Designing for Bicyclist Safety

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April 11, 2017

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  - ❑ **April 27: Intersections and Crossings**
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Plan and register an event at walkbiketoschool.org

Federal Highway Administration

Webinar 1—April 11, 2017

DESIGNING FOR BICYCLIST SAFETY

MEET YOUR PANELISTS

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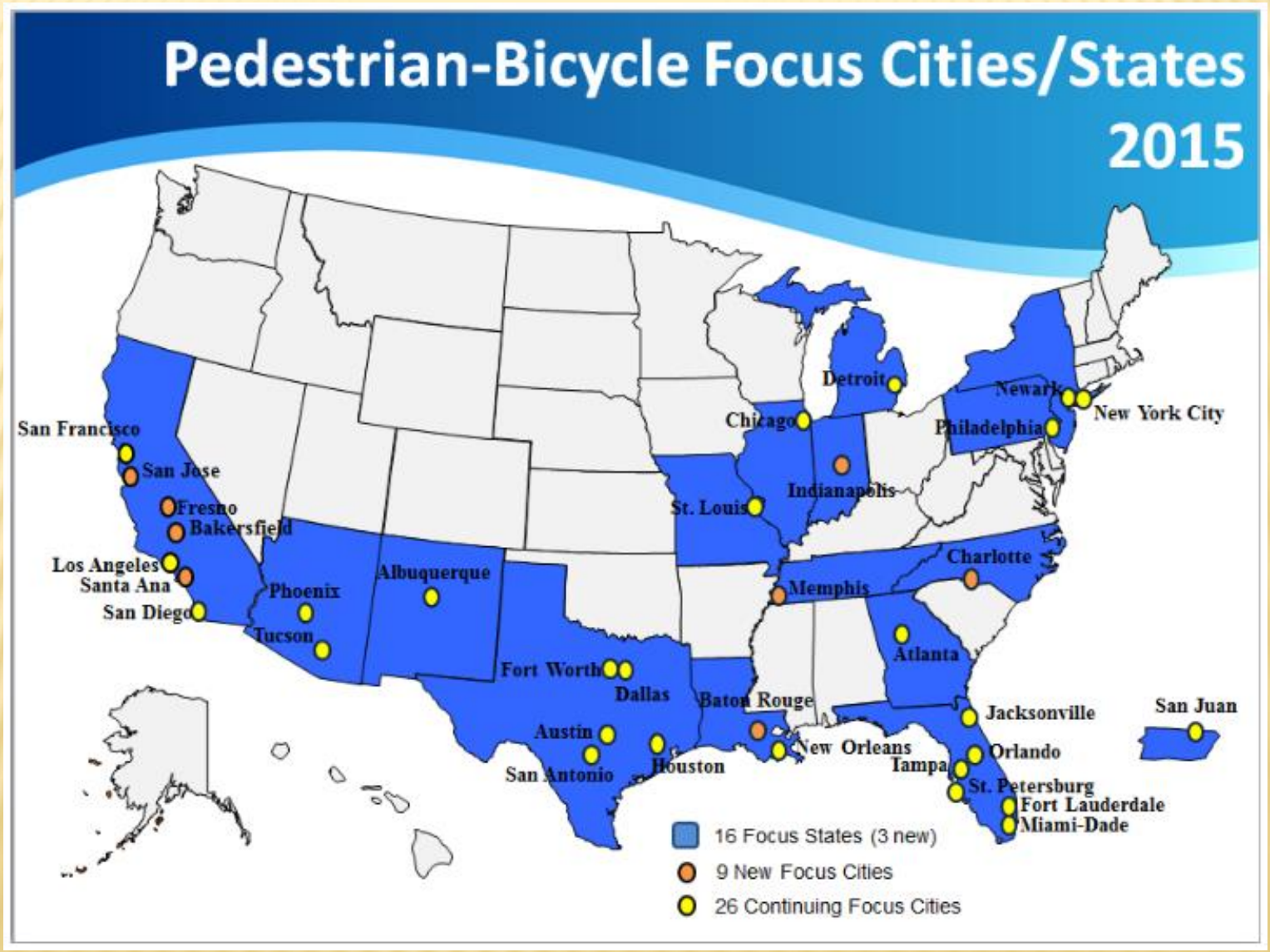
FHWA FOCUS APPROACH TO SAFETY



NOTE OF CAUTION

The knowledge and practice of designing for bicyclists is rapidly changing. Images in these materials and other guidelines may be outdated. Always check for the latest MUTCD interim and experimental TCD's.

Designing for Bicyclist Safety

IMPERATIVE FOR IMPROVEMENT

WHAT ARE THE OPPORTUNITIES?

- 50 % of trips are ≤ 3 miles
- > 1/3 of U.S. adults say they would commute by bike if safe facilities were available
- 1 out of every 11 U.S. households do not own an automobile

BICYCLIST SKILL & COMFORT

Experienced & Confident

- Navigate on streets
- Some prefer bike lane, shoulders, shared-use paths when available
- Prefer direct route
- Speeds up to 25 mph on level and 45 mph on downgrade
- Longer trips

Casual/Less Confident

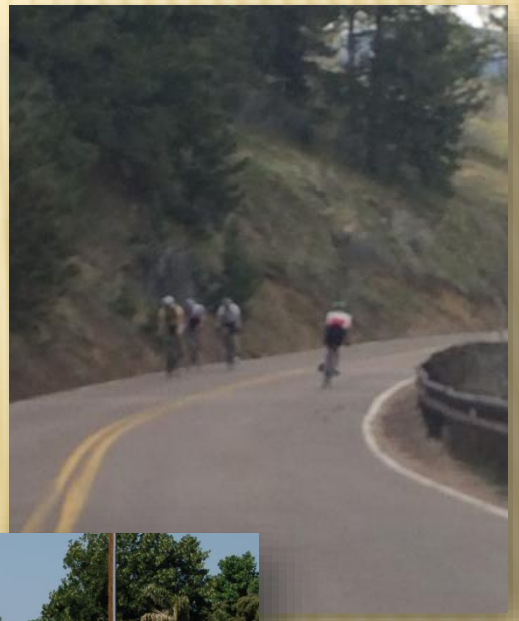
- Difficulty gauging traffic or unfamiliar with rules of road
- Prefer shared use paths or bike lanes on low volume streets
- Prefer separation from traffic
- May ride on sidewalk
- Avoid traffic
- Speeds of 8 to 12 mph
- Trips of 1 to 5 miles

BICYCLIST CHARACTERISTICS

- Reasons for bicycling
  - Recreation 26.0%
  - Exercise or health reasons 23.6%
  - To go home 14.2%
  - Personal errands 13.9%
  - To visit a friend or relative 10.1%
  - Commuting to school/work 5.0%
  - Bicycle ride 2.3%
  - Other 4.9%

BICYCLIST CHARACTERISTICS

- Preferences
  - Feel safe
  - Feel secure
  - Lower speed
  - Lower volume
  - Lower truck %
  - Fewer lanes



- Behaviors
  - Violate traffic control
  - Slow on uphill
  - Fast on downhill

DEATHS AND INJURIES

In 2015

- 818 killed
- 45,000 injured
- Cyclists accounted for 2.3% of all traffic fatalities

...but make up 1% of all trips.

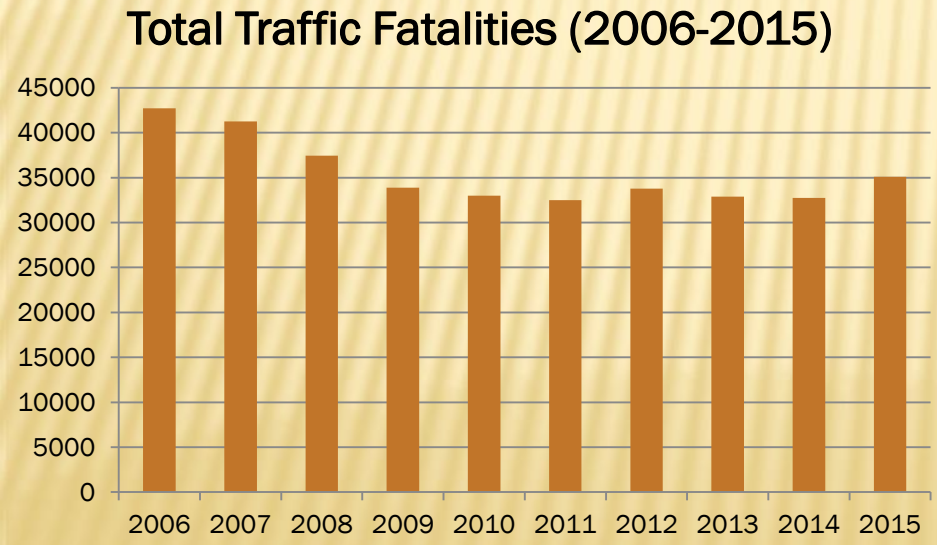
BICYCLING ON SIDEWALKS

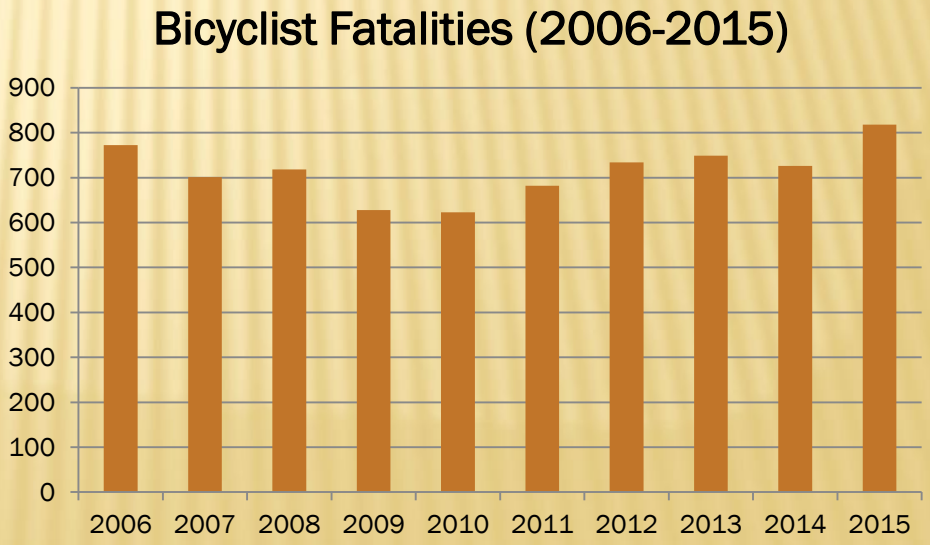
- Legal many places
- Increases crash rate
- Motorists must yield

BICYCLE FATALITIES BY YEAR

From 2006 to 2015

- Total traffic fatalities decreased by 18%
- Bicyclist fatalities increased by 6%

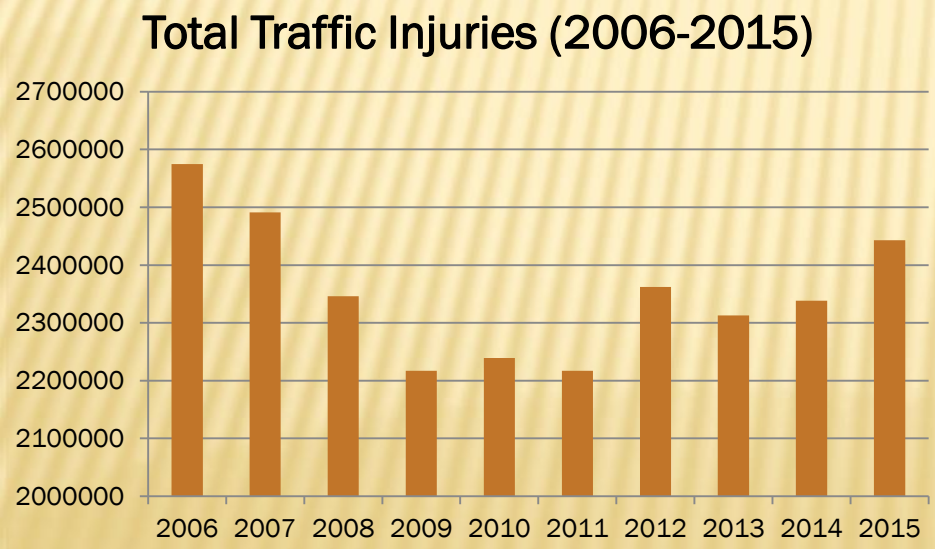


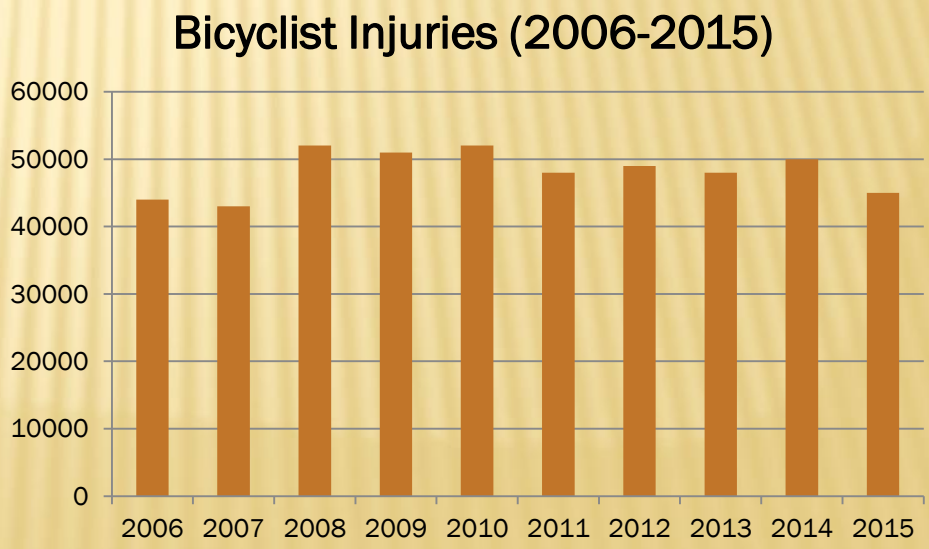


BICYCLE INJURIES BY YEAR

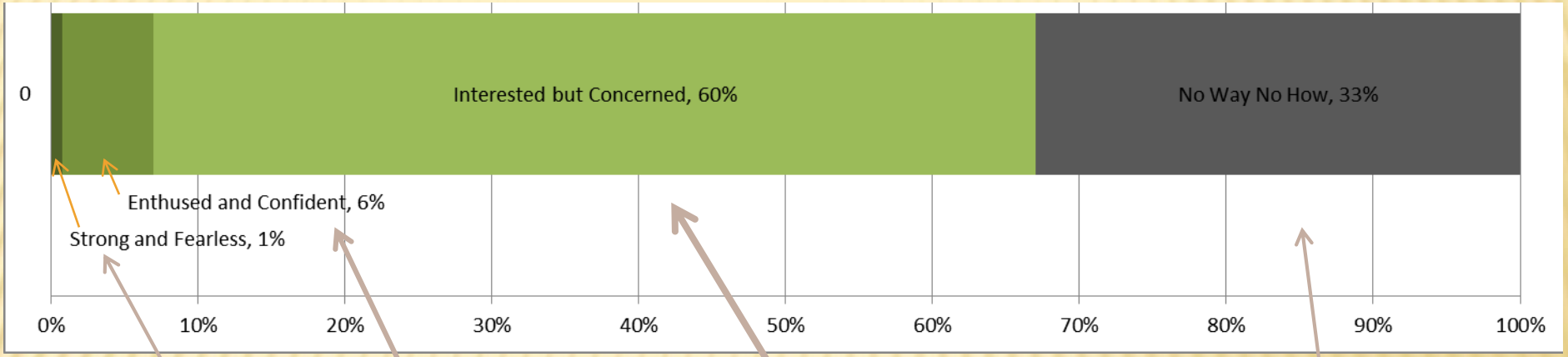
From 2006 to 2015

- Total traffic injuries decreased by 5%
- Bicyclist injuries increased by 2%





TYPES OF BICYCLISTS – CITY OF PORTLAND



Strong & Fearless

Enthused & Confident

Interested, but Concerned

Not Interested

LEVELS OF TRAFFIC STRESS (LTS)

- LTS 1: Suitable for almost all
- LTS 2: Suitable to most adult cyclists
- LTS 3: More traffic stress
- LTS 4: Strong and fearless

LEVELS OF TRAFFIC STRESS (LTS)

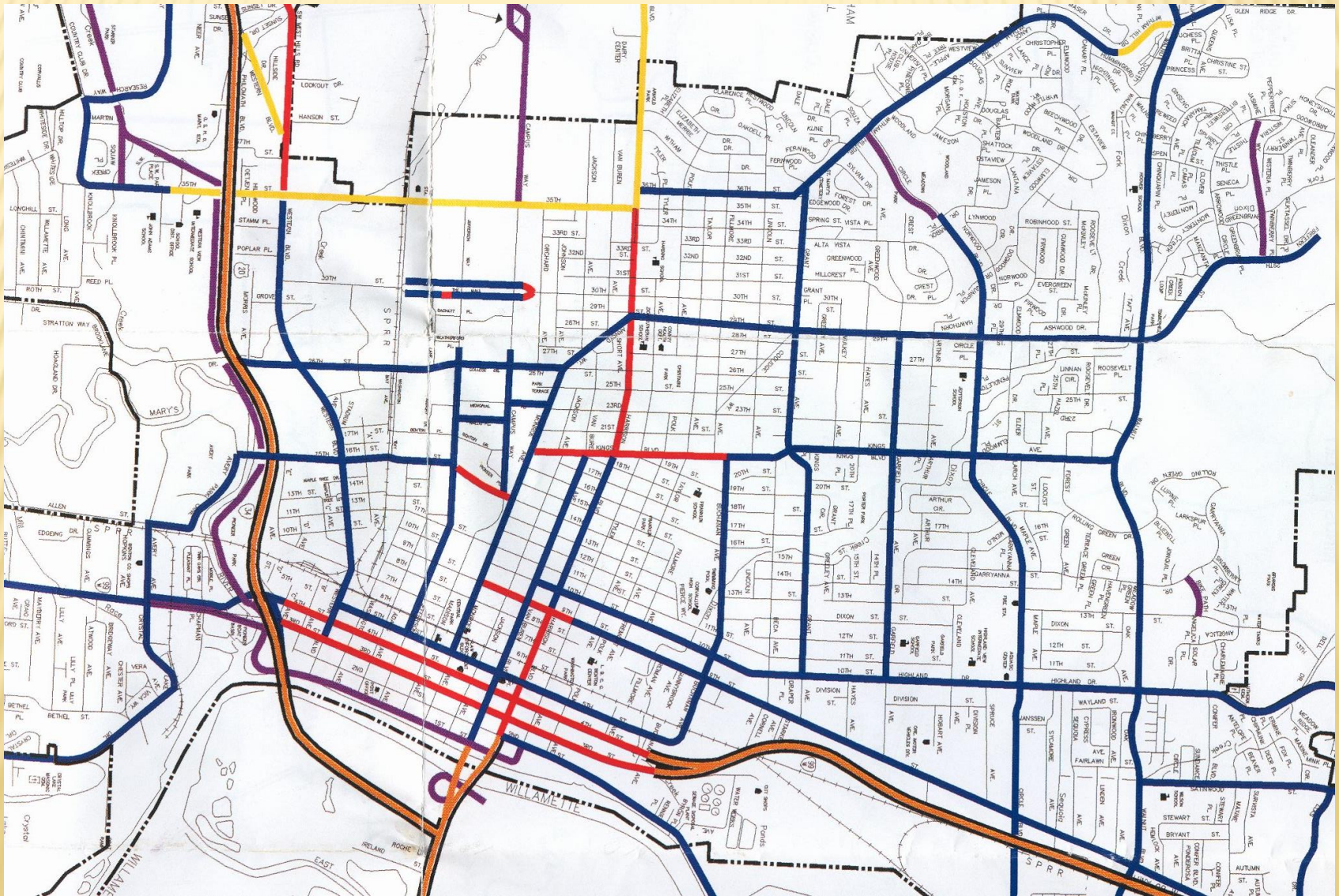
Levels of Traffic Stress			
LTS 1	LTS 2	LTS 3	LTS 4
• Physically separated from traffic or low-volume, mixed-flow traffic at 25 mph or less • Bike lanes 6 ft wide or more • Intersections easy to approach and cross • Comfortable for children	• Bike lanes 5.5 ft wide or less, next to 30 mph auto traffic • Unsignalized crossings of up to 5 lanes at 30 mph • Comfortable for most adults • Typical of bicycle facilities in Netherlands	• Bicycle lanes next to 35 mph auto traffic, or mixed-flow traffic at 30 mph or less • Comfortable for most current U.S. riders • Typical of bicycle facilities in U.S.	• No dedicated bicycle facilities • Traffic speeds 40 mph or more • Comfortable for "strong and fearless" riders (vehicular cyclists)

CASUAL/LESS CONFIDENT

In order for this group to regularly choose bicycling as a mode of transportation, a physical network of visible, convenient, and well-designed bicycle facilities is needed.

AASHTO Guide for the Development of Bicycle Facilities 2012

WELL-CONNECTED NETWORK



Designing for Bicyclist Safety

CORE SAFETY CONCEPTS

KEY SAFETY FACTORS

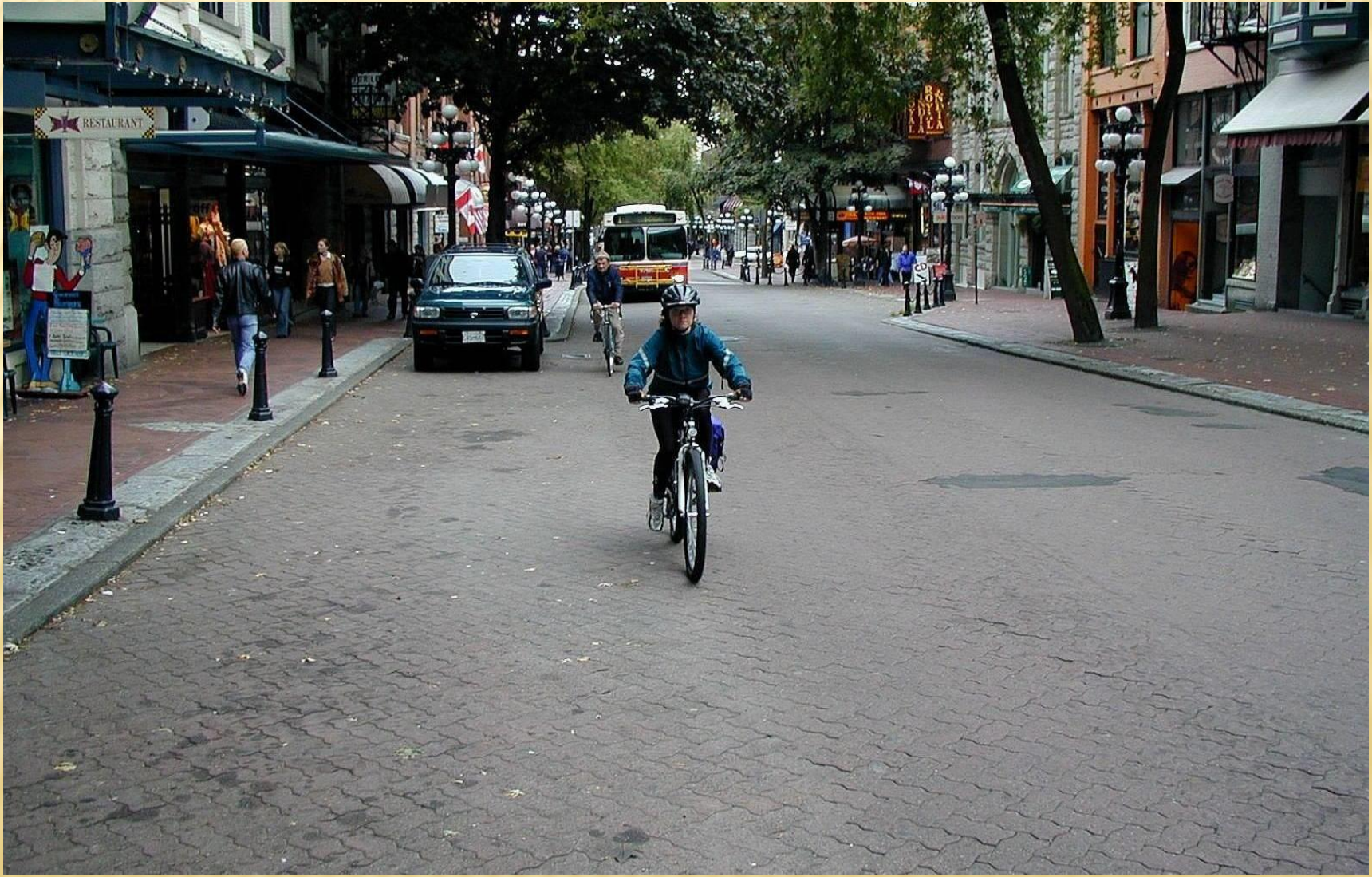
Important Message

- Speed
- Number of lanes
- Visibility
- Traffic volume & composition
- Conflict points
- Proximity
- Bike control
- Connectivity

COMPLETE STREET

Portland, Oregon

BICYCLIST ORIENTED: LOW RISK

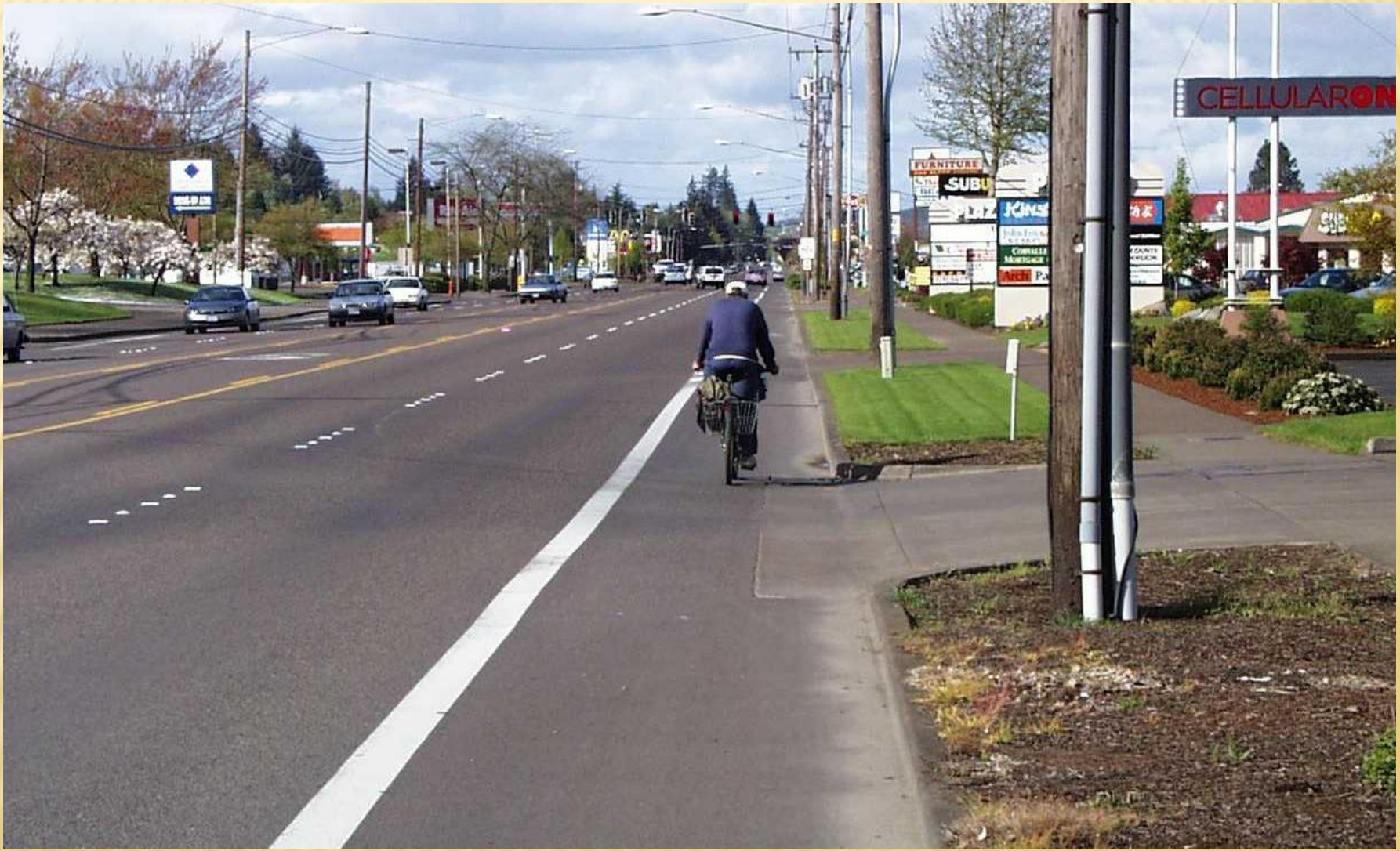


Vancouver, British Columbia

AUTO ORIENTED: HIGH RISK

Las Vegas, Nevada

PROVIDE SPACE ON STREET…



Corvallis, Oregon

…OR SLOW DOWN TRAFFIC

Corvallis, Oregon

Where can we put bicyclists?

Corvallis, Oregon

How can we design to better include bicyclists?

Designing for Bicyclist Safety

DESIGN POLICIES

FEDERAL LAW

- Consider bicycle facilities, where appropriate, with new construction and reconstruction.
- Consider safety and contiguous routes for bicyclists in plans and projects.

What does consider mean?

USDOT POLICY

Signed on March 11, 2010 and announced March 15, 2010

Every transportation agency, including DOT, has the responsibility to improve conditions and opportunities for walking and bicycling and to integrate walking and bicycling into their transportation systems.

USDOT POLICY

Recommended Actions:

- Consider bicycling as equal with other modes
- Ensure transportation choices for all ages and abilities, especially children
- Go beyond minimum design standards
- Integrate bicycle accommodation on bridges
- Collect data on bicycle trips
- Remove snow – same maintenance as roads required for facilities built with federal funds
- Improve bicycle facilities during maintenance projects

Designing for Bicyclist Safety

EVALUATING NEEDS

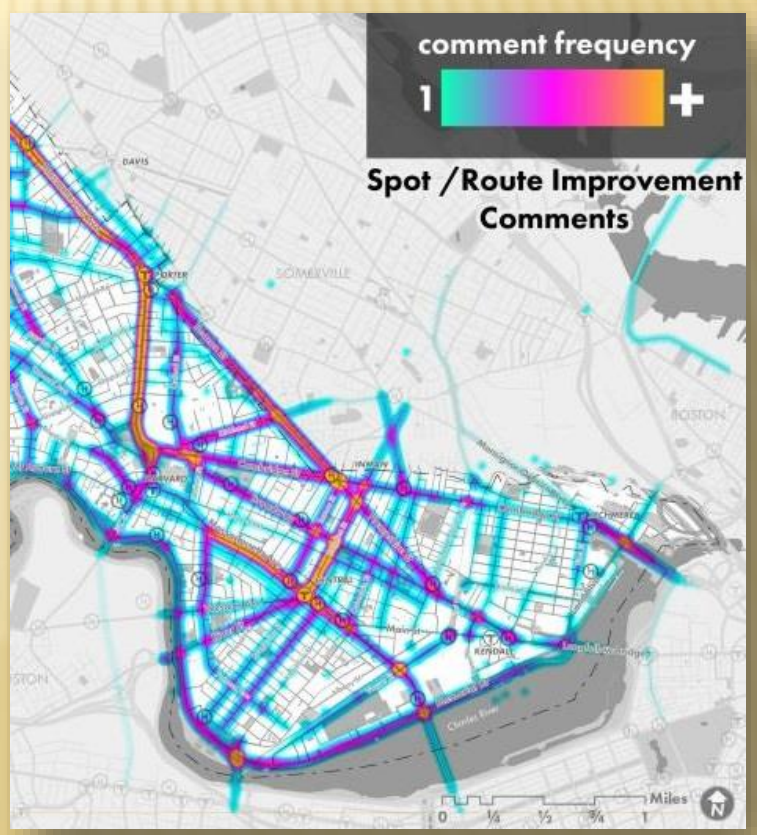
DATA COLLECTION GOALS

- Identify high crash locations, corridors, areas
- Identify locations, corridors, areas with high crash potential
- Prioritize high crash locations, corridors, areas
- Identify appropriate treatments

CRASH DATA

Understanding the limitations:

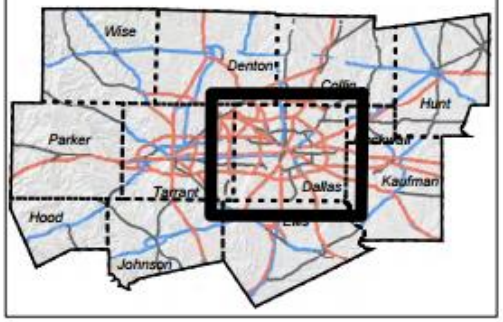
- Crashes usually dispersed
- Data does not include “near-misses”
- Public may perceive locations without a crash history as being unsafe
- Data may be incomplete or inaccurate



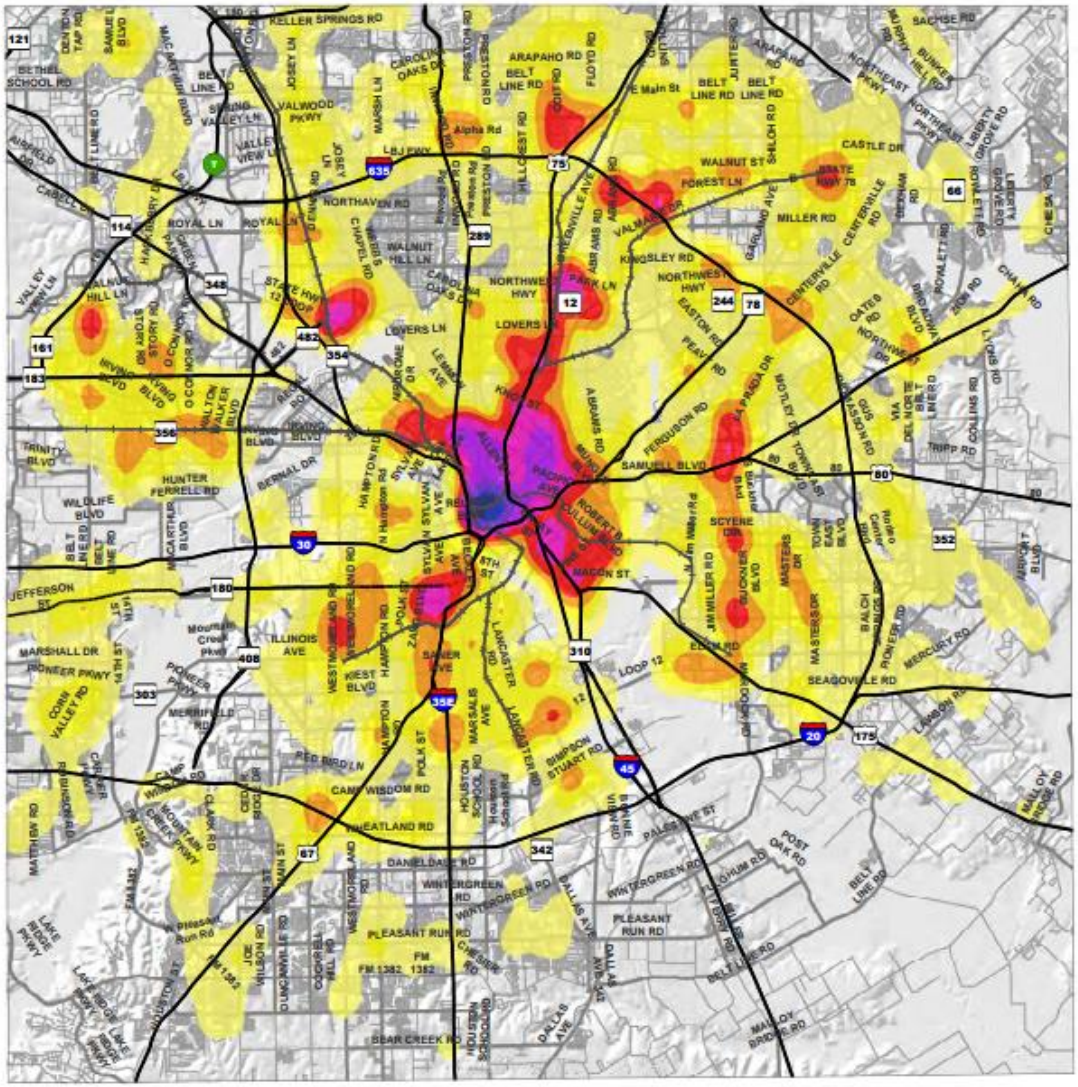
Dallas County
Bicycle & Pedestrian Crash Density (2010 - 2014)

- No Crash Density
- Low Crash Density
- Medium Crash Density
- High Crash Density
- Very High Crash Density
- Highway
- Major Arterial
- Minor Arterial
- Passenger Rail

NCTCOG 12 County Metropolitan Planning Area



Note: Density concentration is calculated as a magnitude per unit area from crash point features and is based on each county's geography. Blue symbolizes higher concentration of crashes and yellow displays lower concentrations.

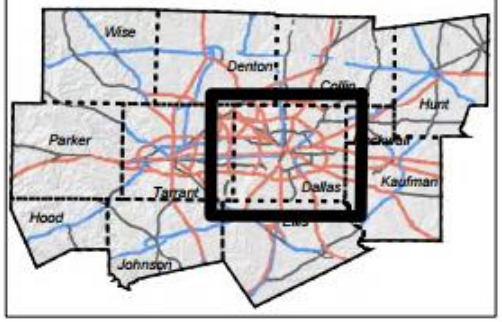


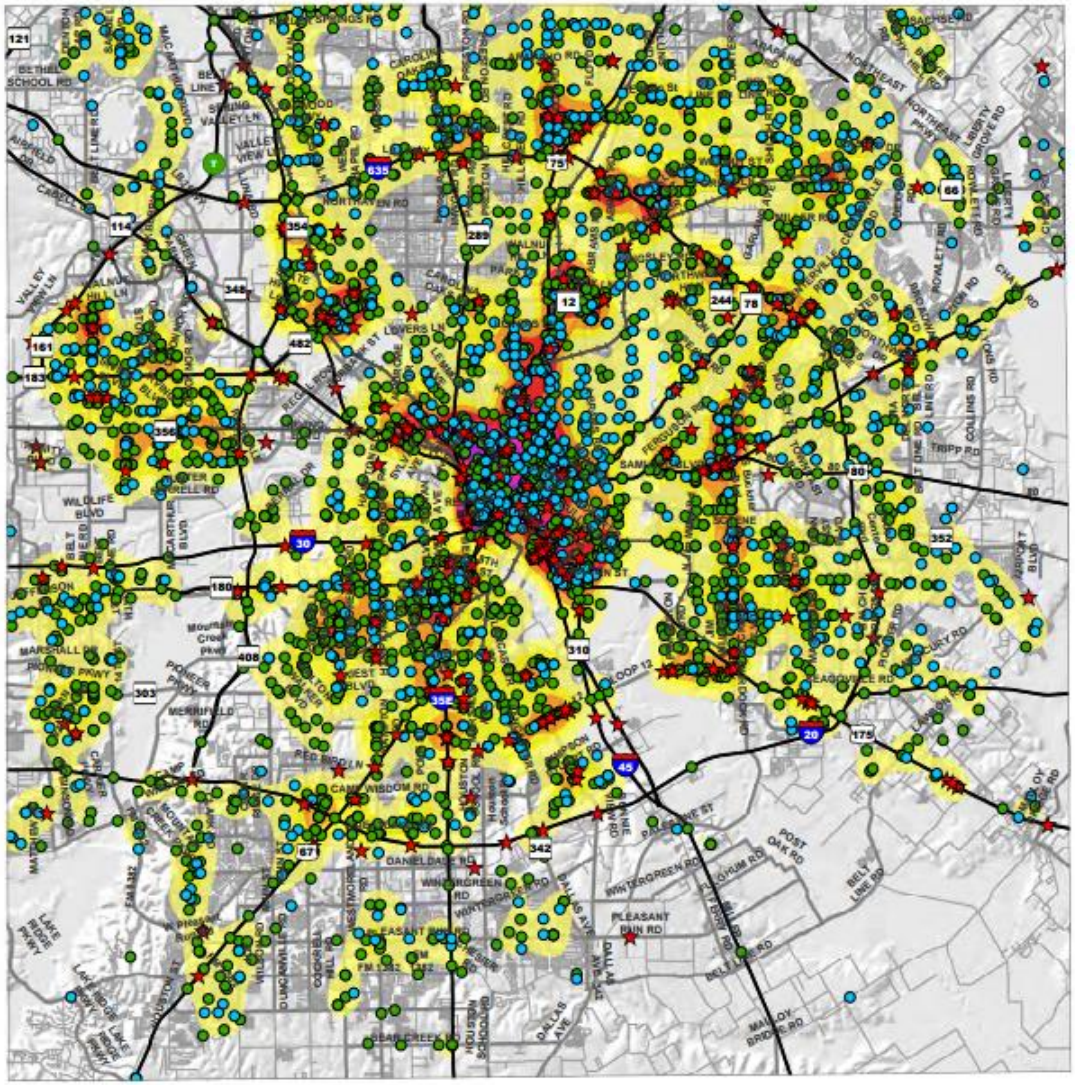
Dallas County

Bicycle and Pedestrian Crash Locations and Density (2010 - 2014)

- Bicycle and Pedestrian Fatal Crash Location - (263)
- Bicycle Crash Location - (995)
- Pedestrian Crash Location - (3,064)
- No Crash Density
- Low Crash Density
- Medium Crash Density
- High Crash Density
- Very High Crash Density
- Highway
- Major Arterial
- Minor Arterial
- Passenger Rail

NCTCOG 12 County Metropolitan Planning Area





Note: Density concentration is calculated as a magnitude per unit area from crash point features and is based on each county's geography. Blue symbolizes higher concentration of crashes and yellow displays lower concentrations.

SAFETY EVALUATION TOOLS

- Highway Safety Manual
- Bicycle Intersection Safety Indices
- Highway Capacity Manual
- Road Safety Audit
- BIKESAFE

HSM METHODOLOGY

- Urban & Suburban Segments

$$N_{biker} = N_{br} \times f_{biker}$$

  - N_{biker} – vehicle-bicycle collision frequency
  - N_{br} – crash frequency, excluding bikes and peds
  - f_{biker} – bicycle crash adjustment factor
    - -- < or > 30 mph posted speed
    - -- road type (2U, 3T, 4U, 4D, 5T)
    - -- values range from 0.002 to 0.050

CMF LIMITATIONS

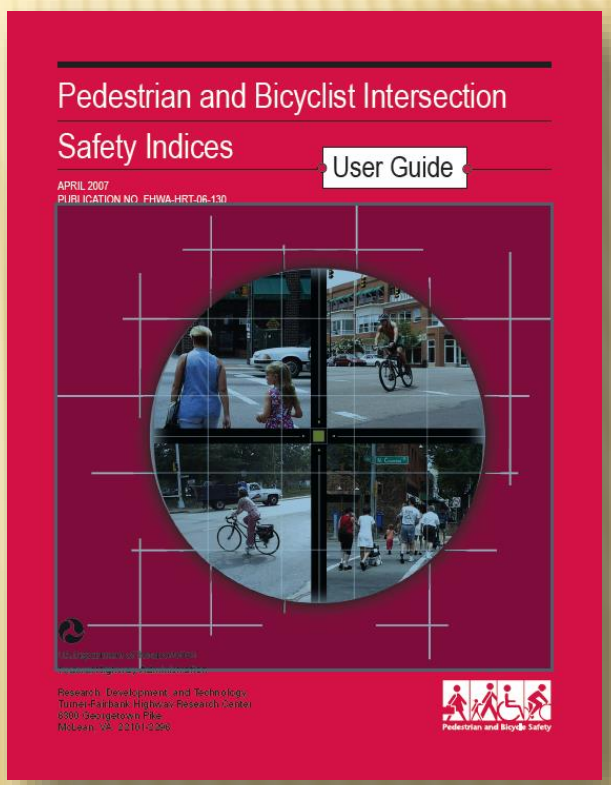
▼ Countermeasure: Install bicycle lanes

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
1.05	-5	★★★☆☆	All	All	Urban	Jensen, 2008	
0.944	5.6	★★★☆☆	All	All	Urban	Chen et al., 2012	
1.509	-50.9	★★★☆☆	Vehicle/bicycle	All	Urban	Chen et al., 2012	
1.057	-5.7	★★★☆☆	All	All	Urban	Chen et al., 2012	Includes signalized, all-way stop controlled, ... [*read more*]
1.281	-28.1	★★★☆☆	Vehicle/bicycle	All	Urban	Chen et al., 2012	Includes signalized, all-way stop controlled, ... [*read more*]

BICYCLIST INTERSECTION SAFETY INDICES

Prioritize intersections crossings and intersection approaches for bicycle safety improvements

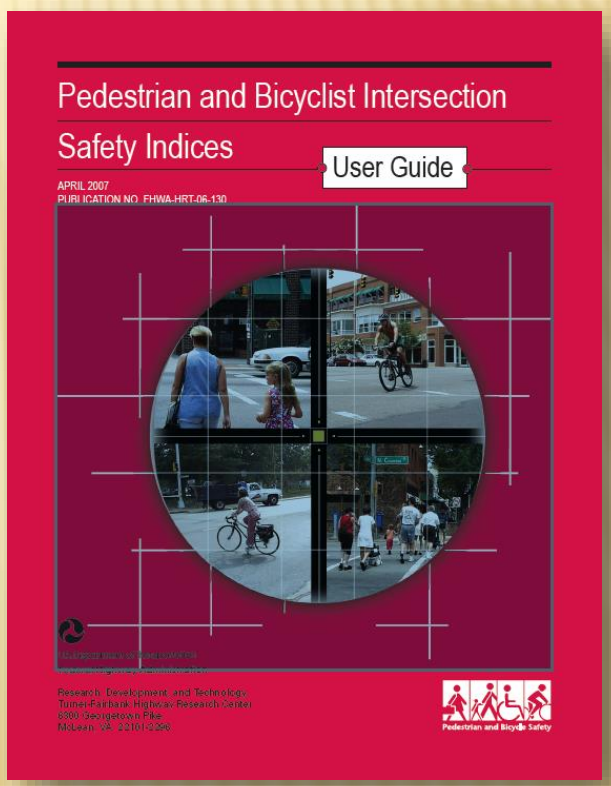
- Score of 1 (safest) to 6 (least safe)
- Score for each movement (thru, left turn, right turn)



BICYCLIST INTERSECTION SAFETY INDICES

Inputs:

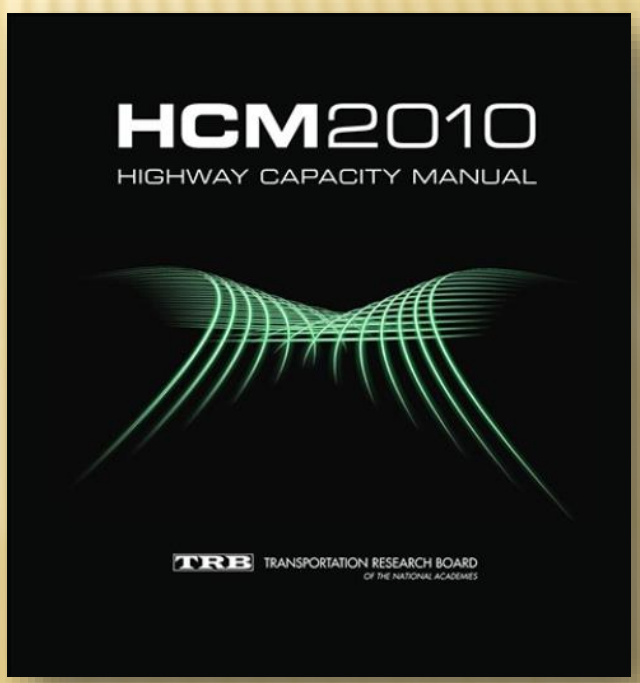
- ADT on main and cross streets.
- Number of through vehicle lanes on cross street.
- Number, type, and configuration of traffic lanes on main street approach.
- Speed limit on main street.
- Presence of on-street parking on main street approach.
- Type of traffic control on approach of interest (signal or no signal).



BICYCLE LEVEL-OF-SERVICE

Interrupted flow:

- LOS reported separately for each mode
  - Purpose, length, and expectation differs
- Travel speed
- Intersection delay
- Bicyclist perception



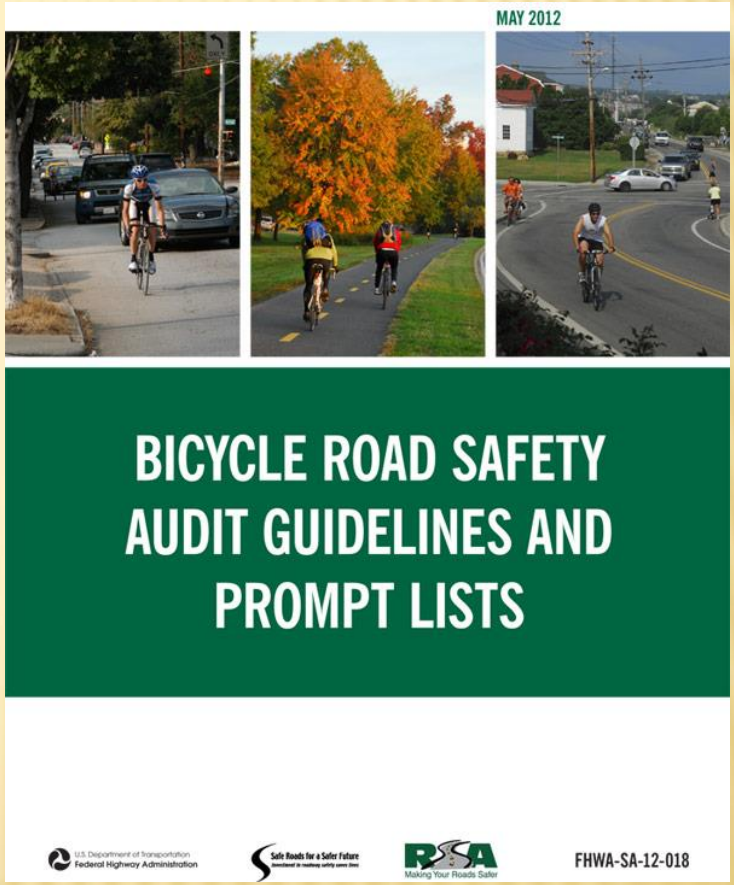
BICYCLE LEVEL-OF-SERVICE

Factors in bicycle LOS score:
Interrupted flow

- Motorized vehicle volume
- % heavy vehicles
- % occupied parking
- # lanes
- Outside lane width
- Median
- Curb
- Access
- Pavement condition
- Motorized vehicle speed

ROAD SAFETY AUDIT

- Formal safety examination conducted by an independent, experienced, multidisciplinary team
- RSA Prompt List
- Bikeability checklist



RSA PROMPT LIST

D.8: Are the intersection/transition and paths leading to the transition adequately lit (see C.8)?

D.9: Is the visibility of cyclists as they make the transition from one facility or roadway geometry to another adequate from the perspective of all road users?

The transition, whether along a roadway or at an intersection, should allow drivers to see cyclists and understand their path and intent, and vice versa. The following should be investigated:

- Obstructions caused by roadside features (e.g., fences and vegetation).
- Adequacy of warning signs.
- Location of the transition with respect to roadway geometry (e.g., shoulder drop and turn lanes) (see also A.9 and C.9).

The picture to the left depicts a bike lane that hooks right through a major intersection and transitions to a protected bikeway. Chevrons on the pavement help guide cyclists and show motorists the path provided for cyclists through the intersection (note that the chevron pavement markings do not conform to the MUTCD).

D.10 and D.11: Are signs and markings at transition areas appropriate?

Transitions and termini should be appropriately signed and marked to warn cyclists of conditions ahead, particularly at locations at which cyclists do not expect transitions or termini. Likewise, motorized vehicles should have adequate warning when off-road bicycle facilities transition to on-road facilities. The intended paths of all road users should also be appropriately signed and marked at the point of transition. Additional attention may be given to locations with high volumes of unfamiliar users or tourists.

BIKEABILITY CHECKLIST

Go for a ride and use this checklist to rate your neighborhood's bikeability.

How bikeable is your community?

Location of bike ride (be specific):

Rating Scale: 1 awful; 2 many problems; 3 some problems; 4 good; 5 very good; 6 excellent

1. Did you have a place to bicycle safely?

a) On the road, sharing the road with motor vehicles?

- ☐ Yes
- ☐ Some problems (please note locations):
  - ☐ No space for bicyclists to ride
  - ☐ Bicycle lane or paved shoulder disappeared
  - ☐ Heavy and/or fast-moving traffic
  - ☐ Too many trucks or buses
  - ☐ No space for bicyclists on bridges or in tunnels
  - ☐ Poorly lighted roadways

  Other problems: _____

b) On an off-road path or trail, where motor vehicles were not allowed?

- ☐ Yes
- ☐ Some problems:
  - ☐ Path ended abruptly
  - ☐ Path didn't go where I wanted to go
  - ☐ Path intersected with roads that were difficult to cross
  - ☐ Path was crowded
  - ☐ Path was unsafe because of sharp turns or dangerous downhills
  - ☐ Path was uncomfortable because of too many hills
  - ☐ Path was poorly lighted

  Other problems: _____

2. How was the surface that you rode on?

- ☐ Good
- ☐ Some problems, the road or path had:
  - ☐ Potholes
  - ☐ Cracked or broken pavement
  - ☐ Debris (e.g. broken glass, sand, gravel, etc.)
  - ☐ Dangerous drain grates, utility covers, or metal plates
  - ☐ Uneven surface or gaps
  - ☐ Slippery surfaces when wet (e.g. bridge decks, construction plates, road markings)
  - ☐ Bumpy or angled railroad tracks
  - ☐ Rumble strips

  Other problems: _____

Overall Surface Rating: (circle one)
1 2 3 4 5 6

3. How were the intersections you rode through?

- ☐ Good
- ☐ Some problems:
  - ☐ Had to wait too long to cross intersection
  - ☐ Couldn't see crossing traffic
  - ☐ Signal didn't give me enough time to cross the road
  - ☐ Signal didn't change for a bicycle
  - ☐ Unsure where or how to ride through intersection

  Other problems: _____

Designing for Bicyclist Safety

SELECTING COUNTERMEASURES

DESIGN GUIDELINES

FHWA Memorandum – August 20, 2013
"Bicycle and Pedestrian Facility Design Flexibility"

Support for taking a flexible approach

Guide for the Development of Bicycle Facilities (AASHTO)
Designing Urban Walkable Thoroughfares (ITE)
Urban Bikeway Design Guide (NACTO)

New 2015: Separated Bike Lanes Planning & Design Guide (FHWA)

New 2016: Achieving Multimodal Networks: Applying Flexibility and Reducing Conflicts (FHWA)

New 2017: Small Town and Rural Multimodal Networks (FHWA)

PEDBIKESAFE.ORG

The **Bicycle Safety Guide and Countermeasure Selection System** is intended to provide practitioners with the latest information available for improving the safety and mobility of those who bike. The online tools provide the user with a list of possible engineering, education, or enforcement treatments to improve bicycle safety and/or mobility based on user input about a specific location.

GUIDE

Background
Understand what is needed to create a viable bicycle network.

Analysis
How crash typing can lead to the most appropriate countermeasures.

Statistics
Learn about the factors related to thebicycle crash problem.

Implementation
Needed components for treatments.

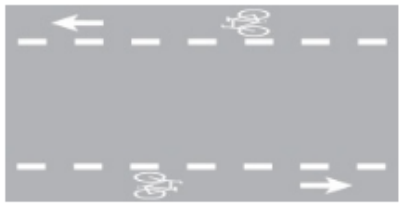
COUNTERMEASURES

Selection Tool
Find countermeasures based on desired objectives.

Countermeasure List
A comprehensive list of all countermeasures.

Selection Matrices
Find countermeasures based on crash types and performance objectives.

TRAFFIC CONTROL DEVICES

Subject to Experimentation	Available through Interim Approval	Interpretations
 Two-Stage Turn Box	 Green-Colored Pavement	 Use of R4-11 Sign on Roads with Speed Limits Above 35mph
 Dashed Bicycle Lanes	 Alternate Design for the U.S. Bicycle Route (M1-9) Sign	 Modified Bicycle Destination Sign
 Destination Guide Signs for Shared-Use Paths	 Bicycle Signal Faces	 Installation of Advance Turn and Directional Assemblies for Bike Route Signs
 Green-Colored Pavement for Use with the Shared-Lane Marking	 Bicycle Box	 Pavement Markings for Designated Bicycle Routes

Designing for Bicyclist Safety

SUMMARY THOUGHTS

IMPERATIVE FOR CHANGE

- 1-5 mile trip typical for casual rider
- 50% of all trips are less than 3 miles
- Most U.S. facilities are LTS 3
- Most adult bicyclists comfortable on LTS 2

KEY SAFETY FACTORS

Important Message

- Speed
- Number of lanes
- Visibility
- Traffic volume & composition
- Conflict points
- Proximity
- Bike control
- Connectivity

Designing for Bicyclist Safety

QUESTIONS

Discussion

- Send us your questions 
- Follow up with us:
  - Brooke Struve brooke.struve@dot.gov
  - Michael Cynecki mcynecki@lee-eng.com
  - Peter Lagerwey plagerwey@tooledesign.com
  - General Inquiries pbic@pedbikeinfo.org
- Archive at www.pedbikeinfo.org/webinars