Greenville County Mobility & Thoroughfare Plan (MTP)

BY ASANGWUA IKEIN

Goals of the MTP

Present the current transportation paradigm.

Present alternative options for meeting people's transportation needs.

Outline

Existing Conditions

Goals of the Network

Roadways Safety

- Tactical Urbanism
- Safety Toolkit

Recommendations

- Integration of Strategies into UDO
- Funding Sources and Strategies

Introduction

The Greenville County Mobility & Thoroughfare Plan (MTP) is a primary recommendation from Greenville County's Comprehensive Plan adopted in January 2020.

Existing Conditions

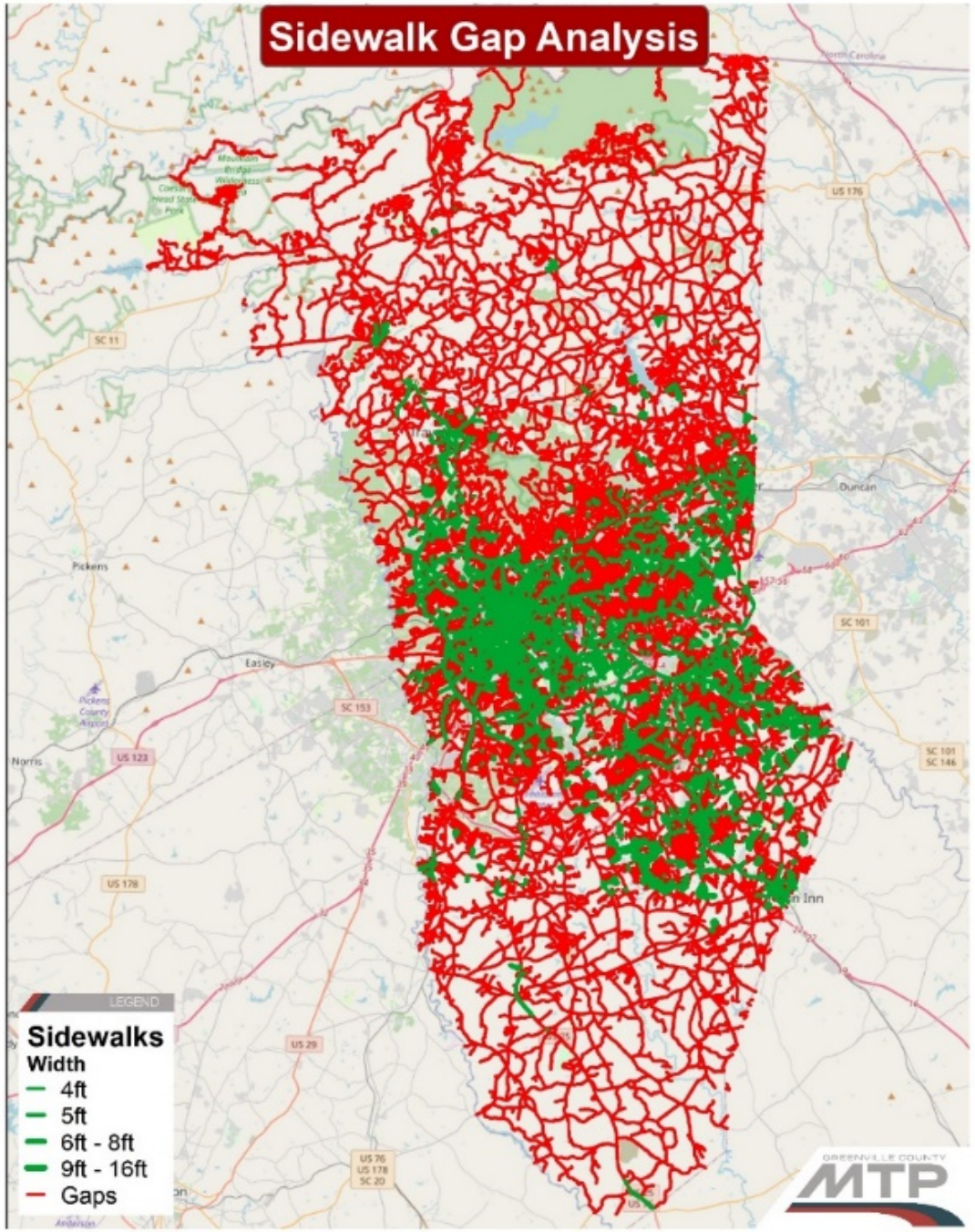
Greenville County, SC has an estimated population of 547,950 as of the 2022 American Community Survey (ACS), and 242,845 jobs as of the 2021 ACS.

	Transportation Options within ¼mi							
	Sidewalks		Protected Bikeways		Greenlink		Roadways - Driving	
	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Population	381,295	100.00%	22,462	100.00%	98,618	100.00%	537,983	100.00%
16+	303,818	79.68%	18,443	82.11%	79,875	80.99%	429,155	79.77%
Jobs	185,964	100.00%	10,468	100.00%	45,869	100.00%	259,768	100.00%

Existing Conditions - Walking

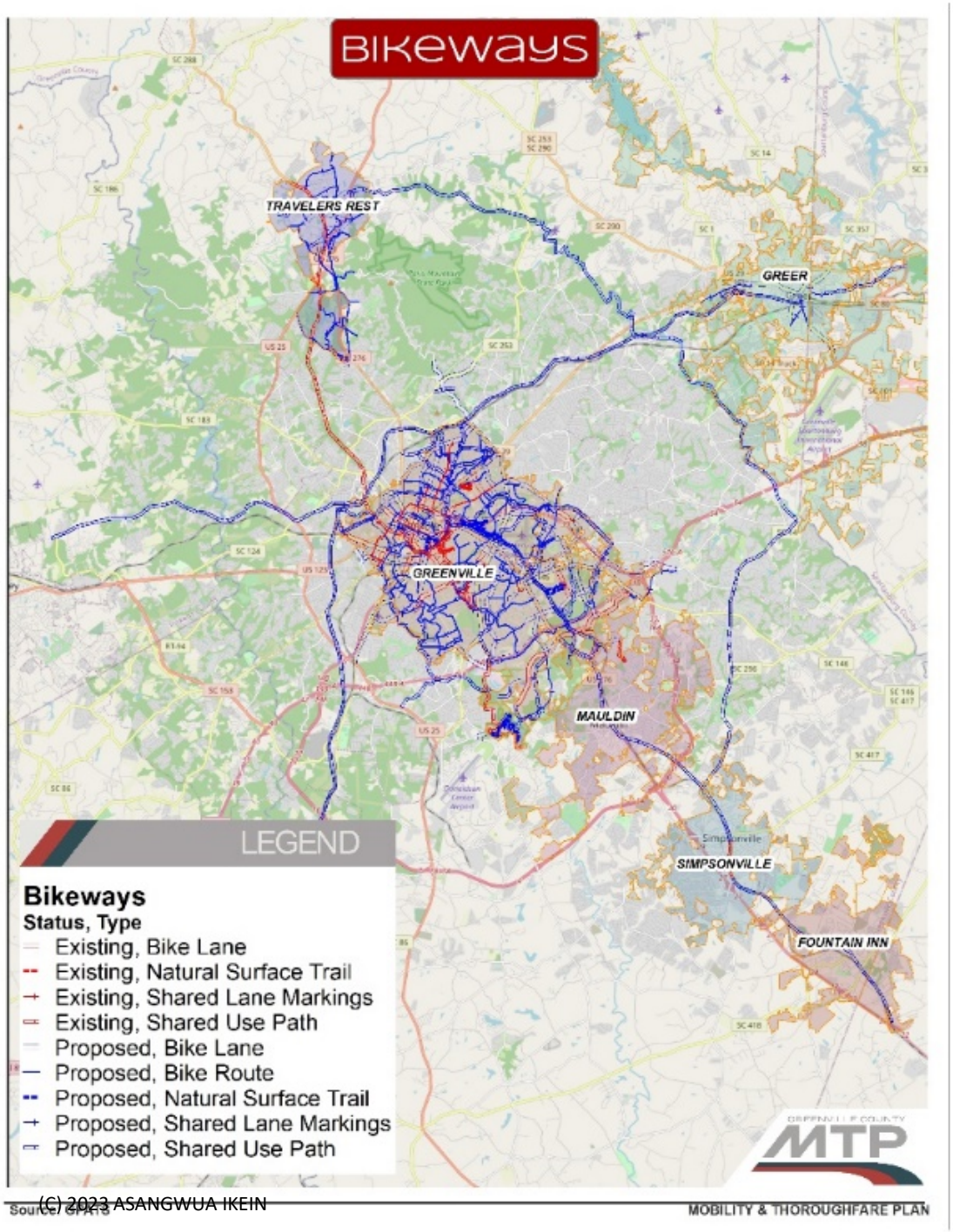
Over 55% of the population is within ¼ mi of sidewalks infrastructure.

But when sidewalks do exist, **lack of crosswalks, crossing distances, traffic speeds, lack of separation from fast moving traffic, origin and or destination, and sidewalks gaps, make walking an untenable transportation option**.



Existing Conditions - Biking

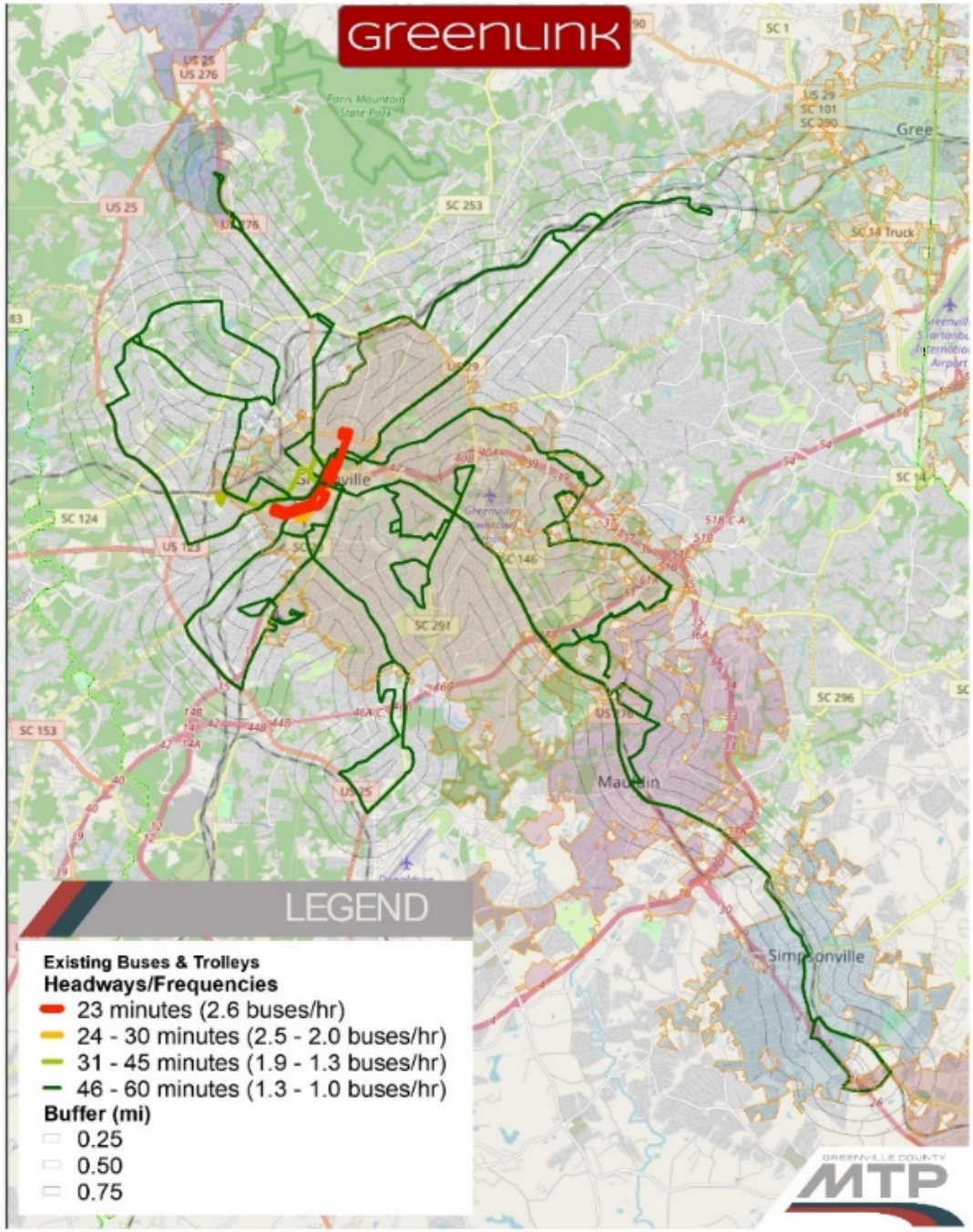
About 4% of the population is within ¼ mi of protected bikeways. Because so little of the population and employment along with origins and destinations is within proximity of protected bikeways, biking is a useful transportation option for few people.



Existing Conditions – Riding Transit

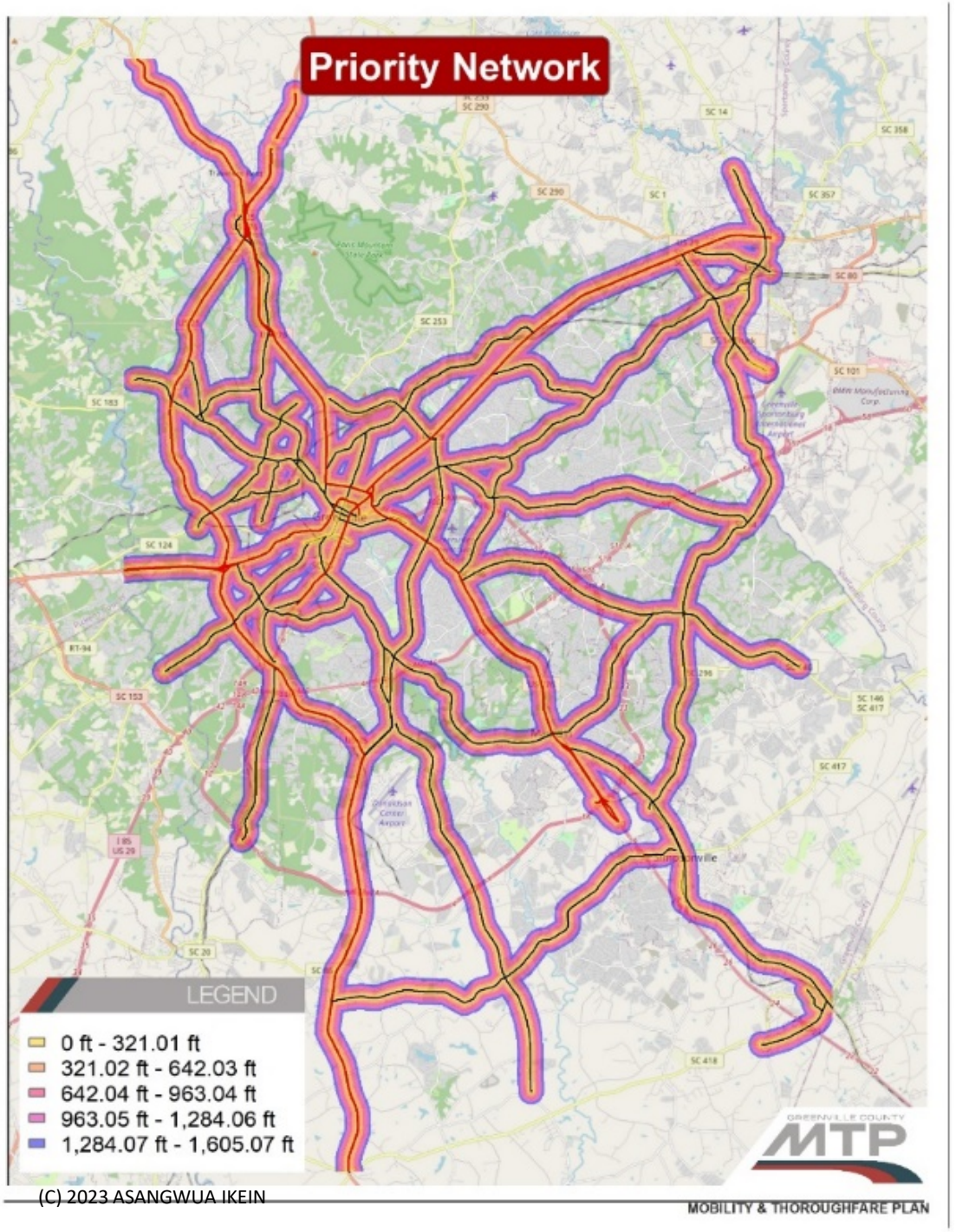
Approximately 18% of the population is within ¼ mi of transit services.

Also, there's an absence of sidewalks and bikeways leading to bus stops preventing people from accessing transit services.



Goals of Network – Analysis – Priority Network

Greenville County used several criteria including the State Primary Highways Network, Annual Average Daily Traffic (AADT), and activity generating land uses (commercial, industrial, and service) to identify the priority network.



Goals of Network – Analysis – Priority Network

This chart below shoes population with a ¼, ½, and ¾ miles of the priority network.

	Source: U.S. Census Bureau, Esri Forecasts for 2021 (Priority Corridors 259mi)					
	¼mi		½mi		¾mi	
	Total	**Percentage**	**Total**	**Percentage**	**Total**	**Percentage**
Population	167,771	100.00%	293,967	100.00%	364,237	100.00%
16+ Years Old	135,647	80.85%	235,468	80.10%	291,001	79.89%
Jobs	83,434	100.00%	145,995	100.00%	180,904	100.00%

Goals of Network – Analysis – Priority Network

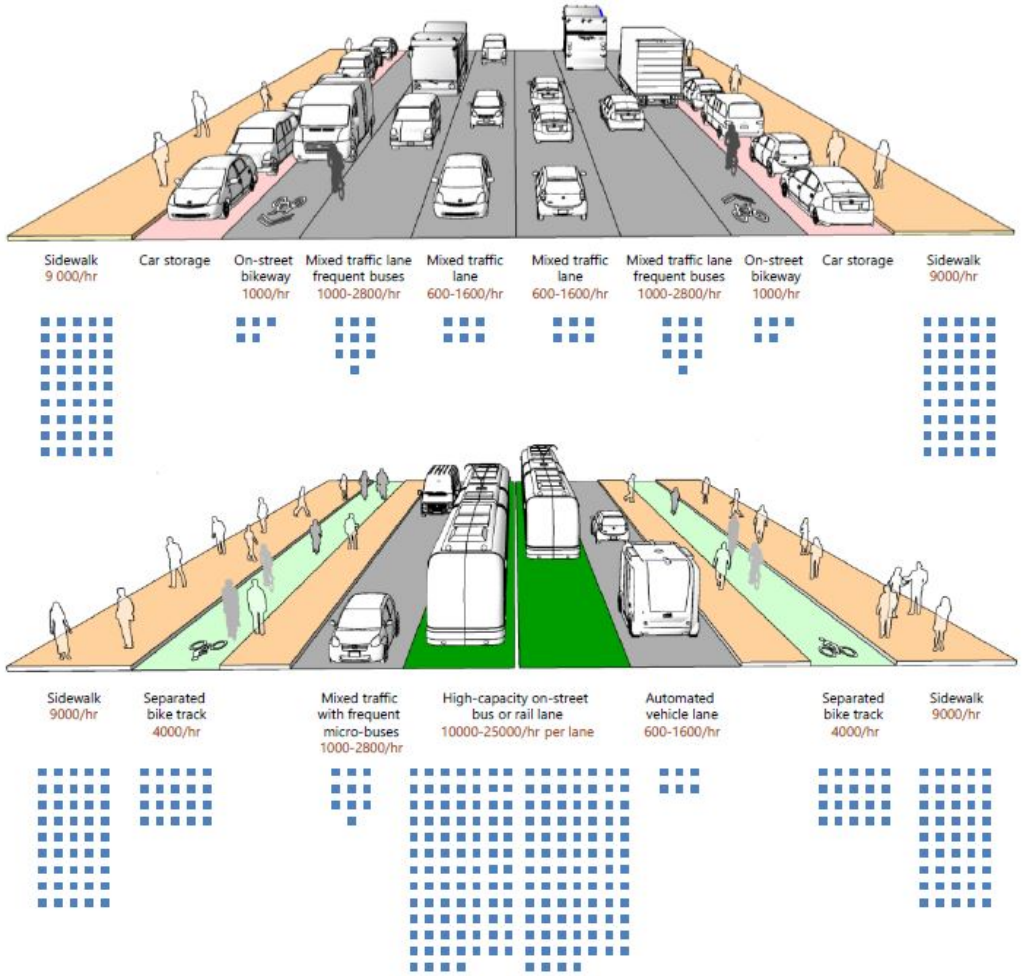
The vast majority of transportation resources are dedicated to rush hour worker commutes, amounts to less than 1/5 of trips includes walking, biking, riding transit, and driving.

Over 4/5 of trips taken are for other reasons including shopping, schools, churches, recreation, and other destinations.

Goals of Network – Analysis – Priority Network

Though roadway design prioritizes vehicles to move people, personal vehicles are the least efficient transportation option in urban settings.

Figure 13: **Moving more people with fewer vehicles**

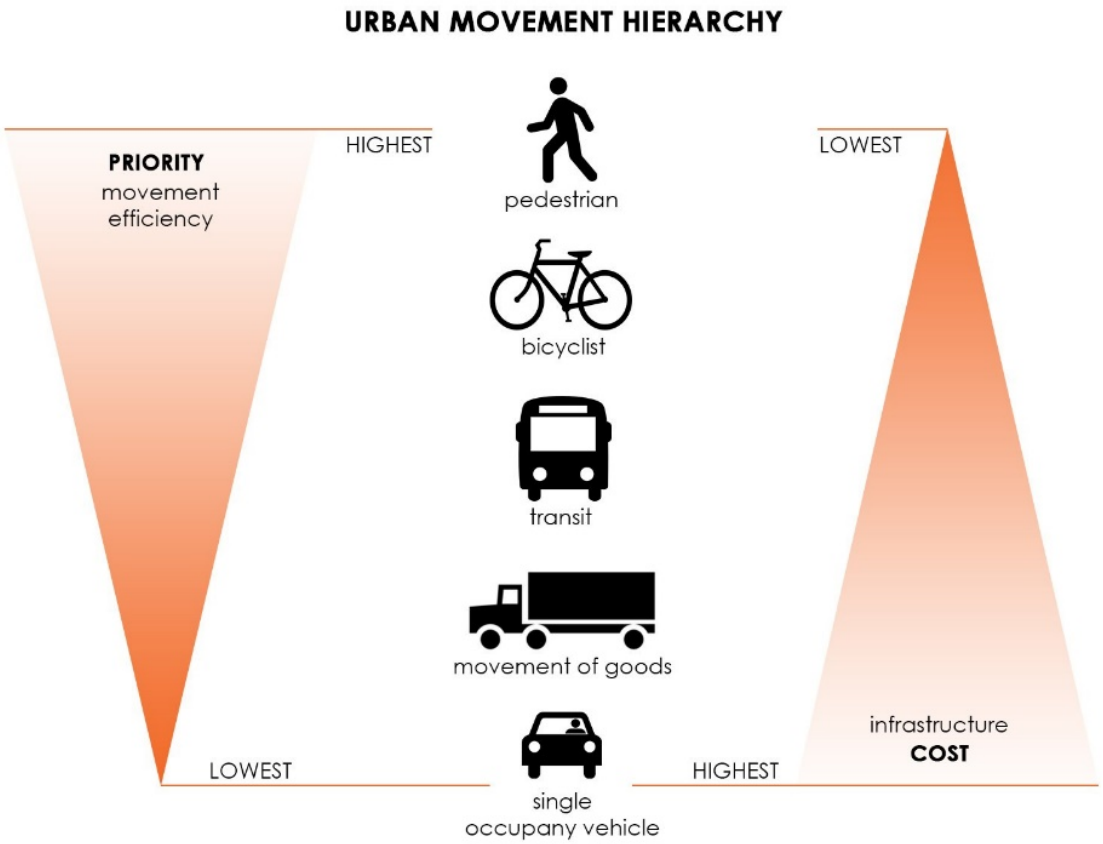


e: Adapted from (NACTO, 2017).

Goals of Network – Analysis – Priority Network

The cheapest transportation infrastructure options are walking, biking, and riding transit.

Roadways are the most expensive infrastructure option and user are restricted based on their age, potential disability, ability to afford a private vehicle, and driver's license.



Goals of Network – Analysis – Sidewalks & Crosswalks

A minority of walking trips, ~6%, are people commuting to and from work. The rest, ~94%, are dedicated to shopping, schools, churches, recreation, and other destinations.

	Population & Employment within Proximity of Sidewalks					
	¼mi		½mi		¾mi	
	Total	**Percentage**	**Total**	**Percentage**	**Total**	**Percentage**
Population	381,295	100.00%	471,081	100.00%	498,372	100.00%
16+	303,818	79.68%	374,665	79.53%	396,234	79.51%
Jobs	185,964	100.00%	229,371	100.00%	242,419	100.00%

Goals of Network – Analysis – Sidewalks & Crosswalks

Whether people know it or not, all intersections are crosswalks. It doesn't matter if the intersection has a traffic control device or a crosswalk, marked or unmarked.

South Carolina, and all states, have the same right-of-way laws for people walking.

WHAT PEOPLE DRIVING MUST KNOW ABOUT PEOPLE WALKING

People driving in lanes going in the same direction **MUST STOP** for people walking in a crosswalk when the person walking is anywhere on your side of the street.

People driving **MUST STOP** for people walking in the crosswalk when people walking are approaching in the lane where people driving are traveling in the opposite direction.

Goals of Network – Analysis – Sidewalks & Crosswalks

From *An Expanded Functional Classification System for Highways and Streets (2018)*.

Expanded FCS Interaction Matrix for People Walking					
Context/ Roadway	Rural	Rural Town	Suburban	Urban	Urban Core
Principal Arterial	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced
Minor Arterial	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced
Collector	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced
Local	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced
Pedestrian traffic levels: P1 = rare/occasional, P2 = low, P3 = medium, P4 = high Pedestrian facility width: * = site specific, Min = minimum, Wide = greater than minimum, Enhanced = wide for large congregating pedestrian groups Pedestrian facility separation should be considered in conjunction with driver target speeds.					

Goals of Network – Analysis – Sidewalks & Crosswalks

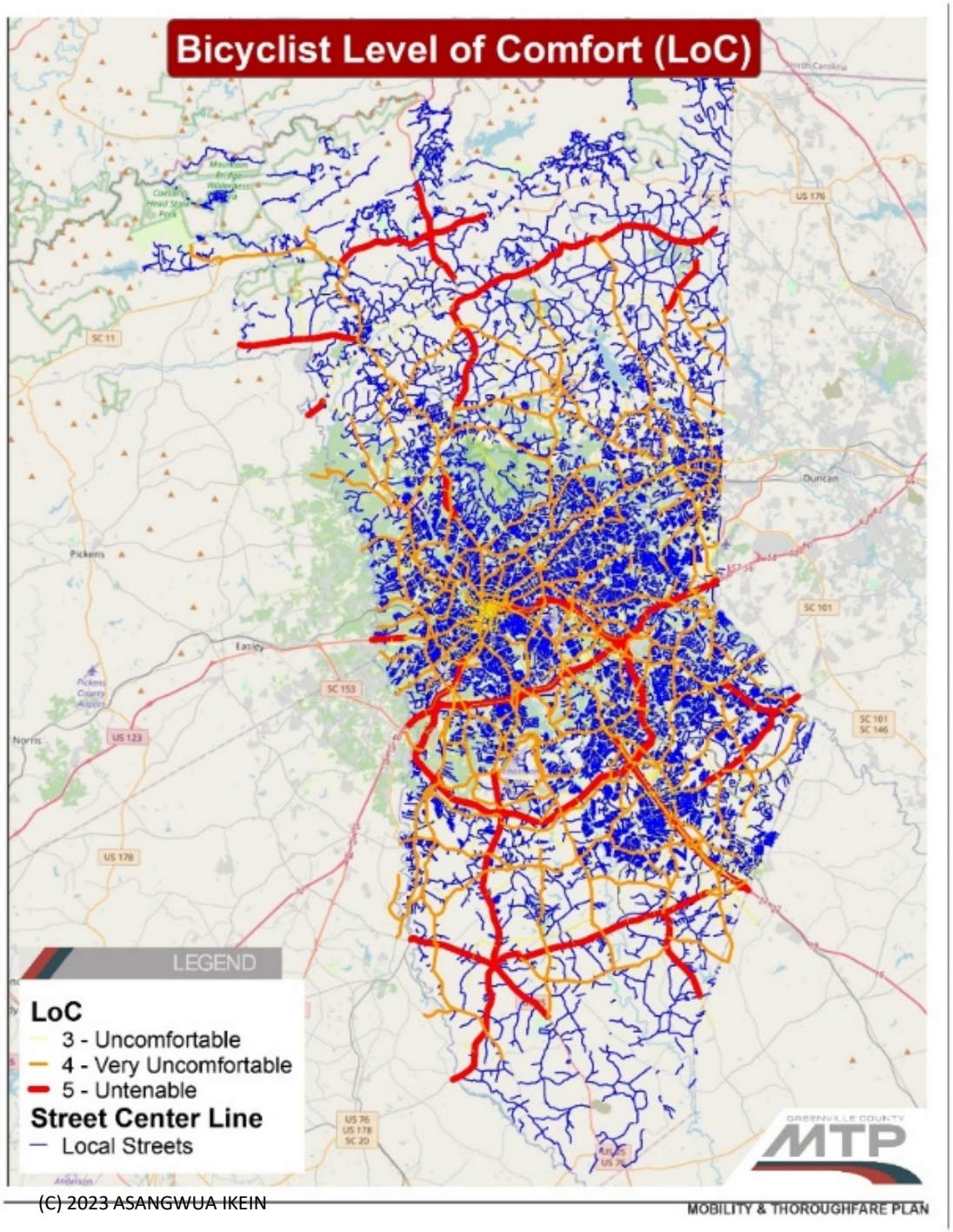
Figure represents the desired widths of different sidewalk zones. Desired width can depend on the needs of the particular location.

Street Design Classification	Frontage Zone	Pedestrian Through Zone	Sidewalk Buffer Furnishing Zone	Bicycle Facility	Street Buffer Furnishing Zone *exclusive of curb width*	6" Curb
Civic Main Street	2.5′	8′	1′ minimum, at least 4′ ideal width	See Portland Protected Bicycle Lane Planning and Design Guide	3′ minimum, at least 4′ ideal width	
Neighborhood Main Street	2.5′	8′				
Civic Corridor	1.5′	6′				
Neighborhood Corridor	1.5′	6′				
Community Corridor	1.5′	6′				
Regional Corridor	0.5′	6′				
Industrial Road	0.5′	6′				
Local Street	N/A	N/A	N/A	N/A	N/A	

Goals of Network – Analysis – *Bikeways – On Streets*

People decide not to bike because biking, as a transportation option, lacks safe bikeway infrastructure.

Even when bike lanes are available, traffic speeds and volumes dissuade potential people from biking.



Goals of Network – Analysis – *Bikeways – On Streets*

Population & Employment within Proximity of Protected Bikeways.

	Population & Employment within Proximity of Protected					
	¼mi		½mi		¾mi	
	Total	**Percentage**	**Total**	**Percentage**	**Total**	**Percentage**
Population	22,462	100.00%	54,008	100.00%	83,119	100.00%
16+	18,443	82.11%	44,166	81.78%	67,461	81.16%
Jobs	10,468	100.00%	24,710	100.00%	38,408	100.00%

Goals of Network – Analysis – *Bikeways – On Streets*

From *An Expanded Functional Classification System for Highways and Streets (2018)*.

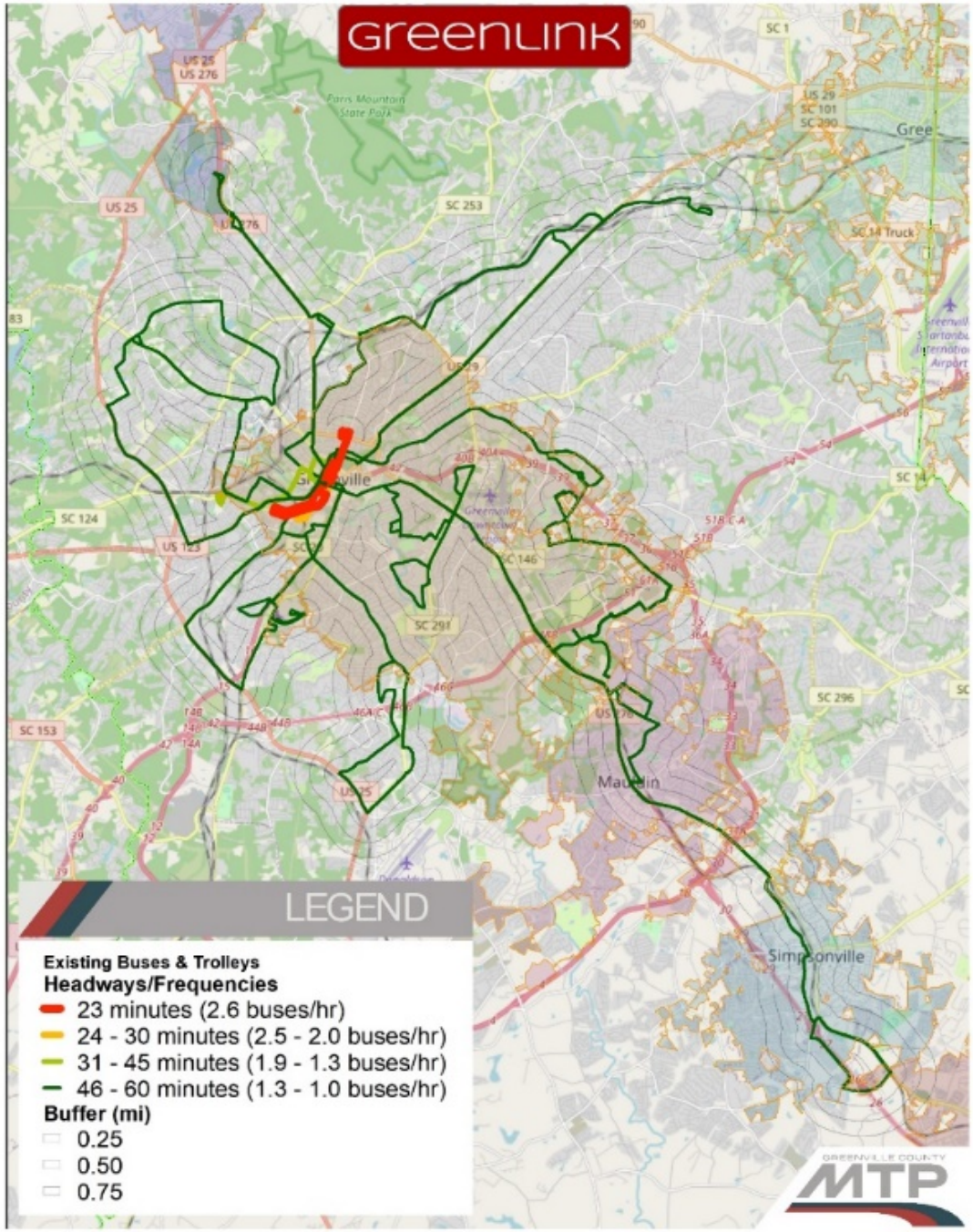
Expanded FCS Interaction Matrix for People Biking					
Context/ Roadway	Rural	Rural Town	Suburban	Urban	Urban Core
Principal Arterial	LC: L separation; NC: M separation; CC: H separation	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: M separation; CC: H separation	LC: L separation; NC: M/H separation; CC: H separation	LC: L separation; NC: M separation; CC: M separation
Minor Arterial	LC: L separation; NC: M separation; CC: H separation	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: M separation; CC: H separation	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: M separation; CC: M separation
Collector	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: L separation; CC: M separation	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: L separation; CC: M separation
Local	LC: L separation; NC: L separation; CC: L separation	LC: L separation; NC: L separation; CC: L separation	LC: L separation; NC: L separation; CC: L separation	LC: L separation; NC: L separation; CC: L separation	LC: L separation; NC: L separation; CC: L separation
Bicycle facility class: CC = citywide connector, NC = neighborhood connector, LC = local connector, Separation level: H = high, M = medium, L = low					

Goals of Network – Analysis – Transit

Less than 1/3, are people commuting to and from work.

The rest, more than 2/3, are dedicated to shopping, schools, churches, recreation, and other destinations.

Currently, most bus services in Greenville County operate at a frequency of one bus per hour.



Goals of Network – Analysis – Transit

Population & Employment within Proximity of Greenlink.

	Population & Employment within Proximity of Greenlink					
	¼mi		½mi		¾mi	
	Total	**Percentage**	**Total**	**Percentage**	**Total**	**Percentage**
Population	98,618	100.00%	165,707	100.00%	197,176	100.00%
16+	79,875	80.99%	133,815	80.75%	159,203	80.74%
Jobs	45,869	100.00%	78,309	100.00%	93,476	100.00%

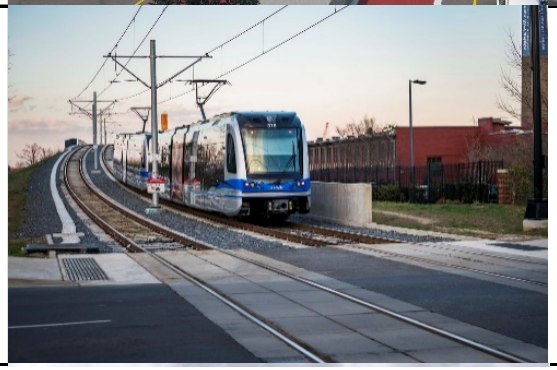
Goals of Network – Analysis – Transit

Transit agencies choose technology based on a tradeoff of capacity of service, type of service (typology – local, circulator, express, commuter, regional), speed of service, grade separation (below, at, or above grade), cost, speed of implementation, and the frequency of services.

Goals of Network – Analysis – Transit

Typology	Stop Spacing (mi)		Technology		
	Minimum	Maximum			
Local	0.25	1	bus	Greenlink	
			rail	NYC Subway	

Goals of Network – Analysis – Transit

Typology	Stop Spacing (mi)		Technology		
	Minimum	Maximum			
Express	1	3	bus	Lowcountry Rapid Transit	
			rail	Lynx Blue Line	

Goals of Network – Analysis – Transit

Typology	Stop Spacing (mi)		Technology		
	Minimum	Maximum			
Commuter	3	10	bus	Houston Metro	
			rail	Music City Star	

Goals of Network – Analysis – Transit

People riding transit are unable to access transit services because of a lack of adequate sidewalks, bikeways, and bike parking.

This diminishes potential ridership as people walking to access transit is the most critical factor to transit success.

Goals of Network – Analysis – Driving – Congestion

A minority of driving trips, less than 1/5, are people commuting to and from work. The rest, more than 4/5, are dedicated to shopping, schools, churches, recreation, and other destinations.

	Population & Employment within Proximity of Roadway					
	¼mi		½mi		¾mi	
	Total	**Percentage**	**Total**	**Percentage**	**Total**	**Percentage**
Population	537,983	100.00%	563,154	100.00%	574,358	100.00%
16+	429,155	79.77%	449,597	79.84%	458,593	79.84%
Jobs	259,768	100.00%	271,459	100.00%	276,854	100.00%

Goals of Network – Analysis – Driving – Congestion

Roadway design hierarchy facilitates the occurrence of congestion.

Nevertheless, **the quickest roadways make up the smallest amount of the roadways in the network**. In Greenville County, **urban arterials and freeways account for 10% of roadways**.

Goals of Network – Analysis – Driving – Congestion

From *An Expanded Functional Classification System for Highways and Streets (2018)*.

Expanded FCS Interaction Matrix for People Driving					
Context/ Roadway	Rural	Rural Town	Suburban	Urban	Urban Core
Principal Arterial	H speed H mobility- L access	L/M speed M mobility- H access	M/H speed M mobility- M access	L/M speed M mobility- M access	L speed M mobility- M access
Minor Arterial	H speed H mobility- L access	L/M speed M mobility- H access	M speed M mobility- M access	L/M speed M mobility- M/H access	L speed M mobility- M/H access
Collector	M speed M mobility- M access	L speed M mobility- H access	M speed M mobility- H access	L speed M mobility- H access	L speed M mobility- H access
Local	M speed M mobility- M access	L speed M mobility- H access	L speed L mobility- H access	L speed L mobility- H access	L speed L mobility- H access
L = low (<30mph), M = medium (30-45mph), H = high (>45mph)					

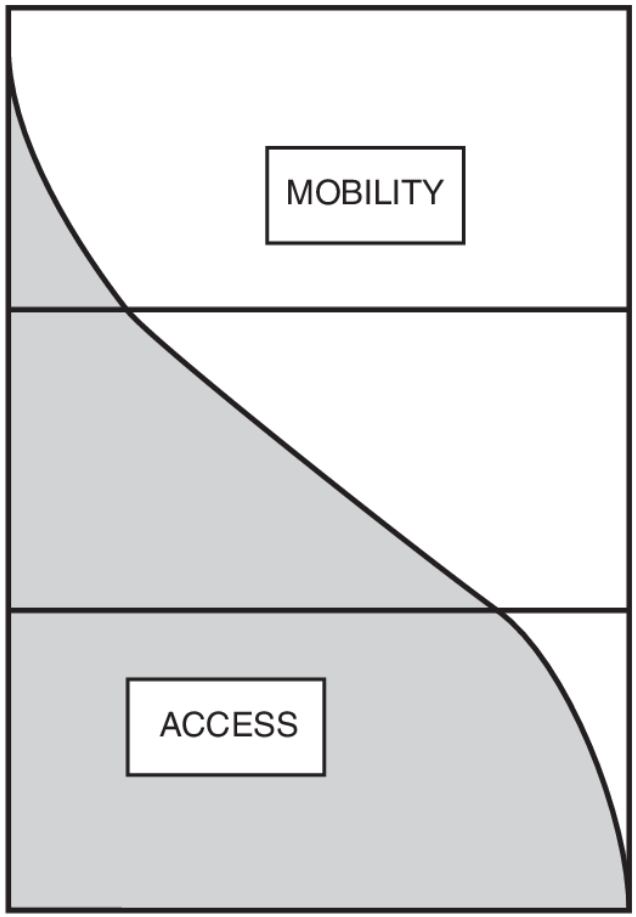
Expanded FCS Interaction Matrix for People Walking, Biking, & Driving

From *An Expanded Functional Classification System for Highways and Streets (2018)*.

Context/ Roadway	Rural	Rural Town	Suburban	Urban	Urban Core
Principal Arterial	H speed H mobility- L access	L/M speed M mobility- H access	M/H speed M mobility- M access	L/M speed M mobility- M access	L speed M mobility- M access
	LC: L separation; NC: M separation; CC: H separation	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: M separation; CC: H separation	LC: L separation; NC: M/H separation; CC: H separation	LC: L separation; NC: M separation; CC: M separation
	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced
Minor Arterial	H speed H mobility- L access	L/M speed M mobility- H access	M speed M mobility- M access	L/M speed M mobility- M/H access	L speed M mobility- M/H access
	LC: L separation; NC: M separation; CC: H separation	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: M separation; CC: H separation	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: M separation; CC: M separation
	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced
Collector	M speed M mobility- M access	L speed M mobility- H access	M speed M mobility- H access	L speed M mobility- H access	L speed M mobility- H access
	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: L separation; CC: M separation	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: M separation; CC: M separation	LC: L separation; NC: L separation; CC: M separation
	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced
Local	M speed M mobility- M access	L speed M mobility- H access	L speed L mobility- H access	L speed L mobility- H access	L speed L mobility- H access
	LC: L separation; NC: L separation; CC: L separation	LC: L separation; NC: L separation; CC: L separation	LC: L separation; NC: L separation; CC: L separation	LC: L separation; NC: L separation; CC: L separation	LC: L separation; NC: L separation; CC: L separation
	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P1: *; P2: Min; P3: Wide; P4: Wide	P2: Min; P3: Wide; P4: Enhanced	P3: Wide; P4: Enhanced
L = low (<30mph), M = medium (30-45mph), H = high (>45mph)					
Bicycle facility class: CC = citywide connector, NC = neighborhood connector, LC = local connector, Separation level: H = high, M = medium, L = low					
Pedestrian traffic levels: P1 = rare/occasional, P2 = low, P3 = medium, P4 = high Pedestrian facility width: * = site specific, Min = minimum, Wide = greater than minimum, Enhanced = wide for large congregating pedestrian groups Pedestrian facility separation should be considered in conjunction with driver target speeds.					

Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

Roadway Functional Classification System (FCS) hierarchy balances mobility – how fast people and goods can move from place to place – and access – what's in a place.



Freeways

STRATEGIC ARTERIALS

Other Arterials

Collectors

Locals

(Source: ITE Committee 6Y-19, Planning Urban Arterial and Freeway Systems, Institute of Transportation Engineers, Washington, D.C., 1988.)

Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

An alternative to the FCS hierarchy is;

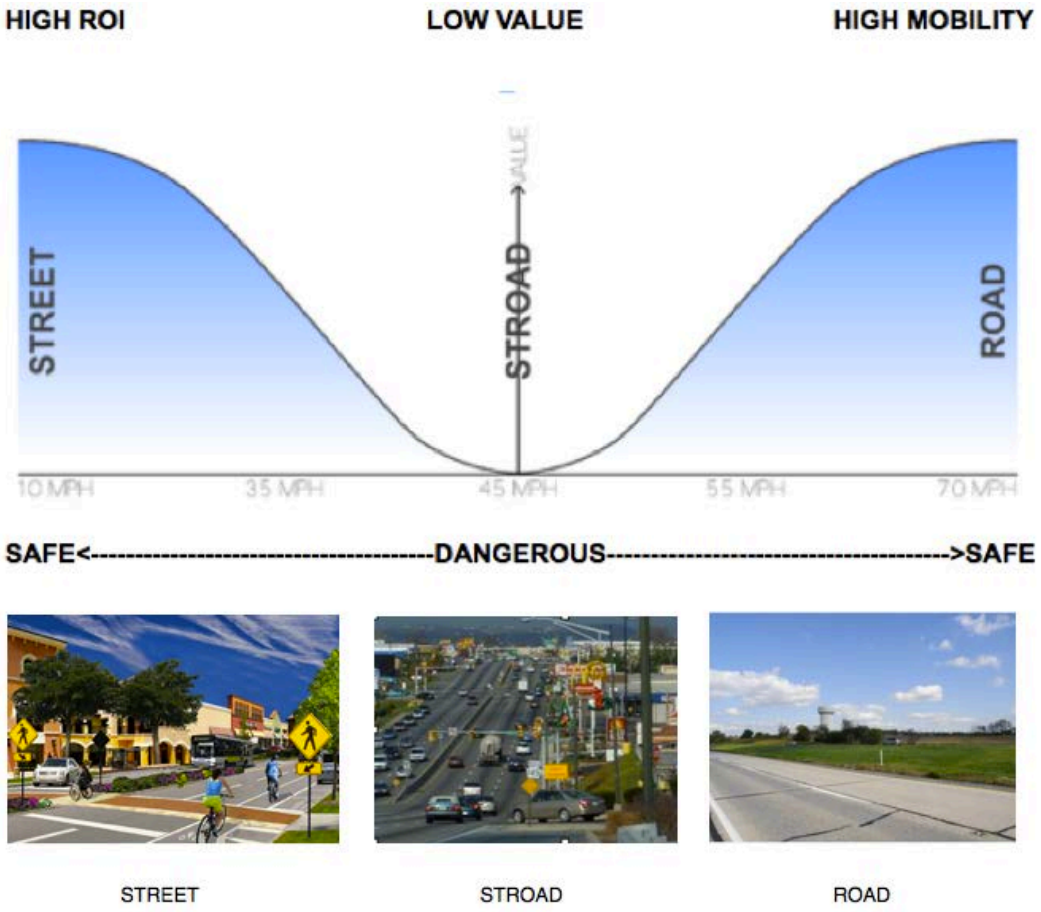
- **Street** – a place to access surrounding homes and businesses that generate tax revenue.
- **Road** – a high-speed connection between two places.
- **Stroad** – a street road hybrid.
- **Boulevard** - a multiway roadway that serves moderate high-speed connections between places in the middle of the roadway while having axillary side streets that provides access to adjacent houses and businesses.
- **Roadway** – refers to roads, stroads, boulevards, and streets regardless of context.

Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

State law is in conflict with these definitions. In particular, SC state law defines streets and highways (roads) as one and the same.

Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

Streets and roads are safe while stroads are dangerous and expensive.



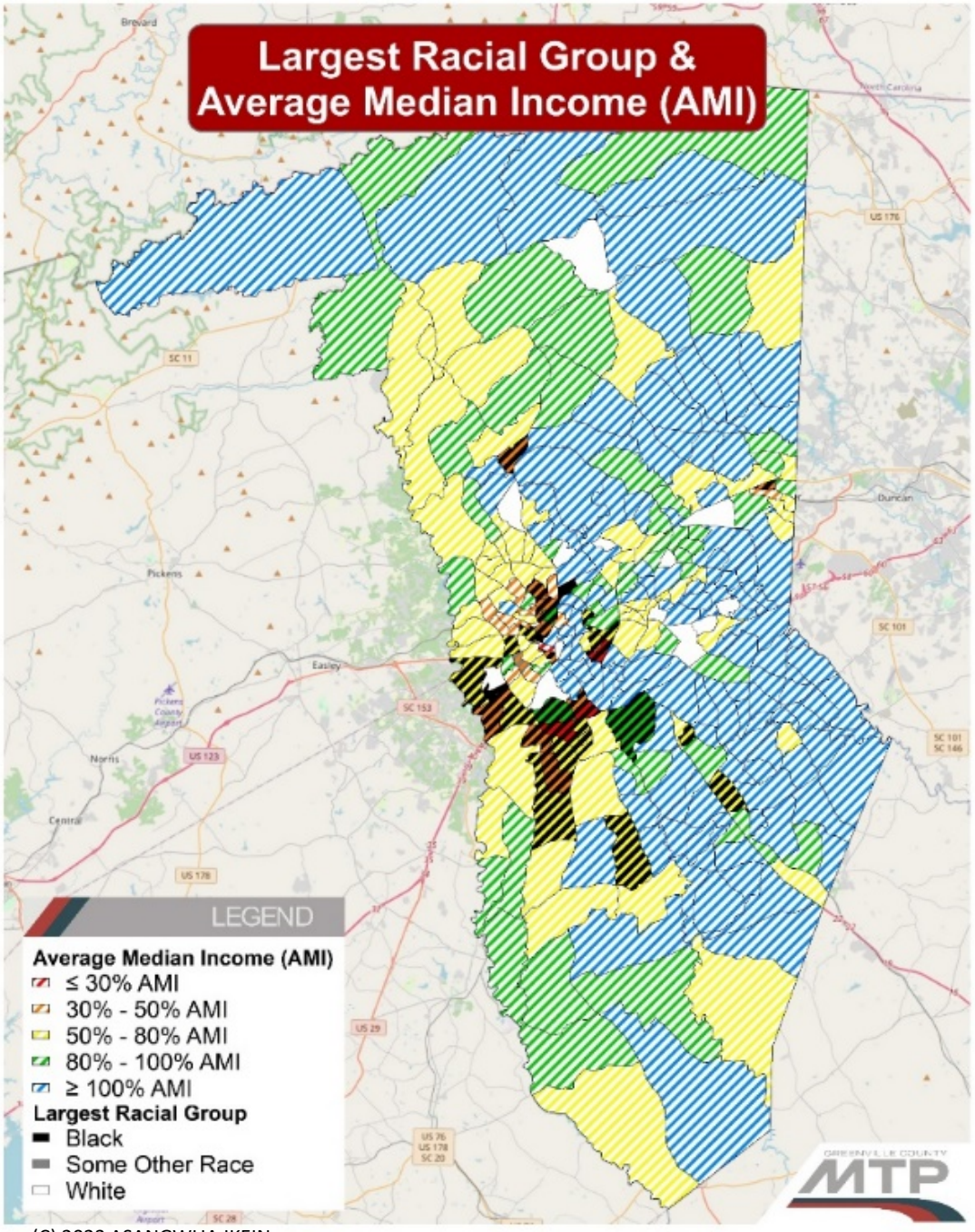
Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

Arterials and collectors qualify as stroads making up 14.55% of the total roadways within Greenville County while accounting for 71.01% of the traffic incidents.

	Greenville County 2016 - 2020 Crash Data											
	Total Incidents			Killed or Seriously Injuried (KSI)			Deaths			Amount of Roadway		
	Counts		Percentages	Counts		Percentages	Counts		Percentages	Miles		Percentage
Urban -- Minor Collector	63	63,926	0.07%	1	960	0.07%	-	241	0.00%	2.82	645.68	0.06%
Urban -- Major Collector	13,031		14.48%	222		15.47%	46		12.71%	353.48		7.97%
Urban -- Minor Arterial	27,865		30.95%	388		27.04%	94		25.97%	192.12		4.33%
Urban -- Principal Arterial	22,967		25.51%	349		24.32%	101		27.90%	97.25		2.19%
		71.01%			66.90%			66.57%			14.55%	

Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

This map breaks down Greenville County by Income and Race using 2020 ACS.



Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

Areas with higher proportion of Non-White and low-income people, tend to have higher rates of traffic incidents.

Average Median Income (AMI) $62,422	All Incidents		Injuries(Incapacitating & Non-Incapacitating) & Fatalities			Amount of Area			
	Counts	Percentage	Counts	Percentage Total Incidents	Percentage of Injuries & Fatalities	SqMi	All Incidents /SqMi	Injuries & Fatalities /SqMi	Percentage
≤ 30% AMI	1,896	2.11%	151	0.17%	2.56%	2.32	817.24	65.09	0.29%
30% - 50% AMI	6,330	7.04%	477	0.53%	8.08%	12.54	504.78	38.04	1.58%
50% - 80% AMI	25,092	27.91%	1,742	1.94%	29.50%	186.65	134.43	9.33	23.46%
80% - 100% AMI	14,110	15.69%	999	1.11%	16.92%	194.14	72.68	5.15	24.40%
≥ 100% AMI	37,239	41.42%	2,236	2.49%	37.86%	382.80	97.28	5.84	48.12%
No Data	5,244	5.83%	301	0.33%	5.10%	17.05	307.57	17.65	2.14%
	89,911	100.00%	5,906	6.57%	100.00%	795.50			100.00%

Race	All Incidents		Injuries(Incapacitating & Non-Incapacitating) & Fatalities			Amount of Area			
	Counts	Percentage	Counts	Percentage Total Incidents	Percentage of Injuries & Fatalities	SqMi	All Incidents /SqMi	Injuries & Fatalities /SqMi	Percentage
Black	11,944	13.29%	875	0.97%	14.82%	35.76	334.00	24.47	4.50%
Some Other Race	274	0.30%	20	0.02%	0.34%	0.34	805.88	58.82	0.04%
White	77,683	86.41%	5,011	5.57%	84.85%	759.40	102.30	6.60	95.46%
	89,901	100.00%	5,906	6.57%	100.00%	795.50			100.00%

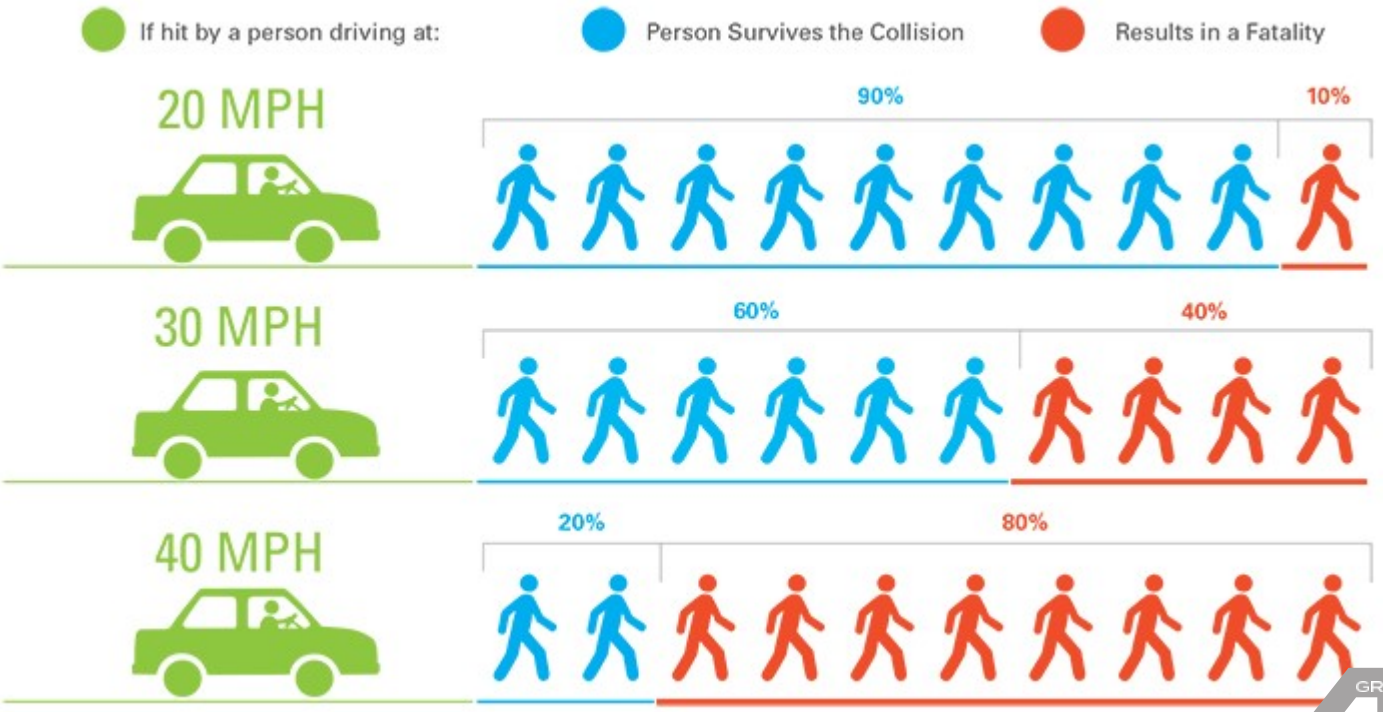
Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

Current roadway design practices emphasize Level of Service(LoS) to measure the speed and capacity of a roadway for people driving. **When LoS is applied to roads, it's appropriate because a road serves a high-speed mobility function to connect places**.

However, applying LoS to stroads and streets is inappropriate. People driving quickly on stroads are at constant odds with people driving to access adjacent properties, other people driving making turns across traffic, and people who might be walking or biking.

Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

An adult struck by the average midsize sedan has a 90% chance of surviving.



Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

The amount of energy transferred depends on the mass and speed of the vehicle. This energy transfer is best shown by the Kinetic Energy Equation, $KE = \frac{mv^2}{2}$, where m=mass and v=velocity. This means that doubling speed quadruples kinetic energy.

			Mass			Velocity		
			Pounds (lbs)	Comparative Roadway Damage (Ratio)	Kilograms (kg)	Miles per Hour (mph)	Meters per Second (m/s)	Kinetic Energy (J)
		Average Bicycle	18	8.85E-10	8.2	20	8.9	326
						30	13.4	734
						40	17.9	1,305
		Average Motorcycle	700	2.02E-03	317.5	20	8.9	12,688
						30	13.4	28,548
						40	17.9	50,751
		Midsize Sedan	3,300	1	1,496.6	20	8.9	59,814
						30	13.4	134,582
						40	17.9	239,256
Light Trucks	Class 1	Minivans, Cargo Vans, SUV, Pickup Truck	6,000	11	2,721.1	20	8.9	108,753
						30	13.4	244,694
						40	17.9	435,011
	Class 2	Minivans, Cargo Vans, Full-Size Pickup Truck, Step	10,000	84	4,535.1	20	8.9	181,255
						30	13.4	407,823
						40	17.9	725,019
	Class 3	Walk-In, Box Truck, City Delivery, Heavy-Duty Pickup	14,000	324	6,349.2	20	8.9	253,757
						30	13.4	570,953
						40	17.9	1,015,027
Medium Trucks	Class 4	Large Walk-In, Box Truck, City Delivery, Heavy-Duty Pickup	16,000	553	7,256.2	20	8.9	290,008
						30	13.4	652,517
						40	17.9	1,160,030
	Class 5	Bucket Truck, Large Walk-In, City Delivery	19,500	1,219	8,843.5	20	8.9	353,447
						30	13.4	795,255
						40	17.9	1,413,787
	Class 6	Beverage Truck, Single, Axle, School Bus, Rack Truck	26,000	3,853	11,791.4	20	8.9	471,262
						30	13.4	1,060,340
						40	17.9	1,585,050
Heavy-Duty Trucks	Class 7	Truck Tractor, Refuse, Furniture, City Bus Transit	33,000	10,000	14,966.0	20	8.9	1,450,038
						30	13.4	3,262,586
						40	17.9	5,800,152
	Class 8	Sleeper Cab, Truck Tractor, Dump Truck, Cement Truck	80,000	345,386	36,281.2	20	8.9	1,450,038
						30	13.4	3,262,586
						40	17.9	5,800,152

Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

Vehicle weight also has an exponential effect on roadway damaged produced. This is best shown by the Generalized Fourth Power Law $= \left(\frac{W_1}{W_2}\right)^4$.

For this equation, W_1 = the weight of other vehicles (lbs) compared to W_2 = the average midsize sedan (lbs).

			Mass			Velocity		
			Pounds (lbs)	Comparative Roadway Damage (Ratio)	Kilograms (kg)	Miles per Hour (mph)	Meters per Second (m/s)	Kinetic Energy (J)
		Average Bicycle	18	8.85E-10	8.2	20	8.9	326
						30	13.4	734
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	Class 3	Walk-In, Box Truck, City Delivery, Heavy-Duty Pickup	14,000	324	6,349.2	20	8.9	253,757
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						30	13.4	1,060,340
						40	[illegible]	[illegible]
Heavy-Duty Trucks	Class 7	Truck Tractor, Refuse, Furniture, City Bus Transit	33,000	10,000	14,966.0	[illegible]		
						[illegible]		
	Class 8	Sleeper Cab, Truck Tractor, Dump Truck, Cement Truck	80,000	345,386	36,281.2	20	8.9	1,450,038
						30	13.4	3,262,586
						40	17.9	5,800,152

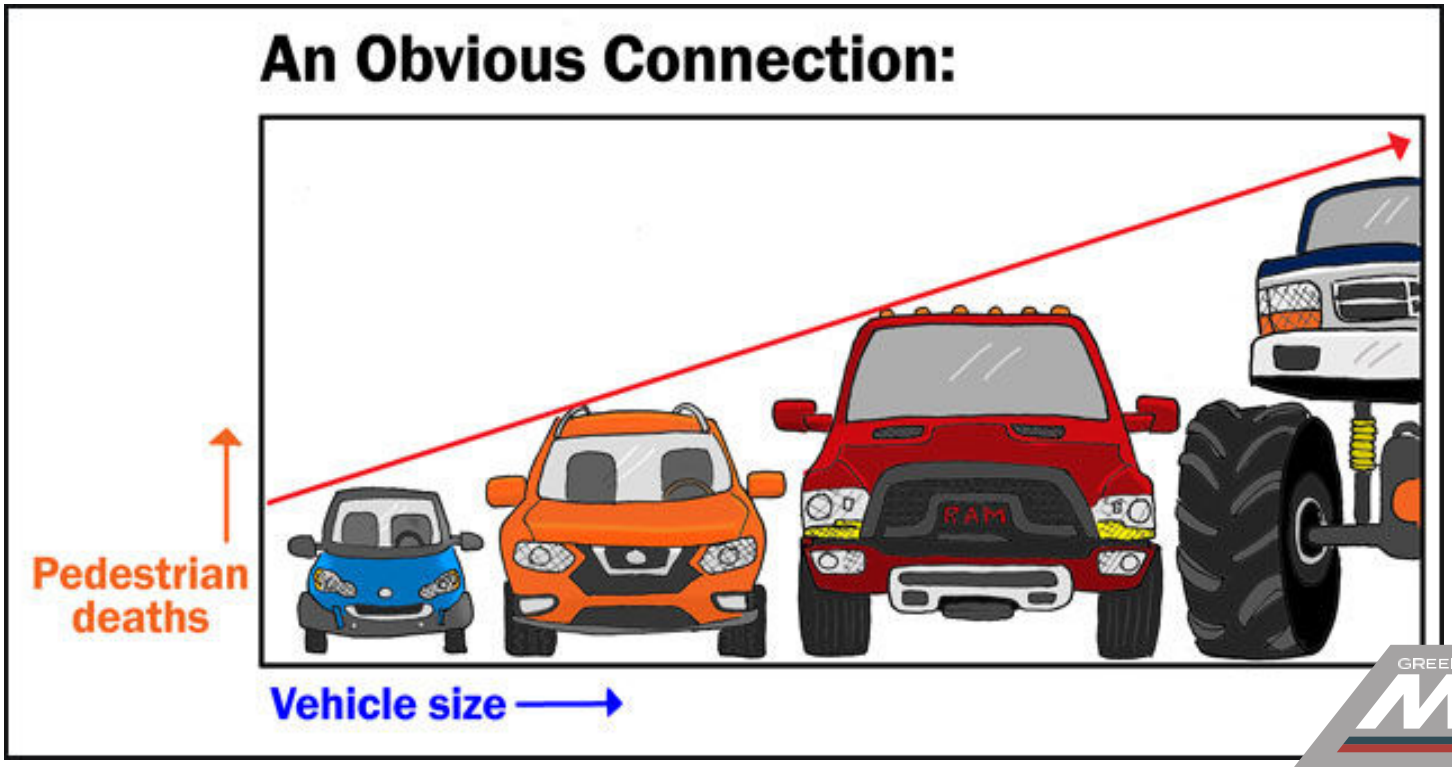
Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

This table presents maximum speed related to infrastructure based on best practices to prevent serious injury and death.

Type of infrastructure and traffic	kilometers per hour (kph)	miles per hour (mph)	Notes
Locations with possible conflicts between people walking and driving.	30	18.65	**Local Streets** Shared use streets.
Intersections with possible side impacts between people driving.	50	31.08	**Collectors** Roadway speed mustn't exceed 30mph on road that cross multiple intersections. People walking and biking MUST be separated from people driving. Driveways/Minor streets can only be right in/out.
Roads with possible frontal impacts between people driving.	70	43.51	**Arterials** **Two-directional roadways with speeds exceeding 45mph need median separation.** People walking and biking MUST be separated from people driving. Driveways/Minor streets can only be right in/out.
Roads with no possibility of a side impact or frontal impact (only impact with the infrastructure).	100+	62.15+	**Highways** Limited or Restricted Controlled Access - No intersections or curbcuts. Must access through ramps. Partial Controlled Access - Intersections and curbcuts allowed but left and right turn lanes needs to access intersections and curbcuts.

Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

Though larger vehicles – SUVs and trucks – are safer for people inside the vehicle, people outside of the vehicle are imperiled by their size and power.



Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

Safety guidelines are mandated at the federal level and, unfortunately, don't include metrics for the safety of people outside of vehicles. Nevertheless, jurisdictions have moved to curve deaths and serious injuries on their roadways by implementing roadway registration fees based on vehicle weight.

Goals of Network – Analysis – **Trees as Essential Infrastructure**

A study found that when trees, outdoor furniture, and other forms of roadway beautification are added to a streetscape, crashes reduced by 67%.

Goals of Network – Analysis – Safety – for the Most Vulnerable Roadway Users (Non-motorized)

Applying forgiven design principles, developed for roads, to streets and stroads, transfer risk from people driving, to people who are walking and biking. Along streets and stroads, what would be considered the clear zone would include on-street parking, bike lanes, sidewalks, and store fronts.

Forgiving Streets	Forgiving Roads
• Narrow lanes (9.5ft-10ft)	• Wide Lanes (11ft-12ft)
• Tight curves	• Smooth Curves
• Edge Friction (street trees and on-street parking)	• Clear Zones
• Maximum Travel Speeds (≤ 25mph)	• Design Speeds

Tactical Urbanism

What's Tactical Urbanism? Tactical Urbanism is an approach to neighborhood building and activation using short-term, low-cost, and scalable interventions and policies (Lydon & Garcia, 2015).

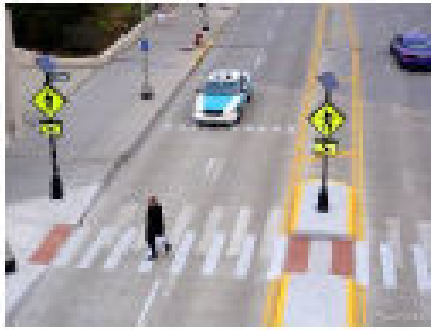
Intersection repair was done by painting a mural to slow down traffic and upgrade public space.

Source 1: urbanfinland

Slip lane was removed with paint and posts so people driving will have to slow down so people walking feel safe crossing a wide street.

Safety Toolkit for People Walking

Tactical Urbanism can be paired with the Safety Toolkit to find the best project ideas for improving safety for vulnerable roadway users.



Refuge islands and medians create a safe space for people crossing the roadway, especially on high-speed roadways with multiple travel lanes in one direction. Can be painted or concrete. *Crashes reduced by 56%* [1].

commons.wikimedia

High-visibility crosswalk styles have been shown to improve yielding behavior. *Crashes reduced by 48%* [1].

Source 2:

Safety Toolkit for People Biking

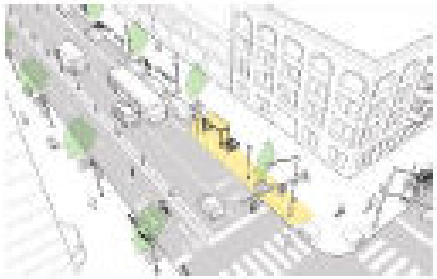
Tactical Urbanism can be paired with the Safety Toolkit to find the best project ideas for improving safety for vulnerable roadway users.

Bike boulevards streets with low numbers of people driving and driving slow, designated and designed to give people biking priority through use of signs, pavement markings, and speed and volume management. *Crashes reduced by 63%* [16].

Protected (Dutch) intersections maintains the separation of protected bike lanes through intersections to improve sight lines for people driving and biking, slows the turning speed of people driving, and to give people biking a head-start. *Crashes reduced by 63%* [17].

Safety Toolkit for People Riding Transit

Tactical Urbanism can be paired with the Safety Toolkit to find the best project ideas for improving safety for vulnerable roadway users.



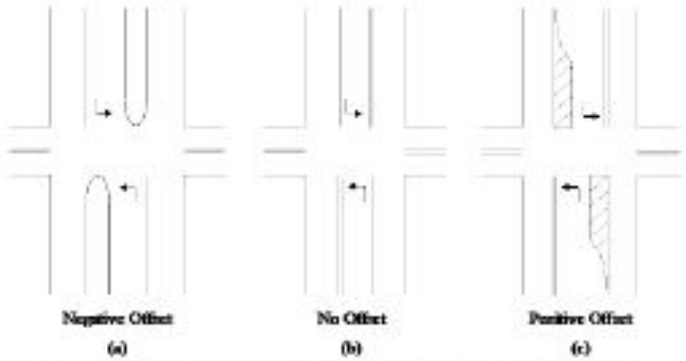
Bus bulbs allow bus operators to stop without having to merge back into traffic, decreasing risk of conflict with people driving and biking while making the bus route more efficient. *Improves bus efficiency while providing safe space for people walking* [26].

Dedicated median bus lanes eliminate conflicts with potential drop-offs, deliveries, or people illegal parking along the roadway edge *[28]*.

Source 37: NACTO

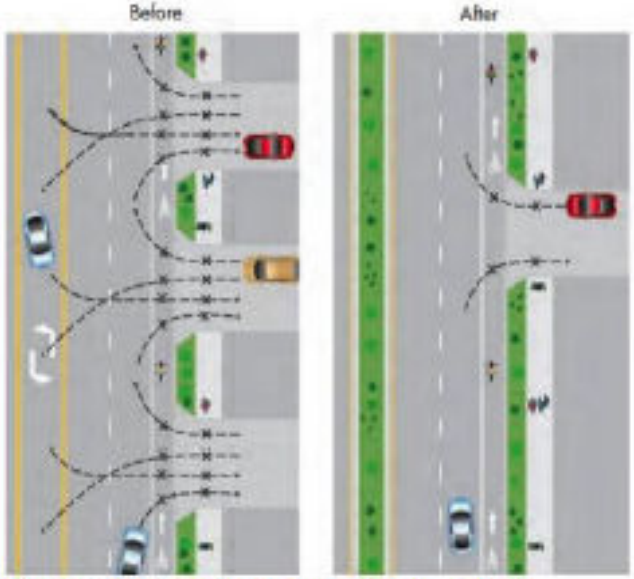
Safety Toolkit for People Driving

Tactical Urbanism can be paired with the Safety Toolkit to find the best project ideas for improving safety for vulnerable roadway users.



Offset left-turn treatments shift the left-turn lanes to the left, which reduces crossing and exposure time and improves sight distances and gap recognition [33].

Source 42: FHWA



Driveway consolidation and relocation minimizes curb cuts and reduces traffic conflicts [34].

Source 43: pedbikesafe

Recommendations

The Greenville County Comprehensive Plan highlighted the importance of considering both land use and transportation when making development decisions.

The MTP has taken strides towards implementing this and has generated strategies to better coordinate between transportation staff and jurisdictions in the county.

Recommendations - Contextual Matrix

Staff aggregated roadway based on context..

- This matrix references an approach used *An Expanded Functional Classification System for Highways and Streets (2018)*, breaking development into five primary areas: rural, rural town, suburban, urban, and urban core.

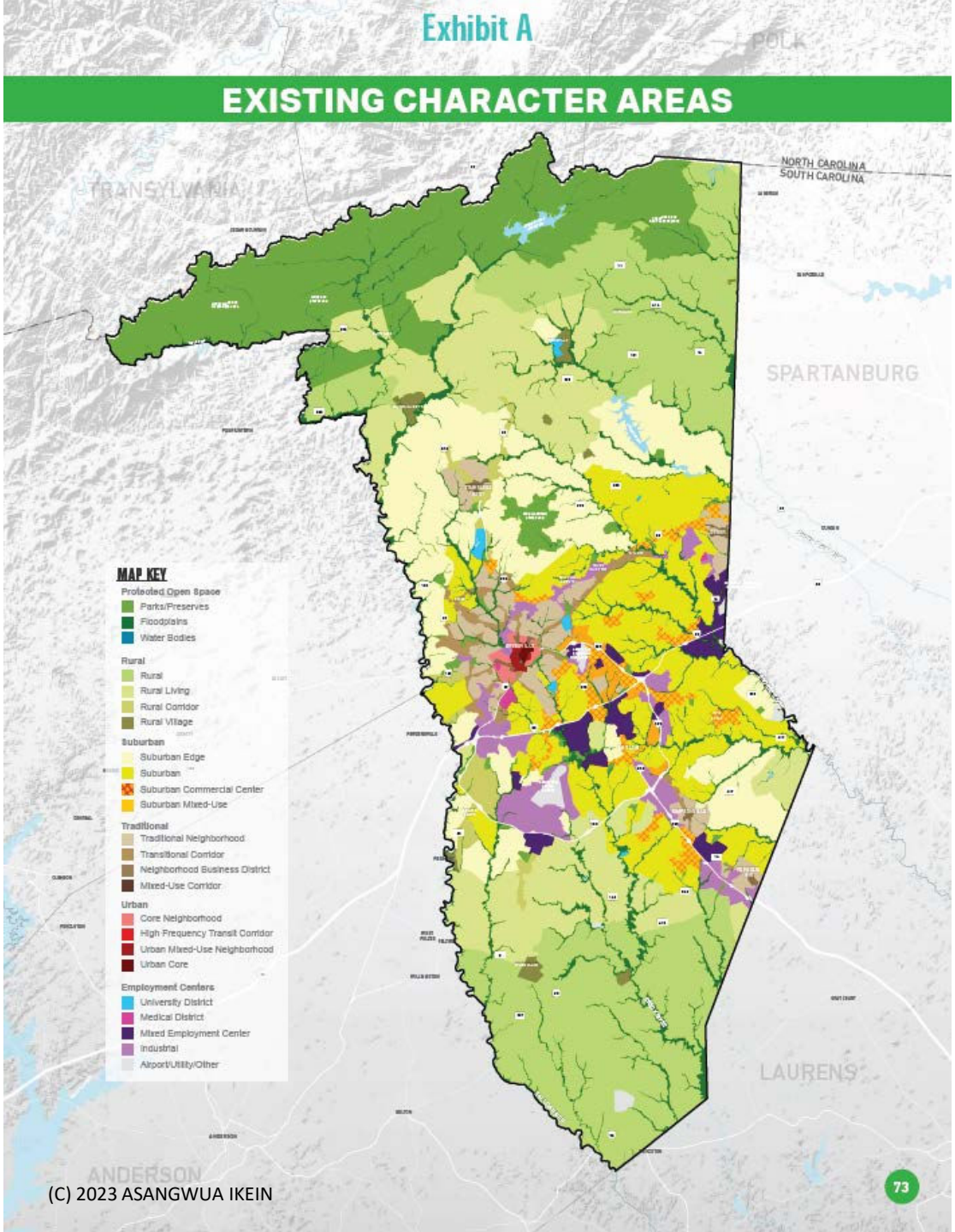
Recommendations - Contextual Matrix

Shows the potential different context area followed by the potential Context Area

	CharacterArea	Context01	Context02	Context03
11	Industrial	Suburban	Urban	Urban
12	Medical District	Suburban	Urban	Urban
13	Suburban Center	Suburban	Urban	Urban
14	Suburban Edge	Suburban	Suburban	Suburban
15	Suburban Mixed Use	Suburban	Urban	Urban
16	Suburban Neighborhood	Suburban	Urban	Suburban
17	University District	Suburban	Urban	Urban

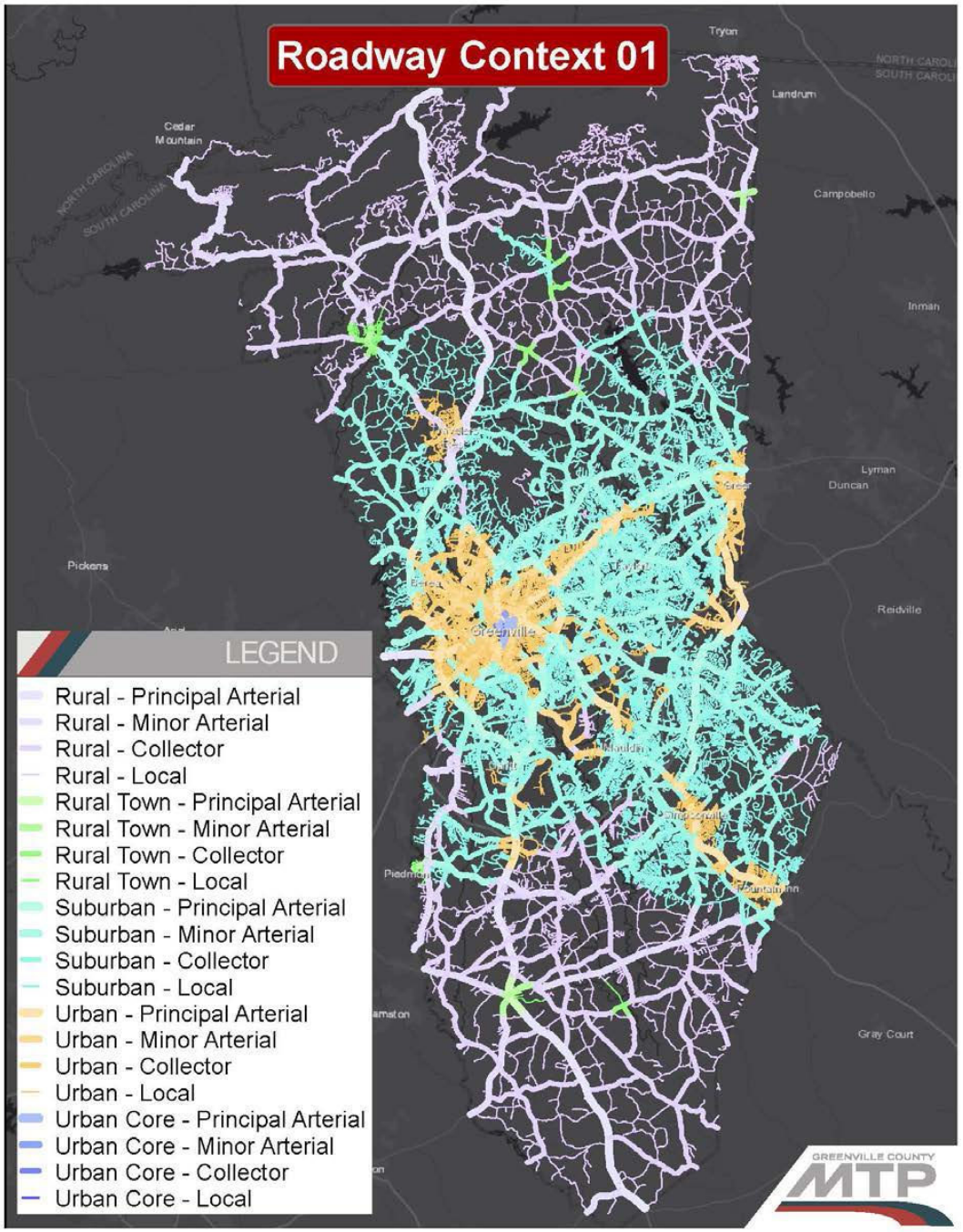
Recommendations - Contextual Matrix

Character areas from Greenville County Comp Plan.



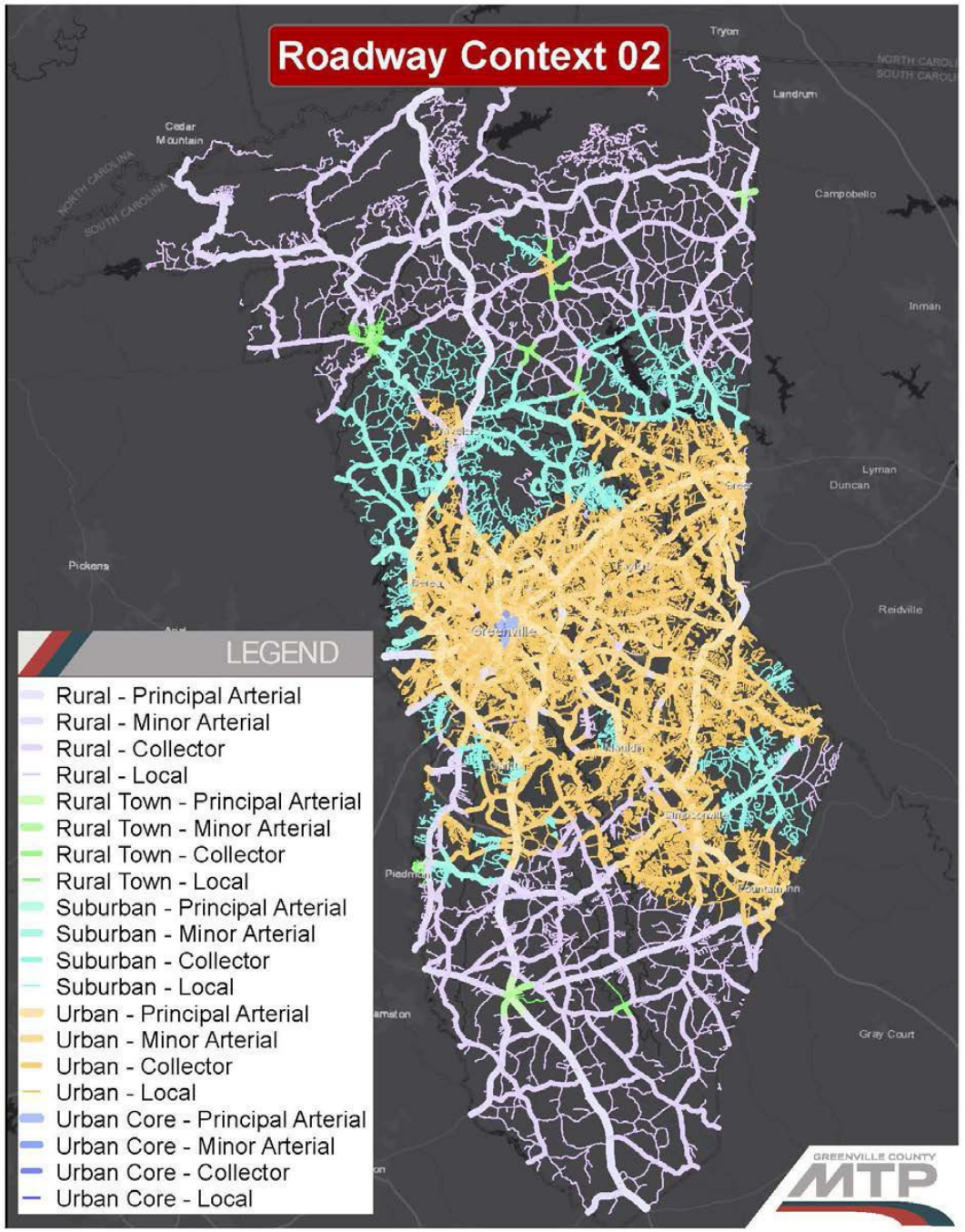
Recommendations - Contextual Matrix

Roadways broken down by Context 1 option.



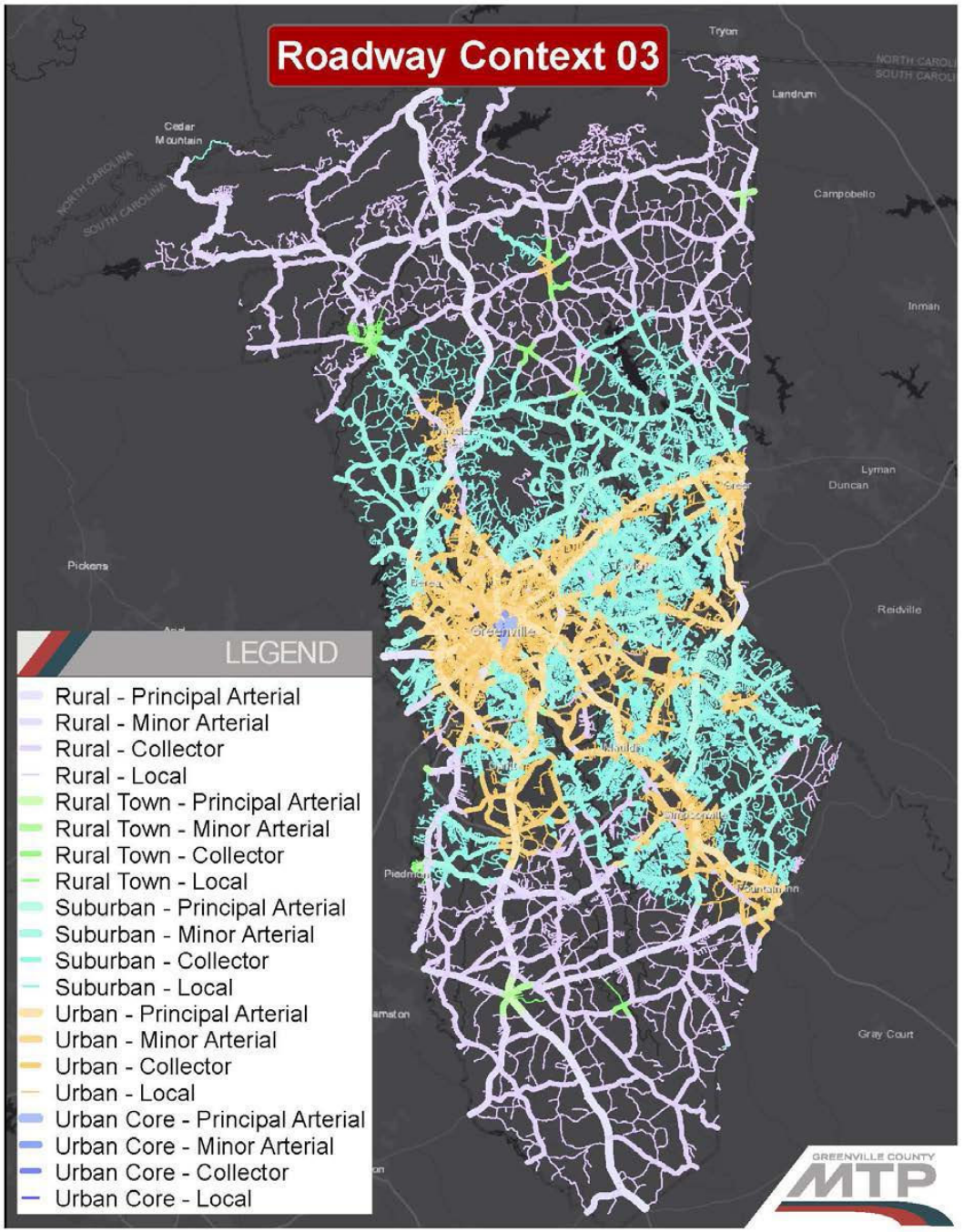
Recommendations - Contextual Matrix

Roadways broken down by Context 2 option.



Recommendations - Contextual Matrix

Roadways broken down by Context 3 option.



Recommendations - Consideration of Maintenance Costs

Moving forward, Greenville County staff should consider future maintenance costs, to the best of their abilities, before accepting additional roadway mileage.

Integration of Strategies into the UDO - Connectivity

Set maximum perimeters and maximum block lengths to city block (City of Cincinnati, OH, 2022).

- Require a street grid so people have alternative routes to avoid choke points.
- If block length exceeds a set amount, it should be interrupted by junctions – walkways and crosswalks (Fishers, IN, 2018).

Integration of Strategies into the UDO - Connectivity

Rank transportation project on their ability to deliver **accessibility through transportation options for reaching destinations**, not just speed for people driving (Littman, 2021).

Integration of Strategies into the UDO - Connectivity

Increase the degree of walkability by requiring street length ranges between 250ft – 500ft and requiring street midblock crossings every 300ft – 600ft when roadway lengths over 500ft (World Resource Institute (WRI) Ross Center for Sustainable Cities, 2015).

Dead-end Cul-de-sac should continue as bikeway and walkway easements when connections to other streets, cul-de-sacs, and off-street trails are within 300 feet, measured from the shortest distance between the two points. (Chapter 6 Streets, Sidewalks, and Trails).

Integration of Strategies into the UDO – Roadway Design & Classifications

- Implement design requirements for street design for arterial, collector, and local streets, that require separated sidewalks and bikeways between people driving, walking and biking depending on roadway context (National Cooperative Highway Research Program (NCHRP) , 2018).
  - Require trees in buffer to enhance sidewalks to protect people walking and encourage people driving to slow down (Klinkenberg, 2013).

Integration of Strategies into the UDO – Roadway Design & Classifications

Functional Classification System	Lane Width	Center Turn Lane Width	Shoulder	Bus Only Lane Width	Center Roadway Divider	Sidewalk Width	Bikeways Width	On-Street Parking	Planting Strip Width Minimum
Rural - Collector	10	10	Yes	11	Yes	10	8	Yes	7
Rural - Interstate	12	N/A	Yes	12	Yes	0	N/A	N/A	In Center Divider
Rural - Local	9.5	N/A	Yes	11	No	8	0	Yes	7
Rural - Minor Arterial	10	10	Yes	11	Yes	10	8	Yes	7
Rural - Principal Arterial	10	10	Yes	11	Yes	12	10	Yes	7
Rural Town - Collector	10	10	No	11	Yes	10	8	Yes	7
Rural Town - Interstate	12	N/A	Yes	12	Yes	0	N/A	N/A	In Center Divider
Rural Town - Local	9.5	N/A	No	11	No	8	N/A	Yes	7
Rural Town - Minor Arterial	10	10	No	11	Yes	10	8	Yes	7
Rural Town - Principal Arterial	10	10	No	11	Yes	12	10	Yes	7
Suburban - Collector	10	10	No	11	Yes	10	8	Yes	7
Suburban - Interstate	12	N/A	Yes	12	Yes	0	N/A	N/A	In Center Divider
Suburban - Local	9.5	N/A	No	11	No	8	N/A	Yes	7
Suburban - Minor Arterial	10	10	No	11	Yes	10	8	Yes	7
Suburban - Principal Arterial	10	10	No	11	Yes	12	10	Yes	7

Integration of Strategies into the UDO – Roadway Design & Classifications

Functional Classification System	Lane Width	Center Turn Lane Width	Shoulder	Bus Only Lane Width	Center Roadway Divider	Sidewalk Width	Bikeways Width	On-Street Parking	Planting Strip Width Minimum
Suburban - Principal Arterial	10	10	No	11	Yes	12	10	Yes	7
Urban - Collector	10	10	No	11	No	10	8	Yes	7
Urban - Interstate	12	N/A	Yes	12	Yes	0	N/A	N/A	In Center Divider
Urban - Local	9.5	N/A	No	11	No	8	N/A	Yes	7
Urban - Minor Arterial	10	10	No	11	Yes	10	8	Yes	7
Urban - Principal Arterial	10	10	No	11	Yes	12	10	Yes	7
Urban Core - Collector	10	10	No	11	No	10	8	Yes	7
Urban Core - Interstate	12	N/A	Yes	12	Yes	0	N/A	N/A	In Center Divider
Urban Core - Local	9.5	N/A	No	11	No	8	N/A	Yes	7
Urban Core - Minor Arterial	10	10	No	11	Yes	10	8	Yes	7
Urban Core - Principal Arterial	10	10	No	11	Yes	12	10	Yes	7

Integration of Strategies into the UDO – Parking

Reduce and or eliminate parking requirements (ReasonTV, 2010).

Unbundle parking from rental pricing (Anderson, 2022).

Integration of Strategies into the UDO – Parking

Require new subdivisions to have alleys for parking access behind buildings to reduce need for an individual curb cut per house (Greenville, SC, 2021).

- When alleys aren't possible, require parking to be located on the side and/or rear of buildings.

Integration of Strategies into the UDO – Sidewalk Standards

- Require property owners, to build, fix, and repair broken and disconnected sidewalks in front of their property.
- Require eight (8) foot wide sidewalks on both sides of the street to make it easier for deaf people to converse and people in wheelchairs to pass each other (Maiwald & Dooling, 2022).

Integration of Strategies into the UDO – Sidewalk Standards

Create policies that allow for the installation of crosswalks along streets without using USDoT's Manual on Uniform Traffic Control Devices (MUTCD) by assuming that certain places generate biking and walking trips (Packer, 2022) (Nemani & Rasmussen, 2022).

Integration of Strategies into the UDO – Bikeway Standards

Design standards for bike facilities for all street types and developments to provide adequate safe for biking.

Integration of Strategies into the UDO – Bikeway Standards

Eliminate any and all laws that can be used to criminalize people on bikes (National Association of City Transportation Officials (NACTO), 2022).

- Those that regulate **equipment**, such as helmet laws, light or bell laws, bike registration requirements, or laws related to a bike's physical condition.
- Those that regulate **behaviors**, such as running red lights or stop signs, or failing to yield to pedestrians.
- Those that regulate **location** on the street, such as biking on the sidewalk or biking the wrong way in a bike lane or other travel lane.

Integration of Strategies into the UDO – Street Tree Plantings

Require property owners to keep trees and shrubs trimmed to prevent overhang that would interfere with free passage for people walking (San Antonio, TX, 2021).

Integration of Strategies into the UDO – Land Use

Set property lot width maximums.

- Lots with wide widths decrease the amount of properties served by utilities while increasing the unit cost of utilities to serve those properties.

Allow properties zoned for single-family to develop duplexes, triplexes, fourplexes, and ADUs (Opticos Design, Inc., 2019).

Integration of Strategies into the UDO – Land Use

Jurisdictions - South Carolina	Current Population as of 2019 ACS	Total Single-Family Homes	Single-Family Unit (1-4 People)		Home + ADU or Duplex (2-8 People)		Rowhouse or Triplex (3-12 People)		Quadplex or Fourplex (4-16 People)		Sixplex (6-24 People)		5-Story Apartment or Condo (12-48 People)	
			Low # of People	High # of People	Low # of People	High # of People	Low # of People	High # of People	Low # of People	High # of People	Low # of People	High # of People	Low # of People	High # of People
Greenville - County	507,003	164,885	164,885	659,540	329,770	1,319,080	494,655	1,978,620	659,540	2,638,160	989,310	3,957,240	1,978,620	7,914,480
Greenville - City	70,635	16,230	16,230	64,920	32,460	129,840	48,690	194,760	64,920	259,680	97,380	389,520	194,760	779,040
Greer	33,373	8,087	8,087	32,348	16,174	64,696	24,261	97,044	32,348	129,392	48,522	194,088	97,044	388,176
Mauldin	25,409	7,041	7,041	28,164	14,082	56,328	21,123	84,492	28,164	112,656	42,246	168,984	84,492	337,968
Simpsonville	24,221	7,574	7,574	30,296	15,148	60,592	22,722	90,888	30,296	121,184	45,444	181,776	90,888	363,552
Fountain Inn	10,441	2,770	2,770	11,080	5,540	22,160	8,310	33,240	11,080	44,320	16,620	66,480	33,240	132,960
Travelers Rest	5,346	1,772	1,772	7,088	3,544	14,176	5,316	21,264	7,088	28,352	10,632	42,528	21,264	85,056
Municipalities	169,425	43,474	43,474	173,896	86,948	347,792	130,422	521,688	173,896	695,584	260,844	1,043,376	521,688	2,086,752

Integration of Strategies into the UDO – Land Use

Creating zoning policies that incentivize infill development including along priority corridors to facilitate Transit-Oriented Development (TOD).

Transit-Oriented Development that promotes mixed-use walkable environments that alleviates the need for a private vehicle while bringing destinations closer to people allowing people to walk, bike and ride transit to reach their destinations.

Funding Sources and Strategies

Reallocation of Current Funding

Sales Tax

- The County of Greenville remains one of few Counties in South Carolina without a dedicated sales tax in addition to the one established by the State.
  - York County: I cent Capital Projects Sales Tax called Pennies For Progress. Estimated to produce $278 million for roadway capacity and safety improvements
  - Richland County: 2% Local Option Sales Tax
  - Charleston County: Half-cent sales tax. Generates $9 million for transportation projects per year
  - Spartanburg County: 1 cent sales tax. Generates approximately $7,554,418 for roadways and bridges, along with funding for a judicial facility, the replacement of City Hall, and the replacement of the County Administrative Building
  - Laurens County: 1% sales tax.
  - Pickens County: 1% local option sales tax
  - Anderson County: 1% sales tax

Funding Sources and Strategies

Property Taxes– As a Dedicated Source

State and Federal Grants

- Grant programs available for infrastructure projects include, but are not limited to, the Transportation Alternatives (TA) Program, the Recreational Trails Program (RTP), the Appalachian Regional Commission (ARC), and the Greenville County Legislative Delegation Transportation Committee.

Questions?

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