



FDOT DDI Design Webinar Series Signals, Signs and Pavement Markings

July 16, 2021

FDOT DDI Design Webinar Series

- 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 & Marking and Signals	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





DDI Signals, Signs and Pavt. Markings– Webinar Instructors



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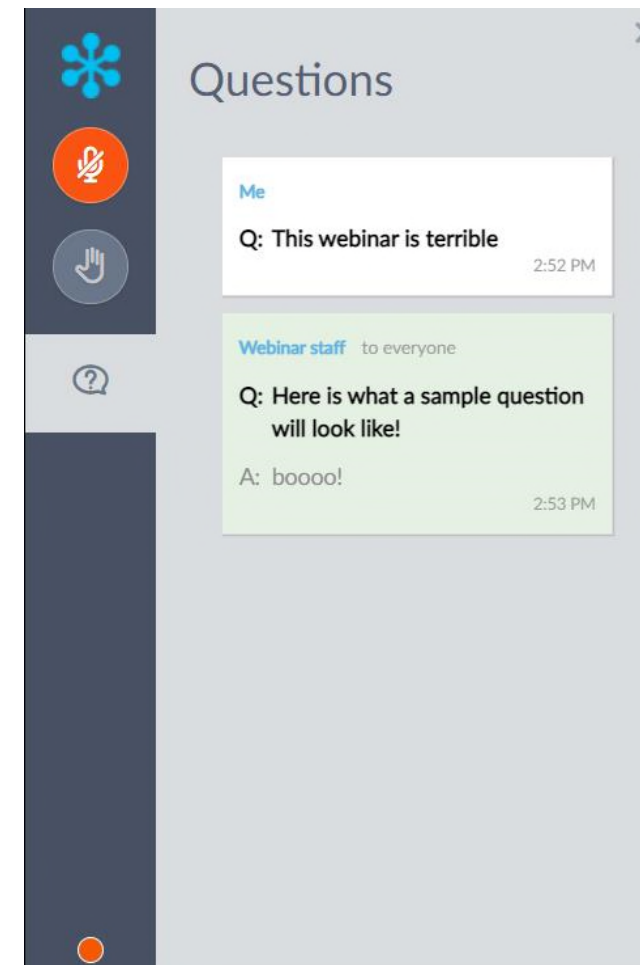
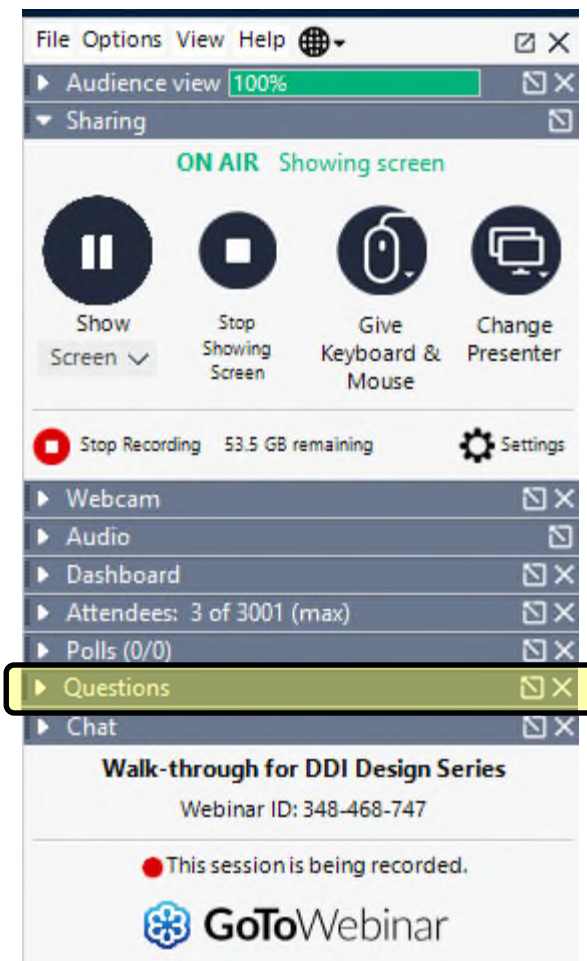
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DDI Signals, Signs and Pavt. Markings – Webinar Logistics

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



DDI Signals, Signs and Pavt. Markings - AGENDA

- Signs & Pavement Markings
- Signalization
- Lighting
- Pedestrian and Bicycle Accommodations



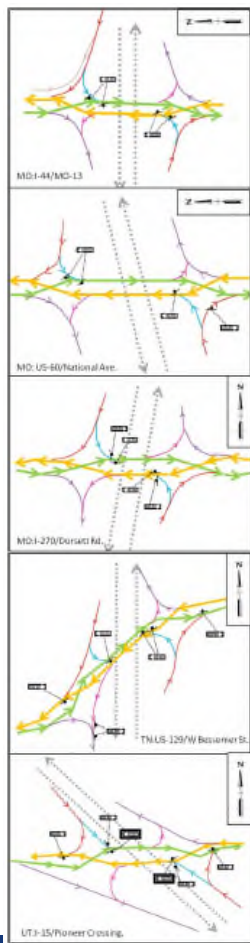
DDI Signing and Pavement Markings

Signing and Pavement Markings

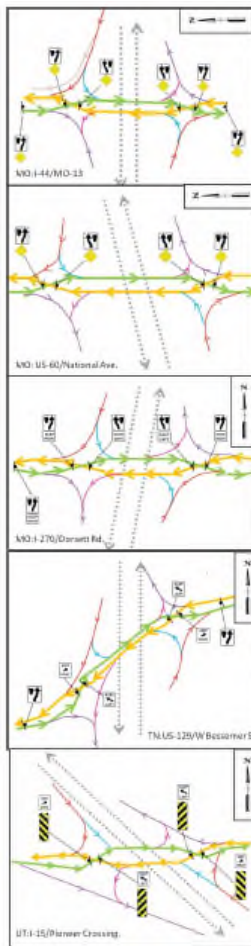
■ Signs

- MUTCD does not explicitly address DDI signing details
- Practices are still evolving
- A lot of options
- Minimize confusion

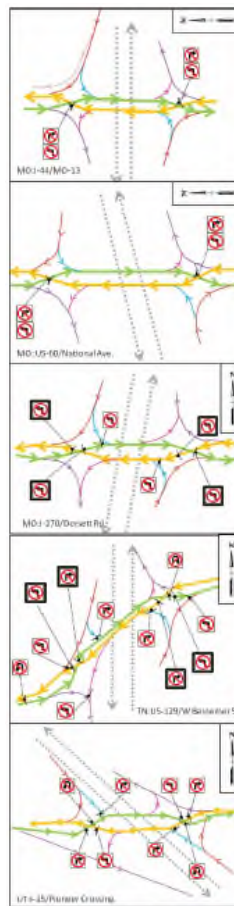
One Way Signs



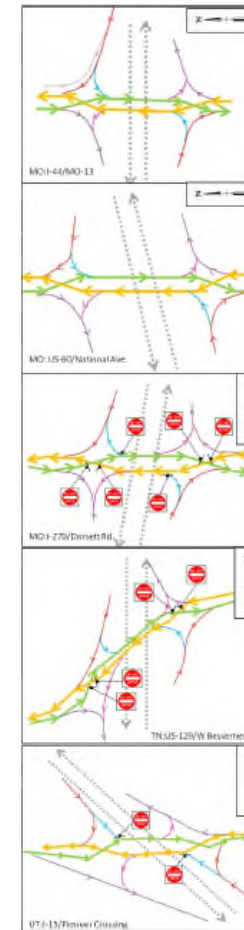
Keep Right/Left Signs



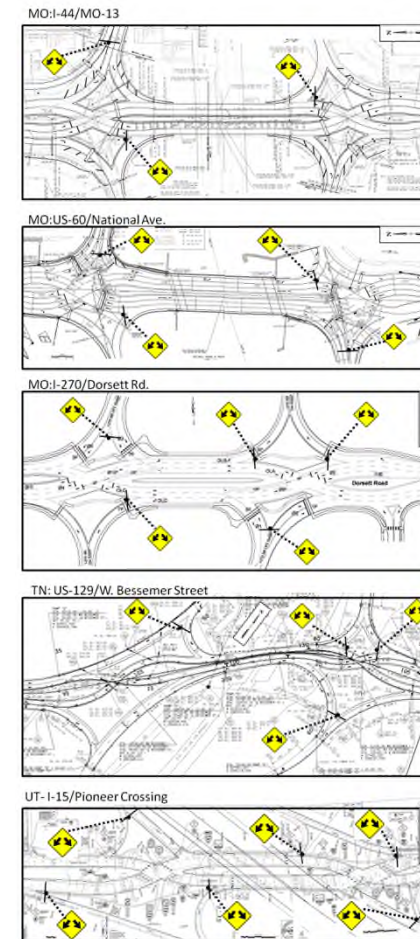
No Turn Signs



Do Not Enter

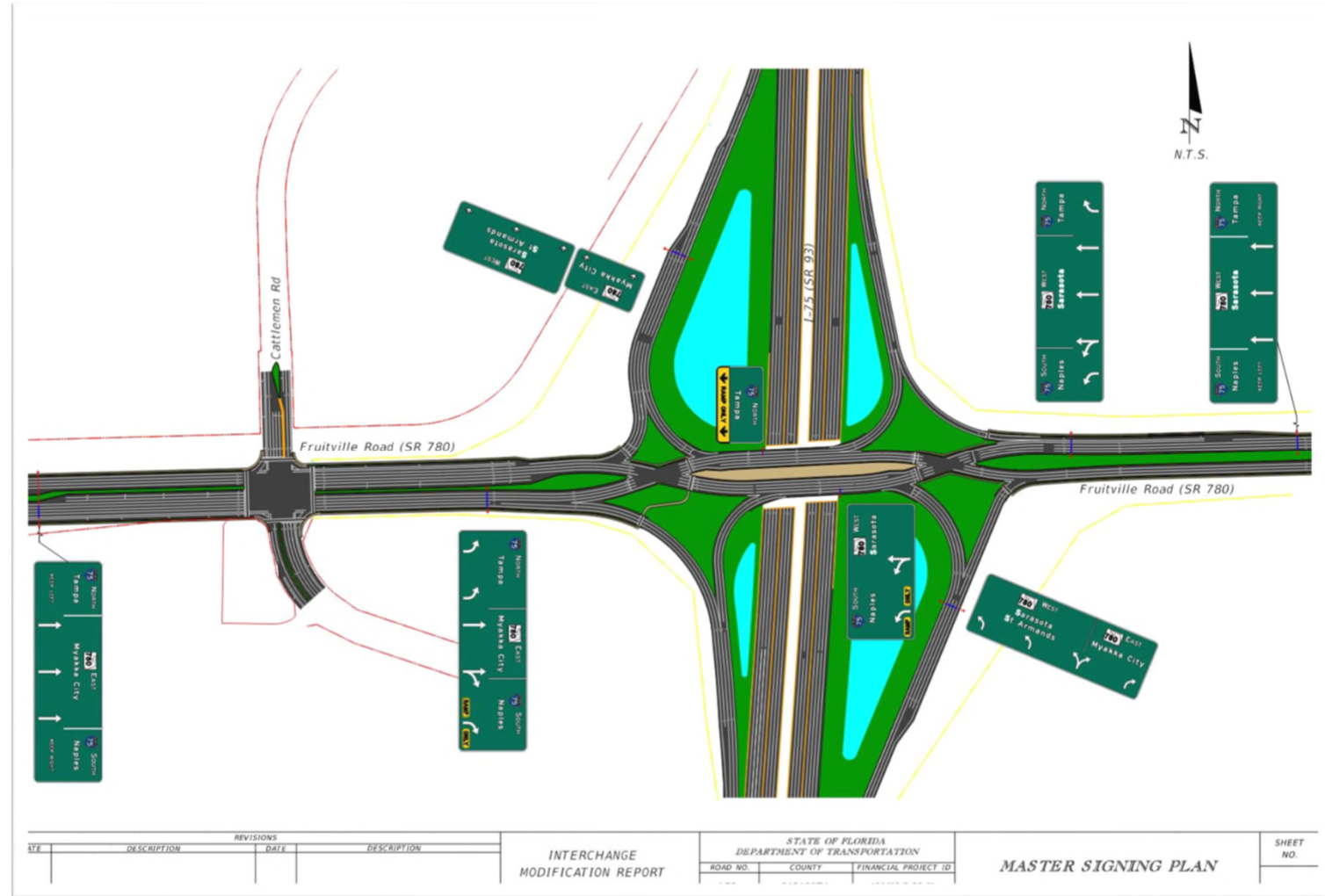


Lane Split Signs



Guide Signs

- **Master Signing Plan**
 - Initial guide sign layout
 - Follows MUTCD sign sequence criteria
 - Early guidance for motorists approaching the DDI



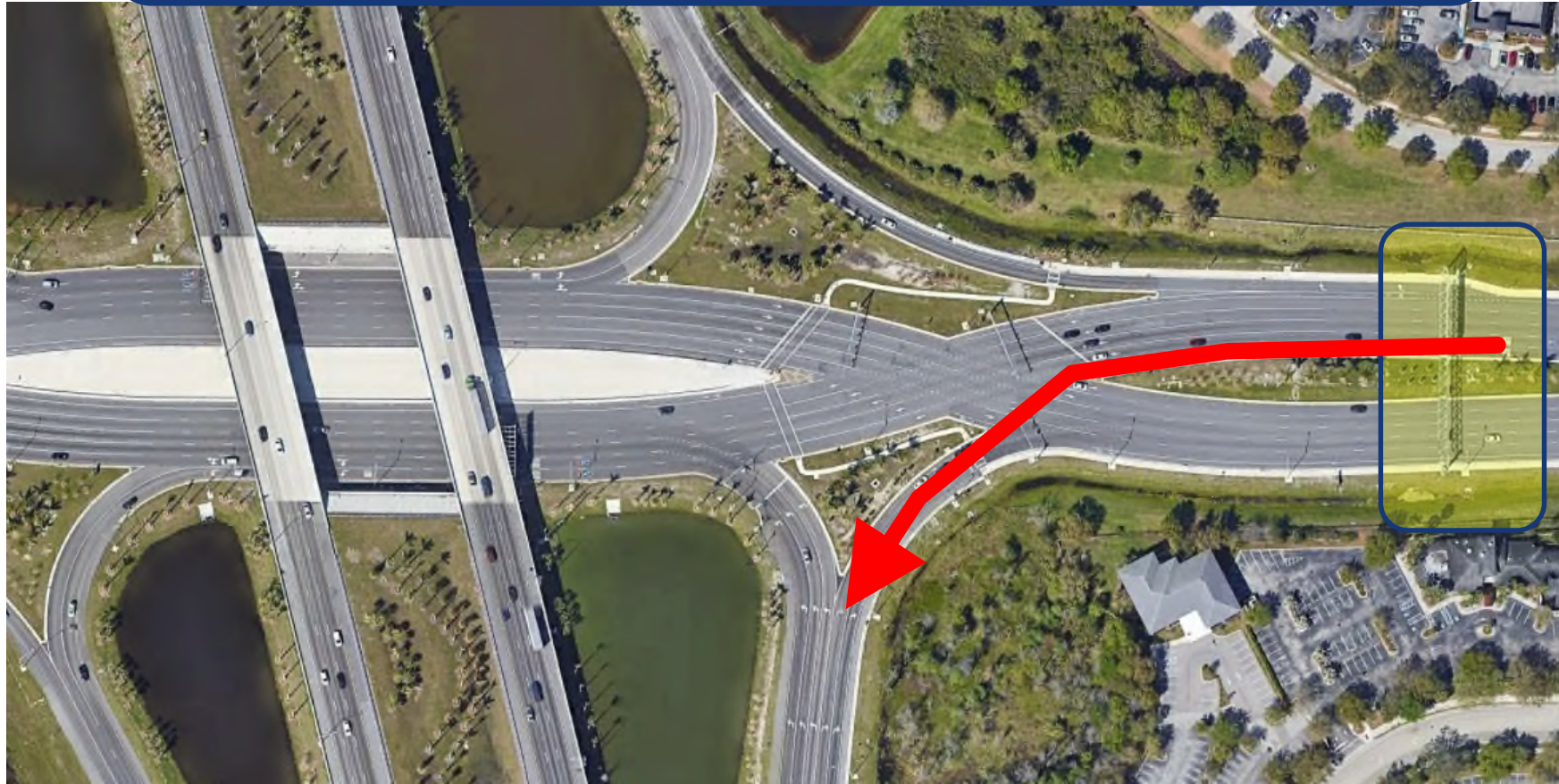
Guide Signs

- **Arrow per lane sign**
 - Shared lanes have left & thru arrow
 - Could the left turn arrows cause a wrong way movement?



Guide signs

- Arrow per lane sign
 - Could the left turn arrows cause a wrong way movement?



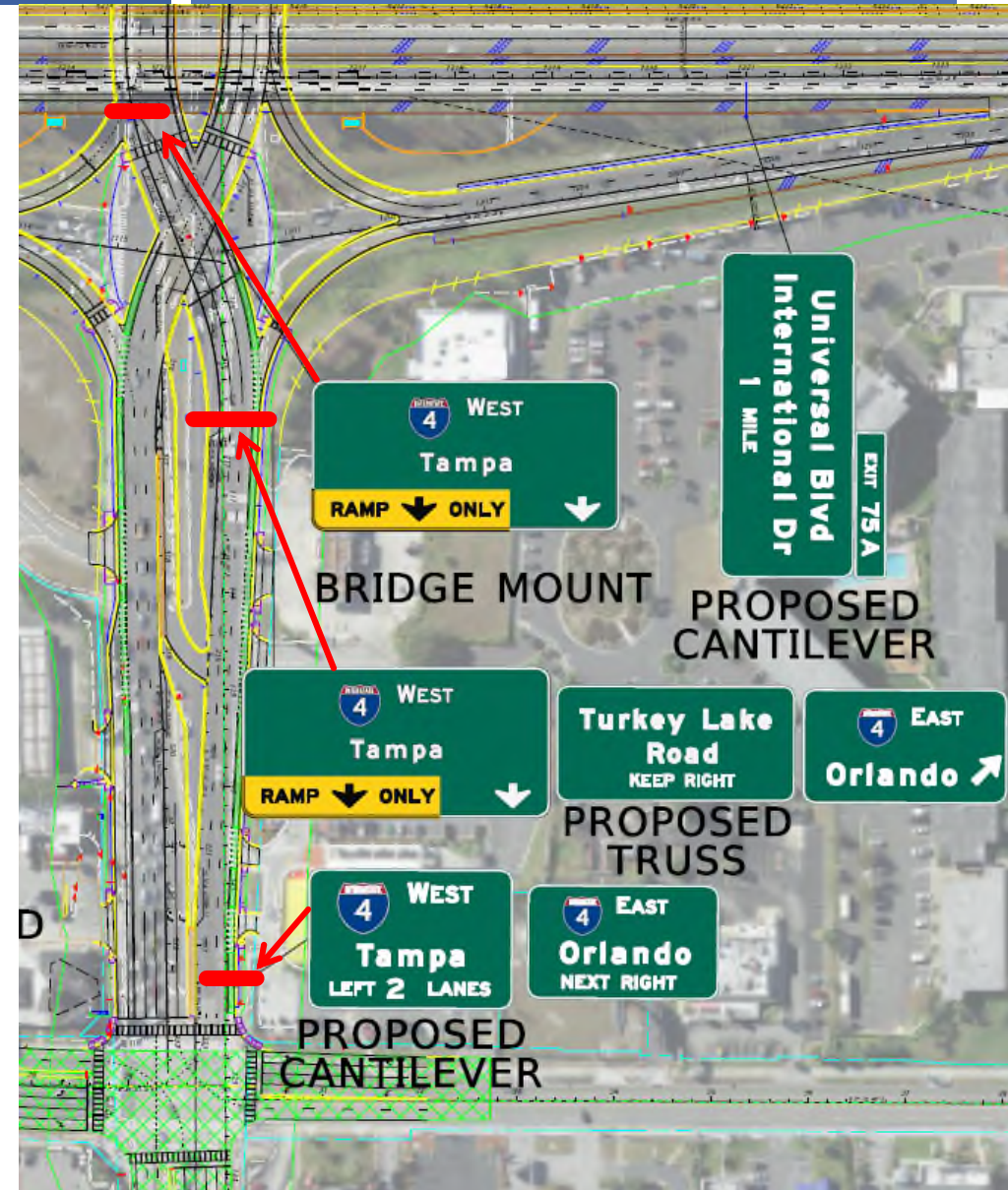
Guide signs

- **Arrow per lane sign**
 - Could the left turn arrows cause a wrong way movement?
- **Benefit**
 - Advance notification of on-ramp drop lane



Guide Signs

- **Multiple overhead advance signs consideration**
 - Approaches with unique or congested adjacent intersections
 - Shared on-ramp entrance lanes
 - Larger interchanges
- **Previous Interchange**
 - How different is the DDI from the old interchange?



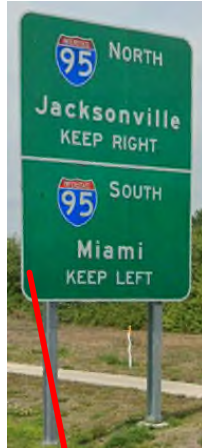
Guide Signs

- **Advance Signs Example**
 - Old loop on-ramp replaced with a DDI
 - Left vs right side of the road



Guide Signs

- Single overhead with multi-post advance signs
- Best for:
 - Fewer lanes
 - Less congestion
 - Easier to make a last minute lane change
- No bridge mount when arterial goes over the interstate



DDI Signing

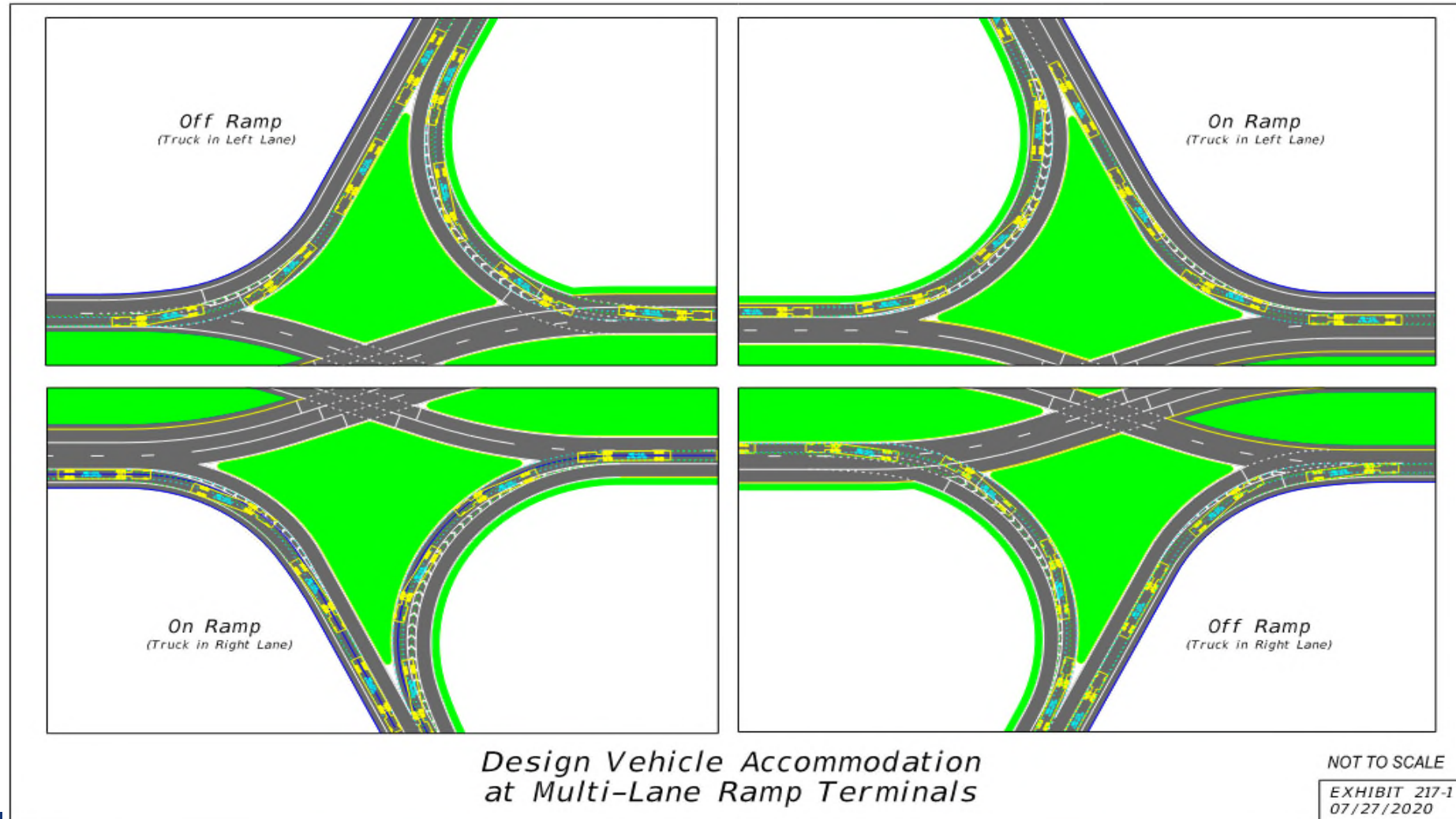
- At crossover intersections
 - Thru arrows & lane prohibition



Signing and Pavement Markings

■ Pavement Markings

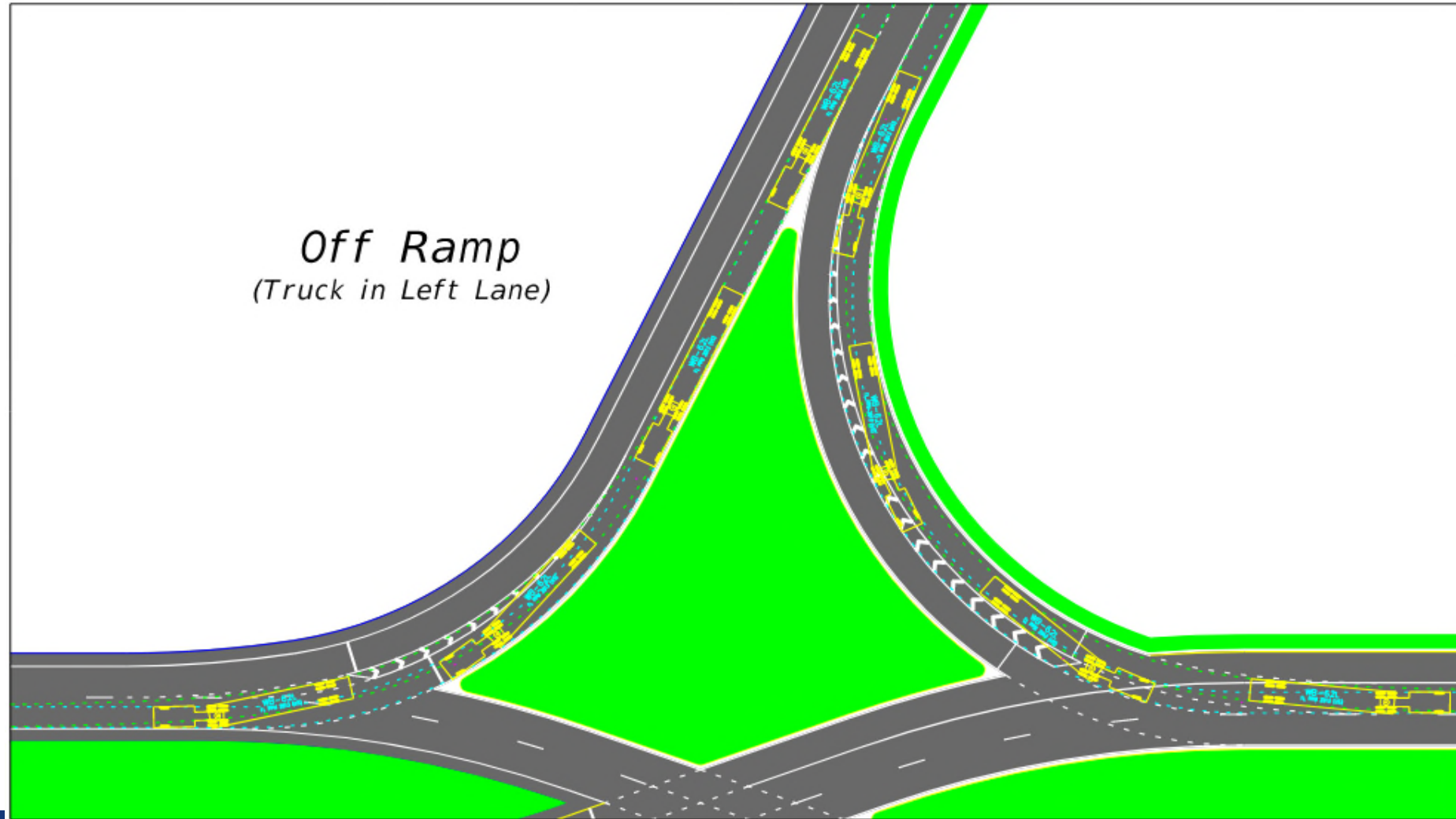
- Identify the appropriate design vehicles, especially for dual lane turning movements
- Place excess pavement between lanes in the middle for use by trucks from both turn lanes



Signing and Pavement Markings

■ Pavement Markings

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Signing and Pavement Markings

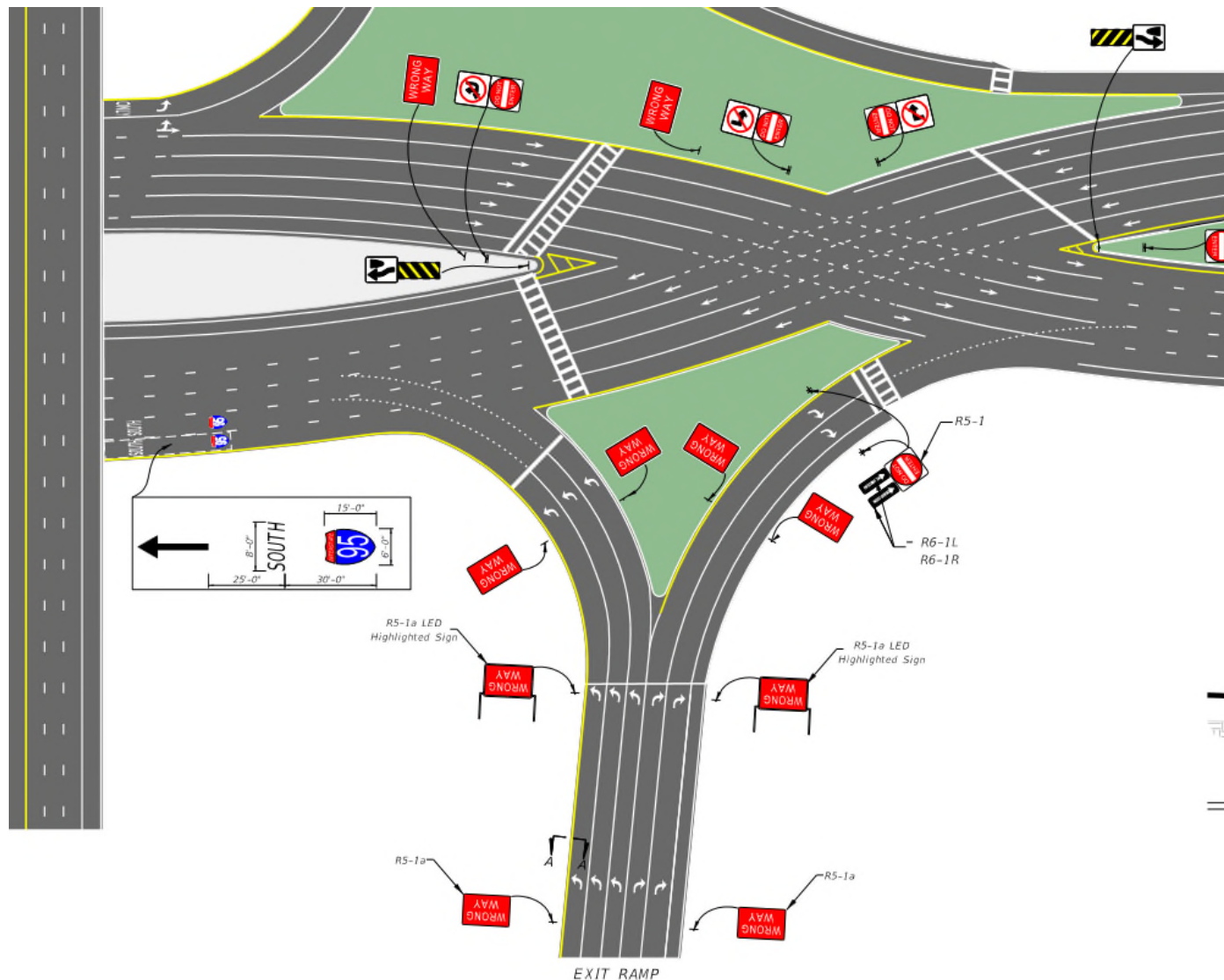
■ Pavement Markings

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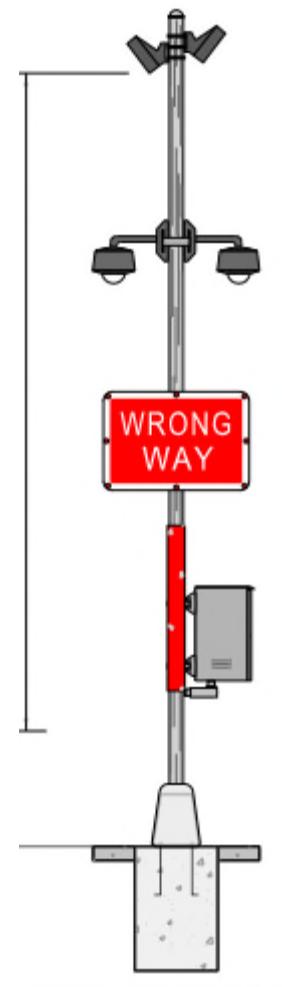
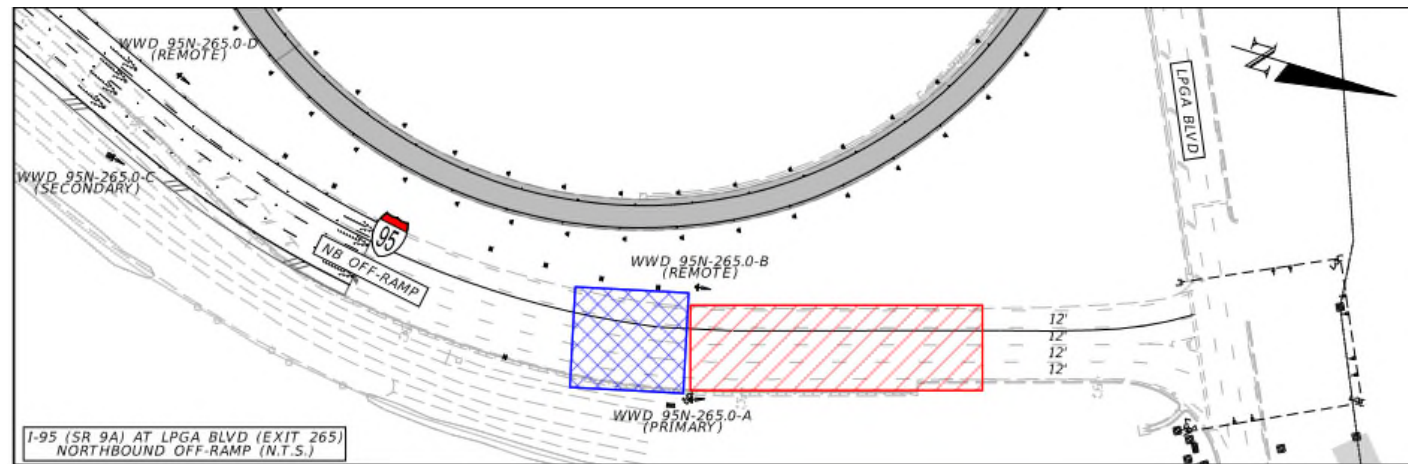
Wrong Way Driving

- FDM Exhibit 230-2
- Pavement Markings
 - Interstate route shields and thru arrows before & after crossovers
 - 2-4 dotted stripes through the crossovers
- Signs
 - Turn prohibitions
 - Do not enter
 - Wrong Way



Wrong Way Driving

- **Wrong Way Driving Detection System**
 - Detection, Red RRFB, CCTV, Communication
 - Detection zones
 - Detail from District 5's Smart Roads website
 - Wireless or fiber communication





DDI Signalization

Mast Arm Layout

■ Strategy 1

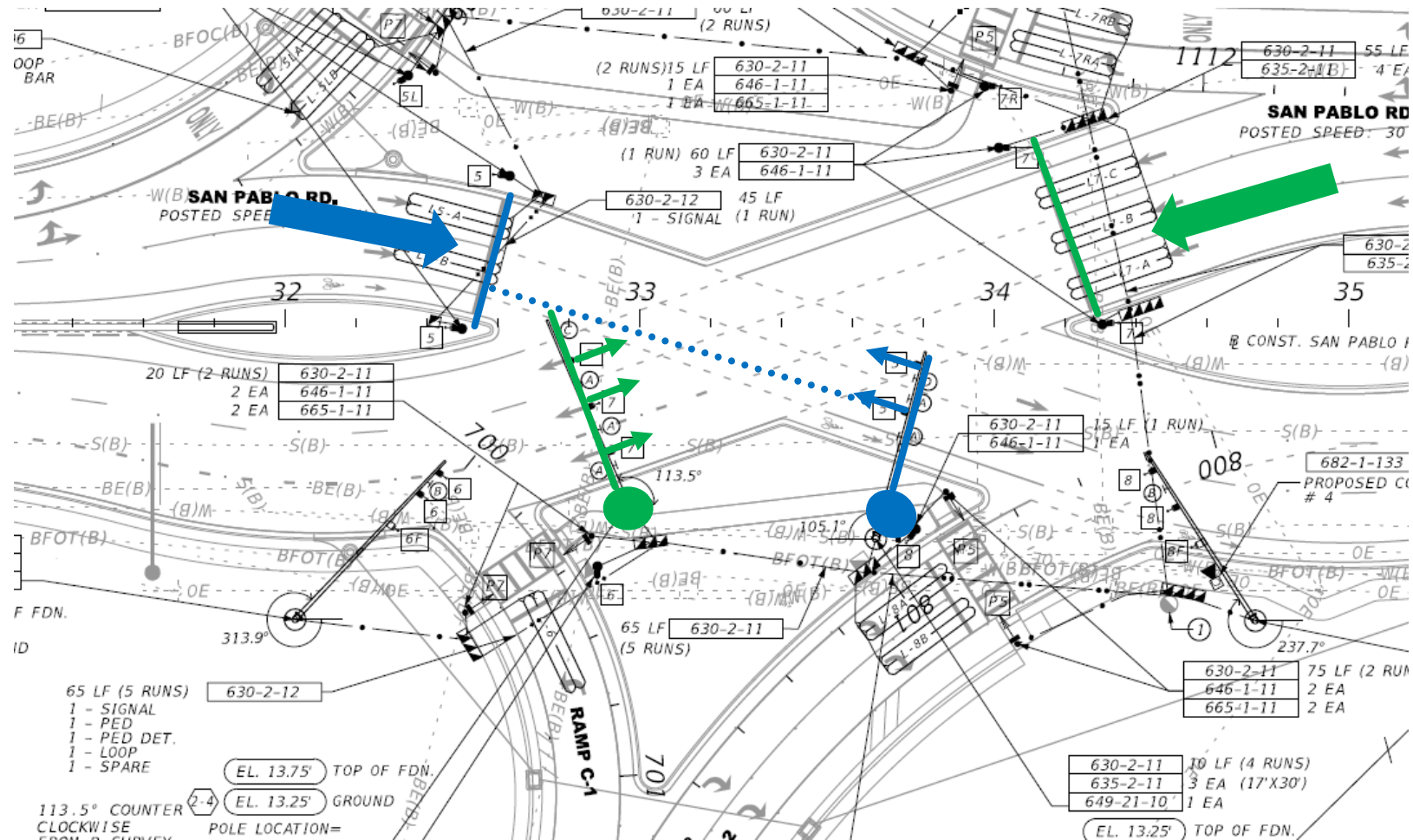
- Mast arms on the far side of the crossover
- Don't block signal visibility with the opposing mast arm



Mast Arm Layout

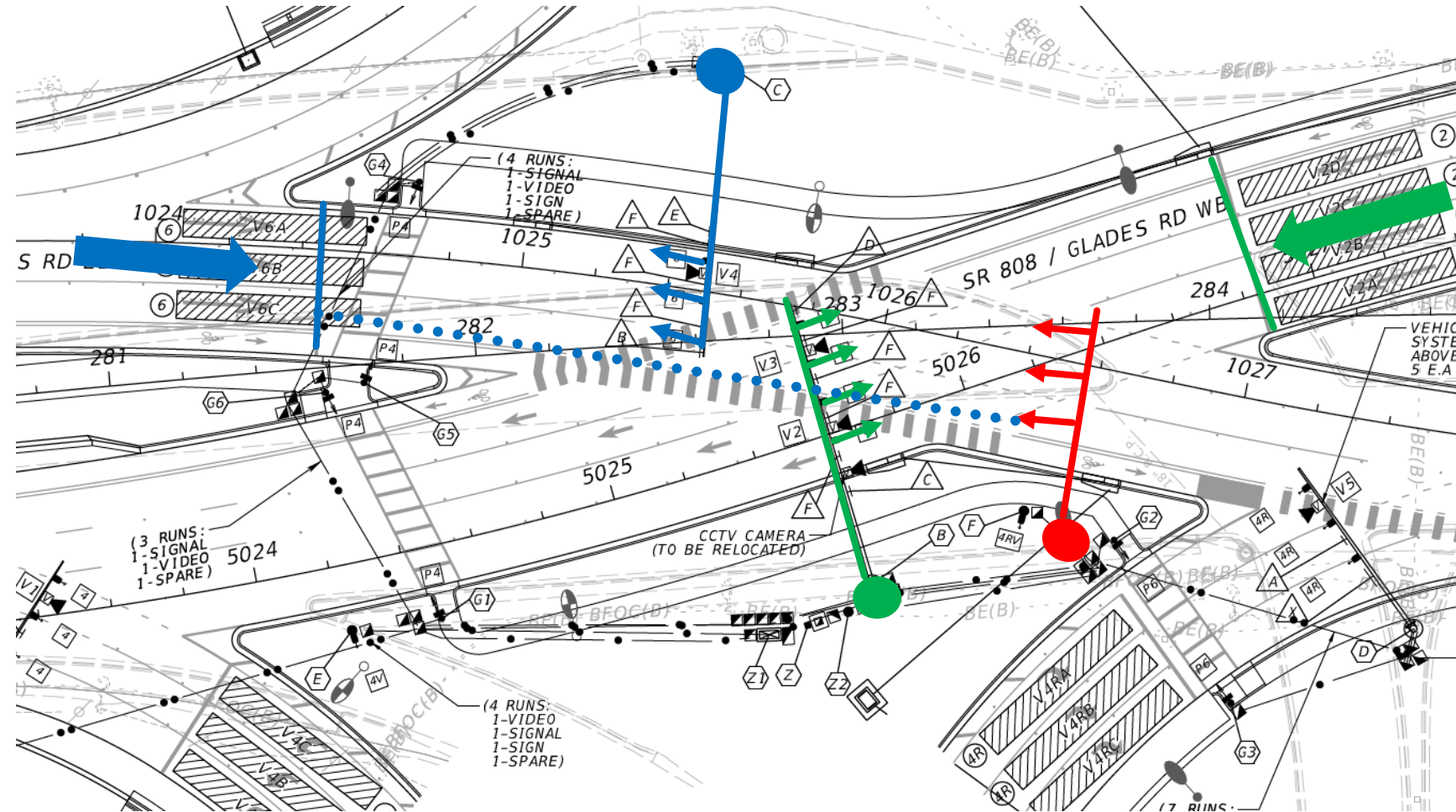
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Mast Arm Layout

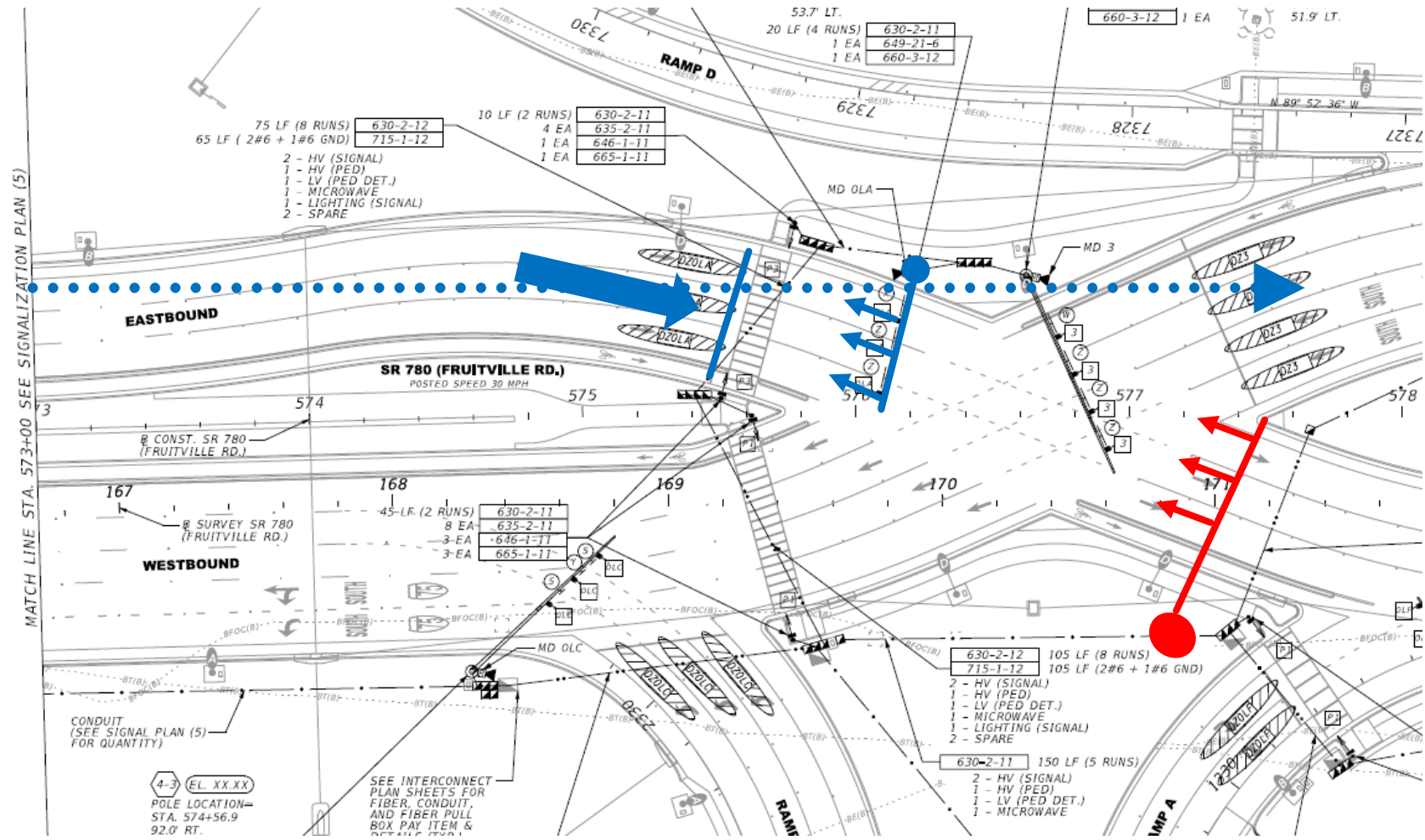
- Strategy 1 Modified
 - Near-side of the crossover in one direction to avoid sight distance conflict



Mast Arm Layout

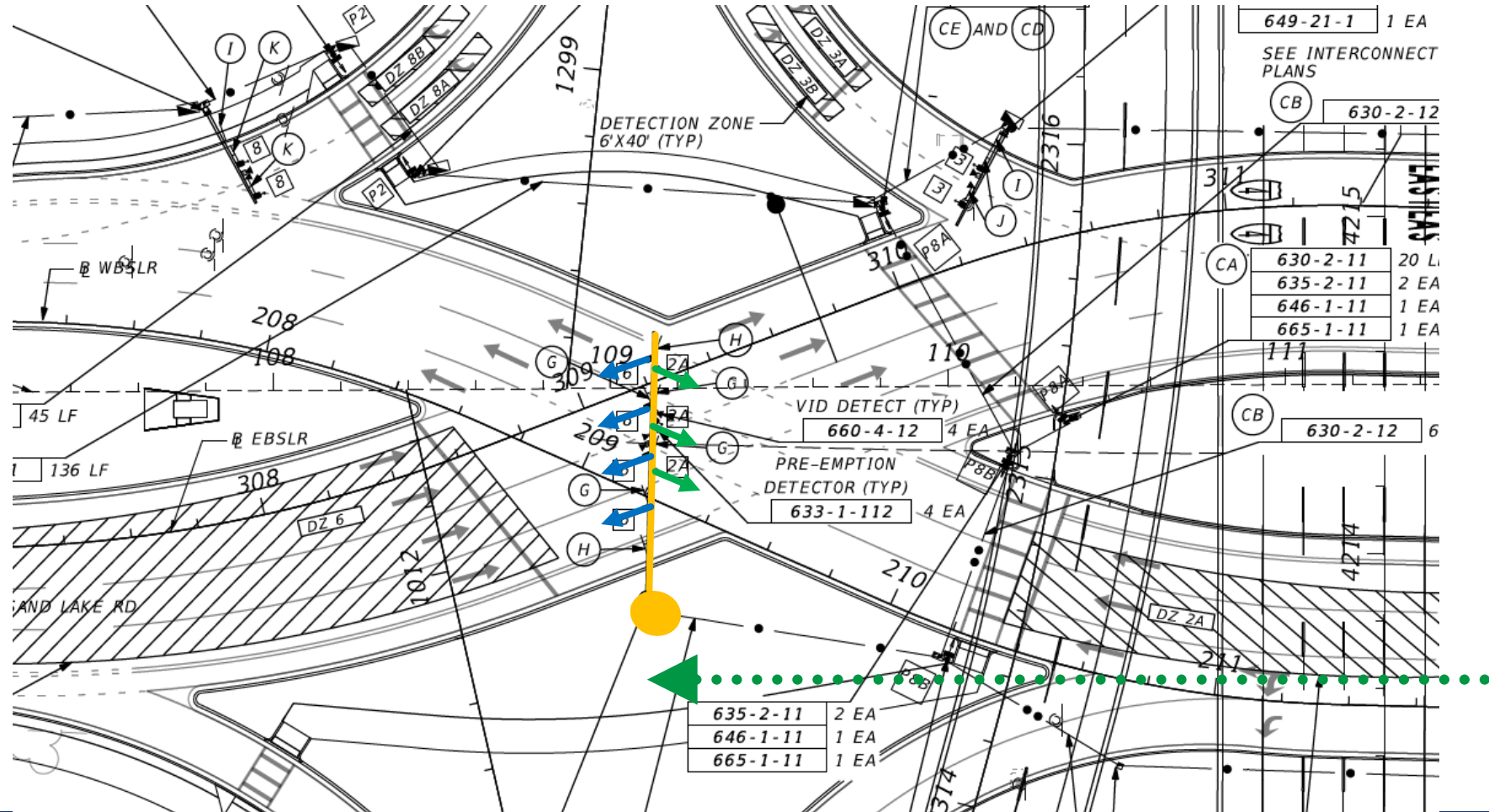
■ Near-side

- Consider a driver's view upstream of the stop bar



Mast Arm Layout

- **Single mast arm for both directions**
 - Signals back to back
 - 7 signal heads
 - 6 signs
- **Visual clutter**
- **Supplemental signal heads**



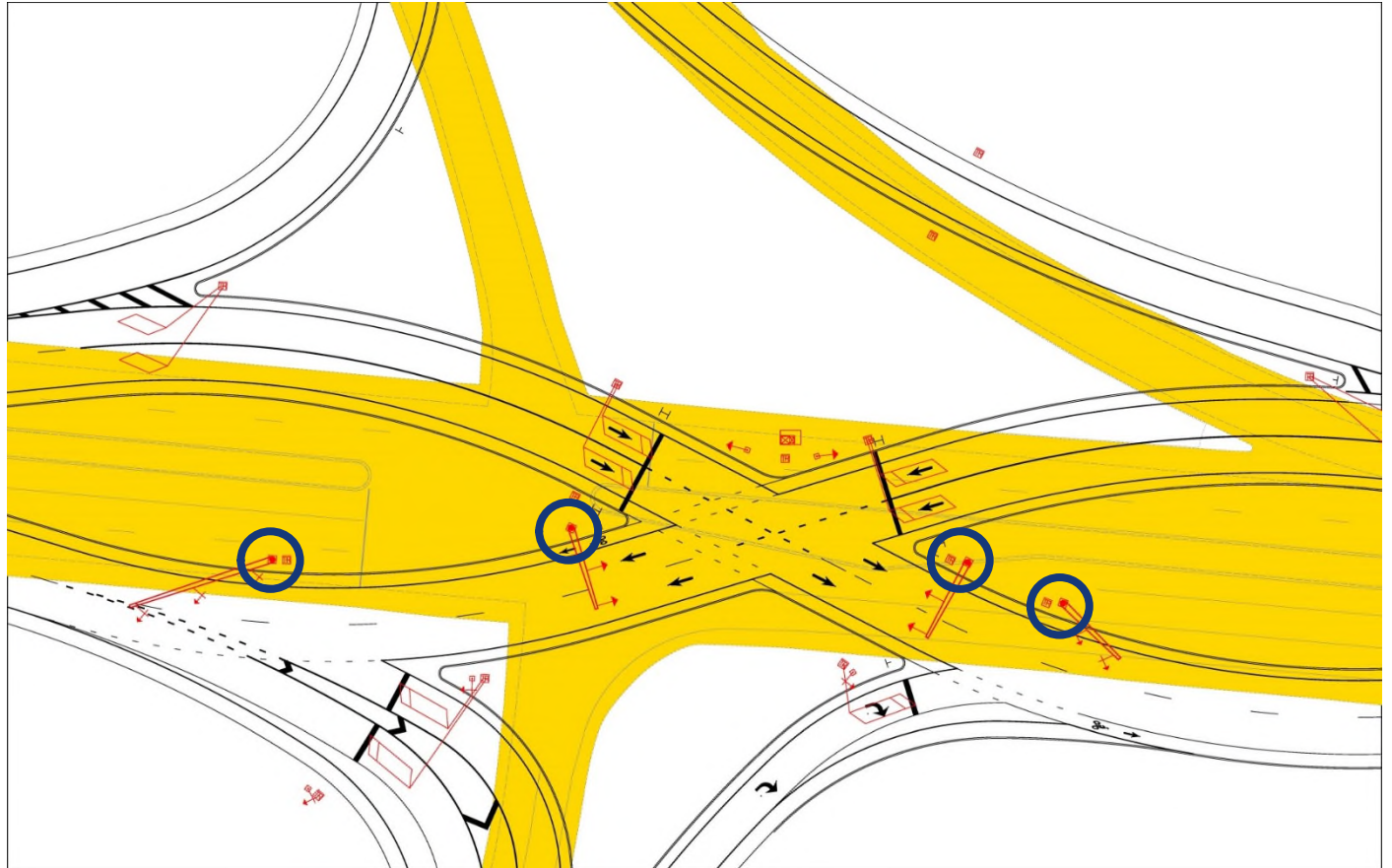
Mast Arm Layout

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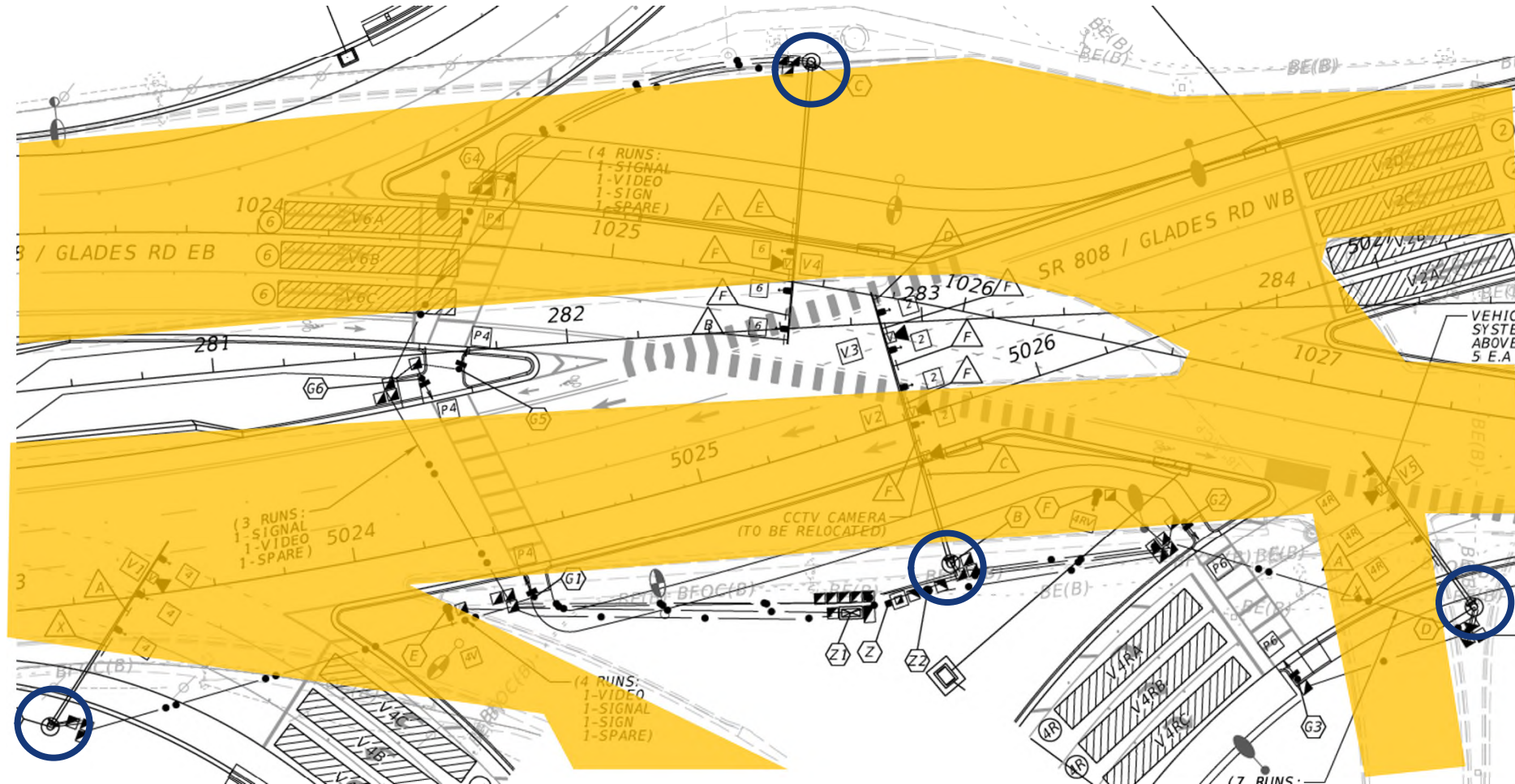
Mast Arm Layout

- Avoid placement of the mast arms in the existing pavement for ease of constructability and testing



Mast Arm Layout

- Poles placed outside the existing roadway



Traffic Signals

- **Signal Head Placement**
 - Supplemental head usage



Traffic Signals

- **Signal Head Placement**
 - Supplemental head usage
 - Seeing the signal head along the ramp when approaching



Traffic Signals

■ Signal Head Placement

- Supplemental head usage
- Seeing the signal head along the ramp when approaching
- Avoid confusion



Signal Head Layout



Signal Head Layout



Signal Head Layout



Signal Head Layout



Signal Head Layout



Signal Head Layout



Traffic Signals

- **Signal Head Placement**

- Crossover Intersection
- Basic green ball



Traffic Signals

- **Signal Head Placement**
 - Crossover Intersection
 - Basic green ball
 - Straight up arrow



Traffic Signals

■ Signal Head Placement

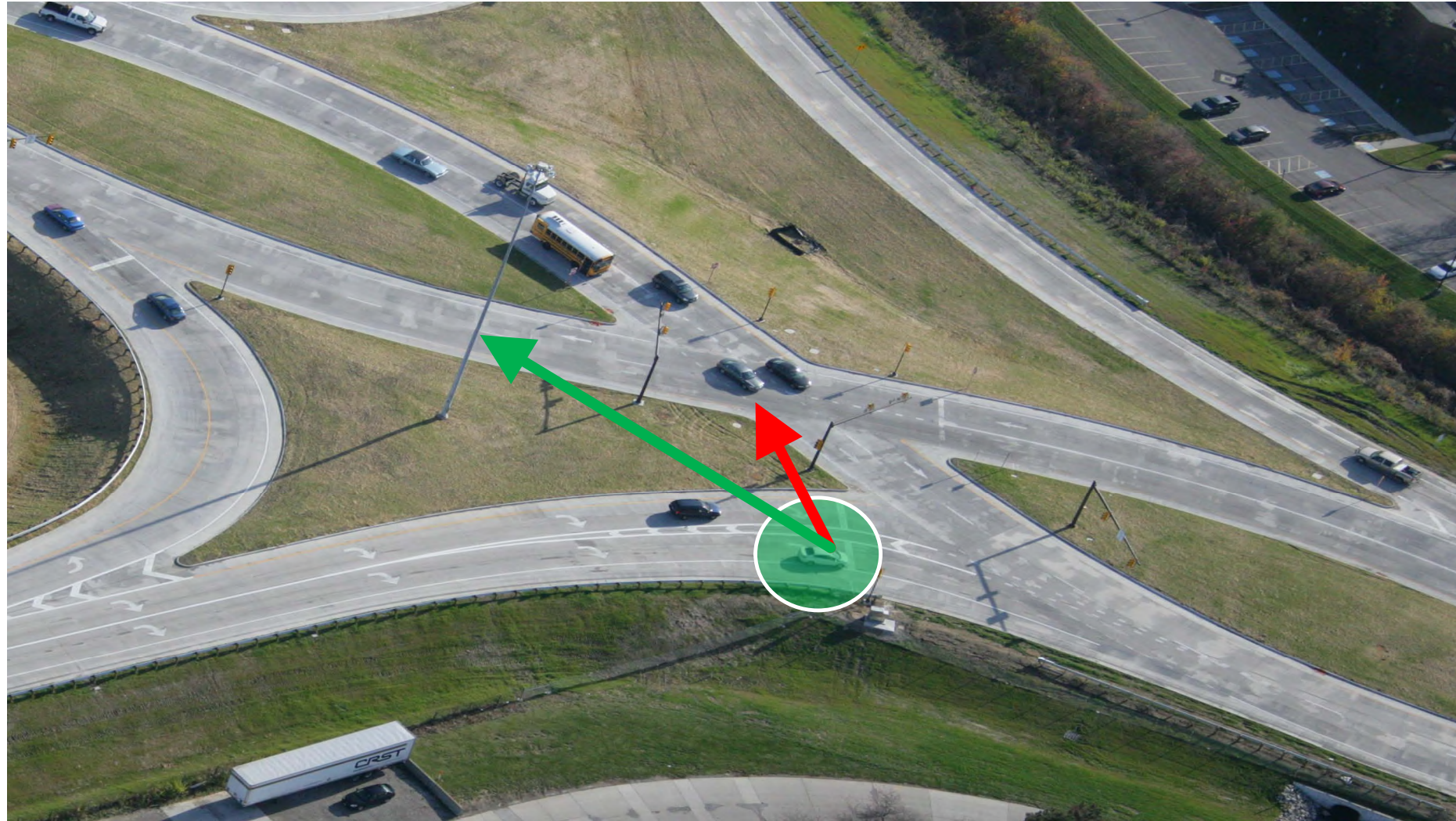
- Crossover Intersection
 - Basic green ball
 - Straight up arrow
 - Diagonal arrow (up)



Traffic Signals

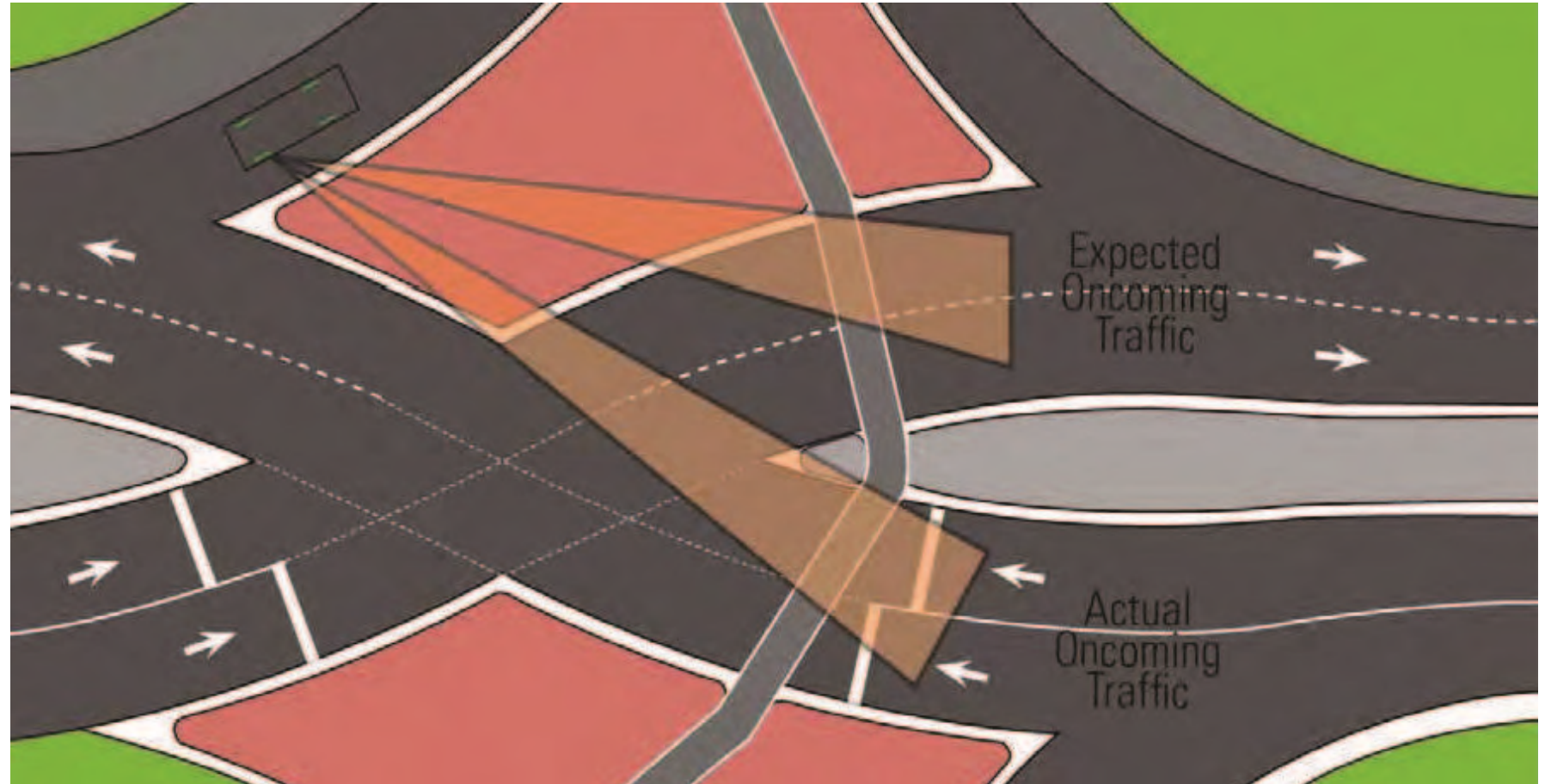
■ Signalized Right Turns

- Poor sight lines can lead to driver error
- Dual turn lanes can cause sight line obstructions



Signal Head Layout

- Signalized Right Turns
 - No Turn on Red



Source: MoDOT DDI
Lessons Learned –2010

Traffic Signals

- **Signalized Right Turns**
 - Poor sight lines can lead to driver error
 - Dual turn lanes can cause sight line obstructions
 - No turns on red



Traffic Signals

■ Signalized Right Turns

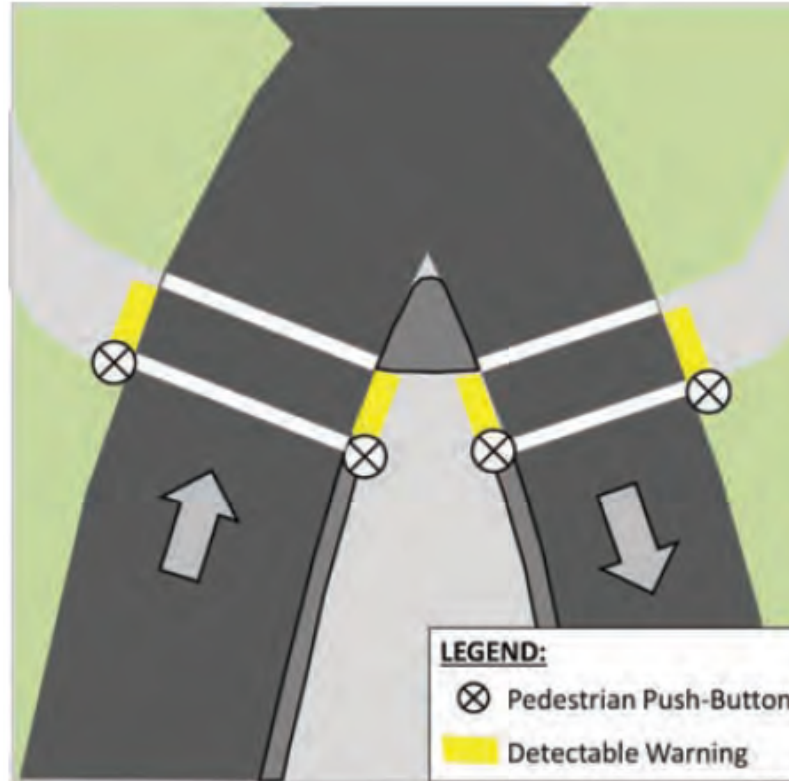
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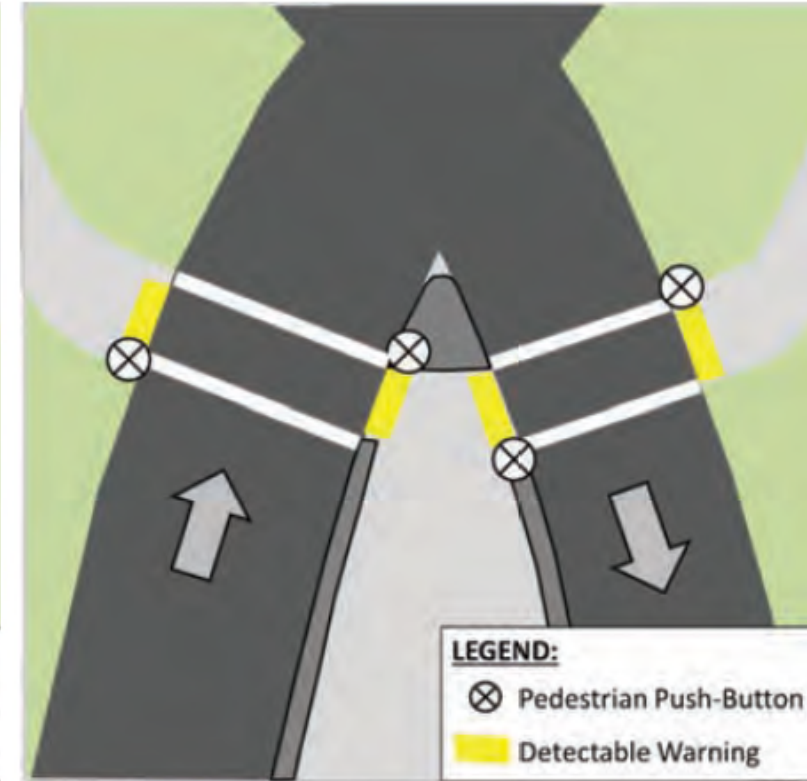
Traffic Signals

■ Pedestrian Signals

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



(a) Pedestrian Signals on Same Side



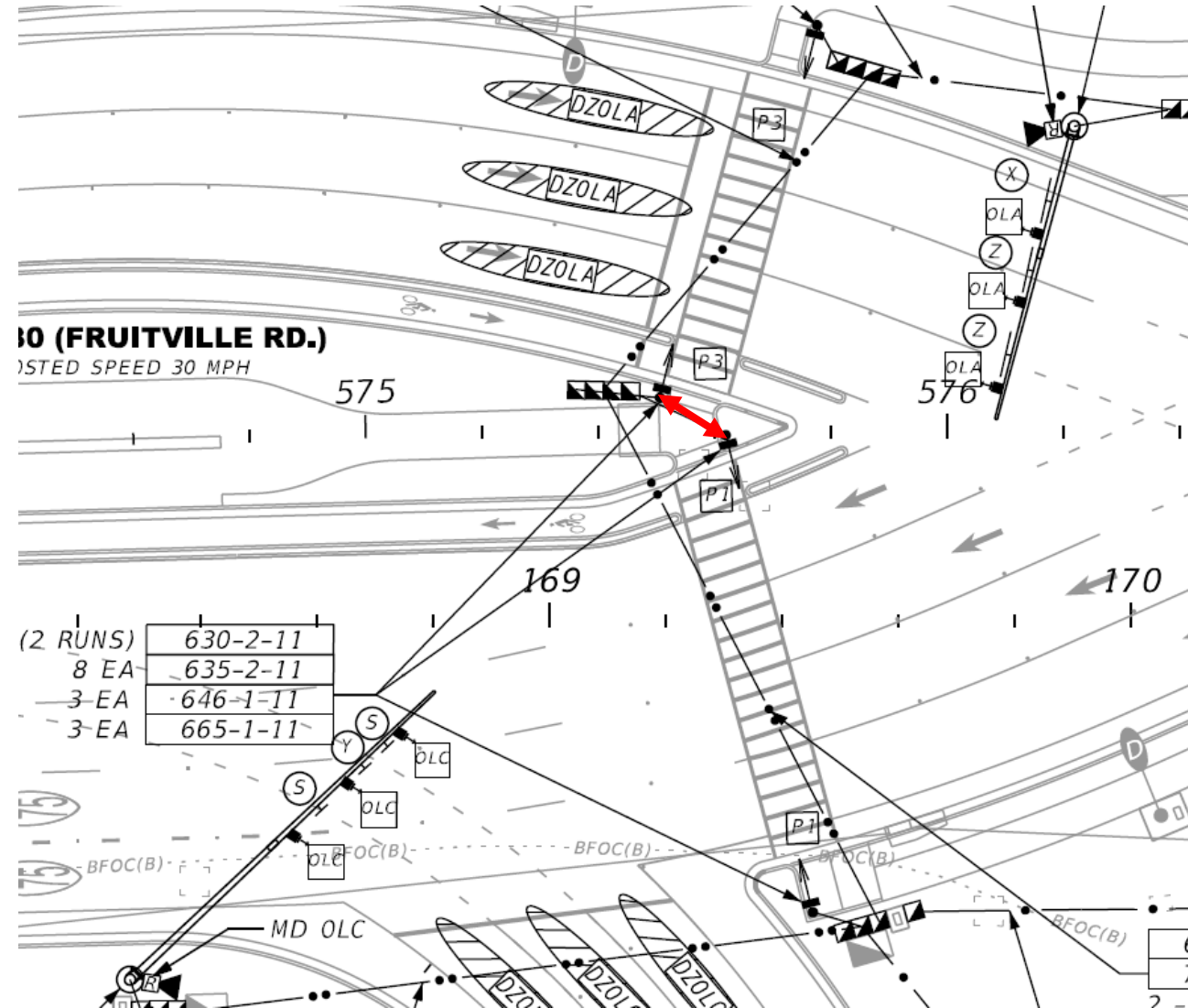
(b) Diagonal Pedestrian Signals

Source: DDI Information Guide, Second Edition (2021)

Traffic Signals

■ Pedestrian Signals

- Meeting 10' separation between pedestrian push buttons is difficult in the narrow median
- Consider moving stop bar back where median is wider
- Increases clearance distance



Traffic Signals

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



Source: DDI Information Guide, Second Edition (2021)

Signal Cabinet Options

- **Number of signal cabinets**
 - One or two cabinets can be used.
 - Use two if there's concern of connection loss to the controller.
 - If the controller is on one side of a bridge and controlling the signal on the other side.
 - GPS clocks alleviate some of the two cabinet concerns.



Traffic Signals

■ Number of Signal Cabinets

- One or two cabinets can be used
- Use two if there is concern of connection loss to the controller
 - If the controller is on one side of a bridge and controlling the signal on the other side
- GPS clocks alleviate some of the two cabinet concerns

Source: DDI Information Guide, Second Edition (2021)

Exhibit 7-14. Considerations for one versus two signal controllers at a DDI.

One Signal Controller	Two Signal Controllers
+ Reduced hardware and installation costs	+ More transparency in signal design and cabinet set-up for designers and technicians
+ Potentially avoids the need for communication infrastructure between crossovers (if no adjacent intersections)	+ Ability to control offsets directly rather than through overlap phases or other programming
+ Improved flow during “free” signal operations (e.g., late night)	+ Easier for technicians to see operations from the cabinet
– More complicated signal design and cabinet set-up for designers and technicians	+ More room in each cabinet to allow for complicated scenarios (e.g., light-rail)
– More difficult maintenance and troubleshooting for technicians	– Additional hardware and installation costs
– Additional wiring required from signal equipment to controller	– Need for controllers to communicate and potential for time drift that may impact progression
– More difficult for technicians to see operations at both crossovers from the cabinet	– May result in undesirable gap-out situations during low-volume periods

Note: Benefits are shown with a (+) and challenges with a (-).



Multimodal Accommodations

Multimodal Accommodations

■ Pedestrian Accommodations

- Inside (center) of the interchange
- Outside of the interchange



Multimodal Accommodations

- Refuge in center median island



Multimodal Accommodations

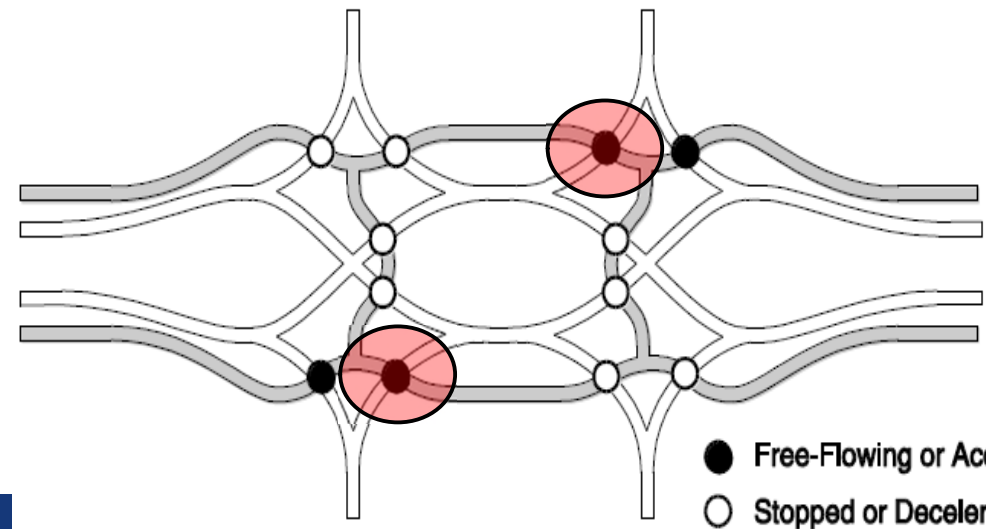
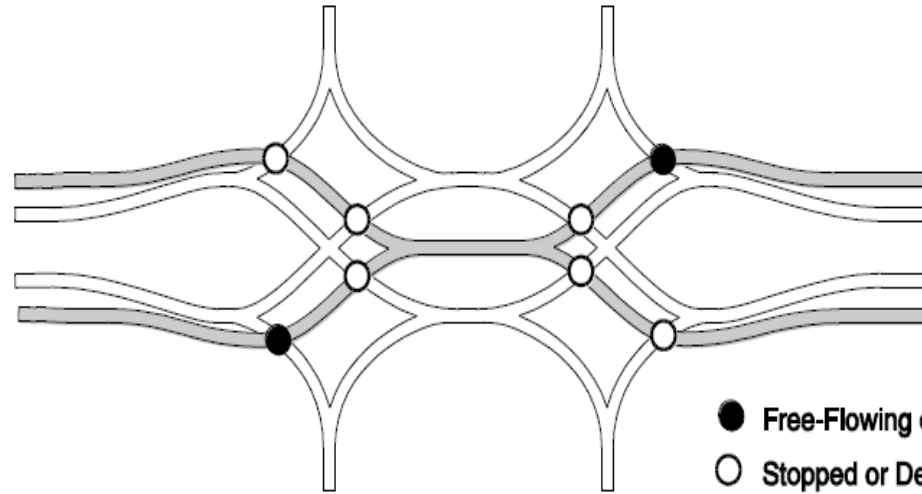
- **Signalizing the right turns provides pedestrian signal heads so they know when to cross**



Multimodal Accommodations

■ Pedestrian Accommodations

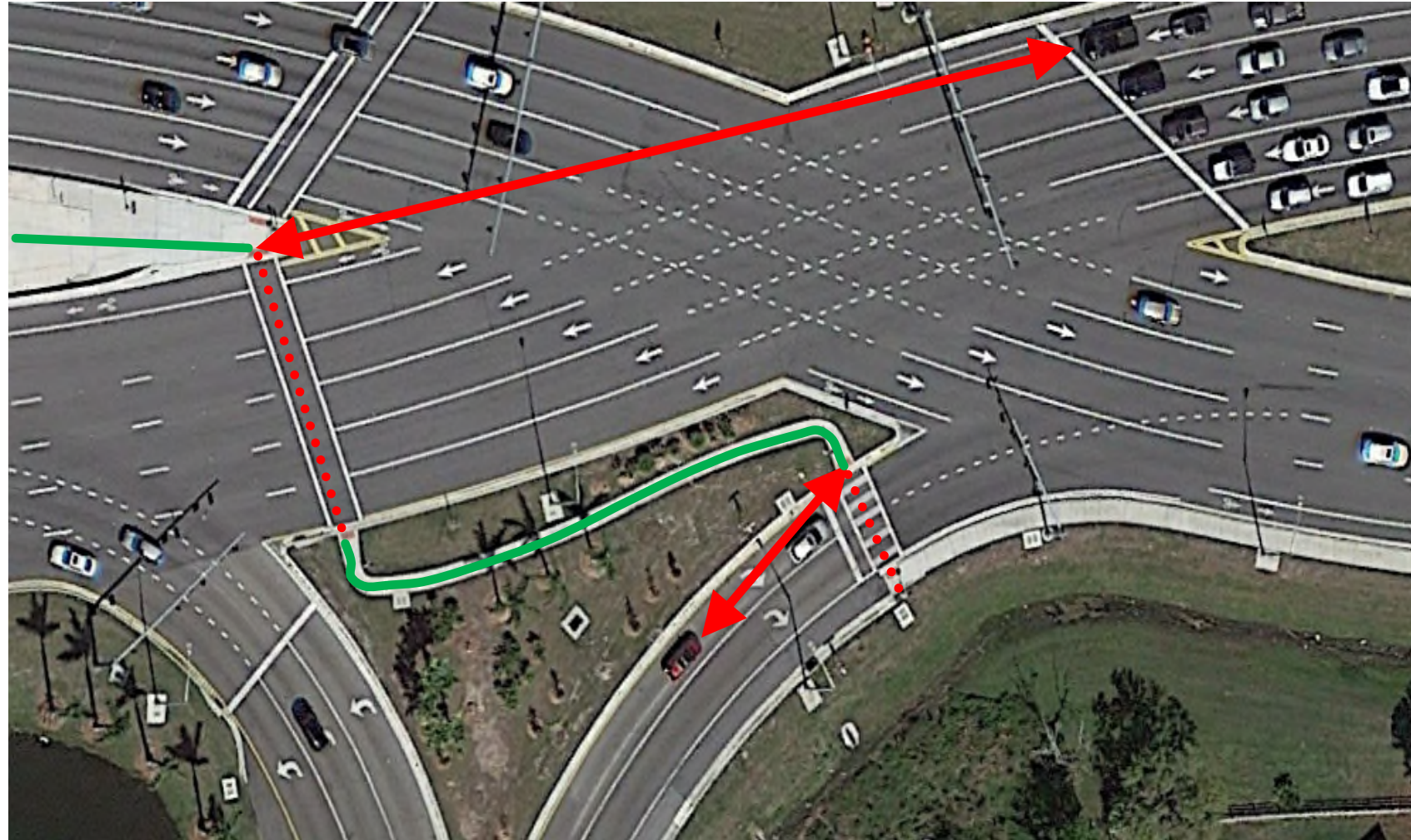
- *Center walkway is preferred in Florida*
- Avoids free-flow left turning movement



Multimodal Accommodations

■ Pedestrian Accommodations

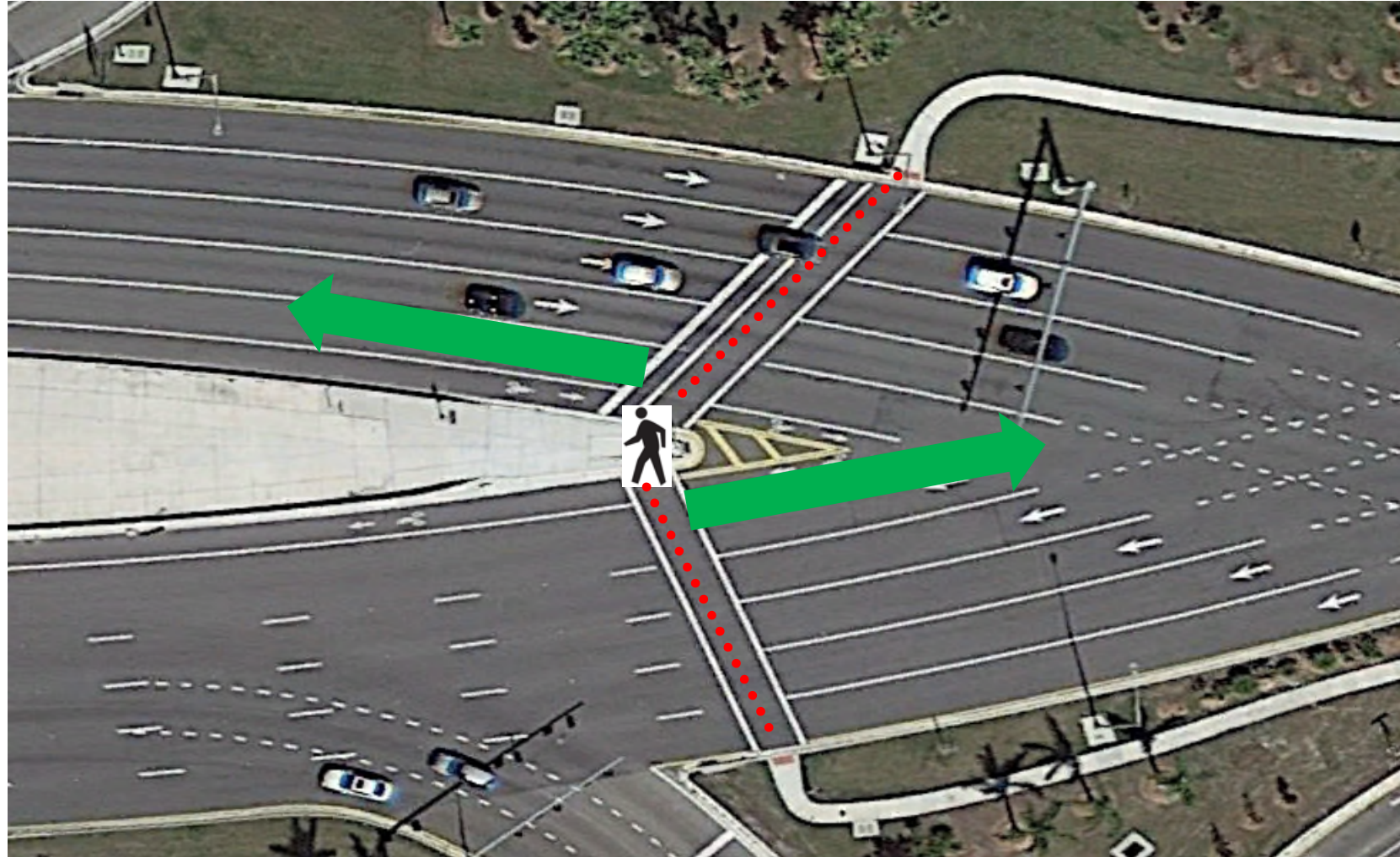
- *Center walkway is preferred in Florida*
 - Avoids free-flow left turning movement
 - Improve line of sight for between pedestrians and drivers



Multimodal Accommodations

■ Pedestrian Accommodations

- *Center walkway is preferred in Florida*
 - Avoids free-flow left turning movement
 - Improve line of sight for between pedestrians and drivers
- Cross at signalized crossover intersection consistent with expectations
 - pedestrians looking left first



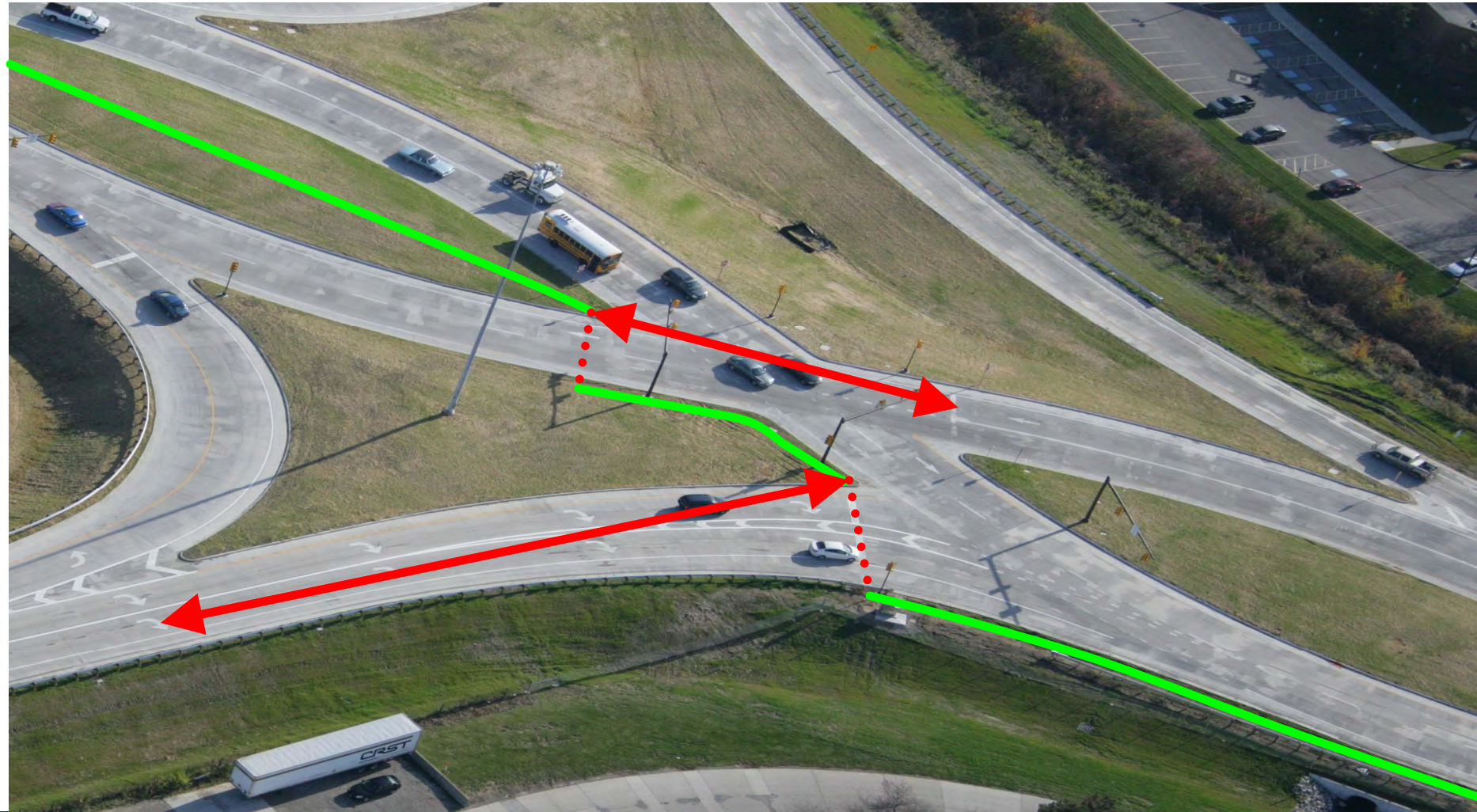
Multimodal Accommodations

- **Pedestrians – Outside**
 - Provide clear line of sight at all crossings, especially free-flow crossings



Multimodal Accommodations

- Provide adequate sight distance of the pedestrian crossings



Multimodal Accommodations

- Signaling the right turns provides pedestrian signal heads so they know when to cross



Multimodal Accommodations

- **Pedestrians – Outside**
 - Provide clear line of sight at all crossings, especially free-flow crossings



Multimodal Accommodations

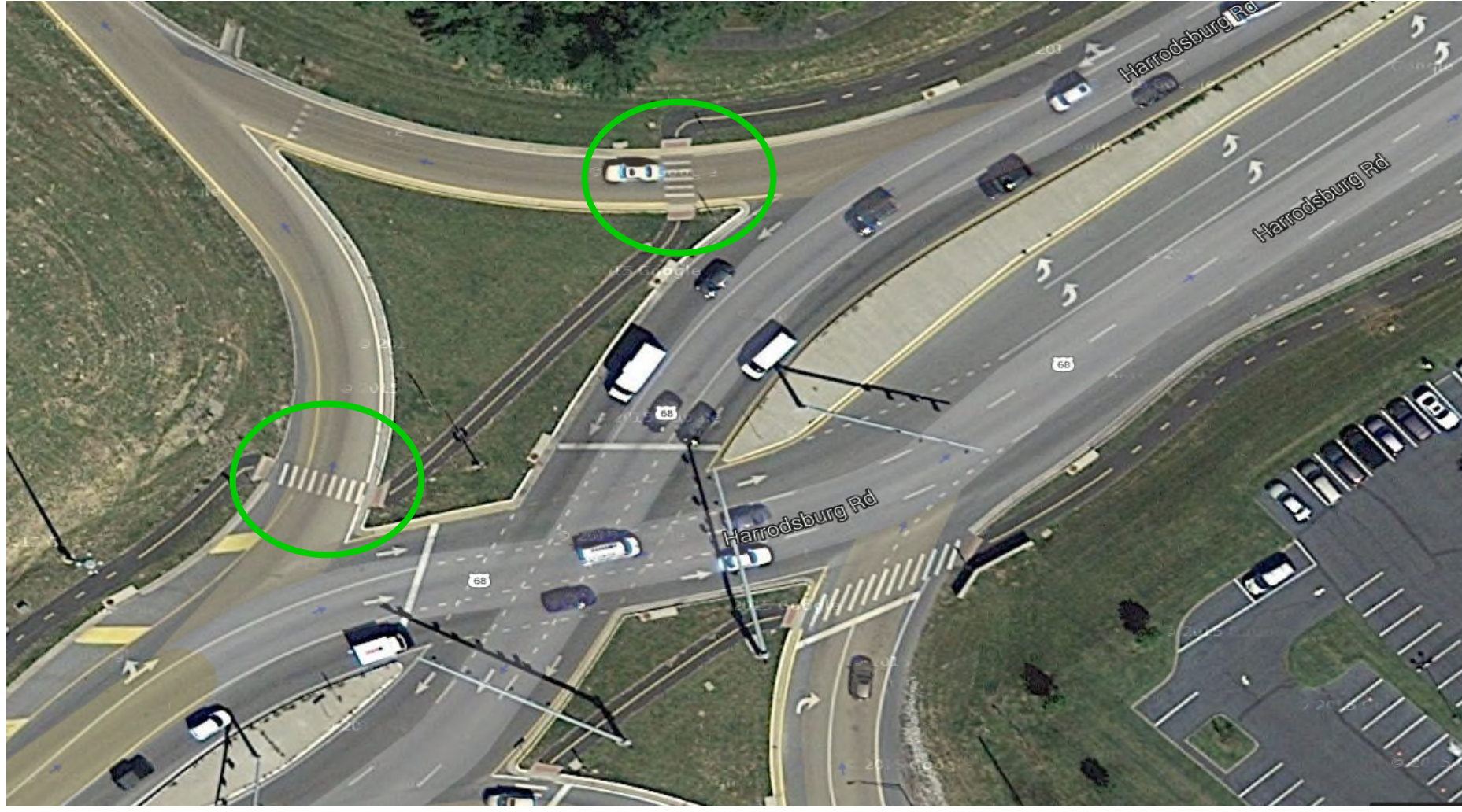
- **Pedestrians – Outside**
 - Provide clear line of sight at all crossings, especially free-flow crossings
 - Perpendicular crossings



Multimodal Accommodations

■ Pedestrians – Outside

- Provide clear line of sight at all crossings, especially free-flow crossings
- Perpendicular crossings
- Position the crossings close to the arterial to reduce high-speed conflicts



Multimodal Accommodations

■ Bicyclists

- 3 possible treatments at a DDI
 - Separated bicycle lanes or shared use paths
 - Marked bicycle lanes
 - Bicyclists share the driving lanes with vehicular traffic
 - This treatment should be used only in very low-speed conditions



Multimodal Accommodations

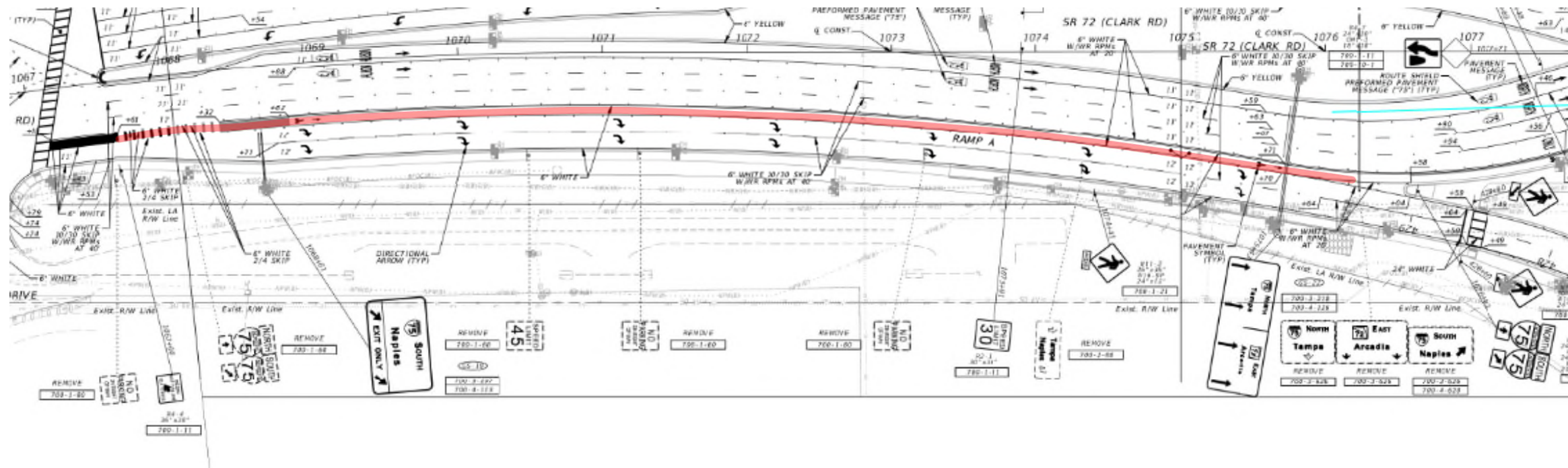
■ Bicyclists

- Keep to the right of the right-most travel lane
- Will position the bicyclist on the “inside of the roadway” across the freeway but still are to the right of the driver



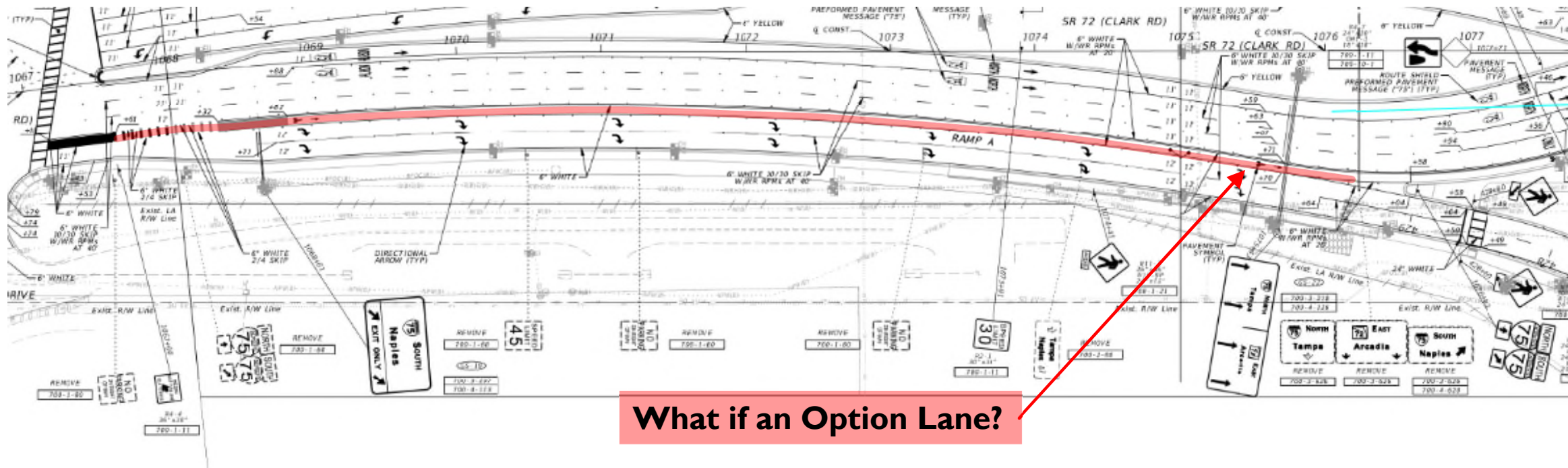
Multimodal Accommodations

- **Bicyclists**
 - Avoid lengthy “key holed” bicyclists if possible



Multimodal Accommodations

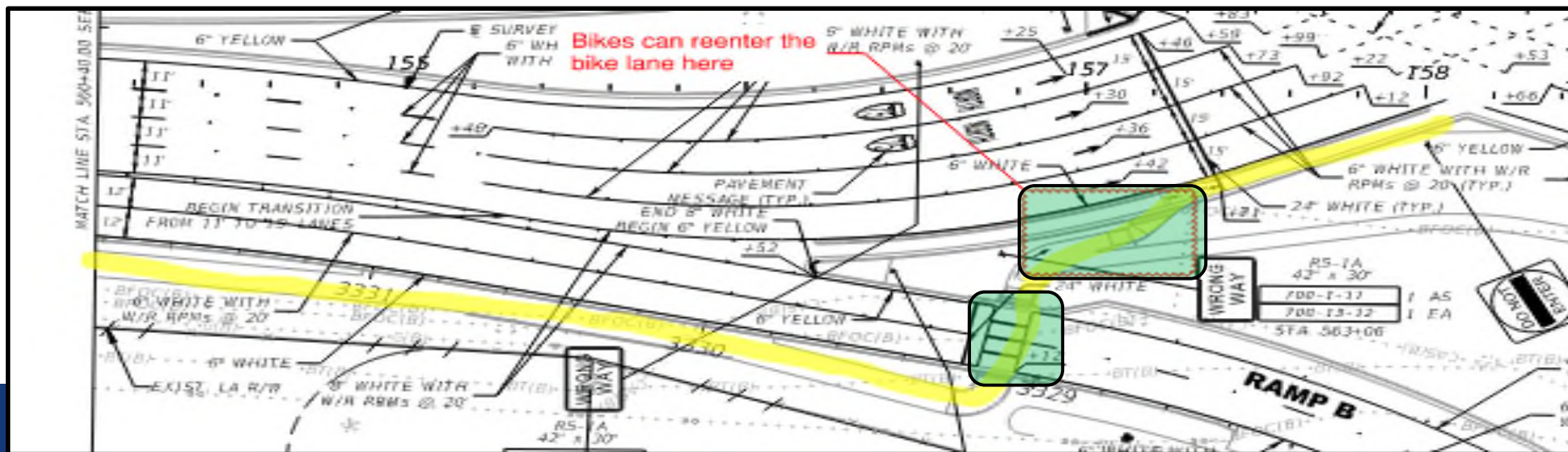
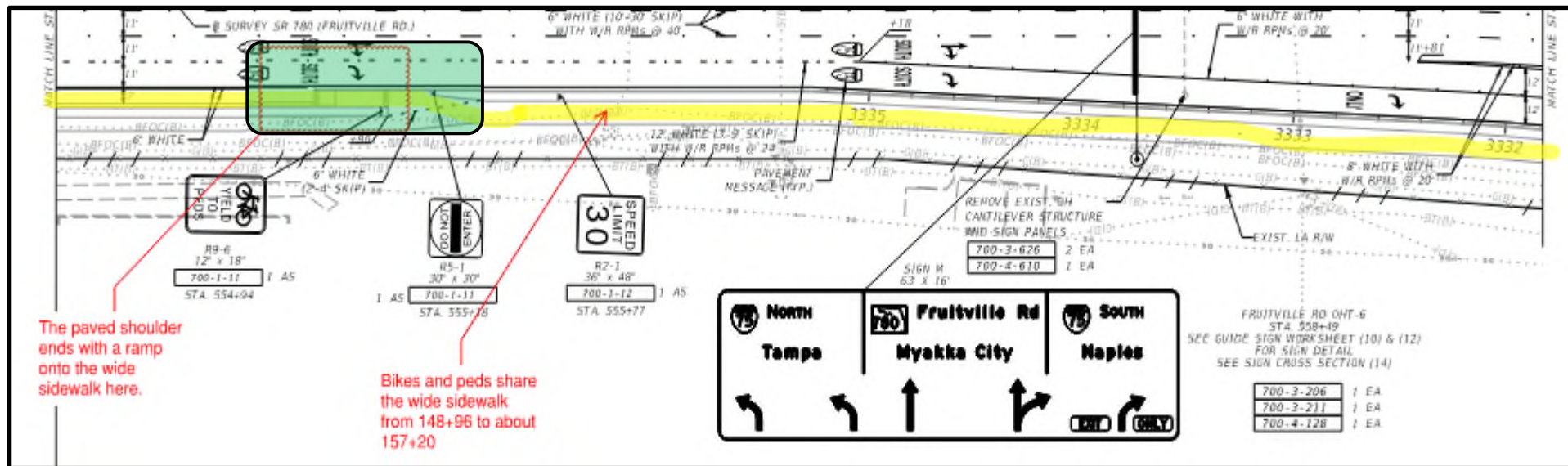
- **Bicyclists**
 - Or option lanes where bicyclists are unclear where drivers are going



Multimodal Accommodations

■ Bicyclists

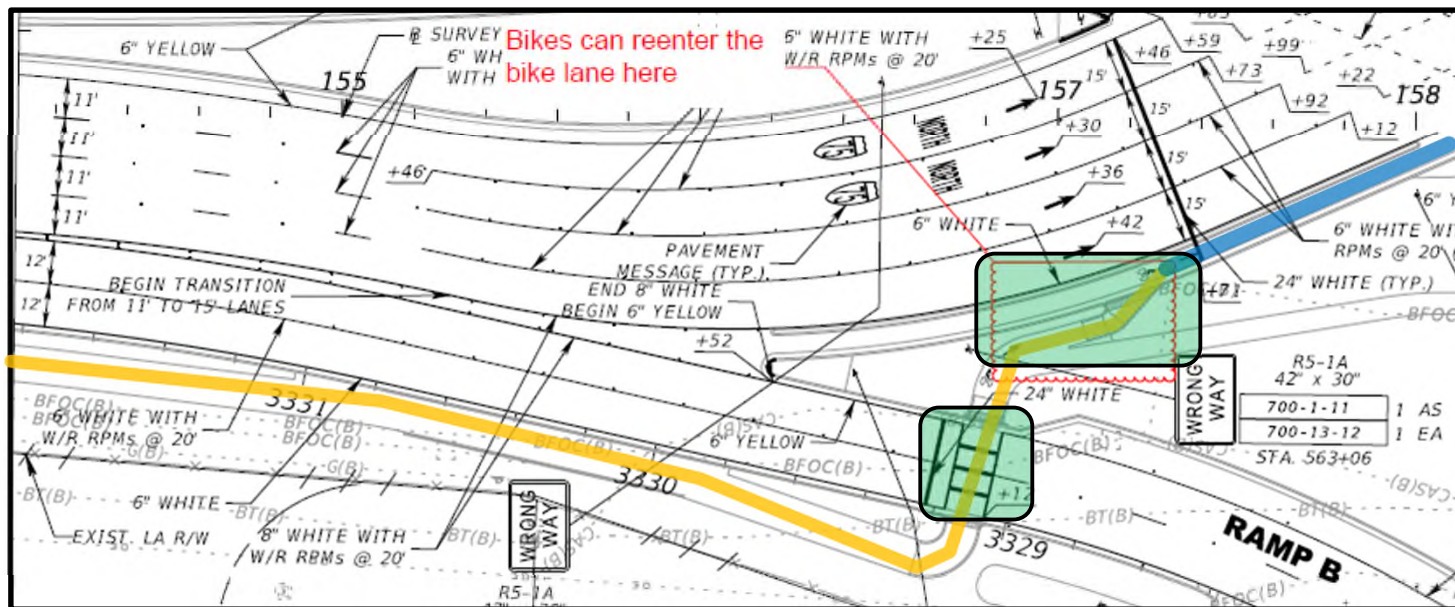
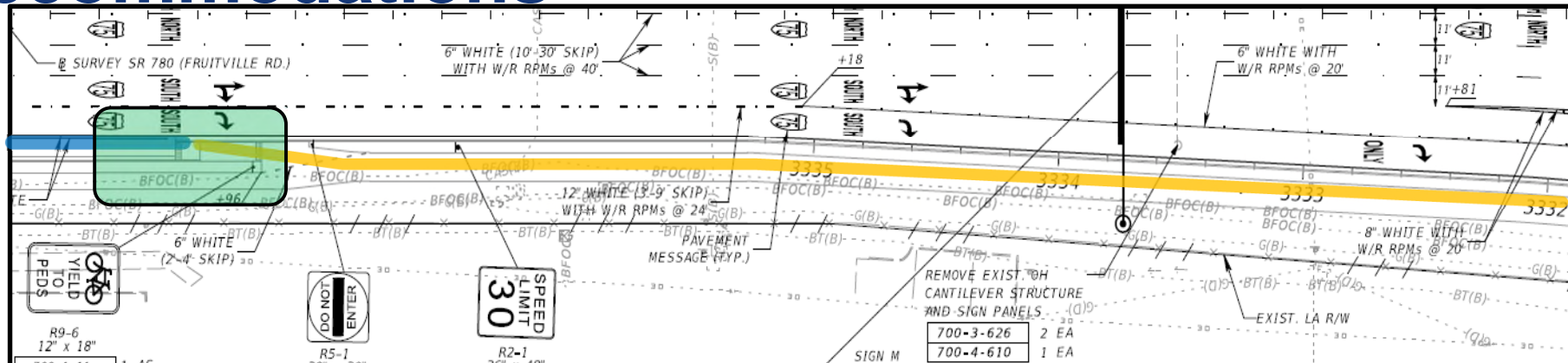
- If the “key hole” occurs, one option is to shift them to a wider sidewalk along the outside
- Cross the free-flow ramp with the pedestrians
- Then re-enter the bike lane prior to the crossover



Multimodal Accommodations

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Multimodal Accommodations

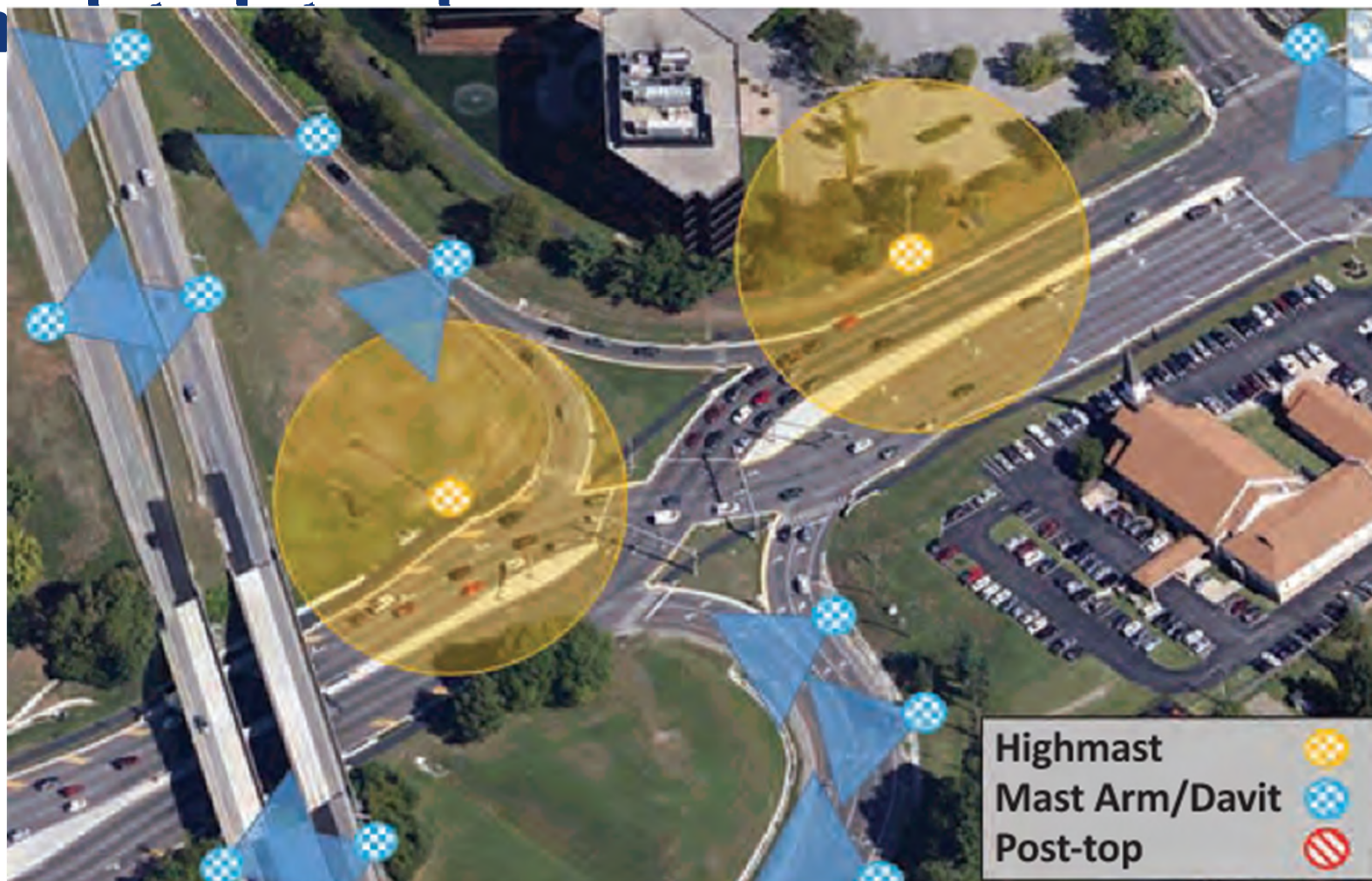




DDI Lighting

DDI Lighting – Conventional

- High mast, conventional poles, or combination
- Primary focus on conflict areas, merge/diverge areas, and raised objects
- Give uniformity and reduction of glare additional attention



DDI Lighting – Pedestrian Lighting

- Position of light poles to front light pedestrians
- Consider fixture with forward throw for median pedestrian path

