

Lecture 5:

Designing for Pedestrians

What is the core safety issue?

Pedestrians and drivers must use the streets together



- 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”?

Walking Along the Street



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



...a safer road for everyone

Discussion: 1. What changed?

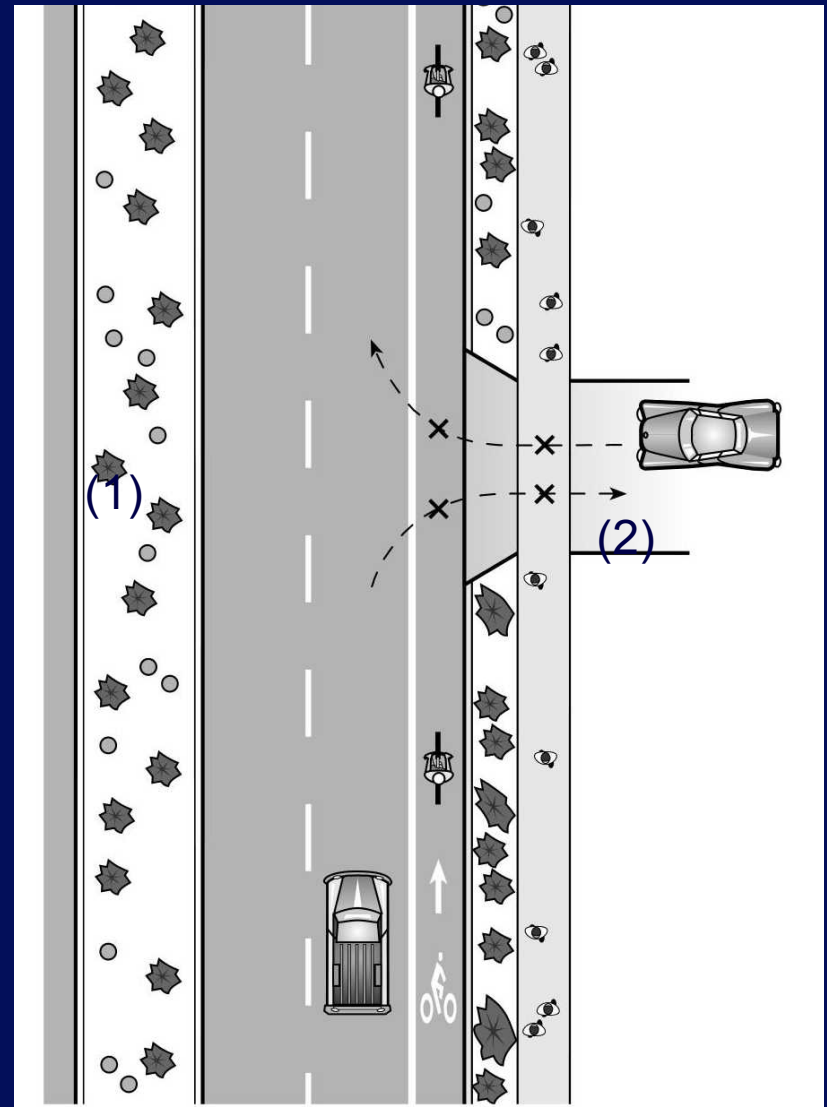
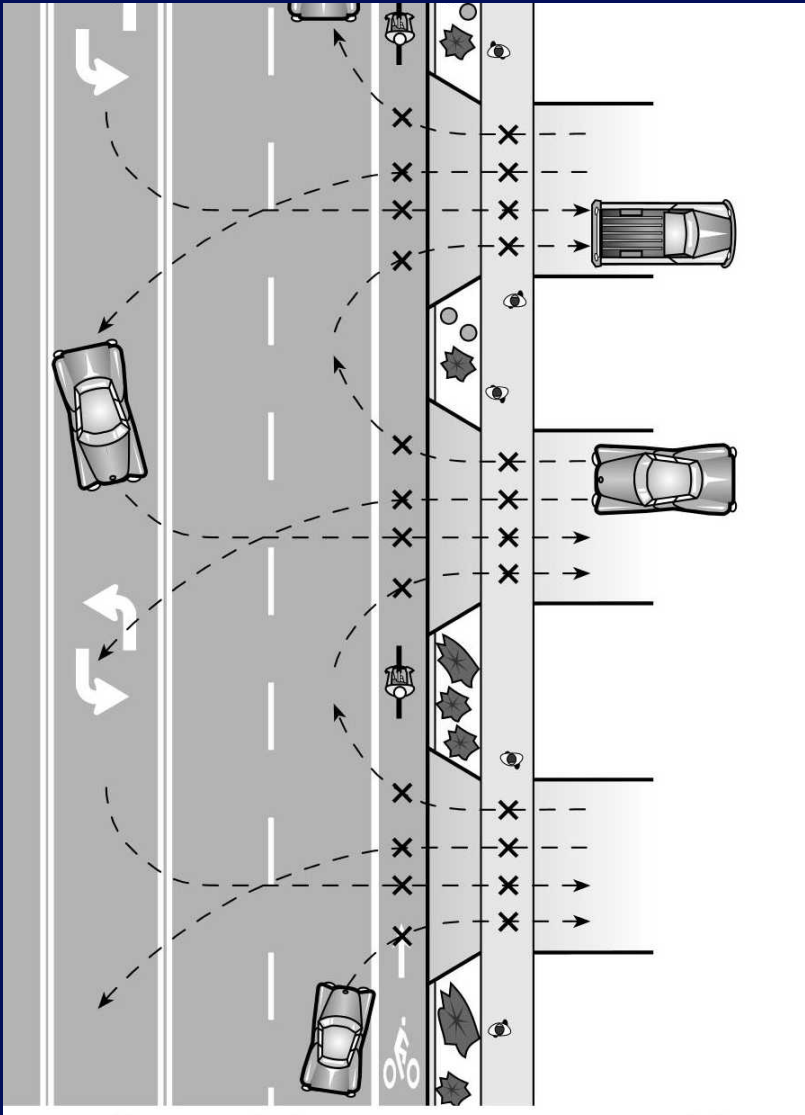
Discussion: 2. What didn't change?



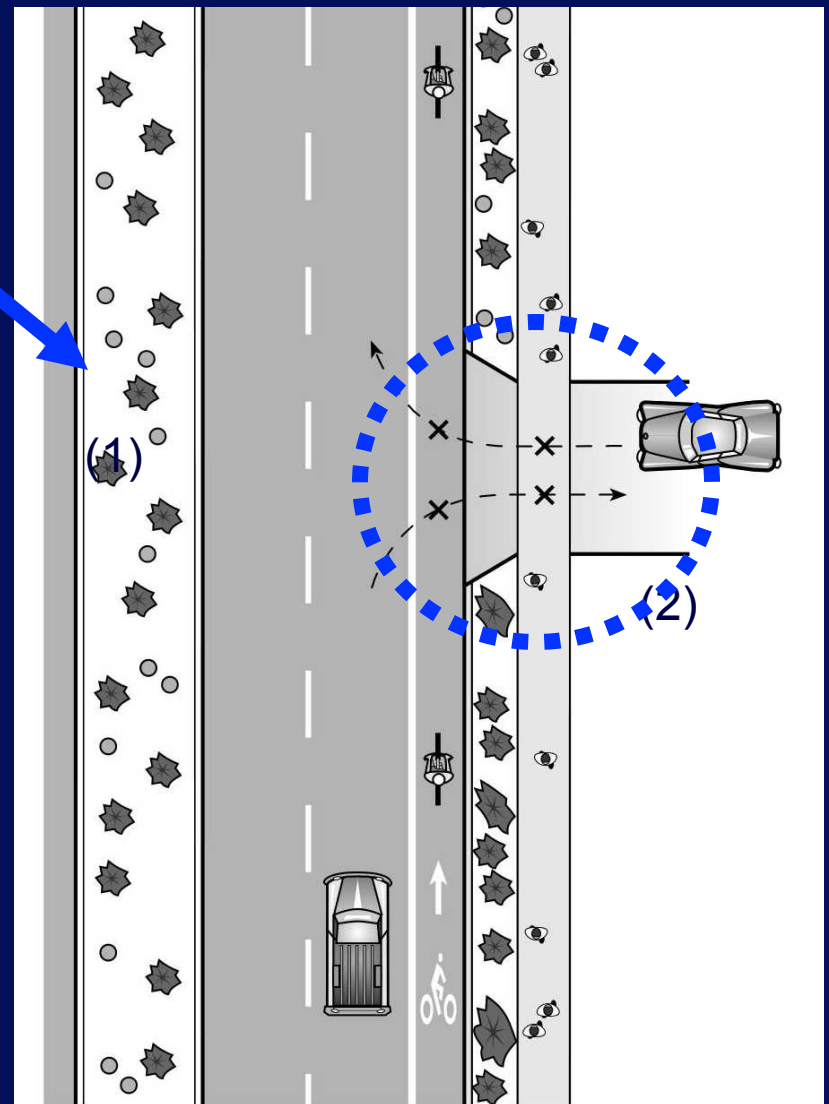
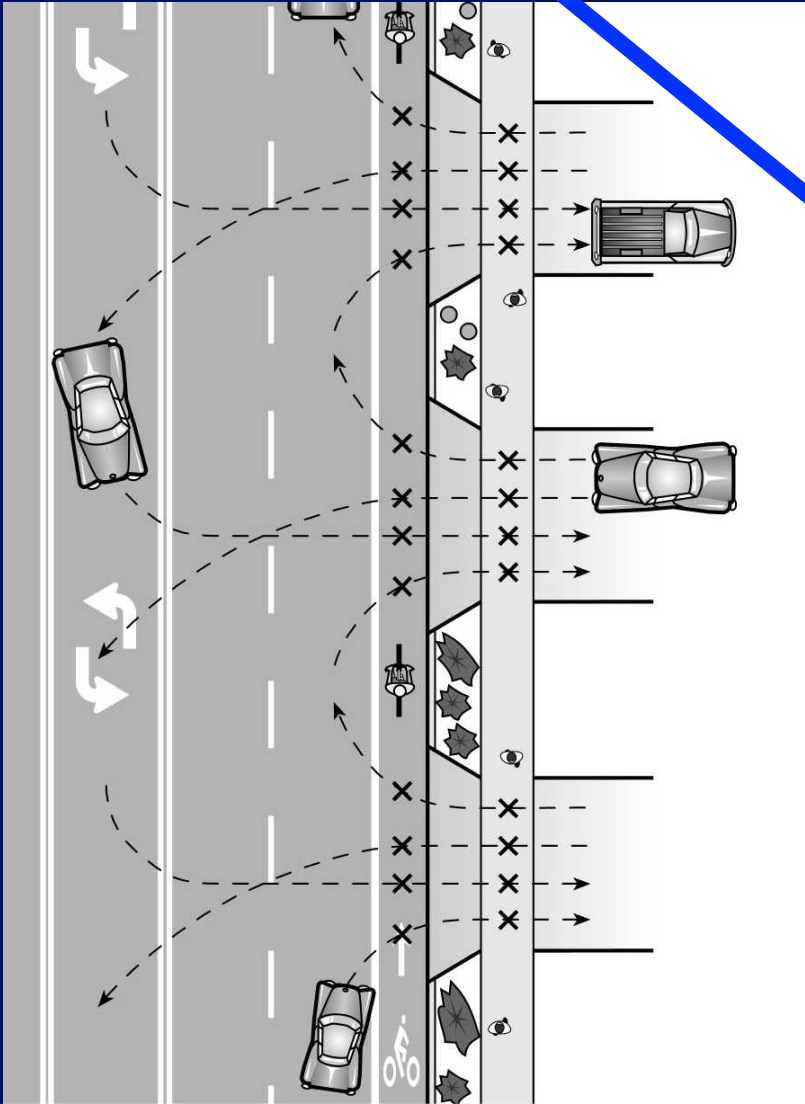
Drivers and pedestrians must make choices:
Walk in front or in back? Pull forward or back up?

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?



Walking along the road accounts for 10-15% of pedestrian crashes:

- Fewer in urban areas
- More in rural areas

They're easily preventable



Crash Reduction Factor (CRF):

- Paved shoulders reduce pedestrian crashes 70%
- Sidewalks reduce pedestrian crashes 88%
 - *(most sidewalk crashes occur at driveways)*

CRF: % fewer crashes experienced on a road with a given treatment than on similar road without treatment

Shoulders improve safety for all users



For motorists: room to avoid crashes



Sidewalks reduce pedestrian crash risk by 88%

Salem OR

Curbs & sidewalks slow traffic more than speed sign



Sidewalks define an urban street

A sidewalk on 1 side only is not OK



Discussion:

Why are sidewalks on one side not OK?

Answer:

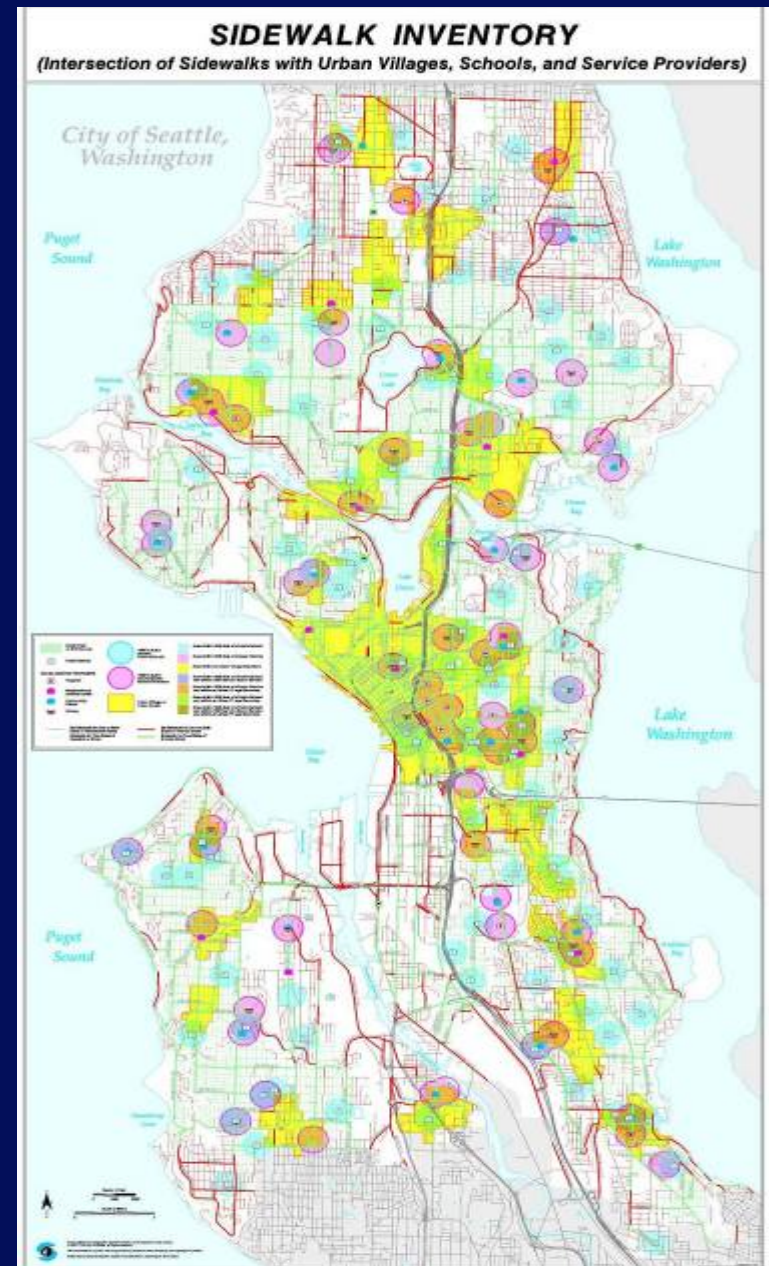
Pedestrians walk in street, or cross twice

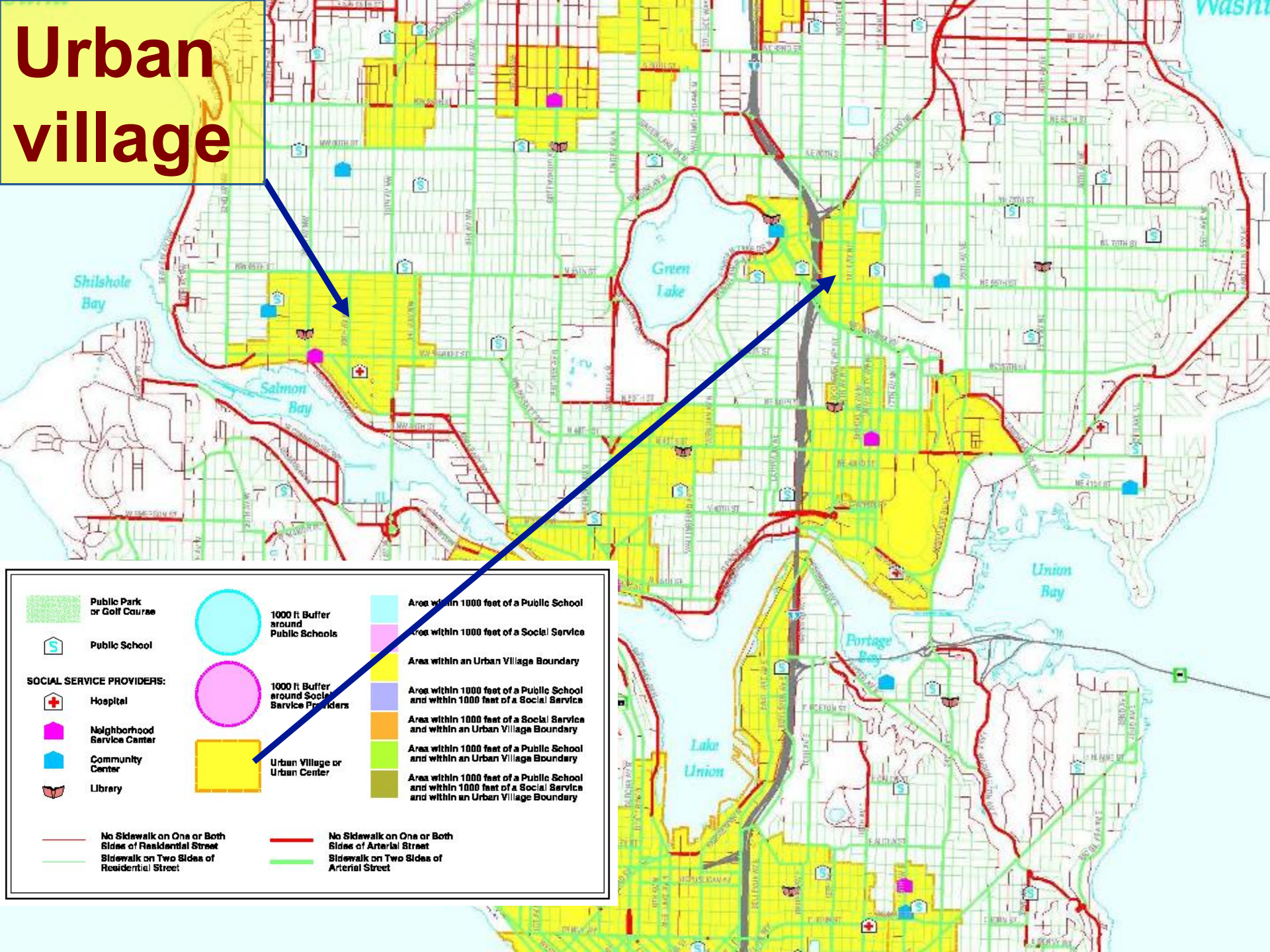
- Sample Implementation Strategy to retrofit existing streets with sidewalks; how to develop a program to fill in missing sidewalks over 20 years




How do you make such a daunting task manageable?


Seattle example: divide it into bite-size chunks, with overlapping priorities







**Urban
village**


**Public Park or Golf Course**


**Public School**


SOCIAL SERVICE PROVIDERS:


**Hospital**


**Neighborhood Service Center**


**Community Center**


**Library**


**1000 ft Buffer around Public Schools**


**1000 ft Buffer around Social Service Providers**


**Urban Village or Urban Center**


**Area within 1000 feet of a Public School**


**Area within 1000 feet of a Social Service**


**Area within an Urban Village Boundary**


**Area within 1000 feet of a Public School and within 1000 feet of a Social Service**


**Area within 1000 feet of a Social Service and within an Urban Village Boundary**


**Area within 1000 feet of a Public School and within an Urban Village Boundary**

**Area within 1000 feet of a Public School and within 1000 feet of a Social Service and within an Urban Village Boundary**

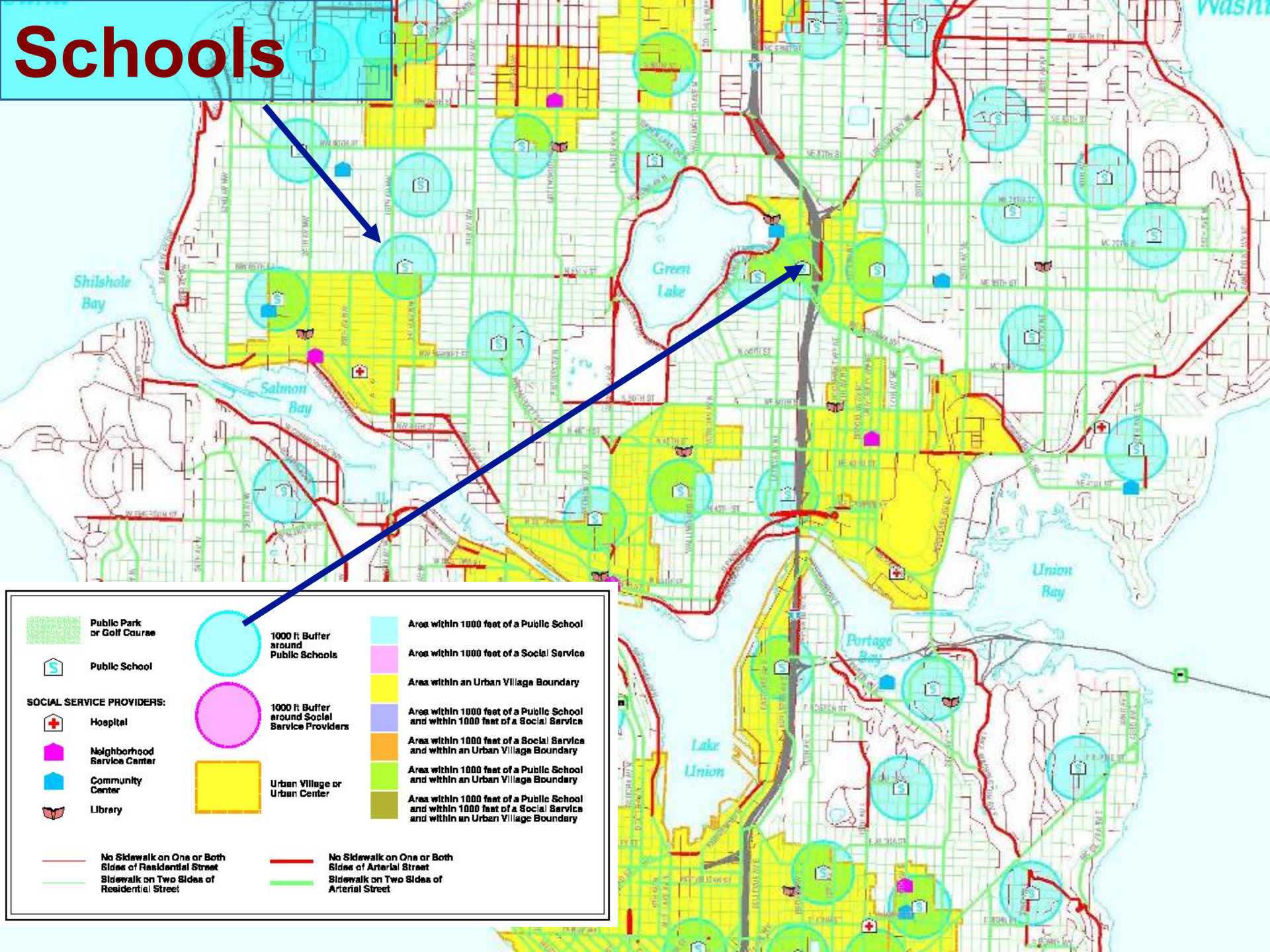
**No Sidewalk on One or Both Sides of Residential Street**

**Sidewalk on Two Sides of Residential Street**

**No Sidewalk on One or Both Sides of Arterial Street**

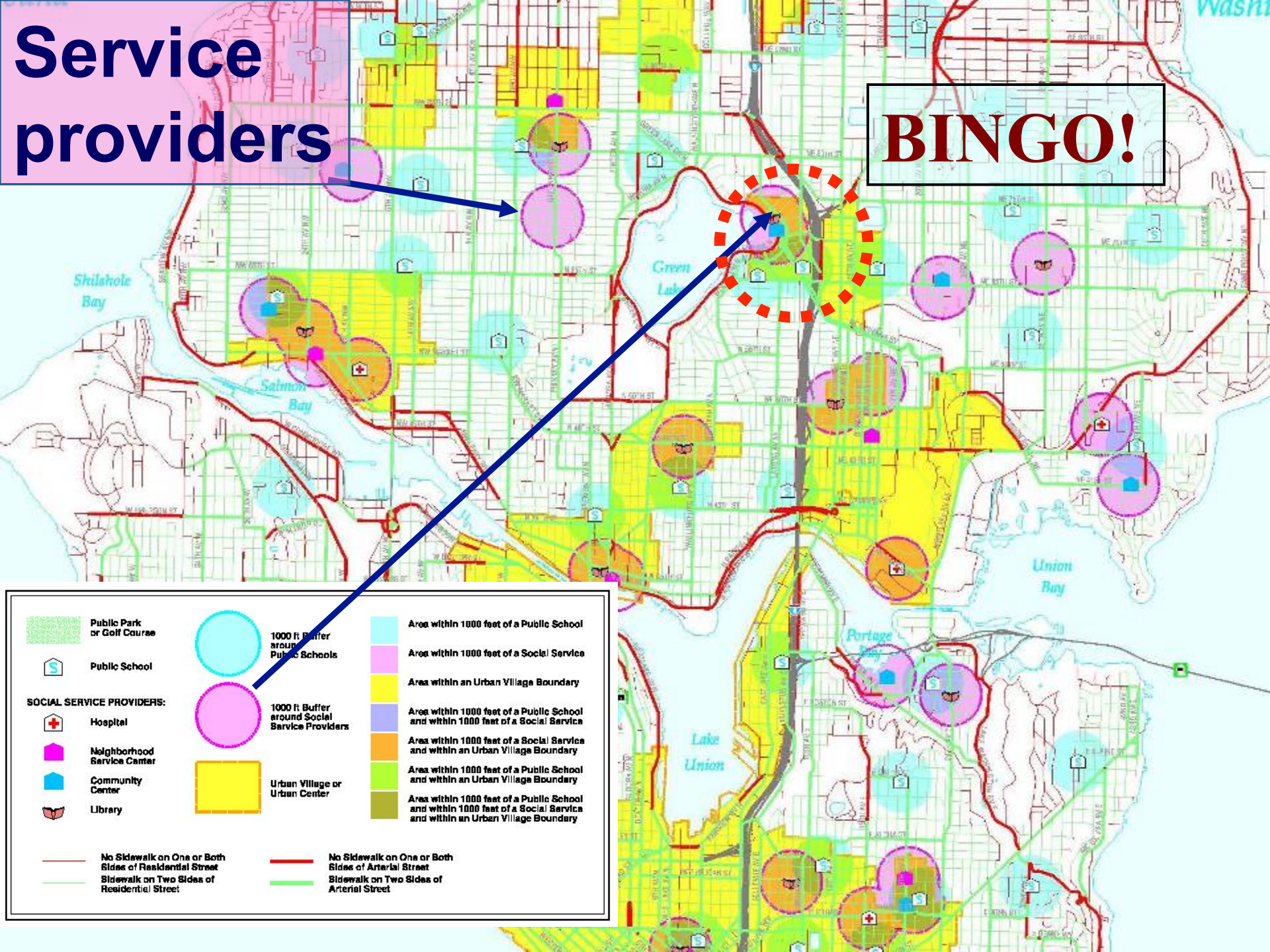
**Sidewalk on Two Sides of Arterial Street**

Schools



Service providers

BINGO!

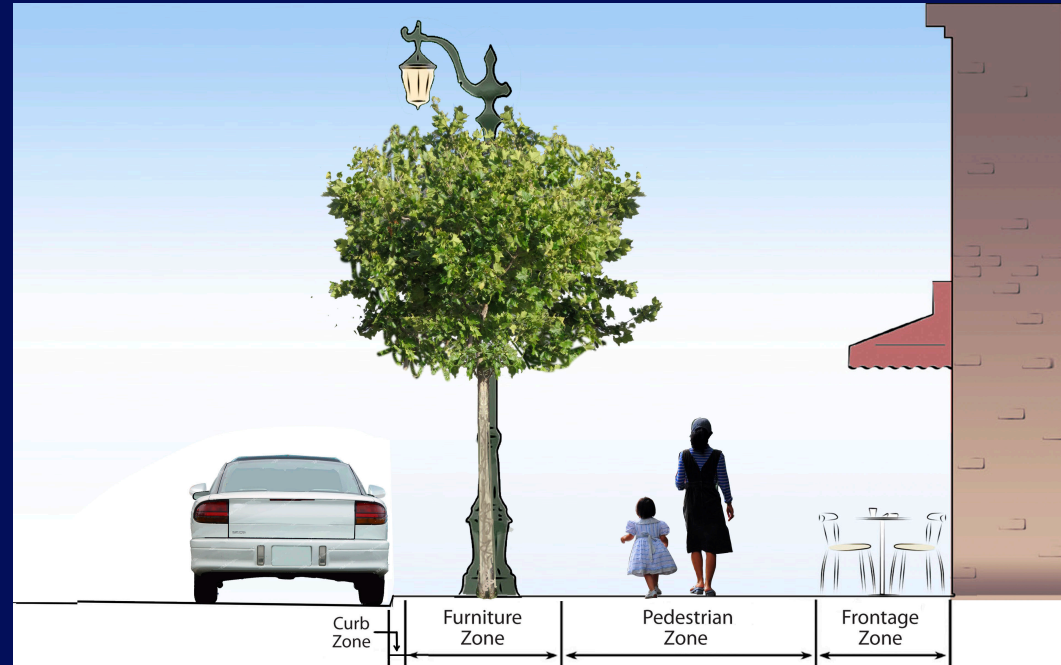


Sidewalk Corridor

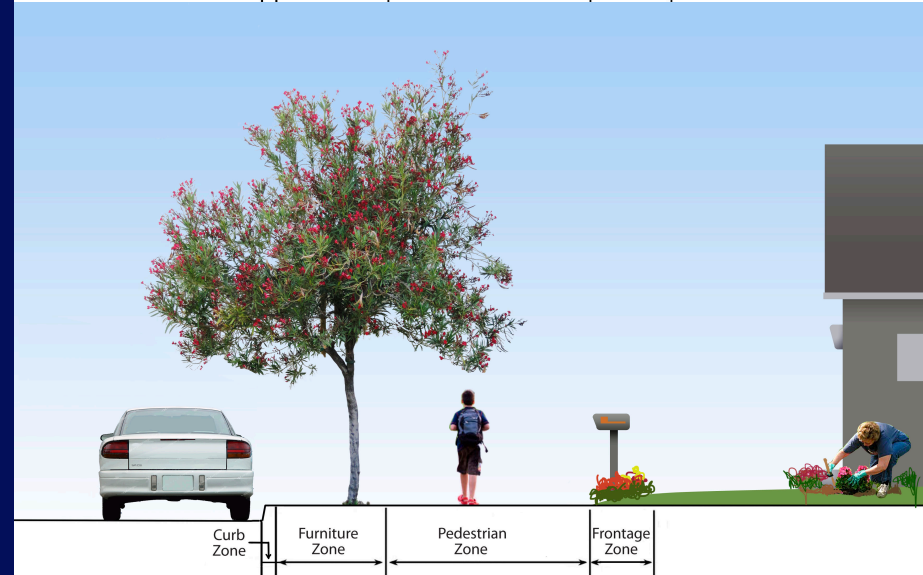
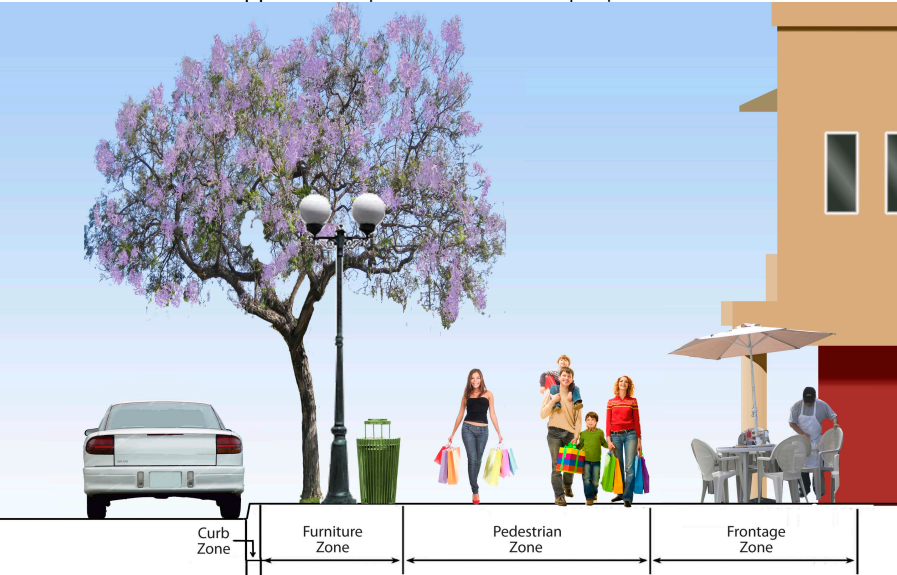
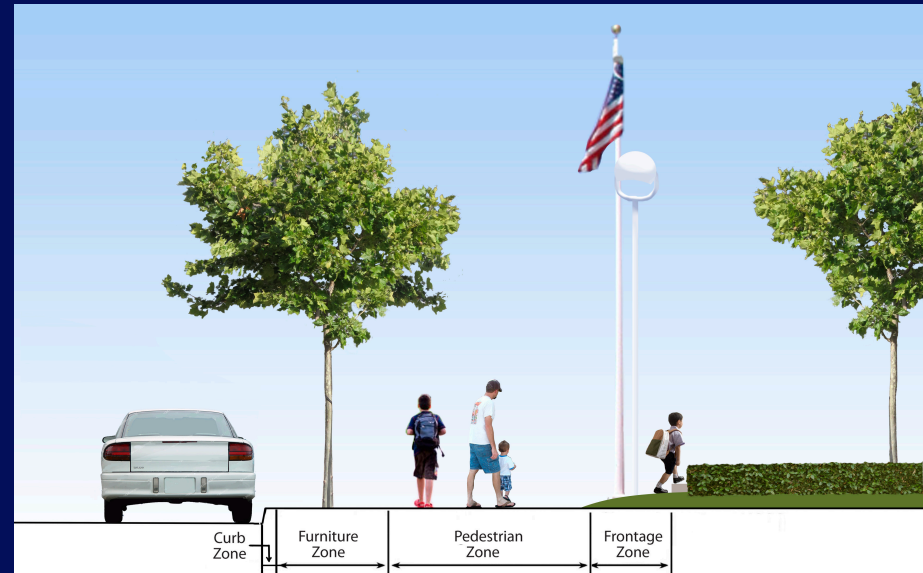
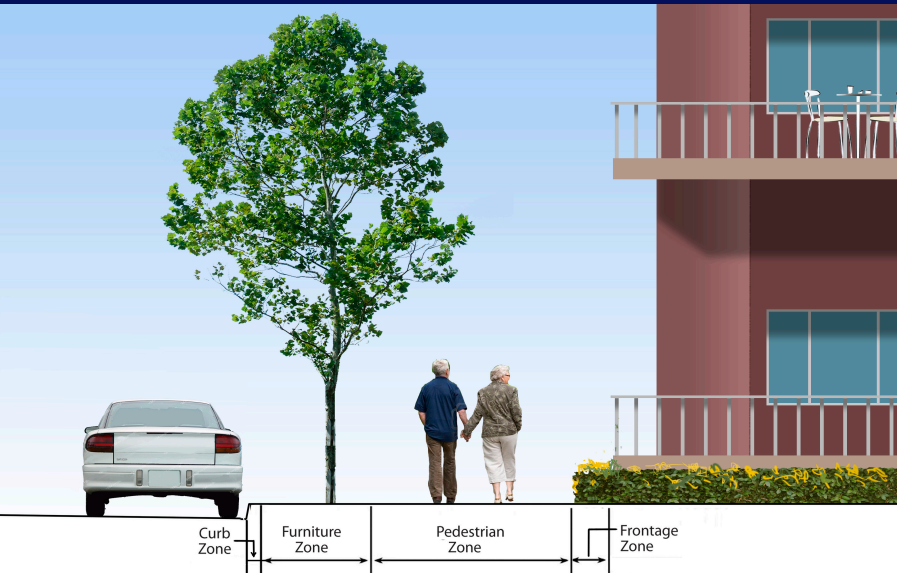
The Zone System

Sidewalk corridor extends from the edge of roadway to the edge of right-of-way:

- **Curb zone**
- **Furniture zone**
- **Pedestrian zone**
- **Frontage zone**



Need 4-Zone Sidewalk Design Guidelines for Different Streets and Land Uses





Curbs & drainage are the greatest sidewalk cost



This sidewalk cost little to install w/o curb



The furniture zone keeps the sidewalk clear



Planter strip helps define driveways, it's easier for drivers to find them and they're more likely to yield to pedestrians



Shy distance concept applies to pedestrians, who will shy away from a vertical face; extra width is needed

Without Zone System



Randomly placed street furniture clutters sidewalk



ADA requirements for sidewalks

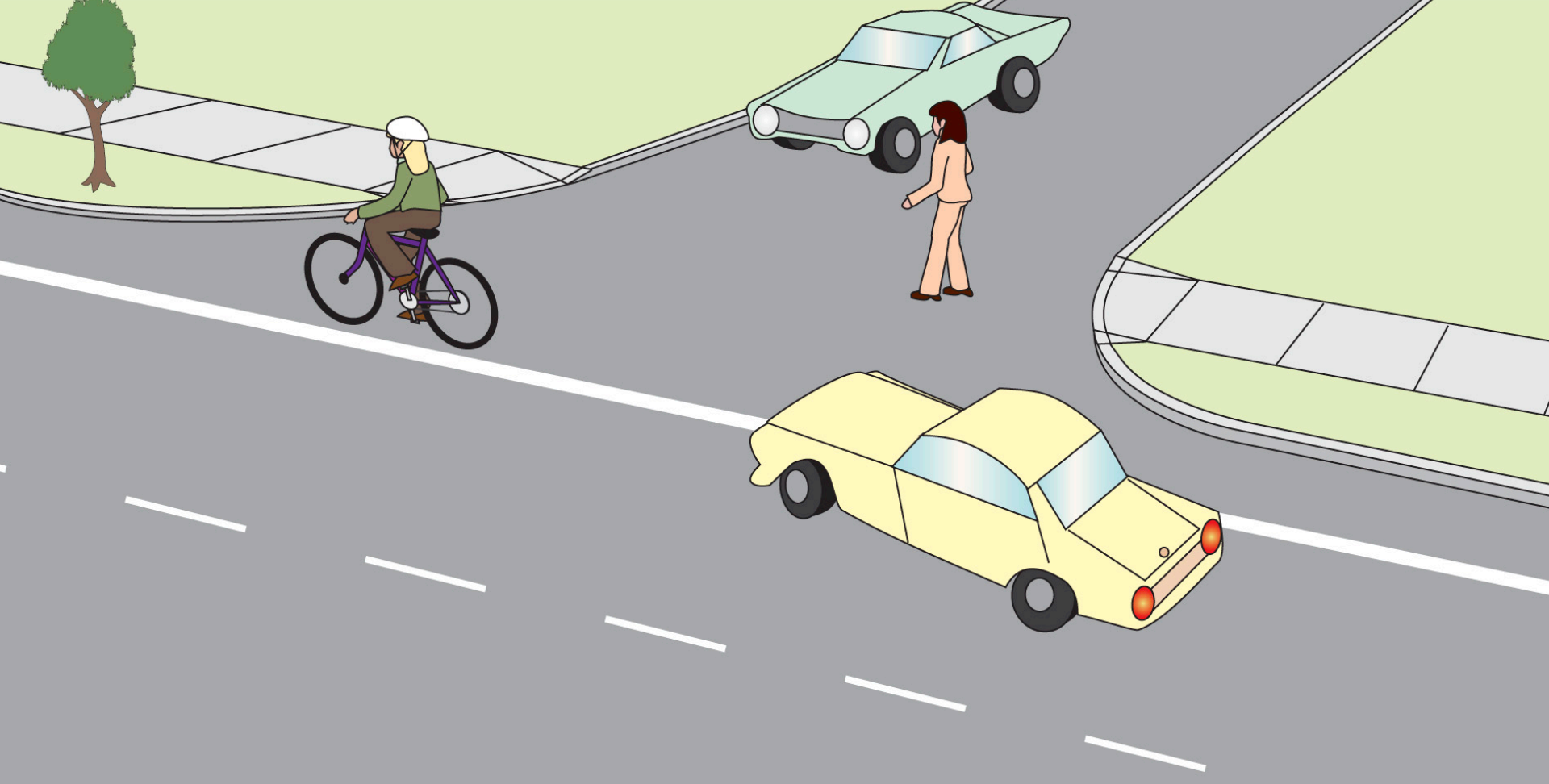
Well-designed sidewalks meet ADA:

- Sidewalks should be clear of obstructions:
 - *3' min clearance, 4' proposed*
- Sidewalk should have smooth surface
- Sidewalk should be at 2% max cross-slope including at driveways

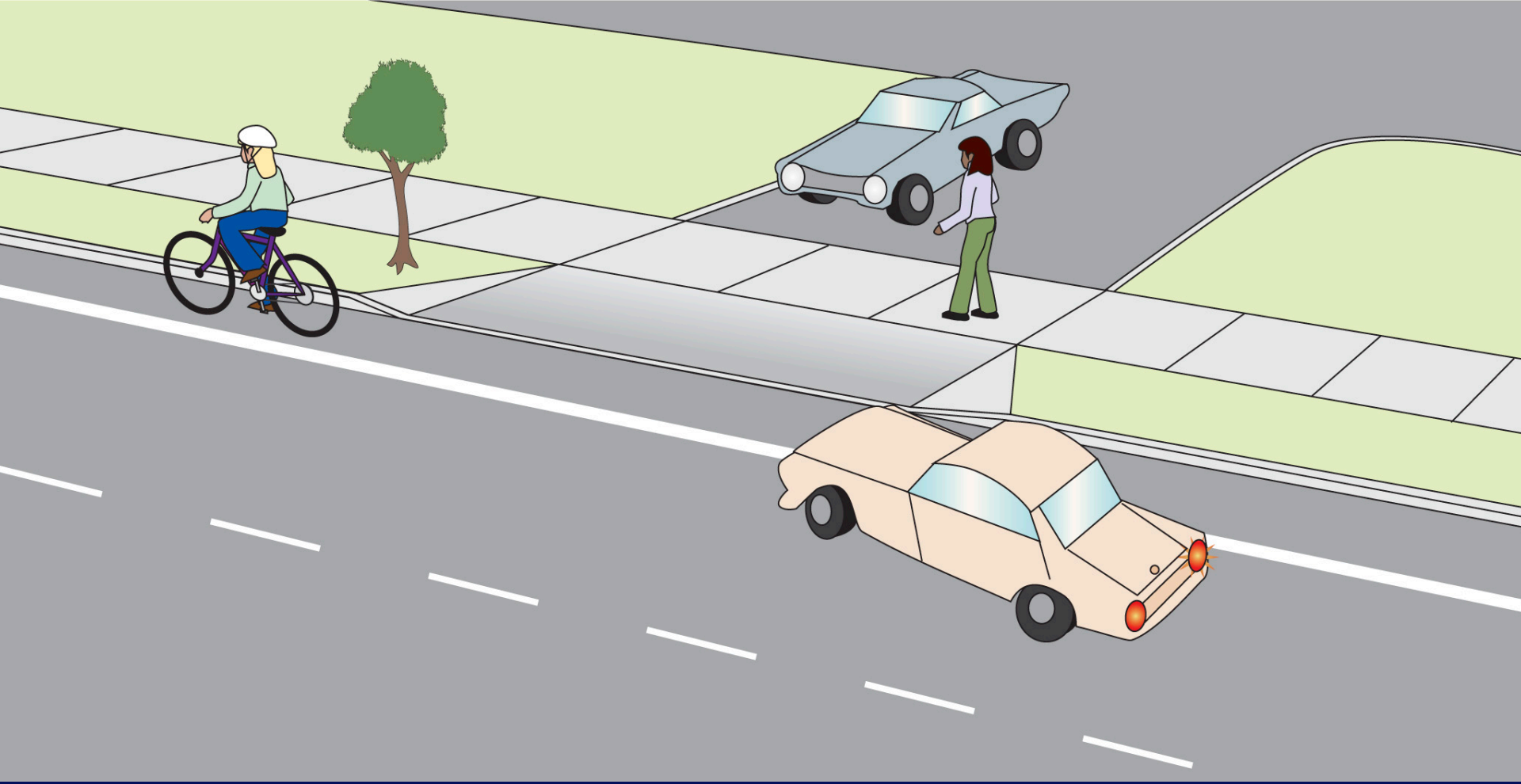
The zone system creates a safer and more pleasant place to walk, and makes it easier to meet ADA requirements.



Note: many slides include older photos that show non-compliant sidewalk features, especially ramps without the truncated domes

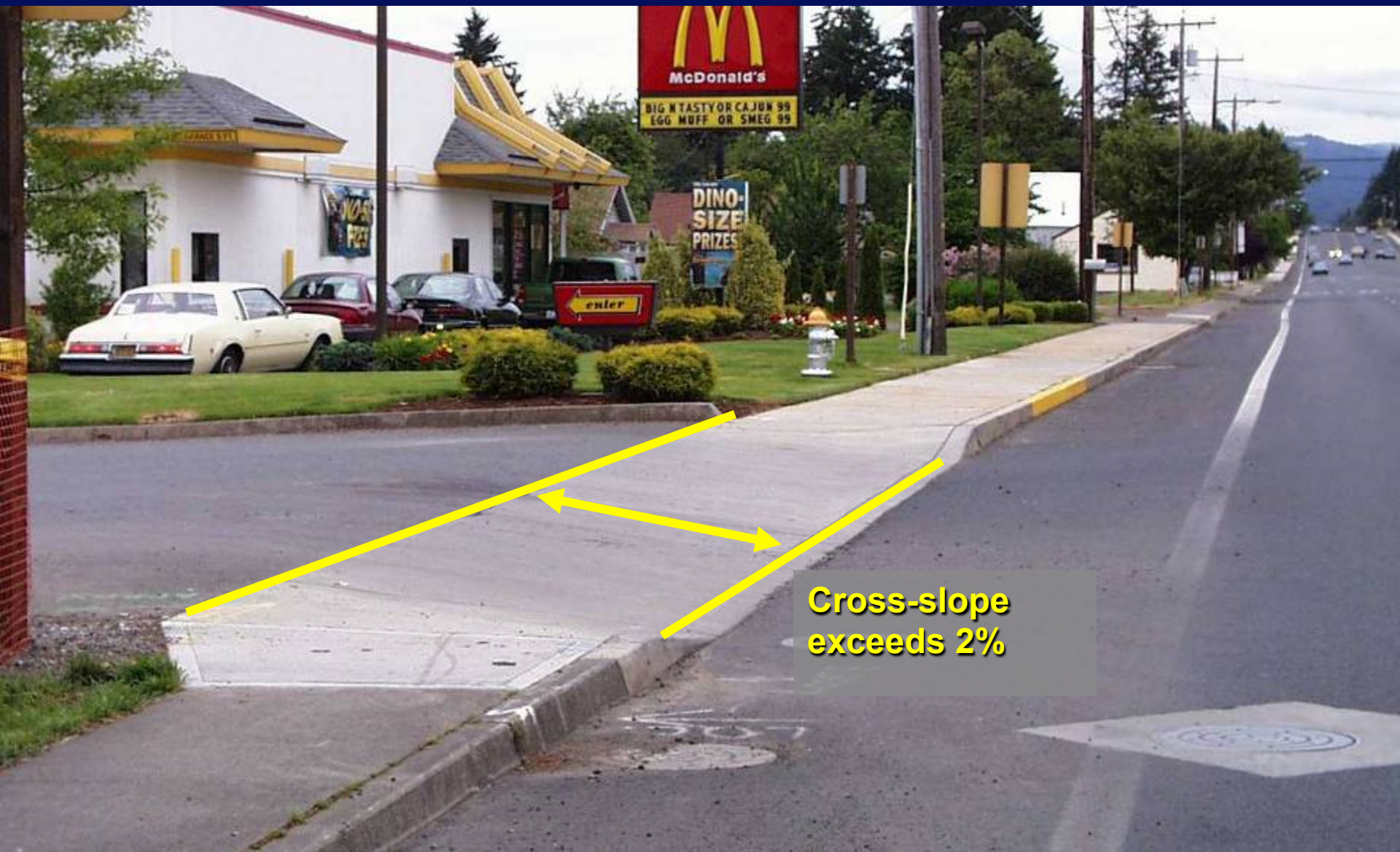


**Driveways built like intersections
encourage high-speed turns**



**Driveways built like driveways
encourage slow-speed turns**

Without zone system (curbside sidewalk) hard to meet ADA



Street Crossings

Part 1: General Principles



**Why do people cross the street?
Because there's someplace good on the other side**



People shouldn't have to run to cross a street

Depoe Bay OR

Designing for Pedestrian Safety
– Crossing Principles



But we can't provide signals everywhere people cross



**These people are not criminals...
They're simply trying to deal with a situation**

General Principles

1. Pedestrians want & need to cross streets safely
2. Drivers need to understand pedestrians' intent
3. Keep crossings short
4. Speed Matters
5. Pedestrians will cross where it's convenient

Good design makes use of these principles

Principle # 1



Pedestrians want & need to cross the street safely

Principle # 2



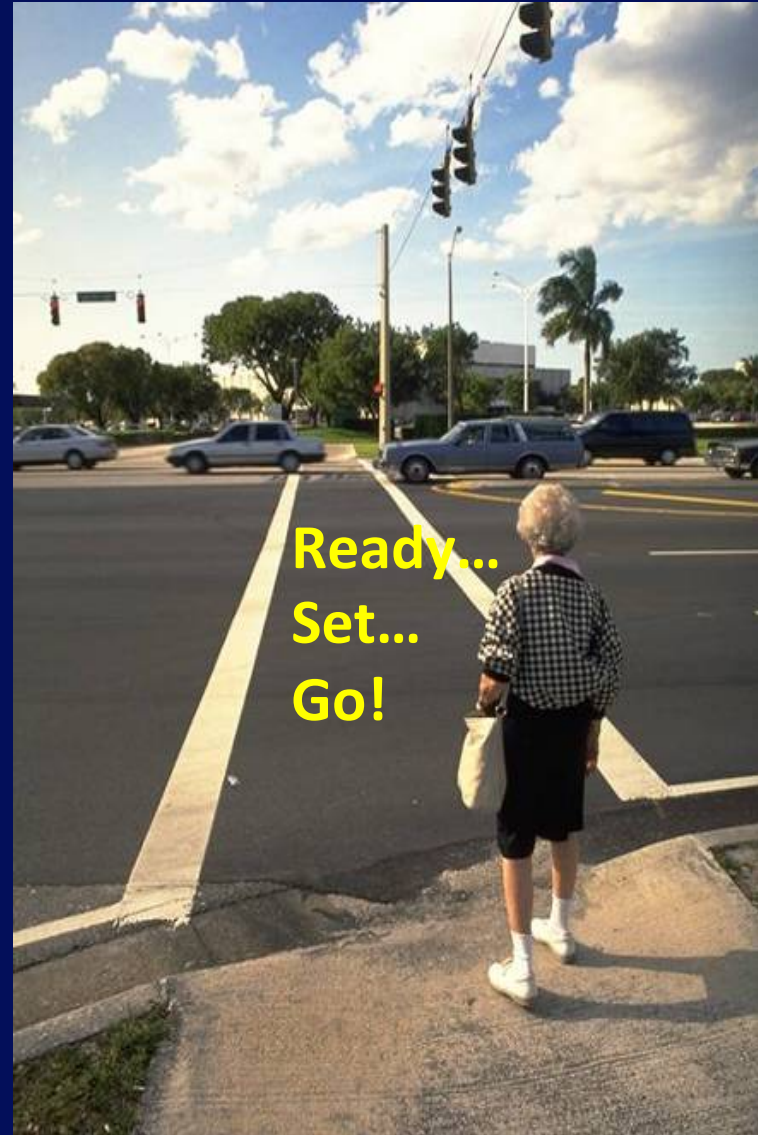
Drivers need to understand pedestrians' intent

Principle # 3

Keep Crossings Short

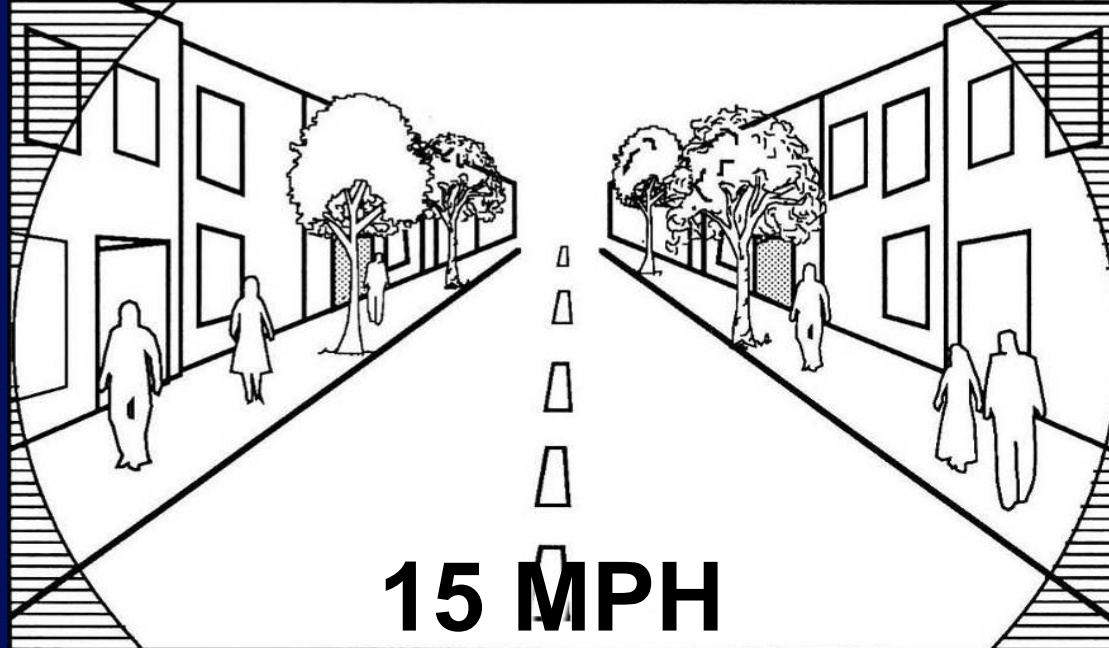
Impacts of long crossing distance:

- Increases exposure time
- Increases vehicle-pedestrian conflict
- Increases vehicle delay
- Decreases ability of slower pedestrians to cross

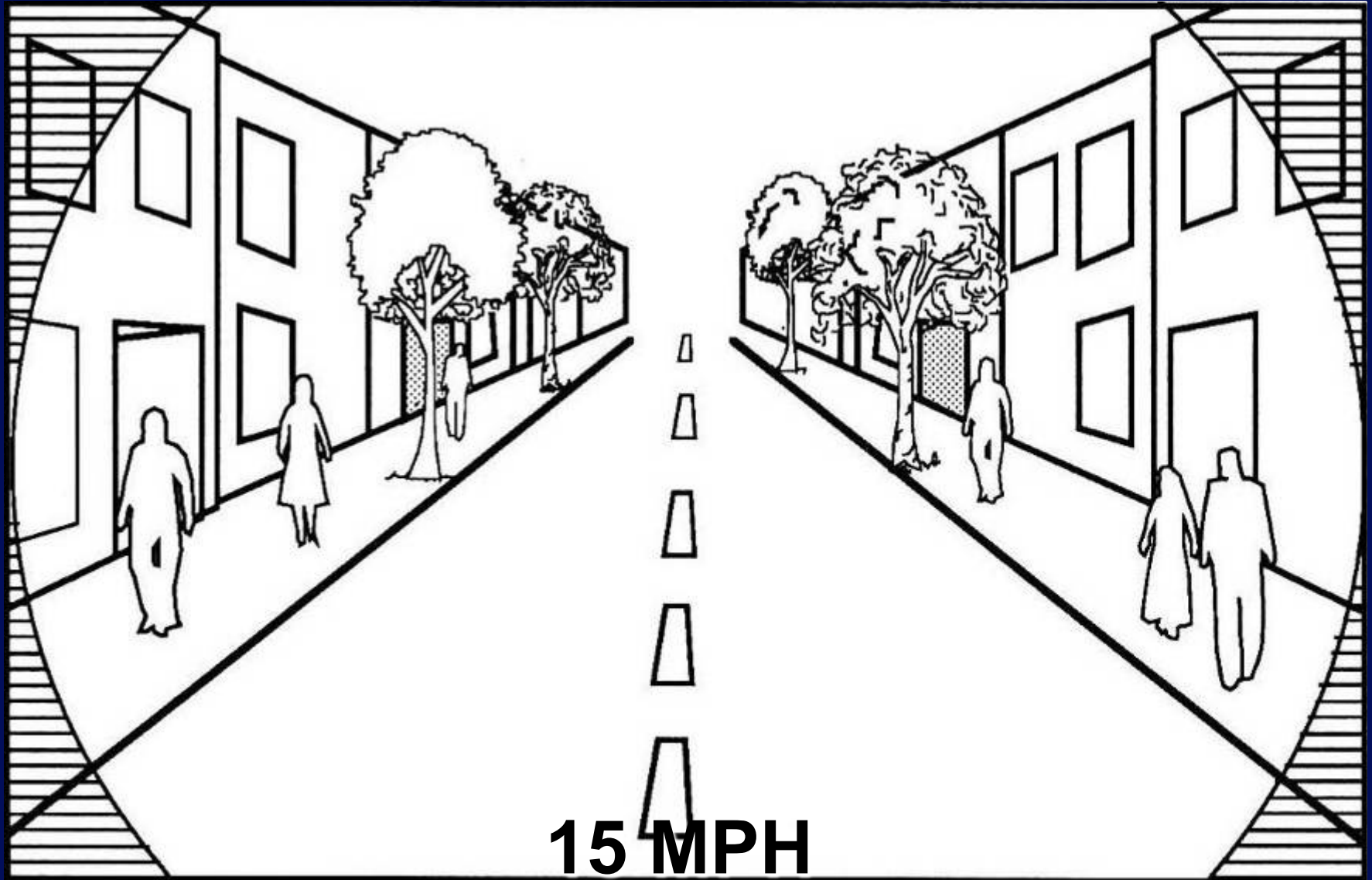


Principle # 4: Speed Matters

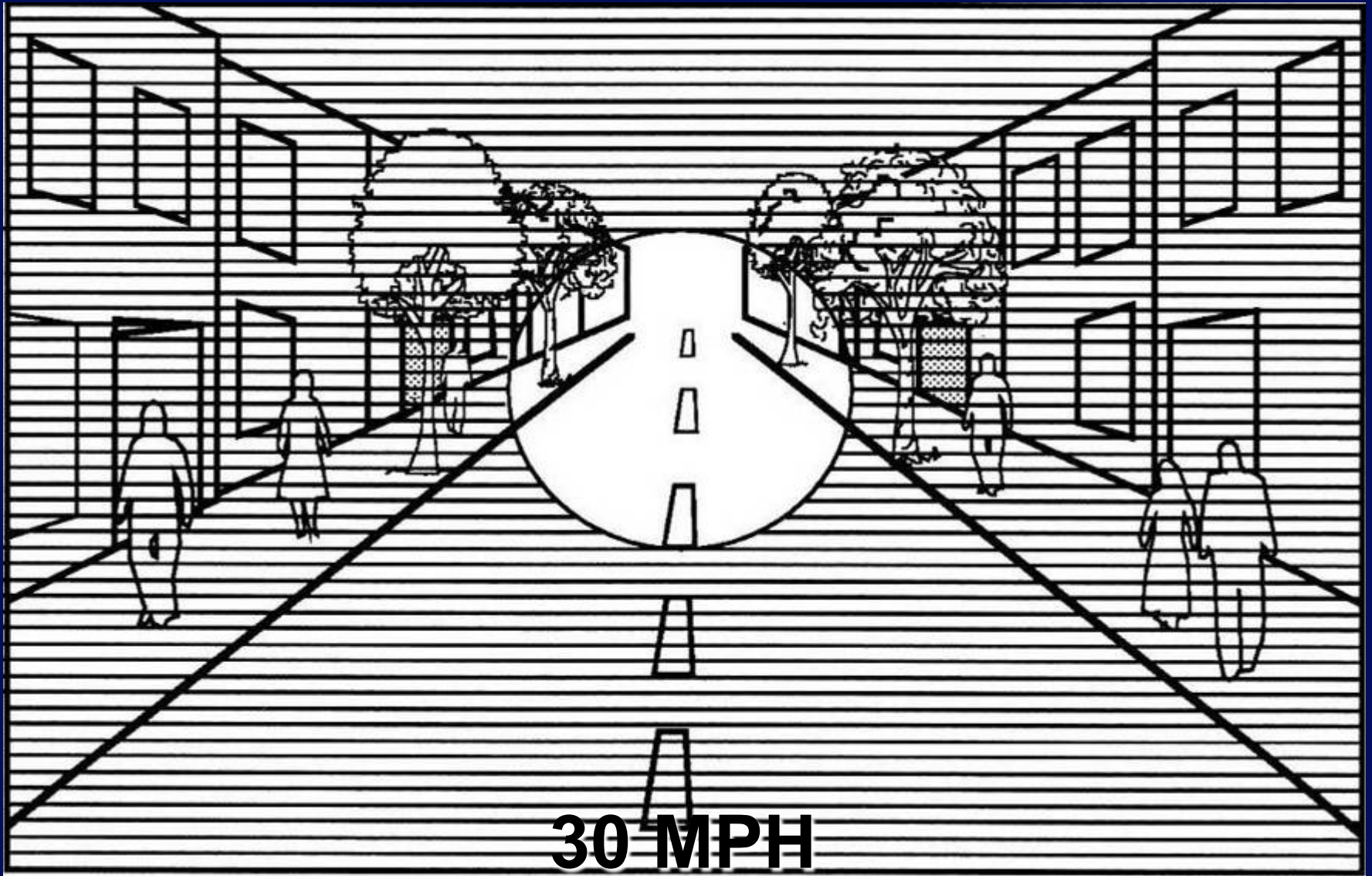
1. Drivers' field of vision & ability to see pedestrians
2. Drivers' ability to react and avoid a crash
3. Crash Severity



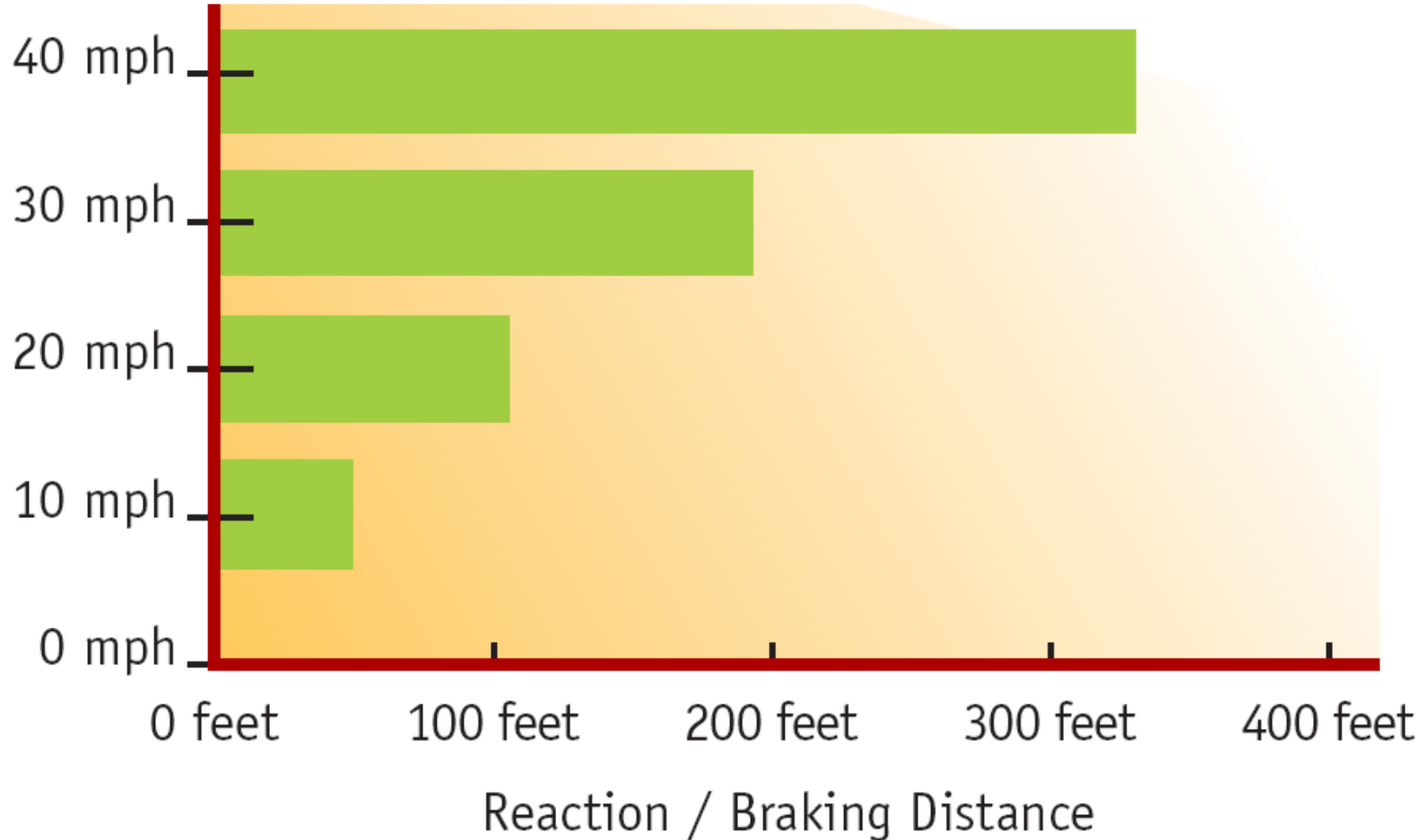
As speed increases, driver focuses less on surroundings



As speed increases, driver focuses less on surroundings



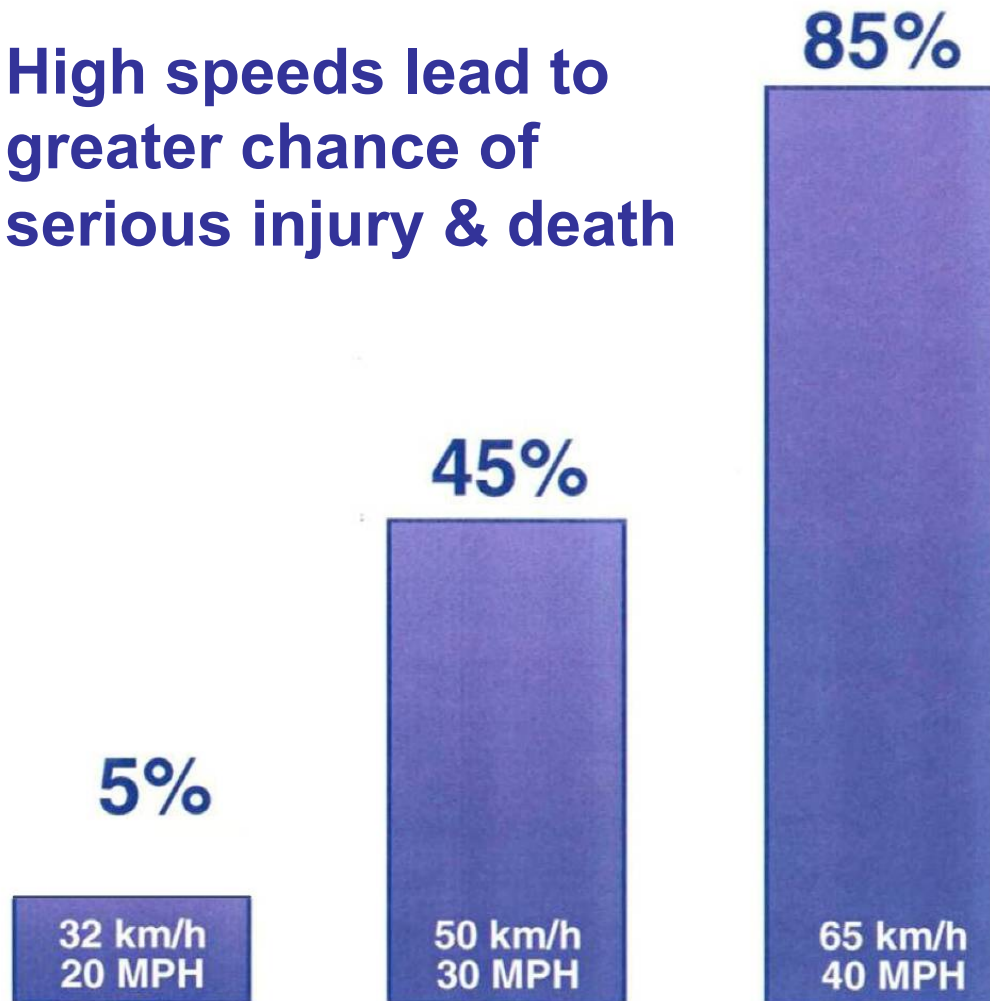
Speed Affects Crash Avoidance



High speeds equate to greater reaction and stopping distance

Speed Affects Crash Severity

High speeds lead to
greater chance of
serious injury & death



Pedestrians' chances of death if hit by a motor vehicle

SOURCE: *Killing Speed and Saving Lives*, UK Department of Transportation

California laws governing pedestrian safety

Legislative intent:

21949. (a) The Legislature hereby finds and declares that it is the policy of the State of California that safe and convenient pedestrian travel and access, whether by foot, wheelchair, walker, or stroller, be provided to the residents of the state.

(b) In accordance with the policy declared under subdivision (a), it is the intent of the Legislature that all levels of government in the state, particularly the Department of Transportation, work to provide convenient and safe passage for pedestrians on and across all streets and highways, increase levels of walking and pedestrian travel, and reduce pedestrian fatalities and injuries.

California laws governing pedestrian crossings

Drivers must yield to pedestrians:

21950. (a) The driver of a vehicle shall yield the right-of-way to a pedestrian crossing the roadway within any marked crosswalk or within any unmarked crosswalk at an intersection, except as otherwise provided in this chapter.

But...

(b) This section does not relieve a pedestrian from the duty of using due care for his or her safety. No pedestrian may suddenly leave a curb or other place of safety and walk or run into the path of a vehicle that is so close as to constitute an immediate hazard.

California laws governing pedestrian crossings

Pedestrians may cross midblock – must yield to traffic:

21954. (a) Every pedestrian upon a roadway at any point other than within a marked crosswalk or within an unmarked crosswalk at an intersection shall yield the right-of-way to all vehicles upon the roadway so near as to constitute an immediate hazard.

But...

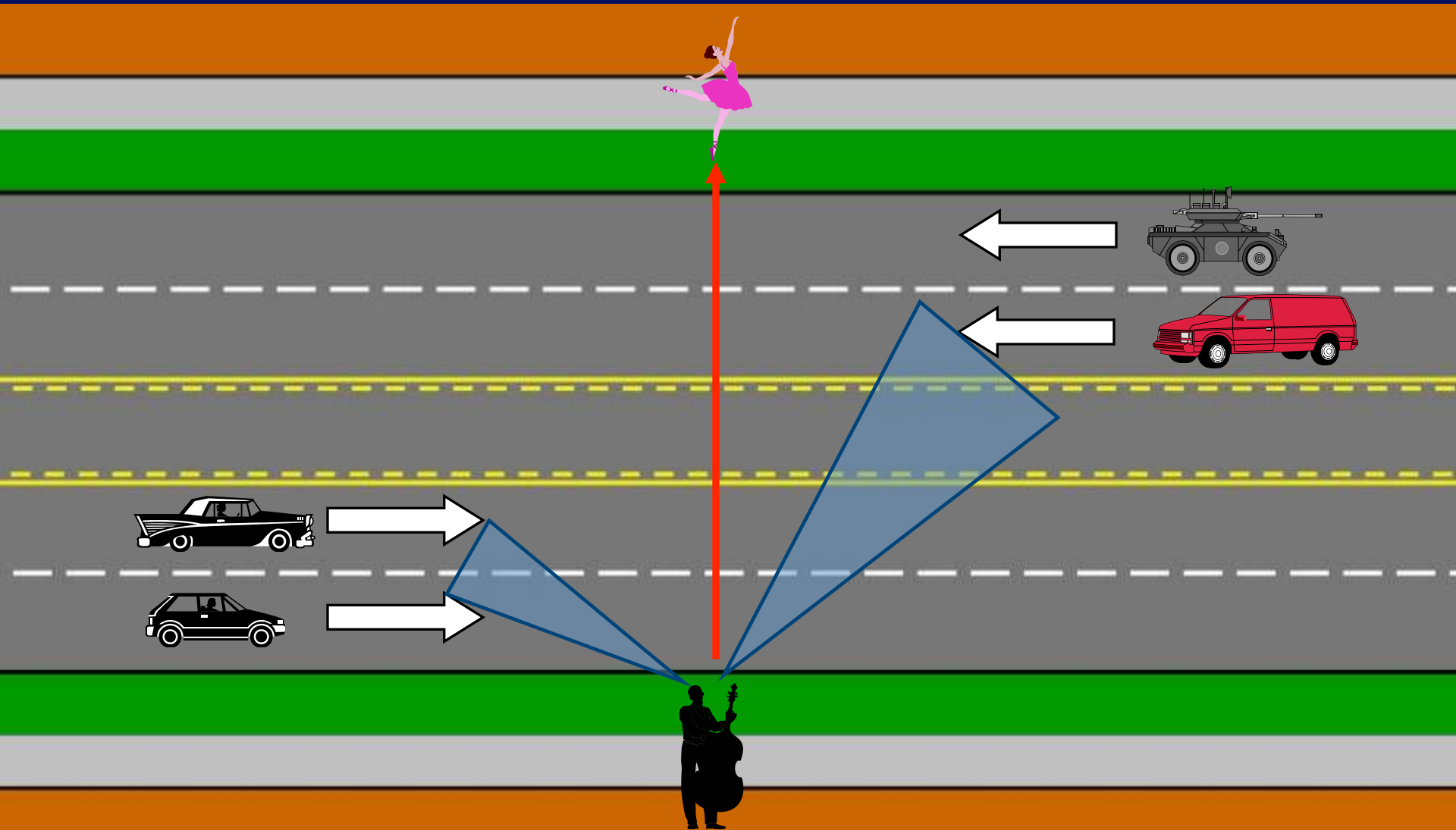
(b) The provisions of this section shall not relieve the driver of a vehicle from the duty to exercise due care for the safety of any pedestrian upon a roadway.

Pedestrians may not cross midblock :

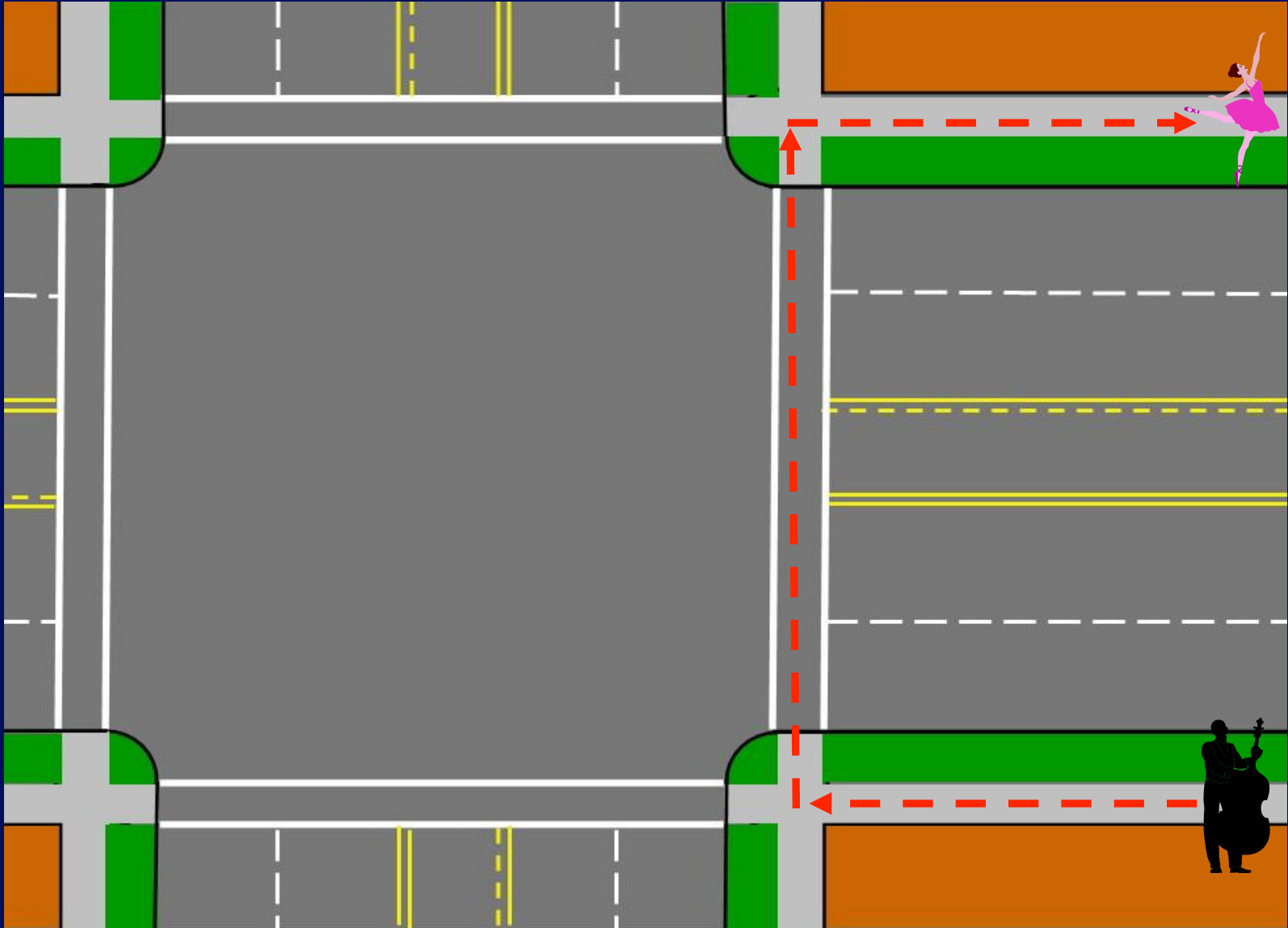
21955. Between adjacent intersections controlled by traffic control signal devices or by police officers, pedestrians shall not cross the roadway at any place except in a crosswalk.

**What is the relative risk of
crossing midblock vs.
crossing at an intersection?**

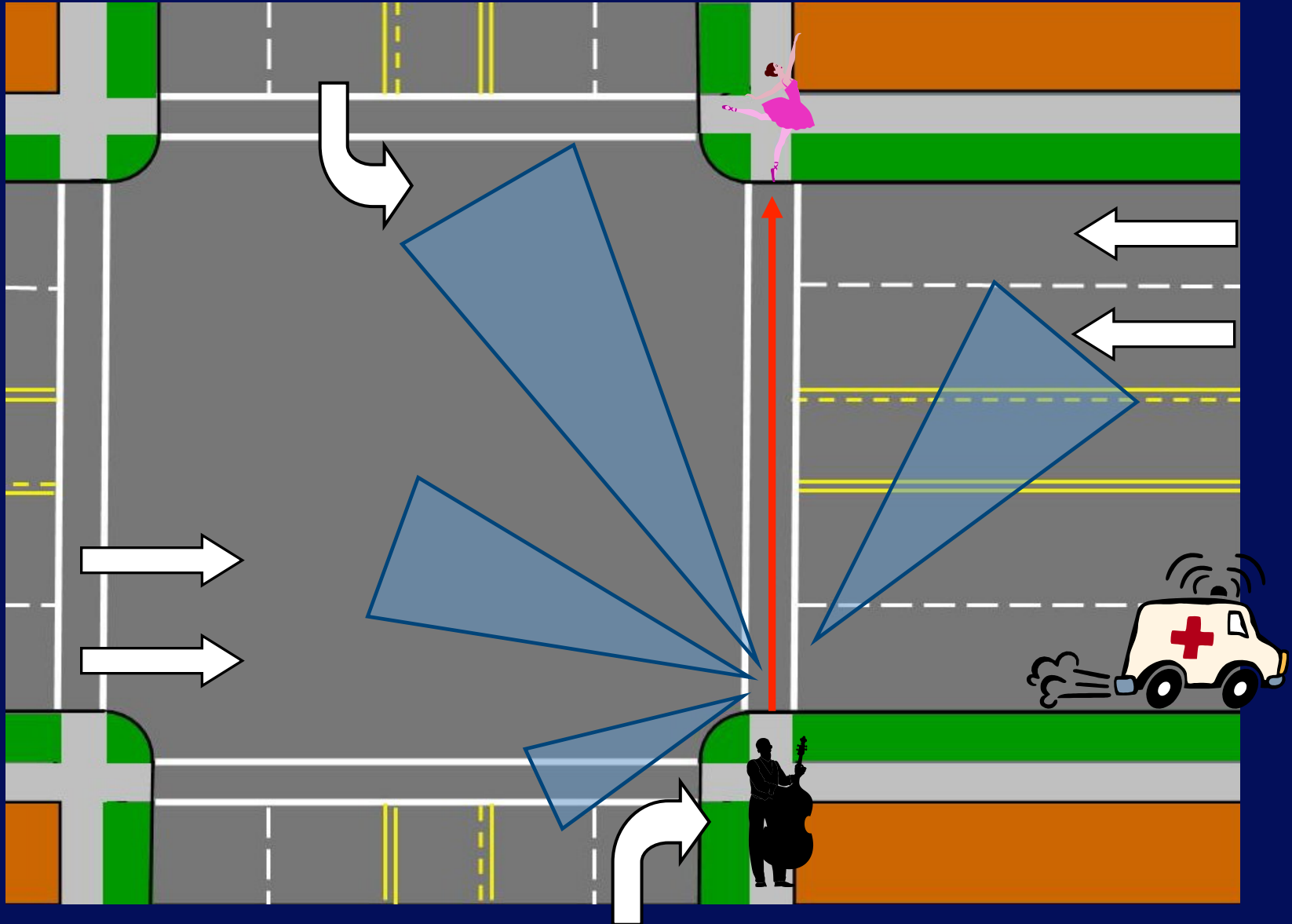
Midblock: pedestrian faces 2 directions of traffic



Intersection: pedestrian must walk out-of-direction



Intersection: pedestrian faces other conflicts





Not a good location for a marked crosswalk:
Poor sight distance

Many Locations are Suitable for a Marked Crosswalk



Suitable location for a marked crosswalk:
Two-lane, high use, driver expectancy



Suitable location for a marked crosswalk:
Slow speed, high use, driver expectancy

3. Do marked crosswalks increase safety, or encourage people to cross without looking?



Marked vs. Unmarked Analysis

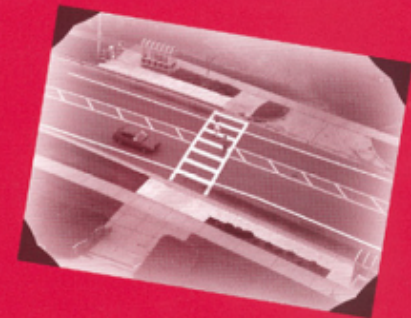
- Two-lane roads: No significant difference in crashes
- Multilane roads (*3 or more lanes*)
 - Under 12,000 ADT: no significant difference in crashes
 - Over 12,000 ADT w/ no median: crashes marked > crashes unmarked
 - Over 15,000 ADT & w/ median: crashes marked > crashes unmarked

Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations

Final Report and
Recommended Guidelines

FHWA PUBLICATION NUMBER: HRT-04-100

SEPTEMBER 2005



U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296



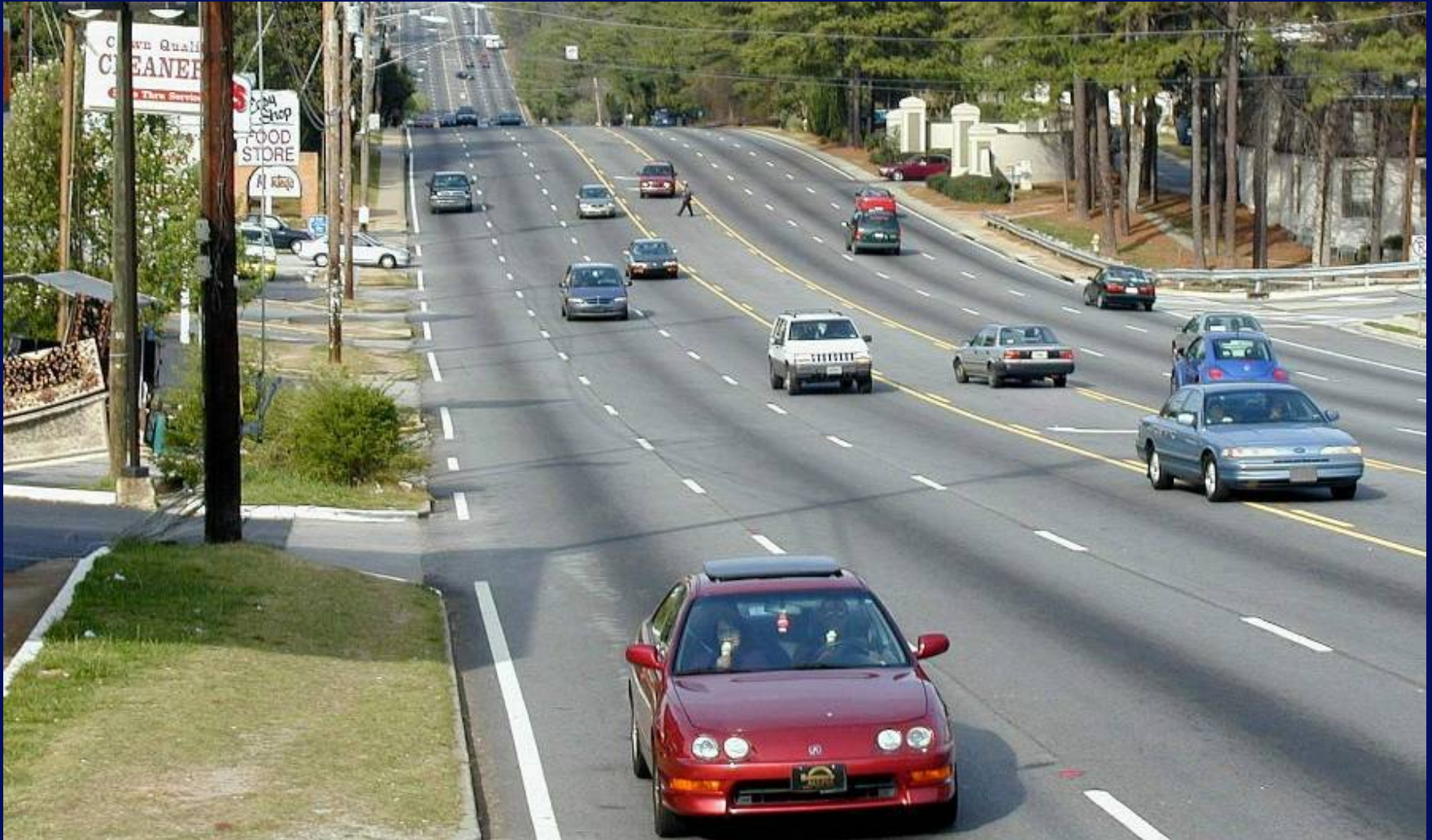
Study Results

1. Median reduces crashes by 40%
2. Pedestrians over 65 are over-represented in crosswalk crashes
3. Pedestrians are not less vigilant in marked crosswalks:
 - *Looking behavior increased after crosswalks installed*



Study Results

4. Crashes correlate with ADT & number of travel lanes.
 - *Other studies have shown same results*



Text in the 2009 MUTCD

New marked crosswalks alone, without other measures designed to reduce traffic speeds, shorten crossing distances, enhance driver awareness of the crossing, and/or provide active warning of pedestrian presence, should not be installed across uncontrolled roadways where the speed limit exceeds 40 mph and either:

- Has 4 or more lanes without a raised median or island and ADT of 12,000 or more, or
- 4 or more lanes with raised median island and ADT of 15,000 or more

(2009 MUTCD Section 3B.18)



Increase Effectiveness Of Crosswalks With:

- Proper location
- High Visibility Markings
- Illumination
- Signing
- Advance Stop Bars
- Median Islands
- Curb Extensions
- Signals

Key Quotes from the Study Conclusion

“When considering marked crosswalks at uncontrolled locations, the question should not be simply, “Should I provide a marked crosswalk or not?” ...

“Regardless of whether marked crosswalks are used, there remains the fundamental obligation to get pedestrians safely across the street. In most cases, marked crosswalks are best used in combination with other treatments (e.g., curb extensions, raised crossing islands, traffic signals, roadway narrowing, enhanced overhead lighting, traffic calming measures)....

“In all cases, the final design must accomplish the goal of getting pedestrians across the road safely....”

“The design question is, “How can this task [getting pedestrians across the road safely] best be accomplished?”

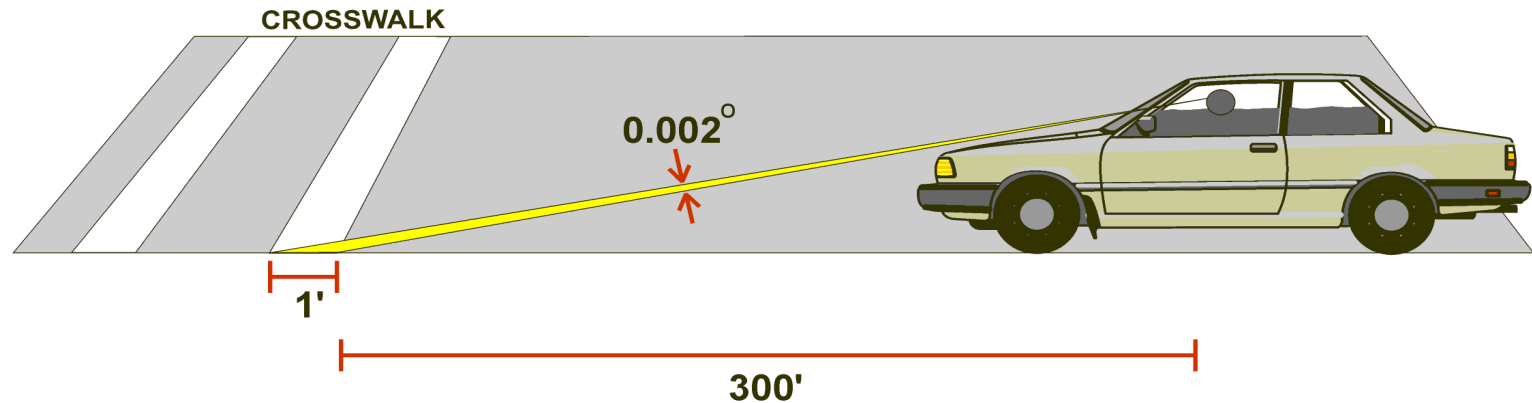
Crosswalk Visibility



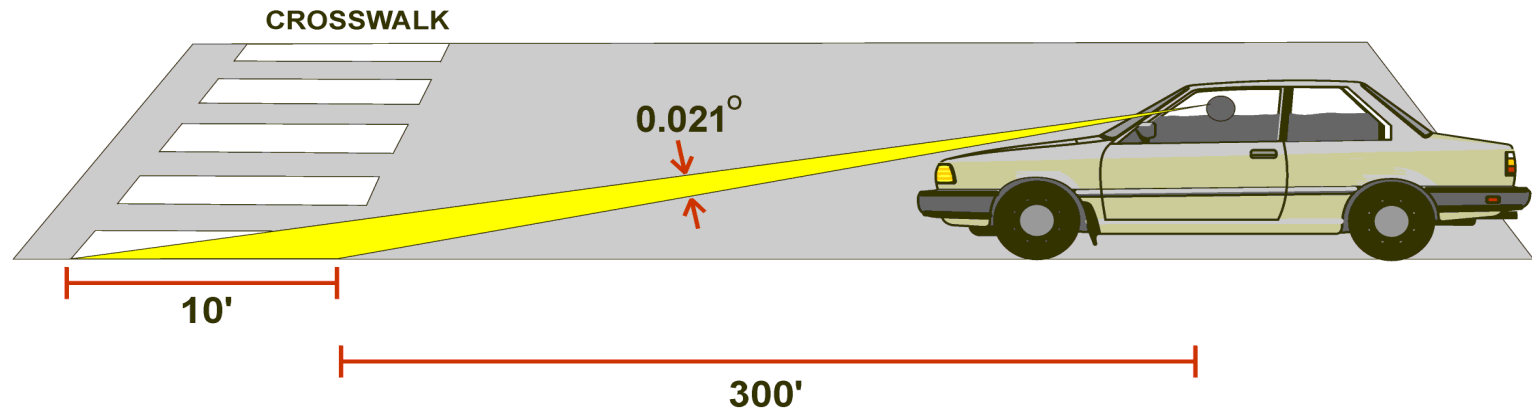
Crosswalk Marking Types

Crosswalk Visibility

LATERAL 12" STRIPE



LONGITUDINAL MARKING



Longitudinal markings are more visible to driver from afar

Textured crosswalks: how effective are they?



In theory, more visible. Reality?



What the pedestrian sees

Corvallis OR

Designing for Pedestrian Safety
– Crossing Countermeasures



What the driver sees

Corvallis OR

Designing for Pedestrian Safety
– Crossing Countermeasures



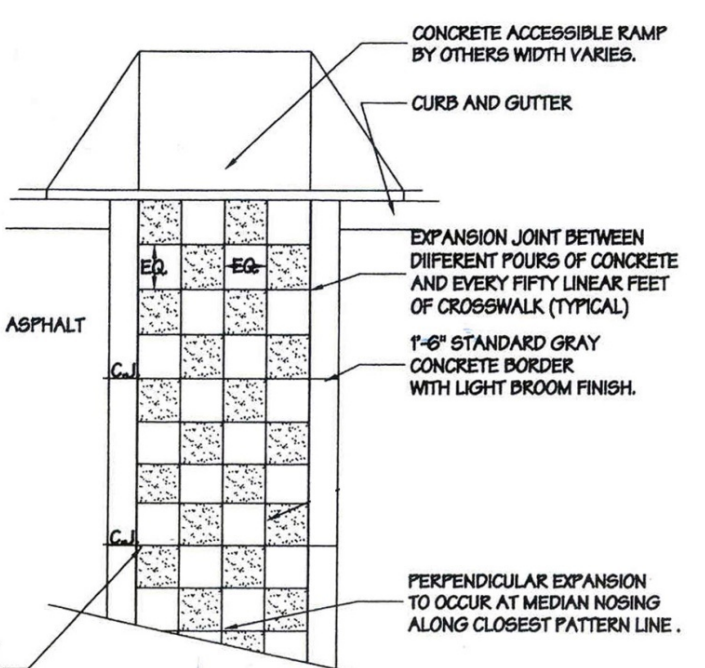
**Brick crosswalks: prone to failure,
difficult for wheelchair users**



Brick street with (asphalt-coated) concrete crosswalks

Orlando FL

Designing for Pedestrian Safety
– Crossing Countermeasures



Checkerboard pattern created by alternating brushed concrete with exposed aggregate (use fine rock)



Idea: imbed white crosswalk within contrasting color



Driver perspective: crosswalks show up well

Crosswalk Lighting: Sample Illustrations from New FHWA Report

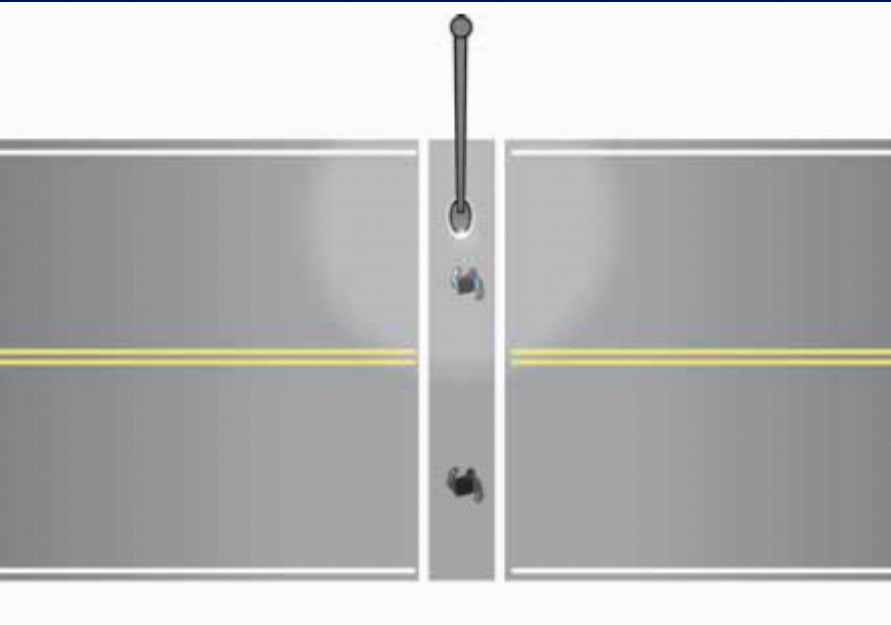


Fig 11. Traditional midblock crosswalk lighting layout

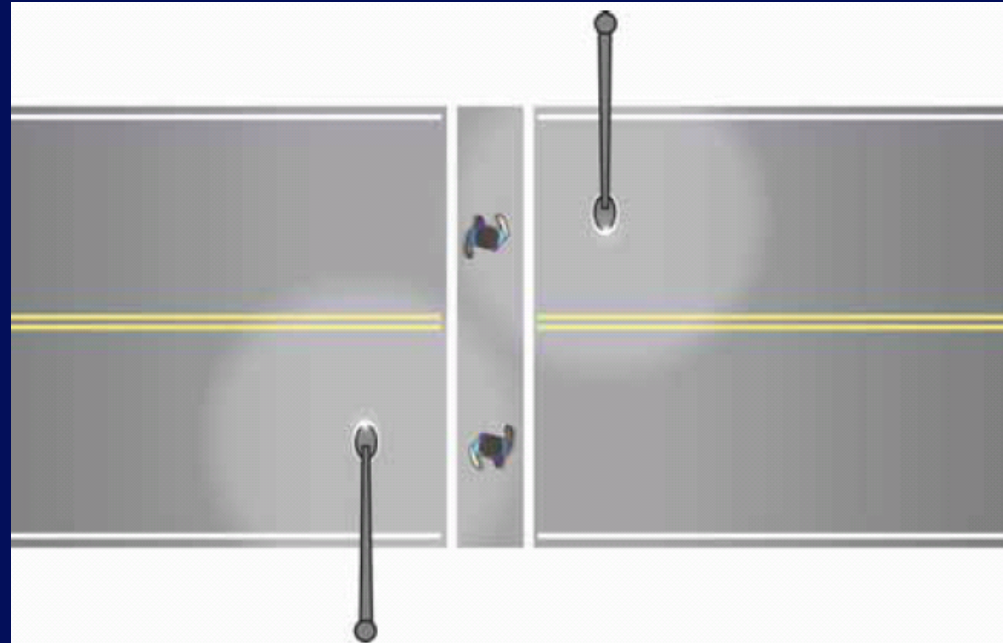


Fig 12. New design for midblock crosswalk lighting layout

Recommended lighting level: 20 lux at 5' above pavement

Available at <http://www.tfhr.gov/safety/pubs/08053/08053.pdf>

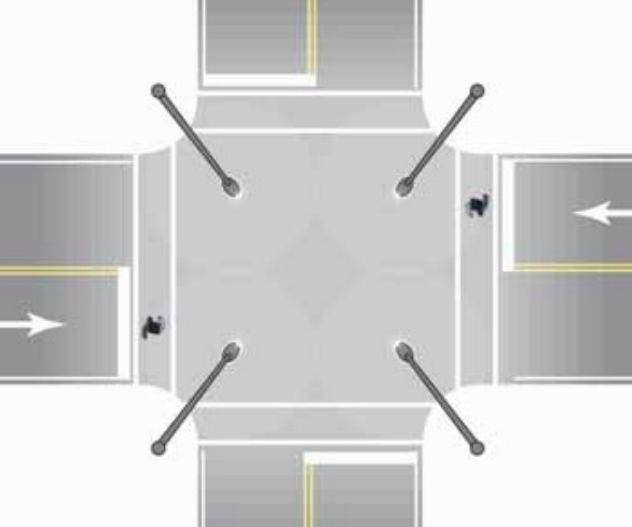


Fig 13. Traditional intersection lighting layout

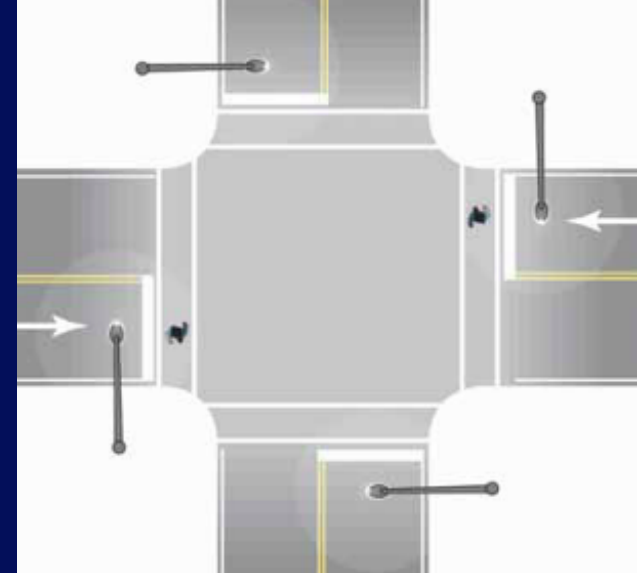


Fig 14. New design for intersection lighting layout for crosswalks.

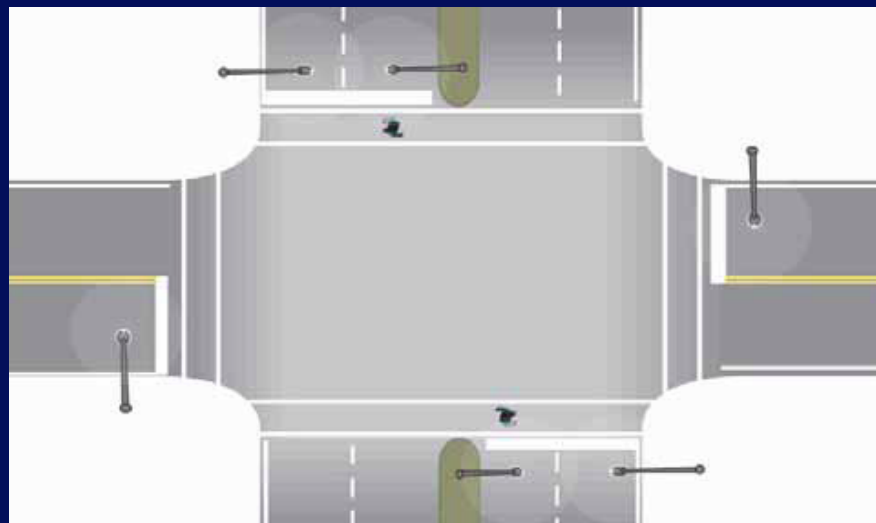


Fig 15. New design for wide roadway intersection lighting layout for crosswalks



In-street signs increase yield rates,
especially on slow-speed streets

Pedestrian crossing sign with flashing beacon



Improves visibility of sign and crosswalk;
CRF unknown

Rectangular Rapid Flash LED Beacon

- Not in MUTCD – received Interim approval from FHWA in July 2008
- Studies indicate motorist yield rates increased from about 20% to 80%
- Beacon is yellow, rectangular, and has a rapid “wig-wag” flash
- Beacon located between the warning sign and the arrow plaque
- Must be pedestrian activated (pushbutton or passive)



http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/fhwamemo.htm



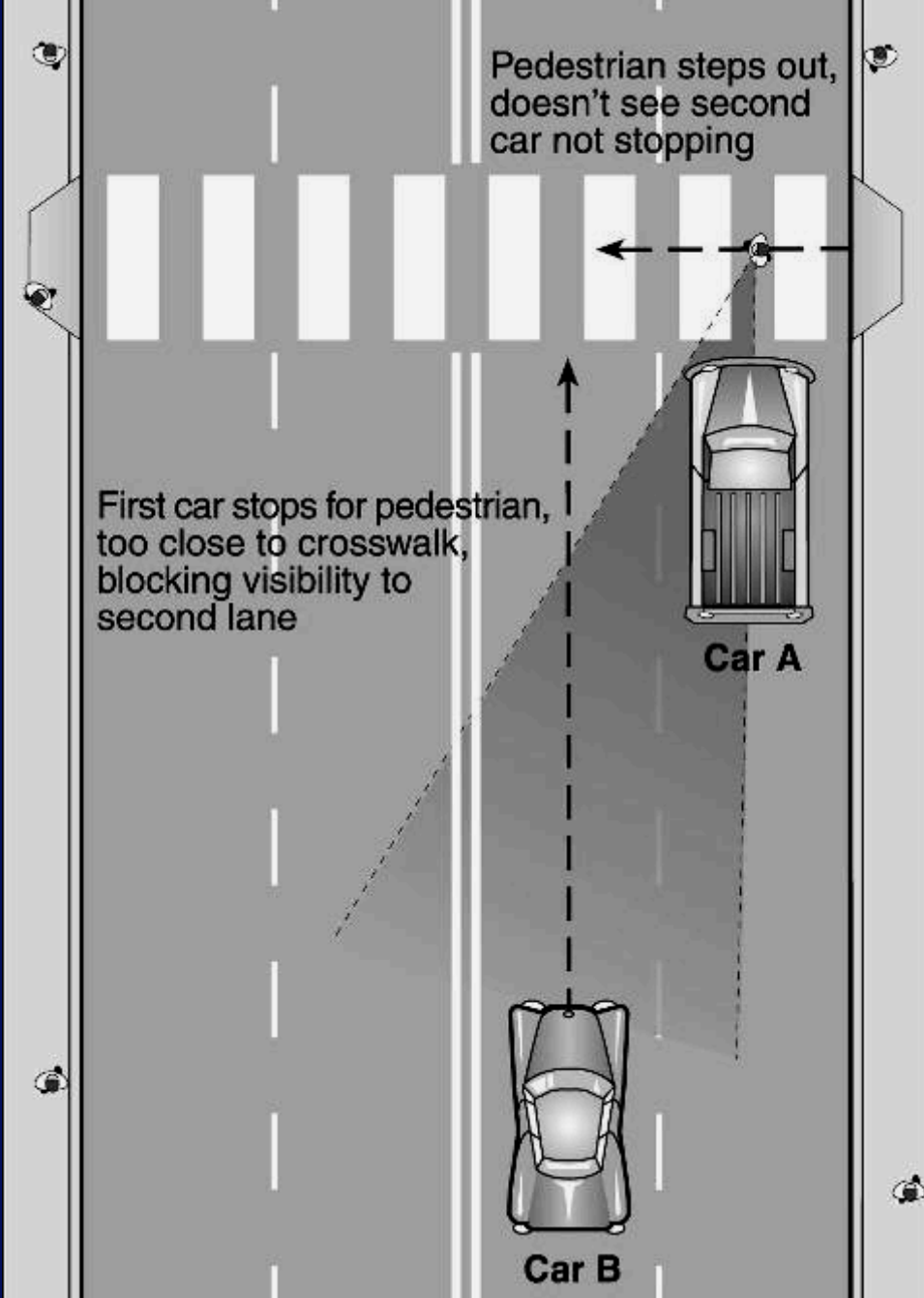
Beacons required on the both right side and
on the left side or in a median if practical

Advance Stop or Yield Line: Reduces Multiple-threat Crashes

Multiple Threat Crash Problem

1st car stops to let pedestrian cross, blocking sight lines

2nd car doesn't stop, hits pedestrian at high speed

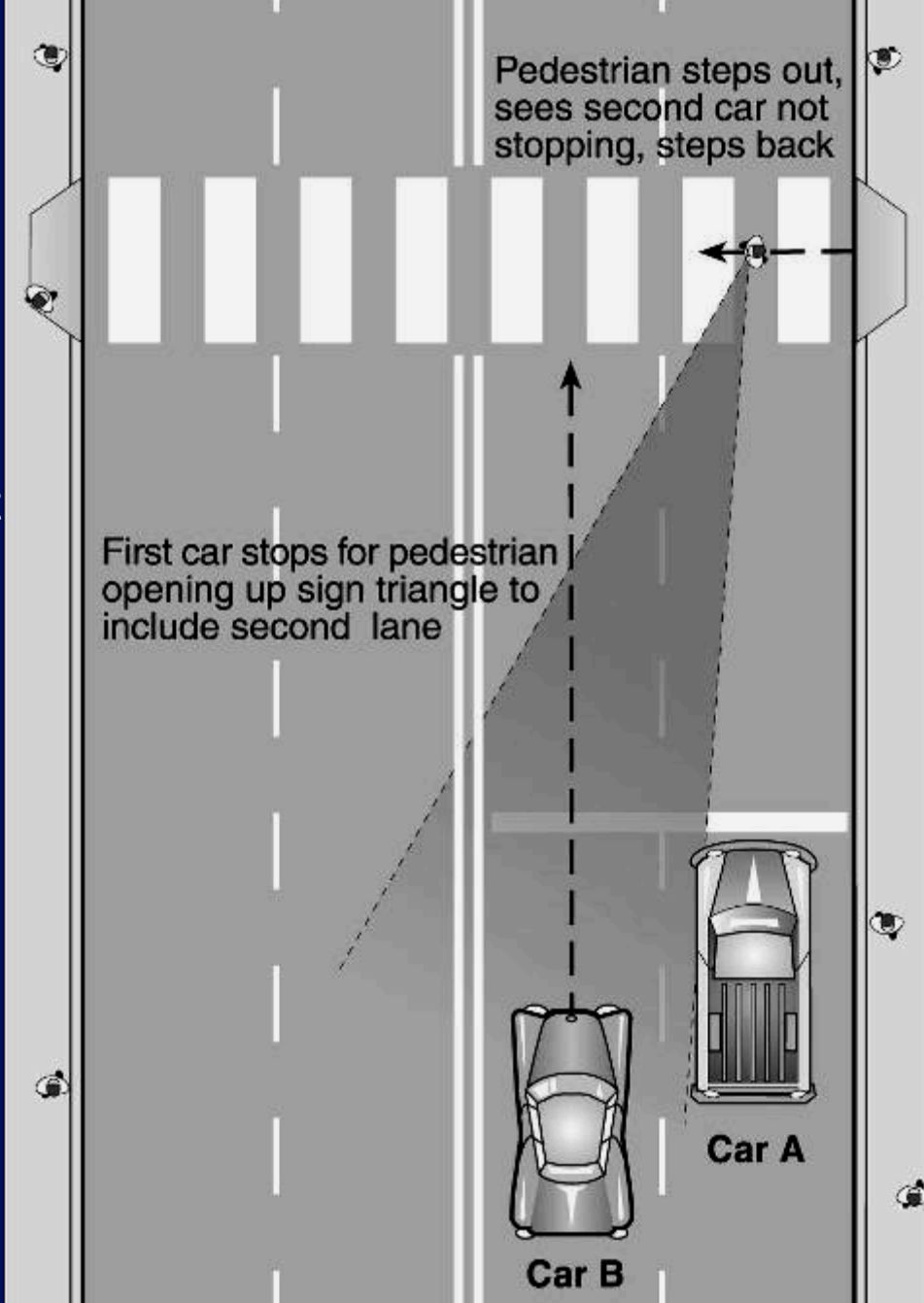


Multiple Threat Crash Solution

Advance stop/yield line

1st car stops further back, opening up sight lines

2nd car can be seen by pedestrian





R1-5



R1-5a

(Use where local law says yield to pedestrians)



R1-5b



R1-5c

(Use where local law says stop for pedestrians)



Advance yield line (shark's teeth) & sign

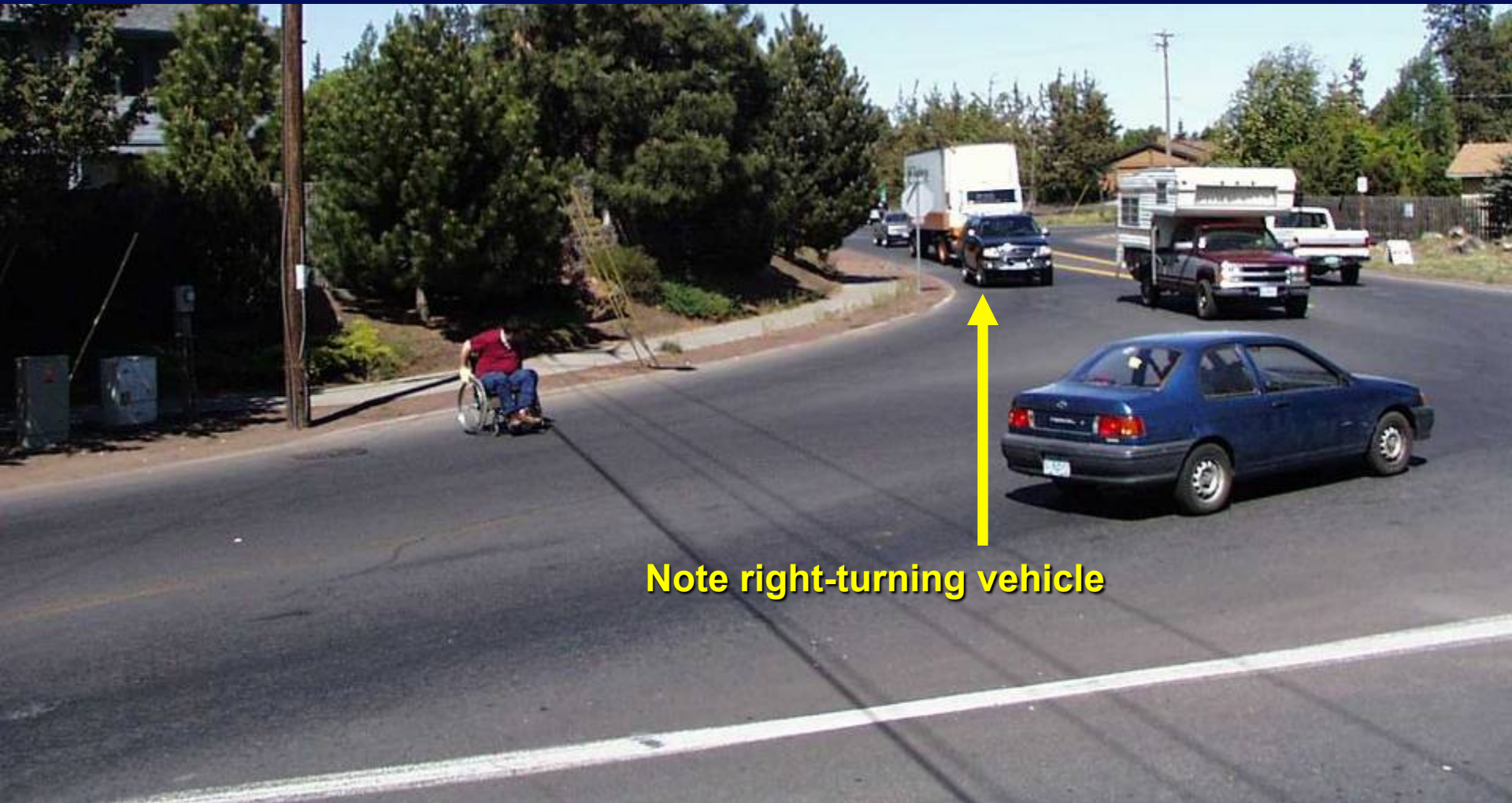
2009 MUTCD Section 3B.16 and Figure 3B-17

Milwaukee WI

Designing for Pedestrian Safety
– Crossing Countermeasures

Intersection Geometry

Effect of large radius on crosswalk:



Note right-turning vehicle

... and makes it hard to figure out where to cross

Effect of large radius on drivers



They drive fast, ignoring pedestrians

Minimize curb radius

3. Don't choose larger design vehicle than necessary



Bus makes turn several times an hour

Canyonville OR

Designing for Pedestrian Safety
– Intersection Geometry

Minimize curb radius

3. Don't choose larger design vehicle than necessary



Moving van, once or twice a year; peds cross every day

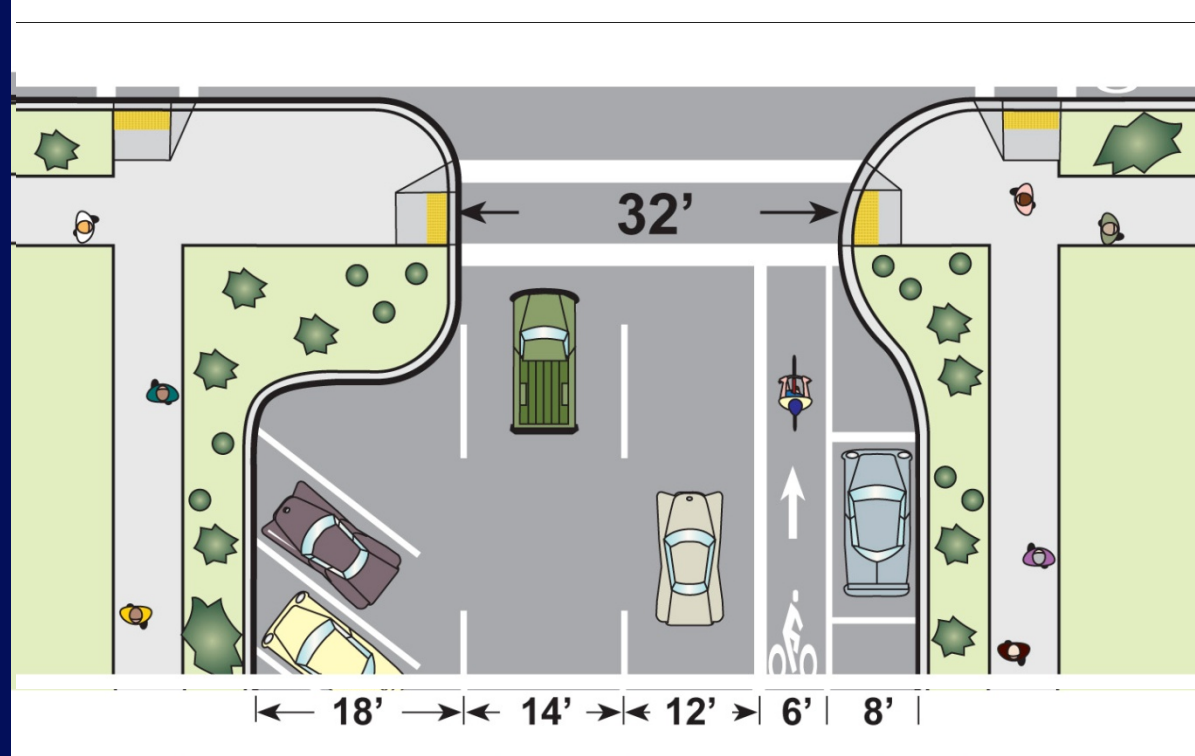
Curb extensions

Most focus is on reduced crossing distance

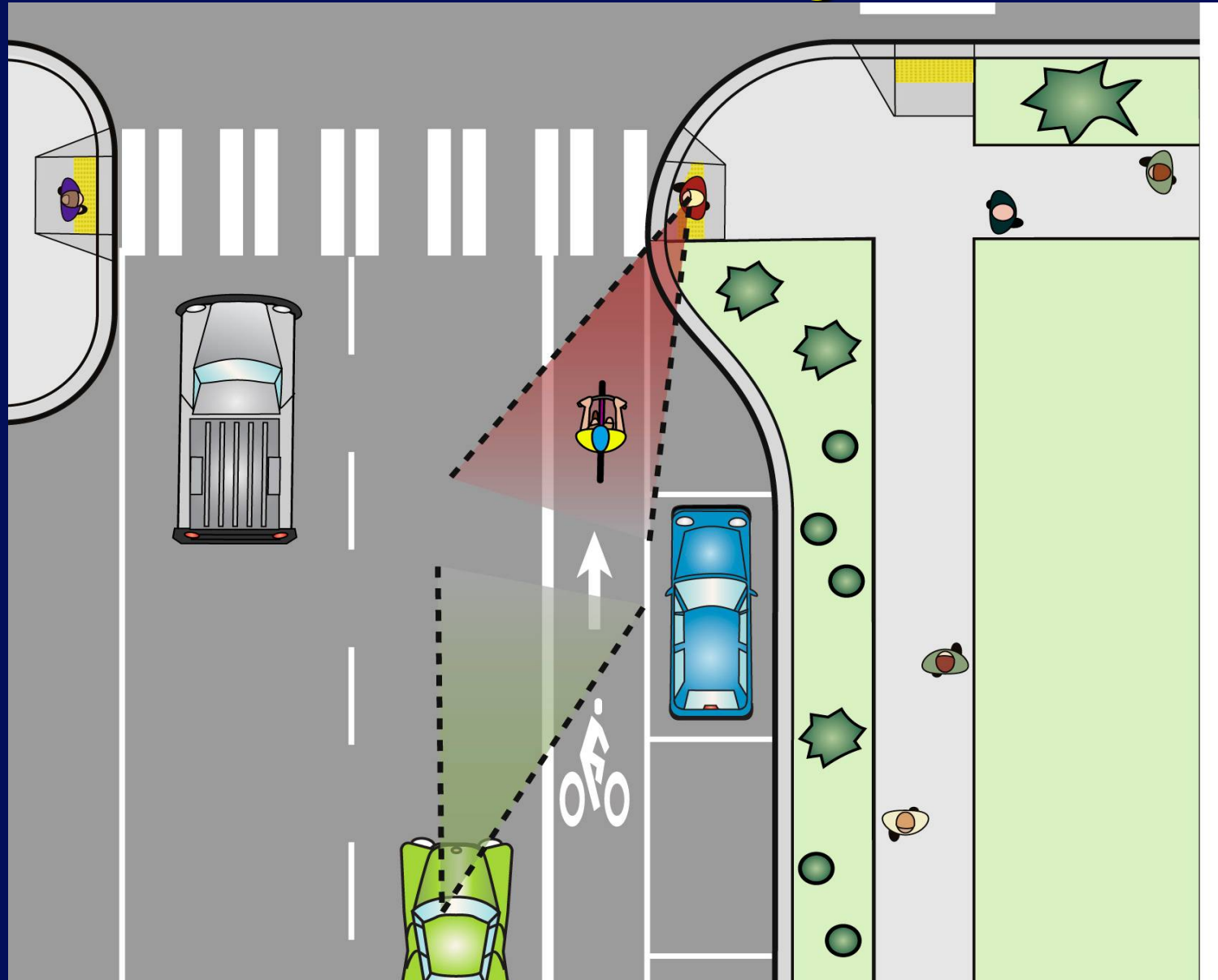
Other advantages:

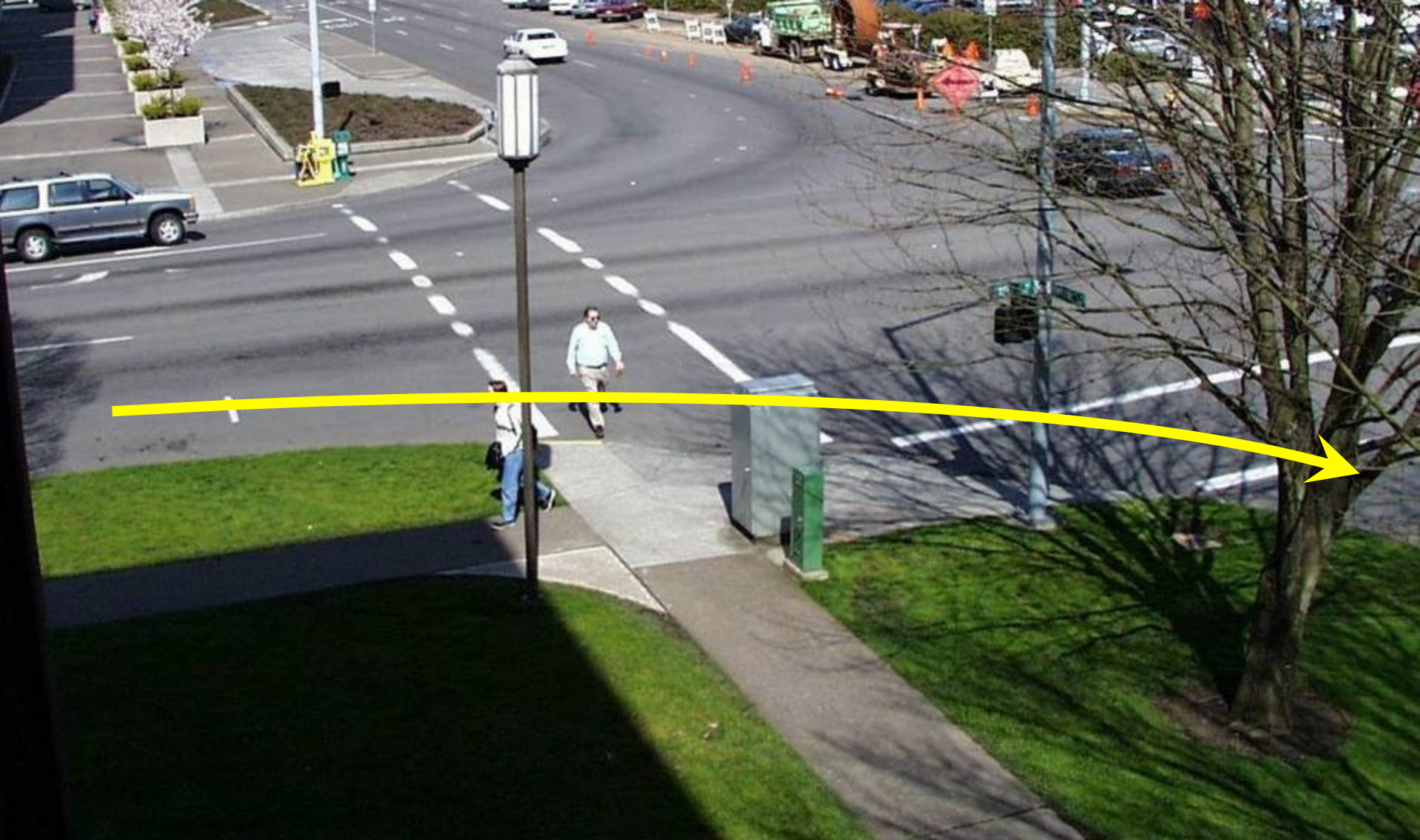
- Better visibility between peds and motorists
- Traffic calming
- Room for street furniture

Curb extensions should be the width of the parking lane and not encroach on bike lanes or travel lanes



Better Visibility





Before: high speed right-turns



After: slow speed right-turns

Curb extension and new corner radius must be designed together – see earlier radius discussion



Public art



Newspaper boxes



Bike parking



Street trees

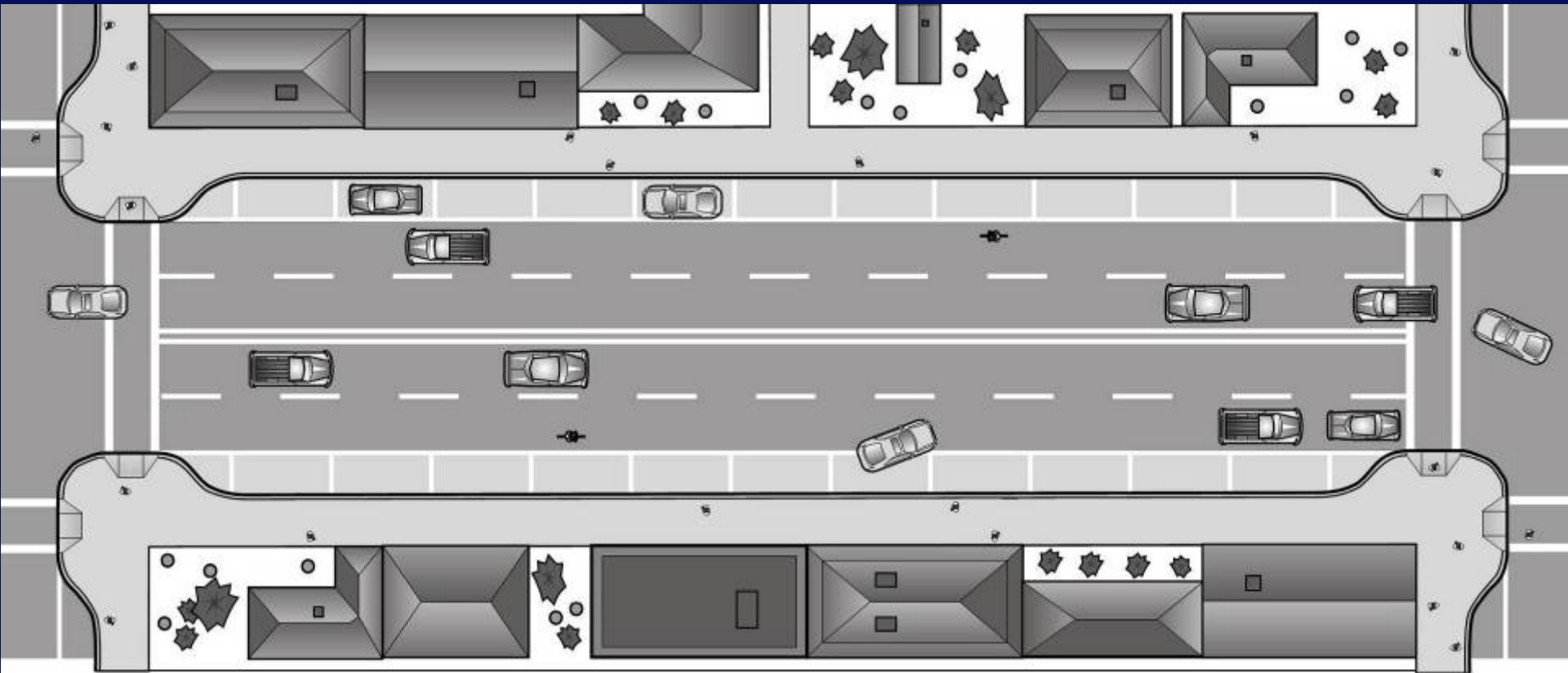
Curb extensions allow room for street furniture
But use care not to block sight lines

Designing for Pedestrian Safety
– Intersection Geometry



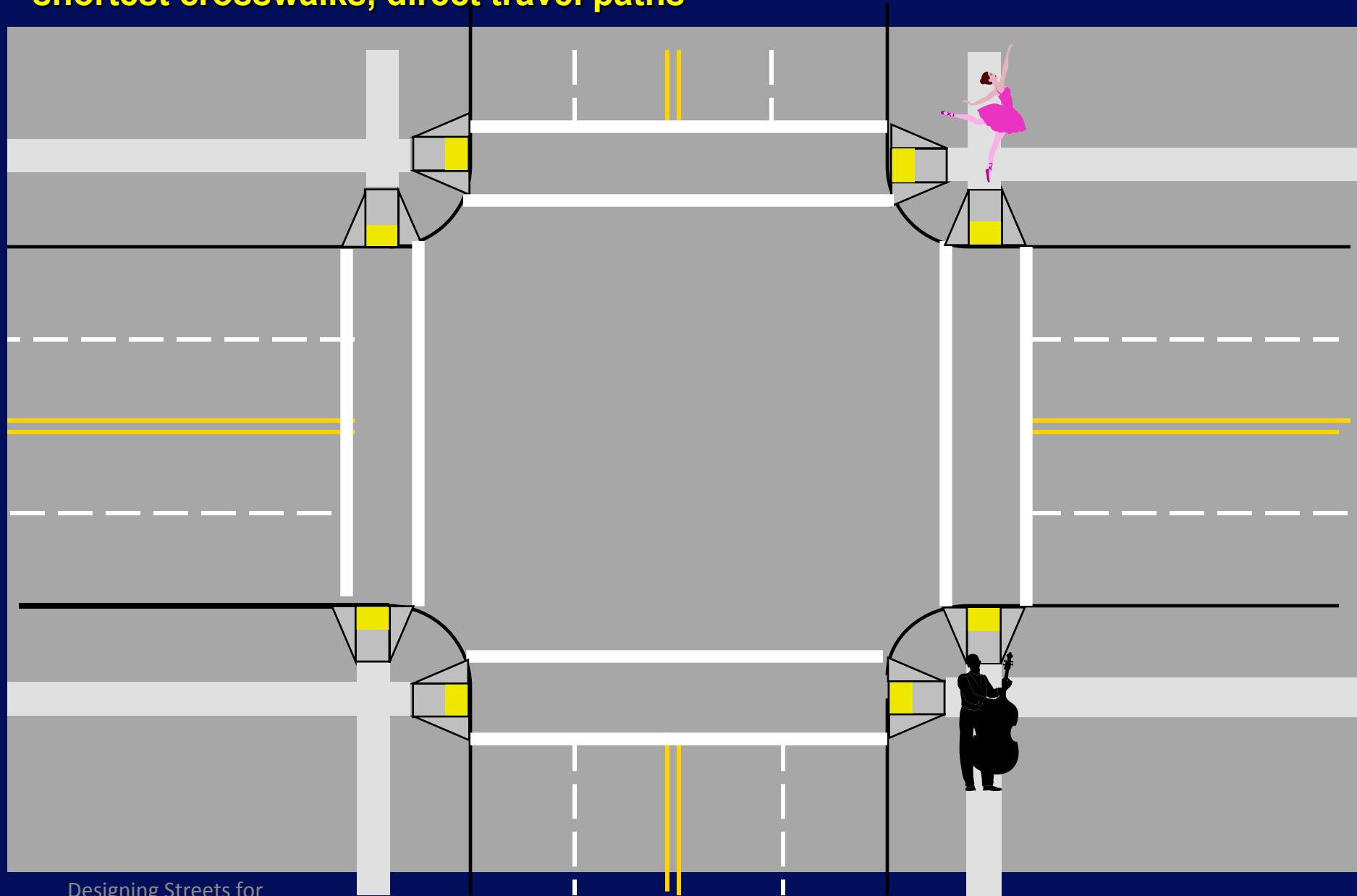
Curb extensions enable signs to be moved in

Curb Extension Integrated with the Sidewalk

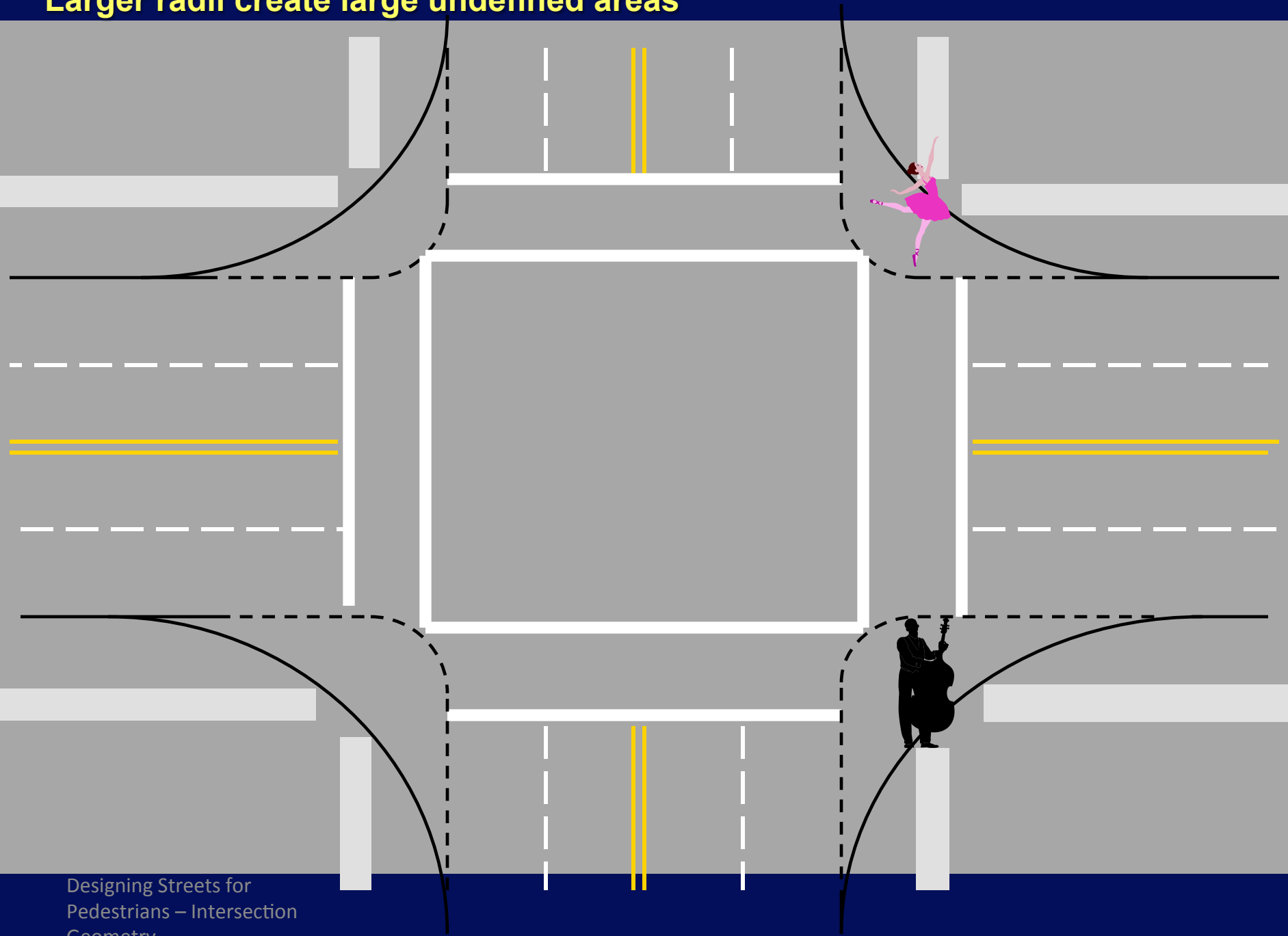


“Parking pockets” in furniture zone have similar surface materials as the sidewalk

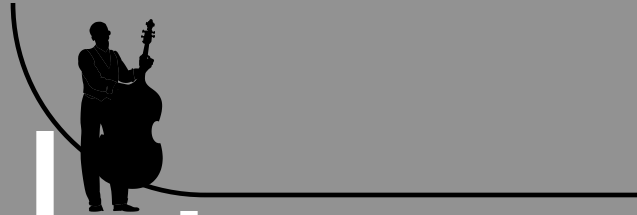
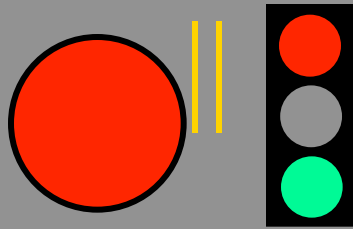
Small corner radii allow two ramps, shortest crosswalks, direct travel paths



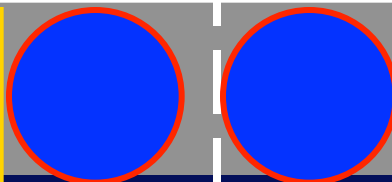
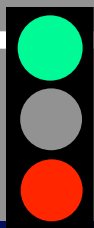
Larger radii create large undefined areas



Permissive Left Turns

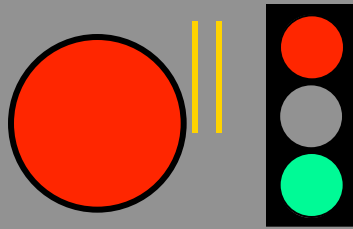


**Pedestrians cross at same
time as left-turning car;
Drivers turning left on a green
ball don't look for pedestrians.**

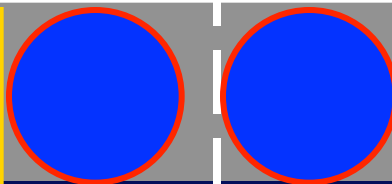


Designing for Pedestrian Safety – Signalized
Intersections

Protected Left Turns



**Pedestrians cross after left-turning car, with thru-traffic;
Pedestrian and car not in conflict**



Designing for Pedestrian Safety – Signalized Intersections

Exclusive Pedestrian Phase (Barnes Dance)



Popular because all traffic stops and pedestrians can cross in any direction (*must ban turns on red*)



**Pedestrians pay a price in delay:
Pedestrians wait for traffic in one direction**



- In this example a high-tech signal was used to help slower pedestrians cross the street with minimal delay to traffic.
- A slower crossing speed would delay traffic significantly



Microwave sensors are aimed at the crosswalks to track peds

Portland OR

Designing for Pedestrian Safety – Signalized Intersections

If complex, break it up





Bulb-out with double curb ramps

Curb Extensions



Crossing island





Raised crosswalk

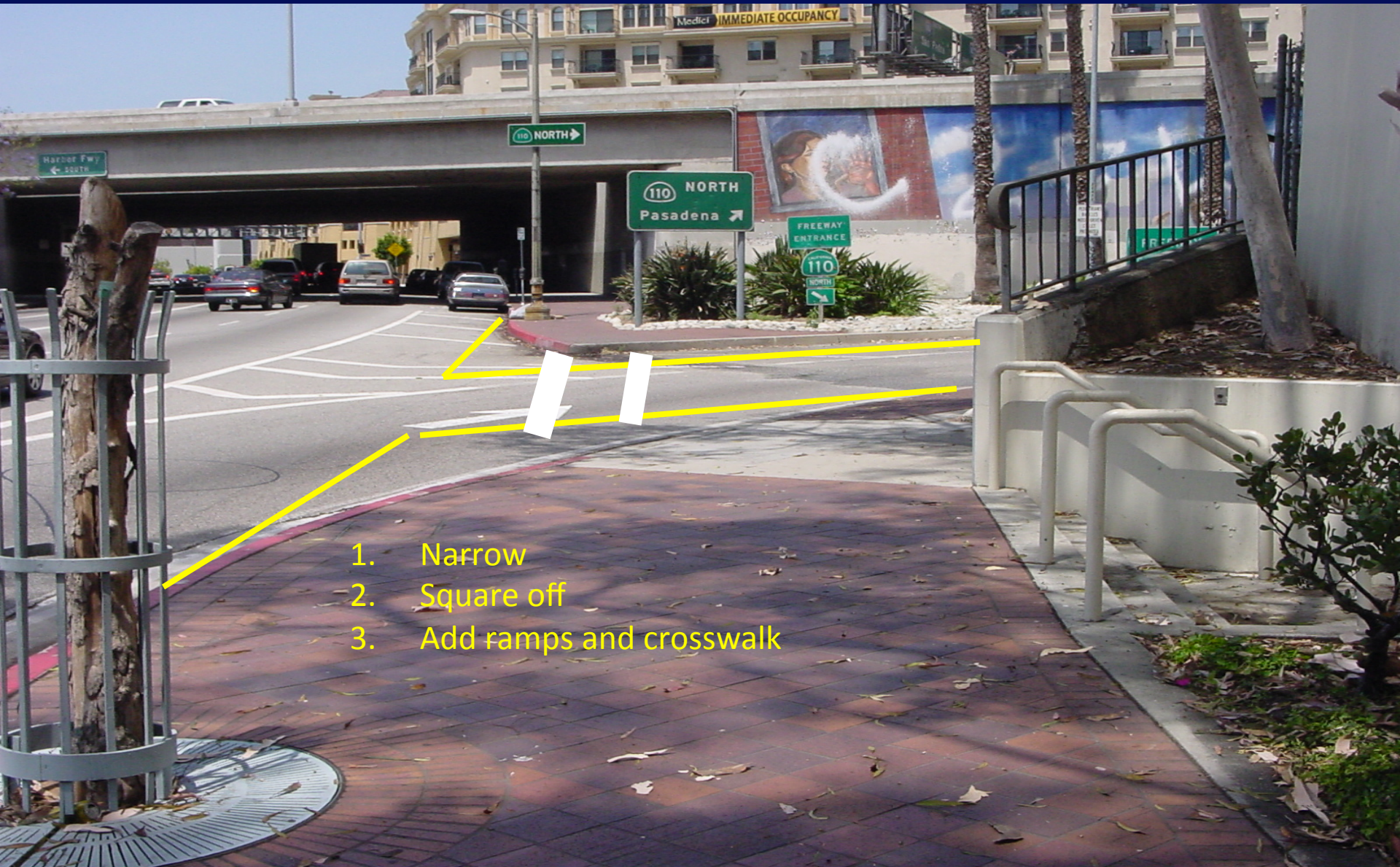


2 HOUR
PARKING
7AM-6PM

D. ROSE'S
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& Furnishings

WASHINGTON
975

Freeway Ramp Treatment



1. Narrow
2. Square off
3. Add ramps and crosswalk

Bus bulb

Urbanized areas with transit-first policy



Landscaping



Placemaking









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Walk Streets

The Following Slides for General Guidance Only

- Recommendations provide guidance as to where devices are COMMONLY used
- Engineering judgment necessary for each location
- Other devices may be needed

Common Treatments at Uncontrolled Crossings of Two-Lane Streets

- Marked crosswalks
- Signs
- Perpendicular curb ramps
- Tactile warning devices
- Advanced yield bars

Common Treatments at Uncontrolled Crossings of Three-Lane Streets

- Marked crosswalks
- Signs
- Perpendicular curb ramps
- Tactile warning devices
- Advanced yield bar
- Crossing islands
- Bulb-outs

Common Treatments at Uncontrolled Crossings of Four and Five-Lane Streets – ADTs < 25,000 to 35,000

- Marked crosswalks
- Signs
- Perpendicular curb ramps
- Tactile warning devices
- Advanced yield bar
- Crossing islands
- Bulb-outs
- Flashing beacons/Rapid-flash beacons
- Use more devices

Common Treatments at Crossings of Four-Lane +Streets ADTs >25,000 to 35,000

- Signals
- Advanced stop bars
- High-visibility crosswalks
- Countdown signals
- Bulb-outs
- Crossing islands



Overpasses and Underpasses

In theory, grade separation = no conflicts



In reality, pedestrians often ignore structures
Placing themselves in greater danger

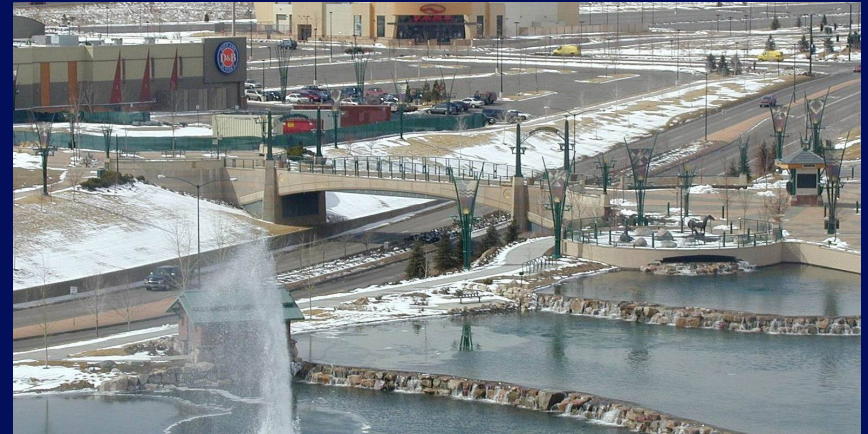


Why don't they get used? Longer travel distance

Grade separation is more useful for purposes beyond simply crossing from sidewalk to sidewalk



To connect buildings



To connect land uses

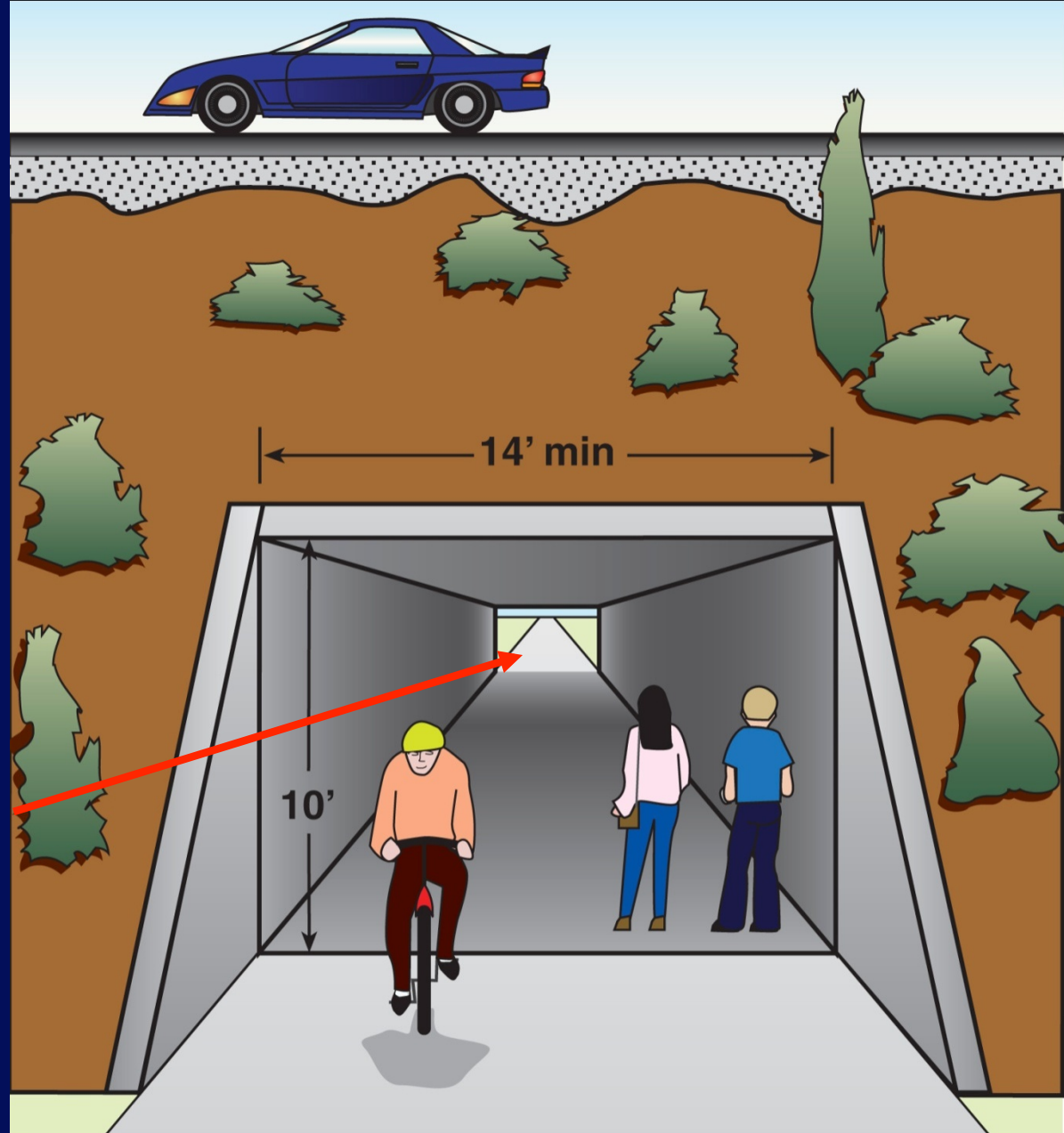


To cross freeways



Light rail stations

Undercrossings require generous dimensions to be attractive: security is the main issue



Good design practice:
Users must see light at the
end of the tunnel



Undercrossing must not intimidate potential user



Original elevation of highway

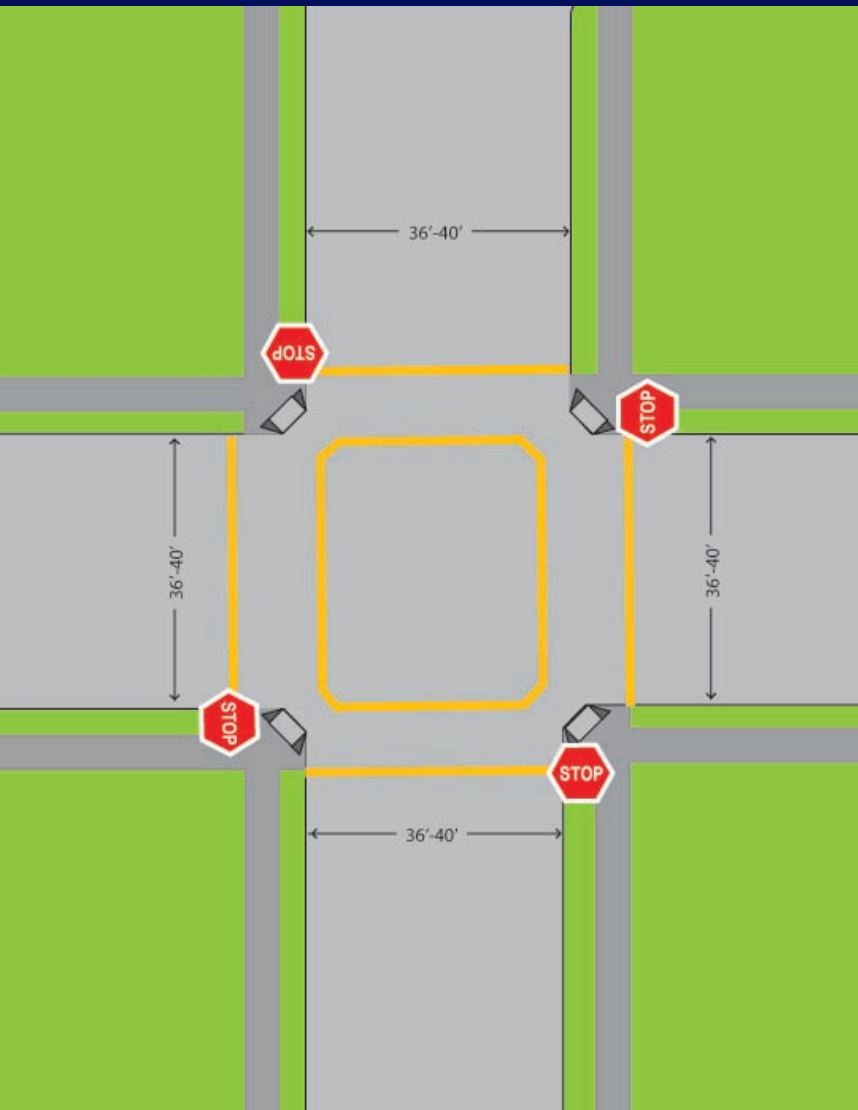
Undercrossings work best if roadway is elevated, even if it is just a small amount



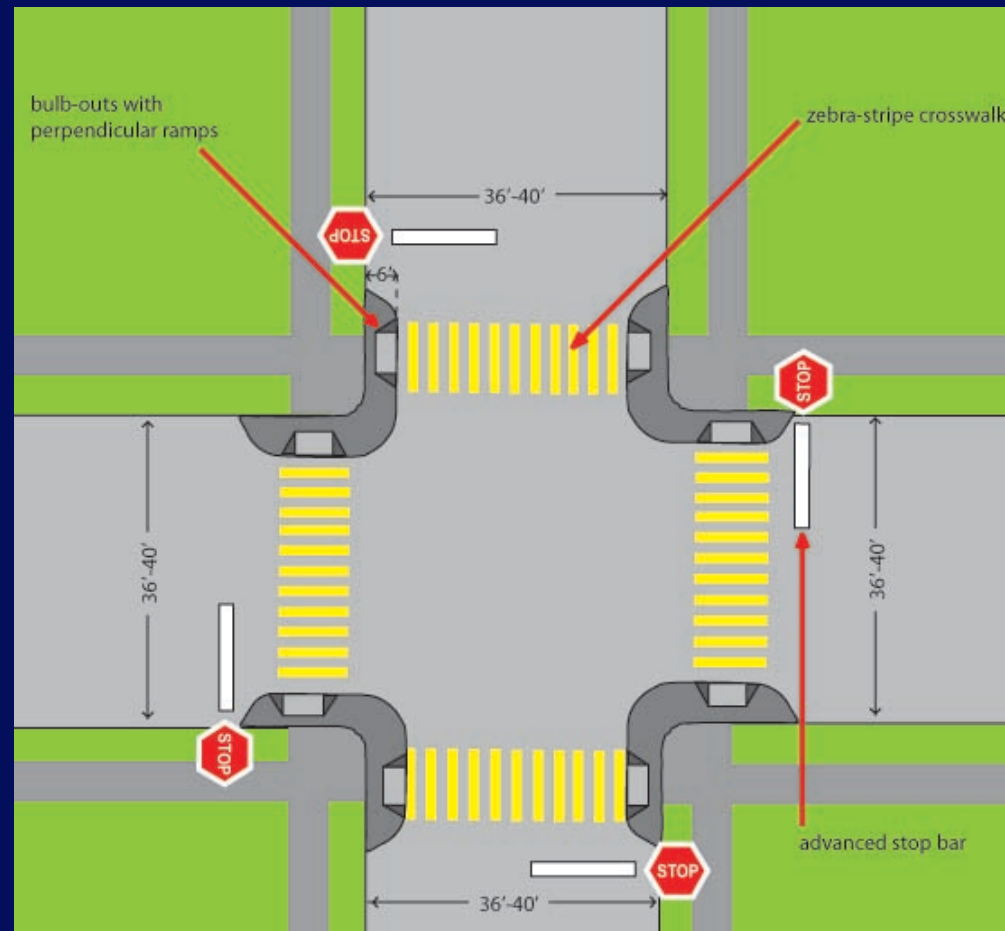
Elevated roadway allows open, airy undercrossing

Sample Site Plans

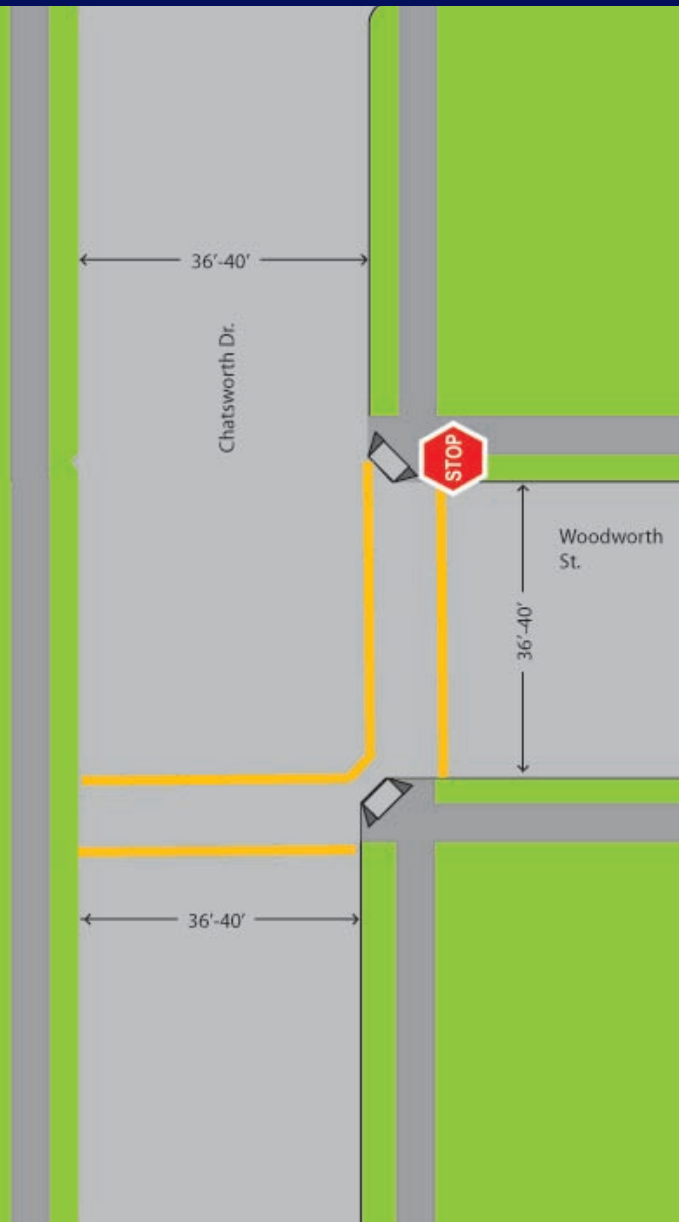
Existing



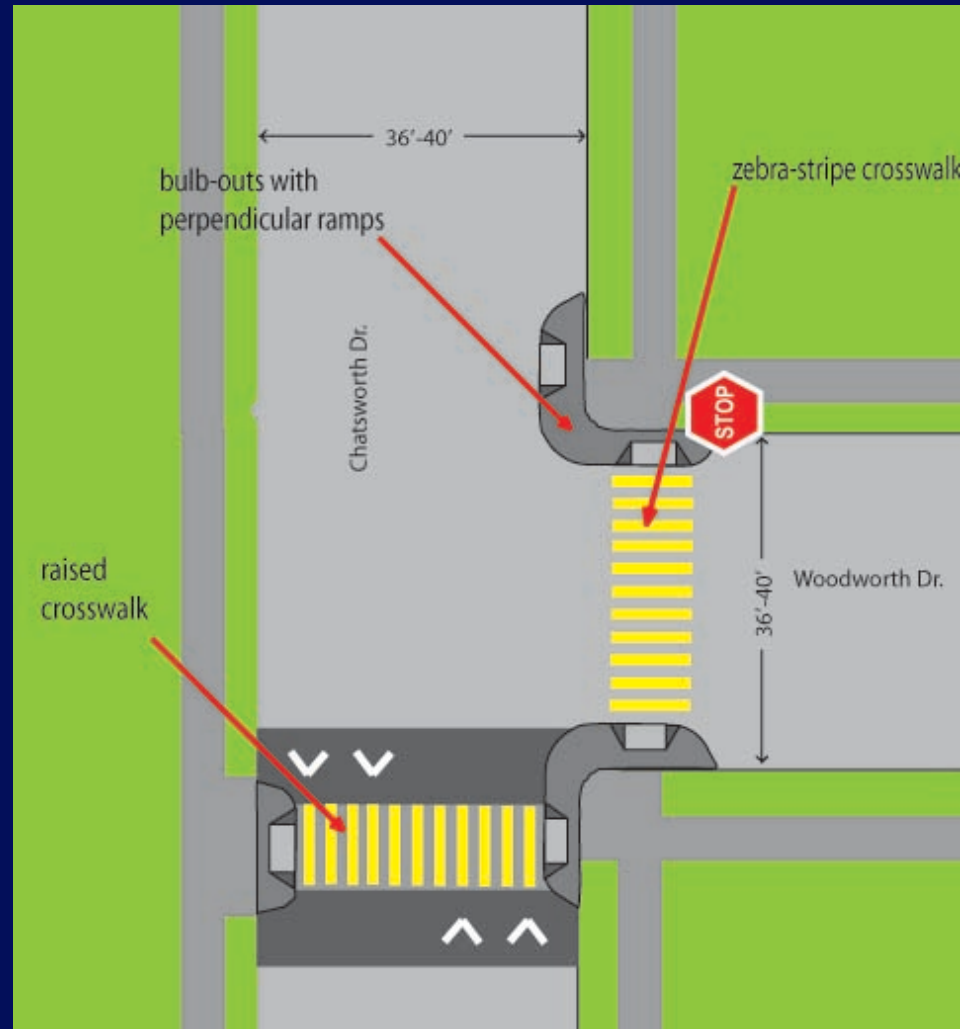
Proposed



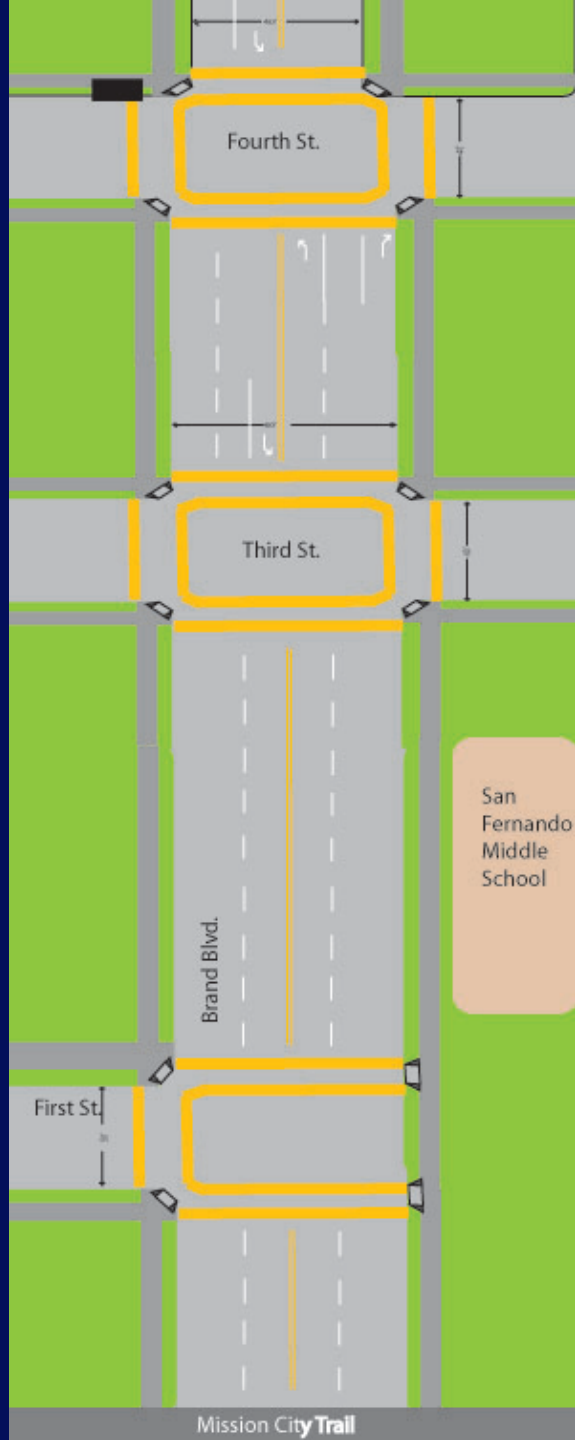
Existing



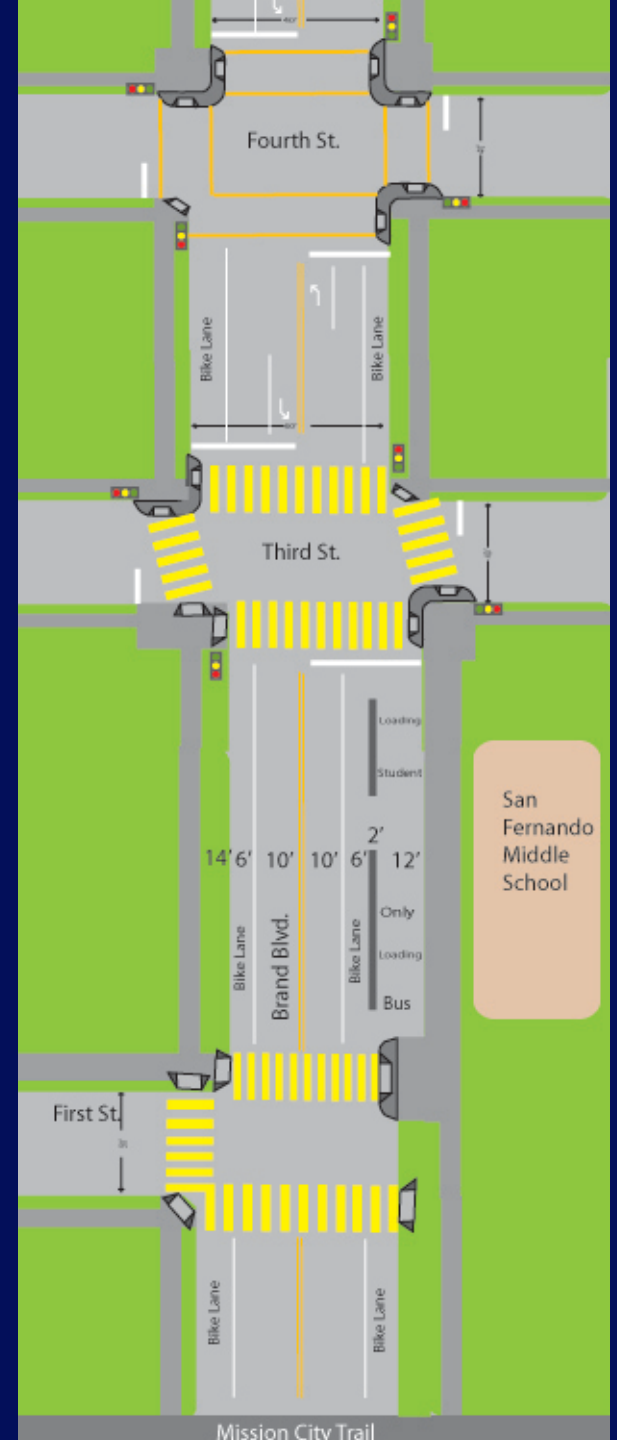
Proposed

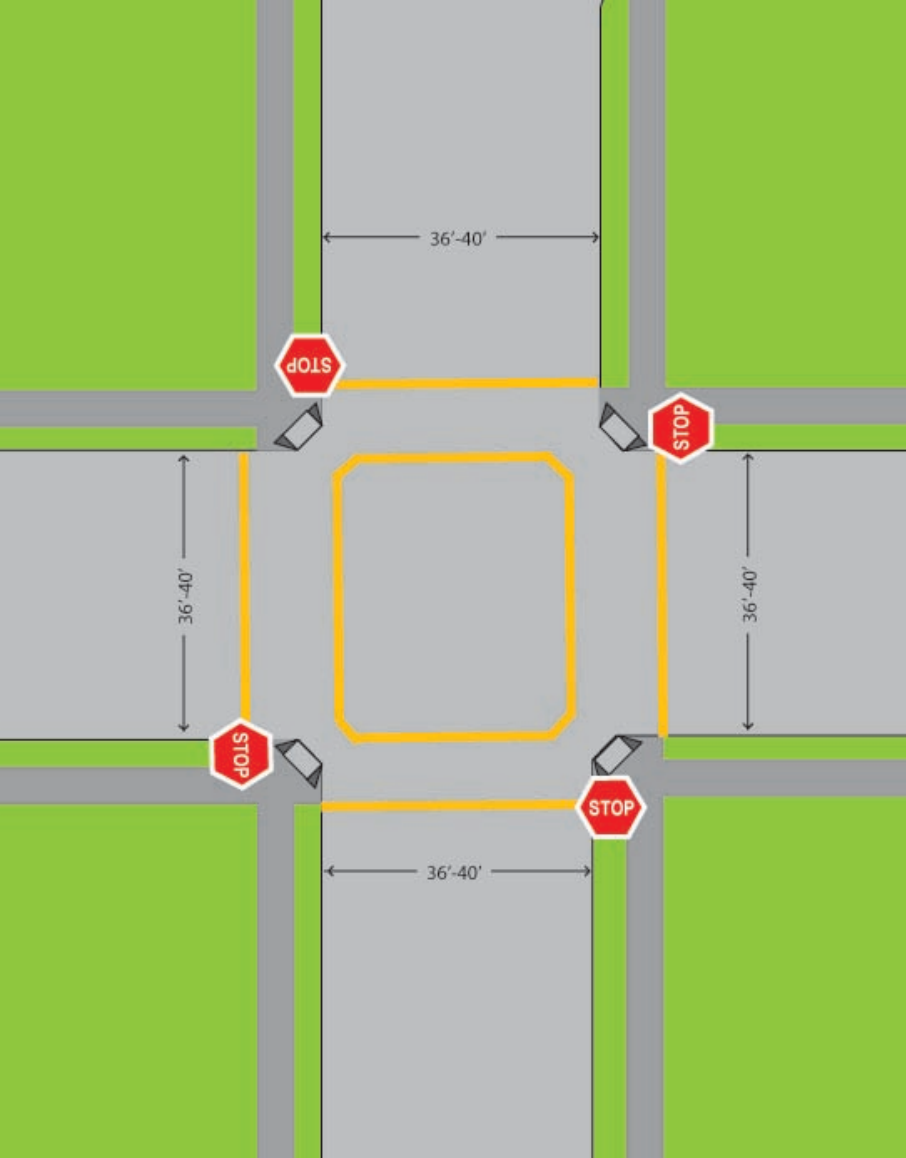


Existing

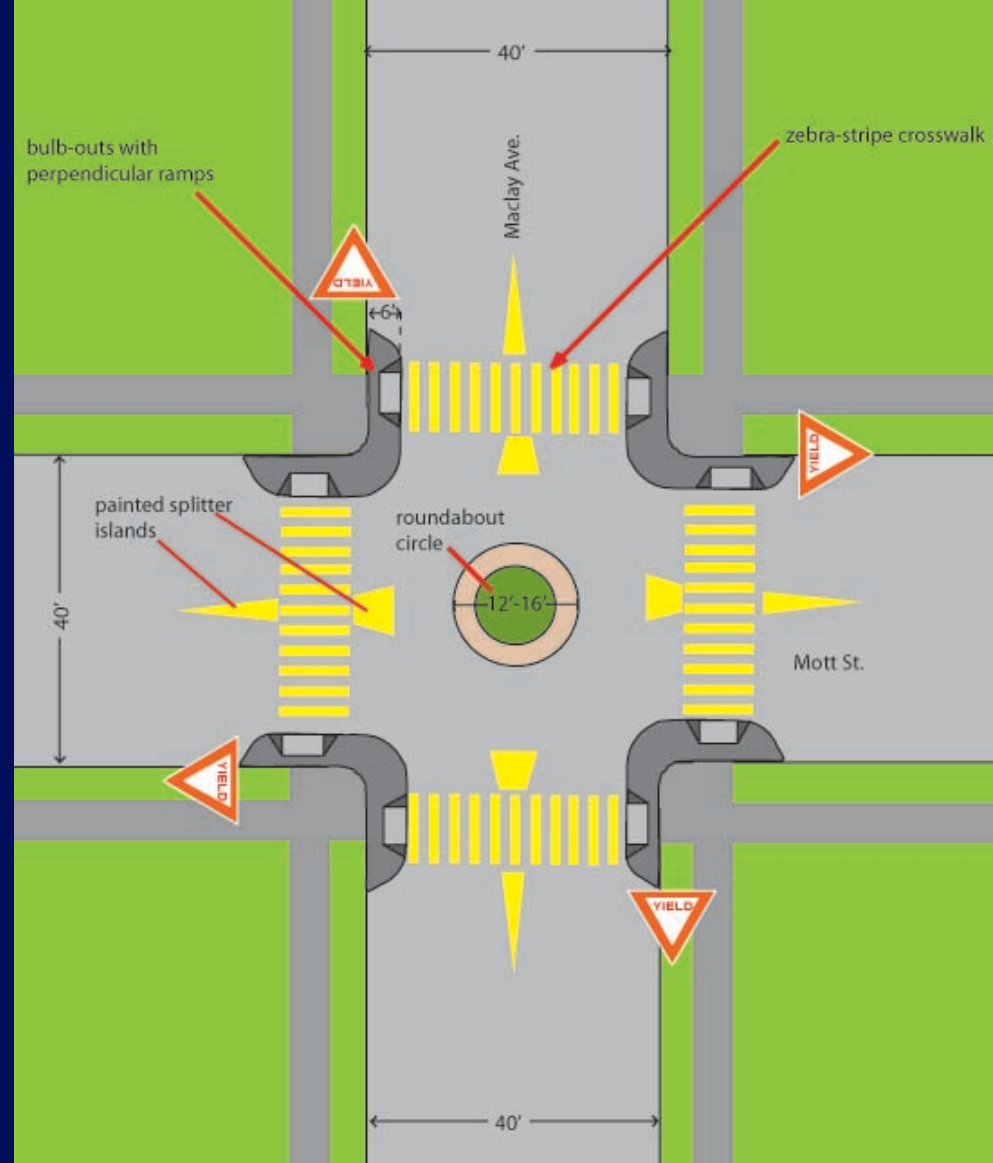


Proposed





Existing



Future

Foster Avenue

Vineland Avenue

Curb reduction

Advanced stop line

Perpendicular ramps with truncated domes

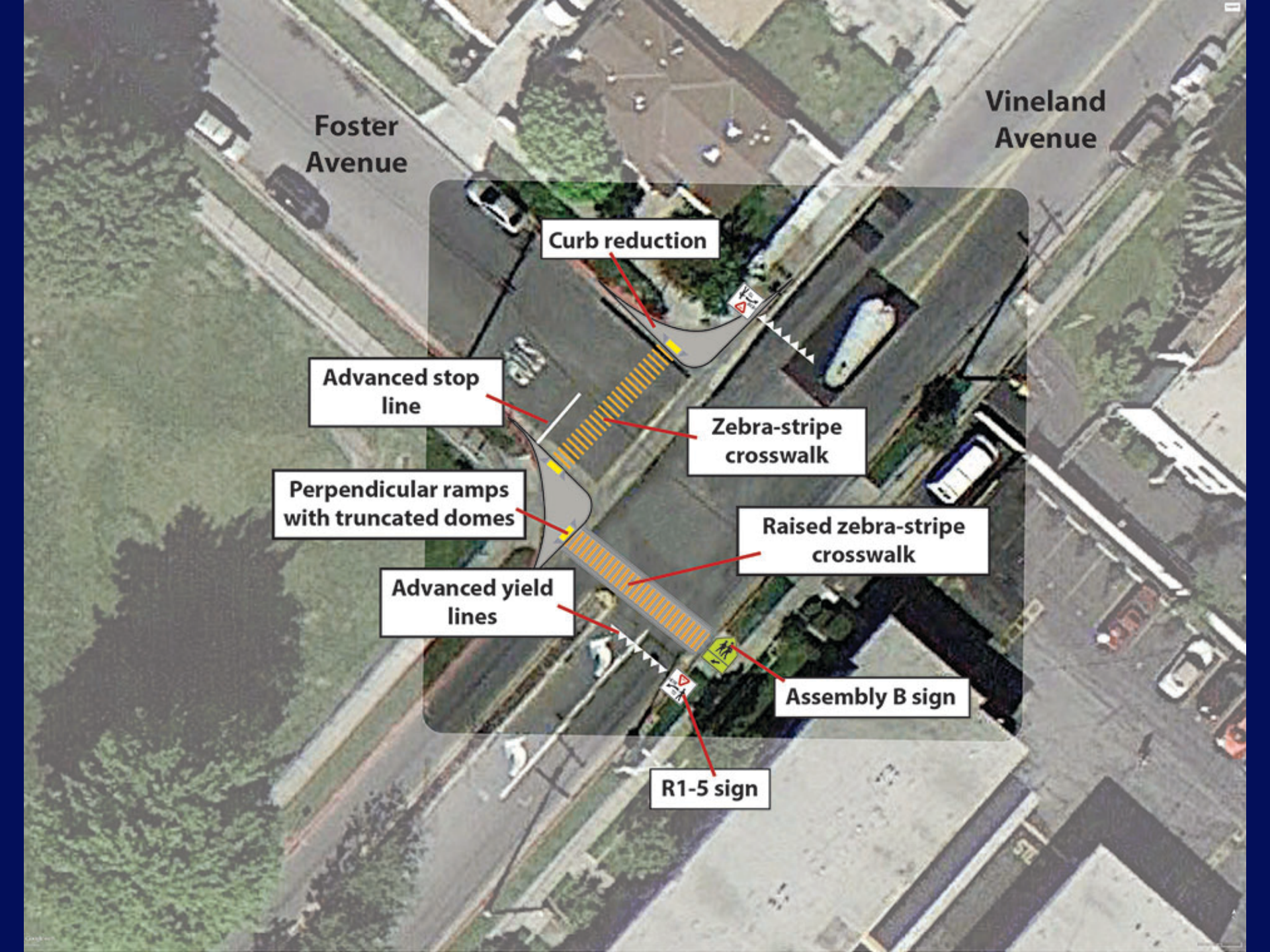
Advanced yield lines

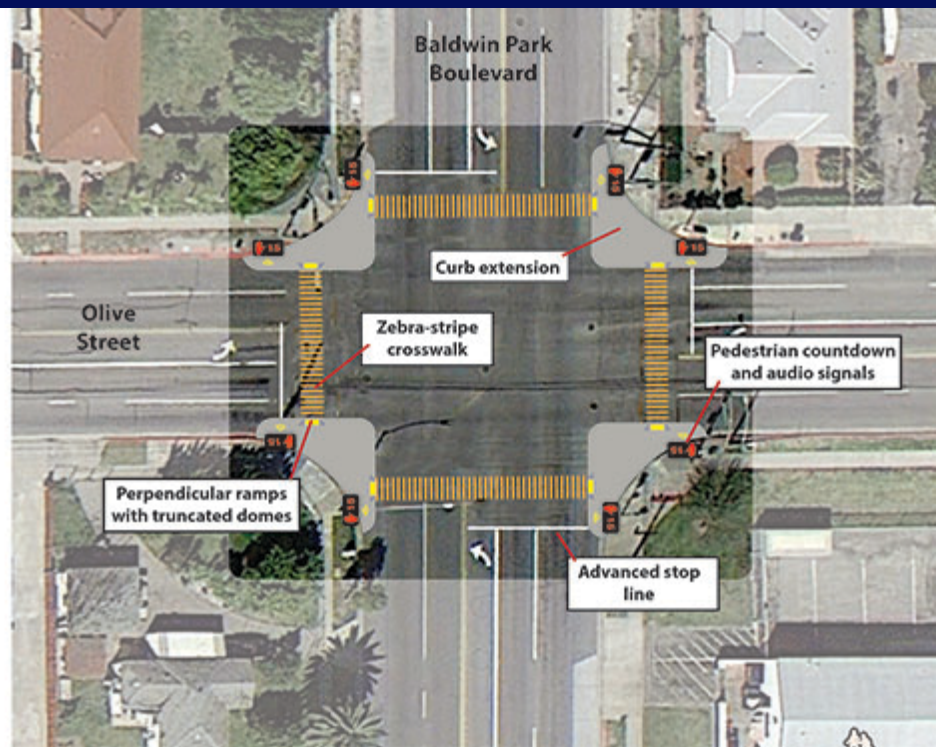
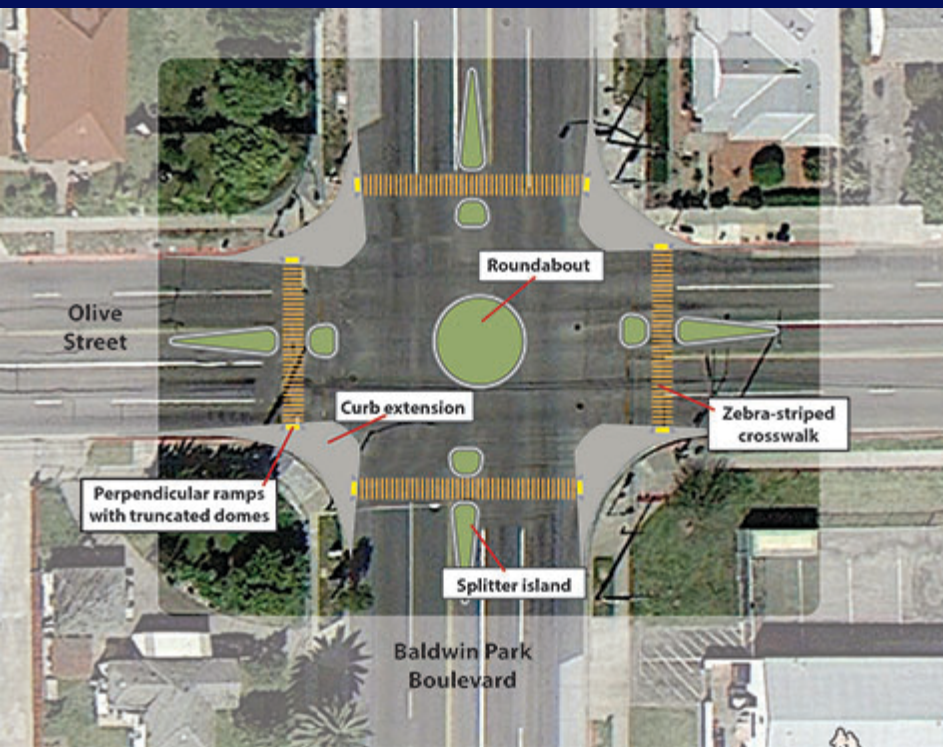
Zebra-stripe crosswalk

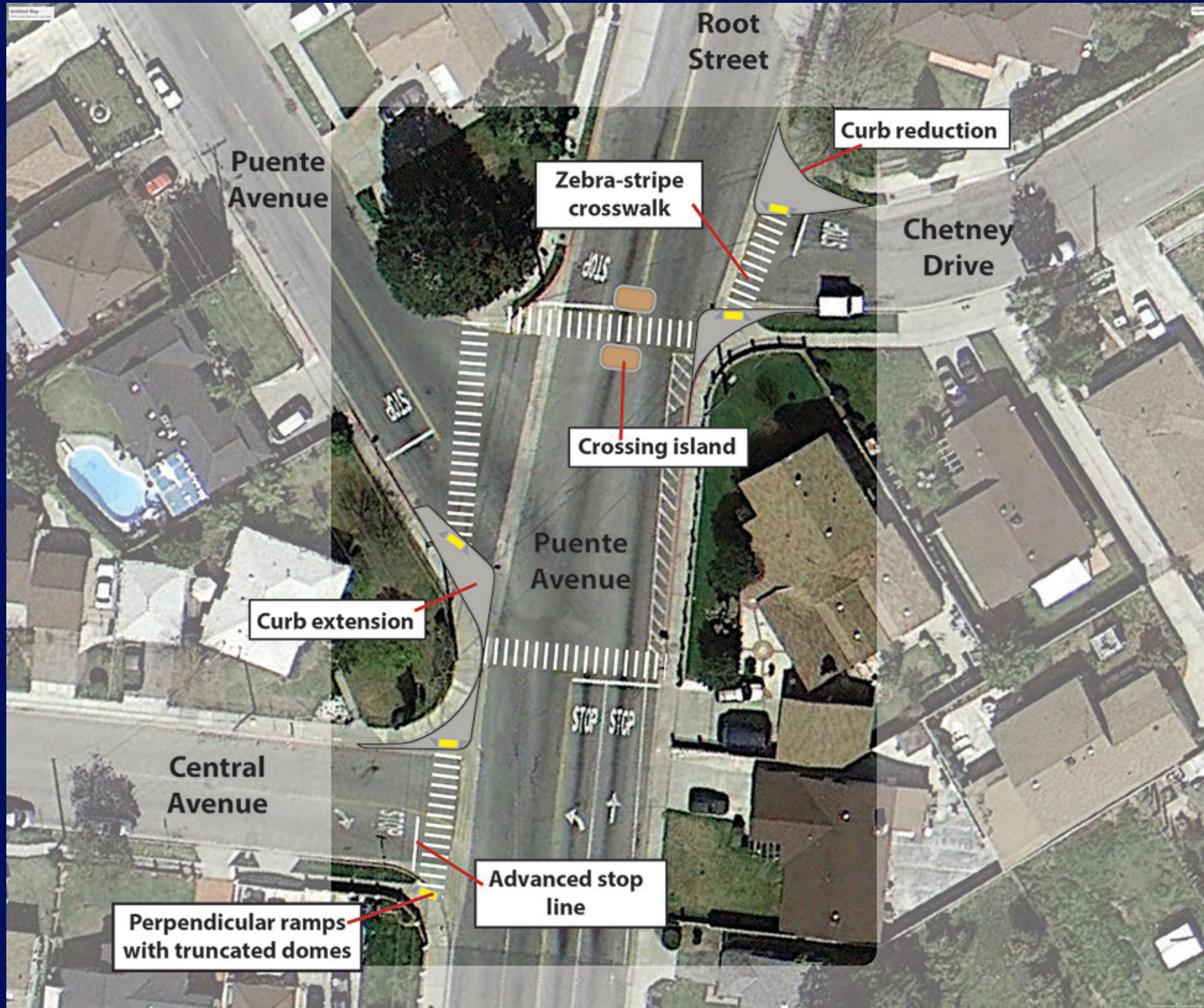
Raised zebra-stripe crosswalk

Assembly B sign

R1-5 sign









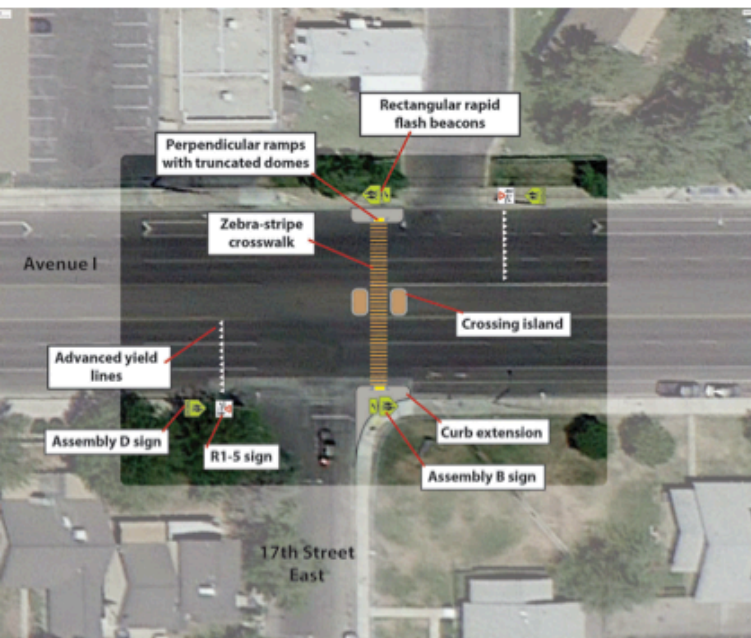
C2. 17th St. East & Kettering St.

Existing

- 4-way stop
- Yellow transverse crosswalks on the east and south legs
- Crossing guard

Proposed

- Add a yellow zebra-stripe crosswalk to all legs (4)
- Add advanced stop lines to all legs (4)
- Add curb extensions to all crossing faces (after new sidewalks are installed on the NW corner) (8)



C3. 17th St. & Ave. I

Existing

- No marked crosswalk

Proposed

- Add a yellow zebra-stripe crosswalk on the east leg (1)
- Add large curb extensions to both sides of the east leg crosswalk (2)
- Add advanced yield lines to crossing approaches of the east leg crosswalk (2)
- Add R1-5 signs to crossing approaches to the east leg crosswalk (2)
- Add Assembly D signs to crossing approaches to the east leg crosswalk (2)
- Add Assembly B signs to the east leg crosswalk (2)
- Add crossing islands to the east leg crosswalk (1 pair)
- Add pedestrian-activated rapid flash beacons to the east leg crosswalk (1 set)



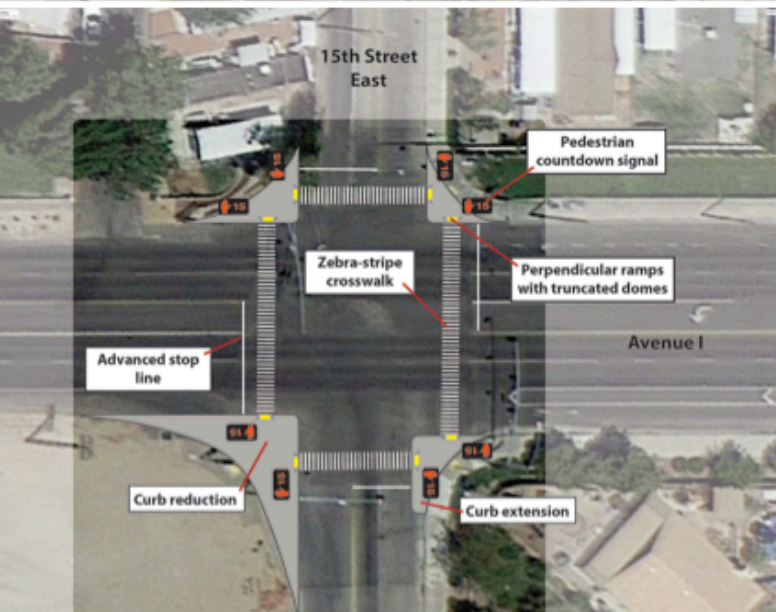
C6. 15th St. East & Kettering St.

Existing

- No marked crosswalk

Proposed

- Add a new zebra-stripe crosswalk on the south leg (1)
- Add advanced yield lines to both crossing approaches of the south leg crosswalk (2)
- Add R1-5 signs to both crossing approaches of the south leg (2)
- Add Assembly D signs to both crossing approaches of the south leg (2)
- Add Assembly B signs to the south leg crosswalk (2)
- Add crossing islands to the south leg crosswalk (1 pair)



C7. 15th St. East & Ave. I

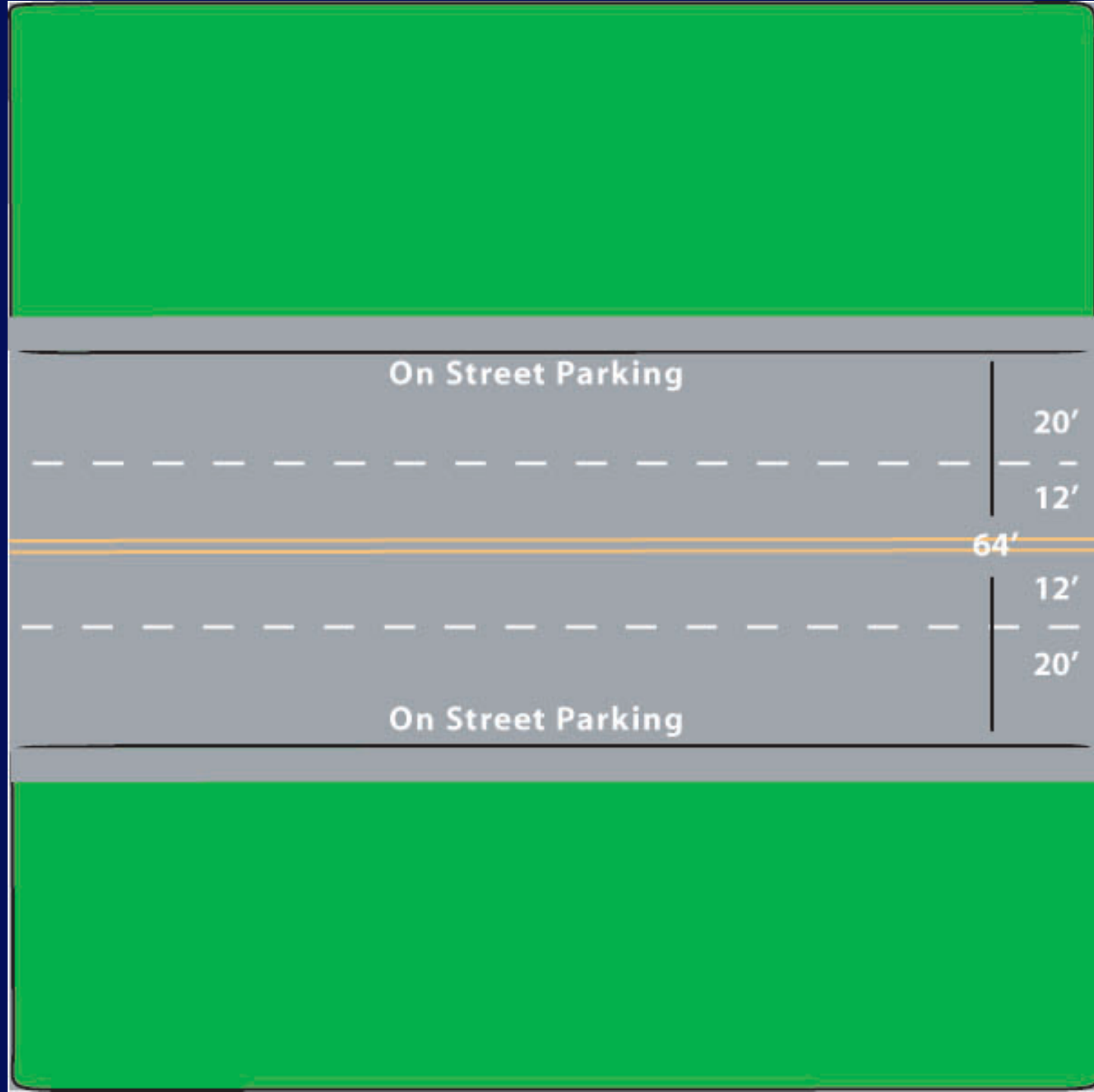
Existing

- Signalized intersection
- Transverse-line crosswalks on all legs
- Protected left-turns from Ave. I onto 15th St. East
- Crossing guard

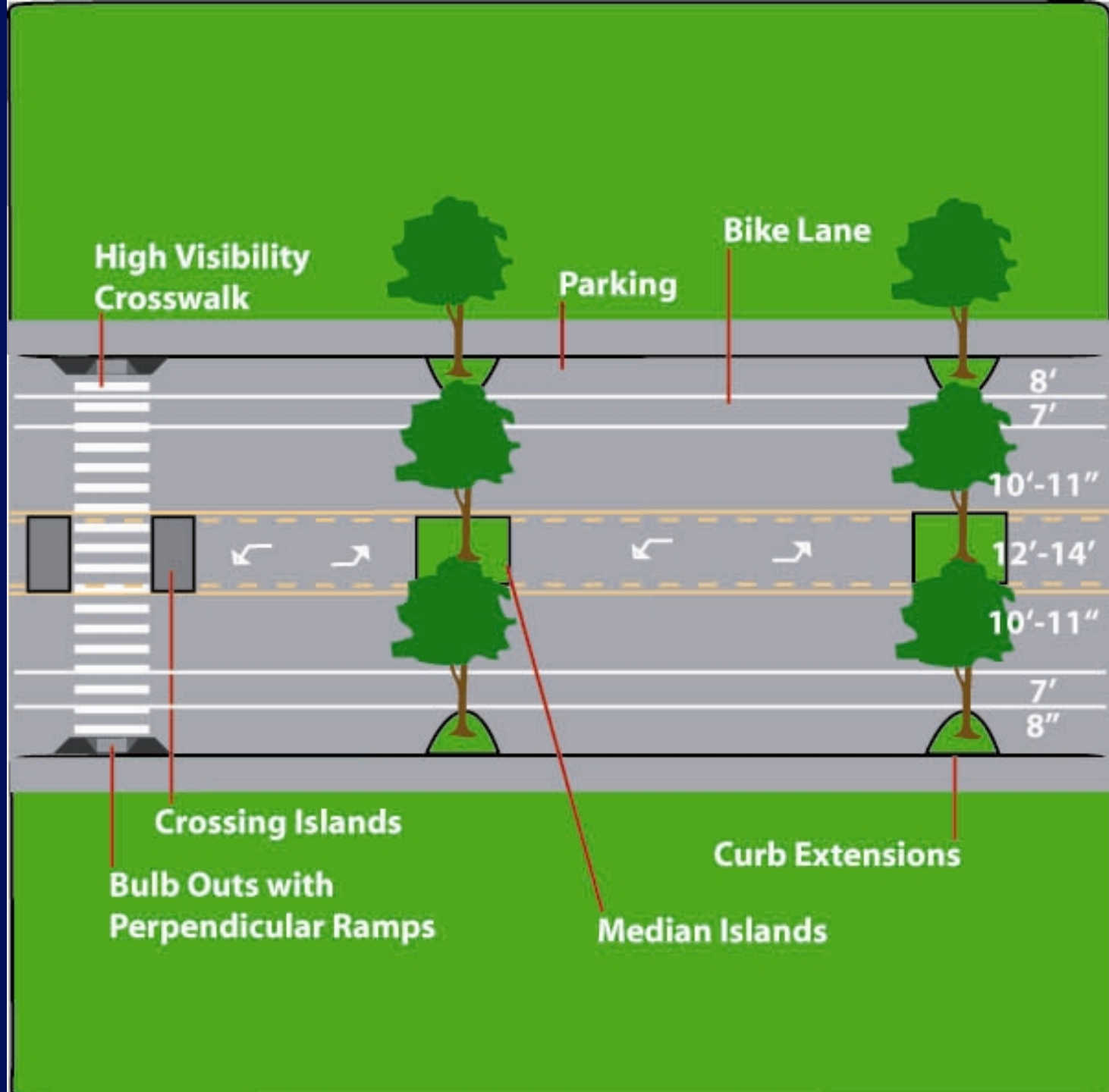
Proposed

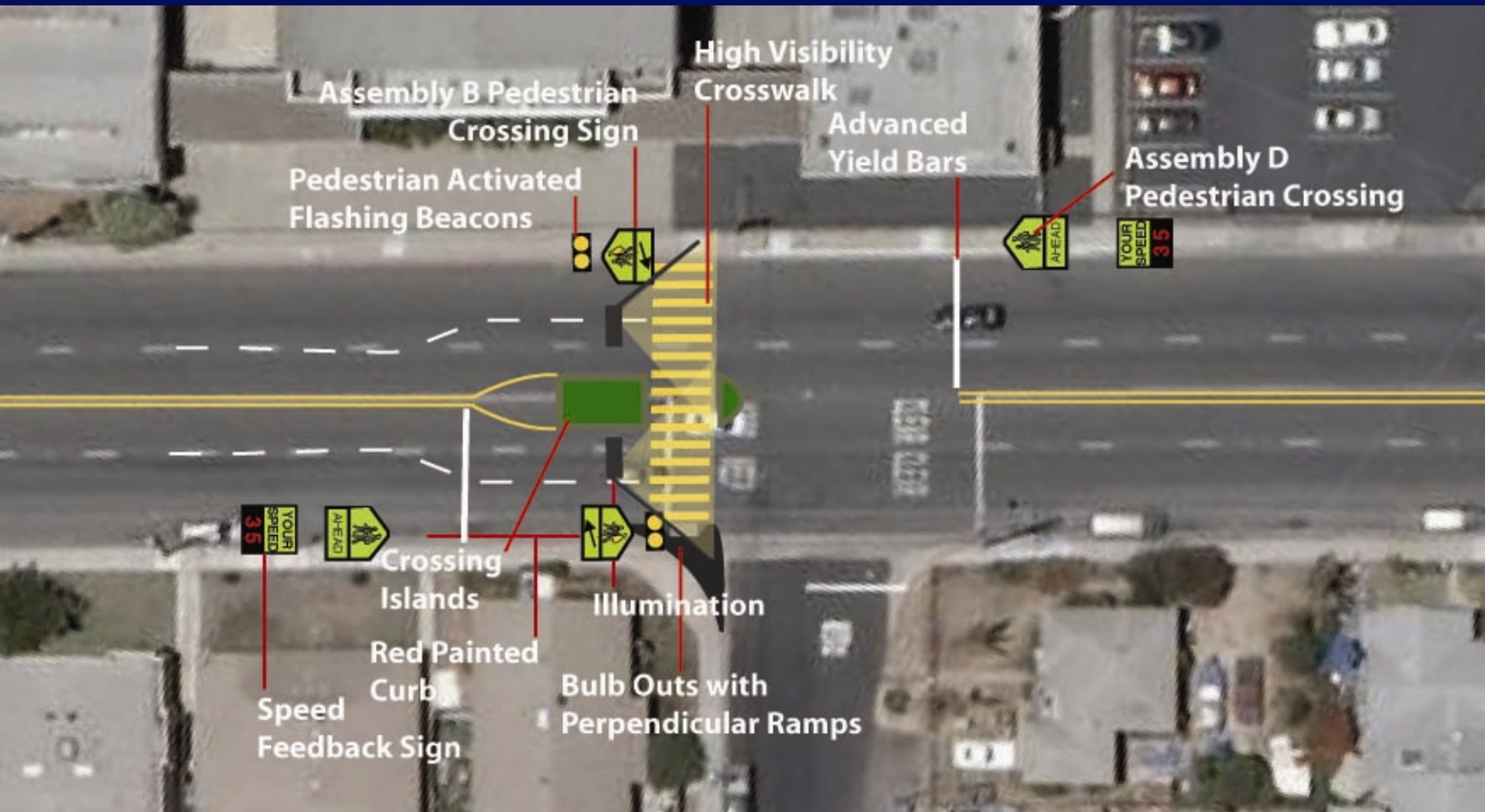
- Add a zebra-stripe crosswalk on all legs (4)
- Add an advanced stop line to the crosswalks on all legs (4)
- Add countdown signals to all crossings (8)
- Add a curb extension to the SE crossing face of Ave. I (1)
- Reduce the curb returns on the NW, NE, and SW corners (3)

Existing



Proposed













PROHIBITED
THIS PORTION OF THE STREET IS SUBJECT TO
CRUISING CONTROLS. REPETITIVE DRIVING
THROUGH THIS PORTION OF THE STREET WITHIN A
4-HOUR PERIOD AFTER WRITTEN NOTICE HAS
BEEN GIVEN IS **PROHIBITED**.
VIOLATORS SUBJECT TO FINES.
HPMC \$4-7.906 / VEHICLE CODE \$2100(K)

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Anniversary
Celebration

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Ciao Bella!

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