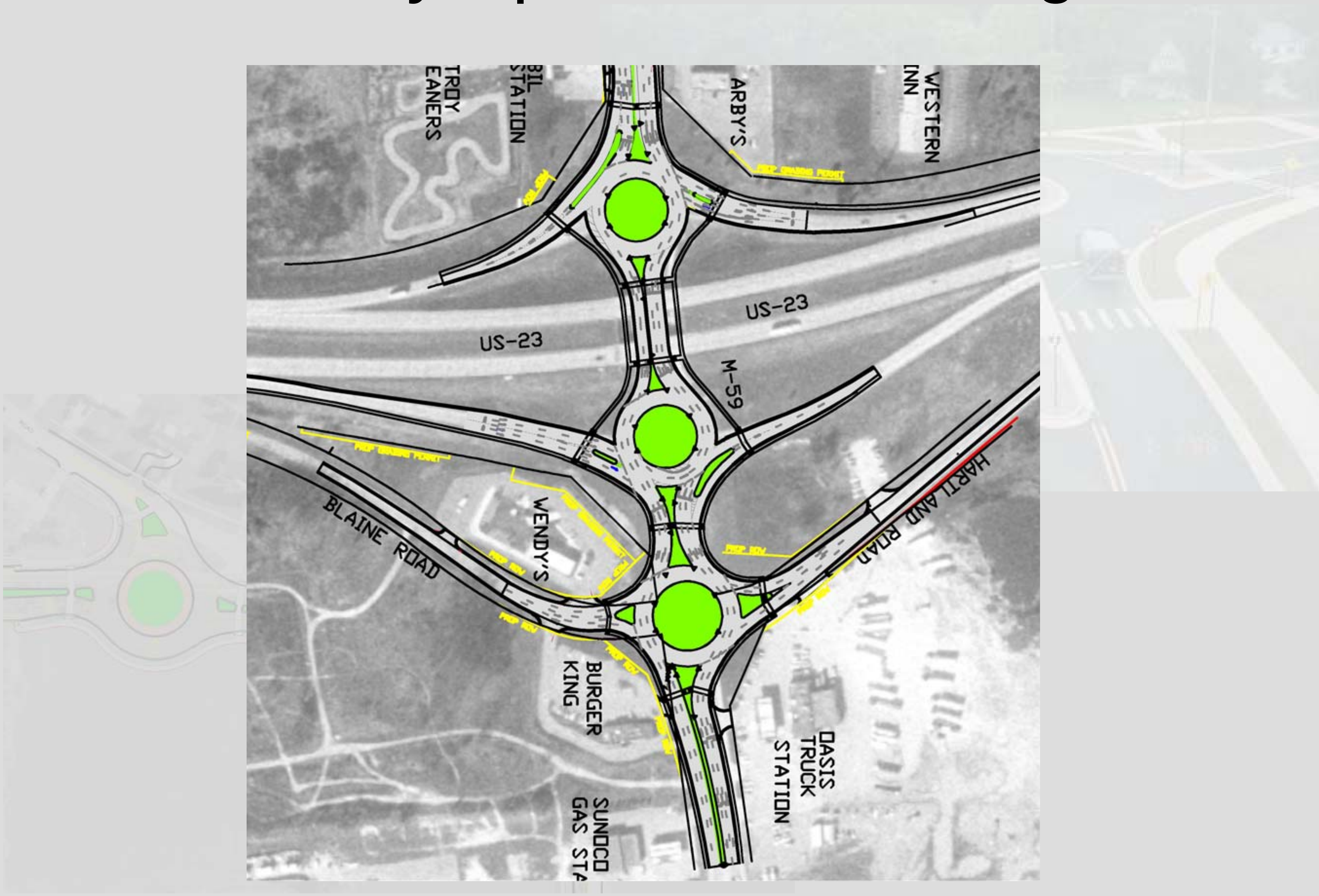
Skewed Intersections - Safety

Congested Intersections

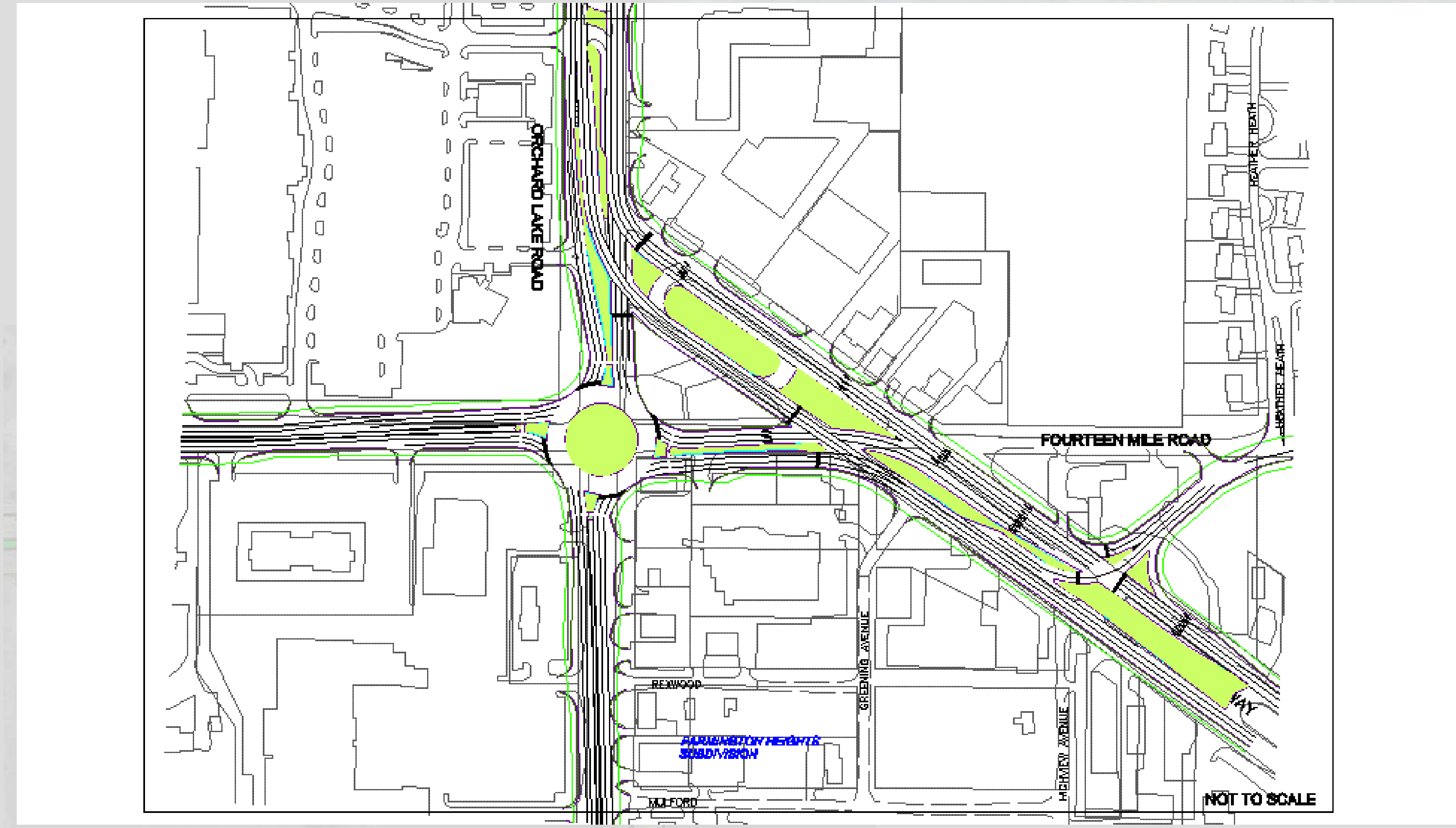
Urban 2 Lane

- **Aesthetic improvements**
- **Context sensitive – partner with community**
- **Lots of landscaping and lights**
- **ADA pedestrian facilities**

Closely Spaced Interchange

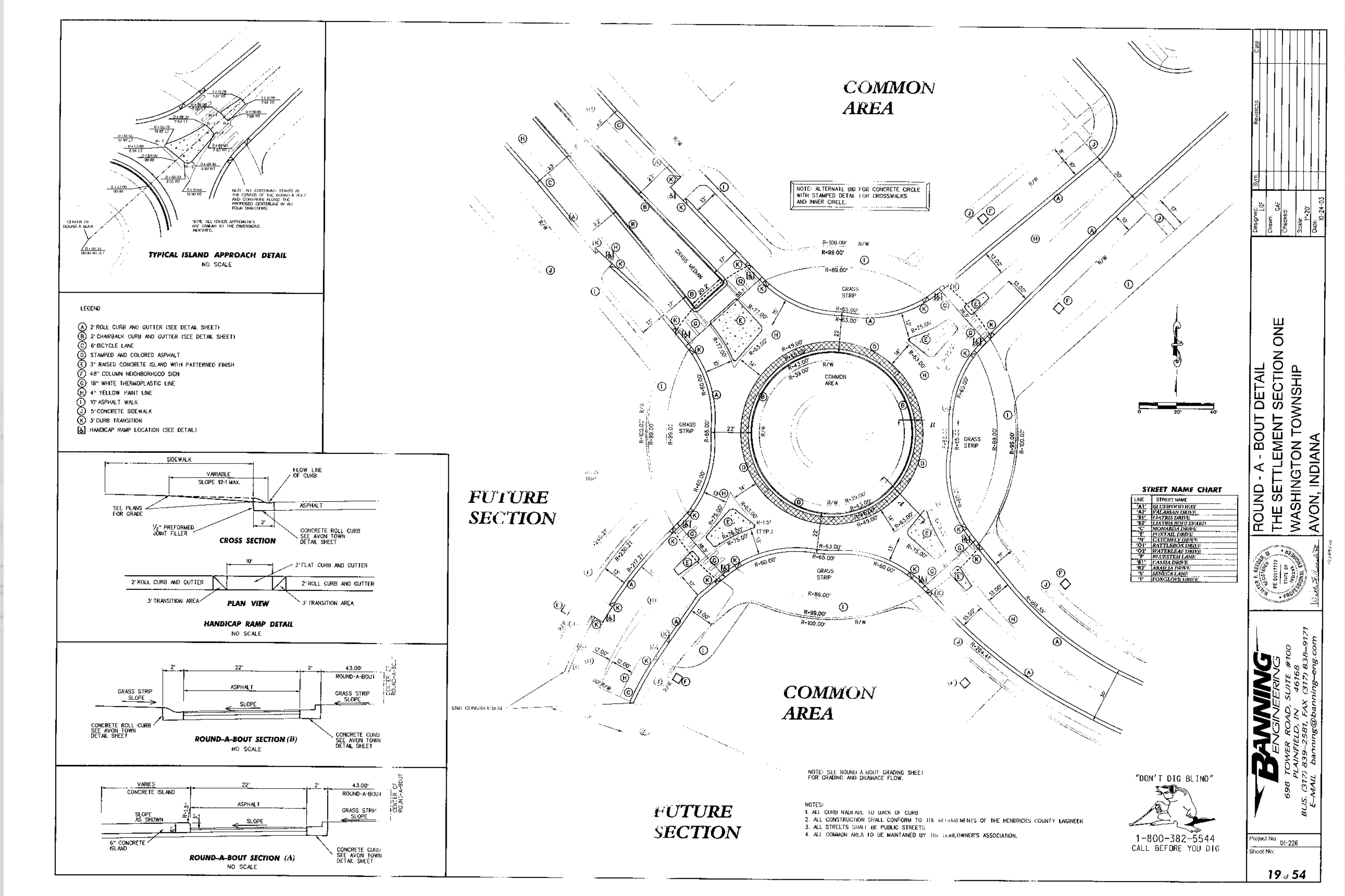


Closely Spaced Intersections



Residential Areas

Residential Areas



Gateway Entrance

Unusual Geometry

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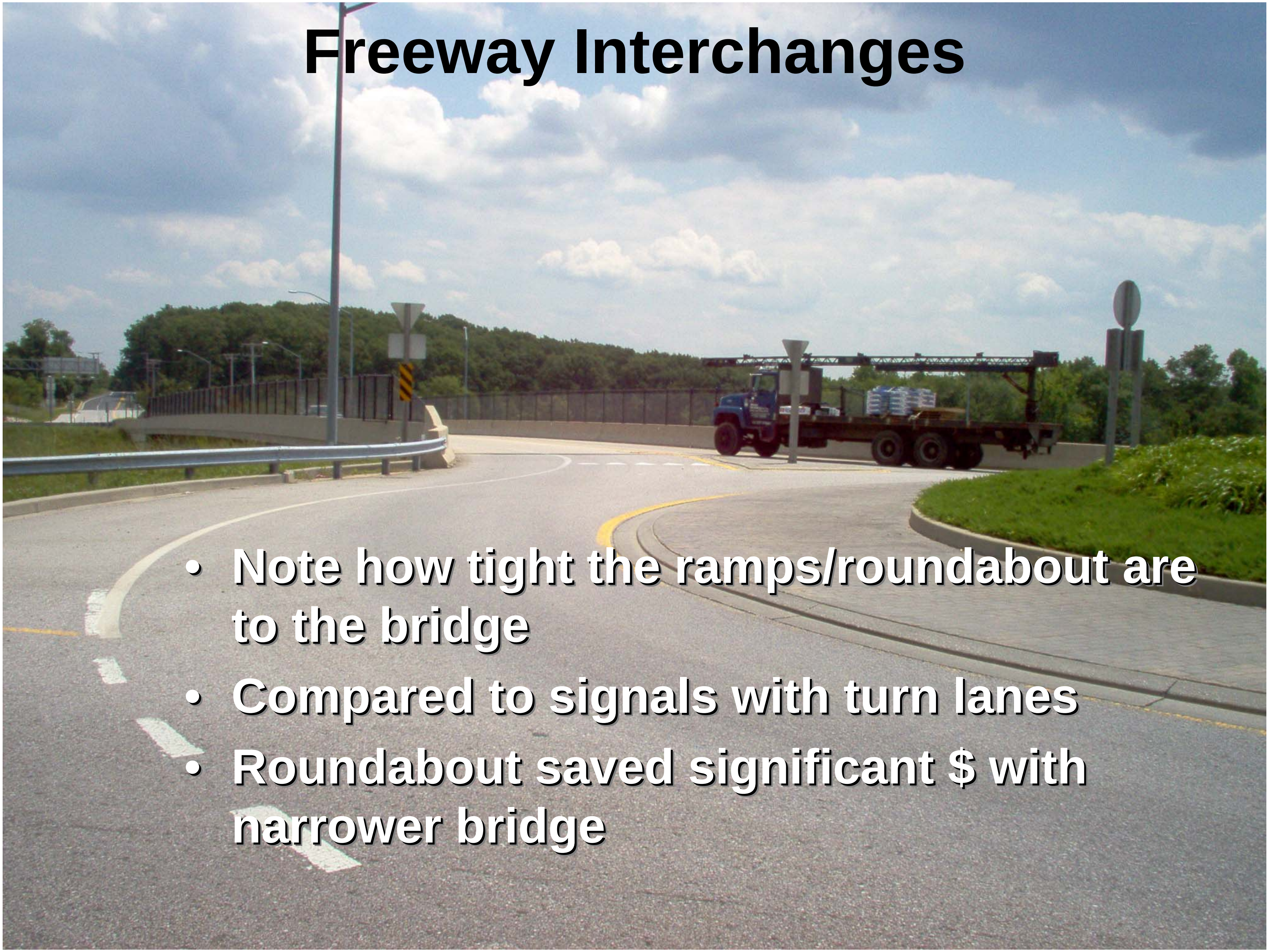
Freeway Interchanges

Constraint – Interchange Bridge

Freeway Interchanges



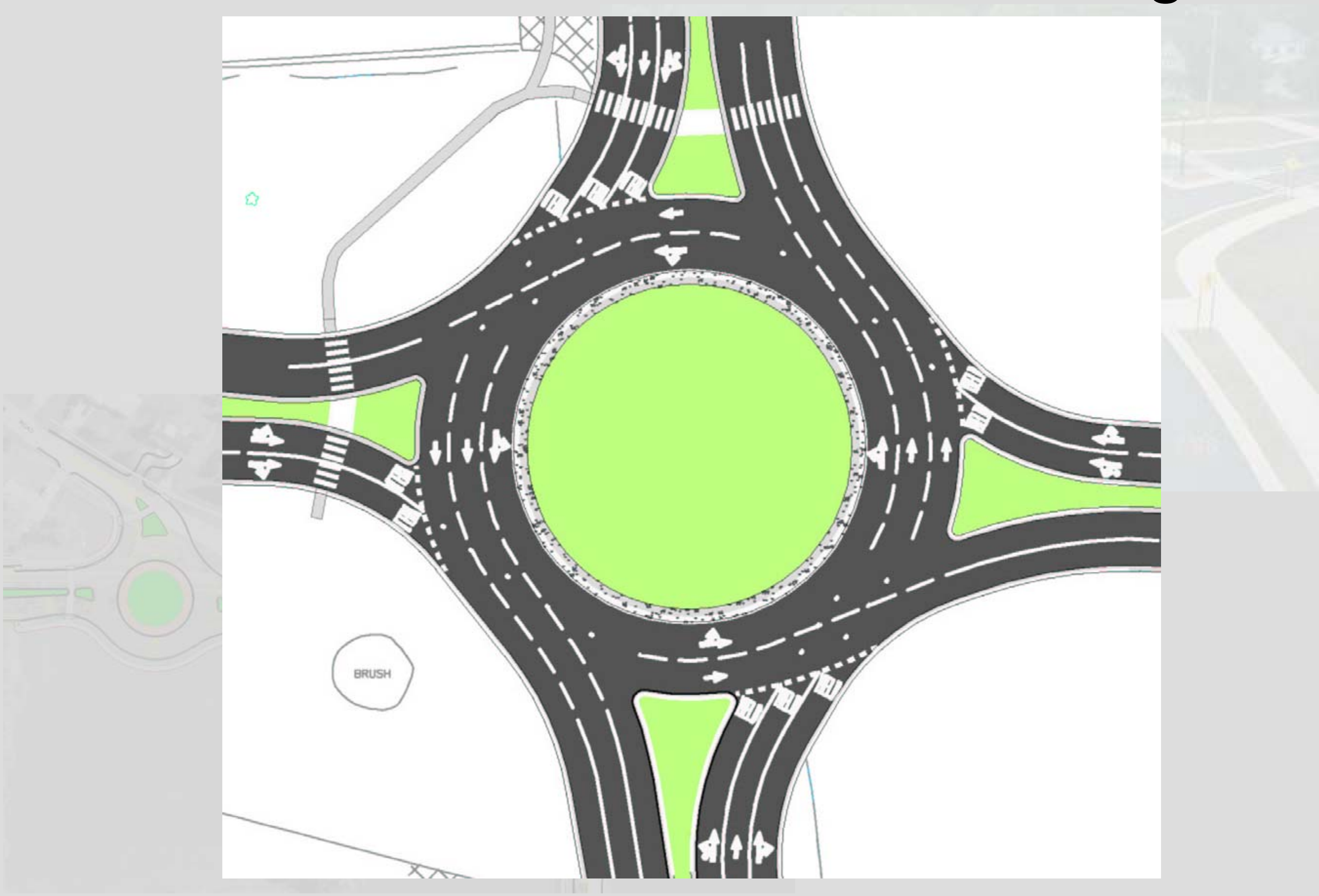
- Note how tight the ramps/roundabout are to the bridge
- Compared to signals with turn lanes
- Roundabout saved significant $ with narrower bridge

Freeway Interchanges

Freeway Interchanges

Connecting Freeways

3-Lane Roundabout at Interchange

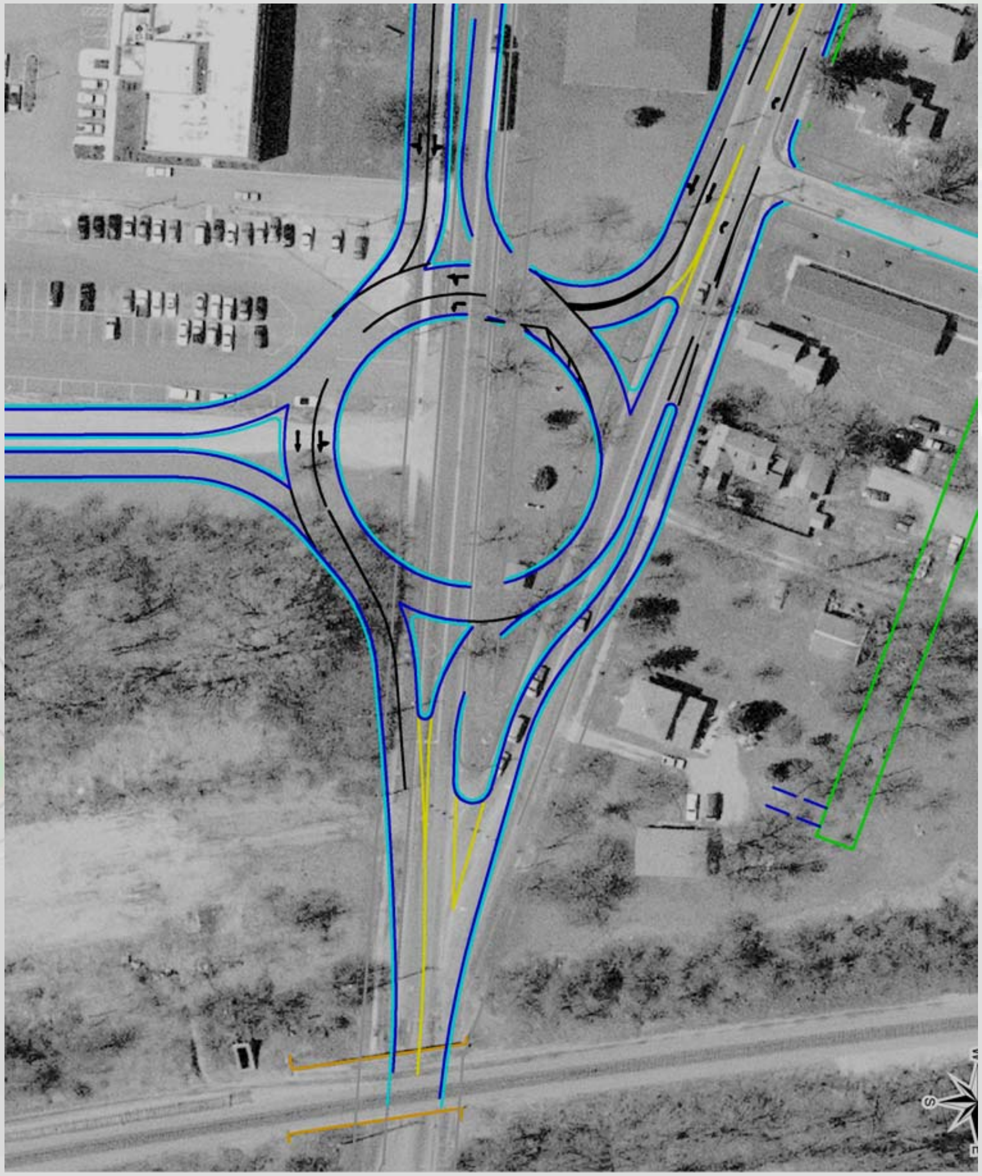


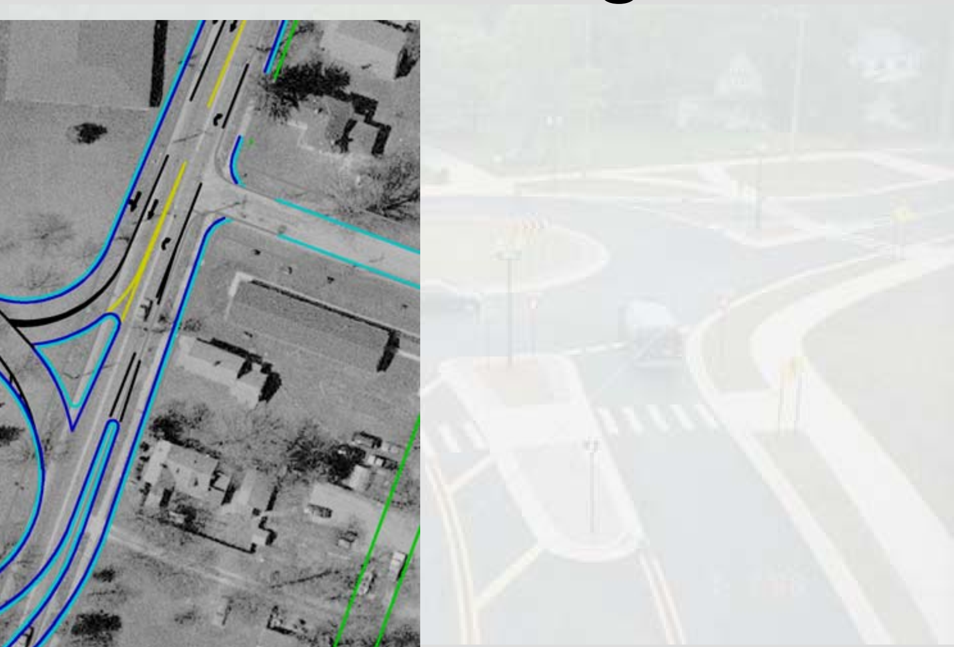
3-Lane Roundabout at Interchange

Freeway Interchanges

Single Lane Roundabouts at Diamond Interchange in Maryland – Similar to MDOT's concept for M-81 and I-75 Interchange near Saginaw

Tight Constraint – Rail Bridge





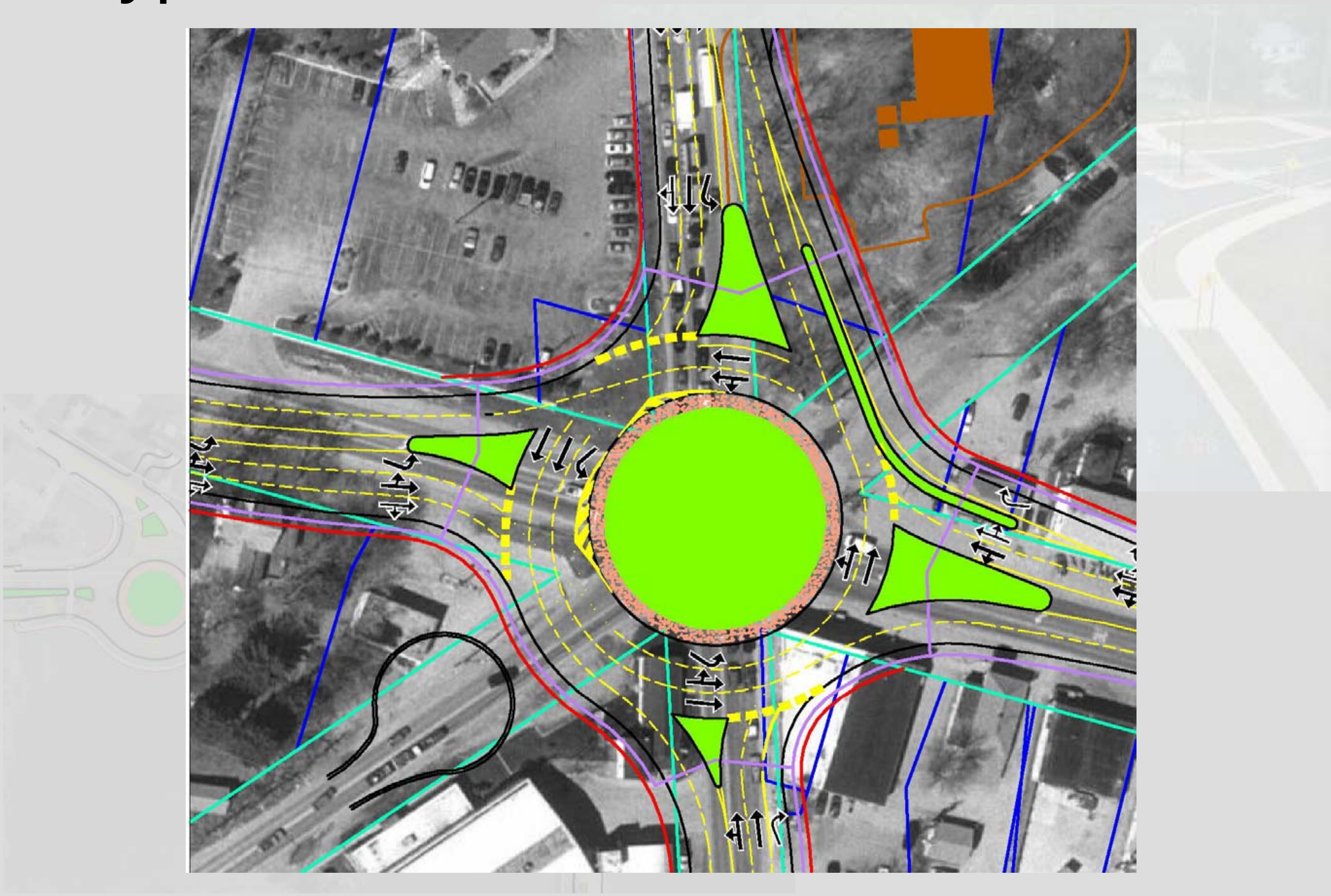
Tight Constraint – Mini Roundabout

Longton Old Rd Mini/Urban Compact

Tight Constraints – Urban Compact

Context Sensitive – Light Rail

Bypass Lanes – 3 Lane Roundabout

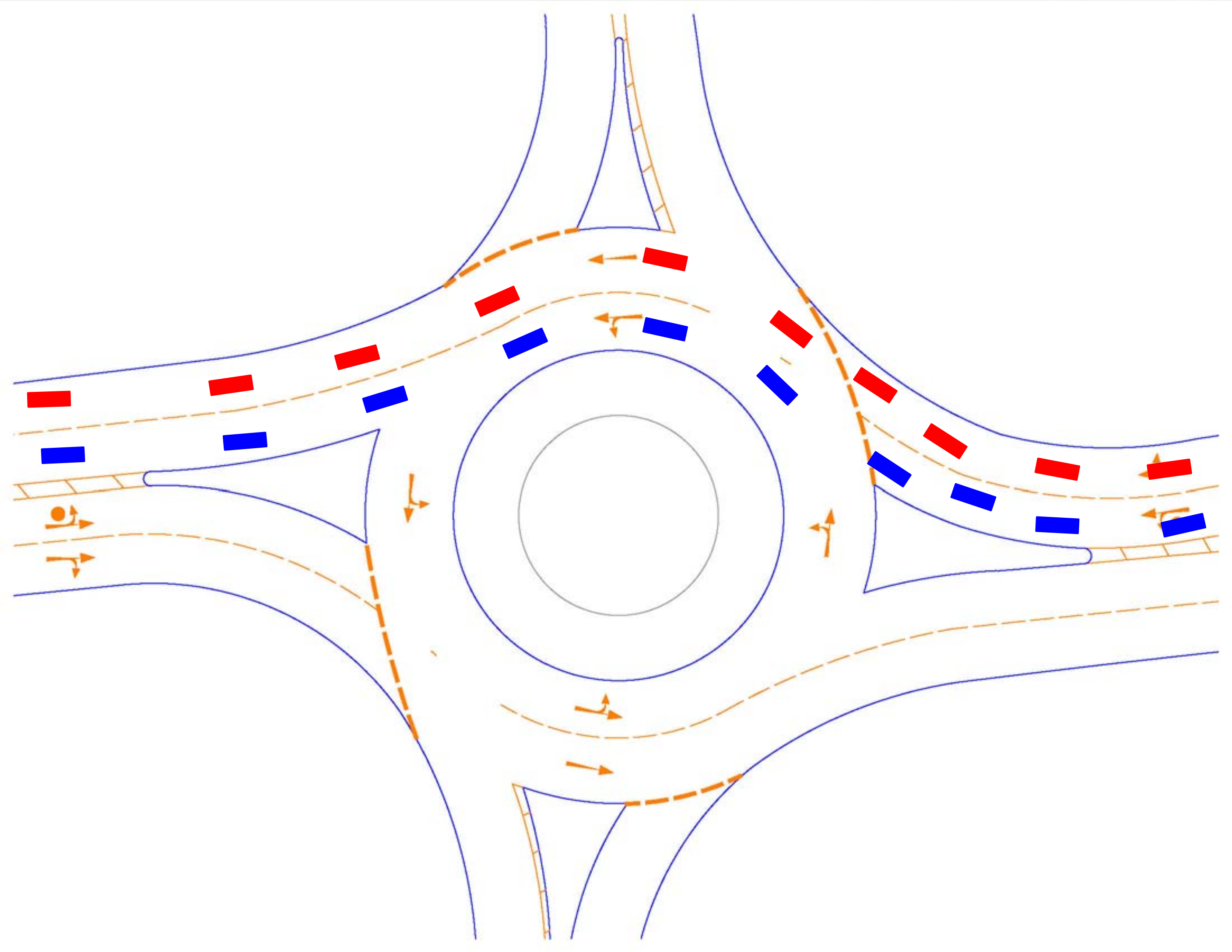


How Not to Drive a Roundabout

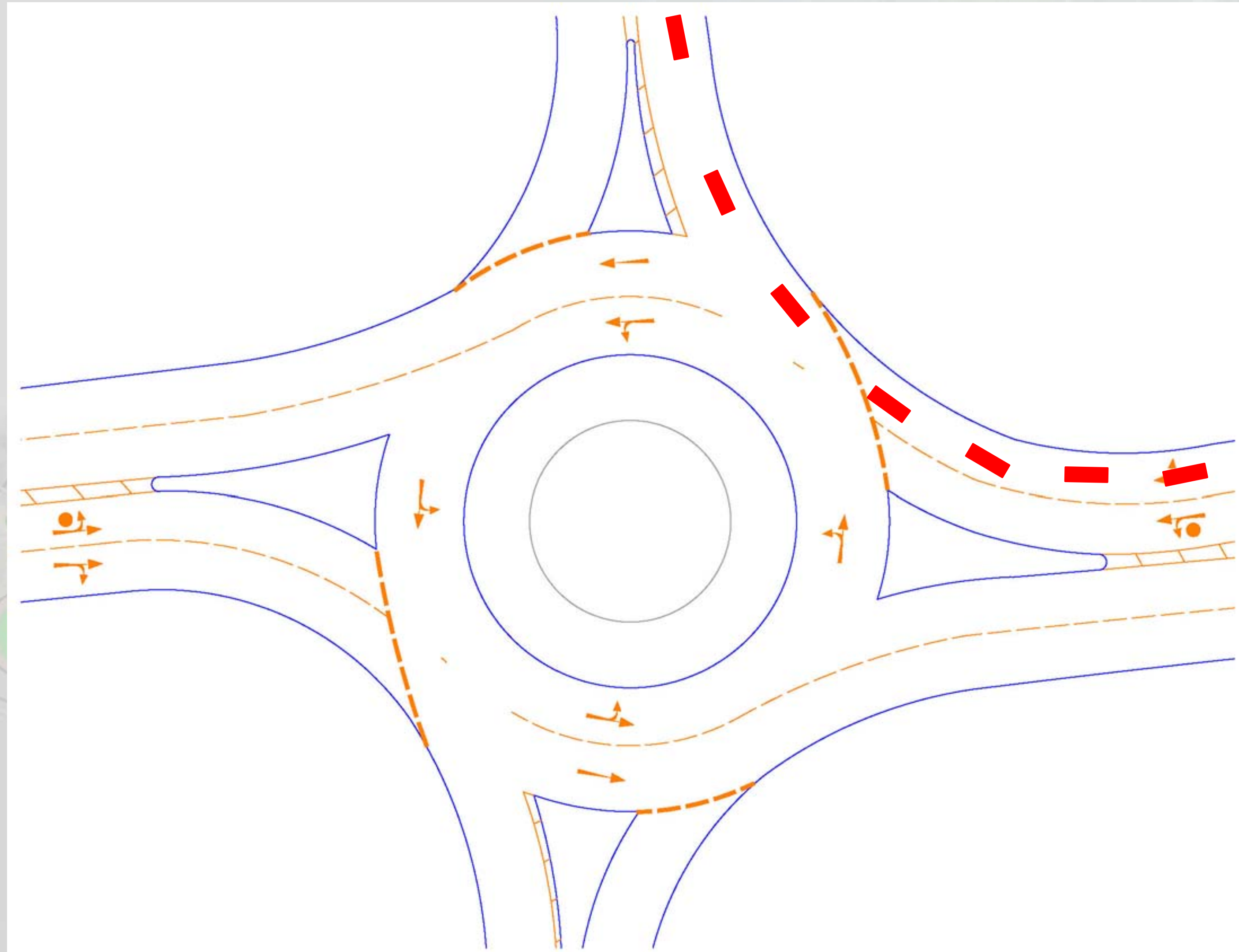
How to Drive a Roundabout

- Basic concepts identical to traffic signal
- Signs and pavement markings will guide you
- Select your lane before the yield line
- Yield to traffic within the roundabout before entering
- Stay in the same lane as you enter, circulate and exit
- Do not change lanes or weave
- Left turns are made from the left (inside) approach lane
- Allow adequate space for large trucks
- Yield to pedestrians in the crosswalks

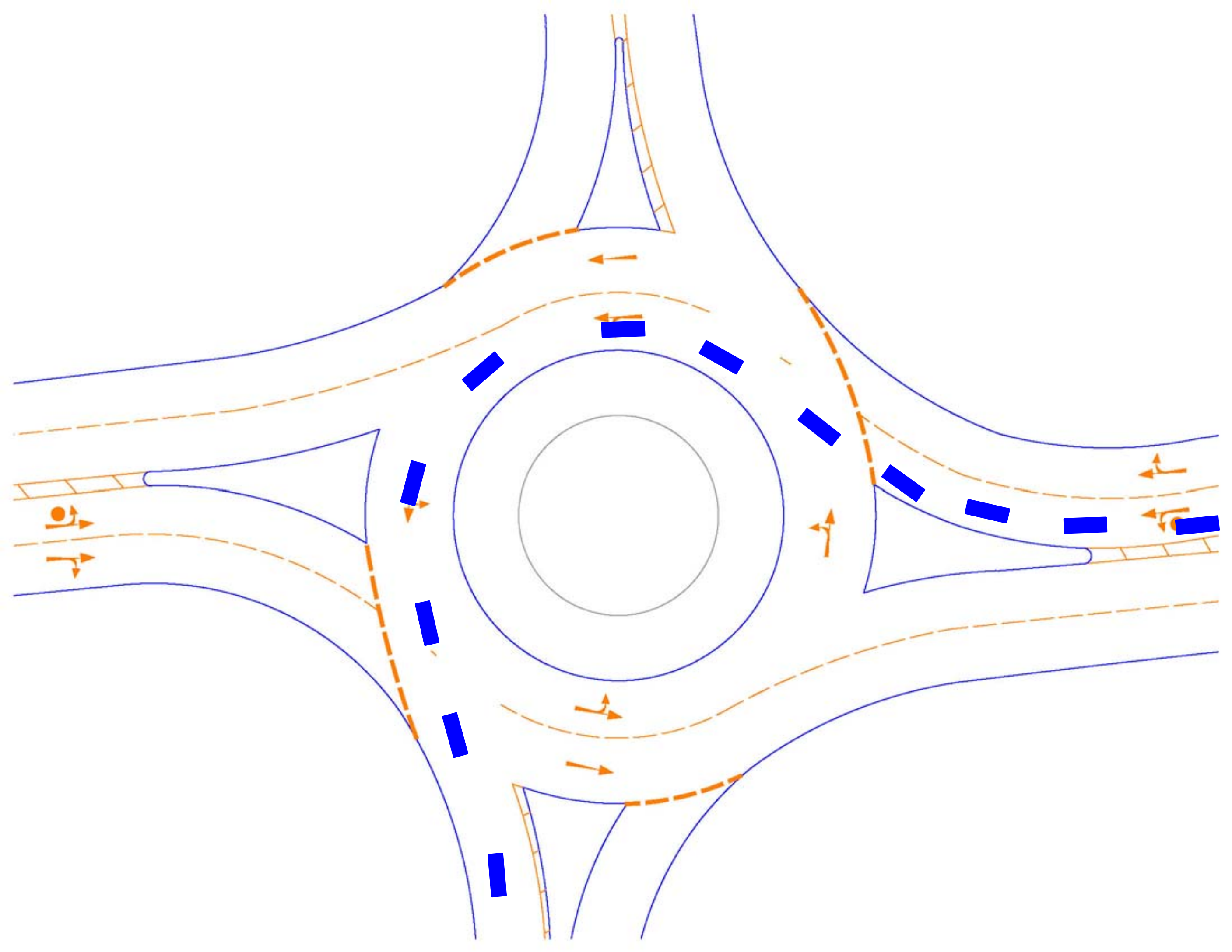
Through Movement



Right Turn



Left Turn



Roundabouts vs. Traffic Signals

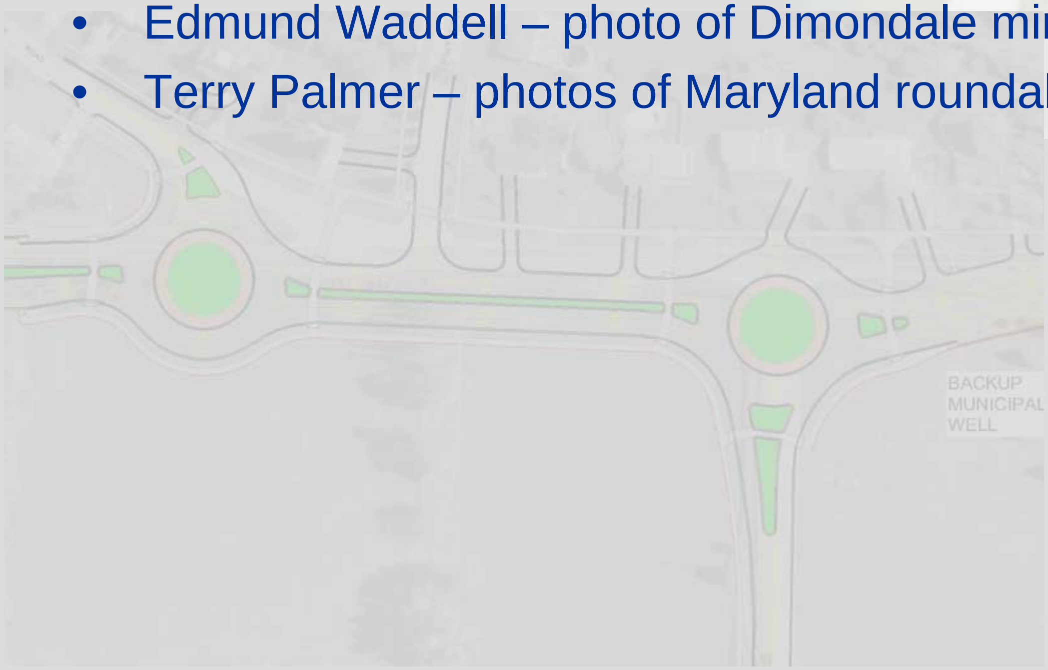
- No simple answer … Hard to generalize
- Depends on cost / benefit analysis
- Sometimes one fits ROW far better
- Large left turn flows   =   Roundabout?
- Low turning flows   =   Traffic Signals?
- Safety = Roundabout (far less PIAs)
- Need to assess and compare alternatives
- Roundabouts & Signals are complimentary
- Roundabouts are not suited for all locations

Roundabout Guides/Resources

- *Roundabouts: An Informational Guide*, FHWA, 2000
- *Roundabout Design Guidelines*, Ourston Roundabout Engineering, 2001
- *MUTCD*, roundabout information under review, do not recommend using current version
- State Guides – WI, MD, FL, OR, others
- Use caution – most information correct, some incorrect or can be easily misapplied
- Guides are no substitute for experience

Credits

- R. Barry Crown, Rodel Software Limited – miscellaneous information adapted for use in several slides
- NYDOT – photo of Kingston roundabout and map of roundabout locations
- Dave Sonnenberg – photo of Marsh – Hamilton roundabout
- Edmund Waddell – photo of Dimondale mini-roundabout
- Terry Palmer – photos of Maryland roundabouts



Select Topics

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Topics

- Geometry, Capacity and Traffic Operations
- Safety
- Pavement Markings
- Signage
- Trucks
- Pedestrians
- Public Education
- Construction Staging
- Questions

Capacity

- Design capacity must be sufficient for peak hour volumes
- The capacity of an entry depends on:
  - GEOMETRY of the entry
  - CIRCULATING VOLUMES passing the entry
- Capacity typically equal or greater than signal
- Powerful relationships benefit designers
  - Capacity is very sensitive to geometry
  - Capacity is also sensitive to traffic volumes.
- Six main geometric elements affect capacity

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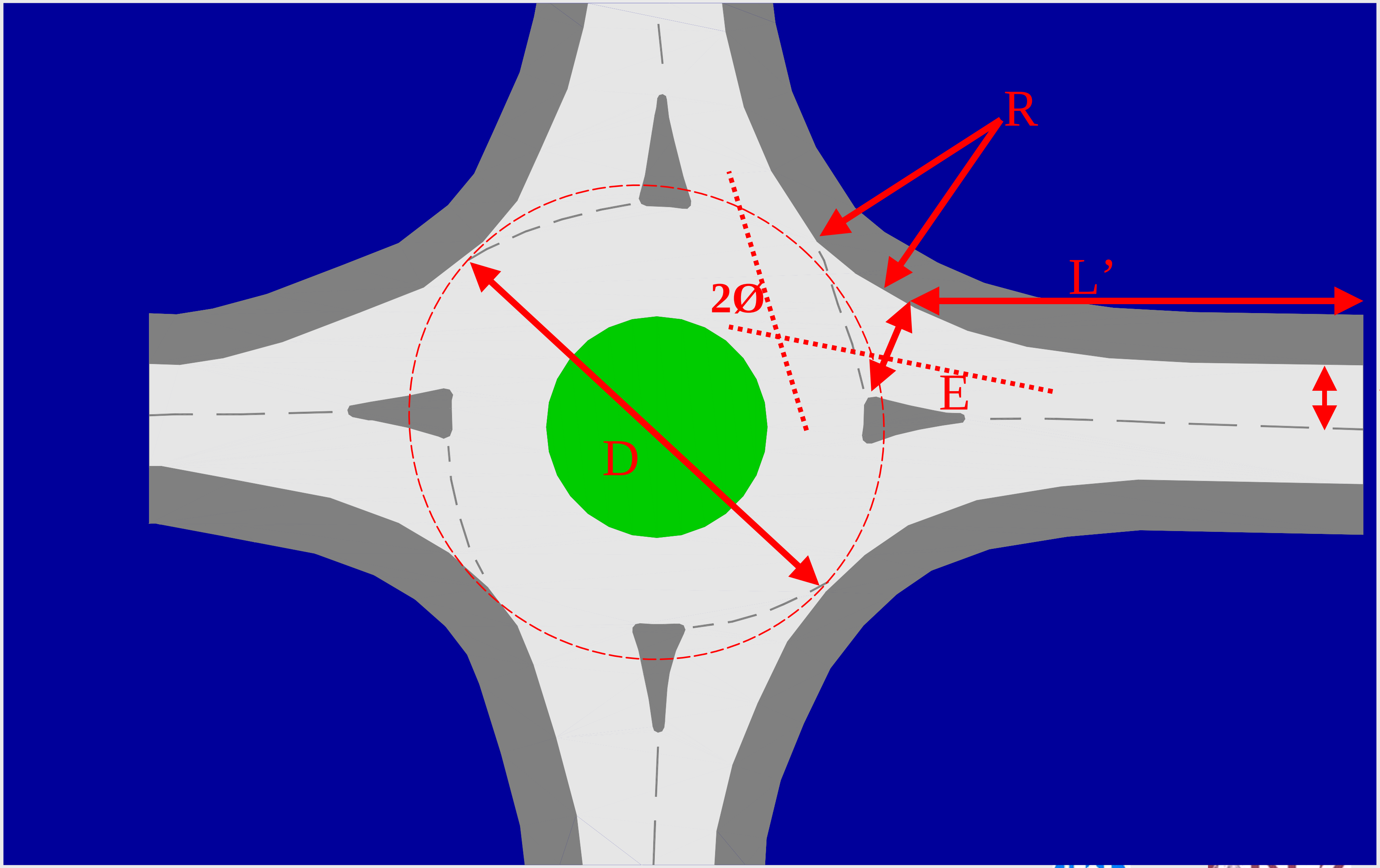
Geometry and Capacity



Capacity and Geometry - Software

- Computer aids are an essential tool:
  - Predict capacity, queues, delays, and crashes
  - Determine geometry
- Two types of software – very different results:
  - Gap acceptance theory
    - Same underlying theory used for HCS stop control
    - Theoretical capacity based on critical gap, number of gaps, follow-on-time
    - SIDRA (Australia)
  - Regression equations from empirical data
    - Actual measurements of capacity and geometry in U.K.
    - Capacity measured during ‘at capacity’ operation
    - Statistically rigorous equations relating geometry and capacity
    - Rodel and ARCADY (U.K.)

Gap Theory vs. Empirical Model

- Gap theory is very useful as basic tool, BUT does not account for some geometry and driver behaviors at roundabouts
- Geometry and behavior have direct effect on capacity
- Empirical method accounts for these; gap theory does not
- Gap theory will not accurately predict capacity for some situations:
  - Over-predicts capacity with low circulating flows = under-design
  - Under-predicts capacity with high circulating flows = over-design
  - Designer has no understanding of geometry – capacity relationship
- DLZ prefers empirical model - Rodel
- MDOT uses Rodel

Rodel Output Example

```
*****************************************************************************
*                                                                           *
*  5:11:03                      MIDLAND FOUR LEG                       36   *
*                                                                           *
*****************************************************************************
*                                                  *                        *
* E     (m)    12.00    8.00  12.00    8.00        * TIME PERIOD    min   90 *
* L'    (m)    30.00   20.00  60.00 100.00         * TIME SLICE     min   15 *
* V     (m)     7.20    3.60   7.20    3.60        * RESULTS PERIOD min 15 75 *
* RAD   (m)    20.00   20.00  20.00   20.00        * TIME COST    $/hr 15.00 *
* PHI   (d)    30.00   30.00  30.00   30.00        * FLOW PERIOD    min 15 75 *
* DIA   (m)    75.00   75.00  75.00   75.00        * FLOW TYPE  pcu/veh  VEH *
* GRAD SEP         0       0      0       0        * FLOW PEAK am/op/pm   PM *
*                                                  *                        *
*****************************************************************************
* LEG NAME *PCU *FLOWS (1st exit 2nd etc...U)*FLOF*CL*  FLOW RATIO   *FLOW TIME*
*          *    *                            *    *  *               *          *
* SEB SAG  *1.05*  355  906   87  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NEB ASHM *1.05*   62   62  112  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* NWB SAG  *1.05*  473 1494  199  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
* SWB ASHM *1.05*  106  311  174  0          *1.00*50*0.75 1.125 0.75*15 45 75 *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*          *    *                            *    *  *               *          *
*****************************************************************************
*                                                         *                 *
* FLOW        veh     1348     236    2166     591        *                 *
* CAPACITY    veh     2512    1186    2989    1122        * AVDEL s     4.5 *
* AVE DELAY  mins     0.05    0.06    0.08    0.12        * L  O  S       A *
* MAX DELAY  mins     0.07    0.08    0.12    0.20        * VEH HRS     5.4 *
* AVE QUEUE   veh        1       0       3       1        * COST  $    81.6 *
* MAX QUEUE   veh        2       0       4       2        *                 *
*                                                         *                 *
*****************************************************************************
```

Gap Theory vs. Empirical Model

- NCHRP research underway to develop capacity and crash model for U.S.
- NCHRP project:
  - Insufficient funds for empirical model ($700 K)
  - Insufficient data set in U.S. for empirical model (narrow range of geometry and flows)
  - Accurate empirical model not possible
- Makes gap theory model look attractive, especially to academics
- Concern since model could be sanctioned by FHWA and widely used
- Early indications:
  - U.S. roundabout capacity less than UK regression equations?
  - Limited measurements of roundabouts at capacity

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Safety Statistics - Automobiles

- Conversion from stop/signal to roundabout
- Persaud et. al. (Insurance Institute for Highway Safety), 2000 (U.S.)
  - 23 US intersections studied
  - 40% reduction in total crash frequency
  - 80% reduction in injury crash frequency
  - 90% reduction in fatal and incap. injury crash frequency
  - Changes to rate similar
  - Avg age of drivers involved in crashes did not increase
- 2002 intersection statistics in Michigan
  - 373 fatalities (29% of all fatalities)
  - 4,000 incapacitating injuries (38% of all incapacitating inj's)

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Safety Statistics - Automobiles

- TRB, 1998 (U.S.)
  - 37% reduction in total crash frequency
  - 51% reduction in injury crash frequency
  - 29% reduction in property damage crash frequency
  - Changes to rate similar
- Schoon and Van Minnen, 1994 (Netherlands)
  - 47% reduction in total crash frequency
  - 71% reduction in fatal crash frequency
- Maryland DOT Accident Evaluation, 2004
  - Similar results
  - ~15:1 benefit - cost ratio for installation of single lane roundabouts
- Others with generally similar results

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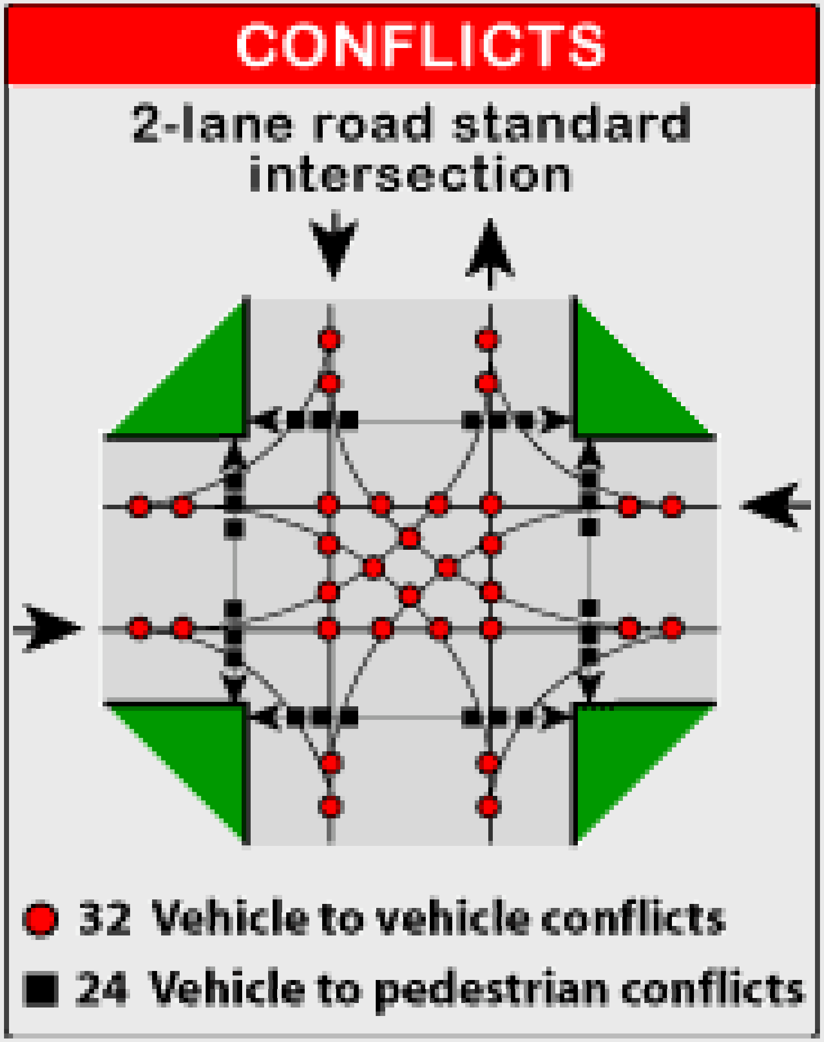
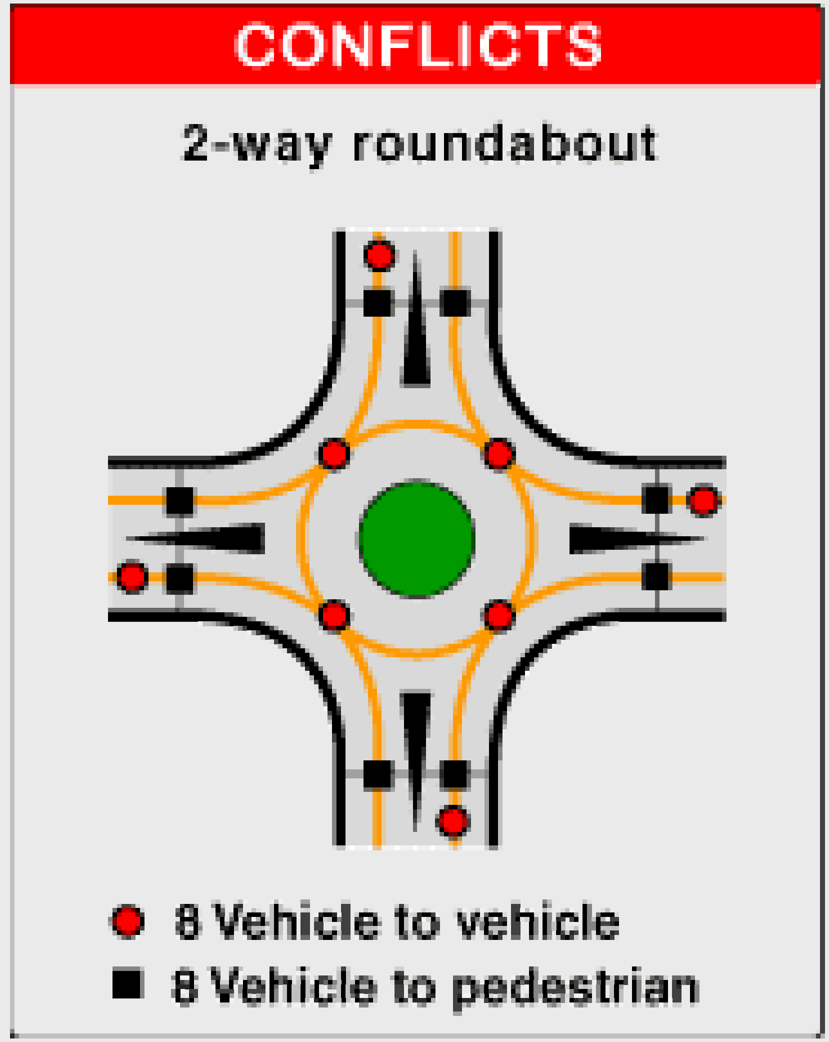
Conflict Points





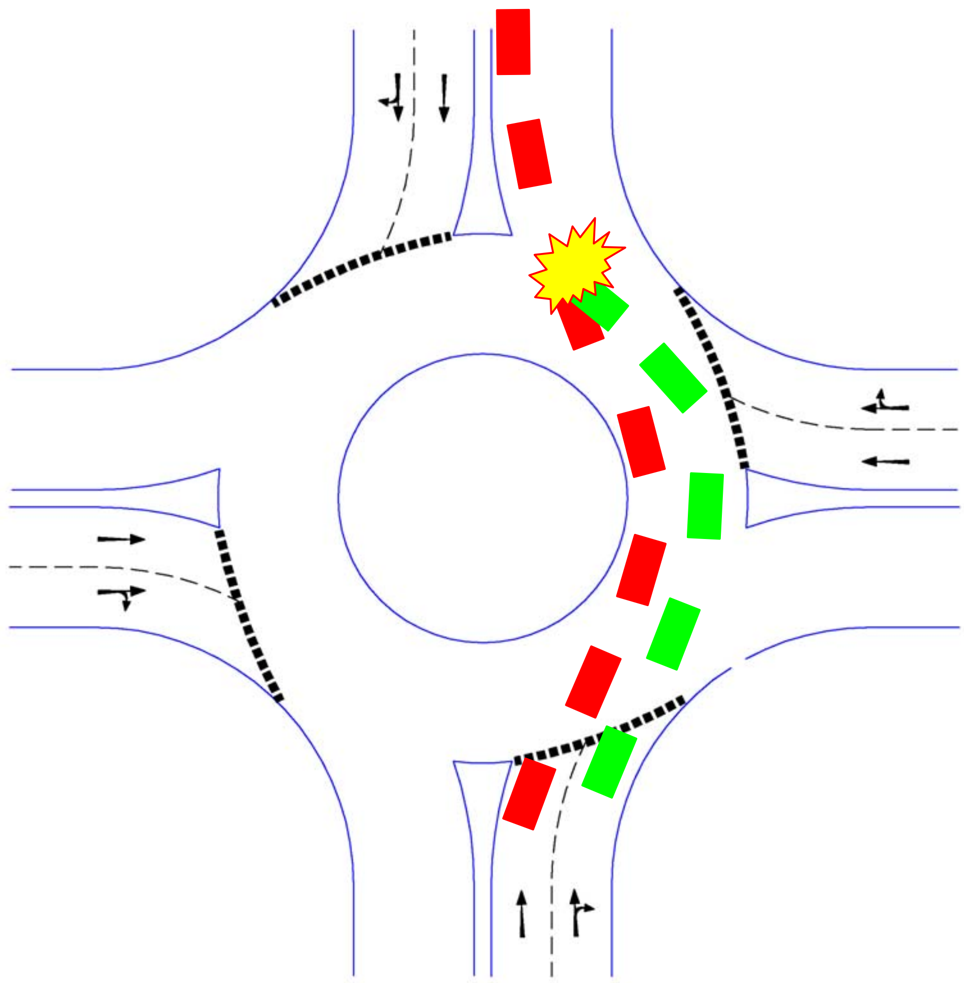
Factors Affecting Roundabout Safety

- Extensive research in U.K. and elsewhere
- Traffic volumes - single most important factor
- Other factors
  - Geometry
  - Pavement markings and signing
  - Sight distance (stopping, entry, exit)
  - Lighting – chevrons and central island
  - Bicycle routing
  - Pedestrian facilities
  - Education

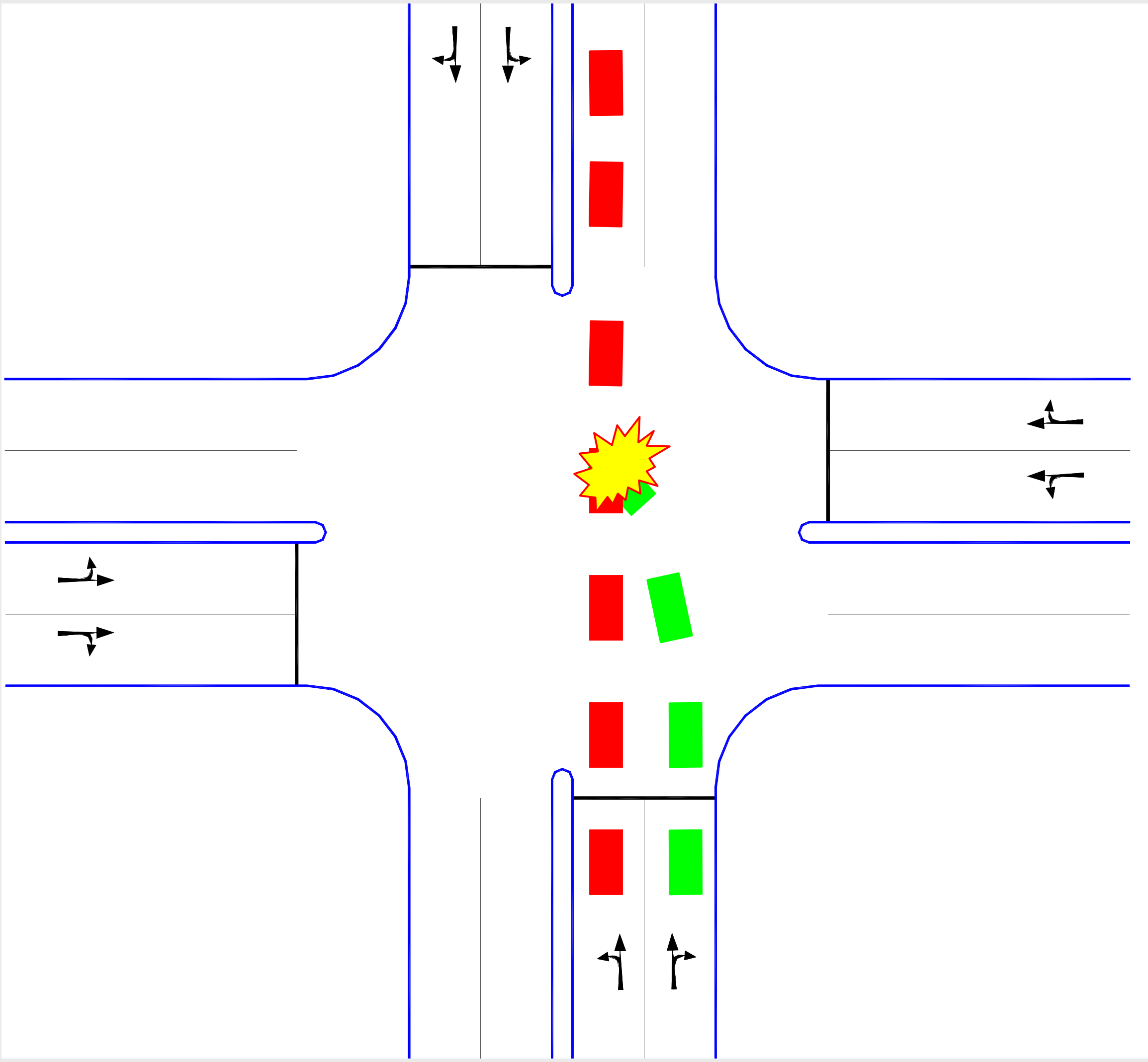
Safety and Lane Use

- Problem: Improper lane use at multi-lane roundabouts causes exit crashes
  - Most common crash problem at U.S. multi-lane roundabouts
  - no pavement markings or improper markings
  - sometimes compounded by geometry/body language
- Examples
  - Clearwater, Florida (highly publicized)
  - Converted traffic circle on MSU campus

Left Turn at Roundabout



Left Turn at Traffic Signal



Clearwater Roundabout

- Exceptional safety example
- Opened midnight on 31st December 1999
- Two lane roundabout
- An Australian/German style design using SLR techniques
  - Very small entry and exit radii
  - Very large entry and exit angles
- 300 crashes in first 6 months
- Over 500 crashes in first 18 months
- Low severity
- Two crash locations

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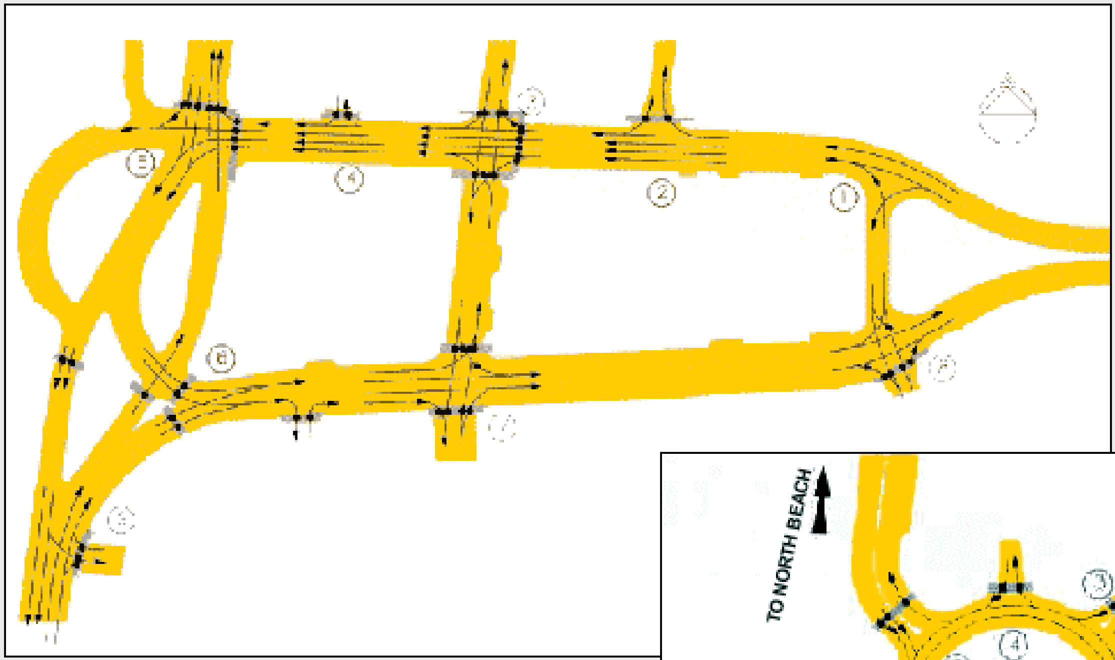
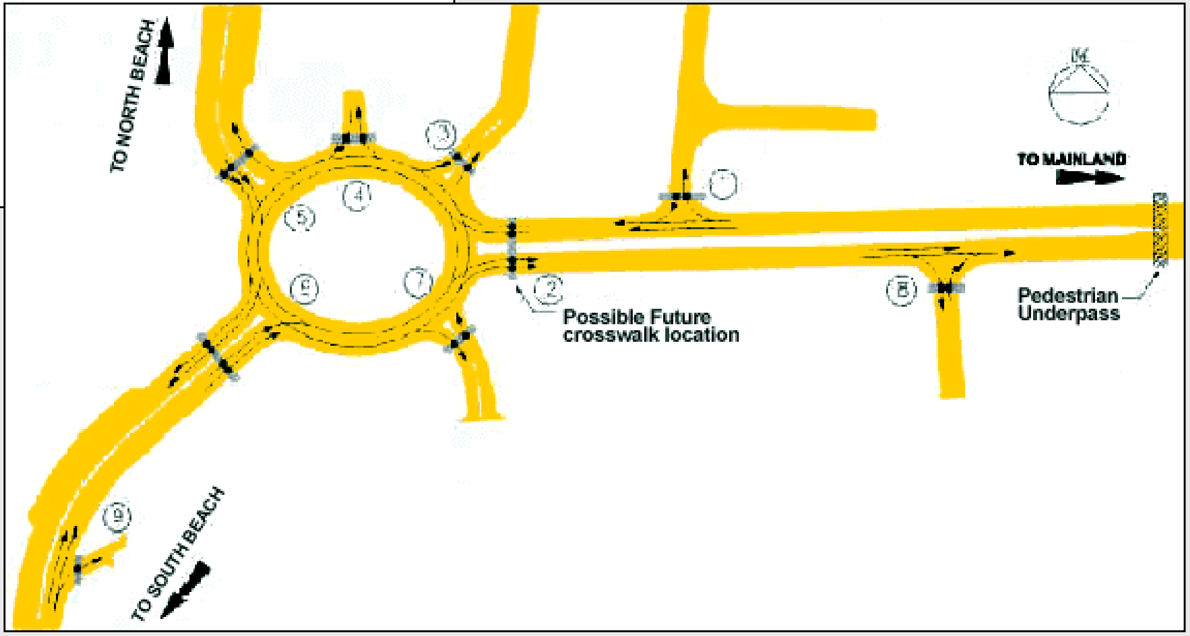
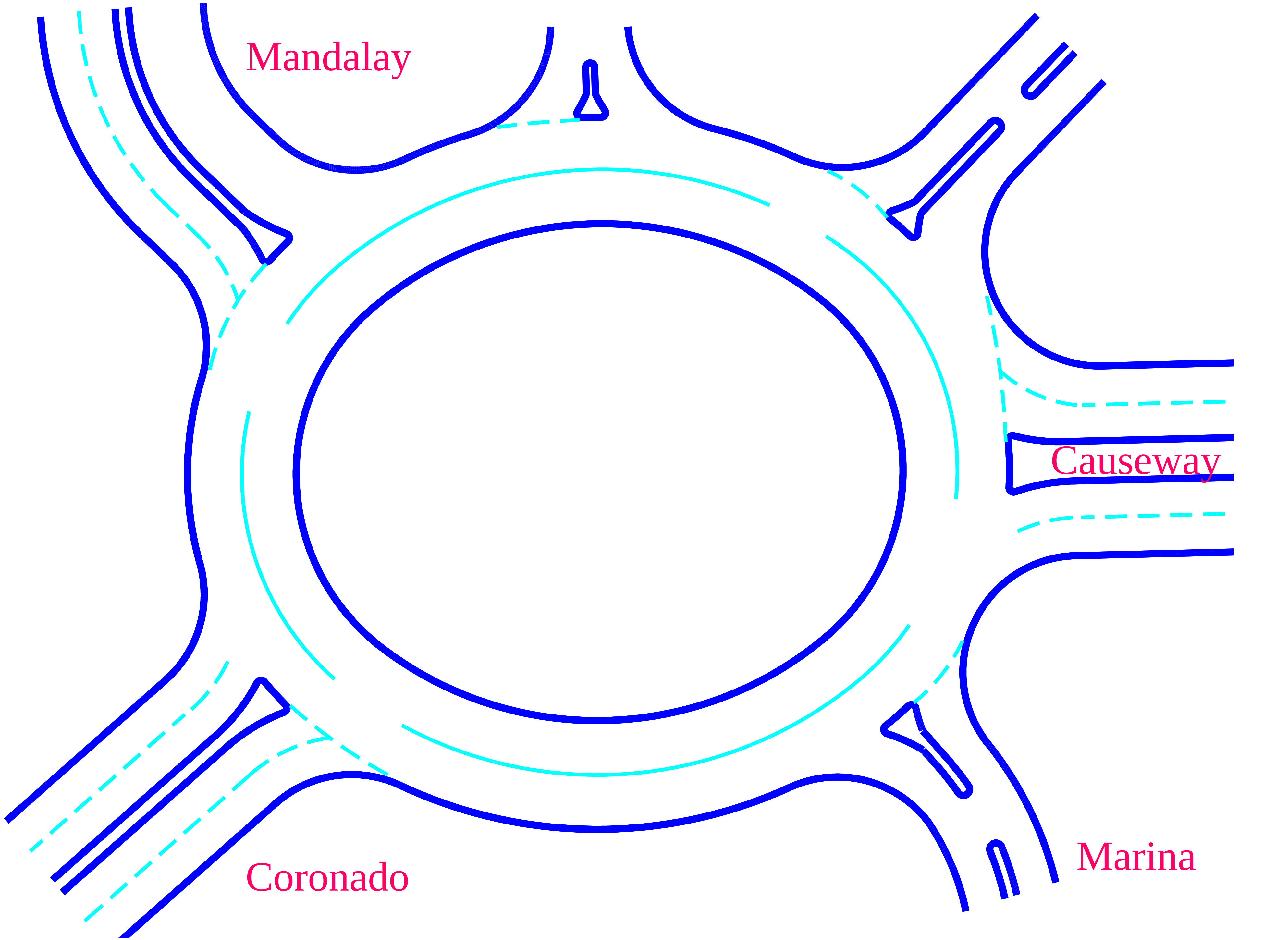
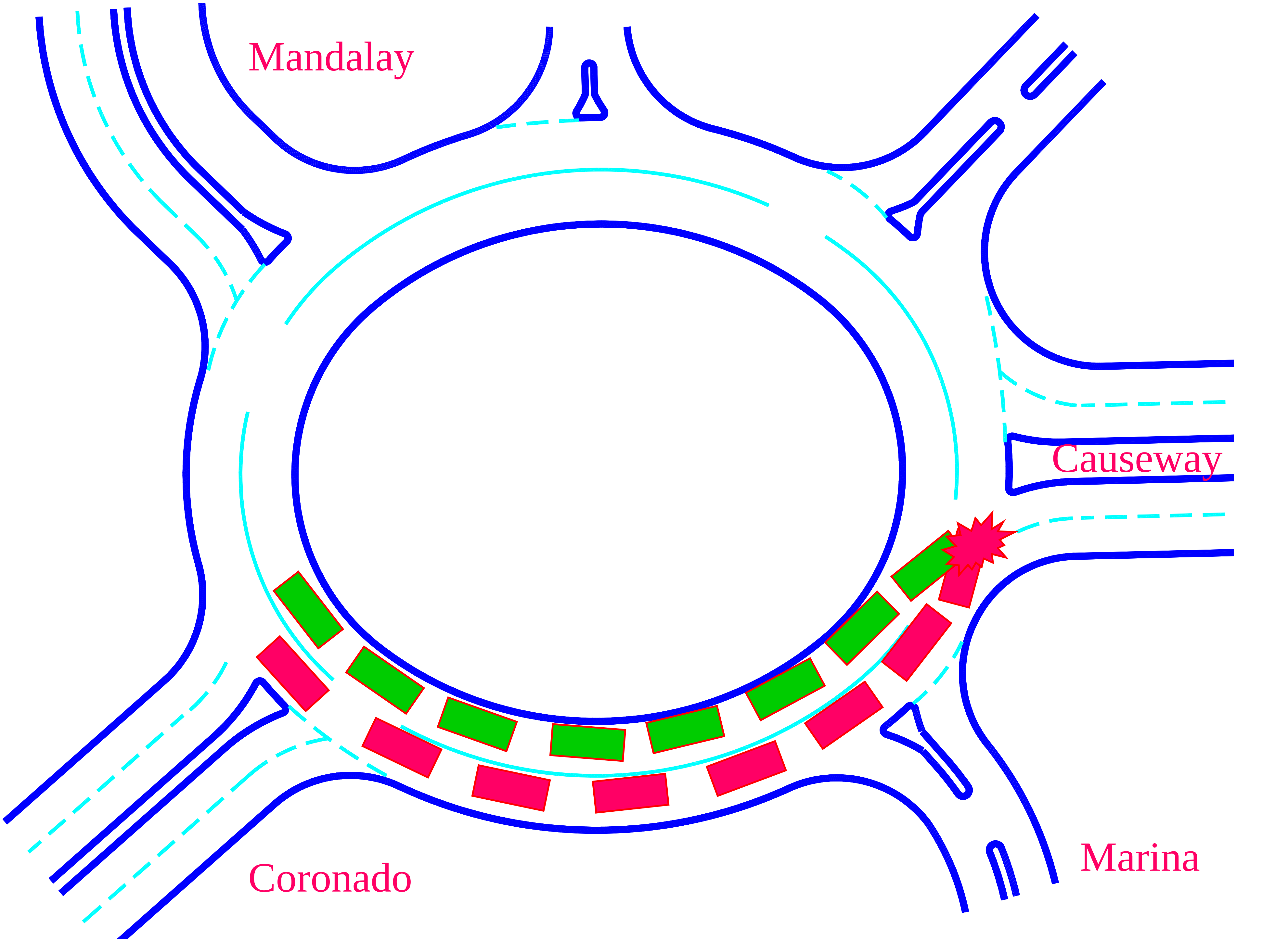
Before and After





Clearwater Roundabout


Mandalay
Causeway
Marina
Coronado


Mandalay
Causeway
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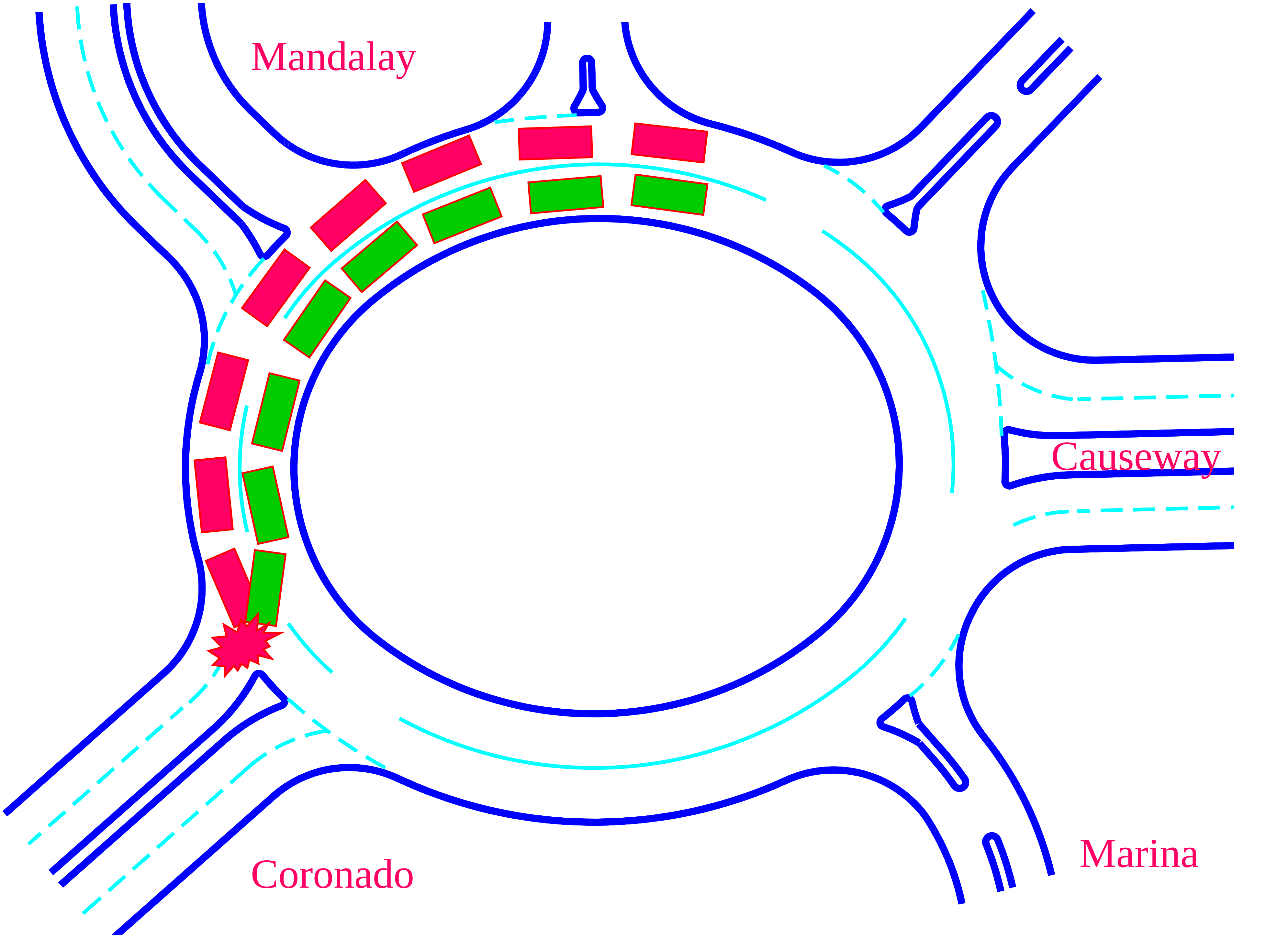
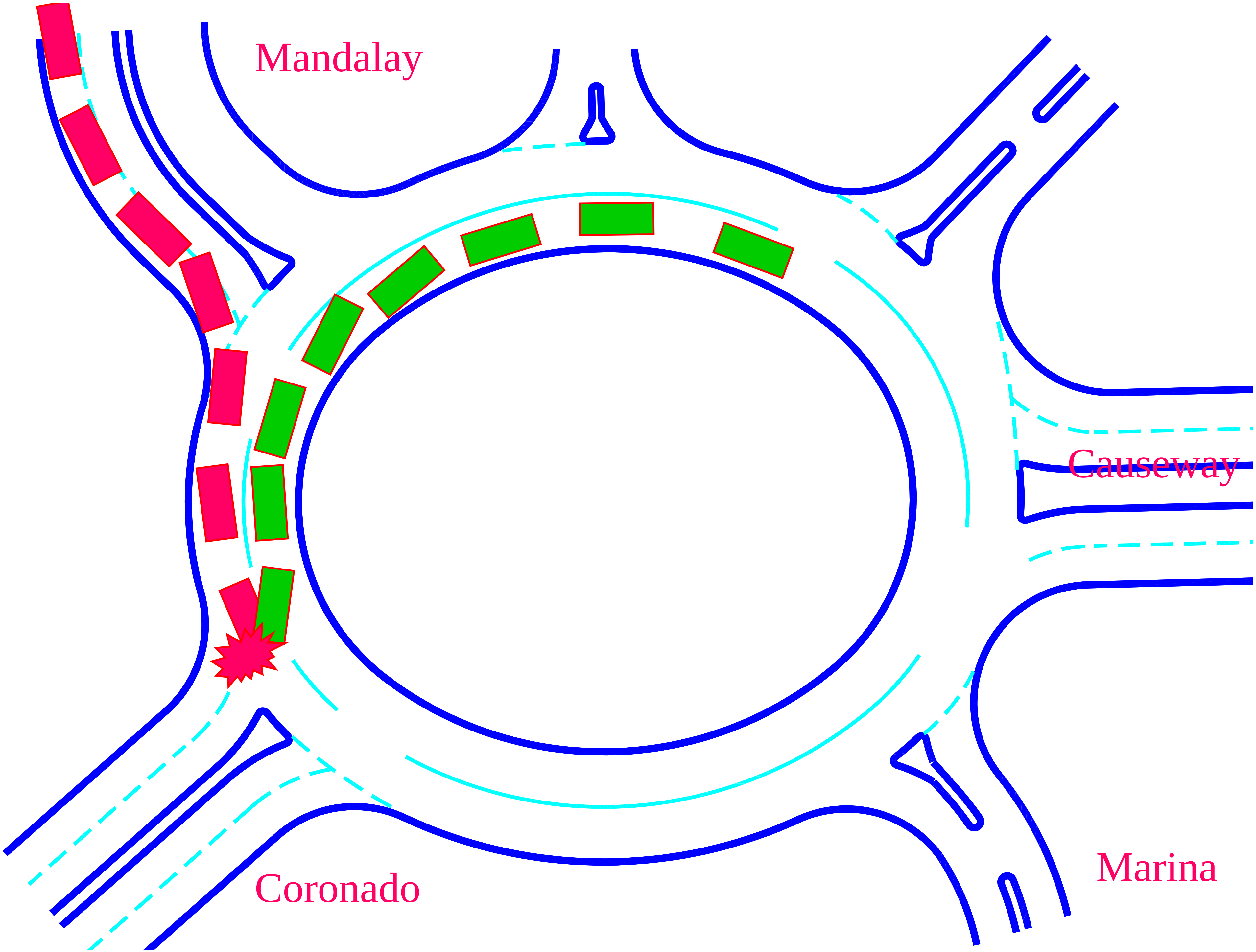
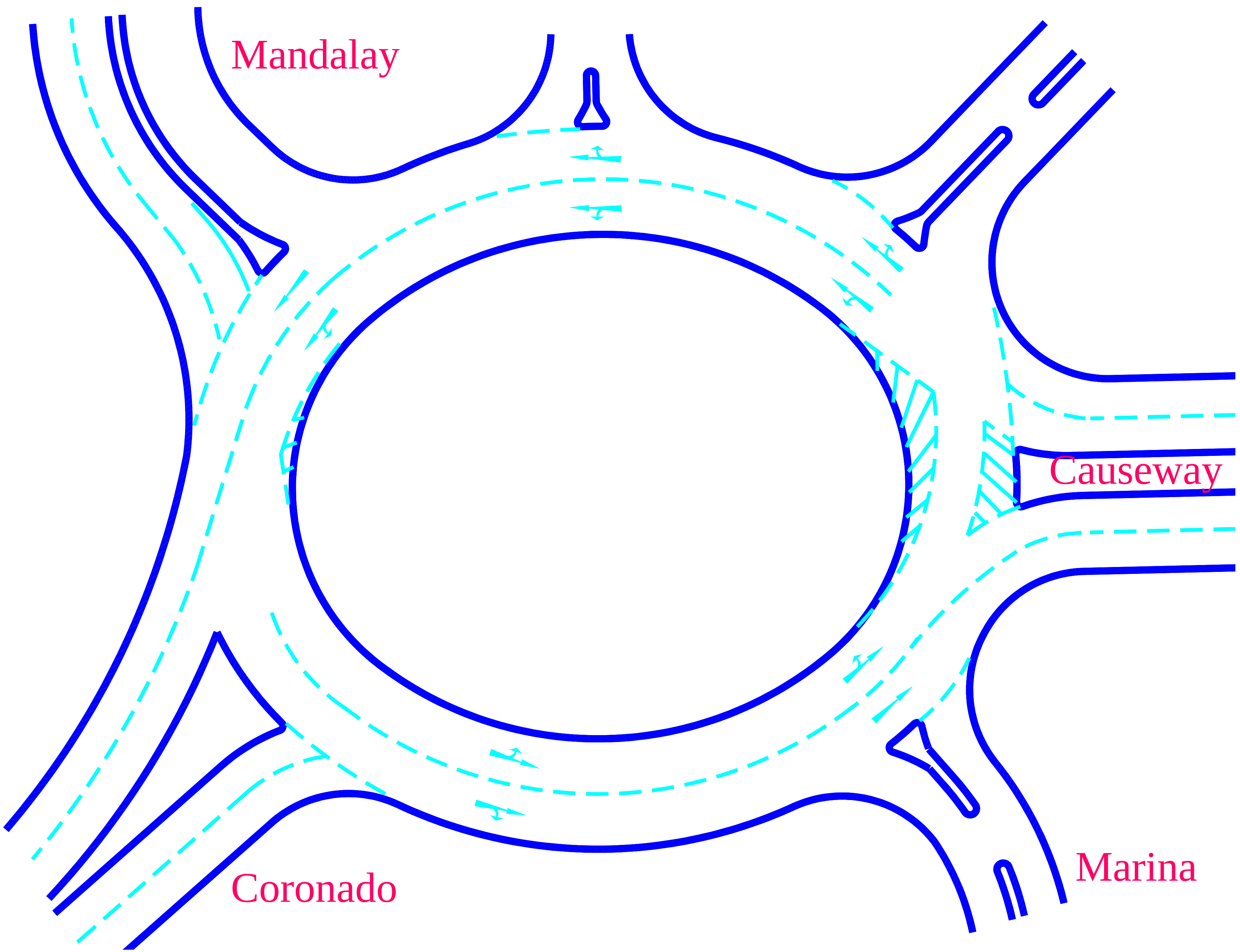
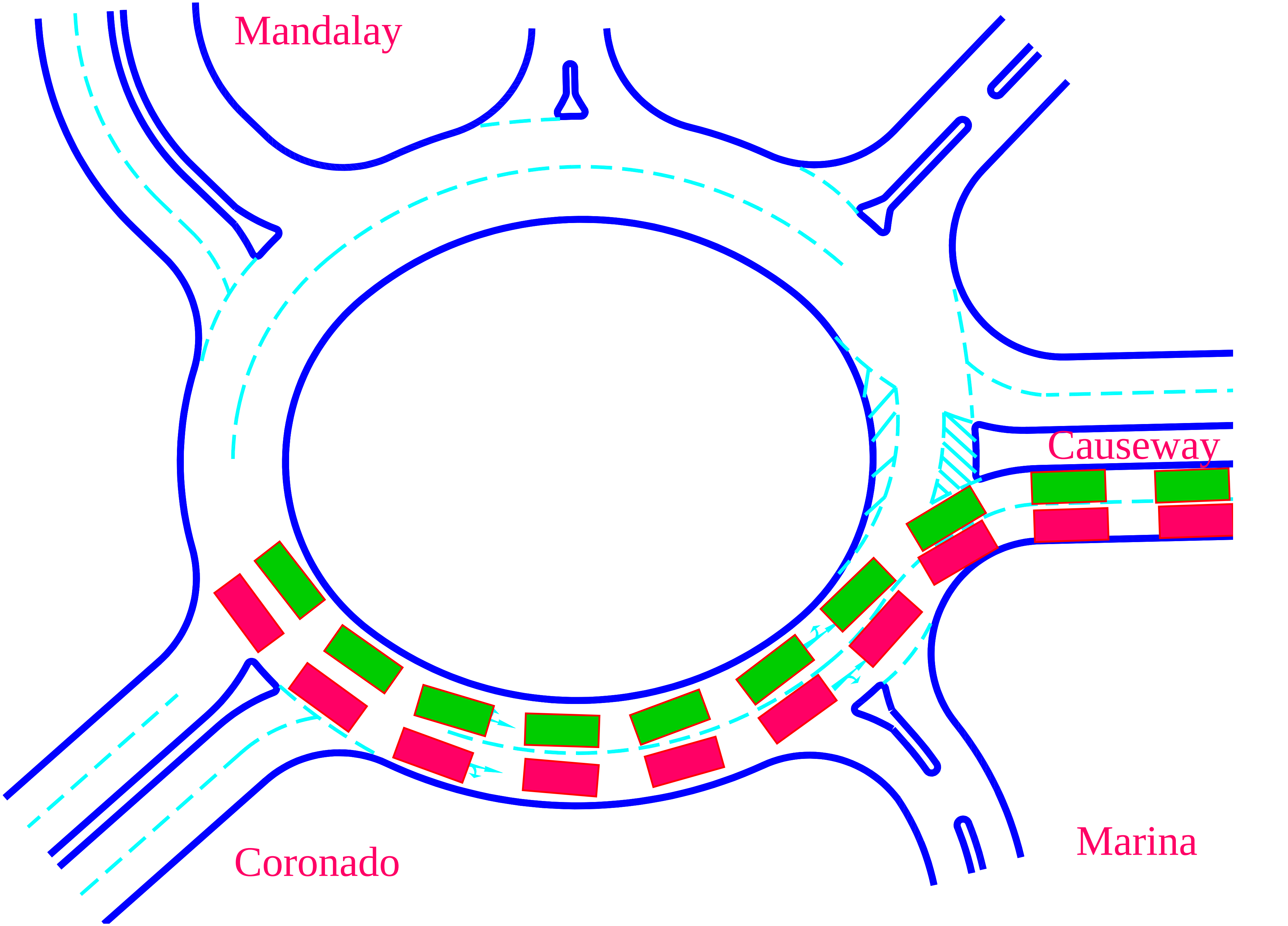
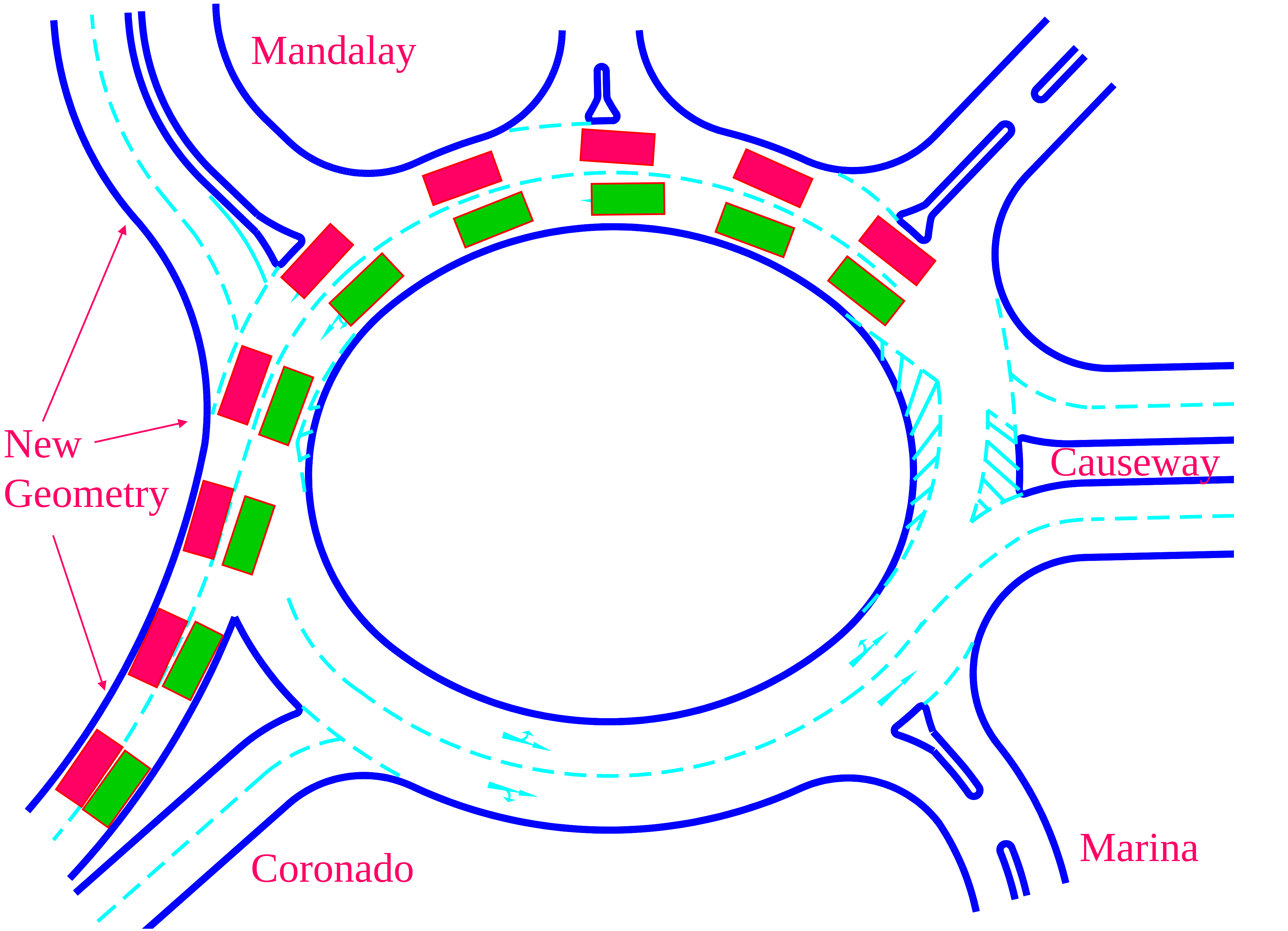
Coronado

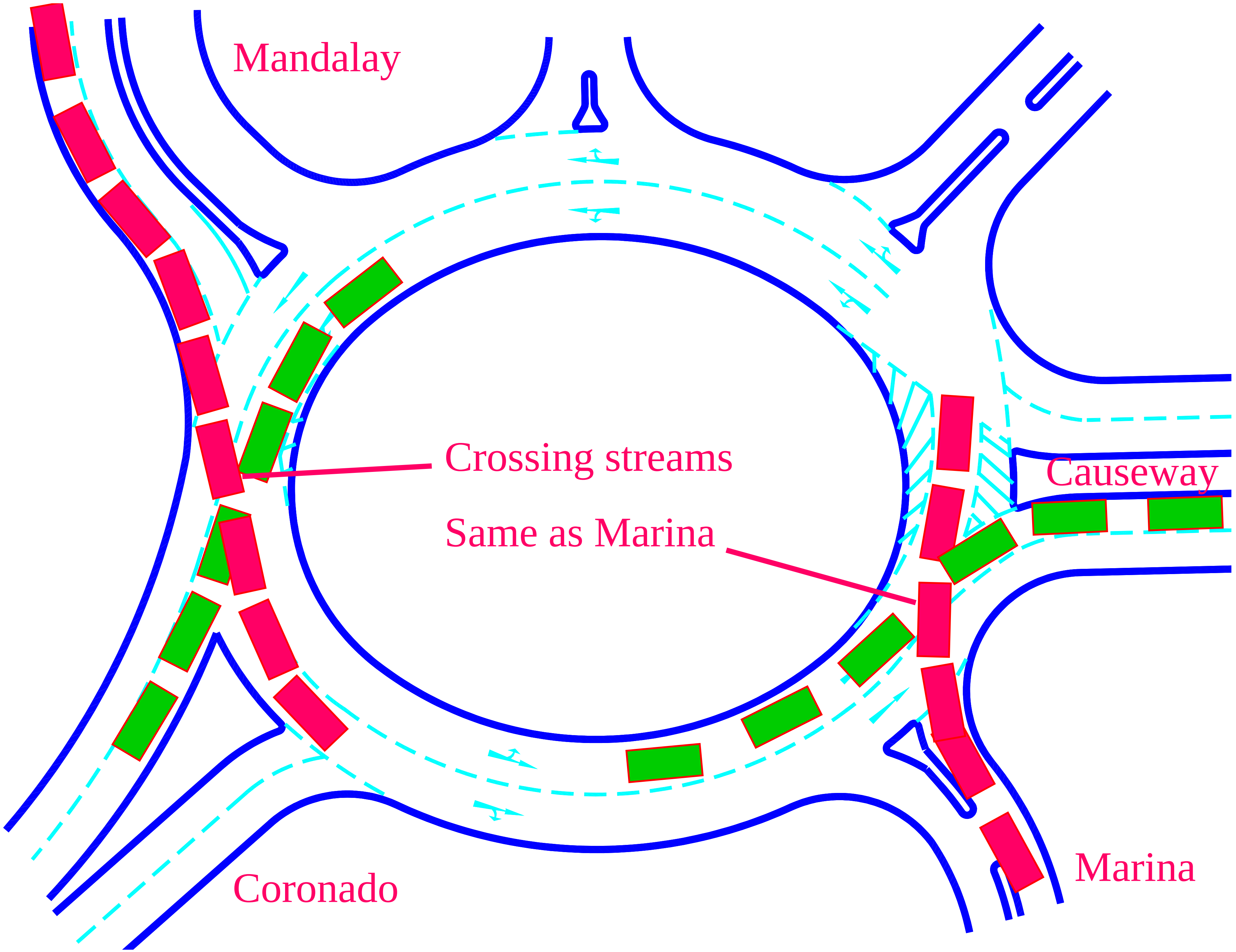

Mandalay
Causeway
Marina
Coronado


Mandalay
Causeway
Marina
Coronado


Mandalay
Causeway
Marina
Coronado


Mandalay
Causeway
Coronado
Marina


Mandalay
New
Geometry
Causeway
Coronado
Marina


Mandalay
Crossing streams
Causeway
Same as Marina
Marina
Coronado

Clearwater Roundabout

- Spiral striping
- Flattened exit radius – moved curb
- Eliminated reverse curve
- Larger entry angle creates safe entry conflict
- Fountain ripped out
- Moved crosswalks
- Crashes dramatically dropped – only 3 minor crashes in 15 months following changes

Clearwater Roundabout

- The cost:
  - City Manager lost job
  - $1-2 M property damage
  - Bad publicity about roundabouts – WSJ article
  - $400,000 in reconstruction costs
  - Other roundabouts not constructed as a result = more injuries and deaths elsewhere
- The lessons:
  - Plan for suppressed traffic demand
  - Proper design techniques crucial
  - Appropriate pavement markings are powerful
  - MLRs require experienced designers

Pavement Markings

- Pavement markings work together with roundabout signing and geometry
- Provide guidance to motorists
  - Approaching
  - Circulating
  - Exiting
- Goal is to enhance roundabout safety and operations and address problems
- Some guidance available in U.S., but still being debated and worked out
- FHWA, MUTCD, and state DOTs are key players
- MUTCD Draft Guidance
- Wide variety of applications

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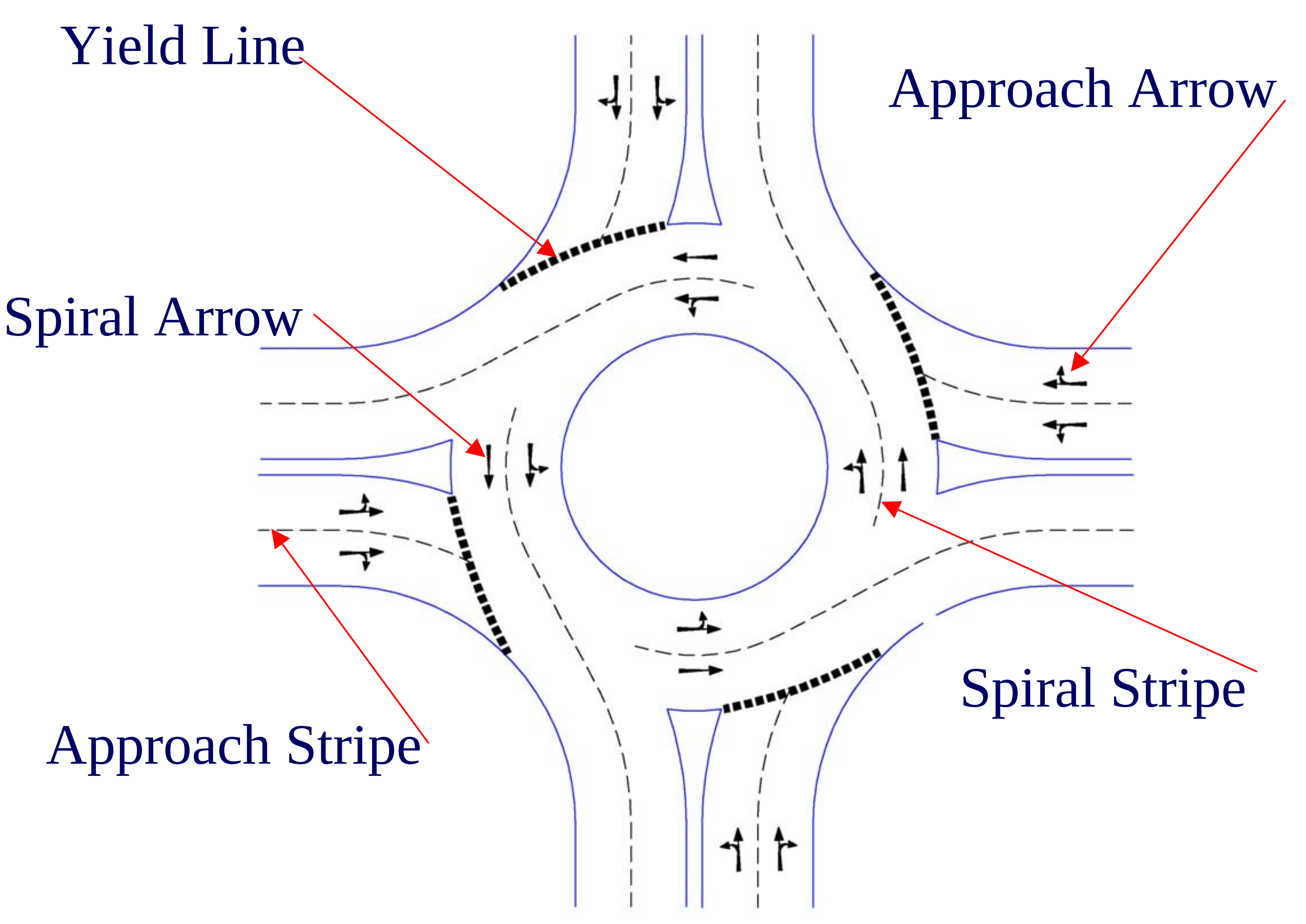
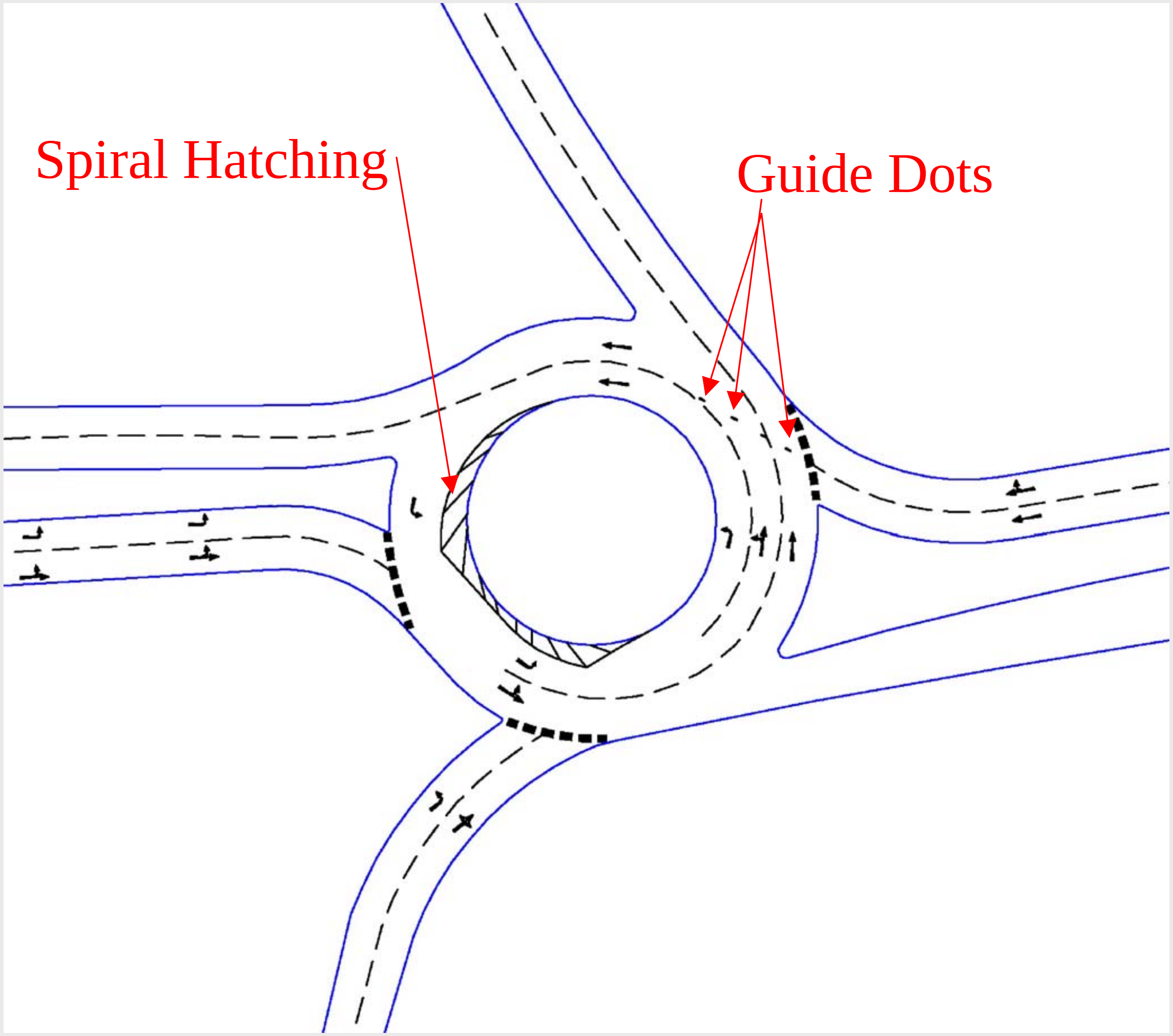
Definitions



Definitions



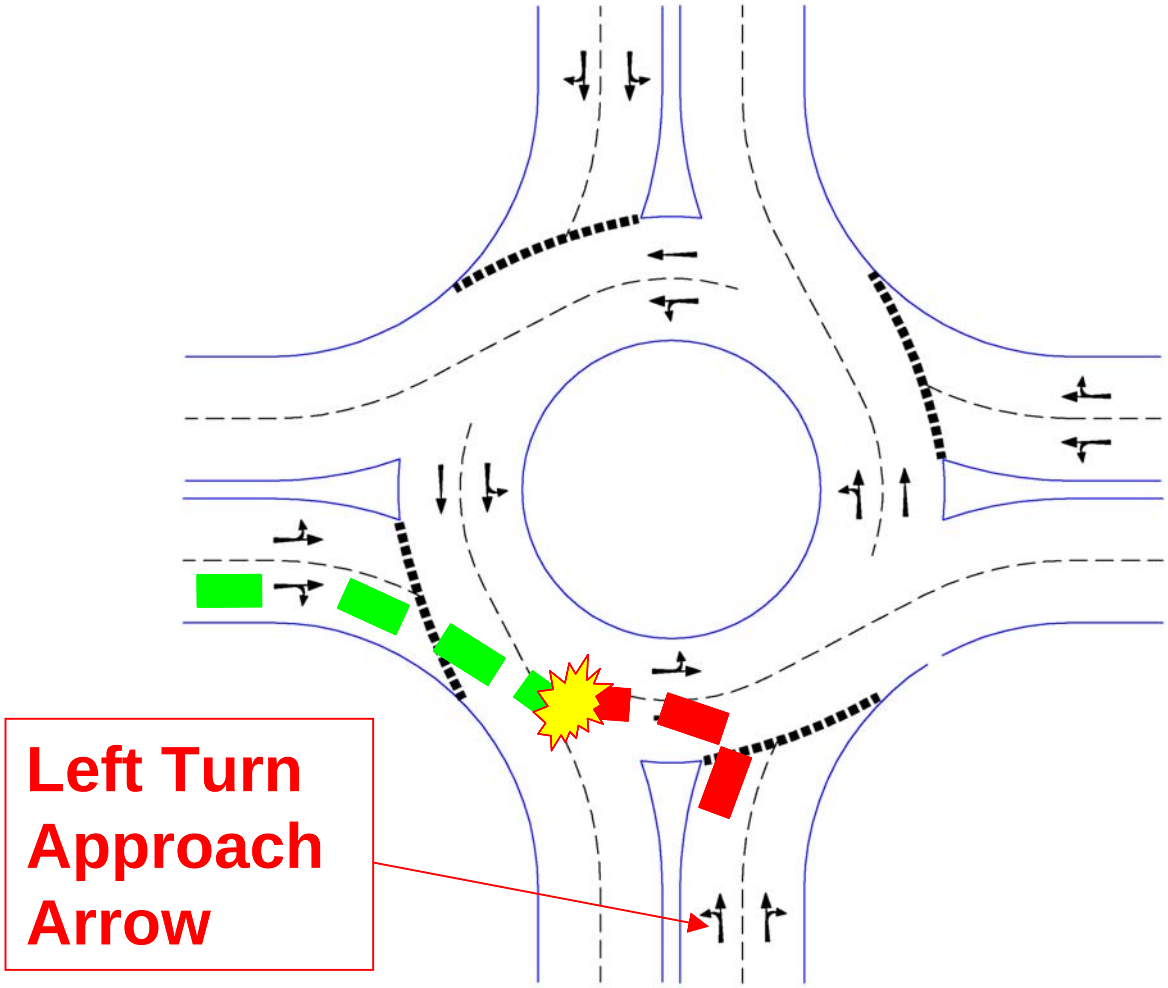
Benefits of Markings

- Why markings at MLRs?
  - Improve safety and traffic operations
  - Guide motorists from approaches to exits without changing lanes/weaving – <u>solves 95% of problems</u>
  - Makes driving roundabouts easy for motorists
  - Educates drivers about lane use
  - Self regulating
  - Lane discipline reduces speeds
  - Crucial for some intersections – will not work without it

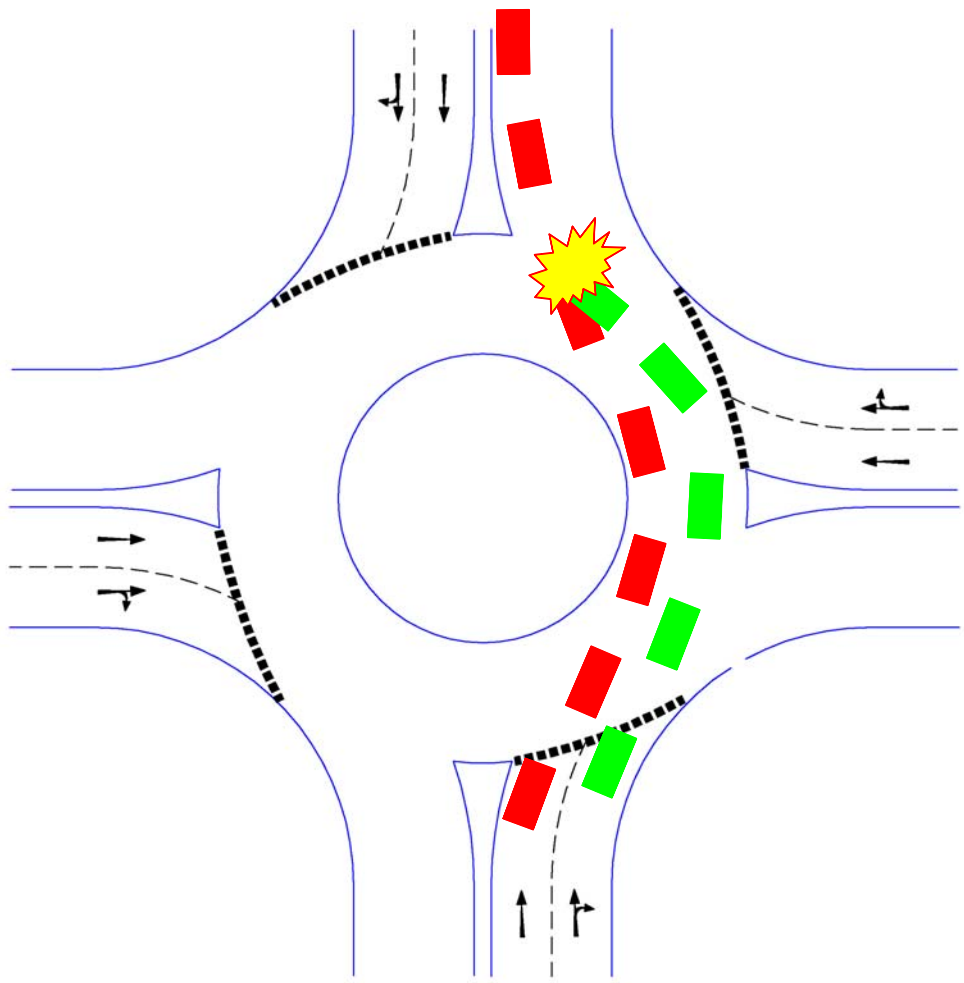
Concerns with Markings

- Why not markings at MLRs?
  - Not appropriate in all situations – conflicting AM and PM turning patterns can preclude
  - Some intersections work fine without (2-laners)
  - Lots of misinformation out there
  - Many ways to get it wrong
- Like fire – powerful and beneficial, but dangerous if used improperly

Fear about Left Turn Arrow



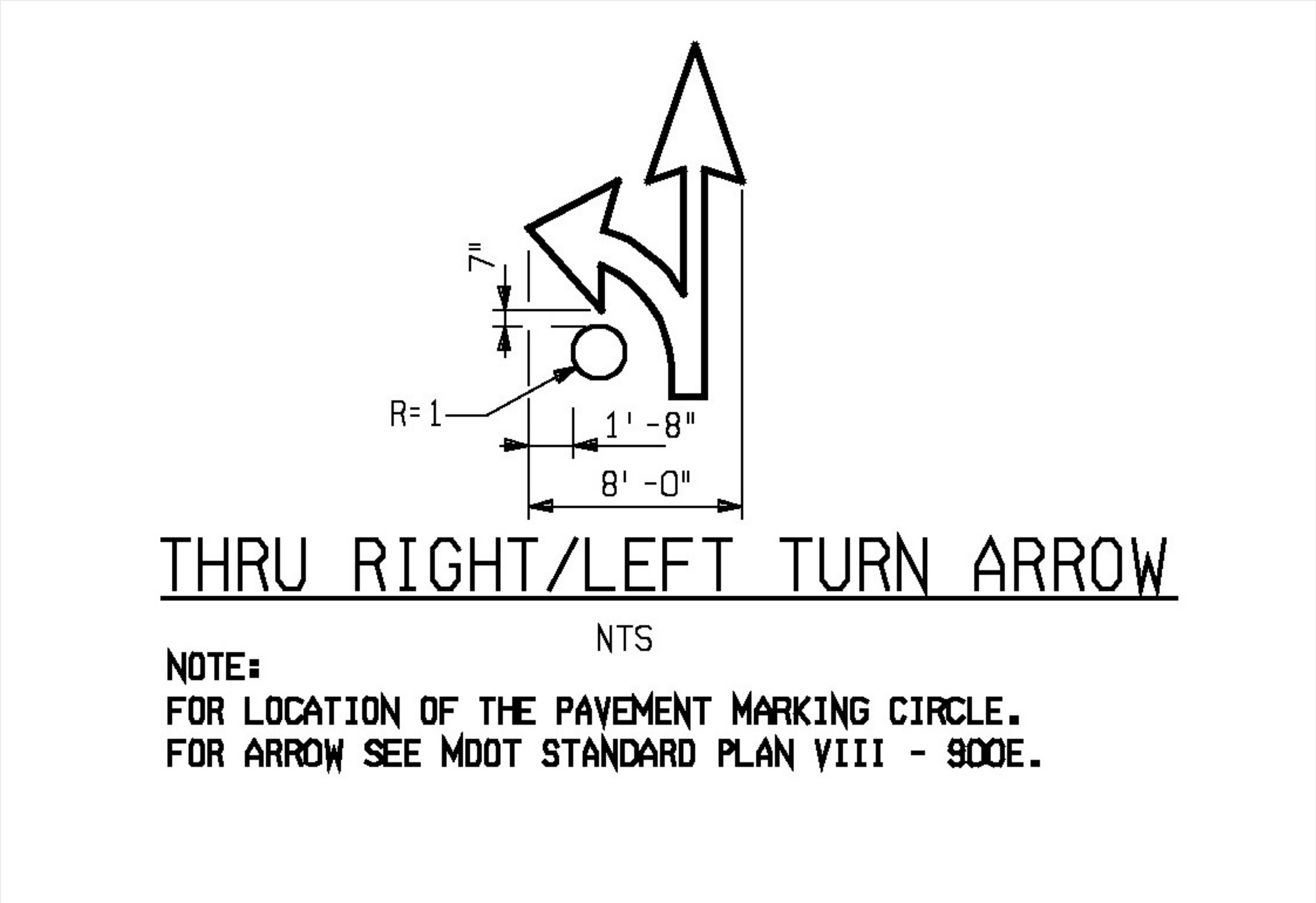
Left Turn at Roundabout



Left Turn Approach Arrow?

- Fear left turn approach arrow will cause illegal turns at yield line – wrong way in circulating road
- Very rare at roundabouts - not a problem
- Indicators not to do it:
  - Roundabout ahead warning signs – point proper direction
  - Destination guide signs – point proper direction
  - Lane use control signs – point other direction
  - Chevrons – point proper direction
  - One-way signs – point proper direction
  - Extremely tight turn radius – 130^{o} turn
  - Spiral arrows in circulating road – point proper direction
  - Traffic on circulating road – travels in proper direction
- On balance, risk from not using left turn arrows (exit crashes) far greater than the risk caused by using them

Left Turn Approach Arrow?

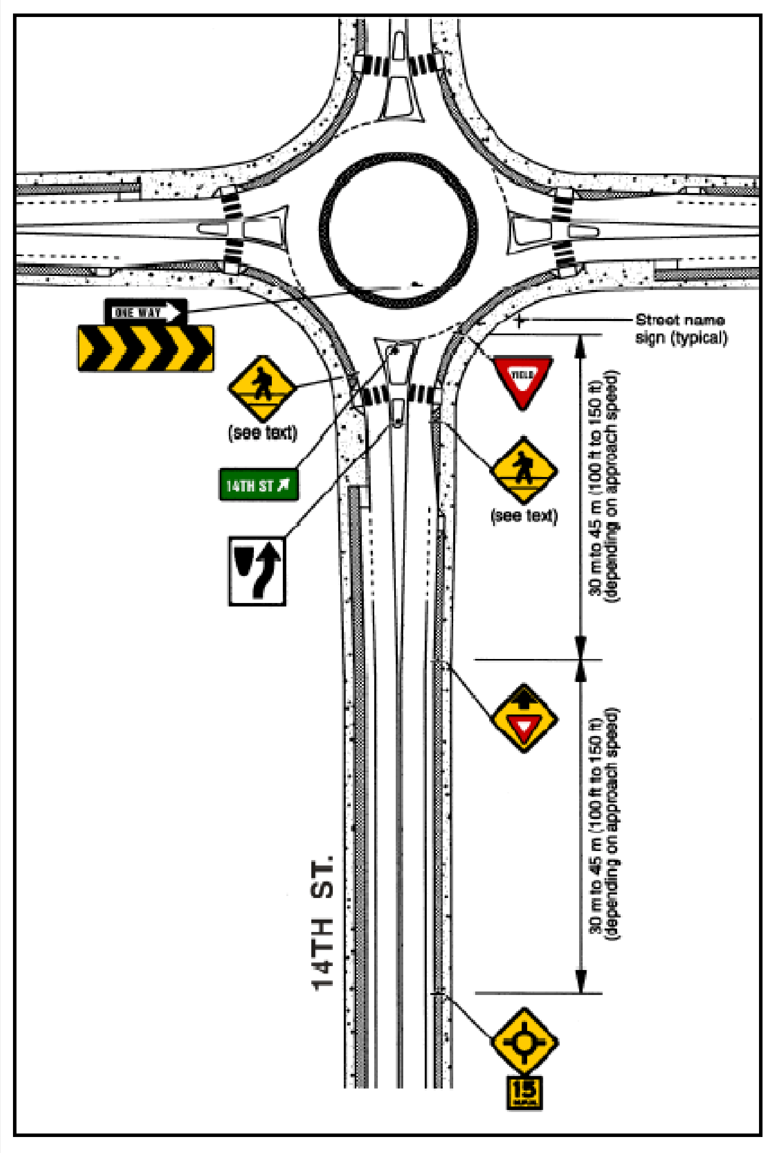


Signing

- Signs work with pavement markings
- Some clear direction, but many areas where debate is ongoing
- FHWA Guide does good job – best single source
  - References MUTCD – legally required, but MUTCD has some questionable advice
  - Lane use control signing section could be improved

DLZ

Signing

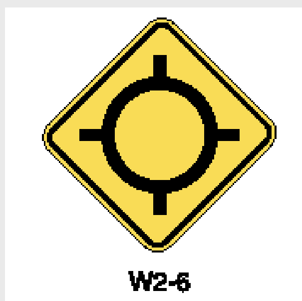


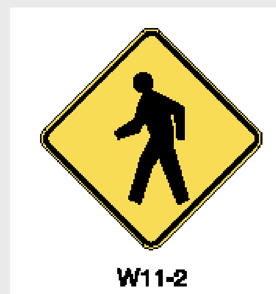
FHWA Guide – overall layout

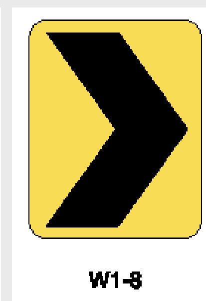
Signing

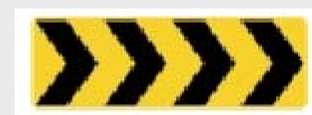
- Regulatory signs

- Warning signs









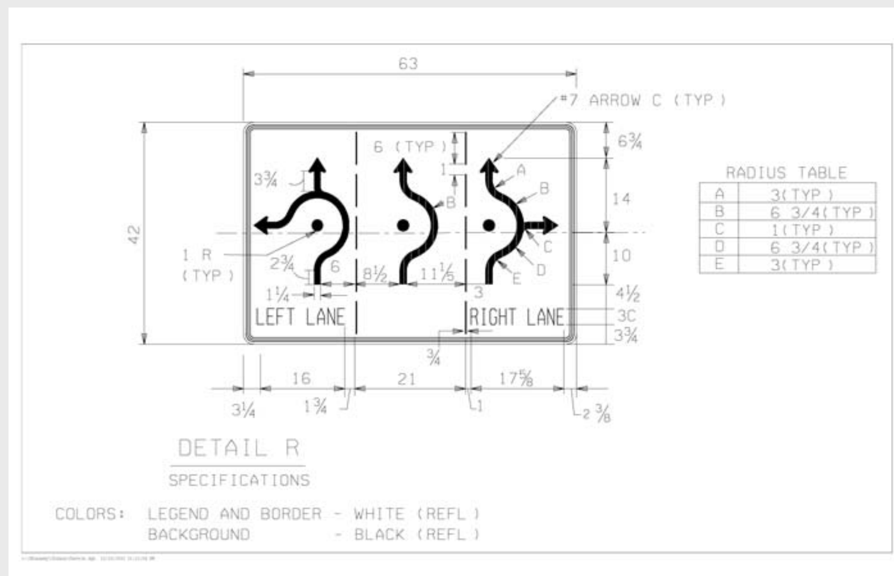
Signing

- Guide signs
  - Advance destination guide signs
  - No clear guidance provided

  - Exit guide signs

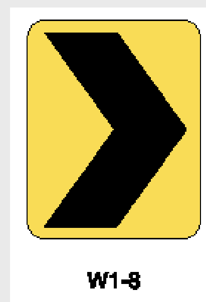
Signing

- Debate over lane use control signs
  - Standard signs - same concerns as left turn approach arrows (illegal left turns at yield line)
  - Other possibilities?



Signing

- Chevrons
  - Staggered single plates for stopping sight distance?
  - Location in central island relative to approaching traffic is important

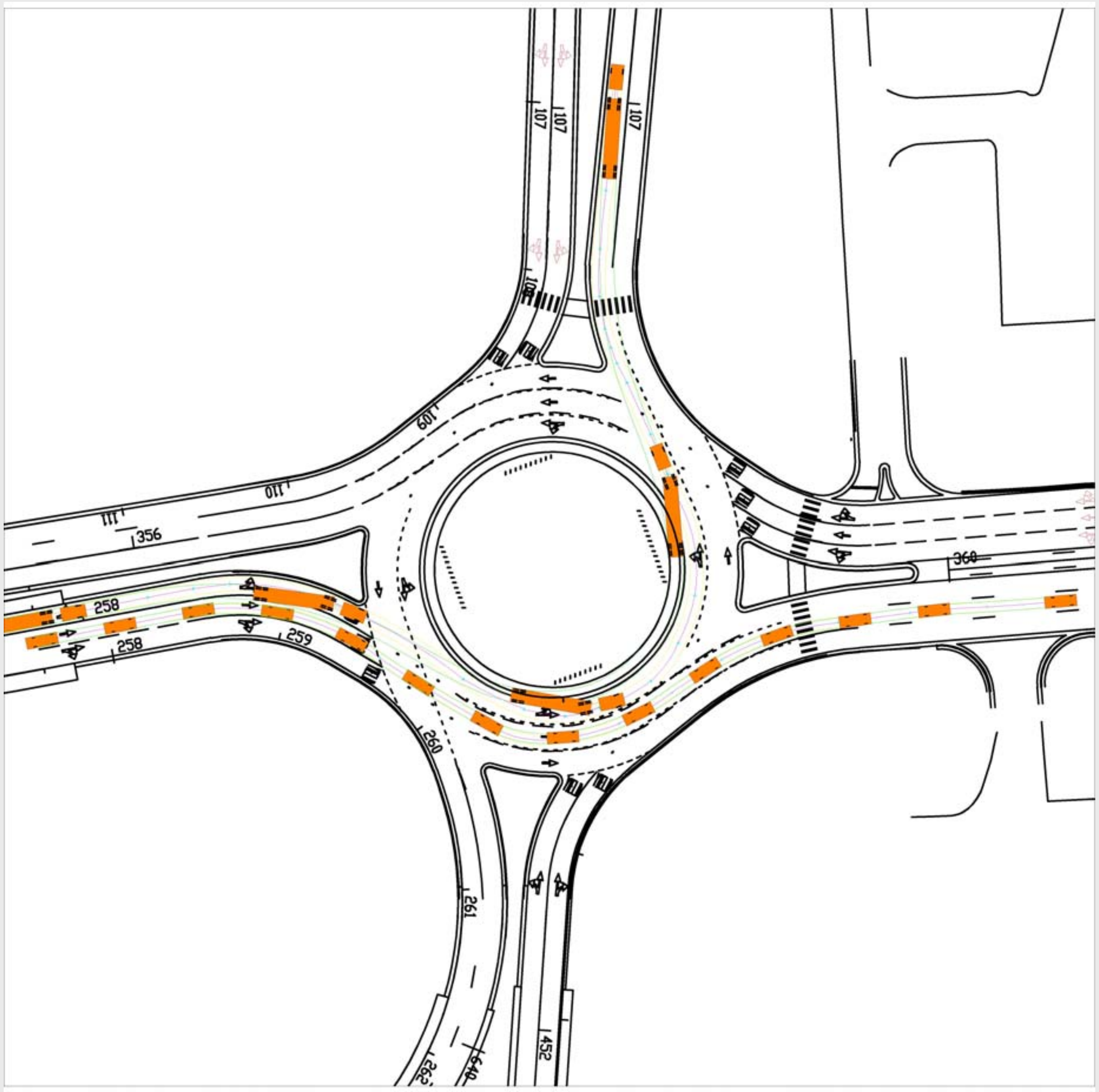


Trucks at Roundabouts

- Roundabouts can be designed to accommodate all types of trucks
- Design vehicle
- Sometimes requires changing geometry
- Can require truck apron in central island
- Test using software such as Autoturn
- Video clips from actual roundabouts
- Also assure emergency vehicles can negotiate (especially large fire trucks)

DLZ

Turning Radii



Okemos Roundabout

Maryland Roundabout

Maryland Roundabout

Pedestrian Safety

- Roundabouts shown to be safer than other types of intersections (signals, stop control)
- Function of vehicle speeds on approach and departure (low speed for roundabouts)
- Design is crucial element in safety (entry and exit radii)
- Only cross one direction of traffic at a time
- Motorists deal with pedestrian crossing separate from entering roundabout

DLZ

Statistics – Pedestrians & Bicycles

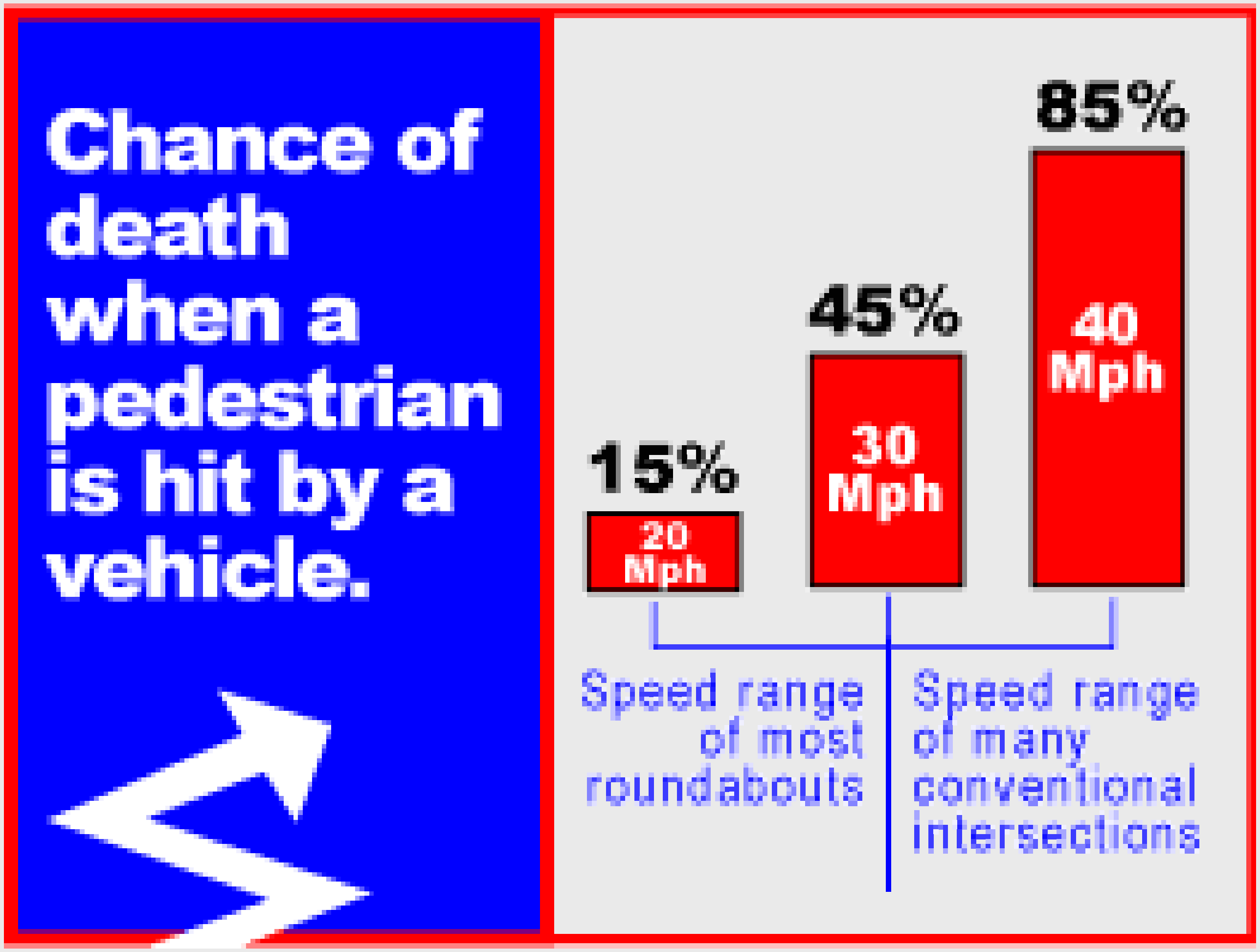
- US - minimal information – anecdotal
- Tumber, 1997 (Australia)
  - Most ped crashes on approaches and in circulating road (less at exits)
  - Severity of ped crashes lower than other intersection types
- Peel, 2002 (U.K.)
  - Crash rates for bicyclists significantly higher than traffic signals when they circulate inside roundabout
- Brude, 1997 (Sweden)
  - Single lane roundabouts safer than multi-laners for both peds and bicyclists
- Lalani, 1975 (U.K.)
  - Ped crash frequency dropped 46% after conversion to roundabouts
  - Fatal and serious ped crash frequency dropped 70%

DLZ

Crosswalks

- Located one to three vehicle lengths BEHIND the yield line
- Pedestrians cross BEHIND the vehicle waiting to enter.
- Refuge on splitter island and need only look one way when crossing

Exit Speeds and Pedestrian Safety



Pedestrians – Heavier Volumes

Blind Pedestrians

- Blind US pedestrians not used to roundabouts – have raised concerns
  - Quieter, so traffic is harder to hear
  - Harder to differentiate exiting and circulating cars
  - They may learn to do this?
- UK - no notable problems
- Options include
  - Signalized crosswalks with auditory cues
  - Tactile paving
  - Split crosswalk with barriers (shorter walk time, timings more flexible)
- Questions
  - Will green crosswalk light confuse drivers in US?
  - What is the impact on entry capacity?
  - What about exit capacity?

Blind Pedestrians

- Cost of signalized crosswalk ~ $100,000
- May lead to signals constructed where roundabouts would have been otherwise
- Net injuries are more than with a Roundabout
  - Blind benefit, but
  - Non-blind motorists have an increase in injuries
- Need for balance
  - When peds are too few for signalized crosswalk
  - Blind volumes are extremely low or nonexistent
- Access Board draft guidelines - controversy
- Issue still unresolved - needs further debate

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Public Education

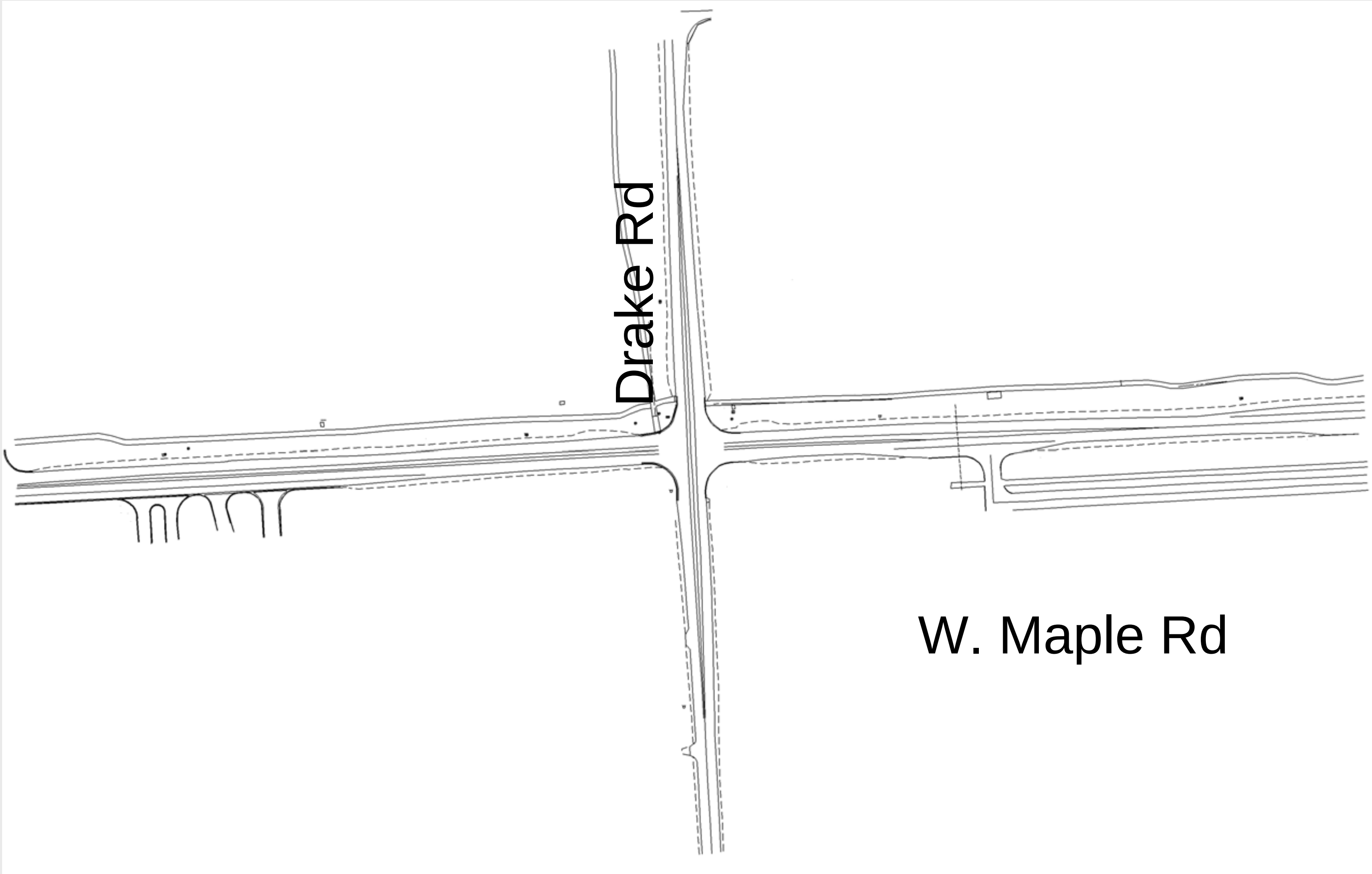
- Very important
- During studies, prior to construction
- Many misperceptions (traffic circles, etc.)
- Variety of tools
  - Photos
  - Videos
  - Simulations
  - Media outlets
  - Meetings
  - Graphics
  - Radio stations
  - Expertise

Maintenance of Traffic

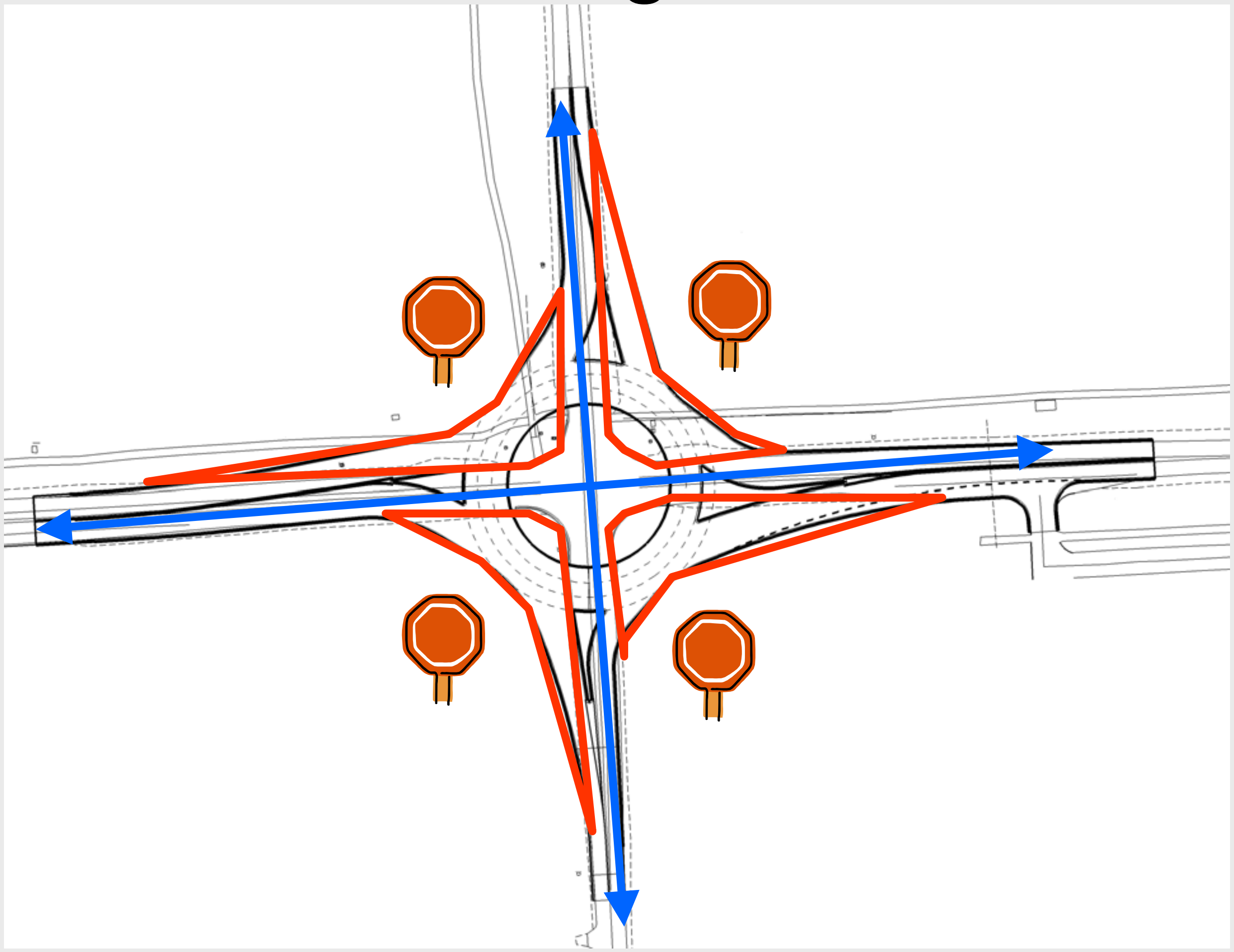
- Stage 1:
  - Construction of outside portion of roundabout in all quadrants.
  - Use of stop control or temporary signals is necessary
- Stage 2:
  - Construction of the remaining roundabout including central island and approach tapers
  - Traffic uses circulating road
  - Use stop control or temporary signals
- Stage 3:
  - Complete remaining portions of circulating roadway

- Other Options include part width construction (For 2 lane roundabouts)
- If roundabout is not centered on intersection and/or if intersection is skewed, more complicated.

Construction Staging - Existing Conditions

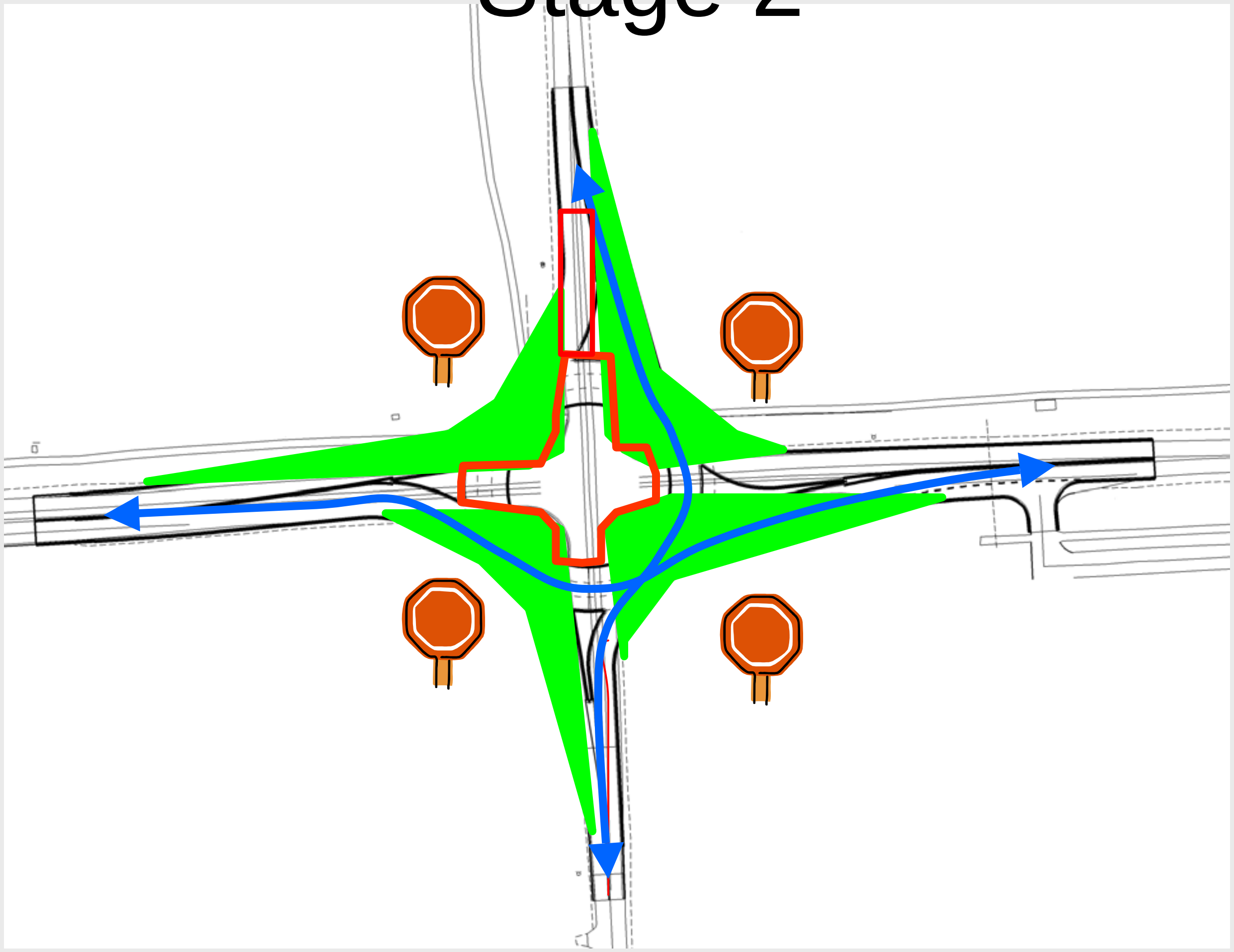


Stage 1



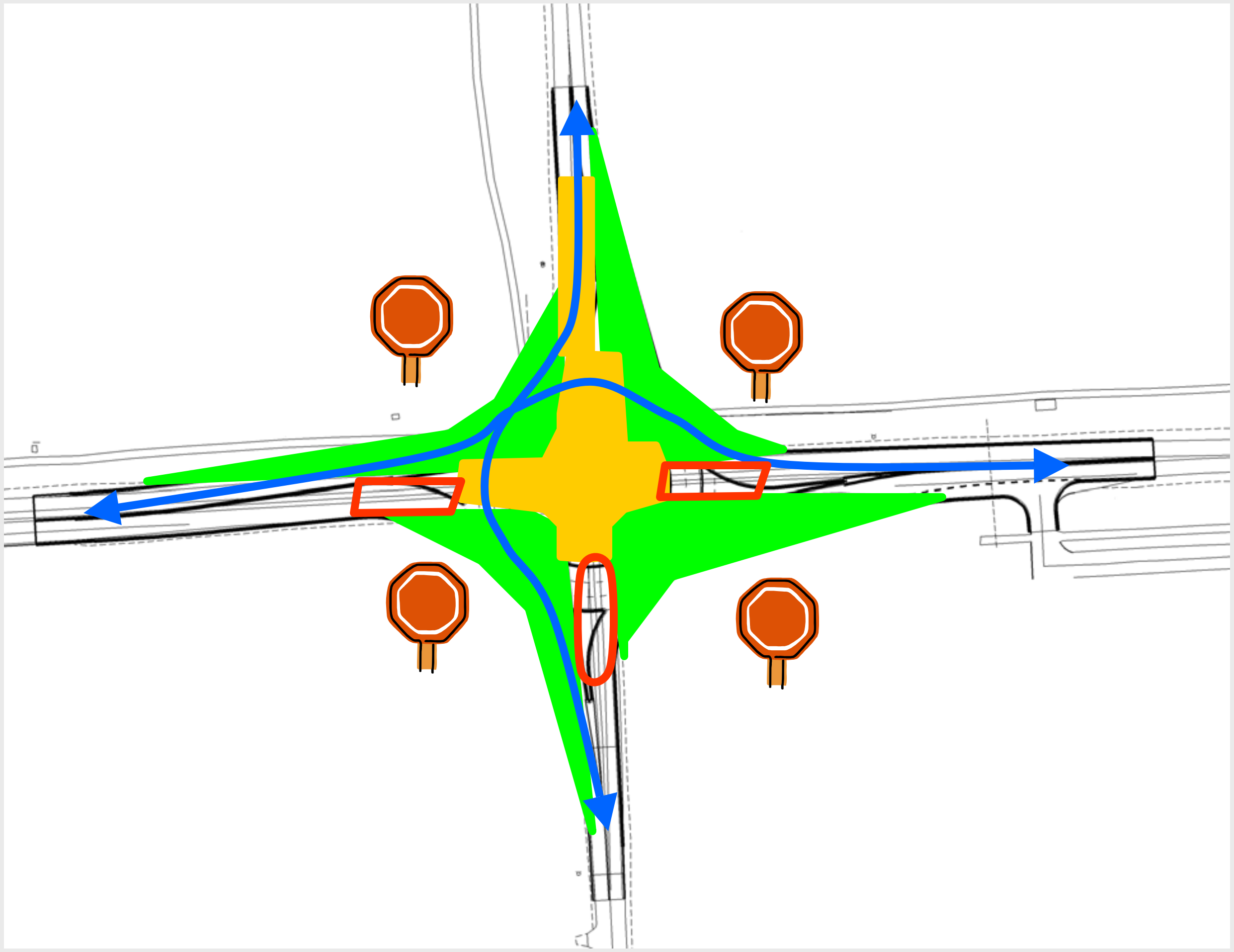
- Construct in 4 corners outside traveled portion of roadway

Stage 2



- Construct central island

Stage 3



- Construct remaining portions of circulating roadway

Northwestern Connector Project
Oakland County, MI

Topics

- Background
- Problems to be addressed
- Comparison of alternative solutions
- Preferred Alternative
- Next Steps

Background

N
West Maple Road
14 Mile Road
M-5
Haggerty Road
Halsted Road
Drake Road
Farmington Road
Orchard Lake Rd
Northwestern Highway (M-10)
Oakland County
Oakland
Saginaw Bay
Lake Michigan
MAPLE ROAD
PLANTERS
LIGHT TYPICAL
CROSSWALKS
KEY
ROAD
PROPOSED BOULEVARD
PROPOSED TREES
TRAFFIC MOVEMENT
NORTH
0
20
40
80
DLZ

Background

- Transportation improvement study to address severe traffic congestion and crashes
- 40+ years of debate, studies, and litigation
- Task: Assess benefits and impacts of road widenings, improved signals, and modern roundabouts
- Included NEPA compliance documentation and Early Preliminary Engineering
- Massive public involvement campaign
- Challenging consensus building
- Funding investigation and report
- Develop phased construction approach
- Study initiated in 1999, completed in 2001

Background -
Steering Committee

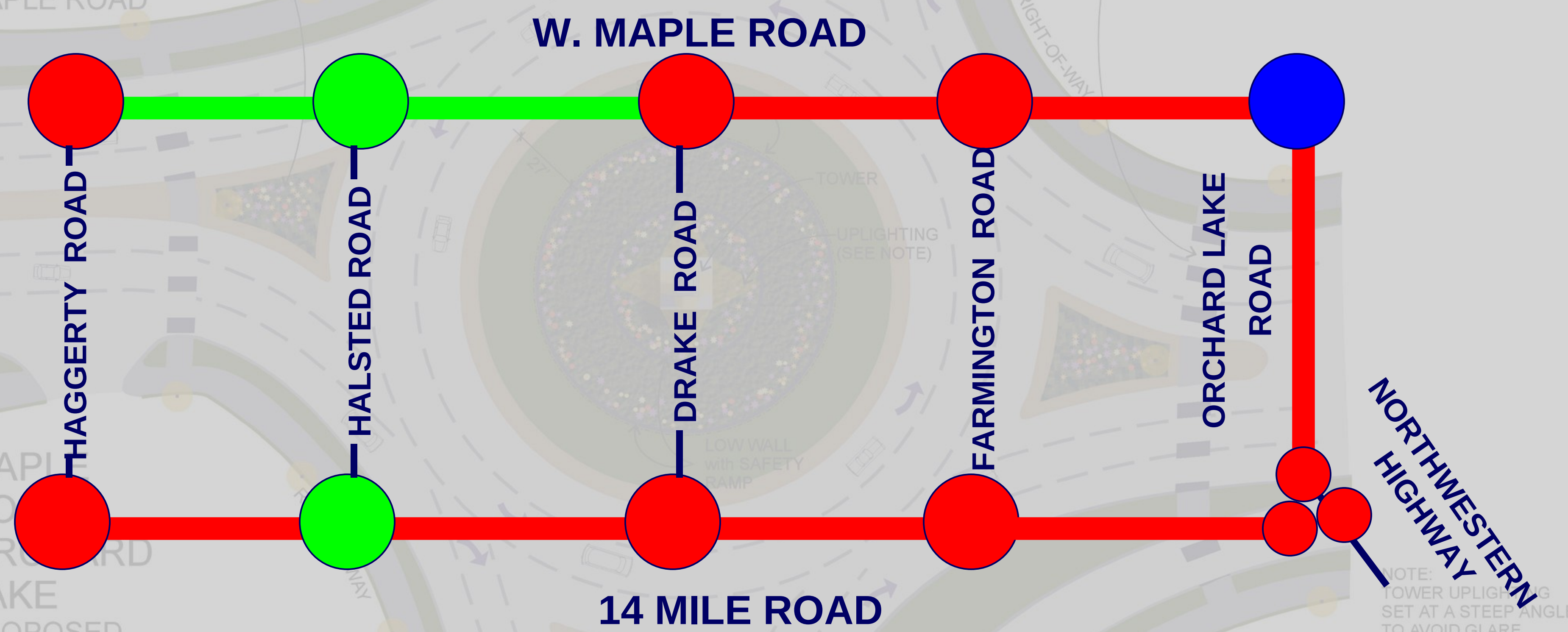
Voting Members:

- City of Farmington Hills
- Charter Township of West Bloomfield
- Road Commission for Oakland County
- Michigan Department of Transportation

Advisory Members:

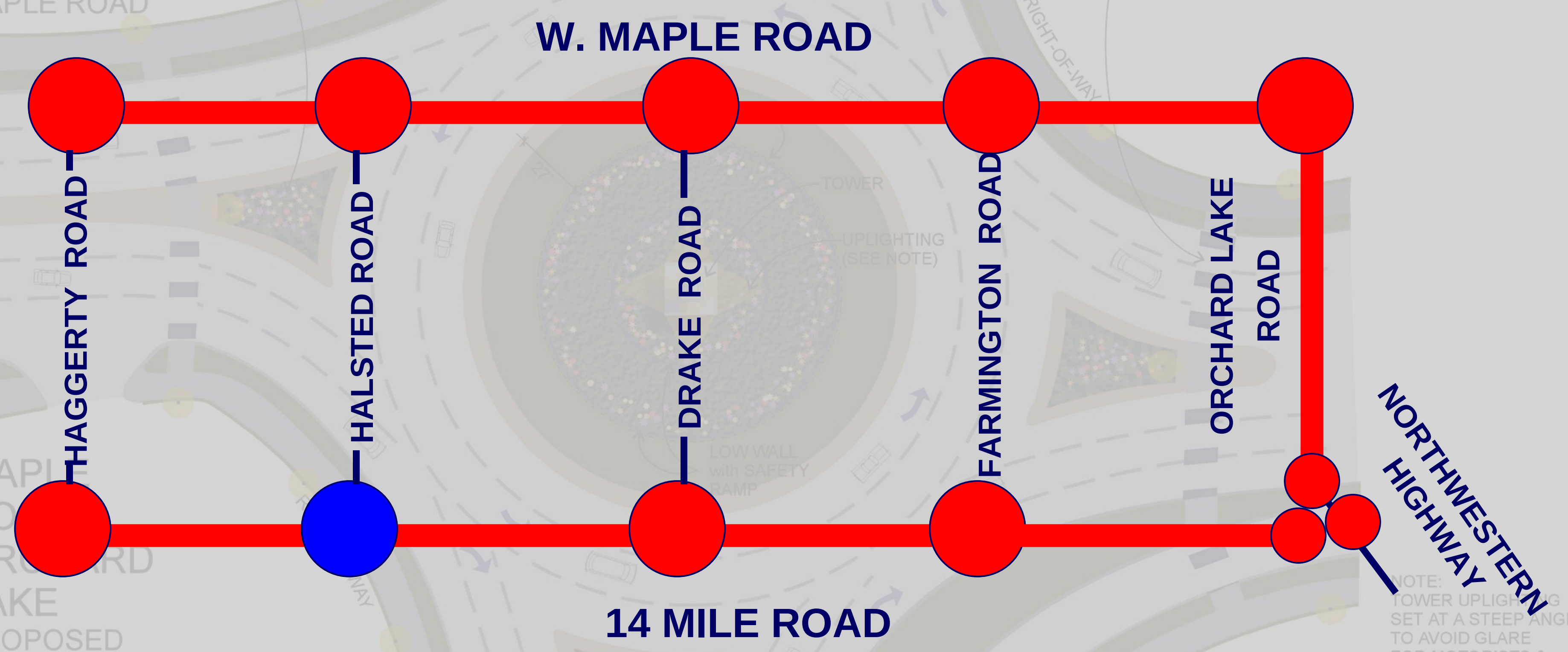
- City of Novi
- Commerce Charter Township
- Federal Highway Administration (FHWA)
- Southeast Michigan Council of Governments (SEMCOG)
- SMART

Existing (1999) Traffic Delays
Afternoon Rush Hour



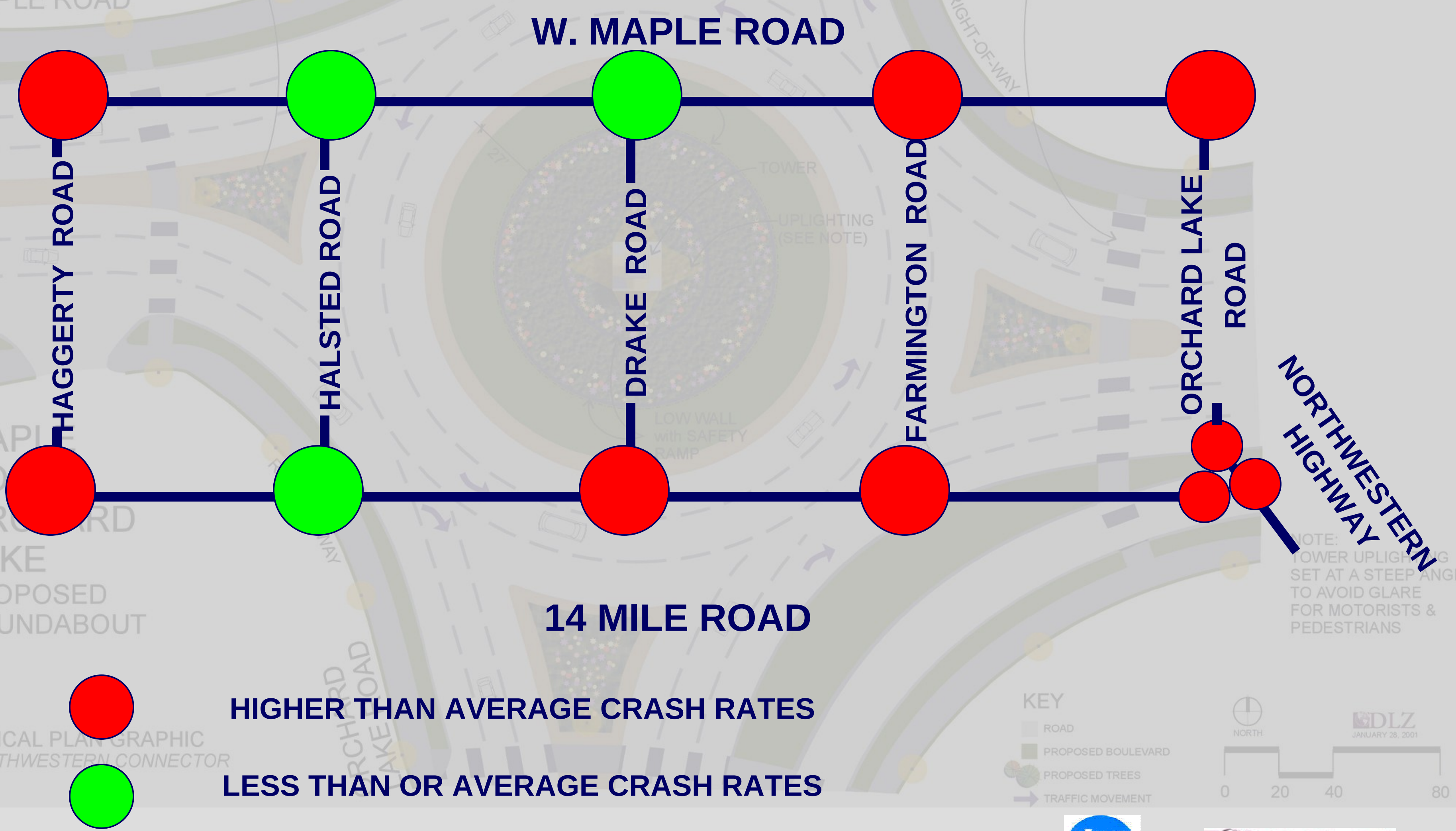
LOS		INTERSECTION DELAY
A-C	Green	<35 SECONDS
D	Blue	35 - 55 SECONDS
E-F	Red	>55 SECONDS

2020 No Build Traffic Delays
Afternoon Rush Hour



LOS		INTERSECTION DELAY
A-C	Green	<35 SECONDS
D	Blue	35 - 55 SECONDS
E-F	Red	>55 SECONDS

Existing Crash Rates at Major Intersections



Crash Causes

- 789 crashes in 1999 in project area
- Majority rear-end or angle crashes (congestion related)
- Principle cause is congestion and driver error/impatience
- Lack of left turn signal phases at some intersections
- Number of access points to Orchard Lake Road (existing service drives have short throat depth)

Practical Alternatives

- Orchard Lake Road (ex. 5-lane)
  - 4-lane boulevard
  - 6-lane boulevard
- West Maple Road (ex. 2-3-lane)
  - 5-lane roadway
  - 4-lane boulevard
- Fourteen Mile Road (ex. 2 lane)
  - 3-lane roadway
- Intersections (most signalized)
  - Improved traffic signals
  - Modern roundabouts
- Northwestern Hwy.
  - Grade separation w/6-lane boulevard
- Other improvements
  - TSM measures
  - Access management
  - Transit (SMART)
  - Bypasses
  - Eliminate service drives along Orchard Lake Road

Criteria Used to Evaluate the Practical Alternatives

- Traffic Operations
- Safety (vehicles and pedestrians)
- Access
- Cost
- ROW Impacts
- Land use and Socio-Economic Impacts
- Environmental Impacts
- Public Input

LOS and Delay

Intersection	1999 PM Peak/ADT		2020 No-Build		2020 Signal Alternative		2020 Roundabout Alternative	
	Entering ADT	PM Peak	LOS	Delay	LOS	Delay	LOS	Delay
Maple / Haggerty	45,330	3,355	F	137	C	28	B	14
Maple / Drake	38,575	2,855	F	172	C	23	A	5
Maple / Farmington	43,300	3,205	F	140	C	26	A	5
Maple / Orchard Lake	71,600	5,300	F	140	C	23	A	8
14 Mile / Haggerty	48,370	3,580	F	268	C	27	A	4
14 Mile / Drake	37,360	2,765	F	194	C	23	A	3
14 Mile / Farmington	45,530	3,370	F	181	C	24	A	4
14 Mile / Orchard Lake	66,340	4,910	F	129	C	23	A	8

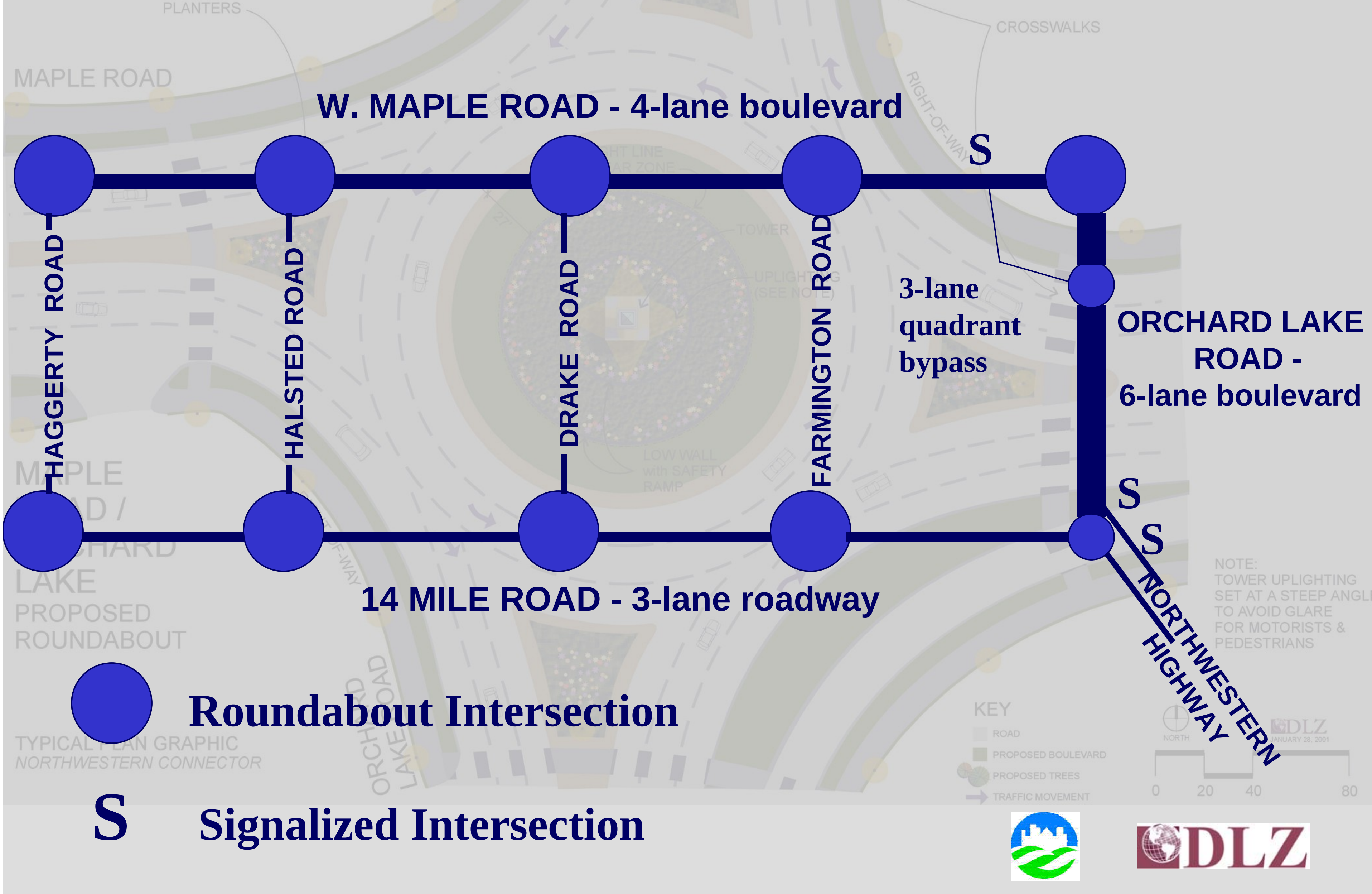
Measures of Effectiveness (MOEs)

MOE	Explanation	Signalized Alternative	Roundabout Alternative
Intersection LOS	Number of intersections projected to operate at LOS B or better during pm peak traffic hour for the year 2020.	4 of 14	12 of 15 (3 signals)
Intersection LOS	Number of intersections projected to operate at LOS D or better during pm peak traffic hour for the year 2020.	14 of 14	15 of 15
Total Annual Intersection Delay	Estimated total annual hours of vehicle delay at project area intersections for the year 2020. An estimate of total annual number of vehicles entering all intersections is provided in parentheses for each alternative.	946,000 hours (240,586,000 vehicles)	408,000 hours (250,000,000 vehicles)
Average Delay per Vehicle	Estimated average delay per vehicle per intersection for the year 2020 based on annual delay totals.	14.2 seconds	5.9 seconds
Relocations	Number of residences and businesses requiring relocation.	5 relocations	5 relocations

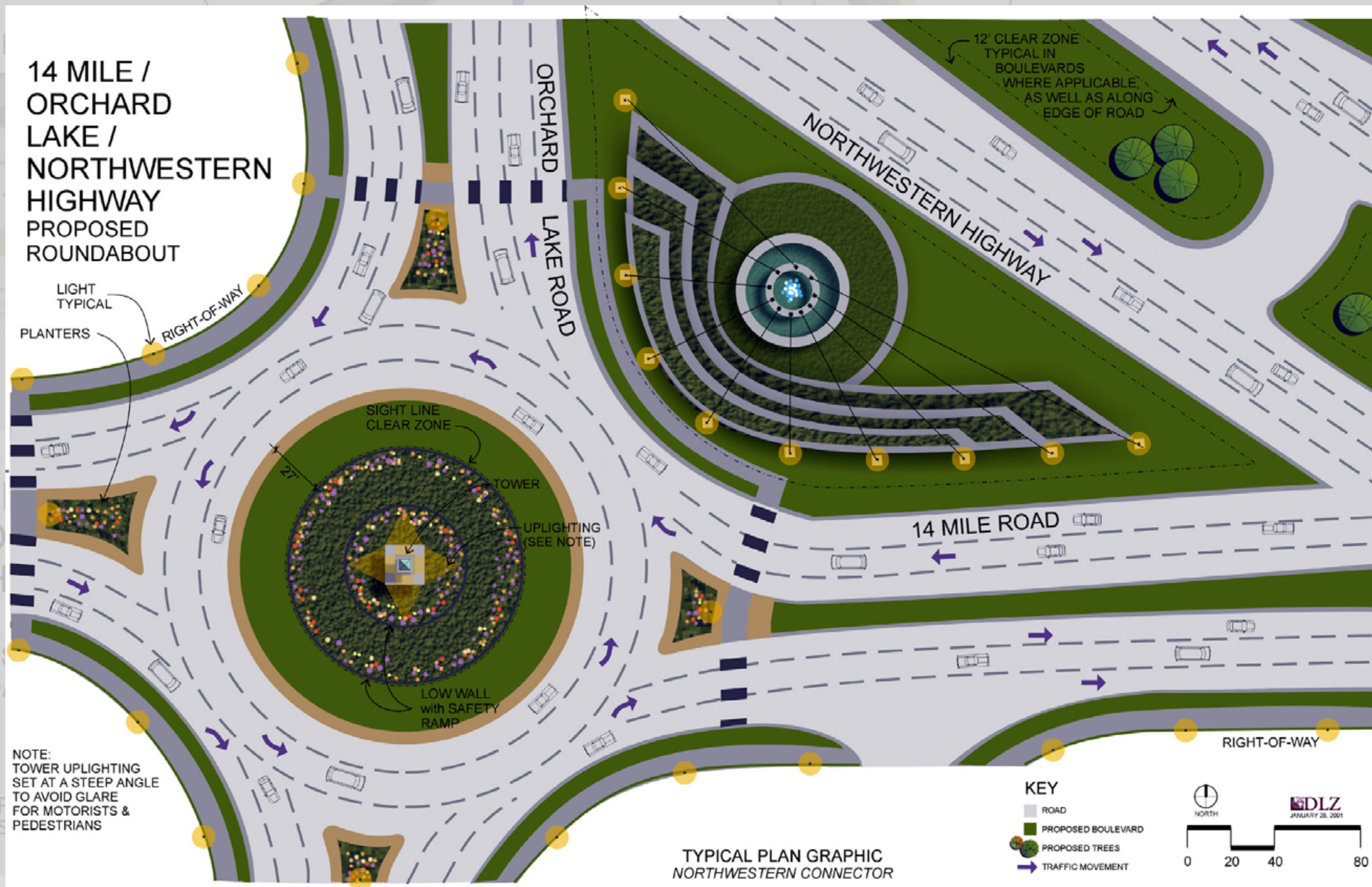
More MOE's

MOE	Explanation	Signalized Alternative	Roundabout Alternative
Annual injury crashes	Estimated number of injury crashes for the year 2020.	262 crashes	141 crashes
Crash rate	Estimated crash rate in project area for the year 2020.	5.9 crashes/million vehicle miles	4.4 crashes/million vehicle miles
Total Cost	Total estimated cost includes cost of design, ROW acquisition, utility relocation, mitigation, and construction (in year 2000 dollars).	$92.7 Million	$90.3 Million
ROW acquisition	Acres of ROW acquisition required.	29.5 acres	28.5 acres
Wetland Impacts	Acres of wetlands impacted by filling	2.7 acres	2.9 acres
Annual Crash Cost	Estimated annual cost of all crashes projected for year 2020 (in year 2000 dollars). Costs include wage and productivity losses, medical expenses, administrative expenses, motor vehicle damages, employer expenses, and reduced quality of life (based on surveys).	$18.1 Million	$8.0 Million

Preferred Alternative

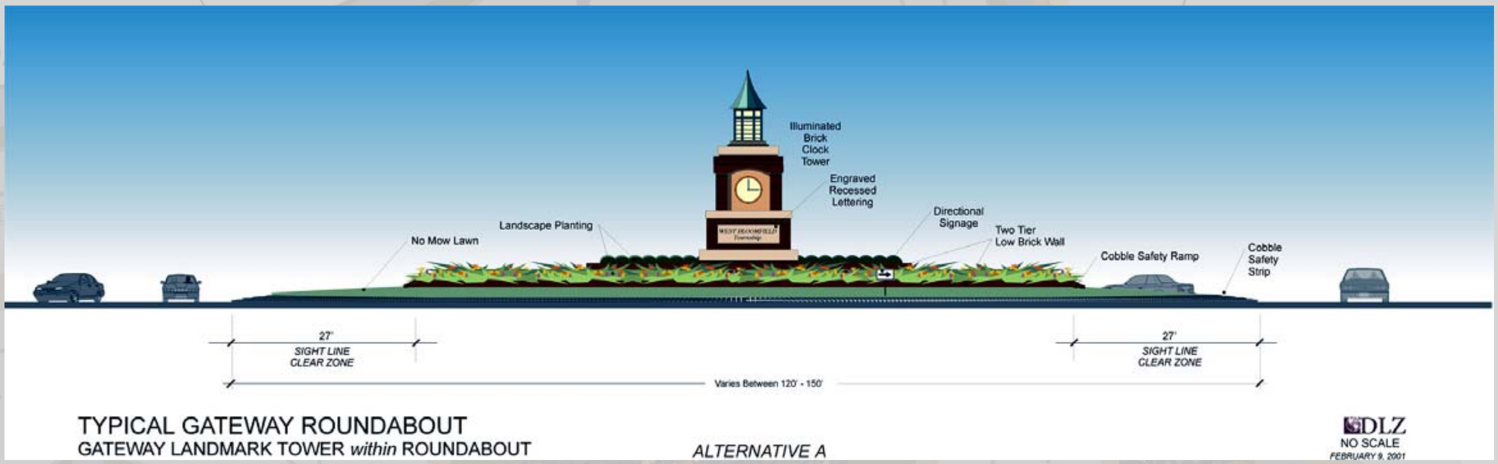


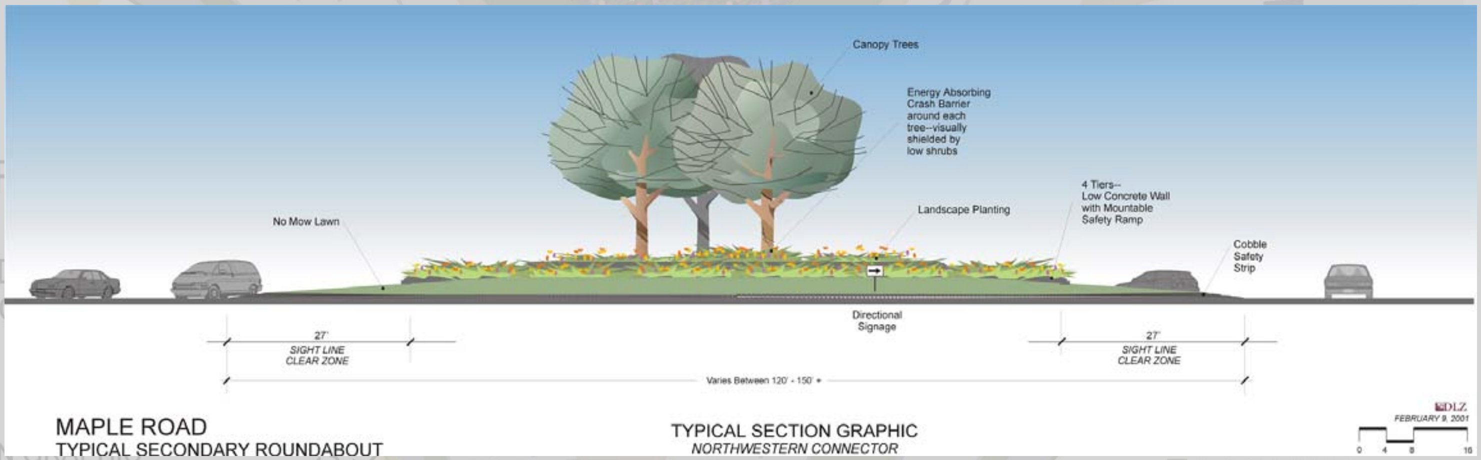
Aesthetics



14 MILE / ORCHARD LAKE / NORTHWESTERN HIGHWAY
PROPOSED ROUNDABOUT
LIGHT TYPICAL
PLANTERS
RIGHT-OF-WAY
ORCHARD LAKE ROAD
NORTHWESTERN HIGHWAY
12' CLEAR ZONE TYPICAL IN BOULEVARDS WHERE APPLICABLE, AS WELL AS ALONG EDGE OF ROAD
SIGHT LINE CLEAR ZONE
27'
TOWER
UPLIGHTING (SEE NOTE)
LOW WALL with SAFETY RAMP
14 MILE ROAD
RIGHT-OF-WAY
NOTE:
TOWER UPLIGHTING SET AT A STEEP ANGLE TO AVOID GLARE FOR MOTORISTS & PEDESTRIANS
TYPICAL PLAN GRAPHIC
NORTHWESTERN CONNECTOR
KEY
ROAD
PROPOSED BOULEVARD
PROPOSED TREES
TRAFFIC MOVEMENT
NORTH
DLZ
JANUARY 28, 2001
0
20
40
80

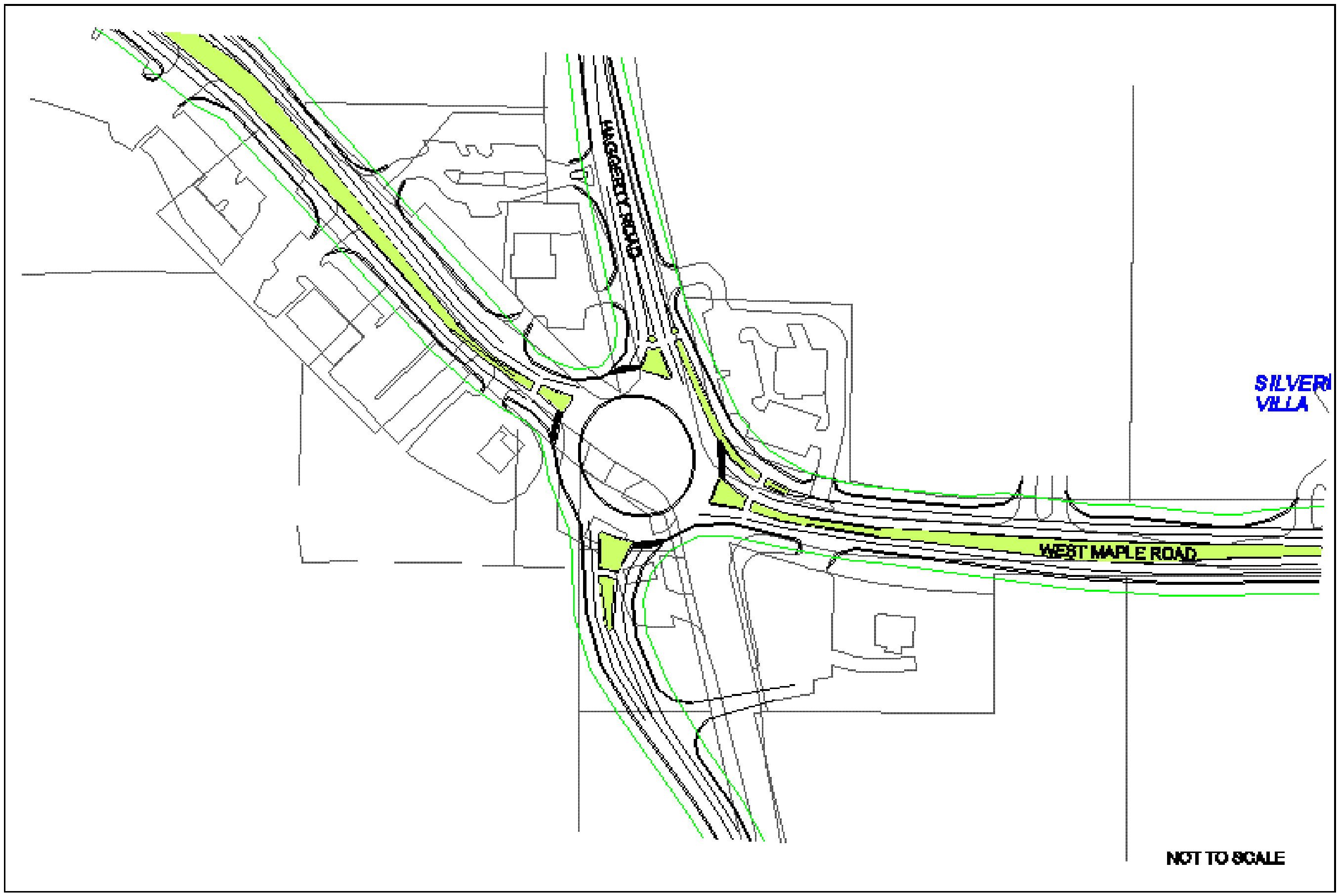
Aesthetics



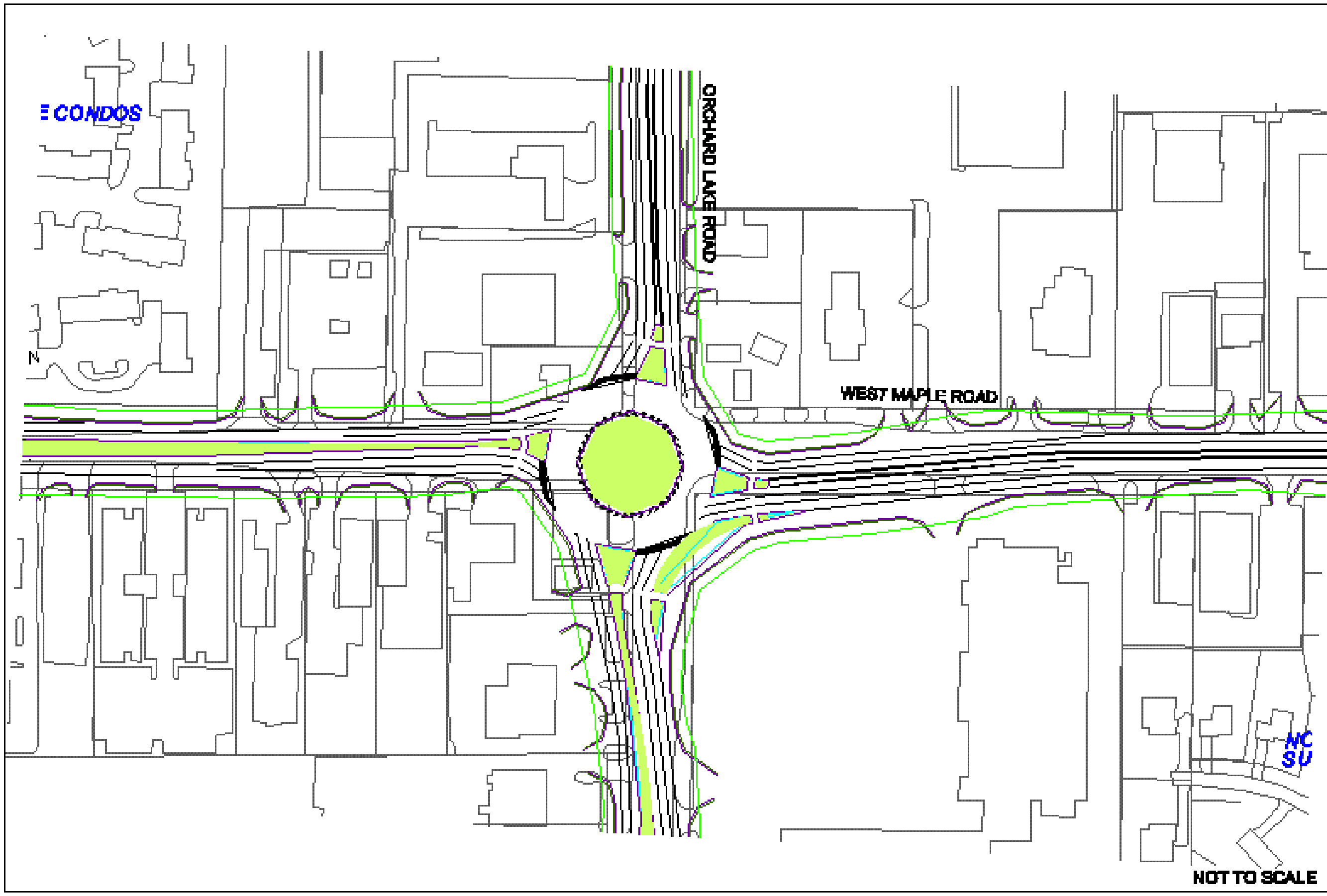


NOTE:
TOWER UPLIGHTING SET AT A STEEP ANGLE TO AVOID GLARE FOR MOTORISTS & PEDESTRIANS

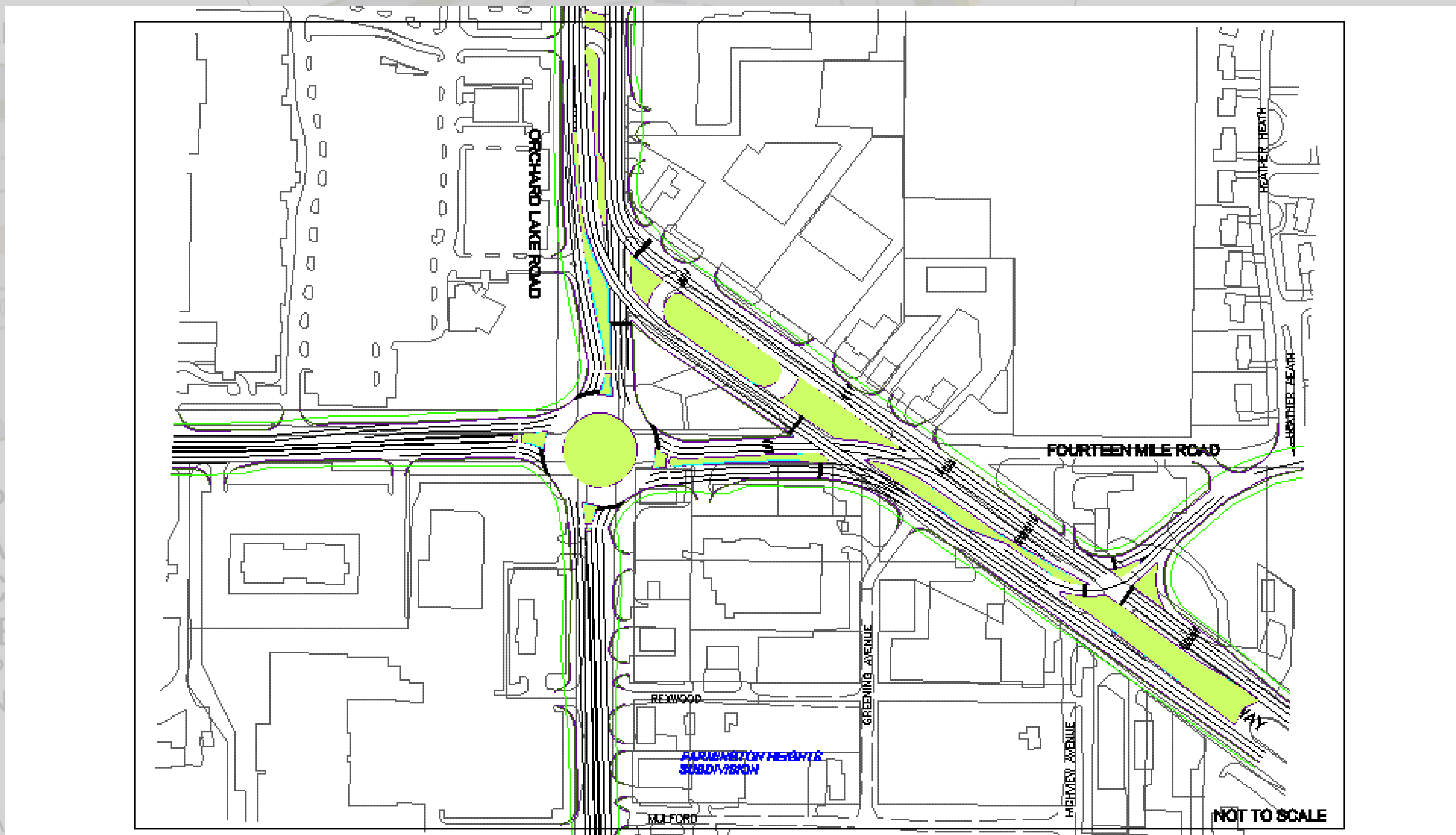
West Maple – Haggerty Intersection



West Maple – Orchard Lake Intersection



The “Bermuda” Triangle



Next Steps

- FONSI signed by FHWA - November 2002
- Funding sources identified for Phase 1
  - $45 M
  - Nine roundabouts
  - Widen Orchard Lake
  - Bypass road
- Design underway
- Construction 2005-2007

Conclusions

- Detailed micro-analysis and comparison
- Roundabouts had better traffic operations
- Roundabouts had better safety performance
- Cost is same
- Roundabouts are aesthetically pleasing
- Signals crucial at a some intersections
- Add capacity where needed (intersections) – widenings not always the solution
- Proceed with caution at high capacity roundabouts
- Largest concentration of high capacity roundabouts in U.S.
- Web Page: www.dlzcorp.com/seg

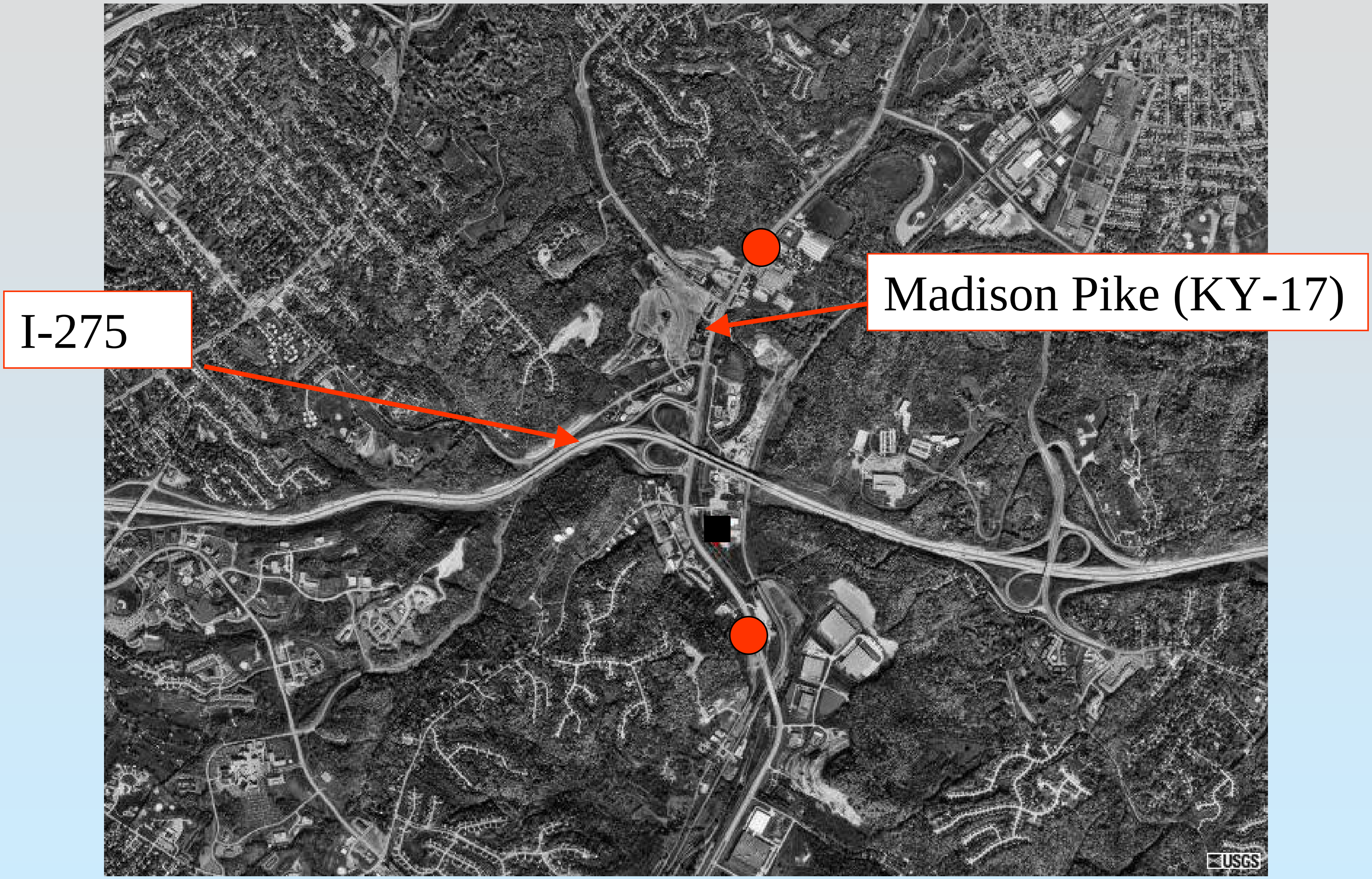
Initial Assessment of Madison Pike Roundabouts

Preliminary Thoughts and Ideas

Background

- Madison Pike (KY 17)
- Primary non-interstate north-south route in Kenton County
- Substantial residential and commercial growth projected for corridor
- Comprehensive study within City of Fort Wright
- *Madison Pike Corridor Land Use and Economic Development Plan*
- 2.4-mile segment along KY-17 includes I-275 interchange
- Transportation elements included in plan
- Two roundabouts under consideration – northern and Southern locations

General Locations



Northern Roundabout

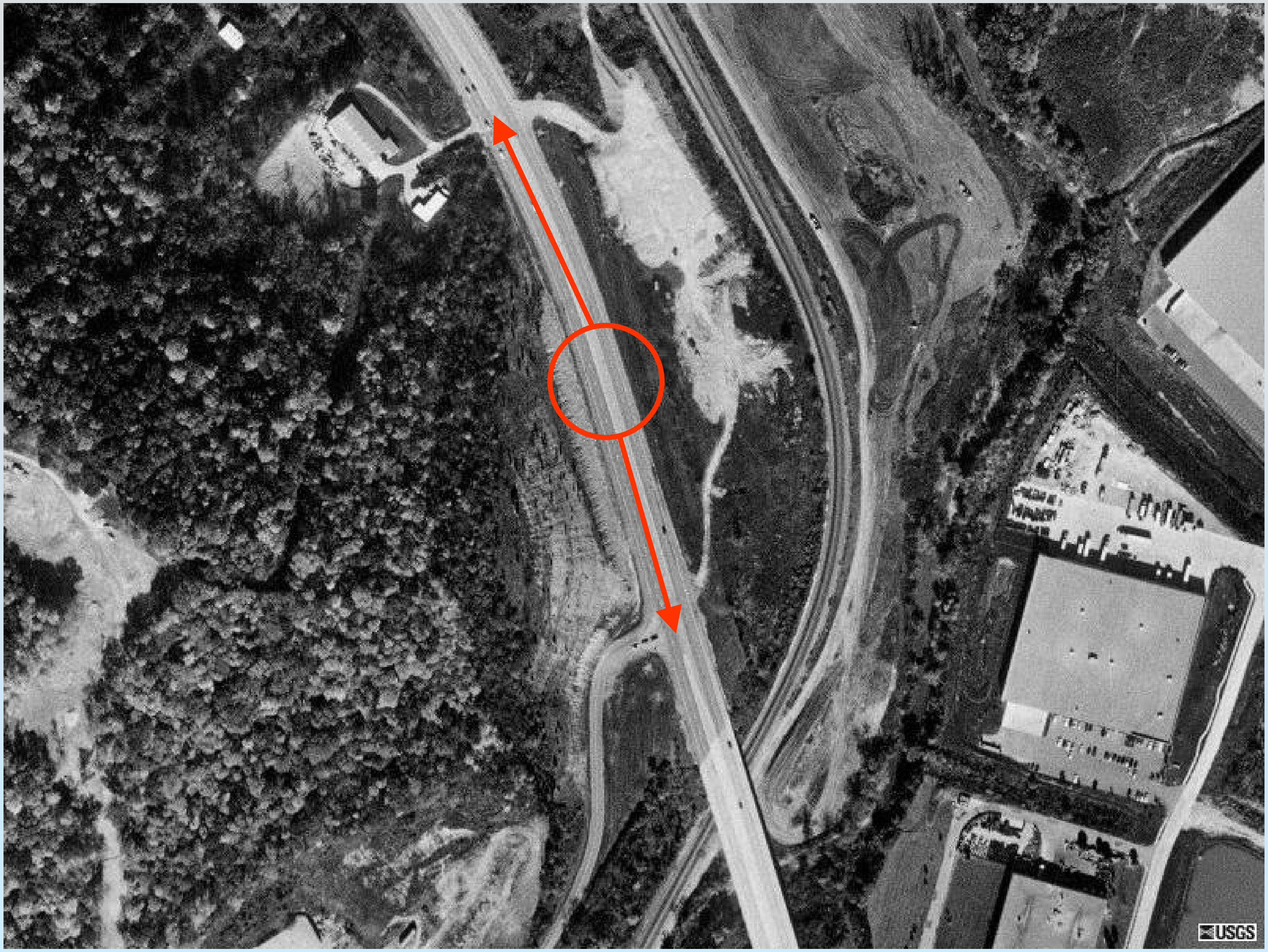
Northern Roundabout

- 5-lane existing cross section on Madison Pike
- Entrance to TANK is east leg
- West leg would be new access road
- New Wal-Mart near here
- Traffic volumes currently about 24,000/day (2 directional)
- Roundabout:
  - Must accommodate AM and PM peak hour traffic
  - 20-year projections, including new access road
  - Peak hour turning movements are used
  - Truck % (busses)
- Minimum of 2-lane roundabout (ICD = 150-180 feet)
- May need 3-lane roundabout (ICD = 210-250 feet)
- Need will be based on 20-year traffic projections
- Relatively complex design

Northern Roundabout

Directional photos from roundabout location (North to top)

Southern Roundabout



Southern Roundabout

- 4-lane existing cross section with median & 5-lane
- Location is flexible
- West leg new access road connecting to Old Madison Pike
- Traffic volumes currently about 38,000/day (2 directional)
- Likely need 3-lane roundabout (ICD = 210-250 feet)
- Need will be based on 20-year traffic projections
- Relatively complex design

Southern Roundabout

Directional photos
from roundabout
location (north to top)

General Conclusions

- Appear to be good locations for roundabouts
- Need detailed feasibility evaluation with concepts
- Opportunities to integrate non-motorized facilities
- Could be attractive gateway into area
- TANK's needs can be met if integrated into concept development
- Can be designed for good traffic operations and safety
- Stakeholder and public education are key
- Important for access management strategy
  - Narrow, non traversable median
  - U-turns
  - Helps preserve overall corridor capacity

DLZ

General Conclusions

- Potential issues:
  - Grades/vertical profile
  - 20-year traffic projections
  - Interaction with adjacent traffic signals
  - Minimizing ROW impacts
  - Integration into access management plan
  - Very important to get proper expertise – these designs are complex!
  - Public education
  - Accommodation of design vehicle/TANK busses
  - Coordination with key stakeholders, especially KTC
  - Accommodation of non-motorized facilities