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# State Route Prioritization

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# 1 EXECUTIVE SUMMARY

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The Georgia Department of Transportation's (GDOT's) State Highway System consists of a diverse mixture of roadways including multi-lane Interstates, business spurs, US Highways, State Routes, city streets, and county roads. The State Highway System should ensure a well-connected network of high quality roads that comply with Georgia State Code and Federal law. GDOT undertook an assessment of the State's 18,000 centerline miles, using Geospatial Information System (GIS) technology to graphically display and assist with the evaluation of proposed criteria, to establish the State Route Prioritization Network. Prioritization criteria were established in internal workshops, with additional input from members of GDOT management. Four categories of State Routes were established: *Critical*, *High*, *Medium*, and *Low*. GDOT implemented the results of this research to effectively allocate maintenance funding, and ensure a high level of service and quality on Critical and High Priority routes. GDOT will focus its resources on the components of the transportation system that are most important to Georgia's economy, specifically, those that serve a significant role in freight movement, intrastate travel, tourism, and business travel.

## 2 INTRODUCTION

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### 2.1 BACKGROUND

The state of Georgia has become both a destination and a key hub for international travel and commerce. Atlanta’s airport is the busiest in the world and the ports in Brunswick and Savannah are among the nation’s leading and fastest growing in shipments. Pedestrians, bicyclists, motorists, commercial truckers, airports, and harbors depend upon a reliable, efficient, and safe road system. As such, it is important to keep the State’s roadways properly maintained and operating at the highest levels possible. Central to that effort is the need for the Georgia Department of Transportation to prioritize the maintenance of State Routes.

The effort began when Georgia DOT’s Office of Transportation Data (OTD) initiated a research project to answer simple questions: 1) Which routes have a higher priority? 2) Which routes have a lower priority? and 3) What are the criteria?

The Georgia State Highway System consists of a mixture of roadways, including multi-lane Interstates, business spurs, and two-lane roads. GDOT maintains records of all roads by type in Georgia (Table 1). Although GDOT only owns 18% of the total lane mileage, 59% of the total vehicles miles traveled within the state are on these roadways (7).

Since the 1970s, Georgia DOT has maintained the total Georgia State Highway System centerline mileage at approximately 18,000 miles through the transfer of ownership with the local governments. The Department carefully balances the bulk of the state-owned mileage through negotiations and transfers to local governments; however, mileage is added to the system as additional lane miles are constructed (Figure 1). In 2017, the total lane mileage was 49,141.

Table 1 2017 Georgia Roadway Statistics

Statistic (1) (2)	Mileage
State Routes	17,959
<i>Interstates</i>	1,247
County Roads	84,852
City Streets	22,618
<b>Total Centerline Mileage</b>	<b>125,429</b>

## Prioritization of Georgia State Routes

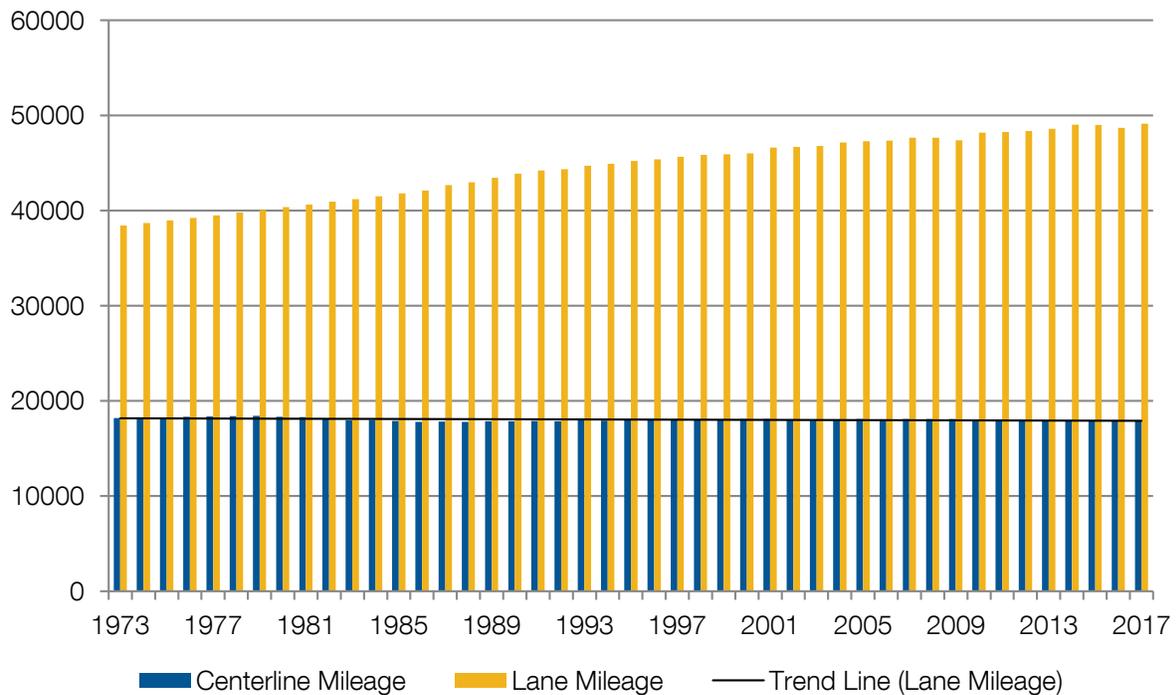


Figure 1 State Route Centerline and Lane Mileage (1973 - 2017)

## 2.2 TERMS

The following terms provide background information that is useful in understanding the Georgia State Highway System:

- *Centerline miles* represent the total length of a roadway from its starting point to its end.
- *Common routes*, also known as *Concurrent Routes* or *Travel-Over Routes*, share the same physical pavement with another State Route.
- A *frontage road* segregates local traffic from higher speed through-traffic and intercepts driveways, and other properties. GDOT maintains these roads, but they are not part of the official State Route System.
- The *Interstate System*, officially known as the Dwight D. Eisenhower National System of Interstate and Defense Highways, shall consist of routes of highest importance which are constructed to the standards of 23 U.S.C. 109(h), and connects principal metropolitan areas, cities, and industrial centers (3).
- *Intermodal connectors* are roadways that provide direct service to shipping ports, railways or other modes of transportation that may or may not be on the State Route System.
- *Lane miles* are the centerline mileage of a road multiplied by the number of lanes for each roadway section.
- The *National Highway System (NHS)* is a network of selected principal arterial routes identified as essential for international, inter-state, and regional commerce and travel, national defense, and the transfer of people and goods to and from major intermodal

facilities. The NHS is comprised of four sub-types of road systems: Interstates, STRAHNET routes, other principal arterials, and intermodal connectors.

- *STRAHNET routes* or the Strategic Highway Network are defined by the U.S. Department of Defense as critical roadways for national defense purposes.
- *U.S. Routes* are an integrated network of roads and highways numbered within a nationwide grid. State or local governments have maintained U.S. Routes since their initial designation in 1926. In Georgia, all state-owned routes are, first, a State Route and then some have additional designations, such as U.S. Routes.

### 2.3 LITERATURE REVIEW

The literature review uncovered a few research efforts focused on evaluating the State Highway System from an asset management perspective. For example, Louisiana Department of Transportation and Development's (LDOTD) *Right-Sizing the Louisiana State Highway System: Transferring 5,000 State Miles to Local Governments* research approached the evaluation of the State Highway System as a means to determine which routes could potentially be cooperatively transferred to the local governments, rather than from a maintenance perspective. However, their research provided a useful perspective for evaluating a State Highway System. LDOTD focused its resources on the most important components of the transportation system while ensuring connectivity, movement between and through urban areas, and a farm-to-market network in rural areas (4).

The literature review uncovered an extensive variety of approaches related to the expenditure of roadway maintenance funds, ranging from sampling customer priorities and road usage to basing it solely upon the condition of the roadway. The research, *Long-term Network Performance: Function of Pavement Management System Maintenance Selection Policy*, by Rohde, Pinard, and Sadzik stated, "Most road agencies operate under a scenario in which the maintenance need exceeds the available maintenance funds. In this environment, pavement managers are forced to select maintenance and rehabilitation actions on the basis of a defined methodology." Their research studied various approaches such as "fix worst first", using a priority index, maximizing asset value, minimizing transportation costs, and the traditional maximization of area under a condition curve approach. The outcomes were analyzed and it was concluded that the maintenance policy should be compatible with the agencies' long-term maintenance objectives (5).

Other research, such as the *Development of a Knowledge-Based Formula to Prioritize Pavement Rehabilitation Projects*, prioritized rehabilitation projects based on experts' opinion. The Arizona Department of Transportation (AZDOT) surveyed a group of experts to determine which sections should receive rehabilitation, what type of treatment was recommended, and what priority should be assigned to each preservation project. The results of the survey indicated that rutting, functional classification, roughness, cracking, traffic, and maintenance cost significantly influence the priority assigned to a preservation project (6).

GDOT previously allocated resources to the roadway with the highest need for maintenance. The literature review inspired research into establishing a priority index. Experts' opinions were sought through workshops and surveys, similar to the research described above. OTD also approached this research from the same perspective as LDOTD to determine which roads are essential, where should funding be concentrated, and which roads should not be a part of the network.

## 2.4 PRINCIPAL FINDINGS

All States strive to have a State Highway System with a well-connected network of high quality roads that comply with State Code (7) and Federal law. Roads that play a significant role in freight movement, intrastate travel, or have a Federal designation should be given a High Priority. Conversely, a State Route should not function as a neighborhood street or an unconnected road not serving a population center. Roads carrying extremely low traffic volumes or those that do not meet current design standards should be evaluated to determine if they should remain a part of the State Highway System.

One of the primary objectives of this research was to develop criteria to evaluate and prioritize the State Routes for maintenance purposes. Prioritization criteria were initially determined in an internal workshop, with additional input from members of GDOT management. A simplistic hierarchy consisting of four State Route categories was established: *Critical*, *High*, *Medium*, and *Low*. GDOT implemented the results of this research to effectively allocate maintenance funding, and ensure a high level of service and quality on Critical and High Priority routes. A second and a third workshop were held at 2 year increments after the first to further refine the criteria and solicit input from members of GDOT management. The main body of this paper is organized as follows: a discussion of the workshop recommendations and an overview of the data analysis; and a presentation of the results.

## 3 METHODOLOGY AND ANALYSIS

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### 3.1 WORKSHOP 1

On March 12, 2014, OTD invited participants from other Georgia DOT offices to provide their thoughts on the State Route analysis and prioritization efforts. To evaluate a system, it is first necessary to establish what the essential components are, or for the purpose of this study, what can be identified as a High Priority State Route. For example, Interstates and U.S. Highways would be obvious high priority components of the network. Participants established a second grouping of roads, the Medium Priority State Routes. This category is comprised of roads that are important to the State Highway System, but have a lower priority. The participants established a third category, Low Priority State Routes, which have low traffic volumes and low connectivity.

Participants recommended that the focus should not only be on identifying priority roads, but should also identify roads that could be good candidates for potential transfer to a local government. Individuals cited several specific examples of low volume roads traveling through a residential “Main Street type” area. Further consideration should be given to the Low Priority State Routes to determine if particular routes should remain as part of the State Highway System.

Participants initially proposed other criteria, but ultimately discarded the suggestions. The group proposed various economic and mobility criteria for consideration, but they concluded that sources of information would be difficult to locate, maintain, and update. The group also concluded that identifying geographic areas with greater tourism, memorial or economic impacts may not be adequate criteria for determining State Route Priority.

### 3.2 WORKSHOP 1 ANALYSIS

OTD was unable to identify data sources for a couple of the proposed criteria. Participants considered that roads in South Georgia might have originally provided or still provide access for freight trucks traveling to and from logging or agricultural product areas. However, OTD was unable to identify a data source for the “farm-to-market” routes that these heavy-load trucks are traveling. The group also recommended that State Routes connecting to regional hospitals should be a Medium Priority State Route, but OTD was unable to find a statewide GIS authoritative source for the data.

OTD created a draft of the State Prioritization Network based upon the initial established criteria. The draft showed the breakdown among the High Priority State Routes, the Medium Priority State Routes, and the Low Priority State Routes. As recommended by the workshop participants, OTD sent the draft map to each of Georgia DOT’s seven Districts, the Office of Maintenance, and the Office of Planning for review and comments. After receiving their feedback, OTD researched and resolved a few cases where suggestions had overlaps or conflicts. Additionally, executive management reviewed the network maps and recommended routes identified as National Freight Routes, State Freight Routes, Interstates and Intermodal Connectors be separated from the other High Priority State Routes in order to create a fourth category, Critical State Routes.

### **3.3 WORKSHOP 2**

On September 25, 2015, OTD invited participants from other Georgia DOT offices to provide their thoughts on the State Route analysis and prioritization efforts. The goal was to allow input and further refine the criteria. Modifications were made to the criteria, based upon participants' suggestions.

### **3.4 WORKSHOP 2 ANALYSIS**

OTD revised the State Prioritization Network based upon the Workshop 2 criteria. For the Medium and Low Priority categories, OTD used statistical methods to identify geographic regions across the state with similar traffic characteristics (Appendix A). The AADT of a traffic segment is compared to the mean AADT of a geographic area. Since traffic volumes on average are much higher in urban areas than in rural areas, this approach allows routes, which have lower traffic when compared statewide, but still have regional importance, to have a higher prominence.

### **3.5 WORKSHOP 3**

On October 5, 2017, OTD again invited participants from other Georgia DOT offices to provide their thoughts on the State Route analysis and prioritization efforts. The goal was the same as previous years, to allow input and further refine the criteria. OTD proposed modifications to the criteria for the group to consider. Participants asked for time to review the new criteria and additional information on how the changes would affect the mileage in each category. After their review, participants agreed with the modifications. Participants recommended future workshops are held every five years (versus two years), because the Districts need consistent criteria to measure their pavement performance against.

### **3.6 WORKSHOP 3 ANALYSIS**

OTD revised the State Prioritization Network based upon the Workshop 3 criteria. The main modifications consisted of demoting U.S. Routes from High to Medium; promoting GEMA from Medium to High; demoting Intermodal Connectors from Critical to High; removing the National Truck Network; and expanding the AADT volume threshold to all categories, except Critical.

## 4 DISCUSSION OF RESULTS

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OTD categorized State Routes into Critical, High, Medium, and Low Priorities (Figures 2-3). State Route Prioritization Maps were created to display the results for the seven GDOT Districts and statewide (Figures 4-11). The criteria for the four categories are as follows:

- Critical
  - Interstates,
  - STRAHNET/STRAHNET Connectors
  - State Freight Corridors
- High
  - NHS/Intermodal Connectors
  - Governor's Road Improvement Program
  - Georgia Emergency Management Agency Evacuation Routes, Hurricane Evacuation Routes
  - Annual Average Daily Traffic – High\*
- Medium
  - U.S. Highways
  - 4 or More Lanes
  - Annual Average Daily Traffic – Medium\*
- Low
  - All Unclassified Routes Including: Less than 4 Lanes, Annual Average Daily Traffic – Low\*

*\*Variable thresholds based upon geographic area.*

Prioritization of Georgia State Routes

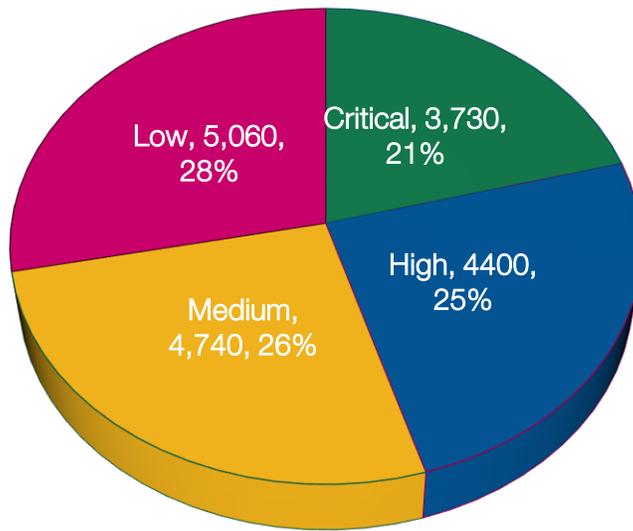


Figure 2 State Route Prioritization Mileage by Category

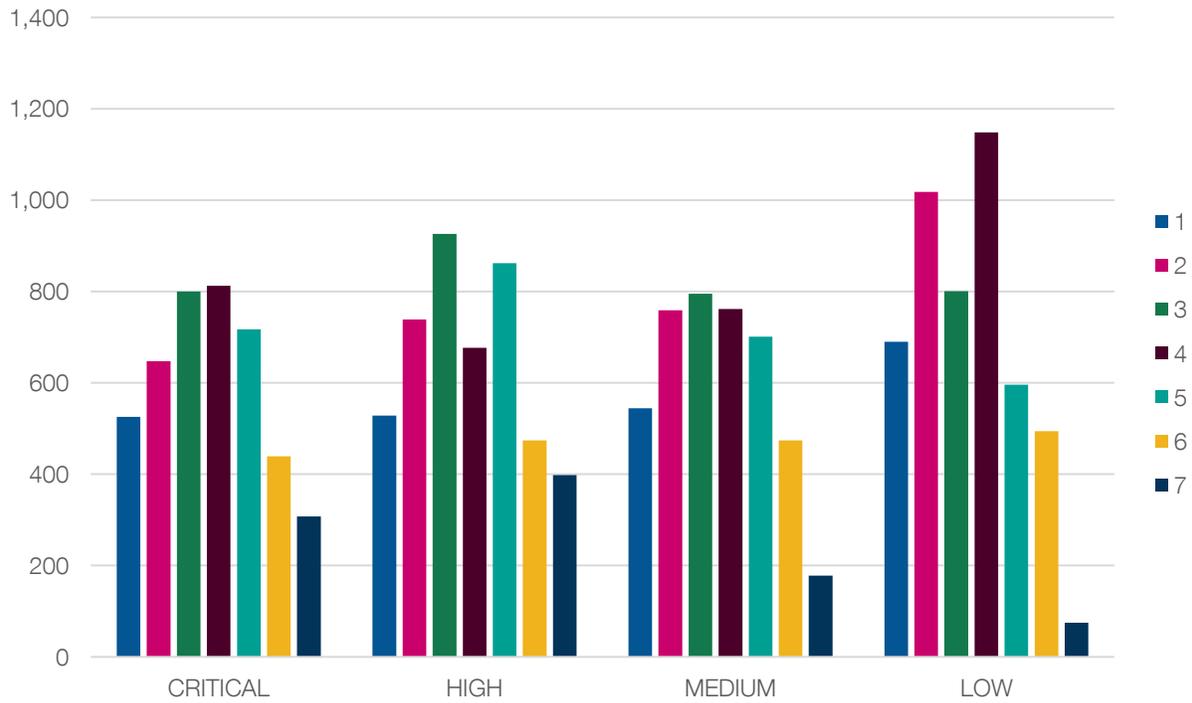


Figure 3 State Route Prioritization Mileage by District and Category

# Prioritization of Georgia State Routes

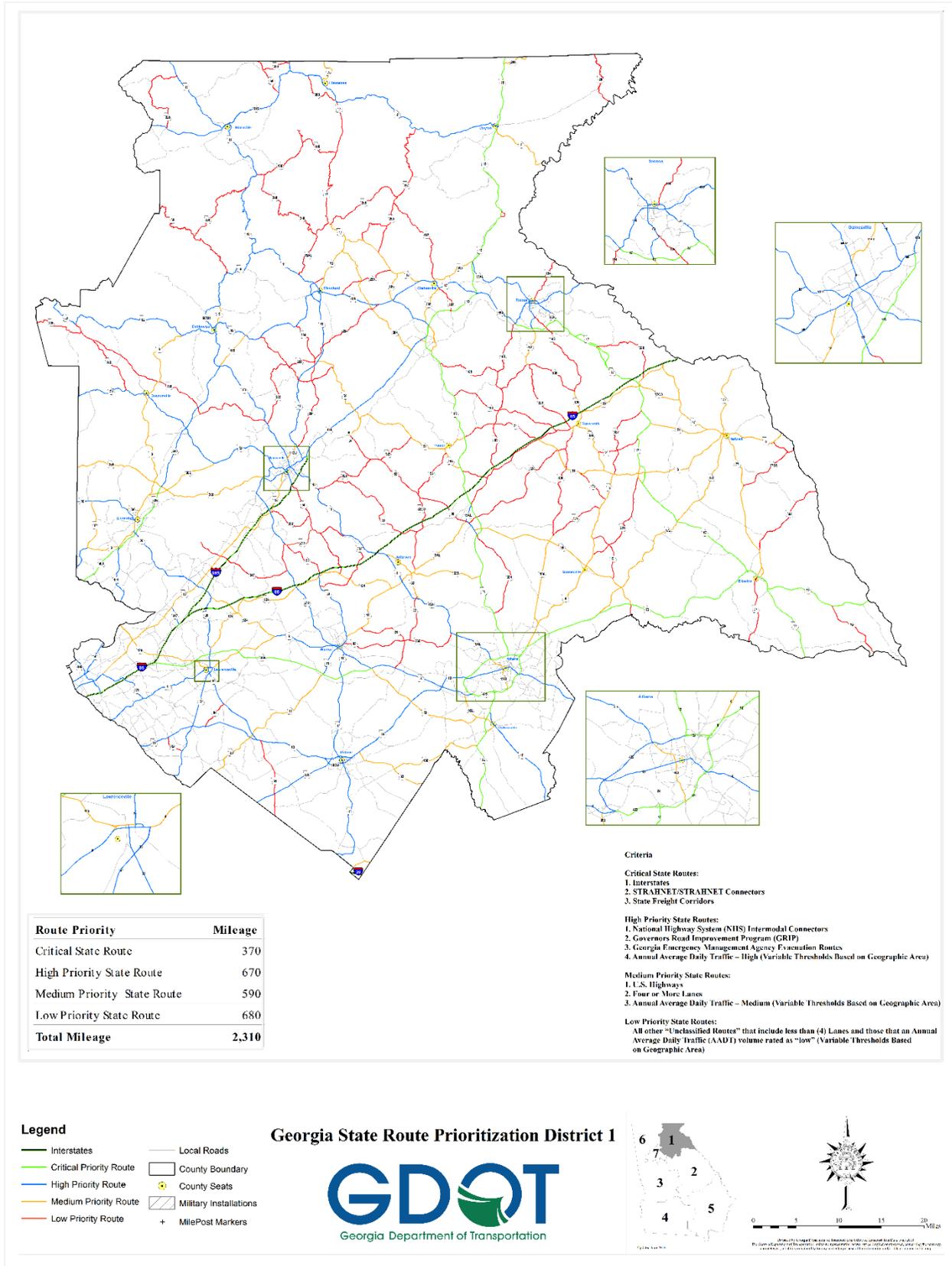


Figure 4 Georgia State Route Prioritization – District 1

# Prioritization of Georgia State Routes

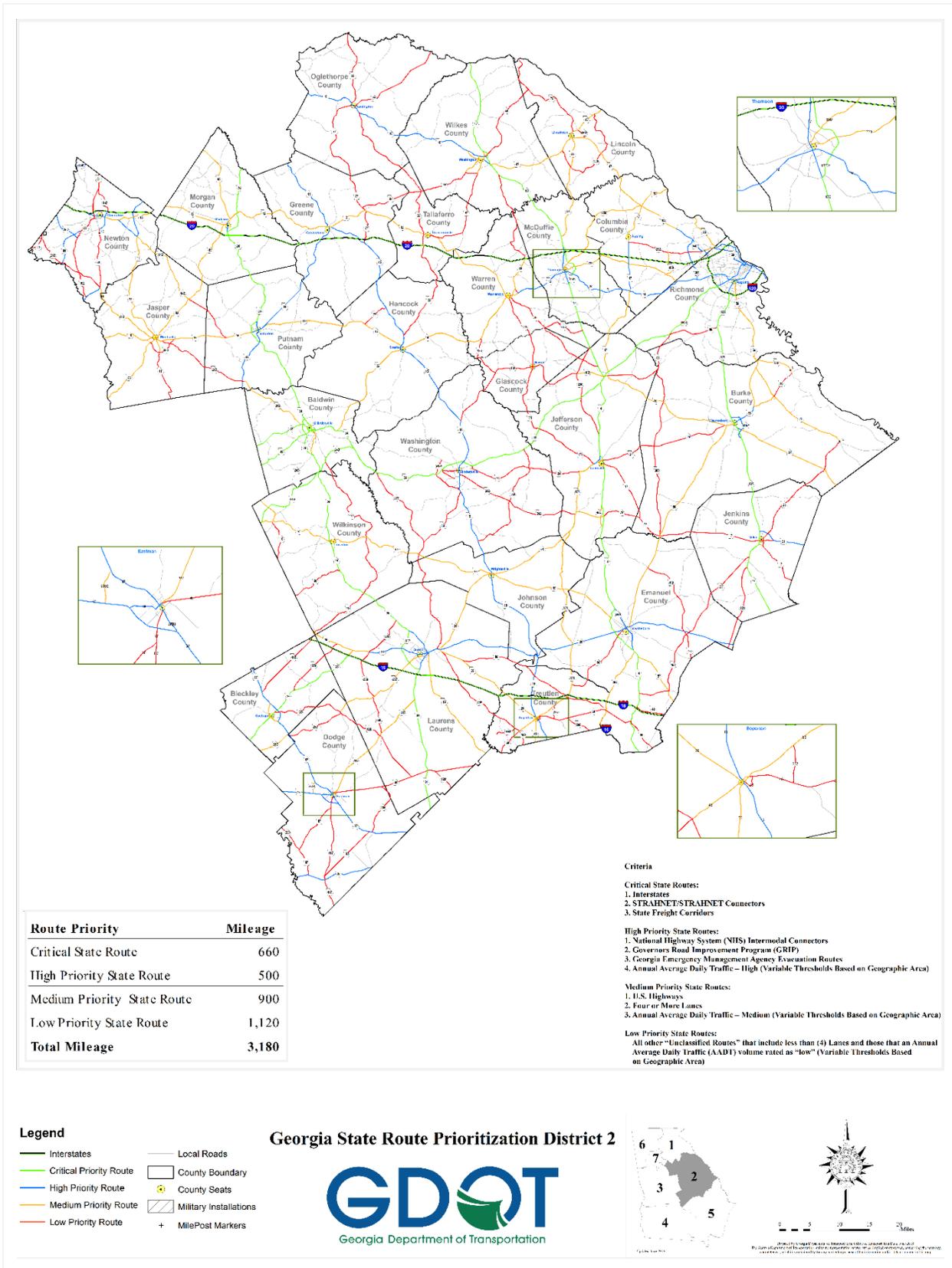


Figure 5 Georgia State Route Prioritization – District 2

# Prioritization of Georgia State Routes

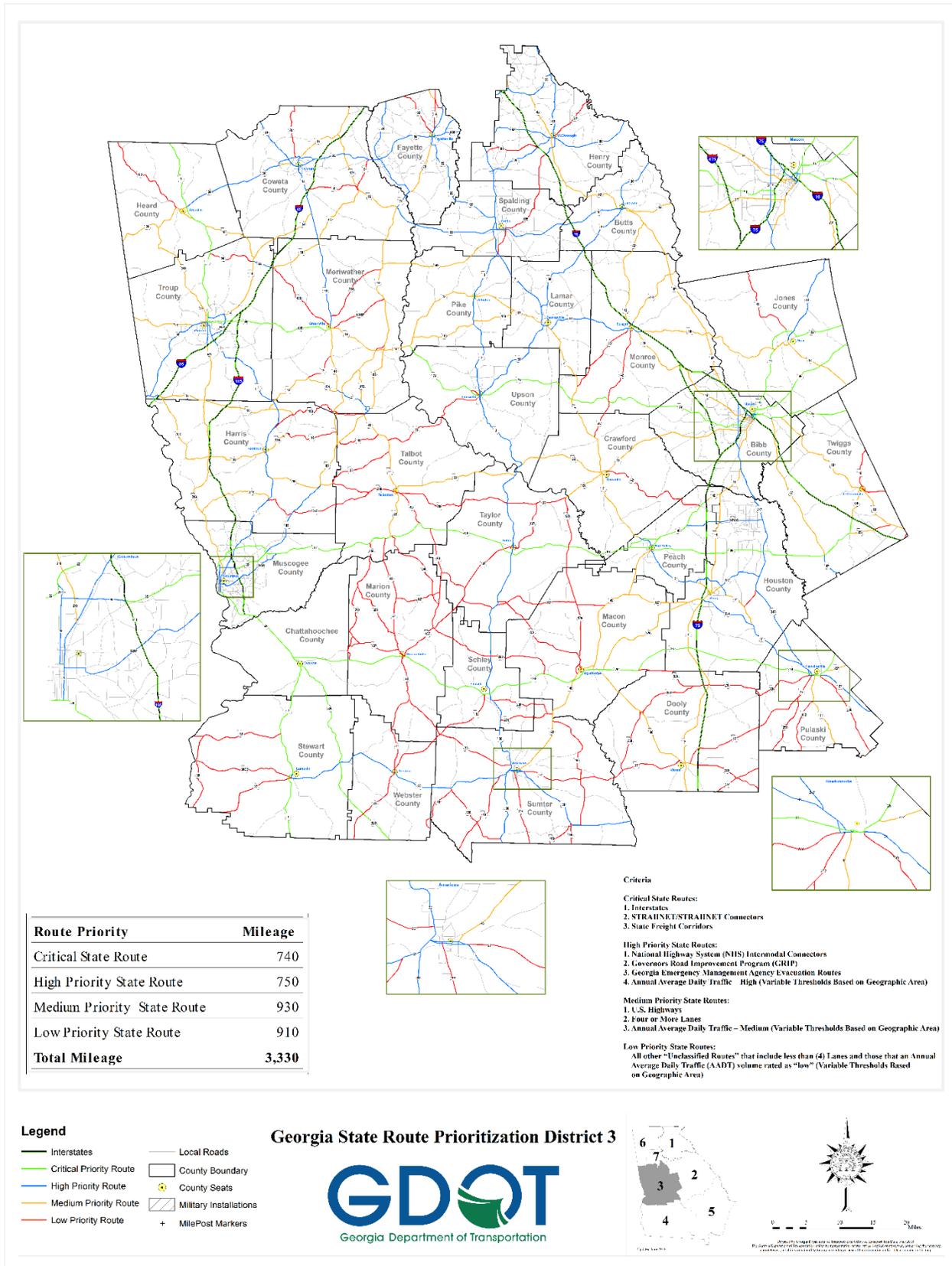


Figure 6 Georgia State Route Prioritization – District 3

# Prioritization of Georgia State Routes

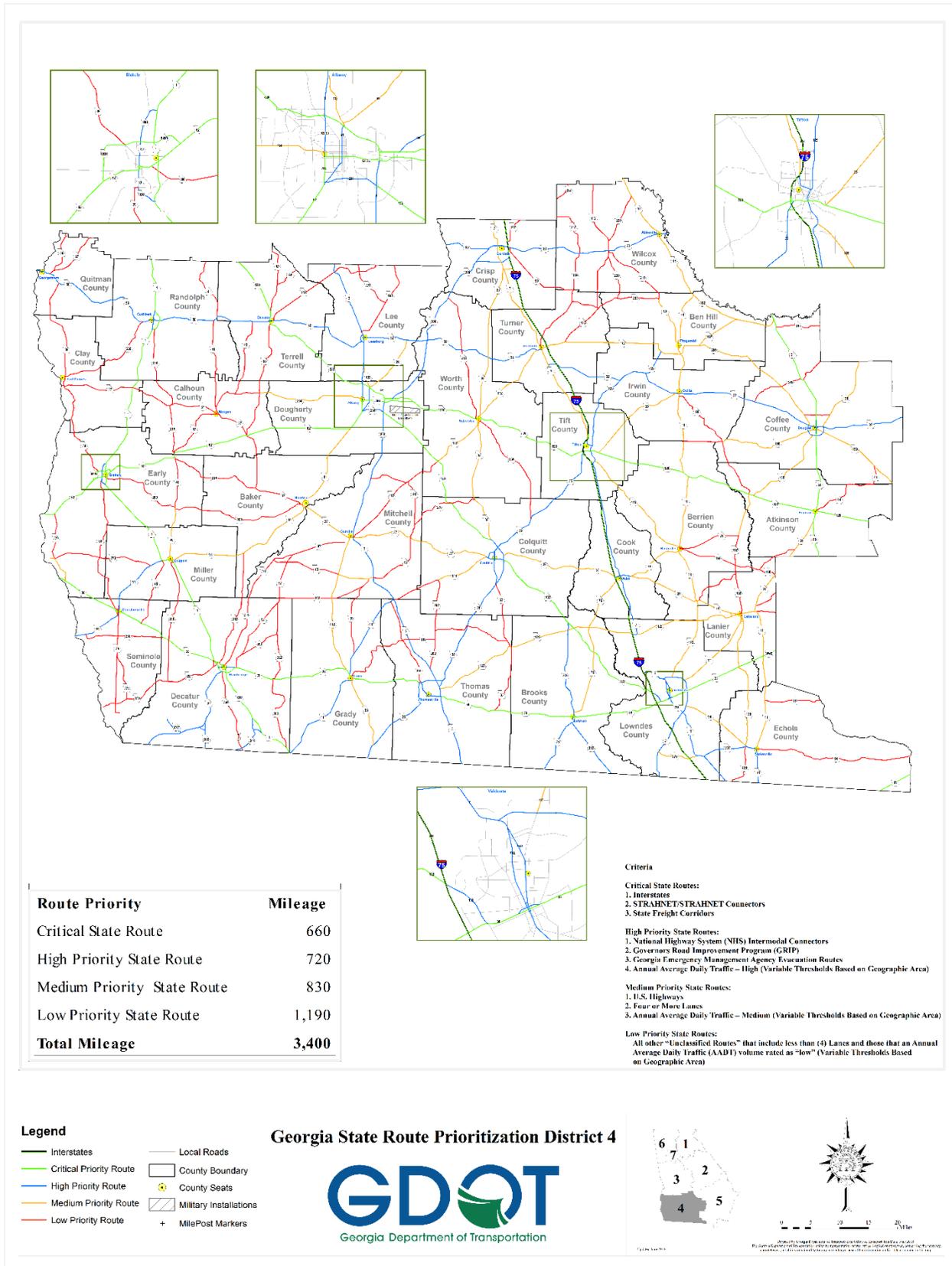


Figure 7 Georgia State Route Prioritization – District 4

# Prioritization of Georgia State Routes

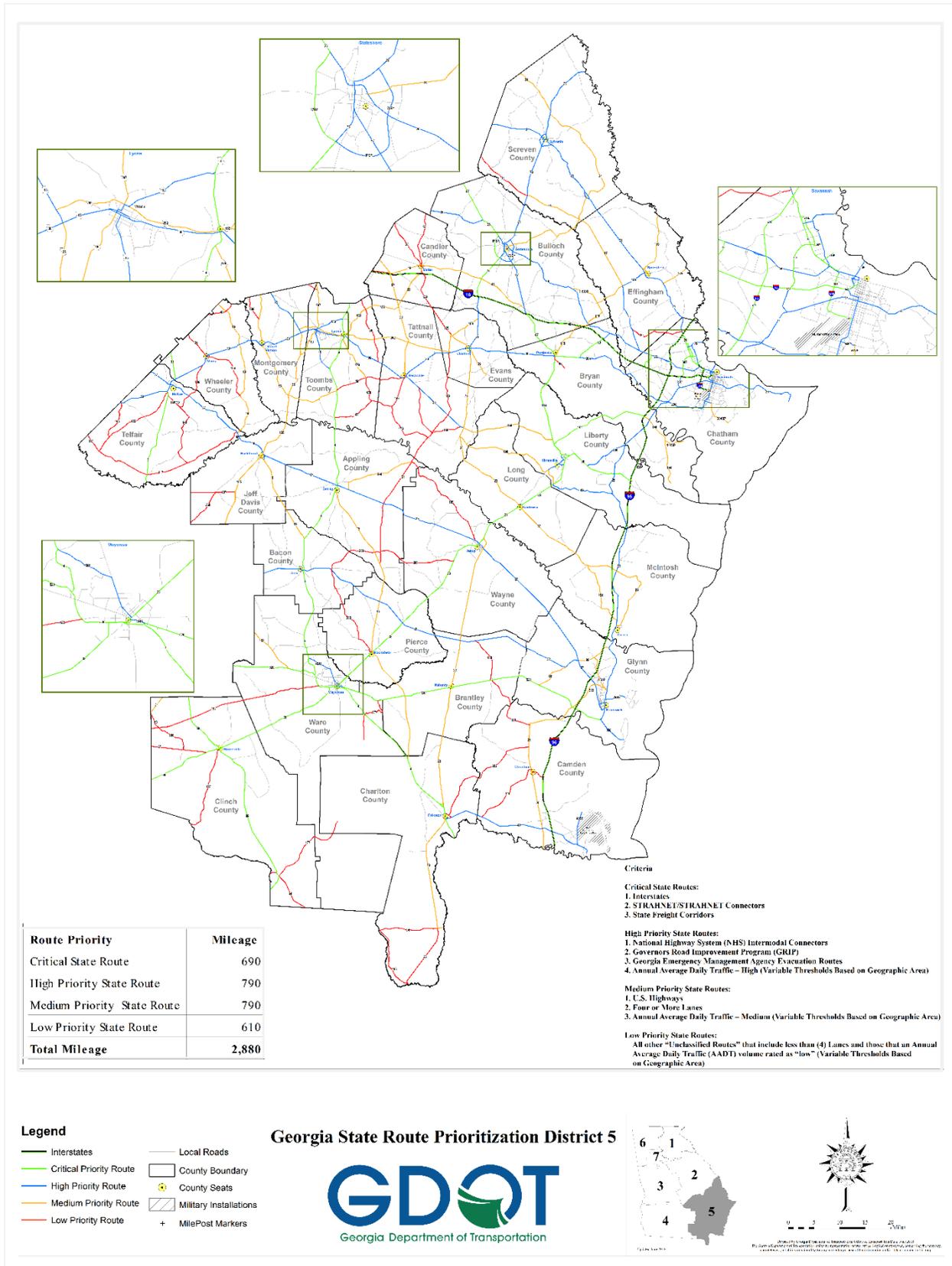


Figure 8 Georgia State Route Prioritization – District 5

# Prioritization of Georgia State Routes

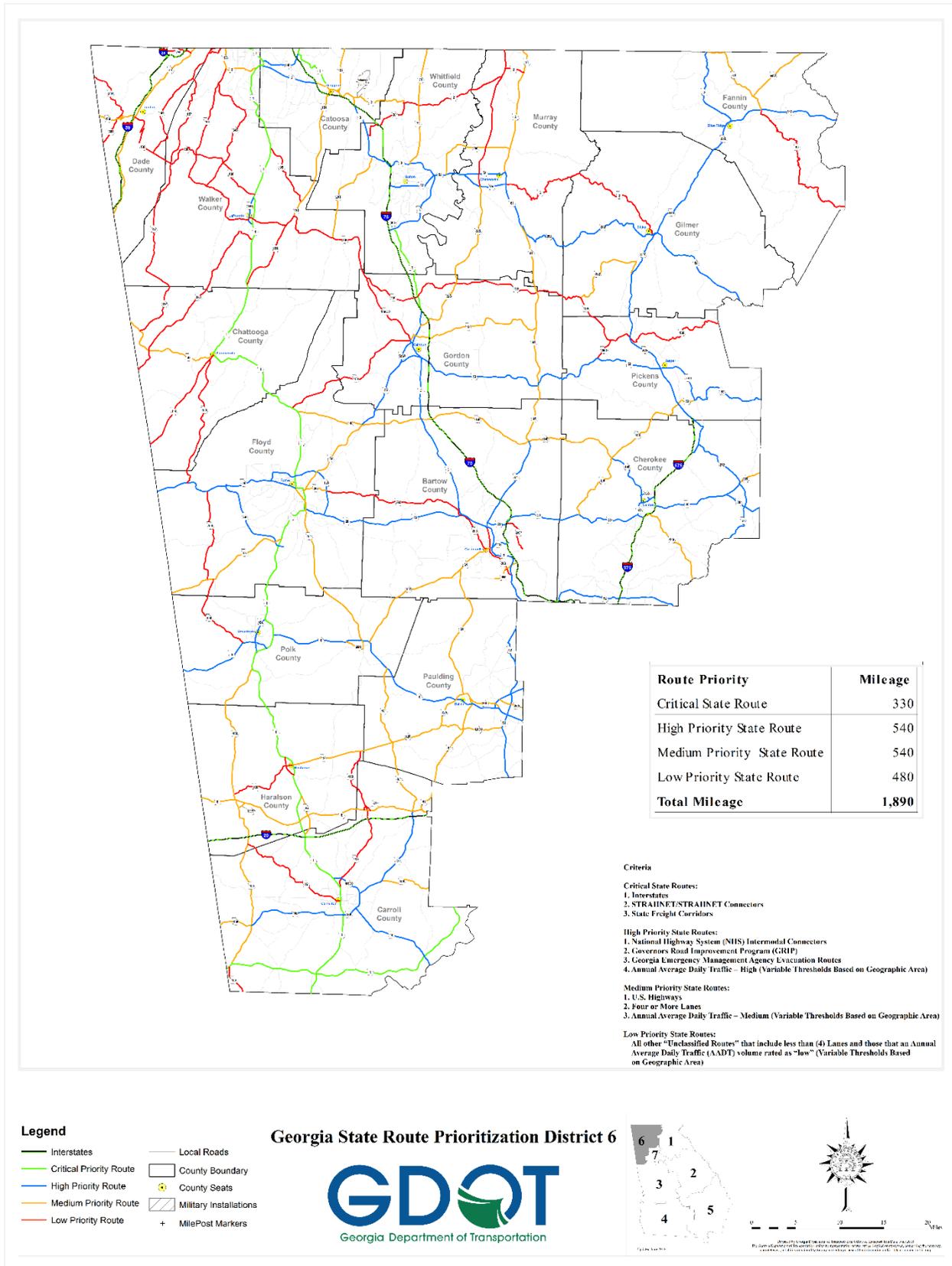


Figure 9 Georgia State Route Prioritization – District 6

# Prioritization of Georgia State Routes

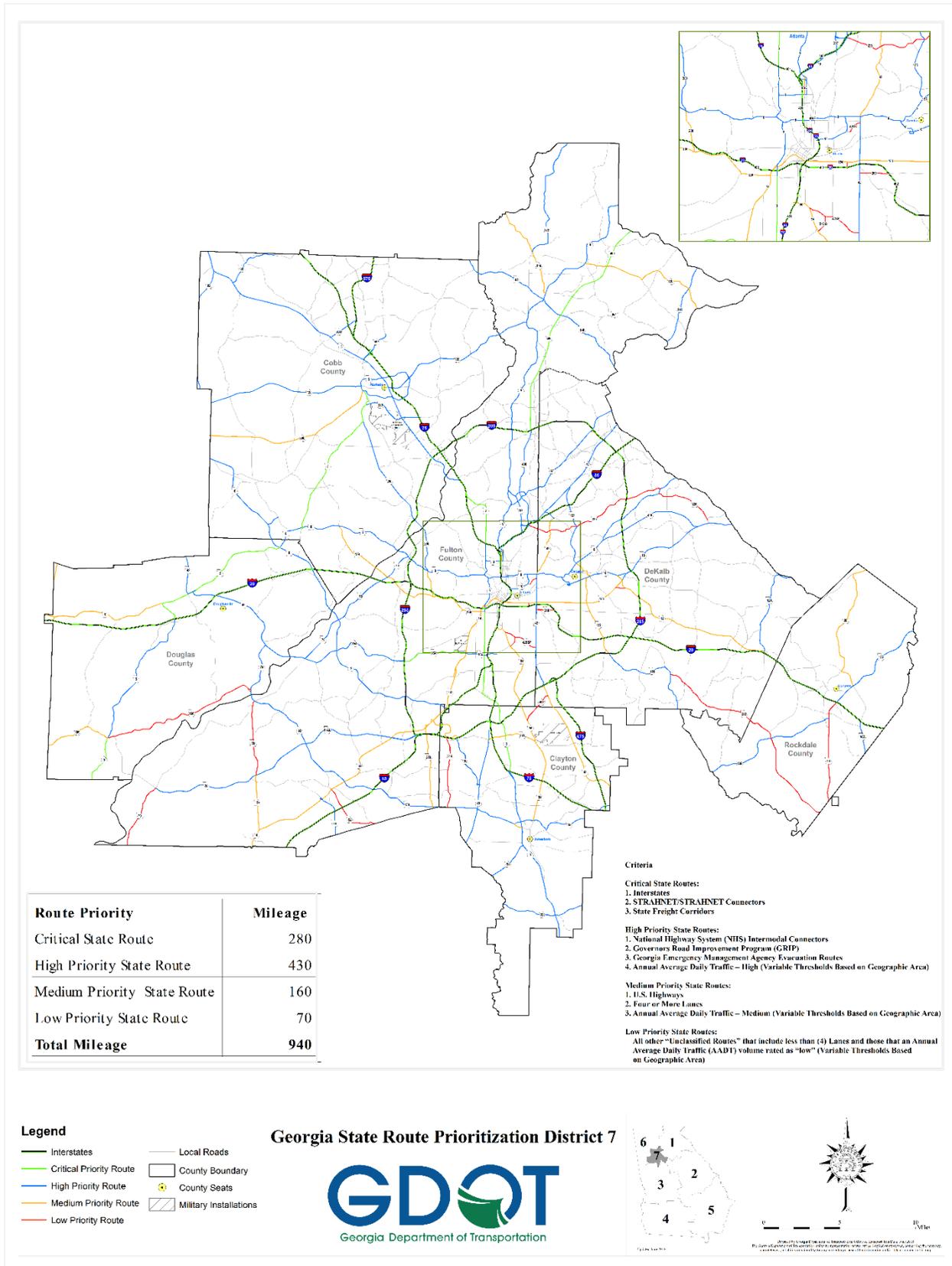


Figure 10 Georgia State Route Prioritization – District 7

# Prioritization of Georgia State Routes

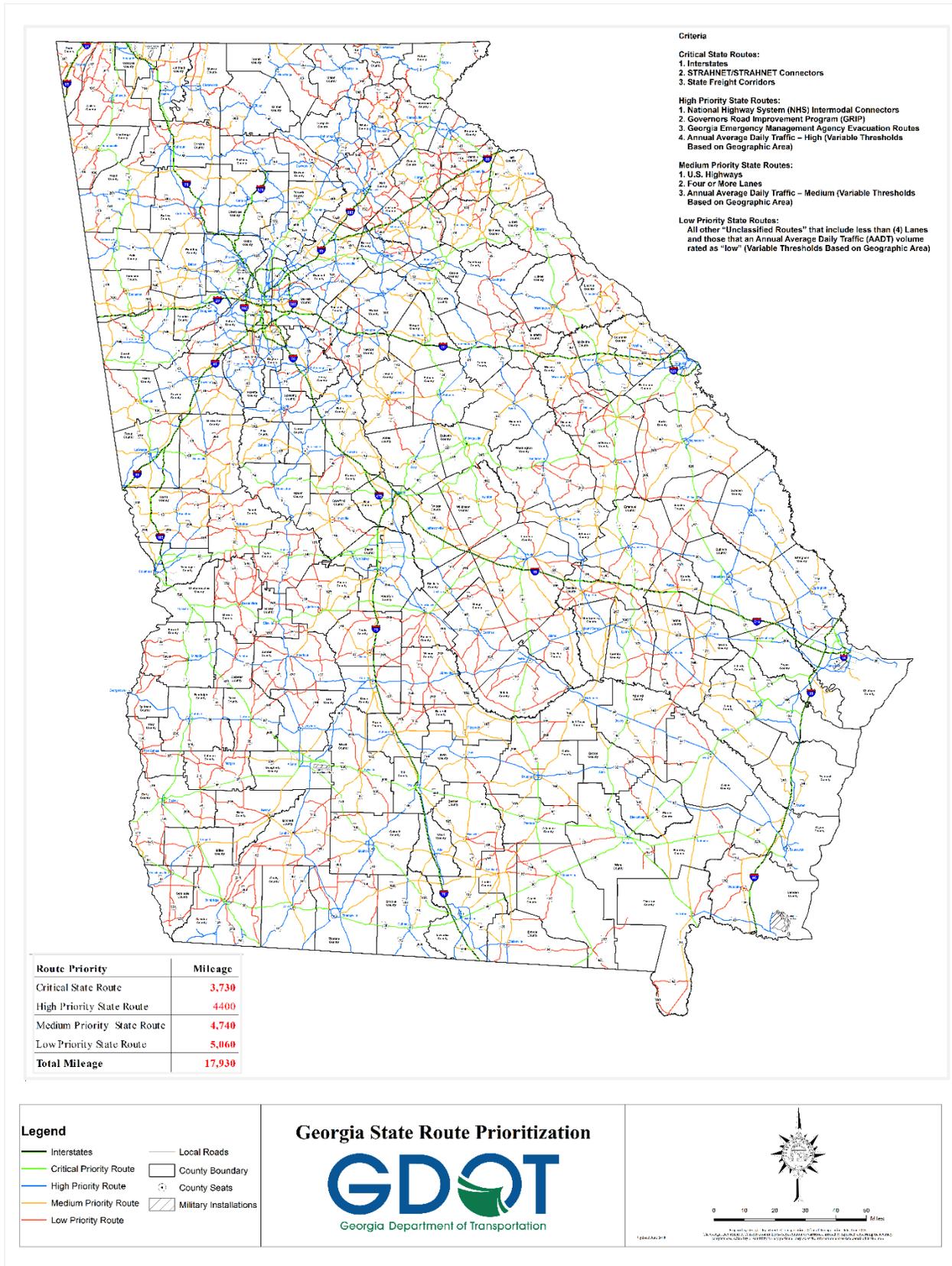


Figure 11 Georgia State Route Prioritization - Statewide

## 5 CONCLUSION

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In 2014, GDOT implemented the initial State Route Prioritization plan and GDOT continues to adjust the plan periodically. GDOT's Office of Maintenance began using the established priorities to assist in the allocation of funding for road maintenance responsibilities; and by doing so this also aligned with GDOT's strategic asset management plan. GDOT will focus its resources on the components of the transportation system that have significance to Georgia's economy, specifically, those that serve a primary role in freight movement, intrastate travel, tourism, and business travel.

State Route Prioritization is not intended to be a static product; it is the beginning of an evolving effort. Annually, OTD will assign a State Route priority to new routes and remove routes no longer on the State Highway System. Biennially, GDOT will review the prioritization criteria and further refine them.

## 6 ACKNOWLEDGEMENTS

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The author acknowledges Mr. Russell McMurry, P.E., Commissioner of the Georgia Department of Transportation (GDOT), for the original request for an evaluation of the State Route Network.

The author expresses appreciation to Mr. Paul Tanner, State Transportation Planning Administrator; and Mr. Eric Conklin, State Transportation Data Administrator, for their input, guidance and useful critiques. Mr. Sean Diehl and Ms. Felicia Harris performed the data analysis for Workshop 2 and contributed the *Appendix A: Discussion of Annual Average Daily Traffic (AADT) Variable Thresholds*. Mr. Subodha Khanal, Transportation Specialist 2, and Ms. Emily Kimani, GIS Analyst 3, performed the data analysis based upon the results of Workshop 3 and created the maps shown in this document.

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## 8 APPENDIX A: DISCUSSION OF ANNUAL AVERAGE DAILY TRAFFIC (AADT) VARIABLE THRESHOLDS

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### 8.1 SUMMARY

This appendix explains the methods used to create AADT Variable Threshold criteria discussed in Section 3.4. These methods include:

- The assumptions used to separate Georgia into geographic and rural/urban regions for analysis.
- The Analysis of Variance (ANOVA) and post hoc tests used to test similarity and difference of AADT values within the geographic regions.
- The analysis of means through standard deviations and frequency distributions of each grouping that generated the AADT Variable Threshold criterion.

### 8.2 BACKGROUND

The approximately 18,000 centerline miles of State Routes in Georgia have many different attributes, characteristics, and levels of functionality, which can be used to prioritize them in the overall system. The current prioritization methodology uses network and highway systems characteristics<sup>1</sup> as criteria for Critical, High, and select Medium routes. These criteria prioritize approximately 12,000 miles of the system. Network characteristics alone, however, do not fully prioritize the State Route System because not all State Routes necessarily belong to a network or share other identified prioritization criteria. The remaining approximately 6,000 miles of State Routes are prioritized by the traffic by method of the AADT Variable Thresholds discussed in this appendix.

### 8.3 ASSUMPTIONS

Prioritizing a route based on traffic volume could be done in many different ways. For example, segments could be compared to the entire State Route System, pushing the highest volumes into a Medium category and the lowest volumes into a Low category. However, this would prioritize State Routes in the high-volume urban areas as Medium and the most rural areas as Low, regardless of their potential regional importance to the system, because traffic volumes on average are much higher in urban areas than in rural areas.

A statistically based approach was undertaken to identify geographic regions across the state with similar traffic characteristics. This approach supports a logical system management perspective, as well as stratifying traffic data groupings throughout Georgia. The output of this effort provides a comparison between the traffic of a route and the traffic in the assigned geographic region for

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<sup>1</sup> Network, highway systems, and characteristic criteria other than traffic: Critical – National Freight Network, State Freight Corridors, Interstates, STRAHNET, STRAHNET Connectors; High – National Highway System, U.S. Routes, Georgia Road Improvement Program (GRIP); Medium – GEMA Evacuation Routes, Sole Connections Between County Seats, routes with 4 or more lanes not on a higher priority network.

prioritization criteria consideration. However, the statistical models and tests require some level of assumptions from which to base the analysis.

Georgia Traffic Factor Groups<sup>2</sup> and staff subject matter expertise were used in the initial assumptions regarding geographic regions. Traffic Factor Groups have several methods by which they can be determined as outlined in the Federal Highway Administration's (FHWA) Traffic Monitoring Guide (TMG). Georgia currently uses the Cluster Analysis method detailed on pages 3-10 of the TMG. Since Traffic Factor Groups in Georgia were already separated into Rural, Small Urban, Urban, and Atlanta groupings on the arterial networks where a majority of the State Route System exists; a similar application specific to the State Route Prioritization Network is a logical progression for further refined criteria.

An assumption was made that AADT would have statistically similar groupings when grouped by urban area. Further, the hypothesis was that a difference between rural and small urban groupings would emerge among GDOT Districts. Additionally, Atlanta was separated into metro<sup>3</sup> and perimeter areas<sup>4</sup>.

## 8.4 STATISTICAL ANALYSIS STEP 1: STATISTICAL COMPARISON OF GEOGRAPHIC REGIONS FOR SIMILARITY/DIFFERENCE

### 8.4.1 Overview

To test the AADT grouping hypothesis, a statistical test was needed. The Analysis of Variance (ANOVA), described below tests similarity, which can be used to conversely infer difference.

### 8.4.2 Test

A Two-Way analysis of variance (ANOVA) Multiple Comparisons<sup>5</sup> with a Newman-Keuls<sup>6</sup> post-hoc procedure confirmed the hypothesis that Urban Code<sup>7</sup> would have similar groupings based on AADT. The analysis shows potential similar groupings of urban areas. By comparing descriptive statistics, such as the means and standard deviations, groups were chosen for further comparative

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<sup>2</sup> See the Georgia Traffic Monitoring Guide for more information on Traffic Factor Groups

<sup>3</sup> Metro Atlanta as defined by counties DeKalb, Fulton, Cobb, Gwinnett, and Clayton.

<sup>4</sup> Perimeter Atlanta as defined by counties Barrow, Bartow, Carroll, Cherokee, Coweta, Dawson, Douglas, Fayette, Forsyth, Hall, Haralson, Henry, Jackson, Newton, Paulding, Pike, Rockdale, Spalding, and Walton.

<sup>5</sup> The two-way ANOVA compares the mean differences between groups that have been split on two independent variables (called factors). The primary purpose of a two-way ANOVA is to understand if there is an interaction between the two independent variables on the dependent variable.

<sup>6</sup> The Newman-Keuls or Student-Newman-Keuls (SNK) method is a stepwise multiple comparisons procedure used to identify sample means that are significantly different from each other. This procedure is often used as a post-hoc test whenever a significant difference between three or more sample means has been revealed by an analysis of variance (ANOVA). The procedure is more likely to reveal significant differences between group means.

<sup>7</sup> Status given to roadways, which correspond to federal census data. The urban codes delineate routes into the following categories: Urban, Small Urban, and Rural.

analysis. A Single Factor ANOVA <sup>8</sup>of the chosen eight categories, identified as “Zones” in the chart below, demonstrated that they are not statistically similar as a group. Because the eight categories are not similar in terms of their mean AADT, an inference can be made that it is likely that they are each different from one another. To support the assertion that independent pairings are different from one another, a t-Test: Two-Sample Assuming Equal Variances<sup>9</sup> was conducted on the most similar of the groupings (the most similar of the groupings was a clear choice). The results showed a significant difference between the two.

### 8.4.3 Results

The results showed (Table A-1) that treating the following geographic network populations separately is statistically valid:

Table A - 1 Results of Statistical Analysis Step 1

Zone	Districts	Urban_ID
1	1,6,7	Rural
2	2,3,4,5	Rural
3	1,6	Small Urban
4	2,3,4,5	Small Urban
5	N/A	Atlanta (Metro)
6	N/A	Urban Areas: Augusta, Columbus, and Savannah
7	N/A	Urban Areas: Athens, Gainesville, Rome, Hinesville, Atlanta (Perimeter)
8	N/A	Urban Areas: Dalton, Macon, Albany, Brunswick, Cartersville, Valdosta, Warner-Robins, and Chattanooga

## 8.5 STATISTICAL ANALYSIS STEP 2: COMPARISON OF AADT TO CREATE VARIABLE THRESHOLDS

### 8.5.1 Overview

The comparison of AADT described in this step compared the AADT of a single segment to all of the segments within the geographic region it resides. The result being that the AADT of the traffic segment relative to the mean AADT of a geographic region is used to determine and assign Low and Medium status for routes not otherwise prioritized by any other criteria.

### 8.5.2 Test

After determining which regions are similar, the descriptive statistics of the means, standard deviations, and frequency distributions of the AADTs by geographic region are used to identify cutoff values for Low and Medium State Route prioritization criteria. Consideration for the base

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<sup>8</sup> The one-way analysis of variance (ANOVA) is used to determine whether there are any significant differences between the means of three or more independent (unrelated) groups.

<sup>9</sup> A two-sample t-test is used to test the difference (d0) between two population means. A common application is to determine whether the means are equal.

## Prioritization of Georgia State Routes

population comparative statistics include State Routes functionally classified as Other Principal Arterials, Minor Arterials, Major Collectors, Minor Collectors, and Local Roads. The break points between Low and Medium Priority for each region are a function of the mean AADT and standard deviation for that population. By doing so, each segment's AADT has importance relative to the geographic network population in which it resides.

An examination of the distributions of the means for each region determined the appropriate distance from the mean to set a break point between Low and Medium Priority AADT. The distributions were similar enough among all groups to uniformly set the threshold between low and medium as -1/2 standard deviation below the mean.

### 8.5.3 Results

The results showed (Table A-2) the following AADT thresholds:

Table A - 2 Results of Statistical Analysis Step 2

Districts	Urban_ID	AADT Threshold between Low and Medium Priority	AADT Threshold between Medium and High Priority
1,6,7	Rural	2,600	7,900
2,3,4,5	Rural	1,500	4,600
1,6	Small Urban	6,800	12,600
2,3,4,5	Small Urban	5,300	9,500
N/A	Atlanta (Metro) <sup>8</sup>	18,600	31,200
N/A	Urban Areas: Augusta, Columbus, and Savannah	13,400	23,800
N/A	Urban Areas: Athens, Gainesville, Rome, Hinesville, Atlanta Perimeter Counties <sup>9</sup>	11,300	21,400
N/A	Urban Areas: Dalton, Macon, Albany, Brunswick, Cartersville, Valdosta, Warner-Robins, and Chattanooga	8,600	16,200

## 8.6 CONCLUSION

The methods of this appendix examined AADT as a characteristic for the prioritization of State Routes. A relative comparison of the traffic of segments and of the assigned geographic region was examined to control for known, consistent volume differences between urban and rural routes. The results of the study supported the assumption that geographic regions across the state would stratify by traffic data with statistical meaning. The outcome of this study resulted in a methodology for the prioritization of State Routes not otherwise covered by established criteria. By using the methods outlined in this paper, a process for assigning these remaining State Routes to Medium and Low priority categories can be repeated in future prioritization evaluations of the State Route System.