



GREENVILLE-PICKENS AREA TRANSPORTATION STUDY | HORIZON 2050: LONG RANGE TRANSPORTATION PLAN

ACOG Travel Demand Model Review for GPATS MPO Area

5/27/2026



LONG-RANGE TRANSPORTATION PLAN

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Background

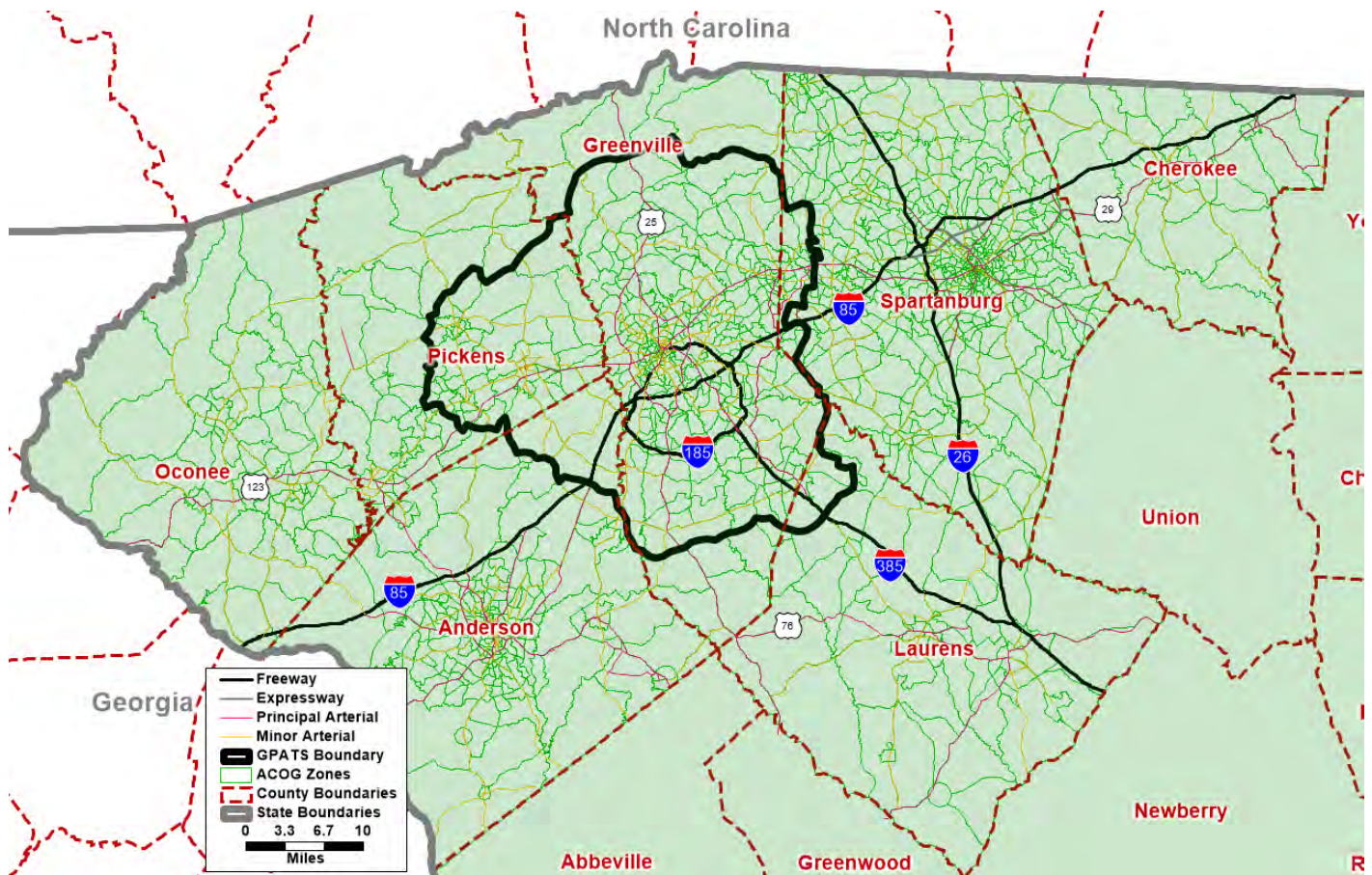
The ACOG (Appalachian Council of Governments) travel demand model (TDM) files were received from the Greenville-Pickens Area Transportation Study (GPATS) Metropolitan Planning Organization (MPO) and ACOG. The model, referred to as ARM (Appalachian Regional Model), was developed by CDM Smith in 2025 and includes a 2022 base year and 2050 forecast year. The ARM was developed to run in Version 9 of TransCAD and is the 2nd version of ARM.

HDR reviewed the ARM modeling procedures, inputs and outputs for the GPATS portion of the model in preparation for the GPATS Long-Range Transportation Plan (LRTP). The findings from that review are summarized in this memorandum.

Model Structure

The ARM model is a traditional trip-based TDM that includes the four standard steps of Trip Generation, Trip Distribution, Mode Choice, and Traffic Assignment. Please note that the Mode Choice procedure splits person trips into auto, transit and other trips using static percentages and not a logit procedure that can dynamically model transit trips that adjust for service and demographic changes giving it limited ability to model transit trips. The model represents a seven-county area with the GPATS MPO near the center as shown in **Figure 1**.

Figure 1 - GPATS MPO Boundary within ARMv2 Model



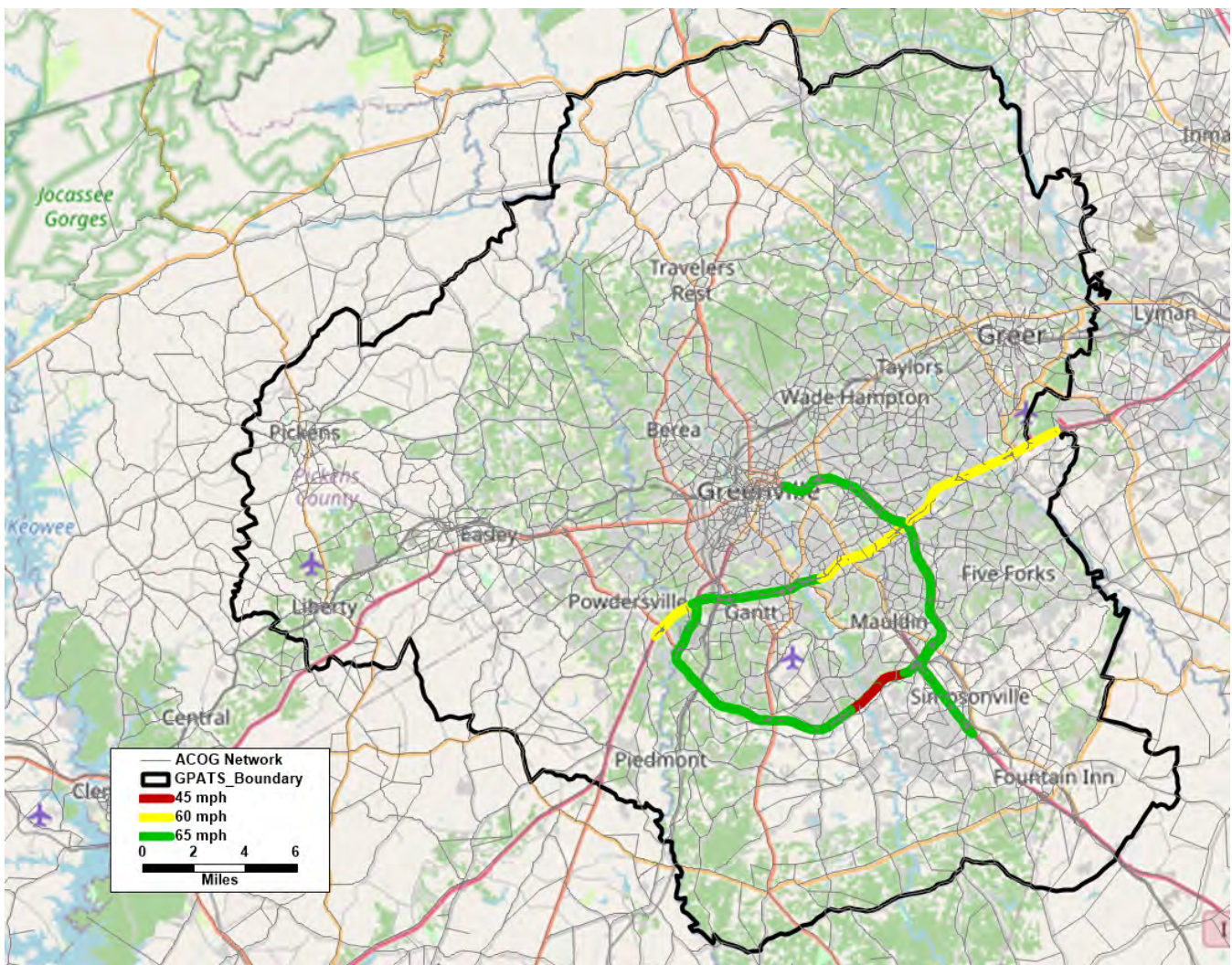
Road Network

The primary network inputs, including speeds, capacities, lanes, counts, and functional class were reviewed within the GPATS boundary. The “No-Build” future road projects were also identified and reviewed.

Speeds

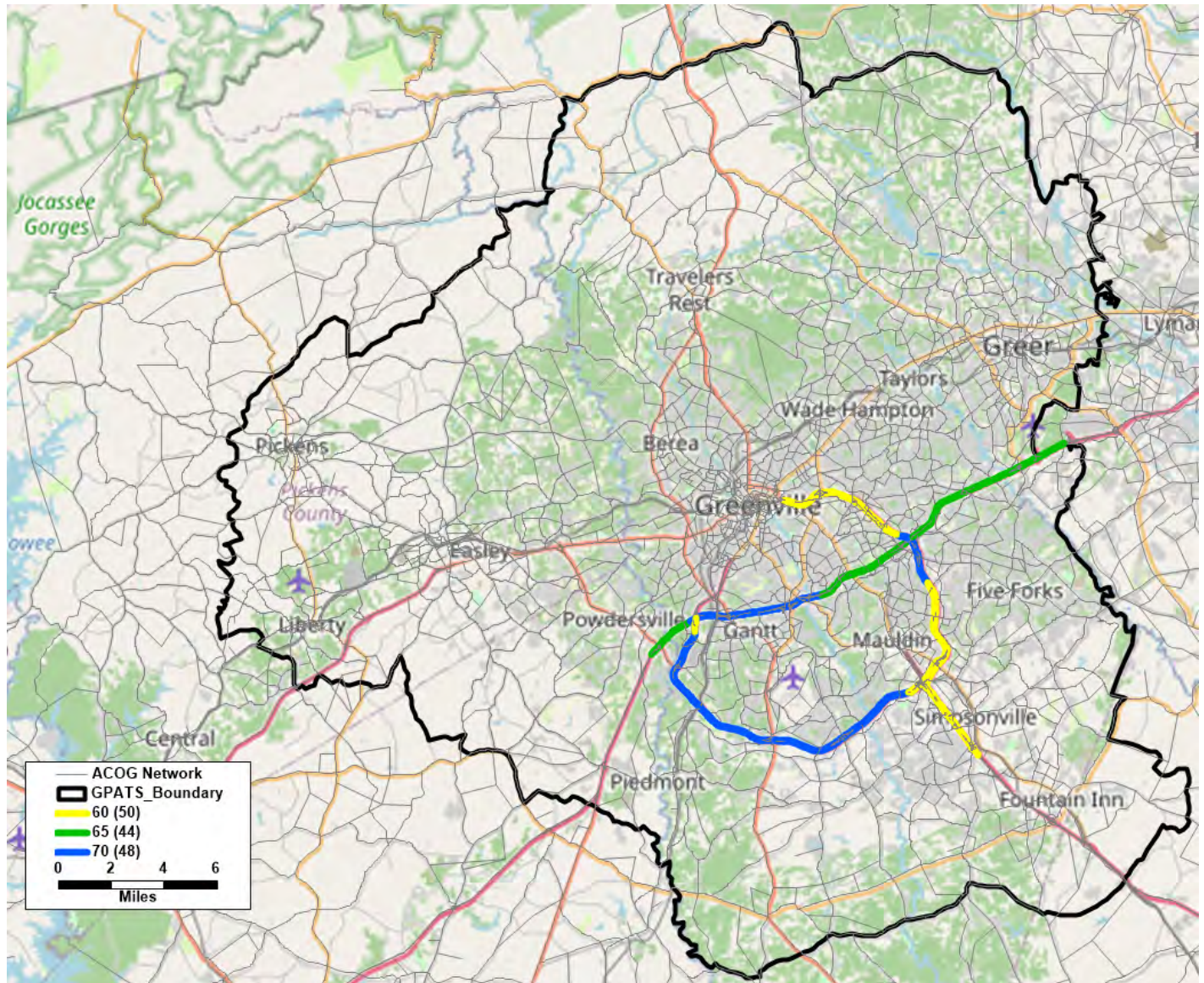
The speeds were reviewed for accuracy within the GPATS portion of the ARM. The input speeds used by the model were spot-checked by comparing with posted speed limit signs found on Google Street View. In most cases, the model input speeds matched the speed limit signs. When reviewing the speeds on the interstate, there was a uniform difference of 5 mph between the speeds posted (observed in Google Street View) and the speeds in the base_speed field on the ACOG network. This difference was only noticed on the interstates (I-85, I-185, and I-385). The real-world observed speeds are visualized in **Figure 2**, and speeds shown on the ACOG base_speed field are visualized in **Figure 3**. Note the 45 mph change in **Figure 2** is due to the toll booth (Southern Connector Toll road).

Figure 2 - Real World Observed Speeds



*Note the two links with a 45 mph speed link is due to the toll booth on I-185 (Southern Connector Toll Road).

Figure 3 - ACOG Base Speed



Capacities

The model capacities and associated volume delay function coefficients used during highway assignment were determined based on SCDOT input according to the model documentation. These capacities were reviewed and compared to other TDMs and published daily planning model capacities from the 2009 Florida Department of Transportation Quality / Level-of-Service Handbook (FDOT QLOS). A comparison of the model capacities versus FDOT QLOS Level-of-Service E planning capacity values is shown in **Table 1**.

The ARM daily capacity values are consistently higher than the FDOT QLOS values, particularly on Principal Arterial roads. No changes to these capacities are recommended as an input to the model because the model has been calibrated using these values, but FDOT QLOS values were added to the network to show more congestion for mapping purposes.

Table 1 - ACOG Model Capacities Versus FDOT Quality Level-of-Service Handbook Capacities

Functional Class / Lanes	ACOG Model (Undivided-Divided)	FDOT QLOS
Freeway		
2	42,000	39,700
4	84,000	79,400
6	126,000	122,700
Principal Arterial		
2	31,000 - 35,650	17,500
4	62,000 - 71,300	38,600
6	93,000 - 106,950	58,100
Minor Arterial		
2	26,000 - 29,900	16,200
4	52,000 - 59,800	35,100
6	78,000 - 89,700	53,100
Collector		
2	17,000 - 19,550	14,900
4	34,000 - 39,100	31,900

The FDOT QLOS daily capacity values do not represent a maximum number of vehicles that can use the roadway in 24 hours. Instead, the capacity values represent the highest number of vehicles that can use the roadway to meet a particular Level-of-Service threshold. For example, during a 24-hour timeframe there are many hours that a road is underutilized but during peak hours it may be overutilized resulting in a lower Level-of-Service. The daily values used thus approximate a peak hour limitation on the roadway but can be compared to model daily volumes.

Future Road Network

The user can select various sets of future road projects to include in a future model run including EC (existing roadways and committed future road projects), LRP (fiscally constrained long-range plan road projects), SWM (projects included in the South Carolina DOT statewide model), and Vision (fiscally unconstrained future road projects). The EC and SWM projects together represent the “No Build” scenario projects, which are projects that are anticipated to be completed even if no fiscally-constrained dollars are allocated to them in the LRTP. **Figure 4** shows the locations of these projects in the GPATS portion of the TDM and **Table 2** provides a description of the projects.

Figure 4 – “No Build” Future Road Projects

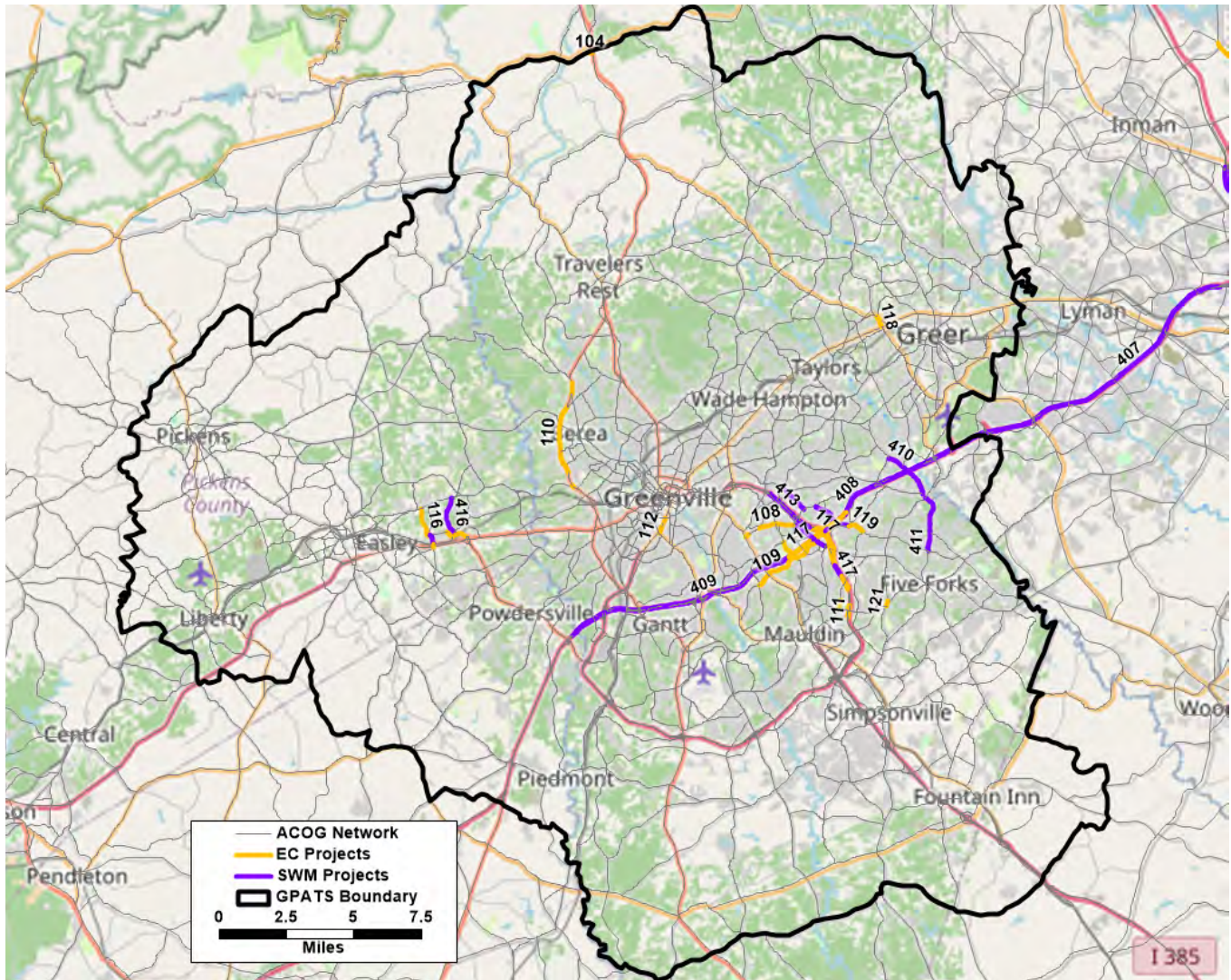


Table 2 - EC and SWM Future Road Projects in GPATS Area

Project Number	Project Group	Year	Road	Description
104	EC	2020	US 25/SC11 interchange	Add loop to interchange & turn lanes on SC11
106	EC	2020	S-23-434/Fairforest Way	Widen to 4 lanes
108	EC	2020	Woodruff Road	Widen to 5 lanes divided (with medians)
109	EC	2020	Millenium Blvd	New 4 lane divided
110	EC	2020	US 25 (White Horse Rd)	Widen to 7 lanes
111	EC	2020	I-385	Widen to 6 lanes
112	EC	2020	US 29 (Church St)	40 to 45 mph
113	EC	2020	Butler Road (S-107)	Widen to 4ln divided
114	EC	2020	Prince Perry Rd (S-135) / US 123	Intersection improvement
116	EC	2020	SC 153 Extension	Extension / New Construction of 2 lane road
117	EC	2020	I-385/I-85	New interchange
118	EC	2020	SC 101/290	Widen to 5 lanes
119	EC	2020	S-23-548	Widen to 3 lanes
120	EC	2020	S-23-326/127/Local Road	Widen to 4L w/ raised median
121	EC	2020	SC 14	Widen to 5 lanes
407	SWM	2025	I-85	Widen 1 lane/direction
408	SWM	2020	I-85	Widen 1 lane/direction
409	SWM	2025	I-85	Widen to 8 lanes
410	SWM	2025	Batesville Road (S-23-164/312)	3 Lane C&G
411	SWM	2022	Batesville Road (S-23-164/312)	3 Lane C&G
412	SWM	2025	Woodruff Road Parallel	4 Lane raised median
413	SWM	2050	I-385	Widen one lane in either direction
414	SWM	2020	S-23-547	Widen to 3 lanes
415	SWM	2020	S-23-548/183	Widen to 3 lanes
416	SWM	2020	Price Perry Rd/ Rock Springs Rd	Change from Undivided to Divided Highway
417	SWM	2050	I-385	Widen one lane in either direction

Socioeconomic Data

Base year (2022) and horizon forecast year (2050) socioeconomic data was reviewed for reasonableness in the GPATS portion of the model using thematic mapping and spot-checking individual zones against aerial photos.

Base Year Socio Economic Data

Household and employment densities were calculated for each TAZ as shown in **Figure 5** and **Figure 6**. Employment density is highest near the central business district and along major corridors including the interstates, Wade Hampton Boulevard, and Calhoun Memorial Highway while population is more evenly dispersed but primarily toward the eastern half of the GPATS boundary.

Figure 5 – Base Year Household Density

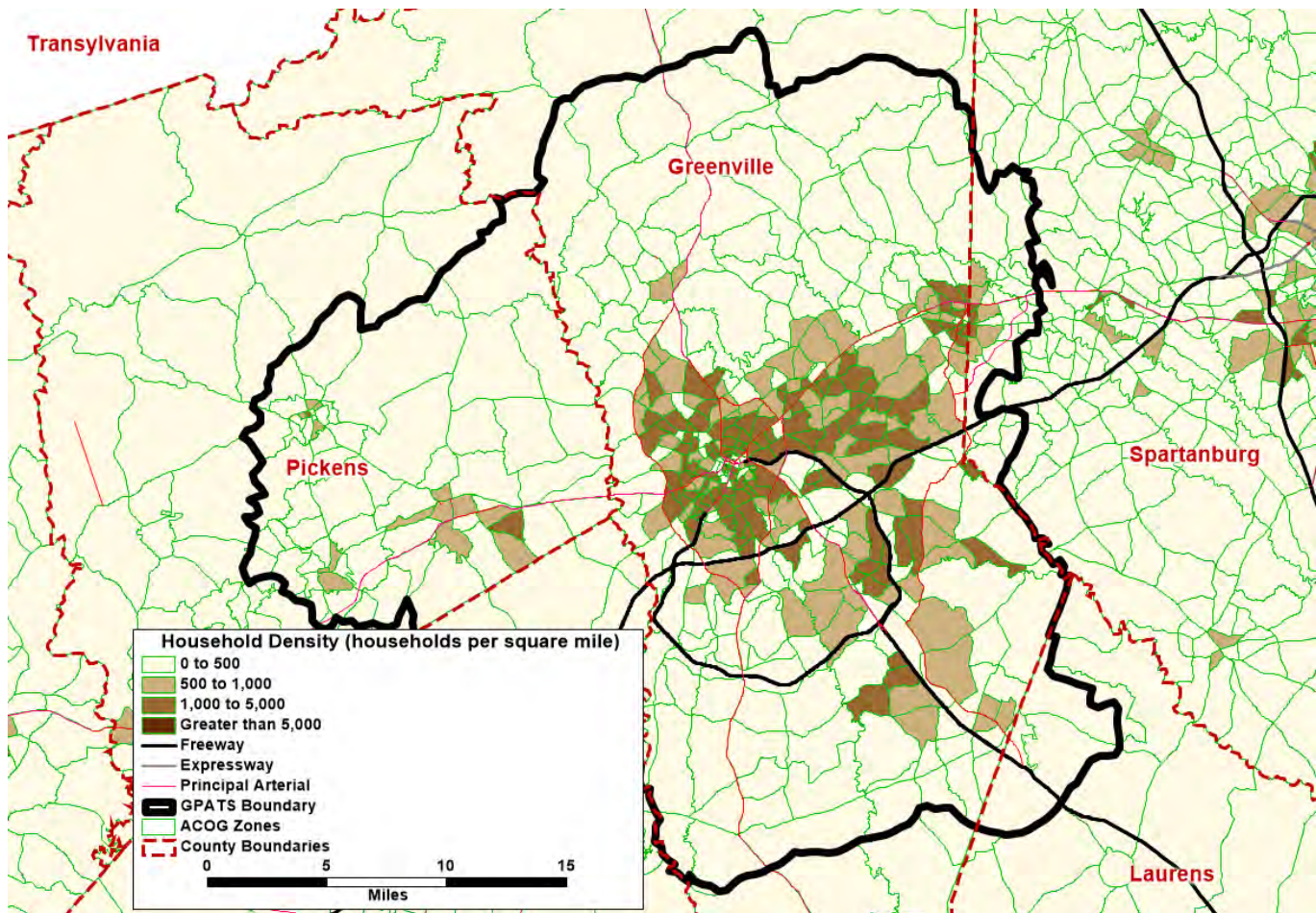
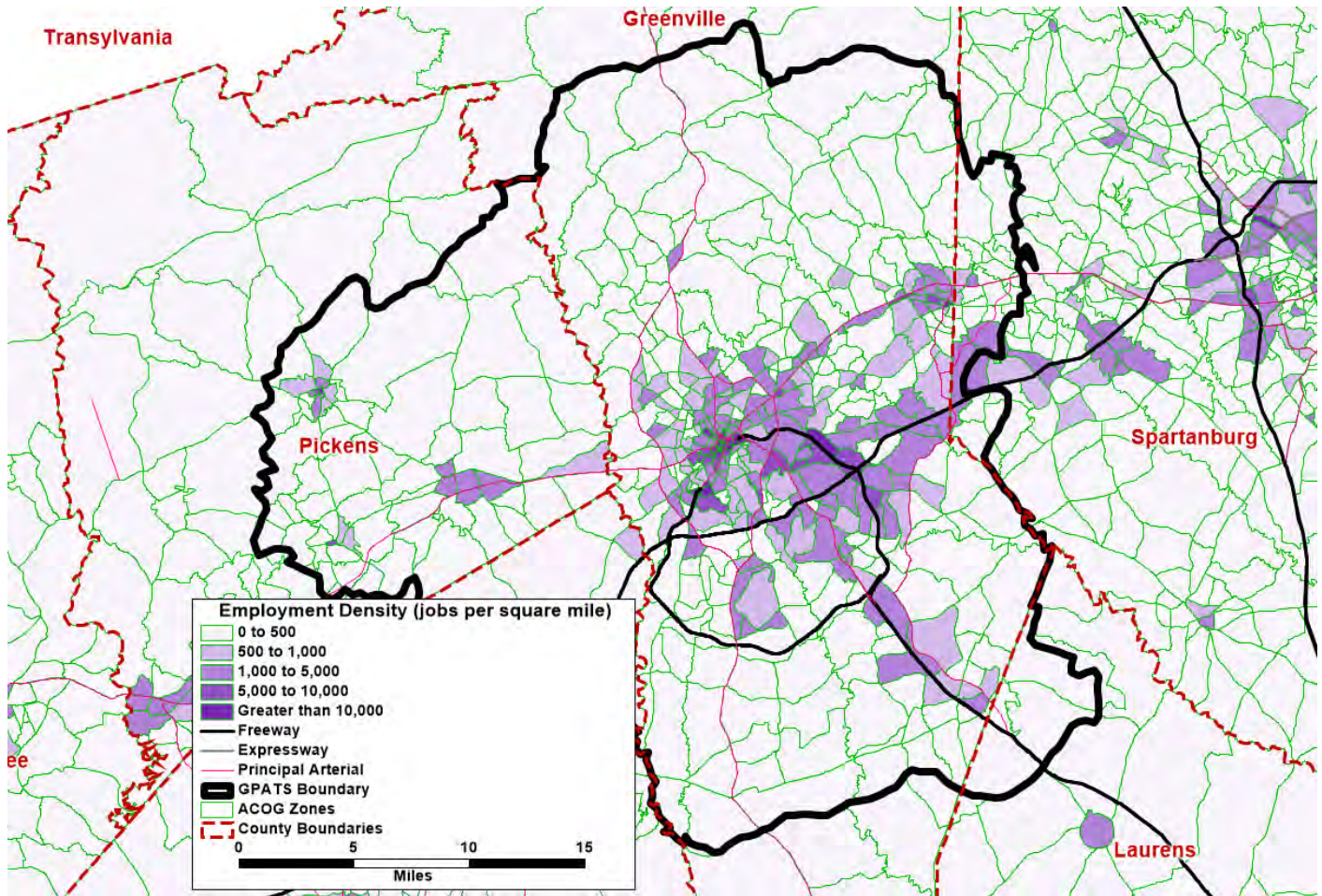


Figure 6 – Base Year Employment Density



Socioeconomic Data Growth

Figure 7 and Figure 8 show the absolute growth in households and jobs from the 2022 model base year to 2050. Household growth is widely dispersed but more heavily concentrated outside of the I-185 / I-385 loops and near the periphery of the GPATS boundary. Employment growth is also widely dispersed throughout the GPATS boundary but is more heavily concentrated along interstate corridors.

Figure 7 – Household Growth (2022 to 2050)

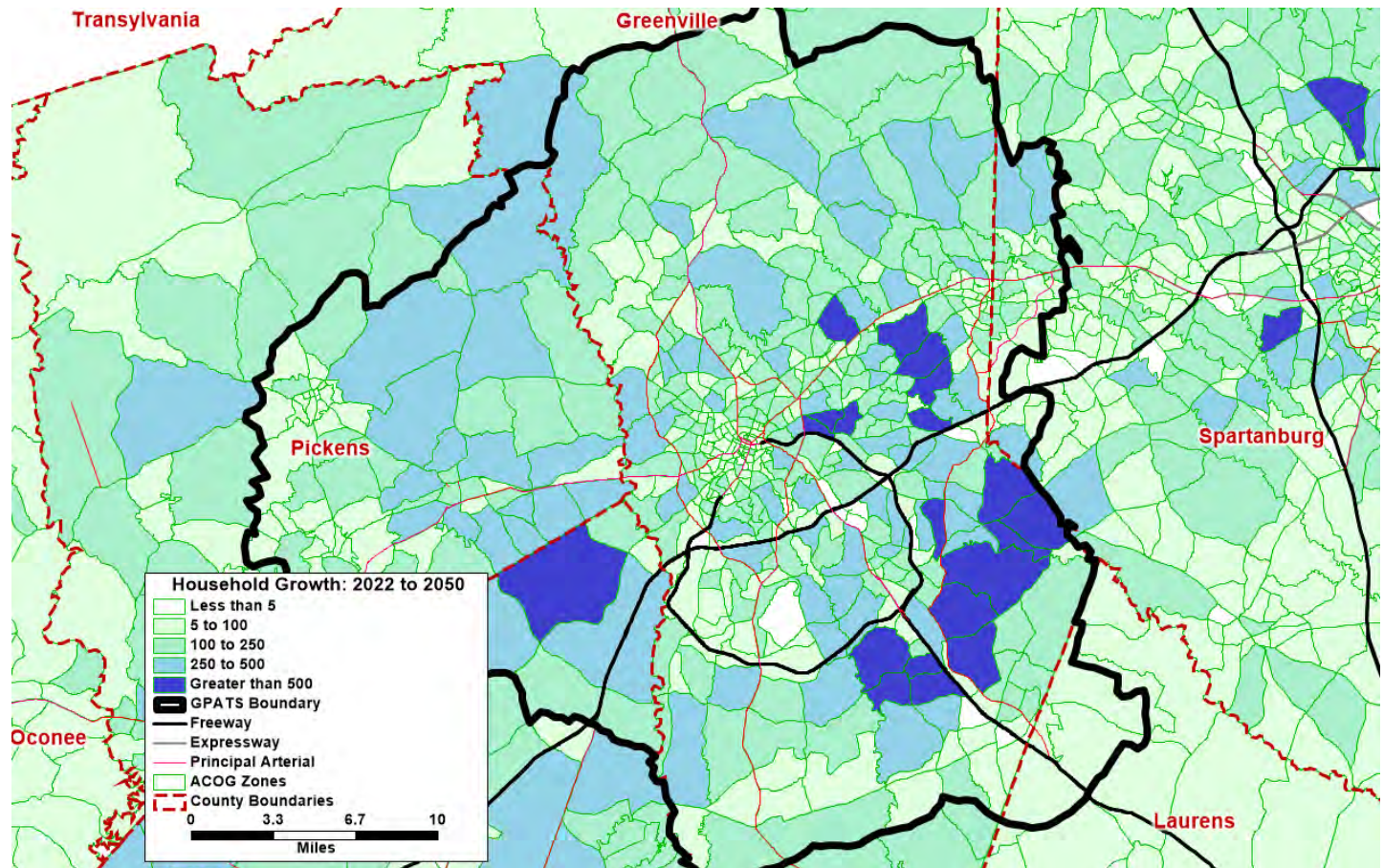


Figure 8 – Employment Growth (2022 to 2050)

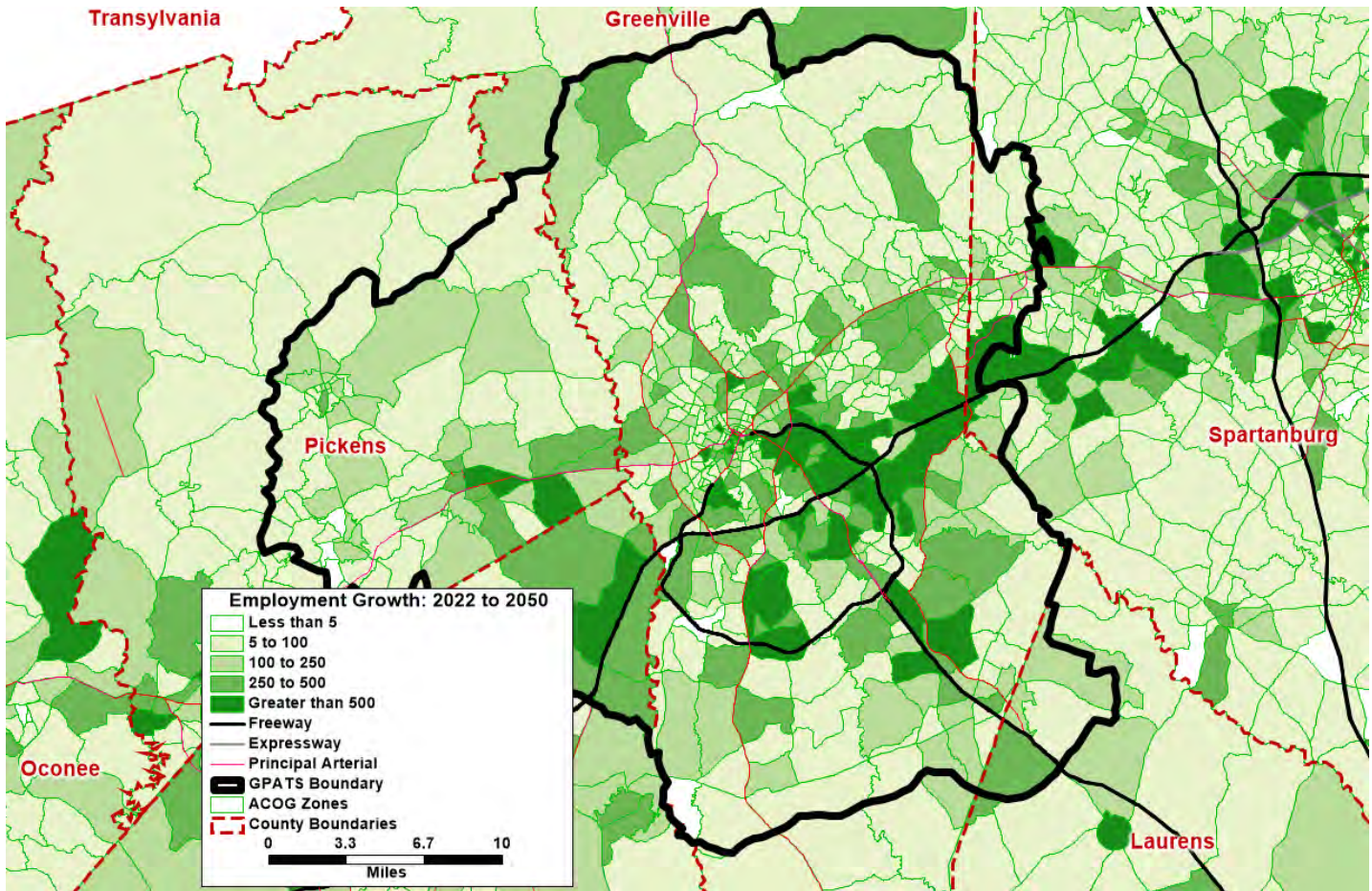


Table 3 summarizes both household and employment growth for the GPATS area and the entire model and includes a comparison with the previous model (2010-2045) annual growth as well as data from Census American Community Survey for the GPATS area. The forecasted household growth is more conservative than the previous model, but employment growth is more aggressive. For the GPATS MPO area only, the household growth is forecasted to be higher than the average for the entire model but employment growth is lower. Forecast household growth in the model is also more conservative than recent growth in the GPATS area according to the Census data. This suggests that the model predicts growth may slow compared to the most recent decade.

Table 3 – Compound Annual Growth Rate (CAGR) for Entire Model (2022-2050) and GPATS Area Only in Current (2022-2050) and Previous (2010-2045) Models and Census Data (2014-2025)

	Entire Model	GPATS Area Only	Previous Model Entire Model	Previous Model GPATS Area Only	GPATS Area Census Data
Households	0.95%	1.02%	1.14%	1.18%	1.53%
Employment	1.36%	1.22%	1.15%	1.14%	N/A

Outputs

Final model assignment results were reviewed for both the entire model area and the GPATS area only to try to identify large differences or any potential calibration improvements that could be made to the GPATS area.

Validation

The model-estimated volumes compared to counts were calculated for both the entire model and for the GPATS portion of the model. **Table 4** summarizes the results. Please note that the percentages for the entire model are nearly identical to the values shown in the model documentation but may differ because of slight differences in rounding or because of slight differences in the inputs being used for the model at the time that the original model documentation was prepared. Please also note that the model does not include any counts less than 1,000.

Both the percent RMSE and the volume error are similar for each volume group and generally within the benchmark thresholds defined in the model documentation with minor exceptions. For example, the volume error percentage for the GPATS Area in the 50,000-59,999 volume class is higher than for the entire model area and outside of the benchmark. Yet, this is because of a limited number of counts (8) compared to the number of counts in this volume class for the entire model area (22) which leads to more volatile results.

Table 4 – Percent RMSE and Volume Error by Volume Group for Entire Model and GPATS Area Only

Volume Class	%RMSE			Volume Error		
	Entire Model	GPATS Area Only	Benchmark*	Entire Model %Error	GPATS Area Only %Error	Benchmark*
>1,000-4,999	72%	81%	<= 100%	-1%	-2%	+/-25%
5,000-9,999	53%	56%	<= 45%	2%	2%	+/-25%
10,000-14,999	37%	38%	<= 35%	3%	-2%	+/-20%
15,000-19,999	36%	40%	<= 30%	6%	-10%	+/-20%
20,000-29,999	25%	29%	<= 27%	2%	-4%	+/-15%
30,000-49,999	17%	18%	<= 25%	4%	8%	+/-15%
50,000-59,999	13%	18%	<= 20%	5%	15%	+/-10%
60,000+	16%	16%	<= 19%	16%	16%	+/-10%
Overall	38%	37%	<= 45%	3%	2%	+/-5%

*Benchmark values obtained from ACOG Regional Travel Demand Model Update Report (ARMv2 build 20250808)

In terms of functional class, the percent RMSE is very similar for the entire model and just the GPATS area (**Table 5**).

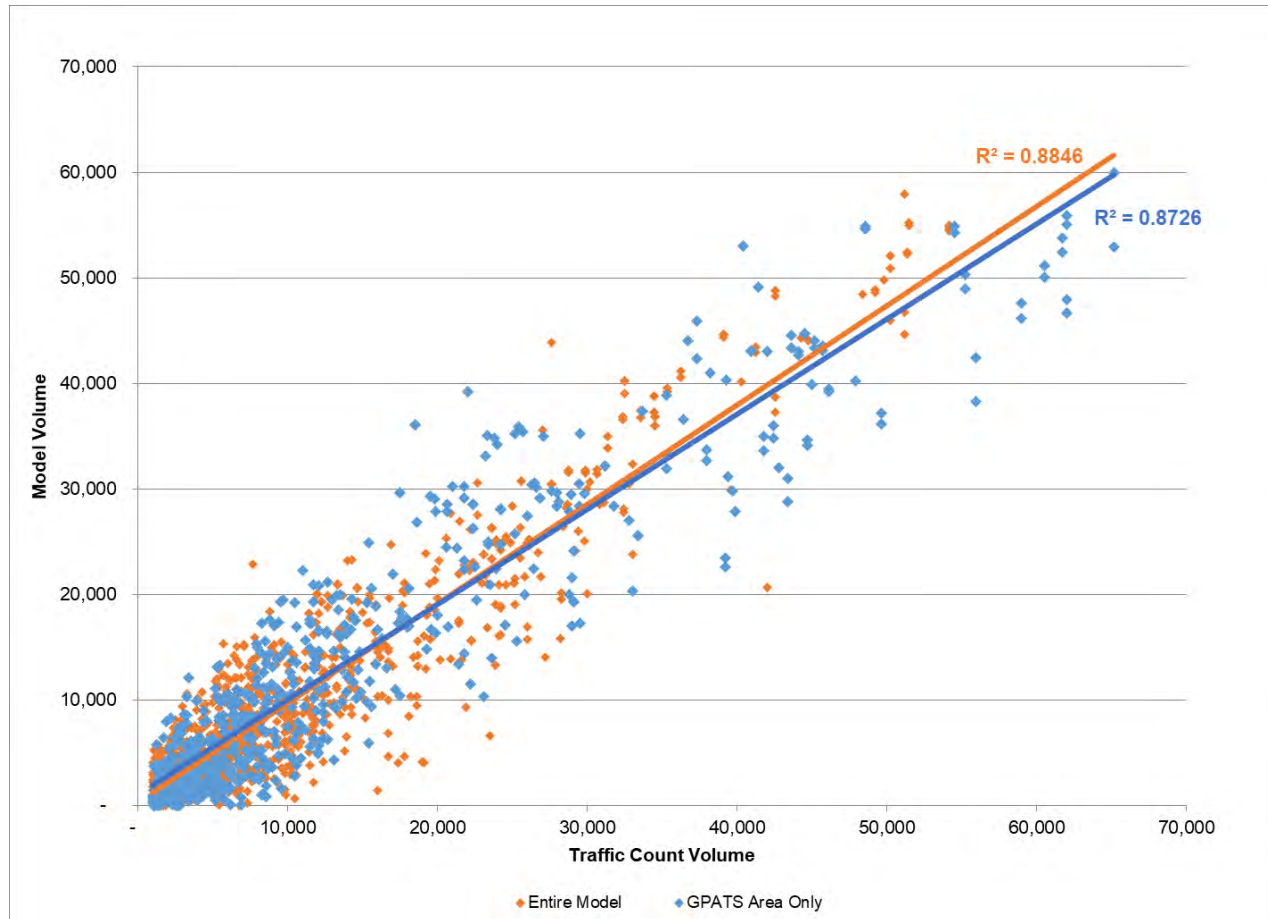
Table 5 – Percent RMSE by Functional Class for Entire Model and GPATS Area Only

Facility Type	Entire Model	GPATS Area Only
Freeway/Expressway	16.69%	18.88%
Principal Arterial	31.72%	28.64%
Minor Arterial	48.66%	43.75%
Collector	65.25%	59.85%
Total	38.01%	37.38%

A graphical comparison of the model assignment results compared to counts for the GPATS area versus the entire model area is shown in **Figure 9**. The R² values measure how well the trendlines fit the data. An R² of 1

would mean that the model-estimated volumes and the count data are a perfect match. The entire ARM model has an R^2 of 0.88 and the GPATS area only has an R^2 of 0.87 which both indicate an acceptable fit. The similar R^2 values suggests that there is not significantly more error within the GPATS boundary as compared to the rest of the model.

Figure 9 – Coefficient of Determination for Entire Model and GPATS Area Only



Level of Service

The model capacities and associated volume delay function coefficients used during highway assignment were determined based on SCDOT input according to the model documentation. Level-of-Service letter grades are calculated by the model script during a model run using the volume to capacity ratio for each roadway link. No changes were made to these model inputs, but initial Level-of-Service maps showed less congestion than anticipated.

The capacities were compared with other models and industry-standard values and ultimately updated to values consistent with the FDOT QLOS which ensures that the model volume to capacity ratios will display an approximated peak hour constraint. The lower FDOT QLOS capacities are rooted in the Highway Capacity Manual methodology and represent a better picture of peak hour conditions. The LOS letter grade thresholds were also updated to use more even and rounded volume-to-capacity ratio (V/C ratio) values. **Table 6** summarizes the alterations.

Table 6 – Level-of-Service Grade Alterations

Level-of-Service Grade	Original (V/C Ratio)	Revised (V/C Ratio)
A	0.00 – 0.50	0.00 – 0.60
B	0.50 – 0.75	0.60 – 0.70
C	0.75 – 1.00	0.70 – 0.80
D	1.00 – 1.15	0.80 – 0.90
E	1.15 – 1.35	0.90 – 1.00
F	Greater than 1.35	Greater than 1.00

The model output volumes were divided by the revised capacities to calculate revised V/C ratios. The updated LOS V/C ratio thresholds were then used to assign a letter grade for each road. **Figure 10** shows the 2022 base year and **Figure 11** shows the 2050 scenario with existing and committed projects (EC) and statewide model road projects (SWM).

Figure 10 – 2022 Base Model Revised Capacities Level-of-Service

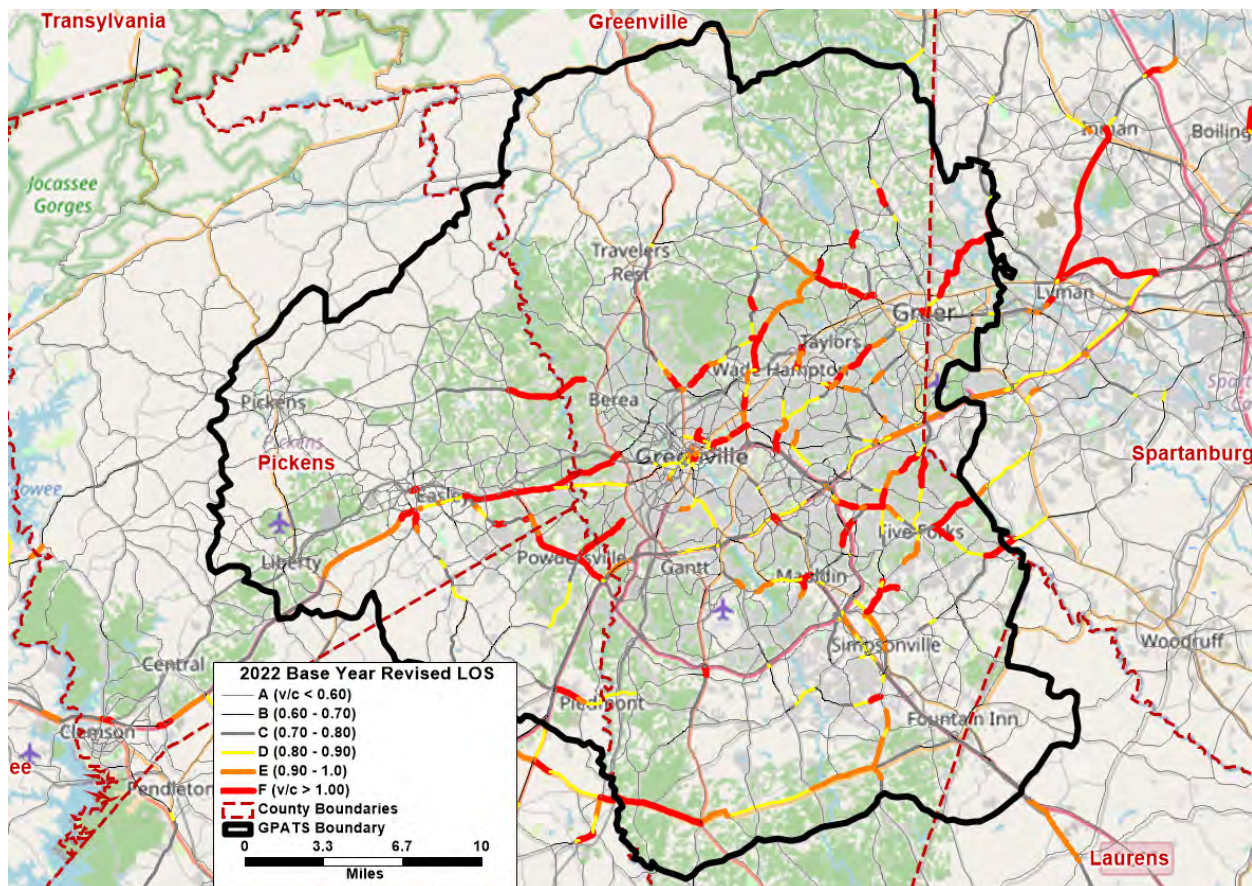
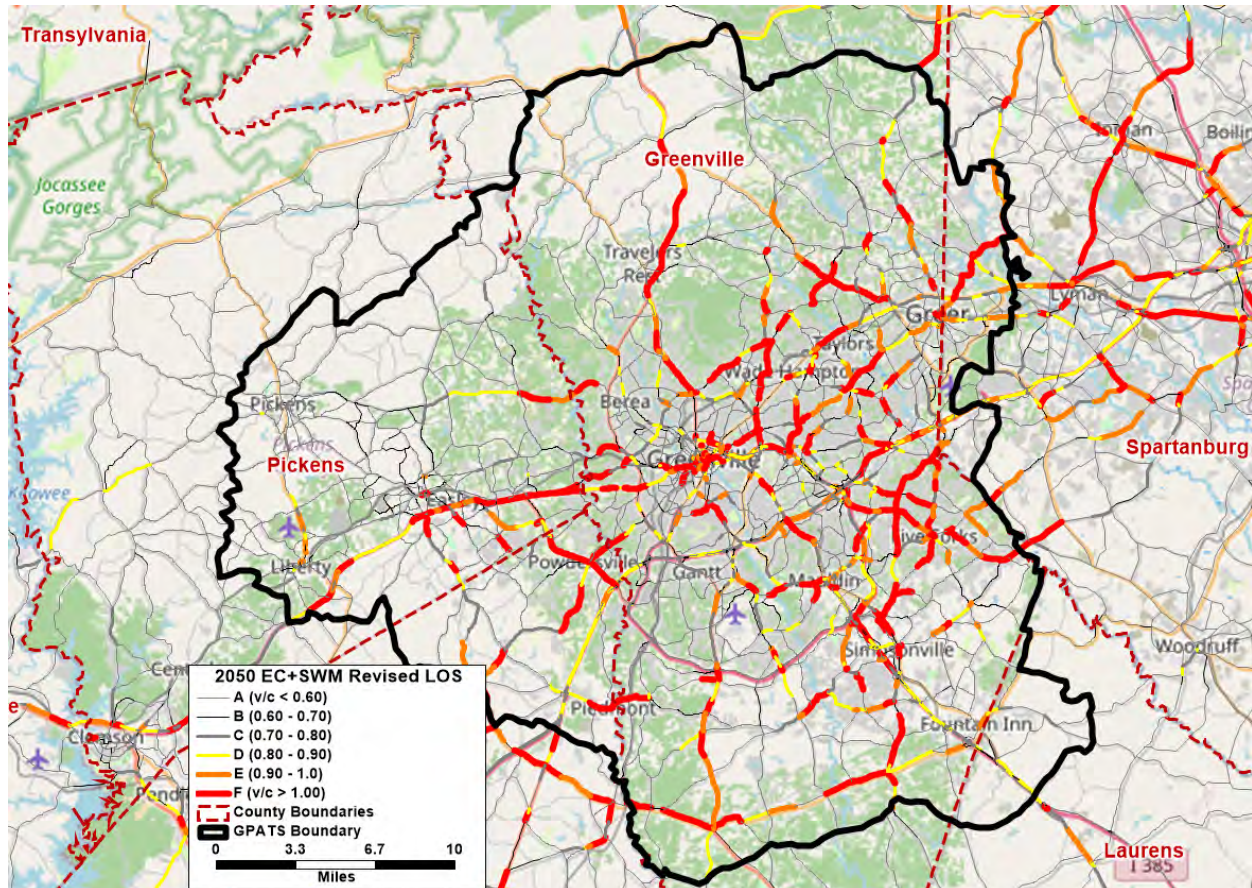


Figure 11 – 2050 EC + SWM Revised Capacities Level-of-Service



Another method to identify congestion is to find roads that have the largest decrease in speeds from freeflow conditions to the most congested peak time period. **Figure 12 and Figure 13** show the decrease in speeds from what is posted to the most congested peak. In both the base year and 2050, I-85 has the largest decrease in speed. Most other locations with the largest speed reductions are on other interstates and highways with arterial and collector roads not showing as frequent speed reductions.

Figure 12 - Average Speed Reduction from Posted to Peak Time Period Speeds in 2022 Base Scenario

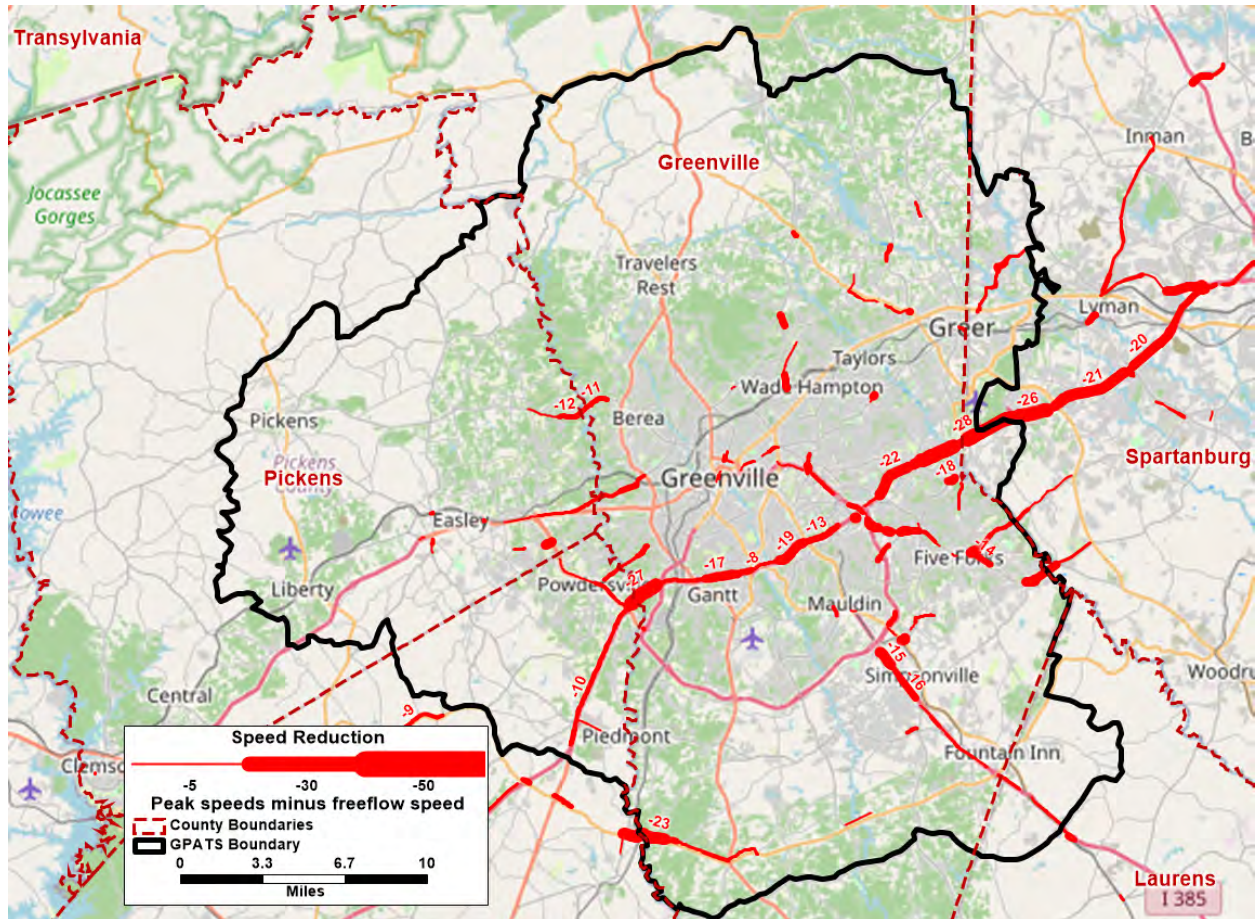
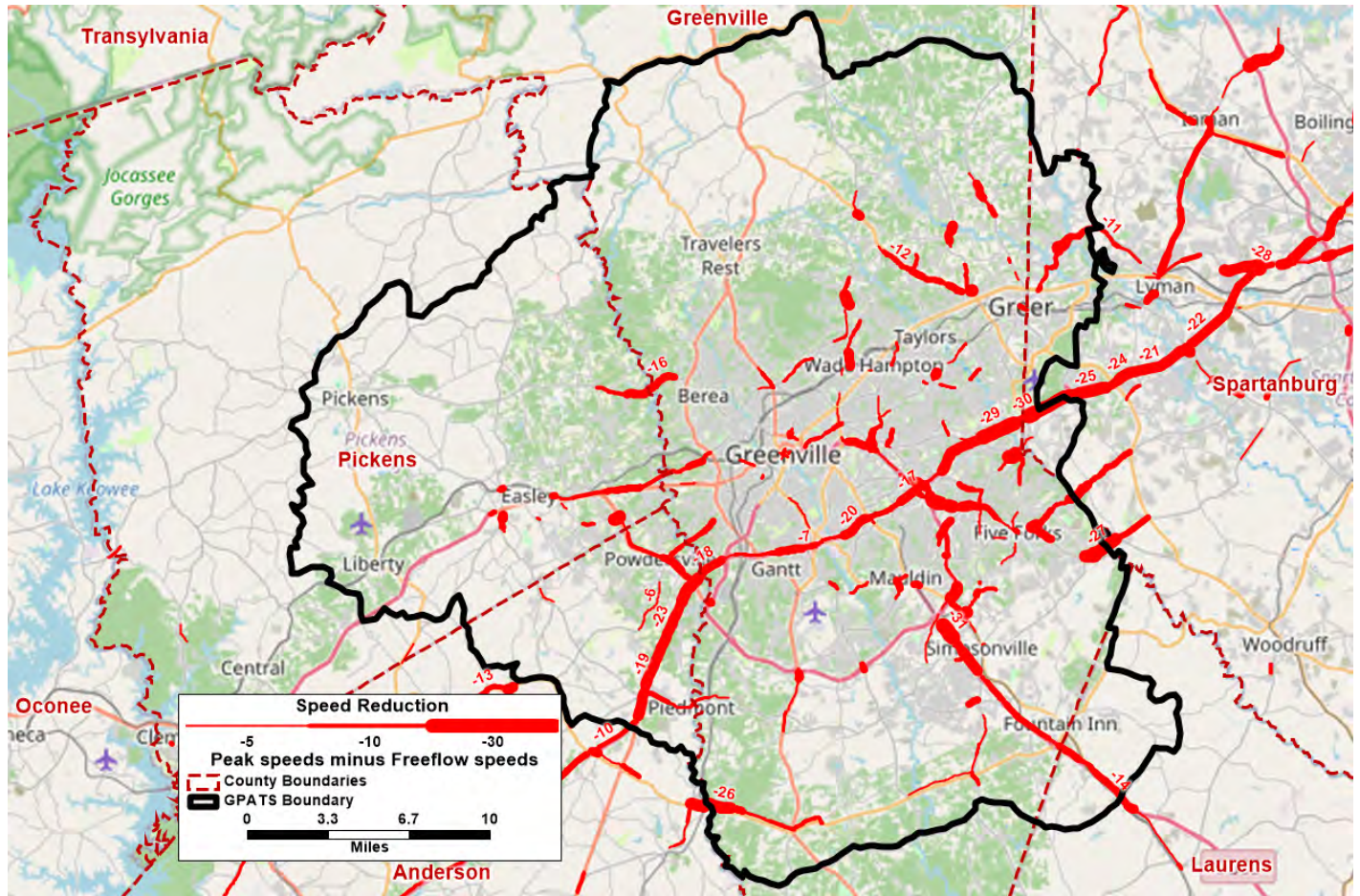


Figure 13 – Average Speed Reduction from Posted to Peak Time Period Speeds in 2050 EC + SWM Scenario



As a time period reasonableness check, each of the three time periods were compared to determine which time period had the slowest speeds (**Table 7**). The PM time period (4 - 7 pm) shows the most congestion, followed by the off-peak time period (9 am – 4 pm, 7 pm – 6 am). Typically, the AM time period (6 - 9 am) has more congestion in most communities. This may be a result of the household travel survey data sampled or the time period capacity factors used. While the time period distribution of trips likely has only a small impact on overall daily model volumes, it is recommended that the time period inputs be reviewed during the next model update.

Table 7 – Links with most Delay in GPATS area by Time Period

Time Period	Number of Links	Percent
AM Slowest	586	16%
PM Slowest	1738	46%
Off-Peak Slowest	933	25%
Same Speeds (no delay)	517	14%
Sum	3774	100%

Growth Summary

A summary of the growth in the model is shown in **Table 8**. Households and trips in the GPATS area grow by slightly more than the ARM model on the whole. Employment growth is higher than household growth for the entire model and the GPATS area only but because most trip purposes balance to household-generated productions, the trip growth more closely aligns with households. VMT typically grows more than households and trips in models because household growth tends to be highest on the fringes of the urban area and therefore trips must travel farther to reach city centers where there is the most employment activity. In the GPATS area, VMT growth is slightly *lower* than trip growth. This may be the case because the model has a large amount of employment growth near the fringes of the urban area, thus the model distributes a large number of trips to suburban employment centers in the future year making average trip lengths shorter. VHT typically grows faster than VMT growth because more congestion is expected in the future. Both the entire ARM model area and the GPATS area only suggest that to be the case.

Table 8 – Growth Summary for the Entire Model and the GPATS Area Only

	Entire Model			GPATS Area Only		
	2022	2050 EC+SWM	Growth	2022	2050 EC+SWM	Growth
Population	1,394,097	1,816,155	30%	646,926	859,640	33%
Households	535,852	697,743	30%	249,405	331,465	33%
Total Employment	688,452	1,004,170	46%	334,839	470,252	40%
Balanced Trips	4,899,229	6,424,582	31%	2,402,066	3,200,621	33%
VMT	39,026,614	52,762,590	35%	14,819,006	19,410,730	31%
VHT	835,101	1,178,504	41%	327,996	451,098	38%
Average Household Size	2.60	2.60		2.59	2.59	
Trips per Household	9.14	9.21		9.63	9.66	
Average Trip Speed	46.73	44.77		45.18	43.03	
Average Trip Length	7.97	8.21		6.17	6.06	
Average Trip Time	10.23	11.01		8.19	8.46	

Overall, the data indicate that both the GPATS area and the ACOG area on the whole are expected to grow at a moderate to high growth rate with more congestion expected in 2050 if only committed and statewide model projects are built.