

Bicycle & Pedestrian Safety: Getting to Vision Zero



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Toole Design
Group

May 3, 2016

@tooledesign



Principle #1: It's all about SPEED



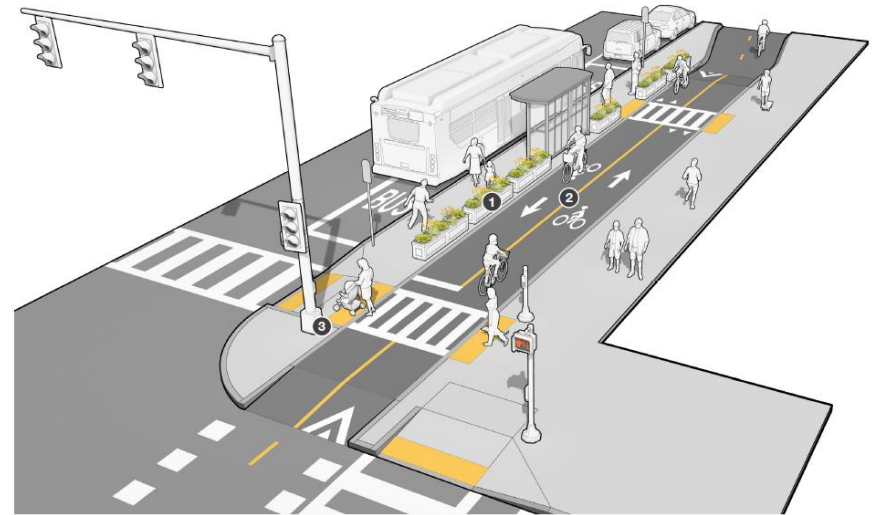
It's about Look and Feel of the Road



“Addressing the issue through law enforcement alone often leads to temporary compliance at a significant cost. A more permanent way to reinforce the need to reduce speed is to change the look and feel of the road by installing traffic calming treatments that communicate to drivers that the function of the roadway is changing.”

-- FHWA TechBrief: Traffic Calming on Main Roads Through Rural Communities

A Way to Design Streets that are Self-enforcing



Principle #2: Inclusive Design



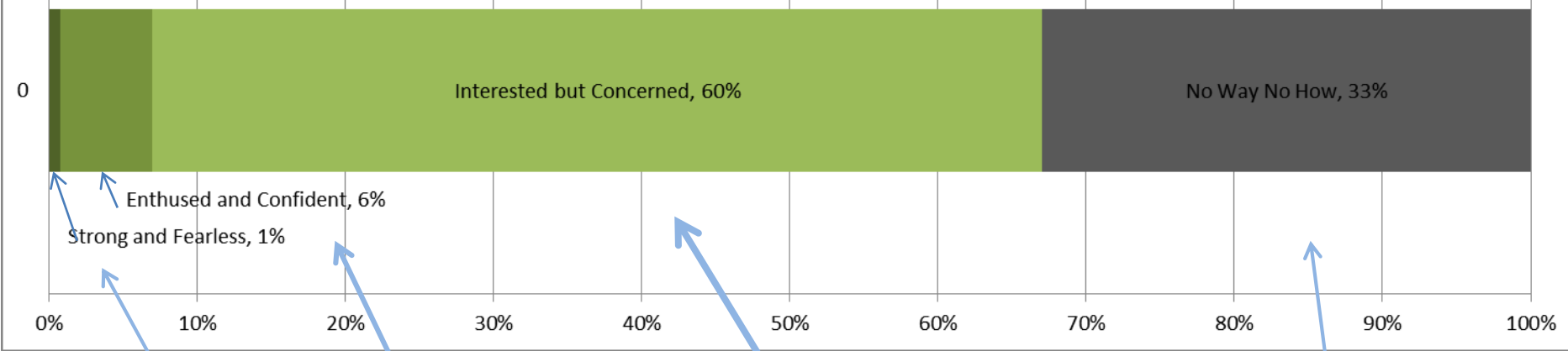
We are All Pedestrians

Universal Design





Types of Bicyclists – City of Portland



Strong & Fearless



Enthused & Confident



Interested but Concerned

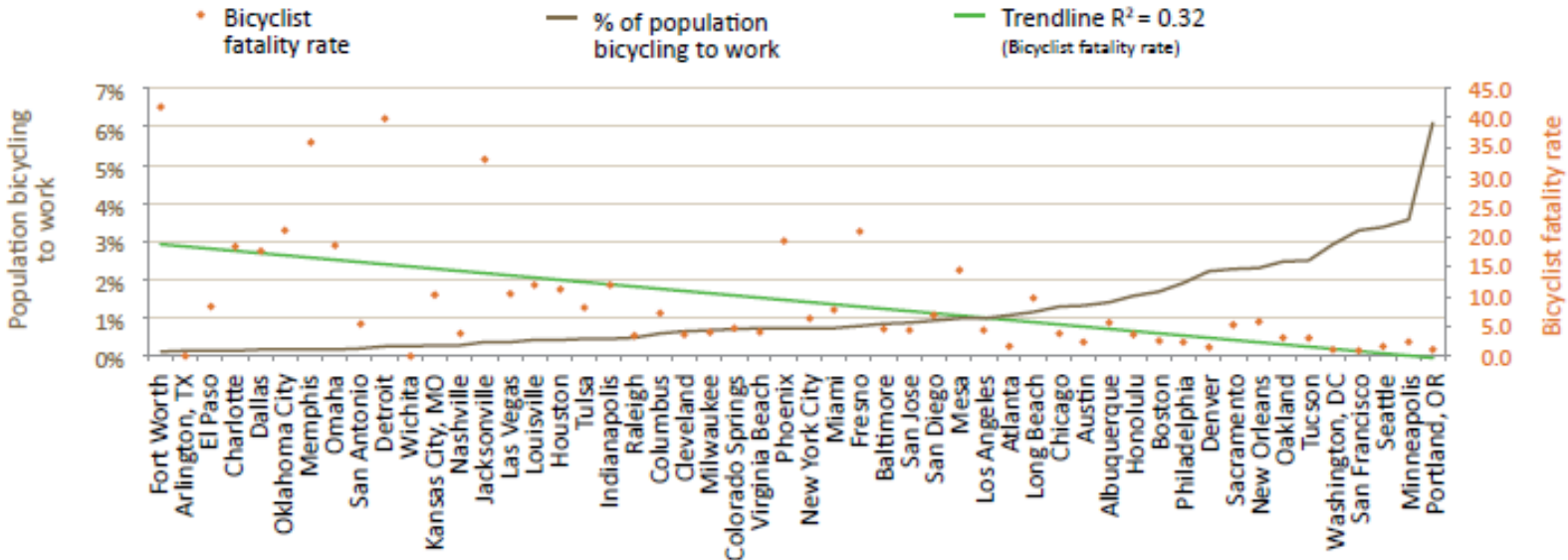


Not Interested



Principle #3: Fatalities go down when use goes up

Comparing Bicycling to Work and Bicyclist Fatality Rates in Large Cities

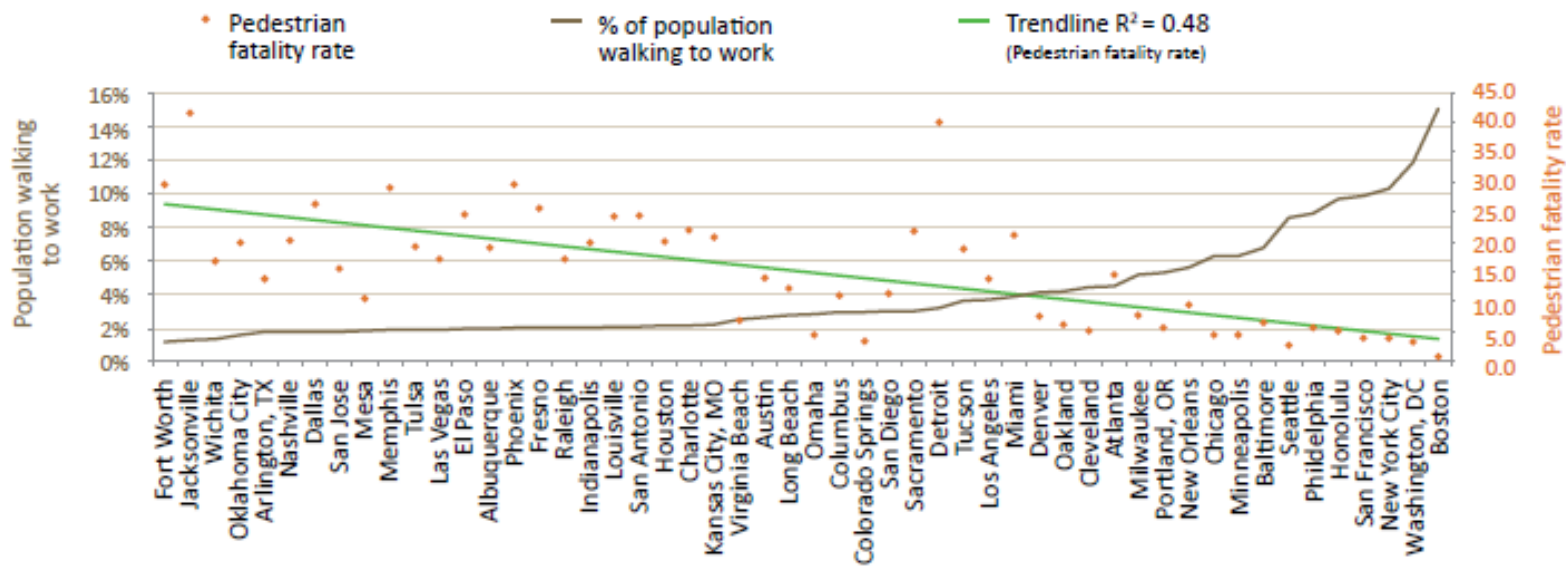


Sources: ACS 2009–2011, FARS 2009–2011



Fatalities go down when use goes up

Comparing Walking to Work and Pedestrian Fatality Rates in Large Cities



Sources: ACS 2009–2011, FARS 2009–2011

Principle #4: Design for Pedestrians First, then Bicyclists



Principle #5: Use FHWA CMFs to Make Decisions



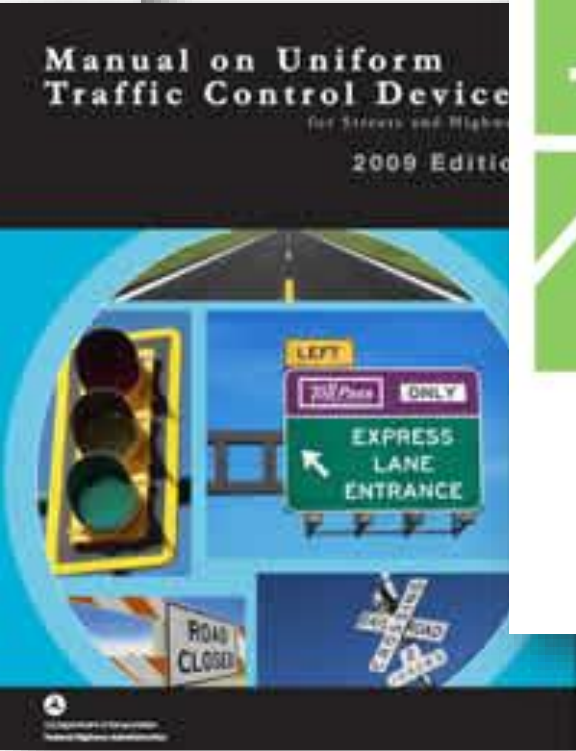
A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site.

<http://www.cmfclearinghouse.org>



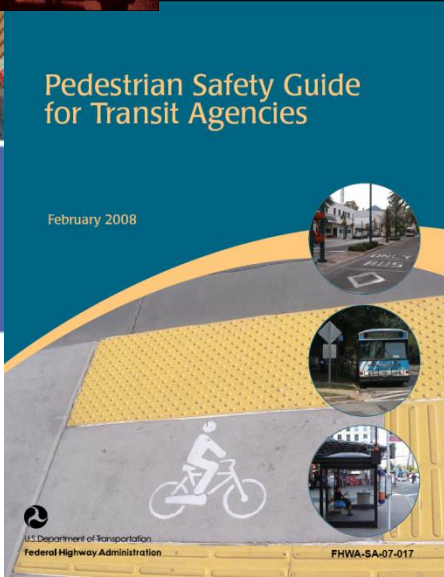
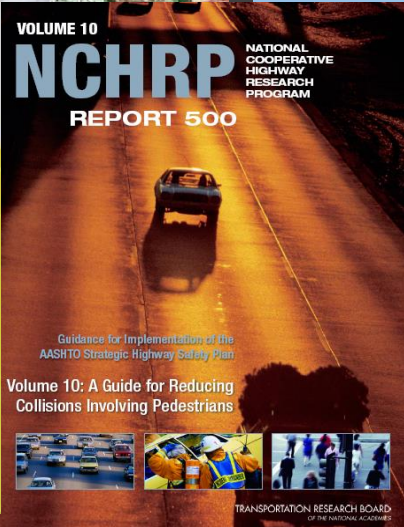
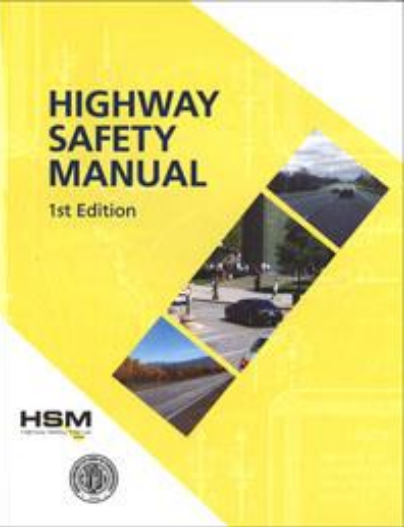
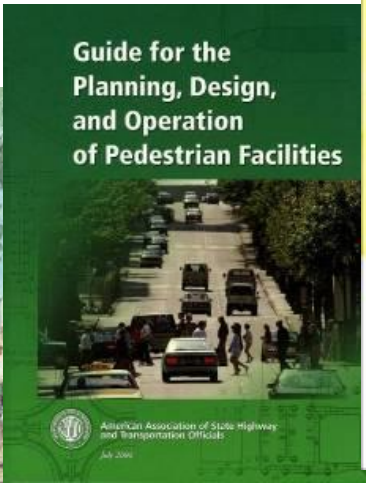
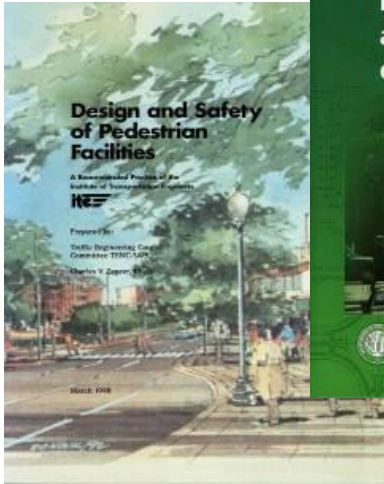
Principle #6: National Design Resources

**Guide for the Development of
Bicycle Facilities**
2012 • Fourth Edition



ACHIEVING MULTIMODAL NETWORKS
APPLYING DESIGN FLEXIBILITY
& REDUCING CONFLICTS
U.S. Department of Transportation
Federal Highway Administration
APRIL 2016

Resources



- PBIC: www.walkinginfo.org
- FHWA: safety.fhwa.dot.gov
- NHTSA: nhtsa.dot.gov
- ITE: www.ite.org
- AASHTO/NCHRP: safety.transportation.org

Principle 7: It's Federal Policy



Safer People, Safer Streets:

Summary of U.S. Department of
Transportation Action Plan to Increase
Walking and Biking and Reduce
Pedestrian and Bicyclist Fatalities

September 2014



*“The Department will promote the development of **multimodal networks** which include **interconnected** pedestrian/and or bicycle transportation facilities that allow people of **all ages and abilities** to safely and conveniently get where they want to go.”*

- USDOT, Sept 2014

Principle #8: Use Engineering judgment



“The treatments described reflect typical situations; local conditions may vary and engineering judgment should be applied.”



Engineering

- **Data Collection**
- Walking Along the Street
- Walking Across the Street
- Intersection Geometry
- Signals
- On-Street Bicycle Facilities

Land Use & Site Design

Education & Enforcement

Performance Measures

Principles of Collaboration



Types of Safety Projects



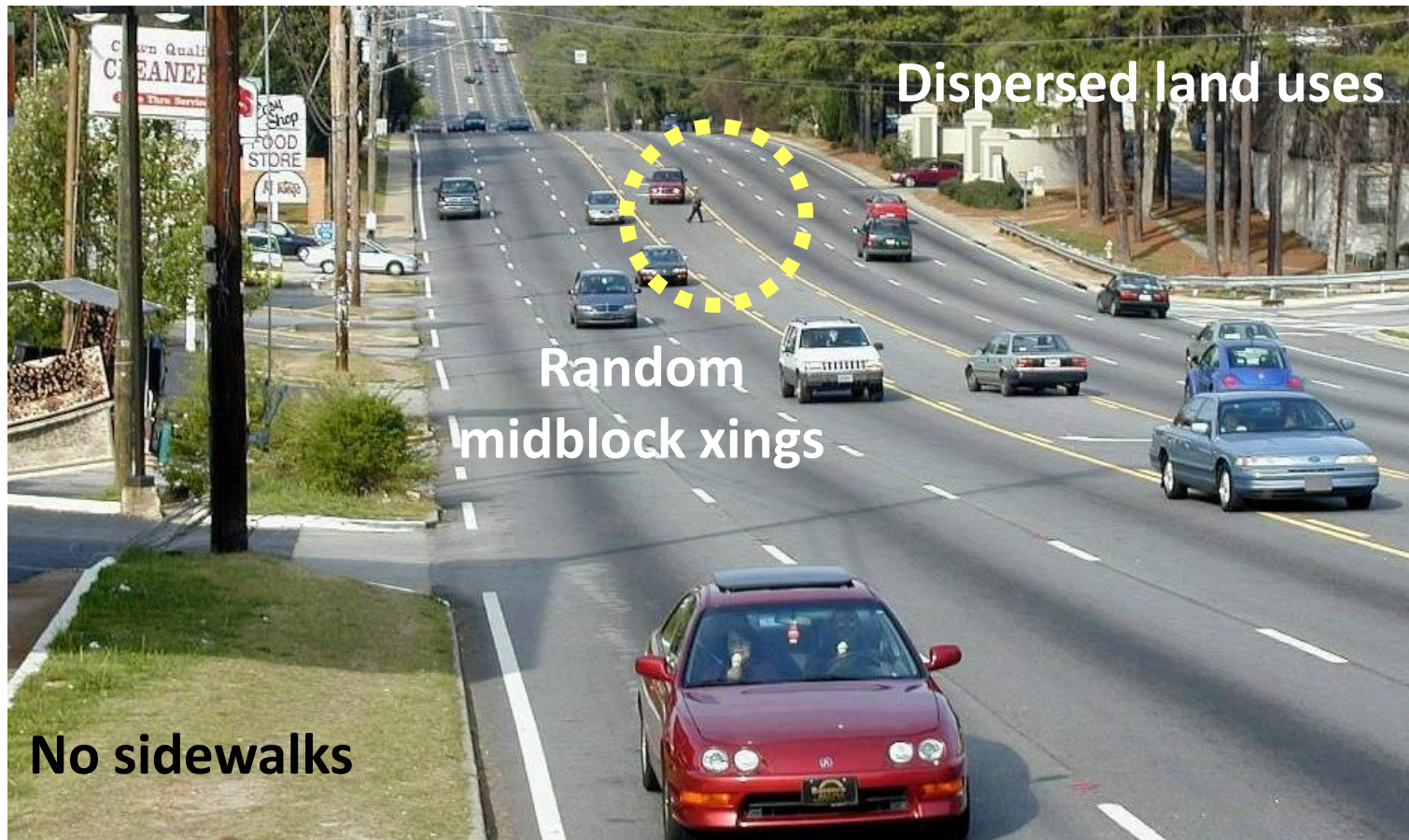
1. Spot Locations (individual intersections and non-intersections)
2. Corridors ($\frac{1}{2}$ mile to 5 or more miles in length)
3. Targeted Areas (neighborhood, business district, or large area where pedestrian crashes are high)
4. Entire Jurisdictions (addressed through system-wide changes)

Types of Safety Projects: Spot Locations



EG: Single intersection with high crash rate

Types of Safety Projects: Corridors



Example: Long corridor with high crash rate

Corridor Solutions Are Repeatable



Corridor Solutions Are Repeatable



Types of Safety Projects: Entire Jurisdiction

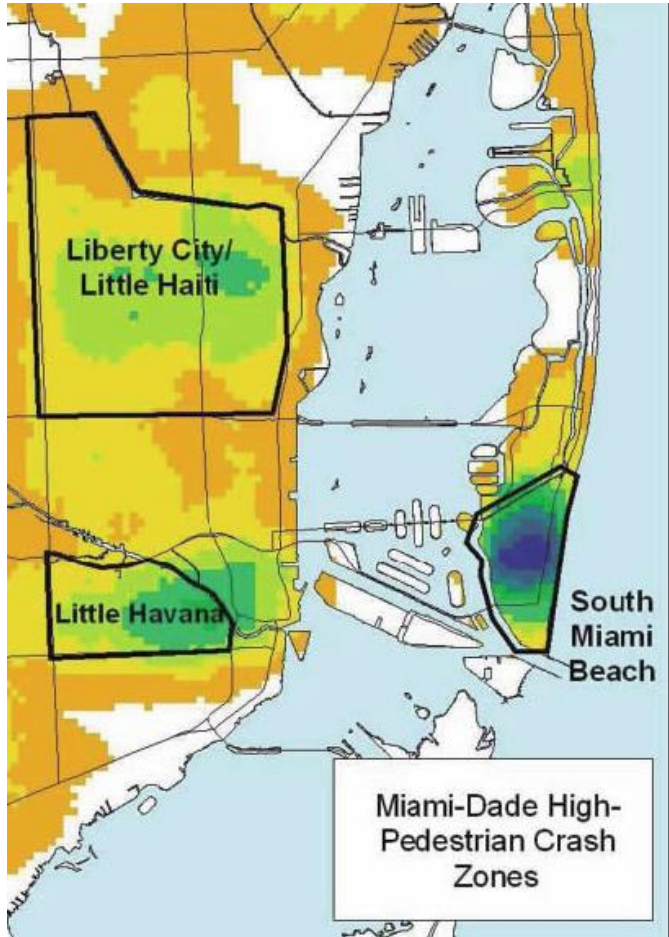
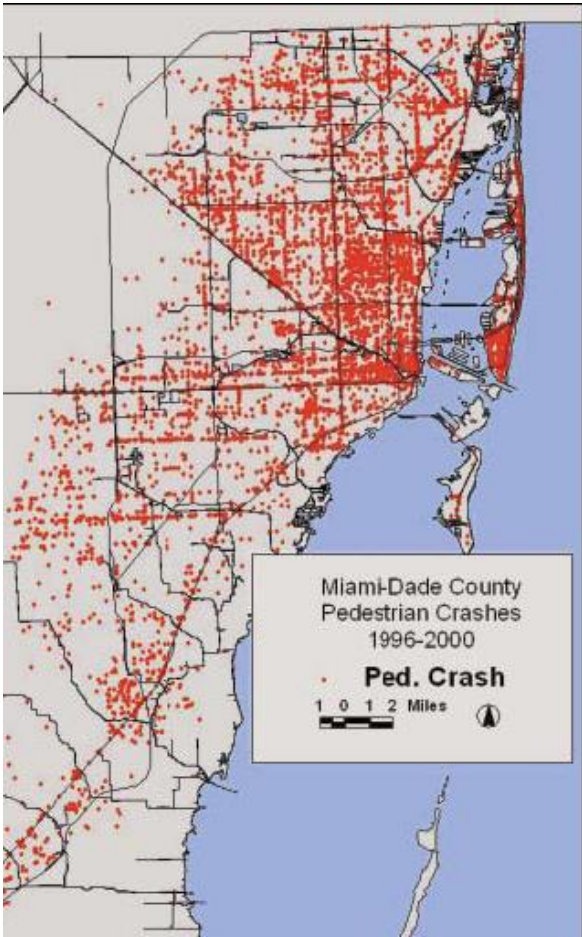


- Example: Lack of ped heads at signals

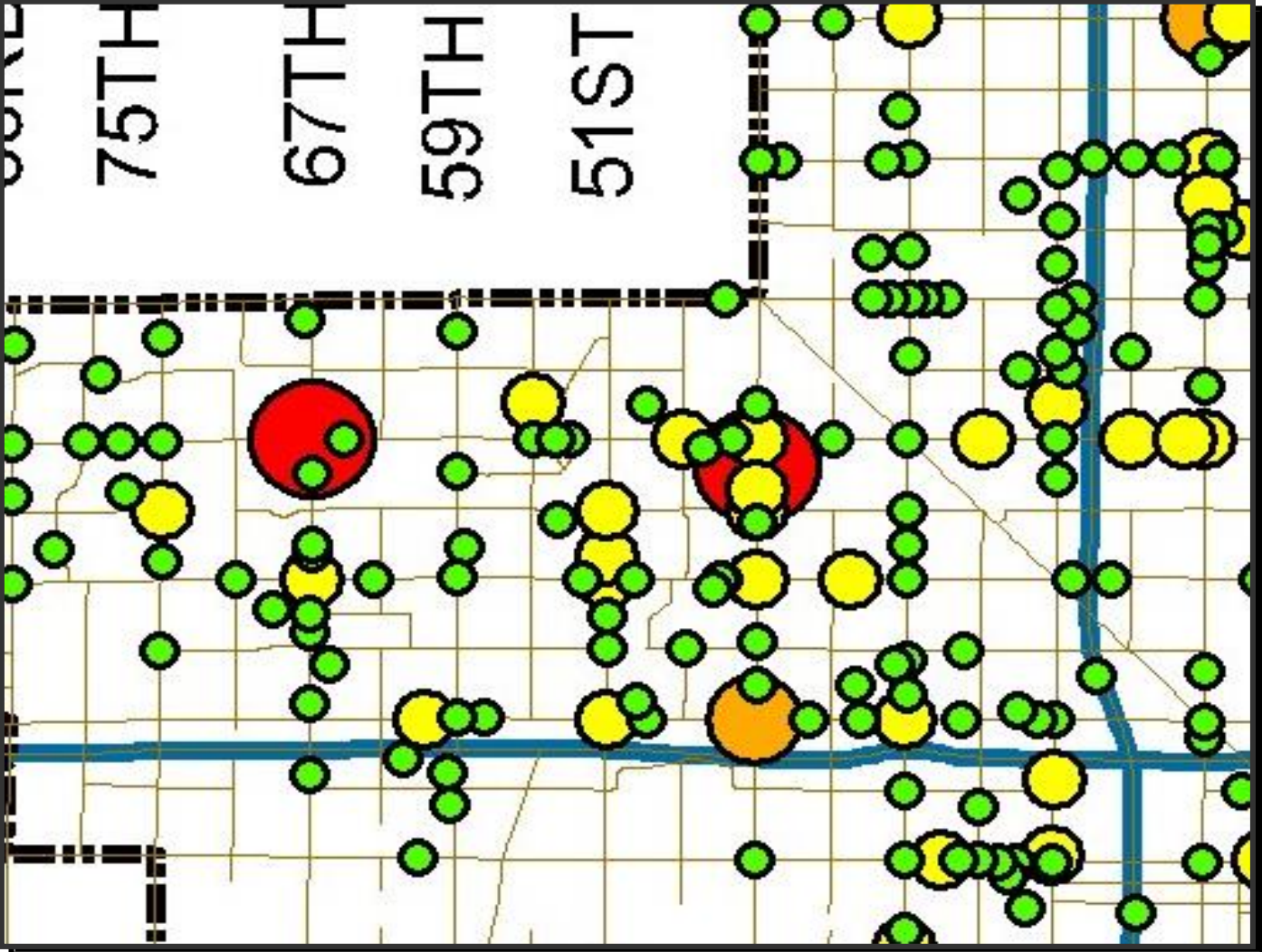




Plot crashes on a map: Area-wide problem



Plot crashes on a map: Area-wide problem





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Shoulders improve safety for all users

- For pedestrians: a place to walk
- 10 TO 15% OF ALL CRASHES: CMF = 0.3 (CRF = 70%)



Benton Co. OR

6' width preferred



Sidewalk Widths

- 5 feet necessary for two people to walk comfortably side by side or to pass each other; 6' preferred



Henderson, NV

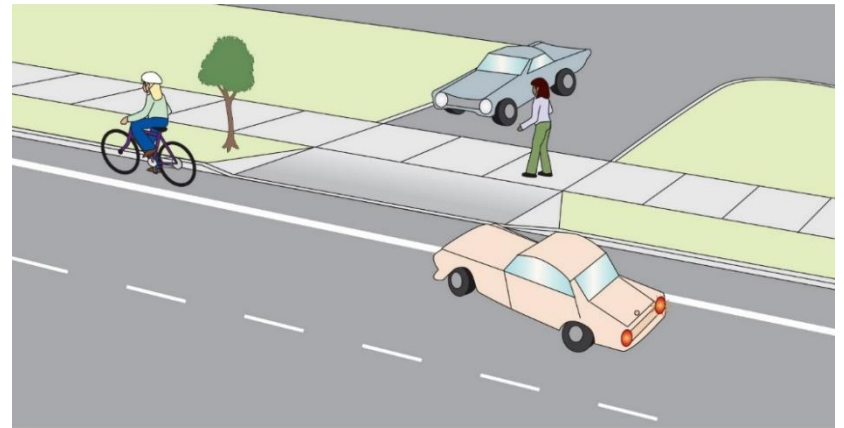
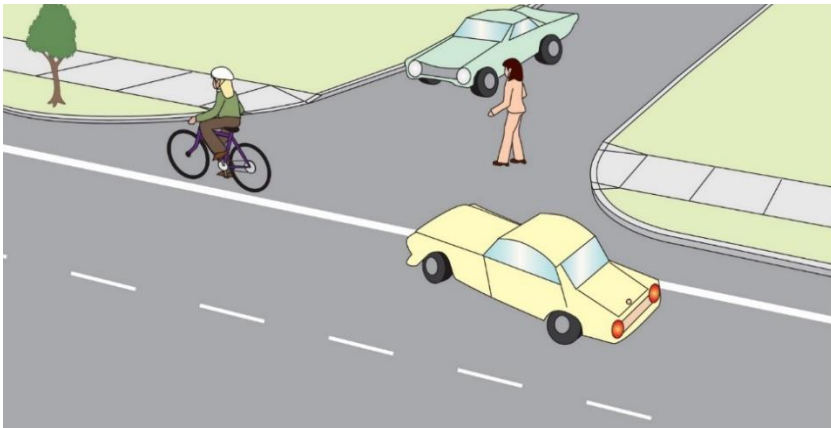
Discussion: Why are sidewalks on one side not OK?



Brawley CA

- Answer: Pedestrians walk in street, or cross twice

Driveways - Good Engineering Invites Right Use



Curb Zones Matter



- Why the curb zone matters: Mountable curbs are inappropriate on local streets



Sacramento



Sidewalks Need Buffers

4 Types of Buffers

- Planting strip
- Parked cars
- Bike Lane
- Furniture Zone





Curbs & sidewalks slow traffic more than speed sign

- Sidewalks define an urban street



Coburg OR



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Why are marked crosswalks provided



1. To indicate to pedestrians where to cross
2. To indicate to drivers where to expect pedestrians
3. At mid-block locations, crosswalk markings legally establish the crosswalk.



Safety research - Findings

Three Significant Variables

1. Speed
2. Number of Lanes
3. ADT

Median Crossings

1. Significant crash reduction
2. Cut number of lanes in half
3. Reduces ADT by half





Crosswalk installation recommendations

Table 11. Recommendations for installing marked crosswalks and other needed pedestrian improvements at uncontrolled locations.*

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT < 9,000			Vehicle ADT >9,000 to 12,000			Vehicle ADT >12,000–15,000			Vehicle ADT > 15,000		
	Speed Limit**											
	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)
Two lanes	C	C	P	C	C	P	C	C	N	C	P	N
Three lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multilane (four or more lanes) with raised median***	C	C	P	C	P	N	P	P	N	N	N	N
Multilane (four or more lanes) without raised median	C	P	N	P	P	N	N	N	N	N	N	N

C = Compliant
P = Possibly compliant
N = Not compliant. Markings should not be installed without additional safety treatments



Challenge – Criteria not met



Zegeer Study – Obligation to get pedestrians safety across the street

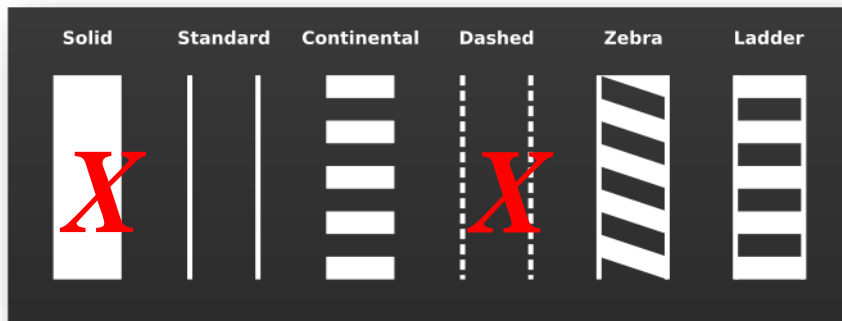




Crosswalk Markings

'Standard' Markings

- Locations with positive traffic control
- Less preferred at uncontrolled locations

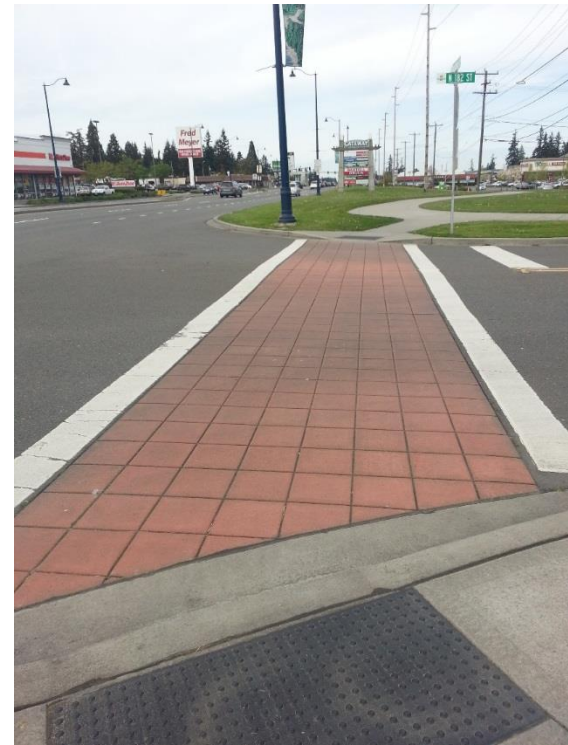


High Visibility Markings

- Uncontrolled Locations
- School Crossings (residential streets)



Challenges





Engineering

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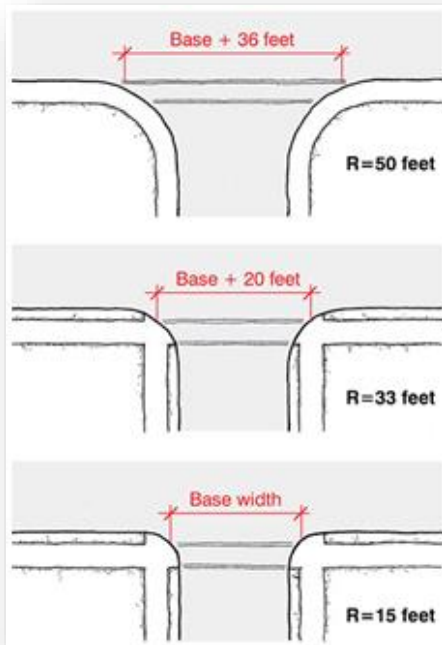


Intersection Geometrics marked Crosswalks & Ramps

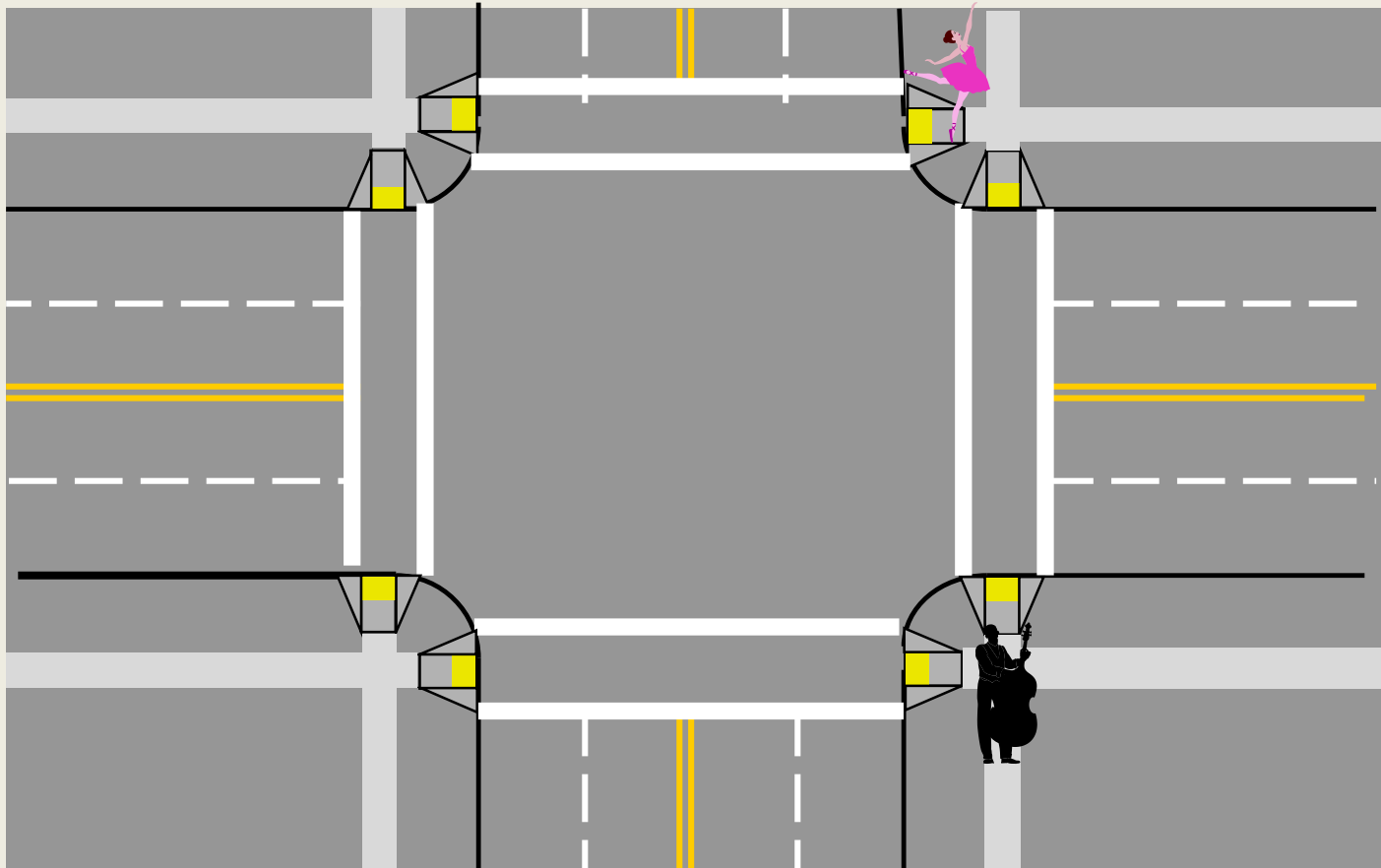


Larger Curb Radii
Increase the Exposure Time

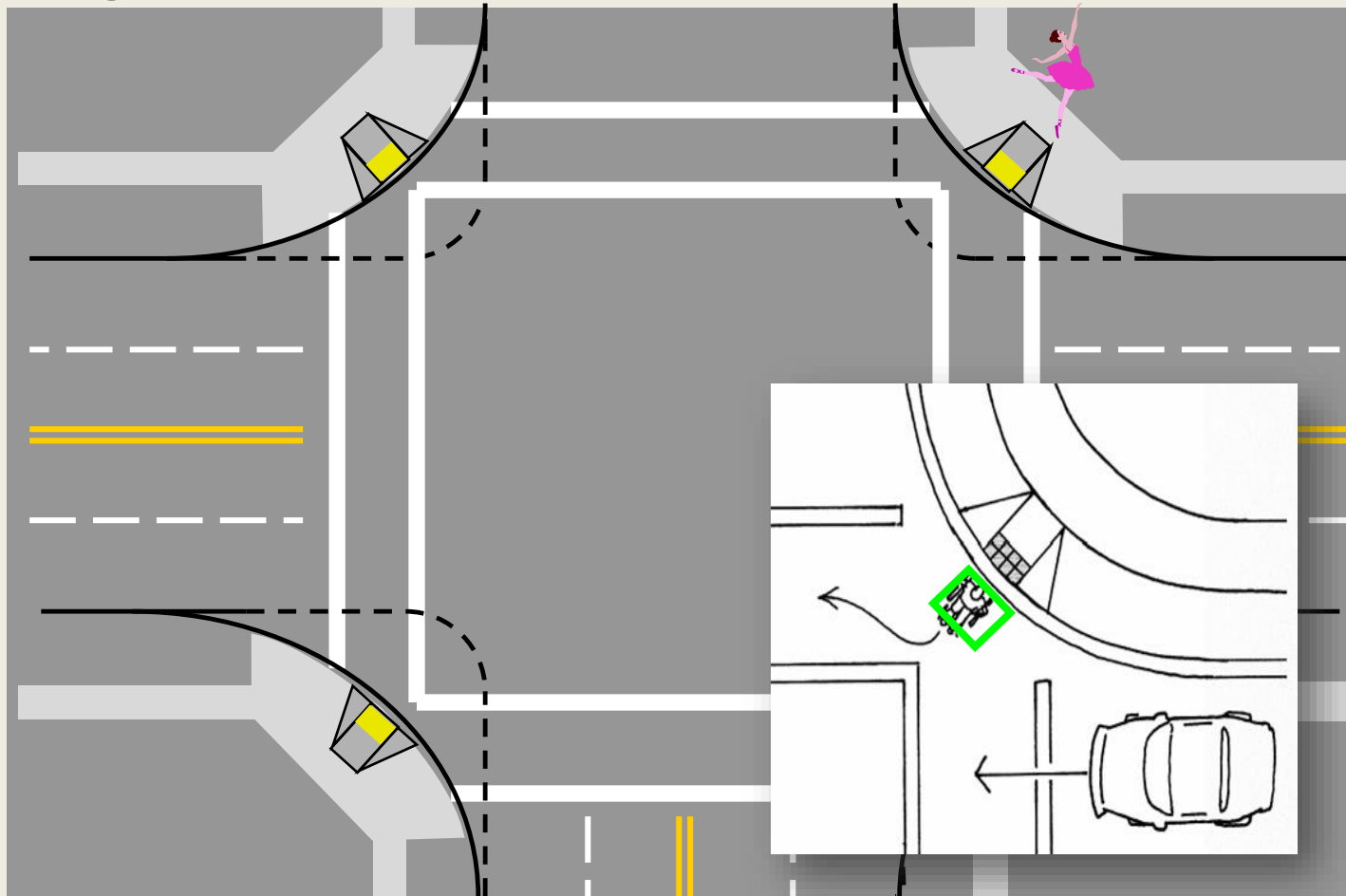
Smaller Curb Radii
Reduce Turning Speeds



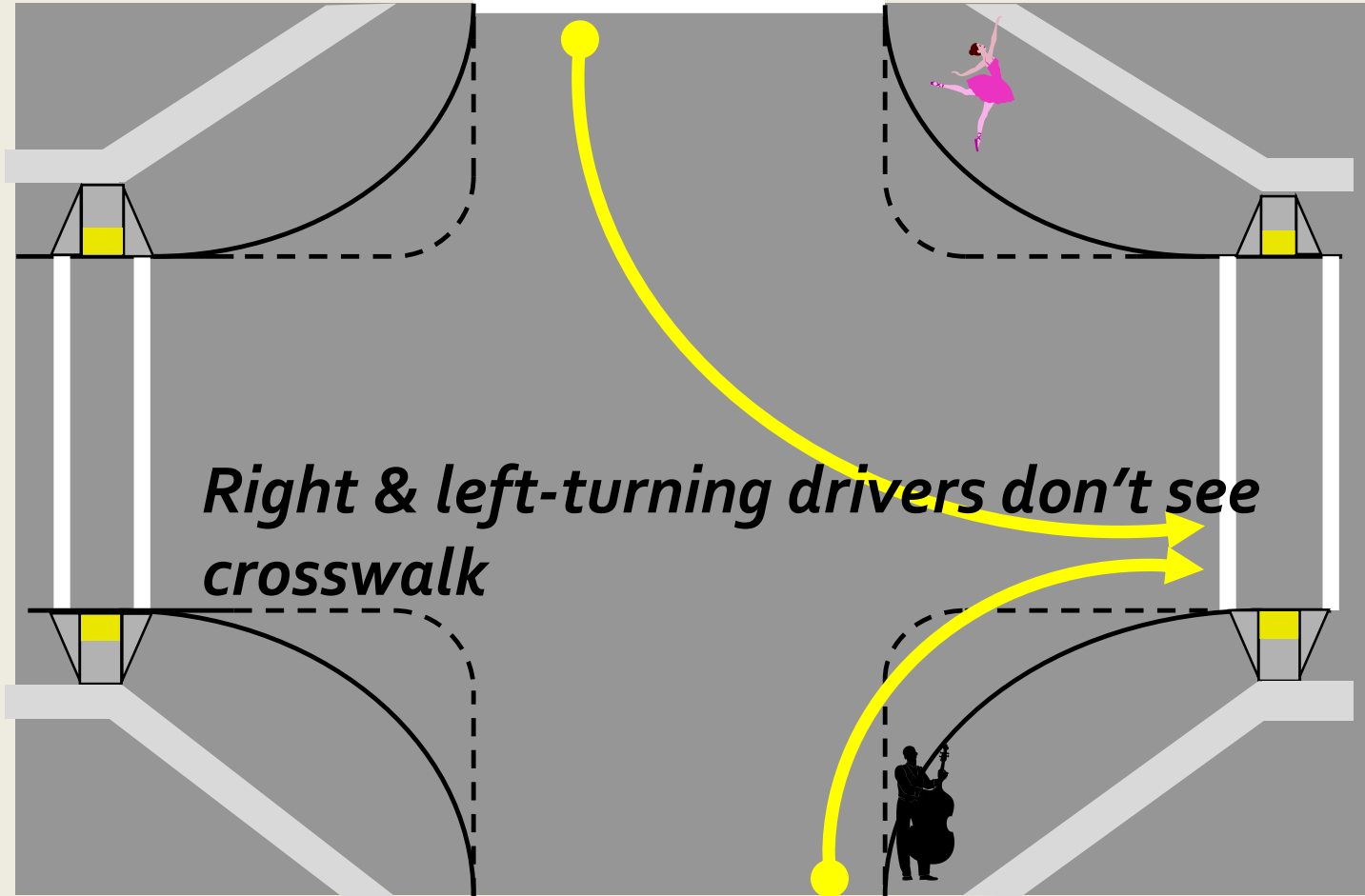
**Small corner radii allow two ramps,
shortest crosswalks, direct travel paths**



Single ramp reduces crosswalk setback but lengthens crosswalk

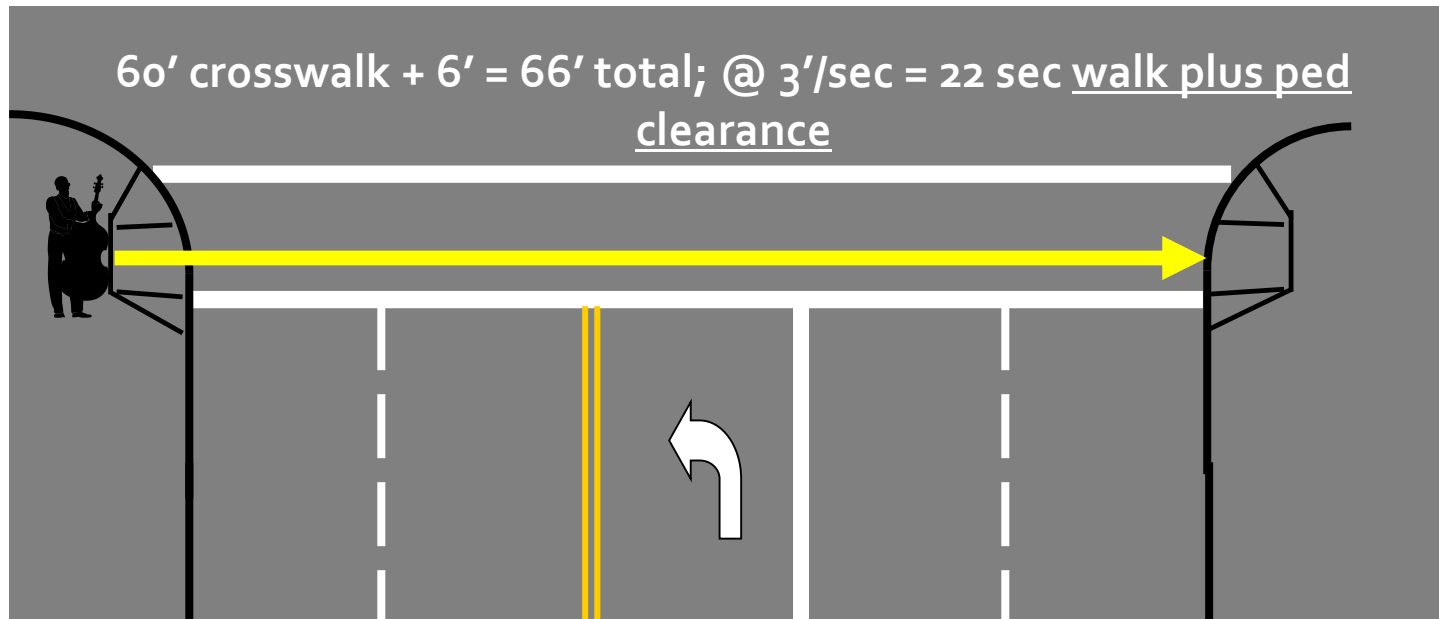


Crosswalks at shortest crossing = longer walking distance



*Right & left-turning drivers don't see
crosswalk*

Guidance for walk plus clearance: Calculate time from pushbutton (or 6' from curb) to curb on other side at 3'/sec



Note: pushbutton is considered the departure point for older pedestrians and people in wheelchairs.

Minimize curb radius



Canyonville OR

3. Don't choose larger design vehicle than necessary

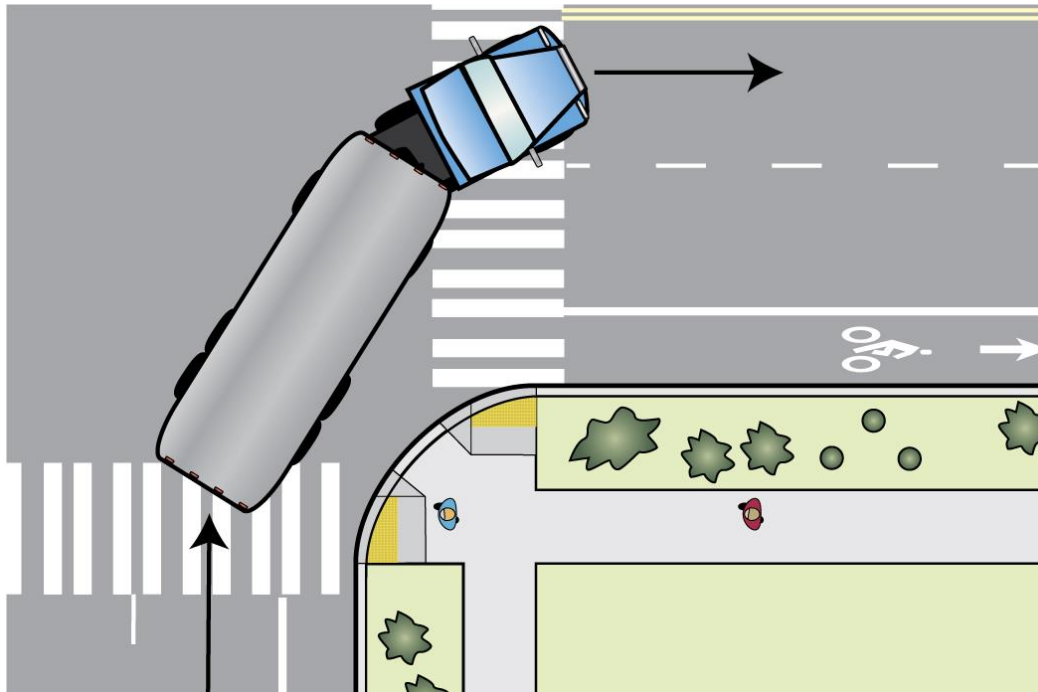


Bus makes turn several times an hour

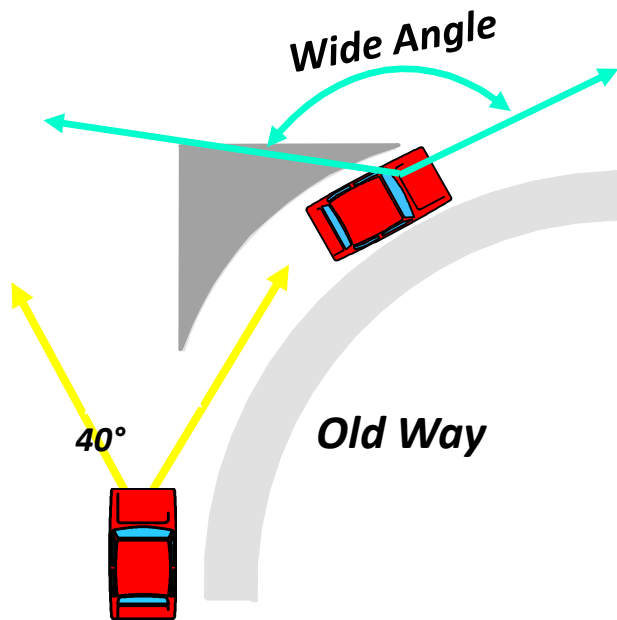
Minimize curb radius



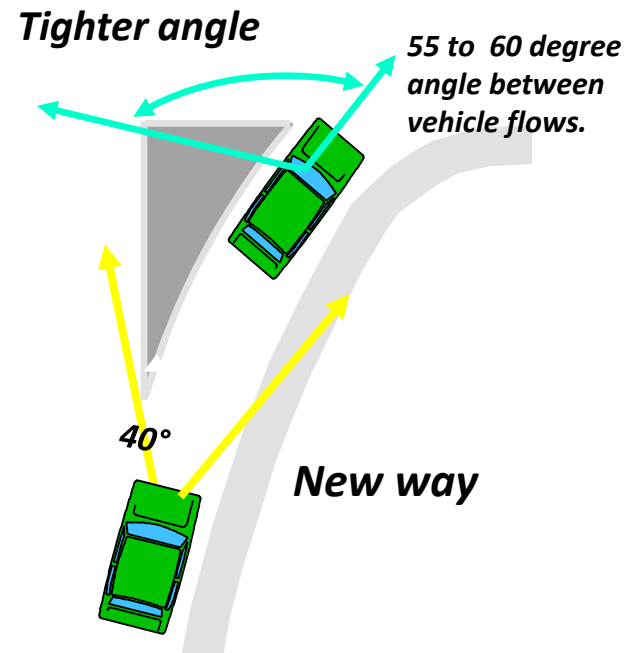
4. Where appropriate, let trucks use 2nd lane



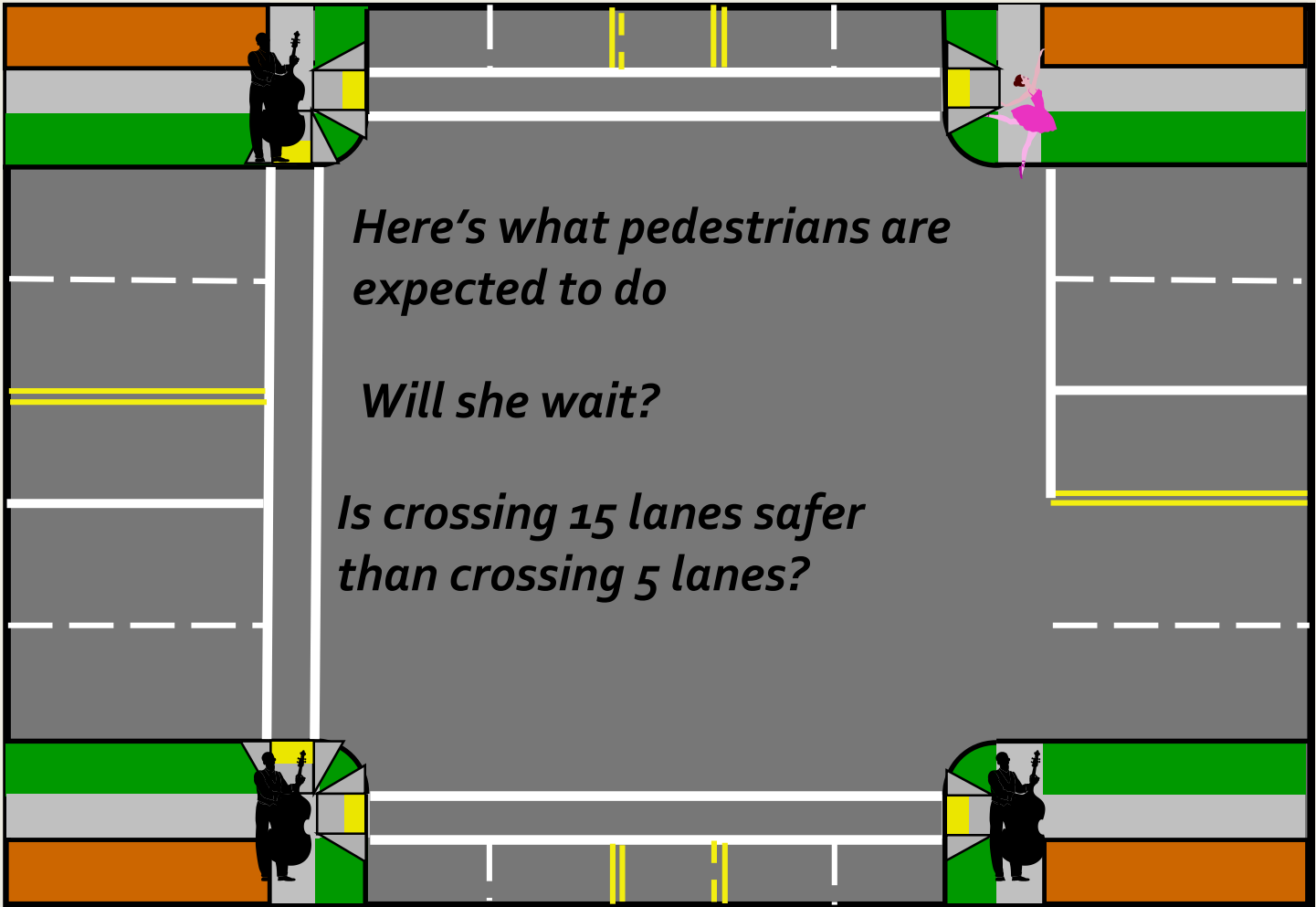
Right-Turn Slip Lane: Design for Pedestrians



High speed, head turner = low visibility of pedestrians



Slow speed, good angle = good visibility of pedestrians



Here's what pedestrians are expected to do

Will she wait?

Is crossing 15 lanes safer than crossing 5 lanes?

Should we add a marked crosswalk?



OF COURSE



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Land Use & Site Design

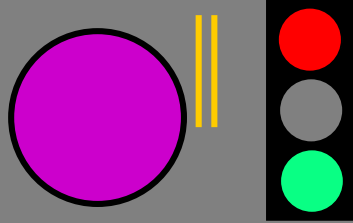
Education & Enforcement

Performance Measures

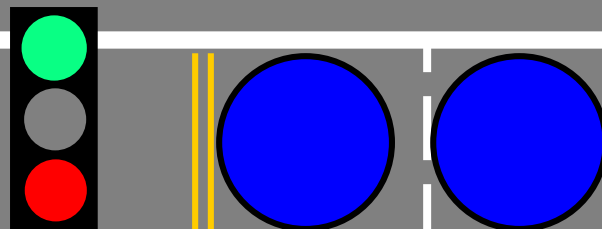
Principles of Collaboration



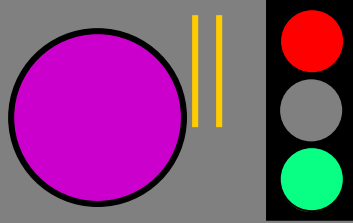
Permissive Left Turns



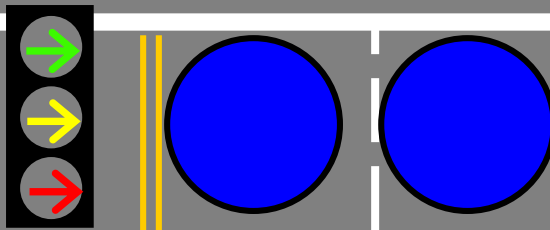
Pedestrians cross at same time as left-turning car;
Drivers turning left on a green ball don't look for pedestrians.



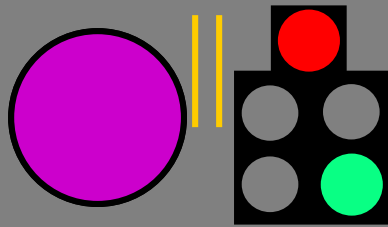
Protected Left Turns



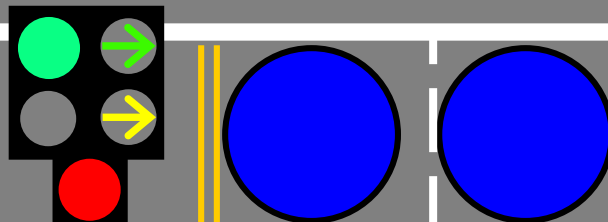
Pedestrians cross after left-turning car, with thru-traffic;
Pedestrian and car not in conflict



Protected/permissive Left Turns



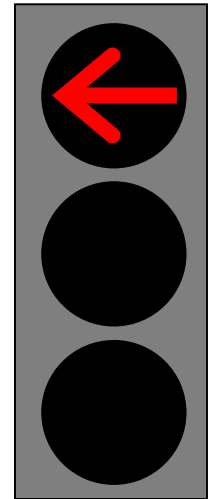
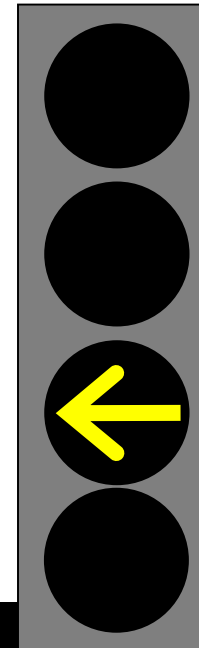
Pedestrians cross after most left-turning cars (protected phase);
Pedestrian and remaining cars are in conflict (permissive phase)



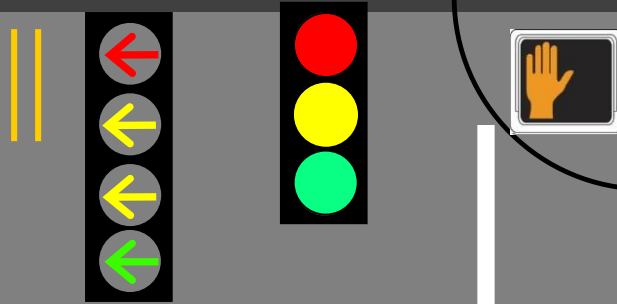
Protected/permissive Left Turns: Solutions



1. Provide protected-permissive phasing by default, but revert to protected-only when pedestrian button is pushed or based on time of day
2. Flashing Yellow Arrow (details on the next slide)



Flashing Yellow Arrow



Flashing left yellow arrow during steady green ball warns drivers: yield to pedestrians and oncoming vehicles



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Principles of Collaboration



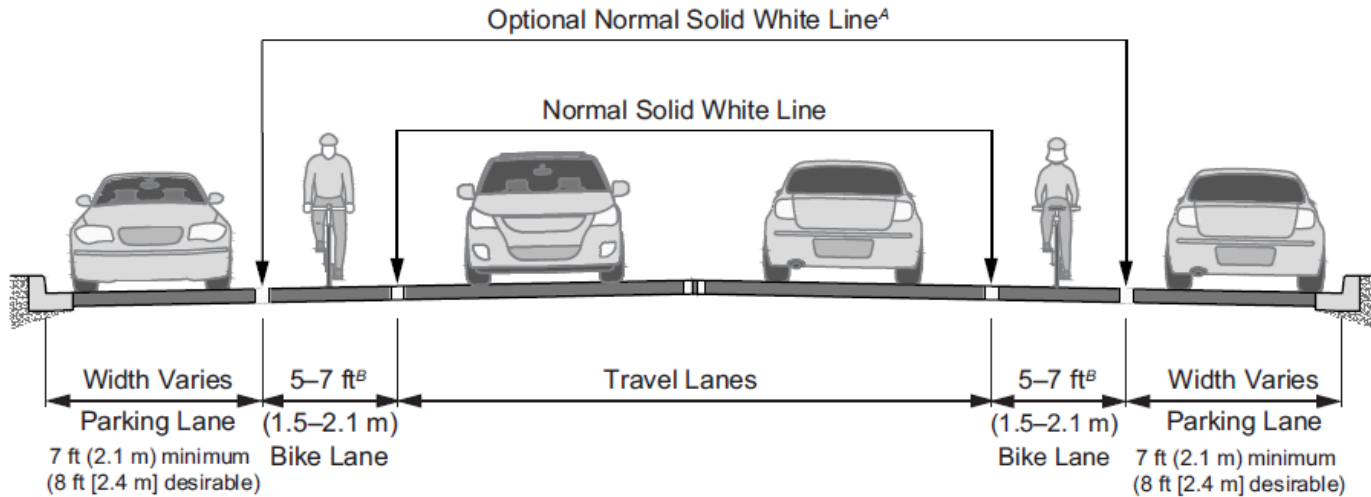
Bicyclist and bicycle lane basics



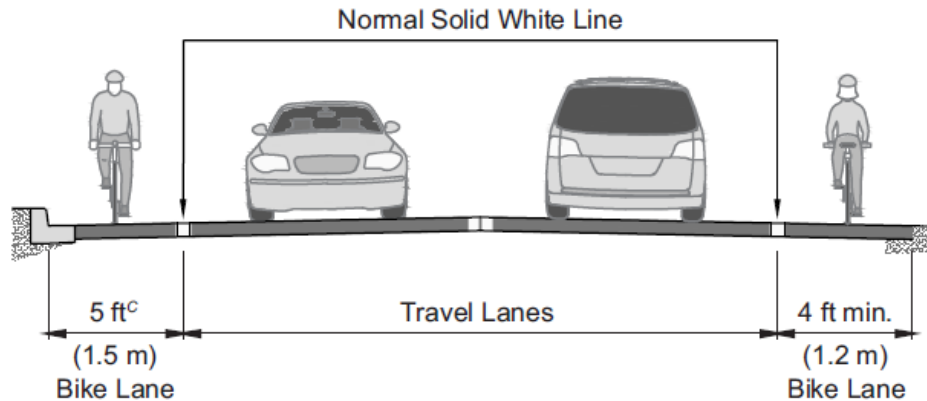
- Allow cyclists to choose operating speed
- Preferred over shared lanes/wide outside lanes
- Bicyclists prefer bicycle lane continuity
- Still sensitive to adjacent traffic volumes and speeds



Bicycle lane widths



On Street Parking



Parking Prohibited

Drainage considerations with curbside bike lanes



- Useable width of 4 feet is recommended
- Drainage grates
 - Reduce effective width of bike lane
 - Use bicycle compatible grates
- Widen bike lane or relocate grate if the clear bike lane operating space falls below 4 feet



Designs to Reduce Dooring



Wider Bike Lanes



Wider Parking Lanes



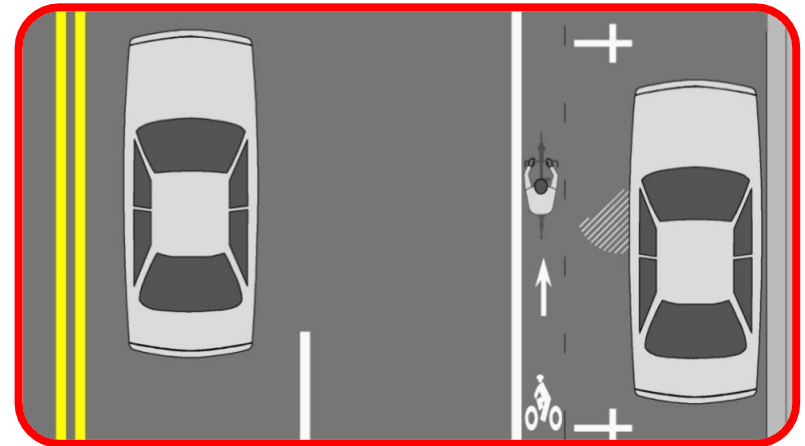
Designs to Reduce Dooring



Buffered door zone



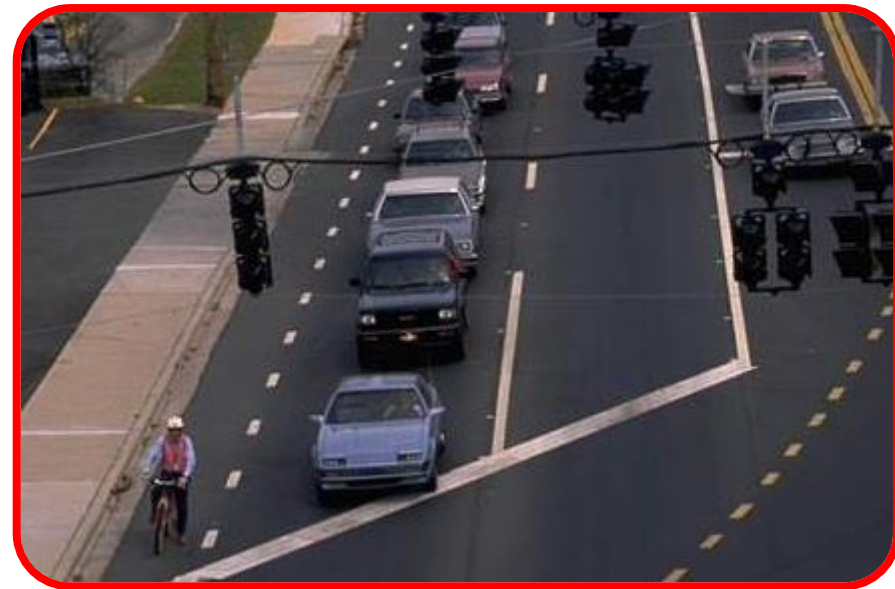
Parking "Tees"



Solid lane lines vs dotted



- Solid lane lines discourage crossing or merging
- Dashed lane lines encourage crossing or merging
- Consider state and local laws for motorists turning at intersections



Green Colored bicycle Lanes



- Guide incorporates Green Lane FHWA interim approval
 - http://mutcd.fhwa.dot.gov/resources/interim_approval/ia14/ia14grnpmbiketl




U.S. Department
of Transportation
**Federal Highway
Administration**

Memorandum

Subject: **INFORMATION:** MUTCD – Interim
Approval for Optional Use of Green
Colored Pavement for Bike Lanes (IA-14)

Date: APR 15 2011

From: 
Jeffrey A. Lindsey
Associate Administrator for Operations

In Reply Refer To:
HOTO-1

To: Federal Lands Highway Division Engineers
Division Administrators

Purpose: The purpose of this memorandum is to issue an Interim Approval for the optional use of green colored pavement in marked bicycle lanes and in extensions of bicycle lanes through intersections and other traffic conflict areas. Interim Approval allows interim use, pending official rulemaking, of a new traffic control device, a revision to the

Green Colored bicycle Lanes



- Guide incorporates Green Lane FHWA interim



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...in marked bicycle lanes...extensions of bicycle lanes through intersections and other traffic conflict areas.

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Dotted lines through intersections



Dotted lines and Colored pavement



- Green can be dashed to match dotted lines
- Green can be utilized to silhouette standard MUTCD word and symbol markings



Bike Boulevards



Source: NACTO



Median Island

Neighborhood Traffic Circle

Pinchpoint

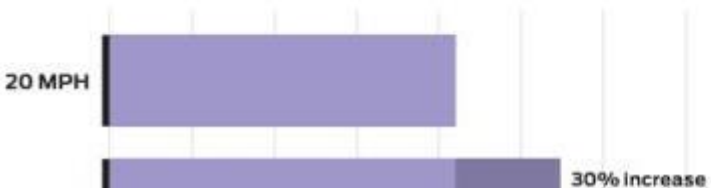
Neckdown

- 10** Guidance for vertical traffic calming features:
- Slopes should not exceed 1:10 or be less steep than 1:25.
 - Side slopes on tapers should be no greater than 1:6 to reduce the risk of bicyclists losing their balance.

Optional Features

- 12** Speed management may be implemented on a trial basis to gauge residents' support prior to finalizing the design. Temporary speed humps, tables, and lumps are available. Temporary traffic calming should be used with caution as they can diminish residents' opinions due

Depending on motor vehicle speeds, a bicyclist will be passed by a car going the same direction this many times during a 10 minute trip:



Right Hook Countermeasure



Highlight Conflict Zone

- Green increases conspicuity and awareness of conflict area
- Green can be dotted to match dotted lines within merging area



Right & Left Hook Countermeasure



- ## Bicycle boxes

- Provide head start for bicyclists
- Improve bicyclists visibility at on-set of green signal

Solid Colored pavement - Driveways



Lane diets



- *Narrow arterial lanes up to 10 feet acceptable - AASHTO.*
- *10' and 11' travel lanes don't increase crash rates in urban and suburban areas – NCHRP Project 17-26*

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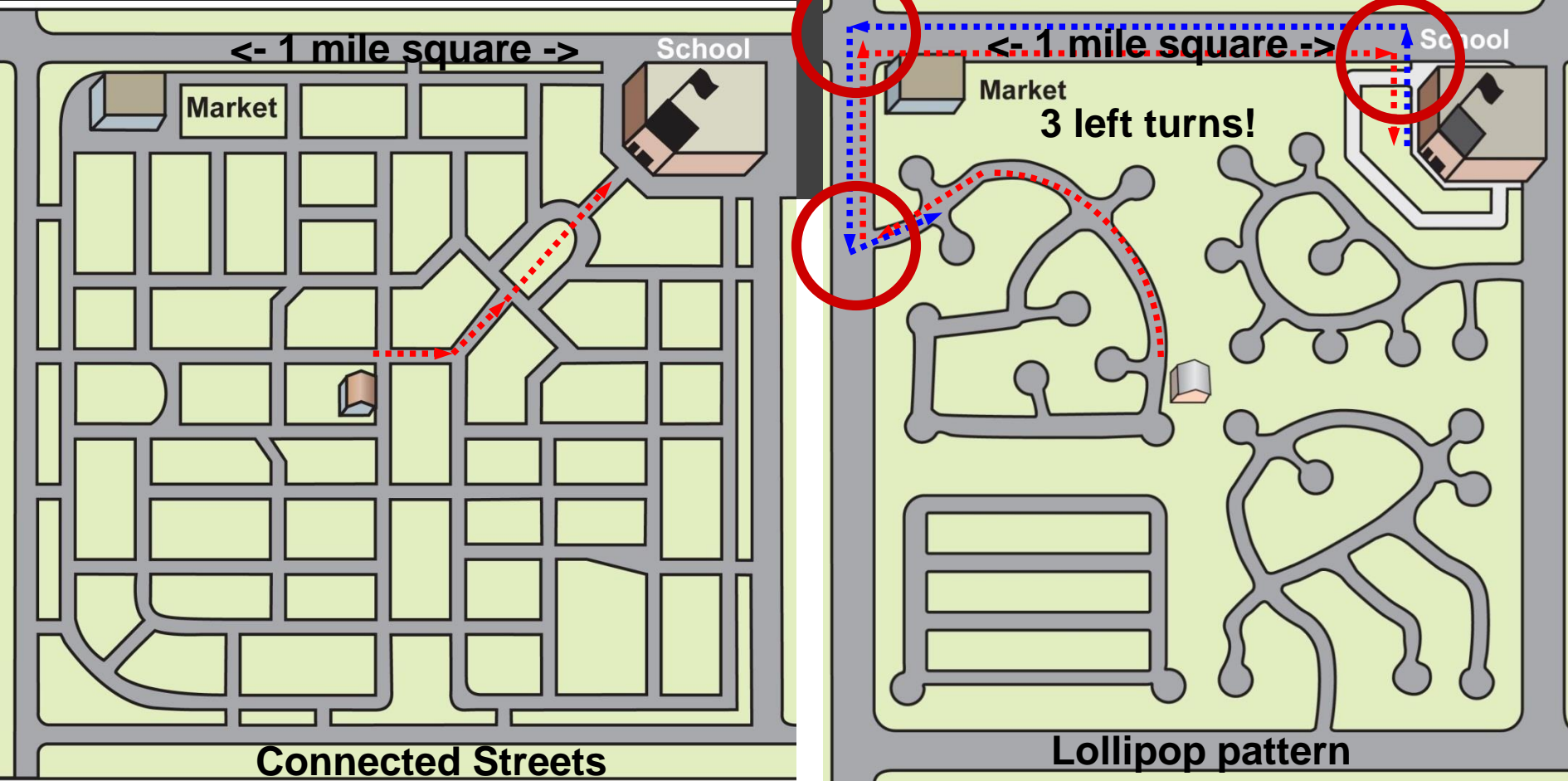
Land Use & Site Design

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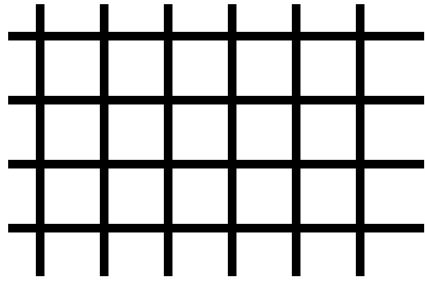
Principles of Collaboration



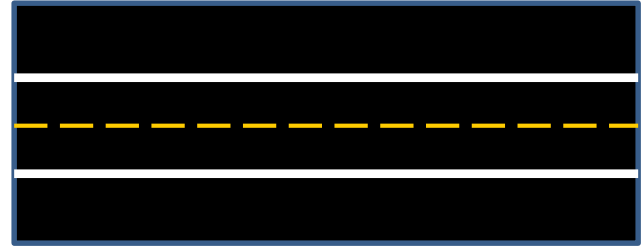


- Connectivity creates a walkable street system by:
- Reducing walking distances;
- Offering more route choices on quiet local streets;
- Dispersing traffic – reducing reliance on arterials for all trips

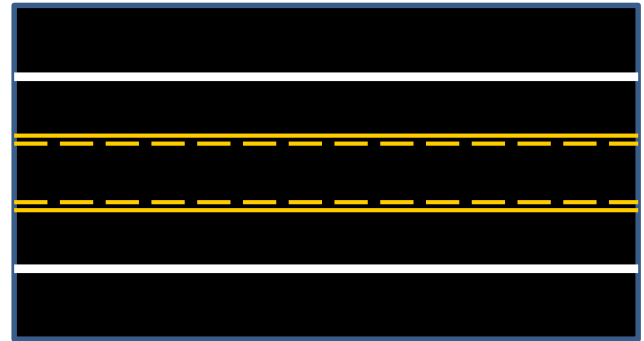
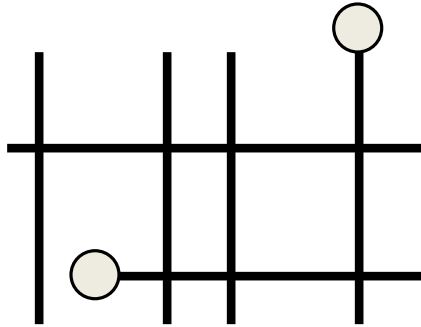
High Connectivity



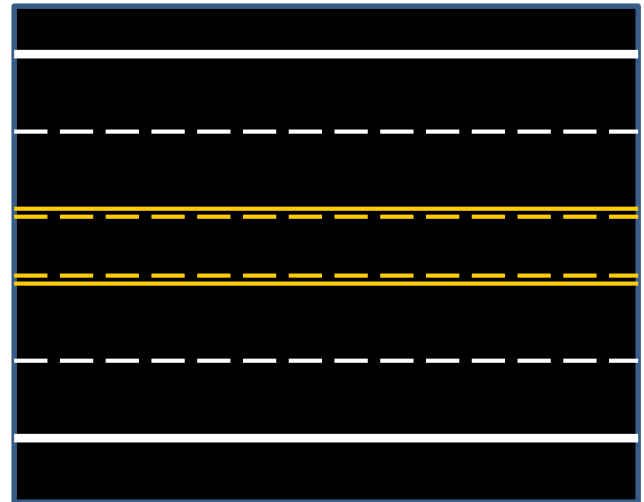
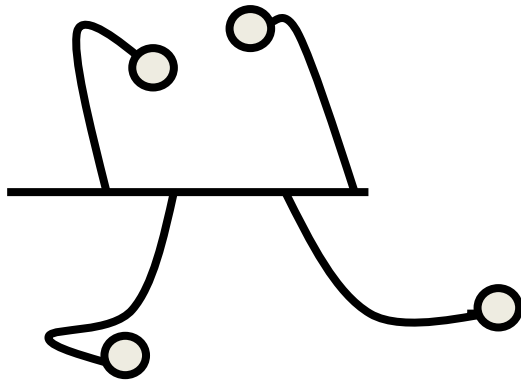
Travel Lanes Required



Moderate Connectivity



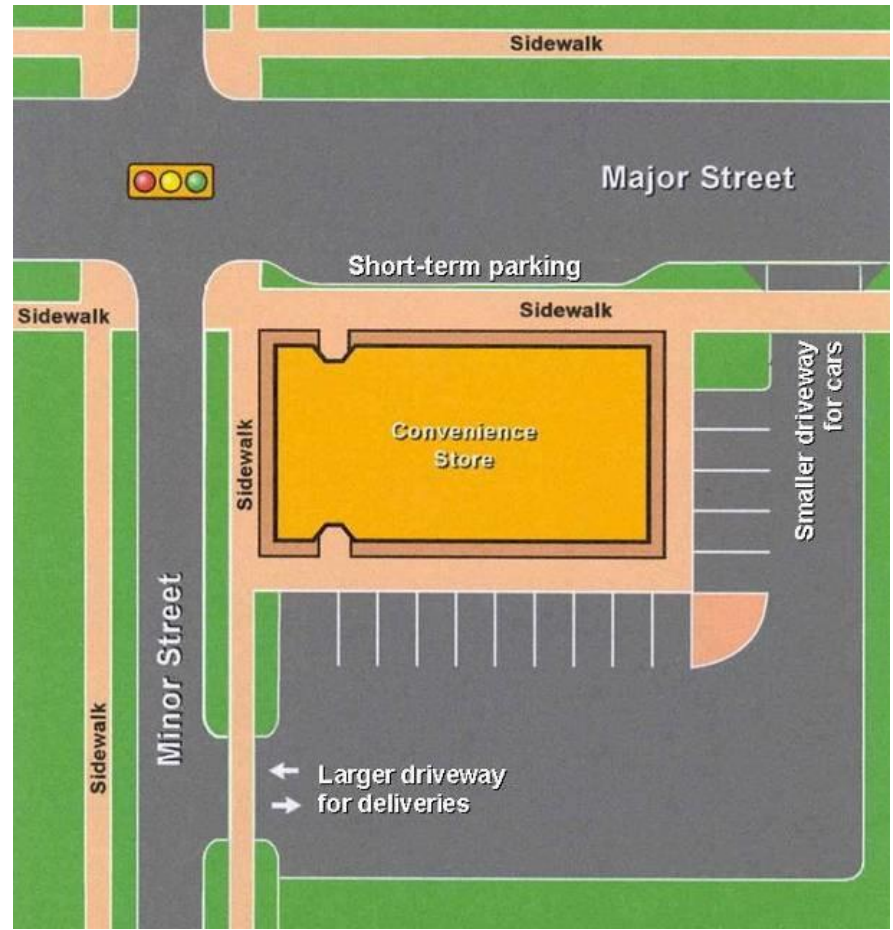
Low Connectivity





Bringing Buildings closer to the Street

- Creates a street where drivers know to expect pedestrians



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Defining Education-Related Problems and Goals



- Goals of Education:
- Should be specific, measurable, and address identified problems



Educating Pedestrians



- Reach out to most vulnerable: children and seniors



Why Children and Seniors?



They are:

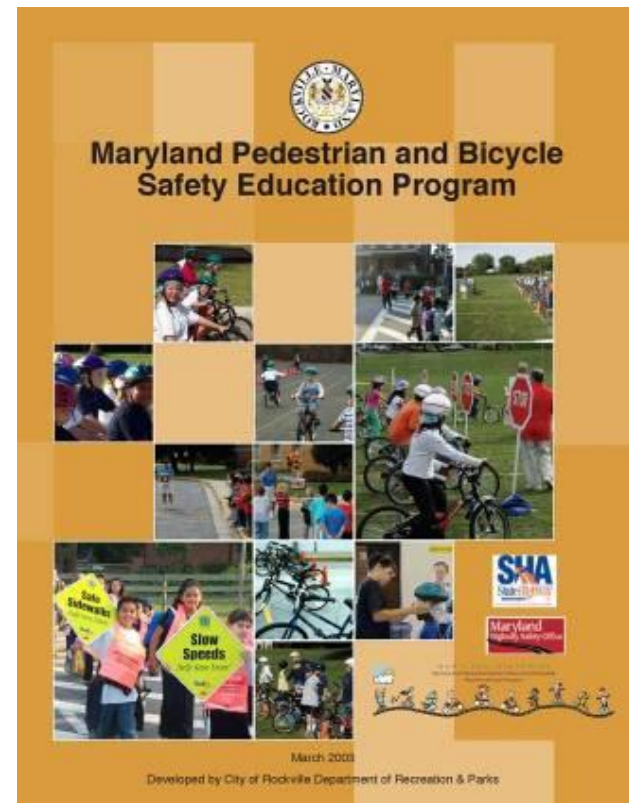
- Overrepresented in ped crashes
- More vulnerable in a crash
- Less likely to understand how to cross safely
- Less able to judge traffic or understand signals



Example: Maryland Statewide Education Curriculum



- Comprehensive, hands-on K-2 curriculum:
 - Series of lessons and skill training
 - Administrators Guide, Teachers Guide, and Lesson Handbook
 - Has reached over 7,000 students at 10 schools



Role of Law Enforcement Officers



- Teach safety
- Evaluate traffic concerns
- Provide police presence
- Monitor drivers and pedestrians
- Not “just hand out tickets”



When is Enforcement Effective?



- The 85% Concept
- The Six Week Concept



The 85% Concept



- If 85% of motorists are doing the wrong thing, then enforcement will do little
- If 85% of motorists are doing the right thing, then enforcement can effectively manage the other 15%



The 6-Week Concept



- Enforcement changes behavior for up to 6 weeks
- Behavior will return without additional enforcement
- Engineering and education needed for permanent change





Engineering

- Data Collection
- Walking Along the Street
- Walking Across the Street
- Intersection Geometry
- Signals
- On-Street Bicycle Facilities

Land Use & Site Design

Education & Enforcement

Performance Measures

Principles of Collaboration



Performance Measures



U.S. Department of Transportation
Federal Highway Administration

GUIDEBOOK FOR DEVELOPING PEDESTRIAN & BICYCLE PERFORMANCE MEASURES



MARCH
2016

- Pedestrian and Bicycle Trips
- Injury Crashes & Fatalities
- Street Counts
 - Transit, Pedestrian, Bike
- Widgets
 - Number of bike racks installed
 - Linear feet of sidewalk installed
- System Performance
 - Gaps in system
 - Barriers removed



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Stakeholder Roles



**Responsibility
for ROW**

Users of ROW

**Adjacent
property
owners**

Non-motorized
People of all ages and abilities
Pedestrians
Bicyclists

Motorized
Motorists (private vehicle)
Truck drivers
Transit agencies

Both
Transit riders

Public land
Residences
Commercial
Offices
Industrial

State DOT
Local DOT

Overlapping Responsibilities



Planning/ Developers	City/ Property Owner	Traffic Engineering	City/ Property Owner	Planning/ Developers
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Three Step Process to Citizen Empowerment



I. Presentation



II. Walkabout



III. Plan of Action





Questions?