



INTERCHANGES

Module 7

Learning Outcomes

7-2

- At the end of this module, you will be able to:
- Identify how land uses around freeway interchanges create pedestrian trips
- Explain how and why pedestrian crashes occur at interchanges (driver expectation of pedestrians is very low; high-speed, free-flow movements)
- Select slow-speed, right-angle urban designs

Land Use, Vehicles and Pedestrians

7-3

Medford OR

- Large commercial tracts generate traffic
- Employees walk to jobs at retailers, restaurants, service stations, & hotels
- Visitors walk to and from restaurants and hotels
- Pedestrians must cope with vehicles entering and exiting the freeway

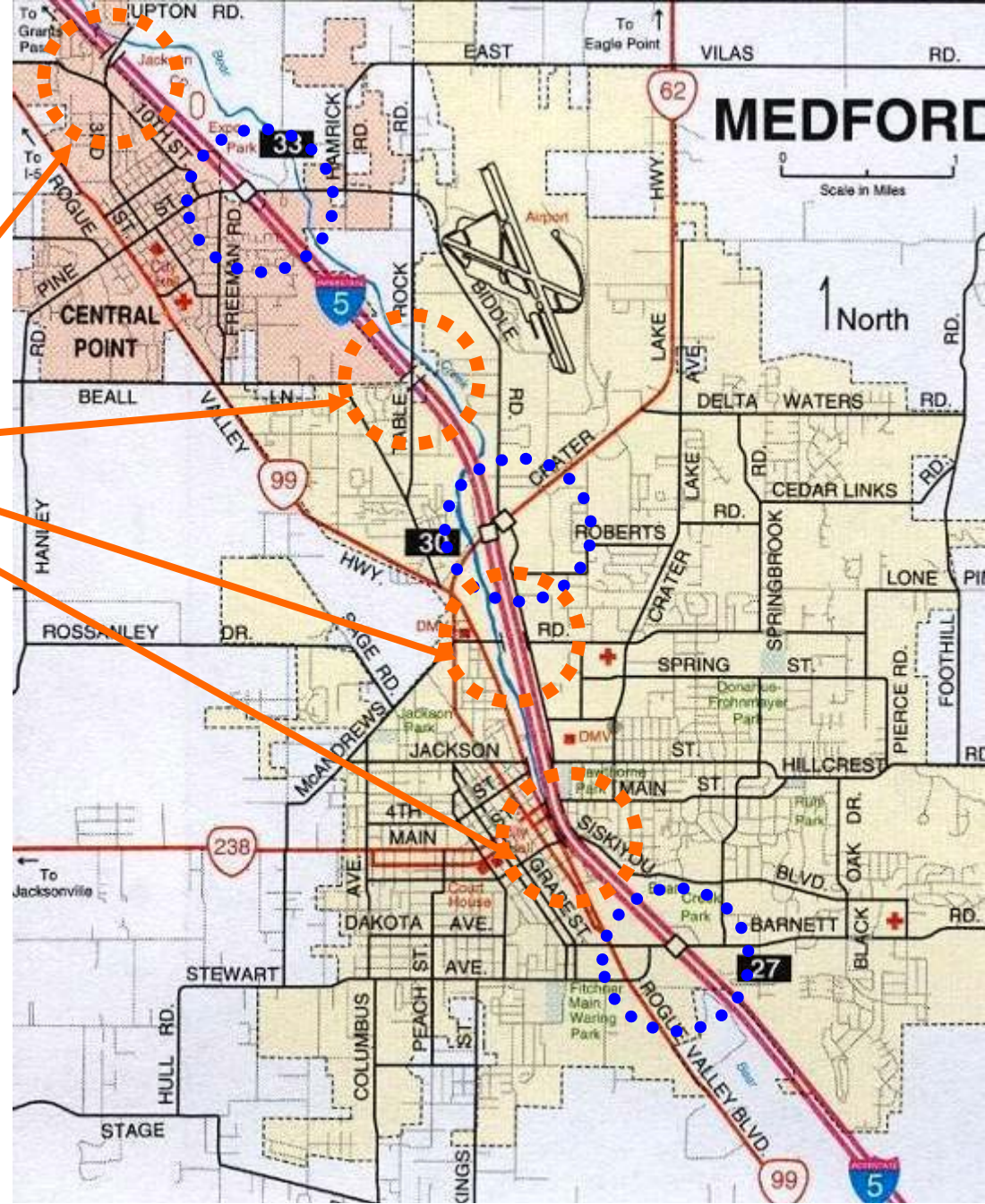


Typical city has a few freeway interchanges

And some non-interchange crossings

Non-interchange crossings are easier for pedestrians

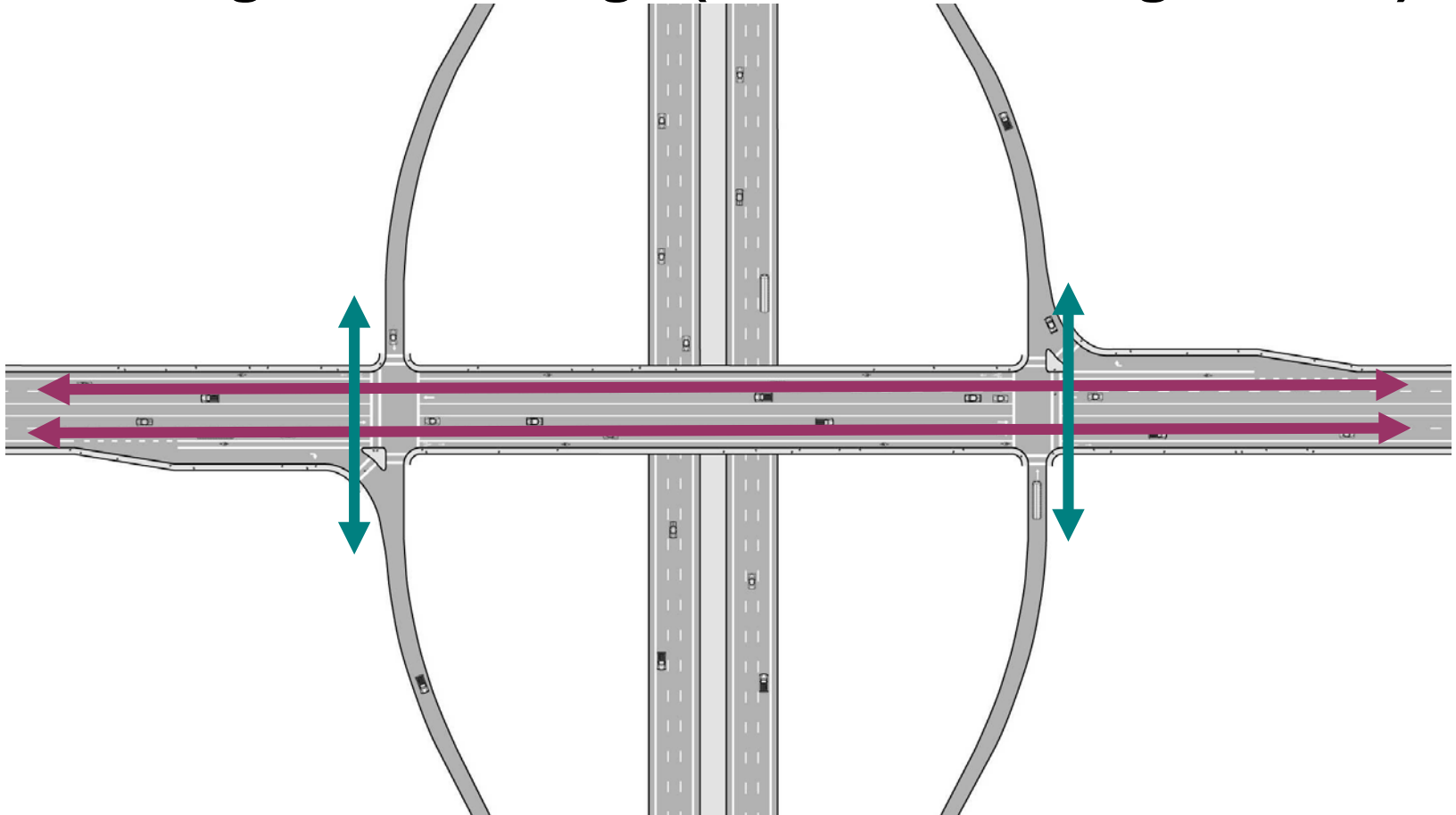
Interchanges have many conflicts



Accommodate all pedestrian movements

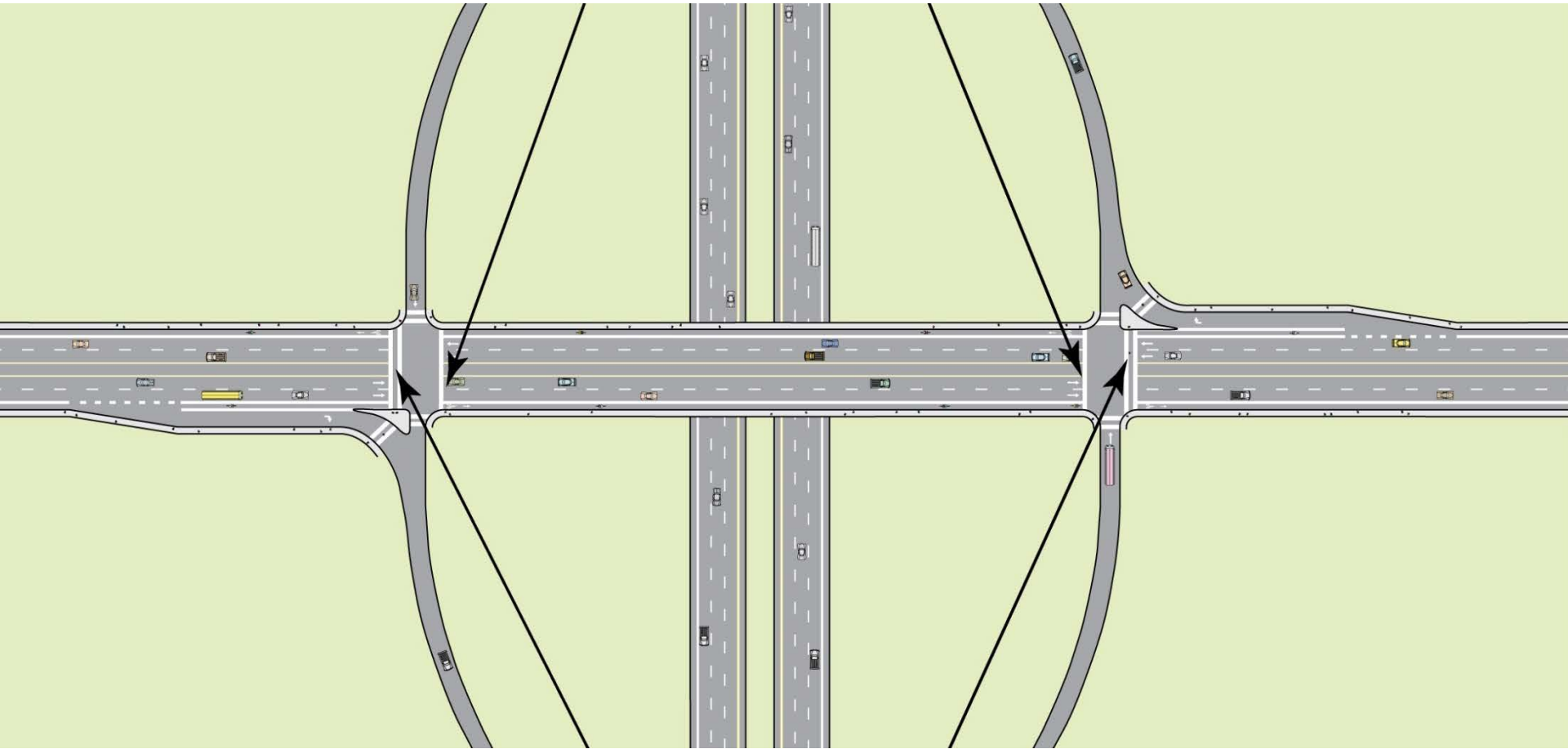
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1. Through interchange (east-west along arterial)



2. Across the arterial (north-south)

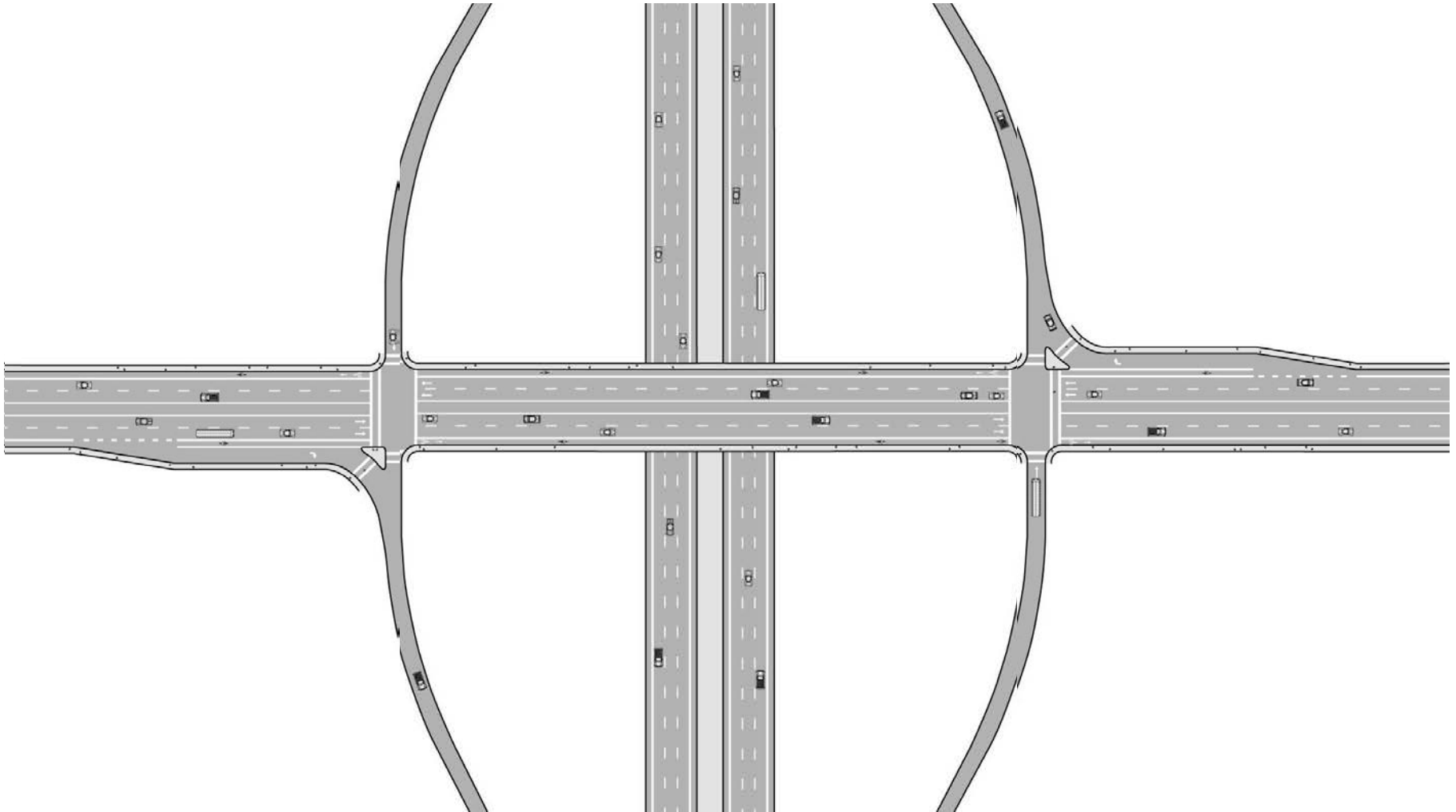
These inside crosswalks may be closed



These crosswalks must be open

Interchange then becomes a Large Intersections

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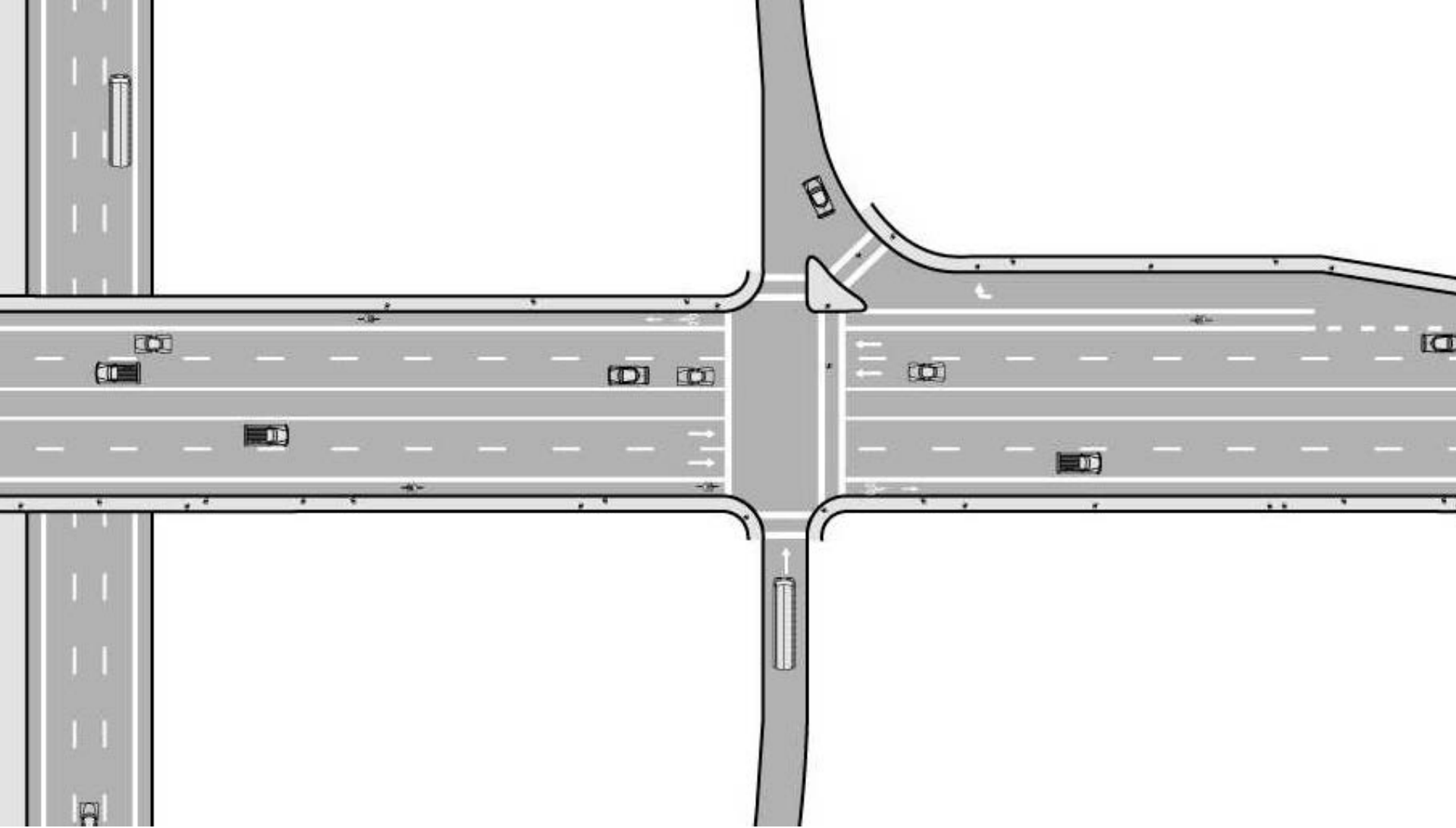




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Baker City OR

- Design interchanges to look like an intersection, then drivers are more likely to expect pedestrians



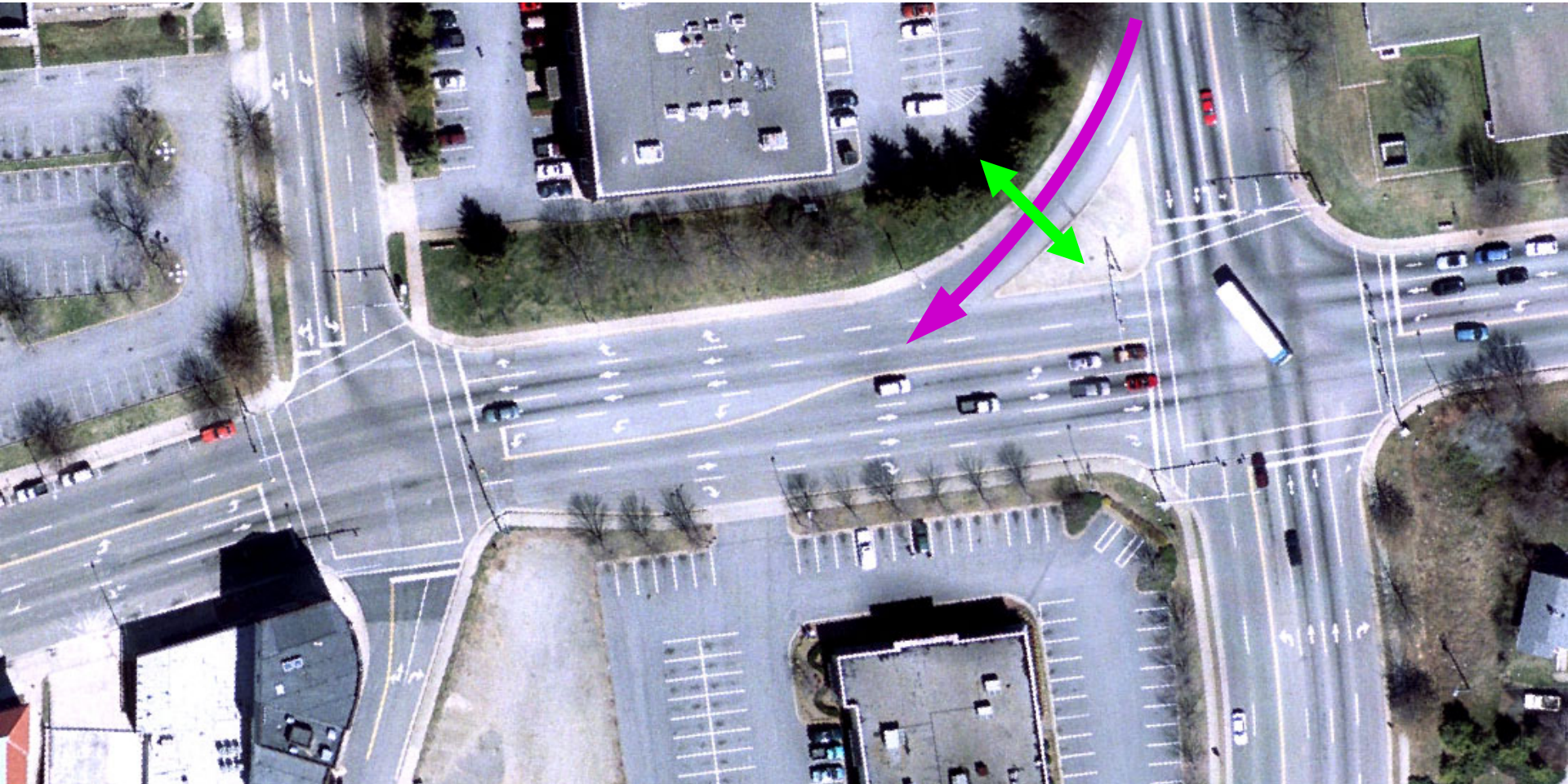
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Consider each terminus as $\frac{1}{2}$ an urban intersection

Avoid free-flow movements...

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Asheville NC



... they are difficult for pedestrians to cross

Positive Example: Reconfigured Ramp Terminus

7-11

Springfield OR

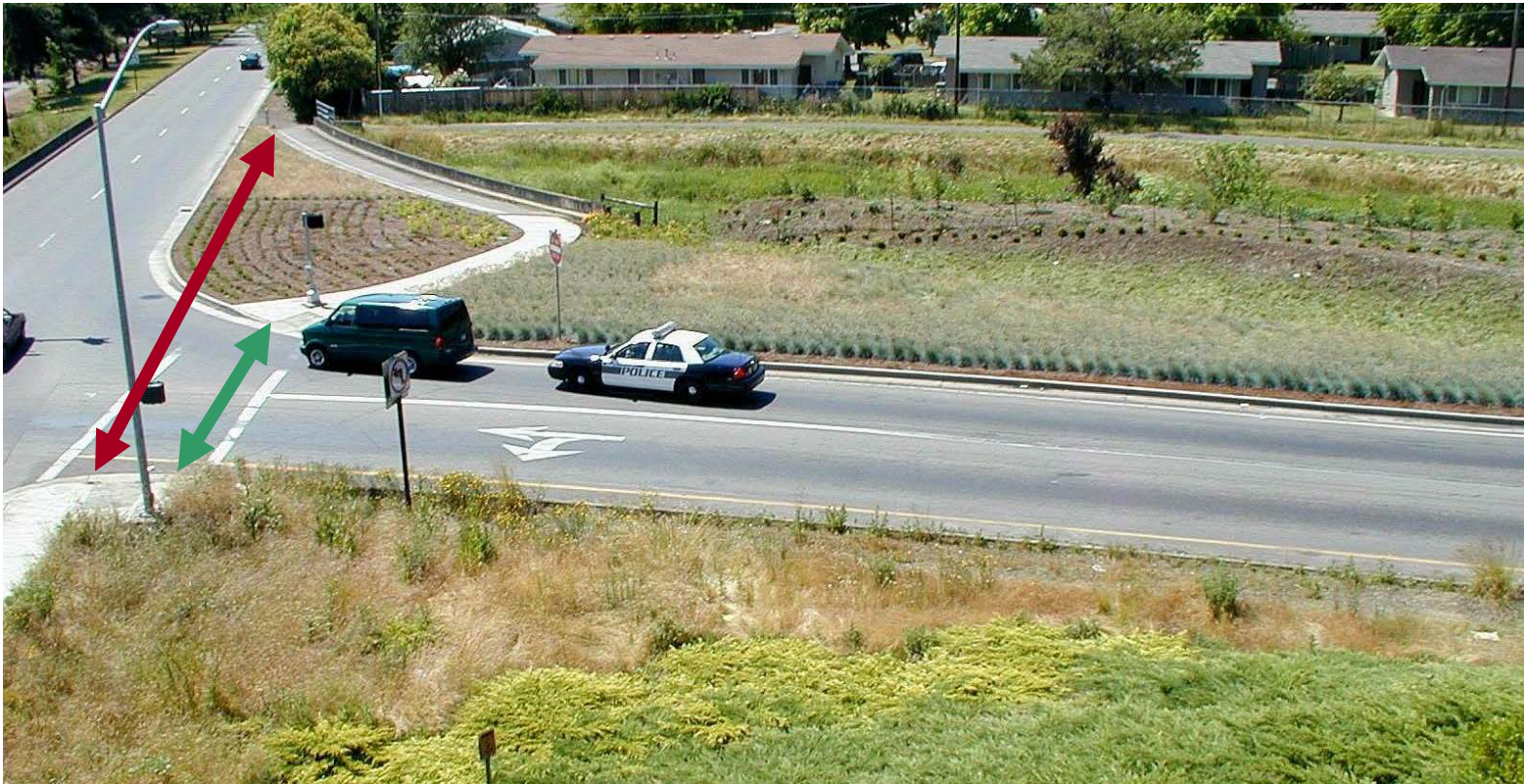


- Flat angle = wide crossing & high-speed turns
- Tight angle = short crossing & slow speed turns

Positive Example: Reconfigured Ramp Terminus

7-12

Springfield OR



- Red line = old crosswalk
- Green line = new crosswalk

Where free-flow ramps exist, good crosswalk placement is critical

7-13

- Reminder from geometry module – crosswalk placement requires balancing goals:
- Shortest crosswalk length
- Minimal crosswalk setback to:
 - Reduce out-of-direction travel
 - Provide good sight lines between peds and motorists
- Proper ramp placement



7-14 Salem OR

- Where free-flow ramps are used (least desirable)
Crosswalk should be placed where it's visible



7-15

Salem OR

Barrier should not obscure crosswalk

Crosswalk Placement

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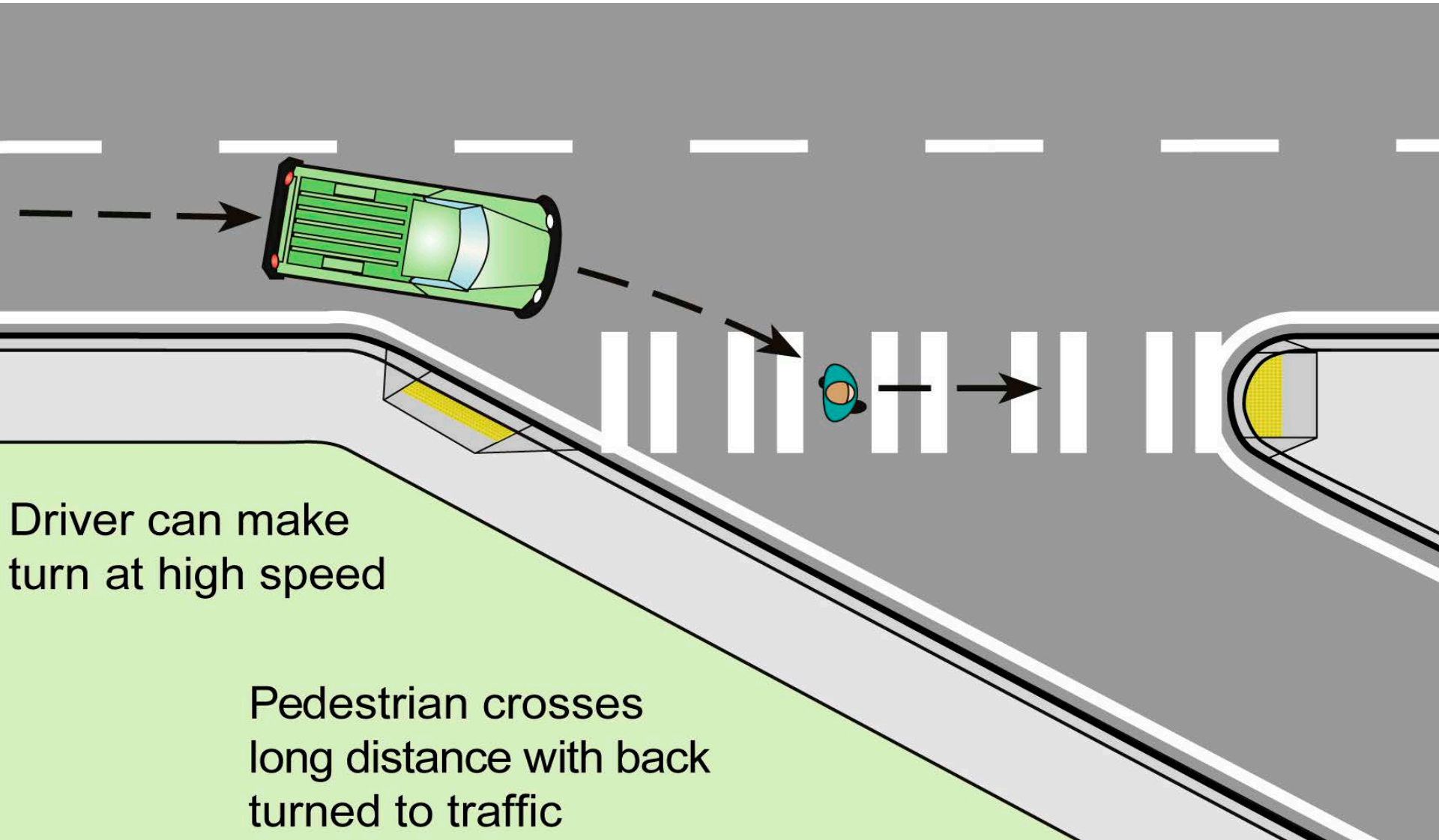
Choosing the best crosswalk placement where it's not clear what's most logical for the driver or the pedestrian:

3 choices:

- Most direct route
- Shortest crosswalk
- “Compromise” - midway solution

Most Direct Route

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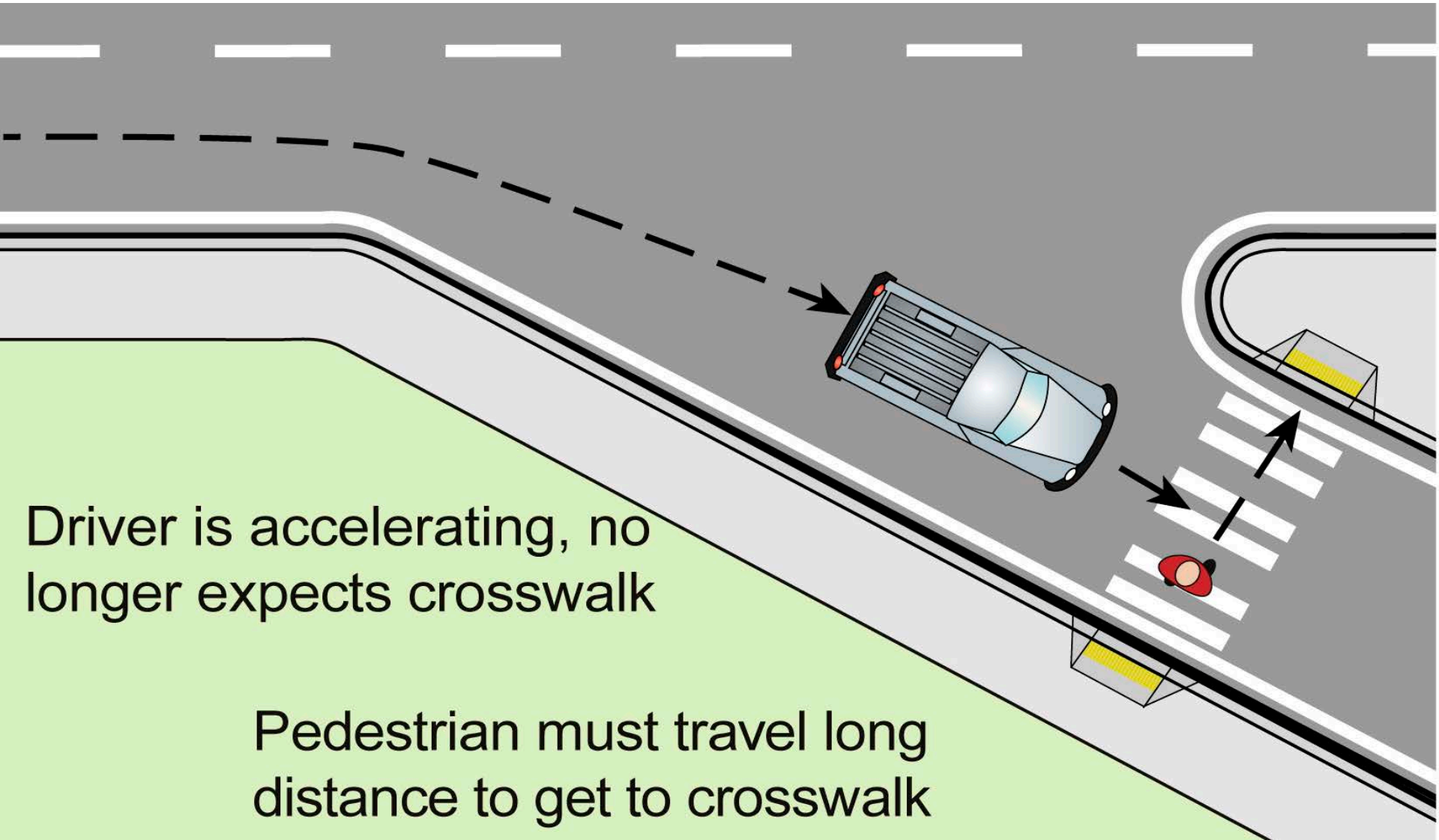


Driver can make
turn at high speed

Pedestrian crosses
long distance with back
turned to traffic

Shortest Crosswalk

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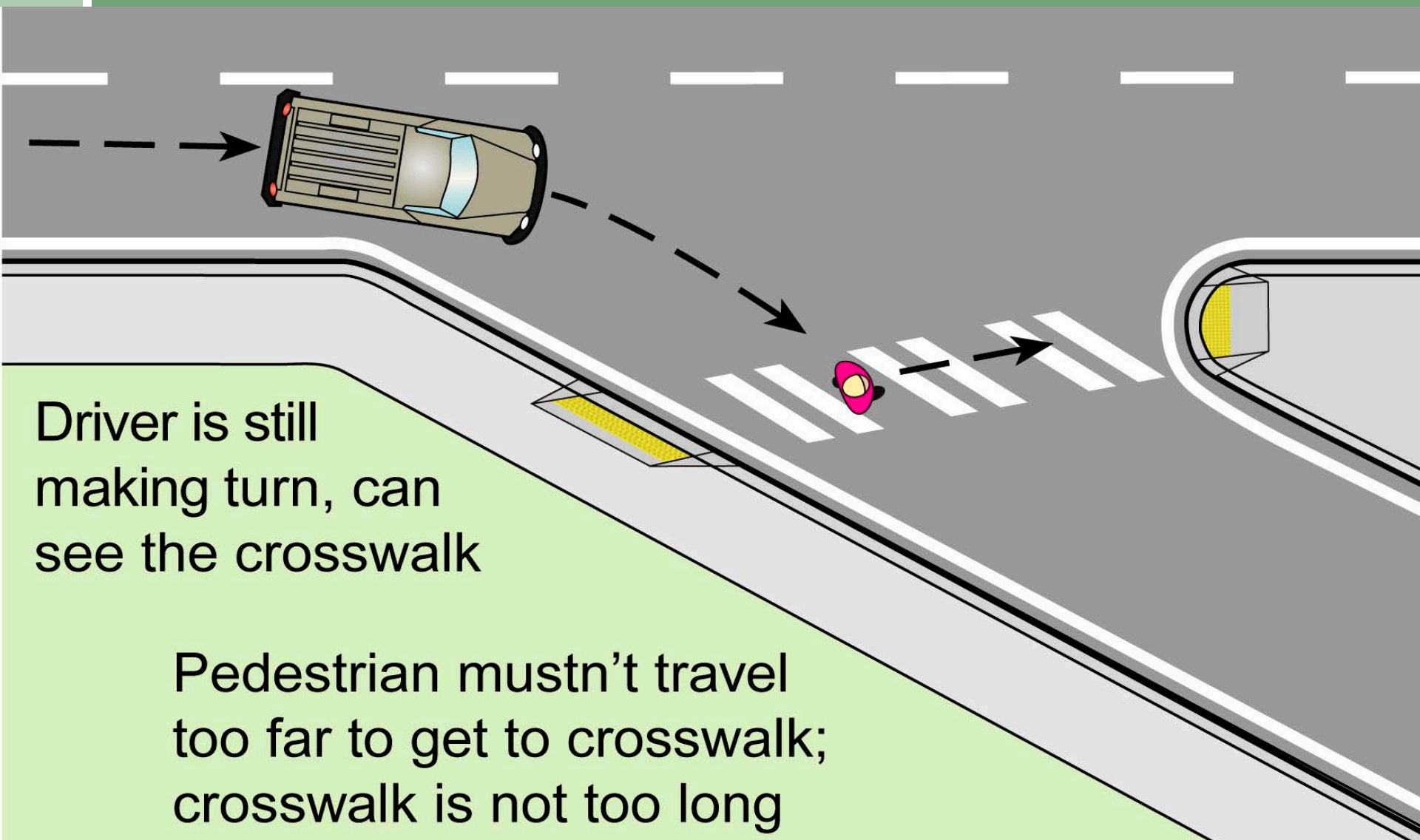


Driver is accelerating, no longer expects crosswalk

Pedestrian must travel long distance to get to crosswalk

Midway Solution – Balances Goals

7-19



Driver is still making turn, can see the crosswalk

Pedestrian mustn't travel too far to get to crosswalk; crosswalk is not too long



Where to place crosswalk?

Observe pedestrians

7-20

Washington DC

- ❑ Younger woman takes direct route (*looks over shoulder*)
- ❑ Older man seeks crosswalk
- ❑ Midway would be used by both
- ❑ **YIELD TO PED** signs indicate a problem

Select An Interchange

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- Single Point Urban Interchange (SPUI)
- Diverging Diamond Interchange (DDI)
- Restricted Crossing U-Turn (RCUT)
- Median U-Turns
- Displaced Left Turn

7-22

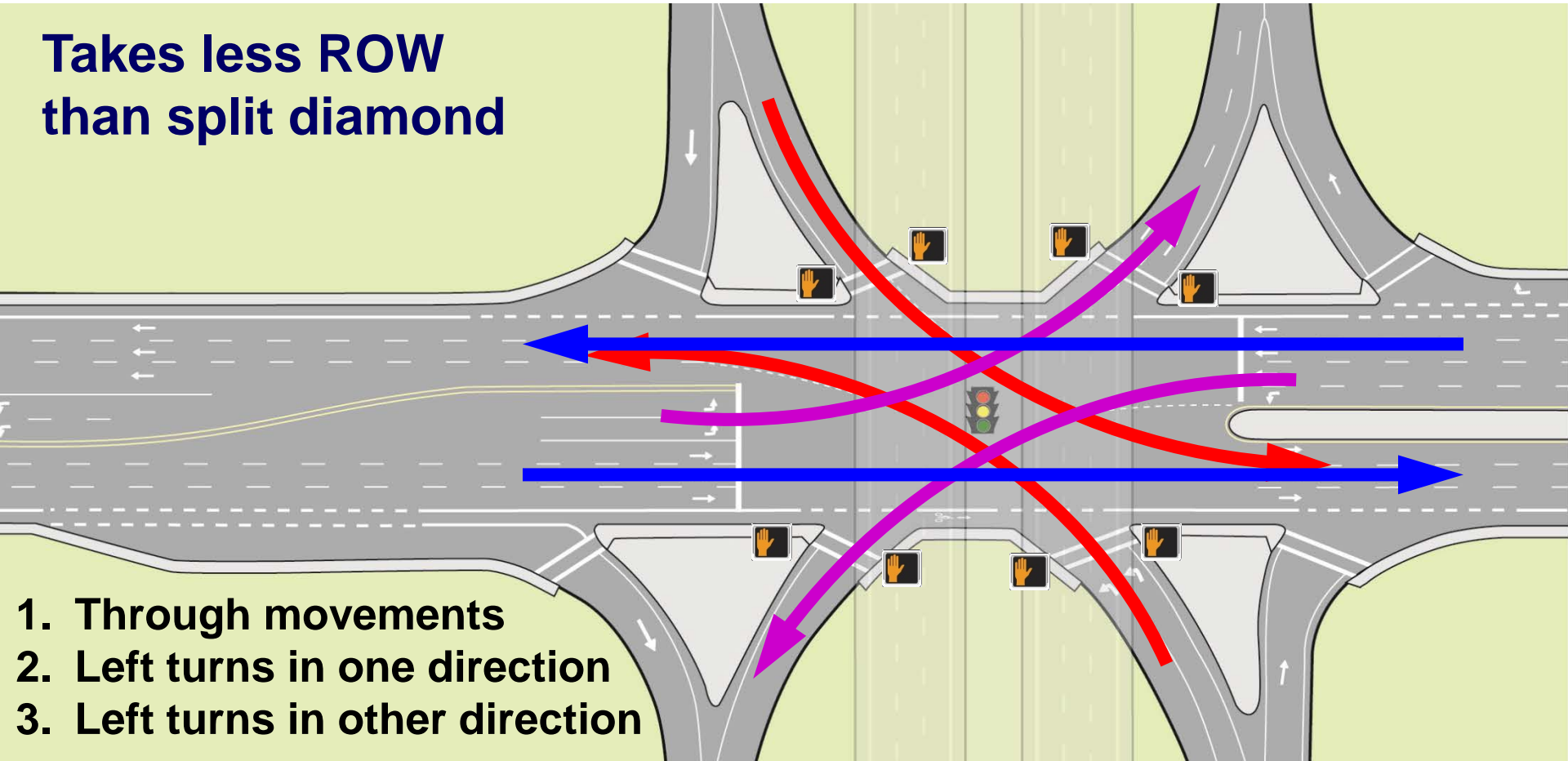
Single Point Urban Interchange (SPUI)



Single Point Urban Interchange

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**Takes less ROW
than split diamond**



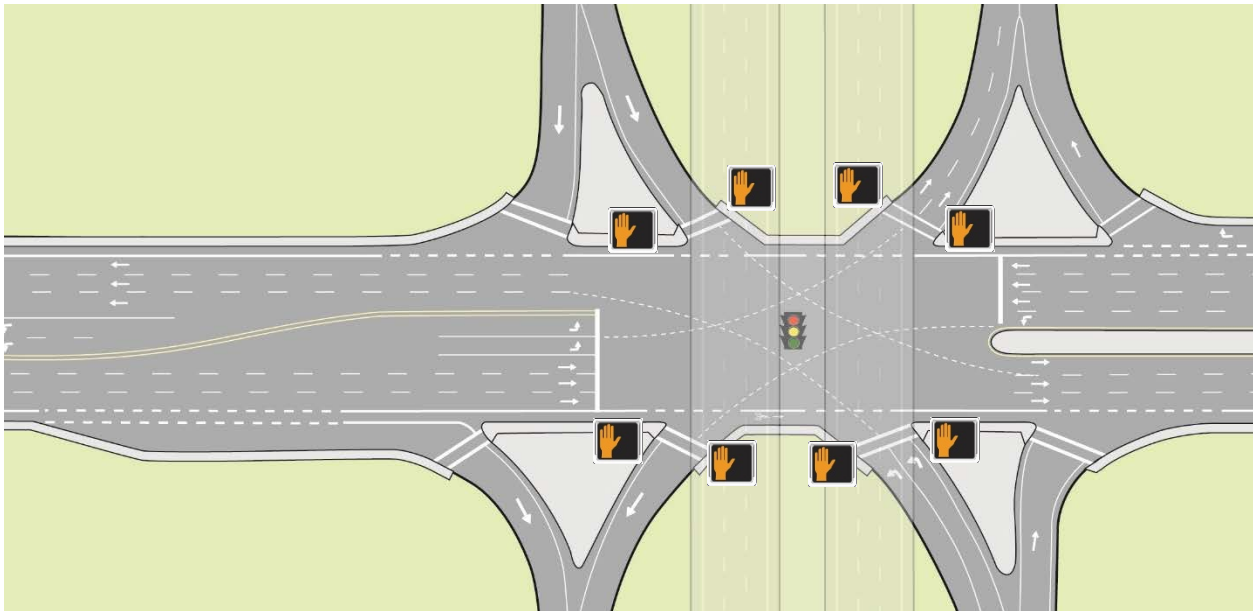
- 1. Through movements**
- 2. Left turns in one direction**
- 3. Left turns in other direction**

Signal timing; 3 movements are run through one signal

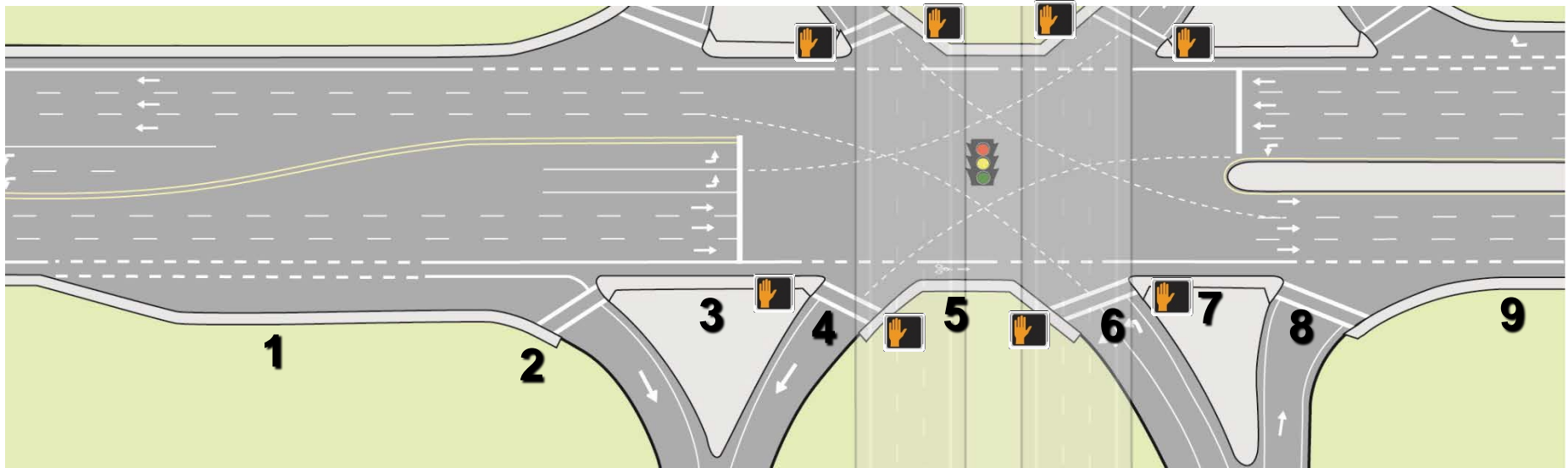
How to make SPUI work for pedestrians:

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- Provide continuous sidewalks
- Break up crossings into several small steps
- Use good geometry; create tight, right-angle crossings;
- Make it clear to drivers where to expect pedestrians

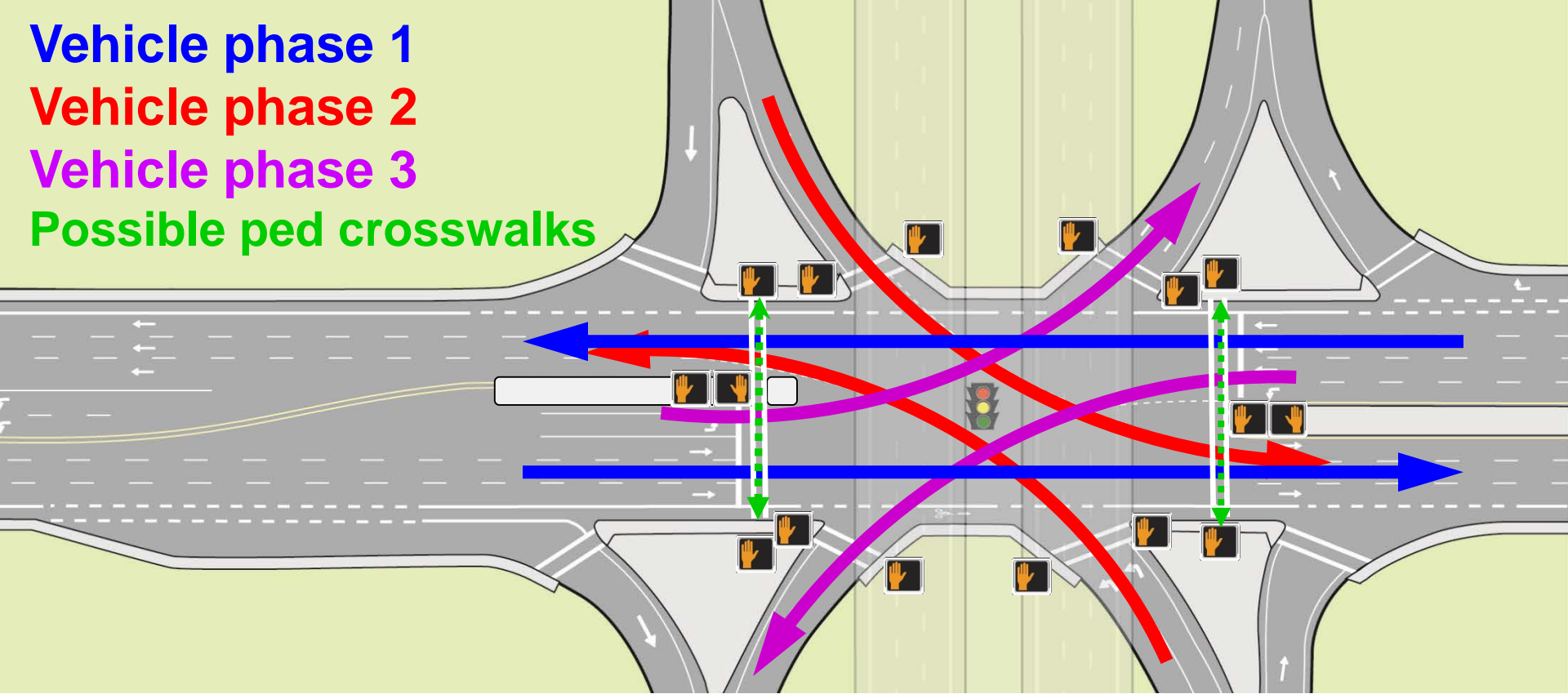


SPUI Pedestrian crossing sequence:



1. Ped walks next to well defined right-turn lane (RTL)
2. Ped crosses RTL at a point with good visibility; drivers yield to peds
3. Ped proceeds on island
4. Ped crosses entry lane; signal controlled
5. Ped proceeds on sidewalk on or under bridge
6. Ped crosses exit lane; signal controlled
7. Ped proceeds on island
8. Ped crosses exit lane; stop controlled; drivers yield to peds
9. Ped continues on his merry way

Vehicle phase 1
Vehicle phase 2
Vehicle phase 3
Possible ped crosswalks



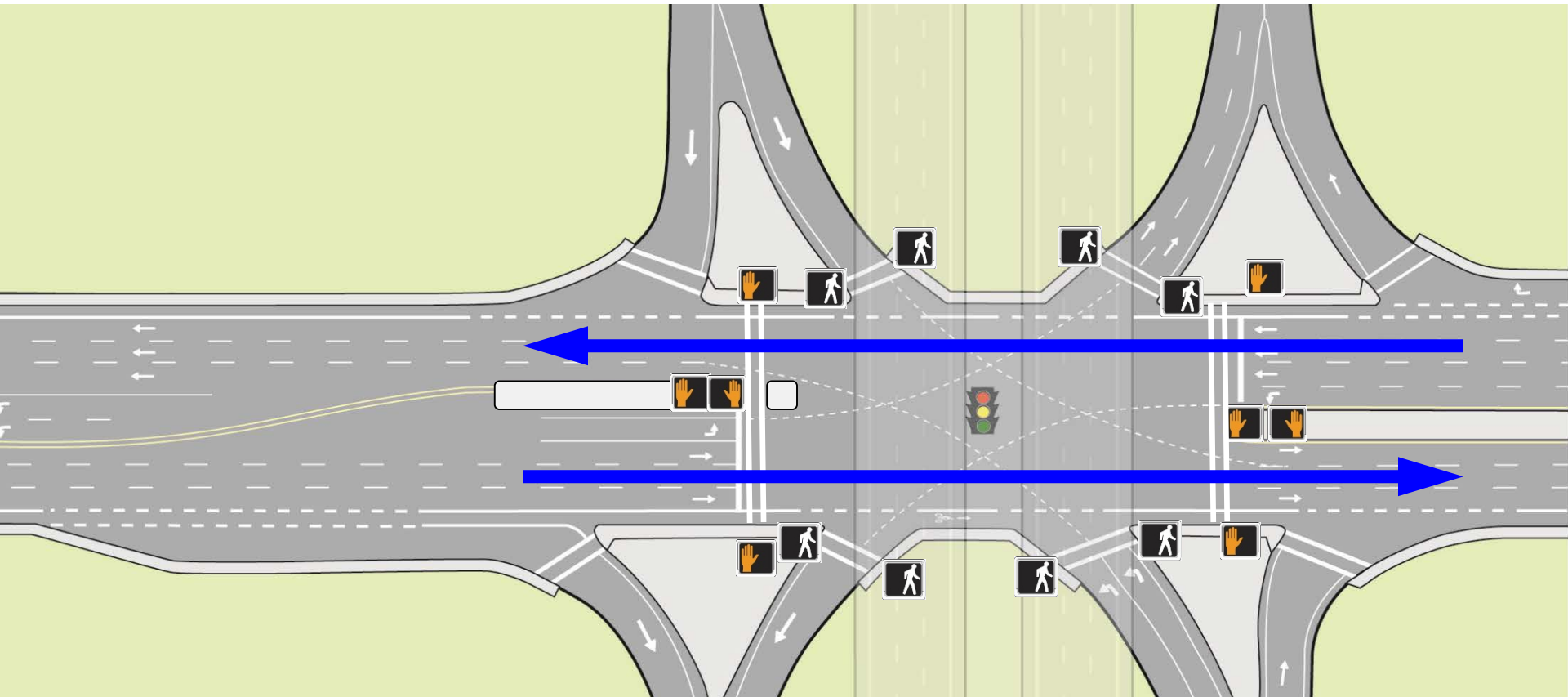
With most SPUIs there is never a phase when pedestrians can cross the urban arterial without conflict

Solution 1: Two-step crossing (one step during vehicle phase 2 and the other during vehicle phase 3) NOTE: requires median refuge & Ped Signals

Solution 2: Nearby midblock signalized ped crossing, or nearby signalized intersection with crosswalks

Getting Pedestrians Across a SPUI

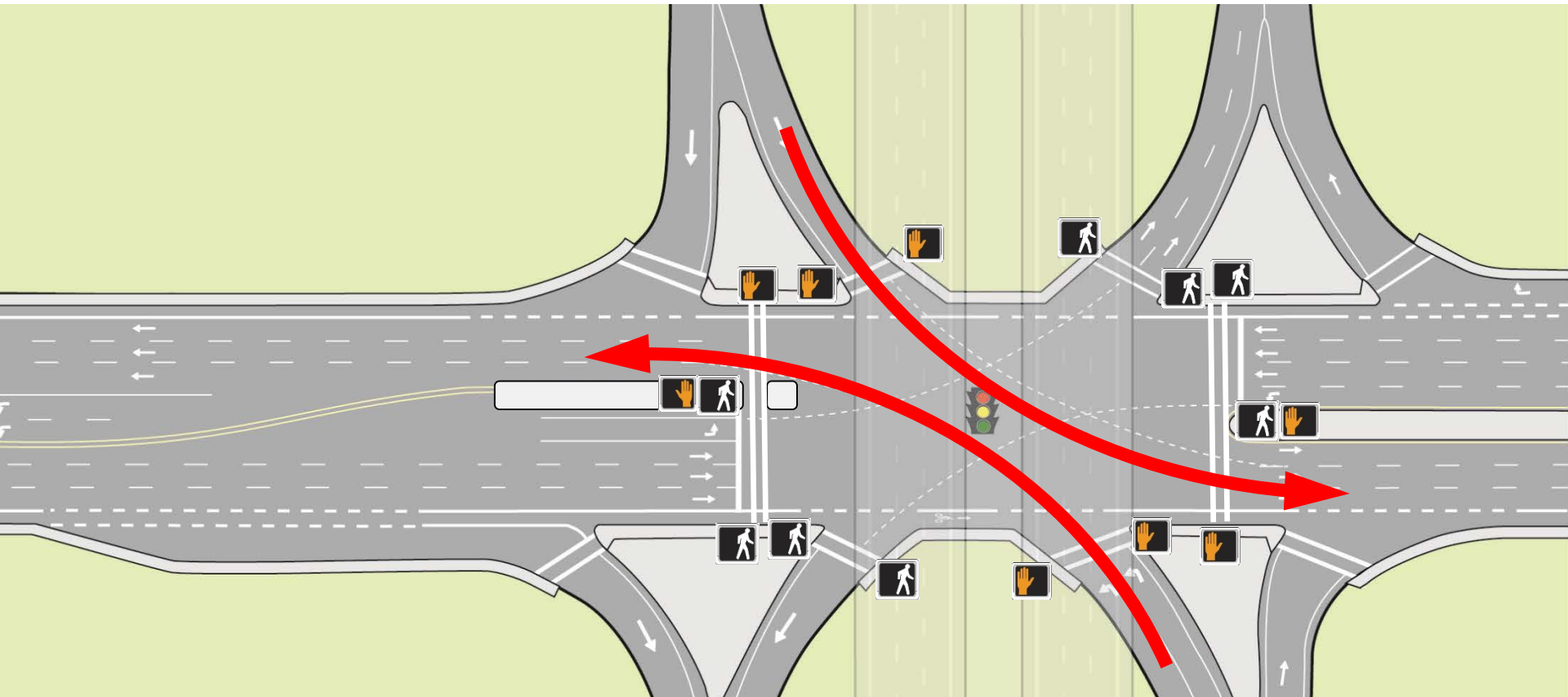
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Vehicle phase 1

Getting Pedestrians Across a SPUI

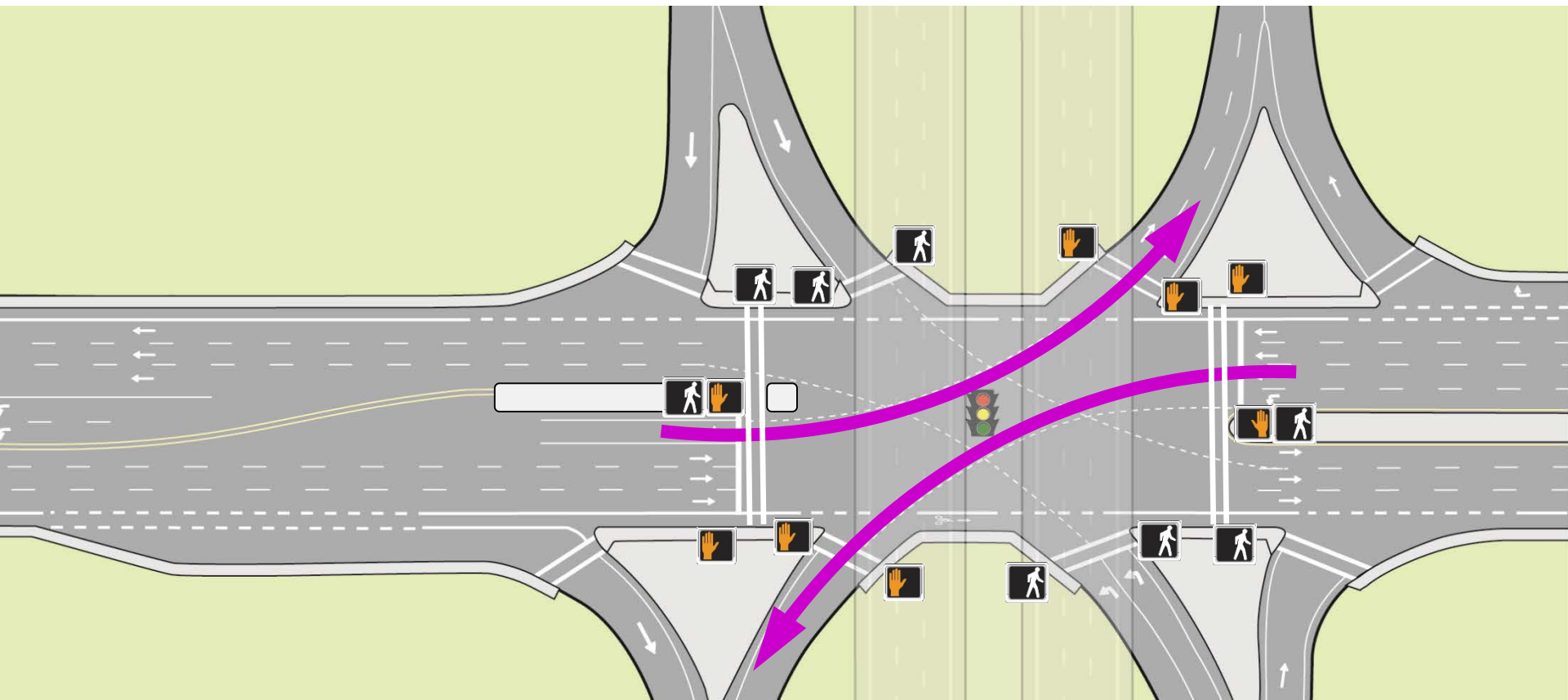
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Vehicle phase 2

Getting Pedestrians Across a SPUI

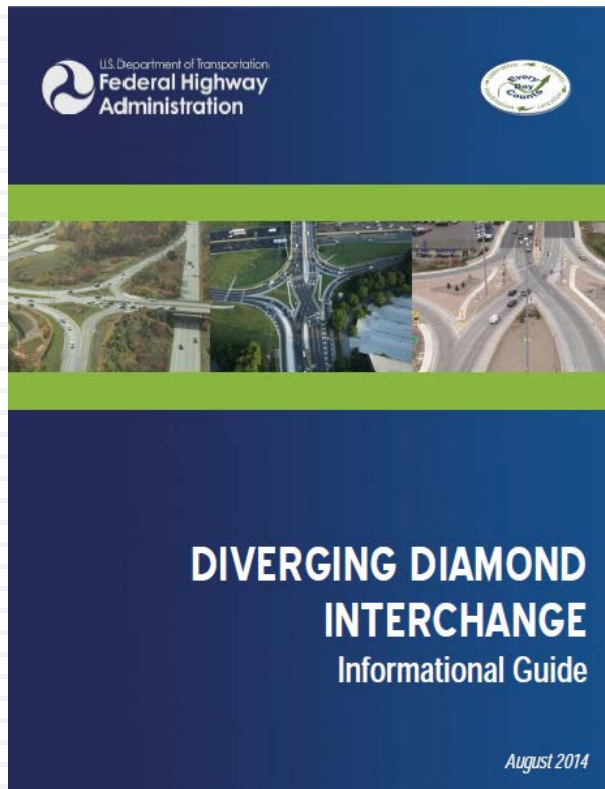
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Vehicle phase 3

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Diverging Diamond



DDI How they work

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DDI and Pedestrians

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Right-of-way availability for multimodal facilities.

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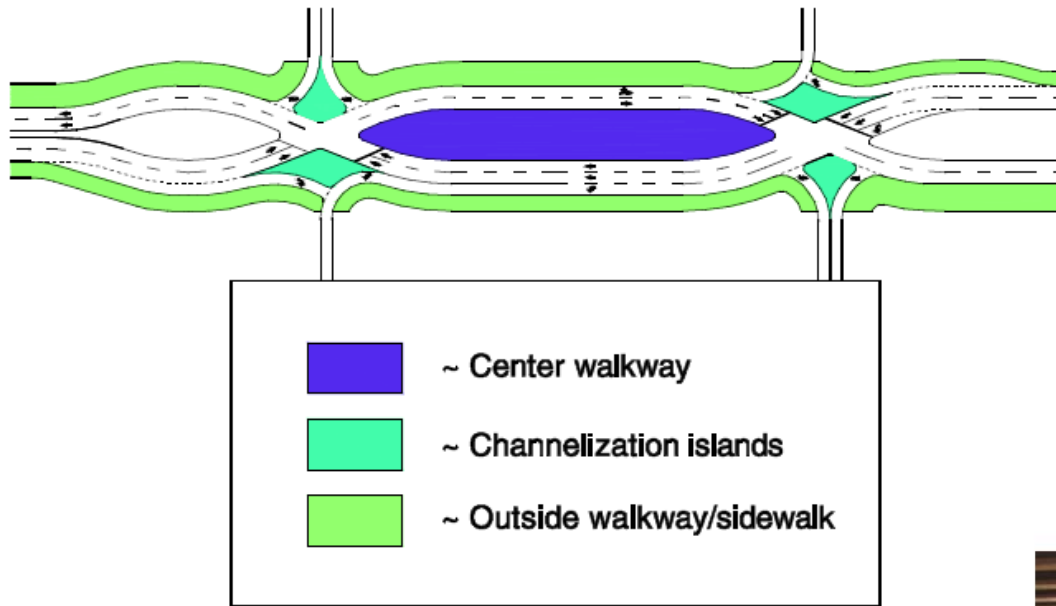


Exhibit 3-2. Center walkway at MO 13 (Springfield, MO).⁽¹⁴⁾



Exhibit 3-3. Outside walkway at Dorsett Road (Maryland Heights, MO).⁽¹⁴⁾

Ped Signal: Center and Outside

7-34



Exhibit 3-5. Pedestrian facilities in center of DDI (Springfield, MO).⁽²⁶⁾



Exhibit 3-6. Pedestrian facilities on outside of DDI (Maryland Heights, MO).⁽²⁶⁾

Crosswalk Placement: Center vs. Outside

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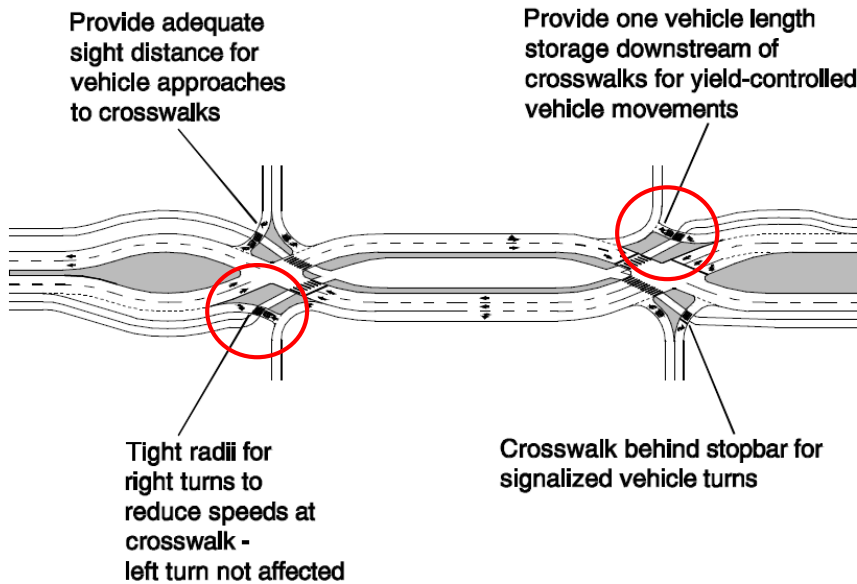


Exhibit 3-9. Pedestrian-focused DDI – center walkway.

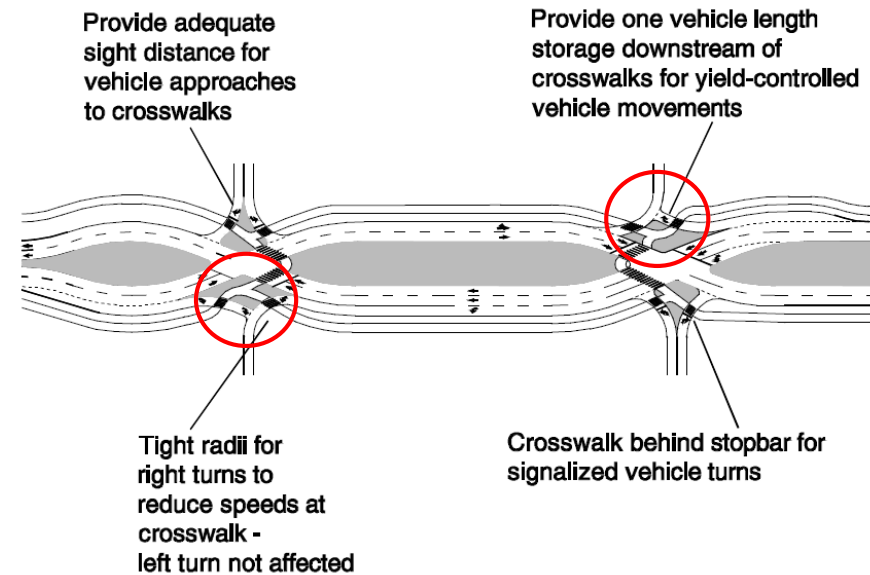


Exhibit 3-10. Pedestrian-focused DDI – outside walkway.

Center Walkway

Advantages & Challenges

7-36

Exhibit 3-7. Center walkway pedestrian safety and comfort.

	Advantages	Challenges
Street Crossings	Crossing of the arterial street provided at DDI for full pedestrian access	Crossing of free-flow right-turn movements to/from freeway
	Crossing one direction of traffic at a time	Pedestrians may not know to look to the right when crossing to center
	Short crossing distances	Wait at center island dictated by length of signal phase for through traffic
	No exposure to free-flowing left turns to freeway	Location of pedestrian signals can conflict with vehicular signals at crossovers
	Protected signalized crossing to walkway	
	Pedestrian clearance time generally provided in crossover signal phasing	
Walkway Facility	Pedestrian delay to center minimized by short cycles at two-phase signals	
	Side walls provide a positive barrier between vehicular movements and pedestrians	Center walkway placement counter to typical hierarchy of street design
	Walls low enough to avoid “tunnel” effect that could impact pedestrian comfort	Potential discomfort from moving vehicles on both sides of walkway
	Recessed lighting can provide good illumination of walkway	Sign and signal control clutter

Outside Sidewalk

Advantages and Challenges

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Exhibit 3-8. Outside path/sidewalk pedestrian safety and comfort.

	Advantages	Challenges
Street Crossings	Crossing one direction of traffic at a time	Crossing of free-flow right-turn movements to/from freeway
	Ramp crossing distances are often shorter than through traffic crossing distance due to fewer travel lanes	Conflict with free-flow left turns to freeway, where fast vehicle speeds are likely (acceleration to freeway)
		Crossing of the arterial street sometimes not provided at DDI
		Potential sight obstruction of pedestrian crossing left turns from behind barrier wall
		Pedestrians may not know which direction to look in, when crossing turn lanes
		Unnatural to look behind to check for vehicles before crossing when traveling out of the DDI (depends on angle of approach and direction of travel)
Walkway Facility	Extension of existing pedestrian network (natural placement on outside of travel lanes)	Need for widened structure on outside for overpass
	Pedestrian typically has view of path ahead (depends on sight lines and obstructions)	Potential for additional right-of-way for underpass or construction of retaining wall under bridge
	Walkway doesn't conflict with center bridge piers (at underpass)	Need for additional lighting for underpass
	Opportunity to use right-of-way outside of bridge piers (at underpass)	

Reminders Might be Helpful

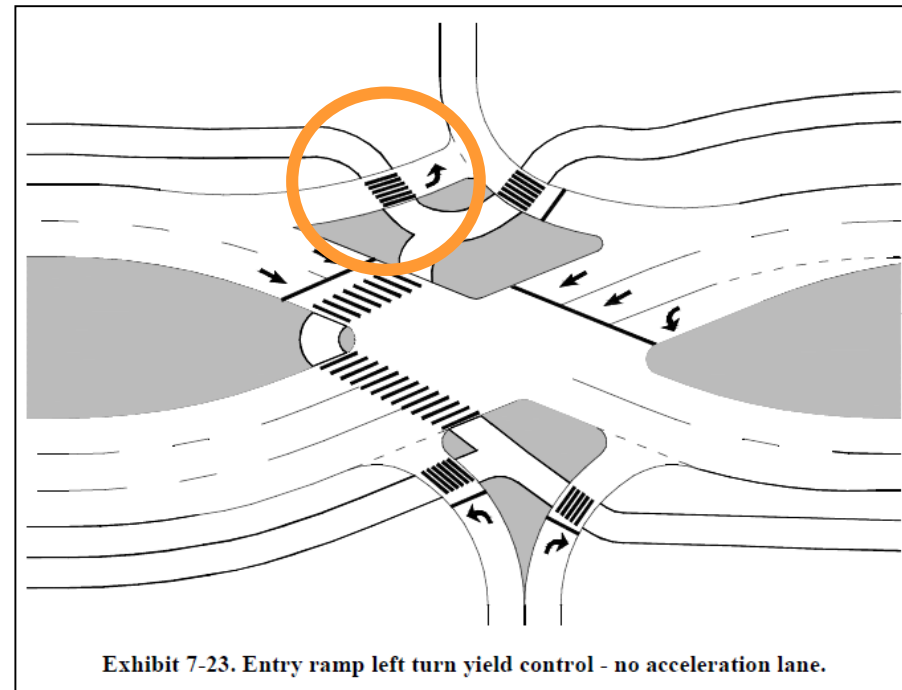
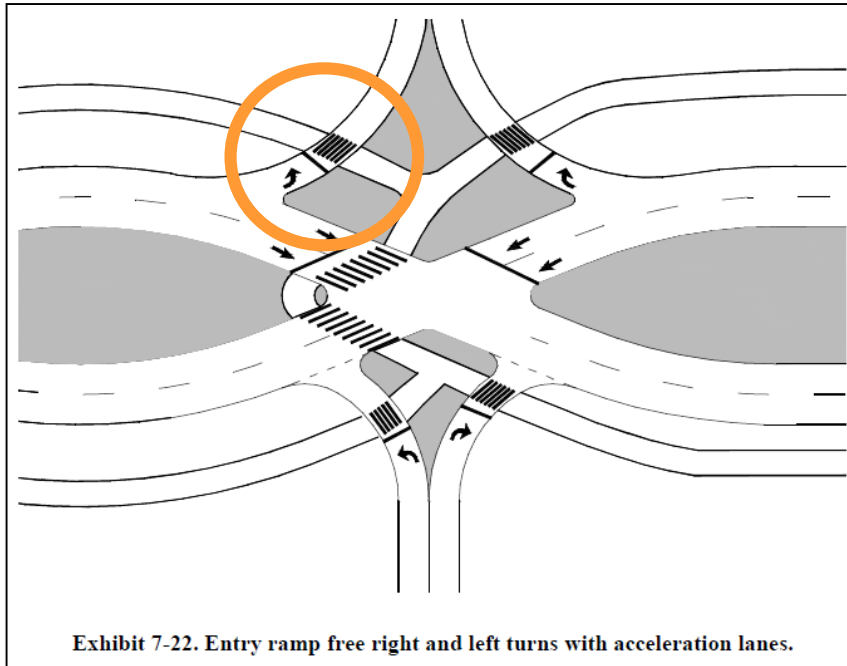
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Exhibit 3-17. Pedestrian markings to indicate directionality of traffic (Maryland Heights, MO).⁽¹⁴⁾

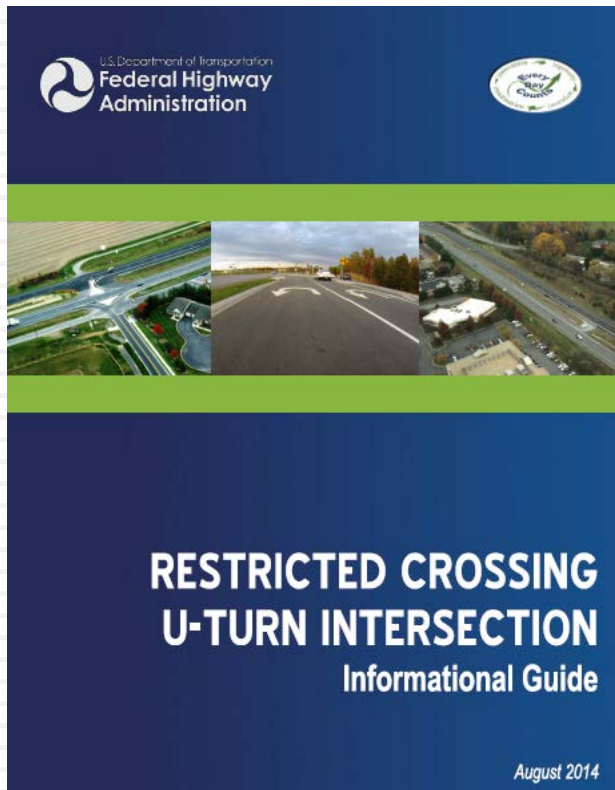
Crosswalk Markings with and w/o Acceleration Lane

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Restricted Crossing U-Turn



Restricted Crossing U-Turn

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Restricted Crossing U-Turn Pedestrians

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Pedestrian Movement

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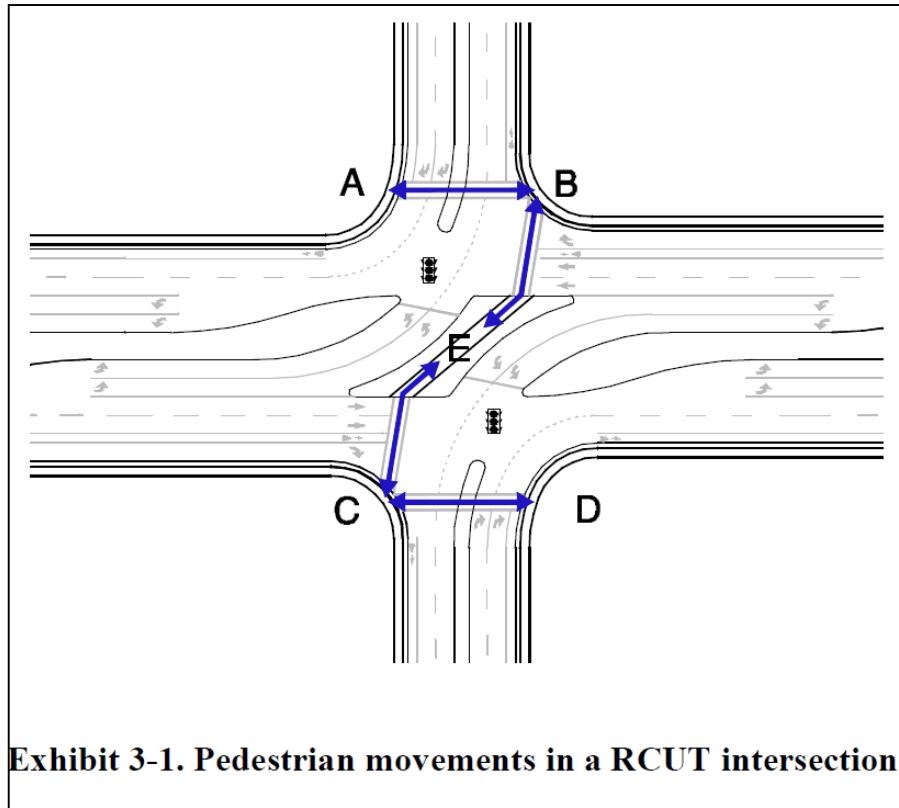


Exhibit 3-1. Pedestrian movements in a RCUT intersection.

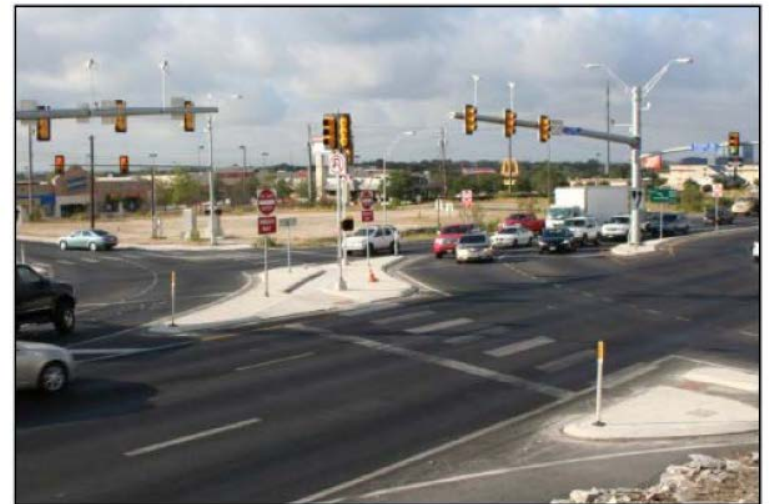


Exhibit 3-2. Signalized RCUT with “Z” crossing near San Antonio, TX.⁽³⁾

Pedestrian Path Offset Approaches

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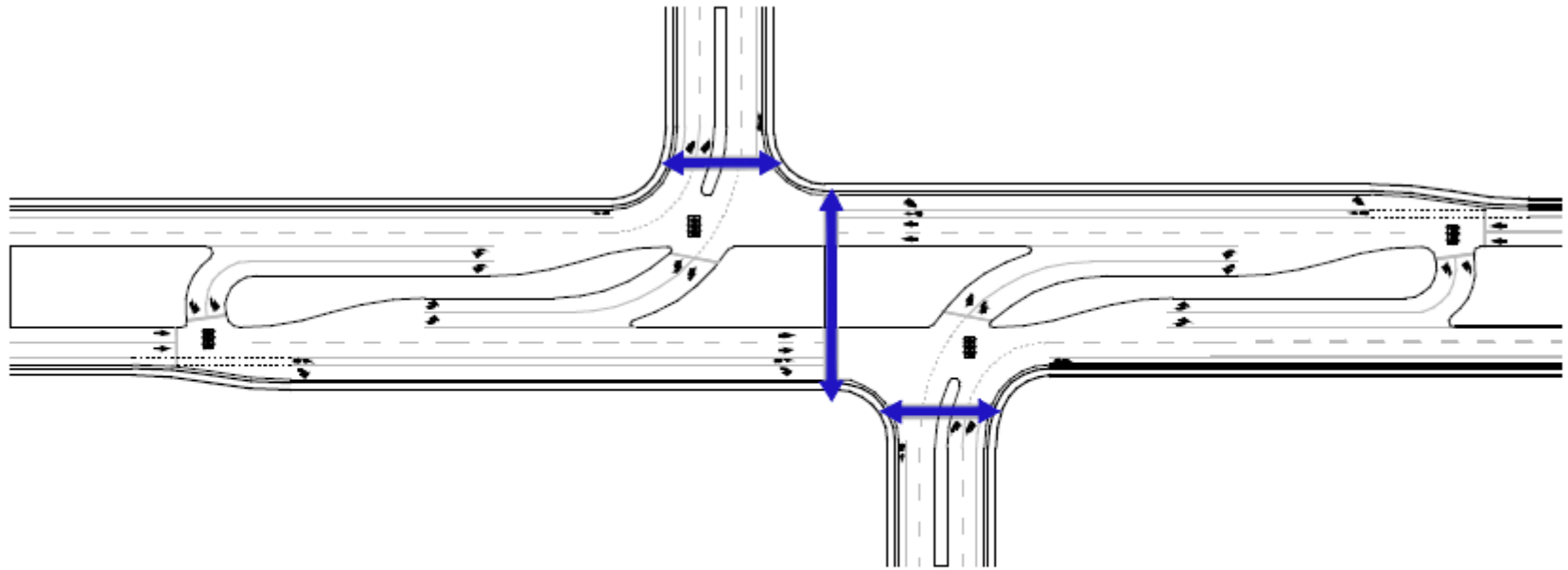
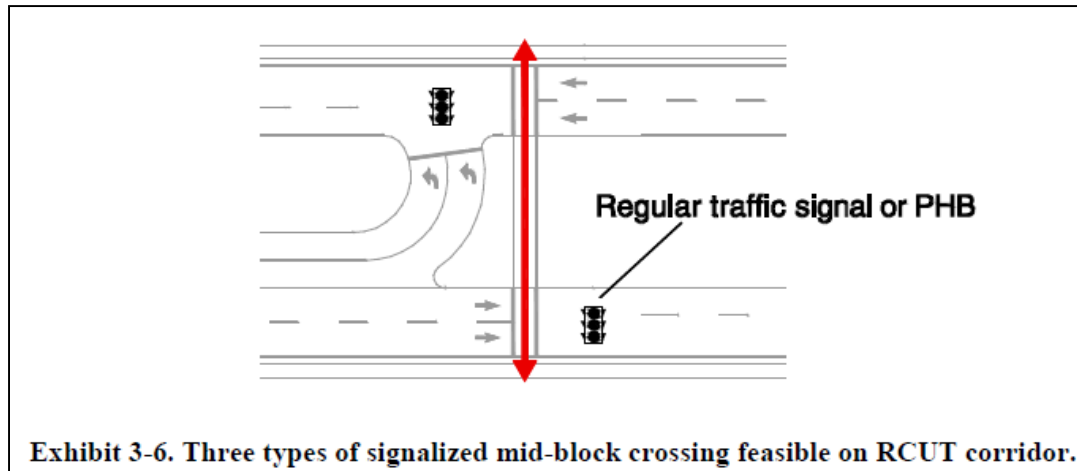
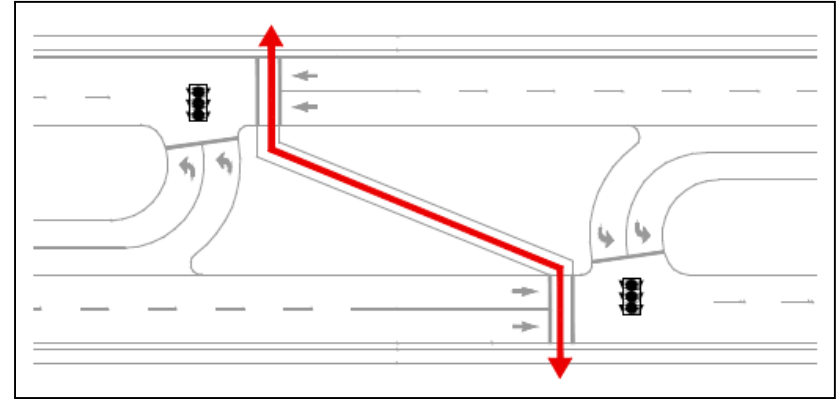
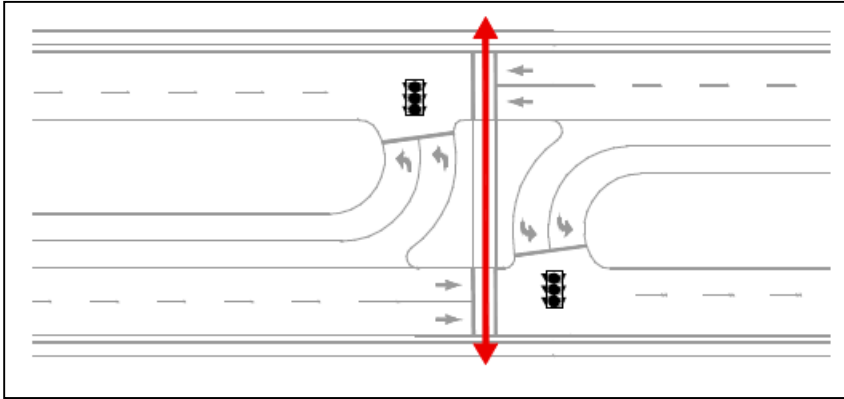


Exhibit 3-5. RCUT intersection with minor street approaches offset to produce a shorter pedestrian crossing.

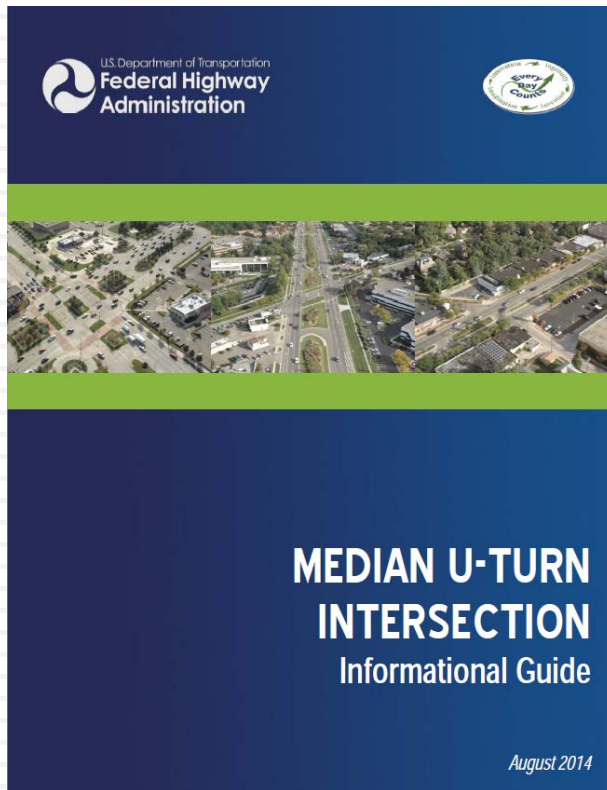
Signalized Crossing

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Median U-Turns



Median U-Turns

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Median U-Turns Pedestrians

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Single or Two Stage Crossings

7-49

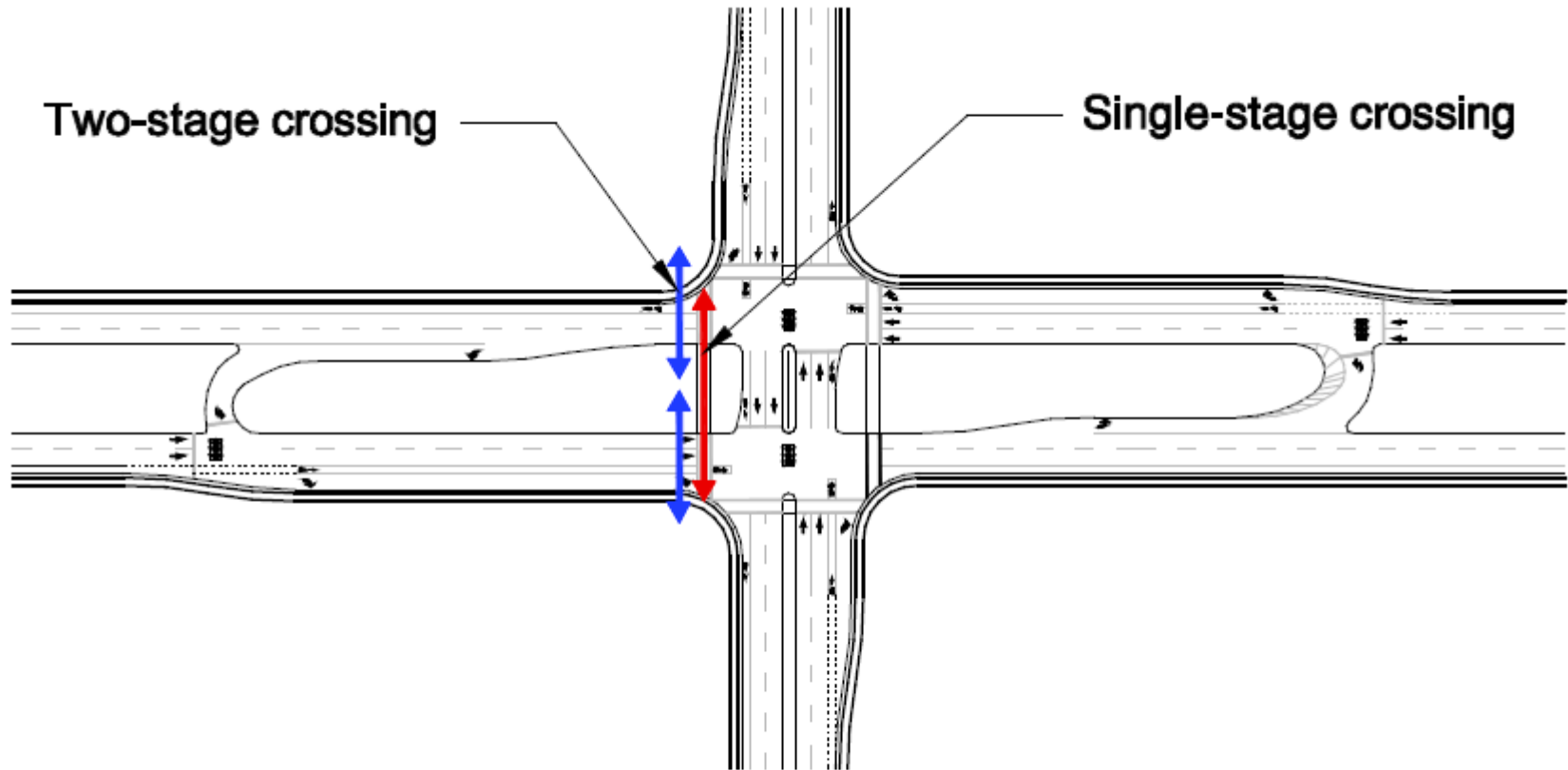


Exhibit 3-4. Single- versus two-stage pedestrian crossings.

Mid-block Crossing

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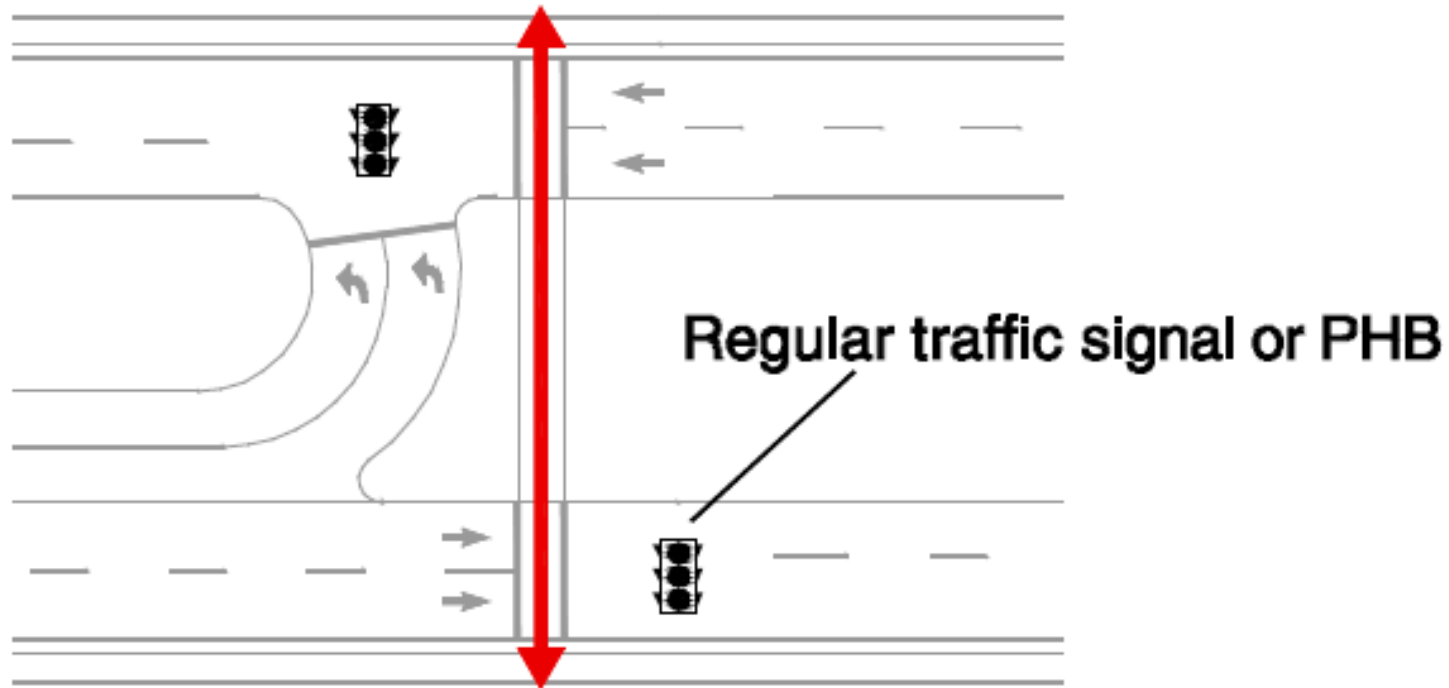
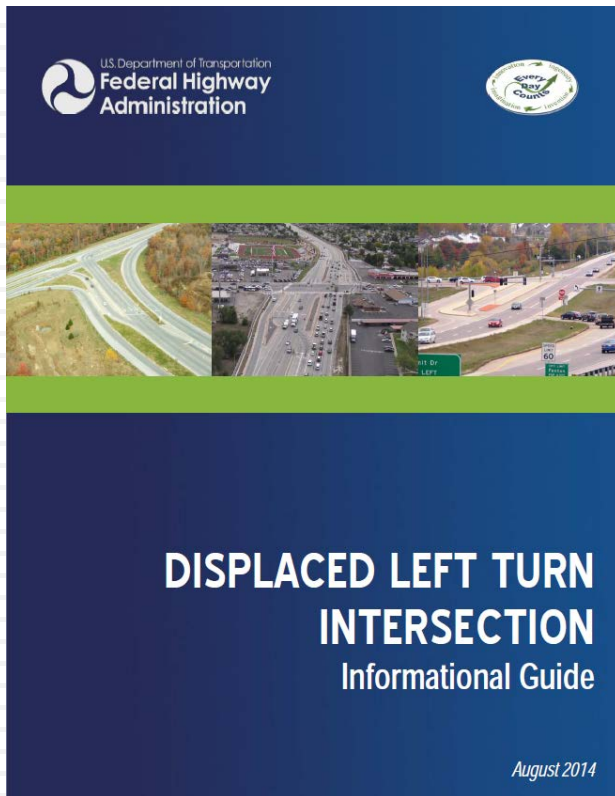


Exhibit 3-5. Signalized mid-block crossing.

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Displaced Left Turn



Displaced Left Turn

7-52



Displaced Left Turn Pedestrians

7-53



Bangerter Highway
West Valley City, UT

Pedestrian Crossings

7-54

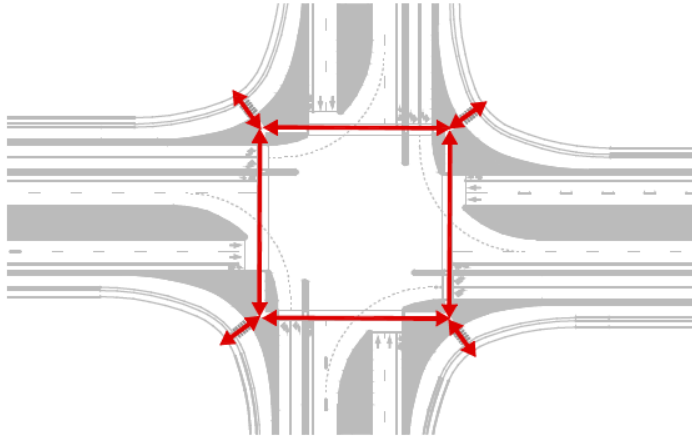


Exhibit 3-2. Possible pedestrian movements with one-stage crossings of main line at a D intersection.

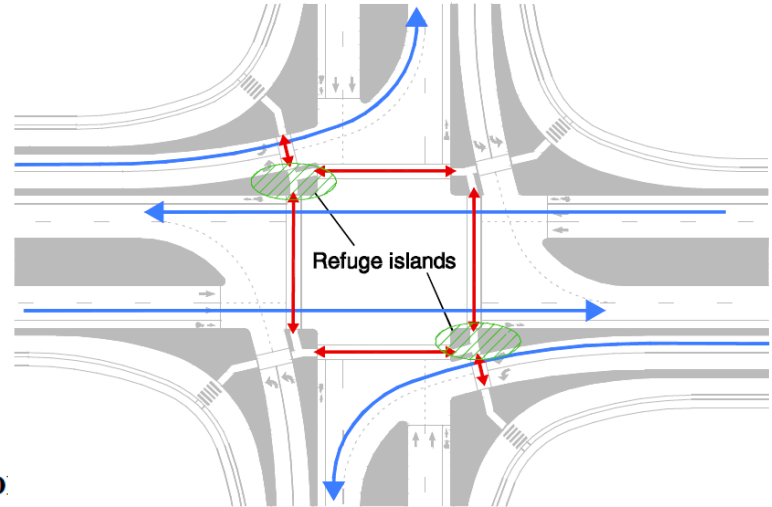


Exhibit 3-4. Refuge islands between left-turn and through lanes.



Exhibit 3-1. DLT in Dayton, OH with two-stage crossings of main line.⁽¹⁾

Let's Recap

7-55

- Why is controlling land uses important?
 - Attractors create pedestrian demand
- Why do ped crashes occur at freeway interchanges?
 - Driver expectation of pedestrians is very low
 - They're driving fast
- What kind of movements should be avoided?
 - High-speed, free-flow
- How can one mitigate for these problems?
 - With slow-speed, right-angle urban design
 - With improved crosswalk placement

Learning Outcomes

7-56

- You should now be able to:
- Identify how land uses around freeway interchanges create pedestrian trips
- Explain how and why pedestrian crashes occur at interchanges (driver expectation of pedestrians is very low; high-speed, free-flow movements)
- Select slow-speed, right-angle urban designs

7-57

Questions?