DEVELOPMENT OF GEORGIA STATEWIDE MODEL

Development of Statewide Model Report

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1.0 INTRODUCTION AND PURPOSE

This document describes the development of the Georgia Statewide Model. The purpose of the Statewide Model is to develop analysis tools that have the capacity to analyze the impact of the modal diversion for people and goods, major changes in land use and economic policies and alternative modes of person travel. The model also provides for the analysis of the impact of future transportation infrastructure investments and strategies. The model may also be used to assist with future Metropolitan Planning Organization (MPO) model updates, to test various project alternatives, and to update Georgia Department of Transportation (GDOT) statewide long range plans. The Statewide Model can provide external travel for the MPO models and forecast future travel demand both in pass-through and internal-external travel. It can assist with assessing the impact of large scale corridor improvements such as interstate widening, corridor toll system analysis, construction of new facilities, and so on. It can also help perform policy level analysis such as freight diversion analysis between truck and rail and estimate the potential daily ridership for intercity passenger rail services and high speed rail alternatives in Georgia. The model was developed based on the most current data sources available at the time. The current model is limited by the existing data available for long distance travel especially internal to external travel but can be enhanced as more data become available.

It should be noted that the Statewide Model is not appropriate for some applications. The statewide model should not be used to analyze travel patterns and demand such as those listed below, and particularly for travel within MPO model areas. The individual MPO models should be used for these types of applications.

- Detailed Personal and Vehicle Travel Patterns and Demands with MPO areas
- Identification of Future Bottlenecks within MPO areas
- Detailed Intermodal Freight Movements within MPO areas

The Statewide Model includes two major model components, the freight and passenger models. Both sub-level models use the four-step modeling process which includes trip generation, trip distribution, mode choice, and traffic assignment steps. Each model performs the modeling steps process independently except during the traffic assignment step, where the freight trucks and auto passenger/commercial vehicles are assigned together in order to reflect congested highway conditions. To appropriately account for the level of congestion in the highway network, the model also incorporated a feedback loop system in which the model only finishes the final assignment when congestion reaches a stable condition. Transearch data was the main data source for the freight model and the National Household Travel Survey (NHTS) 2009 Georgia add-on data was the main data source for the passenger model. The initial base year for the model calibration and validation was 2006. Based on the availability of more current data, the base year for the model calibration and validation has been updated to the year 2010 with more zones added in the MPO areas.

2.0 HIGHWAY NETWORK

The highway network is the backbone of the Statewide Model. It serves as the basic infrastructure that is utilized to develop travel demand and patterns. The network was developed using various data sources and subsequently validated by comparing the reported mileage statistics from GDOT. The National Highway Planning Network (NHPN) was the primary data source for the Statewide Model network and GDOT's Road Characteristic (RC) file was used as a supplementary source where cross-checking was performed to ensure the quality of network. In addition, the GDOT planners also reviewed the network for accuracy. The network for the Statewide Model covers the entire lower 48 states. The extent of the network helps to ensure a reasonable capture of the interstate travel that can be critical along some major gateway corridors. This is particular important for measuring the major freight flows crossing the state line where truck travel can be problematic in congestion buildup and safety of the highway travel. The primary focus of the model is to study the travel within Georgia and to some extent its immediate neighboring states. The level of network detail varies by location. The level of roadway detail and zonal geography is more detailed for the state of Georgia and the surrounding states. Outside Georgia and the five surrounding southeastern states, the roadway network is kept at the Interstate highway system level. This is because the Statewide Model is designed to primarily assess the travel patterns within the state of Georgia, details in the roadway network are less important outside Georgia. On the other hand, the closer the region is to the Georgia study area, the details in the roadway network are more important for the assessment of cross-border travel patterns. Consequently, a four (4)-layered system for the network was created as listed below depending on the distance from Georgia. The layered system is designed in a way so that details in the highway network diminish as it expands outward from the state of Georgia to the rest of the country.

The layer system was defined as follows.

- Georgia study area region (all 159 Georgia counties)
- 50-mile Georgia border surrounding buffer region (including the adjacent portions of the five (5) southeastern states of Alabama, Florida, North Carolina, South Carolina, and Tennessee)
- The rest of the five (5) southeastern states
- Outlying states (the rest of the 43 states plus the District of Columbia)

The highway network within Georgia consists of all of the functionally classified roadways from minor arterial and above and all state routes. Limited collectors and local roads are included in the network within Georgia only to provide necessary connectivity in regions with little highway system. For the buffer regions between Georgia and the outlying states, the network includes the appropriate level of detail required. Outside the southeastern states, the network only represents the interstate freeway system because it has minimal impact on the travel within and immediately surrounding Georgia. The facilities included in the network by the different regions are listed in **Table 2-1**.

Table 2-1: Network Detail Layer by Region

Network Region	Interstate	Major Arterials	Minor Arterials	Collectors/Local Roads (partial)
Georgia	✓	✓	✓	✓
50 miles Buffer Around Georgia	✓	✓	✓	
Rest of Adjacent States	✓	✓		
Rest of Nation	✓			

Source: Georgia Statewide Travel Demand Model

The network mileage by the different geographical regions is shown in **Table 2-2**. The base year network includes over 80,000 miles of roadway with 23% of the roadways located in the State of Georgia. **Figure 2-3** shows the extent of the highway network with the layer system defined.

Table 2-2: Network Mileage by Region

Network Region	Mileage	% of Total
State of Georgia	20,805	25%
50-mile Georgia border buffer region	8,117	10%
The rest of the 5 southeastern states	17,031	21%
Outlying states	36,679	44%
Total	**82,632**	**100%**

Source: Georgia Statewide Travel Demand Model

With such a large scale network, it is important to ensure that the network reasonably represents the existing highway system. To assist with this effort, the network links' distances were summarized by the Federal Highway Functional Classification System and compared with the highway mileages reported in GDOT's 455 Report. **Table 2-3** lists the comparison of the results on both centerline miles and lane-mile basis. The comparison is consistent with the structure of the network layout. The difference in mileage for highway classifications below the Principal is significant because not all collectors are included and roadway system within MPO areas is less in detail. The small differences for higher facilities are likely due to the skeleton of links and nodes in the network and the true distance along the highways.

Table 2-3: Comparison of Network Mileage with GDOT 445 Report

	Centerline Mile			Lane-mile		
Highway Facility	**GDOT**	**Model**	**% Diff**	**GDOT**	**Model**	**% Diff**
Interstate	1,249	1,220	-2%	6,959	6,796	-2%
Principal Arterial	4,748	4,637	-2%	15,884	15,905	0%
Minor Arterial	9,508	7,498	-21%	17,866	17,049	-5%
Collector	22,955	7,318	-68%	36,395	14,892	-59%
Local	80,314	132	-100%	160,760	266	-100%

Source: GDOT Mileage By Route Type and Functional Classification Reports (445 Reports)
Georgia Statewide Travel Demand Model

The functional classification system was also used to determine the facility type for the network links. The facility types are used to determine the highway capacity and free flow speed. **Table 2-4** lists the functional classifications used in the network. **Table 2-5** shows the network link capacity and free flow speeds by facility and by the area type. The area type for the network links is determined by the population density in the vicinity of the network links.

Table 2-4: Functional Classes

Functional Class	Description
1	Rural Interstate
2	Rural Principal Arterial
6	Rural Minor Arterial
7	Rural Major Collector
8	Rural Minor Collector
9	Rural Local
11	Urban Interstate
12	Urban Freeway or Expressway
14	Urban Principal Arterial
16	Urban Minor Arterial
17	Urban Collector
19	Urban Local

Source: Georgia Statewide Travel Demand Model

Table 2-5: Link Capacity and Free Flow Speed

	MPO	Small Urban	Rural
Capacity (Vehicles/Day)			
Interstate	19,125	17,275	15,750
Principal Arterials	13,788	12,713	13,450
Minor Arterials	7,750	7,650	7,450
Major Collectors	6,300	6,150	7,450
Minor Collectors	6,300	6,150	6,050
Local Roads	6,300	6,150	6,050
Free Flow Speed (Miles/Hour)			
Interstate	65	68	70
Principal Arterials	50	55	63
Minor Arterials	40	45	55
Major Collectors	35	40	45
Minor Collectors	30	35	40
Local Roads	20	25	30

Source: Georgia Statewide Travel Demand Model

Table 2-6 lists the attributes in the highway network. The highway network was originally built the National Planning Highway Network and some of the link attributes were taken from this network.

Table 2-6: Highway Network Attributes

Attribute Name	Description
Distance	Link distance (in miles)
Primary _Name	Primary road route sign
Secondary_Name	Secondary road route sign
Lname	Local street name
Fclass	Functional classification 1 - Rural Interstate 2 - Rural Principal Arterial 6 - Rural Minor Arterial 7 - Rural Major Collector 8 - Rural Minor Collector 9 - Rural Local 11 - Urban Interstate 12 - Urban Freeway or Expressway 14 - Urban Principal Arterial 16 - Urban Minor Arterial 17 - Urban Collector 19 -Urban Local 32 - Centroid Connector
Lanes	Number of lanes
Status	Status of current road 0 - Proposed/Under construction 1 - Open to traffic 2 - Ferry route
NHS - 2005	National highway system - 2004 0 - Not on NHS 1 - Interstate 2 - NA 3 - Non-Interstate STRAHNET 4 - STRAHNET Connector 5 - NA 6 - NA 7 - Other NHS 8 - Approved Intermodal Connector

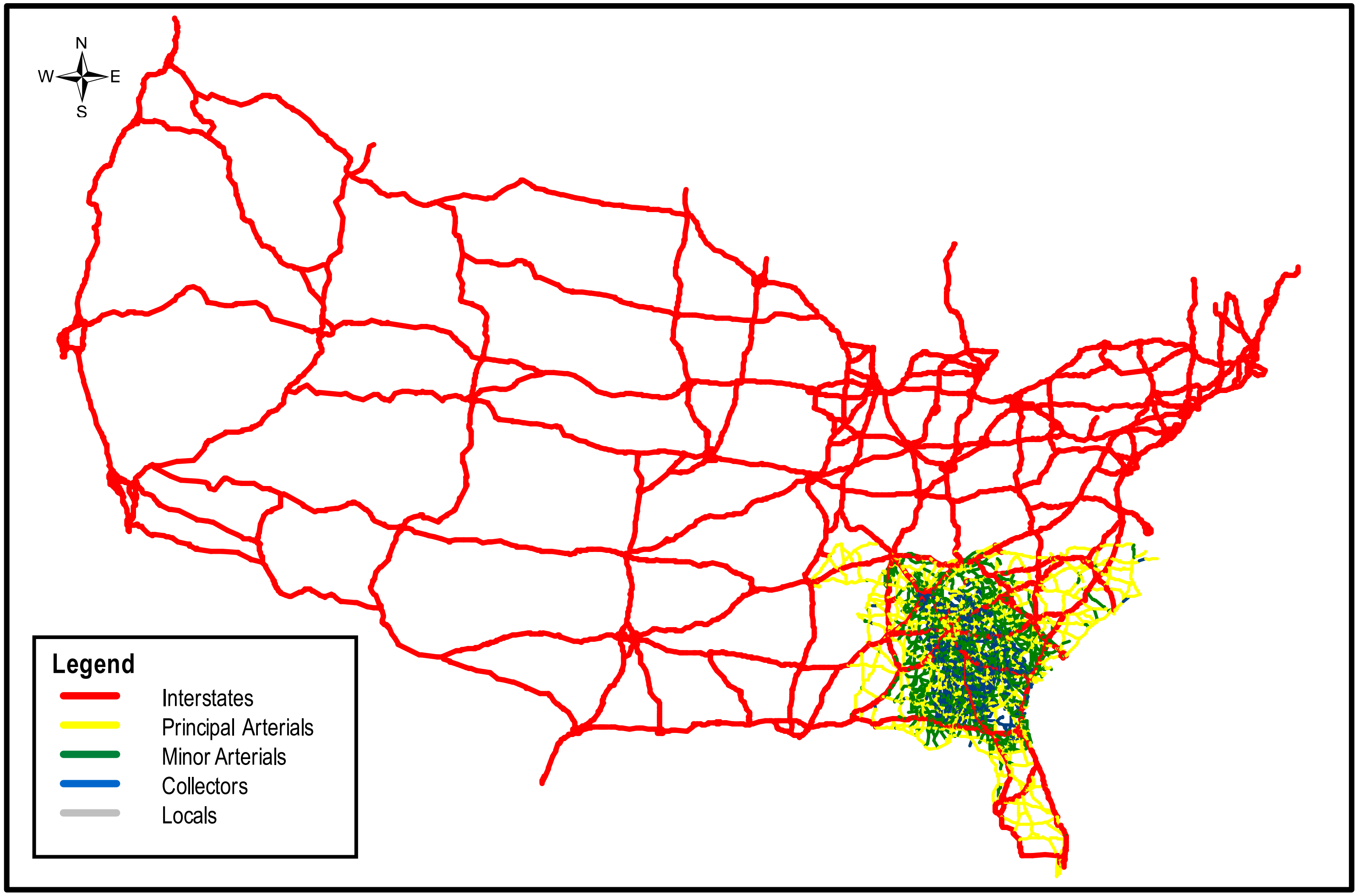
Attribute Name	Description
STRAHNET - 2005	Strategic highway system 0 - Not on STRAHNET 1 - STRAHNET Priority 1 Connector 2 - STRAHNET Priority 2 Connector 3 - Non-Interstate STRAHNET 4 - Interstate Urban 16ft Vertical Clearance Route 5 - Interstate - Non-designated Urban 16ft Vertical Clearance Route 6 - Interstate-all other
County	County name - text format
Tc_number	Traffic count station number - text format
MPO	MPO name - text format The 19 county non-attainment area is designated for the Atlanta area - Gainesville or Hall County is also included in the Atlanta nonattainment area but is specified separately
TMA	N/A (not used)
Screenline	Screenline location 1 - Chattahoochee River S of Lake Lanier 2 - Oconee River 3 - Norfolk Southern RR S N/S 4 - Norfolk Southern RR N N/S 5 - CSX RR E/W 6 - Chattahoochee River N of Lake Lanier
CT2007	Two way traffic counts 2007
X007	One way traffic counts 2007
FIPS	County FIPS code
Trk_Per	Traffic count truck percentage
CT2006	Two way traffic counts 2006
Staterouteflag	State route indicator (0 = not on State Route System) (1 = on State Route System
Ext_Station	State External Location 1 - State External Station 0 - Not a State External Station
Ext_Direction	State External Location by Orientation 1 - Northern Boundary 2 - Eastern Boundary 3 - Southern Boundary 4 - Western Boundary

Attribute Name	Description
MPO_Station	MPO External Station Ranges 10,000 - 10,999 - Albany 20,000 - 20,999 - Athens 30,000 - 39,999 - Atlanta 40,000 - 40,999 - Augusta 50,000 - 50,999 - Brunswick 60,000 - 60,999 - Columbus 70,000 - 70,999 - Dalton 80,000 - 80,999 - Hinesville 90,000 - 90,999 - Macon 100,000 - 100,999 - Rome 110,000 - 110,999 - Savannah 120,000 - 120,999 - Valdosta 130,000 - 130,999 - Warner Robins
Pctoll	Passenger toll section
Trktoll	Truck toll section
Use	Truck only lane indicator
AADT2010	2010 Traffic Counts
TRK2010	2010 Truck Traffic Counts
REMI	REMI districts (1 - 42) Refer to Appendix A for a map and list of the districts
FC2010	2010 HPMS Functional Classification
NHS2010	2010 National Highway System
MPO_Code	1 - Albany 2 - Athens 3 - Atlanta 4 - Augusta 5 - Brunswick 6 – Chattanooga/Catoosa 7 - Columbus 8 - Dalton 9 - Hinesville 10 - Macon 1 1- Rome 1 2- Savannah 1 3- Valdosta 14 – Warner Robins

Source: Georgia Statewide Travel Demand Model

Highway Network

Figure 2-1: Base Year Highway Network by Functional Classification



Source: Georgia Statewide Travel Demand Model

3.0 TAZ SYSTEM

A traffic analysis zone (TAZ) is a geographical area that encompasses residential, social and economic activities. Each zone represents an origin and destination for a trip within the model area, and contains aggregated socioeconomic (SE) data which is used to estimate the trip generation (trip productions and attractions) for that zone. In the Georgia Statewide Model there are 3,505 TAZs representing 48 states and the District of Columbia. Similar to the layered network system, the TAZs are more numerous and smaller in size within Georgia to provide finer detail for analysis of travel within the state. The TAZs then progressively become larger and less detailed moving outward from the state. This is also to ensure the zone system and network is comparable in design.

The development of the TAZ system for the Georgia Statewide Model required the collection of the GIS geographic boundary files, census data, and employment data. The major data sources used were U.S Census data, Census TIGER files, Bureau of Economic Analysis (BEA), and Georgia Department of Labor (DOL). The boundaries of TAZs are built to be consistent with the geographic boundaries of the Census data. The TAZ system includes not only the individual geographic locations of the TAZs, but also contains the socioeconomic data associated with the zones. The SE data for each zone reflects the amount of activities that can produce trips to and from the zone.

Development of TAZ Boundaries

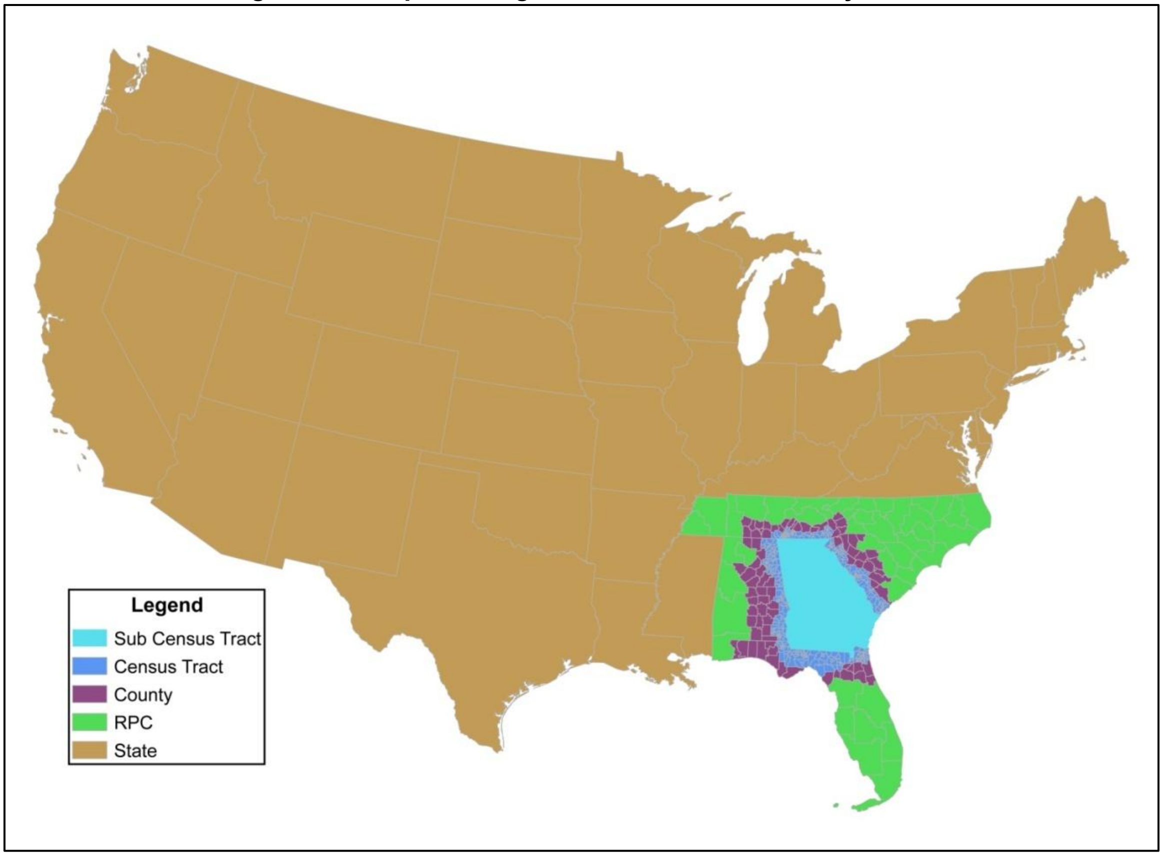
U.S. 2010 Census TIGER/Line files were the primary GIS data source for the development of the TAZ boundaries. The Census data collected in developing the TAZ boundaries are:

- U.S. States
- U.S. Counties
- U.S. Census Tracts
- U.S. Census Blocks
- Water Boundaries
- Urban Area Boundaries
- TIGER/Line Street centerline

The water and urban area boundary files were used to establish the natural boundaries for TAZs, and the TIGER/Line street line file was used for any street delineation that might be missed by both the National Highway Planning Network (NHPN) and the GDOT RC centerline network file. A five (5) TAZ layer or strata system was developed in concert with the network structure and is listed below. The overall Statewide Model TAZ layout structure is shown in **Figure 3-1**, which displays the extent for each of the TAZ geographic layers.

- State of Georgia (TAZs Census Tract size or smaller; Tracts aggregated in urbanized areas)
- Adjacent Census Tracts (Buffer region in counties immediately surrounding Georgia)
- Surrounding Counties (Counties outside the census tract buffer region)
- Surrounding Regional Planning Council (RPC) regions (Within adjacent states outside the surrounding county buffer)
- States (Beyond the 5 states adjacent to Georgia)

Figure 3-1: Map of Georgia Statewide Model TAZs by Strata



Source: Georgia Statewide Travel Demand Model

Within Georgia, the census tracts were used as the basic building blocks on which subdivisions were created to develop finer TAZs. The subdivisions are built from splitting the census tracts by the major highway links. The zone boundary therefore consists of the model network centerline alignment as well as the roadway centerlines in the TIGER/Line file. The urban and water boundaries were also used to assist in defining the TAZ boundary delineation. TAZs are relatively smaller in size within and around the urbanized areas. The Statewide Model will primarily be used for intercity travel forecasts. Intra-urban travel is difficult to be represented comprehensively at the statewide level and the MPO models should be used for this purpose. Tiny census tracts however are common within urbanized areas. These tracts were aggregated to form larger TAZ boundaries. As a rule, census tract boundaries do not violate a county boundary. As a result, the TAZs created by subdividing the census tracts also conform to county boundaries and do not violate existing overlapping MPO TAZ boundaries. TAZ areas increase in size the further away they are located from urbanized areas. This parallels the definitions of census tracts in that census tracts are usually smaller in urbanized areas where population density is high and the roadway system is complex and more detailed. The subdivision of the census tracts created 2978 traffic analysis zones within the state of Georgia. **Table 3-1** presents the stratification of Georgia Statewide Model TAZs. The highest zone number is 3826 in the model. There are 300 dummy zones, ranging from 2979 to 3229 reserved for possible model expansion. Additional zones should replace the dummy zone number first. Georgia MPO boundaries are preserved within the

TAZ system. Table 3-2 shows the TAZ numbering range and total number of TAZs by MPO represented in the model.

Table 3-1: TAZ Numbering by Region and Total Number

Region	From	To	# of Zones
Georgia	1	2978	2978
Census Tract Buffer	3300	3663	364
County Buffer	3664	3743	80
RPC Buffer	3744	3783	40
Other States	3784	3826	43

Source: Georgia Statewide Travel Demand Model

Table 3-2: TAZ Numbering for MPOs

Region	From	To	# of Zones
Atlanta	1	948	948
Rome	949	1000	52
Athens	1001	1096	96
Dalton	1097	1147	51
Augusta	1148	1227	80
Macon	1228	1294	67
Columbus	1295	1368	74
Warner Robins	1369	1413	45
Albany	1414	1451	38
Hinesville	1452	1495	44
Savannah	1496	1618	123
Brunswick	1619	1679	61
Valdosta	1680	1725	46
Chattanooga/Catoosa	1726	1767	42

Source: Georgia Statewide Travel Demand Model

Separate technical memorandums have been prepared which provides detailed documentation on the definition of the zone geography and the preparation of the socio-economic data. Refer to these technical memorandums for more detail.

4.0 FREIGHT MODEL

There are many modes used in the transportation of freight. These include highways, railroads, pipelines, waterways, and so on. Within this framework it is important to remember that freight movement is not restricted to just the state level. Rather it has more of a regional and national structure. The commodity flow database, Transearch, from Global Insights, was the basis for assessing commodity flows within and out of the state and was used as the survey data to estimate the freight model. The Statewide Model mainly focuses on the commodity flows on the highway and rail systems which accounts for more than 75% and 22% of total commodity flows nationwide respectively. The potential interaction between the modes is important in evaluating the truck movement along the critical corridors of the interstate system. The model provides a tool kit that can evaluate the potential shift of commodity traffic between highway and rail. A description of the rail network variables is list in Appendix B.

4.1 Trip generation

The trip generation model produces the zonal commodity productions and attractions. This is similar to the trip production and attraction models in the conventional four-step passenger model. It creates two trip ends for each pair of origin-destination (O-D) flow. Rather than passenger trips created, commodity flows are generated in the freight model. The freight trip generation model was estimated using the O-D flow by commodity type in the Transearch database. There are 761 commodities identified by the Standard Transportation Commodity Code (STCC) code in the database. These commodities were grouped into 16 major commodity groups according to the two digits STCC codes. **Table 4-1** shows the aggregated commodity groups in the freight model and the abbreviations used in the following tables. Regression analysis was performed to estimate trip productions and trip attractions using different types of employment as the indicator variables for these commodity groups. The reason being that commodity flows are dictated by the location of the sectors that make and use all of these commodities. The locations of these sectors then can be identified by the types of employment.

Table 4-1: Freight Model Commodity Groups

ID	Commodity Group	Abbreviation
1	Agriculture products	Agri
2	Non-metallic mining	Ming
3	Food and tobacco products	Food
4	Textile and apparel products	Text
5	Lumber, wood, and furniture products	Lumb
6	Paper and printing products	Papr
7	Chemical products	Chem
8	Petroleum and coal products	Petr
9	Rubber, plastic, and leather products	Rubb
10	Clay, stone, glass, and concrete products	Ston
11	Primary metal products	Pmtl
12	Fabricated metal products	Fmtl
13	Machinery and transportation equipment	Mach
14	Instruments, and miscellaneous manufacturing products	Inst

ID	Commodity Group	Abbreviation
15	Waste, scrap, and hazardous materials	Wast
16	Mail,freight forward,miscellaneous,secondary,intermodal,and warehouse freight shipments	Fmsc

Source: Transearch data 2007

Regression analysis was also used to identify the statistically significant employment variables for estimating productions and attractions by commodity group. These are the key indicator variables that drive the production and consumption of certain types of commodities. For commodity production, the employment variable identified was closely associated with the producing industry. For attractions, one or several employment variables were identified as significant. This indicates that while each commodity is primary produced by one industry sector it is consumed by multiple other sectors. The selected employment variables were also compared with the BEA's industrial Input-Output matrix as a reasonableness check shown in **Table 4-2** and **Table 4-3**.

Table 4-2: Production Make Table – BEA Industrial Input-Output Matrix

	Industry																			
Commodity	**Agri**	**Chem**	**Cnst**	**Fmtl**	**Food**	**Govt**	**Inst**	**Lumb**	**Mech**	**Ming**	**Papr**	**Petr**	**Pmtl**	**Retl**	**Rubb**	**Serv**	**Ston**	**Text**	**Wsle**	**Total**
Agri	99%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**100%**
Chem	0%	92%	0%	0%	1%	0%	0%	0%	0%	0%	0%	3%	0%	0%	3%	0%	0%	0%	0%	**100%**
Fmsc	0%	0%	0%	0%	0%	17%	0%	0%	0%	0%	1%	0%	0%	8%	0%	73%	0%	0%	0%	**100%**
Fmtl	0%	0%	0%	95%	0%	0%	1%	0%	2%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	**100%**
Food	0%	0%	0%	0%	98%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	**100%**
Inst	0%	0%	0%	0%	0%	0%	97%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**100%**
Lumb	1%	0%	0%	0%	0%	0%	0%	97%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**100%**
Mach	0%	0%	0%	1%	0%	0%	1%	0%	98%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**100%**
Ming	0%	0%	0%	0%	0%	0%	0%	0%	0%	99%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**100%**
Papr	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	98%	0%	0%	0%	0%	0%	0%	0%	0%	**100%**
Petr	0%	1%	0%	0%	0%	0%	0%	0%	0%	6%	0%	93%	0%	0%	0%	0%	0%	0%	0%	**100%**
Pmtl	0%	0%	0%	3%	0%	0%	1%	0%	1%	0%	0%	0%	94%	0%	0%	0%	0%	0%	0%	**100%**
Rubb	0%	6%	0%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	89%	0%	0%	2%	0%	**100%**
Ston	0%	0%	86%	0%	0%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	6%	0%	0%	**100%**
Text	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	98%	0%	**100%**
Wast	0%	0%	0%	1%	0%	17%	0%	0%	1%	0%	1%	0%	1%	0%	0%	79%	0%	0%	0%	**100%**
Wsle	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	97%	**100%**

Source: BEA Industrial Input-Output Matrix, 2010

Table 4-3: Consumption Use Table – BEA Industrial Input-Output Matrix

	Industry																			
Commodity	**Agri**	**Chem**	**Cnst**	**Fmtl**	**Food**	**Govt**	**Inst**	**Lumb**	**Mech**	**Ming**	**Papr**	**petr**	**Pmtl**	**Retl**	**Rubb**	**Serv**	**Ston**	**Text**	**Wsle**	**Total**
Agri	29%	0%	1%	0%	61%	1%	0%	2%	0%	0%	0%	0%	0%	1%	0%	3%	0%	1%	0%	**100%**
Chem	5%	30%	3%	2%	2%	10%	3%	1%	2%	1%	4%	1%	0%	0%	12%	21%	1%	1%	1%	**100%**
Fmsc	1%	2%	5%	1%	2%	10%	2%	1%	2%	1%	2%	0%	0%	5%	1%	57%	0%	0%	7%	**100%**
Fmtl	0%	2%	22%	9%	5%	4%	6%	2%	24%	2%	2%	0%	2%	1%	2%	10%	1%	0%	4%	**100%**
Food	7%	1%	0%	0%	46%	7%	0%	0%	0%	0%	0%	0%	0%	6%	1%	31%	0%	0%	1%	**100%**
Inst	0%	1%	8%	1%	1%	9%	31%	1%	14%	0%	2%	0%	1%	2%	2%	23%	0%	1%	3%	**100%**
Lumb	0%	0%	28%	0%	0%	3%	2%	38%	2%	0%	5%	0%	0%	1%	1%	16%	0%	0%	2%	**100%**
Mech	1%	1%	7%	1%	1%	10%	1%	0%	57%	1%	1%	0%	1%	6%	0%	7%	0%	0%	6%	**100%**
Ming	0%	1%	31%	0%	0%	2%	0%	0%	0%	4%	0%	55%	2%	0%	0%	1%	2%	0%	1%	**100%**
Papr	0%	2%	1%	1%	9%	15%	7%	1%	2%	0%	30%	0%	0%	3%	2%	23%	1%	0%	4%	**100%**
Petr	4%	6%	16%	0%	1%	18%	0%	0%	0%	1%	1%	13%	0%	1%	2%	12%	0%	0%	23%	**100%**
Pmtl	0%	0%	2%	20%	2%	1%	14%	2%	32%	1%	0%	0%	21%	0%	1%	2%	0%	0%	1%	**100%**
Rubb	1%	5%	9%	1%	6%	4%	8%	3%	14%	1%	2%	0%	0%	3%	20%	12%	0%	6%	4%	**100%**

	Industry																			
Commodity	Agri	Chem	Cnst	Fmtl	Food	Govt	Inst	Lumb	Mech	Ming	Papr	petr	Pmtl	Retl	Rubb	Serv	Ston	Text	Wsle	Total
Ston	2%	3%	12%	1%	3%	16%	2%	1%	3%	3%	2%	2%	2%	4%	2%	35%	3%	1%	3%	100%
Text	1%	0%	3%	0%	1%	5%	3%	6%	8%	0%	4%	0%	0%	5%	4%	10%	0%	47%	3%	100%
Wast	0%	1%	2%	1%	1%	25%	1%	0%	1%	0%	4%	0%	14%	3%	1%	40%	0%	0%	5%	100%
Wsle	2%	3%	9%	2%	6%	9%	6%	2%	8%	1%	4%	2%	2%	6%	2%	17%	1%	1%	18%	100%

Source: BEA Industrial Input-Output Matrix, 2010

During the analysis, some discrepancies were found between the regression estimated employment variables and BEA's industry Input-Output table. This can be attributed to statistically insignificant employment indicators and other unexplained logistics imbedded in the Transearch data.

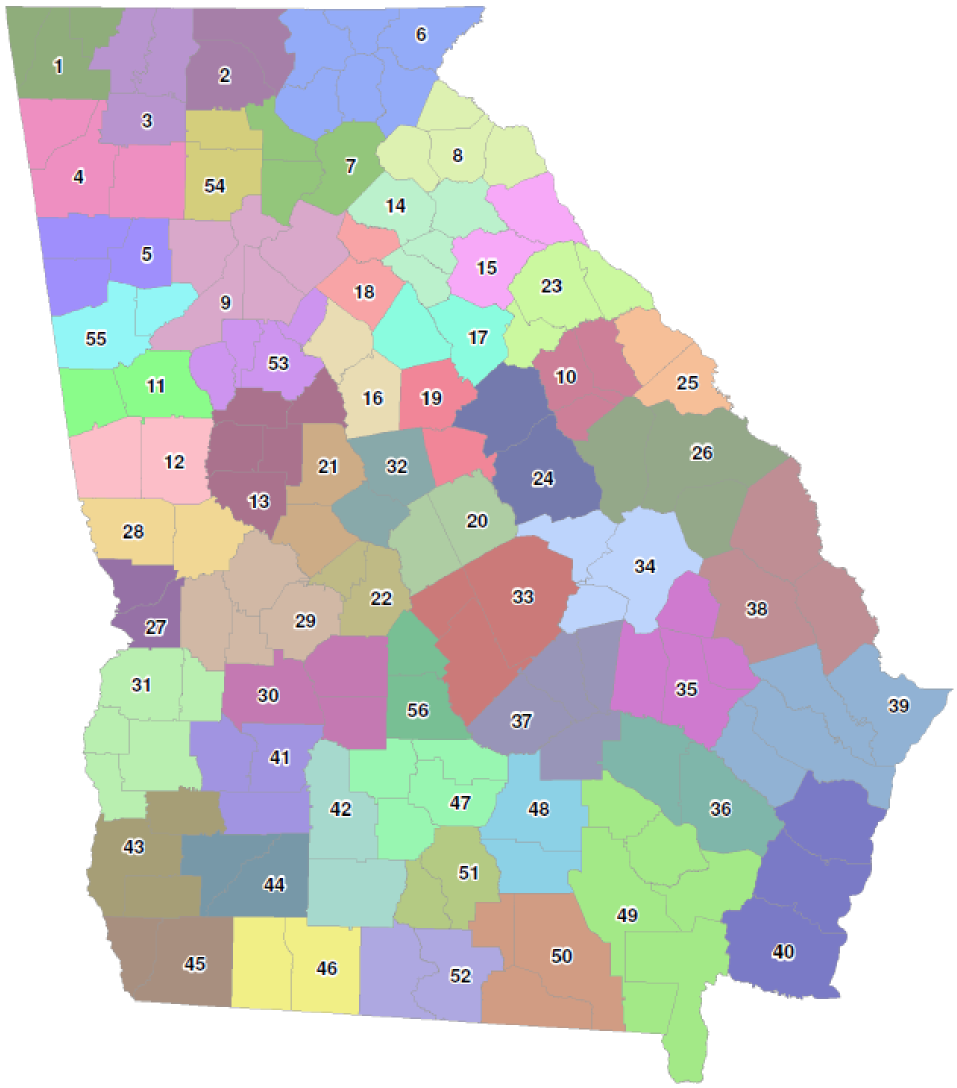
Commodity flows exhibit different shipping patterns depending on the types of commodity being shipped and the regions involved. For example, perishable goods tend to have shorter shipping distance than durable goods and different regions in the country can have widely different industry mix and the level of productivity. Therefore, it is reasonable to analyze the travel patterns by the range of geographic reach. The regression analysis was performed at the following three levels of geography.

- II-Short range (internal Georgia)
- IE-Median range external (between Georgia and its 5 adjacent states)
- IEE-Long range external (between Georgia and other US continent states)

Regression equations for trip production and attraction were both estimated for the three geographic stratifications. The Transearch data was then split into the three geographic regions according to the stratifications to prepare for the model estimation. The 159 Georgia counties were aggregated into 56 districts shown in **Figure 4-1** because the locations where the commodity was shipped as indicated in Transearch data might not be the same location as where it was produced and where the associated employment was located. The district scheme provides data points based on the aggregated counties thus mitigating some of this adverse effect in the regression analysis.

Tables 4-4 to **4-9** display the regression analysis results for commodity productions and attractions. The resulting linear equations equate the amount of commodity that can be produced and consumed to the key employment drivers. Each production and attraction equation includes its indicating employment variables as well as the coefficients associated with it. Fulton and Chatham County in the Transearch data show significant amount of commodity flows generated. This is due to the major rail intermodal yards in both counties and the ocean port in Chatham County. Both counties handle enormous commodity flows but do not necessarily have the commodity producing and consuming sectors within them. The two counties were considered as outliers in the regression analysis and were therefore treated as special generators in the model. Special commodity production and attraction rates were developed for the rail intermodal yards and the ocean ports. These trip rates represent additional flows due to the existence of the intermodal facilities. **Table 4-10** shows the rates for the special generators. The rates reflect additional annual tonnage flows generated per employee and are stratified by movement type.

Figure 4-1: Transearch Data Regression Analysis Districts



Source: Georgia Statewide Travel Demand Model

Table 4-4: II Production Equations (Georgia Internal)

Commodity	Coeff 1	Employment Variable 1	Coeff 2	Employment Variable 2	R^2	DF
Agriculture products	30.08	Agriculture			0.56	49
Non-metallic mining	2478.41	Mining	181.57	Construction	0.73	54
Food and tobacco products	72.58	Food			0.61	52
Textile and apparel products	13.92	Textile			0.96	55
Lumber, wood, and furniture products	128.97	Agriculture	322.48	Lumber	0.64	52
Paper and printing products	61.79	Paper			0.81	49
Chemical products	35.16	Chemical			0.71	51
Petroleum and coal products	4867.20	Petroleum			0.89	52
Rubber, plastic, and leather products	3.71	Rubber & Instruments			0.79	53
Clay, stone, glass, and concrete products	1404.10	Stoneware	521.60	Mining	0.80	54
Primary metal products	102.97	Primary metal			0.83	51
Fabricated metal products	9.91	Fabricate metal & Instruments			0.94	51
Machinery and transportation equipment	24.77	Machinery			0.66	55
Instruments, and miscellaneous manufacturing products	3.80	Instruments			0.95	52
Waste and scrap materials	14.71	Petroleum, Chemical, & Agriculture			0.06	55
Mail,freight forward, and miscellaneous freight shipments	9.42	Wholesale, Services, & Government			0.91	55

Source: Georgia Statewide Travel Demand Model

Table 4-5: II Attraction Equations (Georgia Internal)

Commodity	Coeff 1	Employment Variable	R^2	DF
Agriculture products	32.42	Agriculture	0.39	44
Non-metallic mining	235.10	Construction	0.75	48
Food and tobacco products	2.25	Food & Service (Georgia Internal)	0.85	53
Textile and apparel products	1.09	Textile, Retail, & Wholesale	0.81	53
Lumber, wood, and furniture products	8.32	Agriculture, Lumber, & Service	0.90	50
Paper and printing products	0.58	Paper, Wholesale, & Service	0.86	51
Chemical products	1.63	Textile & Wholesale	0.77	54
Petroleum and coal products	2.75	Petroleum, Rubber, Construction, Wholesale, & Government	0.94	54
Rubber, plastic, and leather products	2.90	Rubber & Instruments	0.63	55
Clay, stone, glass, and concrete products	1555.20	Stoneware	0.73	55
Primary metal products	11.75	Primary Metal & Machinery	0.58	54
Fabricated metal products	11.17	Instruments	0.68	55
Machinery and transportation equipment	1.71	Machinery & Retail	0.76	53
Instruments, and miscellaneous manufacturing products	2.52	Machinery	0.55	52
Waste and scrap materials	56.29	Chemical	0.39	55
Mail,freight forward, and miscellaneous freight shipments	21.44	Retail, Food, Paper, & Government	0.83	46

Source: Georgia Statewide Travel Demand Model

Table 4-6: IE Median Range Production Equations (Georgia External)

Commodity	Coeff 1	Employment Variable 1	Coeff 2	Employment Variable 2	R^2	DF
Agriculture products	13.65	Agriculture			0.62	55
Non-metallic mining	1200.00	Mining			0.26	54
Food and tobacco products	50.30	Food			0.84	53
Textile and apparel products	25.52	Textile			0.99	53
Lumber, wood, and furniture products	53.00	Agriculture	107.84	Lumber	0.66	54
Paper and printing products	74.70	Paper			0.53	54
Chemical products	131.97	Chemical			0.44	54
Petroleum and coal products	1016.49	Petroleum			0.89	52
Rubber, plastic, and leather products	4.12	Rubber & Instruments			0.75	55
Clay, stone, glass, and concrete products	218.64	Stoneware & Mining			0.60	55
Primary metal products	41.43	Primary metal			0.68	53
Fabricated metal products	10.14	Fabricate metal & Instruments			0.82	54
Machinery and transportation equipment	25.43	Machinery			0.70	53
Instruments, and miscellaneous manufacturing products	3.72	Instruments			0.91	55
Waste and scrap materials	97.55	Chemical			0.57	55
Mail,freight forward, and miscellaneous freight shipments	3.14	Services			0.92	55

Source: Georgia Statewide Travel Demand Model

Table 4-7: IE Median Range Attraction Equations (Georgia External)

Commodity	Coeff 1	Employment Variable	R^2	DF
Agriculture products	27.04	Lumber & Food	0.47	48
Non-metallic mining	95.36	Construction	0.47	51
Food and tobacco products	1.80	Food & Service	0.76	51
Textile and apparel products	0.27	Retail & Service	0.57	53
Lumber, wood, and furniture products	2.46	Agriculture, Lumber, & Service	0.99	47
Paper and printing products	2.27	Paper & Wholesale	0.65	45
Chemical products	2.64	Textile & Wholesale	0.74	52
Petroleum and coal products	23.49	Chemical & Rubber	0.18	40
Rubber, plastic, and leather products	4.40	Rubber & Instruments	0.89	54
Clay, stone, glass, and concrete products	6.33	Stoneware, Retail, & Wholesale	0.69	51
Primary metal products	27.68	Machinery	0.62	54
Fabricated metal products	8.55	Instruments	0.89	54
Machinery and transportation equipment	1.10	Retail	0.91	53
Instruments, and miscellaneous manufacturing products	0.37	Machinery & Instruments	0.57	53
Waste and scrap materials	39.95	Chemical & Primary Metal	0.39	54
Mail,freight forward, and miscellaneous freight shipments	9.32	Retail & Government	0.87	45

Source: Georgia Statewide Travel Demand Model

Table 4-8: IEE Long Range Production Equations (Georgia External)

Commodity	Coeff 1	Employment Variable 1	Coeff 2	Employment Variable 2	R^2	DF
Agriculture products	33.83	Agriculture			0.53	53
Non-metallic mining	2.41	Mining & Construction			0.26	44
Food and tobacco products	103.40	Food			0.66	49
Textile and apparel products	52.82	Textile			0.99	53
Lumber, wood, and furniture products	23.71	Agriculture	72.49	Lumber	0.63	52
Paper and printing products	67.03	Paper			0.65	50
Chemical products	376.25	Chemical			0.58	53
Petroleum and coal products	1588.78	Petroleum			0.96	52
Rubber, plastic, and leather products	22.77	Rubber & Instruments			0.84	45
Clay, stone, glass, and concrete products	267.94	Stoneware & Mining			0.35	48
Primary metal products	161.82	Primary metal			0.41	55
Fabricated metal products	17.35	Fabricate metal & Instruments			0.91	54
Machinery and transportation equipment	84.87	Machinery			0.64	55
Instruments, and miscellaneous manufacturing products	5.39	Instruments			0.57	55
Waste and scrap materials	20.69	Chemical			0.57	45
Mail,freight forward, and miscellaneous freight shipments	1.57	Wholesale, Services, & Government			0.64	54

Source: Georgia Statewide Travel Demand Model

Table 4-9: IEE Long Range Attraction Equations (Georgia External)

Commodity	Coeff 1	Employment Variable 1	Coeff 2	Employment Variable 2	R^2	DF
Agriculture products	92.11	Food	4.78	Agriculture & Wholesale	0.73	53
Non-metallic mining	3249.00	Primary metal			0.35	46
Food and tobacco products	1.93	Food & Service			0.63	53
Textile and apparel products	0.90	Wholesale			0.16	55
Lumber, wood, and furniture products	0.87	Service & Retail			0.85	53
Paper and printing products	53.57	Paper			0.84	54
Chemical products	8.82	Textile & Wholesale			0.71	53
Petroleum and coal products	32.49	Chemical			0.20	55
Rubber, plastic, and leather products	15.12	Chemical & Instruments			0.55	55
Clay, stone, glass, and concrete products	2.19	Construction			0.54	54
Primary metal products	8.06	Primary metal & Construction			0.53	55
Fabricated metal products	3.30	Instruments & Wholesale			0.91	54
Machinery and transportation equipment	4.99	Machinery & Retail			0.87	53
Instruments, and miscellaneous manufacturing products	2.27	Machinery & Instruments			0.67	54
Waste and scrap materials	294.36	Petroleum	25.61	Chemical & Paper	0.81	53
Mail,freight forward, and miscellaneous freight shipments	10.35	Retail & Government			0.71	54

Source: Georgia Statewide Travel Demand Model

Table 4-10: Special Generator (Annual Tons per Employee)

	II (Georgia Internal)		IE Median Range (Georgia External)		IEE Long Range (Georgia External)	
	Production	Attraction	Production	Attraction	Production	Attraction
Chatham Intermodal	141.96	46.90	54.23	211.64	73.94	49.55
Chatham Ports	283.72	67.53	337.10	205.21	251.48	130.91
Fulton Intermodal	21.71	21.45	7.64	42.04	7.86	12.45

Source: Georgia Statewide Travel Demand Model

4.2 Trip distribution

The trip distribution model was developed using the conventional gravity model. The commodity flow productions and attractions developed from the trip generation process are the inputs to the gravity model. The gravity model distributes the commodity flows according to the magnitude of zonal productions and attractions as well as the travel impedance between the O-D pairs. The gravity model is applied at the following five geographic levels for each of the 16 commodity groups.

- Georgia internal flows (II)
- Georgia region to adjacent states (IE) - median distance range
- Adjacent states to Georgia region (EI) - median distance range
- Georgia region to other states (IEE) - long distance range
- Other states to Georgia region (EEI) - long distance range

Unlike the passenger trips, commodity flows do not make round trips within a day and the average outbound travel route may not be the same as inbound one. Therefore, the IE and EI commodity flows are applied in separate gravity models to reflect the unique directional travel pattern. The external flows were also categorized into median range and long range. The median range is defined as shipping between Georgia and the five adjacent states and the long range is between Georgia and other states. The separation of the external flow by the two directions in the distribution model also reflects the level of aggregation used in the statewide zone system, the different characteristics of the commodity flows by distance and region, as well as the trip generation process that was developed separately for these two categories. The difference of the economic situation between the southeast US and rest of the nation was also taken into account by the different geographic levels.

Highway travel distance is used as the impedance in the gravity model. The impedance is reflected in the friction factors which are developed from the exponential equation shown below. **Table 4-11** shows the y coefficients used in the exponential equation to calculate friction factors for the gravity models.

$$\mathrm{FF} = e^{-\gamma * Distance}$$

γ: *coefficient base on the inverse of the average observed flow distance*

Table 4-11: y Coefficient for Friction Factors

4.2.1.1 Commodity	4.2.1.2 II	4.2.1.3 IE	4.2.1.4 IEE	4.2.1.5 EI	4.2.1.6 EEI
Agriculture	0.0222	0.0035	0.0010	0.0026	0.0011
Mining	0.0250	0.0027	0.0014	0.0200	0.0020
Food	0.0014	0.0025	0.0011	0.0026	0.0011
Textile	0.0014	0.0031	0.0011	0.0022	0.0006
Wood	0.0015	0.0028	0.0010	0.0032	0.0013
Paper	0.0167	0.0033	0.0012	0.0025	0.0010
Chemical	0.0014	0.0027	0.0010	0.0020	0.0013
Petroleum	0.0014	0.0033	0.0016	0.0024	0.0015
Rub & plastic	0.0014	0.0028	0.0011	0.0027	0.0008

4.2.1.1 Commodity	4.2.1.2 II	4.2.1.3 IE	4.2.1.4 IEE	4.2.1.5 EI	4.2.1.6 EEI
Stone	0.0154	0.0031	0.0013	0.0030	0.0014
Primary metal	0.0036	0.0025	0.0014	0.0036	0.0011
Fabricated metal	0.0014	0.0025	0.0011	0.0029	0.0010
Machinery	0.0017	0.0026	0.0010	0.0020	0.0009
Instruments	0.0025	0.0021	0.0010	0.0022	0.0007
Waste	0.0011	0.0037	0.0017	0.0027	0.0014
Miscellaneous freight	0.0042	0.0029	0.0012	0.0029	0.0013

Source: Georgia Statewide Travel Demand Model

The gravity model was validated against the Transearch data by average flow distance and flow distance frequency distribution. The closer the model outputs match the Transearch data the better the model replicated the existing travel pattern. **Table 4-12** shows the average flow distance of the commodity groups from the Transearch data and **Table 4-13** lists the gravity models' average flow distance. In general, the gravity model produced reasonable results when compared to the 2007 Transearch data considering only one year's data were available for the model estimation effort.

Table 4-12: Transearch Average Trip Length (miles)

Commodity	II	IE	IEE	EI	EEI
Agriculture	64	282	997	412	911
Mining	61	267	895	313	511
Food	126	405	947	384	946
Textile	142	327	938	451	1,561
Wood	147	352	976	314	796
Paper	67	304	852	329	994
Chemical	136	374	970	376	750
Petroleum	134	301	627	422	682
Rubber & plastics	147	363	944	364	1,202
Stone	71	324	760	336	733
Primary Metal	130	403	705	280	879
Fabricated Metal	123	402	950	339	1,035
Machinery	135	379	1,047	398	1,096
Instruments	116	471	956	358	1,532
Wastes	176	272	605	365	695
Miscellaneous freight	102	349	843	343	788

Source: Transearch data 2007

Table 4-13: Average Trip Distance by Commodity (in miles)

Commodity	II	IE	IEE	EI	EEI
Agriculture	66	287	963	450	897
Mining	63	291	1,000	300	517
Food	110	405	937	377	941
Textile	121	316	934	454	1,550
Wood	142	341	958	301	969
Paper	70	318	850	301	1,056
Chemical	104	382	955	350	773
Petroleum	120	329	614	422	675
Rubber & plastics	84	349	936	365	1,195
Stone	75	317	792	331	738
Primary metal	120	400	780	267	883
Fabricated metal	88	396	939	334	1,023
Machinery	124	363	1,030	352	1,102
Instrument	100	428	958	349	1,529
Wastes	154	289	613	339	707
Miscellaneous freight	105	341	843	331	788

Source: Georgia Statewide Travel Demand Model

A further examination of the model results was also performed at the aggregated level that included all movements for each commodity group. The aggregated average flow distances as well as the flow distance frequency distribution curves were analyzed. **Figure 4-2** shows the aggregated average trip length comparison by commodity group between the model outputs and Transearch data. Coincidence ratio and R Squared values were used to measure the frequency distribution. As shown in the **Table 4-14** except for the mining commodity category, all coincidence ratios are above 0.75, indicating a reasonable correlation between model output and the Transearch data.

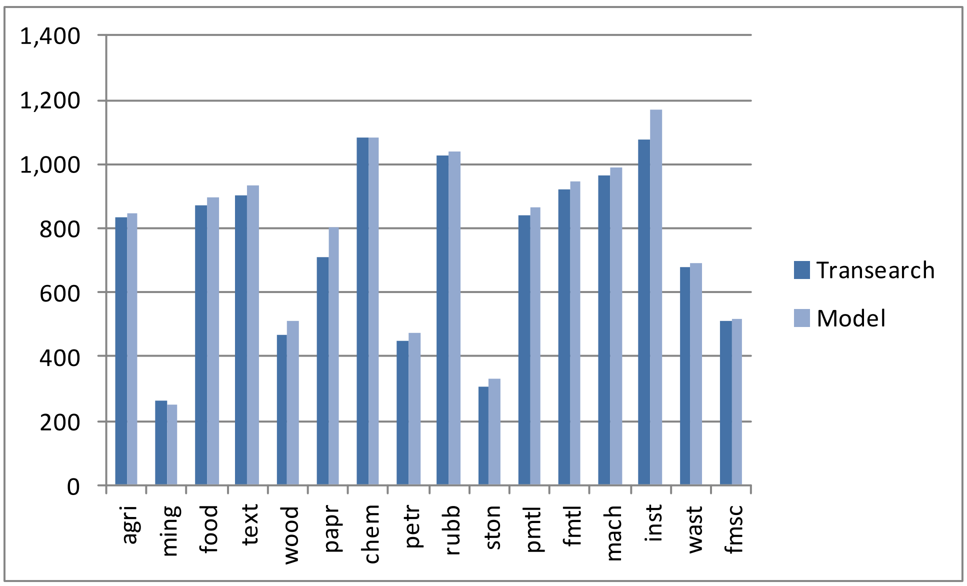
Table 4-14: Gravity Model Trip Length Validation

	Frequency Distribution		Average Trip Distance - Mile		
Commodity	**Coincidence**	**RSQ**	**Transearch**	**Model**	**% Difference**
Agriculture	0.83	0.84	833	846	2%
Mining	0.69	0.85	261	251	(4%)
Food	0.92	0.94	871	897	3%
Textile	0.92	0.97	903	932	3%
Wood	0.89	0.98	465	509	9%
Paper	0.78	0.69	709	803	13%
Chemical	0.95	0.99	1,080	1,082	0%
Petroleum	0.81	0.92	448	471	4%
Rubber & plastics	0.94	0.97	1,029	1,038	1%

	Frequency Distribution		Average Trip Distance - Mile		
Commodity	Coincidence	RSQ	Transearch	Model	% Difference
Stone	0.80	0.93	305	328	8%
Primary metal	0.92	0.95	842	867	3%
Fabricated metal	0.92	0.95	918	944	3%
Machinery	0.90	0.94	967	989	2%
Instrument	0.79	0.52	1,073	1,166	9%
Waste	0.86	0.89	678	688	1%
Fabricated metal	0.90	0.95	511	514	0%

Source: Georgia Statewide Travel Demand Model

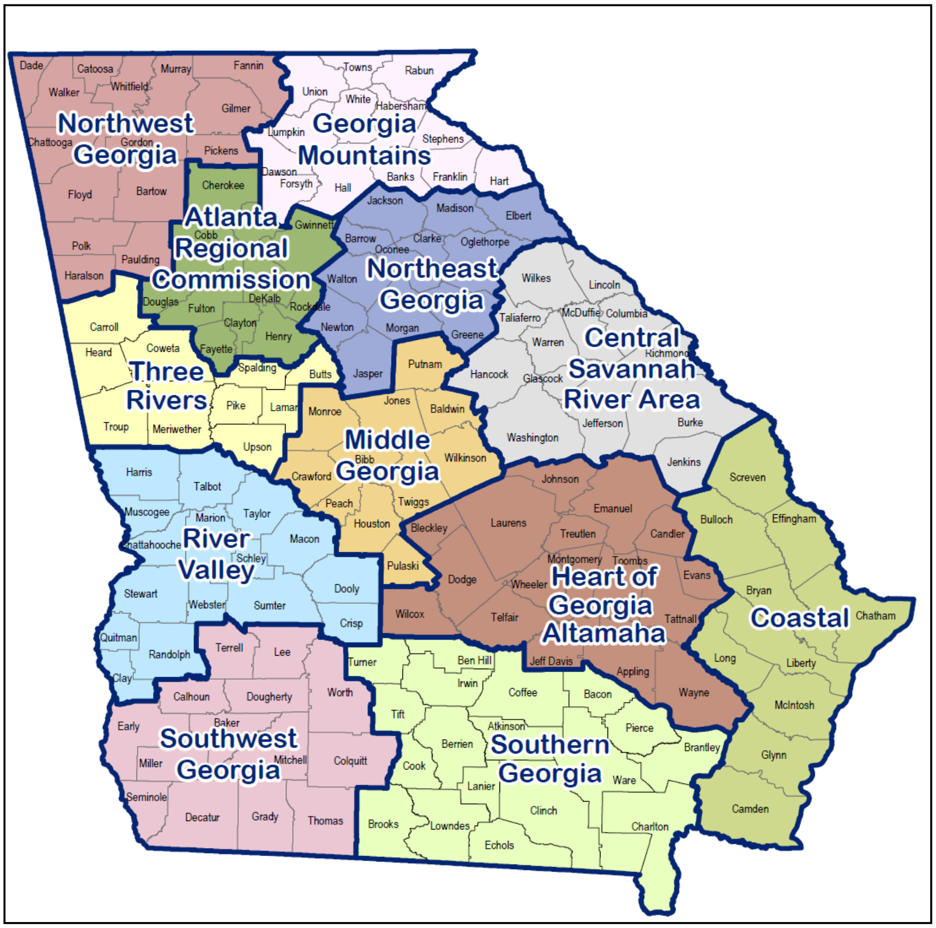
Figure 4-2: Trip Length Validation



Source: Georgia Statewide Travel Demand Model

To improvement the validation of the Gravity model, it is also helpful to examine the pattern of the commodity flows at the regional level between the model and the Transearch data. The state was divided into 12 districts according to the Georgia Regional Commission Districts (RDC). Each RDC consists of multiple counties. The district scheme helps to measure the cross region commodity flows at an aggregated level. The district to district commodity flows from the 2007 Transearch data were developed for this purpose. **Figure 4-3** shows the districts layout for the state of Georgia.

Figure 4-3: Georgia Regional Commission Districts



Source: Georgia Association of Regional Development Centers

Table 4-15 and **Table 4-16** show the district to district freight commodity flows in annual tonnage from the Gravity model and the Transearch data. **Figure 4-4** graphically shows the freight commodity flows in **Table 4-15** and **Table 4-16** within the state of Georgia**.** The results from the gravity model generally match the Transearch survey data. It is expected that there will be some discrepancies in the comparison since both the model and the survey data contains certain levels of inaccuracy. **Figure 4-5** and **Figure 4-6** show the comparison of freight commodity flows between the two areas with the largest amount of freight movements, Atlanta and Coastal district (which includes Savannah) and the rest of the county. Again the results from the model are reasonably similar to the Transearch data.

Another way to look at the comparison of freight movements by district is use the scatter plot. The scatter plot can show the correlation between the two data variables and indicate how well one data variable explains the other. The plot displays the travel flow between each district to district pair for both model and the Transearch survey. The better the plotted points lie along a straight line and have similar x and y axis number, the better the model explains the travel patterns in the survey data.

Table 4-15: District to District Freight Commodity Flow in Annual Tonnage - Gravity Model (In Thousands)

	NW GA	GA Mountains	ARC	Three Rivers	NE GA	Mid GA	Ctr. Savh River	River Valley	Heart of GA	SW GA	S GA	Coastal	Total
NW GA	2,164	513	10,031	176	424	311	220	213	97	125	135	252	14,659
GA Mountains	322	584	3,326	48	329	134	167	86	51	57	65	137	5,307
ARC	4,259	2,021	71,852	1,470	3,308	3,063	2,172	1,995	902	1,115	1,204	2,294	95,657
Tree Rivers	142	49	2,196	217	79	155	76	207	45	64	60	105	3,395
NE GA	330	652	7,119	111	1,917	526	767	150	148	97	119	325	12,260
Mid GA	405	297	11,295	581	1,210	3,980	1,205	849	1,120	337	472	1,133	22,885
Ctr. Savh River	266	424	6,368	159	1,292	1,162	4,956	232	987	141	294	1,782	18,063
River Valley	328	116	6,140	738	285	1,277	257	2,178	348	654	422	445	13,188
Heart of GA	136	70	1,910	59	158	346	342	172	697	158	364	1,003	5,415
SW GA	242	94	3,591	258	237	823	259	1,142	486	3,210	2,272	894	13,509
S GA	200	87	2,628	85	180	433	270	330	518	592	1,643	1,086	8,052
Coastal	182	99	2,234	72	244	448	658	234	758	230	562	6,111	11,834
Total	8,977	5,006	128,690	3,974	9,664	12,658	11,349	7,789	6,157	6,781	7,611	15,567	224,224

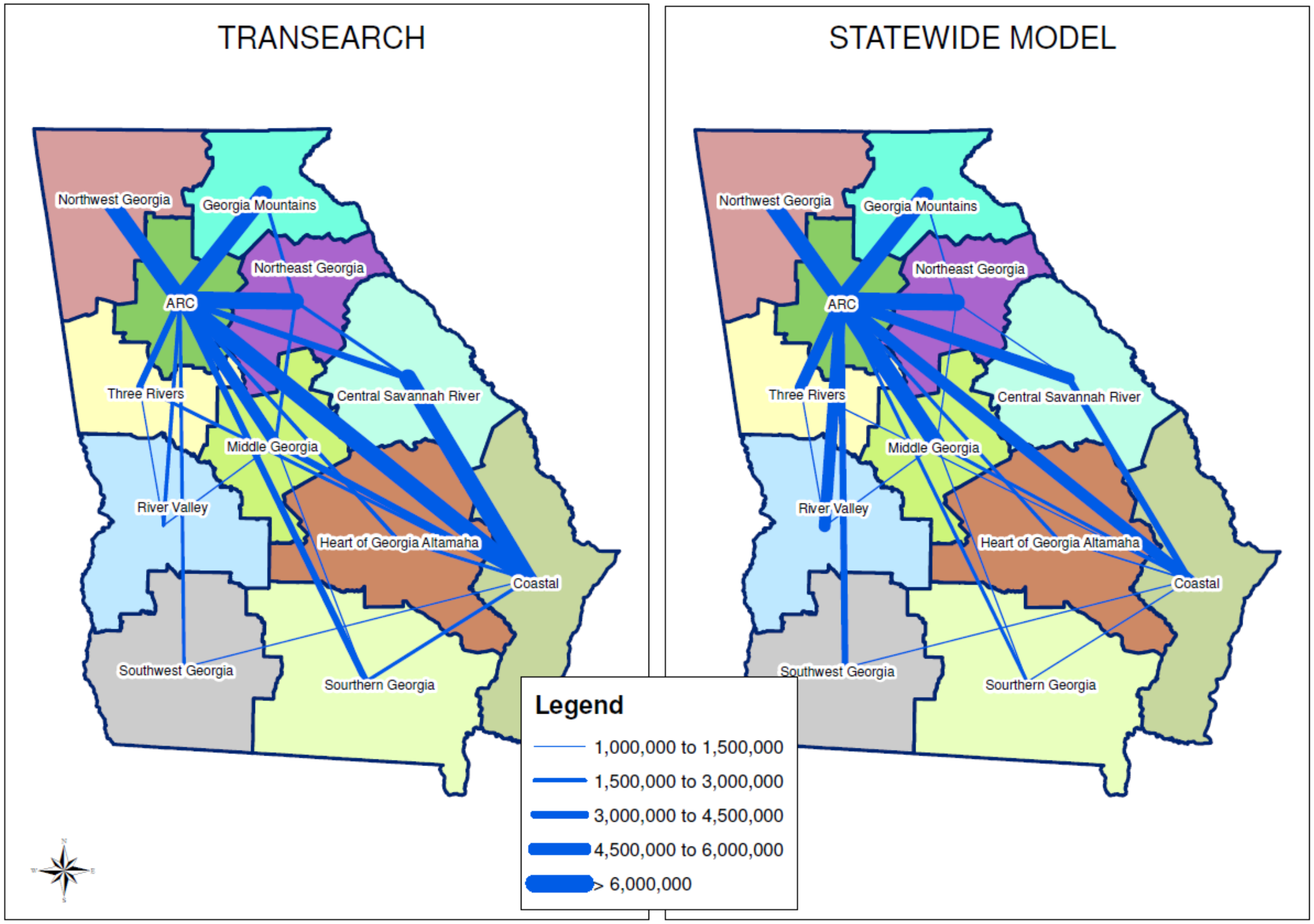
Source: Georgia Statewide Travel Demand Model

Table 4-16: District to District Freight District Flow in Annual Tonnage – Transearch Data (In Thousands)

	NW GA	GA Mountains	ARC	Three Rivers	NE GA	Mid GA	Ctr. Savh River	River Valley	Heart of GA	SW GA	S GA	Coastal	Total
NW GA	3,669	755	16,995	344	233	352	206	306	115	191	287	307	23,758
GA Mountains	257	4,343	8,257	205	1,443	924	274	196	121	281	346	198	16,843
ARC	3,239	2,242	56,728	2,619	3,187	4,682	3,061	2,485	1,532	1,263	2,087	2,666	85,789
Tree Rivers	323	116	4,347	732	164	703	59	1,293	622	143	222	196	8,920
NE GA	369	1,773	6,704	307	3,390	2,454	1,914	291	328	275	485	392	18,682
Mid GA	308	145	2,782	283	303	1,610	375	626	454	324	1,302	3,855	12,366
Ctr. Savh River	320	132	1,996	174	259	884	4,144	259	698	206	304	6,196	15,574
River Valley	340	100	1,929	937	144	1,106	132	1,759	198	793	489	711	8,639
Heart of GA	173	113	1,721	144	136	275	251	143	816	139	488	1,662	6,062
SW GA	261	150	2,325	213	194	372	250	446	131	1,824	734	1,212	8,112
S GA	326	218	3,840	261	280	377	156	263	236	337	1,339	462	8,095
Coastal	746	312	8,348	2,362	409	685	1,041	693	1,219	328	1,557	10,183	27,884
Total	10,332	10,400	115,971	8,581	10,141	14,425	11,862	8,758	6,470	6,102	9,641	28,040	240,724

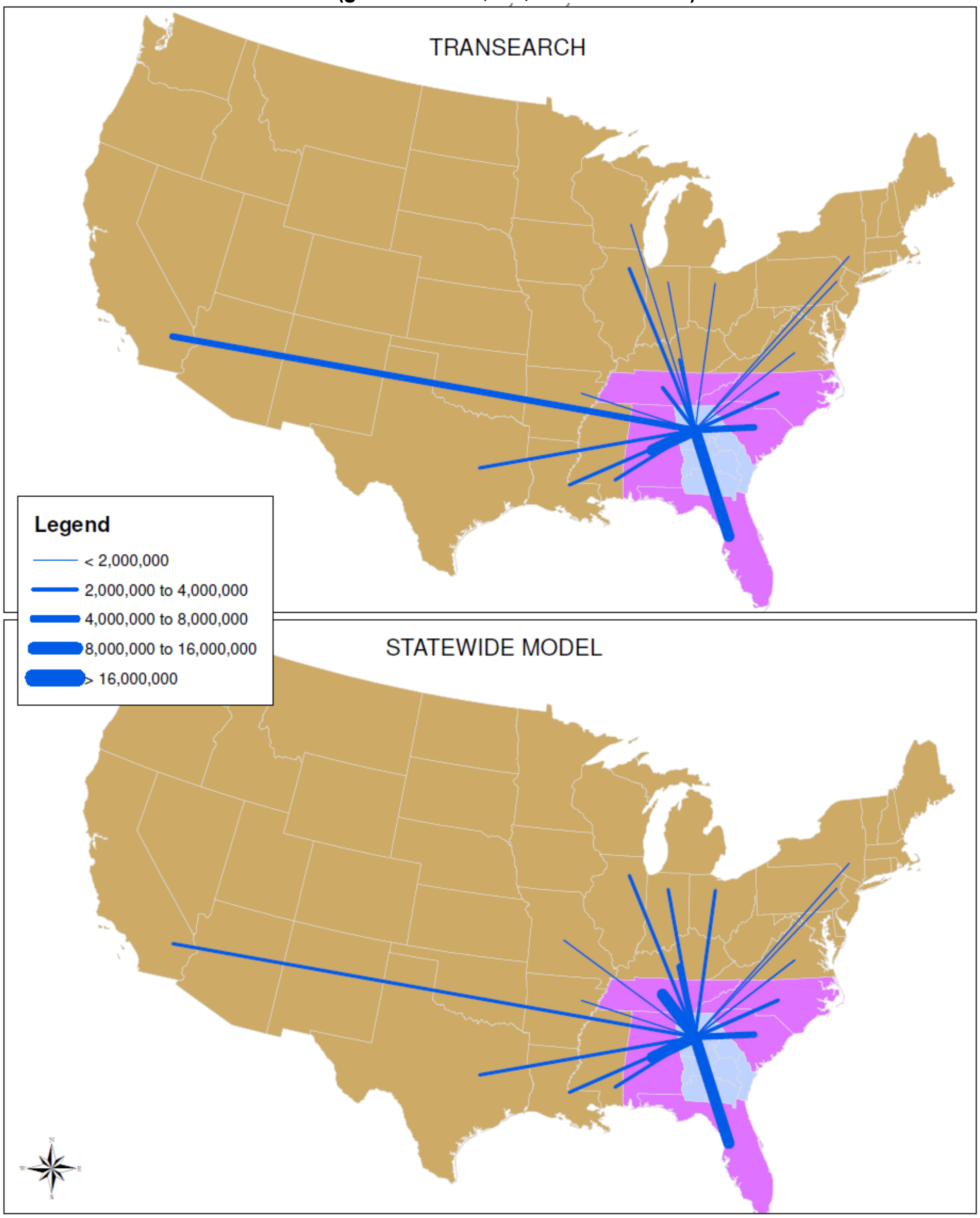
Source: Transearch 2007

Figure 4-4: Freight Commodity District to District Flows in Annual Tonnage Greater than 1,000,000 Tons (within Georgia)



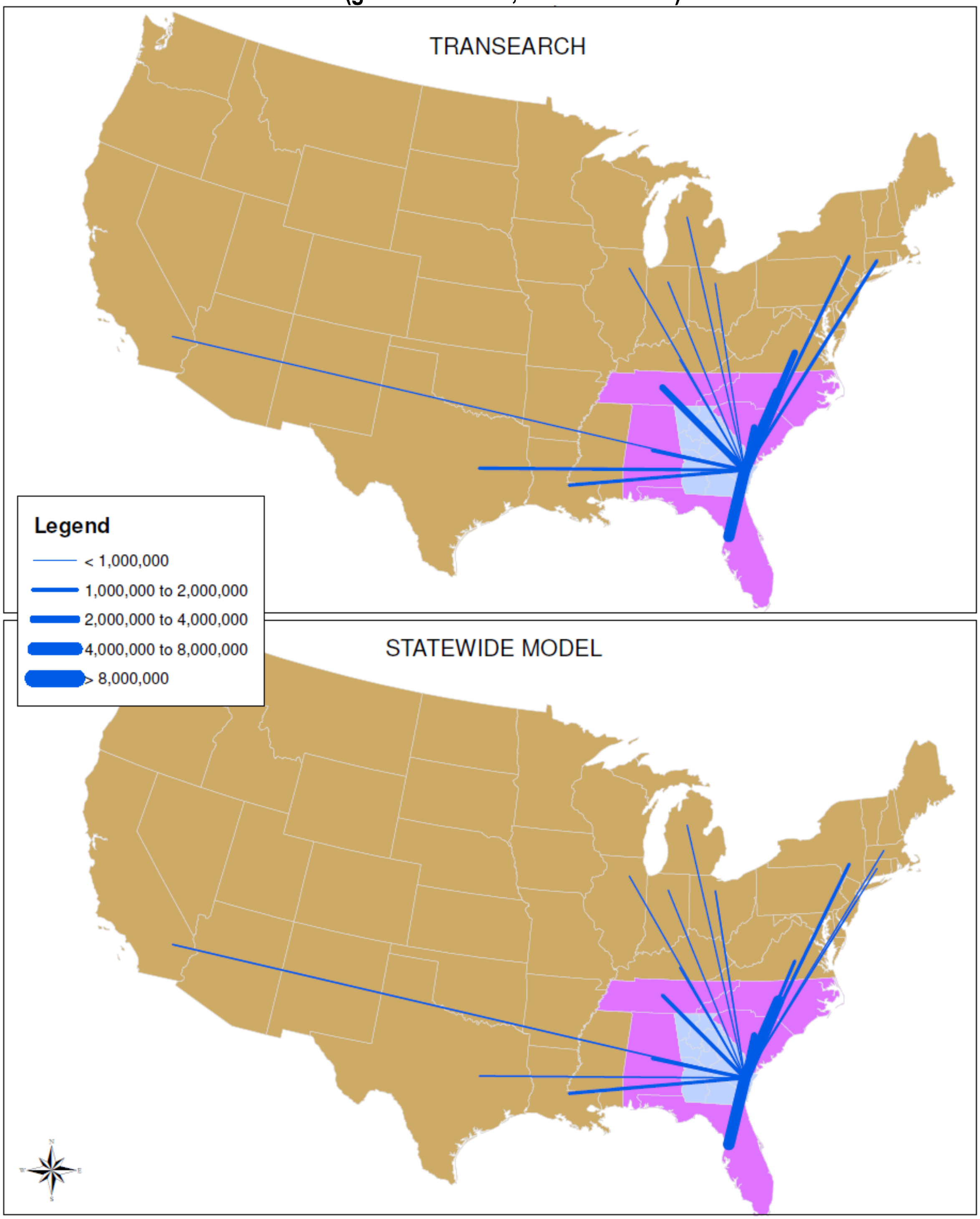
Source: Georgia Statewide Travel Demand Model, Transearch 2007

Figure 4-5: Freight Commodity Flows between Atlanta and Rest of US
(greater than 1,000,000 annual tons)



Source: Georgia Statewide Travel Demand Model, Transearch 2007

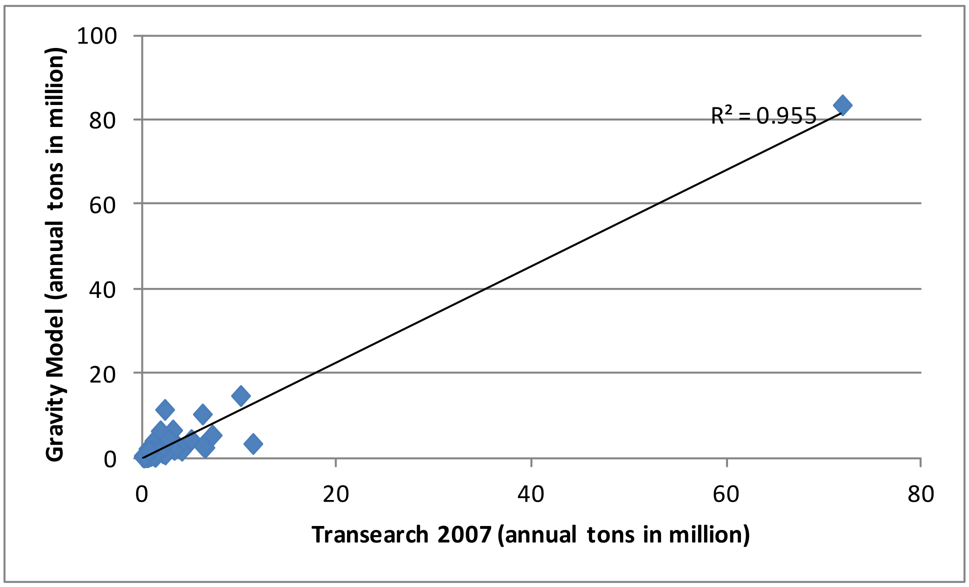
Figure 4-6: Freight Commodity Flows between Savannah and Rest of US (greater than 500,000 annual tons)



Source: Georgia Statewide Travel Demand Model, Transearch 2007

Figure 4-7 shows the scatter plot using the individual flow from the gravity model and Transearch data between each O-D pair as listed in **Table 4-15** and **Table 4-16**. The R squared is 0.95, meaning the model's flows have a good correlation with district to district flows in the Transearch data. The gravity model replicates the existing commodity flow patterns in a reasonable manner.

Figure 4-7: Freight District to District Flow Scatter Plot



Source: Georgia Statewide Travel Demand Model

The Federal Highway Administration (FHWA) Freight Analysis Framework (FAF) is a database that provides a comprehensive national picture of freight flows and trends, and a baseline forecast to support policy studies. The data provides annual tonnage commodity flows between the states and major metropolitan areas. However, the data does not provide detailed commodity flow information at regional and local levels. **Figure 4-8** shows the current available geographical regions in the FAF database for the state of Georgia. The three regions available with data in Georgia are Atlanta, Savannah, and the rest Georgia. Because the Atlanta region and Savannah area account for the majority of the commodity flows activities in Georgia, a comparison for the flows can be also be meaningful. In addition, the 2007 Transearch data is also aggregated at the FAF geographic level as another supplementary comparison. **Table 4-17** shows the district to district commodity flow comparison based on the FAF geographic regions using the outputs from gravity model, the FAF data, as well as the Transearch data. **Table 4-18** shows the percent difference between the comparisons. As the tables show, the differences exist when the comparison was made between different data sources. This is due to the variation of the methods and assumptions applied in estimating the true commodity flows. Unlike the household survey where a person's travel between origin and destination is definitive, commodity flows are highly influenced by the logistics used during the transport process as well as the level of data aggregation required. It is not unexpected to see the difference between the data sources. The model outputs generally fall within a reasonable approximation to the commodity flow pattern.

Figure 4-8: FHWA Freight Analysis Framework

Source: Georgia Statewide Travel Demand Model

Table 4-17: Commodity Flows between the FAF districts (in thousands)

4.2.1.7 Model	4.2.1.8 Atlanta	4.2.1.9 Savannah	4.2.1.10 Rest	4.2.1.11 Non-
Atlanta	82,469	1,670	21,683	60,712
Savannah	1,705	3,796	3,003	18,758
Rest of GA	50,948	4,766	53,833	63,570
Non-GA	112,477	12,975	57,183	281,791
FAF 2010				
Atlanta	186,774	3,274	18,984	55,526
Savannah	5,010	19,137	4,328	16,737
Rest of GA	12,604	4,410	38,828	49,772
Non-GA	82,056	21,969	96,954	-
Transearch 2007				
Atlanta	96,950	2,505	27,086	46,980
Savannah	10,611	8,082	6,661	28,822
Rest of GA	32,614	12,108	44,108	66,899
Non-GA	91,356	15,204	76,048	249,369

Source: FAF 2010 Provisional Dataset, Transearch 2007, Global Insight

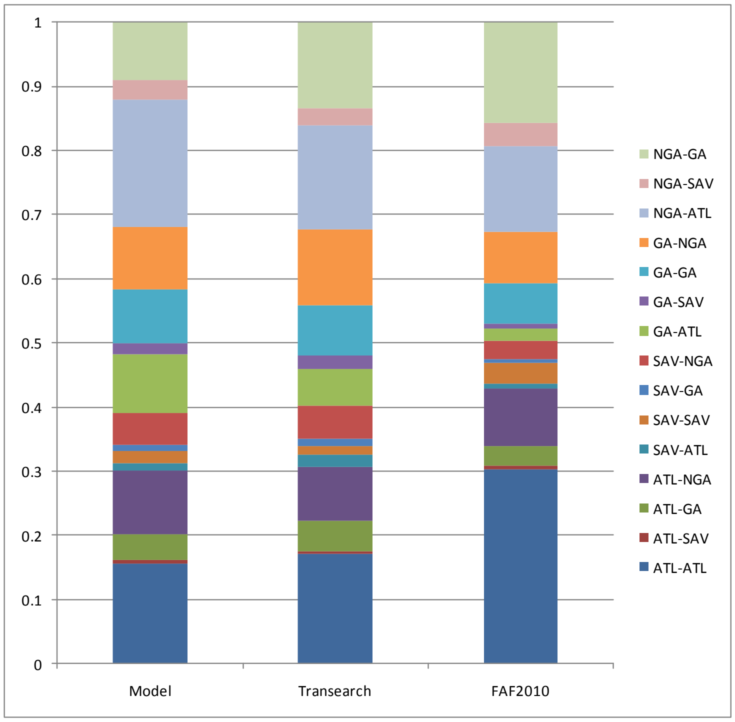
Table 4-18: Percent Differences in Commodity Flows between the FAF districts

Percent Difference between Gravity Model & FAF Data				
	Atlanta	Savannah	Rest of GA	Non-GA
Atlanta	(56)%	(49)%	14%	9%
Savannah	(66)%	(80)%	(31)%	12%
Rest of GA	304%	8%	39%	28%
Non-GA	37%	(41)%	(41)%	-
Percent Difference between Gravity Model & Transearch Data				
Atlanta	(15)%	(33)%	(20)%	29%
Savannah	(84)%	(53)%	(55)%	(35)%
Rest of GA	56%	(61)%	22%	(5)%
Non-GA	23%	(15)%	(25)%	-

Source: FAF 2010 Provisional Dataset, Transearch 2007, Global Insight

Table 4-19 graphically shows the share of each commodity by FAF district. This table shows that the model is replicating the commodity flows from Transearch and FAF in the same order-of–magnitude. Most of the shares are approximately the same size as indicated by the color blocks with the exception of the Atlanta-Atlanta FAF movements. Again this is a function of how the data is collected and summarized.

Table 4-19: Percent Differences in Commodity Flows between the FAF districts by Commodity



Source: FAF 2010 Provisional Dataset, Transearch 2007, Global Insight

4.3 Mode Choice

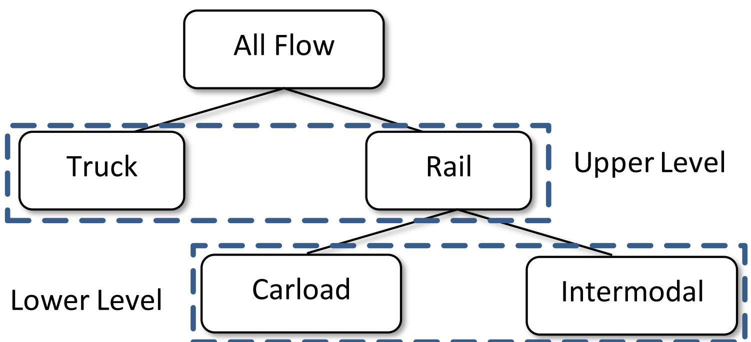
The mode choice model allocates the total commodity flow estimated from the gravity model into different shipping modes according to the availability, costs, and convenience of the different modes. A mode choice model was developed for the freight model using the Transearch data. It was developed based on a cost-based incremental logit model. This model uses the existing mode shares between each O-D pair as a pivot point upon which future forecasts of mode shares are estimated by taking into account the changes in the travel costs between base year and future year as a result of the change in the transportation system and socioeconomic activities. To implement this method, observed base year mode shares for each commodity were developed from the Transearch data. There are a total of five modes available for the commodity flows in the Transearch data as listed below.

- Truck
- Carload
- Intermodal
- Air
- Water

However, not all of these modes are included in the freight model. Because over 97% of the commodities are shipped either by highway or by rail, the mode choice model only focuses on these two modes. The ability to measure the shift of freight traffic between truck and rail is addressed by the freight model. Freight traffic by truck is referring to travel by heavy-duty trucks which usually consist of double-trailers. Freight traffic by heavy duty trucks accounts for 95% of total commodity flows while freight traffic by railroads account for 22%. Intermodal traffic represents the combined shipping arrangement between highway and rail. This mode is usually associated with intermodal facilities such as rail yards and ocean ports. The intermodal commodity flow accounts for about 2% of all flows and was included in the mode choice model. Additional data such as major transfers and annual tonnage of commodity handled at each logistic transfer will be required to improve this mode in the model. Due to the minimal amount of commodity flows shipped by other modes, it was assumed that the commodity mode share for Air and Water will be kept constant over time.

A nested logit model structure is used for the mode choice model. The nest structure is shown in **Figure 4-9** below. All commodity flows estimated from the gravity model will first be allocated into either truck or rail mode. As intermodal commodity flow is predominated by the rail leg of the trip and heavily relies on the intermodal rail facility, it is nested below rail mode. The two-level model structure completes the entire mode choice model.

Figure 4-9: Nested Logit Model



The mode choice model was calibrated and validated by each of the commodity groups and by distance ranges, because preference for modes shifts as distance increases. For example, commodity shipping can capitalized on the economy of scale provided by the railroad only when shipping distance is longer than 500 miles. In addition, the type of commodity also determines the preferred shipping mode. For short haul commodity flow, trucking provides a better alternative, particular for perishable and time sensitive commodities. The calibration was performed by comparing the mode share of the observed data with the model outputs at the following six distance ranges.

- Less than 50 miles
- 50-100 miles
- 100-200 miles
- 200-300 miles
- 300-500 miles
- Greater than 500 miles

To calibrate the incremental logit model by the distance ranges, a set of six scale factors corresponding to each distance range was developed for each of the commodity groups. The scale factors define the level of sensitivity in mode share responding to the change in the travel costs. They were adjusted during the model calibration to produce mode shares that reasonably match the observed mode shares from the Transearch data. Some commodities are predominantly shipped by only one mode due to certain transportation restrictions. For example, the waste or hazard material group is 100% carried by rail. For these special commodities, no mode choices were applied. They are 100% allocated to a particular mode. The scale factors were applied in two levels as the structure of logit model shows. Two sets of the scale factors were calibrated for this purpose to capture the different sensitivities in allocating the commodity shares. **Table 4-20** and **Table 4-21** show the scale factors used in upper level and lower level of the logit model. Refer to **Table 4-1** for an explanation of the commodity group abbreviations.

Table 4-20: Upper Level Scale Factors

Distance	Agri	Ming	Food	Text	Wood	Papr	Chem	Petr	Rubb	Ston	Pmtl	Fmtl	Mach	Inst	Wast	Fmsc
<50 miles	0.160	0.150	0.130	0.160	0.080	0.100	0.036	0.160	0.160	0.160	0.120	0.160	0.120	0.160	0.001	0.200
50-100 miles	0.084	0.086	0.145	0.160	0.066	0.055	0.016	0.160	0.160	0.110	0.160	0.160	0.085	0.160	0.001	0.162
100-200 miles	0.056	0.030	0.060	0.160	0.066	0.035	0.026	0.160	0.056	0.008	0.060	0.125	0.066	0.120	0.001	0.078
200-300 miles	0.052	0.015	0.060	0.160	0.086	0.006	0.036	0.088	0.200	0.045	0.050	0.180	0.090	0.180	0.001	0.060
300-500 miles	0.042	0.001	0.050	0.160	0.076	0.001	0.022	0.085	0.200	0.040	0.050	0.180	0.030	0.180	0.001	0.070
>500 miles	0.028	0.001	0.080	0.160	0.100	0.025	0.082	0.012	0.300	0.023	0.062	0.300	0.080	0.300	0.001	0.060

Source: Georgia Statewide Travel Demand Model

Table 4-21: Lower Level Scale Factors

Distance	Agri	Ming	Food	Text	Wood	Papr	Chem	Petr	Rubb	Ston	Pmtl	Fmtl	Mach	Inst	Wast	Fmsc
<50 miles	0.160	0.150	0.130	0.160	0.080	0.100	0.060	0.161	0.160	0.200	0.160	0.160	0.130	0.160	0.300	0.200
50-100 miles	0.084	0.086	0.150	0.160	0.300	0.100	0.120	0.161	0.160	0.200	0.170	0.160	0.110	0.160	0.300	0.162
100-200 miles	0.056	0.030	0.060	0.160	0.300	0.035	0.058	0.300	0.056	0.300	0.300	0.125	0.066	0.120	0.050	0.078
200-300 miles	0.052	0.015	0.300	0.160	0.300	0.100	0.080	0.300	0.200	0.300	0.300	0.180	0.300	0.180	0.080	0.060
300-500 miles	0.042	0.001	0.080	0.160	0.060	0.100	0.060	0.300	0.200	0.300	0.300	0.180	0.032	0.180	0.120	0.070
>500 miles	0.028	0.001	0.180	0.160	0.220	0.160	0.160	0.300	0.300	0.300	0.300	0.300	0.120	0.300	0.160	0.060

Source: Georgia Statewide Travel Demand Model

The calibration results by the distance ranges are shown in **Table 4-22**. The model estimated mode shares are in a close approximation to the mode shares from the Transearch data. Detailed calibration results by each commodity are shown in the series of tables in the Appendix C.

Table 4-22: Mode Share Validation

	Transearch Mode Share		Model Mode Share	
Distance	**Truck**	**Rail**	**Truck**	**Rail**
<50 miles	19%	0%	15%	1%
50-100 miles	8%	1%	10%	2%
100-200 miles	11%	8%	11%	10%
200-300 miles	9%	6%	7%	6%
300-500 miles	11%	28%	12%	20%

	Transearch Mode Share		Model Mode Share	
Distance	**Truck**	**Rail**	**Truck**	**Rail**
>500 miles	43%	57%	44%	62%
Total	**100%**	**100%**	**100%**	**100%**

Source: Georgia Statewide Travel Demand Model and Transearch 2007

Up to this point, the commodity flows estimated are in the unit of annual tons. The annual tonnage flows have to be converted into average daily commodity flows. For truck mode, this requires converting the daily commodity flow into average daily number of trucks. The trucks are assigned onto the highway network and then the resulting volumes can be validated against the actual ground traffic counts. The 2002 Vehicle Inventory & Use Survey (VIUS), the latest survey available, was used to develop the conversion factors or payload factors (average commodity tonnage carried per truck) that translate the tonnage flow into the number of trucks required. This survey includes the type of truck required for different commodities and for different ranges of distance traveled. It also takes the partially loaded and empty trucks into consideration, reflecting average tonnage load per truck typically on the highway. Because the truck loadings are highly influenced by the length of the trips, the analysis was carried out by distance. The payload factors were therefore developed for the following five distance ranges as well as by the different types of commodity

- Less than 50 miles
- 50-100 miles
- 100-200 miles
- 200-500 miles
- Greater than 500 miles

Table 4-23 shows the resulting payload factor for each of the five distance ranges and by the commodity groups. These numbers represent the average amount of tonnage that each truck usually carries on the highways. In general, they are larger for high density durable commodities and smaller for large volume and perishable commodities. As the distance increases, the payload factors also increase as the economy of scale become significant. In estimating the daily trucks, it is assumed that there are 6 working days a week in a year. Deducting the 7 national holidays, there are 306 working days per year. Together with the payload factors, the actual working days translate the average annual O-D truck tonnage flows into average daily trucks O-D trips. The annual tonnage for rail is not converted into daily traffic due to the lack of information regarding average carloads and actual schedule of rail freight movement.

Table 4-23: Payload Factor (Commodity Tonnage per Truck)

Commodity Group	Distance Ranges (miles)				
	<50	**50-100**	**100-200**	**200-500**	**>500**
Agriculture	9	10	14	17	19
Mining	10	15	18	19	19
Food	7	10	14	16	19
Textile	11	11	13	15	22
Wood	9	14	15	15	15

Commodity Group	Distance Ranges (miles)				
	<50	50-100	100-200	200-500	>500
Paper	8	10	15	19	20
Chemical	11	11	14	17	15
Petroleum	10	14	16	22	22
Rubber & plastics	8	10	12	17	17
Stone	12	16	17	17	18
Primary metal	4	10	13	16	18
Fabricated metal	3	3	7	11	14
Machinery	6	9	12	15	18
Instruments	5	6	7	13	19
Wastes	8	10	14	17	17
Miscellaneous freight	7	11	15	17	17

Source: 2002 Vehicle Inventory & Use Survey (VIUS)

4.4 Assignment

The daily truck assignment is performed using the average daily truck tables estimated from the mode choice step above. The assigned highway volumes were compared with the ground truck counts. Additionally, trip tables were also developed from the Transearch data and assigned onto the highway network. This helps to compare the model assignment results against those from Transearch trip assignment. **Table 4-24** summaries the comparison between assignment results from the freight model and the Transearch data. The comparison was made by measuring Vehicle Miles Traveled (VMT). The total difference in the VMT is about 4%, indicating a close match to the Transearch flow data.

Table 4-24: Truck VMT by Functional Class (in thousands)

Facility	Transearch	Model	% Diff
Freeways & Interstates	10,435	10,519	1%
Principal Arterials	2,232	2,487	11%
Minor Arterials	1,048	1,111	6%
Collectors	155	182	17%
Total	13,870	14,299	3%

Source: Georgia Statewide Travel Demand Model and Transearch 2007

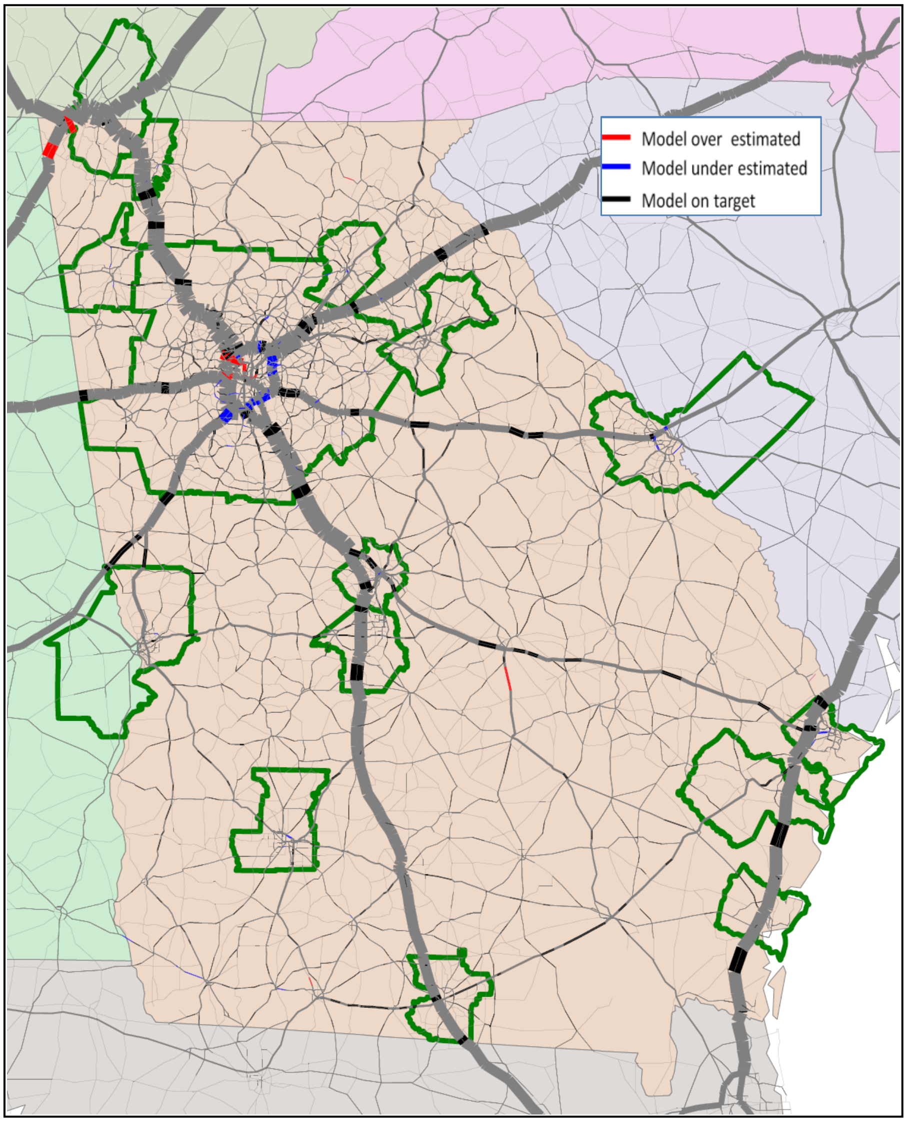
The comparison between model volumes and traffic counts was made for the interstate highway system as well as for major arterials since these are the key facilities for freight traffic. The available truck counts on these facilities especially on the interstate highway are considered more reliable than those off the interstate system. The freight model is designed to forecast major intercity and inter-regional freight flow movements. The truck counts on the lower level of highway facilities and on highways within urbanized areas include not only the freight trucks but also smaller delivery and commercial trucks which are not a part of the freight model. These trucks provide short distance services within urbanized area and are included in the passenger model. Therefore, only counts on major arterial and interstate system were considered. In addition, only count stations with available GDOT truck estimates were included. The percent Root Mean Square Error (RMSE) by volume group is shown in the **Table 4-25** below. The percent RMSEs are smaller on higher volume facilities. Traffic counts on higher volume facilities are usually less volatile than those on low volume facilities. Smaller errors on the high volume facilities indicate that the model forecasts volumes on critical corridors with better accuracy. The table also shows that all truck counts on major arterials are below 5,000 daily volume thresholds. This is expected because freight trucks are commonly restricted on certain non-interstate facilities. Thus, the majority of them are on the interest system. Therefore, the truck counts on the major arterials are relatively less reliable than those on the interstates. This raises overall the percent RMSE. **Figure 4-10** shows the truck flows from the traffic assignment. The modeled freight volumes along the interstate system are all within the maximum desired deviation except for sections within major urbanized areas. The maximum desired deviation defines a volume range based on the magnitude of the ground traffic counts. The variation of the assigned volumes within the range is reasonably acceptable. The exceptions are locations within the urban areas such as Atlanta. This is due to the less detailed highway network and aggregated zone system in the model. The freight model is mainly designed to provide forecasts for intercity and inter-regional travel. Thus, the volume inaccuracies within specific urban areas do not have a significant impact on overall model results.

Table 4-25: Truck VMT %RMSE by Volume Group

		Number of Traffic Counts (Rural)		
Volume Group	**%RMSE**	**Interstate**	**Major Arterial**	**Total**
<5,000	57%	12	221	233
5,000-10,000	14%	12	0	12
>10,000	19%	14	0	14
All Counts	25%	38	221	259

Source: Georgia Statewide Travel Demand Model and GDOT Truck Counts

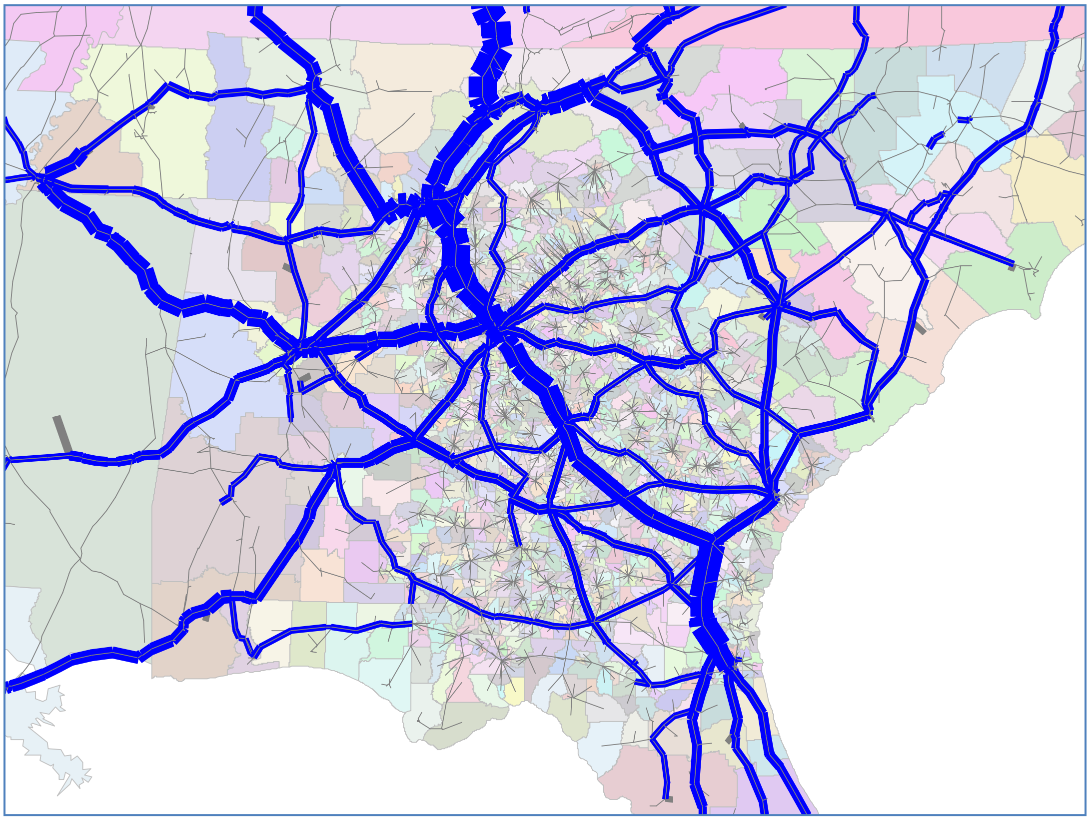
Figure 4-10: Truck Traffic Assignment



Source: Georgia Statewide Travel Demand Model

The annual tonnage flows for rail were also assigned onto the rail network. However, no attempt was made to convert the annual tonnage into daily carload loads due to the lack of data regarding rail routing logistics. The rail flows were assigned onto the Class I railways identified in the region. Like the highway network, centroid connectors were drawn between the zone centroids and the rail network to facilitate the commodity flow loading. The centroid connectors were drawn based on the shortest distance. **Figure 4-11** shows the annual rail tonnage flow assignment. The purpose of this assignment is to provide a general image of the major likely commodity flow corridors. It does not reflect the true routing decision for the commodity flows due to the unknown logistic arrangement of the rail freight companies.

Figure 4-11: Rail Traffic Assignment



Source: Georgia Statewide Travel Demand Model

4.5 Freight Model Sensitivity Tests

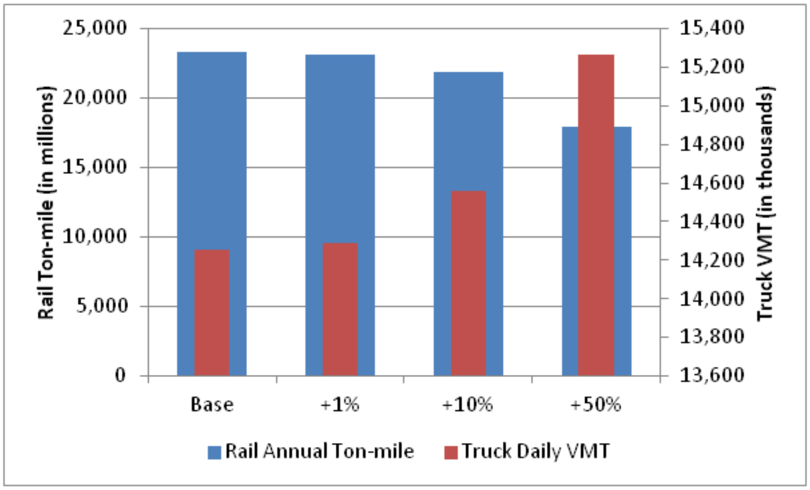
The freight model is primarily designed to focus on the rail and truck freight traffic. The ability to test the model's sensitivity to general policy is preferred. Such analysis can include how much shift of traffic between rail and highway can occur due to an increase or decrease in the costs for different transportation modes. Therefore, sensitivity tests were performed as a part of model validation to evaluate the model's response to external changes such as shipping costs. By using the travel cost skim as a proxy to the cost of shipping, one can evaluate the changes in the highway and rail commodity flows and the interaction between the two modes. The following tests were performed for both highway and rail modes. While the shipping cost for one mode changes, the cost the other mode was kept constant.

- 1% reduction shipping costs
- 10 % reduction in shipping costs
- 50 % reduction in shipping costs
- 1% increase in shipping costs

- 10 % increase in shipping costs
- 50 % increase in shipping costs

Figure 4-12 shows the changes in rail ton-miles as a result of the 1%, 10%, 50% increase in rail shipping costs. The figure shows that as the costs of rail shipping increase, rail freight shifts to trucks. **Table 4-26** shows the change in rail and truck freight traffic due to the increase in rail costs. For example, 1% increase in rail shipping cost leads to 0.7% decrease in rail freight traffic and 0.3% increase in freight truck traffic. **Figure 4-13** and **Table 4-27** show the analysis results for the reduction in rail shipping costs.

Figure 4-12: Shift of Commodity Flows Due to Increase in Rail Shipping Costs



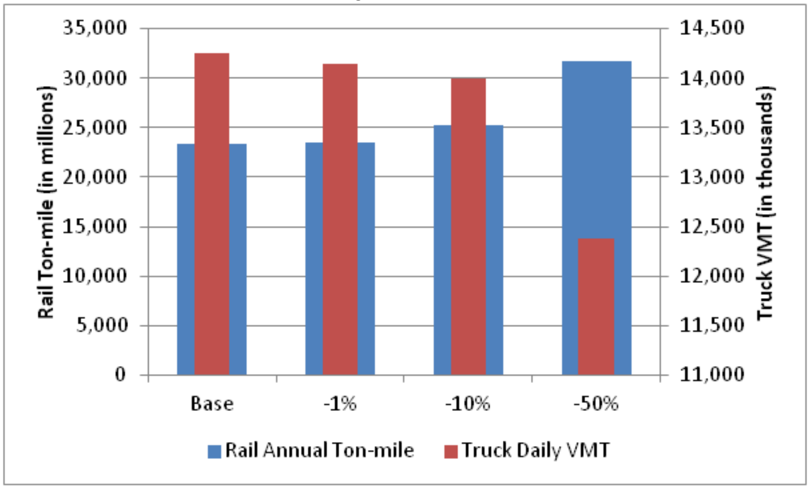
Source: Georgia Statewide Travel Demand Model

Table 4-26: Change of Commodity Flows Due to Increase in Rail Shipping Costs

Change in Rail Shipping Costs	1%	10%	50%
% Change in Rail Ton-mile	(0.7%)	(6.4%)	(23.0%)
% Change in Truck VMT	0.3%	2.1%	7.1%

Source: Georgia Statewide Travel Demand Model

Figure 4-13: Shift of Commodity Flows Due to Reduction in Rail Costs



Source: Georgia Statewide Travel Demand Model

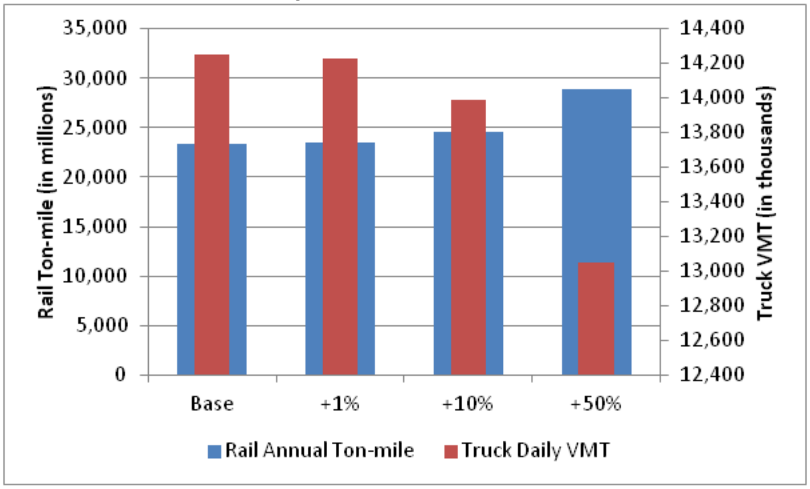
Table 4-27: Change of Commodity Flows Due to Reduction in Rail Costs

Change in Rail Shipping Costs	-1%	-10%	-50%
% Change in Rail Ton-mile	0.5%	7.9%	35.9%
% Change in Truck VMT	(0.7%)	(1.8%)	(13.1%)

Source: Georgia Statewide Travel Demand Model

Likewise, similar tests were performed on changes in truck shipping costs while keeping rail shipping costs constant. **Figure 4-14** and **Table 4-28** show that increased truck shipping costs lead to reduced truck freight and increased rail freight. For instance, 1% increase in truck shipping cost leads to 0.2% reduction in truck freight and 0.5% increase in rail freight. **Figure 4-15** and **Table 4-29** show the result for the reduction in truck shipping cost. It is noticed that the rail freight flows show more sensitivity to the change in transportation costs. The changes in rail shipping costs have a significant impact on rail freight traffic more than on the truck freight traffic. Rail freight is also more sensitive to changes in truck shipping costs than truck freight. This is due to the fact that over 85% of the commodity flows rely on freight trucks (Transearch 2007). It is expected that equivalent shift of freight traffic will result in large change in rail freight than in truck freight.

Figure 4-14: Shift of Commodity Flows Due to Increase in Truck Shipping Costs



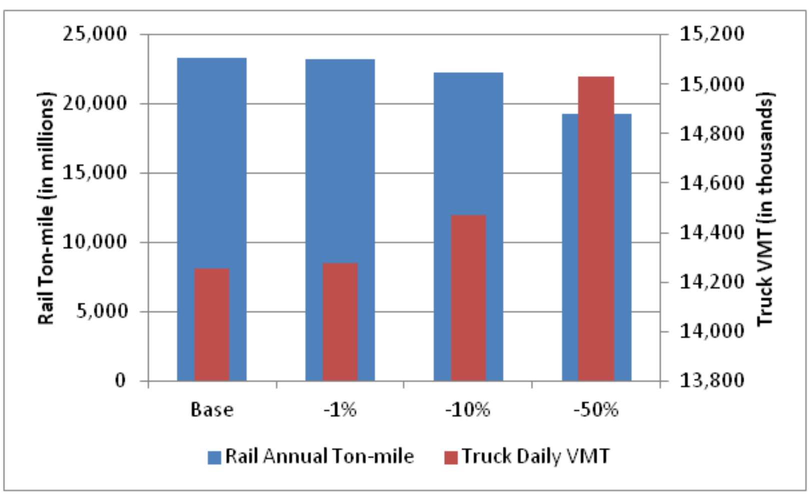
Source: Georgia Statewide Travel Demand Model

Table 4-28: Change of Commodity Flows Due to Increase in Truck Shipping Costs

Change in Truck Shipping Costs	1%	10%	50%
% Change in Rail Ton-mile	0.5%	5.3%	24.0%
% Change in Truck VMT	(0.2%)	(1.9%)	(8.4%)

Source: Georgia Statewide Travel Demand Model

Figure 4-15: Shift of Commodity Flows Due to Reduction in Truck Shipping Costs



Source: Georgia Statewide Travel Demand Model

Table 4-29: Change of Commodity Flows Due to Reduction in Truck Shipping Costs

Change in Truck Shipping Costs	-1%	-10%	-50%
% Change in Rail Ton-mile	(0.5%)	(4.5%)	(17.5%)
% Change in Truck VMT	0.2%	1.5%	5.4%

Source: Georgia Statewide Travel Demand Model

The sensitivity analysis can be summarized by the measure of cost elasticity which shows the percent change in the commodity flows for every percent change in shipping costs. **Table 4-30** shows the own cost elasticity for both rail and truck commodity flows compared with the survey elasticity conducted by US Army Corps of Engineers. The sensitivity tests show that the freight model reasonably responds to the change in transportation costs compared with the range of reported data.

Table 4-30: Commodity Flow Own Cost Elasticity Comparison

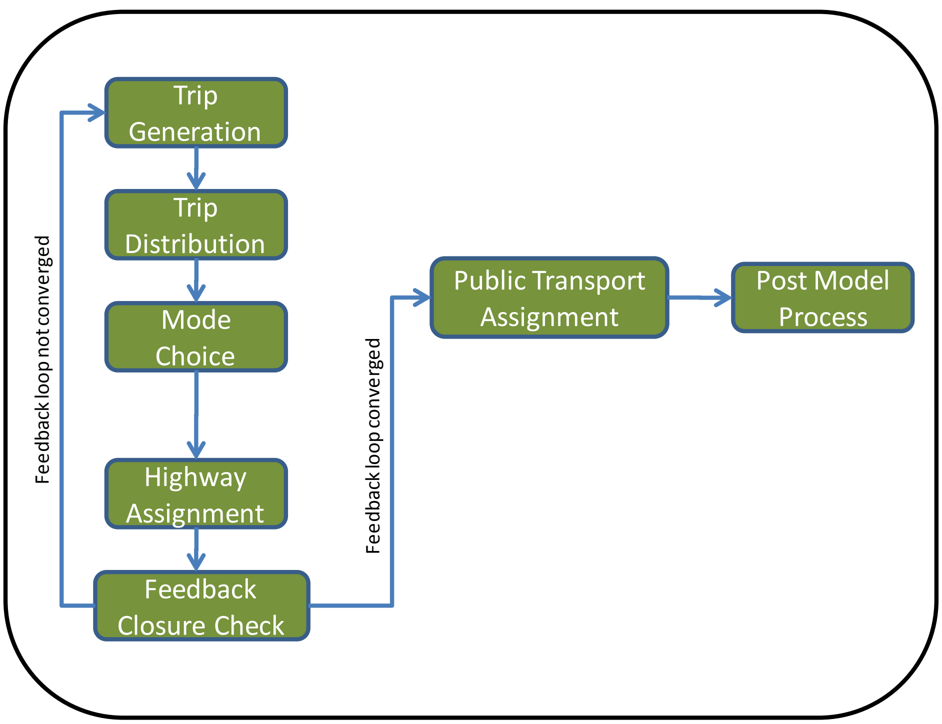
Mode	Freight Model	Range Surveyed	Most Likely Range
Rail	-0.79 to -0.46	-1.52 to -0.60	-1.20 to -0.40
Truck	-0.19 to -0.11	-1.34 to -0.05	-1.10 to -0.70

Source: A Survey of The Freight Transportation Demand Literature and a Comparison of Elasticity Estimates, The Navigation Economic Technologies Program, US Army Corps of Engineers, January, 2005

5.0 PASSENGER MODEL

The passenger model is another integrated part of the Statewide Model. The modeling process is based on the current GDOT MPO modeling procedures but with more emphasis on statewide scale and application. The passenger model includes both auto passenger and commercial vehicle travel. It is independent from the freight model in the trip generation, distribution and mode choice phases. The two models merge at the traffic assignment phase in which both auto passenger/commercial vehicles and freight trucks are loaded on the network at the same time. The purpose of this combined assignment is to account for congestion caused by both trucks and passenger cars/commercial vehicles. The passenger model also follows the traditional four-step model process with the trip generation, trip distribution, mode choice, and traffic assignment model components. In addition, a feedback loop is incorporated in the model which circles from trip generation to highway assignment. The feedback loop takes the loaded network from the assignment and incorporates it as new highway input network that reflect the congestion buildup in the highways. This process cycles through the passenger model until the highway link volumes from the new round of the assignment are not significantly different from the link volumes from previous assignment. This signals that the congestion in the network has reached a steady state of equilibrium and the model is ready to produce reliable results. **Figure 5-1** shows the passenger model flow chart.

Figure 5-1: Passenger Model Flow Chart



Source: Georgia Statewide Travel Demand Model

The passenger model was developed based on the 2009 National Household Travel Survey (NHTS), Georgia add-on data. This data includes the travel patterns for the households across the Georgia. It includes the household location, the work place location, the model of transportation and travel time etc. It represents a total of 7,000 households with around 50,000 reported trips.

5.1 Trip generation

Trip generation translates the zonal socioeconomic activities into personal trips to and from the zone using predetermined trip rates. It includes two trip end components, production and attraction. The trip rates were developed from the NHTS Georgia add-on data. Unlike the MPO models that simulate the majority of the short distance intra-urban travel, long distance travel is an important aspect of travel that the Statewide Model needs to address. Therefore, the NHTS data was analyzed by trip length as well as by different market segments. Trips were divided into two categories, short and long based on their trip length. The short trips represent trips with total travel time less than 75 minutes which represents travel mostly within urbanized areas. The long distance trips have a travel time at least 75 minutes and longer representing primarily inter-regional travel. This travel time reflects the average time required under free-flow condition. The trips were also divided by the geographic ranges that define the internal and external travel. The internal travel represents trips that have both trip ends located within the state of Georgia, while the external trips have at least one leg of the trip located outside the state.

The market segments analyzed include home-based work (HBW), home-based other (HBO), non-home-based (NHB), as well as commercial trucks. Because the freight model already estimates long distance truck travel, the trucks included in the passenger model are commercial trucks representing trips with a travel time less than 75 minutes or the urban area trips.

The detailed definition for trip market segments used in the model is detailed as follows.

- **Home Based Work (HBW)**: All travel made for the purpose of work and which begins or ends at the traveler's home.
- **Home Based Other (HBO):** Any non-work trip made with one trip end at the home**.**
  Non Home Based (NHB): Any trip that neither begins nor ends at home.
- **Commercial Truck:** Internal trips made by commercial vehicles.

There are many cross-border urban areas in Georgia which include Columbus to the west, Chattanooga to the north, Augusta and Savannah to the east, and Valdosta to the south. All these urban areas attract substantial amount of cross-border trips or internal-external (IE) trips. These trips were analyzed with the market segments described. However, for long distance IE trips, trips that go far beyond the adjacent border, only one general market segment was created due to the lack of quality data. **Table 5-1** shows the organization of the trips by market segment and by type of geographic ranges. For external pass-through trips with both trip ends outside the state of Georgia, an aggregated total passenger vehicle trip table was developed separately using the matrix estimation method as well as external zonal socioeconomic data.

Table 5-1: Trip Purpose by Distance by Model

	Geographic Range	HBW	HBO	NHB	Truck
Short Distance (Urban Trips)	II	PS	PS	PS	PS
	IE	PS	PS	PS	PS
Long Distance (Intercity Trips)	II	PS	PS	PS	FT
	IE	PS (aggregated)			FT
Through Trips	EE	ME			FT

PS: Passenger model trip generation; FT: Freight model trip generation; ME: Matrix Estimation
Source: Georgia Statewide Travel Demand Model

5.1.1 Trip Production

Trip production is directly related to the households where trips originate. Thus, the trip rates for production are household based. The procedure for computing trip productions uses cross-classified data from the household stratification model which is used as a standard modeling process to calculate HBW, HBO, and NHB production trip rates. The household stratification model subdivides the total number of households in each TAZ by household size. However, stratifying the households using the NHTS add-on data proved to be difficult due to insufficient data points in the sample. Stratification was then adopted from the data from the 2000 Census Transportation Planning Package (CTPP) which is more representative and complete. Using the zonal average household size, the model allocates the total zonal households to each of the cross-classified cell by a predetermined probability that a household belongs to a particular household size. The probability lookup tables used in the household stratification model are shown in **Table 5-2**.

Table 5-2: Household Stratification Lookup Table

Average Persons/HH		Estimated probability by Household Size			
From	To	1	2	3	4+
0.0	1.0	1.0000	0.0000	0.0000	0.0000
1.0	1.2	0.7810	0.2060	0.0130	0.0000
1.2	1.4	0.6900	0.2570	0.0330	0.0200
1.4	1.6	0.5750	0.3130	0.0690	0.0430
1.6	1.8	0.4840	0.3510	0.1020	0.0630
1.8	2.0	0.4140	0.3540	0.1280	0.1040
2.0	2.2	0.3490	0.3560	0.1460	0.1490
2.2	2.4	0.2870	0.3470	0.1690	0.1970
2.4	2.6	0.2390	0.3270	0.1880	0.2460
2.6	2.8	0.1940	0.3140	0.1990	0.2940
2.8	3.0	0.1550	0.2950	0.2080	0.3420
3.0	3.2	0.1250	0.2750	0.2070	0.3920
3.2	3.4	0.1150	0.2490	0.2000	0.4360
3.4	3.6	0.1120	0.2120	0.1930	0.4830
3.6	3.8	0.1040	0.2040	0.1690	0.5230
3.8	4.0	0.1030	0.2030	0.1610	0.5330

Source: Georgia Statewide Travel Demand Model

Trip production rates were developed directly from the NHTS add-on data and were stratified into the urban versus rural, long versus short, internal versus external, low income versus non-low income, and different market segments. The trip production rates summarized from the NHTS data for the statewide model are shown from **Table 5-3** to **Table 5-6**.

Table 5-3: Internal-Internal Short Trip Rates

Income	Area	Persons/HH	HBW	HBO	NHB
Low	Urban	1	0.245	1.955	0.973
		2	0.658	3.523	1.667
		3	1.667	5.375	3.208
		4	1.154	7.769	5.026
	Rural	1	0.136	2.318	1.273
		2	0.891	2.609	1.804
		3	1.200	4.636	3.455
		4	1.056	6.278	4.333
Non-Low	Urban	1	0.264	2.078	1.086
		2	0.798	3.648	2.000
		3	1.399	5.057	2.889
		4	1.391	8.079	3.792
	Rural	1	0.278	1.773	1.170
		2	0.723	3.329	2.184
		3	1.384	4.516	3.204
		4	1.393	7.202	4.199

Source: Georgia Statewide Travel Demand Model

Table 5-4: Internal-Internal Long Trip Rates

Income	Area	Persons/HH	HBW	HBO	NHB
Low	Urban	1	0.001	0.036	0.005
		2	0.002	0.063	0.009
		3	0.003	0.083	0.020
		4	0.005	0.060	0.154
	Rural	1	0.045	0.016	0.010
		2	0.043	0.087	0.130
		3	0.003	0.045	0.040
		4	0.167	0.667	0.056
Non-Low	Urban	1	0.003	0.013	0.010
		2	0.005	0.041	0.017
		3	0.009	0.041	0.054
		4	0.015	0.127	0.036
	Rural	1	0.002	0.032	0.021
		2	0.022	0.104	0.042
		3	0.007	0.095	0.087
		4	0.022	0.081	0.059

Source: Georgia Statewide Travel Demand Model

Table 5-5: Internal-External Short Trip Rates

Income	Area	Persons/HH	HBW	HBO	NHB
Low	Urban	1	0.005	0.010	0.036
		2	0.018	0.045	0.027
		3	0.020	0.020	0.030
		4	0.026	0.179	0.103
	Rural	1	0.002	0.015	0.005
		2	0.002	0.020	0.010
		3	0.182	0.022	0.012
		4	0.015	0.025	0.015
Non-Low	Urban	1	0.010	0.024	0.021
		2	0.038	0.065	0.033
		3	0.089	0.035	0.073
		4	0.038	0.036	0.074
	Rural	1	0.008	0.030	0.011
		2	0.007	0.042	0.024
		3	0.015	0.050	0.042
		4	0.031	0.048	0.028

Source: Georgia Statewide Travel Demand Model

Table 5-6: Internal-External Long Trip Rates

Income	Area	Persons/HH	Total
Low	Urban	1	0.008
		2	0.045
		3	0.025
		4	0.077
	Rural	1	0.045
		2	0.020
		3	0.091
		4	0.056
Non-Low	Urban	1	0.016
		2	0.046
		3	0.051
		4	0.051
	Rural	1	0.015
		2	0.035
		3	0.052
		4	0.070

Source: Georgia Statewide Travel Demand Model

Trip productions for commercial trucks are calculated using the following regression equation adopted from the GDOT MPO models.

Commercial Truck Production=0.48*(manufacturing+wholesale)+0.64*retail+0.23*service+0.06*pop

5.1.2 Trip Attraction

Unlike the trip production procedure which is household based, the trip attraction routine estimates the number of trips attracted to each TAZ based on employment. Using the socioeconomic data and the NHTS add-on survey, the following regression equations were estimated for trip attractions by purpose. It is assumed that commercial truck attractions are equal to productions.

HBW=1.00*total employment

HBO=5.3*retail+1.5*service+0.5*non-retail/service+0.95*household

NHB=0.40*pop+2.90*(retail+wholesale)+0.55*service

Commercial Truck=Commercial Truck Production

The trip attraction rates are less reliable comparing with the household based production rates because employment data is more dynamic than household data. Eventually, all trip productions have to be linked with associated trip attractions to complete a trip. Therefore, the trip attractions were subsequently scaled to match the total productions in the model.

5.1.3 Trip Density Measure

Travel patterns vary by region in Georgia due to different local economic conditions, existing transportation infrastructure, and demographic composition. Since all of these factors significantly influence trip decision makings and frequency, adjustments to the trip rates were deemed necessary to reflect these differences and to facilitate the model calibration. A trip density measure was introduced in the trip generation process to account for these varying situations. The trip density measures the level of convenience for individuals to reach major employment and population centers. The level of the convenience indirectly influences the frequency in trip making. For each zone, the trip density measure was calculated using the following equation.

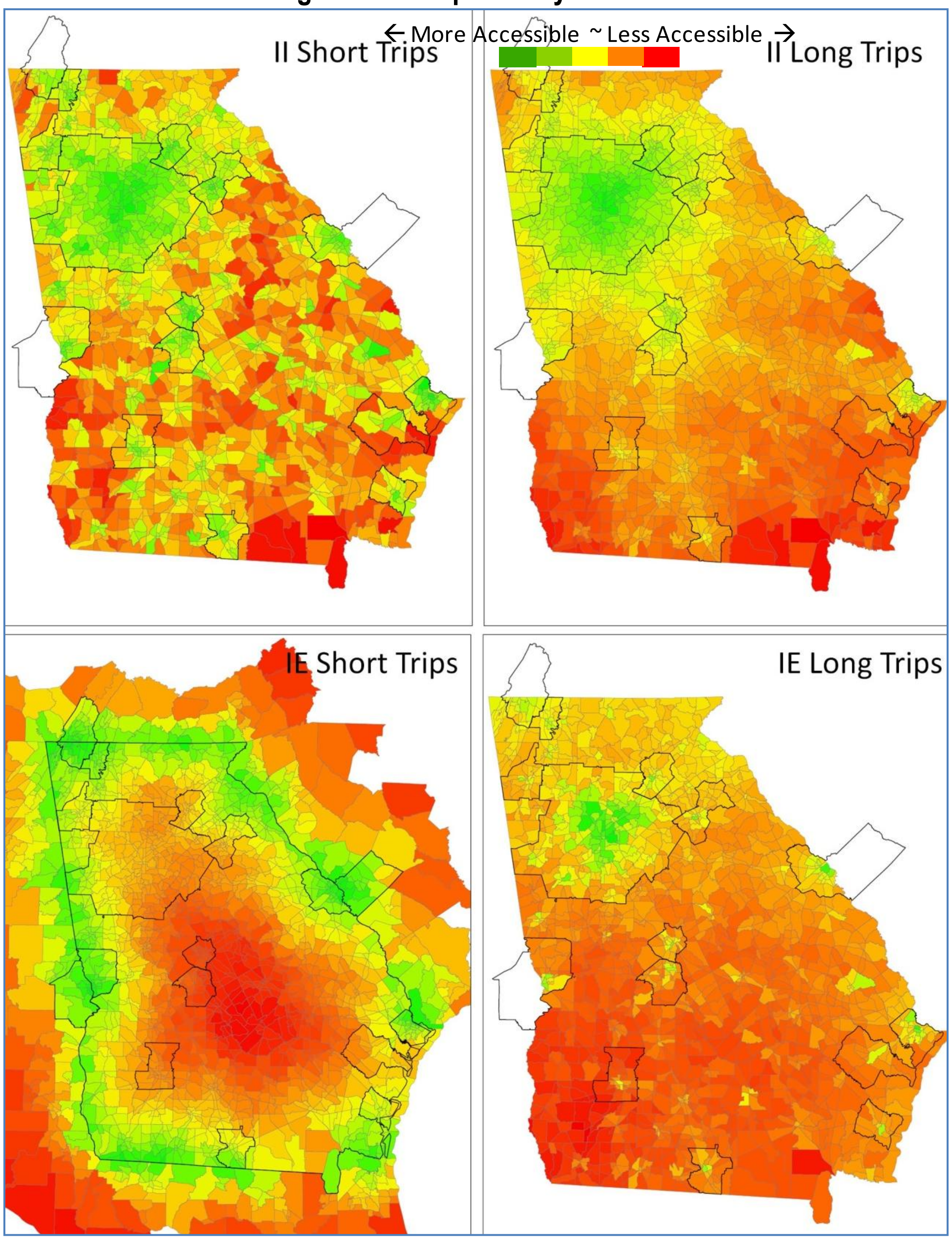
Trip density Measure=Ln(∑((Employment+Population)/(Travel Time)^x))

x: calibration parameters

For example, the more accessible an area is, the more likely people will make short trips to access jobs and goods and services in the area. This is the general case for the urbanized areas where people tend to have most of their activities within their convenient reach. On the other hand, there is less incentive for people to make long trips to access these same activities outside the area. This is reflected in the equation where the employment and population are the proxies for activities and travel time is the proxy for convenience. The density measure thus depends on the land use as well as the transportation network. As the land use pattern and transportation network change, the trip density measure will respond to the changes accordingly. The potential induced travel as a result of this change can be captured by the model especially for future alternative analysis. The trip density measure produces an index number which is then scaled and applied to the trip rates to make the adjustment that reflects the level of accessibility. This adjustment is made to the existing trip rates but is not the main driver for the trip rate. The index thus is scaled to adjust the original trip rate within 1 standard deviation. The trip density measure by trip type is illustrated in **Figures 5-2**. As the figure shows, the higher the density measure the better the level of accessibility. The measure was applied to the production and attraction rates to reflect the difference in accessibility.

The total person trips calculated from the trip generation by market segment and by geographic range is shown in **Table 5-7**. The EE trips were developed separately from matrix estimate and were not created as a part of the trip generation.

Figure 5-2: Trip Density Measure



Source: Georgia Statewide Travel Demand Model

Table 5-7: 2010 Base Year Passenger Model Trips (in thousands)

	Flow Movement	HBW	HBO	NHB	Total Person Trips	Truck Trips
Short Distance (Urban Trips)	II	3,388	16,776	8,936	29,100	2,140
	IE	65	79	80	224	20
Long Distance (Intercity Trips)	II	17	112	57	186	NA
	IE	243			243	NA
Total Trips		**3,470**	**16,967**	**9,073**	**29,510**	**2,160**

Source: Georgia Statewide Travel Demand Model

The resulting aggregated trip rates after the density measure adjustment was validated against the experience from peer statewide models as well as the NHTS add-on data. **Table 5-8** presents a summary of aggregated trip rates identified in the passenger trip model comparing with the range observed in peer statewide models. These comparisons indicate that there is a wide difference across the statewide models due to the size of zones, size of population and employment, as well as length of trip modeled. However, the aggregated passenger model trip rates are reasonably within the range of other statewide models' experience.

Table 5-8: Aggregated Trip Rates Summary

	Statewide Model	NCHRP Range
Person Trips/TAZ	9,913	2,134~16,197
Person Trips/Person	3.05	1.95~4.24
Person Trips/Household	8.23	5.41~10.33
Person Trips/Employee	5.63	4.41~8.76

* Values from Validation and Sensitivity Considerations for Statewide Model NCHRP Project 836-B Task 91, September, 2010

Table 5-9 shows the comparison between the model results and the 2009 Georgia NHTS add-on data. The passenger model's trip rates are within a close approximation to the NHTS add-on data after the adjustments by the trip density measure.

Table 5-9: NHTS Add-on Trip Rates Comparison

	Statewide Model	2009 NHTS Add-on
Person Trips/Household	8.26	7.80
Person Trips/Person	3.05	3.20
% HBW Trips	12%	13%
HBW Trips/Household	0.97	1.00
HBO Trips/Household	4.73	4.50
NHB Trips/Household	2.53	2.30

Source: 2009 Georgia NHTS Add-on and Statewide Travel Demand Model

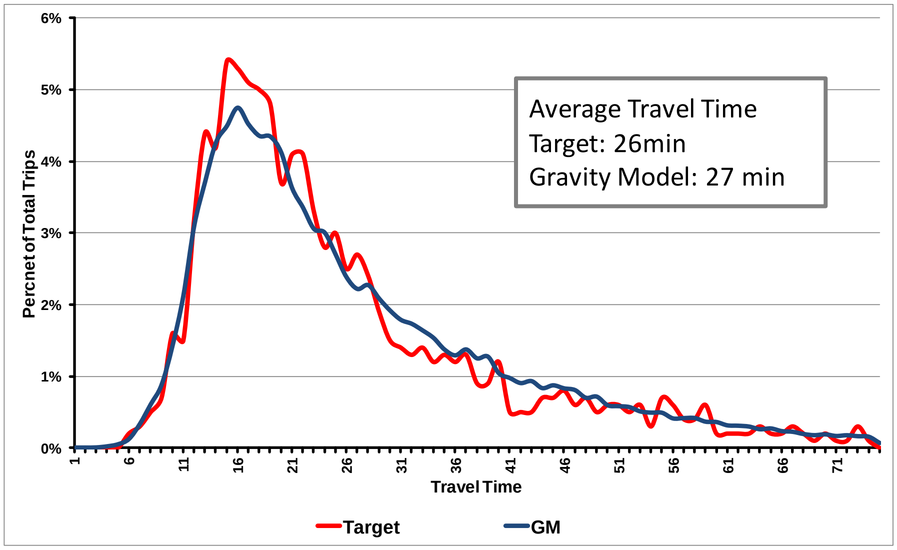
5.2 Trip distribution

The trip distribution uses the traditionally gravity model process. The estimated number of person trips travelling between any O-D pair will, in general, be proportional to the number of trip ends (mass) and inversely proportional to the travel time. The trip ends are the productions and attractions calculated from the trip generation step. The travel time reflects the minimum time for trips traversing between each O-D pair in a congested highway condition. Intrazonal travel time is the travel time for trips with both origin and destination within a zone. Intrazonal trips are very short trips that do not have an impact on the highway congestion. The amount of the intrazonal trips is determined by the size of the zones and the intrazonal travel time is calculated from the travel time to nearest zones. Terminal times were assigned between O-D pairs and were based on the employment density of the origin and destination TAZ's. At the trip origin, terminal time generally refers to the walk time from one's residence to the car. At the destination end, it generally represents the time it takes to go from one's car to the destination. Depending on the characteristics of the zone, terminal time can vary. The following terminal time were used in the model to reflect the different area types.

- Urbanized area: 5 min
- Suburban area: 3 min
- Rural area: 1 min

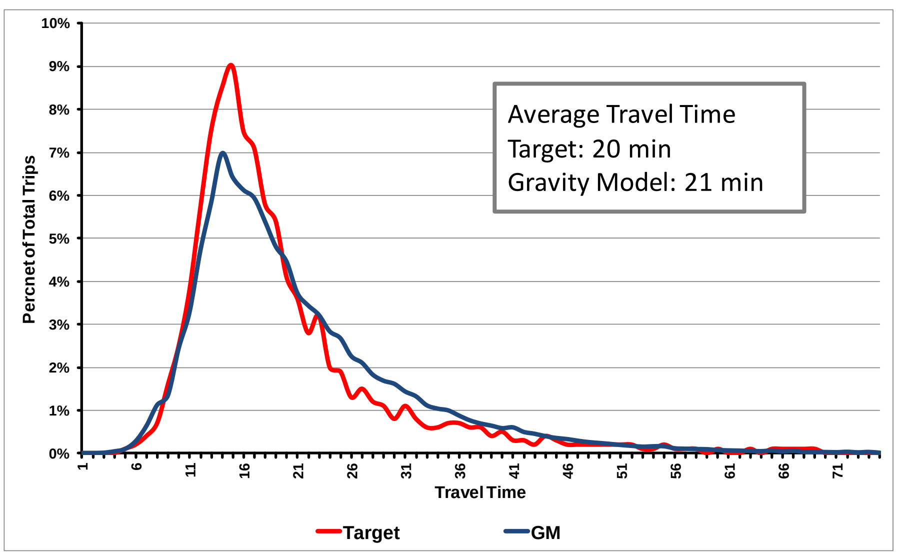
The total travel time between each O-D pair is converted into travel time impedance factors or friction factors. These factors along with production and attraction trip ends are the inputs to the gravity model which links the trip ends into complete trips. During the process of converting the trip ends into completed trips, the gravity model was validated against the distribution patterns observed. These include the average travel time as well as the trip length frequency distribution. The NHTS add-on data was geo-coded by trip origin and destination and survey trip tables were developed to facilitate the gravity model validation. The trip distribution pattern estimated from the gravity model was then compared against that from the NHTS data. The gravity model was calibrated by adjusting the friction factors until the resulting distribution pattern sufficiently replicates the NHTS survey. **Figures 5-3** through **5-11** show the comparison of the trip length frequency distribution for internal short and long trips as well as the external short trips. The gravity model for short trips produces better results in matching the trip distribution pattern than the longer trips. For example, HBW short trips show that the gravity model's trip length frequency distribution curve is closely matching the survey target as well as the average travel time of 28 minutes. The mismatch of long distance and external trips between the gravity model and the NHTS survey is due to insufficient data for longer distance travel in the NHTS survey. Additional data for those trip types would help improve the comparison for the long and external trip types.

Figure 5-3: II HBW Short Trips



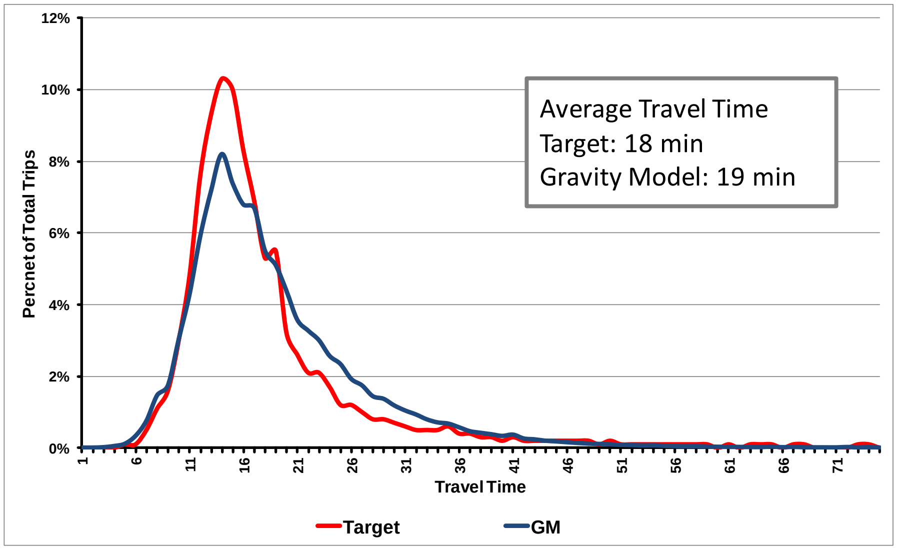
Source: Georgia Statewide Travel Demand Model

Figure 5-4: II HBO Short Trips



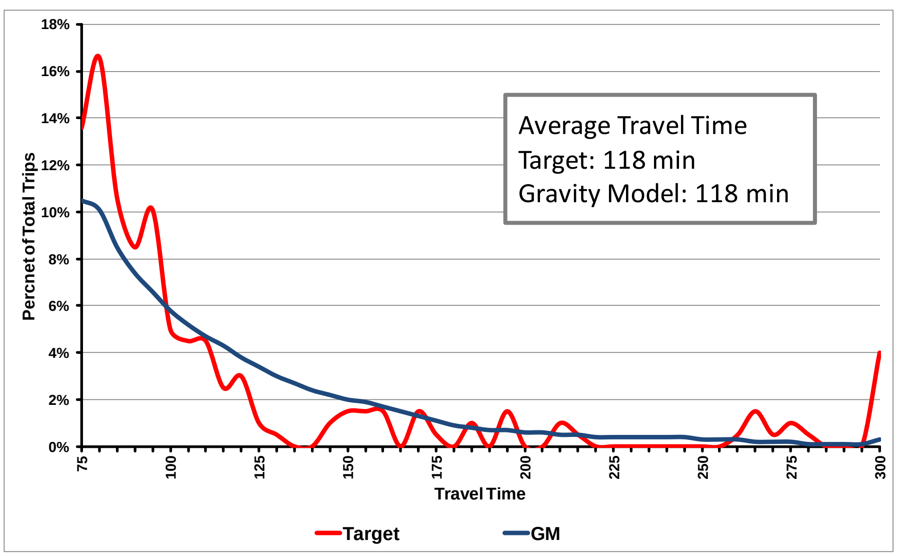
Source: Georgia Statewide Travel Demand Model

Figure 5-5: II NHB Short Trips



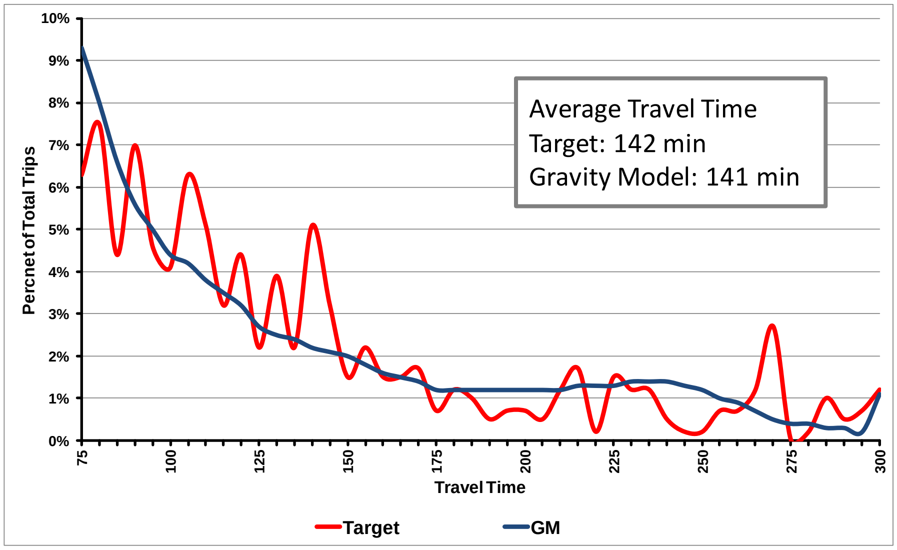
Source: Georgia Statewide Travel Demand Model

Figure 5-6: II HBW Long Trips



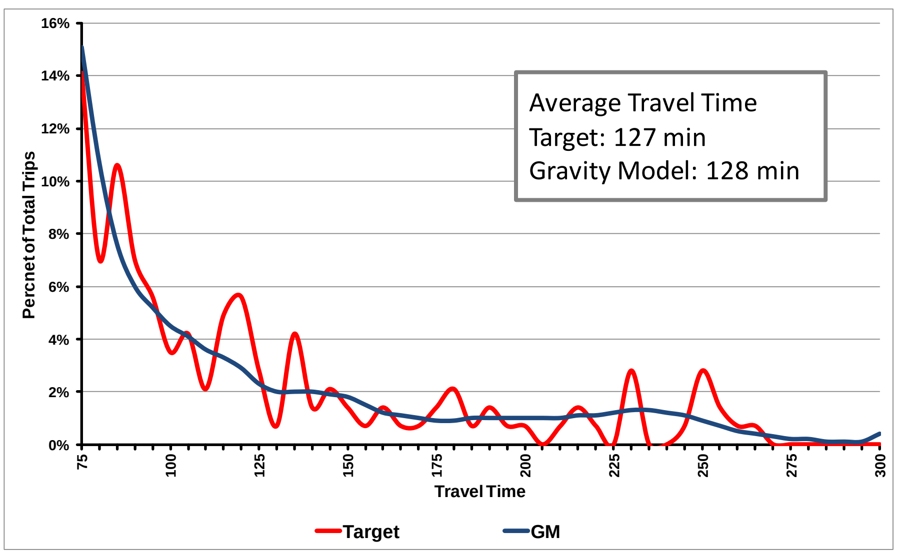
Source: Georgia Statewide Travel Demand Model

Figure 5-7: II HBO Long Trips



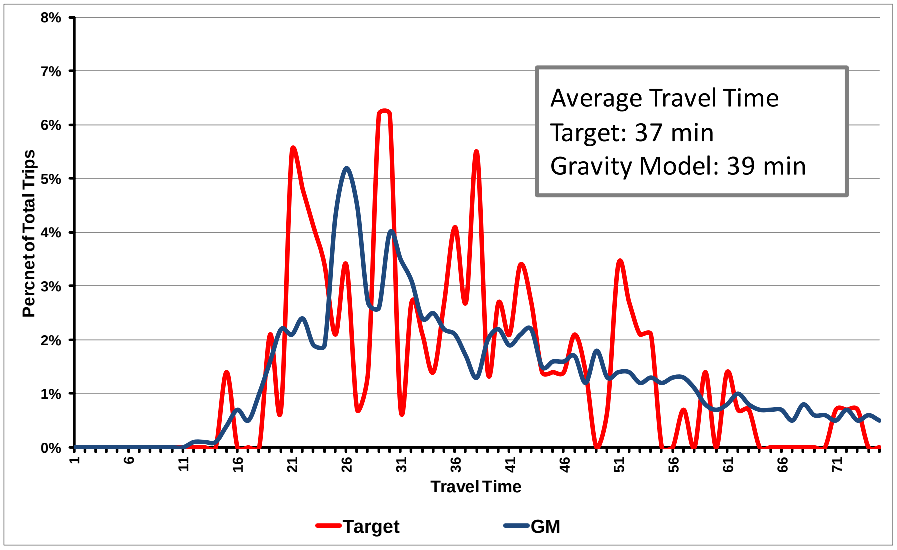
Source: Georgia Statewide Travel Demand Model

Figure 5-8: II NHB Long Trips



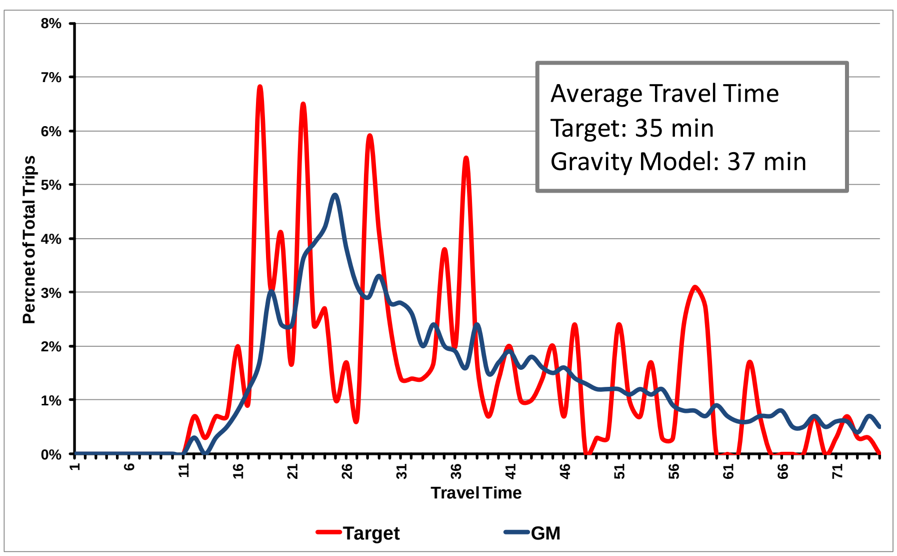
Source: Georgia Statewide Travel Demand Model

Figure 5-9: IE HBW Short Trips



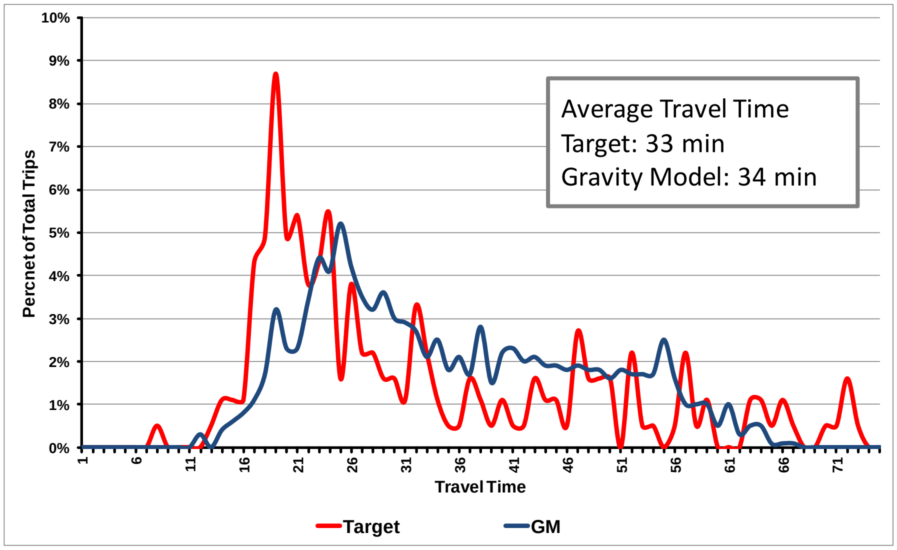
Source: Georgia Statewide Travel Demand Model

Figure 5-10: IE HBO Short Trips



Source: Georgia Statewide Travel Demand Model

Figure 5-11: IE NHB Short Trips



Source: Georgia Statewide Travel Demand Model

Unlike MPO models, statewide models cover much larger areas and produce more long trips. Statewide models include cross-regional trips that are typically modeled as external trips in MPO models. The average trip length in the statewide models is clearly longer than those in the MPO models. Thus, the average travel time can vary greatly depending on the size of the modeled area. The average travel time from the gravity model was thus compared with the experience from other statewide models to check the model's reasonableness. **Table 5-10** summarizes the average trip lengths for short trips and the comparison between those found in other peer statewide models and surveys. Because the definition for long distance trips can be widely different, this comparison only focus on the short trips defined in the Georgia Statewide Model. The average trip lengths from the model are within a reasonable range when compared to the other peer statewide models.

Table 5-10: Statewide Model Short Distance Trip Average Length Comparison (minutes)

Trip Purpose	Statewide Model	2009 Georgian NHTS Add-on	Other Statewide Models*		Travel Survey		NCHRP	
			Low	High	Low	High	Low	High
HBW	27	26	11	23	16	24	11	35
HBO	21	20	9	19	14	16	10	17
NHB	19	18	9	23	13	23	9	19

Note: * Values from Validation and Sensitivity Considerations for Statewide Model, NCHRP Project 836-B Task 91, September, 2010

The best way to measure the travel pattern resulting from major trip movement across the region is to perform a district to district flow analysis. This provides a clear view on how well the gravity model allocates trips on an aggregated level compared with the existing condition. Similar to the freight gravity model validation, the 12 districts based on the Georgia RDCs were used (see Figure 4.3 for a map). To facilitate the validation effort, the cross region work flows from the 2009 NHTS add-on survey were also developed according to these districts. The comparison therefore was made between the gravity model and NHTS data. **Table 5-11** and **Table 5-12** show the comparison of district to district work trips between the Gravity model and the NHTS survey while **Figure 5-12** graphically shows the comparison. It is expected that there will be some discrepancies in the comparison since both the model and survey data contain certain levels of inaccuracy. The model results are continuous due to the mathematical formula while the survey data are discrete. As discussed earlier, the NHTS data also lacks sufficient data for long distance and external travel data. Considering these factors, the model generally matches the survey well overall.

Table 5-11: District to District Work Flow - Gravity Model

	NW GA	GA Mountains	ARC	Three Rivers	NE GA	Mid GA	Ctr. Savh River	River Valley	Heart of GA	SW GA	S GA	Coastal	Total
NW GA	206,934	700	12,525	27	12	7	5	10	1	1	1	1	220,224
GA Mountains	3,018	76,451	10,085	2	2,919	6	21	3	1	1	1	2	92,509
ARC	10,908	3,928	1,826,765	8,537	9,516	1,169	243	388	36	43	34	53	1,861,619
Three Rivers	13	2	8,345	52,052	194	2,786	6	2,380	3	6	3	4	65,792
NE GA	9	3,362	10,689	137	93,988	3,446	425	4	3	2	2	5	112,069
Mid GA	8	4	1,027	982	1,132	159,483	238	2,768	5,670	38	332	38	171,719
Ctr. Savh River	7	18	485	4	1,068	1,308	151,011	7	2,722	4	7	2,100	158,740
River Valley	11	2	578	3,286	9	1,039	9	115,917	147	3,361	3,232	18	127,608
Heart of GA	4	3	299	7	15	760	368	642	90,621	44	5,948	3,009	101,721
SW GA	3	1	205	10	5	81	6	532	19	120,478	3,069	30	124,441
S GA	3	1	206	6	7	96	24	78	455	6,687	130,557	1,932	140,051
Coastal	3	3	190	4	12	80	256	16	6,071	26	828	221,148	228,637
Total	220,922	84,476	1,871,399	65,052	108,876	170,261	152,610	122,745	105,748	130,689	144,012	228,340	3,405,130

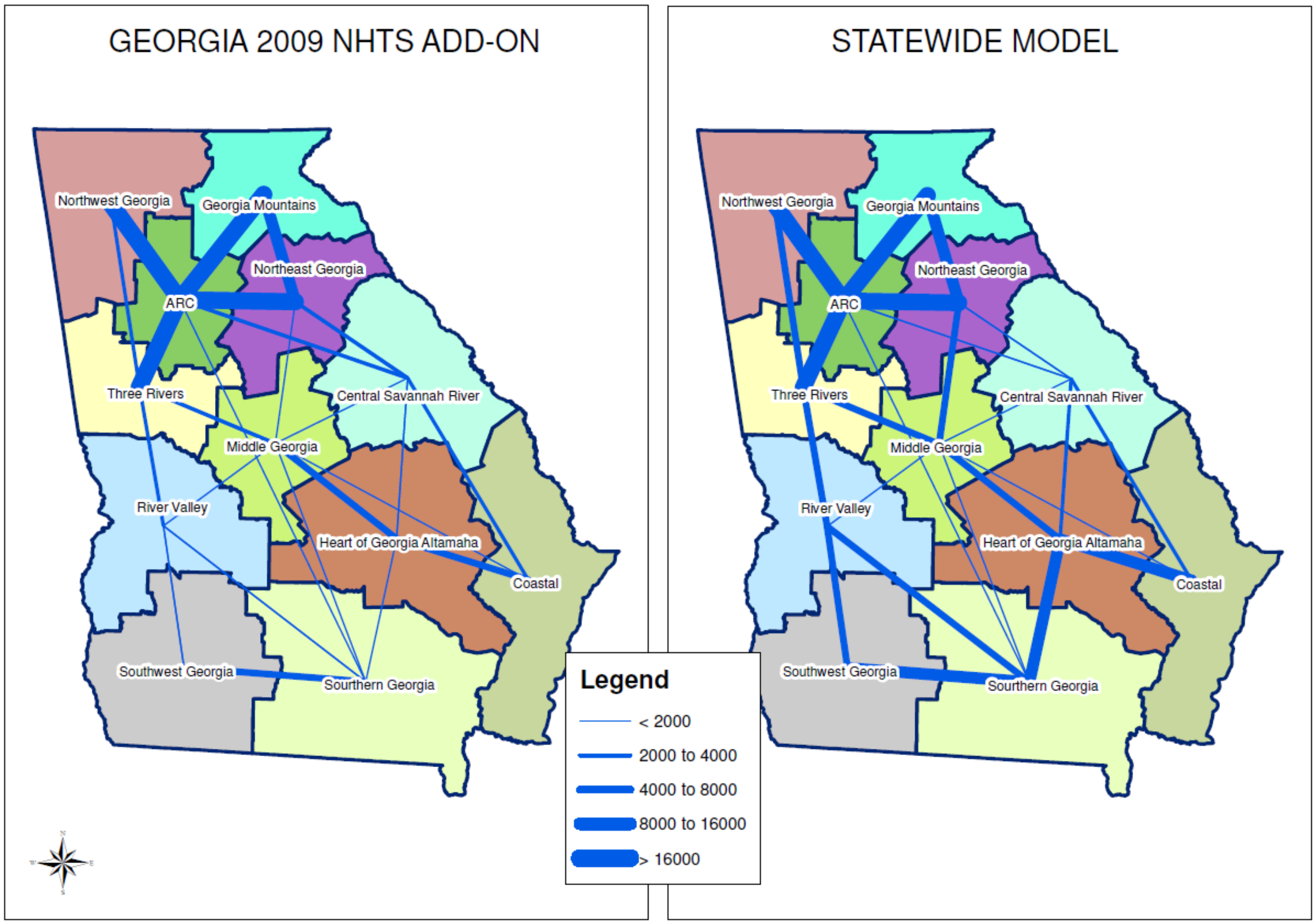
Source: Georgia Statewide Travel Demand Model

Table 5-12: District to District Work Flow - Georgia 2009 NHTS Add-on Survey

	NW GA	GA Mountains	ARC	Three Rivers	NE GA	Mid GA	Ctr. Savh River	River Valley	Heart of GA	SW GA	S GA	Coastal	Total
NW GA	229,117	0	48,987	2,473	54	0	0	0	0	0	0	0	280,631
GA Mountains	482	131,765	35,611	0	7,886	0	0	416	0	0	219	0	176,378
ARC	38,552	21,925	1,513,935	17,424	30,196	94	2,638	0	0	110	0	55	1,624,930
Three Rivers	1,891	0	25,326	121,506	869	2,272	0	472	0	0	0	0	152,336
NE GA	54	15,179	31,320	869	148,660	1,172	2,439	0	0	0	0	0	199,692
Mid GA	93	0	430	2,504	959	246,907	1,099	779	4,576	0	1,246	310	258,903
Ctr. Savh River	0	0	2,958	0	2,439	0	141,828	0	1,515	307	0	2,095	151,141
River Valley	0	0	0	2,528	0	1,257	0	104,713	0	1,380	1,723	817	112,417
Heart of GA	0	0	0	0	0	2,931	1,768	312	64,197	0	1,360	4,012	74,580
SW GA	101	0	0	0	0	0	0	1,491	0	168,370	2,191	0	172,153
S GA	0	219	1,807	101	0	0	47	1,695	203	4,695	142,242	322	151,330
Coastal	0	0	55	145	410	1,098	694	0	1,133	0	139	230,394	234,068
Total	270,290	169,089	1,660,429	147,550	191,473	255,731	150,513	109,878	71,623	174,860	149,119	238,006	3,588,560

Source: 2009 Georgia NHTS Add-on Survey

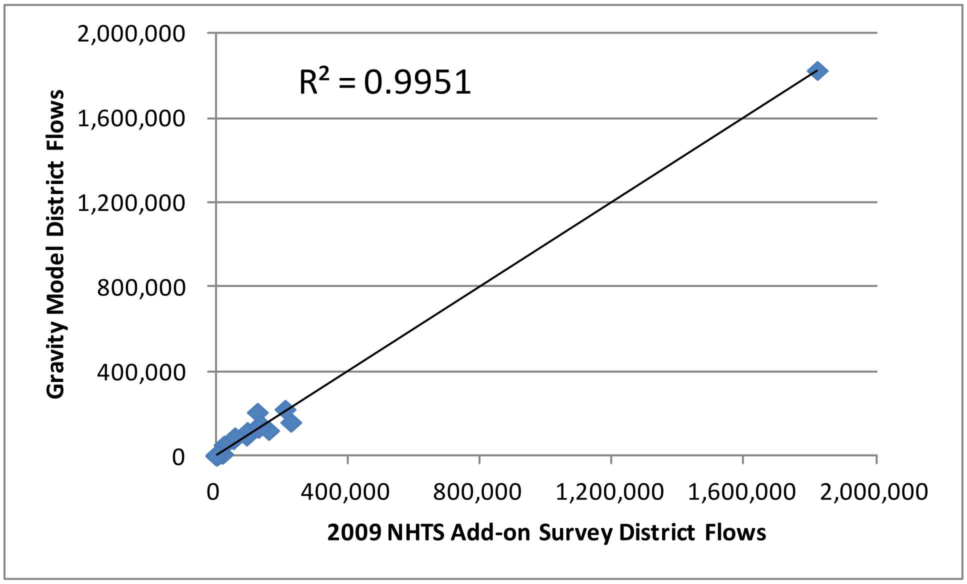
Figure 5-12: District to District Work Trips between Model and 2009 NHTS Add-on Data (greater than 1,000 trips)



Source: Georgia Statewide Travel Demand Model, 2009 Georgia NHTS Add-on Survey

Another way to look at the comparison is to plot the data on a scatter plot. The scatter plot shows the correlation between two data variables and indicates how well one data variable explains the other. **Figure 5-13** shows the scatter plot using the flow between the individual district to district pairs. The R squared is 0.99, meaning the model district flows explained the variation in the survey district flow well.

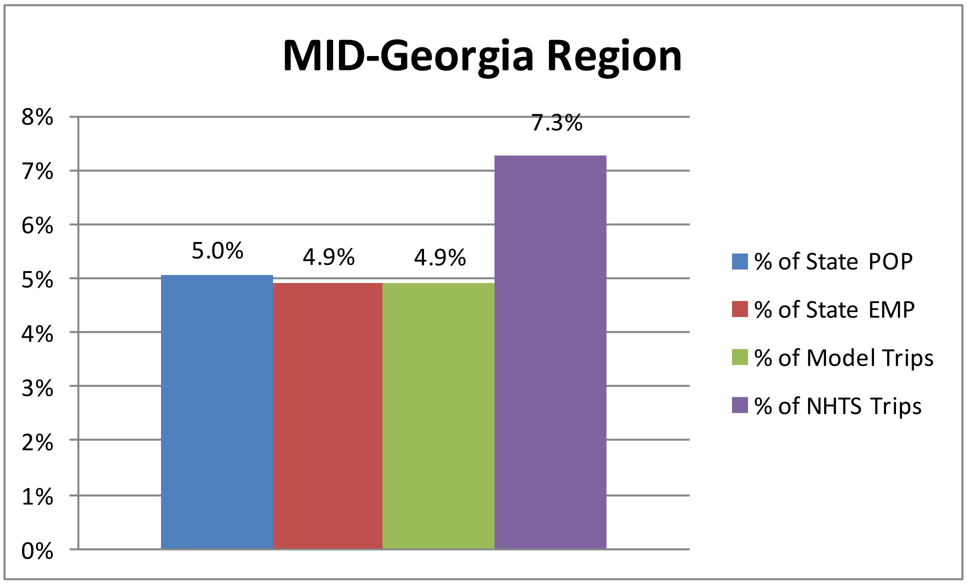
Figure 5-13: Comparison of District Work Flows (2009 NHTS Add-on Data)



Source: 2009 Georgia NHTS Add-on Survey

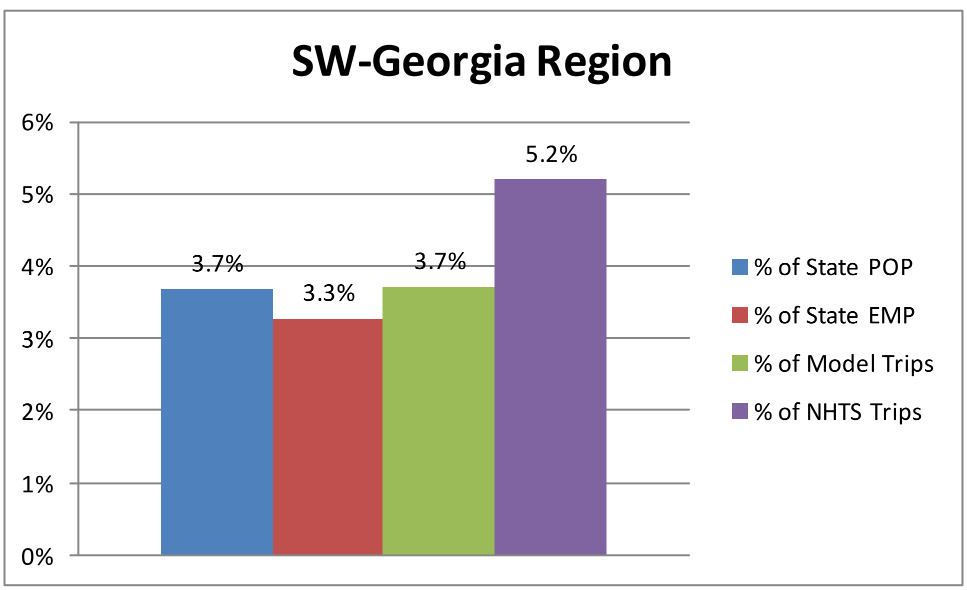
It is also important to note that the NHTS data only provides a snapshot of the travel pattern in a particular period and the data is limited to the small sample size and the accuracy in reporting. For example, according to the **Table 5-11** and **Table 5-12,** the NHTS reported 246,907 and 168,370 internal work trips in Mid-Georgia and SW-Georgia regions respectively. The model produces 154,944 and 119,298 internal work trips for the two regions, substantially lower than the NHTS. A closer look at the NHTS data shows that it is over estimating the work trips. Work trips are closely associated with employment. By observing the level of employment in these regions, one can check the reasonableness of the reported work trips. **Figure 5-14** and **Figure 5-15** show the comparison of the employment distribution and work trip distribution as a percent of the total for the state for Mid-Georgia and SW-Georgian regions. In **Figure 5-14**, for instance, the Mid-Georgia region accounts for less than 5% of the state employment force but produced more than 7% of total work trips, according to the NHTS data. On the other hand, model forecasted trips are close in line with the region's employment size.

Figure 5-14: Comparison of Internal Work Trips (MID-Georgia Region)



Source: Georgia Statewide Travel Demand Model

Figure 5-15: Comparison of Internal Work Trips (SW-Georgia Region)

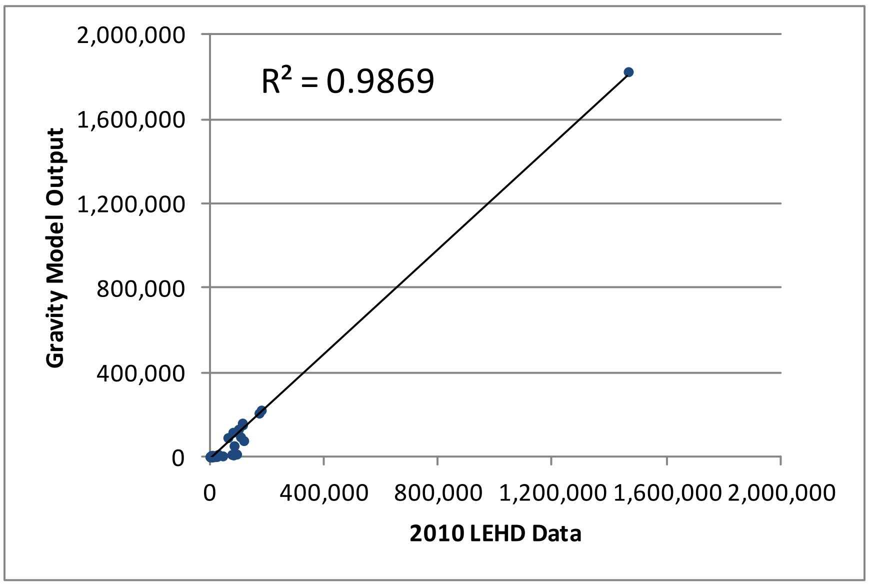


Source: Georgia Statewide Travel Demand Model

In addition to the NHTS data, other secondary data sources were also explored in an effort to further the validation of the gravity model. These include the Census's Longitudinal Employer-Household Dynamics (LEHD) data (2010) and the American Community Survey (ACS) three year data set (2006-2008). Both data sets are available at county level and were produced using different methodologies. These data sets are helpful to check the model's reasonableness.

The LEHD data was produced using modern statistical computing techniques to combine federal and state administrative data on employers and employees. The data provides work flows down to the census block to block level and can be aggregated into district to district flows. **Figure 5-16** shows the scatter plot comparing the district flows between the LEHD data and gravity model. Again, the model results show high correlation with the LEHD data. The model has explained the majority of the variation in the existing travel patterns.

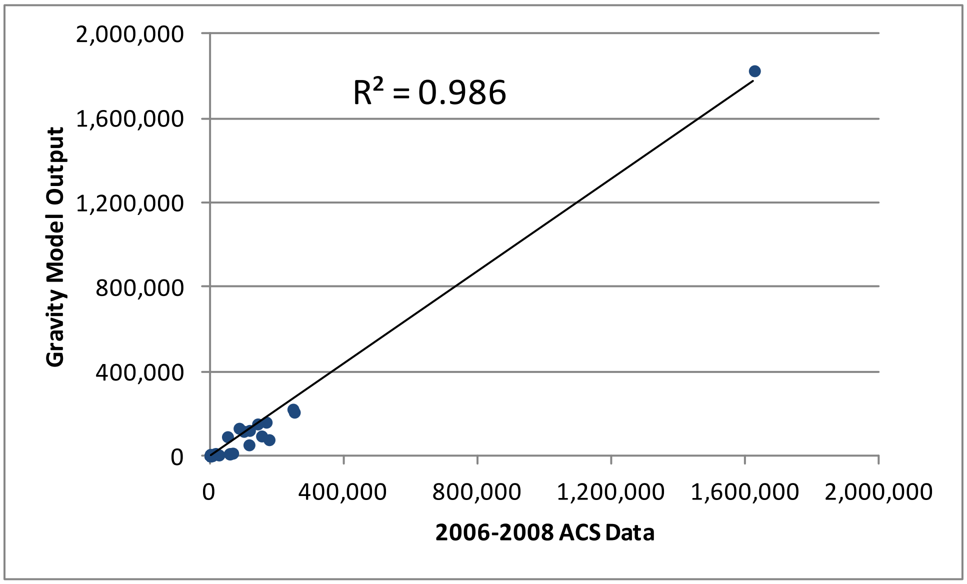
Figure 5-16: Comparison of District Work Flows (2010 LEHD Data)



Source: 2010 US Census LEHD Data

ACS also provides county to county work flows. The data organized information on where workers live and where they work as well as the work flow between those places. However, the data is only limited to geographic areas with population at least 20,000 or greater. As a result, there are only 90 counties of the 159 total Georgia counties available in the three-year 2006-2008 dataset. Nevertheless, the data still provides a reasonable benchmark for measuring the gravity model results. **Figure 5-17** shows the comparison of work flow between the model and ACS data. The correlation between the ACS data and the gravity model also indicates that the model explains the general travel patterns in the ACS dataset reasonably well.

Figure 5-17: Comparison of District Work Flows (ACS Data)

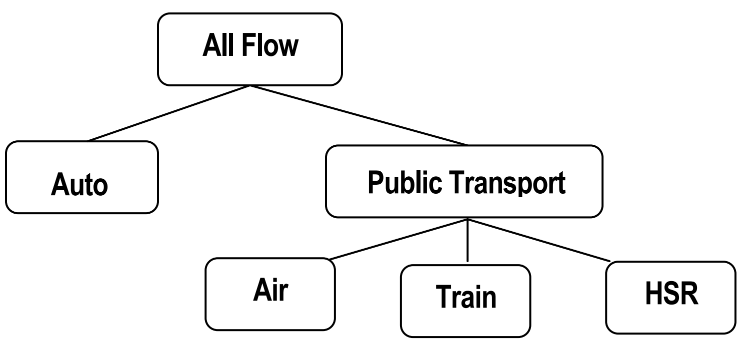


Source: ACS three-year 2006-2008 County to County work flow data

5.3 Mode Choice

The mode choice process determines what mode of travel will be used to complete the passenger trips between zones. The alternative modes considered in the statewide model are autos, inter-city train, high speed rail, and air. The model structure is shown below.

Figure 5-18: Passenger Mode Choice Model Structure



The mode choice model was applied to trips with both trip ends located within Georgia or external trips with the external trip end located in the immediate surrounding region. Long distance external trips between Georgia and regions beyond the immediate adjacent areas were not included. The mode choice for this type of trips uses a simple mode split with fixed auto passengers share by distance shown in **Table 5-13**. These shares were developed from 2001 national NHTS survey.

Table 5-13: IE Long Distance Trips Mode Split

Distance Range (miles)	< 500	500-750	750-1000	1000-1500	>1500
Auto Share	95%	62%	42%	32%	15%

Source: 2001 NHTS

A mode choice model usually requires a well designed survey built specifically for the model development. Unfortunately, the existing NHTS add-on data for Georgia doesn't have sufficient observations to develop a complete mode choice model. The model therefore had to be borrowed from another similar model. Typically by adjusting the coefficients of the adopted model, the model can be recalibrated to match existing travel observations in Georgia. The mode choice model therefore was adopted from the "Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study" which includes the mode for air, trains, and high speed rail. The model coefficient then were adjusted to produce results that reasonably match the overall mode shares observed in Federal Aviation Administration (FAA) airport boarding data, Amtrak boarding data, and 1995 American Travel Survey data for long distance travel for Georgia. Due to the limitations of the data, it is recommended that the mode choice model be used with caution for the rail and air components. It should be used to estimate general modal trends and not be used to produce detailed absolute ridership.

The non constant coefficients for the logit choice model are shown in **Table 5-14**. These coefficients were applied to each of the input variables to calculate the utility value for each of the modes. Passenger trips were categorized as work related and non-work related. These trips belong either to HBW trip or non work based trip in the statewide model. The costs reflect the real monetary measure of fees for transportation. The air fare is current market fair from the FFA origin and destination survey. The fare for the train is the average dollar amount per mile at current market price which is $0.30/mile. In-vehicle time is the time spent in the selected mode of transportation. The values are obtained by skimming the network associated with the different mode. Out-of vehicle time is the time used to travel from origin zone to the zones with designated boarding facilities for specific mode. These facilities can be train stations or airports. No out-of-vehicle time is assigned to highway travel. Headway was defined as the number of flights or trains available per day. Reliability reflects the possibility of delay caused by external factors. The reliability is 70% for air travel, 98% for train, and 90% for auto.

Table 5-14: Logit Choice Model Coefficients exclude Constants

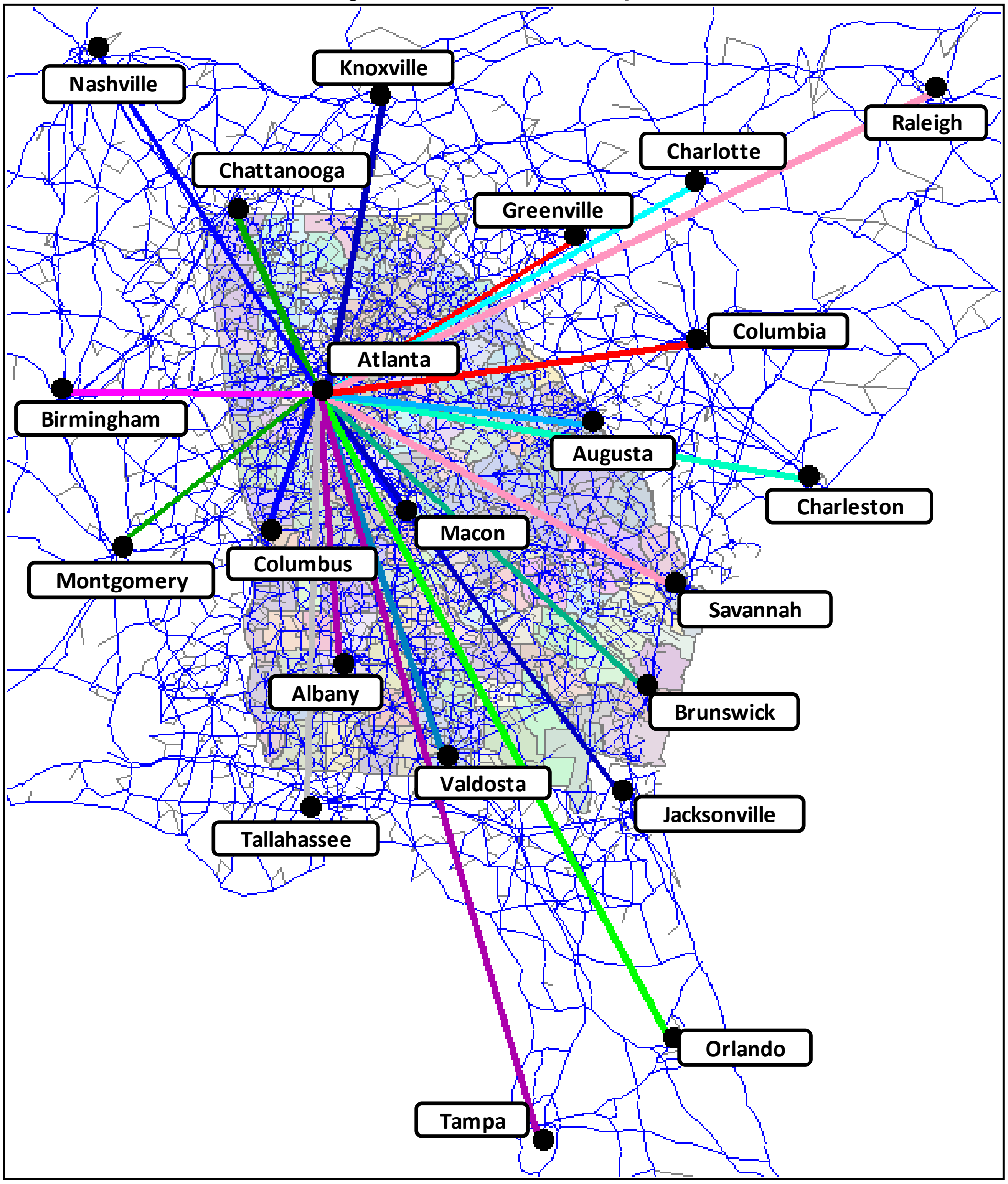
Trip Type	Costs	In-Vehicle Time	Out-of-Vehicle Time	Headway	Reliability	Household size
Work/Business	-0.016	-0.016	-0.060	-0.003	0.001	0.070
Non-Work/Business	-0.035	-0.011	-0.030	-0.003	0.005	0.225

Source: Georgia Statewide Travel Demand Model

Due to the limitation of the zone sizes and the lack of mode data, there are restrictions applied to the mode choice model. For example, for air mode, only direct flight services within Georgia are considered and trips with a distance less than 100 miles were excluded. This is because there is not sufficient data available to model the transferring flights and flying less than 100 miles is a less likely event. In addition, unlike highway travel, airlines operate at a hub and spoke system, common method for them to organize their flights. In southeastern US, Atlanta is a major hub for several airlines. **Figure 5-19** displays the hub and spoke system that links Atlanta to other hubs or regional airports included in the model. A listing of the variables in the airline network is listed in Appendix B.

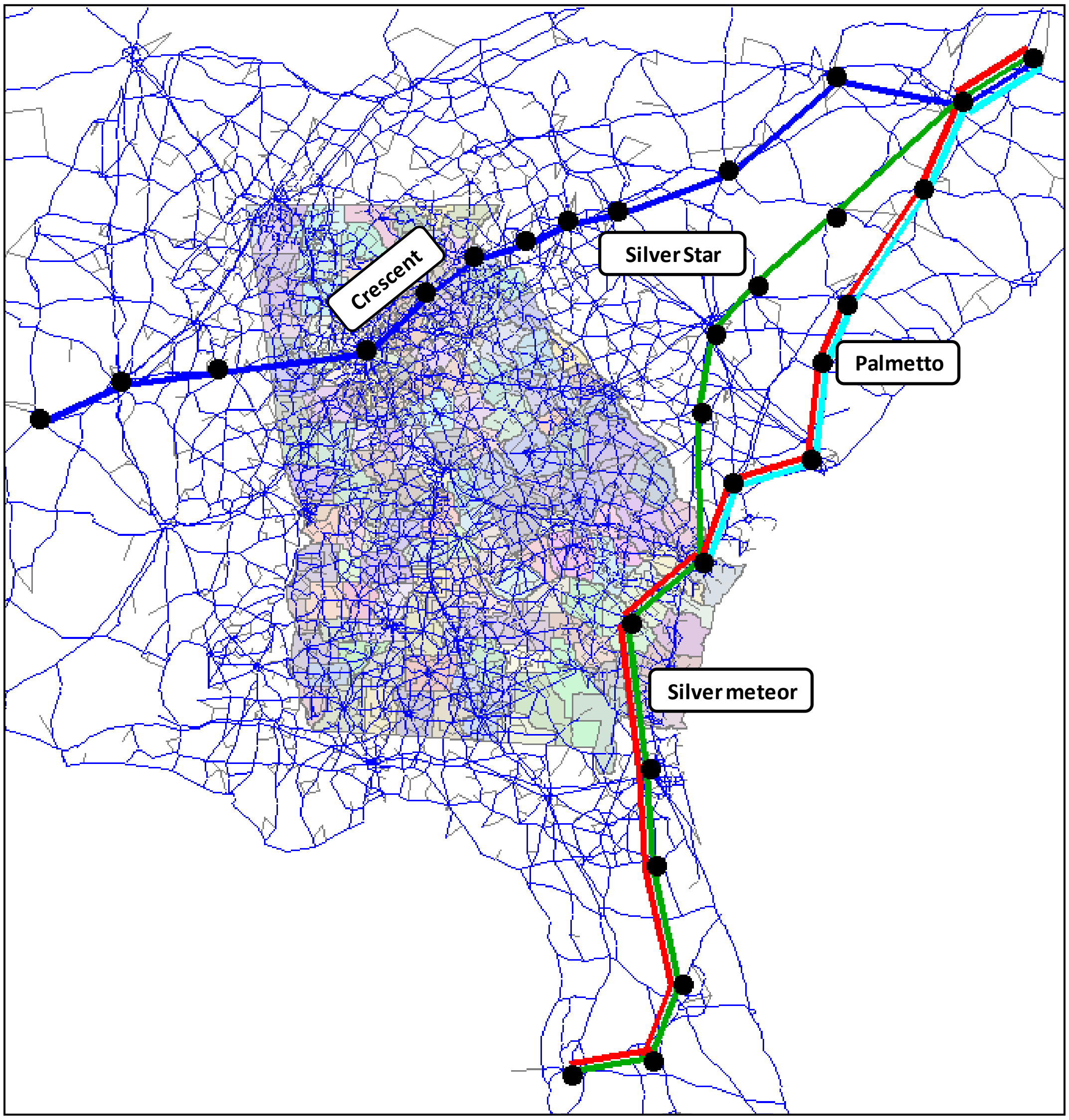
The conventional train mode mainly represents the Amtrak services. Currently, there are 4 major services running through Georgia, with one serving Atlanta and the other three connecting Savannah to rest of the regions. The four services are Crescent, Silver Star, Silver Meteor and Palmetto. **Figure 5-20** shows the Amtrak routes and the stops along the routes. As the figure shows, the train mode only includes passenger travel that must have a trip end within Georgia. External pass through trips are not considered by the mode choice model due to the limitations discussed earlier. In addition, as the train is used primarily for medium to long distance travel, trips less than 50 miles are not considered in the model. A listing of the variables in the inter-train network is listed in Appendix B.

Figure 5-19: Modeled Airports



Source: Georgia Statewide Travel Demand Model

Figure 5-20: Amtrak Passenger Rail Routes



Source: Georgia Statewide Travel Demand Model

The mode choice model was calibrated by adjusting the constant coefficient in the logit formula. The utility values calculated will be used to allocate the share of modes between each O-D trip pair. The mode choice model was validated at both the aggregated level and at individual route level. At the aggregated level, the mode share results for travel were compared with the American Travel Survey (ATS). This data collects the information about long distance travel of persons living in the United States. The information was used to identify characteristics of current use of the nation's transportation system. **Table 5-15** shows the comparison between the model results and ATS data. According to ATS, the vast majority of travelers in Georgia use automobile as their prime choice for transportation. Less than 2% of travelers relied on the non-highway transportation system.

Table 5-15: Mode Share Comparison

Mode	Model	1995 ATS
Air	1.2%	1.3%
Train	0.1%	0.2%
Auto & Other	98.7%	98.5%

Source: American Travel Survey, 1995; Statewide Travel Demand Model

At the individual route level, the model results were compared with FAA original-destination survey. This data includes a 10% sample of airline tickets from reporting carriers collected by the Office of Airline Information of the Bureau of Transportation Statistics. Data includes origin, destination and other itinerary details of passengers transported. This database is used to determine air traffic patterns, air carrier market shares and passenger flows. **Table 5-16** shows the comparison between the model results and the survey by individual service route. The model in general replicated the existing travel patterns.

Table 5-16: Air Travel Model Calibration Results

Route	Observed	Model	% Difference
Atlanta-Nashville	180	189	5%
Atlanta-Birmingham	20	10	-50%
Atlanta-Chattanooga	3	77	2467%
Atlanta-Charlotte	502	726	45%
Atlanta-Augusta	13	73	462%
Atlanta-Charleston	138	131	-5%
Atlanta-Savannah	279	302	8%
Atlanta-Brunswick	24	24	0%
Atlanta-Jacksonville	840	897	7%
Atlanta-Valdosta	8	21	163%
Atlanta-Albany	7	9	29%
Atlanta-Tallahassee	80	98	23%
Atlanta-Greenville	10	8	-20%
Atlanta-Columbus	3	5	67%
Atlanta-Macon	1	1	-0%
Atlanta-Montgomery	9	8	-11%
Atlanta-Knoxville	31	22	-29%
Atlanta-Columbia	35	31	-11%
Atlanta-Orlando	1,873	1,881	0%
Atlanta-Tampa	1,614	1,813	12%
Total	**5,671**	**6,326**	**12%**

Source: FAA Origin and Destination Survey (DB1B) ,2010

The conventional rail mode represents the Amtrak service. The boarding information was collected from both the AMTRAK Factsheets and the origin-destination survey. The mode results were compared with the survey data in **Table 5-17**.

Table 5-17: Amtrak Rail Model Calibration Results

Route	Observed	Model	%
Crescent	42	67	60%
Palmetto	8	1	-88%
Silver	28	8	-71%
Silver star	10	8	-20%
Total	**88**	**84**	**-5%**

Source: AMTRAK Factsheet and Origin and Destination Survey 2007

Currently, there is no High Speed Rail (HSR) facility in Georgia. This mode component has not been calibrated and is left as space holder for future model improvement.

The output from the mode choice model is person trips for each mode of transportation. The automobile trips have to be converted into vehicle trips which then are assigned to the highway network. This conversion reflects the carpooling of trips. These factors are borrowed from the GDOT MPO models, and subsequently adjusted during the model calibration. The conversion factors are listed in **Table 5-18** along with the average auto occupancy rates founded in other statewide models.

Table 5-18: Auto Occupancy Rate

	Short Trips			Long Trips		
	Georgia Statewide Model	Other Statewide Model*		Georgia Statewide Model	Other Statewide Model*	
Trip Type		Low	High		Low	High
HBW	1.1	1.10	1.19	1.5	1.19	2.43
HBO	1.5	1.54	1.78	2.0	1.31	2.69
NHB	1.5	1.56	1.79	2.0	1.31	2.69
IE	2.0	1.50	2.26	2.0	1.50	2.55

* Values from Validation and Sensitivity Considerations for Statewide Model NCHRP Project 836-B Task 91, September, 2010

5.4 Assignment

The last step in the modeling sequence is the assignment of the trip tables to logical routes in the transportation network. Highway trip assignment is performed using the equilibrium assignment technique. The traffic assignment algorithm is iterative, running through successive applications until equilibrium occurs. Equilibrium occurs when no trip can take an alternate path without increasing the overall travel costs of all other trips in the network. The equilibrium assignment is an iterative process that simulates travel demand along the minimum time paths as well as the effects of congestion accumulated. In each iteration, vehicles are loaded onto network links and the links' travel impedances are adjusted in response to the volumes to capacity relationships. Final link volumes are derived by summing weighted average volumes from the all iterative loadings. The travel impedances are generalized costs which include link travel time as well as vehicle operating costs. Values of time for the passenger and freight truck assignment are $15/hour and $60/hour respectively. The vehicle operating costs for auto passenger car and freight truck are $0.12/mile and $0.50/mile respectively. Peak and off-peak impedances are defined. The peak impedance reflects congested conditions where all network links are loaded with estimated amount of traffic. The off-peak impedance is the weighted average of congested and free flow conditions. The peak impedance is primarily used for the short trips, mostly commute trips within urbanized areas where travel is sensitive to local congestion levels. The off-peak impedance is used for longer trips which are less sensitive to localized traffic congestion. These trips include intercity passenger trips and long haul freight trucks.

The assignment attaches additional network link attributes to the input network to store the results. These additional attributes provide volumes, travel time, speed, and so on which can be used to summarize network-wide link statistics. A list of these added attributes is shown in **Table 5-19** below.

Table 5-19: Statewide Model Output Network Attributes

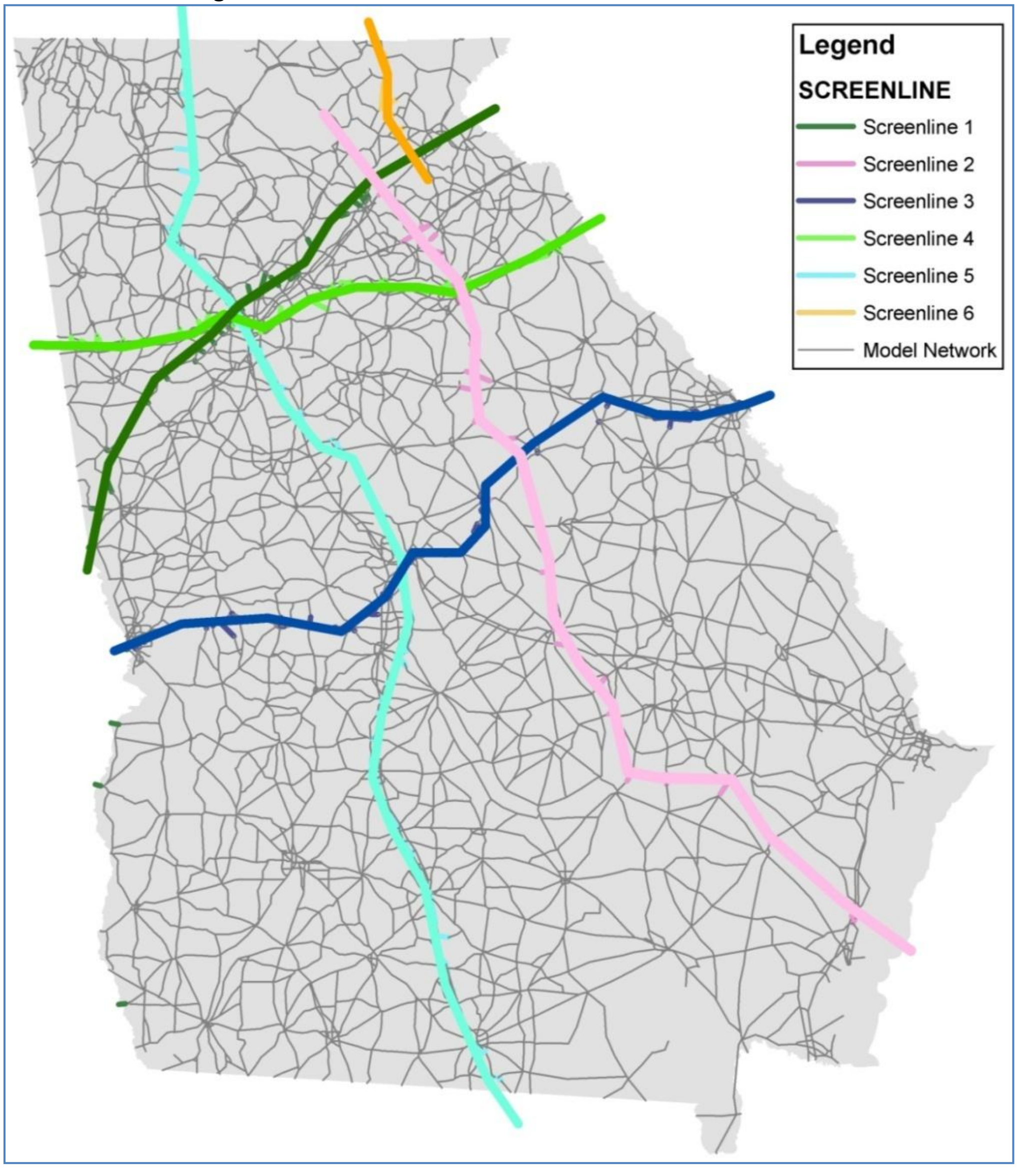
Attribute Name	Description
TAZ	Nearest Taz ID
AREATYPE	Area Type
FTYPE	Facility Type
SPEED	Freeflow Speed in Mile per Hour (Miles per Hour)
TIME_FF	Free Flow Travel Time (Minutes)
CAPACITY	Daily Capacity (Vehicles per Day)
TIME_1	Congested Link Travel Time
CSPD_1	Congested Speed (Miles per Hour)
EEPC	Georgia Through Passenger Daily Vehicle Volumes
PC_V	Passenger Daily Vehicle Volumes
PC_VT	Passenger Daily Vehicle Volumes (Two-way)
GA_NEAR	Internal Passenger Short Trips
GA_LONG	Internal Passenger Long Trips
IE_NEAR	Internal-External Passenger Short Trips
IE_LONG	Internal-External Passenger Long Trips
FRGHT_V	Freight Daily Vehicle Volumes
FRGHT_VT	Freight Daily Vehicle Volumes (Two-way)
EEFRGHT	Georgia Through Fright Daily Vehicle Volumes
EE	Georgia Through Daily Vehicle Volumes
TOTAL_V	Total Daily Vehicle Volumes
TOTAL_VT	Total Daily Vehicle Volumes (Two-way)
VC	Daily Volume over Capacity Ratio
VMT	Total Daily Vehicle Mile of Travel
VHT	Total Daily Vehicle Hour of Travel
FRGHT_VMT	Total Daily Freight Vehicle Mile of Travel
FRGHT_VHT	Total Daily Freight Vehicle Hour of Travel
VERSION	Model Version (Date Released)

Source: Georgia Statewide Travel Demand Model

The assignment model was calibrated so that the base year model volumes reasonably replicate observed 2010-level ground traffic volumes. The base year model volumes were checked using a variety of measures such as the percent error of assigned volumes compared with ground traffic volume counts, the screenline analysis, and the reasonableness of the model's Vehicle-Miles Traveled (VMT) statistics. Model volumes were validated against traffic counts at several levels – regional, corridor, and individual links. Regional evaluations include VMT, percent Root Mean Squared Error (RMSE) and R-Squared calculations. Corridor evaluations primarily include screenline comparisons. Because the Statewide Model will be used to provide external volumes for the current GDOT MPO models, the model volumes were also validated at the MPO boundaries. In addition, traffic flows crossing the state line were checked for reasonableness. Nationally recognized maximum desirable deviation standards are applied to analyze model performance at the link level. These include FHWA's "Calibration & Adjustment of System Planning Models", 1990 and the NCHRP Report 365: "Travel Estimation Techniques for Urban Planning", 1998.

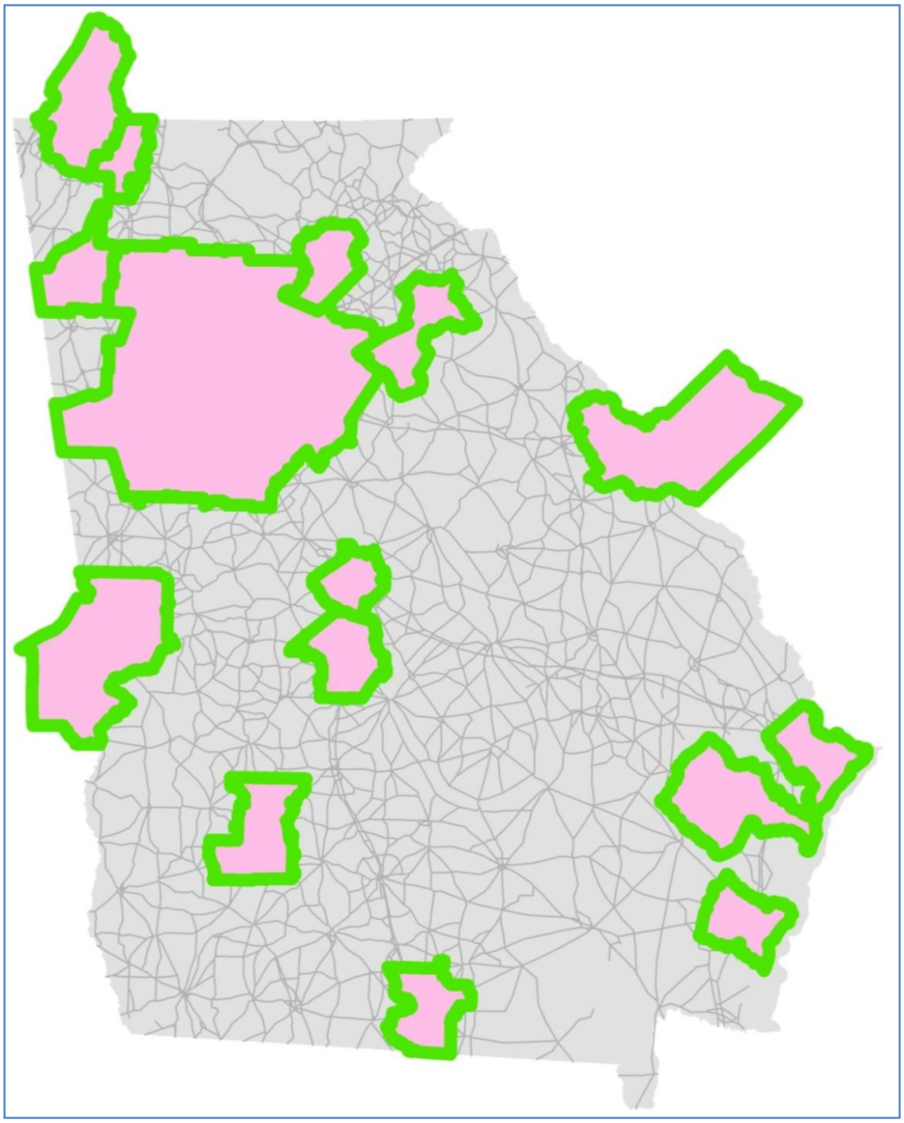
Screenlines are defined by man-made or natural geographic barriers such as railroads, creeks, and rivers. The screenlines are designed to measure the systematic travel across the region and to ensure that the model has reasonably captured those flows. **Figure 5-21** exhibits the locations of the screenlines used in the validation process. Similarly, major roadways crossing the existing MPO boundary were also examined. **Figure 5-22** shows the existing MPO areas covered in the model. The MPO area shown for Atlanta reflects the 20 county non-attainment area which is included in the ARC regional travel demand model.

Figure 5-21: Statewide Model Screenline Locations



Source: Georgia Statewide Travel Demand Model

Figure 5-22: Statewide Model MPO Boundaries



Source: Georgia Statewide Travel Demand Model

Table 5-20 to **Table 5-22** list the summary of travel volume analysis for the screenlines, MPO boundaries, and state line boundaries. Based on the magnitude of observed traffic flows, a maximum desired deviation limit was calculated. The maximum desirable deviation sets the suggested limits for the volume difference and reflects the range within which model results are considered reasonable. Almost all of the model volumes for the analysis are within the acceptable range of observed traffic volumes. In most cases, the largest differences between the model and observed counts occur on the lesser traveled facilities or facilities located within dense areas where a detailed roadway system is not well represented in the model network. This is expected since the Statewide Model is designed to capture higher volume corridors serving major intercity travel and the transportation network is limited in detail at the local level. More detailed tables in Appendix D list the results of the comparison at highway level for each screenline, each MPO boundary, and the state line.

Table 5-20: Screenline Summary

Screenline Name	Volume	Counts	Volume/Count	% Deviation	Maximum Desirable Deviation
1 Chattahoochee River S of Lanier	71,582	81,700	0.88	-12%	±27%
2 Oconee River	204,143	232,403	0.88	-12%	±18%
3 Norfolk Southern RR S N/S	153,829	174,590	0.88	-12%	±20%
4 Norfolk Southern RR N N/S	62,490	80,665	0.77	-23%	±27%
5 CSX RR E/W	340,921	382,395	0.89	-11%	±15%
6 Chattahoochee River N of Lanier	28,730	30,180	0.95	-5%	±39%

Source: Georgia Statewide Travel Demand Model

Table 5-21: MPO Boundary Summary

MPO Name	Volume	Counts	Volume/Count	% Deviation	Maximum Desirable Deviation
1 Albany	52,997	67,460	0.79	-21%	±29%
2 Athens	87,295	105,360	0.83	-17%	±24%
3 Atlanta	622,338	697,421	0.89	-11%	±12%
4 Augusta	173,506	175,257	0.99	-1%	±20%
5 Brunswick	113,900	126,160	0.90	-10%	±23%
6 Columbus	127,555	123,795	1.03	3%	±23%
7 Dalton	196,377	213,975	0.92	-8%	±19%
8 Hinesville	125,869	142,135	0.89	-11%	±22%
9 Macon	240,253	280,580	0.86	-14%	±17%
10 Rome	57,908	73,920	0.78	-22%	±28%
11 Savannah	190,084	222,110	0.86	-14%	±18%
12 Valdosta	128,567	136,555	0.94	-6%	±22%
13 Warner Robins	173,000	191,205	0.90	-10%	±19%

Source: Georgia Statewide Travel Demand Model

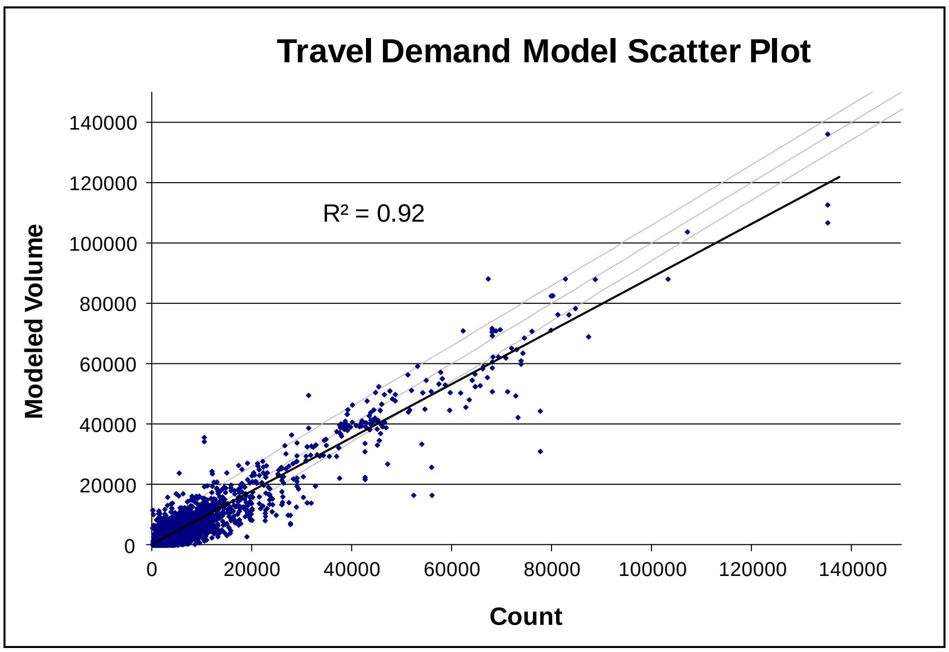
Table 5-22: State Line Summary

State Line Name	Volume	Counts	Volume/Count	% Deviation	Maximum Desirable Deviation
1 North	240,191	277,960	0.86	-14%	±17%
2 East	230,201	241,540	0.95	-5%	±18%
3 South	147,000	137,875	1.07	7%	±22%
4 West	199,738	237,345	0.84	-16%	±18%

Source: Georgia Statewide Travel Demand Model

The validation was also performed on the individual network links through the use of a scatter plot that depicts the relationship between link traffic counts and modeled volumes. **Figure 5-23** shows the relationship between link traffic and observed traffic counts. The graphic indicates that the majority of modeled volumes are consistent with the traffic counts. It should be noted that it is normal to have outliers, both high and low because the model network is only an abstract representation of the existing highway system, omitting many details such as locations where vehicles entering the network and the simplification of localized roadway system. In addition, errors in traffic counts are also common. The R^2 value of 0.92 indicates that the model volumes explained 92% of the variation in the ground traffic pattern, thus the model is replicating base year travel patterns reasonably well.

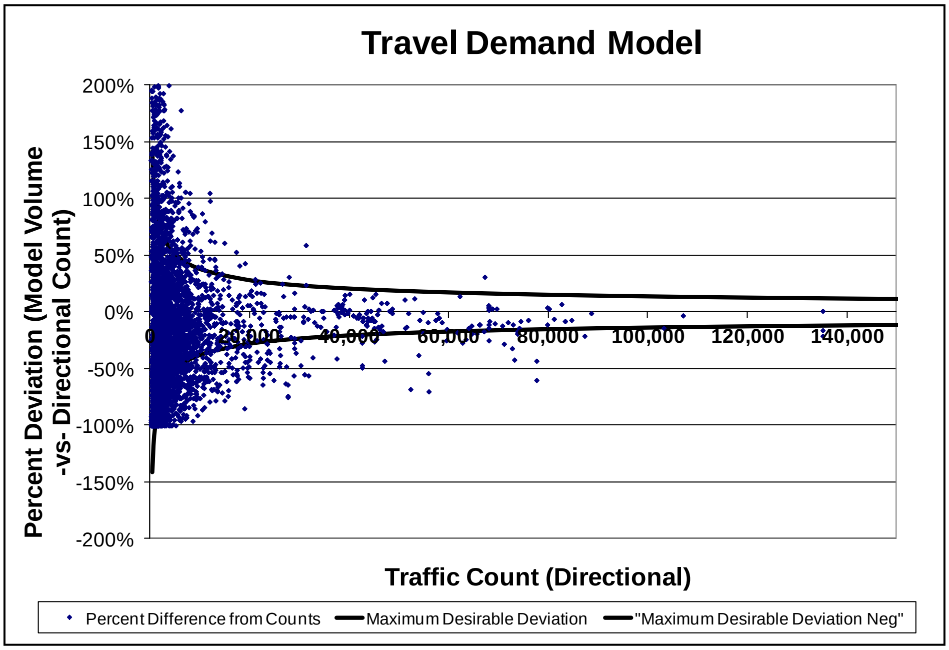
Figure 5-23: Link Volume Scatter Plot



Source: Georgia Statewide Travel Demand Model

Comparing the assigned link volume deviation against the maximum desirable deviation can also reveal the model's performance at individual link level. As discussed earlier, the higher the existing link traffic count, the smaller the maximum desired deviation allowed on that link. Ideally, models should be able to replicate traffic volumes on higher facilities more accurately than those on lower facilities. Therefore, how the model assigns trips on different facilities is another indicator on how well the model is validated and calibrated. **Figure 5-24** shows the comparison of the maximum desired deviation curve and the model assigned volumes. The deviation of link volumes decreases as link traffic counts increase. As expected, the model performs better on higher volume facilities, usually the key corridors in the region. This ensures that the statewide model provides reasonable forecasts for long distance intercity travel.

Figure 5-24: Link Volume Maximum Desired Deviation Scatter Plot



Source: Georgia Statewide Travel Demand Model

The percent RMSE by volume group can provide more detailed information on how each volume group performs. Typically, the percent RMSE statistics should generally decreases as traffic volume increases. All highway links with traffic counts were grouped into seven volume groups from less than 5,000 daily vehicles to over 50,000 daily vehicles. The comparisons were also made based on the link area type as well as the results from other peer statewide models. **Table 5-23** shows that the model consistently performs better in the rural areas which it was designed to do. This is also expected since the major intercity flows heavily use the rural corridors. Inside the urban areas, the model is constrained by the limited number of zones, roadway facilities, as well as the abstraction of centroid connector locations. Because of this, the MPO models should be used instead when performing detailed evaluation of travel conditions and patterns within the MPO areas. The percent RMSE results are also compared with those of peer statewide models. The results are well within other statewide models' experiences.

Table 5-23: Link Volume % RMSE

		Georgia Statewide Model		Other Statewide Models*	
Volume Group	**Count Locations**	**Total**	**Rural**	**Low**	**High**
<5,000	3,066	91	87	22	290
5,000-10,000	936	52	47	22	114
10,000-20,000	804	51	38	22	86
20,000-30,000	471	42	33	19	57
30,000-40,000	270	29	18	14	49
40,000-50,000	179	29	15	12	36
>50,000	354	32	20	5	41
Total	**6,080**	**67**	**54**	**33**	**90**
>5,000	3,014	50	35	N/A	N/A
>10,000	2,078	45	28	N/A	N/A

* Values from Validation and Sensitivity Considerations for Statewide Model NCHRP Project 836-B Task 91, September, 2010

Table 5-23 also shows that the overall percent RMSE is relatively high for the lower level of traffic count volume groups. The modeled volumes on these low-volume facilities are highly sensitive to the location of the centroid connector which is the aggregation of local street system that facilitates trips from zones to adjacent highway network. On the other hand, modeled volumes on the high-volume facilities are less influenced by the centroid connector location. For example, there are no centroid connectors directly connecting to the freeway system. Therefore it is expected that the low-volume facilities tend to have higher percent RMSEs. Close to 60% of the count locations in the model network belongs to the volume group of 5,000 and less and 70% for volumes group of 10,000 and less. The large concentration of links in the low-volume groups can overweight the average percent RMSE. Thus, the overall percent RMSE is heavily relied on the distribution of the count stations across all volume groups.

Table 5-24 shows the distribution of the traffic count stations in the statewide model by facility type, area type, as well as the volume group. Over three quarters of the counts are located within the rural area and the majority of the counts are on the collector and minor arterial system.

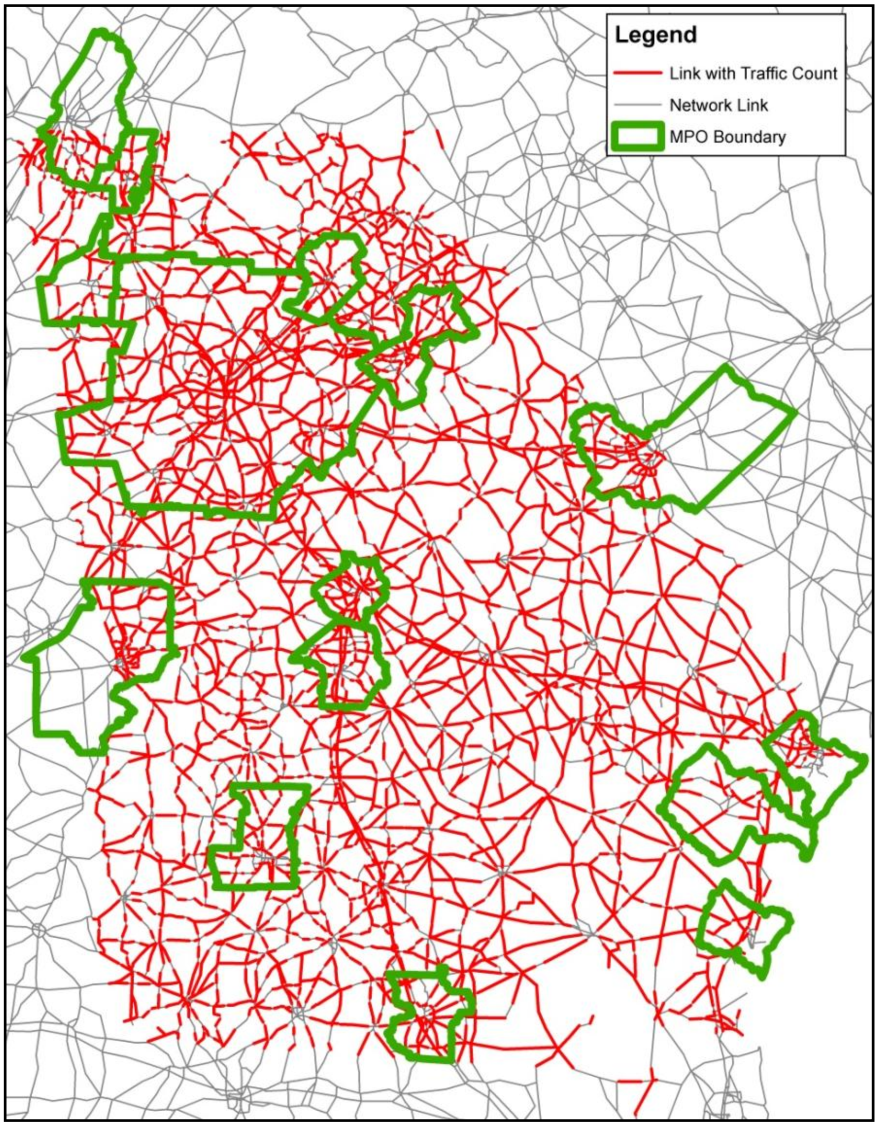
Table 5-24: Traffic Count Volume Group by Facility Type and Area Type

		Traffic Counts - Volume Group								
Area Type	**Facility**	**<5,000**	**5,000-10,000**	**10,000-20,000**	**20,000-30,000**	**30,000-40,000**	**40,000-50,000**	**>50,000**	**Grand Total**	**% of Total**
Rural	Interstate/Freeways	0	0	21	43	47	56	77	244	4%
	Principal Arterials	276	269	170	37	9	0	2	763	13%
	Minor Arterials	1,114	332	92	6	1	4	0	1,549	25%
	Collectors	1,530	81	13	0	0	0	0	1,624	27%
	Locals	1	2	1	0	0	0	0	1	0%
	Subtotal	**2,921**	**684**	**297**	**86**	**57**	**60**	**79**	**4,181**	**69%**
Urban	Interstate/Freeways	0	0	4	18	31	29	259	341	6%
	Principal Arterials	16	97	249	259	136	75	16	848	14%
	Minor Arterials	112	147	242	108	46	15	0	670	11%
	Collectors	19	10	10	1	0	0	0	40	1%
	Subtotal	**147**	**254**	**505**	**386**	**213**	**119**	**275**	**1,899**	**31%**
	Grand Total	**3,068**	**938**	**802**	**472**	**270**	**179**	**354**	**6,080**	**100%**

Source: Georgia Statewide Travel Demand Model

Figure 5-25 shows the locations of the traffic counts over the statewide model network links. Over 90% of the network links were identified with the existing traffic count stations.

Figure 5-25: Location of Traffic Counts



Source: Georgia Statewide Travel Demand Model

In addition to the validation check based on the percent RMSE, the "Travel Model Validation and Reasonability Checking Manual, Second Edition, TMIP, 2010" suggests comparing RMSE relative to per lane highway capacities. If the average error on links (RMSE) is small relative to the associated per lane highway capacities, then it reduces the potential of inappropriately predicting capacity deficiencies. For example, assume a highway segment has a capacity of 12,000 vehicles per day (vpd). If the forecast traffic volume is 7,000 vpd, an RMSE of 4,000 (one-third of a lane of capacity) implies the actual future volume could be as high as 11,000 vpd which is below the capacity; but an RMSE of 8,000 vpd (two-thirds of lane of capacity) implies the actual future volume could be as high as 15,000 vpd which exceeds the capacity. The lower the ratio of the RMSE divided by the per lane capacity, the less likely a highway capacity deficiency will be falsely identified. Table 5-25 shows the ratios of RMSE over the per lane capacity by facility type and area type for the Georgia Statewide Travel Demand Model.

Table 5-25: RMSE Relative to Capacity

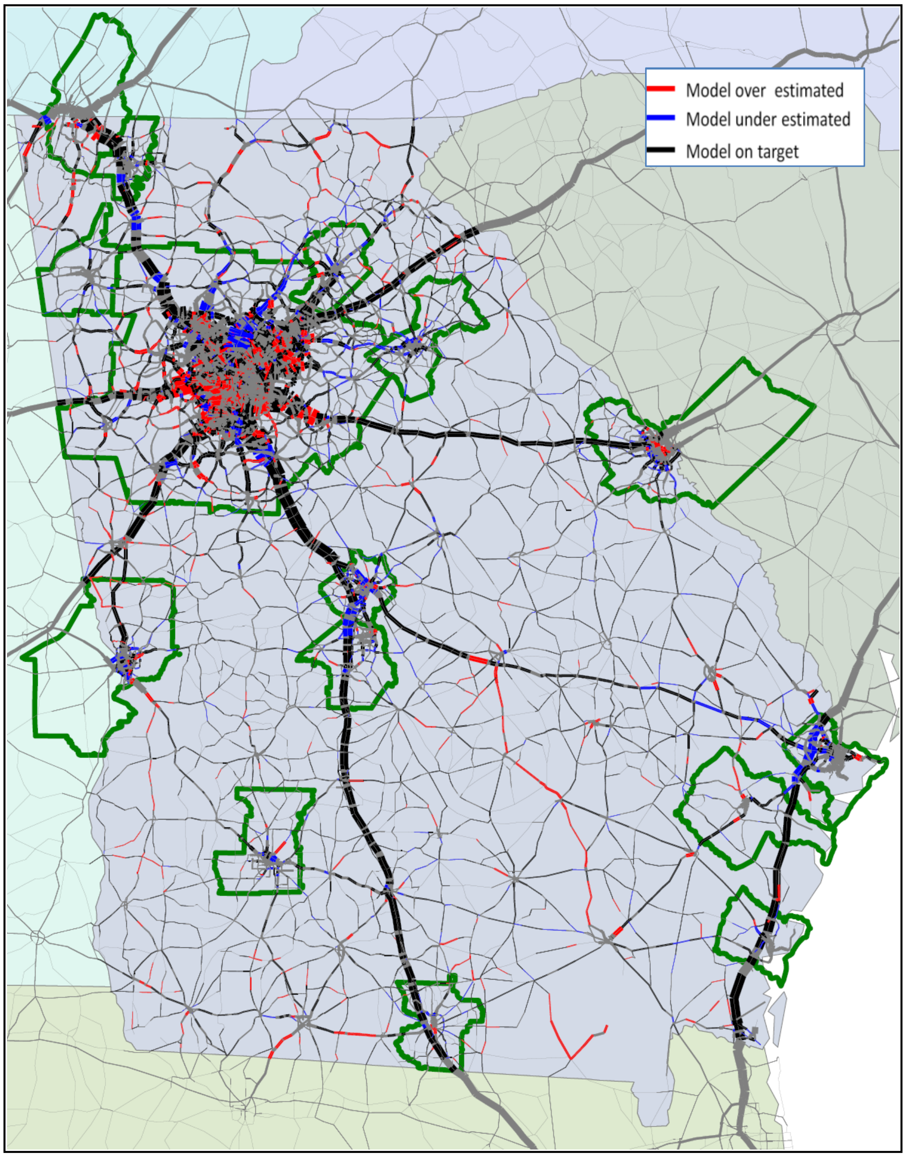
Facility	Rural	Urban	Total
Interstate/Freeways	0.24	1.02	0.78
Principal Arterials	0.19	0.61	0.46
Minor Arterials	0.19	0.44	0.29
Collectors	0.13	0.35	0.14
Locals	0.02	0.00	0.02
Total	**0.18**	**0.74**	**0.49**

Source: Georgia Statewide Travel Demand Model

In general, it is preferable for the ratios in Table 5-25 to be 0.5 or less, which represents an accuracy of one-half a lane of capacity or better. Ratios for rural facilities are all significantly less than 0.5, which indicates that the model performs very well in rural areas, which is the primary purpose of the model. In urban areas, the model performs reasonably well but not within preferred accuracies. However, such reasonableness checks should not be used as a pass-fail test. It simply indicates that there is less confidence in model forecasts within urban areas, which the model is not the model's intended purpose. However, future revisions to the Georgia Statewide Travel Demand model are expected to include changes that will improve results within urban areas.

Figure 5-26 displays the network plot based on the maximum desired deviation. The visual check helps to identify the locations of discrepancy between model volumes and traffic counts. This confirms results observed in the RMSE analysis.

Figure 5-26: Link Volume Maximum Desired Deviation Plot



Source: Georgia Statewide Travel Demand Model

The model assignment was also validated by highway functional class as well. **Table 5-26** shows the model VMT on links with traffic counts. The better match of the model VMT and the count VMT indicates better model performance. This table confirms that the Statewide Model performed well in estimating traffic volumes on the higher facilities such as interstates and principal and minor arterials. It is reasonable to see that the model does not perform as well on lower volume facilities such as collectors and locals due to limitations of the model discussed earlier.

Table 5-26: Link Volume Validation (in thousands)

Model VMT			
VMT	**Rural**	**Urban**	**Total**
Interstate	7,609	22,511	30,120
Principal Arterials	5,083	10,448	15,531
Minor Arterials	3,755	5,090	8,845
Collectors	1,692	724	2,415
Locals	1	0	1
Total	18,140	38,772	56,911
Existing Count VMT			
VMT (Counts)	**Rural**	**Urban**	**Total**
Interstate	7,956	22,077	30,033
Principal Arterials	4,927	11,185	16,112
Minor Arterials	4,504	5,810	10,314
Collectors	2,346	887	3,233
Locals	1	0	1
Total	19,734	39,958	59,692
Percent Difference			
VMT	**Rural**	**Urban**	**Total**
Interstate	-4%	2%	0%
Principal Arterials	3%	-7%	-4%
Minor Arterials	-17%	-12%	-14%
Collectors	-28%	-18%	-25%
Locals	-40%	0%	-40%
Total	-8%	-3%	-5%

Source: Georgia Statewide Travel Demand Model and GDOT Traffic Counts - 2010

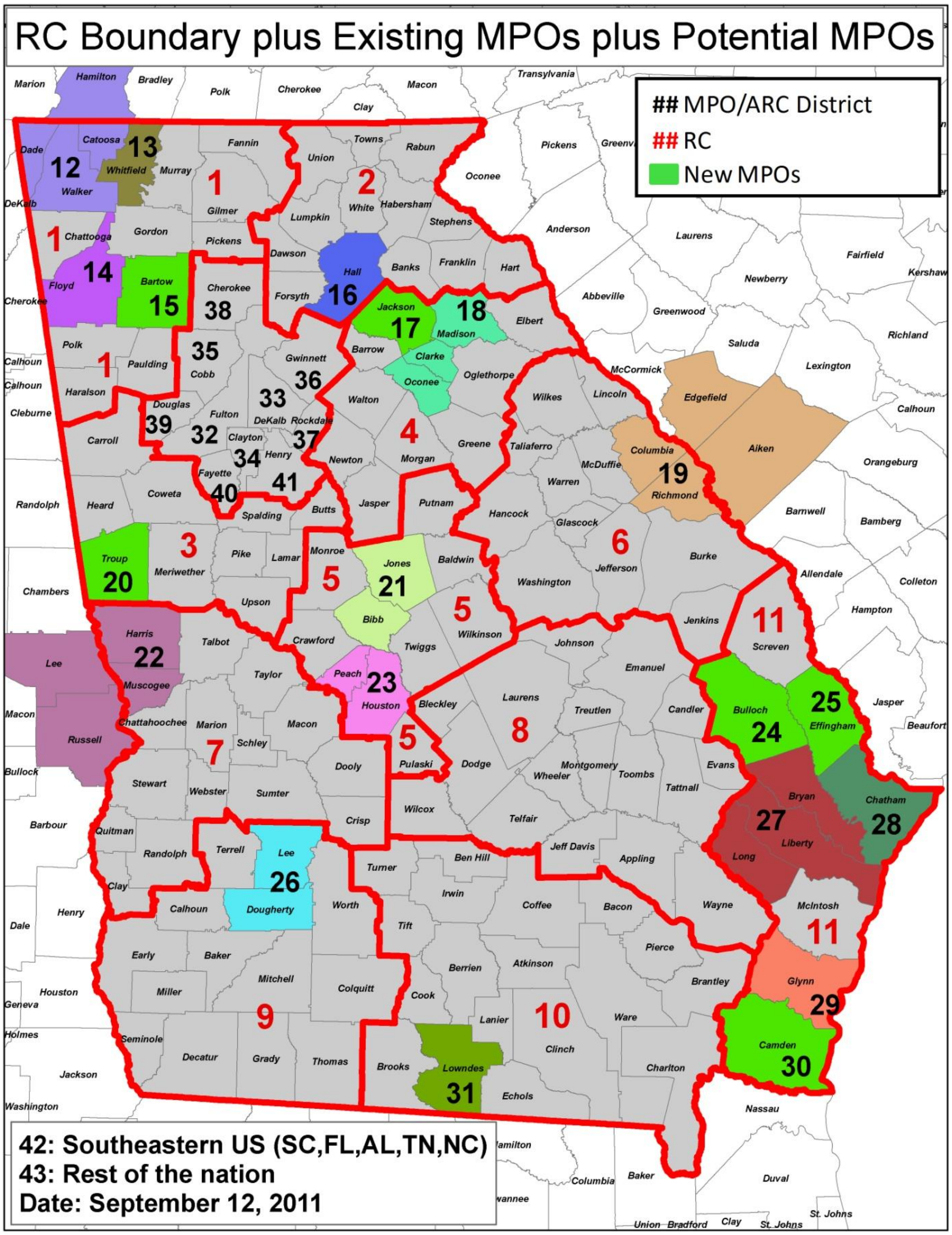
The assigned volumes are also compared with the FHWA suggested criteria. **Table 5-27** shows that the model is performing well within the suggested targets by facility type.

Table 5-27: Percent Assignment Error by Facility Type

Facility	Model	FHWA*
Interstate	0%	±7%
Principal Arterials	-4%	±10%
Minor Arterials	-14%	±15%
Collectors	-25%	±20%
Locals	-40%	N/A

* 1997 FHWA Model Validation and Reasonableness Checking Manual

APPENDIX A – REMI DISTRICTS



Appendix A

Table A-1: List of Counties, MPOs and RDCs for REMI Districts

REMI Region	RC	MPO	County 1	County 2	County 3	County 4	County 5	County 6	County 7	County 8	County 9	County 10	County 11	County 12	County 13	County 14	County 15	County 16	County 17	County 18
1	NW Ga		Chattooga	Fannin	Gilmer	Gordon	Haralson	Murray	Pickens	Polk	Paulding									
2	Ga Mtns		Banks	Dawson	Franklin	Habersham	Hart	Lumpkin	Rabun	Stephens	Towns	Union	White	Forsyth						
3	3 Rivers		Butts	Heard	Lamar	Meriwether	Pike	Upson	Carroll	Coweta	Spalding									
4	NE Ga		Elbert	Greene	Jasper	Morgan	Oglethorpe	Barrow	Newton	Walton										
5	Middle Ga		Baldwin	Putnam	Wilkinson	Crawford	Monroe	Pulaski	Twiggs											
6	Central Sav River		Burke	Glascock	Hancock	Jefferson	Jenkins	Lincoln	McDuffie	Taliaferro	Warren	Washington	Wilkes							
7	River Valley		Talbot	Taylor	Chattahoochee	Clay	Crisp	Dooly	Macon	Marion	Quitman	Randolph	Schley	Stewart	Sumter	Webster				
8	Heart of Ga		Appling	Candler	Emanuel	Evans	Jeff Davis	Johnson	Laurens	Montgomery	Tattnall	Toombs	Treutlen	Wayne	Wheeler	Bleckley	Dodge	Telfair	Wilcox	
9	SW Ga		Baker	Calhoun	Colquitt	Decatur	Early	Grady	Miller	Mitchell	Seminole	Terrell	Thomas	Worth						
10	Southern Ga		Bacon	Brantley	Charlton	Pierce	Ware	Atkinson	Ben Hill	Berrien	Clinch	Coffee	Echols	Irwin	Lanier	Brooks	Cook	Tift	Turner	
11	Coastal Regl		McIntosh	Screven																
12	NW Ga	Chattanoogna	Catoosa	Dade	Walker	Hamilton (TN)														
13	NW Ga	Dalton	Whitfield																	
14	NW Ga	Rome	Floyd																	
15	NW Ga	Cartersville	Bartow																	
16	Ga Mtns	Gainesville	Hall																	
17	NE Ga	Winder	Jackson																	
18	NE Ga	Athens	Clarke	Madison	Oconee															
19	Central Sav River	Augusta	Columbia	Richmond	Edgefield (SC)	Aiken (SC)														
20	3 Rivers	LaGrange	Troup																	
21	Middle Ga	Macon	Jones	Bibb																
22	River Valley	Columbus	Harris	Russell (AL)	Lee (AL)	Muscogee														
23	Middle Ga	Warner Robins	Houston	Peach																
24	Coastal Regl	Statesboro	Bulloch																	
25	Coastal Regl		Effingham																	
26	SW Ga	Albany	Dougherty	Lee																
27	Coastal Regl	Hinesville	Bryan	Liberty	Long															
28	Coastal Regl	Savannah	Chatham																	
29	Coastal Regl	Brunswick	Glynn																	
30	Coastal Regl		Camden																	
31	Southern Ga	Valdosta	Lowndes																	
32	ARC[1]	Fulton																		
33	ARC[1]	DeKalb																		
34	ARC[1]	Clayton																		
35	ARC[1]	Cobb																		
36	ARC[1]	Gwinnett																		
37	ARC[1]	Rockdale																		
38	ARC[1]	Cherokee																		
39	ARC[1]	Douglas																		
40	ARC[1]	Fayette																		
41	ARC[1]	Henry																		
42	SE US	Alabama	Tennessee	Florida	N Carolina	S Carolina														
43	Rest of US																			

Note: [1] *The 20 county ARC region has been subdivided into 10 separate internal districts which match ARC's REMI districts, the remaining 8 counties have been included in their appropriate RDC except for Bartow and Hall which have been separated out into separate districts to reflect the Gainesville and potential Cartersville MPOs.*

APPENDIX B – RAIL, AIR AND TRAIN NETWORK VARIABLES

Table B-1: Rail Network Variables

Link Attribute	Description
A	A node number
B	B node number
STCODE	2-digit state fips code
CTCODE	3-digit county fips code
RROWNER1	Largest owner
RROWNER2	Next owner
RROWNER3	Smallest owner
TR1	Track rights railroad name 1
TR2	Track rights railroad name 2
TR3	Track rights railroad name 3
TR4	Track rights railroad name 4
TR5	Track rights railroad name 5
TR6	Track rights railroad name 6
TR7	Track rights railroad name 7
TR8	Track rights railroad name 8
TR9	Track rights railroad name 9
SUBDIVISIO	Subdivision name
YNAME	Rail yard name
DIRECTION	Directional track
DENSITY	Density category
IND_NAME	N/A
MLC	Mainline class
FNODE	N/A
TNODE	N/A
MILES	Length of segment
LINK	N/A
RAILCODE	Rail class
DISTANCE	Length of segment
PENALTY	N/A
SPEED	Travel speed (mph)

Table B-2: Air Network Variables

Link Attribute	Description
Mode	Air (3)
Headway	Time gap between flights (minutes)
Runtime	Gate to gate time
Oneway	Oneway (1)
Color	Color code on map

Table B-3: Passenger Rail Network Variables

Link Attribute	Description
Mode	Train (1)
Headway	Time gap between trains (minutes)
Xyspeed	Travel speed (mph)
Oneway	Oneway (1)
Color	Color code on map

APPENDIX C – FREIGHT MODE CHOICE VALIDATION TABLES

Table C-1: Mode Choice Validation Tables

Transearch Share - Agriculture			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	96%	4%	100%
100-200 miles	86%	14%	100%
200-300 miles	85%	15%	100%
300-500 miles	77%	23%	100%
>500 miles	62%	38%	100%
Total	68%	32%	100%
Model Share - Agriculture			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	95%	5%	100%
100-200 miles	88%	12%	100%
200-300 miles	85%	15%	100%
300-500 miles	79%	21%	100%
>500 miles	62%	38%	100%
Total	67%	33%	100%

Transearch Share - Mining			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	96%	4%	100%
100-200 miles	74%	26%	100%
200-300 miles	64%	36%	100%
300-500 miles	10%	90%	100%
>500 miles	11%	89%	100%
Total	61%	39%	100%
Model Share - Mining			
Distance	Truck	Rail	Total
<50 miles	99%	1%	100%
50-100 miles	95%	5%	100%
100-200 miles	74%	26%	100%
200-300 miles	63%	37%	100%
300-500 miles	51%	49%	100%
>500 miles	51%	49%	100%
Total	75%	25%	100%

Transearch Share - Food			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	99%	1%	100%
100-200 miles	89%	11%	100%
200-300 miles	89%	11%	100%
300-500 miles	84%	16%	100%
>500 miles	80%	20%	100%
Total	83%	17%	100%
Model Share - Food			
Distance	Truck	Rail	Total
<50 miles	99%	1%	100%
50-100 miles	99%	1%	100%
100-200 miles	89%	11%	100%
200-300 miles	88%	12%	100%
300-500 miles	83%	17%	100%
>500 miles	79%	21%	100%
Total	81%	19%	100%

Transearch Share - Textile			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	100%	0%	100%
200-300 miles	100%	0%	100%
300-500 miles	99%	1%	100%
>500 miles	95%	5%	100%
Total	96%	4%	100%
Model Share - Textile			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	100%	0%	100%
200-300 miles	99%	1%	100%
300-500 miles	99%	1%	100%
>500 miles	92%	8%	100%
Total	96%	4%	100%

Transearch Share - Wood			
Distance	Truck	Rail	Total
<50 miles	93%	7%	100%
50-100 miles	91%	9%	100%
100-200 miles	92%	8%	100%
200-300 miles	95%	5%	100%
300-500 miles	92%	8%	100%
>500 miles	87%	13%	100%
Total	91%	9%	100%
Model Share - Wood			
Distance	Truck	Rail	Total
<50 miles	94%	6%	100%
50-100 miles	91%	9%	100%
100-200 miles	91%	9%	100%
200-300 miles	95%	5%	100%
300-500 miles	92%	8%	100%
>500 miles	83%	17%	100%
Total	90%	10%	100%

Transearch Share - Paper			
Distance	Truck	Rail	Total
<50 miles	97%	3%	100%
50-100 miles	87%	13%	100%
100-200 miles	76%	24%	100%
200-300 miles	57%	43%	100%
300-500 miles	42%	58%	100%
>500 miles	62%	38%	100%
Total	66%	34%	100%
Model Share - Paper			
Distance	Truck	Rail	Total
<50 miles	97%	3%	100%
50-100 miles	87%	13%	100%
100-200 miles	77%	23%	100%
200-300 miles	55%	45%	100%
300-500 miles	51%	49%	100%
>500 miles	63%	37%	100%
Total	67%	33%	100%

Transearch Share - Chemicals			
Distance	Truck	Rail	Total
<50 miles	78%	22%	100%
50-100 miles	63%	37%	100%
100-200 miles	71%	29%	100%
200-300 miles	77%	23%	100%
300-500 miles	67%	33%	100%
>500 miles	81%	19%	100%
Total	79%	21%	100%
Model Share - Chemicals			
Distance	Truck	Rail	Total
<50 miles	77%	23%	100%
50-100 miles	63%	37%	100%
100-200 miles	71%	29%	100%
200-300 miles	77%	23%	100%
300-500 miles	67%	33%	100%
>500 miles	77%	23%	100%
Total	76%	24%	100%

Transearch Share - Petroleum			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	100%	0%	100%
200-300 miles	97%	3%	100%
300-500 miles	92%	8%	100%
>500 miles	58%	42%	100%
Total	83%	17%	100%
Model Share - Petroleum			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	100%	0%	100%
200-300 miles	95%	5%	100%
300-500 miles	93%	7%	100%
>500 miles	57%	43%	100%
Total	80%	20%	100%

Transearch Share - Rubber			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	86%	14%	100%
200-300 miles	99%	1%	100%
300-500 miles	99%	1%	100%
>500 miles	99%	1%	100%
Total	98%	2%	100%
Model Share - Rubber			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	87%	13%	100%
200-300 miles	100%	0%	100%
300-500 miles	100%	0%	100%
>500 miles	87%	13%	100%
Total	88%	12%	100%

Transearch Share - Stoneware			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	98%	2%	100%
100-200 miles	57%	43%	100%
200-300 miles	82%	18%	100%
300-500 miles	76%	24%	100%
>500 miles	62%	38%	100%
Total	81%	19%	100%
Model Share - Stoneware			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	98%	2%	100%
100-200 miles	57%	43%	100%
200-300 miles	82%	18%	100%
300-500 miles	78%	22%	100%
>500 miles	63%	37%	100%
Total	85%	15%	100%

Transearch Share – Primary Metal			
Distance	Truck	Rail	Total
<50 miles	99%	1%	100%
50-100 miles	100%	0%	100%
100-200 miles	88%	12%	100%
200-300 miles	84%	16%	100%
300-500 miles	81%	19%	100%
>500 miles	80%	20%	100%
Total	81%	19%	100%
Model Share – Primary Metal			
Distance	Truck	Rail	Total
<50 miles	98%	2%	100%
50-100 miles	100%	0%	100%
100-200 miles	89%	11%	100%
200-300 miles	84%	16%	100%
300-500 miles	83%	17%	100%
>500 miles	74%	26%	100%
Total	77%	23%	100%

Transearch Share – Fabricated Metal			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	99%	1%	100%
200-300 miles	100%	0%	100%
300-500 miles	100%	0%	100%
>500 miles	99%	1%	100%
Total	99%	1%	100%
Model Share – Fabricated Metal			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	99%	1%	100%
200-300 miles	100%	0%	100%
300-500 miles	100%	10%	100%
>500 miles	91%	9%	100%
Total	92%	8%	100%

Transearch Share - Machinery			
Distance	Truck	Rail	Total
<50 miles	99%	1%	100%
50-100 miles	96%	4%	100%
100-200 miles	94%	6%	100%
200-300 miles	97%	3%	100%
300-500 miles	72%	28%	100%
>500 miles	81%	19%	100%
Total	82%	18%	100%
Model Share - Machinery			
Distance	Truck	Rail	Total
<50 miles	98%	2%	100%
50-100 miles	95%	5%	100%
100-200 miles	91%	9%	100%
200-300 miles	95%	5%	100%
300-500 miles	72%	28%	100%
>500 miles	80%	20%	100%
Total	81%	19%	100%

Transearch Share - Instruments			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	96%	4%	100%
200-300 miles	100%	0%	100%
300-500 miles	100%	0%	100%
>500 miles	98%	2%	100%
Total	98%	2%	100%
Model Share - Instruments			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	98%	2%	100%
200-300 miles	100%	0%	100%
300-500 miles	100%	0%	100%
>500 miles	78%	22%	100%
Total	81%	19%	100%

Transearch Share - Miscellaneous			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	94%	6%	100%
200-300 miles	87%	13%	100%
300-500 miles	90%	10%	100%
>500 miles	78%	22%	100%
Total	87%	13%	100%
Model Share - Miscellaneous			
Distance	Truck	Rail	Total
<50 miles	100%	0%	100%
50-100 miles	100%	0%	100%
100-200 miles	94%	6%	100%
200-300 miles	88%	12%	100%
300-500 miles	90%	10%	100%
>500 miles	76%	24%	100%
Total	86%	14%	100%

APPENDIX D – HIGHWAY ASSIGNMENT VALIDATION TABLES

Table D-1: Screenlines

Screenline 1: Chattahoochee River S of Lake Lanier					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
U29	2,721	9,170	0.3	-70%	40%
I85	32,663	30,970	1.05	5%	23%
U82	1,115	2,590	0.43	-57%	69%
S219	1,524	1,545	0.99	-1%	86%
U27	8,653	7,290	1.19	19%	44%
S39	122	1,590	0.08	-92%	85%
S91	1,976	1,690	1.17	17%	83%
U27 A	7,784	10,090	0.77	-23%	38%
S5	7,570	3,170	2.39	139%	63%
S109	1942	3,700	0.52	-48%	59%
S10	978	1,575	0.62	-38%	86%
S52	1,278	3,200	0.4	-60%	63%
U84	3,257	5,120	0.64	-36%	51%
Total	**71,582**	**81,700**	**0.88**	**-12%**	**27%**

Screenline 2: Oconee River					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
I85	40,720	46,460	0.88	-12%	20%
82 S	3,945	1,980	1.99	99%	78%
S335	1,982	2,330	0.85	-15%	72%
I20	27,042	28,110	0.96	-4%	24%
S15	1,130	3,260	0.35	-65%	62%
S44	8,813	10,410	0.85	-15%	38%
S16	485	1,100	0.44	-56%	100%
S57	1985	2,050	0.97	-3%	76%
I16	15,908	20,060	0.79	-21%	28%
S46	702	1,080	0.65	-35%	101%
U280	4639	4390	1.06	6%	55%

Screenline 2: Oconee River					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
U221	3,280	3,320	0.99	-1%	62%
U1	2,959	4,780	0.62	-38%	53%
S121	1,738	2,453	0.71	-29%	71%
U25	15,548	13,920	1.12	12%	33%
I95	46,785	45,860	1.02	2%	20%
U17	3,041	7,450	0.41	-59%	44%
U17	3,105	7,450	0.42	-58%	44%
U23	13,831	19,840	0.7	-30%	28%
S15	5,174	3,850	1.34	34%	58%
U278	1,331	2,250	0.59	-41%	73%
Total	**204,143**	**232,403**	**0.88**	**-12%**	**18%**

Screenline 3: Norfolk Southern RR S N/S Screenline					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S355	1,836	2,070	0.89	-11%	76%
S41	900	620	1.45	45%	129%
S240	1	610	0	-100%	130%
S96	4,479	3,700	1.21	21%	59%
U19	3,181	2,800	1.14	14%	67%
S128	725	1,790	0.41	-59%	81%
S96	3,797	5,950	0.64	-36%	48%
S247C	3,753	7,730	0.49	-51%	43%
S49	10,169	11,160	0.91	-9%	36%
S42	856	2,560	0.33	-67%	69%
I75	50981	55,760	0.91	-9%	18%
I16	22,575	22,670	1	0%	27%
Henderson Rd	1581	1,470	1.08	8%	88%
S18	391	2,150	0.18	-82%	75%
S Mail St	3,068	3,300	0.93	-7%	62%
S243	2,795	2,740	1.02	2%	67%
S15	4,571	3,500	1.31	31%	60%
S278	2108	1,950	1.08	8%	78%

Screenline 3: Norfolk Southern RR S N/S Screenline					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S80	2121	1,810	1.17	17%	81%
S10	1,893	5,550	0.34	-66%	49%
U78	3290	4,790	0.69	-31%	53%
U221	2121	1,760	1.21	21%	82%
U78	4039	5,980	0.68	-32%	48%
U221	485	1,760	0.28	-72%	82%
U78	7714	5,980	1.29	29%	48%
S137	43	710	0.06	-94%	121%
U221	2618	1,760	1.49	49%	82%
U78	4892	5,980	0.82	-18%	48%
U78	6847	5,980	1.14	15%	48%
Total	**153829**	**174,590**	**0.88**	**-12%**	**20%**

Screenline 4: Norfolk Southern RR N N/S Screenline					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S100	510	3,425	0.15	-85%	61%
U78	302	5,800	0.05	-95%	49%
U27	12,413	10,980	1.13	13%	37%
S101	7,321	7,660	0.96	-4%	43%
S101	5,295	7,660	0.69	-31%	43%
S22	1,734	1,800	0.96	-4%	81%
S72	4,464	5,095	0.88	-12%	51%
S17	4,750	6,250	0.76	-24%	47%
S77	3,064	6,090	0.5	-50%	48%
S316	22,635	25,905	0.87	-13%	25%
Total	**62,490**	**80,665**	**0.77**	**-23%**	**27%**

Screenline 5: CSX RR E/W Screenline					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
I75	53,175	58,570	0.91	-9%	18%
I75	76,417	83,330	0.92	-8%	15%
S140	324	150	2.16	116%	239%
U411	330	2700	0.12	-88%	68%
U411	3167	2880	1.1	10%	66%
U411	2363	2615	0.9	-10%	69%
S156	1,049	1,310	0.8	-20%	93%
S53	4,971	8,140	0.61	-39%	42%
S20	19,381	17,780	1.09	9%	30%
S155	15,021	17,560	0.86	-14%	30%
Old Bethel Rd	4,128	4,530	0.91	-9%	54%
S36	7,082	4,960	1.43	43%	52%
S16	4,218	5,160	0.82	-18%	51%
S83	1665	2,100	0.79	-21%	76%
Farmers Mkt Rd	782	1,680	0.47	-53%	83%
S27	2,703	5,460	0.49	-51%	50%
S300	5159	7,990	0.65	-35%	42%
33C	33	900	0.04	-96%	109%
Pinehurst Rd	1282	860	1.49	49%	112%
I75	38318	43,490	0.88	-12%	20%
S18	3313	2,980	1.11	11%	65%
1st St	874	1,420	0.62	-38%	90%
S230	158	1,865	0.08	-92%	80%
S26	633	1,460	0.43	-57%	89%
U41	689	1,510	0.46	-54%	87%
S32	491	820	0.6	-40%	114%
S112	5,032	4,460	1.13	13%	54%
Golden Isl Pkwy	3,700	2,410	1.54	54%	71%
U341	864	3,960	0.22	-78%	57%
U41	1219	2,030	0.6	-40%	77%
247 S	326	4,010	0.08	-92%	57%
U41	946	2,030	0.47	-53%	77%
U41	942	1,710	0.55	-45%	83%
Chula Whiddon Rd	181	570	0.32	-68%	133%
U41	2030	2,300	0.88	-12%	73%

Screenline 5: CSX RR E/W Screenline					
Road Name	**Volume**	**Counts**	**Volume/Count**	**% Deviation**	**Max Desirable Deviation**
U41	1451	1,910	0.76	-24%	79%
S547	339	620	0.55	-45%	129%
Old Coffee Rd	1122	1,490	0.75	-25%	88%
U41	7543	5,650	1.34	34%	49%
B41	2631	2,720	0.97	-3%	68%
U41	4992	6,110	0.82	-18%	47%
I75	37687	36,875	1.02	2%	22%
U411	13429	11,970	1.12	12%	35%
U23	8762	9,350	0.94	-6%	39%
Total	**340921**	**382,395**	**0.89**	**-11%**	**15%**

Screenline 6: Chattahoochee River N of Lake Lanier					
Road Name	**Volume**	**Counts**	**Volume/Count**	**% Deviation**	**Max Desirable Deviation**
S17	2,242	2,120	1.06	6%	75%
S356	7	1,500	0	-100%	88%
U76	6,833	7,580	0.9	-10%	43%
S17	6,630	6,490	1.02	2%	46%
S255	1,375	1,510	0.91	-9%	87%
S115	7,621	5,290	1.44	44%	51%
S384	4,021	5,690	0.71	-29%	49%
Total	**28,730**	**30,180**	**0.95**	**-5%**	**39%**

Table D-2: MPO Boundaries

Albany MPO External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S234	248	1,500	0.17	-83%	88%
S62	1,215	2,090	0.58	-42%	76%
Tallahassee Rd	80	260	0.31	-69%	188%
Tarva Rd	896	440	2.04	104%	149%
S118	403	850	0.47	-53%	112%
U82	9,795	13480	0.73	-27%	34%
S32	1,050	710	1.48	48%	121%
U19	2830	4000	0.71	-29%	57%
S91	2,477	3,230	0.77	-23%	63%
S377	36	750	0.05	-95%	118%
U19	8,195	8,790	0.93	-7%	40%
S195	225	700	0.32	-68%	122%
S Shaw Rd	109	1,730	0.06	-94%	82%
S300	5,473	7,280	0.75	-25%	44%
U82	16,144	13,210	1.22	22%	34%
S32	2,542	2,830	0.9	-10%	66%
S133	1,172	4,780	0.25	-75%	53%
Spring Hats Rd	106	830	0.13	-87%	113%
Total	**52,997**	**67,460**	**0.79**	**-21%**	**29%**

Athens MPO External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
U78	9,712	13,400	0.72	-28%	34%
S316	11,714	18,650	0.63	-37%	29%
Snows Mill Rd	1,762	1,230	1.43	43%	95%
S186	705	1,670	0.42	-58%	84%
Tallassee Rd	2,640	1,870	1.41	41%	79%
U129	7,068	13,050	0.54	-46%	34%
U129	6,791	6,510	1.04	4%	46%
U441	11,950	13,250	0.9	-10%	34%

Athens MPO External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S98	6,917	4,470	1.55	55%	54%
S15	1,130	3,260	0.35	-65%	62%
S Main St	3,006	2,840	1.06	6%	66%
S106	3,575	2,280	1.57	57%	73%
U78	6,586	8,720	0.76	-24%	41%
U29	3,546	3,630	0.98	-2%	60%
S22	1,848	1,650	1.12	12%	84%
S281	1,927	1,660	1.16	16%	84%
S172	1,956	2,125	0.92	-8%	75%
S72	4,464	5,095	0.88	-12%	51%
Total	**87,295**	**105,360**	**0.83**	**-17%**	**24%**

Atlanta MPO External Station volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S5	2,003	3,710	0.54	-46%	59%
S100	5,892	3,850	1.53	53%	58%
S166	1624	0	0	0%	0%
I20	35,113	34,710	1.01	1%	22%
Five Points Rd	0	5,085	0	-100%	51%
Unknown	8,932	9,970	0.9	-10%	38%
U27	6,773	9,000	0.75	-25%	40%
U27	8,579	5,980	1.43	43%	48%
U78	5,256	5,780	0.91	-9%	49%
S113	3,629	2,860	1.27	27%	66%
S113	2,724	3,700	0.74	-26%	59%
S293	1,671	1,630	1.03	3%	84%
U278	3,437	3,980	0.86	-14%	57%
S140	7,564	7,270	1.04	4%	44%
U278	8,693	7,360	1.18	18%	44%
S34	3,313	3,180	1.04	4%	63%
S113	9,522	7,170	1.33	33%	44%
U411	9567	13,680	0.7	-30%	33%

Atlanta MPO External Station volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
Corinth Rd	6,269	1,150	5.45	445%	98%
U41	757	5,950	0.13	-87%	48%
U29	264	4,800	0.05	-95%	53%
I75	55,247	57,990	0.95	-5%	18%
I85	41,234	44,280	0.93	-7%	20%
U411	5,405	4,480	1.21	21%	54%
S74	1,698	3,950	0.43	-57%	57%
Kings Bridge Rd	650	1,860	0.35	-65%	80%
S108	4,237	2,770	1.53	53%	67%
S362	687	3,220	0.21	-79%	63%
S5	13,593	23,450	0.58	-42%	26%
S53	5,996	5,240	1.14	14%	51%
U19	10,903	11,000	0.99	-1%	37%
Yellow Creek Rd	2,233	2,830	0.79	-21%	66%
U41	7,321	7,970	0.92	-8%	42%
I75	70,940	75,930	0.93	-7%	16%
Jackson Rd	1,413	1,500	0.94	-6%	88%
S9	9,434	6,170	1.53	53%	47%
S16	8,742	9,300	0.94	-6%	39%
Lumpkin Camp Rd	5,842	3,180	1.84	84%	63%
U23	8,097	8,380	0.97	-3%	41%
U19	9,967	27,610	0.36	-64%	25%
S53	12,227	12,550	0.97	-3%	35%
Keys Ferry Rd	2,897	4500	0.64	-36%	54%
S136	10,115	6,930	1.46	46%	45%
S60	8,998	7,300	1.23	23%	44%
S36	5,990	4,350	1.38	38%	55%
S212	2,446	4,520	0.54	-46%	54%
S124	5,519	5,180	1.07	7%	51%
I85	53458	57,310	0.93	-7%	18%
S52	3,261	1,840	1.77	77%	80%
S53	8,410	7,130	1.18	18%	44%
S284	1,093	980	1.12	12%	105%
S60	2,012	3,920	0.51	-49%	58%
U129	7,115	9,560	0.74	-26%	39%

Atlanta MPO External Station volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S11	1,455	2,200	0.66	-34%	74%
U129	6,594	8,280	0.8	-20%	42%
S82	2,921	1,190	2.45	145%	97%
S142	988	2840	0.35	-65%	66%
I20	33229	32,680	1.02	2%	23%
S11	5,235	4,360	1.2	20%	55%
U278	1,546	1,630	0.95	-5%	84%
S53	3,886	3,580	1.09	9%	60%
U78	9,712	13,400	0.72	-28%	34%
S319	2,430	1,100	2.21	121%	100%
S82	1,908	3,550	0.54	-46%	60%
S316	11,714	18,650	0.63	-37%	29%
U29	4,346	7,206	0.6	-40%	44%
Snows Mill Rd	1,393	1,100	1.27	27%	100%
U23	15,076	23,440	0.64	-36%	26%
S83	773	3,610	0.21	-79%	60%
Newborn Rd	368	610	0.6	-40%	130%
Total	**622,338**	**697,421**	**0.89**	**-11%**	**12%**

Augusta External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
I20	29,515	30,740	0.96	-4%	23%
S150	3,743	1,130	3.31	231%	99%
S223	1,236	2,130	0.58	-42%	75%
S47	3,556	4,660	0.76	-24%	53%
U78	3,290	6,020	0.55	-45%	48%
U221	2121	1,630	1.3	30%	84%
U221	2,693	1,730	1.56	56%	82%
S88	1,821	1,180	1.54	54%	97%
S28	18,428	19,530	0.94	-6%	29%
U25	10,391	8,030	1.29	29%	42%
I20	57,441	50,330	1.14	14%	19%

Augusta External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
U25 B	8,699	14,000	0.62	-38%	33%
U25	21,720	18,000	1.21	21%	30%
S28	3,062	10,077	0.3	-70%	38%
U1	5,790	6,070	0.95	-5%	48%
Total	**173,506**	**175,257**	**0.99**	**-1%**	**20%**

Brunswick External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
U82	5,138	8,300	0.62	-38%	42%
S32	210	2,060	0.1	-90%	76%
U25	4,380	5,080	0.86	-14%	51%
U17	83	2,450	0.03	-97%	71%
I95	51,157	47,510	1.08	8%	19%
I95	46,785	45,860	1.02	2%	20%
U17	3,041	7,450	0.41	-59%	44%
U17	3,105	7,450	0.42	-58%	44%
Total	**113900**	**126,160**	**0.9**	**-10%**	**23%**

Columbus External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S103	6,843	2,600	2.63	163%	69%
S219	5,060	2,490	2.03	103%	70%
I185	17,420	17,430	1	0%	30%
U27	33,013	20,850	1.58	58%	28%
U27	5,212	6,515	0.8	-20%	46%
S354	891	890	1	0%	110%
S315	118	1720	0.07	-93%	82%
S116	46	955	0.05	-95%	107%
U27 A	1863	3465	0.54	-46%	61%
S208	2,654	2,510	1.06	6%	70%

Columbus External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
U80	5,017	8,930	0.56	-44%	40%
Unkonwn	26,700	23,290	1.15	15%	26%
U280	22,717	32,150	0.71	-29%	23%
Total	**127555**	**123795**	**1.03**	**3%**	**23%**

Dalton External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S201	2,330	3,060	0.76	-24%	64%
I75	82,730	80,100	1.03	3%	15%
S2	6,447	9,800	0.66	-34%	39%
Carbondale Rd	3,362	2,070	1.62	62%	76%
I75	54,720	63,960	0.86	-14%	17%
U41	2,996	4,180	0.72	-28%	56%
S71	5,631	4,000	1.41	41%	57%
U76	24,936	25,280	0.99	-1%	26%
Airport Rd	2,120	4,250	0.5	-50%	56%
S286	3,542	5,870	0.6	-40%	48%
S2	1,271	1,980	0.64	-36%	78%
U41	6,291	9,425	0.67	-33%	39%
Total	**196,377**	**213,975**	**0.92**	**-8%**	**19%**

Hinesville External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
U25	1,663	2,365	0.7	-30%	72%
S196	1,556	3,515	0.44	-56%	60%
S144	2,371	2,540	0.93	-7%	70%
U25	15,548	13,920	1.12	12%	33%
S57	1,175	1,630	0.72	-28%	84%
I95	39,281	42,640	0.92	-8%	20%
U17	13,319	19,160	0.7	-30%	29%

Hinesville External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S144	443	6,490	0.07	-93%	46%
U17	2,992	1,755	1.7	70%	82%
I95	39,296	46,060	0.85	-15%	20%
S119	8,225	2,060	3.99	299%	76%
Total	**125,869**	**142,135**	**0.89**	**-11%**	**22%**

Macon External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S74	844	2,460	0.34	-66%	71%
U80	1,414	4,820	0.29	-71%	53%
I475	41,195	41,950	0.98	-2%	20%
U41	613	4,870	0.13	-87%	52%
Hartley Bridge Rd	3,301	3,620	0.91	-9%	60%
I75	29,475	36,840	0.8	-20%	22%
I75	61,146	73,750	0.83	-17%	16%
U23	17,594	7,880	2.23	123%	42%
Houston Rd	7,676	7,710	1	0%	43%
U41	3,259	5,300	0.61	-39%	50%
U41	20,633	22,860	0.9	-10%	27%
Upper River Rd	3,287	1,570	2.09	109%	86%
U129	11,319	16,150	0.7	-30%	31%
I16	22,575	22,670	1	0%	27%
U23	177	2,170	0.08	-92%	75%
S49	7,074	14,540	0.49	-51%	33%
S57	8,335	6,460	1.29	29%	46%
U80	335	2,140	0.16	-84%	75%
Zebulon Rd	0	2,820	0	-100%	66%
Total	**240,253**	**280,580**	**0.86**	**-14%**	**17%**

Rome External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S20	4,842	5,460	0.89	-11%	50%
S100	951	1,270	0.75	-25%	94%
S100	208	1,410	0.15	-85%	90%
Old Cave Spring Rd	2,961	2,020	1.47	47%	77%
U27	8,094	10,010	0.81	-19%	38%
S101	2,883	5,840	0.49	-51%	48%
S156	881	1,890	0.47	-53%	79%
U411	9,567	15,300	0.63	-37%	32%
S293	1,671	2,420	0.69	-31%	71%
S53	7,698	9,930	0.78	-22%	38%
S140	7,564	7,270	1.04	4%	44%
U27	10,588	11,100	0.95	-5%	37%
Total	**57,908**	**73,920**	**0.78**	**-22%**	**28%**

Savannah External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
I16	21,985	26,220	0.84	-16%	25%
S204	332	3,610	0.09	-91%	60%
Old River Rd	167	2,360	0.07	-93%	72%
S17	5,036	3,220	1.56	56%	63%
I95	50,927	68,000	0.75	-25%	17%
U17	9,025	0	0	0%	0%
SR30	5,934	5,690	1.04	4%	49%
U17	16,443	18,780	0.88	-12%	29%
S21	12,666	28,810	0.44	-56%	24%
I95	44,695	45,590	0.98	-2%	20%
U17	5,333	5,820	0.92	-8%	48%
S17 A	17,543	14,010	1.25	25%	33%
Total	**190,084**	**222,110**	**0.86**	**-14%**	**18%**

Valdosta External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
U84	11,887	10,350	1.15	15%	38%
Morven Rd	2,230	550	4.05	305%	136%
S122	1,255	1,920	0.65	-35%	79%
CR-273	527	590	0.89	-11%	131%
I75	43,421	38,960	1.11	11%	21%
U41	2,519	2,190	1.15	15%	74%
S94	4,000	11,090	0.36	-64%	37%
S31	3,288	2,990	1.1	10%	65%
Unknown	1,845	4,150	0.44	-56%	56%
S125	10,231	11,860	0.86	-14%	36%
S94	2536	2,030	1.25	25%	77%
I75	37,687	36,875	1.02	2%	22%
U41	259	1,310	0.2	-80%	93%
S376	714	1,990	0.36	-64%	77%
U221	1,248	3,130	0.4	-60%	64%
Howell Rd	1,260	640	1.97	97%	127%
U84	3,312	4,620	0.72	-28%	54%
S135	349	1,310	0.27	-73%	93%
Total	**128,567**	**136,555**	**0.94**	**-6%**	**22%**

Warner Robins External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S96	3,797	5,950	0.64	-36%	48%
S49	3,255	2,510	1.3	30%	70%
U341	3,169	3,820	0.83	-17%	58%
S224	107	0	0	0%	0%
S127	941	1,220	0.77	-23%	96%
S42	1174	2,380	0.49	-51%	72%
S224	516	2,940	0.18	-82%	65%
S26	1,471	1,720	0.86	-14%	82%
Howell Rd	5161	2130	2.42	142%	75%
I75	41,512	43,990	0.94	-6%	20%

Warner Robins External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
U41	0	690	0	-100%	123%
I75	60069	73750	0.81	-19%	16%
Elko Rd	702	640	1.1	10%	127%
Houston Rd	7,676	5,945	1.29	29%	48%
U41	6,249	6,990	0.89	-11%	45%
U341	4,935	3,860	1.28	28%	58%
S96	4,504	7,300	0.62	-38%	44%
U129	23,710	21,020	1.13	13%	28%
U129	3,465	3,440	1.01	1%	61%
S26	585	910	0.64	-36%	109%
Total	**173,000**	**191,205**	**0.9**	**-10%**	**19%**

Table D-3: Stateline Boundary

North External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
I24	33,220	45,010	0.74	-26%	20%
I24	50506	61,660	0.82	-18%	17%
U27	26572	22,280	1.19	19%	27%
I75	82322	88960	0.93	-7%	15%
S71	5,631	4,000	1.41	41%	57%
S225	2,875	1,350	2.13	113%	92%
U411	330	2,700	0.12	-88%	68%
S5	3,653	7,370	0.5	-50%	44%
S60	1598	3990	0.4	-60%	57%
S60 S	632	2,690	0.23	-77%	68%
U19	4229	4390	0.96	-4%	55%
S66	303	1,090	0.28	-72%	101%
S17	7,638	7,170	1.07	7%	44%
S75	1053	3,190	0.33	-67%	63%
U23	8175	9530	0.86	-14%	39%
S28	135	390	0.35	-65%	157%
S-193	4,405	7,340	0.6	-40%	44%
S151	6,916	4,850	1.43	43%	52%
Total	**240,191**	**277,960**	**0.86**	**-14%**	**17%**

East External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
U76	5,800	4,735	1.22	22%	53%
S184	603	1,570	0.38	-62%	86%
U123	6387	5,480	1.17	17%	50%
I85	46499	40020	1.16	16%	21%
U29	2,816	3,840	0.73	-27%	58%
S72	1,169	1,660	0.7	-30%	84%
U378	387	2,260	0.17	-83%	73%
U221	2,693	1,730	1.56	56%	82%

East External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S28	15,083	11990	1.26	26%	35%
S415	19241	22930	0.84	-16%	27%
U25 B	8,699	14,000	0.62	-38%	33%
S28	11024	12,755	0.86	-14%	34%
U301	883	1,970	0.45	-55%	78%
I95	44695	45590	0.98	-2%	20%
U17	5333	5,820	0.92	-8%	48%
S415	20,151	22,930	0.88	-12%	27%
S17 A	18595	16560	1.12	12%	31%
S181	1,065	930	1.15	15%	108%
S119	1,616	1,840	0.88	-12%	80%
S415	17,461	22,930	0.76	-24%	27%
Total	**230,201**	**241,540**	**0.95**	**-5%**	**18%**

South External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S97	1102	820	1.34	34%	114%
S302	4473	1,120	3.99	299%	99%
S309	11	1280	0.01	-99%	94%
S241	679	490	1.39	39%	143%
U27	4,399	4,770	0.92	-8%	53%
S111	3,617	2,260	1.6	60%	73%
Meridian Rd	1,234	590	2.09	109%	131%
U319	16225	8750	1.85	85%	41%
U19	2815	2,620	1.07	7%	69%
S33	2051	390	5.26	426%	157%
U221	279	1,110	0.25	-75%	100%
S33	149	810	0.18	-82%	114%
S31	3288	2,990	1.1	10%	65%
I75	37687	36875	1.02	2%	22%
U41	259	1,250	0.21	-79%	95%
S135	128	520	0.25	-75%	139%

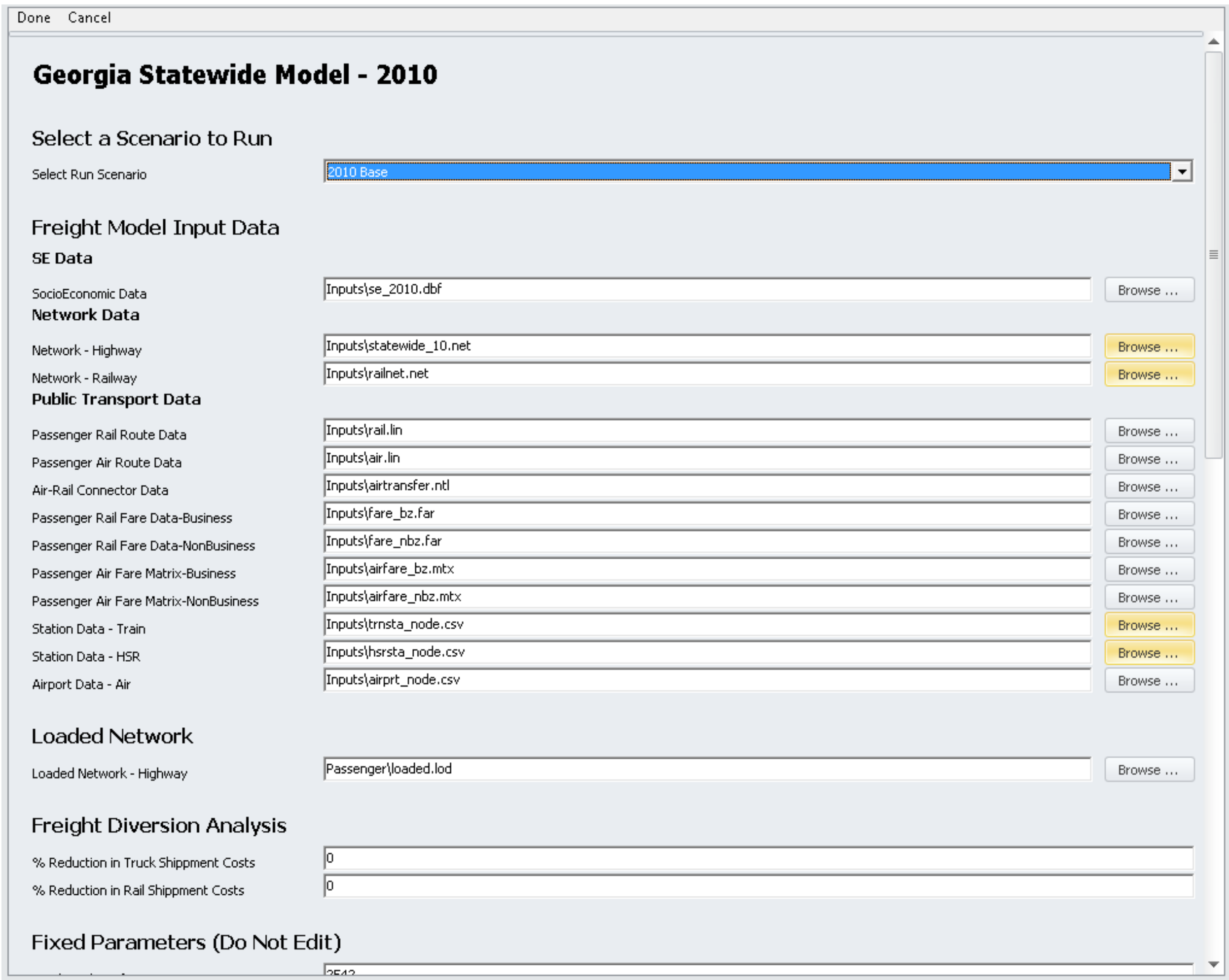
South External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
U129	1008	910	1.11	11%	109%
S368	3376	1,320	2.56	156%	93%
U441	314	660	0.48	-52%	125%
S94	92	890	0.1	-90%	110%
S23	40	1,090	0.04	-96%	101%
U1	4665	7,580	0.62	-38%	43%
U17	4051	3090	1.31	31%	64%
I95	54,675	54,770	1	0%	18%
S122	384	920	0.42	-58%	108%
Total	**147,000**	**137,875**	**1.07**	**7%**	**22%**

West External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S136	259	3,600	0.07	-93%	60%
S301	396	3,010	0.13	-87%	65%
S48	4,321	2,180	1.98	98%	74%
S20	4842	5,460	0.89	-11%	50%
S114	3,563	3,925	0.91	-9%	58%
U411	2,550	3,570	0.71	-29%	60%
S166	1,953	3,500	0.56	-44%	60%
S5	1,382	2,700	0.51	-49%	68%
I20	29865	31,650	0.94	-6%	23%
U78	626	2,160	0.29	-71%	75%
U278	3,534	2,955	1.2	20%	65%
S34	2,988	1,680	1.78	78%	83%
S18	2,115	9,170	0.23	-77%	40%
I85	32,663	30,970	1.05	5%	23%
U82	1,115	2,590	0.43	-57%	69%
S62	1278	3,200	0.4	-60%	63%
S37	978	2,100	0.47	-53%	76%
S39	93	1,150	0.08	-92%	98%
U84	3,257	5,090	0.64	-36%	51%

West External Station Volumes					
Road Name	Volume	Counts	Volume/Count	% Deviation	Max Desirable Deviation
S91	1957	1690	1.16	16%	83%
S285	339	375	0.9	-10%	160%
U27	27,336	31,090	0.88	-12%	23%
S301	655	1,500	0.44	-56%	88%
I59	16,058	14,000	1.15	15%	33%
S109	1942	3,700	0.52	-48%	59%
U80	26,722	40,680	0.66	-34%	21%
Unknown	26,700	23,290	1.15	15%	26%
S109	250	360	0.69	-31%	163%
Total	**199,738**	**237,345**	**0.84**	**-16%**	**18%**

APPENDIX E – PROCEDURE TO RUN MODEL

To run the statewide freight model, run the **GDOT_Statewide_GA_2010.s** script. The model interface screen is shown below.



All model input files are located in a separate folder called "INPUTS". The model application requires a variety of input files discussed in the following section. All files under the "PARAMETER" folder contain model constant parameters. They should not be changed unless the model structure has been changed such as change of zones system. As part of the development of the statewide model, change of current model has to be made in consultation with GDOT staff.

Input Information

E-1 Scenario

Enter the "Select Run Scenario". There are three choices in the list; "2010Base", "2010 Alternative", and "Future Alternative" depending on the kind of scenario run. Normally, the 2010Base year has already been run. Alternatives based on the 2010 model choose "2010 Alternative" and Alternatives related to future years choose "Future Alternative". The choice has to be set appropriately for the model to run correctly.

E-2 SE Data

The socio-economic file is a DBF file (SE_YEAR.DBF). It must contain the following information by N or zone. Currently, SE data for three future horizon years are available for 2040. The model includes over 300 gap zones ranging from zone number 2979 to 3299 reserved for possible zone expansion. Any new zones added should replace the gap zones first. It is important that zone change also has to be reflected in the network and mode script as well. The field names in SE data file are listed below.

Field Name	Description
N	Zone Number
POP	Total Population
HH	Total Household
AGRI	Agriculture Employees
MING	Mining Employees
FOOD	Food Employees
TEXT	Textile Employees
LUMB	Lumber Employees
PAPR	Paper Employees
CHEM	Chemical Employees
PETR	Petroleum Employees
RUBB	Rubber & Plastic Employees
STON	Stone Employees
PMTL	Primary Metal Employees
FMTL	Fabricated Metal Employees
MECH	Machinery Employees
INST	Instrument Employees
CNST	Construction Employees
RETL	Retail Employees
WSLE	Wholesale Employees
SERV	Service Employees
GOVT	Government Employees
DOT_AGRI	Agriculture Employment (Passenger Model)
DOT_MANF	Manufacture Employment (Passenger Model)
DOT_WSLE	Wholesale Employment (Passenger Model)
DOT_RETL	Retail Employment (Passenger Model)

Field Name	Description
DOT_SERV	Service Employment (Passenger Model)
DOT_TOTL	Total Employment (Passenger Model)
SQMI	Square Mile

E-3 Network Data

The model requires two (2) input network files under the "INPUTS" folder.

1. Statewide highway network (statewide_yr.net)
   This highway network should reflect the current running scenario. New projects or highway modifications must be correctly reflected in the network. Zone change in the model should be reflected in the network as well.

2. Statewide railway network (railnet.net)
   The rail network was built from the National Transportation Atlas Database (NTAD) 2007. Centroid connectors were added to connect zones to the railway network. This network is established for freight model. Zone change in the model should be reflected in the network as well.

E-4 Public Transport Data

This section contains the input files related to the passenger rail and air models.

1. Passenger rail route data (rail.lin)
   This file contains the current Amtrak routes related to Georgia. The network was developed using Public Transport in the Cube software and has to be edited in the CUBE Base software.

2. Passenger air route data (air.lin)
   This file contains the current airline routes between Atlanta and major cities in and surrounding Georgia. It has to be edited in the CUBE Base software.

3. Air to rail transfer link data (airtransfer.ntl)
   This file contains airport to rail station transfer links. It can be edited in a text editor.

4. Passenger rail fare data for business travel (fare_bz.far)
   This file contains the rail fare rates for business travel. It can be edited in a text editor.

5. Passenger rail fare data for non-business travel (fare_nbz.far)
   This file contains the rail fare rates for non-business travel. It can be edited in a text editor.

6. Passenger air fare data for business travel (airfare_bz.mtx)
   This file contains the air fare rates for business travel. It can be edited in a text editor.

7. Passenger air fare data for non-business travel (airfare_nbz.mtx)
   This file contains the air fare rates for non-business travel. It can be edited in a text editor.

8. Train station data (trnsta_node.csv)
   This file contains the train station taz# and network node#. It can be edited in a text editor.

9. High speed rail station data (hsrsta_node.csv)
   This file contains the high speed rail station taz# and network node#. It can be edited in a text editor.

10. Airport data (airprt_node.csv)
    This file contains the airport taz# ,network node#, fare zone#, and annual enplanement data. It can be edited in a text editor.

E-5 Output Data

The model will create two additional folders to store the model outputs. The "PASSENGER" folder stores model files generated by the passenger model and the "FREIGHT" folder stores all files related to freight model. The final output network link contains both passenger and freight volumes. There is an option to let the user save the model output network in a specified folder with the file name the user prefers. The default network output location is the "PASSENGER" folder.

E-6 Freight Diversion Analysis (Optional)

This section contains inputs for freight diversion analysis.

1. % reduction in truck shipment costs
   This input assumes a reduction in existing truck transportation costs in the model

2. % reduction in rail shipment costs
   This input assumes a reduction in existing rail transportation costs in the model

E-7 Fixed Parameters (Do Not Edit)

This section contains prefixed inputs for the model. Consultation with GDOT staff should occur before making any changes in this section.