

Urban Applications of Innovative Intersection Designs

Best Slides from Research Effort, Pt 1:
Rational for the Work

Chris Cunningham, PE (Principal Investigator, NCSU-ITRE)



Celen Pasalar, Ph.D. (Co-PI, NCSU-College of Design)

College of Design

Michael R. Brown, PE, AICP (Co-PI, Urban Innovators)

URBAN Innovators

February 10th and 13th, 2023

Meet the PI's



Chris Cunningham, PE



- Director, Highway Systems Group
- NC Professional Civil Engineer
- Co-author of ITE's *Manual of Transportation Engineering Studies*



Mike Brown, PE, AICP



- UT and NC Professional Civil Engineer
- TRB Intersections Committee
- Founder of Urban Innovators
- Creator of below websites



Celen Pasalar, Ph.D.



- Associate Professor of Landscape Architecture and Environmental Planning
- Urban Design, Smart Cities, Community Design

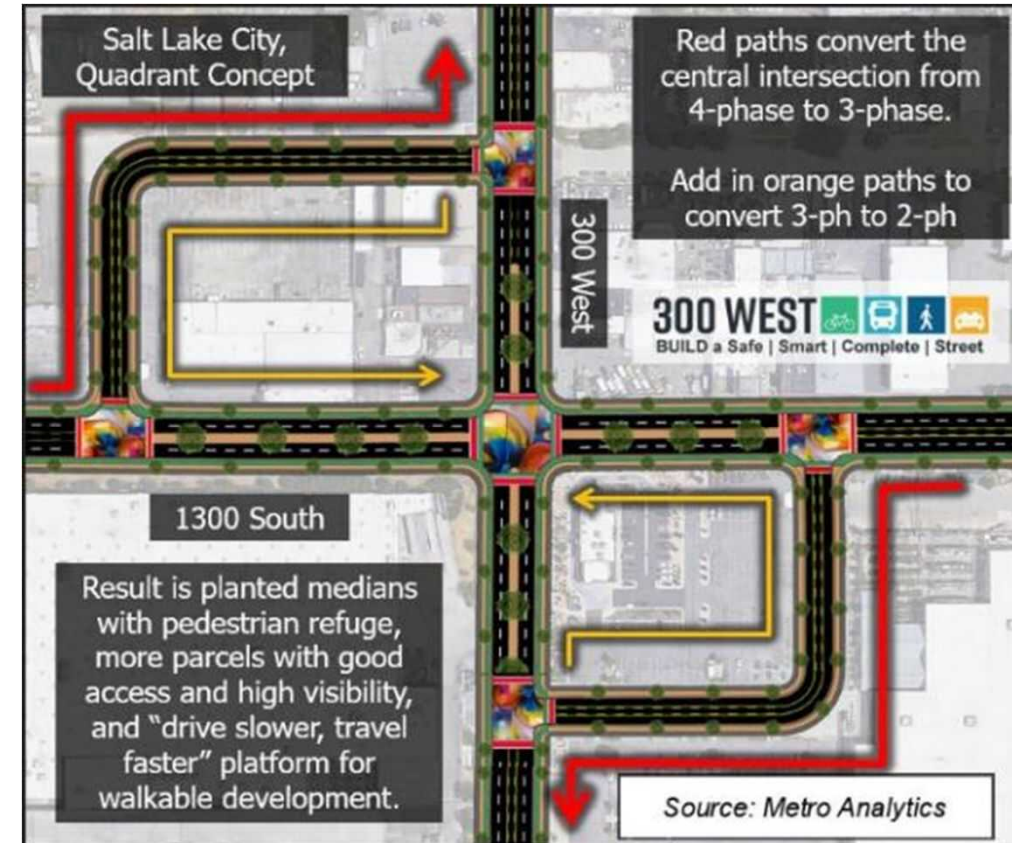
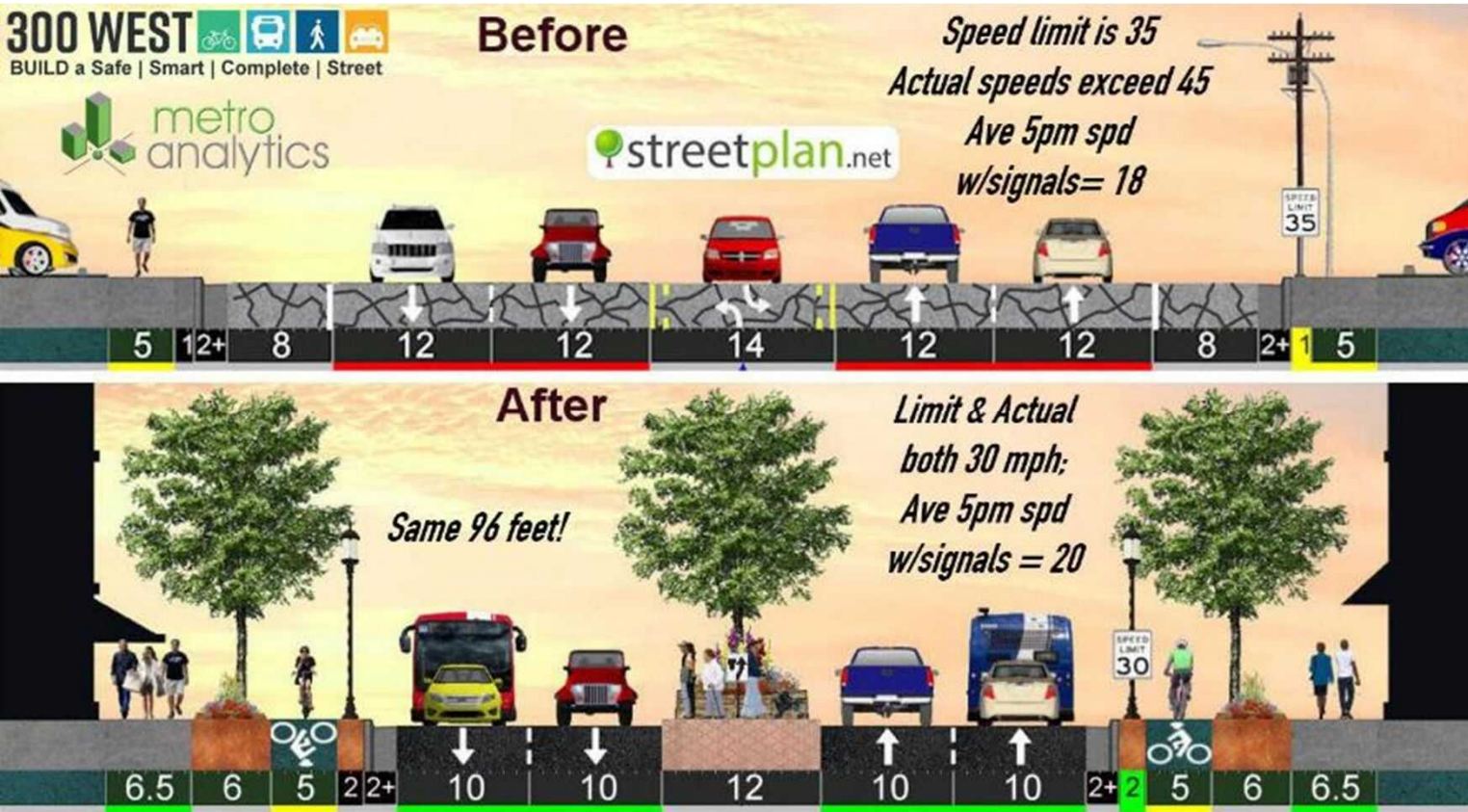


Stroads to **Streets**

Converting
Anywhere, USA
into
Walkable, USA

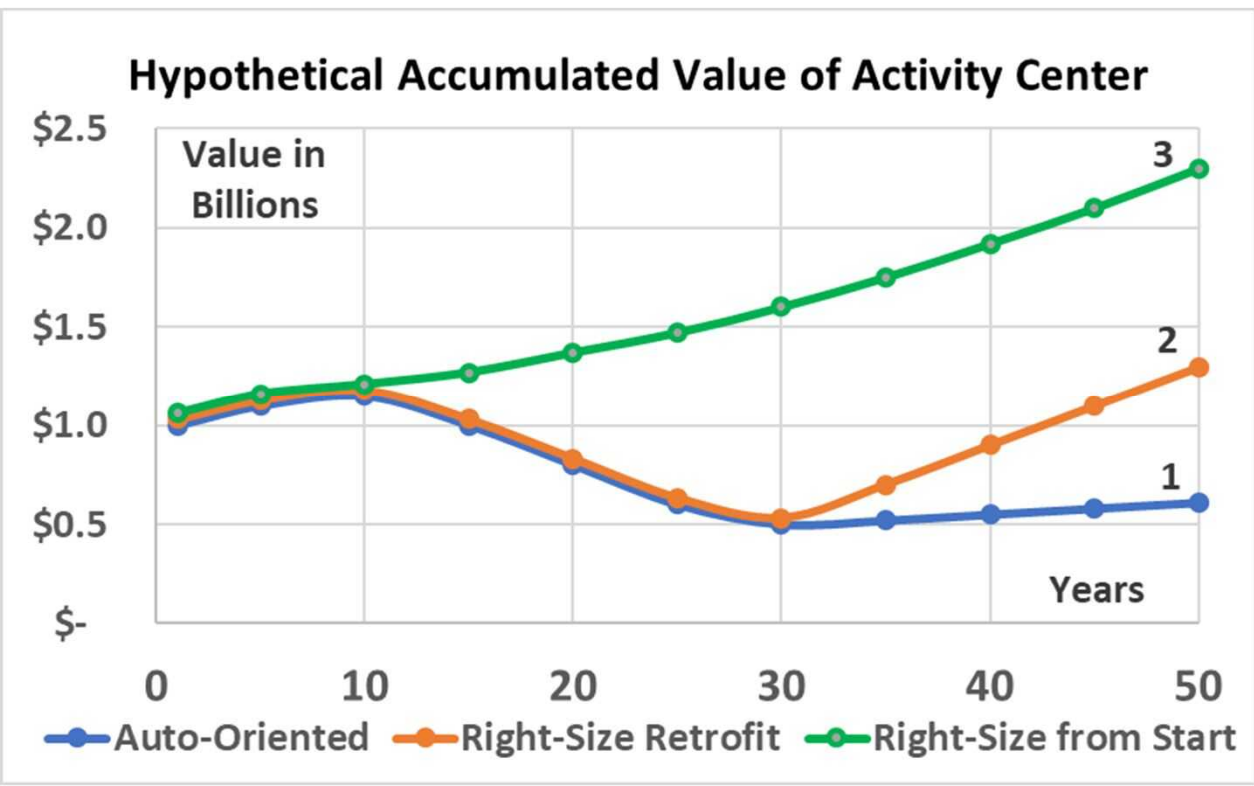
Cutting-Edge Techniques

Managing High Volumes and Creating Great Places



Stroads Create Greyfields Greyfields Create Duplicative Infrastructure

1. Cheap retail center emerges but degrades by year 30. It then struggles forever to recover, as there is no mechanism
2. Yeah! A recovery mechanism is discovered! (This research!) Never as good as if planned well from start, but far better!
3. How future Greenfield centers will emerge, now that they have better mechanisms for securing value.



Typical? (One-Way Splits)



Palm Springs Town Center



Courtesy: Metro Analytics

Courtesy: Metro Analytics

Task 2: Literature Review



State-of-the-Practice of T4+ walkable examples of corridors that include AIs



Best practices of T4+ for Complete Streets and Place Making



NCDOT Complete Street guidelines and NCHRP Right-Sizing guidebook



Insights on adapting AIs to Complete Streets

NCDOT Complete Streets Guideline

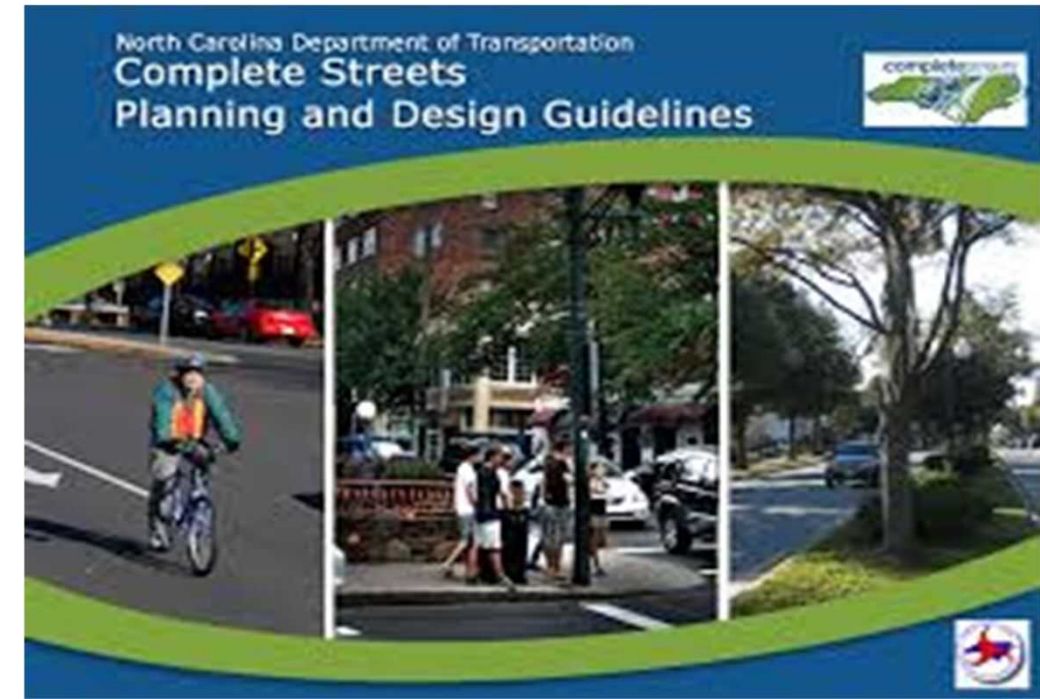
❖ Complete Streets Policy (2009)

- Consider and incorporate multimodal alternatives when designing new projects or making improvements to existing infrastructure

❖ Complete Streets Planning and Design Guidelines (2012)

- All users should be considered during the planning, design, construction, funding, and operations of the state's transportation system

- The NCDOT Roadway Design Manual as the authoritative reference for Complete Streets design
- The AASHTO and the NACTO guides for street design
- The FHWA guidance for selecting appropriate bicycle and pedestrian facilities



NCDOT Complete Street Evaluation

- ❖ Based on 43 stakeholder interviews
- ❖ Performance Metrics
 - Safety (stand-alone bicycle and pedestrian crashes, vehicle crashes)
 - Congestion (multimodal level of service)
 - Inventory (updated pedestrian and bicycle infrastructure network geodatabase)
 - Economic Development (stimulate commercial and recreational trips)
- ❖ Practical Recommendations
 - Clearly establishing roles and responsibilities for better accountability
 - Improving the project prioritization, funding and tracking process
 - Regularly updating the design guidelines
 - Communications with internal and external stakeholders

Caltrans Complete Streets Elements Toolbox

❖ Technical guidance on the implementation of Complete Streets:

- Bicycle Elements
- Pedestrian Elements
- Road Space Reallocation
- Transit Related Elements
- Landscaping Elements



Complete Streets Elements
Toolbox
Version 2.0



Los Angeles, CA
Los Angeles Street
US-101 Off-Ramp



West Sacramento, CA
W Capitol Avenue

Prepared by:

Smart Mobility and Active Transportation Branch
Office of Smart Mobility and Climate Change
Division of Transportation Planning

Updated: July 23, 2018



COMPLETE STREETS IMPLEMENTATION PLAN

M2D2: Multimodal Development and Delivery

December 2015



The Florida Department of Transportation and Smart Growth America



FDOT Complete Streets Implementation Plan

- ❖ Incorporate Complete Streets into the planning, design and construction of all projects in urban and suburban areas
- ❖ Revising guidance, standards, manuals, policies and other documents
- ❖ Updating decision making
- ❖ Modifying approaches for measuring performance
- ❖ Managing communication and collaboration during implementation
- ❖ Education and Training

VDOT Multimodal System Design Guidelines



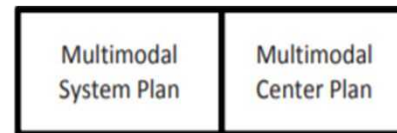
MULTIMODAL SYSTEM
DESIGN GUIDELINES

March 2020

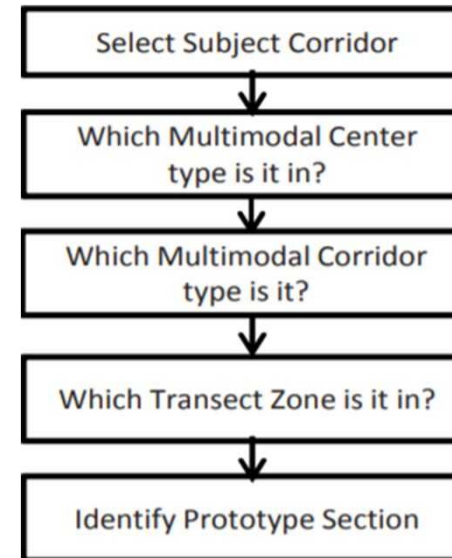
-DRPT-

10 Multimodal Corridor Design

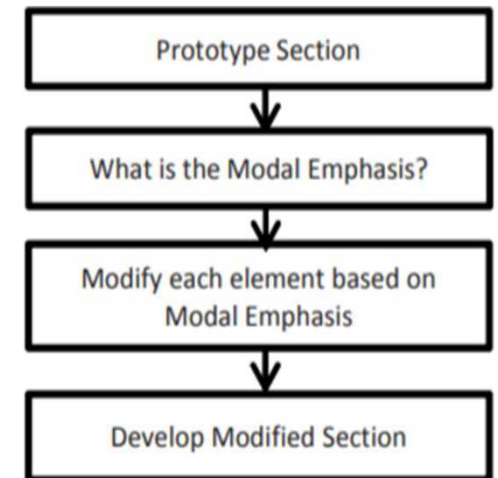
PLANNING CONTEXT



DEVELOP PROTOTYPE SECTION



DEVELOP MODIFIED SECTION



NJDOT Complete Streets Design Guide

Integrating Complete Streets into the Planning and Design Process

- Sidewalks
 - Sidewalk zones, Street trees, Furnitures, Bus shelters, Lights, Stormwater, Parklets, etc.
- Roadways
 - Design speed, Traffic calming, Road diet, On-street parking, Design vehicle, Bikeway, etc.
- Intersections
 - Accessibility, Gateways, Corners, Curb, Islands, Raised crossings, Channelization, etc.



2017 State of New Jersey

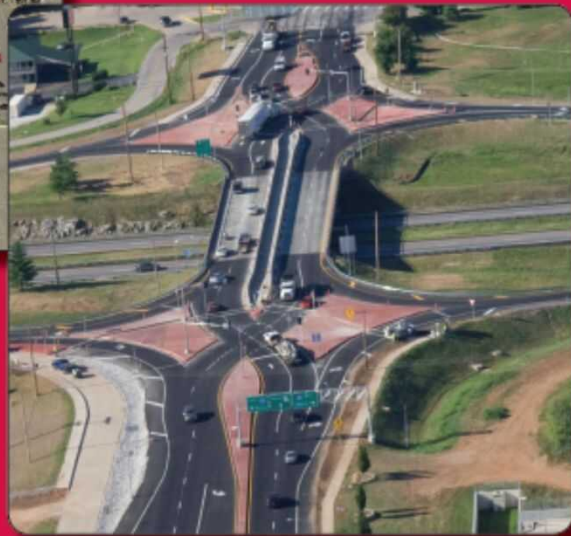
Complete Streets Design Guide



Alternative Intersections/Interchanges: Informational Report (AIIR)

PUBLICATION NO. FHWA-HRT-09-060

APRIL 2010



U.S. Department of Transportation
Federal Highway Administration

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

FHWA - AIIR

❖ Four Alternative Intersections

- Displaced Left-turn Intersection (DLT)
- Median U-Turn Intersection (MUT)
- Restricted Crossing U-Turn Intersection (RCUT)
- Quadrant Roadway Intersection (QR)

❖ Guidance on Accommodation of Pedestrians, Bicyclists, and Transit Users:

- Pedestrian refuges
- Wayfinding signing
- Right-turn channelized islands
- Accessible devices to disabled pedestrians

NCHRP

Project Number 07-25

Guide for Pedestrian and Bicycle Safety at Alternative and Other Intersections and Interchanges

TRANSPORTATION RESEARCH BOARD
NAS-NRC

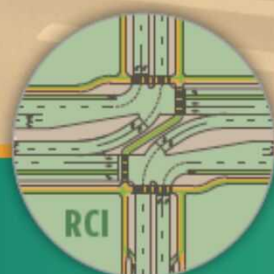
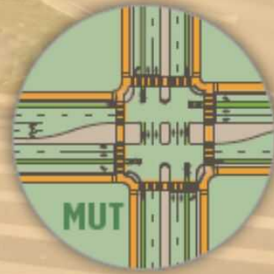
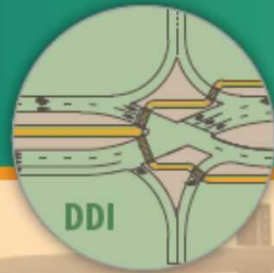
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Kittelson & Associates, Inc.

In association with:
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at North Carolina State University
Toole Design Group
Accessible Design for the Blind
Advanced Transportation Solutions



NCHRP 07-25

- ❖ Three Alternative Intersections
 - MUT, RCUT, DLT
- ❖ Pedestrian Accommodation
 - Wayfinding
 - Street crossing
 - Pedestrian routing and delay
- ❖ Bicyclist Accommodation
 - On-street/ Separated/ Shared bike lanes
 - Bikeway selection
 - Bicyclist routing and delay
- ❖ Assessments & Elements Design

NCHRP

RESEARCH REPORT 917

NATIONAL
COOPERATIVE
HIGHWAY
RESEARCH
PROGRAM

Right-Sizing Transportation Investments: A Guidebook for Planning and Programming



The National Academies of
SCIENCES • ENGINEERING • MEDICINE


TRANSPORTATION RESEARCH BOARD

NCHRP 917, Right-Sizing

- ❖ Matching infrastructure to emerging uses
- ❖ Value-capture, Economic Analysis
- ❖ Urban catalytic techniques, (AIs, etc.)
- ❖ North Carolina, Utah, Georgia, Iowa

Urban

Street

Design

Guide

National Association of City Transportation Officials

Urban Street Design Guide

❖ Complete Streets

- Vision
- How to bring them to fruition

❖ Toolbox and Tactics

- Safer, more livable, and more economically vibrant streets

Keeper Slides from Interim Meetings

Discussion Items

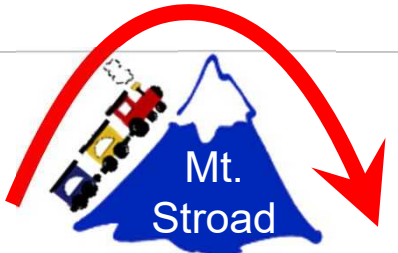
- NCDOT Research Update
- NSF CIVIC Update
- Shared Goals/Outcomes Survey
- Discussions
- Schedule Update



Image courtesy of www.opus-group.com

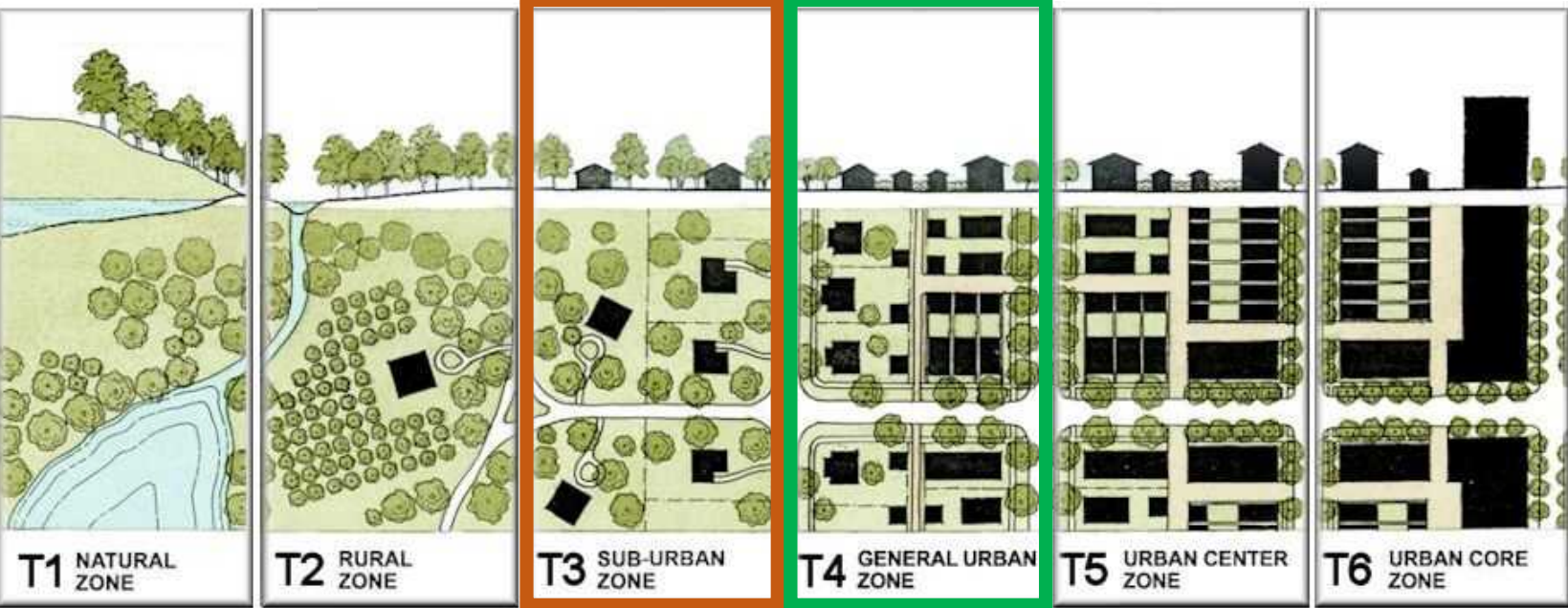


I think I can!
I think I can!



FROM here TO here

Courtesy: Urban Innovators



Almost Nothing Small Towns Mostly 1-story Mostly 2-3 story Mostly 3-5 story Many 5+ stories

“Mount Stroad” blocks languishing suburban commercial from becoming walkable. **Can we get over this hump?**

We Can!



There aren't many tools that address both Traffic and Placemaking.

This research creates such tools.

Arterials and the Evolution Adjacent Land



Stuck in T3!

Land gets stuck in T3 suburban and even goes backward!

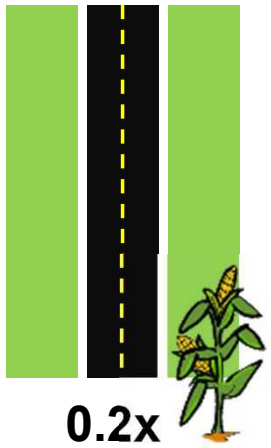
Goal: stabilize T3 with pockets of successful T4 and T5.

Arterials and the Story of Value

1x is a "New and Shiny Built out suburb," with a density or cash value of "1x".

Rural Highway

T2

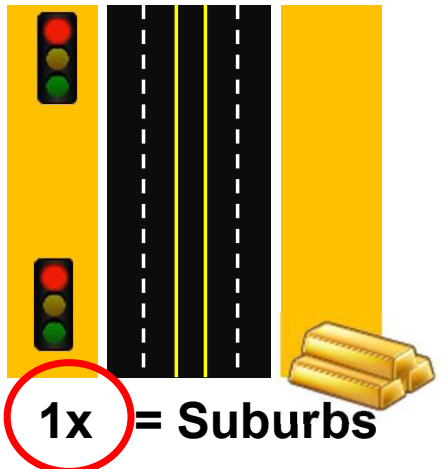


Greenfield Phase 1


Max: 65 mph
Ave: 55 mph
Rare stops

Shiny "Stroad"

T3, Early

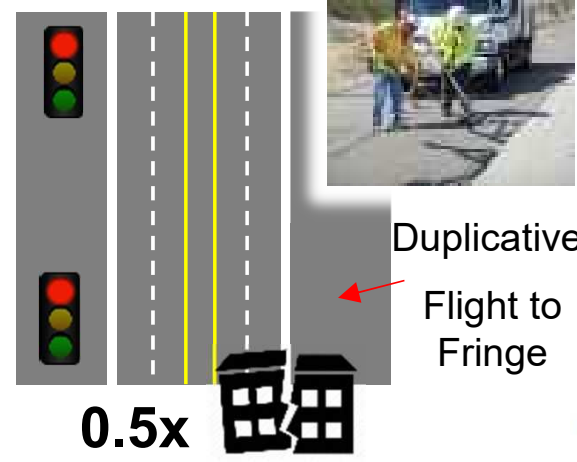


Goldfield Phase 2


Max: 45 mph
Ave < 25 mph
frequent Red Lights 

Ugly "Stroad"

T3, Collapsing

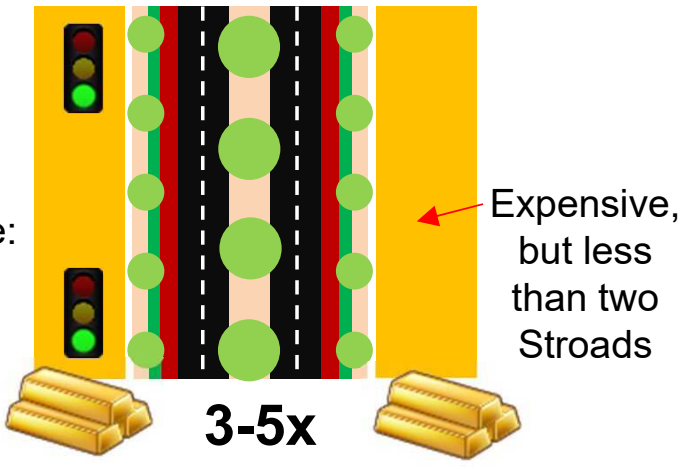


Greyfield Phase 3


Max: 45 mph
Ave: 30 mph
frequent Red Lights 

Goal: Reclaim as Complete Street

T4, T5: Stable



Golden Opportunity Phase 4 (our work)

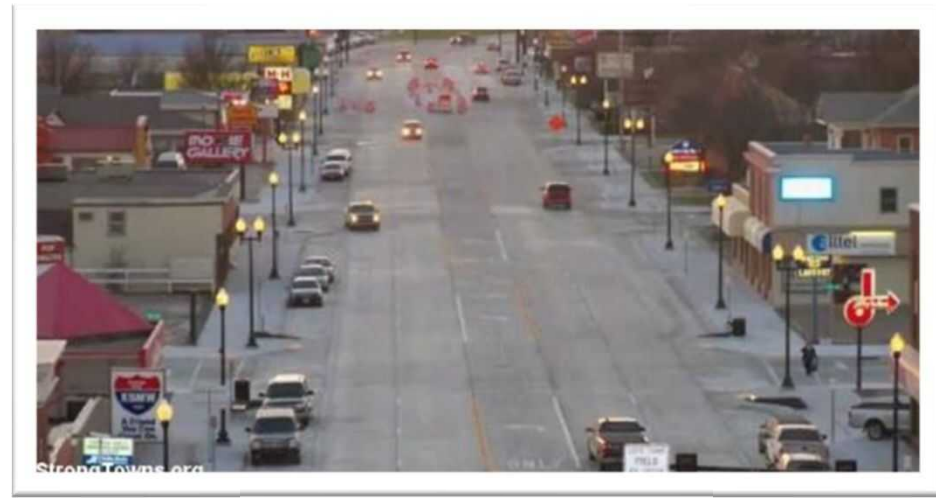
Max: 35 mph
Ave ~25 mph
many Green Lights! 

What is NCDOT Hearing?

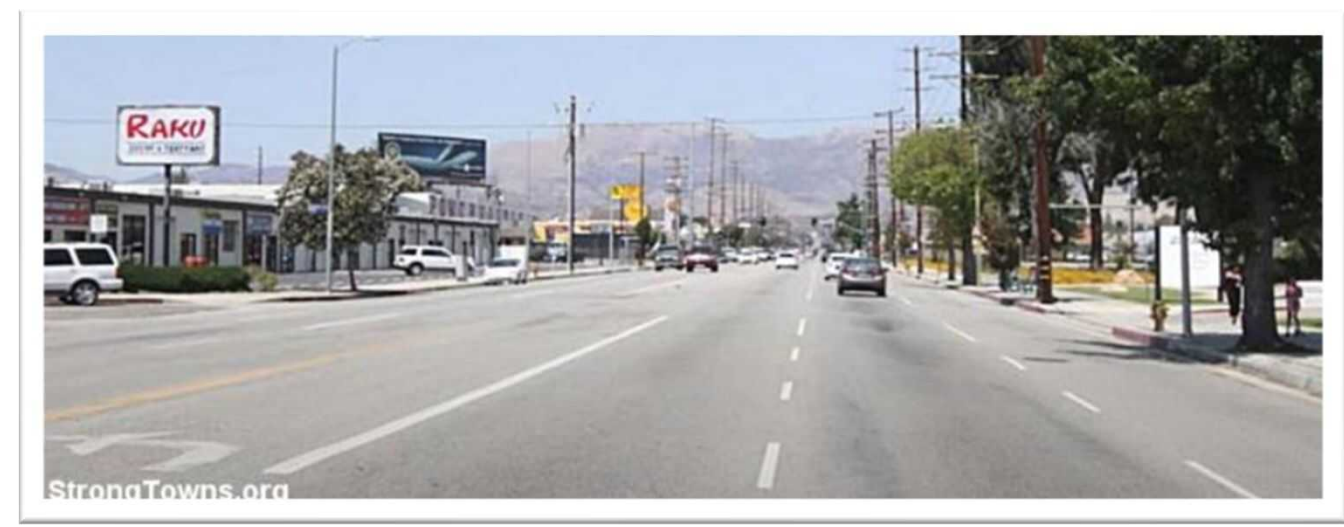
- Communities are frustrated with “Stroads”
- Communities want more walkable “Places”



He's walking... but is it “walkable”?



Almost walkable?



These are all “Stroads”

SPEED 45 + = Slow

SPEED 35 + = Winner!

SPEED 45 + = Slow

SPEED 30 + = Winner!

Delete one or the other depending on how you need to use the rest of the space.

Use if need different speeds

Engineers

Planners



Wrestling for the upper hand? Shake hands!

NCDOT 

Engineers



Planners



Win-Lose: Cars or Place?

With so much car dependency, guess who usually wins?

Instead of **Win-Lose**, we're
discovering **Win-Win-Win!**

**Why wrestle for the upper
hand, when there are good
ways to shake hands!**



Great Couch



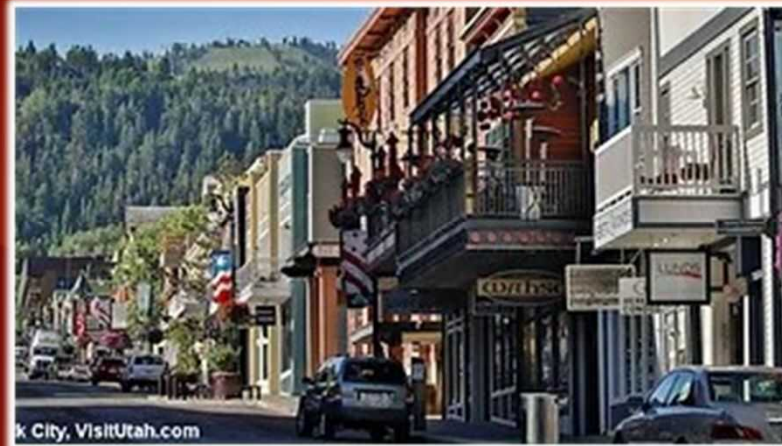
Great Bed



Futon *uncomfortable couch, AND uncomfortable bed*



Great Street

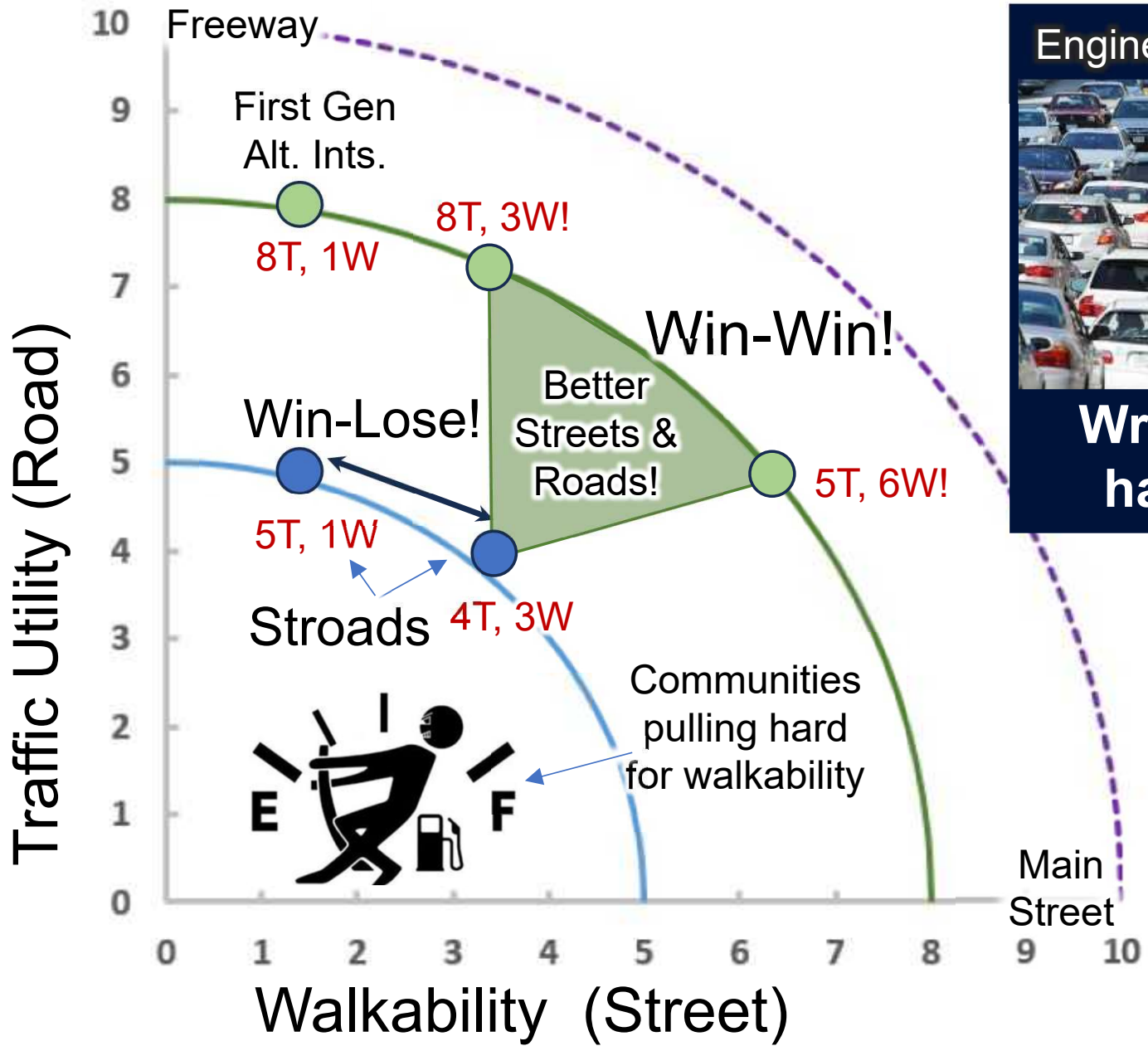


Great Road



Stroad *tries to be vibrant, AND tries to be fast, but fails*





Engineers

Planners

Wrestling for the upper hand? Shake hands!

Placemaking Alternative Intersections improve walkability AND traffic utility.

Win-Win!

Drive Slower, Travel Faster - Why does it matter?



Stroads have inefficient Four-Phase signals.

Engineers “Solve inefficient” by adding more lanes & higher speed limits!

This is 150 ft wide, or half a football field! Imagine Grandma making a run like that!

Overloaded!



Traditional Four-Phase Signal

A diagram showing four phases of a traffic signal cycle. Phase 1: Left-turn arrows (yellow circle 1). Phase 2: Through and right-turn arrows (orange circle 2). Phase 3: Right-turn arrows (yellow circle 3). Phase 4: Through and left-turn arrows (orange circle 4). A blue circular arrow indicates the sequence from 1 to 2 to 3 to 4 and back to 1.

Four-phase signals are SLOW!

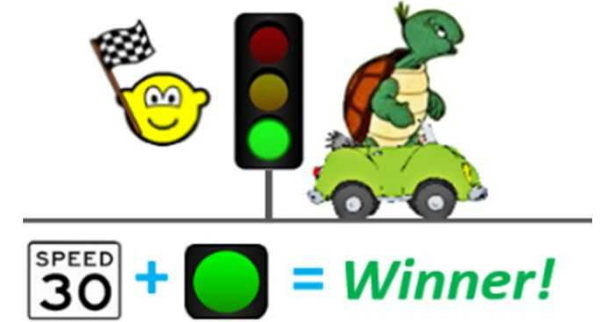
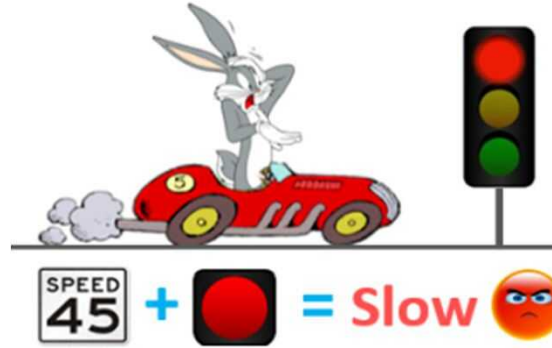
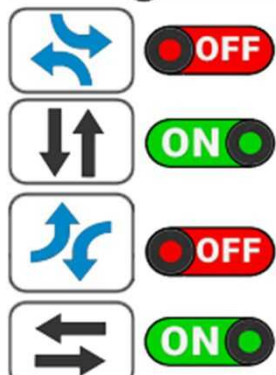
Left turn arrows cause delay.



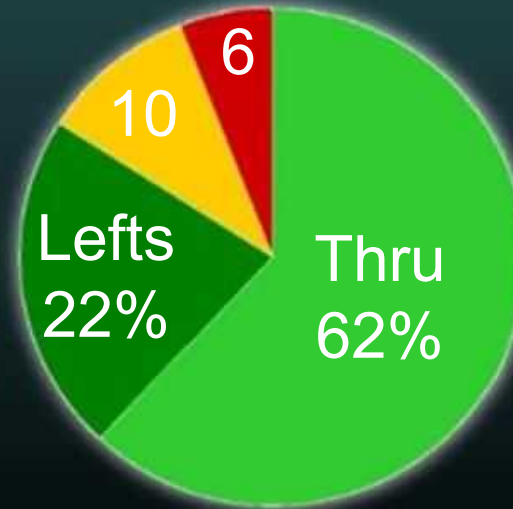
**4-Phase,
Overloaded!**

**3-Phase,
Good**

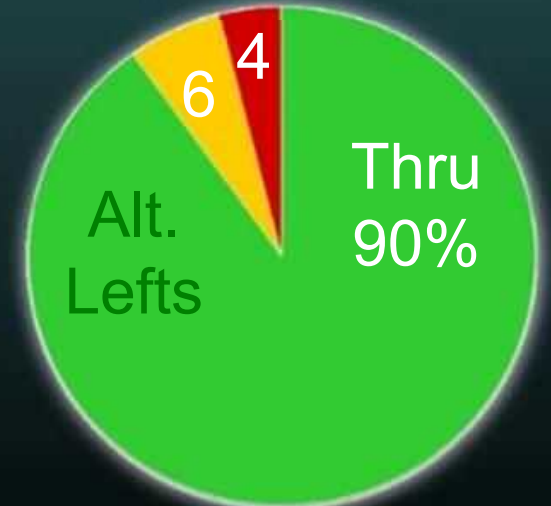
**2-Phase,
Excellent!**



4-Phase



2-Phase



4-Phase Signal

Overloaded!



4 movements, 1-spot

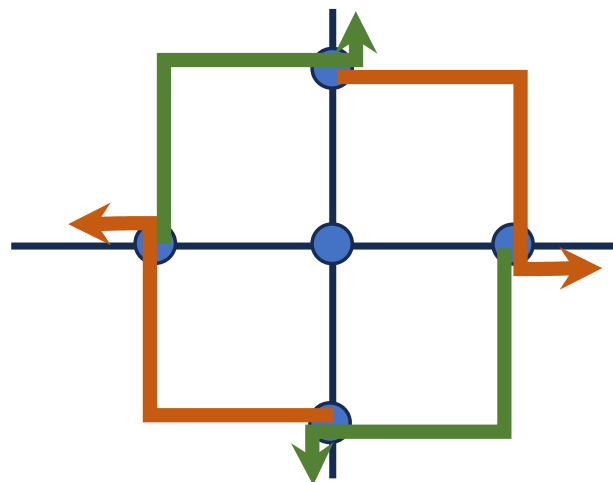


Quadrant Intersections

Excellent!



Lefts go to secondary

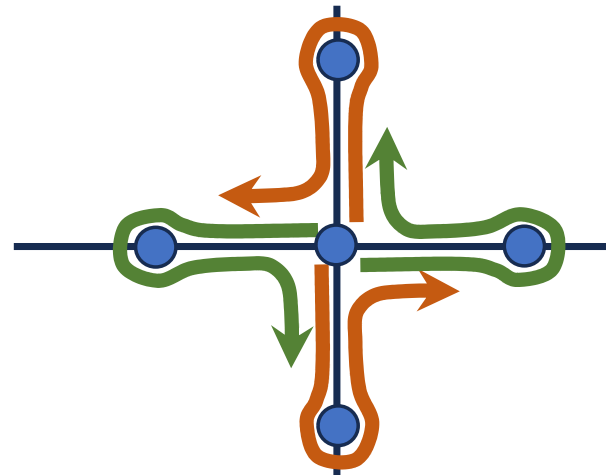


U-Turn Intersections

Excellent!



Left = U + Right

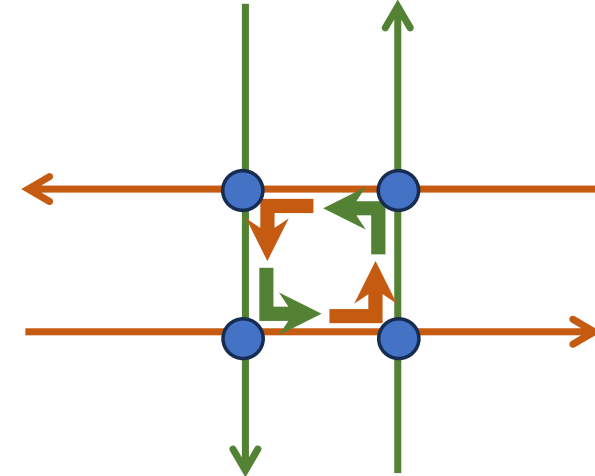


One-Way Split Intersections

Excellent!



Four small beats one big



3-phase if only green redirected. 2-phase if both green & brown.

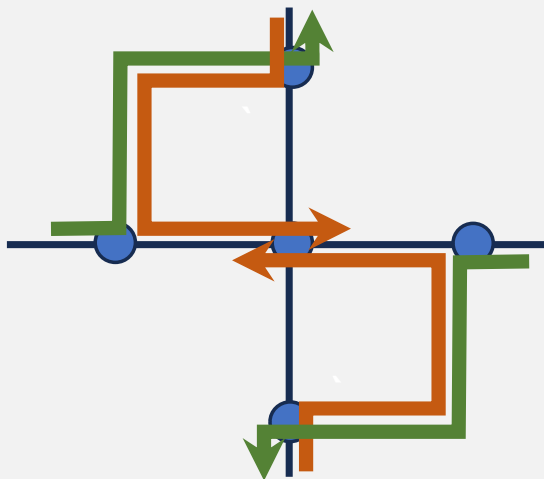


3-phase if only green is rerouted

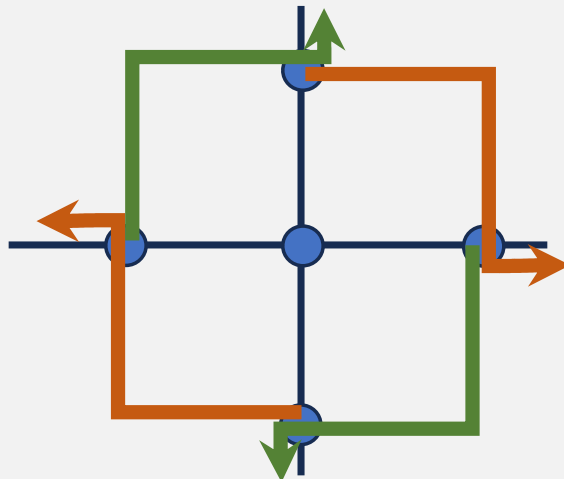
2-phase if both green & brown rerouted

2-ph using 2-quads | 2-ph using 4-quads

4-lefts, 2-quads

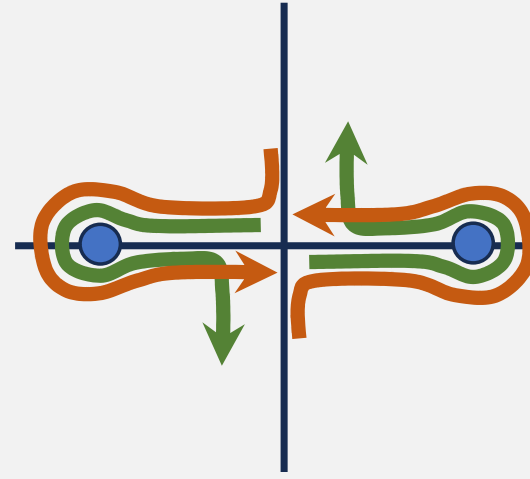


4-lefts, 4-quads

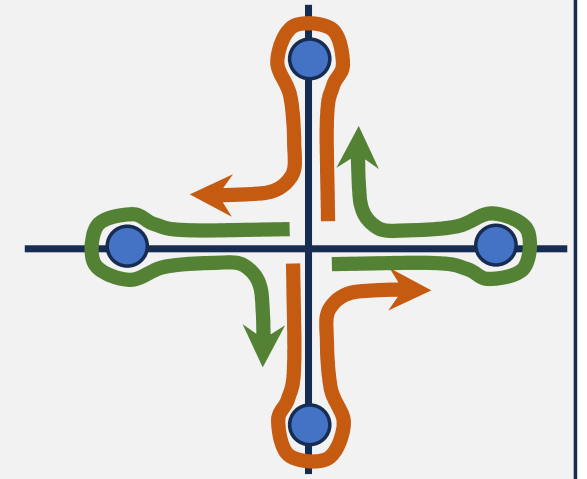


2-ph using 2-U's | 2-ph using 4-U's

4-lefts, 2-U's

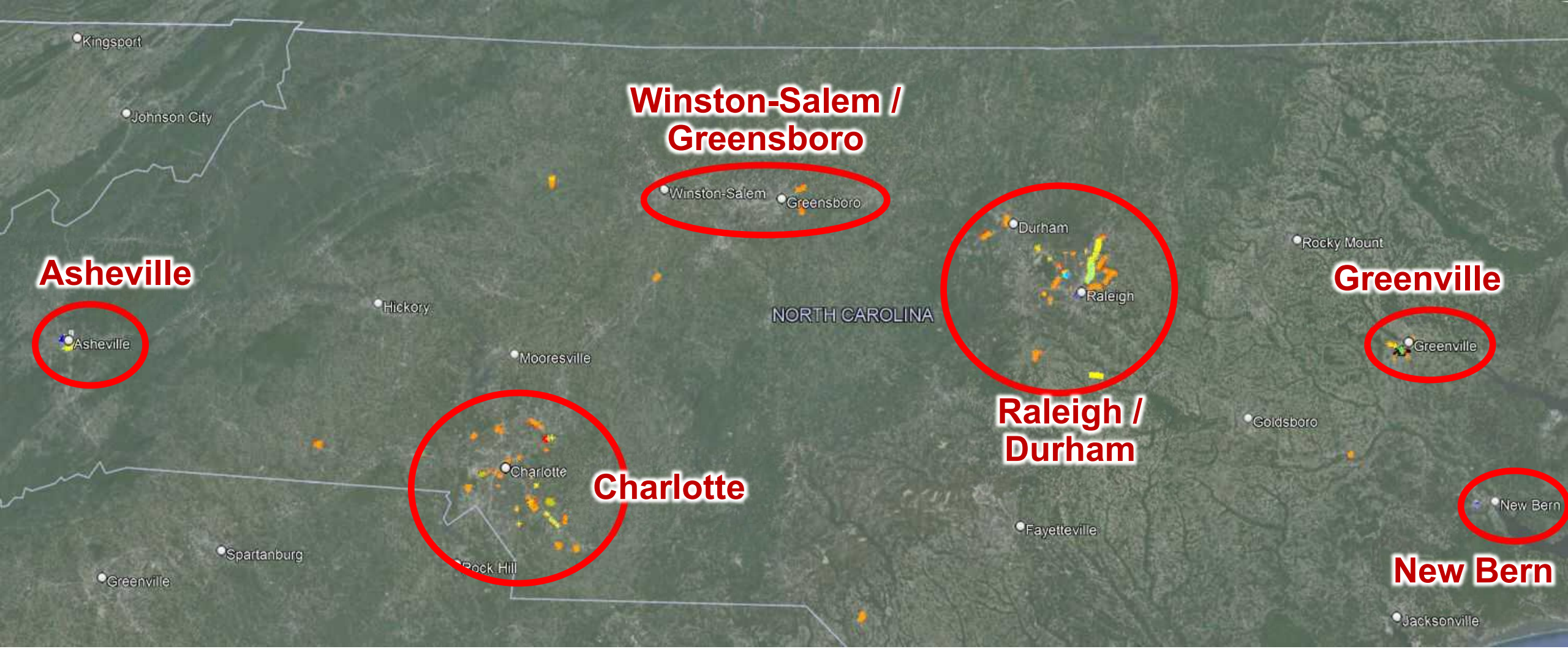


4-lefts, 4-U's

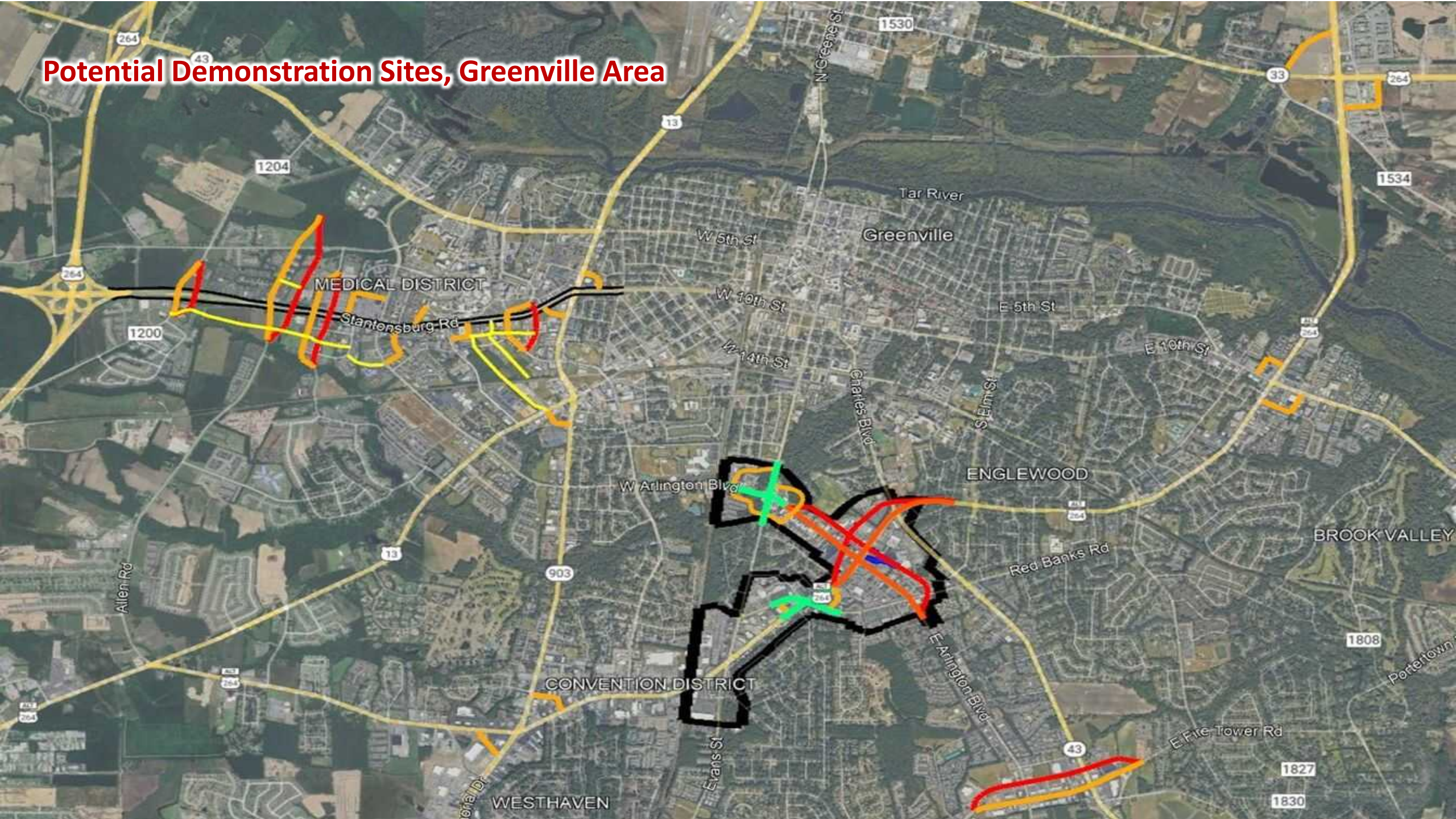


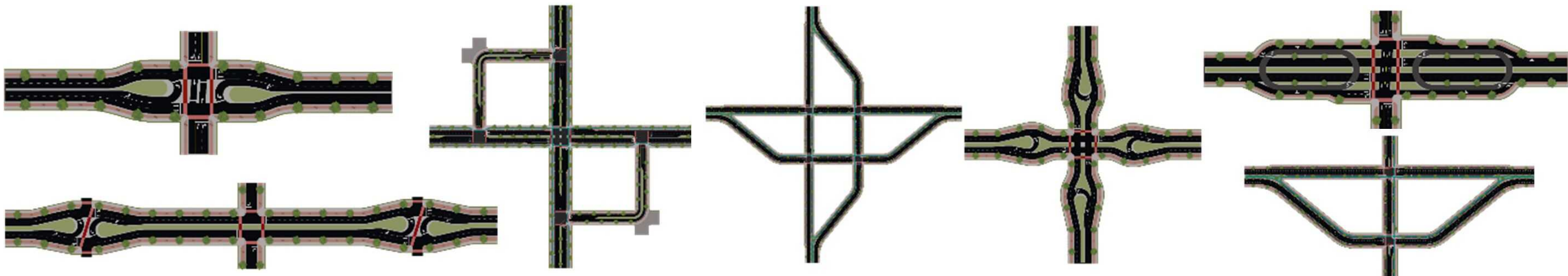
Both designs can be 3-phase (green only) or 2-phase (green+brown)

Over 100 potential applications discovered very quickly. Certainly, far more yet to be discovered!



Potential Demonstration Sites, Greenville Area






From our library of “Legos,” which can be overlaid in Google Earth for corridor study concept development.



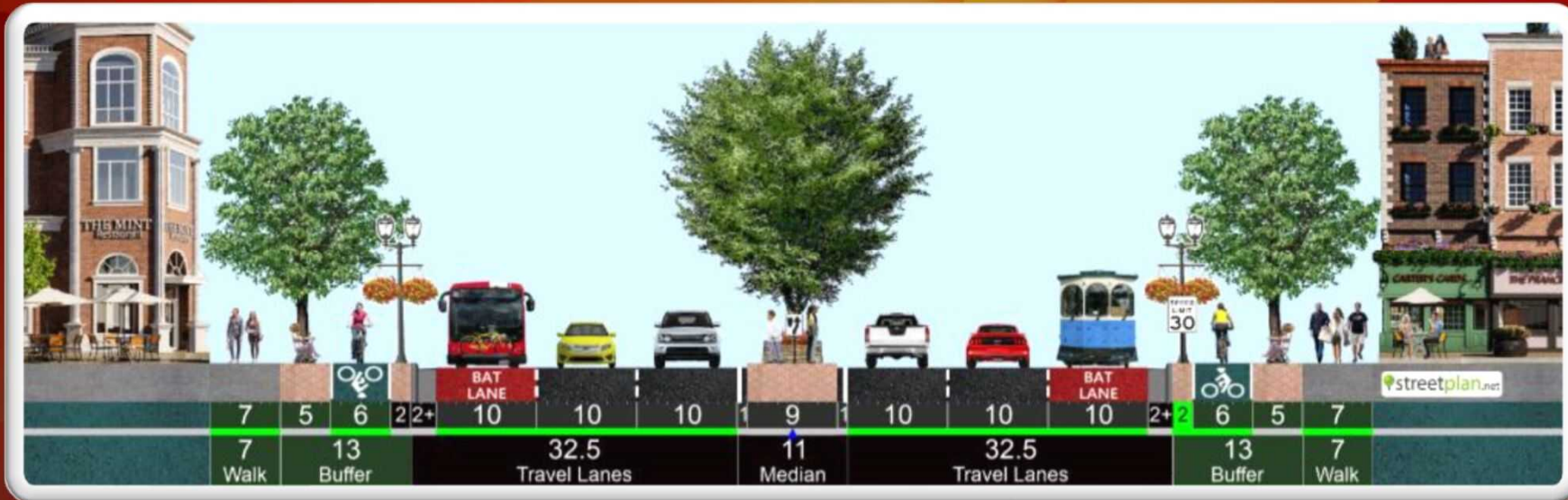


Better for Traffic AND for Placemaking? 



Drive Slower, Travel Faster Techniques for Converting Stroads into Complete Streets

Placemaking Alternative Intersections

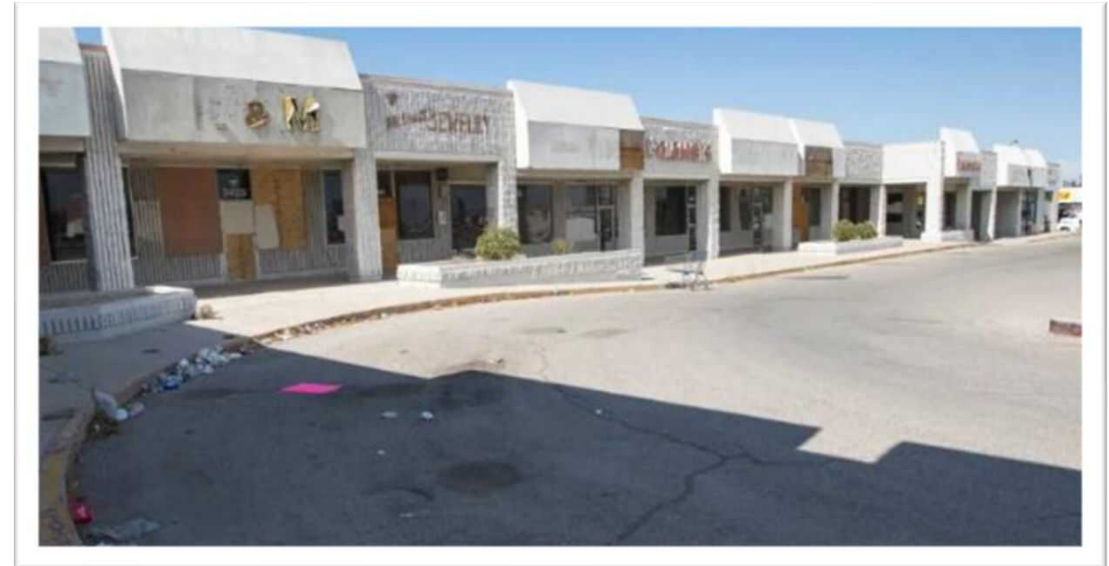


NCDOT's Dilemma

- **Lots of Traffic**: Many Stroads do and always will carry huge amounts of traffic
- **Concern over delay**: Engineers worry that slowing traffic for walkability may also exacerbate delay and congestion.
- **Lack of Tools**: Even when engineers are on-board with supporting walkable development, they don't know what to do.
 - NCDOT sponsored this research to expand their toolbox of techniques

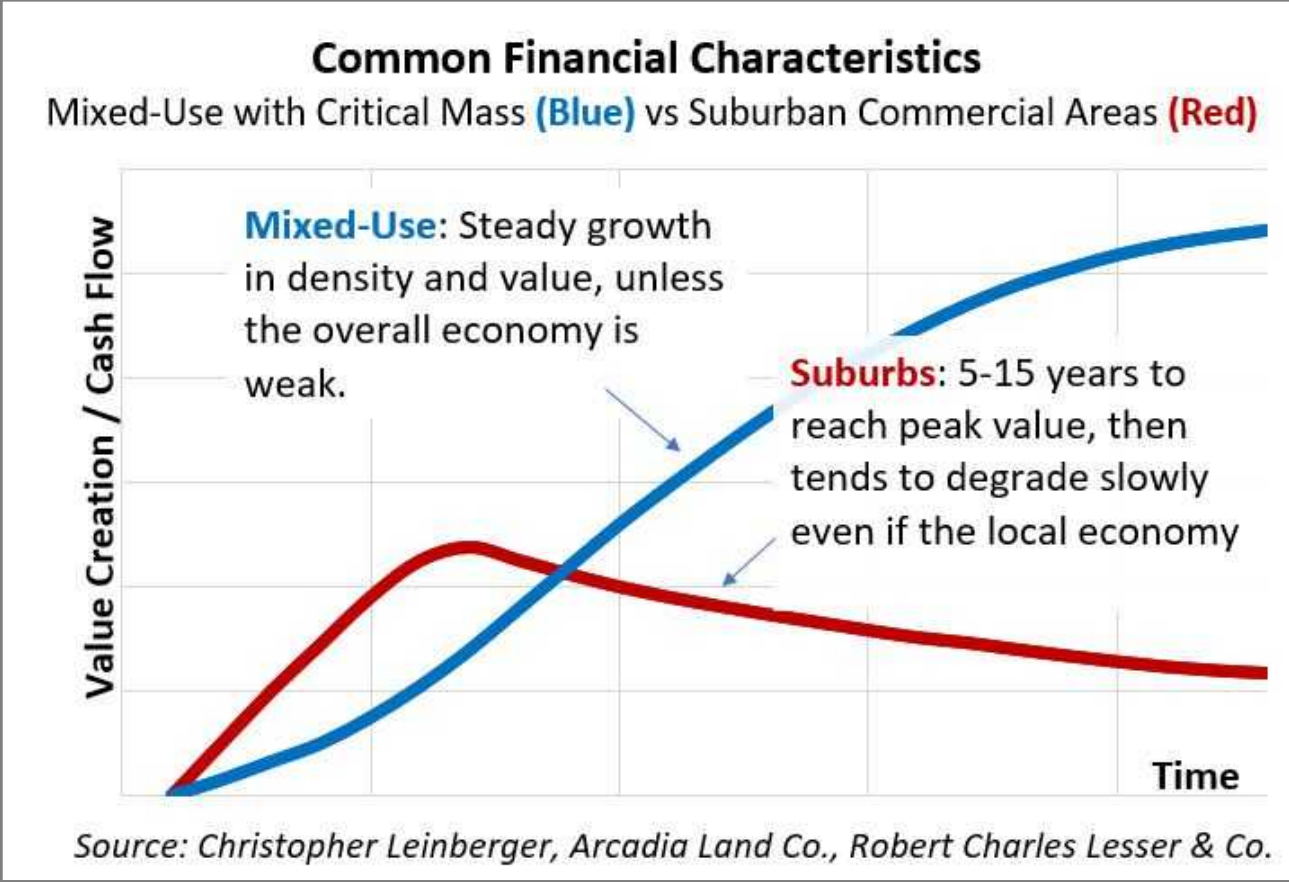
Do Stroads Contribute to Blight?

- Probably... How much? Hard to say.
- If we reinvent Stroads, can we bring back prosperity?

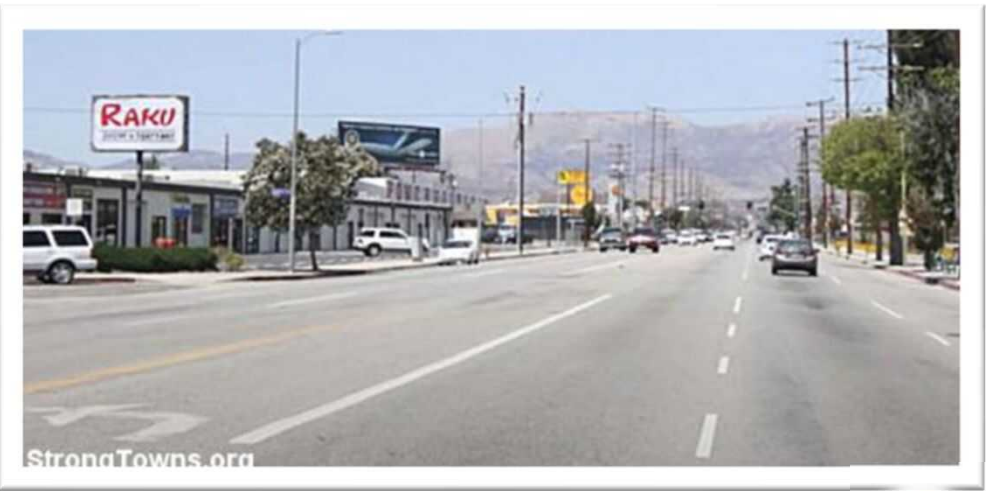




Our Expert Focus Groups and Research Below Agree: Stroads are Major Contributors to Declining Commercial Real Estate Value



Cheaper per Mile vs Cheaper per Square Mile



Cheaper per Mile, but...



Few to pay for it



Expensive per Mile, but...



Many to pay for it



What are the Realities of T3 Auto-Oriented Suburban Commercial and T4 Walkable Mixed-Use Environments?

Feature	T3 Suburban	T4 Urban
Street Trees	Random, Private, Pathetic	Uniform, Public, Many
Arterial Streets	40-55 mph, few ped crossings	25-35 mph, many ped crossings
Off-Street Parking	Too much: Underutilized	Shared, right-sized
On-Street Parking	Non-existent or barely used	Significant, heavily used
Sidewalks	Token 4-5 feet, weeds	6ft+, buffered, trees & furniture
Bikes, Low-Speed Vehicles	For Athletes & the Fearless	Increasingly Desirable Facilities
Transit	30-60 min, if at all	15-min is common
Block Sizes	8 to 50 acres per block	4 to 8 acres per block
Network	Disconnected: Congested at low densities	Connected: congests after high densities
*FAR (100 acres+), Zoning	.10 to .25, Segregated Uses	.26 to .50, Form-Based Zoning
Land Use Opportunities	Repels Residential	Big Market for Mixed Use

* FAR = Floor Area Ratio

DOTs can help provide excellent Street Trees, reduced speeds, frequent pedestrian crossings, on-street parking where appropriate, good sidewalks, better biking or “slow lanes” (for bike-like four-wheelers).

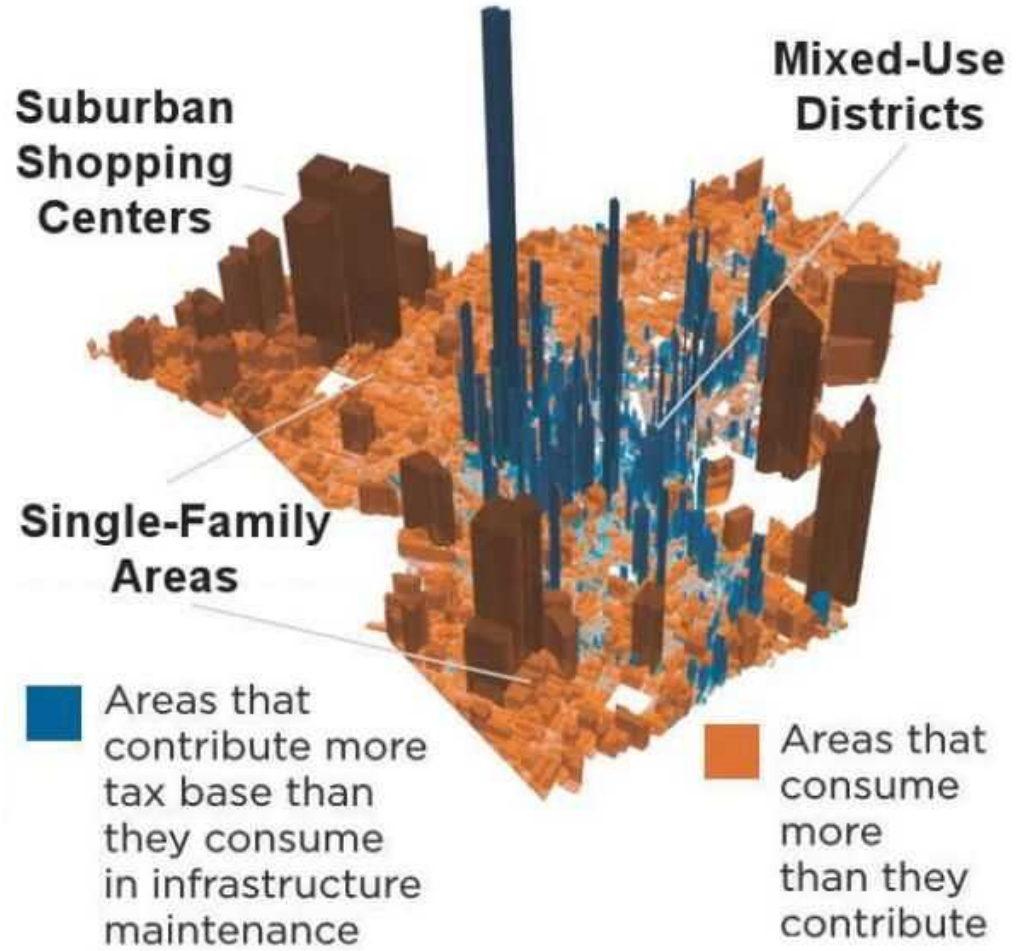
They can also provide “Placemaking Alternative Intersections!”

All else usually requires a city to make it happen. NCDOT investment to catalyze walkable mixed uses only makes sense if the city is doing all they can to reduce obstacles to mixed-use development. Without most of this, it may not work well.

Higher density mixed-use areas help offset more expensive suburban residential and commercial.

MIXED-USE MAKES MONEY!

LAFAYETTE, LOUISIANA

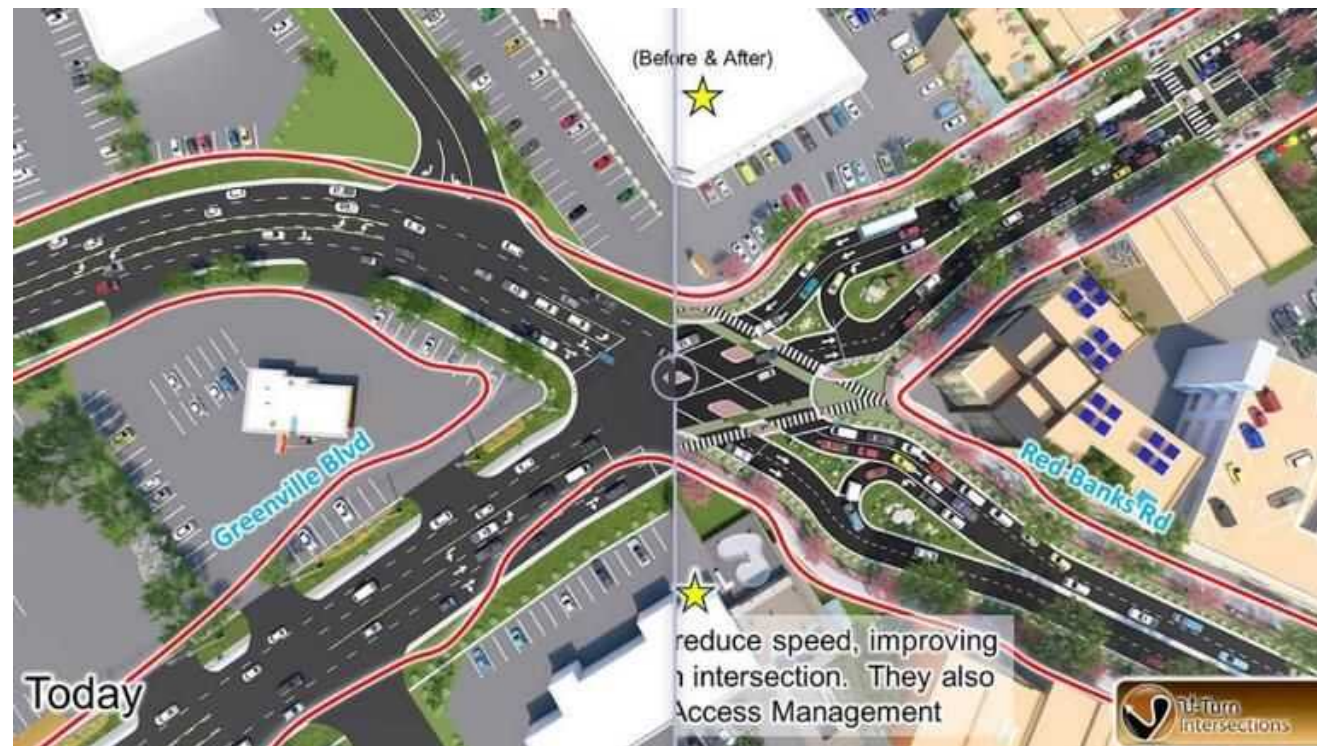


Source: Urban3, StrongTowns
Also featured in APA's Planning Magazine, Aug / Sept 2020

Website with Research Summaries, Before/After Sliders

urbaninnovators.com/pr-ncdot-ai-research

Or just go to UrbanInnovators.com and find “Projects”



Our “Big Ideas” for Converting Stroads into Complete Streets & Catalyzing Mixed-Uses

- ❖ “Slow Lanes” for Bikes, Cars, Transit – anything going “Bike Speed”
- ❖ Convert private parking into on-street public parking
- ❖ Neighborhood Electric Vehicles (aka, “Tiny Cars” or “Glorified Golf Carts”)
- ❖ Placemaking Alternative Intersections: Quadrants, U-Turns, One-Ways



Planetizen

The Disruptive Power of 'Minimobility'

Small, lightweight vehicles similar to golf carts could eliminate many Americans' need for a second car and make roads safer for all users.

Read Time: 1 minute
November 9, 2022, 6:00 AM PST
By Diana Ionescu @aworkoffiction



Jillian Cain Photography / Golf carts in The Villages, Florida

Planetizen

Why Golf Carts Could Quietly Revolutionize Transportation

More communities are catching on to the benefits of golf carts as a safe, low- emissions mode of transport for neighborhood trips.

Read Time: 2 minutes
August 16, 2022, 8:00 AM PDT
By Diana Ionescu @aworkoffiction



Golf carts in The Villages, Florida. | Jillian Cain Photography / Golf carts

Neighborhood Electric Vehicles



Battery improvements are making “tiny cars” affordable and practical for short neighborhood trips – the majority of all trips.



“Moving Sidewalk” shuttle, and two tiny cars fit in one parking space, at “The Villages” in Florida



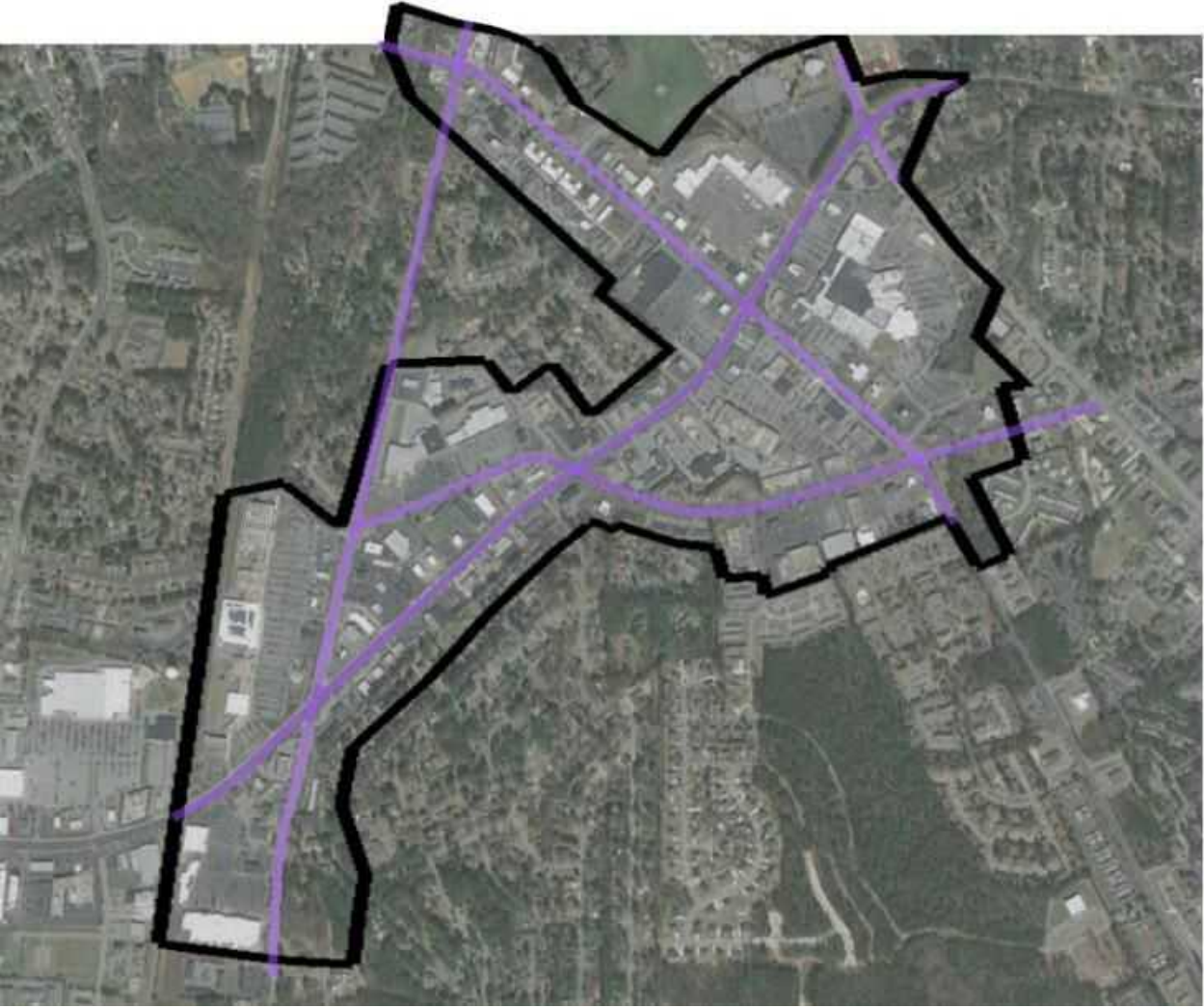
Golf carts and tiny cars are popular at McIntosh High School in Peachtree, Georgia. “2-car households,” are becoming “1-car, 1-cart”



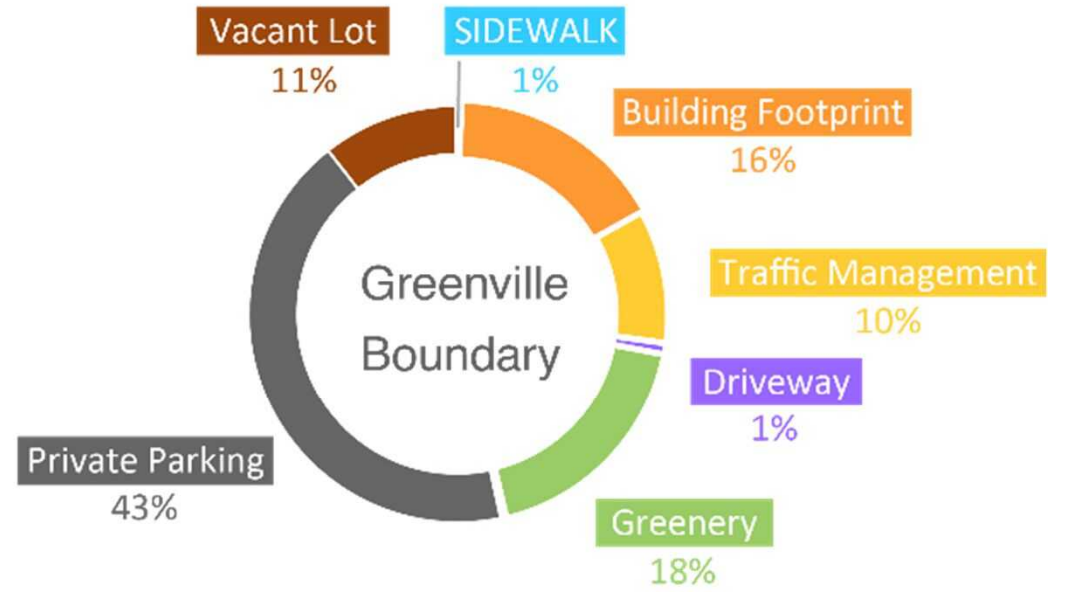
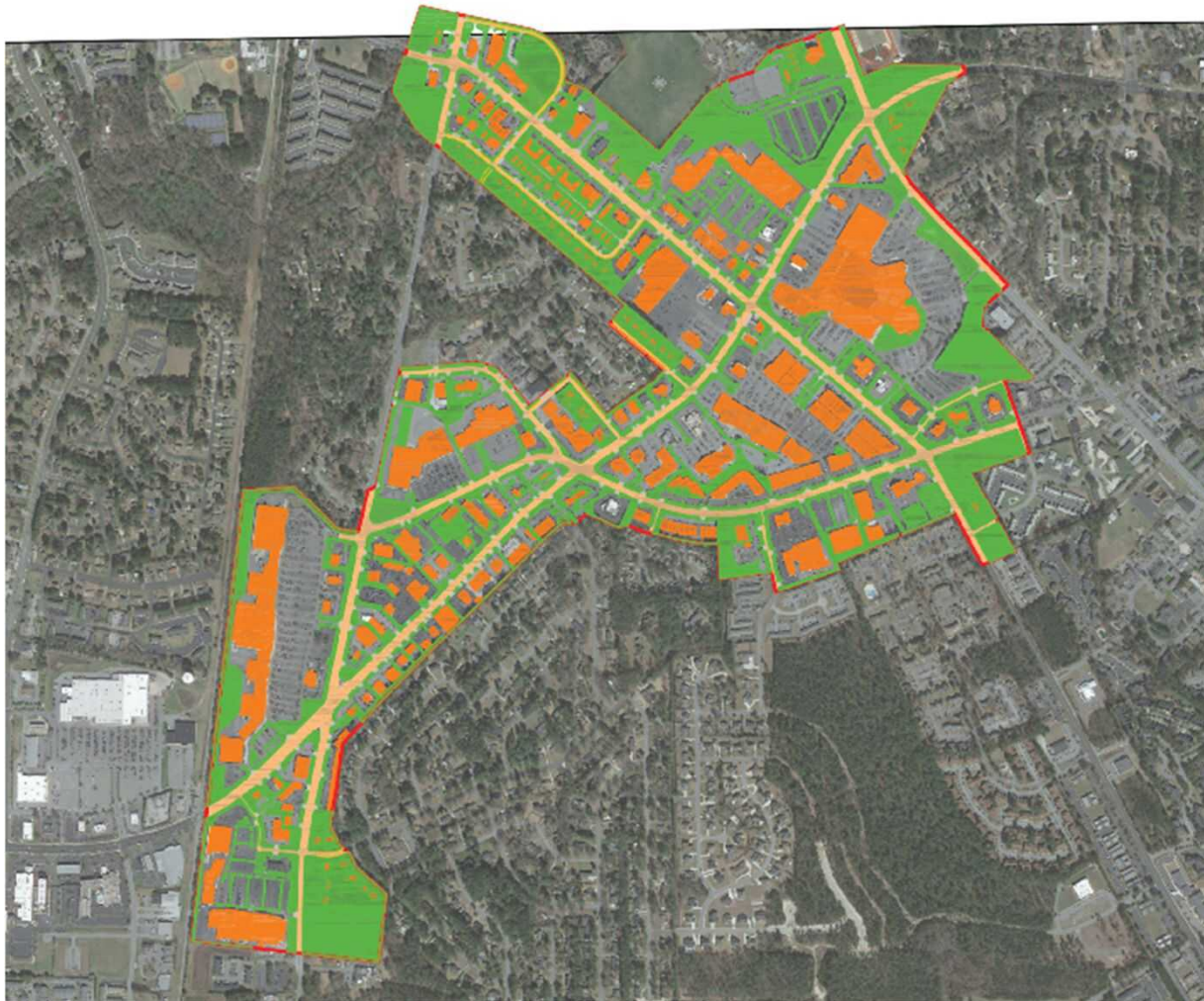
Square Foot Analysis, Percentage Use Analysis

- The following slides were developed by creating polygons in Autocad of the entire Greenville study area, and a walkable block in New Bern.
- The square feet in each category were totaled, and converted into “acres of ____, per hundred acres” (i.e., percent).
- A cool spreadsheet was created using a “Waffle Chart” technique. Search for:
 - “Greenville_NewBern_SqFt_WaffleChart_Analysis.xlsx”

Greenville Boundary

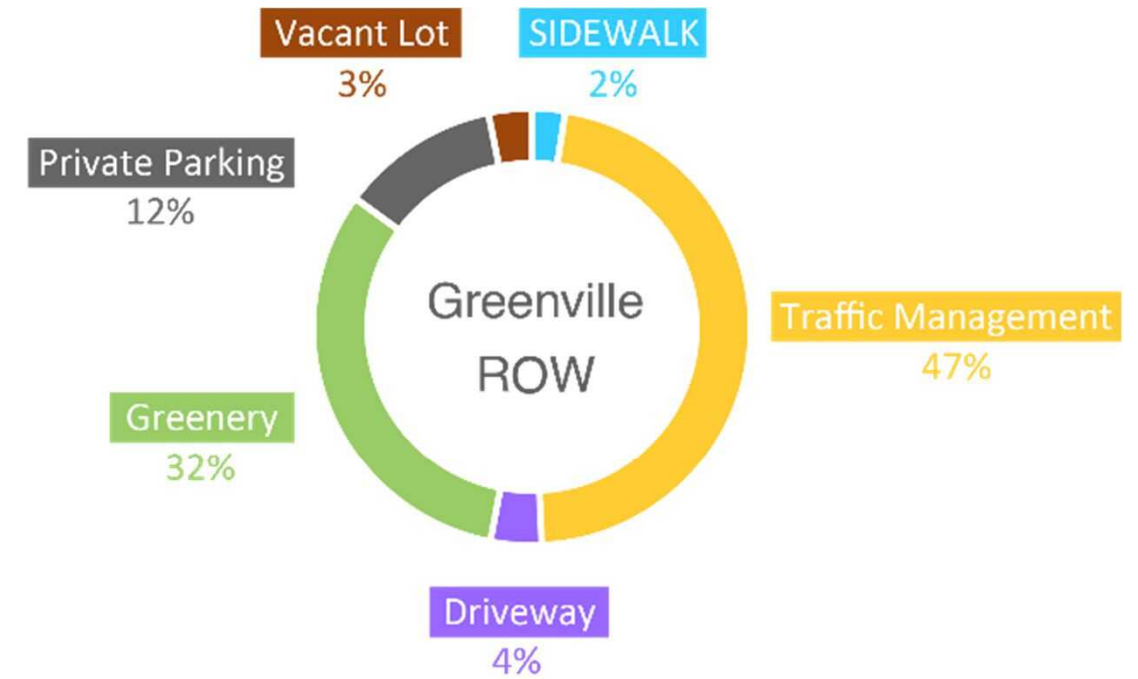


Greenville Boundary



- Sidewalk
- Greenery
- Building Footprint
- Public Parking
- Traffic Management
- Private Parking
- Driveway
- Vacant Lot

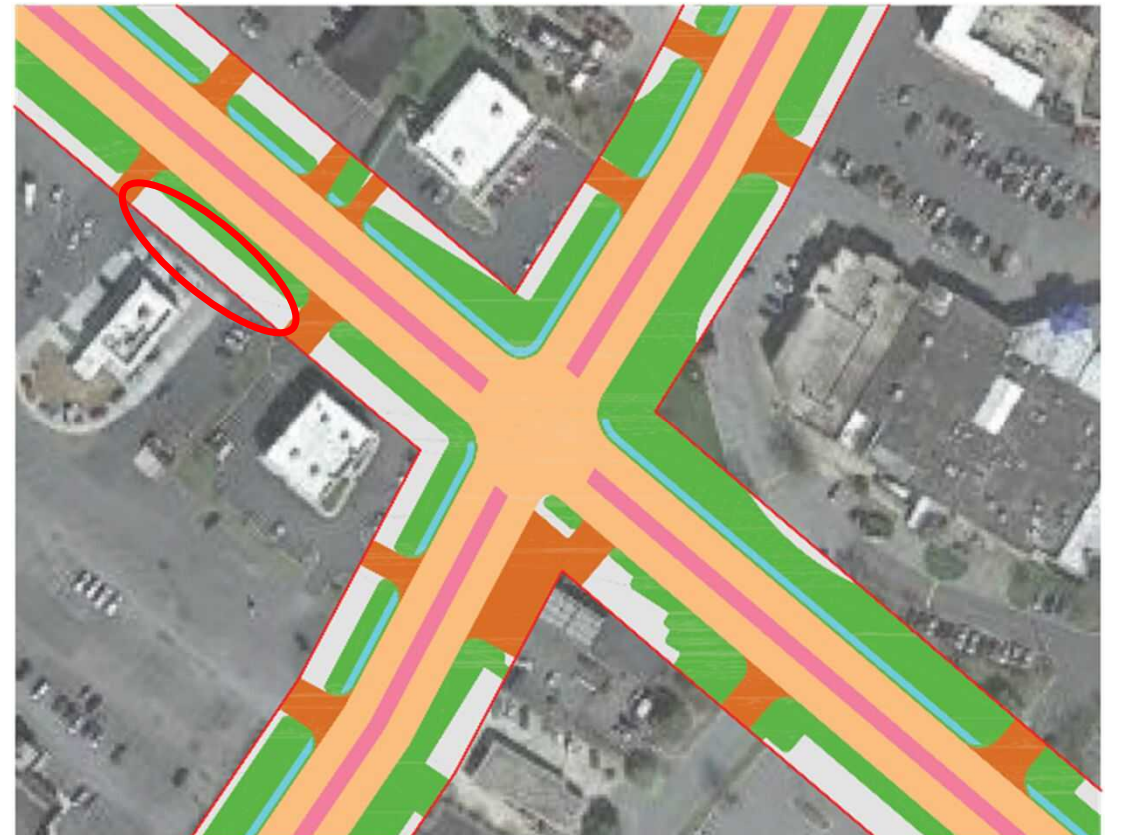
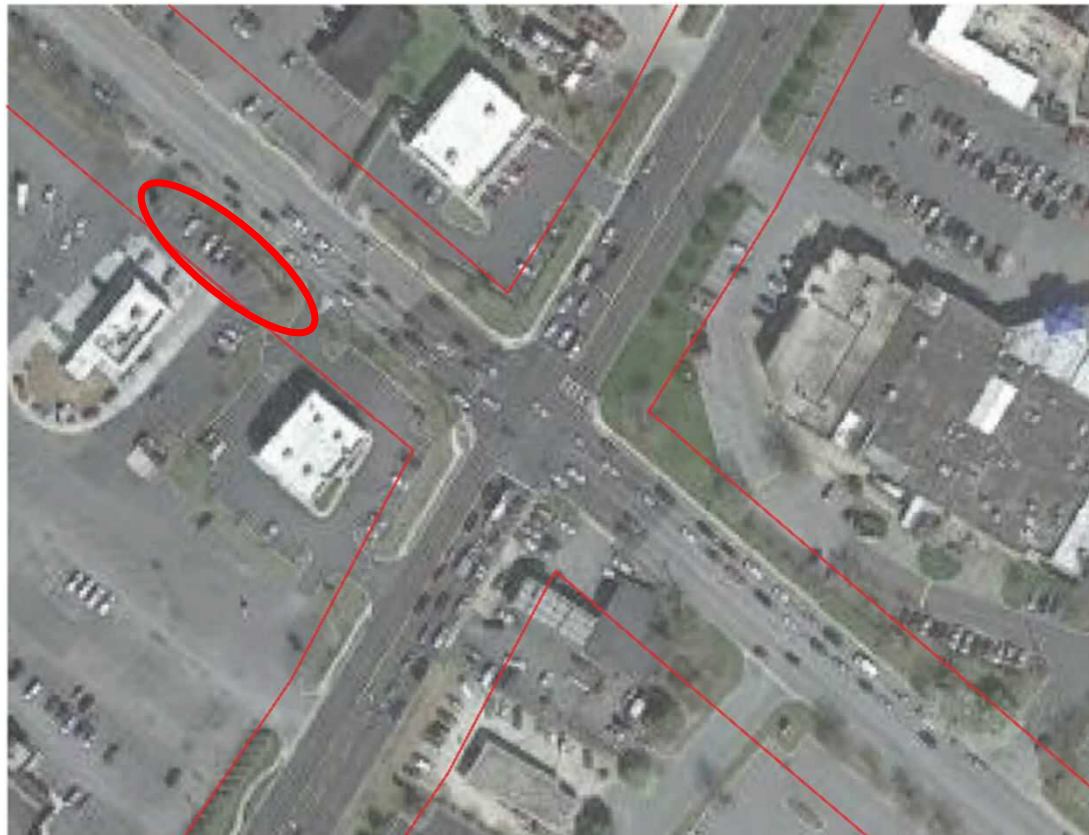
Greenville Potential ROW



- Sidewalk
- Greenery
- Building Footprint
- Public Parking
- Traffic Management
- Private Parking
- Driveway
- Vacant Lot



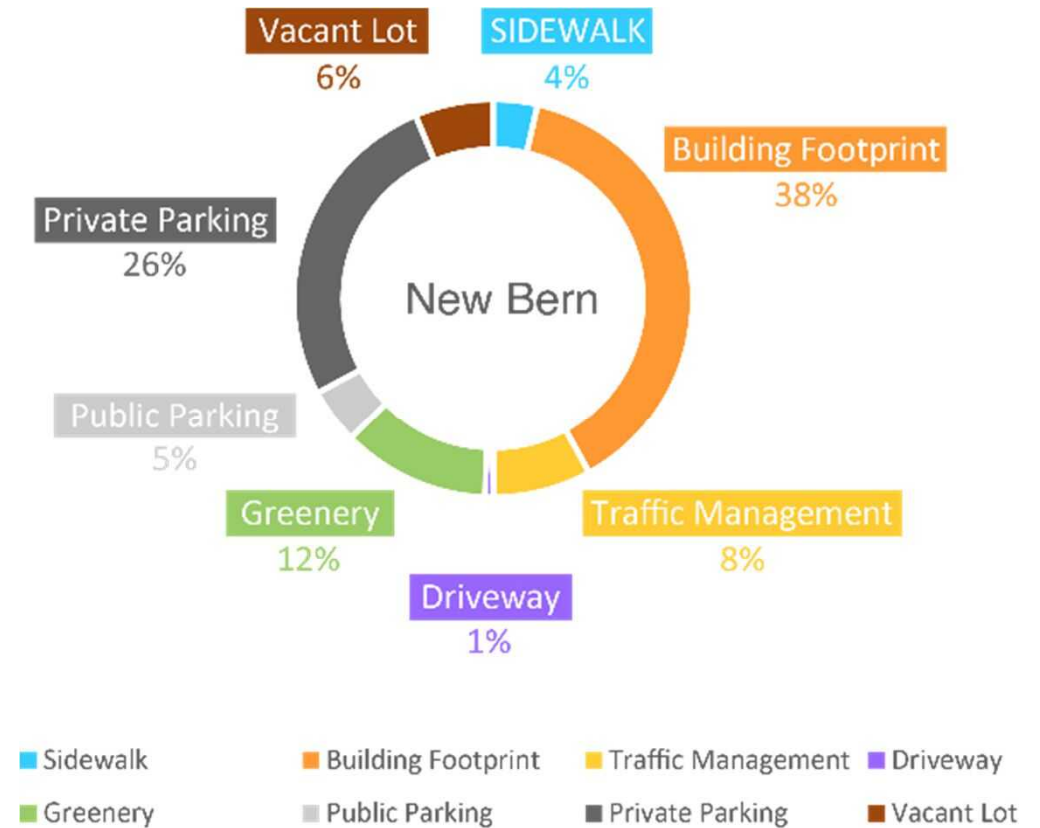
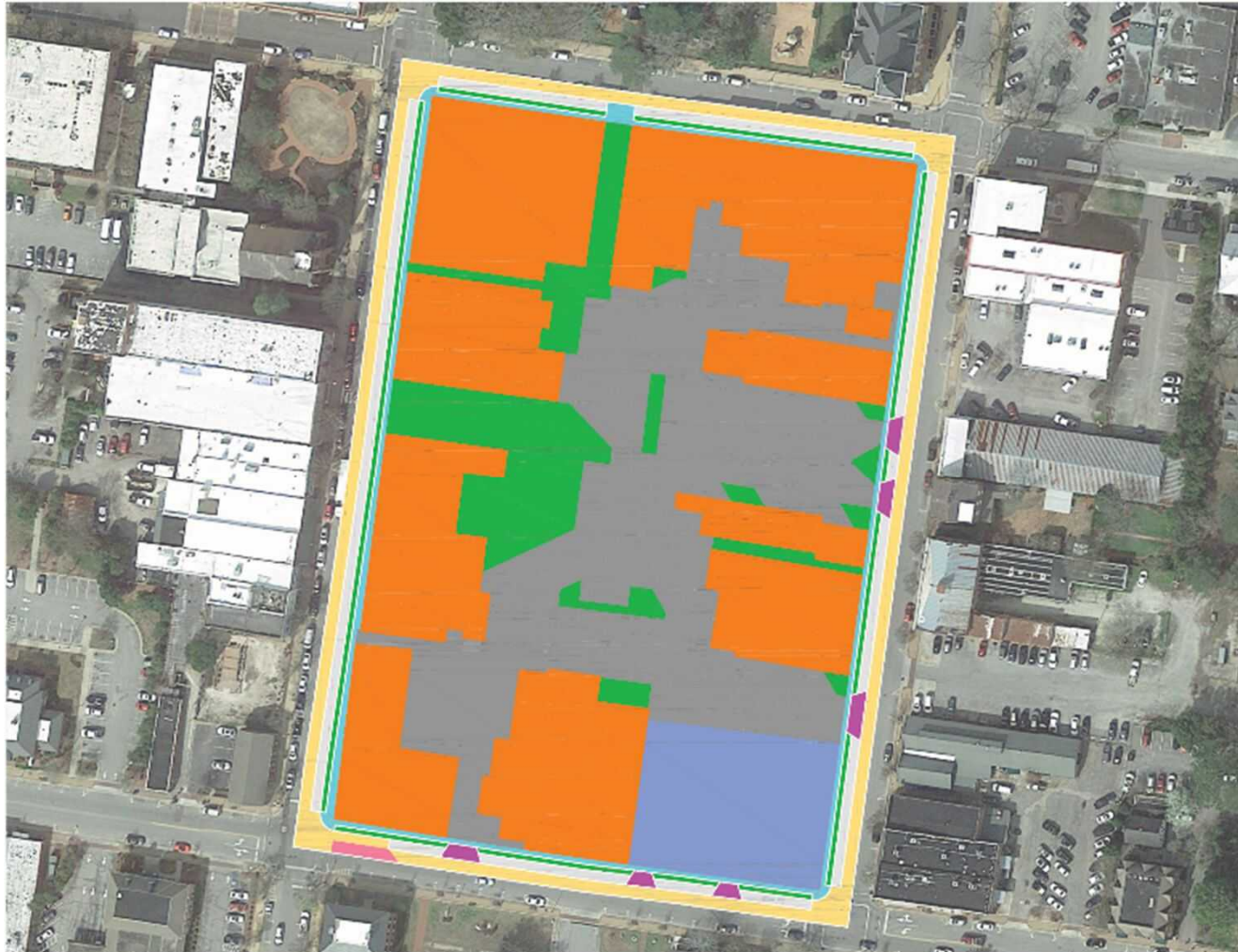
Greenville Potential ROW



Downtown New Bern, NC



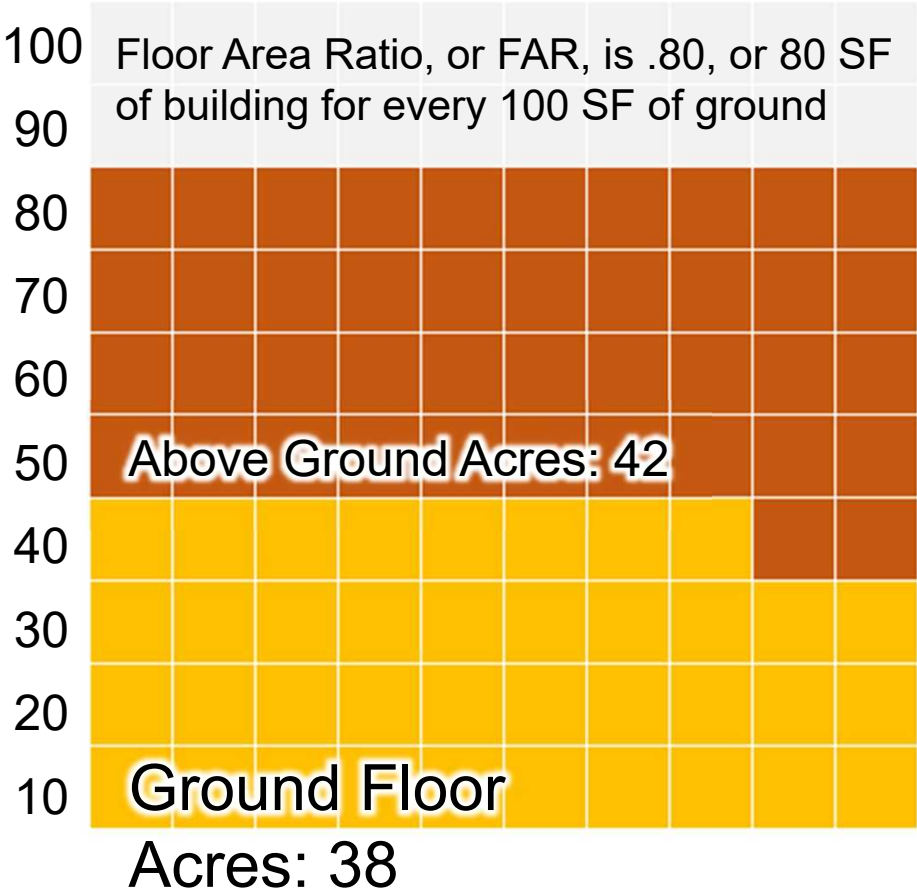
Downtown New Bern, NC



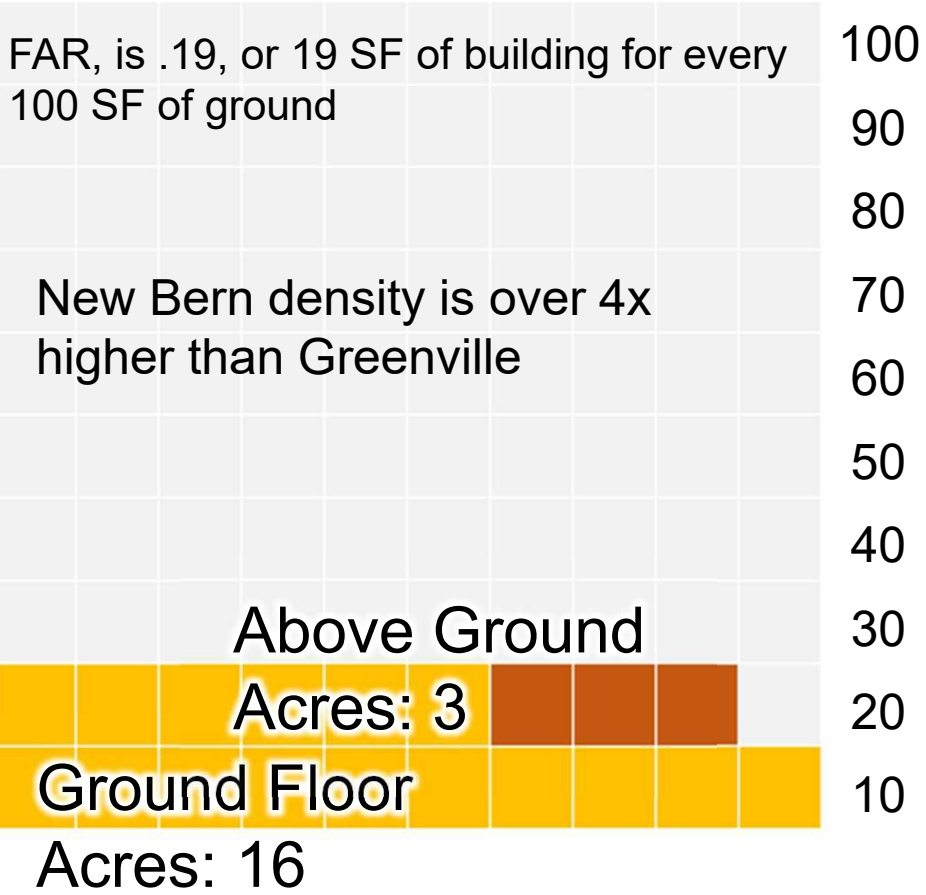


For every 100 Acres of Study Area

New Bern Buildings

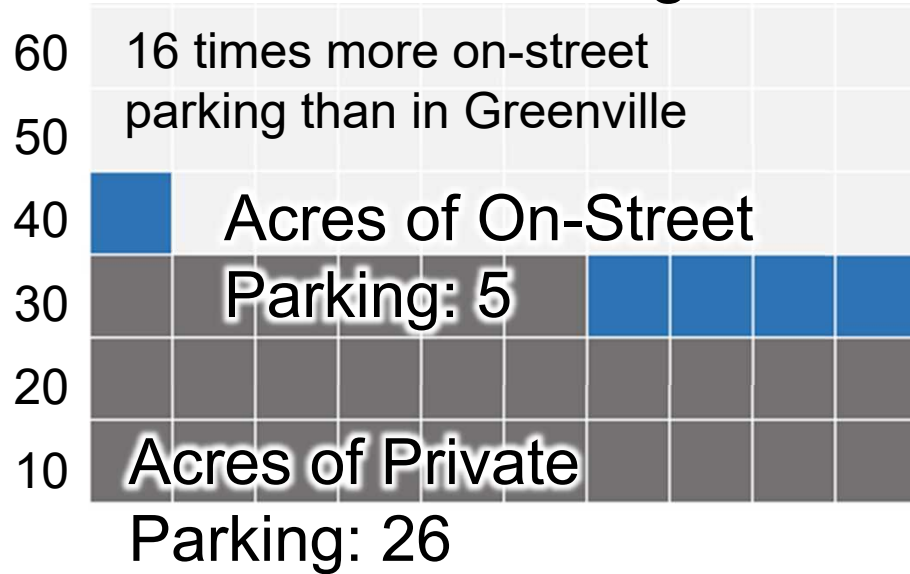


Greenville Buildings



For every 100 Acres of Study Area

New Bern: Parking

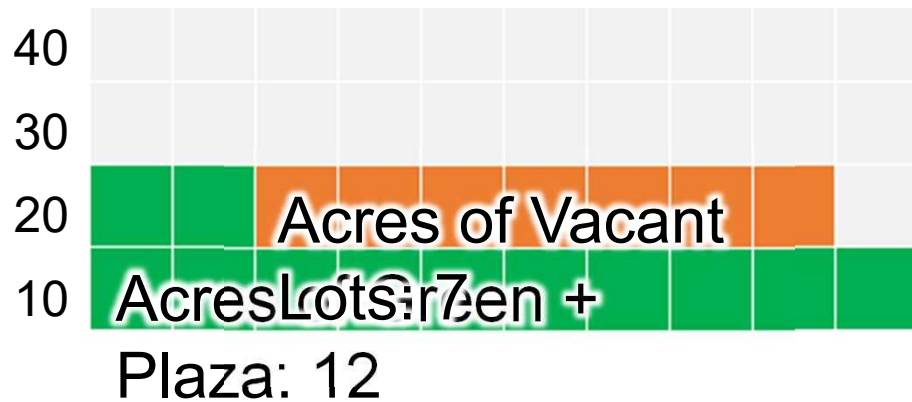


Greenville: Parking

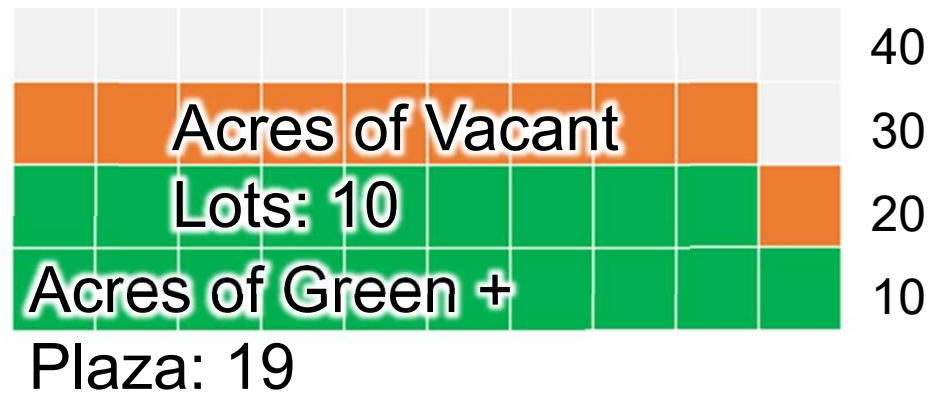


For every 100 Acres of Study Area

New Bern: Open Space

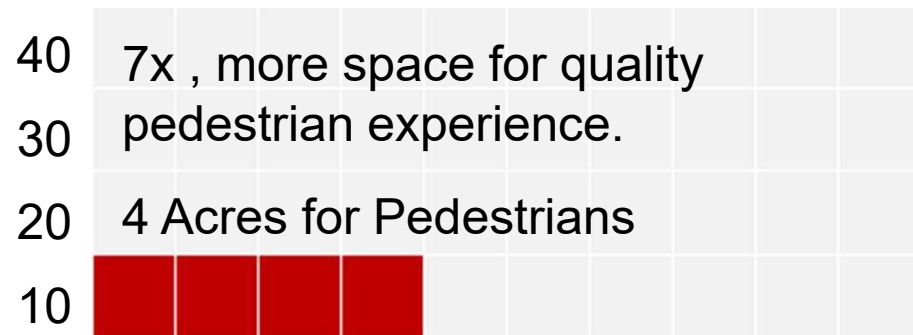


Greenville: Open Space



For every 100 Acres of Study Area

New Bern: Pedestrian Space



Greenville: Pedestrian Space



For every 100 Acres of Study Area

New Bern: Traffic Management



Greenville: Traffic Management

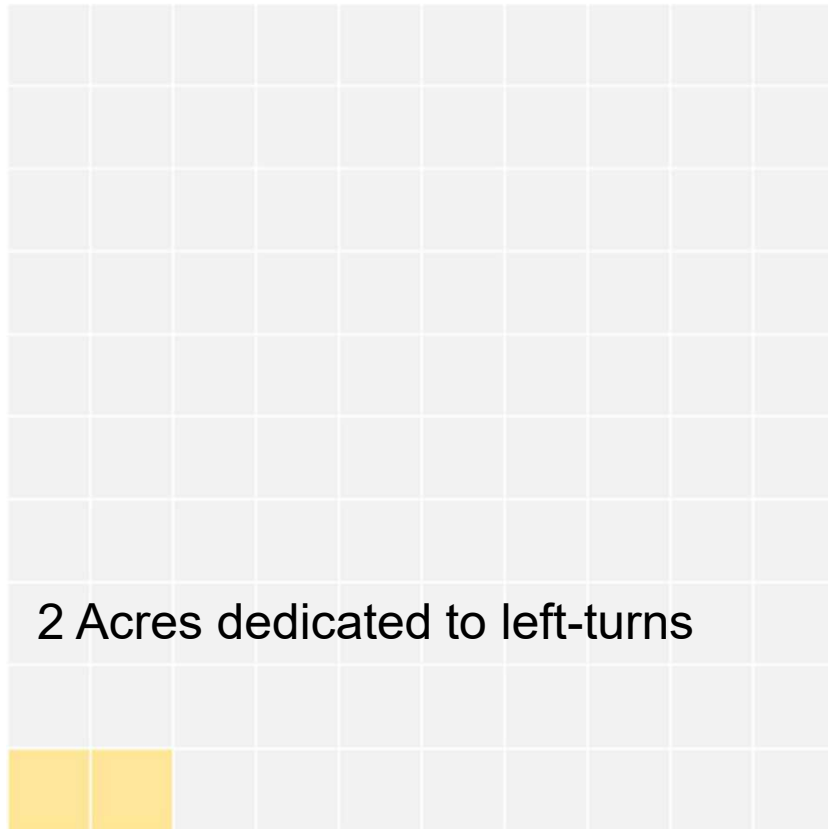


8x more left-turn space

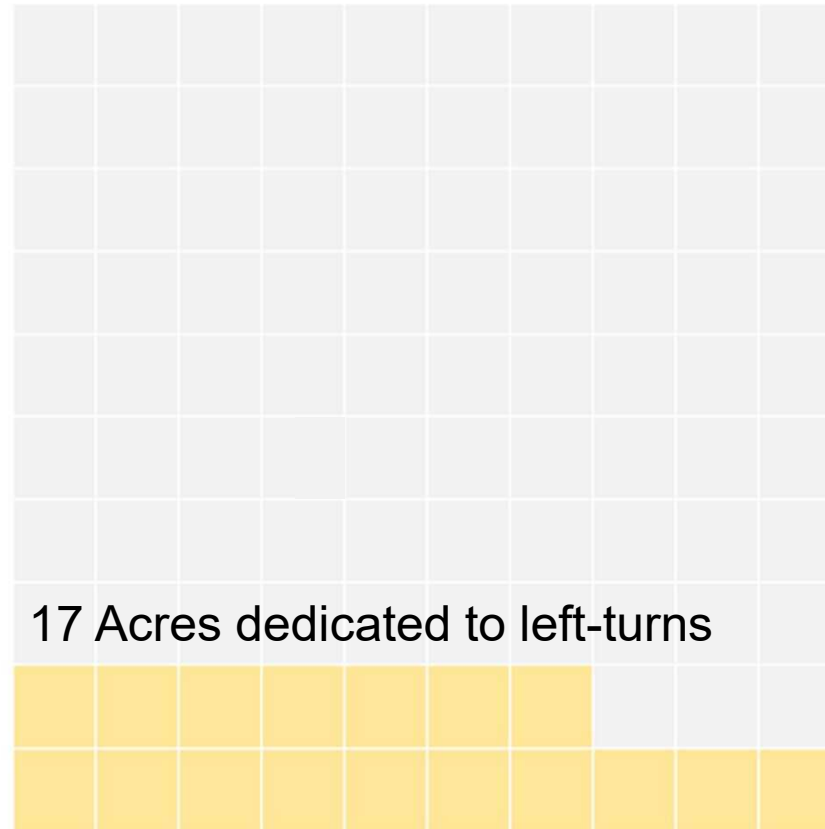


For every 100 Acres of Pavement for Traffic

New Bern
Left Turn Lanes



Greenville
Left Turn Lanes

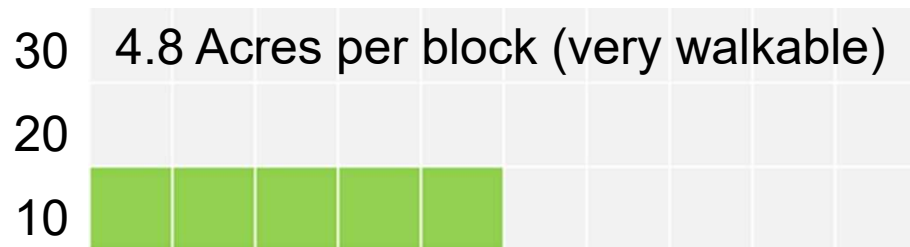


8x more left-turn space

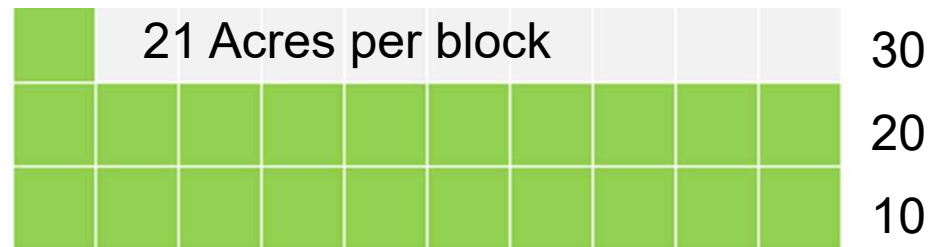


Comparing Block Sizes

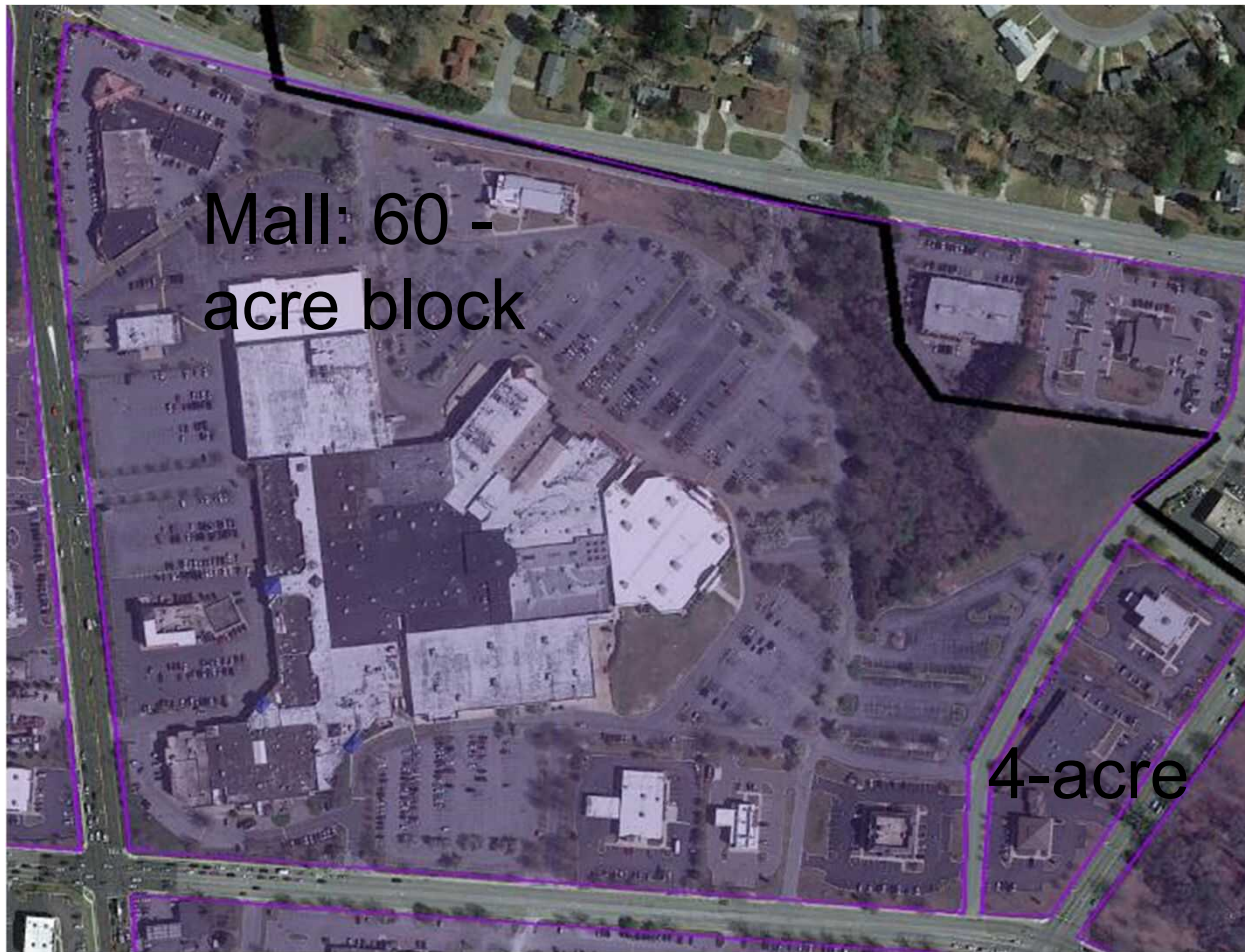
New Bern: Acres per Block



Greenville: Acres per Block



Comparing Block Sizes



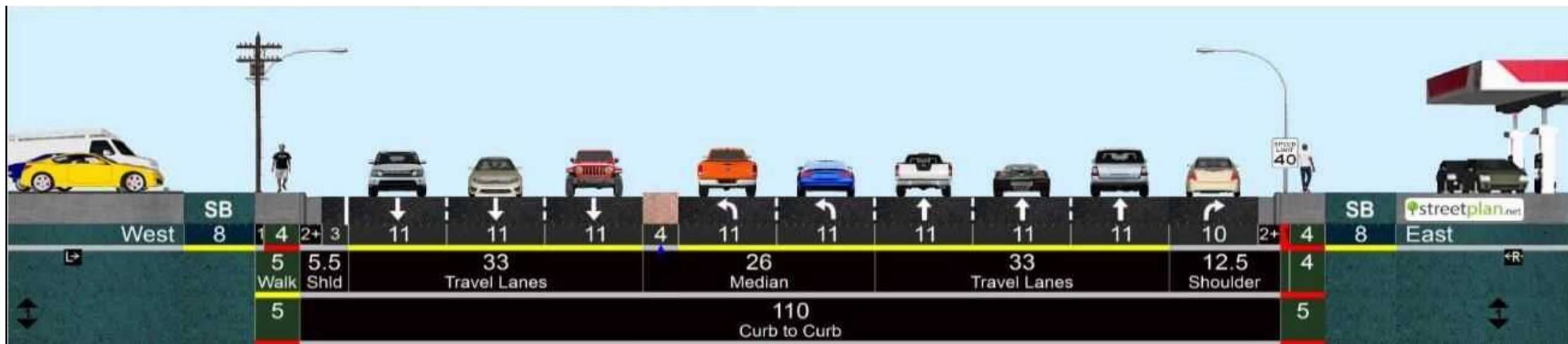
6 blocks,
29 acres
~ = 5 ac/block

Traffic Engineering 101

Target: 5-min

- ❖ Why are Stroads both Fast and Slow?
- ❖ Overview of Placemaking Alternative Intersections
 - Designs with potential to make things slower and safer, but also faster.

Looks Fast and Furious, but is Slow and Sad

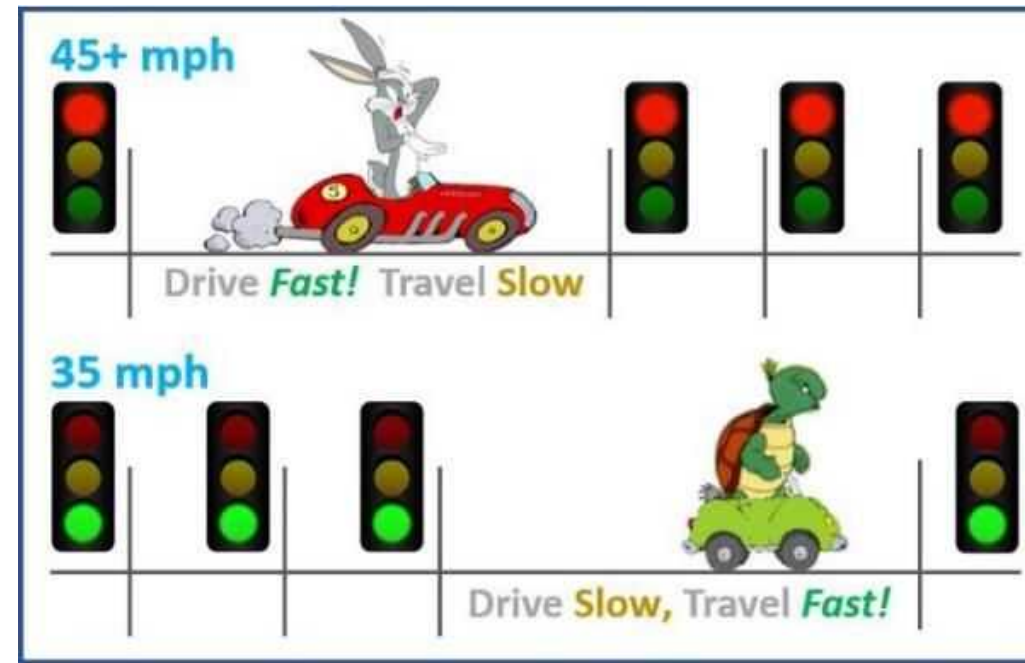


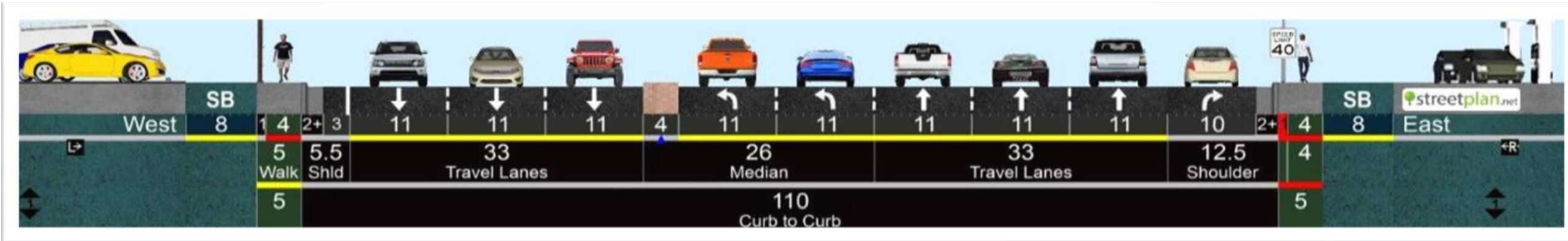
“Drive Fast, Travel Slow”

- Defines “Anywhere, USA”

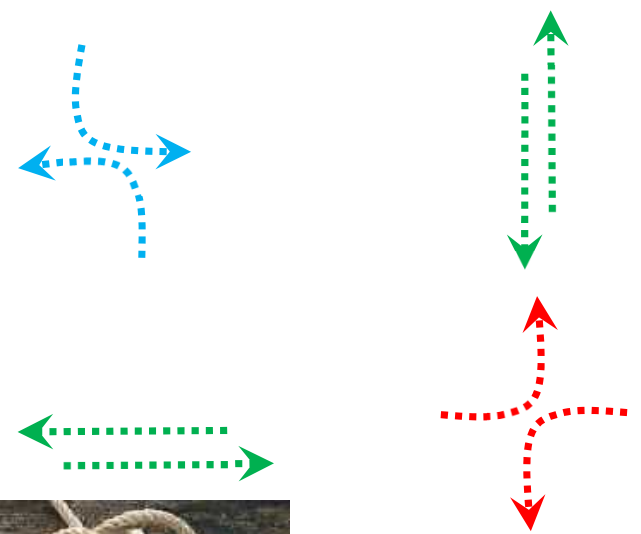
“Drive Slow, Travel Fast”

- Is that an option?
- With more green time, yes!





Looks Fast and Furious,
but is Slow and Sad

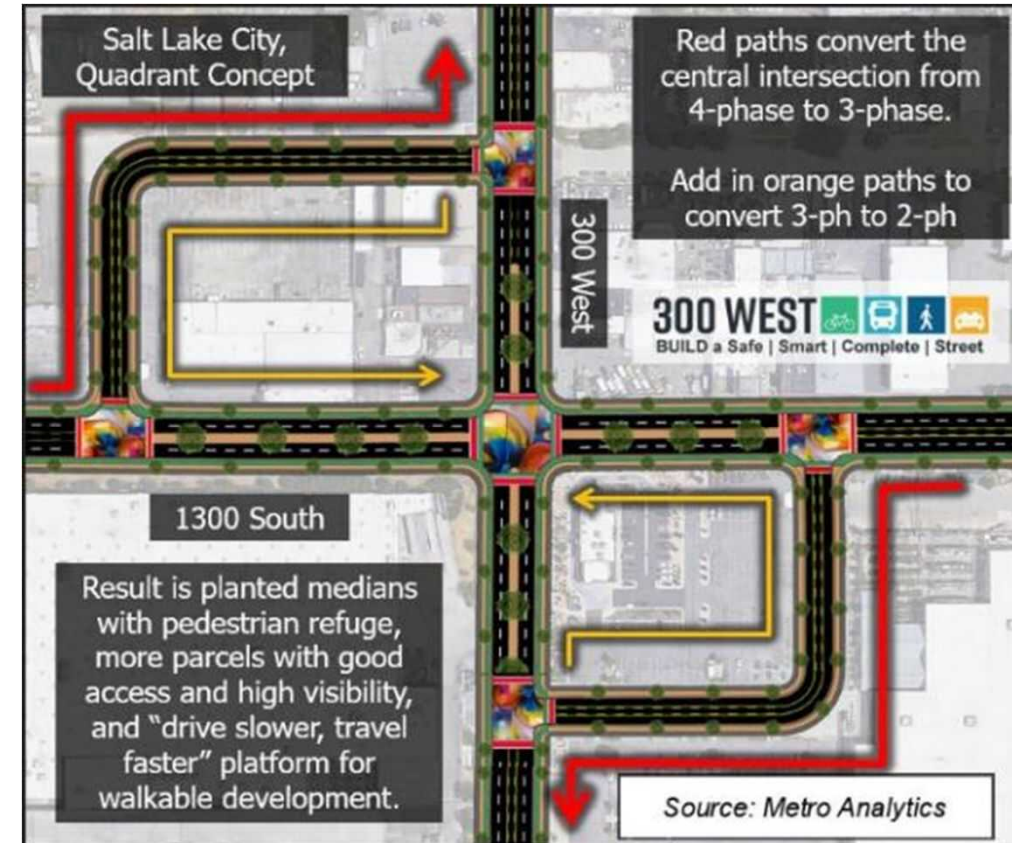
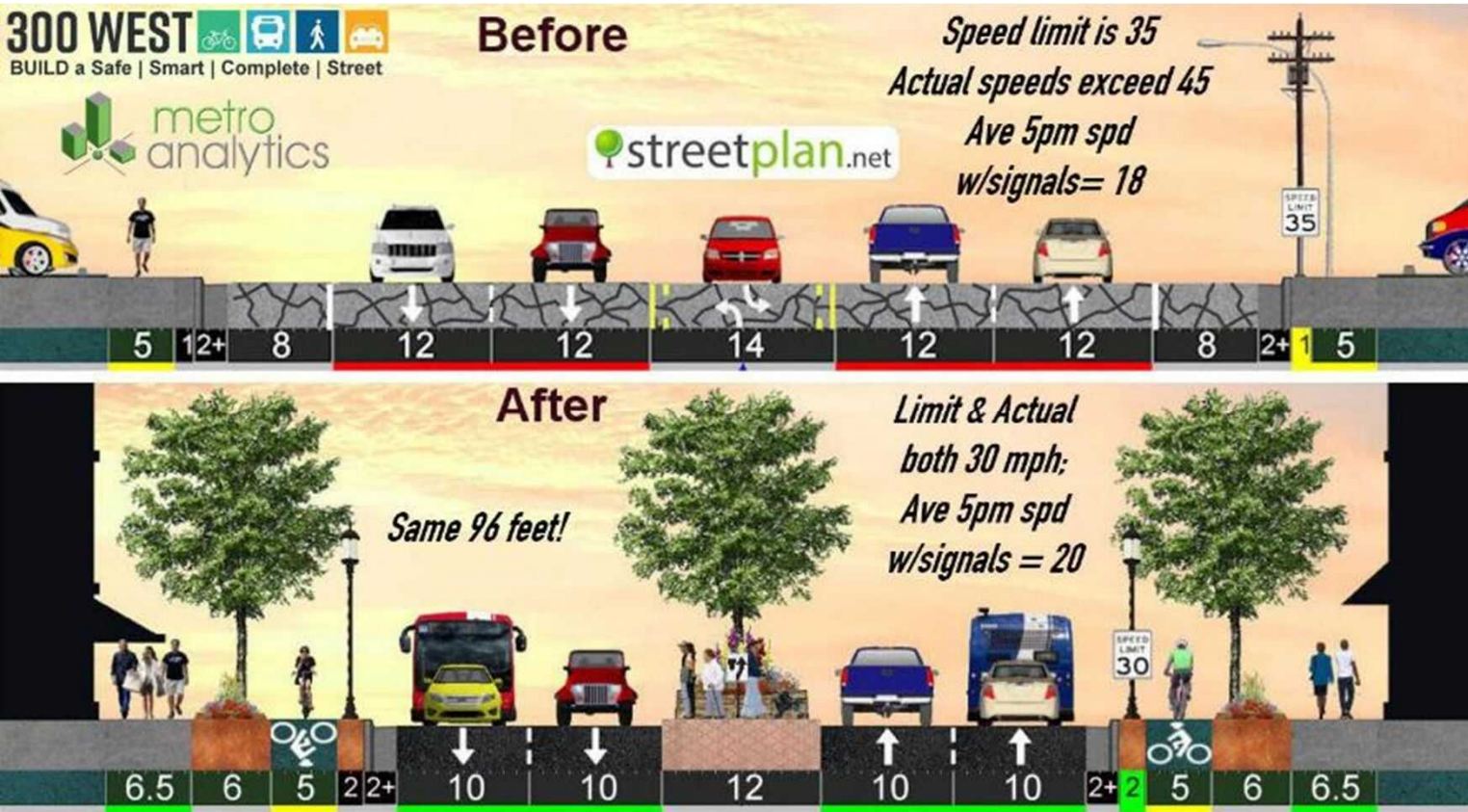


A complex diagram comparing two intersection types. On the left, a 'Traditional Four-Phase Signal' is shown with four phases: 1 (left turn), 2 (through/right turn), 3 (right turn), and 4 (left turn). Below it, a '9-Lanes at Intersection' is shown with arrows indicating traffic flow. On the right, a 'Typical "Stroad" Intersection' is shown with an aerial view. A green field is overlaid on the intersection, with a 150-foot width and a 300-foot length. A speed limit sign for 45 mph is shown, with a red light icon and the text 'Slow' and a sad face emoji. The text 'Hopelessly Unlivable?' is written at the bottom.



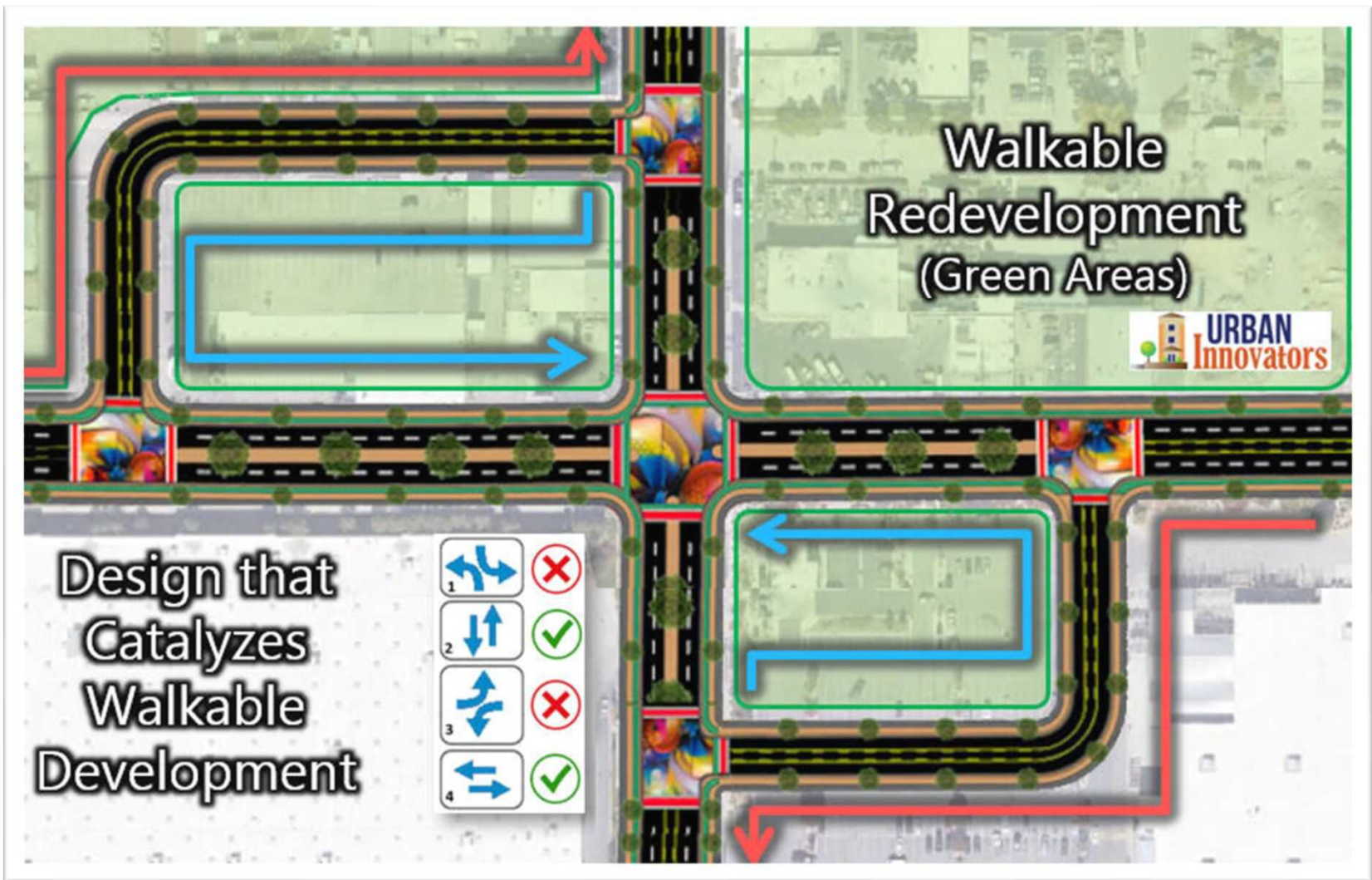
This is why you can't
get through the light!

Managing High Volumes and Creating Great Places



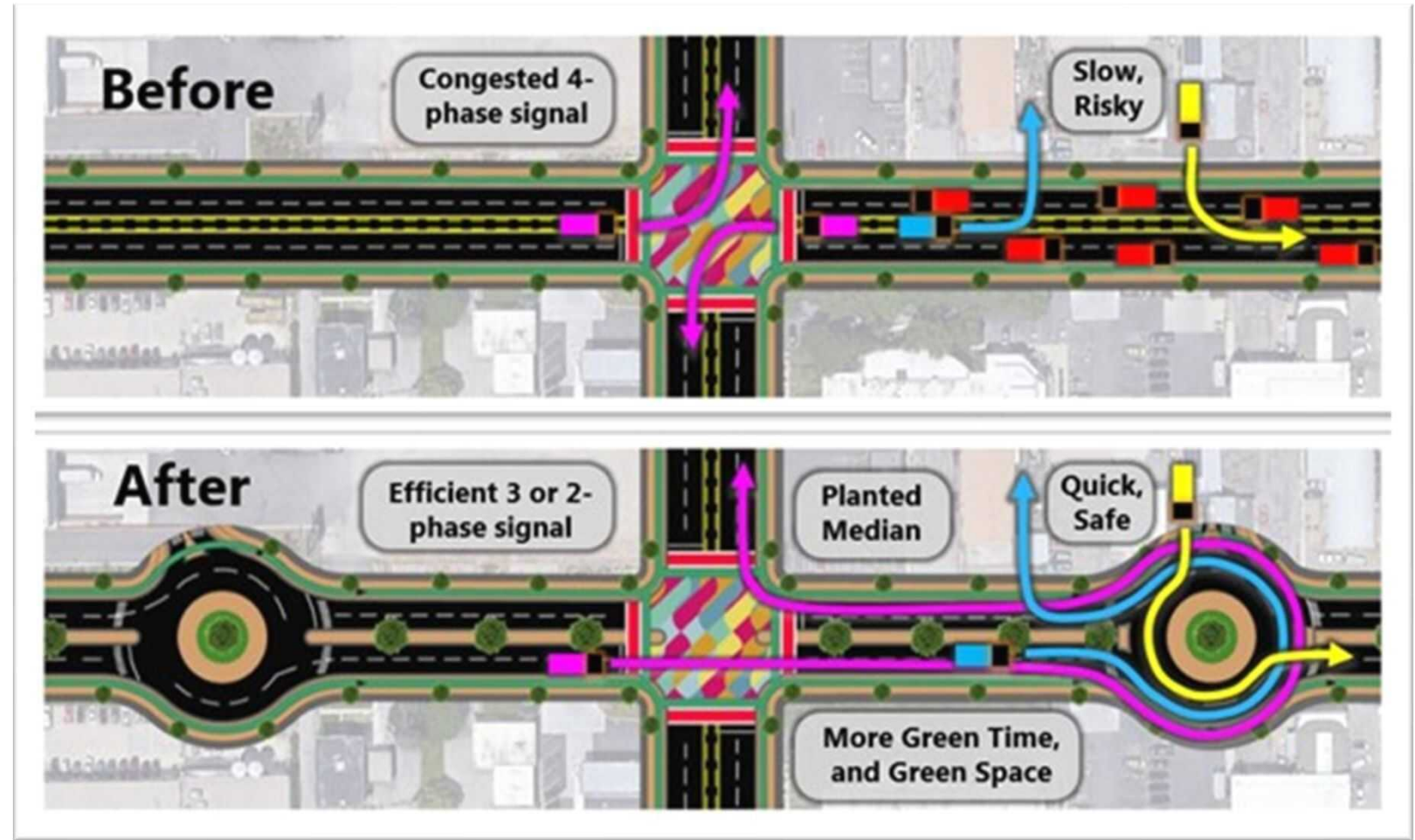


What is a Quadrant Intersection?





What is a U-Turn Intersection?



What is a One-Way Split Intersection?



- ❖ Four small intersections better than one huge!
- ❖ Right-on-red AND Left-on-red



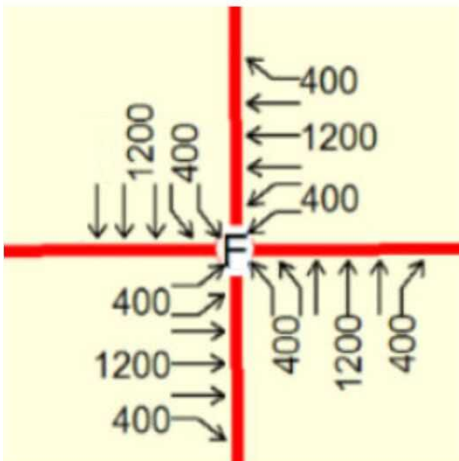
Completed Town Center Intersection: Elfin Forest Hwy & San Elijo Rd., San Marcos, CA

Which handles more traffic?

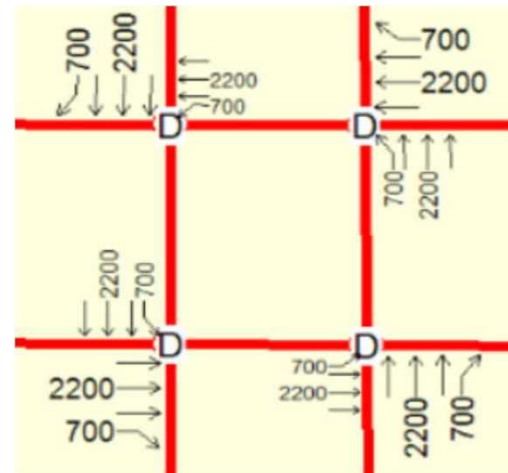
One gargantuan intersection?



or Four human-scale intersections?



8,000/hr at LOS F



14,000/hr at LOS D

(Unique vehicles, as all but rights involve 2-3 intersections)

Search for OneWayVsTwoWay_Footprint.JPG

Huge Double-Left Stroud Intersection

Pavement Pedestrian

8,000 vehicles per hour at LOS F

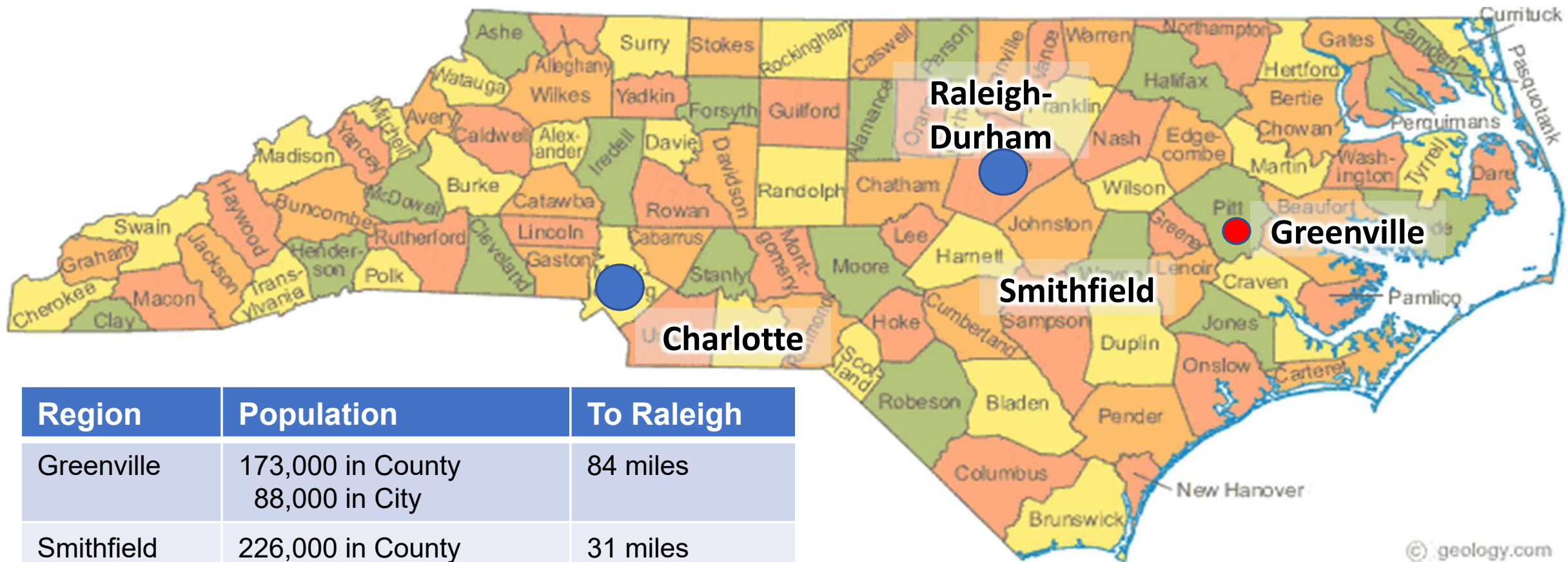
Reclaimed Space w/Crossing Couplets

Pavement Pedestrian

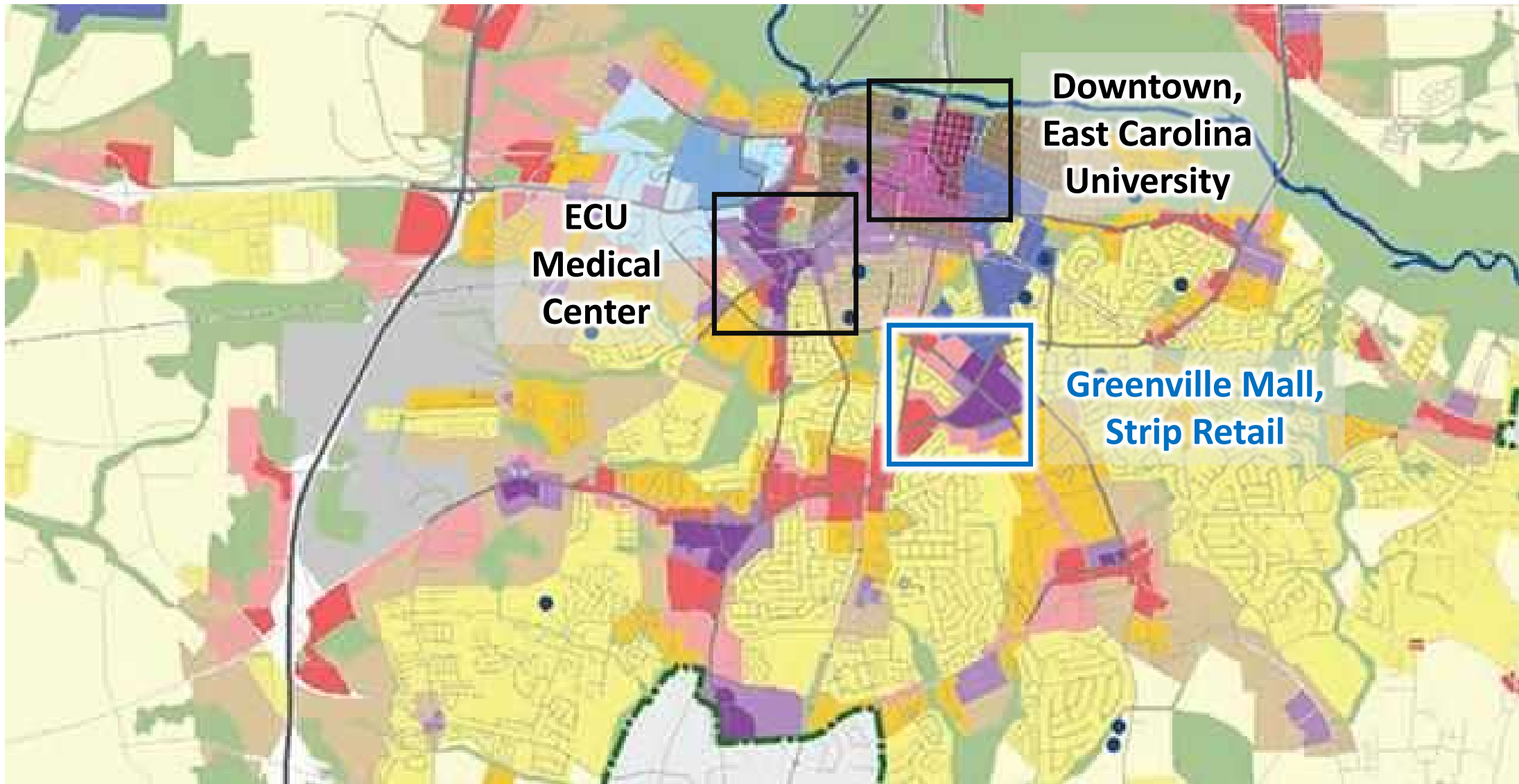
14,000/hour at LOS D
(Unique vehicles, as all but rights involve 2-3 intersections)

Four small intersections serves traffic better, *and* catalyzes a true Activity Center

Context for Greenville and Smithfield



Region	Population	To Raleigh
Greenville	173,000 in County 88,000 in City	84 miles
Smithfield	226,000 in County 13,000 in City	31 miles
Raleigh	2.1 Million in MSA	
Charlotte	2.7 Million in MSA	



**ECU
Medical
Center**

**Downtown,
East Carolina
University**

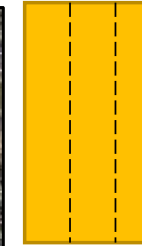
**Greenville Mall,
Strip Retail**

Traffic Performance Measures

- Operational Improvements in terms of Weighted Average Travel Time
 - ✓ *Assuming no fundamental change in number of lanes and traffic demand*
- Additional Capacity
 - ✓ *Additional traffic flow that AI designs can accommodate at Level of Service (LOS) E without adding lanes*
- Maximum Capacity
 - ✓ *Maximum flow at LOS E by adding additional lanes within the available Right-of-Way (ROW)*

Simulation Scenarios

- Scenario A: Current Design
 - ✓ Set traffic demand to generate 60s average delay per vehicle (i.e., average travel time 110s)
- Scenario B: Alternative Design
 - ✓ Attempting to match current design in lane configuration, same traffic demand as Scenario A
- Scenario C: Alternative Design
 - ✓ Attempting to match current design in lane configuration, increase traffic demand until get back to similar travel time as Scenario A
- Scenario D: Alternative Design
 - ✓ Max number of lane, increase traffic demand until get back to similar travel time as Scenario A



Economics Analysis

- Microsoft Excel Tool “Development Scale Calculator”

Planning-level tool that determine how much walkable development they can support before similar congestion and delay return

Capacity Analysis																
Existing Volume	Scenario	Capacity (vph)	Pass-thru (vph)	Pre-reduct V/C		Post-reduct V/C		Reduced Demand, Area 1								
				Starting VPH	V/C	Reduced VPH	V/C,R	Net. Con.	Int. Capt.	Transit	Walk	Bike	Com-bined	vs Exist	Reduced VPH	Reduced V/C
4,000																
Int 1: North Quad	Existing	3,700	1,500	4,000	1.08	4,000	1.08	0.0%	10.5%	2.0%	5.7%	1.9%	20.1%	0.0%	4,000	1.08
	Step 1	3,700	1,500	3,700	1.00	3,700	1.00	0.0%	12.0%	2.0%	5.9%	1.9%	21.7%	1.6%	3,700	1.00
	Step 2	5,700	1,500	3,700	0.65	3,700	0.65	0.0%	12.0%	2.0%	5.9%	1.9%	21.7%	1.6%	3,700	0.65
	Step 3	5,700	1,500	5,600	0.98	5,500	0.96	0.0%	11.8%	1.9%	5.9%	1.8%	21.4%	1.3%	5,500	0.96
	Step 4	5,700	1,500	5,600	0.98	4,600	0.81	10.0%	13.4%	3.7%	10.7%	4.3%	42.2%	22.1%	4,600	0.81
Step 5	5,700	1,500	6,500	1.14	5,300	0.93	10%	13.6%	4%	10.7%	4.4%	42.5%	22.4%	5,300	0.93	

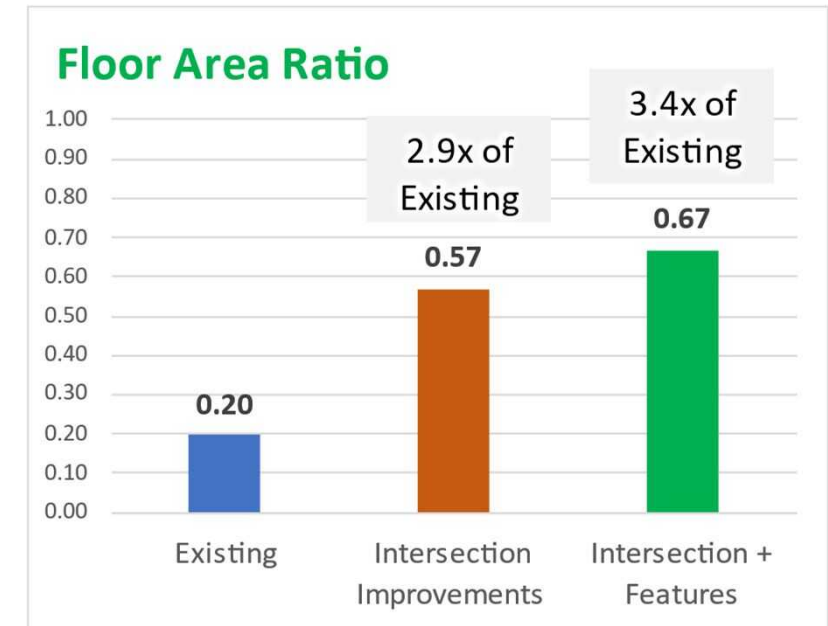
Land Use and Trip Generation											Trip Distribution %				
Description	Type	Unit Type	PM Peak Trip Rate	Number of Units					Internal Capture:	Pre-Reduction V/C Ratio:	Post-Reduction V/C Ratio:	Floor / Area Ratio (FAR):	Int. 1	Int. 2	Int. 3
				Existing	Step 1	Step 2	Step 3	Step 4							
Single Family	Residential	DU	0.94	100	100	100	100	100	100			50%	30%	15%	
Multi-Family	Residential	DU	0.51	150	500	500	1,100	1,100	1,400						
Retail	Retail	KSF	6.59	60	90	90	150	150	200						
Office	Office	KSF	1.44	260	300	300	600	600	700						
Industrial	Industrial	KSF	0.34	0	0	0	0	0	0						
TOTAL															
				Internal Capture:	10.5%	12.0%	12.0%	11.8%	13.4%	13.6%					
				Pre-Reduction V/C Ratio:	1.08	1.00	0.65	0.98	0.98	1.14					
				Post-Reduction V/C Ratio:	1.08	1.00	0.65	0.96	0.81	0.93					
				Floor / Area Ratio (FAR):	0.14	0.23	0.23	0.42	0.42	0.52					

RCI U-Turn Design



- U-Turn increases vehicle capacity from 3,800 to 6,000 per hour – 58% more
- Before / After travel time is 100 seconds, despite lowering speed limit from 45 to 35
- System can support 3 to 3.5 times the existing density (FAR) at same travel time

Proposed AI Design	Measure	Existing	Alternative Design	
		A: Capacity at 60-sec	B: New Des, Same Vol	C: New Des, Add Vol
RCI / U-Turn	Speed Limit	45	35	35
	Travel Time (sec)	100	90 (-12%)	100
	Vehicles per hour	3800	3800	6000 (+58%)

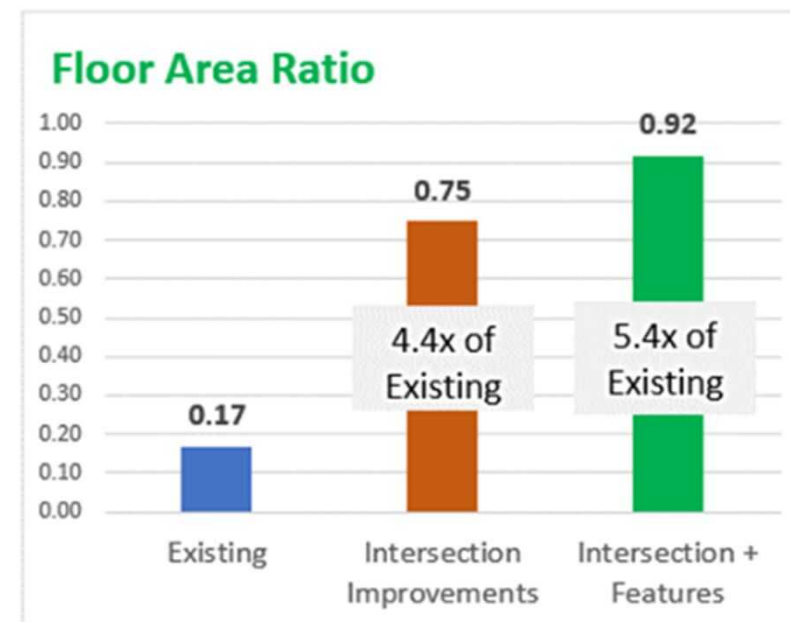




One-Way Split Design

- Crossing one-ways increase vehicle capacity from 3,700 to 7,100 per hour – 91% more
- Before / After travel time is 100 seconds, despite lowering speed limit from 45 to 35
- System can support 4 to 5 times the existing density (FAR) at same travel time

Proposed AI Design	Measure	Existing	Alternative Design	
		A: Capacity at 60-sec	B: New Des, Same Vol	C: New Des, Add Vol
One-way Couplet	Speed Limit	45	35	35
	Travel Time (sec)	100	60 (-41%)	100
	Vehicles per hour	3700	3700	7100 (+91%)

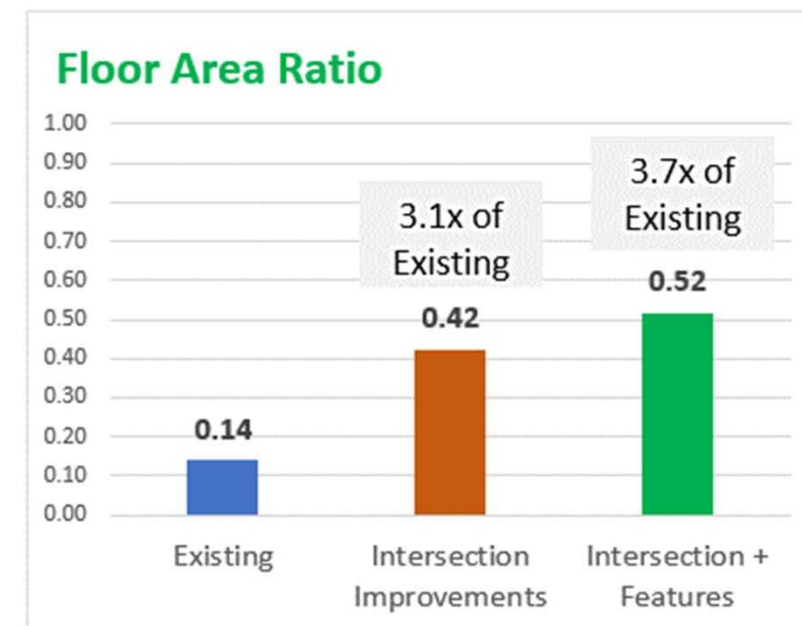




Quadrant Design

- Quadrant increases vehicle capacity from 3,600 to 5,700 per hour – 58% more
- Before / After travel time is 110 seconds, despite lowering speed limit from 45 to 35
- System can support 3 to 4 times the existing density (FAR) at same travel time

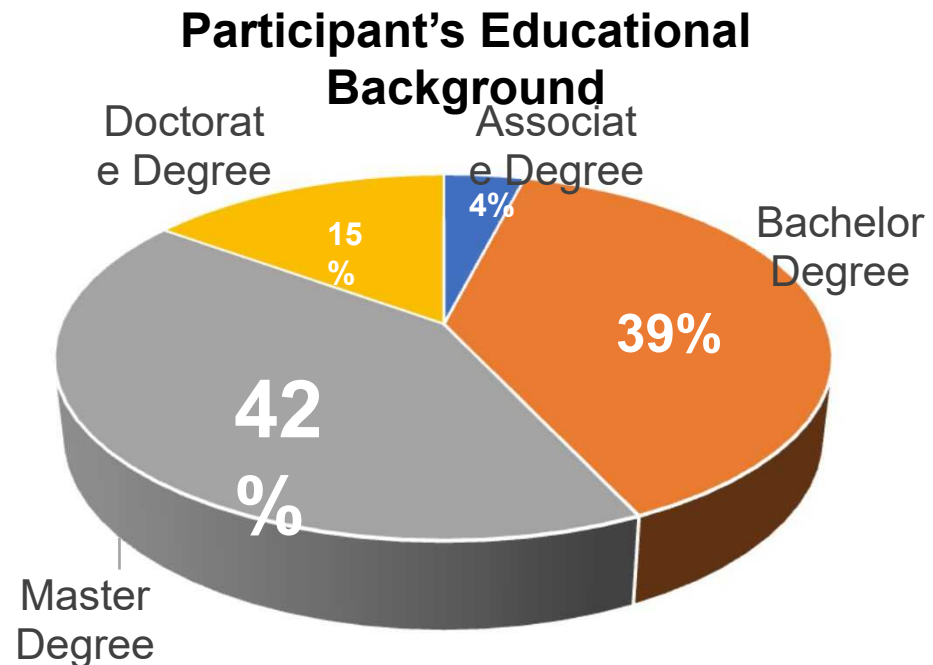
Proposed AI Design	Measure	Existing	Alternative Design	
		A: Capacity at 60-sec	B: New Des, Same Vol	C: New Des, Add Vol
Quadrant Roadway	Speed Limit	45	35	35
	Travel Time (sec)	110	90 (-17%)	110
	Vehicles per hour	3600	3600	5700 (+58%)



Focus Groups

Participants

27 participants from NC, CO, TX, SC, KS, NY, and British Columbia



Occupation and Specialty

- ✓ Non-profit advocates for bike/pedestrians and road safety
- ✓ Traffic engineers
- ✓ Transportation planners and consultants
- ✓ City planners and land use experts
- ✓ University professors and researchers
- ✓ City engineers
- ✓ Urban economist
- ✓ Transit planner and manager
- ✓ Real-estate economics specialist
- ✓ Developer, mixed-use and shopping centers

Opening Focus Group Questionnaire

Question A: Will the cost of housing across North Carolina continue to increase substantially?

Question B: Is there a need to rezone / redesign commercial areas to attract a mix of uses?

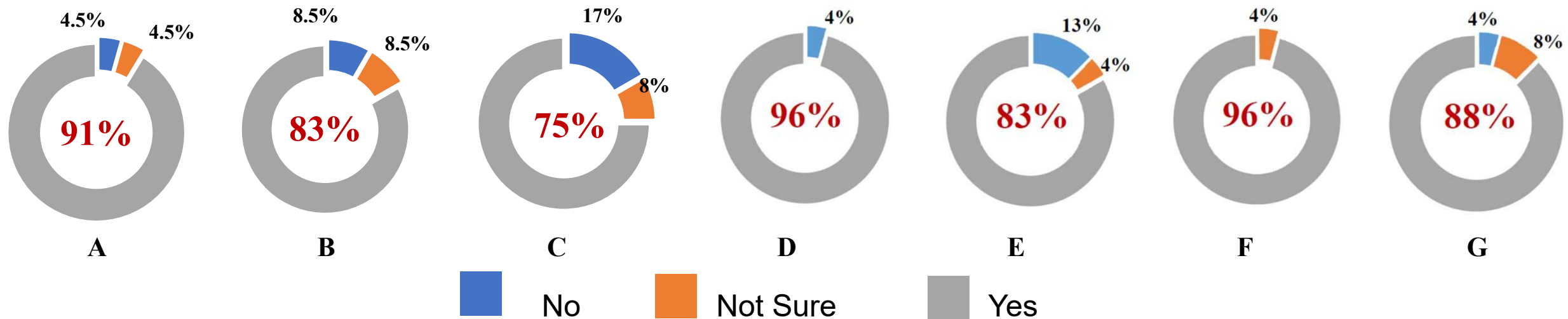
Question C: Will demand for high-density development increase substantially in the future?

Question D: Will demand for alternatives to driving increase substantially?

Question E: Are suburban highways too fast, unsafe, and unappealing for walkable development to take root?

Question F: Are well-maintained street trees and streetscape critical for catalyzing mixed-use development?

Question G: Is it important to reduce maximum traffic speeds for walkable areas to emerge?



Discussion – Stroad vs Complete Street



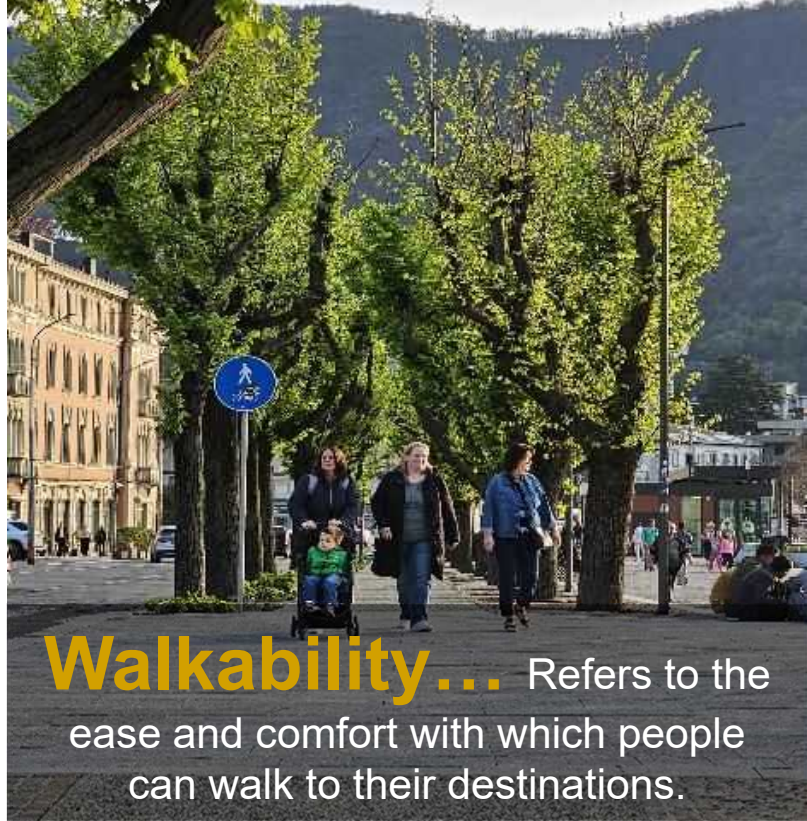
Stroad vs Complete Street



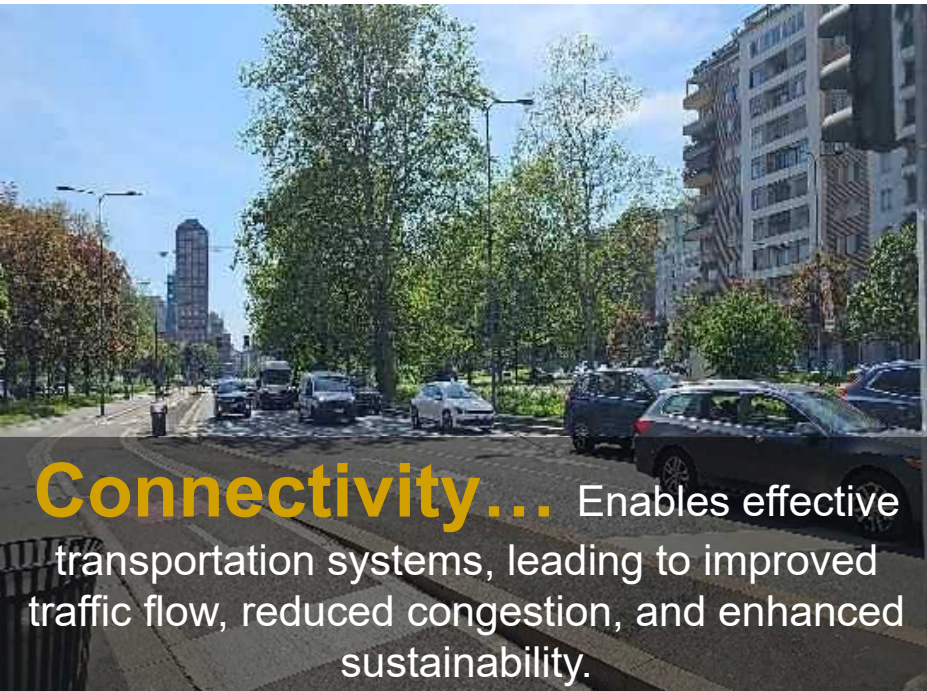
Traffic flow... A critical aspect of urban mobility. Relying on private cars solely, roads become congested, resulting in extended travel times and diminished air quality.



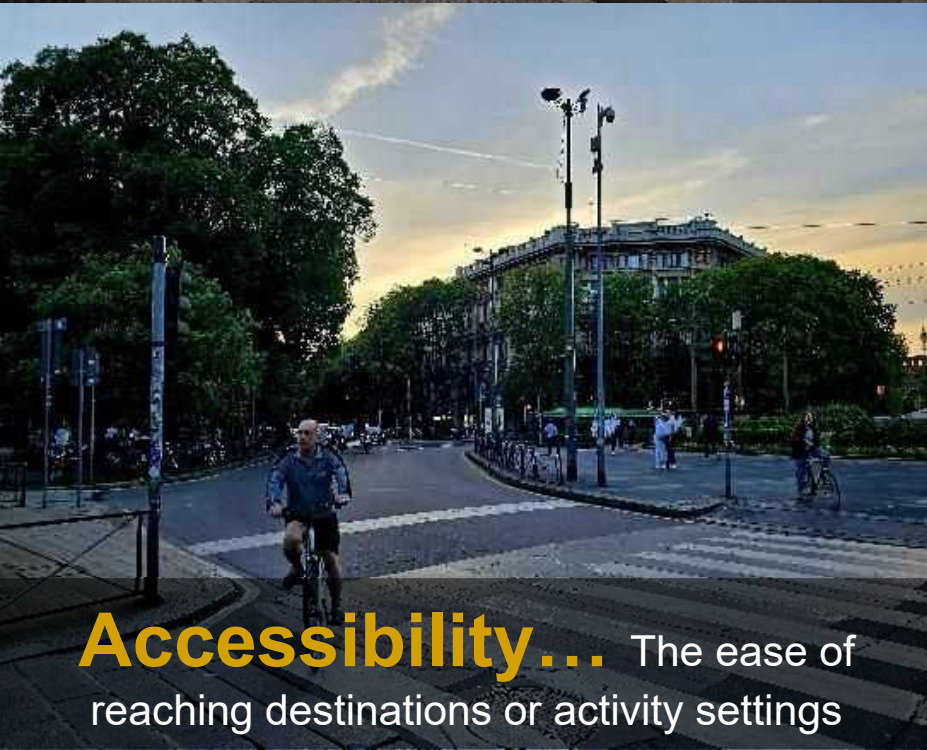
Safety... creating safe environment and safety culture is essential for our communities.



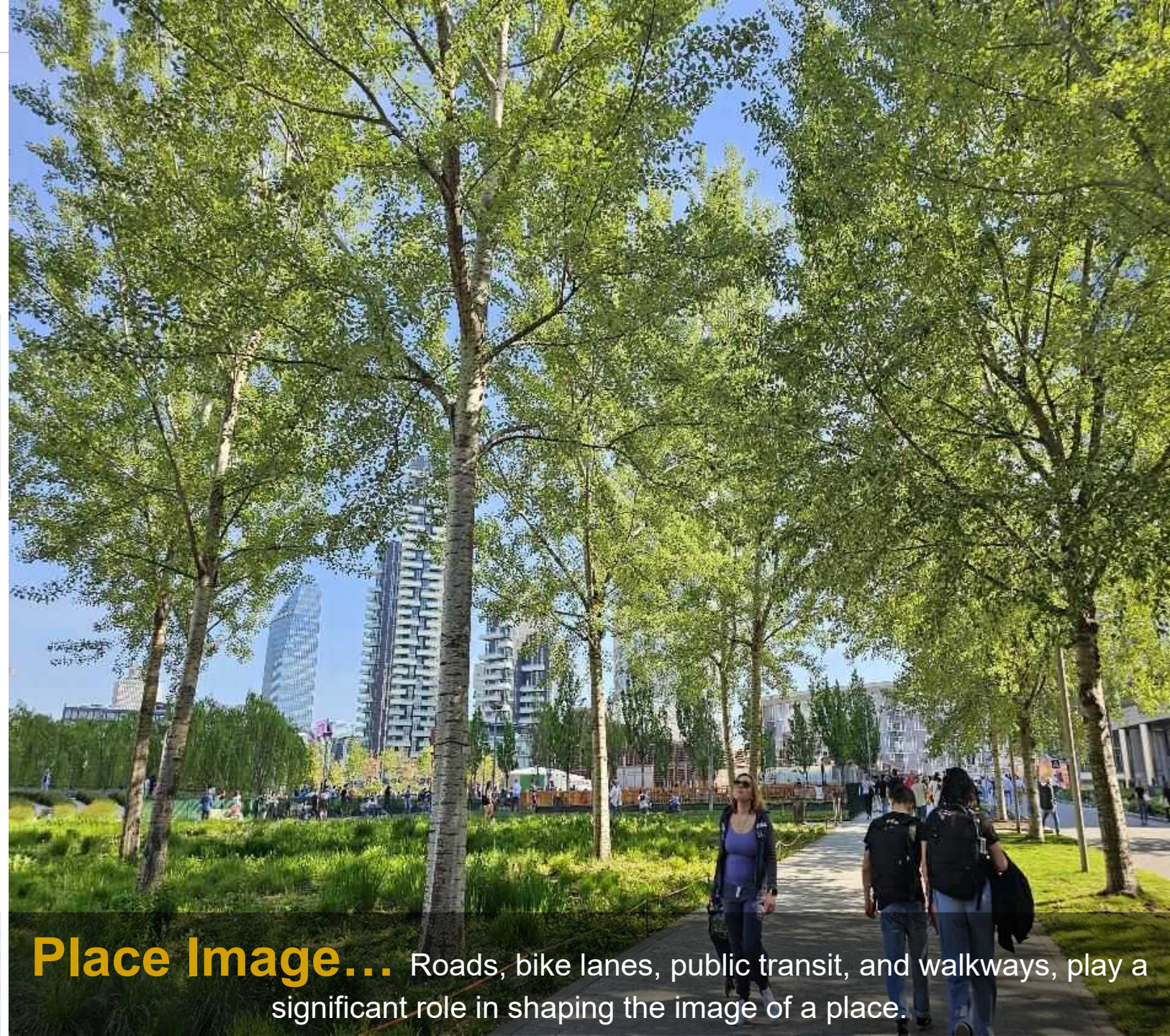
Walkability... Refers to the ease and comfort with which people can walk to their destinations.



Connectivity... Enables effective transportation systems, leading to improved traffic flow, reduced congestion, and enhanced sustainability.



Accessibility... The ease of reaching destinations or activity settings



Place Image... Roads, bike lanes, public transit, and walkways, play a significant role in shaping the image of a place.



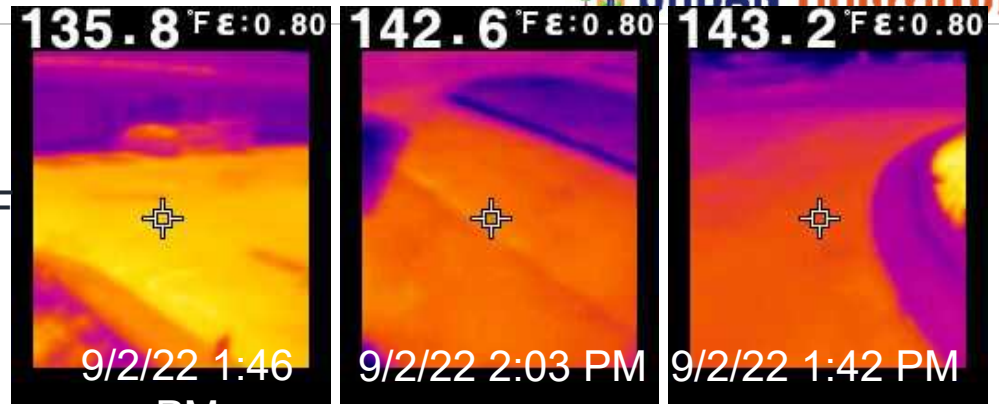
Comfort and Convenience... availability, efficiency, convenience, and sustainability of transportation systems. These factors shape traveler's experience. The relationship between human mobility behavior and climate (weather and environmental conditions) can influence of comfort.



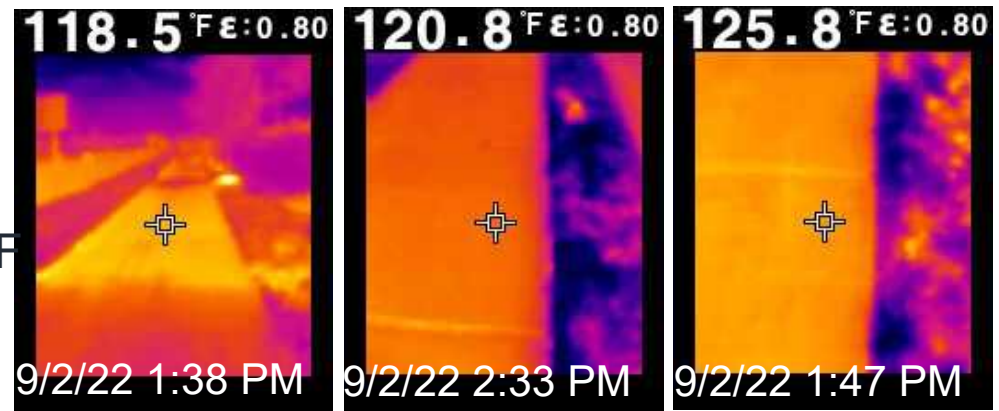
Another reason why compact development with Great Street Trees matters!



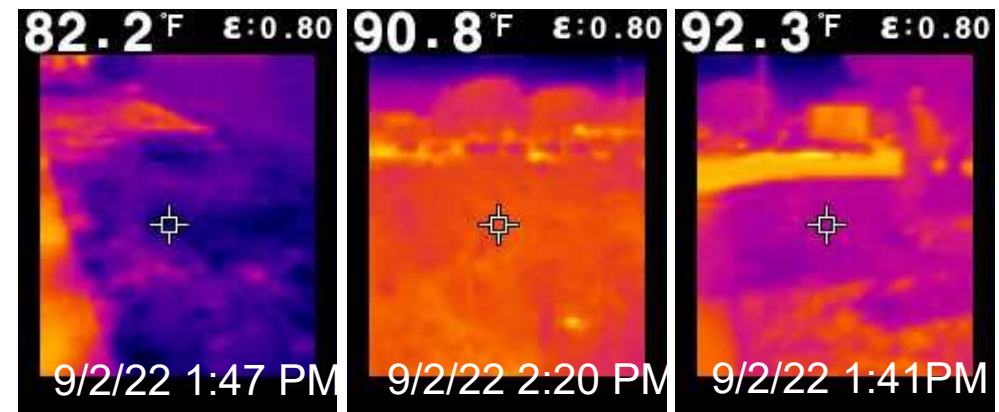
Asphalt
Range: 135.8°F - 143.2°F
Average: 141° F



Concrete
Range: 118.5°F - 125.8°F
Average: 122° F



Vegetation
Range: 82.2°F - 92.3°F
Average: 88°F



* Temperature readings from Greenville, September afternoon, 2022.

Thank You!

We hope you drive home slowly, and safely, but also travel faster!

