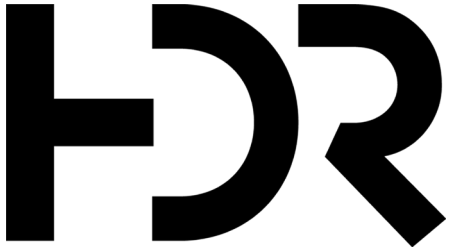
Special Thanks to our NCSITE Diamond Annual Sponsors













Pedestrian Crossing Assessment

Sarah O'Brien

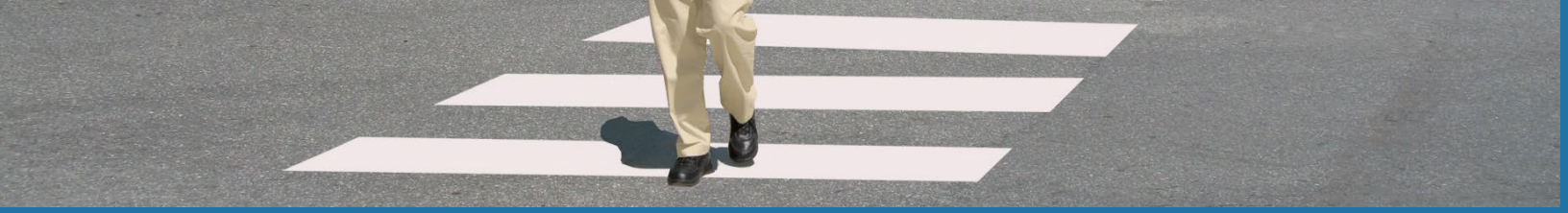
September 22, 2020

NCSITE – Back to Basics



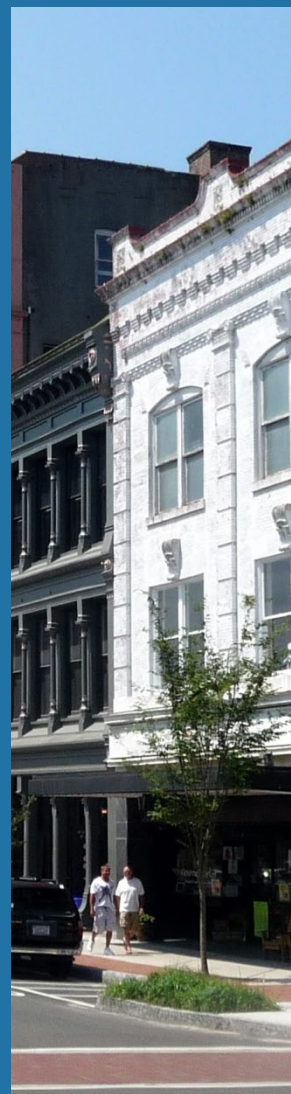
THE UNIVERSITY OF NORTH CAROLINA
HIGHWAY SAFETY RESEARCH CENTER

www.hsrc.unc.edu



Literature Review

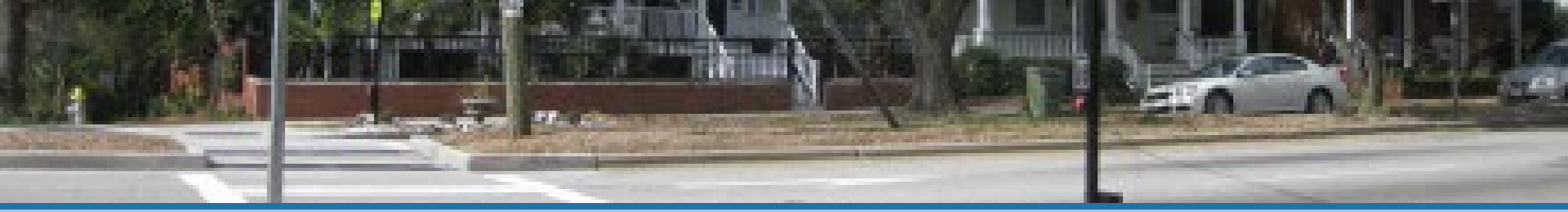
- Key data and sources:
  - Zegeer et al. research on safety of marked vs. unmarked crosswalks
  - MUTCD – Pedestrian signal warrants, PHB guidance, etc.
  - Current guides: Minnesota, Boulder, Sacramento
  - NCHRP Report 562 on Unsignalized Pedestrian Crossings
  - Interviews with 14 NCDOT Divisions and 9 NC municipalities





What Matters to Pedestrians?

- Crossing distance
  - Number of lanes
  - Lane widths
  - Median refuge island
- Traffic volume
  - Truck traffic
- Speed
- Curb ramps
- Sidewalk
- Gap availability
- Driver yielding behavior
- Information on when to cross
  - Can I use the traffic signals?
  - Are there pedestrian signal heads?
  - Do I need APS?
- Pleasant environment
- Lighting



High-Level Flow Chart Organization

- Introduction to Guidance
- When to Use Flowchart
- Step 1: Document Existing Characteristics / Signalized Crossing Assessment
- Step 2: Unsignalized Crossing or Midblock Crossing Assessment
- Step 3: Additional/Alternative Treatments Assessment
- Step 4: Pedestrian Hybrid Beacon (PHB) Assessment
- Detailed Footnotes to provide details



The Flowchart

NCDOT Pedestrian Crossing Treatment Evaluation Guidance

ITRE

July 17, 2015

This flowchart lays out a process to evaluate the need for treatments to assist pedestrians at potential crossing locations and aims to establish consistency in the use of pedestrian treatments. It is not intended to be used to prioritize sidewalk improvements or to evaluate the connectivity of a pedestrian network. It is intended to be applied at the approach level for each leg of an intersection or for mid-block locations. The flowchart may also be applied to shared-use path, trail, or other crossing locations where bicyclists and other non-motorized users may share the same facility as pedestrians; however, the research supporting this flowchart is based on pedestrian-only usage. Several general principles and considerations for the use of this flowchart are given below:

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For further background, resources, or references that support the Flowchart, please consult the North Carolina Pedestrian Crossing Guidance report at www.ncdot.gov

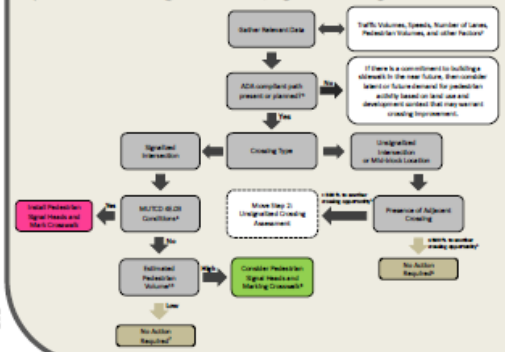
When to Use this Flowchart?

The use of this flowchart may be prompted through a variety of mechanisms, including:

- Citizen requests or roundabout requests
- Development of a pedestrian or greenway plan
- Identification of a pedestrian crash hot spot location
- Systematic review of existing crossing locations
- As a component within an established operations and maintenance assessment process

An ADA request[1] follows a different process.

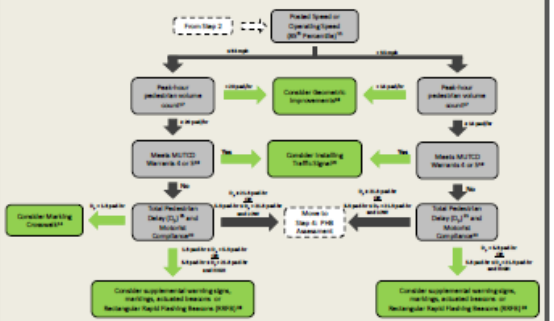
Step 1: Document Existing Characteristics / Signalized Crossing Assessment



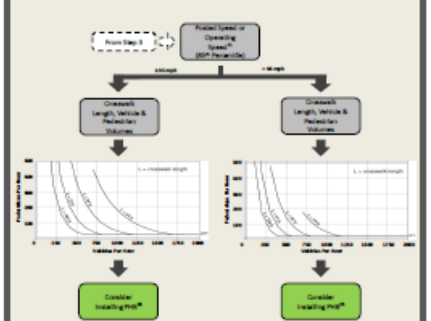
Step 2: Unsignalized Crossing or Midblock Crossing Assessment



Step 3: Additional/Alternative Treatments Assessment[26]



Step 4: Pedestrian Hybrid Beacon (PHB) Assessment[24]

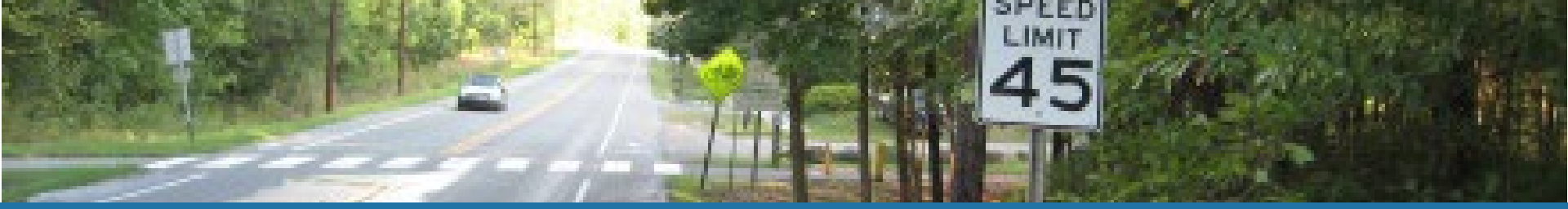






Variables of Interest

- traffic volume
- speed limit
- operating speed
- quantity and type of pedestrian activity
- pedestrian crash history
- roadside features and condition
- area factors
- signing or other traffic control device options
- Others?



When to Use this Flowchart?

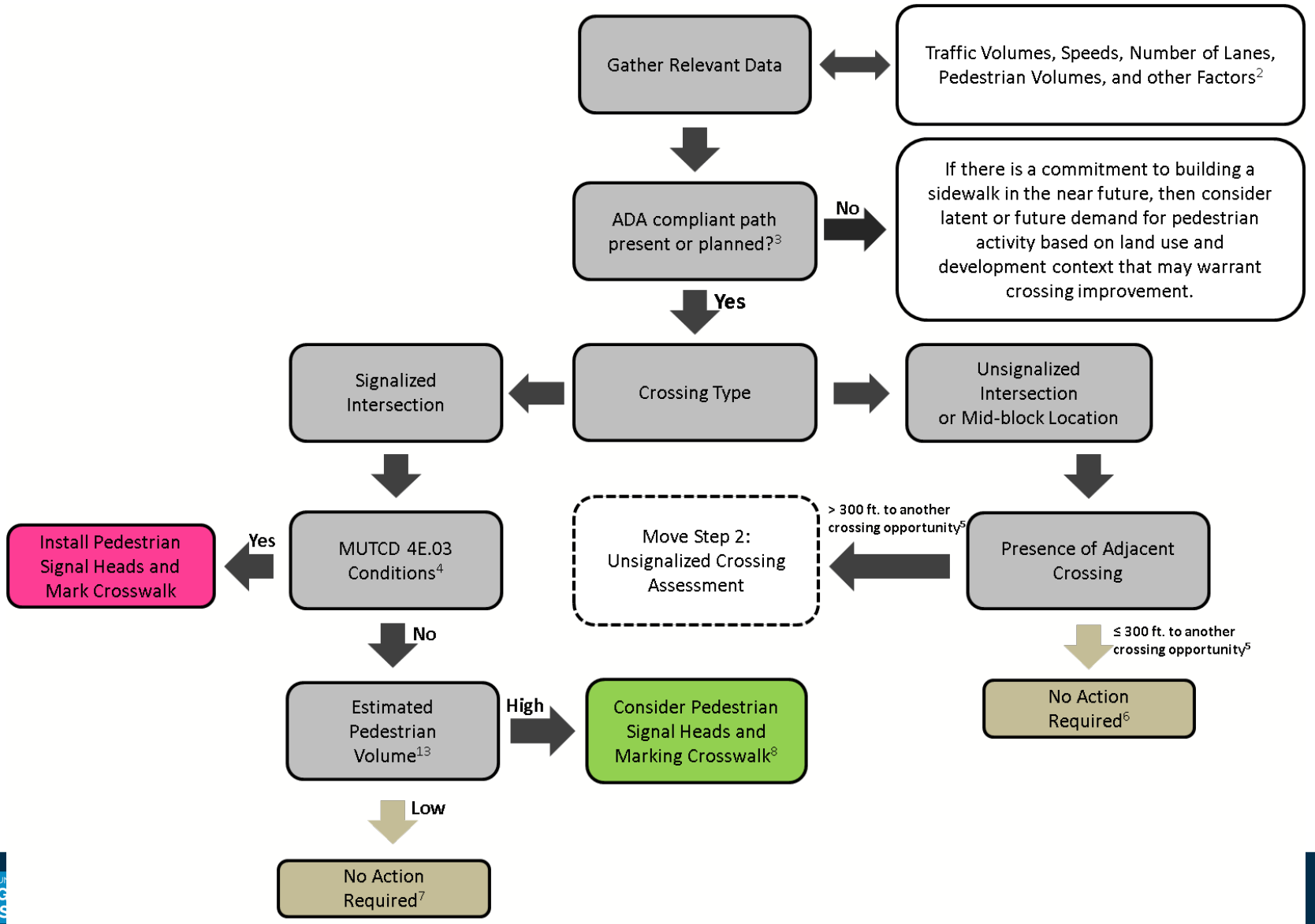
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- **Citizen requests or municipal requests**
- **Development of a pedestrian or greenway plan**
- **Identification of a pedestrian crash hot spot location**
- **Systematic review of existing crossing locations**
- **As a component within an established operations and maintenance assessment process**

An ADA request[1] follows a different process.

(1) The ADA only applies to locations with existing pedestrian facilities. Crosswalks constitute distinct elements of the right-of-way intended to facilitate pedestrian traffic. Resurfacing of a crosswalk requires the provision of **curb ramps** at that crosswalk. (*DOJ-DOT Joint Technical Assistance on Title II ADA requirements*, 7/8/2013).

Step 1: Document Existing Characteristics / Signalized Crossing Assessment

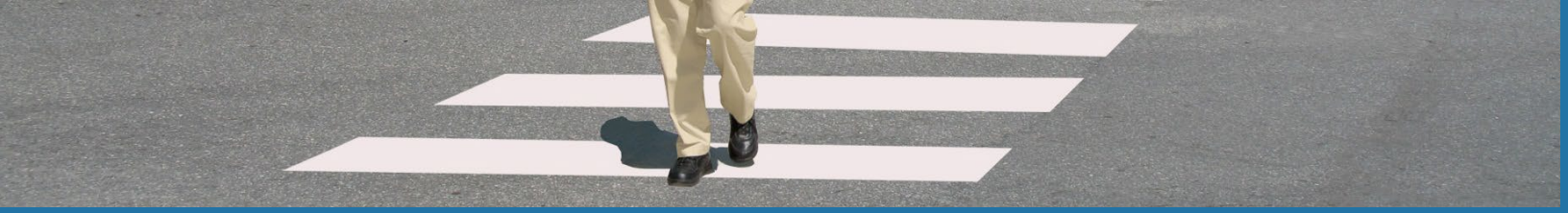




“Low” Pedestrian Volume?

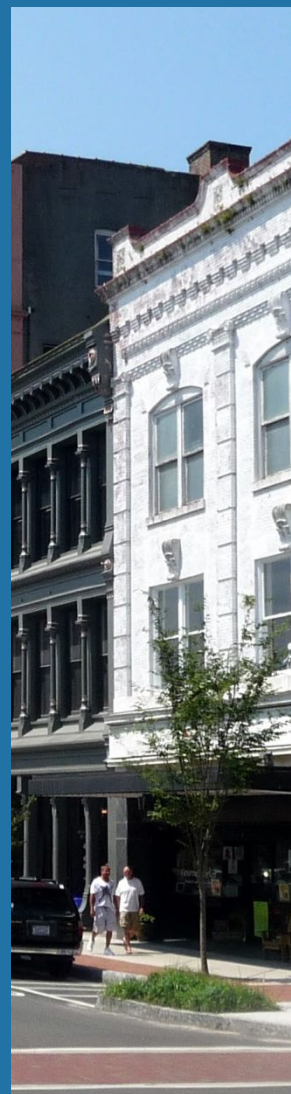
(13) Consider whether **pedestrian volume ,** obtained through observational data or estimated by proxy measures based on land use context, is sufficient to prioritize location for marking crosswalk. Use judgment to choose appropriate “low” volume threshold. Considerations include:

- Is not near high pedestrian trip generators
- Does not connect complementary land uses
- Has less than 25 pedestrians per pedestrian peak hour or less than 100 pedestrians/day. For mid-block locations only: has less than 25 pedestrians per hour for at least four hours (see *NCDOT Standard Practices for Crosswalks – Mid-Block (Unsignalized) Signing and Pavement Markings*, Feb 2008)
- Lower volume thresholds may be considered for crossings with a significant presence of a special population such as children or the elderly



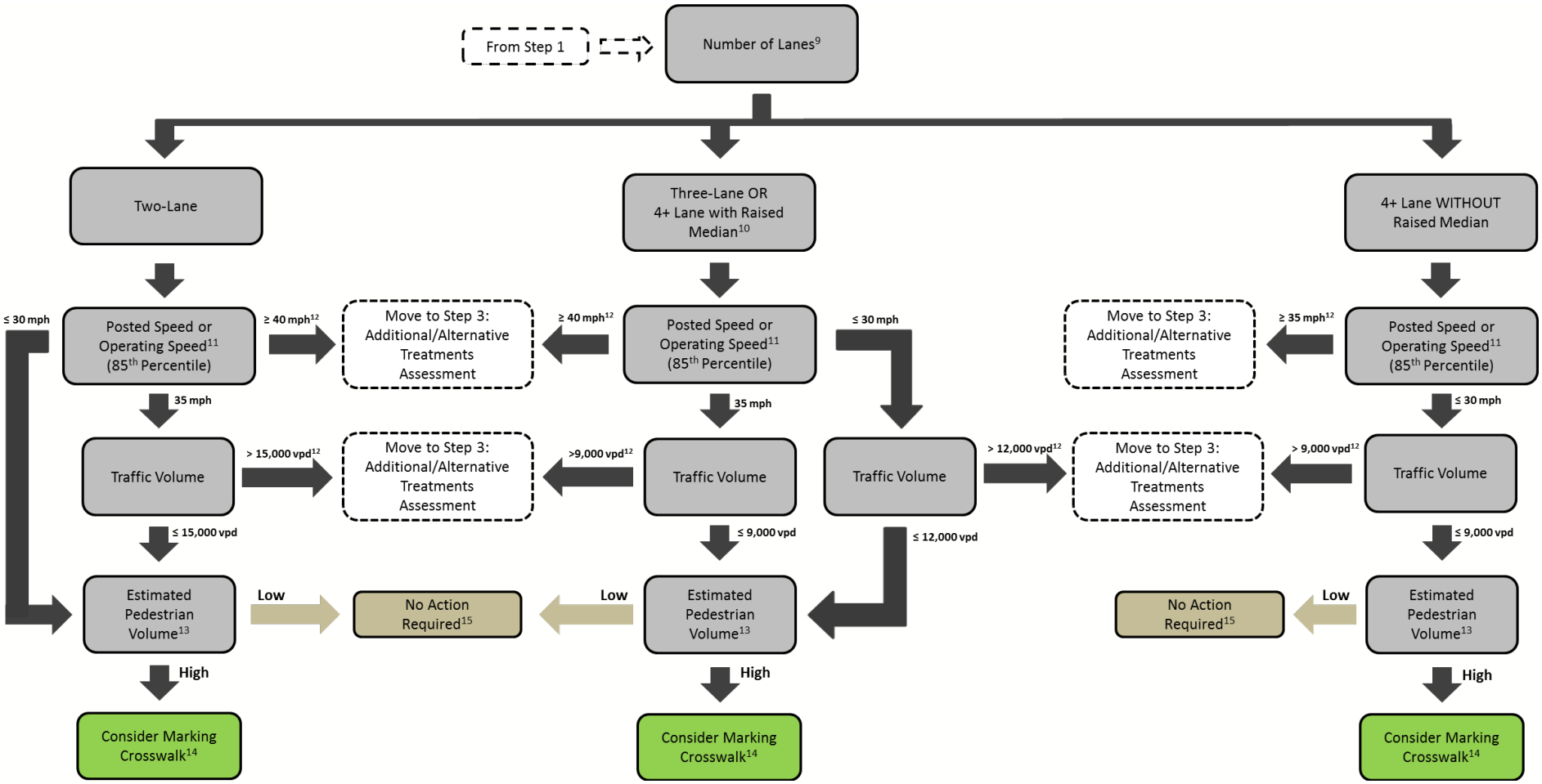
Background Case 1

- Suburban Signalized Intersection
- high speed
- high AADT

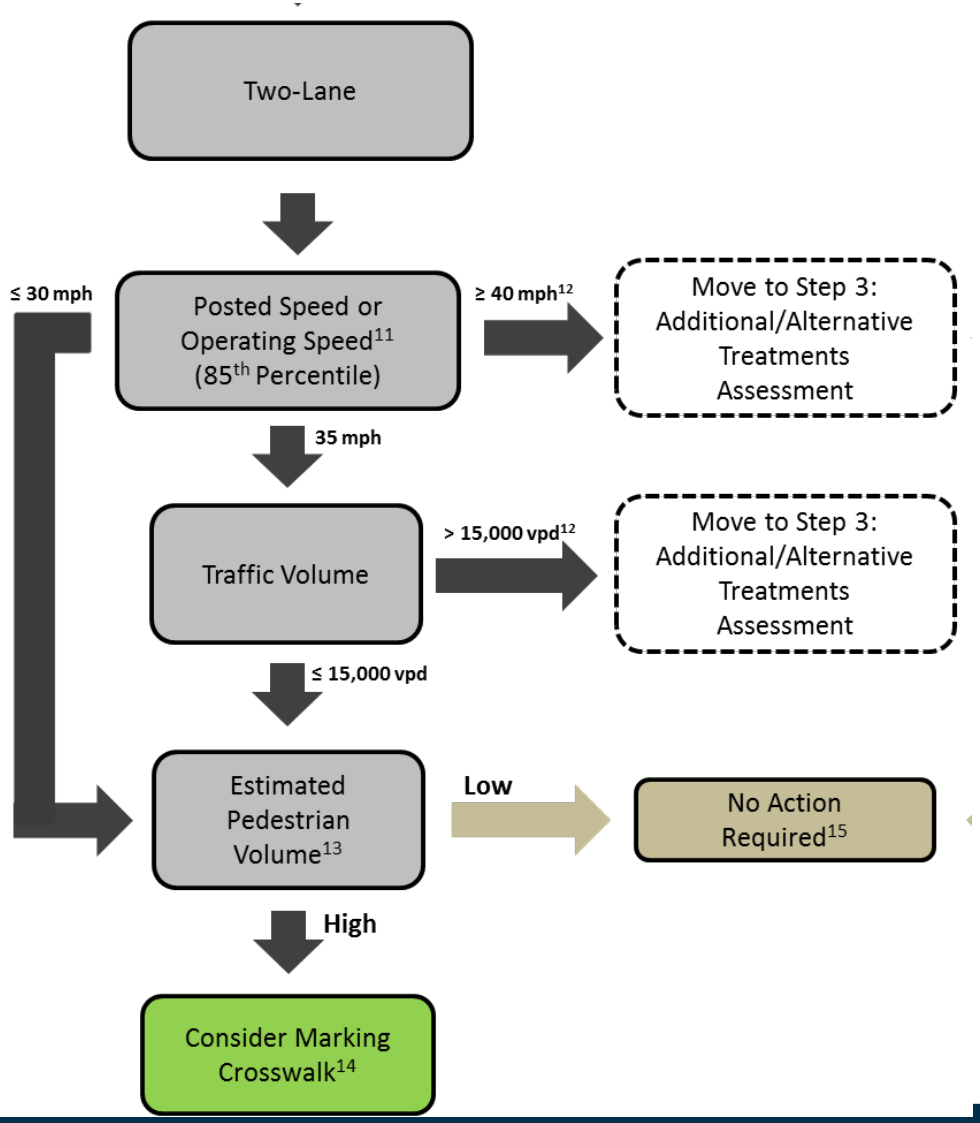



Judd Parkway at US 401
Fuquay Varina, NC
East
6 Lanes-35 mph-
31,000 vpd
West
5 Lanes-35 mph-
21,000 vpd
South
4 Lanes-35 mph -
16,000 vpd

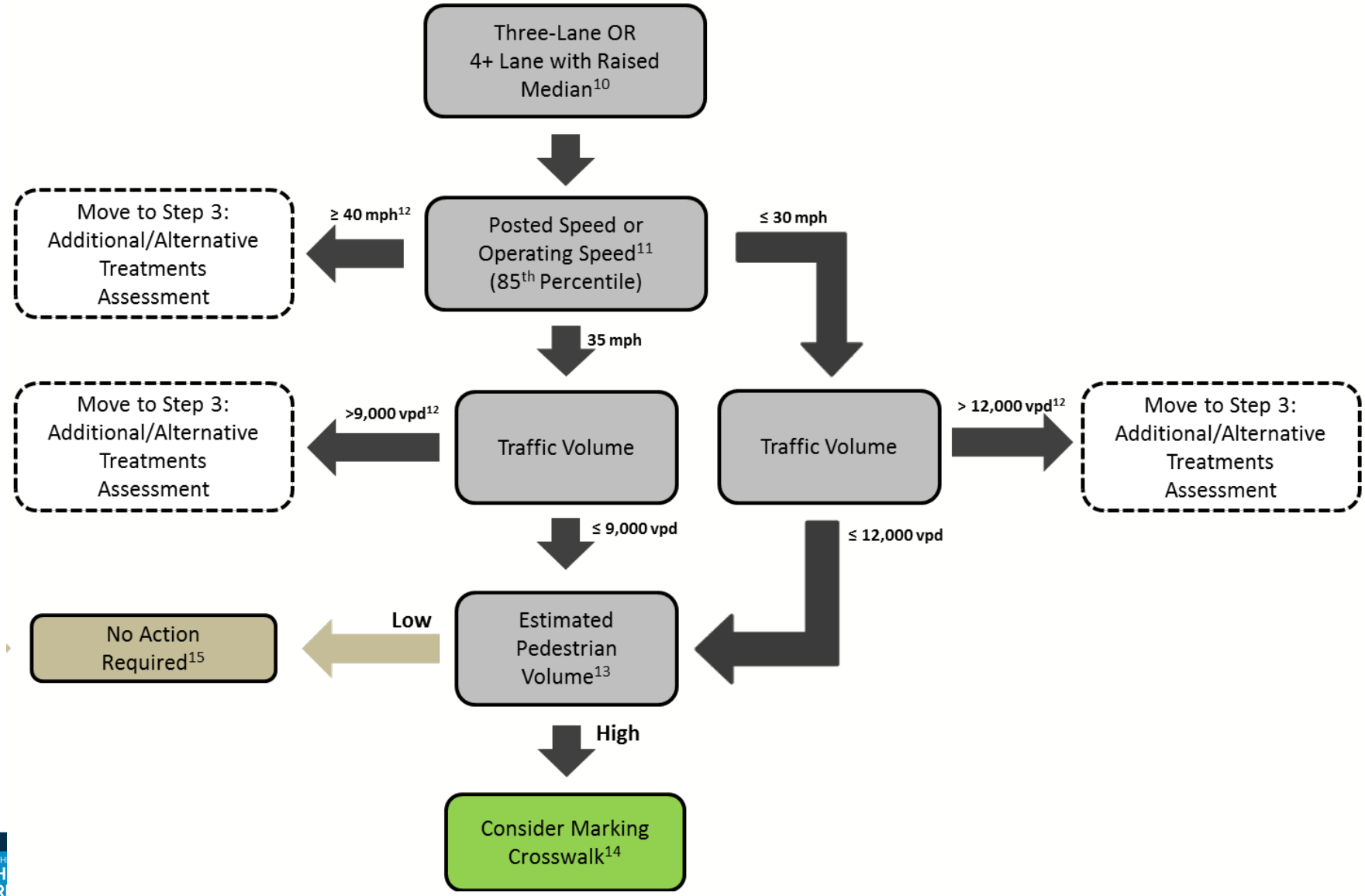
Step 2: Unsignalized/Midblock Crossing Assessment



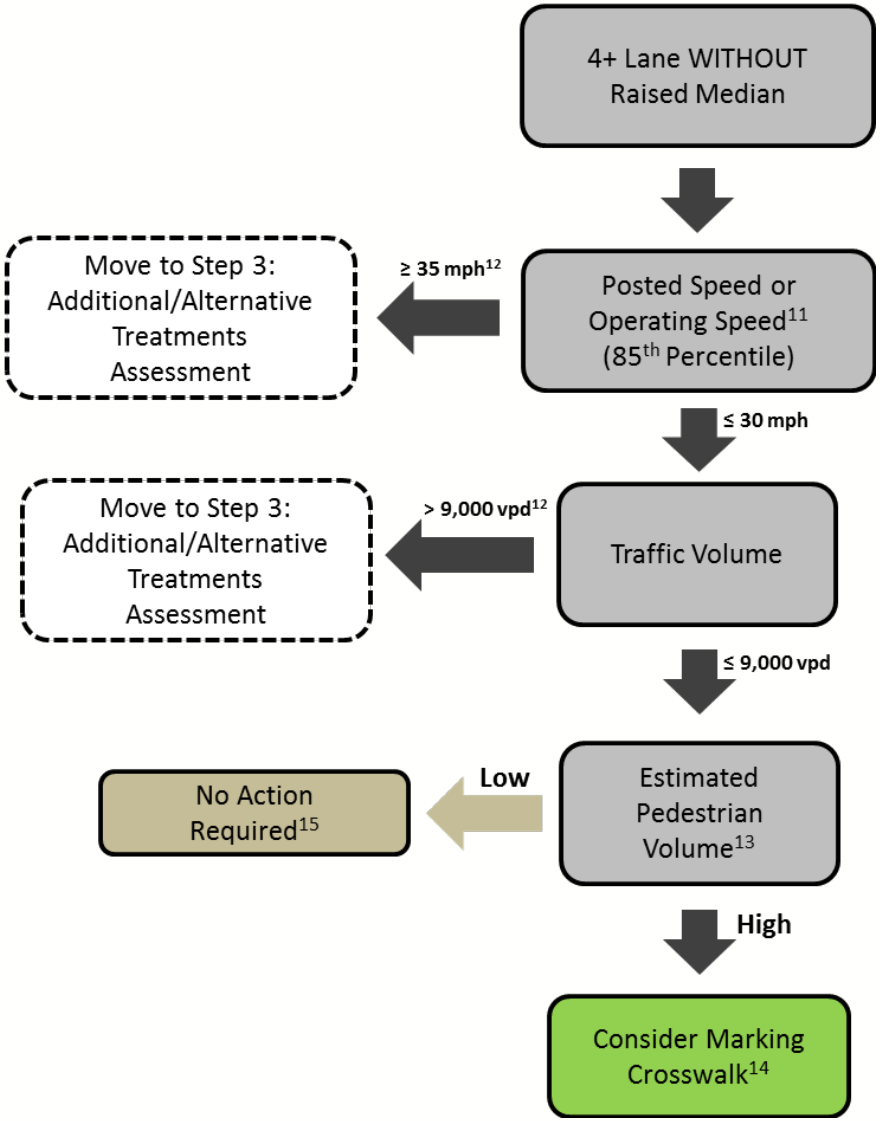
Step 2: Unsignalized/Midblock Crossing Assessment

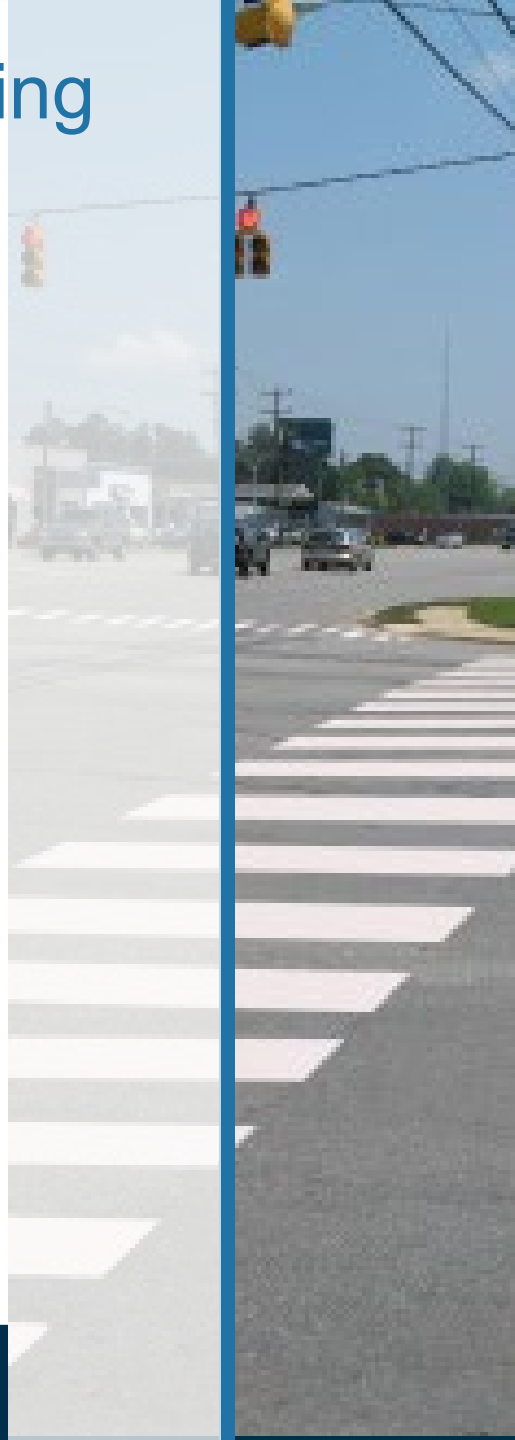


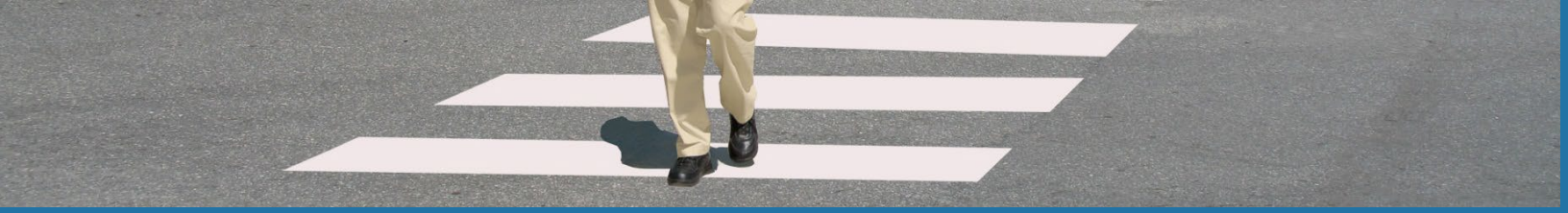
Step 2: Unsignalized/Midblock Crossing Assessment



Step 2: Unsignalized/Midblock Crossing Assessment

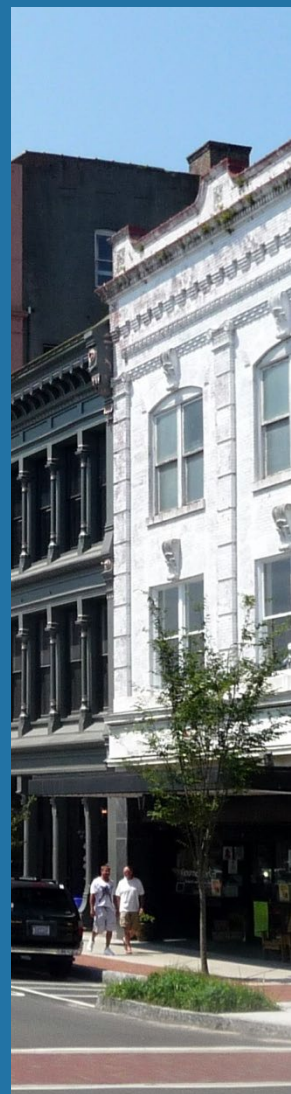




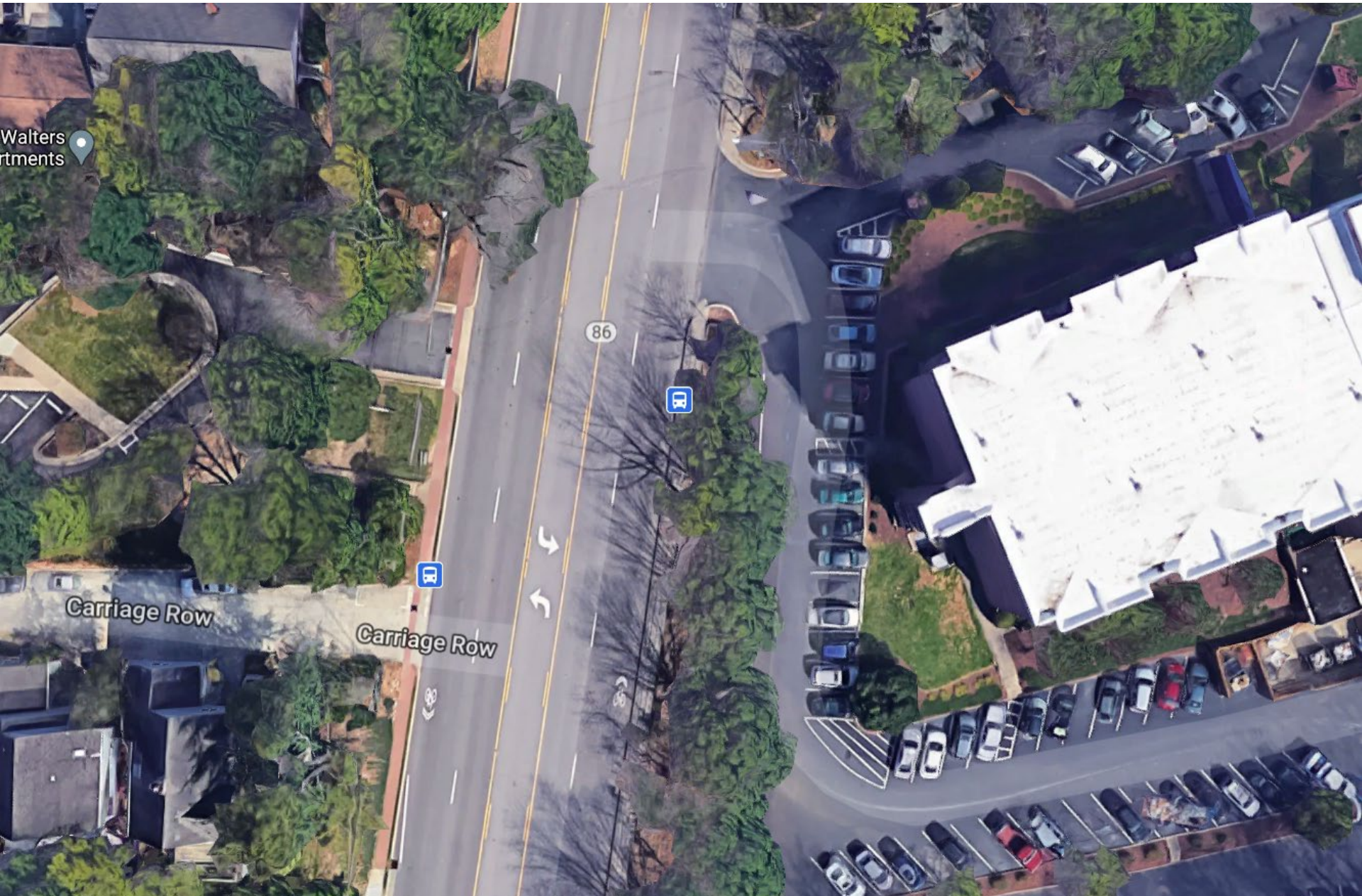


Background Case 2

- Suburban Mid-block crossing
- 5 lanes
- 35 mph
- 16,000 vpd



Mid-Block Location 1: NC86, Chapel Hill, NC

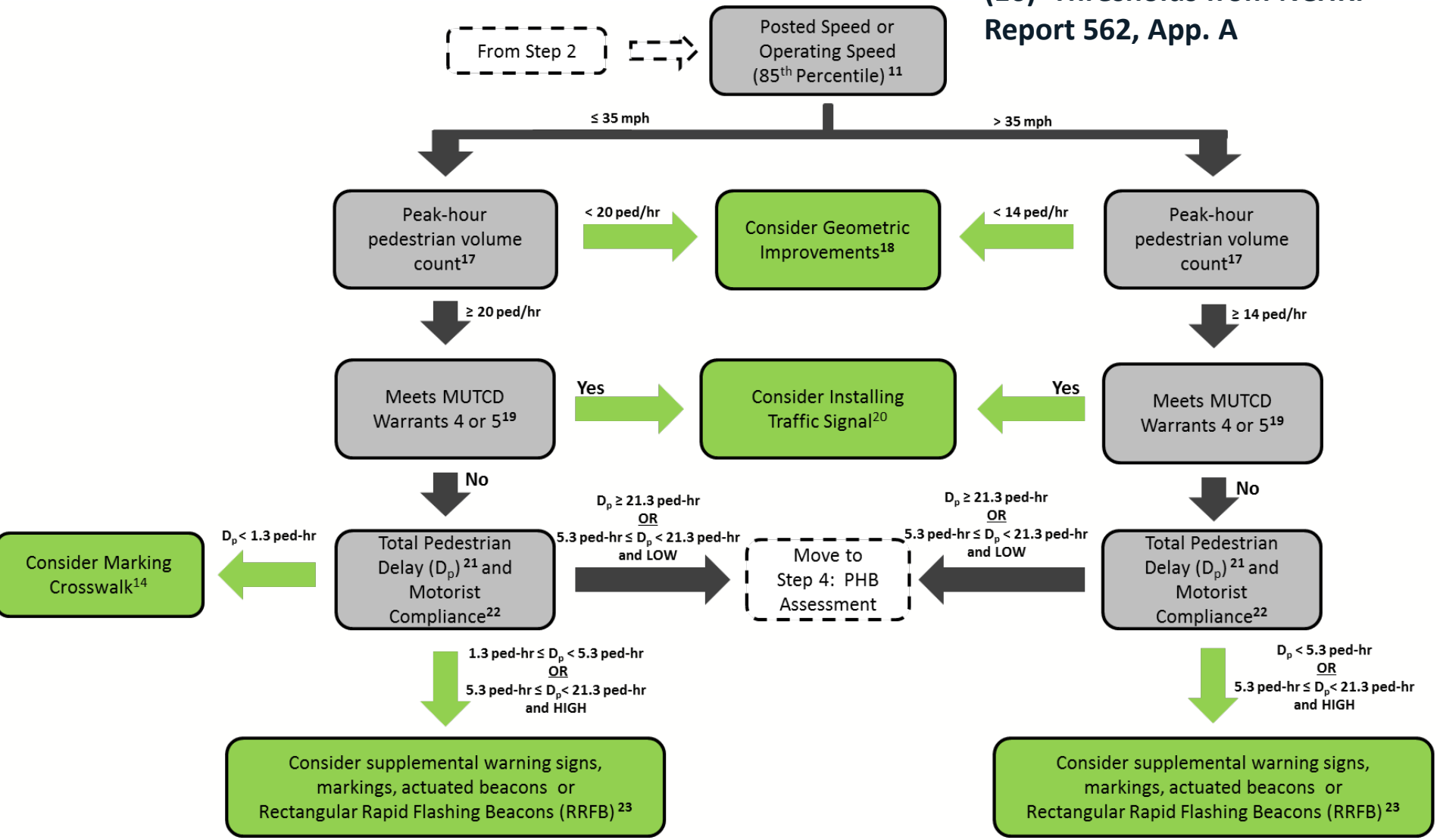


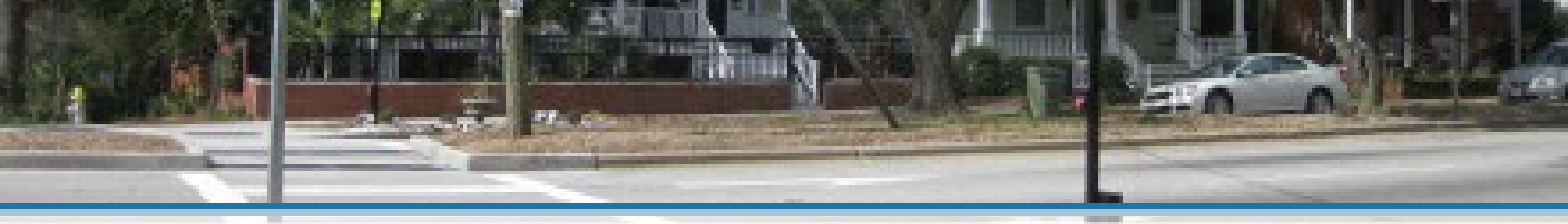
Mid-Block Location 2: NC86, Chapel Hill, NC



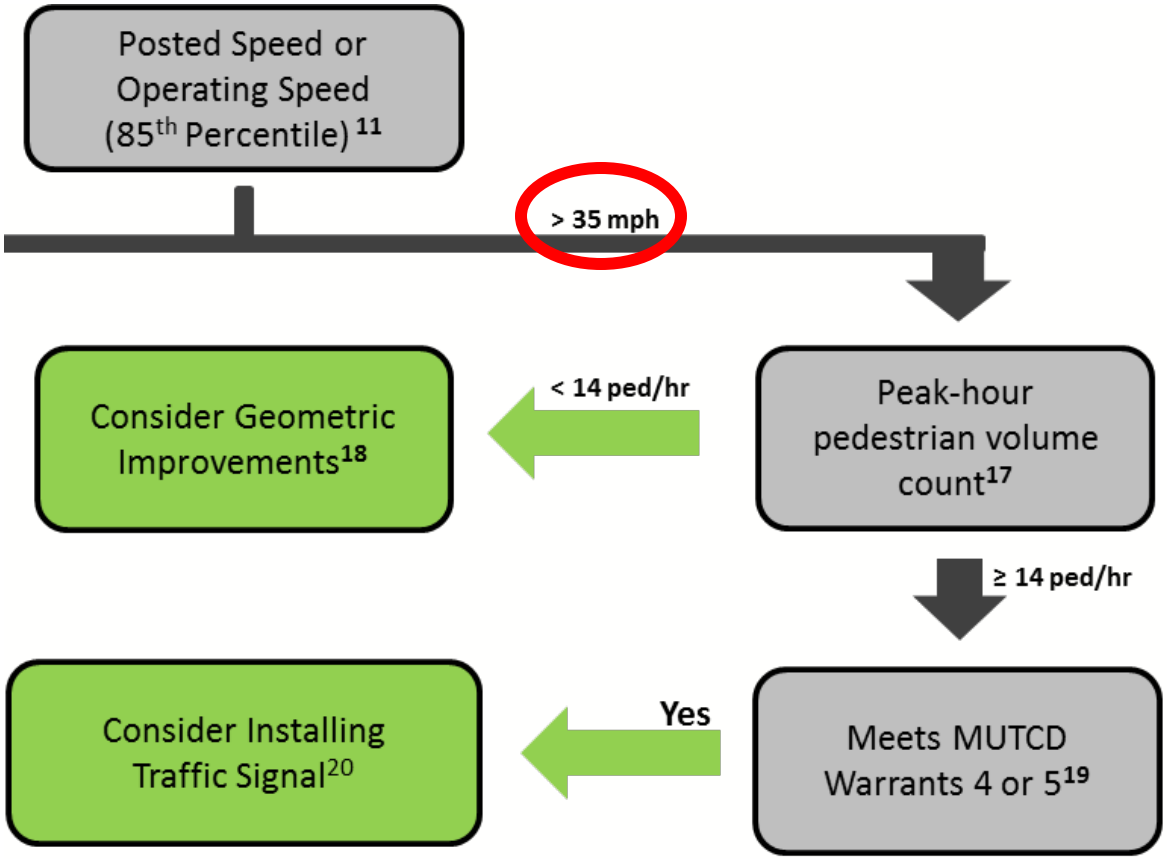
Step 3: Additional Treatments Assessment[16]

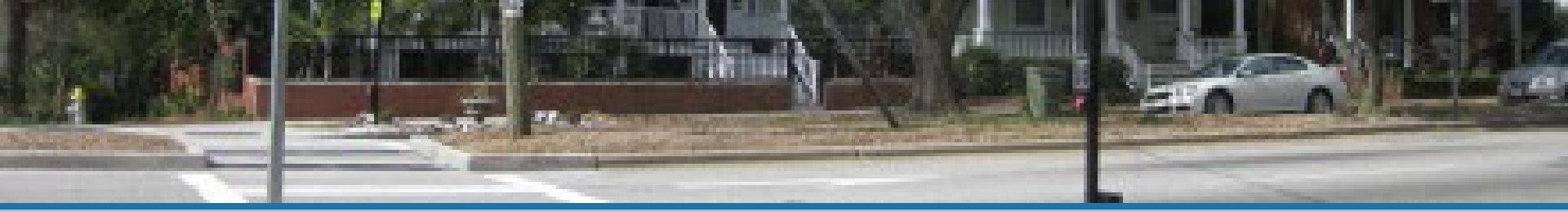
(16) Thresholds from NCHRP Report 562, App. A





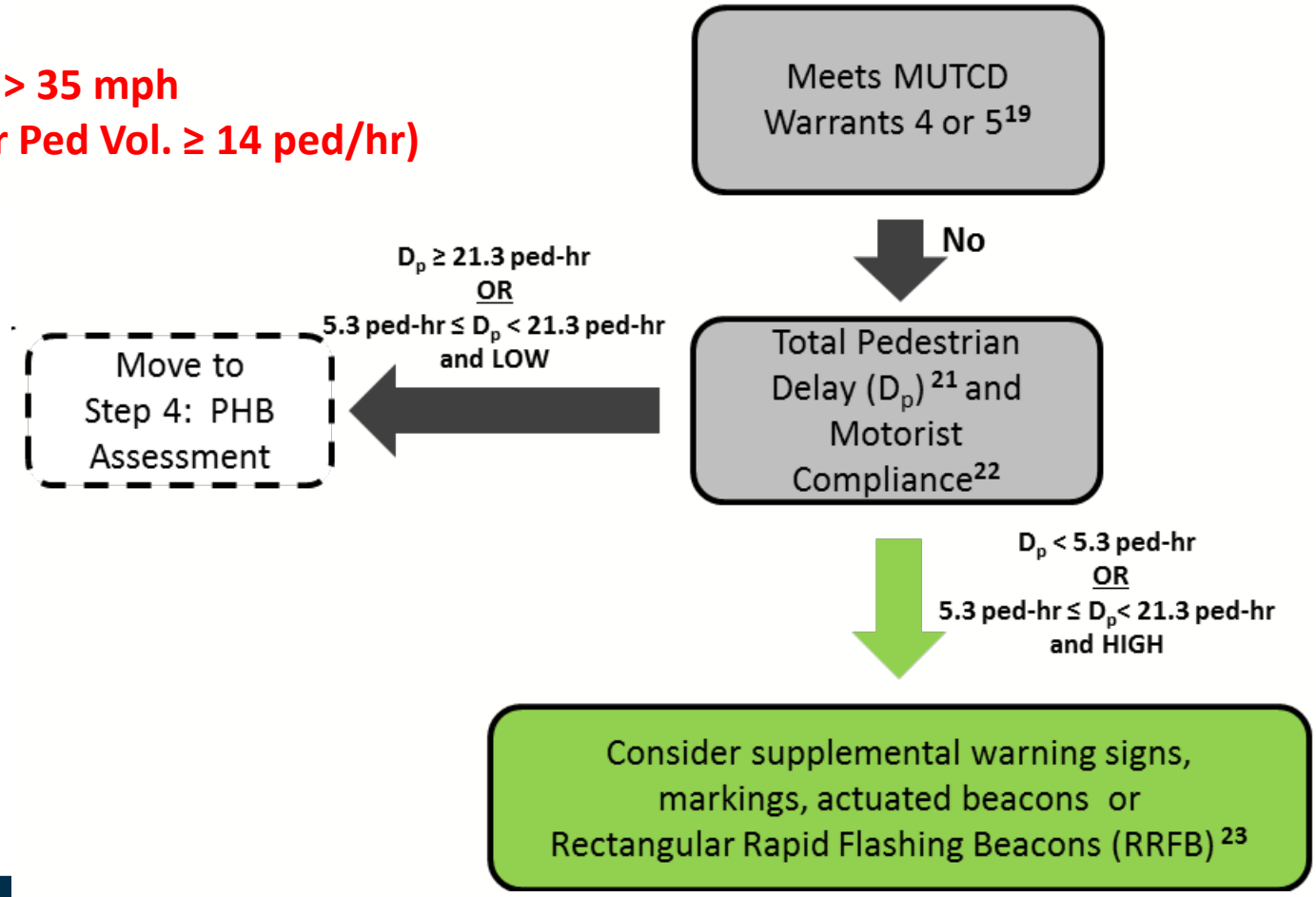
Step 3: Additional Treatments Assessment





Step 3: Additional Treatments Assessment

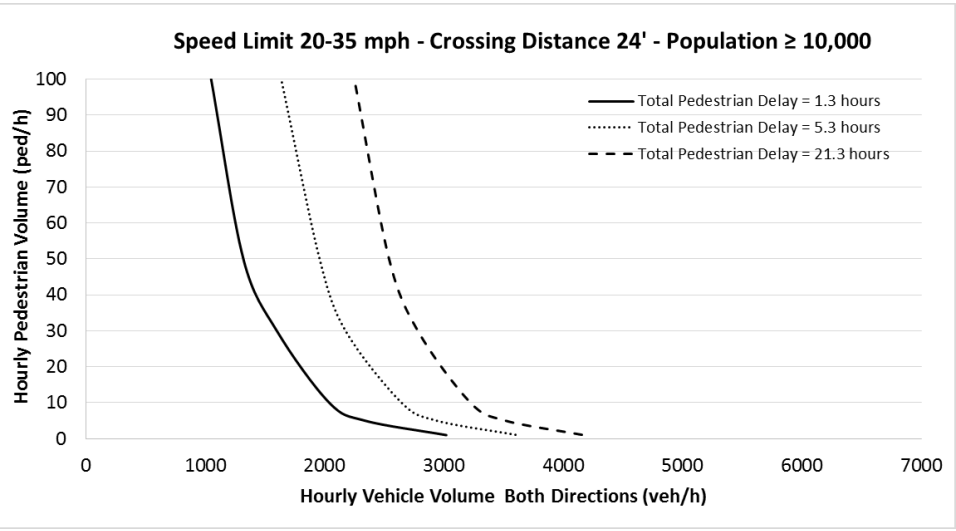
(Speed > 35 mph
Peak-hr Ped Vol. ≥ 14 ped/hr)

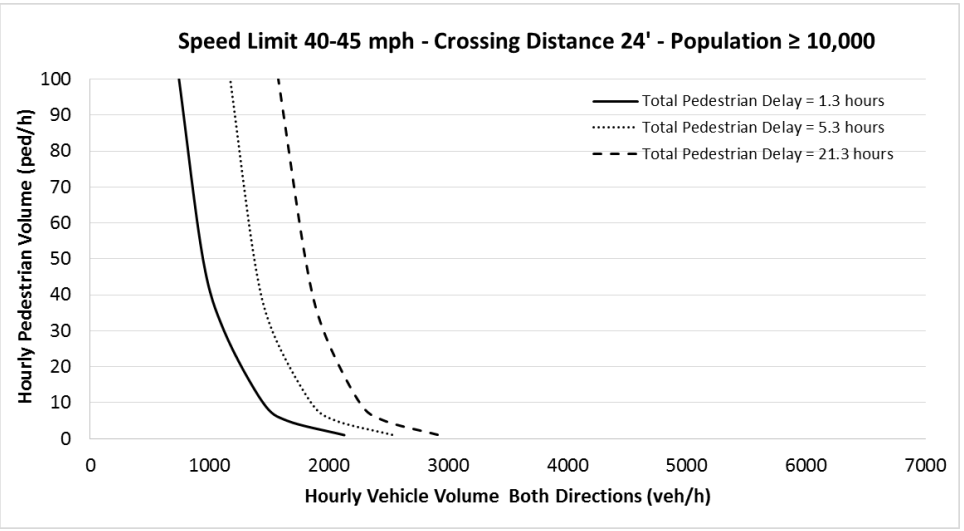


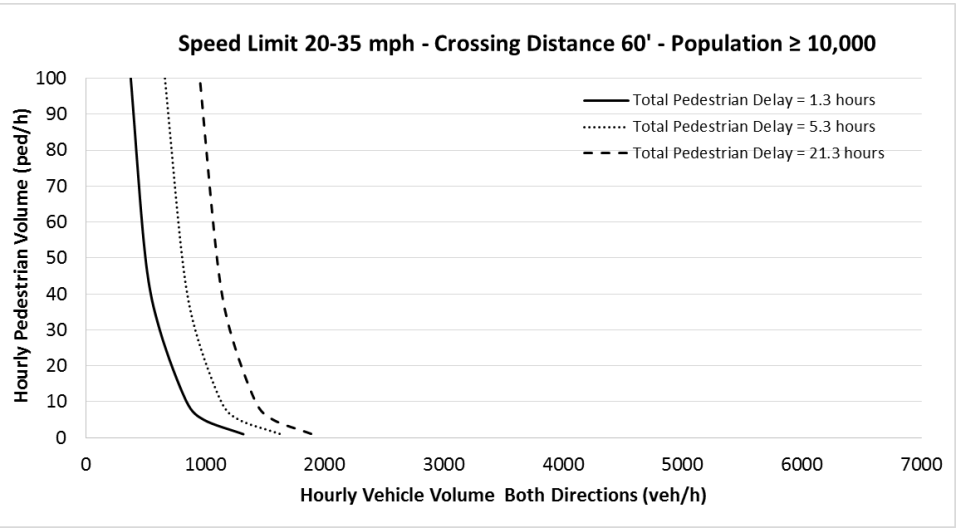
Guidance for Pedestrian Delay

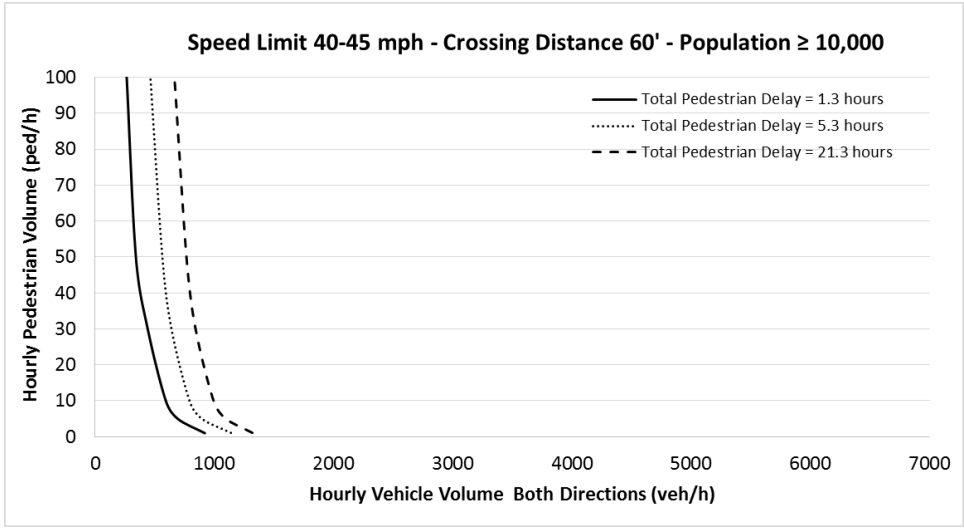
1. Use the appropriate graph to estimate pedestrian delay
   - See next page for example
   - Team provides 15 graphs total in report
2. Based on where your situation falls, use table to identify a treatment.
   - Low Delay: <1.3 pedestrian-hours
   - Medium-Low Delay: 1.3 to 5.3 pedestrian hours
   - Medium-High Delay: 5.3 to 21.3 pedestrian hours
   - High Delay: >21.3 pedestrian hours

Speed Limit	Motorist Compliance	Pedestrian Delay			
		Low (< 1.3 ped-hr)	Medium-Low (≥ 1.3 ped-hr to < 5.3 ped-hr)	Medium-High (≥ 5.3 ped-hr to < 21.3 ped-hr)	High (≥ 21.3 ped-hr)
≤ 35 MPH	Low	Consider Marking Crosswalk	Consider Supplemental Treatments	Move to Step 4: PHB Assessment	Move to Step 4: PHB Assessment
	High	Consider Marking Crosswalk	Consider Supplemental Treatments	Consider Supplemental Treatments	Move to Step 4: PHB Assessment
> 35 MPH	Low	Consider Supplemental Treatments	Consider Supplemental Treatments	Move to Step 4: PHB Assessment	Move to Step 4: PHB Assessment
	High	Consider Supplemental Treatments	Consider Supplemental Treatments	Consider Supplemental Treatments	Move to Step 4: PHB Assessment

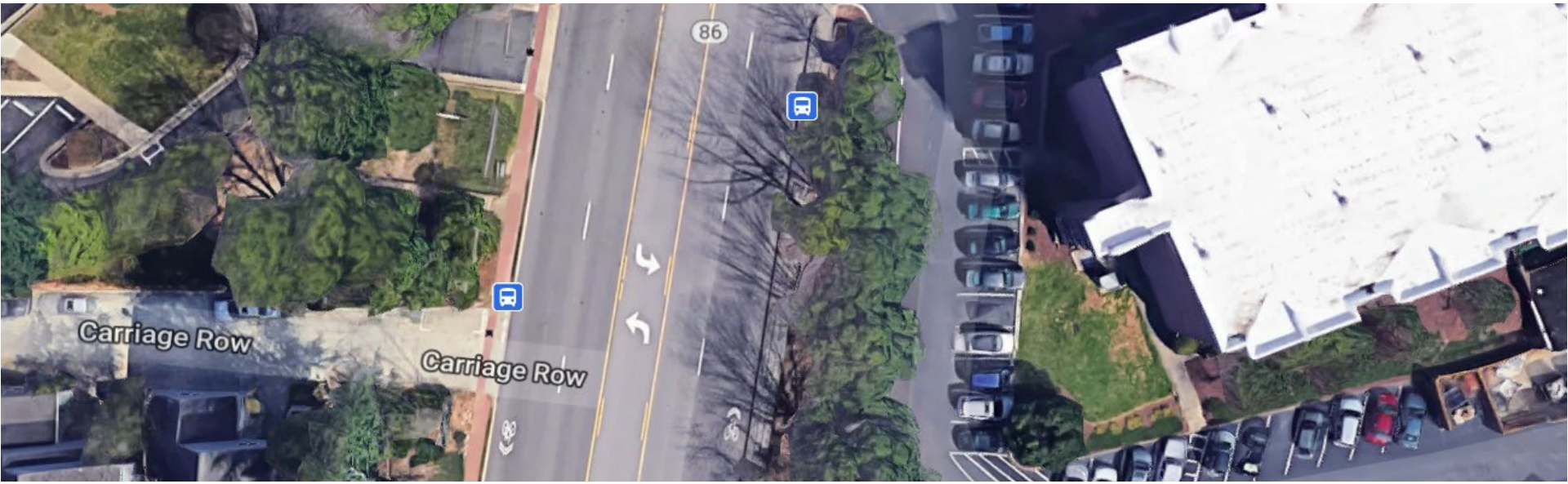

Speed Limit 20-35 mph - Crossing Distance 24' - Population ≥ 10,000
Hourly Pedestrian Volume (ped/h)
Hourly Vehicle Volume Both Directions (veh/h)
Total Pedestrian Delay = 1.3 hours
Total Pedestrian Delay = 5.3 hours
Total Pedestrian Delay = 21.3 hours


Speed Limit 40-45 mph - Crossing Distance 24' - Population ≥ 10,000
Hourly Pedestrian Volume (ped/h)
Hourly Vehicle Volume Both Directions (veh/h)
Total Pedestrian Delay = 1.3 hours
Total Pedestrian Delay = 5.3 hours
Total Pedestrian Delay = 21.3 hours


Speed Limit 20-35 mph - Crossing Distance 60' - Population ≥ 10,000
Hourly Pedestrian Volume (ped/h)
Hourly Vehicle Volume Both Directions (veh/h)
Total Pedestrian Delay = 1.3 hours
Total Pedestrian Delay = 5.3 hours
Total Pedestrian Delay = 21.3 hours


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Mid-Block Location: NC86, Chapel Hill, NC





Step 4: Pedestrian Hybrid Beacon (PHB) Assessment[24]

From Step 3

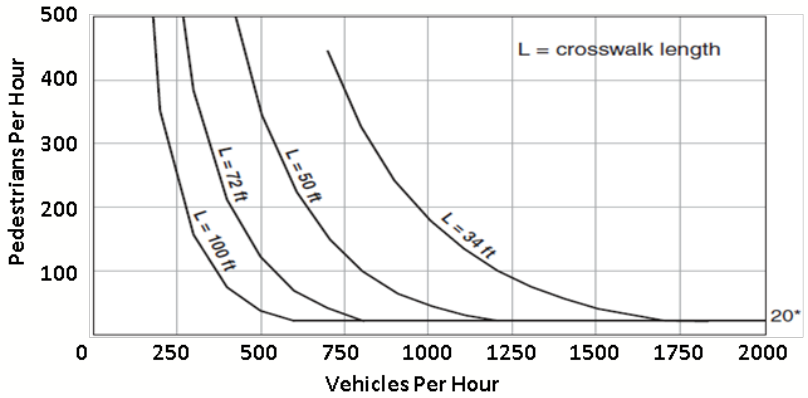
Posted Speed or Operating Speed[11] (85th Percentile)

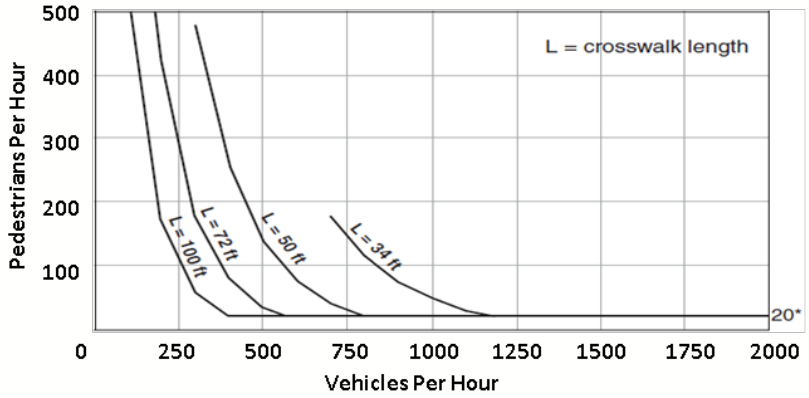
≤ 35 mph

> 35 mph

Crosswalk Length, Vehicle & Pedestrian Volumes

Crosswalk Length, Vehicle & Pedestrian Volumes





Consider Installing PHB[25]

Consider Installing PHB[25]



The Flowchart

NCDOT Pedestrian Crossing Treatment Evaluation Guidance

ITRE

July 17, 2015

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An ADA request[1] follows a different process.

Step 1: Document Existing Characteristics / Signalized Crossing Assessment

Step 2: Unsignalized Crossing or Midblock Crossing Assessment

Legend

- Factor or Site Characteristic
- No Action Required
- Recommended Action
- Required Action
- Further Analysis Needed

Step 3: Additional/Alternative Treatments Assessment[26]

Step 4: Pedestrian Hybrid Beacon (PHB) Assessment[24]

STEP Process

1 COLLECT DATA AND ENGAGE THE PUBLIC

- Collect pedestrian crash and safety data
- Review existing highway safety plans
- Initiate a pedestrian safety action plan
- Pedestrian safety policy analysis
- Request and receive public input
- Conduct a walkability audit

2 INVENTORY CONDITIONS AND PRIORITIZE LOCATIONS

- Inventory roadway characteristics and pedestrian crossings
- Conduct crash cluster analysis
- Conduct systemic analysis

3 ANALYZE CRASH TYPES AND SAFETY ISSUES

- Create crash diagrams
- Identify crash factors
- Conduct an RSA

4 SELECT COUNTERMEASURES

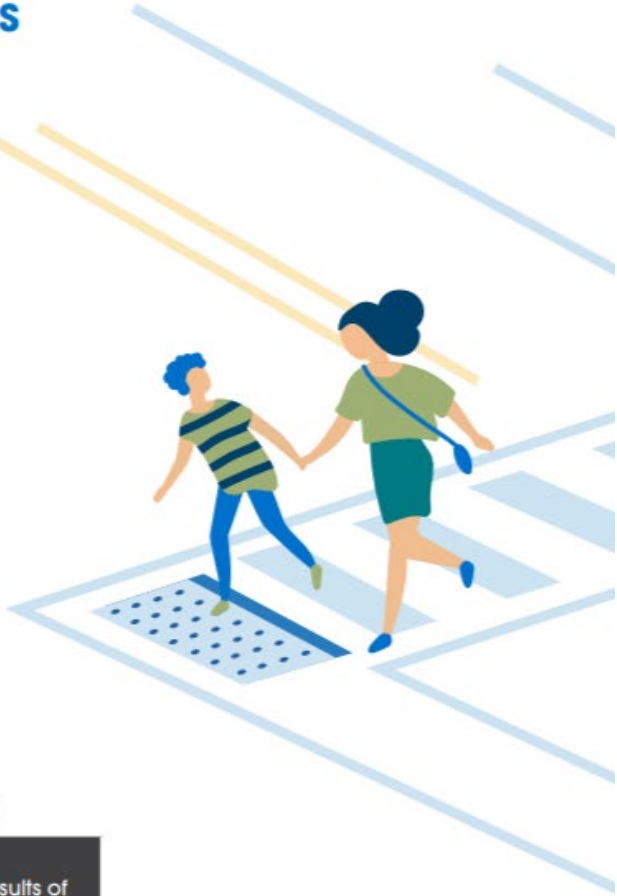
- Review Table 1 (roadway features)
- Review Table 2 (safety issues)
- Review Table 3 (implementation & operations considerations)

5 CONSULT DESIGN AND INSTALLATION RESOURCES

- MUTCD Guidance
- AASHTO & State Guidance
- Local and Other Guidance

6 IDENTIFY OPPORTUNITIES AND MONITOR OUTCOMES

- Identify implementation opportunities
- Consider funding options
- Construct improvements
- Monitor results of implementation



Credit: FHWA STEP Studio

Click a topic to learn more

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	❶ 2 4 5 6	❶ 5 6 7 9	① 5 6 ❼ ❾	❶ 4 5 6	❶ 5 6 7 9	① 5 6 ❼ ❾	❶ 4 5 6 7 9	① 5 6 7 9	① 5 6 ❾
3 lanes with raised median (1 lane in each direction)	❶ 2 3 4 5	❶ ❸ 5 7 9	① ❸ 5 ❼ ❾	① 3 4 5 7 9	① ❸ 5 ❼ ❾	① ❸ 5 ❼ ❾	① ❸ 4 5 7 9	① ❸ 5 ❼ ❾	① ❸ 5 ❾
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	❶ 2 3 4 5 6 7 9	❶ ❸ 5 6 7 9	① ❸ 5 6 ❾	① 3 4 5 6 7 9	① ❸ 5 6 ❼ ❾	① ❸ 5 6 ❾	① ❸ 4 5 6 7 9	① ❸ 5 6 ❾	① ❸ 5 6 ❾
4+ lanes with raised median (2 or more lanes in each direction)	❶ ❸ 5 7 8 9	❶ ❸ 5 7 8 9	① ❸ 5 8 ❾	① ❸ 5 7 8 9	① ❸ 5 ❼ 8 ❾	① ❸ 5 8 ❾	① ❸ 5 ❼ 8 9	① ❸ 5 8 ❾	① ❸ 5 8 ❾
4+ lanes w/o raised median (2 or more lanes in each direction)	❶ ❸ 5 6 7 8 9	① ❸ 5 ❻ 7 8 9	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ 7 8 9	① ❸ 5 ❻ ❼ 8 ❾	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ ❼ 8 9	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ 8 ❾

Given the set of conditions in a cell,

\# Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.

● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.

○ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

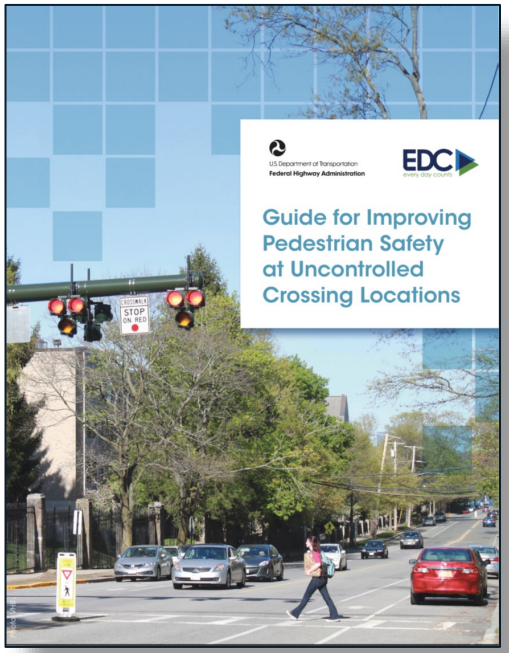
The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
2 Raised crosswalk
3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
4 In-Street Pedestrian Crossing sign
5 Curb extension
6 Pedestrian refuge island
7 Rectangular Rapid-Flashing Beacon (RRFB)**
8 Road Diet
9 Pedestrian Hybrid Beacon (PHB)**

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Spectacular 7: STEP Countermeasures

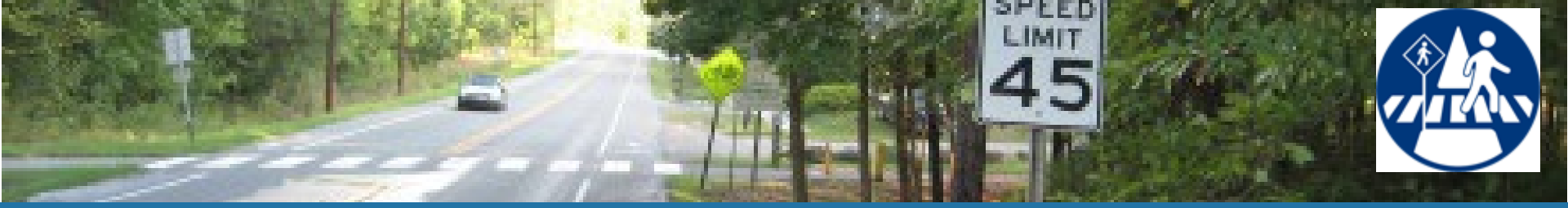
- Raised Crosswalk
- Pedestrian Refuge Island
- Road Diet
- Pedestrian Hybrid Beacon (PHB)
- Leading Pedestrian Intervals
- Crosswalk Visibility Enhancements
- Rectangular Rapid Flashing Beacon (RRFB)





Raised Crosswalk

- ↓ pedestrian crashes by 45%
- ↓ motor vehicle crashes by 30%
- ↓ speed of approaching vehicles
- Typically installed on lower speed, lower volume roads



Medians and Pedestrian Crossing Islands

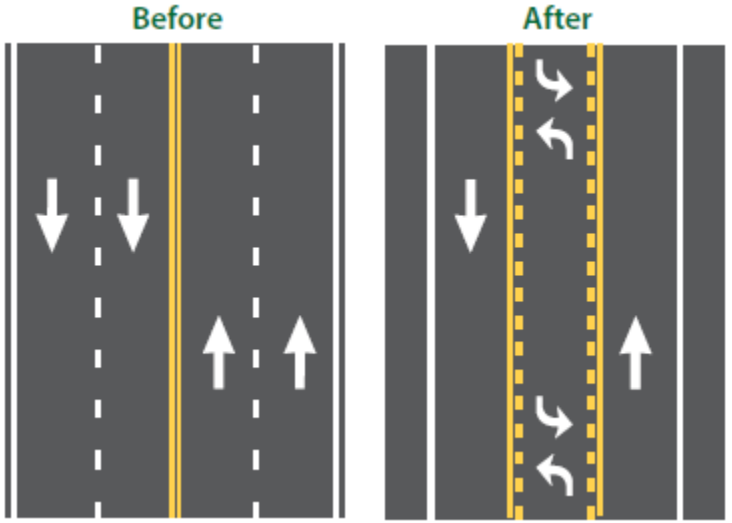
- ↓ pedestrian crashes by 32%
- ↓ motor vehicle crashes by 39%
- ↓ motorist delay
- ↓ speed of approaching vehicles
- Provide access management
- Enhance visibility of crossing





Road Diets

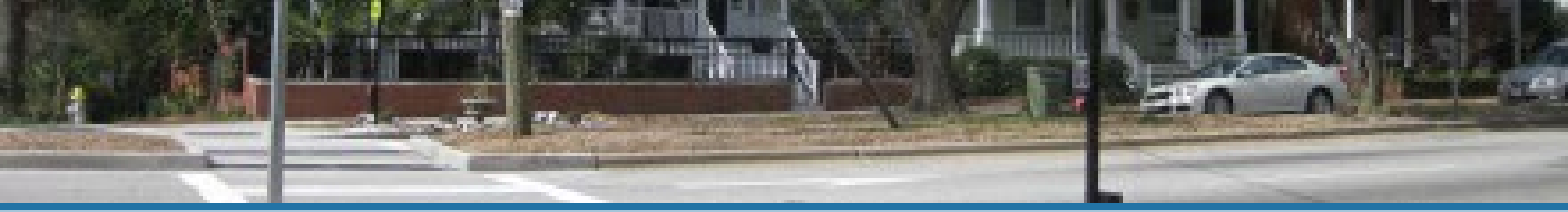
- ↓ crashes by 19 to 47%
- ↓ speed differential
- ↓ vehicle speeds
- ↓ vehicle conflicts (RE, LT, SS)
- Reallocate space for sidewalk, bike lane, buffer zone, parking, etc.
- Rebalance ROW for “complete street”



Pedestrian Hybrid Beacon

- ↓ pedestrian crashes by 55%
- ↓ total roadway crashes by 29%





Other Supplemental Treatments

Crosswalk Visibility Enhancements

- High Vis Marking: ↓ pedestrian crashes by 48%
- Adv. Yield or Stop Sign/Marking: ↓ pedestrian crashes by 25%
- Improved Lighting: ↓ pedestrian crashes by 23%

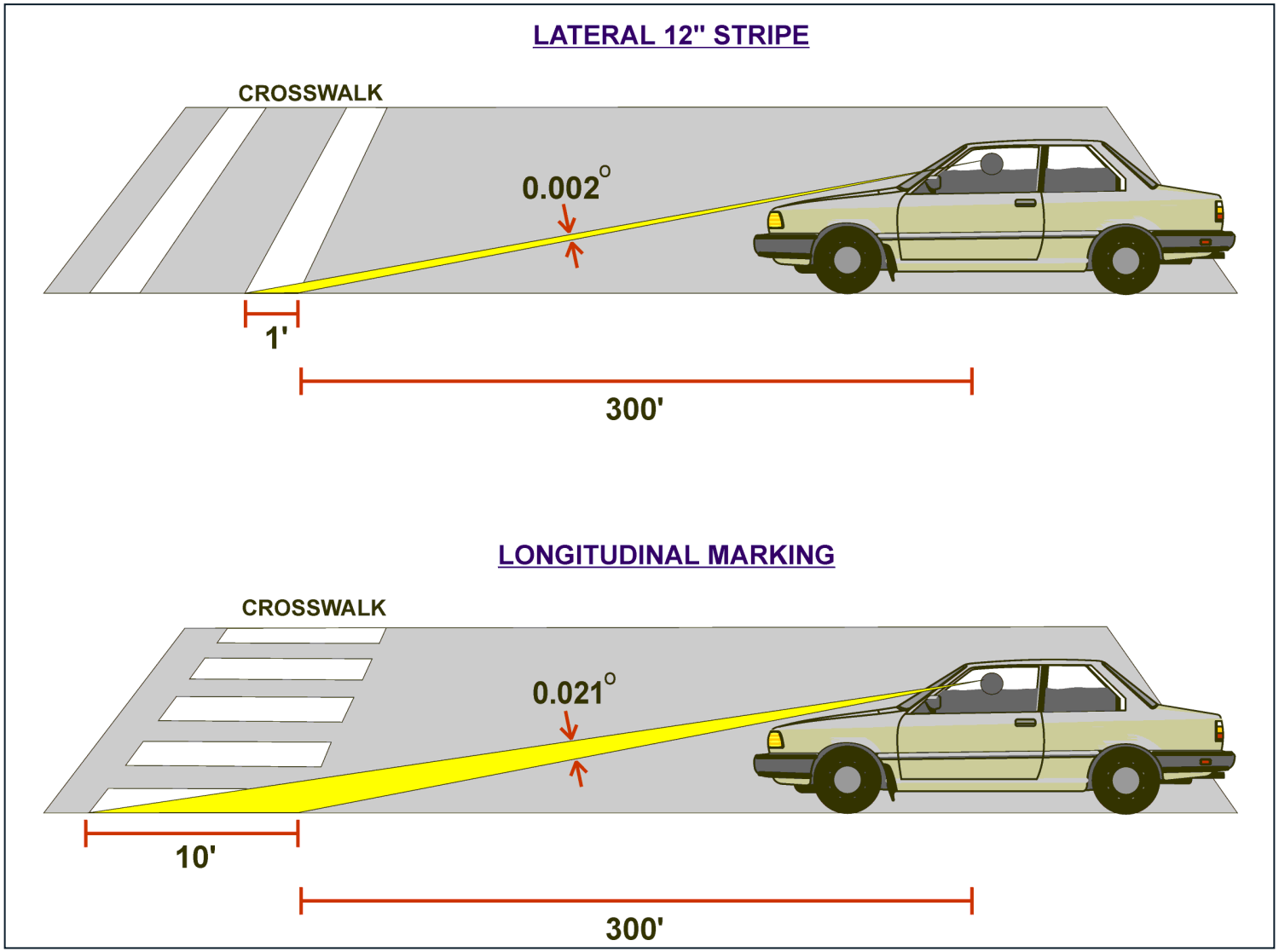
Leading Pedestrian Intervals

- ↓ pedestrian crashes by 13%

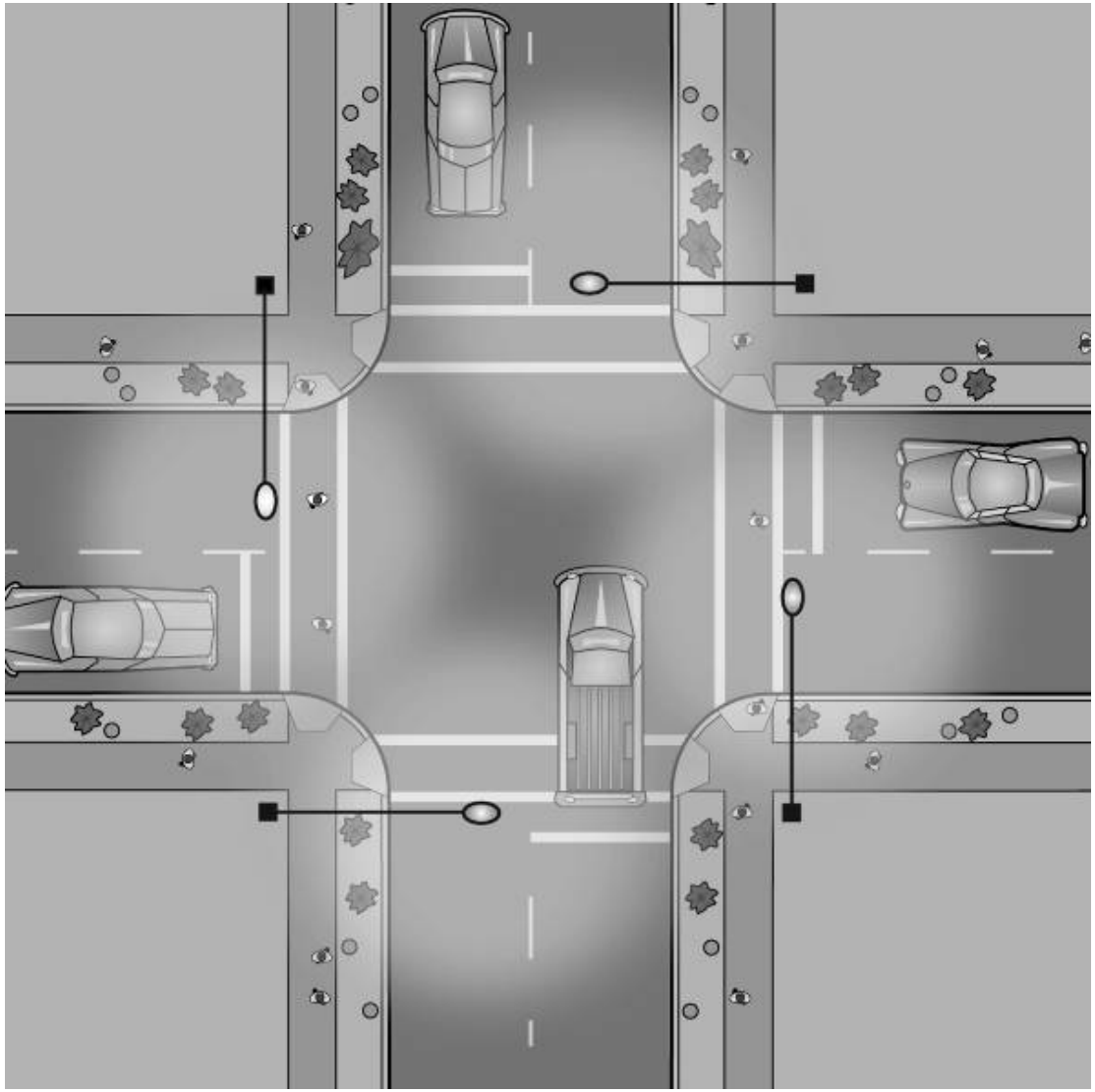
Rectangular Rapid Flashing Beacon (RRFB)

- ↓ pedestrian crashes by 47%
- Most effective on roads < 40 mph

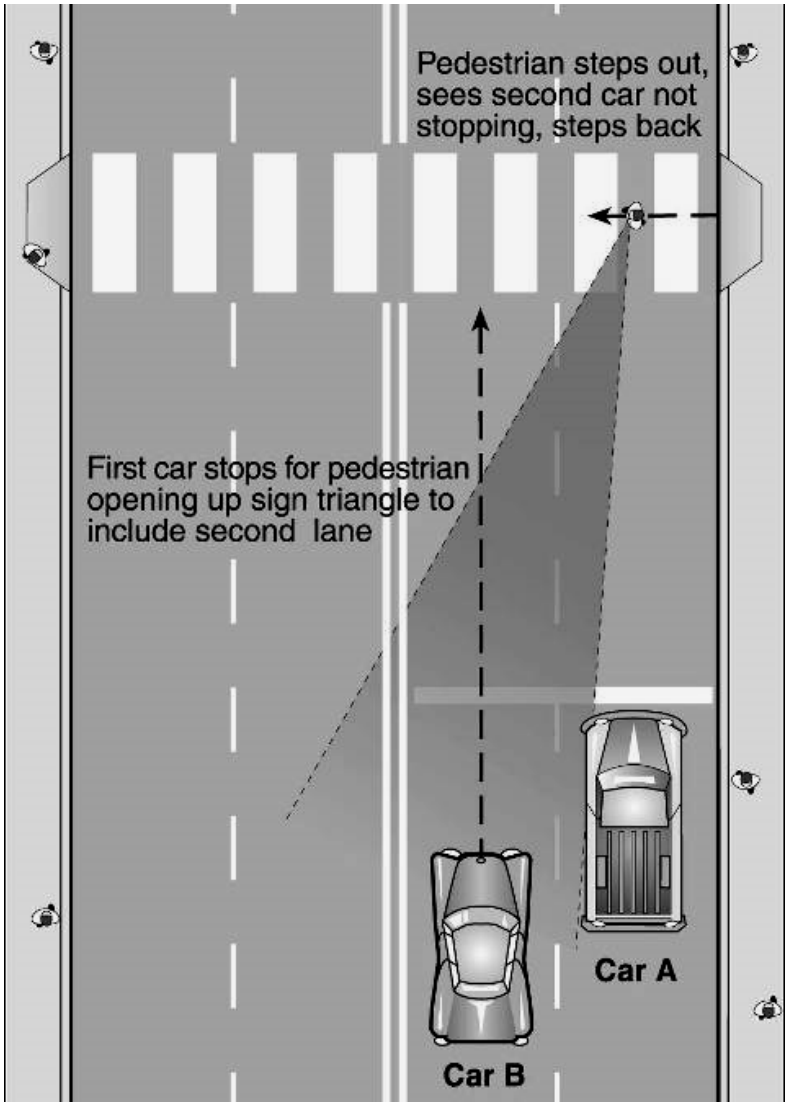
Crosswalk Visibility



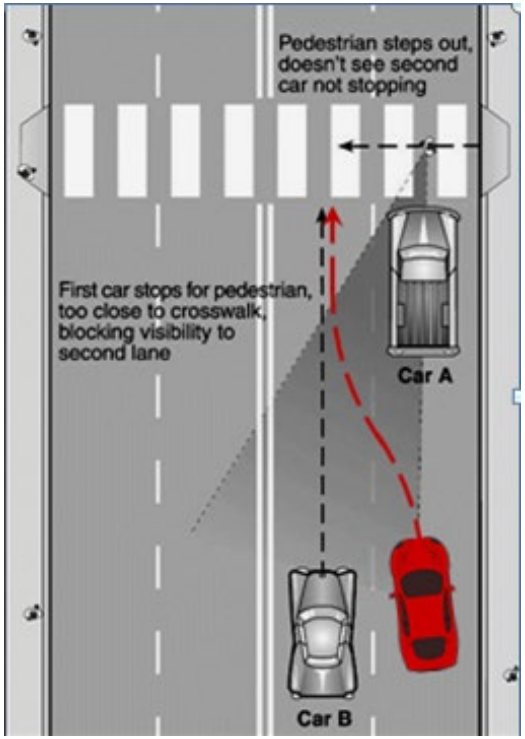
Illumination

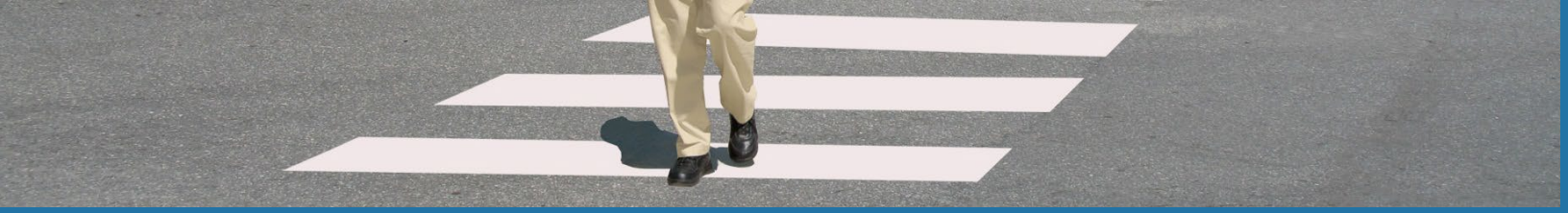


Advanced Yield Lines

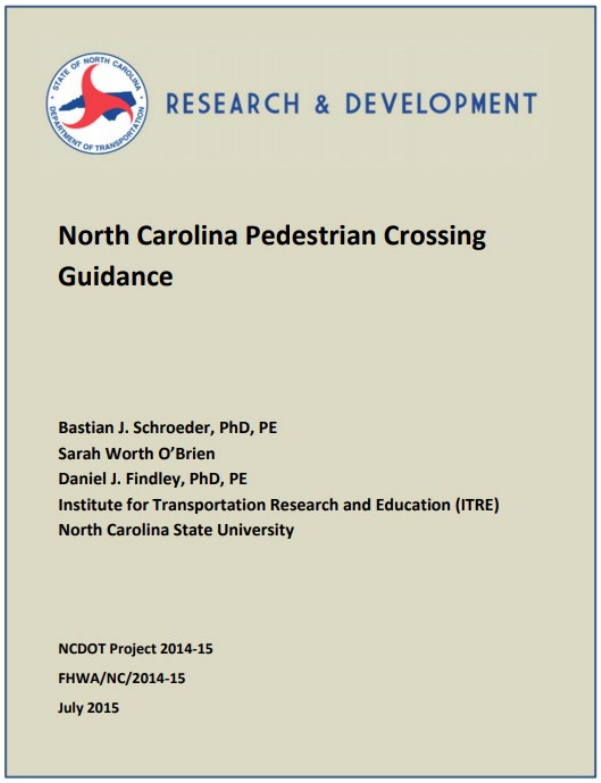








Resources



https://connect.ncdot.gov/resources/safety/Teppl/Pages/Teppl-Topic.aspx?Topic_List=P37



https://safety.fhwa.dot.gov/ped_bike/step/resources/docs/step_studio.pdf

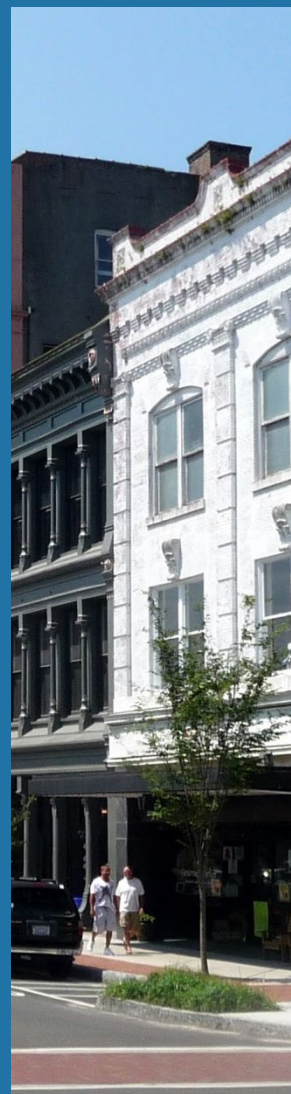
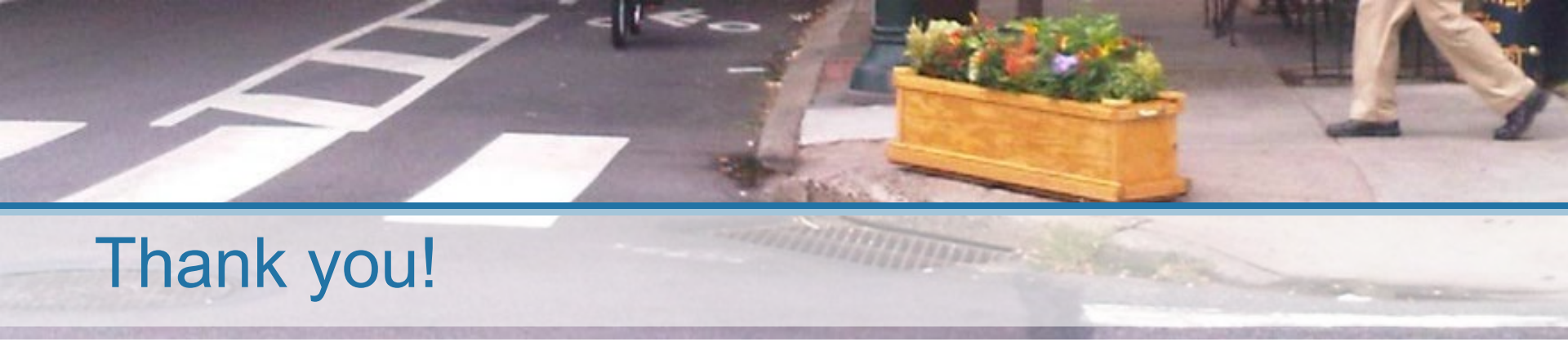


Table 3 – Implementation and Operations



Click the check marks to learn more

	High Visibility Crosswalk Marking	In-Street Sign	Advance Yield or Stop Sign and Marking	Parking Restrictions on Crosswalk Approach	Curb Extension	Improved Nighttime Lighting	Raised Crosswalk	Pedestrian Refuge Island	Rectangular Rapid-Flashing Beacon (RRFB)	Road Diet	Pedestrian Hybrid Beacon (PHB)	Leading Pedestrian Interval (LPI)	Other Pedestrian Signal Options
Primary Safety Issues Addressed													
Reduce crashes at crossing locations	CRF: 48% (Peds)	UNK	CRF: 25% (Peds)	CRF: 30% (Peds)	UNK	CRF: 23% (Peds)	CRF: 45% (Peds)	CRF: 32% (Peds)	CRF: 47% (Peds)	CRF: 19-47% (all crashes)	CRF: 55% (Peds)	CRF: 13% (Peds)	CRF: 25% (Peds - Ped Countdown Signal)
Reduces vehicle speeds					✓		✓			✓			✓
Improves conspicuity/visibility	✓	✓	✓	✓	✓	✓	✓		✓			✓	
Improves separation from traffic					✓			✓		✓			
Installation Priorities													
Higher Pedestrian Volumes	✓						✓				✓	✓	✓
Public Response / Education							✓		✓	✓	✓		
Midblock (non-intersection) Location	✓	✓	✓		✓	✓	✓	✓	✓		✓		✓
Intersection Location					✓	✓	✓	✓		✓		✓	✓
Multi-Lane Crossings			✓					✓	✓	✓	✓		
Operations & Maintenance Considerations													
Transit / Emergency Vehicles	✓				✓		✓			✓			
Snow Removal					✓		✓	✓					
Drainage					✓		✓	✓					
Traffic & Bicycle Operations					✓					✓	✓	✓	✓
Push Button Maintenance									✓		✓		✓
MUTCD Reference	3B.18 2C.50	2B.12	3B.16 2B.11	2B.46 3B.19 3B.23			3B.25	3B.10 3B.23 3B.18	2C.50 7B.08 IA-21		Figure 4F-1 Figure 4F-2 Part 4F	4E.06	



Thank you!

Questions

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