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Designing for active transportation

Minimum design often doesn't mean quality design for walking and bicycling

- Every mode needs quality accommodations
  - Safe
  - Direct
  - Comfortable
  - Reliable
- Design to *maximize* these goals for walking and bicycling rather than designing to minimum requirements

Critical element of success:
Scope a project before setting the budget

Importance of early scoping: Michigan DOT

Available design resources

- AASHTO Green Book
- Flexibility in Highway Design (FHWA & AASHTO)
- AASHTO Bicycle and Pedestrian Guides
- ITE/CNU Designing Walkable Urban Thoroughfares
- NACTO Urban Street Design Guide and Urban Bikeway Design Guide
- ITE Planning Urban Roadway Systems
- CROW Design Manual for Bicycle Traffic

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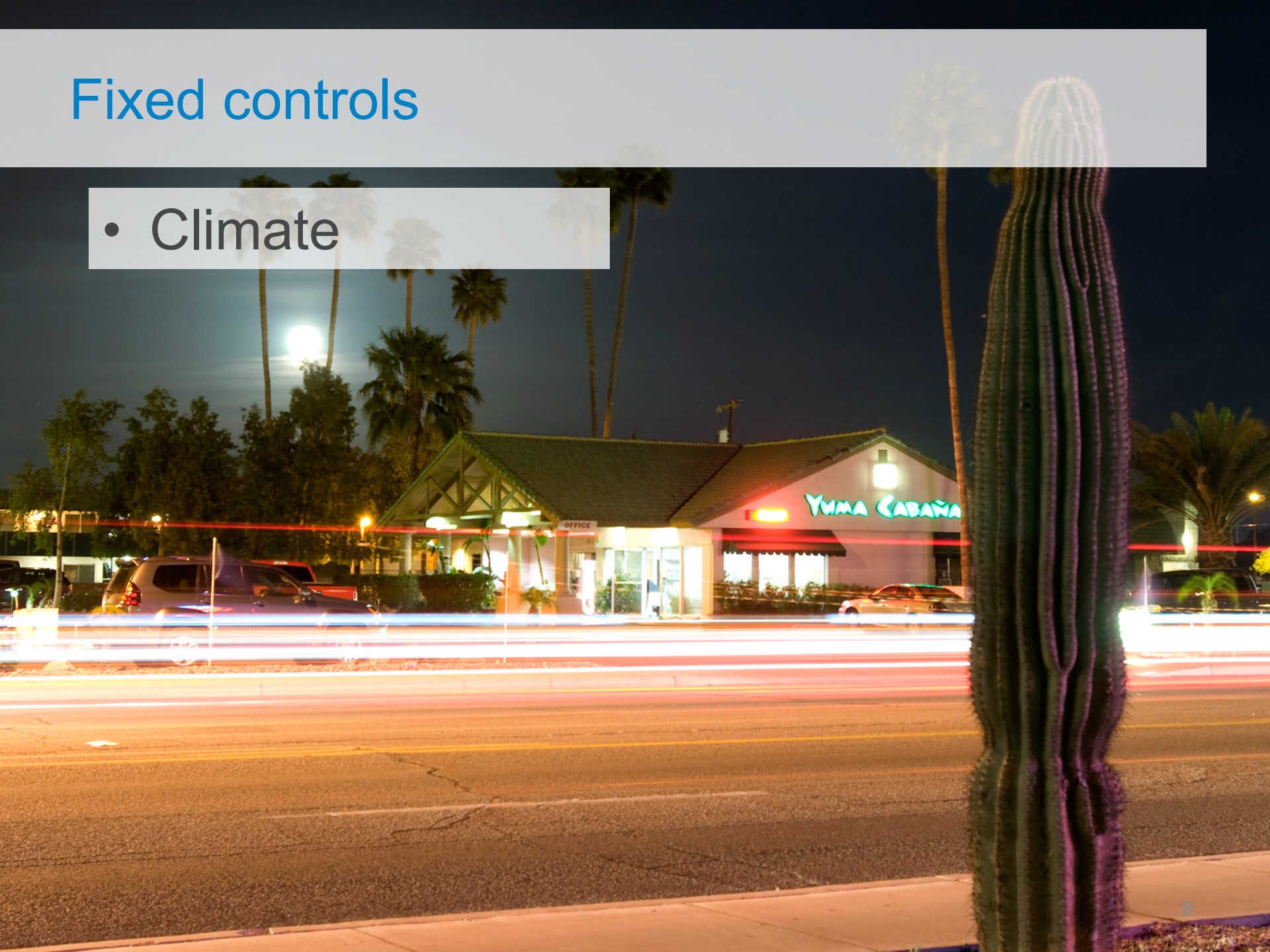
Design controls

Fixed controls

- Geography

Fixed controls

- Climate



Design controls

- Functional classification
- Design speed
- Design vehicle
- Peak hour and LOS
- Lane width
- Intersection design
- Signalization

Old paradigm: “passive” design

- “Forgives” behavior through design, assumes worst case
- Designed for high speeds and high volumes
- Encourages high-risk behaviors from all users:
  - Driving too fast; crossing mid-block; bicycling on sidewalks
- Limits land use and building types, street life

New paradigm: “proactive” design

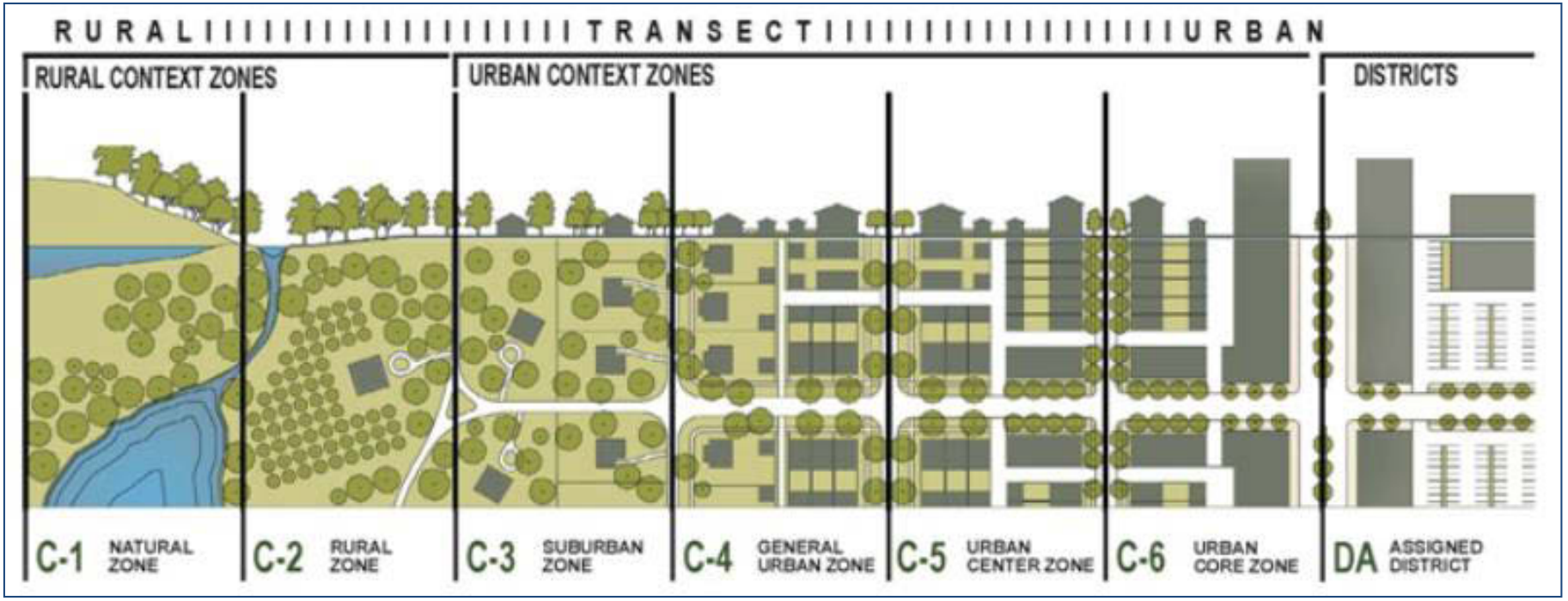
- Changes behavior through design
- Guides users through physical and environmental cues
- Slows vehicle speeds
- Encourages walking, bicycling, transit use
- Key to successful Complete Streets implementation

Functional classification

Complete Streets design

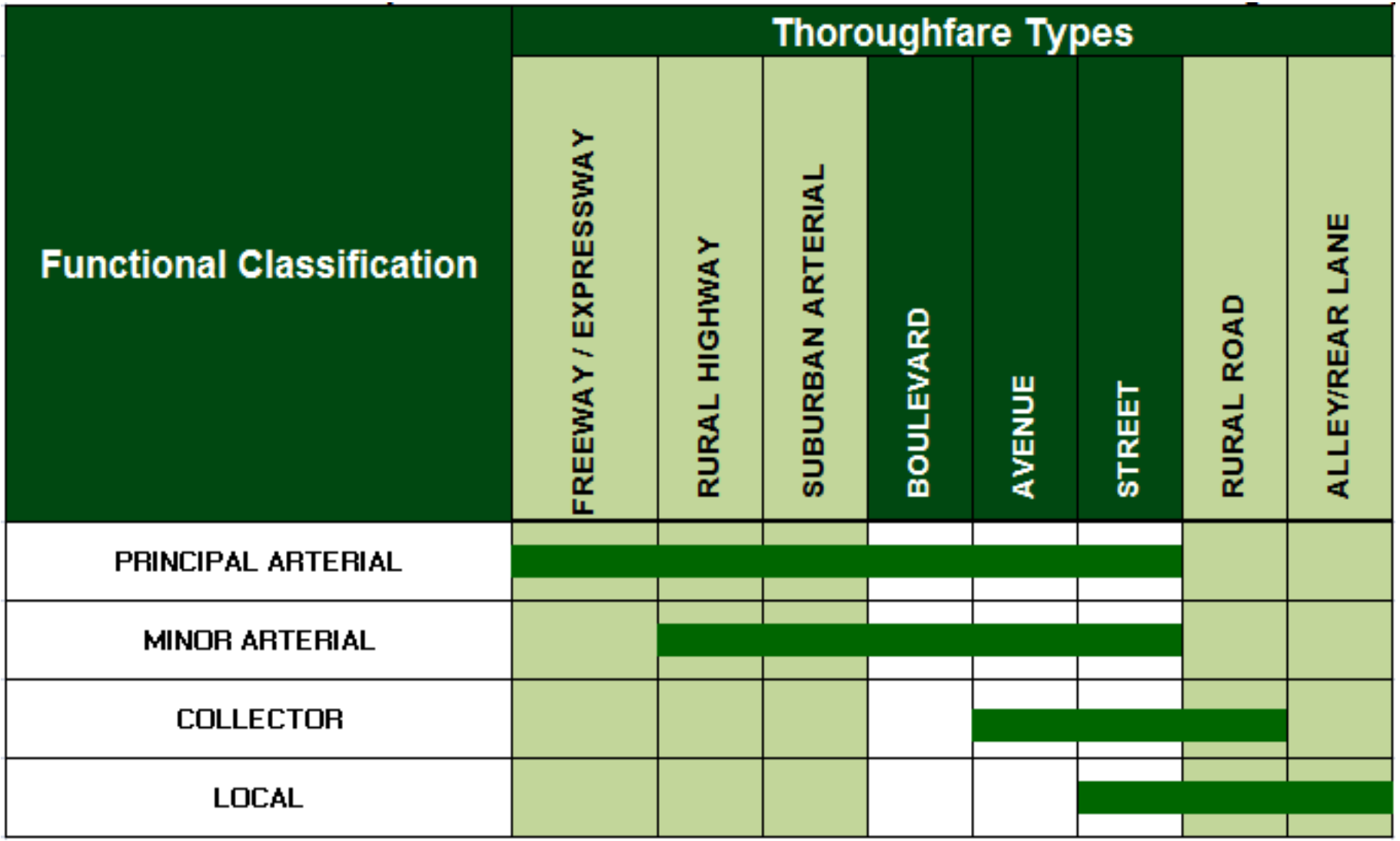
- Context-sensitive
- Beyond urban or rural binary, beyond arterial, collector or local classification
- Consider predominant land uses, site designs, buildings—current & planned
  - Planned land uses and designs may be different than existing!
- Work with stakeholders to understand needs & goals
- Embrace unique characteristics of place

Context zones



Duany Plater-Zyberk and Company

Functional class + type



Context-based, descriptive terms

Pedestrian-oriented

Land uses and street designs

Auto-oriented

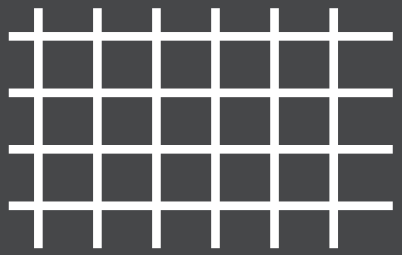
Should street width be based on classification?

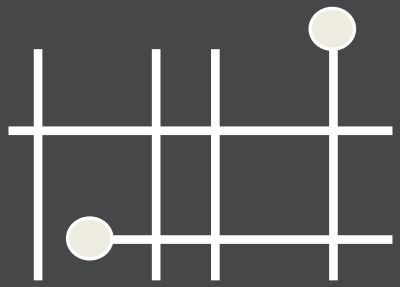
Should street width be based on classification?

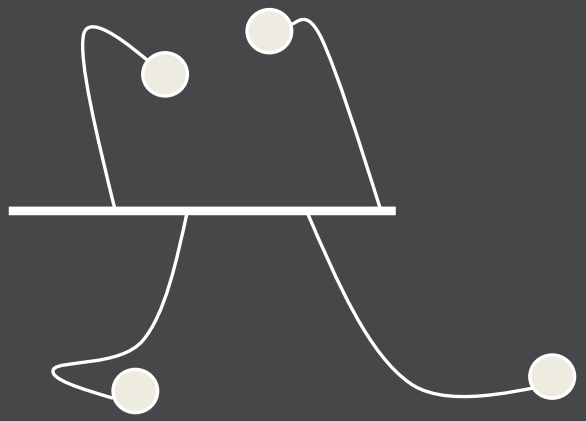
Should street width be based on classification?

Functional classification doesn't adequately describe the street's role in a community

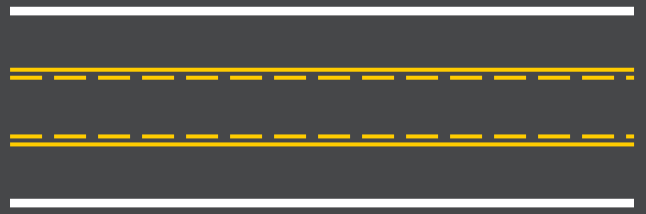
Connectivity

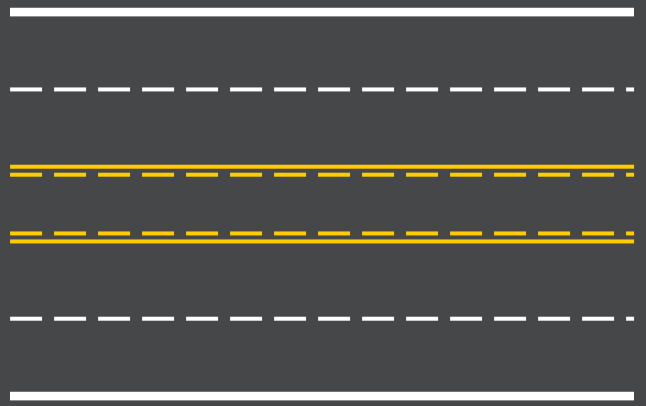






Travel lanes





Low connectivity → few but large streets

Low connectivity → few but large streets

Speed

Speed may be the most important factor in designing for walking and bicycling

SPEED (MPH)	STOPPING DISTANCE (FT)*	CRASH RISK (%)†	FATALITY RISK (%)†
10–15	25	5	2
20–25	40	15	5
30–35	75	55	45
40+	118	90	85

* Stopping Distance includes perception, reaction, and braking times.

† Source: Traditional Neighborhood Development: Street Design Guidelines (1999), ITE Transportation Planning Council Committee 5P-8.

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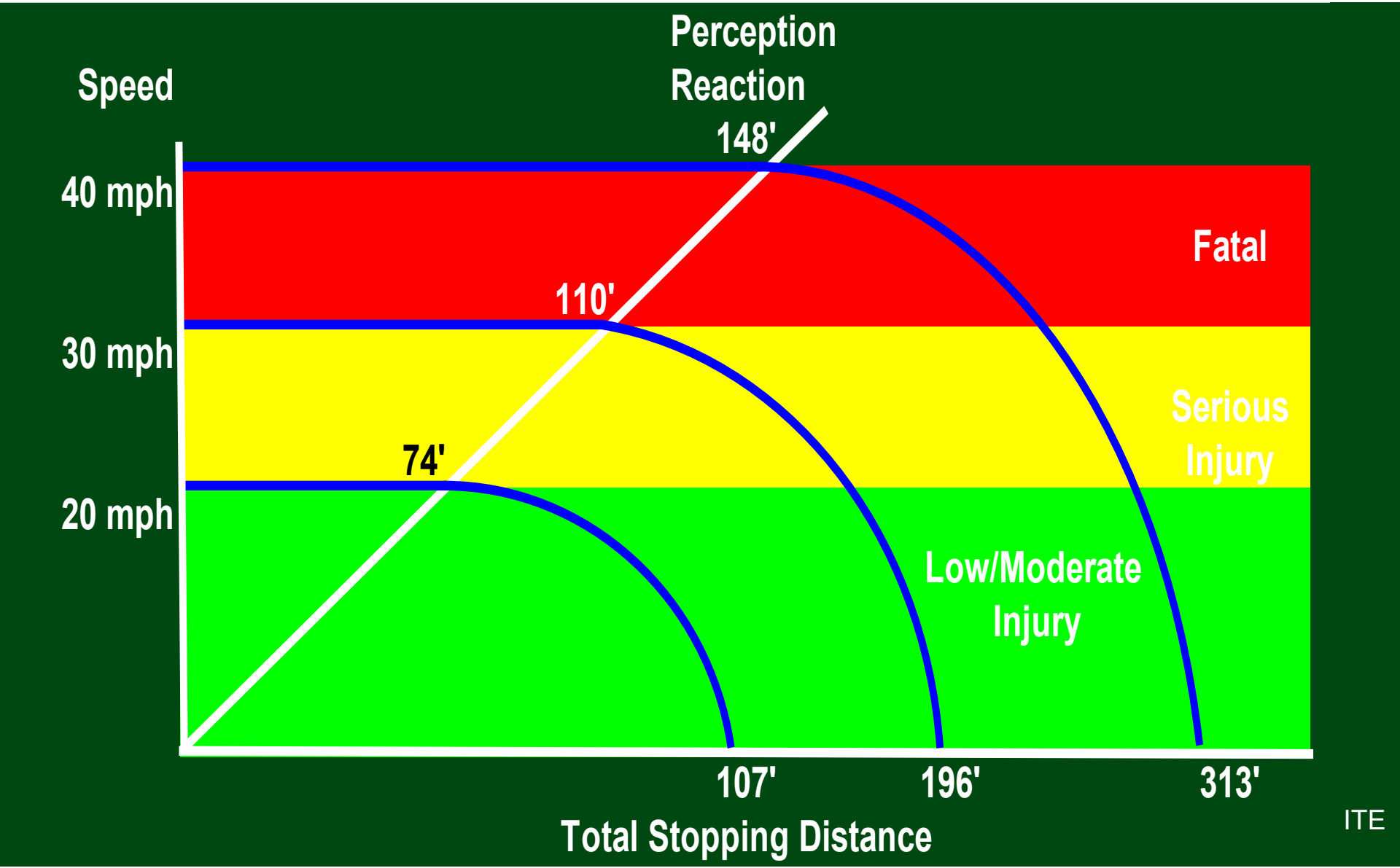
Source: NACTO

Speed & crash severity



ITE

How speed affects driver perception

PERIPHERAL VISION AT 10-15 MPH

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Source: NACTO

How speed affects driver perception

PERIPHERAL VISION AT 20-25 MPH

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Source: NACTO

How speed affects driver perception

PERIPHERAL VISION AT 30-35 MPH

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Source: NACTO

How speed affects driver perception

PERIPHERAL VISION AT 40+ MPH

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Source: NACTO

Design speed vs. target speed

Target speed

=

Design speed

=

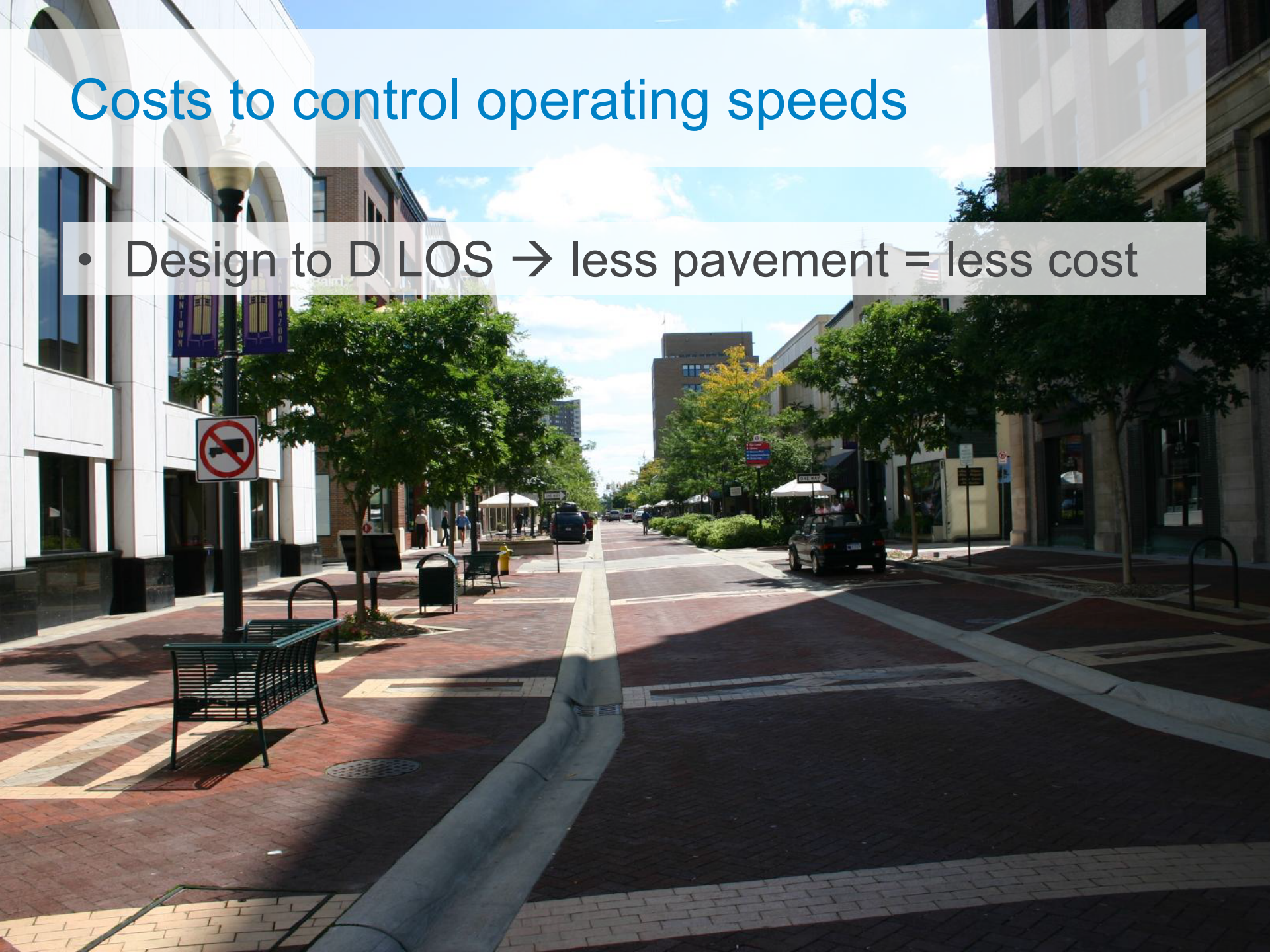
Posted speed

To reduce operating speed:

- Narrower lane widths
- Narrower roadway
- Add “friction” with on-street parking, landscaping
- Space and synchronize signals for moderate speeds
- Smaller curb radii
- Reduced “shy distance” from median
- No superelevation
- Design of right turn lanes
- Horizontal deflection: curb extensions, chicanes
- Vertical deflection: speed humps, tables
- Textured paving
- Coordinate with building design to constrain sightlines

Costs to control operating speeds

- Design to D LOS → less pavement = less cost

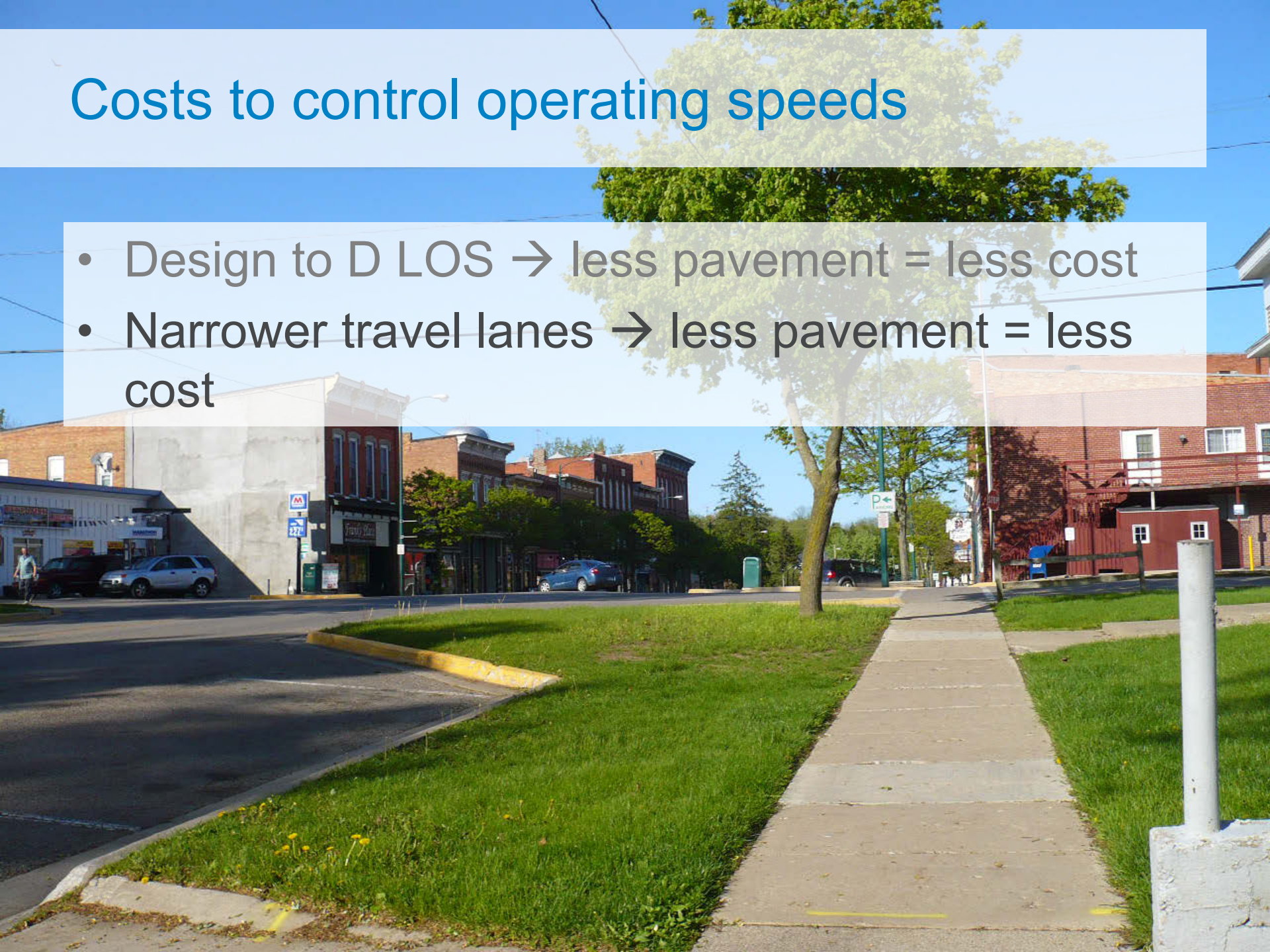


Costs of designing to LOS C

- Pavement, longer crossings, more delay at intersections
- Consider LOS as one of many performance measures

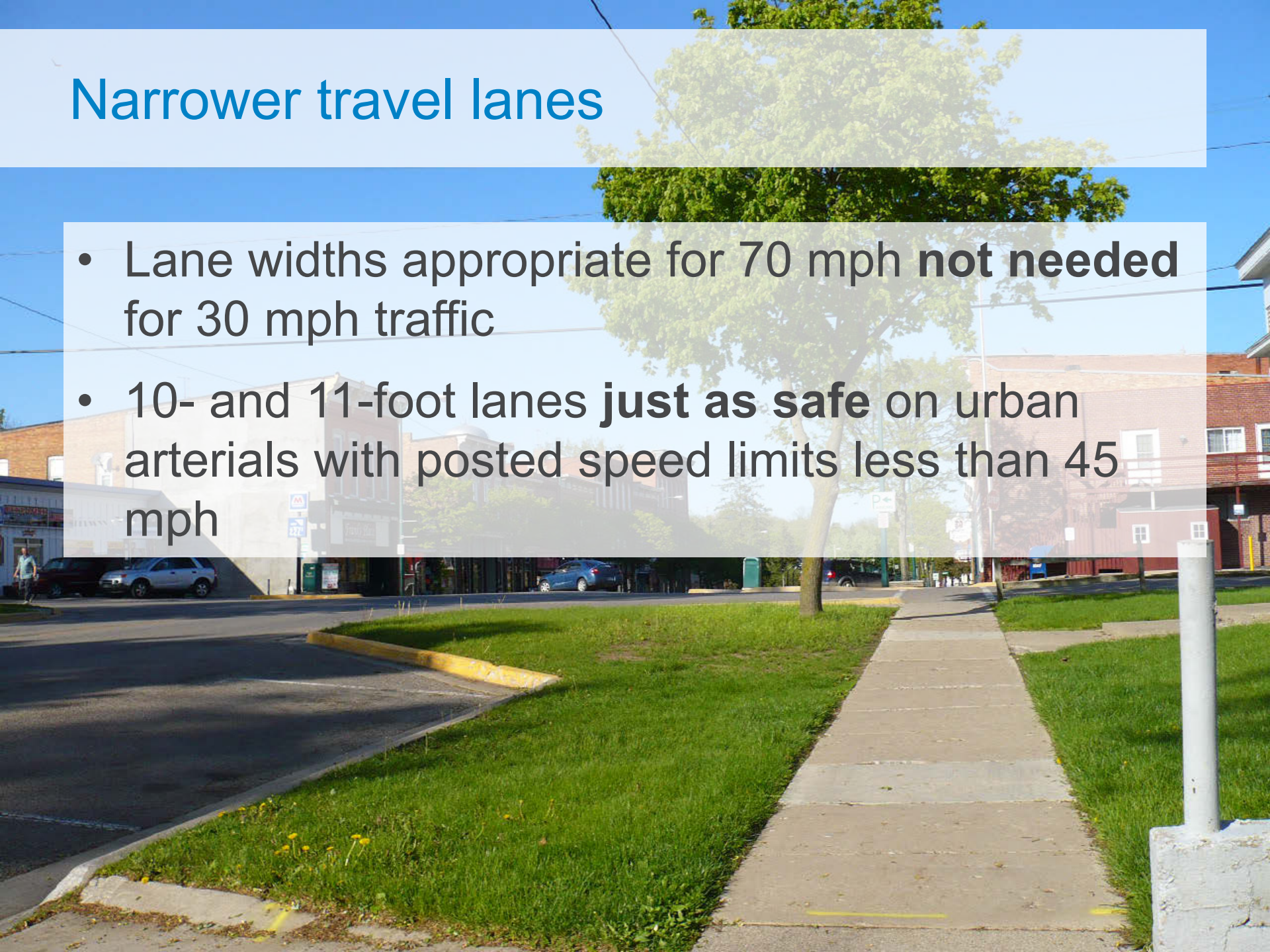
Costs to control operating speeds

- Design to D LOS → less pavement = less cost
- Narrower travel lanes → less pavement = less cost



Narrower travel lanes

- Lane widths appropriate for 70 mph **not needed** for 30 mph traffic
- 10- and 11-foot lanes **just as safe** on urban arterials with posted speed limits less than 45 mph



Costs to control operating speeds

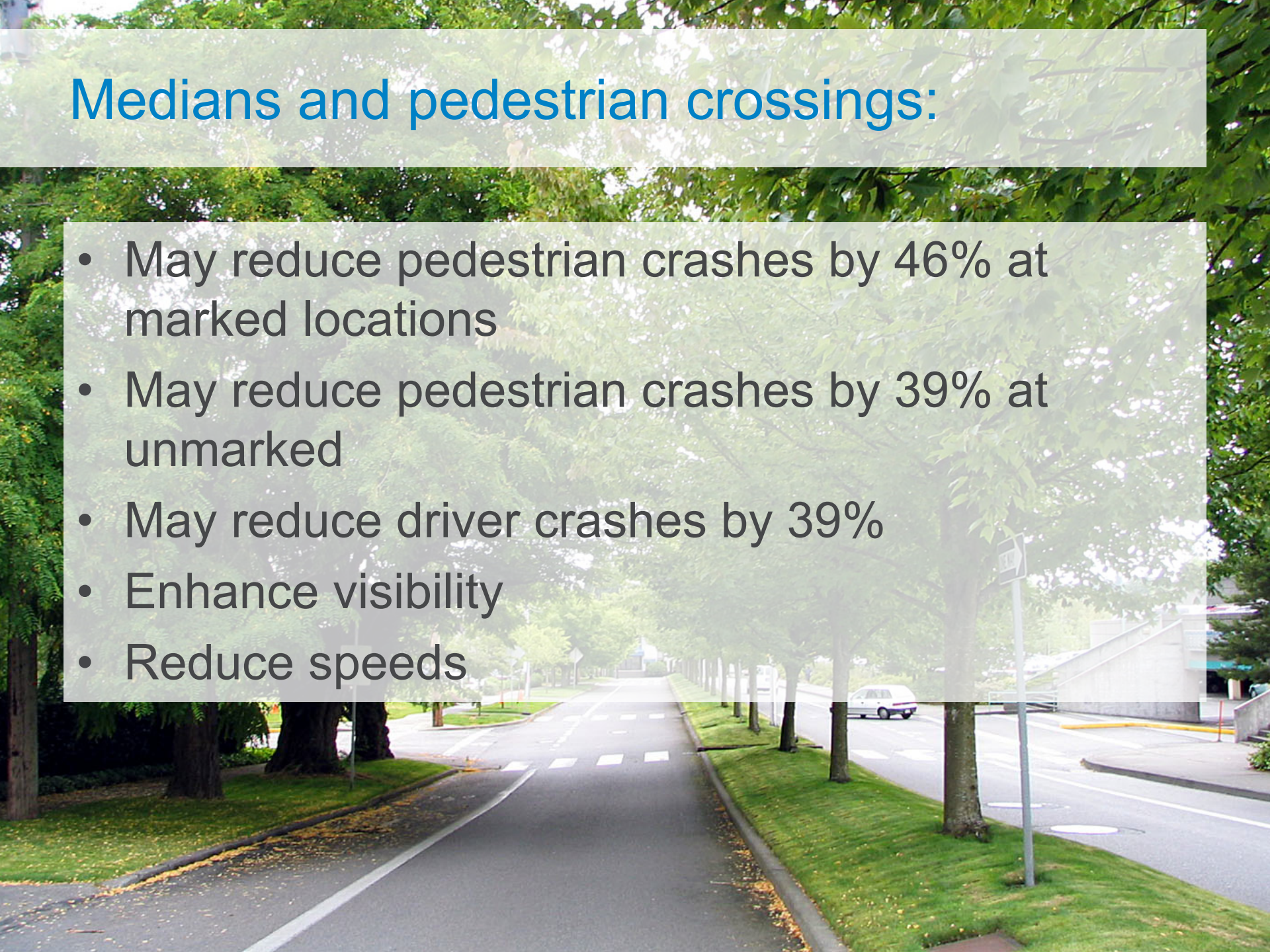
- Design to D LOS → less pavement = less cost
- Narrower travel lanes → less pavement = less cost
- Signal progression → cost to interconnect

Costs to control operating speeds

- Design to D LOS → less pavement = less cost
- Narrower travel lanes → less pavement = less cost
- Signal progression → cost to interconnect
- Raised medians → include in project scope

Medians and pedestrian crossings:

- May reduce pedestrian crashes by 46% at marked locations
- May reduce pedestrian crashes by 39% at unmarked
- May reduce driver crashes by 39%
- Enhance visibility
- Reduce speeds



Consider medians:

- Multi-lane roadways
- Urban and suburban
- Mixture of people walking and driving (12k ADT)

Design:

- 8’ preferred, 4’ minimum

Costs to control operating speeds

- Design to D LOS → less pavement = less cost
- Narrower travel lanes → less pavement = less cost
- Signal progression → cost to interconnect
- Raised medians → include in project scope
- On-street parking → revenue from meters

Costs to control operating speeds

- Design to D LOS → less pavement = less cost
- Narrower travel lanes → less pavement = less cost
- Signal progression → cost to interconnect
- Raised medians → include in project scope
- On-street parking → revenue from meters
- Road diets → minimal costs with resurfacing

Do we have to widen roads to fit everything?

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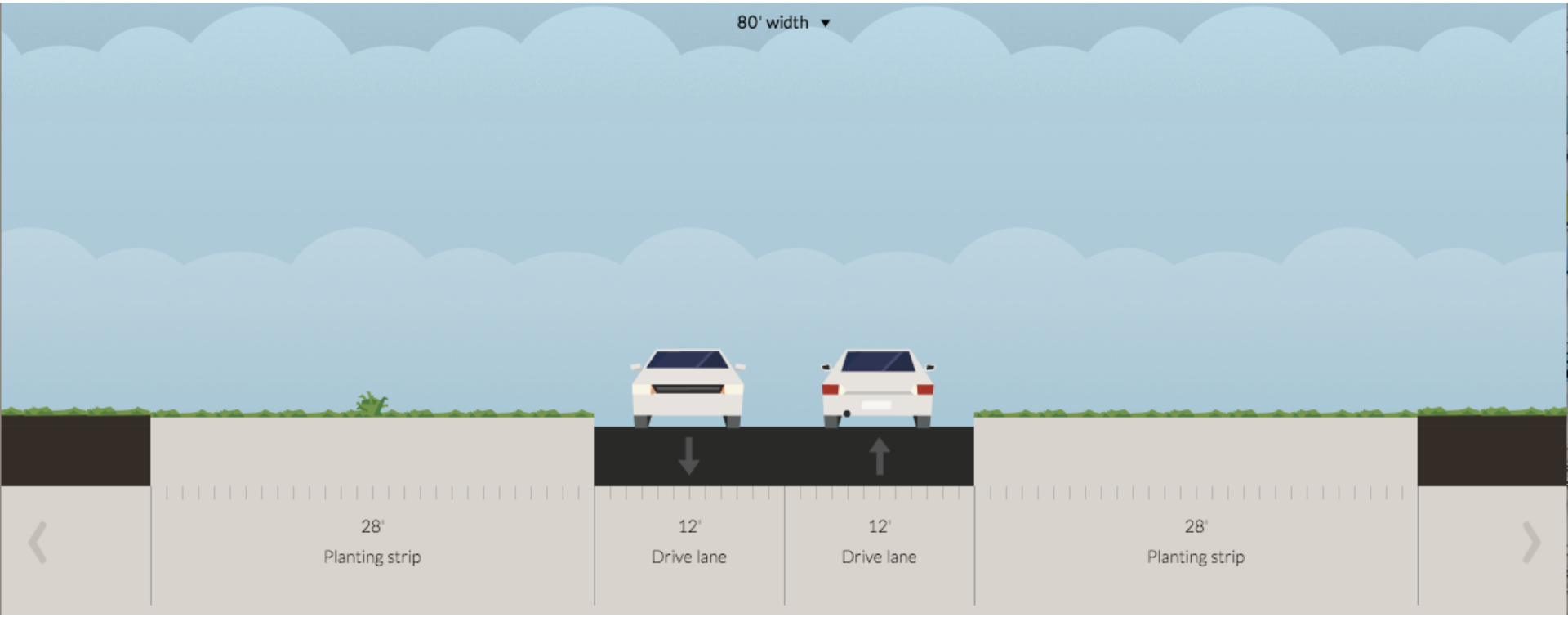
Graphic: Ian Lockwood

Don’t ask “How much do we need?”

Ask:

- How much do we have?
- What do we want?
- How do we design it to fit?

28’ roadway & ditches in 80’ ROW



24’ of traveled way = 30% of R.O.W.

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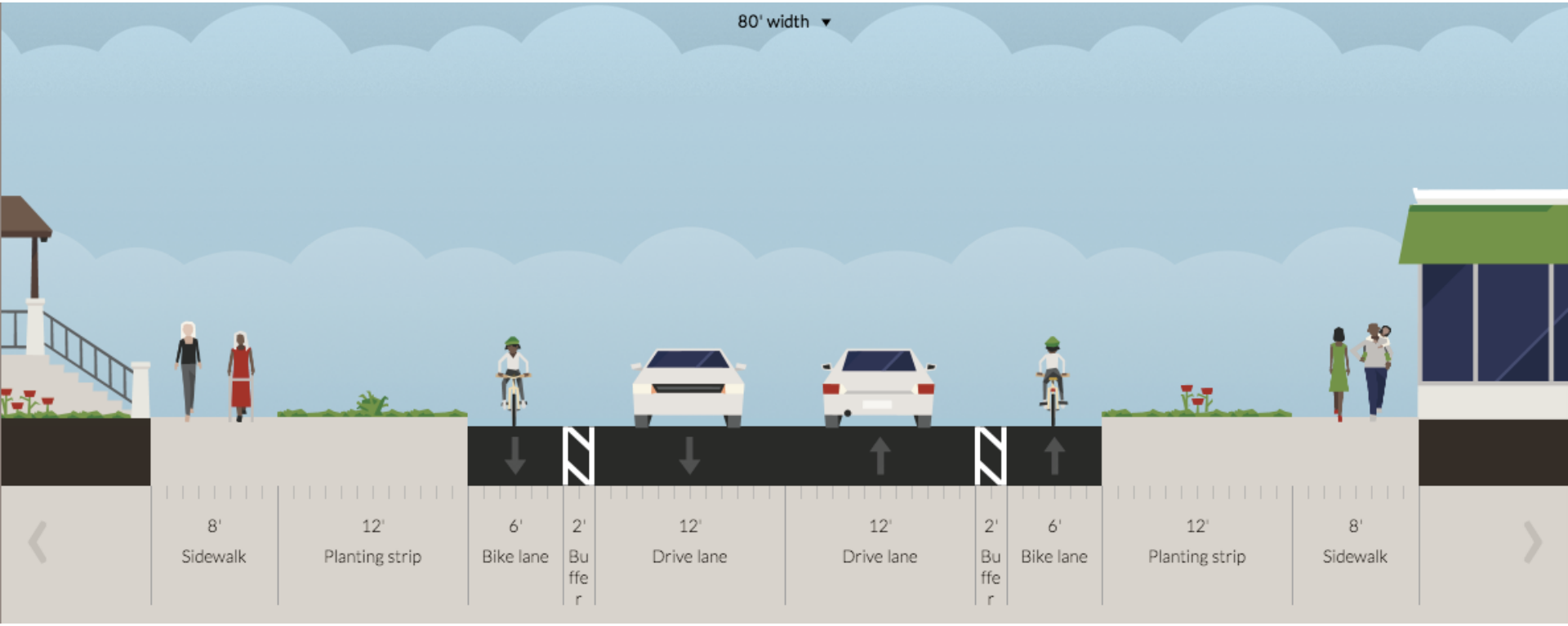
“Add” bike lanes, sidewalks, planting strip…



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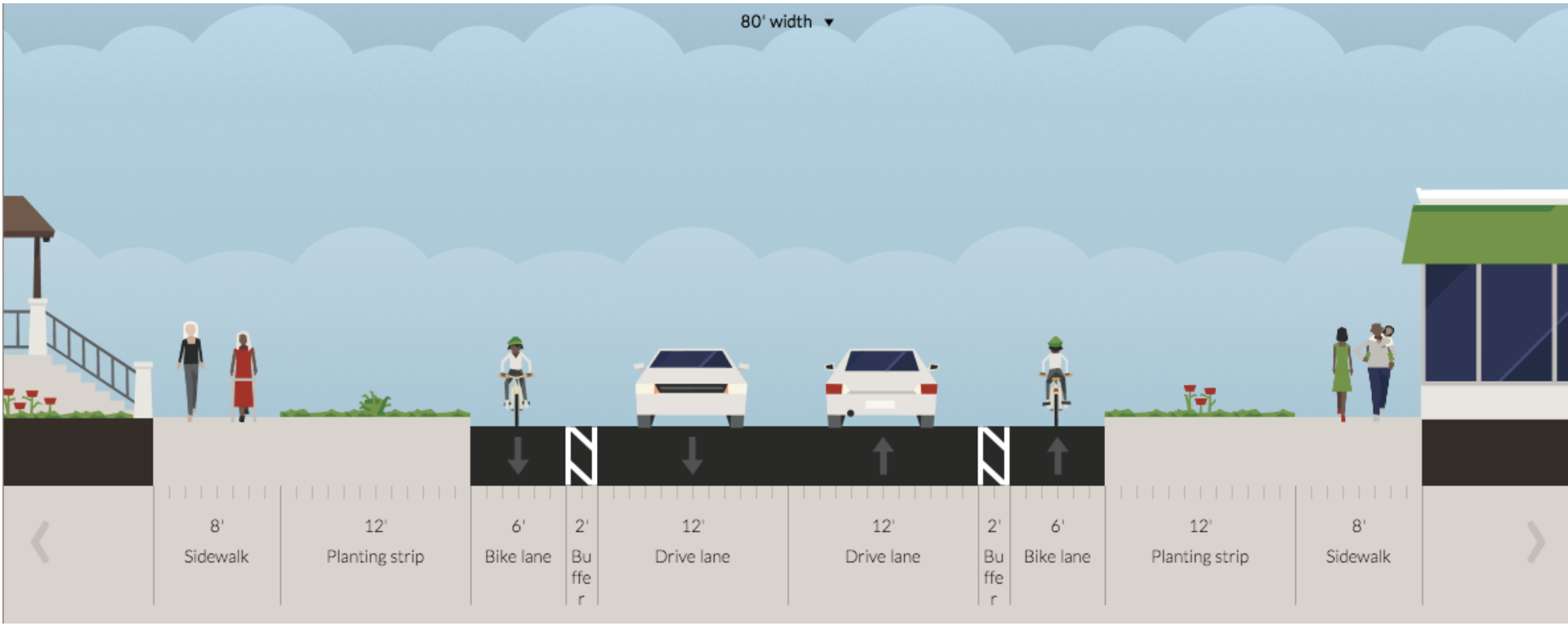
Everything fits, no problem!



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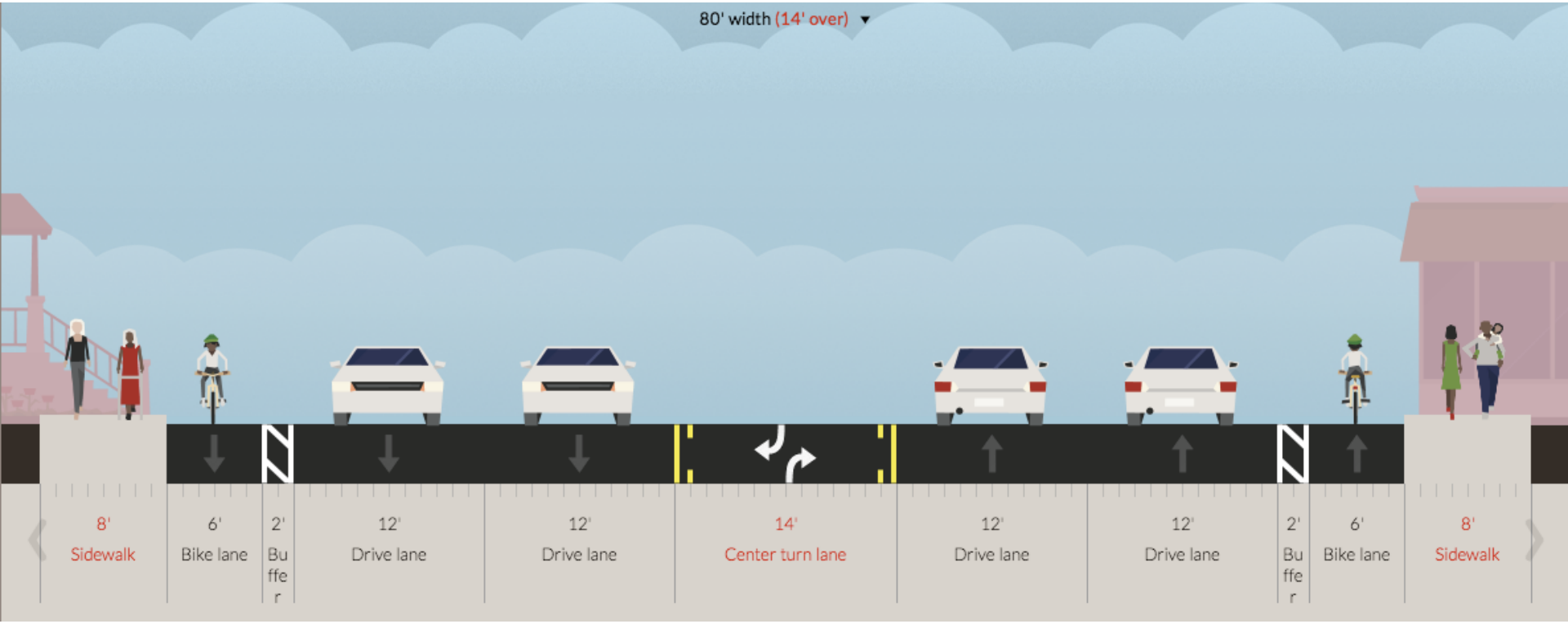
Add 2 more travel lanes and TWLTL…



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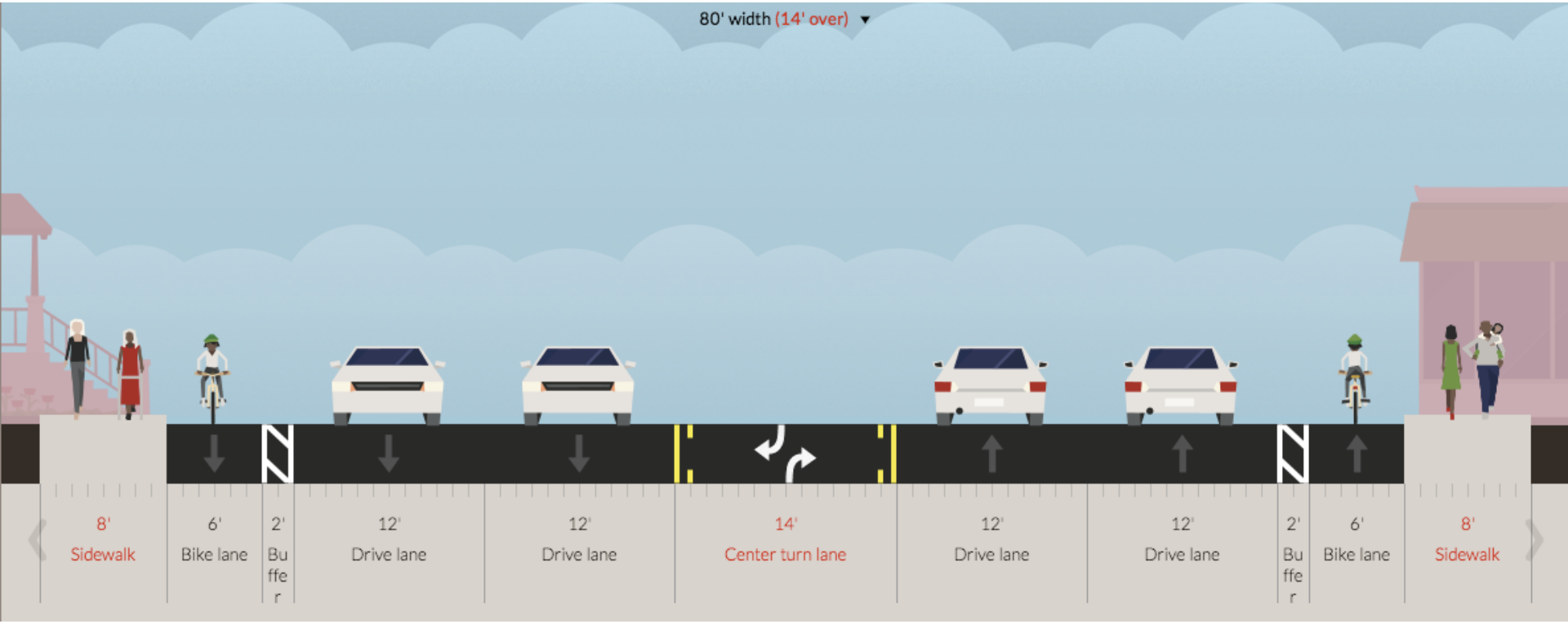
Who's taking up most of the ROW?



62' of traveled way = 77.5% of R.O.W.

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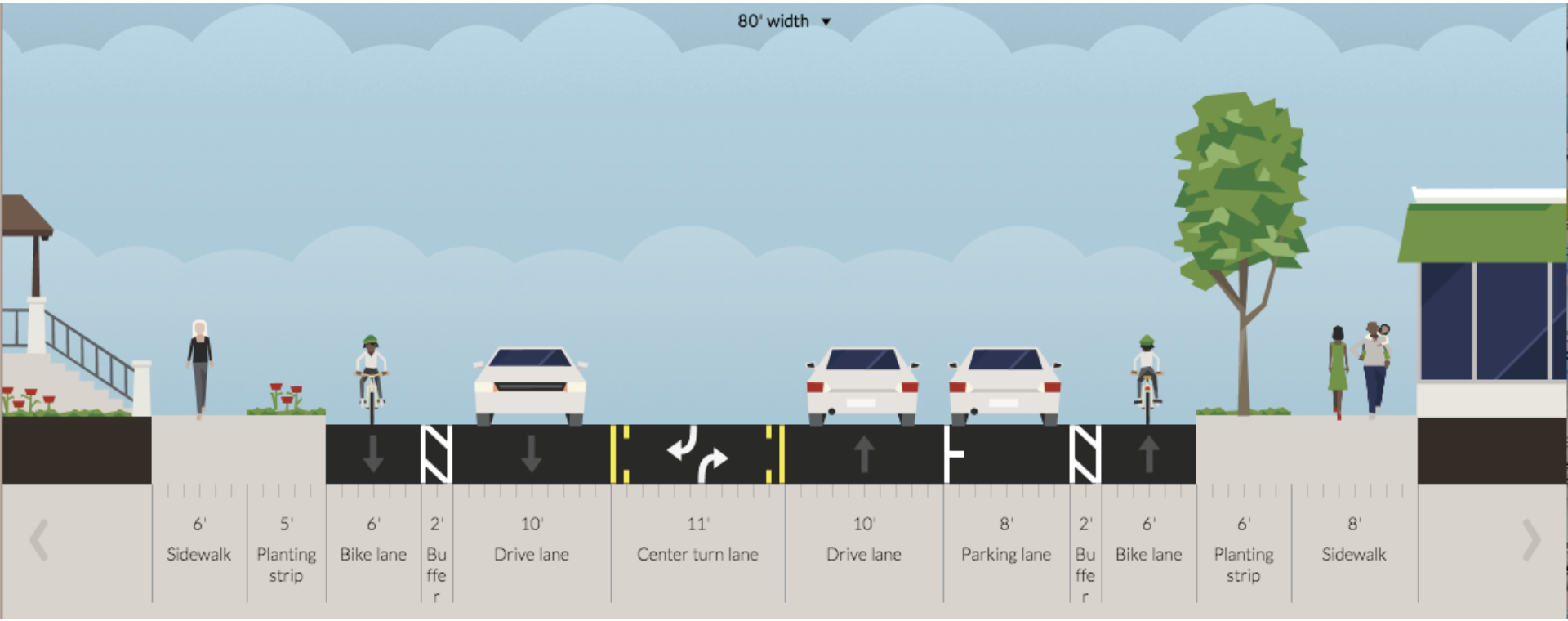
New design: from the outside in



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New approach: from the land use in

Result:
Context-appropriate. Sidewalks, bike lanes, & adequate travel lanes

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Constrained corridor? Rightsize it!

Convert 4-Lane Road to 3-Lane and TWLTL

29% crash reduction for ALL users

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FHWA proven safety countermeasure

"Road diets can be low cost if planned in conjunction with reconstruction or simple overlay projects, since a road diet mostly consists of restriping. Roadways with Average Daily Traffic (ADT) of 20,000 or less may be good candidates for a road diet and should be evaluated for feasibility."

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Rightsizing tool: Narrower travel lanes

Ten feet should be the default width for general purpose lanes at speeds of 45 mph or less.

ITE Traffic Engineering Handbook, 7th Edition

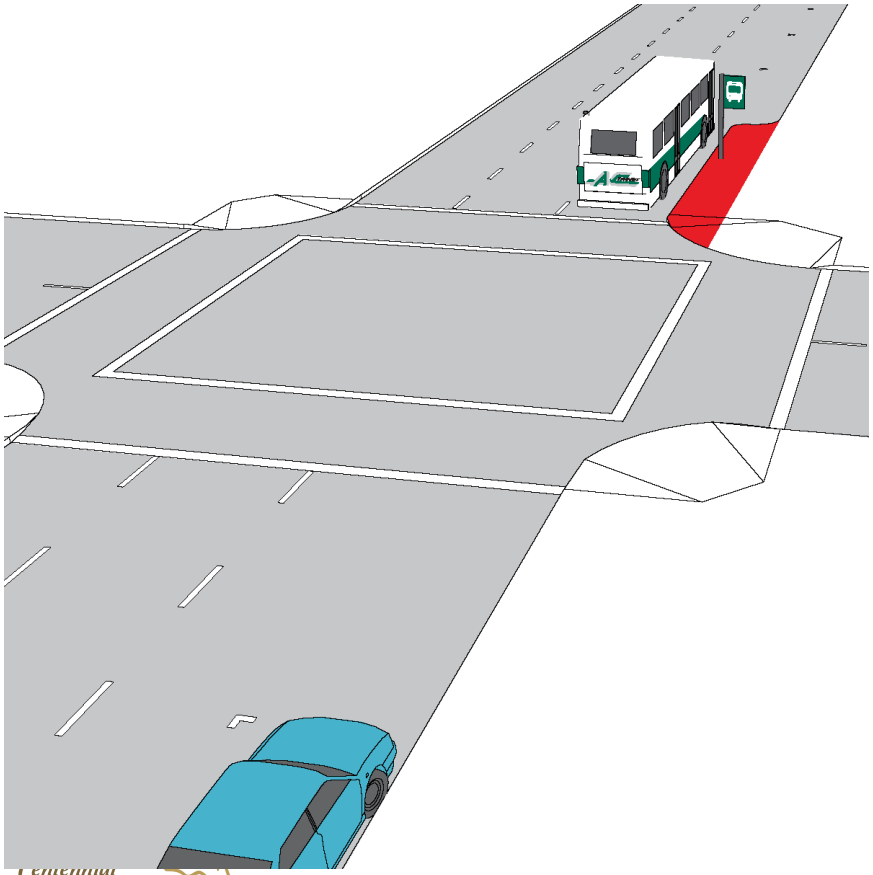
Rightsizing tool: Curb extensions

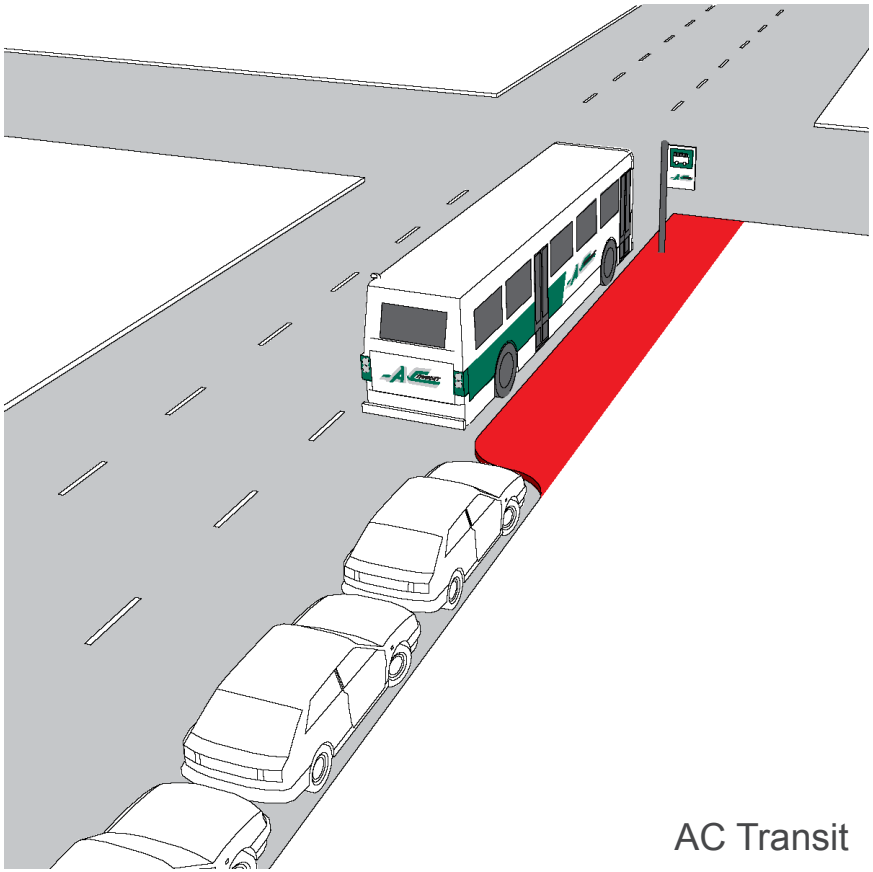
Rightsizing tool: Curb extensions

Can help manage stormwater

Rightsizing tool: Curb extensions

Can provide place for transit customers





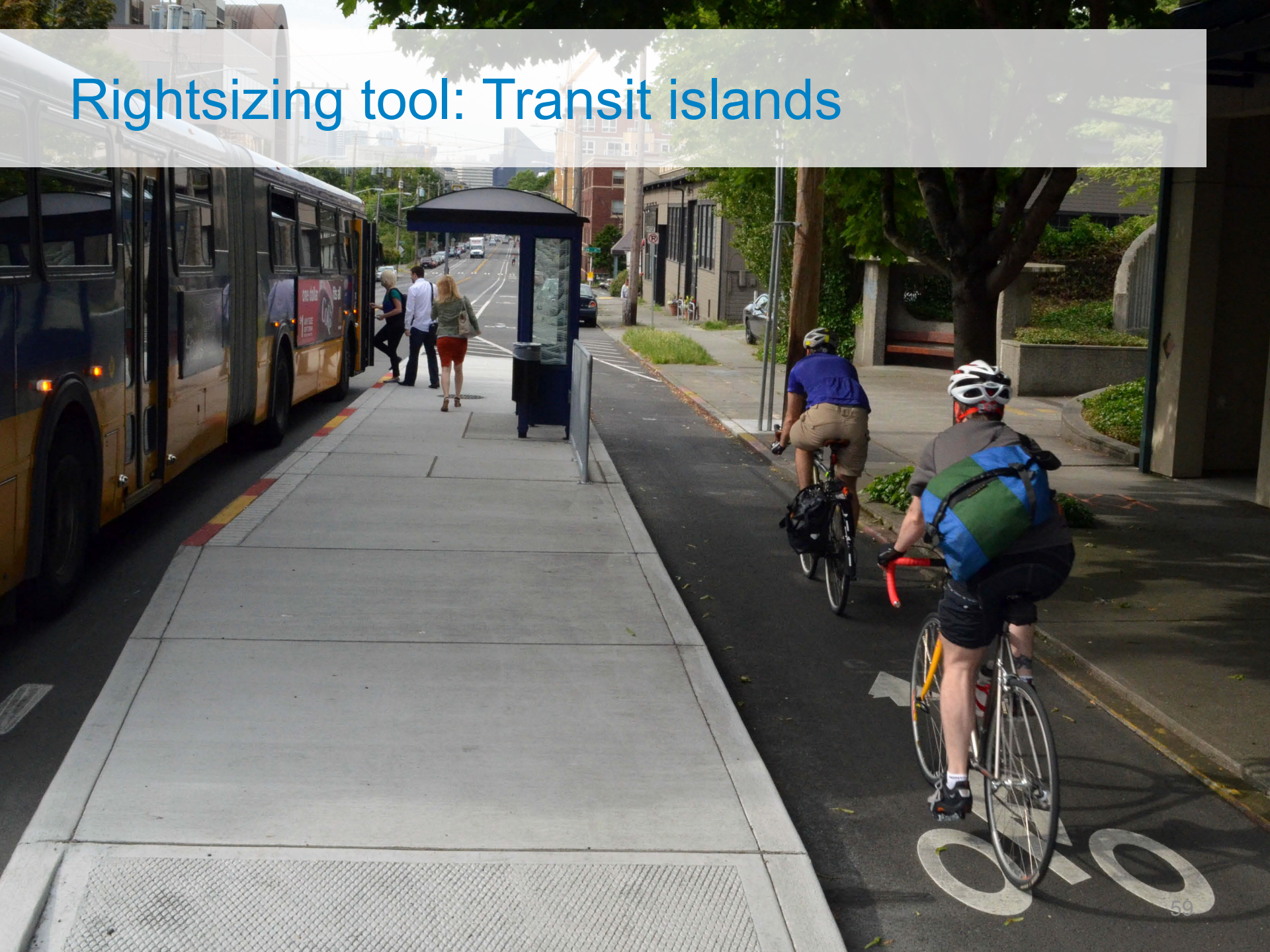
AC Transit

Rightsizing tool: Curb extensions

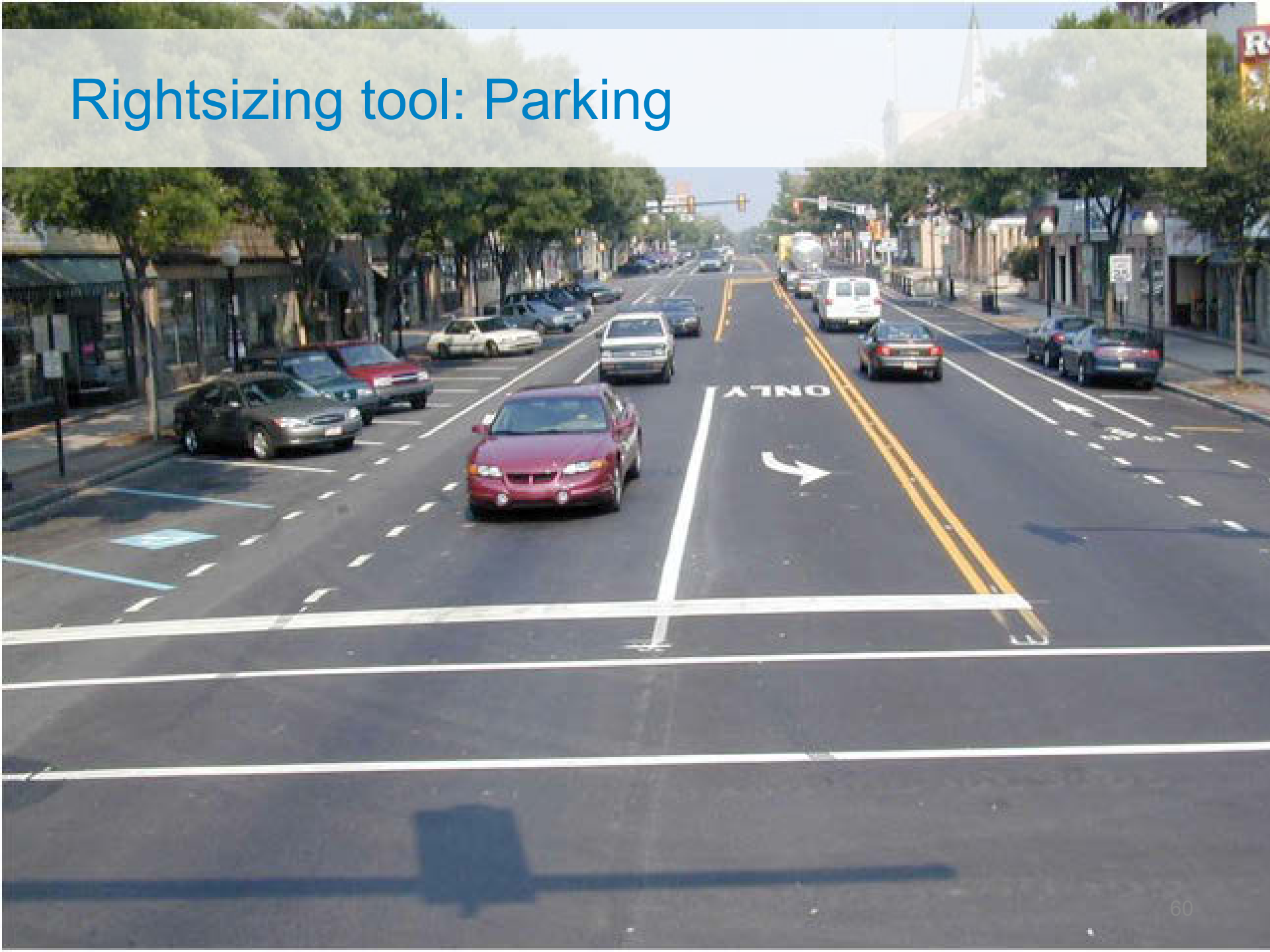
Quick, cheap, meaningful change

Rightsizing tool: Bike lanes

Rightsizing tool: Transit islands



Rightsizing tool: Parking



Rightsizing tool: Parklets and plantings

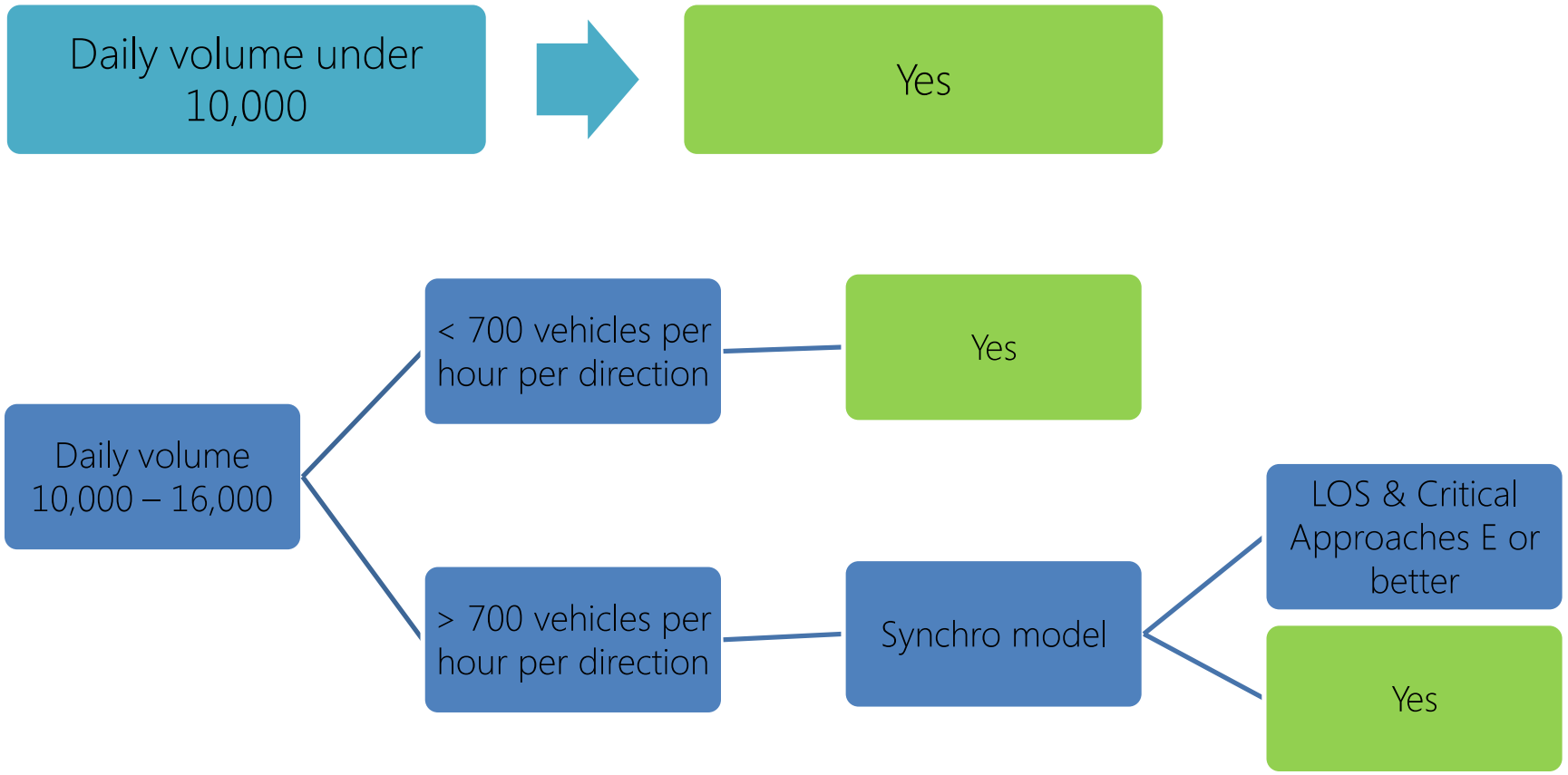
Rightsizing tool: Wider sidewalks

Rightsizing tool: Transit-only ROW

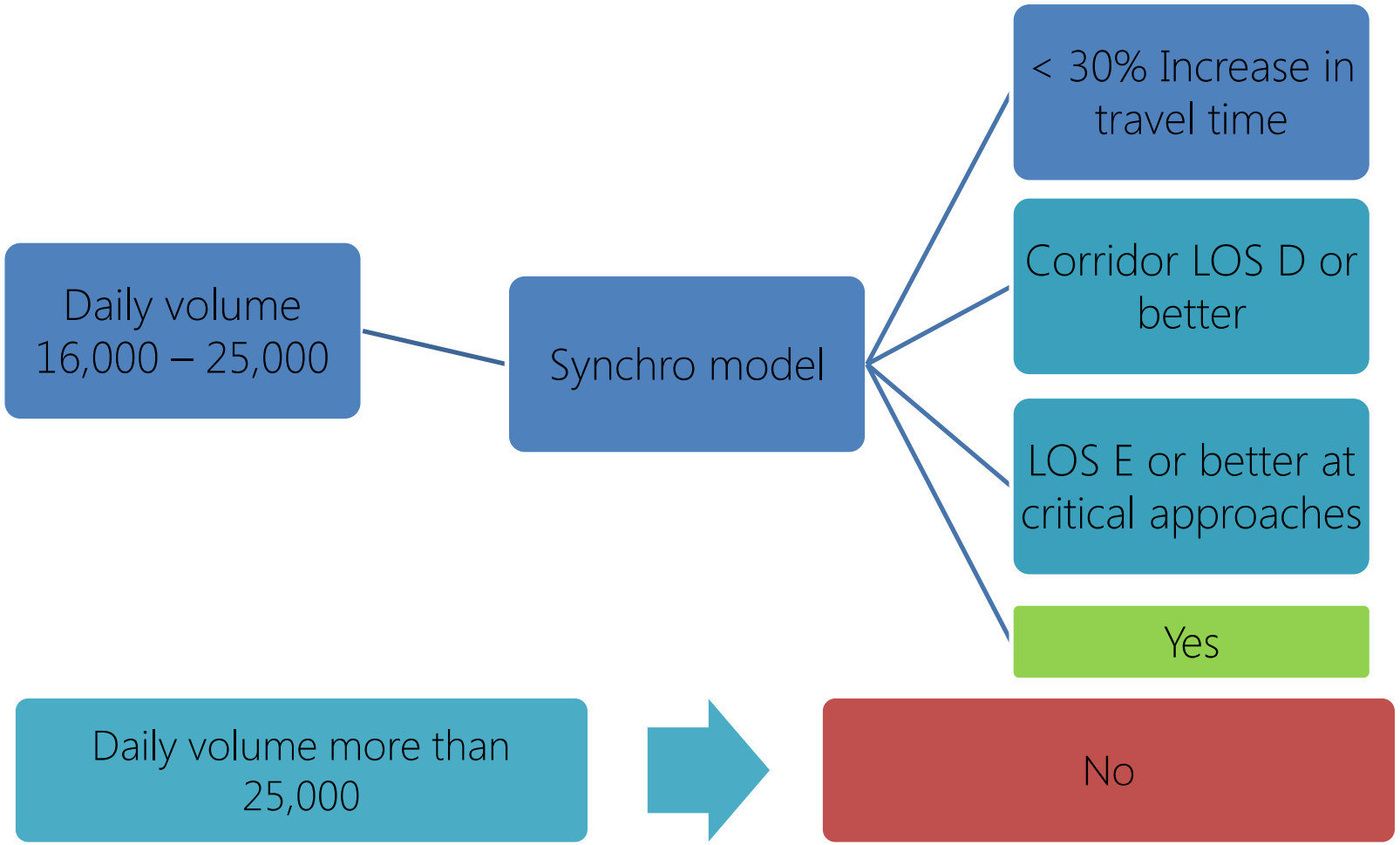
In selection process, Seattle considers:

- Volume of traffic -- less than 25,000 vpd
- Number of collisions -- all modes (motor vehicle, pedestrian, bicycle)
- Vehicle speed
- Number of lanes
- Freight usage
- Bus stops and routing
- Travel time
- Accessibility

Seattle's Guidelines for Rightsizing



Seattle's Guidelines for Rightsizing



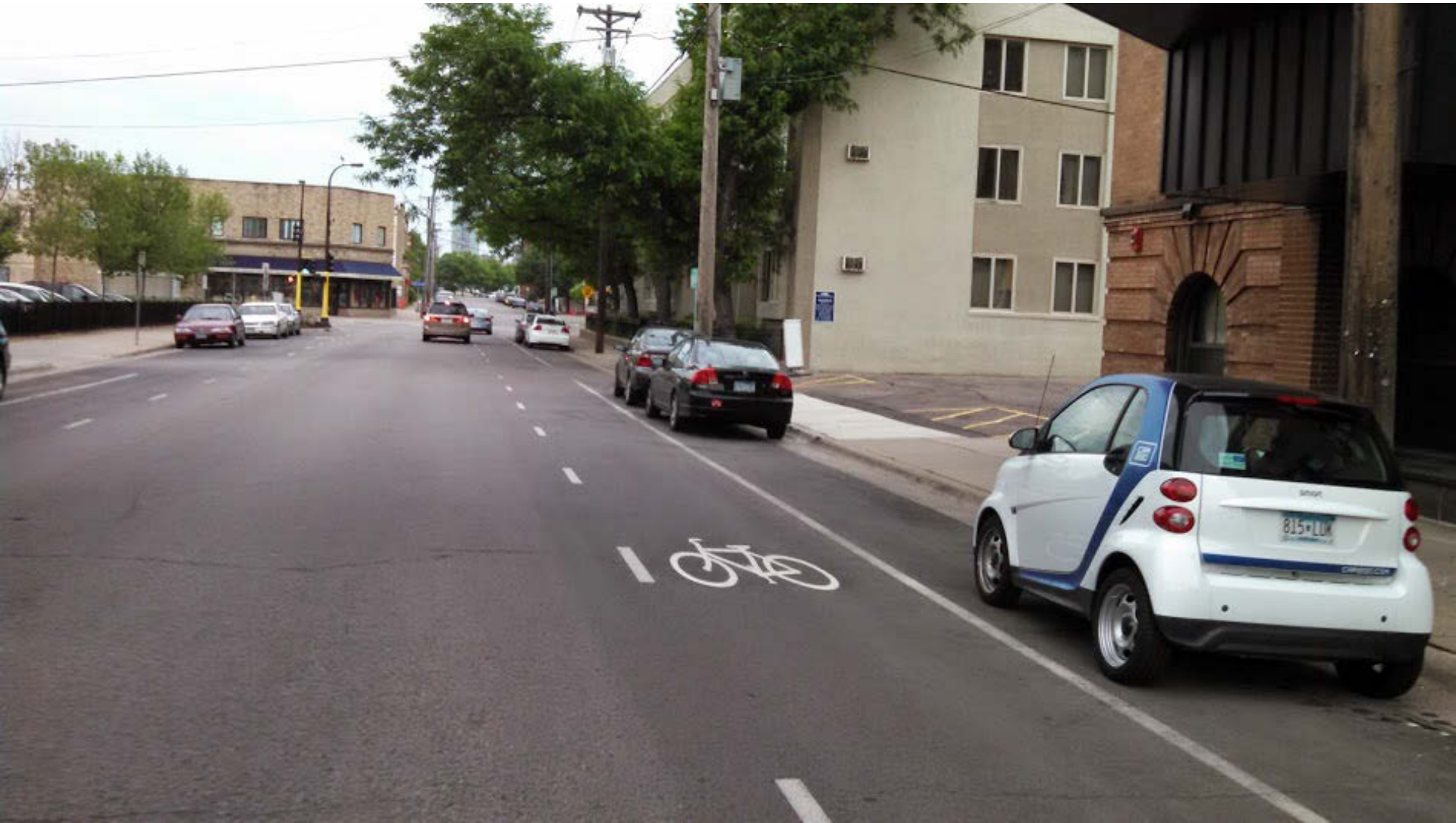
Every street is different, these are just guidelines

Following construction, Seattle measures:

- Volume of the principal street's peak hour capacity
- Speed and collisions
- Traffic signal level of service
- Volume of traffic on parallel arterials
- Travel times
- Bicycle volumes

Sharing space

Sharing limited space: Advisory bike lanes



Advisory bike lanes

- Encourage slow travel in shared space
- Low-volume, narrow streets
- Similar to standard bike lanes, but with solid white outside lane, dotted white line on left
- Remove yellow center line, but not overall width or space for maneuvering vehicles
- OK to drive in bike lane if person on bike isn't present
- Experimental
- May require higher level of support

Typical Dutch application

- Usually collector roads
- Speeds of 30-50km/h in urban areas, up to 60 km/h in rural
- Up to 8000 ADT

Advisory bike lane on narrow rural road

Advisory bike lanes, modified

Sharing space: “Super Sharrows”

“Super Sharrows”

Sharing space: bus-bike lanes

Sharing space: parking lane planters

Parking lane planters

Parking lane planters

- Downtown commercial and residential environments, esp with limited ROW
- Design options:
  - Join with adjacent sidewalk planter
  - Separate from curb (with optional decorate grate)
  - Allow stormwater infiltration
- Soil improvements needed
- Should not extend beyond the parking lane
- Trees need to be pruned

Parking lane planters

Sharing space: Woonerfs

Capacity and delay

Defining mobility

- Typical experience:
  - 45 mph speed
  - 2 min wait at signal

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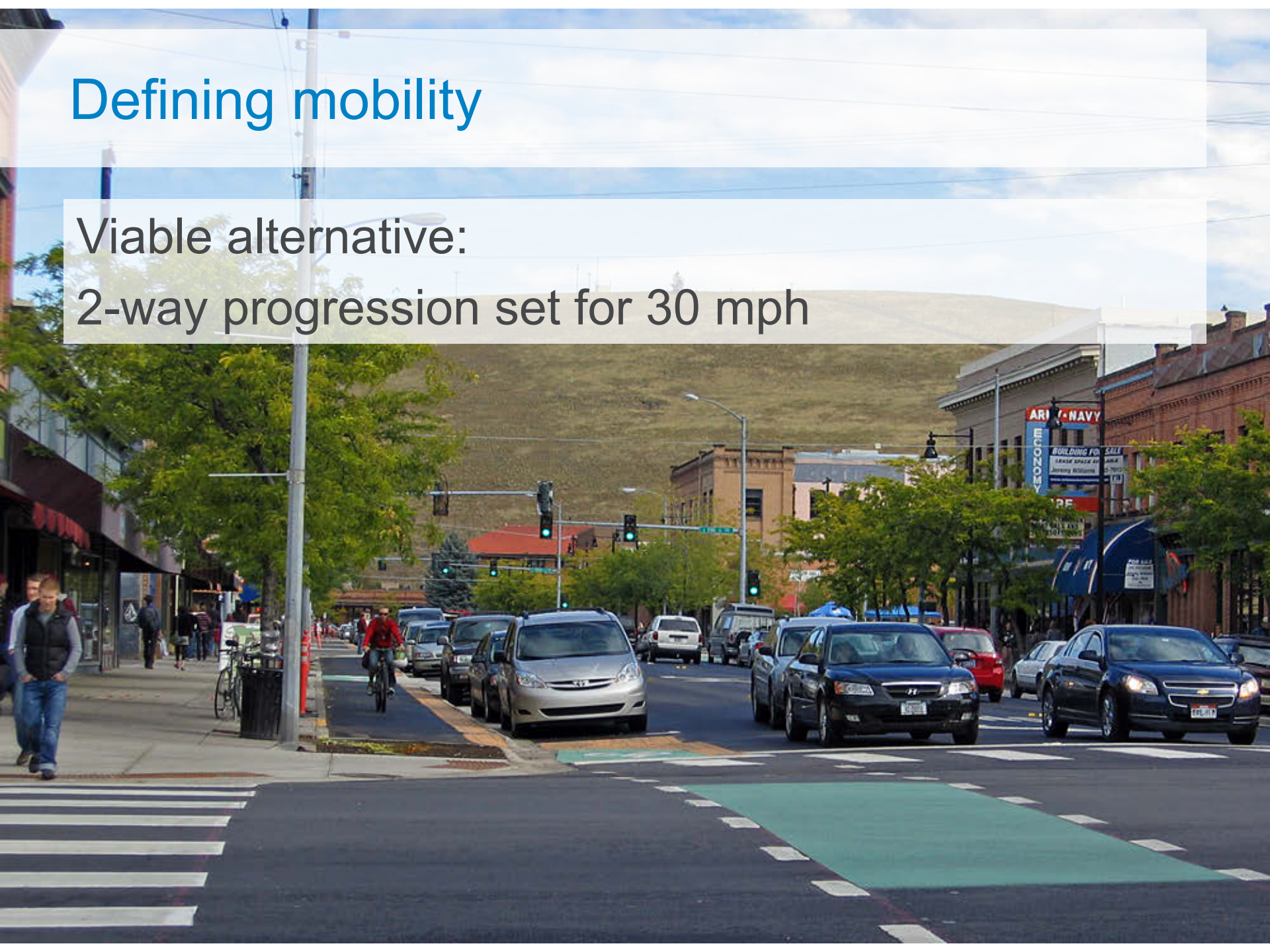
Defining mobility

Viable alternative:

2-way progression set for 30 mph



Benefit/Cost Analysis

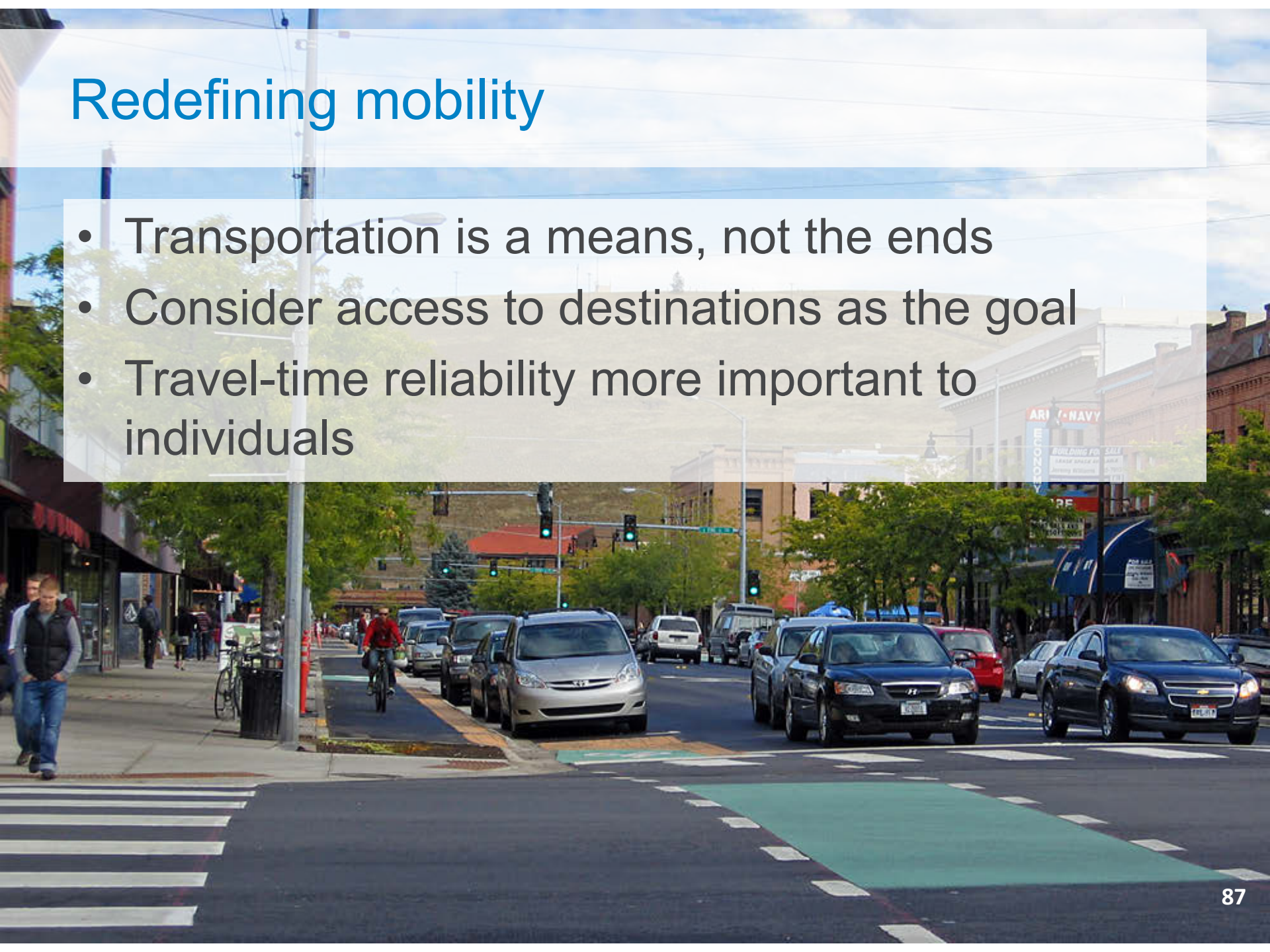
- Reducing speed from 45 mph to 30 mph
  - For a 5-mile trip, a 3.33-minute delay
  - Assume 30,000 ADT and $20/hr driver cost
  - $12.154 million in yearly loss to economy, right?
- Wrong!
  - Delay for each person is still 3.33 minutes
  - Less time than their daily stop for Starbucks
- Community benefit
  - Slower operating speeds
  - Safer and more comfortable ped crossings

Defining mobility

Signal progression for driving and bicycling

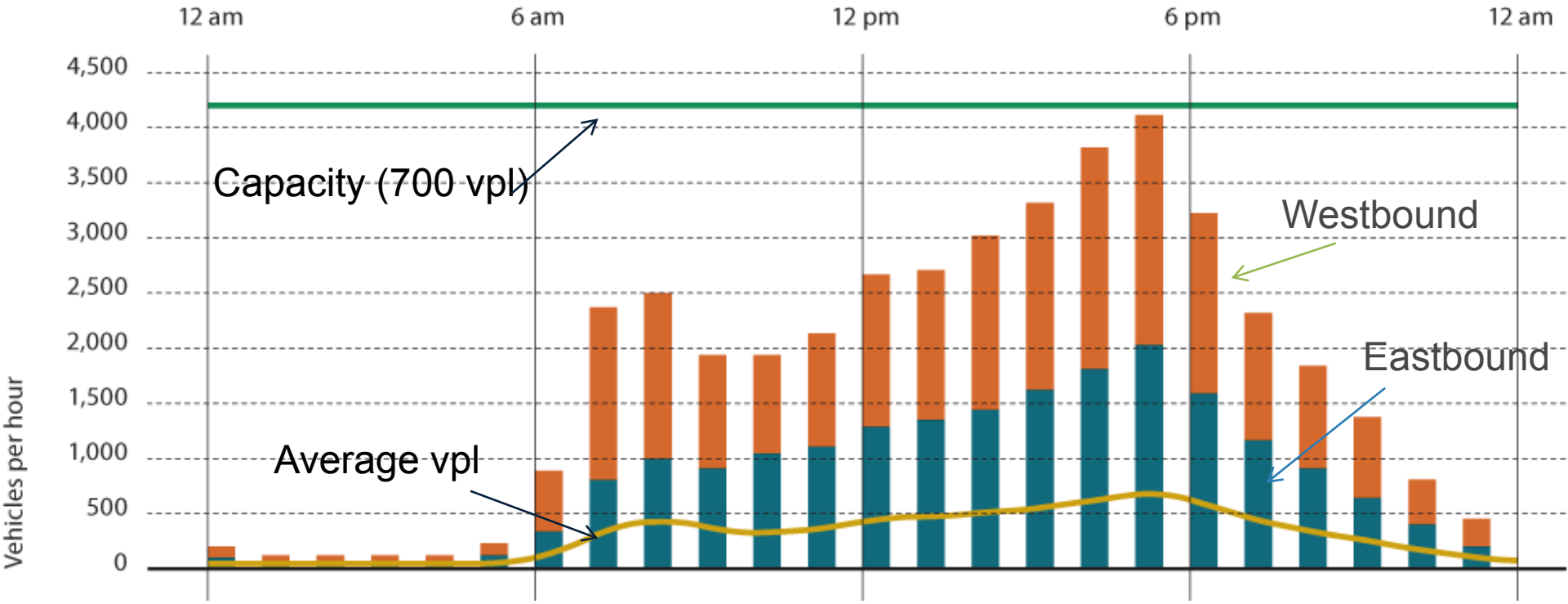
Redefining mobility

- Transportation is a means, not the ends
- Consider access to destinations as the goal
- Travel-time reliability more important to individuals



Peak hour and overall capacity

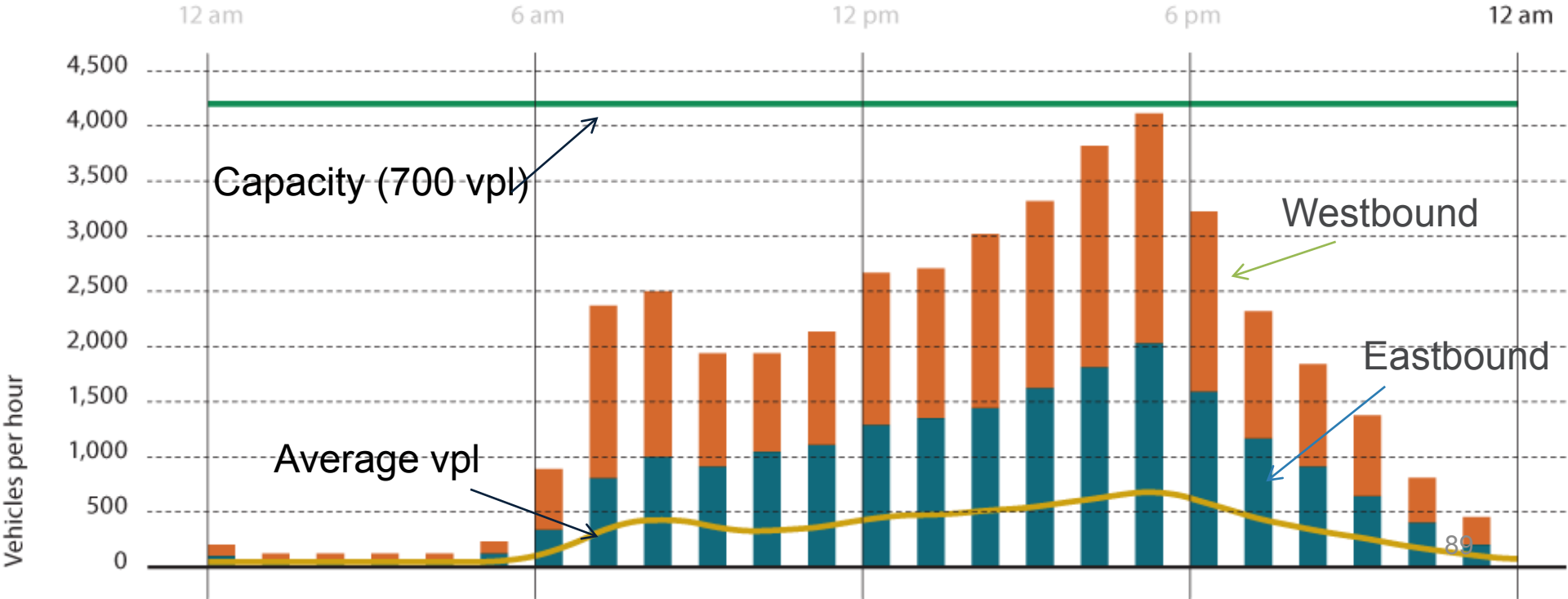
Consider a typical 6-lane urban arterial with ADT of approx. 42,000:



NACTO

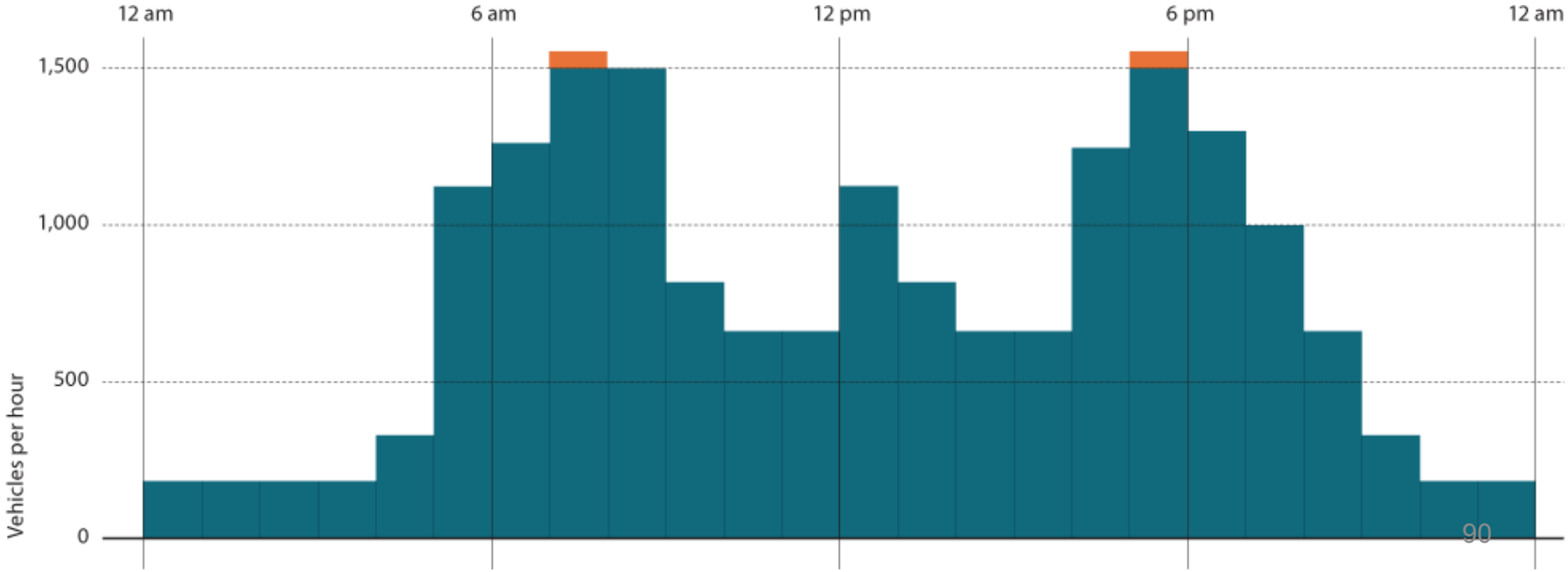
Peak hour and overall capacity

- Auto traffic is well below capacity most hours of the day
- Are 6 lanes really needed? Can the space be repurposed for walking, bicycling, transit?

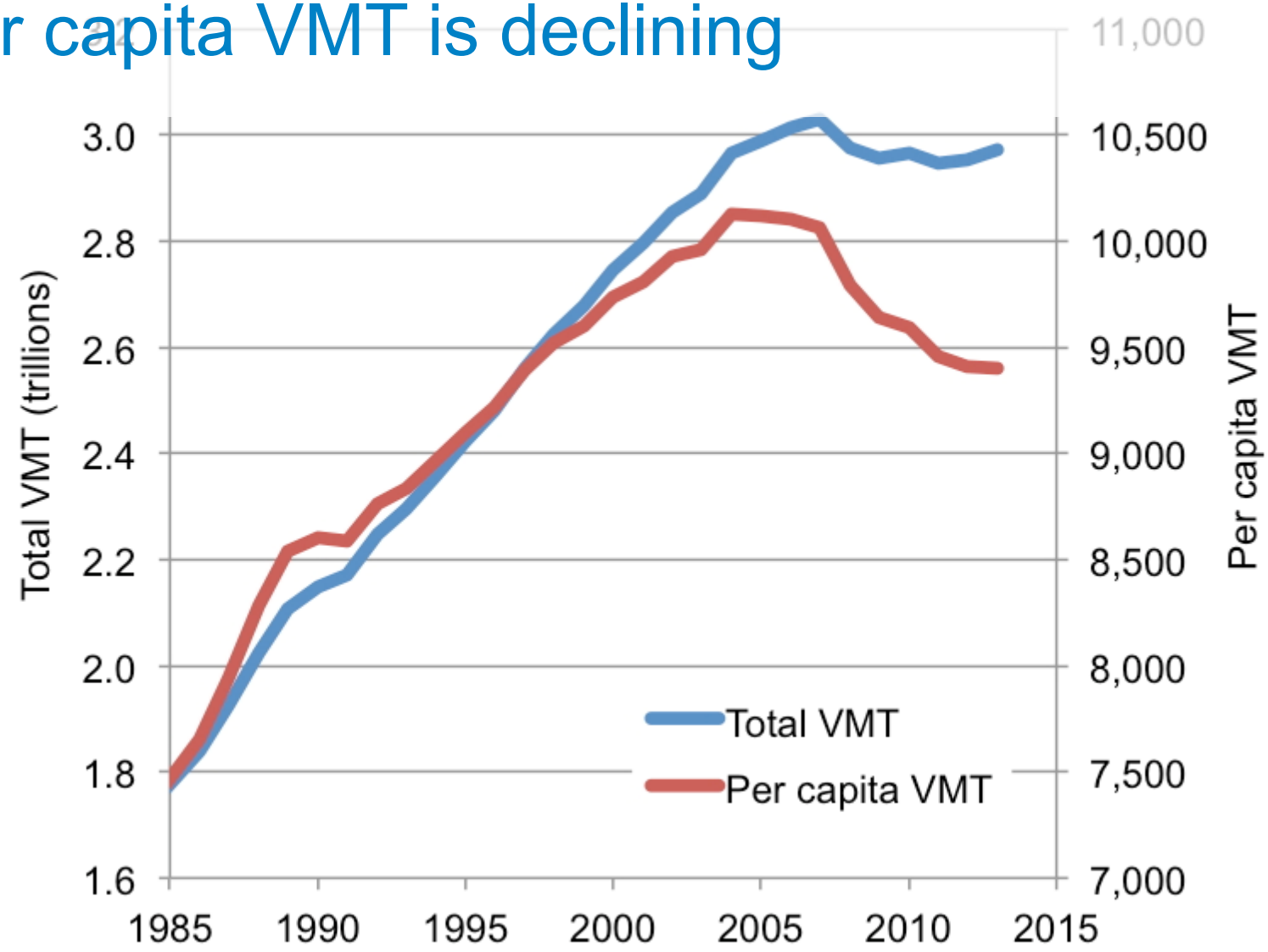


Peak hour

- Collect multi-modal data over 2-4 hours of peak traffic
- Use signal timing or TDM to shift congestion
- Use corridor-level performance measures rather than specific intersection peak LOS
- Look for solutions at the network level



Per capita VMT is declining



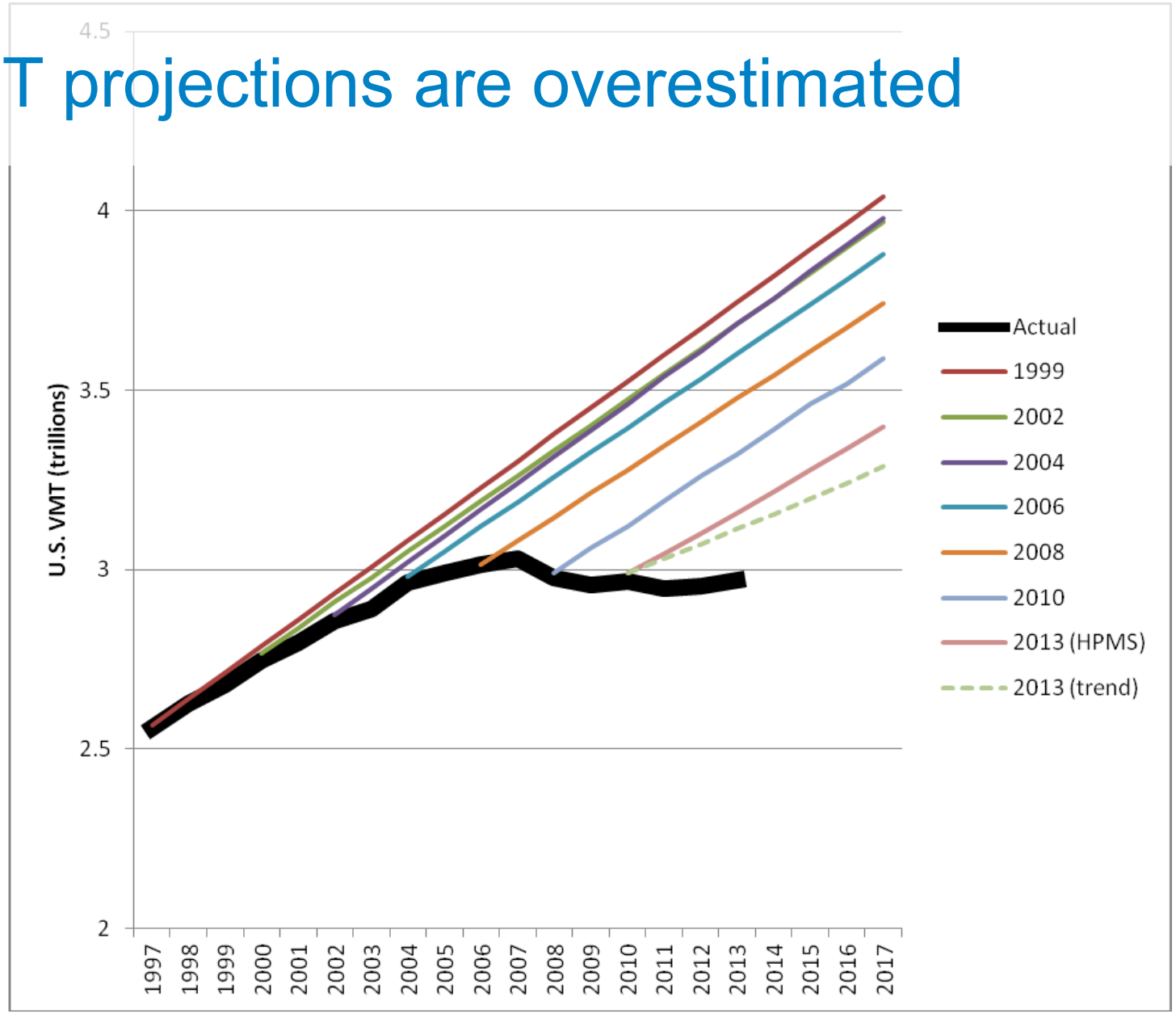
Source: FHWA and Census Bureau, SSTI

VMT has reached inflection point

- Stabilized trends: income, car ownership, licensing
- Travel time budget constraints have been hit
- Combined cost of auto travel: maintenance, parking, insurance, etc.
- Lifestyle and travel choices

McCahill, 2013

VMT projections are overestimated



U.S. VMT (in trillions) as tracked by FHWA's Travel Volume Trends ("Actual") and as projected by U.S. DOT's C&P reports (by year reports are dated). Source: SSTI

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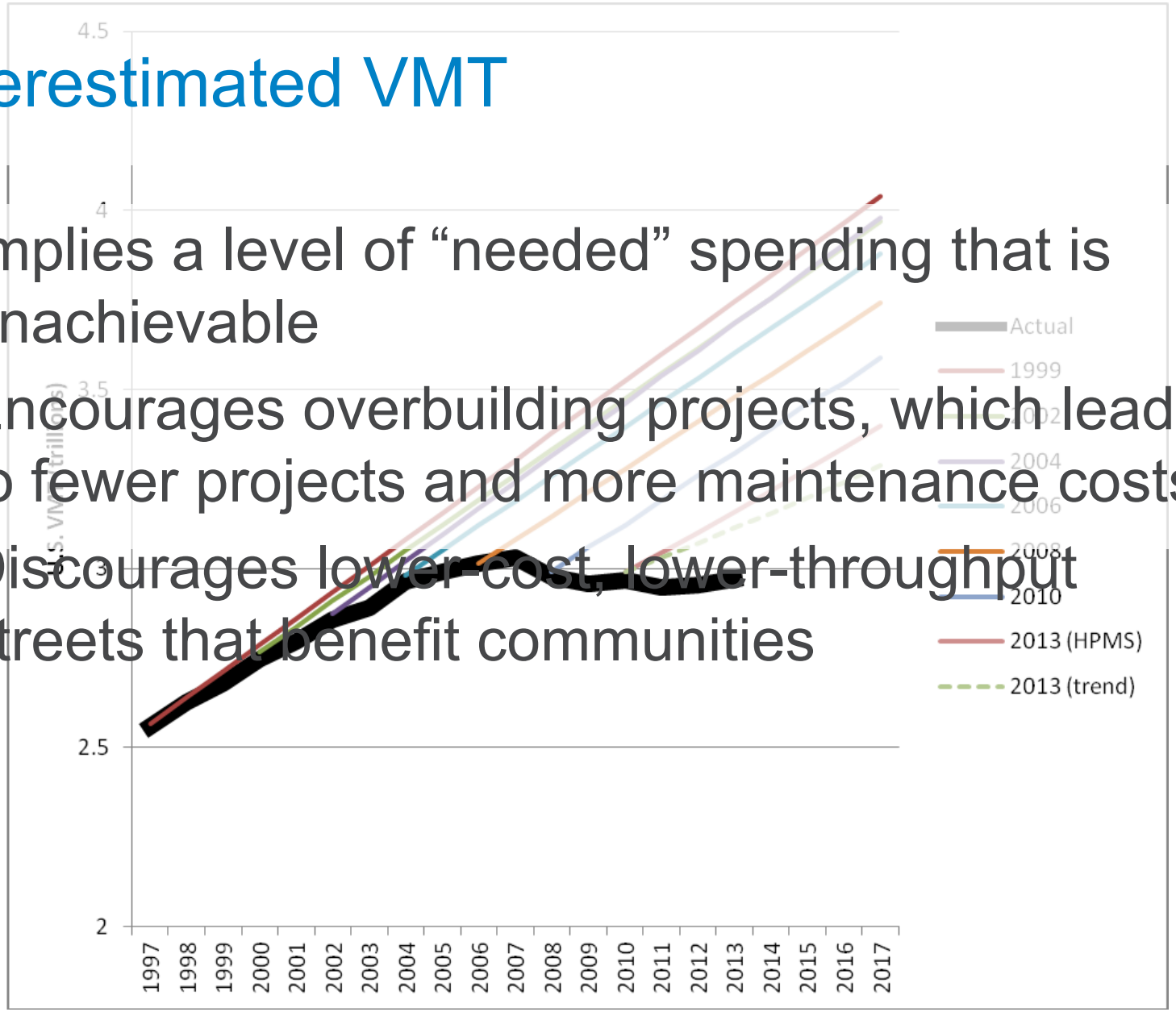
The reality

A post-construction analysis of traffic on arterials and collectors in urban areas revealed traffic forecasts were **overestimated by a significant amount**

Pavithra Parthasarathi and David Levinson, "Post Construction Evaluation of Traffic Forecast Accuracy," Transport Policy (2010): 1–16.

Overestimated VMT

- Implies a level of "needed" spending that is unachievable
- Encourages overbuilding projects, which leads to fewer projects and more maintenance costs
- Discourages lower-cost, lower-throughput streets that benefit communities



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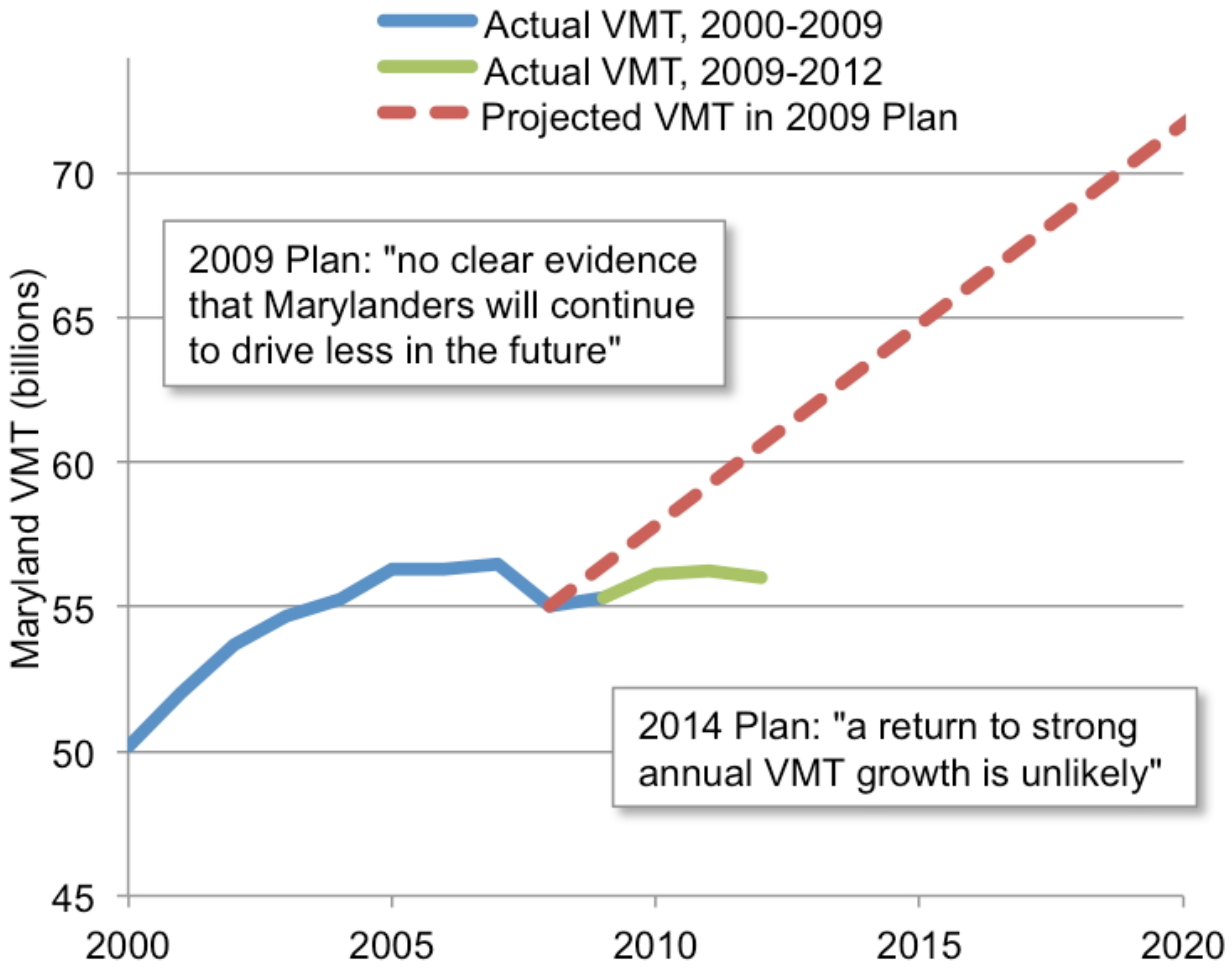
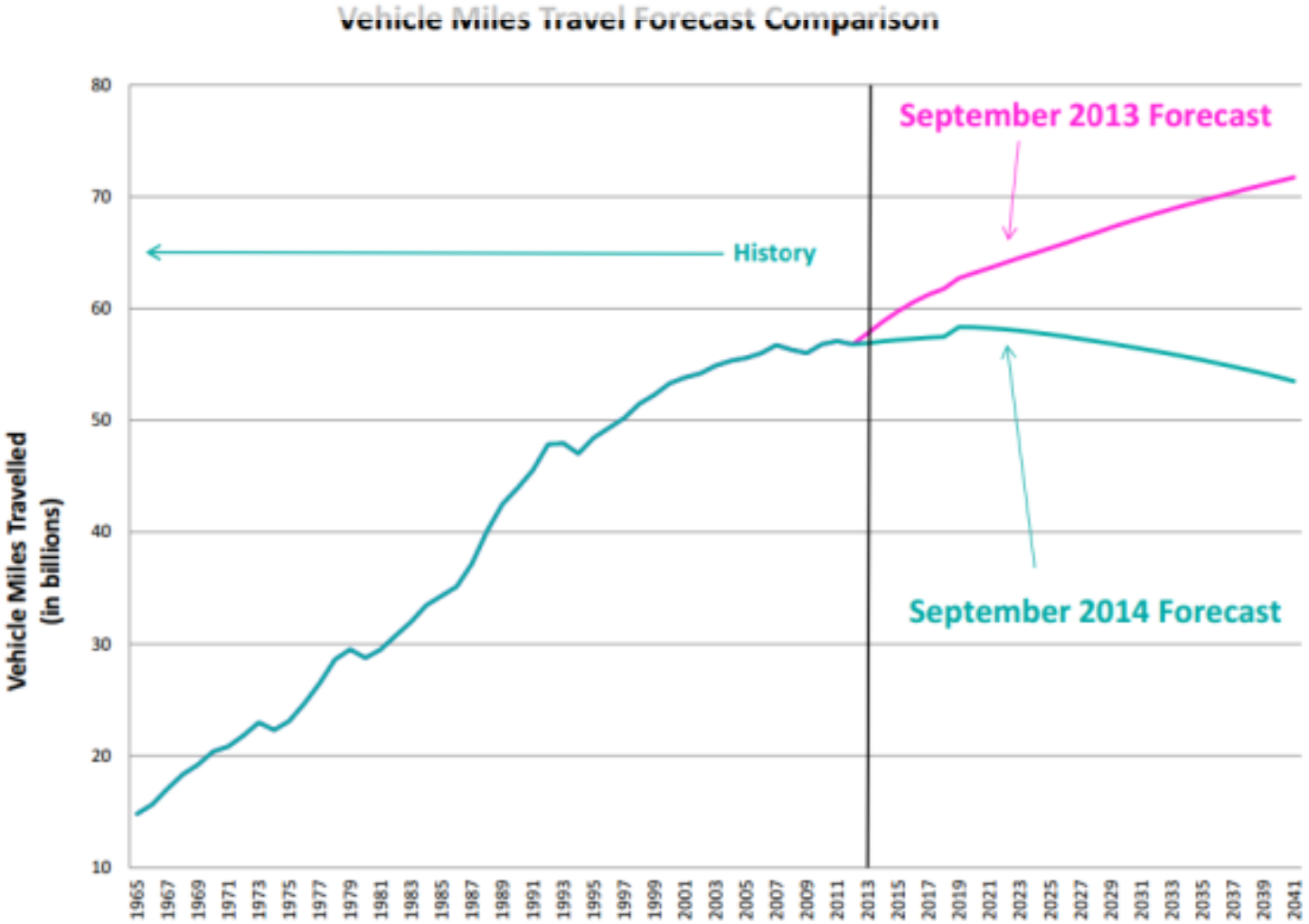
In Maryland:



VMT in Maryland and projected VMT from state long-range plans. Source: FHWA and Maryland Department of Transportation, via SSTI

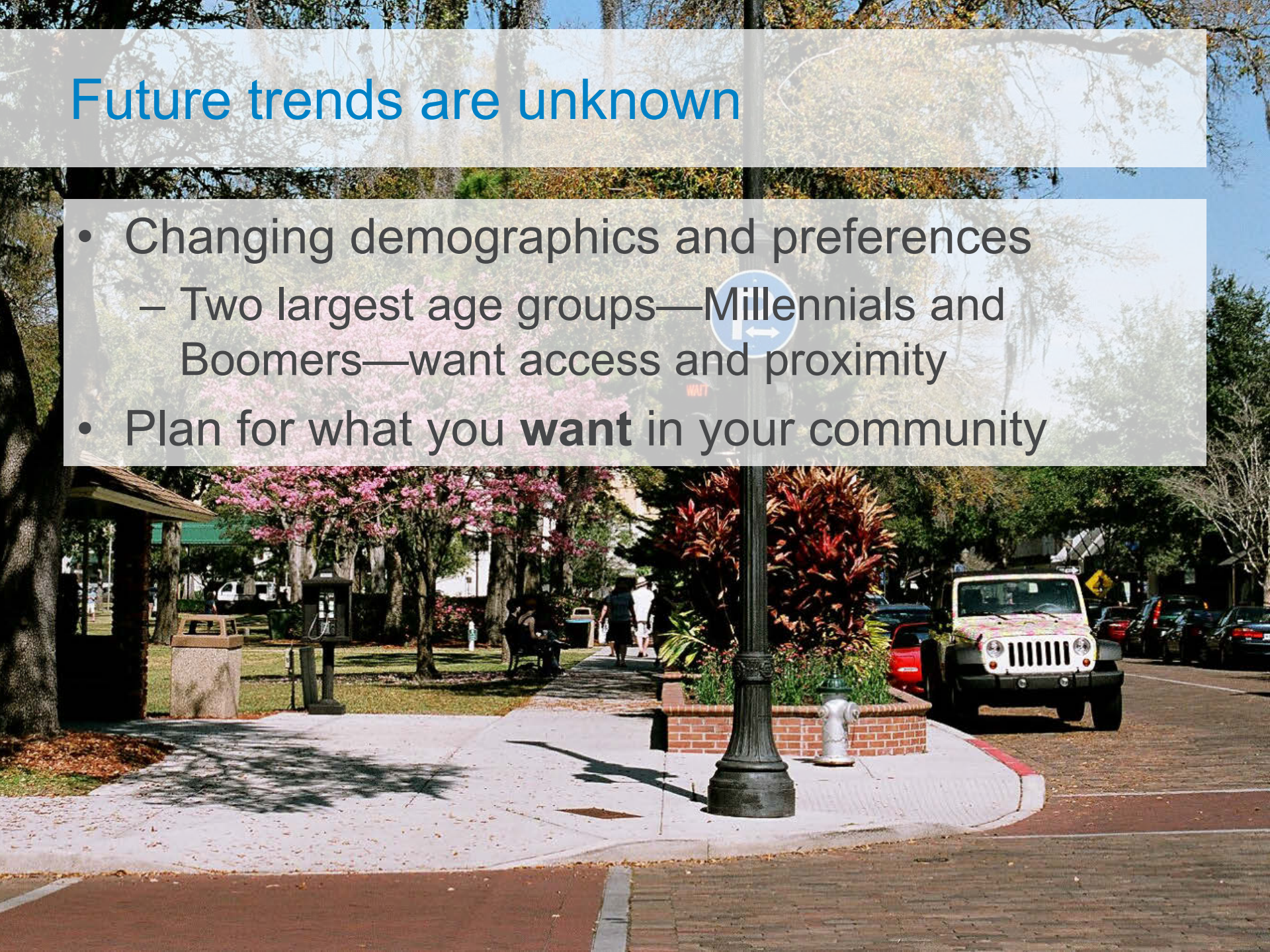
In Washington:



Source: Washington OFM, Transportation Revenue Forecast Council

Future trends are unknown

- Changing demographics and preferences
  - Two largest age groups—Millennials and Boomers—want access and proximity
- Plan for what you **want** in your community



Intersection design

Intersection principles

- Compact
- Self-evident
- Simple, right angles
- Access management
- Timed for safety of all users

INTERSECTION DESIGN ELEMENTS

- Crosswalks and Crossings
  - Crosswalks
  - Conventional Crosswalks
  - Midblock Crosswalks
  - Pedestrian Safety Islands
- Corner Radii
- Visibility/Sight Distance

- Traffic Signals
  - Signalization Principles
  - Leading Pedestrian Interval
  - Split-Phasing
  - Signal Cycle Lengths
  - Fixed vs. Actuated Signalization
  - Coordinated Signal Timing

Source: NACTO

Improving intersections, inexpensive:

- Signal timing
  - Short cycles to function as network
  - Reduce person delay
  - Ensure enough time for people of all ages and abilities to cross
  - Coordinated for low-speed travel
  - Fixed-time signals where pedestrians are expected

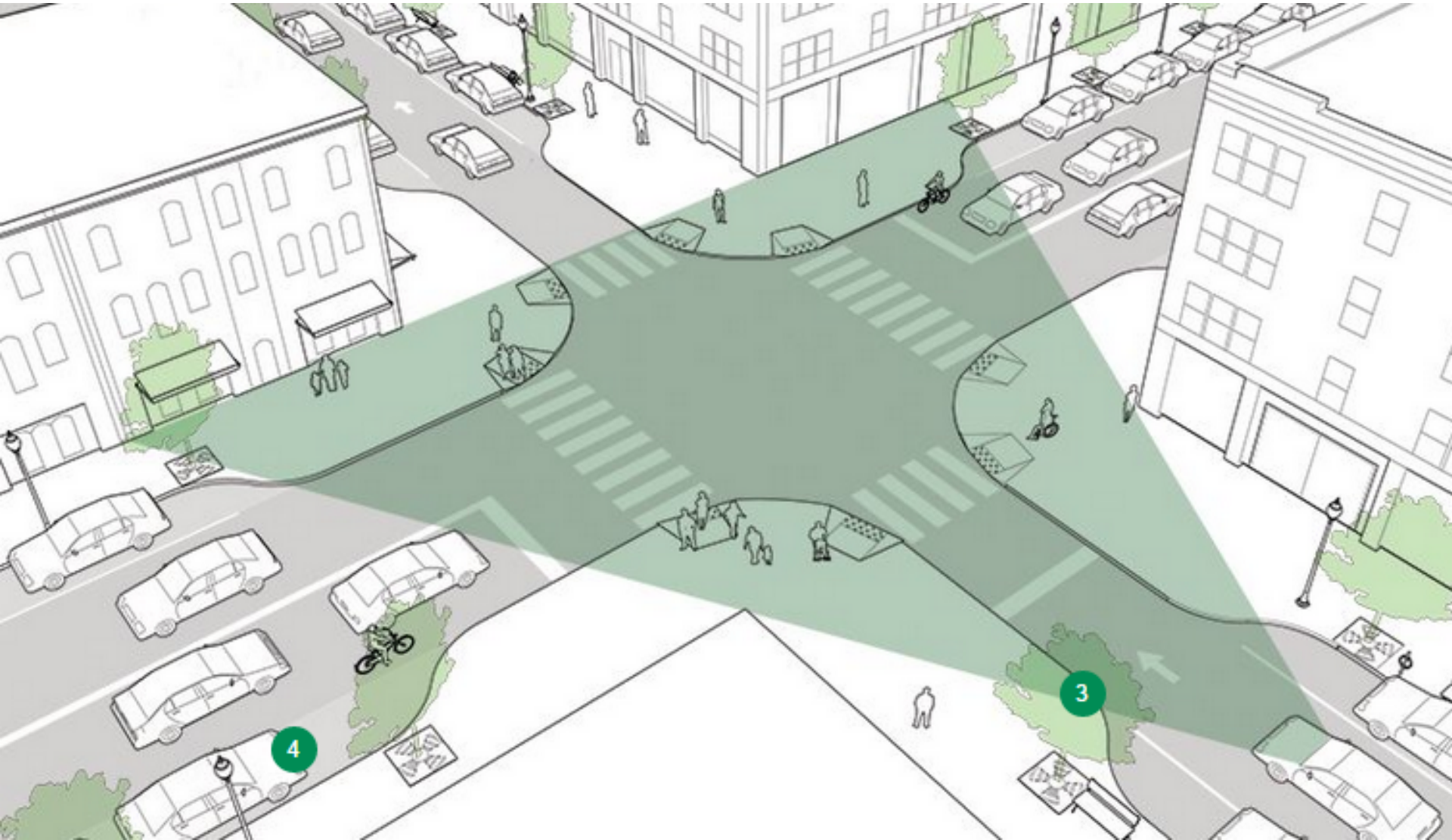
Improving intersections, inexpensive:

- Signal timing
- Leading pedestrian intervals
- Countdown clocks
- HAWK & RRFBs and high visibility crosswalks
- Bike boxes, advance stop lines
- Banning turning movement in crash-prone areas or where walking is prioritized
- Interim design

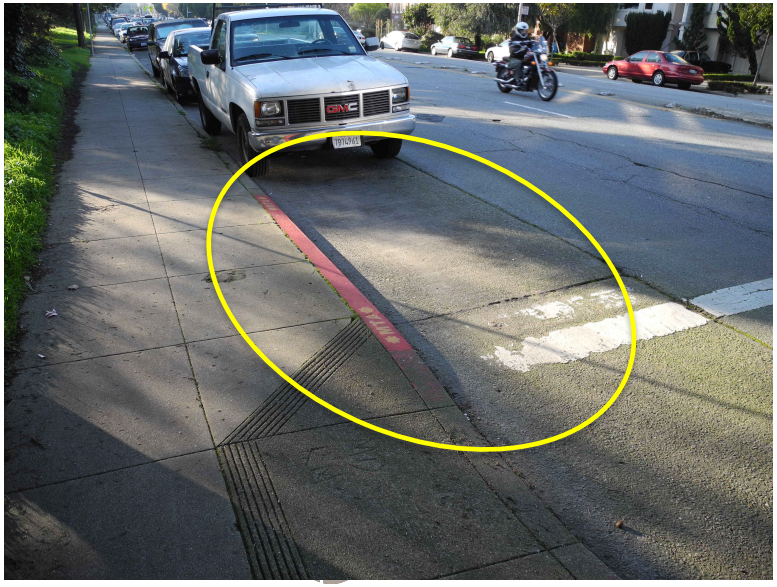
Improving intersections, as part of scope:

- Tighten radii
- Eliminate free right-turn lanes
- Curb extensions
- Modern roundabouts
- Square-off skewed intersections

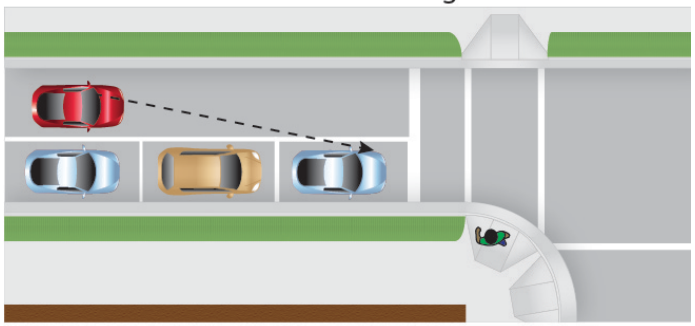
Sight distance at intersections



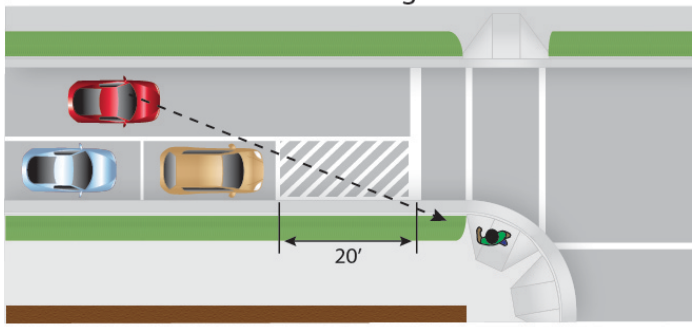
Daylighting



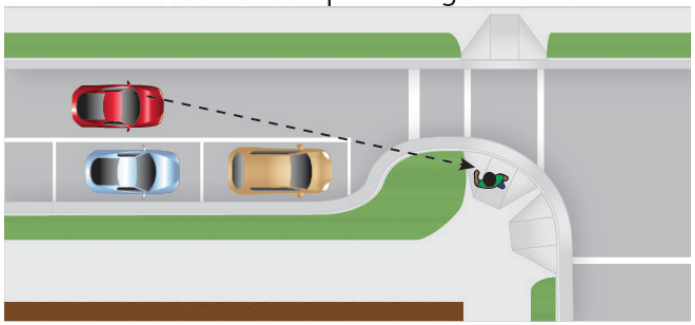
Parked Vehicles Decrease Sight Distance



Parked Setback for Sight Distance



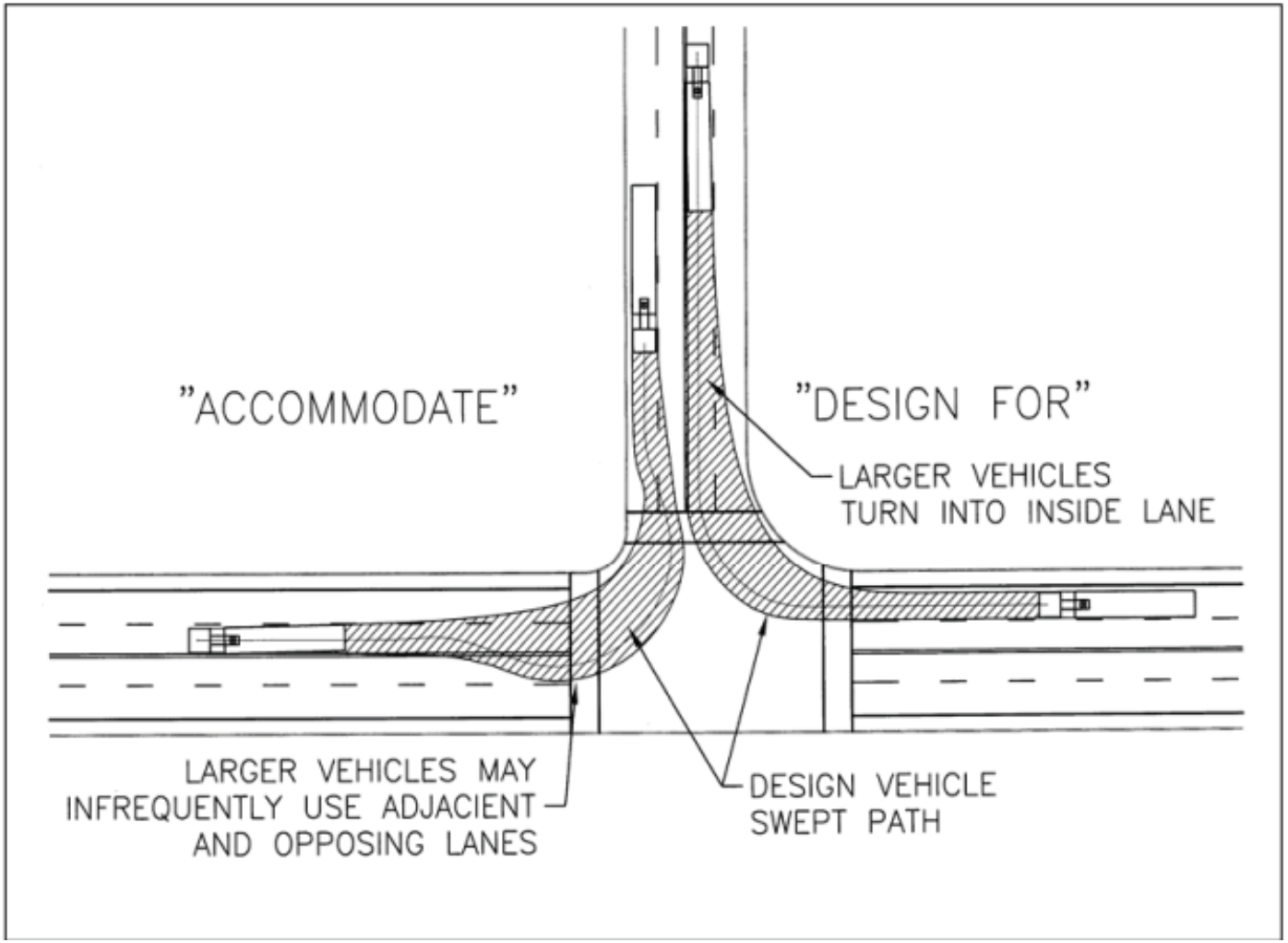
Curb Extension Improves Sight Distance



Simple, low-cost, high-impact

Simple, low-cost, high-impact

Dealing with trucks appropriately



Design Vehicle

Design or control vehicle?

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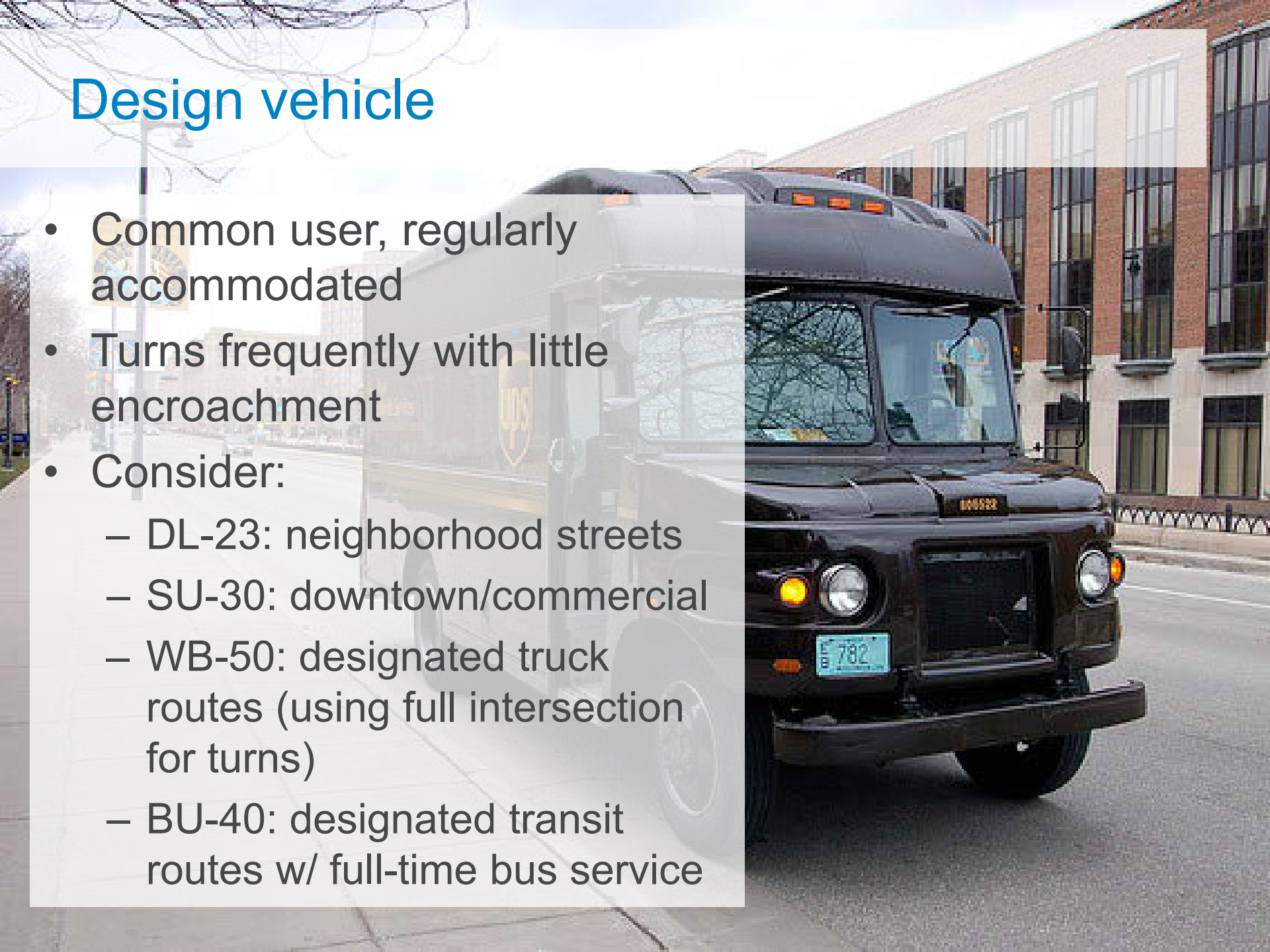
Design or control vehicle?

Design vehicle

- Common user, regularly accommodated
- Turns frequently with little encroachment
- Consider:
  - DL-23: neighborhood streets
  - SU-30: downtown/commercial
  - WB-50: designated truck routes (using full intersection for turns)
  - BU-40: designated transit routes w/ full-time bus service



“Design vehicle” for walking

- Slow-moving older adult
- Vision-impaired people
- Children
- People in wheelchairs
- People walking and texting

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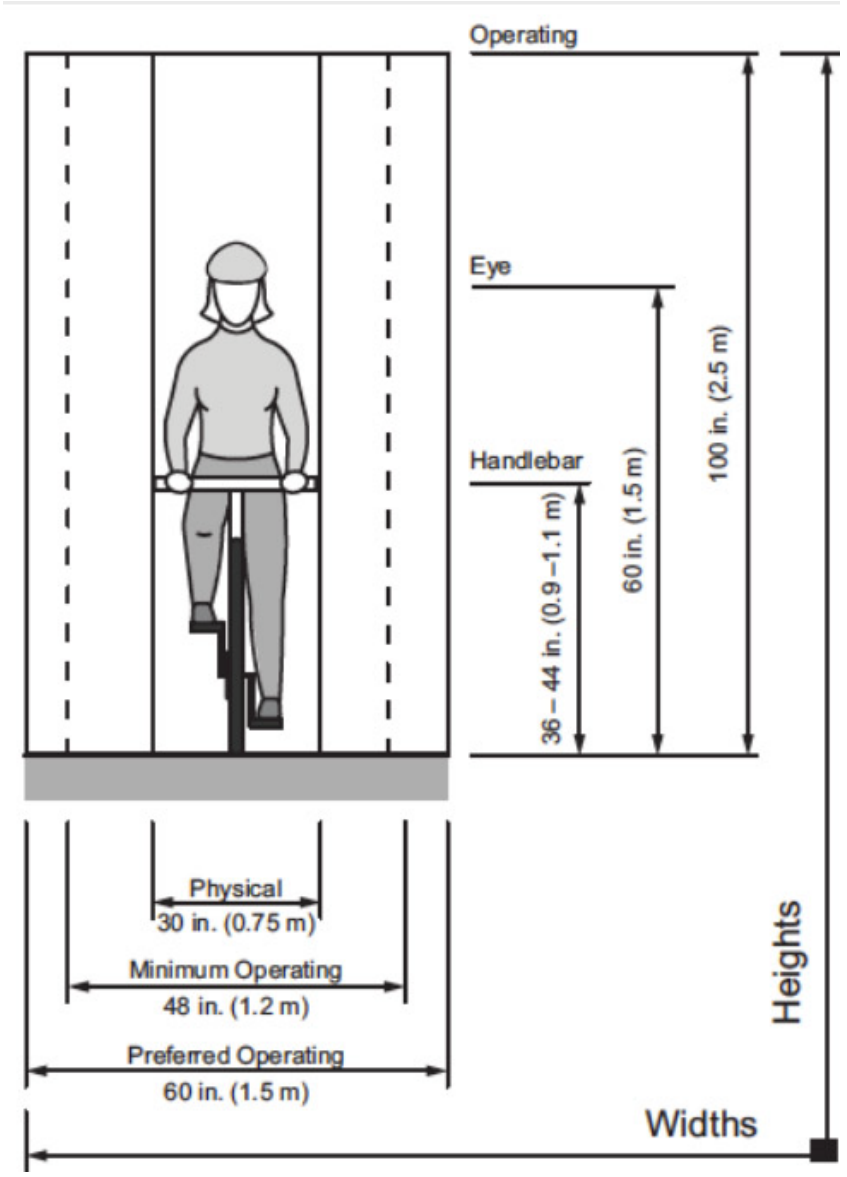
Source: FHWA

“Design vehicle” for bicycling

- Dimensions
- Speed: 18 mph*
- Ages?
- Abilities?
- Other types of bikes?

Source: AASHTO Bike Guide, 4th Edition



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Types of bicyclists

Facilities

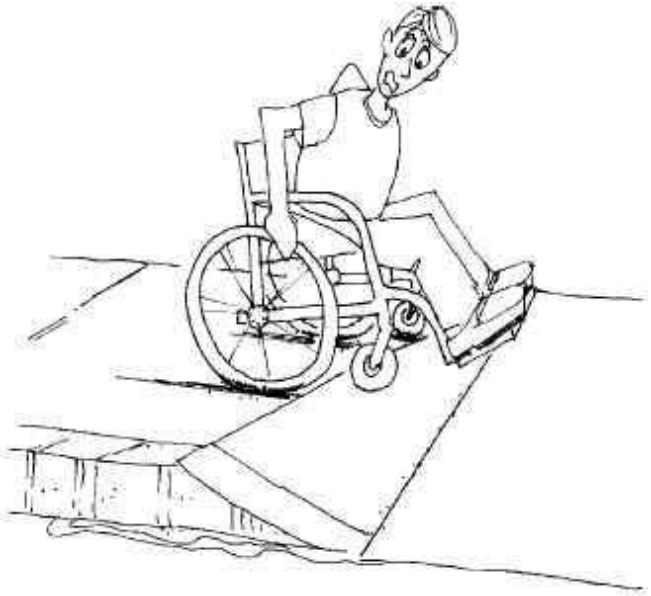
Details matter for walking and bicycling

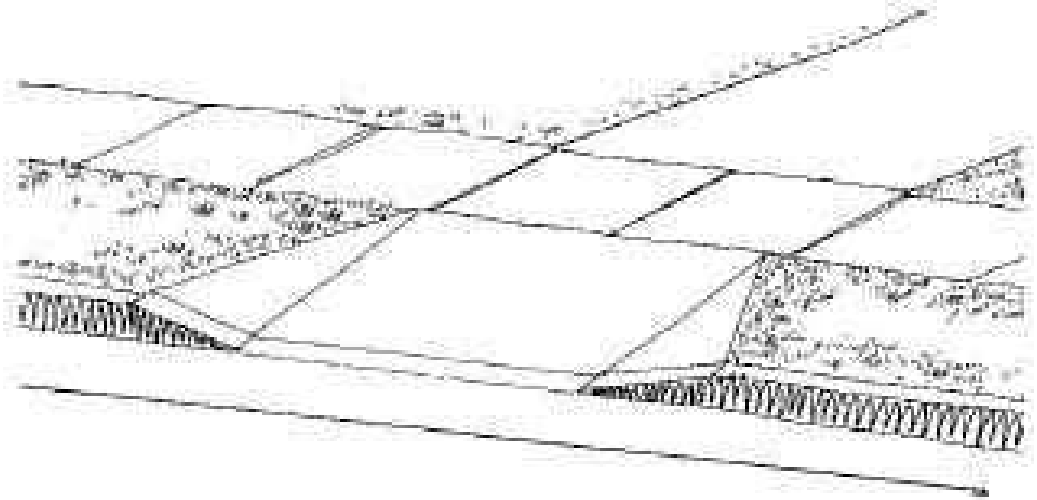
For example:

- Pavement or sidewalk condition
- Repaving that leaves a lip at curb
- Gutter pan seam in bike lane
- Placement and orientation of intersection curb ramps

Sidewalks and driveways

- Safety, accessibility, and comfort





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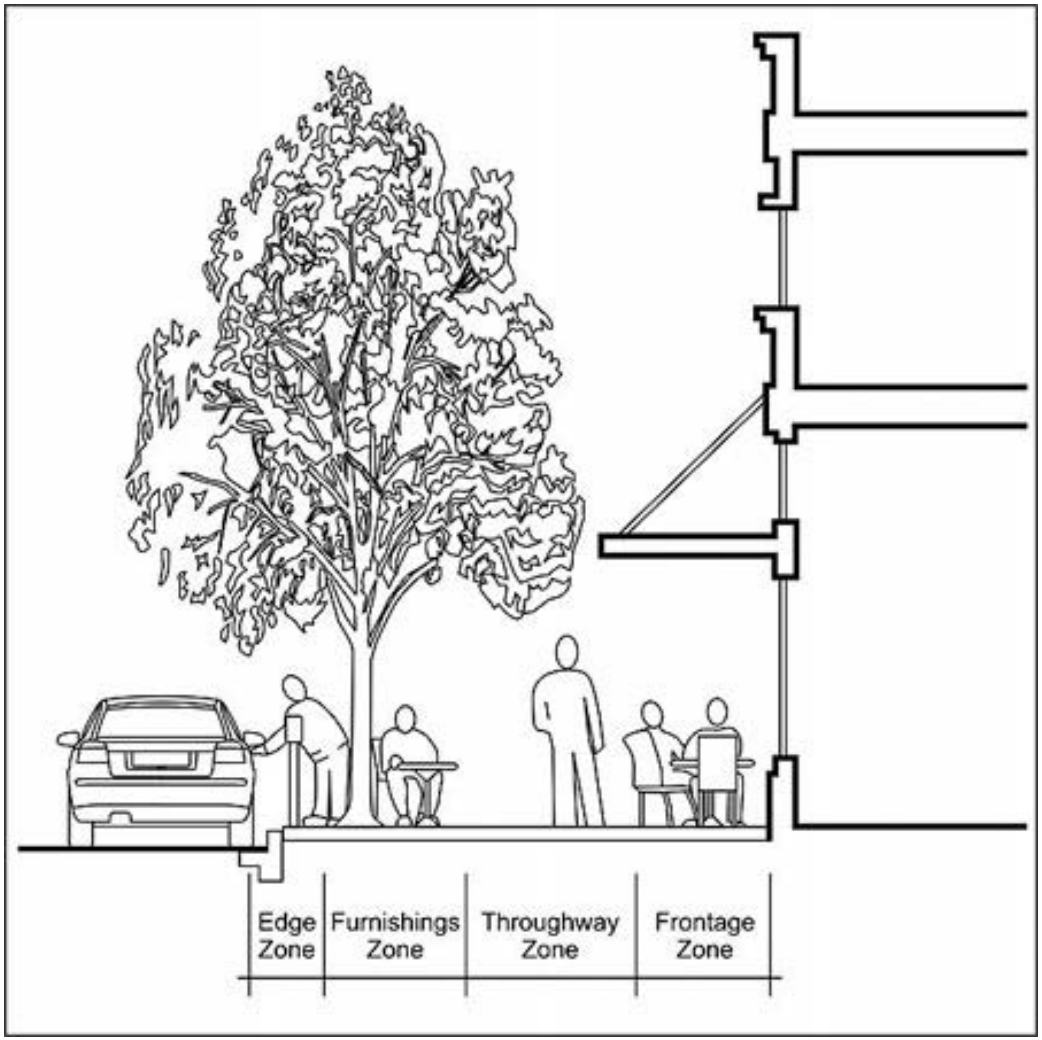
Source: FHWA

Sidewalks: continuous network

Sidewalks: separated from auto traffic



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Source: ITE

Crossings: frequent and near destinations

Crossings: midblock

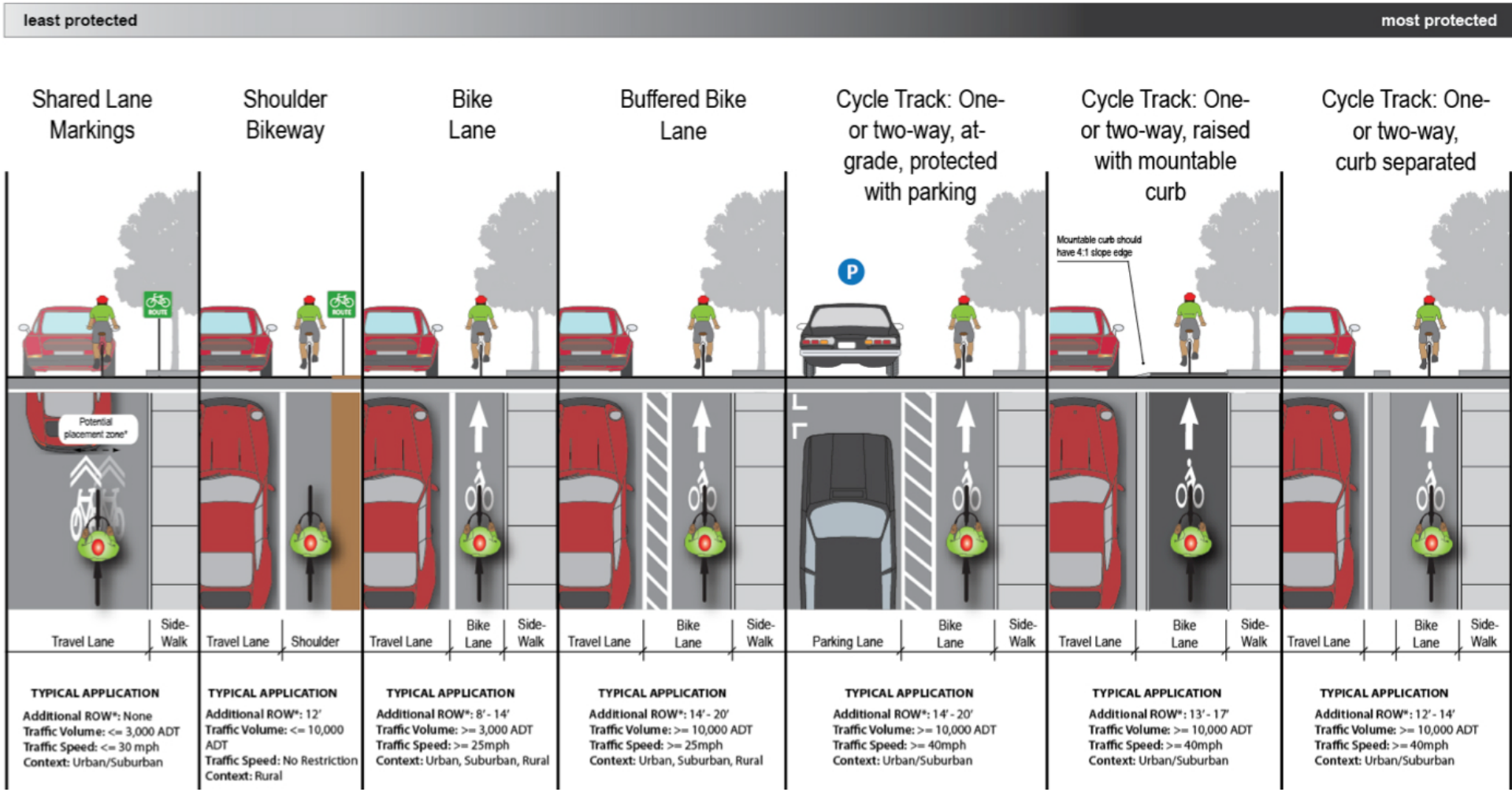
Active treatments

- Pedestrian hybrid beacon “HAWK”
- Rectangular rapid flashing beacon

Choosing the right bicycle facility

- Shared lane markings
- Advisory bike lanes
- Shoulder bikeways
- Conventional bike lanes
- Buffered bike lanes
- Protected bike lanes (cycle tracks)
- Raised cycle tracks
- Shared-use paths
- Bicycle boulevards
- Trails

Choosing the right bicycle facility



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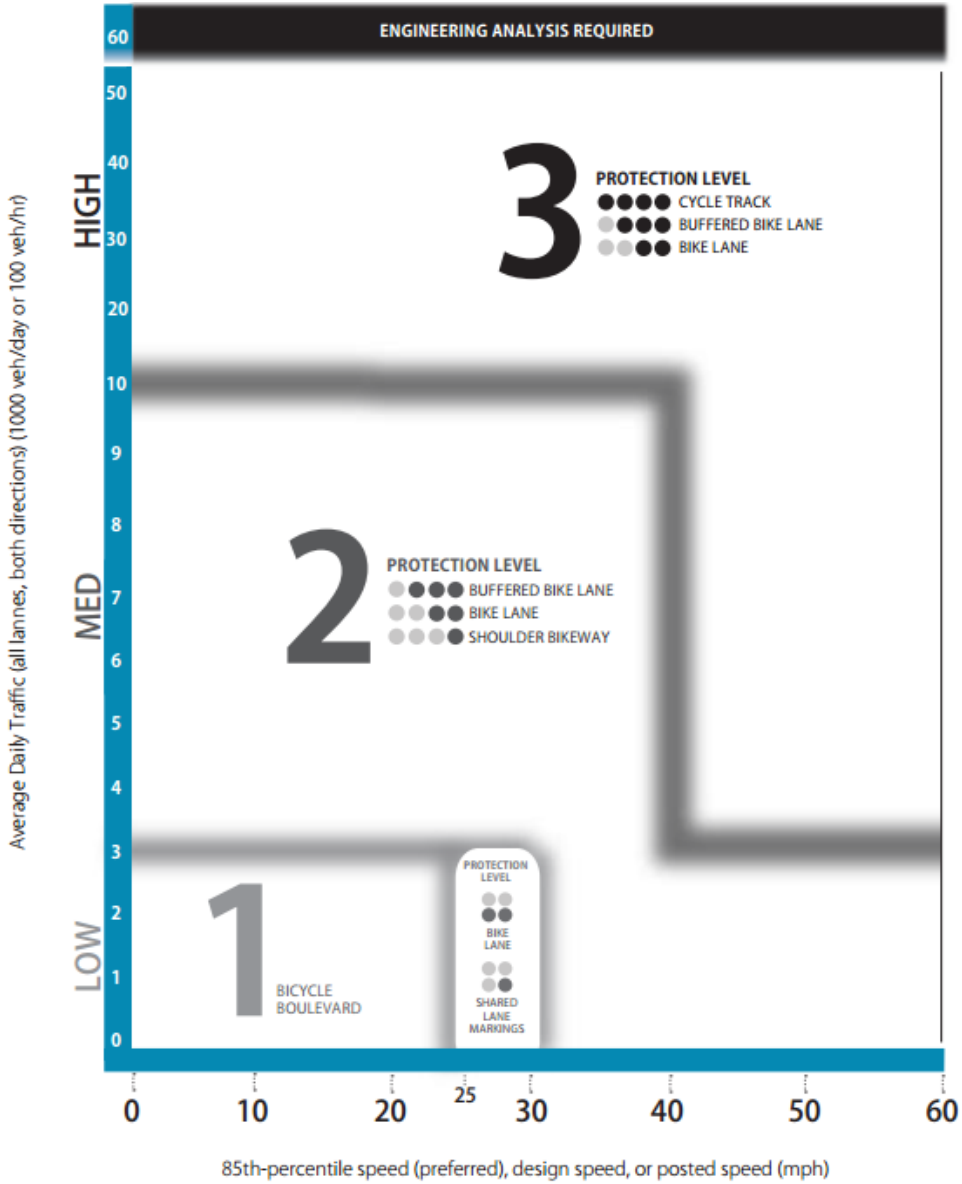
Source: Alta Planning and Design

Choosing the right bicycle facility

- Land use
- User preference
- Automobile speed
- Automobile volume
- Number of travel lanes
- Network needs
- Site-specific circumstances



Source: Washington County, Oregon

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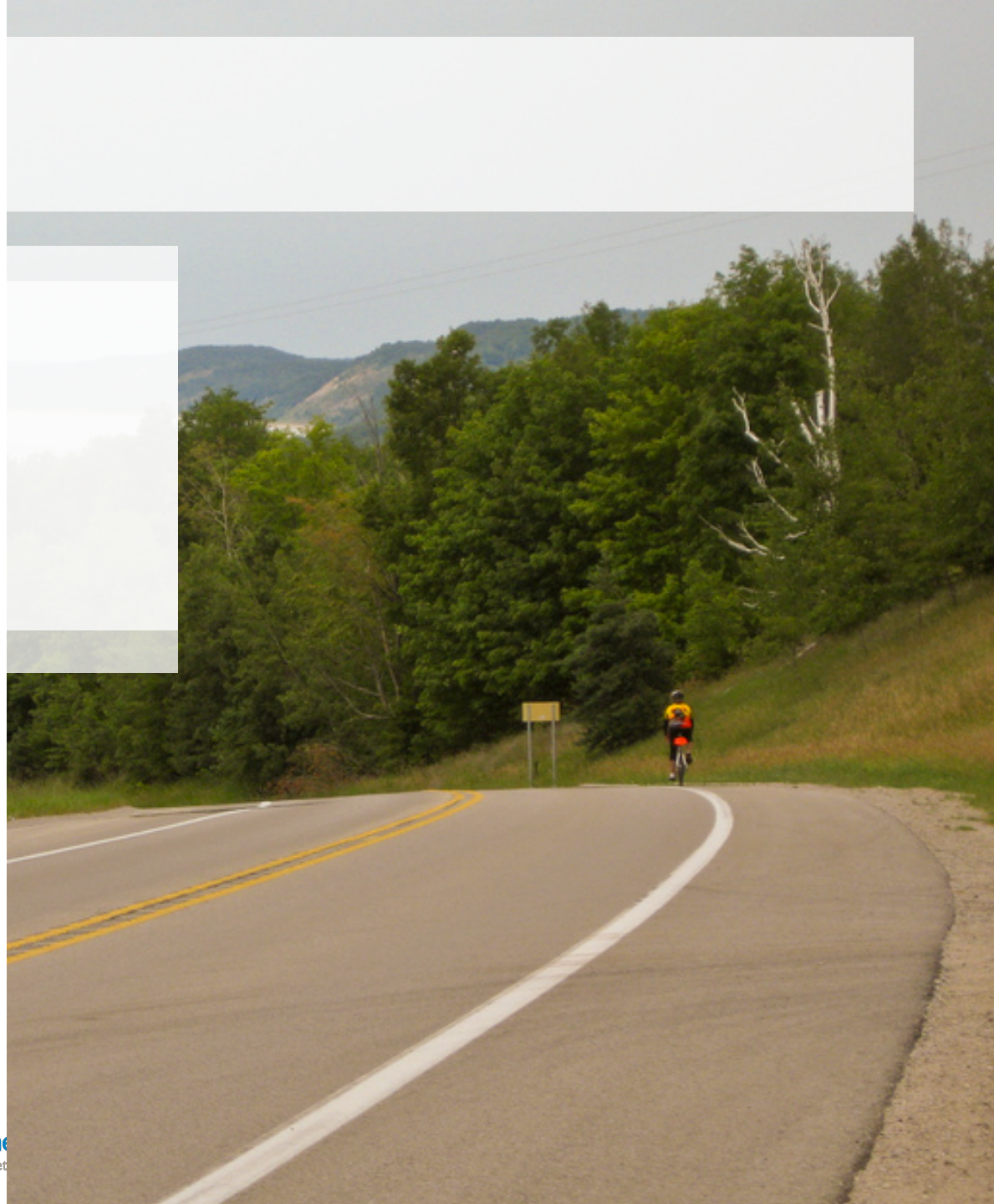
Wide shoulders

- Inter-community connections
- Rural areas
- Touring



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Shared lanes

- Best for lower-speed, lower-volume streets
- Residential areas
- “Neighborhood greenways”
- Supplemental network

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Bicycle lanes

- Minimum of 5 feet
- Consider wider if:
  - Adjacent to on-street parking
  - Bicyclist volumes are high
  - Motor vehicle volumes and/or speeds are high

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Protected lanes

- Higher-volume or higher-speed streets
- Multiple travel lanes
- Buffered, protected with parking or physical barrier
- Suburban or urban areas

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Trails

- Must connect to destinations for practical use
- DOT role: providing quality crossings

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Thinking beyond facility types: LTS

Table 1. Levels of Traffic Stress (LTS)

LTS 1	Presenting little traffic stress and demanding little attention from cyclists, and attractive enough for a relaxing bike ride. Suitable for almost all cyclists, including children trained to safely cross intersections. On links, cyclists are either physically separated from traffic, or are in an exclusive bicycling zone next to a slow traffic stream with no more than one lane per direction, or are on a shared road where they interact with only occasional motor vehicles (as opposed to a stream of traffic) with a low speed differential. Where cyclists ride alongside a parking lane, they have ample operating space outside the zone into which car doors are opened. Intersections are easy to approach and cross.
LTS 2	Presenting little traffic stress and therefore suitable to most adult cyclists but demanding more attention than might be expected from children. On links, cyclists are either physically separated from traffic, or are in an exclusive bicycling zone next to a well-confined traffic stream with adequate clearance from a parking lane, or are on a shared road where they interact with only occasional motor vehicles (as opposed to a stream of traffic) with a low speed differential. Where a bike lane lies between a through lane and a right-turn lane, it is configured to give cyclists unambiguous priority where cars cross the bike lane and to keep car speed in the right-turn lane comparable to bicycling speeds. Crossings are not difficult for most adults.
LTS 3	More traffic stress than LTS 2, yet markedly less than the stress of integrating with multilane traffic, and therefore welcome to many people currently riding bikes in American cities. Offering cyclists either an exclusive riding zone (lane) next to moderate-speed traffic or shared lanes on streets that are not multilane and have moderately low speed. Crossings may be longer or across higher-speed roads than allowed by LTS 2, but are still considered acceptably safe to most adult pedestrians.
LTS 4	A level of stress beyond LTS3.

Level of Traffic Stress

- BLOS
  - Complex, requires lots of input data, difficult to explain how it works
  - Grades don't mean much to residents, electeds, partners
- LTS
  - Based on perceived safety
  - Quick assessment with easily observed/measured inputs (most data already available)
  - Visual, easy to communicate and understand

Level of Traffic Stress

Segment criteria:

- Street width, measured by thru lanes
- Bike lane width, in feet, incl buffer and gutter
- Speed limit or prevailing speed
- Bike lane blockage (rare or frequent)

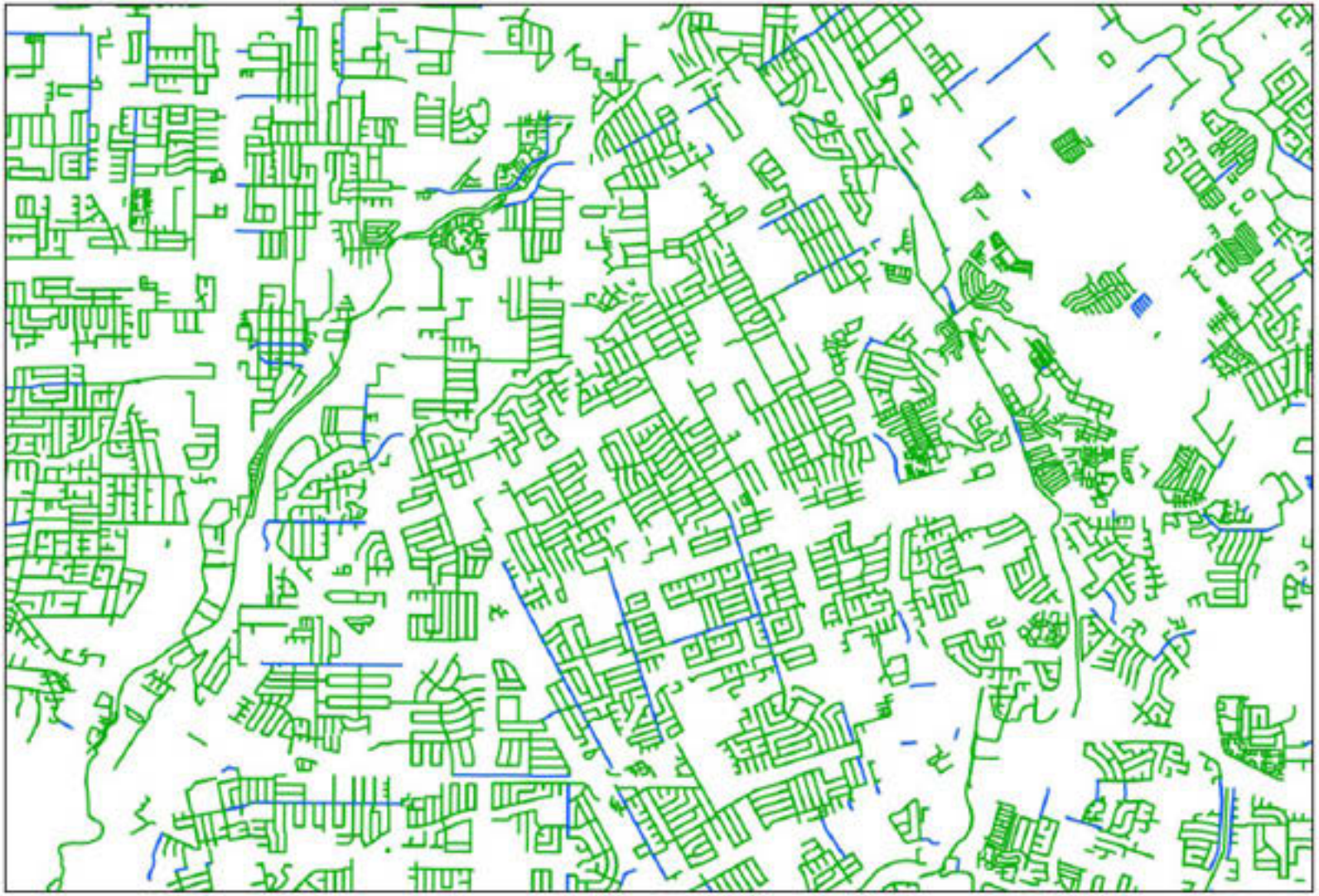
Intersection approach:

- Pocket bike lane or mixed turn lane
  - Length, speed, intersection angle, curb radii

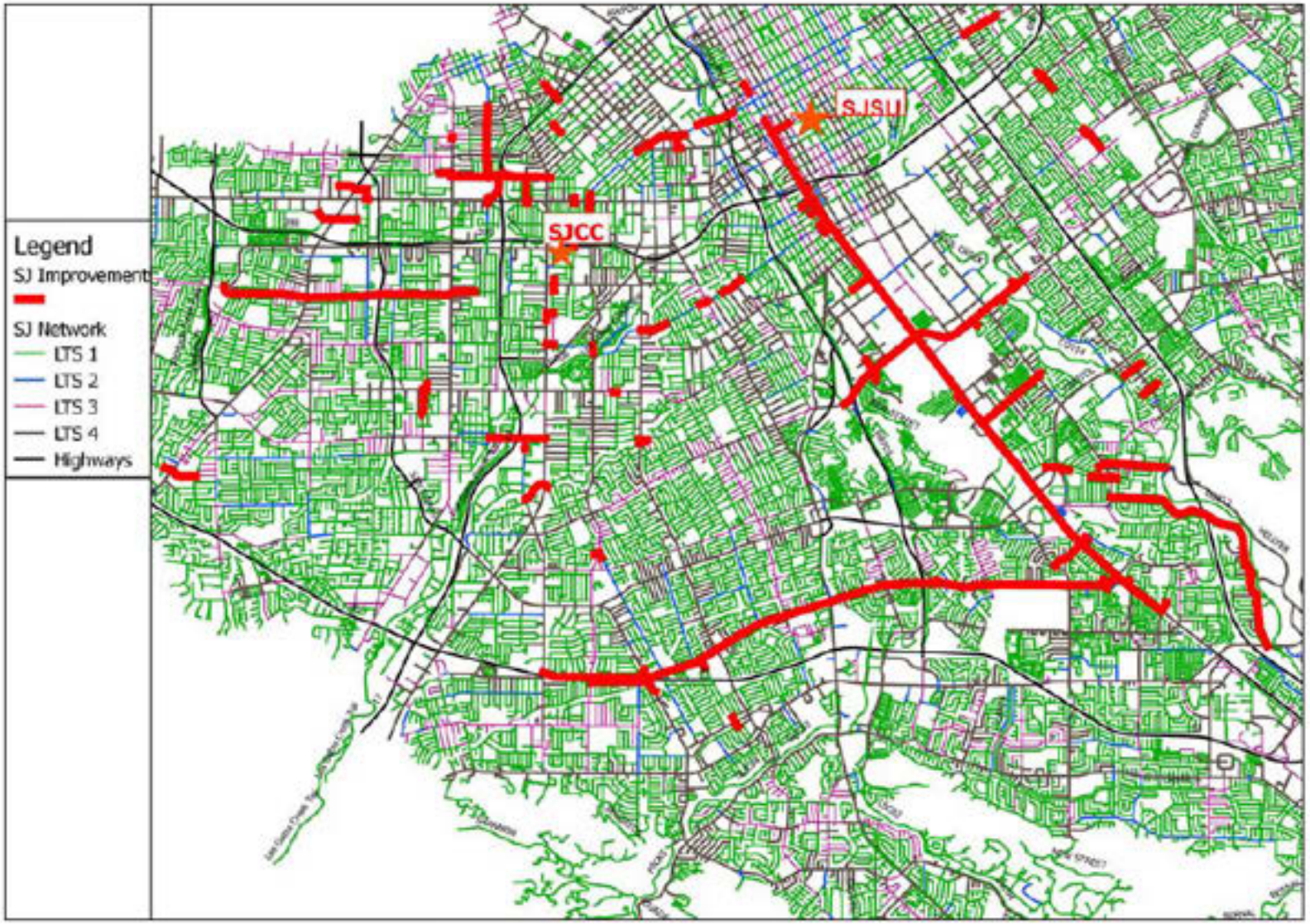
Unsignalized crossings:

- Speed limit of street being crossed, with or without median

LTS: Network gaps



LTS: Potential priority network improvements



Examples

Transit corridor

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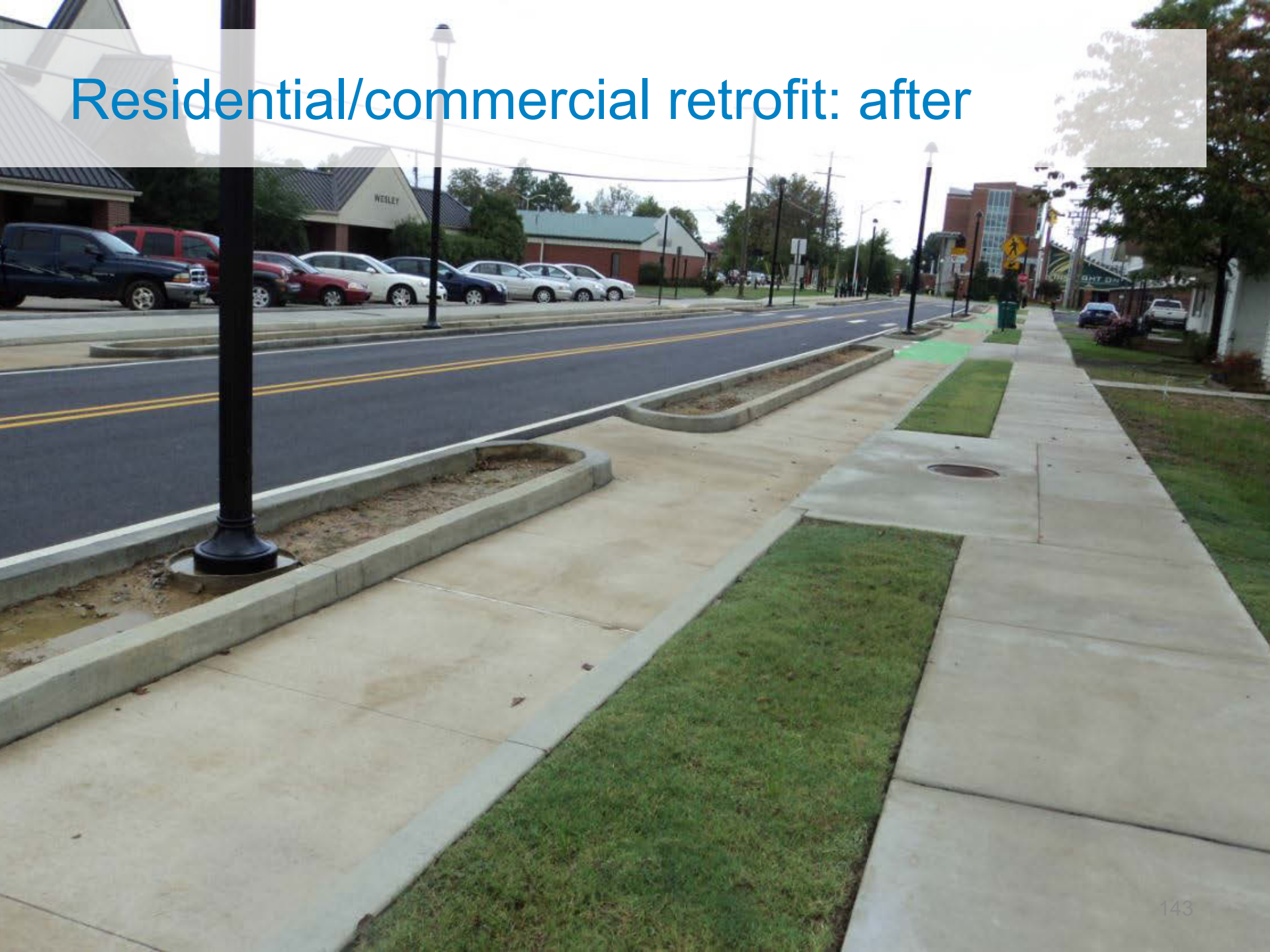
Suburban big box

Suburban residential

Residential/commercial retrofit: before

Residential/commercial retrofit: after



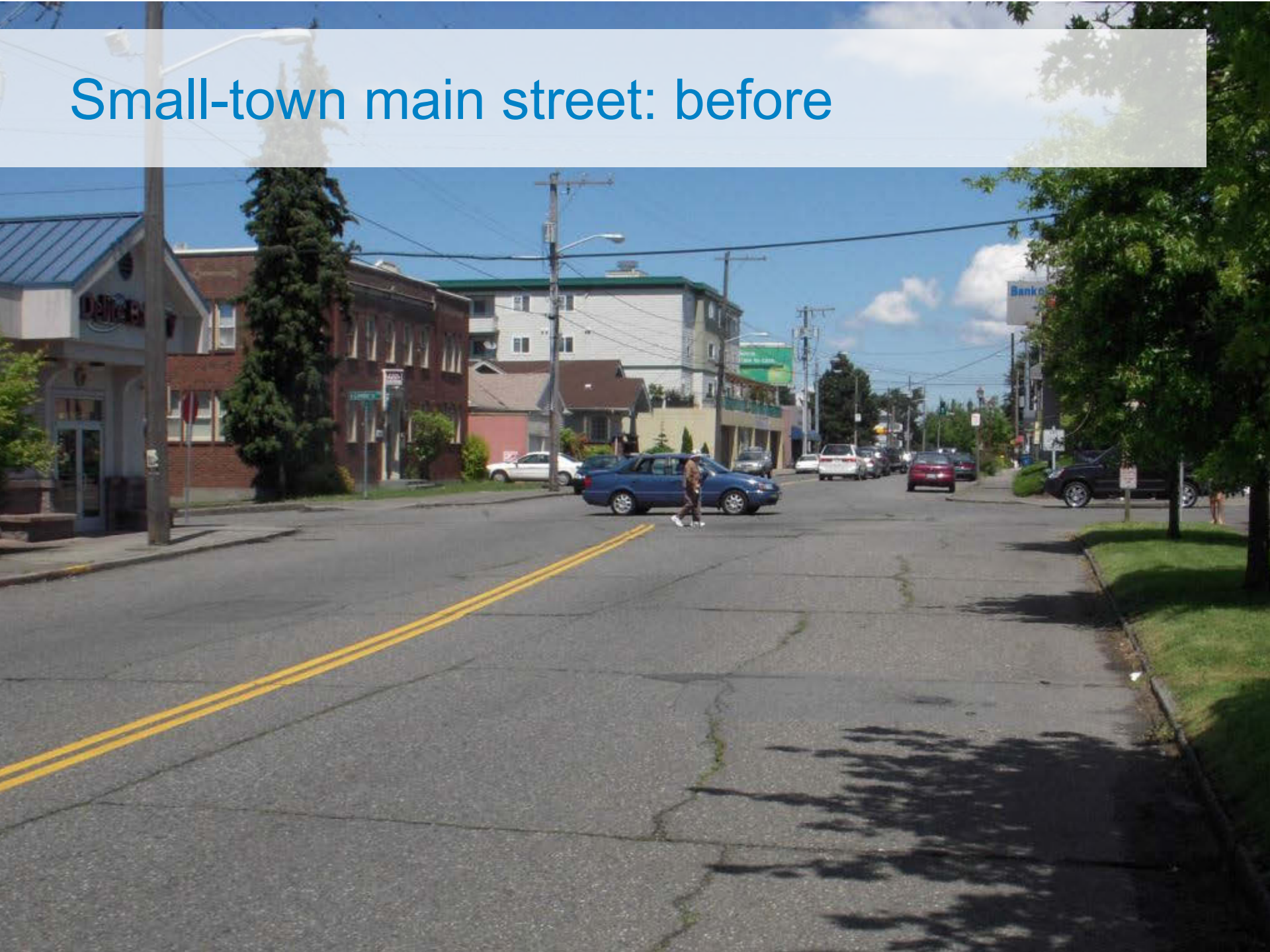
Neighborhood commercial street: before

Neighborhood commercial street: after

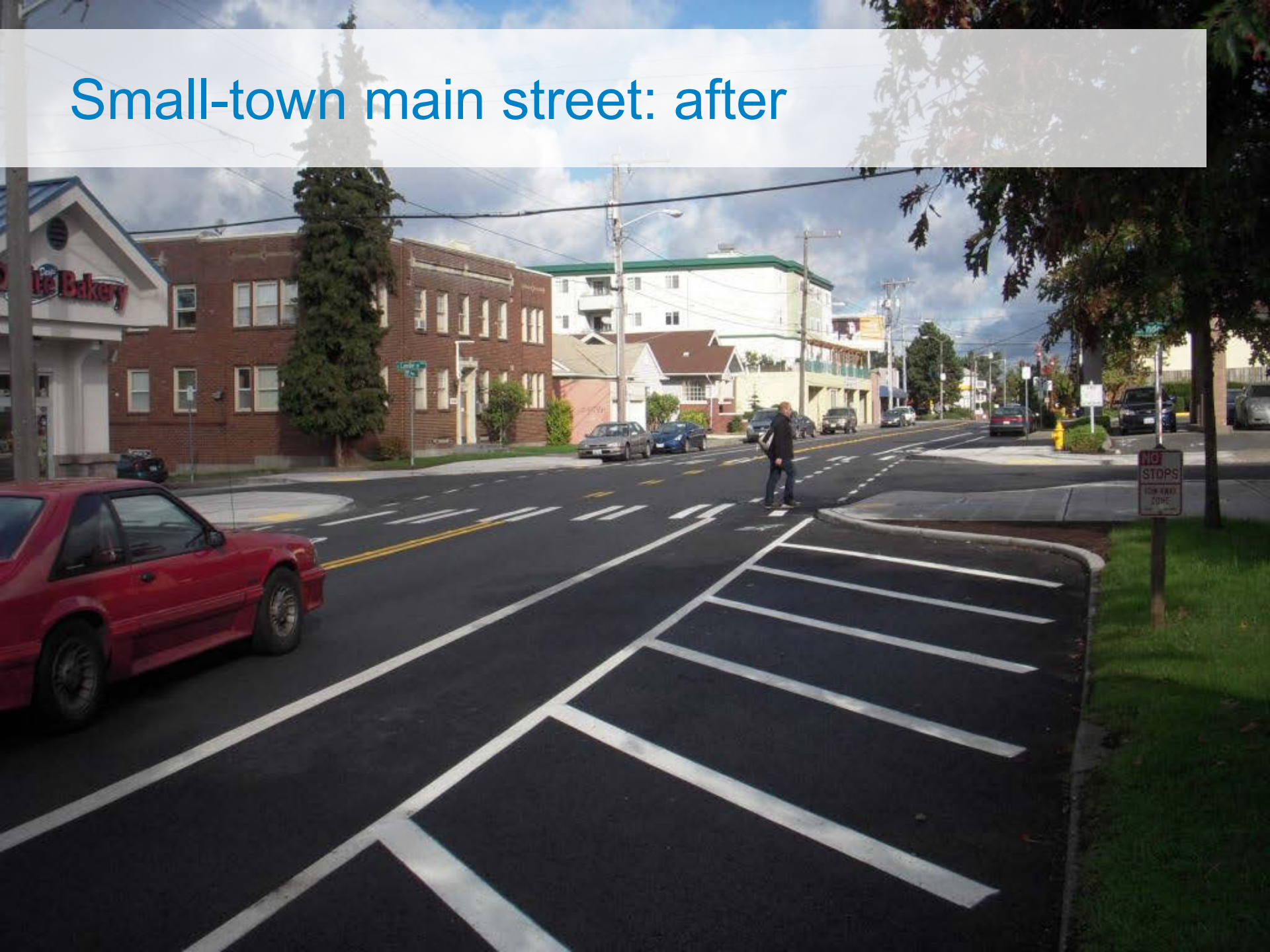
Suburban two-lane road: before

Suburban two-lane road: after

Small-town main street: before



Small-town main street: after

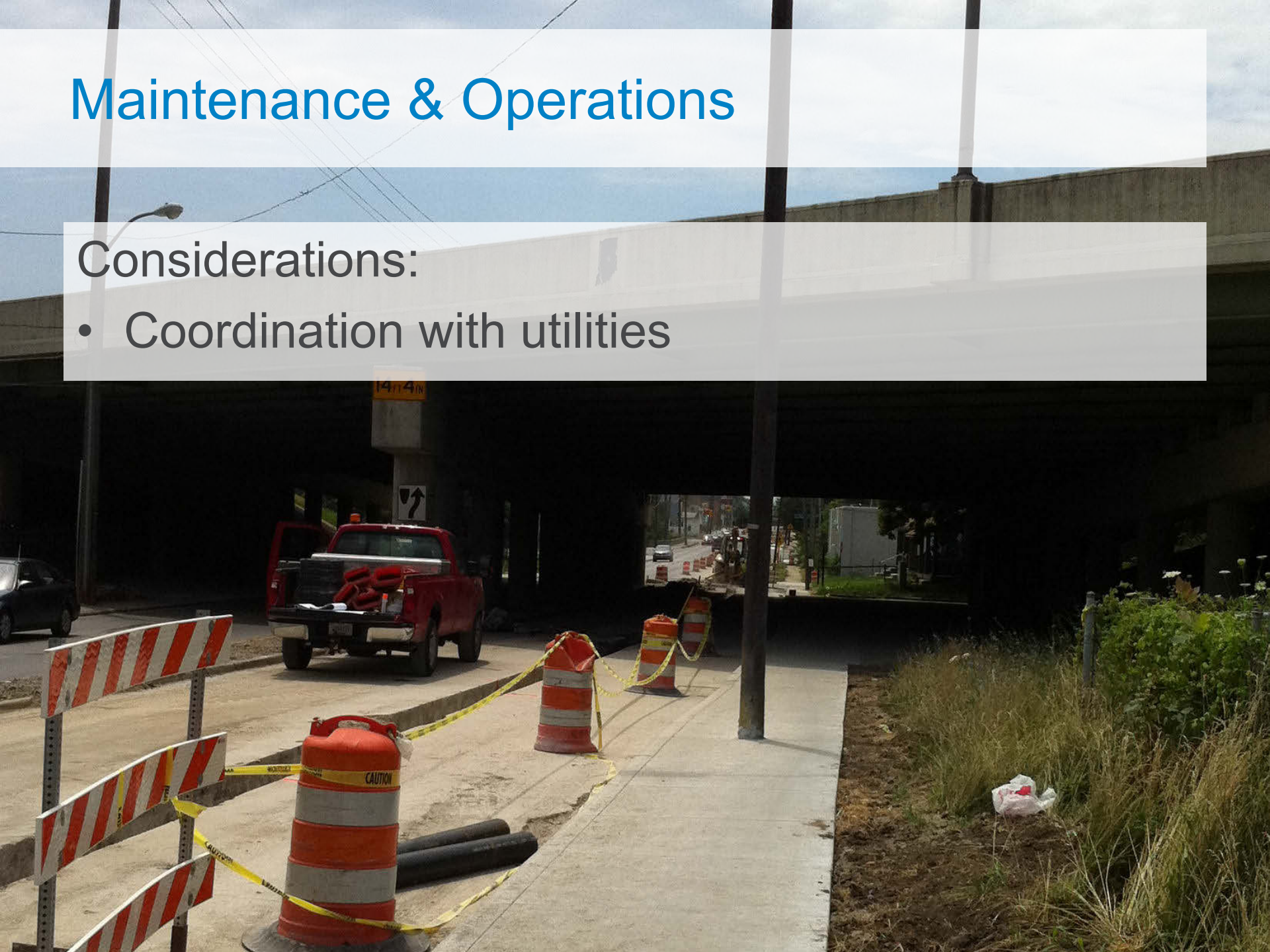


Maintenance and operations

Maintenance & Operations

Considerations:

- Coordination with utilities

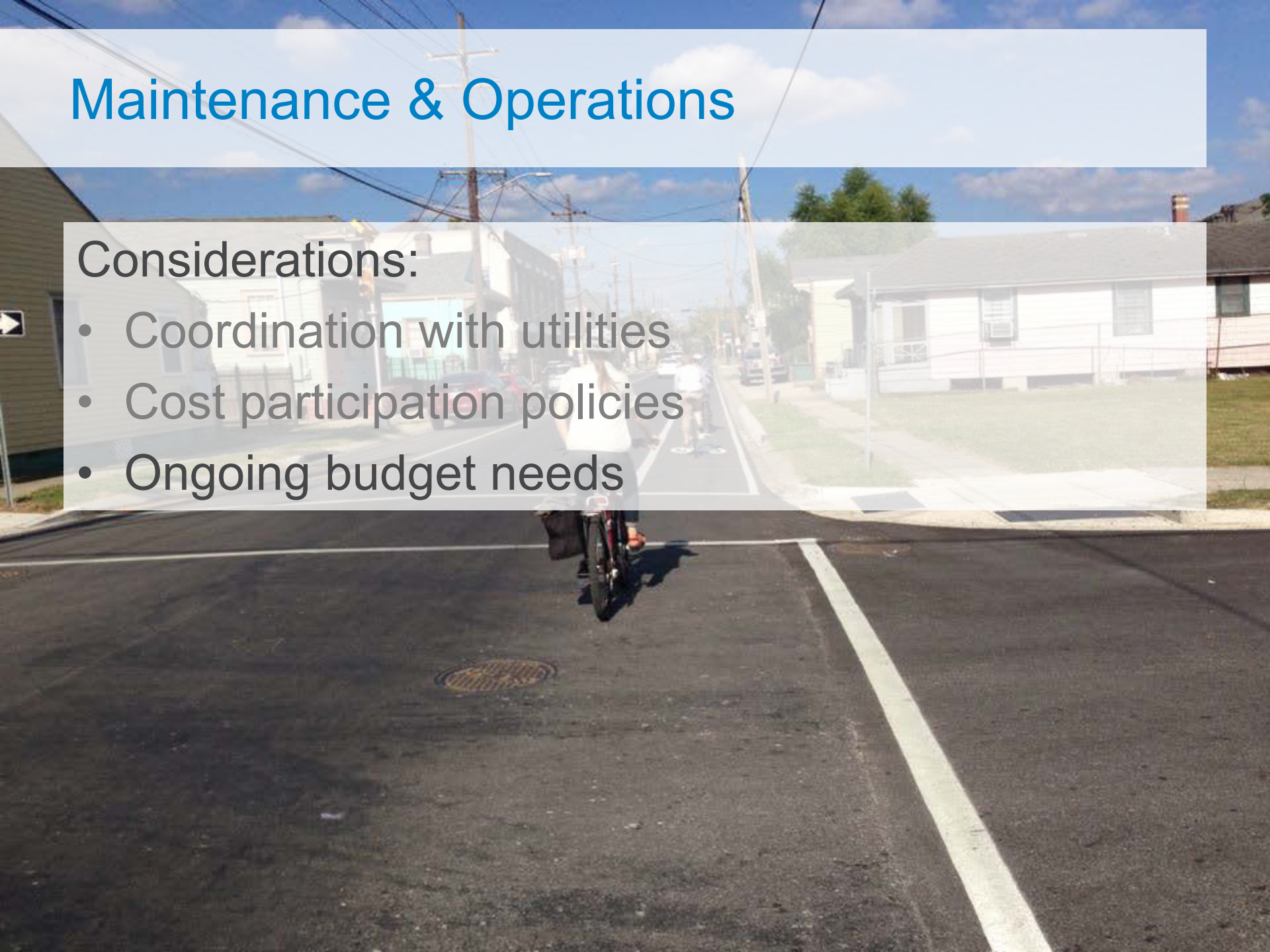


Maintenance & Operations

Considerations:

- Coordination with utilities
- Cost participation policies

Maintenance & Operations



Considerations:

- Coordination with utilities
- Cost participation policies
- Ongoing budget needs