Improving Pedestrian Safety at Uncontrolled Locations

Charlie Zegeer, UNC Highway Safety Research Center
Angela Berry, Charlotte Department of Transportation
Michael Frederick, City of St Petersburg
Richard Nassi, Pima Association of Governments
Peter Eun, Federal Highway Administration
Keith Sinclair, Federal Highway Administration

November 30, 2016

Today's Presentation

- Introduction and housekeeping
- Presentations
- Questions at the end

Webinar Issues

- **Audio issues?**
  Dial into the phone line instead of using "mic & speakers."
- **Webinar issues?**
  Re-Load the webpage and log back into the webinar. Or send note of an issue through the Question box.
- **Questions?**
  Submit your questions at any time in the Questions box.

CM Credits and Email

⇨**Certificate of Attendance**

You will receive a certificate of attendance by email from the UNC Highway Safety Research Center

Pedestrian and Bicycle Information Center

Dear James,

Thank you for registering for "A Resident's Guide for Creating Safer Communities for Walking and Biking".

The Federal Highway Administration just released "A Resident's Guide for Creating Safer Communities for Walking and Bicycling," a free guide offering step-by-step instructions for residents and community groups looking to improve pedestrian and bicyclist safety, access, and comfort. This webinar offers an overview of the guide and will review how two communities used the principles outlined within it to make their communities more walkable and bikeable.

Tamara Redmon, with FHWA's Office of Safety, will introduce the guide and discuss how it fits within the US Department of Transportation's Safer People, Safer Streets Initiative.

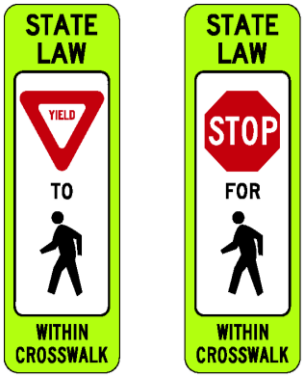
Laura Sandt, with the Pedestrian and Bicycle Information Center, will discuss the content of the new guide and how residents can use it.

Webinars and News

- **Find PBIC webinars and webinar archives**
  pedbikeinfo.org/webinars
- **Follow us on Facebook and Twitter for the latest PBIC News**
  facebook.com/pedbikeinfo
  twitter.com/pedbikeinfo
- **Join our mailing list**
  pedbikeinfo.org/signup

THE UNIVERSITY OF NORTH CAROLINA
HIGHWAY SAFETY RESEARCH CENTER
www.hsrc.unc.edu

NCHRP 17-56: Development of Crash Reduction Factors for Uncontrolled Pedestrian Crossing Treatments



November 30, 2016

Presentation Overview

- Team Overview/Project Background
- Treatment Types
- Task Approach & Data collection
- CMF development
- Results
- NCHRP 17-56 Implementation Opportunities
- Questions/Discussion

Team Overview – Project Team

Team Member	Role
Charlie Zegeer, HSRC	Project PI
Raghavan Srinivasan, HSRC	Statistical Analysis
Bo Lan, Statistician Daniel Carter, HSRC	Statistician Oversee Data Collection
Carl Sundstrom, HSRC	City & Site Selection
Sarah Smith, HSRC	Project Coordination
Kittelson and Associates, Inc (John Zegeer, Erin Ferguson)	Data Collection & Implementing Results
Persaud & Lyon, Inc	Statistical Analysis
CERS (Ron Van Houten)	Technical Advisor

Evaluation of Four Treatment Types

1. Un-signalized advance yield or stop signs and pavement markings (AS)
2. High-intensity activated crosswalk (HAWK) signals (PHB)
   - Also referred to as High-intensity Activated CrossWalK (HAWK)
3. Rectangular rapid flashing beacons (RRFB's)
4. Pedestrian refuge islands (RI)

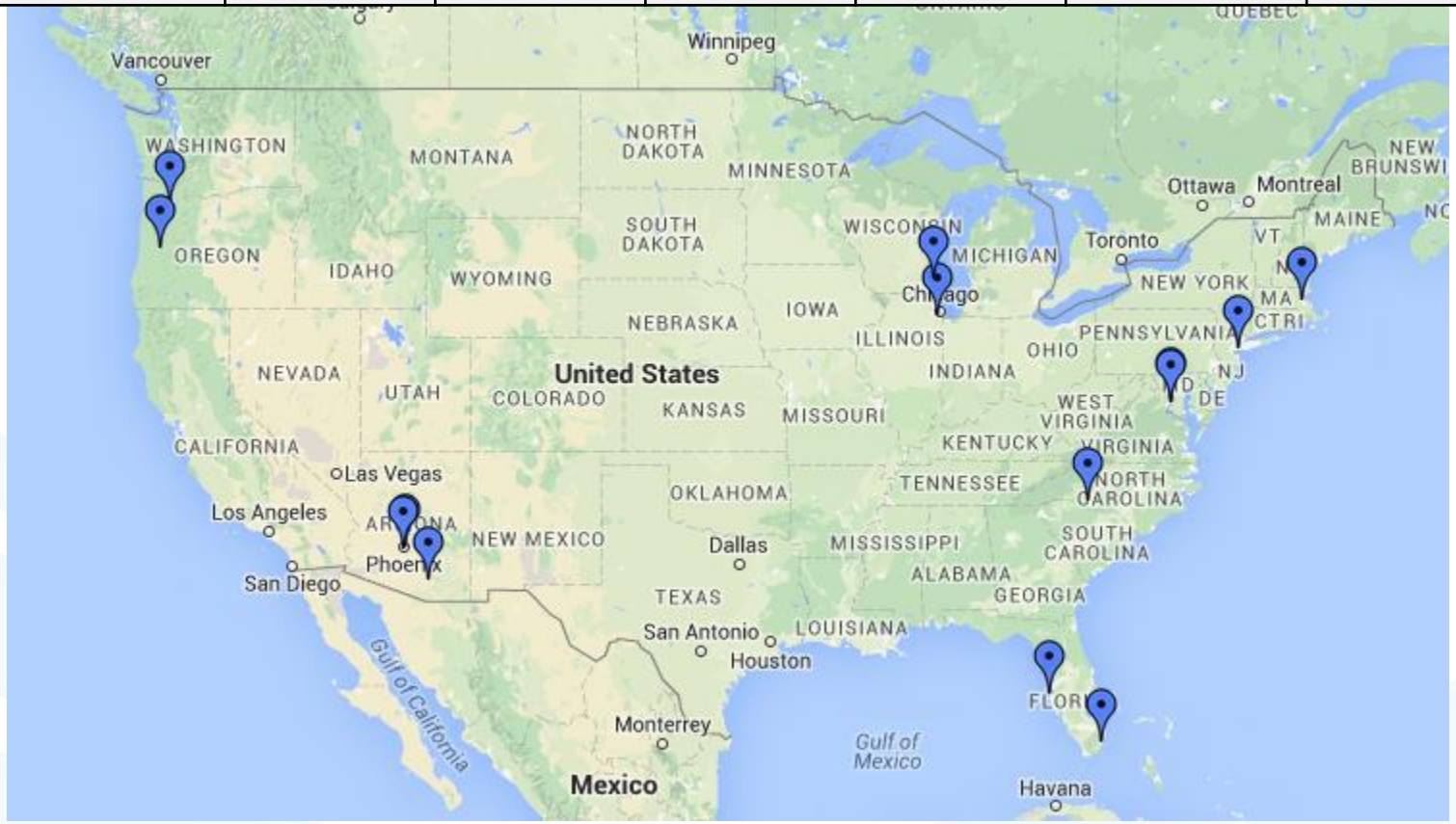
Data Collection
City Selection

- Based on detailed information obtained from each city in terms of available treatments, U.S. distribution of cities, and other factors, 14 cities were selected for the study

Alexandria, VA	Arlington, VA
Cambridge, MA	Chicago, IL
New York City, NY	Miami, FL
St. Petersburg, FL	Tucson, AZ
Scottsdale, AZ	Phoenix, AZ
Portland, OR	Eugene, OR
Charlotte, NC	Milwaukee, WI

Data Collection
Cities and Sites by Treatment Type

CITY (14 Cities)	AS	RI	RRFB	PHB	TREATMENT SITES	COMPARISON SITES
TOTAL as of 16 Jan 2015	294	319	52	97	**509**	**485**



Data Collection
Treatment Selection

- Concentrated on evaluating four treatments based on available project funds, existing data available, and importance of CMF development
  - Advance Yield or Stop Pavement Markings and Signs
  - Pedestrian Hybrid Beacons
  - Rectangular Rapid Flashing Beacons
  - Pedestrian Refuge Areas/Islands

Advanced Yield or Stop Markings and Signs

Advance yield line (shark's teeth) & sign

2009 MUTCD Section 3B.16 and Figure 3B-17

Advance stop line and sign

2009 MUTCD Section 3B.16

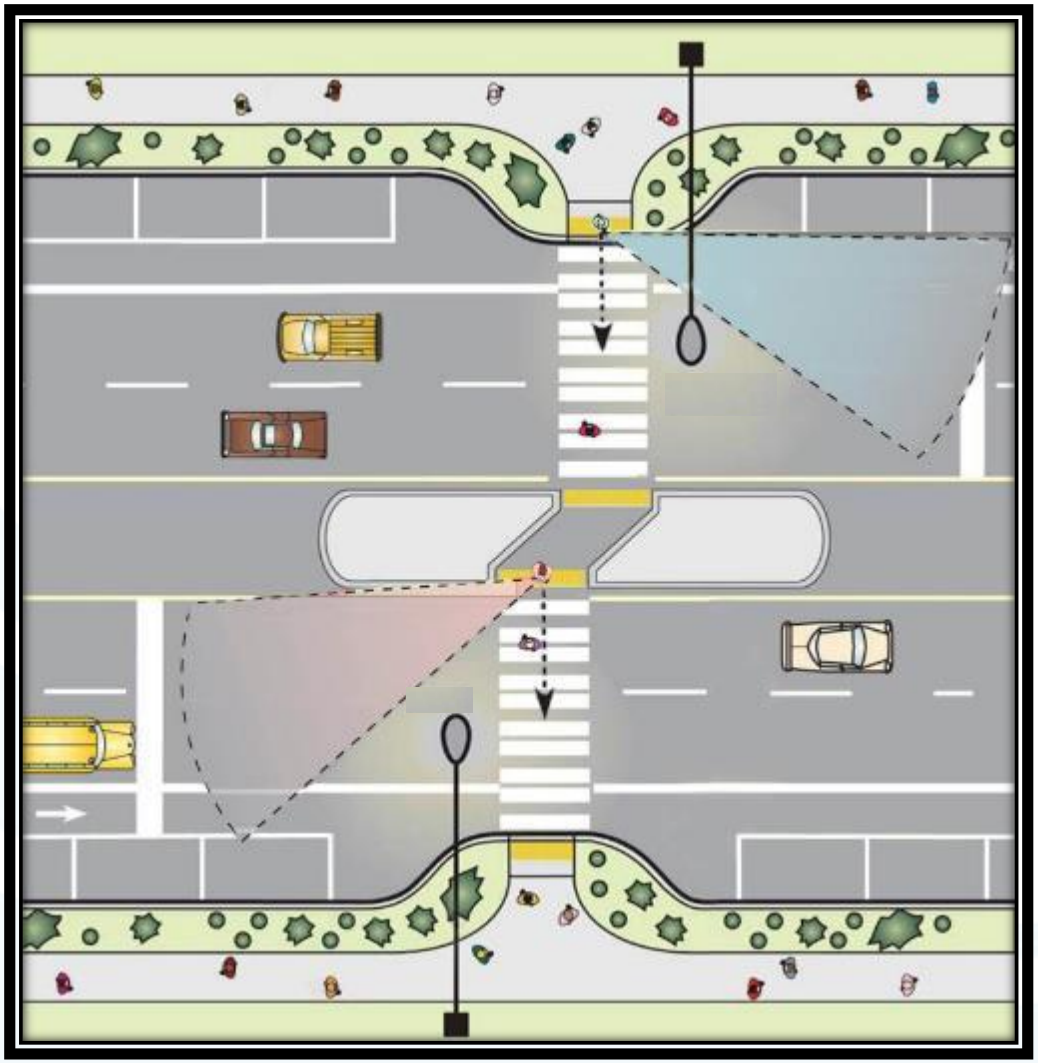
Pedestrian Hybrid Beacon

2009 MUTCD Chapter 4F Pedestrian Hybrid Beacons

Rectangular Rapid Flashing Beacons

- Beacon is yellow, rectangular, and has a rapid “wig-wag” flash
- Beacon located between the warning signs and the arrow plaque
- Must be pedestrian activated (push button or passive)
- Beacons required on both right and left sides or in a median (if practical)

Pedestrian Refuge Areas



Crossing island at marked crosswalk – breaks long complex crossing into two simpler crossings

Advanced Stop/Yield Markings and Signs (AS)

CITY	Advance Stop/Yield
St. Petersberg, FL	113
Phoenix, AZ	16
Tucson, AZ	83
Charlotte, NC	2
Miami, FL	3
Scottsdale, AZ	4
Milwaukee, WI	0
Portland, OR	53
New York, NY	0
Arlington & Alexandria, VA	4
Eugene, OR	3
Cambridge, MA	10
Chicago, IL	3
TOTAL	**294**

Pedestrian Hybrid Beacons (PHB)

CITY	PHB
St. Petersberg, FL	3
Phoenix, AZ	5
Tucson, AZ	82
Charlotte, NC	2
Miami, FL	0
Scottsdale, AZ	2
Milwaukee, WI	0
Portland, OR	2
New York, NY	0
Arlington & Alexandria, VA	1
Eugene, OR	0
Cambridge, MA	0
Chicago, IL	0
TOTAL	**97**

Rectangular Rapid Flashing Beacons (RRFB)

CITY	RRFB
St. Petersberg, FL	32
Phoenix, AZ	1
Tucson, AZ	0
Charlotte, NC	0
Miami, FL	5
Scottsdale, AZ	0
Milwaukee, WI	1
Portland, OR	2
New York, NY	0
Arlington & Alexandria, VA	2
Eugene, OR	6
Cambridge, MA	0
Chicago, IL	3
TOTAL	**52**

Refuge Area/Island (RI)

CITY	Refuge Island
St. Petersberg, FL	19
Phoenix, AZ	11
Tucson, AZ	36
Charlotte, NC	34
Miami, FL	28
Scottsdale, AZ	18
Milwaukee, WI	12
Portland, OR	40
New York, NY	17
Arlington & Alexandria, VA	26
Eugene, OR	28
Cambridge, MA	17
Chicago, IL	33
TOTAL	**319**

Total Treatment and Comparison Sites

CITY	Treatment	Comparison
St. Petersberg, FL	116	45
Phoenix, AZ	18	16
Tucson, AZ	85	65
Charlotte, NC	36	112
Miami, FL	31	38
Scottsdale, AZ	19	16
Milwaukee, WI	12	18
Portland, OR	61	33
New York, NY	17	24
Arlington & Alexandria, VA	30	28
Eugene, OR	29	27
Cambridge, MA	19	26
Chicago, IL	36	37
TOTAL	**509**	**485**

Treatment Combinations

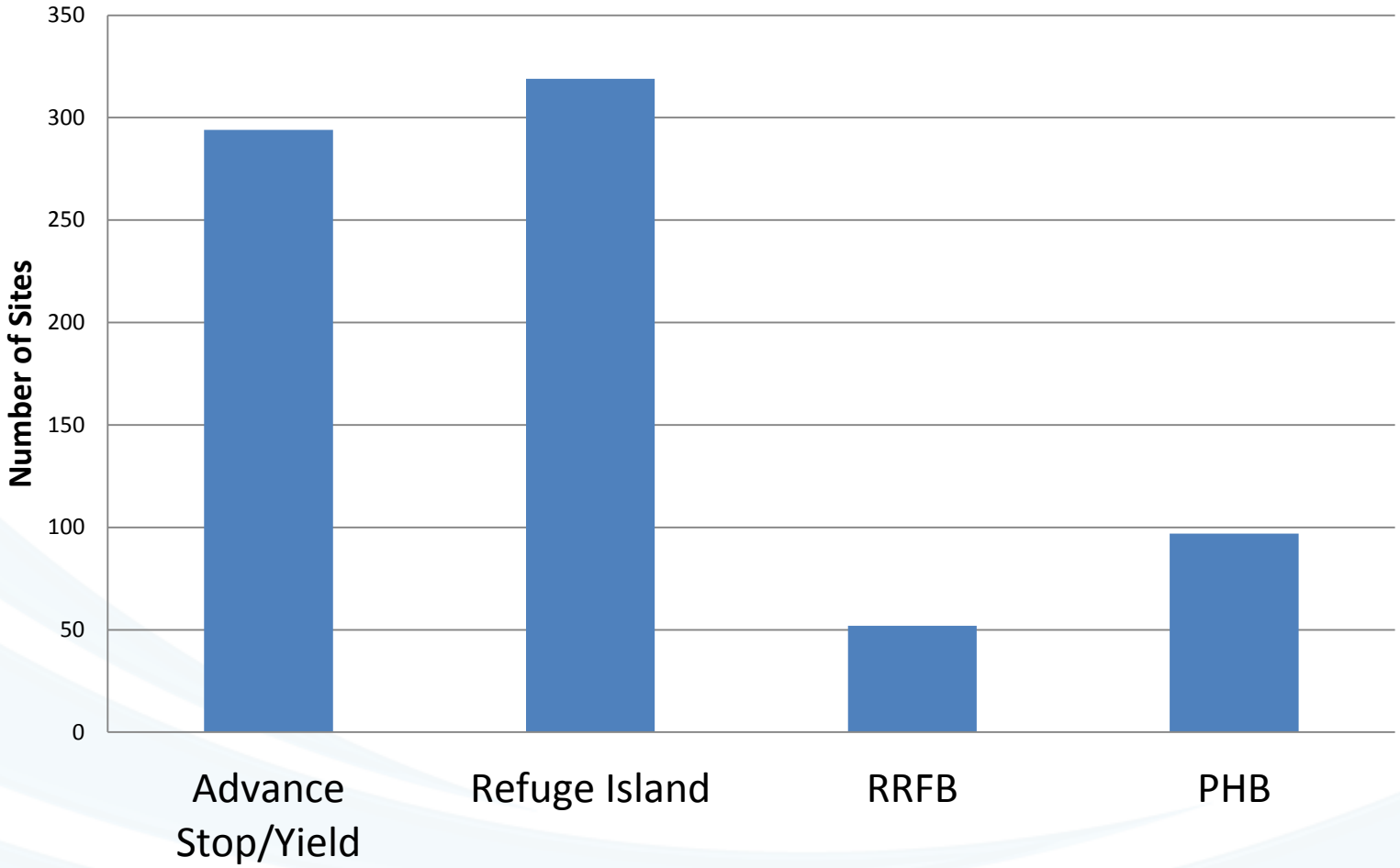
Treatment Combination Type	Number of Sites
AS	98
PHB	3
RRFB	5
RI	203
AS+PHB	57
AS+RRFB	26
AS+RI	59
RI+RRFB	4
AS+RRFB+RI	17
AS+PHB+RI	37
Total	**509**

309 Sites with one treatment

146 Sites with two treatments

54 Sites with three treatments

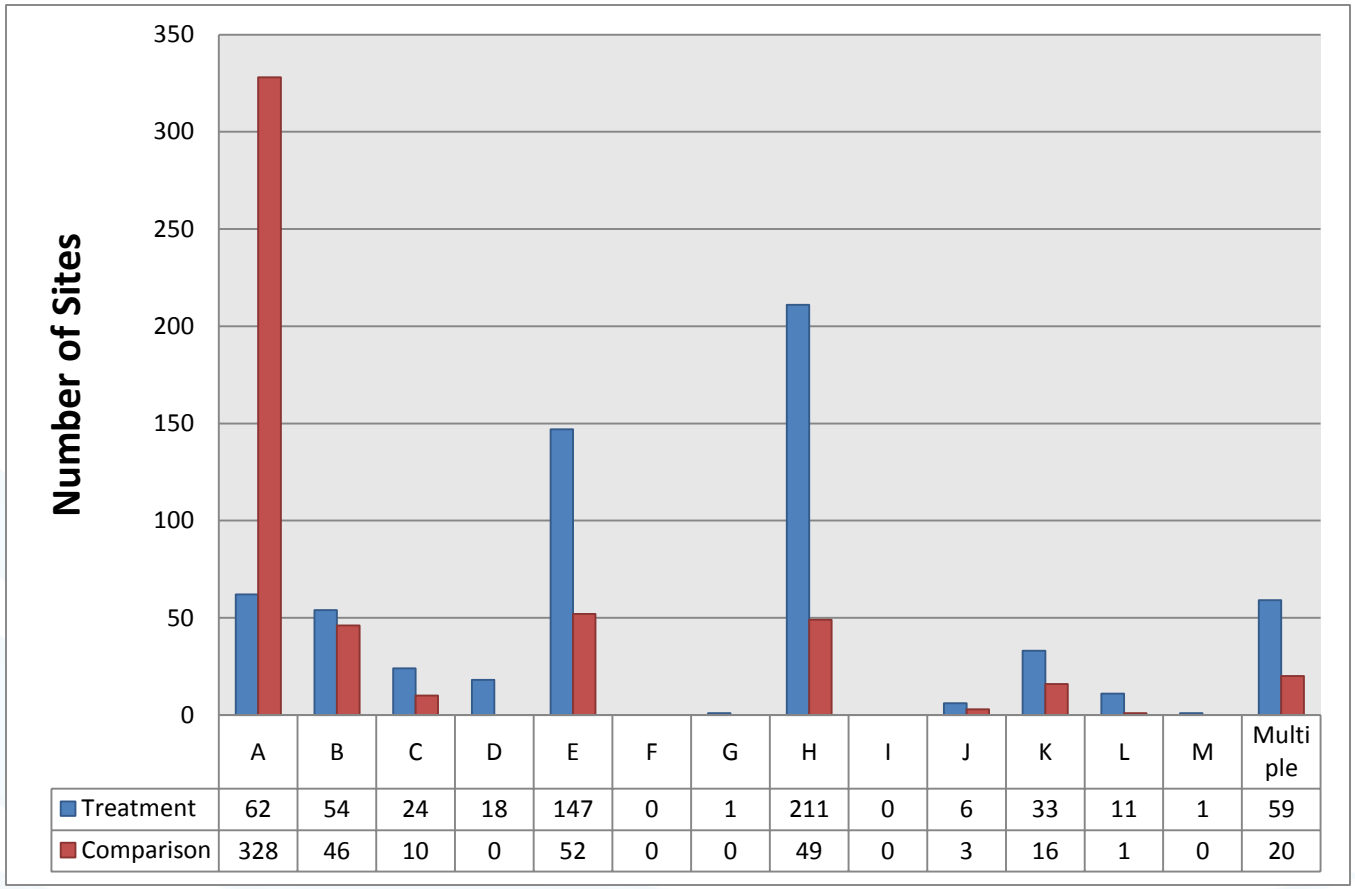
Treatment Type Totals



Data Collection
Site Characteristics

- Relevant geometric and volume data was collected for each site
- Other features also collected using Google Earth imagery and site photographs (signage, crosswalk type, number of lanes, intersection vs midblock, area type, transit association)
- Site characteristic histories and changes were recorded as far back as Google Earth Imagery would allow (generally 10 years)
- Data will be used to develop safety performance functions (in case of before-after study), disaggregate the results by site type, or categorize sites for cross-sectional analysis

Crosswalk Type

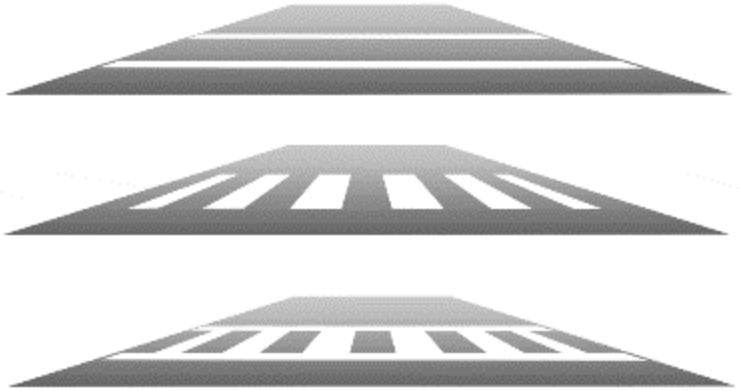


	A	B	C	D	E	F	G	H	I	J	K	L	M	Multiple
Treatment	62	54	24	18	147	0	1	211	0	6	33	11	1	59
Comparison	328	46	10	0	52	0	0	49	0	3	16	1	0	20

Type	Identifier
No Markings	A
White Std	B
Yellow	C
Staggered	D
Ladder	E
Zebra	F
Piano	G
Continental	H
Dbl. Cont	I
Diagonal	J
Brick/Stp/Blk	K
Unknown	L
Raised	M
Combined	Multiple

*Multiple refers to sites with combined crosswalk types
(e.g., diagonal ladder, yellow continental, etc…)

High-visibility Crosswalk Marking Patterns



Common Crosswalk marking types

TOP-Standard

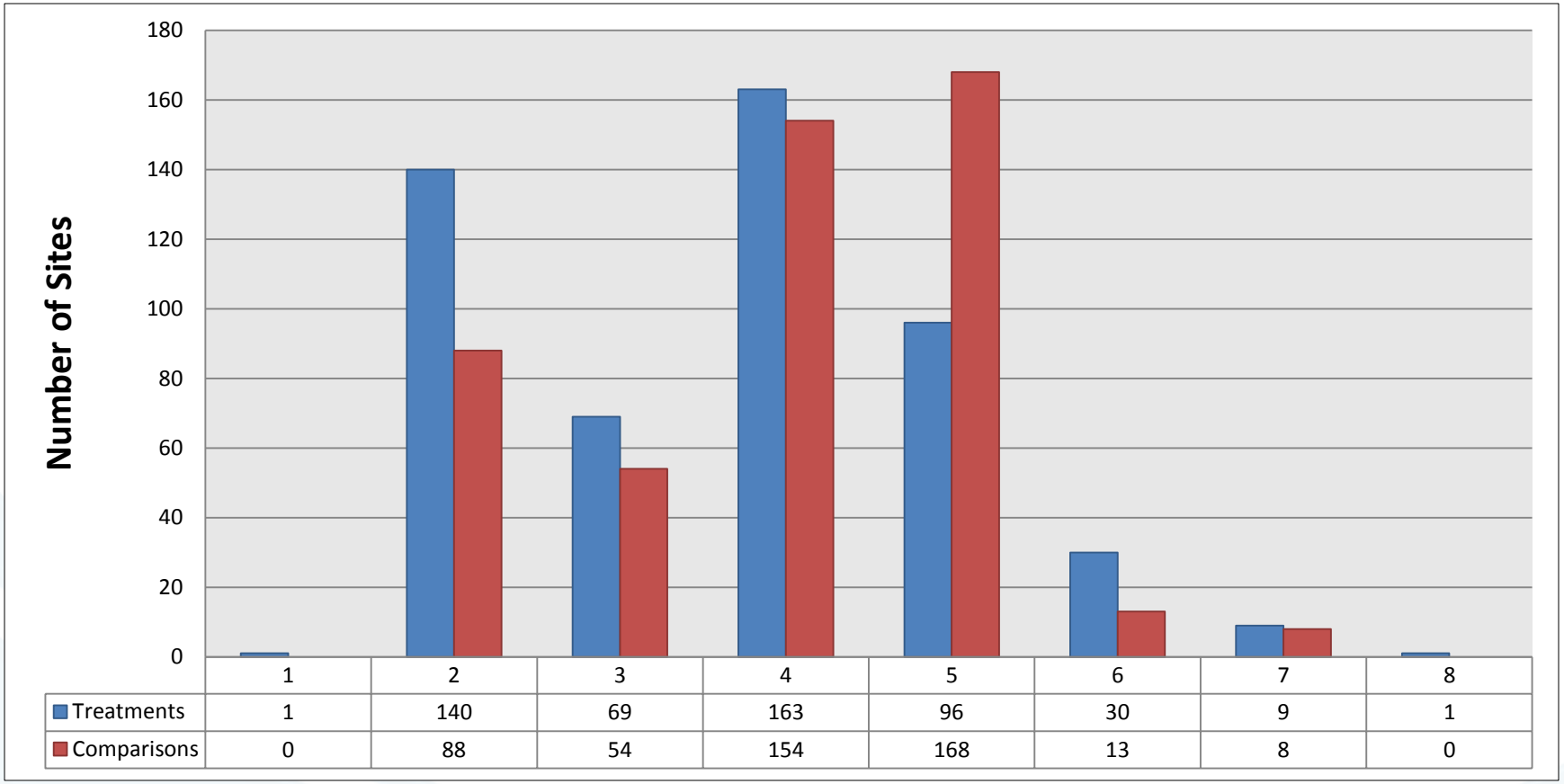
MIDDLE-Continental

BOTTOM- Ladder

Place longitudinal markings to avoid wheel tracks, reducing wear & tear & maintenance

2009 MUTCD Section 3B.18, Paragraph 15

Number of Lanes

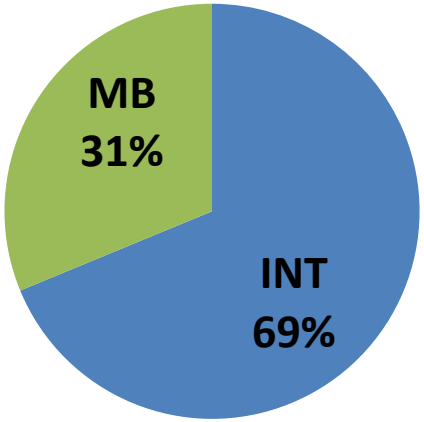


	1	2	3	4	5	6	7	8
Treatments	1	140	69	163	96	30	9	1
Comparisons	0	88	54	154	168	13	8	0

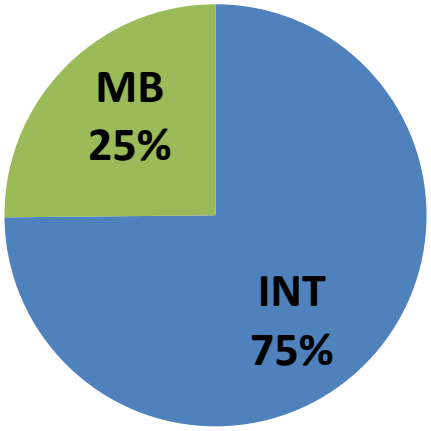
Treatments		Comparisons	
≤ 2 lanes	≥ 3 lanes	≤ 2 lanes	≥ 3 lanes
141 | 28%	**368 | 72%**	**88 | 18%**	**397 | 82%**

Intersection vs Mid-block

Treatment Sites



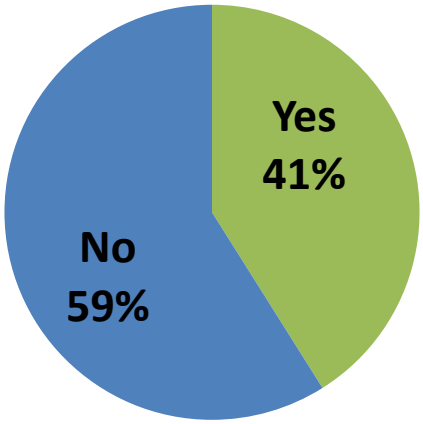
Comparison Sites



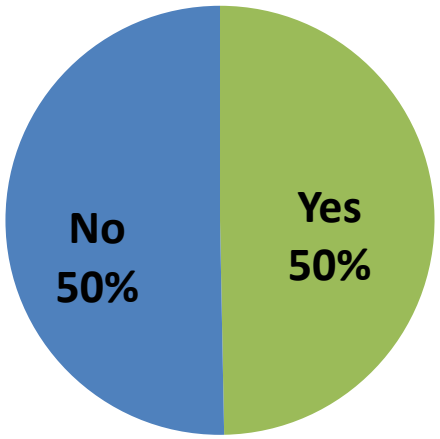
Number of Sites	Treatment	Comparison
Intersection	350	363
Midblock	159	122
Total	509	485

Transit Association

Treatment Sites



Comparison Sites



Number of Sites	Treatment	Comparison
Transit Stop (Yes)	209	241
Transit Stop (No)	300	244
Total	509	485

Data Collection of Pedestrian Volume

- Key Decisions
  - Time of day
  - Length of count
- Used Charlotte existing pedestrian volumes to determine how to proceed

Data Collection
Crash and AADT Data

Crash Data Availability Summary

City	Agency to Provide Crash Data	Years of Data Available	Hard Copies Available	Data Received
Alexandria, VA	Virginia DOT	2004-2013	No	September 2014
Arlington, VA	Virginia DOT	2004-2013	No	September 2014
Cambridge, MA	Cambridge DOT	2004-2013	No	September 2014
Charlotte, NC	HSIS	2004-2013	No	November 2014
Chicago, IL	Chicago DOT	2008-2012	No	April 2014
Eugene, OR	Oregon DOT	2004-2013	No	November 2014
Miami, FL	Florida DOT	2006-2012	No	December 2014
Milwaukee, WI	Wisconsin DOT	2004-2013	No	November 2014
New York City, NY	New York DOT	2008-2012	No	October 2014
Phoenix, AZ	Arizona DOT	2004-2013	No	December 2014
Portland, OR	Oregon DOT	2004-2013	No	November 2014
St Petersburg, FL	Florida DOT	2006-2012	No	December 2014
Scottsdale, AZ	Arizona DOT	2004-2013	No	December 2014
Tucson, AZ	Arizona DOT	2004-2013	No	December 2014

CMF Development

1. Quantify the relationship between pedestrian safety and crossing treatments at uncontrolled locations
2. Develop Crash Modification Factors (CMFs) or functions (CMFunctions) by type and severity for four treatments
3. May have different CMFs for midblock vs intersection sites

Understanding CMFs

Crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a site.

$$\text{CMF} = \frac{\text{Expected crashes with countermeasure}}{\text{Expected crashes without countermeasure}}$$

CMF > 1	CMF < 1
Indicates an expected increase in crashes	Indicates an expected decrease in crashes

Understanding CMFs

Crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a site.

$$CMF = \frac{\text{Expected crashes with countermeasure}}{\text{Expected crashes without countermeasure}}$$

Which of the following CMFs would indicate an expected crash reduction of 25% ?

A	0.25
B	1.25
C	0.75

Understanding CMFs

Crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a site.

$$\text{CMF} = \frac{\text{Expected crashes with countermeasure}}{\text{Expected crashes without countermeasure}}$$

Which of the following CMFs would indicate an expected crash reduction of 25% ?

A	0.25
B	1.25
C	0.75

Understanding CMFs

Crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a site.

$$\text{CMF} = \frac{\text{Expected crashes with countermeasure}}{\text{Expected crashes without countermeasure}}$$

If a treatment with a CMF of 1.25 were applied at a given site, how would the crashes at the site change?

A Decrease by 25%

B Increase by 25%

C Increase by 75%

Understanding CMFs

Crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a site.

$$\text{CMF} = \frac{\text{Expected crashes with countermeasure}}{\text{Expected crashes without countermeasure}}$$

If a treatment with a CMF of 1.25 were applied at a given site, how would the crashes at the site change?

A Decrease by 25%

B Increase by 25%

C Increase by 75%

CMF Development
Possible Approaches

- Two possible approaches for estimating CMFs:

1. Before/After Studies
2. Cross-Sectional Studies

CMF Development
Before-After Method Issues

- Two problems with relying solely on before-after analysis method
  1. Unavailability of before treatment pedestrian volumes at most of the treated sites (treatment itself may significantly change pedestrian exposure)
  2. The difficulty in obtaining sufficiently large samples of sites with a particular treatment or treatment combination

CMF Development
Cross-sectional Models

- Cross-sectional models may produce less reliable CMFs
  - Confounding
  - Correlation between different variables
- Alternative regression models with and without selected factors
- Nearby comparison sites without the treatment
- Flexible functional form
- Data will be combined from multiple jurisdictions for the same treatment to provide more reliable CMFs
- Conduct limited before-after analyses when possible (St. Petersburg, FL RRFBs)

Study Results

CMF Values

Treatment	CMF	Source (B/A or X-section study)
Refuge Islands	0.68	2 studies
Advance Yield/Stop Sign	0.75	2 studies
PHB ("HAWK")	0.45	2 studies
RRFB	0.53	X-section study

NCHRP 17-56 Implementation Opportunities

- AASHTO's Highway Safety Manual, second edition (HSM-2)
- FHWA CMF Clearinghouse
- FHWA Proven Safety Countermeasures website
- NCHRP Report 600 Human Factors Guidelines for Road Systems, Second Edition
- Manual on Uniform Traffic Control Devices (MUTCD)
- Design guidance for uncontrolled pedestrian crossings

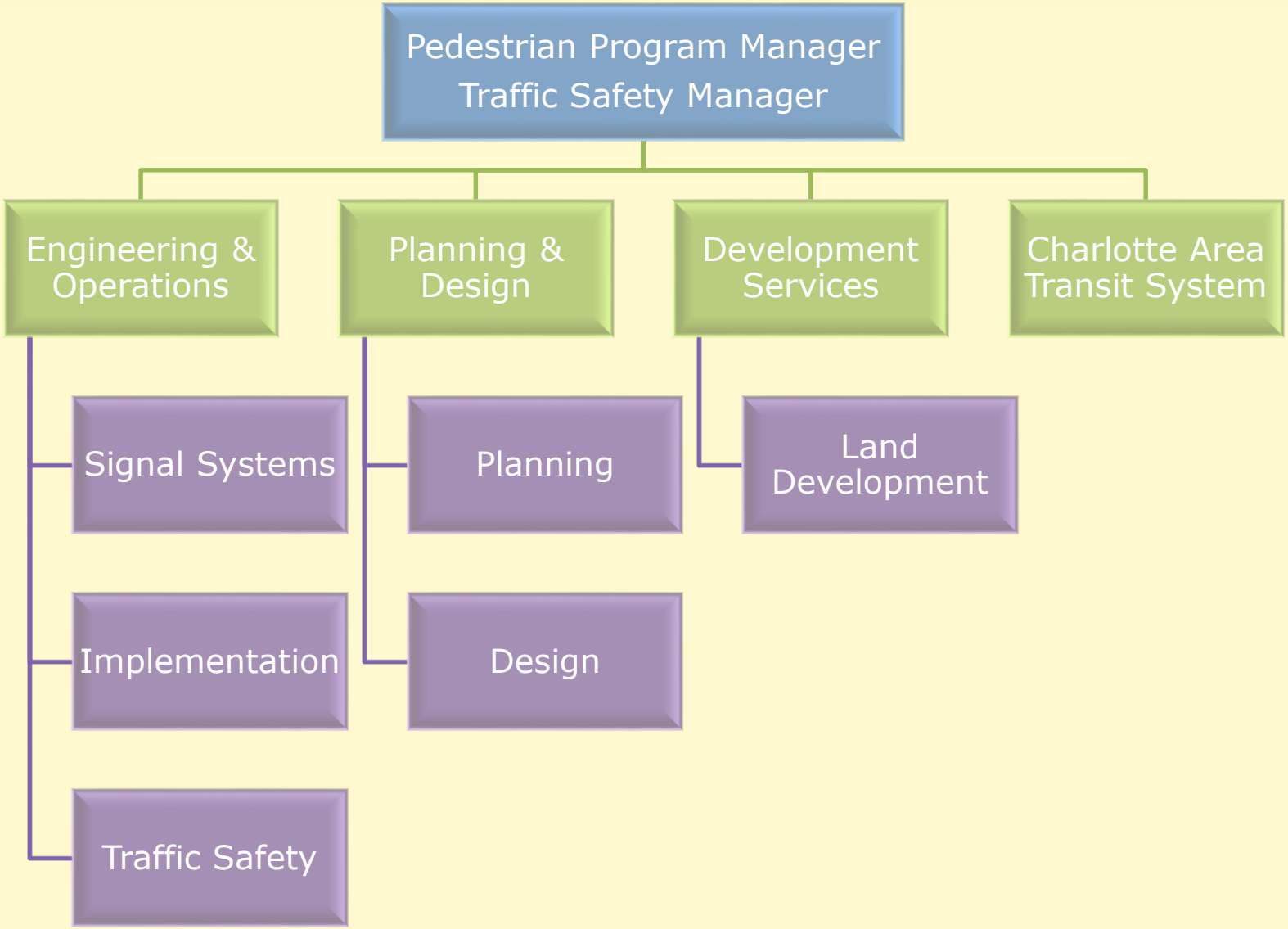
Design Guidance for Uncontrolled Pedestrian Crossings

- State and local agencies frequently establish their own guidelines and/or procedures for when to mark an uncontrolled crosswalk and if or what supplemental treatments to install at a marked crosswalk across on an uncontrolled approach
- The 2005 study from FHWA *Safety Effects of Marked versus Unmarked Crosswalks* by Zegeer et al. is used as a resource for developing the guidelines and/or procedures
- Findings from Project 17-56 will enable state and local agencies to supplement, update, or revise those guidelines currently in-place
- To facilitate these updates, FHWA could create a synthesis report focused on pedestrian uncontrolled crossings integrating the Zegeer et al. (2005) study and findings from Project 17-56

CHARLOTTE.

Improving Pedestrian Safety at Uncontrolled Locations Charlotte, NC

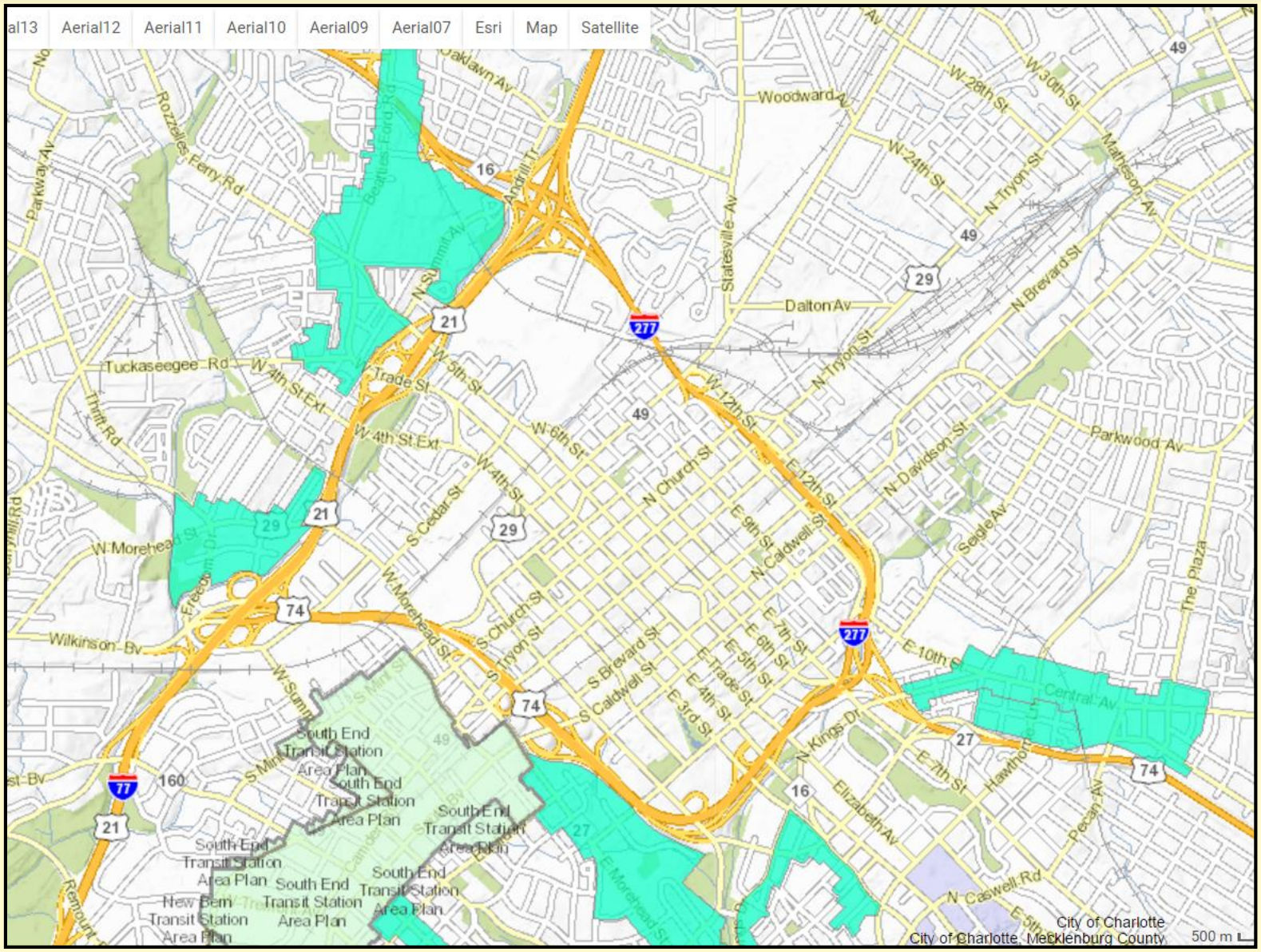
Pedestrian Crossing Committee (PCC)



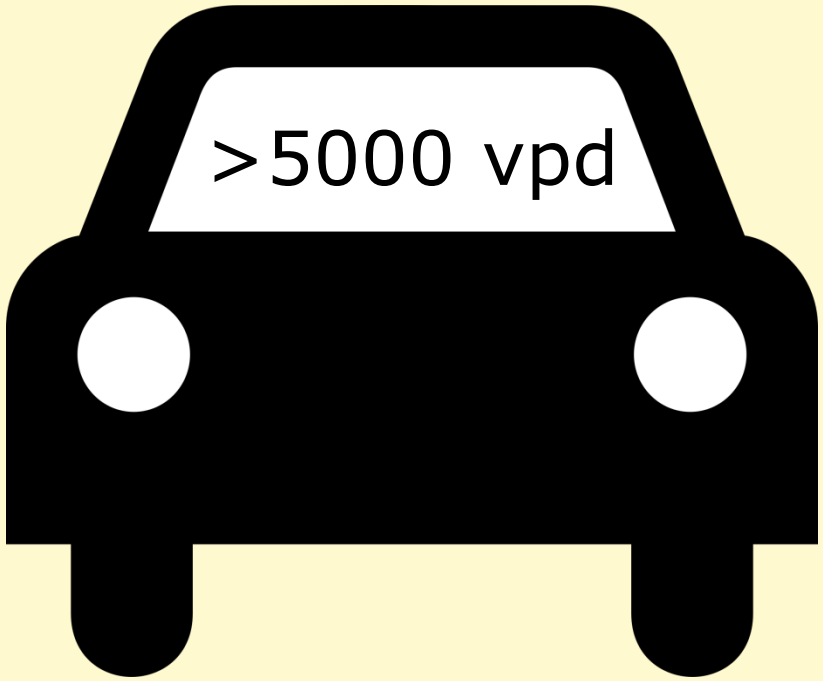
PCC Automatic Criteria

- Center
- Central Business District
- Pedestrian Overlay District
- Transit Station Area
- Main Street

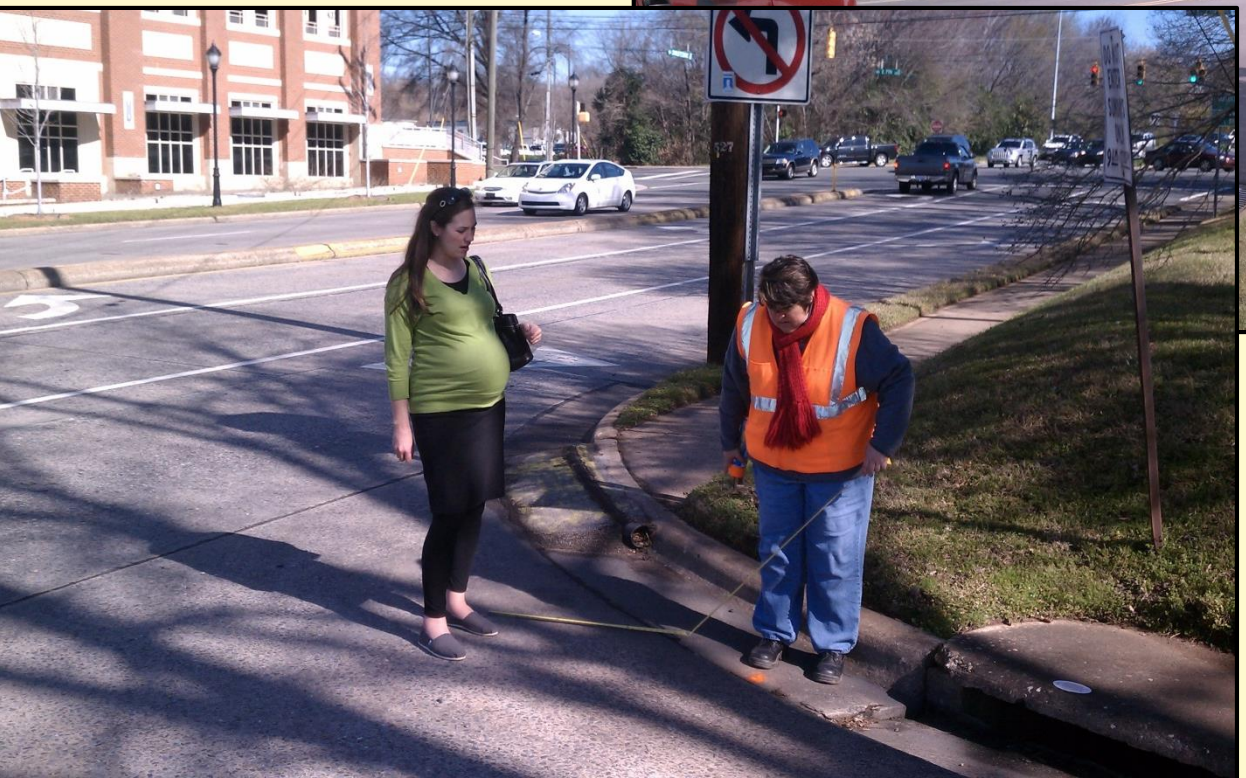
Automatic Criteria Examples



PCC Additional Criteria



Investigative Subcommittees



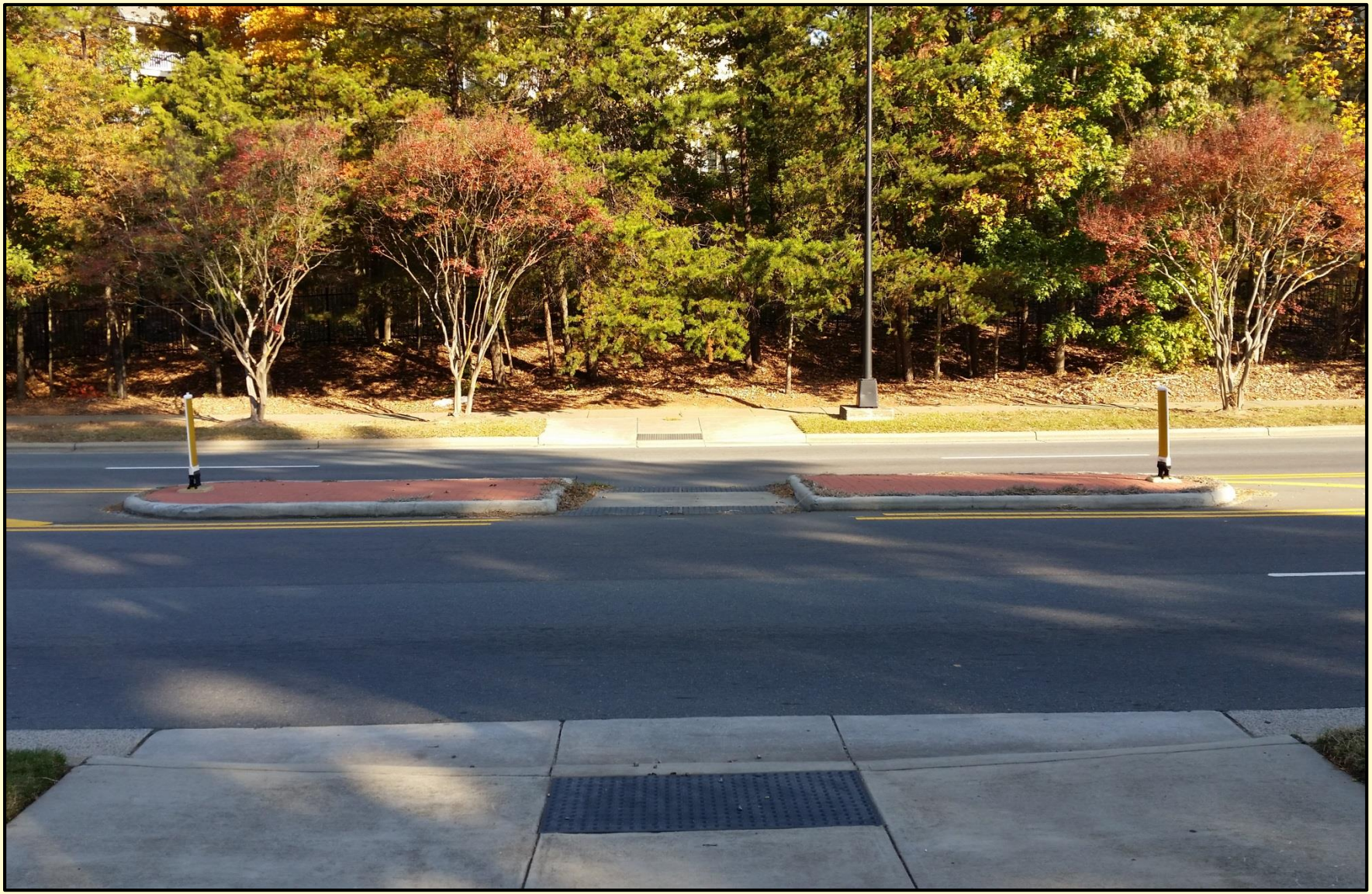
Treatment Type Selection

- Refuge Islands
- Pedestrian Hybrid Beacon with Advanced Stop
- Rectangular Rapid Flashing Beacons

Refuge Island Examples

CHARLOTTE.

Refuge Island Examples

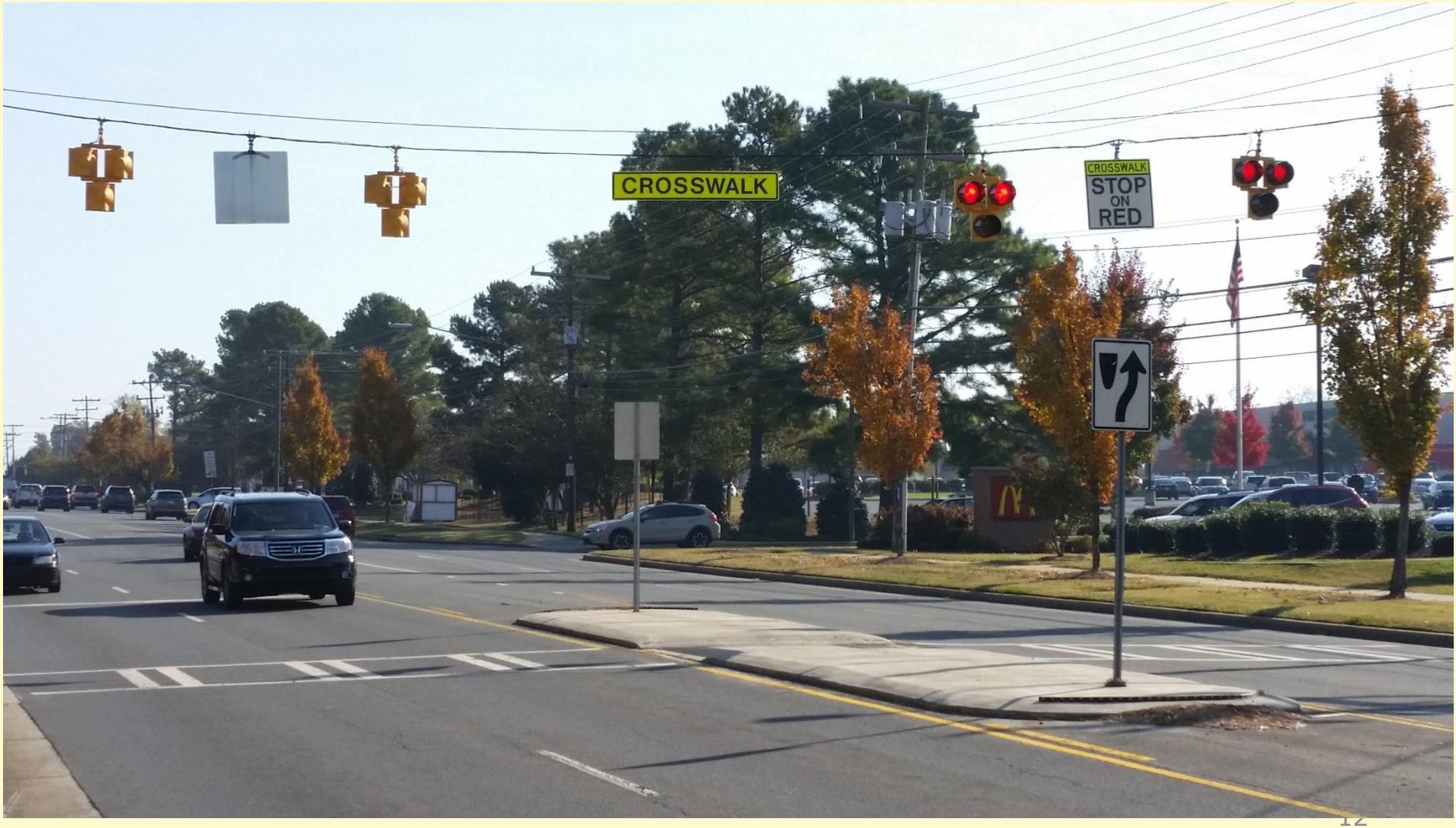


CHARLOTTE.

Refuge Island Examples

Refuge Island Examples

Pedestrian Hybrid Beacon Examples



Pedestrian Hybrid Beacon Examples

Pedestrian Hybrid Beacon Examples

Planned RRFB Locations

CHARLOTTE.

Planned RRFB Locations

Planned RRFB Locations

Questions

Angela M. Berry, P.E.
Traffic Safety Manager
Charlotte Department of Transportation
aberry@charlottenc.gov
704-432-5259

Questions?

- **Archive at www.pedbikeinfo.org/webinars**
  Download a video recording and presentation slides
- **Questions?**
  - **Charlie Zegeer** zegeer@hsrc.unc.edu
  - **Angela Berry** aberry@ci.charlotte.nc.us
  - **Michael Frederick** michael.frederick@stpete.org
  - **Richard Nassi** rnassi1@gmail.com
  - **Peter Eun** peter.eun@dot.gov
  - **Keith Sinclair** keith.sinclair@dot.gov
  - **General Inquiries** pbic@pedbikeinfo.org