2050 MTP

Appendix F:

Travel Demand Model Report

Resolution of the Madison Athens-Clarke Oconee Regional Transportation Study Metropolitan Planning Organization to Accept the Base Year and 2050 "Do-Nothing" Traffic Demand Models

WHEREAS, the Madison Athens-Clarke Oconee Regional Transportation Study (MACORTS MPO) has been designated by the Governor of Georgia as the Metropolitan Planning Organization for the Madison Athens-Clarke Oconee urbanized area; and

WHEREAS, it is necessary to project the long term population growth patterns and resulting traffic volumes using existing traffic counts for 2020 for the purpose of calibrating with the findings for the traffic model for the year 2050; and

NOW, THEREFORE, BE IT RESOLVED that the MACORTS MPO Board accepts the 2020 base year and 2050 Do-Nothing travel demand models based upon the information presented by GDOT staff at the meeting held on March 13, 2024, with the understanding that the model files and supporting documentation will be provided at a later date. The travel demand model will serve as the primary analytical tool to evaluate the performance of potential highway capacity projects for inclusion in the Metropolitan Transportation Plan.

CERTIFICATION
I hereby certify that the above is a true and correct copy of a Resolution adopted by the MACORTS MPO Board at a meeting held on March 13, 2024.

____

Brad Griffin, Director
Madison Athens-Clarke Oconee Regional Transportation Study Metropolitan Planning Organization

MACORTS MPO Travel Demand Model 2024 Update

MACORTS Technical Coordinating Committee Meeting
February 21st, 2024

Presented by: Brandon K. North
Branch Chief for Systems Planning, GDOT- Office of Planning
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Photo Source: Google Image

Background

Federal legislation requires Metropolitan Transportation Plan (MTP) updates every five years
[23 CFR 450.322(b)]

The MTP covers a minimum 20-year planning horizon.
[23 CFR 450.322(b)]

The next MACORTS MPO MTP should be adopted by September 11, 2024.

MAP-21 / FAST Act (Invest in America) requires incorporating performance-based planning and transportation system access into project selection

Background (Cont'd)

§ 450.324 Development and content of the metropolitan transportation plan.

(a) The metropolitan transportation planning process shall include the development of a transportation plan addressing no less than a 20-year planning horizon as of the effective date. In formulating the transportation plan, the MPO shall consider factors described in § 450.306 as the factors relate to a minimum 20-year forecast period. In nonattainment and maintenance areas, the effective date of the transportation plan shall be the date of a conformity determination issued by the FHWA and the FTA. In attainment areas, the effective date of the transportation plan shall be its date of adoption by the MPO.

(b) The transportation plan shall include both long-range and short-range strategies/actions that provide for the development of an integrated multimodal transportation system (including accessible pedestrian walkways and bicycle transportation facilities) to facilitate the safe and efficient movement of people and goods in addressing current and future transportation demand.

(c) The MPO shall review and update the transportation plan at least every 4 years in air quality nonattainment and maintenance areas and at least every 5 years in attainment areas to confirm the transportation plan's validity and consistency with current and forecasted transportation and land use conditions and trends and to extend the forecast period to at least a 20-year planning horizon. In addition, the MPO may revise the transportation plan at any time using the procedures in this section without a requirement to extend the horizon year. The MPO shall approve the transportation plan (and any revisions) and submit it for information purposes to the Governor. Copies of any updated or revised transportation plans must be provided to the FHWA and the FTA.

What is a Travel Demand Model and its Purpose?

- Analysis tool to forecast travel demand and transportation performance

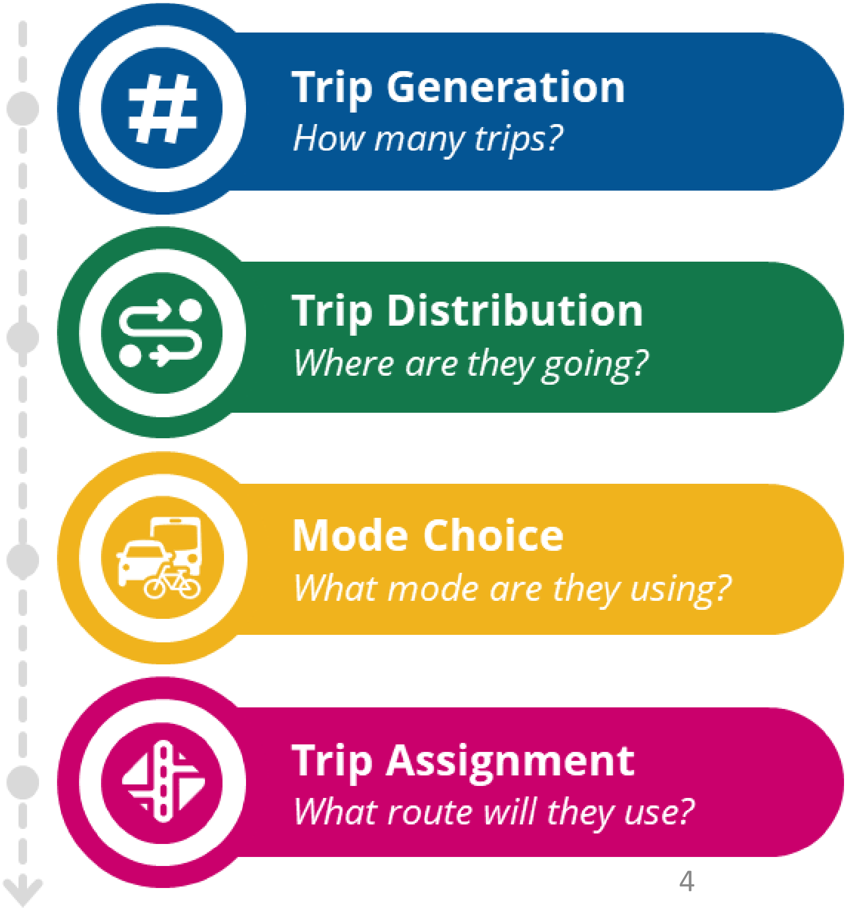
- To replicate the existing trip making characteristics

- To forecast future travel demand

- To identify transportation network deficiencies and prioritize projects

Travel Demand Model

Four-Step Approach



MACORTS MPO Travel Demand Model Application

MACORTS MPO Travel Demand Model **can:**

- Provide daily volumes, travel time, and LOS on functional classified roads within MPO area
- Provide travel shed and origin-destination analysis
- Help identify roadway deficiencies where daily volumes exceed the capacity
- Help evaluate transportation system performance and benefits

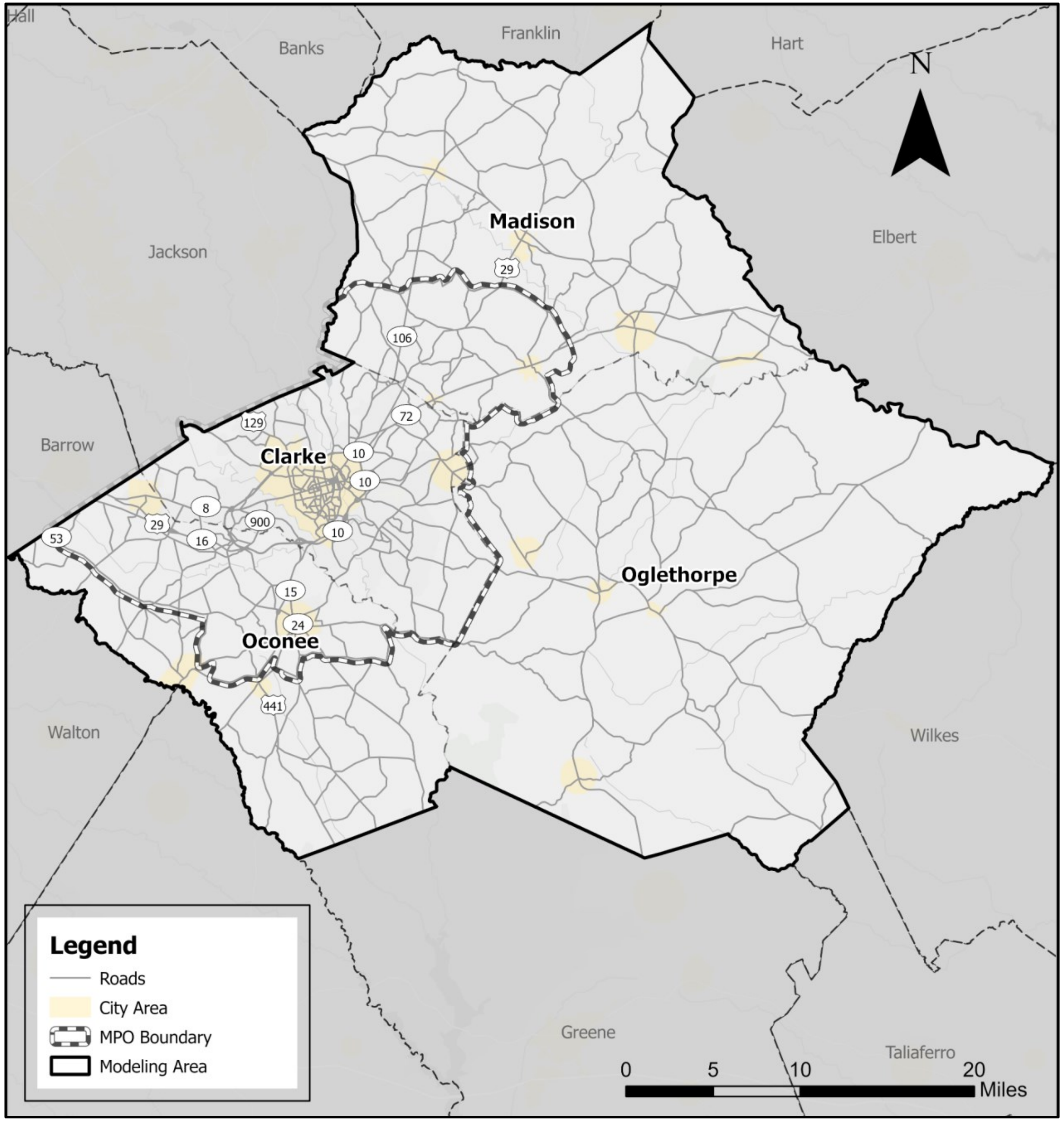
MACORTS MPO Travel Demand Model Application

MACORTS MPO Travel Demand Model **cannot:**

- Provide time-of-day traffic estimates (peak hour or peak periods)
- Provide nonmotorized travel information
- Provide logical termini determination information*
- Provide turning movement traffic performance at intersections

*The TDM can assist in the high-level screening, but more in-depth analysis is required to determine the logical termini.

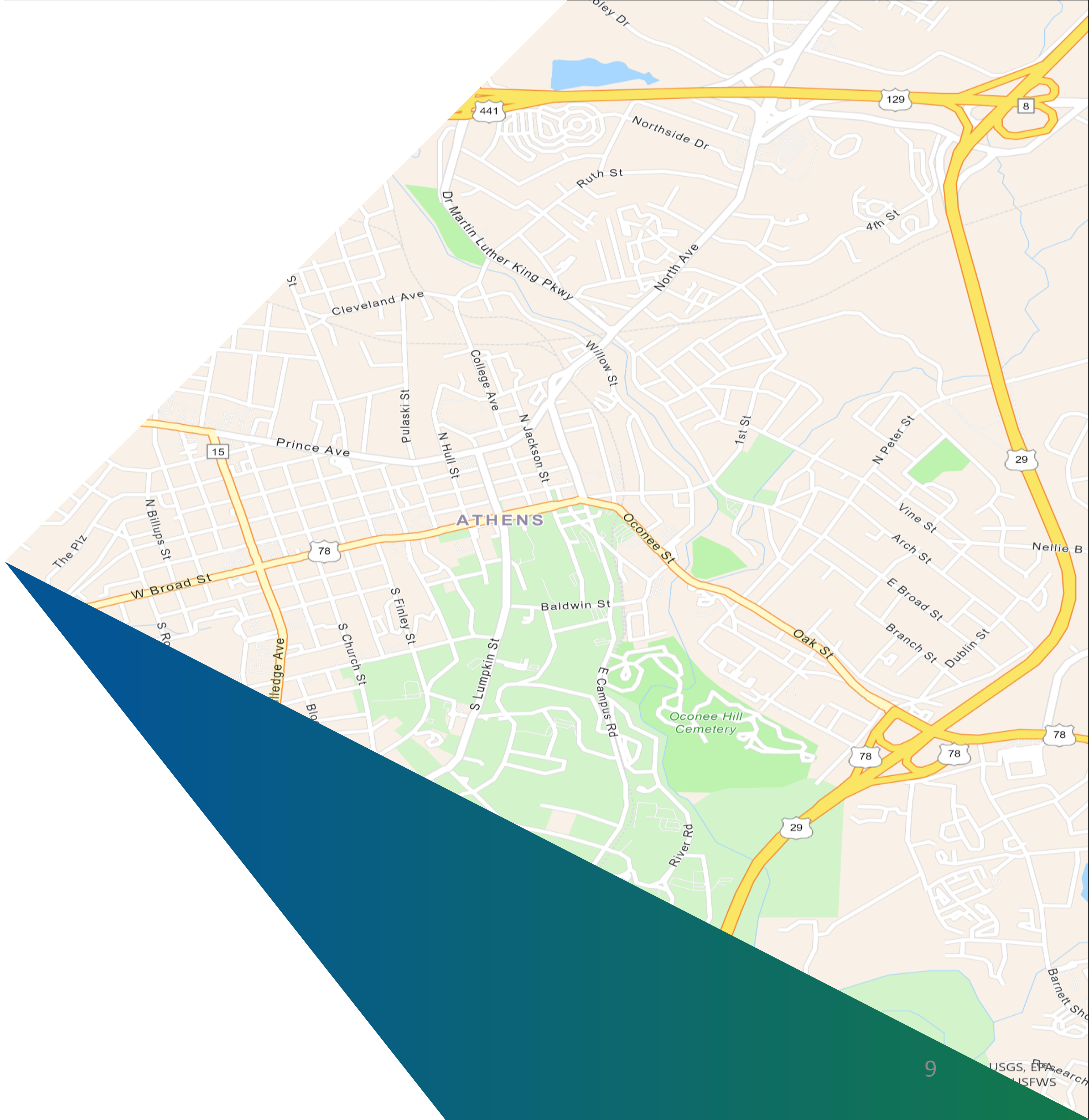
MACORTS MPO Boundary and Modeling Area



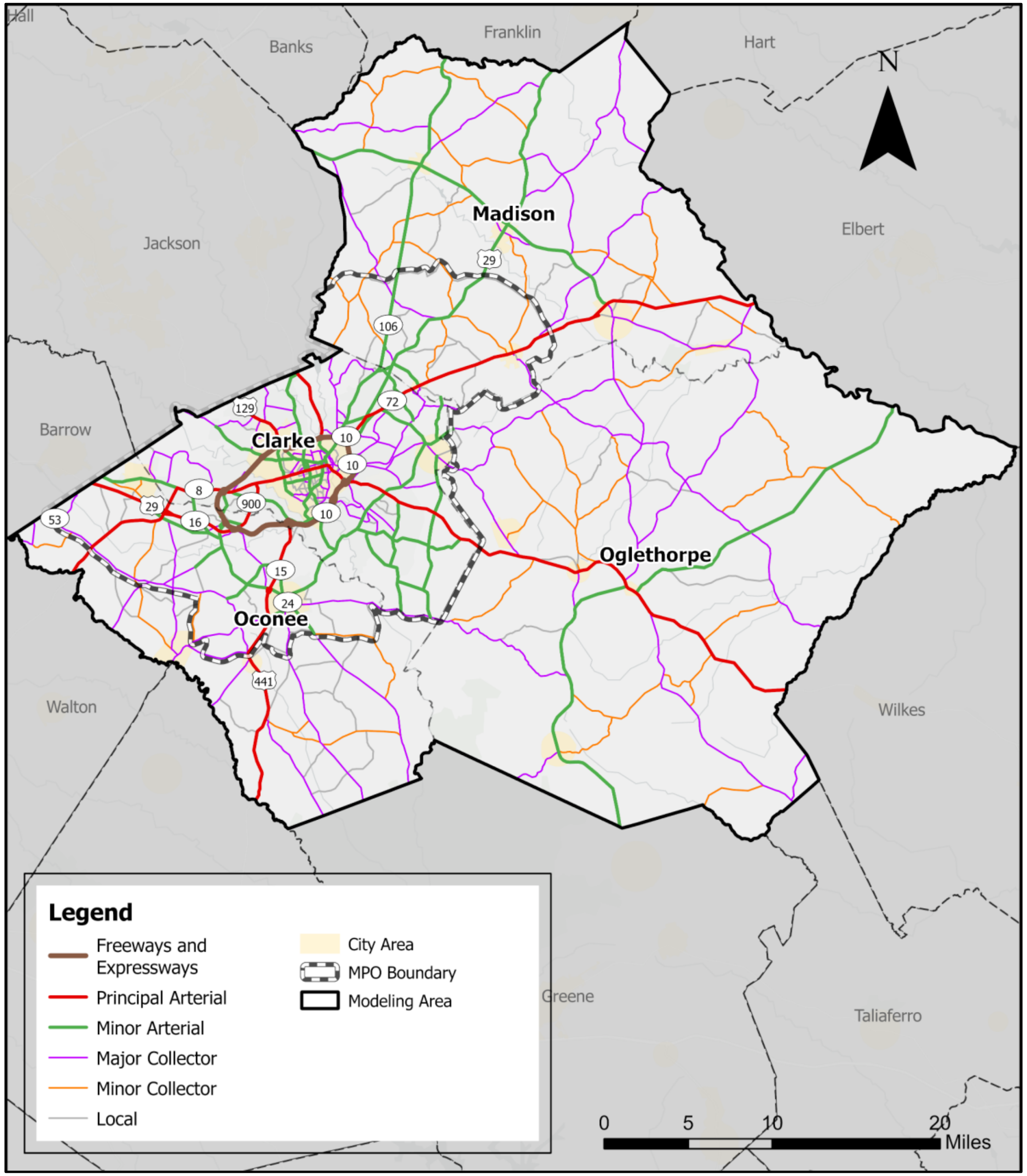
Travel Demand Model Major Activities

1. Review and Update Traffic Analysis Zones
2. Prepare socio-economic data (MPO)
3. Update trip rates based on 2017 NHTS data
4. Update and validate model base year to 2020
5. Develop 2050 Do-Nothing Scenario (Projects provided by MPO)
6. System performance evaluation

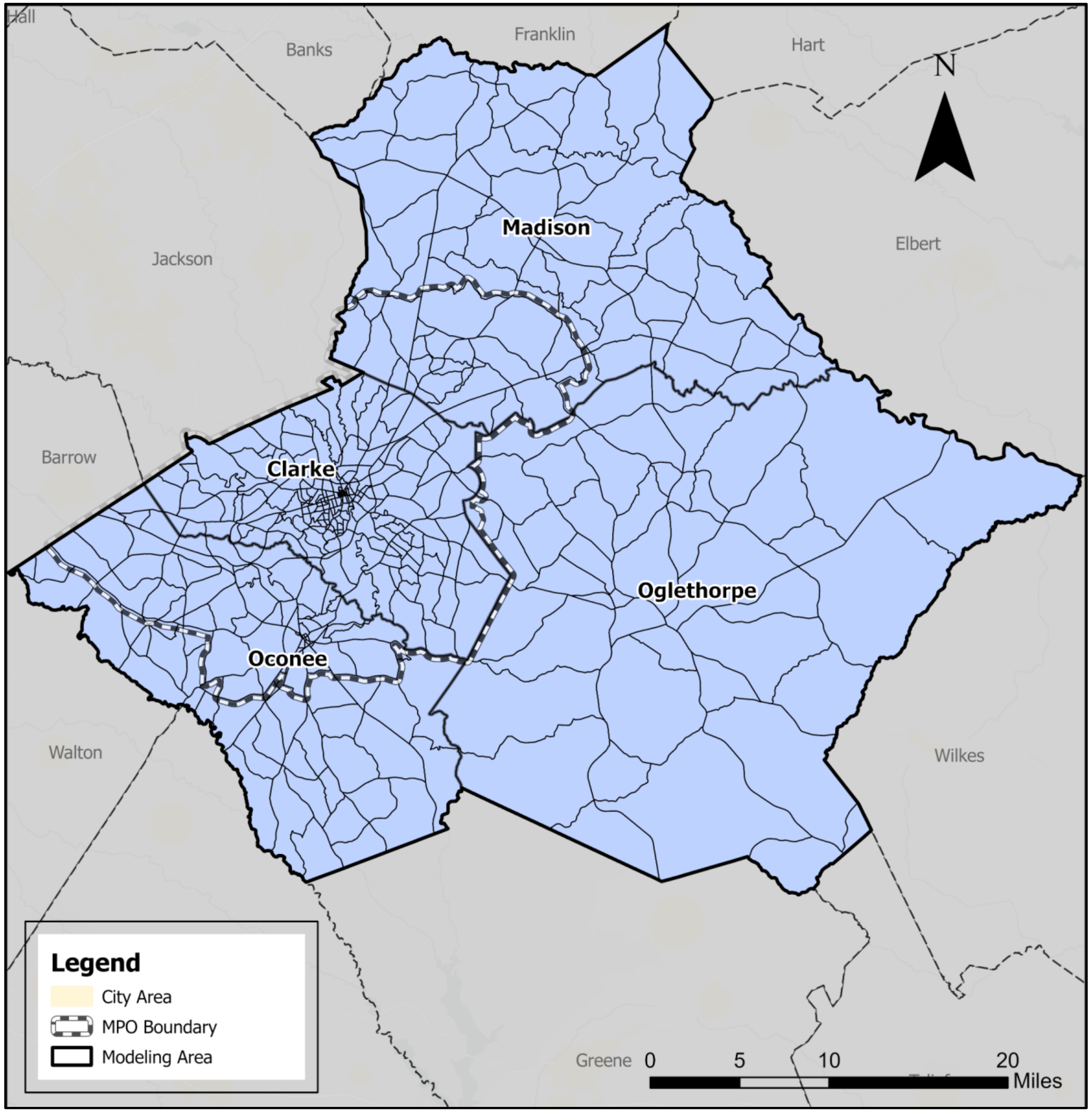
2020 Model Inputs



2020 Roadway Network



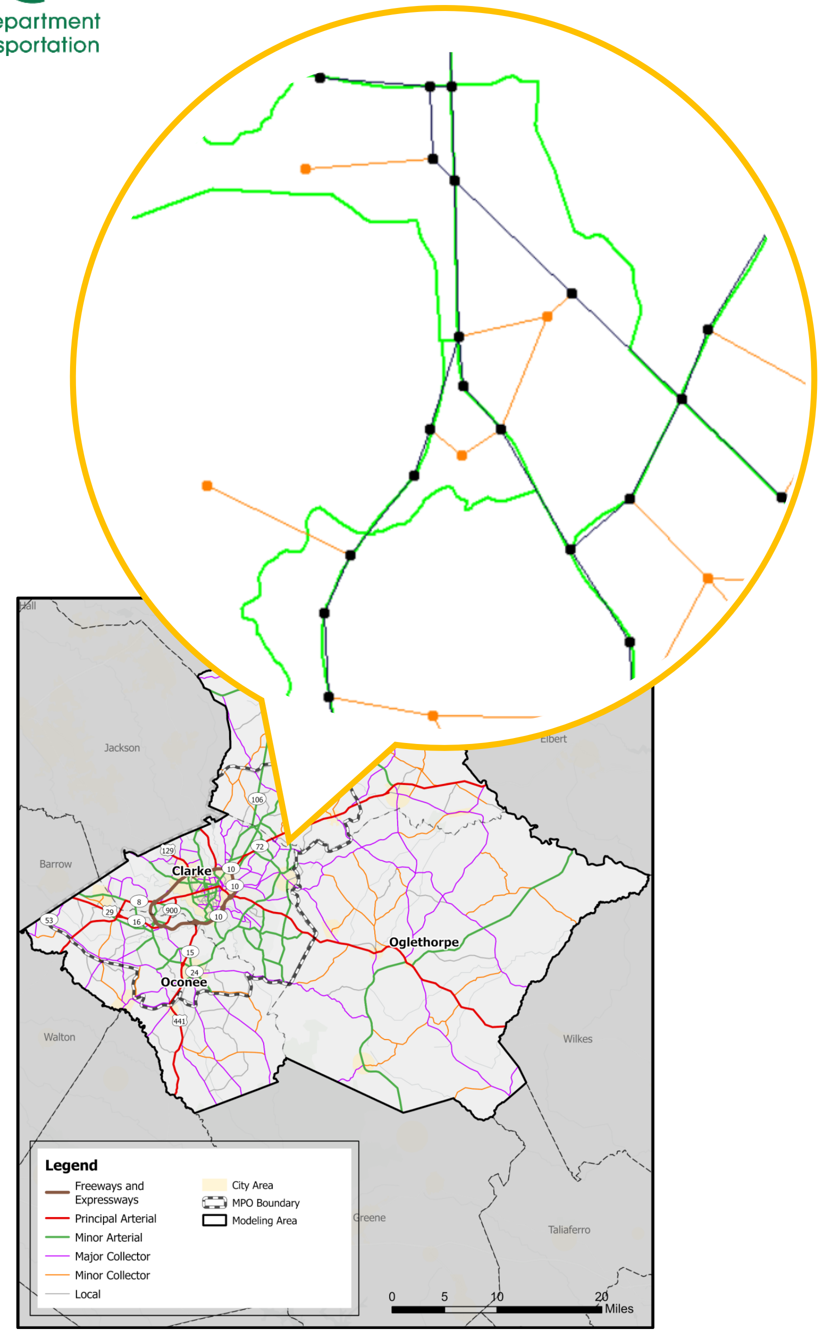
Source: GDOT 2020 Road Inventory Data



2020 Traffic Analysis Zones (TAZs)

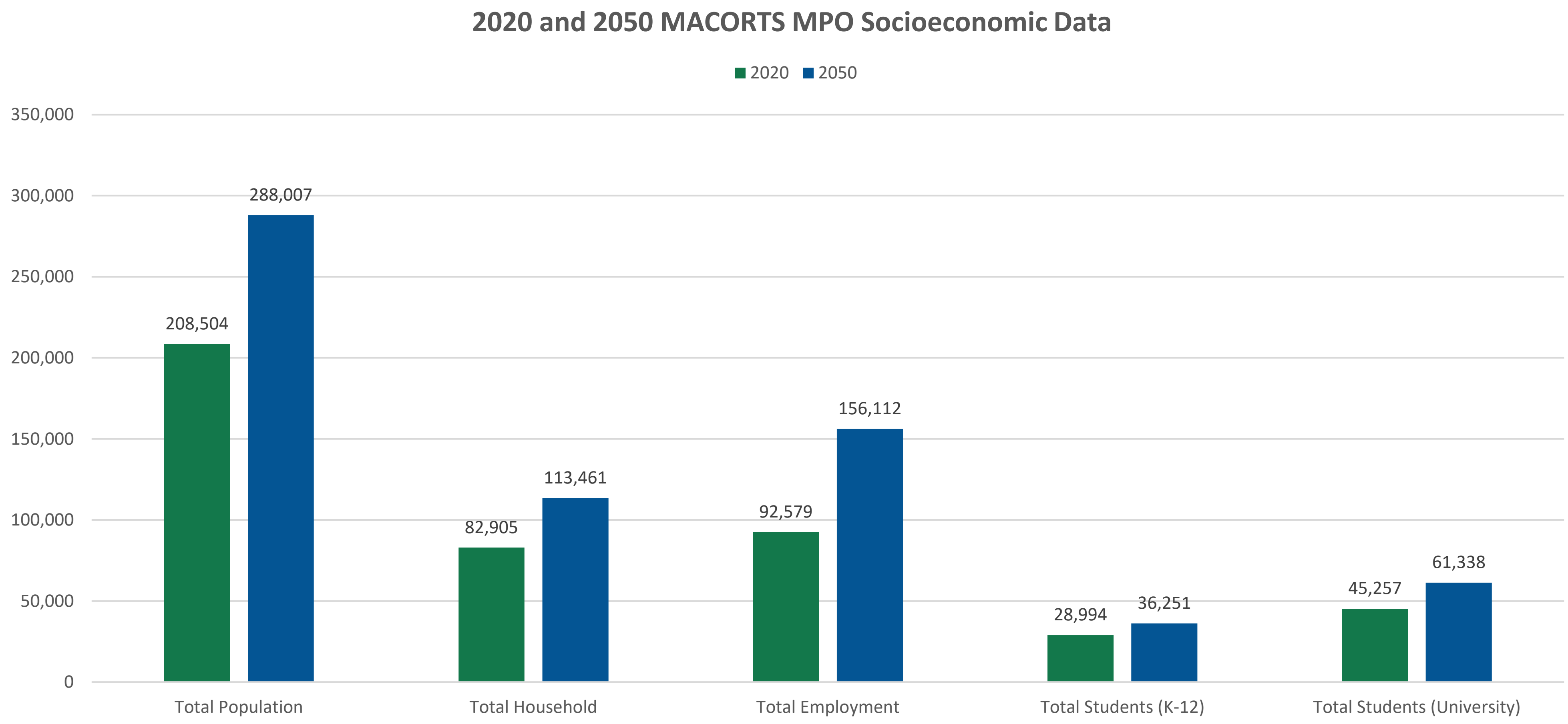
461 TAZs in Modeling Area

How are the TAZs and roads represented in the model?



- **TAZs:** Traffic analysis zones are primary unit of area analysis in travel demand model, representing the land use and socioeconomic characteristics in an area. TAZ sizes range from a few census blocks to large combination of census tracts.
- **TAZ Centroid:** node at center of a TAZ and the start and end point of all trips to and from that TAZ
- **Centroid Connectors**: Connect TAZs with the transportation network
- **Nodes:** points where road links meet. Some nodes represent intersections and may have defined turning restrictions
- **Network Link:** connected links that represent the region's streets, transit lines, bike lanes or multiuse trails. Each link contains data on length, travel speeds, lanes and allowable modes of transportation

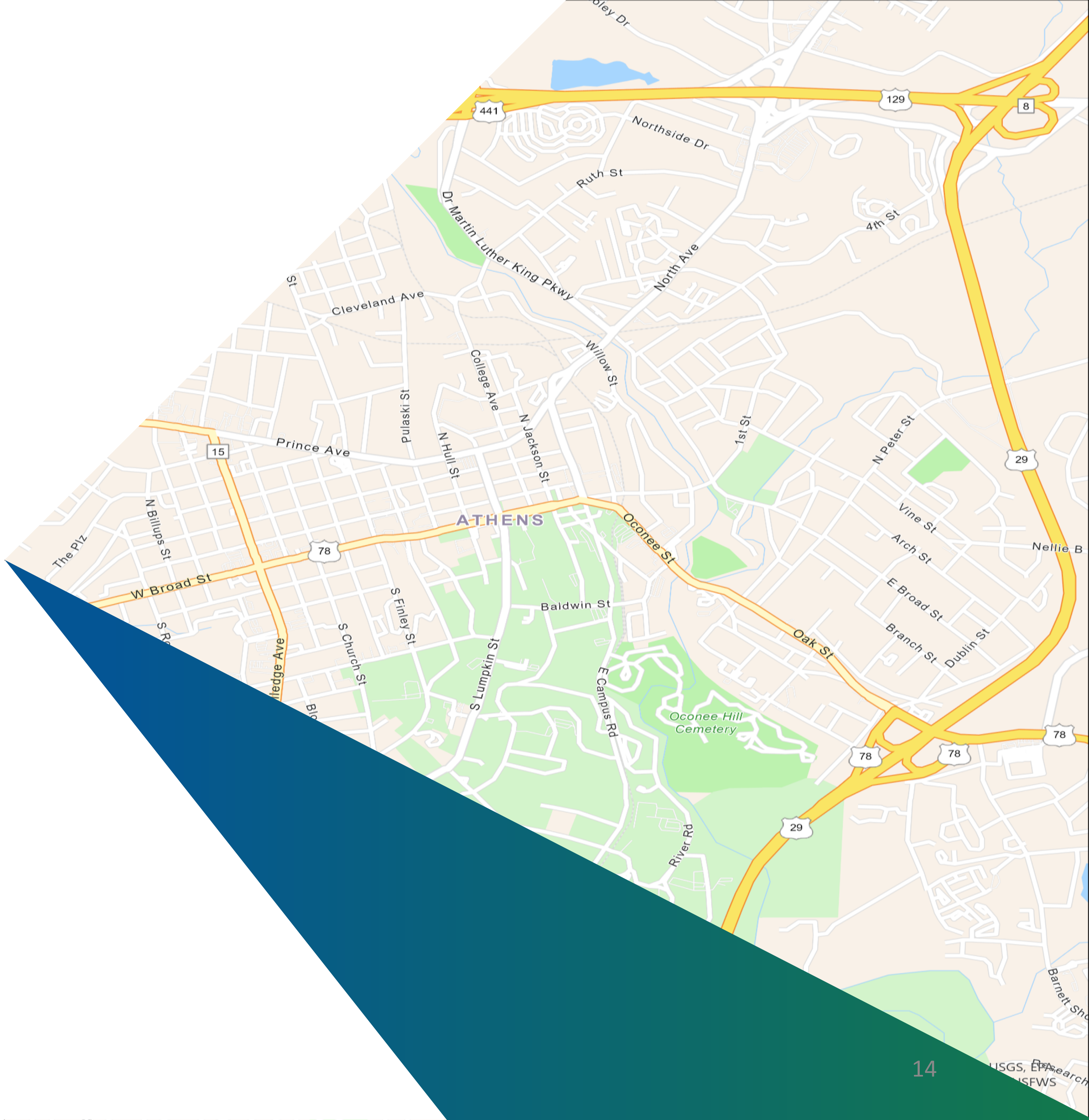
Socio-economic Data Provided by MPO Staff



Percent growth	38% ↑	37% ↑	69% ↑	25% ↑	36% ↑

Base Year (2020) Model Outputs

Model Validation Results



2020 Model Validation

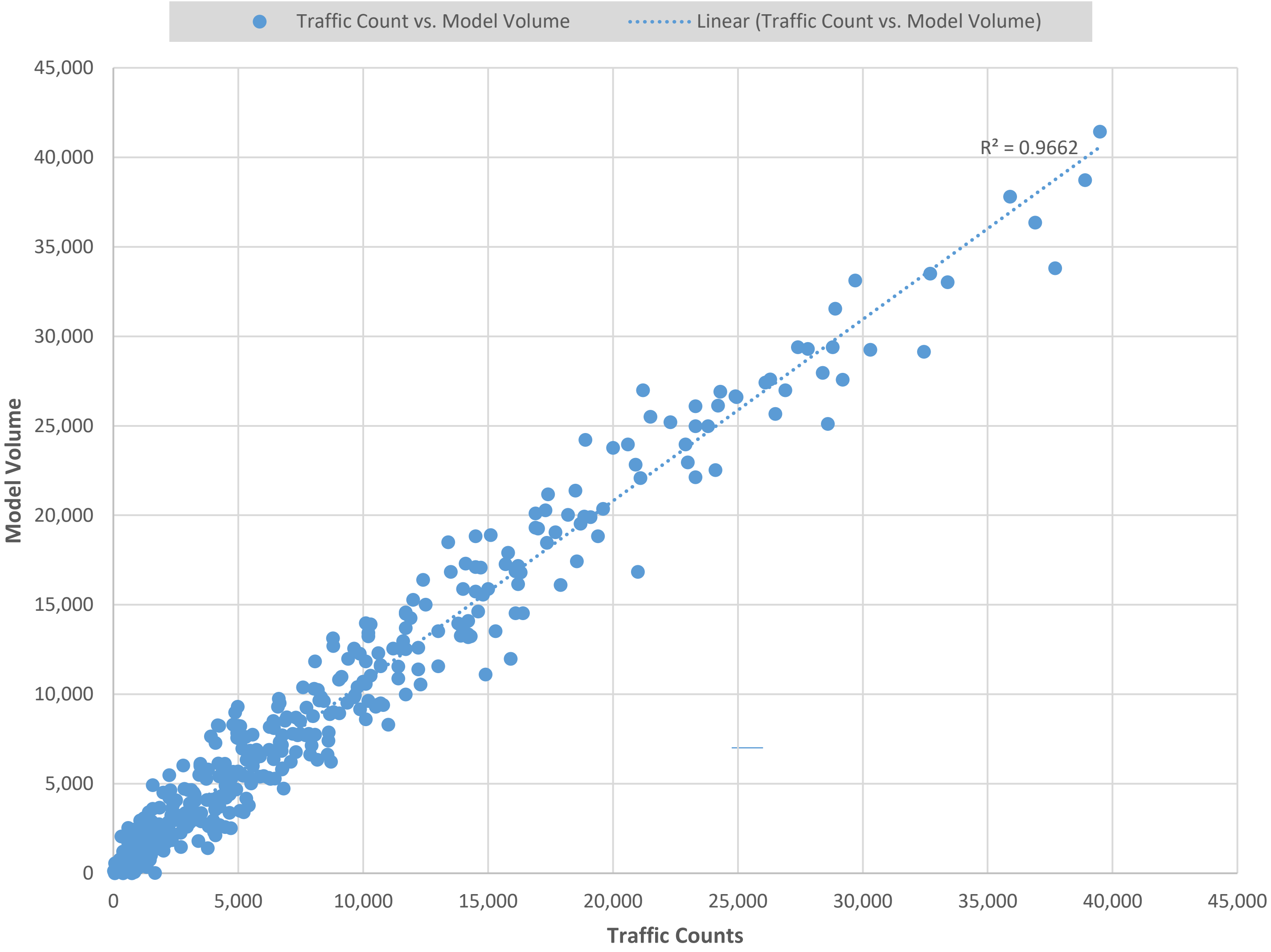
Model Area Roadway Mileage & Vehicle Miles Traveled (VMT) by Facility Type

Facility Type	Mileage		VMT (miles)		VMT Distribution		VMT Difference (Model vs. Observed)	
	Observed (1)	Model	Observed (1)	Model	Observed (1)	Model	Difference	%
Principal Arterials	119	116	2,442,697	2,526,682	47.2%	49.1%	83,985	3.4%
Minor Arterials	204	204	1,518,273	1,450,416	29.3%	28.2%	-67,857	-4.5%
Collectors	503	501	1,215,050	1,165,685	23.5%	22.7%	-49,365	-4.1%
Total	826	821	5,176,020	5,142,783	100.0%	100.0%	-33,237	**-0.6%**

(1) 2019 GDOT VMT – GDOT Mileage by Route and Road System Report 445.
https://www.dot.ga.gov/DriveSmart/Data/Documents/400%20Series/445/445_Report_2019.pdf

2020 Model Validation

Traffic Counts vs. Modeled Volume



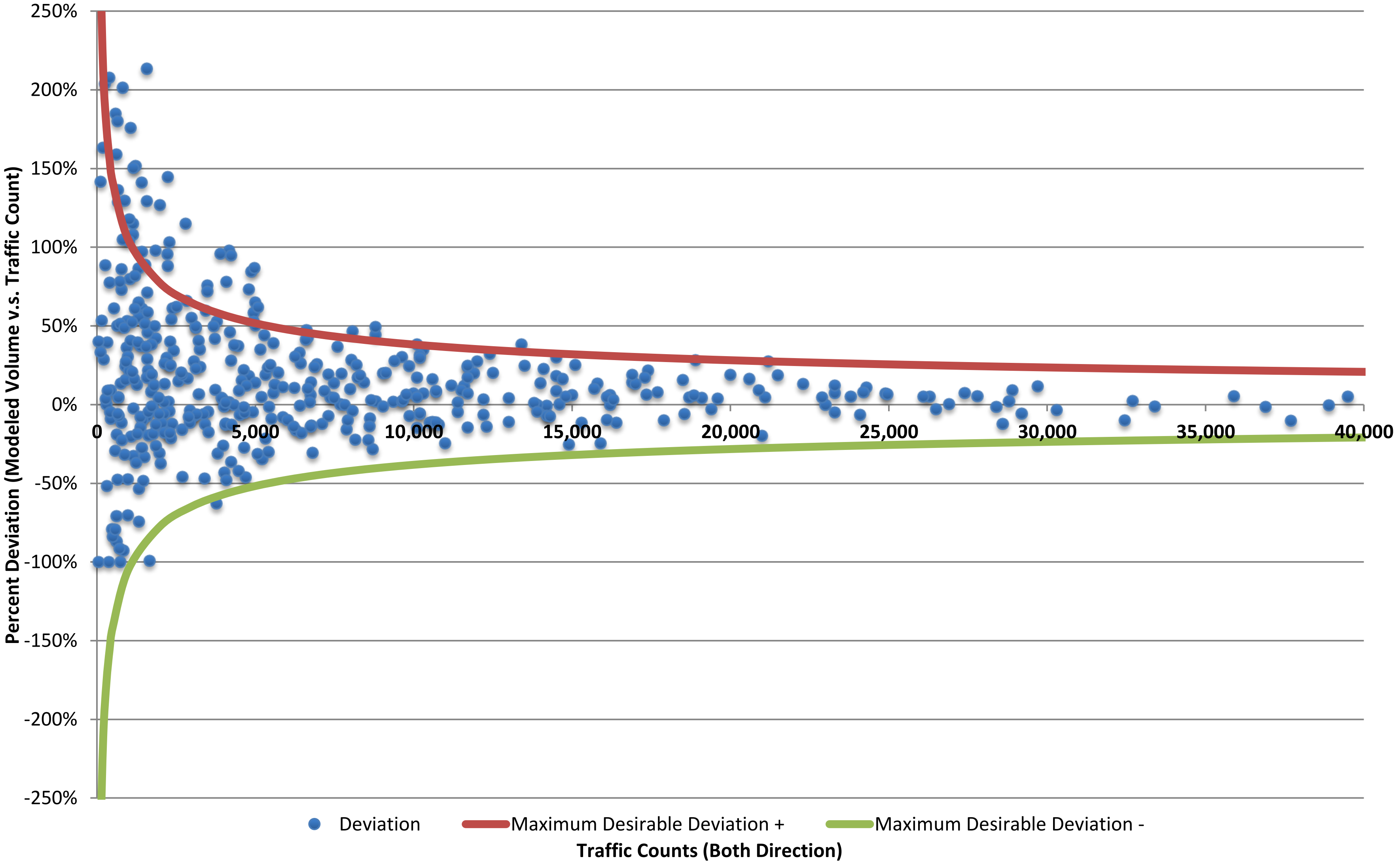
Model R-squared = 0.96

Recommended target R-squared = 0.88

Source:
Model Validation and Reasonableness Checking Manual, Second Edition, FHWA, 2010

2020 Model Validation

Modeled Volume vs. Traffic Counts Deviation



2020 Model Validation

Root-Mean-Square Error (RMSE)

AADT Volume Group	Model	Target Range (1)
0 – 5,000	53%	<100%
5,000 – 10,000	24%	<75%
10,000 – 15,000	17%	<50%
15,000 – 20,000	14%	<30%
20,000 – 30,000	10%	<30%
> 30,000	6%	<30%
Total	**20%**	**<35%**

(1) Target range was determined based on values from Validation and Sensitivity Considerations for Statewide Model, NCHRP Project 836-B Task 91, September 2010

Screenline Validation

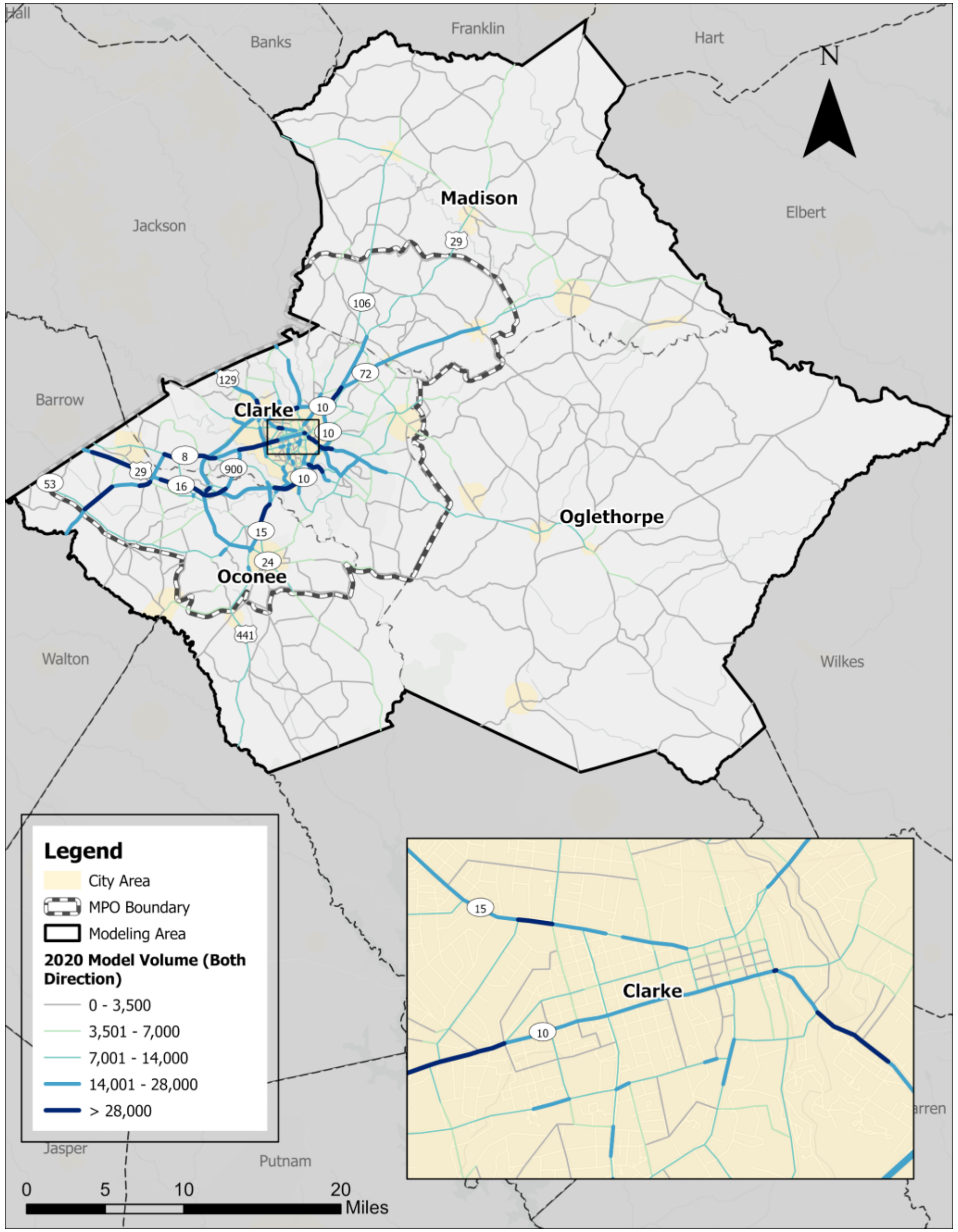
Screenline	Model Volume	Traffic Counts	Max Desirable Deviation	Model Deviation	Validation
1	157,670	146,700	± 21%	-7%	Pass
2	36,320	34,230	± 37%	-6%	Pass
3	11,640	9,990	± 60%	-17%	Pass
4	171,050	162,400	± 21%	-5%	Pass
5	80,550	65,750	± 29%	-23%	Pass
6	25,960	23,740	± 43%	-9%	Pass
7	80,780	71,320	± 28%	-13%	Pass
Total	**563,970**	**514,130**	**± 13%**	**-10%**	**Pass**

Comparison of 2020 modeled trips and 2017 National Household Travel Survey (NHTS) trip data

Trip Purpose	Distribution	
	Model	2017 NHTS
Home-Base-Work (HBW)	12%	12%
Home-Base-Other (HBO)	29%	29%
Home-Base-Shopping/Recreational (HBS)	21%	21%
Non-Home-Based (NHB)	38%	38%
Total	**100%**	**100%**

****2017 NHTS trip data were based on trip surveys collected between April 2016 and May 2017.***

2020 Total Daily Traffic Volumes



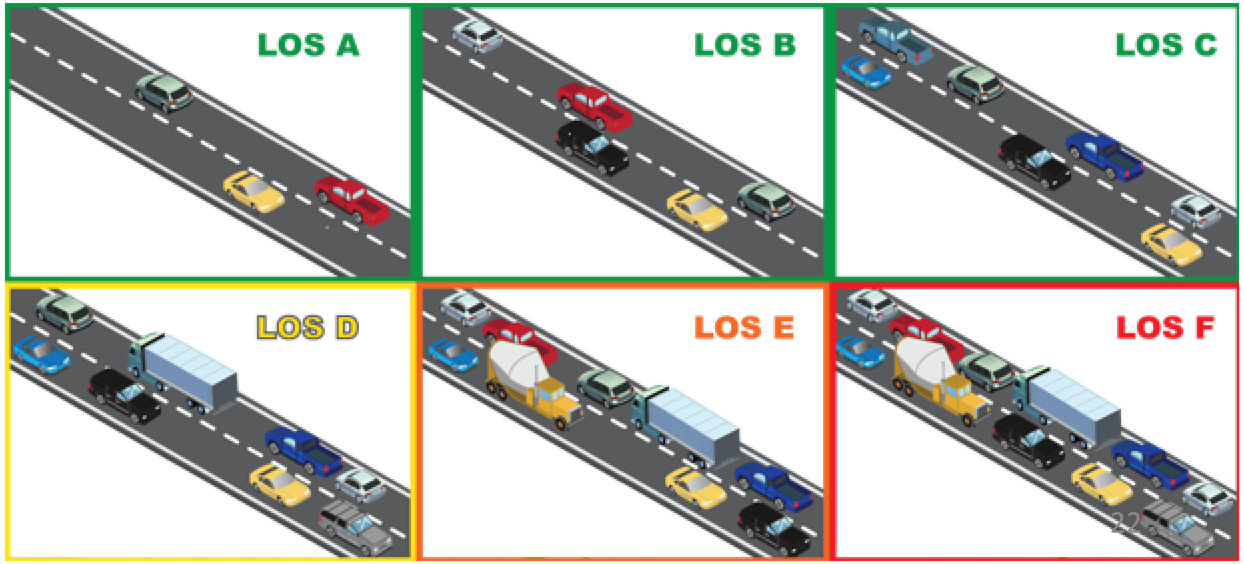
Note: Total volume for both direction

Daily Level of Service (LOS)

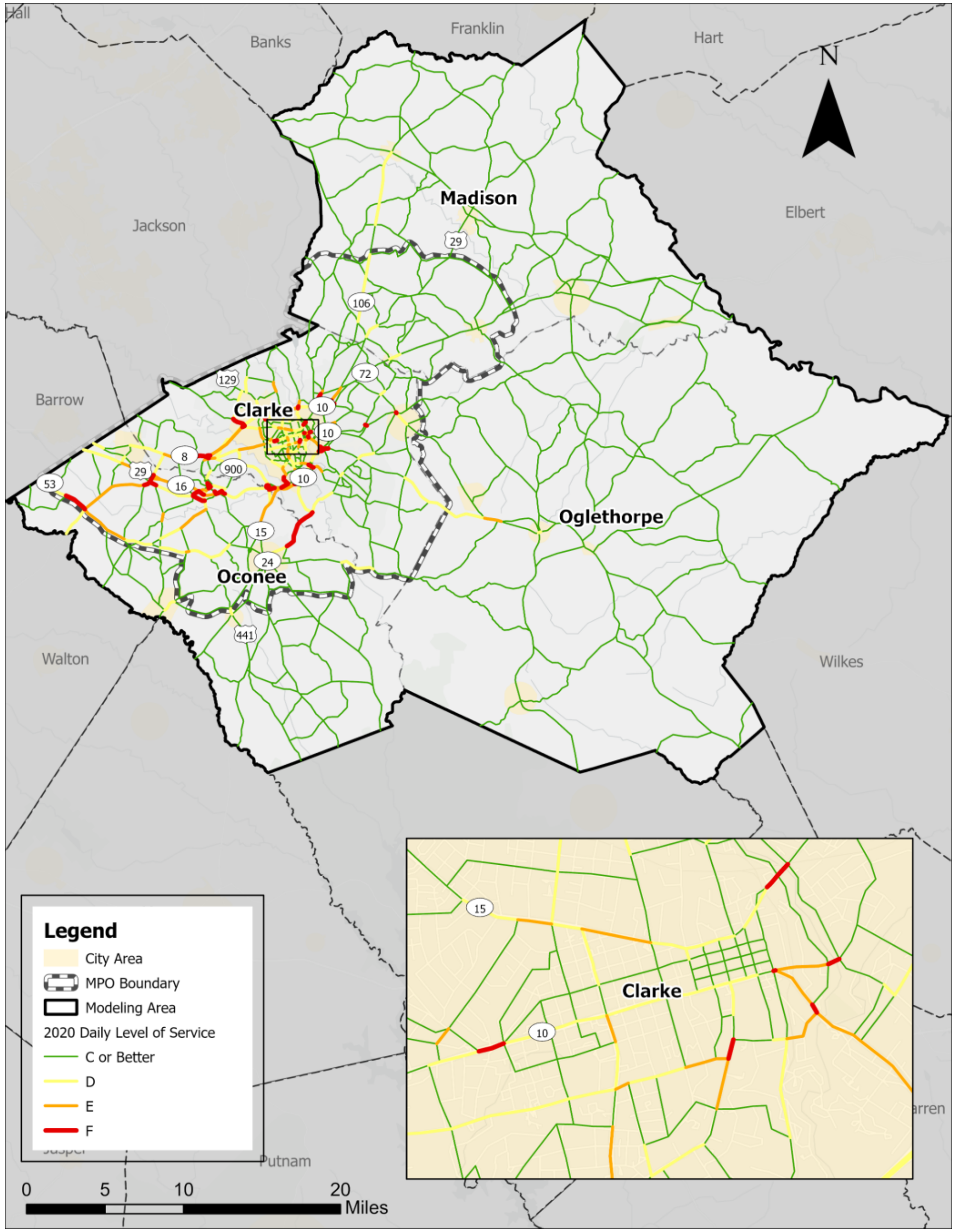
Based on Highway Capacity Manual (HCM) methodology

Daily LOS was derived using the Travel Demand Model

Daily LOS compares daily volumes along the roadway to the capacity of that roadway

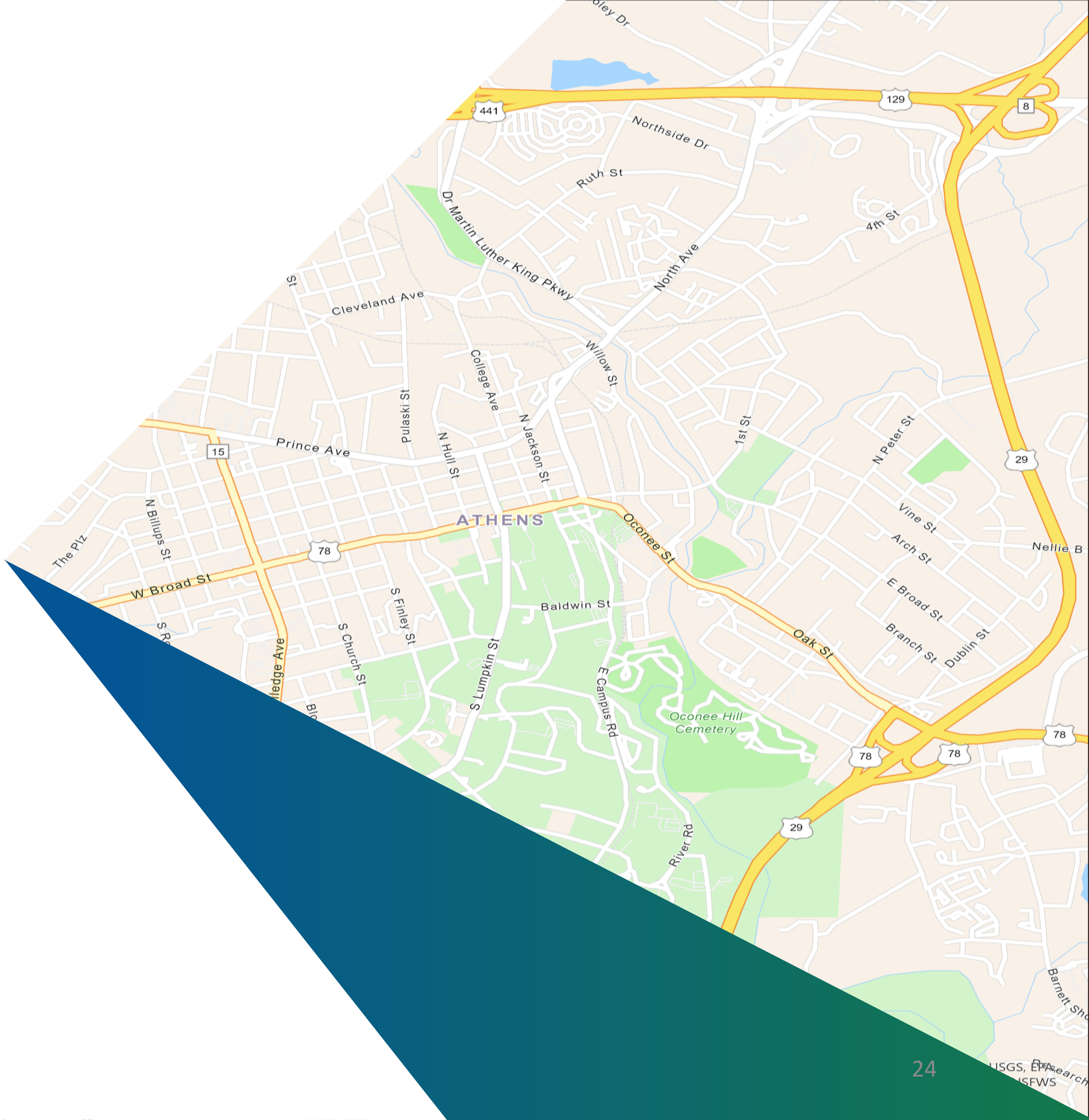


2020 Daily Level of Service (LOS)



$$LOS = \frac{Modeled\ Daily\ Traffic}{Daily\ Capacity}$$

Future Year (2050) Model Outputs



2050 MTP Scenarios

2 Do-Nothing

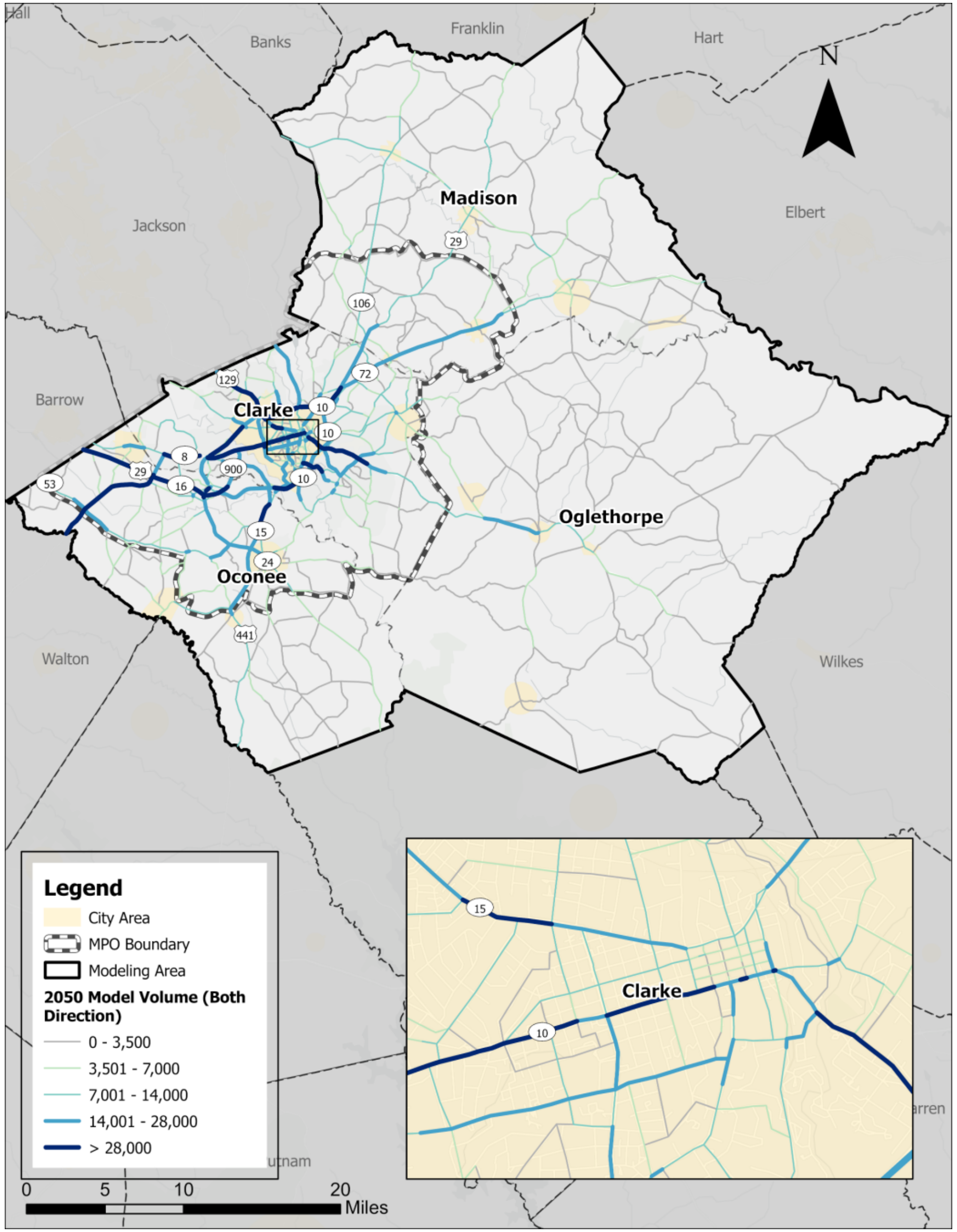
3 Existing + Committed projects

4 Completion of STIP/TIP system projects

5 Metropolitan Transportation Plan system projects

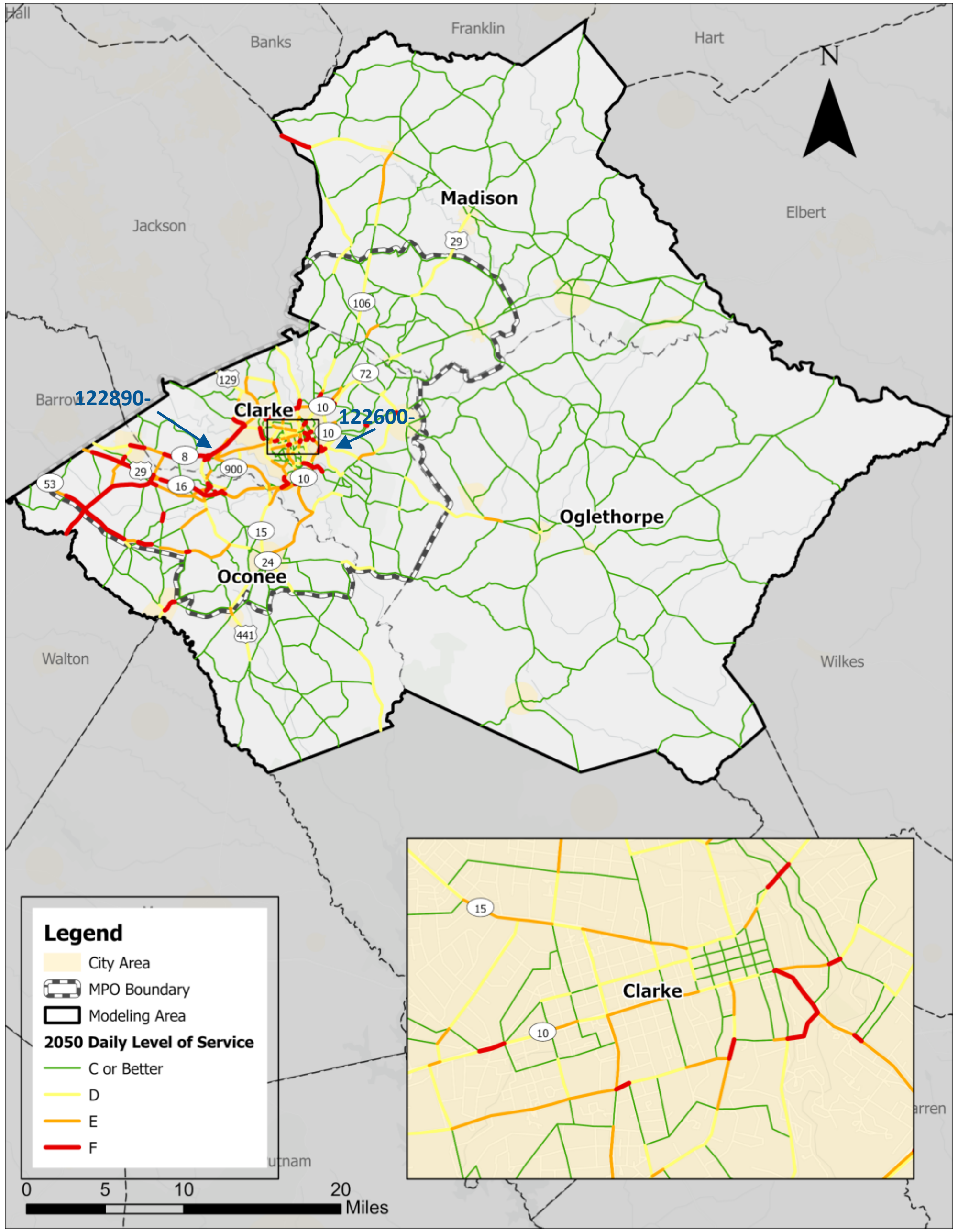
6 Financially Constrained Plan projects

2050 “Do-Nothing” Total Daily Traffic Volumes



Note: Total volume for both direction

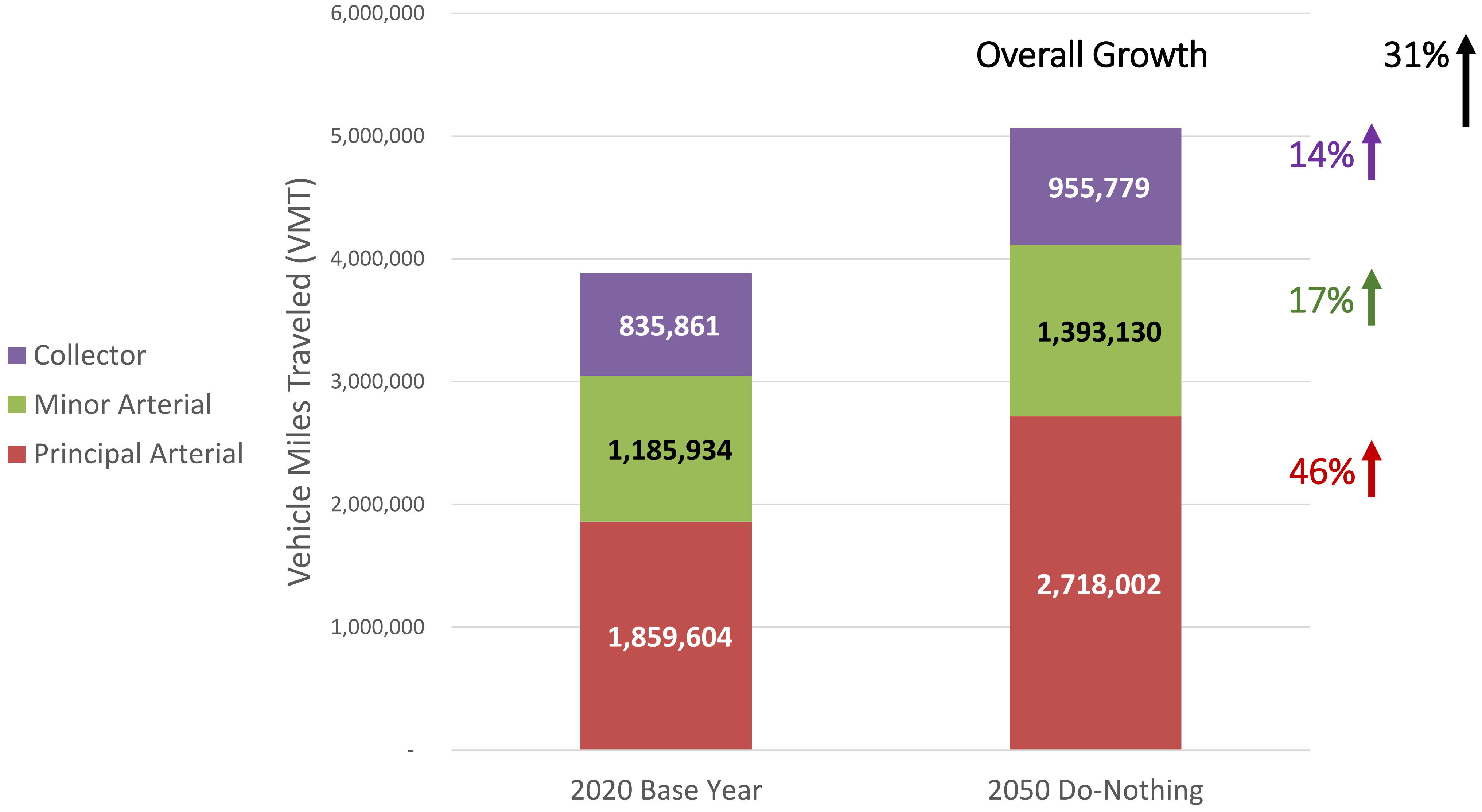
2050 “Do-Nothing” Daily Level of Service (LOS)



Project Coded in the Network

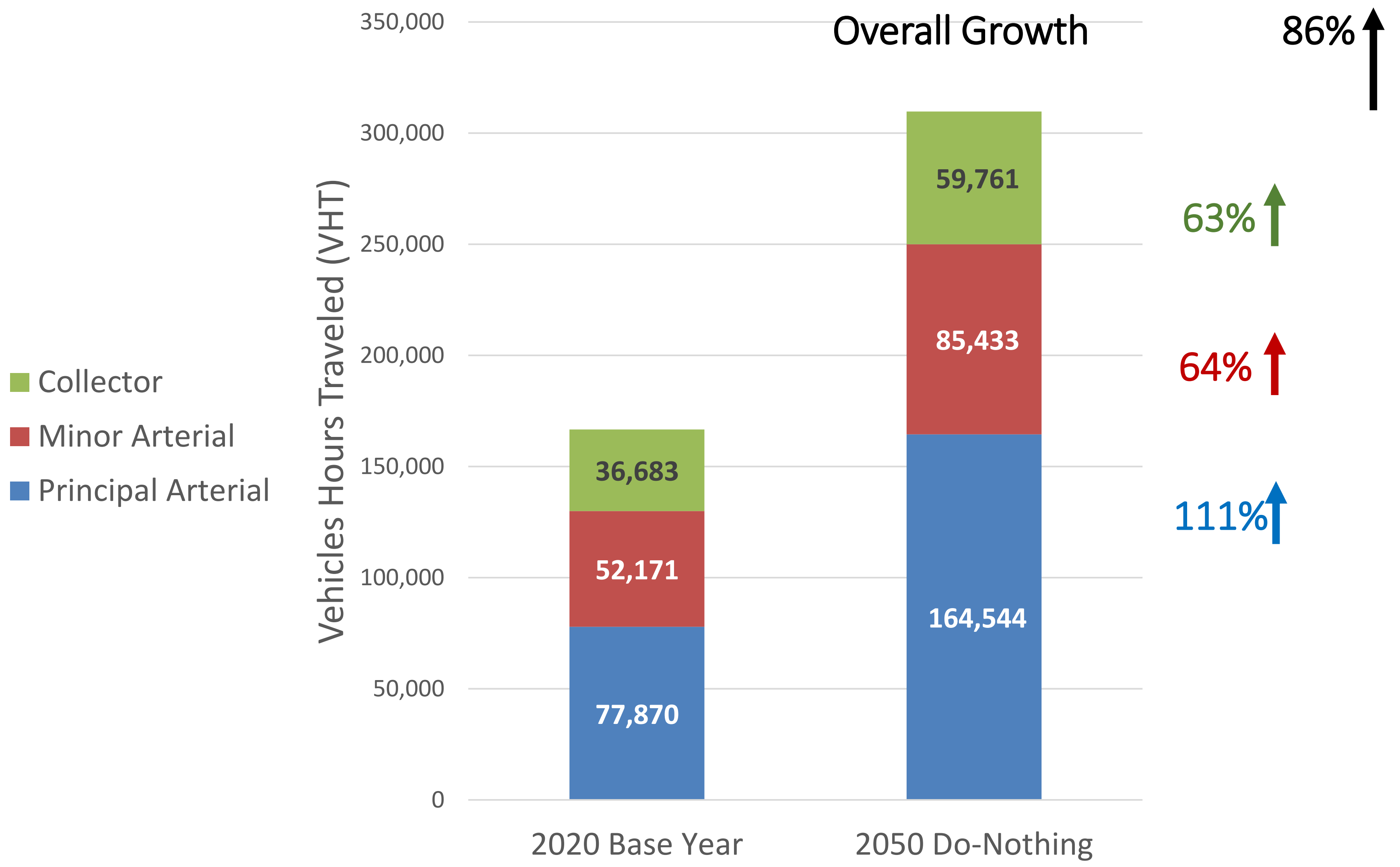
GDOT_PI	Description	Type of Project
122600-	Project STP-014-1(70), P.I. no. 122600- proposes to widen SR 10/US 78/Lexington Hwy from a 4-lane divided roadway to a 6-lane divided roadway with a 20 foot raised median and sidewalks. The project also reconstructs the northbound SR 10 Loop exit and entrance ramps by removing the northbound entrance loop ramp, adding a northbound exit loop ramp for westbound SR 10/US 78 and adding a northbound entrance ramp directly across from Barnett Shoals Road. Median openings and intersections will be modified/removed accordingly.	Widening and Ramp Reconstruction
122890-	This project is to construct a new loop ramp from Atlanta Highway westbound to SR 10 Loop southbound, realigning the existing loop ramp from Atlanta Highway eastbound to SR 10 Loop northbound, and widening Atlanta Highway by adding four lanes and lengthening several turn lanes. The project also includes improvements to the Huntington Road and Atlanta Highway intersection.	Widening and Interchange

Daily Vehicle Miles Travelled (VMT) by Facility Type



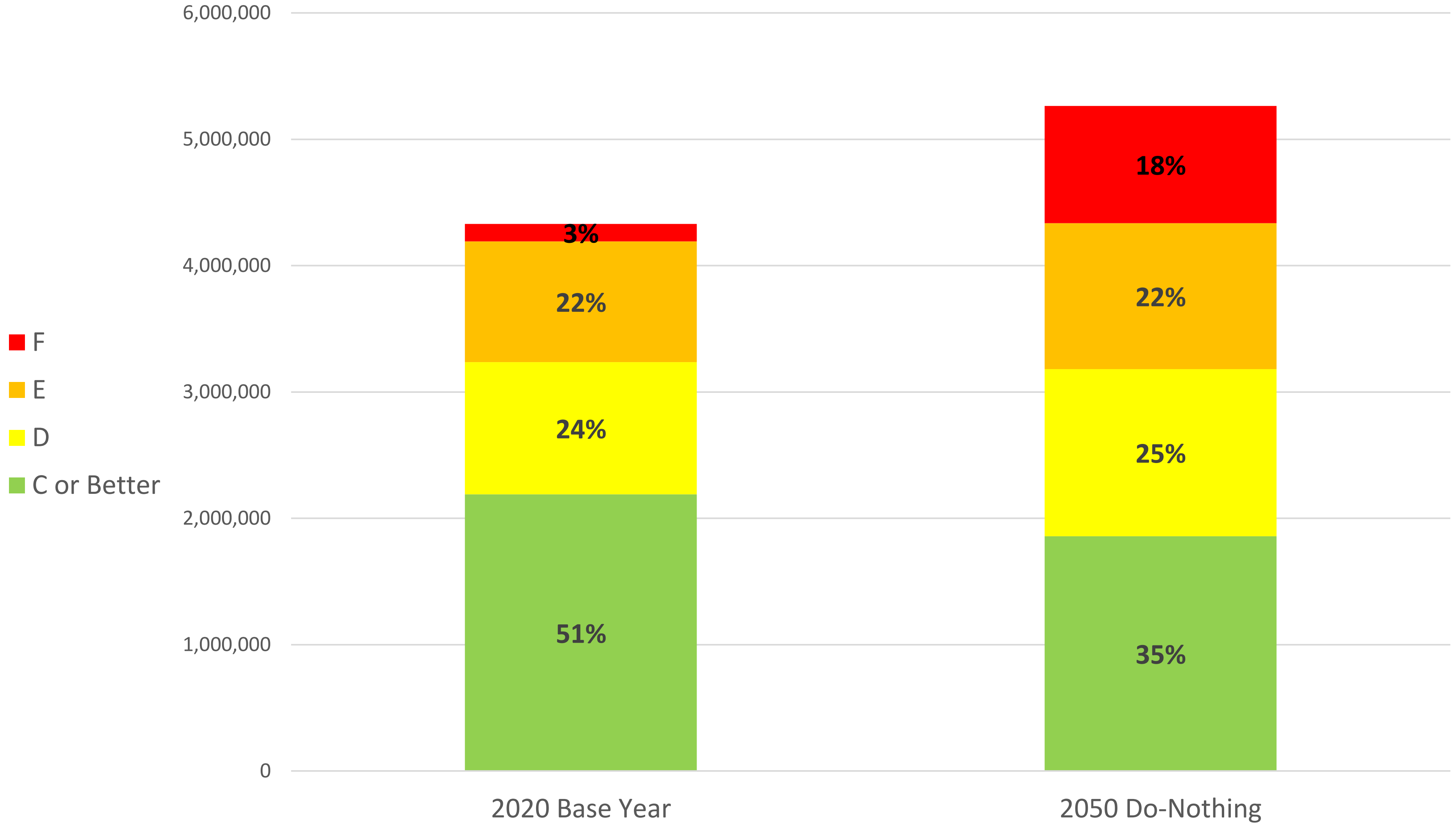
Note: Results represent links that are Collectors and above within the MPO area

Daily Vehicle Hours Travelled (VHT) by Facility Type



Note: Results represent links that are Collectors and above within the MPO area

Daily Vehicle Miles Travelled (VMT) by Level of Service



Note: Results represent links within the MPO area and include some local roads

Next Steps

MPO staff provides project lists for remaining 2050 MTP scenarios

Evaluate remaining future year MTP scenarios

Analyze system performance

Provide outputs to MPO planners to prioritize projects

Discussion

Questions ?

TRAVEL DEMAND MODEL DOCUMENTATION
FOR THE MACORTS MPO AREA TRANSPORTATION

September 2024

GDOT
Georgia Department of Transportation

Prepared for
Georgia Department of Transportation

MODERN MOBILITY partners

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TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

AADT	Annual Average Daily Traffic
MACORTS	Madison Athens-Clarke Oconee Regional Transportation Study
CTPP	Census Transportation Planning Package
E+C	Existing + Committed
FAST	Fixing America's Surface Transportation
FHWA	Federal Highway Administration
GDOT	Georgia Department of Transportation
HBO	Home-Based Other
HBS	Home-Based Shopping
HBW	Home-Based Work
HPMS	Highway Performance Monitoring System
I-E	Internal-External
IEPC	Internal-External Passenger Car
IETRK	Internal-External Truck
I-I	Internal-Internal
IITRK	Internal-Internal Truck
LOS	Level of Service
MPO	Metropolitan Planning Organization
MTP	Metropolitan Transportation Plan
NCHRP	National Cooperative Highway Research Program
NHB	Non-Home-Based
RMSE	Root Mean Squared Error

%RMSE	Percent Root Mean Squared Error
TAZ	Traffic Analysis Zone
TDM	Travel Demand Model
Univ	University
VMT	Vehicle-Miles Traveled
VHT	Vehicle-Hours Traveled
TIP	Transportation Improvement Program

1. INTRODUCTION

1.1 BACKGROUND

The federal legislation requires each Metropolitan Planning Organization (MPO) to update its Metropolitan Transportation Plan (MTP) at least every five years, and for air quality nonattainment or maintenance areas, it should be updated every four years. The MTP covers a minimum twenty-year planning horizon and must be fiscally constrained. The current transportation legislation requires that metropolitan transportation plans include current and projected transportation demands, and existing and proposed transportation facilities that should function as an integrated metropolitan transportation system. It also requires MPOs to evaluate the condition and performance of the transportation system. For those MPOs developing multiple scenarios, an analysis of how the preferred scenario has improved the conditions and performance of the transportation system should be included as well. Among the tools helping MPOs meet the requirements, the Travel Demand Model (TDM) is a state-of-art tool to forecast the transportation demand and assess the performance of the transportation system.

The Madison Athens-Clarke Oconee Regional Transportation Study (MACORTS) is an MPO for the area. The MACORTS consists of the entirety of Madison, Clarke, Oconee and Oglethorpe County. The last MTP for MACORTS was approved in October 2019. The current MTP update must be approved by September 2024. The critical component of the updated MTP is making informed decisions about multiple transportation system improvements. The TDM is one of the many planning tools that help MPOs understand the impact of their decisions. The TDM is commonly used to evaluate the performance of a transportation system within MPO and surrounding areas. TDMs can predict the demand for transportation services and identify potential transportation deficiencies. The TDM developed during the last MTP for MACORTS in 2019 has the base year model reflecting 2015 conditions and a horizon year of 2050. In the current MTP process, the TDM has been updated to 2020 Base Year, and 2050 Future Year. The purpose of this document is to provide an overview of the MACORTS TDM update that would be used as a tool for the development of the 2050 MTP.

1.2 TRAVEL DEMAND MODEL INTRODUCTION

1.2.1 What is a Travel Demand Model?

The task of travel demand modeling is an essential component of planning for regional infrastructure improvements. Regional TDMs provide the scale needed to analyze the benefits of transportation investments. It is a state-of-the-art analysis tool that can replicate the existing travel demand, forecast future travel demand, identify transportation network deficiencies, and prioritize projects. The critical questions surrounding any transportation investment include not only “Where is a facility needed?” but also “When and why is a facility needed?” These questions can be answered through the regional perspective provided by large-scale TDMs. The process of travel demand forecasting uses what is known about the existing world to predict what conditions will be like in the future. It is a projection based on empirical data and foreseeable circumstances.

Most TDMs utilize a traditional four-step approach to estimate travel demands and patterns, how many trips will be generated, where they are going, what modes they are using, and which routes they will use. In the broadest sense, the MPO TDM consists of three elements: 1) model inputs, 2) a series of models conducting mathematical procedures, and 3) model outputs. Further details on each are provided below.

1.2.1.1 Model Inputs

The model inputs are based on the roadway system, land use, and socioeconomic (SE) data. SE Data such as population, household, and employment by type, represent land use. Future year projections of SE data were based on existing land uses including land development, as well as region-wide forecasts of population, household, and employment. Future year forecasts also considered planned major transportation improvements. It is in this area of TDM development that land use and community planning are connected to the transportation planning process. SE data and the highway network serve as the basic inputs to the TDM.

1.2.1.2 A Series of Mathematical Procedures

The typical 4-step TDM forecasts travel demand based on the following steps: 1) trip generation, 2) trip distribution, 3) mode choice, and 4) trip assignment. The first step, trip generation, estimates how many trips are produced by each household for each trip purpose (work, shopping, etc.) and how many trips are attracted to each location (workplaces, shopping centers, other activity areas, etc.). The second step, trip distribution, determines where the generated trips go (i.e. their origin and destination). The third step, mode choice, determines what modes will be utilized (i.e. passenger vehicles, transit, etc.). The fourth step, trip assignment, determines what routes will be taken to get from travelers' origin to destination.

1.2.1.3 Model Outputs

The outputs or results of the TDM forecast traffic volumes and other traffic metrics (i.e., travel speeds, travel time, congestion levels, etc.) of the transportation network. These metrics can be used to help identify transportation system deficiencies. TDMs are often used to assist in prioritizing transportation projects as well. **Figure 1-1** illustrates the structure of a TDM and its purpose.

Figure 1-1: TDM Structure

1.2.2 What the MPO's Regional TDM Can and Cannot Provide

TDMs across the country were developed at the regional and statewide levels. Its respective capabilities in forecasting traffic vary depending on the features of the model. The model developed for large metropolitan areas may include time-of-day, transit, and freight components. There are a few that even include non-motorized trip (bicycle, pedestrian, etc.) components. However, given the smaller nature of the MPO areas in Georgia outside Atlanta and the purposes of the travel demand model for MACORTS, the modeling process and components included in MACORTS's TDM are simpler. The regional TDM in Georgia, outside Atlanta, generally provides users with forecasted highway volumes for roadways with the functional classifications of collectors and above. The highway volumes are typically average daily volumes for long-range forecasts; 20 to 30 years out. The TDM can help MPOs to identify roadway deficiencies where daily volumes exceed the roadway capacities, evaluate impacts of major highway improvements, and evaluate transportation system performance for the purpose of MTP development. For MPOs within the air quality nonattainment areas, the TDM is also used as the basis for air pollution emission estimates and for congestion management system statistics.

Because of its aggregate nature and regional scope, these TDMs are not designated to forecast the following metrics:

- The peak hour or peak period travel demands.
- The freight demands.

- The number of bicycling and walking trips.
- The logical termini determination.

1.2.3 Who is Responsible for What?

The MPO's TDM development is a process that requires collaboration between each MPO and the Georgia Department of Transportation (GDOT). While GDOT leads the development efforts of the MPO's TDM forecasts, the MPOs develop the inputs including the base year and forecasted SE data and future transportation project lists. **Table 1-1** summarizes the major activities and their lead agencies for a typical MPO's TDM development process. Note that MPOs' input of SE information, project lists, and MTP scenarios drive the model forecast, and GDOT provides the technical services of the TDM development and forecast results.

Table 1-1: TDM Major Activities and Lead Agencies

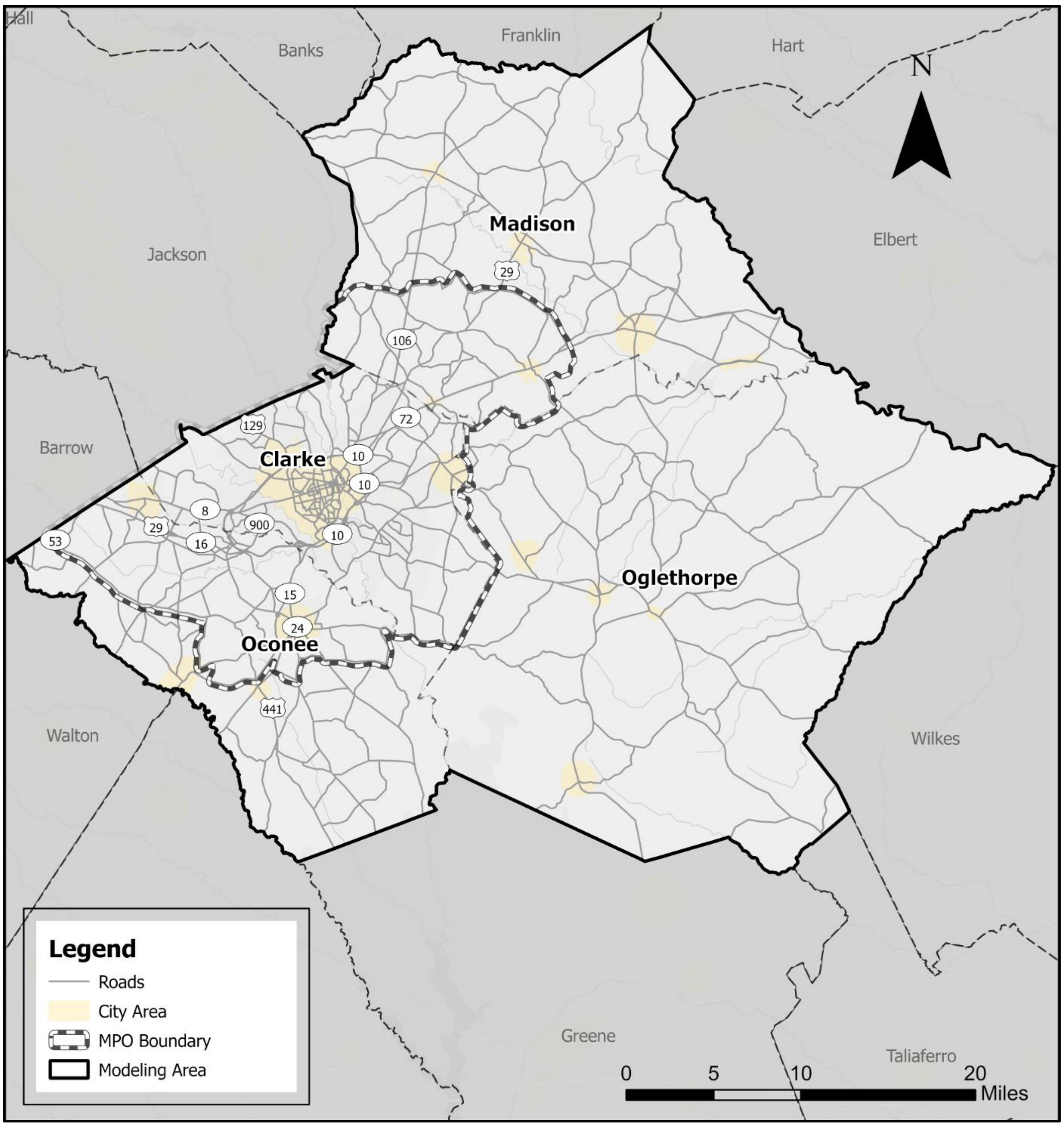
Activities	Lead Agencies
TDM Kick-Off Meeting	GDOT with MPO
Prepare and review base year SE data	MPO
Review base year SE data	GDOT
Base year model development and validation	GDOT
Prepare and review future year SE data	MPO
Review future year SE data	GDOT
Presentation of initial model results prior to proceeding with forecast of MTP scenarios	GDOT at MPO TCC/PC meetings
Develop and provide project lists for MTP network scenarios	MPO
Develop each MTP network scenarios and provide model outputs	GDOT

**TCC/PC: Technical Coordinating Committee / Policy Committee*

1.2.4 MPO Area

MACORTS includes all of Athens-Clarke, Madison, Oconee, and Oglethorpe County. **Figure 1-2** illustrates the modeling area for MACORTS.

Figure 1-2: MACORTS Modeling Area



2. 2020 BASE YEAR MODEL UPDATE

2.1 WHAT HAS BEEN UPDATED?

To update the base year model to 2020 in support of the MACORTS 2050 MTP update, the following listed changes were made to the MACORTS 2015 TDM:

- **Modification to TAZ boundaries and TAZ Renumbering:**
  - The boundaries of certain TAZs were reviewed and refined.
- **Update of Base year Socioeconomic Data**
  - Updated 2015 base year SE data to 2020 using MACORTS provided 2020 SE Data.
- **Update of 2020 Base Year Highway Network:**
  - Updated Highway Performance Monitoring System (HPMS) functional classification.
  - Verification of the number of lanes.
  - Updated traffic count locations and traffic counts from 2015 to 2020.
  - Reflected projects that have been completed between 2015 to 2020.
  - Included additional local roads to improve roadway connectivity
  - Added other road characteristics including road names, intersection geometries (such as interchange ramps), etc.
- **Update of 2020 Base Year model validation components:**
  - Added and modified screenlines.
  - Updated trip generation model.
  - Updated trip distribution model.
  - Updated trip assignment procedure; and
  - Updated external stations and trip datasets.
- **Development 2050 Future Year Scenarios**
  - Developed 2050 scenarios based on projects provided by MPO.

2.2 MODEL UPDATE

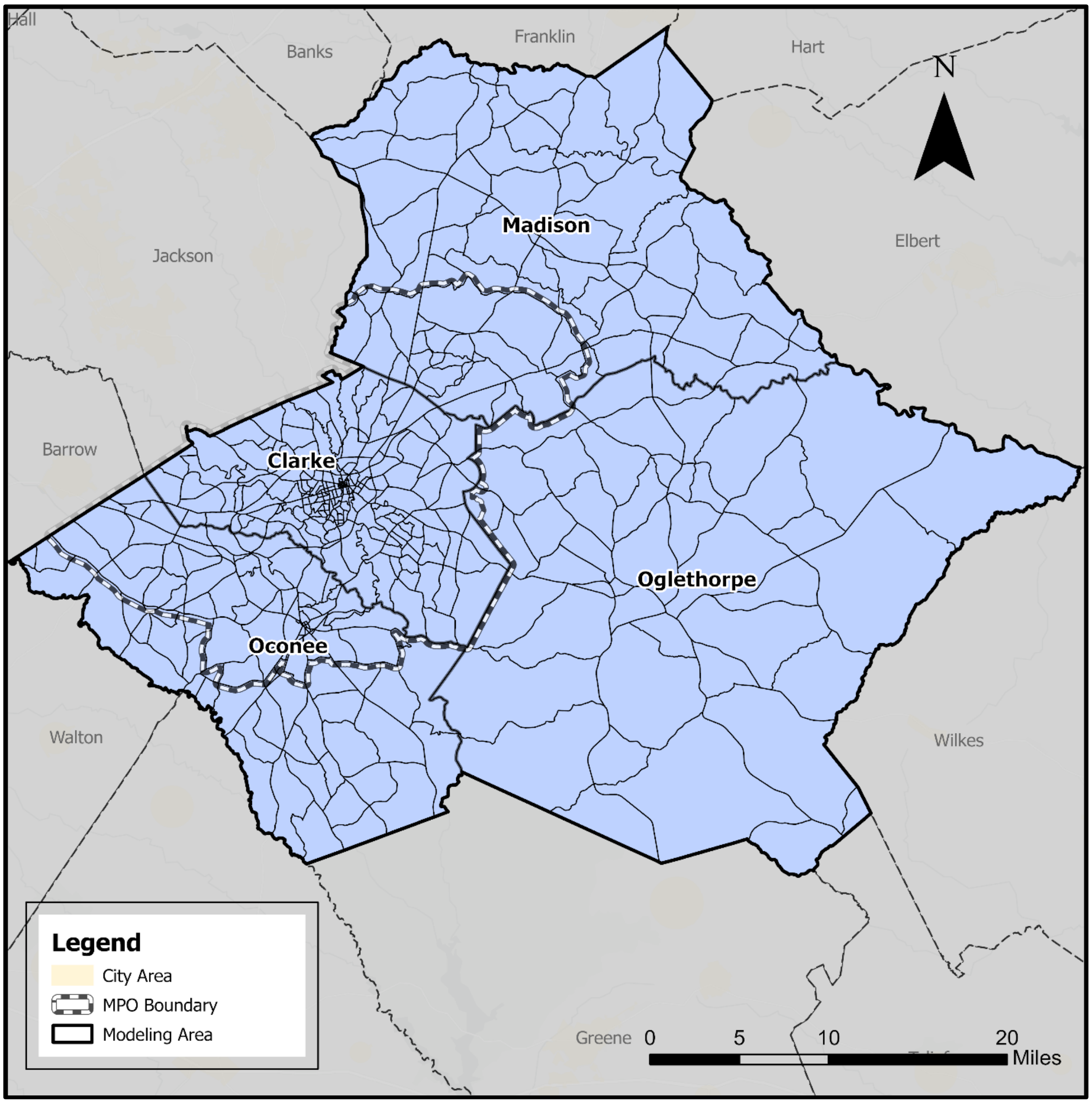
The following sections provide details on the model update, as well as each principal model element.

2.2.1 Traffic Analysis Zone Boundary Changes

The study area embraces 461 internal TAZs which are all within the MPO modeling boundary spanning Madison, Clarke, Oconee, and Oglethorpe County. There are an additional 38 external stations that facilitate traveling in and out of the region via individual facilities.

Figure 2-1 shows TAZs within MACORTS.

Figure 2-1: MACORTS TDM TAZs



2.2.2 Model Inputs – 2020 SE Data Summary

The MPO provided 2020 base year SE data for the model. The review memo for the SE data is included in section 6.1 of the Appendix**.** For each of the 461 TAZs, the SE variables listed below were developed by the MPO for use in the trip generation model using a combination of external data sources including US Census data to verify county population and employment. Please note that the SE data categories have been updated in conjunction with MPO TDM enhancements. More detailed information on SE data updates can be found in section 6.1 of the Appendix. The updated categories include:

1) Manufacturing & Transportation, Communication, Utilities, and Warehousing (MTCUW)- The Wholesale employment category is combined with Manufacturing and other categories as the MTCUW employment
2) Retail
3) Service
4) Agriculture, Mining, and Construction (AMC)

The following provides a description of the SE data variables in the MACORT MPO TDM:

- **Population:** The total number of individuals that are residing in a given TAZ;
- **Households:** Total number of occupied households in a given TAZ;
- **Total Employment:** The total number of employed persons in a given TAZ;
- **Manufacturing, Transportation, Communication, Utilities, Warehousing (MTCUW) Employment**: The number of employees working for manufacturing-based, transportation-based, communication-based, utility-based, and warehousing-based businesses in each TAZ where the business is located.
- **Service Employment:** The number of employees working for service-based businesses in each TAZ where the business is located.
- **Retail Employment:** The number of employees working for retail-based businesses in a given TAZ where the business is located.
- **Agriculture, Mining, Construction (AMC) Employment:** The number of employees working for agriculture-based, mining-based, and construction-based businesses in each traffic analysis zone where the business is located.
- **Median Income:** The median household income in each TAZ in 2020 dollars (per 2020 Census).

- **School Enrollment:** The total number of enrolled K-12 students in each TAZ at educational facilities except for the college level; and
- **College Students:** The total number of enrolled college students in each TAZ with college or university-level facilities.

Table 2-1 summarizes the 2020 SE data provided by the MPO by variables described above.

Table 2-1: Summary of 2020 SE Data Provided by the MPO

SE Variable	MPO Total
Population	208,504
Household	82,905
Total Employment	92,579
MTCUW Employment	13,165
Service Employment	64,870
Retail Employment	10,164
AMC Employment	4,380
Median Income	54531
School Enrollment	28,994
College Students	45,257
Acreage	662417

Model Inputs - 2020 Network Update

In this effort, the following features were updated:

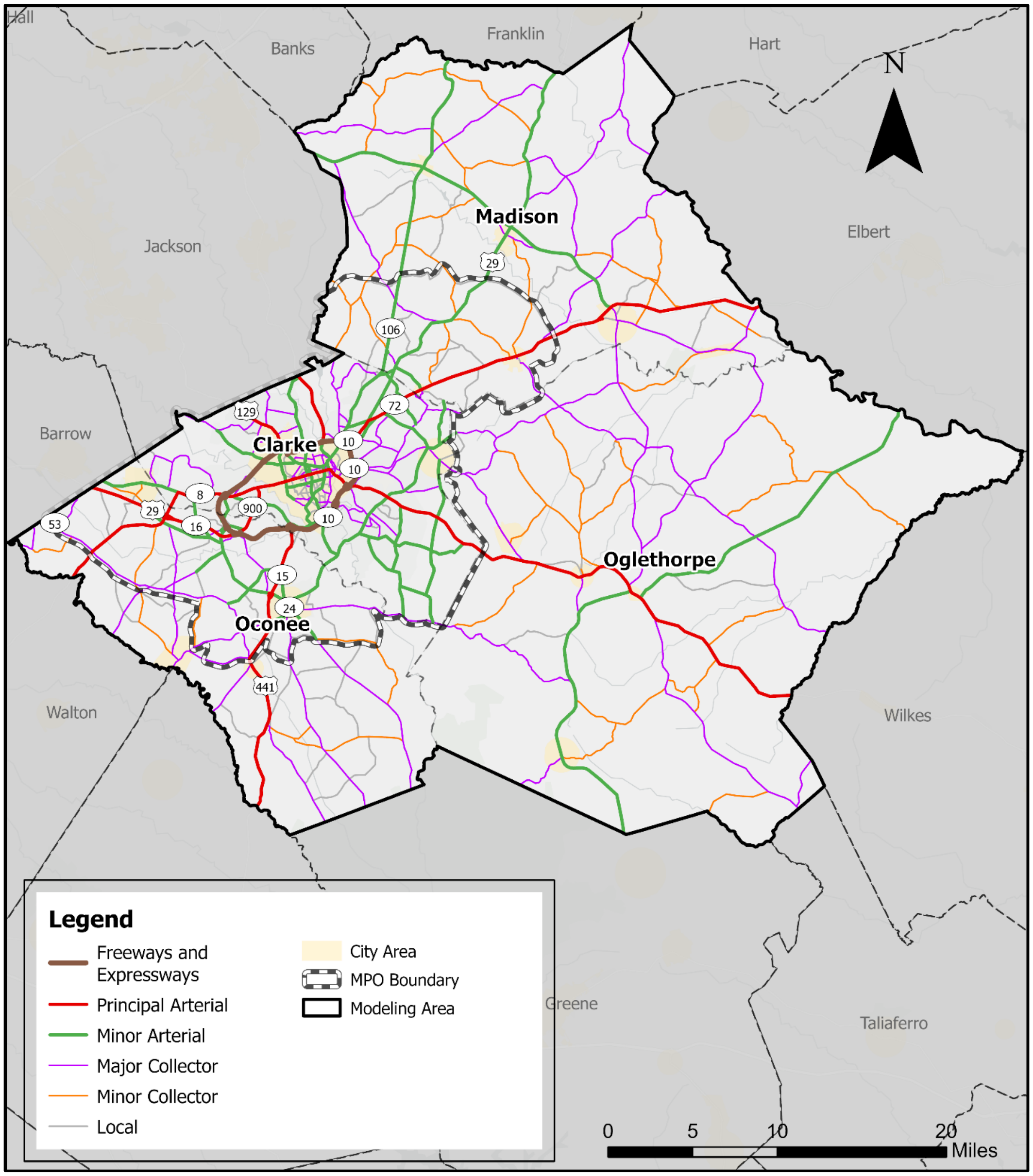
1. Functional classification
2. Facility type and area type
3. Number of lanes
4. Capacity
5. Speeds
6. Traffic count location

External stations and traffic details of the update are provided in the following sections.

2.2.2.1 Functional Classification

The updated functional classification categories were made using GDOT's Roadway Inventory Data. **Figure** 2-2 shows the functional classification within MACORTS.

Figure 2-2: 2020 Model Network Functional Classification



The transportation infrastructure can be classified by facility type such as interstates, freeways, arterials, etc. Similarly, service areas can be classified as urban, suburban, rural, etc. The characteristic of a facility varies by the facility and area type such as free flow speed, capacity, etc. In the TDM, the facility type, and area type provide the framework for organizing the network into sub-groups so that free-flow speeds and capacities can be assigned. In combination with the distance and number of lanes, these attributes constitute the base layer of highway network data needed to update and apply to the TDM. The facility type and area type definitions used in the highway network and modeling process are shown in **Table 2-2** and **Table 2-3**, respectively. The facility types were coded based on each roadway's designated functional classification. The area types were defined during the model calculation based on the geographic distribution of the SE data.

Table 2-2 Facility Types

Code	Facility Type
1	Interstate
2	Freeway
3	Expressway
4	Parkway
6	Freeway to Freeway Ramp
7	Freeway Entrance Ramp
8	Freeway Exit Ramp
11	Principal Arterial – Class I
12	Principal Arterial – Class II

Code	Facility Type
13	Minor Arterial – Class I
14	Minor Arterial – Class II
15	One Way Arterial
21	Major Collector
22	Minor Collector
23	One Way Collector
30	Local Road
32	Centroid Connector

Table 2-3: Area Types

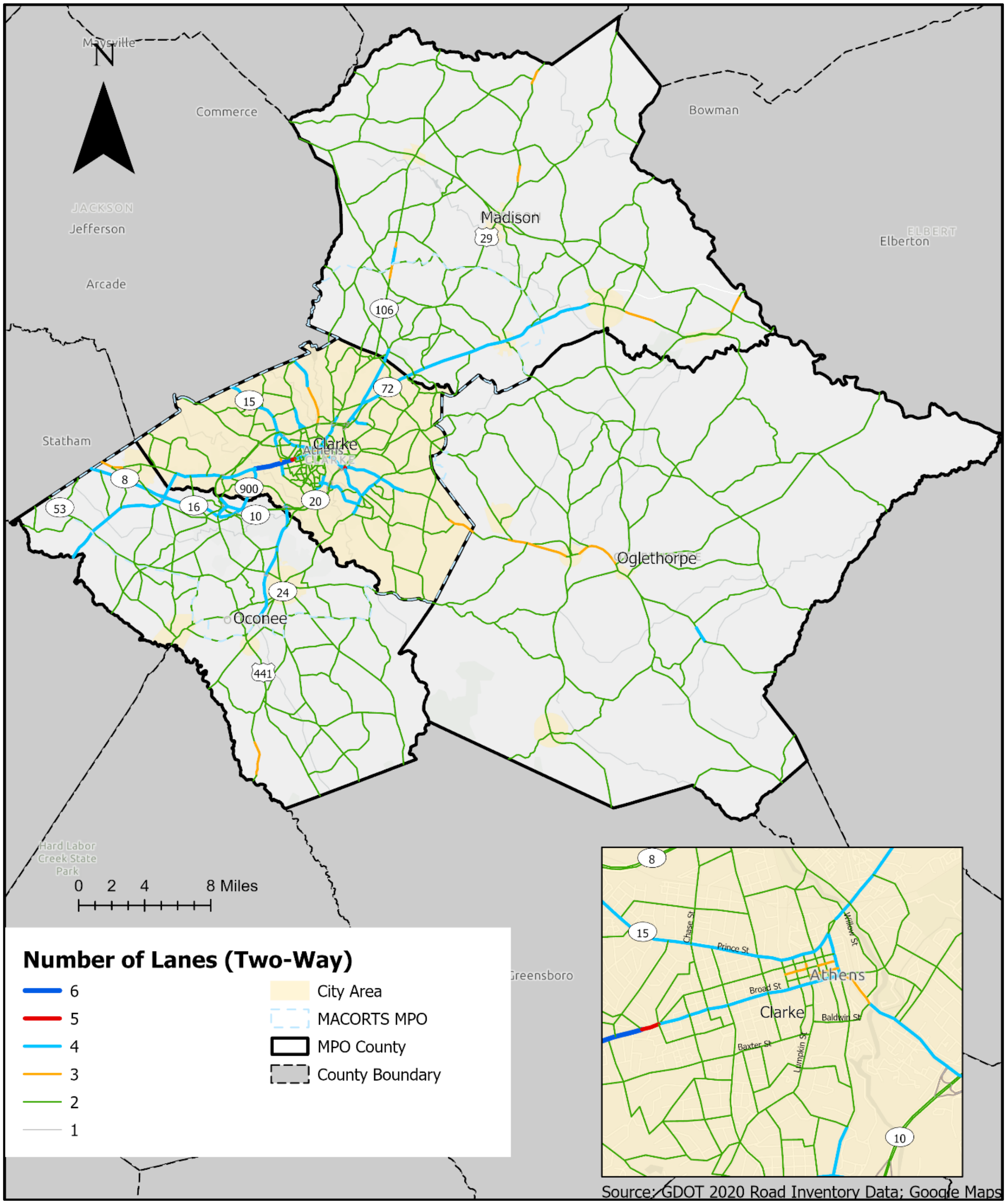
Code	Area Type
1	High Density Urban
2	High Density Urban Commercial
3	Urban Residential
4	Suburban Commercial

Code	Area Type
5	Suburban Residential
6	Exurban
7	Rural

2.2.2.2 Number of Lanes

The number of lanes on each roadway link was updated and checked against Google Earth Imagery to ensure the accuracy of 2020 base year conditions. **Figure 2-3** shows total number of lanes for both directions within MACORTS.

Figure 2-3: Number of Lanes



2.2.2.3 Traffic Count Locations

There were 152 count stations coded in MACORTS after updating the traffic count station information and adding count stations in the study area with reference to the online traffic data provided by GDOT. The count stations were updated with 2020 count information to assist the model validation.

2.2.2.4 External Stations and Traffic

The external trip locations were updated in the 2020 input network. There are 18 external stations established. The external stations in MACORTS boundary remained the same, as they were in the previous model. The available 2020 traffic count data, including annual average daily traffic and truck percents at or near the external stations, were obtained and coded for each external station. If there were external stations with no traffic counts available, appropriate daily volume estimations were estimated based on the best knowledge and professional judgment. The external-external trip percentages and truck percentages were estimated based on the functional classification of the external station facilities.

2.2.2.5 Network Attributes Summary

Table 2-4 and **Table 2-5** lists the attributes that are coded in the 2020 input network with their description.

Table 2-4: Link Attributes

Attribute Name	Description/Coding System
COUNTY	County FIPS Code
ROAD_NAME	Roadway Name
FTYPE	Facility Type
TOTAL_LANE	Total Number of Lanes

Table 2-5: Link Attributes Continued

Attribute Name	Description/Coding System
LANES	Number of Lanes for Each Direction
STATIONID	2015 Traffic Count Station Number
SCREENLINE	Screenline ID
CUTLINE	Cutline ID
GDOT_PI	GDOT Project Identification Number
LOCAL_PI	Local Project Identification Number
DISTANCE	Roadway Link Length in miles
MPO	1 – In MACORTS; 0 – Outside of MACORTS
TCOUNT20	2020 AADT – Both Directions
COUNT20	2020 AADT – Each Direction
FC2020	The HPMS Functional Classification Codes (7 Categories)

2.2.3 Modeling Procedures

2.2.3.1 Trip Generation

Trip generation is the first step in the four-step modeling process. It estimates the number of trips that will begin and end in each individual traffic analysis zone (TAZ). These are referred to as "trip ends." Trip ends generated by households are referred to as productions. Trip ends calculated from employment or school enrollment figures are referred to as attractions. This process is accomplished by establishing relationships between trips and SE variables. This process estimates the number of trip ends, or productions and attractions, for each TAZ by various trip purposes. Trip generation does not determine the origin and destination of each trip, and this step estimates the total trips produced and attracted by the SE characteristics of each TAZ.

In 2017, GDOT purchased add-on data from National Household Travel Survey (NHTS) which is used to update trip generation models in the MACORTS TDM. The trip generation process includes trip production and trip attraction sub-models. For all trips that have origins and destinations inside MACORTS, excluding trucks, the trip production sub-model applies trip rates through a cross-classification of household size (1, 2, 3, 4+) and automobiles available (0, 1, 2, 3+). The aggregate household data for each traffic analysis zone is disaggregated into 16 cross-classified cells using a household stratification model. This model breaks out the total number of MACORTS households into cross-classification cells using zonal income and MACORTS area specific data from the Census Transportation Planning Package (CTPP). The trip production sub-model applies regression equations for other trip purposes. The trip attraction sub-model applies regression equations for all trip purposes.

There were eight trip purposes that were included in the trip generation process. These purposes are summarized below:

- **Home-Based Work (HBW)**: Includes all travel made for the purpose of work that begins or ends at the traveler's home;
- **Home-Based Other (HBO)**: Includes any trip made with one end at the home except those for the purpose of work or shopping;
- **Home-Based Shopping (HBS)**: Includes trips made for the purpose of shopping, and which begins or ends at the traveler's home;
- **Non Home-Based (NHB)**: Includes any trip that neither begins nor ends at home;
- **University (Univ)**: Includes travel made for a university which begins and ends at the trip makers' residence;
- **Internal-Internal Truck (IITRK)**: Includes internal trips made by commercial vehicles;
- **Internal-External Passenger Car (IEPC)**: Includes internal trips beginning or ending outside the modeled area, excluding trucks; and

Internal-External Truck (IETRK): Includes internal truck trips beginning or ending outside the modeled area.

Household Stratification Model

The household stratification model subdivides the total number of households by TAZ into 16 household strata defined by household size and the number of automobiles available. The stratification is done using zonal income, MACORTS SE Data from the MTP, and data from household survey. The model distributes the total households in a TAZ to each cross-classification cell by calculating a relative[1] probability that a household will be a particular size with a particular number of automobiles. The relative probability is calculated with the following equation:

*P(i,j) = S * I * CF, where*

P(i,j) = Relative probability that a household will be size i and own j autos

S = Household size factor from CTPP lookup table

I = Income factor from CTPP lookup table

CF = Composite household factor from Augusta household survey lookup table.

[1] *The term "relative probability" is used because the value is not technically a statistical probability.*

The estimate of the number of households in a particular cross-classification cell is then calculated by multiplying the total number of households in the TAZ by the corresponding relative probability. The final number of households in each cross-classification cell is calculated by applying an adjustment factor to each calculated value. The adjustment factor is applied to ensure that the sum of the resulting disaggregated households equals the original aggregate number of households. This process is represented mathematically with the following equations:

$$HHij\ (est.) = HH * P(i,j), \text{ where}$$

$HHij\ (est.)$ = *Estimated number of households of size i that own j autos*

HH = *Total number of households in the TAZ*

$$HHij = HHij\ (est.) * F, \text{ where}$$

$HHij$ = *Final number of households*[2] *of size i that own j autos*

F = $HH / \Sigma HHij\ (est.)$, *control total adjustment factor.*

Trip Productions

The routine for computing trip productions uses cross-classified data from the household stratification model and applies trip rates to calculate HBW, HBO, HBS and NHB trips. The trip rates for each purpose used the updated GDOT Daily Trip Production Rates that are based on 2017 NHTS as the initial trip generation rate. Then, further adjustments were applied to the initial results of trip production during the validation and calibration process.

The trip end productions for other purposes are calculated using the following regression equations:

*I-I Truck Productions = 0.388*Household + 1.206*Retail Employment + 1.362*(MTCUW Employment) + 0.514*Service Employment*

*I-E Passenger Car Production = 0.331*Household + .724*Total Employment*

*I-E Truck Productions = 0.078*Retail + 0.78*MTCUW Employment*

[2] *Not rounded to an integer value to eliminate problems with round off errors.*

Trip Attractions

The trip attraction routine to compute the estimated number of trips attracted to each TAZ uses the following regression equations:

*Home-Based Work Attractions = 0.977*Total Employment*

*Home-Based Other Attractions = 0.6432*Population + 0.7934*Total Employment + 0.7183*School Enrollment*

*Home-Based Shopping Attractions = 5.585*Retail Employment*

*Non-Home-Based Attractions = 0.377*Population + 1.17803*(Retail Employment) + 1.4047 *Service Employment*

*University Attractions = 1.532 * College Students*

Internal Truck Attractions = Internal Truck Productions

I-E Attractions = Based on counts and EE% (internal zones=0)

I-E Truck Attractions = Based on counts, EE%, and Truck% (internal zones=0)

Balancing Productions and Attractions

For most trip purposes in MACORTS, production and attraction trip ends are computed separately using 2020 SE data. With such, the sum of productions across all zones does not necessarily equal the sum of attractions. In reality, each trip has two trip ends. There is one that is a production or origin and the other is an attraction or destination. Hence, it makes sense to equalize the sum of productions with the attractions across all zones. This, in effect, "balances" the two types of trip ends. This balancing or reconciliation is performed in the trip generation phase following the steps listed below:

- The productions and attractions are calculated for all internal TAZs by purpose;
- The zonal attractions for each trip purpose are proportionally adjusted so the total attractions equal the total productions by purpose (i.e. attractions balanced to productions) for all internal zones;
- The special generator productions and attractions are added or subtracted;
- The university productions are set equal to university attractions (university attractions are calculated from university enrollment, which provides a better indicator for student trip making behavior);
- The NHB productions are set equal to NHB attractions (NHB trip productions were generated in the "home" zone, but by definition, NHB trips do not begin or end at the home. Therefore, the

assumption is that the attraction variables are a better indicator of total trips than home-based characteristics);

- The attractions are balanced to productions for all internal zones (except NHB and Universities);
- The I-E attractions, including trucks, are calculated for external stations;
- The I-E productions, including trucks, are balanced to the calculated attractions (assumes that because I-E attractions are based on traffic counts or external station projections, they provide the best controls); and
- The I-E productions and attractions are appended to the I-I trip end file to produce the final productions and attractions.

2.2.3.2 Internal and External Trips

The total number of internal-external (I-E) trips for each external station is calculated by subtracting the estimated number of external-external (E-E) trips, based on an assumed percentage from the station's daily traffic volumes. Then the total I-E trips are separated into I-E truck trips and other I-E trips based on an assumed truck percentage at each external station.

2.2.3.3 Trip Distribution

Trip distribution is the second major step in the TDM process. Trip distribution is the modeling process calculating the trip interchanges between each zone pair that eventually have to be accommodated by the transportation system. The gravity model, the most widely used method for trip distribution, is adopted to distribute trips among TAZs in the MPO model. The gravity model for transportation planning is based on the gravitational theory of Newtonian physics. It predicts that the relative number of trips made between two TAZs is directly proportional to the number of trip ends (productions or attractions) in each TAZ and inversely proportional to a function of the spatial separation between those two areas. Mathematically, the gravity model is expressed as follows:

$$T_{ij} = P_i \left[\frac{A_j F_{ij}}{\sum_j A_j F_{ij}} \right]$$

Tij = Number of trips that are produced in TAZ i and attracted to TAZ j

Pi = Total number of trips produced in TAZ i

Aj = Number of trips attracted to TAZ j

Fij = Friction factor, a value which is an inverse function of travel time

There are many different measures of impedance that can be used such as travel time, travel distance, or travel cost. The potential impedance functions that can be used to derive the relative attractiveness of each TAZ from the impedance include: (1) exponential, (2) inverse power, and (3) gamma functions. In MACORTS, exponential functions were used to calculate travel impedance based on travel time. The impedance function, also known as the friction factor, is shown below:

$$f(d_{ij}) = e^{-c(d_{ij})}$$

Where, d_{ij} is the distance between TAZ i and TAZ j and where, c is a parameter that needs to be calibrated based on observed data. This parameter *(c)* needs to be calibrated, such that the model estimated trip length frequency distributions match the observed or target trip length frequency distributions for each of the trip purposes. In this study, the average trip length is used as the criteria. The calibration of parameter c is described in Chapter 3, 2020 Base Year Model Validation Section 3.2 Trip Distribution.

Derivation of Target Trip Lengths

2019 American Community Survey (ACS) 5-yr estimates Travel Time to Work data, Replica County to County Flow data, and the population and geographic size of the modeled area were used to develop target average trip length by trip purpose, including HBW, HBO, HBS, NHB.

The targeted trip lengths for the different trip purposes for the entire TDM area are summarized in **Table 2-6**. These are the target trip lengths to validate the trip distribution during the modeling process.

Table 2-6 MACORTS 2020 TDM Targeted Average Trip Lengths

Trip Purpose	Average Trip Lengths (mins)
Home-Based Work	21.6
Home-Based Other	17.3
Home-Based Shopping	17.3
Non-Home-Based	16.2

Development of Minimum Time Paths

The minimum time paths for the network were calculated during the modeling process. These times include all turn prohibitions and turn penalties. The turn prohibitions are where specific turning movements are prohibited in the model. The turn penalties are where a time penalty is added to the model to discourage and ultimately decrease the number of turns made at a specific location. The minimum times were then adjusted to include the intra-zonal times and terminal times. The intra-zonal times, the average time it takes to make a trip inside a particular TAZ, were created using travel time to the nearest four TAZs. The terminal times were assigned based on the employment density of the origin and destination TAZs. When at the trip origin, terminal time generally refers to the walk from one's residence to their car. When at the destination end, it generally represents the time it takes to go from one's car to their destination.

Table 2-7 summarizes the terminal time criteria.

Table 2-7: MACORTS TDM Terminal Time Criteria

Zone	Employment Density (Total Employees per Acre)				
	0-15.00	>15.00			
Origin	1 minute	2 minutes			
	0-3.00	3.00-25.00	25.00-50.00	50.00-75.00	>75.00
Destination	1 minute	2 minutes	3 minutes	4 minutes	5 minutes

The gravity model input consists of a set of travel time impedance factors (friction factors), in addition to the production trip ends, attraction trip ends and minimum time skim. These parameters force the gravity model to produce sets of trips by purpose, whose distributions approximate an observed travel time distribution. Those parameters were adjusted due to the expansion of the model study area during the model validation process.

2.2.3.4 Mode Split

The mode choice process determines what mode of travel will be used to make the trips between zones. FHWA's NCHRP 255 Calibration and Adjustment of Systems Planning Models, (FHWA-ED-90-015), acknowledges that in small or medium urban areas, transit patronage may be too insignificant to warrant an adjustment of person trips to transit trips. The transit data provided by the MACORTS indicates that the total number of transit trips is significantly smaller than a +/-5% margin of error associated with the model. Therefore, the full mode choice step was omitted from the model.

The trip generation process estimates person trips for internal trip purposes (HBW, HBO, HBS and NHB). With this consideration, it is necessary to convert person trips to vehicle trips before trip assignment. The average auto occupancy rates by purposes are used to do this. The average auto occupancy rates by purpose from various sources such as U.S. Census Journey-to-Work Data and National Travel Surveys (e.g., National Household Travel Survey), NCHRP Report 365 and NCHRP Report 716 were used to estimate the MACORTS TDM average auto occupancy rate. The other trip tables, including those for internal truck and I-E and E-E passenger car and truck trips, were calculated in terms of vehicle trips at their inception. The conversion to a vehicle trip table enables comparison to vehicle counts and capacity analyses.

Table 2-8 includes vehicle occupancy rates or factors that were used in MACORTS's TDM.

Table 2-8: MACORTS 2020 TDM Vehicle Occupancy Rates (Persons/Vehicle)

Trip Purpose	Occupancy Rate
Home-Based Work	1.11
Home-Based Other	1.67
Home-Based Shopping	1.44
Non-Home-Based	1.66
University	1.0
Internal Trucks	1.0
Internal-External	1.0
Internal-External Trucks	1.0

2.2.3.5 Trip Assignment

The last step in the modeling sequence is the assignment of the trip tables created in previous steps to logical routes in the highway network. Trip assignment for the MACORTS was accomplished using the equilibrium assignment technique. The trip assignment algorithm is iterative, running through successive applications until equilibrium occurs. Equilibrium occurs when no trip can be made by an alternate path without increasing the total travel time of all trips in the network. The equilibrium assignment is an iterative process that reflects travel demand assigned to minimum time paths as well as the effects of congestion. In each iteration, traffic volumes are loaded onto network links and travel times are adjusted in response to the volume-to-capacity relationships. The final assigned volumes are derived by summing a percentage of the loadings from each iteration. The percentages reflect congested conditions that usually influence motorists' path selection for a portion of the day, not the entire day.

Output Network Attributes

The model run has additional network link attributes that are attached to the input network. These store the assignment results as well as the values used in the trip assignment. These additional attributes provide volumes, travel time, speed, and so on for each link. These attributes can be used to summarize network-wide link statistics. The list of these attributes is shown in **Table 2-9.**

Table 2-9: MACORTS TDM Output Network Attributes

Attribute Name	Description
V_1	Daily Volume (Each Direction)
VC_1	Daily Volume Capacity Ratio
VT_1	Daily Volume (Both Direction)
LOS	Estimated Level of Service (LOS) (directional) Link level LOS is decided by the area type and estimated volume to capacity ratios:

LOS	V/C thresholds
C or Better – Little or no delay, travel speeds are slightly lower than the posted speed, shown as green	V/C <= 0.7
D – travel speeds are well below the posted speed with few opportunities to pass and considerable intersection delay, shown as yellow	0.7 < V/C <= 0.85
E – the facility is operating at capacity and there are virtually no useable gaps in the traffic, shown as orange	0.85 < V/C <= 1
F – more traffic desire to use a particular facility than it is designed to handle resulting in extreme delays, shown as red	V/C > 1

3. 2020 BASE YEAR MODEL VALIDATION

GDOT requires refinements to various model parameters until the 2020 base year model sufficiently replicates the observed 2020 travel patterns and conditions. The base year model was checked for accuracy under each of the major steps in the TDM process starting from trip generation to trip assignment. The inputs and outputs were checked for accuracy and reasonableness via review of the transportation network and attributes, trip generation and distribution parameters, average trip lengths by purposes, vehicle-miles traveled statistics and percent root mean squared error. The modeled volumes were validated against traffic counts at several levels – regional, corridor, and link-by-link. The results from each of these validation steps are presented in the following sections.

3.1 TRIP GENERATION

The GDOT trip generation process primarily uses parameters from NHTS and U.S. Census. Minor adjustments are made to GDOT standard procedures to reflect unique characteristics in each area being modeled. The various validation checks are made to ensure that trip generation results are reasonable. The national data sources are used as reasonableness checks for trip generation results.

The comparison between target ranges of calibration measures and modeled results for trip generation are summarized in **Table 3-1**. The trip generation measures are within the range of established targets.

Table 3-1: Trip Generation Model Reasonableness Checks

	Target Range / Value[3]		
Calibration Measures	Min	Max	Model Results
SE Data			
Persons / Household	2	3	2.51
Workers / Household	1	3	1.12
School / Population	0.14	0.2	0.14
Trip Generation			
Person Trips Per Household	8.5	9.2	8.78
Person Trips Per Person	3	4	3.5
HBW Trips / Employee	0	2	0.8
Shopping Trips / Retail Employment			12.4
P/A Ratio Before Balancing (HBW)	0.9	1.1	0.96
P/A Ratio Before Balancing (HBO)	0.9	1.1	1.01
P/A Ratio Before Balancing (HBShop)	0.9	1.1	0.99
P/A Ratio Before Balancing (NHB)	0.9	1.1	1.00

3.2 TRIP DISTRIBUTION

The trip distribution parameters are calibrated to produce reasonable average trip lengths for auto trips by purposes and truck trips. The expected average trip lengths were estimated from 2017 NHTS data, 2019 ACS 5-yr estimates Travel Time to Work data, and the population and geographic size of the modeled area. The travel times from trip assignment were used as input for trip distribution (i.e., feedback), which strengthens the validity of the modeled trip lengths. The comparisons between the target trip lengths and modeled trip lengths are summarized in **Table 3-2**.

[3] *Source:* General Summary of Recommended Travel Demand Model Development Procedures for Consultants, MPOs and Modelers*, GDOT, May 2013*.

Table 3-2: Trip Length Validation Measures

Trip Purpose	I-I HBW	I-I HBO	I-I HBS	I-I NHB	University	Truck	I-E Passenger Car	I-E Truck
Target[4] Average Trip Length (mins)	21.0	18.3	16.8	15.5	19.9	25.8	21.0	18.3
Model Average Trip Length (mins)	22.37	20.7	18.61	17.09	13.58	21.12	22.37	20.7
Model/Target Ratio	106.7%	113.3%	110.5%	110.4%	68.2%	81.9%	106.7%	113.3%

3.3 TRIP ASSIGNMENT

The trip assignment validation process includes the comparison of the model outputs to observed targets. Targets for various model parameters have been compiled by GDOT from multiple sources. The following documents serve as the primary sources for checking the reasonableness of model parameters and results:

- *Model Validation and Reasonableness Checking Manual*, Travel Model Improvement Program (TMIP), FHWA, 2010;
- *NCHRP Report 716 Travel Demand Forecasting: Parameters and Techniques,* Transportation Research Board, 2012*; and*
- *Calibration and Adjustment of System Planning Models*, USDOT, FHWA, 1990.

The primary targets GDOT uses for validating the trip assignment process are outlined in **Table 3-3**. In this model, 2020 US Census Data was used to validate the 2019 traffic conditions. This was completed to reflect traffic conditions before COVID-19. The MACORTS 2020 TDM validation results are described in the following sections.

[4] *Sources: CTPP 2015 Journey to Work data;* NCHRP Report 365 *and* Report 716*;* Calibration and Adjustment of System Planning Models*, USDOT, FHWA, December 1990;* General Summary of Recommended Travel Demand Model Development Procedures for Consultants, MPOs and Modelers*, GDOT, May 2013.*

Table 3-3: Trip Assignment Validation Measure Targets

Validation Measures	Target Range/Value
VMT (based on GDOT 445 reports)	
VMT - Interstates	Less than 6% - 7%
VMT – Principal Arterials	Less than 10% - 15%
VMT – Minor Arterials	Less than 10% - 15%
VMT – Collectors	Less than 15% - 25%
VMT – Total	Less than 5%
Volumes for Individual Links	
Volumes to Count Deviation	Less than Maximum Desirable Deviation (NCHRP Report 255)
Screenlines	
Volumes to Count Deviation for Each Line Group	Less than Maximum Desirable Deviation (NCHRP Report 255)
Volume RMSE	
Volume Group: 0 – 5,000	Less than 100%
Volume Group: 5,001 – 10,000	Less than 75%
Volume Group: 10,001 – 15,000	Less than 50%
Volume Group: 15,001 – 20,000	Less than 30%
Volume Group: 20,001 – 30,000	Less than 30%
Volume Group: >30,001	Less than 30%
System Total	Less than 35%

3.3.1 Overall Vehicle-Miles Traveled Summary

The daily regional VMT is calculated by multiplying the amount of daily traffic on a roadway segment by the length of the segment, then summing the VMT for all roadway segments to give a total for a geographical area of concern.

The comparison of model VMT and observed VMT by functional classification is shown in **Table 3-4** below. Overall, the total model VMT is within 0.5 percent of the observed VMT with the modeled VMT slightly lower than the observed. For each functional classification, the model VMT matches the observed VMT closely, with a maximum % difference of -5.3 for collector roads.

Table 3-4: MACORTS 2020 TDM VMT

Functional Classification	Mileage (miles)		VMT (Thousand miles)		VMT Distribution			
	Observed[5]	Model	Observed	Model	Observed	Model	Difference	% Difference
Principal Arterial	119	116	2,443	2,537	47.2%	49.3%	94	3.8%
Minor Arterial	204	204	1,518	1,461	29.3%	28.4%	-57	-3.8%
Collectors	503	501	1,215	1,150	23.5%	22.3%	-65	-5.3%
Total	**826**	**821**	**5,176**	**5,148**	**100.0%**	**100.0%**	**-28**	**-0.5%**

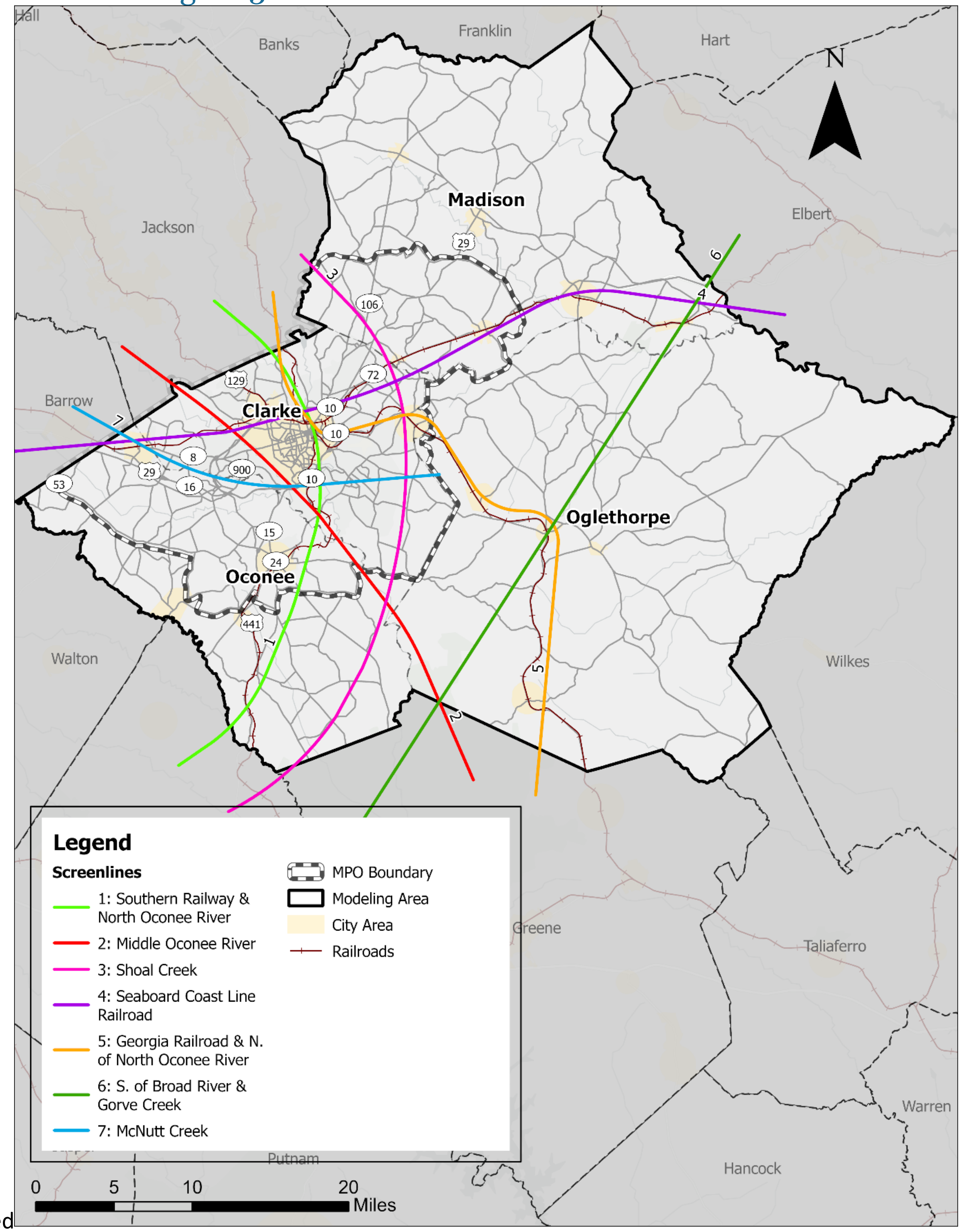
3.3.2 Screenlines and Cutlines Summary

One of the many steps in the validation process involves checking how well the model is validated at the screenlines and cutlines. Cutlines typically intersect several parallel roads to form a corridor while the screenlines divide the study area into two parts. These are often defined by physical features such as railroads, creeks, and rivers. These types of features serve to funnel traffic into corridors so that all trips can be analyzed where the crossing of these features is possible because all roadways are not reflected in the TDM.

Figure 3-1 depict the locations of screenlines in the model area. The location at which each screenline crosses a roadway can be identified by following the color-coded links across MACORTS.

[5] *Source:* 2019 GDOT VMT – Mileage by Route and Road System Report 445, *GDOT*

Figure 3-1: MACORTS 2020 TDM Screenlines



3.3.2.1 Model Screenlines Analysis Results

Table 3-5 provides a summary of total volume and total counts comparisons on the screenlines. The volume-to-count percent deviation on the several established screenlines is well below the corresponding maximum desirable percent deviation.

Table 3-5: MACORTS 2020 TDM Screenline Results

Screenlines	Total Volumes	Total Counts	Maximum Desirable Percent Deviation[6]	Volume to Count Percent Deviation
1 Southern Railway & North Oconee River	157,670	146,700	± 21%	7%
2 Middle Oconee River	36,320	34,230	± 37%	6%
3 Shoal Creek	11,640	9,990	± 60%	17%
4 Seaboard Coast Line Railroad & N. of North Oconee River	171,050	162,400	± 21%	5%
5 Georgia Railroad & N. of North Oconee River	80,550	65,750	± 29%	23%
6 S. of Broad River and Grove Creek	25,960	23,740	± 43%	9%
7 McNutt Creek	80,780	71,320	± 28%	13%
Total	**563,970**	**514,130**	**± 13%**	**10%**

3.3.2.2 Model Cutlines Analysis Results

Figure 3-2 depicts the locations of cutlines in the model area. The location at which each cutline crosses a roadway can be identified by following the color-coded links across MACORTS.

[6] *Sources:* NCHRP Report 255, Report 365 *and* Report 716; General Summary of Recommended Travel Demand Model Development Procedures for Consultants, MPOs and Modelers, *GDOT, May 2013*.

Figure 3-2 MACORTS 2020 TDM Cutlines

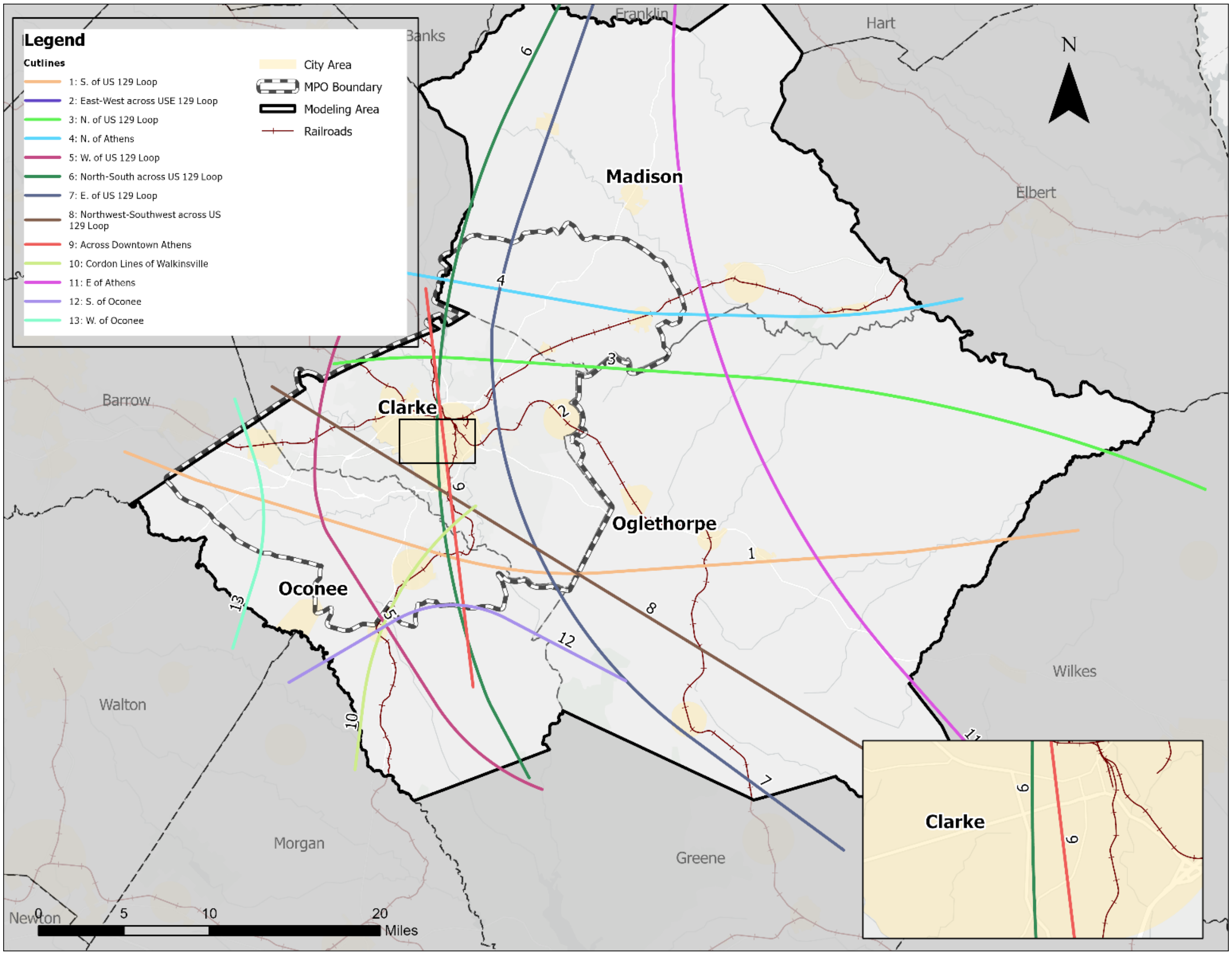


Table 3-6 provides a summary of total volume and total counts comparisons on the cutlines. The volume-to-count percent deviation on each of the 13 established cutlines are well below the corresponding maximum desirable percent deviation.

Table 3-6: MACORTS 2020 TDM Cutlines Results

Cutlines	Total Volumes	Total Counts	Maximum Desirable Percent Deviation[7]	Volume to Count Percent Deviation
1 - South of US-129 Loop	42,120	36,840	± 36%	14%
2 - East-West across US-129 Loop	198,700	188,560	± 19%	5%
3 - North of US-120 Loop	79,270	70,800	± 28%	12%
4 - North of Athens	35,300	27,850	± 40%	27%
5 - West of US-129 Loop	119,590	107,690	± 24%	11%
6 - North-South across US-129 Loop	88,730	81,380	± 27%	9%
7 - East of US-129 Loop	107,470	101,560	± 25%	6%
8 - Northwest-Southeast across US-129 Loop	74,890	68,250	± 29%	10%
9 - Across Downtown Athens	143,860	128,720	± 23%	12%
10 - Cordon Lines of Watkinsville	35,840	34,380	± 37%	4%
11 – East of Athens	19,650	16,560	± 49%	19%
12 – South of Oconee	16,410	17,780	± 48%	-8%
13 – West of Oconee	68,750	58,360	± 30%	18%
Grand Total	**1,030,580**	**938,730**	± 11%	**10%**

[7] *Sources:* NCHRP Report 255, Report 365 *and* Report 716; General Summary of Recommended Travel Demand Model Development Procedures for Consultants, MPOs and Modelers, *GDOT, May 2013*.

3.3.3 Modeled Volume Summary

3.3.3.1 Link Volume Percent Deviation

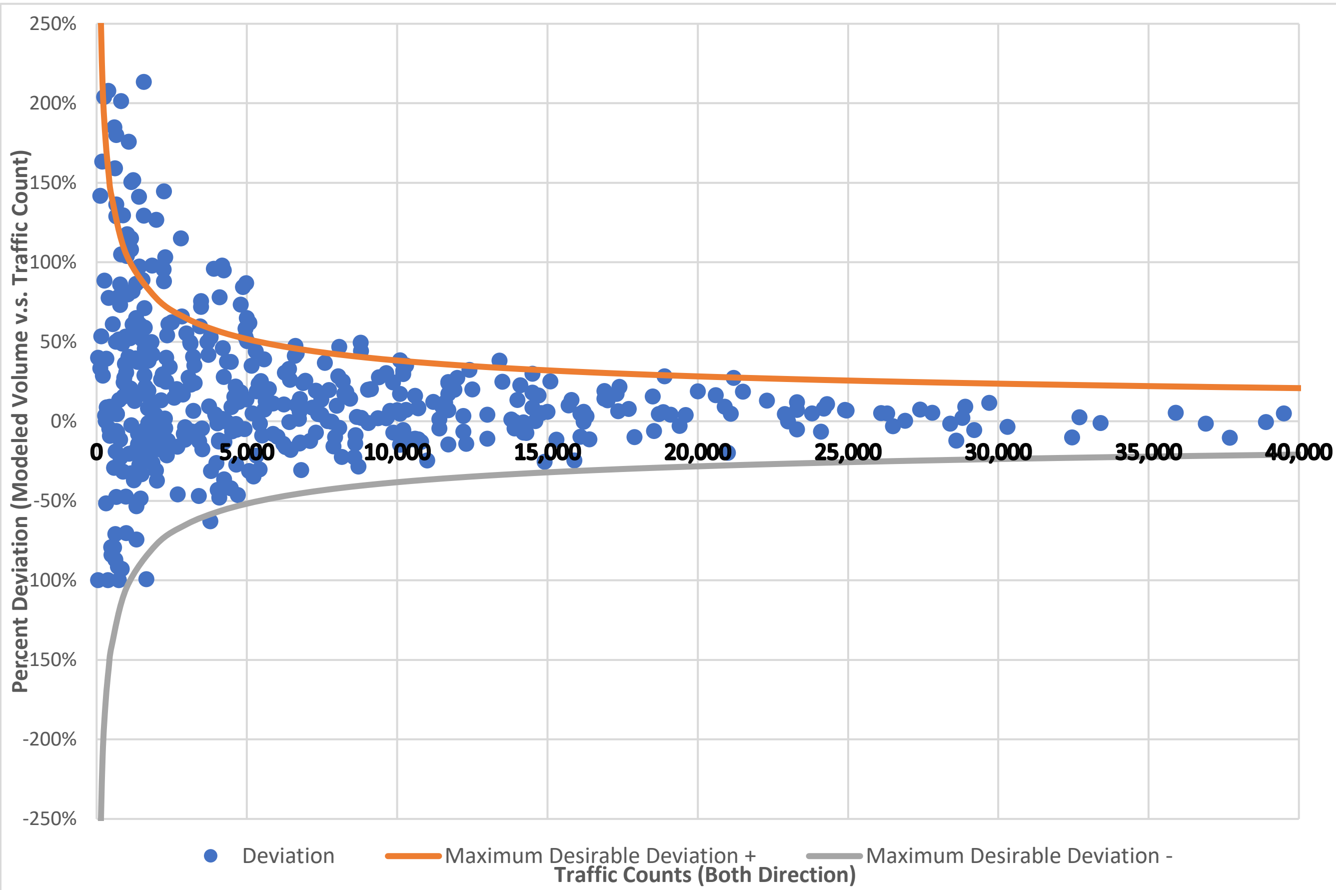
The percent deviation is described in *Calibration and Adjustment of System Planning Models*[8]. This method is used to calibrate a model for system-wide studies. It is based on the expectation that the TDM should accurately predict the number of through-lanes required to provide a specific level of service (LOS) for a given facility. The trip assignment deviation should not result in a design deviation of more than one highway travel lane. Therefore, the expected accuracy of the model increases as the annual average daily traffic (AADT) on a facility increases.

Figure 3-3 shows the deviation between the 2020 base year volumes assigned by the TDM and observed traffic counts. Most of the link-level model deviation points are concentrated between the maximum positive desirable deviation line and the maximum negative desirable deviation line. The following conclusions can be drawn from the graph:

- Almost all the model highway links were assigned volumes that were in reasonable agreement with the traffic counts.
- The observed traffic counts for most of the highway links were under 40,000 per day.

[8] *Calibration and Adjustment of System Planning Models. https://trid.trb.org/View/484613*

Figure 3-3: MACORTS 2020 TDM Link Volume Percent Deviation



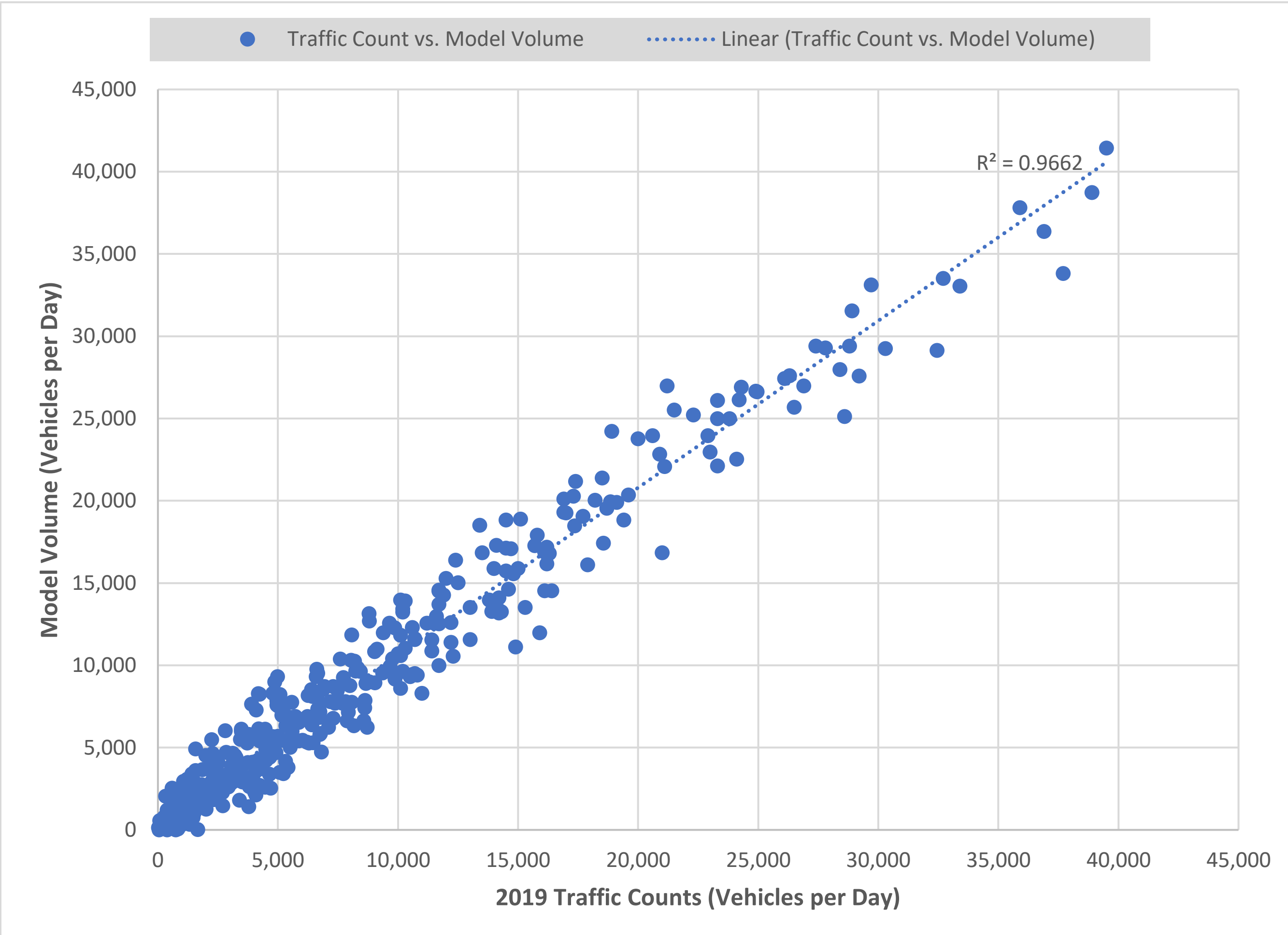
3.3.3.2 R-Square / Scatter Plot

The coefficient of determination (R^2) represents the proportion of variability in values of the dependent variable (traffic volume) that is explained by the model. It helps in the understanding of the model's predictive power. The MACORTS TDM achieves a system R^2 equal to 0.95, which is greater than the model validation target R^2 of 0.88 that is recommended by federal model validation guidelines.[9]

The scatter plot of modeled volumes versus traffic counts helps identify outliers. Indicated in **Figure 3-4** is modeled volumes that are clustered within the 45-degree line.

[9] Model Validation and Reasonableness Checking Manual, Second Edition, *FHWA, 2015*.

Figure 3-4: MACORTS TDM Link Volume Scatter Plot



3.3.3.3 Percent Root Mean Square Error

Percent RMSE (%RMSE) is a measure of the average deviation between the actual counts and the base year assigned volumes. It is another indicator to illustrate how closely the model volumes match the traffic counts. The %RMSE is calculated as follows:

$$\%RMSE = \frac{\sqrt{\sum_i \frac{(V_i - C_i)^2}{(N-1)}}}{\frac{\sum_i C_i}{N}} \times 100$$

where,

Vi = model volume at link i;

Ci = traffic count at link i;

N = number of count stations

The MACORTS 2020 TDM achieved an overall %RMSE of 25 percent, which is lower than GDOT's recommended target of 35 percent. In addition, all volume groups were within the range of recommended targets as summarized in **Table 3-7**.

Table 3-7: MACORTS 2020 TDM %RMSE

Volume Group	MACORTS 2020 TDM	Target Range
0 – 5,000	53%	<100%
5,001 – 10,000	24%	<75%
10,001 – 15,000	17%	<50%
15,001 – 20,000	14%	<30%
20,001 – 30,000	10%	<30%
> 30,000	6%	<30%
System Total	**20%**	**<35%**

4. 2020 BASE YEAR LEVEL OF SERVICE

The TDM assists in the evaluation of future travel conditions and deficiency analysis in the study area. Besides the traffic volumes, another key output from the TDM is the daily volume-to-capacity ratio for each roadway segment. The volume-to-capacity ratio corresponds to a LOS based on accepted methodologies. LOS is a qualitative measure of traffic flow describing operating conditions. There are six LOS as defined by the FHWA in the *Highway Capacity Manual* for use in evaluating roadway operating conditions. They are given letter designations from A to F, with LOS A representing the best operating conditions and LOS F representing the worst operating conditions. LOS F represents a V/C ratio greater than 1, meaning that the volume exceeds the capacity of the road and subsequently LOS A-E represents V/C ratios lower than 1. A facility may operate at a range of levels of service depending upon time of day, day of week or period of the year. A qualitative description and depiction of the different levels of service is provided in

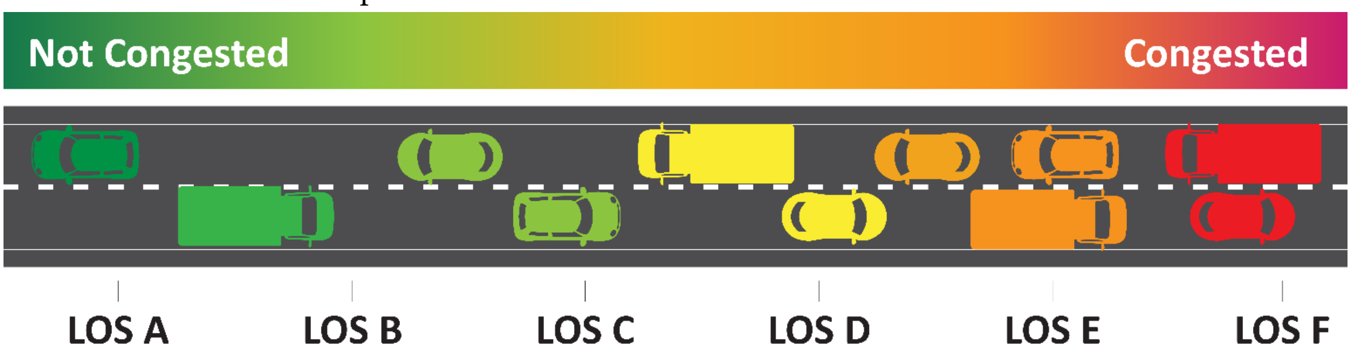


Figure 4-1 . Figure 4-2 illustrates the 2020 LOS for MACORTS.

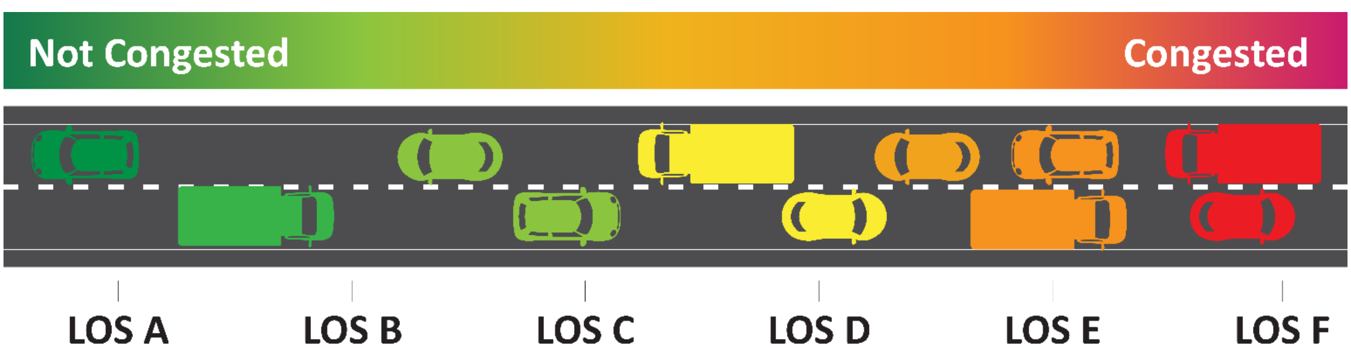
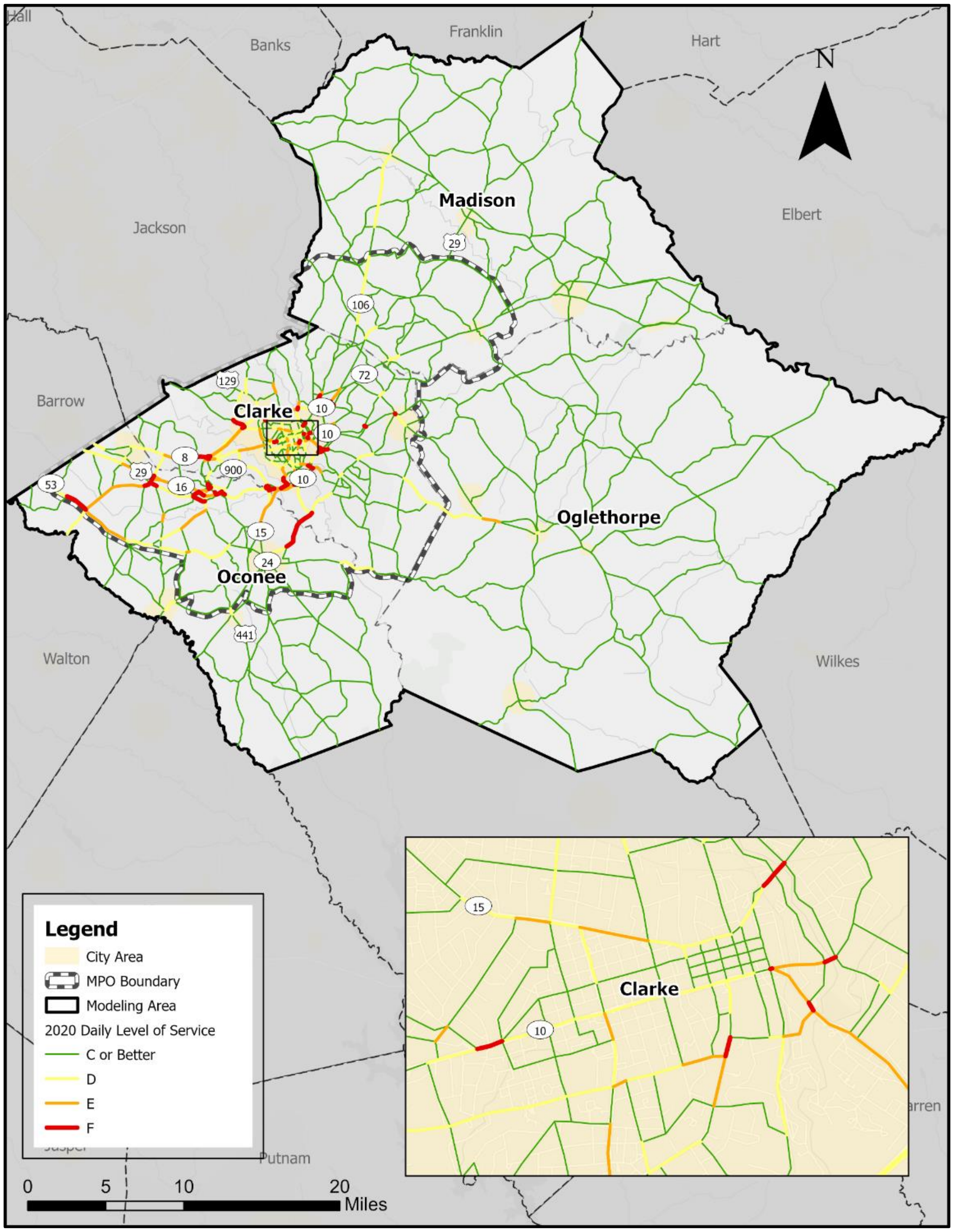


Figure 4-1: Level of Service Depiction

Figure 4-2: 2020 LOS for MACORTS



5. 2050 TRAVEL DEMAND MODELS

5.1 2050 LONG-RANGE TRANSPORTATION PLAN NETWORKS

When the 2020 base year TDM was calibrated and validated, the model was able to be used to forecast the traffic conditions for the future year 2050. To simulate the future travel demand in MACORTS, the following information was updated based on the information that MACORTS provided:

- 2050 Highway Network;
- 2050 SE Data; and
- External Station Traffic Forecasting.

The 2050 MTP networks include network scenarios based on the inputs from MACORTS and their MTP.

- **The 2nd Network - Do-Nothing**: 2020 base year network plus any projects that either opened to traffic since 2020 or are currently under construction.
- **The 3rd Network –** 3rd Network is identical to the 2nd Do-Nothing Network. The projects with construction funded in 2021-2024 TIP either were on local roads not in the network or were not capacity-adding projects.
- **The 4th Network – STIP+MTP Projects Network**: 2nd Network + capacity projects with preliminary engineering (PE) and right of way (ROW) funded in the 2021-2024 TIP.
- **The 5th Network – MTP Network**: 4th Network plus all projects to address future transportation needs identified through the MTP process.
- **The 6th Network – Financially Constrained Projects:** MTP Financially Constrained: 4th network plus all financially constrained projects identified through the MTP process.

The detailed definitions of the networks represented above can be found in the **Appendix 6.2**. The projects that were included in each 2050 network are provided in the LOS maps (**Figure 5-1** through **Figure 5-4**).

5.2 2050 SOCIEOECONOMIC DATA PROJECTIONS

The 2050 SE data was developed by MACORTS and used as input into the TDM to forecast the number of future year trips. Table 5-1 shows SE data comparison between 2015 and 2050 for the entire TDM area.

Table 5-1: SE Data Comparison between 2020 and 2050

	2020	2050	% Change
Population	208,504	288,007	38%
Household	82,905	113,461	37%
Total Employment	92,579	156,112	69%
AMC Employment	13,165	21,011	60%
MTCUW Employment	64,870	111,931	73%
Service Employment	10,164	13,614	34%
Retail Employment	4,380	9,556	118%
K-12 Enrollment	28,994	36,251	25%
College Students	45,257	61,338	36%

5.3 EXTERNAL STATION TRAFFIC

The year 2050 external station traffic was estimated based on historic AADT trends at the external stations where traffic count data was available and growth rates of surrounding TAZs. Professional judgment was also used during the estimation process. Future Year Level of Service Output Results

Figure 5-1 through **Figure 5-4** illustrate the LOS estimated for each 2050 network. These maps were provided to MACORTS after each model network scenario was run. MACORTS used these maps as one of tools to develop their project lists for the subsequent scenarios.

Figure 5-1 shows the 2050 Do-Nothing Network which consists of all existing and committed projects. This includes all projects that were either constructed or started construction between 2020 and 2023. **Figure 5-2** shows the 2050 TIP Network which consists of capacity projects with preliminary engineering (PE) and right of way (ROW) funded in the 2021-2024 TIP.

Figure 5-3 shows the 2050 MTP Network which consists of all existing and committed projects and additional MTP identified projects as listed in Table 5-2 .

Figure 5-4 shows the 2050 financially constrained network which consists of all financially constrained projects identified through the MTP process.

Figure 5-1: The 2nd Network - 2050 Do-Nothing

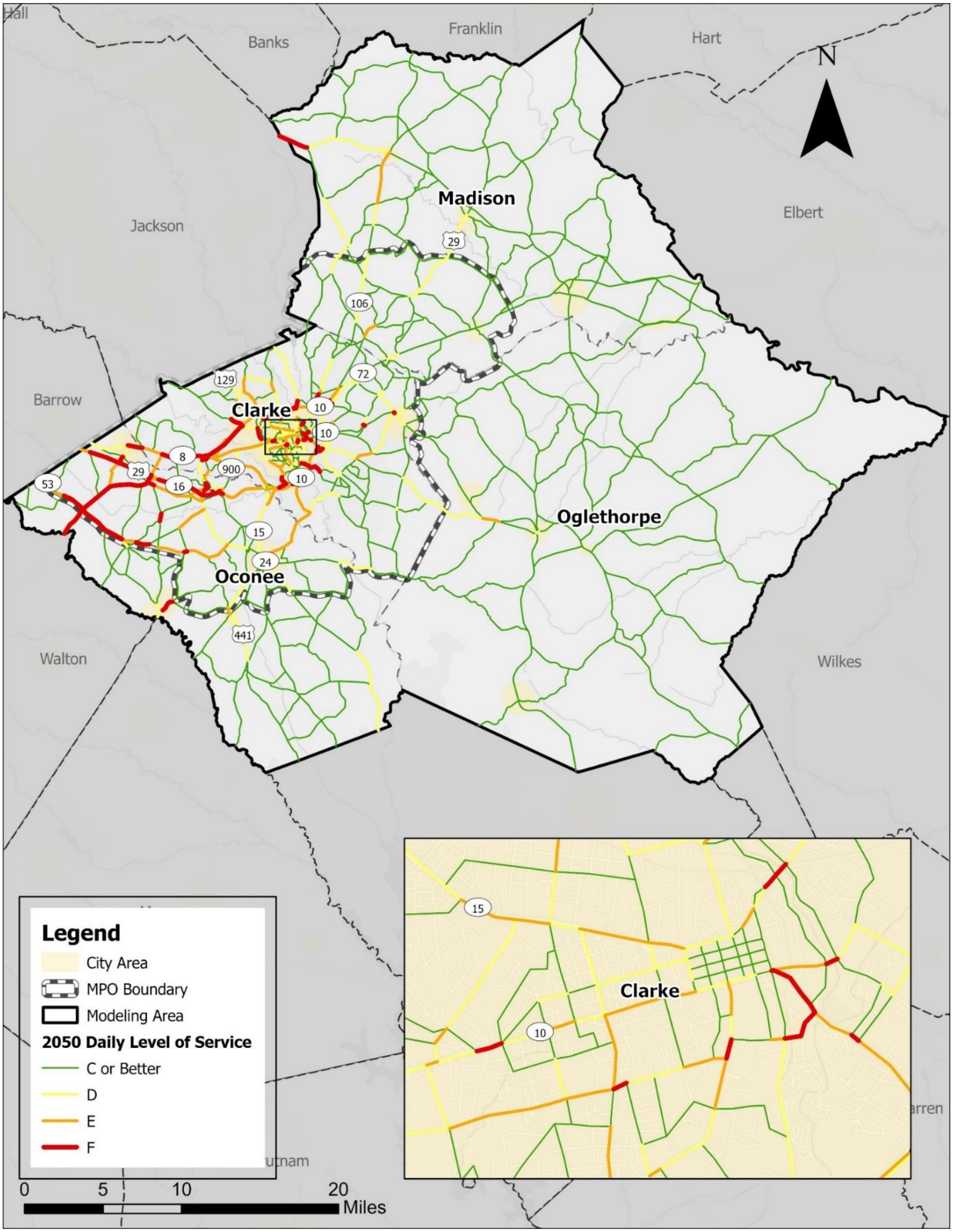


Figure 5-2: The 4th Network - 2050 STIP

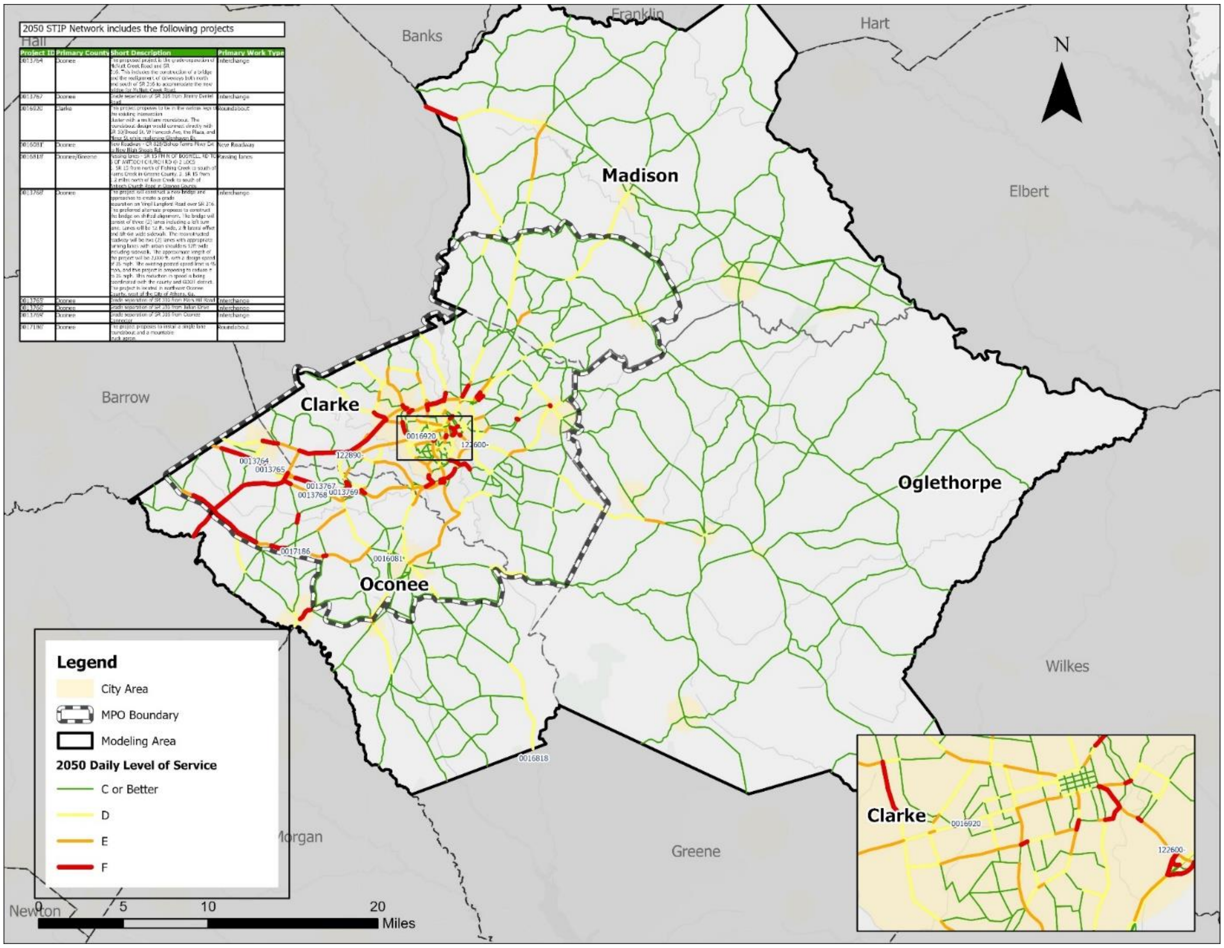


Figure 5-3: 5th Network - 2050 MTP Network

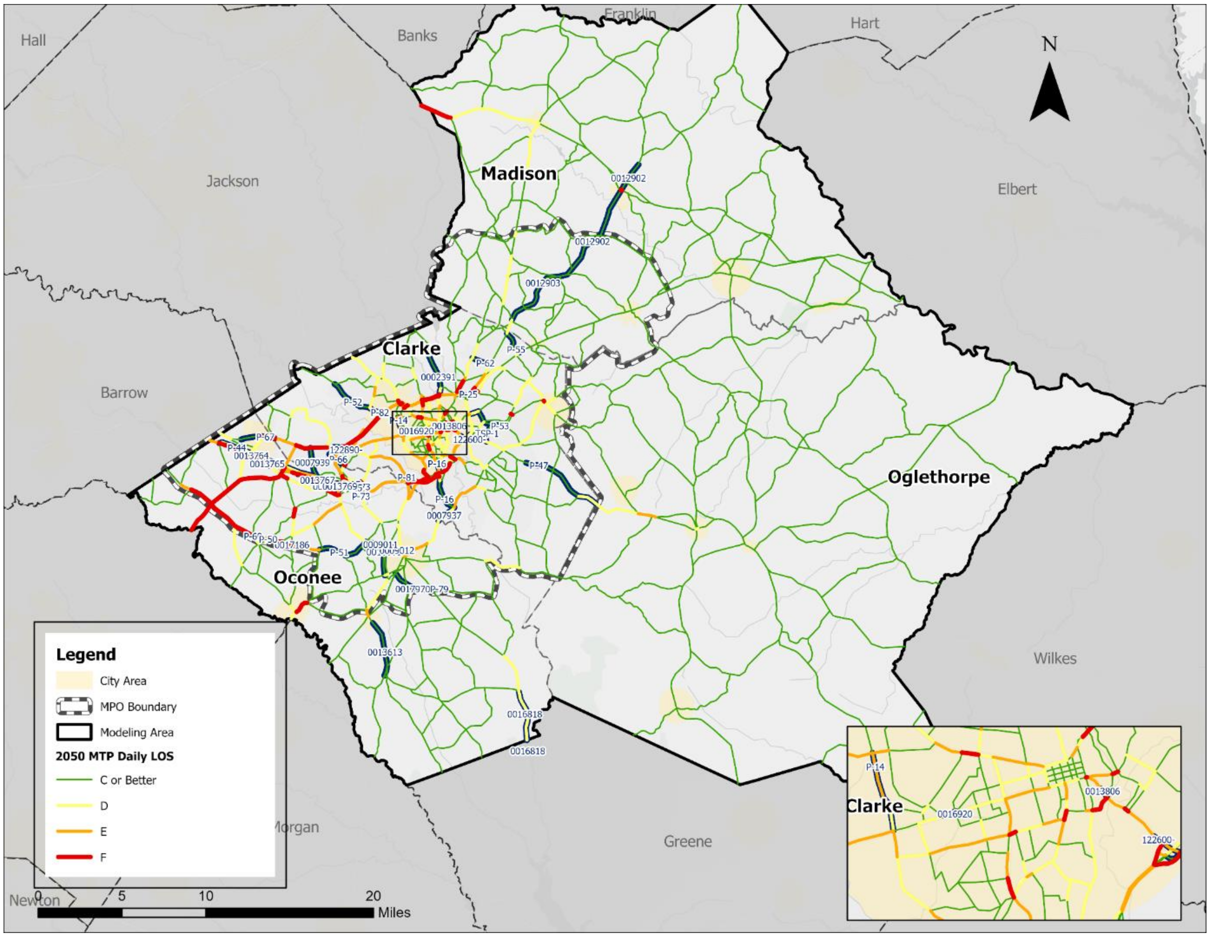
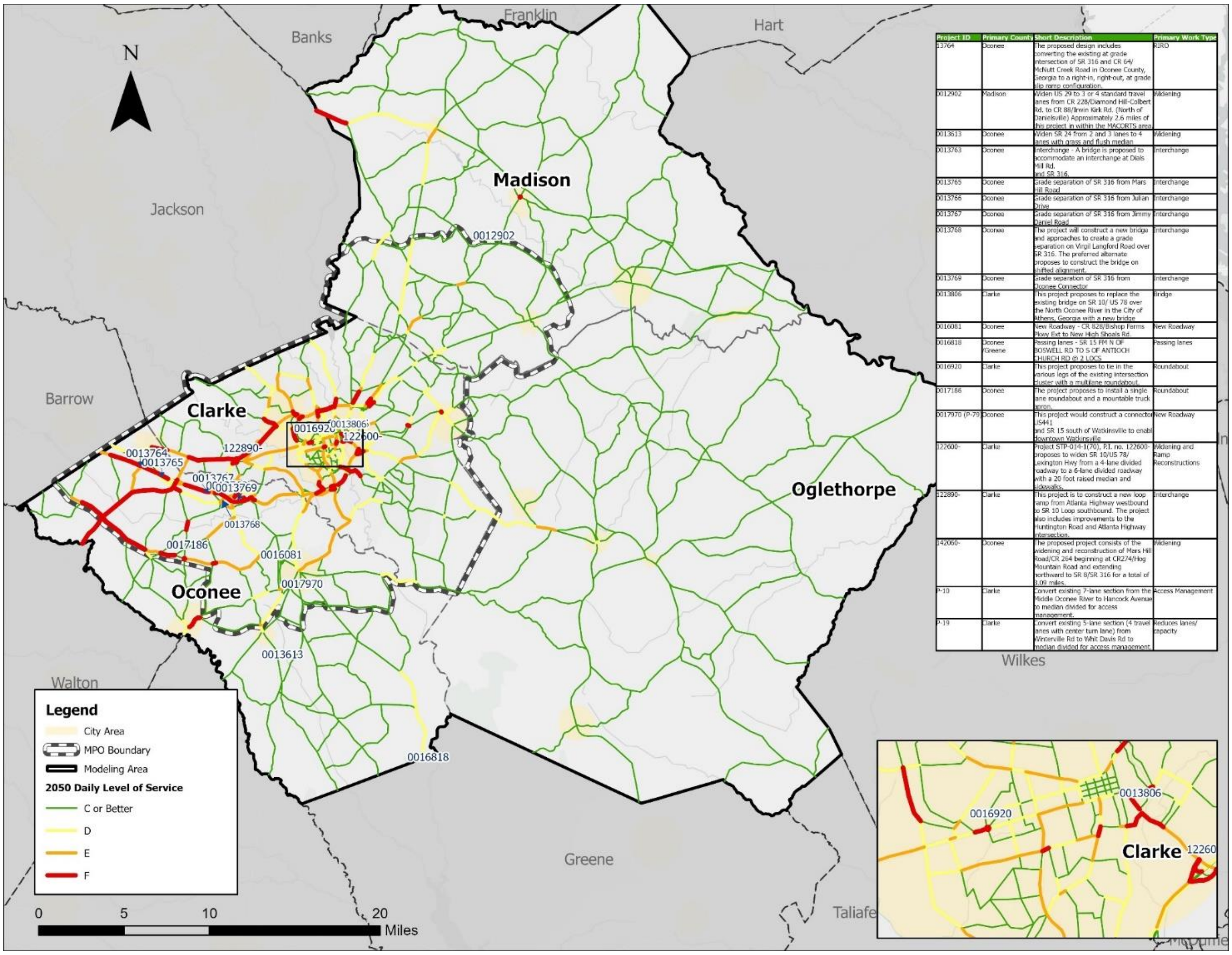


Figure 5-4: 6th Network – 2050 Financially Constrained Network



Project ID	Primary County	Short Description	Primary Work Type
13764	Oconee	The proposed design includes converting the existing at grade intersection of SR 316 and CR 64/ McNutt Creek Road in Oconee County, Georgia to a right-in, right-out, at grade slip ramp configuration.	RIRO
0012902	Madison	Widen US 29 to 3 or 4 standard travel lanes from CR 228/Diamond Hill-Colbert Rd. to CR 88/Irwin Kirk Rd. (North of Danielsville) Approximately 2.6 miles of this project in within the MACORTS area.	Widening
0013613	Oconee	Widen SR 24 from 2 and 3 lanes to 4 lanes with grass and flush median	Widening
0013763	Oconee	Interchange - A bridge is proposed to accommodate an interchange at Dials Mill Rd. and SR 316.	Interchange
0013765	Oconee	Grade separation of SR 316 from Mars Hill Road	Interchange
0013766	Oconee	Grade separation of SR 316 from Julian Drive	Interchange
0013767	Oconee	Grade separation of SR 316 from Jimmy Daniel Road	Interchange
0013768	Oconee	The project will construct a new bridge and approaches to create a grade separation on Virgil Langford Road over SR 316. The preferred alternate proposes to construct the bridge on shifted alignment.	Interchange
0013769	Oconee	Grade separation of SR 316 from Oconee Connector	Interchange
0013806	Clarke	This project proposes to replace the existing bridge on SR 10/ US 78 over the North Oconee River in the City of Athens, Georgia with a new bridge	Bridge
0016081	Oconee	New Roadway - CR 828/Bishop Farms Pkwy Ext to New High Shoals Rd.	New Roadway
0016818	Oconee /Greene	Passing lanes - SR 15 FM N OF BOSWELL RD TO S OF ANTIOCH CHURCH RD @ 2 LOCS	Passing lanes
0016920	Clarke	This project proposes to tie in the various legs of the existing intersection cluster with a multilane roundabout.	Roundabout
0017186	Oconee	The project proposes to install a single lane roundabout and a mountable truck apron.	Roundabout
0017970 (P-79)	Oconee	This project would construct a connector US441 and SR 15 south of Watkinsville to enabl downtown Watkinsville	New Roadway
122600-	Clarke	Project STP-014-1(70), P.I. no. 122600- proposes to widen SR 10/US 78/ Lexington Hwy from a 4-lane divided roadway to a 6-lane divided roadway with a 20 foot raised median and sidewalks.	Widening and Ramp Reconstructions
122890-	Clarke	This project is to construct a new loop ramp from Atlanta Highway westbound to SR 10 Loop southbound. The project also includes improvements to the Huntington Road and Atlanta Highway intersection.	Interchange
142060-	Oconee	The proposed project consists of the widening and reconstruction of Mars Hill Road/CR 264 beginning at CR274/Hog Mountain Road and extending northward to SR 8/SR 316 for a total of 3.09 miles.	Widening
P-10	Clarke	Convert existing 7-lane section from the Middle Oconee River to Hancock Avenue to median divided for access management.	Access Management
P-19	Clarke	Convert existing 5-lane section (4 travel lanes with center turn lane) from Winterville Rd to Whit Davis Rd to median divided for access management.	Reduces lanes/ capacity

Table 5-2 MTP Network Project List

Project ID	Short Description	Primary Work Type
P-66	Jennings Mill Parkway from Huntington Rd. to Jennings Mill Rd. - Construct a new 4-lane divided highway between Commerce Blvd. and SR 10 with turn lanes at major intersections and bicycle and pedestrian facilities and a grade separated crossing of the SR 10 Loop.	New Roadway
P-44	Construct frontage road along the north side of SR 316 from Mars Hill Rd to Dials Mill Rd.	New Roadway
P-45	Construct frontage road along the north side of SR 316 from Mars Hill Rd to Jimmie Daniel Rd.	New Roadway
P-67	Add additional travel lane on portion of Atlanta Hwy that is not currently 3 lanes from Dials Mill Road to Oconee County Line.	Widening
TSP-1	The Athens-Ben Epps Airport Access Road project creates a new road from Lexington Road to Beaverdam Road to improve access to the airport.	New Roadway
142060-	The proposed project consists of the widening and reconstruction of Mars Hill Road/CR 264 beginning at CR274/Hog Mountain Road and extending northward to SR 8/SR 316 for a total of 3.09 miles. This project is the first phase of three. Along this corridor which has a posted speed limit of 45 MPH the existing typical section is a two-lane roadway with variable width, grassed shoulders. These roadways provide primary access for the residential communities' northwest of Watkinsville to and from SR 316 and the major shopping and employment centers in Clarke County, including the University of Georgia and nearby Athens. The proposed construction will provide a four-lane urban roadway, with two 12' lanes in each direction, a 20' raised, grassed median, 4' bicycle lanes, and 5' sidewalks on each side.	Widening
122890-	This project is to construct a new loop ramp from Atlanta Highway westbound to SR 10 Loop southbound, realigning the existing loop ramp from Atlanta Highway eastbound to SR 10 Loop northbound, and widening Atlanta Highway by adding four lanes and lengthening several turn lanes. The project also includes improvements to the Huntington Road and Atlanta Highway intersection.	Interchange
122600-	Project STP-014-1(70), P.I. no. 122600- proposes to widen SR 10/US 78/Lexington Hwy from a 4-lane divided roadway to a 6-lane divided roadway with a 20-foot raised median and sidewalks. The project also reconstructs the northbound SR 10 Loop exit and entrance ramps by removing the northbound entrance loop ramp, adding a northbound exit loop ramp for westbound SR 10/US 78 and adding a northbound entrance ramp directly across from Barnett Shoals Road. Median openings and intersections will be modified/removed accordingly.	Widening and Ramp Reconstruction s
0013763	Interchange - A bridge is proposed to accommodate an interchange at Dials Mill Rd. and SR 316. The intersection of Dials Mill Ext. at SR 316 is proposed to be closed.	Interchange

Project ID	Short Description	Primary Work Type
0016920	This project proposes to tie in the various legs of the existing intersection cluster with a multilane roundabout. The roundabout design would connect directly with SR 10/Broad St, W Hancock Ave, the Plaza, and Minor St while realigning Glenhaven Dr.	Roundabout
0013767	Grade separation of SR 316 from Jimmy Daniel Road	Interchange
0013764	The proposed design includes converting the existing at grade intersection of SR 316 and CR 64/McNutt Creek Road in Oconee County, Georgia to a right-in, right-out, at grade slip ramp configuration. The project length will be approximately 2.6 miles from exit sign to exit sign and the proposed construction length will be approximately 0.77 miles and includes at-grade on and off ramps for SR 316 to connect to McNutt Creek Road. The existing at grade crossover will be removed and replaced with a 44-ft depressed grass median section.	RIRO
0017186	The project proposes to install a single lane roundabout and a mountable truck apron.	Roundabout
13768	The project will construct a new bridge and approaches to create a grade separation on Virgil Langford Road over SR 316. The preferred alternate proposes to construct the bridge on shifted alignment. The bridge will consist of three (3) lanes including a left turn lane. The lanes will be 12 ft. wide, 2 ft lateral offset and 6ft-6in wide sidewalk. The reconstructed roadway will be two (2) lanes with appropriate turning lanes with urban shoulders 12ft wide including sidewalk. The approximate length of the project will be 2,000 ft. with a design speed of 35 mph. The existing posted speed limit is 45 mph, and this project is proposing to reduce it to 35 mph. This reduction in speed is being coordinated with the county and GDOT district. The project is located in northeast Oconee County, west of the City of Athens, Ga.	Interchange
0016818	Passing lanes - SR 15 FM N OF BOSWELL RD TO S OF ANTIOCH CHURCH RD @ 2 LOCS 1. SR 15 from north of Fishing Creek to south of Harris Creek in Greene County. 2. SR 15 from 1.2 miles north of Rose Creek to south of Antioch Church Road in Oconee County.	Passing lanes
0013766	Grade separation of SR 316 from Julian Drive	Interchange
0013765	Grade separation of SR 316 from Mars Hill Road	Interchange
0013769	Grade separation of SR 316 from Oconee Connector	Interchange
0016081	New Roadway - CR 828/Bishop Farms Pkwy Ext to New High Shoals Rd.	New Roadway
0009011	Widen SR 53 to 4 lanes and construct turn lanes as needed from the Hog Mountain Rd to US 441. Sidewalks and bicycle lanes are planned for this corridor.	Widening
0013613	Widen SR 24 from 2 and 3 lanes to 4 lanes with grass and flush median	Widening

Project ID	Short Description	Primary Work Type
0013768	The project will construct a new bridge and approaches to create a grade separation on Virgil Langford Road over SR 316. The preferred alternate proposes to construct the bridge on shifted alignment	Bridge
0007937	Increase lane width on Whitehall Road to 2 standard travel lanes with turn lanes at key intersections from Barnett Shoals Rd. to Milledge Ave, widen to 4 lanes from Milledge Ave to the Oconee County line. Pedestrian and bicycle improvements included.	Safety Improvements
0009012	Widen SR 53 / Mars Hill Road to 4 lanes and construct turn lanes from the U 441 / Watkinsville Bypass to US 441 Business in Watkinsville. Sidewalks and bicycles lanes are included	Widening
0013806	This project proposes to replace the existing bridge on SR 10/ US 78 over the North Oconee River in the City of Athens, Georgia with a new bridge matching the existing grade with four 12-ft lanes, a northbound left turn lane to Williams Street, 2-ft gutters, a sidewalk along the north side of the bridge and a raised shared use path on the south side of the bridge.	Bridge
0002391	Widen US441 from LOOP 10 N to Clarke County Line to a 4-lane median divided roadway.	Widening
0007939	Widen/reconstruct Jimmy Daniell Rd / New Jimmie Daniel Rd from CR 263/Mars Hill Road to SR 10 to 4 lanes with additional turn lanes and sidewalks.	Widening
0012902	Widen US 29 to 3 or 4 standard travel lanes from CR 228/Diamond Hill-Colbert Rd. to CR 88/Irwin Kirk Rd. (North of Danielsville) Approximately 2.6 miles of this project in within the MACORTS area.	Widening
0012903	Widen US 29 to 4 standard travel lanes from SR 106 through Madison County to CR 288 Dimond Hill - Colbert Rd.	Widening
P-14	Widen Hawthorne Ave to a 5-lane roadway from Broad St. to Oglethorpe Avenue. Pedestrian and bicycle facilities are included in this project.	Widening
P-16	Widen/reconstruct Milledge Ave to 2-lane typical section from Whitehall Rd. to E Campus Rd with 2-way center left turn lane and dedicated left turn lanes at key intersections. Included in the project are bicycle and pedestrian facilities. The 4-lane typical section in the vicinity of the SR 10 Loop will be retained.	Widening
P-25	Reconstruct the SR 10 Loop at US 29 interchange to serve the principal traffic movement to remain on SR 10 Loop. Construct entrance and exit ramps to serve traffic onto and off of SR 10 Loop from US 29.	Interchange
P-47	Widen US 78, SR 10 to 4-lane divided highway with turn lanes at major intersections from Whit Davis Rd. to Oglethorpe County line	Widening
P-50	Construct 1 or 2 lane roundabout at Snows Mill Road and SR 53 intersection	Roundabout

Project ID	Short Description	Primary Work Type
P-51	Widen SR 53 to a 4-lane cross-section from Mars Hill Rd to Elder Rd.	Widening
P-52	Widen Tallassee Road from SR 10 Loop to Lavender Road to a 4-lane divided pkwy with turn lanes at key intersections along the corridor and bicycle and pedestrian facilities.	Widening
P-53	Widen segments of Olympic Dr. to Indian Hills Rd and to Winterville Rd from 2 to 4 lanes from SR 10 Loop to Beaverdam Rd. with a divided 4 lane roadway, turn lanes at selected locations and bicycle facilities.	Widening
P-55	Widen Glenn Carrie Rd to 4 lanes from US 29 to SR 72 with bicycle and pedestrian facilities.	Widening
P-62	Construct a 2-lane roadway from Danielsville Road & Lombardy Drive intersection east to US 29 with turn lanes at key intersections to provide east-west circulation.	New Roadway
P-69	Construct 1 or 2 lane roundabout at SR 53 / Clotfelter Road intersection.	Roundabout
P-73	Extension of Daniells Bridge Rd with 2-12' lanes and 5' sidewalks on both sides from north of Chestnut Hill Rd to Jennings Mill Parkway south of Old Epps Bridge Rd, a bridge over SR 10 Loop and signals at key intersections.	New Roadway
0017970 (P-79)	This project would construct a connector road between SR 24/US441 and SR 15 south of Watkinsville to enable truck traffic to avoid downtown Watkinsville (exact location undetermined)	New Roadway
P-80	The Health Science Campus Foster Rd extension project aims to improve transportation infrastructure for the Health Science Campus by extending Foster Rd to create a new intersection at Pound St and Prince Ave.	New Roadway
P-81	The Timothy Road and Highway 441 project involves potentially constructing a roundabout and enhancing Multiuse Path connectivity to improve safety, reduce speeds, and provide a gateway to Athens from Oconee County.	Roundabout
P-82	Constructing a roundabout at the intersection of Mitchell Bridge Road and Tallassee Road. Additionally, it includes filling in a gap of bike facilities along Oglethorpe Ave. These enhancements aim to improve traffic flow for vehicles, enhance safety, and provide better connectivity for cyclists.	Roundabout

6. Appendix

6.1 2020 AND 2050 SOCIOECONOMIC DATA REVIEW MEMO

6.1.1 2020 Socioeconomic Data Review Memo

Introduction

This memo summarizes Modern Mobility Partner's review, on behalf of the Georgia Department of Transportation (GDOT), of the 2020 travel demand model socio-economic (SE) data prepared by the Madison Athens-Clarke Oconee Regional Transportation Study (MACORTS) Metropolitan Planning Organization (MPO) Metropolitan Transportation Plan (MTP). Overall, the methodology and assumptions used in the SE data preparation are sound and in-line with GDOT's planning recommendations.

The following section includes the review and observations of the MACORTS MPO SE data for the year 2020 input into the travel demand model (TDM). The SE data was reviewed at two geographic levels: the aggregated TDM region and individual traffic analysis zones (TAZs).

The **regional level** review included a summary overview of:

1. 2020 Total Population
2. 2020 Total Households
3. 2020 Total Employees and Employees by Category
4. 2020 Total Students
5. Density Ratios

The **individual TAZ-level** review included a reasonableness check on:

1. TAZs with No 2020 SE data
2. 2020 Persons per Household Ratio
3. 2020 Household Density
4. 2020 Population Density
5. 2020 Student to Service Employment Ratio
6. 2020 School Enrollment.

Absent local development knowledge, the review was conducted purely based on the existing 2020 SE data provided and *GDOT's Georgia MPO Travel Demand Models Socio-Economic Data Development Guide (2022)* (abbreviated as *"GDOT's SE Data Guide"* hereafter). This document offers the observed facts that need attention and confirmation. The observations do not necessarily suggest any revisions if the SE data reasonably reflects the region's condition.

6.1.1.1 Regional Level SE Data Review

TABLE 6-1 provides a summary of the 2020 SE data in the TDM area of MACORTS MPO including Athens-Clarke County, Jackson County, Madison County, Oconee County and Oglethorpe County.

TABLE 6-1: TDM AREA 2020 SE DATA SUMMARY

SE Variable	Total
Population	208,504
Households	82,905
Total Employment	92,579
Manufacturing, Transportation, Communication, Utilities, Warehousing	13,165
Service	64,870
Retail	10,164
Agriculture, Mining, Construction	4,380
K12 Students	28,994
University Enrollment	42,657

TABLE 6-2 represents some commonly used ratios to check the SE data. At the regional level, the persons per household ratio, the employees per household ratio, the school enrollment to population ratio, population density, and household density appear to be within reasonable limits compared to GDOT standards.

TABLE 6-2: COMMONLY USED RATIOS OF DENSITY

Variable	2020	GDOT's Recommended Range
Persons per Household	2.51	2.00 - 3.00
Employees per Household	1.12	1.00 - 3.00
Proportion of Population Enrolled in K12 Schools	14%	Around 20%
Persons per Acre	0.31	≤ 10.00
Households per Acre	0.13	≤ 6.00

6.1.1.2 Traffic Analysis Zone (TAZ) Level SE Data Review

A TAZ-level review was conducted following *GDOT's SE Data Guide* to ensure the existing estimations meet the requirements and reasonableness from a Travel Demand Model (TDM) perspective.

TAZs with no SE Data

As indicated in ***TABLE 6-3***, there are 3 TAZs with zero total population, households, and employment; 27 TAZs with zero total population and households; and 51 TAZs with population and households but no employment. These values need to be rechecked and confirmed.

TABLE 6-3: TAZS WITH NO 2020 SE DATA

Zero Value Field	TAZ ID
Population, Households, and Employment	12,21,33
Population and Households Only	7 ,13,14,15,18 ,24,25,47,51,52,55,56,85,86,87, 131,139,152,233,234,241,242,243,254,282,283,404
Employment Only	20 ,36,42,43,58,145,153,169,230,239,261,263, 277,310,311,312,409,414,415,427,433,436,439,441, 442,461,500,515,521,533,535,536,537,542,543,544,549, 551,608,617,618,620,621,625,629,632,633,634,635, 637,640

Persons per Household Ratio

According to *GDOT's SE Data Guide,* the ratio of persons per household should range between 1 and 7. The population per household ratio should not be less than 1 as a household is an occupied housing unit. Values exceeding 7 should correspond to some form of group housing within the TAZ. This ratio for most TAZs in the MACORTS MPO model ranges between 1 and 7. Among 461 TAZs, 2 TAZs have a persons per household ratio above 7 or below 1.

TABLE 6-4: TAZS WITH 2020 PERSONS PER HOUSEHOLD RATIO > 7 OR <1

TAZ ID	Population	Household	Person per Household Ratio
65	209	26	8.04
285	18	2	9.00

Household Density

According to *GDOT's SE Data Guide,* the number of households per acre in most TAZs should be no more than 6. A value of 6 typically corresponds to a three-story multi-family building. Values exceeding 6 should correspond to larger or denser multi-family housing.

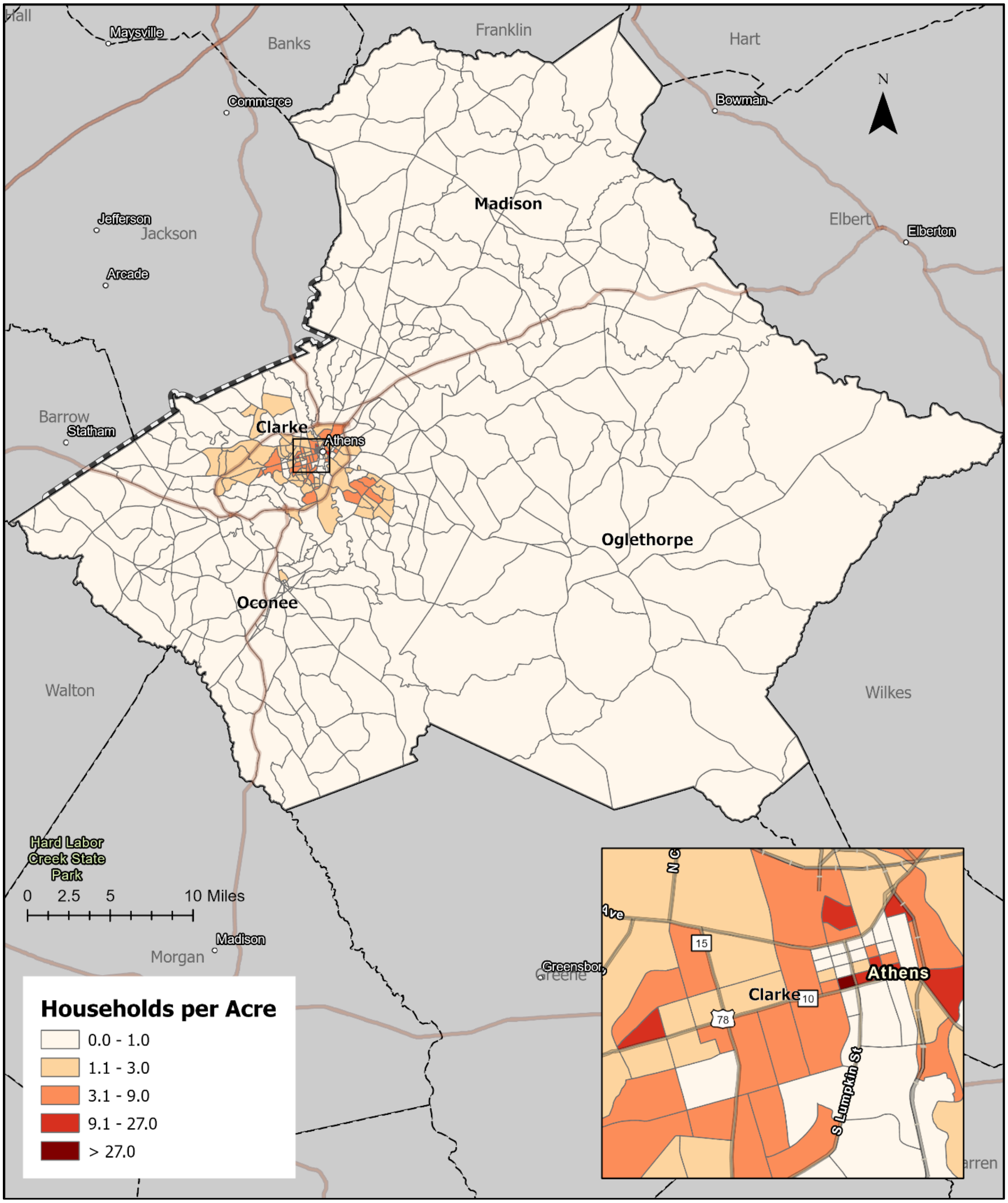
A household density map was prepared and reviewed based on SE data provided by the MPO. ***FIGURE 6-1*** on next page illustrates the household density by TAZ for the MACORTS MPO TDM region. Among 461 TAZs, 15 of those have a household density greater than 6.

TABLE 6-5 lists TAZs with households per acre greater than 6. These TAZs need to be further reviewed by the MPO to verify if they have multi-family or group housing located within the area.

TABLE 6-5. TAZS WITH 2020 HOUSEHOLDS PER ACRE GREATER THAN 6

TAZ ID	Population/Acre
76	6.20
34	6.29
280	6.52
2	7.15
28	7.30
54	7.79
9	8.69
5	9.26
1	9.40
17	10.24
99	10.88
30	13.42
27	13.78
3	24.80
8	46.86

FIGURE 6-1: 2020 HOUSEHOLD DENSITY PER TAZ



Population Density

According to *GDOT's SE Data Guide,* the ratio of population to acres should not exceed 10. TAZs with persons per acre higher than 10 are generally identified as multi-family or group housing land use.

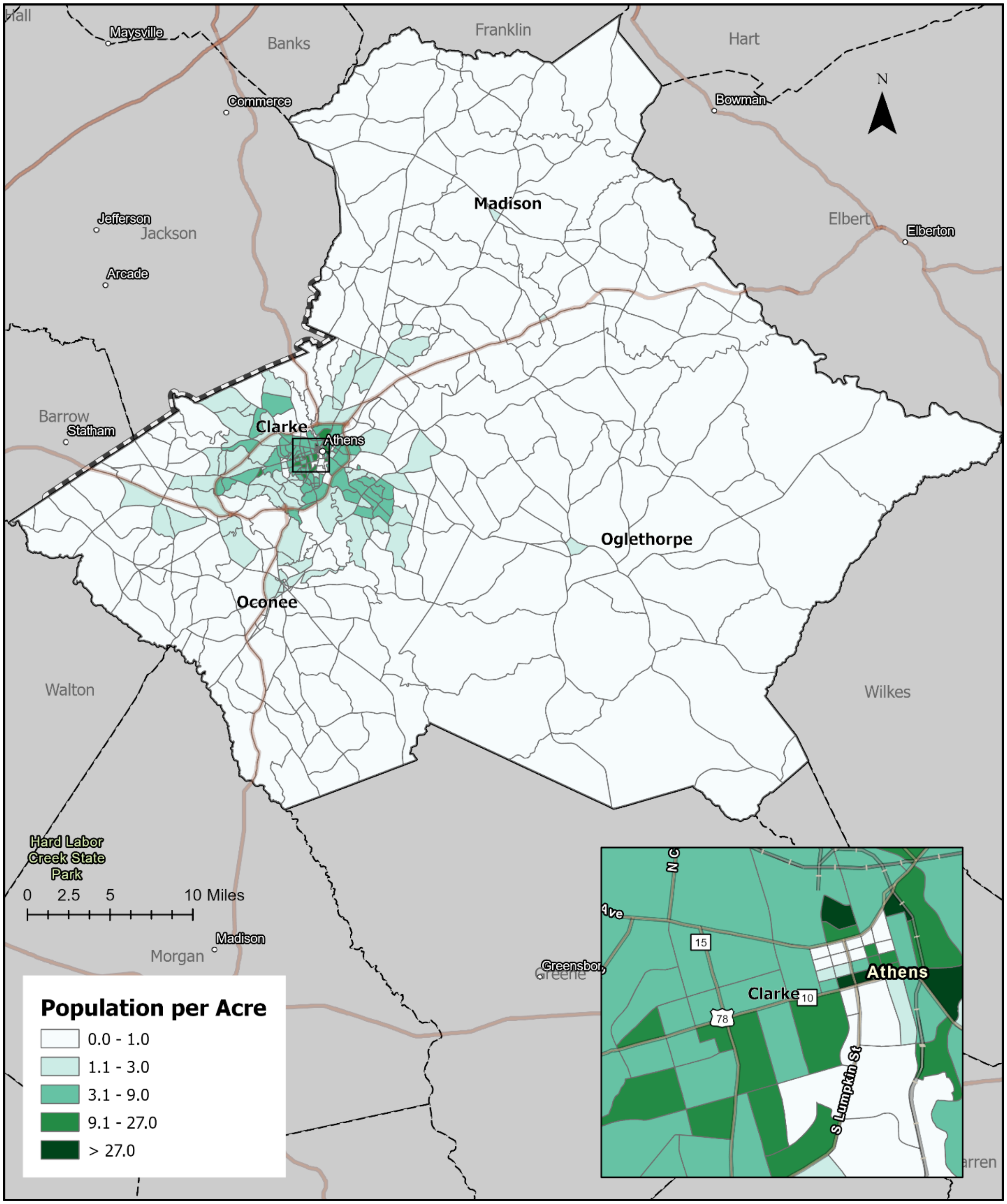
A population density map was prepared and reviewed based on SE data provided by the MPO. Figure 2 illustrates the population density by TAZ for the MACORTS MPO region. Among 461 TAZs, 22 of those have a population density greater than 10.

TABLE 6-6 lists TAZs with population per acre greater than 10. These TAZs need to be further reviewed by the MPO to verify if they have multi-family or group housing located within the area.

TABLE 6-6: TAZS WITH 2020 POPULATION PER ACRE GREATER THAN 10

TAZ ID	Population/Acre
88	10.38
76	10.93
19	11.71
74	11.78
54	12.25
34	12.68
280	12.73
66	12.77
16	12.94
28	14.56
1	14.87
6	16.46
2	16.54
50	18.03
64	18.44
99	21.16
5	22.49
17	29.74
3	33.63
30	36.66
27	46.08
8	57.86

FIGURE 6-2: 2020 POPULATION DENSITY PER TAZ



Student to Service Employment Ratio

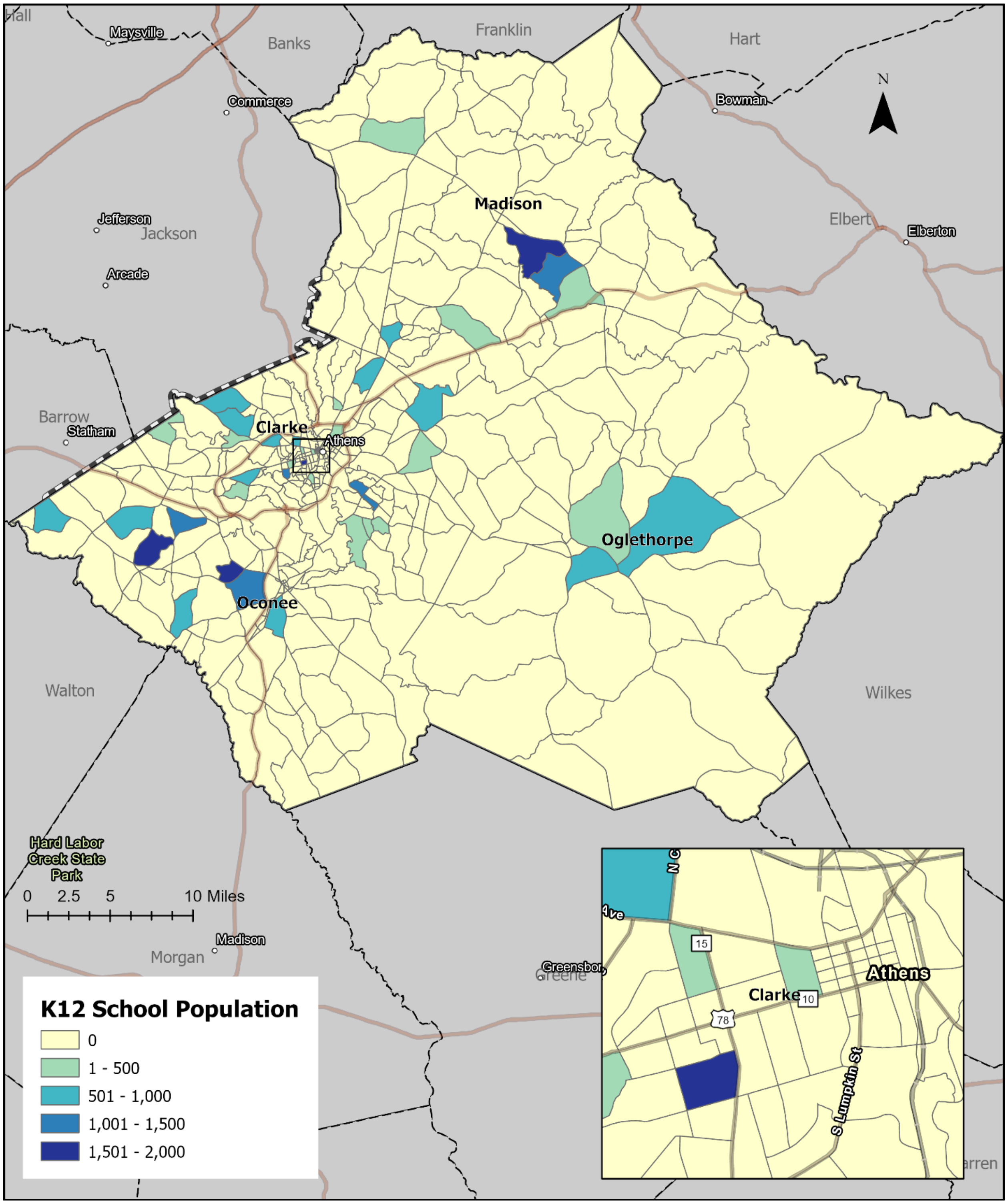
In TAZs that have school enrollments, there is typically one service employee to every 12 students. If the student to service employee ratio is significantly higher than 12, those TAZs should be confirmed that unique or atypical schools exist. All TAZs fall under the recommended student to service employment ratio.

Additionally, TAZ 149 was shown to have a school (Athens Christian School) but has no K12 population. This TAZ should also be checked.

2020 School and University Enrollment

Overall, the ratio of K12 school enrollment to total population is 14% in 2020. In the 2015 SE data the K12 students were 21% of the total population. A recheck of the school enrollment data is recommended. There are 41 TAZs that include school enrollment. Figure 3 illustrates the K12 school locations.

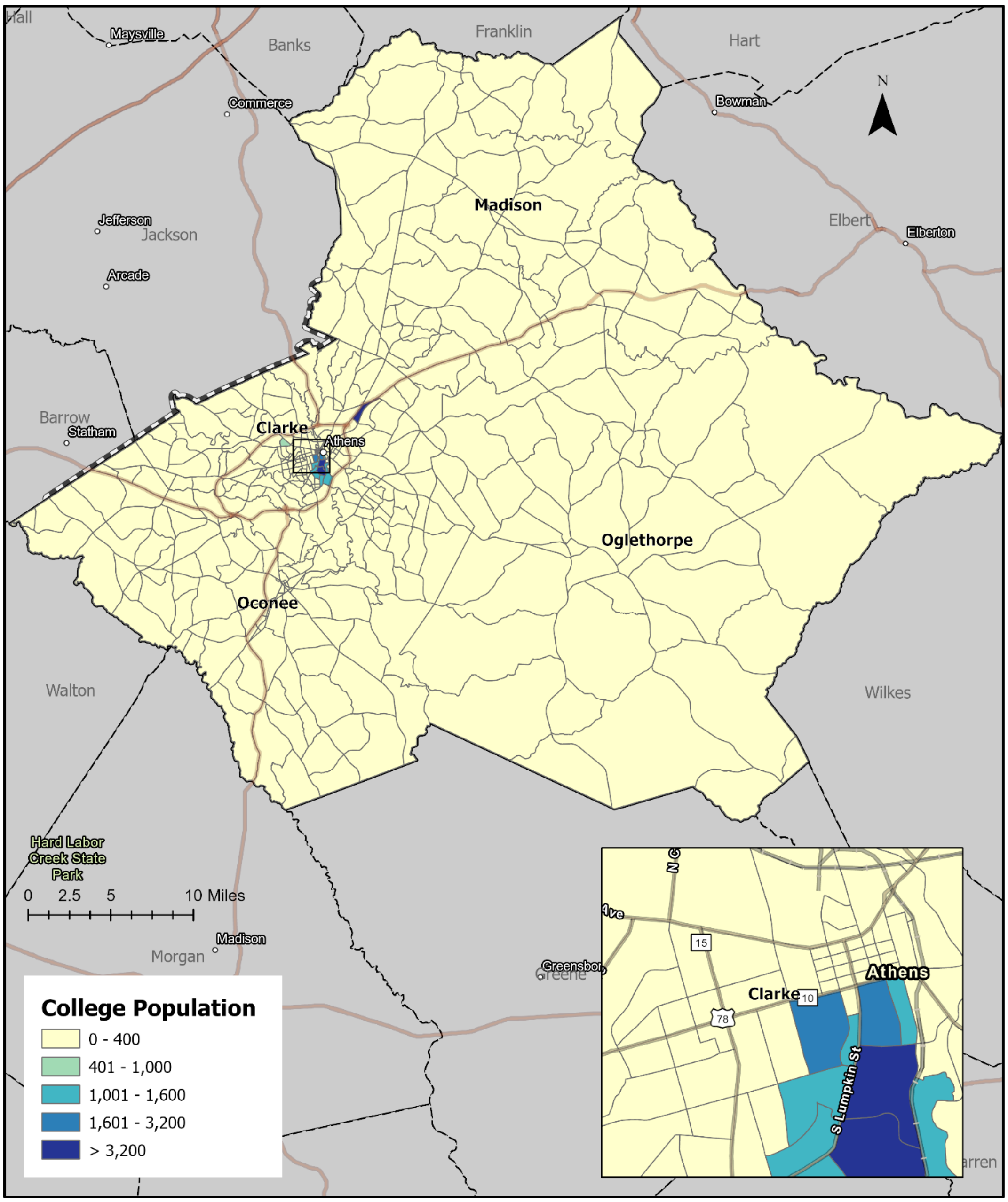
FIGURE 6-3: 2020 SCHOOL LOCATIONS



There is a total of 15 TAZs with a college population where University of Georgia, Athens Technical College, and Piedmont College are located. These TAZs are shown in Figure 4.

University of North Georgia Oconee is located at TAZ 204 based on Google Maps, but the college population is showing 0 data, which needs to be verified.

FIGURE 6-4 2020 COLLEGE LOCATIONS



Median Income

If detailed income data is not available for smaller geographic areas, TAZ income data can be estimated from its associated census tracts (or block groups) data. Income should be reported in 2020 dollars. TAZ income data should not be blank if the TAZ has household. All TAZs with households have income data.

6.1.1.3 Conclusions

Overall, the methodology and assumptions used in the SE data preparation are sound and in-line with best practices. However, it is recommended the MPO review and confirm the following:

- Check the population, household, and employment values for TAZs listed in ***TABLE 6-3***. These TAZs have zero values for population, household, and/or employment.
- Check the population and household value, and the housing types, of TAZs listed below. All the cases should be verified by the MPO.
  - ***TABLE 6-5*** shows the TAZ with households per acre greater than 6, which should correspond to some form of group housing within the TAZ.
  - ***TABLE 6-6*** shows the TAZ with population per acre greater than 10, which should correspond to multi-family or group housing located within the area.
  - Check TAZ 149 which is showing a school but has no K12 population data.
  - Check TAZ 204 which has a college there according to Google maps but is showing 0 college population data

6.1.2 2050 Socioeconomic Data Review Memo

Introduction

This memo summarizes Modern Mobility Partner's review, on behalf of the Georgia Department of Transportation (GDOT), of the 2050 travel demand model socio-economic (SE) data prepared by RS&H for Madison Athens-Clarke Oconee Regional Transportation System (MACORTS) Metropolitan Transportation Plan (MTP). Overall, the methodology and assumptions used in the SE data preparation are sound and in-line with GDOT's planning recommendations.

The following section includes the review and observations of the MACORTS MPO SE data for the year 2050 input into the travel demand model (TDM). The SE data was reviewed at two geographic levels: the aggregated TDM region and individual traffic analysis zones (TAZs).

The **regional level** review included a summary overview of:

6. 2050 Total Population;
7. 2050 Total Households;
8. 2050 Total Employees and Employees by Category;
9. 2050 Total Students;
10. Density Ratios.

The **individual TAZ-level** review included a reasonableness check on:

7. TAZs with No 2050 SE data;
8. Growth Rates between 2020 and 2050 SE Data;
9. 2050 Persons per Household Ratio;
10. 2050 Household Density;
11. 2050 Population Density;
12. 2050 Student to Service Employment Ratio; and
13. 2050 School Enrollment.

Absent local development knowledge, the review was conducted based on the 2050 SE data provided and *GDOT's Georgia MPO Travel Demand Models Socio-Economic Data Development Guide (2022)* (abbreviated as *"GDOT's SE Data Guide"* hereafter). This document offers the observed facts that need attention and confirmation. The observations do not necessarily suggest any revisions if the SE data reasonably reflects the region's approved development plans.

6.1.2.1 Regional Level SE Data Review

Table 6-7 provides a summary of the SE data in the TDM area for 2020 and 2050 and shows the growth in absolute and percentage terms by the overall TDM area. Between 2020 and 2050, the average annual growth rates are -1.09% for population, 1.06% for households, and 1.76% for employment, respectively. Among the four categories of employment, Agriculture, Mining, and Construction has the highest average annual growth rate of 2.63% and Retail has the lowest annual growth rate of 0.98%. The Service industry has the highest absolute growth with an added 47,235 additional jobs.

Table 6-7 TDM AREA 2050 SE DATA

SE Variable	2020	2050	Absolute Growth	Growth Rate (2020 – 2050)	Average Annual Growth Rate (2020 - 2050)
Population	208,504	288,580	80,076	38.41%	1.09%
Households	82,905	113,712	30,807	37.16%	1.06%
Total Employment	92,400	156,078	63,678	68.92%	1.76%
Manufacturing, Transportation, Communication, Utilities, Warehousing	13,165	21,011	7,846	59.60%	1.57%
Service	64,691	111,926	47,235	73.02%	1.84%
Retail	10,164	13,613	3,449	33.93%	0.98%
Agriculture, Mining, Construction	4,380	9,536	5,156	117.72%	2.63%
K-12 Students	28,994	36,251	7,257	25.03%	0.75%
College Students	42,657	45,257	2,600	6.10%	0.20%

Table 6-8 applies some commonly used ratios to check the SE data. At the regional level, persons per household, the ratio of population to employment, population density, and household density in 2050 are within the GDOT's Recommended Ranges. However, the proportion of population enrolled in K12 schools is only 12.56% which is lower than recommended GDOT range of 20%.

Table 6-8 COMMONLY USED DENSITY RATIOS

Variable	2020	2050	Change (2020 - 2050)	GDOT's Recommended Range
Persons per Household	2.51	2.54	0.03	2.00 - 3.00
Population to Employment	2.26	1.85	-0.41	-
Employees per Household	1.11	1.37	0.26	1.00 - 3.00
Proportion of Population Enrolled in K12 Schools	13.91%	12.56%	-1.34%	Around 20%
Persons per Acre	0.31	0.44	0.13	< 10.00
Households per Acre	0.13	0.17	0.04	< 6.00

6.1.2.2 Traffic Analysis Zone (TAZ) Level SE Data Review

A TAZ-level review was conducted following *GDOT's SE Data Guide* to ensure the existing estimations are consistent with reasonable changes.

TAZs with no SE Data

All TAZs have 2050 SE data recorded. However, as indicated in Table 6-9, there are no TAZs with zero total population, households, and employment; 28 TAZs with zero total population and households; and 29 TAZs with population and households but no employment. These TAZs need to be rechecked and confirmed.

Table 6-9 TAZS WITH NO 2050 SE DATA

Zero Value Field	TAZ ID
Population, Households, and Employment	NONE
Population and Households	7, 12, 13, 14, 15, 18, 21, 24, 25, 33, 47, 52, 55, 56, 85, 86, 87, 139, 152, 233, 234, 241, 242, 243, 254, 282, 283, 404

Employment Only	36, 43, 58, 145, 153, 169, 230, 239, 261, 263, 277, 310, 311, 312, 409, 414, 415, 427, 433, 439, 461, 500, 521, 537, 542, 543, 620, 632, 637

Growth Rates between 2020 and 2050 SE Data

As per *GDOT's SE Data Guide*[10], TAZs that have 2050 population/households grown by more than 500% should be reviewed for any planned developments. Table 6-10 shows that the population and household growth rates of TAZs 117, 155 and 180 are greater than 500%.

Table 6-10 TAZS WITH GROWTH GREATER THAN 500%

Growth Rate Greater than 500%	TAZ ID
Population	117, 155, 180
Households	117, 155, 180

Persons per Household Ratio

According to *GDOT's SE Data Guide,* the ratio of persons per household should range between 1 and 7. Values exceeding 7 should correspond to some form of group housing within the TAZ. GDOT. There are no TAZs that have a ratio of persons per household lower than 1, but TAZ 118 has a ratio of persons per household higher than 7, which should be verified by the MPO.

Table 6-11 TAZS WITH 2050 PERSONS PER HOUSEHOLD > 7 OR <1

TAZ ID	Population	Households	Persons per Household Ratio
118	8	1	8

Household Density

According to *GDOT's SE Data Guide,* the number of households per acre in most TAZs should be less than 6. A value of 6 typically corresponds to a three-story multi-family building. Values exceeding 6 should correspond to larger or denser multi-family housing.

A household density map was prepared and reviewed based on SE data provided by the MPO. Figure 1 illustrates the household density by TAZ for the MACORTS MPO region. Among 461 TAZs, 19 of those have household density greater than 6.

[10] *Georgia MPO Travel Demand Models – Socio-Economic Data Development Guide. GDOT. 2023-08-23.*

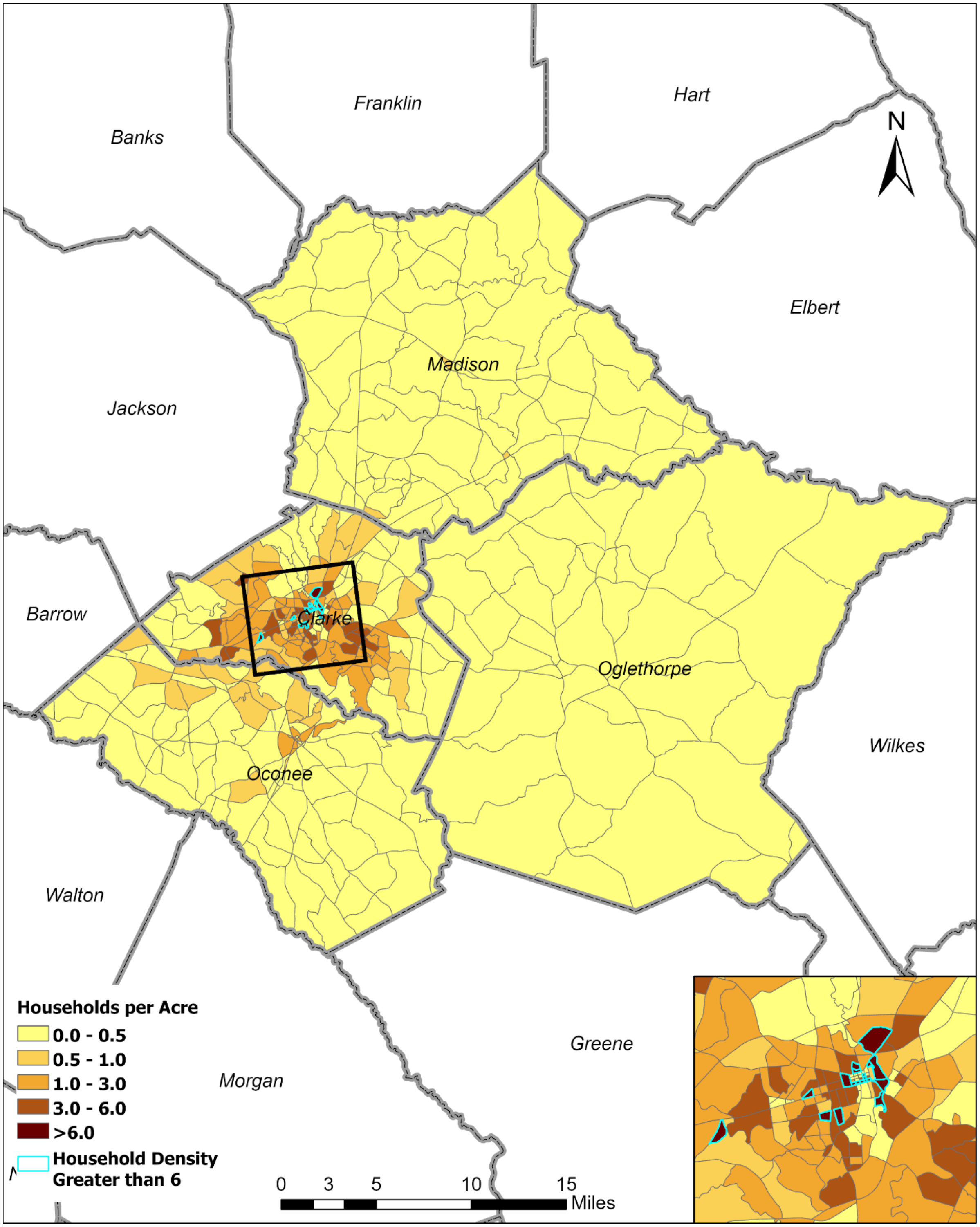
Table 6-12 lists all the TAZs with households per acre greater than 6 for the year 2050 and their 2020 values in order of ascending Households/Acre ratio. These TAZs need to be further reviewed by the MPO to verify if they have multi-family or group housing located within the area.

Table 6-12 TAZS WITH 2050 HOUSEHOLDS PER ACRE GREATER THAN 6

TAZ ID	Households/Acre in 2020	Households/Acre in 2050
19	5.64	6.51
16	5.60	6.60
64	5.79	6.82
76	6.20	7.32
34	6.29	7.42
280	6.52	7.69
2	7.15	8.49
28	7.30	8.61
70	3.55	10.01
9	8.69	10.32
54	7.79	10.53
5	9.26	11.03
1	9.40	11.23
99	10.88	12.83
30	13.42	15.83
27	13.78	16.23
17	10.24	23.39
3	24.80	29.64
8	46.86	46.86

Figure 6-5 shows the 2050 Household density per TAZ map for the MACORTS region. The highlighted TAZs have a household density greater than 6 households/acre.

Figure 6-5 2050 HOUSEHOLD DENSITY PER TAZ



Population Density

According to *GDOT's SE Data Guide,* the ratio of population to acres should not exceed 10. TAZs with population per acre higher than 10 are generally identified as multi-family or group housing land use.

A population density map was prepared and reviewed based on SE data provided by the MPO. Figure 6-6 illustrates the population density by TAZ for the MACORTS MPO region. Out of 461 TAZs, 32 TAZs have a population density greater than 10.

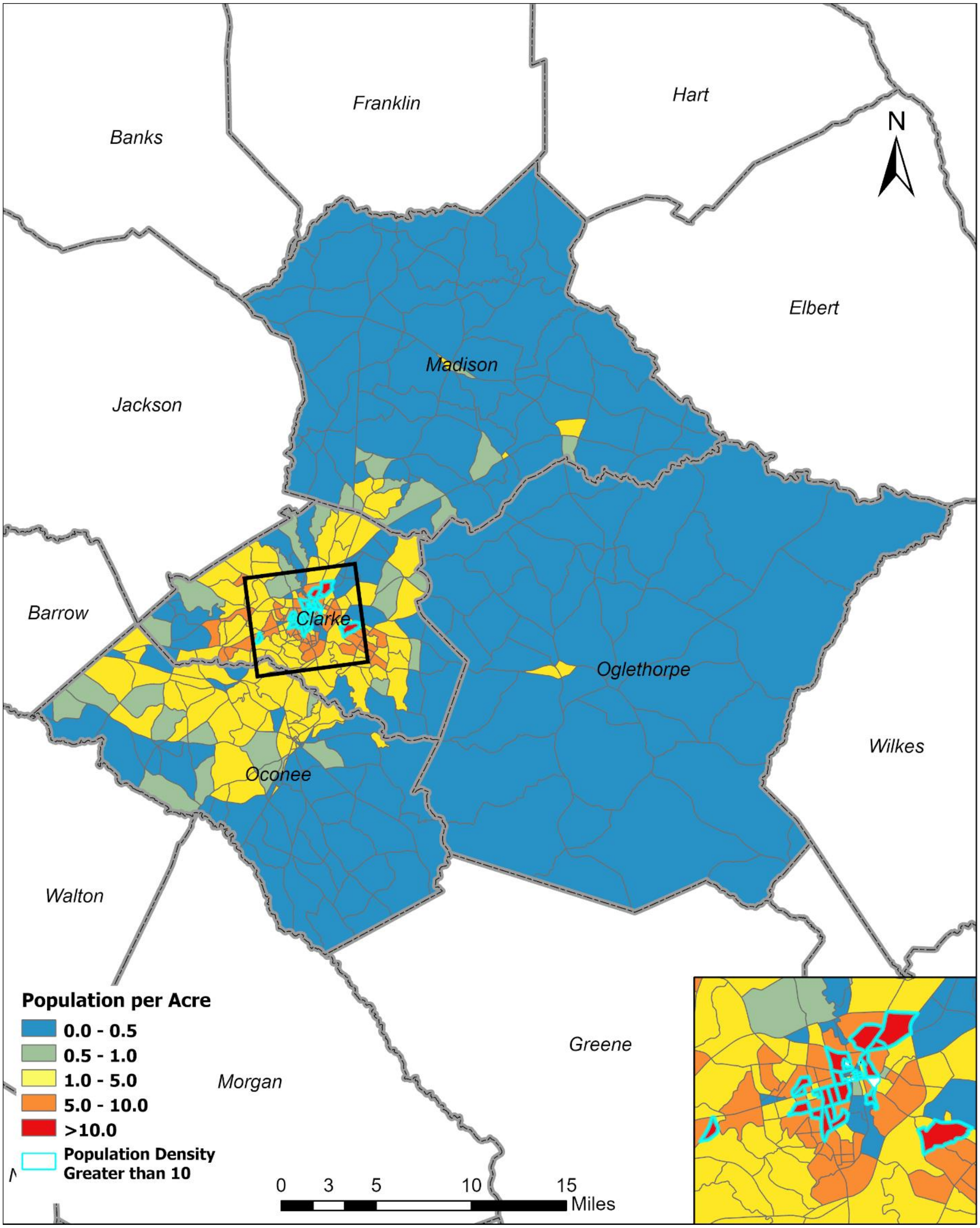
Table 6-13 lists TAZs with population per acre greater than 10 in order or ascending population/acre ratios. These TAZs are also highlighted in light blue in Figure 6-6. The TAZs where the population per acre is greater than 10 in 2050 while their 2020 value is less than 10 will specifically need to be further reviewed by the MPO to verify if they will have multi-family or group housing planned for the area by 2050.

Table 6-13 TAZS WITH 2050 POPULATION PER ACRE GREATER THAN 10

TAZ ID	Population/Acre in 2020	Population/Acre in 2050
9	8.69	10.32
100	8.74	10.32
38	8.90	10.50
446	8.98	10.61
73	9.42	11.10
114	5.99	11.14
180	1.61	11.14
75	7.62	11.74
88	10.38	12.26
66	12.77	12.77
76	10.93	12.91
36	8.71	13.50
19	11.71	13.88
74	11.78	13.89
34	12.68	14.96
280	12.73	15.02
16	12.94	15.31
28	14.56	17.17
1	14.87	17.60
54	12.25	17.81
50	18.03	18.91
6	16.46	19.45

2	16.54	19.66
70	5.74	20.99
64	18.44	21.76
99	21.16	24.99
5	22.49	26.46
3	33.63	41.04
30	36.66	43.26
27	46.08	54.35
8	57.86	57.86
17	29.74	62.07

Figure 6-6 2050 POPULATION DENSITY PER TAZ



Service Employment

For TAZs that contain schools, there is typically one service employee for every 12 students. If the ratio of students to service employees is significantly higher than 12, those TAZs should be confirmed that unique or atypical schools exists or are planned. There are no TAZs that have a student to service employee ratio greater than 12 in the 2050 SE data.

School and University Enrollment

Overall, the ratio of K12 school enrollment to total population in 2050 is 12.56%. There are 42 TAZs that include K12 school enrollment. TAZ 149 has an increase of 683 K12 enrollment from 0 in 2020 which could mean development of a new school.

Figure 6-7 illustrates the school locations. TAZs 152, 204, and 251 are where Athens Technical College, University of North Georgia, and Georgia Institute of Cosmetology are located, respectively. University of Georgia spans 12 TAZs: 31, 32, 47, 48, 49, 50, 51, 52, 53, 55, 56, and 73, with the Health Science Campus in 111. These TAZs are highlighted in light blue in Figure 3.

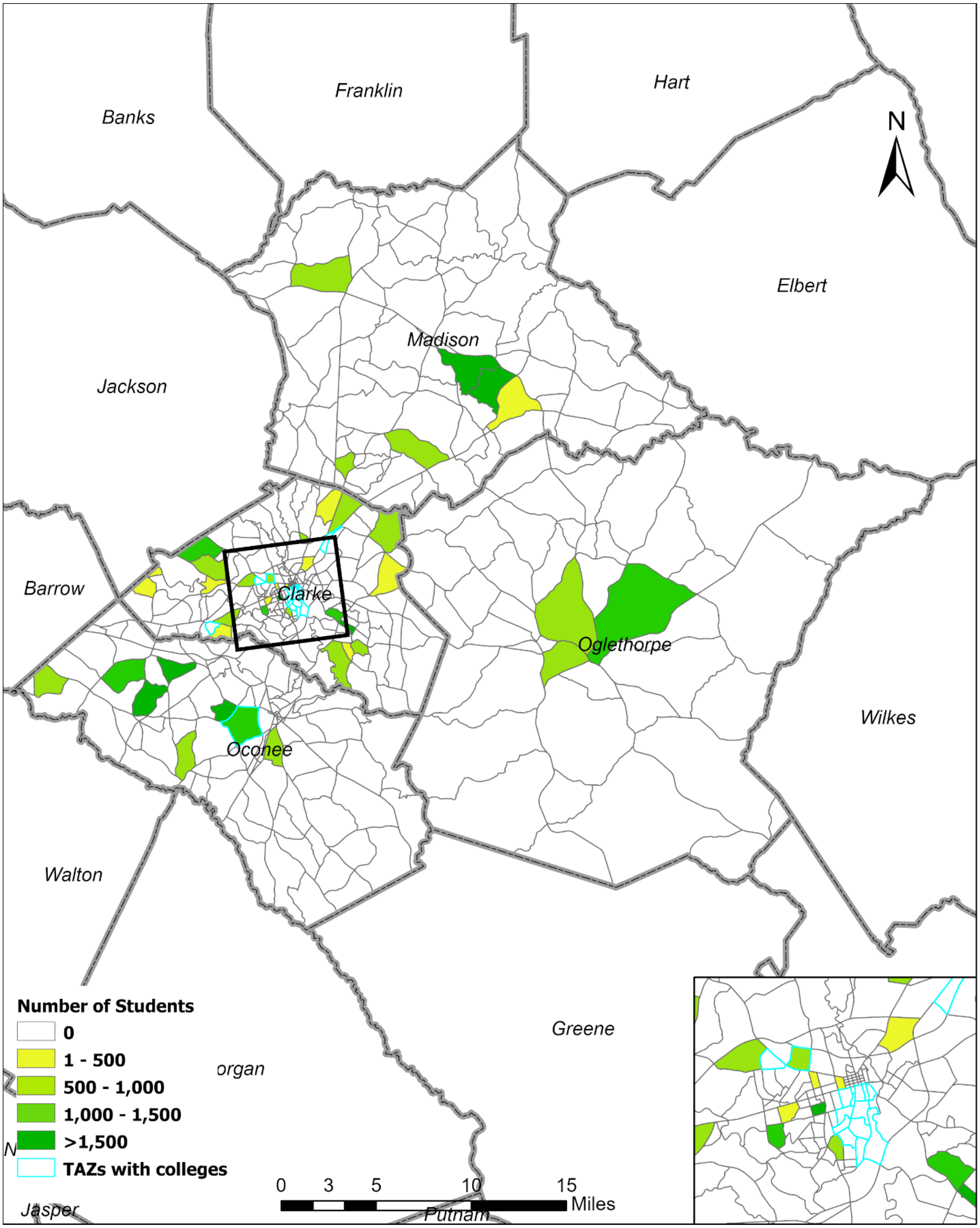
Piedmont University is located in TAZ 113, but TAZ 113 does not have university student data, which needs to be verified.

Table 6-14 TAZS WITH CHANGES IN COLLEGE DEVELOPMENT

TAZ ID	College Student(2020)	College Student (2050)
204	0	2600

There have been changes in college development which is shown in Table 6-14.

Figure 6-7 2050 SCHOOL LOCATIONS



Median Income

There was no median income data to review.

6.1.2.3 Conclusions

Overall, the methodology and assumptions used in the SE data preparation and forecasts are sound and in-line with best practices. However, it is recommended the MPO review and confirm the following:

- Based on Table 6-9, confirm that no future residential development is expected for TAZs 7, 12, 13, 14, 15, 18, 21, 24, 25, 33, 47, 52, 55, 56, 85, 86, 87, 139, 152, 233, 234, 241, 242, 243, 254, 282, 283, or 404. These TAZs have zero total population and households.
- Based on Table 6-9, confirm that no future industrial or business development is expected for TAZs 36, 43, 58, 145, 153, 169, 230, 239, 261, 263, 277, 310, 311, 312, 409, 414, 415, 427, 433, 439, 461, 500, 521, 537, 542, 543, 620, 632, 637. These TAZs have zero employment.
- Based on Table 6-10, TAZs with household and population growth greater than 500% between 2020 and 2050 should be double checked. These include TAZs 117, 155, 180
- Check the population and household value, and the housing types, of TAZ 118 in Table 6-11. TAZ 118 has a ratio of persons per household higher than 7, which should correspond to some form of group housing within the TAZ. The group quarter population (dormitories, nursing homes, prisons, etc.) should be removed from the total population in the TAZ since they have different travel patterns. This 2020 SE data showed a similar pattern so this may not need to be rechecked.
- Table 6-12 shows the TAZ with households per acre greater than 6, which should correspond to some form of group housing within the TAZ.
- Based on Table 6-13, verify the housing types for all TAZs that will have population per acre greater than 10 in 2050 but less than 10 in 2020, which indicates multi-family or group housing land use in the TAZ.
- Table 6-14 shows the development in college population for TAZ 204

6.2 DESCRIPTION OF MTP NETWORK

Long Range Transportation Plan (MTP) Networks

1. 2015 Base year (1st Network)

2. Do-nothing system projects (2nd Network)

2015 Base year (1st Network) + any projects which either opened to traffic since the base year or currently under construction

3. Existing + Committed (E+C) system projects (3rd Network)

Do-Nothing (2nd Network) + projects with construction (CST) funded in the STIP years 2021-2024

4. Completion of STIP system projects (4th Network)

E+C (3rd Network) + projects with preliminary engineering (PE) and right of way (ROW) funded in the STIP years 2021-2024

5. Metropolitan Transportation Plan System projects (5th Network)

Completion of STIP (4th Network) + all identified projects to address future transportation needs through 2050

6. Financially Constrained (6th Network)

4th network plus all financially constrained projects identified through the MTP process.