FAST

Freeway And Street-based Transit network

vhb

FAST Network Study

and Implementation Playbook

RTA REGIONAL BUSINESS LEADERSHIP

GO Triangle

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

February 2021

Funding partners

Consultant team

About the funding partners

The Regional Transportation Alliance (RTA) business coalition is the voice of the regional business community on transportation in North Carolina's Research Triangle region.

> ***"The regional business community and our study partners are committed to the transformation of our highway network into true multimodal freeways and streets that provide significant and sustainable advantages for public transit, along with enhanced accessibility and mobility for all modes of travel." - Joe Milazzo II, PE, executive director, Regional Transportation Alliance***

GoTriangle is the Triangle's regional transit provider, improving our area's quality of life by connecting people and places through safe, reliable and easy-to-use travel choices.

> ***"GoTriangle is constantly looking for more efficient and innovative ways to serve the growing Triangle region. The FAST approach offers an additional array of tools that can be used by our agency and other transit providers in the region to continue to improve transit and transportation for our community." – Michael Parker, chair, GoTriangle Board of Trustees***

The NC Department of Transportation mission is connecting people, products and places safely and efficiently with customer focus, accountability and environmental sensitivity to enhance the economy and vitality of North Carolina.

> ***"The Department believes the FAST approach could serve as a template for many areas across the state to advance regional transit—we greatly appreciate RTA for initiating the study effort." – Julie White, Deputy Secretary for Multimodal Transportation, NC Department of Transportation***

What the Region is saying

"The FAST Study aligns with the City of Durham's goals, to identify the most cost-effective approaches to provide fast, frequent, and reliable transit that serves our community and connects across our region. The FAST study is a road map for delivering the transit priority improvements our community is calling for, in a matter of months rather than years. I want to start by thanking the FAST team for the creative, innovative approach they took to improving bus speed and reliability in the Triangle. We applaud the work of the FAST team and are excited to move their findings and recommendations forward to implementation for the Durham Freeway corridor as well as other corridors such as Fayetteville and Holloway recommended in the report." - Sean C. Egan, Director of Transportation, City of Durham Department of Transportation

"I congratulate the FAST team for their work on elevating the importance and opportunity of transit advantage infrastructure in the Triangle. As the City of Raleigh implements four Bus Rapid Transit corridors this decade, the additions of strategic "FAST" improvements like those described in this study would complement BRT and extend the network of enhanced transit in Raleigh and across the Triangle, and further the City's objectives of improving equity." - Michael Moore, Transportation Director for the City of Raleigh

"The regional business community recognizes the need for effective transportation as our market grows. The preliminary findings from the FAST study provide a game plan to strengthen the mobility connections essential for our region's ongoing success."
– Maeve Gardner, GlaxoSmithKline; chair, Regional Transportation Alliance

"We believe that the accelerated deployment of enhanced transit service using the FAST network approach will advance economic opportunity, equitable prosperity, fiscal responsibility, and environmental sustainability."- Jay Irby, First Citizens Bank; regional transit chair, Regional Transportation Alliance

"We look forward to using this study as a cooperative approach for building transit solutions that will better serve the community, strengthen our transportation network and maintain the region's reputation as a great place to live and work."
- Charles Lattuca, president and CEO, GoTriangle

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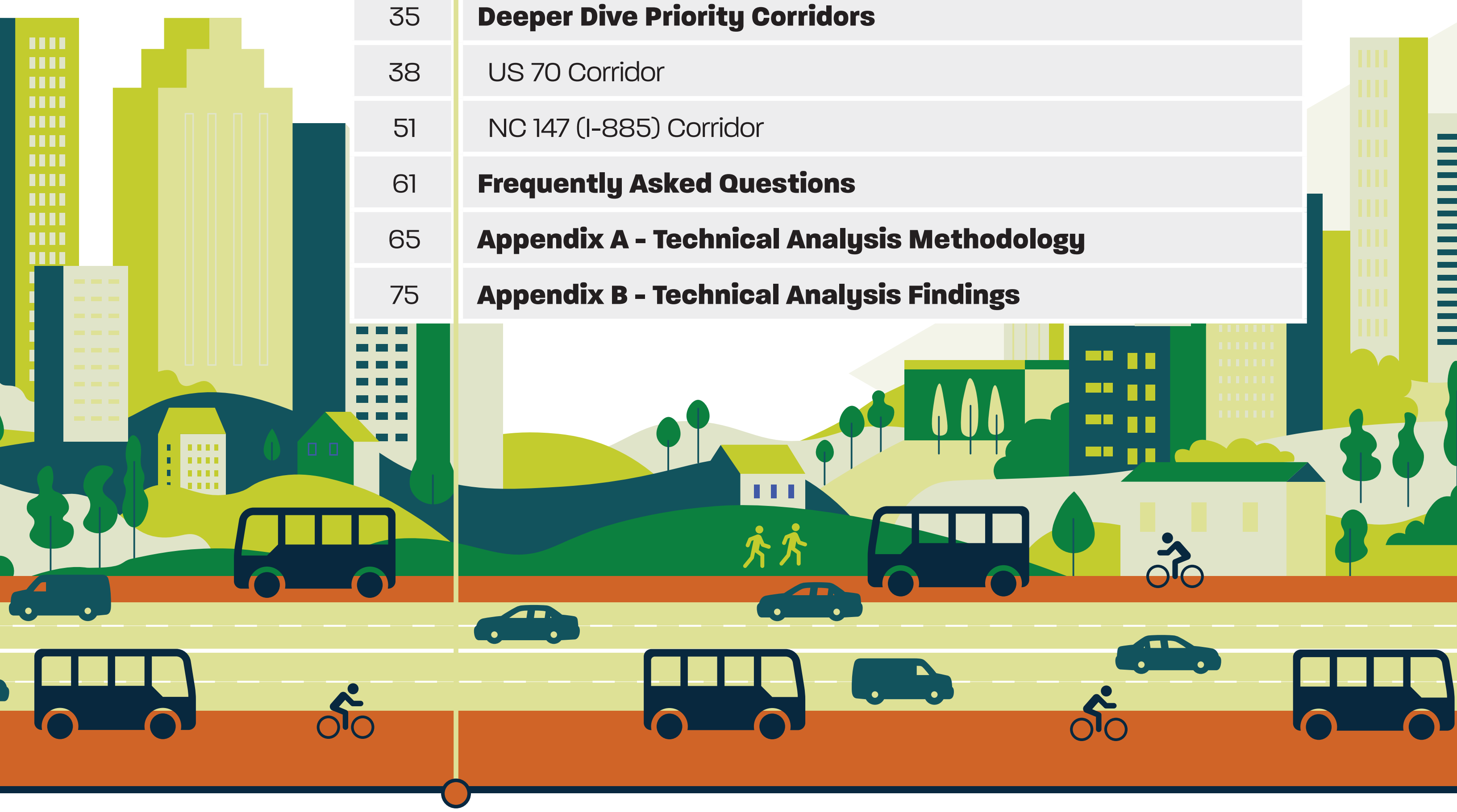

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Triangle FAST Network Study and Findings

Introduction

Visualizing a scalable, regional FAST network sets the framework for advancements in transit service across the region. To gain a better understanding of transit demand on a regional scale, a technical analysis screened potential corridors using mobility criteria inclusive of travel demand, transit performance, traffic, and context, as well as accessibility criteria comprising of equity, planned projects, and missing links. This screening in conjunction with spatial analysis of travel demand to activity centers and existing regional transit service were used to develop illustrative FAST corridors.

To ensure FAST corridors are truly fast, the team investigated best practices of transit advantage infrastructure from across the country. Treatments that were most promising in terms of potential and applicability to North Carolina were brought forth. These freeway and street transit advantage opportunities were then applied to each of the selected FAST corridors to highlight where each transit improvement may be most effective. The resulting FAST corridors and transit advantage infrastructure demonstrate a scalable approach to transform the region's roadways into "multimodal corridors" enhancing mobility and access.

FAST Network: Project and concept overview

The regional business community along with local and state transportation partners seek to **serve the entire Triangle by institutionalizing transit advantage measures** along the state highway network in our region.

Funded by RTA, GoTriangle and NCDOT, the Freeway And Street-based Transit (FAST) study developed an illustrative, scalable approach to transform our roadways into multimodal corridors that can provide rapid, frequent, and reliable transit service across the region.

The FAST study envisions a truly regional enhanced transit network, connecting our largest communities, activity centers, RDU Airport, and Research Triangle Park.

FAST Objectives: Aspirational and Actionable

- Define an illustrative regional FAST network for the Triangle
- Identify rapid projects and pilots for the next 18 months
- Create scalable network buildouts for High Priority, 0-5 Year, 5-10 Year, and 10+ Year horizons
- Develop a FAST guide with statewide applicability for prioritizing transit on roadways

The FAST study is the pre-planning work designed to inspire, inform, and advance ideas for improving regional connectivity, supported by technical analysis.

A FAST network will ***Capitalize*** *on the great work that has already been done by the various agencies in the Triangle,* ***Complement*** *the existing investments being made on transit studies, plans and implementation, and become a* ***Champion*** *to leverage the existing freeway and street system with targeted transit advantage infrastructure to improve accessibility and opportunity.*

Figure 1 shows the objective and purpose of the fast study which was to identify example investment opportunities to connect the BRT and Commuter Rail Line to develop a FAST mindset. Figure 2 shows the regional roadway, transit and rail network which was used to build the FAST network.

Figure 1. FAST Study Objective and Purpose

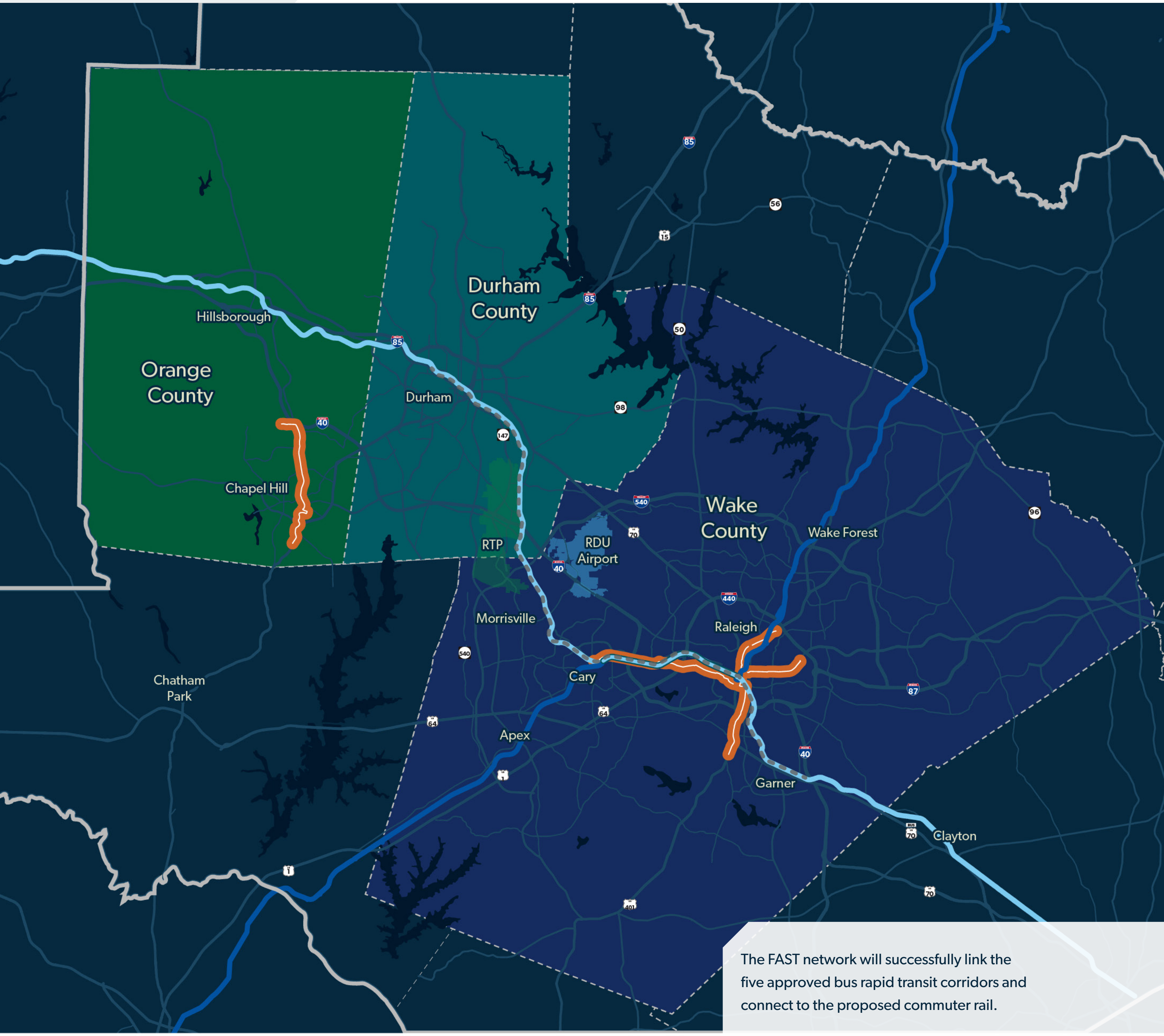


Figure 2. Study Area with Planned Rapid Transit

FAST Network: Analysis Method and Preliminary Findings

A robust technical analysis was conducted that considered a host of evaluation measures for determining relative transit demand potential among various possible corridors:

TIER 1 Mobility

- Travel demand
- Transit performance
- Traffic performance
- Context

▶ Candidates for Improvement

TIER 2 Accessibility

- Access equity
- Planned projects
- Missing links

▶ Candidates for Improvement (preliminary priorities)

Design Standards ▸▸ Measures & Targets

These factors incorporate existing and proposed or projected roadway, transit, land use, population, employment, and travel pattern elements. Refer to Appendix A for details of methodology used for technical analysis. Appendix B shows the results of the technical analysis including weights and composite scores of corridors analyzed.

Future potential transit demand to activity zones shown in Figure 3 was examined using spatial analysis to determine promising areas for enhanced regional connectivity. Figure 4 highlights the broad corridors that emerged from this portion of the analysis.

The demand to these activity zones yielded several corridors with potential transit demand. The corridors studies included:

- US 15-501 Corridor
- NC 751
- NC 147
- NC 147 and I-40
- NC 55
- NC 540 (Western Boulevard)
- NC 540 (Northern Section)
- US 64 to Pittsboro
- Harrison Boulevard
- US 1 from east Raleigh to Regency Park
- Beltline (I-440) corridor
- Capital Boulevard
- US 70
- Six Forks Road
- US 401 S to Fuquay Varina
- Holly Springs Road
- NC 50/Creedmoor Road

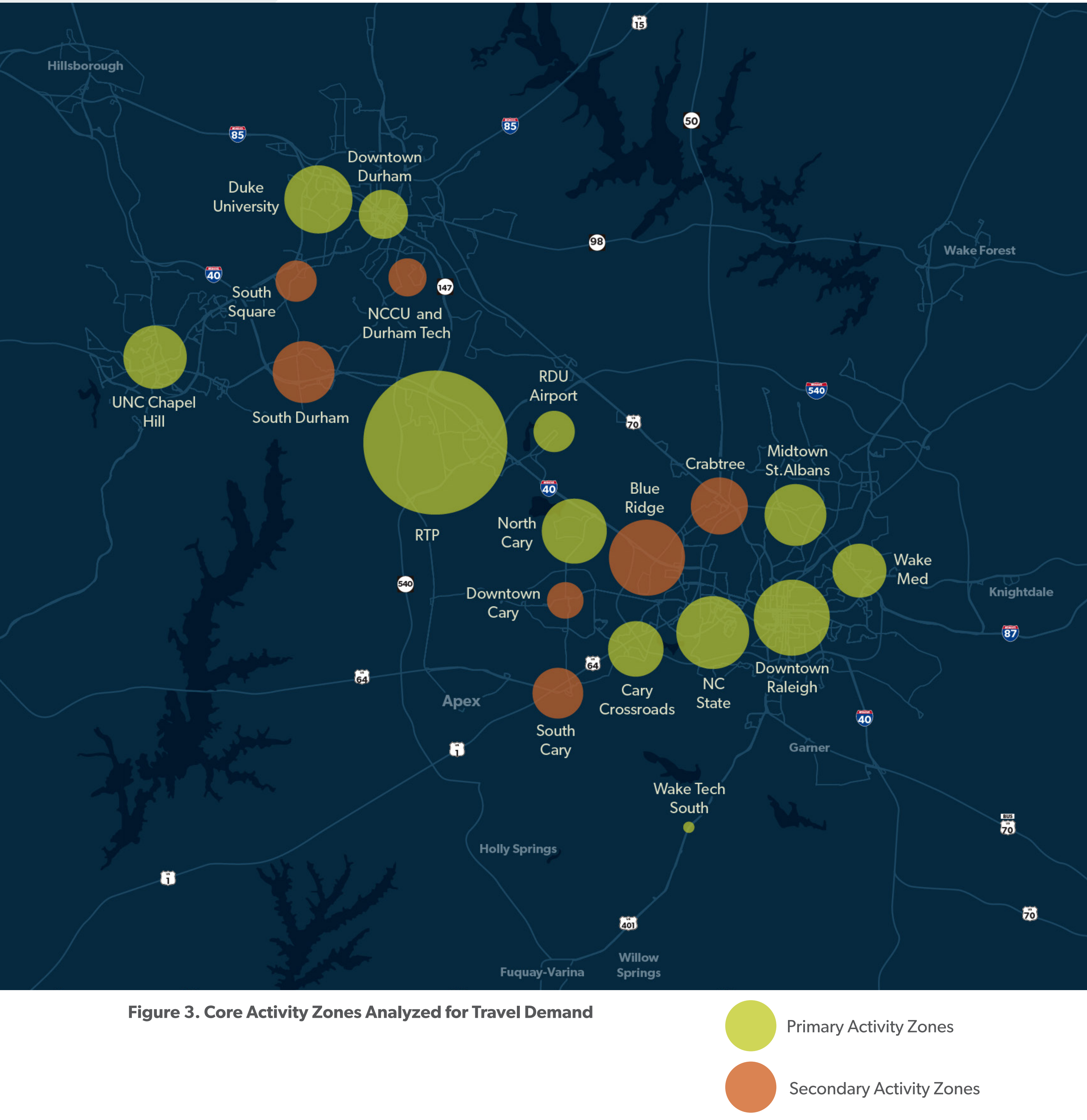


Figure 3. Core Activity Zones Analyzed for Travel Demand

The corridor analysis was based on the travel demand to the activity zones in the AM Peak period for the years 2018 and 2025. The table below shows the proportional demand to each activity zone when compared to 2025 demand to RTP. 2025 traffic demand to RTP zone is the highest of all zones.

Table 1. AM Peak Travel Demand to Activity Zones

Name	2018 Demand	Proportion of 2025 RTP demand	2025 Demand	Proportion of RTP demand
Wake Med	2,085	12%	3,526	20%
Downtown Raleigh	4,139	24%	6,572	37%
NC State	3,746	21%	5,657	32%
Cary Crossroads	2,177	12%	2,485	14%
Midtown St. Albans	2,675	15%	3,437	20%
RDU Airport	1,164	7%	1,278	7%
North Cary	2,908	17%	3,621	21%
RTP	14,533	83%	17,612	100%
Wake Tech South	80	0%	138	1%
UNC Chapel Hill	2,761	16%	2,972	17%
Downtown Durham	1,715	10%	3,031	17%
Duke University	3,273	19%	4,218	24%
Crabtree	2,295	13%	2,540	14%
Blue Ridge	4,046	23%	5,010	28%
South Cary	1,819	10%	2,112	12%
Downtown Cary	895	5%	1,300	7%
South Durham	2,735	16%	2,915	17%
South Square	1,235	7%	1,502	9%
NCCU and Durham Tech	1,034	6%	1,236	7%

After identifying these corridors of promise, and examining the existing GoTriangle regional core transit network as well as the region's proposed five bus rapid transit (BRT) corridors, the consultant team then identified a series of example higher frequency enhanced transit corridors along the region's freeway and street network (i.e., proposed **FAST** corridors).

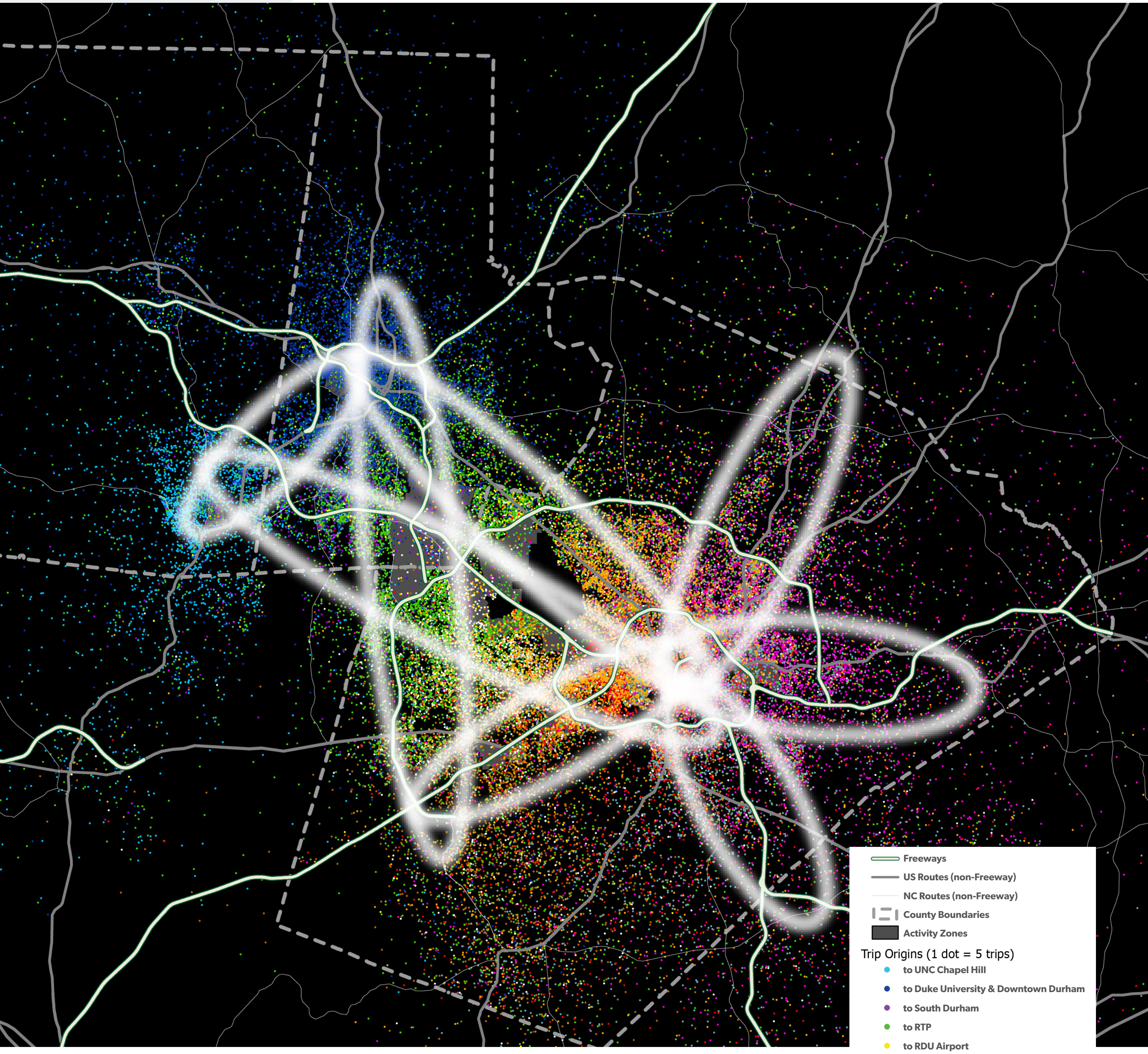


Figure 4. Potential FAST Corridors based on Demand

FAST Features: Sample Transit Advantages

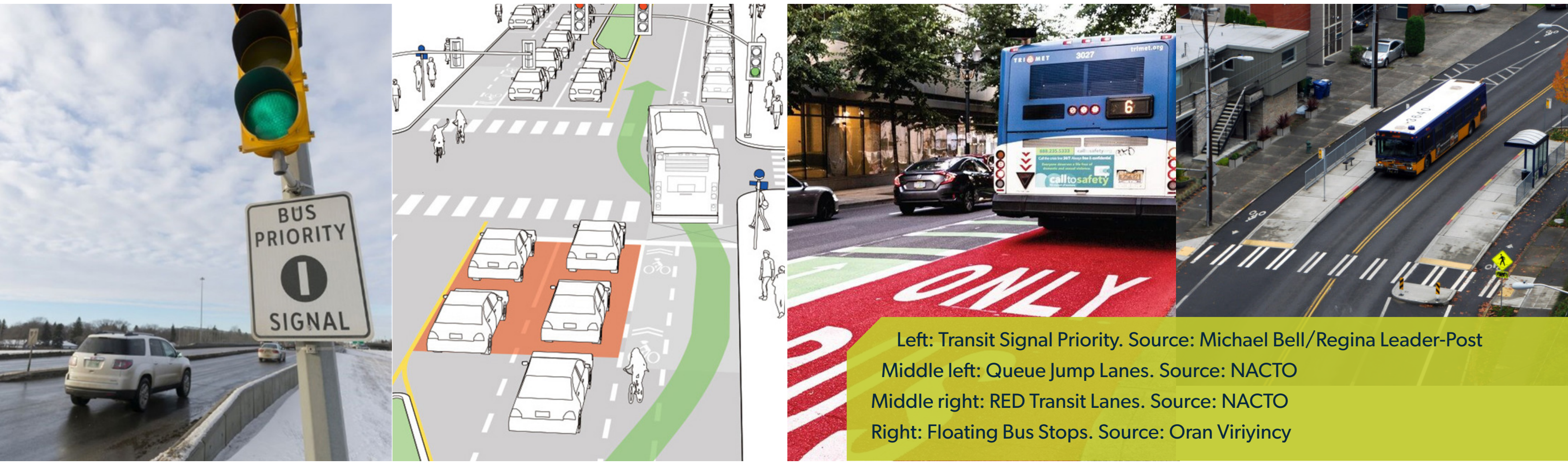
- Freeway priority lanes for transit
- Bus On Shoulder System (BOSS) expansion
- Dedicated 'RED' transit lanes on streets
- Direct linkages, ramps, and bypass lanes for transit
- High quality stations that provide regional accessibility

The FAST study aims to institutionalize "transit advantage" accommodations as part of roadway projects to improve mobility for all travelers.

Identified FAST corridors were then examined at a pre-planning level for possible transit advantage opportunities (as shown in Figure 5 and Figure 6) for the High Priority, 0-5 Year, 5-10 Year, and 10+ Year horizons, including (partial list):

Left: Direct Access Ramps. Source: SounderBruce
Middle: Direct Access Station. Source: SounderBruce
Right: Bus On Shoulder System (BOSS) expansion. Source: u/dm919

Figure 5. Freeway Transit Advantage Opportunities



Left: Transit Signal Priority. Source: Michael Bell/Regina Leader-Post
Middle left: Queue Jump Lanes. Source: NACTO
Middle right: RED Transit Lanes. Source: NACTO
Right: Floating Bus Stops. Source: Oran Viriyincy

Figure 6. Street Transit Advantage Opportunities

Proposed Triangle FAST Corridors

The 10 proposed, interconnected corridors outlined in the table below directly serve Raleigh, Durham, Cary, Chapel Hill, RDU Airport, and Research Triangle Park.

Table 2. Proposed High Priority and 0-5 Years FAST Freeway and Street Corridors, with Future BRT linkages underlined.

Corridor	From	To
1. I-40	future South Wilmington Street BRT	NC 54 / Raleigh Road in South Durham
2. I-885 / NC 147	I-40 in RTP	Duke University
3. US 15-501 freeway	Erwin Road area	US 15-501 arterial
4. US 15-501	future MLK / NC 86 BRT	15-501 freeway
5. Raleigh Rd / NC 54	future MLK / NC 86 BRT	I-40
6. Main / Erwin / Holloway	US 15-501 freeway near Erwin Rd	Holloway Street / future I-885
7. US 70	future Downtown Raleigh BRT	Brier Creek/I-540
8. Six Forks Road	future Capital Boulevard BRT	I-540
9. Capital Boulevard	future Capital Boulevard BRT	I-540
10. Poole Road	future New Bern Avenue BRT	New Hope Road

Figure 7 below shows the 10 proposed, interconnected immediate freeway and street corridors. Table 3 shows various transit advantages recommended for each of the 10 corridors. These corridors and potential enhancements could yield immediate transit benefits.

5 of the 10 FAST corridors connect with current or future intercity rail.
7 of the 10 proposed immediate FAST corridors commence at an approved future BRT corridor.

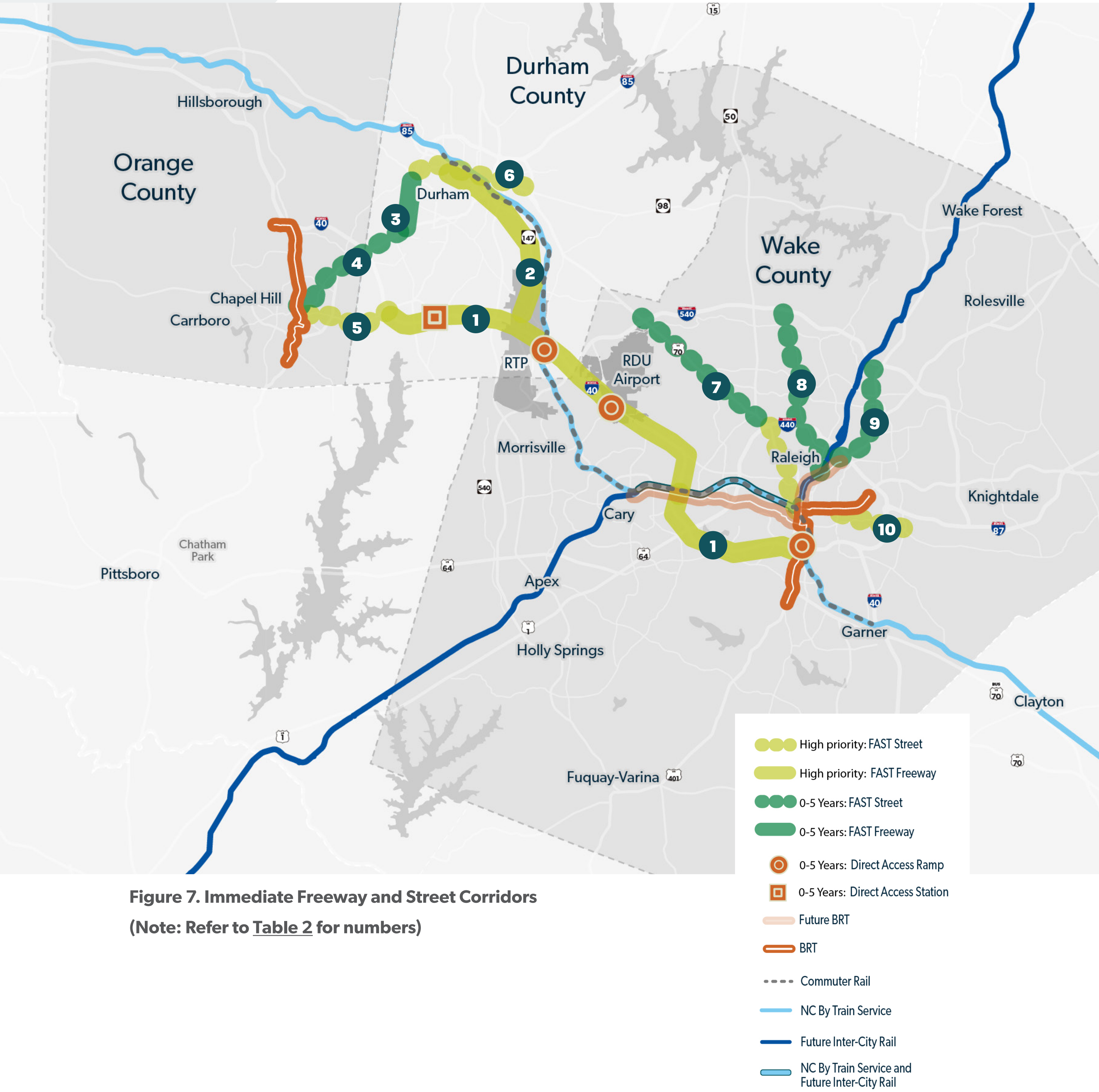


Figure 7. Immediate Freeway and Street Corridors (Note: Refer to Table 2 for numbers)

Table 3. Recommended Transit Advantages for Proposed Corridors

Transit Advantage	Corridor (reference table 2 for numbering)									
	1	2	3	4	5	6	7	8	9	10
Bus On Shoulder System (see page 24)	●	●	●	●						
Transit Priority Lanes (see page 25)									●	
Transit Signal Priority (see page 26)				●	●	●	●	●	●	●
Queue Jump Lanes (see page 27)				●	●	●		●	●	●
RED Bus Lanes (portion) (see page 30)					●		●	●		
Floating Bus Stops (see page 32)						●		●		●
Enhanced Access/ Stops/Boarding (see page 33)				●	●	●	●	●	●	●
Increased Frequency	●	●	●	●	●	●	●	●	●	●
Off-Board Fare Collection (see page 33)	●	●	●	●	●	●	●	●	●	●

Note that seven of the 10 proposed FAST corridors connect with an approved future BRT corridor, *which will leverage and strengthen the upcoming investment in the region's enhanced transit network over the next few years.* In addition, potential trunkline segments can eliminate the need for transferring between BRT and *FAST* networks for some or all of those corridor linkages.

The resulting proposed Freeway And Street-based Transit (*FAST*) network concept is a scalable approach for transforming our roadways into "multimodal corridors" that could quickly provide significant and sustainable advantages for public transit, while also enhancing access and mobility for all modes of travel.

Proposed Triangle SuperFAST Corridors

The following projects and transit advantages could be implemented as Super FAST corridors within next 18-24 months:

a. NC 54/Raleigh Rd (Corridor 5): City of Durham/Town of Chapel Hill can coordinate with the I-40 BOSS Feasibility study and include these transit improvements: Transit Signal Priority and RED Bus Lanes quickly and Queue Jump Lanes and Enhanced Access/Stops/Boarding in the long run.

b. Holloway/Main/Erwin (Corridor 6): City of Durham can work with the GoDurham Planning and Operations Analysis (POA) consultant to look at this corridor for implementing Transit Signal Priority, Queue Jump Lanes, Enhanced Access/Stops/Boarding and Floating Bus Stops.

c. Durham Station Connection (Part of Corridor 1): while this was not an individual project but the deeper dive options (included later in the document) provided for connecting to downtown Durham as part of NC 147 and can be implemented in next 18-24 months.

d. Poole Road (Corridor 10): City of Raleigh can implement these improvements: Queue Jump Lanes, Enhanced Access/Stops/Boarding and Floating Bus Stops. This corridor also connects to New Bern BRT which is the first corridor to be built and would benefit transit improvements along Poole Road.

e. Glenwood Ave (east of I-440 – ITB) (Corridor 7 - High Priority Street Corridor): Enhanced Access/Stops/Boarding, RED Bus Lanes and Contra Flow lanes.
Other recommendations such as:

a. Enhance access to transit.

- Identified stops on route that have no sidewalks or signage.
  - Potential stop locations at Glen Eden Drive.
- Use existing crossings and/or add crossings and signal modifications.

b. Center turning lane at Oberlin an opportunity for transit priority lane

c. Downtown Raleigh - Address bus speed and reliability by implementing:

- Peak hour/peak direction bus lanes by removing existing parking - Can be piloted immediately and then made permanent.

Initial review of potential freeways and streets with longer-term "FAST" opportunities for the 5-10 and 10+ horizon years, including potential connections to future commuter rail, was also recommended. Figure 8 highlights potential future corridors and transit advantages.

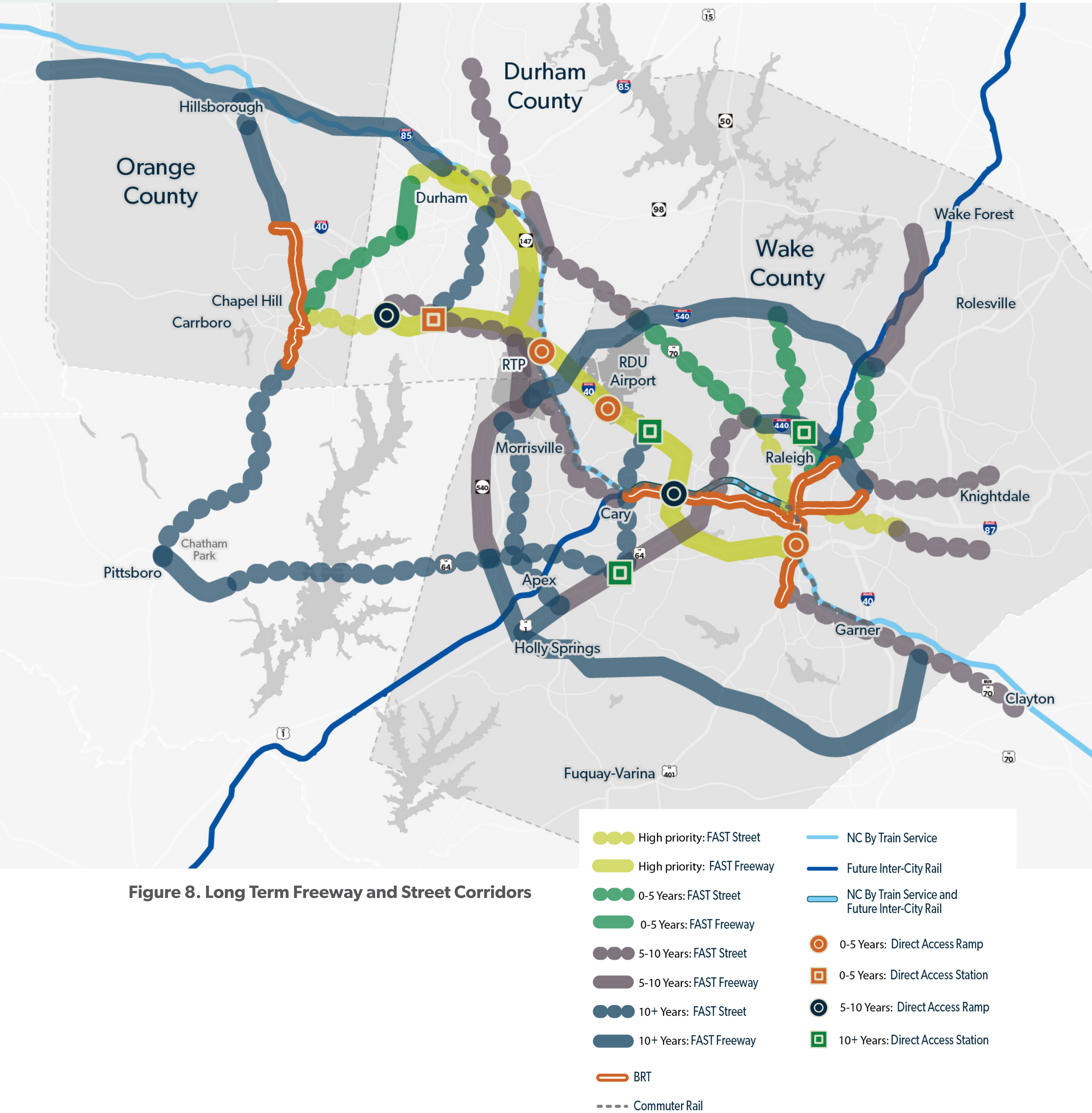


Figure 8. Long Term Freeway and Street Corridors

Triangle FAST Network Implementation Playbook

An implementation "playbook"of beneficial transit infrastructure treatments and operational measures was developed to help guide transit infrastructure investment decisions. A dictionary of standard transit infrastructure strategies provides an easily understandable matrix to inform decision makers in the Triangle and elsewhere in North Carolina about treatment options appropriate for given situations.

How to Use this Document

This document is the culmination of nine months of preliminary study, review, and stakeholder outreach to establish a basic framework and set of guidelines for multimodal planning on freeways and arterial streets in the metropolitan areas in North Carolina. It is important to note that these are guidelines and industry practices customized to a North Carolina context. They are intended as an illustrative resource for local planners, engineers, designers, policy and decision makers, and anyone else engaged in multimodal planning.

Successfully developing a FAST program requires mobilizing numerous resources, partnerships, and innovative implementation mechanisms to help optimize transit investment and infrastructure with private sector needs and goals.

The implementation strategy in this document includes a series of recommended projects and interventions that can convert the FAST plans into reality by providing:

- Monitoring and Evaluation Criteria to help develop and enhance proposed FAST routes
- Phasing Strategy identifying 'Immediate', Short-Term, and Long-Term Projects that are linked to current and future capital programs.
- Resource Planning including project sponsor, operational, and funding recommendations.

In many instances a likely project sponsor and relative cost have been indicated to provide a high-level understanding of a particular treatment's relationship to current public funding programs. These representative examples are meant to provide a starting point.

Future multimodal freeways and streets can be adapted to better serve:

- Equitable Planning Goals by creating an interconnected region-wide service to connect people to county- and city-level services, employment, and housing;
- Bicyclists and Pedestrians by providing connections to express transit service;
- Emerging Technologies by creating an adaptable network to respond to autonomous vehicles, electric vehicles, smart roads, drones, and personal-rapid-transit; and
- Transit by promoting transit advantages that enhance access and mobility.

The purpose of the FAST approach was to leverage the existing freeway and street system in metropolitan areas of North Carolina with targeted transit advantages to improve transit accessibility and opportunities. This innovative approach to solving mobility problems proposed a new way to consider transit and transportation improvements –all FAST recommendations start small with scalable, cost-effective solutions and build towards the ultimate goal of a comprehensive transportation network.

The study intends to encourage a "FAST" mindset embracing quick, low-cost, scalable solutions. As we move forward with implementing local transit plans, a FAST framework will allow local transit providers to:

- Unlock the enormous potential of transit by taking active measures to shorten travel times
- Offer transit service that is more reliable and efficient
- Address the most significant sources of transit delay - street design and traffic operations

The Figure below depicts the basic elements and relationships of the various attributes analyzed for identifying preliminary corridors.

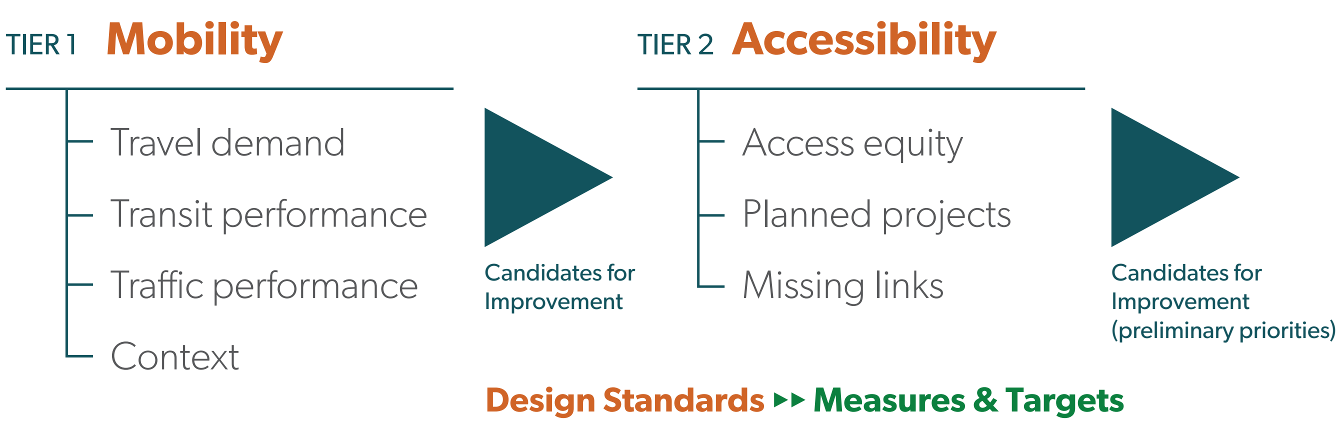


Table 4 and Figure 9 show the linkage between FAST opportunities and funded projects under the State Transportation Improvement Program (STIP) or Capital Improvement program (CIP).

Table 4. FAST Opportunities and Planned Roadway Projects

FAST Corridor			STIP/CIP Projects		
Corridor	**From**	**To**	**Project ID**	**Recommended Sponsor**	**Link Project Timeline (begin construction dates)**
1. I-40	Future South Wilmington Street BRT	NC 54 / Raleigh Road in South Durham	Wake BRT: Western Corridor	City of Raleigh	Planning (2024)
			I-6006	NCDOT	Planning (2028)
			I-5506; I-5700	NCDOT	Under construction
			Wake BRT: Southern Corridor	City of Raleigh	Planning (2024)
2. Future I-885 / NC 147	I-40 in RTP	Duke University	U-5934	NCDOT	Planning (2028)
			U-5937	NCDOT	(>2029)
3. US 15-501 Freeway	Erwin Road area	US 15-501 arterial	None	—	—
4. US 15-501	Future MLK / NC 86 BRT	15-501 freeway	U-5304D/F	NCDOT	Planning (>2029)
5. Raleigh Rd / NC 54	Future MLK / NC 86 BRT	I-40	U-5774B/C	NCDOT	Planning (>2029)
6. Main / Erwin / Holloway	US 15-501 freeway near Erwin Rd	Holloway Street / future I-885	—	City of Durham	Planning (2024)

Table 4. FAST Opportunities and Planned Roadway Projects CONTINUED

FAST Corridor			STIP/CIP Projects		
Corridor	**From**	**To**	**Project ID**	**Recommended Sponsor**	**Link Project Timeline (begin construction dates)**
7. US 70	Future Downtown Raleigh BRT	Brier Creek / I-540	Wake BRT: Northern Corridor	City of Raleigh	Planning (2026)
			U-2823	NCDOT	Planning (>2029)
8. Six Forks Road	Future Capital Boulevard BRT	I-540	Wake BRT: Northern Corridor	City of Raleigh	Planning (>2029)
			Six Forks Road Phase I	City of Raleigh	Design (2025)
9. Capital Boulevard	Future Capital Boulevard BRT	I-540	Wake BRT: Northern Corridor	City of Raleigh	Planning (>2029)
10. Poole Road	Future New Bern Avenue BRT	New Hope Road	Wake BRT: New Bern Avenue	City of Raleigh	Design (2021)

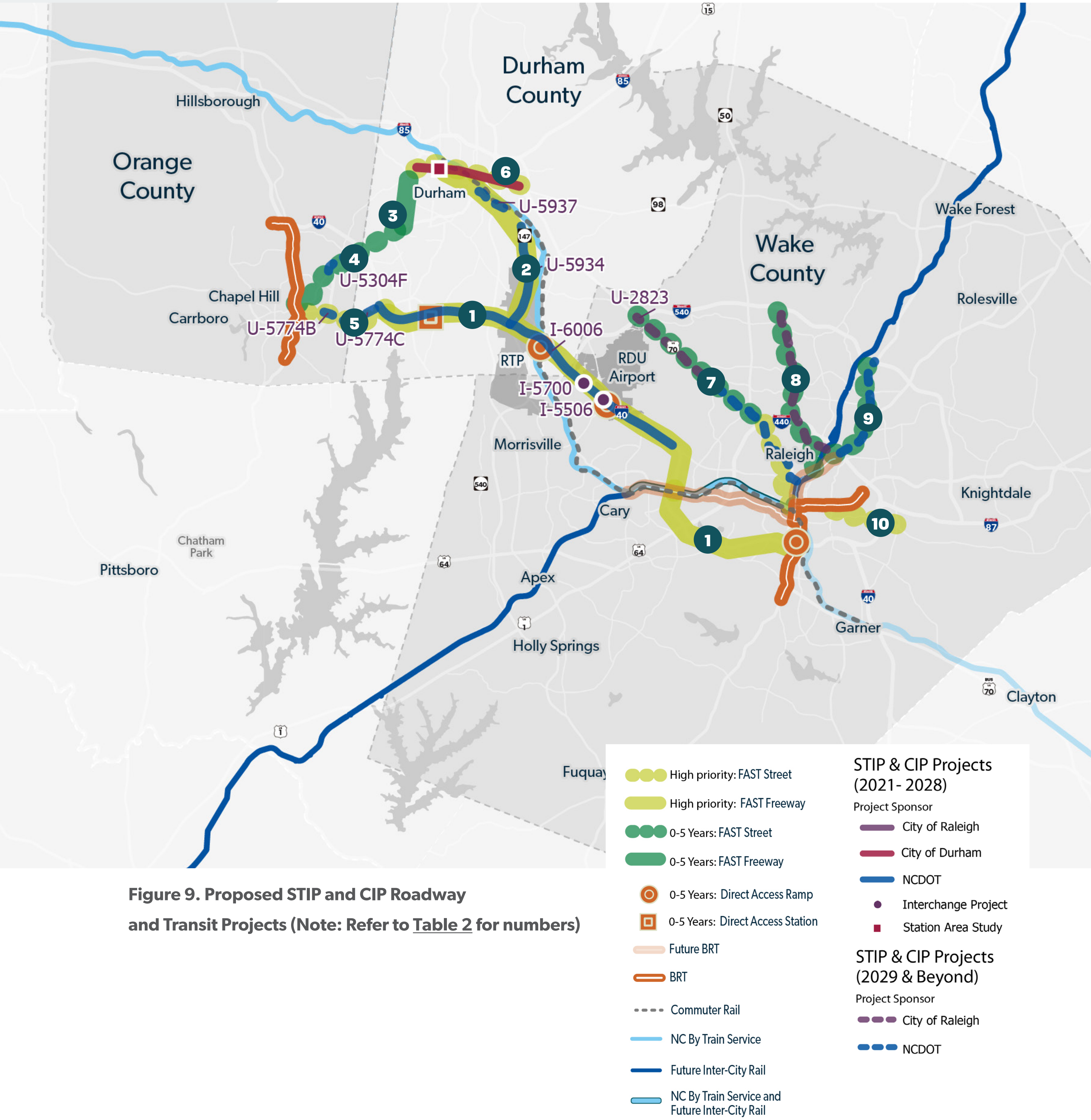


Figure 9. Proposed STIP and CIP Roadway and Transit Projects (Note: Refer to Table 2 for numbers)

Transit Advantages Summary

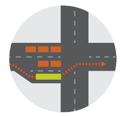
The FAST Study recommends a suite of infrastructure improvements to allow our region to fully unlock the true potential of our current and planned transit investments. Many of these improvements are not new to North Carolina; some are already in use or will be deployed as part of planned Bus Rapid Transit systems. Others, which are higher cost, or require a longer timeline for implementation, could be considered for future freeway investments.

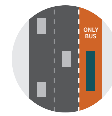
Under Development in BRT System Design:

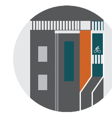

Enhanced Bus Stop


Level Boarding


Transit Signal Priority


Queue Jump Lanes

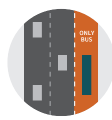

RED Bus Lanes


Floating Bus Stops

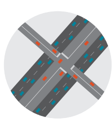
Under Development in Freeway/Highway Expansion Projects:


Transit Priority Lanes


Bus On Shoulder System (BOSS)


RED Bus Lanes

For Consideration in Future Freeway/Transit Projects:


Direct Access Ramps


Direct Access Stations

Table 5 below shows a matrix of qualitative transit advantage in terms of benefits of travel time and reliability. This table also shows the implementation time, cost for implementing the transit recommendation. Additionally, it shows the FAST network roadway type where these improvements can be used, benefits of the transit improvement and recommended lead agency for implementation.

Subsequent figures provide a conceptual drawing and detail information on each of the transit improvement.

Table 5. Transit Advantage Matrix

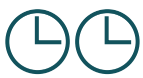
🕓 Timeframe : short/medium/long $ Cost: low/medium/high

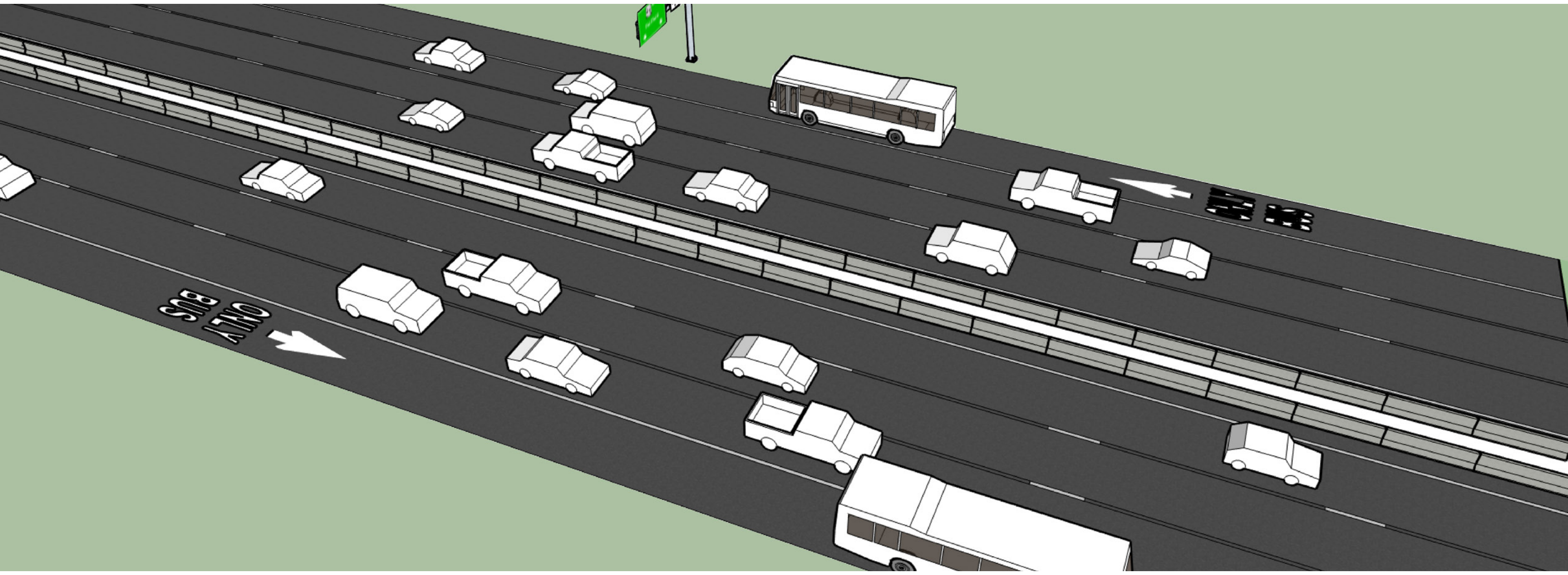
	Transit Advantage	Implementation Time	Cost	Where to Use	Outcome	Common Lead Agency
Bus On Shoulder System (BOSS)	2/5	🕓🕓	$	Arterial-Freeway	Speed + Reliability	State
Express or Transit Priority Lanes	4/5	🕓🕓🕓	$$$	Freeway	Speed + Reliability	State
Transit Signal Priority	3/5	🕓	$$	Arterial	Speed + Reliability	Transit Agency/ City
Queue Jump Lanes	2/5	🕓🕓	$$	Arterial	Speed + Reliability	City
Direct Access Stations	3/5	🕓🕓🕓	$$$	Arterial-Freeway	Access	Transit Agency/ State
Direct Access Ramps	3/5	🕓🕓🕓	$$$	Arterial-Freeway	Access	State
RED Bus Lanes	2/5	🕓	$	Arterial	Speed + Reliability	State/City
Level and Near-Level Boarding	1/5	🕓🕓	$$	FAST Stations and Buses	Enhanced Experience	Transit Agency
Floating Bus Stops	2/5	🕓🕓	$$	Arterial	Speed + Reliability	Transit Agency/ City
Enhanced Bus Stop	1/5	🕓🕓	$$	FAST Stations	Enhanced Experience	Transit Agency

Bus On Shoulder System (BOSS)

Bus-on-shoulder system, also known as BOSS, is a low-cost strategy allowing buses to travel through congested arterial and freeway routes. BOSS is a policy-based alternative to constructing dedicated rights-of-way or restricting lane use to high-occupancy vehicles (HOV).

NCDOT allows certain buses to travel on the shoulders of designated interstate and primary routes as a way to help keep buses on schedule. Currently, select GoTriangle routes use BOSS on Interstate 40 from U.S. 15-501 in Durham to Wade Avenue in Raleigh, continuing on Wade Avenue to Blue Ridge Road. BOSS also is authorized for transit routes using the I-40 shoulder east of Raleigh, from the Beltline to N.C. 42 (Exit 312) in Johnston County.

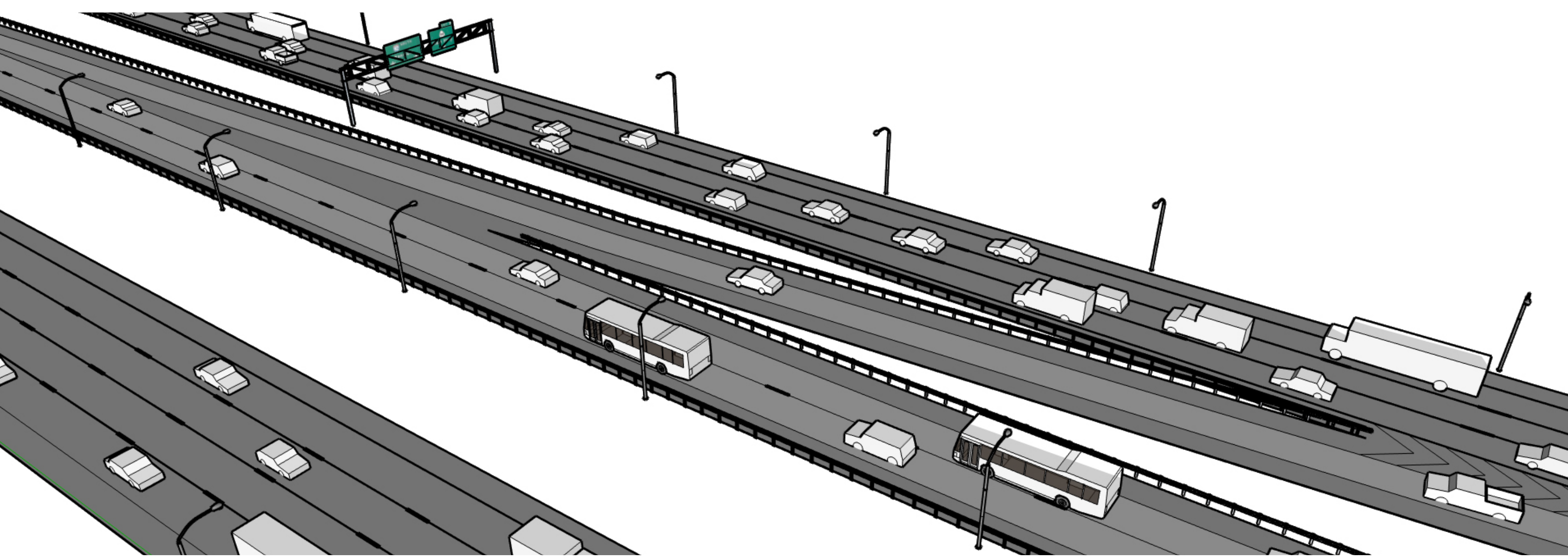
Transit Advantage	**2/5**
Implementation Speed	
Cost	**$**
Where to Use	**Arterial-Freeway**
Outcome	**Speed + Reliability**
Sponsor	**State-led Maintenance/Restriping Project**
Urban Design Considerations	**Requires coordination with ramp designs**



Express or Transit Priority Lanes

Express Lanes are intended to provide a mobility choice and more reliable travel times in peak periods for motorists and bus patrons. They function as toll lanes built within an existing highway corridor, providing additional capacity to accommodate more traffic, offering drivers the option of more reliable travel times. Unlike traditional toll roads, drivers can choose to pay the toll and use the express lanes or continue to drive in the existing non-tolled general-purpose lanes. Express Lanes can also be made available for buses. When buses are able to easily access Express Lanes with minimal weaving across traffic, the transit system experiences fewer delays and reduced travel times. For this reason, Express Lanes are often used in concert with Direct Access Ramps.

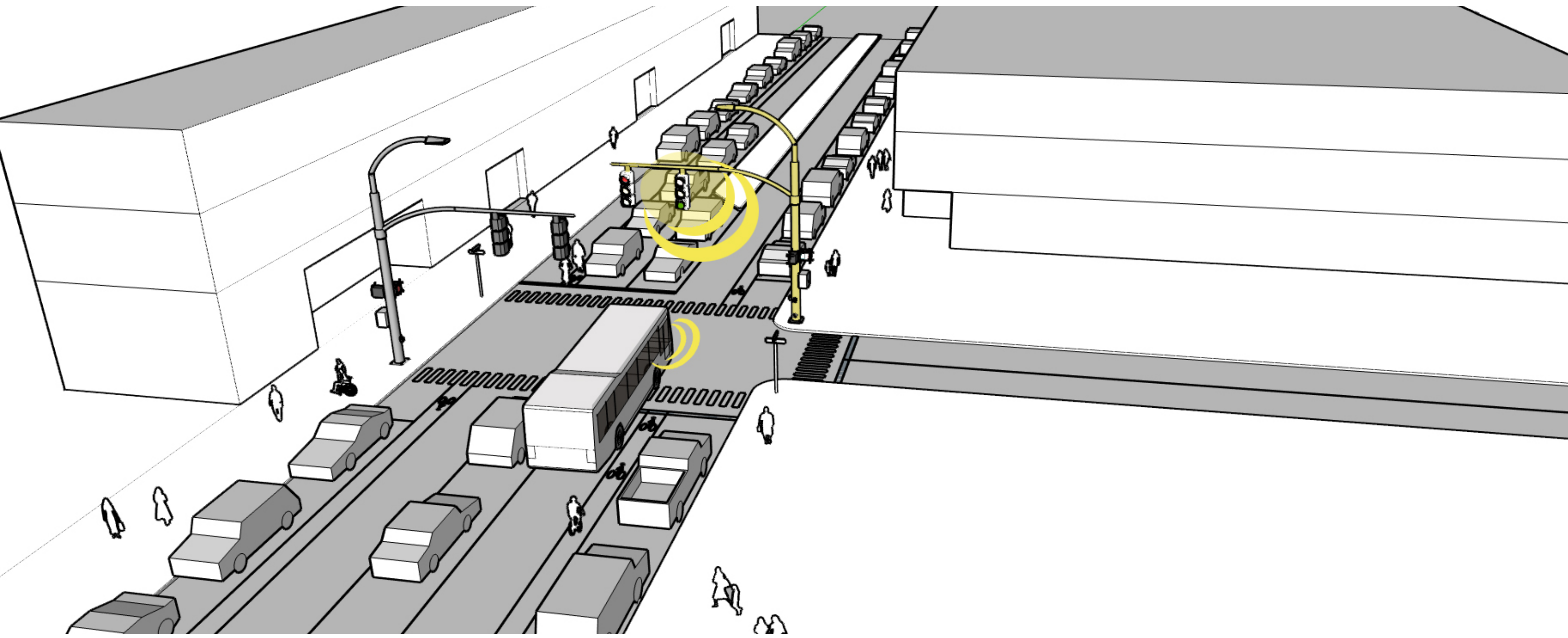
Transit Advantage	**4/5**
Implementation Speed	
Cost	**$$$**
Where to Use	**Freeway**
Outcome	**Speed + Reliability**
Sponsor	**Federally supported, State-led Capital Project**
Urban Design Considerations	**Requires coordination with ramp design**

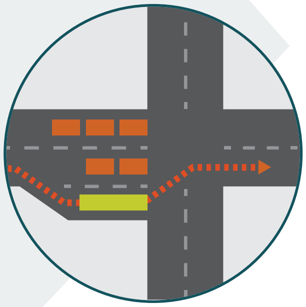


Transit Signal Priority

Transit Signal Prioritization (TSP) is an operational strategy used to allocate priority passage for transit vehicles at signalized intersections. This strategy uses technology to reduce transit signal delay for transit vehicles by holding green lights longer, shortening red lights, or creating a new traffic signal phase dedicated to transit. This strategy is often used in conjunction with other transit advantage techniques such as queue jump lanes. TSP may be implemented at individual intersections , across corridors, or throughout entire street systems and results in improved travel time reliability and reduces delay.

Transit Advantage	**3/5**
Implementation Speed	
Cost	**$$**
Where to Use	**Arterial**
Outcome	**Speed + Reliability**
Sponsor	**Municipal-led Upgrade/Maintenance Or New Capital Project or Transit Agency**
Urban Design Considerations	**Requires coordination with technology**

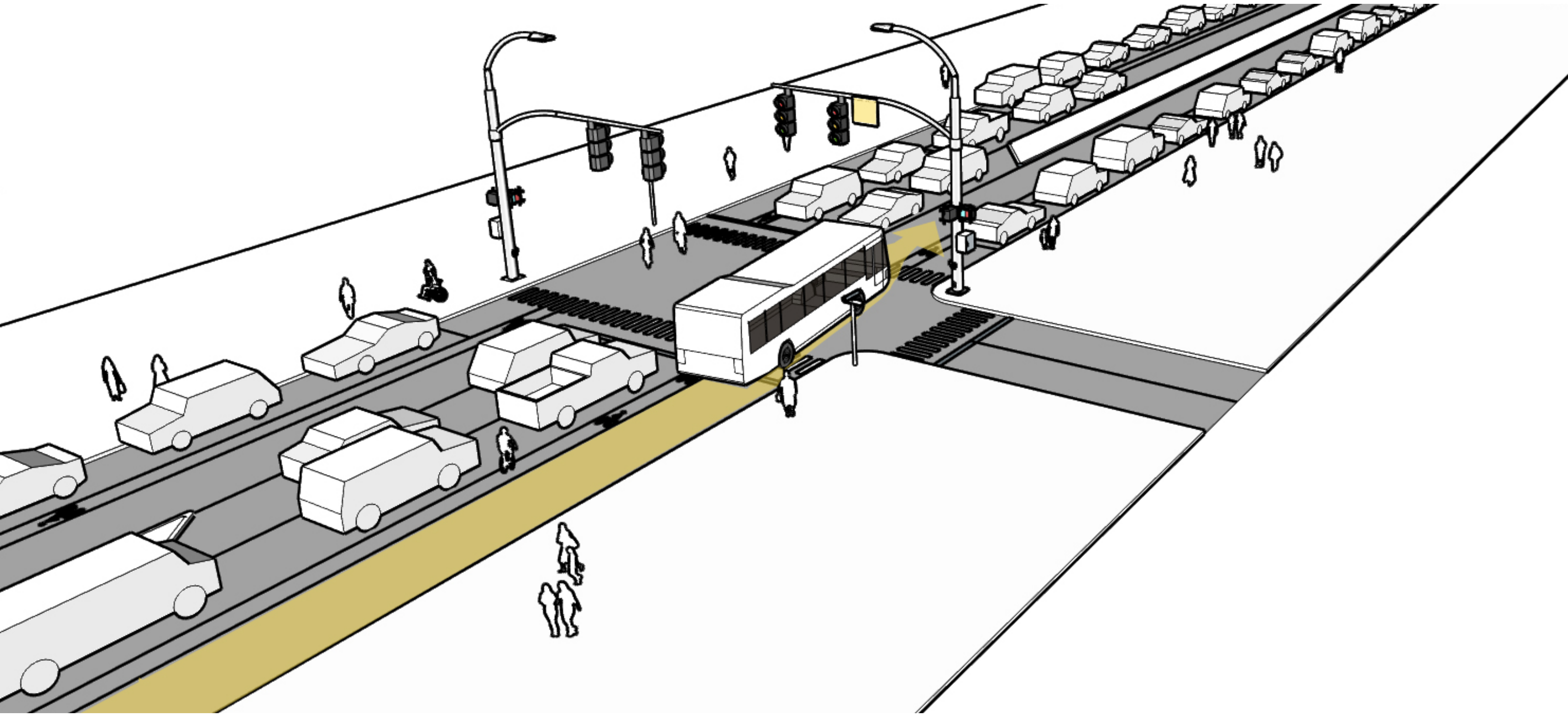


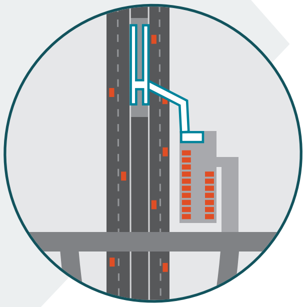


Queue Jump Lanes

A queue jump lane is a short stretch of bus lane combined with transit signal priority. The idea is to enable buses to by-pass waiting queues of traffic and to cut out in front by getting an early green signal. A special bus-only signal may be required. The queue jump lane can be created through the use of a turn lane, allowing bus-only straight-through operations, and/or adding a signal phase or transit signal priority – all relatively lower cost solutions.

Transit Advantage	**2/5**
Implementation Speed	🕒🕒
Cost	**$$**
Where to Use	**Arterial**
Outcome	**Speed + Reliability**
Sponsor	**Municipal-led Capital Project**
Urban Design Considerations	**Requires coordination with private development and bike infrastructure**

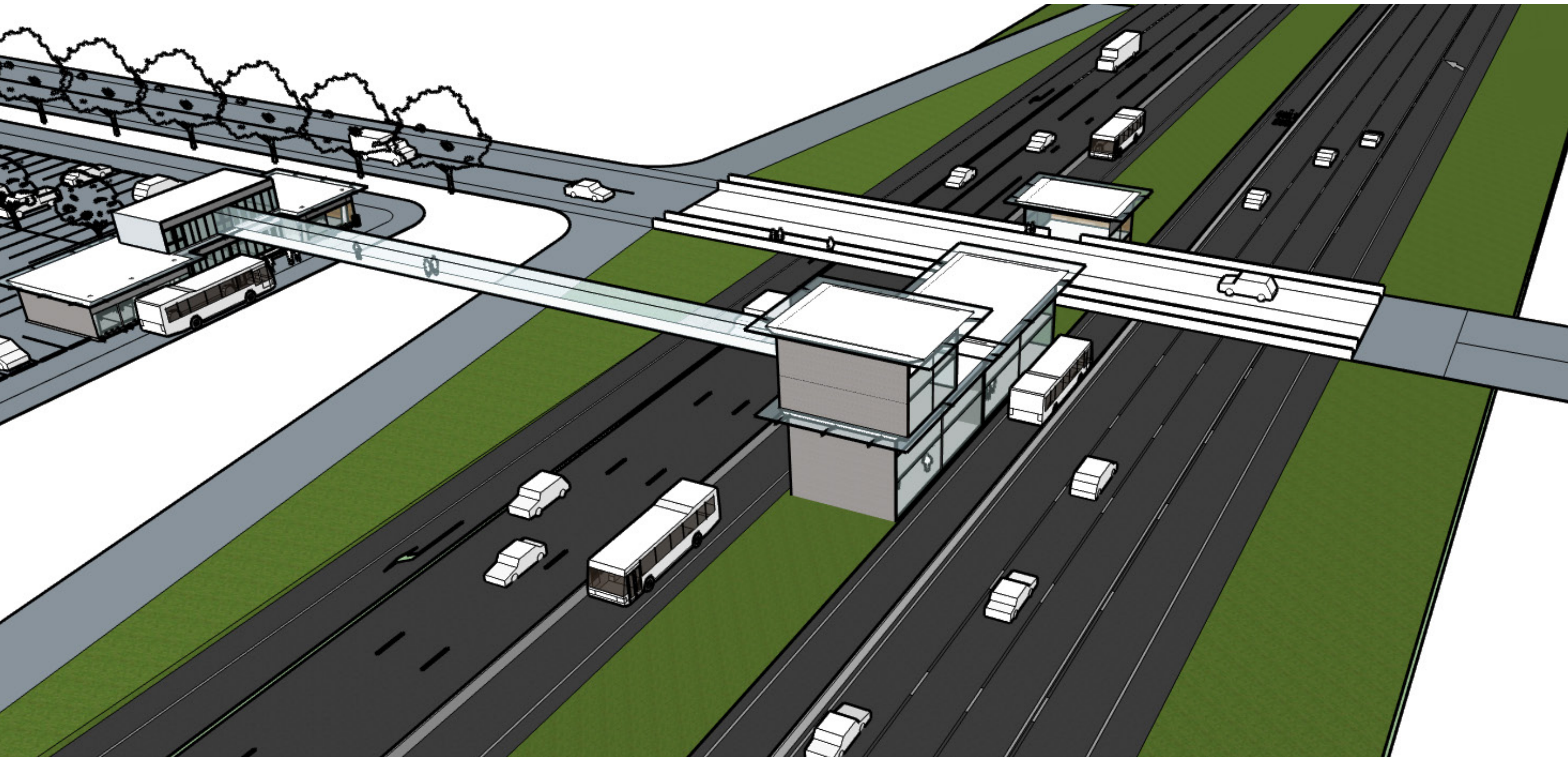


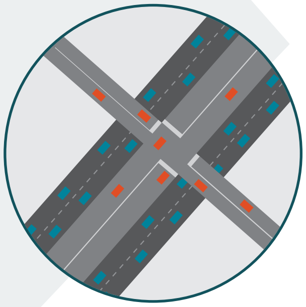


Direct Access Station

Direct Access Stations allow a direct connection from another mode of transportation to a freeway-based transit station. The facility can provide transit riders a seamless connection between modes; often this is accomplished from a park and ride via a pedestrian bridge that crosses over the lanes of freeway travel.

Transit Advantage	**3/5**
Implementation Speed	🕒🕒🕒
Cost	**$$$**
Where to Use	**Arterial-Freeway**
Outcome	**Access**
Sponsor	**Federally supported, State or Transit Agency-led Capital Project**
Urban Design Considerations	**Requires coordination with adjacent land, land uses, TOD potential**

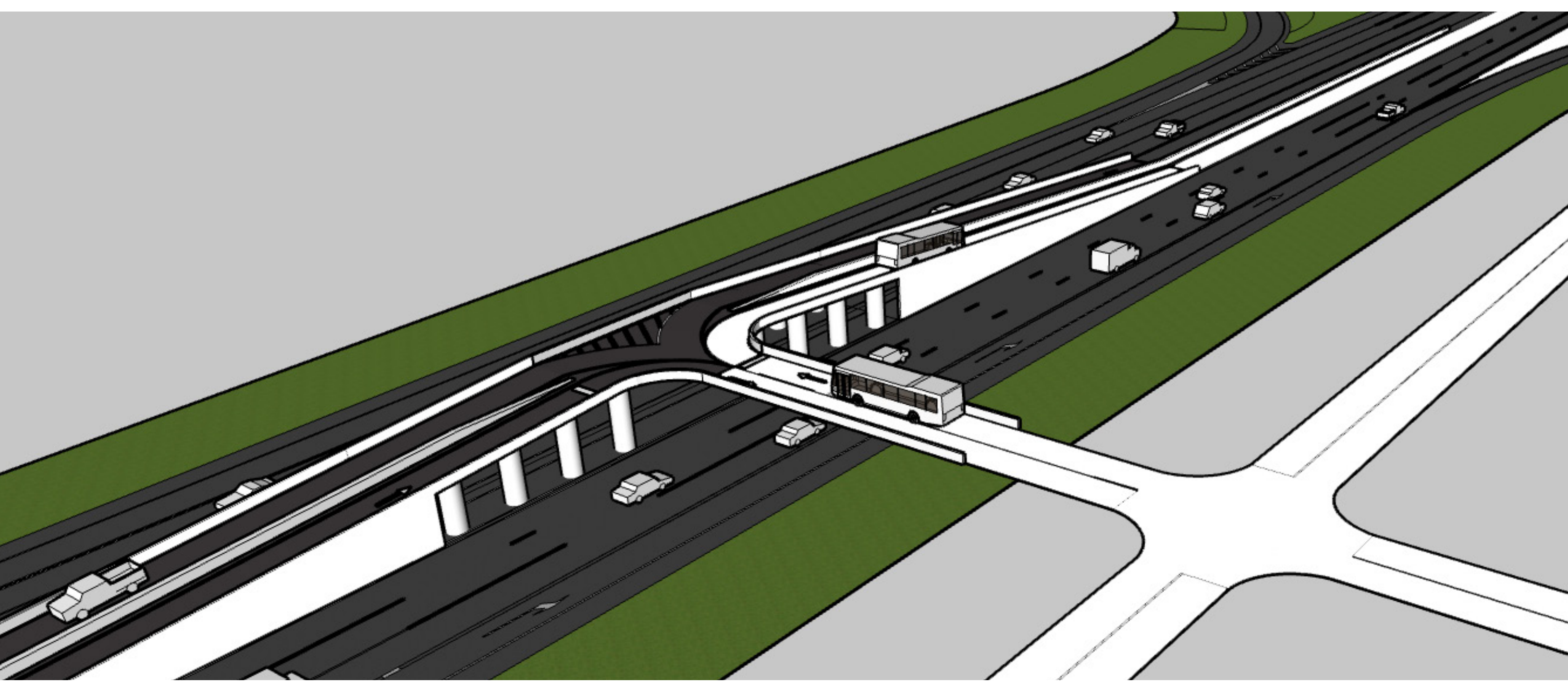


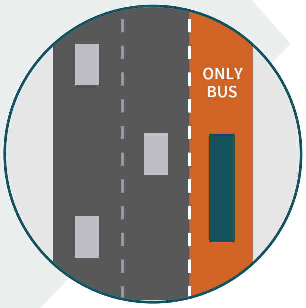


Direct Access Ramps

Direct Access Ramps provide access lanes to allow buses, carpools, and vanpools to directly access the high occupancy vehicle (HOV) lanes in the center of the freeway, allowing these vehicles to avoid the need to weave across the other lanes of traffic. The location of Direct Access Ramps can be coordinated with Park and Ride facilities to allow an easier transfer from cars to express bus routes. Direct access ramps can improve safety, reduce congestion, save time, and increase travel time reliability for transit services.

Transit Advantage	**3/5**
Implementation Speed	
Cost	**$$$**
Where to Use	**Arterial-Freeway**
Outcome	**Access**
Sponsor	**Federally supported, State-led Capital Project**
Urban Design Considerations	**Requires coordination with adjacent land uses/development, TOD potential**



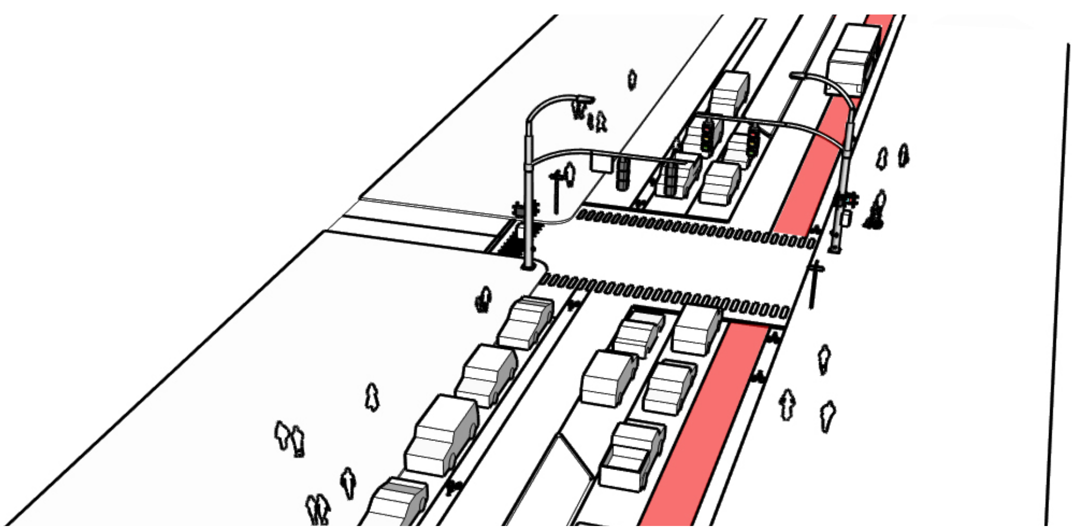


RED Bus Lanes

RED Bus Lanes signify transit priority lanes within a roadway that also permit the complementary uses of **R**ight turns, **E**mergency Vehicles, and **D**riveway access. The Federal Highway Administration (FHWA) approved the optional use of red paint on city streets to give buses their own lane. This is intended to remove vehicles from the bus lanes resulting in faster, more reliable service.

Any jurisdiction that requests and receives approval from FHWA is able to use the red pavement paint for bus travel lanes in designated locations and at transit stops. In some locations the conversion of an existing lane can provide a cost effective means to implement a RED Bus Lane. In congested urban environments, driveways, parking lot access, and on-street parking would be affected and would require outreach and coordination with adjacent landowners.

Transit Advantage	**2/5**
Implementation Speed	
Cost	**$**
Where to Use	**Arterial**
Outcome	**Speed + Reliability**
Sponsor	**Municipal- or State-led Maintenance or Capital Project**
Urban Design Considerations	**Requires coordination with private development and bike infrastructure**



Level and Near-Level Boarding

Level Boarding and Near-Level Boarding is a system that places boarding platforms at or near the same level as the floor of the transit vehicle. Level boarding/near-level boarding buses can be automated to dock precisely at bus stops—"precision docking"—thus providing easy access and enhancing passenger safety to allow boarding to be completed more quickly.

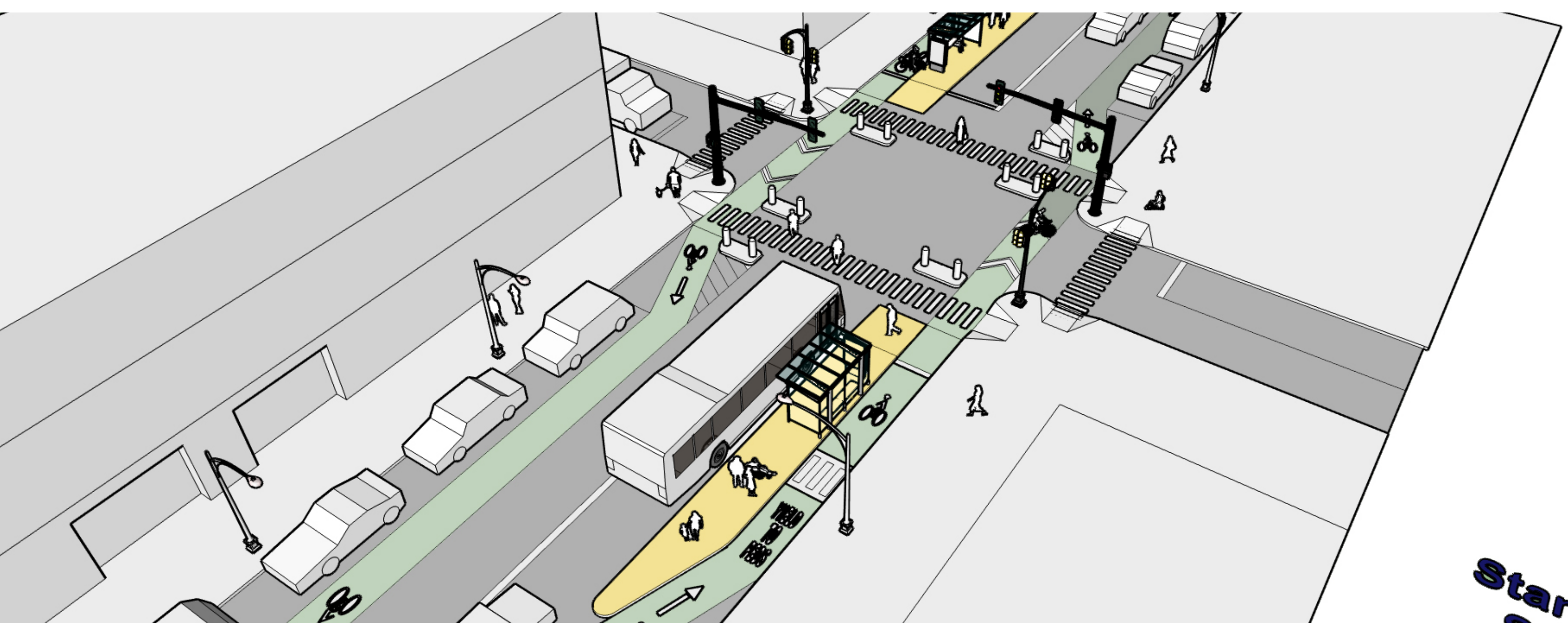
Transit Advantage	**1/5**
Implementation Speed	
Cost	**$$**
Where to Use	**FAST Station and Buses**
Outcome	**Access**
Sponsor	**Transit Agency-led Capital or Maintenance Project**
Urban Design Considerations	**Requires coordination with existing pedestrian infrastructure**

Floating Bus Stop

Floating Bus Stops provide dedicated waiting and boarding areas at a station which is separated from the general sidewalk and bicycle infrastructure. Curbed floating bus stops are separated from the sidewalk by a bike channel for permanent solutions; or temporary platforms and ramps can be used for temporary or pilot projects.

These separated stations streamline transit service and improve accessibility by reducing conflicts between buses and bicyclists and eliminating the wait for bus drivers trying to merge back into traffic after picking up customers.

Transit Advantage	**2/5**
Implementation Speed	
Cost	**$$**
Where to Use	**Arterial**
Outcome	**Speed + Reliability**
Sponsor	**Transit Agency-led Capital or Maintenance Project**
Urban Design Considerations	**Requires coordination with pedestrian/bicycle infrastructure**



Enhanced Bus Stop

Enhanced Bus Stops incorporate a number of features to enhance safety, reduce boarding time and dwell time for buses at stations, and improve the overall experience for bus passengers. Clean, well-lit, weather protected stations with near-level boarding and off-vehicle ticket vending create an inviting environment which assists faster boardings/de-boardings and can reduce the overall travel time of a transit system.

Transit Advantage	**1/5**
Implementation Speed	
Cost	**$$**
Where to Use	**FAST Stations and Buses**
Outcome	**Access**
Sponsor	**Transit Agency-led Capital or Maintenance Project**
Urban Design Considerations	**Requires coordination with existing pedestrian infrastructure**

Table 6 below shows various funding opportunities and programs that can be tapped for implementation of FAST strategies.

Funding Opportunities

Table 6. FAST Funding Opportunities

Formula Grants	Discretionary Grants*	Loans	STIP
Urbanized Area Formula Grants	New Starts	Transportation Infrastructure Finance and Innovation Act (TIFIA)	Metropolitan Planning and Statewide Planning Program (Section 5303 / 5304)
Grants for Buses and Bus Facilities Formula Program	Small Starts	Railroad Rehabilitation and Improvement Financing (RRIF)**	Urban Area Formula Program (Section 5307)
Congestion Management and Air Quality Improvement Program (CMAQ)	Better Utilizing Investments to Leverage Development (BUILD) Transportation Grants Program (formerly TIGER)		Rural Formula Grant Program (Section 5311)
Surface Transportation Block Grant (STBG)	Bus and Bus Facilities Discretionary Grants		Bus and Bus Facilities Program (Section 5339)
State of Good Repair Grants Program	Low or No-Emission (Low-No) Vehicle Program		State Highway Trust Fund
	Core Capacity		State Highway Fund
	Fixed Guideway Modernization		

*Many of the Discretionary Grant Programs carry a minimum investment level; future project definition can meet these thresholds when projects are "bundled"
**Limited applicability for FAST but could be considered for grade-separation and rail bridge replacement projects in the future

Policy Recommendations

- Evaluate existing projects undergoing planning and design to determine feasibility of adding FAST features.
- Identify opportunities for future FAST projects by proactively planning select corridors.
- Strengthen Complete Streets Policies at the State and Local Levels to encourage multimodal features that promote bus transit advantages in all future street projects.
- Expand Complete Streets Policies at the State Level to incorporate transit advantage features in freeway projects.

Deeper Dive Priority Corridors

After identifying candidate corridors for near- and long-term transit projects, the study team took a deeper dive into two corridors, developing conceptual improvements to illustrate the nature of potential alternatives and their general impacts. This task focused on identifying specific projects, treatments, and strategies to accelerate the creation of transit advantages along the regional FAST networks. Illustrative examples of the types of improvements being considered help generate meaningful feedback from stakeholders and the general public. An important outcome of this plan is identifying agency responsibilities and project triggers, constraints, and contingencies.

The Team coordinated with stakeholders to recognize opportunities to integrate FAST proposals with planned or pending roadway and transit projects. Recent and ongoing transit studies (such as CAMPO's BOSS and RED bus lane studies; Go Triangle's Regional Transit Center planning and Commuter Rail Study; Orange and Durham Counties' transit plan updates; and the five BRT corridor plans) were carefully reviewed to ensure that FAST enhancements are optimized to best complement these local and regional transit initiatives.

Deeper Dive Methodology

In order to demonstrate the potential of the **F**reeway **A**nd **S**treet based **T**ransit (FAST) network in the Triangle region, the Project sought to apply the methodology and tools to two corridors. FAST network routes would represent a new type of service. Infrastructure improvements would be designed to improve the speed and reliability of bus operations, on a localized, targeted basis. While the overall approach to the FAST network is defined in previous sections, the on-the-ground reality of what this approach would mean and what it could look like had to be evaluated on identified corridors. Working with stakeholders and funding partners, this analysis identified two corridors and feasibility was tested.

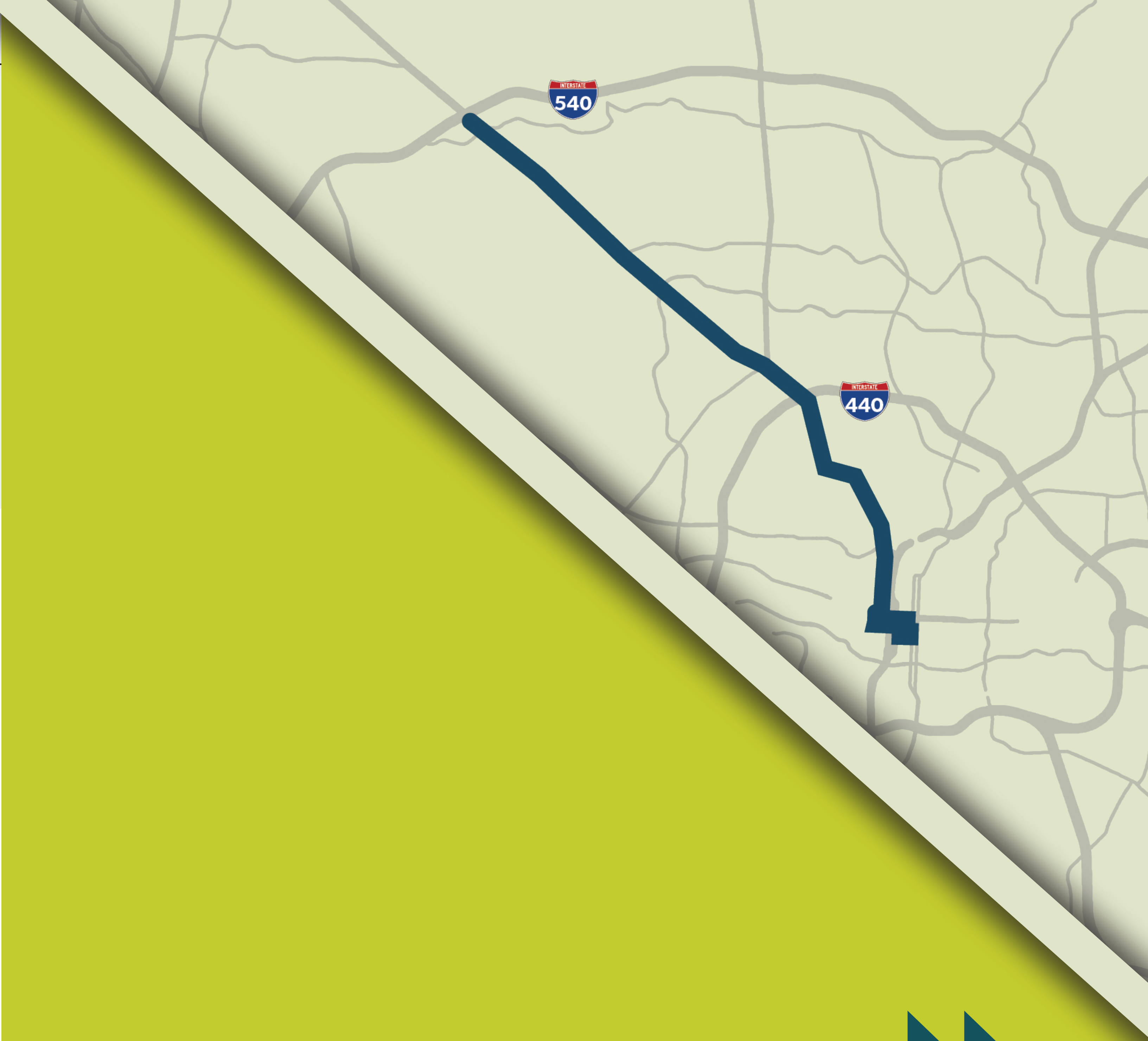
In choosing the two corridors for analysis, a variety of factors were considered. Illustrative corridors traverse a variety of environments, from freeway to limited access corridors to neighborhood and downtown segments. The tested corridors were meant to be regionally significant and of sufficient promise to be early implementation candidates. The corridors could have existing public transportation service, but the overall purpose was to think about how a new service could operate with the associated improvements. The two corridors chosen were the US 70 Corridor from I-540 (near RDU Airport) east to downtown Raleigh and the NC 147 Corridor (Future I-885) from Research Triangle Park north to downtown Durham.

As a first step, the analysis looked at the regional information collected in the earlier part of the study. Existing transit service and ridership were considered, along with proposed long-term BRT and Commuter Rail transit improvements in the Triangle region. Roadway and travel factors such as congestion, volume/capacity and corridor conditions were considered on a segment basis. Adjacent land use, activity centers and origin/destination patterns also underlied the analysis.

As each corridor was evaluated, it was broken down by segment. Segments were determined primarily by similarity of operating environment, regardless of length. Interventions were then evaluated on a segment basis using a few key determinants:

- Focusing on reliability and travel time improvements that could be completed in the short- and mid-term without full reconstruction
- Making more significant interventions in places most needed, for example in congested or high ridership segments
- Considering the totality of the transit experience, including station access, pedestrian connections and adjacent land use/activity
- Parallel construction or implementability with ongoing or planned improvement projects by others
- The physical layout of the corridor and its constraints
- Impacts on other corridor operations including vehicle congestion and parking
- Safety

Complete segment-by-segment concepts were then completed on a planning level. These concepts were developed using the playbook of improvements, with a realistic "transit first" approach where transit accommodations are at minimum equivalized with other modes. As segments differ in character, varying transit improvements are recommended along the corridor, often in combination for individual segments. Where applicable, the analysis also recommended potential route deviations to serve a larger potential group of users, or to corridors with less congestion or greater potential for improvement. Segment by segment details for each of these corridors are included in the subsequent section.



US 70 Corridor

West Raleigh to Downtown Raleigh

Wake County, NC

Existing Service along US 70 corridor

GoRaleigh Routes Served

- Route 70X
- Route 6
- Route 16

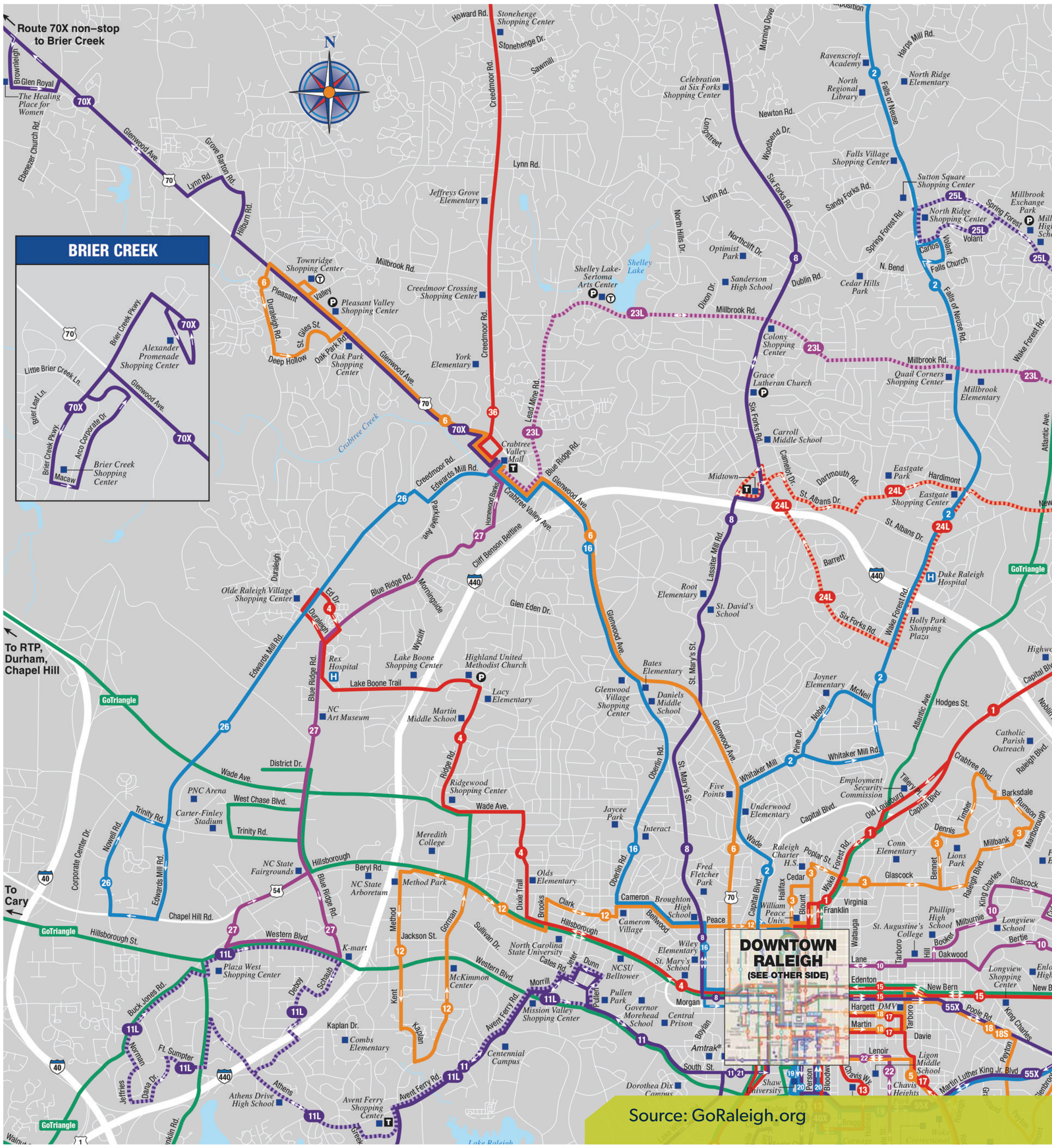


Figure 10. Existing GoRaleigh Transit Service

US 70 Corridor Existing and Future PM Peak Hour Congestion

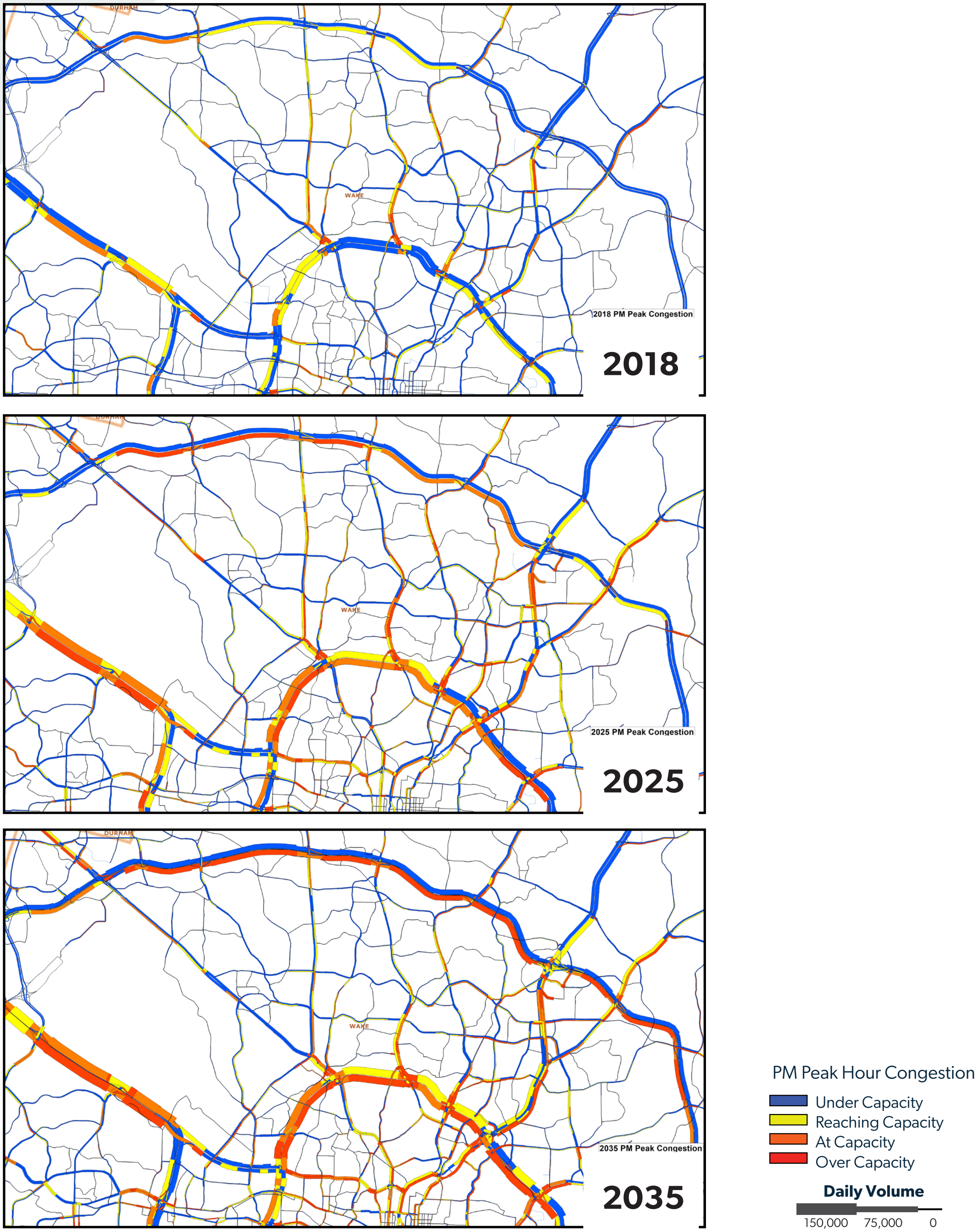


Figure 11. US 70 Corridor Existing and Future Volume/Capacity Ratio

US 70 Corridor Deeper Dive Segments

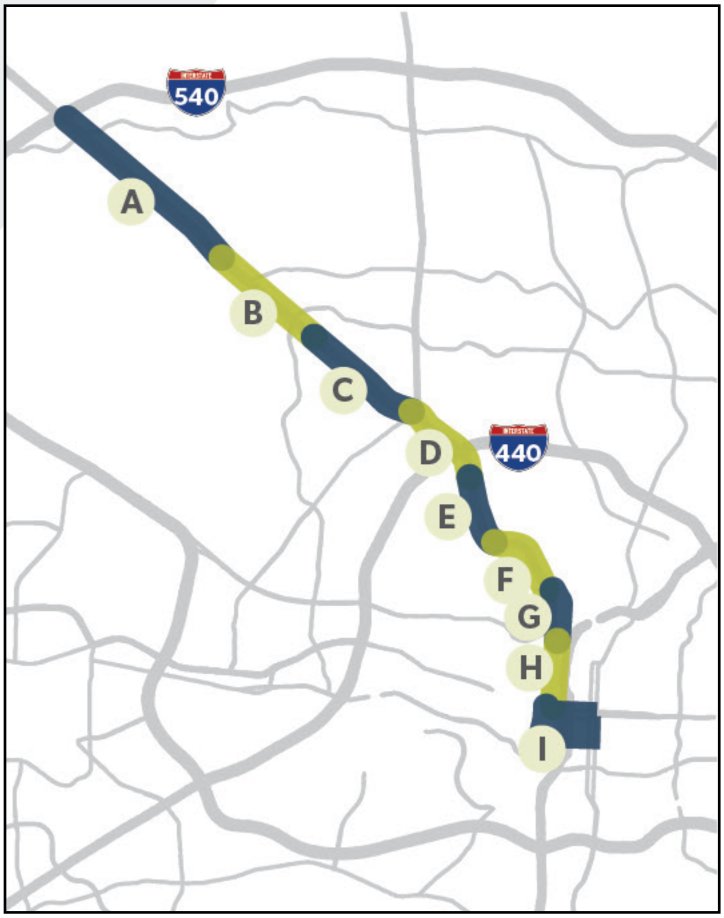


Figure 12. US 70 Deeper Dive Segments

A From I-540 to Ebenezer Church Rd

B From Ebenezer Church Rd to Millbrook Rd/ Duraleigh Rd

C From Millbrook Rd/ Duraleigh Rd to Creedmor Rd

D At Crabtree Valley Mall

E Glenwood Avenue - From I-440 to Oberlin Rd

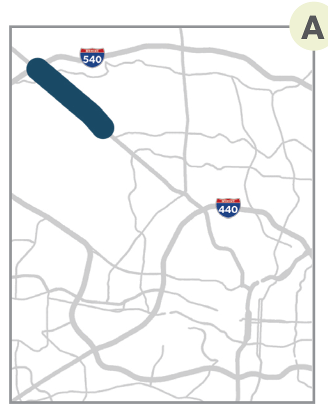
F Glenwood Avenue - From Oberlin Rd to Alexander Rd

G Glenwood Avenue - From Five Points to Wade Ave

H Glenwood Avenue - Between Brooklyn Hill and Glenwood South

I Downtown Raleigh

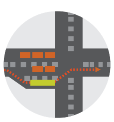
Segment A - From I-540 to Ebenezer Church Rd



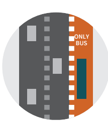
2 US 70 at Ebenezer Church Rd.
Source: VHB

US 70 in western Wake County provides access to RDU Airport, Brier Creek, and Umstead State Park. In addition to serving these regional destinations, the corridor is an alternative to I-40 for travel between Durham and Raleigh. Addressing congestion and access along US 70 are fundamental to enhanced transit service.

- Congestion and signals limit transit reliability and speed along the corridor.



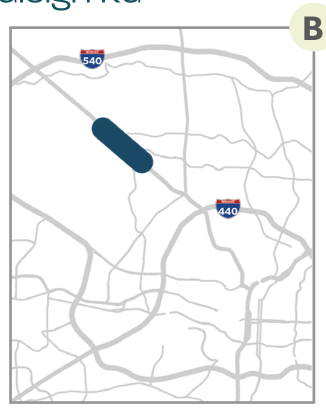
- Bus speed and reliability in this corridor could be improved by queue jumps at signals.
  - Significant roadway delay due to signal density and type which could be improved through intersection improvements and signal modifications.



- Use the ROW (existing shoulder) to widen road for shoulder/transit lane on side or in median.
- **1** Potential connection to RDU.

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Segment B - From Ebenezer Church Rd to Millbrook Rd/ Duraleigh Rd



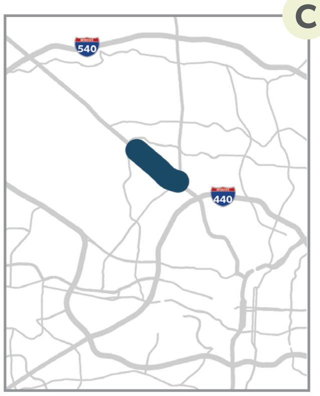
3 Lack of sidewalks on US 70 at Pinecrest Rd. Source: VHB

This stretch of US 70 is characterized by a mix of residential and commercial uses set back from the roadway. Pedestrian and bicycle accommodations along and across the corridor are extremely limited. In making transit more accessible along this corridor, careful consideration needs to be given to how and where pedestrians access transit stops.

- ▸ Signal delay at intersection increases travel times.
  - ▸ Queue jumps at signals to improve bus speed and reliability.
    - Consider using right lane, or even queue jump/left-turn lane if can be done safely or with timing adjustments.
    - Significant roadway delay due to signal density which could be improved by intersection improvement.
- ▸ Lack of pedestrian or bicycle facilities limit accessibility to transit.
  - ▸ There is high activity and density in this corridor, yet it is difficult to serve with transit due to accessibility limitations across US 70. This route could serve more stops and riders, as route 70X does not stop on US 70.
  - ▸ No crosswalks or pedestrian accommodation at likely stops.
  - ▸ Examine signal upgrades or significant intersection modifications to improve accessibility.
- ▸ Use the ROW (existing shoulder) to widen road for shoulder/transit lane on side or in median.

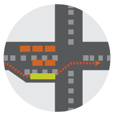
Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Segment C - From Millbrook Rd/ Duraleigh Rd to Creedmor Rd

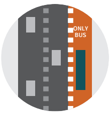


5 US 70 at Pleasant Valley Rd.
Source: GoRaleigh.org

The development at Pleasant Valley is an important node for future transit service. The collection of higher density suburban retail and housing lends itself to enhanced transit services. While sidewalks along this section are common, crossing the wide roadway (US 70) remains unsafe and inconvenient. Since most transit users make round trips, crossing enhancements to US 70 will remain a top priority.



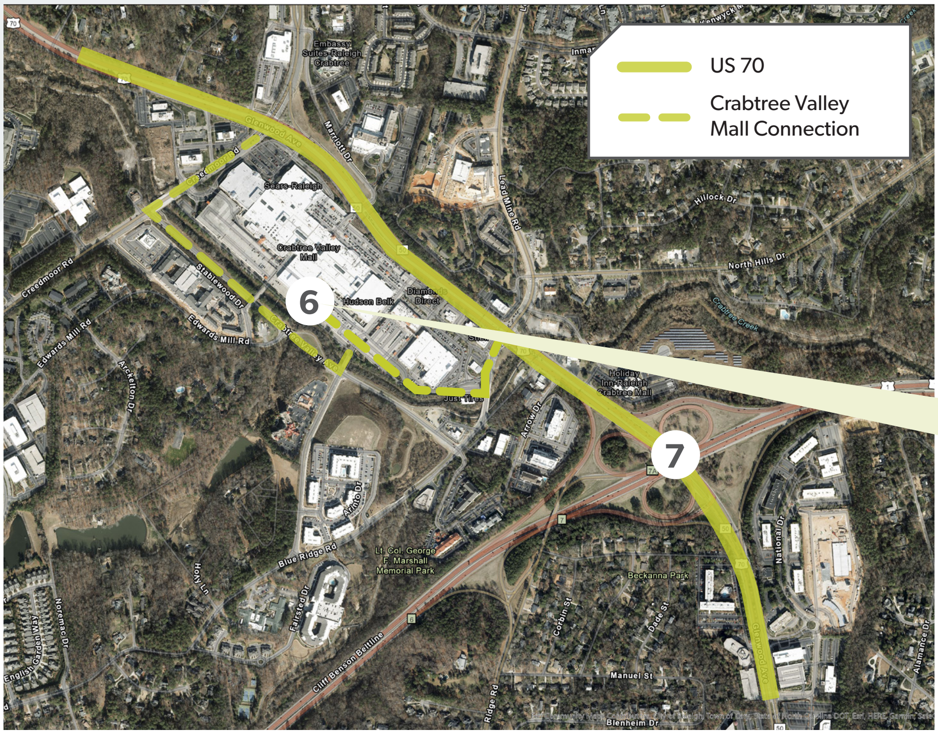
- Enhancements to service on US 70.
  - Introduce enhanced bus stops.
  - Right-Turn – Dedicated transit (marked) and limited right-turns/driveway access.
  - Stops should be far-side of signals with queue jump/right-turn lanes.
- Lack of crossings makes service on US 70 challenging. The existing road design makes it difficult for transit to service this area.
  - Add crossings and signal modifications.
- **4** US 70 widens from 2 to 3 travel lanes and turning lanes east of Glenwood Forest/ Hilburn through NC 50 (Creedmoor).

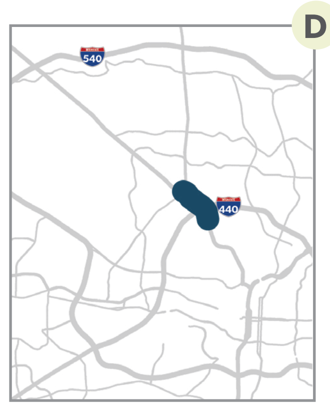


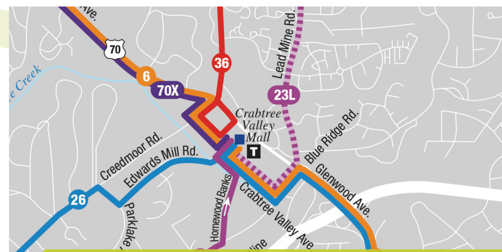
- If Express Service is expanded – Dedicate one lane as transit priority (left lane).

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Segment D - At Crabtree Valley Mall

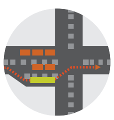


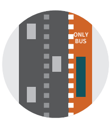




6 Seven GoRaleigh routes converge at Crabtree Valley Mall. Source: GoRaleigh

Crabtree Valley Mall is a critical connection point and destination for GoRaleigh service. With seven routes serving the mall, efficient ingress and egress to and from the transit center are vital to reducing overall trip times. Additionally, the interchange improvements at I-440 should be coordinated with transit partners to ensure FAST transit improvements are considered in the design.

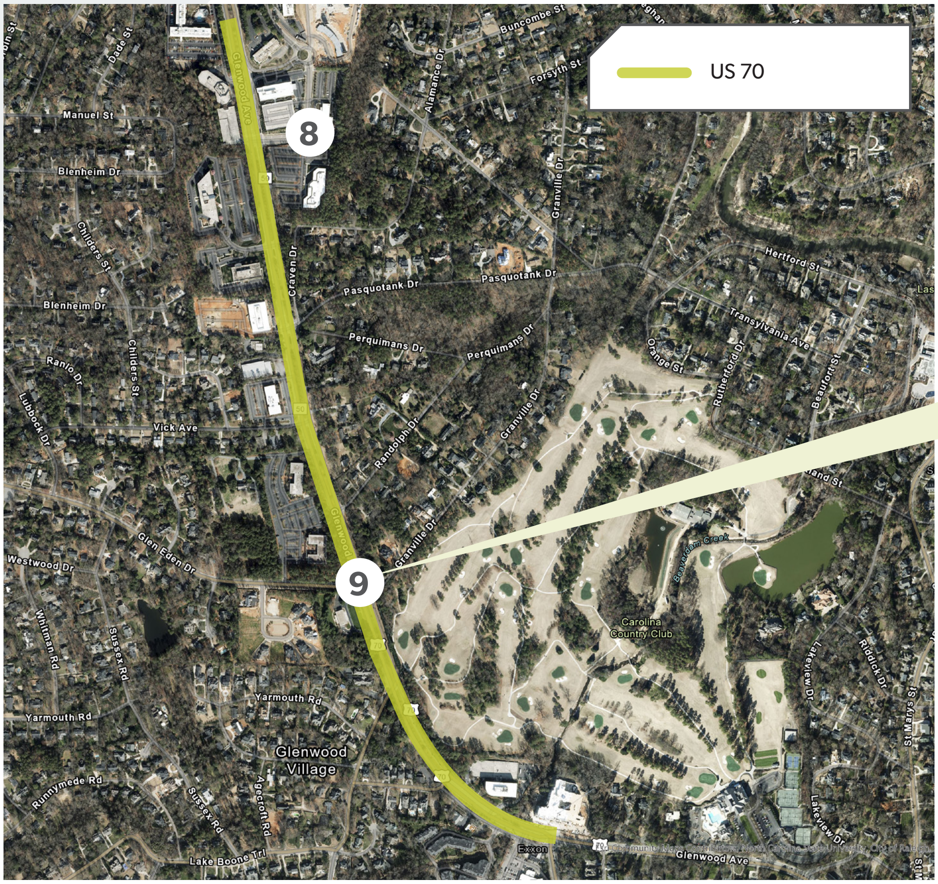


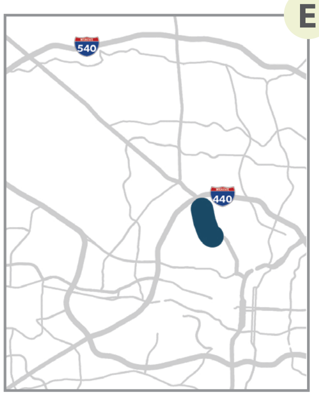


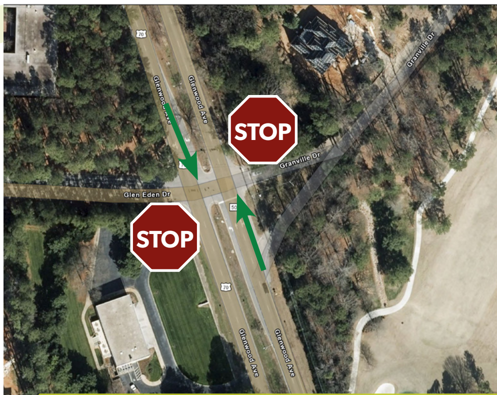
- **6** Crabtree Valley Mall access can be time-consuming for buses.
  - Continue to use mall roads.
  - Consider dedicated lanes on access roads.
  - Queue jumps or dedicated turning lanes at signals.
  - Consider dedicated lane through interchange.
  - Use left lanes.
  - No shoulders available.
- **7** I-440 Interchange improvements.
  - I-5870 deals with the interchange at I-440 which should involve transit coordination.

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Segment E - Glenwood Avenue - From I-440 to Oberlin Rd

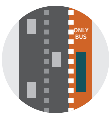


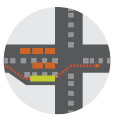




9 Potential stop locations at Glen Eden Drive. Source: VHB

As US 70 transitions from outside to inside the beltline, land uses shift to less auto oriented and higher density employment adjacent to the corridor. Two GoRaleigh routes use this corridor and is planned to be part of the frequent transit network under the Wake Transit Plan.

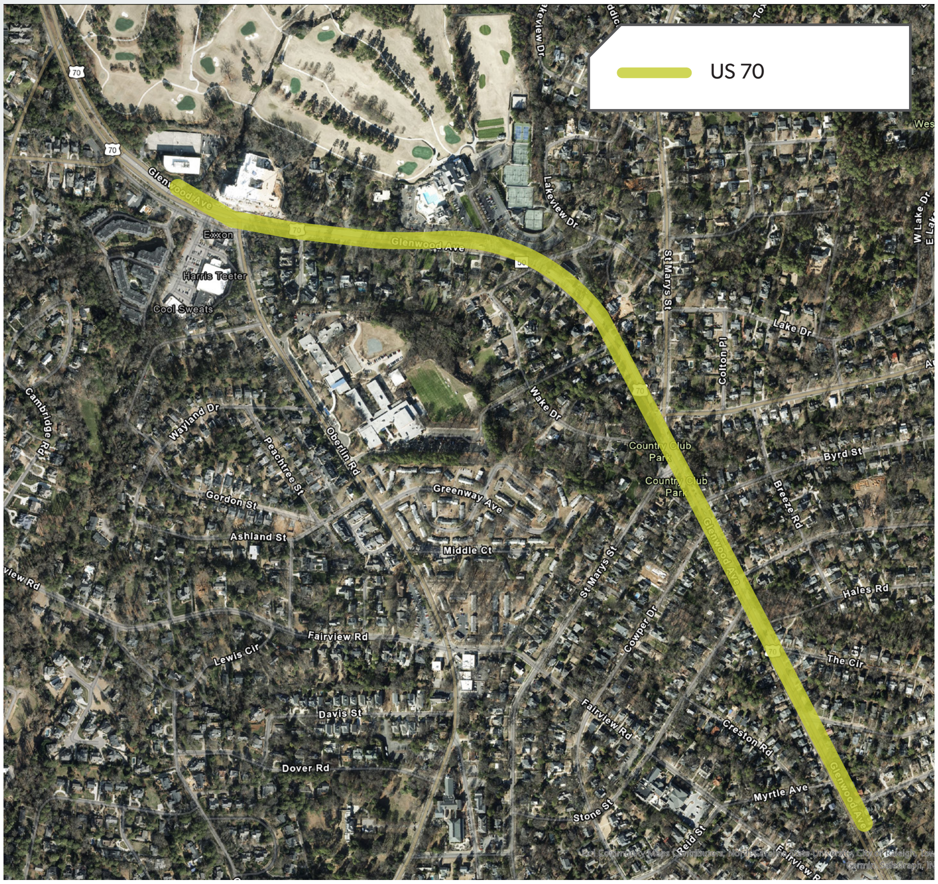


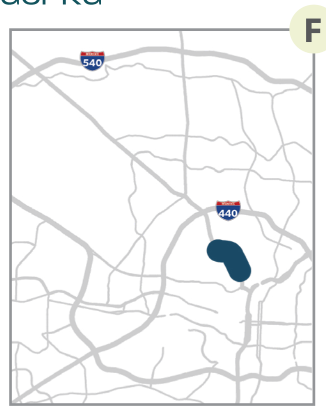


- **8** US 70 narrows back to two travel lanes and turning lanes south of Women's Club Drive.
- Enhance access to transit.
  - Identified stops on route that have no sidewalks or signage.
  - Abutting land use is walkable to transit.
  - Use existing crossings and/or add crossings and signal modifications.
- Right-Turn – Dedicated transit (marked) and limited right-turns/driveway access.
- Stops should be far-side of signals with queue jump/right-turn lanes.

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Segment F - Glenwood Avenue - From Oberlin Rd to Alexander Rd





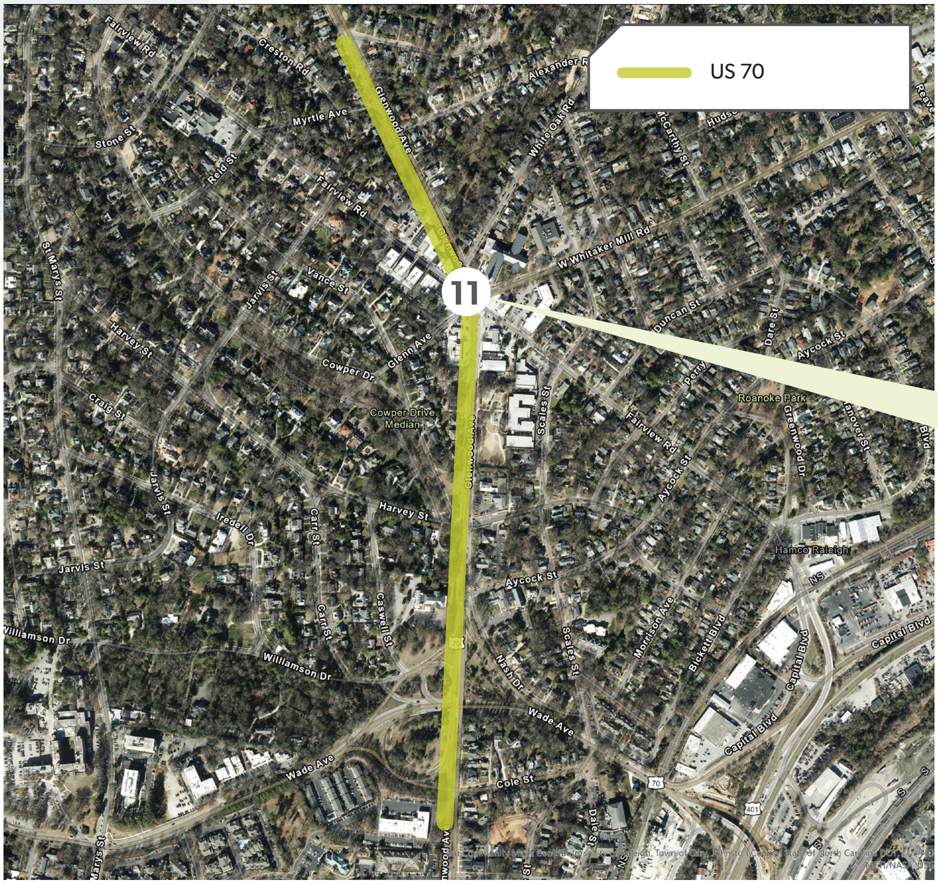
10 Center bus lane, Eugene, OR
Source: Stantec

This section of US 70 is predominantly surrounded by residential development. Identifying and enhancing stops along this corridor can increase access to the surrounding neighborhoods.

- No excessive delays between the intersections but high signal density causes delays at the intersection.
  - Queue jumps and signal priority/phasing improvements where possible.
- Stop accessibility can be limited along the corridor.
  - Existing stops are more frequent, but poorly marked or defined.
  - Sidewalk widening and/or bumpout at stops where three lanes.
- US 70 is not divided southeast of Oberlin.
  - Alignment varies.
  - 2 to 3 lanes in either direction.
  - **10** Center-turning lane an opportunity for transit priority lane as there are long stretches where turns are few or not allowed, and transit could use that space even if only in the peak hour.

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Segment G - Glenwood Avenue - From Five Points to Wade Ave



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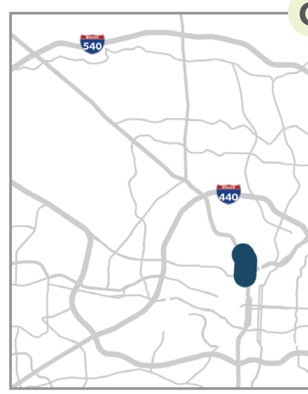


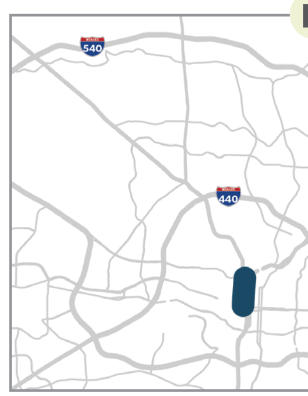
11 Five Points. Source: VHB

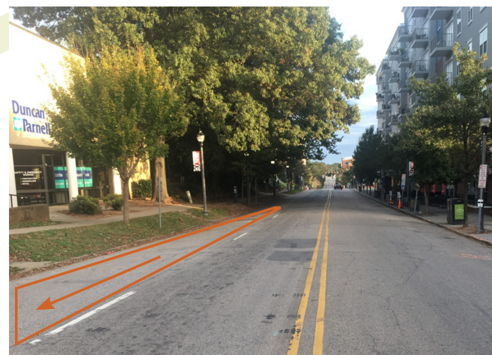
Five Points is a neighborhood center just north of downtown Raleigh. Restaurants, retail, and entertainment options are all easily accessed here. While roadway delay is not excessive along this portion of the corridor, targeted improvements can lead to enhancements to reliability and access.

- No excessive roadway delay or surgical improvements needed.
  - Queue jumps and signal priority/phasing improvements where possible.
- Stop accessibility.
  - Existing stops are more frequent, but poorly marked or defined.
  - Not accessible.
- US 70 alignment varies.
  - 2 to 3 lanes in either direction.
  - Center-turning lane or median.

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Segment H - Glenwood Avenue - Between Brooklyn Hill and Glenwood South

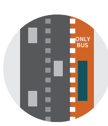




13 Potential peak hour, peak direction transit lane in Glenwood South. Source: VHB

14 On Street Parking at South Glenwood and W Lane St. Source: Bing Maps

US 70 south of Wade Ave transitions from a residential thoroughfare to a bustling downtown district in Glenwood South. In the downtown district, there are a high density of restaurants, retail, and office buildings. Current transit operations in Glenwood South are slow due to the frequent signals, tight geometry, and parallel parking. While this is an important corridor to serve, FAST enhancements could facilitate decreased transit travel times through the corridor.

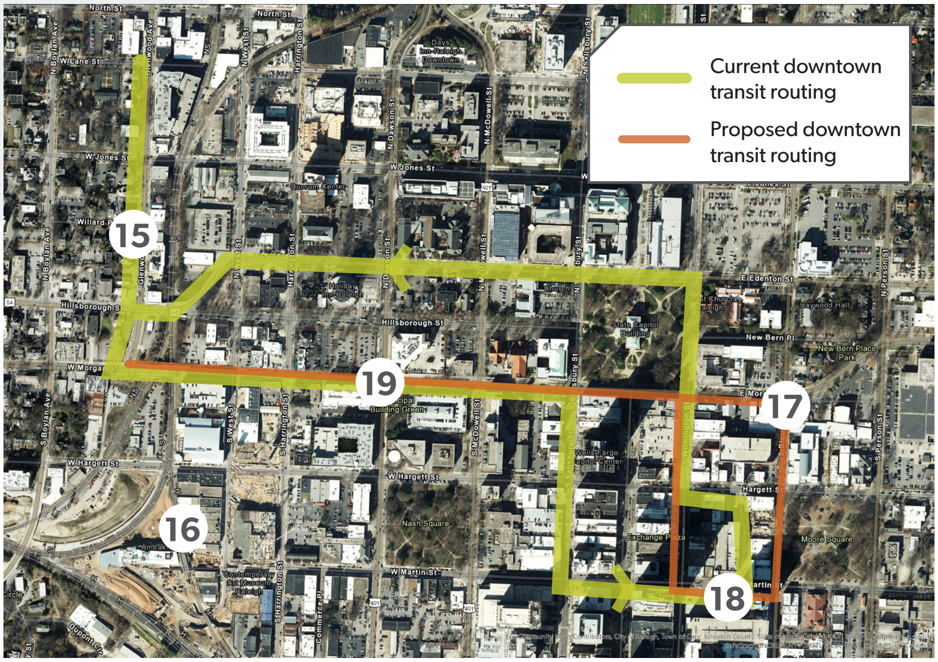


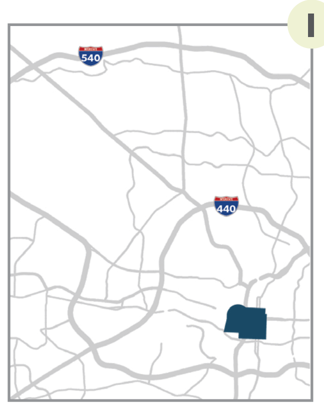
- Existing parallel parking.
  - Removes existing parking during peak direction/hours.
  - Peak hour, peak direction bus lanes.
  - Can be implemented immediately and then made permanent.

- Frequent signals.
  - Signal improvements/priority.
- **12** No excessive roadway delay north of Peace Street.

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Segment I - Downtown Raleigh

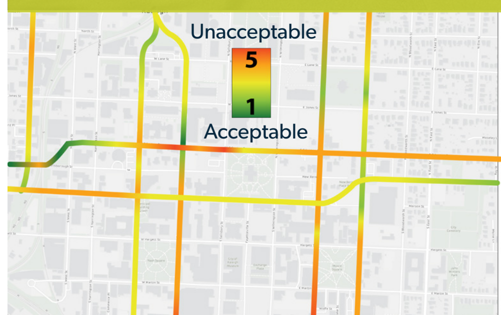




Transit routing within downtown Raleigh is challenging given the blend of one-way pairs, tight geometries, and multitude of destinations. Current routing can be confusing to new riders. Simplifying routing to be more direct and quick to GoRaleigh Station could enhance the rider experience.

- **15** Address bus speed and reliability by implementing:
  - Peak hour/peak direction bus lanes.
  - Removes existing parking.
  - Can be implemented in short- or immediate-term and then made permanent.
  - Signal improvements/priority.
- **16** Planned Raleigh Union Station Bus Facility.
- **17** Contraflow bus lane on Morgan St.
- **18** GoRaleigh Station.

19 On-Street Parking on Morgan St.
Source: VHB



FAST evaluation of 2035 Traffic Performance.
Source: VHB

Level Boarding in Charlotte, NC
Source: CDOT

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

NC 147 Corridor (Future I-885)

Research Triangle Park/South Durham to Downtown Durham

Durham County, NC

Existing Service along NC 147 Corridor

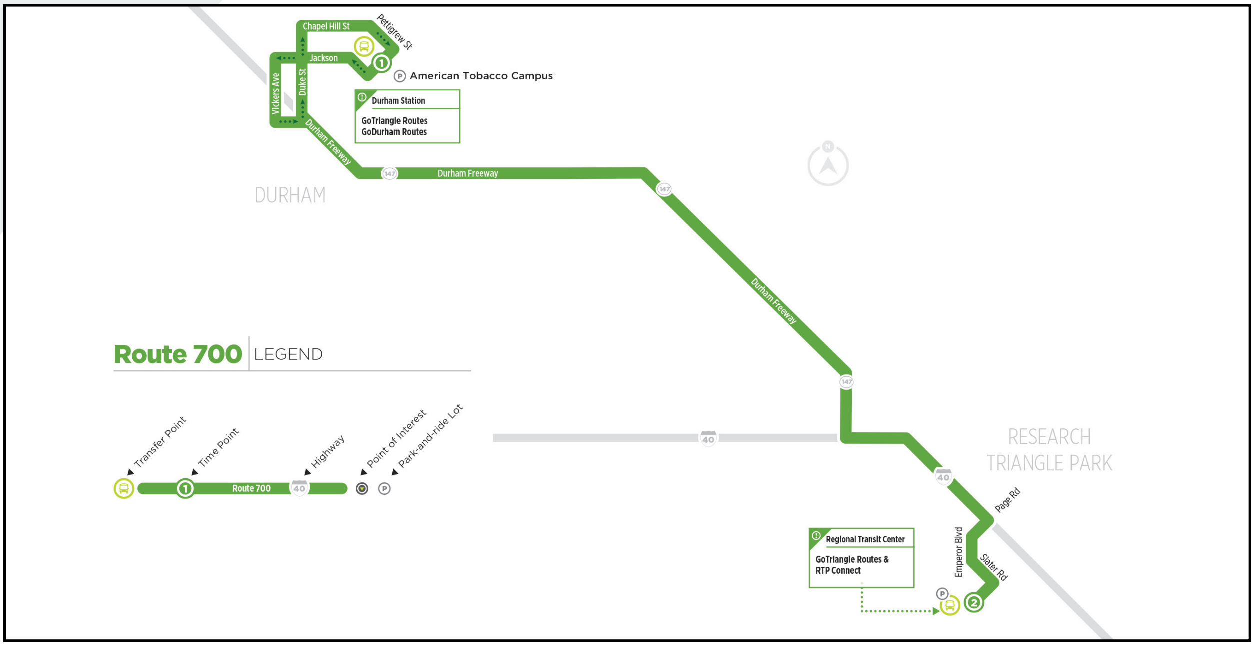


Figure 13. GoTriangle Route 700 from American Tobacco Campus to Research Triangle Park

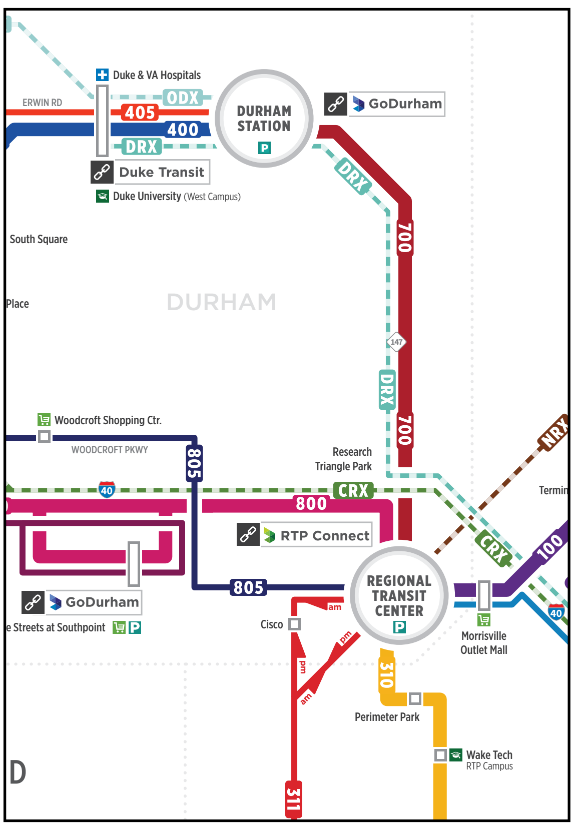
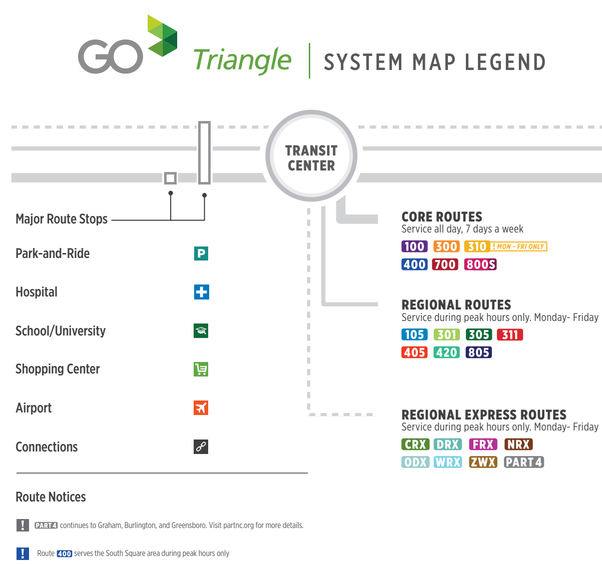


Figure 14. GoTriangle Route Map



Source: GoTriangle.org

NC 147 Corridor Existing and Future PM Peak Hour Congestion

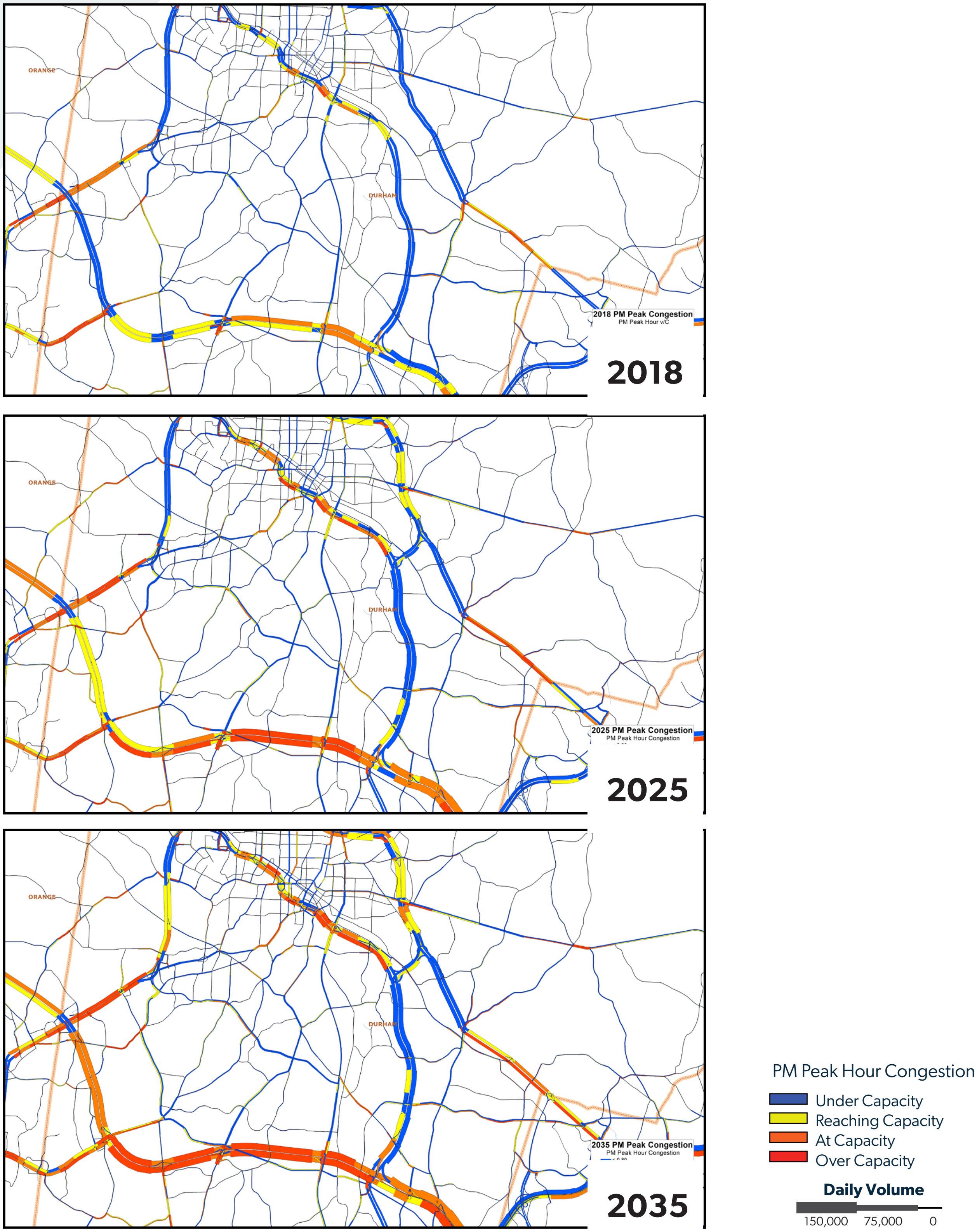


Figure 15. NC 147 Corridor Existing and Future Volume/Capacity Ratio

NC 147 Corridor Deeper Dive Segments

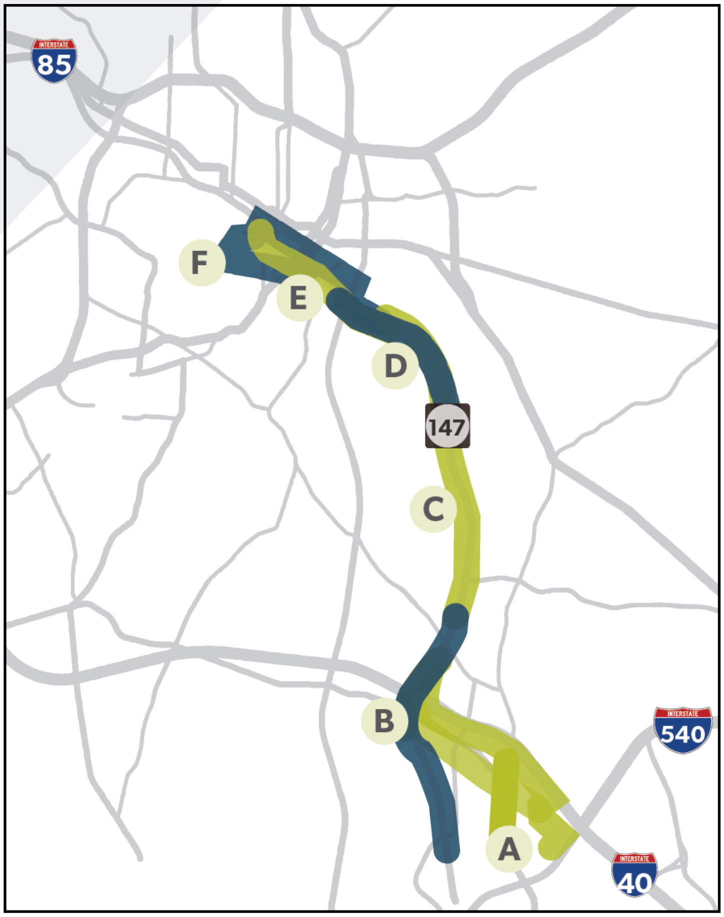


Figure 16. NC 147 Deeper Dive Segments

A From Existing Regional Transit Center at Page Road to Durham Freeway - *Currently there is a study underway (https://gotriangle.org/rtc) for relocating the RTC. The methods and framework used for the FAST study are still applicable. The next phase of feasibility study for this corridor should delve into the specifics details to consider the new location for the RTC.*

B From Hopson Rd to E Cornwallis Rd

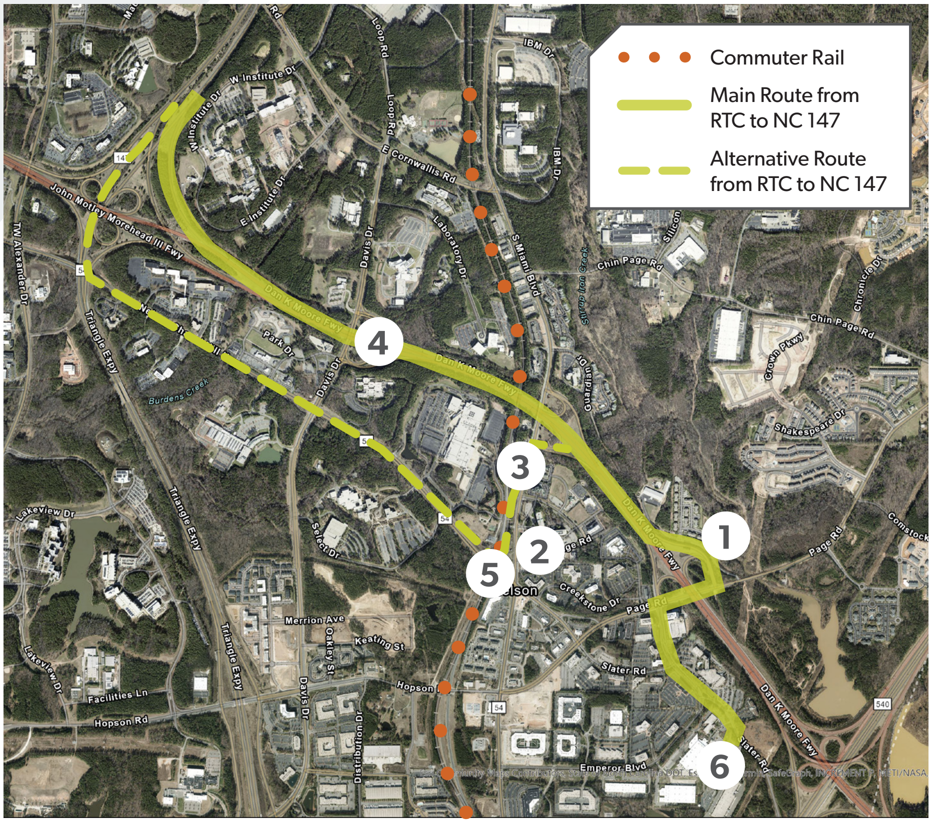
C From TW Alexander Dr to East End Connector (I-885)

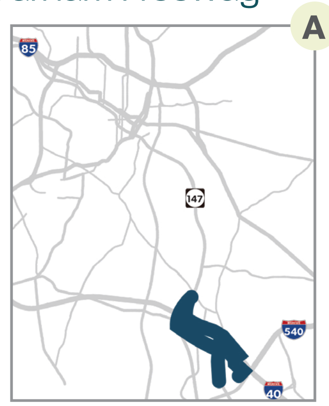
D From East End Connector to Alston Ave

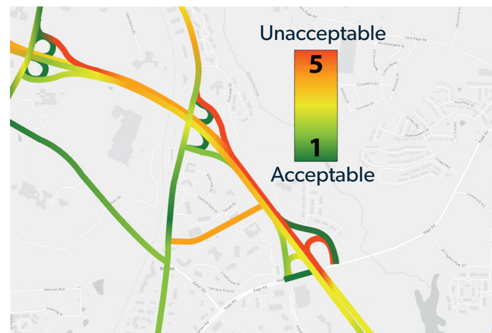
E Downtown Durham Option 1 (From Alston Ave to Durham Station)

F Downtown Durham Option 2

Segment A- From Regional Transit Center at Page Road to Durham Freeway







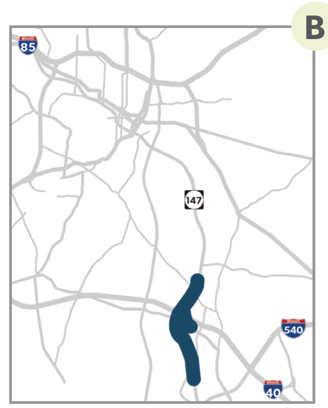
FAST evaluation of Traffic Performance for 2035. Source: VHB

The Regional Transit Center (RTC), located at 901 Slater Road in Durham, is the heart of GoTriangle operations and the primary transfer point between seven GoTriangle routes. As currently situated, buses can take seven to ten minutes to reach I-40 during rush hour which leads to increased overall travel times for cross-region transit trips. Targeted FAST improvements within southern RTP can lead to improved operations to the RTC and increased accessibility to employment centers.

- **1** Ramp congestion on I-40 at Page Rd.
  - Add ramp bypass to tie into BOSS.
- 2/3 limited transit access along NC 54 and Miami Blvd.
  - RED lanes along corridor to maintain acceptable transit travel times.
  - Add enhanced bus stops to increase access to employment opportunities.
- **4** Delay along I-40.
  - Widen shoulders where widths are less than 12′ to accommodate BOSS.
  - Install ramp meters as a part of STIP project I-6006 to enhance BOSS operations.
- **5** Relocate Regional Transit Center to leverage connections to commuter rail.
- **6** Existing Regional Transit Center.

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Segment B- From Hopson Rd to E Cornwallis Rd

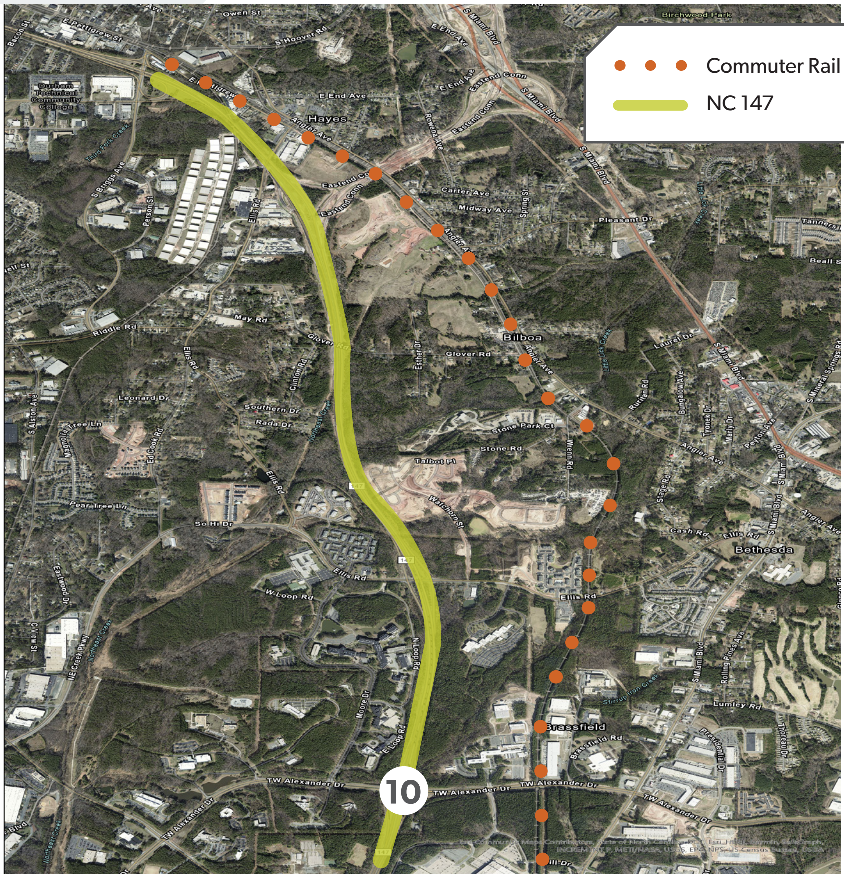


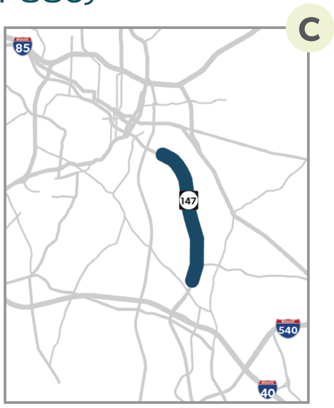
7 NC 147 and I-40 interchange.
Source: Bing StreetView

The NC 147 and I-40 interchange is a critical interchange for regional mobility within the Triangle. To the west is Chapel Hill, to the north is Durham, and to the east is Raleigh. Improvements at the interchange can result in continuous BOSS operations and enhanced regional transit mobility.

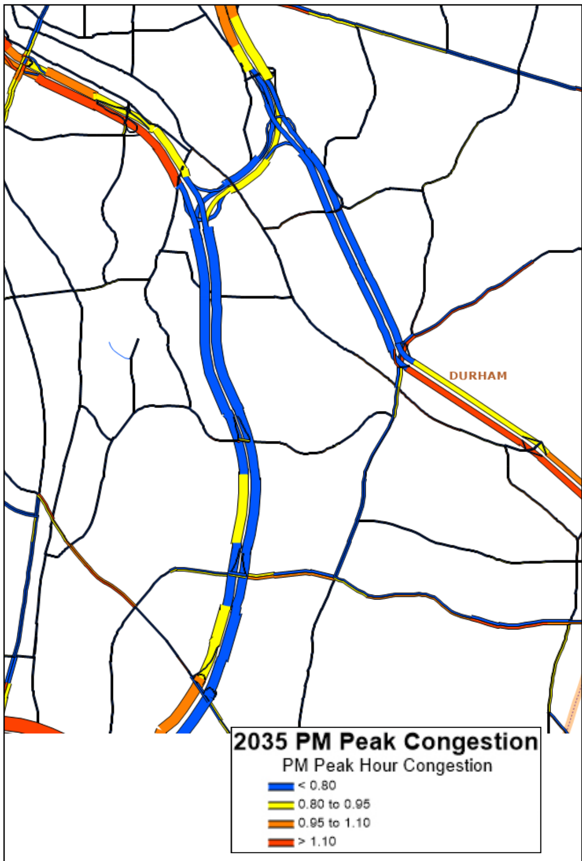

- **7/8** NC 147 SB to I-40 EB ramp merges into center lanes.
  - BOSS to ramp from NC 147 SB to I-40 EB as a part of STIP project U-5934; NC 147 widening.
- **9** NC 147 widens again after I-40 on-ramp.

Segment C- From TW Alexander Dr to East End Connector (I-885)





This section of NC 147 is a key link between downtown Durham, RTP, and I-40. The Durham-Raleigh Express and Route 700 use this section of roadway. FAST enhancements to this corridor will enhance bus travel speeds to reduce travel times between Durham and regional destinations.

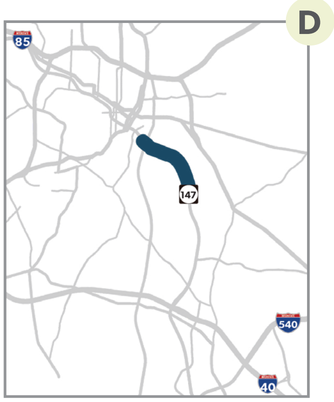


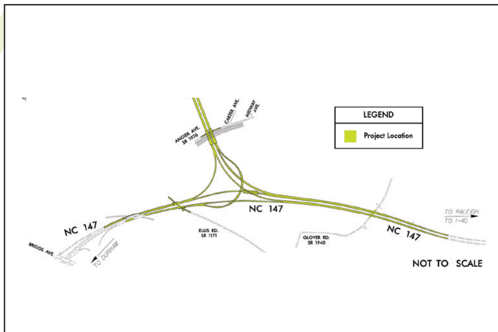
PM Level of Service
Source: Triangle Regional Model

- **10** Significant AM and PM congestion SB from Alexander Drive south and NB from I-885 north.
  - When NC 147 is widened as a part of project U-5934 include a transit priority lane on left side of the highway in both directions.
- There is not sufficient width for bus travel on shoulder, especially at pinch points, bridges, etc.
  - Re-stripe roadway to allow BOSS on left shoulder as a part of U-5934 providing transition between bus lane and vehicle lane.

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Segment D- From East End Connector to Alston Ave





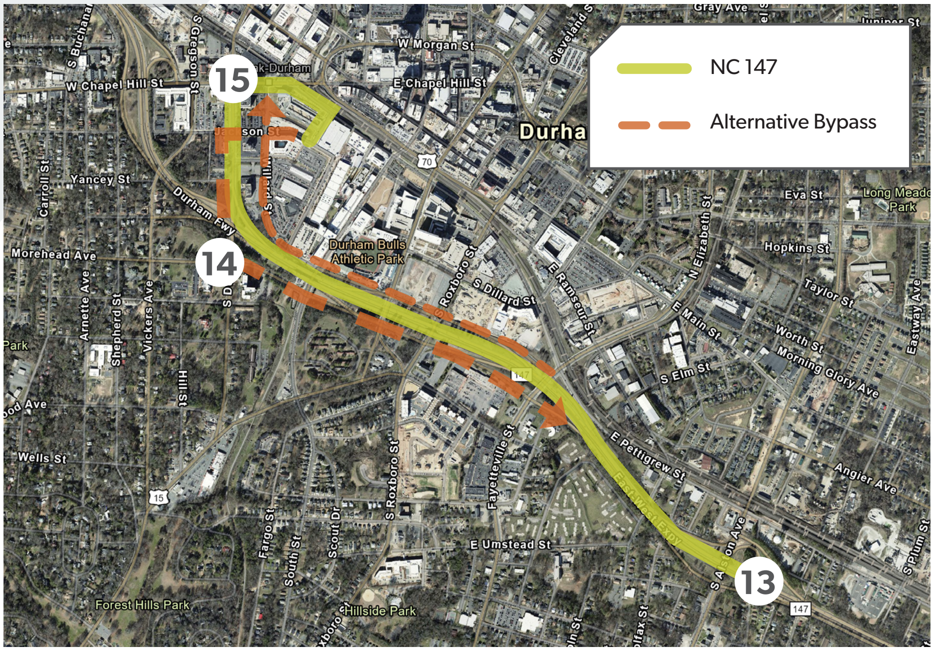
12 East End Connector Plans.
Source: NCDOT

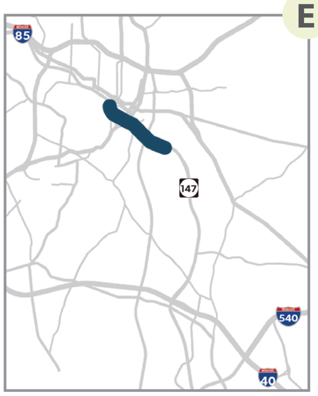
The East End Connector presents both challenges and opportunities for transit along the NC 147 corridor. Taking advantage and building off this investment will be central to enhancing regional transit.

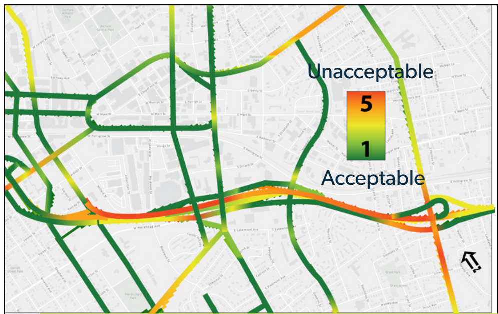
- **11** BOSS
  - Would have to design interaction with frequent interchanges.
  - Some potential time savings if regularly congested.
  - Include BOSS as a part of NC 147 operational improvements project STIP U-5937.
- **12** Not conducive to BOSS. There is limited simple opportunity to add BOSS with the East End Connector and implementing would require significant re-evaluation of the design. There is limited congestion in this stretch and thus minimal benefits to transit interventions. Buses are likely to travel in the left lane (or shoulder) to avoid interchange friction – but space would need to be evaluated.
  – https://www.ncdot.gov/projects/east-end-connector/Pages/default.aspx

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Segment E- Downtown Durham Option 1 (From Alston Ave to Durham Station)







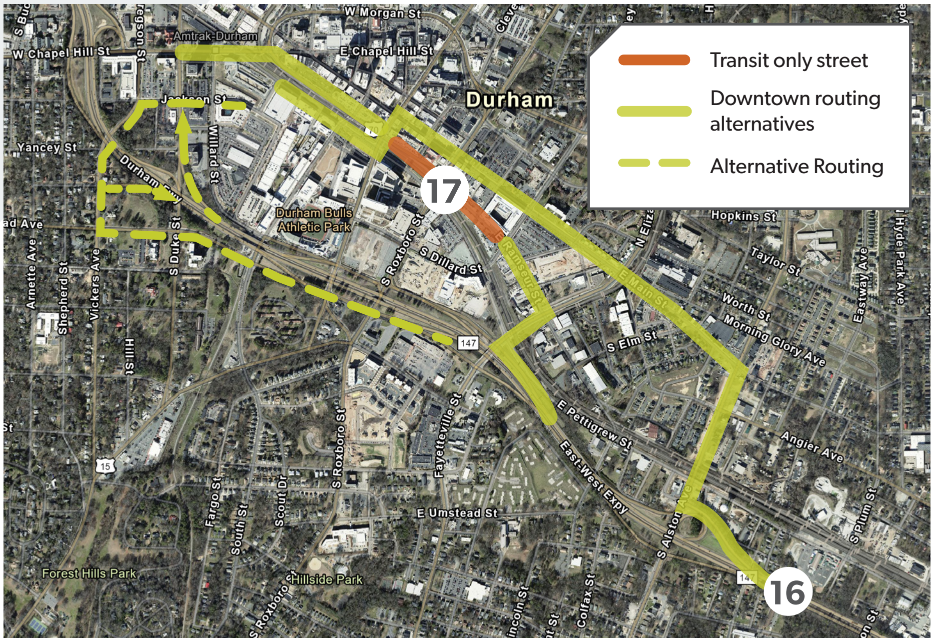
FAST evaluation of 2035 Downtown Durham Traffic Performance. Source: VHB

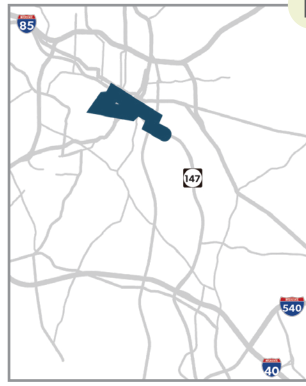
Regional transit routing within Durham and to Durham Station is essential in determining trade-offs in speed and access. Downtown Durham Option 1 considers the use of Jackie Robinson Dr and Morehead Ave as an alternative to current transit routing along NC 147. Use of FAST treatments along this alternative corridor could increase accessibility, while limiting adverse impacts to travel times. Further, The Durham Station Transit Emphasis Zone Study will examine additional ways to prioritize transit in Downtown.

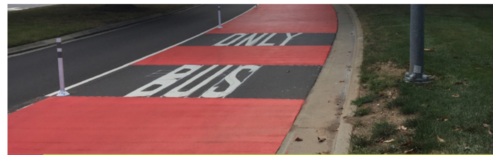
- **13** Congestion along NC 147.
  - Evaluate potential time savings associated with routing on Jackie Robinson Dr w/ RED Lane, peak hour restrictions, signal priority, and bus stops.
  - Include BOSS as part of NC 147 operational improvements project STIP (U-5937).
  - **14** Return on Morehead Ave/service road.
  - Can add transit priority lane (remove parking) and take advantage of existing bus only merge.
  - Signal priority and queue jumps.
  - **15** Contra-flow bus lane on Duke Street.
  - Delays due to games/events. Parking cars, drop-offs, and large pedestrian volumes during PM peak will be fairly frequent, and disruptive.

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

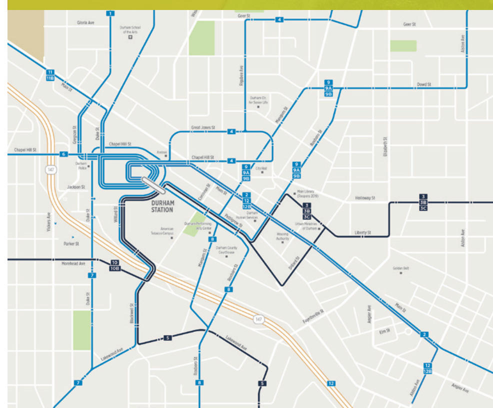
Segment F- Downtown Durham Option 2







RED Lanes in South Durham.
Source: VHB



GoDurham Downtown Routing.
Source: GoDurhamTransit.org

Downtown Durham option 2 reviews the potential for alternative routing along E Main St or S Ramseur St. These alternatives would increase access to rapidly growing Golden Belt and City Center. While this alternative routing to NC 147 may result in increased end-to-end travel times, one outcome is shorter walking trips for riders reaching their final destination within Durham. Including FAST treatments including TSP, RED Lanes, and Enhanced Bus Stops along these alternative corridors can lead to an enhanced transit experience.

- **16** These alternative routings may operate at a slower rate, but increase accessibility.
  - TSP to reduce signal delay.
  - Enhanced Bus Stop to increase comfort.
  - RED Lanes to enhance reliability.
  - Buses on/off 147 sooner, reducing delays associated with freeway congestion.
  - Provides better access to Downtown along with redeveloping mixed-use and government services east of Downtown.
  - FAST improvements here would benefit more local routes.
- **17** Transit only on Ramseur St between Dillard and Magnum St.

Orange ▸ = Issue
Blue ▸ = Opportunity
Gray ▸ = Solution

Frequently Asked Questions (FAQs)

FAST Overview

What is "Freeway And Street-based Transit"?

Freeway And Street-based Transit – or "FAST" – is a scalable approach for quickly integrating "transit advantage" infrastructure along the roadway system to support enhanced transit service. The "FAST" approach prioritizes transit efficiency and reliability while improving mobility for all users.

What are some examples of "transit advantage" infrastructure?

A Freeway And Street-based Transit (FAST) corridor incorporates one or more "transit advantages," which are purposeful, scalable infrastructure investments to keep transit moving, including transit priority lanes and shoulders, such as the growing Bus On Shoulder System (BOSS) in the Triangle, as well as direct access ramps, transit signal priority and queue jumps at intersections, and near-level boarding at transit stops and stations.

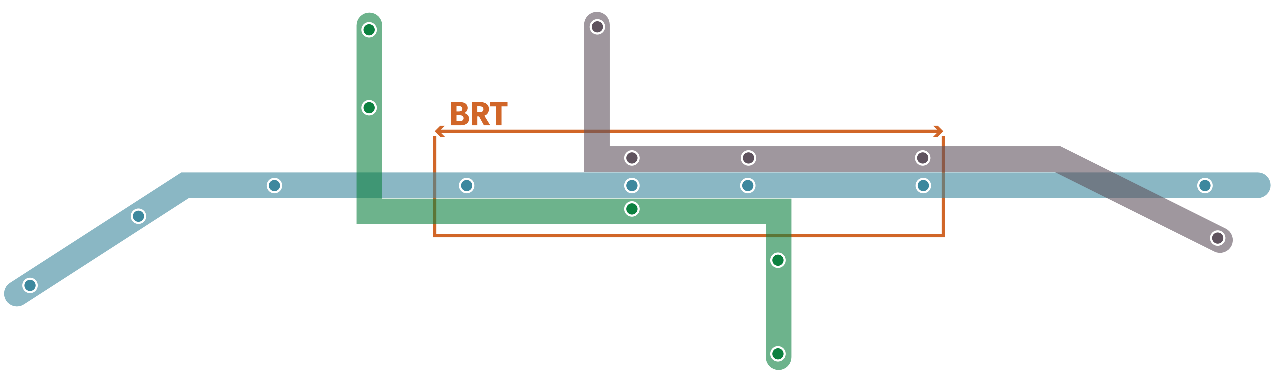
How do FAST corridors compare with, and complement, Bus Rapid Transit (BRT)?

Bus Rapid Transit (BRT) is a highly visible, concentrated corridor investment with extensive transit advantage infrastructure, served by one or more frequent transit routes. Communities can augment BRT with complementary land use policies to focus development. The Triangle area will activate more than 25 miles of BRT this decade, and other areas are exploring BRT.

A Freeway And Street-based Transit (FAST) corridor can effectively provide a low-cost regional extension of and complement to bus rapid transit by enhancing non-BRT roadway segments with varying degrees of transit advantage infrastructure. An example FAST network concept in the Triangle envisions an interconnected regional transit network along 10 area roadways that links to the 5 BRT corridors and future commuter rail.

What are trunkline segments?

Trunkline segments are corridors that are shared by multiple transit routes. FAST routes could utilize BRT infrastructure creating a trunkline to enhance speed and reliability while eliminating the need to transfer.



What is a regional FAST network?

A regional FAST network is a series of interconnected FAST corridors with transit advantage infrastructure that can deliver rapid, frequent, and easy-to-use bus service. A FAST network leverages and improves the roadway system to connect and optimize current and future transit investments, including bus rapid transit and passenger rail, along with complementary services including vanpools and micro-transit.

Creating a regional FAST network accelerates new connections and expands overall transit network benefits, optimizing the user experience.

Can the development of regional FAST networks improve equity for a community?

Regional FAST networks will enable metropolitan areas to quickly create or expand an enhanced, interconnected regional transit system. Doing so will provide improved mobility options to more people, which increases equity and helps optimize a community's investment in public transit.

The FAST approach prioritizes scalability and cost-effectiveness, with a focus on maximizing network benefits to rapidly provide higher quality transit to as many people as possible, as quickly as possible.

FAST study and implementation

What are the goals of the 2020 FAST network study?

The 2020 regional FAST network study was designed to inspire, inform, and advance new ideas for improving mobility by providing an example framework for institutionalizing transit accommodations. The study objectives were to develop and illustrate an example regional FAST network, create a guidance framework for quickly implementing transit advantages for communities in North Carolina, and help institutionalize transit priority measures in the statewide planning and development process.

How was the example regional FAST network in the Research Triangle area developed?

The proposed corridors in the example FAST network for the Research Triangle region were identified through a robust technical process that reviewed existing roadway footprints and proposed enhancements, transit, land use, population, employment, travel, and other considerations that highlight potential demand for enhanced transit. The corridors were also reviewed for the potential to accelerate new connections and expand overall network benefits across the regional roadway system.

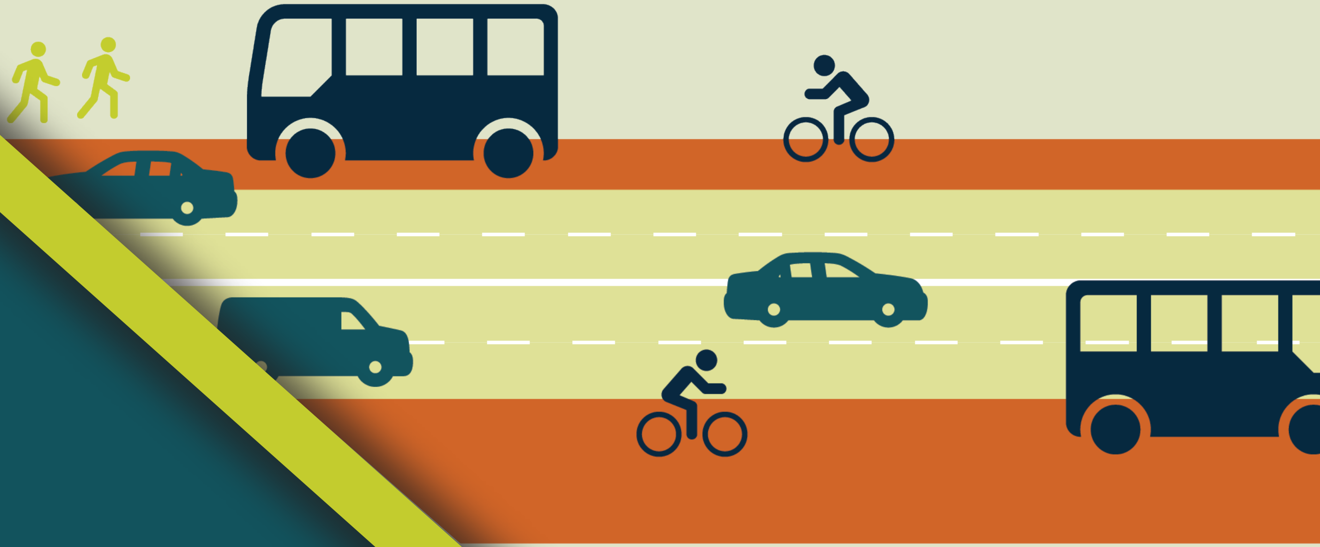
How can the 2020 FAST network study inform local and regional transportation planning efforts?

In the Triangle region, transportation partners can incorporate proposed FAST investment concepts into developing transit plans and corridor studies, and pursue the integration of FAST infrastructure into statewide-funded projects in the Strategic Transportation Improvement Program (STIP).

All regions of the state can utilize the FAST approach to help instill a transit focus in the design and construction of roadway projects, incorporate transit elements into traffic operations including improved trunkline segments, and identify opportunities to enhance and connect regional transit.

How will NCDOT support the implementation of the FAST approach?

NCDOT is committed to making North Carolina's roadways work better for public transit and supports the creation of FAST networks in metropolitan areas across the state. NCDOT is revising the state Roadway Design Manual to include transit advantage elements, and is pursuing changes in the Complete Streets policy to include transit options.



Appendix A

Technical Analysis Methodology

FAST

Freeway And Street-based Transit network

TECH MEMO

Memorandum

To: Joe Milazzo, RTA

Date: May 1, 2020

VHB Project #: 39165.00

From: VHB FAST Team

Re: RTA FAST Network Study
Phase 1 (Visualize) Technical Approach

The scope of work for the FAST Study incorporates two phases:

- **Phase 1: Visualize** identifies routes with potential transit ridership benefits resulting from operational or infrastructure improvements, based on a combination of travel demand, traffic and transit performance, and corridor context. Analyses will proceed from existing conditions through interim years to the ultimate 2045 plan year.
- **Phase 2: Believe** recommends appropriate types of improvements for the opportunities identified in Phase 1 and develops a prioritized plan for implementation. This implementation plan will evolve through a process of iterating among existing, interim year, and 2045 conditions. This process must coordinate FAST recommendations with other transportation infrastructure and land development plans, considering project lives, timing, and integration opportunities.

This memorandum summarizes the technical approach For Phase 1, focusing on developing the FAST network (service, standards, and corridors). The review and incorporation of available studies, plans, and data is a given at the outset of Phase 1. Interim results of the analyses described below will be shared with the Steering Committee for feedback and validation; a status meeting mid-May may be scheduled for this purpose. To maintain schedule, ongoing communications with staff of transit agencies will address specific questions as they arise.

PHASE 1: VISUALIZE

Our approach to the Vision Phase of the FAST study applies multifactor screening to identify corridors and corridor segments with the greatest potential to benefit from FAST enhancement strategies in term of shorter travel times, greater reliability, improved comfort and convenience, broader accessibility. Ultimately, the goal is to define an integrated, implementable set of cost-effective improvements that will increase ridership across a diverse market.

In addition to being compatible with established budget and schedule, a successful approach for this project must be scalable and transferable, rely on readily available and forecastable data, and yield visualizable results that are technically sound yet easily communicated. Outcomes will focus on opportunities with impact potential, projects that "move the needle" in the near term, while building a foundation for future progress. This boils down to determining the size of the travel market affected multiplied by the magnitude of the transit service improvement realized. These benefits will be further analyzed to assess the equity of the distribution of benefits (and costs) by market type, especially underserved communities or disadvantaged populations.

The proposed metrics for determining the suitability of a range of possible transit improvements are organized into two tiers, each of which consider both existing and future conditions. Each metric will be weighted to reflect importance, uncertainty, and associated contingencies. The first set of metrics is applied to screen corridors to

Memorandum

establish potential transit mobility benefits, identify candidate improvement types, and provide a preliminary estimate of the type and magnitude of benefits.

The second screening tier is applied to candidate projects that have demonstrated potential for improving mobility in the Tier 1 analyses. Tier 2 consists primarily of quantifying accessibility benefits and identifying the socio-economic profiles associated with the user communities who benefit (or who are harmed). This second analysis tier also considers the impacts of planned projects and identifies "missing links" in the transit network. **Figure 1** depicts the basic elements and relationships of the two tiers in Phase 1.

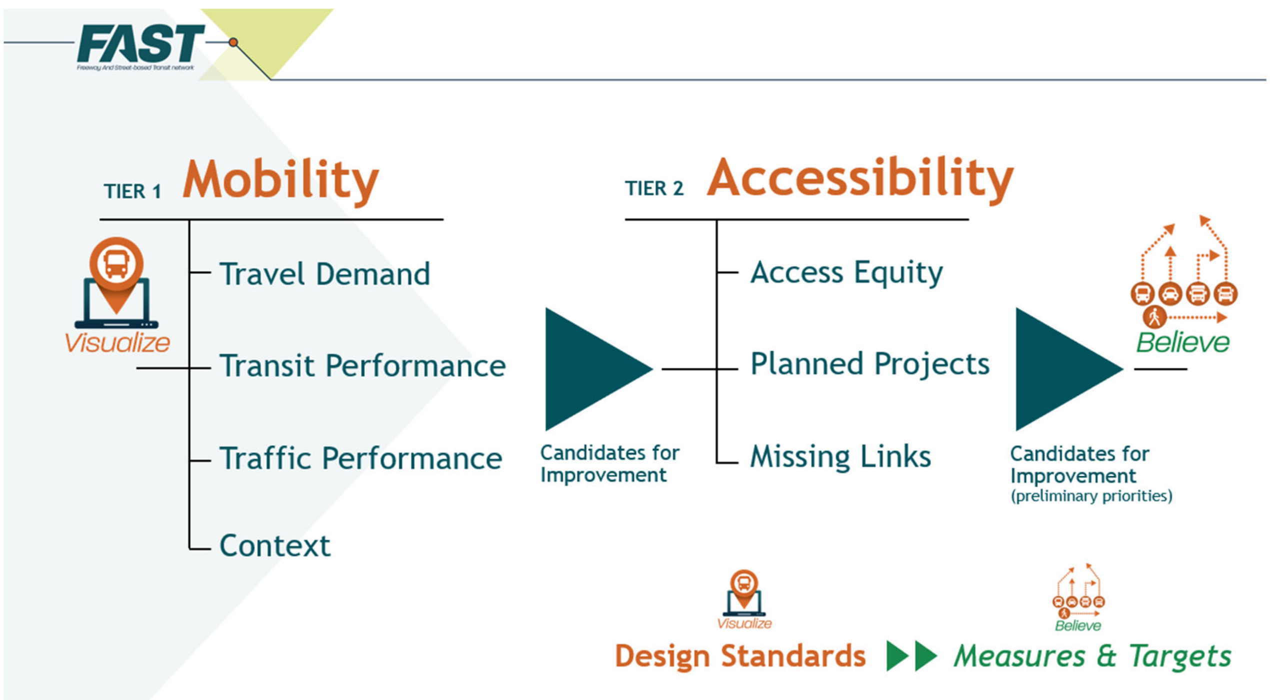


Figure 1: Tiered Phase 1 Process

<u>Tier 1 – Mobility</u>

The mobility tier includes four sets of metrics:

- Travel Demand
- Transit Performance
- Traffic Performance
- Context

Each potential metric is summarized below. The single most suitable metric in each category (in terms of explanatory power, availability, simplicity, ease of forecasting, and reliability), is listed first and tagged with an asterisk. Within each category, multiple metrics would be assigned a weight. Although there is value in maintaining these subtotal scores, relative weights could also be applied to each category total to generate composite score. The final form of the metrics and the relative weighting decisions will depend on testing of initial results.

These metrics lend themselves to GIS analysis and display. Overlaying the results of each metric category will help both in quantitative analysis and in communicating findings. **Figure 2** is an example from a commuter study of the Metrolina Region, depicting AM commuter travel demand along with current transit routes categorized by service frequency. **Figure 3** represents the levels of road congestion relative to transit service. Analyzing and combining results from these and similar maps (depicting land use, accessibility, facility type, and other attributes) provides a basis for identifying and quantifying opportunities for improvement.

Although both existing and future conditions will be evaluated, it is anticipated that existing conditions will weigh more heavily due to this project's emphasis on Super FAST implementation, and the uncertainty associated with future forecasts. Additional consideration of future conditions will take place in the Tier 2 analysis.

Travel Demand (whether in terms of traffic or transit ridership) must be great enough to yield enough benefits to warrant improvements. There must be a sizeable market for potential ridership growth, and travel demand should be increasing over time.

- *Traffic volumes** (AADT) are readily available from count programs and travel demand models and provide the best single indicator of travel demand in a corridor.
- *Transit ridership* provides a baseline of current transit demand, but in itself does not indicate potential for increases, outside of model results.

Transit Performance reflects critical characteristics of transit operations or service that can significantly affect its attractiveness as a travel option.

- *Frequency** (or alternately, effective headway) is the simplest representation of the level of transit service provided in a corridor, especially when headways are short enough that they do not affect scheduling decisions for potential riders. It can also be a surrogate for demand, since higher frequency typically correlates with higher demand. This is an easily obtained metric that can be evaluated under a range of future policy scenarios.
- *Reliability* (or schedule adherence) is an important factor both for providing a functional service and in attracting additional riders. Typically thought of in terms of lateness, an even more disruptive problem for users is uncertainty about <u>early</u> arrivals. Transfers place an even greater premium on reliability. GPS tracking adds a more objective, quantifiable measure to user/operator feedback. Accurately forecasting reliability is a challenge, however.

Memorandum

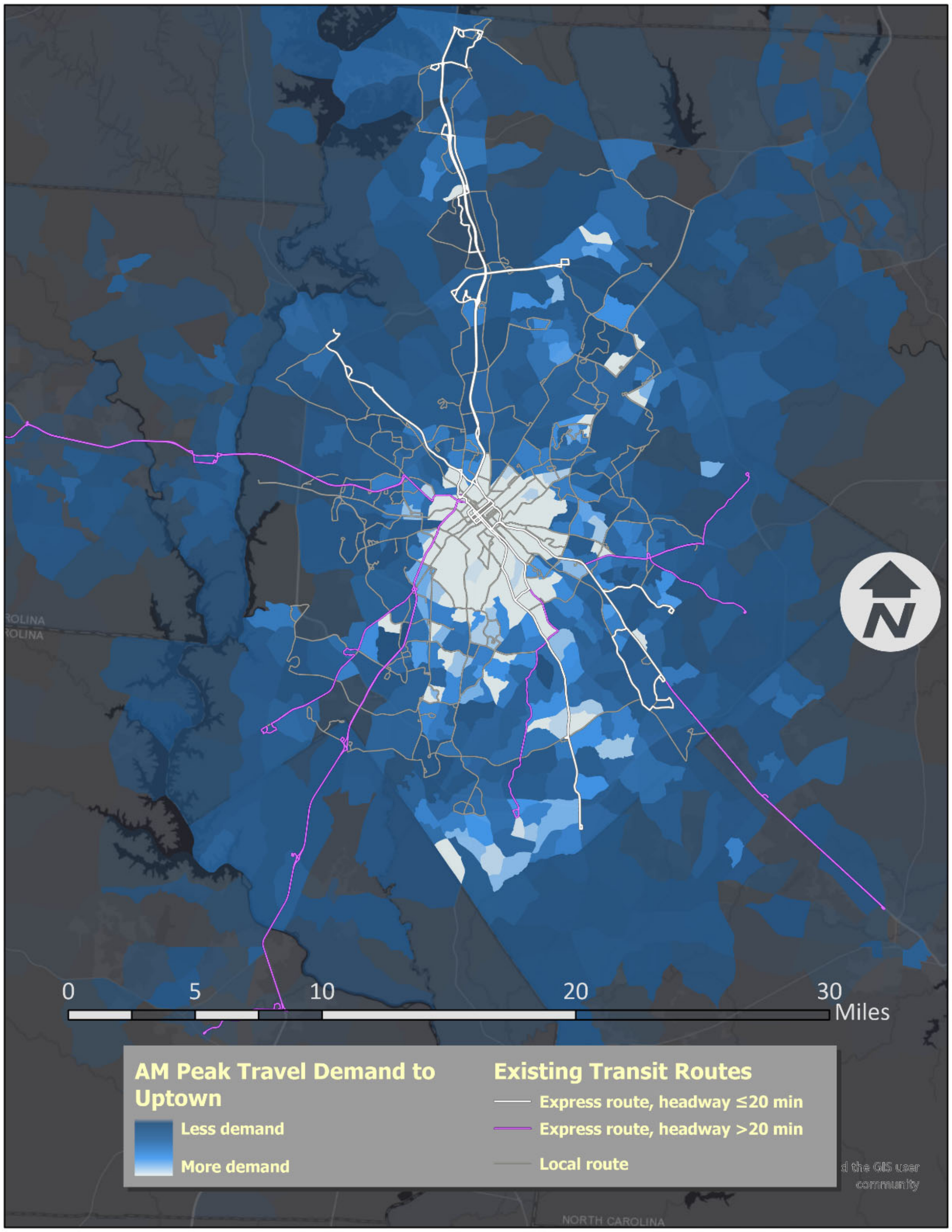


Figure 2: Travel Demand with Transit Service (Metrolina)

Memorandum

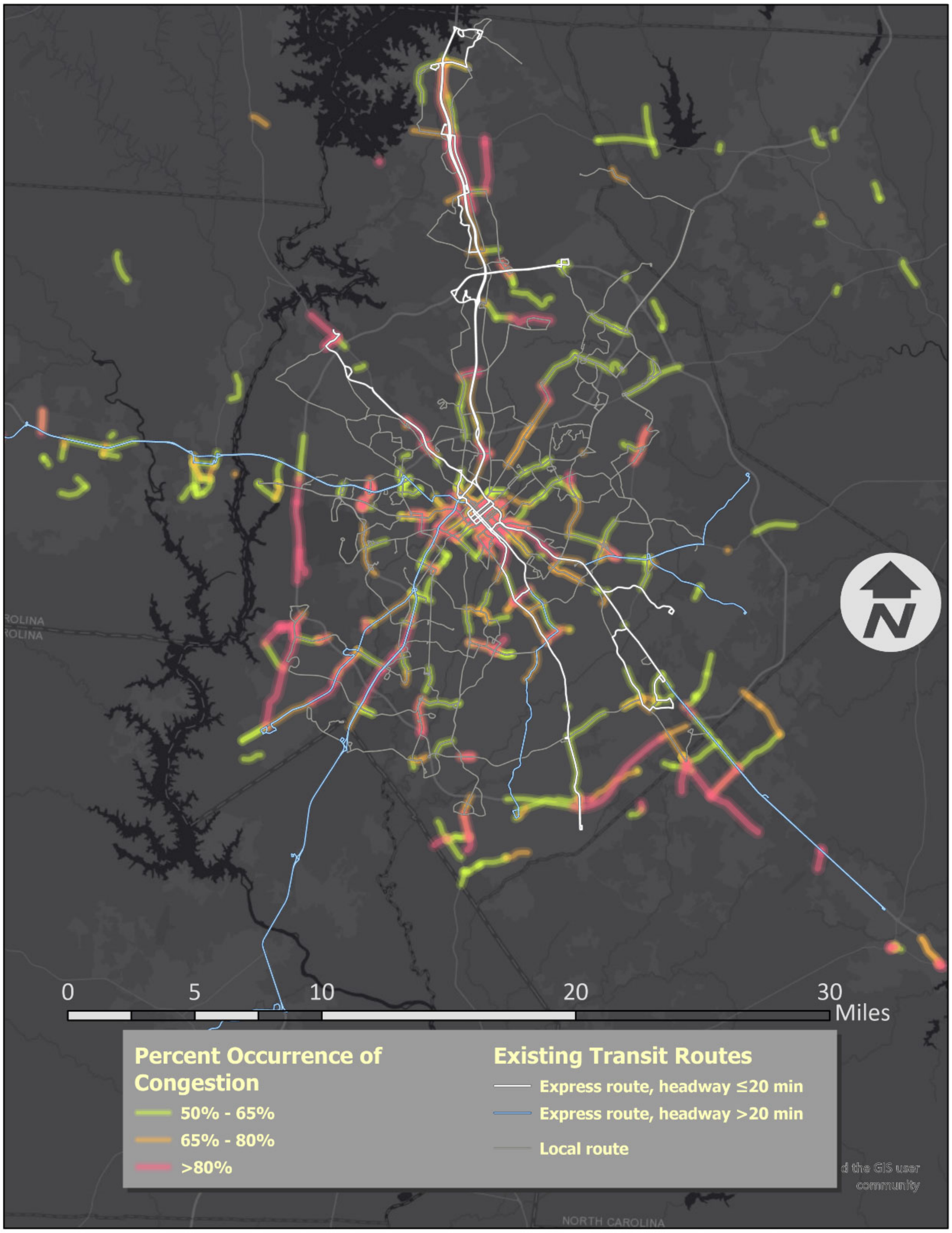


Figure 3: Traffic Congestion with Transit Service (Metrolina)

- *Speed* (or alternately, travel time) is most useful as an indicator of relative performance, rather than as an absolute value. Changes in average transit speed over time, or by time of day, or relative to traffic speeds can be of value in selecting and prioritizing potential solution options. Obtaining and forecasting reliable speed data can be challenging, although GPS tracking systems are useful in establishing baseline conditions.

Traffic Performance measures congestion that can delay buses operating in mixed traffic and impede schedule adherence. High levels of congestion can reduce the relative attractiveness of driving over transit. If congestion is minimal, there may be little opportunity for the types of transit improvements in this study to yield significant benefits.

- *Delay** is a measure of congestion (relative to free-flow or other targeted conditions) that can be obtained from HERE data and estimated from regional travel demand models. It is essential to capture the various dimensions of delay in terms of intensity, extent, timing, duration, and variability/predictability. These attributes greatly influence the type and effectiveness of potential solutions and can determine whether full-time or part-time implementation is most appropriate.
- *Volume/capacity ratios* can be estimated from regional travel demand models; detailed capacity analysis is not practical within the scope of this study. Variations by direction and time of day must be considered. Understanding the unused or reserve capacity available along a roadway segment can help determine the suitable solution options.

Context refers to the type of roadway facility and its surrounding land use. The distinction between freeway and non-freeway facilities is important, due to differences in operational characteristics, land use interactions, and potential solutions alternatives. Number of lanes and right-of-way limits can be important considerations for both freeway and non-freeway facilities, although these attributes will probably more useful in identifying specific projects and prioritizing implementation in Phase 2.

- Freeway segments
- Arterial/non-freeway segments
  - *Intersection density* reflects both the intensity of adjacent land use and the type of transit improvements that might be most effective.
- Land use attributes are most relevant to non-freeway corridors. Key measures are the type, mix, and density of commercial, institutional and residential development along the corridor. Major activity centers and special generators (such as RDU, major universities and medical centers, arenas, regional shopping centers, and CBDs) may require special treatment.

Some processing of results will be needed to develop projects that are practical in terms of scale. Lane-based treatments such as running on shoulder or red lanes have minimum feasible segments; individual intersection interventions such as queue jumps or signal priorities typically provide minimal improvement unless combined in series.

Memorandum

Tier 2 – Accessibility

The set of viable mobility improvement options identified for corridors and segments generated in Tier 1 will be assessed in terms of their impacts on transit accessibility and utility for various populations of interest. Communities of concern (based on socio-economic characteristics) will be emphasized in our analysis. Accessibility can be derived via GIS analysis and from travel demand modeling.

Accessibility to transit refers to a user's ability to reach a destination with relative ease. This study will focus on the relative change in accessibility for certain populations under various improvement scenarios. For example, the number of jobs available within 30 minutes of travel by transit. This metric can be posed from the perspective of either trip end: how many employees or patrons can reach my establishment within a given travel time, or how many jobs or shopping or other opportunities are available to individuals or households. We can further disaggregate our analysis by business type or by socio-economic characteristics of communities served, in order to assess equity impacts, or equitable distribution of opportunities. This analysis also lends itself to quantitative visualizing an analysis by GIS.

As part of Tier 2 screening, two other analyses will be conducted:

Planned projects will be reviewed for impacts, constraints, and opportunities relative to the Tier 1 findings. For example, a near-term widening project might eliminate a red lane recommendation, or it might lead to incorporation of red lanes, depending on the timing and situation. Other roadway improvements might shift transit to another route. Transit improvements such as BRT or commuter rail could change demand patterns and routing as well, either though competition/replacement or as complementary service or connection. Even major developments will need to be considered.

Missing links in the transit network will be identified. Some promising new connections might not be identified through the process described above, since there may be no existing traffic or transit data. This is true for new facilities, and especially for connecting with or complementing pending BRT corridors. Dedicated freeway entry/exit points may also be considered.

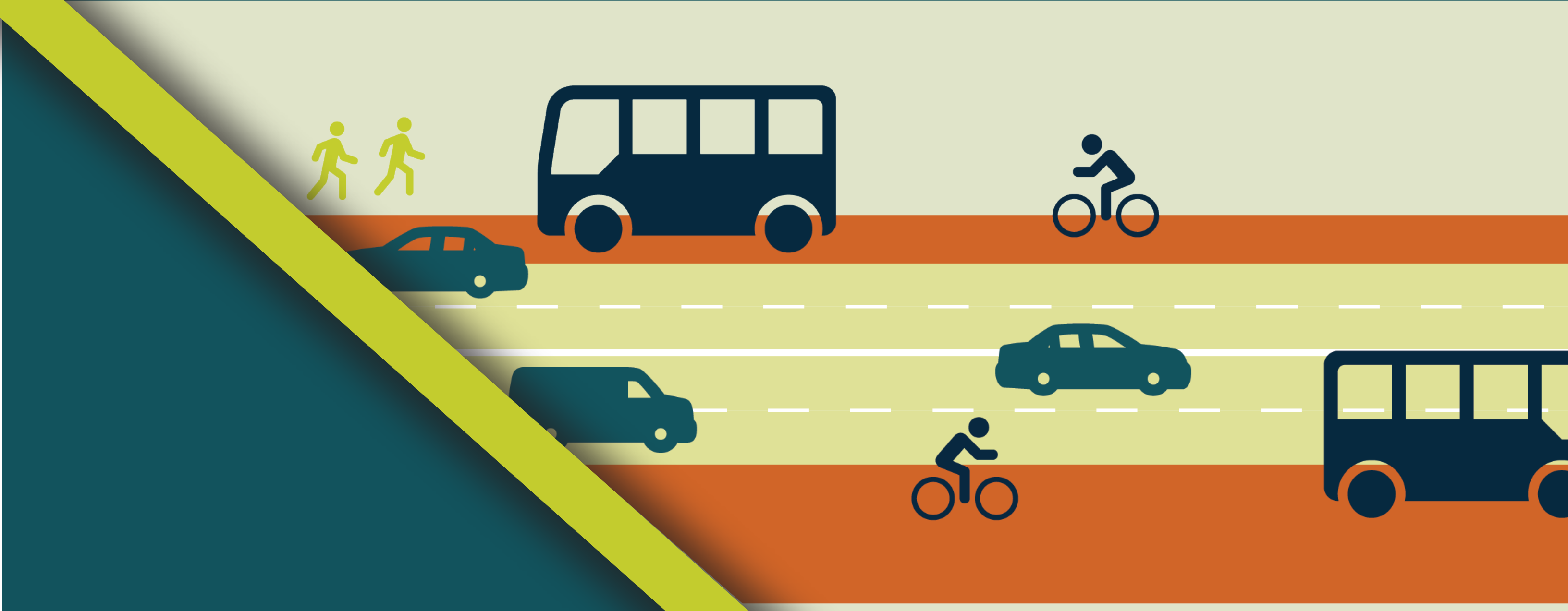
Upon completion of the data analysis inputs from the funding partners will be received via the Steering Committee meeting as per the schedule provided in the scope.

Design Standards

Design standards for both infrastructure and service will evolve through an iterative process beginning in Phase 1 and carrying through Phase 2. As potential markets and corridors are identified, the characteristics of the trips, travelers, roadways, and land uses will be used to group candidate projects into categories. Each of these categories will be associated with a set of appropriate potential improvements. Design standards will be proposed and tested for these improvement categories. Typical infrastructure design standards can include maximum stops per mile; minimum percentage of intersections with TSP; presence of level boarding; and availability of off-board fare collection. Service design standards might include maximum headways and minimum span of service. Draft design standards will be developed based on existing conditions and peer comparisons and will be refined along with alternatives in Phase 2, based on the trade-offs of benefits, costs, and risks. As design standards are finalized, specific performance measures will be developed in support of each design standard, along with associated performance targets. These measures and targets will serve not only to guide the design and prioritization of recommendations, but to monitor performance during and after implementation.

PHASE 2: BELIEVE

Upon completing this two-tiered corridor screening, a set of feasible improvement options with basic performance ratings will be available for more detailed analysis and refinement towards implementation as part of **Phase 2**. This will be a focus of Stantec's input, as the VHB transit operations/simulation tool—customized for the FAST study—evaluates multiple routing scenarios, and our spreadsheet model analyzes operations and costs.



Appendix B

Technical Analysis Findings

Fast Score Model: Data Requirements:

Category	Variable	Comments	Sub Model Status	2018		2025	
				Final Category Score	Final Weighting	Final Category Score	Final Weighting
Travel Demand	Traffic Volume		✓	✓	✓	✓	✓
	Transit Ridership		✓				
Transit Performance	Service Frequency		✓	✓		✓	
	Bus Speed		-				
Traffic Performance	Traffic Delay		✓	✓		✓	
	Volume Capacity		✓			✓	
Context	Landuse Density		✓	✓		✓	
	Intersection Density		✓			✓	
Access Equity	Change in Jobs		✓	n/a	n/a	✓	n/a

Travel Demand:

Variable:		**Traffic Volume**
	Data source:	2018 AADT data (use only as a reference) 2018 TRM Highway data 2025 TRM Highway data 2035 TRM Highway data FCGroup - 1 – freeway FCGroup <> 1 – nonfreeway Add AB_Vol_Daily and BA_Vol_Daily to get volume (daily)
	Years included:	2018, 2025 and 2035
	Scores	

Freeway Volume Range	**FAST Score**	**Non-Freeway Volume Range**

0 – 30,000	1	0 – 10,000
30,000 – 50,000	2	10,000 – 20,000
50,000 – 70,000	3	20,000 – 30,000
70,000 – 100,000	4	30,000 – 50,000
> 100,000	5	> 50,000

Notes/ Comments

1. FCGroup contained values other than 1 and 2. I reclassed everything other than a 1 as nonfreeway.
2. Freeway Volume Fast Scores
    a. Included low value up to but not including high value (0 <= vol < 30000)
    b. There are no freeway segments that get a fast score of 5 (there are Non Freeway segments that get a score of 5

Team Responses:

If DIR is anything but 0, Double the volume

```
ef reclass (a):
    if 0.90 <= a < 1.00:
        a = 1
    elif 0.80 <= a < 0.90:
        a = 2
    elif 0.70 <= a < 0.80:
        a = 3
    elif 0.50 <= a < 0.70:
        a = 4
    elif 0.50 >= a:
        a = 5
    return a
```

Variable:	**Transit Ridership**
Data source:	Transit Ridership.xlsx, use Totals field, join to TRM segments using Link ID in xls and ID in GIS
Years included:	2018 only, not modelling for future
Scores:	

Transit Corridor Ridership Range	**FAST Score**

0 – 1,000	1
1,000 – 5,000	2
5,000 – 10,000	3
10,000 – 20,000	4
> 20,000	5

Notes:

```
def reclass (a):
    if 0 <= a < 1000:
        a = 1
    elif 1000 <= a < 5000:
        a = 2
    elif 5000 <= a < 10000:
        a = 3
    elif 10000 <= a < 2000:
        a = 4
    elif a >= 20000:
        a = 5
    return a
```

Transit Performance:

Variable:	**Service Frequency**
Data source:	**Agency Routes with XLS**
Years included:	2018
Scores:	

Buses / Hour	FAST Score	New Fast Scores
0	0	0 - 1
1 – 2	1	1 -2

	2 – 4	2	2-3
	4 – 8	3	3-4
	8 – 12	4	4-6
	> 12	5	6+
Notes:	60 / round(float(!Peak_AM_Headway!), 2) Con(IsNull("bph_x"),0, "bph_x") `(r"%Input Workspace%”\BPH_1") + Raster(r"BPH_2") + Raster(r"BPH_3") + Raster(r"BPH_5")` Need fast score of 0 to be assigned to the TRM features in the end		

Traffic Performance:

Variable:		**Traffic Delay**
	Data source:	Have HERE 2018 (can use this as a cross reference) TRM **Congested_speed**: [Length_daily] / ([MAX_TIME] / 60) **MAXFFTIME** (the larger value of ABFFTIME or BAFFTIME) **Freeflow speed:** MAXFFTIME **Traffic Delay**: [Length] / ([MAX_TIME] / 60) / MAXFFtime **Use posted speed in model: UST_SPD (speed)**
	Years included:	2018, 2025, 2035
	Scores:	

Congested / Free-flow Speed	FAST Score
1.00 – 0.90	1
0.90 – 0.80	2
0.80 – 0.70	3
0.70 – 0.50	4

		< 0.50 | 5
	Notes	• A few unrounded Delay Speed values were > 1 (like 1.000056, which rounds to 1). I looked at the MAX time and FF Times and in these cases the MAX time was a tiny bit higher than FFTime (like .000056 higher) • Bins include low value of range, but exclude high value of range.
Variable		**Volume Capacity**
	Data source:	TRM: AB_VOC, BA_VOC (for both AM and PM), MAX_VOC, MAX_VOC_PM
	Years included:	2018, 2025, 2035
	Scores:	see table below
	Notes:	• Bins include low value of range, exclude high value of range

Volume / Capacity	FAST Score
< 0.75	1
0.75 – 0.85	2
0.85 – 0.90	3
0.90 – 0.95	4
> 0.95	5

Context (Non freeway only, polygon):

Variable:		**Landuse Density (Activity Density)**
	Data source:	Landuse layer: Connect_2045_Adopted_MTP_Output_Grid_Allocation_Only file from TJCOG
	Calculation:	(Population + Employment) / Acres
	Years included:	• only 1 set of data, represents change between 2013 & 2045 • TRM estimates for years in question
	Scores:	**Score | Pop + Emp / Acres** 1 | < 1 2 | 1 – 5 3 | 5 – 20

<table>
<tr><td></td><td></td><td>4 | 20 – 50
5 | > 50</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td>Notes:</td><td>1. Base year: TAZ with SE population and employment information. Proportion LU DNS by area inside ½ mile buffer of Freeways.
a. Do I dissolve buffers by transit ID, so we can get total density of entire transit or
b. Do I dissolve buffers into a single feature that cuts TAZ?
c. To calc adjusted LU_DNS: (sum pop and emp) * new area / old area / new area (yes, new area cancels itself out)
2. Future Year: get additions from grid level that falls in buffer. Proportion accordingly. Sum by taz and add to taz, then rerun model on new layer.</td></tr>
<tr><td colspan="2">Variable</td><td>Intersection Density</td></tr>
<tr><td></td><td>Data source:</td><td>Data
Metadata: https://www.epa.gov/smartgrowth/smart-location-mapping</td></tr>
<tr><td></td><td>Years included:</td><td></td></tr>
<tr><td></td><td>Scores:</td><td>Score | Intersections/SQMI
1 | 0 – 50
2 | 50 – 100
3 | 100 – 150
4 | 150 – 200
5 | > 200</td></tr>
</table>

Access Equity (polygon):

<table>
<tr><td colspan="2">Variable:</td><td>Change in jobs</td></tr>
<tr><td></td><td>Data source:</td><td>Landuse layer</td></tr>
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RTAFastNetwork\Correspondence\TJCOG\Connect_2045_Adopted_MTP_Output_Grid_Allocation_Only</td></tr>
<tr><td>Years included:</td><td>only 1 set of data, represents change between 2013 & 2045</td></tr>
<tr><td>Scores:</td><td>
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<tr><th>% Change in Accessed</th><th>Jobs</th><th>FAST Score</th></tr>
<tr><td>+/-</td><td>1%</td><td>0</td></tr>
<tr><td>+/-</td><td>1% – 10%</td><td>+/- 1</td></tr>
<tr><td>+/-</td><td>10% – 25%</td><td>+/- 2</td></tr>
<tr><td>+/-</td><td>25% – 50%</td><td>+/- 3</td></tr>
<tr><td>+/-</td><td>50% – 100%</td><td>+/- 4</td></tr>
<tr><td>+/-</td><td>> 100%</td><td>+/- 5</td></tr>
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</td></tr>
<tr><td>Notes:</td><td>• Some TAZ are not represented in landuse grid (northwest corner)
• If assuming linear growth, need to trim off years 2013 – 2018?</td></tr>
</table>

Mobility

Weighting

Travel Demand

- Traffic Volume: 60%
- Transit Ridership: 40%

Transit Performance

- Service Frequency: 70%
- Bus Speed: 30%
- *On-Time Performance:* --

Traffic Performance

- Traffic Delay: 60%
- Volume/Capacity: 40%

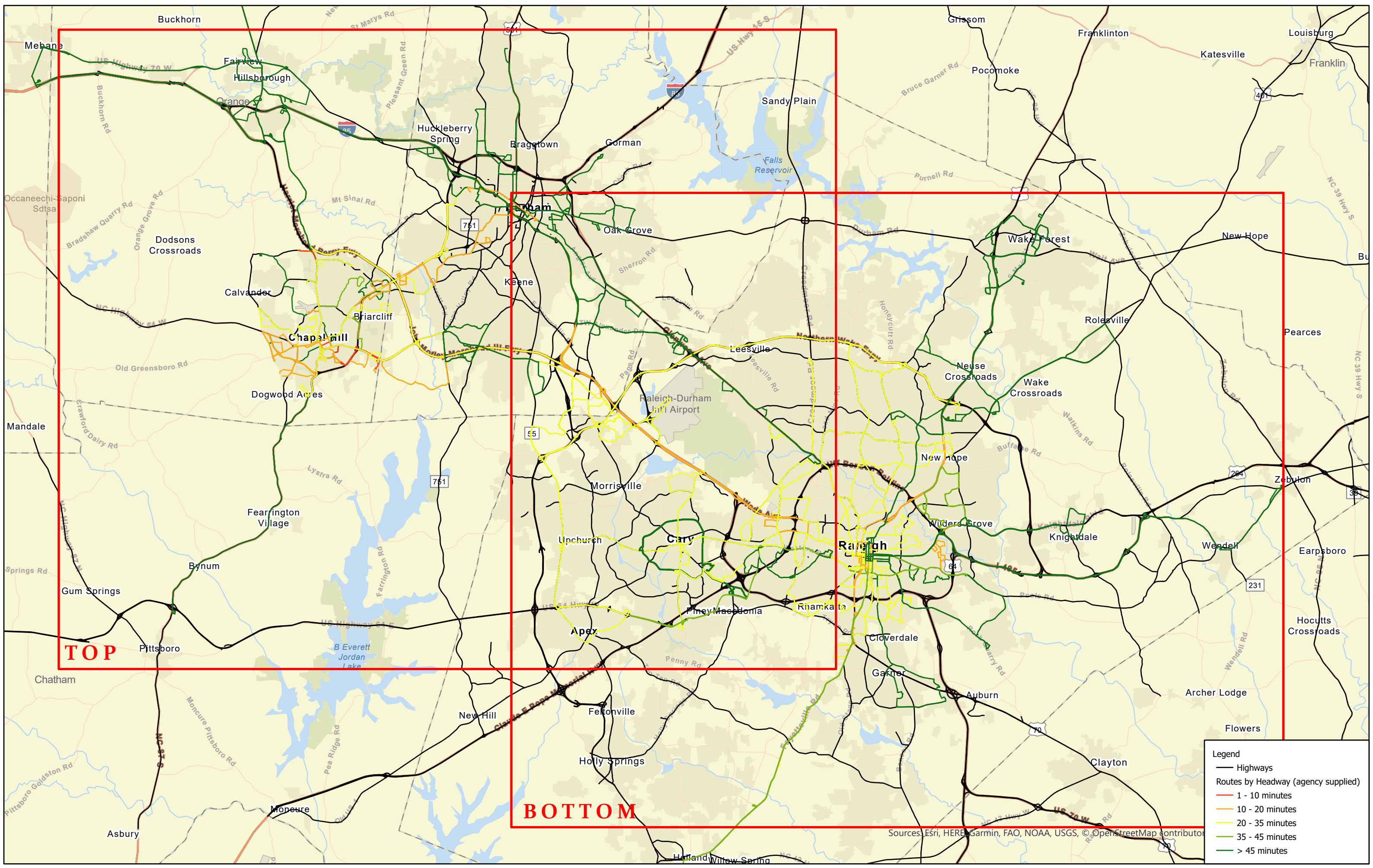
Context

- Land Use Density: 60%
- Intersection Density: 40%

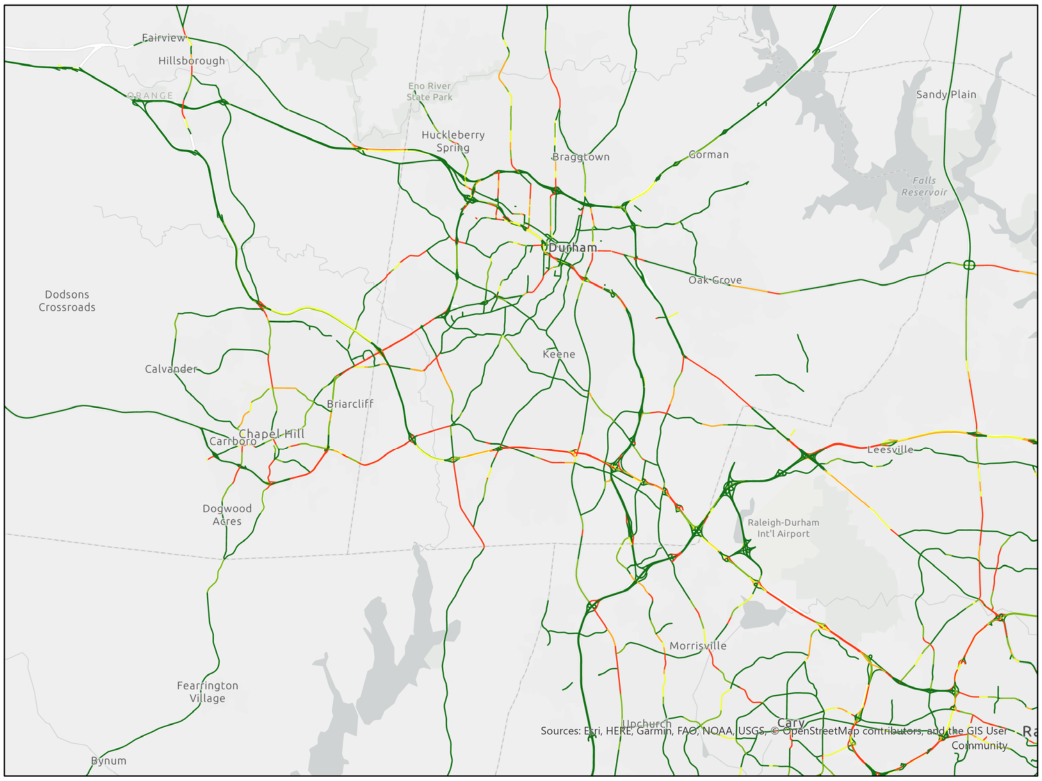
Composite

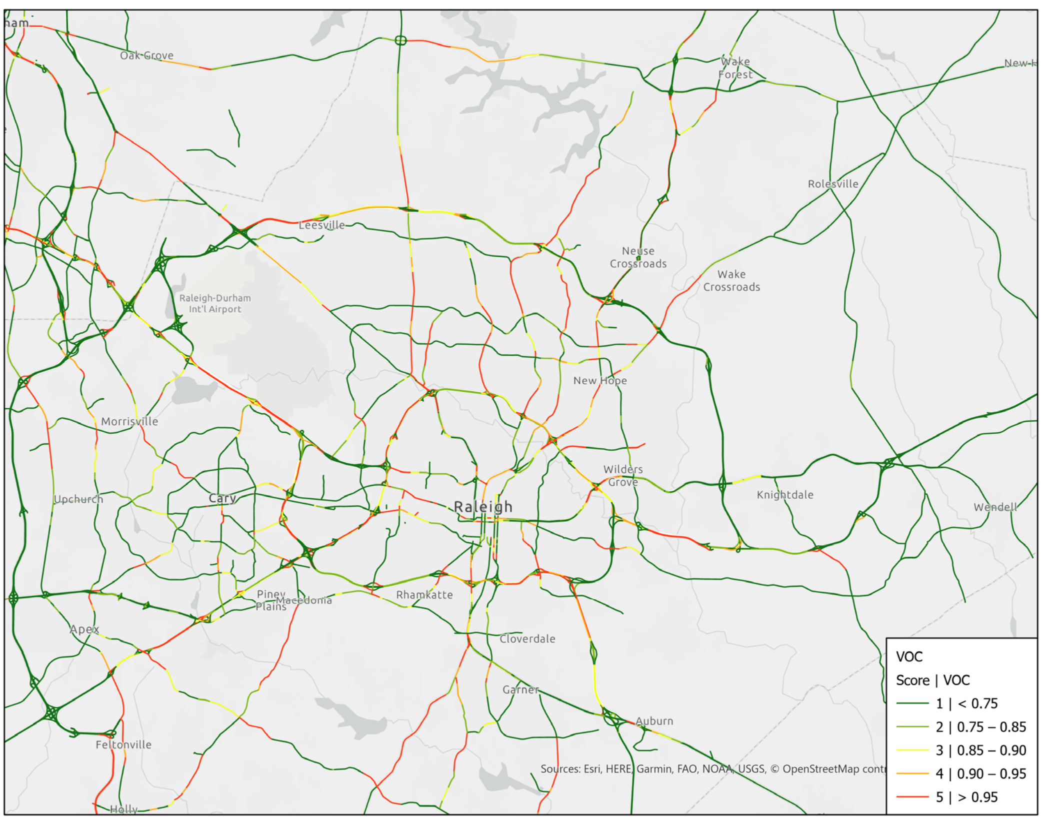
- Travel Demand: 30%
- Transit Performance: 20%
- Traffic Performance: 30%
- Context: 20%

Preliminary Draft

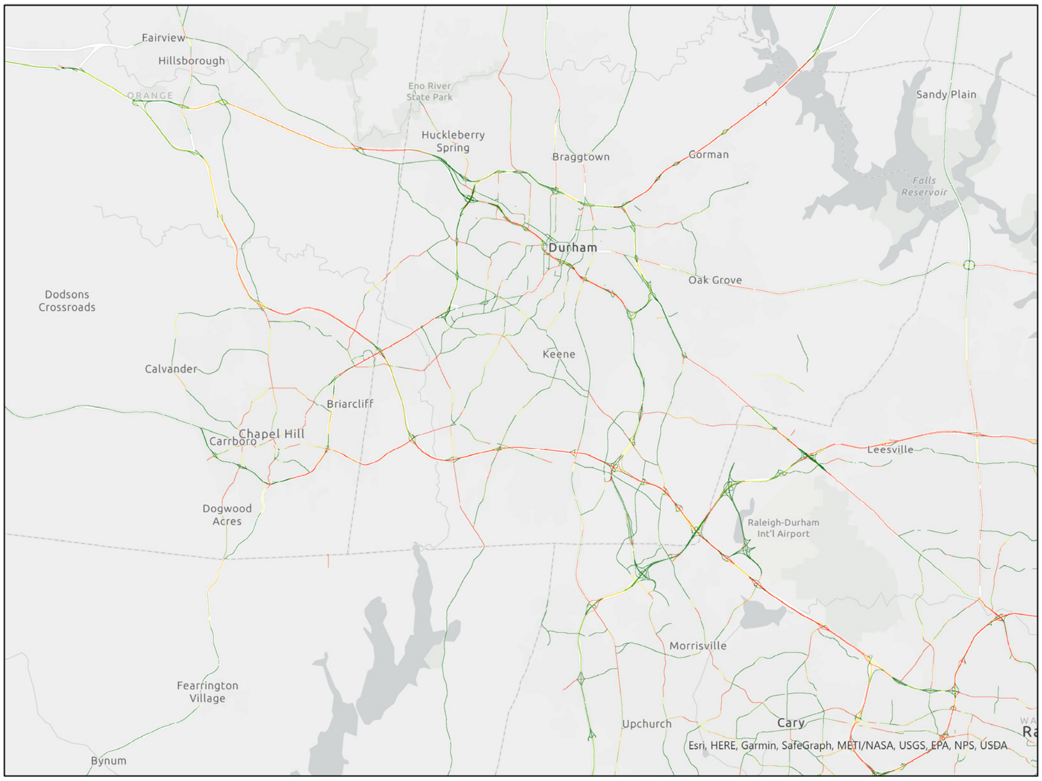


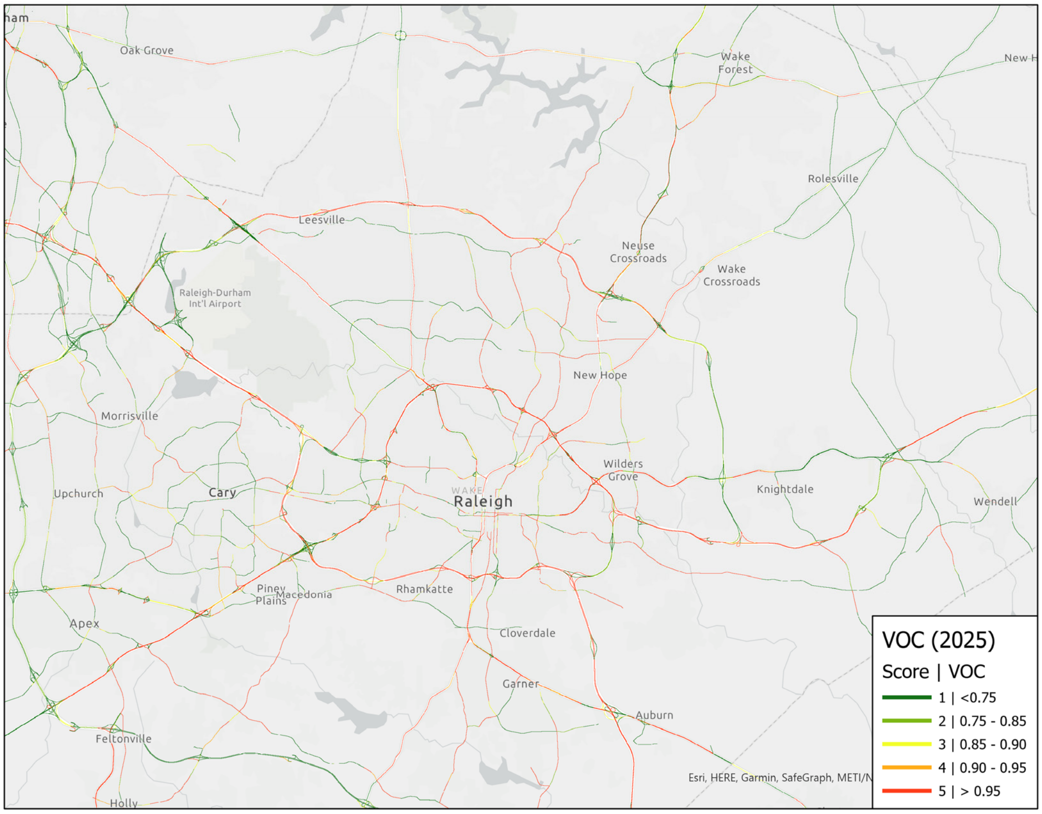
Overview of Routes by Headway for the Region



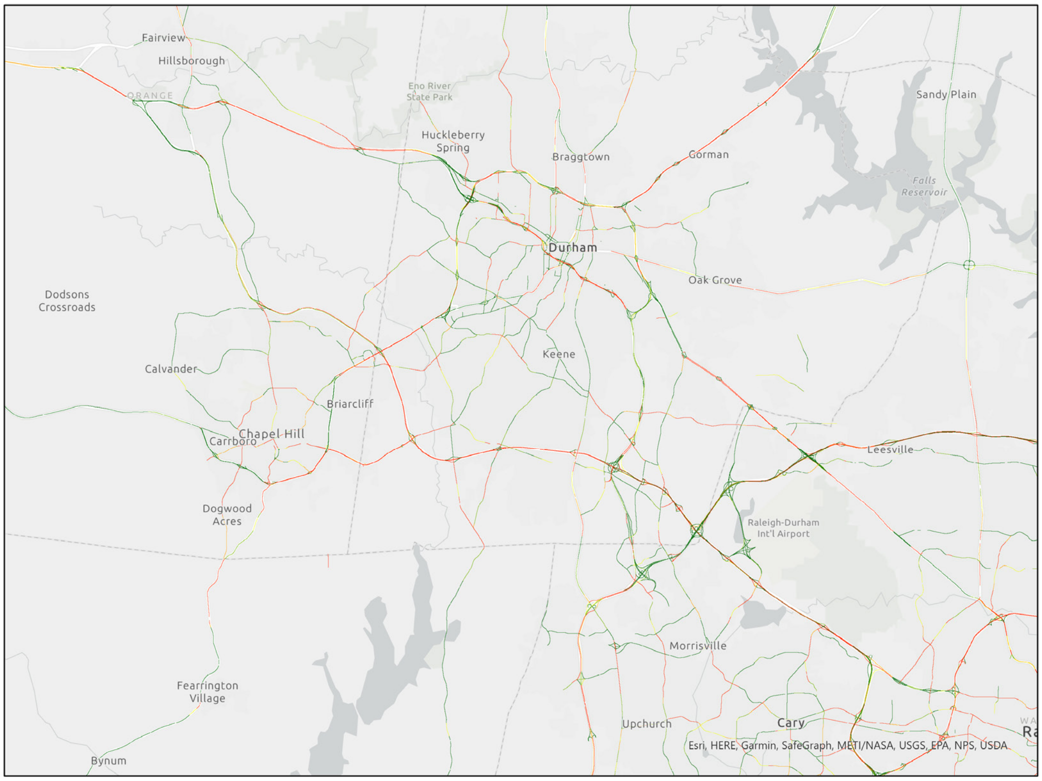


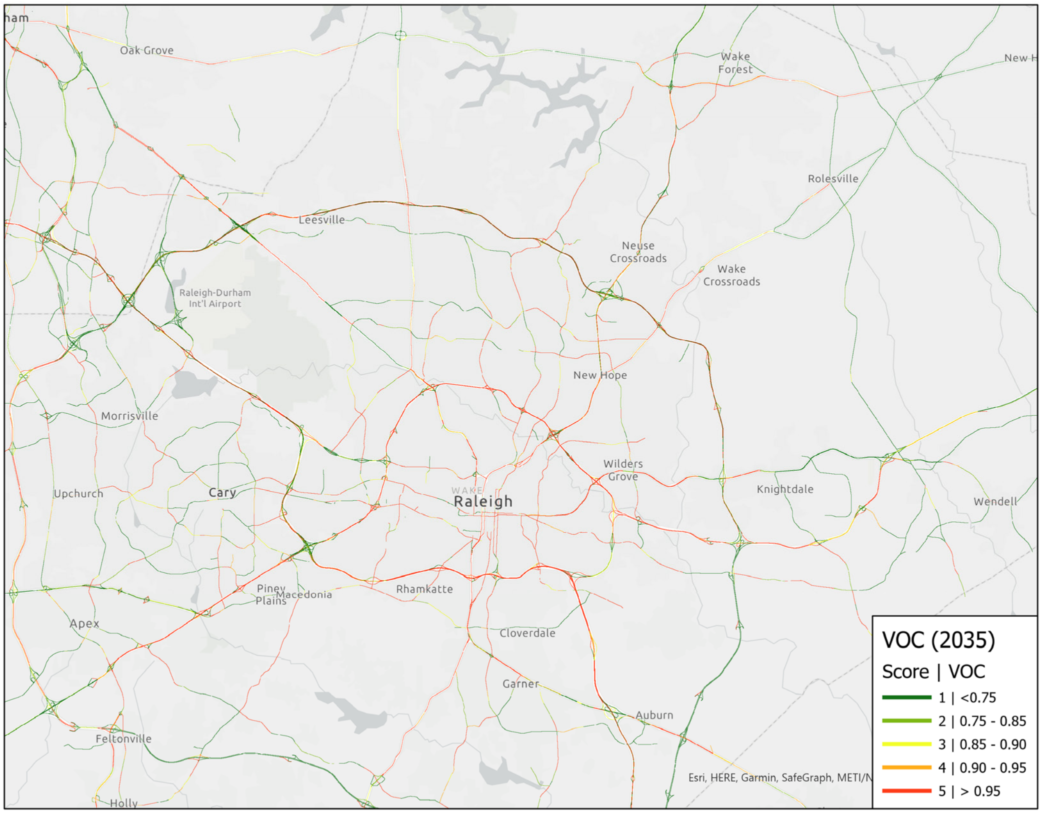
2018 Regional Congestion (Volume over Capacity)



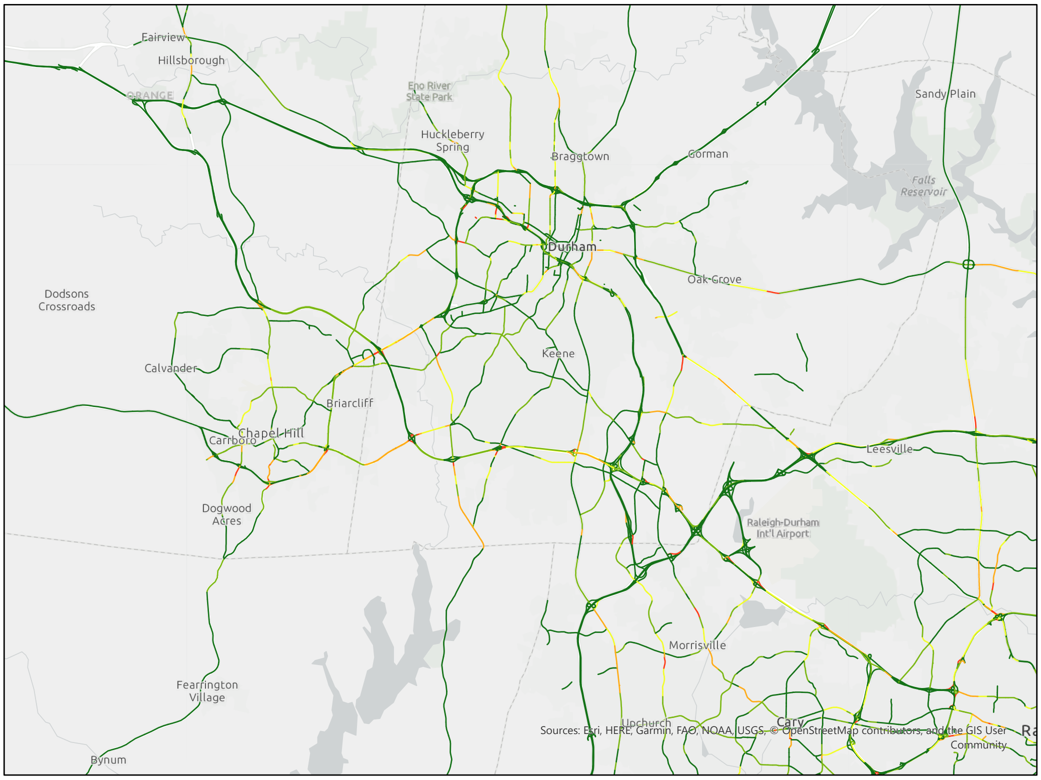


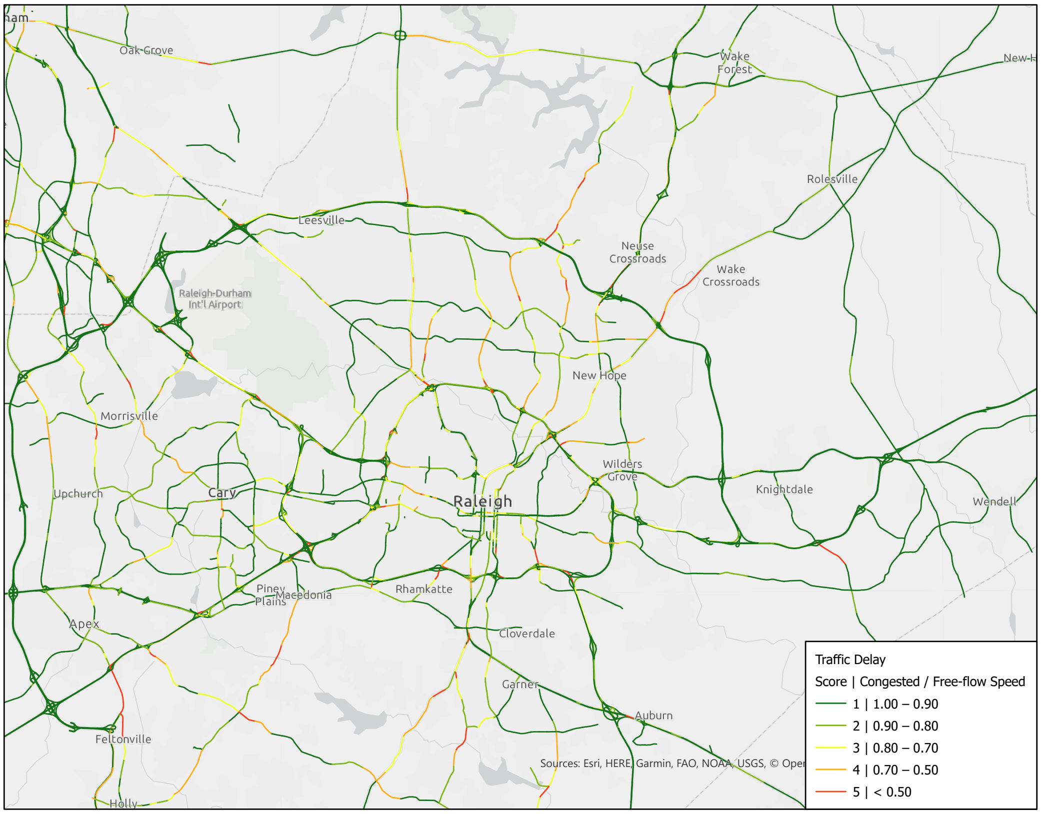
2025 Regional Congestion (Volume over Capacity)



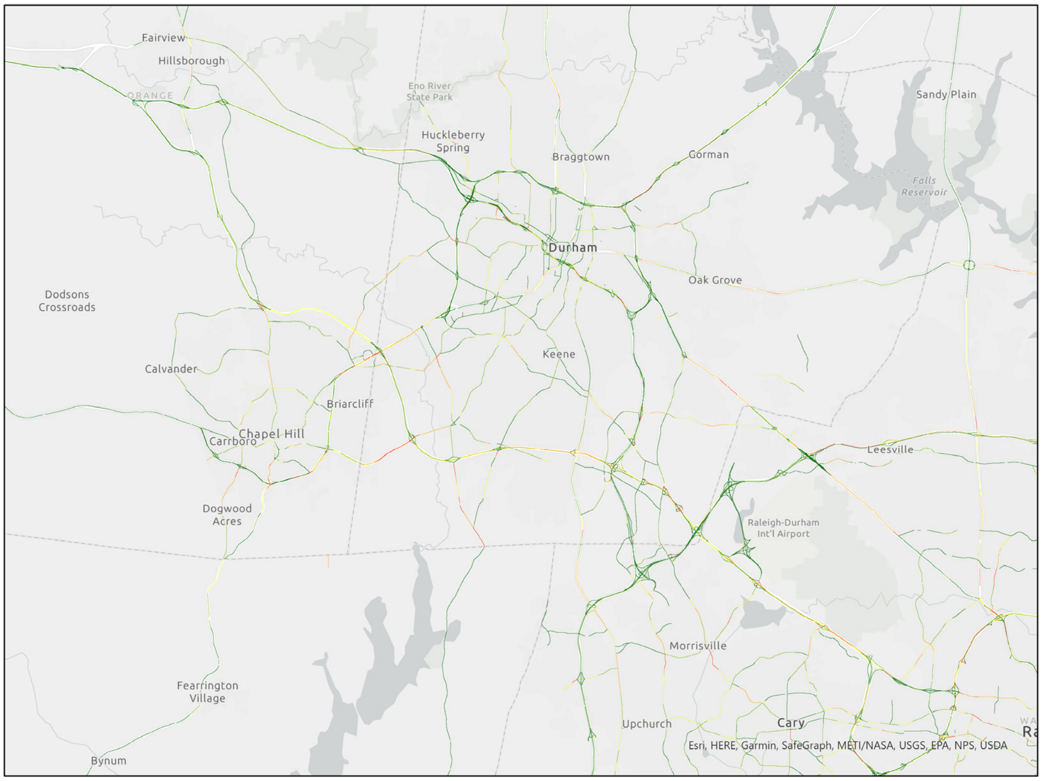


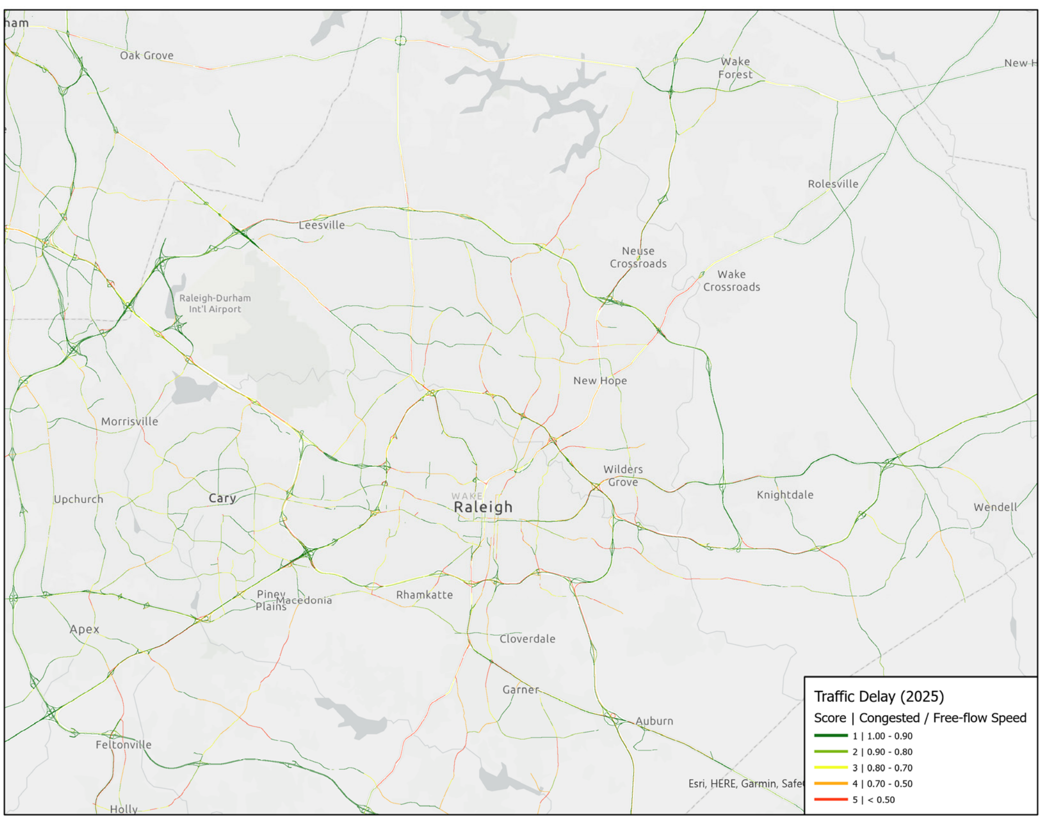
2035 Regional Congestion (Volume over Capacity)



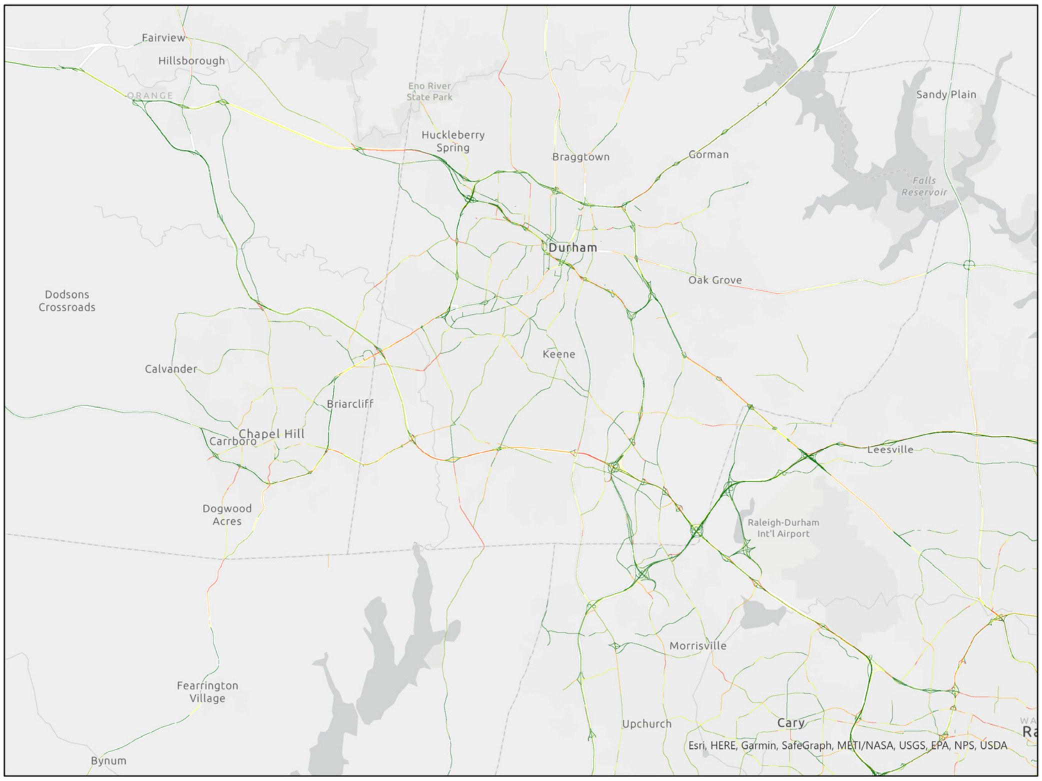


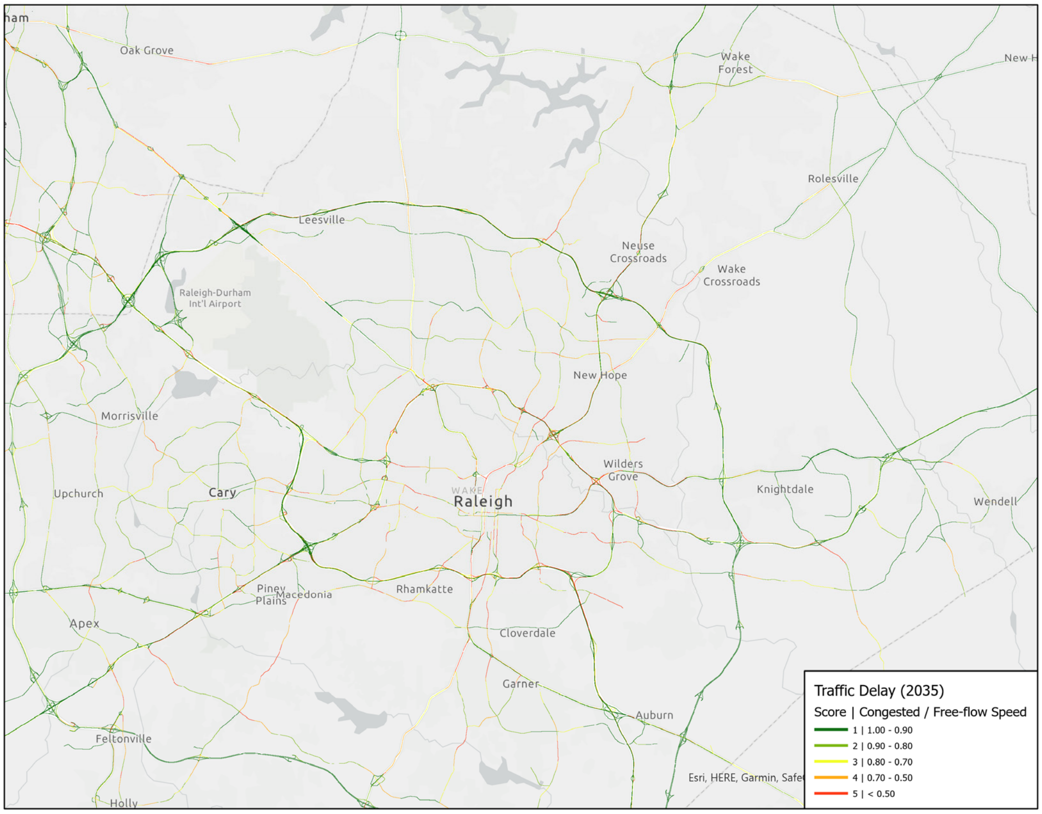
2018 Traffic Delay Scores for the Region



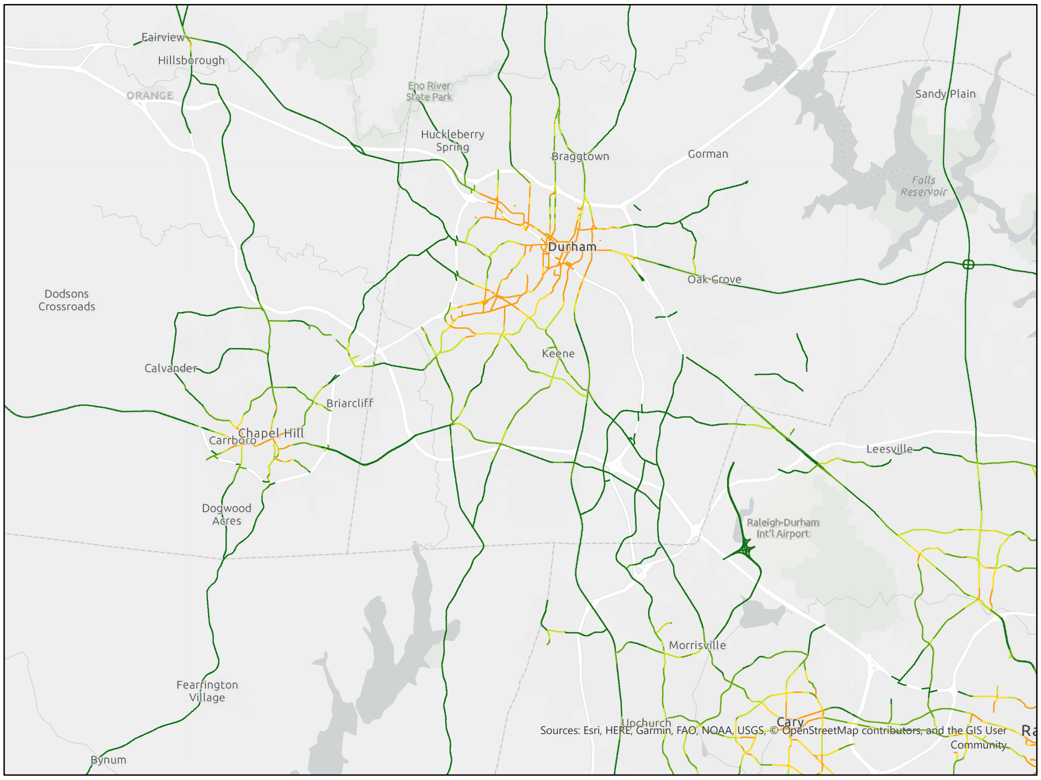


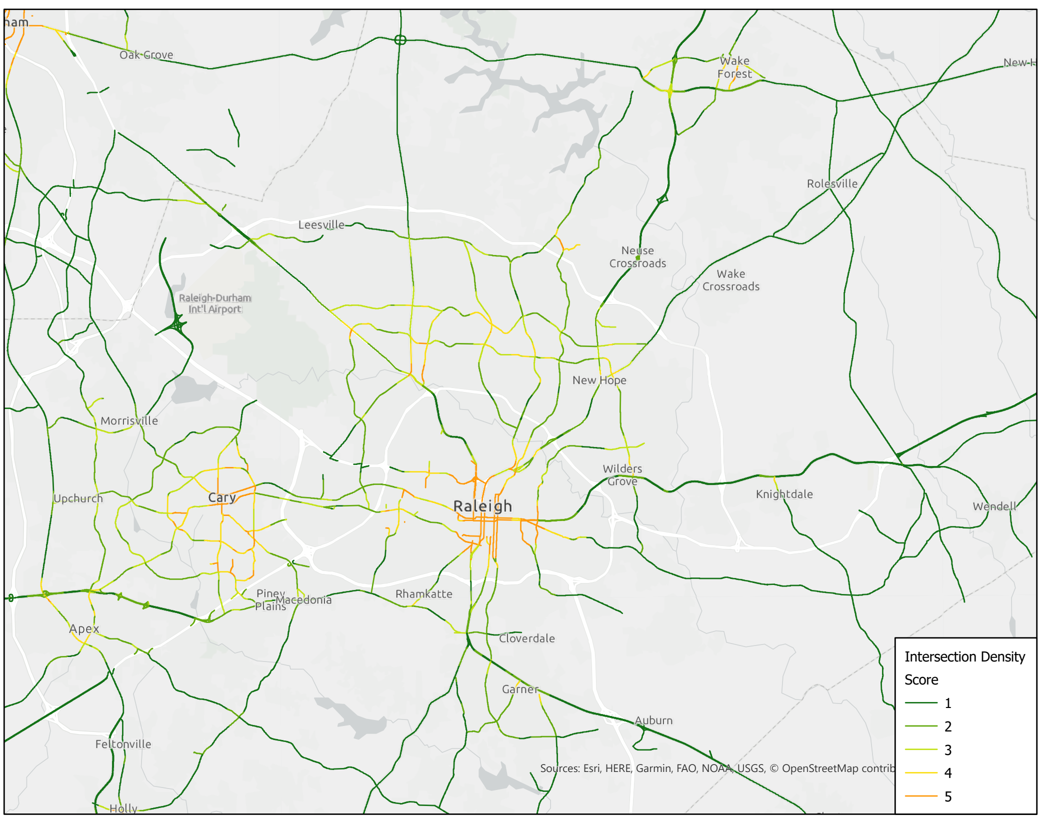
2025 Traffic Delay Scores for the Region



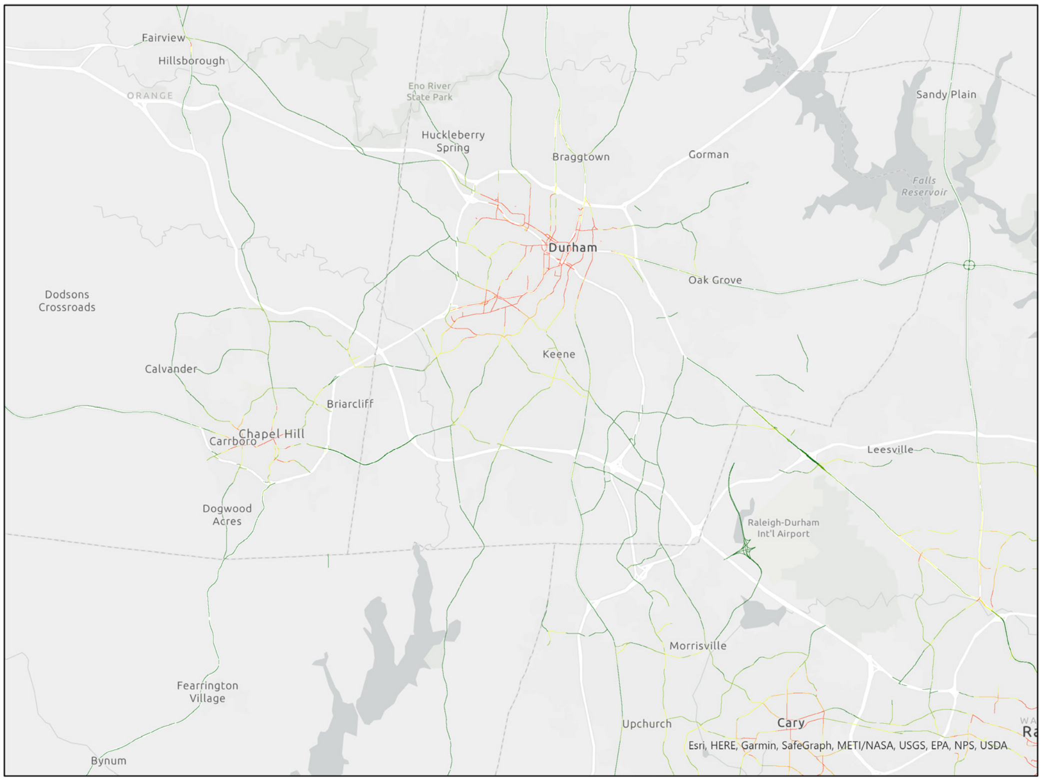


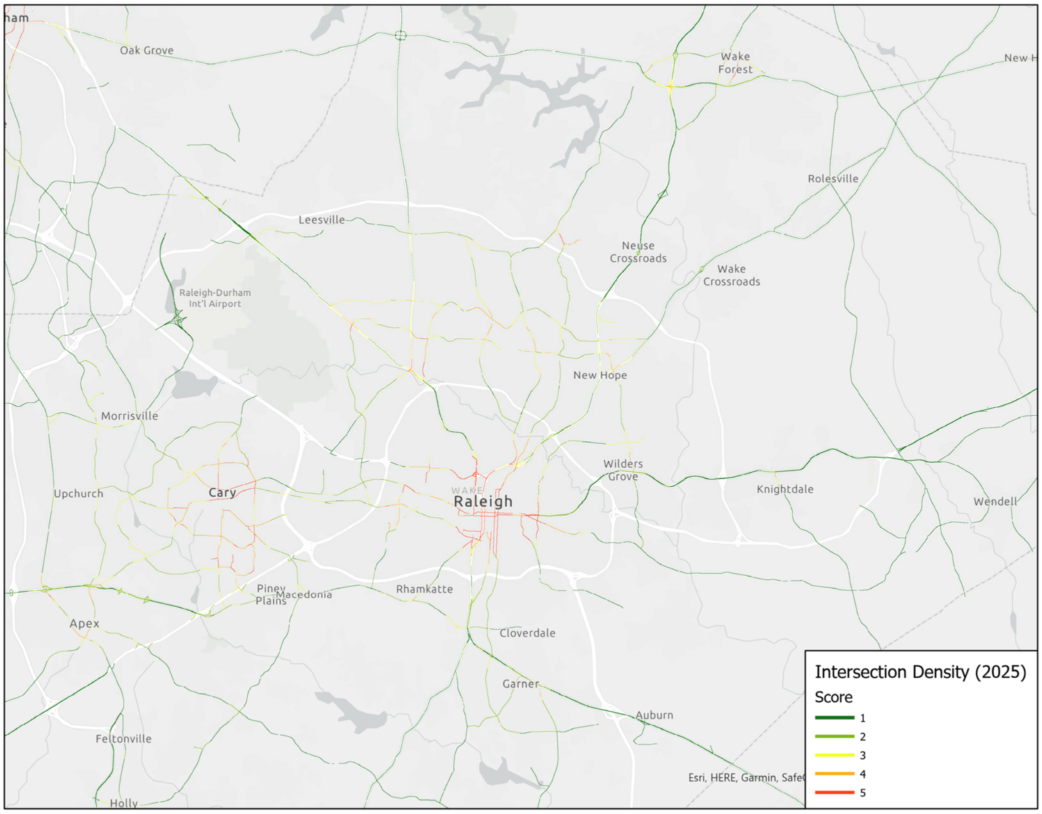
2035 Traffic Delay Scores for the Region



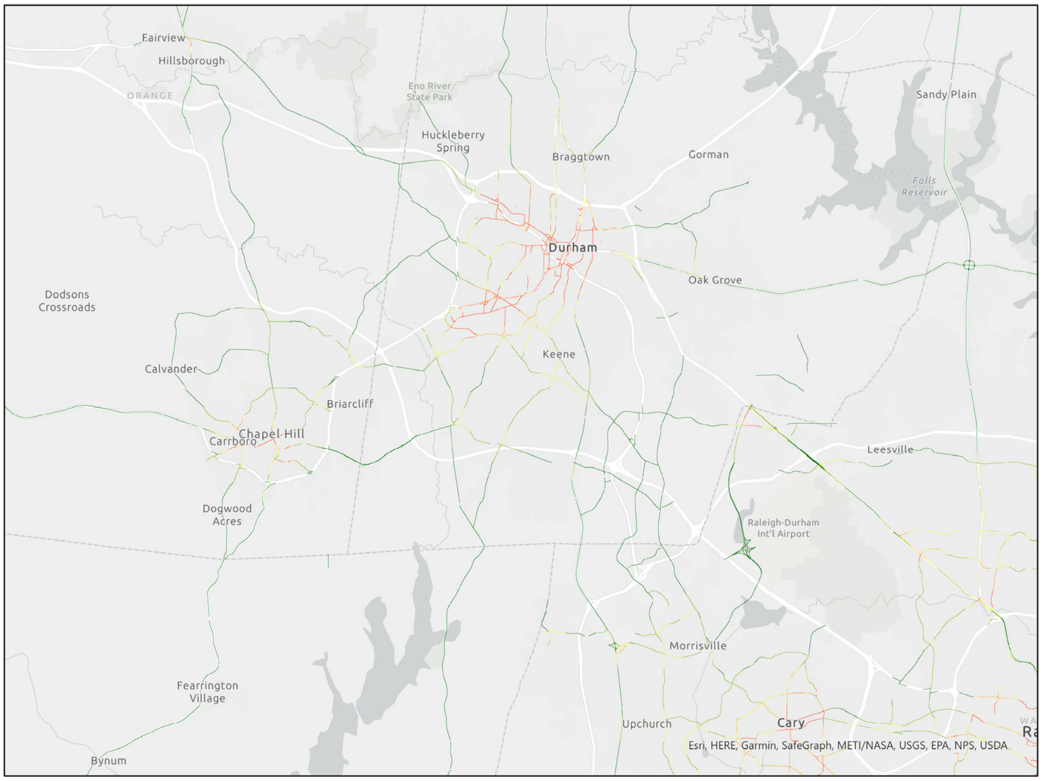


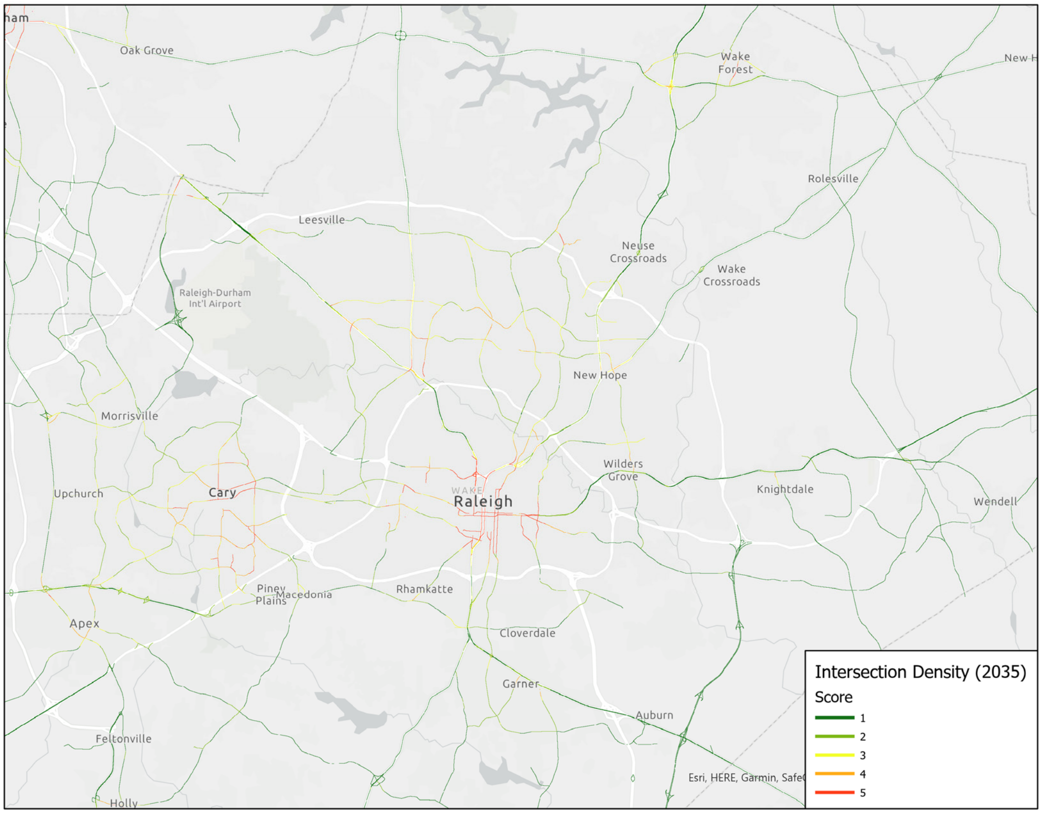
2018 Intersection Density Scores for the Region



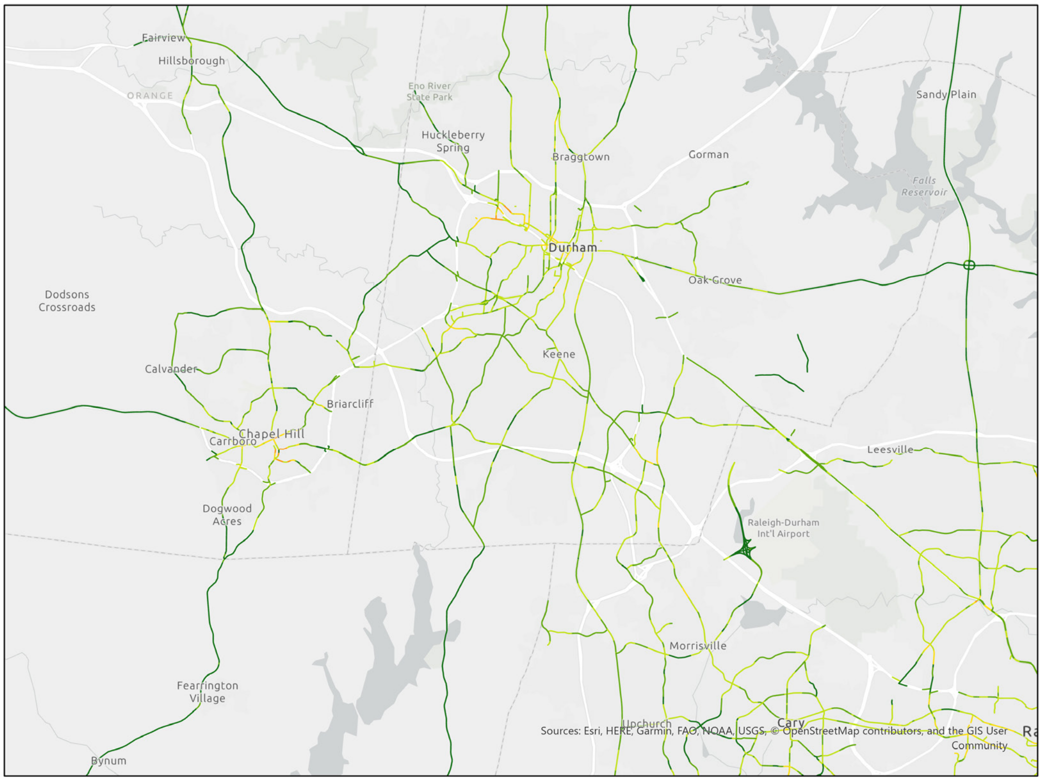


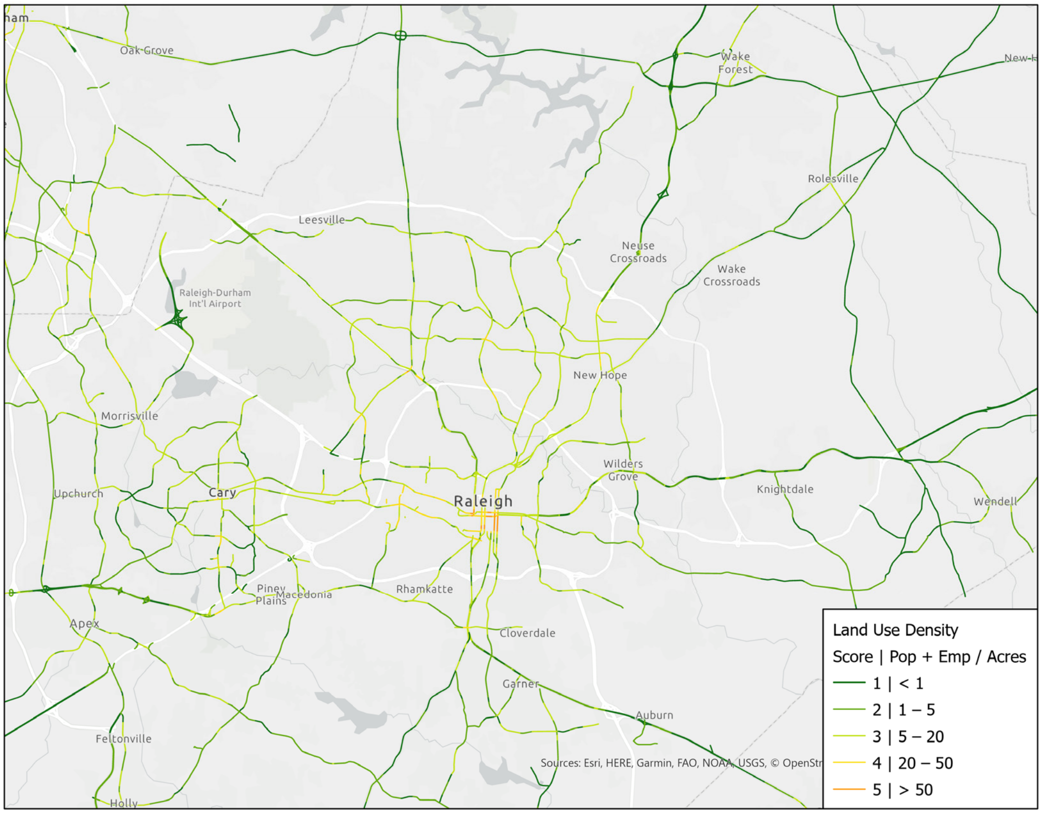
2025 Intersection Density Scores for the Region



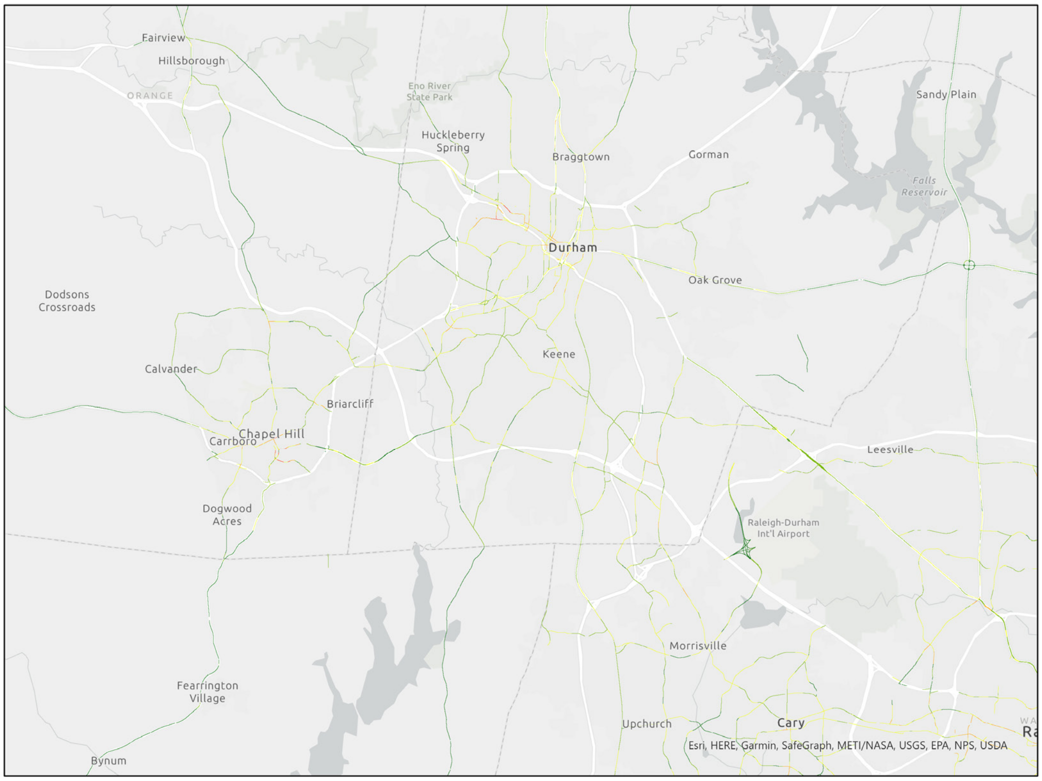


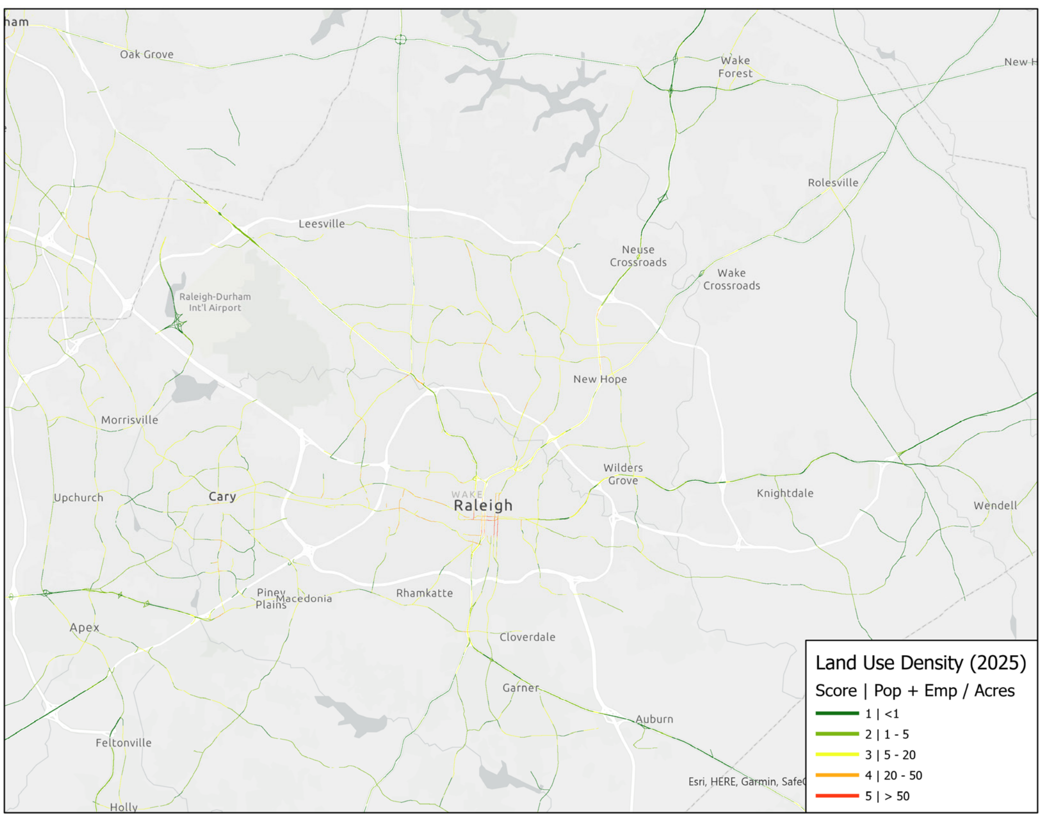
2035 Intersection Density Scores for the Region



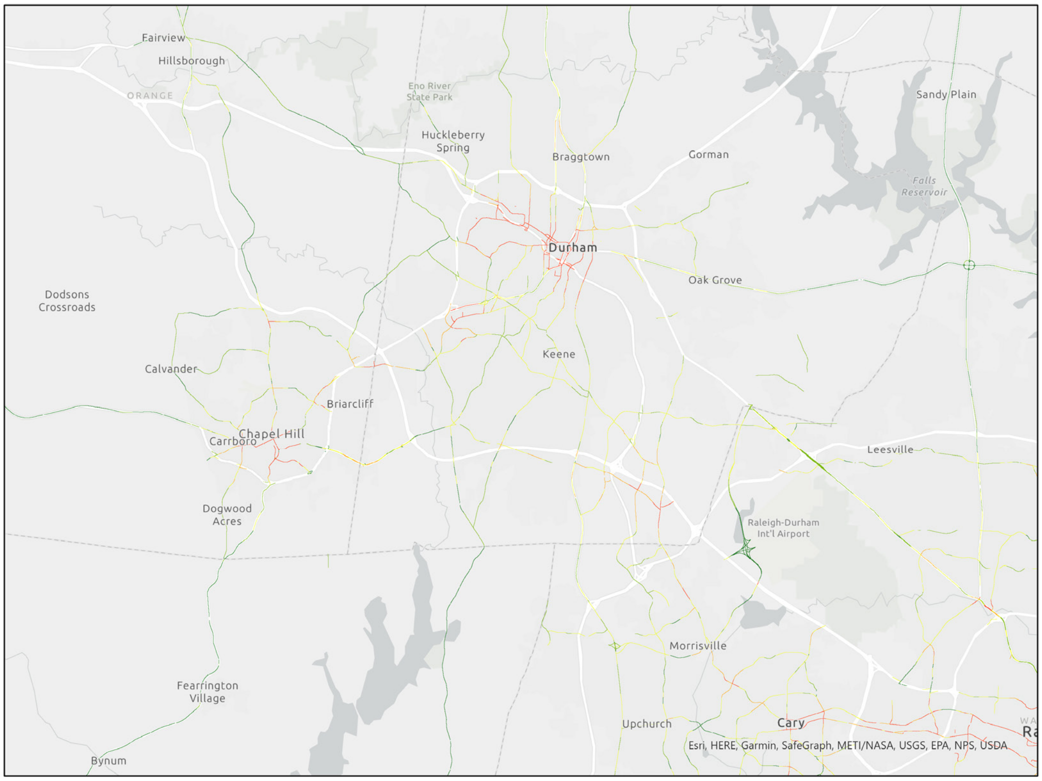


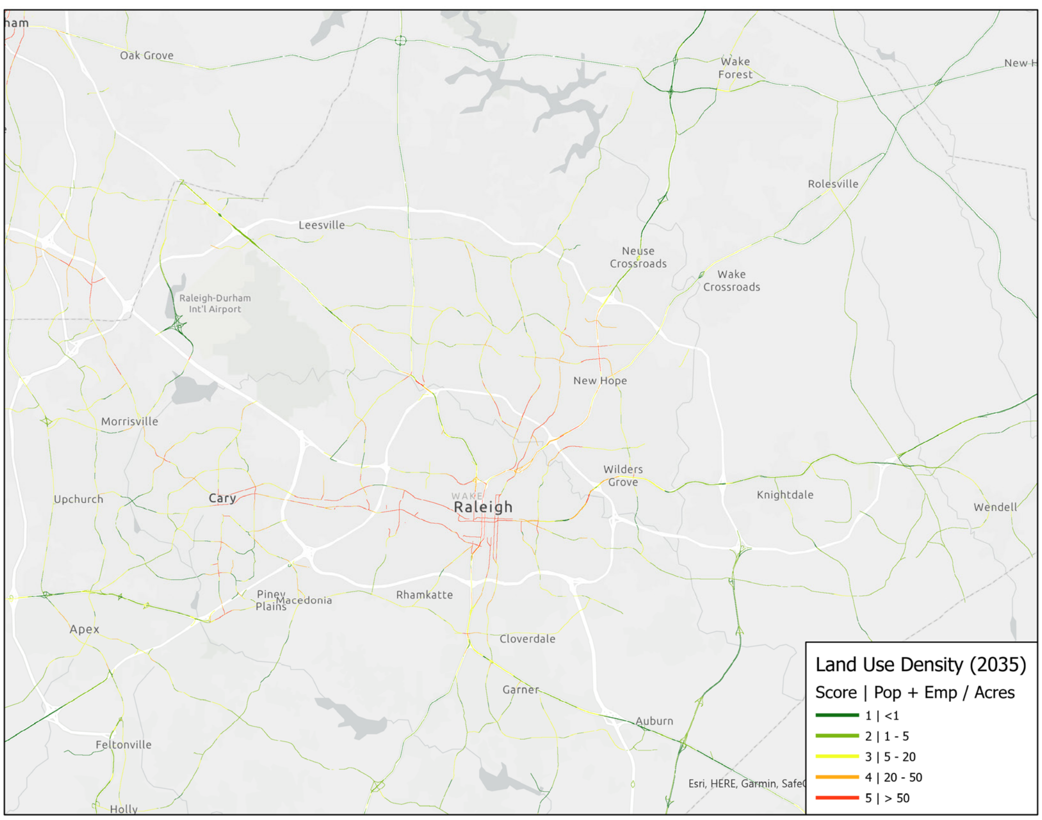
2018 Land Use Density Scores for the Region



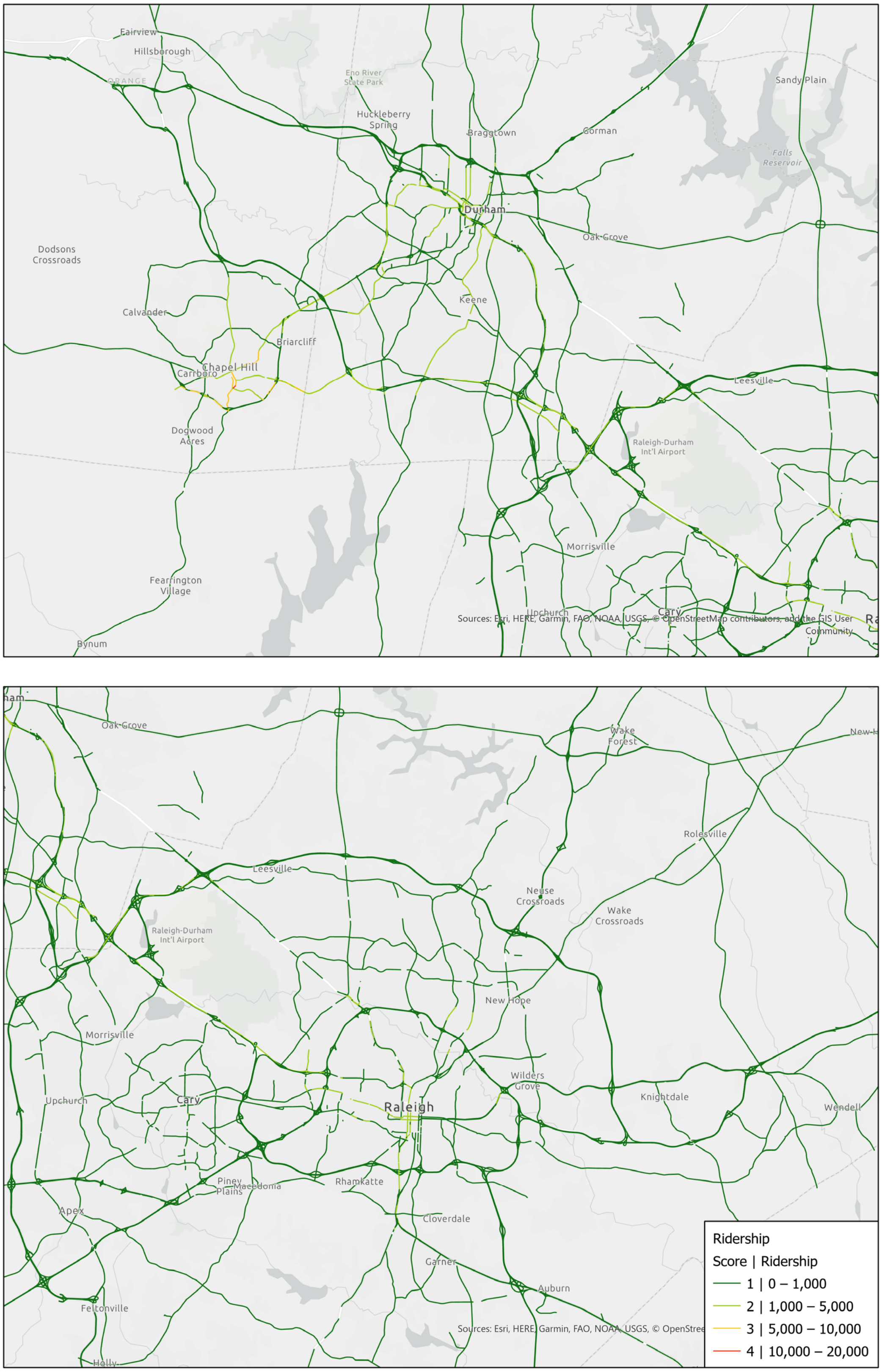


2025 Land Use Density Scores for the Region

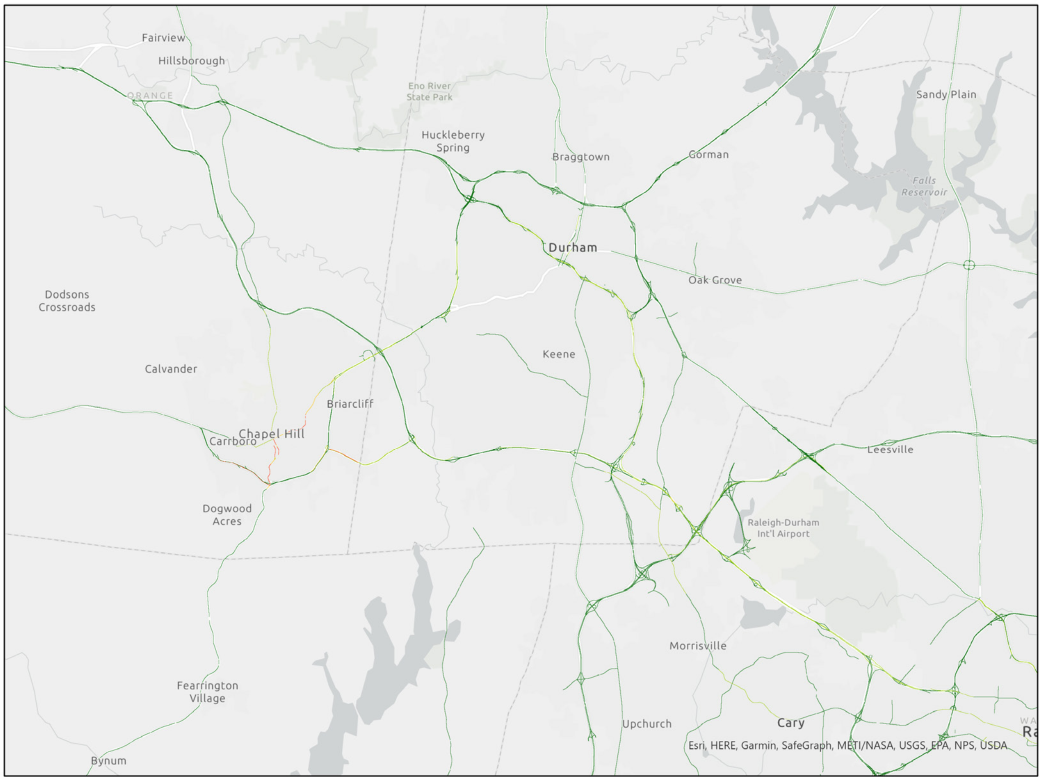




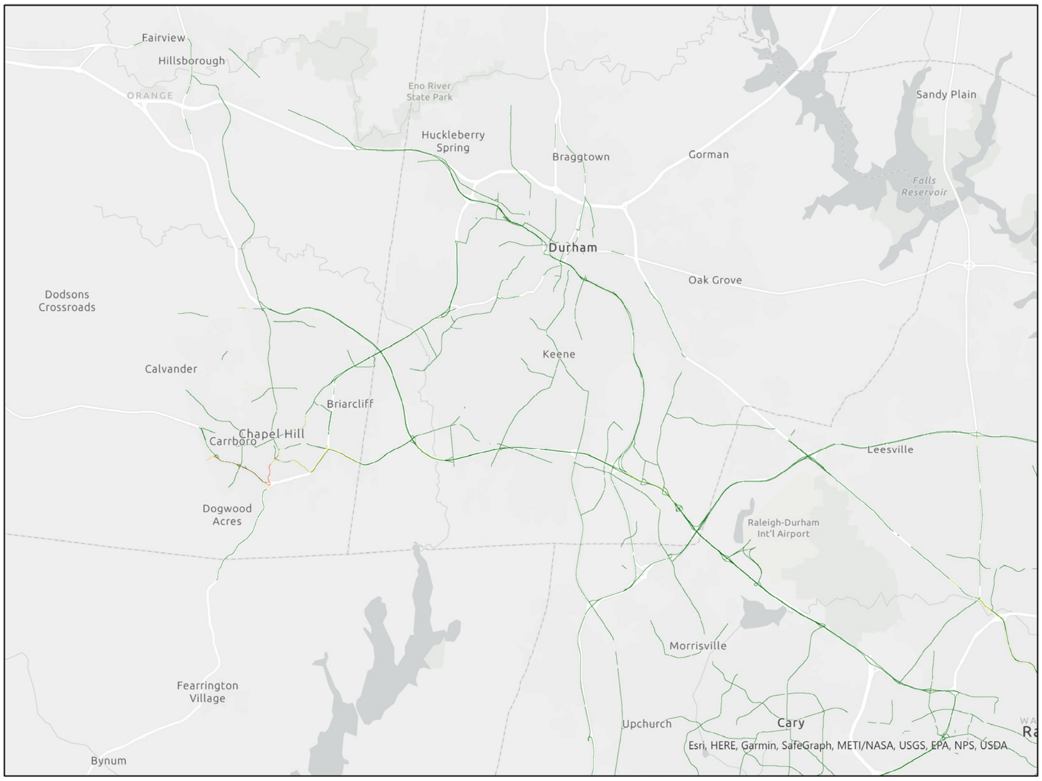
2035 Land Use Density Scores for the Region

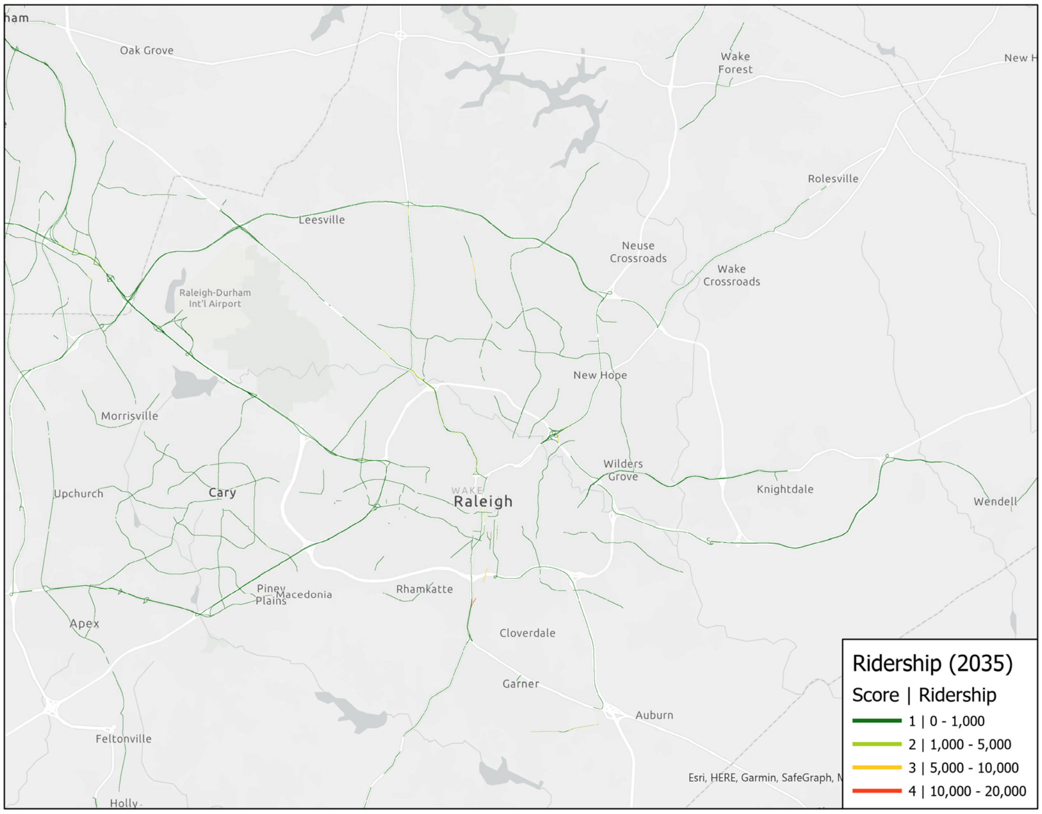


2018 Ridership Scores for the Region

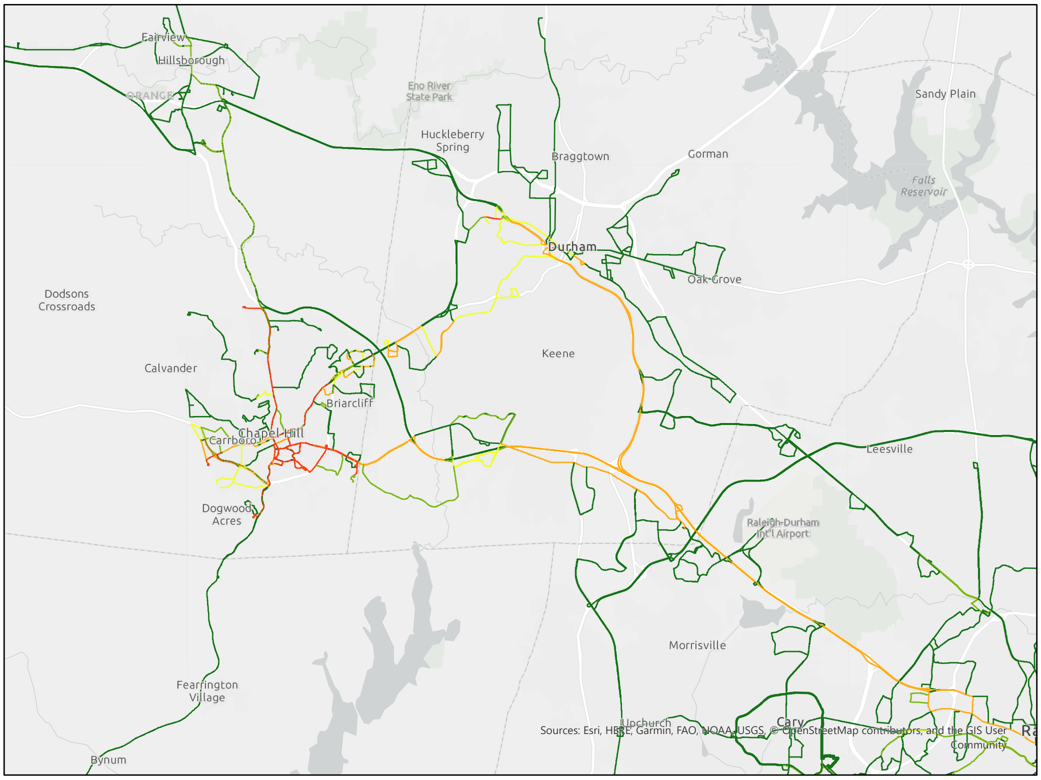


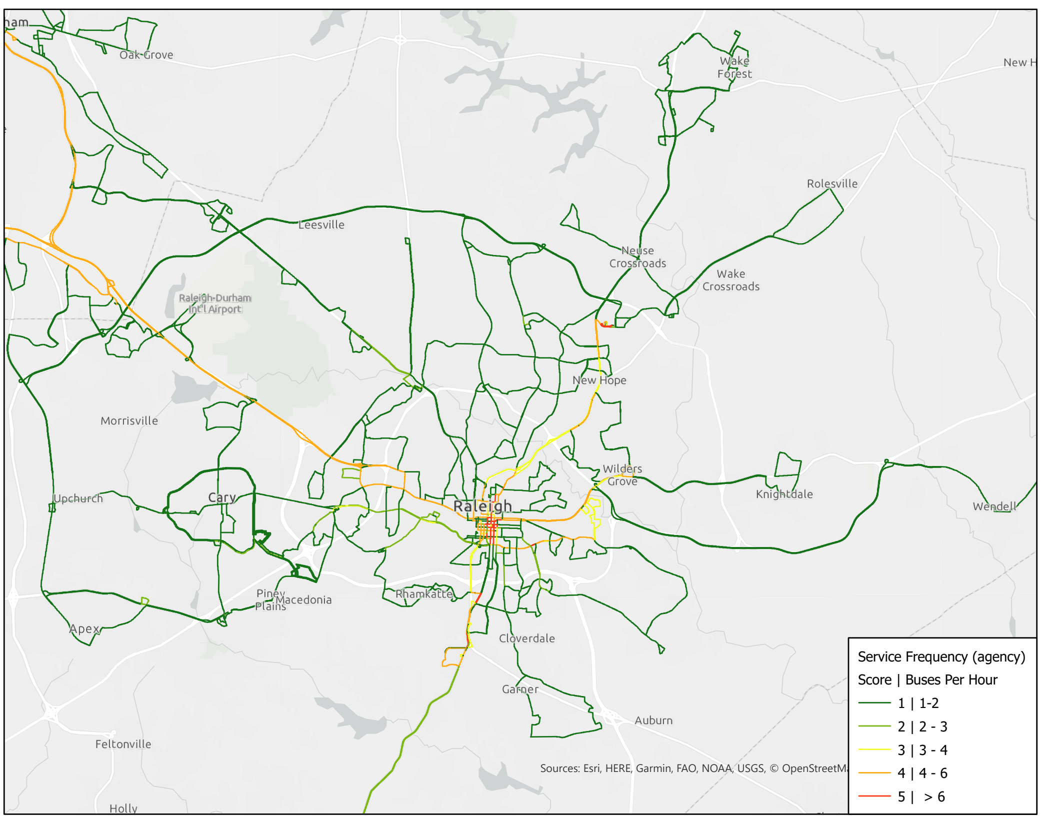
2025 Ridership Scores for the Region



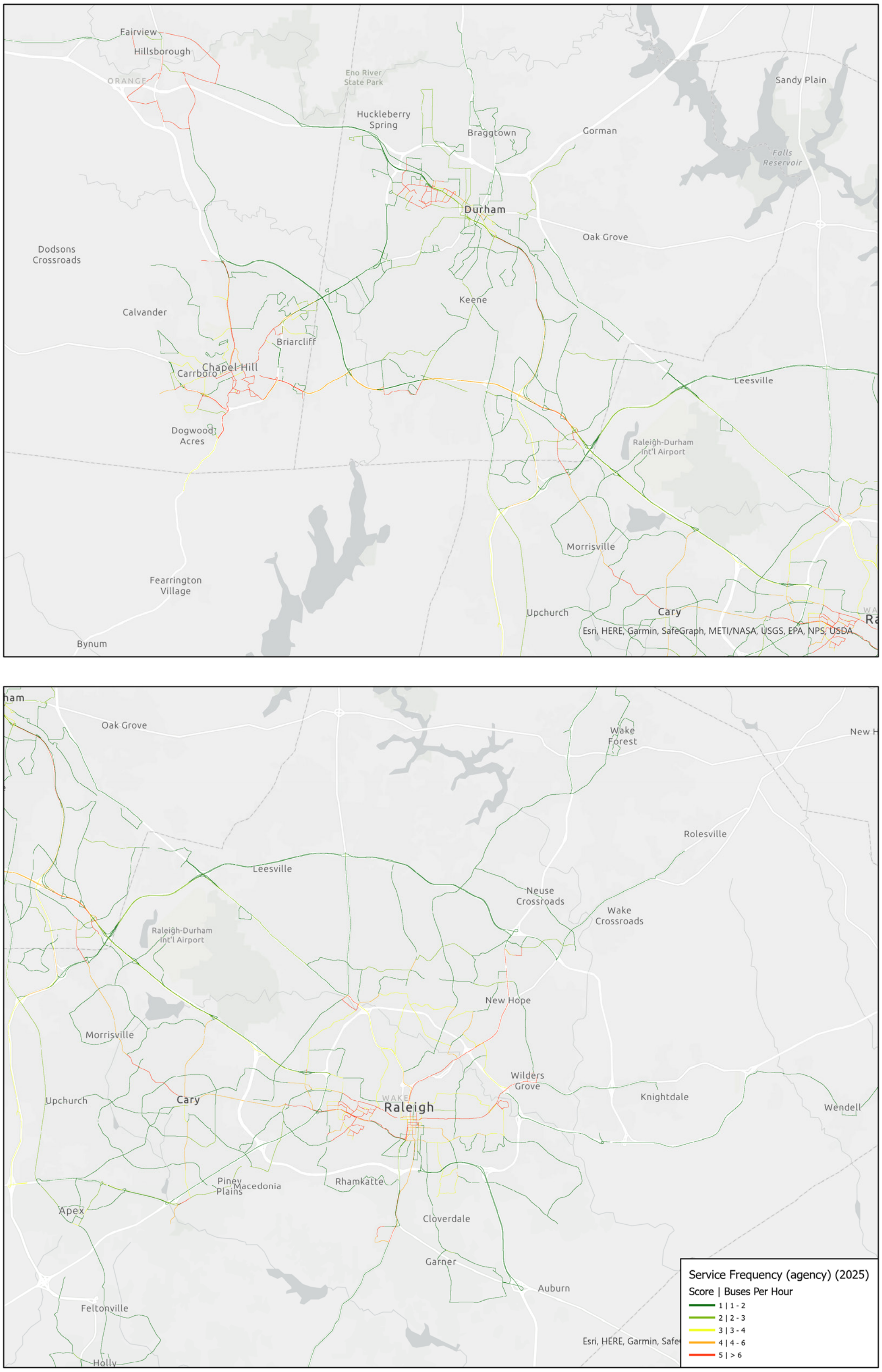


2035 Ridership Scores for the Region

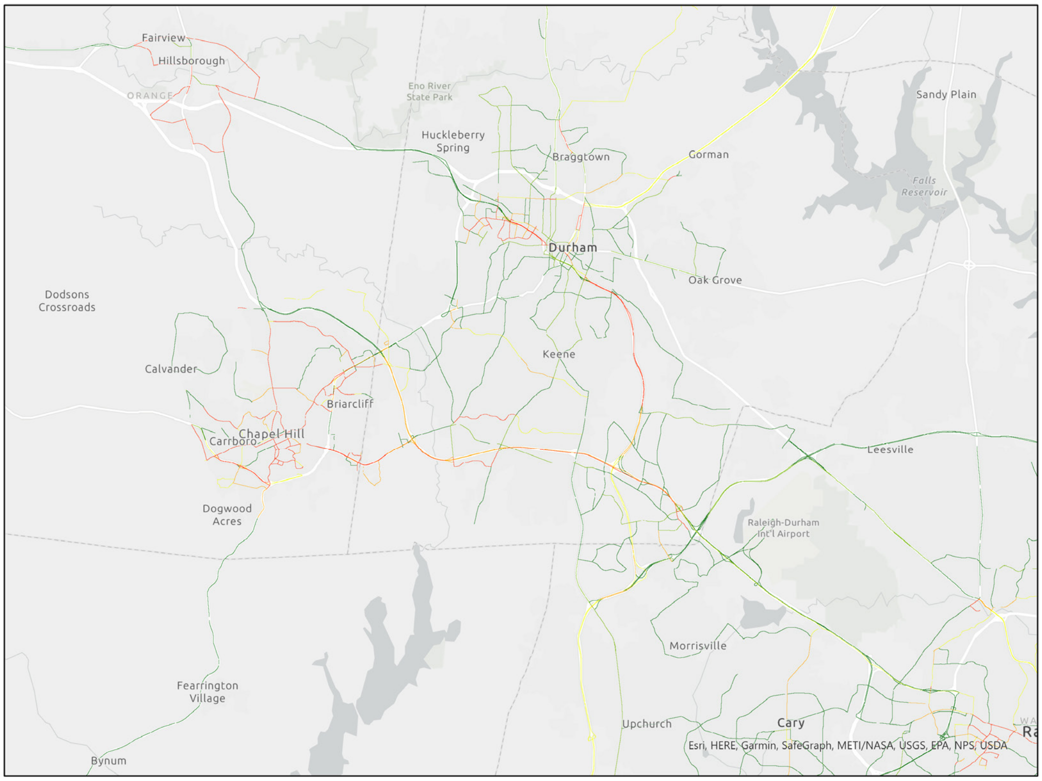


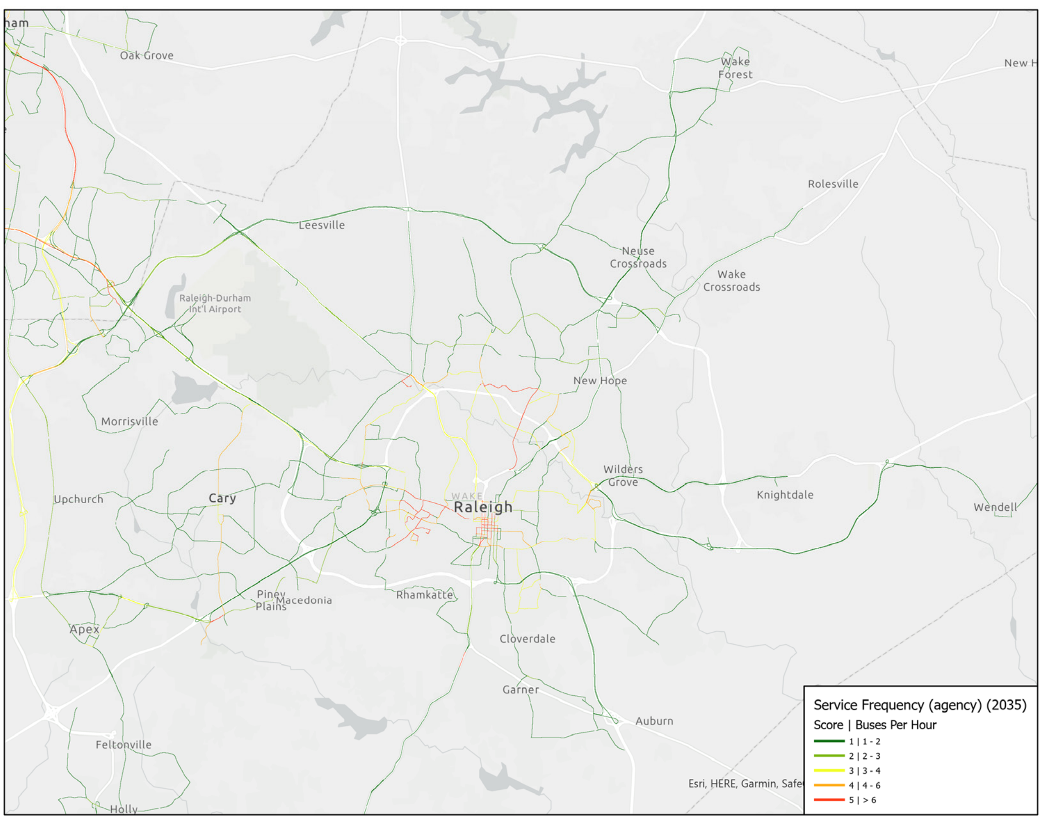


2018 Service Frequency Scores for the Region

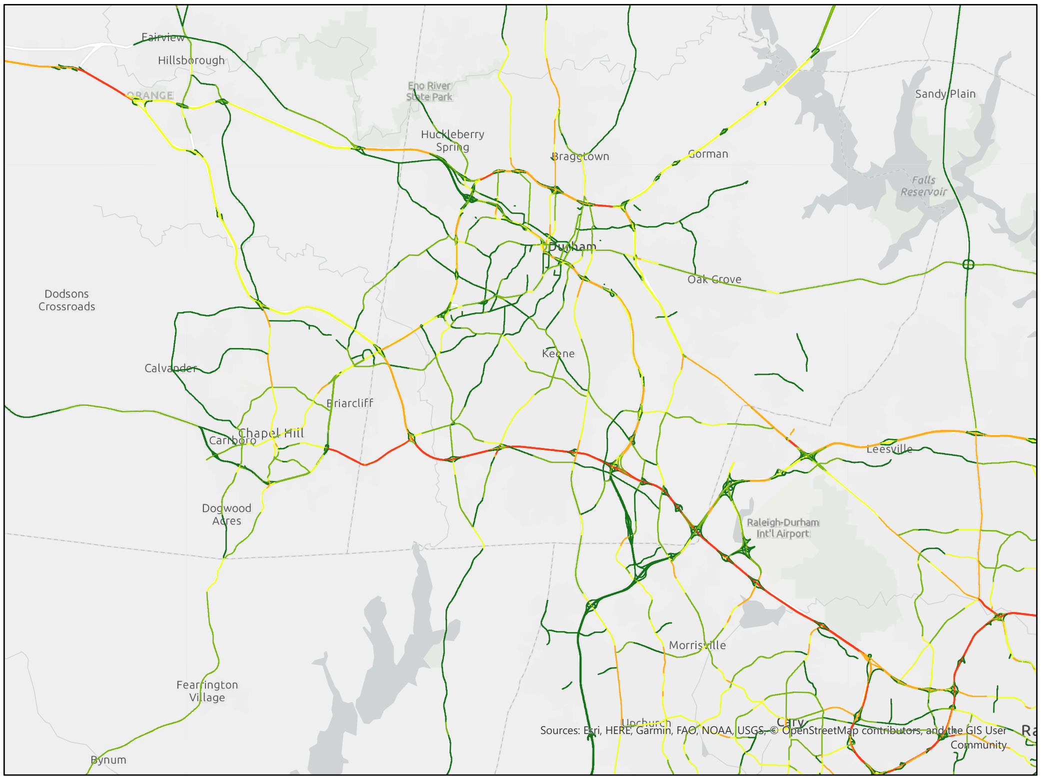


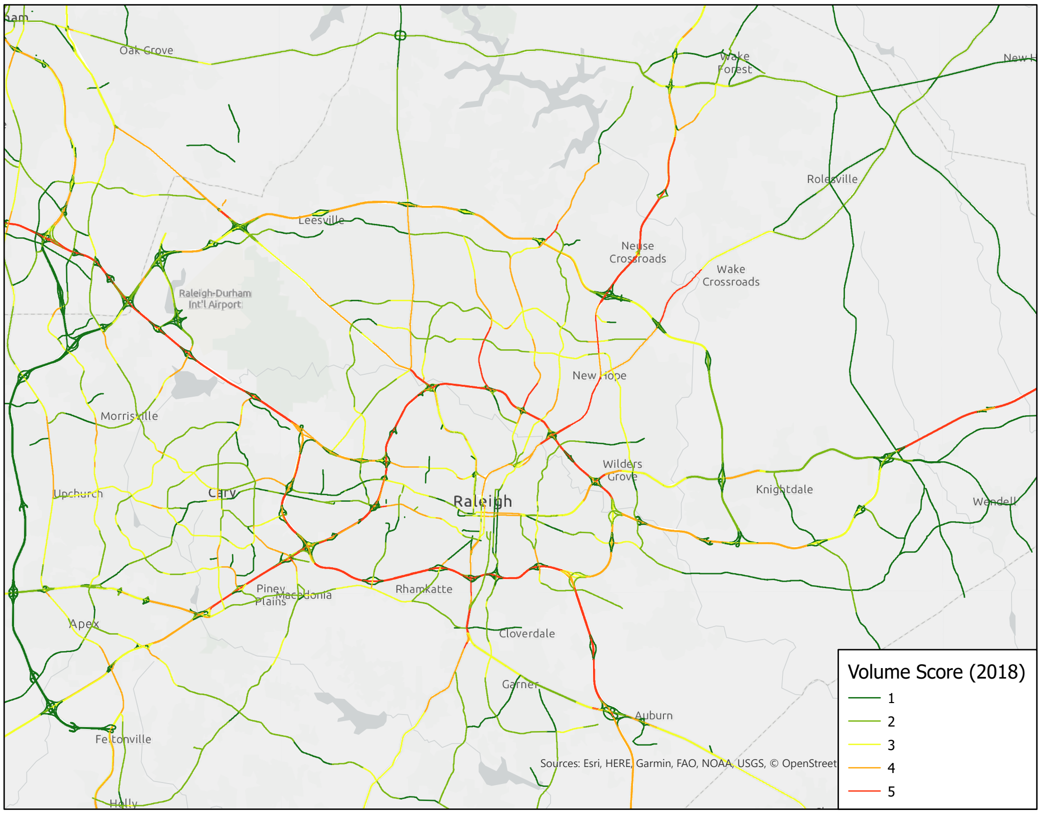
2025 Service Frequency Scores for the Region



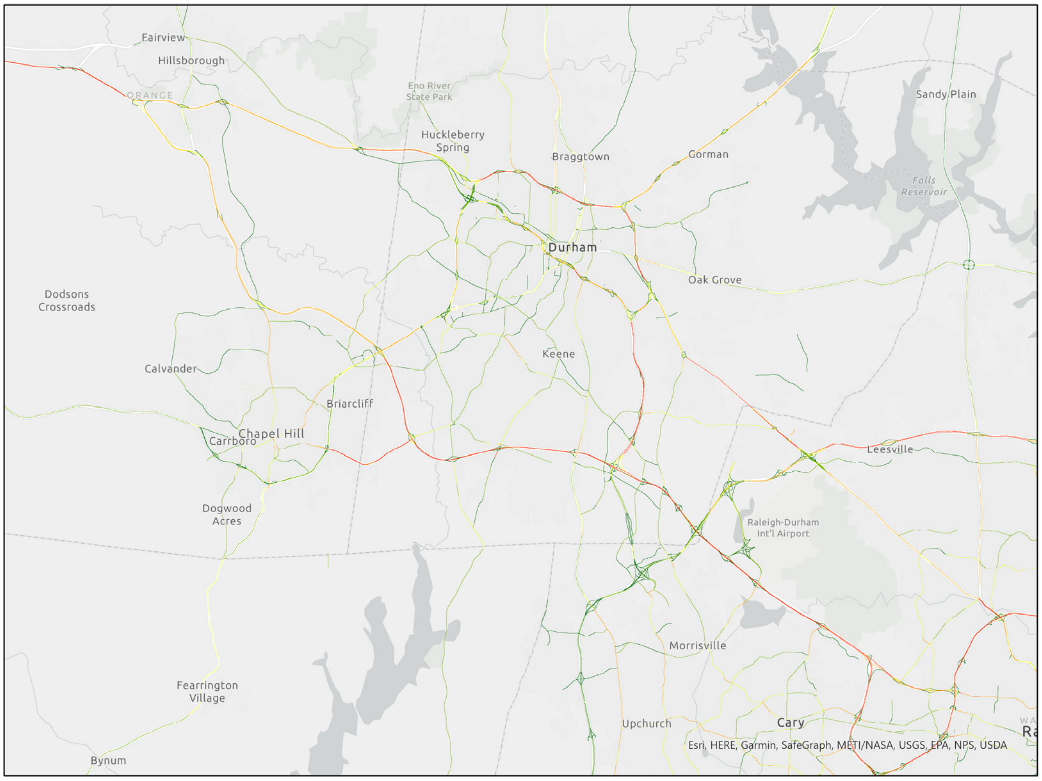


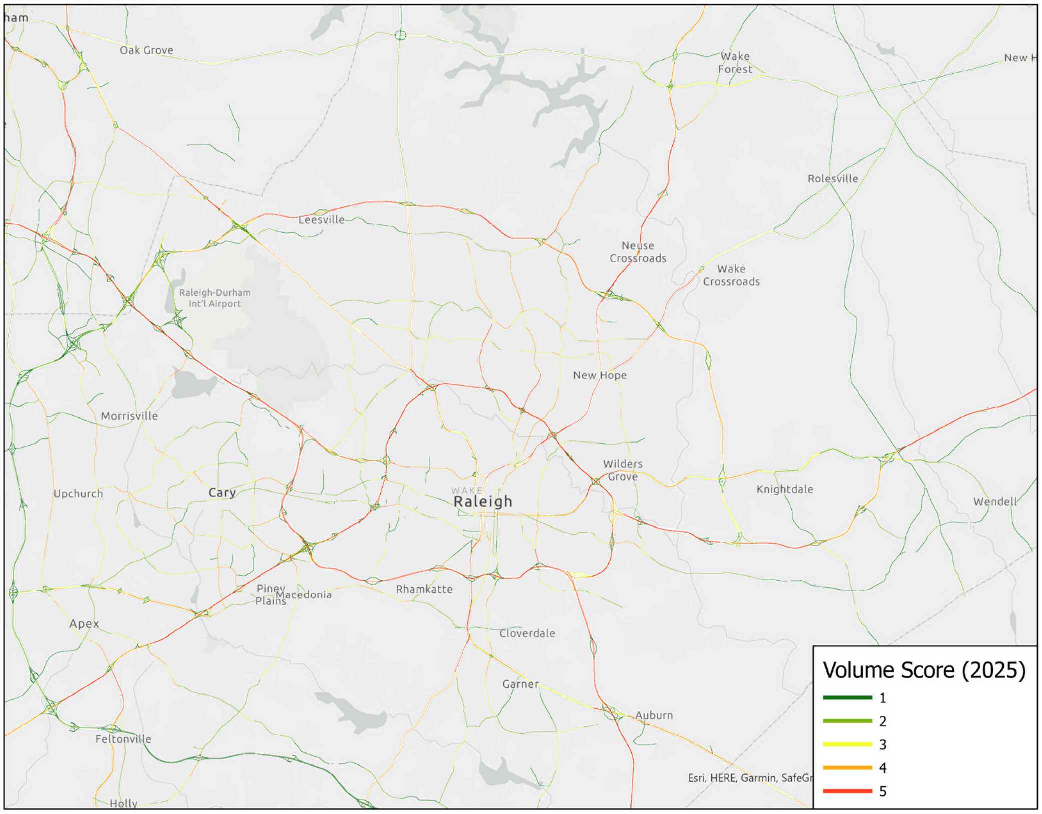
2035 Service Frequency Scores for the Region





2018 Volume Score for the Region





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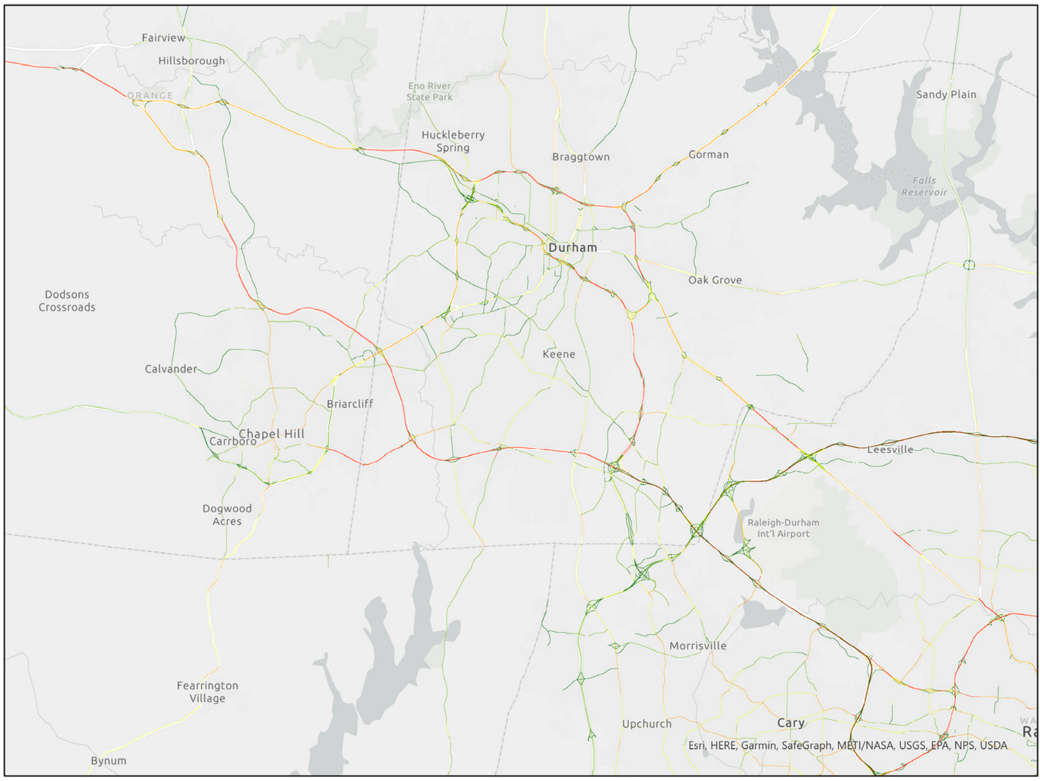

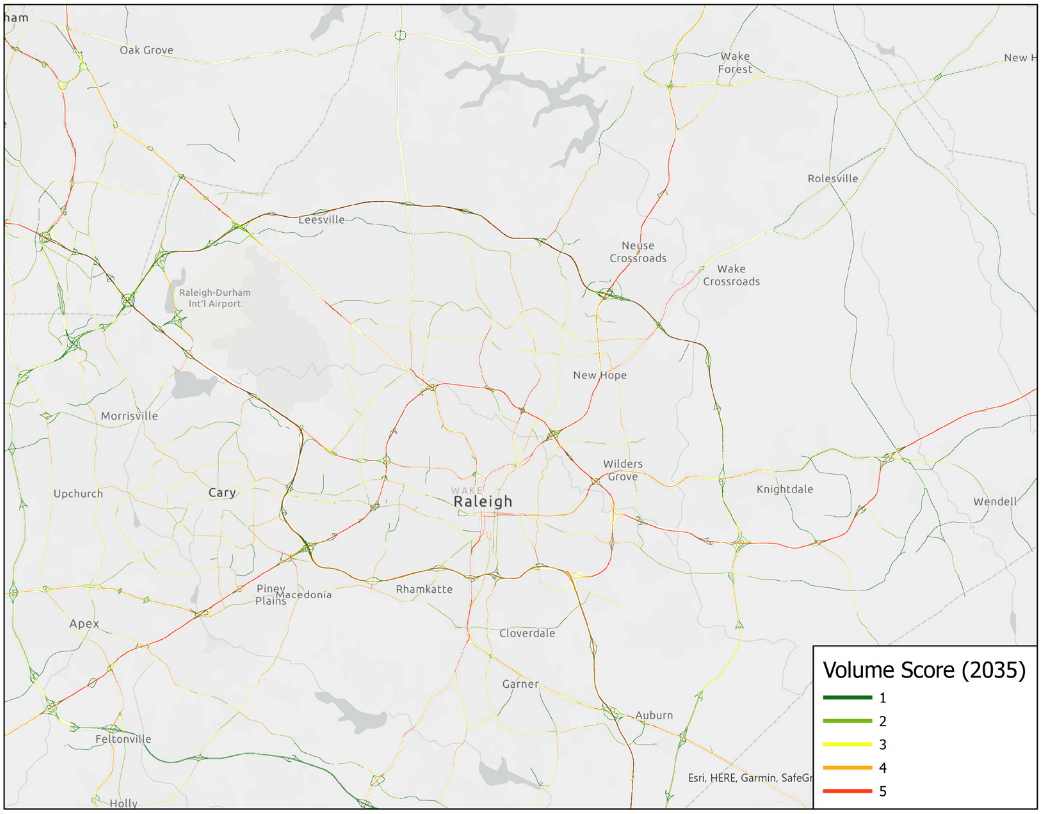

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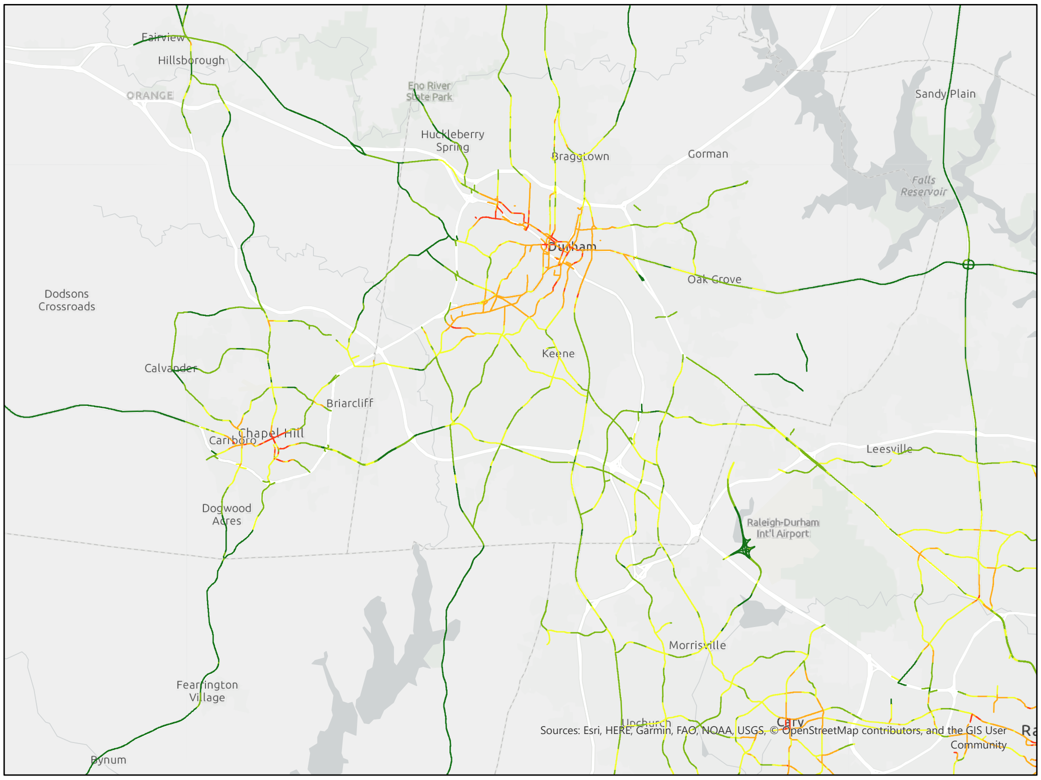
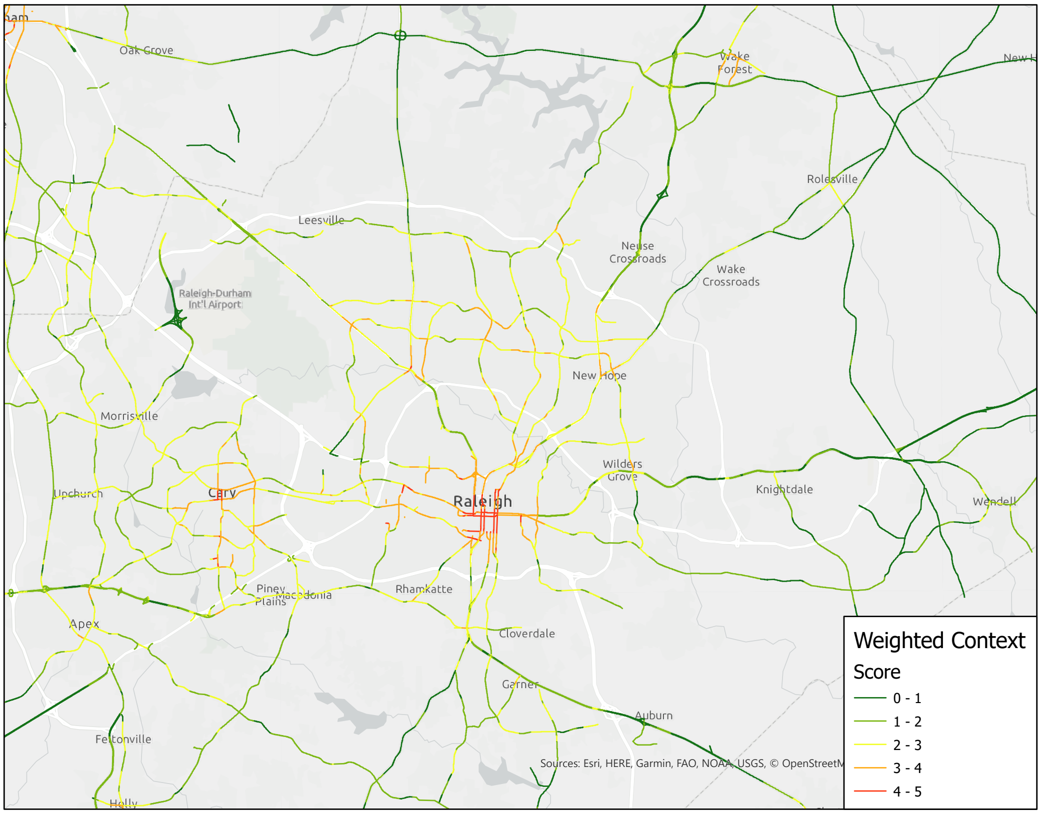
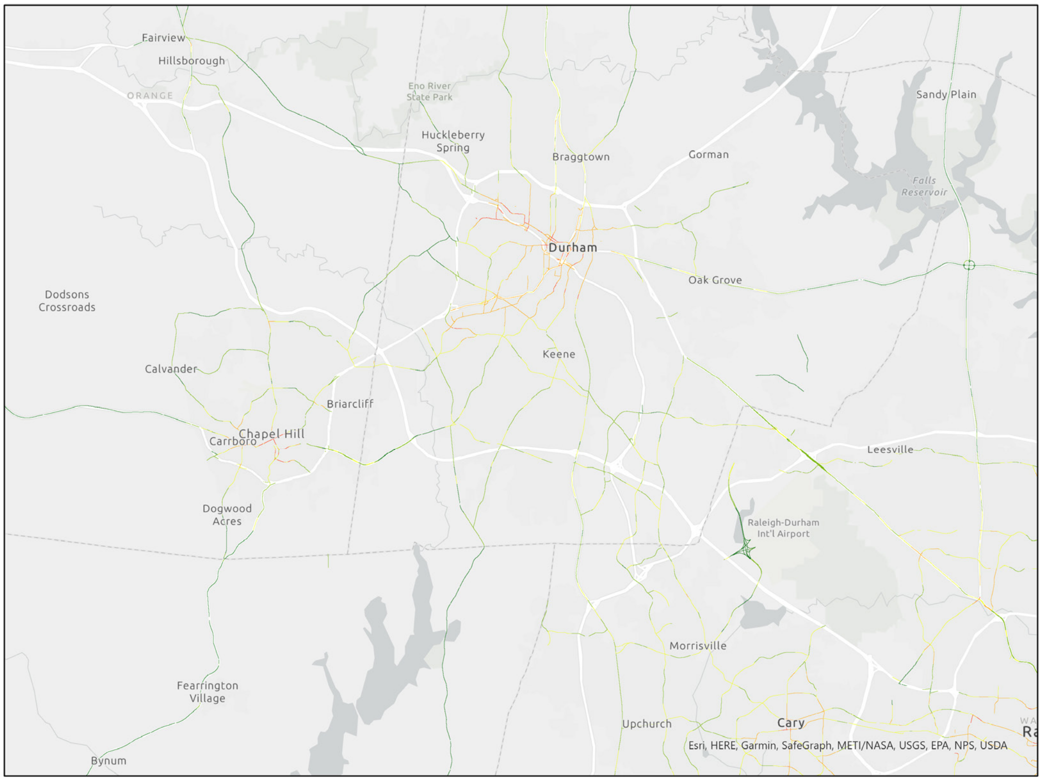
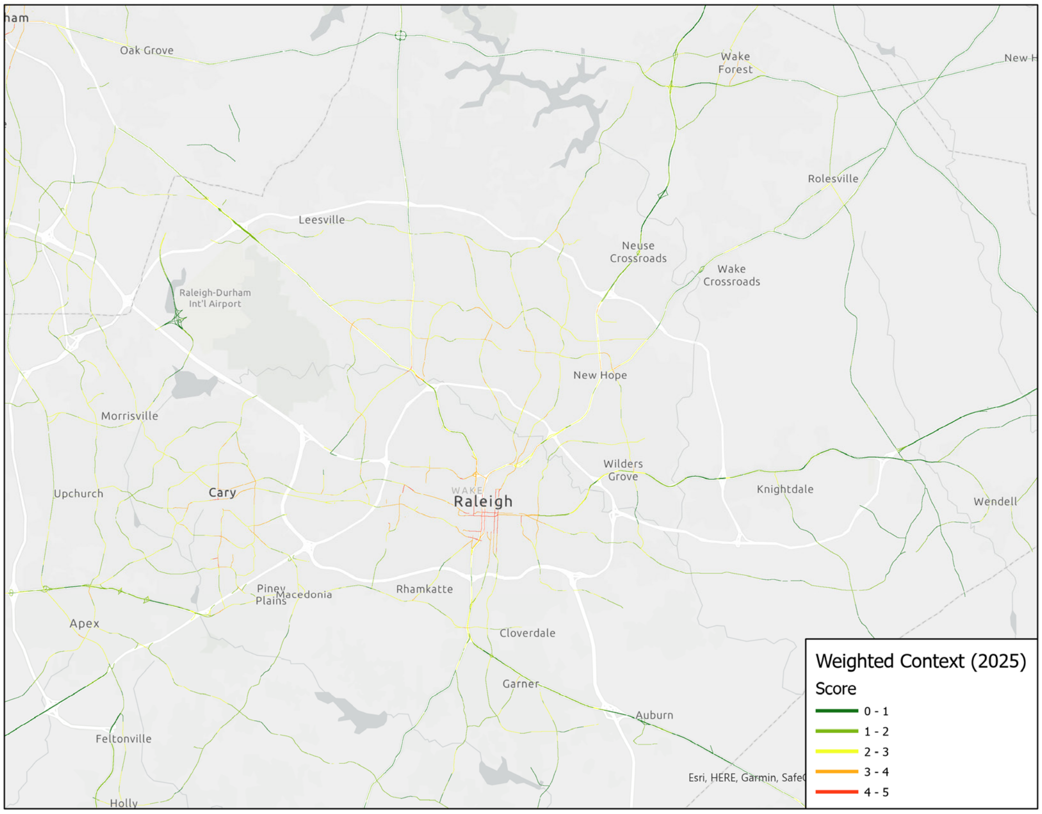


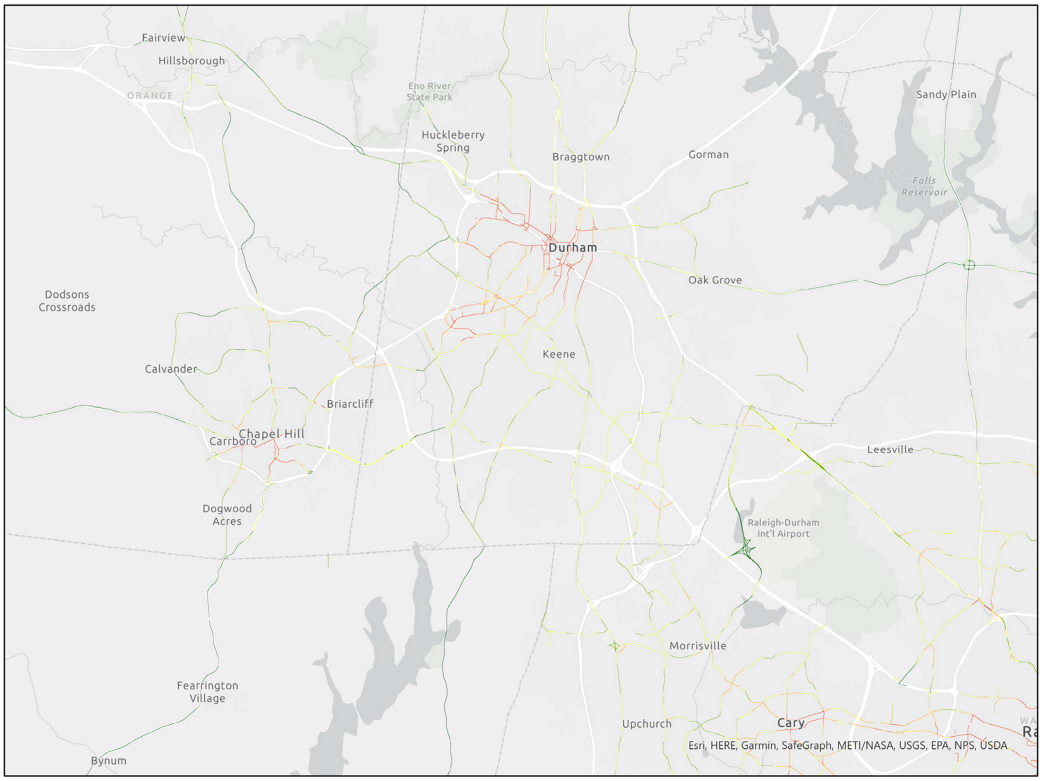


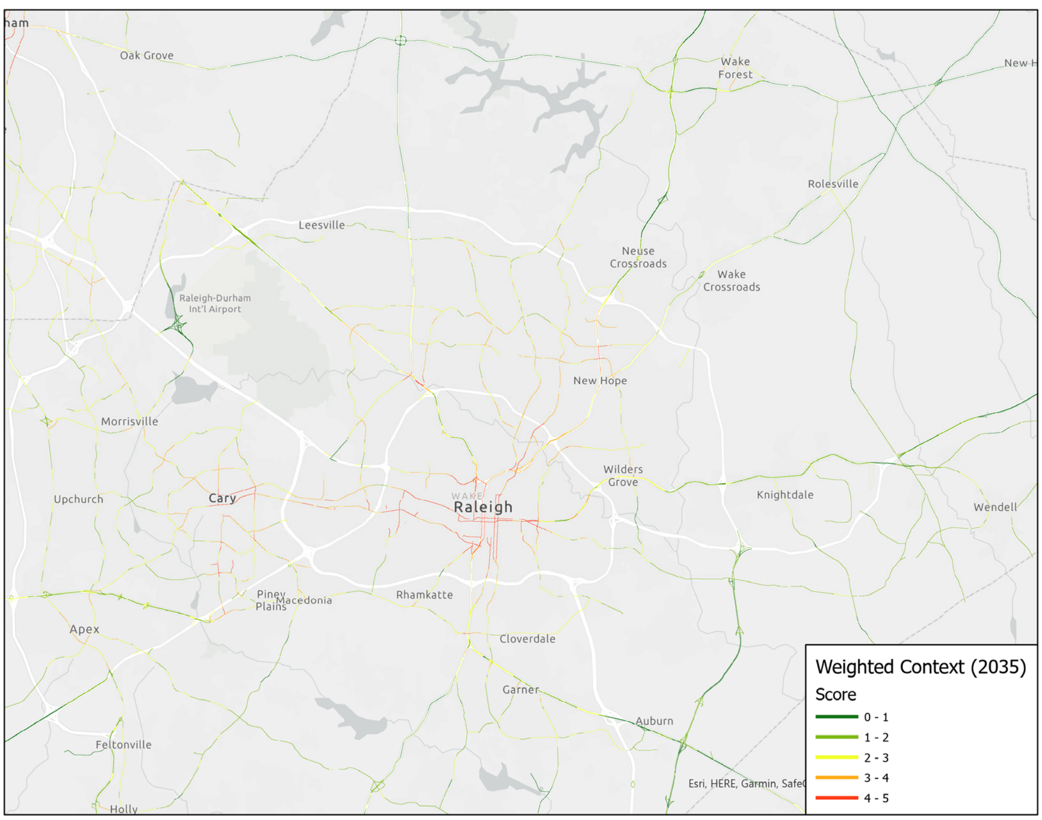
2018 Weighted Context Score for the Region





2025 Weighted Context Score for the Region





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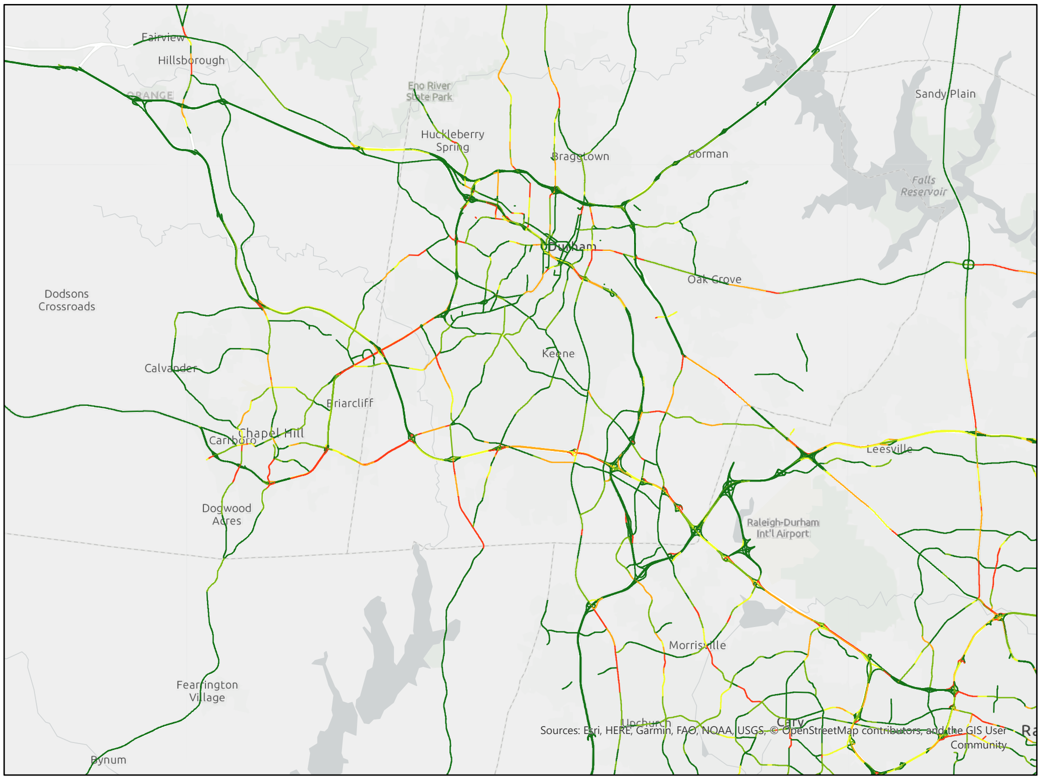
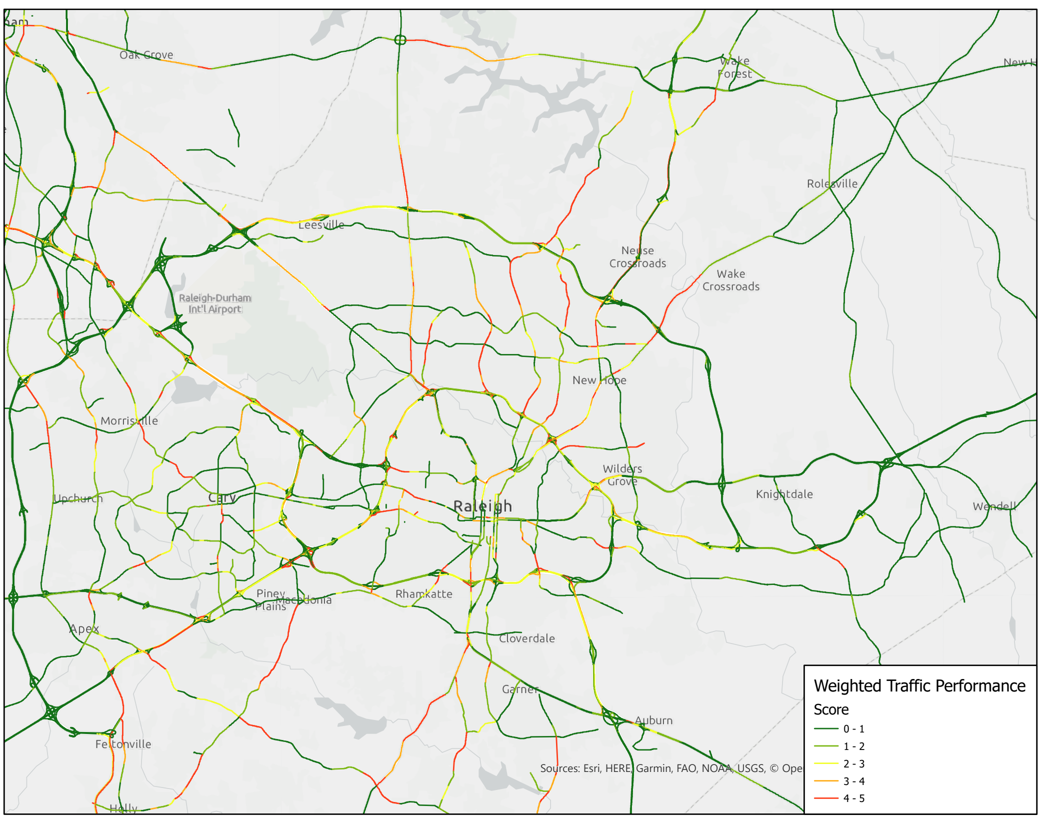
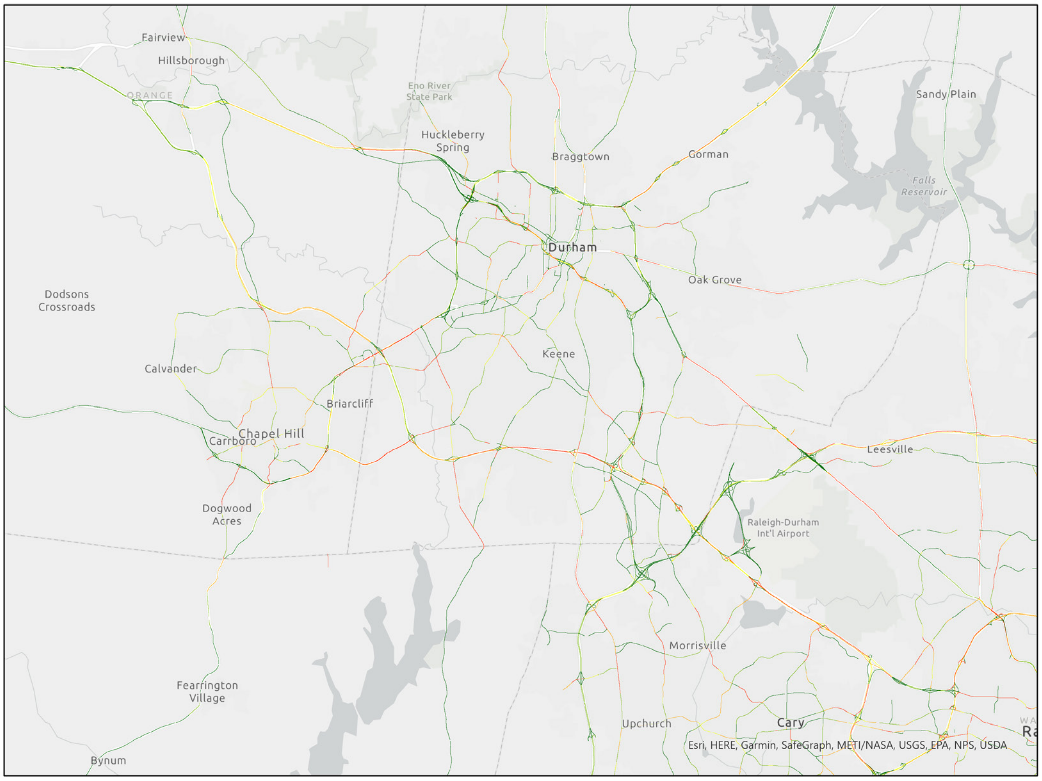
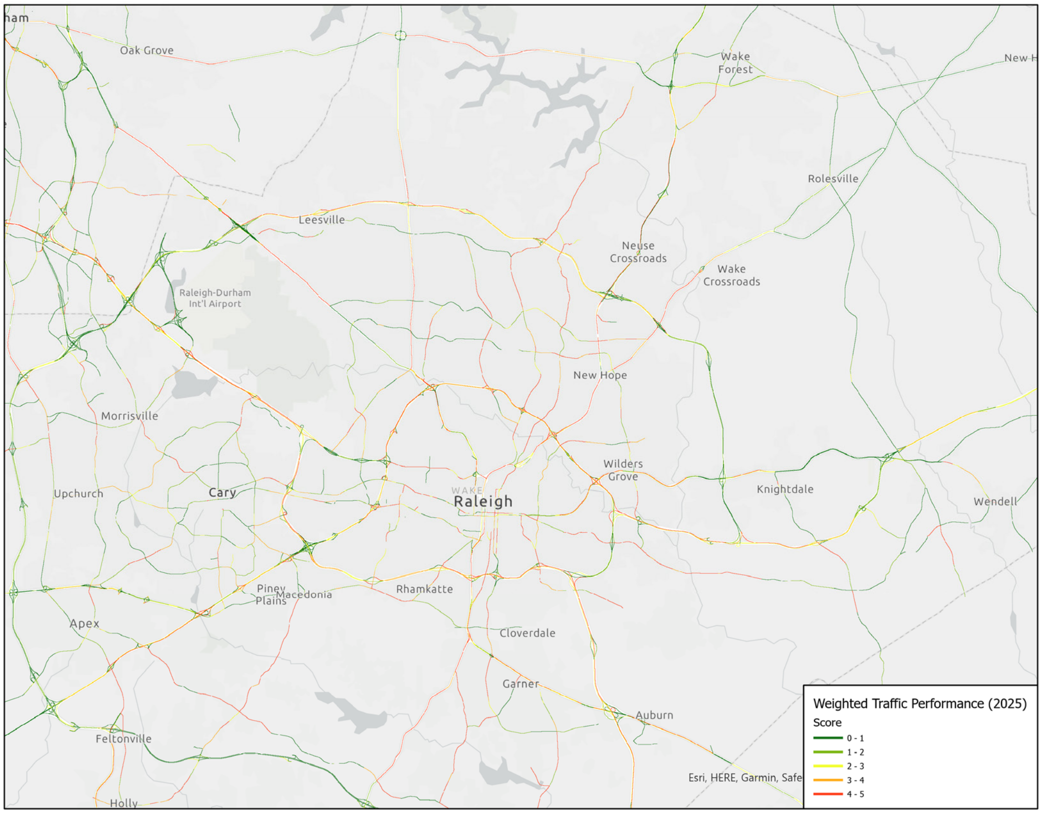




2018 Weighted Traffic Performance Score for the Region





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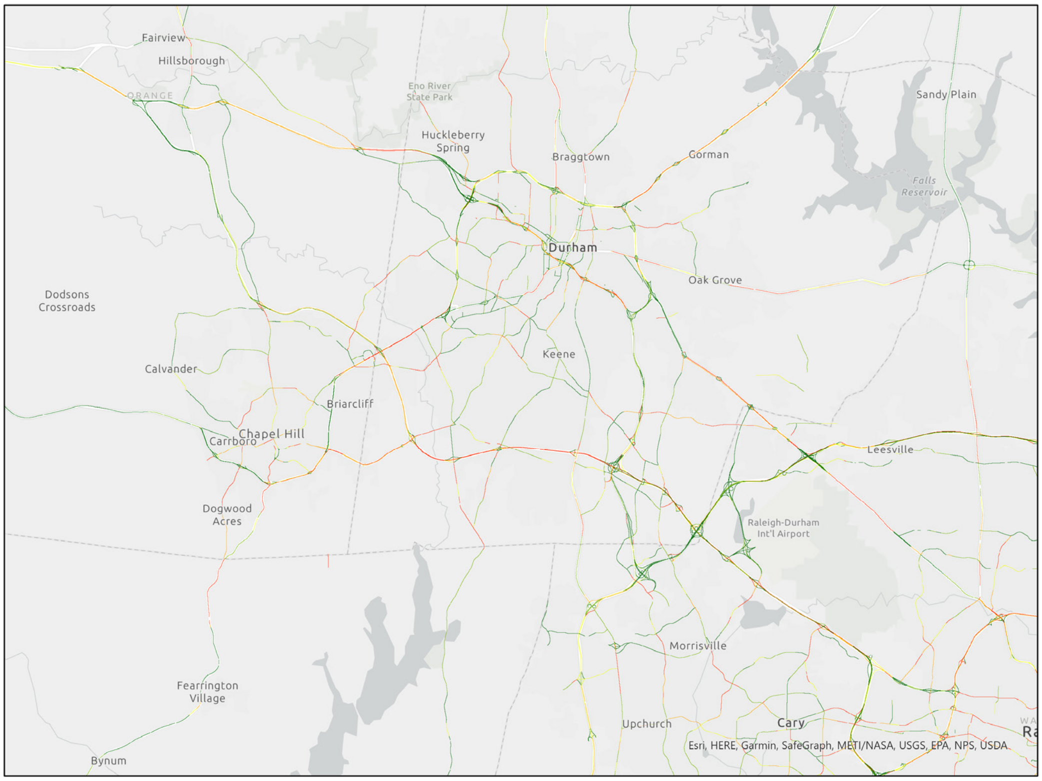

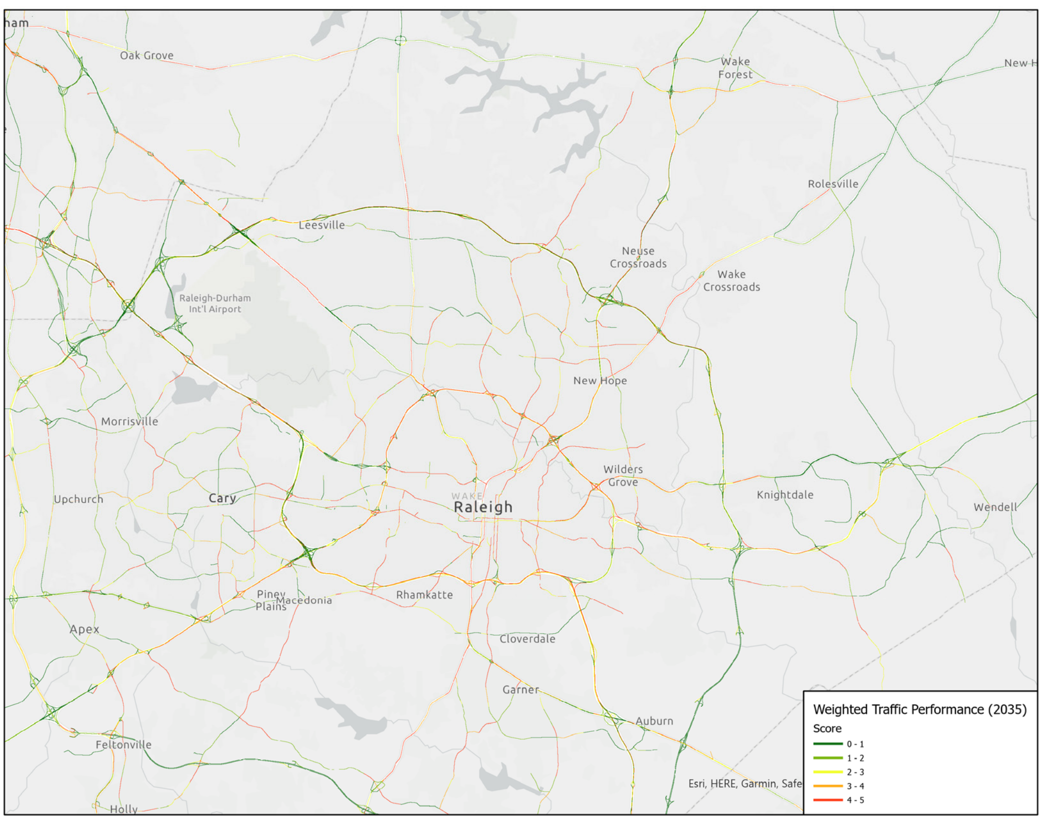

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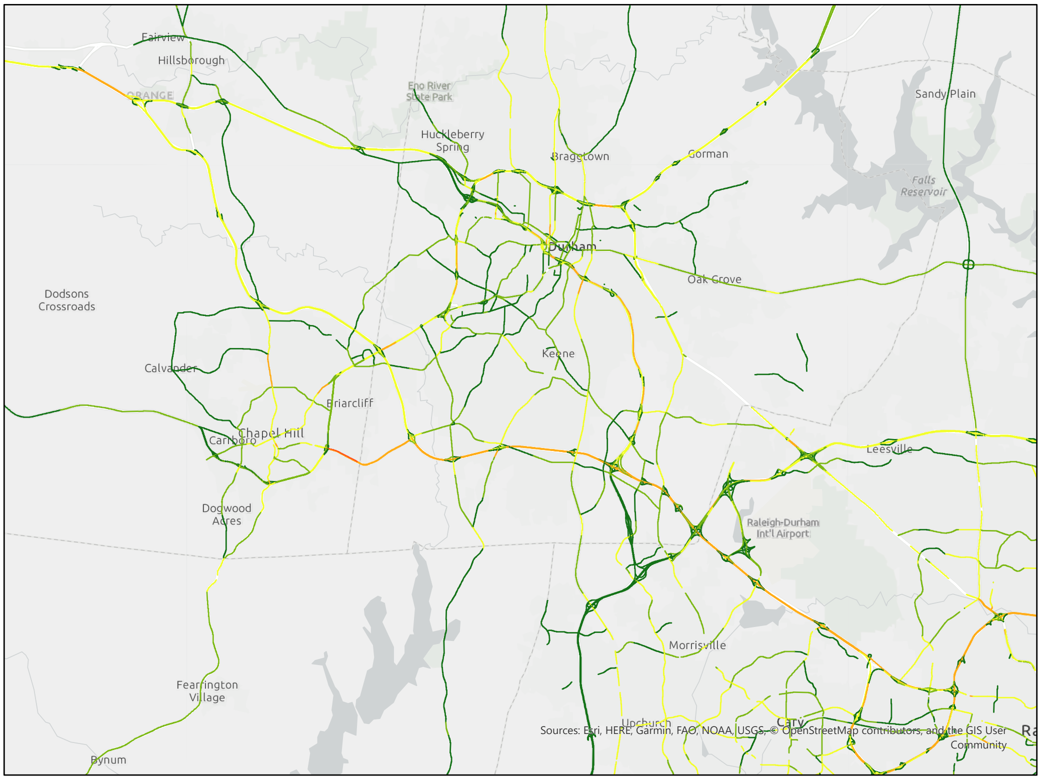
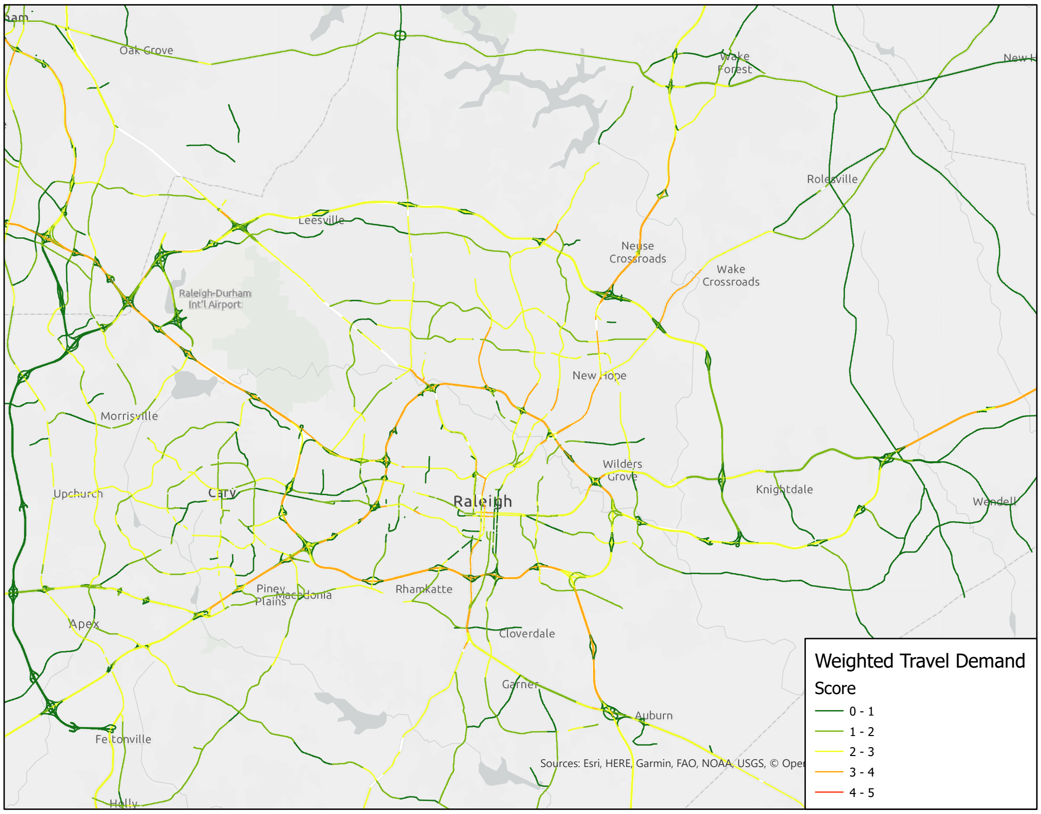
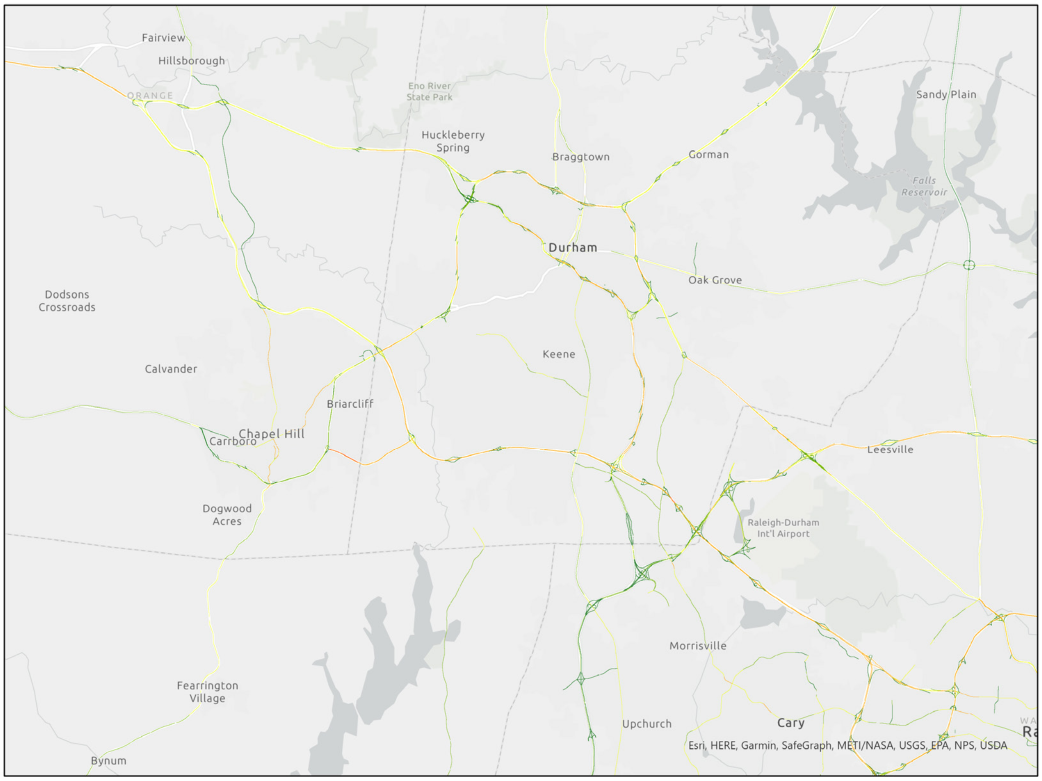
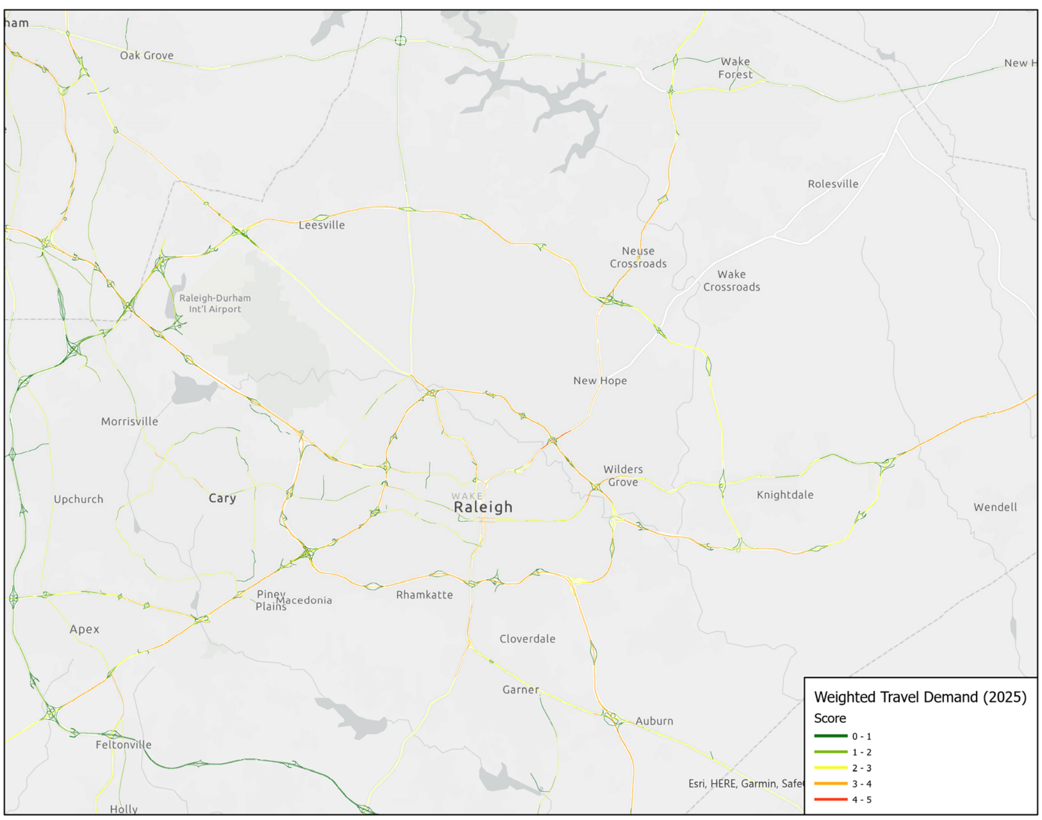


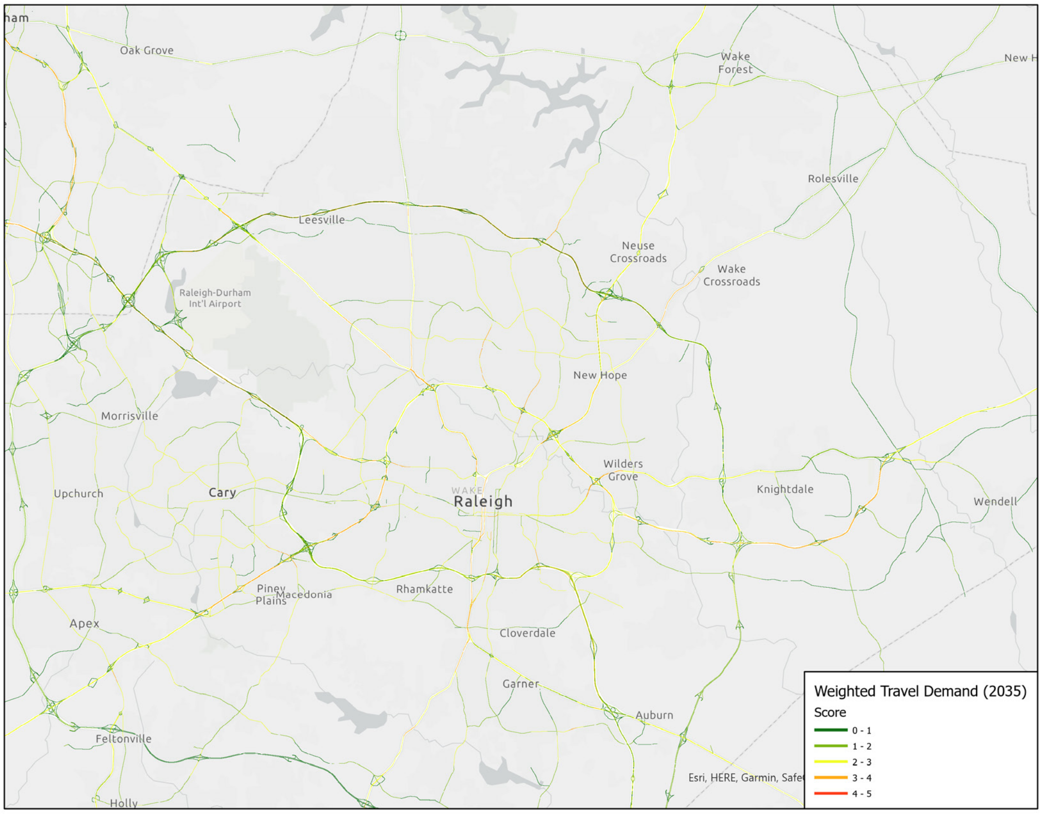


2018 Weighted Travel Demand Score for the Region





2025 Weighted Travel Demand Score for the Region

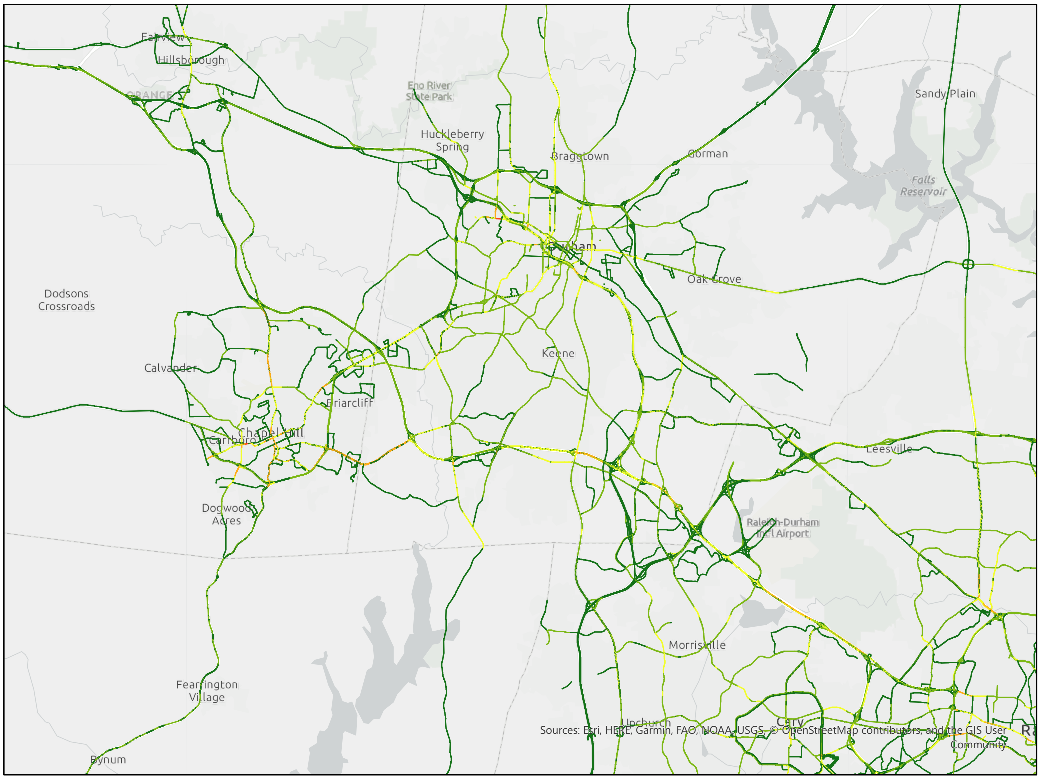


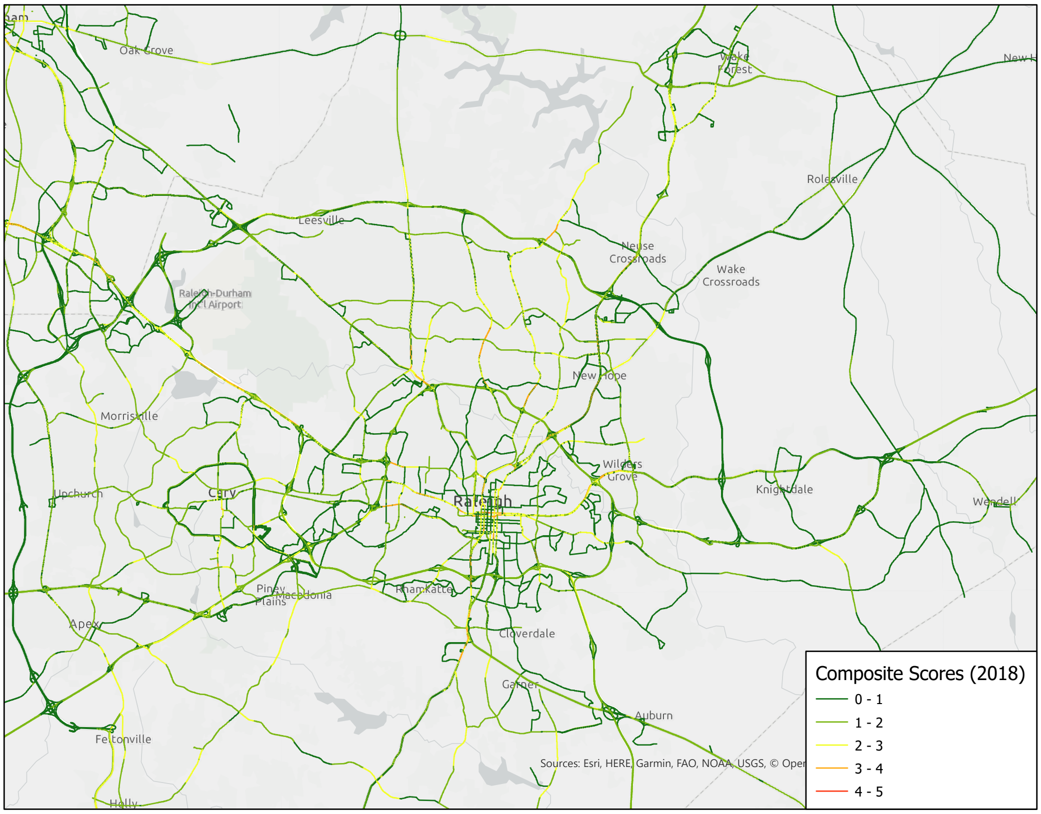
2035 Weighted Travel Demand Score for the Region

Composite Score by Corridor

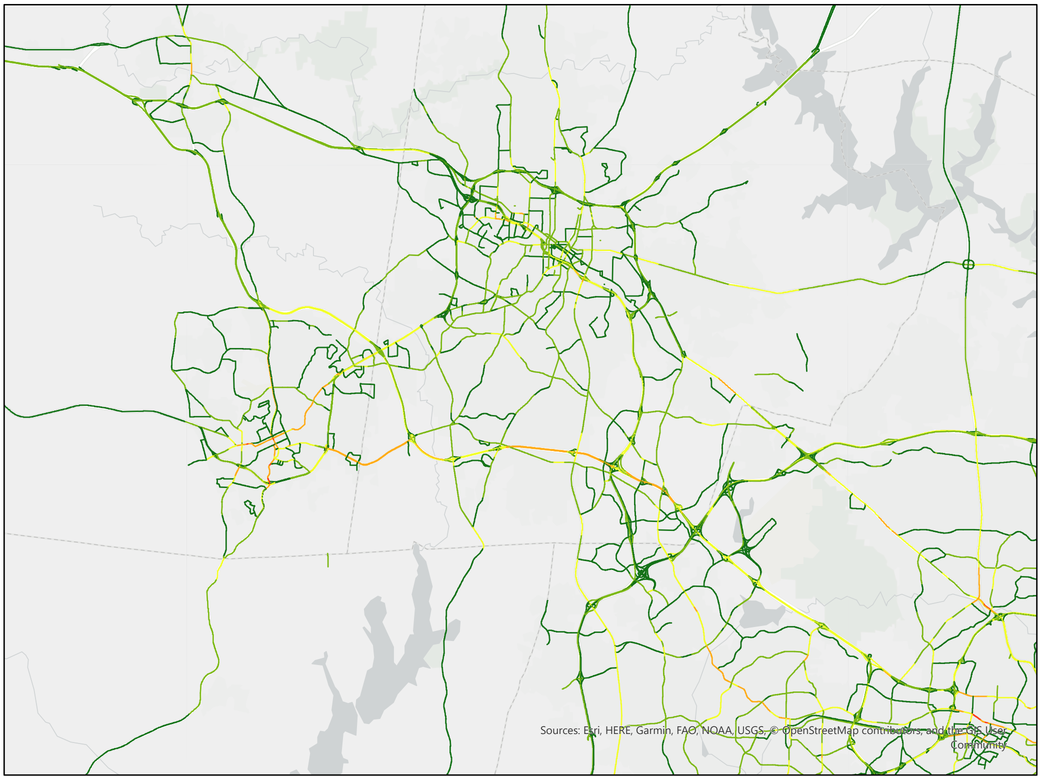
	Corridor	Limits	Volume	Riders	Service Freq.	VOC	Delay	LUDNS	INTDNS	Travel Demand	Transit Perform.	Traffic Perform.	Context	Composite Score
1	NC 54	Fordham - I-40	4.88	2.27	4.36	4.47	3.40	2.02	1.01	3.84	4.36	3.83	1.62	3.50
2	Capital Blvd	440 - 540	4.74	1.50	3.70	4.23	3.13	2.85	2.09	3.45	3.70	3.57	2.55	3.36
3	Franklin St	Columbia - Elliot	3.11	2.52	4.41	2.18	1.66	2.66	2.39	2.87	4.41	1.87	2.55	2.82
4	NC 54	Aviation - Harrison	2.97	1.37	2.78	3.10	2.96	2.63	2.79	2.33	2.78	3.02	2.69	2.70
5	Creed-moor Rd	540 - US 70	3.98	1.00	1.02	4.32	3.39	2.39	2.84	2.79	1.02	3.76	2.57	2.68
6	US 15/501 - Franklin St	Elliot - 15/501 Bus	3.07	1.62	1.77	4.40	3.27	2.00	2.75	2.49	1.77	3.72	2.30	2.68
7	Six Forks Rd	540 - Capital	3.56	1.00	1.50	3.41	2.81	2.85	2.75	2.54	1.50	3.05	2.81	2.54
8	Erwin/ Main	15/501 - Duke	1.63	1.78	3.26	1.90	2.08	3.46	4.17	1.69	3.26	2.01	3.75	2.51
9	US 70	Miami - 540	4.35	1.00	1.00	3.44	2.70	2.20	1.47	3.01	1.00	3.00	1.91	2.38
10	US 1 S	US 64 - NC 55 south	3.74	1.00	1.07	4.24	2.36	2.48	1.58	2.64	1.08	3.11	2.12	2.37
11	Glen-wood Ave	440 - Capital	3.41	1.63	2.09	2.94	2.00	2.19	2.04	2.69	2.09	2.37	2.13	2.36
12	Poole	New Hope - New Bern	2.43	1.00	1.86	3.32	3.02	2.34	2.61	1.86	1.86	3.14	2.45	2.36
13	Hollo-way	US-70 - Roxboro	2.00	1.00	1.50	3.29	2.61	2.90	4.47	1.60	1.50	2.88	3.53	2.35
14	Rock Quarry	New Hope - New Bern	2.63	1.00	1.51	3.27	2.82	2.61	1.98	1.98	1.51	3.00	2.36	2.27
15	Capital Blvd	540 - NC 98	4.71	1.00	1.00	3.10	2.34	1.59	1.11	3.23	1.00	2.65	1.39	2.24
16	US 501 N	W Chapel Hill - Latta	3.28	1.19	1.30	2.72	2.27	2.44	2.64	2.44	1.30	2.45	2.52	2.23
17	US 1 S	Western - US 64	4.15	1.00	1.01	3.29	1.78	1.72	2.30	2.89	1.01	2.39	1.95	2.17
18	US 64 Bus	440 - Smithfield	3.47	1.08	1.79	3.05	2.02	1.93	1.20	2.51	1.79	2.43	1.64	2.17
19	US 70	540 - 440	3.28	1.17	1.51	2.38	1.90	2.44	2.01	2.44	1.51	2.09	2.27	2.12
20	NC 54	Slater - Aviation	2.40	1.31	2.67	1.68	1.80	2.83	1.11	1.96	2.67	1.75	2.15	2.08

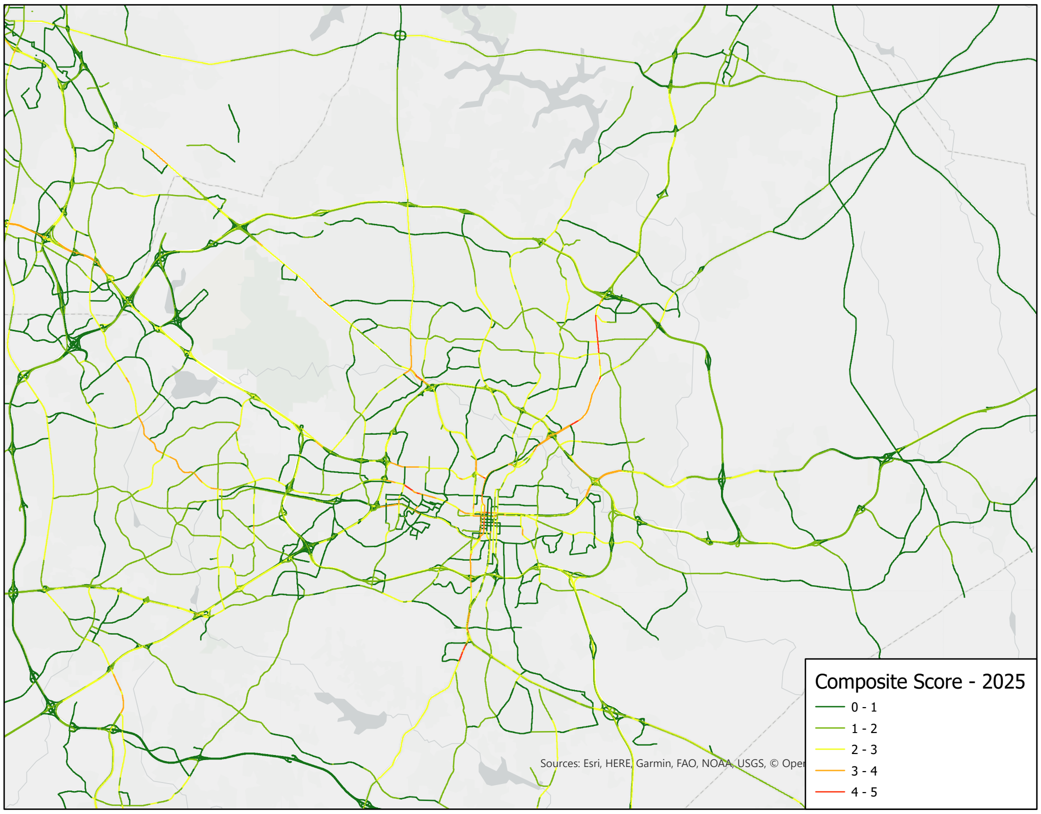
	Corridor	Limits	Volume	Riders	Service Freq.	VOC	Delay	LUDNS	INTDNS	Travel Demand	Transit Perform.	Traffic Perform.	Context	Composite Score
21	Roxboro	Holloway - Latta	2.77	1.03	1.00	2.71	2.32	2.46	2.52	2.07	1.00	2.47	2.49	2.06
22	Ed Mill/ Blue Ridge	US 70 - Western	2.42	1.15	1.99	2.17	1.73	2.78	2.24	1.91	1.99	1.91	2.57	2.06
23	NC 54	I-40 - NC 55	2.13	1.22	1.94	2.84	2.26	2.19	1.59	1.76	1.94	2.49	1.95	2.05
24	Fayette-ville St	Renaissance - MLK	2.88	1.51	1.93	1.77	1.68	2.14	2.23	2.33	1.93	1.72	2.18	2.04
25	Fayette-ville St	MLK - Main	1.97	1.71	1.85	1.37	1.53	3.00	3.67	1.87	1.85	1.47	3.27	2.02
26	US 70	Tryon - I-40	3.02	1.01	1.50	2.75	1.74	1.91	1.35	2.22	1.50	2.14	1.69	1.94
27	US 15/501	15/501 Bus - Cameron	3.35	1.82	1.00	1.68	1.38	1.83	1.25	2.74	1.00	1.50	1.60	1.79
28	US 64	US 1 - NC 55	3.17	1.12	1.25	1.79	1.45	1.63	1.54	2.35	1.25	1.59	1.59	1.75
29	US 70	I-40 - Robertson	3.38	1.00	0.50	2.41	1.79	1.21	1.00	2.43	0.50	2.04	1.13	1.66
30	NC 54	NC 55 - Miami	1.13	1.72	2.68	1.01	1.01	2.40	1.00	1.37	2.68	1.01	1.84	1.62
31	US 70	NC 98 - Miami	3.13	1.00	1.00	1.11	1.03	1.47	1.64	2.28	1.00	1.06	1.54	1.51



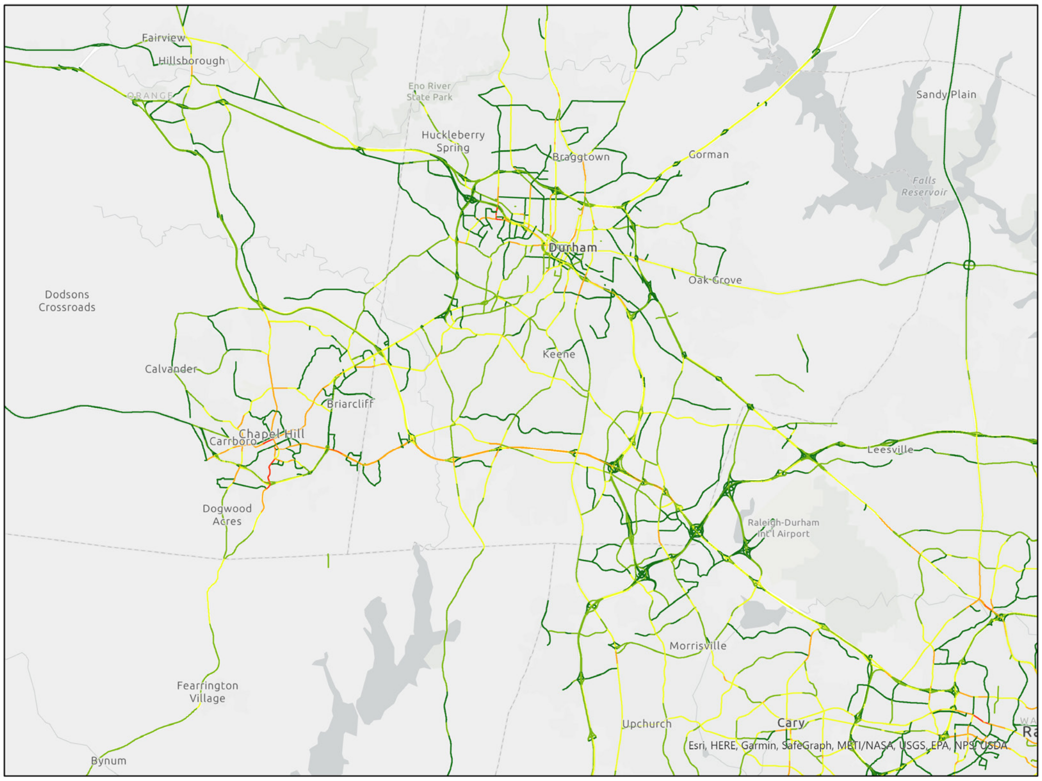


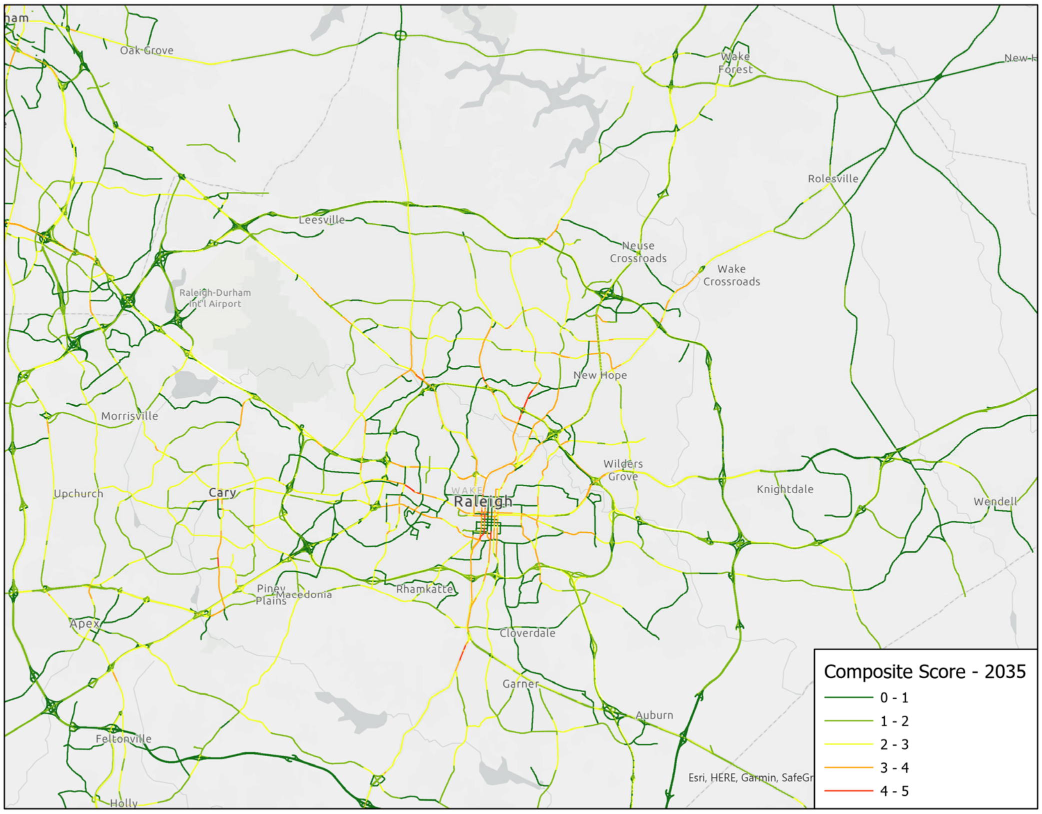
2018 Composite Scores for the Region





2025 Composite Scores for the Region





2035 Composite Scores for the Region

FAST

Freeway And Street-based Transit network

vhb