

DESIGNING FOR PEDESTRIAN SAFETY



Logistics

1-2

- Health and safety (emergency exits, procedures for evacuation, etc.)
- Please silence your cell phones/pagers
- Breaks (when, restrooms, snacks)
- Lunch arrangements
- Other site-specific issues

Self Introductions

1-3

- Please tell us:
- Your Name and Title
- Your employer
- What is your ONE pedestrian safety issue?

Instructors:



1-4

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- 602-443-8476

This is a workshop: Expect to do some work!

1-5



- Ask questions and issues as you have them
- May be covered in course material or
- Will be placed on the “Park Bench” for later
- Exercises, questions, and discussions – YOU provide the answers!
- Field trip: Assess the situation, apply the principles, and make recommendations
- Identify and prioritize potential policies and procedures

Designing for Pedestrian Safety

Workshop Outcomes

1-6

- At the end of this workshop, you will be able to:
- Describe the influence of planning factors: land use, street connectivity, access management, site design, and level of service.
- Describe how pedestrians should be considered and provided for during the planning, design, work zone, maintenance, and operations phases.
- Describe how human behavior affects the interaction between pedestrians and drivers
- Identify good practices and effective solutions to enhance pedestrian safety and accessibility.

Overview of Pedestrian Safety Problem

1-7

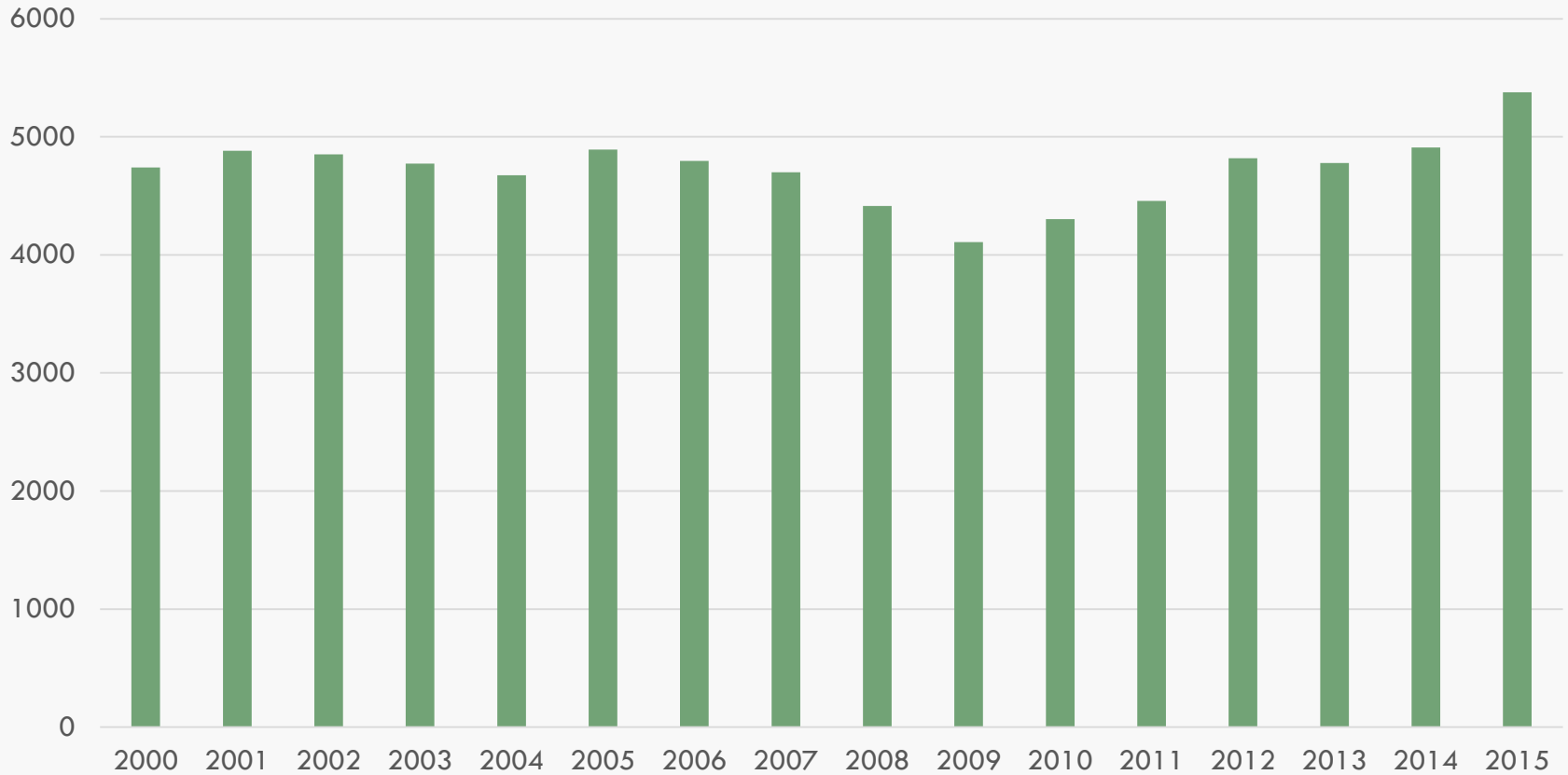
- Annually more than 5,000 pedestrians are killed in traffic crashes, representing about 15% of all traffic deaths.
- Nearly 70,000 pedestrians are injured each year
- Most crashes occur when the pedestrian crosses a road
- Most fatalities and serious injuries occur on roads designed with little attention for pedestrian safety.
- Pedestrians are less likely to be killed in walkable environments.



Pedestrian Fatalities by Year U.S. Data

1-8

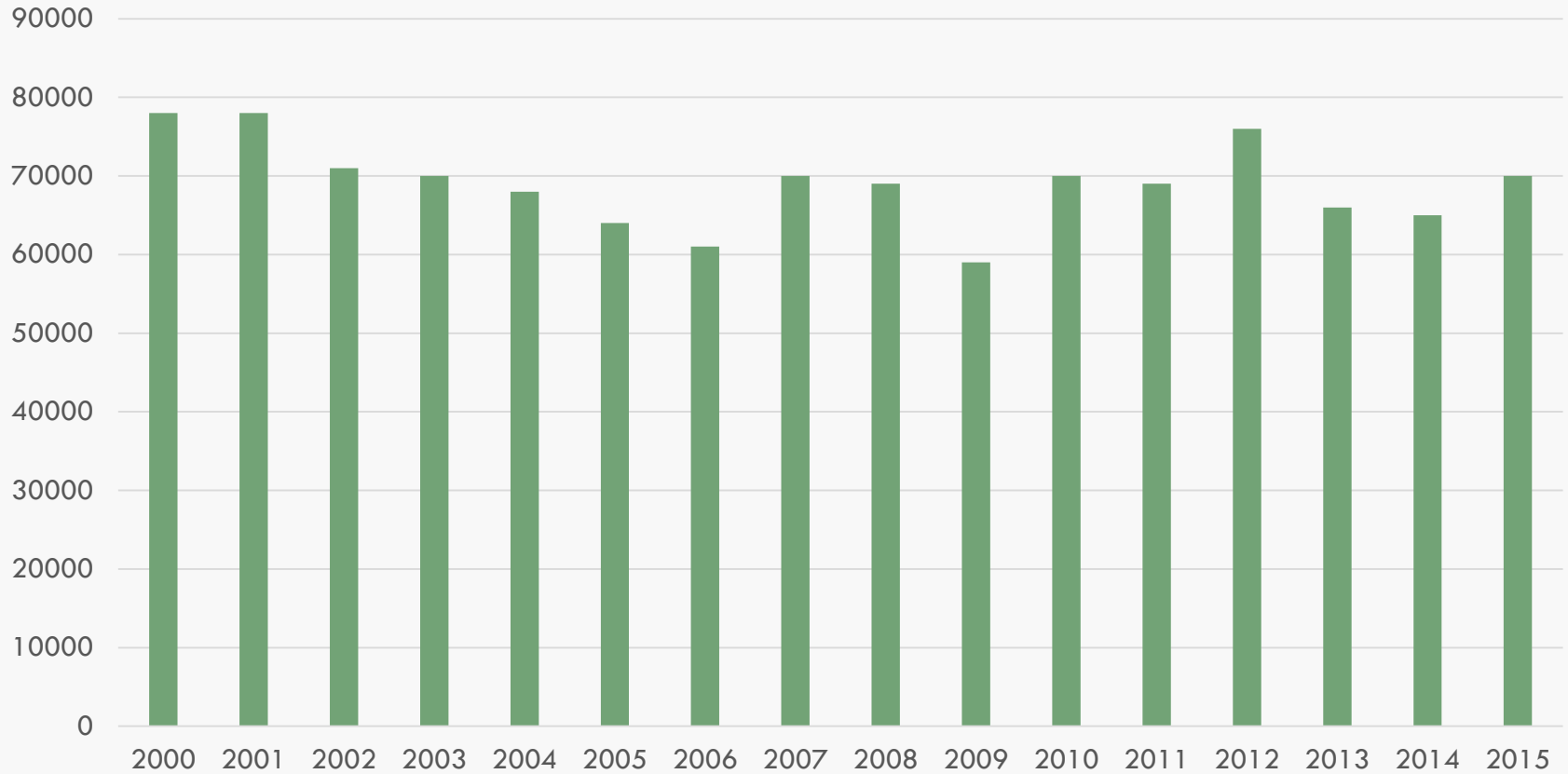
Pedestrian Fatalities



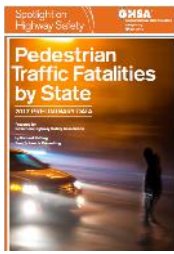
Pedestrian Injuries by Year U.S. Data

1-9

Estimated Pedestrian Injuries



GHSA Pedestrian Traffic Fatalities by State 2017 Preliminary Report



I-10

Table 2

Pedestrian Fatalities by State per 100,000 Population, 2016

Source: State Highway Safety Offices and U.S. Census Bureau

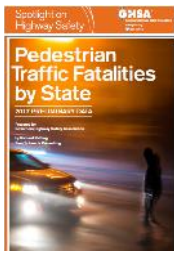
Table 2 shows the rate of pedestrian fatalities per 100,000 population by state for 2016, based on the number of pedestrian fatalities reported by the states

Sorted by State

State	Pedestrian Fatalities per 100K Population - 2016
Alabama	2.51
Alaska	1.62
Arizona	2.85
Arkansas	1.64
California	2.43
Colorado	1.52
Connecticut	1.73
Delaware	2.83
DC	1.32
Florida	3.22
Georgia	2.25
Hawaii	2.24
Idaho	0.71
Illinois	1.15
Indiana	1.28

Sorted by Fatality Rate

State	Pedestrian Fatalities per 100K Population - 2016
New Mexico	3.45
Florida	3.22
South Carolina	2.96
Arizona	2.85
Delaware	2.83
Nevada	2.76
Louisiana	2.73
Alabama	2.51
Texas	2.44
California	2.43
Vermont	2.41
Oklahoma	2.32
Georgia	2.25
Hawaii	2.24
North Carolina	2.00



Crash Factor - Lighting

1-EX-11

Table 4 States Where $\geq 80\%$ of Pedestrian Fatalities Occurred in the Dark (2014-2016)

State	Total Pedestrian Fatalities with Known Light Levels	Pedestrian Fatalities that Occurred in Dark	
		#	%
New Mexico	201	169	84%
South Carolina	373	309	83%
Texas	1,695	1,356	80%
Delaware	89	71	80%
Louisiana	334	266	80%

Source: FARS

Agenda overview

1-12

- Planning factors: land use, street connectivity, access management, site design, and level of service
- Walking along the road: Effectiveness of sidewalks
- Street crossings: Human behavior, midblock crossings, crosswalks, medians, signals, over/under-crossings
- Pedestrian-friendly intersections: Geometry, radii, curb extensions, islands, crosswalks
- Signalized Intersections: Making them better for pedestrians
- Interchanges: Providing pedestrian safety and accessibility
- Roundabouts: Making them work for pedestrians
- Transit: Stop locations & pedestrian crossings
- Road diets: Making room for pedestrians
- Field Exercise: Apply what we have learned
- Policy Discussion – Optional based on time

Why is it important to accommodate pedestrian safety and accessibility?

I-13



Because we are all pedestrians

Why?

1-14



Because many people do not drive

Why?

1-15



Because other modes depend on walking

Why?

1-16



Because it's good for business – people walk into stores

Why?

1-17



Because pedestrians use and belong on streets and highways

Why?

1-18



Because walking is healthy exercise

Why?

1-19



Because it will make roads safer for all road users

Why?

I-20

- Myth: Accommodating pedestrians increases liability
- Fact: ignoring a problem increases liability
- A good solution is to identify the problem and have a plan to address it.

“A Circuit Court civil jury ... awarded \$3.3 million to relatives of a woman killed by a motorist as she walked on a stretch of Pennsylvania Avenue that did not have a sidewalk or guard rails. The jury found the state of Maryland liable in the wrongful death lawsuit, and voted to award \$2.5 million to Kayla Martin, the daughter of Kelay Smith, who was struck and killed by a motorist on Aug. 12, 2008.”

--Washington Post; March 11, 2011

- To reduce liability

Why?

I-21

Sisters OR



AASHTO: “Because of the demands of vehicular traffic in congested areas, it is often extremely difficult to make adequate provisions for pedestrians. Yet this should be done, because pedestrians are the lifeblood of our urban areas...”

(2011 edition, AASHTO Green Book, page 2-78)

Why?

1-22

- USDOT Policy Statement on Bicycle & Pedestrian Accommodation (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

It's also been Federal Policy since ISTEA (1991)



Former U.S. Transportation Secretary Anthony Foxx

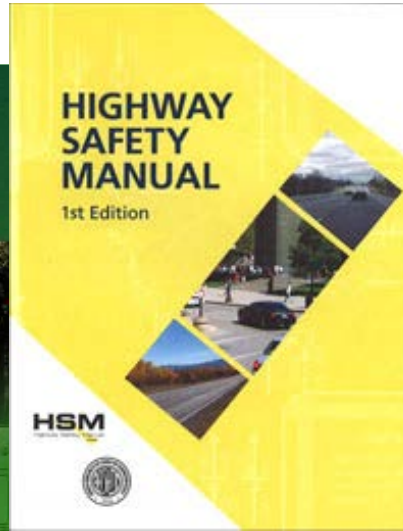
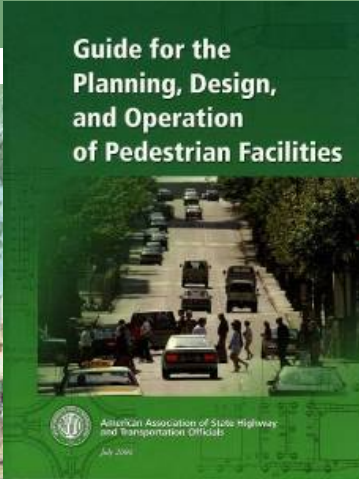
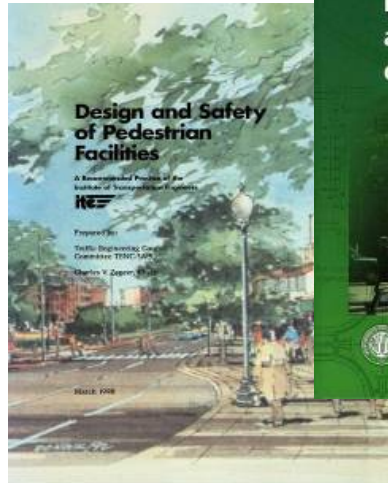
Why?

I-23

- USDOT Policy Statement – Actions to integrate non-motorized modes into future projects:
- Consider walking and bicycling as equals with other transportation modes;
- Ensure convenient choices for people of all ages and abilities;
- Go beyond minimum design standards;
- Collect data on walking and biking trips;
- Set mode share targets for walking and bicycling
- Maintain sidewalks paths, including snow removal
- Improve non-motorized facilities during maintenance projects.

Resources

1-24



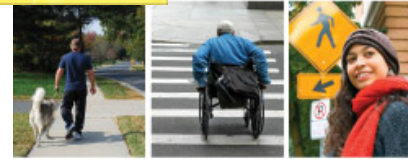
ACHIEVING MULTIMODAL NETWORKS
APPLYING DESIGN FLEXIBILITY & REDUCING CONFLICTS



U.S. Department of Transportation
Federal Highway Administration



BICYCLE ROAD SAFETY AUDIT GUIDELINES AND PROMPT LISTS



A RESIDENT'S GUIDE FOR CREATING SAFE AND WALKABLE COMMUNIT

U.S. Department of Transportation
Federal Highway Administration

PEDBIKESAFE Pedestrian Safety Guide and Countermeasure Selection System
Bicycle Safety Guide and Countermeasure Selection System

<p>The Pedestrian 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 walk.</p>	<p>PEDSAFE</p> <p>Index Explore all available resources.</p> <p>Guide Create a viable pedestrian system.</p>	<p>Countermeasures Also: selection tool, matrices.</p> <p>Case Studies Examples of various treatments.</p>
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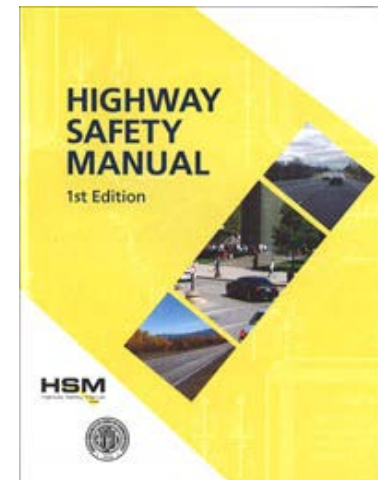
<p>BIKESAFE</p> <p>Index Explore all available resources.</p> <p>Guide Create a viable bicycling system.</p>	<p>Countermeasures Also: selection tool, matrices.</p> <p>Case Studies Examples of various treatments.</p>	<p>The Bicycle Safety Guide and Countermeasure Selection System is intended to provide practitioners with the latest information available for improving the safety and mobility of those who bicycle.</p>
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- PBIC: www.pedbikeinfo.org
- FHWA: safety.fhwa.dot.gov
- NHTSA: nhtsa.dot.gov
- ITE: www.ite.org
- AASHTO/NCHRP: safety.transportation.org

Highway Safety Manual

I-25

- Science-based technical approach for safety analysis
- AASHTO HSM Website:
 - www.highwaysafetymanual.org
- FHWA HSM Website:
 - <http://safety.fhwa.dot.gov/hsm/>
- TRB Highway Safety Performance Committee Website:
 - www.safetyperformance.org
- FHWA RC HSM Webinar Series
 - <http://www.highwaysafetymanual.org/Pages/FHWAResourceCenterHSMWebinarSeries.aspx>



Calculating Reduction in Number of Crashes

2-26

Crash Modification Factor (CMF): factor used to compute the expected number of crashes after implementing a given countermeasure.

Crash Reduction Factor (CRF): % fewer crashes experienced on a road with a given countermeasure than on similar road without the countermeasure

Relationship between CMF and CRF:

$$\text{CMF} = 1 - (\text{CRF}/100)$$

$$\text{CRF} = 100 * (1 - \text{CMF})$$

CMF/CFR Clearinghouse: www.cmfclearinghouse.org

CMF - Important Concepts

1-27

- May apply to all crashes, or crash specific subsets (e.g., run-off-road, night, wet weather, multi-vehicle, etc.)
- Same treatment in different contexts or highway types may have different effects and different CMF values

The screenshot shows the homepage of the Crash Modification Factors Clearinghouse. At the top left is the logo with the letters 'CMF' in large, bold, white font on a dark blue background, with 'CRASH MODIFICATION FACTORS CLEARINGHOUSE' written below it. To the right of the logo is a navigation bar with links: 'Skip to main content | Site Map | Notice | Home'. Below the navigation bar is another set of links: 'About CMFs | Find CMFs | Submit CMFs | Resources | Contact'. The main content area is divided into two columns. The left column has a 'Quick Search' section with a text input field containing 'enter search term(s)', four dropdown menus for filtering by 'countmeasure category', 'crash type', 'crash severity', and 'roadway type', and a 'Search CMFs' button. Below the search section are links for 'Advanced Search' and 'Need Help?'. The right column features a 'Featured Resource' section with a background image of a car on a road. The text reads: 'Desktop Reference for Crash Reduction Factors. Developed by the Federal Highway Administration, the Desktop Reference is a compilation of CRFs relating to intersections, roadway departure and other non-intersection crashes, and pedestrian crashes.'

A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The Crash Modification Factors Clearinghouse houses a Web-based database of CMFs along with supporting documentation to help

Recently Added CMFs

Design diamond, trumpet or doveleaf interchange	Physical channelization of left-turn lane on major road	Flashing beacons at four leg stop controlled intersections
CMF: 0.96	CMF: 0.73	CMF: 0.87
CRF: 4	CRF: 27	CRF: 13

Planning elements that affect pedestrian safety:

I-28

- Land Use
- Street Connectivity
- Access Management
- Site Design
- Level of Service

1-29

Land Use

Why do we have cities?

I-30



To minimize travel & maximize exchange (to be closer together)

How have we built our urban roadway system?

I-31



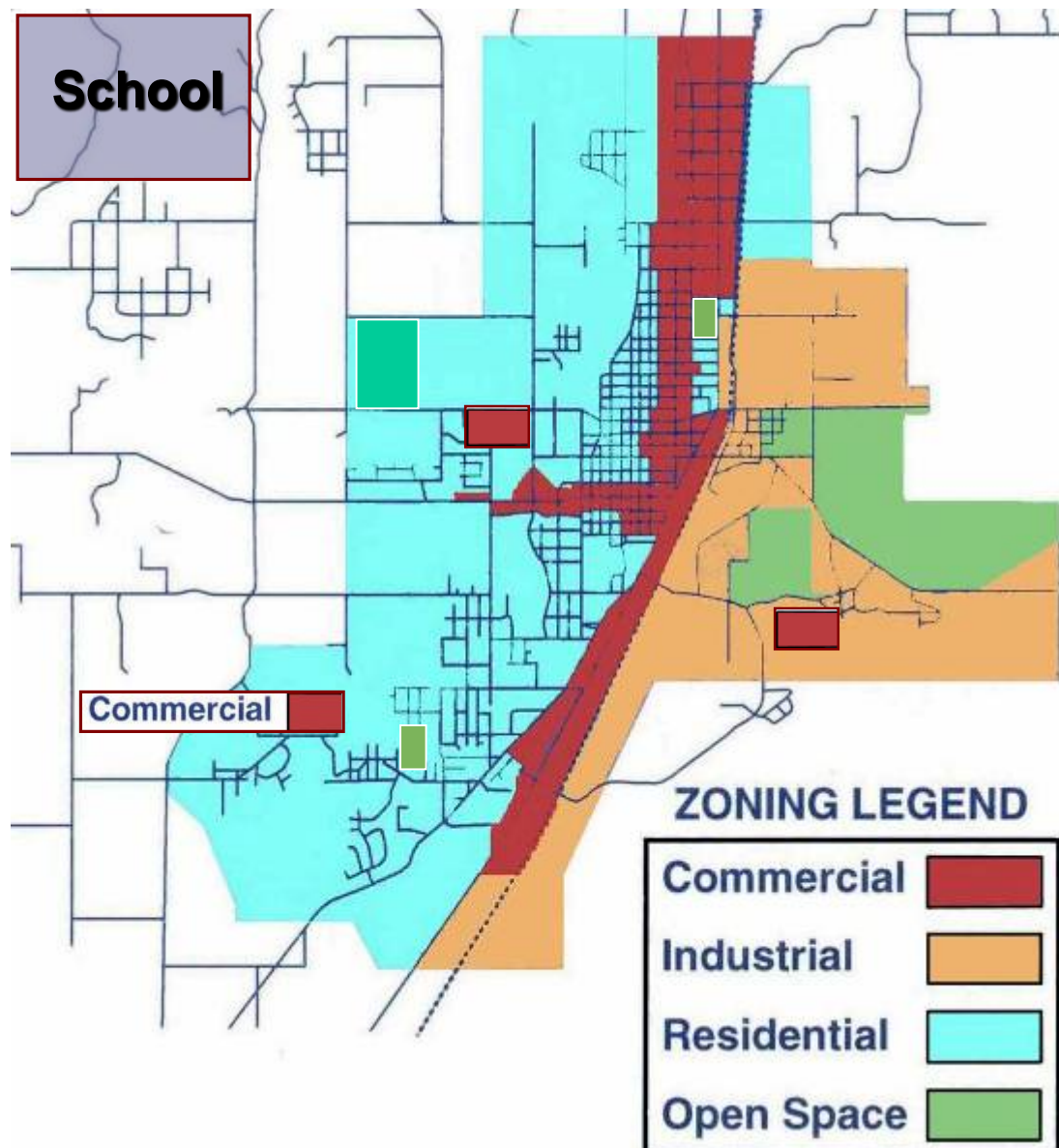
To facilitate travel over longer distances

Reducing travel demand is best achieved through Land Use policies that bring destinations closer together

- The problem:
- Commercial activities concentrated in auto-dominated corridors.
- Segregated land uses
- Result: long travel distances, not conducive to walking

Potential solutions?

1. Allow small-scale retail in neighborhoods
2. Create neighborhood parks
3. Site school closer to residences & parks





I-33

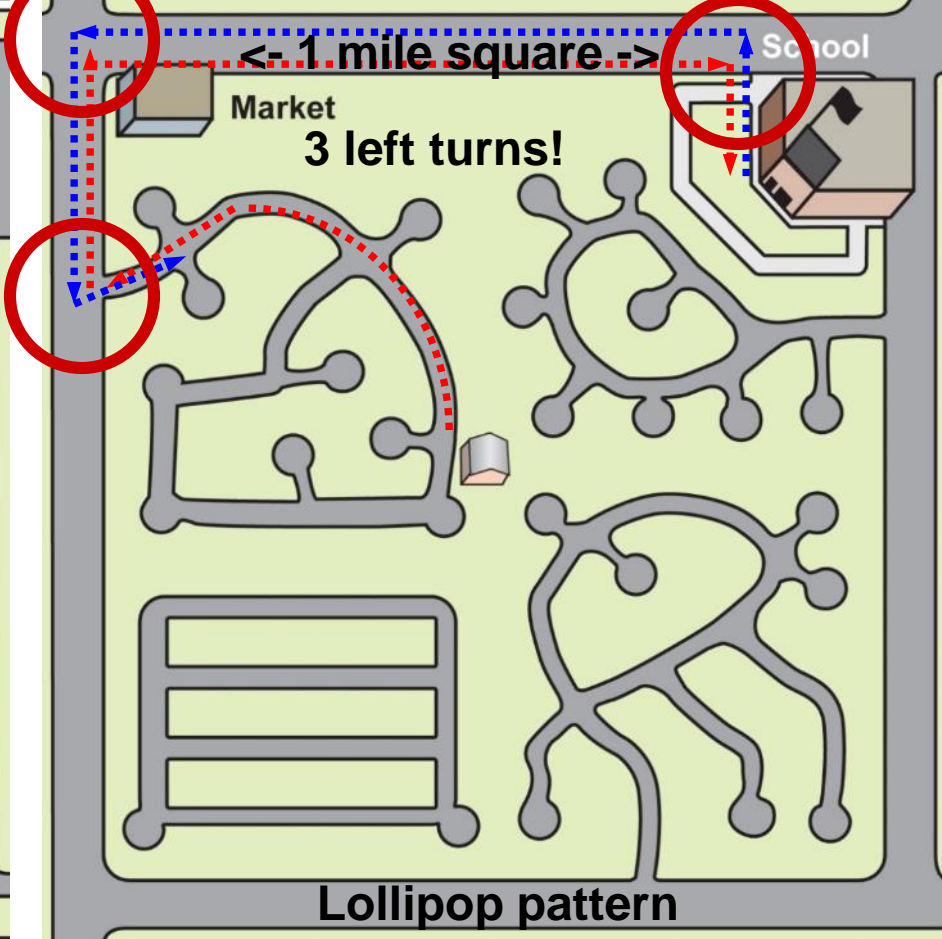
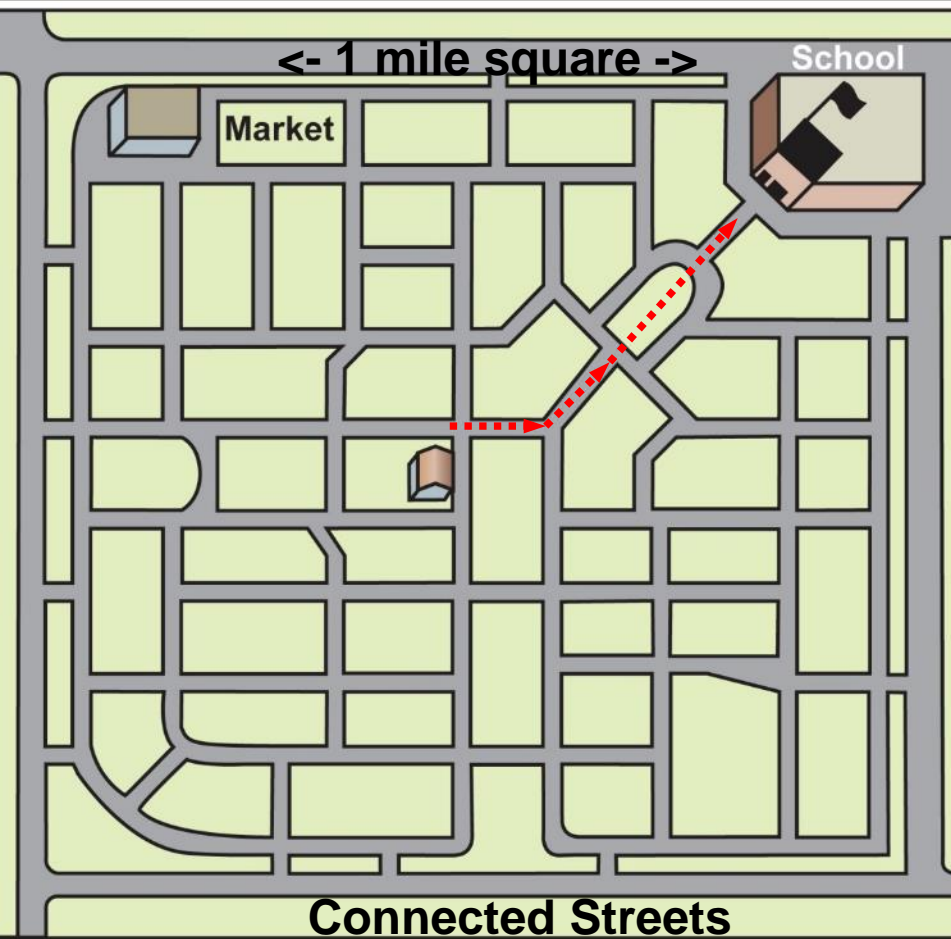
Madison WI

Neo-traditional development: destinations are close to residential areas

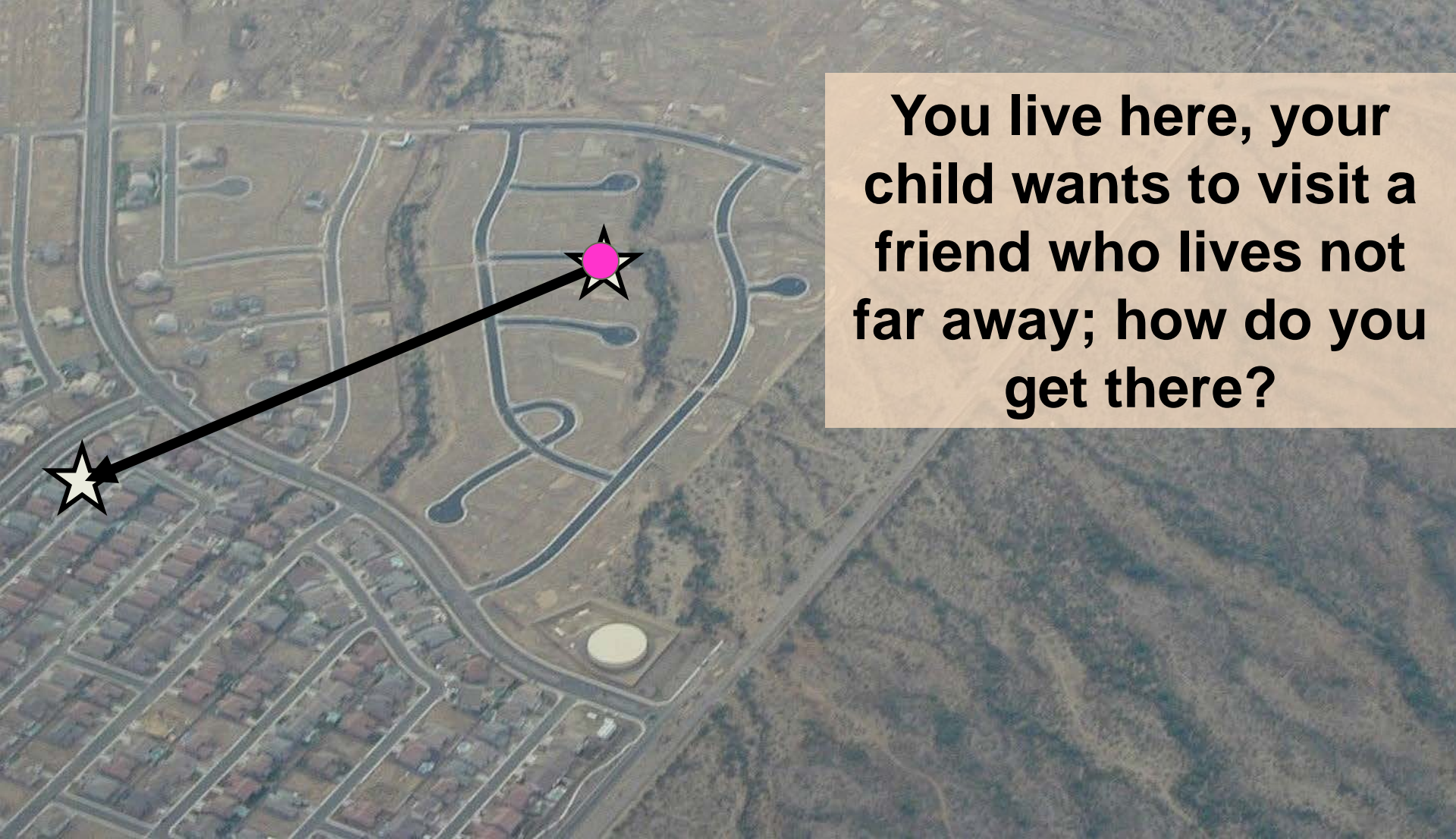
1-34

Street Connectivity



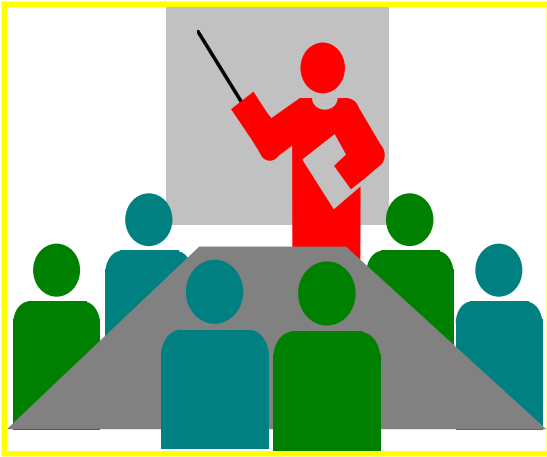


- ❑ Connectivity creates a walkable street system by:
- ❑ Reducing walking distances;
- ❑ Offering more route choices on quiet local streets;
- ❑ Dispersing traffic – reducing reliance on arterials for all trips

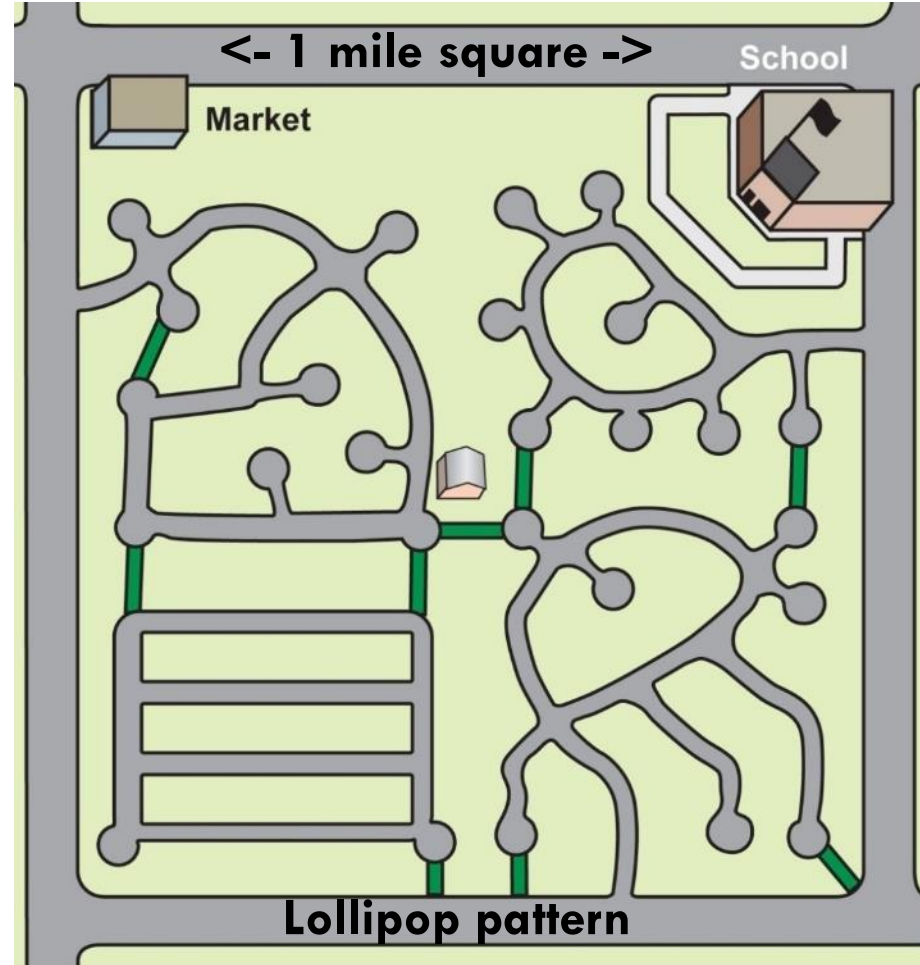


You live here, your child wants to visit a friend who lives not far away; how do you get there?

Cul-de-sac patterns increase walking distances & increase reliance on arterials

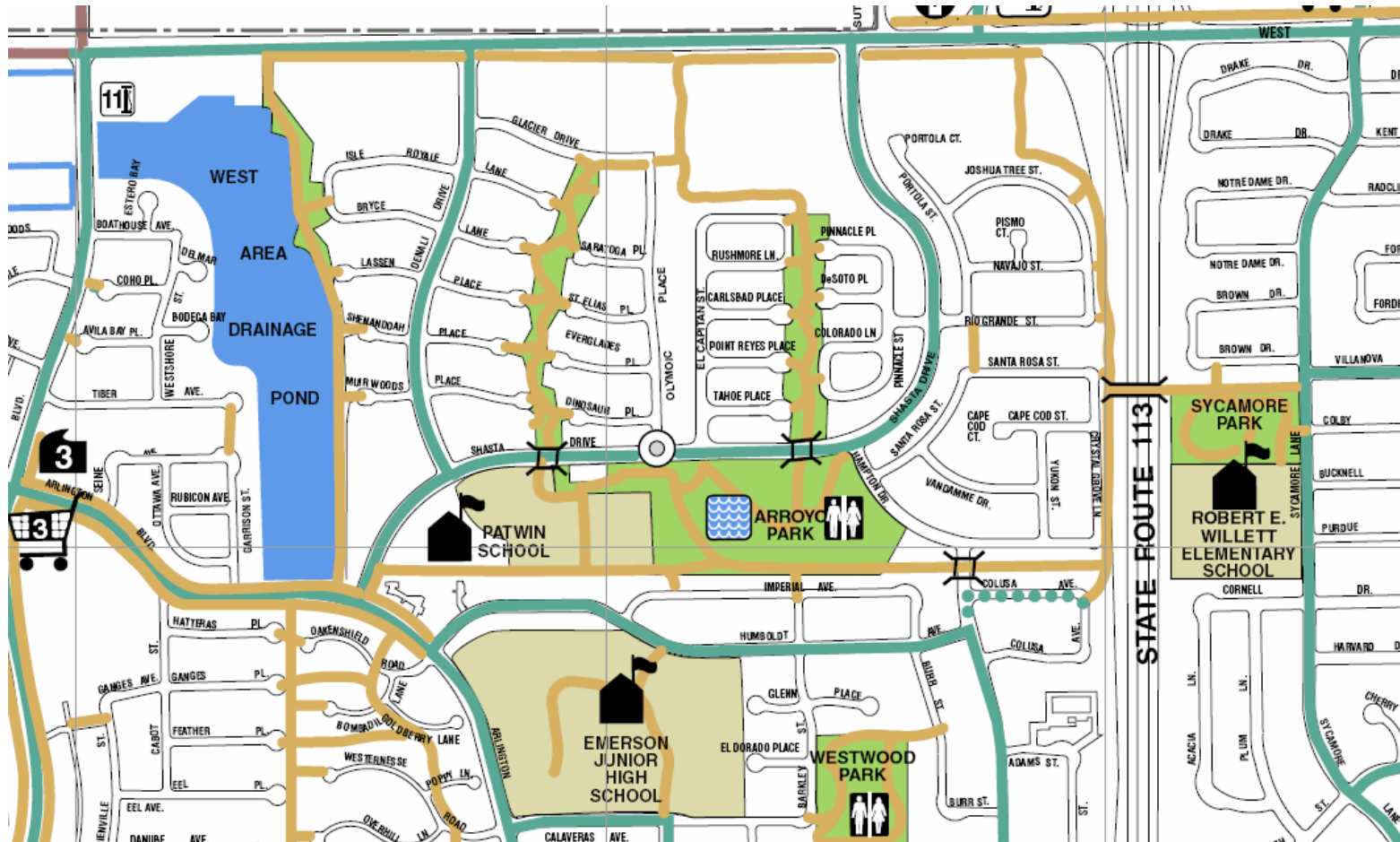


**Can you increase connectivity
with paths, greenways?**



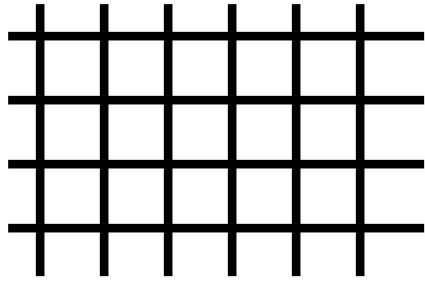
1-37

- Reduces walking distances: YES
- Offers more route choices: YES
- Disperses traffic: NO

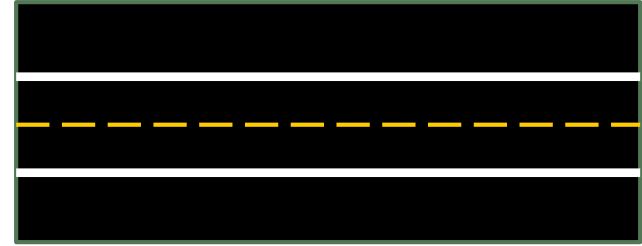


- Dedicate R.O.W. to link cul-de-sacs with linear parks
- Land Use & Connectivity: Schools next to parks.

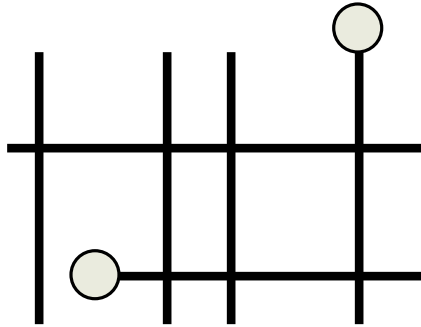
High Connectivity



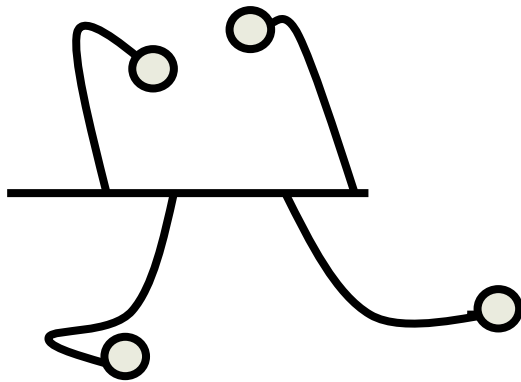
Travel Lanes Required



Moderate Connectivity



Low Connectivity





I-40

Las Vegas NV

Lack of connectivity => overly wide streets



1-41

Albuquerque NM

Lack of connectivity => few but large intersections

Access Management

I-42

Atlanta GA



Every driveway is a potential conflict



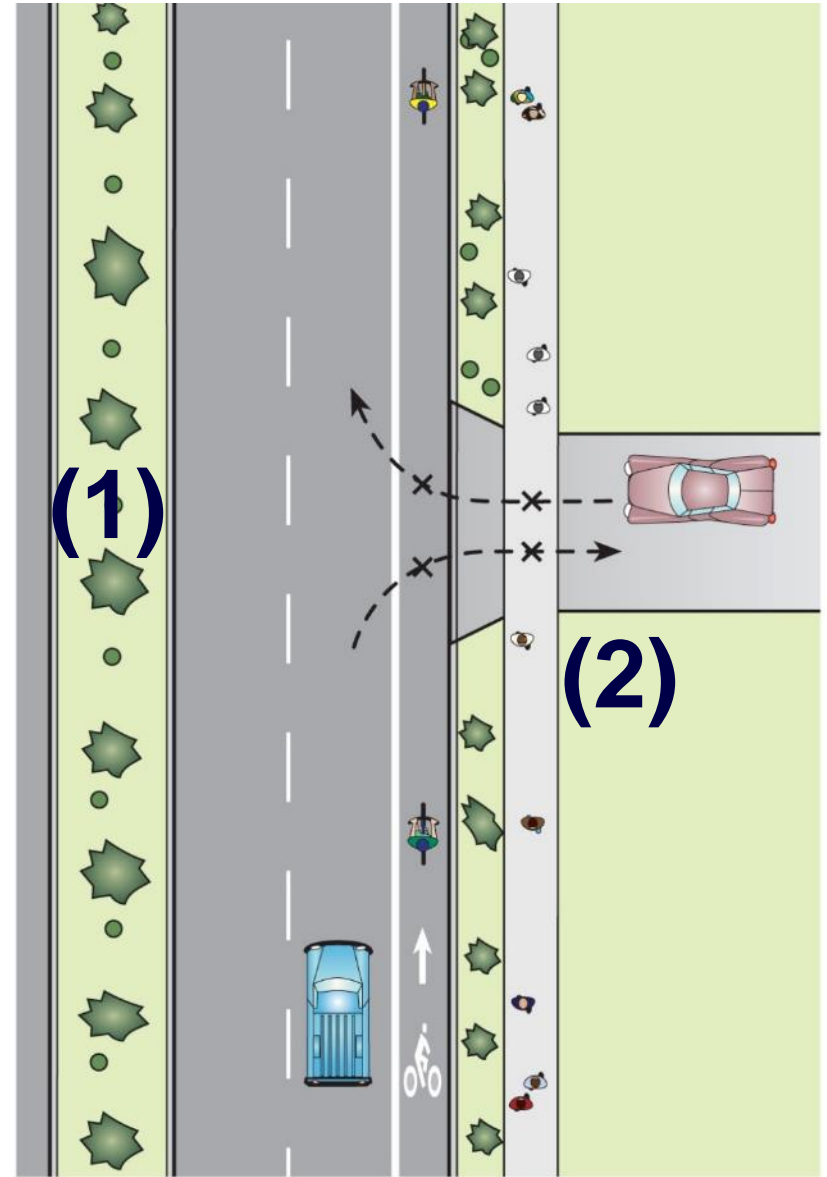
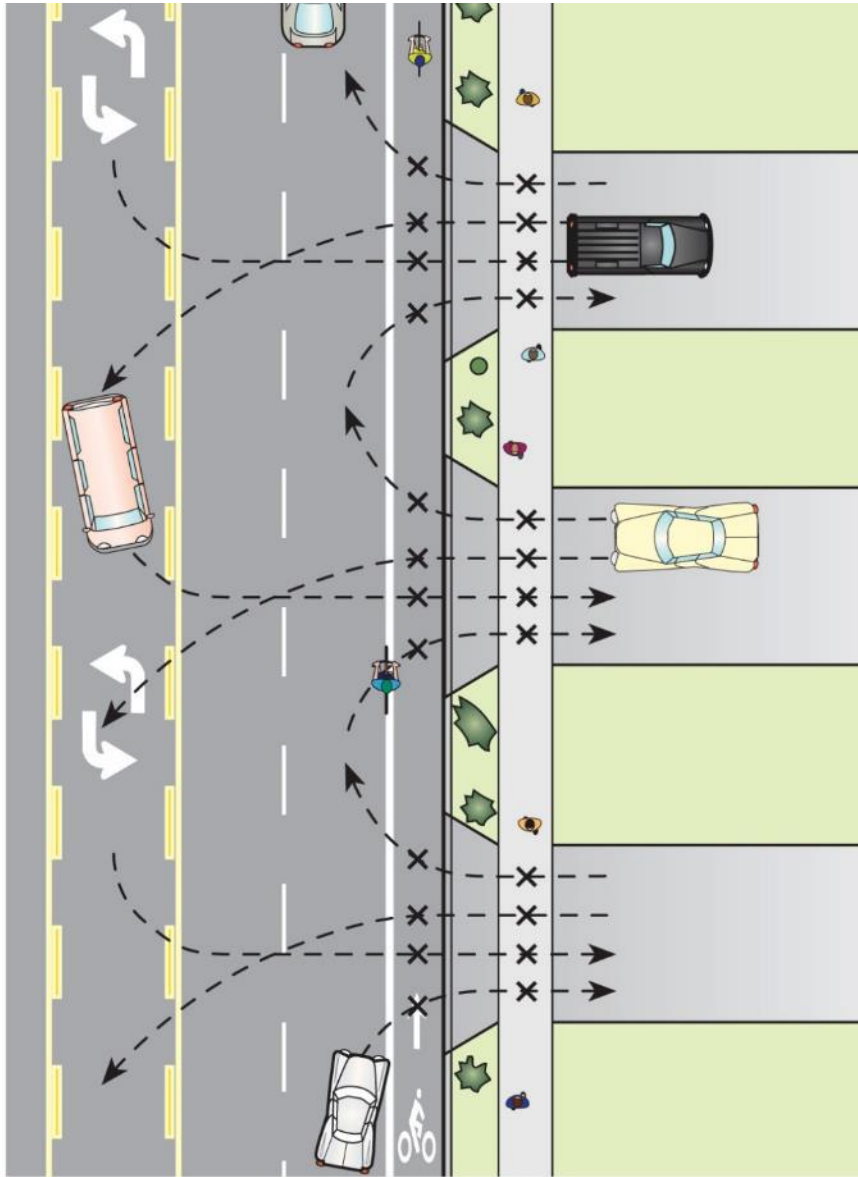
1-43

Portland OR

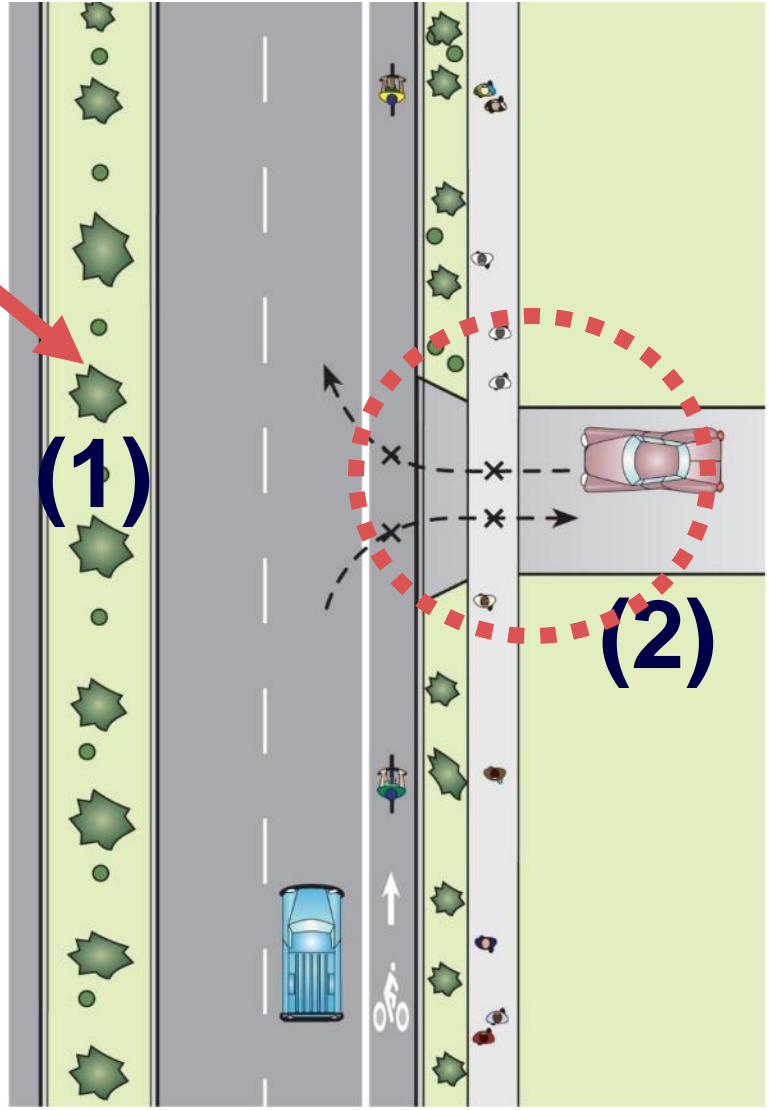
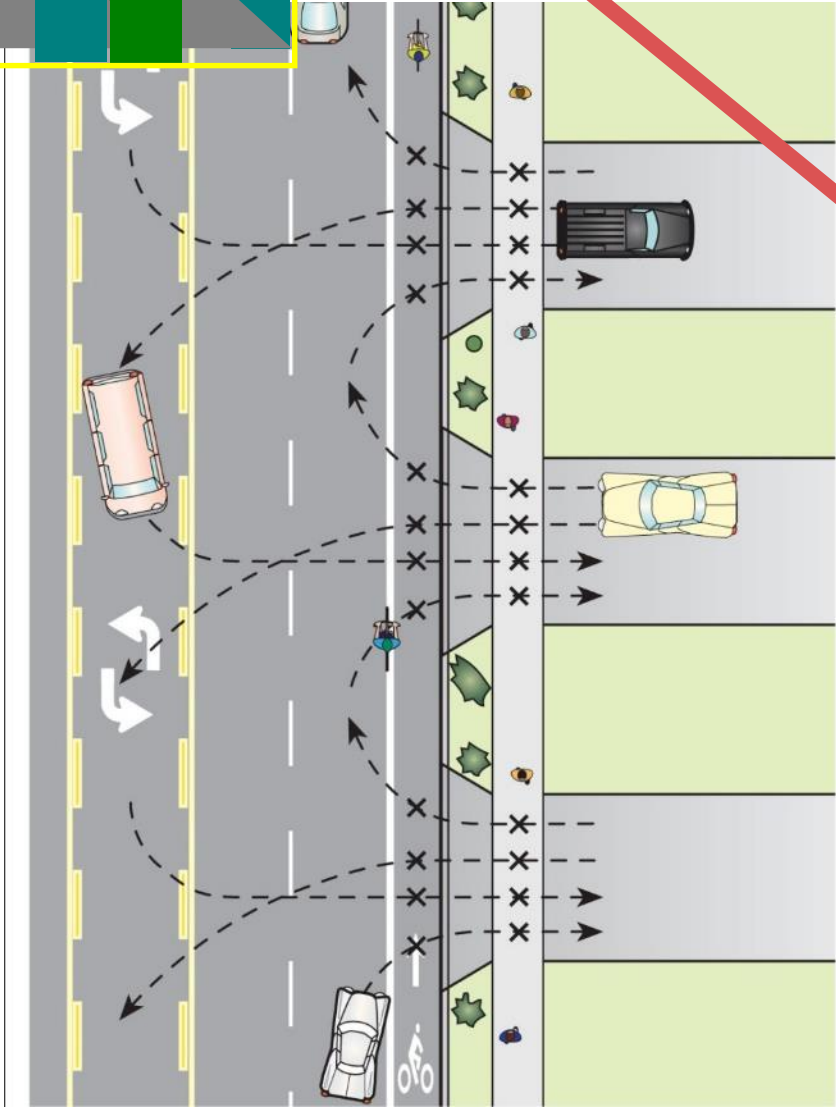
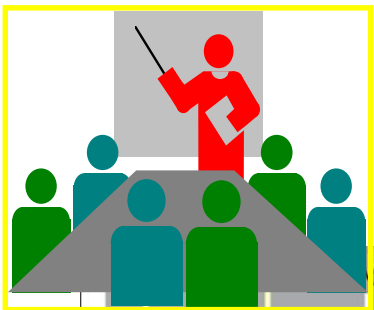
- Drivers and pedestrians must make choices:
- Walk in front or in back? Pull forward or back up?

Access Management => fewer conflicts at driveways

2 techniques: (1) median (no left turns) (2) consolidate driveways



Which has greater crash reduction factor:
(1) Median (no left turns) or
(2) consolidate driveways?





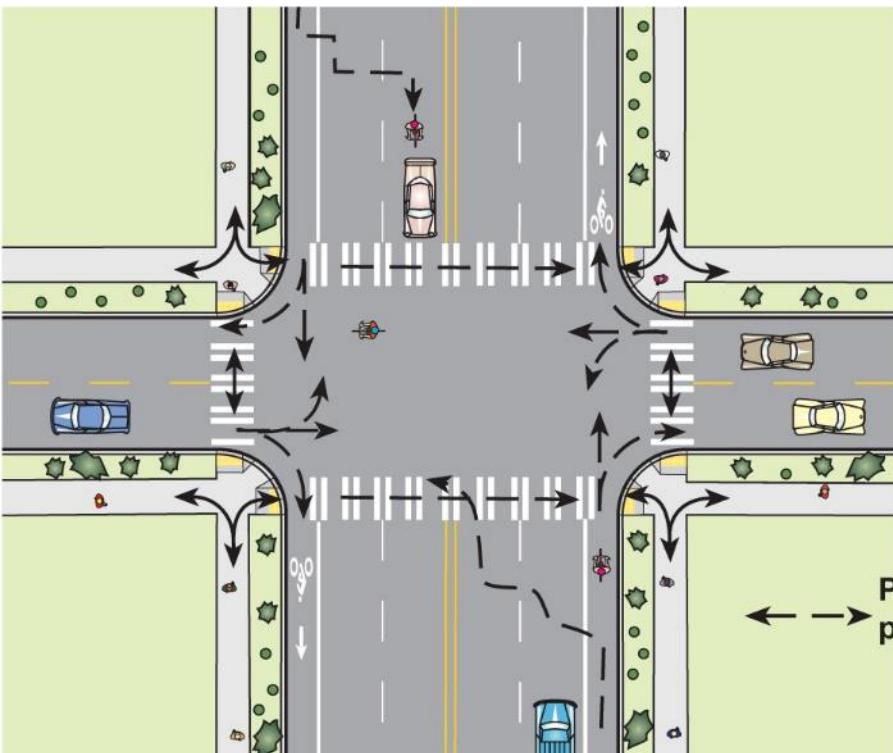
I-46

Salem OR

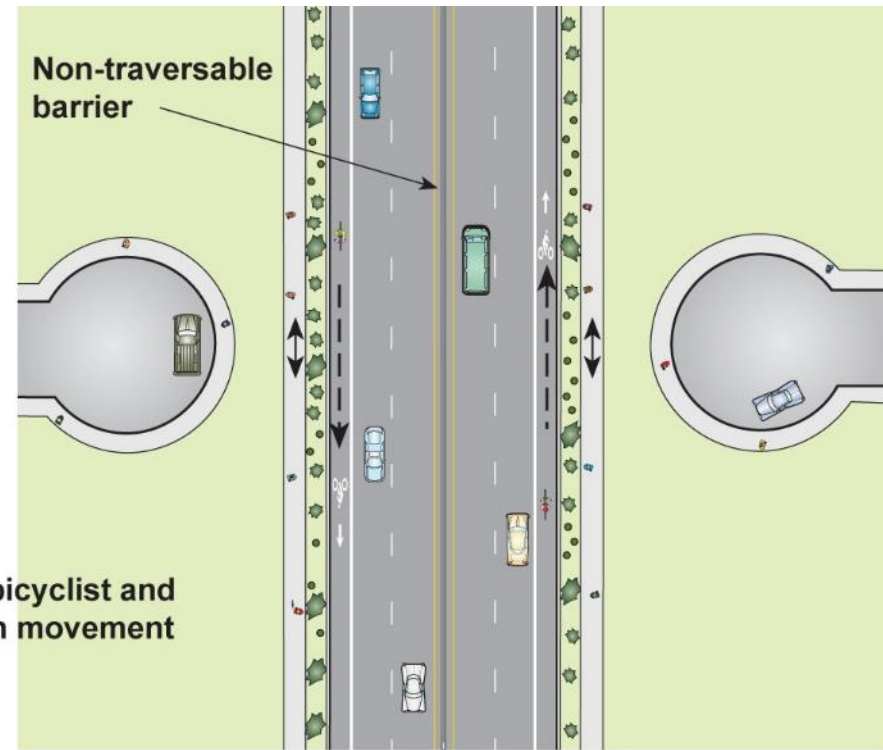
Driveways can be closed for safety

Severing public streets not a desirable access management technique

1-47

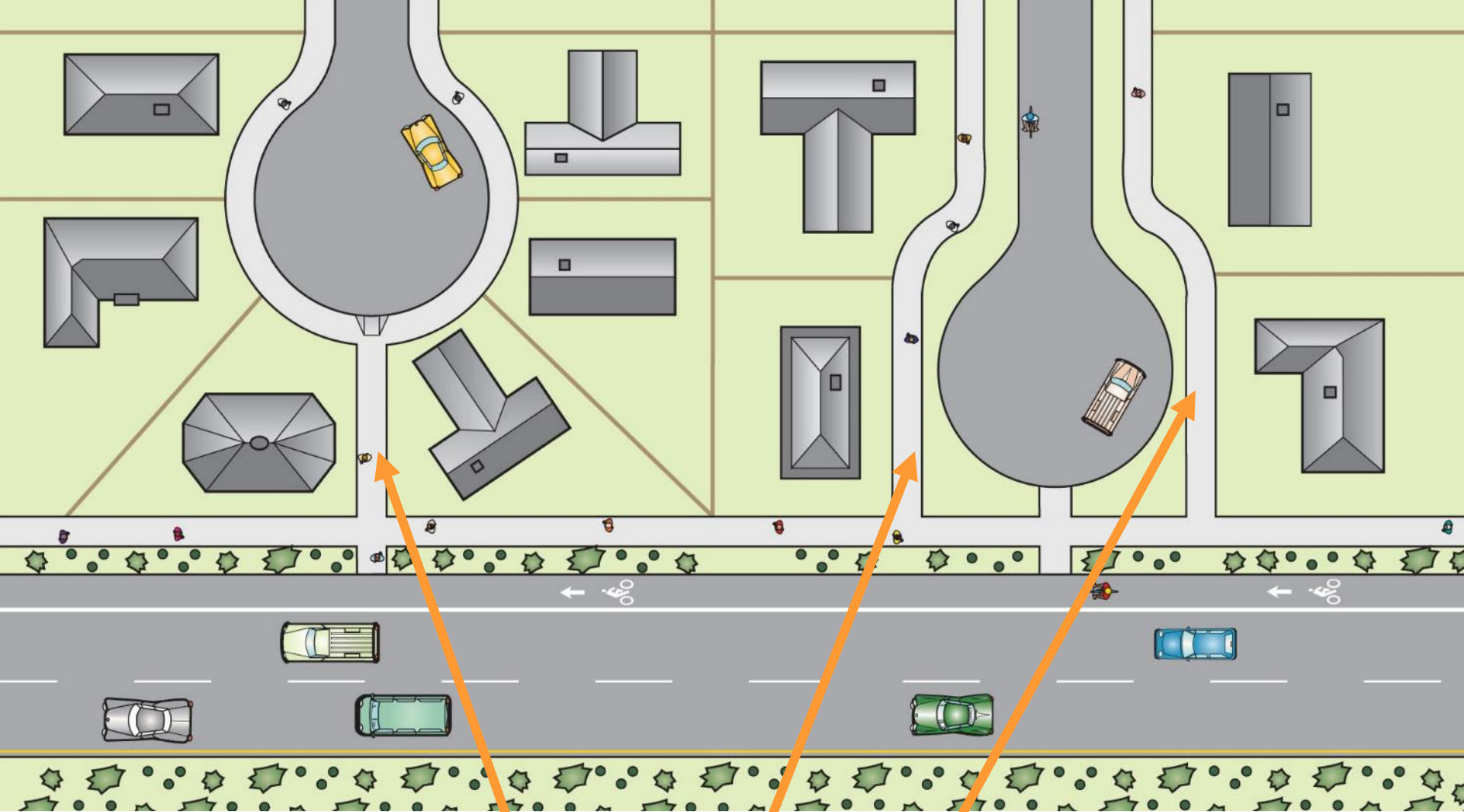


Available crossings and movements before access control



Available crossings and movements after access control

This limits people's ability to walk or bicycle



**Connecting severed streets
reestablishes walking routes**



I-49

Salem OR

Severed street can be reconnected for pedestrians

1-50

Site Design

Bringing Buildings closer to the Street

1-51

- Creates a street where drivers know to expect pedestrians





I-52

Albuquerque NM

Parking between sidewalk and building is not pedestrian-friendly



I-53

Doylestown PA

Building at back of walk: pedestrian-oriented design



I-54

Sweet Home OR

- Fast food typically favors drive-thru over walk-ins
- Pedestrians must cross drive-thru lane



I-55

Portland OR

Alternative design: Direct pedestrian access is provided with no vehicular conflicts



I-56

Portland OR

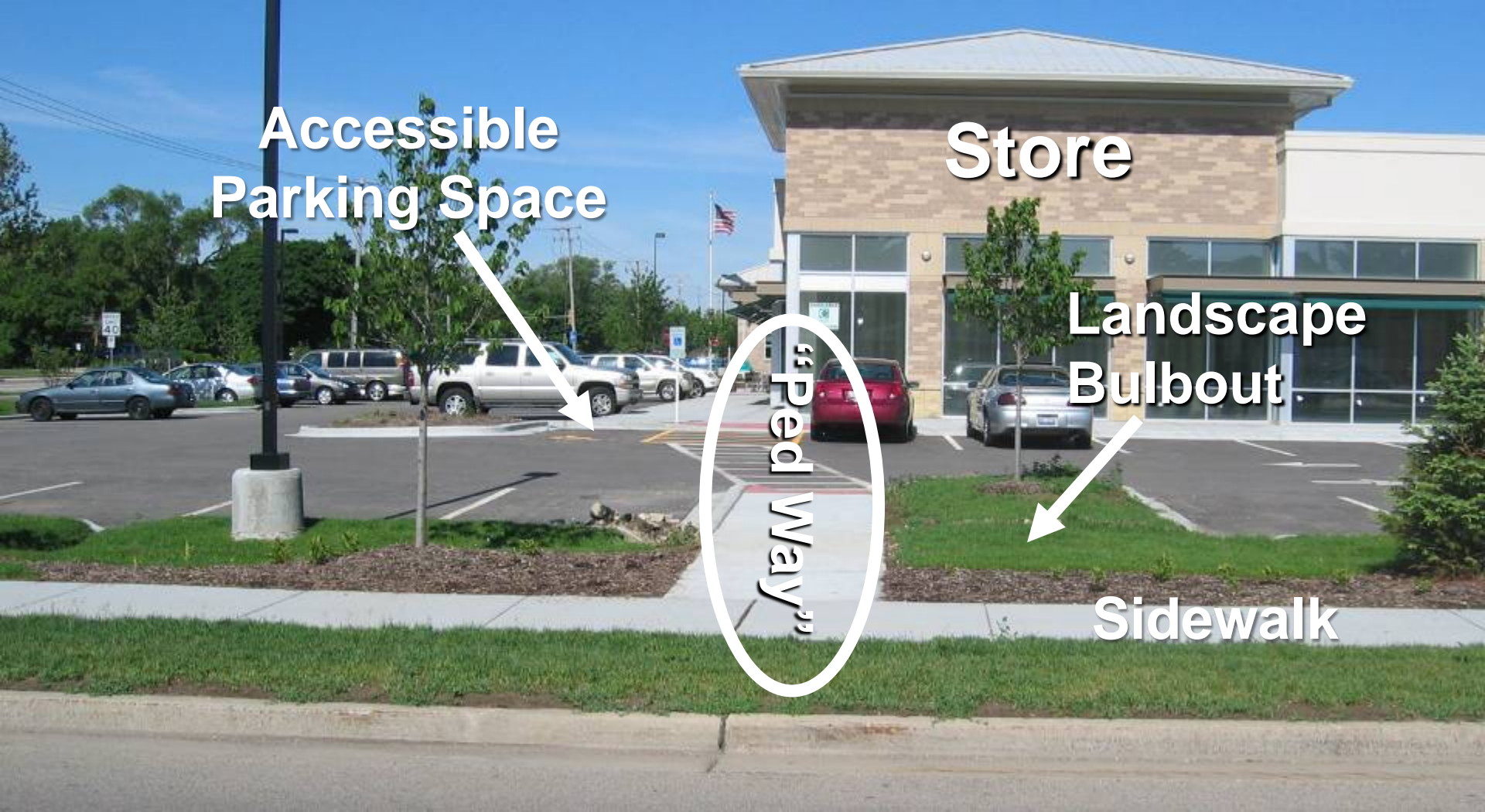
Parking and drive through are still provided



I-57

Milwaukee WI

- Even a gas station / convenience store can be built with pedestrian friendly design, at back of walk



Accessible
Parking Space

Store

Landscape
Bulbout

"Ped Way"

Sidewalk

Pedway retrofitted from sidewalk to building through parking



I-59

Corvallis OR

- ❑ Same principles apply to large-scale developments:
- ❑ Direct, safe & convenient access is provided

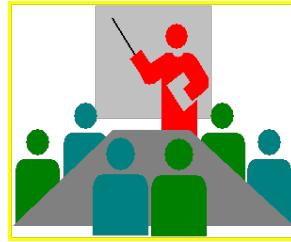


I-60

Eugene OR

Poor Design: Drivers use sidewalk for backing

Do your local ordinances support pedestrian-oriented planning and design?



1-61

- These goals are achieved by local ordinances, which must be enforced.
- They are beyond the scope of road designers, yet contribute greatly to the safety, comfort and aesthetics of the walking experience

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1-62

Rethinking The Role of Urban Streets



Portland, OR

- A “complete street” accommodates many uses and provides for all purposes of a street:
 - ▣ Mobility (all modes)
 - ▣ Access to destinations
 - ▣ Thriving businesses
 - ▣ Beauty



I-64

S. Pasadena CA

Transforming a street



I-65

S. Pasadena CA

Narrow lanes; add bike lanes, median, trees, texture



I-66

S. Pasadena CA

Bring in buildings that face the street



I-67

S. Pasadena CA

More buildings: Infill



I-68

S. Pasadena CA

The street now has life and is safer for pedestrians

1-69

Level of Service

**The impact of LOS standards
on street design and
pedestrian safety**



1-70

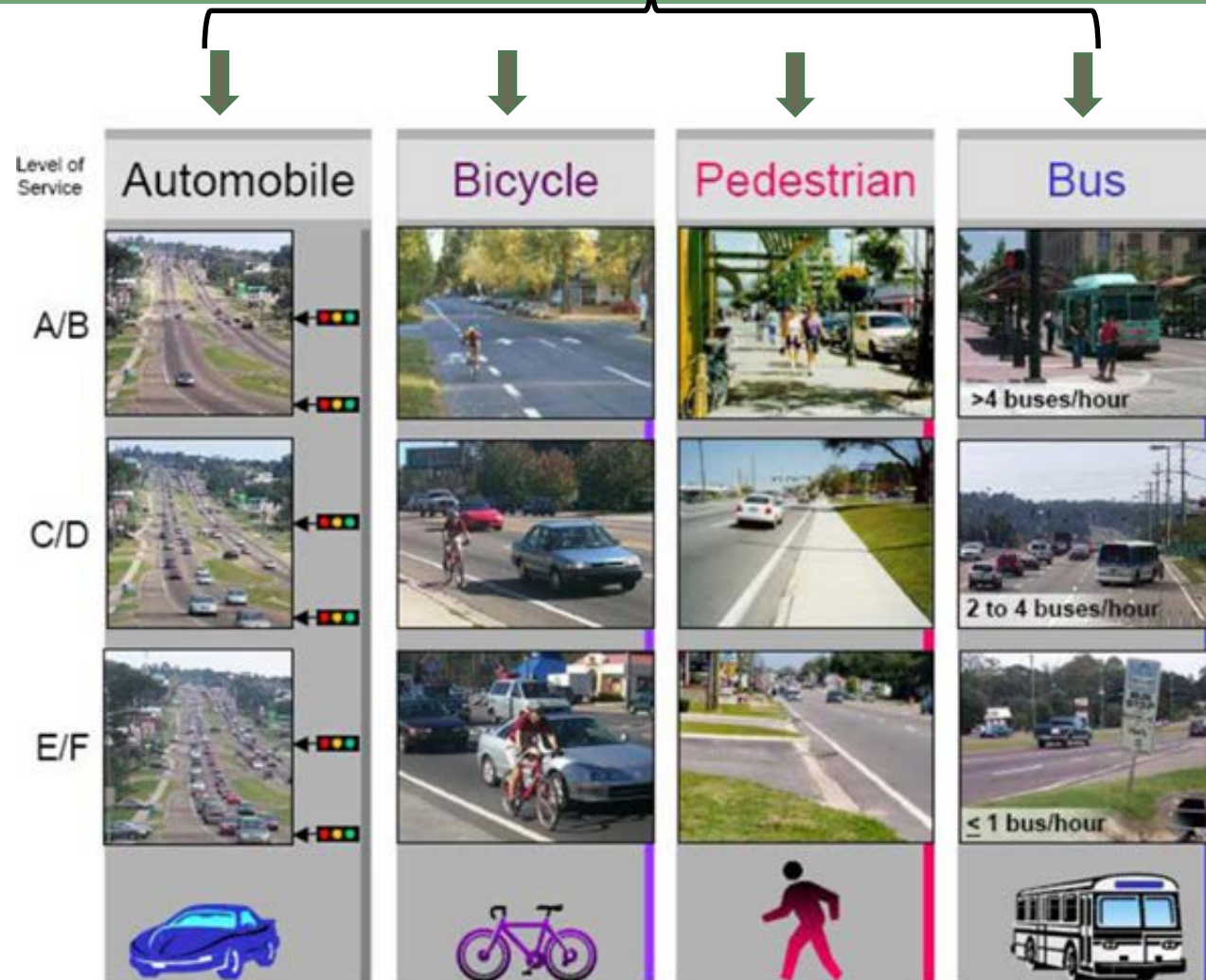
- HCM 2000: ped LOS = F; too many peds!
- New HCM 2010: considers quality and density for peds

HCM 2010 Approach

Interactions

1-71

- Multimodal evaluation for urban streets
 - Emphasizes combined evaluation of auto, bike, and transit modes



Pedestrian LOS

1-72

- LOS model determined from research on pedestrians' perceptions
- LOS models are provided for:
 - Urban street segments
 - Signalized intersections
 - Two Way Stop Controlled (TWSC) intersections
 - Roundabouts
 - Off-street facilities



Pedestrian LOS

1-73

- Urban street segments
 - Density of pedestrians and comfort / perceived exposure
- Signalized intersections
 - Pedestrian delay and perceived exposure

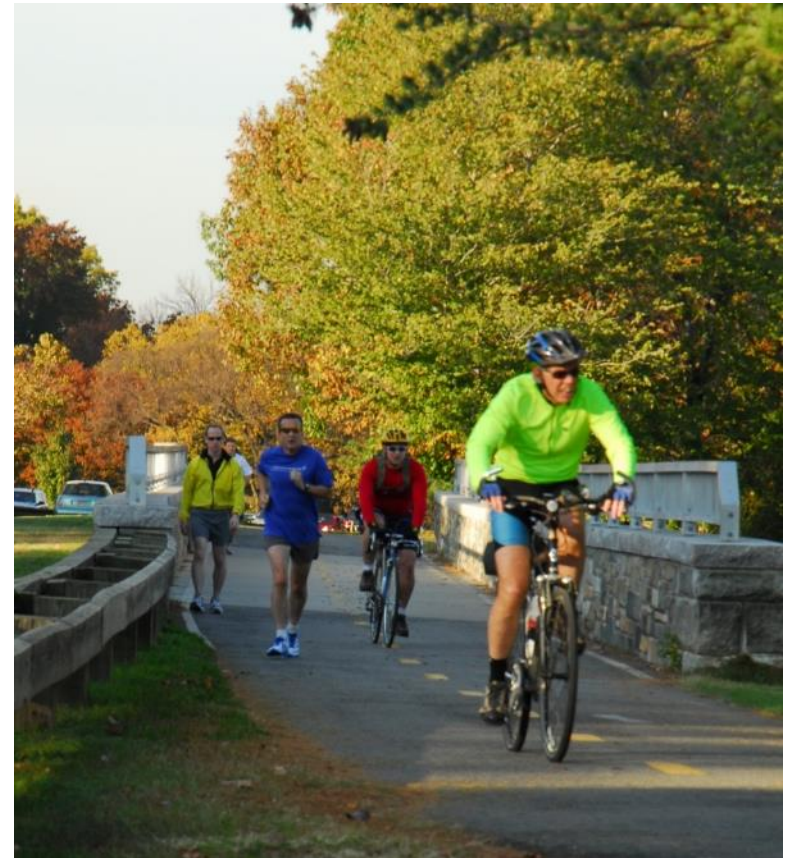


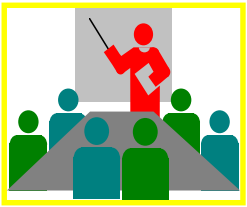
A = actual sidewalk width
E = effective sidewalk width

Pedestrian LOS

1-74

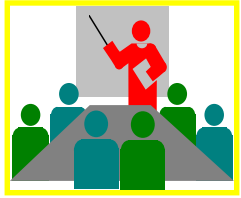
- TWSC intersections
 - Average pedestrian delay crossing major street
- Off-street facilities
 - Affected by bicyclists





1-75

- ❑ Why are pedestrians at high risk on this street?
- ❑ Multi-lane roadway, high speeds



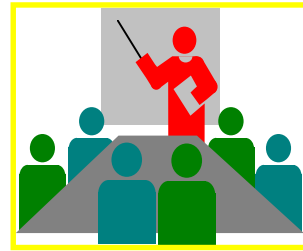
1-76

Vancouver BC

- Why are pedestrians at low risk on this street?
- Narrow roadway, low speeds, busy

What is the core safety issue?

Pedestrians & drivers must use the street together



I-77

Sisters OR

- On-street parking
- Narrow cross-section
- Buildings close to street
- Sidewalks
- Crosswalk
- People!



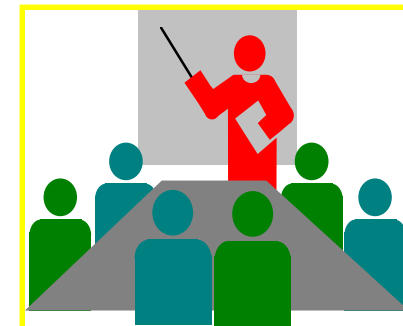
What does the driver see that says “slow down, watch for pedestrians”?



I-78

Portland OR

- Reinventing the roadway:
- Transform a 5-lane commercial strip to ...

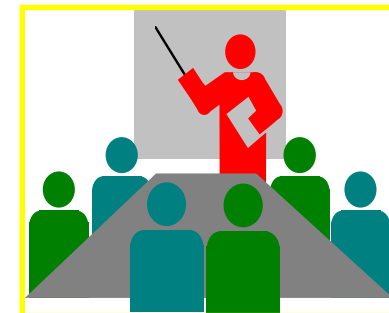




1-79

Portland OR

- ...a safer road for everyone
- Discussion: 1. What changed?
- Discussion: 2. What didn't change?



Let's Recap

I-80

- Why is it important to accommodate pedestrian safety and accessibility?
- How does the street environment influence drivers' and pedestrians' expectations and interactions?
- Where is the information?
- What planning factors influence pedestrian safety and accessibility?

1-81

Questions?