



FDOT

TRANSPORTATION SYMPOSIUM

2019

Traffic Engineering Manual (TEM) Updates

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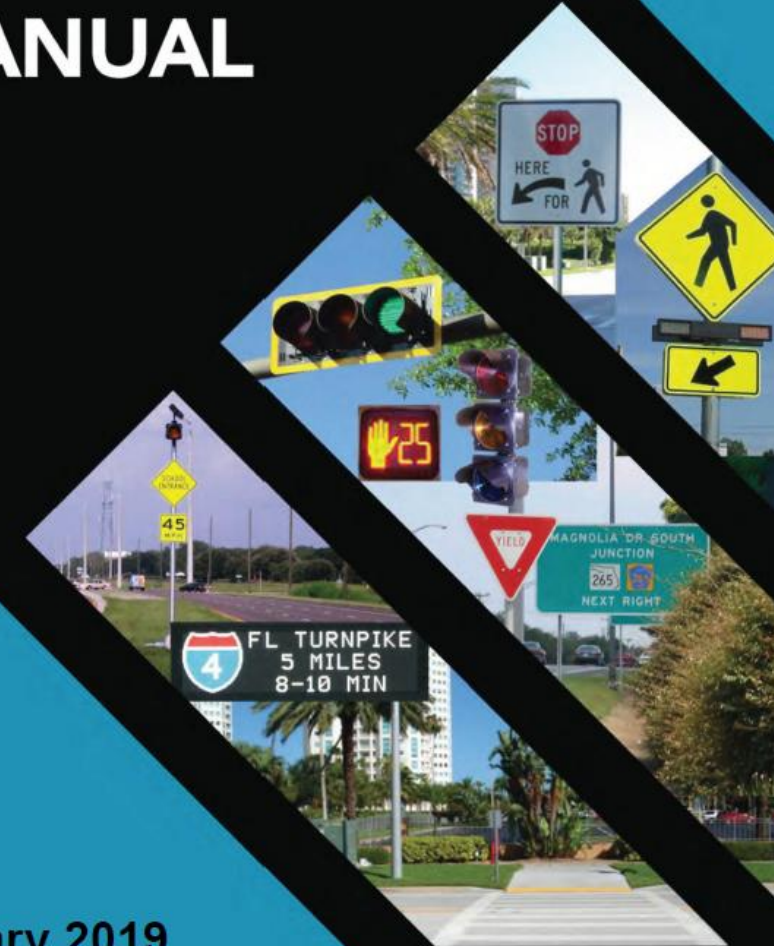
Outline

- Introduction on Traffic Engineering Manual (TEM)
- Updates for TEM Section 2.11
- Updates for TEM Section 3.8
- Updates for TEM Section 3.10
- Updates for TEM Section 3.11

FDOT Traffic Engineering Manual

- To provide traffic engineering standards and guidelines to be used on the Florida State Highway System (SHS)
- Authority
 - Florida Statute 20.23(4)(a)
 - Florida Statute 334.048(3)
 - Chapter 316, F.S. Rule 14-15.010, F.A.C., Manual on Uniform Traffic Control Devices (MUTCD)
- Structure for TEM
 - Chapter 1 Procedure
 - Chapter 2 Signs
 - Chapter 3 Signals
 - Chapter 4 Markings
 - Chapter 5 Specialized Operational Topics

TRAFFIC ENGINEERING MANUAL



January 2019

Chapter 2 Signs

- Provides guidance to Designers and/or Traffic Engineers on WHEN to use specific highway signs on the Florida State Highway System
- Includes purpose, conditions for use, physical characteristics, standards, and installation of diversified highway signs
- Supplements the Manual on Uniform Traffic Control Devices (MUTCD) guidelines
- Includes 42 sections



Chapter 3 Signals

- 3.1 - Signalized intersection flashing mode operation and flashing beacons
- 3.2 - Guidelines for left-turn treatment
- 3.3 - Scheduling traffic-signal studies and funding arrangements
- 3.4 - Emergency traffic-control signals
- 3.5 – Traffic-signal mast arm support boundaries
- 3.6 - Standardization of yellow change and red clearance intervals for signalized intersections
- 3.7 - Accessible pedestrian signals
- 3.8 - Marked pedestrian crosswalks at mid-block and uncontrolled approach locations
- 3.9 – Section rescinded
- 3.10 - Flashing yellow arrow signal application
- 3.11- Leading pedestrian interval signal application (new section)

Chapter 4 Markings

- 4.1 – Crosswalks in heavy pedestrian concentration areas
- 4.2 – Pavement word, symbol, and arrow markings
- 4.3 – Use of blue raised pavement markers to identify fire hydrants
- 4.4 – Roundabout markings



- 4.5 – Express lane markings
- 4.6 – Internally illuminated raised pavement markers

Chapter 5 Specialized Operational Topics

- 5.1 – Golf cart crossing and operation on the State Highway System
 - Developed in response to a growing interest in using golf carts
 - Establish criteria and guidelines for golf carts on state highway systems
 - Mid-block crossing
 - Side street stop controlled intersection
 - Full signalized intersection
 - Provide safety recommendations for the use of golf carts on sidewalks





Procedures for TEM Adoption

- Resources for establishing TEM engineering criteria and standards
 - Recommended practice of the MUTCD
 - Specific research conducted for the FDOT
- State Traffic Operations Engineer (STOE) and District Traffic Operations Engineer (DTOE) will constitute the Manual Review Committee
- Items warranting immediate change will be made with the approval of the STOE
- Substantive revisions or policy-related issues will be approved by the Secretary
- Last updated in November 2018

FDOT TEM Updates

November 1, 2018 Bulletin

Chapter 2 Signs

Section 2.6

Section 2.15

Section 2.29

Chapter 3 Signals

Section 3.4

Section 3.8

Section 3.10

Chapter 4 Markings

Section 4.5

Section 4.6

May 31, 2019 Bulletin

Chapter 2 Signs

Section 2.11

Chapter 3 Signals

Section 3.8

Section 3.11

November 1, 2019 Bulletin

- TBD

Updates for TEM Section 2.11

Section 2.11 Guidelines for Use of Bicycle Signs

- Overview of Section 2.11 and upcoming modifications
- Section name change from 'Guidelines for Bicycle Warning Signs' to 'Guidelines for Use of Bicycle Signs'



Section 2.11 Guidelines for Use of Bicycle Signs

- Importance of Section 2.11
 - Provides guidance on the use of bicycle signs
- Objective of using bicycle signs
 - Improve motorist awareness of people biking on State roadways

Topic No. 750-000-005
Traffic Engineering Manual
Signs

March 1999
Revised: May 31, 2019

Section 2.11

GUIDELINES FOR USE OF BICYCLE SIGNS

2.11.1 PURPOSE

To provide guidance on the use of bicycle signs when a documented need exists. The objective of using bicycle signs is to improve motorist awareness of people biking on State roadways.

2.11.2 GENERAL

Chapter 9B and Section 2C.49 of the MUTCD establish the standards for bicycle signs installed on public roadways. The MUTCD must be reviewed and considered with bicycle sign requests.

The use of bicycle signs as a warning is shown in Section 9B.18 and Section 2C.49 of the MUTCD. The use of bicycle signs as regulatory is shown in Section 9B.06 of the MUTCD.

Bicycle signs shall be installed only at locations reviewed and approved by the District Traffic Operations Engineer.

The District Bicycle/Pedestrian Coordinator and District Bicycle/Pedestrian Safety Specialist will provide recommendations for all bicycle sign requests and should consider the following conditions when reviewing requests for bicycle signs:

- (a) Context classification
- (b) Land use
- (c) Volumes
- (d) Crash data
- (e) Geometric criteria

Bicycle signs shall be mounted in accordance with existing Department standards.

2.11.3 CONDITIONS FOR USE

- (1) Bicycle signs should be used only at locations where a documented need exists to enhance the awareness of bicycles on a facility or where required by a Standard.
- (2) The BICYCLES MAY USE FULL LANE (R4-11) sign is used when it is important to inform road users that bicyclists might occupy the travel lane such as where commuter bicyclists are common users of the facility. The BICYCLES MAY USE

Updates for TEM Section 2.11

- Key Points

- Removed focus on the 'Share the Road' sign to the 'Bicycles May Use Full Lane' sign
- Bicycles May Use Full Lane message is much clearer in conveying intended message that people biking are expected to use the full lane
- Share the Road message may not be well understood by majority



R4-11

Updates for TEM Section 2.11

- Bicycle sign installations require District Traffic Operations Engineer approval
- Reviews for bicycle sign requests should consider the following conditions:
 - Context classification
 - Land use
 - Volumes
 - Crash data
 - Geometric criteria

Updates for TEM Section 2.11

- Bicycles May Use Full Lane sign may be installed when a shared lane marking is present or when all of the following conditions exist:
 - Where travel lanes are less than 14 feet wide
 - No bicycle lane is present
 - No rideable paved shoulder of 4 feet width or greater is present
- Requests to install Bicycles May Use Full Lane sign on multilane roadways:
 - Submitted to the State Traffic Operations Engineer by the District Traffic Operations Engineer
 - Reviewed and approved by the State Traffic Operations Engineer

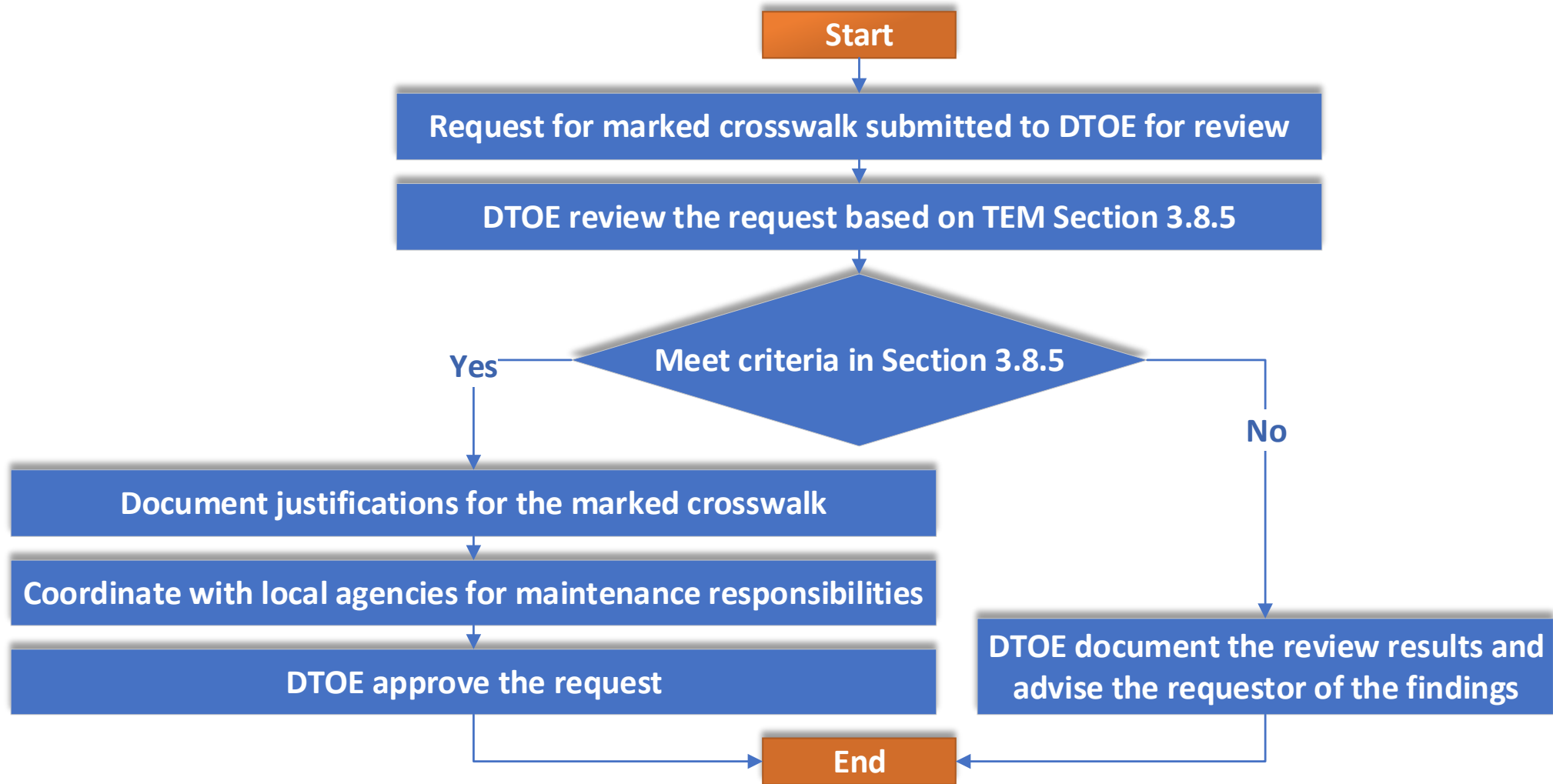
Updates for TEM Section 3.8

Section 3.8 Marked Pedestrian Crosswalks at Midblock and Uncontrolled Approach Locations

- Purpose
 - To establish criteria for installation and operation of marked pedestrian crosswalks at mid-block and unsignalized intersections
- Objectives for marked crosswalks
 - Improve pedestrian connectivity
 - Reduce instances of pedestrians crossing at random and unpredictable locations
- Marked crosswalks are not suitable for all locations



Procedures for Installing Marked Crosswalk



Evaluation Factors for a Marked Crosswalk

- Proximity to significant generators
- Pedestrian demand
 - Minimum level of pedestrian demand
- Pedestrian-vehicle crash history
- Safety considerations
- Distance between crossing locations
 - Minimum location characteristics

Request for marked crosswalk submitted to DTOE for review

Engineering Study for Marked Crosswalk

- Field data to demonstrate the need for a marked crosswalk
- Potential links between pedestrian generators and attractors
- All safety considerations
- Proposed crossing location and corresponding signing, marking, and signal treatment
- Any pedestrian-vehicle crash history within the vicinity of the proposed crosswalk
- Transit stop activity data and the location of transit stop within the vicinity of the proposed crosswalk



Meet criteria in Section 3.8.5

Pedestrian Crossing Treatments

- Special Emphasis Crosswalk Marking
- Traffic Control Signal
- Pedestrian Hybrid Beacon (PHB or aka HAWK)
- Rectangular Rapid Flashing Beacons
- Flashing Yellow Warning Sign Beacons
- In-Roadway Lights
- Passive Pedestrian Detection



Additional Treatments

- STOP HERE FOR PEDESTRIAN sign (R1-5)
- In-Street Pedestrian Crossing Sign (R1-6 or R1-6a)
- Pedestrian Refuge Island
- Curb extensions
- Raised crosswalk
- Speed reduction treatment
- Overhead lighting
- Highlighted LED Signs

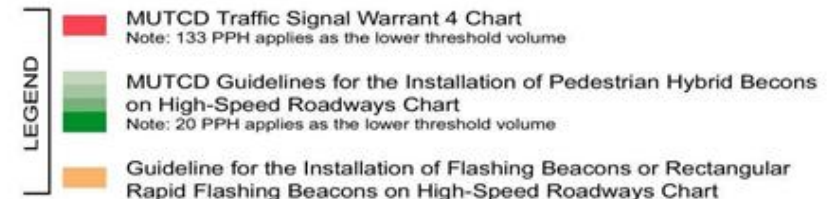
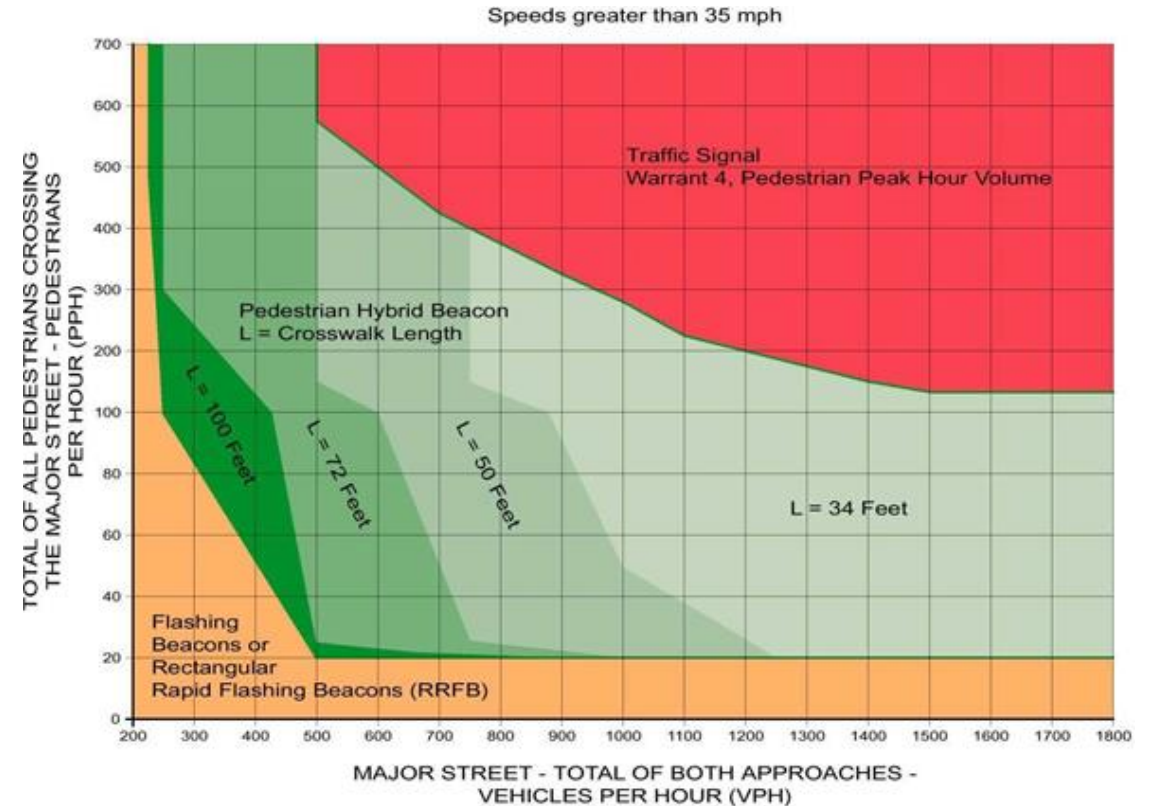
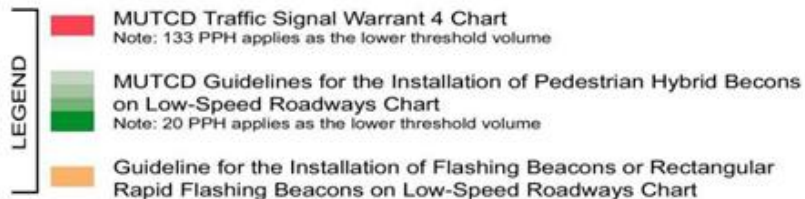
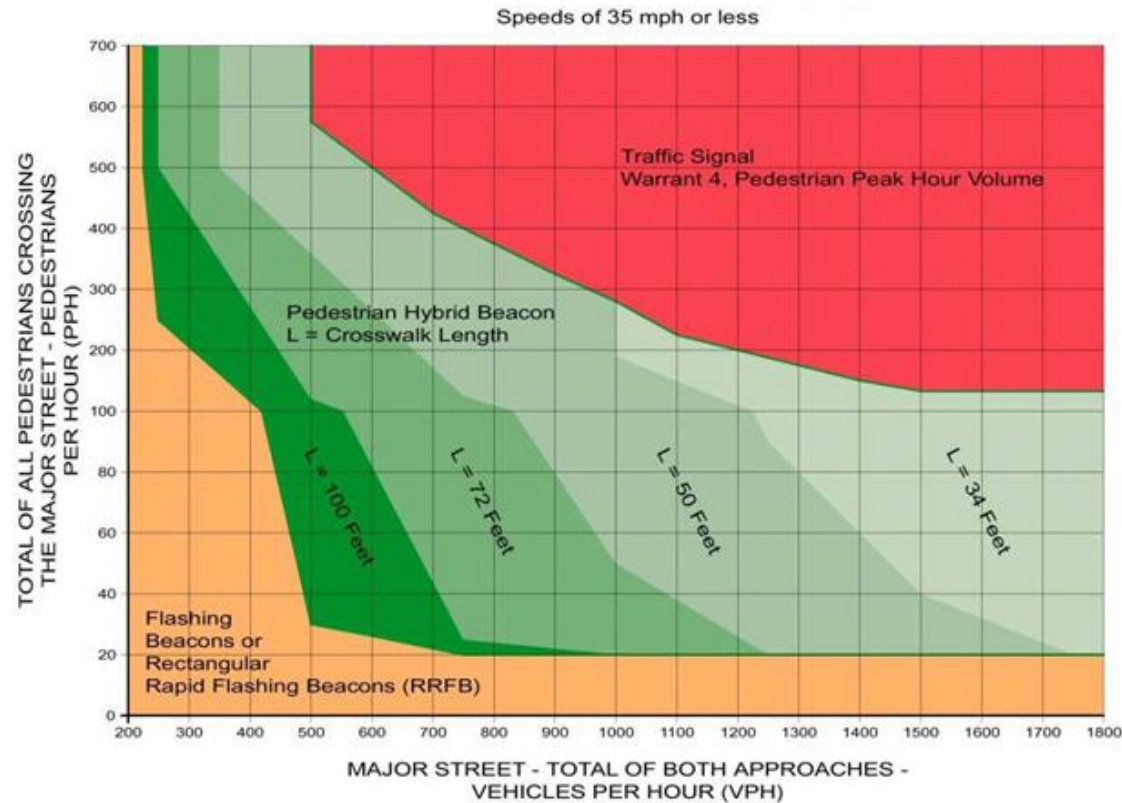
Monday @ 3:00 pm

Midblock Crosswalks

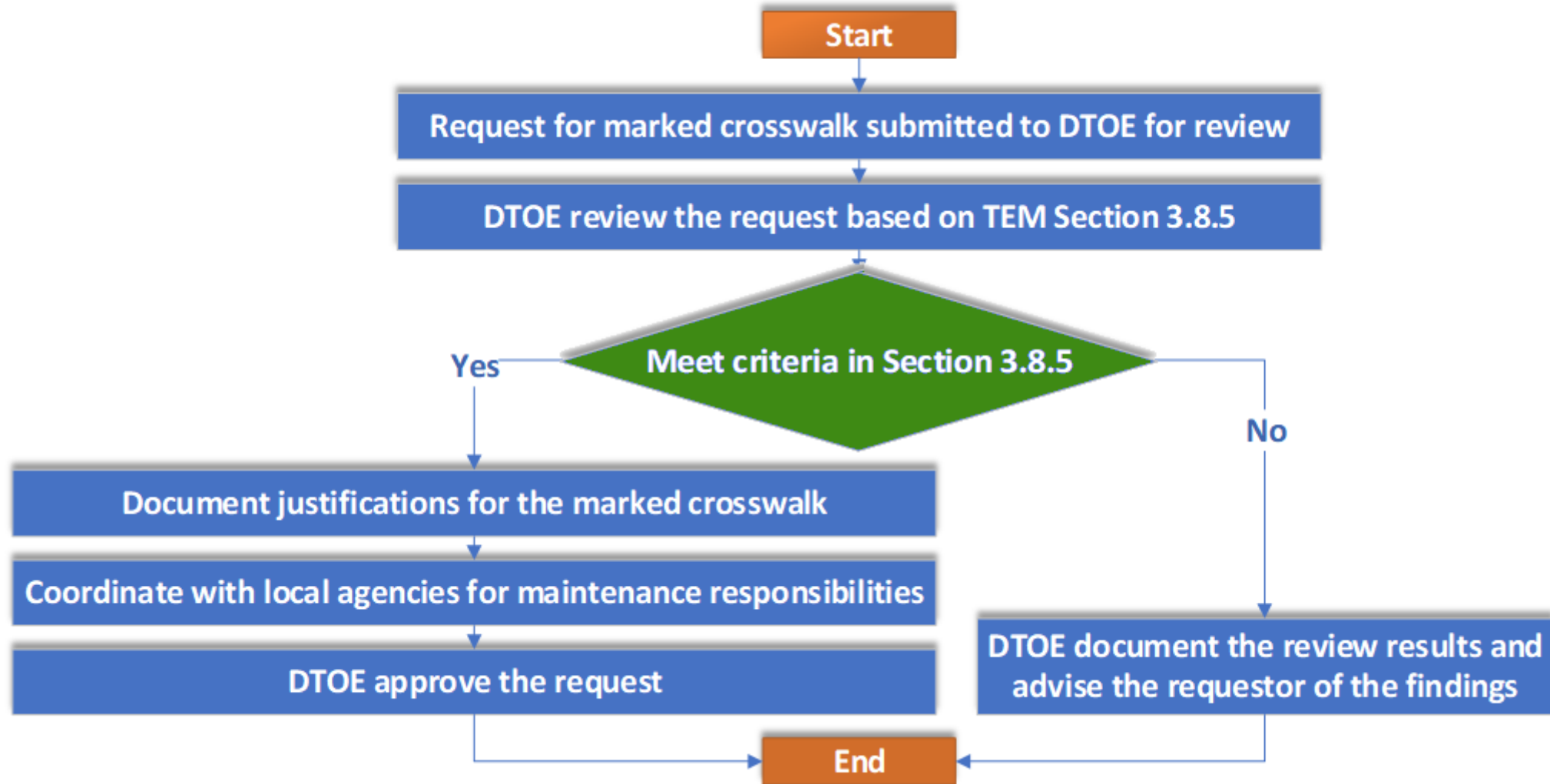
Trey Tillander and Alan El-Urfali



Guidelines for the Installation of Pedestrian Treatments



New Procedures for Installing Marked Crosswalk



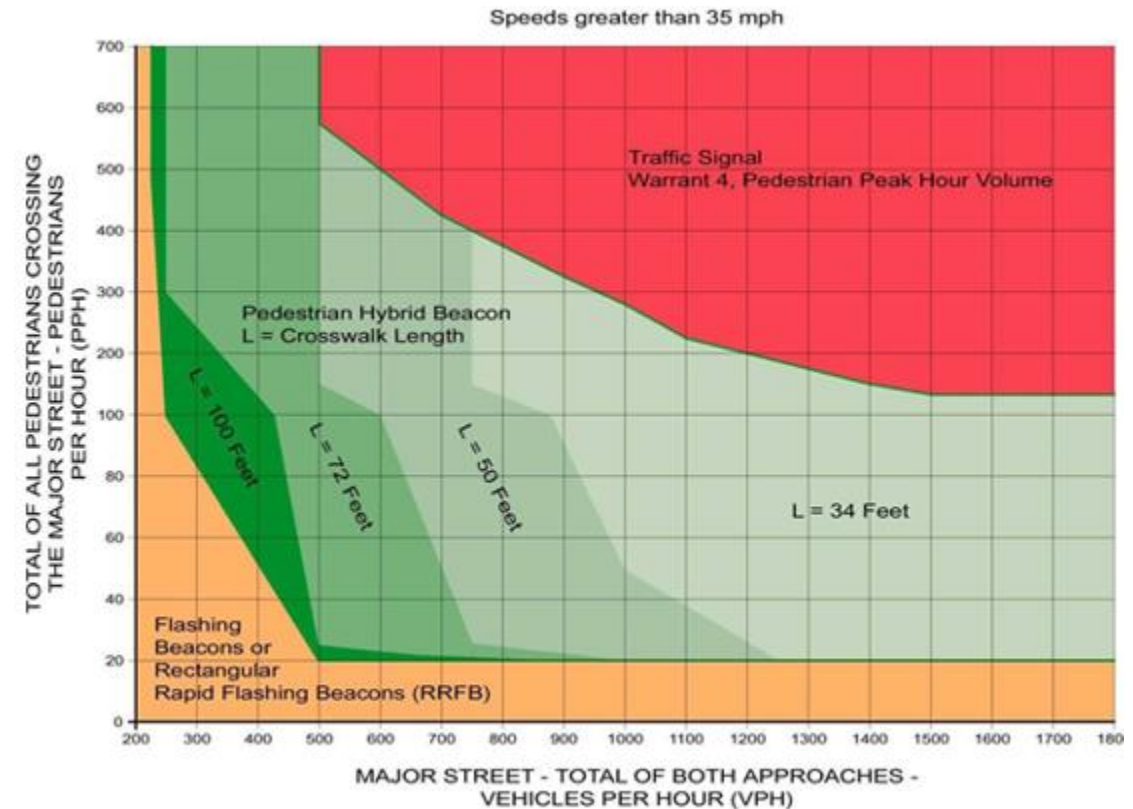
Exemptions for Minimum Pedestrian Per Hour

- Exemptions for minimum pedestrian volume:
 - Rectangular rapid flashing beacons
 - Flashing beacons
 - Marked crosswalk
- Maximum speed for exemption by context classification:
 - C2T (Rural town): 35 MPH
 - C4 (Urban general): 45 MPH
 - C5 (Urban center): 35 MPH
 - C6 (Urban core)



Traffic Signal Warrant 4 Option

Pedestrian Traffic Signal
Warrant 4 Pedestrian Peak Hour
133 PPH

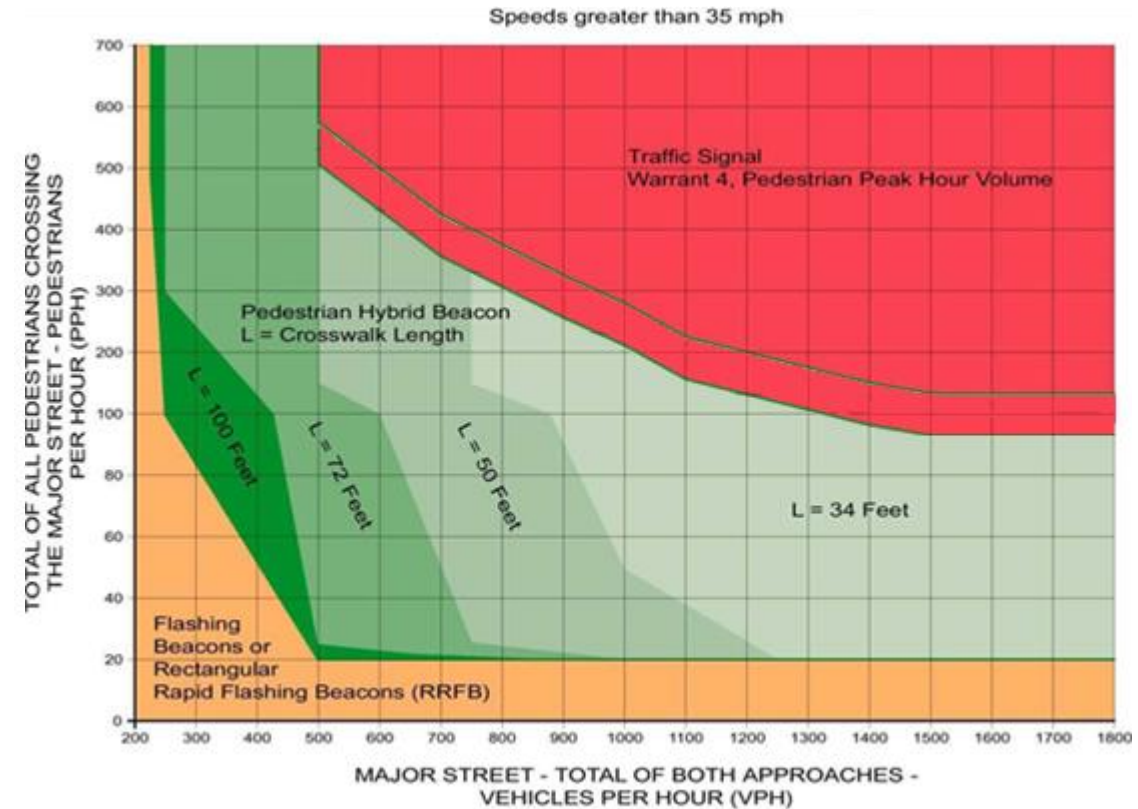


Traffic Signal Warrant 4 Option

Pedestrian Peak Hour (70% Factor)

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 35 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000.

93 PPH

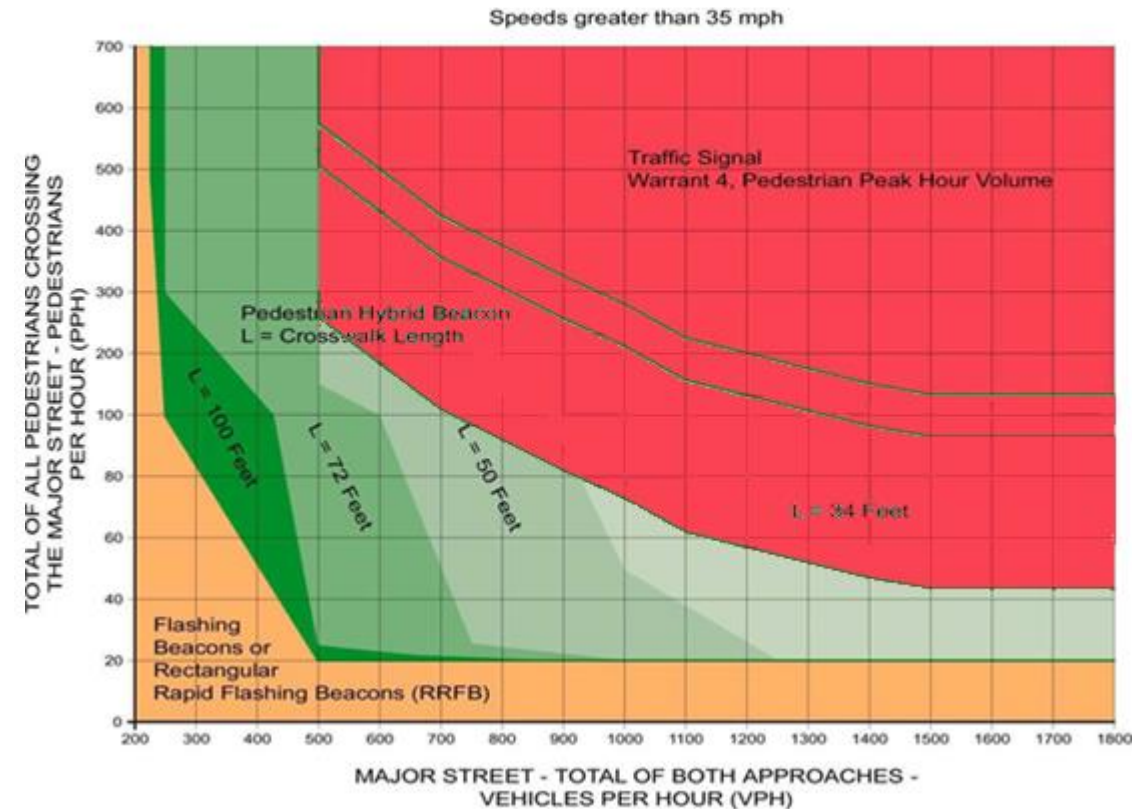


Traffic Signal Warrant 4 Option

Section 4C.05 Option 07

The criterion for the pedestrian volume crossing the major street may be reduced as much as 50 percent if the 15th-percentile crossing speed of pedestrians is less than 3.5 feet per second.

47 PPH



Updates for TEM Section 3.10

Section 3.10 Flashing Yellow Arrow Signal Application

- Flashing Yellow Arrow for Protected/Permissive (PPLT) Mode and Protected Only Mode Left Turns
 - Approved in **2009 edition MUTCD**, [Section 4D.18](#)
- Purpose
 - To establish criteria for the installation and operation of left turn flashing yellow arrow (FYA) signals
 - To provide guidelines and best practices for installation of FYA signals at new and existing intersections

Topic No. 750-000-005
Traffic Engineering Manual
Signals

November 2018

Section 3.10

FLASHING YELLOW ARROW SIGNAL APPLICATION

3.10.1 PURPOSE

To establish criteria for the installation and operation of left and right turn flashing yellow arrow (FYA) signals. Also, to provide guidelines and best practices for installation of FYA signals at new and existing intersections consistent with [Section 4D.20 of the MUTCD](#).

3.10.2 BACKGROUND

- (1) For many years, some engineers have had concerns that drivers turning left on a permissive circular green signal indication might inadvertently mistake that indication as implying the left turn has the right of way over opposing traffic, especially under some geometric conditions.
- (2) To date, research studies and guidelines have only been conducted for left turning FYA treatments. However, the use of right turn FYA treatments is permissible in accordance with the MUTCD and this section. Further guidance for right turn FYA treatments will be included upon research findings, implementation, and case studies.
- (3) In 2003, National Cooperative Highway Research Program (NCHRP) completed research for the "Evaluation of Traffic Signal Displays for Protected/Permissive Left-Turn Control" and published the [NCHRP Report 493](#). The key findings of the research are as follows:
 - (a) The FYA was found to be a good overall alternative to the circular green as the permissive signal display for a left-turn movement.
 - (b) The FYA was found to have a high level of understanding and correct response by left-turn drivers, and a lower fail-critical rate than the circular green.
 - (c) The FYA display in a separate signal face for the left-turn movement offers more versatility in field application. It is capable of being operated in any of the various modes of left-turn operation by time of day, and is easily programmed to avoid the "yellow trap" associated with some permissive turns at the end of the circular green display.

Flashing Yellow Arrow

3.10.2 Background

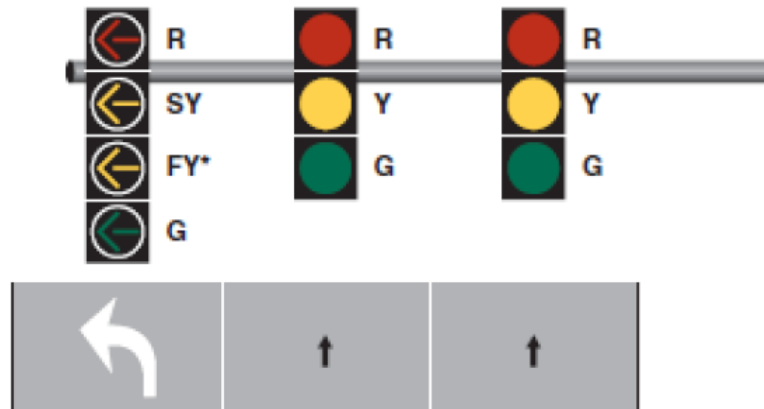
- Findings from NCHRP project “Evaluation of Traffic Signal Displays for Protected/Permissive Left-Turn Control”
 - The best alternative to the circular green display as the permissive signal display
 - A high level of understanding and correct response by left-turn drivers
 - A lower fail-critical rate than the circular green display
 - A separate signal face for the left-turn movement offers more versatility in field application
 - Capable of being operated in any of the various modes of left-turn operation by time of day
 - Easily programmed to avoid the "yellow trap" associated with permissive turns
- FHWA CMF Clearinghouse
 - $CMF=0.857$ for installation of left turn flashing yellow arrow signals

Flashing Yellow Arrow

3.10.3 Operational Requirements

Four-Section Signal Protected-Permissive Left Turn Mode

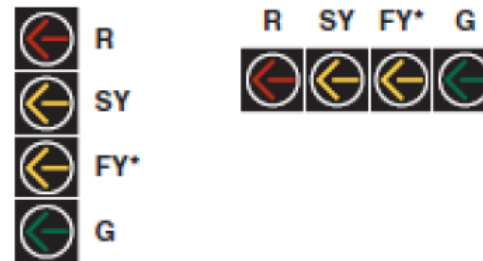
A – Typical Position



Legend

- Direction of travel
- SY Steady yellow
- FY Flashing yellow

B – Typical Arrangements



* Shall not be displayed when operating in the protected only mode



Flashing Yellow Arrow (FYA)

3.10.6 Variable Mode of Operation

- Variable mode operation
 - Change between protected only to protected/permissive mode by time of day
 - Change between protected/permissive to permissive only operation by time of day
- Variable mode possible with the four-section FYA signal face
 - This type of operation is beneficial
- Ensure traffic signal controller capable of switching between modes
 - FYA indication and opposing through movement indication terminate together
- When switching between protected/permissive to permissive only
 - Ensure that the controller is capable of reassigning the left turn detectors to call the associated through phases by time of day

Flashing Yellow Arrow (FYA)

3.10.8 Education

- Education is always a key component
 - Example of a “tip card” available for the FYA
 - Florida DMV Handbook (2019)

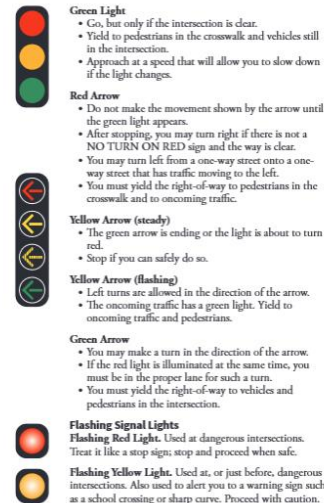
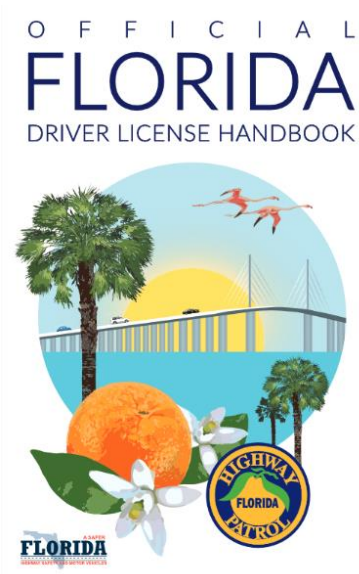


Figure 3.10-2. Flashing Yellow Arrow Tip Card



Flashing Yellow ARROW

What you need to know!

What is a flashing yellow arrow?

A new traffic signal that means you can turn left if there is a safe gap in traffic



SEE THIS	DO THIS
	Turn left.
	Prepare to stop or complete your left turn.
	Turn left provided there is a safe gap in vehicle and pedestrian traffic.
	Stop.

www.FLSams.org

Flashing Yellow Arrow

3.10.9 Signal Retrofit Checklist

- The MUTCD does not include a standard sign for FYA installation
 - FYA display is intuitively obvious in meaning to drivers
 - An explanatory sign is unnecessary
- FDOT “Left Turn Signal – Yield on Flashing Arrow” sign
 - *FTP-85-13, [Standard Plans Index 700-102, FDOT Design Manual](#)*
 - Can be installed adjacent to the new head for additional clarification
- FYA face is to be installed at an existing location
 - Verify the sign can be installed
 - Ensure “Left Turn Yield on Green” sign (R10-12) is removed if in place

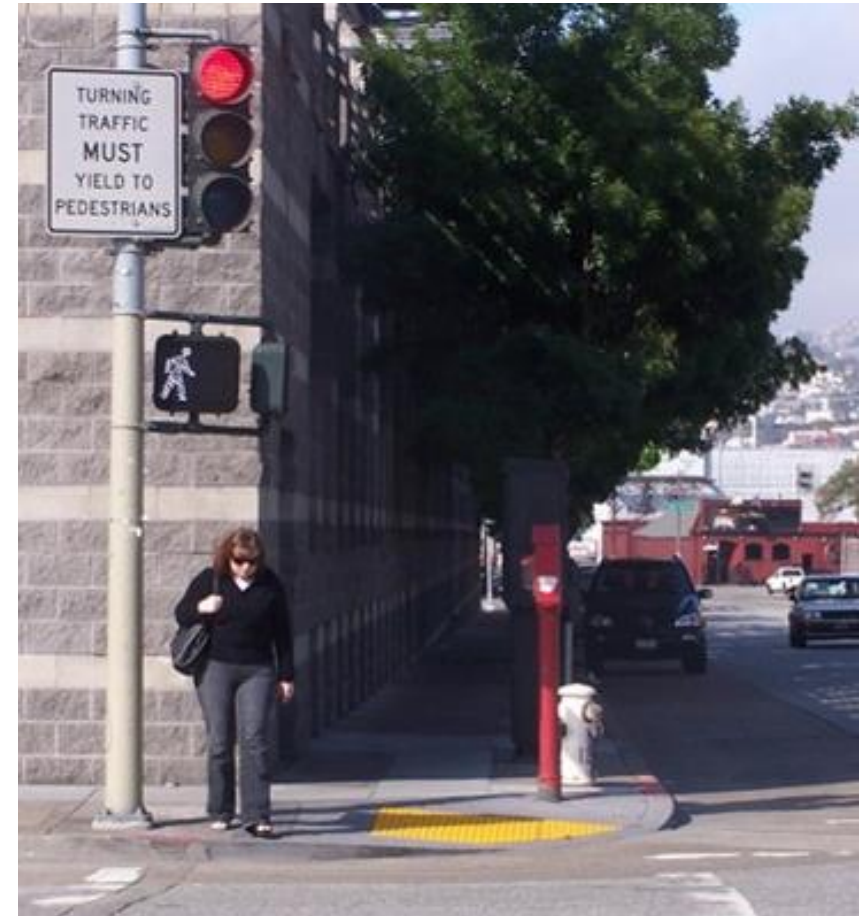
Figure 3.10-3. Flashing Yellow Arrow Sign



Updates for New TEM Section 3.11

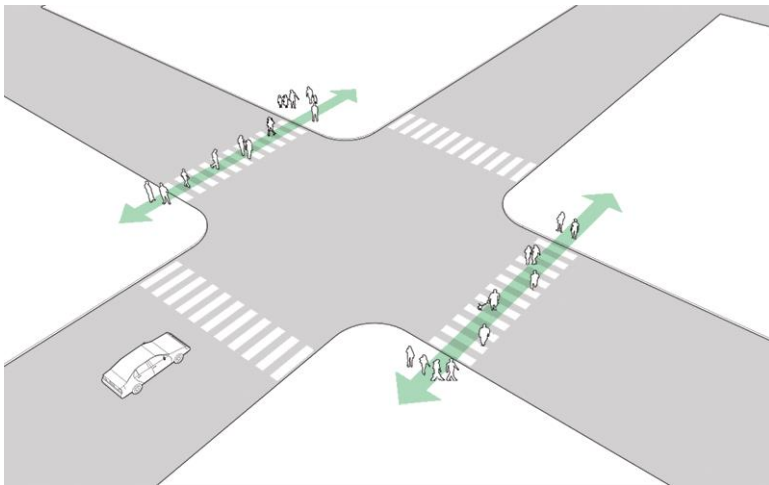
Section 3.11 Leading Pedestrian Interval Signal Application

- New section for FDOT TEM
- Leading pedestrian interval (LPI)
 - Also know as “pedestrian head start” or “delayed vehicle green”
- Purpose
 - To establish criteria for implementing LPI at new and existing signalized intersections



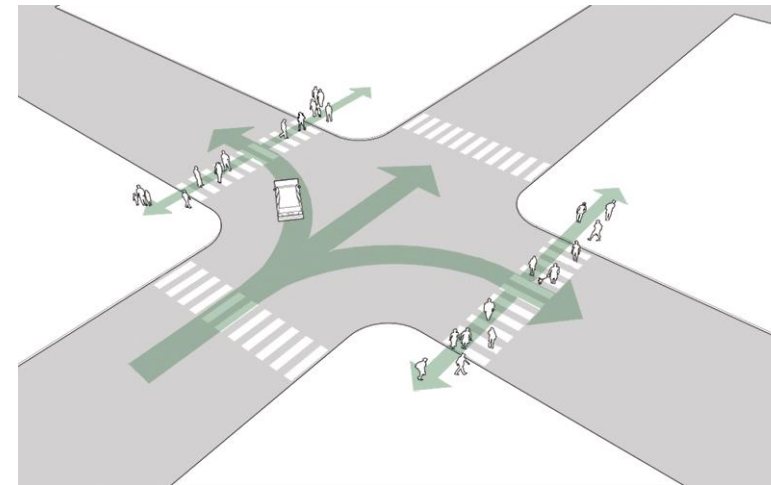
Leading Pedestrian Interval

- A low-cost countermeasure for pedestrian and vehicular traffic control at signalized intersections
- Gives pedestrian an advance “walk” signal indication before a concurrent green signal is provided to vehicles



Phase 1: Pedestrians only

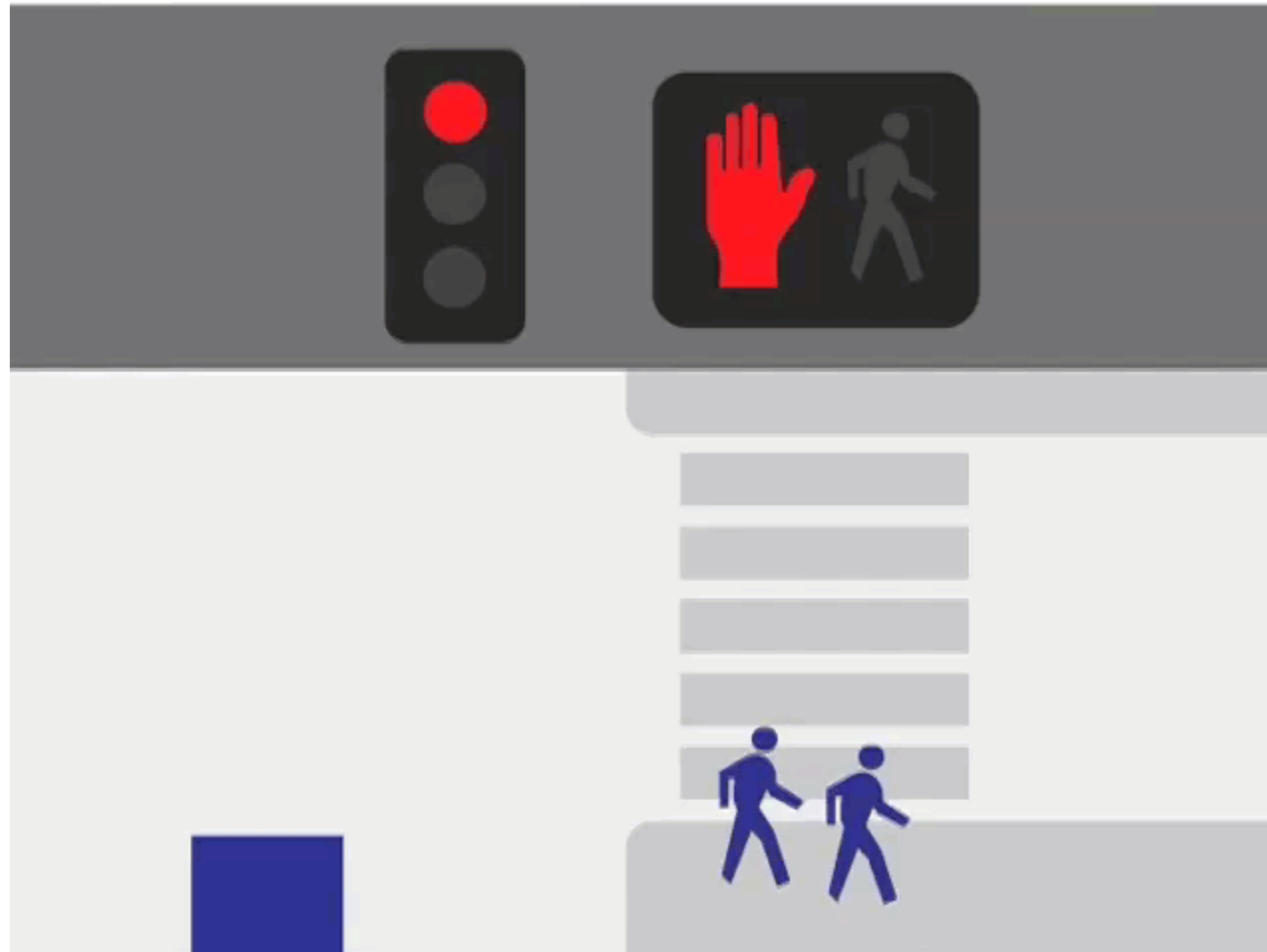
Pedestrians are given a minimum of three to seven second head start entering the intersection.



Phase 2: Pedestrians and cars

Through and turning traffic are given the green light. Turning traffic yields to pedestrian already in the crosswalk.

Operation of an LPI



Benefits for Leading Pedestrian Intervals

- Increased visibility of crossing pedestrians
- Reduced conflicts between pedestrian and vehicles
- Increased likelihood of motorists yielding to pedestrians
- Enhanced safety for pedestrians who may be slower to start into the intersection
- 60% reduction in pedestrian-vehicle crashes at intersections



Development of Statewide Guidelines for Implementing Leading Pedestrian Intervals in Florida



- Research results:
 - A low-cost measure that can help
 - Eleven (11) Intersections tested in Florida
 - Pedestrian-vehicle conflicts were reduced with no appreciable reduction in vehicle throughput (majority of locations)
 - In some cases, the LPI cleared the crosswalk more quickly and slightly reduced the average waiting time for a right turn.

Leading Pedestrian Interval in Florida



Before Period



After Period

FDOT LPI TEM Implementation

- CUTR Report (Development of Statewide Guidelines for Implementing Leading Pedestrian Intervals in Florida):
 - Identifies best practices and identified 8 LPI Warrants.
- FDOT TEM 3.11:
 - Does not use the 8 LPI Warrants.
 - Context Classification based criteria.

Criteria for LPI Signal Application

- All applications shall comply with MUTCD Section 4E.06
- Context classification for LPI without traffic engineering study
 - C4 – General urban
 - C5 – Urban center
 - C6 – Urban core
- Context classification for LPI with traffic engineering study
 - C1 – Natural
 - C2 – Rural
 - C2T – Rural town
 - C3R – Suburban Residential
 - C3C – Suburban Commercial

Criteria for LPI Signal Application

- LPI timing should allow pedestrians to clear the width of one lane in the direction of moving traffic (and the width of a parking lane, if any) to increase the visibility of pedestrians to turning traffic.
 - A minimum of 3-second LPI duration is required MUTCD.

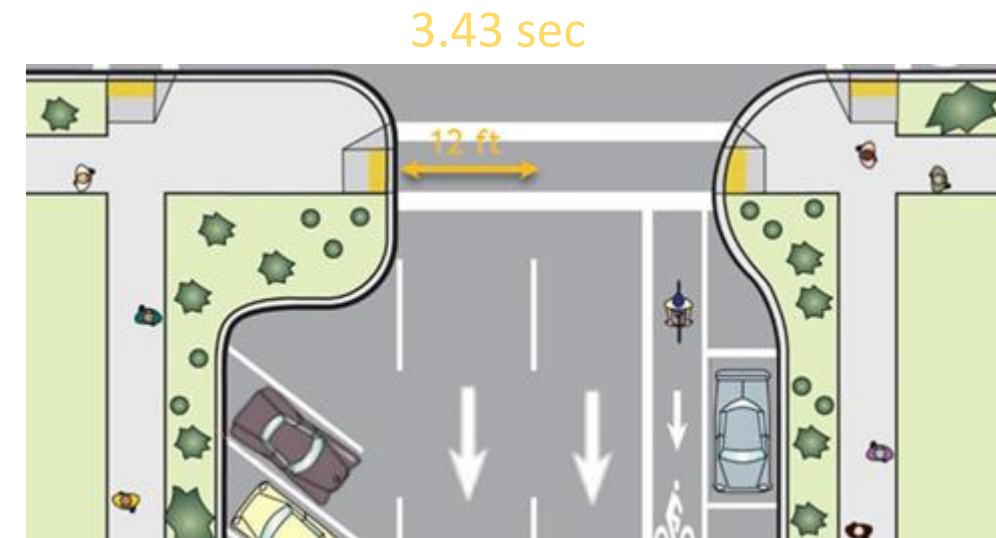
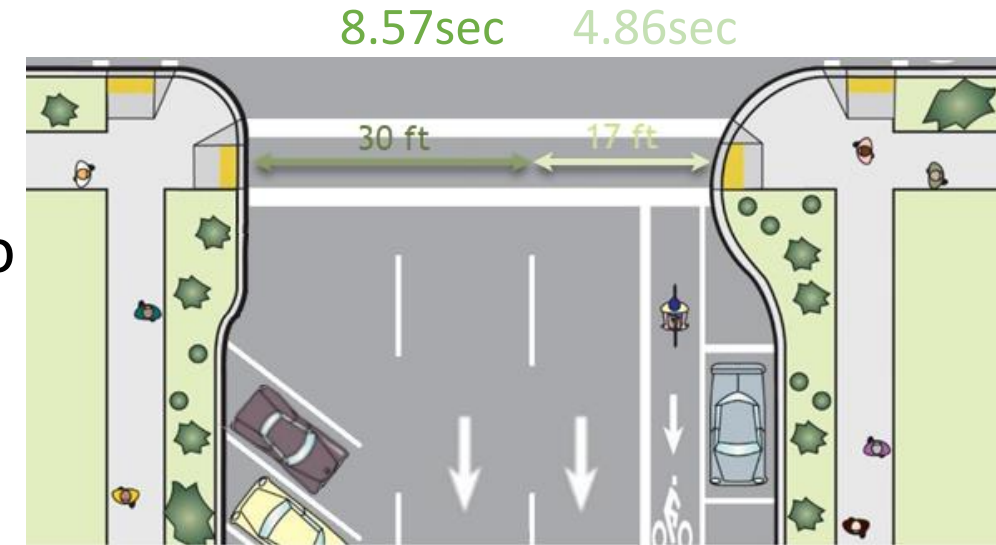
Formula 3.11.3-1

$$\text{LPI} = \text{ML}/\text{W}$$

LPI = Number of seconds (rounded value between onset of “Walk” signal for pedestrians and green indication for vehicles

ML= Distance on crosswalk to clear width of through lane from the edge of curb, in ft.

W = Walking speed (3.5 ft./s for pedestrian clearance calculation suggested by MUTCD, or 3 ft./s)



Considerations for LPI Application

- Consider “No Turn On Red” sign to enhance LPI implementation
- Extended LPI for approaches with large portion of slower pedestrians
- Consider Accessible Pedestrian Signal when LPI is used
- Provide education about LPI operation
- Conduct field observations and safety improvement evaluations after LPI implementation
- Avoid lengthy traffic signal cycles



R10-11

FDOT TEM Updates

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May 31, 2019 Bulletin

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Questions?

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