Commuter Corridors Study

prepared for

Capital Area MPO

prepared by

Baseline Mobility Group, Inc.

with

Resource Systems Group, Inc.

NC Capital Area Metropolitan Planning Organization

December, 2019

Commuter Corridors Study

Final Report

prepared for

Capital Area Metropolitan Planning Organization (CAMPO)

prepared by

Baseline Mobility Group, Inc.

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Resource Systems Group, Inc.

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Table of Contents

List of Tables

List of Figures

Executive Summary

The Commuter Corridors Study was initiated in December of 2018 by the Capital Area Metropolitan Planning Organization (CAMPO), in cooperation with the North Carolina Department of Transportation (NCDOT). The purpose of the study was to understand the underlying causes of traffic congestion along major commuter corridors in the region, explore the emerging growth and mobility trends, and test hypothetical future scenarios in terms of their impacts on mobility, safety, accessibility, and the environment.

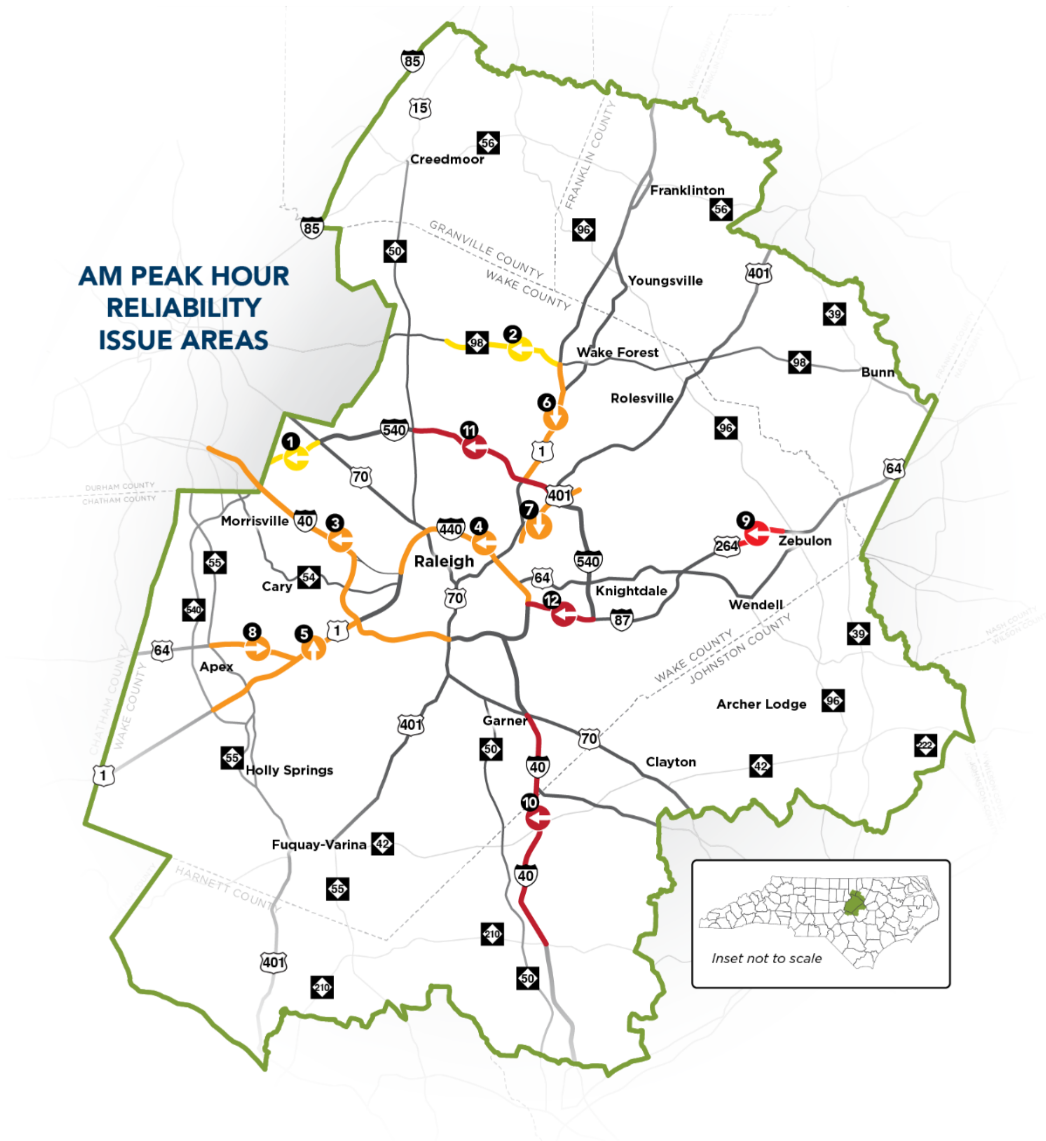
The region's adopted 2045 Metropolitan Transportation Plan (MTP) shows that all interstates and highways in the region are projected to have some level of traffic congestion in the future. Traffic volumes are anticipated to exceed capacity for these roadways by the year 2045. This congestion forecast is based on the region's growth projections of two million people, one million jobs, and nine million trips. These growth projections were adopted as part of the region's 2045 MTP. These commuter corridors serve as the economic backbone of the region as they connect the City of Raleigh's employment centers with the commercial centers, educational institutions, medical facilities, logistics centers, and suburban communities in Wake and several neighboring Counties (i.e., Durham, Chatham, Harnett, Johnston, Nash, Franklin, and Granville) as well as the Research Triangle Park (RTP). This observation led to the question: Why is there so much red on the map despite approved plans for significant roadway and transit investments? This led to the launch of the Commuter Corridors Study.

The study involved a consultant team from Baseline Mobility Group and Resource Systems Group, and a technical steering committee that consisted of several CAMPO members and partner agencies. The technical steering committee guided the development and analysis of future scenarios. This included a broad-based scenario planning approach where realistic as well as unrealistic/hypothetical scenarios could be tested. The study area included four Interstates, seven U.S. Highways, and six N.C. highways for a total of 17 corridors, listed below.

- Interstates: I-40, I-440, I-87, I-540
- U.S. Highways: US 1, US 1 Alt., US 64 Bus, US 70, US 70 Bus, US 401
- NC Highways: NC 55, NC 55 Bypass, NC 540, NC 50, NC 54, and NC 98

The existing conditions analysis entailed a detailed review of speed and travel time reliability data during AM and PM commuting peak hours. The travel time reliability issues have been documented using several thresholds of the Buffer Index metric that measures how much extra time is needed to arrive on-time 95 percent of the time.

The key travel time reliability issues in the Capital MPO region during the AM peak and PM Peak commuting hours are summarized in maps shown on the next two pages by each commuter corridor segment in terms of Moderate (60 to 100%, shown in yellow) to Very High (200 to 350%, shown in dark red) Buffer Time and by direction of travel (shown using a directional arrow).



Moderate Buffer Time (60 to 100%)

- 1 I-540 WB, along the RDU area between US 70 and I-40
- 2 NC 98 WB, between US 1 and Six Forks Rd

Moderate to High Buffer Time (60 to 200%)

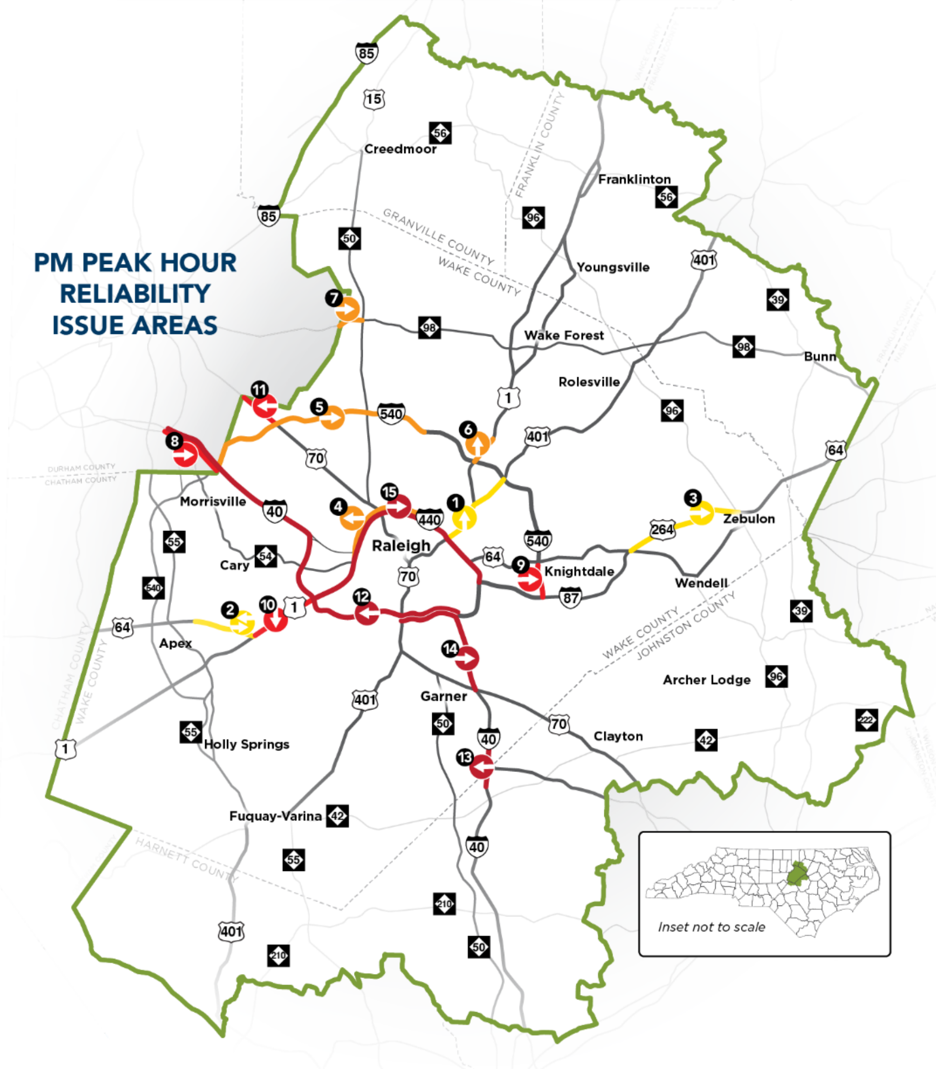
- 3 I-40 WB, along downtown Raleigh, Cary, RDU airport, and RTP areas
- 4 I-440 WB, along the North Raleigh area between I-87 and Wade Ave
- 5 US 1 NB, along the Apex and Cary areas between NC 540 and I-40
- 6 US 1 SB, along the NE Raleigh area between NC 98 and I-540
- 7 US 401 SB, between US 401 Business and I-540
- 8 US 64 EB, along the Apex and Cary areas between NC 55 and US 1

High Buffer Time (100 to 200%)

- 9 US 64 WB, along the Zebulon area between NC 96 and Lizard Lick Rd

High to Very High Buffer Time (100 to 350%)

- 10 I-40 WB, along the Garner area between NC 210 and US 70 Business
- 11 I-540 WB, along the NE Raleigh area between US 401 and NC 50
- 12 I-87 WB, between I-540 and I-440



Moderate Buffer Time (60 to 100%)

1. US 401 NB, between US 1 and I-540
2. US 64 EB and WB, between Lake Pine Rd and US 1
3. US 64 EB, between US 64 Business and US 264

Moderate to High Buffer Time (60 to 200%)

4. I-440 WB, between Six Forks Rd and Wade Ave
5. I-540 EB, between I-40 and Six Forks Rd
6. US 1 (Capital Blvd) NB, between I-540 and Durant Rd
7. NC 98 EB, between Coley Rd and NC 50

High Buffer Time (100 to 200%)

8. I-40 EB, along the RTP and RDU airport areas
9. I-540 EB, between US 64 Business and I-87
10. US 1 SB, between I-40 and US 64
11. US 70 WB, along the Brier Creek area west of I-540

High to Very High Buffer Time (100 to 350%)

12. I-40 WB, along downtown Raleigh, RDU airport, and RTP areas
13. I-40 WB, along the Garner area around the US 70 Bypass interchange area
14. I-40 EB, along downtown Raleigh, and Garner areas between South Saunders Rd to US 70 Business
15. I-440 EB, between I-40/US 1 and I-87

For future conditions analysis, a total of six scenarios were developed and analyzed by the consultant team using a combination of land use, travel demand and benefit-cost analysis models. All six scenarios were developed by pivoting from the socio-economic projections that are embedded in the 2045 MTP. These six scenarios were measured using a host of traffic congestion measures such as level of traffic saturation, travel speed, travel time reliability, and modal split between Single-Occupant Vehicle (SOV), Carpool, Bus, Rail, Walking and Biking. These scenarios were also analyzed using benefit-cost measures to understand the net economic, social and environmental benefits of a scenario.

HWYX – Highway Mega Expansion: This scenario hypothetically assumed doubling of the number of General-Purpose lanes along congested commuter corridor segments in the CAMPO region including I-40, I-440, I-540, US 1, US 64, US 70, and US 401.

> OUTCOME: This scenario was deemed unrealistic and infeasible due to huge costs and community impacts, so it was excluded from the list of final scenarios modeled.

TOLL3 – Congestion Pricing - Dynamic Tolling: This scenario was intended to capture the emerging trend of applying tolls to ease traffic congestion in urban areas. The study assumed dynamic pricing, meaning the price fluctuates in real-time, during peak periods along the region's freeway corridors. It was also assumed that the peak toll pricing is only applicable to Single-Occupant Vehicles (SOVs) and trucks, but not to High-Occupancy Vehicles (HOVs) and buses.

> OUTCOME: This scenario was deemed feasible for some corridors such as I-40 and I-540 where we looked at tolling on managed lanes only, but was considered very difficult for the I-440 corridor where we looked at tolling all lanes of travel due to right-of-way restrictions and community impacts.

> NOTE: It should be mentioned that the tolling scenario was modeled at a regional scale, with a very high toll rate in future year (2045) morning and afternoon peak period conditions for single-occupant vehicles and trucks for using the future managed lanes along I-40, I-540, NC 540 and NC 147 that are part of the adopted MTP. In addition, the tolling scenario hypothetically considered a high toll rate for all lanes along I-440, Wade Avenue, and the I-440 interchange ramps that serve traffic to/from downtown Raleigh. This tolling scenario was modeled in a way that considered traffic redistribution effects across parallel corridors and traffic shifts to alternate modes such as transit. These traffic redistribution effects were considered for work as well as for non-work trips. This combination of high peak period toll rates and regional redistribution of traffic to alternate routes and modes resulted in broad-based negative community impacts. In reality, the tolling strategy will be implemented over phases with a ramp-up period, and by priority corridor to minimize or offset any unintended impacts to the communities of concern.

ETOD – Equitable Transit-Oriented Development: This scenario is a transit-emphasis scenario. It was assumed that more of the anticipated future growth can be redirected towards station areas through supportive zoning policies and other incentives. The study assumed 50 percent additional growth in affordable multi-family, office and retail use within half-mile of each planned transit station in the region, and a 100 percent increase in transit frequency for future transit routes in the region.

> OUTCOME: This scenario was deemed realistic and feasible, and has the potential to curb future traffic congestion in the region.

RESY – Regional Resiliency: This scenario was intended to illustrate the importance of resiliency planning for traffic disruptions due to extreme weather events. The study assumed a 50 percent reduction in the number of available lanes at several commuter corridor segments that were deemed to be vulnerable to flooding in an extreme weather event.

> OUTCOME: This scenario was deemed necessary for resiliency planning. Potential negative impacts could worsen if adequate roadway connectivity is not built into the commuter corridors.

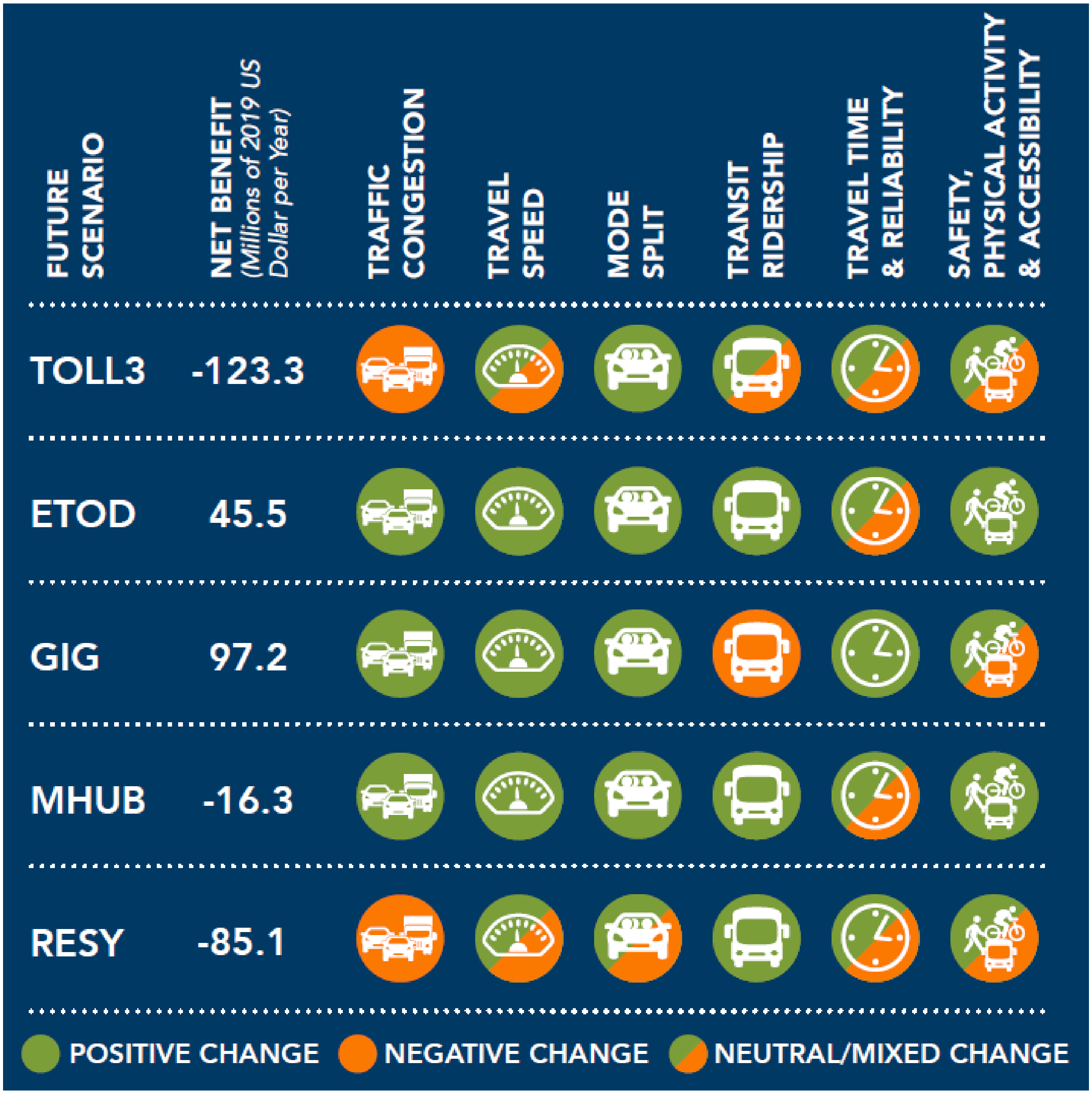
GIG – Gig Economy of Mobile Workers: This scenario was intended to capture the emerging socio-economic trend where an increasing number of people work from home due to the growth of mobile (telecommuting), part-time, and independent workers. Guided by national estimates, the study assumed a 25 percent reduction in work-related commute trips for medium-income and high-income households.

> OUTCOME: This scenario was deemed realistic based on the current trend. It has the potential to curb freeway traffic congestion during regular commuting hours but may cause negative impacts on off-peak travel conditions or local arterials.

MHUB – Smart Mobility Hubs: This scenario was intended to capture the new mobility trend of using shared-ride services for first-mile and last-mile trips. The study identified thirteen future mixed-use center locations around the edges of the region as hypothetical future smart mobility hubs. This scenario also assumed 50 percent additional growth in household, office, and retail use within one and one half-mile band of each of the identified mobility hubs, along with high-frequency premium transit service during commuting hours to connect each mobility hub with downtown Raleigh and the Research Triangle Park (RTP).

> OUTCOME: This scenario was deemed realistic and feasible based on current trends, and has the potential to curb future traffic congestion in the region.

A summary assessment of the performance measures for the future scenarios is illustrated below:



1.0 Introduction

The goal of the Capital Area Metropolitan Planning Organization (CAMPO) Commuter Corridors Study was to explore the pattern and duration of traffic congestion along the major commuter corridors in the Capital Area region and develop appropriate congestion management and congestion mitigation strategies for sustaining future economic growth and developments. The study involved developing future land use-transportation scenarios, preparing scenario analysis using a combination of the region's land use and travel demand models, preparing benefit cost analysis using a new economic analysis tool, developing outreach materials, and recommending congestion management and implementation strategies that can be utilized in the CAMPO's 2050 Metropolitan Transportation Plan (MTP) development process.

The purpose of this final report for the CAMPO's Commuter Corridors study is to document the existing and future travel conditions along the commuter corridors in the Capital Area. These commuter corridors include four Interstates, seven US Highways, and six NC highways for a total of 17 corridors. These corridors are listed below and depicted in the study area map (see Figure 1.1).

- Interstates: I-40, I-440, I-87, I-540
- US Highways: US 1, US 1 Alt., US 64, US 64 Bus, US 70, US 70 Bus, US 401
- NC Highways: NC 55, NC 55 Bypass, NC 540, NC 50, NC 54, NC 98, and Wade Avenue

These study area commuter corridors serve as the economic backbone of the region as they connect the City of Raleigh's employment centers with the commercial centers, educational institutions, medical facilities, logistics centers, and suburban communities in Wake and several neighboring Counties (i.e., Durham, Chatham, Harnett, Johnston, Nash, Franklin, and Granville).

The future year (2045) conditions analysis involved the following:

- Land Use analysis using the Triangle region's CommunityViz model, Version 5.1, dated December 2018 for the 2045 Adopted MTP model
- Travel demand analysis using the Triangle Regional Model, Version 6-2 (TRMv6-2)[1] dated January 26, 2019 for the 2045 Adopted MTP model

It should be mentioned that the TRMv6-2 uses 2013 as the Base Year. Therefore, future year forecasts are tied to model's base year validation to 2013 traffic conditions. Based on limited field observations during the study, it appears that current traffic conditions are significantly worse, especially along the study area commuter corridors. As such, the existing conditions analysis presented in this report relied on the following data sets:

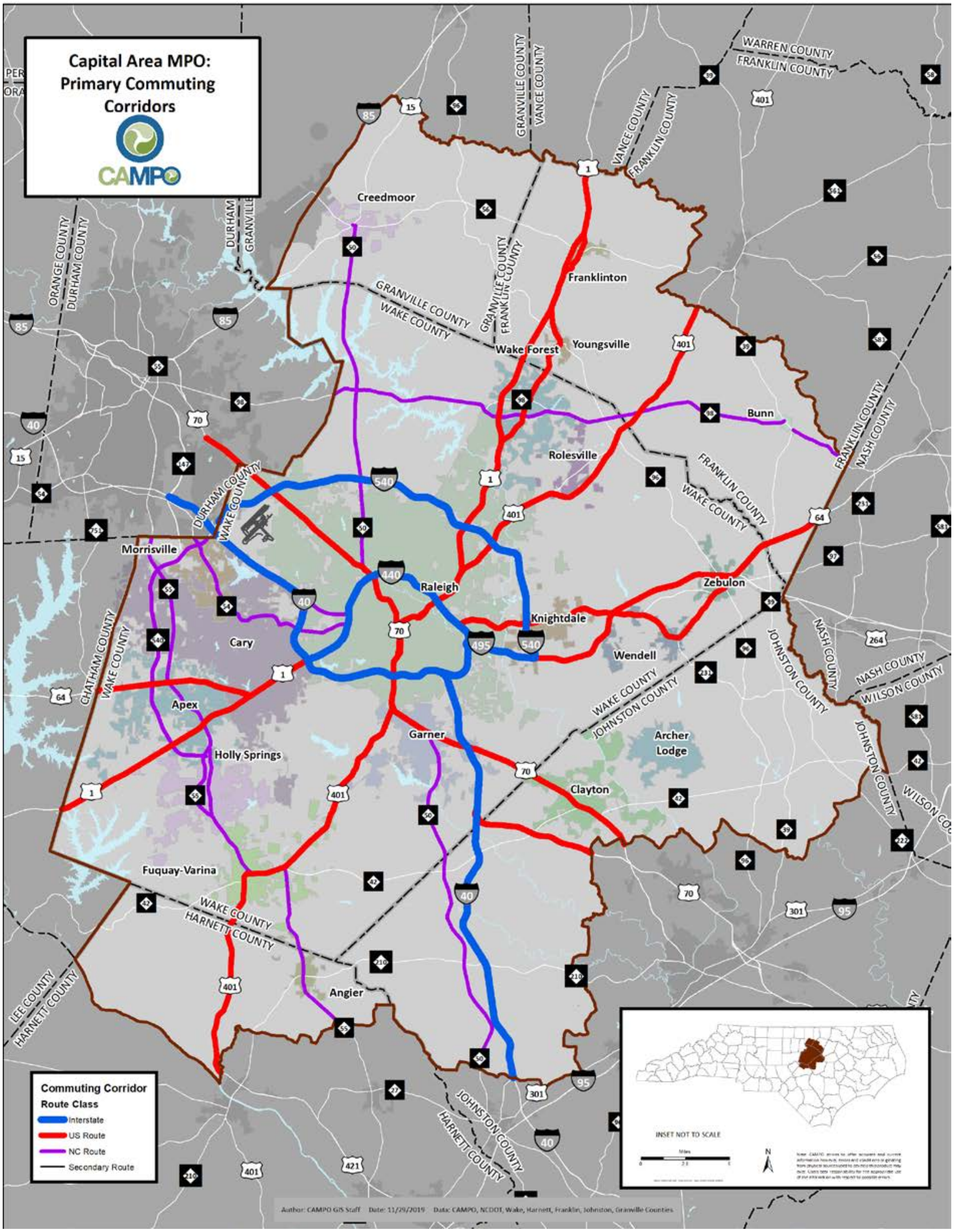
- 2017 Annual Average Daily Traffic (AADT) data from the North Carolina Department of Transportation (NCDOT)
- 2018 Speed and Travel Time Data from the Regional Integrated Transportation Information System (RITIS)
- Five-year crash data (2013-2017) from the NCDOT

[1] The TRMv6-2 Model Files were obtained from the TRM Service Bureau,

- Three-year transit ridership data (2016-2018) from the GoRaleigh and the GoTriangle

It should also be mentioned that the region's CommunityViz model allocates growth based on place types and suitability factors that were heavily weighted for transit-oriented growth and developments. This land use model factored in the Durham-Orange Light Rail Transit (DO LRT) project in future growth allocation. Given that this DO LRT project was cancelled in March of 2019, it is now uncertain if those growth allocations would still be realistic.

Figure 1.1 Study Area Map



2.0 Existing Conditions

This section presents a summary of existing traffic volumes in the study area based on readily available data from NCDOT and other local sources.

2.1 Existing Traffic Volumes

The geometric and traffic characteristics of the study area corridors are summarized in Table 2.1 by 67 commuter corridor segments. These commuter corridor segments were broadly defined to explore traffic demand and capacity values and how they vary from segment to segment as the commuter corridors connect the region by linking downtowns and urban centers with suburban areas and towns.

For many of the longer corridor segments, traffic volumes sometime varied significantly depending on the presence of major activity centers along the corridor. The tabular summary in Table 2.1 focused on the highest observed Annual Average Daily Traffic (AADT) values in 2017 to explore the maximum current demand along the corridor. Similarly, this tabular summary focused on the highest speed limit in the segment to understand the corridor's maximum throughput capacity. A map of the 2017 AADT traffic volumes is presented in Figure 2.1. This summary presentation, both tabular and graphical data, reveals that the following 14 commuter corridor segments, ranked 1 through 14, can be deemed as Tier 1 ranked segments because they carried very high traffic demand of 100,000 to 200,000 vehicles per day in 2017:

1. I-40, From NC 147 to I-540: 195,000 vehicles per day (Segment# 1 in Table 2.1)
2. I-40, From I-540 to Wade Ave: 181,000 vehicles per day (Segment# 2)
3. I-440, From US 70/NC 50 (Glenwood Ave) to US 1 (Capital Blvd): 147,000 vehicles per day (Segment# 12)
4. US 1, From US 64/Tryon Rd to I-40: 140,000 vehicles per day (Segment# 23)
5. I-40, From US 1 to US 70/US 401/NC 50: 128,000 vehicles per day (Segment# 4)
6. I-440, From Wade Ave to US 70/NC 50 (Glenwood Ave): 124,000 vehicles per day (Segment# 11)
7. I-40, From Wade Ave to US 1: 123,000 vehicles per day (Segment# 3)
8. I-40, From US 70/US 401/NC 50 to I-440: 116,000 vehicles per day (Segment# 5)
9. I-40, From I-440 To US 70: 115,000 vehicles per day (Segment# 6)
10. I-440, From US 1 (Capital Blvd) to I-87/I-495/US 64/US 264: 115,000 vehicles per day (Segment# 13)
11. I-540, From US 70 to I-40: 105,000 vehicles per day (Segment# 18)
12. I-440, From I-87/I-495/US 64/US 264 to I-40: 103,000 vehicles per day (Segment# 14)
13. I-540, From US 1 (Capital Blvd) to NC 50: 102,000 vehicles per day (Segment# 16)
14. I-540, From NC 50 to US 70: 100,000 vehicles per day (Segment# 17)

The two I-40 segments through the Research Triangle Park (RTP) and the RDU airport area, ranked 1 and 2 above, carried the highest traffic in the region, followed by the I-440 segment through the Crabtree-North Hills-North Raleigh area, and the US 1 segment through the Cary area that carried the third and fourth highest traffic volumes in the region. These high traffic volumes reveal the Capital Area MPO region's significant reliance on the I-40, I-440, I-540, and US 1 freeways for personal, commuting and business travel.

Table 2.1 Characteristics of the Study Area Commuter Corridors

Segment ID	Commuter Corridor	Segment	Distance (in miles)	Cross-section	Highest Speed Limit	Functional Class	Highest 2017 AADT	Tier Ranking
1	I-40	NC 147 to I-540	3.27	8 to 10 Lanes	65 mph	Interstate	195,000	1
2	I-40	I-540 to Wade Ave	6.44	8 to 10 Lanes	65 mph	Interstate	181,000	1
3	I-40	Wade Ave to US 1	3.86	6 to 7 Lanes	65 mph	Interstate	123,000	1
4	I-40	US 1 to US 70/US 401/NC 50	5.45	6 to 10 Lanes	65 mph	Interstate	128,000	1
5	I-40	US 70/US 401/NC 50 to I-440	3.1	8 to 10 Lanes	65 mph	Interstate	116,000	1
6	I-40	I-440 To US 70	4.36	6 to 7 Lanes	65 mph	Interstate	115,000	1
7	I-40	US 70 to US 70 Bypass	4.37	4 to 5 Lanes	65 mph	Interstate	87,000	2
8	I-40	US 70 Bypass to NC 210	8.76	4 Lanes	70 mph	Interstate	64,000	2
9	I-40	NC 210 to I-95	9.00	4 Lanes	70 mph	Interstate	45,000	2
10	I-440	US 1 to Wade Ave	3.84	4 to 6 Lanes	65 mph	Interstate	89,000	2
11	I-440	Wade Ave to US 70/NC 50 (Glenwood Ave)	2.71	6 to 7 Lanes	60 mph	Interstate	124,000	1
12	I-440	US 70/NC 50 (Glenwood Ave) to US 1 (Capital Blvd)	4.19	7 to 10 Lanes	60 mph	Interstate	147,000	1
13	I-440	US 1 (Capital Blvd) to I-87/I-495/US 64/US 264	3.00	7 to 10 Lanes	60 mph	Interstate	115,000	1
14	I-440	I-87/I-495/US 64/US 264 to I-40	2.80	7 to 10 Lanes	60 mph	Interstate	103,000	1
15	I-540	I-87/I-495/US 64/US 264 to US 1 (Capital Blvd)	9.57	6 to 7 Lanes	70 mph	Interstate	77,000	2
16	I-540	US 1 (Capital Blvd) to NC 50	6.88	6 to 8 Lanes	70 mph	Interstate	102,000	1
17	I-540	NC 50 to US 70	5.17	6 to 7 Lanes	70 mph	Interstate	100,000	1
18	I-540	US 70 to I-40	4.37	6 to 10 Lanes	70 mph	Interstate	105,000	1
19	I-87	I-440 to I-540	3.96	6 to 8 Lanes	65 mph	Interstate	91,000	2
20	I-87	I-540 to US 64 Business	5.84	4 to 6 Lanes	65 mph	Other Frwy/Expy	81,000	2
21	US 1	Old US 1 to NC 55	10.7	4 Lanes	70 mph	Other Frwy/Expy	34,000	3
22	US 1	NC 55 to US 64/Tryon Rd	3.14	4 to 5 Lanes	65 mph	Other Frwy/Expy	59,000	2

Segment ID	Commuter Corridor	Segment	Distance (in miles)	Cross-section	Highest Speed Limit	Functional Class	Highest 2017 AADT	Tier Ranking
23	US 1	US 64/Tryon Rd to I-40	3.78	6 to 7 Lanes	65 mph	Other Frwy/Expy	140,000	1
24	US 1	I-440 to US 401	2.32	8 to 10 Lanes	45 mph	Other Principal Arterial	76,000	2
25	US 1	US 401 to I-540	2.61	6 to 10 Lanes	45 mph	Other Principal Arterial	60,000	2
26	US 1	I-540 to Durant Rd	1.57	6 to 7 Lanes	55 mph	Other Principal Arterial	64,000	2
27	US 1	Durant Rd to NC 98	5.3	4 to 6 Lanes	65 mph	Other Principal Arterial	54,000	2
28	US 1	NC 98 NC 96	5.96	4 to 5 Lanes	65 mph	Other Principal Arterial	46,000	2
29	US 64	NC 751 to NC 55	4.23	4 to 5 Lanes	55 mph	Other Principal Arterial	31,000	3
30	US 64	NC 55 to US 1/Tryon Rd	4.79	4 to 5 Lanes	55 mph	Other Principal Arterial	48,000	2
31	US 64/US 264	US 64 Business (Knightdale Blvd) to US 264 Split	7.4	4 to 8 Lanes	70 mph	Other Principal Arterial	64,000	2
32	US 64	US 264 Split to NC 231	10.0	4 Lanes	70 mph	Other Principal Arterial	29,000	3
33	US 64 Business	I-440 to I-540	4.05	4 to 8 Lanes	45 mph	Other Principal Arterial	40,000	2
34	US 64 Business	I-540 to I-87	5.21	4 to 8 Lanes	45 mph	Other Principal Arterial	37,000	3
35	US 64 Business	I-87 to NC 96 (Arendell Ave)	8.16	4 to 5 Lanes	45 mph	Minor Arterial	17,000	3
36	US 70	NC 98 to I-540	8.05	4 to 9 Lanes	55 mph	Other Principal Arterial	55,000	2
37	US 70	I-540 to I-440	7.45	4 to 9 Lanes	55 mph	Other Principal Arterial	52,000	2
38	US 70 (Glenwood Ave)	I-440 to US 401	3.15	4 to 5 Lanes	45 mph	Other Principal Arterial	29,000	3

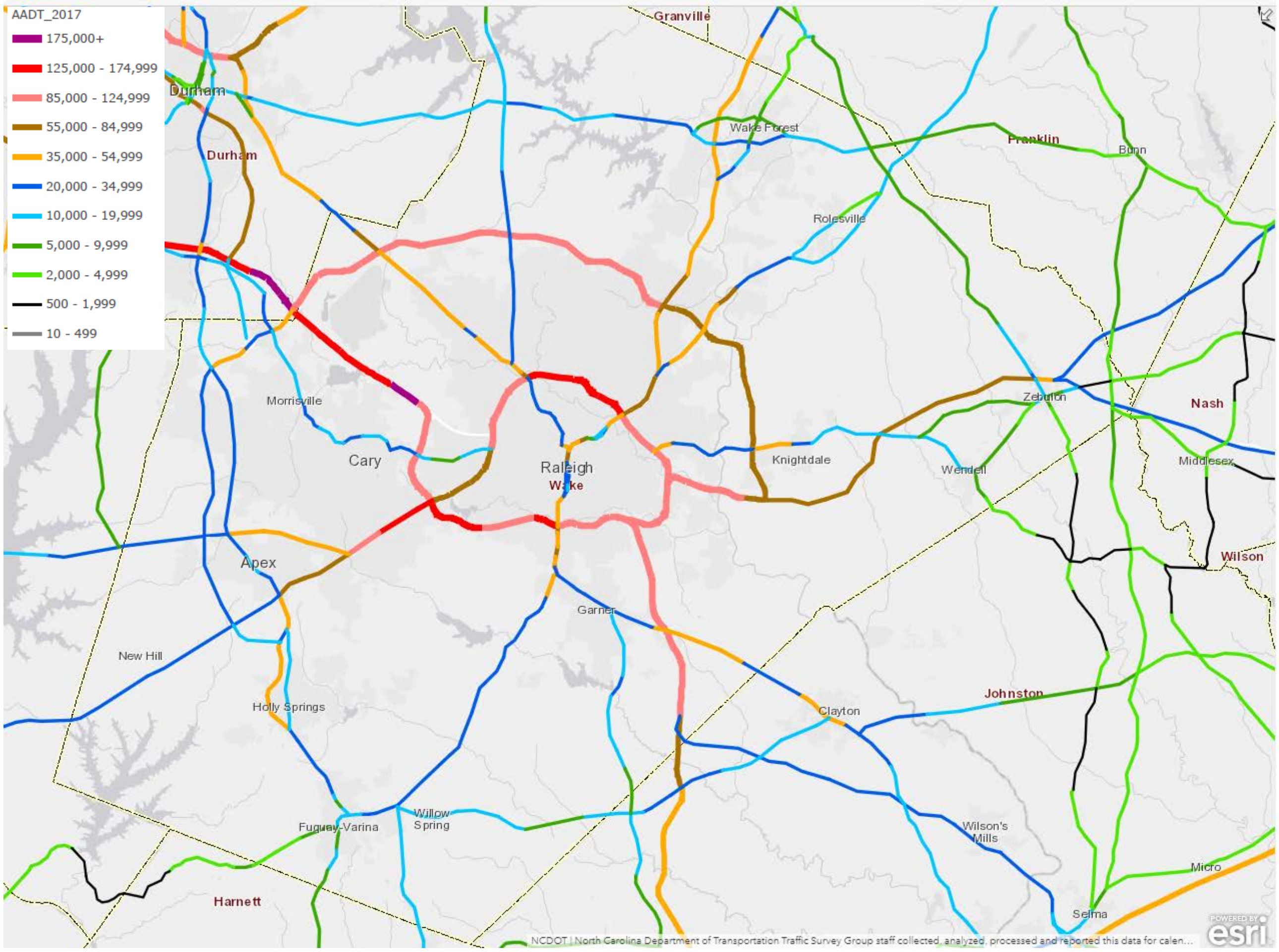
Segment ID	Commuter Corridor	Segment	Distance (in miles)	Cross-section	Highest Speed Limit	Functional Class	Highest 2017 AADT	Tier Ranking
39	US 70	US 401 to I-40	4.76	4 to 6 Lanes	45 mph	Other Principal Arterial	31,000	3
40	US 70	I-40 to US 70 Bypass (Clayton)	11.3	4 to 5 Lanes	55 mph	Other Principal Arterial	39,000	3
41	US 70 Bypass	I-40 to Clayton	9.13	4 Lanes	55 mph	Other Frwy/Expy	32,000	3
42	US 401	NC 55 to Ten Ten Rd	5.99	4 to 5 Lanes	45 mph	Other Principal Arterial	34,000	3
43	US 401	Ten Ten Rd to US 70	5.29	4 to 6 Lanes	45 mph	Other Principal Arterial	44,000	2
44	US 401	US 70 to I-40	1.83	6 to 8 Lanes	45 mph	Other Principal Arterial	58,000	2
45	US 401	I-40 to I-440	5.70	8 to 10 Lanes	45 mph	Other Principal Arterial	63,000	2
46	US 401	I-540 to US 401 Business	4.59	4 to 6 Lanes	45 mph	Other Principal Arterial	55,000	2
47	US 401	US 401 Business to NC 96 (Zebulon Rd)	5.43	4 to 6 Lanes	45 mph	Other Principal Arterial	16,000	3
48	NC 540	I-40 to NC 55	3.95	6 to 10 lanes	70 mph	Other Frwy/Expy	45,000	2
49	NC 540	NC 55 to US 64	6.66	6 to 7 lanes	70 mph	Other Frwy/Expy	31,000	3
50	NC 540	US 64 to NC 55 Bypass	5.78	6 to 7 lanes	70 mph	Other Frwy/Expy	27,000	3
51	NC 55	Hopson Rd to US 64	9.04	4 to 7 lanes	55 mph	Other Principal Arterial	26,000	3
52	NC 55	US 64 to US 1	3.15	3 to 6 Lanes	45 mph	Other Principal Arterial	27,000	3
53	NC 55 Bypass	US 1 to NC 55 (S Main St)	5.86	4 to 5 Lanes	55 mph	Other Principal Arterial	45,000	2
54	NC 55	NC 55 (S Main St) to US 401	4.09	4 to 5 Lanes	55 mph	Other Principal Arterial	30,000	3
55	NC 55	US 401 to NC 210 (E Depot St)	6.39	3 to 4 Lanes	55 mph	Minor Arterial	19,000	3

Segment ID	Commuter Corridor	Segment	Distance (in miles)	Cross-section	Highest Speed Limit	Functional Class	Highest 2017 AADT	Tier Ranking
56	NC 54	I-40 to NC 540	2.14	3 to 6 Lane	45 mph	Other Principal Arterial	25,000	3
57	NC 54	NC 540 to Aviation Pkwy	2.9	4 to 6 Lanes	45 mph	Other Principal Arterial	14,000	3
58	NC 54	Aviation Pkwy to I-40	5.72	3 to 6 Lane	45 mph	Other Principal Arterial	27,000	3
59	NC 54	I-40 to I-440	3.00	3 to 6 Lane	45 mph	Other Principal Arterial	15,000	3
60	NC 50	US 70 to I-540	4.92	4 to 6 Lanes	45 mph	Minor Arterial	34,000	3
61	NC 50	I-540 to NC 98	5.02	4 Lanes	55 mph	Minor Arterial	21,000	3
62	NC 50	NC 98 to NC 56 (Wilton Ave)	9.44	2 to 3 Lanes	55 mph	Minor Arterial	12,000	3
63	NC 98	NC 50 to US 1	8.64	2 to 4 Lanes	55 mph	Minor Arterial	20,000	3
64	NC 98	US 1 to NC 96 (Zebulon Rd)	6.24	3 to 5 Lanes	55 mph	Principal and Minor Arterial	30,000	3
65	NC 98	NC 96 (Zebulon Rd) to NC 39	10.5	2 to 3 Lanes	55 mph	Minor Arterial	8,300	3
66	Wade Ave	I-40 to I-440	2.99	8 Lanes	60 mph	Other Frwy/Expy	96,000	2
67	Wade Ave	I-440 to US 401 (Capital Blvd)	3.2	4 to 5 Lanes	45 mph	Other Principal Arterial	42,000	2

Sources: NCDOT, Google Street View, and OpenStreetMap.org

Note: Tier ranking of 1, 2 and 3 was assigned to each corridor segment based on AADT volume thresholds

Figure 2.1 Existing Traffic Volumes - 2017 Annual Average Daily Traffic



Source: NCDOT

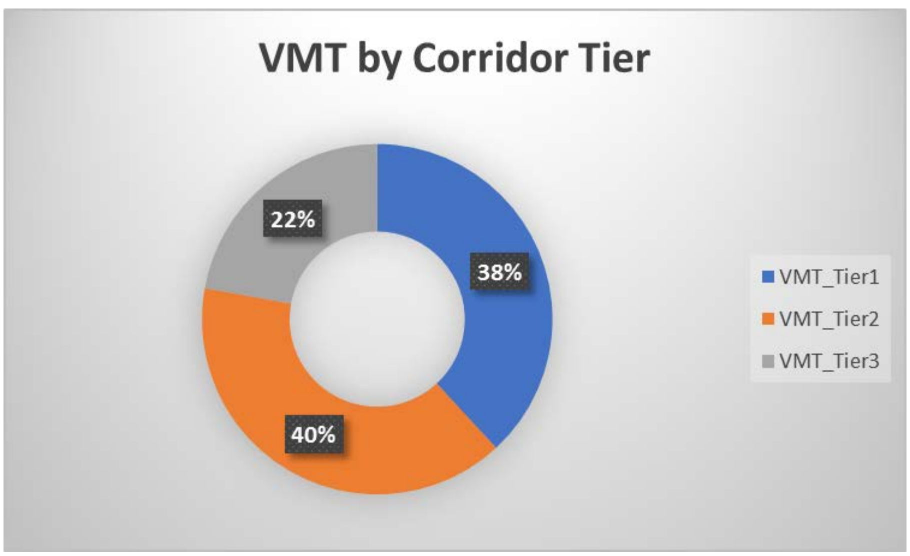
2.2 Existing Vehicle Miles of Travel

The study area commuter corridors reflect a 364-mile highway network that carried 20 million Vehicles Miles of Travel (VMT) every day. This network was ranked into three tiers based on AADT thresholds:

- Tier 1: AADT is between 100,000 to 200,000
- Tier 2: AADT is between 45,000 to 100,000
- Tier 3: AADT is between 8,000 to 45,000

The Tier 1 segments add to 60 miles of roadway network in the region, carrying 7.63 million VMT, or 38 percent of the total daily VMT along the commuter corridors. The Tier 2 commuter corridor segments, which carried AADT in the range of 45,000 to 100,000 vehicles per day, add to 132 miles of roadway network carrying 7.95 million VMT, or 40 percent of the total daily VMT. The Tier 3 commuter corridor segments, which carried AADT in the range of 8,000 to 45,000 vehicles per day, add to 172 miles of roadway network carrying 4.43 million VMT, or 22 percent of the total daily VMT. This VMT distribution by commuter corridor tier is illustrated in Figure 2.2. This implies that traffic congestion in the network will contribute to proportionate amount of vehicle hours delay as reflected in the VMT allocation.

Figure 2.2 Allocation of 20 Million Daily VMT by Commuter Corridor Tier



2.3 Existing Traffic Congestion

2.3.1 Full-Year Scan

Traffic congestion in the study area was explored by reviewing HERE probe-vehicle based speed data available from the Regional Integrated Transportation Information System (RITIS).[2] The speed data was averaged for each month (January through December) in 2018 for weekdays. The resulting congestion scans were reviewed for three measures:

- Average Traveling Speed
- Travel Time Index (i.e., Ratio of Peak Period Travel Time to Free Flow Travel Time)
- Buffer Index (i.e., Percent of extra time needed to be on-time 95 percent of time)

The Average Traveling Speed is the average of probe vehicle traveling speed through a roadway segment. The Travel Time Index is the ratio of the peak-period travel time to the free-flow travel time. This measure is computed for the AM peak period (6 am to 9 am) and PM peak period (4 pm to 7 pm) on weekdays. In contrast, the Buffer Index is a measure of travel time reliability. It calculates the extra "buffer" time, in percent, that is necessary to travel on-time 95 percent of the time. In the Commuter Corridors study, it was deemed necessary to focus on the Buffer Index to explore the travel time reliability issues in the region. The study area corridors were segmented into 26 segments using the RITIS's Probe Data Analytics tool and were analyzed for year 2018 weekday conditions. These Buffer Index congestion scans are provided in Appendix A for each corridor segment by two peak periods (AM and PM) for the first six months (Jan-Jun) in one scan and the second six months (July-Dec) in another scan. The goal was to explore month-to-month recurrent traffic congestion pattern that are symptomatic of capacity-related traffic congestion and are separate from incident or construction related traffic congestion.

A summary of the year 2018 weekday congestion scans from 6 to 9 am (i.e., AM peak period) and from 4 to 7 pm (i.e., PM peak period) are documented in Table 2.2 for the commuter corridors where individual segment congestion scans show unreliable travel times (i.e., high Buffer Index).

The indicators that are reflective of significant peak hour traffic congestion (i.e., Travel Time Index is 1.3 or more) or very unreliable travel time (i.e., peak period Buffer Index is 0.50 or more) are highlighted in red. For example, Table 2.2 shows that it takes 60 percent more time to travel in the I-40 eastbound direction during PM peak period compared to off-peak travel time, when going from the Durham Freeway (NC 147) in RTP to NC 42 in Johnston County (NC 42 Exit 312). This same route is also very unreliable as one would need to allow 86 percent extra time (or 41 minutes more) to ensure on-time arrival. The sum of Buffer Index is a surrogate measure of cumulative time penalty that industries would likely experience. For daily commuters, the time penalty could be worse if their commute pattern is tied to the peak traffic direction as they would face worst traffic conditions in both directions. For example, commuters from Johnston County to RTP would need to allow 99 percent buffer time during their morning commute and 86 percent buffer time during the afternoon commute, or a total of extra 89 minutes for on-time arrivals.

[2] RITIS data was accessed via the web portal (https://www.ritis.org/intro)

Table 2.2 Traffic Congestion Scan Summary for the Commuter Corridors

Corridor, Travel Direction	Segment	AM Speed (mph)	PM Speed (mph)	AM Travel Time (Minutes)	PM Travel Time (Minutes)	AM Travel Time Index	PM Travel Time Index	AM Buffer Index	PM Buffer Index	Sum of Buffer Index
I-40, Eastbound	NC 147 (Exit 279) to NC 42 (Exit 312)	65.5	41.1	30.0	47.9	1.01	1.60	0.17	0.86	1.03
I-40, Westbound	NC 42 (Exit 312) to NC 147 (Exit 279)	48.1	56.3	49.1	42.0	1.38	1.18	0.99	0.60	1.59
I-440, Northbound	US 1 to US 70 and I-40/I-440 Split to I-495	55.6	47.6	10.2	11.9	1.05	1.22	0.41	0.82	1.23
I-440, Southbound	US 70 to US 1 and I-495 to I-40/I-440 Split	56.0	43.0	10.3	13.4	1.04	1.36	0.23	0.80	1.03
I-440, Eastbound	US 70 to US 64 Business	62.9	49.1	6.2	8.0	0.95	1.22	0.11	0.81	0.92
I-440, Westbound	I-495 to US 70	44.6	58.3	9.5	7.3	1.34	1.03	0.98	0.34	1.32
I-540, Eastbound	I-40 to I-87/I-495	69.7	50	21.4	29.8	0.98	1.37	0.09	0.71	0.80
I-540, Westbound	I-87/I-495 to I-40	57.0	69.5	26.0	21.3	1.20	0.99	0.66	0.09	0.75
I-87, Eastbound	I-440 to US 64 Business	69.3	63.7	8.5	9.2	1.01	1.10	0.09	0.44	0.53
I-87, Westbound	US 64 Business to I-440	65.1	70.1	9.1	8.4	1.07	0.99	0.30	0.11	0.41
US 1, Northbound	Old US 1 to US 64/Tryon Rd	61.8	67.1	12.6	11.6	1.11	1.02	0.40	0.16	0.56
US 1, Eastbound	US 64/Tryon Rd to I-40	48.8	47.6	4.1	4.2	1.26	1.29	0.85	0.88	1.73
US 1, Westbound	I-40 to US 64/Tryon Rd	65.1	48.5	3.3	4.4	0.94	1.26	0.10	1.08	1.18
US 1, Southbound	US 64/Tryon Rd to Old US 1	69.3	63.7	11.0	12.0	0.99	1.07	0.08	0.23	0.31
US 1 (Capital Blvd), Northbound	US 401 (Louisburg Rd) to NC 98 (Durham Rd)	43.9	31.6	14.7	20.5	0.98	1.37	0.18	0.56	0.74
US 1 (Capital Blvd), Southbound	NC 98 (Durham Rd) to US 401 (Louisburg Rd)	39.3	41.1	23.5	22.5	1.13	1.08	0.52	0.17	0.69
US 64, Eastbound	NC 540 to US 1/ Tryon Rd	47.2	39.8	11.5	13.6	1.00	1.19	0.42	0.53	0.95

Corridor, Travel Direction	Segment	AM Speed (mph)	PM Speed (mph)	AM Travel Time (Minutes)	PM Travel Time (Minutes)	AM Travel Time Index	PM Travel Time Index	AM Buffer Index	PM Buffer Index	Sum of Buffer Index
US 64, Westbound	US 1/ Tryon Rd to NC 540	48.4	40.8	11.2	13.3	0.97	1.15	0.17	0.45	0.62
US 64, Eastbound	Rolesville Rd to US 264	70.2	61.5	6.3	7.2	1.00	1.14	0.09	0.68	0.77
US 64, Westbound	US 264 to Rolesville Rd	65.8	68.1	8.6	8.3	1.06	1.03	0.23	0.12	0.35
US 70, Eastbound	Leesville Rd to Capital Blvd	37.2	30.3	23.4	28.8	0.93	1.18	0.25	0.34	0.59
US 70, Westbound	Capital Blvd to Leesville Rd	34.8	31.2	24.6	27.5	1.04	1.16	0.40	0.40	0.80
US 70, Eastbound	US 401 (Fayetteville Rd) to I-40	40.0	29.6	7.2	9.7	0.88	1.18	0.21	0.76	0.97
US 70, Westbound	I-40 to US 401 (Fayetteville Rd)	37.7	38.2	7.5	7.4	0.97	0.96	0.26	0.27	0.53
US 70, Eastbound	I-40 to US 70 Business	68.2	70.3	7.5	7.3	1.02	0.99	0.13	0.12	0.25
US 70, Westbound	US 70 Business to I-40	66.5	67.1	7.2	7.1	1.05	1.04	0.23	0.18	0.41
US 401. Northbound	Tryon Rd to I-540	36.7	32.8	16.3	18.2	0.96	1.07	0.28	0.38	0.66
US 401, Southbound	I-540 to Tryon Rd	36.5	32.9	16.7	18.7	0.96	1.07	0.34	0.38	0.72
US 401. Northbound	NC 55 to US 70	36.8	35.8	22.5	23.1	1.05	1.08	0.44	0.29	0.73
US 401, Southbound	US 70 to NC 55	41.5	36.0	18.8	21.6	0.98	1.13	0.24	0.37	0.61
NC 55, Eastbound	US 1 to US 401	33.8	28.4	13.5	16.1	1.00	1.19	0.24	0.49	0.73
NC 55 Westbound	US 401 to US 1	28.5	29.1	16.0	15.7	1.15	1.13	0.49	0.28	0.77
NC 55 Bypass, Northbound	S Main St to E Williams St	41.6	41.9	6.4	6.3	1.09	1.08	0.52	0.18	0.70
NC 55 Bypass Southbound	E Williams St to S Main St	46.4	30.3	5.7	8.8	0.97	1.49	0.15	1.17	1.32
Wade Ave (Freeway), Eastbound	I-40 to I-440	54.4	38.4	3.5	5.0	1.10	1.55	0.44	0.75	1.19
Wade Ave (Freeway), Westbound	I-440 to I-40	33.5	51.8	5.4	3.5	1.76	1.14	2.00	0.60	2.60

Corridor, Travel Direction	Segment	AM Speed (mph)	PM Speed (mph)	AM Travel Time (Minutes)	PM Travel Time (Minutes)	AM Travel Time Index	PM Travel Time Index	AM Buffer Index	PM Buffer Index	Sum of Buffer Index
Wade Ave, Eastbound	I-440 to US 1	28.7	26.7	7.2	7.8	1.00	1.07	0.42	0.40	0.82
Wade Ave, Westbound	US 1 to I-440	28.7	26.0	6.9	7.6	0.99	1.09	0.45	0.36	0.81
NC 54, Eastbound	NC 540 to I-440	30.4	23.5	24.3	31.4	1.05	1.36	0.30	0.44	0.74
NC 54, Westbound	I-440 to NC 540	30.3	27.3	24.6	27.3	1.06	1.17	0.38	0.41	0.79

Source: RITIS, Probe Data Analytics Suite, Performance Summaries using HERE Data, Year 2018 Weekdays

2.3.2 Two-Month Scan

In addition to taking annual average congestion scans for each commuter corridor, HERE's probe vehicle speed data were also analyzed for a shorter time period for two months, April and May of 2018, to get a combined scan of all of the commuter corridors. The purpose was to develop system-wide Buffer Index maps of traffic congestion and travel time reliability by time of day, for a time period when travel conditions are not significantly influenced by weather events or holiday season. Consequently, the months of April and May of 2018 were chosen to generate system wide scans of typical weekday traffic conditions.

The results of this two-month (April-May, 2018) weekday congestion scans are presented in Figure 2.3 for the 7 am snapshot, in Figure 2.4 for the 8 am snapshot, and in Figure 2.5 for the 9 am snapshot.

Similarly, Figure 2.6 shows the 4 pm congestion snapshot, Figure 2.7 shows the 5 pm congestion snapshot, and Figure 2.8 shows the 6 pm congestion snapshot.

These congestion snapshots show Buffer Index values in the following six color thresholds:

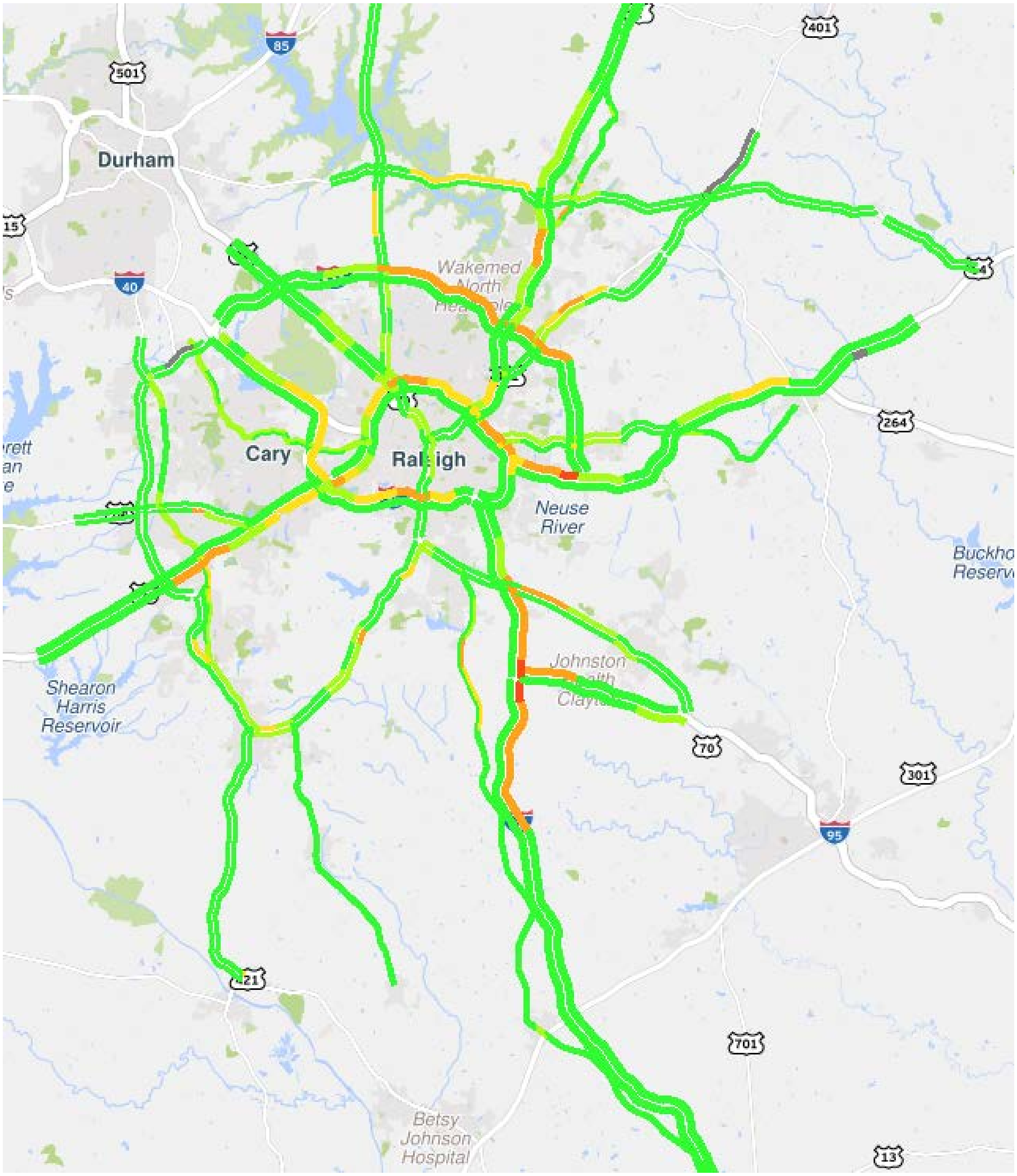
- Green – Buffer Index is 0.3 or less, reflecting MINIMAL travel time reliability problems
- Yellowish Green – Buffer Index is between 0.3 and 0.6, reflecting LOW travel time reliability problems
- Yellow – Buffer Index is between 0.6 and 1.0, reflecting MODERATE travel time reliability problems
- Orange – Buffer Index is between 1.0 and 2.0, reflecting HIGH travel time reliability problems
- Red – Buffer Index is between 2.0 and 3.5, reflecting VERY HIGH travel time reliability problems
- Dark Red – Buffer Index is 3.5 and above, reflecting SEVERE travel time reliability problems

The AM peak hour snapshots in Figures 2.3, 2.4 and 2.5 reveal the following significant travel time reliability issues:

- I-40 Westbound direction shows Moderate to High travel time reliability problems during the AM peak hours traveling along downtown Raleigh, Cary, RDU, and RTP areas
- I-40 Westbound direction shows High to Very High travel time reliability problems during the AM peak hours traveling along the Garner area between NC 210 and US 70 Business
- I-440 Westbound direction shows Moderate to High travel time reliability problems during the AM peak hours traveling along the North Raleigh area between I-87 and Wade Avenue
- I-540 Westbound direction shows Moderate travel time reliability problems during the AM peak hours traveling along the RDU area between US 70 and I-40
- I-540 Westbound direction shows High to Very High travel time reliability problems during the AM peak hours traveling along the Northeast Raleigh area between US 401 and NC 50
- I-87 Westbound direction shows High to Very High travel time reliability problems during the AM peak hours traveling along the East Raleigh area between I-540 and I-440

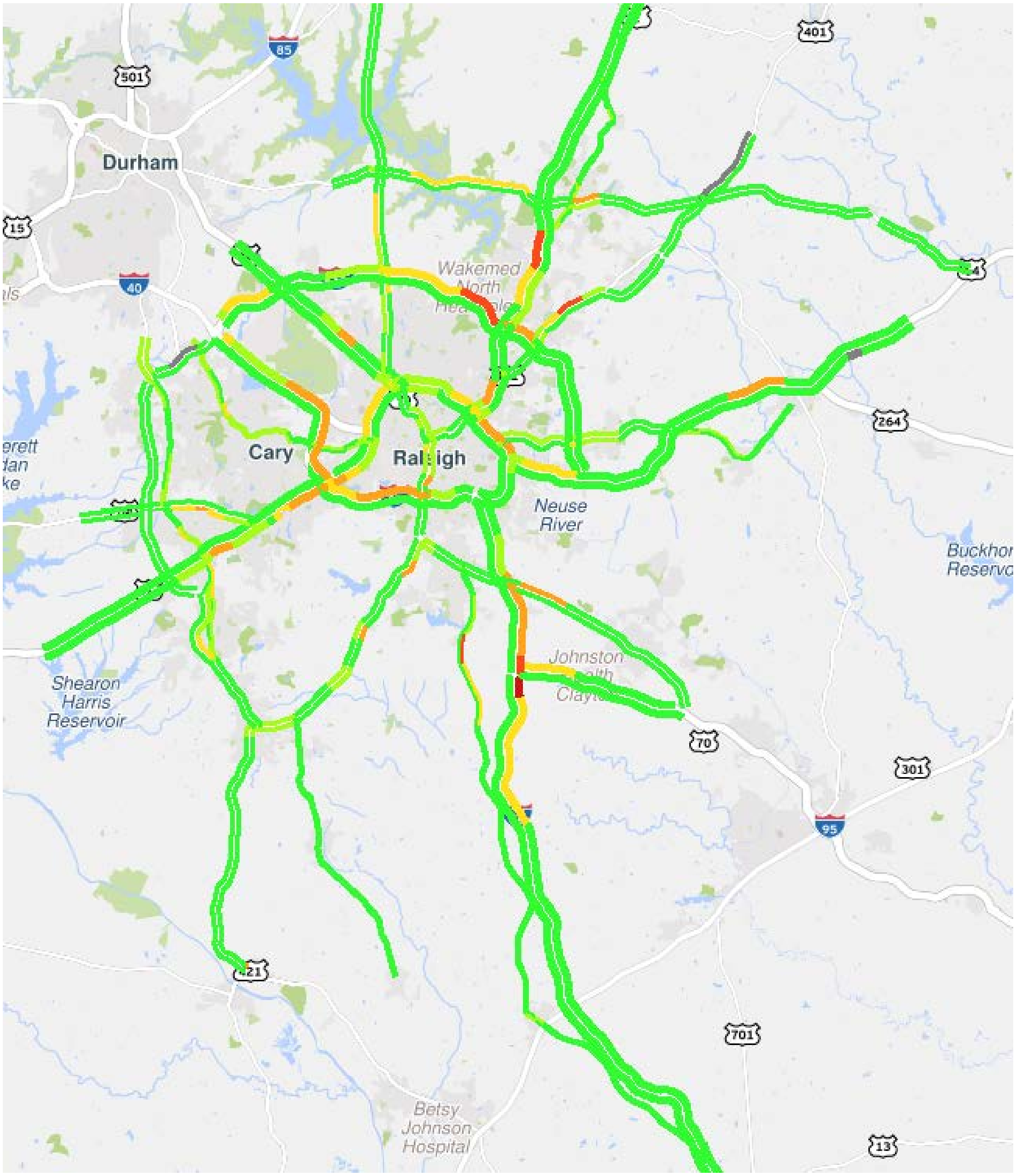
- US 1 Northbound direction shows Moderate to High travel time reliability problems during the AM peak hours traveling along the Apex and Cary areas between NC 540 and I-40
- US 1 Southbound direction shows Moderate to Very High travel time reliability problems during the AM peak hours traveling along the Northeast Raleigh area between NC 98 and I-540
- US 401 Southbound direction shows Moderate to High travel time reliability problems during the AM peak hours traveling along the Northeast Raleigh area between US 401 Business and I-540
- US 64 Eastbound direction shows Moderate to High travel time reliability problems during the AM peak hours traveling along the Apex and Cary areas between NC 55 and US 1
- US 64 Westbound direction shows High travel time reliability problems during the AM peak hours traveling along the Knightdale-Zebulon area between NC 96 and Lizard Lick Rd
- NC 98 Westbound direction shows Moderate travel time reliability problems during the AM peak hours traveling along the Wake Forest and Stony Hill areas between US 1 and Six Forks Rd

Figure 2.3 Average Weekday Traffic Congestion Scans – 7 AM



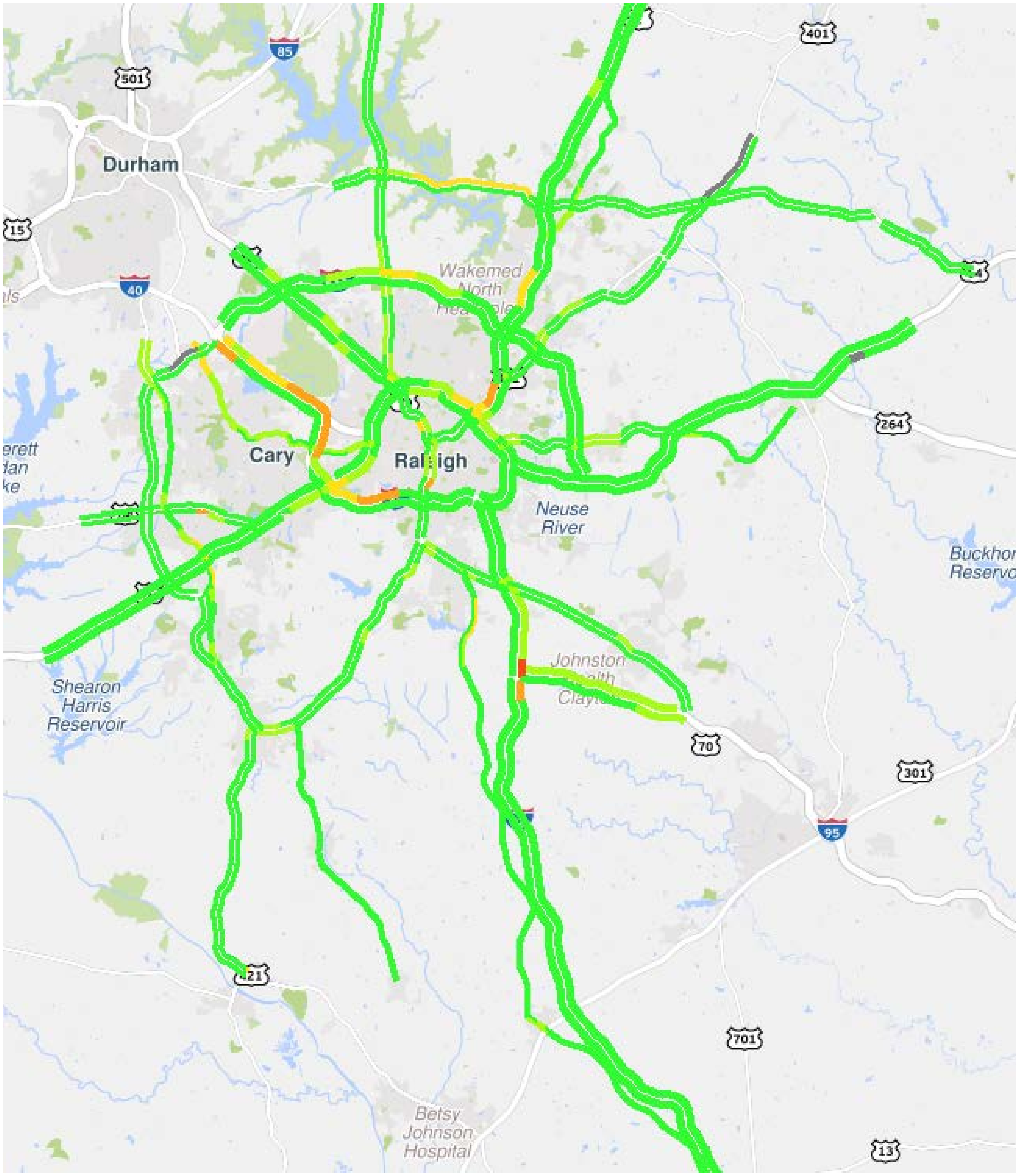
Source: RITIS, HERE Data, Buffer Index, Average for all weekdays in April-May, 2018

Figure 2.4 Average Weekday Traffic Congestion Scans – 8 AM



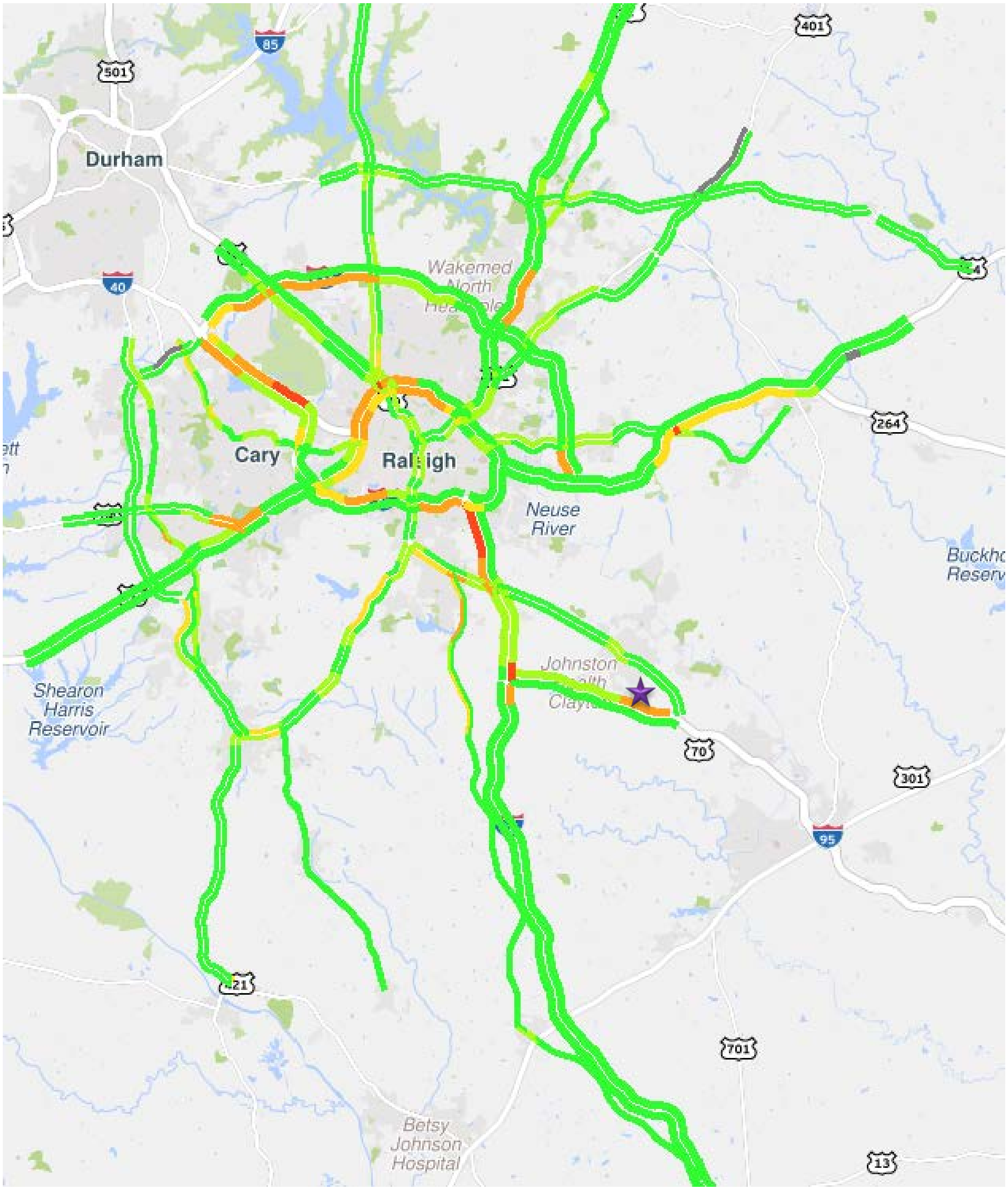
Source: RITIS, HERE Data, Buffer Index, Average for all weekdays in Apr-May, 2018

Figure 2.5 Average Weekday Traffic Congestion Scans – 9 AM



Source: RITIS, HERE Data, Buffer Index, Average for all weekdays in Apr-May, 2018

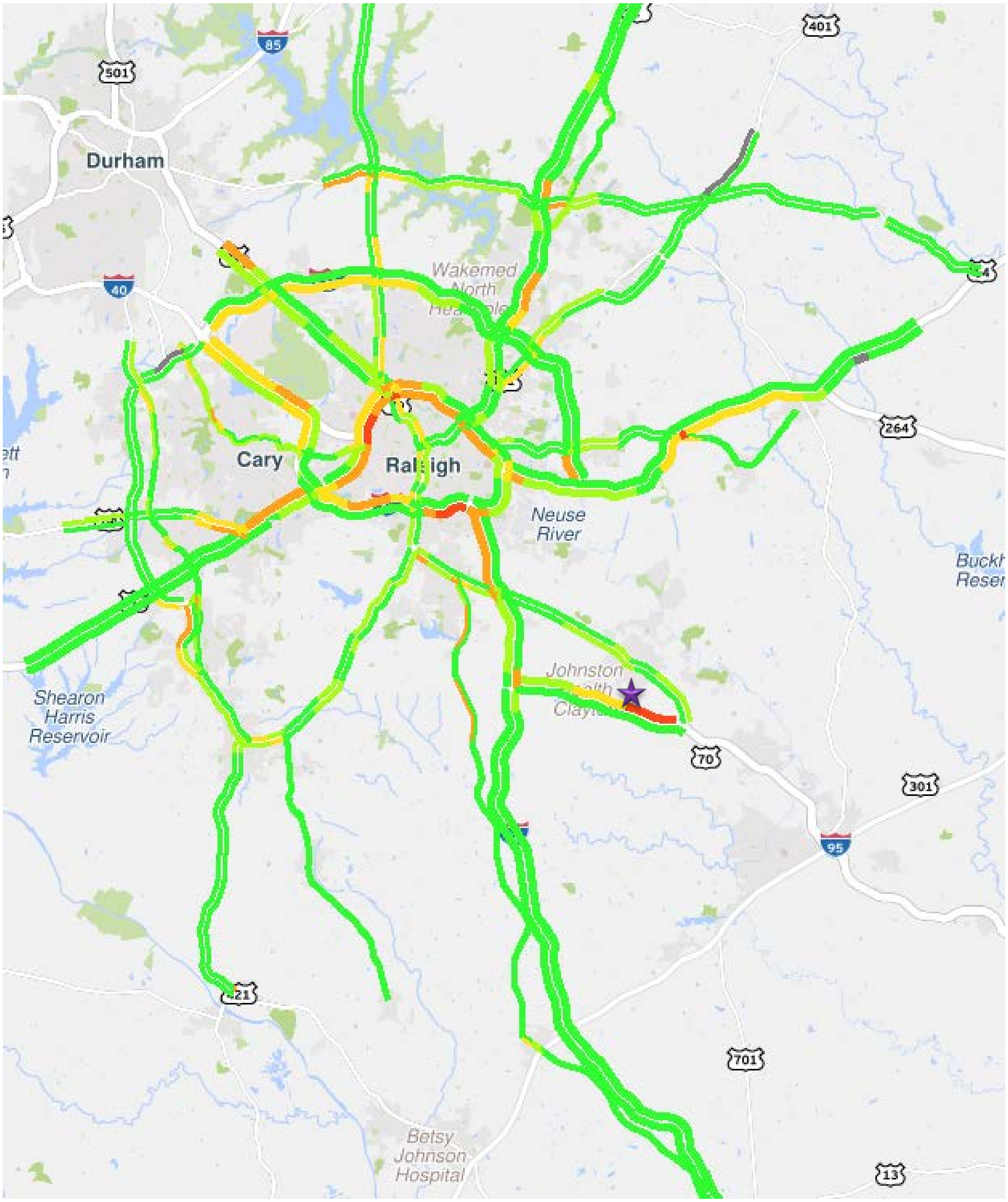
Figure 2.6 Average Weekday Traffic Congestion Scans – 4 PM



Source: RITIS, HERE Data, Buffer Index, Average for all weekdays in Apr-May, 2018

Note: The Buffer Index along westbound US 70 Bypass (Clayton Bypass) show orange, only in April and May of 2018, but not during other months. So, the April-May congestion scan along US 70 Bypass is an anomaly in the data and may reflect construction or other road closure activities.

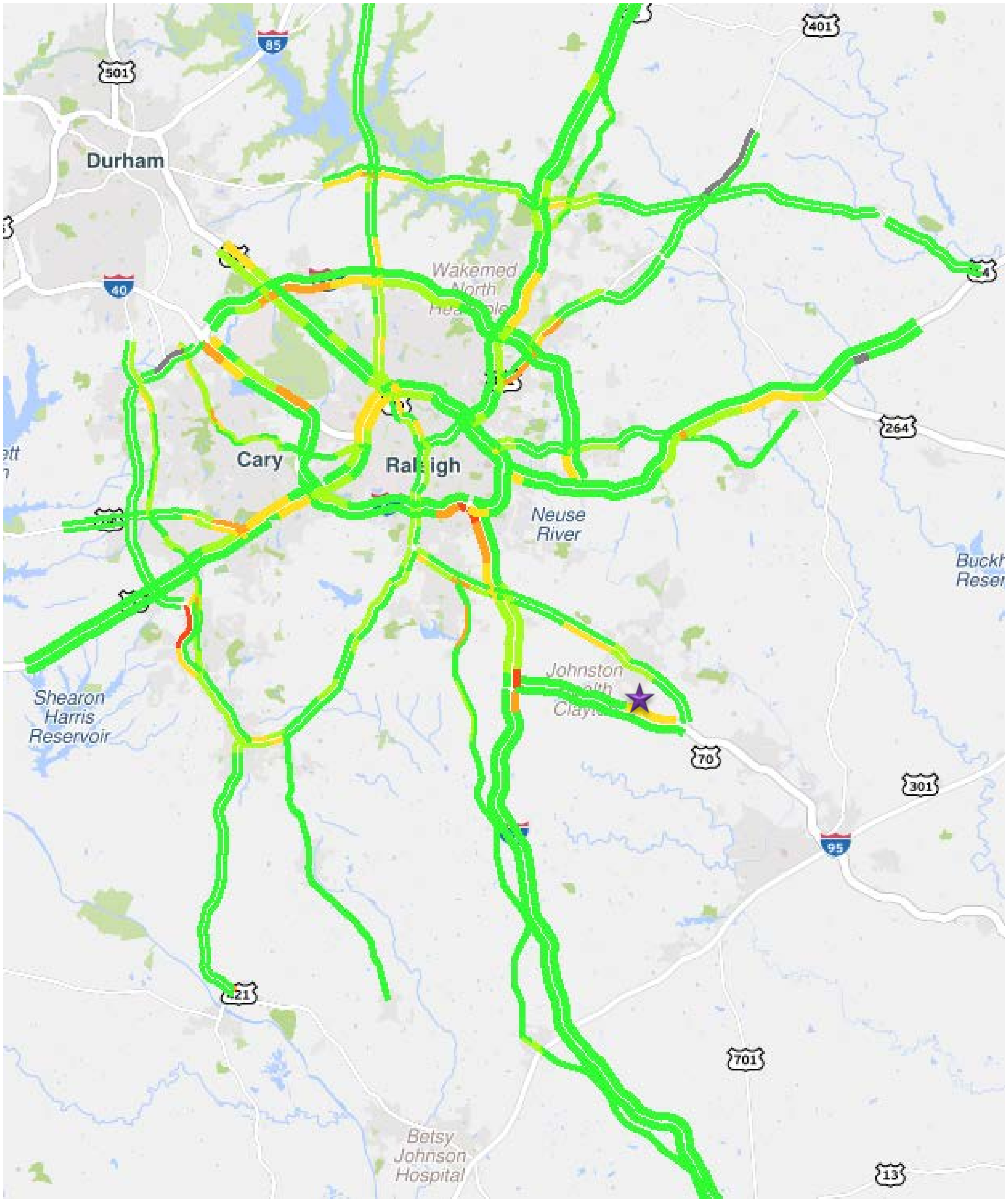
Figure 2.7 Average Weekday Traffic Congestion Scans – 5 PM



Source: RITIS, HERE Data, Buffer Index, Average for all weekdays in Apr-May, 2018

★ Note: The Buffer Index along westbound US 70 Bypass (Clayton Bypass) show yellow and orange, only in April and May of 2018, but not during other months. So, the April-May congestion scan along US 70 Bypass is an anomaly in the data and may reflect construction or other road closure activities.

Figure 2.8 Average Weekday Traffic Congestion Scans – 6 PM



Source: RITIS, HERE Data, Buffer Index, Average for all weekdays in Apr-May, 2018

★ Note: The Buffer Index along westbound US 70 Bypass (Clayton Bypass) show yellow, only in April and May of 2018, but not during other months. So, the April-May congestion scan along US 70 Bypass is an anomaly in the data and may reflect construction or other road closure activities.

The PM peak hour snapshots in Figures 2.6, 2.7 and 2.8 reveal the following significant travel time reliability issues:

- I-40 Westbound direction shows High to Very High travel time reliability problems during the PM peak hours traveling along downtown Raleigh, RDU, and RTP areas
- I-40 Westbound direction shows High to Very High travel time reliability problems during the PM peak hours traveling along the Garner area around the US 70 Bypass interchange area
- I-40 Eastbound direction shows High to Very High travel time reliability problems during the PM peak hours traveling along downtown Raleigh, and Garner areas between S. Saunders Rd to US 70 Business
- I-40 Eastbound direction shows High travel time reliability problems during the PM peak hours traveling along the RTP and RDU areas
- I-440 Westbound direction shows Moderate to High travel time reliability problems during the PM peak hours traveling along the Crabtree Mall and UNC Rex Hospital area between Six Forks Rd and Wade Avenue
- I-440 Eastbound direction shows High to Very High travel time reliability problems during the PM peak hours traveling between I-40/US 1 and I-87
- I-540 Eastbound direction shows Moderate to High travel time reliability problems during the PM peak hours traveling along the RDU and Brier Creek area between I-40 and Six Forks Rd
- I-540 Eastbound direction shows High travel time reliability problems during the PM peak hours traveling between US 64 Business and I-87
- US 1 Southbound direction shows High travel time reliability problems during the PM peak hours traveling along the Cary area between I-40 and US 64
- US 1 (Capital Blvd) Northbound direction shows Moderate to High travel time reliability problems during the PM peak hours traveling along the Northeast Raleigh area between I-540 and Durant Rd
- US 401 Northbound direction shows Moderate travel time reliability problems during the PM peak hours traveling along the Northeast Raleigh area between US 1 and I-540
- US 64 Eastbound and Westbound directions show Moderate travel time reliability problems during the PM peak hours traveling along the Apex and Cary areas between Lake Pine Rd and US 1
- US 64 Eastbound direction shows Moderate travel time reliability problems during the PM peak hours traveling along the Knightdale-Zebulon area between US 64 Business and US 264 split
- US 70 Westbound direction shows High travel time reliability problems during the PM peak hours traveling along the Brier Creek area west of I-540
- NC 98 Eastbound direction shows Moderate to High travel time reliability problems during the PM peak hours traveling along the Stony Hill areas between Coley Rd and NC 50

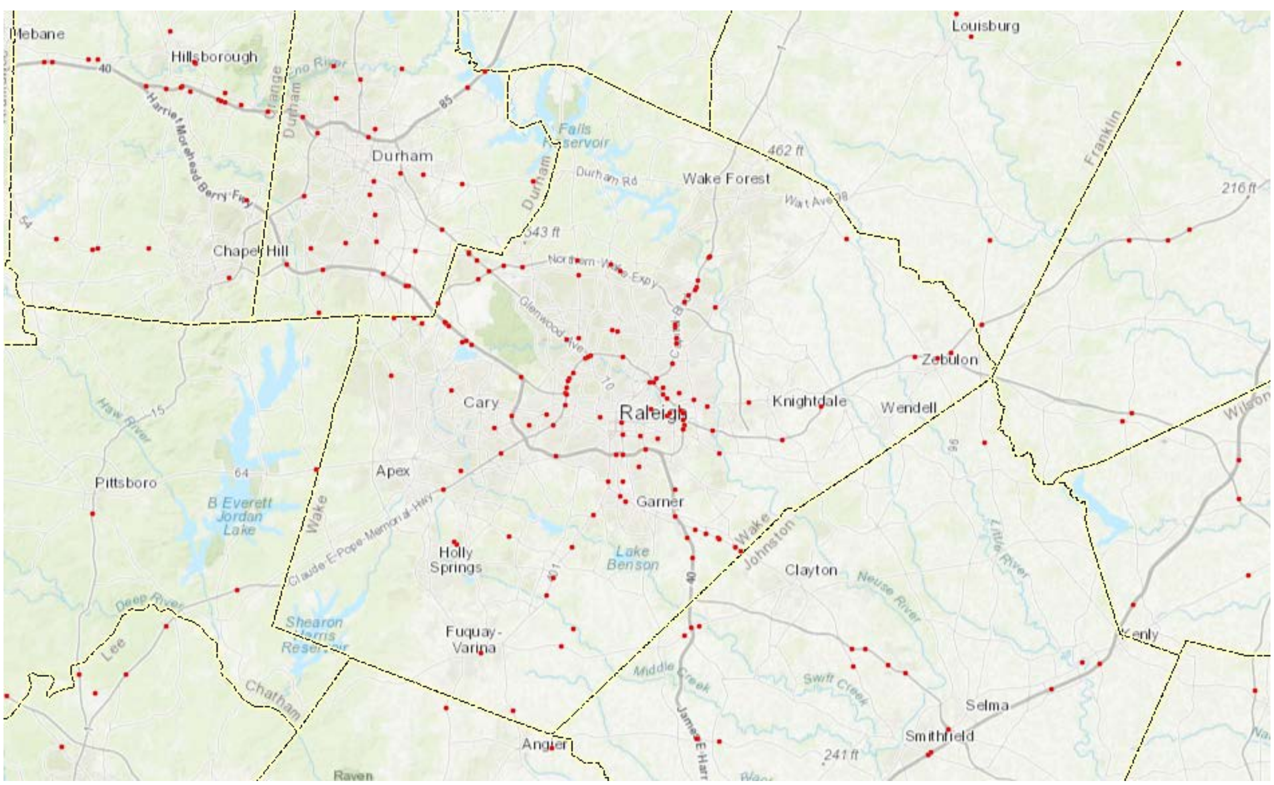
2.4 Traffic Safety Analysis

This study analyzed readily available crash data and statistics for the study area roadways from NCDOT's Traffic Safety Division. This safety analysis included reviews of Fatal and Sever Injury Crash Locations and Planning Level Safety Scores that the NCDOT developed based on latest 5-year crash data (2013-2017). This safety analysis reviews are summarized in Appendix B.

Figure 2.9 presents a map that shows the fatal and sever injury crash locations in the region that were classified as rear-end crashes. This map shows that many of these rear-end crashes were along the commuter corridors, indicating presence of traffic congestion along the commuter corridors.

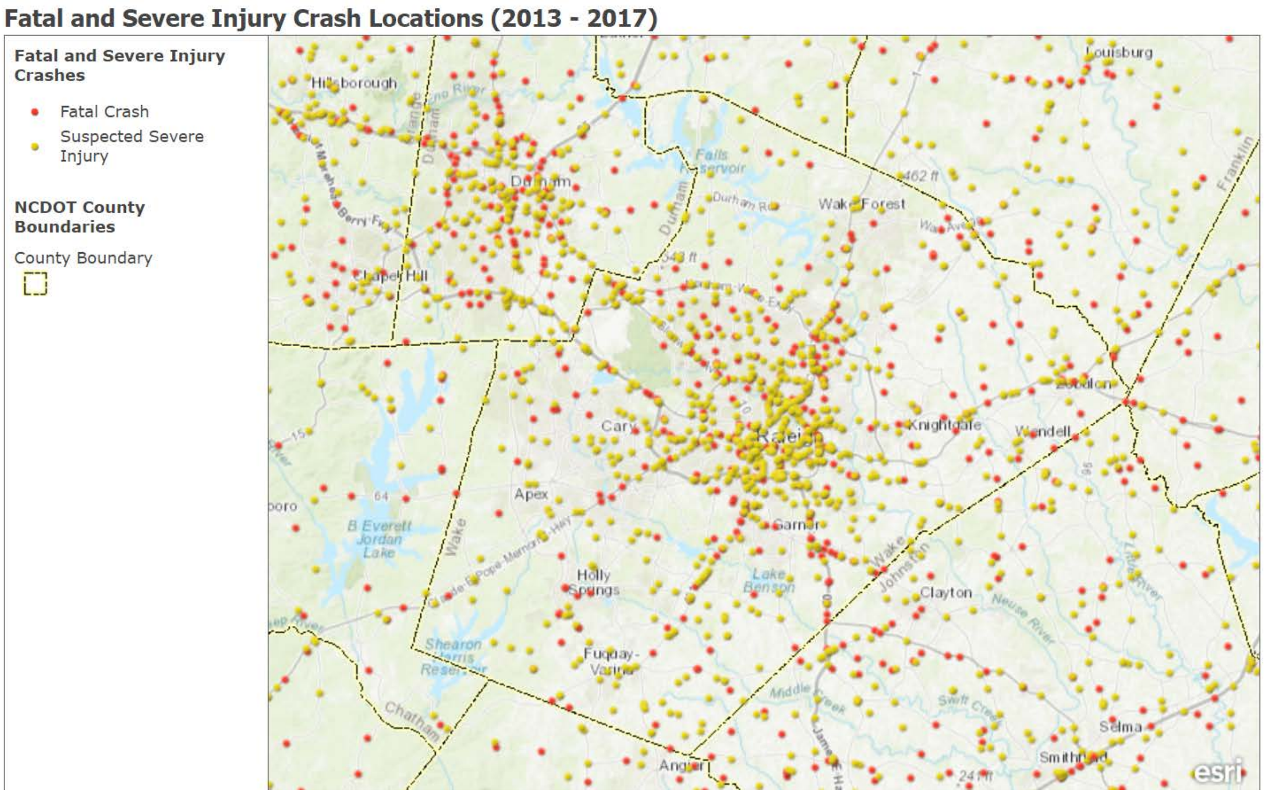
Figure 2.10 presents a map that shows all of the fatal and sever injury crash locations in the region. This map shows that many of the fatal crashes were along the commuter corridors, indicating the strong correlation between traffic congestion, traffic safety, and travel time reliability. In essence, reducing traffic congestion along the commuter corridors provides the triple bottom line – reduced crashes, improved travel time reliability, and cost savings.

Figure 2.9 Fatal and Severe Injury Crash Locations - Rear-End Crashes



Source: NCDOT Crashes (2013-2017)

Figure 2.10 Fatal and Severe Injury Crashes – All Crash Types



Source: NCDOT Crashes (2013-2017)

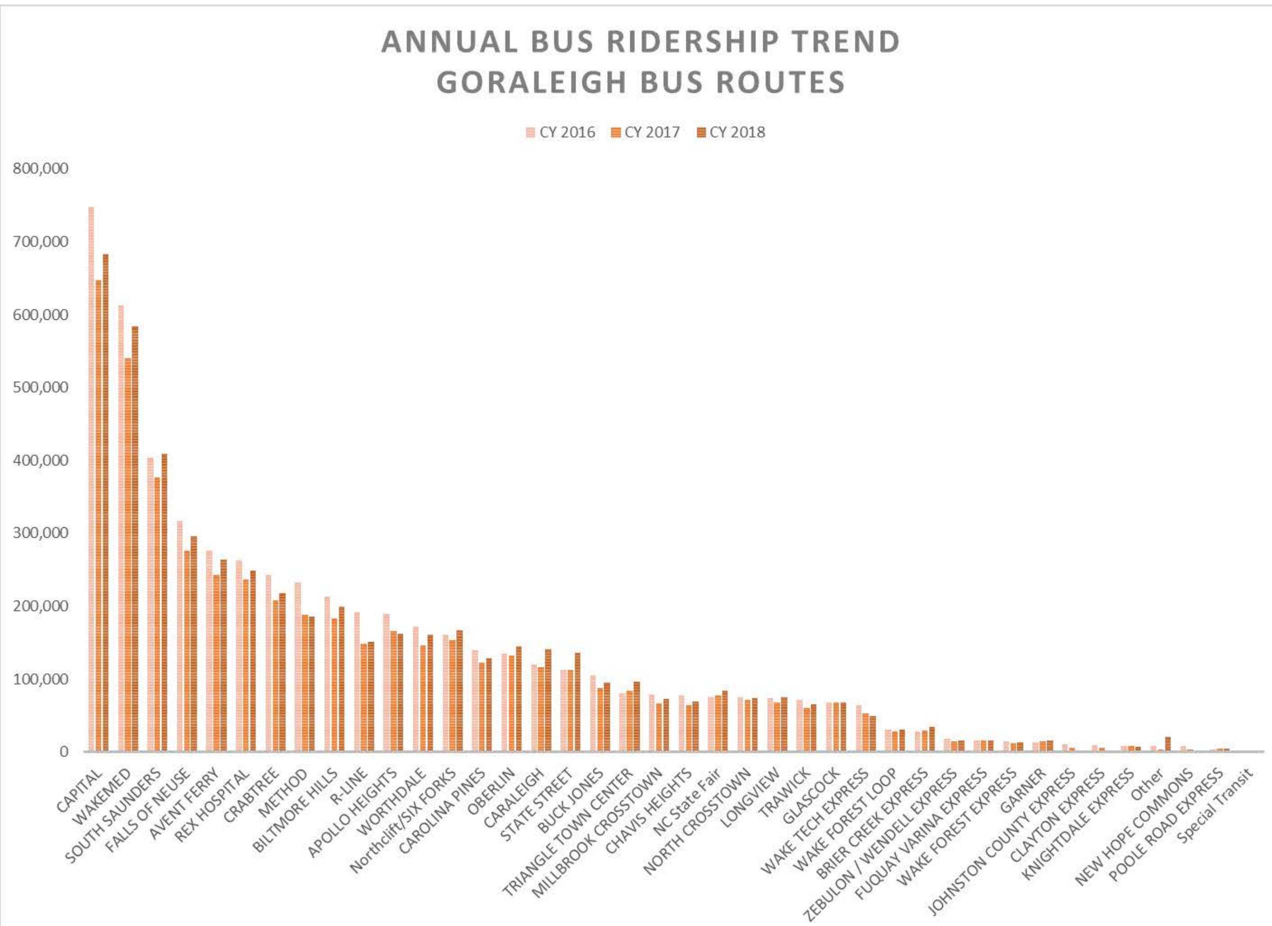
2.5 Transit Ridership Trends

This section documents the transit ridership data that was reviewed to explore the recent transit trends in the Capital Area region. This review entailed obtaining the annual ridership estimates based on the transit farebox data for years 2016, 2017 and 2018.

2.5.1 GoRaleigh Bus Routes

The GoRaleigh ridership data is depicted in Figure 2.11 for three years, 2016 through 2018 by annual ridership estimates for each regional bus route. This data reveals that there were 5.2 million riders in 2018 and this systemwide ridership number was 7 percent higher than the 2017 estimate. However, the systemwide ridership was 5 percent higher in 2016 compared to year 2018. In essence, the GoRaleigh transit system is gaining back the ridership that it lost in 2017.

Figure 2.11 GoRaleigh Bus Ridership Trend in 2016-2018

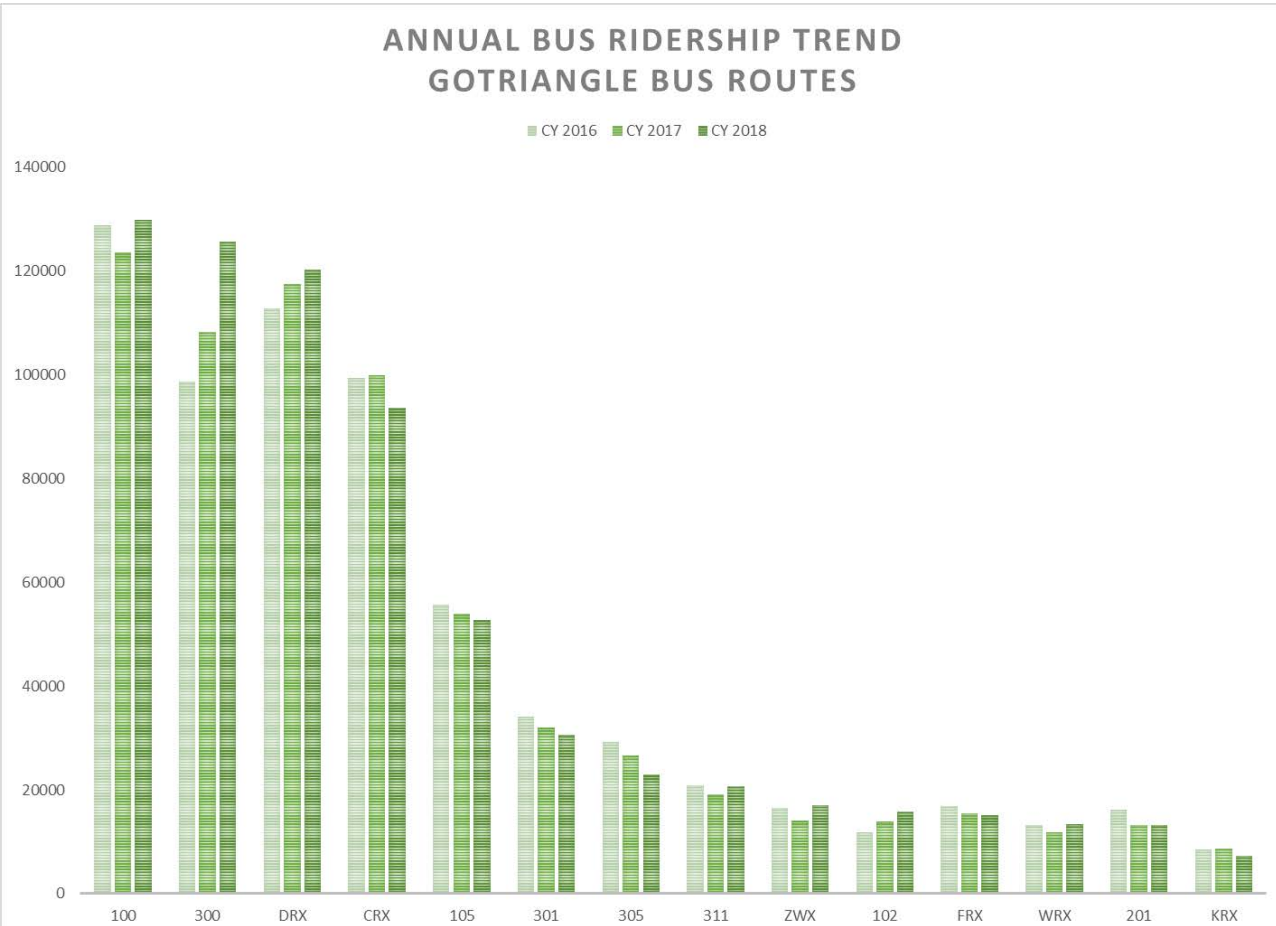


The route-based comparison reveals that the top seven high performing routes, namely CAPITAL, WAKEMED, SOUTH SAUNDERS, FALLS OF NEUSE, AVENT FERRY, REX HOSPITAL, and CRABTREE, each carried 4 to 14 percent of the GoRaleigh total ridership in 2018, or 52 percent of the riders, when combined. These high performing routes had experienced 6 to 13% decline in 2017, or 11 percent as a group, but each regained ridership by 4 to 9 percent since 2017, or 7% up as the core bus service.

2.5.2 GoTriangle Bus Routes

The GoTriangle ridership data is depicted in Figure 2.12 for three years, 2016 through 2018 by annual ridership estimates for each regional bus route. This data reveals that there were 0.7 million riders in 2018 and this systemwide ridership number was 3 percent higher than the 2017 estimate, and 2.6 percent higher than the 2016 estimate. In essence, the GoTriangle transit system has experienced a modest bump in ridership since 2016.

Figure 2.12 GoTriangle Bus Ridership Trend in 2016-2018



The route-based comparison reveals that the four seven high performing routes, namely Route 100, Route 300, Route DRX, and Route CRX, each carried 13 to 19 percent of the GoTriangle total ridership in 2018, or 69 percent of the riders, when combined.

2.6 Trip Origin-Destination Analysis using Big Data

Baseline Mobility procured Origin-Destination (O-D) trip matrices based on passively collected location data from smartphones (i.e., Big Data). The data was procured from AirSage for the month of March, 2019 for weekday conditions. The O-D data was captured for the CAMPO region for approximately 800 zones, averaged for weekdays in the month of March, 2019. This passive O-D data was analyzed for three trip purposes, namely Home-Based Work (HBW), Home-Based Other (HBO), and Non-Home Based (NHB). The analysis provided a quick look at an alternate data source to understand the daily O-D trip patterns in the region for residents and visitors. It should be mentioned that no validation adjustments were made to the passively collected O-D data. Passively collected Big Data, while has its limitations, offered an alternative data source to understand the trip pattern in the region in addition to the model-based forecasts. However, it should be mentioned that Big Data, by their nature are generally not random samples, and consequently have biases such as with respect to trip lengths.

The analysis of passively collected O-D data is summarized in Table 2.3. The data shows that the residents and visitors of the triangle region made over 7 million trips on a typical weekday in year 2019, of which 88 percent was by residents and 12 percent was by visitors. In 2019, on a typical weekday, downtown Raleigh was the destination of around 64,000 trips, RTP was the destination of around 34,000 trips, NCSU was the destination of over 54,000 trips, RDU Airport was the destination of around 21,000 trips, and the WakeMed Raleigh Campus was the destination of over 11,000 trips.

Table 2.3 Summary of Passive O-D Data Analysis for the Triangle Region

Trip Makers	Trip Purpose	Trip Destination Zone(s)	Number of Trips per Weekday
Residents	All	Regionwide	6.36 million
Residents	Home-Based Work (HBW)	Regionwide	0.78 million
Residents	Home-Based Other (HBO)	Regionwide	3.20 million
Residents	Non-Home Based (NHB)	Regionwide	2.38 million
Visitors	All	Regionwide	0.87 million
Visitors	HBW	Regionwide	0.04 million
Visitors	HBO	Regionwide	0.13 million
Visitors	NHB	Regionwide	0.70 million
Residents	All	Downtown Raleigh	63,736
Residents	HBW	Downtown Raleigh	7,894
Residents	HBO	Downtown Raleigh	15,600
Residents	NHB	Downtown Raleigh	40,242
Residents	All	Research Triangle park (RTP)	33,808
Residents	HBW	RTP	6,339
Residents	HBO	RTP	6,451
Residents	NHB	RTP	21,018

Trip Makers	Trip Purpose	Trip Destination Zone(s)	Number of Trips per Weekday
Residents	All	NC State University (NCSU)	54,365
Residents	HBW	NCSU	9,227
Residents	HBO	NCSU	25,075
Residents	NHB	NCSU	20,063
Residents	All	RDU Airport	21,002
Residents	HBW	RDU Airport	1,235
Residents	HBO	RDU Airport	6,955
Residents	NHB	RDU Airport	12,812
Residents	All	WakeMed Raleigh Campus	11,284
Residents	HBW	WakeMed Raleigh Campus	2,035
Residents	HBO	WakeMed Raleigh Campus	3,865
Residents	NHB	WakeMed Raleigh Campus	5,384

The O-D patterns of average weekday trips made by residents of the regions are depicted in Figure 2.13. Similarly, the O-D patterns of average weekday trips made by visitors to the regions are depicted in Figure 2.14.

The O-D data analysis have also been illustrated using dot-density plots of trips to five selected destination zones in the region:

1. HBW, HBO and NHB trips to **Downtown Raleigh** (see Figures 2.15, 2.16, and 2.17)
2. HBW, HBO and NHB trips to **Research Triangle Park** (see Figures 2.18, 2.19, and 2.20)
3. HBW, HBO and NHB trips to **NC State University** (see Figures 2.21, 2.22, and 2.23)
4. HBW, HBO and NHB trips to **RDU Airport** (see Figures 2.24, 2.25, and 2.26)
5. HBW, HBO and NHB trips to **WakeMed Raleigh Campus** (see Figures 2.27, 2.28, and 2.29)

Figure 2.13 Weekday Trip Origin-Destination Pattern for RESIDENT Trips

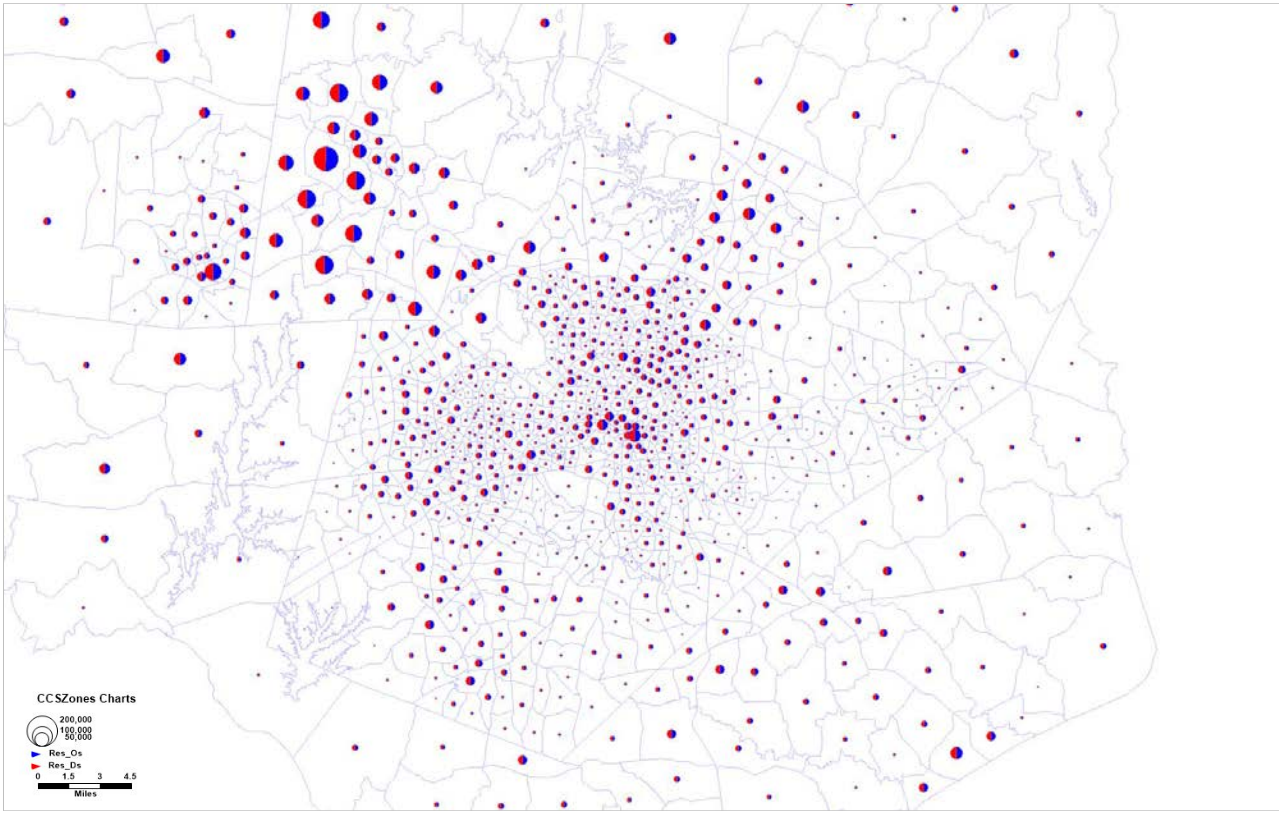


Figure 2.14 Weekday Trip Origin-Destination Pattern for VISITOR Trips

Figure 2.15 Home-Based Work Trips to Downtown Raleigh

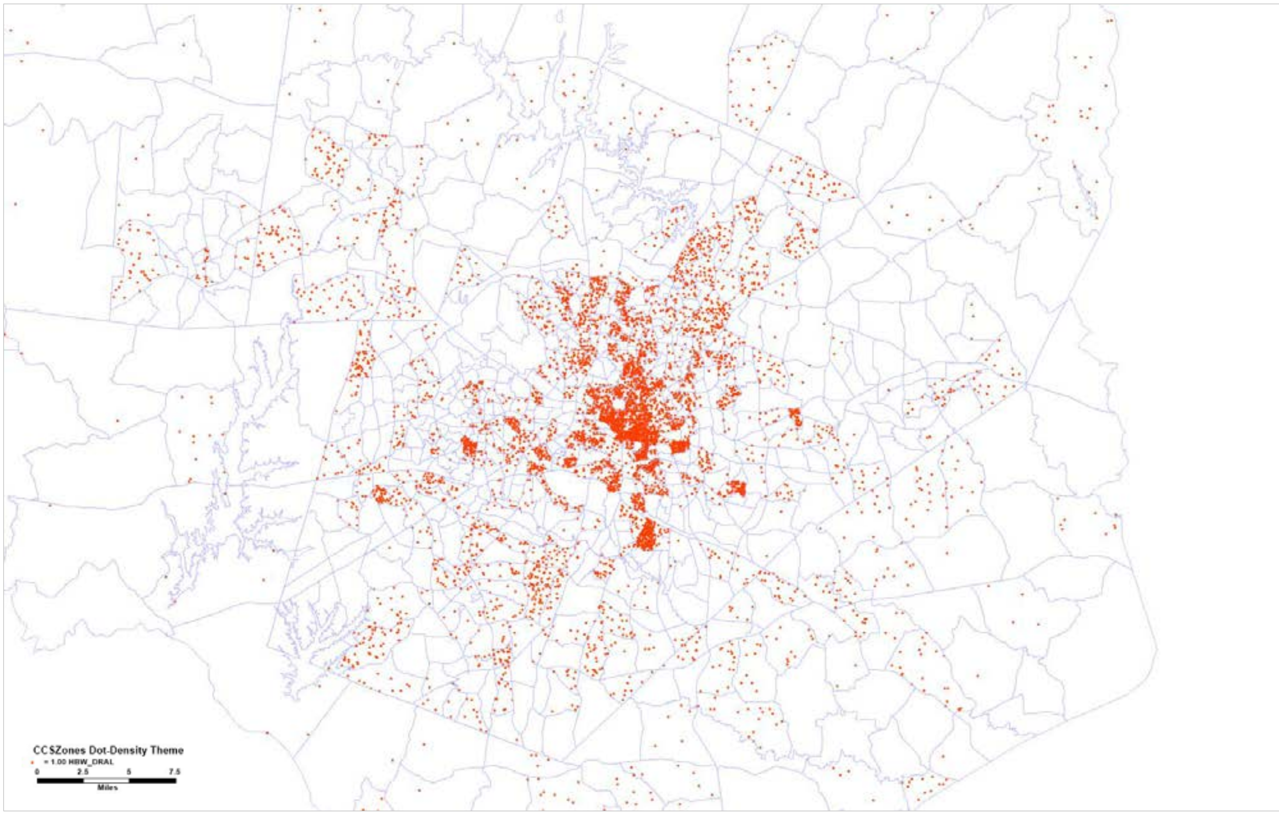


Figure 2.16 Home-Based Other Trips to Downtown Raleigh

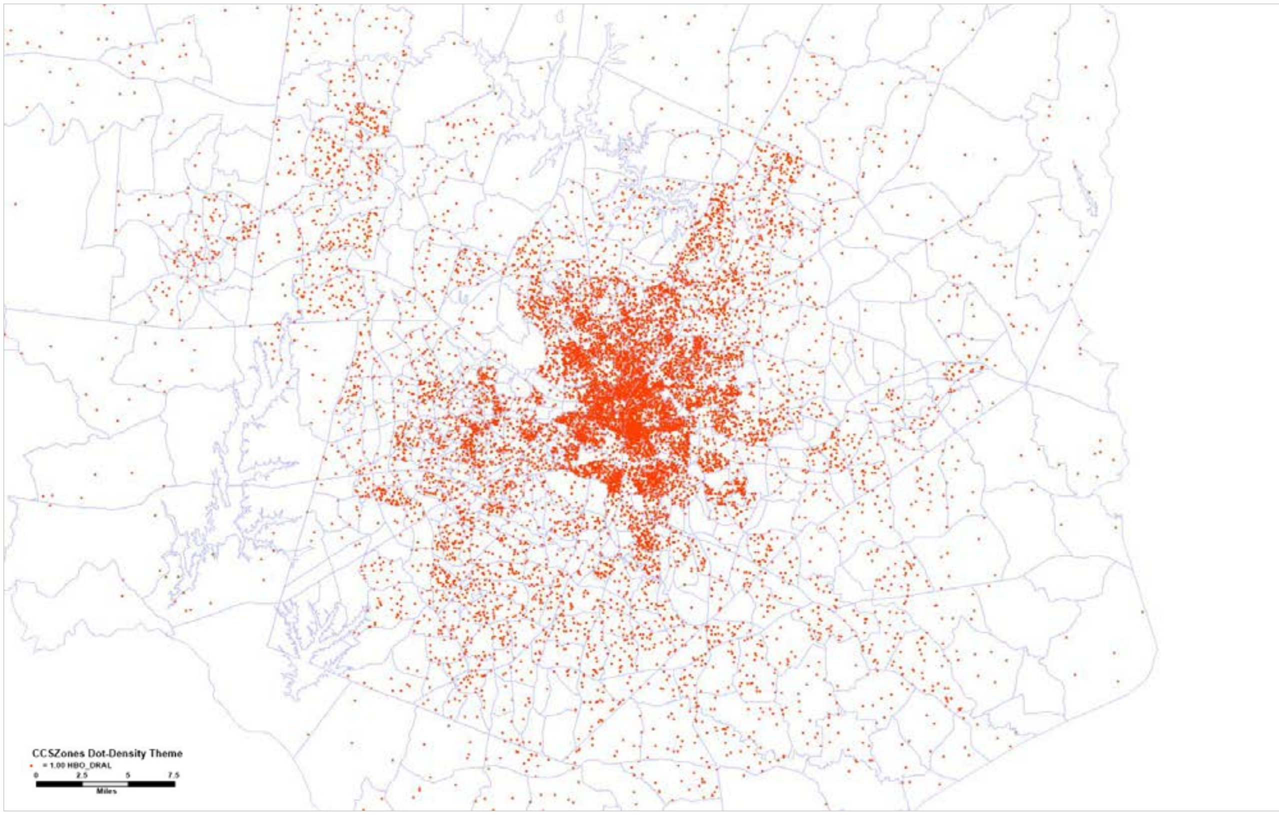


Figure 2.17 Non-Home Based Trips to Downtown Raleigh

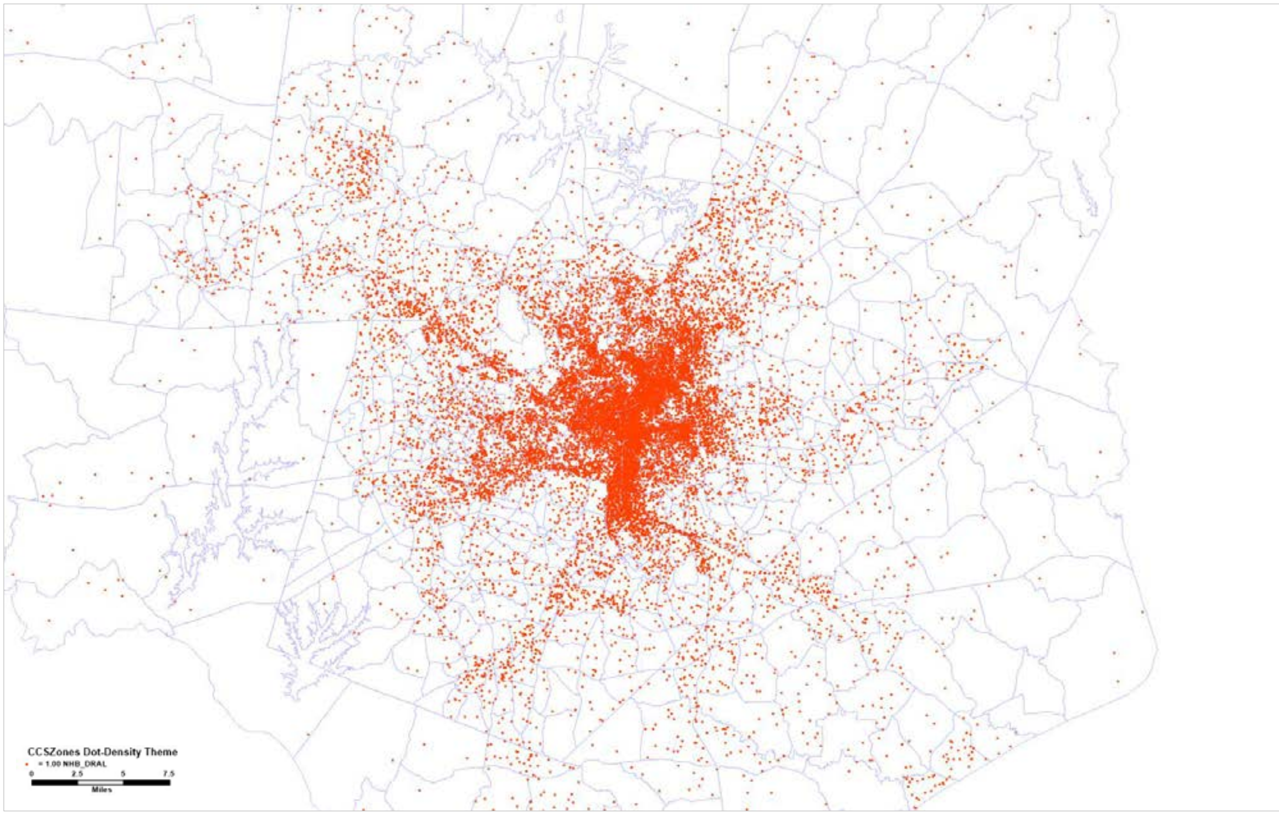


Figure 2.18 Home-Based Work Trips to Research Triangle Park (RTP)

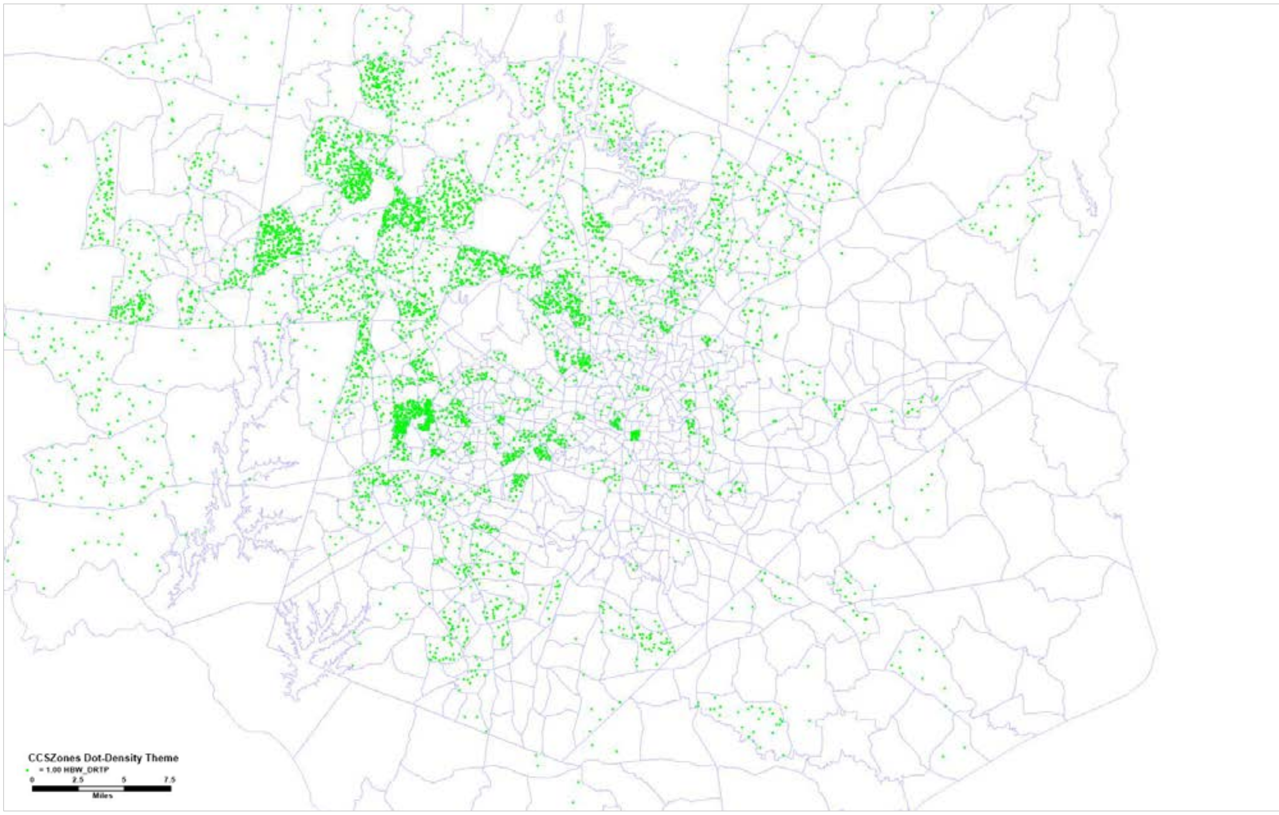


Figure 2.19 Home-Based Other Trips to Research Triangle Park (RTP)

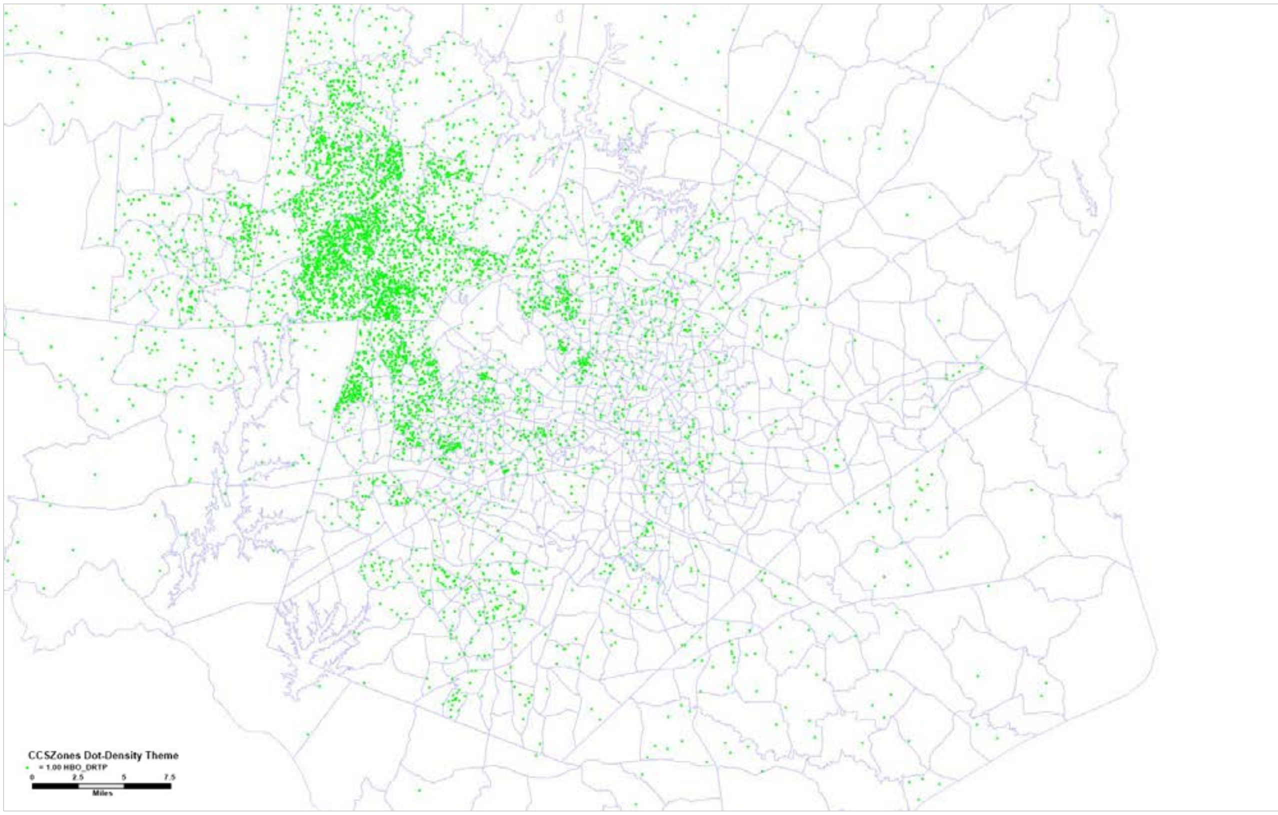


Figure 2.20 Non-Home Based Trips to Research Triangle Park (RTP)

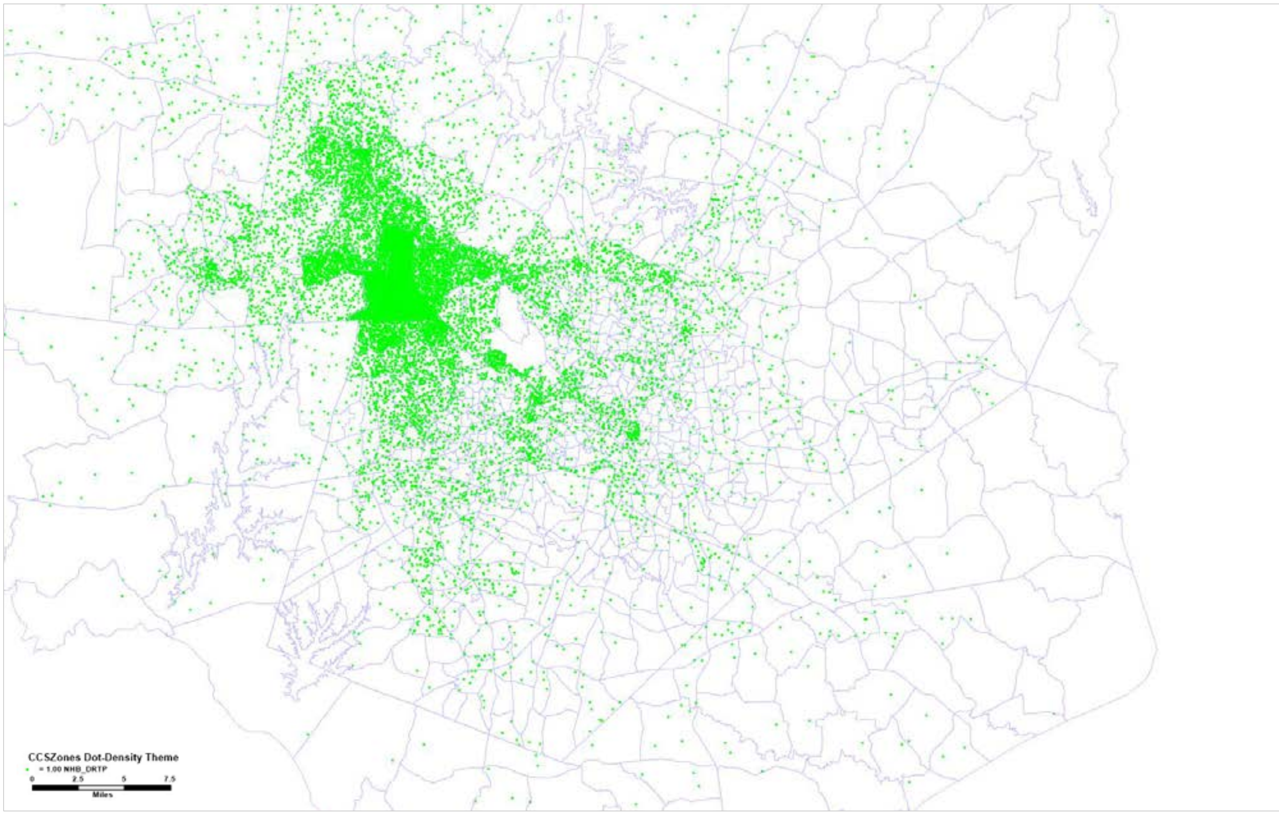


Figure 2.21 Home-Based Work Trips to North Carolina State University

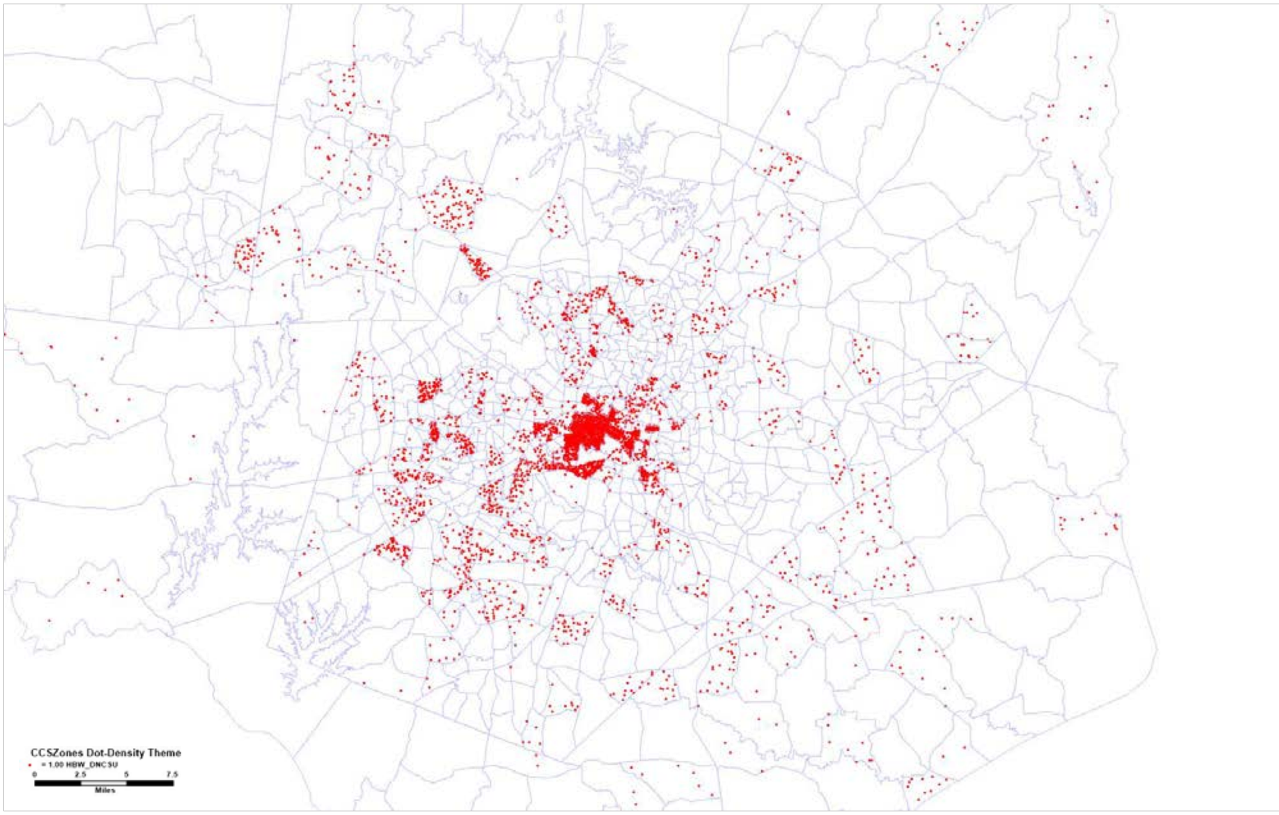


Figure 2.22 Home-Based Other Trips to North Carolina State University

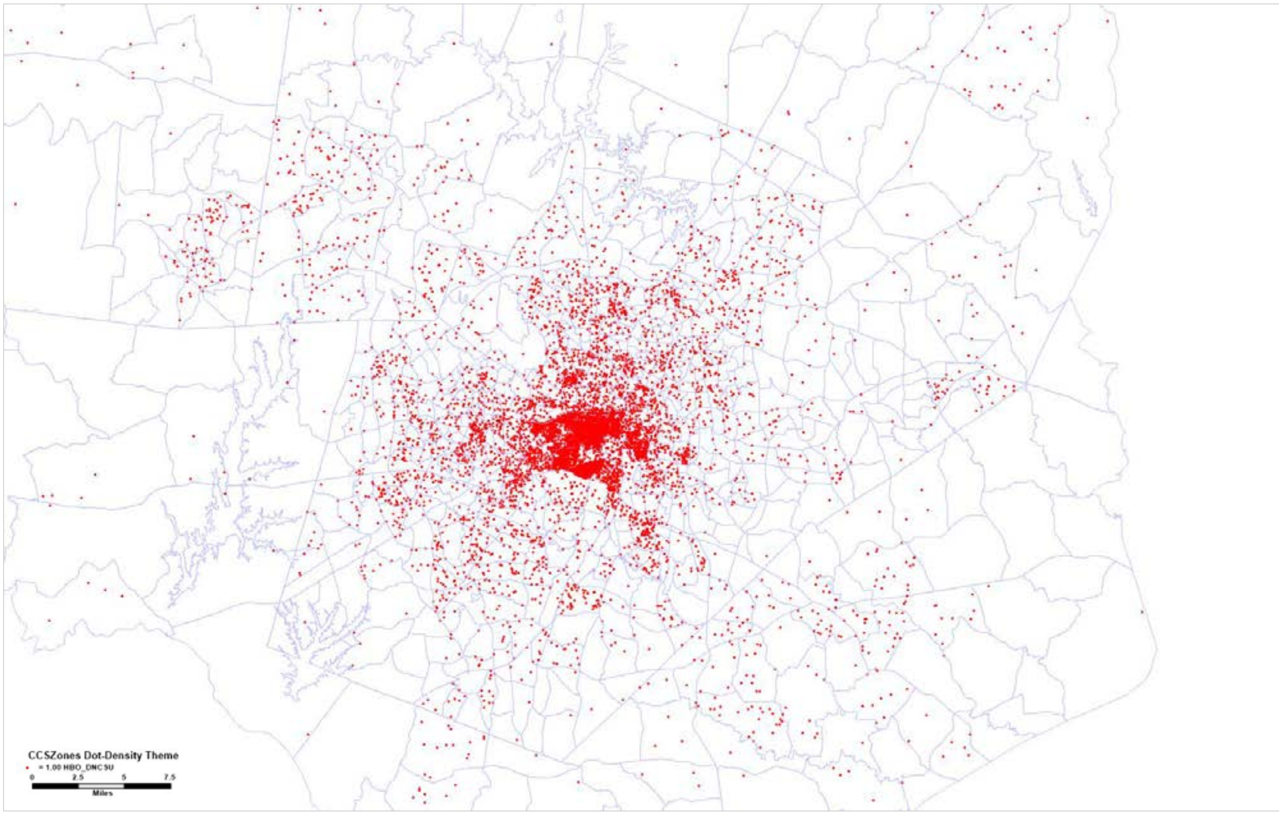


Figure 2.23 Non-Home Based Trips to North Carolina State University

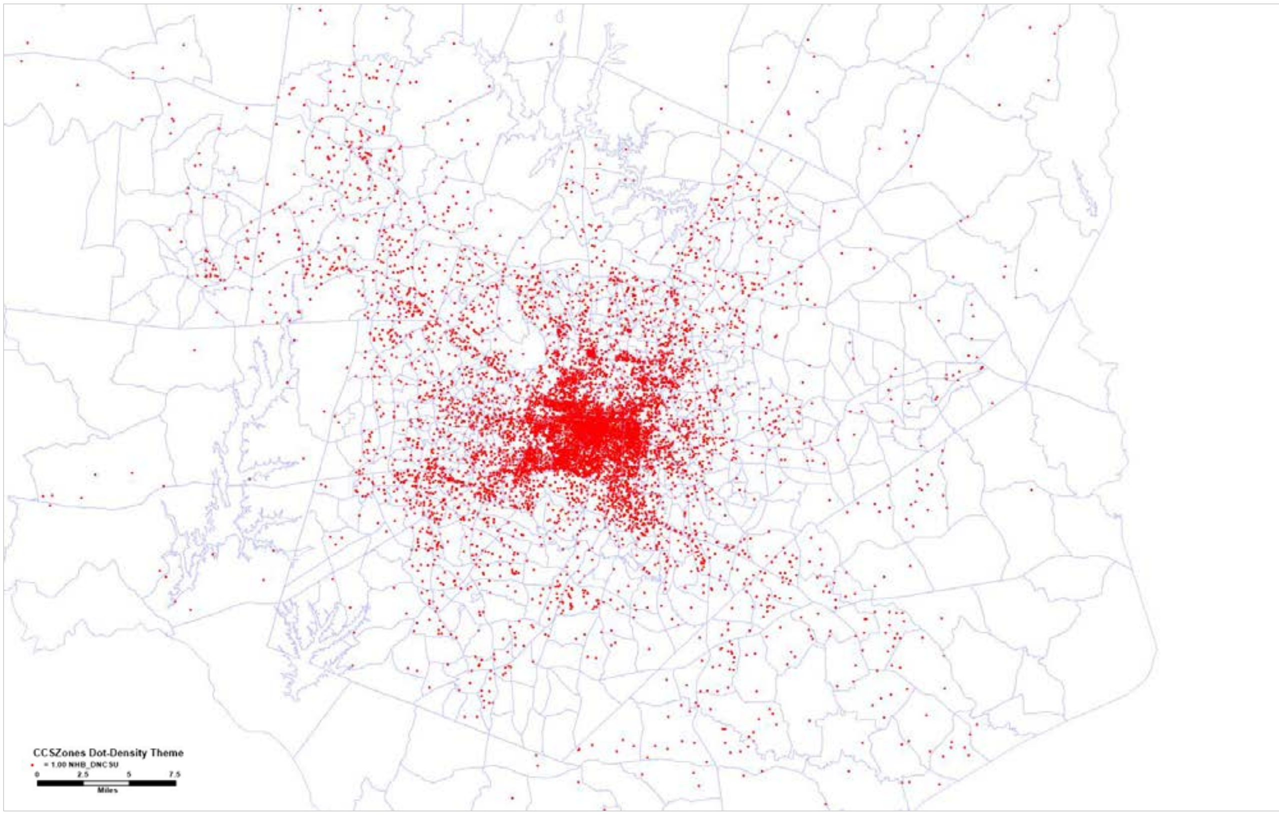


Figure 2.24 Home-Based Work Trips to RDU Airport

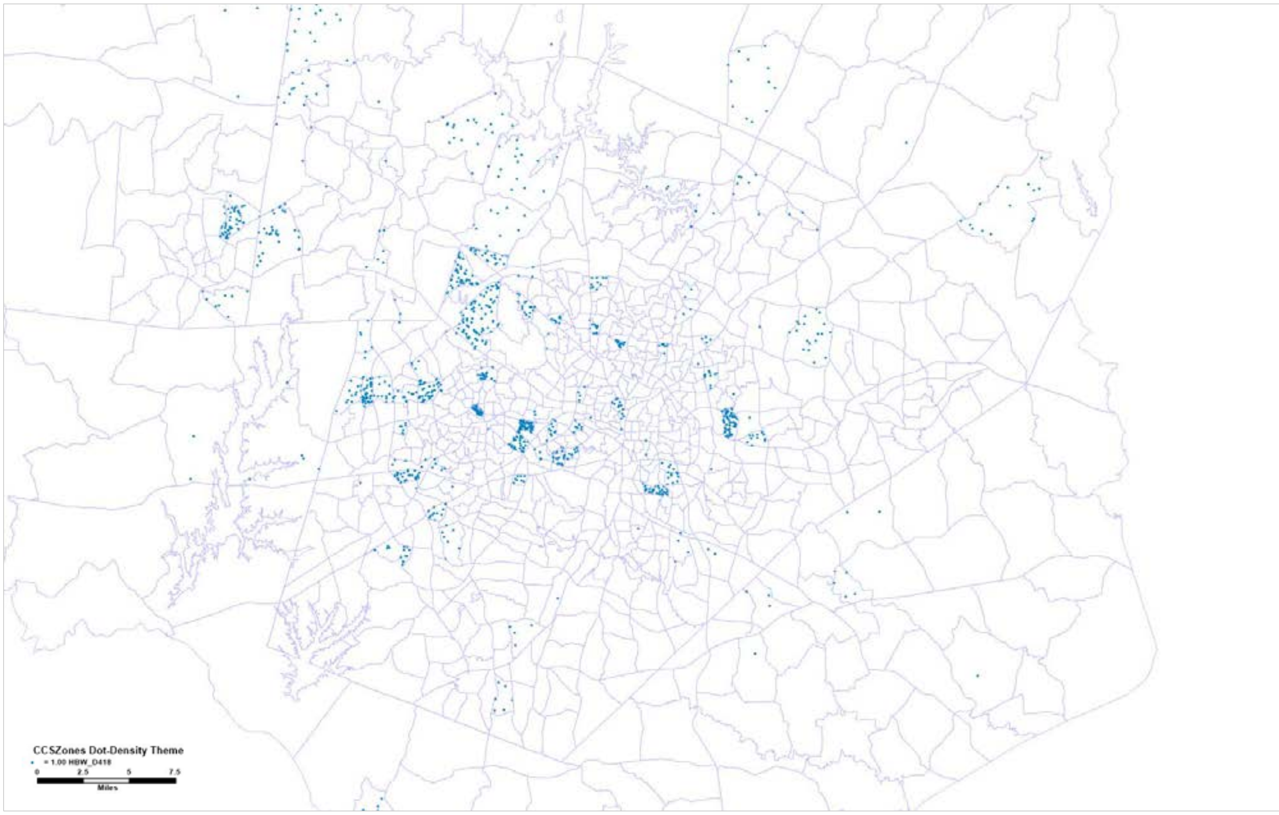


Figure 2.25 Home-Based Other Trips to RDU Airport

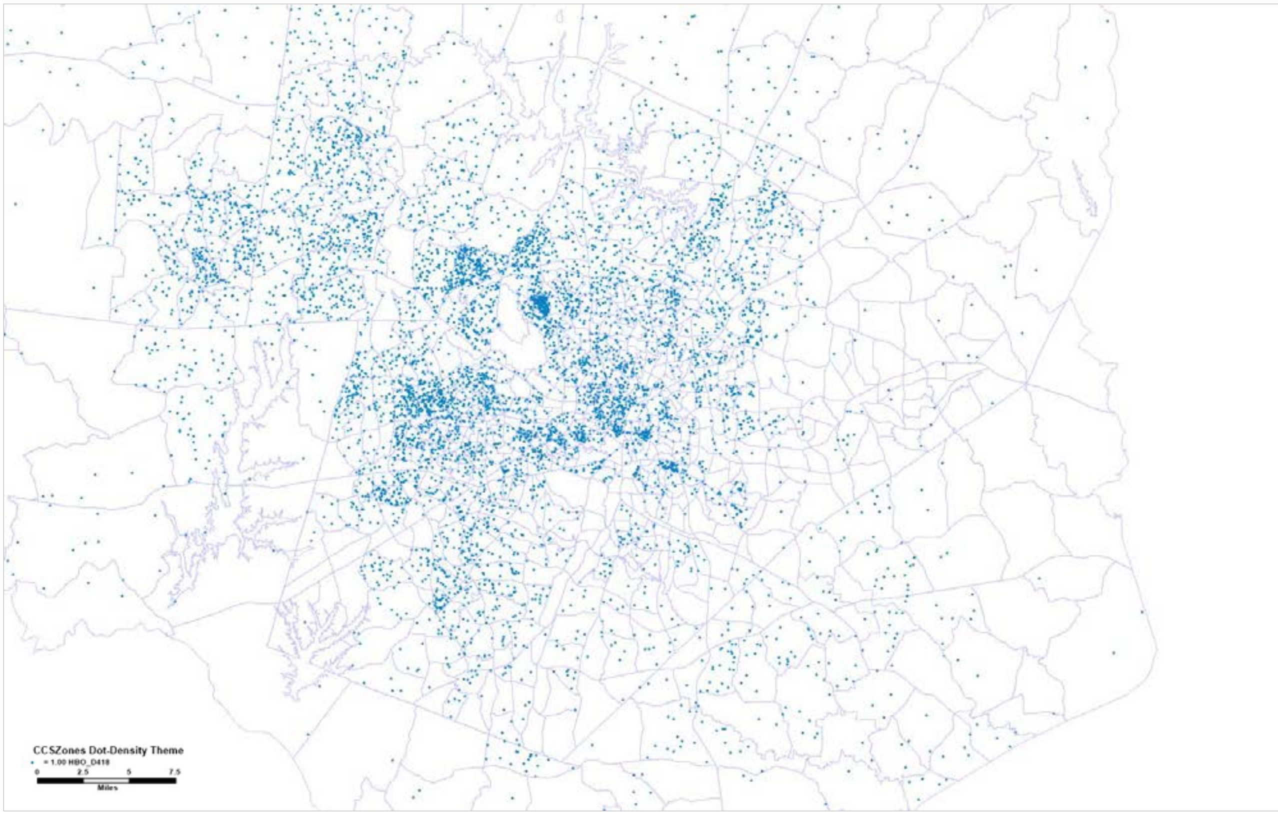


Figure 2.26 Non-Home Based Trips to RDU Airport

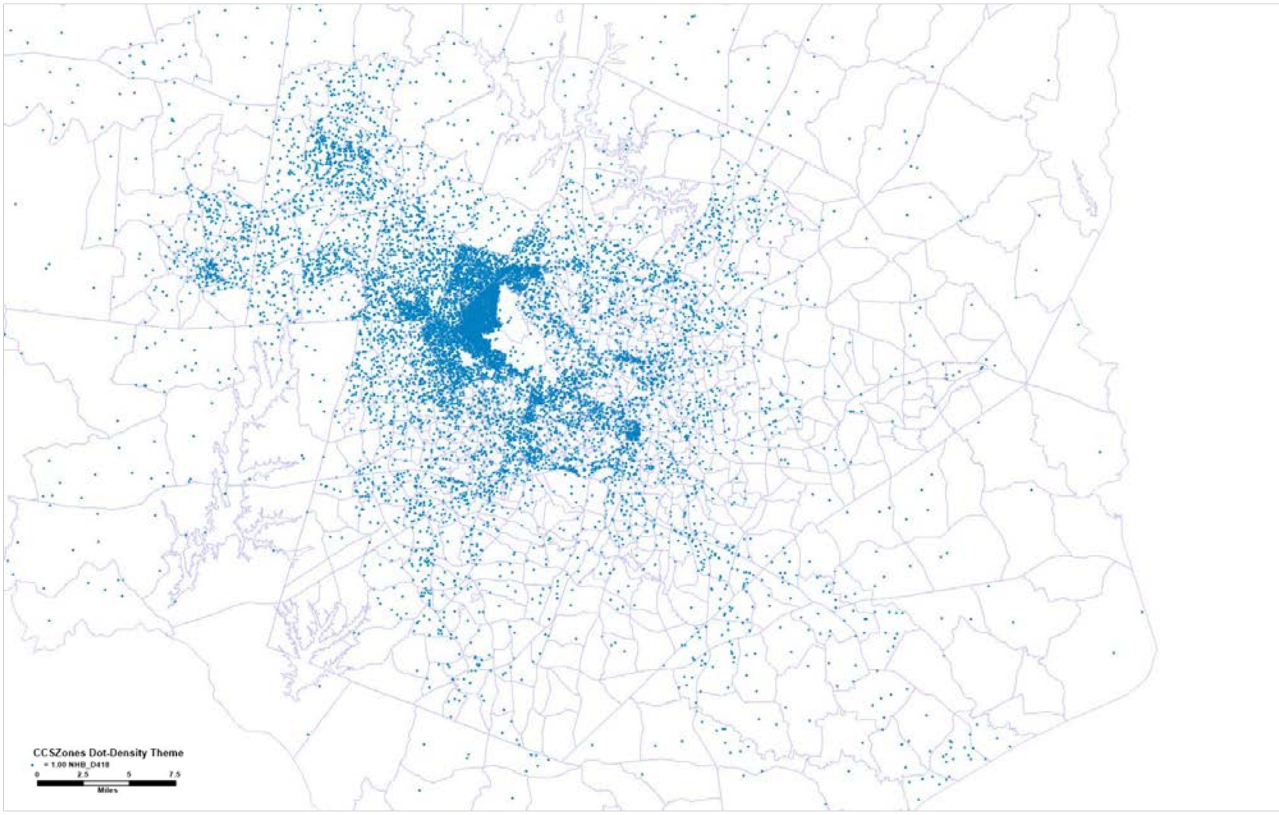


Figure 2.27 Home-Based Work Trips to WakeMed Raleigh Campus

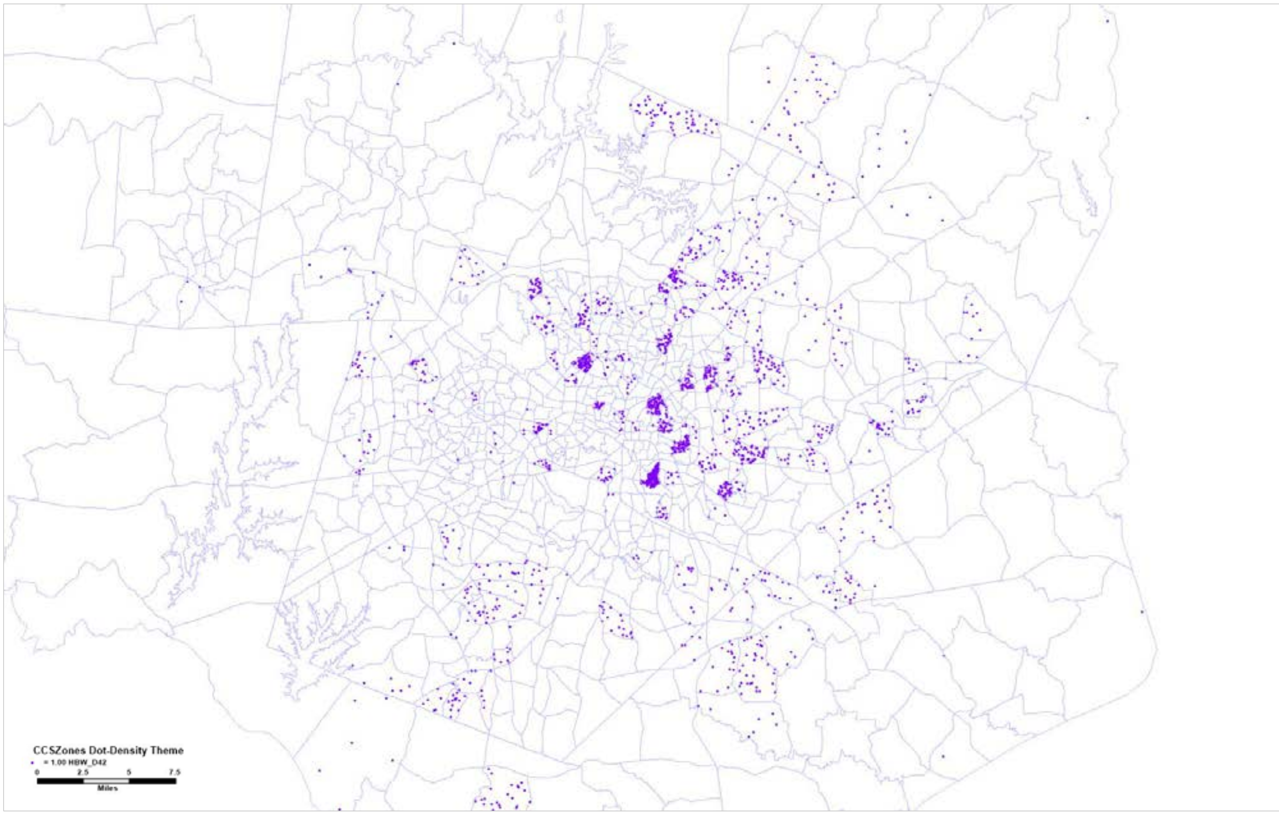


Figure 2.28 Home-Based Other Trips to WakeMed Raleigh Campus

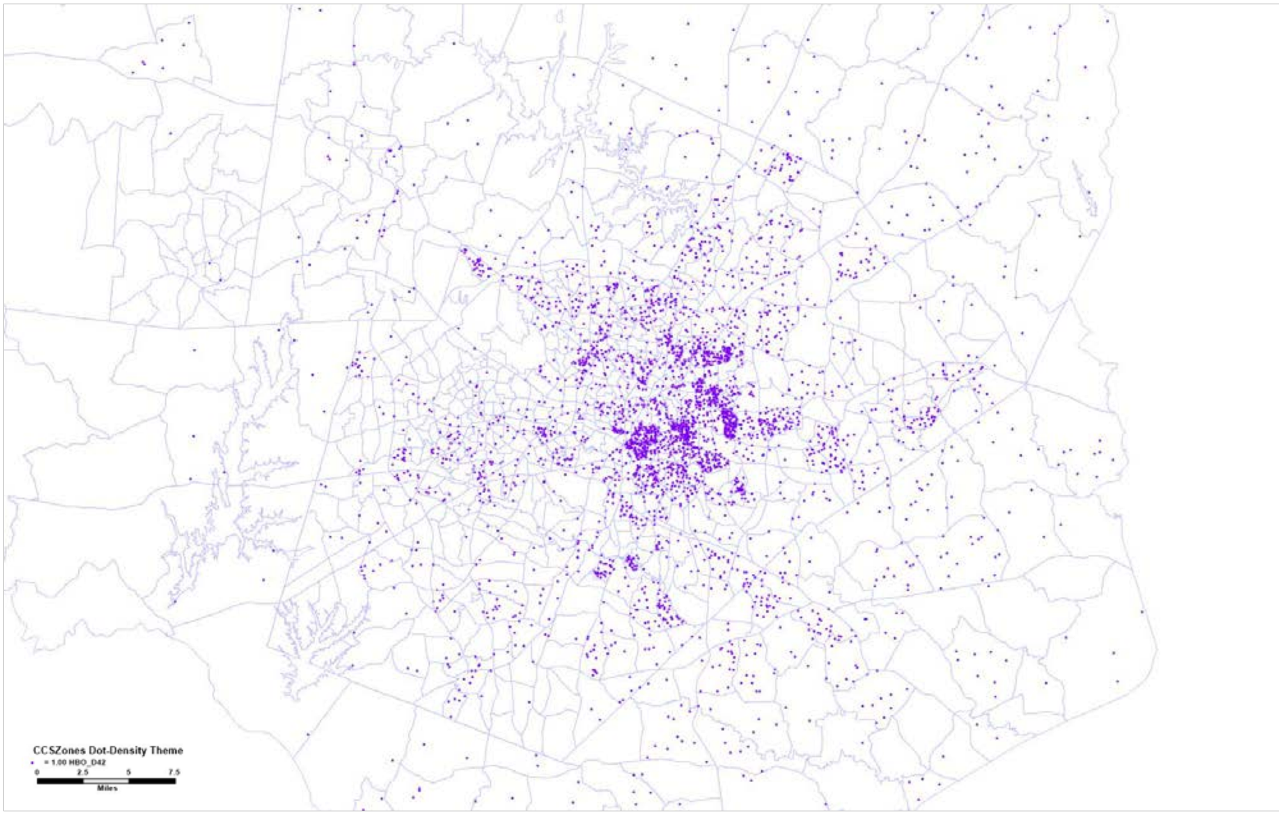
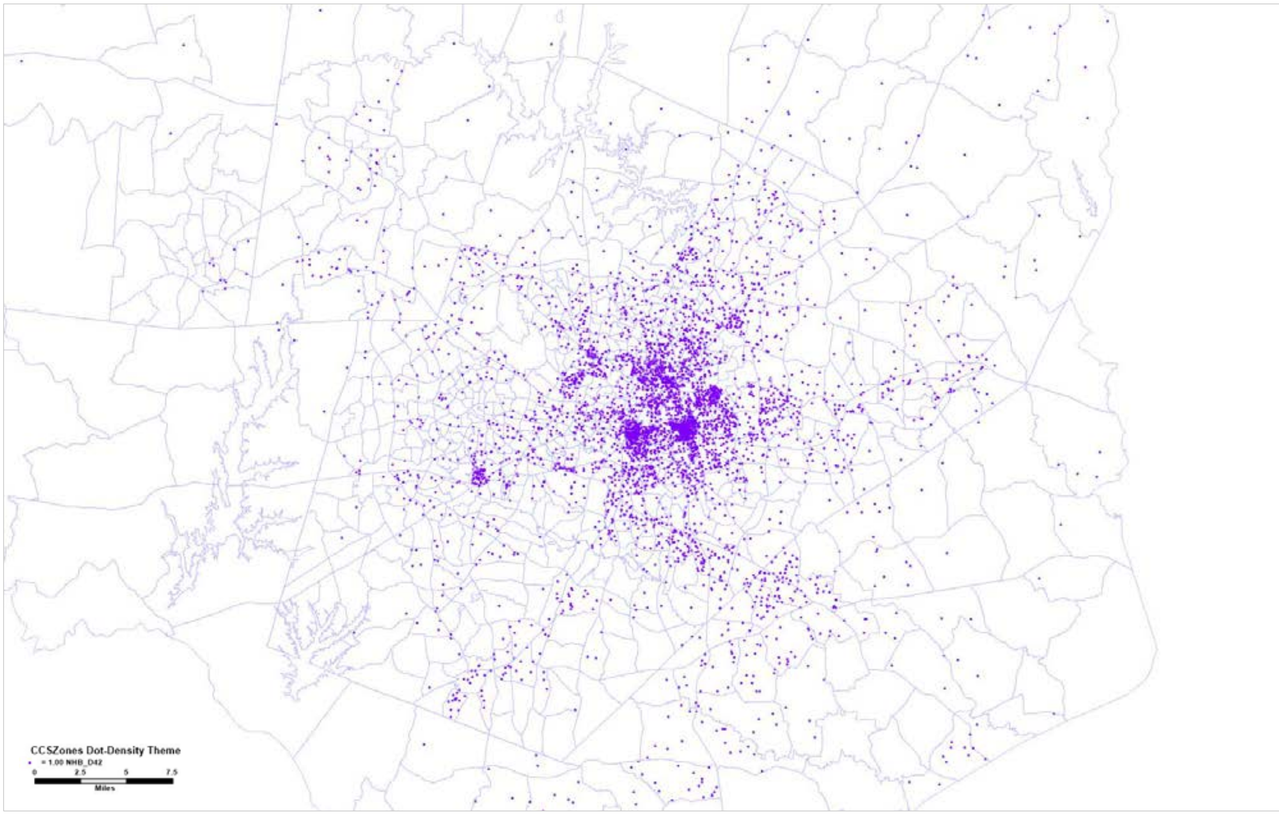


Figure 2.29 Non-Home Based Trips to WakeMed Raleigh Campus



3.0 Future Conditions

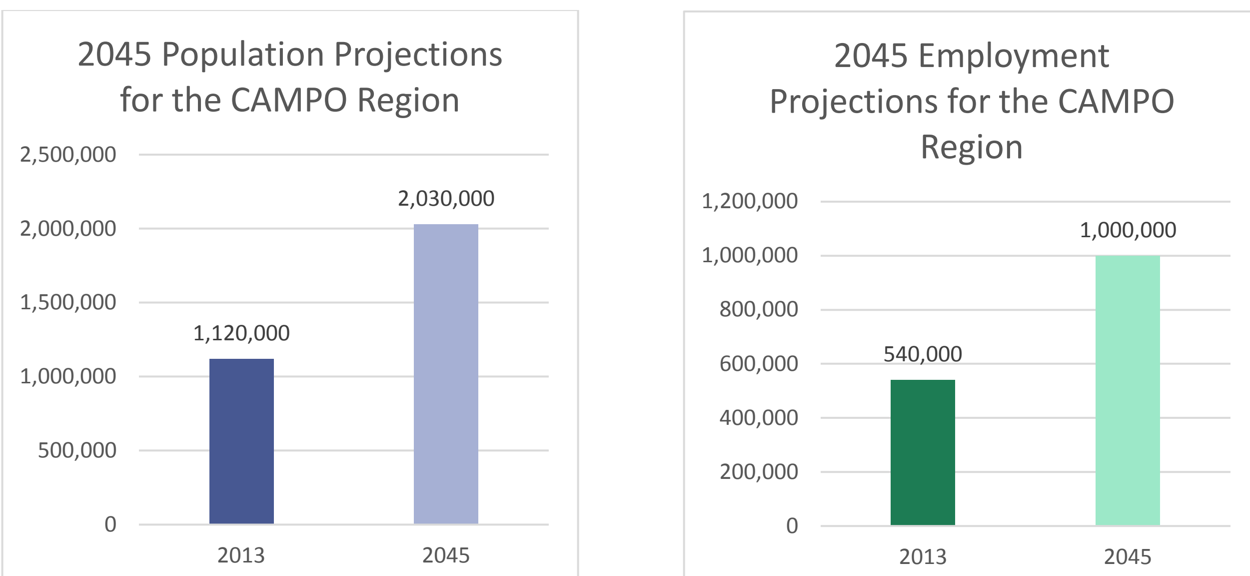
This section presents a summary of future year (2045) traffic conditions in the study area based on the following modeling and analysis steps:

- Land Use analysis using the Triangle region's CommunityViz model, Version 5.1, dated December 2018 for the 2045 Adopted MTP model
- Travel demand analysis using the Triangle Regional Model, Version 6-2 (TRMv6-2) dated January 26, 2019 for the 2045 Adopted MTP model

3.1 Socio-Economic Projections

This section presents a summary of future socio-economic projections (year 2045) in the study area based on the Triangle Regional Model's 2045 Adopted MTP socio-economic (S-E) data. These S-E data projections for the Capital Area MPO region are presented in Figure 3.1. These regionwide projections reveal that the region is expected to add 910,000 people by year 2045, reflecting 82 percent growth compared to the 2013 base year data. This population growth rate is matched by 86 percent jobs growth rate by year 2045 (compared to the 2013 base year), or 460,000 new jobs by year 2045.

Figure 3.1 Population and Employment Projections for the CAMPO Region



These regionwide population and employment growth were allocated to smaller zones, also known as the Traffic Analysis Zones (TAZs), for travel demand analysis. The following S-E projections for year 2045 were reviewed for the Capital Area MPO region TAZs:

- Household Population (see Figure 3.2)
- Office Employment (see Figure 3.3)
- Retail Employment (see Figure 3.4)

- Service (Low Trip Rate) Employment (see Figure 3.5)

These S-E data projections and growth allocations utilized in developing the region's 2045 Metropolitan Transportation Plan (MTP) are illustrated in Figures 3.2 for year 2045 population, in Figure 3.3 for office employment, in Figure 3.4 for retail employment, and in Figure 3.5 for low trip rate service employment. These maps use scaled circles, placed in the middle of each TAZ to illustrate the projected S-E data. In essence, bigger circles reflect higher projected growth for the respective S-E data.

The population allocation map reveals larger circles in southwest and northeast areas of Wake County, and along the US 70 and the I-95 corridors in Johnston County. These areas of the Capital Area MPO region are projected to have higher proportion of future population growth.

In contrast, the employment projection map in the office jobs category show the larger circles in the main activity centers such as downtown Raleigh, the North Carolina State University, the Research Triangle Park, downtown Durham, the Duke University, and the University of North Carolina at Chapel Hill, reflecting anticipated higher densification of these areas.

The retail employment map shows similar anticipated densification of the region's existing retail shopping centers along major highways and urban centers. In addition, the retail map reveals growth in future mixed-use centers in the region's transit station areas as well as in suburban areas of the region.

The service (low rate) employment map also reveals larger circles in existing hospital areas of the region such as the WakeMed Hospitals in Raleigh and Cary, Rex Hospital along Blue Ridge Rd, Duke Hospital in Durham and UNC Hospitals in Chapel Hill. These areas are anticipated to densify for future jobs growth in the service industries.

Figure 3.2 Population Projections for Year 2045

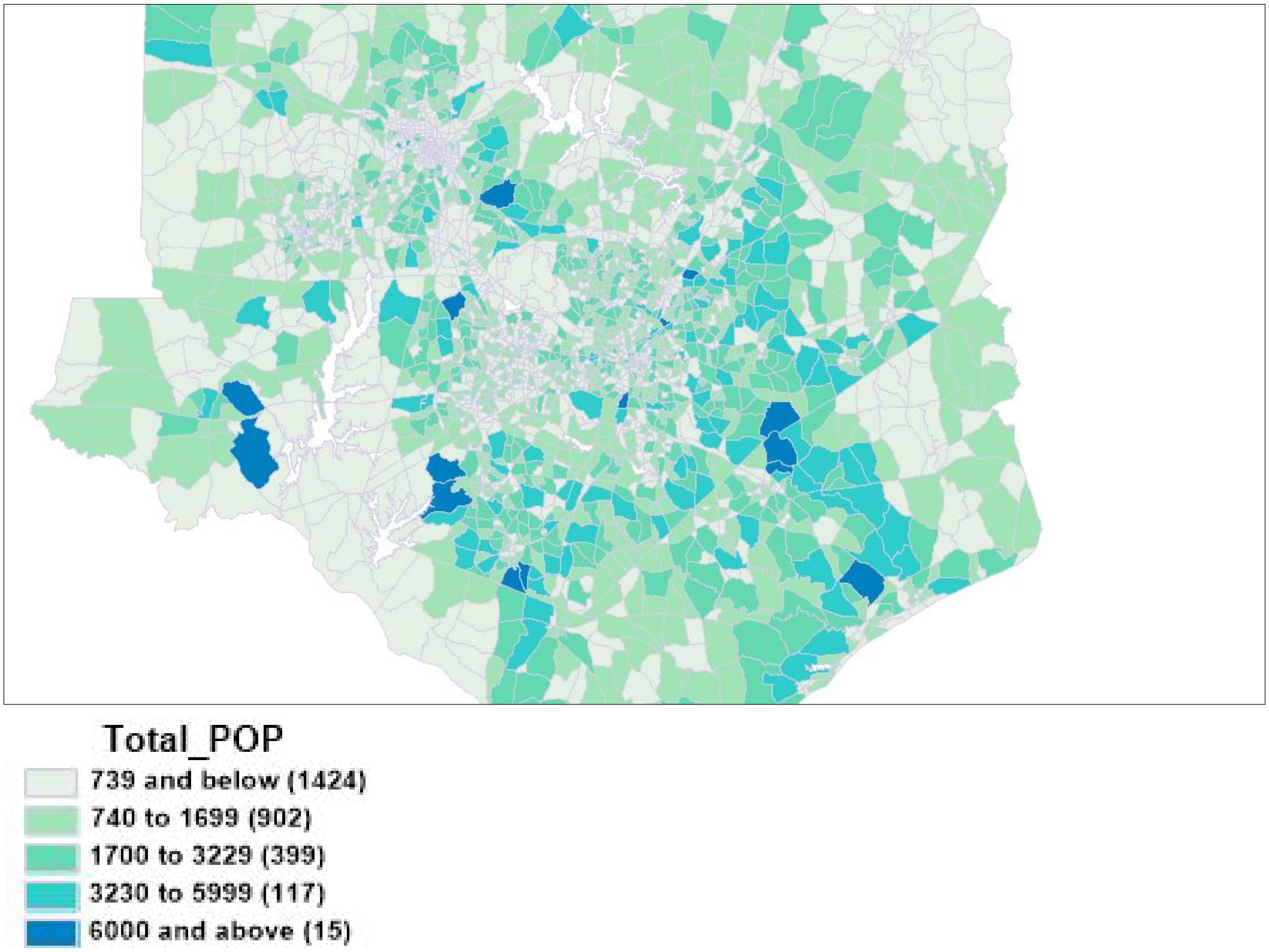


Figure 3.3 Office Employment Projections for Year 2045

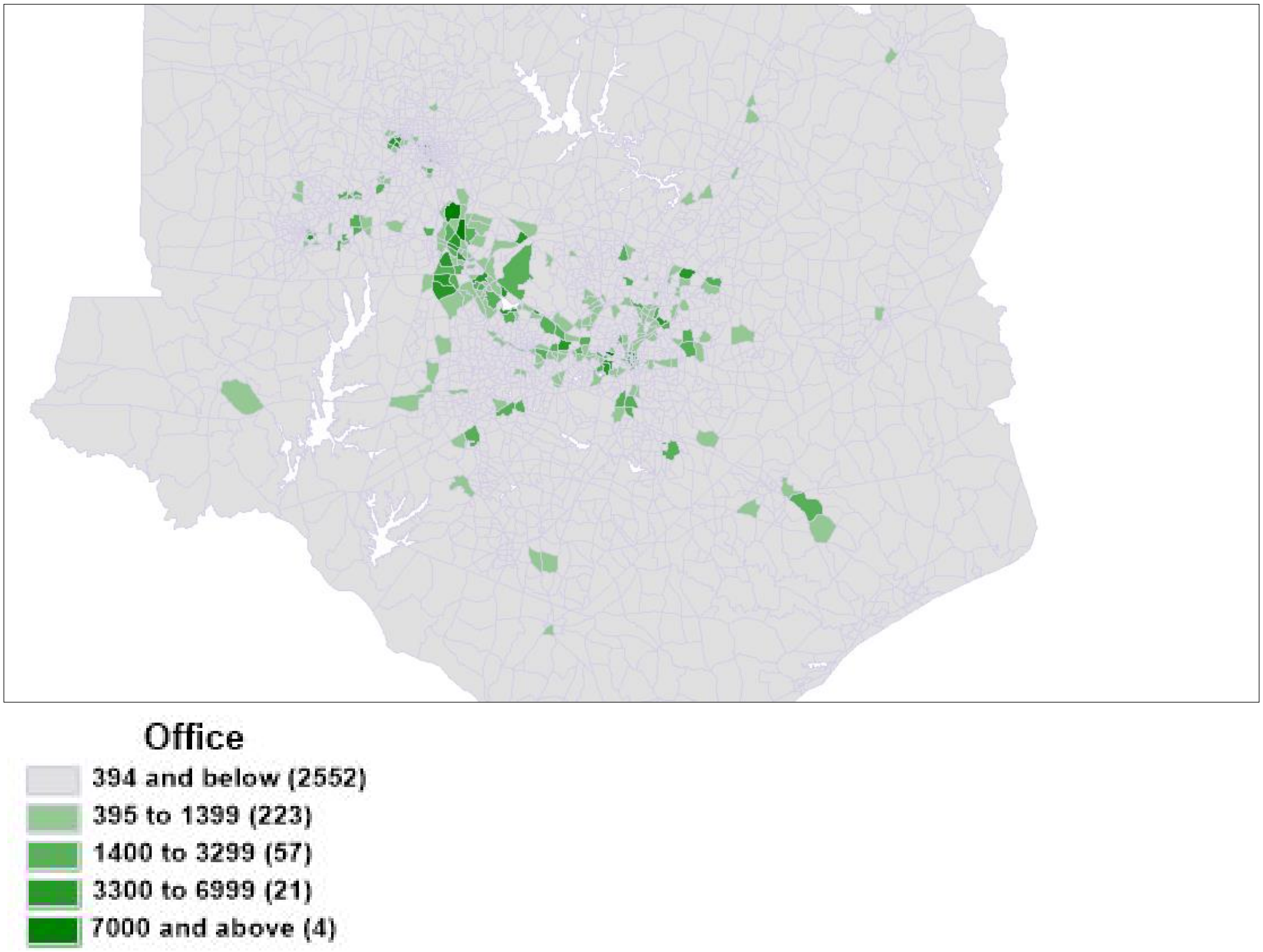


Figure 3.4 Retail Employment Projections for Year 2045

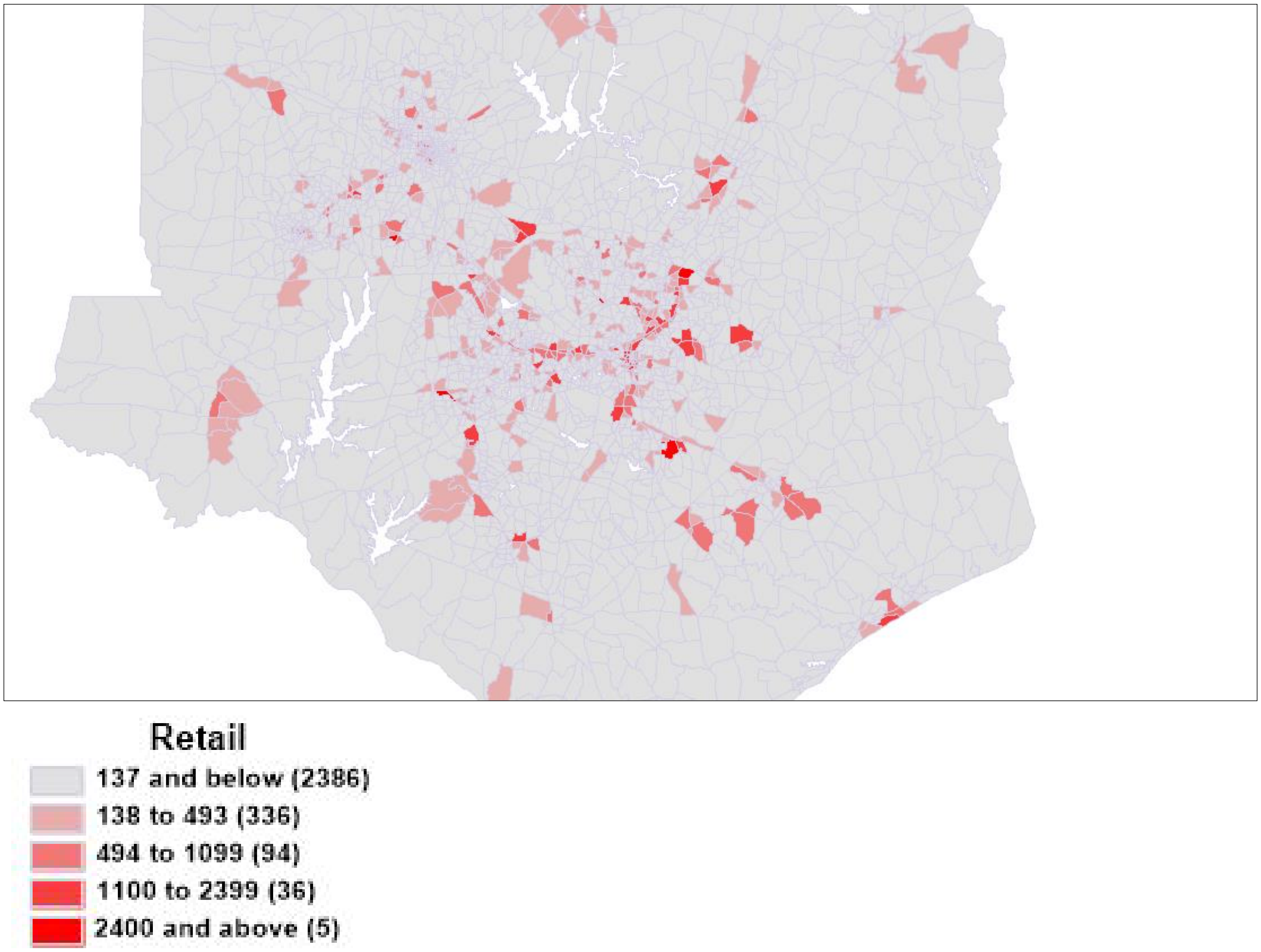
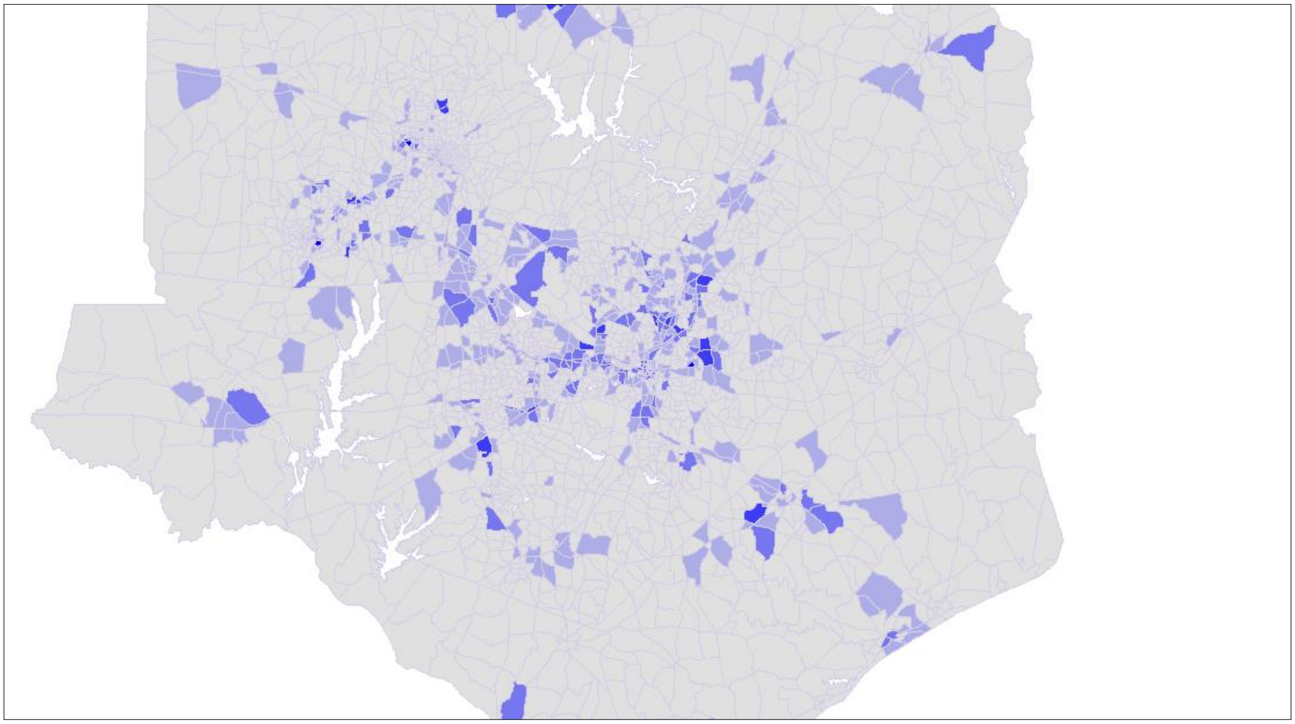


Figure 3.5 Service (Low Trip Rate) Employment Projections for Year 2045



Service_RateLow

- 180 and below (2291)
- 181 to 639 (436)
- 640 to 1699 (109)
- 1700 to 7999 (18)
- 8000 and above (3)

3.2 Land Use Plan

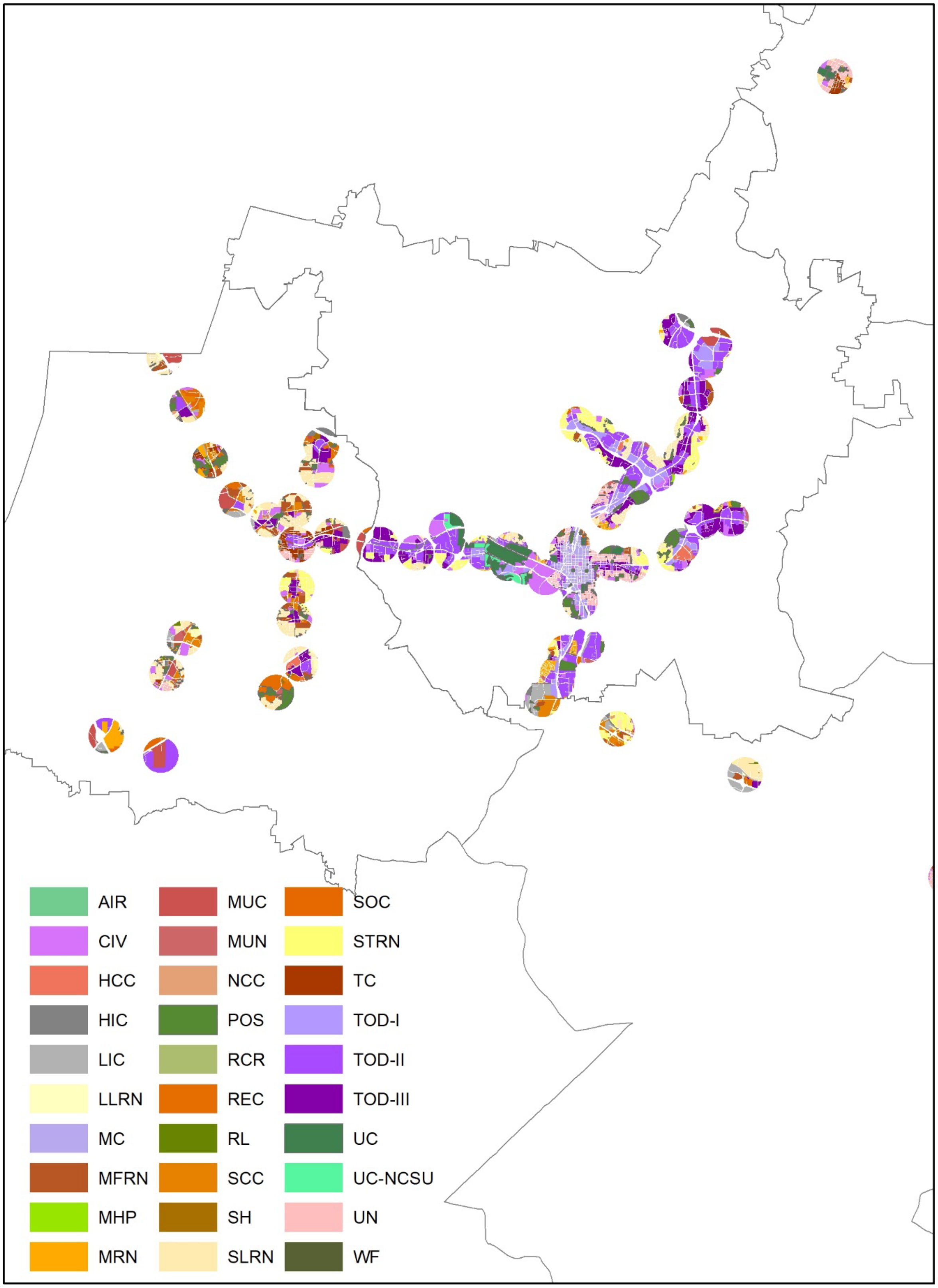
This section presents a summary of the future land use plan in the study area based on data from the region's CommunityViz land use model. The CommunityViz land use model utilizes parcel level data within 16 subregions in the 10-county modeled area to compute parcel-level build-out development potential based on environmental and other constraints that limits developments such as water bodies, wetlands, and stream buffers, as well as existing and future place types and the intensity of each place type within each planning jurisdiction. The parcel-level capacity analysis is rolled up to over 100,000 grid cells for further land use analysis related to Land Suitability Scores and for new growth allocation based on control totals that are developed for each county and each socio-economic variables such as single-family residential households, multi-family residential households, office employment, retail employment, and service (high and low trip rates) employment.

Our review of the CommunityViz model data started from the 2045 Adopted MTP land use scenario. The review included the 37 place types defined in the model that describe different development pattern allowed under Rural, Suburban, City & Town, Industrial and Special land use contexts. The review was targeted to understand the place types and the underlying assumptions defined for the region's station areas that have been defined with half-mile radius around a future light-rail, commuter rail, or high-frequency bus stations as part of the Adopted MTP land use scenario.

The station areas defined as part of the Adopted MTP land use scenario were found to have a variety of place types, including Metropolitan Centers (MC), Transit-Oriented Development (TOD), Type-I, Type-II, and Type-III, Multi-Family Residential Neighborhoods (MFRN), Mixed Use Centers (MUC), and Town Centers (TC). These station area place types are illustrated in Figure 3.6 and the corresponding Development Status are illustrated in Figure 3.7. These figures reveal that the station areas have been targeted for higher density place types and many of the parcels are designated as re-developable (REDEV) or under-developed (UNDER).

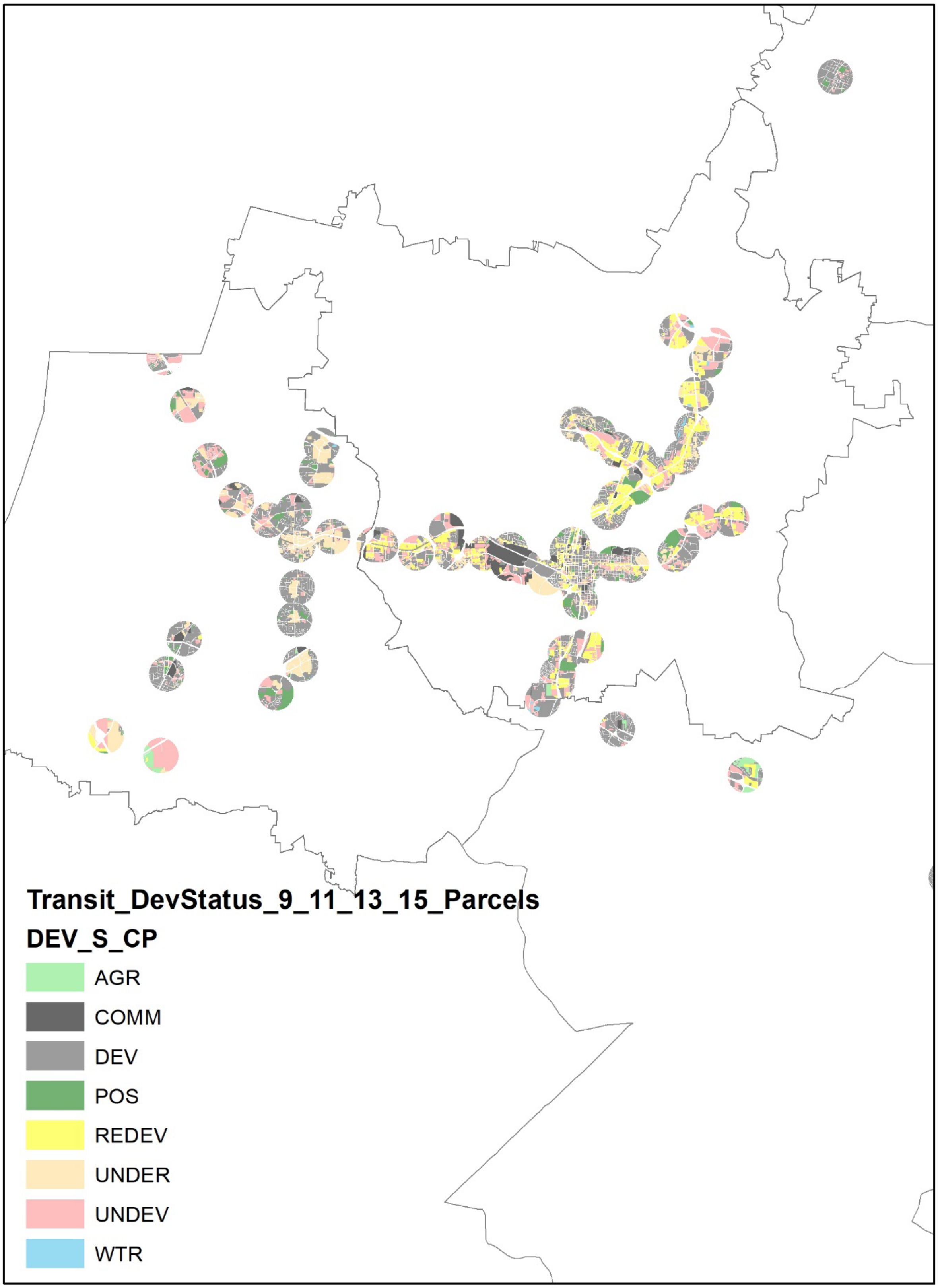
The CommunityViz land use model's grid-level allocation of future 2045 employment (EMP_ALLO) is depicted in Figure 3.8. Similarly, future 2045 single-family dwelling unit allocation (SFDU_ALLO) is depicted in Figure 3.9 and 2045 multi-family dwelling unit allocation (MFDU_ALLO) is depicted in Figure 3.10. These growth allocation maps reveal that the Adopted MTP scenario has allocated higher employment and multi-family dwelling units' growths along the future transit corridors in the region. The growth allocation for single-family dwelling units are anticipated in the suburbs of Southwest and Northeast Wake County as well as in Johnston County.

Figure 3.6 Station Area Place Types for the MTP Land Use Plan



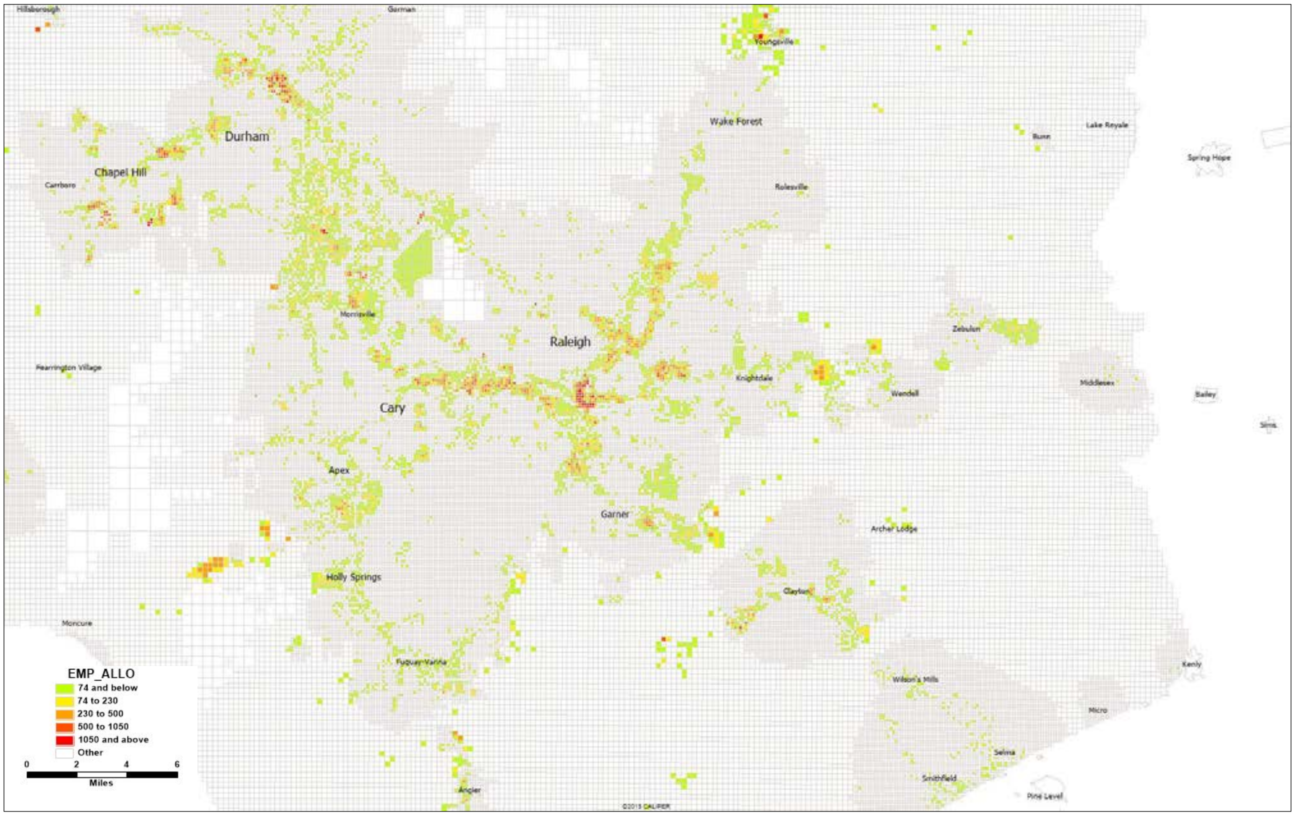
Source: CommunityViz Model – Connect 2045 Adopted MTP Scenario

Figure 3.7 Station Area Development Status for the MTP Land Use Plan



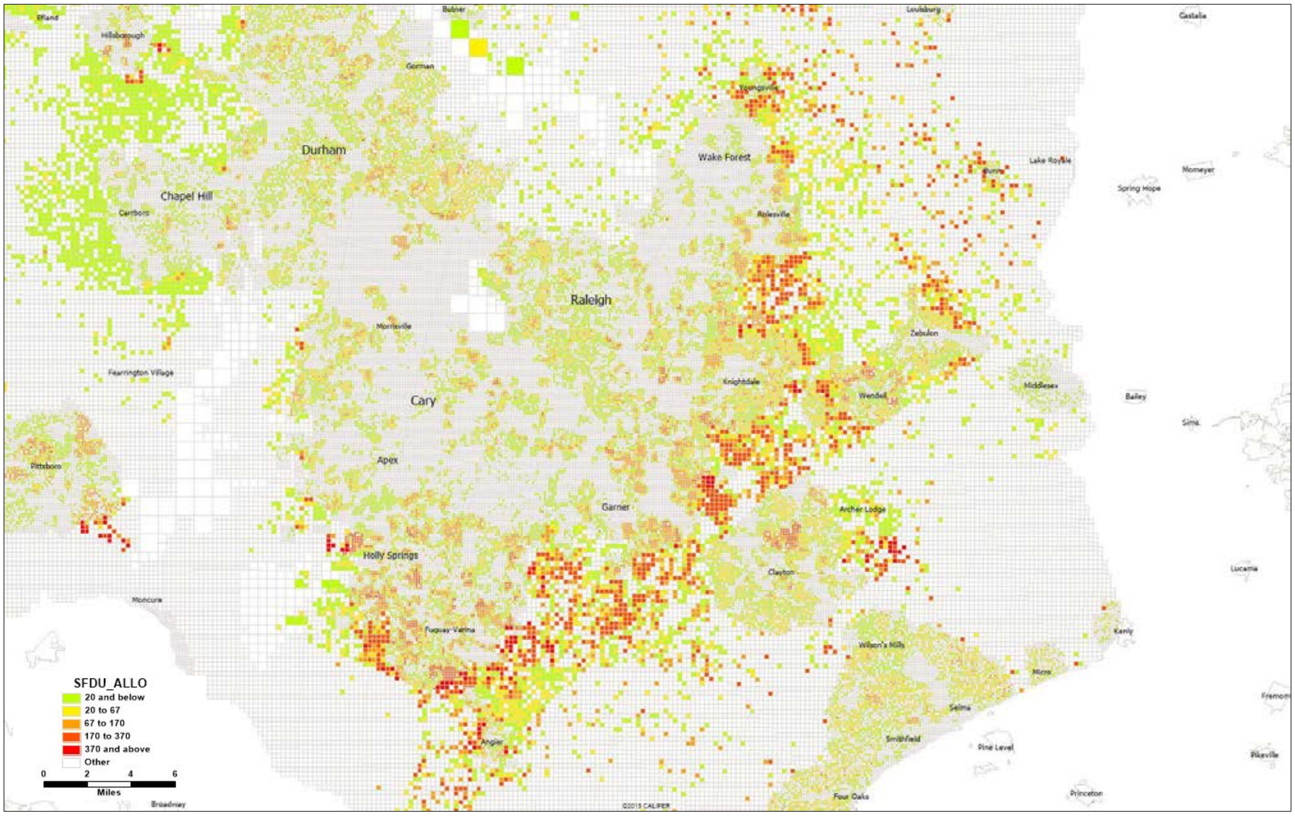
Source: CommunityViz Model – Connect 2045 Adopted MTP Scenario

Figure 3.8 2045 Adopted MTP – Grid Cell Allocation of Employment Growth



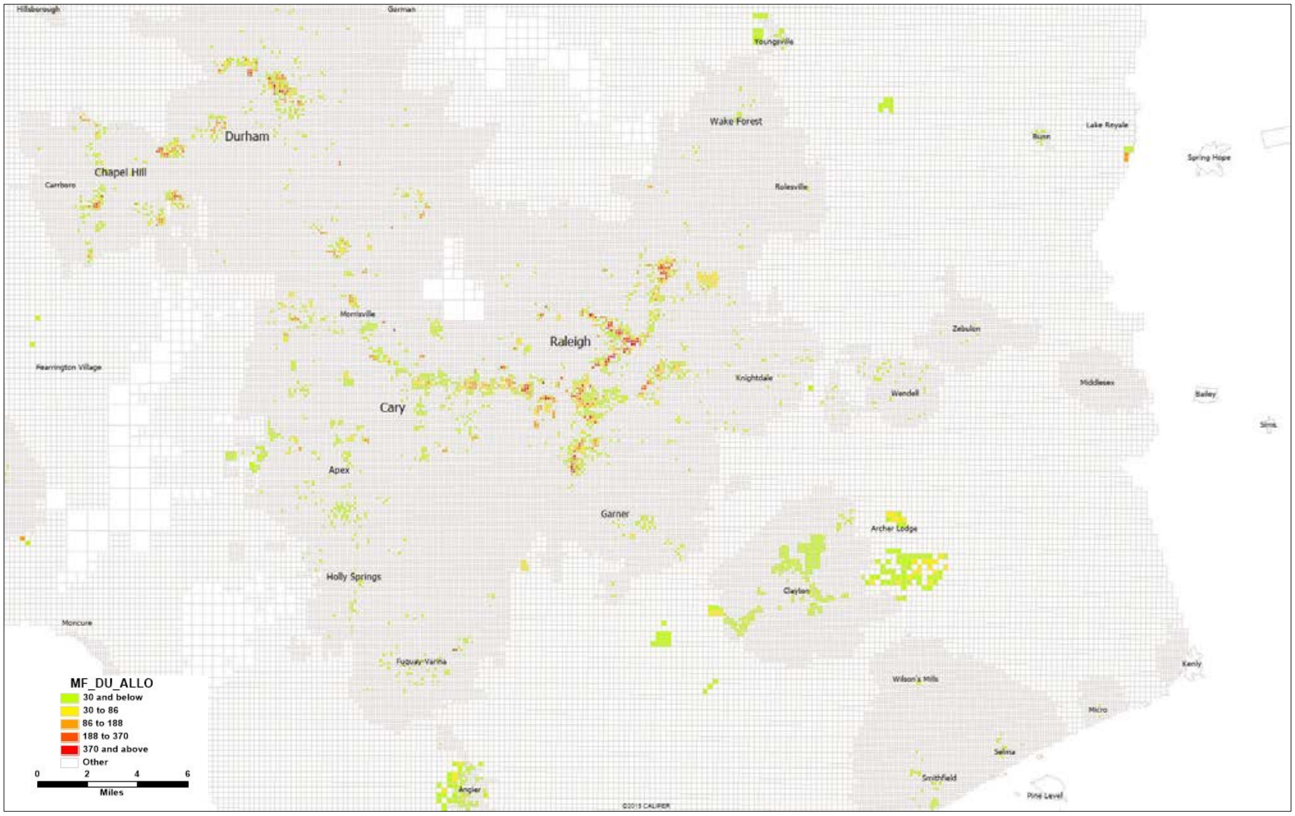
Source: CommunityViz Model – Connect 2045 Adopted MTP Scenario

Figure 3.9 2045 Adopted MTP – Grid Cell Allocation of Single-Family Dwelling Units Growth



Source: CommunityViz Model – Connect 2045 Adopted MTP Scenario

Figure 3.10 2045 Adopted MTP – Grid Cell Allocation of Multi-Family Dwelling Units Growth



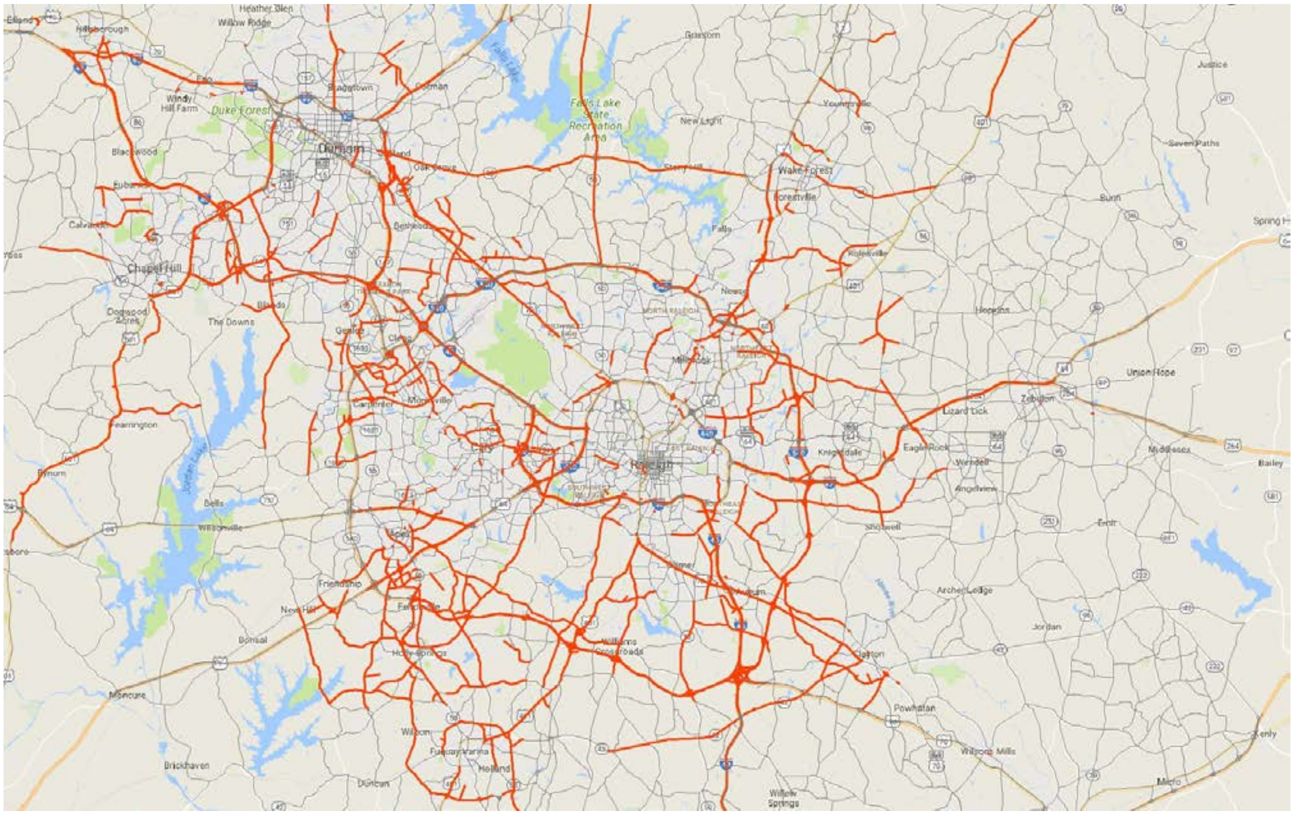
Source: CommunityViz Model – Connect 2045 Adopted MTP Scenario

3.3 Planned Projects

The Capital Area MPO's 2045 Metropolitan Transportation Plan (2045 MTP) was reviewed to identify future planned and programmed projects by year 2045. This review focused only on the capacity-enhancement type projects that are expected to improve mobility and reduce traffic congestion in the Capital Area MPO study area. These future projects are herein referred to as the mobility projects and included capacity enhancement to the highway network (i.e. Roadway projects) and transit network (i.e., Public Transit Projects). These planned/programmed future mobility projects along the study area commuter corridors are summarized next.

The roadway projects planned/programmed in the study area that are part of the Statewide Transportation Improvement Plan (STIP) and the 2045 Adopted MTP are depicted in Figure 3.11 with redlined roadways.

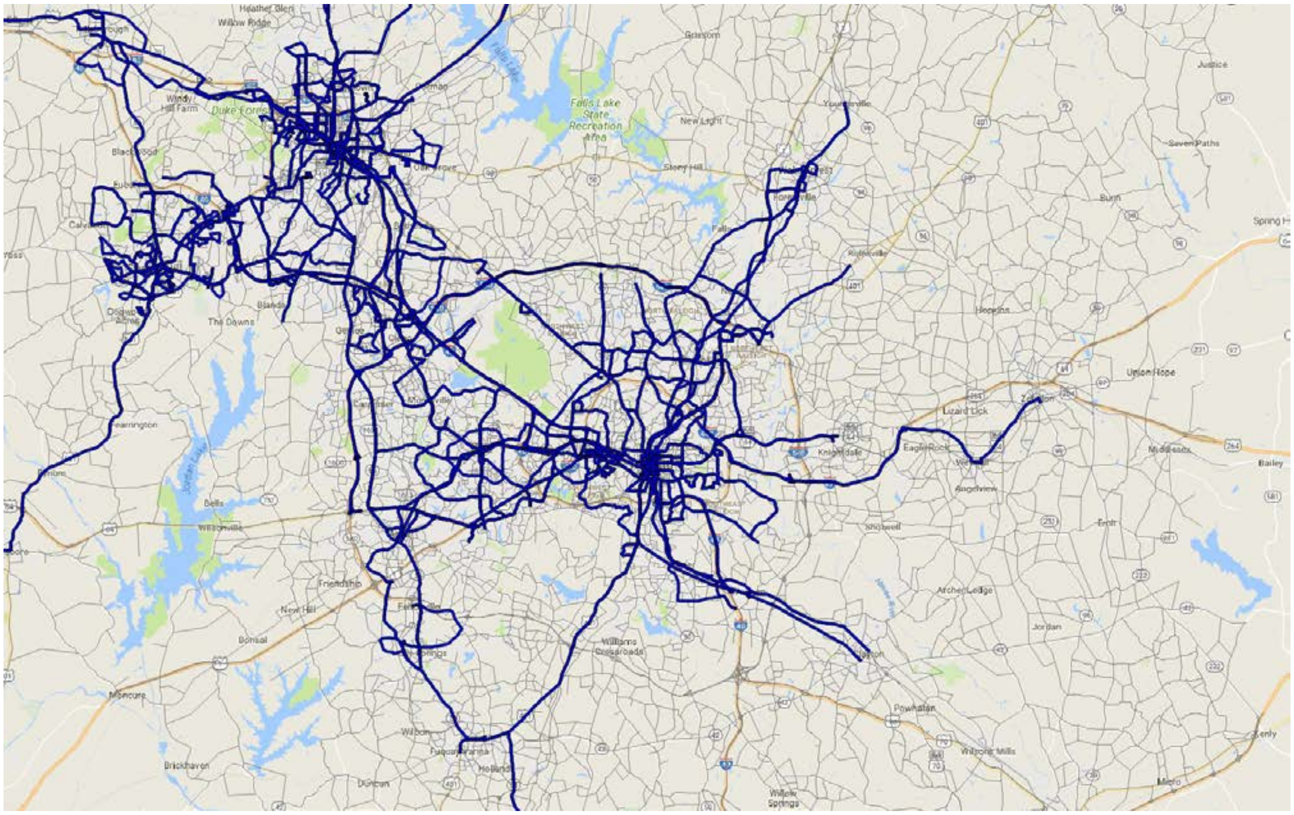
Figure 3.11 2045 Adopted MTP – Planned Highway Projects



Source: TRMv6 - 2045 MTP Highway Network

The transit projects planned/programmed in the study area that are part of the regional and countywide transit plans and the 2045 Adopted MTP are depicted in Figure 3.12 with blue lines. This future transit service map shows limited transit services in Southwest and Northeast Wake County and Johnston County areas. Also, it should be noted that the 2045 Adopted MTP assumed the light rail project between Chapel Hill and Durham, which was cancelled in March of 2019 due to lack of support from major stakeholders along the corridor. This transit project has significant influence on the regional transit system, and as such future transit network and ridership estimates will need to be updated prior to initiating the 2050 MTP planning process.

Figure 3.12 2045 Adopted MTP – Planned Transit Service Projects



Source: TRMv6 - 2045 MTP Transit Network

3.4 Travel Demand Pattern

This section presents a detailed look at travel pattern anticipated along the commuter corridors using the region's latest travel demand model TRMv6 for the 2045 MTP modeled network.

3.4.1 Travel Demand Forecasts for the 2045 Adopted MTP

The 2045 Adopted MTP model was run to prepare the future travel demand in the study area. The results of the Adopted MTP scenario is summarized in Table 3.1 using a host of performance measures including Vehicle Miles of Travel (VMT), Vehicle Hours of Travel (VHT), Percent of VMT experiencing congestion during average weekday and peak periods, modal shares, and transit ridership.

Table 3.1 Travel Demand Analysis of the 2045 Adopted MTP Network

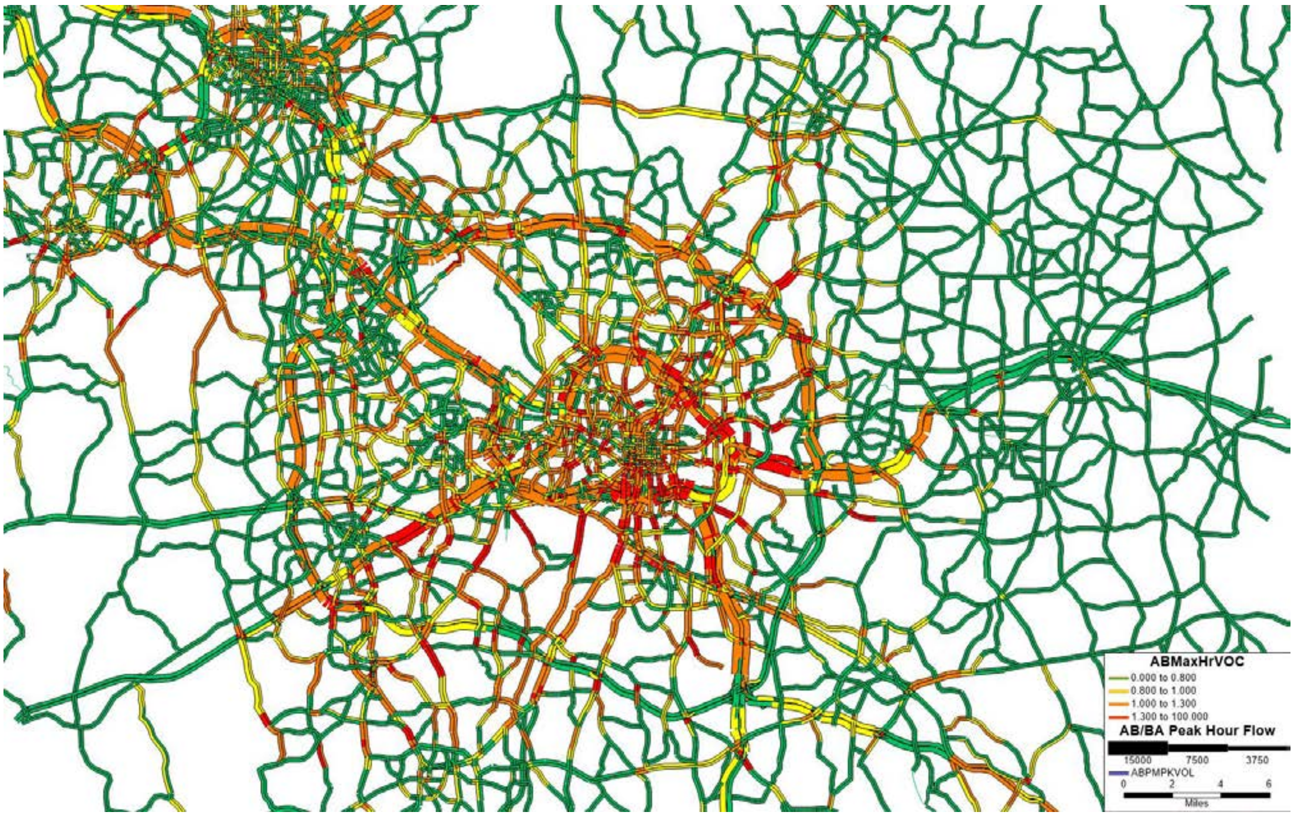
Travel Demand Analysis Performance Measure	Value for the CAMPO Region
Total Vehicle Miles Traveled or VMT (daily)	
- All Facility (no Centroid Connectors)	54,732,612
Total Vehicle Hours Traveled or VHT (daily)	

Travel Demand Analysis Performance Measure	Value for the CAMPO Region
- All Facility (no Centroid Connectors)	1,589,074
Average Speed by Facility (miles/hour)	
- Freeway	55.4
- Arterial	36.9
- All Facility	42.9
Peak Average Speed by Facility (miles/hour)	
- Freeway	51.8
- Arterial	35.6
- All Facility	40.7
Daily Average Travel Length - All Person Trips	
- Travel Time	17.19
- Travel Distance	7.74
Daily Average Travel Length - Work Trips	
- Travel Time	26.76
- Travel Distance - Work Trips	14.09
Peak Average Travel Length - All Person Trips	
- Peak Travel Time	16.75
- Peak Travel Distance	6.98
Daily Average Travel Length - All Commercial Vehicle Trips	
- Travel Time	11
- Travel Distance	7.14
Daily Average Travel Length - Truck Trips	
- Travel Time	12.79
- Travel Distance	8.61
Hours of Delay (daily)	344,875
Truck Hours of Delay (daily)	10,941
Percent of VMT experiencing congestion - All Day	
- Freeway	14.90%
- Arterial	9.30%
- All Facility	10.40%
Percent of VMT experiencing congestion - Peak	
- Freeway	25.20%
- Arterial	14.60%
- All Facility	16.80%

Travel Demand Analysis Performance Measure	Value for the CAMPO Region
- Designated truck routes	9.40%
- Facilities w/bus routes	15.80%
Mode Share Measures	
All Trips - Daily	
- Drive alone (single occupant vehicle -SOV)	4,207,352
- Carpool (Share ride)	3,742,429
- Bus	92,346
- Rail	20,664
- Non-Motorized (Bike and Walk)	749,185
Work Trips - Daily	
- Drive alone (single occupant vehicle -SOV)	1,042,146
- Carpool (Share ride)	146,955
- Bus	49,654
- Rail	7,289
- Non-Motorized (Bike and Walk)	55,414
All Trips - Peak Hours	
- Drive alone (single occupant vehicle -SOV)	2,269,659
- Carpool (Share ride)	2,228,706
- Bus	55,637
- Rail	13,824
- Non-Motorized (Bike and Walk)	391,994
Transit Measures	
Transit Ridership by Prod. Ends – Total Peak and Off-peak	
- GoTriangle (Including Rail)	75,321
- GoRaleigh	121,505
- Wolfline	16,007
- GoCary	4,470
Total Ridership for the CAMPO Region	217,303
Total Daily Person Trips	8,811,976
Work Person Trips	1,301,458
Total Daily Commercial Vehicle Trips	559,628
Daily Truck Trips	234,192
Lane Miles	9,245
Transit Supply – Service Miles in the CAMPO Region	57,019

The resulting traffic congestion for the 2045 Adopted MTP network is illustrated in Figure 3.13 in terms of Maximum Volume-to-Capacity (VOC) ratios anticipated during either AM or PM peak periods. The Figure 3.13 reveals that many segments along the study area commuter corridors are anticipated to experience moderate degree of traffic congestion with VOC ranging between 1.0 to 1.3 (shown in orange links on the map) and several segments would experience severe traffic congestion with VOC exceeding 1.3 (shown in red links on the map).

Figure 3.13 2045 MTP - Maximum Volume to Capacity Ratios during Peak Periods



3.4.2 Trip Origin-Destination Pattern of Key Commuter Corridors

The demand analysis included conducting select-link analysis of high traffic volume locations along the study area commuter corridors using the 2045 Adopted MTP highway network for AM peak commuting time period. This analysis was prepared for the following eleven high traffic volume locations by tracking traffic's path and origin-destination, in both directions of travel, that are passing through these select-link locations during the AM peak period:

1. I-40, east of I—540 near the RDU Airport
2. I-40, west of US 401 near downtown Raleigh
3. I-40, north of Jones Sausage Rd in Southeast Raleigh
4. I-440, west of Six Forks Rd near North Hills

5. I-540, east of US 70 near Brier Creek
6. US 1, west of I-40 in Cary
7. US 70 (Glenwood Ave), west of NC 50 near Crabtree Valley Mall
8. US 1 (Capital Blvd), north of I-440 in Northeast Raleigh
9. I-87, east of I-540 in Knightdale
10. US 70 (Clayton Bypass), east of I-40 in Garner
11. US 401, south of US 70 in Garner

The results of this analysis are summarized in a series of select-link maps:

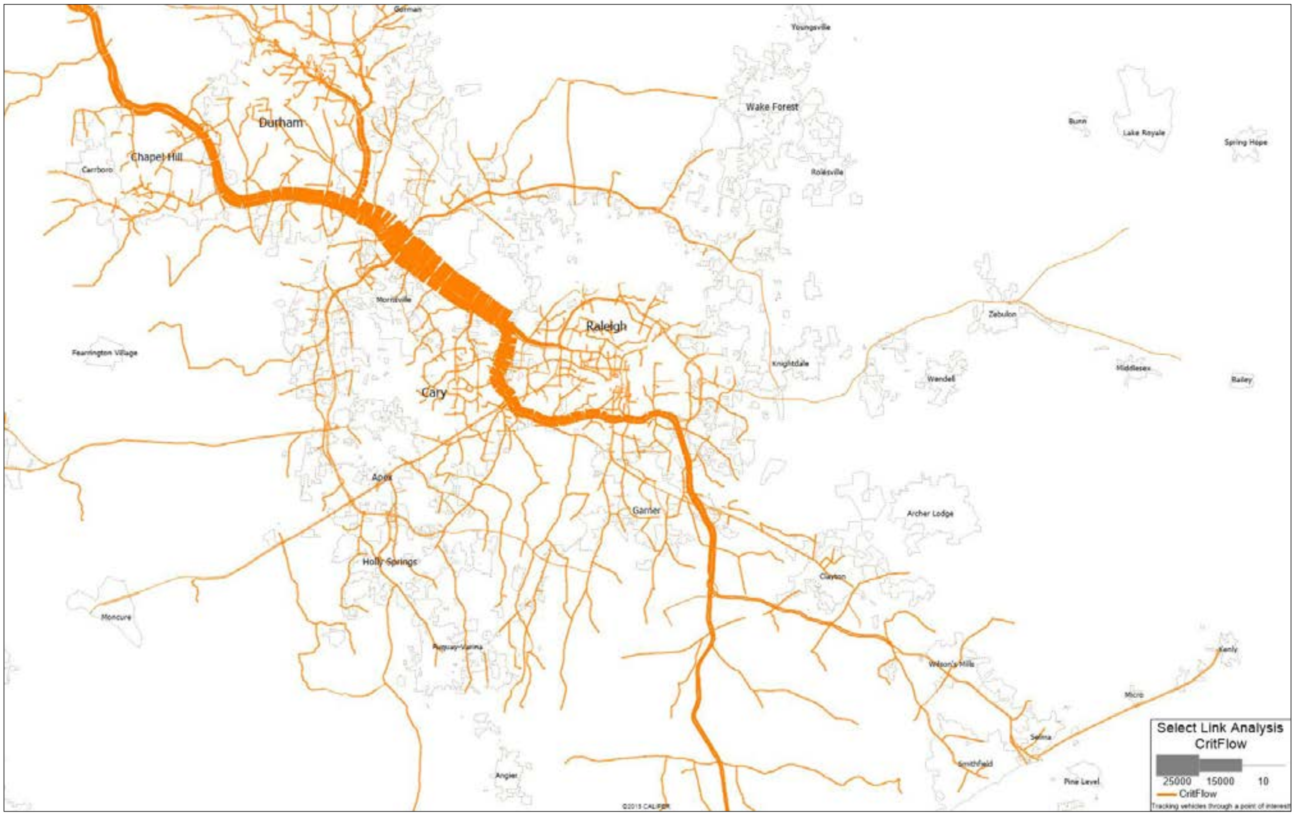
- First, in terms of Travelshed during AM peak period to show how trips are flowing into and out of the selected commuter corridor segments using different roads and the relative peak period volume illustrated by line width (labeled as CritFlow on the map legend), and

- Second, in terms of zonal origins and destinations (O-Ds) during AM peak hour to show the commuter corridor segment's influence area and relative magnitude of that influence by size of the pie charts (pie charts also show the breakdown of trip origins in red, and trip destinations in blue).

For each select-link location, the Travelshed map is presented first and then the trip O-D map is presented. These maps are meant to be compared visually pairwise for each select link location. For example, Figures 3.14 and 3.15 was compared side by side visually to explore the traffic flow pattern in the AM peak hour. These maps were prepared using the same geographic extent and scale. It should be mentioned that the Travelshed maps were prepared using a minimum threshold of 15 trips to reduce clutter. Consequently, these Travelshed maps have a few gaps in the routes at the peripheral areas. The Trip O-D maps were also prepared using the same geographic extent and pie chart scale.

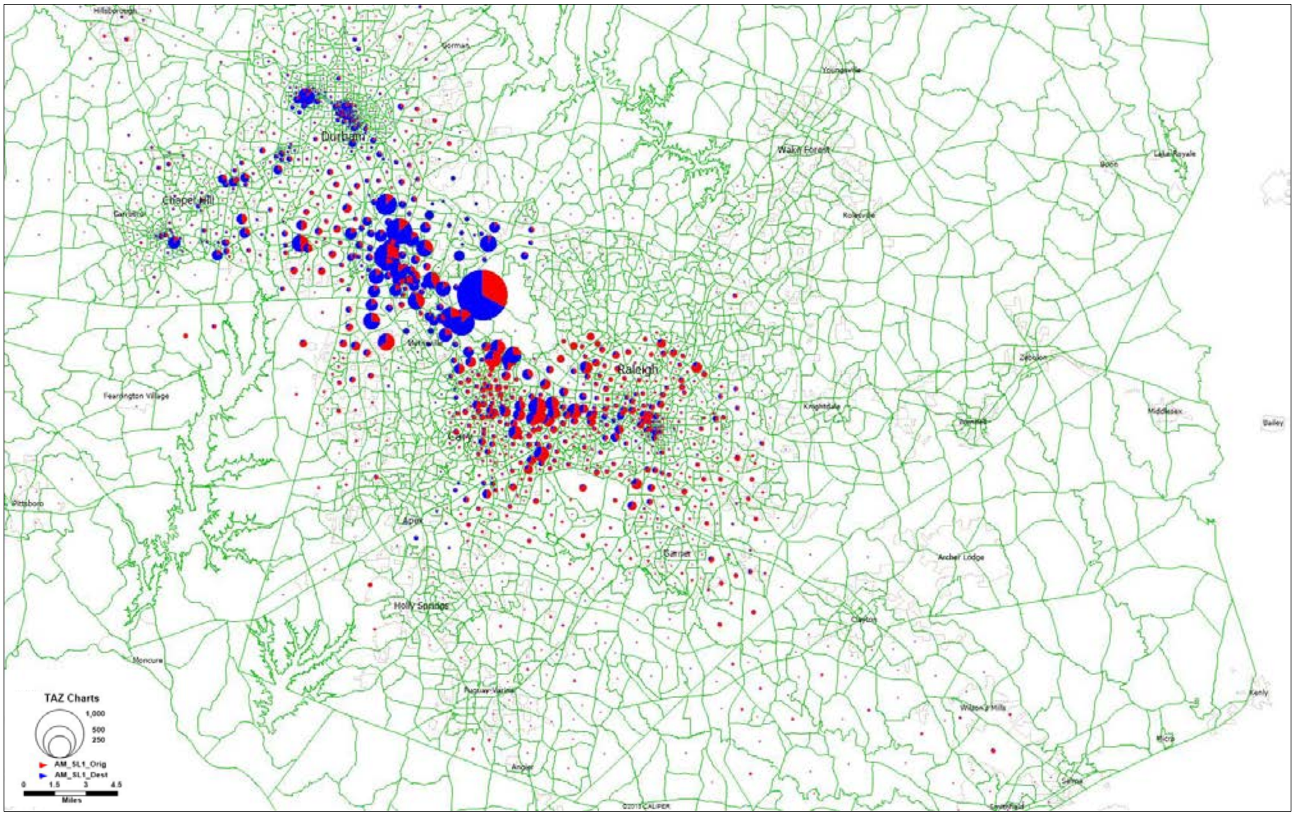
Our observations from these select link analysis reviews are noted in call out texts presented under each of the select-link demand analysis map.

Figure 3.14 Travelshed of I-40, east of I-540 – 2045 AM Peak



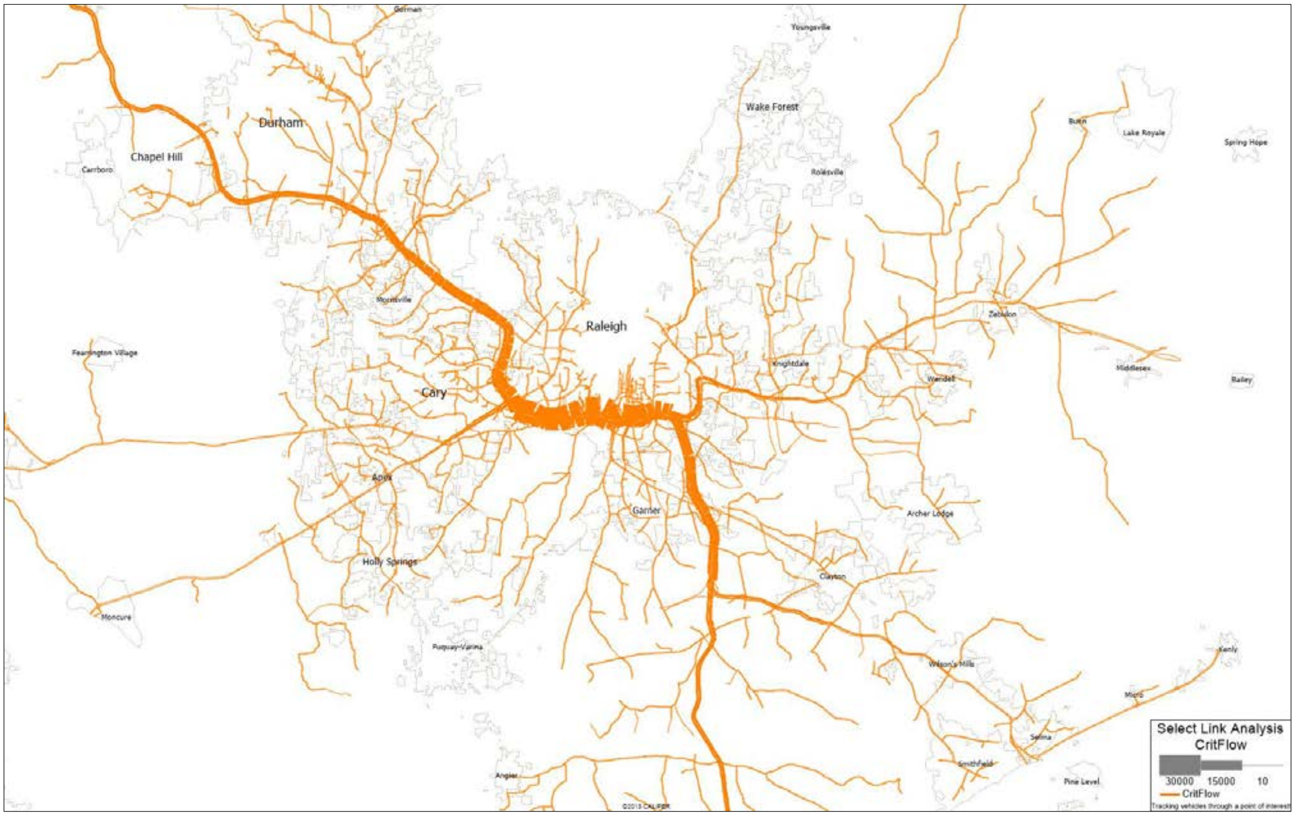
- The I-40 commuter corridor will continue to attract both local and regional trips passing through the area.
- The I-40 segment, located east of I-540, is anticipated to carry mostly commuters from Raleigh, Cary and Johnston County areas into the RTP, RDU airport, Durham, Duke University, and Chapel Hill areas.
- The Travelshed of the I-40 segment located east of I-540 shows long arterial veins in Southwest Wake County, reflecting a dispersed trip distribution pattern in Southwest Wake County for a small number of trips.

Figure 3.15 Trip O-D of I-40, east of I-540 – 2045 AM Peak



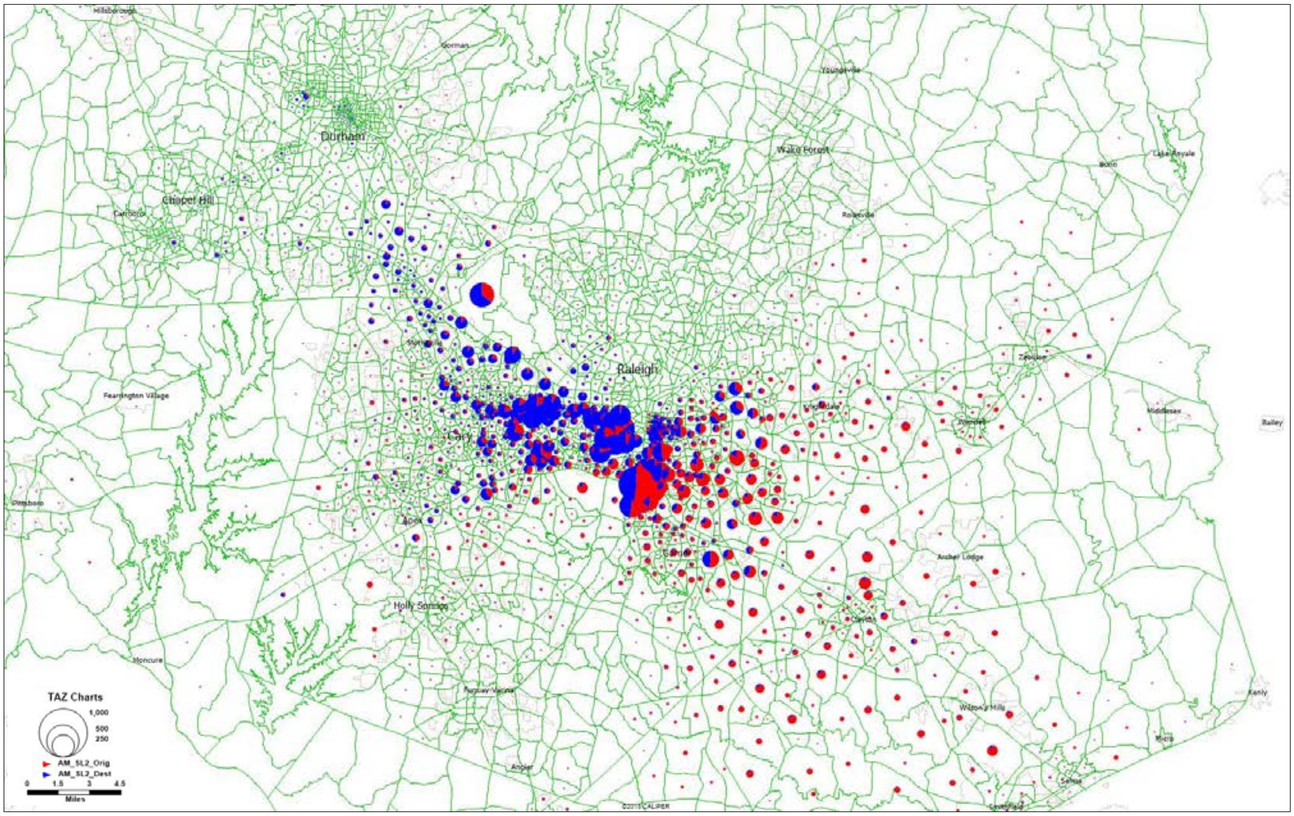
- The I-40 commuter corridor will continue to attract both local and regional trips passing through the area.
- The I-40 segment east of I-540 is anticipated to carry mostly commuters from Raleigh and Cary areas into the RTP, RDU airport, Durham, Duke University, UNC Chapel Hill Hospitals, and other areas along the US 15-501 corridor.

Figure 3.16 Travelshed of I-40, west of US 401 – 2045 AM Peak



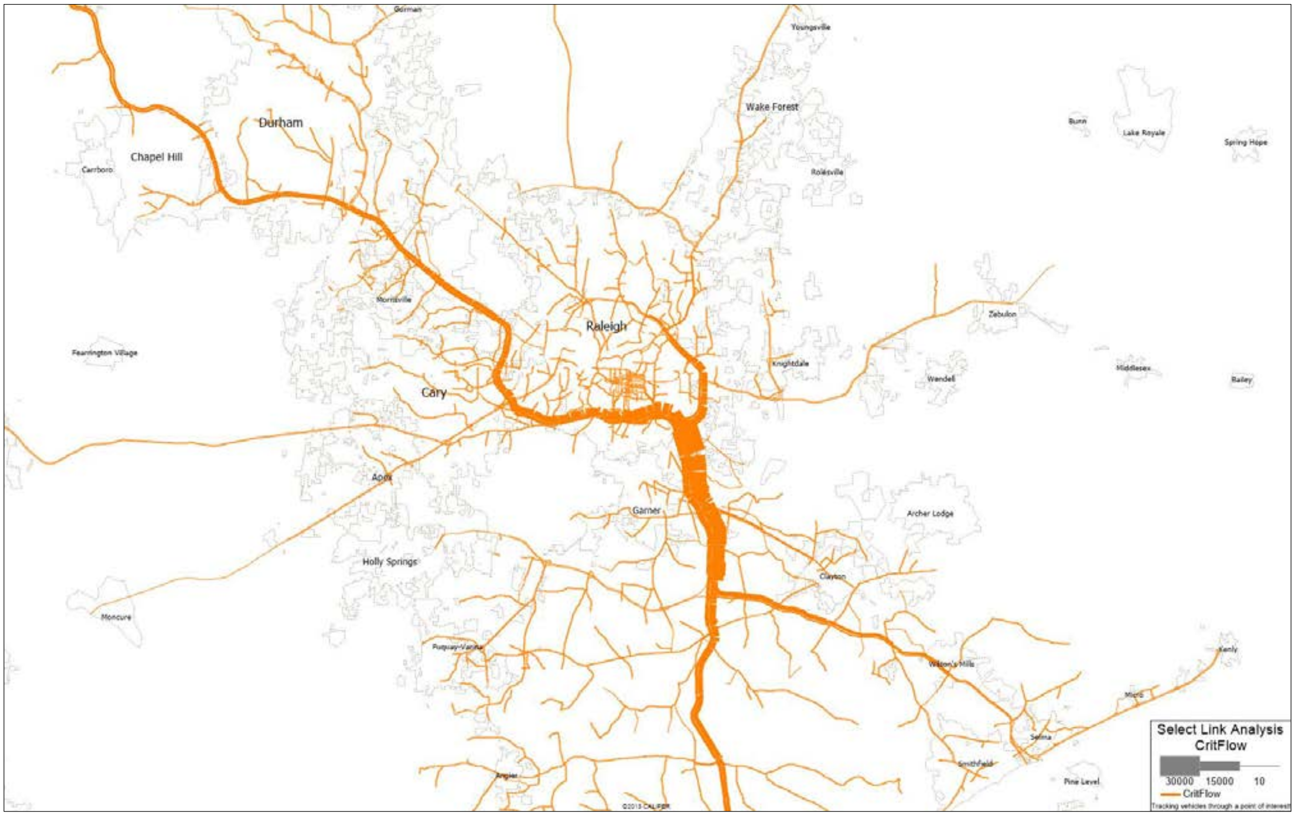
- The I-40 Commuter corridor will continue to attract both local and regional trips passing through the area.
- The I-40 segment, west of US 401, is anticipated to carry mostly commuters from Southeast Raleigh, Garner, Clayton, and Johnston County to NC State, Cary, Morrisville, and RDU airport areas.
- The Travelshed of the I-40 segment located west of US 401 shows long arterial veins in Southwest and Northeast Wake County and in Johnston County, reflecting a dispersed trip distribution pattern in these areas for a small number of trips.

Figure 3.17 Trip O-D of I-40, west of US 401 – 2045 AM Peak



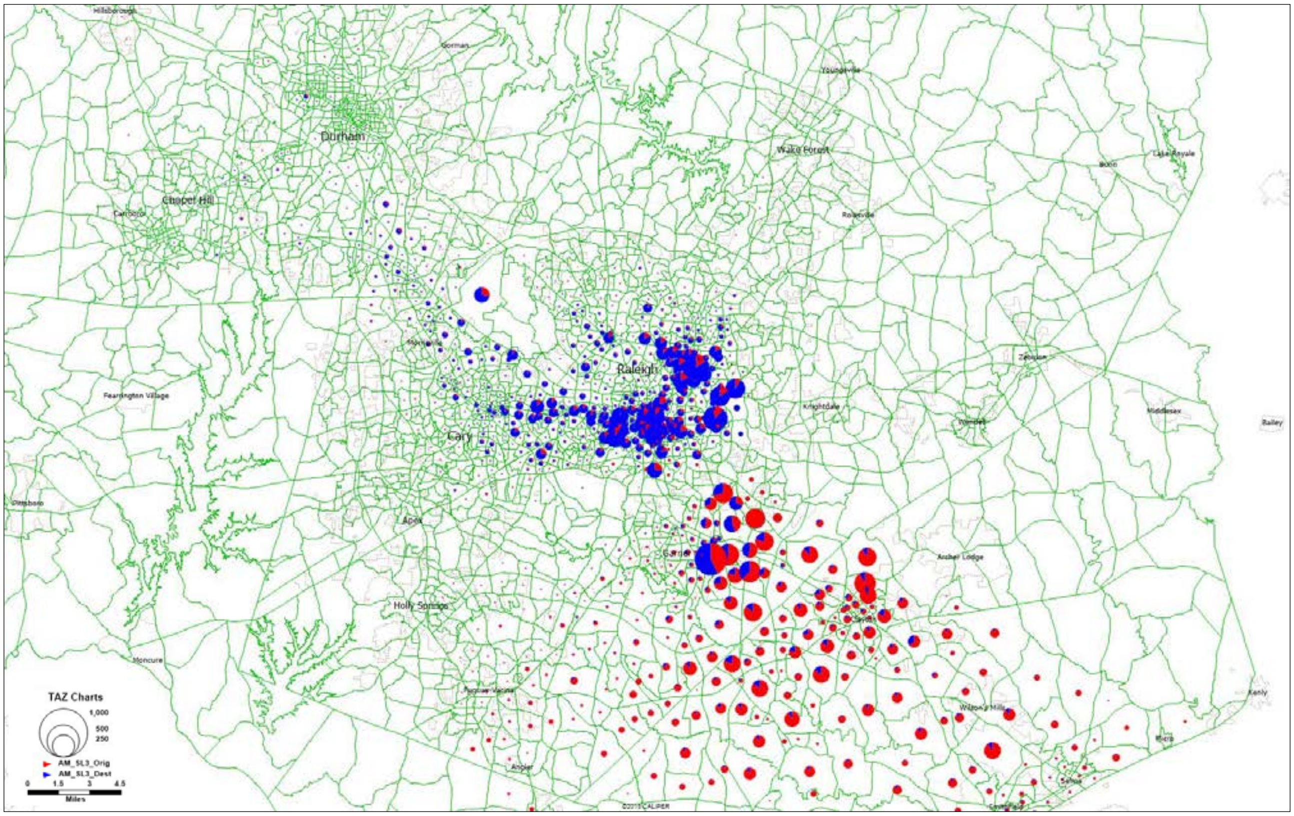
- The I-40 Commuter corridor will continue to attract both local and regional trips passing through the area.
- The I-40 segment west of US 401 is anticipated to carry mostly commuters from Southeast Raleigh, Garner, Clayton, and Johnston County to NC State, Cary, Morrisville, and RDU airport areas.

Figure 3.18 Travelshed of I-40, north of Jones Sausage Road – 2045 AM Peak



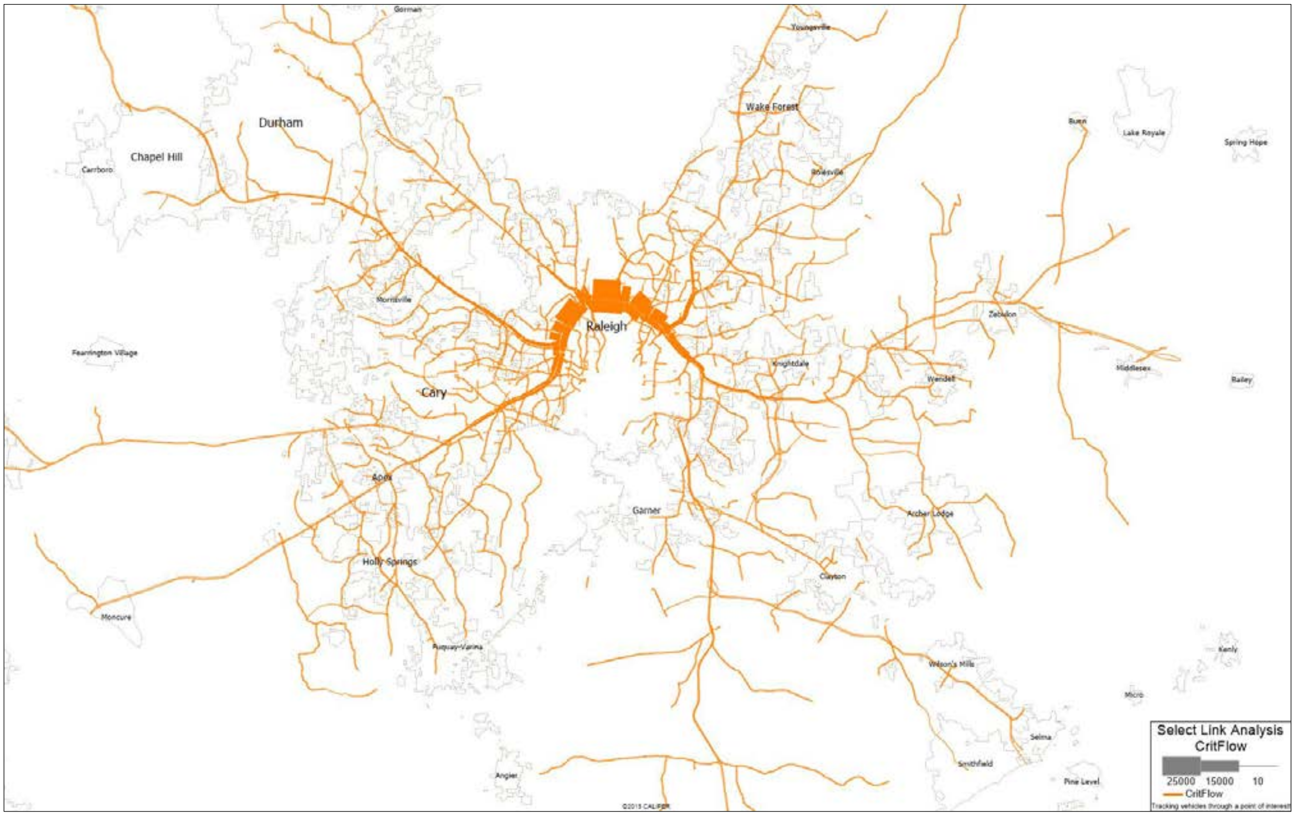
- The I-40 Commuter corridor will continue to attract both local and regional trips passing through the area.
- The I-40 segment, north of Jones Sausage Road, is anticipated to carry mostly commuters from Garner, Clayton, and Johnston County to South Raleigh, East Raleigh and East Cary employment areas.
- The Travelshed of the I-40 segment located north of Jones Sausage Road shows long arterial veins in Johnston County, reflecting a dispersed trip distribution pattern in the area for a small number of trips.

Figure 3.19 Trip O-D of I-40, north of Jones Sausage Road – 2045 AM Peak



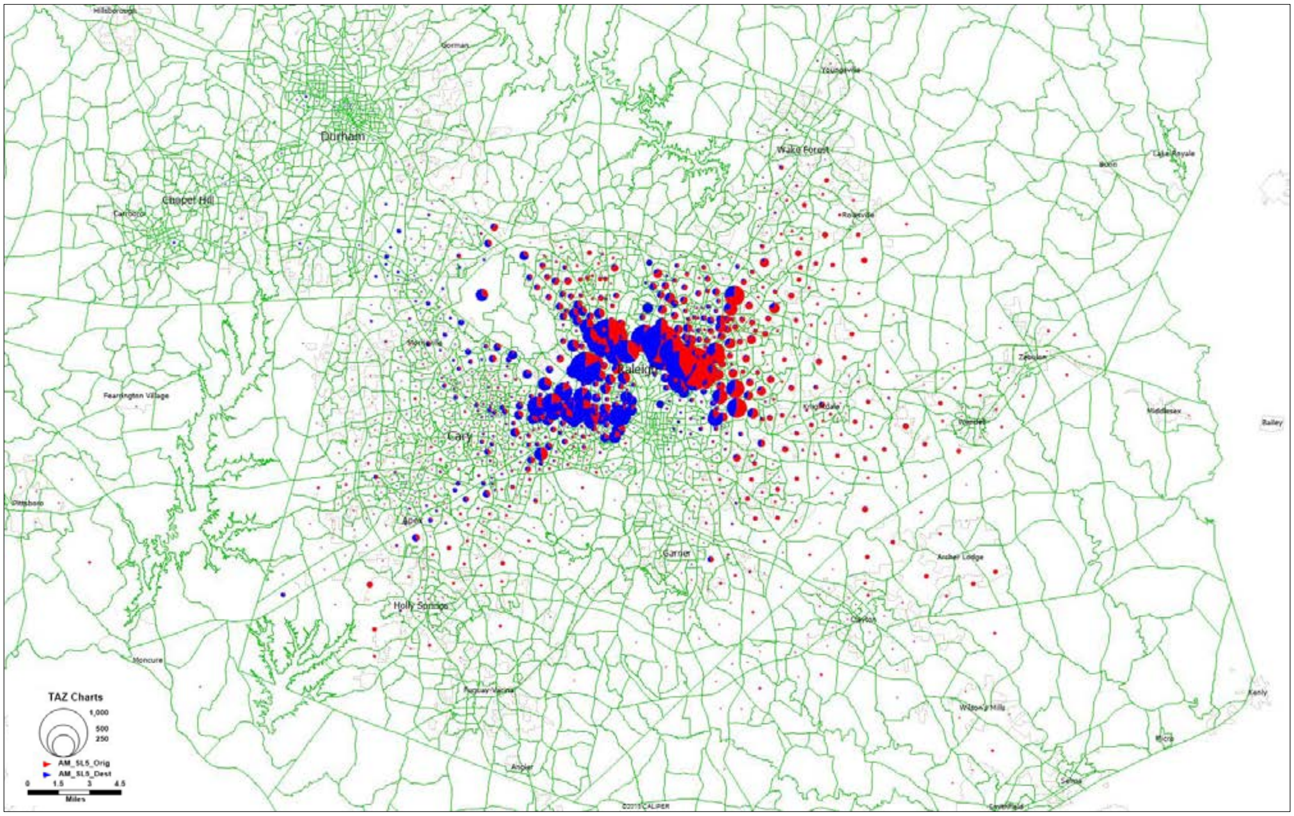
- The I-40 Commuter corridor will continue to attract both local and regional trips passing through the area.
- The I-40 segment west of US 401 is anticipated to carry mostly commuters from Garner, Clayton, and Johnston County to South Raleigh, East Raleigh and East Cary employment areas.

Figure 3.20 Travelshed of I-440, west of Six Forks Road – 2045 AM Peak



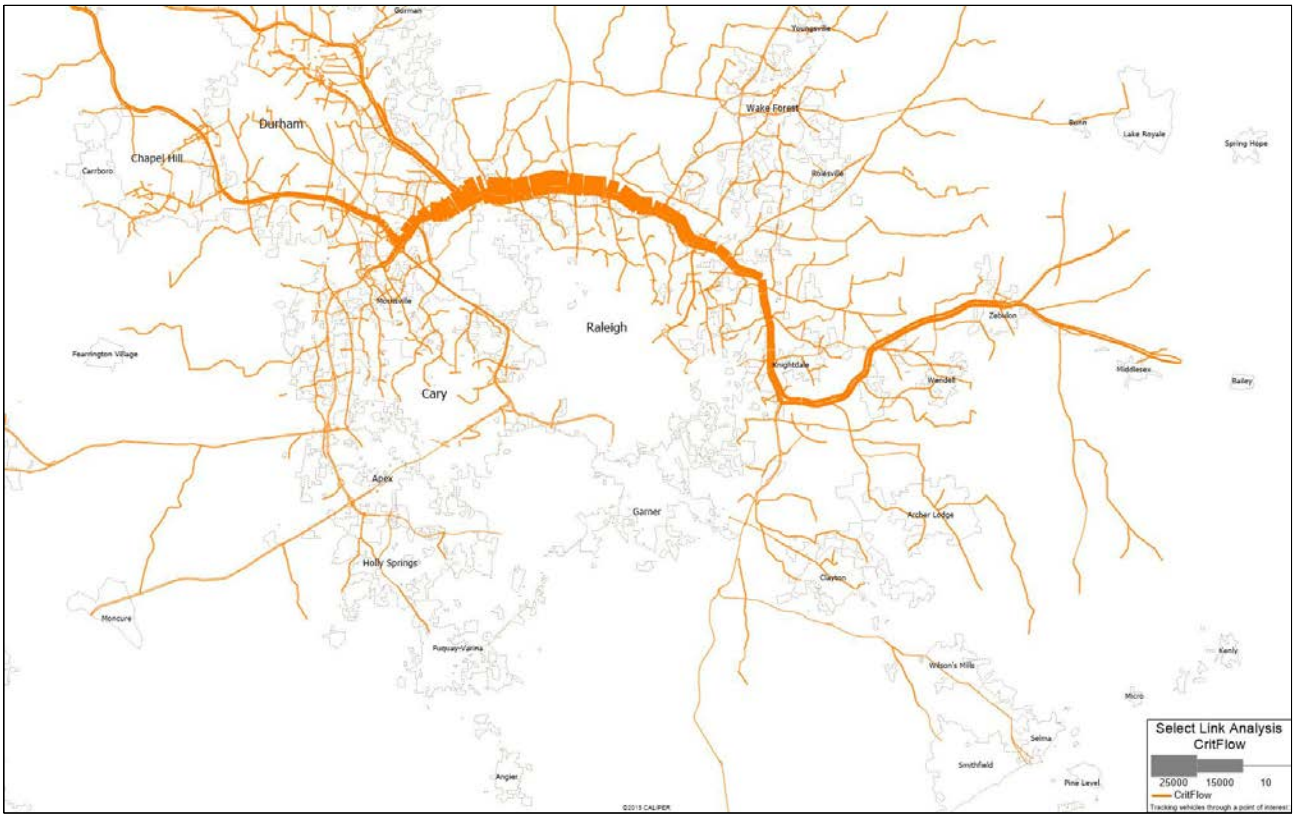
- The I-440 segment, west of Six Forks Road is anticipated to carry mostly commuters from Northeast Raleigh, Knightdale, and Northeast Wake County to North Hills Mall, Crabtree Valley Mall, Blue Ridge Road, Rex Hospital, East Cary and Apex employment areas.
- The Travelshed of the I-440 segment located west of Six Forks Road includes the northern half of the inner beltline and several radial commuter corridors centered around Raleigh (e.g., US 1, US 401, US 64, and US 70).
- The Travelshed of the I-40 segment located west of Six Forks Road shows long arterial veins in Southwest Wake County, reflecting a dispersed trip distribution pattern in the area for a small number of trips.

Figure 3.21 Trip O-D of I-440, west of Six Forks Road – 2045 AM Peak



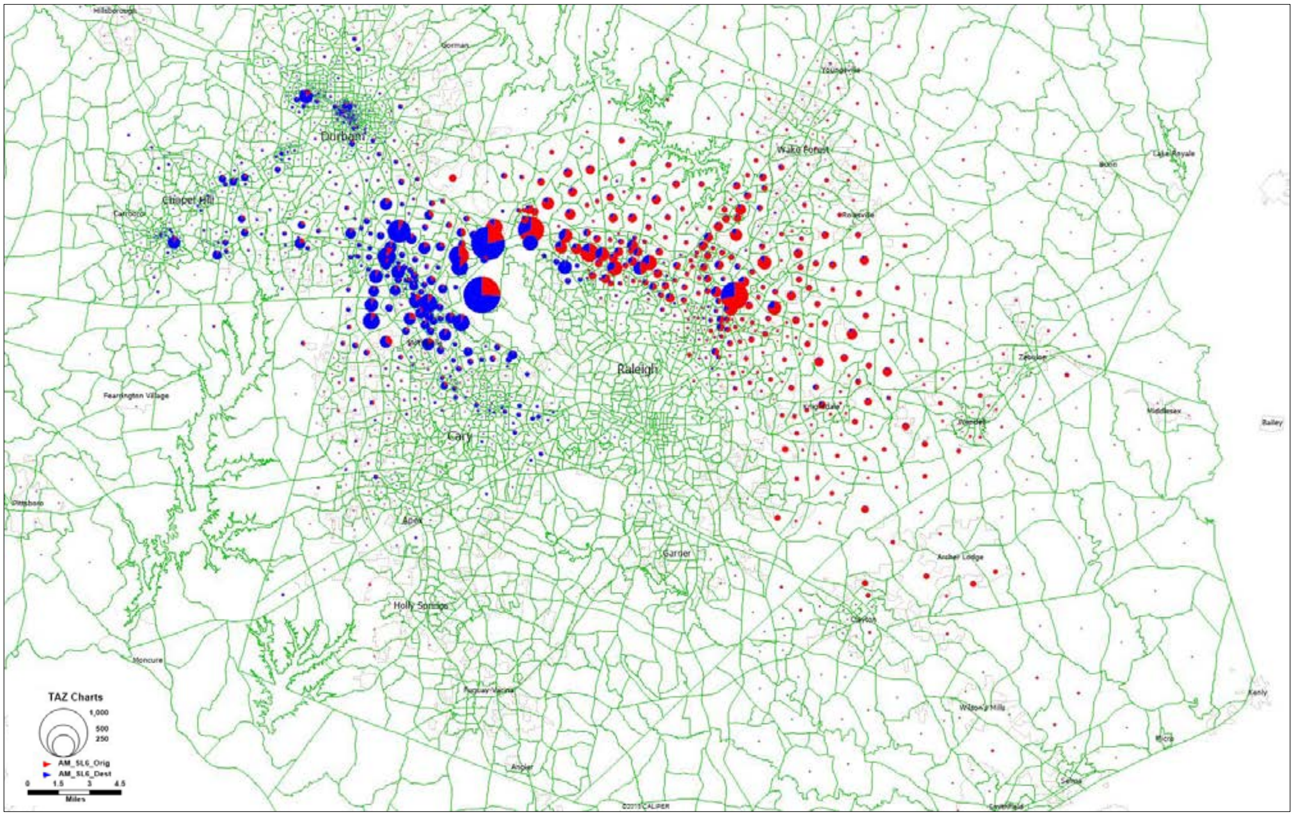
- The I-440 segment, west of Six Forks Road is anticipated to carry mostly commuters from Northeast Raleigh, Knightdale, and Northeast Wake County to North Hills Mall, Crabtree Valley Mall, Blue Ridge Road, Rex Hospital, East Cary, and Apex employment areas.

Figure 3.22 Travelshed of I-540, east of US 70 – 2045 AM Peak



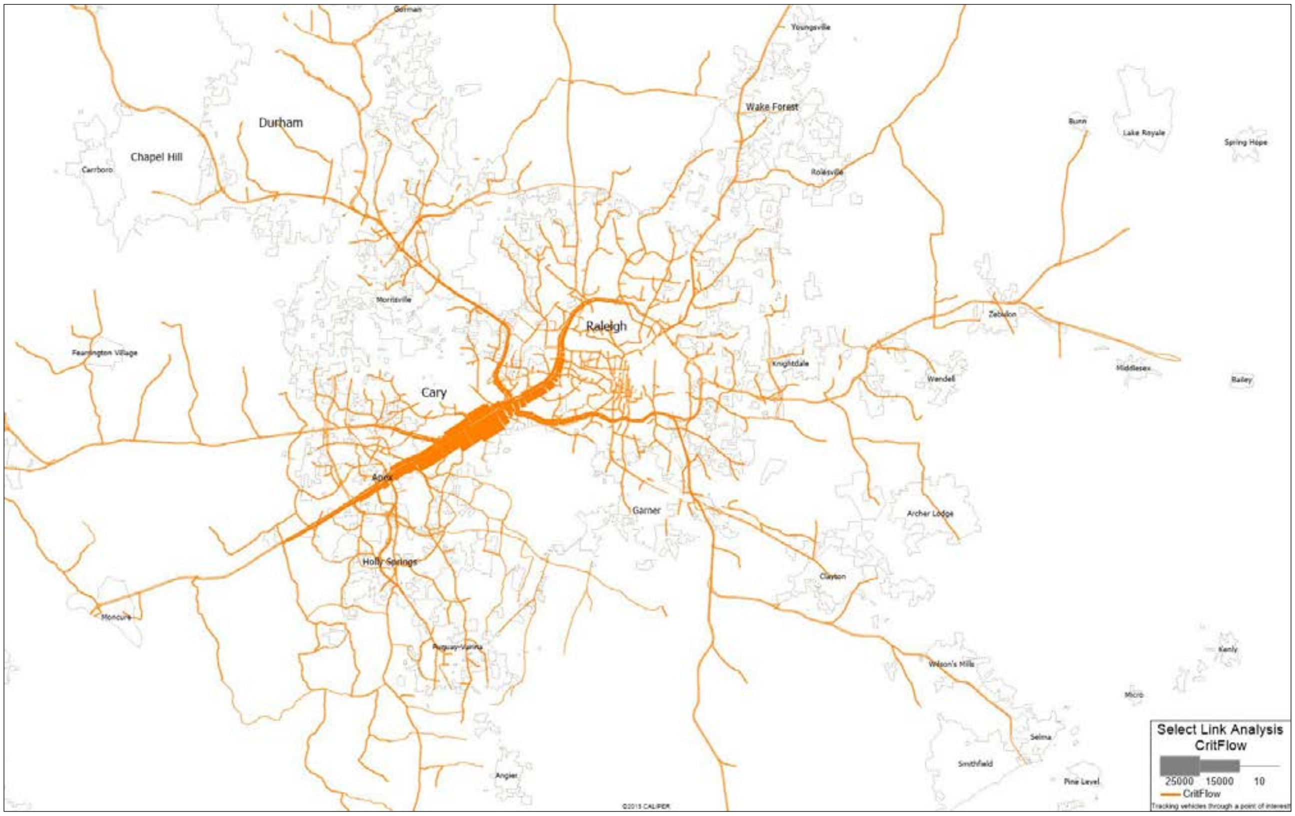
- The I-540 segment located east of US 70 will continue to attract both local and regional trips passing through the area.
- The I-540 segment located east of US 70 is anticipated to carry mostly commuters from North Raleigh, Wake Forest, Rolesville, and Knightdale areas to the RTP, RDU airport, Durham, and Chapel Hill employment areas.
- The Travelshed of the I-540 segment located east of US 70 show long arterial veins in Northeast Wake County that reflects a dispersed trip distribution pattern in the area for a small number of trips.

Figure 3.23 Trip O-D of I-540, east of US 70 – 2045 AM Peak



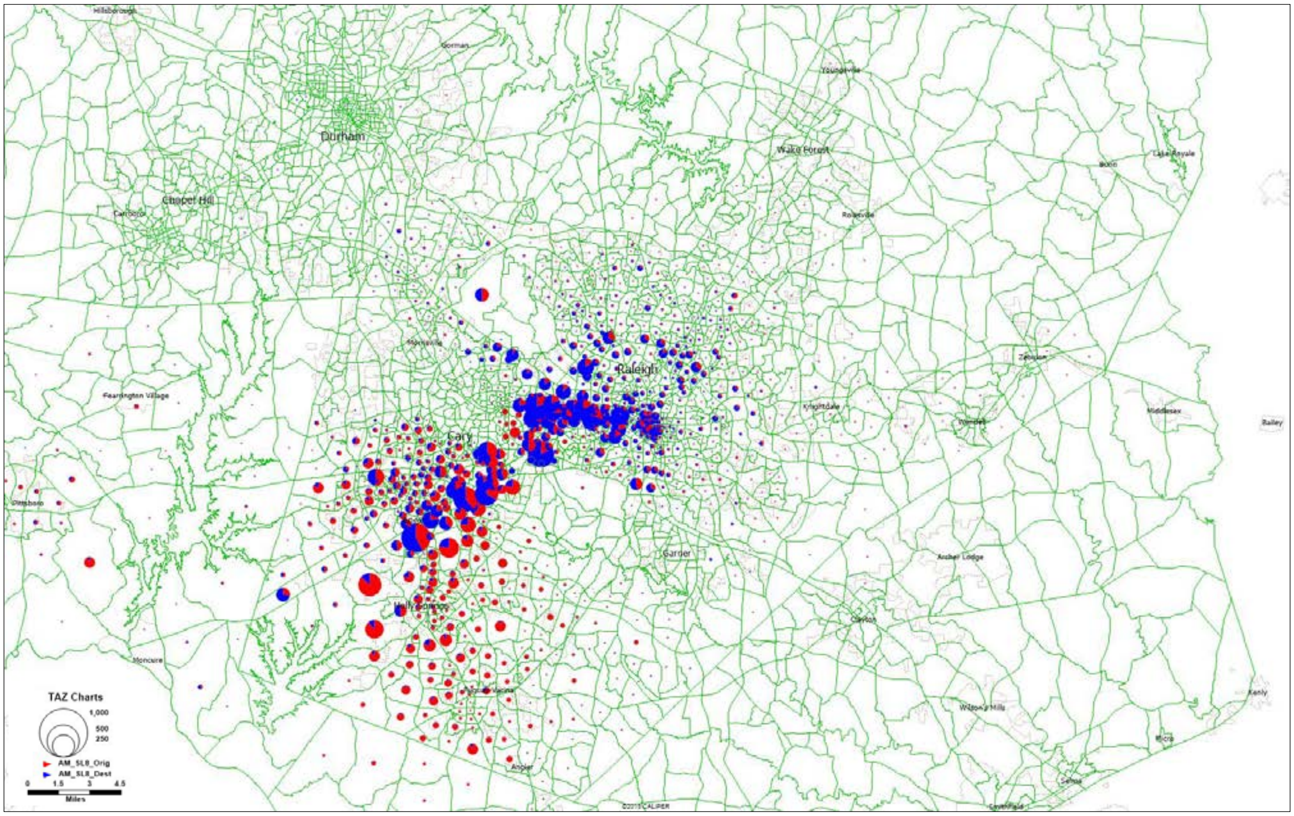
- The I-540 segment located east of US 70 will continue to attract both local and regional trips passing through the area.
- The I-540 segment located east of US 70 is anticipated to carry mostly commuters from North Raleigh, Wake Forest, Rolesville, and Knightdale areas to the RTP, RDU airport, Durham, and Chapel Hill employment areas.

Figure 3.24 Travelshed of US 1, west of I-40 – 2045 AM Peak



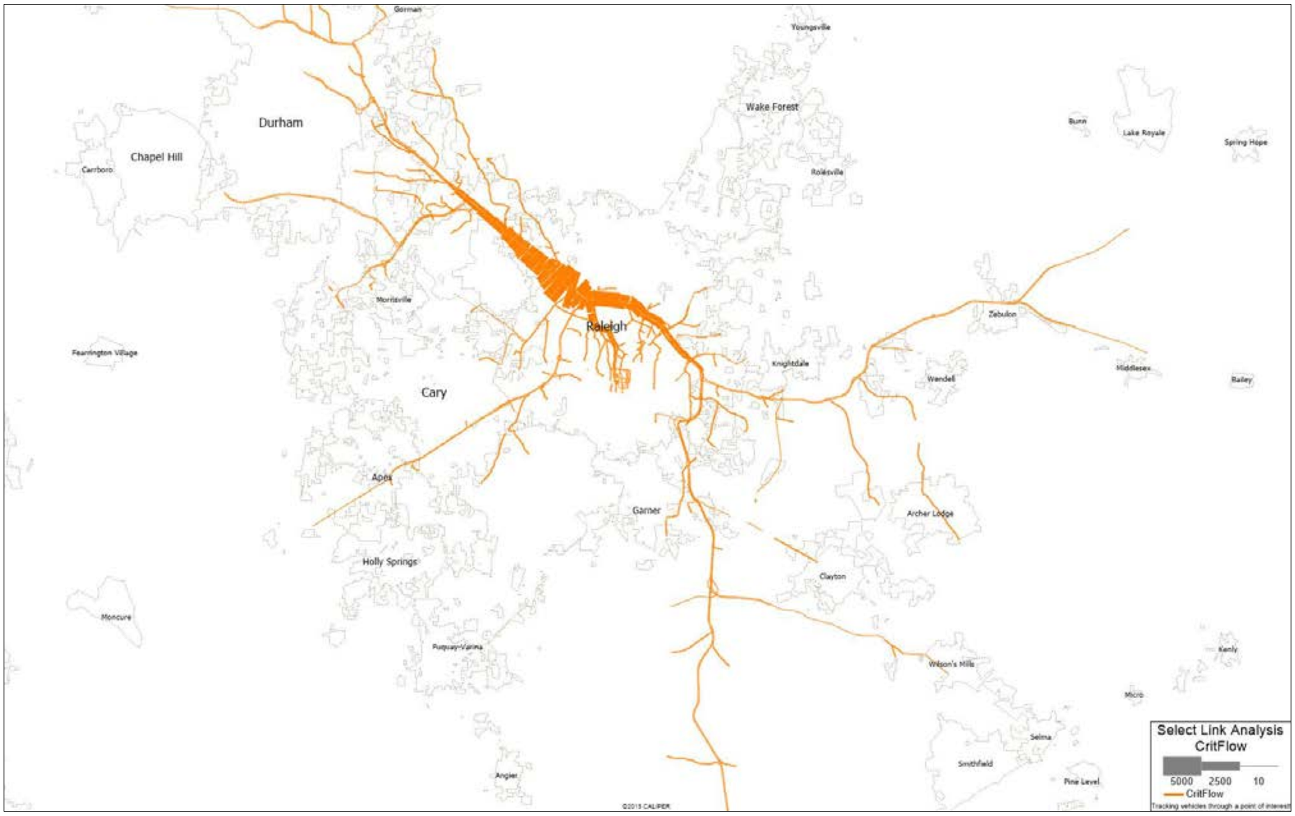
- The US 1 segment located west of I-40 in Cary is anticipated to carry mostly commuters from Southeast Wake County to downtown Raleigh, NC State, and North Raleigh employment areas.
- The Travelshed of the US 1 segment west of I-40 shows long arterial veins in Apex, Holly Springs and Fuquay Varina reflecting a larger draw area for the US 1 corridor from existing and future residential communities (such as Veridea).

Figure 3.25 Trip O-D of US 1, west of I-40 – 2045 AM Peak



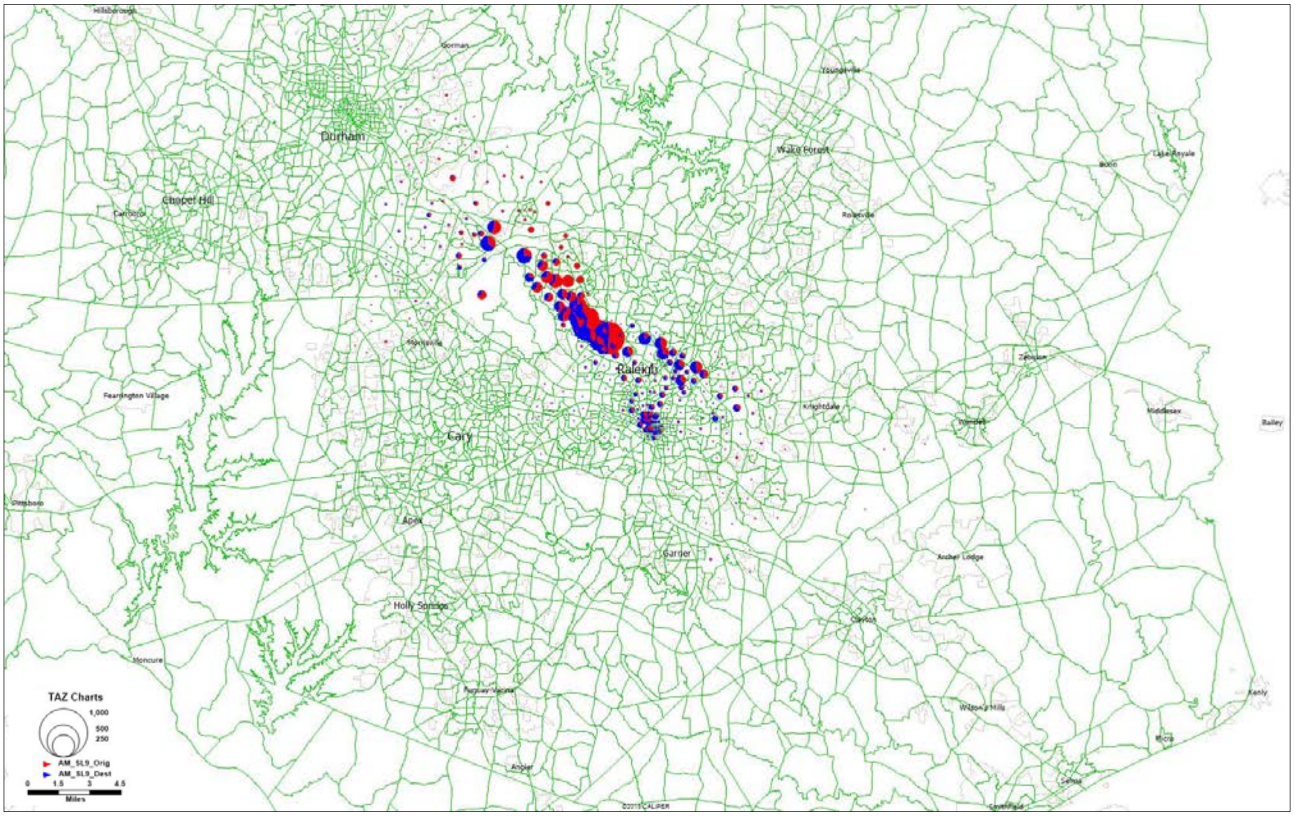
- The US 1 segment located west of I-40 in Cary is anticipated to carry mostly commuters from Southeast Wake County to downtown Raleigh, NC State, and North Raleigh employment areas.
- This corridor segment also provides connectivity to the US 64 corridor to/from Chatham County.

Figure 3.26 Travelshed of US 70 (Glenwood Avenue), west of NC 50 – 2045 AM Peak



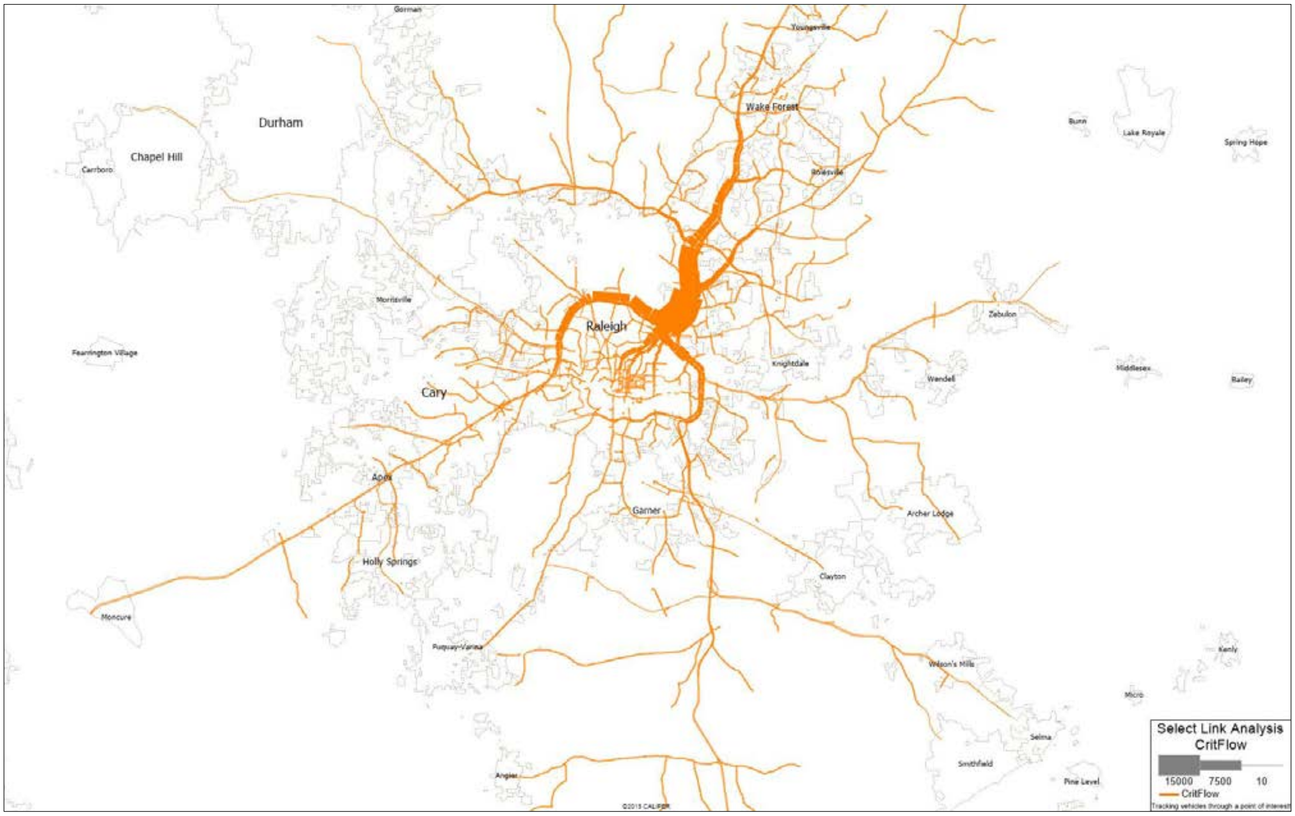
- The US 70 segment located west of NC 50 near Crabtree Valley Mall is anticipated to carry mostly commuters from Durham, Brier Creek area, and RDU airport area to Crabtree Valley Mall and downtown Raleigh employment areas.
- The Travelshed shows long freeway veins along I-40 and I-87, reflecting the corridor's importance as the connector roadway between the region's two other freeways namely I-85 and I-95.

Figure 3.27 Trip O-D of US 70 (Glenwood Avenue), west of NC 50 – 2045 AM Peak



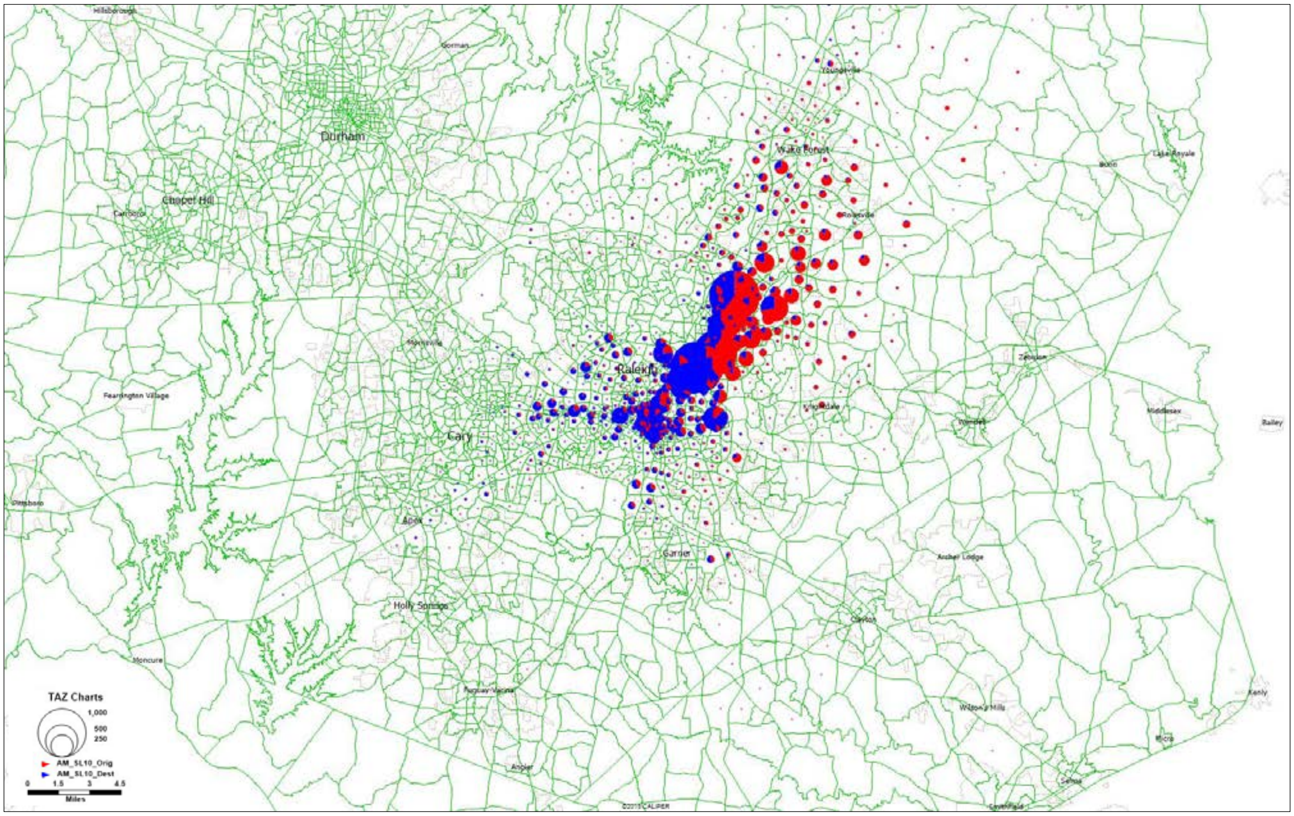
- The US 70 segment located west of NC 50 near Crabtree Valley Mall is anticipated to carry mostly commuters from Durham, Brier Creek area, and RDU airport area to Crabtree Valley Mall and downtown Raleigh employment areas.

Figure 3.28 Travelshed of US 1 (Capital Blvd), north of I-440 – 2045 AM Peak



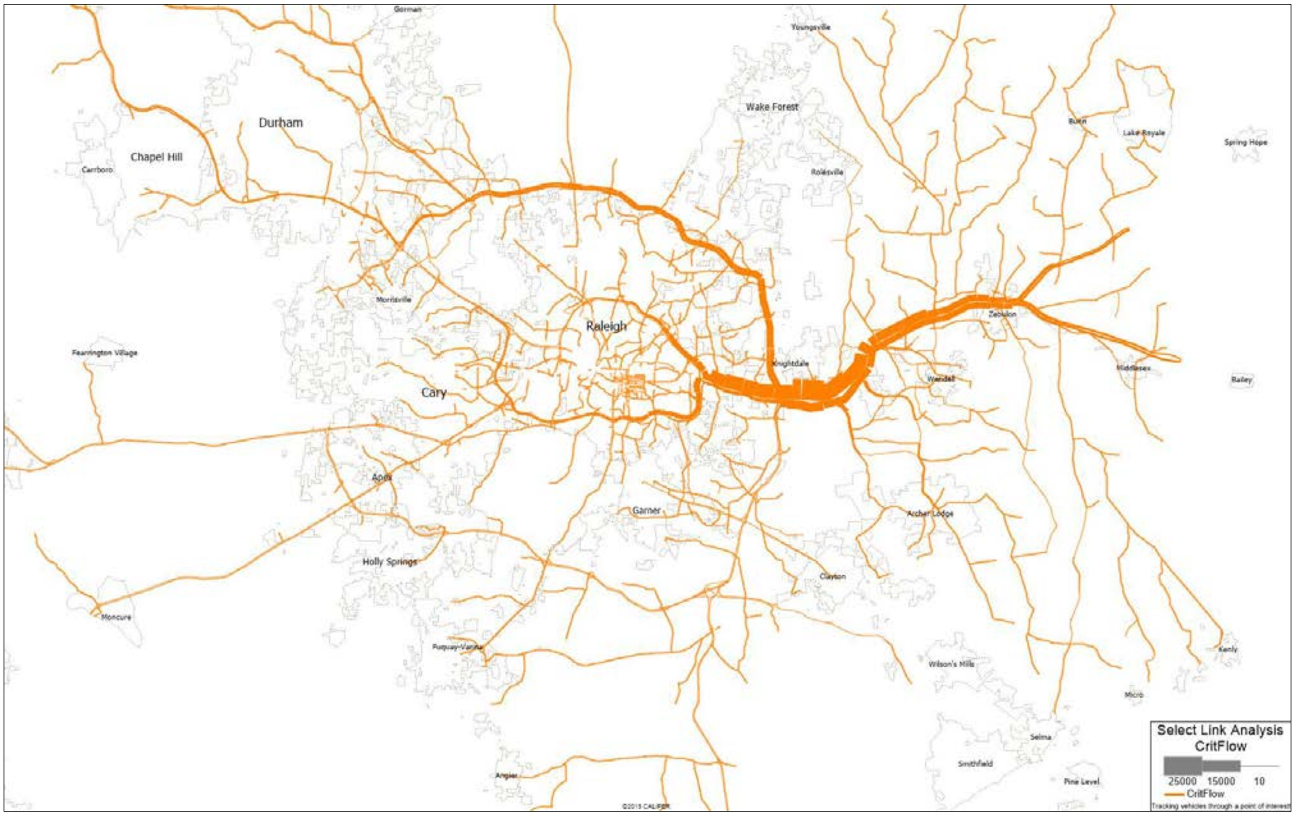
- The US 1 (Capital Blvd) segment located north of I-440 is anticipated to carry mostly commuters living inside the Inner Beltline and in east Cary to employment areas located along the Capital Blvd corridor, and in Wake Forest and Youngsville.
- The US 1 (Capital Blvd) Travelshed shows long arterial veins in Southeast Wake County reflecting a smaller draw of. trips scattered from a larger area.

Figure 3.29 Trip O-D of US 1 (Capital Blvd), north of I-440 – 2045 AM Peak



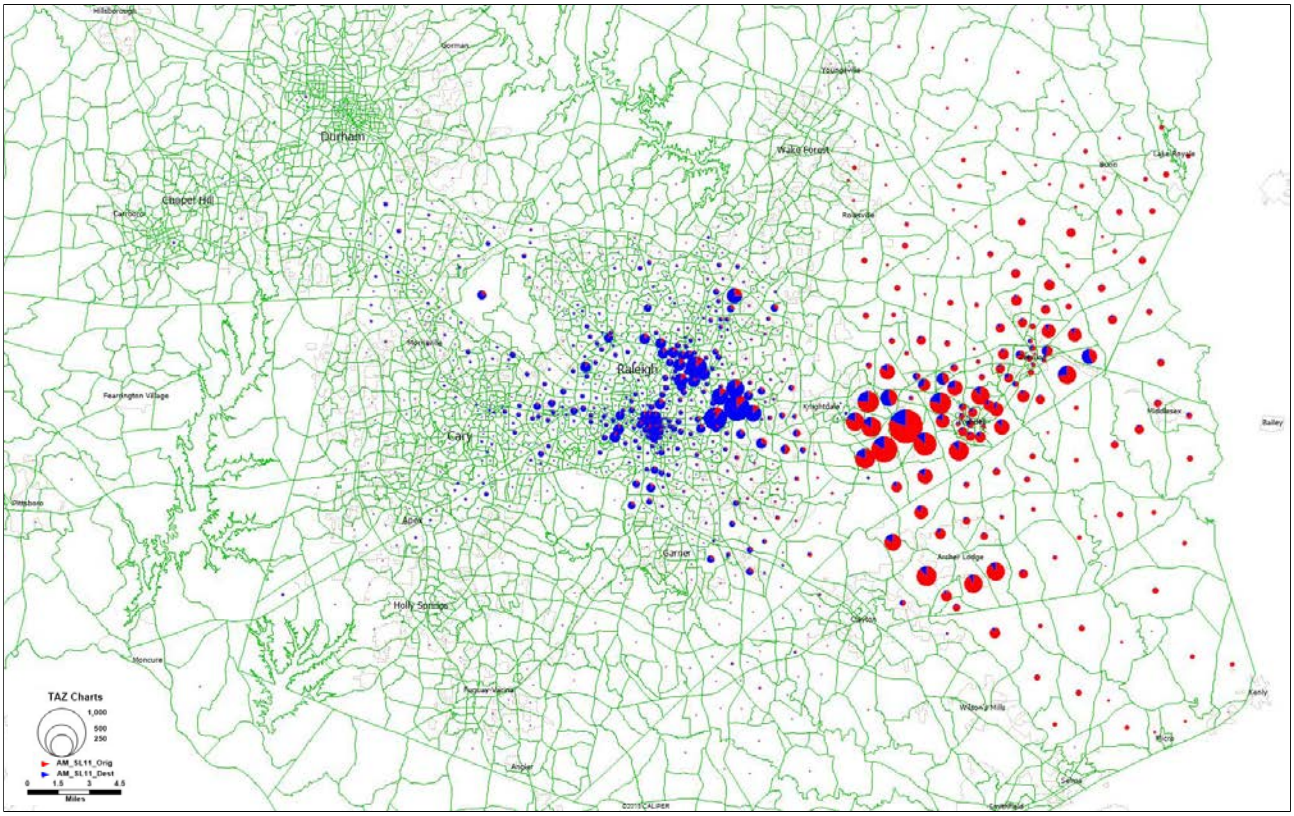
- The US 1 (Capital Blvd) segment located north of I-440 is anticipated to carry mostly commuters living inside the Inner Beltline and in east Cary to employment areas located along the Capital Blvd corridor, and in Wake Forest and Youngsville.

Figure 3.30 Travelshed of I-87, east of I-540 – 2045 AM Peak



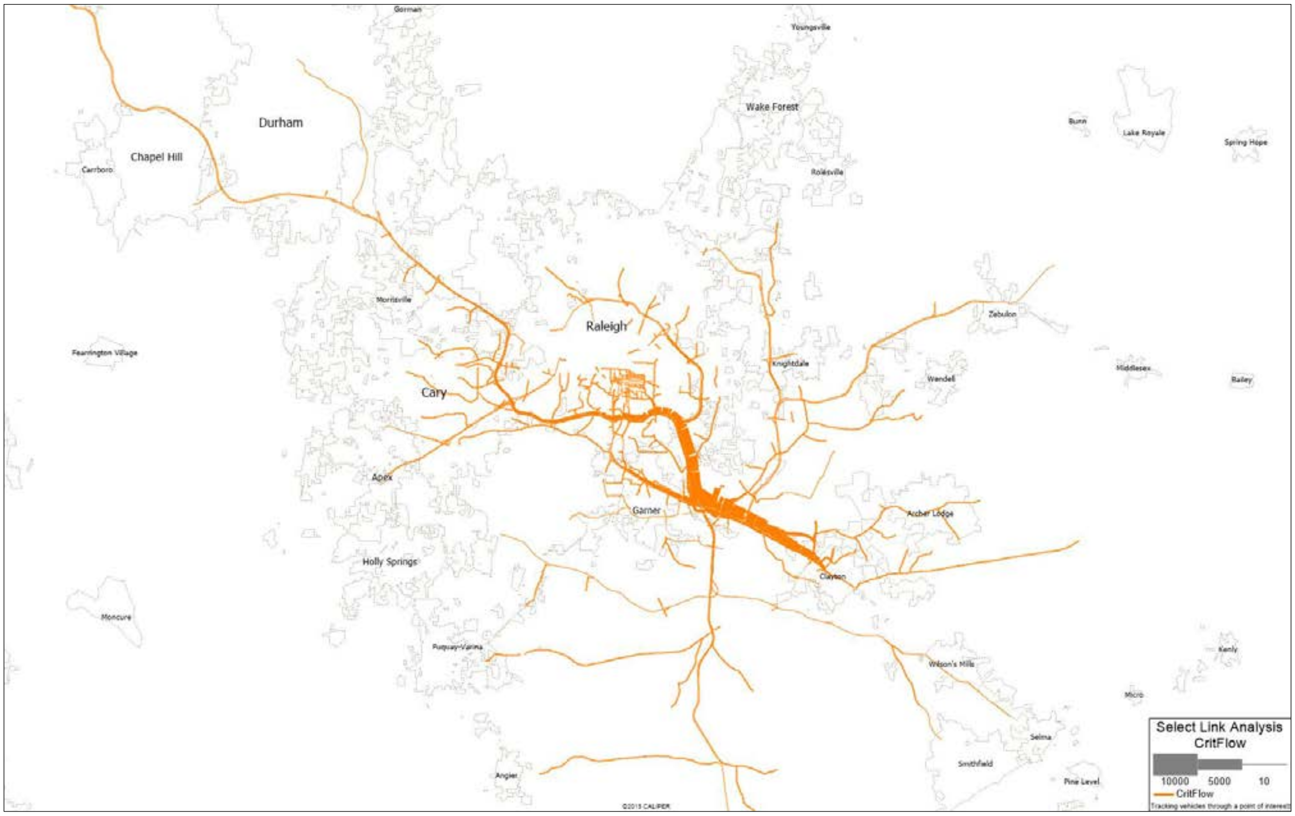
- The I-87 segment located east of I-540 is anticipated to carry mostly commuters living in Knightdale, Wendell, Zebulon and Archer's Lodge areas to employment areas located in East Raleigh, downtown Raleigh, and South Raleigh.
- The I-87 Travelshed shows long arterial veins north and south of the I-87 corridor reflecting a larger draw of. trips from East Wake County and North Johnston County.

Figure 3.31 Trip O-D of I-87, east of I-540 – 2045 AM Peak



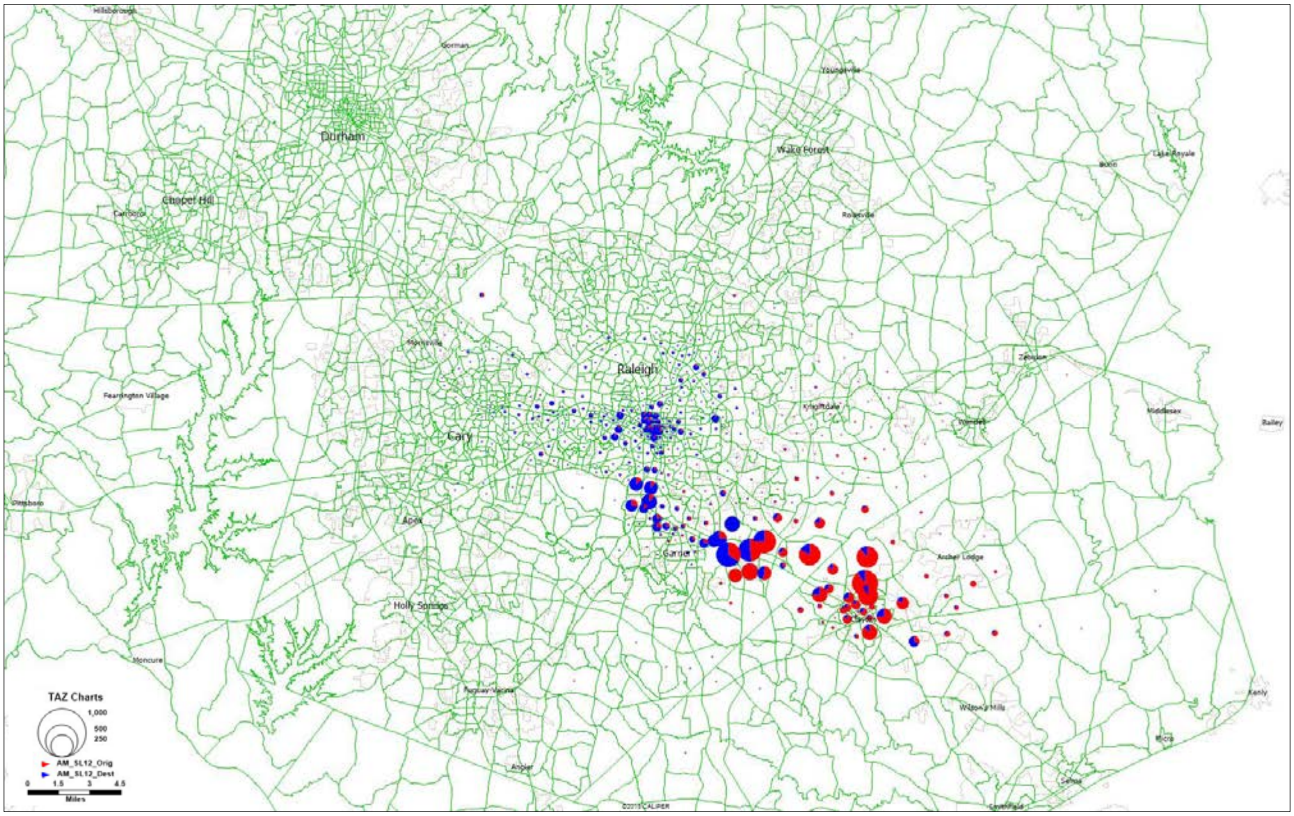
- The I-87 segment located east of I-540 is anticipated to carry mostly commuters living in Knightdale, Wendell, Zebulon and Archer's Lodge areas to employment areas located in East Raleigh, downtown Raleigh, and South Raleigh.

Figure 3.32 Travelshed of US 70 (Clayton Bypass), east of I-40 – 2045 AM Peak



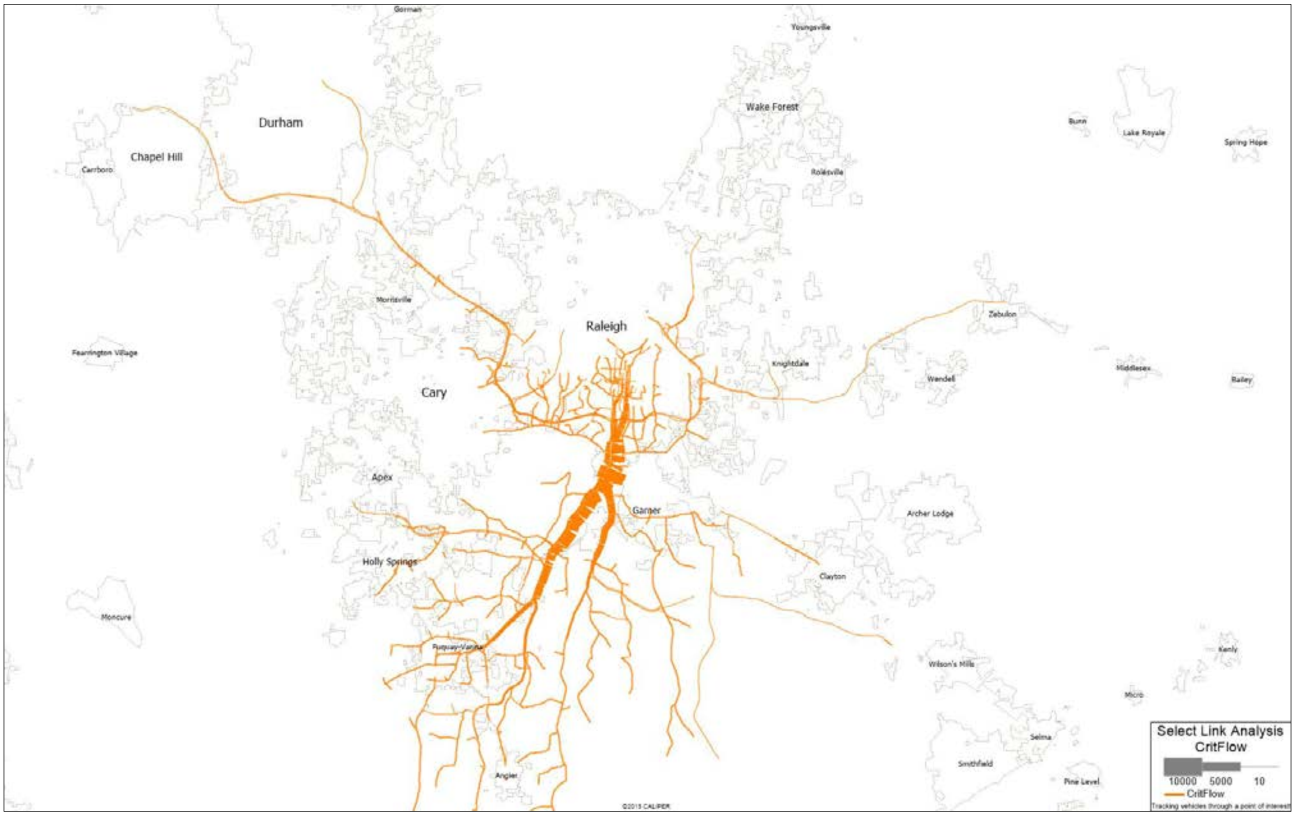
- The US 70 (Clayton Bypass) segment located east of I-40 is anticipated to carry mostly commuters living in east Garner and Clayton areas to employment areas located in South Raleigh, downtown Raleigh, and NC State University.
- The US 70 (Clayton Bypass) Travelshed shows long freeway veins along I-40 and I-87 reflecting some long-distance inter-regional trips along the corridor.

Figure 3.33 Trip O-D of US 70 (Clayton Bypass), east of I-40 – 2045 AM Peak



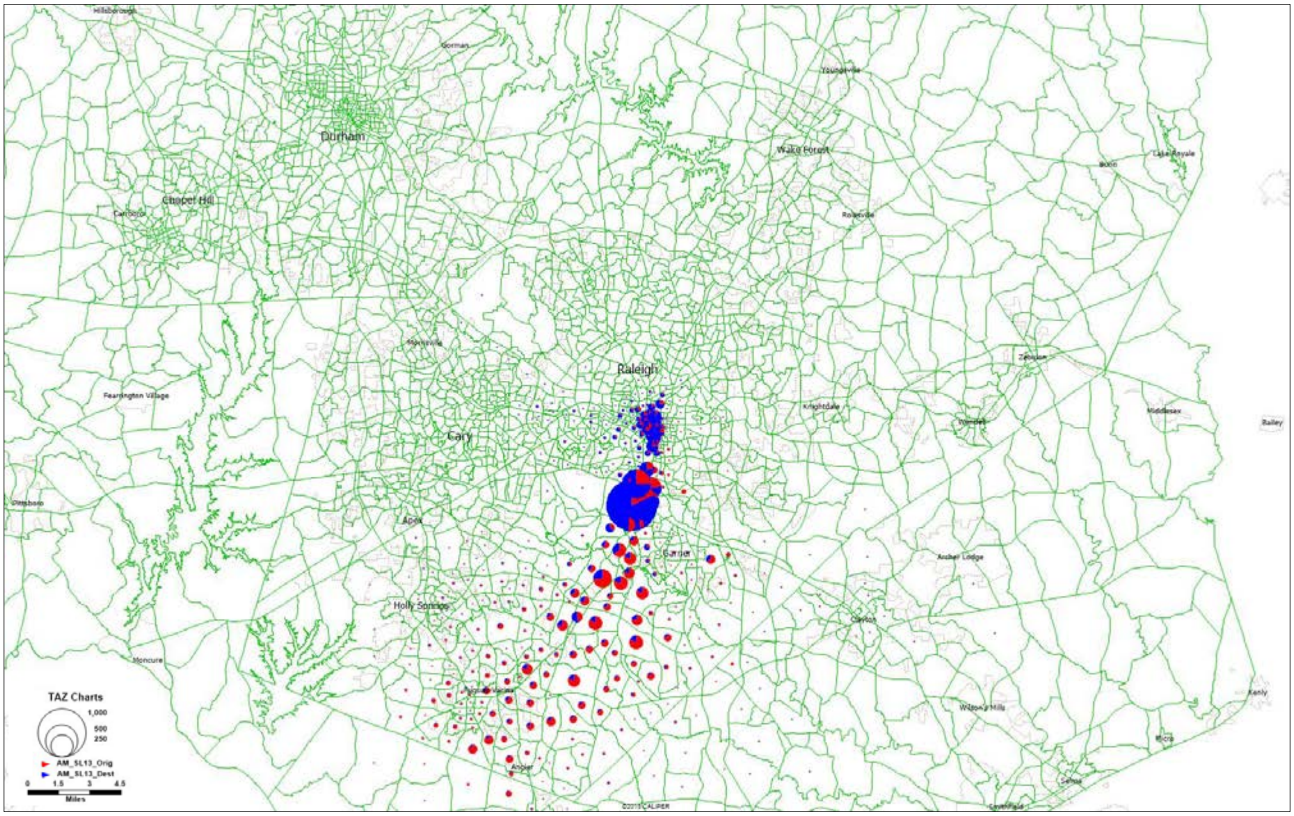
- The US 70 (Clayton Bypass) segment located east of I-40 is anticipated to carry mostly commuters living in east Garner and Clayton areas to employment areas located in South Raleigh, downtown Raleigh, and NC State University.

Figure 3.34 Travelshed of US 401 (Fayetteville Road), south of US 70 – 2045 AM Peak



- The US 401 (Fayetteville Road) segment located south of US 70 is anticipated to carry mostly commuters living along the corridor in Fuquay Varina and Angier to employment areas located in the Walmart Supercenter commercial area, Garner Town Square, downtown Raleigh, and Cameron Village areas.
- The US 401 (Fayetteville Road) Travelshed shows long freeway veins along I-40 and I-87 reflecting some long-distance inter-regional trips along the corridor.
- The US 401 (Fayetteville Road) Travelshed also shows long arterial veins in Fuquay Varina reflecting larger draw area from the residential suburban communities.

Figure 3.35 Trip O-D of US 401 (Fayetteville Road), south of US 70 – 2045 AM Peak



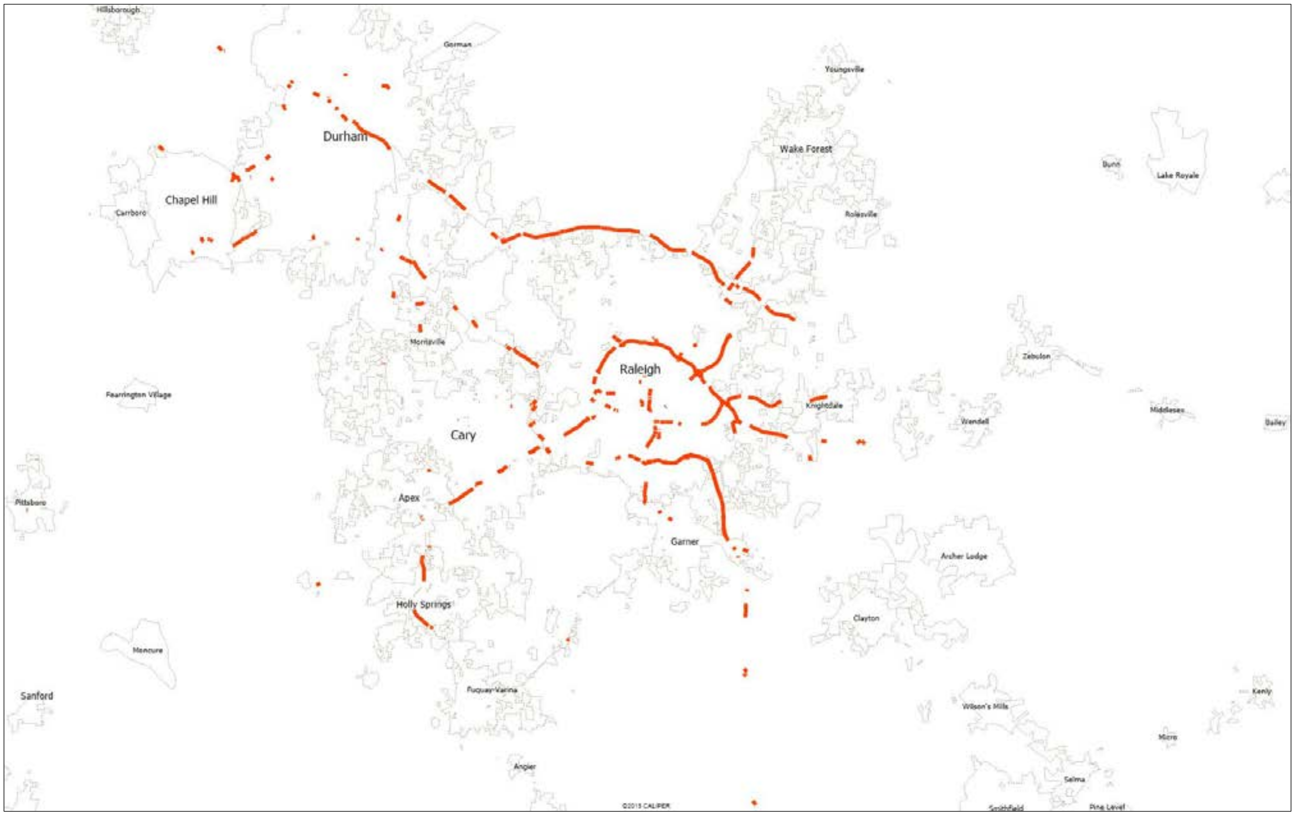
- The US 401 (Fayetteville Road) segment located south of US 70 is anticipated to carry mostly commuters living along the corridor in Fuquay Varina and Angier to employment areas located in the Walmart Supercenter commercial area, Garner Town Square, downtown Raleigh, and Cameron Village areas.

3.5 Traffic Congestion Measures

The future year analysis relied on the standard traffic congestion measure that is computed as the Volume over Capacity (VOC) ratio during AM and PM peak period commuting times. These AM and PM peak period VOCs were computed using the anticipated 2045 travel demand for the Adopted MTP highway network. When the peak period VOCs exceed 1.0, travel conditions are expected to worsen and traffic congestion are expected to build up from moderate slow down to crawl conditions.

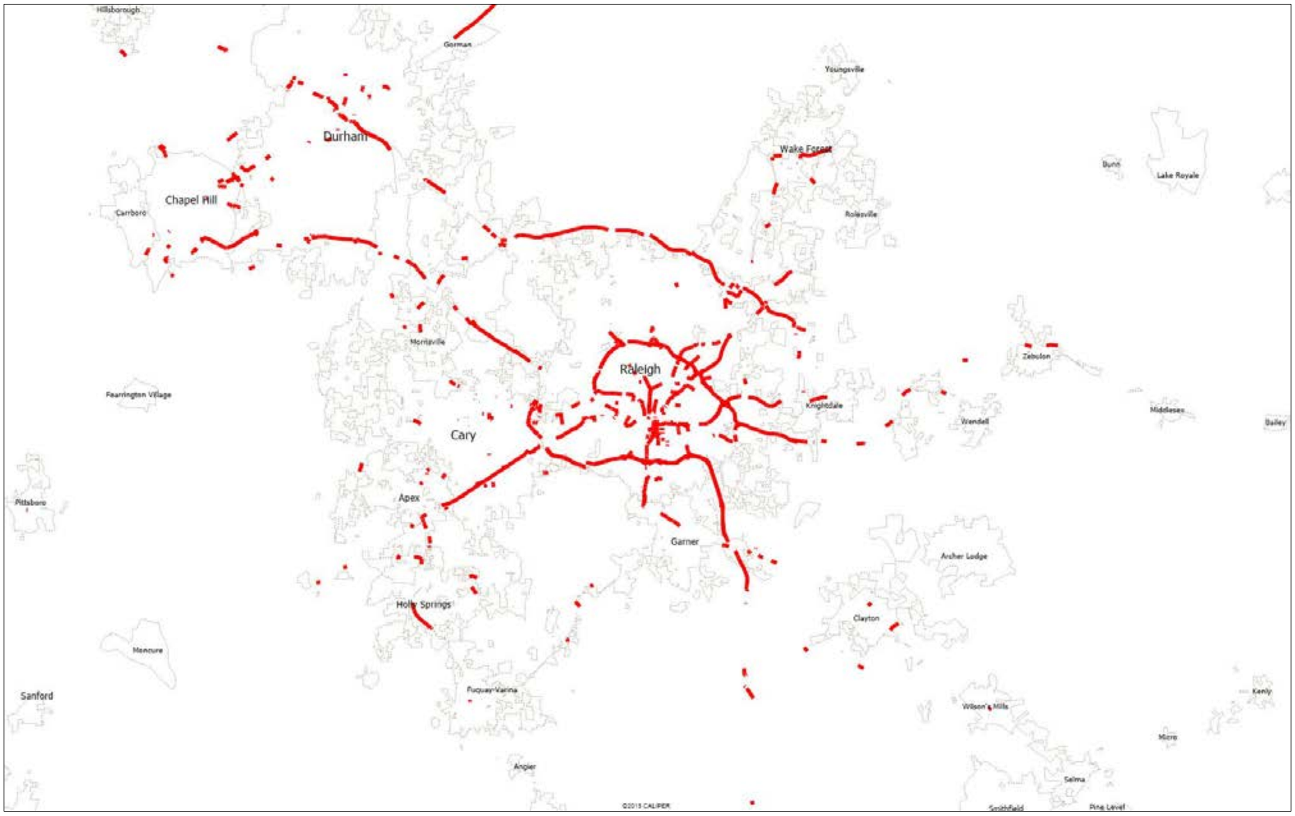
The roadway segments that are forecast to experience moderate to high traffic congestion in a recurrent basis during the AM peak period are depicted in Figure 3.36. Similarly, the roadway segments that are forecast to experience moderate to high traffic congestion in a recurrent basis during the PM peak period are depicted in Figure 3.37.

Figure 3.36 2045 Adopted MTP – Roadway Segments with AM Peak Period VOC 1.0 or Higher



Source: TRMV6 – 2045 Adopted MTP Highway Network

Figure 3.37 2045 Adopted MTP – Roadway Segments with PM Peak Period VOC 1.0 or Higher



Source: TRMV6 – 2045 Adopted MTP Highway Network

3.6 Mobility Trends

This section briefly discusses future mobility trends that are likely to influence traffic congestion in the future. These emerging mobility solutions are technology-and service driven that have the potential to reduce traffic congestion, but can also be disruptive to future mobility conditions. In ideal conditions, these future mobility solutions have the potential to move people and goods through our region more efficiently, more safely, more affordably, and more equitably. Therefore, it is imperative that the Capital Area MPO takes small-scale pilot initiatives to understand these trends and incorporate adaptive strategies to integrate these future mobility solutions in preparing the 2050 MTP. These future mobility solutions are discussed next.

3.6.1 Connected/Autonomous Vehicles (CAVs)

Car manufacturers will soon launch the next generation of CAVs that can free up driver's time to do other activities while commuting. Initially, these CAVs are expected to function on limited areas and ideal weather conditions. The launch of full-scale CAVs that work on all roads and in all conditions is still further out, although several companies (Google and Uber) have plans to accelerate their development.

The CAVs have the potential to increase safety and accessibility for travelers of all ages. However, the CAVs can also create more congestion if there are a lot of Zero-Occupant Vehicle (ZOV) trips in an unmanaged network. The success of this mobility option is dependent on how well the roads, vehicles and infrastructure are connected up and the adoption rates by consumers.

Some experts believe that CAVs have the potential to require less parking space, which can free up space for new commercial and residential development opportunities including construction of multi-level parking garages that can be converted into retail uses in the future, and construction of larger zero-car homes.

3.6.2 Transportation Network Companies (TNCs)

Ride-hailing service providers like Uber and Lyft are referred to as the Transportation Network Companies, or TNCs. These TNCs match passengers with nearby vehicles in real time through web site or mobile apps. This mobility option is also an example of shared mobility solution as these TNCs also offer shared ride systems like UberPool and Lyft Line and offer discounted fares based on shared riders. The TNCs have become extremely popular in many cities and countries, as evident from the growth of TNCs in the world (Note: There are more than 36 TNCs in the world).

The TNCs use dynamic pricing models to vary the price of the ride based on supply and demand at the time of the ride. Recent survey data from larger metropolitan regions (New York and San Francisco) show that traffic congestion increased and transit ridership decreased as a result of the TNCs. Similar survey should be carried out to explore the impact of TNCs in the Triangle region.

3.6.3 Microtransit

Microtransit is relatively a new mobility option for niche market areas. It is a privately operated transit system, but generally follows the operations of public transit agencies, but on limited routes or service areas. The microtransit fares are typically higher than the public transit bus fares for similar routes.

Current microtransit providers include Chariot (San Francisco and Austin), Bridj (Boston and Kansas City), Via, Lyft Shuttle and others. The main difference from public transit is their flexibility to implement service changes without engaging public outreach and to match short-term changes in travel pattern by using Big Data and crowdsourcing.

Microtransit has the potential to reduce congestion if the service is carefully designed to complement the public transit as opposed to competing with the public transit.

3.6.4 Shared Mobility

The private sector is developing new shared mobility solutions. For example, BlaBlaCar is a French online marketplace for carpooling. Its website and mobile apps connect drivers and passengers willing to travel together between cities and share the cost of the trip.

On the other hand, car-sharing services like Car2Go provide travelers the option of driving a car on a rental basis, but without rental offices or return stations. This mobility option allows travelers to avoid the cost of owning a car, parking fees, car maintenance costs, and car insurance costs.

The number of shared mobility users are expected rapidly increase in the future from its current market share. Researchers have estimated that shared mobility makes up about one percentage point today of the 30 percent of annual vehicle miles traveled that it could currently address. Limitations include the lack of availability of these solutions in low density urban, suburban or rural settings. Also, shared mobility is less attractive for commuting, running errands or multi-stop shopping trips. Shared-mobility solutions are typically favored for traveling to social events in urban areas. The advent of self-driving and self-parking cars would further enable shared mobility trend as costs start to reduce and new mobility players enter the market. These shared mobility options have the potential to change future traffic congestion in the region, but hopefully in the positive direction.

4.0 Future Land Use-Transportation Scenarios

This section documents the future year (2045) land use-transportation scenario analysis. A total of six future scenarios were developed in the study. These six scenarios were modeled and analyzed, first using the region's CommunityViz model for land use reallocations (when modifications in growth allocations were necessary), second using the Triangle Regional Model (TRM) for travel demand forecasting and traffic congestion analysis, and third using a Benefit Cost Analysis (BCA) Tool for developing social, economic and equity performance metrics. This section presents the results from the TRM modeling and analysis, and the next section (5.0) presents the BCA results.

4.1 Highway Mega Expansion (HWYX)

The Highway Mega Expansion (HWYX) scenario was developed purely for a hypothetical test to explore traffic conditions for a roadway network where the major commuter corridors in the CAMPO region are simply doubled in lane capacity regardless of feasibility or cost. Although unrealistic, this bookend scenario was developed to illustrate the level of effort involved in addressing traffic congestion using only the highway widening strategy that is increasingly becoming expensive, time consuming, and flawed due to the associated environmental and community impacts.

The TRM roadway network for the HWYX scenario was developed by starting from the 2045 Adopted Metropolitan Transportation Plan (MTP) network and then doubling the number of available General-Purpose (GP) lanes for the non-tolled congested commuter corridors in the region. These roadway widenings are illustrated in Figure 4.1 with highlighted corridors in the TRM highway network. The roadway widenings were assumed regardless of feasibility, impacts or costs, and in addition to the roadway projects already planned in the adopted MTP. The HWYX scenario assumed the same level and allocation of future 2045 population and employment growth as in the adopted MTP. Also, the same level of transit service as in the adopted MTP was assumed.

The HWYX scenario analysis results are summarized in Table 4.1, in comparison with the adopted MTP scenario. The results reveal that freeway travel condition would significantly improve to 60.2 mph during peak period as expected due to mega capacity expansion. However, Drive Alone trips is anticipated to increase by 0.1%, or 2,700 more car trips every weekday, and transit ridership is expected to reduce by 1.3 percent, or 7,000 less transit riders.

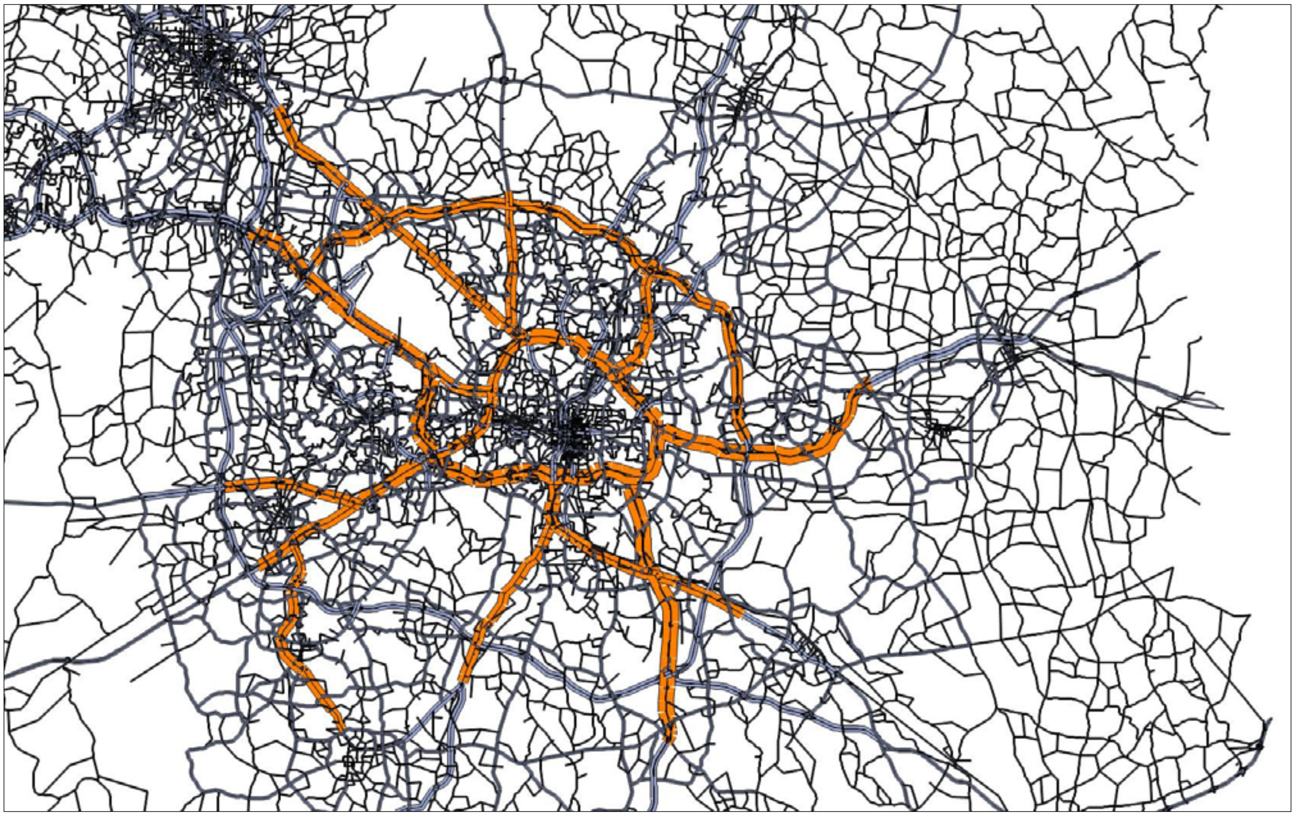
The traffic congestion analysis based on the maximum volume to capacity ratio (Max VOC[3]) is illustrated in Figure 4.2 for the HWYX scenario network in TRM. Figure 4.3 presents the same Max VOC information for only the study area commuter corridors and highlighting in red only those corridor segments and interchange ramps or vicinity that have Max VOC ratio over 1.3, reflecting future travel demand exceeding future roadway capacity by more than 30 percent. These figures reveal that Max VOC would remain mostly below 1.3 for major commuter corridors, with very few exceptions as illustrated in Figure 4.3.

Figure 4.4 presents the distribution of daily work trips in the HWYX scenario by five modes of travel, which shows 80 percent of the daily commuters travel by Single-Occupant Vehicle (SOV), 11 percent by Shared

[3] Maximum Volume Over Capacity Ratios during AM and PM peak hours were calculated using the Triangle Regional Model (TRM)

Ride/Carpool, 4 percent by Bus, 4 percent by Non-Motorized (Bicycle and Walk), and less than one percent by Rail.

Figure 4.1 Roadway Widening for the HWYX Scenario



Source: TRMv6 HWYX Scenario Network; Widened roadways highlighted in brown

Table 4.1 Travel Demand Analysis of the HWYX Scenario

Travel Demand Analysis Performance Measure	MTP	HWYX	Difference
Total Vehicle Miles Traveled or VMT (daily)			
- All Facility (no Centroid Connectors)	54,732,612	55,300,331	567,719
Total Vehicle Hours Traveled or VHT (daily)			
- All Facility (no Centroid Connectors)	1,589,074	1,489,835	-99,239
Average Speed by Facility (miles/hour)			
- Freeway	55.4	61.4	6.0
- Arterial	36.9	37.6	0.7
- All Facility	42.9	46.0	3.1
Peak Average Speed by Facility (miles/hour)			
- Freeway	51.8	60.2	8.4
- Arterial	35.6	36.6	1.0

Travel Demand Analysis Performance Measure	MTP	HWYX	Difference
- All Facility	40.7	45.0	4.3
Daily Average Travel Length - All Person Trips			
- Travel Time	17.19	16.45	-0.74
- Travel Distance	7.74	7.71	-0.03
Daily Average Travel Length - Work Trips			
- Travel Time	26.76	25.0	-1.76
- Travel Distance - Work Trips	14.09	14.03	-0.06
Peak Average Travel Length - All Person Trips			
- Peak Travel Time	16.75	16.05	-0.70
- Peak Travel Distance	6.98	6.98	0.00
Daily Average Travel Length - All Commercial Vehicle Trips			
- Travel Time	11	10.92	-0.08
- Travel Distance	7.14	7.29	0.15
Daily Average Travel Length - Truck Trips			
- Travel Time	12.79	12.69	-0.10
- Travel Distance	8.61	8.8	0.19
Hours of Delay (daily)	344,875	246,164	-98,711
Truck Hours of Delay (daily)	10,941	7,028	-3,913
Percent of VMT experiencing congestion - All Day			
- Freeway	14.90%	3.10%	-0.12
- Arterial	9.30%	6.60%	-0.03
- All Facility	10.40%	4.7%	-0.06
Percent of VMT experiencing congestion - Peak			
- Freeway	25.20%	4.0%	-0.21
- Arterial	14.60%	10.0%	-0.05
- All Facility	16.80%	6.8%	-0.10
- Designated truck routes	9.40%	4.8%	-0.05
- Facilities w/bus routes	15.80%	6.2%	-0.10
Mode Share Measures			
All Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	4,207,352	4,210,063	2,711
- Carpool (Share ride)	3,742,429	3,742,375	-54

Travel Demand Analysis Performance Measure	MTP	HWYX	Difference
- Bus	92,346	98,673	6,327
- Rail	20,664	19,957	-707
- Non-Motorized (Bike and Walk)	749,185	740,944	-8,241
Work Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	1,042,146	1,044,054	1,908
- Carpool (Share ride)	146,955	146,387	-568
- Bus	49,654	55,334	5,680
- Rail	7,289	6,963	-326
- Non-Motorized (Bike and Walk)	55,414	48,738	-6,676
All Trips - Peak Hours			
- Drive alone (single occupant vehicle -SOV)	2,269,659	2,272,371	2,712
- Carpool (Share ride)	2,228,706	2,228,589	-117
- Bus	55,637	61,936	6,299
- Rail	13,824	13,132	-692
- Non-Motorized (Bike and Walk)	391,994	383,801	-8,193
Transit Measures			
Transit Ridership by Prod. Ends – Total Peak and Off-peak			
- GoTriangle (Including Rail)	75,321	73,869	-1,452
- GoRaleigh	121,505	120,385	-1,120
- Wolfline	16,007	16,060	53
- GoCary	4,470	4.499	-4,466
Total Ridership for the CAMPO Region	217,303	210,318	-6,985
Total Daily Person Trips	8,811,976	8,812,012	36
Work Person Trips	1,301,458	1,301,476	18
Total Daily Commercial Vehicle Trips	559,628	559,628	0
Daily Truck Trips	234,192	234,192	0
Roadway Lane Miles	9,245	10,218	973
Transit Supply (Service Miles) in the CAMPO Region	57,019	57,019	0

Source: TRMv6 scenario runs and analysis with the adopted MTP and HWYX networks.

Figure 4.2 Max VOC for the HWYX Scenario Network

Source: TRMv6 scenario run and analysis with the HWYX network.

Figure 4.3 Commuter Corridors with Max VOC over 1.3 in HWYX Scenario

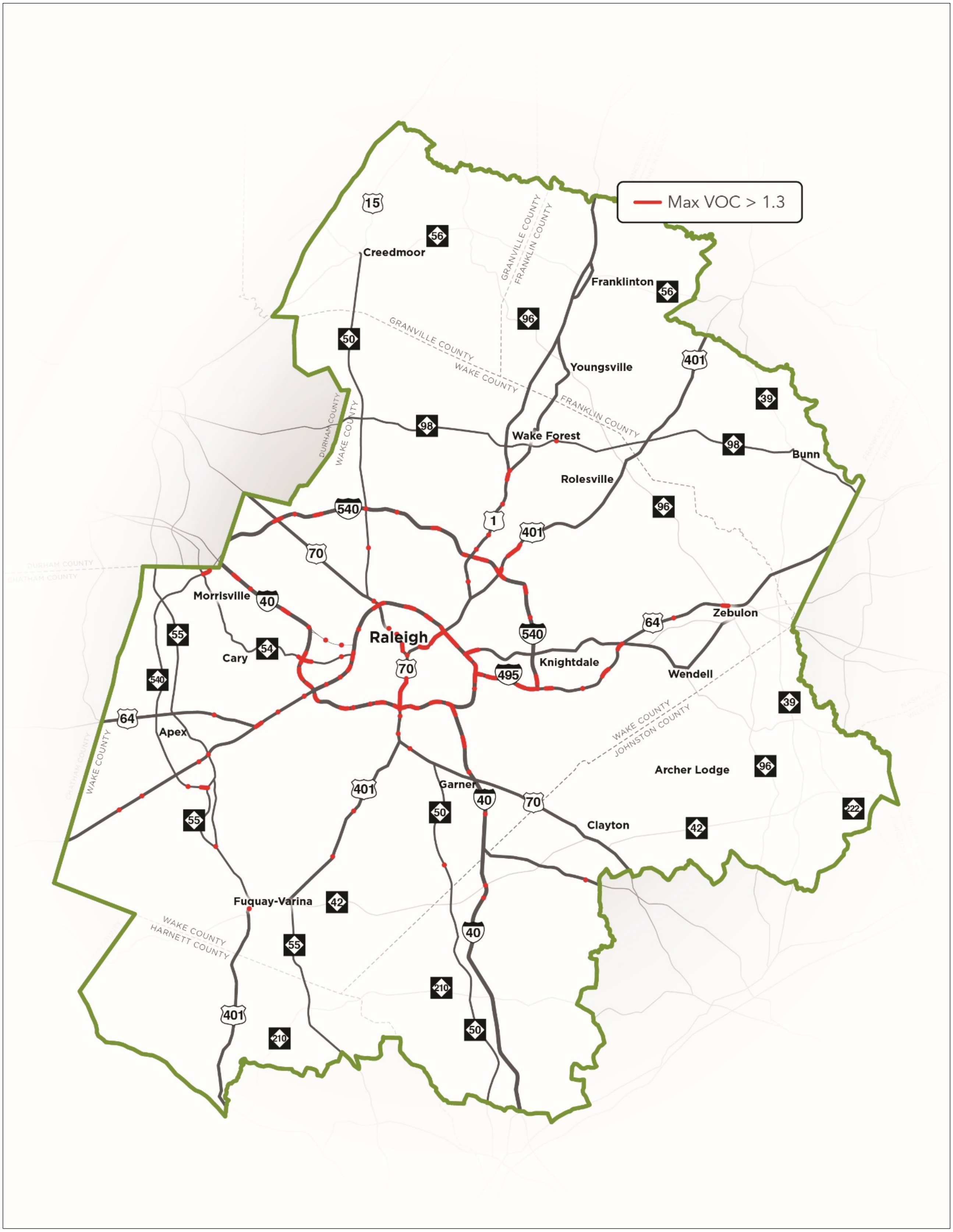
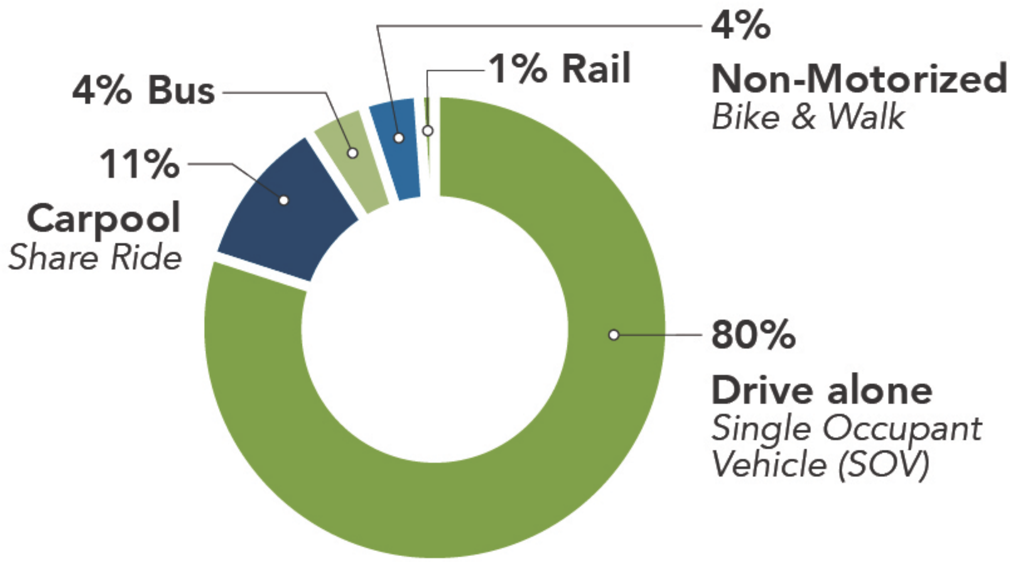


Figure 4.4 Mode Share for Daily Work Trips in HWYX Scenario



4.2 Dynamic Tolling (TOLL3)

The Dynamic Tolling (TOLL3) scenario was developed to explore traffic conditions for a roadway network where the major freeway corridors in the CAMPO region (i.e., I-40, I-540, I-440, and NC 540) and the I-440 interchange ramps that carry traffic to/from downtown Raleigh have dynamic tolls during peak hours. This scenario was developed to illustrate the impacts of a dynamic tolling strategy for traffic congestion management in the region.

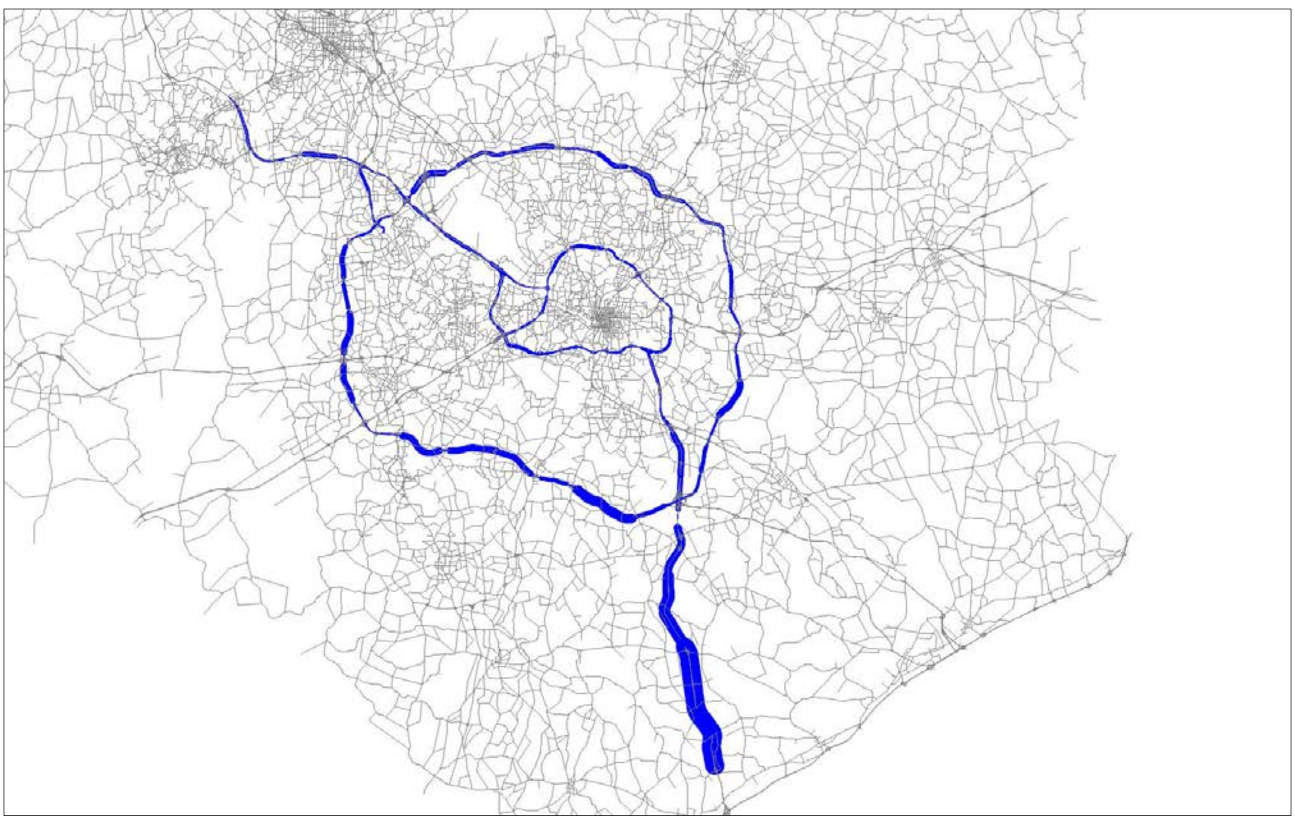
The TRM roadway network for the TOLL3 scenario was developed by starting from the 2045 Adopted MTP network and then increasing the toll rate from $0.15 to $0.90 per mile on express lanes along I-40, I-540, and for all lanes along NC 540 to reflect potential peak pricing during AM and PM peak hours of travel. In addition, $0.90 per mile toll rates were coded in the model for all lanes along I-440 and the I-440 interchange ramps that carry traffic to and from downtown Raleigh, as a proxy to area-based tolling for the urban core. These peak toll rates were only applicable to Single-Occupant Vehicles (SOVs) and trucks, but not on High-Occupancy Vehicles (HOVs) to incentivize carpool and transit travel. These roadway tolling locations are illustrated in Figure 4.5 with highlighted corridors in the TRM highway network. The roadway tolls were assumed regardless of feasibility, impacts or costs. The TOLL3 scenario assumed the same level and allocation of future 2045 population and employment growth as in the adopted MTP. Also, the same level of transit service was assumed as in the adopted MTP.

The TOLL3 scenario analysis results are summarized in Table 4.2, in comparison with the adopted MTP scenario. The results reveal that freeway travel condition is expected to improve to 53.6 mph during peak period. However, arterial travel condition is expected to worsen by 8%, from 35.6 mph to 32.8 mph. Drive Alone trips is anticipated to reduce by 1.2%, or 49,000 less car trips every weekday. In contrast, number of carpools is expected to increase by over 40,000 trips, but transit ridership would decline by 0.7%, or 1800 less number of riders.

The traffic congestion analysis based on the Max VOC metric is illustrated in Figure 4.6 for the TOLL3 scenario network in TRM. Figure 4.7 presents the same Max VOC information for only the study area commuter corridors and highlighting in red only those corridor segments and interchange ramps or vicinity that have Max VOC ratio over 1.3, reflecting future travel demand exceeding future roadway capacity by more than 30 percent. These figures reveal that Max VOC would remain over 1.3 for many major commuter corridor segments, as illustrated in Figure 4.7.

Figure 4.8 presents the distribution of daily work trips in the TOLL3 scenario by five modes of travel, which shows 78 percent of the daily commuters travel by SOV, 12 percent by Shared Ride/Carpool, 4 percent by Bus, 6 percent by Non-Motorized (Bicycle and Walk), and less than one percent by Rail.

Figure 4.5 Dynamic Tolling for the TOLL3 Scenario



Source: TRMv6 TOLL3 Scenario Network; Tolled roadways highlighted in blue

Table 4.2 Travel Demand Analysis of the TOLL3 Scenario

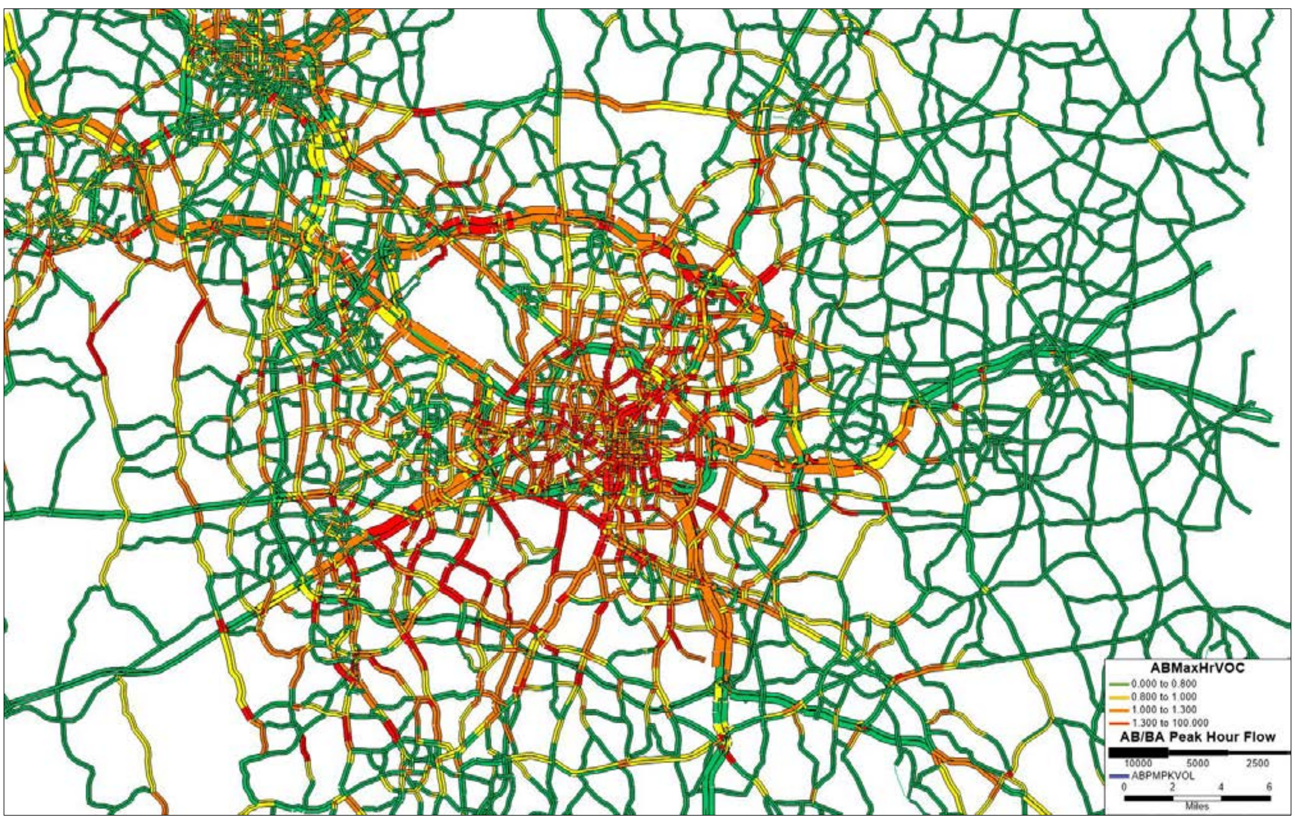
Travel Demand Analysis Performance Measure	MTP	TOLL3	Difference
Total Vehicle Miles Traveled or VMT (daily)			
- All Facility (no Centroid Connectors)	54,732,612	53,717,551	-1,015,061
Total Vehicle Hours Traveled or VHT (daily)			
- All Facility (no Centroid Connectors)	1,589,074	1,694,182	105,108
Average Speed by Facility (miles/hour)			
- Freeway	55.4	57.1	1.7
- Arterial	36.9	35.1	-1.8
- All Facility	42.9	41.3	-1.6
Peak Average Speed by Facility (miles/hour)			
- Freeway	51.8	53.6	1.8
- Arterial	35.6	32.8	-2.8
- All Facility	40.7	38.3	-2.4
Daily Average Travel Length - All Person Trips			
- Travel Time	17.19	17.24	0.05
- Travel Distance	7.74	8.05	0.31
Daily Average Travel Length - Work Trips			
- Travel Time	26.76	25.95	-0.81
- Travel Distance - Work Trips	14.09	14.36	0.27
Peak Average Travel Length - All Person Trips			
- Peak Travel Time	16.75	16.92	0.17
- Peak Travel Distance	6.98	7.36	0.38
Daily Average Travel Length - All Commercial Vehicle Trips			
- Travel Time	11	10.41	-0.59
- Travel Distance	7.14	6.71	-0.43
Daily Average Travel Length - Truck Trips			
- Travel Time	12.79	12.15	-0.64
- Travel Distance	8.61	8.18	-0.43
Hours of Delay (daily)	344,875	425308	80433
Truck Hours of Delay (daily)	10,941	13603	2662
Percent of VMT experiencing congestion - All Day			

Travel Demand Analysis Performance Measure	MTP	TOLL3	Difference
- Freeway	14.90%	9.80%	-5.10%
- Arterial	9.30%	14%	4.70%
- All Facility	10.40%	11%	0.60%
Percent of VMT experiencing congestion - Peak			
- Freeway	25.20%	18.10%	-7.10%
- Arterial	14.60%	22.20%	7.60%
- All Facility	16.80%	17.90%	1.10%
- Designated truck routes	9.40%	11.60%	2.20%
- Facilities w/bus routes	15.80%	17.10%	1.30%
Mode Share Measures			
All Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	4,207,352	4,158,678	-48,674
- Carpool (Share ride)	3,742,429	3,782,734	40,305
- Bus	92,346	92,859	513
- Rail	20,664	20,918	254
- Non-Motorized (Bike and Walk)	749,185	777,941	28,756
Work Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	1,042,146	1,009,886	-32,260
- Carpool (Share ride)	146,955	157,685	10,730
- Bus	49,654	49,212	-442
- Rail	7,289	7,380	91
- Non-Motorized (Bike and Walk)	55,414	77,273	21,859
All Trips - Peak Hours			
- Drive alone (single occupant vehicle -SOV)	2,269,659	2,214,556	-55,103
- Carpool (Share ride)	2,228,706	2,260,353	31,647
- Bus	55,637	55,763	126
- Rail	13,824	14,401	577
- Non-Motorized (Bike and Walk)	391,994	425,805	33,811
Transit Measures			
Transit Ridership by Prod. Ends – Total Peak and Off-peak			
- GoTriangle (Including Rail)	75,321	74577	-744
- GoRaleigh	121,505	120810	-695
- Wolfline	16,007	80486	64479

Travel Demand Analysis Performance Measure	MTP	TOLL3	Difference
- GoCary	4,470	35674	31204
Total Ridership for the CAMPO Region	217,303	215,528	-1,775
Total Daily Person Trips	8,811,976	8,833,130	21,154
Work Person Trips	1,301,458	1,301,436	-22
Total Daily Commercial Vehicle Trips	559,628	559,628	0
Daily Truck Trips	234,192	234,192	0
Roadway Lane Miles	9,245	9,245	0
Transit Supply (Service Miles) in the CAMPO Region	57,019	57,019	0

Source: TRMv6 scenario runs and analysis with the adopted MTP and TOLL3 networks.

Figure 4.6 Max VOC for the TOLL3 Scenario Network



Source: TRMv6 scenario run and analysis with the TOLL3 network.

Figure 4.7 Commuter Corridors with Max VOC over 1.3 in TOLL3 Scenario

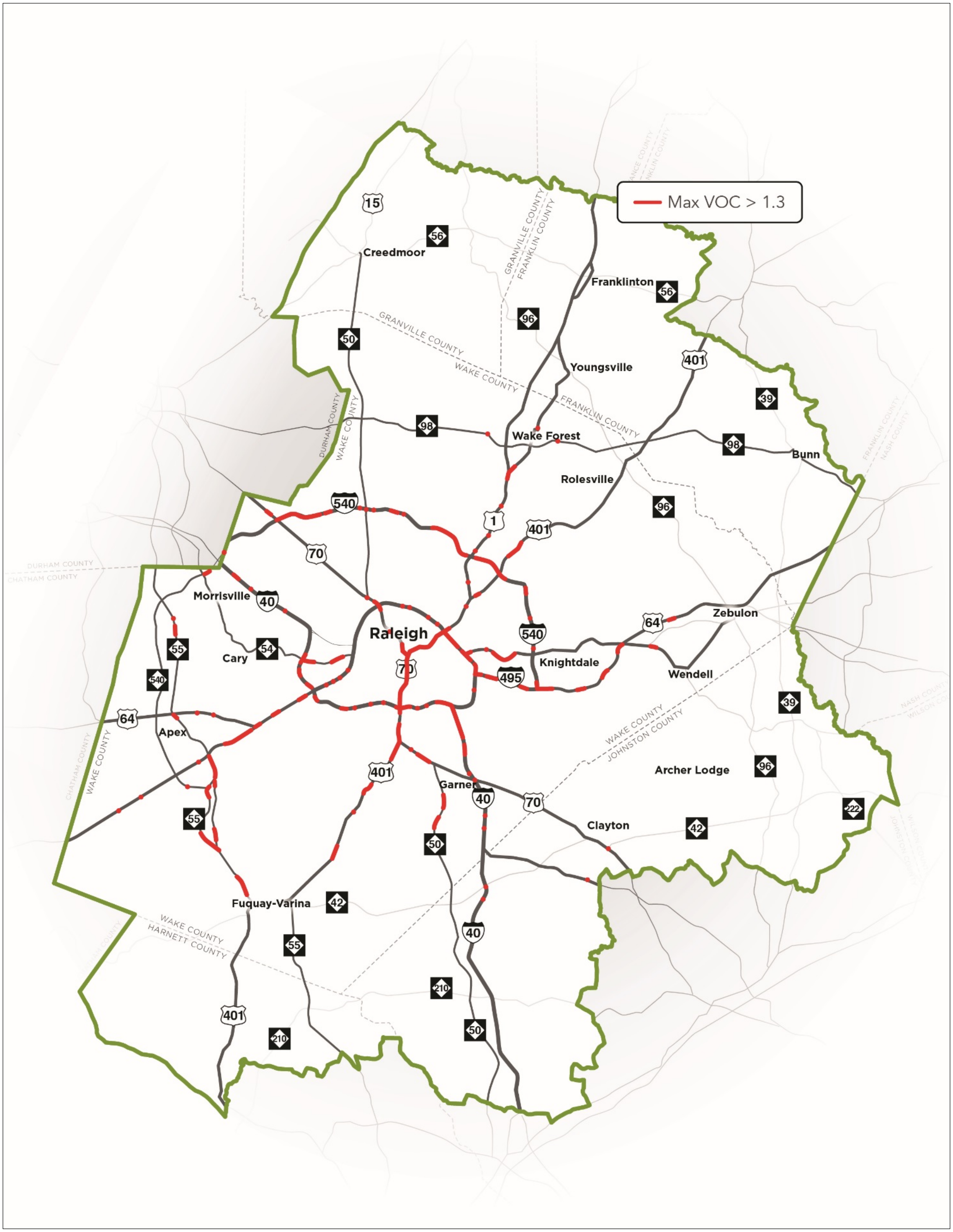
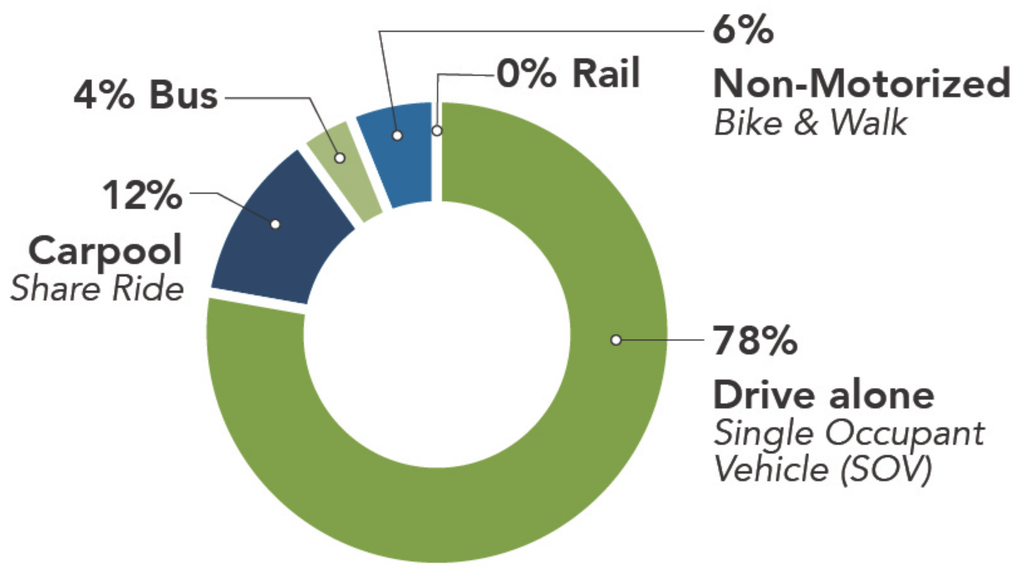


Figure 4.8 Mode Share for Daily Work Trips in TOLL3 Scenario



4.3 Equitable Transit Oriented Development (ETOD)

The Equitable Transit-oriented Development (ETOD) scenario was developed to explore traffic conditions with additional affordable housing near future transit stations in the region and by providing additional transit service. This scenario was developed to illustrate the level of land use densities needed around the planned transit stations in the region to address growing traffic congestion issues in the region. This scenario also supports demographic shifts with millennials who prefer renting than buying and living close to work.

The TRM roadway network for the ETOD scenario remained the same as the 2045 Adopted MTP network. However, future growth allocations were modified using the region's CommunityViz model to assume higher densities around transit stations. More specifically, the following modifications were made to develop the ETOD scenario:

- Assumed 50 percent additional growth in multi-family, office and retail uses within half-mile of each planned transit station area

- Adjusted projected growth in non-station areas to stay within the adopted 2045 socio-economic forecasts
- Assumed 100 percent increase in transit frequency for future transit routes

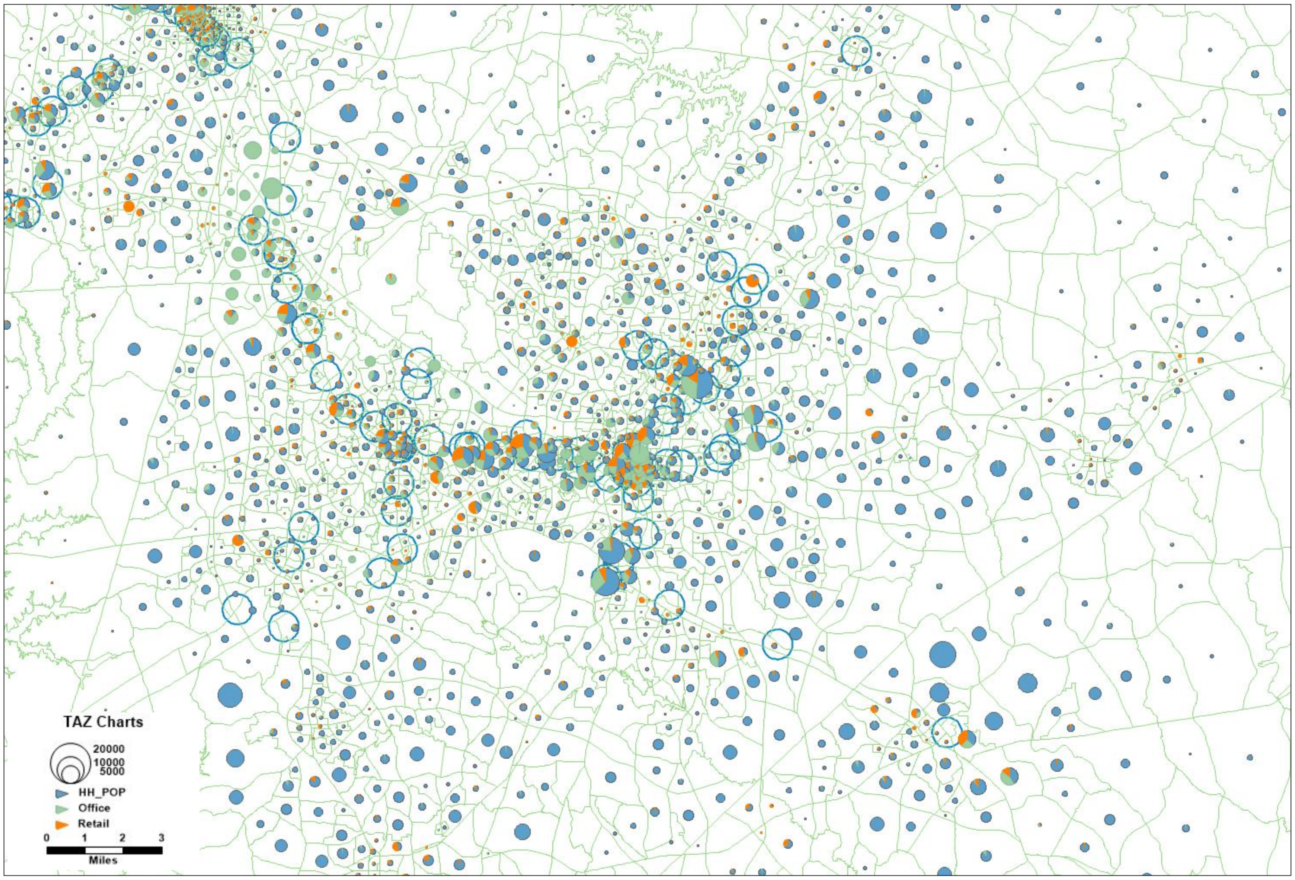
The resulting household population, office and retail growth allocations for the ETOD scenario are illustrated in Figure 4.9 with pie charts for each TRM zone. This scenario is estimated to require additional transit investments in the range of $10-$20 million per year. In addition, this scenario will require station area-specific TOD planning and affordable housing policies for implementation.

The ETOD scenario analysis results are summarized in Table 4.3, in comparison with the adopted MTP scenario. The results reveal that freeway travel condition is expected to improve by 0.8%, from 51.8 mph to 52.2 mph, but arterial travel condition would slightly worsen from 35.6 mph to 35.4 mph during peak period. However, Drive Alone trips is anticipated to reduce by 4%, or 167,000 less car trips every weekday, and transit ridership is expected to increase by 38%, or 75,350 new transit riders every weekday.

The traffic congestion analysis based on the Max VOC is illustrated in Figure 4.10 for the ETOD scenario network in TRM. Figure 4.11 presents the same Max VOC information for only the study area commuter corridors and highlighting in red only those corridor segments and interchange ramps or vicinity that have Max VOC ratio over 1.3, reflecting future travel demand exceeding future roadway capacity by more than 30 percent. These figures reveal that Max VOC would remain mostly below 1.3 for major commuter corridors, with very few exceptions as illustrated in Figure 4.11.

Figure 4.12 presents the distribution of daily work trips in the ETOD scenario by five modes of travel, which shows 80 percent of the daily commuters travel by SOV, 11 percent by Shared Ride/Carpool, 5 percent by Bus, 5 percent by Non-Motorized (Bicycle and Walk), and less than one percent by Rail.

Figure 4.9 Growth Allocations in Future Transit Stations in ETOD Scenario



Source: TRMv6 ETOD3 Socio-Economic Data; illustrated in scaled pie charts for each TAZ

Table 4.3 Travel Demand Analysis of the ETOD Scenario

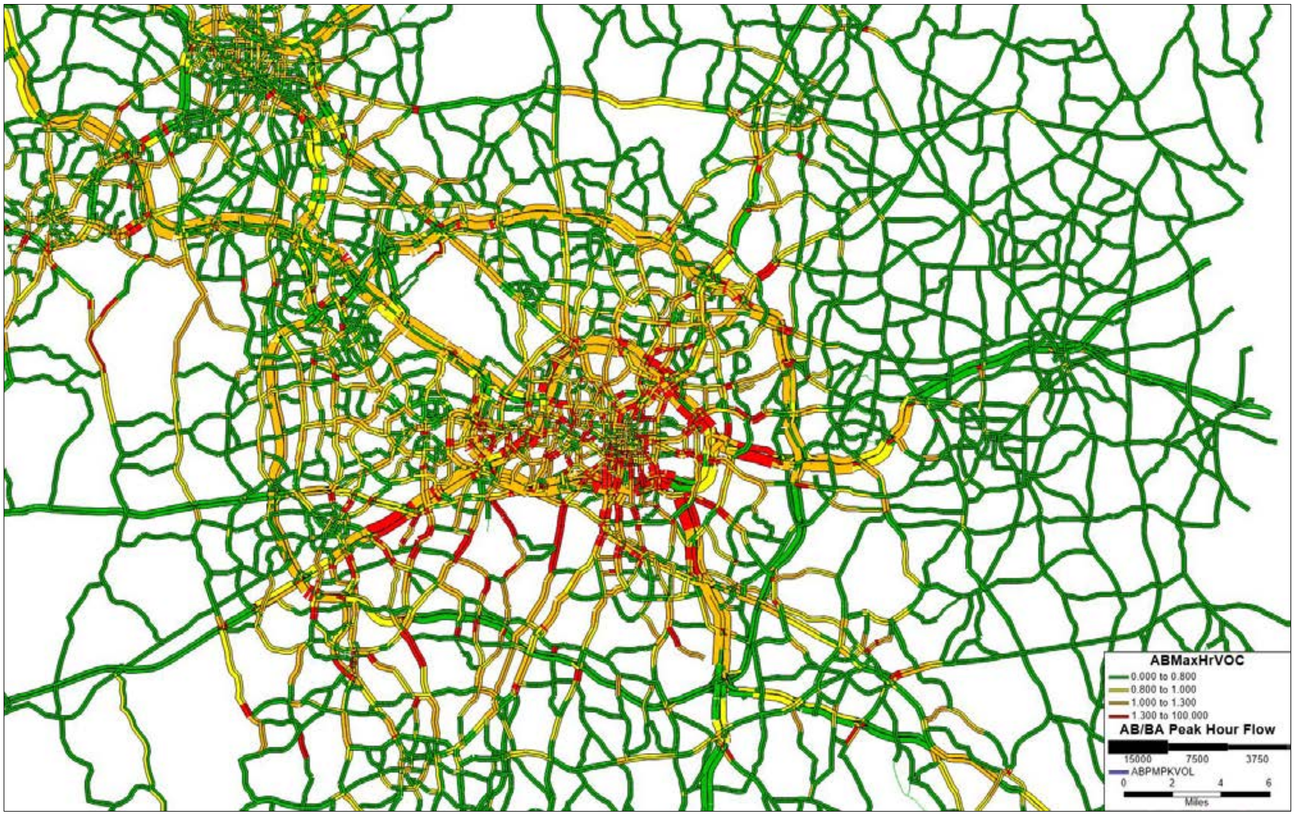
Travel Demand Analysis Performance Measure	MTP	ETOD	Difference
Total Vehicle Miles Traveled or VMT (daily)			
- All Facility (no Centroid Connectors)	54,732,612	53,438,807	-1,293,805
Total Vehicle Hours Traveled or VHT (daily)			
- All Facility (no Centroid Connectors)	1,589,074	1,597,164	8,090
Average Speed by Facility (miles/hour)			
- Freeway	55.4	55.7	0.3
- Arterial	36.9	36.6	-0.3
- All Facility	42.9	42.8	-0.1
Peak Average Speed by Facility (miles/hour)			
- Freeway	51.8	52.2	0.4
- Arterial	35.6	35.4	-0.2

Travel Demand Analysis Performance Measure	MTP	ETOD	Difference
- All Facility	40.7	40.7	0
Daily Average Travel Length - All Person Trips			
- Travel Time	17.19	17.79	0.6
- Travel Distance	7.74	7.7	-0.04
Daily Average Travel Length - Work Trips			
- Travel Time	26.76	27.54	0.78
- Travel Distance - Work Trips	14.09	14.15	0.06
Peak Average Travel Length - All Person Trips			
- Peak Travel Time	16.75	17.3	0.55
- Peak Travel Distance	6.98	6.73	-0.25
Daily Average Travel Length - All Commercial Vehicle Trips			
- Travel Time	11	11.04	0.04
- Travel Distance	7.14	7.07	-0.07
Daily Average Travel Length - Truck Trips			
- Travel Time	12.79	12.84	0.05
- Travel Distance	8.61	8.54	-0.07
Hours of Delay (daily)	344,875	370,840	25,965
Truck Hours of Delay (daily)	10,941	11,071	130
Percent of VMT experiencing congestion - All Day			
- Freeway	14.90%	14.0%	-0.90%
- Arterial	9.30%	10.0%	0.70%
- All Facility	10.40%	10.60%	0.20%
Percent of VMT experiencing congestion - Peak			
- Freeway	25.20%	23.90%	-1.30%
- Arterial	14.60%	15.10%	0.50%
- All Facility	16.80%	17.0%	0.20%
- Designated truck routes	9.40%	10.30%	0.90%
- Facilities w/bus routes	15.80%	15.80%	0.00%
Mode Share Measures			
All Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	4,207,352	4,040,498	-166,854
- Carpool (Share ride)	3,742,429	3,760,350	17,921

Travel Demand Analysis Performance Measure	MTP	ETOD	Difference
- Bus	92,346	121,528	29,182
- Rail	20,664	25,978	5,314
- Non-Motorized (Bike and Walk)	749,185	908,944	159,759
Work Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	1,042,146	1,007,705	-34,441
- Carpool (Share ride)	146,955	149,205	2,250
- Bus	49,654	67,266	17,612
- Rail	7,289	8,500	1,211
- Non-Motorized (Bike and Walk)	55,414	65,338	9,924
All Trips - Peak Hours			
- Drive alone (single occupant vehicle -SOV)	2,269,659	2,139,409	-130,250
- Carpool (Share ride)	2,228,706	2,263,613	34,907
- Bus	55,637	80,908	25,271
- Rail	13,824	19,751	5,927
- Non-Motorized (Bike and Walk)	391,994	480,210	88,216
Transit Measures			
Transit Ridership by Prod. Ends – Total Peak and Off-peak			
- GoTriangle (Including Rail)	75,321	96,889	21,568
- GoRaleigh	121,505	173,623	52,118
- Wolfline	16,007	15,308	-699
- GoCary	4,470	6,132	1,662
Total Ridership for the CAMPO Region	217,303	291,952	74,649
Total Daily Person Trips	8,811,976	8,857,298	45,322
Work Person Trips	1,301,458	1,298,014	-3,444
Total Daily Commercial Vehicle Trips	559,628	561,681	2,053
Daily Truck Trips	234,192	234,884	692
Roadway Lane Miles	9,245	9,245	0
Transit Supply (Service Miles) in the CAMPO Region	57,019	91,422	34,403

Source: TRMv6 scenario runs and analysis with the adopted MTP and ETOD networks.

Figure 4.10 Max VOC for the ETOD Scenario Network



Source: TRMv6 scenario run and analysis with the ETOD3 network.

Figure 4.11 Commuter Corridors with Max VOC over 1.3 in ETOD Scenario

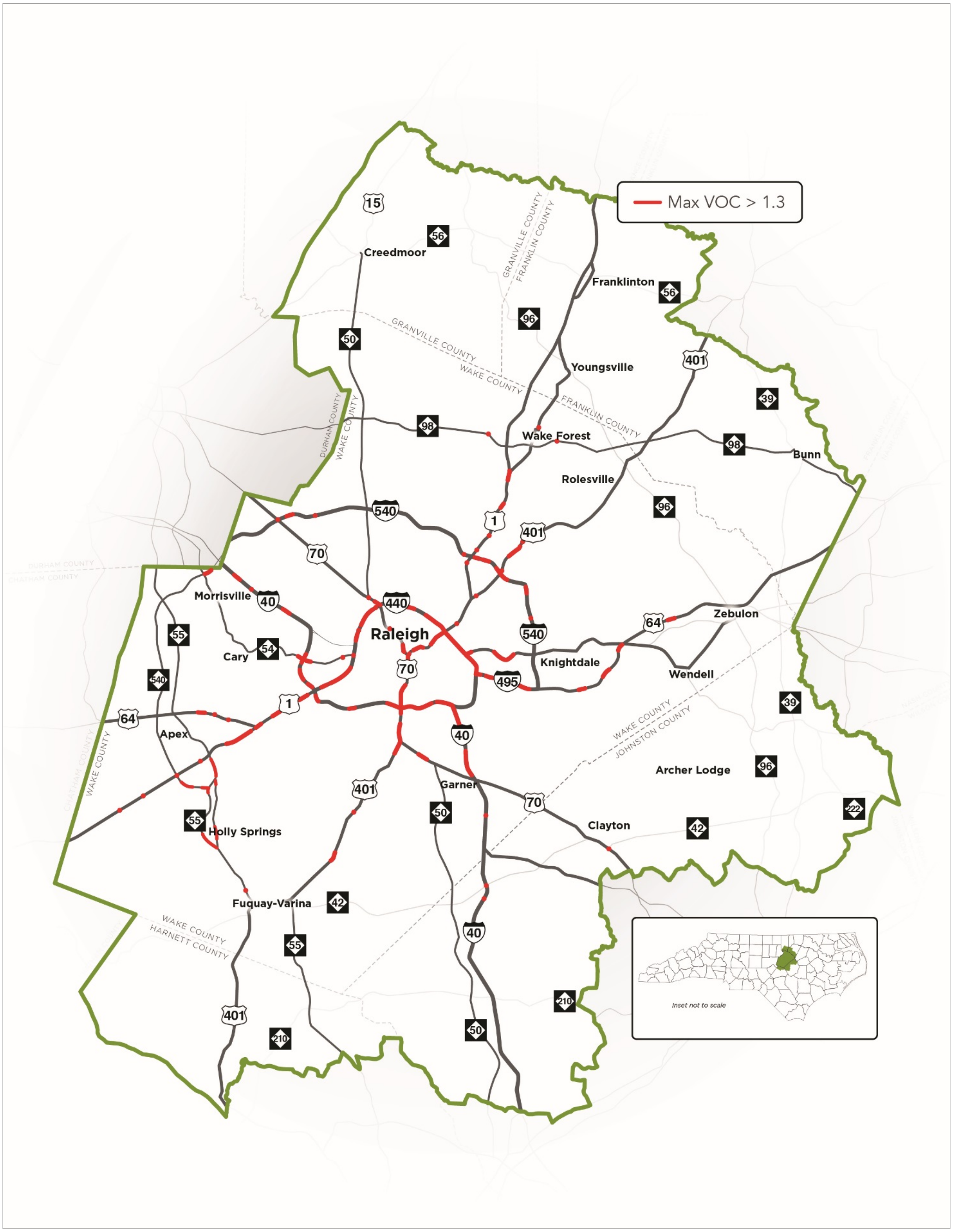
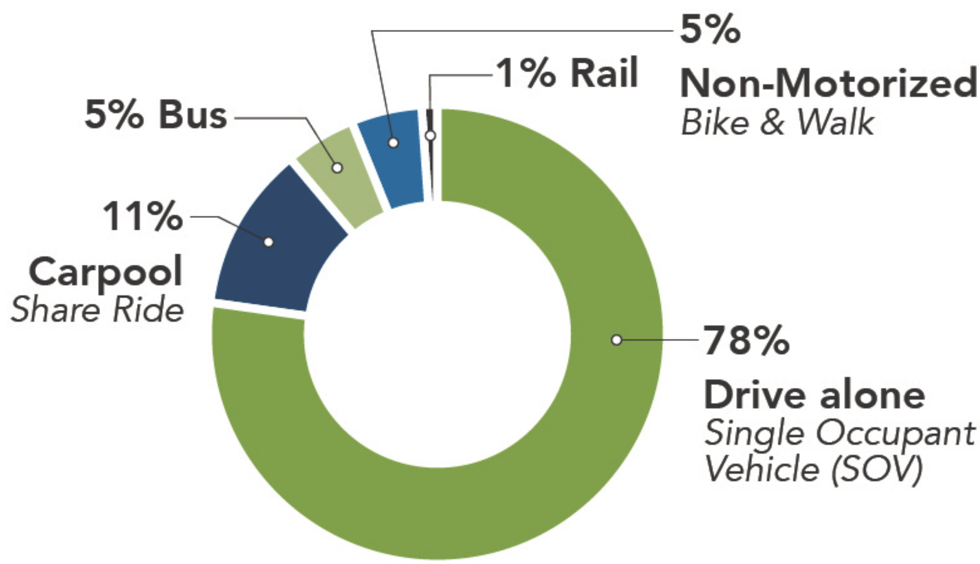


Figure 4.12 Mode Share for Daily Work Trips in ETOD Scenario



4.4 Smart Mobility Hubs (MHUB)

The Smart Mobility Hubs (MHUB) scenario was developed to explore traffic conditions for a multi-modal transportation network with smart mobility hubs located around the edges of the urban core with anticipated growth in mixed uses, to serve first- and last-mile trips with efficiency and smart technology systems. This scenario is in response to growing travel behavior shifts due to advent of Transportation Network Companies (TNCs), Connected and Autonomous Vehicles (CAVs) and emerging shared mobility trends.

In this scenario, thirteen potential smart mobility hub locations were identified around the edges of the CAMPO region that do not have any significant overlaps with planned transit stations in Downtown Raleigh, the NCSU campus, and the Research Triangle Park (RTP). More specifically, the following changes were made to the MTP to develop the MHUB scenario:

- Assumed 50 percent additional growth in household, office and retail uses within one and half-mile band of each of the potential MHUB location

- Adjusted projected growth in non-station and non-MHUB areas to stay within the adopted 2045 socio-economic forecasts
- Assumed high frequency premium transit service during commuting hours to connect MHUBs with downtown Raleigh and the RTP

The MHUB scenario is estimated to require additional transit investments in the range of $5-$10 million per year. It will require community-centric planning to define scope, scale and character of each MHUB in the region. In addition, actual implementation of each mobility hub location will likely require some roadway improvements to mitigate site-specific traffic impacts improvements around each MHUB and to improve access and circulation. Also, deployment of smart technology systems will be required for safety, security, and real-time traveler information.

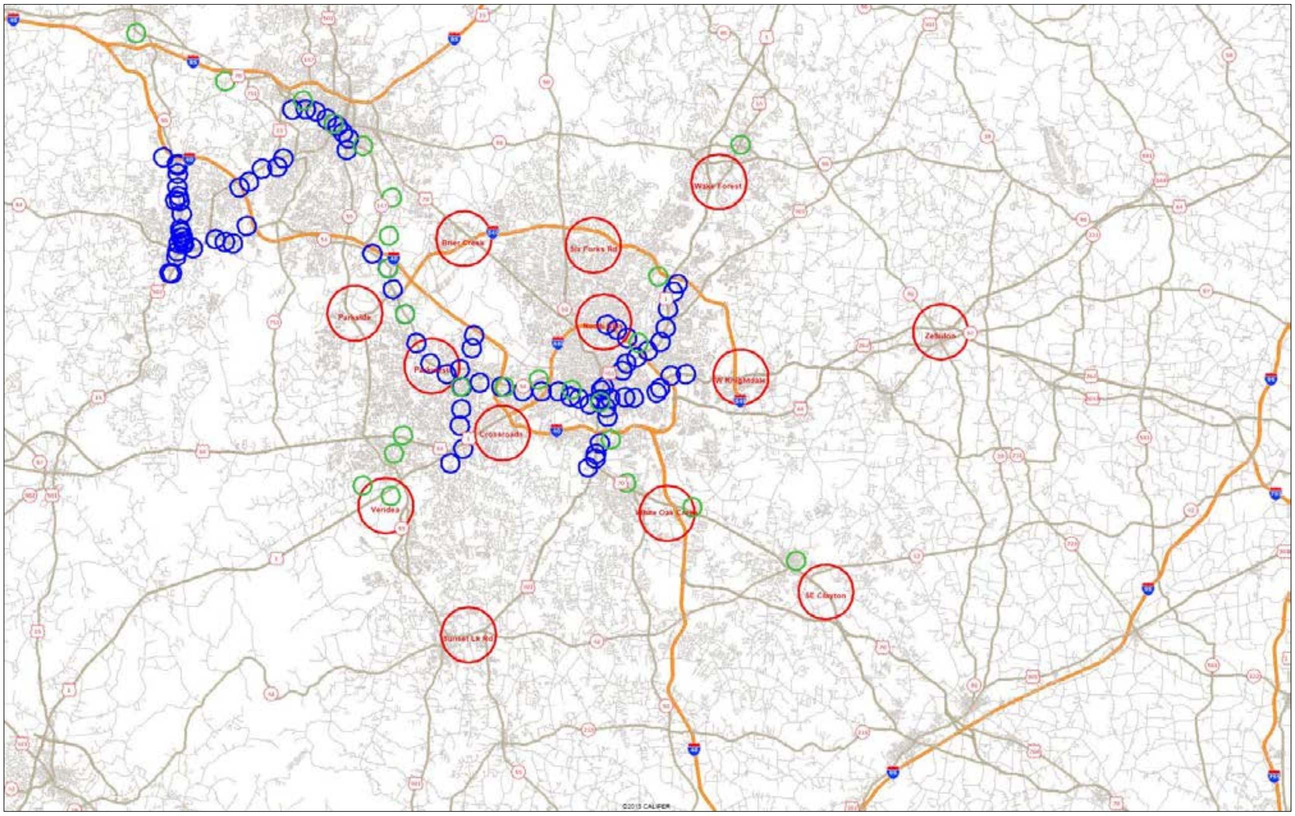
The TRM roadway network for the MHUB scenario was kept the same as the 2045 Adopted MTP network. The TRM transit network was enhanced to add premium transit service during commuting hours to connect MHUBs with downtown Raleigh and the RTP. The MHUB and transit station locations are illustrated in Figure 4.13. The growth allocations for the MHUB scenario is illustrated in Figure 4.14 and the transit routes are illustrated in Figure 4.15.

The MHUB scenario analysis results are summarized in Table 4.4, in comparison with the adopted MTP scenario. The results reveal that freeway travel condition is expected to remain the same at 51.8 mph during peak period. However, arterial travel condition is expected to improve slightly by 0.1%, from 35.6 mph to 35.7 mph. However, Drive Alone trips is anticipated to reduce by 0.1%, or 5,000 less car trips every weekday, and transit ridership is expected to increase by 2 percent, or 4,700 new transit riders every weekday.

The traffic congestion analysis based on the Max VOC is illustrated in Figure 4.16 for the MHUB scenario network in TRM. Figure 4.17 presents the same Max VOC information for only the study area commuter corridors and highlighting in red only those corridor segments and interchange ramps or vicinity that have Max VOC ratio over 1.3, reflecting future travel demand exceeding future roadway capacity by more than 30 percent. These figures reveal that Max VOC would remain mostly below 1.3 for major commuter corridors, with some exceptions as illustrated in Figure 4.17.

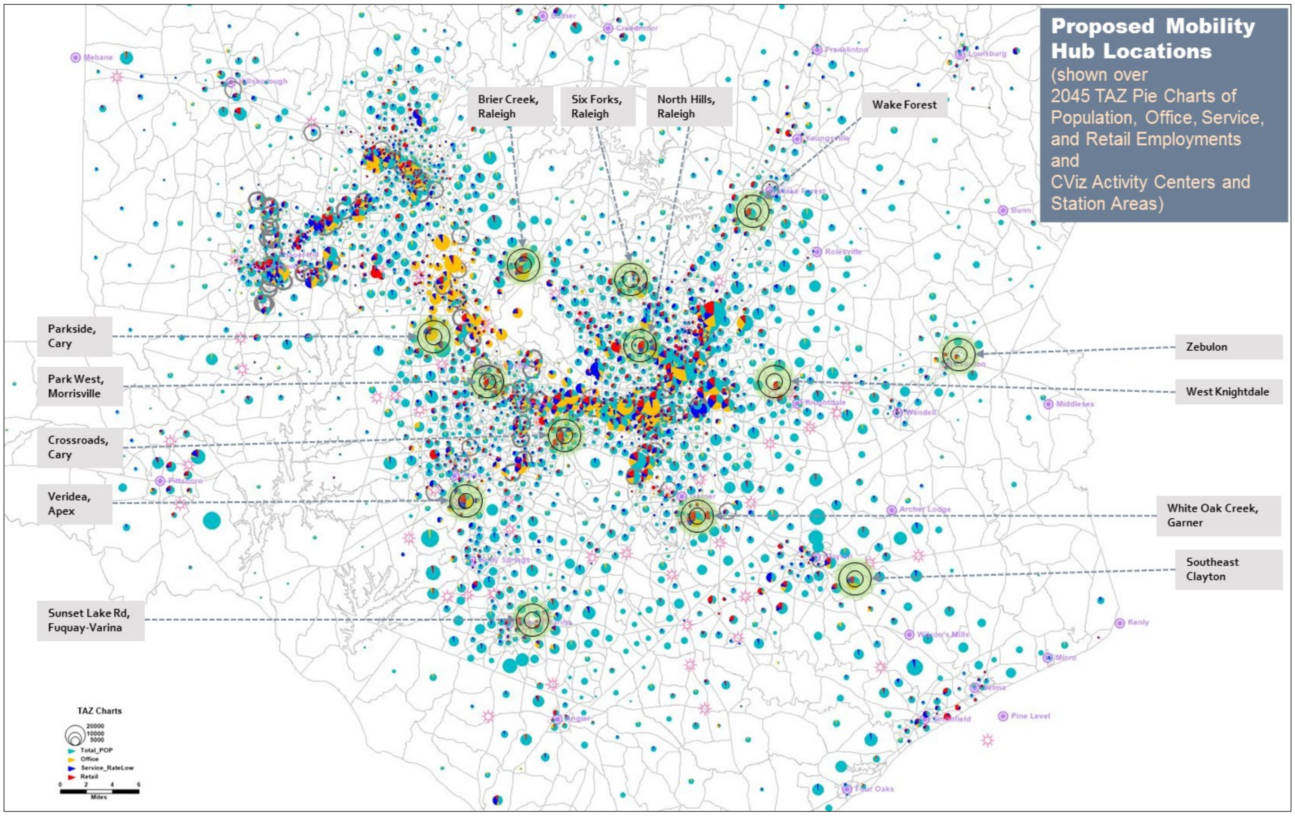
Figure 4.18 presents the distribution of daily work trips in the MHUB scenario by five modes of travel, which shows 80 percent of the daily commuters travel by Single-Occupant Vehicle (SOV), 11 percent by Shared Ride/Carpool, 4 percent by Bus, 4 percent by Non-Motorized (Bicycle and Walk), and less than one percent by Rail.

Figure 4.13 Mobility Hubs and Station Areas for MHUB Scenario



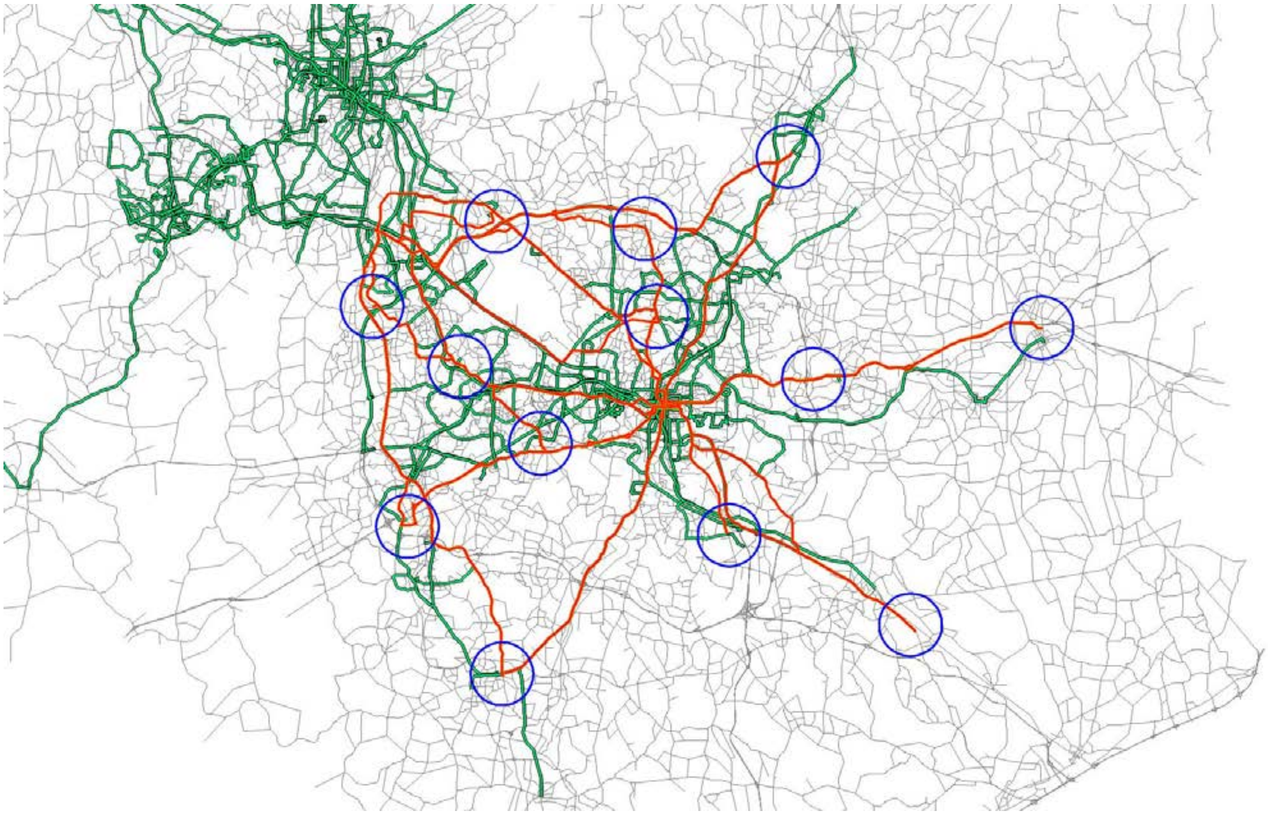
Note: Mobility Hubs are shown in red circles; High-Frequency Transit Stations are shown in blue circles, and Low-Frequency Transit Stations are shown in green circles.

Figure 4.14 Growth Allocations around Smart Mobility Hubs in MHUB Scenario



Source: TRMv6 MHUB Socio-Economic Data; illustrated in scaled pie charts for each TAZ

Figure 4.15 Premium Transit Network in MHUB Scenario



Source: TRMv6 MHUB Scenario; MHUBs in blue circles; MTP transit routes in green; MHUB transit routes in red

Table 4.4 Travel Demand Analysis of the MHUB Scenario

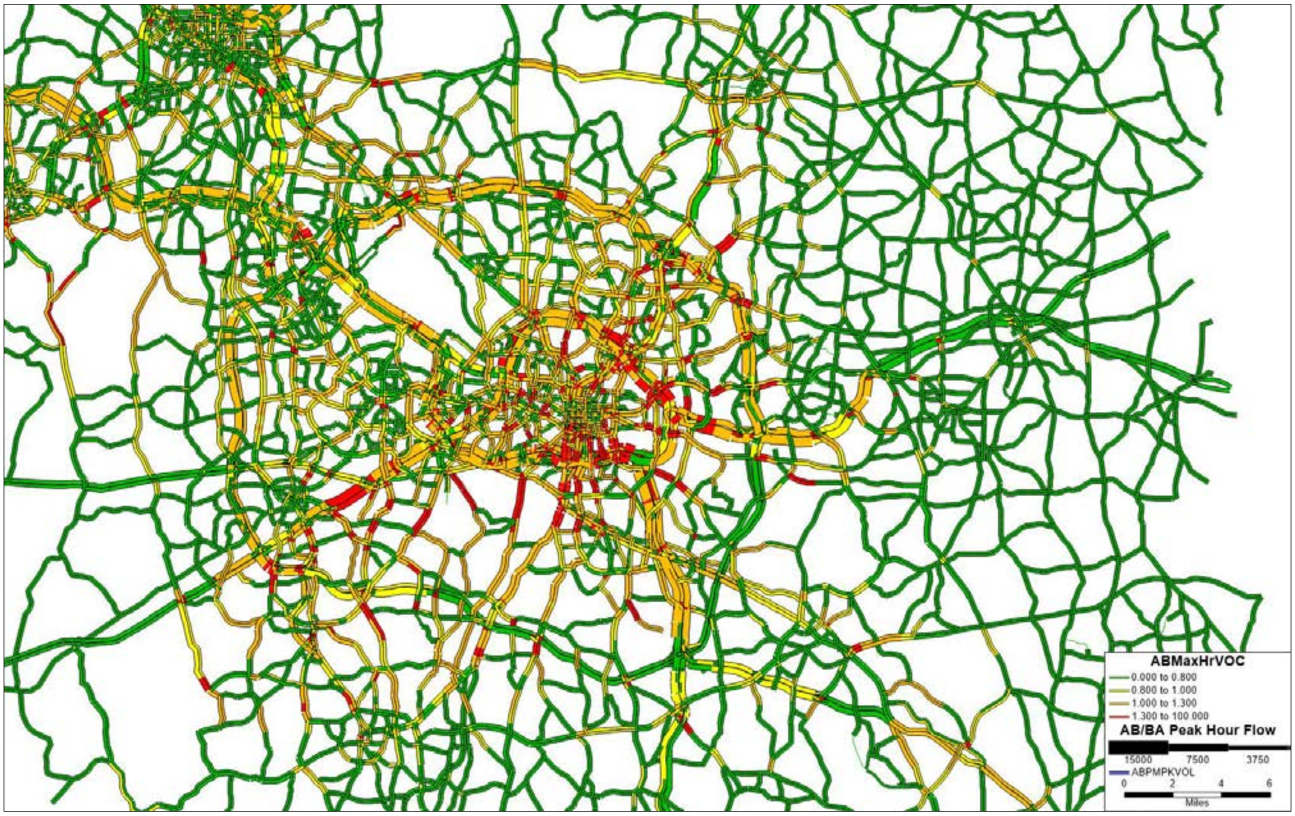
Travel Demand Analysis Performance Measure	MTP	MHUB	Difference
Total Vehicle Miles Traveled or VMT (daily)			
- All Facility (no Centroid Connectors)	54,732,612	54,532,472	-200,140
Total Vehicle Hours Traveled or VHT (daily)			
- All Facility (no Centroid Connectors)	1,589,074	1,584,580	-4,494
Average Speed by Facility (miles/hour)			
- Freeway	55.4	55.4	0
- Arterial	36.9	36.9	0
- All Facility	42.9	42.9	0
Peak Average Speed by Facility (miles/hour)			
- Freeway	51.8	51.8	0
- Arterial	35.6	35.7	0.1

Travel Demand Analysis Performance Measure	MTP	MHUB	Difference
- All Facility	40.7	40.7	0
Daily Average Travel Length - All Person Trips			
- Travel Time	17.19	17.19	0
- Travel Distance	7.74	7.73	-0.01
Daily Average Travel Length - Work Trips			
- Travel Time	26.76	26.76	0
- Travel Distance - Work Trips	14.09	14.11	0.02
Peak Average Travel Length - All Person Trips			
- Peak Travel Time	16.75	16.77	0.02
- Peak Travel Distance	6.98	6.95	-0.03
Daily Average Travel Length - All Commercial Vehicle Trips			
- Travel Time	11	10.96	-0.04
- Travel Distance	7.14	7.1	-0.04
Daily Average Travel Length - Truck Trips			
- Travel Time	12.79	12.75	-0.04
- Travel Distance	8.61	8.57	-0.04
Hours of Delay (daily)	344,875	345,008	133
Truck Hours of Delay (daily)	10,941	10,898	-43
Percent of VMT experiencing congestion - All Day			
- Freeway	14.90%	14.30%	-0.60%
- Arterial	9.30%	9.60%	0.30%
- All Facility	10.40%	10.30%	-0.10%
Percent of VMT experiencing congestion - Peak			
- Freeway	25.20%	24.40%	-0.80%
- Arterial	14.60%	14.90%	0.30%
- All Facility	16.80%	16.70%	-0.10%
- Designated truck routes	9.40%	9.60%	0.20%
- Facilities w/bus routes	15.80%	15.40%	-0.40%
Mode Share Measures			
All Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	4,207,352	4,202,310	-5,042
- Carpool (Share ride)	3,742,429	3,736,526	-5,903

Travel Demand Analysis Performance Measure	MTP	MHUB	Difference
- Bus	92,346	94,514	2,168
- Rail	20,664	19,473	-1,191
- Non-Motorized (Bike and Walk)	749,185	758,069	8,884
Work Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	1,042,146	1,039,941	-2,205
- Carpool (Share ride)	146,955	146,698	-257
- Bus	49,654	51,081	1,427
- Rail	7,289	6,950	-339
- Non-Motorized (Bike and Walk)	55,414	55,443	29
All Trips - Peak Hours			
- Drive alone (single occupant vehicle -SOV)	2,269,659	2,268,182	-1,477
- Carpool (Share ride)	2,228,706	2,226,513	-2,193
- Bus	55,637	57,004	1,367
- Rail	13,824	13,024	-800
- Non-Motorized (Bike and Walk)	391,994	394,053	2,059
Transit Measures			
Transit Ridership by Prod. Ends – Total Peak and Off-peak			
- GoTriangle (Including Rail)	75,321	74,097	-1224
- GoRaleigh	121,505	126,176	4671
- Wolfline	16,007	15,726	-281
- GoCary	4,470	4,383	-87
Total Ridership for the CAMPO Region	217,303	220,382	3,079
Total Daily Person Trips	8,811,976	8,810,892	-1,084
Work Person Trips	1,301,458	1,300,113	-1,345
Total Daily Commercial Vehicle Trips	559,628	559,694	66
Daily Truck Trips	234,192	234,237	45
Roadway Lane Miles	9,245	9,245	0
Transit Supply (Service Miles) in the CAMPO Region	57,019	76,423	19,404

Source: TRMv6 scenario runs and analysis with the adopted MTP and MHUB networks.

Figure 4.16 Max VOC for the MHUB Scenario Network



Source: TRMv6 scenario run and analysis with the MHUB network.

Figure 4.17 Commuter Corridors with Max VOC over 1.3 in MHUB Scenario

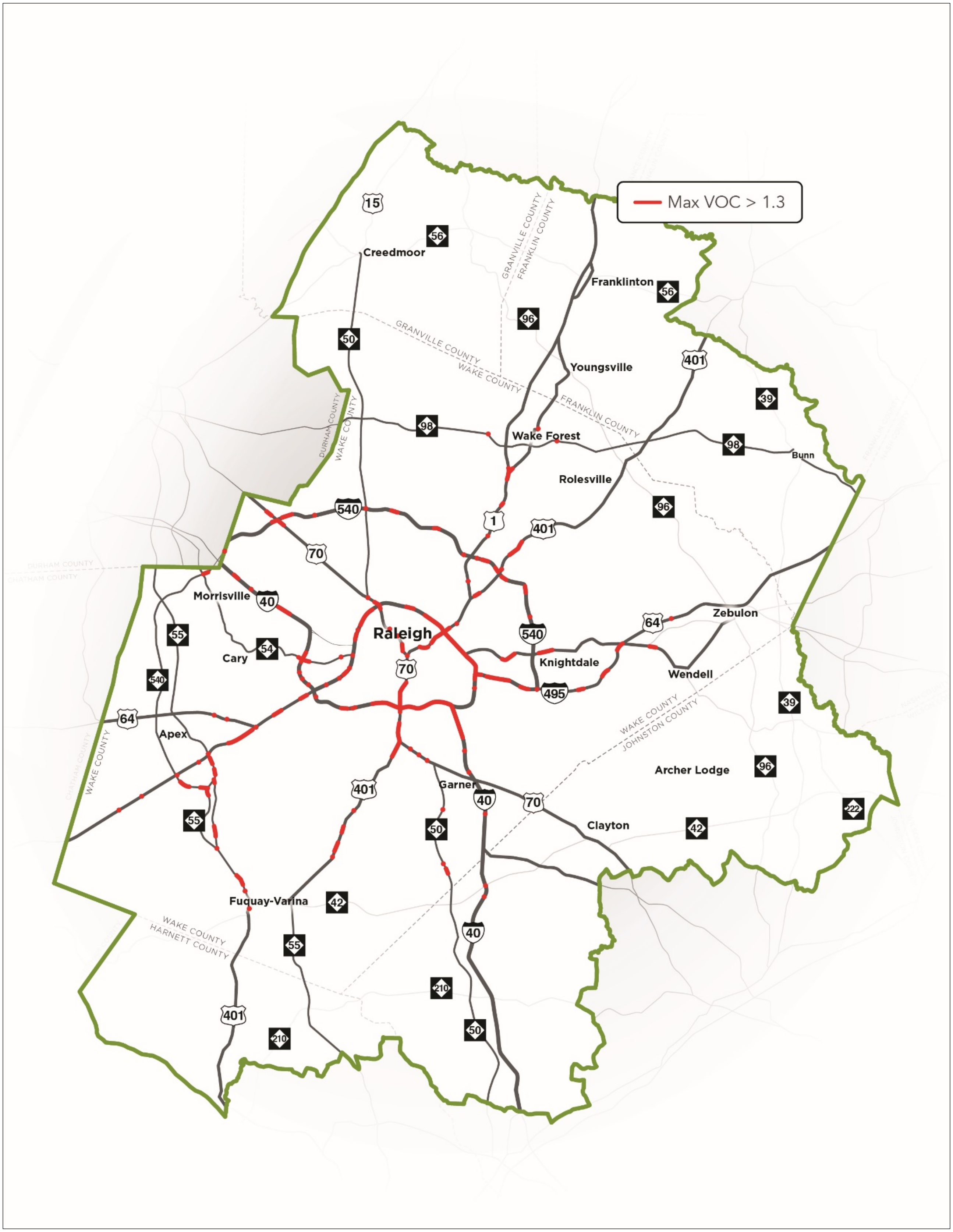
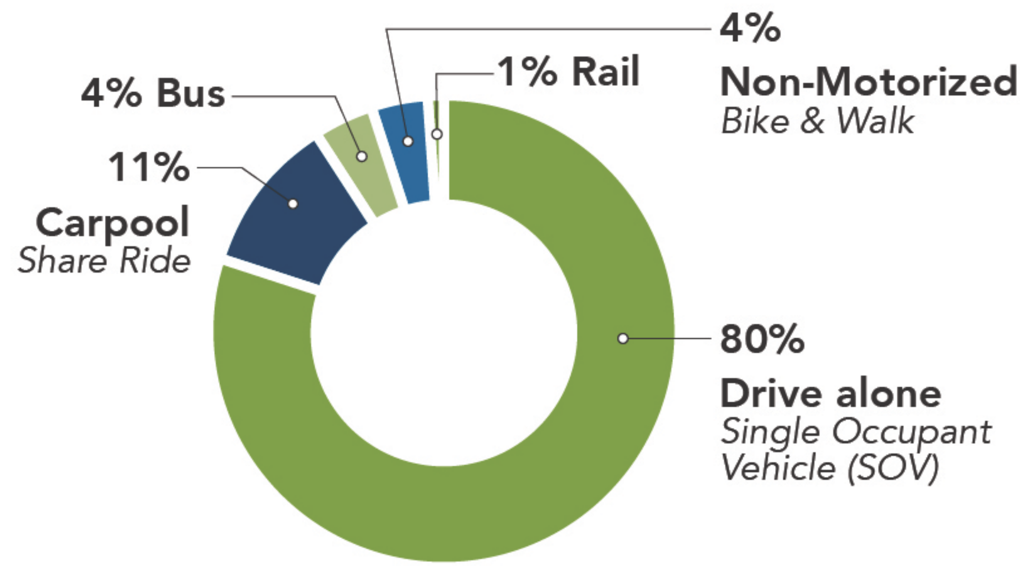


Figure 4.18 Mode Share for Daily Work Trips in MHUB Scenario



4.5 Gig Economy of Mobile Workers (GIG)

The Gig economy of mobile workers (GIG) scenario was developed to explore traffic conditions for an economic future when a significant part of the labor force would consist of mobile, part-time, and independent workers who are likely to work from home, in shared work spaces, or local coffee shops. This scenario was developed based on the national forecasts prepared by the McKinsey Global Institute, which estimated that around 27 percent of working age population, or 68 million people, in the United States work as independent workers for either primary or supplemental income, of which 51 percent are women (Figure 4.19).

The GIG scenario development entailed the following changes as compared to the adopted MTP:

- Assumed 25 percent reduction in work-related commute trips for medium income households with same or a greater number of available cars as the number of workers (Strata 4 in the TRM)

- Assumed 25 percent reduction in work-related commute trips for high income households with one or more cars (Strata 5 in the TRM)

The GIG scenario otherwise assumed the same level and allocation of future 2045 population and employment growth, and the same level of transportation investments in highway and transit as in the adopted MTP.

The GIG scenario analysis results are summarized in Table 4.5, in comparison with the adopted MTP scenario. The results reveal that freeway travel condition would improve to improve by 1.4% to 52.5 mph during peak period. Also, arterial travel condition is expected to improve slightly by 0.8%, from 35.6 mph to 35.9 mph. Drive Alone trips is anticipated to reduce by 3.7%, or156,000 less car trips every weekday. However, transit ridership is also expected to reduce by 17.4 percent, or 35,000 less transit riders every weekday.

The traffic congestion analysis based on the Max VOC metric is illustrated in Figure 4.20 for the GIG scenario network in TRM. Figure 4.21 presents the same Max VOC information for only the study area commuter corridors and highlighting in red only those corridor segments and interchange ramps or vicinity that have Max VOC ratio over 1.3, reflecting future travel demand exceeding future roadway capacity by more than 30 percent. These figures reveal that Max VOC would remain mostly below 1.3 for major commuter corridors, with very few exceptions as illustrated in Figure 4.21.

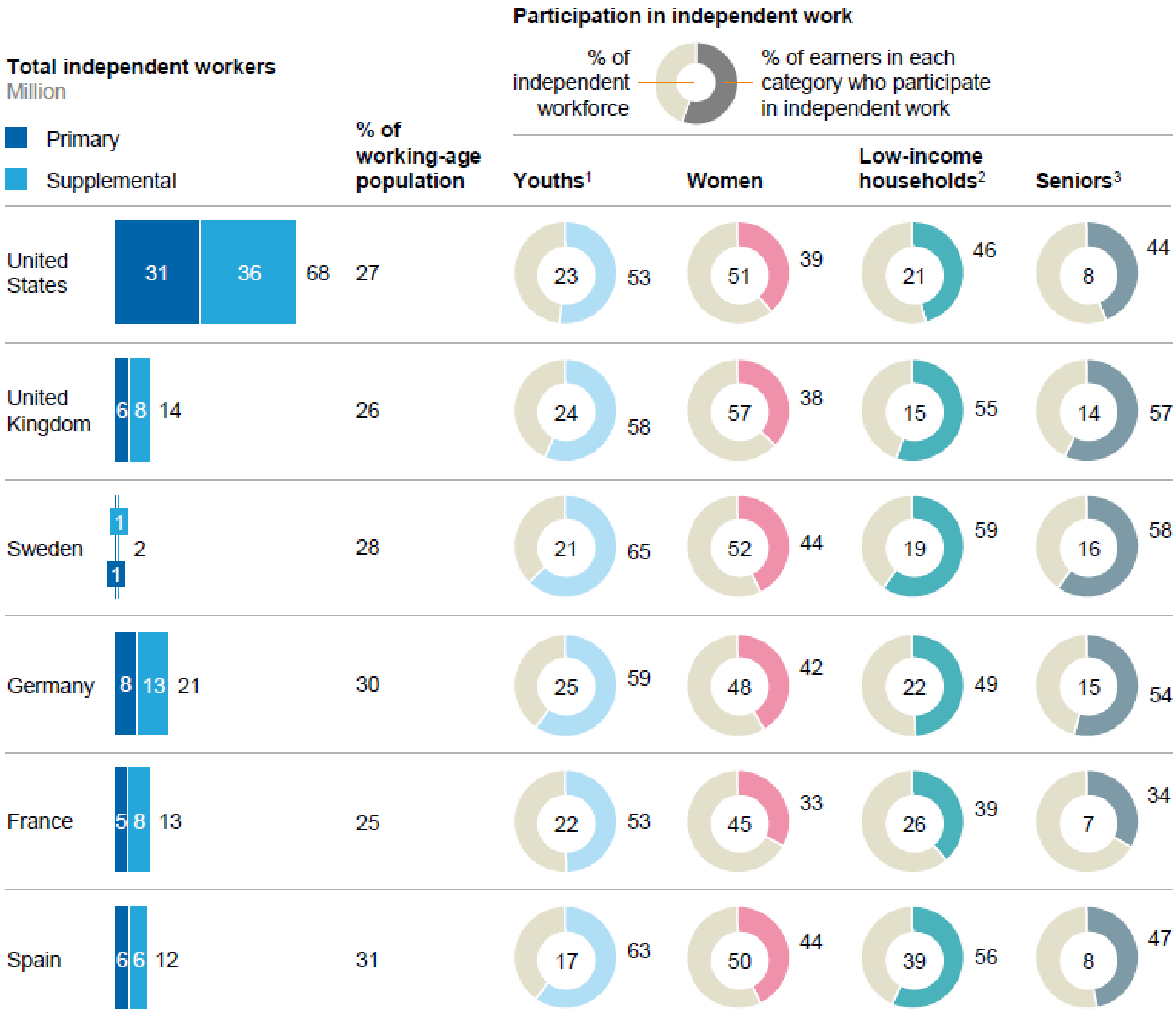
Figure 4.22 presents the distribution of daily work trips in the GIG scenario by five modes of travel, which shows 81 percent of the daily commuters travel by Single-Occupant Vehicle (SOV), 11 percent by Shared Ride/Carpool, 4 percent by Bus, 3 percent by Non-Motorized (Bicycle and Walk), and less than one percent by Rail.

Figure 4.19 Gig Economy National Trends

Exhibit E2

Independent workers span all demographic groups

Responses from MGI Survey



1 Defined as under age 25.
2 Defined as below $25,000 or similar across countries.
3 Defined as ages 65+.
NOTE: Numbers may not sum due to rounding.

SOURCE: Eurostat; BLS; McKinsey Global Institute analysis

Source: McKinsey Global Institute, Independent Work: Choice, Necessity and the Gig Economy, Oct 2016

Table 4.5 Travel Demand Analysis of the GIG Scenario

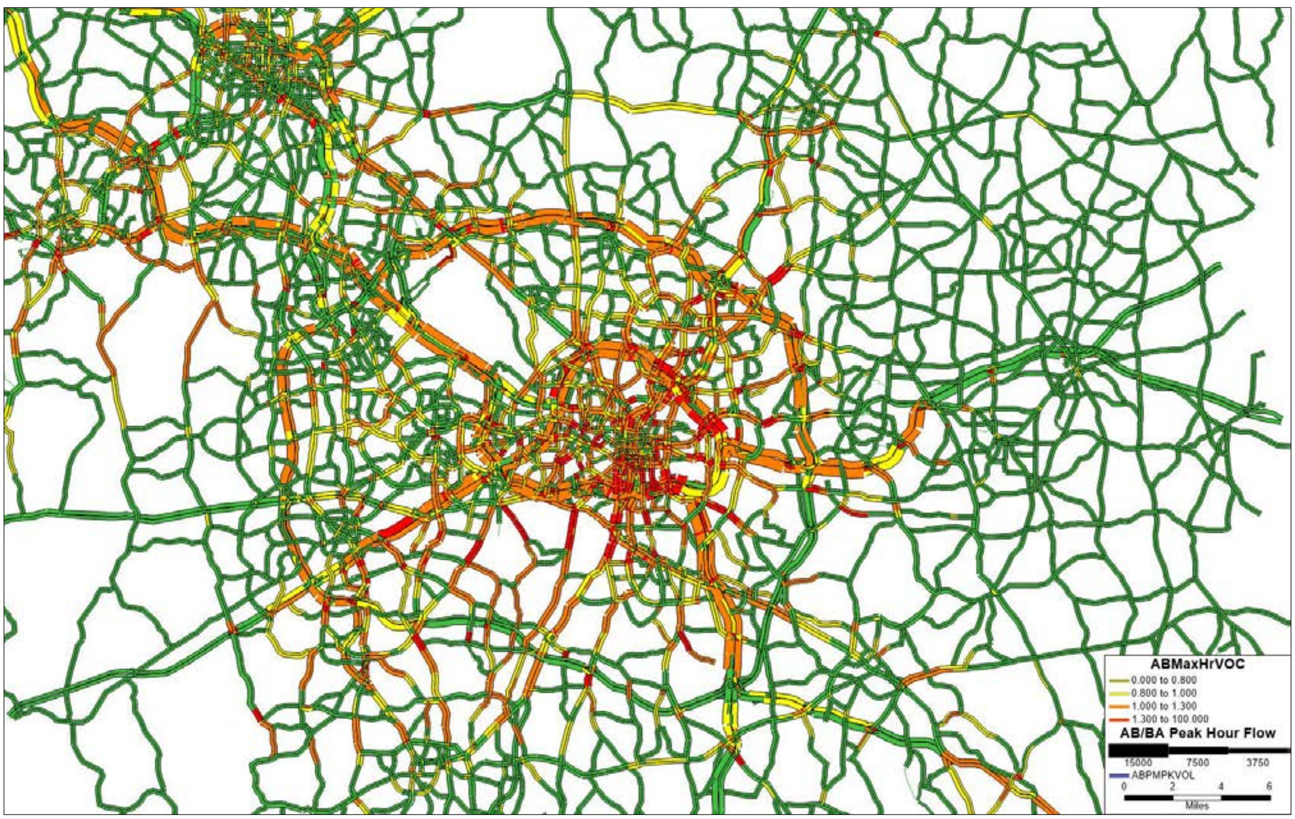
Travel Demand Analysis Performance Measure	MTP	GIG	Difference
Total Vehicle Miles Traveled or VMT (daily)			
- All Facility (no Centroid Connectors)	54,732,612	53,224,005	-1,508,607
Total Vehicle Hours Traveled or VHT (daily)			
- All Facility (no Centroid Connectors)	1,589,074	1,523,076	-65,998
Average Speed by Facility (miles/hour)			
- Freeway	55.4	55.8	0.4
- Arterial	36.9	37	0.1
- All Facility	42.9	43.2	0.3
Peak Average Speed by Facility (miles/hour)			
- Freeway	51.8	52.5	0.7
- Arterial	35.6	35.9	0.3
- All Facility	40.7	41.2	0.5
Daily Average Travel Length - All Person Trips			
- Travel Time	17.19	16.79	-0.4
- Travel Distance	7.74	7.66	-0.08
Daily Average Travel Length - Work Trips			
- Travel Time	26.76	26.22	-0.54
- Travel Distance - Work Trips	14.09	14.36	0.27
Peak Average Travel Length - All Person Trips			
- Peak Travel Time	16.75	16.74	-0.01
- Peak Travel Distance	6.98	7.08	0.1
Daily Average Travel Length - All Commercial Vehicle Trips			
- Travel Time	11	11.65	0.65
- Travel Distance	7.14	7.6	0.46
Daily Average Travel Length - Truck Trips			
- Travel Time	12.79	13.56	0.77
- Travel Distance	8.61	9.18	0.57
Hours of Delay (daily)	344,875	313,008	-31867
Truck Hours of Delay (daily)	10,941	11,460	519
Percent of VMT experiencing congestion - All Day			
- Freeway	14.90%	13.20%	-1.70%

Travel Demand Analysis Performance Measure	MTP	GIG	Difference
- Arterial	9.30%	8.80%	-0.50%
- All Facility	10.40%	9.50%	-0.90%
Percent of VMT experiencing congestion - Peak			
- Freeway	25.20%	22.10%	-3.10%
- Arterial	14.60%	13.50%	-1.10%
- All Facility	16.80%	15.10%	-1.70%
- Designated truck routes	9.40%	9%	-0.40%
- Facilities w/bus routes	15.80%	14.90%	-0.90%
Mode Share Measures			
All Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	4,207,352	4,051,239	-156,113
- Carpool (Share ride)	3,742,429	3,729,378	-13,051
- Bus	92,346	87,750	-4,596
- Rail	20,664	17,669	-2,995
- Non-Motorized (Bike and Walk)	749,185	709,641	-39,544
Work Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	1,042,146	878,760	-163,386
- Carpool (Share ride)	146,955	124,214	-22,741
- Bus	49,654	42,590	-7,064
- Rail	7,289	5,813	-1,476
- Non-Motorized (Bike and Walk)	55,414	33,699	-21,715
All Trips - Peak Hours			
- Drive alone (single occupant vehicle -SOV)	2,269,659	2,113,594	-156,065
- Carpool (Share ride)	2,228,706	2,215,625	-13,081
- Bus	55,637	51,010	-4,627
- Rail	13,824	10,830	-2,994
- Non-Motorized (Bike and Walk)	391,994	352,454	-39,540
Transit Measures			
Transit Ridership by Prod. Ends – Total Peak and Off-peak			
- GoTriangle (Including Rail)	75,321	65,411	-9910
- GoRaleigh	121,505	96,461	-25044
- Wolfline	16,007	16,279	272
- GoCary	4,470	4,373	-97

Travel Demand Analysis Performance Measure	MTP	GIG	Difference
Total Ridership for the CAMPO Region	217,303	182,254	-35,049
Total Daily Person Trips	8,811,976	8595677	-216,299
Work Person Trips	1,301,458	1085076	-216,382
Total Daily Commercial Vehicle Trips	559,628	559628	0
Daily Truck Trips	234,192	234192	0
Roadway Lane Miles	9,245	9,245	0
Transit Supply (Service Miles) in the CAMPO Region	57,019	57,019	0

Source: TRMv6 scenario runs and analysis with the adopted MTP and HWYX networks.

Figure 4.20 Max VOC for the GIG Scenario Network



Source: TRMv6 scenario run and analysis with the GIG network.

Figure 4.21 Commuter Corridors with Max VOC over 1.3 in GIG Scenario

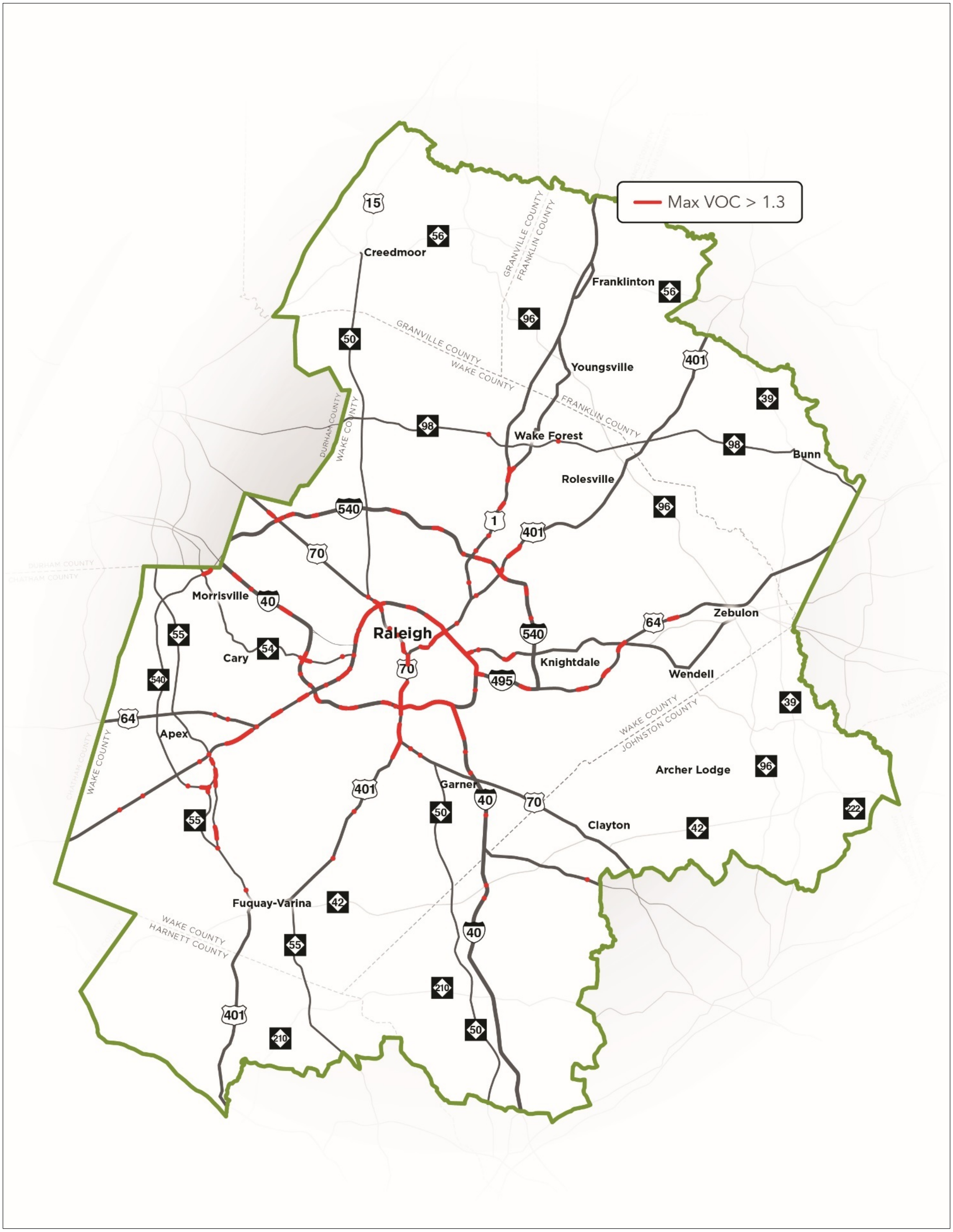
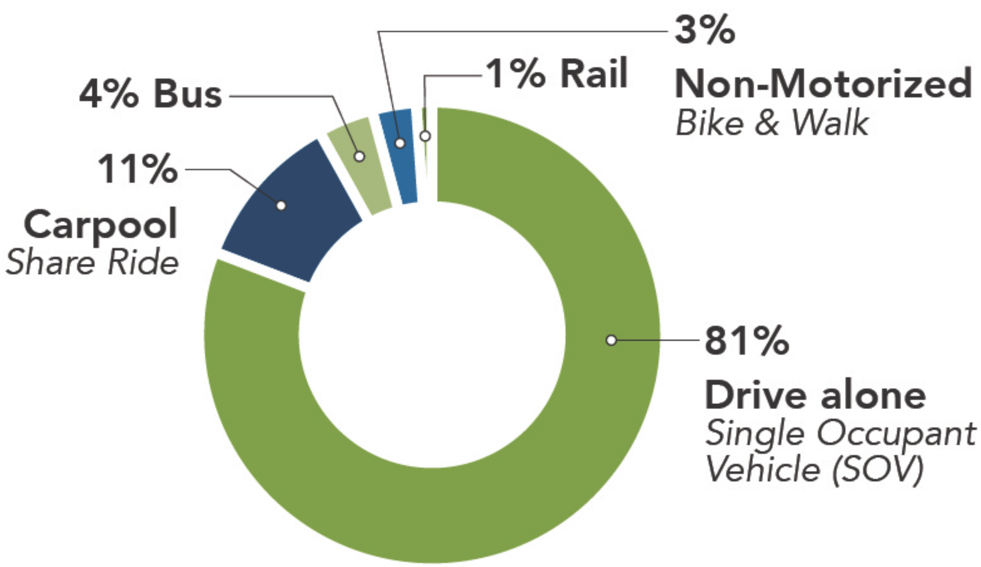


Figure 4.22 Mode Share for Daily Work Trips in GIG Scenario



4.6 Regional Resiliency (RESY)

The Regional Resiliency (RESY) scenario was developed to plan for extreme weather events to build resiliency in the region's commuter corridors. It should be noted that Resiliency planning is consistent with congestion management best practices as many MPOs are developing climate hazard mitigation plans due to recent frequency of extreme weather events across the country.

The Resiliency scenario was developed based on reviews of the Wake County Hazard Mitigation Plan and the 100-year flood prone areas in Wake County. The 100-year flood prone data was utilized to identify flood-risk segments along the commuter corridors and modifying the adopted MTP roadway network for a potential roadway network disruption scenario. In this disruption scenario, it was assumed that 100-year flood prone areas in Wake County can pose risks to traffic flows along major commuter corridors and as such lane capacities were reduced by 50% for all of the identified vulnerable commuter corridor segments.

The TRM roadway network for the RESY scenario was developed by starting from the 2045 MTP network and then reducing the number of available General-Purpose (GP) lanes for the vulnerable corridor segments by

50 percent. These vulnerable corridor segments are illustrated in Figure 4.23 with highlighted corridors in the TRM highway network. The RESY scenario assumed the same level and allocation of future 2045 population and employment growth as in the adopted MTP. Also, the same level of transit service as in the adopted MTP was assumed.

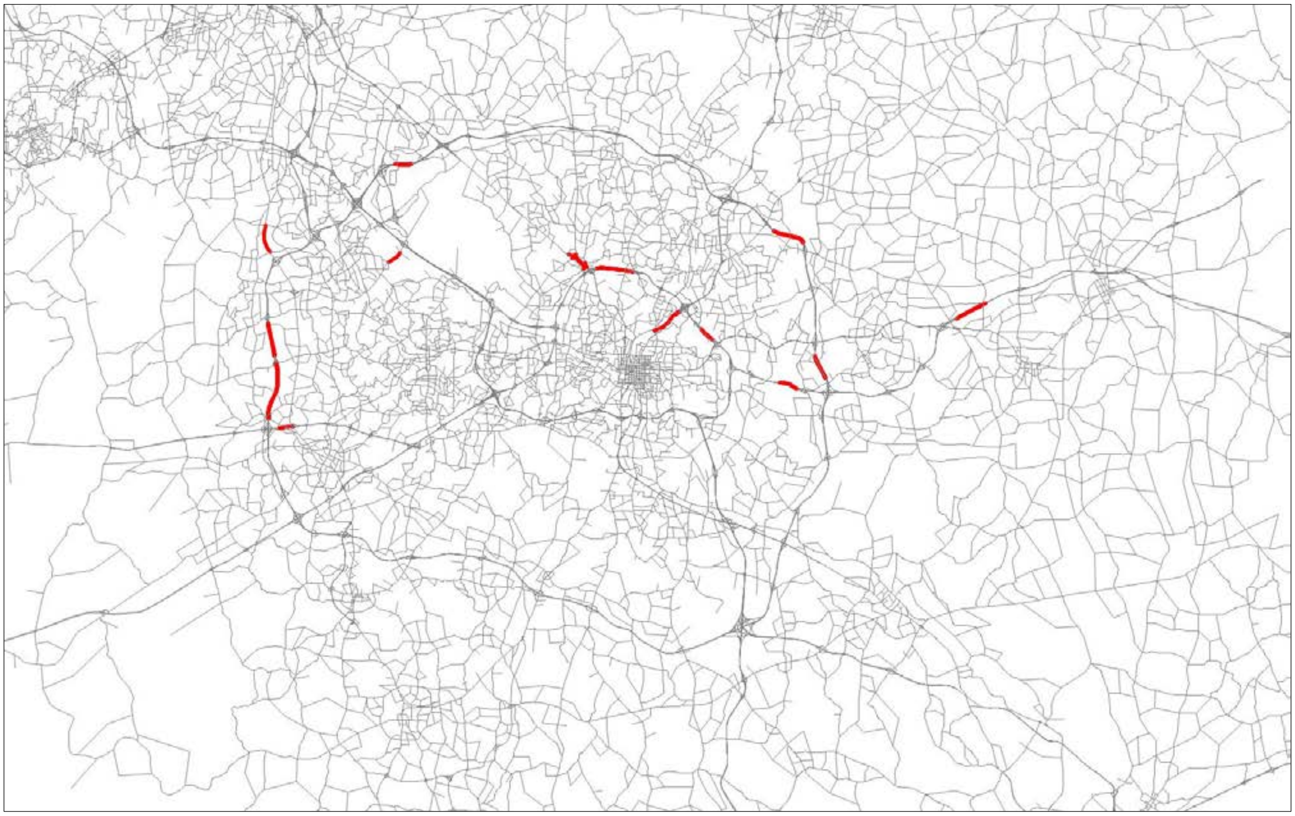
The RESY scenario analysis results are summarized in Table 4.6, in comparison with the adopted MTP scenario. The results reveal that freeway travel condition is expected to remain the same to 51.8 mph during peak period. However, arterial travel condition is expected to worsen by 1.4%, from 35.6 mph to 35.1 mph due to traffic diversions.

Drive Alone trips is anticipated to remain the same and transit ridership is expected to increase by 0.2 percent.

The traffic congestion analysis based on the Max VOC metric is illustrated in Figure 4.24 for the RESY scenario network in TRM. Figure 4.25 presents the same Max VOC information for only the study area commuter corridors and highlighting in red only those corridor segments and interchange ramps or vicinity that have Max VOC ratio over 1.3, reflecting future travel demand exceeding future roadway capacity by more than 30 percent. These figures reveal that traffic congestion would worsen for the major commuter corridors in the region in an extreme weather event situation. However, the region's transportation network appears to have some redundancy to accommodate traffic diversion to alternate routes to avoid weather related traffic disruptions.

Figure 4.26 presents the distribution of daily work trips in the RESY scenario by five modes of travel, which shows 80 percent of the daily commuters travel by Single-Occupant Vehicle (SOV), 11 percent by Shared Ride/Carpool, 4 percent by Bus, 4 percent by Non-Motorized (Bicycle and Walk), and less than one percent by Rail.

Figure 4.23 Commuter Corridors with Flooding Risks for the RESY Scenario



Source: TRMv6 RESY Scenario Network; Potential choke points due to flooding risks are highlighted in red

Table 4.6 Travel Demand Analysis of the RESY Scenario

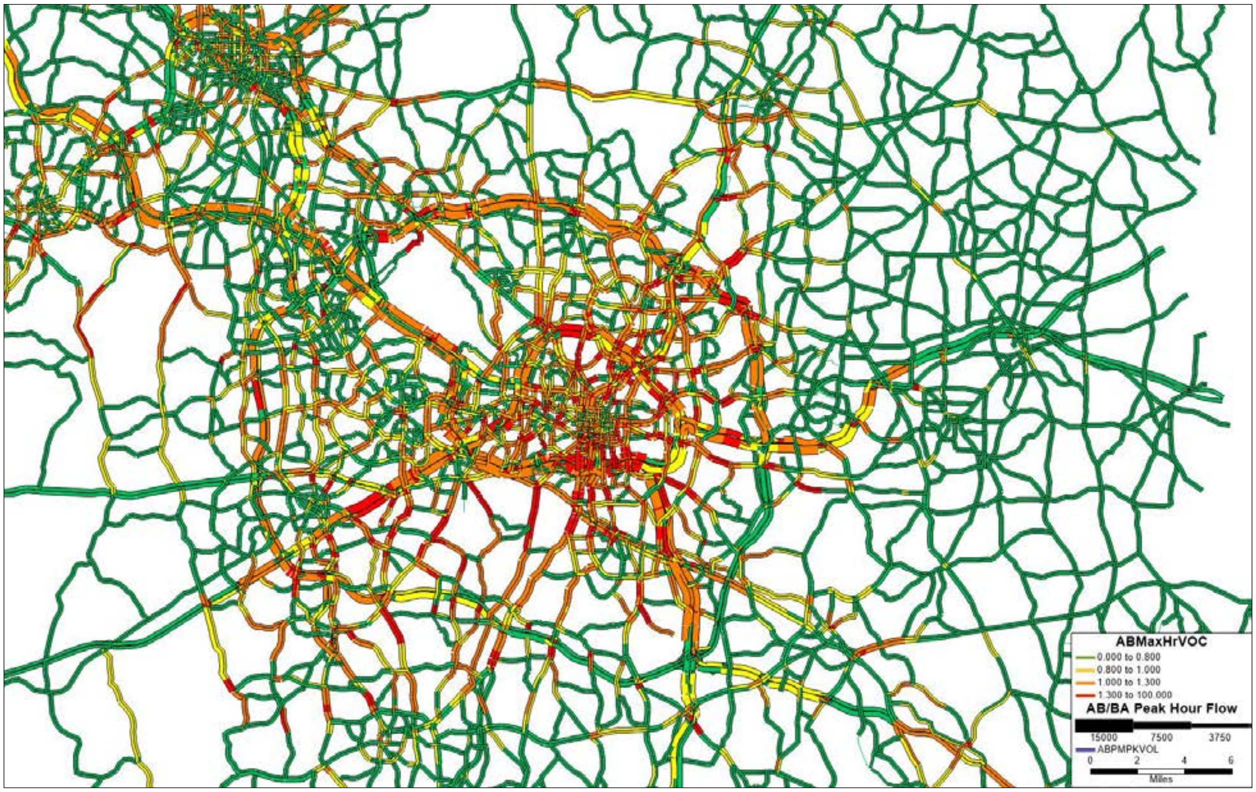
Travel Demand Analysis Performance Measure	MTP	RESY	Difference
Total Vehicle Miles Traveled or VMT (daily)			
- All Facility (no Centroid Connectors)	54,732,612	54555730	-176,882
Total Vehicle Hours Traveled or VHT (daily)			
- All Facility (no Centroid Connectors)	1,589,074	1,622,084	33,010
Average Speed by Facility (miles/hour)			
- Freeway	55.4	55.2	-0.2
- Arterial	36.9	36.5	-0.4
- All Facility	42.9	42.5	-0.4
Peak Average Speed by Facility (miles/hour)			
- Freeway	51.8	51.8	0
- Arterial	35.6	35.1	-0.5
- All Facility	40.7	40.3	-0.4

Travel Demand Analysis Performance Measure	MTP	RESY	Difference
Daily Average Travel Length - All Person Trips			
- Travel Time	17.19	17.47	0.28
- Travel Distance	7.74	7.74	0
Daily Average Travel Length - Work Trips			
- Travel Time	26.76	27.3	0.54
- Travel Distance - Work Trips	14.09	14.1	0.01
Peak Average Travel Length - All Person Trips			
- Peak Travel Time	16.75	17.04	0.29
- Peak Travel Distance	6.98	6.97	-0.01
Daily Average Travel Length - All Commercial Vehicle Trips			
- Travel Time	11	11.06	0.06
- Travel Distance	7.14	7.11	-0.03
Daily Average Travel Length - Truck Trips			
- Travel Time	12.79	12.86	0.07
- Travel Distance	8.61	8.58	-0.03
Hours of Delay (daily)	344,875	375815	30940
Truck Hours of Delay (daily)	10,941	12110	1169
Percent of VMT experiencing congestion - All Day			
- Freeway	14.90%	14.60%	-0.30%
- Arterial	9.30%	10.40%	1.10%
- All Facility	10.40%	10.70%	0.30%
Percent of VMT experiencing congestion - Peak			
- Freeway	25.20%	23.50%	-1.70%
- Arterial	14.60%	16.10%	1.50%
- All Facility	16.80%	16.80%	0.00%
- Designated truck routes	9.40%	9.70%	0.30%
- Facilities w/bus routes	15.80%	16.30%	0.50%
Mode Share Measures			
All Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	4,207,352	4205429	-1,923
- Carpool (Share ride)	3,742,429	3741202	-1,227
- Bus	92,346	90926	-1,420

Travel Demand Analysis Performance Measure	MTP	RESY	Difference
- Rail	20,664	21001	337
- Non-Motorized (Bike and Walk)	749,185	753391	4,206
Work Trips - Daily			
- Drive alone (single occupant vehicle -SOV)	1,042,146	1040813	-1,333
- Carpool (Share ride)	146,955	146582	-373
- Bus	49,654	48376	-1,278
- Rail	7,289	7396	107
- Non-Motorized (Bike and Walk)	55,414	58297	2,883
All Trips - Peak Hours			
- Drive alone (single occupant vehicle -SOV)	2,269,659	2267784	-1,875
- Carpool (Share ride)	2,228,706	2227445	-1,261
- Bus	55,637	54191	-1,446
- Rail	13,824	14176	352
- Non-Motorized (Bike and Walk)	391,994	396217	4,223
Transit Measures			
Transit Ridership by Prod. Ends – Total Peak and Off-peak			
- GoTriangle (Including Rail)	75,321	75,524	203
- GoRaleigh	121,505	121,659	154
- Wolfline	16,007	80,683	64676
- GoCary	4,470	4,470	0
Total Ridership for the CAMPO Region	217,303	217,655	352
Total Daily Person Trips	8,811,976	8,811,949	-27
Work Person Trips	1,301,458	1,301,464	6
Total Daily Commercial Vehicle Trips	559,628	559,628	0
Daily Truck Trips	234,192	234,192	0
Roadway Lane Miles	9,245	9,207	-38
Transit Supply (Service Miles) in the CAMPO Region	57,019	57,019	0

Source: TRMv6 scenario runs and analysis with the adopted MTP and RESY networks.

Figure 4.24 Max VOC for the RESY Scenario Network



Source: TRMv6 scenario run and analysis with the RESY network.

Figure 4.25 Commuter Corridors with Max VOC over 1.3 in RESY Scenario

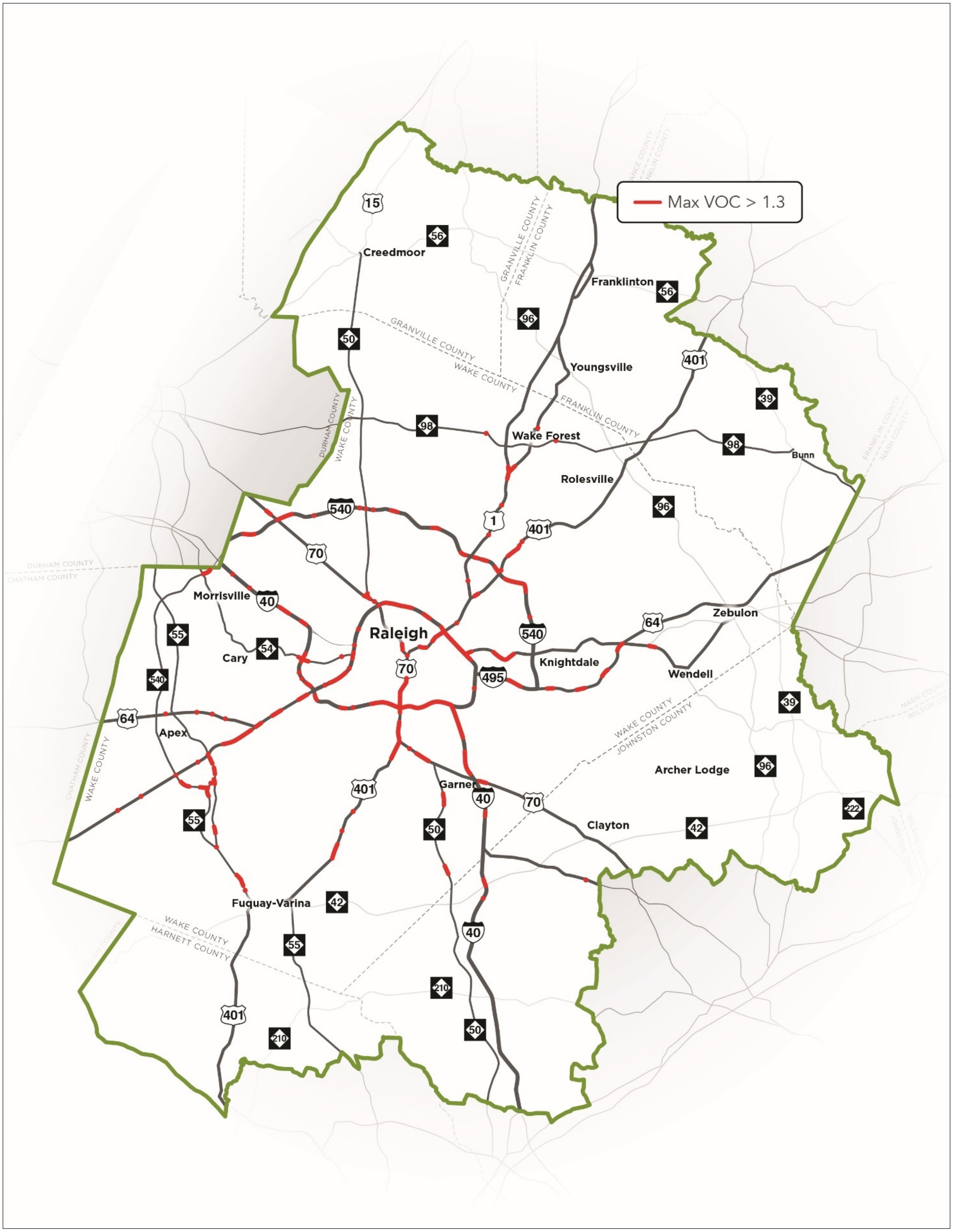
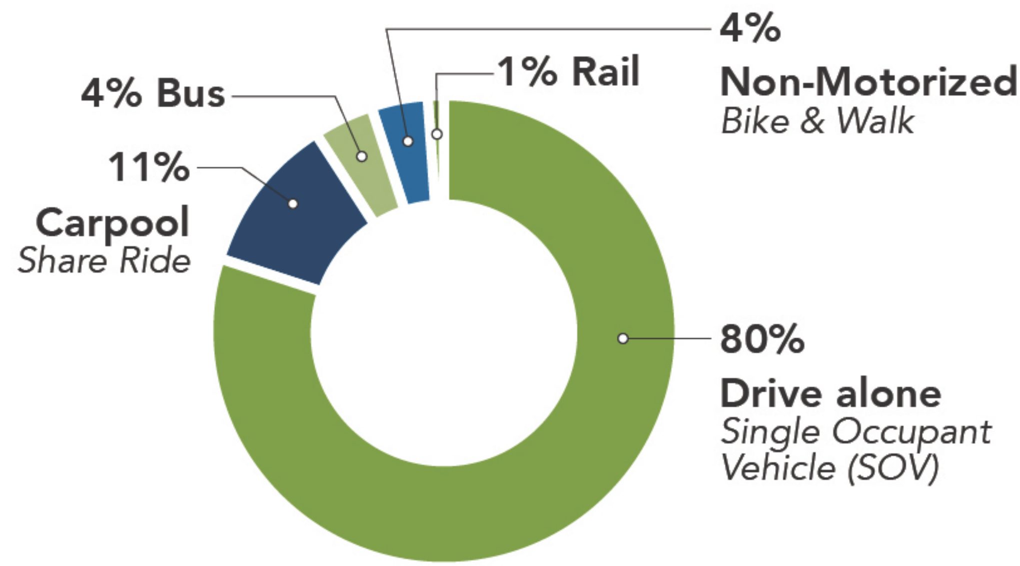


Figure 4.26 Mode Share for Daily Work Trips in RESY Scenario



4.7 Scenario Comparison

This section presents a summary comparison of the six scenarios analyzed in the study. This summary comparison is based on changes compared to the 2045 Adopted MTP. The scenario analysis results are summarized for the following six scenarios:

- HWYX – Highway Mega Expansion: This scenario hypothetically assumed doubling of the number of General-Purpose lanes along congested commuter corridor segments in the CAMPO region including I-40, I-440, I-540, US 1, US 64, US 70, and US 401. This was a bookend, hypothetical scenario and was deemed unrealistic and infeasible. Hence, information about the scenario is presented in the report, but any comparison to other scenarios are discouraged.
- TOLL3 – Dynamic Tolling: This scenario assumed congestion pricing during peak periods along the region's freeway corridors. Assumed $0.90 per mile toll rates on express lanes along I-40, I-540, and for all lanes along NC 540 during AM and PM peak periods. Also, assumed $0.90 per mile toll rates on all lanes along I-440 and the I-440 interchange ramps that carry traffic to and from downtown

Raleigh (as a proxy to area-based tolling for the urban core). It was also assumed that the peak toll pricing is only applicable to Single-Occupant Vehicles (SOVs) and trucks, but not on High-Occupancy Vehicles (HOVs) to incentivize carpool and transit travel in the region.

- ETOD – Equitable Transit-Oriented Development: This scenario assumed 50 percent additional growth in multi-family, office and retail use within half-mile of each planned transit station area in the region, and a 100 percent increase in transit frequency for future transit routes in the CAMPO region.
- RESY – Regional Resiliency: This scenario assumed a 50 percent reduction in the number of available lanes at several commuter corridor segments that were deemed to be vulnerable to flooding in an extreme weather event.
- GIG – Gig Economy of Mobile Workers: This scenario assumed a 25 percent reduction in work-related commute trips for medium income households with same or a greater number of available cars as the number of workers, and for high income households with one or more cars. This scenario reflects growth of mobile, part-time, and independent workers who are likely to work from home, shared work spaces, or local coffee shops.
- MHUB – Smart Mobility Hubs: This scenario identified thirteen (13) locations around the edges of the region as future smart mobility hubs. This scenario also assumed 50 percent additional growth in household, office, and retail uses within one and half-mile band of each of the identified mobility hub. Also, assumed high-frequency premium transit service during commuting hours to connect each mobility hub with downtown Raleigh and the Research Triangle Park (RTP).

The scenario analysis results have been summarized in Table 4.7. (The detailed TRM performance measures have been provided in Appendix C). The analysis reveals that the ETOD, MHUB and GIG scenarios have the potential to reduce traffic congestion along the commuter corridors in the region. The ETOD and MHUB scenarios considered a combination of land use growth re-allocations paired with premium high frequency transit to increase connectivity and convenience. The MHUB scenario supports recent travel behavior shifts due to advent of Transportation Network Companies (TNCs), Connected and Autonomous Vehicles (CAVs) and emerging shared mobility trends. The GIG scenario illustrates the likely potential for travel demand management strategies, such as tele-commuting and flexible work hours and flexible work week, in reducing traffic congestion. The TOLL scenario shows positive results for freeway express lanes, but is likely to have negative impacts on local arterial traffic due to potential traffic diversions.

Table 4.7 Summary Comparison of the Land Use-Transportation Scenarios

Performance Measures	MTP	HWYX	TOLL3	ETOD	RESY	GIG	MHUB
Total Daily VMT, All Facility (no C Connectors)	54,732,612	1.0%	-1.9%	-2.4%	-0.3%	-2.8%	-0.4%
Total Daily VHT, All Facility (no C Connectors)	1,589,074	-6.2%	6.6%	0.5%	2.1%	-4.2%	-0.3%
Peak Average Speed by Facility (miles/hour)							
- Freeway	51.8	16.2%	3.5%	0.8%	0.0%	1.4%	0.0%
- Arterial	35.6	2.8%	-7.9%	-0.6%	-1.4%	0.8%	0.3%
Truck Hours of Delay (daily)	10,941	-35.8%	24.3%	1.2%	10.7%	4.7%	-0.4%
Percent of VMT experiencing congestion - Peak							
- Freeway	25.2%	-84.1%	-28.2%	-5.2%	-6.7%	-12.3%	-3.2%
- Arterial	14.6%	-31.5%	52.1%	3.4%	10.3%	-7.5%	2.1%
- Designated truck routes	9.4%	-48.9%	23.4%	9.6%	3.2%	-4.3%	2.1%
- Facilities w/bus routes	15.8%	-60.8%	8.2%	0.0%	3.2%	-5.7%	-2.5%
Mode Share Measures							
All Trips - Daily							
- Drive alone (single occupant vehicle -SOV)	4,207,352	0.1%	-1.2%	-4.0%	0.0%	-3.7%	-0.1%
- Carpool (Share ride)	3,742,429	0.0%	1.1%	0.5%	0.0%	-0.3%	-0.2%
- Bus	92,346	6.9%	0.6%	31.6%	-1.5%	-5.0%	2.3%
- Rail	20,664	-3.4%	1.2%	25.7%	1.6%	-14.5%	-5.8%
- Non-Motorized (Bike and Walk)	749,185	-1.1%	3.8%	21.3%	0.6%	-5.3%	1.2%
Transit Measures							
Transit Ridership by Prod. Ends	Total						
- TTA (Including Rail)	75,321	-1.9%	-1.0%	28.6%	0.3%	-13.2%	-1.6%
- CAT	121,505	-0.9%	-0.6%	42.9%	0.1%	-20.6%	3.8%
Demographics Measures							
Population	2,057,266	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Employment	1,003,493	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Total Daily Person Trips	8,811,976	0.0%	0.2%	0.5%	0.0%	-2.5%	0.0%

Performance Measures	MTP	HWYX	TOLL3	ETOD	RESY	GIG	MHUB
Work Person Trips	1,301,458	0.0%	0.0%	-0.3%	0.0%	-16.6%	-0.1%
Total Daily CV Trips	559,628	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%
Daily Truck Trips	234,192	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%
Other Measures							
Highway Lane Miles	9,245	10.5%	0.0%	0.0%	-0.4%	0.0%	0.0%
Transit Service Miles (Triangle, Raleigh & Cary)	53,455	0.0%	0.0%	64.4%	0.0%	0.0%	36.3%

Source: TRMv6 model runs and analysis for six scenarios; Results are compared to the adopted MTP whenever feasible. Positive change for each performance measure is shown in green and negative change is shown in red, and anything in between are shown in lighter shades of green and lighter shades of red such as orange and yellow. The HWYX scenario was not compared as this was considered a bookend, hypothetical, and infeasible scenario.

5.0 Benefit Cost Analysis (BCA)

This section documents the future year (2045) land use-transportation scenario analysis using a Benefit-Cost Analysis (BCA) Tool[4], which is an open-source software tool. The BCA Tool was originally developed by RSG for the Federal Highway Administration (FHWA). The BCA Tool has been applied in other metropolitan regions for scenario planning including Portland, Oregon, and San Diego and San Francisco, California.

The BCA Tool was applied in the study to better understand the benefits and social equity dimensions of the land use and transportation investment decisions with an economic analysis tool. This BCA Tool utilized several performance measures including safety, travel time savings, travel time reliability, vehicle operating costs, vehicle emissions, surface water, noise, physical activity, and accessibility (i.e., travel options and choices).

The BCA Tool was tailored to work with the TRM model outputs, and enhanced with a customized health impacts model to estimate changes in premature mortality between scenarios based on disaggregated travel demand model outputs. This BCA Tool was used to analyze a total of six future scenarios that are described in the previous section. The BCA Tool results are presented by comparing each future year (2045) scenario with the Adopted 2045 Metropolitan Transportation Plan (MTP).

5.1 BCA Methodology Summary

This section presents a summary of the methodology embedded in the BCA Tool. The full methodology underlying the BCA Tool has been documented in Appendix D.

The BCA methodology reflect best practices related to travel benefit-cost estimation techniques applied by several Metropolitan Planning Organizations (MPOs) including the San Diego Association of Governments (SANDAG) in California, the Metropolitan Transportation Commission (MTC) in California, the Puget Sound Regional Council (PSRC) in Washington, and the Portland Metro in Oregon.

The BCA Tool considers nine benefit performance measures in five categories: safety, mobility, environment, livability, and accessibility. These nine benefit performance measures are summarized in Table 5.1 in terms of how they are aggregated in the model, which variables are considered in the computation, and the degree of confidence in the performance measure based on their maturity level.

[4] Benefit Cost Analysis using Activity-Based Models. FHWA Advancing Transportation Planning through Innovation and Research Final Report. November 2016.

Stabler, B., Bernardin, V., Paul, B., and Hauger, K. Development of a Multi-Criteria Evaluation Benefit Calculator to Support Transportation Planning Alternatives Analysis. Presented at 97th Annual Meeting of the Transportation Research Board, Washington, D.C., 2018

Table 5-1 Summary of Benefit Performance Measures

Benefit Performance Measure	Benefit Category	Type of Aggregation	Quantities Utilized in the BCA	Maturity of the Measure	Degree of Confidence
Safety	Safety	Link	Fatal, Injury, Property-Damage Only Crashes	Proven	●●●●○
Travel Time	Mobility	OD	Minutes of travel time saved by mode	Proven	●●●●●
Travel Time Reliability	Mobility	OD	Decrease in travel time variability (standard deviation of travel time)	Emerging	●●○○○
Vehicle Operating Costs	Mobility	Link	Gallons of fuel consumed, VMT-based non-fuel costs	Proven	●●●●○
Emissions	Environment	Link	Tons of CO2e, PM2.5, PM10, NOx, VOC	Proven	●●●●●
Surface Water	Environment	Link	VMT-based cost of impacts	Emerging	●●○○○
Noise	Livability	Link	VMT-based cost of impacts	Emerging	●●○○○
Physical Activity	Livability	OD	Avoided mortality	Emerging	●●●○○
Travel Options / Choices	Accessibility	Zone	Monetary value of additional mode / destination options	Emerging	●●●○○

5.2 BCA Results for the Future Land Use-Transportation Scenarios

This section presents the BCA results for each land use-transportation scenario analyzed in the Commuter Corridors study and a summary comparison of the results.

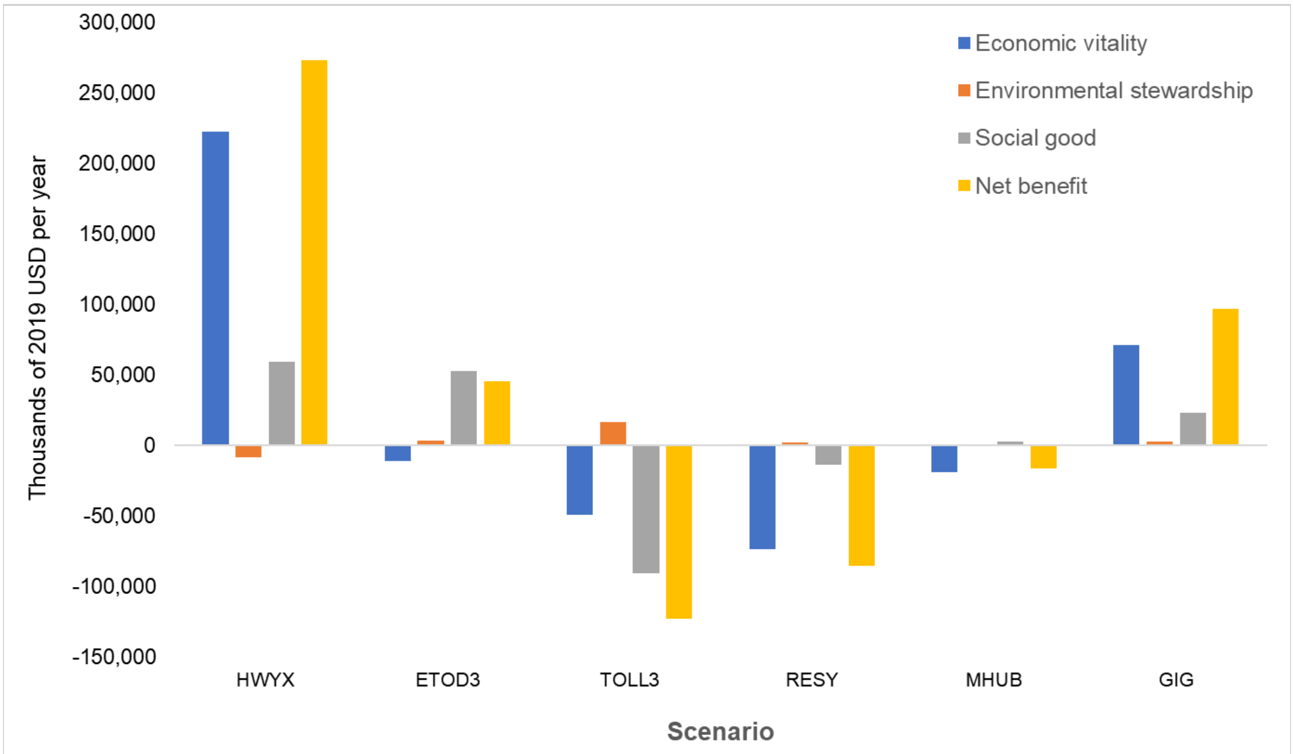
Benefit-cost analysis of the six scenarios considered revealed stark differences between scenarios. While the Highway Mega Expansion (HWYX) scenario has the highest estimated user benefit, this benefit is driven largely by reductions in travel time and increases in reliability and accessibility resulting from the unrealistic (and extremely costly) proposed infrastructure expansion. Of the remaining feasible scenarios, the Equitable Transit Oriented Development (ETOD) and Gig Economy of Mobile Workers (GIG) scenarios are estimated to have net positive user benefits compared to currently adopted 2045 Metropolitan Transportation Plan (MTP) whereas the remaining scenarios, namely Dynamic Tolling (TOLL3), Smart Mobility Hubs (MHUB), and Regional Resiliency (RESY), instead have net negative user benefits (i.e., costs) compared to the adopted 2045 MTP. User benefit results, broken down by benefit category, are summarized in Table 5.2. The same results are also presented in a bar chart in Figure 5.1.

Table 5-2 BCA Performance Measures Comparison

Benefit Category	Benefit Measure	Highway Expansion (HWYX) (see Note 1)	Equitable Transit-Oriented Dvlpmnt. (ETOD)	Dynamic Tolling (TOLL3)	Regional Resiliency (RESY)	Smart Mobility Hubs (MHUB)	Gig Economy of Mobile Workers (GIG)
		Thousands of 2019 USD per year					
Economic vitality	Travel Time	111,982	-13,186	-108,729	-31,694	-2,794	47,453
	Reliability	114,085	-3,862	51,373	-42,953	-17,320	20,972
	Veh. Ops. Costs	-3,653	6,241	8,336	948	1,054	2,864
	Subtotal-Econ	222,414	-10,807	-49,019	-73,699	-19,060	71,288
Environmental stewardship	Emissions	-5,510	1,343	10,768	1,384	-106	904
	Surface Water	-604	1,606	1,131	184	214	1,817
	Noise	-2,442	298	4,766	403	-136	-90
	Subtotal-Environ	-8,556	3,248	16,666	1,970	-28	2,631
Social Goods	Safety	-33,555	18,644	33,363	6,815	2,313	24,298
	Physical Activity	-3,328	23,673	5,544	532	420	-7,357
	Accessibility	96,481	10,725	-129,816	-20,741	71	6,303
	Subtotal-Social	59,597	53,042	-90,909	-13,395	2,803	23,244
		273,455	45,483	-123,262	-85,124	-16,284	97,163

Note 1: HWYX represents an infeasible, 'bookend' scenario. Therefore, direct comparison with other scenarios is discouraged.

Figure 5.1 BCA Performance Measures Comparison



Note: HWYX represents an infeasible, 'bookend' scenario. Therefore, direct comparison with other scenarios is discouraged.

Looking at each benefit category separately (economic vitality, environmental stewardship, and social goods) several tradeoffs between scenarios become apparent. In the economic vitality category, two scenarios (HWYX and GIG) show positive user benefits while all others are negative. It should be noted, however, that in scenarios with increased transit usage (i.e., ETOD and MHUB) negative travel time impacts may be overstated—while travel times may increase slightly as more trips are taken via public transit, users may find other productive uses of that time, such as teleworking, socializing, or resting. This is not accounted for in this analysis.

In the environmental stewardship category, scenarios with the greatest VMT reduction (ETOD, TOLL3, RESY, and GIG) show net positive benefits whereas VMT increases in the HWYX and MHUB scenarios result in negative environmental impacts. In terms of social good, all scenarios net positive benefits aside from TOLL3—which drastically decreases accessibility given high toll rates—and the RESY scenario. Interestingly, the HWYX scenario is predicted to have negative safety outcomes due to increased VMT whereas all other scenarios have positive safety benefits. A shift away from non-motorized modes in the HWYX scenario also results in reduced transportation physical activity while decreased trip-making overall in the GIG scenario does the same. In ETOD and TOLL3, increases in either non-motorized trips or walk-to-transit trips results in increased physical activity and positive user benefits.

The user benefits summarized above are not distributed evenly across the CAMPO region. Most notably, benefits for the ETOD scenario are concentrated in northeast Raleigh, and Wake Forest while negative net benefits are estimated for southeast Raleigh and Cary. In the MHUB scenario, benefits are highly localized - as are some areas of net user costs. Benefits and cost of the HWYX and TOLL3 scenarios, respectively, are distributed more uniformly across the region. Finally, benefits of GIG scenario are concentrated in less urban portions of the region while costs in the RESY scenario are concentrated near the pieces of infrastructure identified as at risk for flooding. These geographic variations are illustrated in maps included in Appendix E – BCA Analysis Performance Measure Maps.

5.3 Equity Analysis

The 2045 Adopted MTP identified six Communities of Concern (CoCs) in the region as listed below:

- Non-white residents
- Hispanic residents
- Households in poverty
- Residents with low English language proficiency
- Zero-vehicle households
- Residents over 70 years of age

The four TAZ-level BCA benefits performance measures, namely Travel Time, Travel Time Reliability, Physical Activity, and Accessibility, were aggregated for each of these COCs. These zonal aggregations are assigned to specific Communities of Concern (CoC) based on the distribution of CoCs in each TRM zone.

While it is straightforward to aggregate zonal and origin-destination benefits to CoCs, the same is not the case for link benefits (i.e., Safety, Vehicle Operating Costs, Pollutant Emissions, Surface Water Quality, and Noise). While link-level benefits could be attributed to the zone in which the link is located, this approach would likely misrepresent impacts on CoCs. For example, a community near a freeway for which fewer crashes are predicted would receive all benefits of this reduction even though it is not the sole beneficiary of reduced crashes. Due to the potential of misrepresenting benefits for certain communities, we present results in two ways: 1) without summarizing link-based measures for CoCs (Table 5.3), and 2) distributing link-level benefits to all zones based on population then summarizing for CoCs proportionally (Table 5.4). Link-level measures are calculated for each roadway link in the model and aggregated across the region, OD-level measures are calculated for each zone-to-zone OD pair in the model and aggregated to the origin zone, and zone-level measures are calculated at the zonal level.

The results of the equity analysis with the four zonal performance measures is summarized in Table 5.3 for six land use-transportation scenarios evaluated in the Commuter Corridors Study. To test the sensitivity of these findings to link-level benefits, the same equity breakouts were re-calculated assuming that the five link-level benefits are distributed evenly across all population groups in the CAMPO region, which is summarized in Table 5.4.

Generally, the Dynamic Tolling (TOLL3) and Regional Resiliency (RESY) scenarios negatively impact CoCs substantially, while the Smart Mobility Hub (MHUB) scenario has slight negative impacts across CoCs when link-level benefits are not considered. The Equitable Transit-Oriented Development (ETOD) scenario has mixed impacts across CoCs and the Gig Economy (GIG) scenario positively impacts all CoCs. This is depicted in Figure 5.2. When link-level benefits are included and distributed evenly across the population, impacts on CoCs are generally more positive, especially for the ETOD scenario (Figure 5.3). However, impacts remain negative across all CoCs for the TOLL3, RESY, and MHUB scenarios.

Table 5-3 BCA Zonal Performance Measures by Communities of Concern (CoC)

CoC Group	Impact	Highway Expansion (HWYX) (see Note 1)	Equitable Transit-Oriented Dvlpmnt. (ETOD)	Dynamic Tolling (TOLL3)	Regional Resiliency (RESY)	Smart Mobility Hubs (MHUB)	Gig Economy of Mobile Workers (GIG)
		Thousands of 2019 USD per year					
Non-white residents	Travel Time	13,773	2,542	-15,367	-4,762	-626	4,463
	Reliability	12,726	1,747	4,669	-5,661	-2,019	830
	Physical Activity	-571	6,182	1,084	114	22	-1,328
	Accessibility	12,546	3,278	-18,130	-2,905	-257	575
	NET IMPACT	38,474	13,748	-27,744	-13,215	-2,880	4,539
Hispanic residents	Travel Time	7,865	-90	-7,493	-2,807	-361	2,705
	Reliability	7,454	483	3,657	-3,335	-1,193	710
	Physical Activity	-255	2,953	527	60	22	-654
	Accessibility	7,165	1,218	-9,721	-1,695	-102	376
	NET IMPACT	22,229	4,564	-13,030	-7,777	-1,634	3,137
Households in poverty	Travel Time	7,248	-5,280	-12,986	-2,535	-321	2,309
	Reliability	7,849	-1,562	2,893	-2,820	-907	424
	Physical Activity	-551	4,728	541	45	-220	-1,062
	Accessibility	7,858	-582	-14,006	-1,673	-14	338
	NET IMPACT	22,404	-2,696	-23,557	-6,982	-1,462	2,010
Residents with low English language proficiency	Travel Time	3,152	-848	-3,824	-1,156	-97	1,143
	Reliability	3,190	-320	1,634	-1,369	-481	297
	Physical Activity	-146	839	218	22	-52	-288
	Accessibility	2,897	266	-4,562	-648	-28	149
	NET IMPACT	9,093	-63	-6,535	-3,151	-657	1,301
Zero-vehicle households	Travel Time	2,174	-935	-3,854	-813	-241	742
	Reliability	2,451	-202	698	-833	-247	229
	Physical Activity	-261	1,823	129	15	8	-354
	Accessibility	2,517	106	-4,525	-599	-42	108
	NET IMPACT	6,881	792	-7,552	-2,230	-521	725
Residents over 70 years of age	Travel Time	124	-18	-148	-47	-4	38
	Reliability	138	1	74	-49	-12	18
	Physical Activity	-4	19	8	1	-7	-8
	Accessibility	134	18	-203	-36	1	6
	NET IMPACT	392	20	-269	-132	-21	54

Note 1: HWYX represents an infeasible, 'bookend' scenario. Therefore, direct comparison with other scenarios is discouraged.

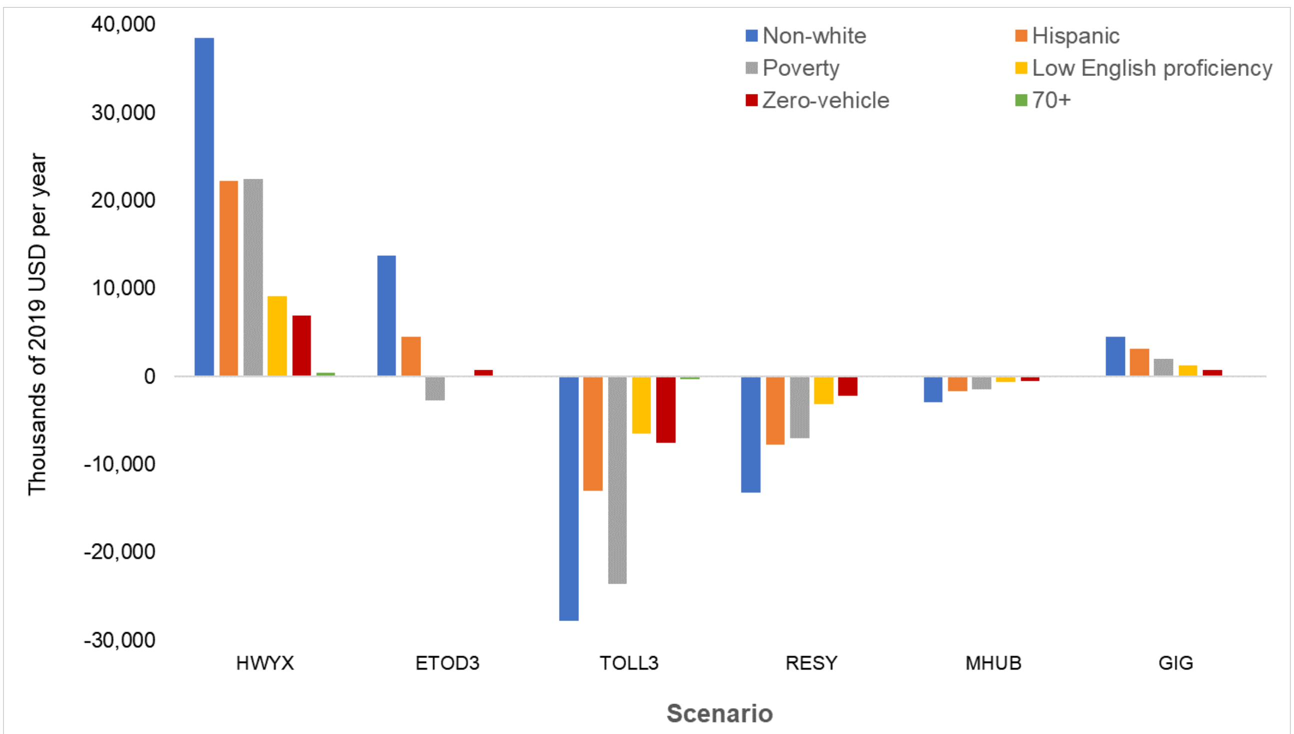
Table 5-4 BCA Zonal and Link Performance Measures by CoC

CoC Group	Impact	Highway Expansion (HWYX) (see Note 1)	Equitable Transit-Oriented Dvlpmnt. (ETOD)	Dynamic Tolling (TOLL3)	Regional Resiliency (RESY)	Smart Mobility Hubs (MHUB)	Gig Economy of Mobile Workers (GIG)
		Thousands of 2019 USD per year					
Non-white residents	All zonal benefits	38,474	13,748	-27,744	-13,215	-2,880	4,539
	Veh, operating costs	-424	723	966	110	122	332
	Emissions	-639	156	1,248	160	-12	105
	Surface water	-70	186	131	21	25	211
	Noise	-283	35	553	47	-16	-10
	Safety	-3,890	2,161	3,868	790	268	2,817
	NET IMPACT	33,169	17,009	-20,978	-12,087	-2,493	7,993
Hispanic residents	All zonal benefits	22,229	4,564	-13,030	-7,777	-1,634	3,137
	Veh, operating costs	-207	353	471	54	60	162
	Emissions	-311	76	609	78	-6	51
	Surface water	-34	91	64	10	12	103
	Noise	-138	17	269	23	-8	-5
	Safety	-1,897	1,054	1,886	385	131	1,374
	NET IMPACT	19,642	6,154	-9,730	-7,226	-1,446	4,821
Households in poverty	All zonal benefits	22,404	-2,696	-23,557	-6,982	-1,462	2,010
	Veh, operating costs	-278	474	633	72	80	218
	Emissions	-419	102	818	105	-8	69
	Surface water	-46	122	86	14	16	138
	Noise	-186	23	362	31	-10	-7
	Safety	-2,550	1,417	2,535	518	176	1,846
	NET IMPACT	18,927	-559	-19,122	-6,243	-1,208	4,274
Residents with low English language proficiency	All zonal benefits	9,093	-63	-6,535	-3,151	-657	1,301
	Veh, operating costs	-106	182	243	28	31	83
	Emissions	-161	39	314	40	-3	26
	Surface water	-18	47	33	5	6	53
	Noise	-71	9	139	12	-4	-3
	Safety	-978	543	972	199	67	708
	NET IMPACT	7,760	757	-4,834	-2,868	-560	2,169
Zero-vehicle households	All zonal benefits	6,881	792	-7,552	-2,230	-521	725
	Veh, operating costs	-84	144	192	22	24	66

	Emissions	-127	31	249	32	-2	21
	Surface water	-14	37	26	4	5	42
	Noise	-56	7	110	9	-3	-2
	Safety	-774	430	770	157	53	561
	NET IMPACT	5,825	1,441	-6,205	-2,006	-444	1,413
Residents over 70 years of age	All zonal benefits	392	20	-269	-132	-21	54
	Veh, operating costs	-1	2	3	0	0	1
	Emissions	-2	0	4	0	0	0
	Surface water	0	1	0	0	0	1
	Noise	-1	0	2	0	0	0
	Safety	-12	7	12	2	1	9
	NET IMPACT	376	30	-249	-128	-20	64

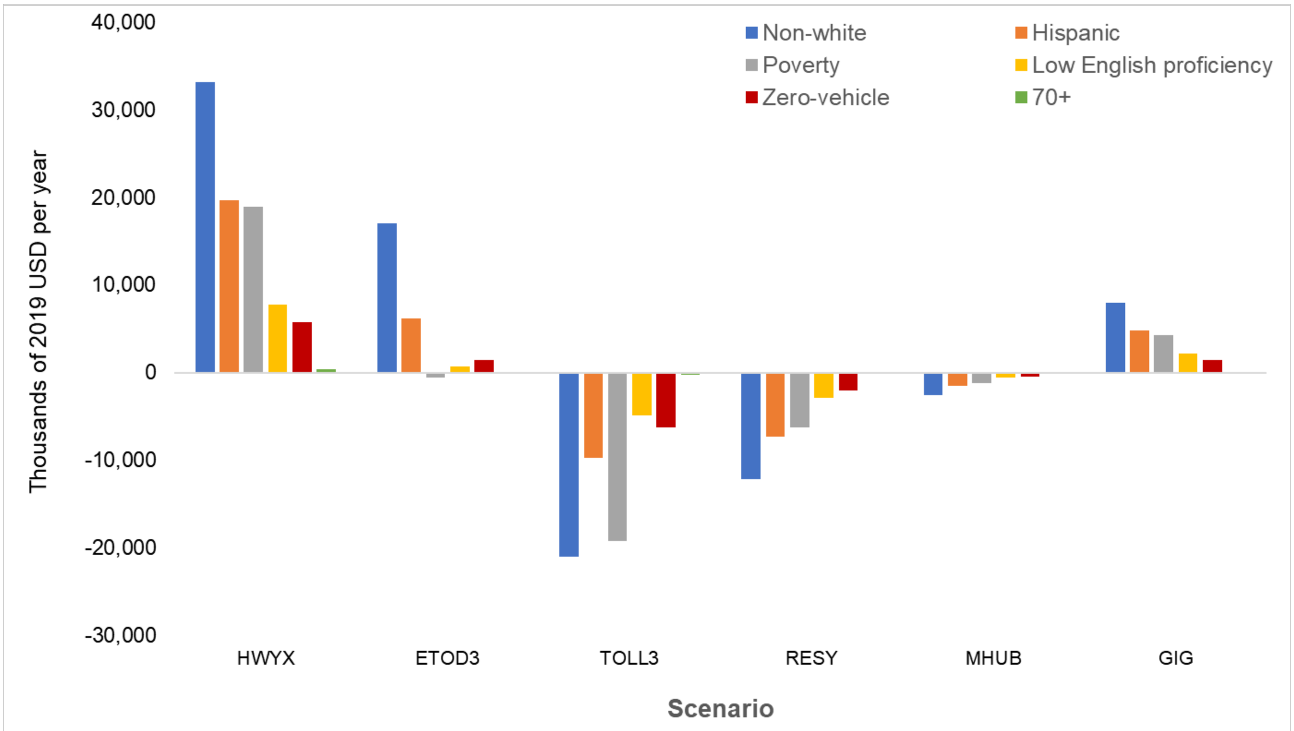
Note 1: HWYX represents an infeasible, 'bookend' scenario. Therefore, direct comparison with other scenarios is discouraged.

Figure 5.2 BCA Zonal Performance Measures by Communities of Concern



Note: HWYX represents an infeasible, 'bookend' scenario. Therefore, direct comparison with other scenarios is discouraged.

Figure 5.3 BCA Zonal and Link Performance Measures by Communities of Concern



Note: HWYX represents an infeasible, 'bookend' scenario. Therefore, direct comparison with other scenarios is discouraged.

6.0 Summary and Recommendations

This section presents an overall summary of the scenario analysis and our general recommendations to manage traffic congestion in the region, to engage public officials and local communities in the upcoming 2050 MTP development process, and a few scenario-specific implementation strategies.

6.1 Summary of Future Scenario Analysis

The six "hypothetical" future scenarios modeled and analyzed in the study are summarized below. These six scenarios were measured using a host of traffic congestion measures such as level of traffic saturation, travel speed, travel time reliability, and modal split between Single-Occupant Vehicle (SOV), Carpool, Bus, Rail, Walking and Biking. These scenarios were also analyzed using benefit-cost measures to understand the net economic, social and environmental benefits of a scenario. A summary of these performance measures is illustrated in Figure 6.1.

HWYX – Highway Mega Expansion: This scenario hypothetically assumed doubling of the number of General-Purpose lanes along congested commuter corridor segments in the CAMPO region including I-40, I-440, I-540, US 1, US 64, US 70, and US 401.

> OUTCOME: This scenario was deemed unrealistic and infeasible due to huge costs and community impacts, so it was excluded from the list of final scenarios modeled.

TOLL3 – Congestion Pricing - Dynamic Tolling: This scenario was intended to capture the emerging trend of applying tolls to ease traffic congestion in urban areas. The study assumed dynamic pricing, meaning the price fluctuates in real-time, during peak periods along the region's freeway corridors. It was also assumed that the peak toll pricing is only applicable to Single-Occupant Vehicles (SOVs) and trucks, but not to High-Occupancy Vehicles (HOVs) and buses.

> OUTCOME: This scenario was deemed feasible for some corridors such as I-40 and I-540 where we looked at tolling on managed lanes only, but was considered very difficult for the I-440 corridor where we looked at tolling all lanes of travel due to right-of-way restrictions and community impacts.

ETOD – Equitable Transit-Oriented Development: This scenario is a transit-emphasis scenario. It was assumed that more of the anticipated future growth can be redirected towards station areas through supportive zoning policies and other incentives. The study assumed 50 percent additional growth in affordable multi-family, office and retail use within half-mile of each planned transit station in the region, and a 100 percent increase in transit frequency for future transit routes in the region.

> OUTCOME: This scenario was deemed realistic and feasible, and has the potential to curb future traffic congestion in the region.

RESY – Regional Resiliency: This scenario was intended to illustrate the importance of resiliency planning for traffic disruptions due to extreme weather events. The study assumed a 50 percent reduction in the number of available lanes at several commuter corridor segments that were deemed to be vulnerable to flooding in an extreme weather event.

OUTCOME: This scenario was deemed necessary for resiliency planning. Potential negative impacts could worsen if adequate roadway connectivity is not built into the commuter corridors.

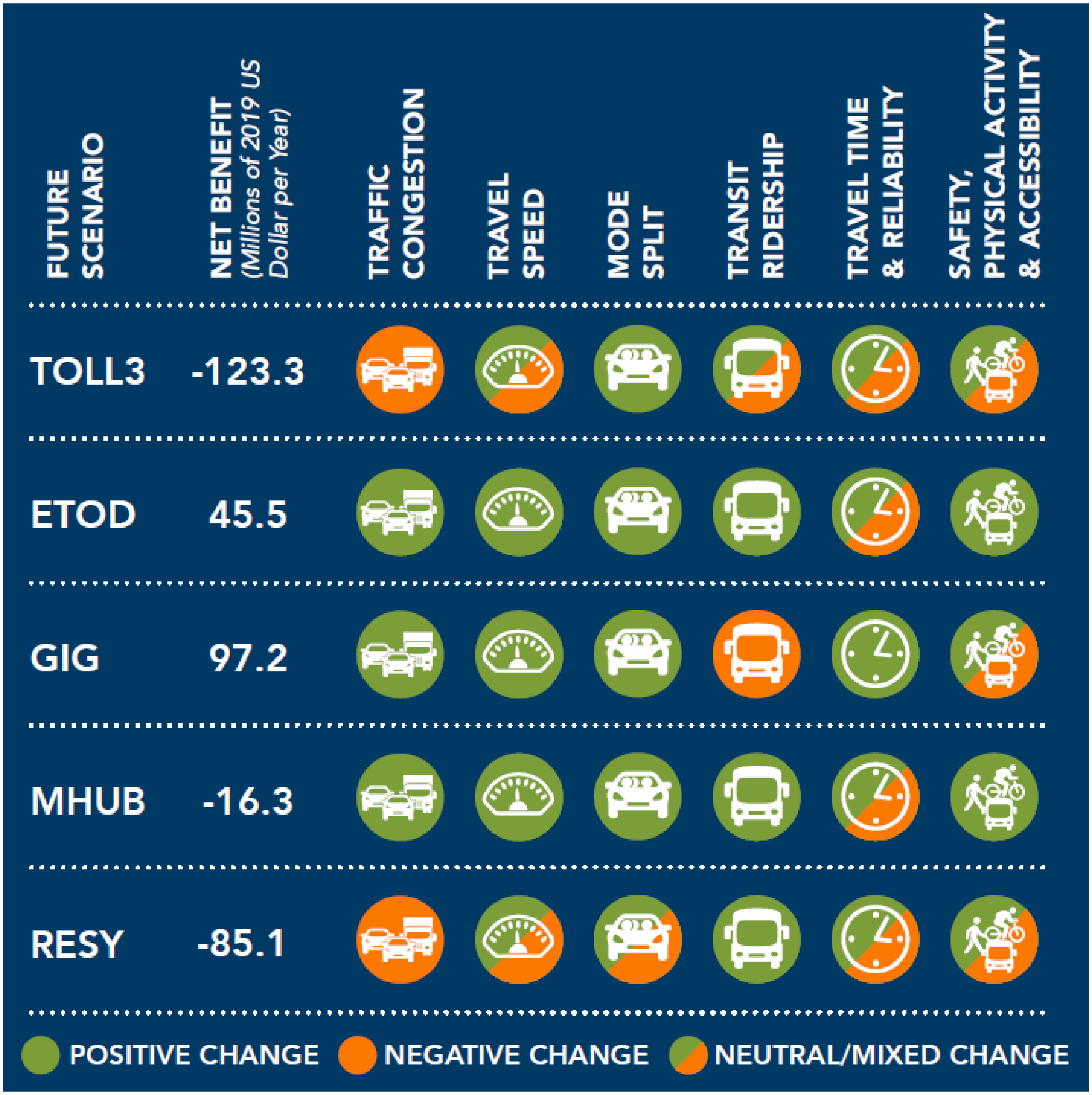
GIG – Gig Economy of Mobile Workers: This scenario was intended to capture the emerging socio-economic trend where an increasing number of people work from home due to the growth of mobile (telecommuting), part-time, and independent workers. Guided by national estimates, the study assumed a 25 percent reduction in work-related commute trips for medium-income and high-income households.

OUTCOME: This scenario was deemed realistic based on the current trend. It has the potential to curb freeway traffic congestion during regular commuting hours, but may cause negative impacts on off-peak travel conditions or local arterials.

MHUB – Smart Mobility Hubs: This scenario was intended to capture the new mobility trend of using shared-ride services for first-mile and last-mile trips. The study identified thirteen (13) future mixed-use center locations around the edges of the region as hypothetical future smart mobility hubs. This scenario also assumed 50 percent additional growth in household, office, and retail uses within one and one half-mile band of each of the identified mobility hubs, along with high-frequency premium transit service during commuting hours to connect each mobility hub with downtown Raleigh and the Research Triangle Park (RTP).

OUTCOME: This scenario was deemed realistic and feasible based on current trends, and has the potential to curb future traffic congestion in the region.

Figure 6.1 Performance Measures for Future Scenarios



Note: Changes in performance measures are reported based on comparison to the 2045 Adopted MTP

6.2 Congestion Management Strategies

This section presents a summary of congestion management strategies that can be applied to address traffic congestion issues in the CAMPO region. These strategies are grouped in three categories:

- SUPPLY SIDE – Strategies that focus on adding more capacity to the multi-modal transportation system, including highways, mass transit and freight distribution network.
- OPERATIONAL – Strategies that focus on improving the operational efficiency of the existing transportation system by using smart technology deployments, reconfiguring or repurposing the existing transportation system, and system optimization and management principles.
- DEMAND SIDE – Strategies that focus on reducing the demand for transportation services through policy priorities and pricing incentives.

The recommended congestion management strategies in these three categories are presented in Figures 6.2, 6.3, and 6.4.

In addition, Figure 6.5 presents the emerging strategies that could have significant influence on how we build and operate transportation system and how urban mobility may shift towards a new Mobility as a Service (MaaS) paradigm with the advent and popularity of the Transportation Network Companies (TNCs) and shared mobility trends in urban areas.

Figure 6.2 Recommended Supply Side Congestion Management Strategies

SUPPLY SIDE - Adding More Capacity to the Transportation System

- Selectively enhance highway & arterial capacities of the commuter corridors
- Build managed lanes along I-40 and I-540
- Increase network connectivity by adding connector roadways
- Upgrade the interchanges where there are recurrent congestion or safety issues
- Upgrade the freeway merge/diverge areas with auxiliary lanes to address operational and safety issues
- Provide railroad grade separations, whenever feasible,
- Accommodate buses along the commuter corridors with enhanced bus stops
- Add premium transit such as Bus Rapid Transit (BRT) and Light Rail Transit (LRT) to connect downtwon Raleigh and the Research Triangle Park (RTP) with rest of the region
- Improve transit connections and park-and-ride lots to reduce wait time and eliminate safety issues
- Add micro-transit services to provide first-mile/last-mile services in the suburbs

Figure 6.3 Recommended Operational Congestion Management Strategies

OPERATIONAL – Getting More out of the Existing Transportation System

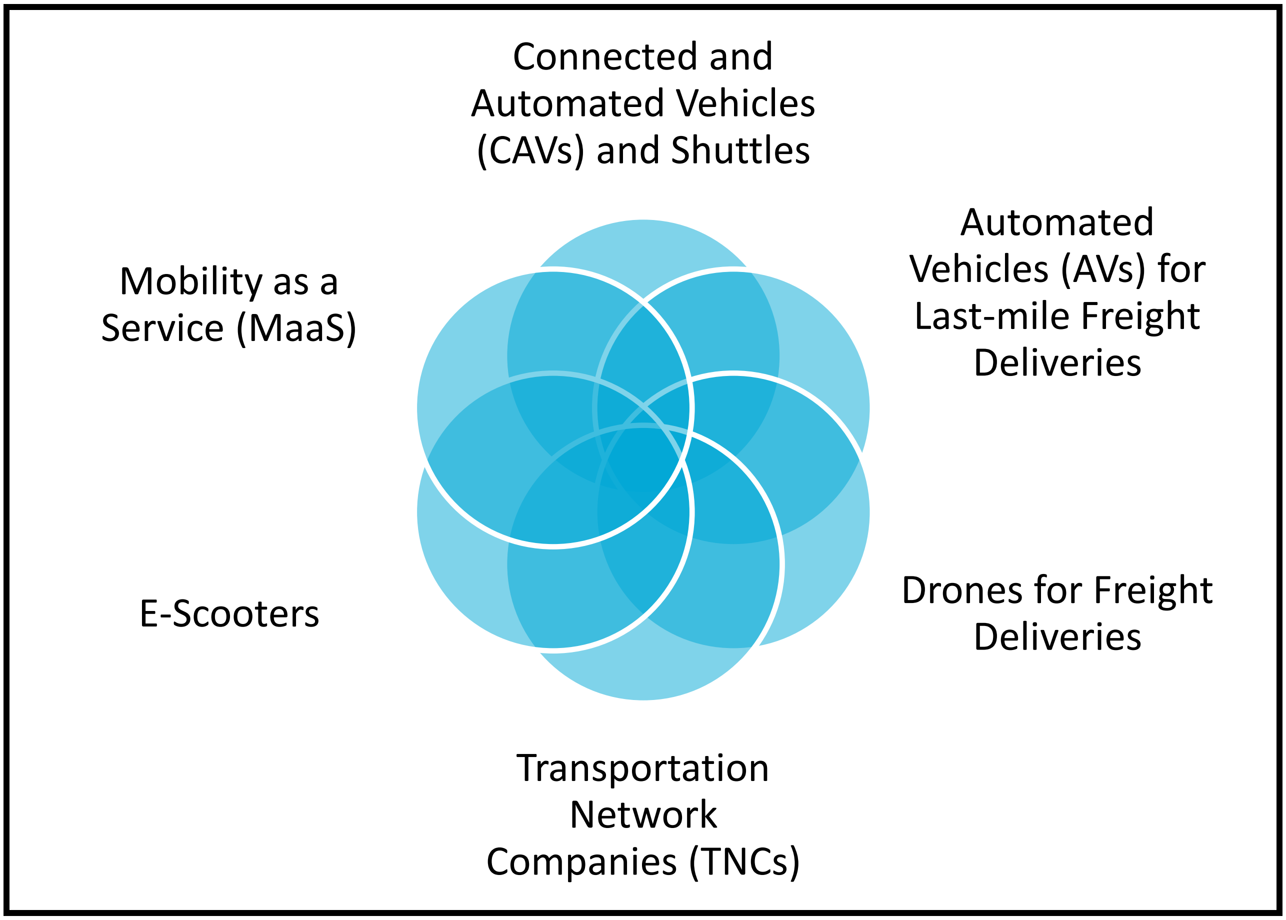
- Continue to prepare hot-spot studies and target small scale intersection improvements in high growth suburban areas
- Continue to modernize the local traffic signal systems for better signal timing coordination and pedestrian safety
- Implement parking management strategies in downtown and high activity areas to balance parking cost vs. convenience
- Monitor the results of freeway ramp metering projects
- Continue to implement electronic tolls along future NC 540 corridor segments
- Continue to invest in deploying new technologies for work zone traffic management
- Continue to partner with other states and the private sector for more integrated traveler information system
- Expand deployment of the AVL technology for better managing the bus services
- Partner with large employers and educational institutions in the region to define incentives on transit fares

Figure 6.4 Recommended Demand Side Congestion Management Strategies

DEMAND SIDE – Reducing Peak Demand on the Transportation System

- Partner with large employers and educational institutions in the region to incentivize alternate work days, alternate work hours, and telecommuting
- Work with local jurisdictions in implementing smart growth land use policies to reduce reliance on SOV travel
- Work with local jurisdictions to promote Transit-Oriented Developments (TODs), affordable housing near transit, and smart mobility hubs
- Collaborate with GoRaleigh, GoTriangle, and GoCary to develop smart mobility hubs and transit stops and stations that are safe, comfortable, and convenient
- Develop parking Incentives for shared ride, shared mobility services, and off-peak travel hours
- Expand congestion pricing on future NC 540 corridor segments
- Implement dynamic congestion pricing on the most congested commuter corridors such as the I-40 through the RTP area

Figure 6.5 Emerging Congestion Management Strategies



6.3 Communication and Outreach Strategies

This section presents a communications and outreach strategy that can be deployed by the Capital Area MPO to engage the CAMPO's Executive Board, various stakeholders and the general public to discuss the various alternative scenarios developed in the Commuter Corridors study and work towards development of the 2050 Metropolitan Transportation Plan (MTP).

This section also presents the outreach materials that were developed to synthesize the findings of the land use and transportation scenario analysis prepared in the Commuter Corridors Study.

6.3.1 Communication Strategy

The Capital Area MPO should implement a communication strategy that is based on the following four-pronged approach:

1. Two-way Information Hub for Message Clarity – Develop clear and consistent messages surrounding the future land use-transportation scenarios to explain how the Capital Area MPO region should best prepare for the next generation of mobility challenges on a central theme such as how we can

envision a cleaner, more equitable and more accessible transportation system for our region. Develop an information hub for the 2050 MTP with data and documents that can foster a two-way engagement platform and create a digital conversation about the process, preliminary messages, and the road ahead. Develop conversation themes such as:

a. Commuting Woes
b. Affordable housing near transit
c. Access to jobs
d. Walkable and bikeable, transit-oriented communities
e. First- and last-mile solutions around smart mobility hubs
f. Expanding intercity rail
g. Connected and Autonomous Vehicles (CAVs)
h. Micro-mobility and Shared Mobility

2. Unbiased Selection of Options – Explain how the technical methods and models used in analysis of the future growth and transportation investment scenarios are objective, comprehensive, and considers a triple bottom line: economic vitality, environmental stewardship, and social equity. Prepare summary statements of contextual and baseline information on the screening and evaluation process, and document the underlying uncertainties in future growth and traffic forecasts utilized in the study. Invite peer-reviews of alternatives analysis methodology to inject external perspective and transparency.

3. Meaningful and Memorable Presentations – Present the initial scenario analysis results in concise 5- to 10-minute presentations to engage with a specific audience whether it is elected officials, blue-ribbon committees, Regional Transportation Alliance, stakeholders, local communities, advocacy groups, or special constituency groups, in a way that does at least five things:

   a. Defines the current mobility problems and issues, and the future challenges in a storyboard that people can understand and want to learn
   b. Explains the strategies, choices and options involved in solving the transportation issues
   c. Outlines the funding needs and any policy changes that might be needed
   d. Relates to the target audience and seeks inputs on making the region more livable, equitable, and prosperous
   e. Outlines the decisions-making process and schedule

4. Mixing it Up for Outreach Avenues – Conduct traditional town hall type meetings, public forums, open houses, and/or focus groups at venues that are convenient as well as exciting, such as the Raleigh convention center, Raleigh Union Station, Moore Square Station, local community centers, museums, downtown cafes, etc. Conduct parallel outreach using website, social media channels as well as online surveys in English and Spanish languages. Consider mixing traditional outreach efforts with innovative approaches, as needed, to foster deeper and broader connections with local communities:

a. Work with a community-based sounding board or an advisory panel to vet alternatives and define local priorities

b. Prepare high quality short videos of community and decision leaders on their personal statements as to why the 2050 MTP is an important milestone for the region.

c. Develop special branding for the 2050 MTP and special data visualizations of the shortlisted scenarios on key growth concepts or mobility challenges

d. Consider doing a design competition on making the region more integrated, more efficient and more technology driven. For example, the CAMPO, in collaboration with the City of Raleigh, could do a design competition on affordable housing near transit to help move the needle forward on the city's affordable housing goals.

e. Host *Dine to Design* forums in downtown food halls to brainstorm ideas over food on how to solve the most pressing traffic congestion along the major commuter corridors such as I-40, I-540 and I-440

f. Create a smartphone app to disseminate key information and survey preferences on solution ideas

The Capital Area MPO should implement this communication strategy for various stakeholders as outlined in Table 6-1.

Table 6-1 Outreach Strategy by Stakeholder Group

Stakeholder Group	Information Hub for 2050 MTP	Study Process, & Priority Setting	Targeted Presentations & Feedback	Public Forums & Focus Groups	Innovative Engagements
CAMPO Board & Elected Officials	High Priority	Medium Priority	High Priority	High Priority	Low Priority
Transportation and Transit Interest Groups	High Priority	Medium Priority	High Priority	-	Low Priority
Public	High Priority	-	-	High Priority	Medium Priority
Local Communities & Special Advocacy Groups	High Priority	-	High Priority	High Priority	Medium Priority

6.3.2 Graphics for Outreach

Results of the BCA analysis previously described in sections 2 and 3, along with more traditional transportation measures presented in prior Technical Memorandums, are ultimately intended to support transportation decision-makers select a preferred scenario to guide the upcoming development of the 2050 MTP. As such, effective communication of this analysis is critical.

The communication and outreach strategy and materials are designed to be clear, concise, and impartial while tailoring specific findings to the correct audience and being sensitive to the decision-making process. During the second meeting with the technical steering committee, three key audiences were identified:

1) Elected officials;

2) Members of the general public; and

3) Advocacy groups.

To communicate with these three audiences, a series of flyers were developed—one for each scenario and one larger flyer comparing across scenarios. These are included in Appendix F – Scenario Flyers.

The design for these flyers follows several key principles:

- Clearly illustrate the difference between each scenario and the currently adopted MTP
- Use the same set of metrics to compare different scenarios to the adopted MTP
- Use neutral and consistent language while avoiding local 'hot-button' issues

6.4 Scenario Implementation Strategies

This section presents our general recommendations for advancing two of the selected land-use transportation scenarios, namely Equitable Transit-Oriented Development (ETOD) and Smart Mobility Hubs (MHUB) in the MTP update process.

6.4.1 Equitable Transit-Oriented Development (ETOD)

In order to advance the ETOD scenario concept in the MTP update, the Capital Area MPO and the partnering jurisdictions will need to take a series of steps, including the following:

1) Start a dialogue with the MPO Board members about the pros and cons of the ETOD scenario and to assess their consensus on the merits of the strategy.

2) If a general consensus is reached around the ETOD concept at the Board level, the MPO should update the land use growth allocation using 50 percent additional growth in multi-family, office and retail uses within half-mile of each planned transit station area. This growth reallocation will also require adjustments to projected growth in non-station areas to stay within the adopted 2045 socio-economic forecasts. The MPO should also update the transit investment level to double the transit frequency along future transit routes. It is estimated to require additional transit investments in the range of $10-$20 million per year.

3) Promote land use development policies that supports transit-oriented developments (TODs) and affordable housing near transit to accommodate demographic shifts with millennials who prefer living close to work.

6.4.2 Smart Mobility Hubs

In order to advance the MHUB scenario concept in the MTP update, the Capital Area MPO and the partnering jurisdictions will need to take a series of steps, including the following:

1) Start a dialogue with the MPO Board members about the pros and cons of the MHUB scenario and to assess their consensus on the merits of the strategy.

2) If a general consensus is reached around the MHUB concept at the Board level, the MPO should update the land use growth allocation using 50 percent additional growth in multi-family, office and retail uses within one and half-mile band of each of the thirteen MHUB location. This growth reallocation will also require adjustments to projected growth in non-station and non-MHUB areas to stay within the adopted 2045 socio-economic forecasts. The MPO should also update the transit investment level to provide premium transit service to connect MHUBs with downtown Raleigh and the RTP. It is estimated to require additional transit investments in the range of $5-$10 million per year.

3) Initiate small area planning studies to define scope, scale and character of each MHUB in the region. The goal is to finalize the proposed locations where multiple modes of transportation can be combined together in one physical location, and preferably clustered around a high-frequency public transit station or stop. These studies should identify the functional spaces for TNCs, carshare stations and bike parking. Also, these studies should address placemaking, wayfinding elements and universal fare payment via a single smartcard or mobile app.

4) Design MHUBs in a way that promotes changing travel behavior in favor of shared mobility living to reduce reliance on car ownership and SOV trips. Promote deployment of smart technology systems at each MHUB in the region for safety, security and real-time traveler information,

5) Promote land use development policies that supports MHUBs and mixed uses around MHUBs to leverage the shared mobility trends and to accommodate first-mile/last-mile trips in local communities.