NC STATE UNIVERSITY

ITRE College of Design URBAN Innovators

Achieving Transportation + Land Use Win-Win Using Quadrant, U-Turn, and One-Way Intersections

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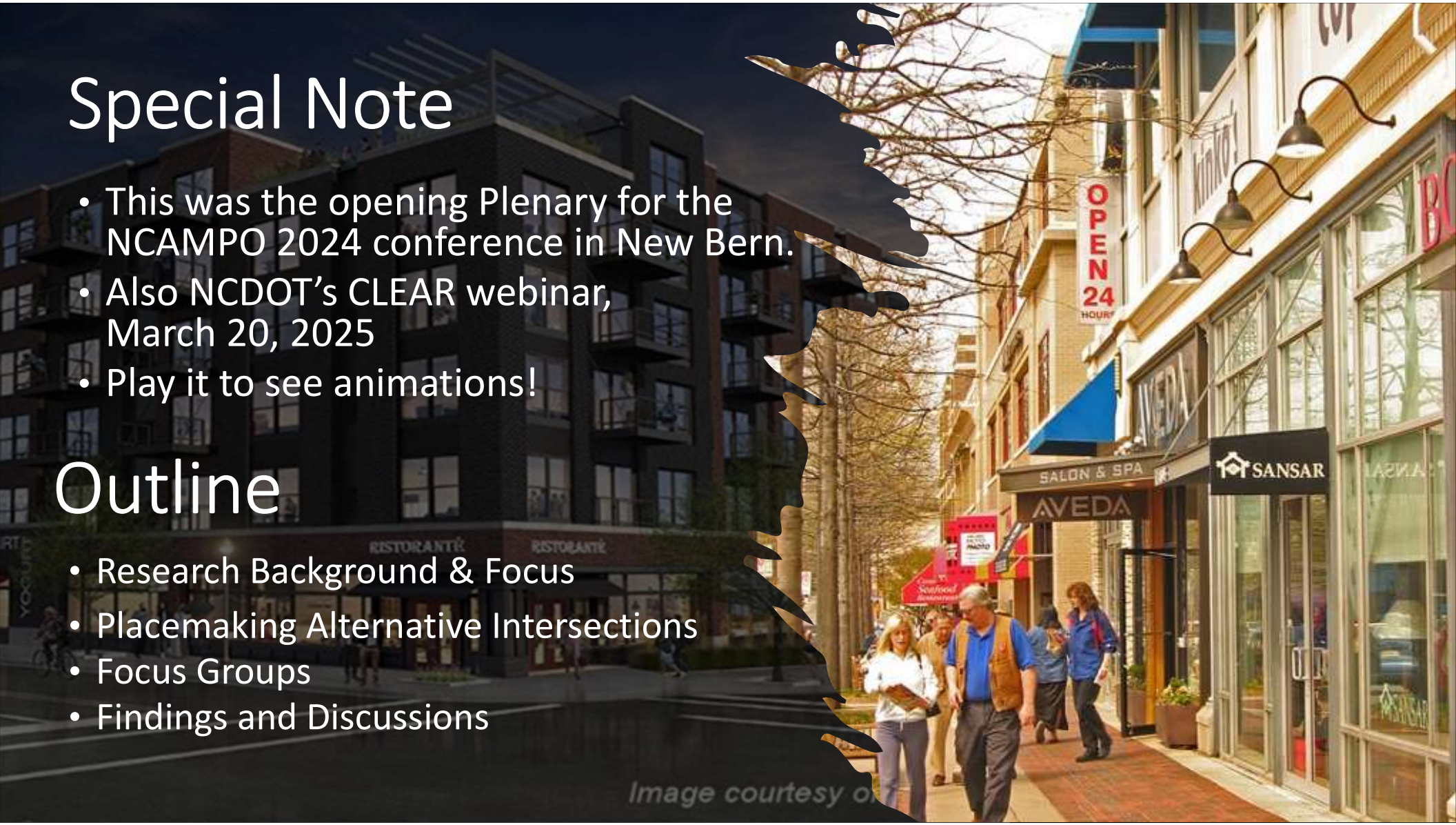
Special Note

- This was the opening Plenary for the NCAMPO 2024 conference in New Bern.
- Also NCDOT's CLEAR webinar, March 20, 2025
- Play it to see animations!

Outline

- Research Background & Focus
- Placemaking Alternative Intersections
- Focus Groups
- Findings and Discussions



RESEARCH BACKGROUND & FOCUS
Placemaking Alternative Intersections

"This Team is the best that I know of in pioneering alternative intersection designs that simultaneously improve traffic flow and catalyze walkable development. Really important stuff!"

– Joseph E. Hummer, PhD, PE: NCDOT State Traffic Management Engineer, and World's leading authority on Alternative Intersections

The Problem? Stroads!

Great Street

Great Road

Stroad

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

Great Couch

Great Bed

Futon

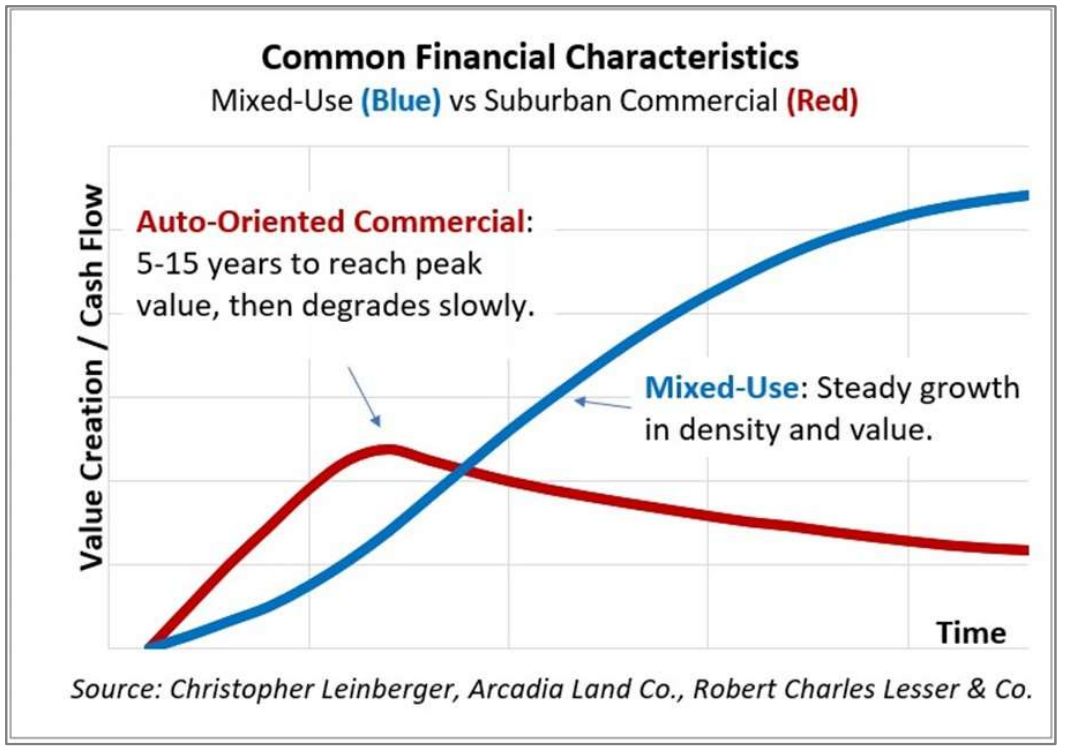
uncomfortable couch, AND
uncomfortable bed

A **Stroad** is a *Street / Road* hybrid - the **Futon** of Transportation.

-- Charles Marohn, Founder of StrongTowns.org

Land Value Along Stroads

degrades over time……



… but **high capacity** is needed to address **excessive delay,** so aren’t Stroads **inevitable?**

Engineers

Planners

Cars or Place?

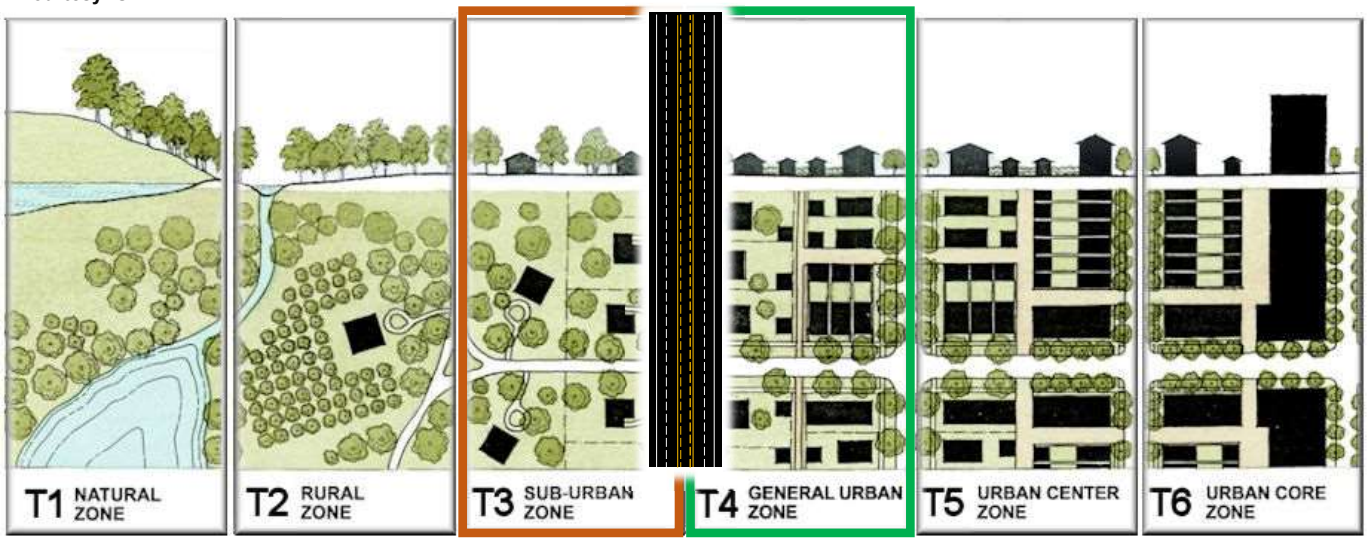
Guess who usually wins?

Instead of **Win-Lose,** we'll reveal how to **Win-Win!**

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

I think I can!
I think I can!

Courtesy: Urban Innovators



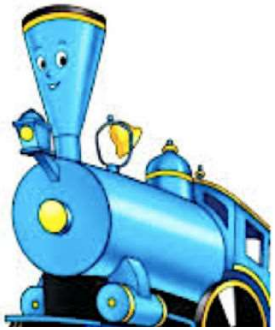
Almost Nothing	Small Towns	Mostly 1-story	Mostly 2-3 story	Mostly 3-5 story	Many 5+ stories

"Mount Stroad"

blocks languishing suburban commercial from becoming walkable.

Can we get over this mountain?

We Can!



Historically, it was one or the other: Traffic **OR** Placemaking.

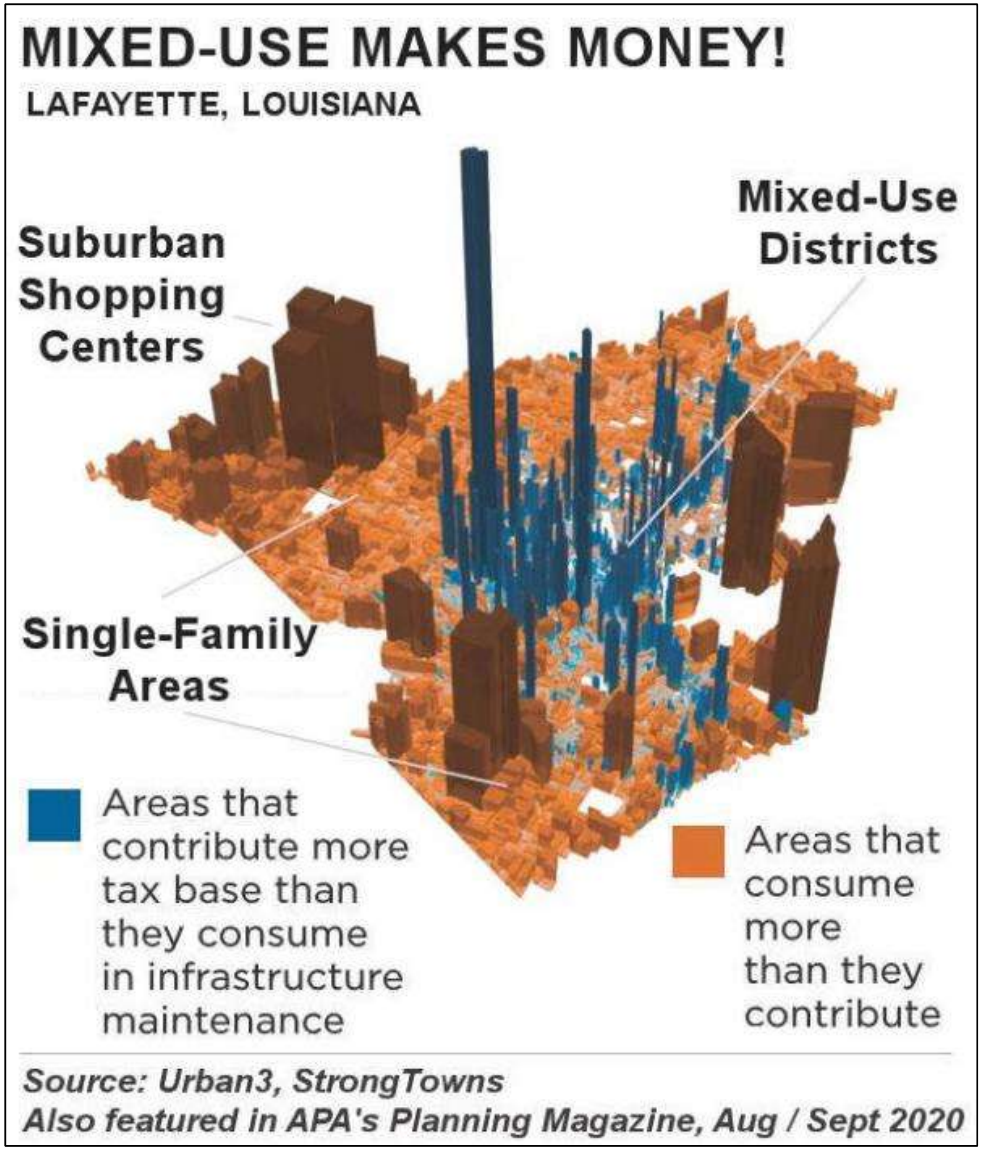
Now we can do both!

Why do we need T4, Walkable Urban Places?

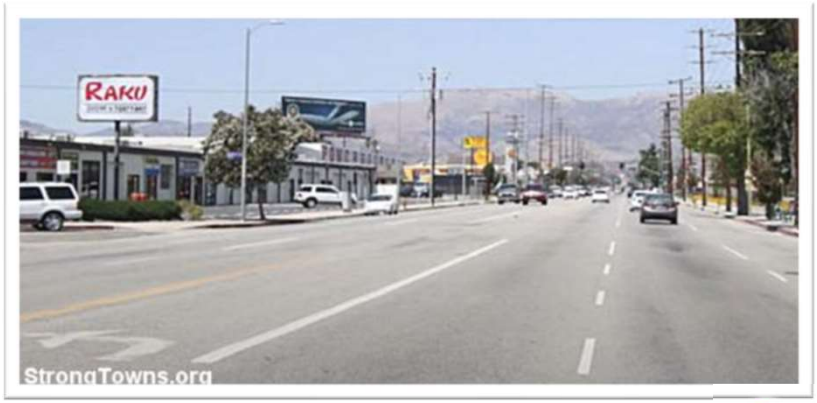
One good reason:

Walkable T4 is fiscally net-positive.

Suburban T3 is net-negative.



Cheaper per Linear Mile vs Cheaper per Square Mile



Cheaper per Mile, but…

Few to pay for it

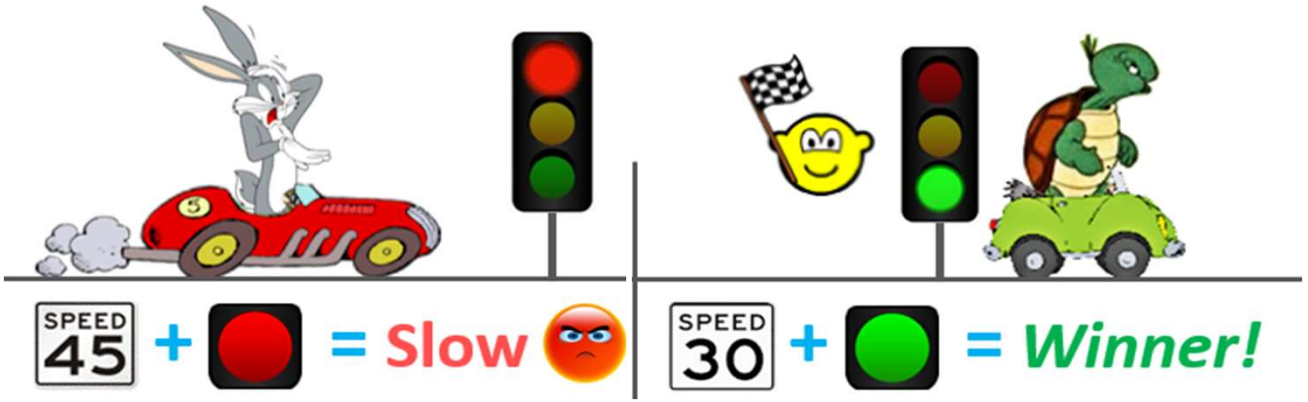
Expensive per Mile, but…

Many to pay for it

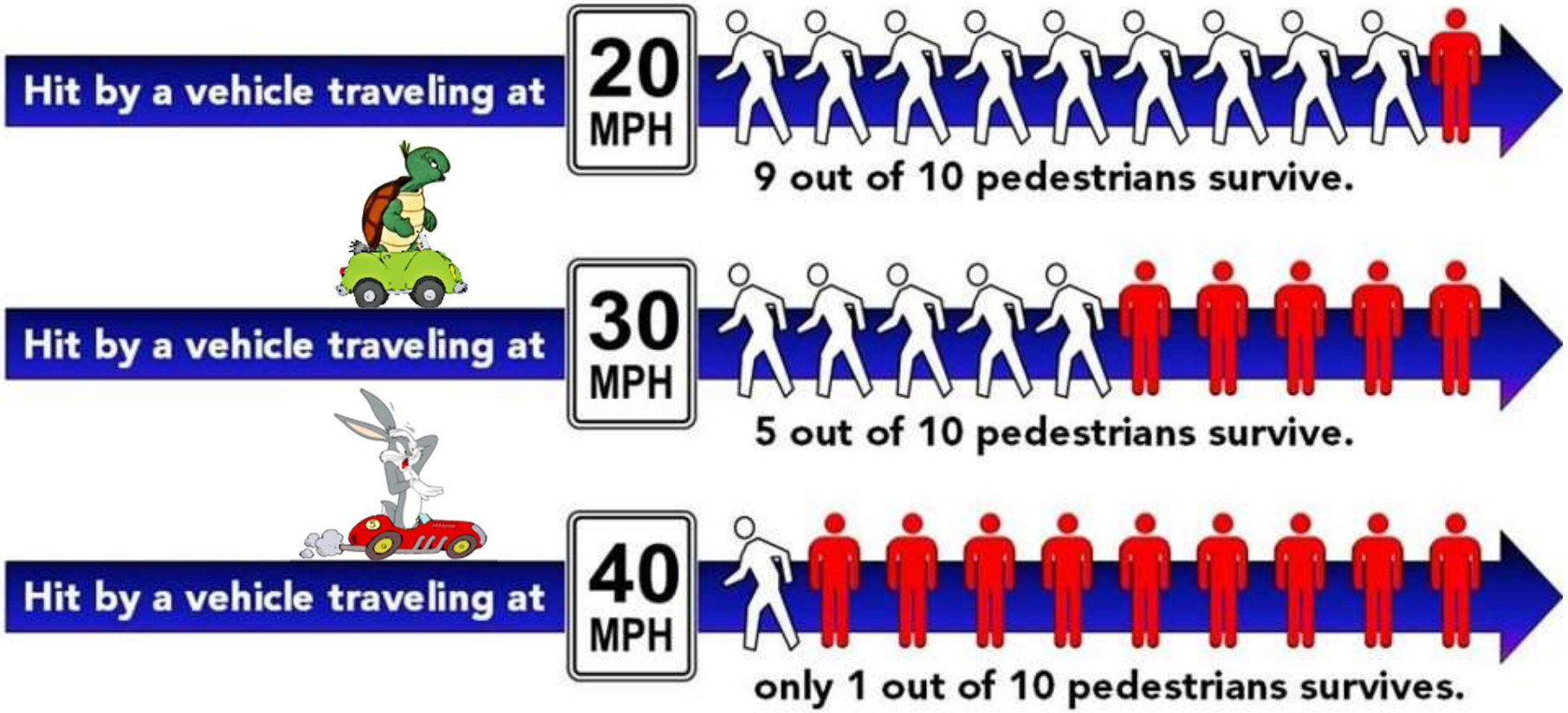
PLACEMAKING ALTERNATIVE INTERSECTIONS

Drive Slower, Travel Faster!

The Key to Win-Win!



Drive Slower, Travel Faster - Why does it matter?



Stroads

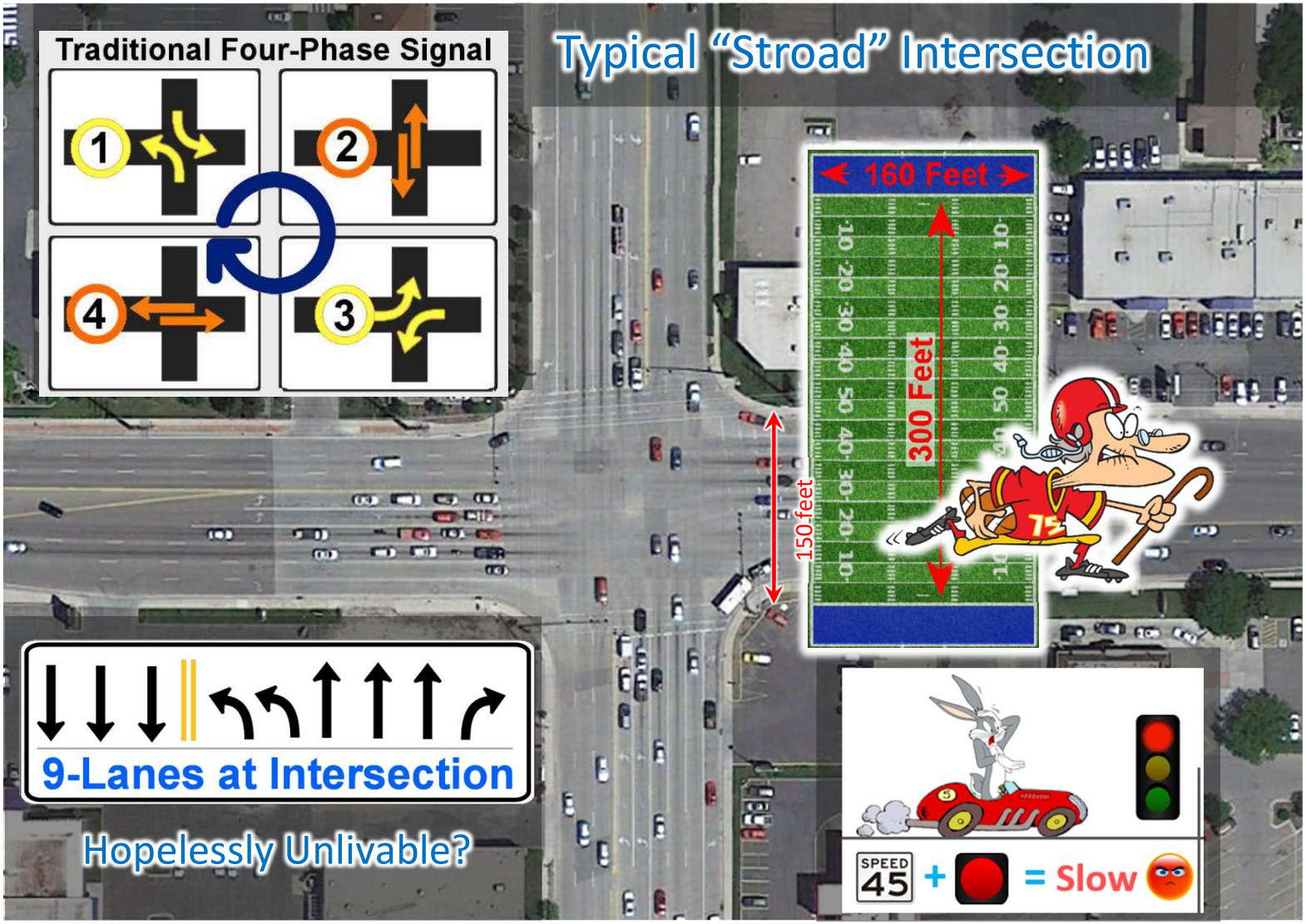
have inefficient Four-Phase signals.

Engineers

"Solve" inefficiency by adding more lanes & higher speed limits!

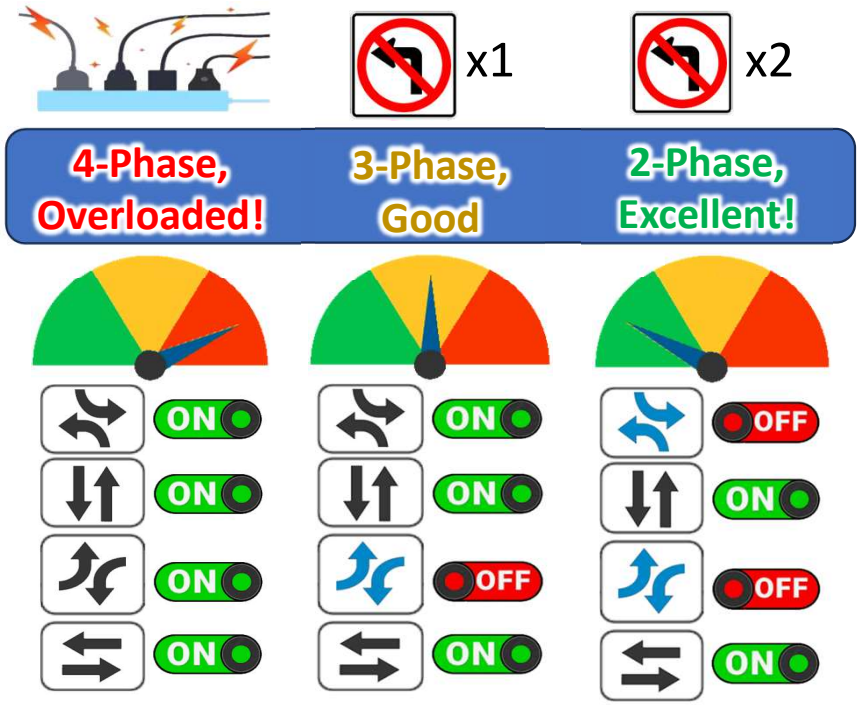
This is 150 ft wide, or half a football field! Imagine Grandma making a run like that!

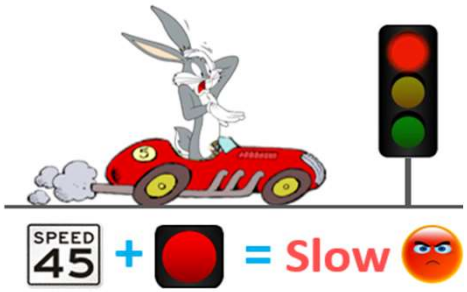
Overloaded!

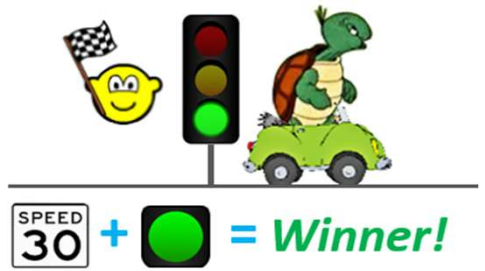


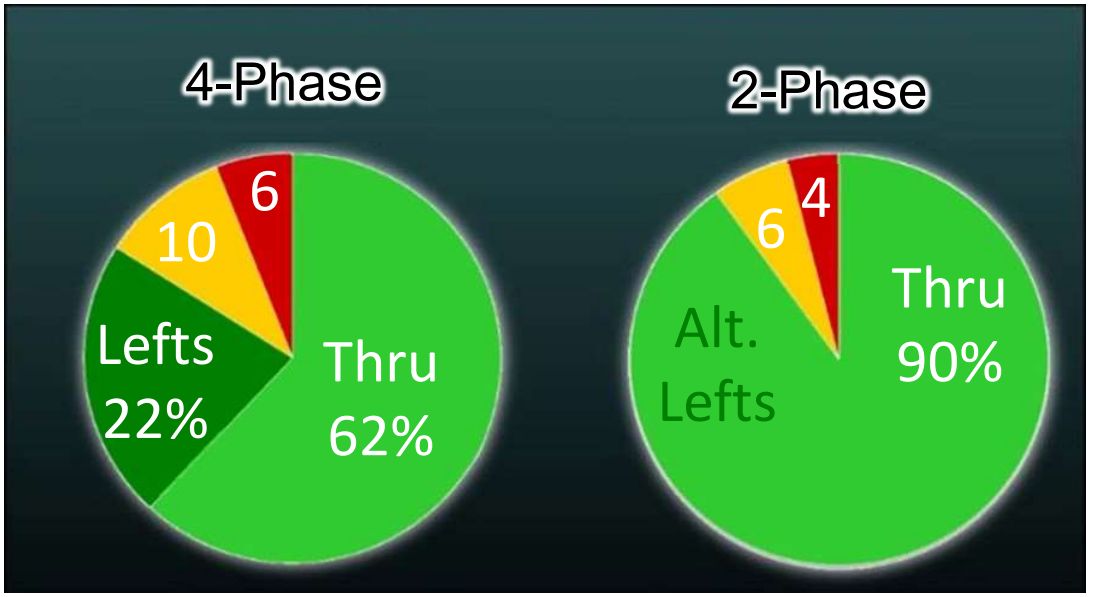
Four-phase signals are SLOW!

Left turn arrows cause delay.



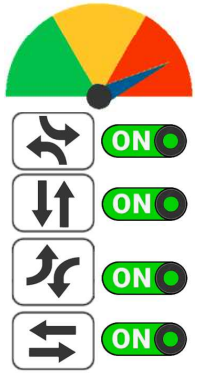




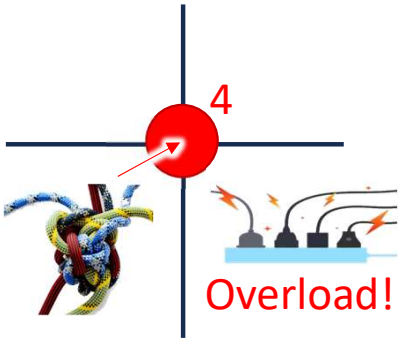


4-Phase Signal

Overloaded!

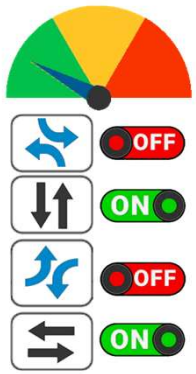


4 movements, 1-spot

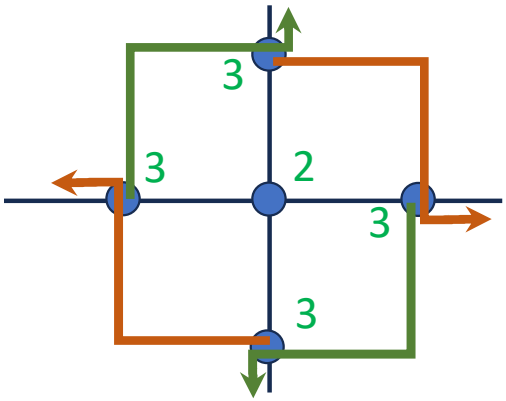


Quadrant Intersections

Excellent!

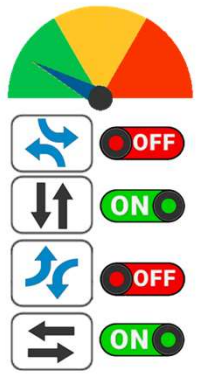


Lefts go to secondaries

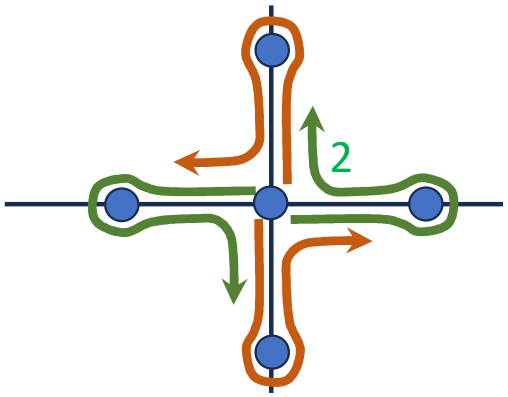


U-Turn Intersections

Excellent!



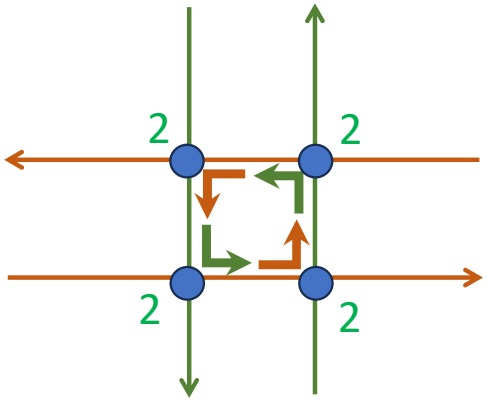
Left = Thru + U + Right



One-Way Split Intersections

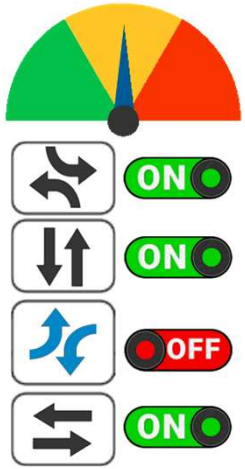
Excellent!

Four small beats one big



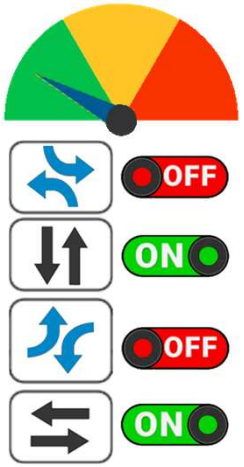
Source: Urban Innovators

One tangled mess vs. Untangle it by using additional, simpler intersections



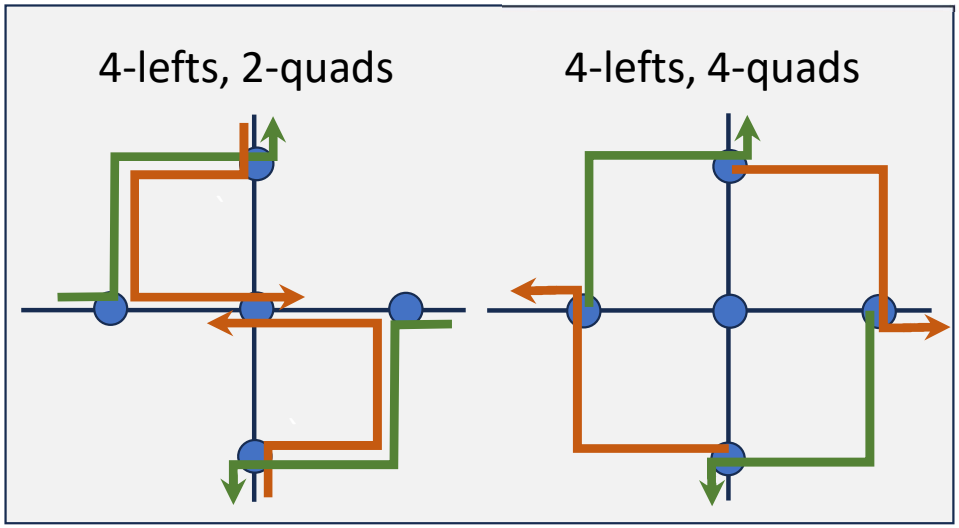
3-phase if only green is rerouted

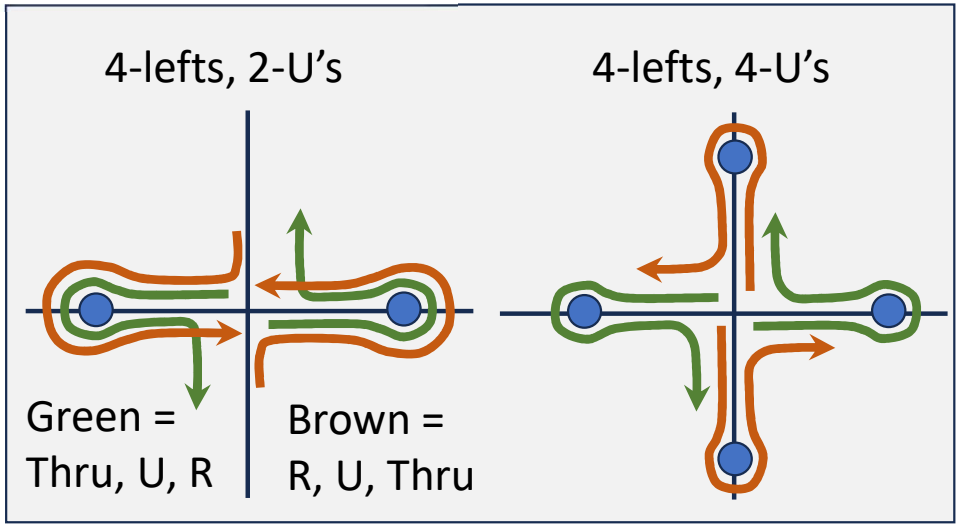
2-phase if both green & brown rerouted



Quadrant Intersections

U-Turn Intersections

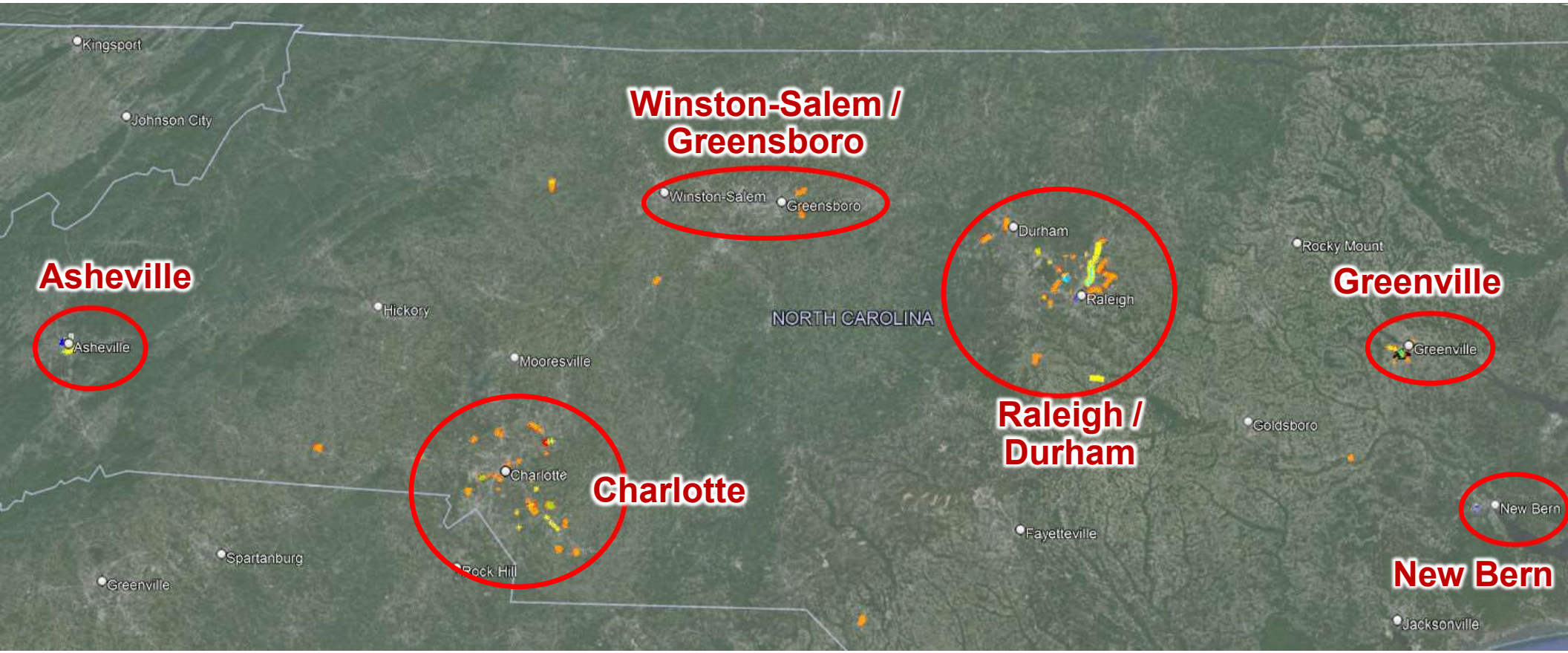




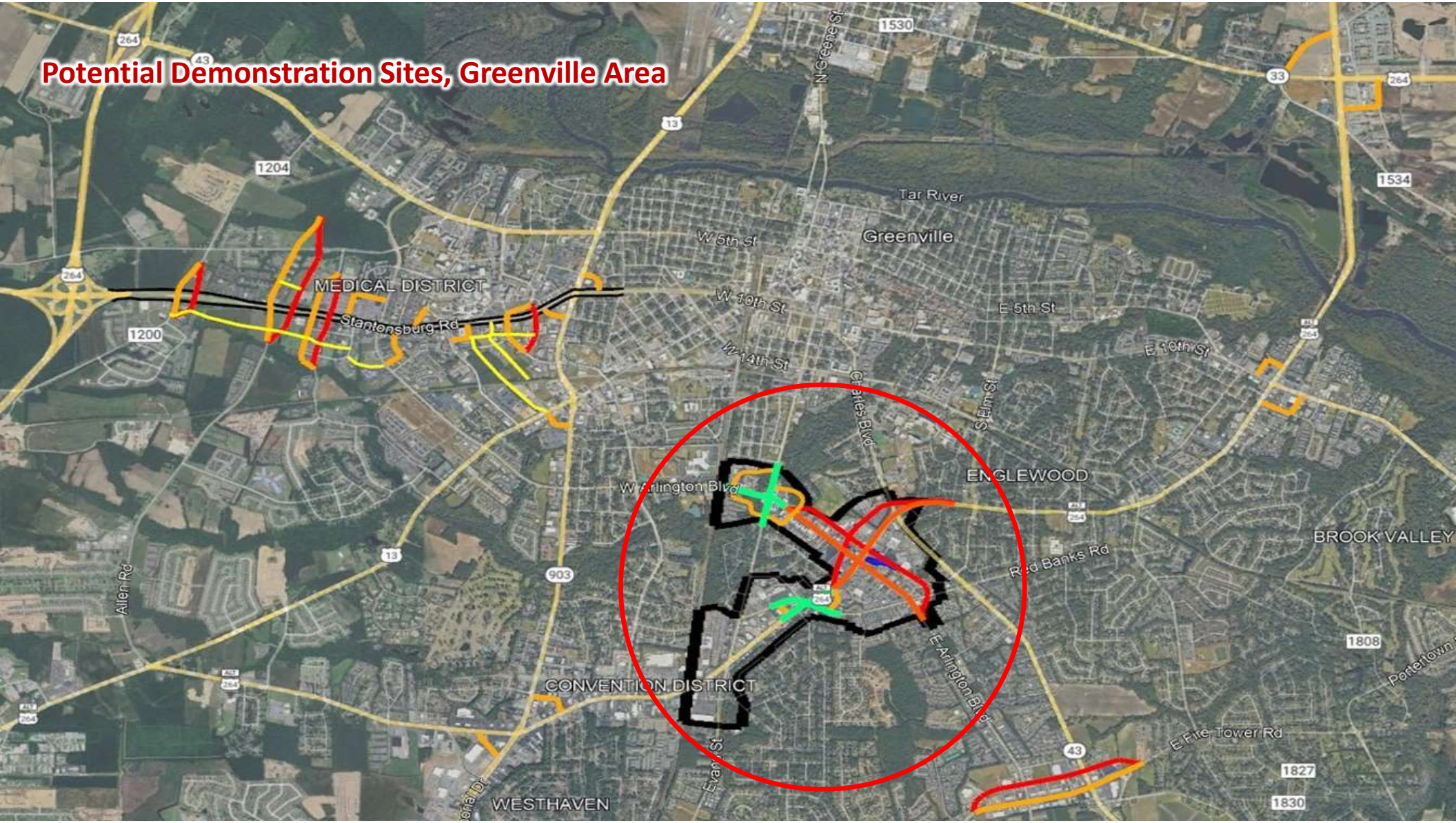
Source: Urban Innovators

Over 100 potential applications discovered in a quick aerial scan.

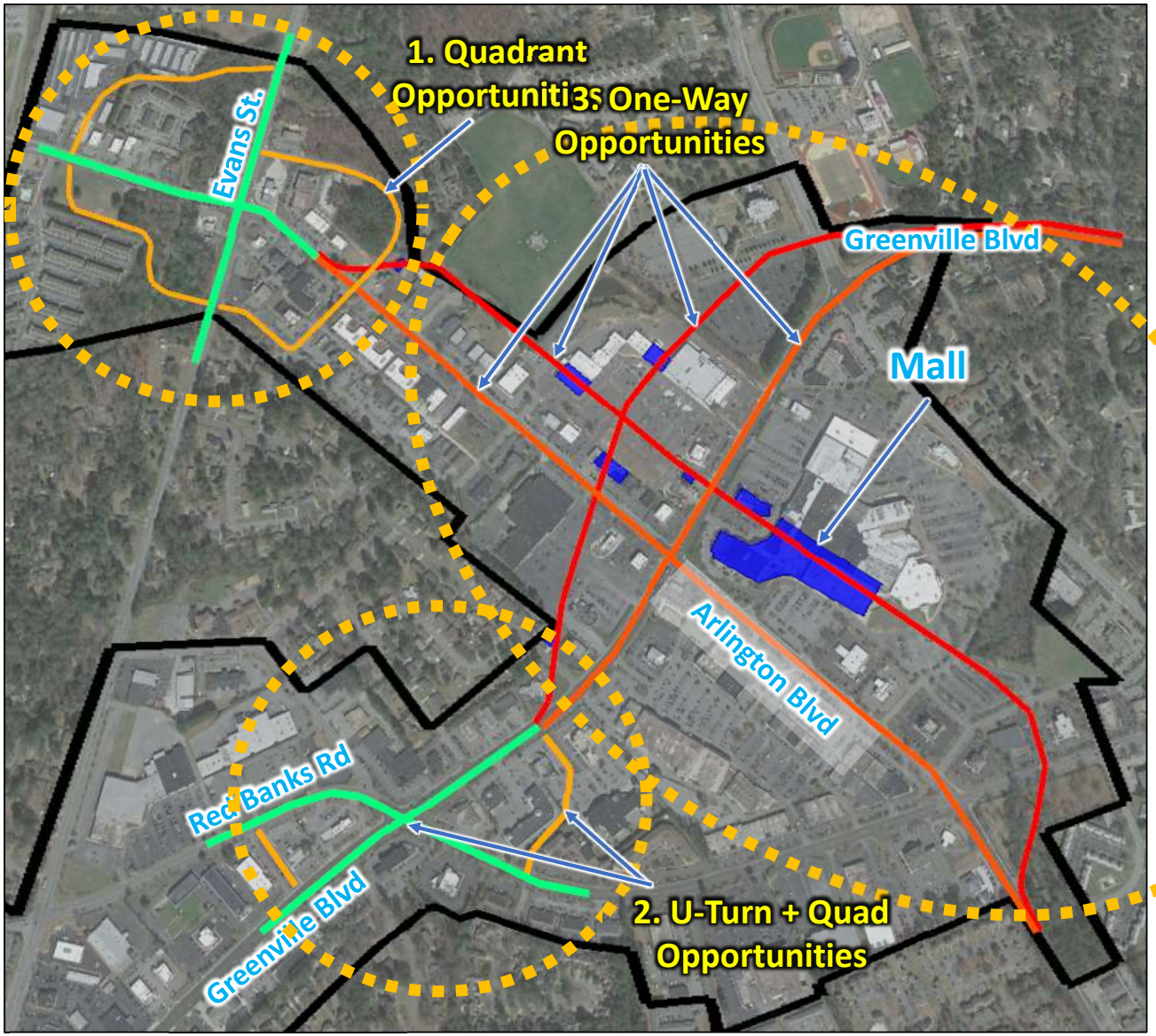
Certainly, far more yet to be discovered!



Potential Demonstration Sites, Greenville Area



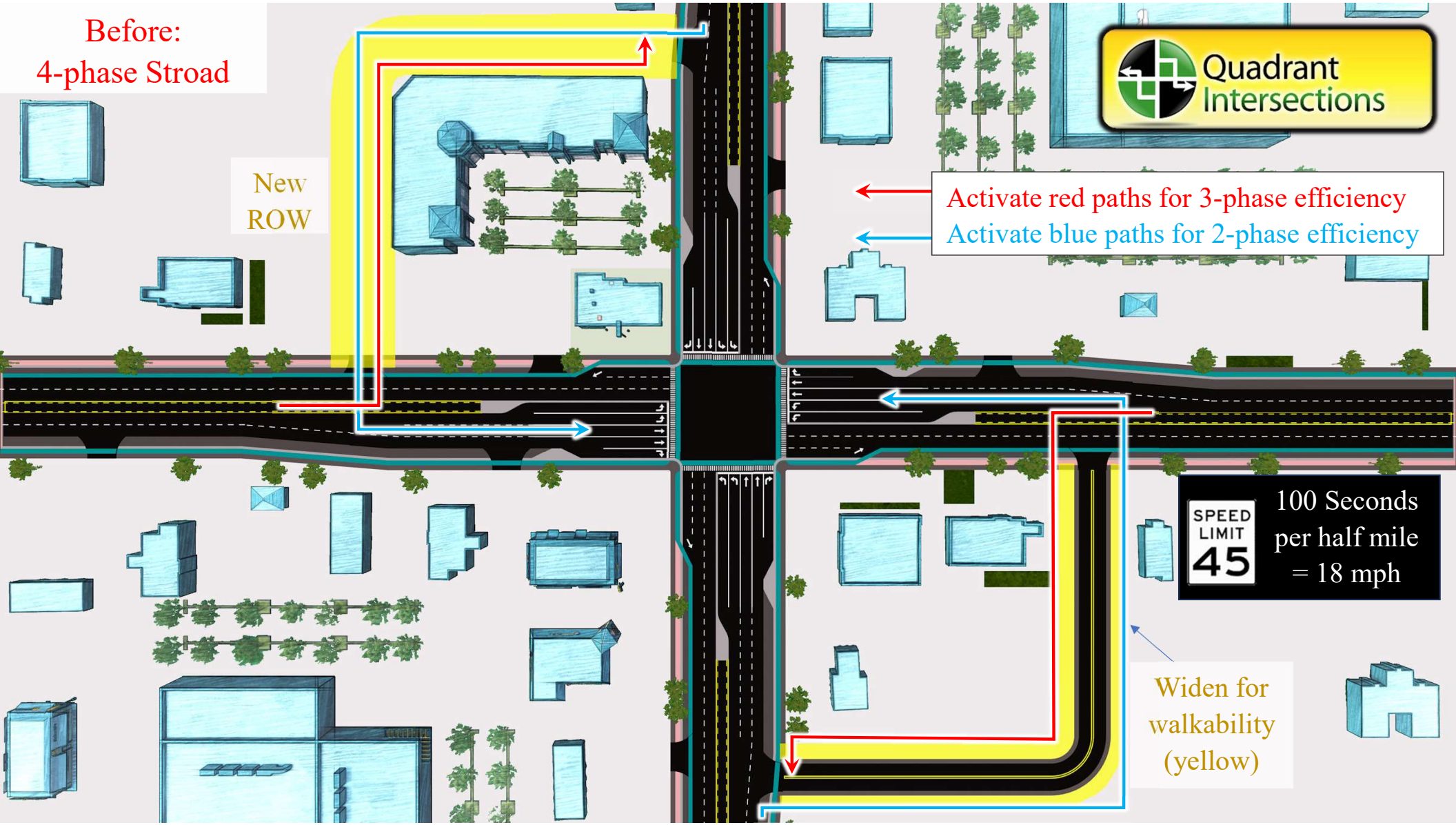
Greenville, NC

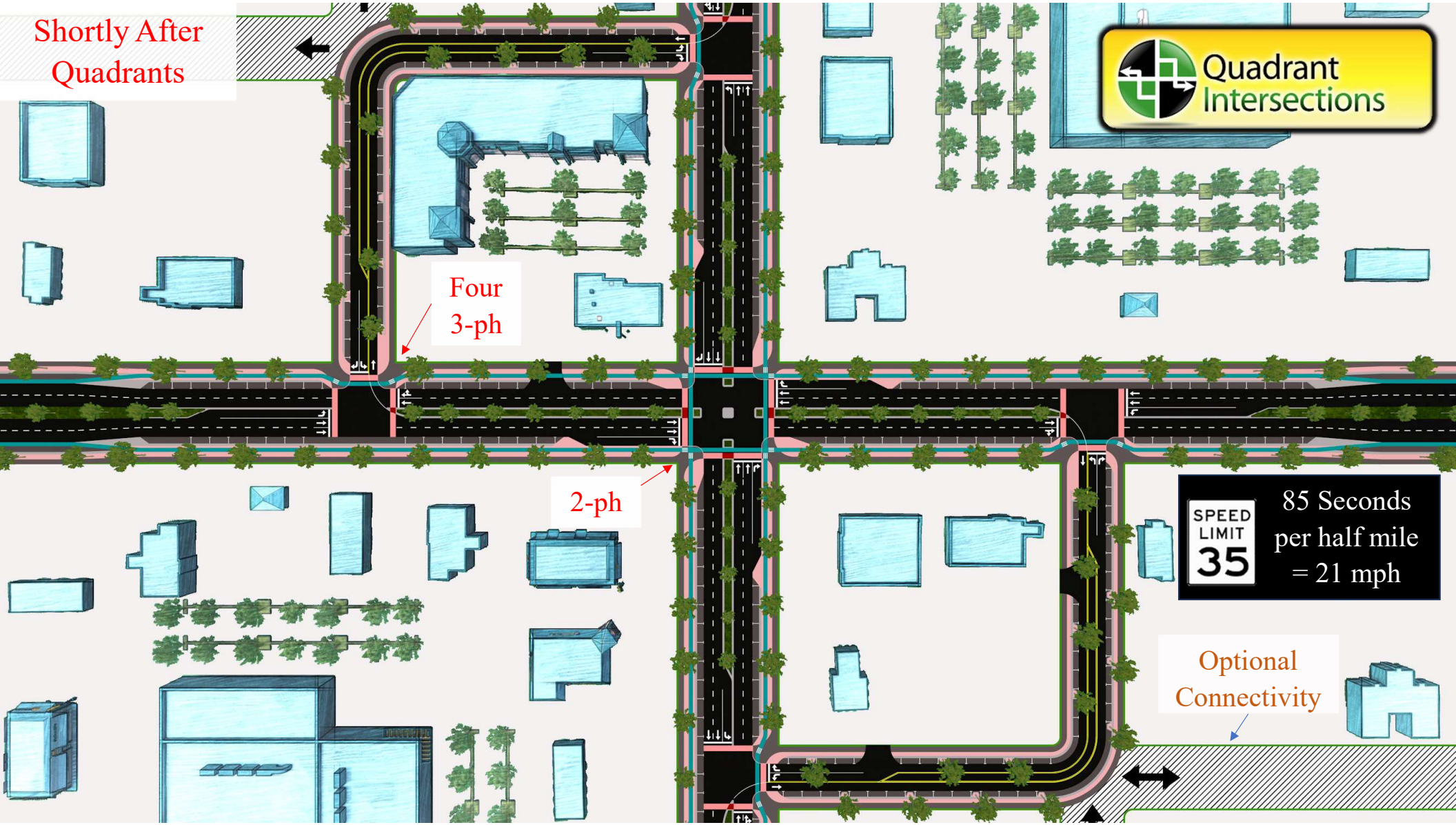


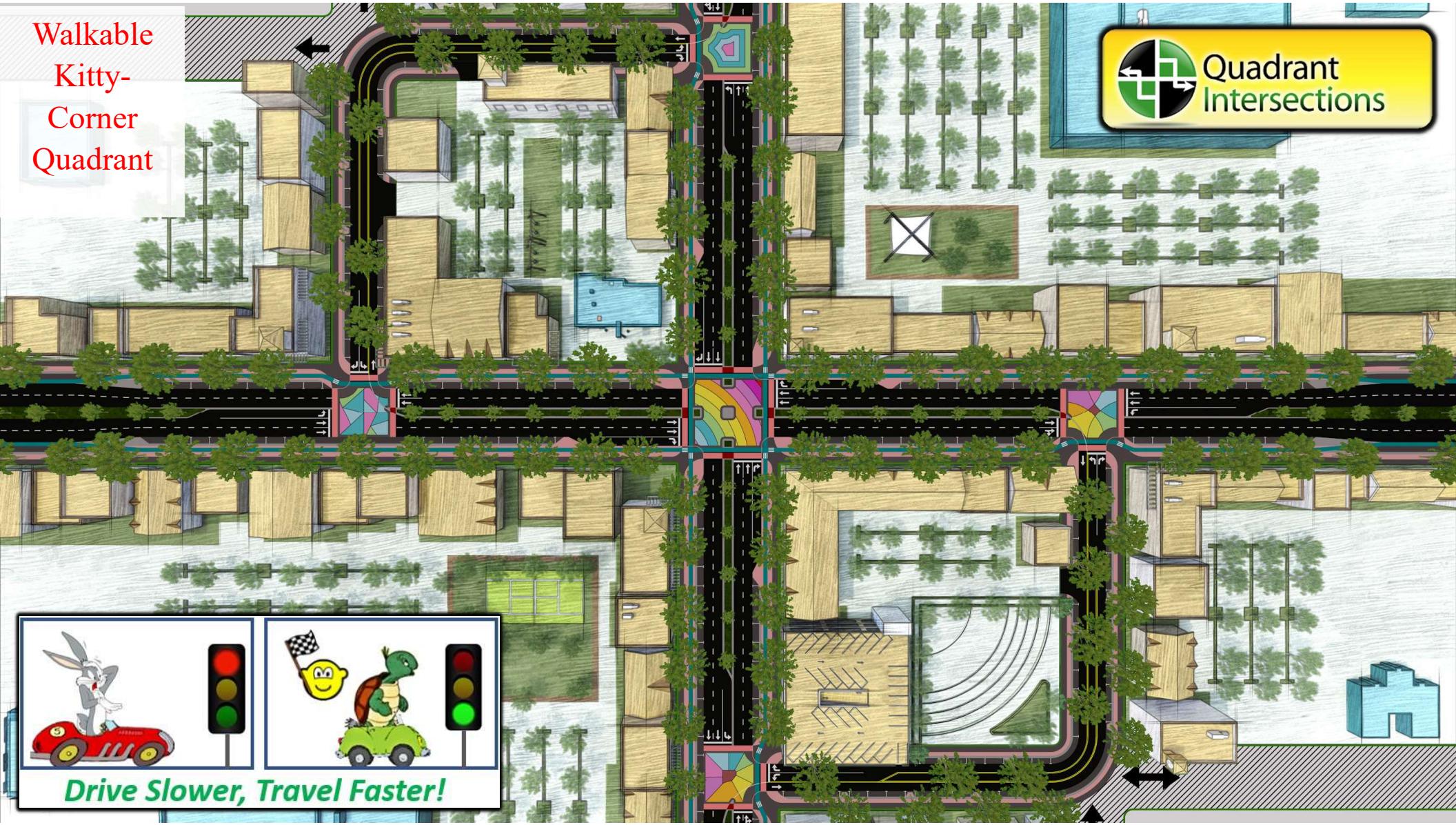
* Unvetted Research Concepts

Quadrant Intersections

Idealized Views, then Conceptual Application
at Greenville's Arlington Blvd and Evans Street


Before:
4-phase Stroad
Quadrant Intersections
New ROW
Activate red paths for 3-phase efficiency
Activate blue paths for 2-phase efficiency
SPEED LIMIT 45
100 Seconds per half mile = 18 mph
Widen for walkability (yellow)


Shortly After Quadrants
Quadrant Intersections
Four 3-ph
2-ph
SPEED LIMIT 35
85 Seconds per half mile = 21 mph
Optional Connectivity


Walkable
Kitty-
Corner
Quadrant
Quadrant
Intersections
Drive Slower, Travel Faster!

Drive Slower, Travel Faster: The Math

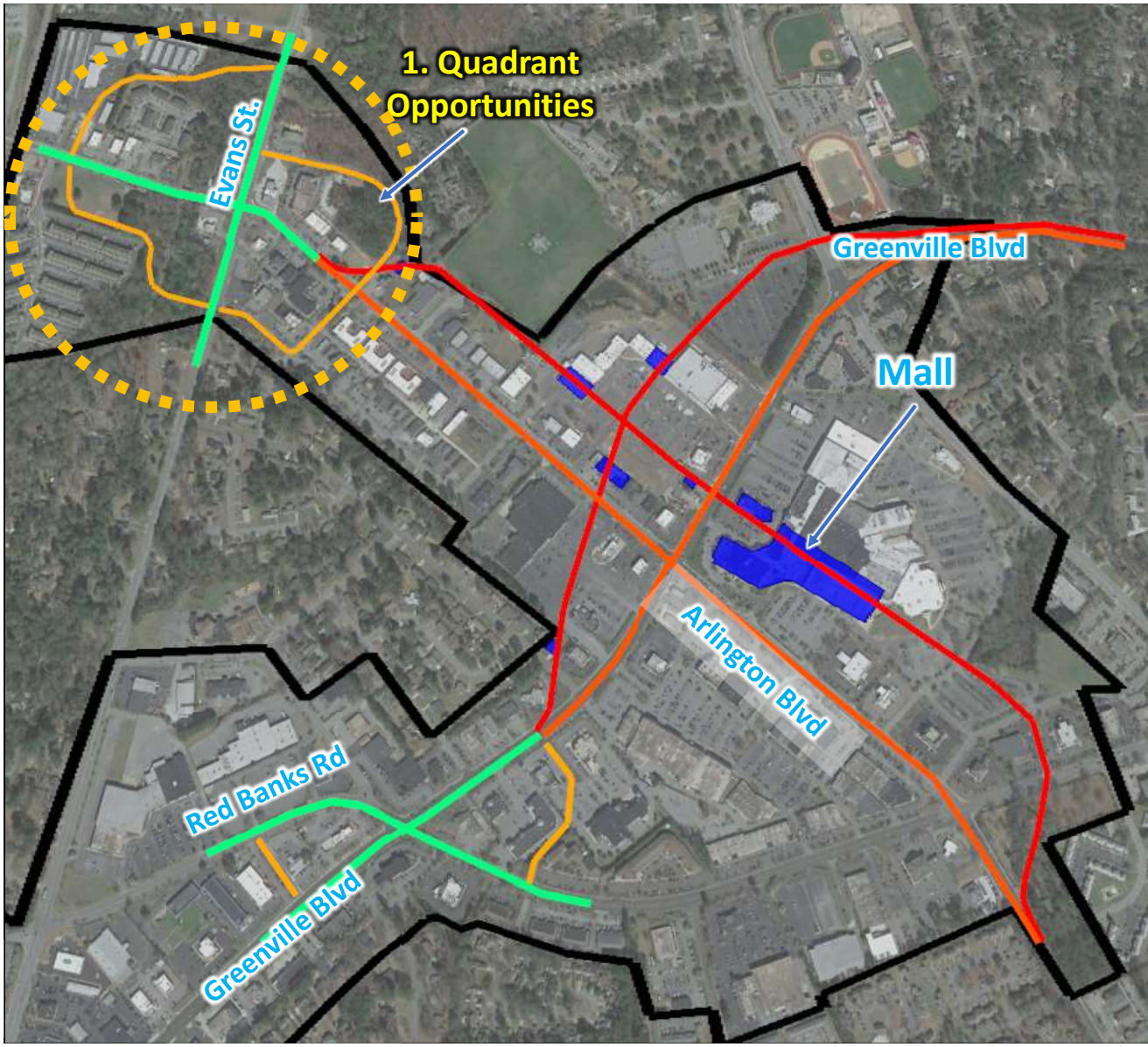
Scenario	Miles	In-Motion Max MPH	Seconds in Motion	Pct Slower	Seconds Stopped	Total Seconds	Ave MPH	Pct Faster
Stroad, 45-mph typical spd	0.5	45	40		60	100	18	
Quadrant, 35-mph typical spd	0.5	35	50	22%	35	85	21	18%

Lose 10 seconds due to traffic calming design

Gain 25 seconds due to better signals

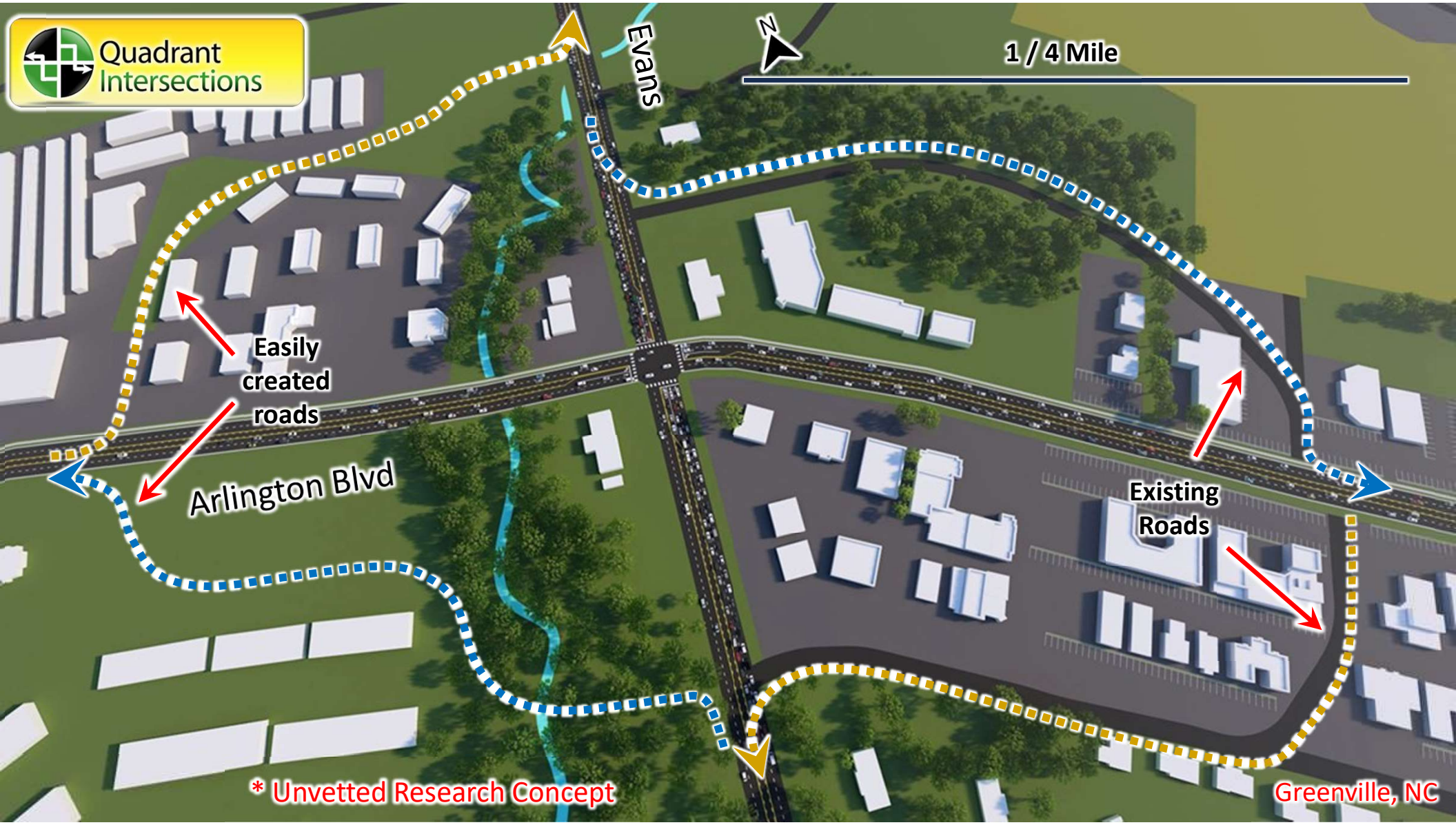
Maximum speeds are slower and safer, but traversing the corridor is also a bit faster!

Quadrant Intersections



Greenville, NC

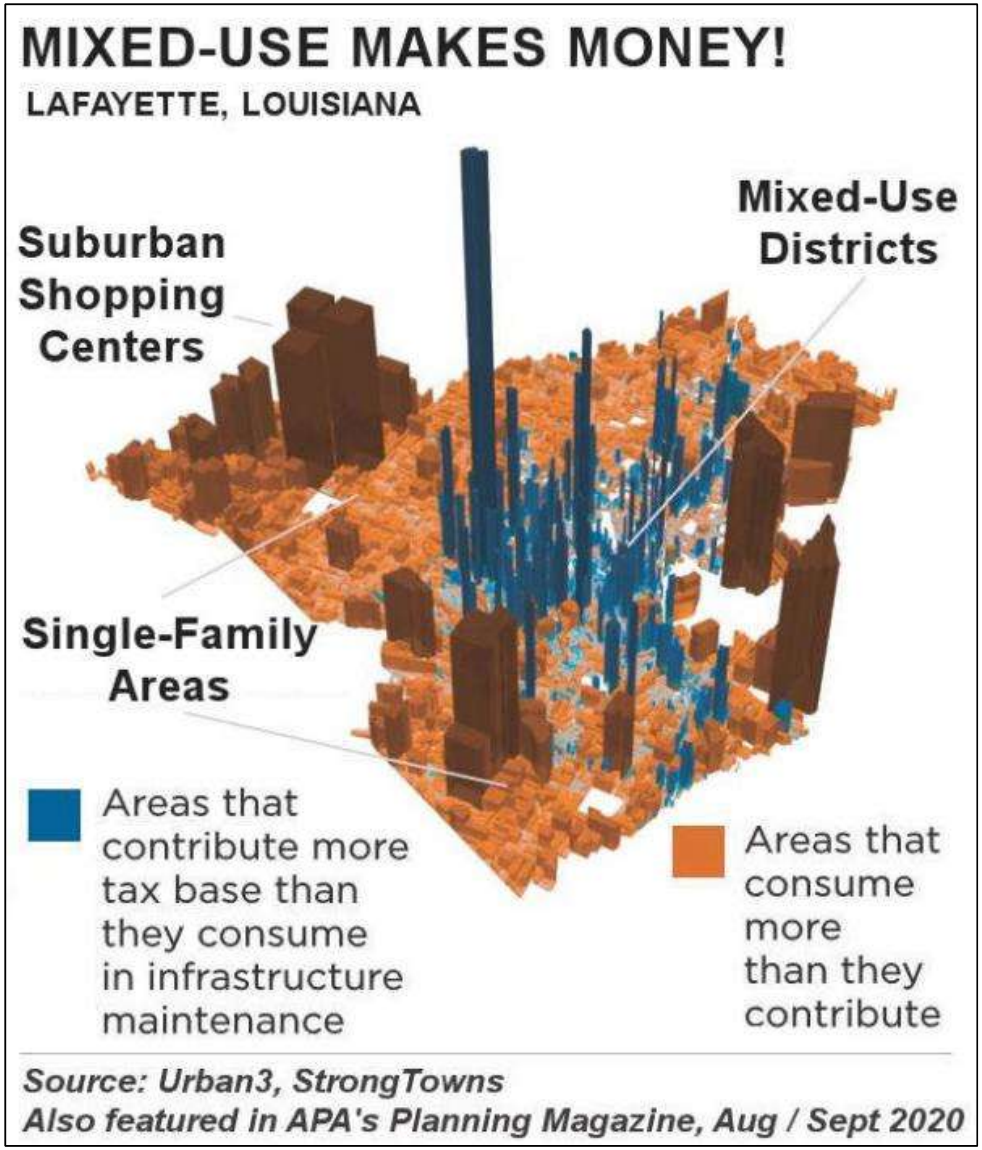
* Unvetted Research Concept

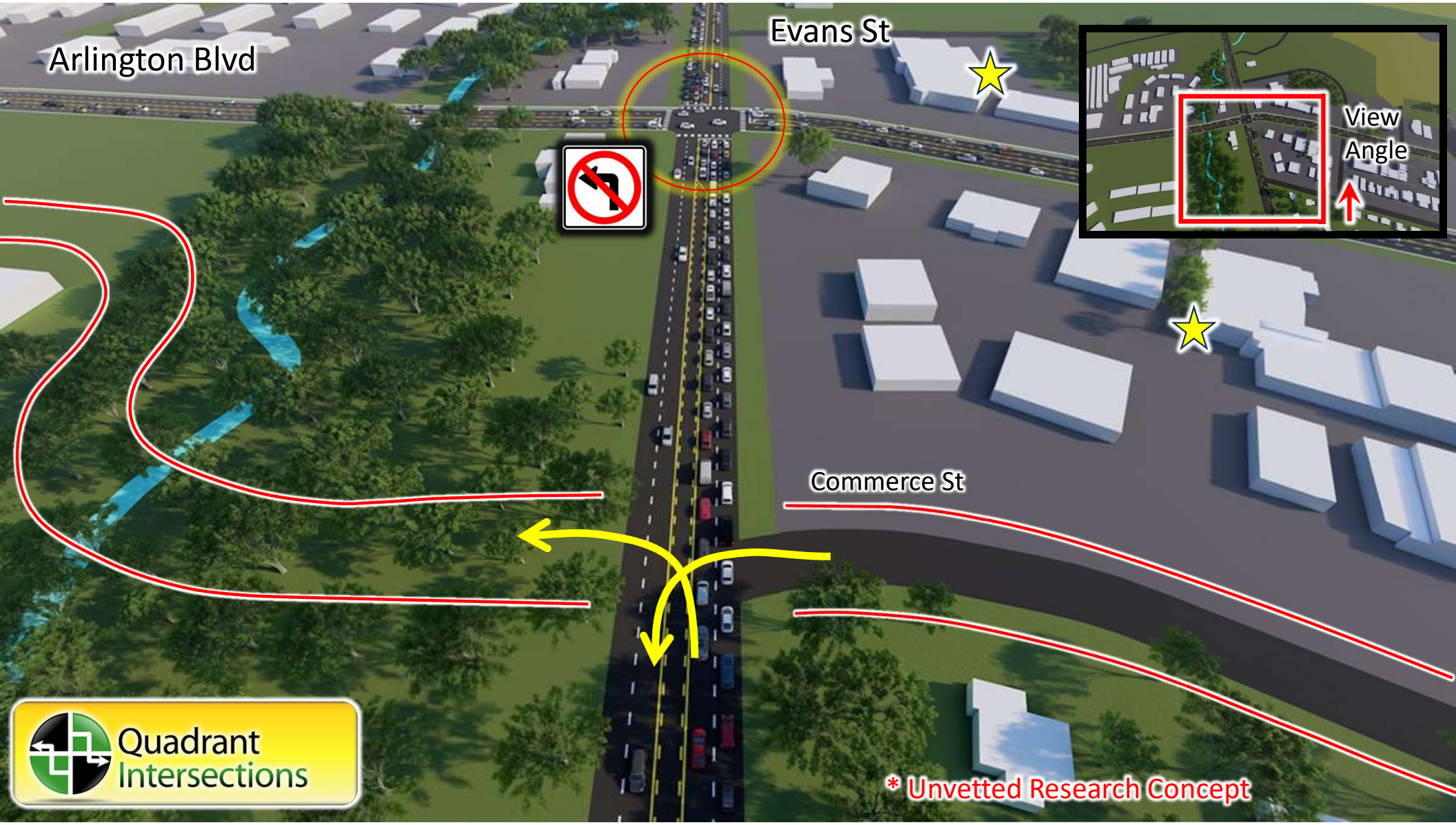

Quadrant Intersections
Evans
N
1 / 4 Mile
Easily created roads
Arlington Blvd
Existing Roads
* Unvetted Research Concept
Greenville, NC


Quadrant Intersections
Evans
Arlington Blvd
* 4x more density
* 50% more capacity
* 10-15 mph slower...
But also faster!
Can Offset
350 Acres
of suburbs, and
10 Miles of Road
* Unvetted Research Concept
Greenville, NC

Walkable T4 is fiscally net-positive.

Suburban T3 is net-negative.




Arlington Blvd
Evans St
Commerce St
View Angle
Quadrant Intersections
* Unvetted Research Concept


Arlington Blvd
Evans St
Commerce St
View Angle
Quadrant Intersections
* Unvetted Research Concept


Quadrant Intersections
Evans St
* Unvetted Research Concept
Clifton St
Arlington Blvd


Quadrant Intersections
Evans St
* Unvetted Research Concept
Clifton St
Arlington Blvd
Can Offset
350 Acres
of suburbs, and
10 Miles of Road
* 4x more density
* 50% more capacity
* 10-15 mph slower...
But also faster!

Backway Access, Pedestrian Refuge,
Connectivity, Higher Tax Base

I thought I could!
I thought I could!

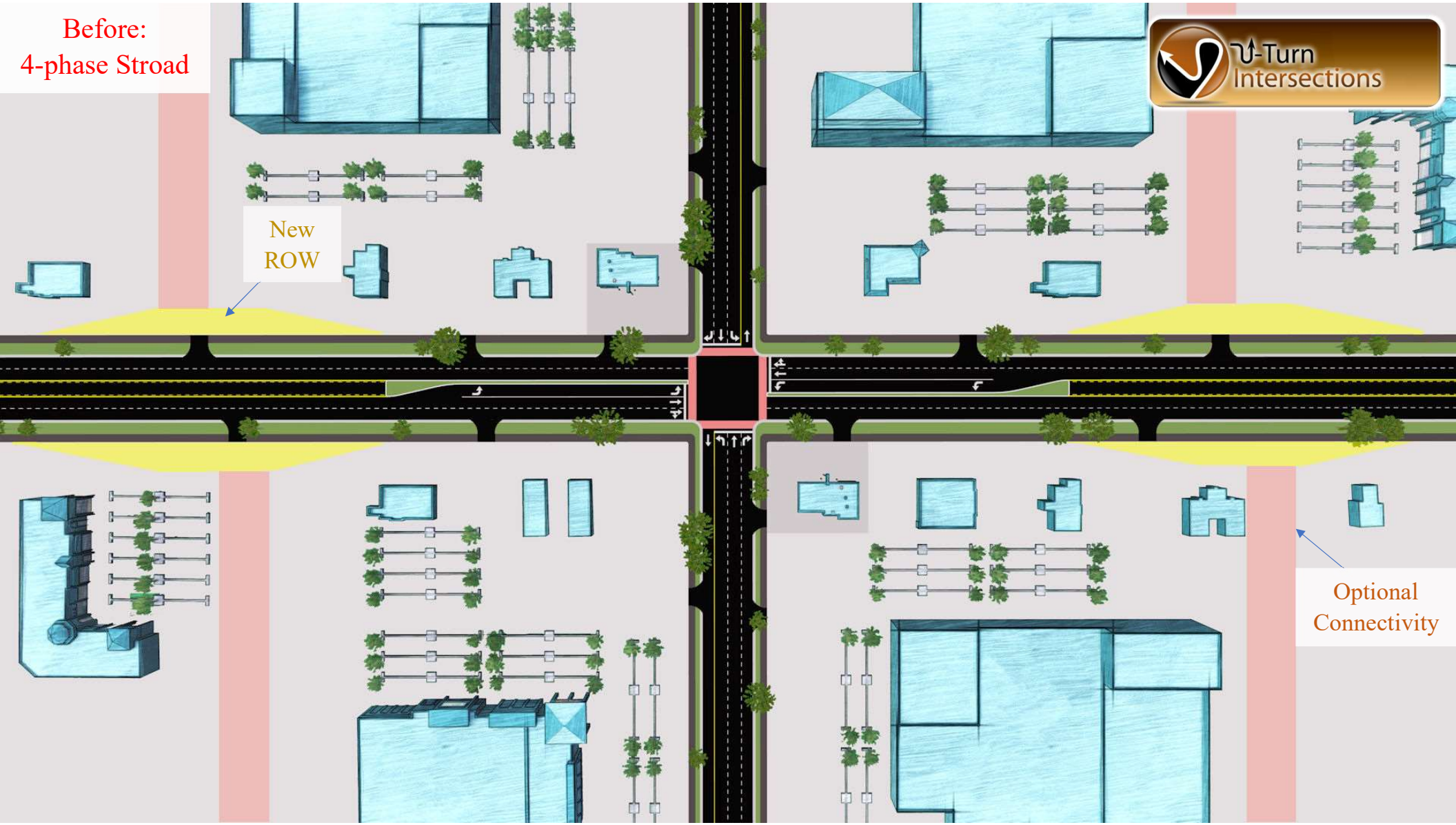
Before

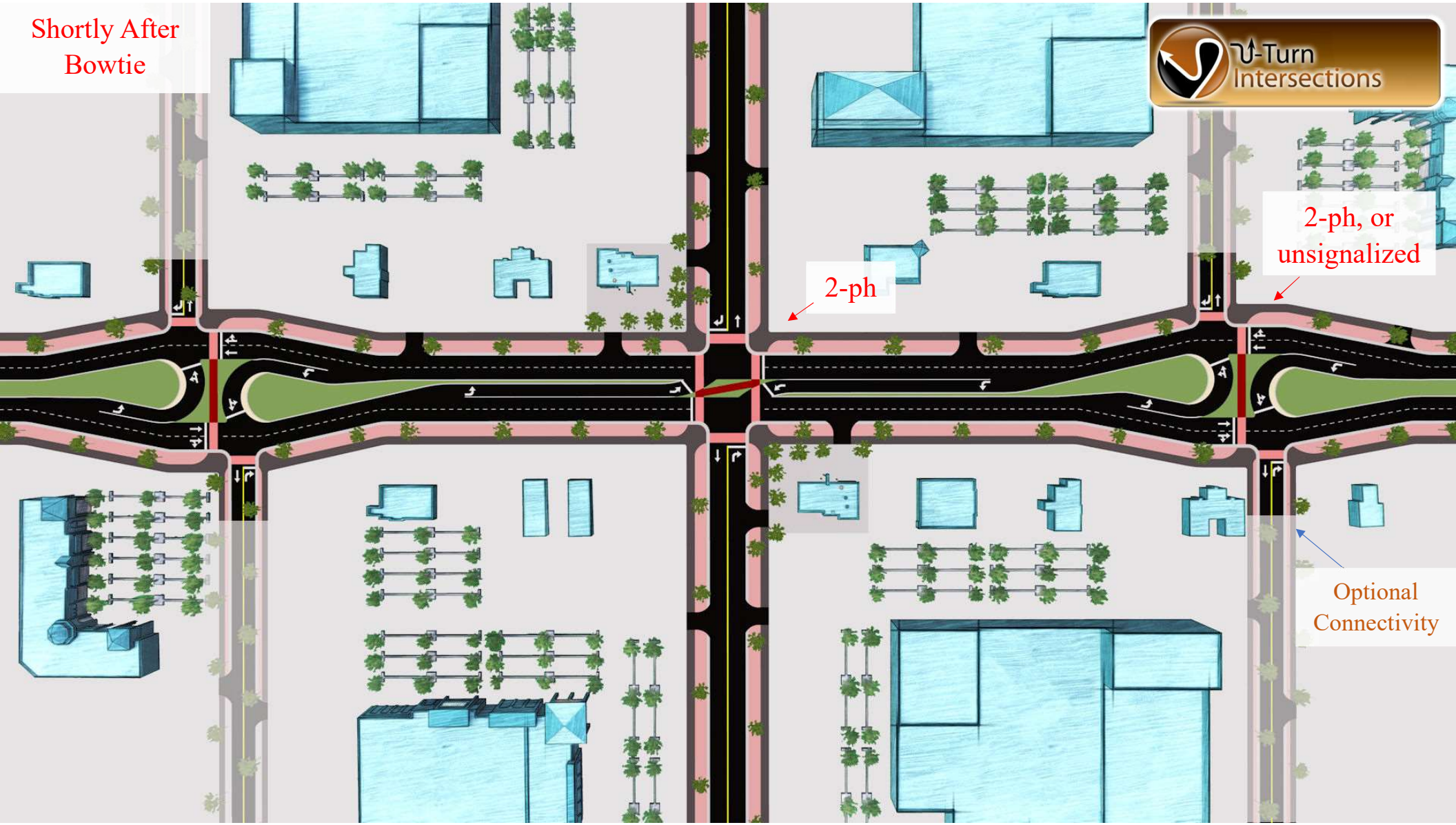
After

Quadrant Intersections

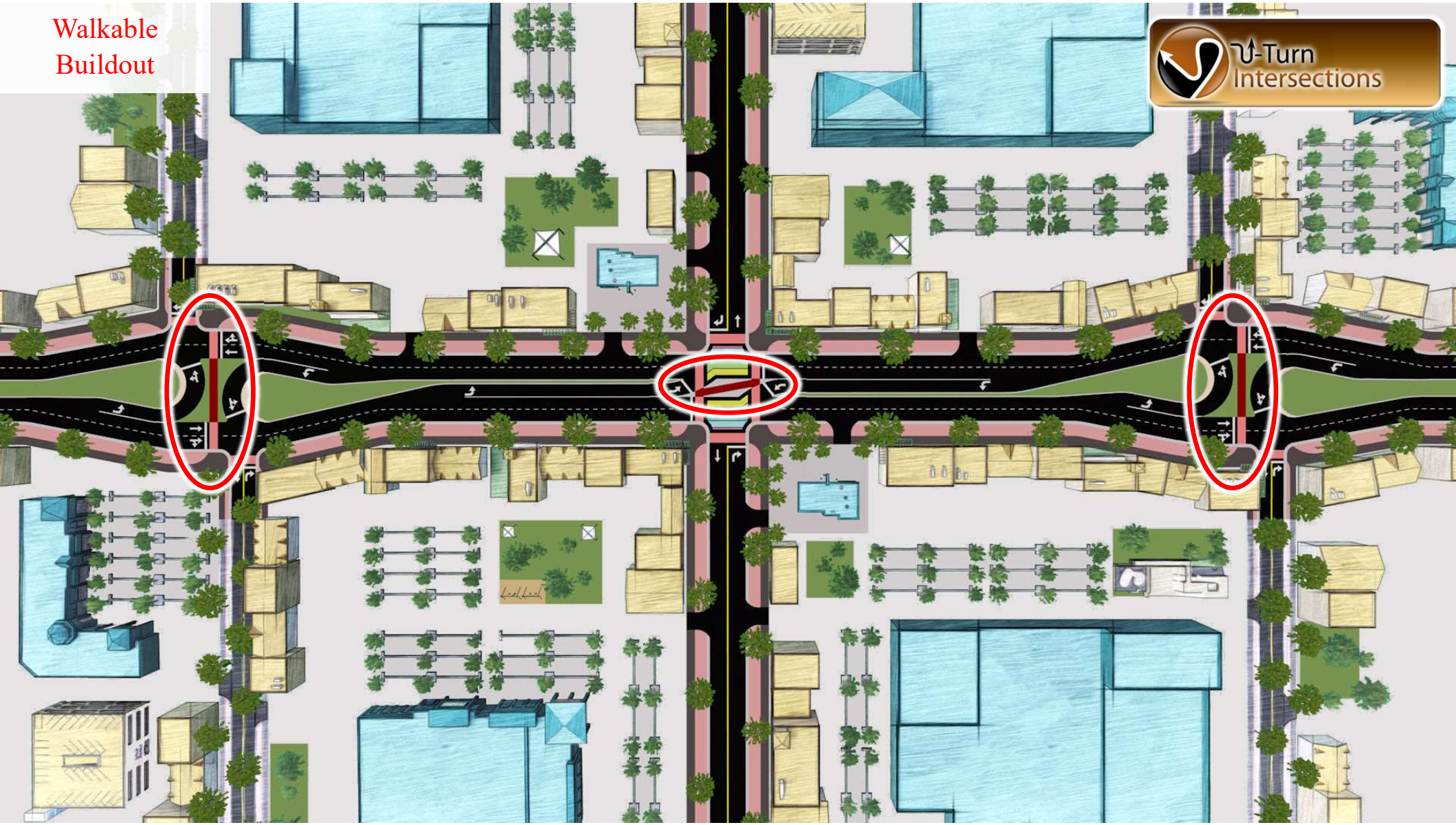
U-Turn Intersections

Idealized Views, then Conceptual Application
at Greenville Blvd and Red Banks Road


Before:
4-phase Stroad
U-Turn
Intersections
New
ROW
Optional
Connectivity


Shortly After Bowtie
U-Turn Intersections
2-ph, or unsignalized
2-ph
Optional Connectivity

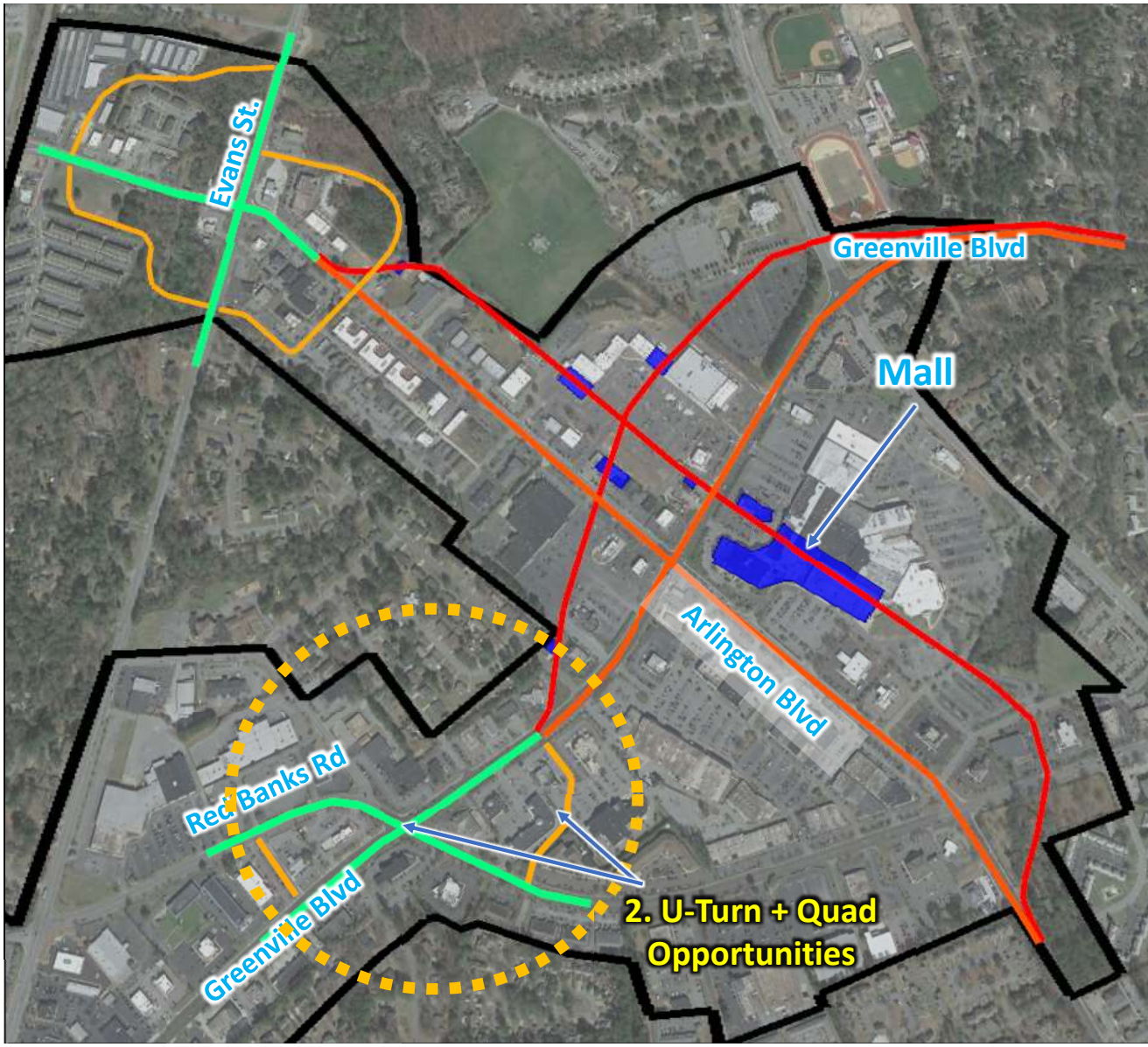
Walkable
Buildout

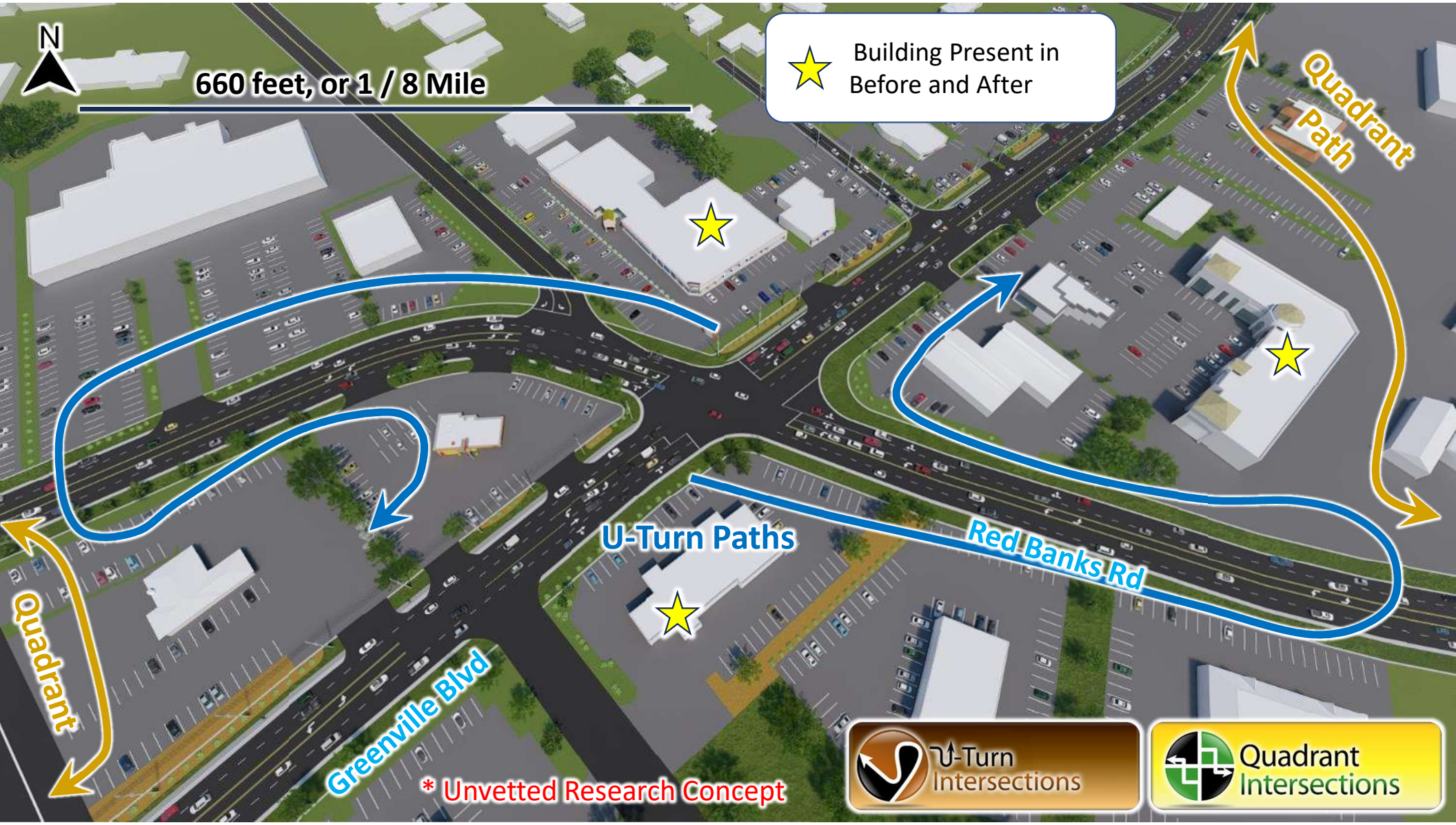


U-Turn Intersections

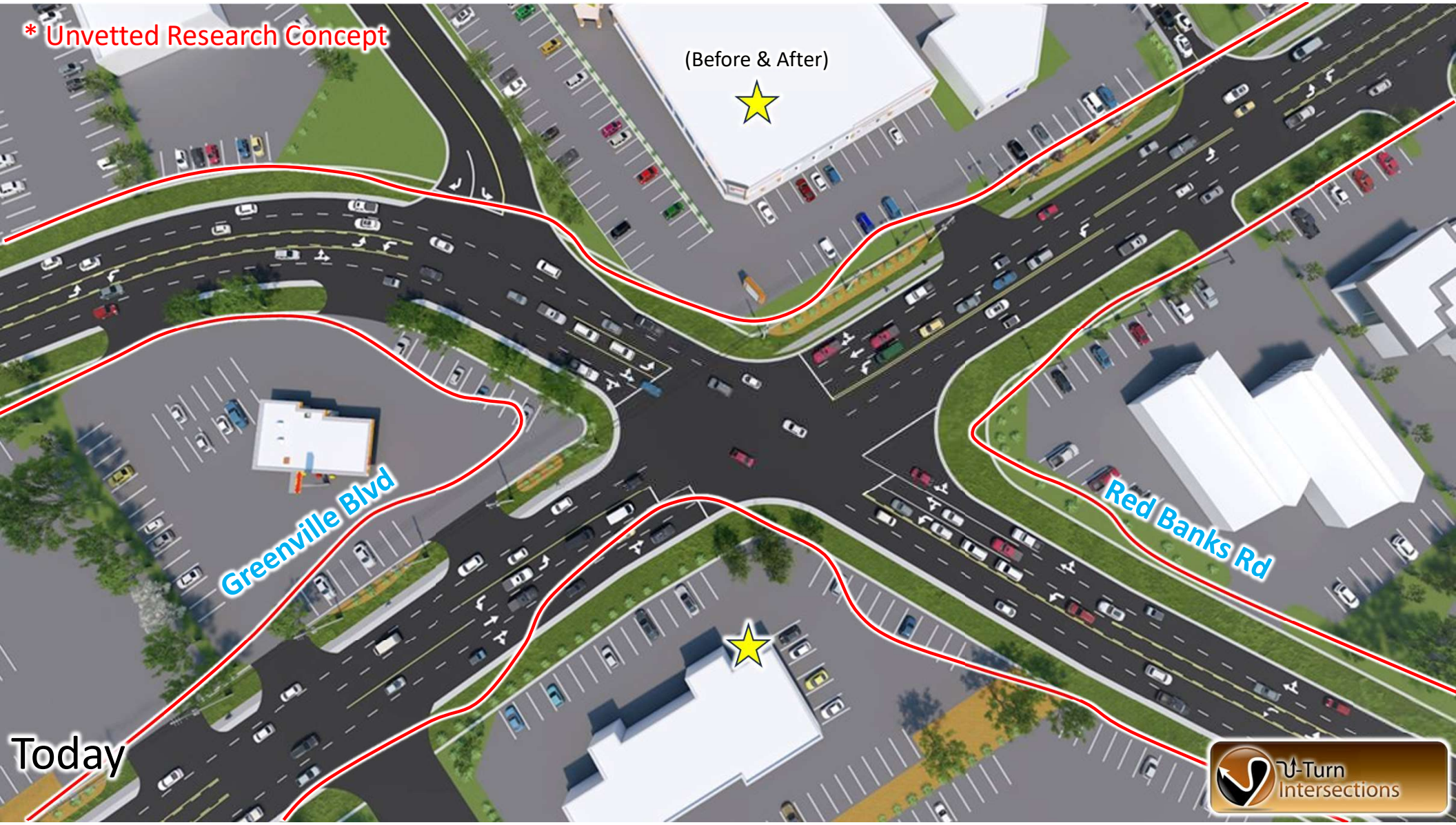
Greenville, NC

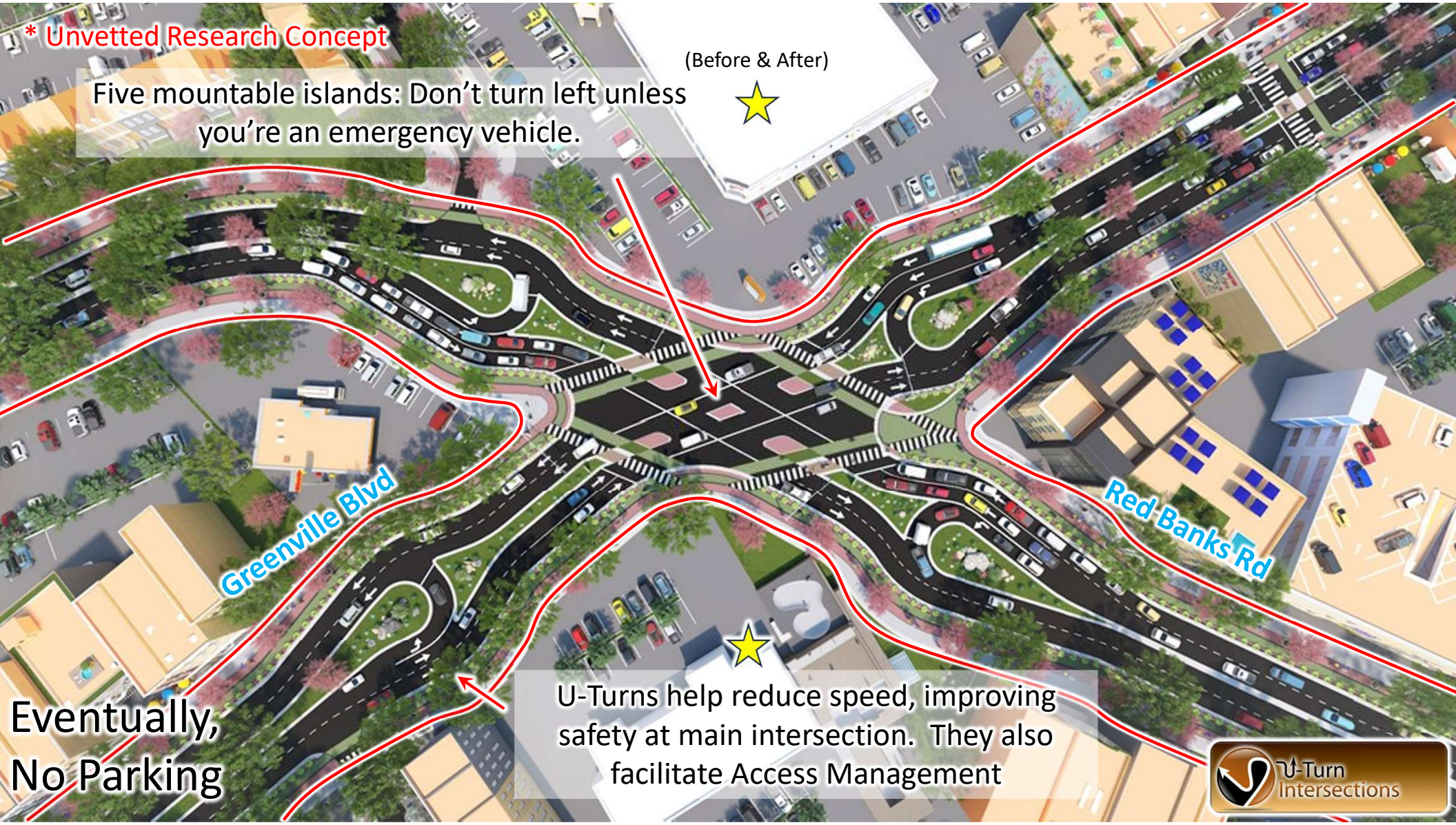
* Unvetted Research Concept



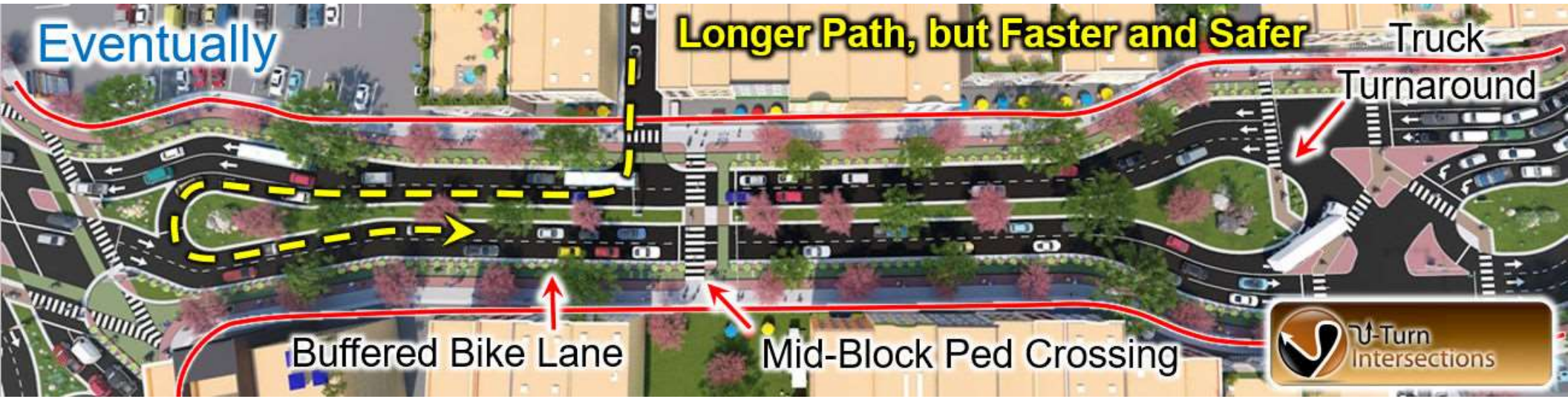

N
660 feet, or 1 / 8 Mile
Building Present in Before and After
Quadrant Path
U-Turn Paths
Red Banks Rd
Quadrant
Greenville Blvd
* Unvetted Research Concept
U-Turn Intersections
Quadrant Intersections


Can Offset
680 Acres
of suburbs, and
19 Miles of Road
* 3x more density
* 60% more capacity
* 10-15 mph slower...
but also faster!
Quadrant Path
U-Turn Paths
Red Banks Rd
Quadrant
Greenville Blvd
* Unvetted Research Concept
U-Turn Intersections
Quadrant Intersections


* Unvetted Research Concept
(Before & After)
Greenville Blvd
Red Banks Rd
Today
U-Turn Intersections


* Unvetted Research Concept
(Before & After)
Five mountable islands: Don't turn left unless you're an emergency vehicle.
Greenville Blvd
Red Banks Rd
Eventually, No Parking
U-Turns help reduce speed, improving safety at main intersection. They also facilitate Access Management
U-Turn Intersections


Today
Long Delays, Very Dangerous
U-Turn Intersections


Eventually
Longer Path, but Faster and Safer
Truck Turnaround
Buffered Bike Lane
Mid-Block Ped Crossing
U-Turn Intersections


View angle
Existing conditions are not capable of catalyzing mixed-use development
U-Turn Intersections

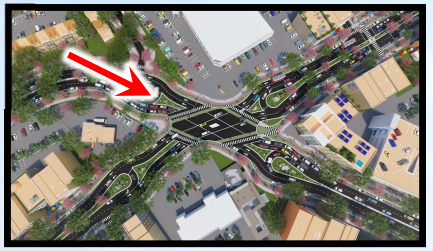

View angle
Outdoor Dining
Mid-Block
Pedestrian
Crossing
BIKE
LANE
Bikes protected with buffer
U-Turn
Intersections

Existing

U-Turn Intersections

I think I can!
I think I can!

View Angle

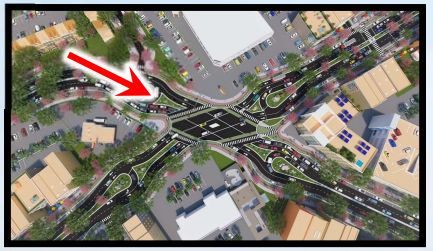


Eventually, No Parking

U-Turn Intersections

I thought I could!
I thought I could!

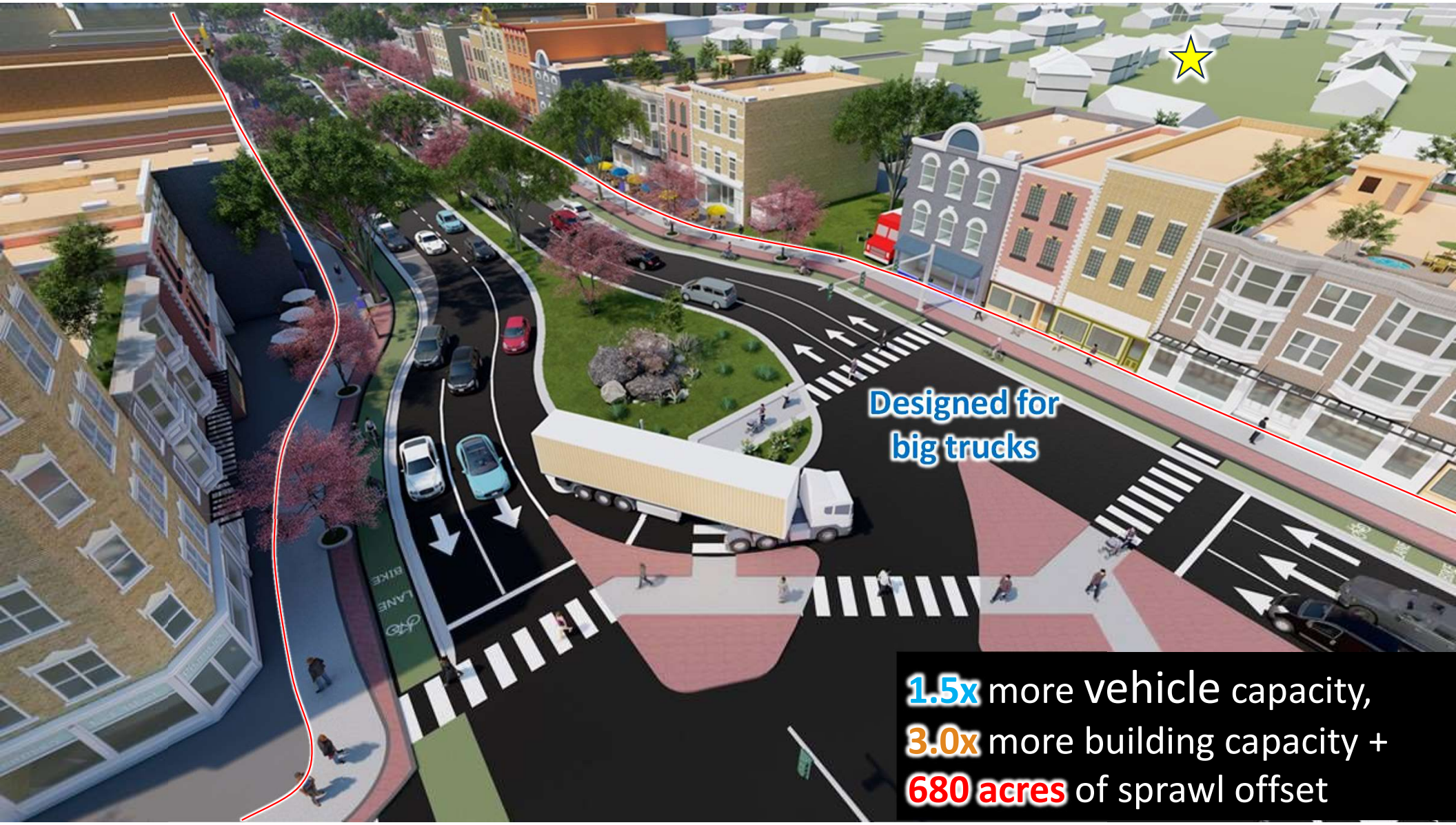
View Angle




View Angle


View Angle


EYEMART
Today
U-Turn
Intersections


Designed for
big trucks
1.5x more vehicle capacity,
3.0x more building capacity +
680 acres of sprawl offset


Watch this unique way to create a “Road Diet” that converts 5-lanes to 4-lanes, but still maintains the capacity of a 5-lane.
Before Path:
Requires Median
U-Turn Intersections


U-turns help convert wide medians to narrow
without loss of safety or functionality
After Path
Does Not
U-Turn
Intersections

One-Way Split Intersections

Idealized Views, then Conceptual Application in Greenville

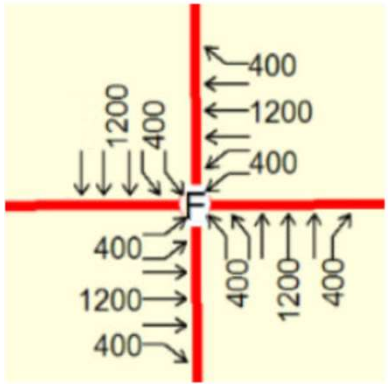
What is a One-Way Split Design?

One-Way Split Intersections

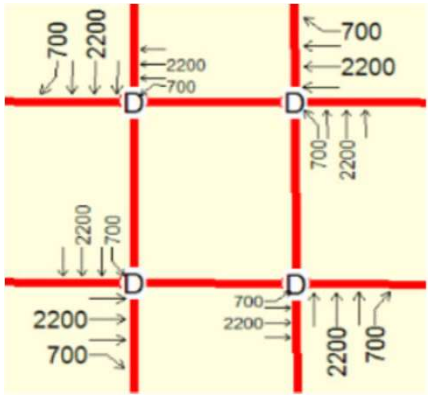
Completed Town Center Intersection: Elfin Forest Hwy & San Elijo Rd., San Marcos, CA

Which handles more traffic?

One gargantuan intersection? or Four human-scale intersections?



8,000/hr at LOS F

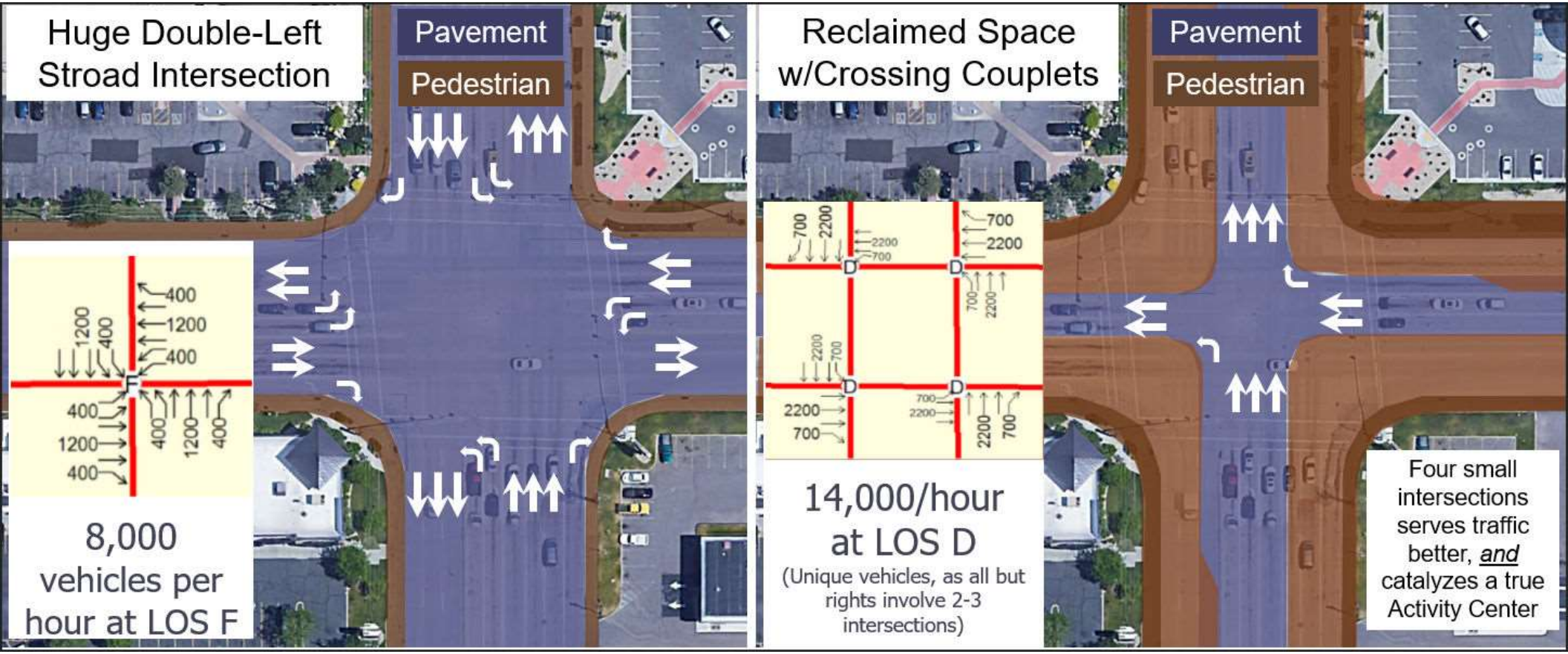


14,000/hr at LOS D

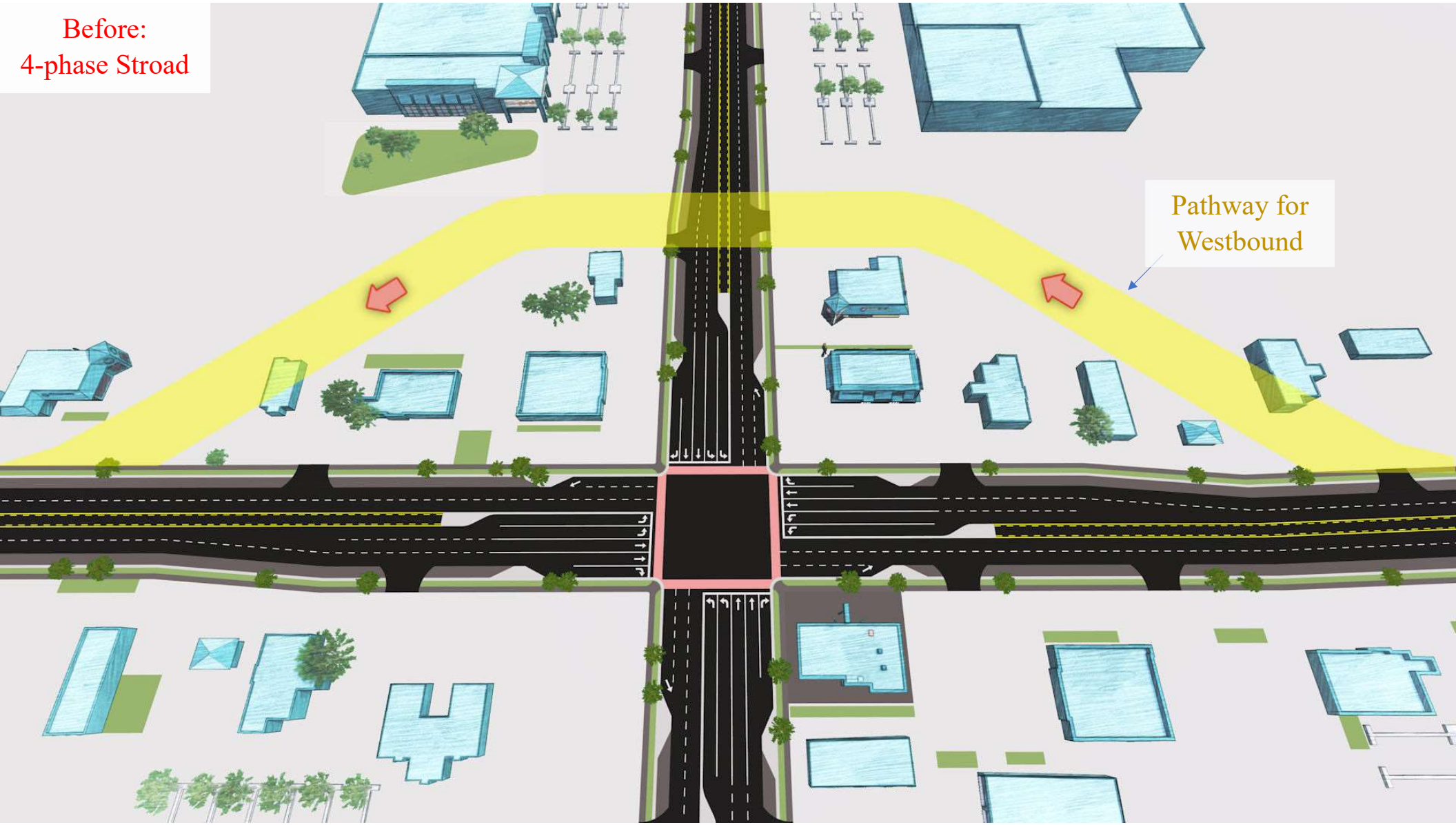
(Unique vehicles, as all but rights involve 2-3 intersections)

Search for OneWayVsTwoWay_TrafficLOS.JPG

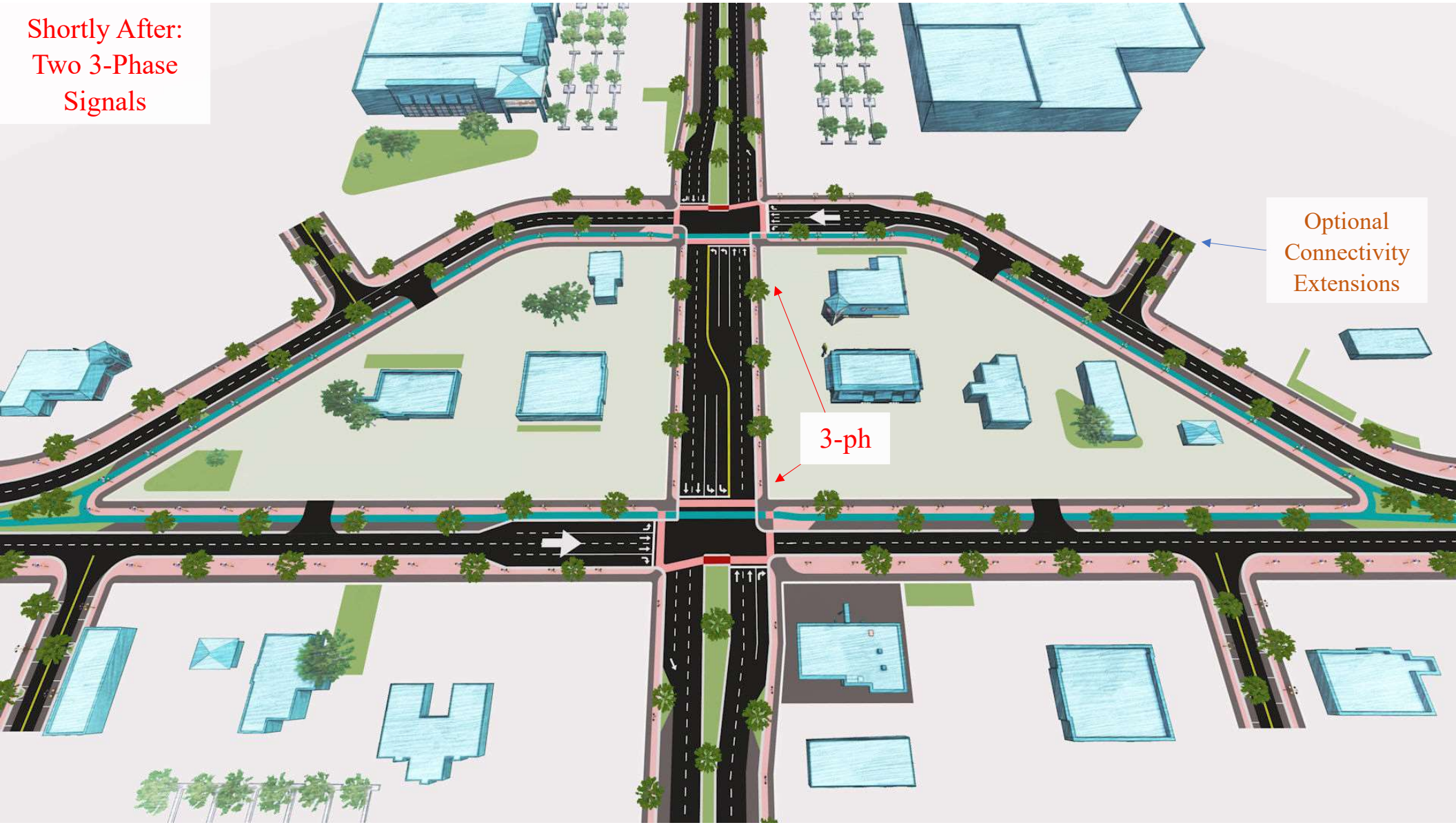
Search for OneWayVsTwoWay_Footprint.JPG



Before:
4-phase Stroad



Shortly After:
Two 3-Phase
Signals

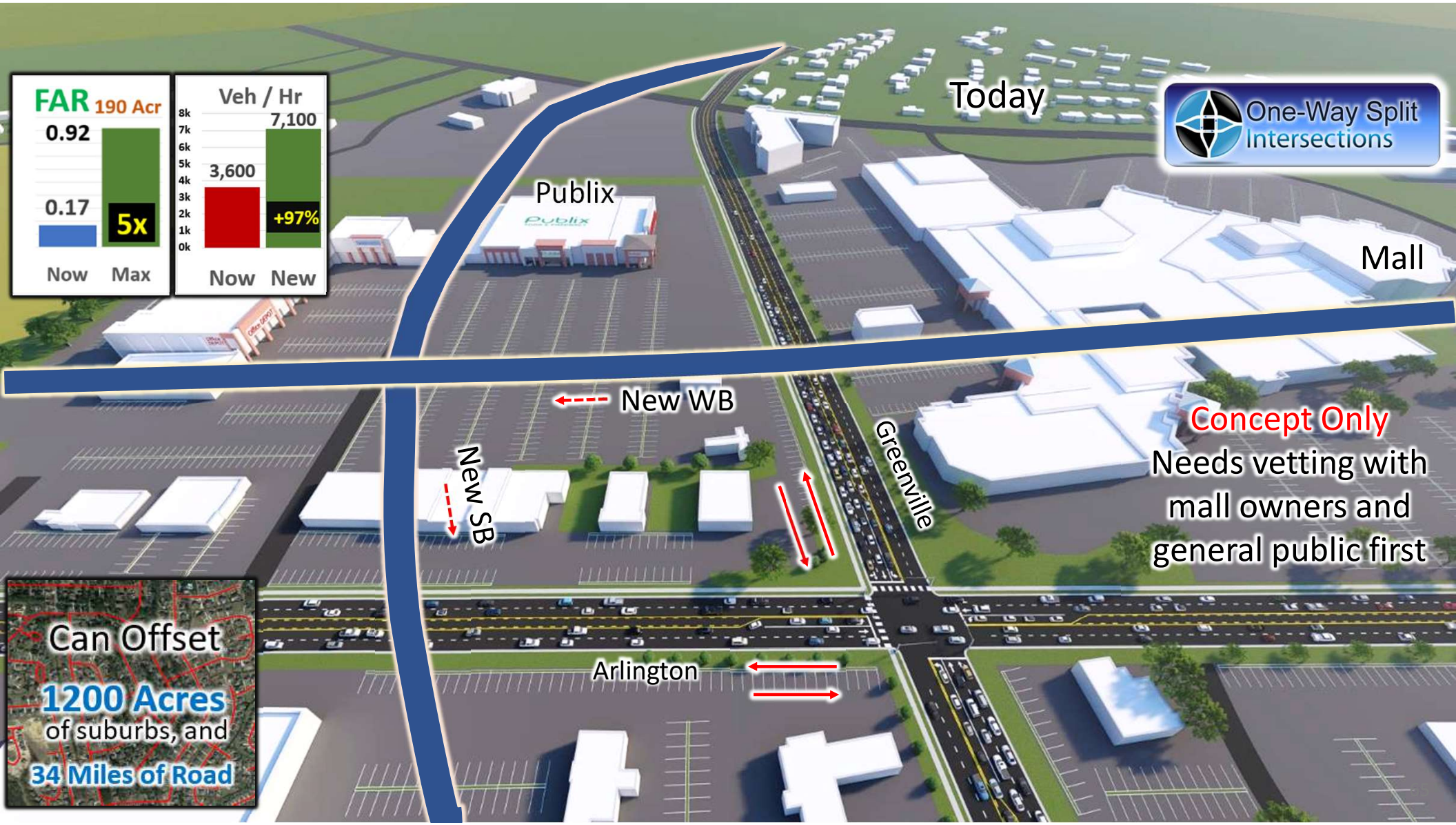


Walkable
Buildout


Today
Limit vs Actual
35 Spd Limit
42 as 2-Way
"Nice Stroad"
GROCERY STORE
SPEED LIMIT 35
YOUR SPEED 42


Default Future?
Limit vs Actual
35 Spd Limit
42 as 2-Way
"Nicer Stroad"
GROCERY STORE
SPEED LIMIT 35
YOUR SPEED 42


One Way Potential
Limit vs Actual
25 Spd Limit
26 as 1-Way
Why? Syncing = compliance!
GROCERY STORE
LANE
BRT
LANE
BIKE
SPEED LIMIT 25
YOUR SPEED 26


FAR 190 Acr
0.92
0.17
5x
Now
Max
Veh / Hr
8k
7k
6k
5k
4k
3k
2k
1k
0k
7,100
3,600
+97%
Now
New
Today
One-Way Split Intersections
Publix
Mall
New WB
New SB
Greenville
Concept Only
Needs vetting with mall owners and general public first
Can Offset
1200 Acres
of suburbs, and
34 Miles of Road
Arlington


FAR 190 Acr
0.92
0.17
5x
Now
Max
Veh / Hr
8k
7k
6k
5k
4k
3k
2k
1k
0k
7,100
3,600
+97%
Now
New
With 5x Development
One-Way Split Intersections
Publix
Small Mall
New WB
New SB
Greenville NB
Arlington EB
Can Offset
1200 Acres
of suburbs, and
34 Miles of Road


Typical Two-Way Stroad Intersection
Would you rather have **one** of these?


Crossing One-Ways
One-Way Split Intersections
Or Four of these?


Arlington Blvd
One-Way Split Intersections
Greenville Blvd
BIKE LANE
BIKE LANE

Example Simulation - Mall Area, One-way Couplet Concept

Current: 3800 veh per hour

Red cars: Significant Delay
Green / yellow: Little Delay

Average Time 100 sec

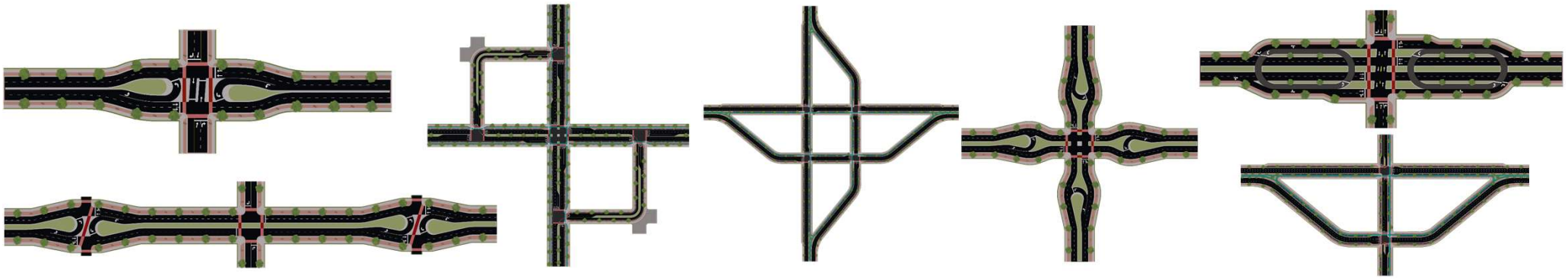
One-Ways with 3800 vph

Average Time 60 sec

One-Ways at 6400 vph

Average Time 100 sec

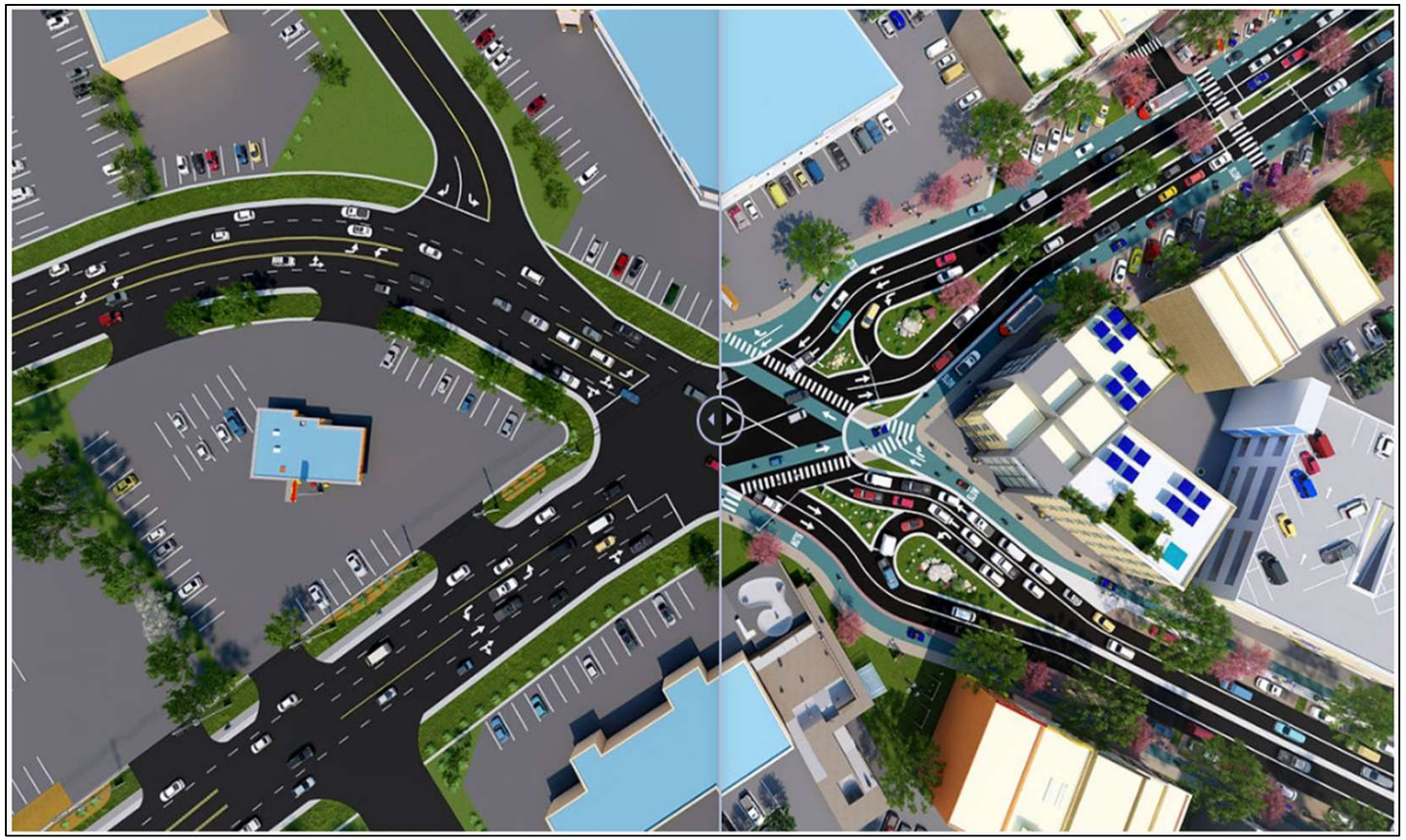
(70% more capacity)



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

Website with Research Summaries, B/A Sliders

URBAN Innovators.com Then look for “Projects”

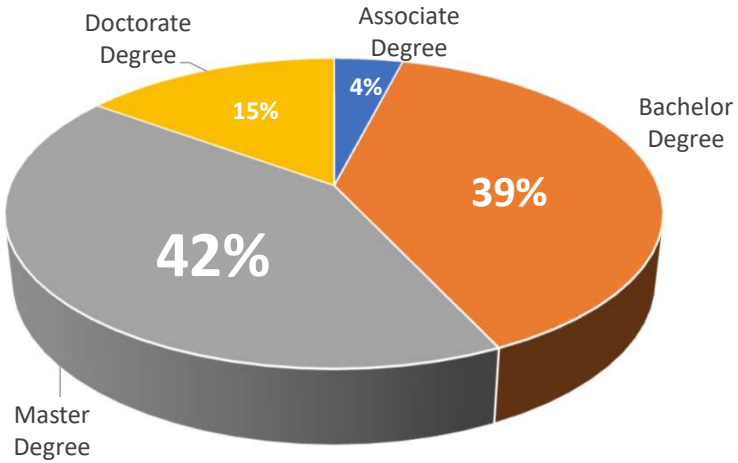


FOCUS GROUPS

Participants

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

Participant's Educational Background



Occupation and Specialty

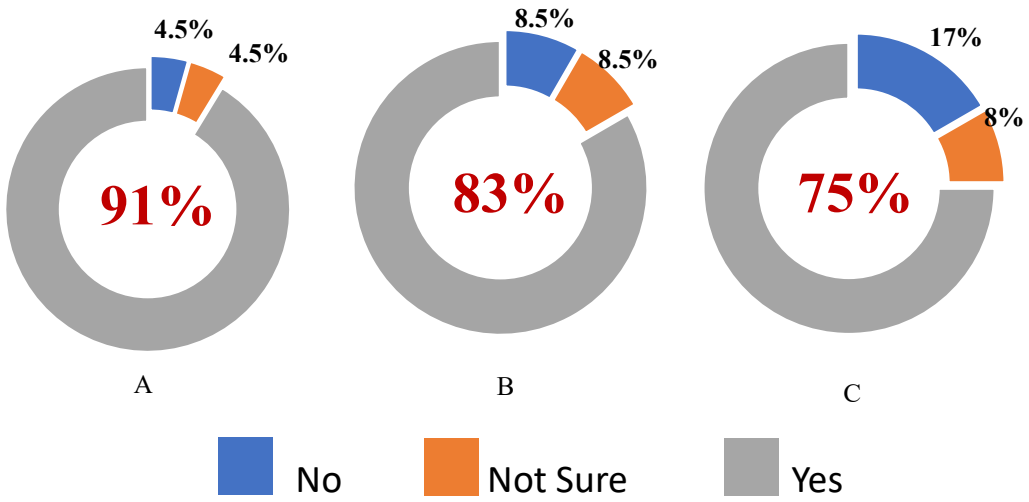
- ✓ Bike/Ped Advocates
- ✓ Traffic engineers
- ✓ Transportation planners and consultants
- ✓ City planners and land use experts
- ✓ University professors and researchers
- ✓ City engineers
- ✓ Urban economist
- ✓ Transit planner and manager
- ✓ Real-estate economics specialist
- ✓ Developers of mixed-use and shopping centers

Focus Group Questionnaire

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

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

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



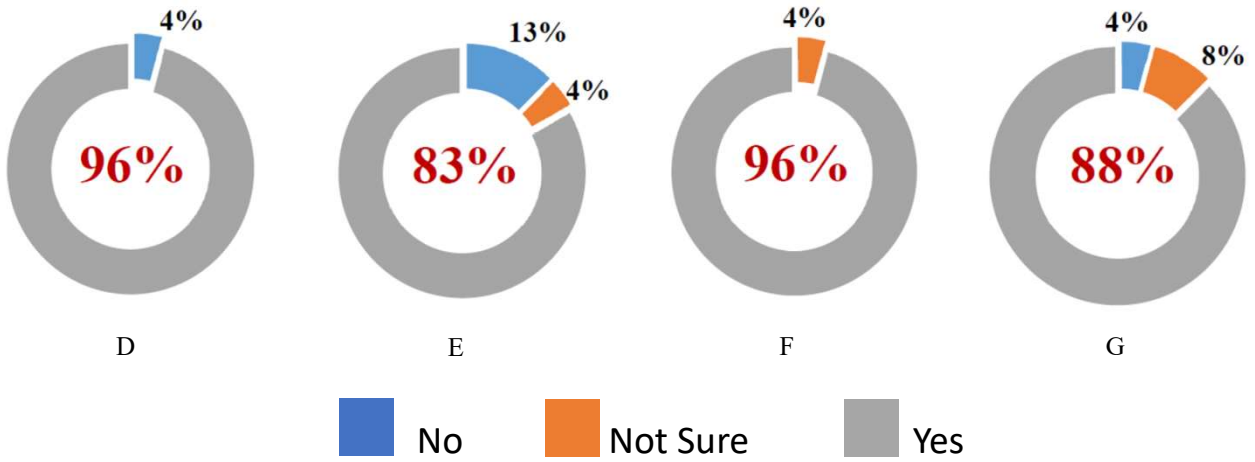
Focus Group Questionnaire

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?

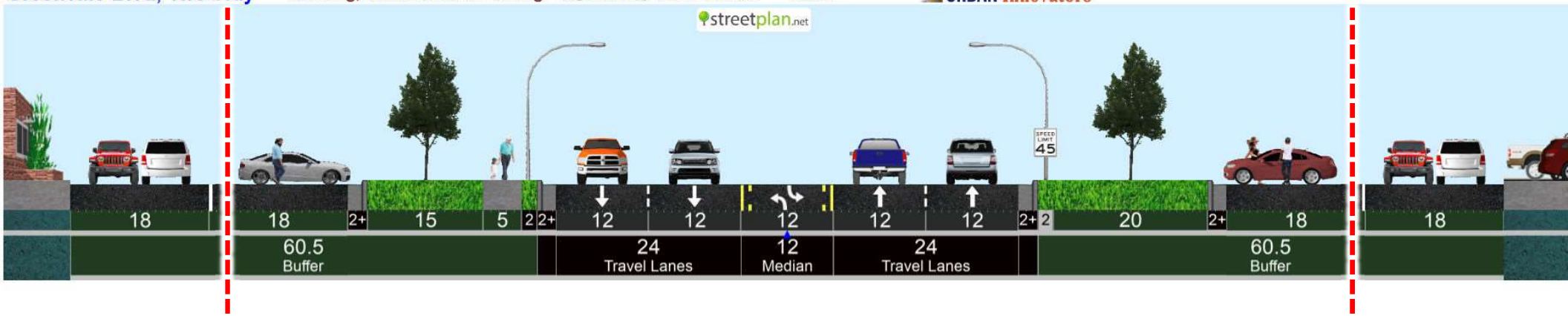
Question F: Are well-maintained street trees and streetscape critical for catalyzing mixed-use development?

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

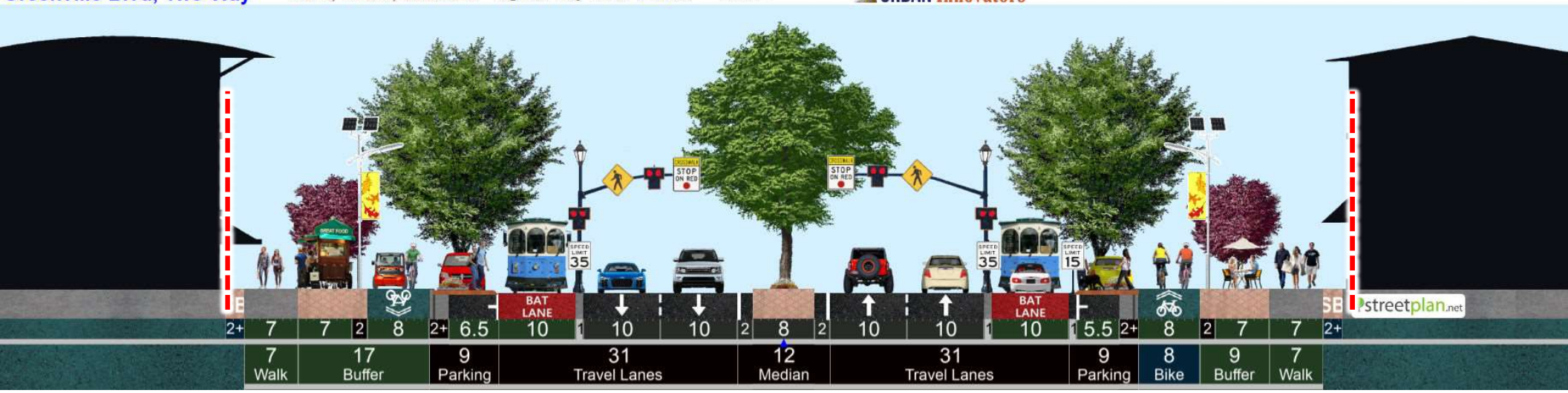


streetplan.net

Greenville Blvd, Two-Way Existing, w/Setbacks & Parking Right-of-Way 186 of 186 feet Share ▼ URBAN Innovators



Greenville Blvd, Two-Way 145-ft, P.Park, Setbacks Right-of-Way 140 of 140 feet Share ▼ URBAN Innovators



Summary of Findings

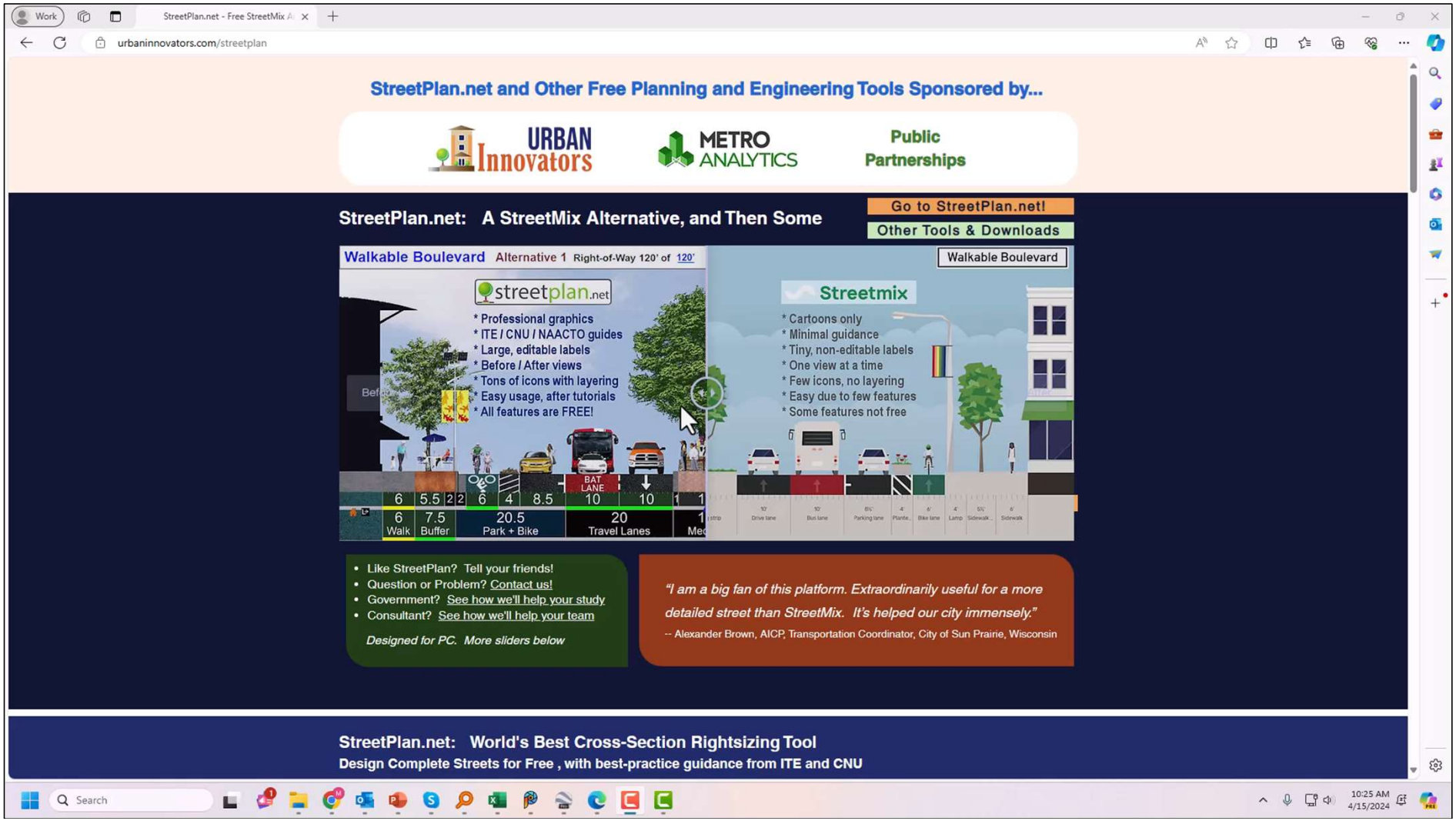
- Alternative designs outperform the conventional design
  - ✓ *Reduced average travel time (Happy Drivers!)*
  - ✓ *Increased capacity, improved safety (Happy DOT!)*
  - ✓ *Encourages walkable development (Happy Businesses and Developers!)*
  - ✓ *More safe and accessible facilities for bicyclists and pedestrians (Happy Everyone!)*

Thank You!

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

*** *This project has been funded by* ***NC Department of Transportation*** *and* ***National Science of Foundation*** ***

streetplan.net + 3DStreet =



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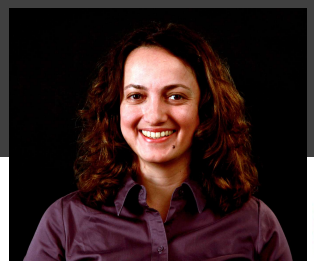

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URBAN Innovators
Livable Cities that Work!

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Founder of Urban Innovators

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