# FDOT DDI Design Webinar Series
# DDI Multimodal Accommodations

August 24, 2021

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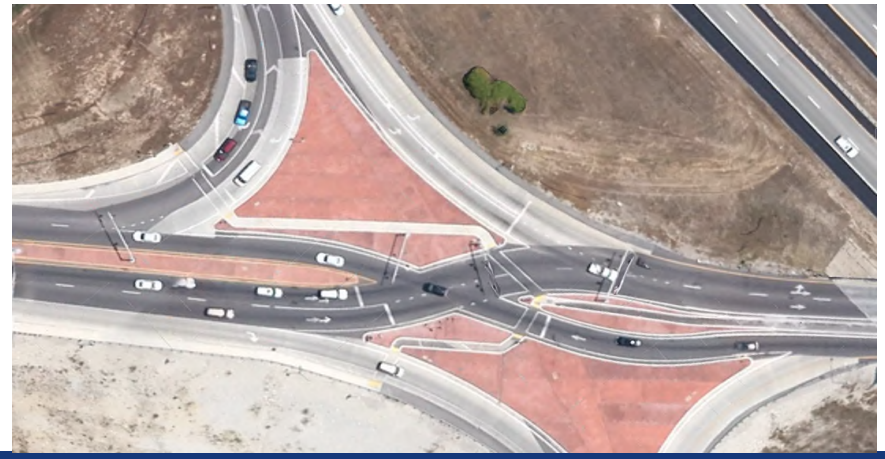
- **Florida Department of Transportation (FDOT) will be hosting a webinar series focused on design and analysis of Diverging Diamond Interchanges (DDI). This series will present guidance on the major elements of DDI project development, including Geometric Design, Signing and Pavement Markings, Traffic Operations, Signalization, Plan Detailing, and Public Involvement.**
- **FDOT Developmental Design Criteria, D217 Diverging Diamond Interchanges, will be covered as well as national design guidance and industry best practices.**
- **Intended Audience: The intended audience for this training includes transportation professionals involved in the planning, design, and review of Diverging Diamond Interchanges.**
- **Schedule:**

| | | |
|---|---|---|
| DDI Overview | June 15, 2021 | 2p-5p |
| DDI Geometric Design | June 29, 2021 | 2p-3p |
| DDI Signing and Pavement Marking | July 16, 2021 | 2p-3p |
| DDI Traffic Operations | August 10, 2021 | 2p-3p |
| DDI Multimodal Accommodations | August 24, 2021 | 2p-3p |
| DDI Plans Detailing & Public Involvement | September 7, 2021 | 2p-3p |



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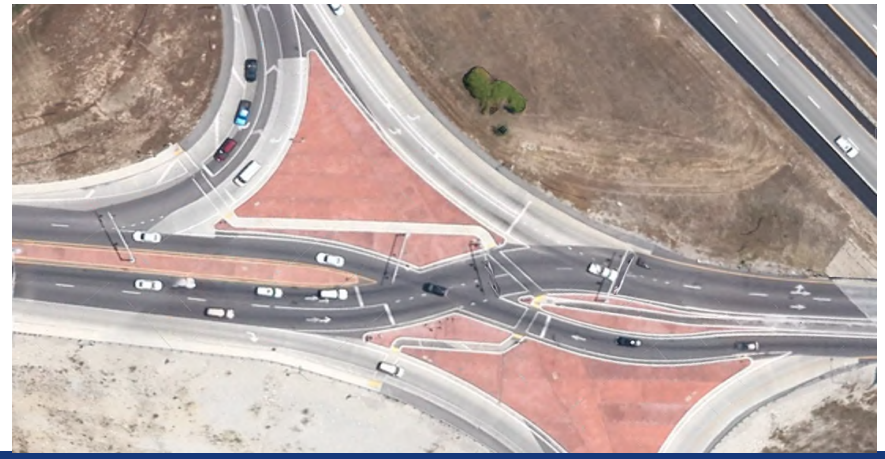

# DDI Overview – Webinar Instructors

**David Amato, PE**
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**Brian Toombs, PE**
**Burgess & Niple, Inc.**
614.459.2050
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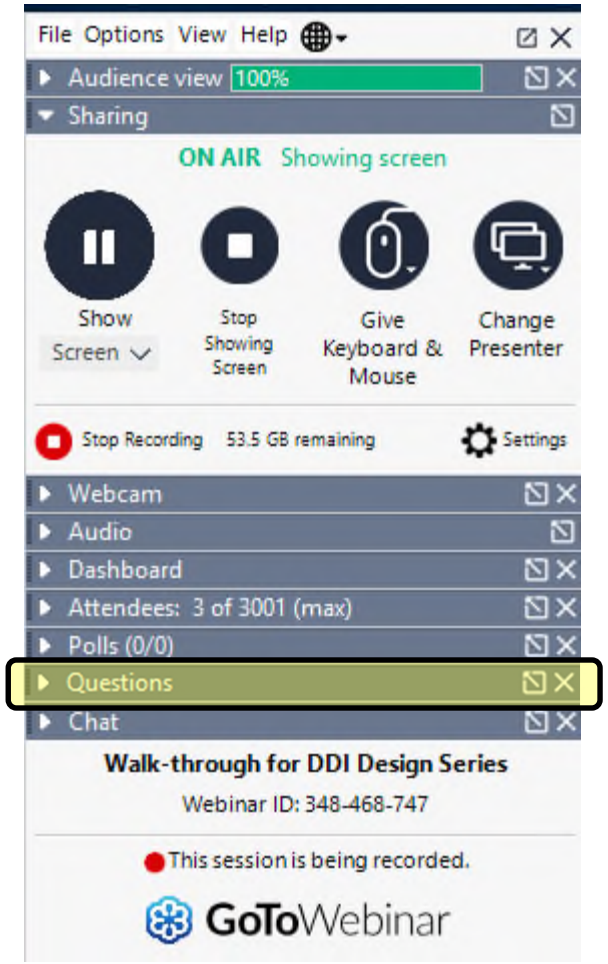
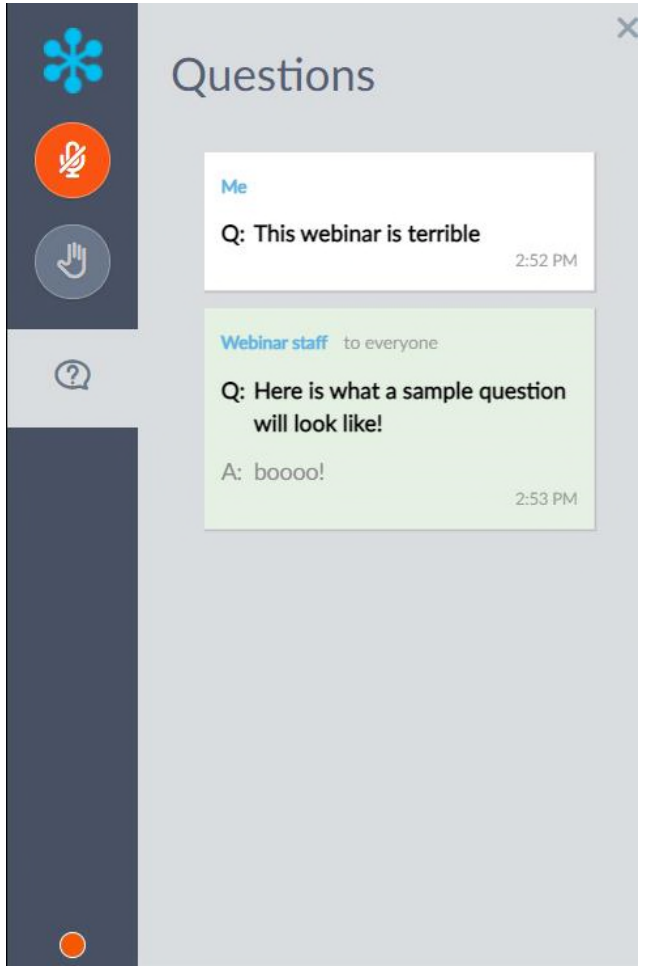
# DDI Overview – Webinar Logistics

- You are MUTED upon entry
- Please ask questions via *Questions* dialogue box



# DDI Multimodal Accommodations - AGENDA

- **Pedestrian Accommodations**
  - Benefits to Pedestrians
  - Sidewalk Placement
  - Crosswalks
- **Bicycle Accommodations**
  - Treatments to Accommodate Bicycles
  - “Key hole” Issue
- **Transit Accommodations**
- **Additional DDI Resources**

# PEDESTRIAN ACCOMMODATIONS

# Pedestrian Accommodations

- **Benefits of DDIs**
  - Reduced overall right-of-way footprint compared to a conventional diamond interchange
  - Two-phase traffic signal control with reduced pedestrian wait time
  - Minimized crossing distances
  - Simplification of conflicts to one-directional vehicular traffic
  - Opportunities for bicycle lanes and multiuse paths through the interchange

# Pedestrian Accommodations

- **Challenges of DDIs**
  - Altered travel paths with travel in the center of the interchange between vehicular lanes
  - Traffic approaching from unexpected directions
  - Unfamiliar signal phases
  - Uncontrolled crossing of turn lanes

# Pedestrian Accommodations

- **Pedestrian Accommodations**
  - Section 217.6 - FDOT DDI Developmental Design Criteria
  - Consider pedestrian accommodations early in the DDI design process
  - Develop a balanced design that meets the safety and mobility needs for all users

# Pedestrian Accommodations

- **Pedestrian Accommodations**
  - 5 key design strategies to pedestrian-focused design of DDIs
    - **Tighten vehicle curve radii to reduce speeds at crosswalks**

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    - **Locate crosswalks downstream of the stop bar for signalized vehicle turns**

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  - 5 key design strategies to pedestrian-focused design of DDIs
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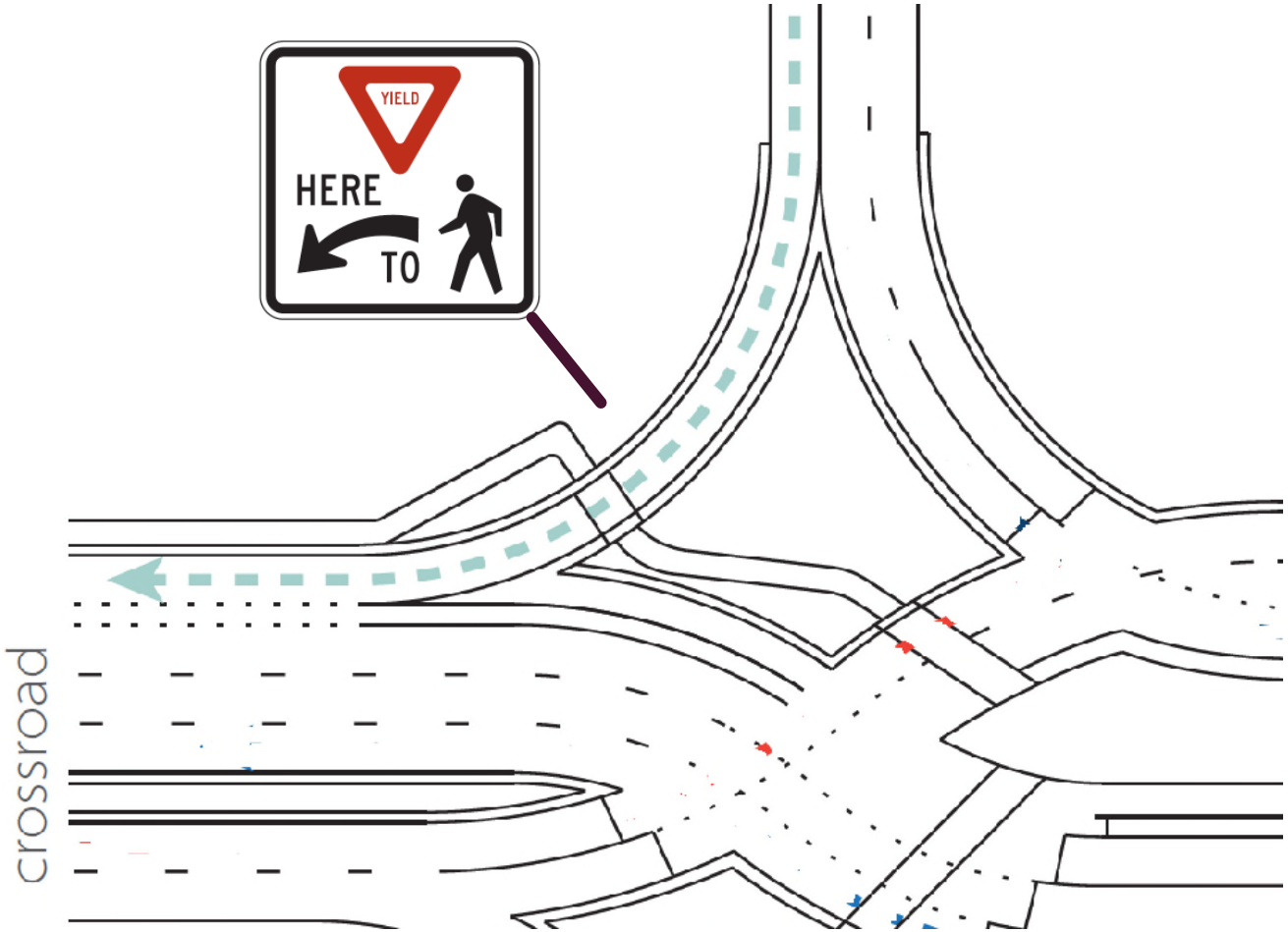
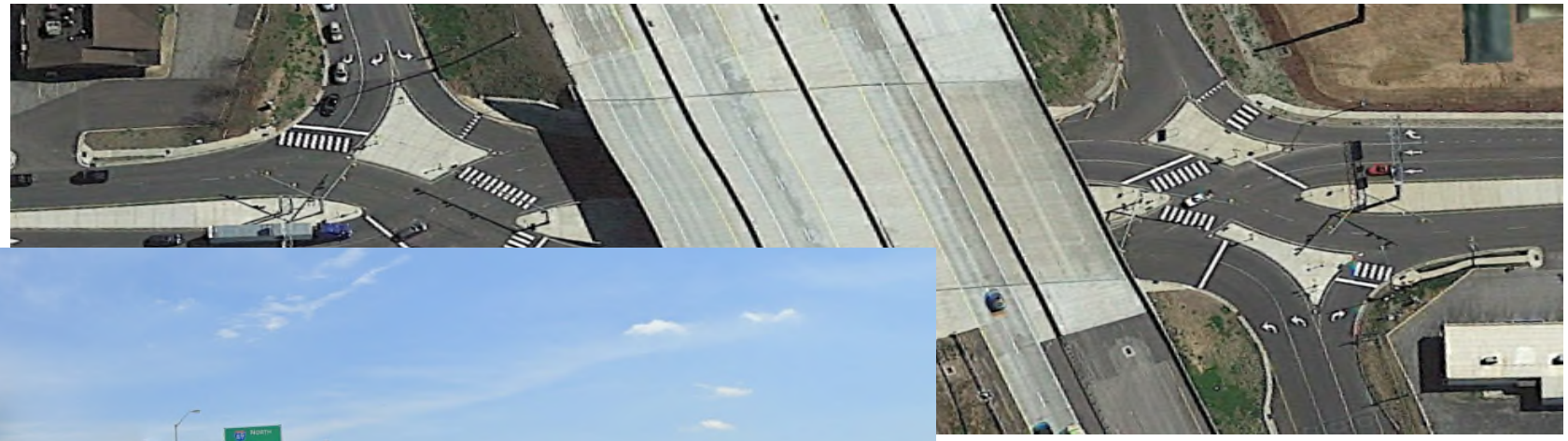
    - Provide appropriate storage downstream of the crosswalks for yield-controlled vehicle movements
    - Locate crosswalks downstream of the stop bar for signalized vehicle turns
    - **Provide appropriate traffic control at ramp terminal**



# Pedestrian Accommodations

- **Sidewalk Placement**
  - Inside (center) of the interchange



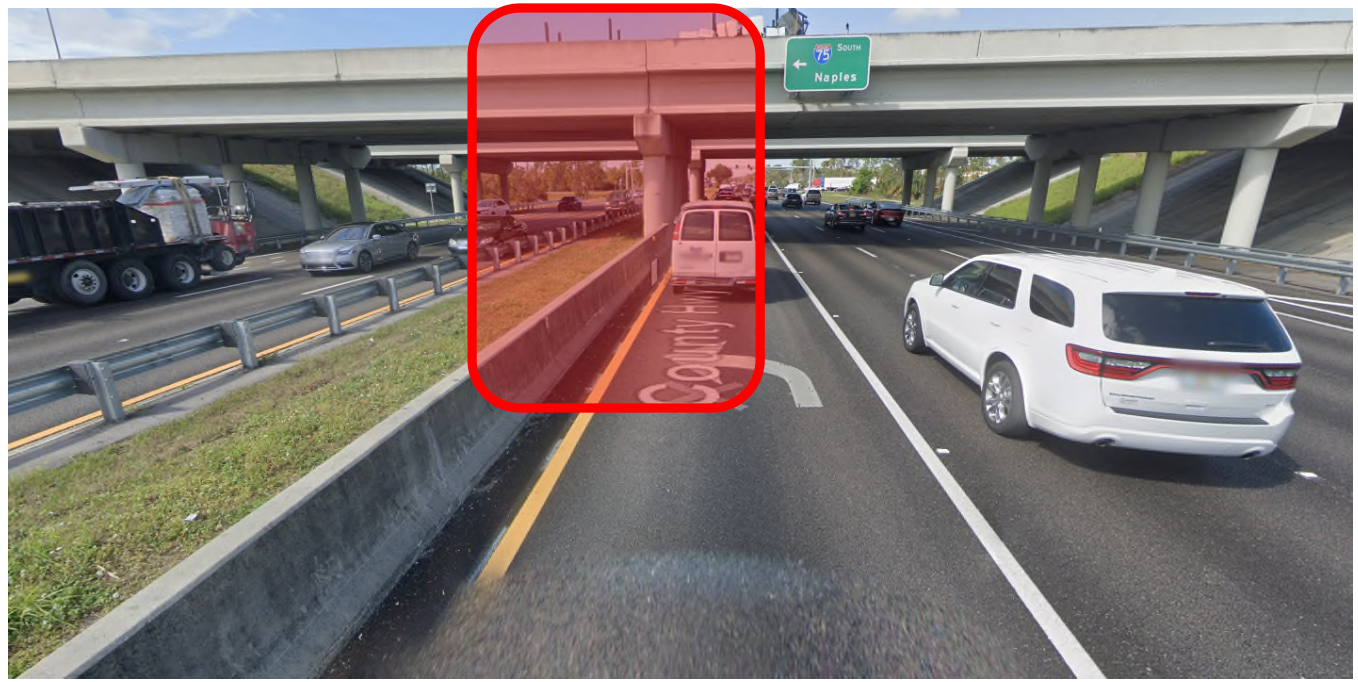
# Pedestrian Accommodations

- **Sidewalk Placement**
  - Outside of the interchange

# Pedestrian Accommodations

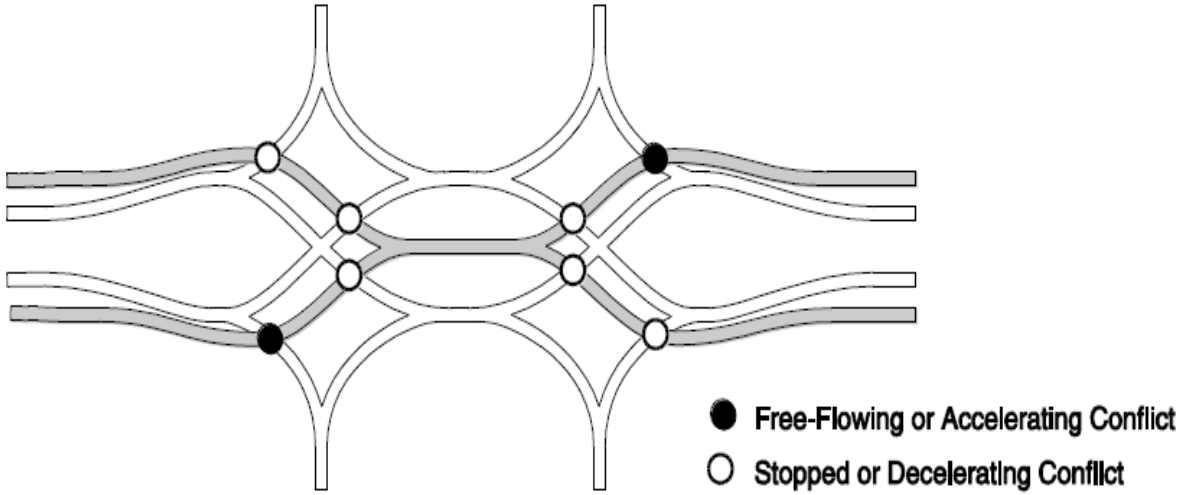
- **Sidewalk Placement**
  - At underpass DDIs, bridge piers and vertical clearance constraints may make placing pedestrians on the outside more practical
  - Pedestrian facilities on the inside minimizes conflicts with left-turning traffic to and from the freeway and allows crossing the interchange in all directions (travel along the arterial and crossing the arterial)

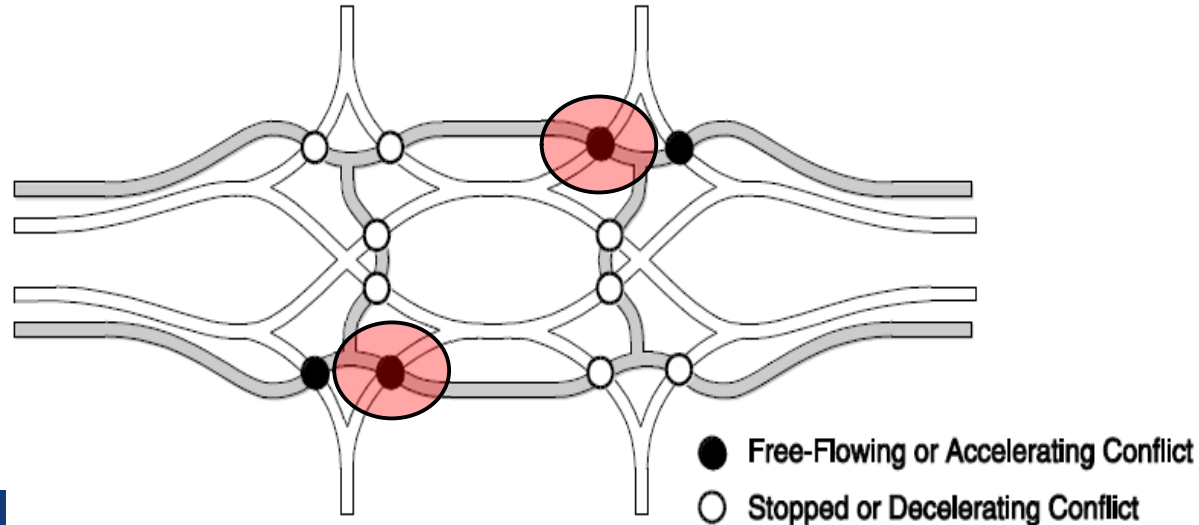
**Can sidewalk fit down the center when this interchange is converted to a DDI?**



# Pedestrian Accommodations

- **Sidewalk Placement**
  - *Center walkway is preferred in Florida*
    - **Avoids free-flow left turning movement**



# Pedestrian Accommodations

- **Sidewalk Placement**
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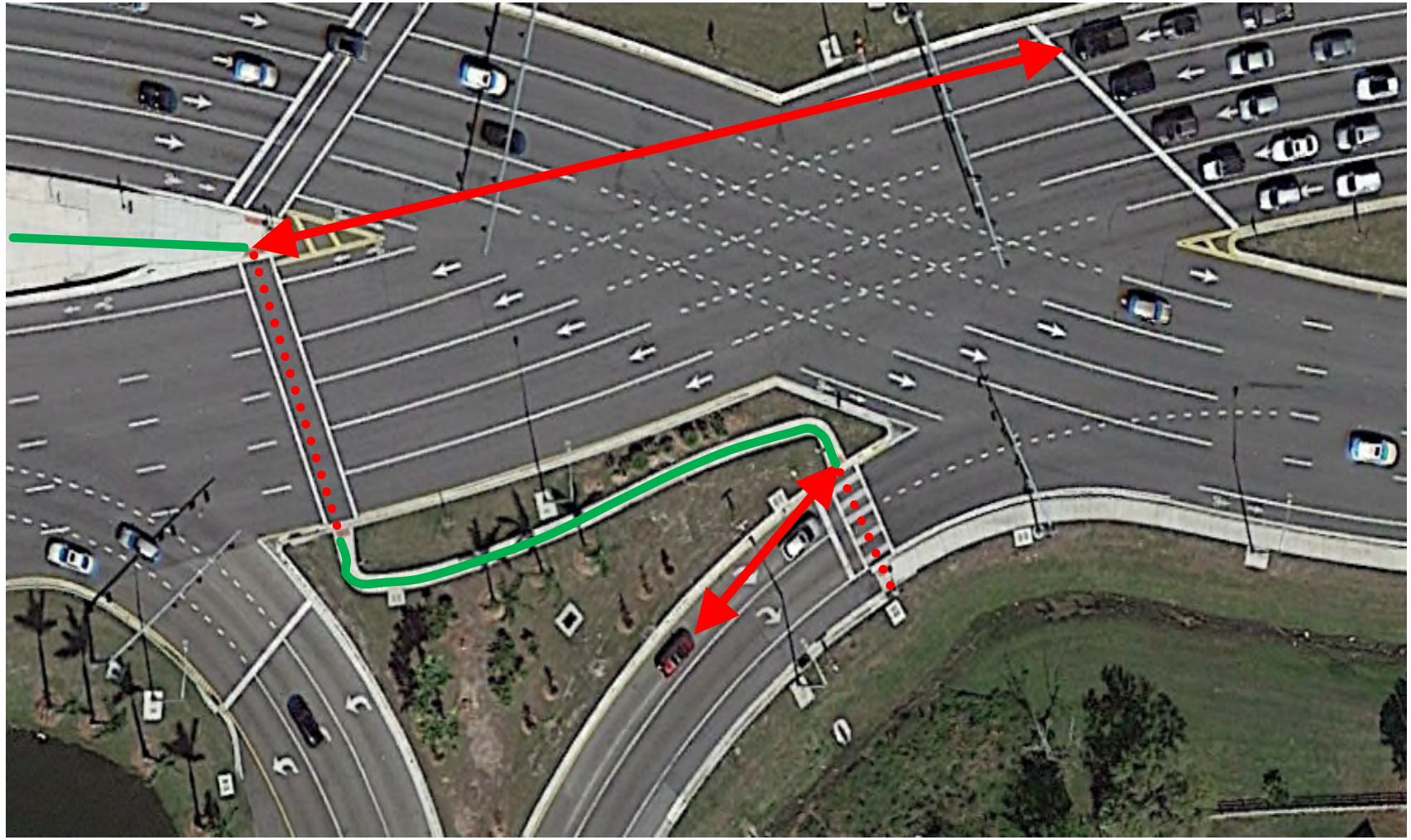
    - **Improve line of sight for between pedestrians and drivers**



# Pedestrian Accommodations

- **Sidewalk Placement**
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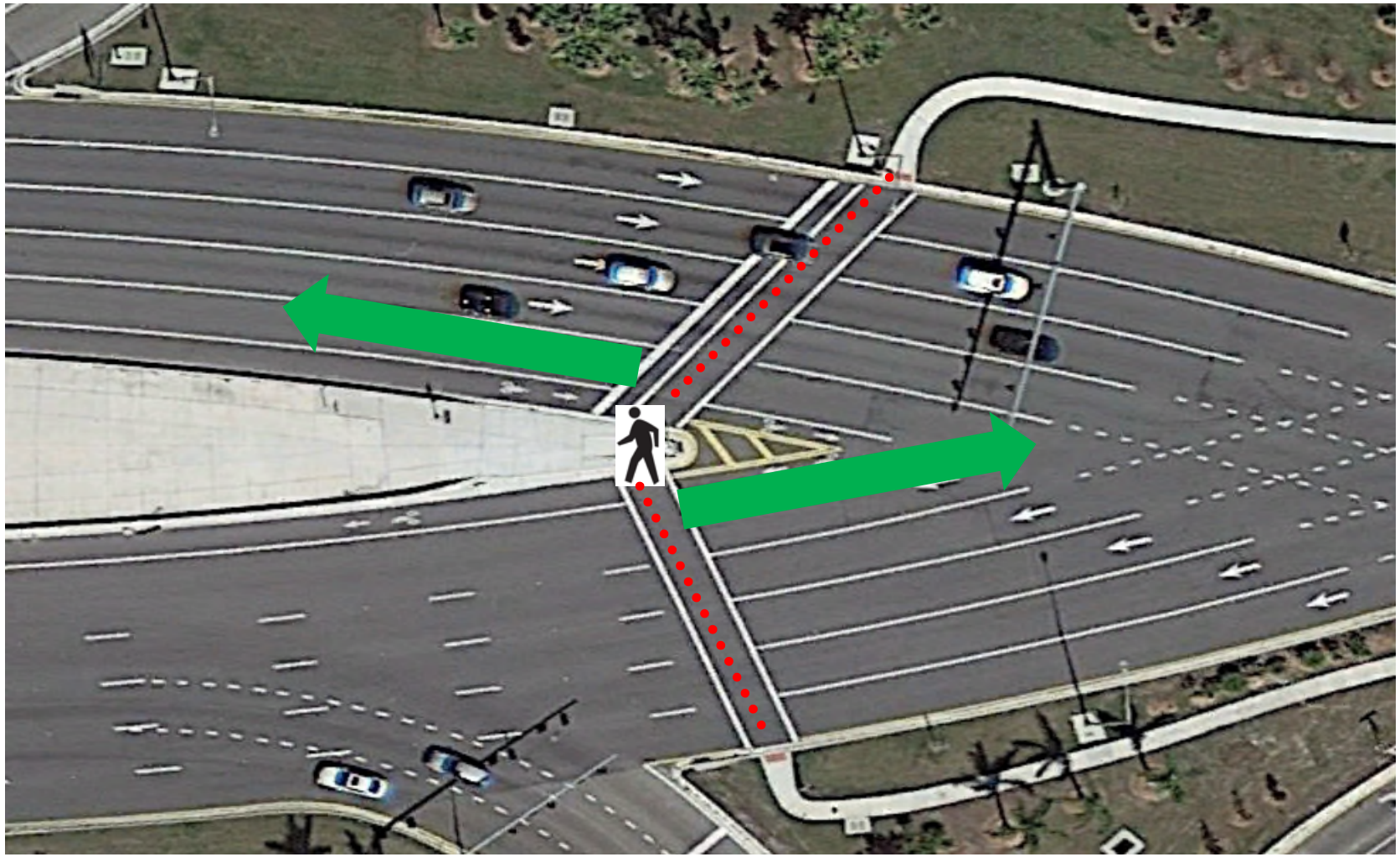
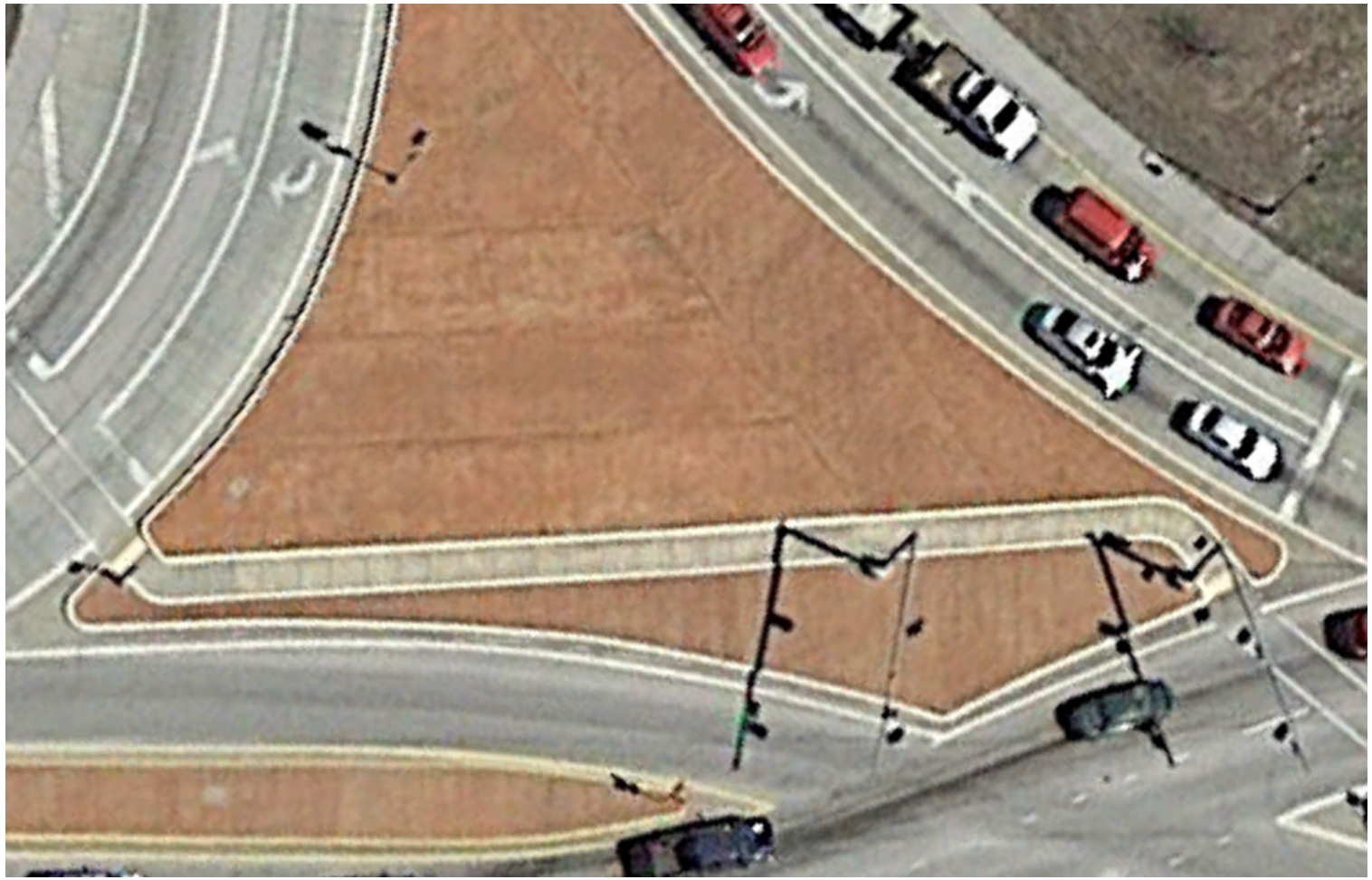
    - **Cross at signalized crossover intersection consistent with expectations**
      - **pedestrians looking left first**



# Pedestrian Accommodations

- **Cut-Through Walkways**
  - **Cut-through walkways clearly define the walkway boundaries and guide pedestrians to the proper crosswalk locations**



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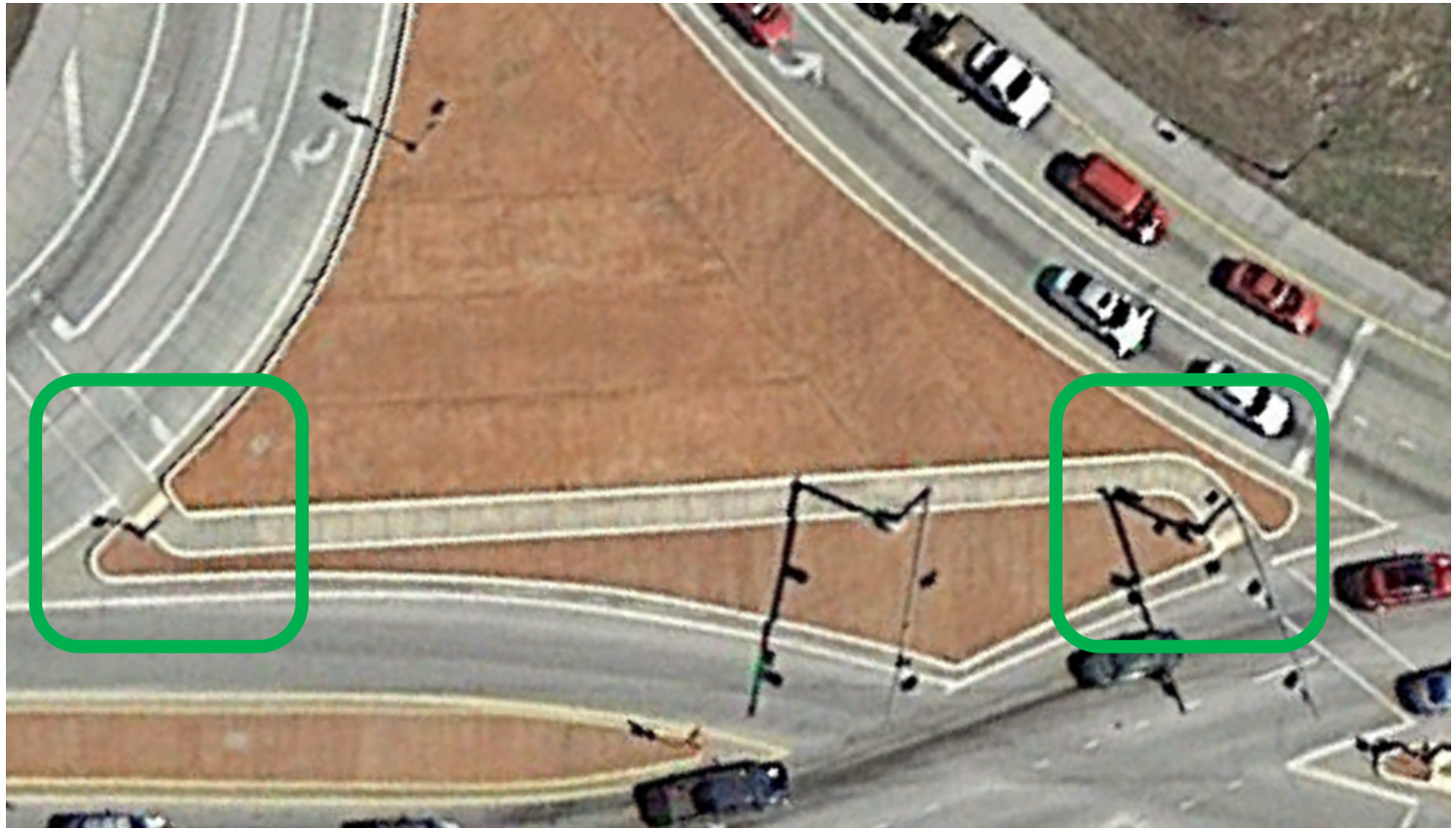
  - **Align cut-through walkways to provide a perpendicular crossing when practical to minimize crossing distance**



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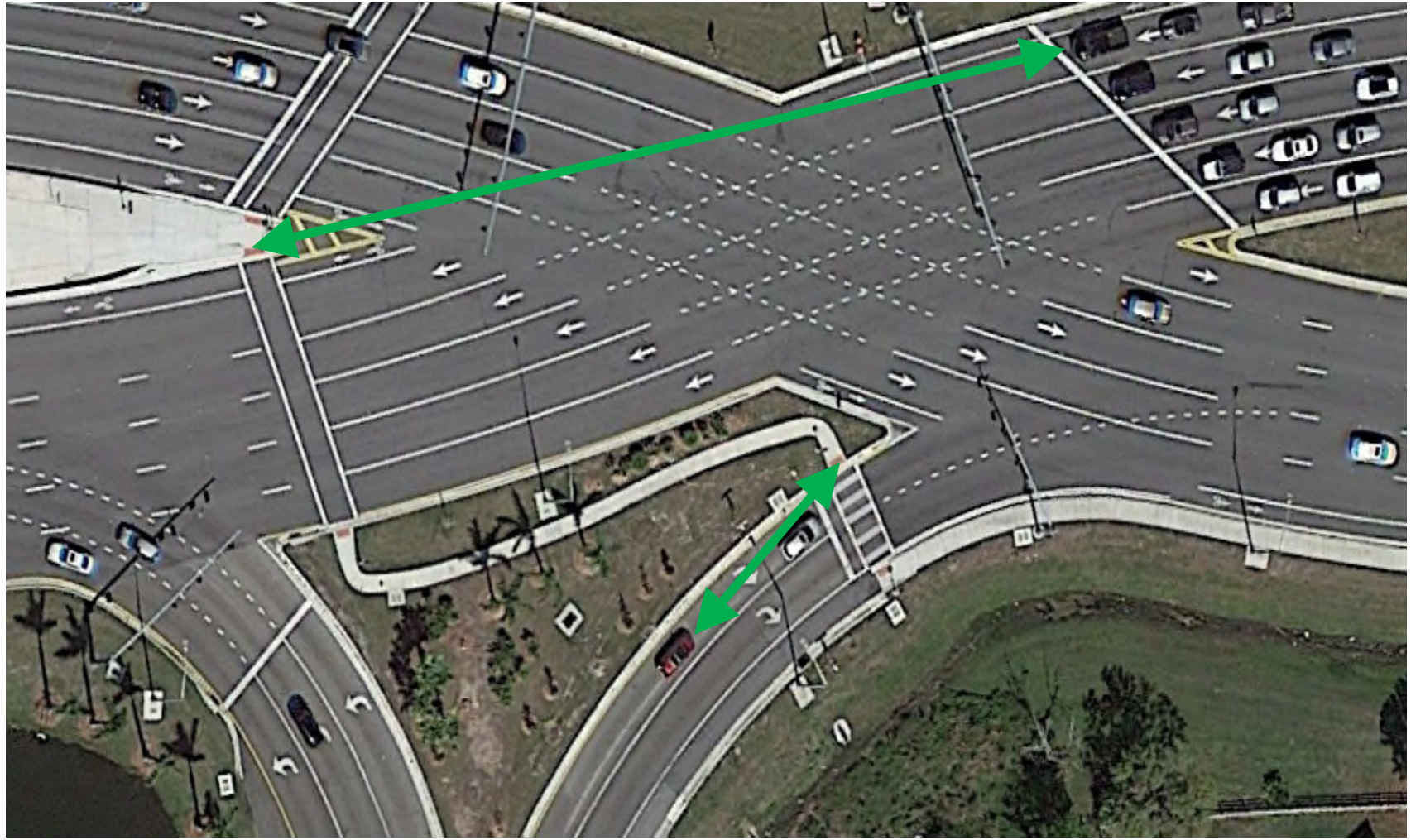

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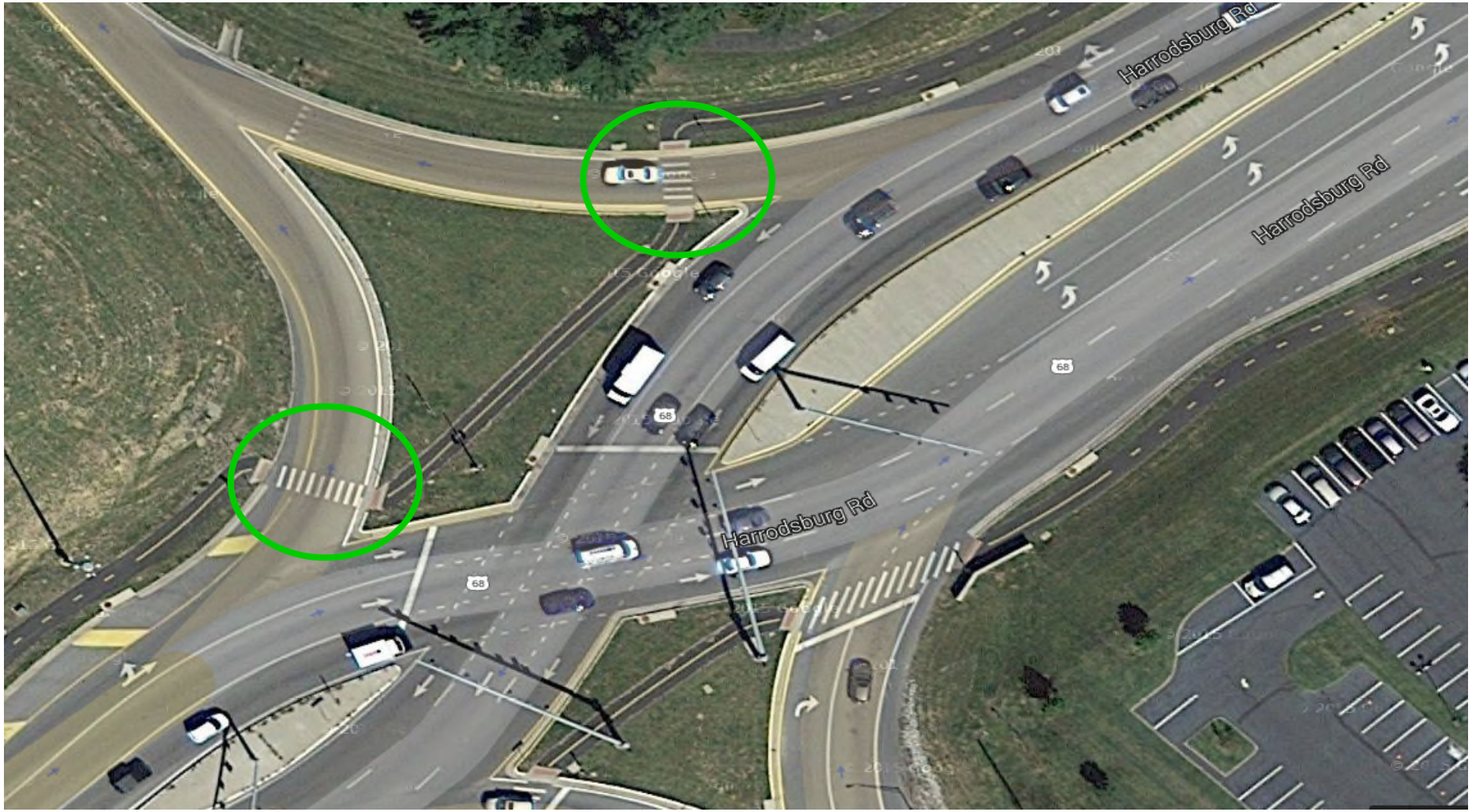
  - Perpendicular crossings
  - **Position the crossings close to the arterial to reduce high-speed conflicts**



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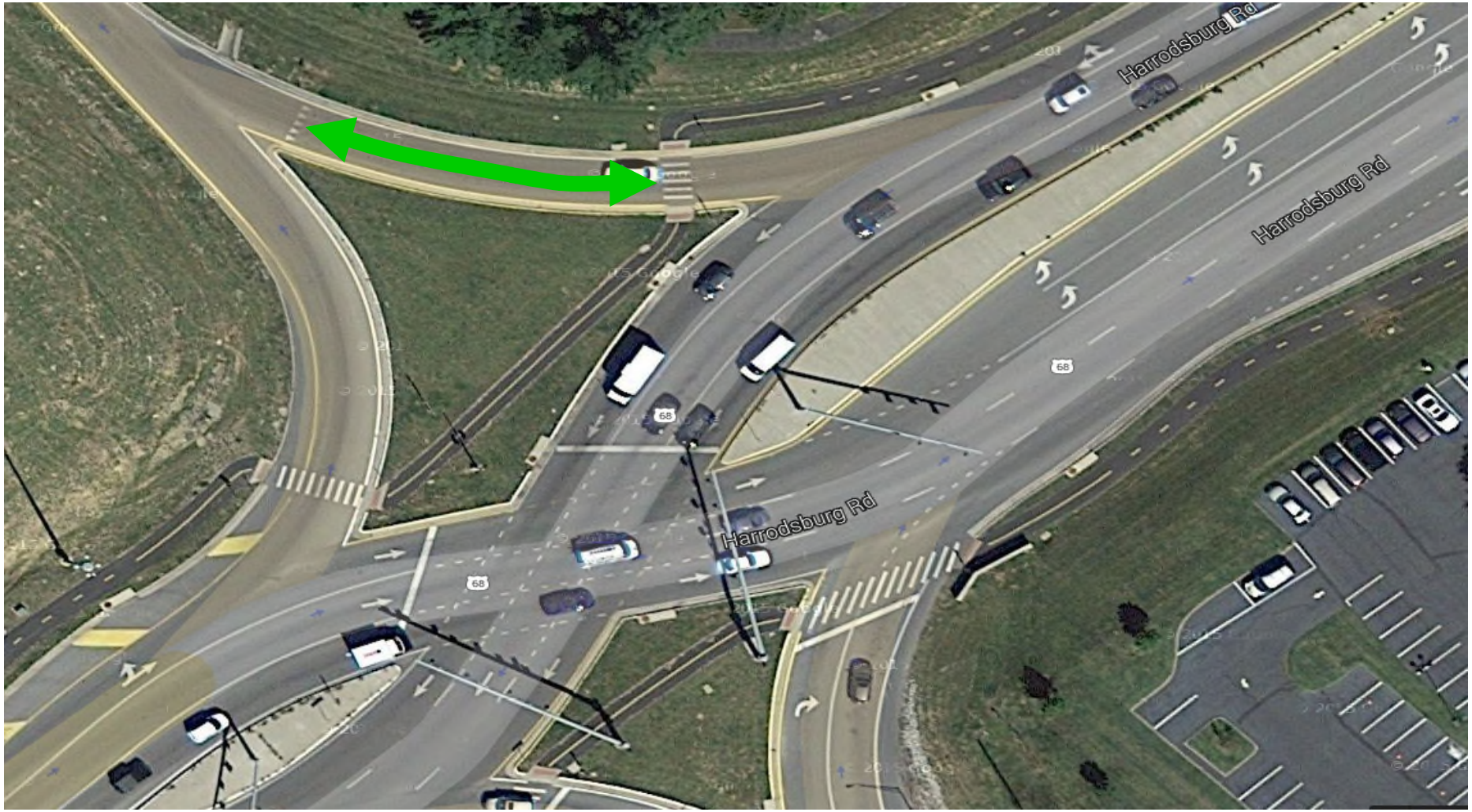
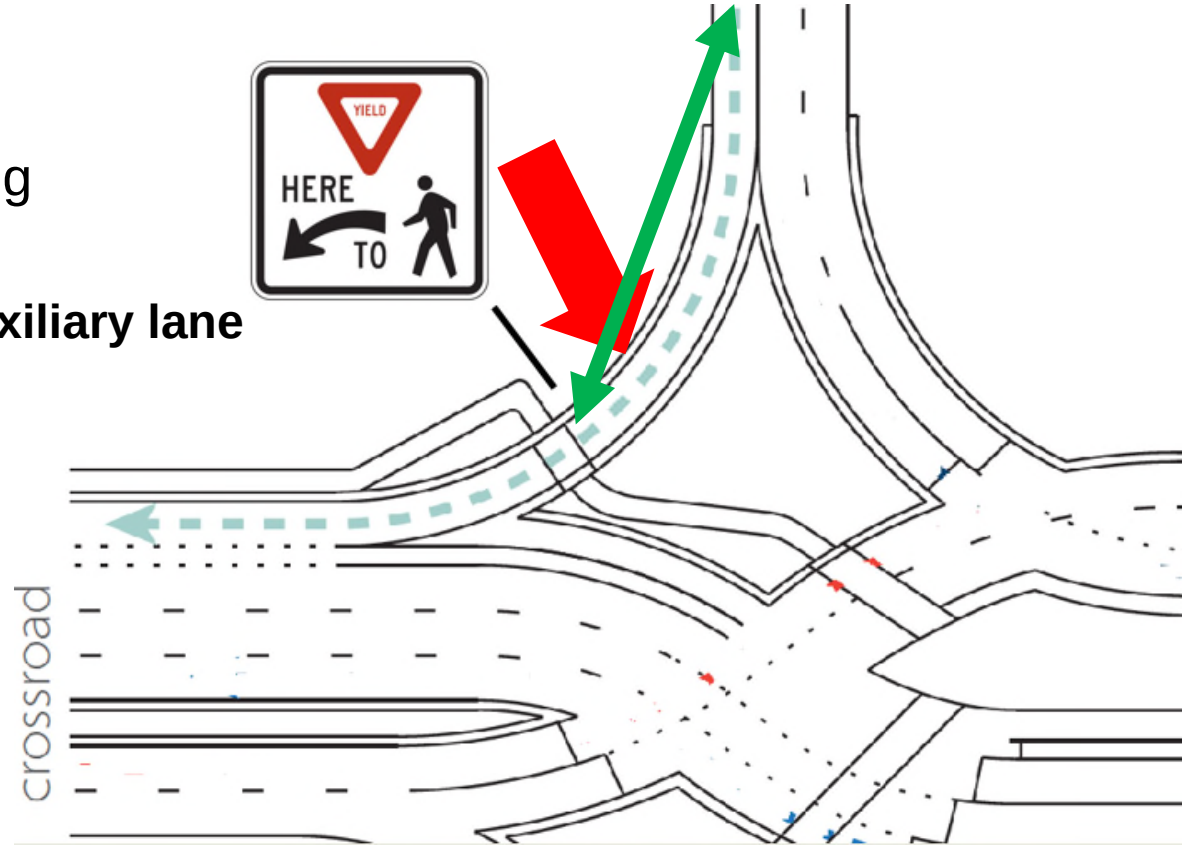


# Pedestrian Accommodations

- **Ramp Terminal Design**
  - 6 basic types of traffic control options for turning movements from exit ramp onto crossroad
    - **Free-flow movement into an acceleration or auxiliary lane**



# Pedestrian Accommodations

- **Ramp Terminal Design**
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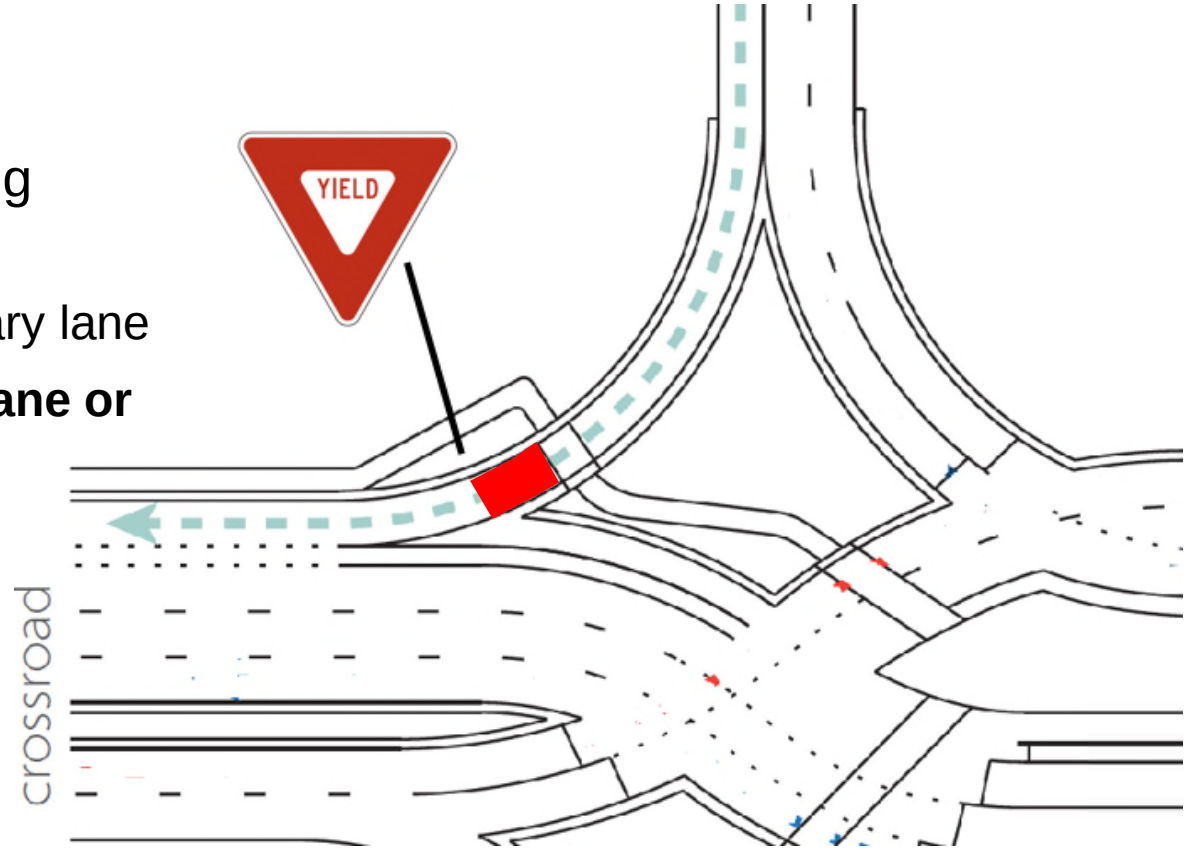
    - **Yield control with a downstream acceleration lane or auxiliary lane**



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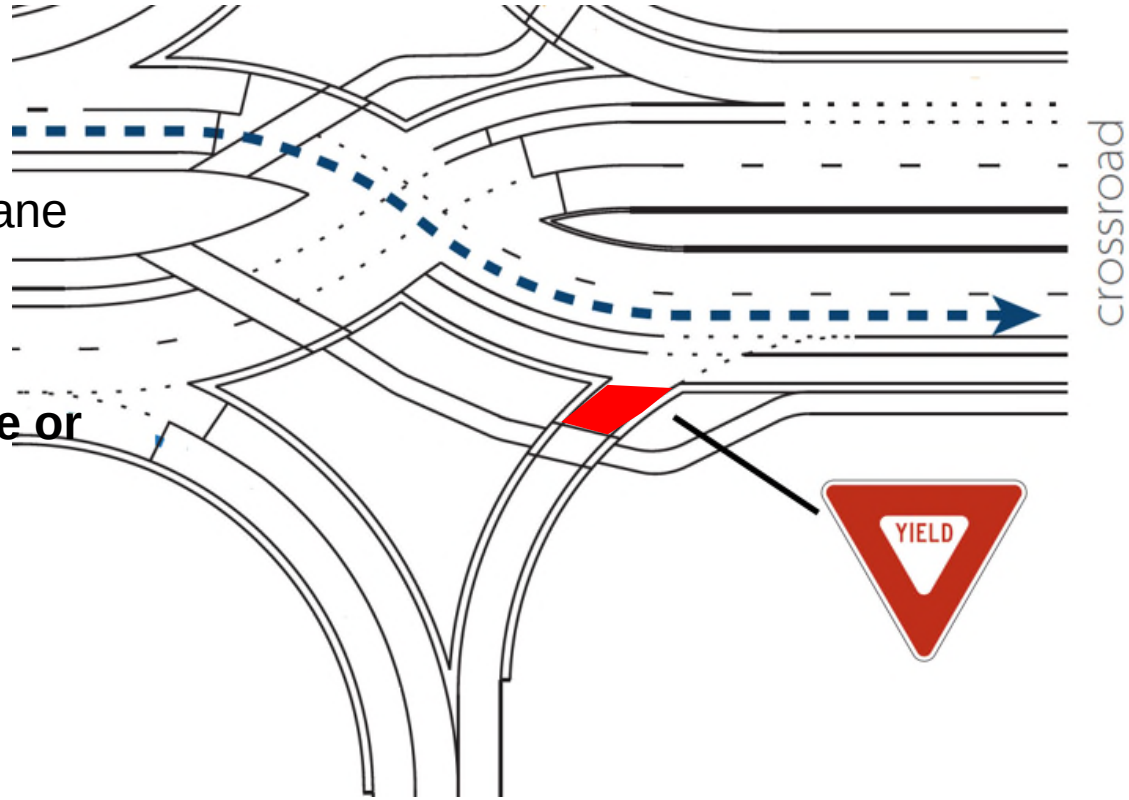

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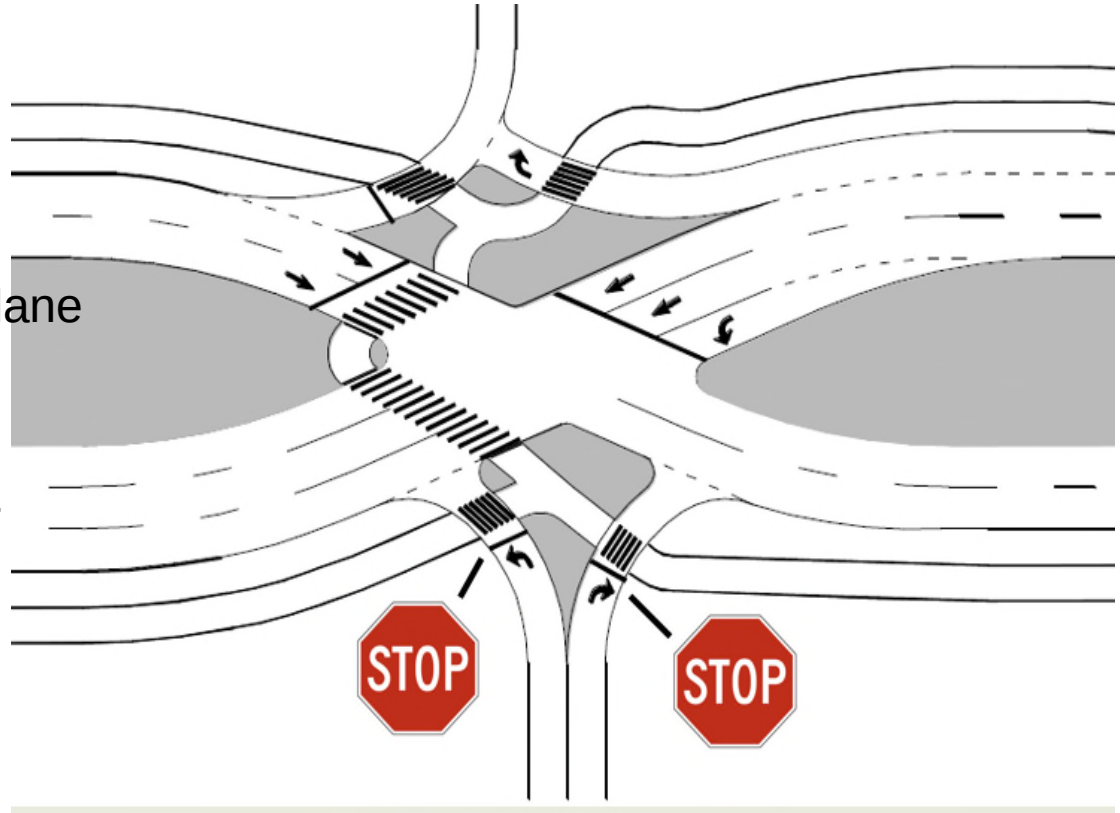
    - **Stop control**



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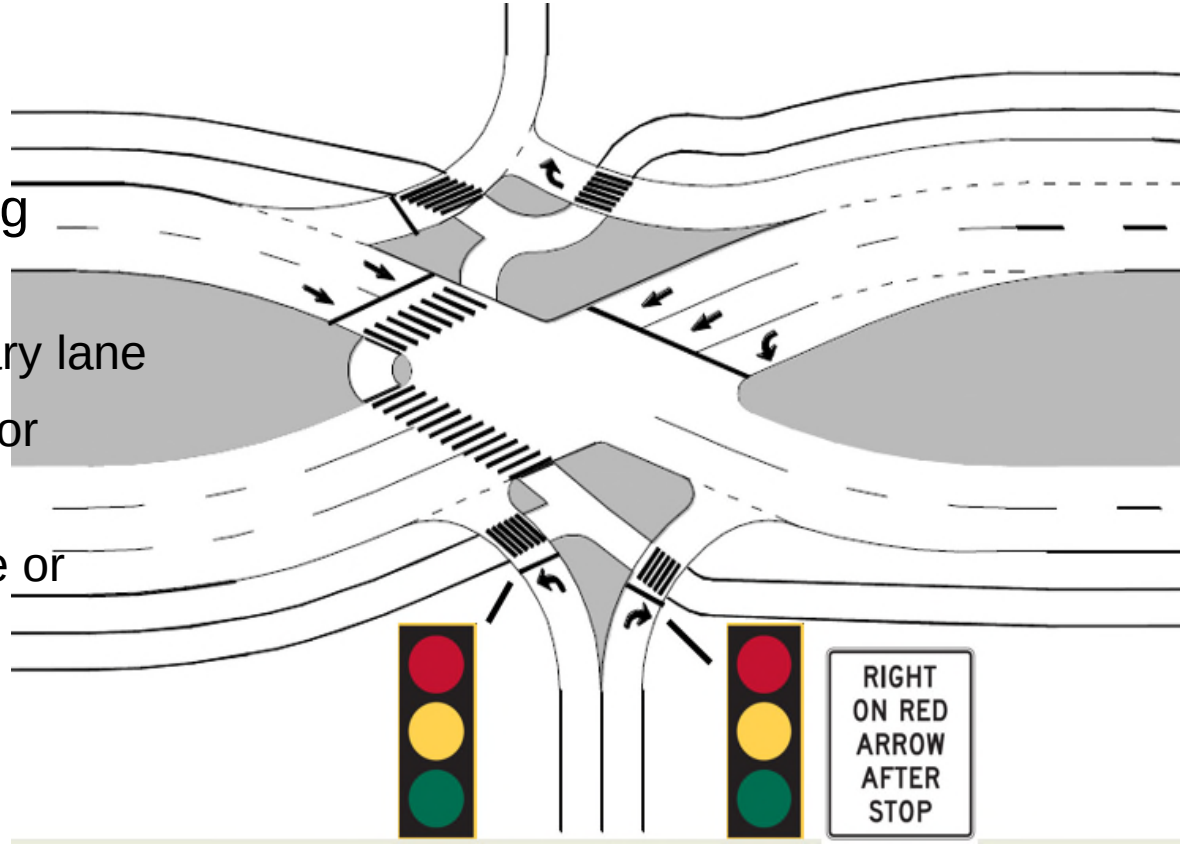
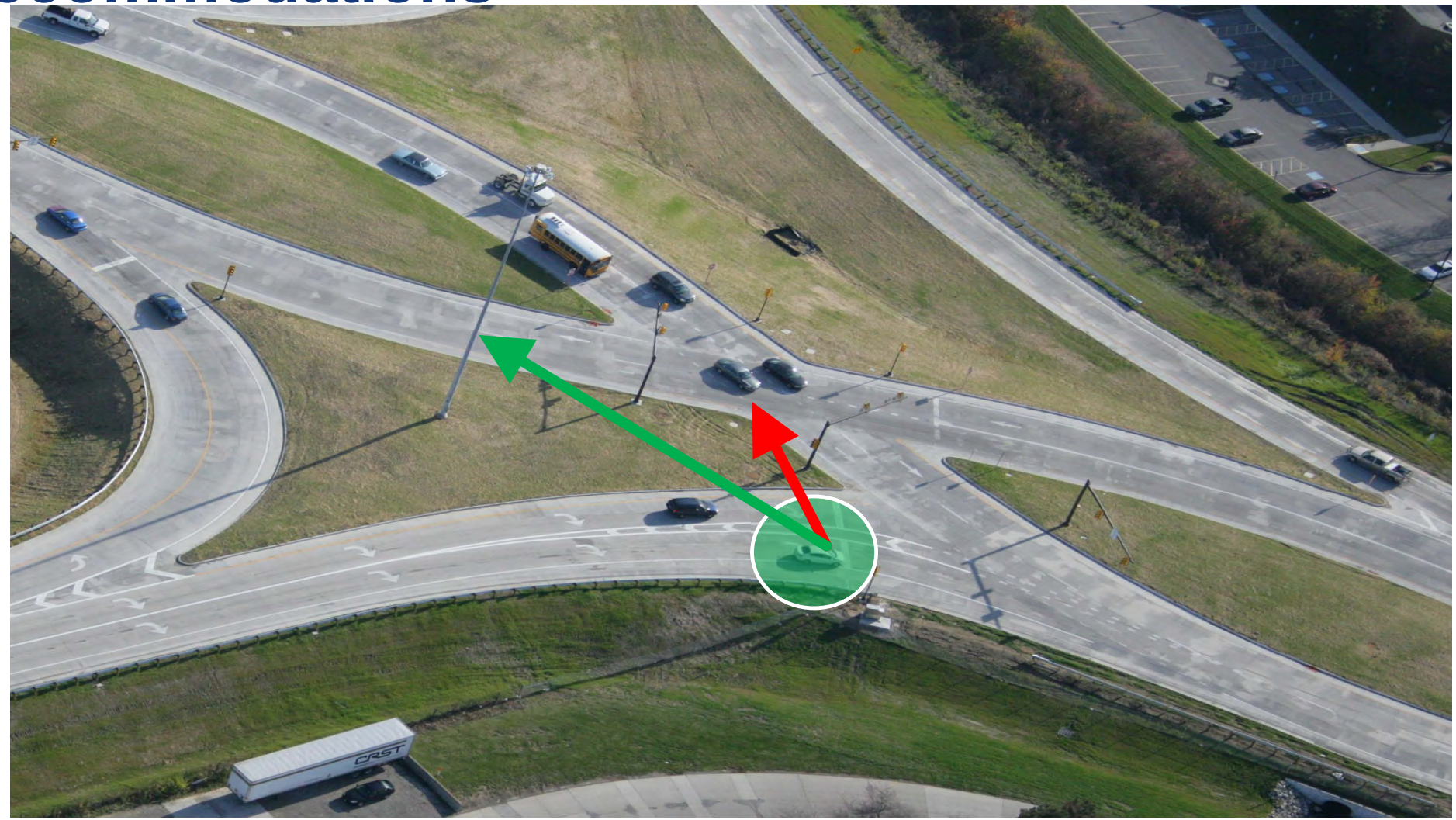
    - Stop control
    - **Signal control with right/left turn on red**



# Pedestrian Accommodations

- **Right Turns on Red**
  - Poor sight lines can lead to driver error
  - Dual turn lanes can cause sight line obstructions



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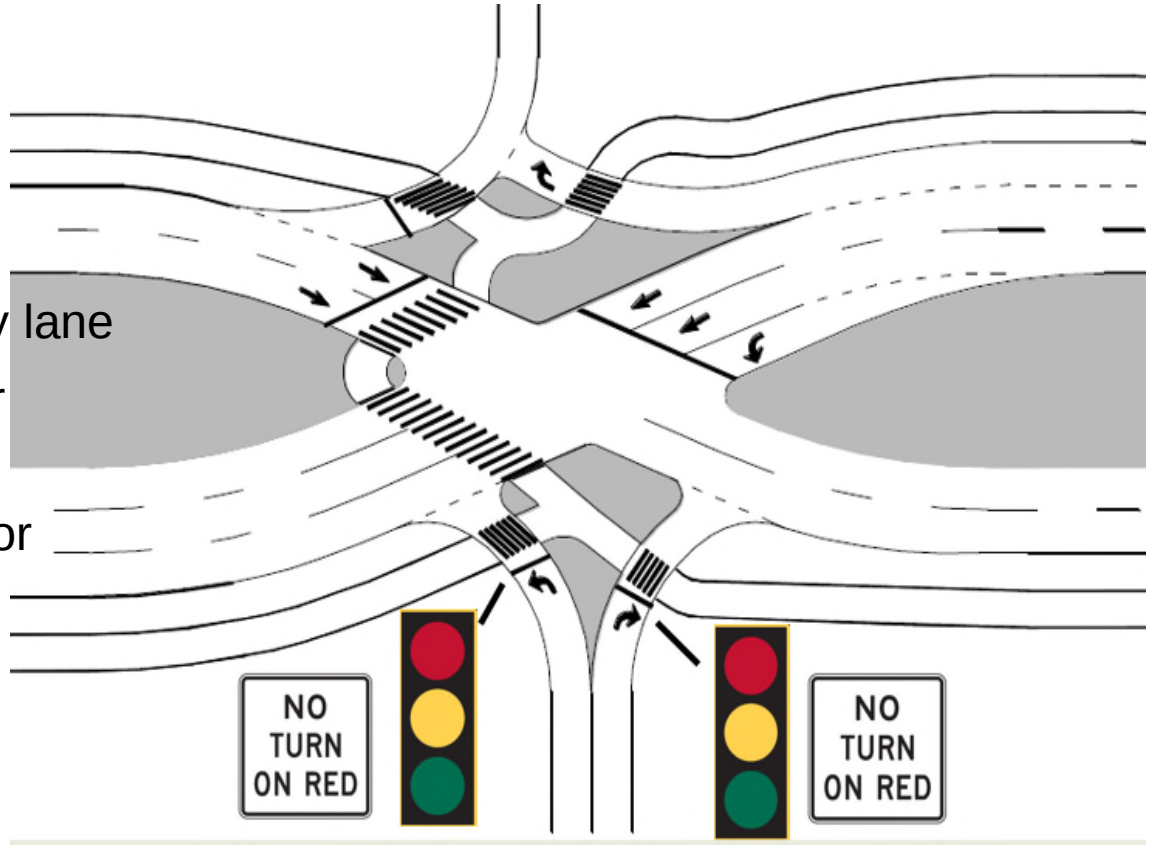
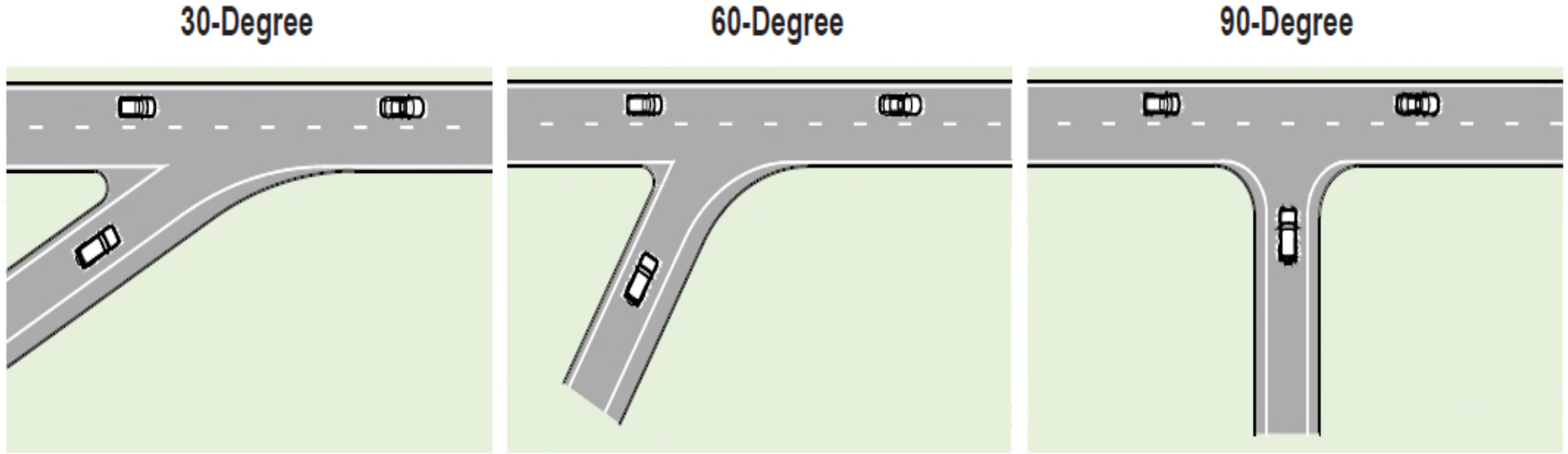


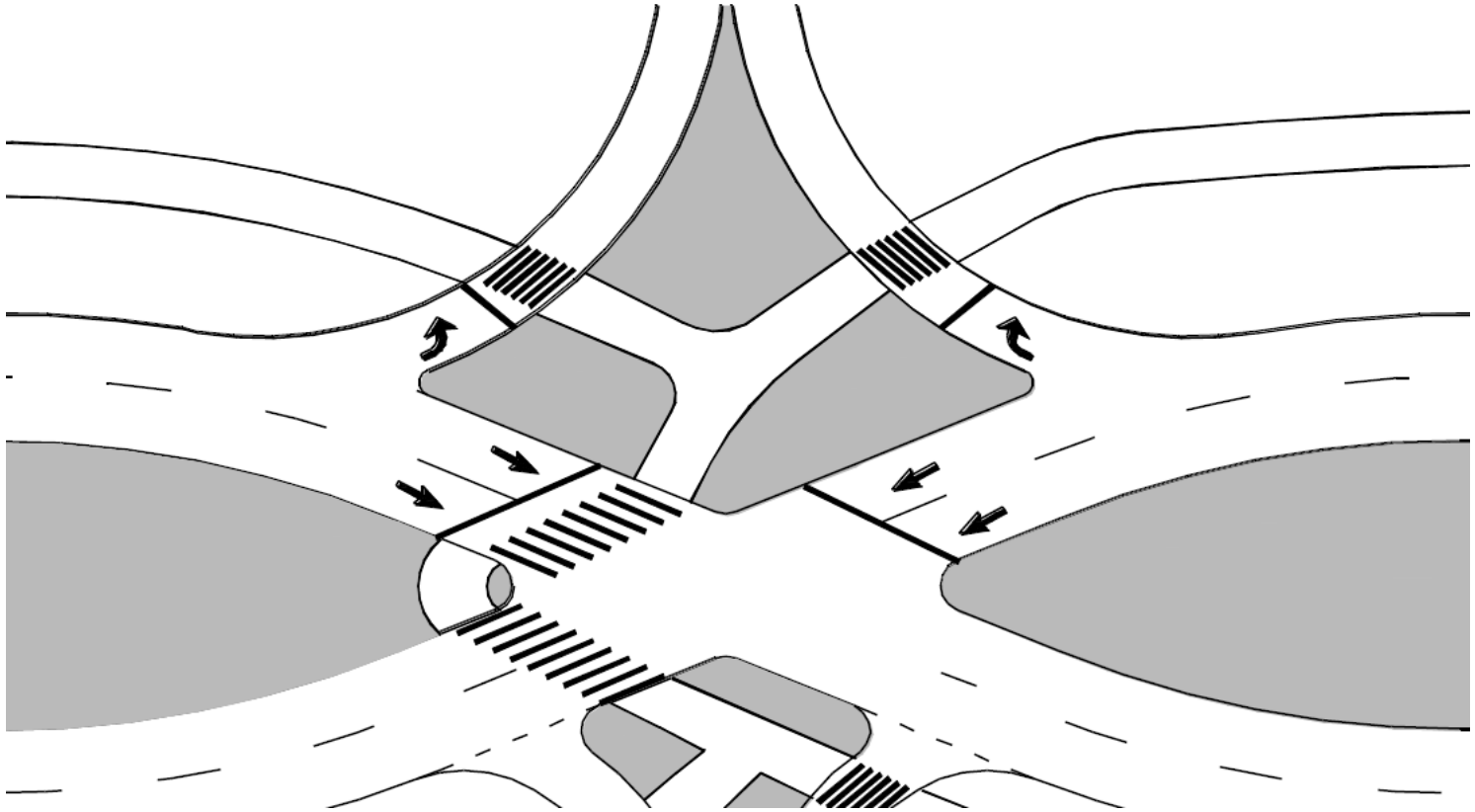
# Pedestrian Accommodations

- **Ramp Terminal Design**
  - Intersection Angle
    - The angle the exit ramp intersects with the crossroad can greatly influence driver's approach speed and willingness to yield to crossing pedestrian and bicyclists
    - May establish a driver's expectation regarding the type of traffic control used at the ramp terminal



# Pedestrian Accommodations

- **Ramp Terminal Design**
  - Entry Ramp Options
    - **Free right and left turns with acceleration lanes**



# Pedestrian Accommodations

- **Ramp Terminal Design**
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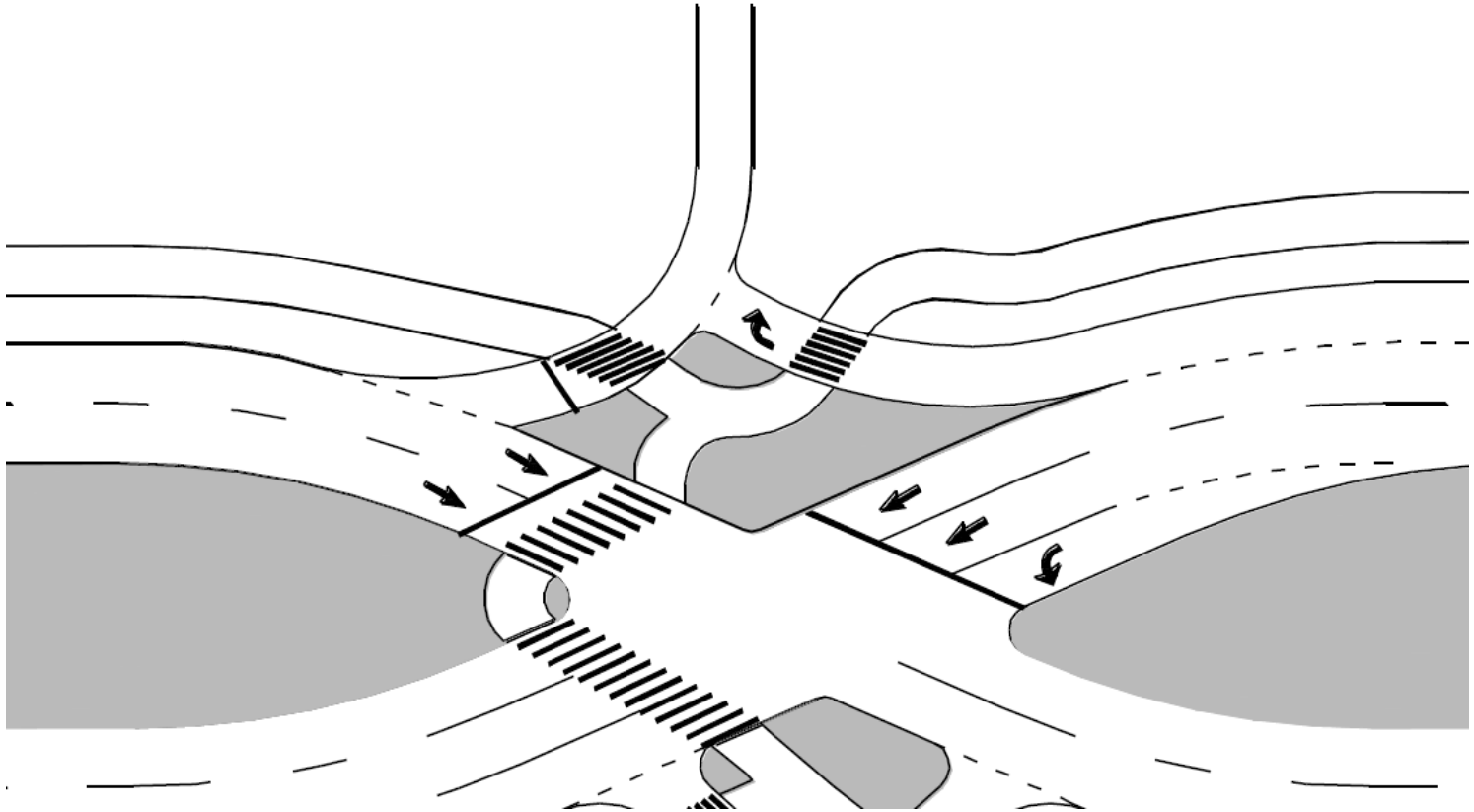
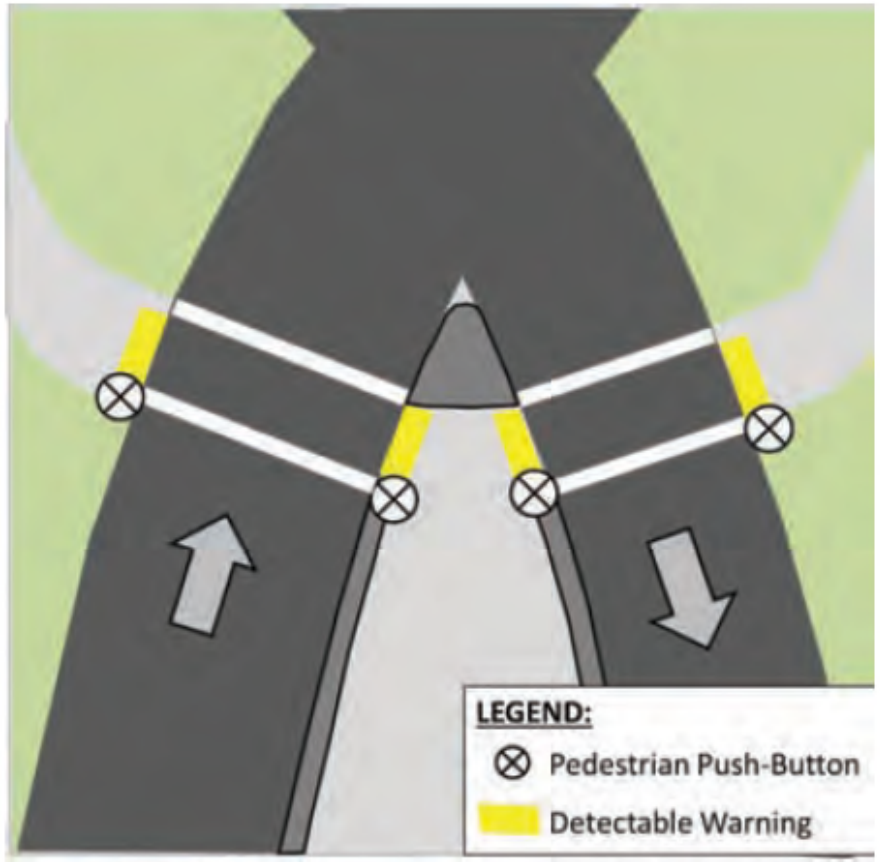
    - **Right turn yield or stop control**



# Pedestrian Accommodations

- **Pedestrian Signals**
  - Pedestrian signals all on the wider side of the median
  - Pedestrian signals separated diagonally with push buttons consistently on the same side

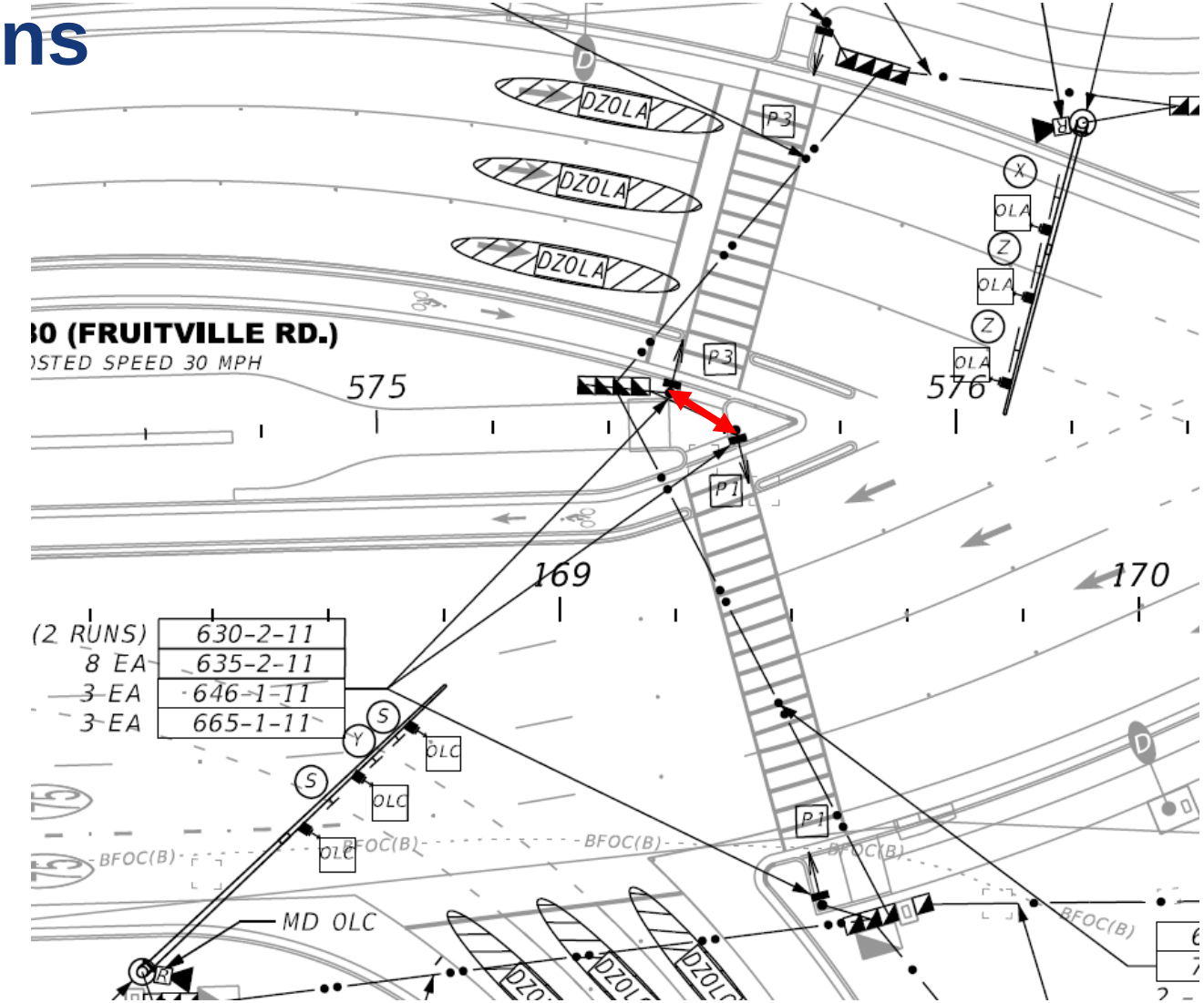



(a) Pedestrian Signals on Same Side

Source: DDI Information Guide, Second Edition (2021)

# Pedestrian Accommodations

- **Pedestrian Signals**
  - Meeting 10’ separation between pedestrian push buttons is difficult in the narrow median
  - Consider moving stop bar back where median is wider
  - Watch – This increases clearance distance



# Pedestrian Accommodations

- **Pedestrian Signals**
  - Single pole can be confusing
  - Narrow median
  - Insufficient pedestrian storage

# BICYCLE ACCOMMODATIONS

# Bicycle Accommodations

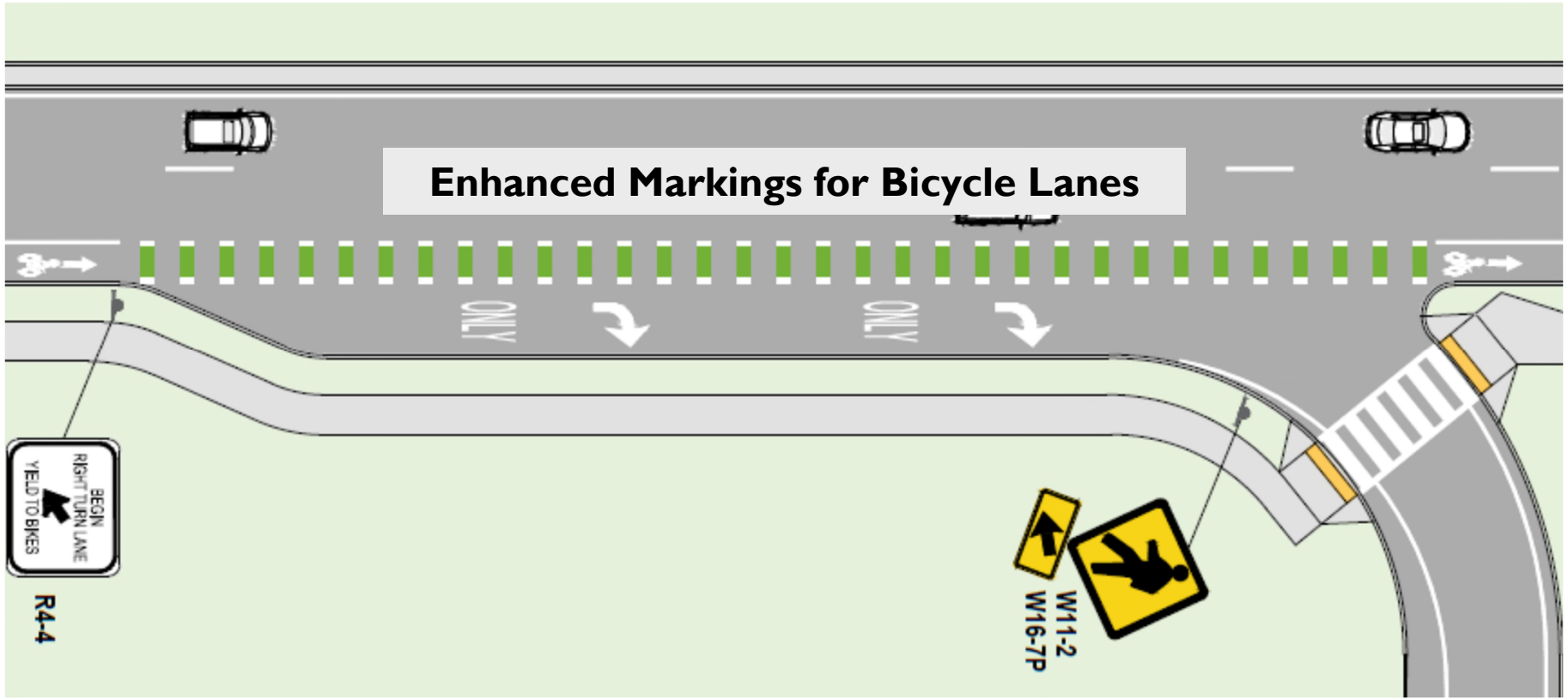
- **Three Basic Options**
  - **Marked bicycle lane through the DDI**

# Bicycle Accommodations

- **Three Basic Options**
  - **Marked bicycle lane through the DDI**
    - Consider wider bicycle lanes to provide additional operating space for a bicyclist to navigate through the curvature and as a buffer to the center barrier
    - Enhanced markings (green color) and/or dashed bicycle lane lines to connect the solid bicycle lines through the crossover intersections

# Bicycle Accommodations

- **Three Basic Options**
  - **Marked bicycle lane through the DDI**



# Bicycle Accommodations

- **Three Basic Options**
  - Marked bicycle lane through the DDI
  - **Separate bicycle way or multi-use path**

**223.2.4.3 Separated Bicycle Lane Widths**

Use wider lanes where higher volumes are expected.

The lane widths for separated bicycle facilities are as follows:

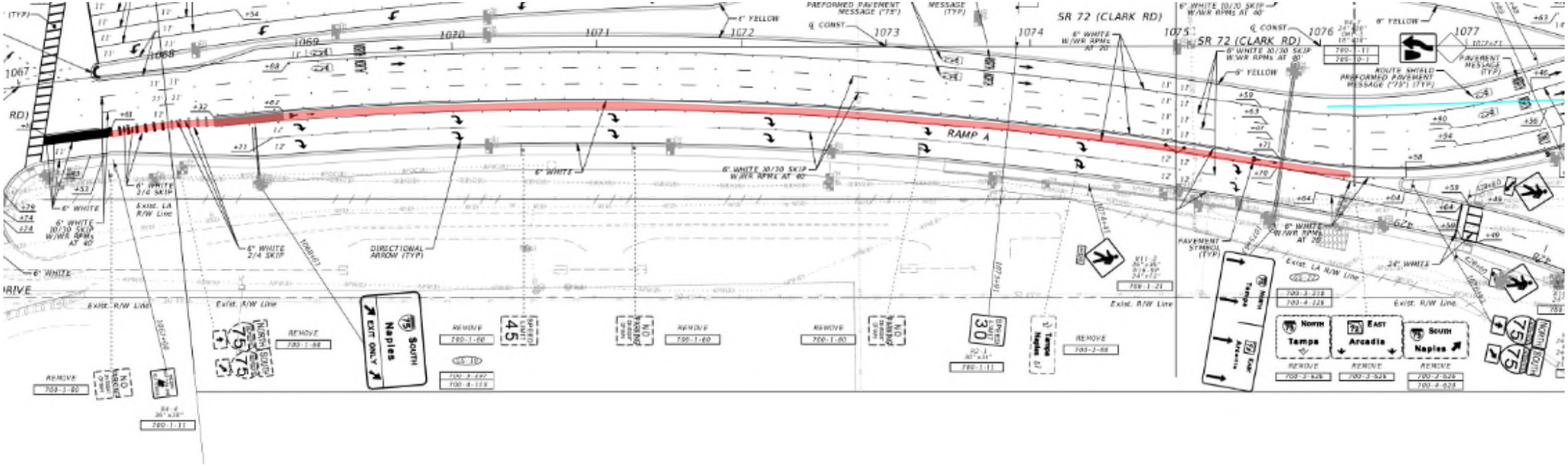
- Two-Way facilities: 12 feet preferred, 10 feet minimum
- One-Way facilities: 7 feet preferred, 6 feet minimum

# Bicycle Accommodations

- **“Keyhole” Issue**
  - Marked

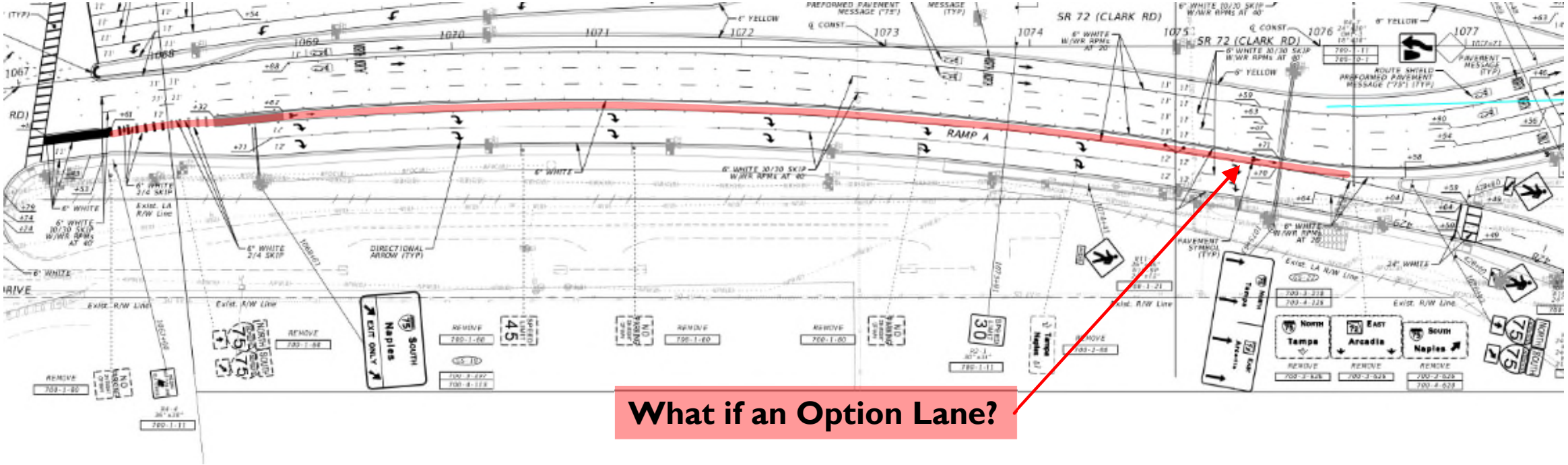
# Bicycle Accommodations

- **“Key hole” Issue**
  - Avoid lengthy “key holed” bicyclists if possible



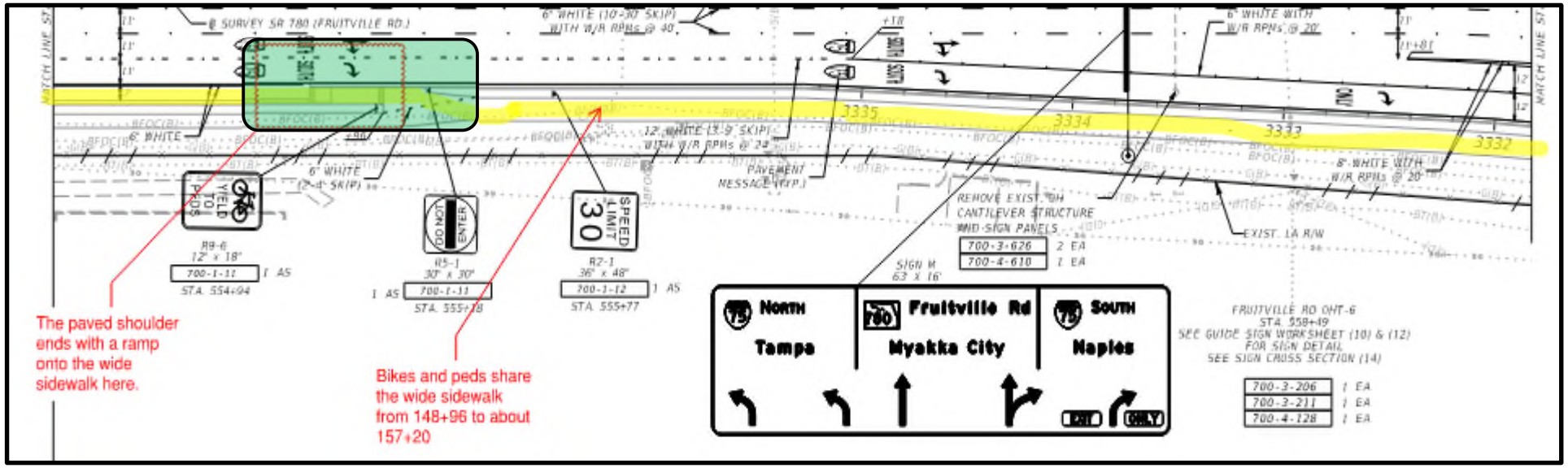
# Bicycle Accommodations

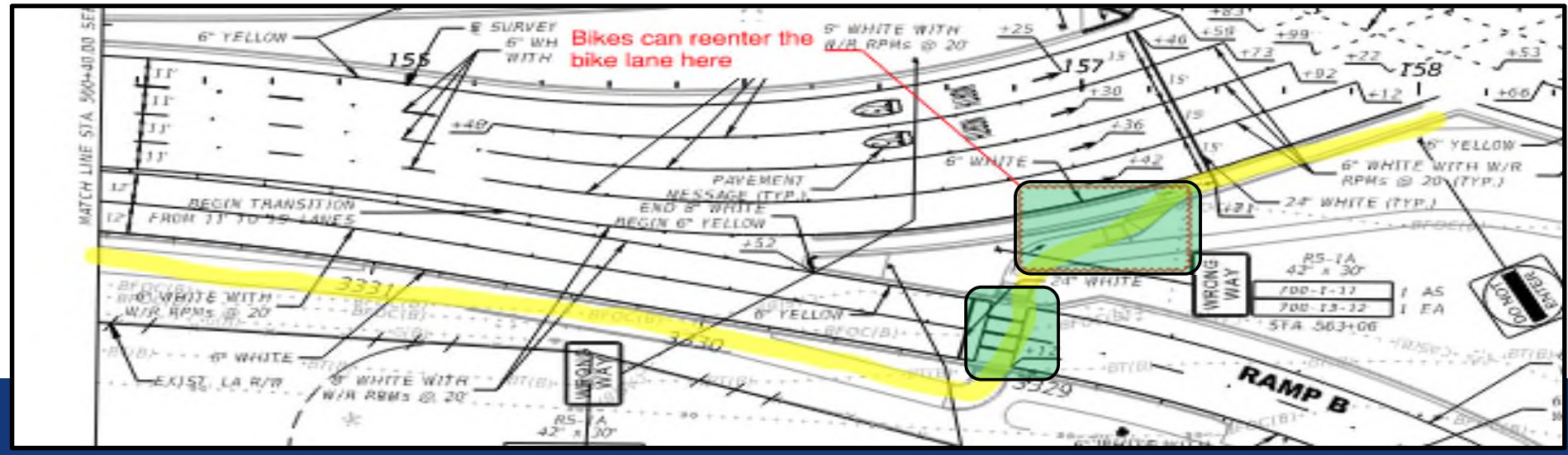
- **“Key hole” Issue**
  - Or option lanes where bicyclists are unclear where drivers are going



# Bicycle Accommodations

- **“Key hole” Issue**
  - If the “key hole” occurs, one option is to shift them to a wider sidewalk along the outside
  - Cross the free-flow ramp with the pedestrians
  - Then re-enter the bike lane prior to the crossover



# Bicycle Accommodations

- **Three Basic Options**
  - Marked bicycle lane through the DDI
  - Separate bicycle way or multi-use path
  - **Terminate the bicycle lane on the approach to the DDI crossover and cyclists share the travel lane**
    - **Should only be used in very low speed conditions**

# TRANSIT ACCOMMODATIONS

# Transit Accommodations

- Bus Stop within the DDI
  - Superior, CO; US 36 & McCaslin Boulevard


# Transit Accommodations

- Center-running light rail transit (LRT)
  - Bloomington, MN; I-494 & 34th Avenue

# ADDITIONAL DDI RESOURCES

# Additional DDI Resources

Topic #625-000-002
FDOT Developmental Design Criteria — Last Revised 10/30/20

## D217 Diverging Diamond Interchanges

### 217.1 General

This chapter provides criteria for the geometric layout of the Diverging Diamond Interchange (DDI). The criteria contained in the FDM are supplemented by guidance provided in the *Federal Highway Administration (FHWA) Diverging Diamond Interchange Informational Guide, August 2014*.

The DDI is an alternative interchange configuration that combines the basic form of a diamond interchange with a pair of directional crossovers on the cross street. The crossovers serve to transpose the directions of travel along the cross street between the ramp terminals on either side of the controlled access facility. Shifting the through movements to the left side of the street between ramp terminals removes conflicts between left turning vehicle to and from the ramps and opposing through traffic on the cross street. This in turn allows for two-phase signal timing at the crossovers improving the operational efficiency of the interchange.

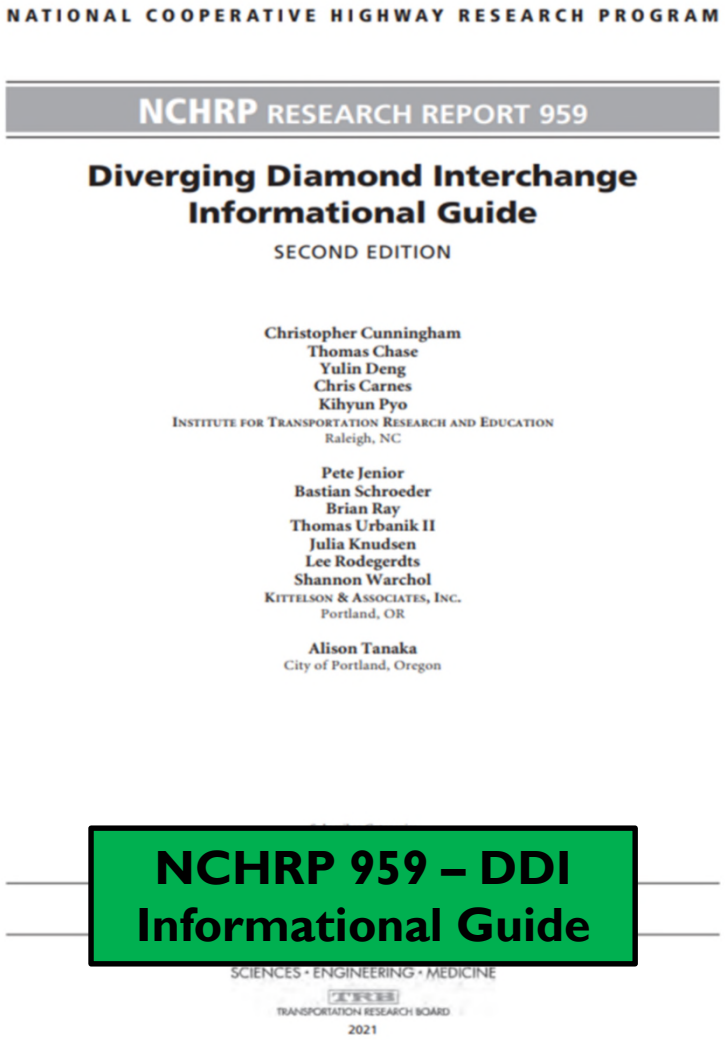
The DDI design significantly reduces the number of vehicle-to-vehicle conflict points compared to a conventional diamond interchange improving overall safety. The DDI also reduces the severity of conflicts, as conflicts between left-turning movements and the opposing through movement are eliminated. The remaining conflicts are reduced to merge/diverge conflicts for turning movements, and the crossover conflict of the two through movements.

### 217.1.1 DDI Terminology

***Figure 217.1.1*** provides a schematic of typical DDI terminology. The terms shown in this section are standard terms or variables used within this chapter.

D217- Diverging Diamond Interchanges

**FDOT Development Design Criteria - DDI**



NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP RESEARCH REPORT 959

## Diverging Diamond Interchange Informational Guide

SECOND EDITION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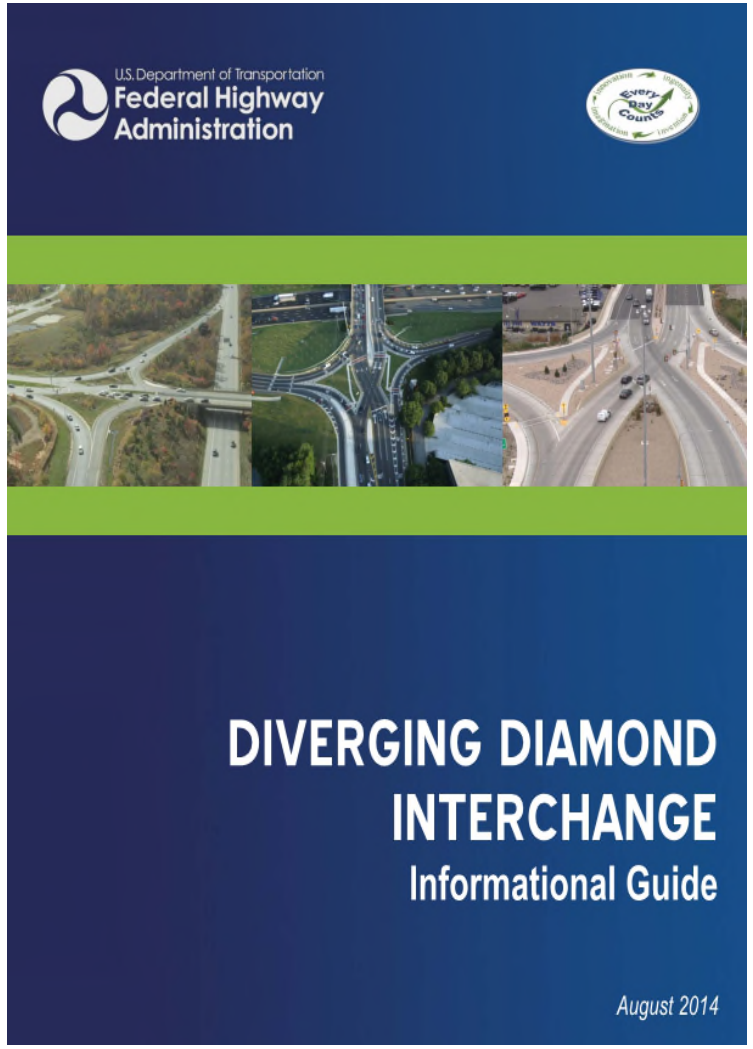
2021


**NCHRP 959 – DDI Informational Guide**

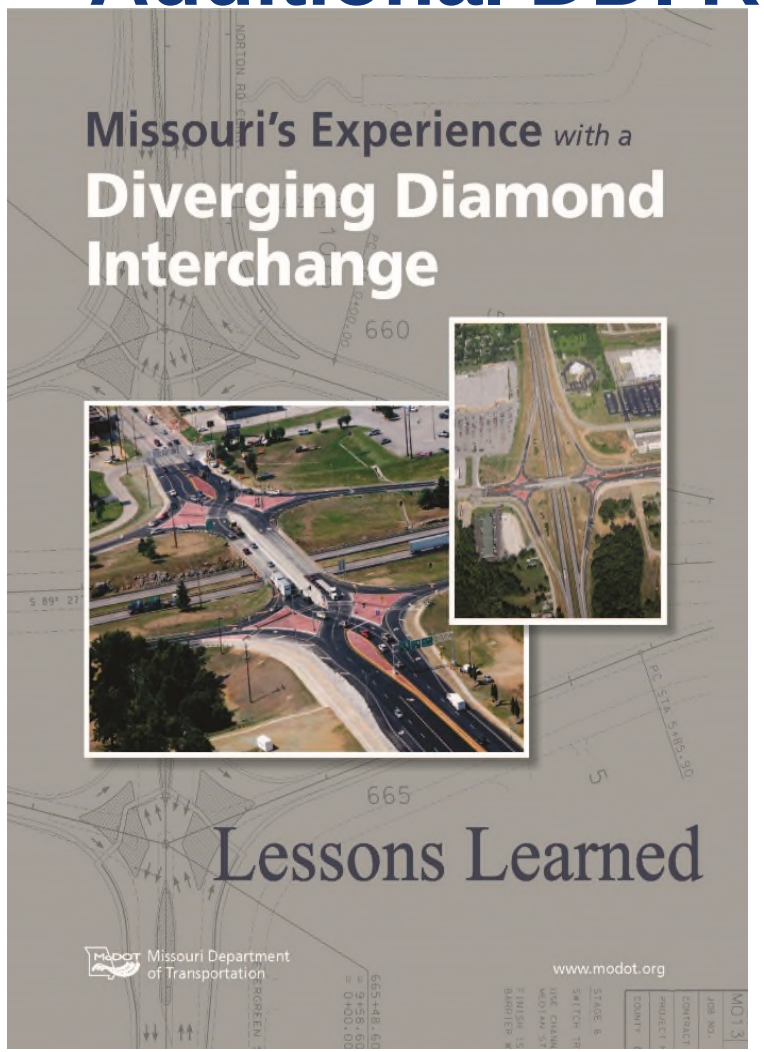


U.S. Department of Transportation
Federal Highway Administration

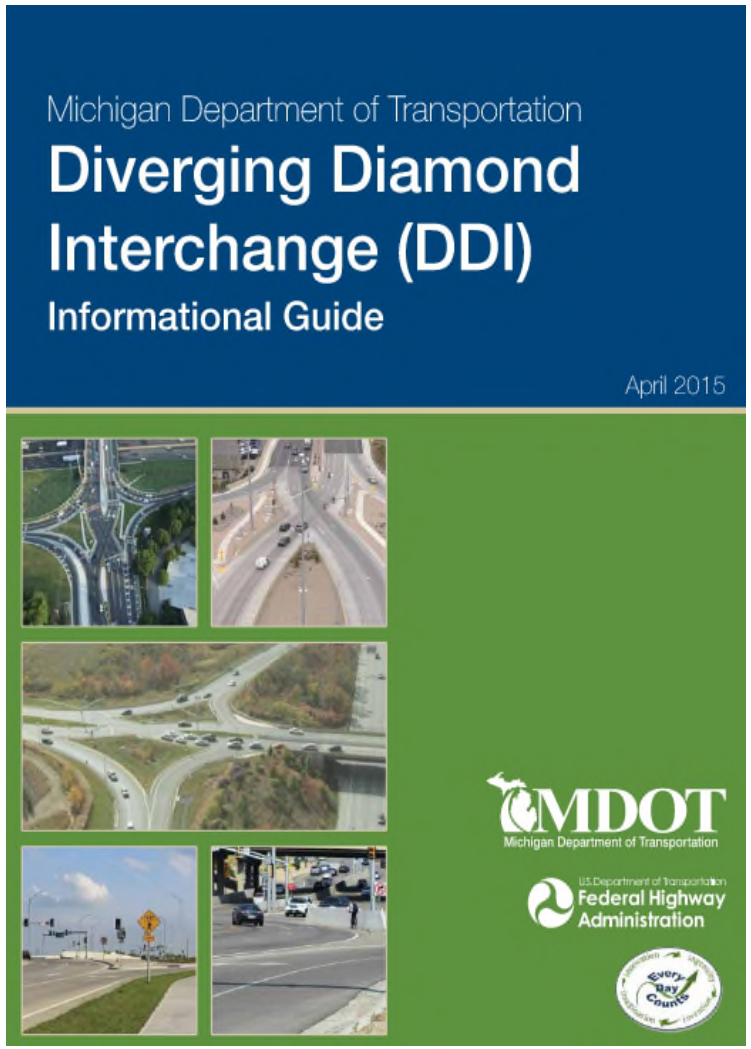
DIVERGING DIAMOND INTERCHANGE
Informational Guide

August 2014

# Additional DDI Resources







# FDOT DDI Design Webinar Series

- **Schedule:**

| | | |
|---|---|---|
| DDI Overview | June 15, 2021 | 2p-5p |
| DDI Geometric Design | June 29, 2021 | 2p-3p |
| DDI Signing and Pavement Marking | July 16, 2021 | 2p-3p |
| DDI Traffic Operations | August 10, 2021 | 2p-3p |
| DDI Multimodal Accommodations | August 24, 2021 | 2p-3p |
| **DDI Plans Detailing & Public Involvement** | **September 7, 2021** | **2p-3p** |

# Questions?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