Transportation Networks: Data, Analysis, Methodology Development and Visualization

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The 2004 to 2008 CPMS does not meet the needs of the transportation system. The program will have outstanding transportation needs for improvements in capacity, safety, and system preservation (bridges and pavement).
The 2018 CPMS transportation program will demonstrate even higher levels of deficiencies and need for additional funding.
Program funds are equitably distributed to programs statewide, including counties that have been identified as "lagging" by the Center for Business and Economic Research at the University of Alabama.
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Executive Summary

This project provides data compilation, analysis methodology and visualization methodology for the current network data assets of the Alabama Department of Transportation (ALDOT). This study finds that ALDOT is faced with a considerable number of challenges in meeting the growing demand for transportation. This project also provides a technology-enabled tool for asset management, to help define issues, and to help managers make data-driven, model-based decisions about work issues and allocation of resources.

Study findings include:

- The 2004 to 2008 CPMS does not meet the needs of the transportation system. The program will have outstanding transportation needs for improvements in capacity, safety, and system preservation (bridges and pavement).
- The 2018 CPMS transportation program will demonstrate even higher levels of deficiencies and need for additional funding.
- Program funds are equitably distributed to programs statewide, including counties that have been identified as “lagging” by the Center for Business and Economic Research at the University of Alabama.
- The CPMS program should be reviewed periodically to ensure it continues to meet performance measures for capacity, safety, and system preservation.

Introduction

The Alabama Department of Transportation (ALDOT), working with the University of Alabama, conducted a study to evaluate the effectiveness of the Comprehensive Project Management System (CPMS) to meet the state's transportation needs. The evaluation focused on the program's ability to address system capacity, safety, and system preservation needs, as well as assessing transportation impacts on economic development statewide. The study effort used a system of tools to quantify needs and match those needs with programmed improvements. Results were mapped using GIS technology, which facilitated the evaluation of the statewide transportation program's effectiveness. Primary focus was on the 2004 to 2008 CPMS program; projections to 2018 have been developed to provide anticipated levels of need over a ten-year horizon.

Capacity Analysis

Congestion is a major transportation concern. As Alabama's population and employment continue to grow, traffic is expected to outpace the state's roadway capacity. Urban areas are already feeling the impacts of congestion and delays on daily commutes. Rural roads are also facing growth in vehicular travel. Future capacity improvements will be critical to maintaining mobility for passenger and commercial traffic.

Roadway system capacity was measured using v/c (vehicle to capacity) formula calculations. The formula produces a level of service (LOS) measure that is graded from A to F – with A being free-flow operations and F severely congested traffic. A LOS of C or worse is considered unacceptable on the rural Interstate system; LOS D or worse is considered unacceptable on urban Interstates. The differentiation is based on the total amount of traffic and operating conditions that characterize rural and urban systems.

The current 2003 Interstate system has 89 miles within unacceptable LOS ranges. By 2008, the number of congested miles will have increased to 184 miles of Interstate roadway with traffic volumes exceeding capacity standards. CPMS funding levels will not keep pace with increasing capacity needs. Projects programmed in the CPMS are expected to address 56 miles of congested Interstate needs in 2008, leaving 128 miles of anticipated Interstate congestion remaining.

By 2018, the situation will further deteriorate. Interstates are forecasted to have 209 miles operating in congested conditions. Projects programmed in the CPMS are expected to address 35 of the 209 miles of congested Interstates by 2018, with 174 miles of congestion remaining statewide, or $947 million not currently programmed.

Congestion on the state route system will mirror that of the Interstate. The state route system's congestion amounts to 38 miles in 2003. By 2008, the state route system will have 77 congested miles. Projects programmed in the CPMS will address 15 miles of identified congested state route needs in 2008, leaving 62 miles of anticipated congestion outstanding.

By 2018, state routes are anticipated to have 101 miles exceeding capacity standards. Projects programmed in the CPMS address 17 of the 101 miles of congested state routes by 2018, with a residual of 84 miles of congestion statewide remaining. By 2018, the financial need to offset future state route congestion will total $175 million.

Safety Analysis

Based on ALDOT CARE (Critical Analysis Reporting Environment) crash database statistics from 1999 through 2002, over 10,800 crashes and 126 fatalities per year occurred on the state's Interstate system. State routes had 12,840 crashes and 247 fatalities over the same period. Truck traffic was involved in approximately 11 percent of the Interstate crashes statewide. To single out safety "hot spots," the study identified roadway sections experiencing crash and fatality rates over one standard deviation above the state average.

Rural Interstates had a lesser number of crashes (5,123 total) but a larger number of fatalities (90 fatalities total). Crashes involving a truck were more evident on rural Interstates (732 crashes with trucks) compared to urban Interstates (469 crashes involved trucks).

State routes experienced 12,840 crashes and 247 fatalities. Of this number, there were 890 crashes that involved trucks. As with the Interstates, the study located "hot spots" – sections of the state route system experiencing crash and fatality rates over one standard deviation above the state average.

CPMS safety projects include a wide range of improvements from guardrail to signalization. However, there are other types of project activities, such as a widening and road reconstruction, that can improve safety even though they are usually not included in the safety category. Widening and reconstruction improve the capacity and operations of a facility, thereby garnering the collateral benefits of improved safety.

There were 360 miles of "hot spot" locations with safety crash incidents exceeding one standard deviation above the state average. A total of $15 million for Interstates and an additional $17 million for state routes are programmed in the CPMS for safety improvements. Projects that solve capacity and bridge needs coincide with 129 miles of safety needs. In addition, special safety projects addressed 5 miles (one percent) of the safety "hot spot" locations for Interstates and state routes. There remain 226 miles with outstanding safety needs that are important to the transportation program.

System Preservation Analysis

Preserving the system's bridges and pavement is an ALDOT priority. Nationwide, the maintenance of road and bridge systems is increasingly difficult as systems age and traffic increases. Early identification of deficient bridges can help alleviate this problem. Similarly, a proactive pavement resurfacing program can do much to maintain the system to acceptable standards.

Bridge Analysis

Alabama's transportation network includes 1,188 Interstate bridges and 4,498 state route bridges. Bridge data from the ABIMS (Alabama Bridge Inventory Management System) and federal NBI (National Bridge Inventory) sources was used to identify bridges with transportation needs related to one or a combination of the following factors: age, sufficiency ratings, structural deficiency, functional obsolescence, and congestion on approaching routes. These factors are regularly used to assess the integrity and performance of bridges in the system.

CPMS projects programmed for 2004 to 2008 will address 188 of the Interstate bridge needs. The program does not address the needs of 487 Interstate bridges that meet the criteria for improvement.

State route bridges were also evaluated. CPMS state route bridge projects programmed for 2004 to 2008 will address 200 of the bridges on the state system identified as having a transportation need. That leaves a balance of 2,726 state route bridges not addressed in the CPMS. Future bridge improvements will require a level of effort of $1.6 billion by 2018 – funds that are currently not in the program.

Pavement Analysis

Asphalt, a flexible pavement, is used for the majority of the 10,865-mile state roadway network. Pavement ratings are maintained by the University's HYDRA (Highway Yearly Data Reduction and Analysis) system. ALDOT prioritizes pavement rehabilitation for roadway sections with a HYDRA rating of below 80-83 (Figure 9). Between 2003 and 2008, 66 percent of the Interstate system (2,532 lane miles) and 51 percent of the state route network (11,354 lane miles) will require resurfacing to maintain the desired HYDRA rating.

ALDOT's State Maintenance Program assesses pavement conditions annually to determine which roads will be resurfaced. The resurfacing budget is approximately $95 million annually; this budget item is a lump sum amount in the CPMS. In addition, the CPMS has identified specific resurfacing projects. These projects total 13,886 lane miles of resurfacing and a level of effort of $1.125 billion necessary for the five-year program. If the State of Alabama maintains that same rate of public investment, 2018 pavement improvements will require $2.3 billion.

Economic Implications

The Center for Business and Economic Research at the University of Alabama recently studied demographic characteristics of Alabama's counties to develop an index of economic vitality (see Appendix A). The Alabama County Economic Index rates counties with indices below 60 as lagging economically.

The 18 counties with the lowest indices make up 9.6 percent of the state's population yet comprise 24.3 percent of its population in poverty, 13.6 percent of its unemployment, 11.6 percent of its citizens without high school diplomas, and 42.1 percent of the state's minority population. A summary of the indices for these 18 counties is provided in Appendix B.

The lagging counties have 746 lane miles of Interstate (18 percent of statewide) and 4,812 lane miles of state routes (20 percent of statewide). Of the state's 1,188 Interstate bridges, 167 (14 percent) are within these 18 counties, as are 1,121 of the state's 4,498 state route bridges (25 percent).

CPMS projects in all categories (capacity, safety, and system preservation) are well represented in these counties. In addition, ALDOT has an Industrial Access Program that facilitates public / private partnerships on transportation projects that create new jobs. The program is funded with $12 million from the Transportation Department's budget. In FY 2002, there were nine projects using $10 million in ALDOT funds that leveraged $439 million in private investments and created 3,166 jobs.
The CPMS includes 111 projects (13 percent) located in the 18 lagging counties. These projects are for widening, safety, and system preservation needs. Improvements to the transportation system in these counties, especially improvements that facilitate access, help to create the conditions for attracting new business and making existing business more competitive.

The percentage of funding for every category is in proportion to the percentage of state population in the lagging counties (9.6 percent), their percentage of bridges statewide, and their percentage of statewide lane miles. The lagging counties have 46 miles of Interstate safety needs (31 percent of the system needs) and 57 miles of state route safety needs (27 percent). A large percentage (26 percent) of the Interstate system safety funding is allocated in the lagging counties. State route safety needs in the 18 counties are funded by 12 percent of the state route system safety funding through 2008.

General Findings

Study findings include:

- The 2004 to 2008 CPMS does not meet the needs of the transportation system. The program will have outstanding transportation needs for improvements in capacity, safety, and system preservation (bridges and pavement).
- The 2018 CPMS transportation program will demonstrate even higher levels of deficiencies and need for additional funding.

- Program funds are equitably distributed to programs statewide, including counties that have been identified as “lagging” by the Center for Business and Economic Research at the University of Alabama.
- The CPMS program should be reviewed periodically to ensure it continues to meet performance measures for capacity, safety, and system preservation.

Appendix A: Project Details

1. Background

Transportation faces many challenges necessitating strategic action on the part of state governments, especially those in the Southeast where growth has been very aggressive. Alabama has attracted significant population growth from other parts of the nation, creating increased demands on the state's transportation systems and infrastructure. As a result, the Alabama Department of Transportation (ALDOT) recognized the need to pay careful attention to how well the state's transportation program can respond to evolving public needs for mobility and access.

With this in mind, ALDOT initiated a transportation system review and assessment to accomplish the following:

- Develop a tool set that could be used to evaluate the relative merits of projects and provide guidance for decision-making based on project impact and merit. The tool set that has been developed as a part of this effort is sufficiently transparent to easily communicate the rationale for project selection to non-technical audiences.
- Evaluate the ability of the 2004-2008 Comprehensive Project Management System (CPMS) to address identified transportation needs within available funding.

The CPMS is the state's work program of transportation projects. It includes projects proposed for implementation using federal and state funds. The CPMS is the source for development of the three-year Statewide Transportation Program (STIP), which is required for establishing federal funding eligibility. The evaluation focused attention primarily on transportation projects in four areas: capacity, safety, system preservation, and economic development. The first three categories were evaluated using operations and condition data; the latter focused on the impacts of the transportation improvements supporting economic development initiatives, especially in portions of the state considered economically lagging.

Projects in the CPMS can be grouped as follows:

- Capacity projects (e.g., turn lanes, passing lanes, ramp revisions, widening)
- Special safety projects (e.g., signalization, guardrail, lighting)
- System preservation (e.g., bridge replacement and rehabilitation, pavement resurfacing and rehabilitation)

CPMS projects are programmed by the phase corresponding to their status in project development: Preliminary Engineering, Right of Way, Utilities, or Construction. Each project varies, and not all projects include all phases. The most current CPMS spans a five-year period from 2004 to 2008, a total of $4.1 billion project programmed funds.

Figure 1 shows the breakdown by expenditure categories of capacity, bridge, pavement, safety, and other. The categories of expenditures are not exclusive: very often improvements in one project category provide benefits across a span of operations categories. For instance, a widening project that provides additional lanes of capacity will improve traffic flow and improve the safety of the facility's operations. The transportation system works as a network.

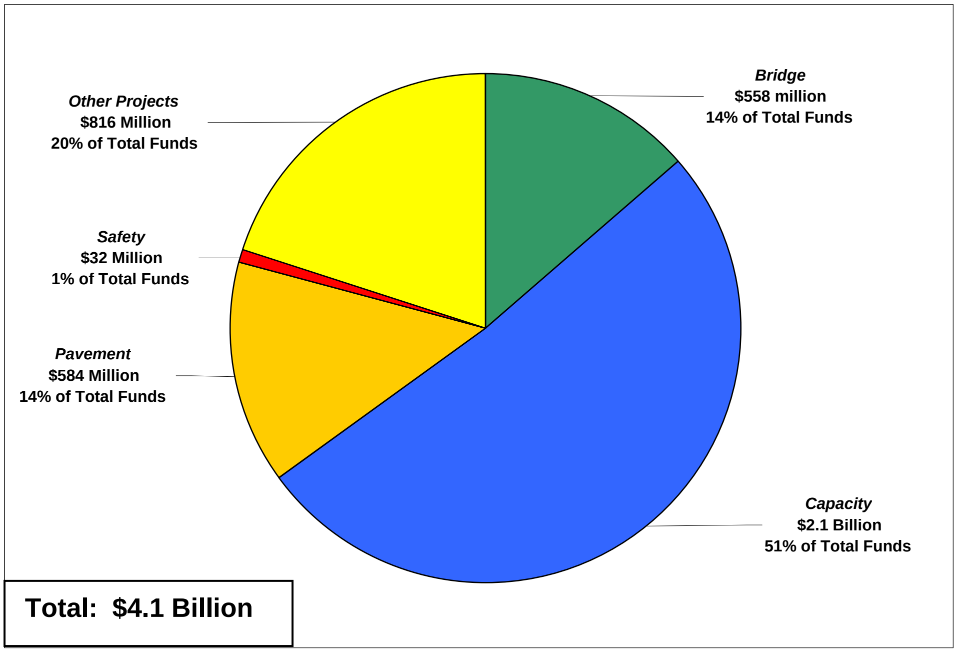

Figure 1
2004 – 2008 Interstate and State Route CPMS Expenditures

System Overview

Table 1 provides a system overview of the state network and selected operations statistics. The 10,851-mile state network is made up of 904 miles of Interstate and 9,947 miles of state routes. The Interstate system is the workhorse of the state's transportation network. Interstate lane miles comprise 14.2 percent of the total road miles in the state system, but serve 22 percent of truck traffic and 38 percent of the total vehicle miles traveled in 2003.

There is a difference between the operations and service provided by the rural portion of the Interstate system and that of the urban portions. The rural portion of the Interstate system was well used by trucks and the traveling public, experiencing 21 percent of the total vehicle miles traveled and 28 percent of the truck traffic. The urban portion of the Interstate system provided service for 17 percent of the vehicle miles traveled statewide and 17 percent of the truck traffic. The non-Interstate state route network experienced the majority of traffic: 62 percent of the vehicle miles traveled and a total of 12 percent of the 2002 truck traffic.

There are 5,686 bridges on the state system, including 1,188 Interstate bridges (21 percent) and 4,498 state route bridges (79 percent). Bridges are functionally classified as Interstate and state route (arterial, collector, or local), and then further divided by urban or rural. Alabama's pavement is predominantly flexible, with 98 percent of the state's system (including Interstates) constructed with asphalt pavement. The majority of the existing rigid or concrete pavement (278 miles or 2 percent of the total) is on Interstate construction and can be found in and around urban areas.

Table 1
System Summary

Functional Class	2003 Center Line Miles	2003 VMT	2008 VMT	2018 VMT	Average AADT (2003)	Average AADT (2008)	Average AADT (2018)	Average Truck (2002)
Rural State Route	8,488	43,836,506	48,981,791	59,293,670	6,599	7,346	8,846	14%
Urban State Route	1,459	27,361,195	29,889,553	34,953,296	20,763	22,581	26,197	7%
State Route Total	9,947	71,197,701	78,871,344	94,246,966	10,743	11,804	13,922	12%
Rural Interstate	606	23,703,611	27,206,033	34,210,865	43,690	50,113	62,960	28%
Urban Interstate	298	20,077,158	22,989,108	28,813,105	76,296	86,507	106,928	17%
Interstate Total	904	43,780,769	50,195,141	63,023,970	61,515	70,009	86,997	22%

Bridge Class	Interstate	State Route
Rural	619	3,739
Urban	569	759
Total	1,188	4,498

State Route Bridge Class	Arterial	Collector	Local	Total
Urban	705	33	21	759
Rural	2,633	1,039	67	3,739

Pavement Type	Interstate	State Route	Total
Flexible	74% (666 Miles)	99.6% (9,961 Miles)	98%
Rigid	26% (238 Miles)	0.4% (40 Miles)	2%

Pavement Rating Below 55 (2002)		
Interstate	**40**	1% (Lane Miles)
State Route	**949**	4% (Lane Miles)

Study Methodology

Transportation needs identified in the planning process have a specific significance in terms of establishing eligibility for federal funding. Potential projects undergo a planning evaluation to determine whether they address a transportation need and their implementation will satisfy a specific public purpose. Projects in the CPMS have been carefully evaluated during the planning process and found to have a "purpose and need." Any project that shows "purpose and need" is considered to have justifiable reasons for implementation and use of federal funds.

This study grouped transportation needs into the following categories: capacity, safety, and system preservation (pavement condition and bridges). The CPMS project implementation schedule was analyzed to determine whether projects address specific needs to improve the safety, operations, and/or condition of the transportation network. The analysis also considered whether there were unmet needs that required additional transportation investments beyond those programmed in the CPMS.

The ALDOT Transportation System Review and Assessment used a broad array of data resources to analyze existing system conditions and forecast future conditions. Transportation conditions that fell short of state and federal standards were identified and their impact on transportation network operations, safety, and infrastructure was documented. Operations threshold measures were used to determine where improvements were needed. Using Geographic Information Systems (GIS), projects in the CPMS were mapped to show the correlation between identified transportation needs and CPMS initiatives.

After needs and projects were identified, costs were analyzed. Project costs vary by type of project and location. There is a price differential in the cost of construction in urban areas compared to rural areas. For instance, a construction project in a rural area may cost less than in an urban area, largely because the cost of right of way in an urban area is usually more. Projects in the CPMS are programmed to reflect the best cost estimates at the time. As projects are developed and progress from preliminary engineering to concept and final plans, cost estimates are revised.

The level of transportation need was measured using operations and conditions thresholds for four areas: capacity, safety, pavement, and bridges. System capacity as measured by volume to capacity ratios (v/c) is indicative of traffic operations in congested conditions. Capacity adding CPMS projects were assessed to determine their potential to address identified capacity transportation demands. Likewise, CPMS safety projects were examined against identified safety needs to see how well the CPMS program addressed this area. Pavement and bridge CPMS projects were similarly reviewed against needs on the system.

The methodology and approach developed to identify transportation demands and determine the impact of CPMS projects on improving system operations and condition can be replicated by ALDOT staff developing future year CPMS programs. A complete copy of the methodology is provided as a separate technical memorandum. The same methodology can be applied to prioritize projects as a group or evaluate the benefits of a given project on transportation needs.

The study focused on methodologies for evaluating system conditions that use existing data sources. ALDOT data resources and companion databases housed at the University of Alabama were applied in the appraisals. The University of Alabama's methodology and process for collecting and analyzing pavement condition was incorporated into the tool set development. Pavement conditions, current and future, are important to transportation operations. ALDOT's State Maintenance Program annually invests $95 million for resurfacing of roads with priority pavement resurfacing needs. The State Maintenance Program is a lump sum program within the CPMS. In addition, the CPMS includes projects for resurfacing that are selected through the planning process. University of Alabama's data resources are identified in Table 2, along with other data sources and format.

Table 2
Data Sources and Format

Analysis Category	**Data Source**	**Format**
Funding	Comprehensive Project Management System (CPMS)	Oracle database converted to GIS shapefile format by ALDOT GIS team
Capacity	RoadStateNetwork	Oracle database converted to GIS shapefile format by ALDOT GIS team
	Traffic Count Database	Oracle database converted to GIS shapefile format by ALDOT GIS team
Safety	CARE (Critical Analysis Reporting Environment)	Access database converted to GIS shapefile format by ALDOT GIS team
	Traffic Count Database	Oracle database converted to GIS shapefile format by ALDOT GIS team
Bridge	Alabama Bridge Inventory Management System (ABIMS)	Oracle database converted to GIS shapefile format by ALDOT GIS team
	National Bridge Inventory (NBI)	Oracle database converted to GIS shapefile format by ALDOT GIS team
	ALDOT Bridge Replacement Projections	Excel spreadsheet produced by ALDOT Maintenance Office
Pavement	Highway Yearly Data Reduction and Analysis (HYDRA)	Access database produced by Univ. of Alabama and converted to GIS shapefile format by ALDOT GIS team

Table 3 (Measures of Condition and Recommended Thresholds) identifies criteria for determining transportation need and level of transportation demand. The following measures of condition were used:

- Capacity: Volume to capacity (v/c) ratio is a standard measure used to quantify capacity. The ratio of actual vehicle volume to the road's capacity is graded for rural and urban areas. A ratio of 0.75 or greater in rural areas identifies a deficient condition (approximately equivalent to a Level of Service C). In an urban area, a ratio of 0.90 or greater was categorized as deficient (approximately equivalent to a Level of Service D).
- Crash and Fatality Rates: The CARE (Critical Analysis Reporting Environment) database includes crashes and fatalities for the Alabama road network. Crashes are geocoded and can be shown on a GIS map. The standard measure for crashes and fatalities is computed based on a rate per 100 million vehicle miles of travel. Locations with crash rates that exceed one standard deviation above the state average are considered in need of improvement.
- Bridges: Bridge data from the ABIMS (Alabama Bridge Inventory Management System) and federal NBI (National Bridge Inventory) system was used to identify bridges with problems associated with age, sufficiency ratings, structural deficiency and functional obsolescence, or congestion on approaching routes. Details related to the data and thresholds applied are provided below.

Table 3
Measures of Condition and Recommended Thresholds

Measures of Condition	Data Items	Data Source	Recommended Thresholds	Comments
Capacity				
Existing Congestion	• Annual Average Daily Traffic (AADT) • Access Control • Functional Classification • Number of Lanes • Annual Average Daily Truck Percentage	ALDOT traffic count database	Acceptable volume to capacity (v/c) ratio: • Rural = less than 0.75 • Urban = less than 0.90	According to the Highway Capacity Manual 2000, acceptable v/c and level of service (LOS) equivalencies are: • Rural LOS C or better • Urban LOS D or better
Safety				
Crash & Fatality Rates	Crash and Fatality Locations	CARE	• Crash and Fatality rates per 100 Million Vehicle Miles of Travel (VMT) will be computed for sales routes • Routes with normalized rates one standard deviation above the study system average will be identified for future consideration	• Crash rate and fatality rate will be used as the primary indicators of safety-related needs
Bridge				
Sufficiency Rating	Sufficiency Rating	ABIMS/NBI	• Replace bridges with a sufficiency rating of below 50	• Bridges in the 50-60 range might also be candidates for replacement
Structure Type*	Structure Type: Steel/Concrete			
Pavement				
Condition	ALDOT Pavement Ratings	HYDRA	• Roadway with an ALDOT pavement rating of marginal or below should be labeled as deficient	• The same quality standard provided to all NHS, STAA and STRAHNET routes
Shoulders**	Shoulder Width	HYDRA	• Right shoulder < 10 feet • Left shoulder less than 4 feet for 4-lane section • Left shoulder < 10 feet for 6-land section	• Shoulder width is potential for examination of safety related issues
Type*	Pavement Type	HYDRA	• Portland Cement Concrete (PCC) is considered an advantageous pavement type	• Roadway sections carrying high levels of commercial vehicles are potential pavement type improvement targets

*Informational purposes only
**Shoulder analysis was not done as part of this study. This evaluation would be valuable and is recommended in a future enhancement.

Age: Alabama DOT replaces bridge structures using a 50-year life cycle.

- *Sufficiency Rating:* A composite score calculated based on separate factors that include structural adequacy and safety, serviceability and functional obsolescence, and essentiality for public use. Each of these factors contributes to a numeric value indicative of a bridge's fitness for service. The result of this formula is a composite score in which 100 percent represents an entirely sufficient bridge and 0 percent represents an insufficient or deficient bridge. ALDOT has set a threshold of equal to or less than 60 percent as the point at which bridges are considered for replacement or improvement.
- *Functional Obsolescence and Structural Deficiency:* Not related to the safety of the bridge structure, this is a measure of the structure's ability to operate under current traffic conditions. Older bridges designed and constructed to meet a given level of traffic ultimately will be overwhelmed by the state's growth and increased traffic volumes. This measure addresses the functionality of the bridge and its ability to serve traffic demands.
- *Congestion on Approaching Routes:* Bridge structures on roads with v/c ratios in excess of 0.9 in urban areas or 0.75 in rural areas are candidates for bridge replacement from congestion relieving measures, such as roadway and bridge widening.

- <u>Pavement:</u> Pavement condition was measured using the University of Alabama's HYDRA (Highway Yearly Data Reduction and Analysis) pavement databases for Alabama roads. The cost calculation methodology follows:
  - *Step 1: Determine Lane Mile Resurfacing Costs*
    - Split CPMS data into Interstate and non-interstate roads.
    - Determine pavement costs over a three-year period from 2001 to 2003 from the CPMS.
    - Allocate costs across number of lanes.
    - Annualize pavement costs.
  - *Step 2: Determine Statewide Deterioration Rate of Pavement*
    - Determine all road segments improved (in 2000, 2001, 2002).
    - For all road segments that were not improved, determine pavement condition rating for 2000 and 2002.
    - Calculate the system-wide decrease average rating.
    - Result (four percent deterioration rate).
  - *Step 3: Create a Pavement Calculator Forecaster Using the Above Data*
    - Assumption: Maintain the roads at the current rating level of 83 for Interstates and 80 for non-Interstate routes.
    - The calculation does not include changes in cost or inflation.
    - Because rigid (concrete) segments constitute less than four percent of all pavement, the calculation includes only flexible (asphalt) road segments.

The composite tool set provides a quantifiable and uniform methodology for measuring and evaluating transportation system condition. Key elements of the transportation network – the roads and bridges and their condition, safety and operations – were analyzed using the study tools. The results identified transportation needs located on the system, which were subsequently matched with CPMS projects in the 2004 to 2008 program.

2. Capacity Analysis

Capacity analysis addresses the ability of the transportation system to serve demand (that is, to accommodate the level of traffic volumes using the system). Separate threshold measures for urban and rural systems were used for this analysis: a v/c ratio of 0.75 or greater in rural areas and 0.90 or greater in urban areas is considered deficient. The thresholds selected are warning signs of congestion.

As previously indicated in Table 1, vehicle miles of travel (VMT) will increase 12.3 percent from 2003 to 2008, with the more aggressive growth occurring on the Interstate network. Annual average daily traffic (AADT) will grow at a similar pace, experiencing a 9.9 percent increase for state routes and 13.8 percent for Interstates from 2003 to 2008.

The capacity of the road system to accommodate future travel is shown in Table 4. Needed capacity improvements are shown for the current system (2003) and future year systems (2008). The projections are separated for rural and urban systems, in centerline mile units and by system classification. The table confirms that approximately ten percent of the 904 miles of Interstate system were at unacceptable levels of service in 2003. The number of congested Interstate miles is expected to increase to 21 percent by 2008.

Table 4
Volume to Capacity Ratio for 2003 and 2008 by System Classification

Functional Class		2003 V/C Deficiency (Centerline Miles)	2008 V/C Deficiency (Centerline Miles)
Rural Interstate		43	102
Urban Interstate		46	82
Total		89	184
Rural State Route	Arterial	12	32
	Collector	0	8
Urban State Route	Arterial	26	37
	Collector	0	0
Total		38	77

*Shoulder analysis was not done as part of this study. This evaluation would be valuable and is recommended in a future enhancement.

Table 5 shows the percent of the total system in need of capacity improvements.

Table 5
Percent of Total Miles Deficient by Functional Class

System	Centerline Miles	2003 Deficient Miles	2008 Deficient Miles
Rural Interstate	606	43 miles (7%)	102 miles (17%)
Urban Interstate	298	46 miles (15%)	82 miles (28%)
Rural State Route	8,488	12 miles (less than 1%)	40 miles (less than 1%)
Urban State Route	1,459	26 miles (2%)	37 miles (2%)
Total	10,851	134 miles (1%)	261 miles (2%)

Capacity demands on the urban Interstate system will continue to increase through 2008. Transportation system investments will be required to address the need for more capacity in urban areas in order to reduce congestion.

Figure 2 shows the distribution of current traffic and the corresponding LOS (level of service) for the Alabama road network. The map is color-coded to reflect those portions of the Interstate system and other state roads that currently fall below the capacity thresholds indicating congested conditions.

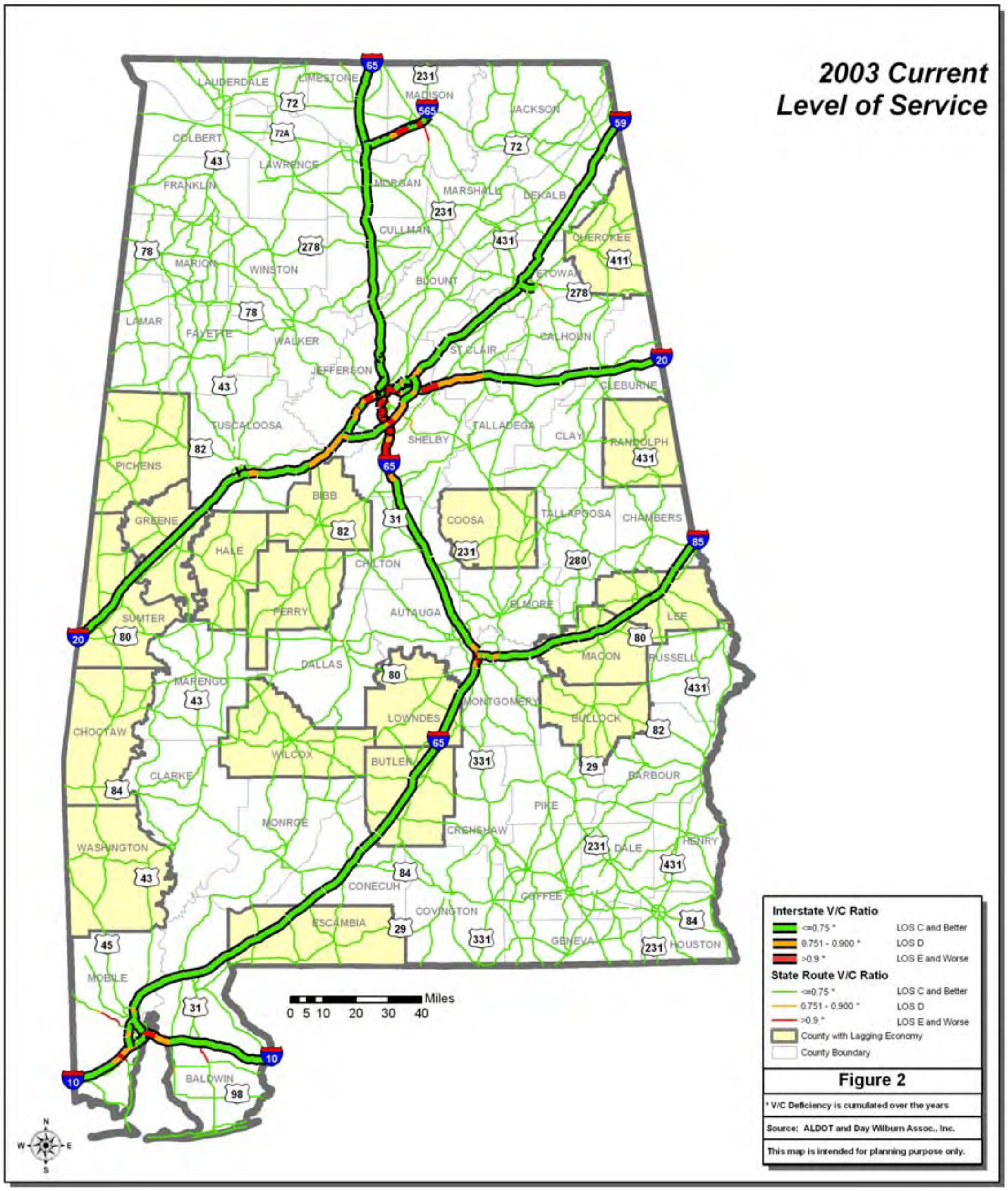

Figure 2 – 2003 Current Level of Service

Figure 3 has similar information for 2008 traffic. Comparison of the two figures shows an increase in road miles that do not meet level of service (v/c) threshold standards in urban and rural areas.

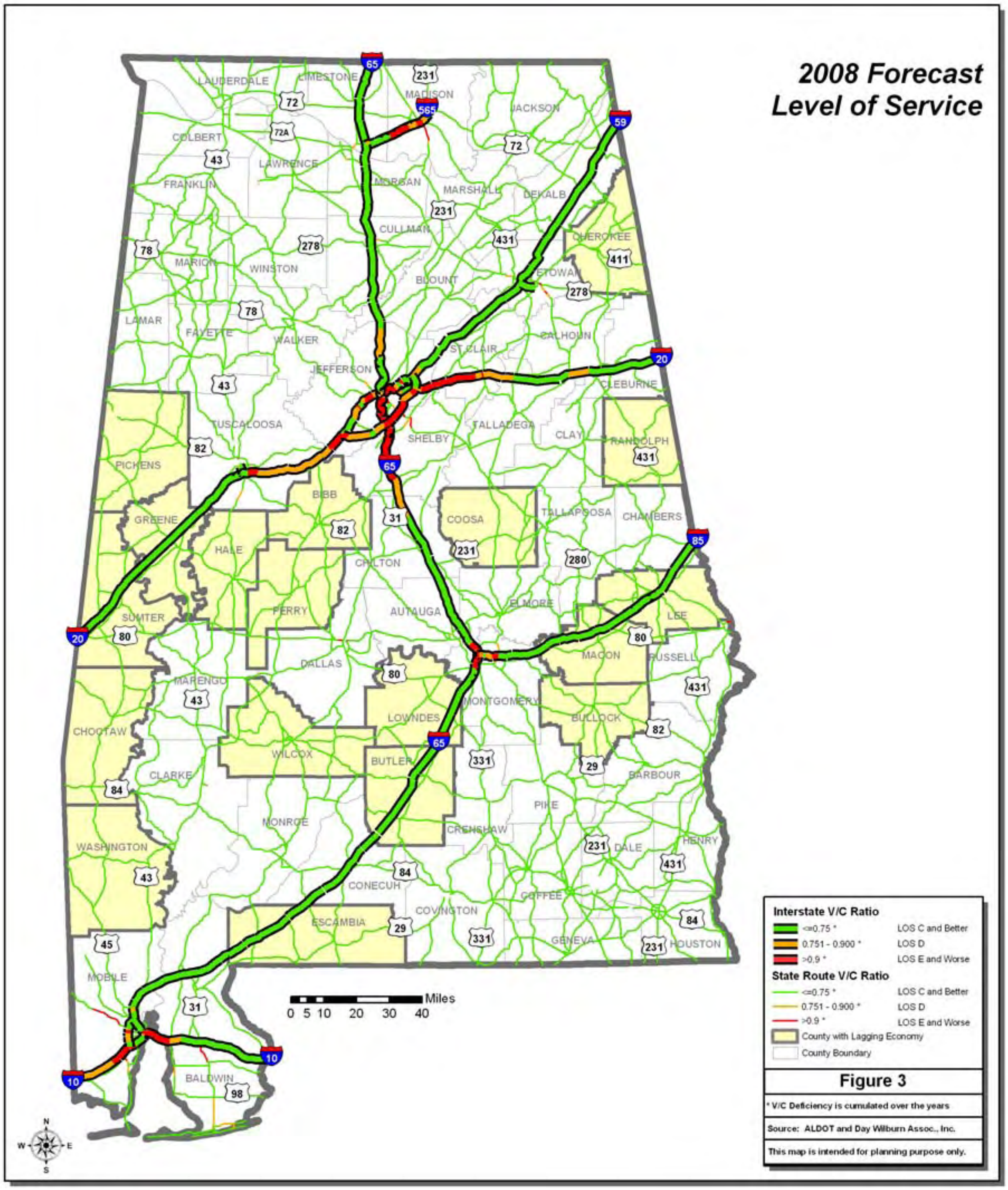

Figure 3 – 2008 Forecast Level of Service

Figure 4 shows the location of CPMS lane widening projects that are proposed in the 2004-2008 program.

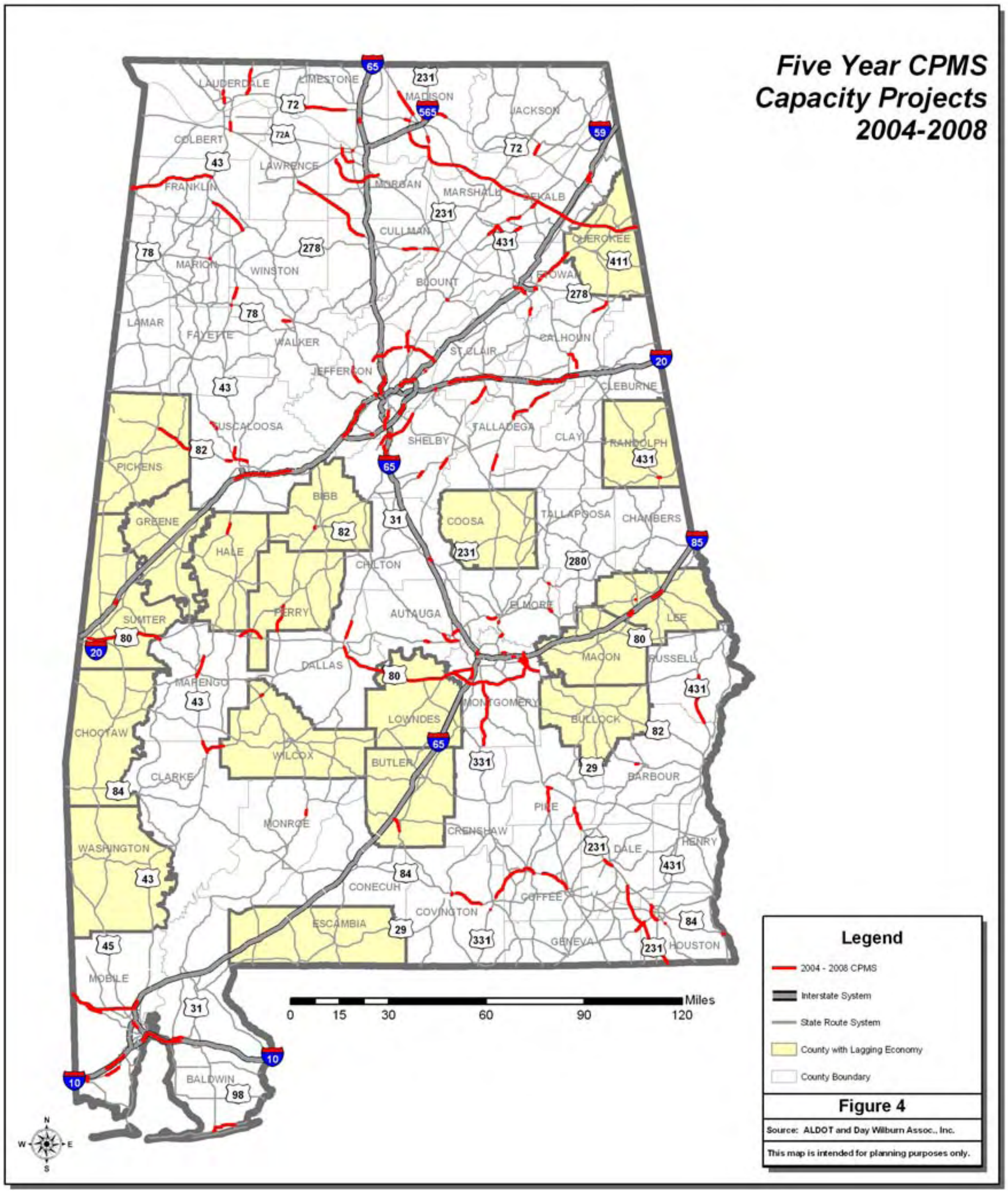

Figure 4 – Five Year CPMS Capacity Projects 2004-2008

Matching the CPMS projects with identified needs shows where the current projects are addressing current and future demands. There are also transportation needs that remain and require programming shifts and/or additional funding. The Interstate system is expected to have the most aggressive rate of congestion growth between 2004 and 2008. The rural Interstate system will more than double the number of congested miles (43 miles in 2003 to 102 miles in 2008), and its urban counterpart will have almost 30 percent operating in congested conditions (82 miles of the total 298 Interstate urban system miles).

Capacity improvements, including new road construction, in the 2004 to 2008 CPMS total $2.1 billion and represent 51 percent of the total program. There is $368 million programmed to address capacity improvements on Interstates and $932 million for state routes, as well as an additional $786 million for new road construction on state routes. The improvements span a wide range of project types, including roadway widenings, interchange improvements, passing lane additions, and the like. The projects will improve the capacity and travel time for the Interstate and state route systems.

Using ALDOT unit costs, the remaining capacity needs were quantified in Table 6. Based on current average cost per lane mile for capacity improvements, programmed funds exceed needs on the state route system in the 2004 to 2008 CPMS; however, Interstate capacity needs are under funded.

Table 6
Congestion Relief Investments*

Based on 2004-2008 Five Year CPMS

Capacity	Interstates	State Routes
2004 – 2008 Total Need	$971 million	$286 million
2004 – 2008 Post CPMS Needs	$676 million	$115 million
2004 – 2008 Funding Not Overlaying Needs	$73 million	$761 million
Unmet Needs	$603 million	($646 million)

*In current dollars

3. Safety Analysis

Providing a safe roadway network is not only an ALDOT priority but a federal concern. Increasingly, the issue of maintaining safe travel throughout the country has become a high profile national transportation goal. The Administration has submitted to Congress a six-year transportation bill reauthorization entitled SAFETEA (Safe, Accountable, Flexible and Efficient Transportation Equity Act of 2003). A major focus of the proposed transportation legislation is reducing fatalities and injuries on the nation's highways.

Analysis of roadway transportation safety is complex due to the interaction of three components: the driver (human factors), the vehicle, and the roadway. Numerous national and state agencies collaborate to ensure overall transportation safety. For example, the National Highway Traffic Safety Administration (NHTSA) evaluates vehicle safety and conducts crash tests to make certain vehicles on the road meet a standard level of safety. In Alabama, the Department of Public Safety manages licensing for individuals and traffic enforcement. The Public Service Commission, Transportation Division supervises commercial carriers. The Department of Economic and Community Affairs, Law Enforcement and Traffic Safety Division administers the Highway Safety Plan Program, which provides highway safety related educational grants. Finally, ALDOT ensures that the state's roadways meet current safety design standards.

For the Transportation System Review and Assessment, existing safety needs on Alabama's Interstate system and state highway system were evaluated using four years of crash and fatality data from 1999 to 2002. The goal was to identify locations which appear to have greater than average crash or fatal crash rates. Of particular concern were crashes in which roadway characteristic deficiencies were cited in the crash database. Safety needs were addressed by recommending location-specific projects to correct the roadway deficiency. To accommodate future safety project needs through 2018, a financial level of effort was determined.

Crash Characteristics

Crash data for this assessment was evaluated through two screening processes. The first screen identified general crash and fatal crash trends across variables by examining the aggregate data. A second screen permitted comparison of locations against each other by calculating normalized crash and fatal crash rates. The normalized annual rates were derived by the following equations:

- Crash Rate = (annual # crashes * 100 million) / (section length * AADT * 365)
- Fatality Rate = (annual # fatalities * 100 million) / (section length * AADT * 365)

For the most meaningful comparison, only like-type facilities are compared against each other. For example, crash locations on the Interstate system are only compared against other Interstate sections.

The variables included in the crash database allow quantification, reporting, and summarization of crashes. Each crash is a unique event occurring at a unique location. Through a query of the database, one can determine the first harmful event in a crash and find out about the physical and temporal conditions at the crash site (weather, pavement, day and time). Other elements in the crash database include more detailed records on the "who" (persons involved in each crash, including drivers, passengers, and/or pedestrians), "what" (vehicles involved in each crash, including all vehicles and commercial vehicles), and "where" (the crash location).

Interstates

For informational purposes, some general statistics from ALDOT's CARE crash database are provided in Table 7. On average from 1999 through 2002, there were approximately 10,800 crashes (44 percent of total crashes) on the Interstate system per year, including 126 fatal crashes (1.2 percent) and 1,200 crashes (11.1 percent) where the causal vehicle was recorded as a truck tractor or other truck. The percent of crashes overall was lower on Interstate sections classified as rural (47 percent) than urban (53 percent). However, more fatal crashes occurred on rural Interstate sections (72 percent) than urban ones (28 percent). Additionally, more rural crashes involve a fatality (1.8 percent of all rural crashes versus 0.6 percent of all urban crashes). Crashes where the causal vehicle was reported as a truck were also greater on rural Interstate (61 percent) than urban (28 percent).

Table 7
Alabama Interstate Crash Profile (1999 – 2002 Annual Average)

Number of Crashes	**All Crashes**	**Fatal Crashes**	**Crashes where Causal Vehicle Type is Truck**
Rural Interstate	5,123	90	732
Urban Interstate	5,682	36	469
Total	10,803	126	1,201
Percent of Total Crashes			
Rural Interstate	47%	72%	61%
Urban Interstate	53%	28%	39%
Total	100%	100%	100%
Composition of Total Crashes			
Rural Interstate		1.8%	14.3%
Urban Interstate		0.6%	8.3%
Total		1.2%	11.1%

Source: ALDOT CARE Crash database, 1999-2002.

The top three primary contributing circumstances for Interstate crashes overall were driver not in control (16 percent), tailgating (11 percent), and misjudged stopping distance (11 percent). For fatal crashes, the top primary contributing circumstances were driver condition (17 percent), driver not in control (16 percent), and over speed limit or driving under the influence (9 percent each). For crashes where the causal vehicle was reported as a truck, the top three primary contributing circumstances were improper lane change (15 percent), unseen object/person (13 percent), and parts/cargo from vehicle (11 percent).

Due to the large number of factors that could contribute to a roadway crash, precisely identifying roadway characteristics that could contribute to crashes is challenging. The CARE database does record road defects such as high/low shoulders, holes or bumps for crashes, but over 99 percent of all Interstate crashes were reported as having no road defects. Another category is whether the crash occurred at a construction zone. Of the total crashes in a construction zone, there was a greater percentage of fatal crashes (9 percent) than there was in total crashes (7 percent).

By calculating normalized rates, locations that have greater than average crash or fatal crash rates can be identified. The normalized crash rate on Alabama's Interstates for 1999 through 2002 was 59 crashes per 100 million vehicle miles traveled on rural Interstate and 99 per 100 million vehicle miles traveled on urban Interstate. The rate of fatal crashes was 1.32 crashes per 100 million vehicle miles traveled on rural Interstate and 0.82 per 100 million vehicle miles traveled on urban Interstate. Locations where the normalized rate exceeds one standard deviation over the system-wide average for Interstates and state routes are shown in Figures 5 and 6.

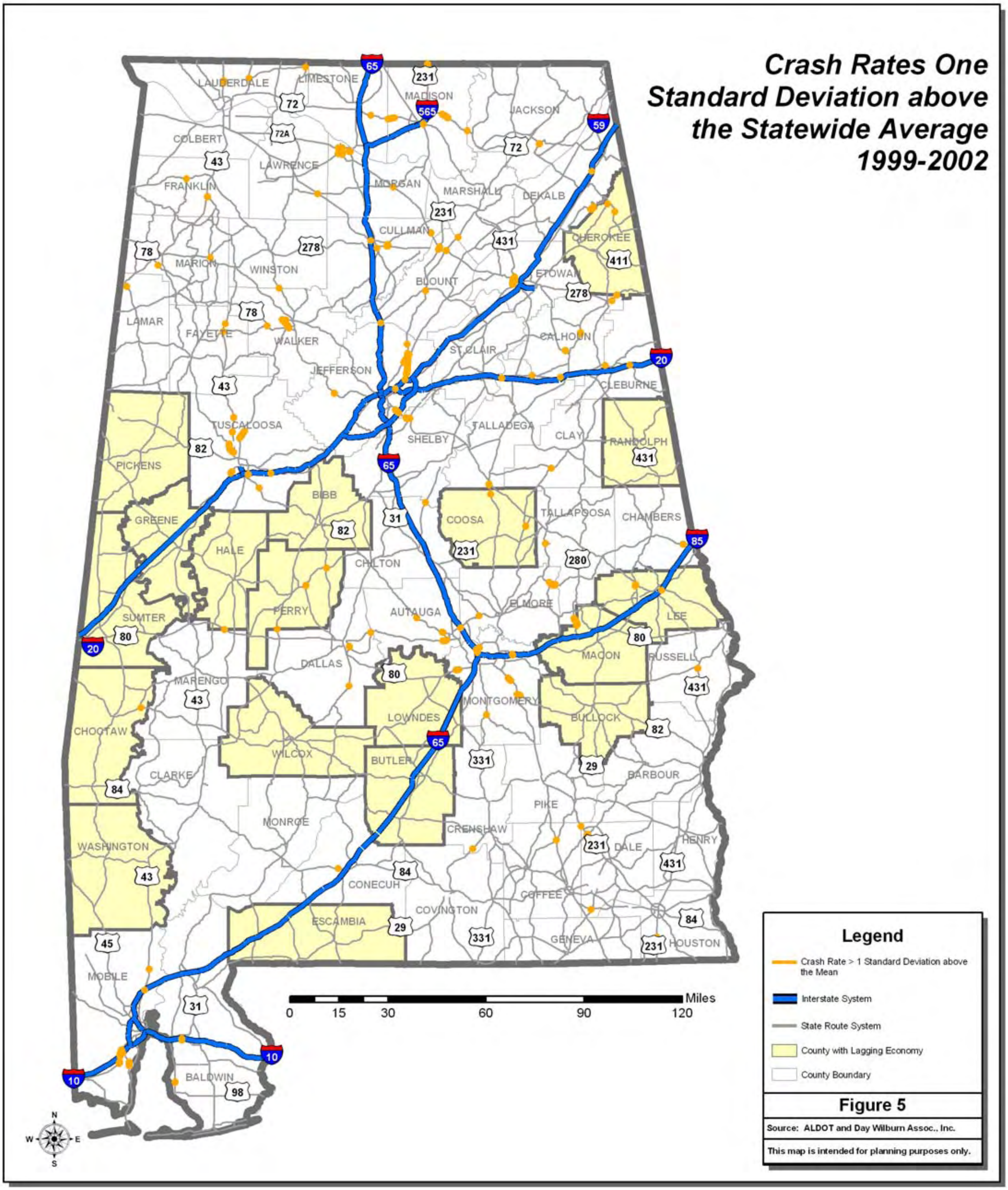

Figure 5 – Crash Rates One Standard Deviation above the Statewide Average 1999-2002

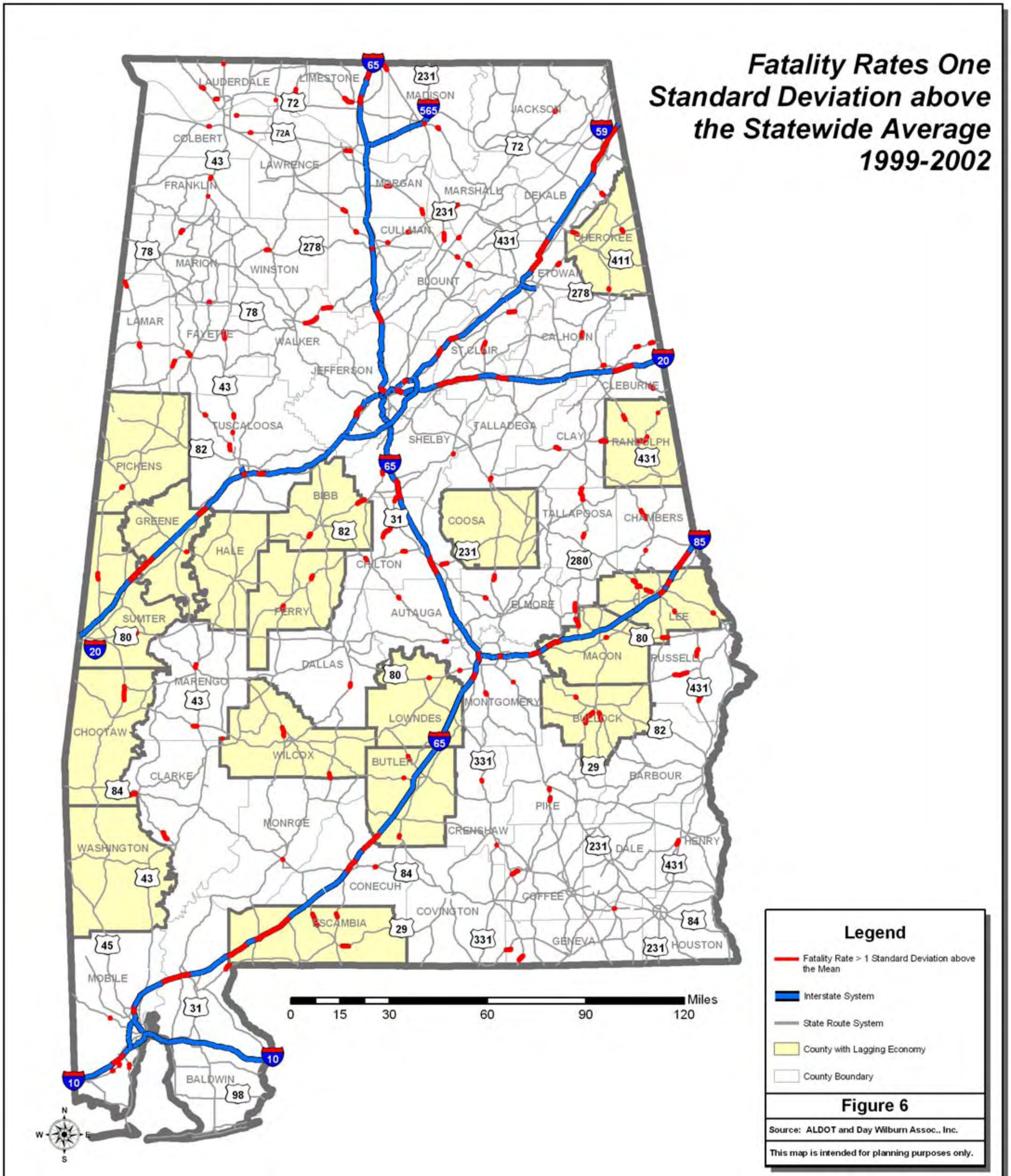

Figure 6 – Fatality Rates One Standard Deviation above the Statewide Average 1999-2002

State Route and Non-Interstate Federal Highways

On average from 1999 through 2002, there were approximately 12,840 crashes (56 percent of total crashes) on Alabama's state routes and federal highways per year. Fatal crashes accounted for 247 (1.9 percent), while crashes where the causal vehicle was recorded as a truck tractor or other truck numbered 890 (6.9 percent).

The top three primary contributing circumstances for state route and federal highway crashes overall were failure to yield right of way (14 percent), unseen object (11 percent), and driver not in control (10 percent). For fatal crashes, the top primary contributing circumstances were failure to yield right of way (14 percent), wrong side of road (14 percent), and driving under the influence (13 percent). For crashes where the causal vehicle was reported as a truck, the top three primary contributing circumstances were unseen object (10 percent), avoid object (9 percent), and misjudge stopping distance (8 percent).

Road defects do not appear to have much significance in state and federal highway crashes. Over 99 percent of all crash types were reported as having no road defects. There was an increase in the rate of fatal crashes (3.3 percent) and crashes involving trucks (5 percent) in construction zones versus crashes outside construction zones (3.1 percent).

CPMS Safety Projects

Whether the higher crash rate and fatal crash rate locations could be remedied by existing projects was reviewed by examining the current list of projects in the CPMS. Safety project categories included in the CPMS include guardrail, signalization, pedestrian overpass, and other related projects that enhance the safety of the traveling public. ALDOT considers these as "Special Safety Projects." Certain types of safety concerns, such as short ramp tapers on Interstates, could be resolved by interchange rehabilitation or reconstruction, but are not always categorized as safety projects. Likewise, suspect weave turbulence contributing to crashes could be resolved with signage improvements or lane re-striping, which are also not categorized as safety projects in the CPMS.

The CPMS for 2004 to 2008 has $15 million programmed to address safety improvements for Interstates and $17 million for state routes. The improvements span a wide range and include guardrail, signalization, pedestrian overpass, and other related projects that enhance the safety of the traveling public. The projects will improve the safety of the Interstate and state route systems.

Safety needs identified in previous sections showed an average of over 23,000 crashes per year throughout the state. Based on historic costs, safety needs were quantified and identified along with funding estimates, as shown in Table 8.

CPMS programs for all safety improvement projects total $32 million, one percent of the total program for 2004 to 2008. Based on historic costs, safety needs exceed funding in the 2004 to 2008 CPMS. When safety needs were matched with other projects which could have collateral benefits, the comparison showed that a larger portion of the safety needs are addressed in the total CPMS program. Of the 360 miles of "hot spot" locations, projects that solve capacity and bridge needs meet 129 miles of safety needs. Special safety projects addressed 5 miles or one percent of the safety needs for Interstates and state routes.

Table 8

Safety Investments*

Based on 2004-2008 Five-Year CPMS

Safety	Interstates	State Routes
2004 – 2008 Total Need	$113 million	$136 million
2004 – 2008 Post CPMS Needs	$98 million	$134 million
2004 – 2008 Funding Not Overlaying Needs	$15 million	$17 million
Unmet Needs	$83 million	$117 million

* In current dollars

4. Economic Development

The Center for Business and Economic Research at the University of Alabama recently studied demographic characteristics of Alabama's counties to develop an index of economic vitality (see Appendix A). Factors collected for each county to measure economic vitality included unemployment rates, per capita income, percent of people of all ages in poverty, licensed physicians per 10,000 population, licensed practical nurses per 10,000 population, and educational attainment (percent of the population 25 years and older with a high school diploma or higher). For comparison purposes, state and national averages were provided where possible.

The factors were synthesized and an Alabama County Economic Index was assigned to each county. Counties assigned indices below 60 were identified as the counties with the lowest Economic Index. These 18 counties are identified on the map figures throughout the report.

The 18 counties with the lowest indices make up 9.6 percent of the state's population yet comprise 24.3 percent of its population in poverty, 13.6 percent of its unemployment, 11.6 percent of its citizens without high school diplomas, and 42.1 percent of its minority population. A summary of the indices for these 18 counties is provided in Appendix B.

The lagging counties have 746 lane miles of Interstate (18 percent of statewide) and 4,812 lane miles of state routes (20 percent of statewide). Of the state's 1,188 Interstate bridges, 167 (14 percent) are within these 18 counties, as are 1,121 of the state's 4,498 state route bridges (25 percent).

Table 9 describes the share of the lagging counties' statewide needs and funding for the five-year CPMS. The percentage of funding for every category is in proportion to the percentage of state population in the lagging counties (9.6 percent), their percentage of bridges statewide, and their percentage of statewide lane miles.

The lagging counties have 38 miles of Interstate safety needs (31 percent of the system needs) and 39 miles of state route safety needs (27 percent). A large percentage (26 percent) of the Interstate system safety funding is allocated in the lagging counties. State route safety needs in the 18 counties are funded by 12 percent of the state route system safety funding through 2008.

Table 9
Lagging Counties' Share of Needs and 2004-08 Funding

Category	Interstate (percent of statewide system)	State Routes (percent of statewide system)
Capacity Needs	7 miles (3%)	1.5 miles (1%)
Capacity Funding	$44 million (12%)	$333 million (19%)
Safety Needs	38 miles (25%)	39 miles (18%)
Safety Funding	$1.4 million (9%)	$2 million (12%)
Bridge Needs	111 bridges (14%)	701 bridges (25%)
Bridge Funding	$9 million (4%)	$36 million (12%)
Pavement Needs	NA	NA
Pavement Funding	$68.1 million (43%)	$92.4 million (22%)

Distribution of roadway and bridge funding is commensurate with needs, population and infrastructure of the lagging counties. Counties in rural areas are more likely to have less congested sections and the need for roadways to meet connectivity needs. Significant roadways in rural, less developed areas are provided not only for connectivity but also economic development purposes. As a result, capacity improvements are installed to meet needs other than v/c ratios.

Potential Strategies

Federal assistance is available for economic development. The various levels of participation by states in FHWA economic development initiatives fall into three categories:

- Funding Programs for Local Access Roads: Includes investment in local connector routes that provide access from intercity highways to local business districts or industrial parks.
- Funding Programs for Inter-City Connector Routes: Includes investment in highway routes that improve access from isolated rural and economically depressed parts of the state to major highway routes and larger economic market centers.
- Policies Recognizing Economic Development as a Factor in Funding Decisions: Alabama may wish to join the 13 states that have formal policies recognizing economic development as criteria in highway decision-making.

ALDOT has taken advantage of the Federal Highway Administration (FHWA) Industrial Access Program and invested $10.1 million in transportation projects throughout the state. Nine projects, ranging from relocating a roadway and constructing a new access road at the Huntsville

International Airport to improving access to retail and industrial properties, have been implemented. FHWA estimates that over 3,100 new jobs and $439 million in private sector investments have been added to Alabama's economy as a result of the $10.1 million public infrastructure investment.

5. System Preservation Analysis

The analysis of system preservation considered the condition of pavement and bridges on Interstates and state routes; the construction, maintenance and operations for which ALDOT is primarily responsible. The Department maintains surveillance and continuously evaluates the program for needed improvements.

Roads and bridges are the backbone of the transportation network. System preservation of these capital resources is a state priority. Nationwide, the maintenance of road and bridge systems is increasingly difficult as systems age and demands from the traveling public swell.

Bridge Analysis

The Alabama transportation network consists of 1,188 Interstate bridges and 4,498 state route bridges. Bridge data from the ABIMS (Alabama Bridge Inventory Management System) and federal NBI (National Bridge Inventory) sources was used to identify bridges with concerns associated with age, sufficiency ratings, structural deficiency and functional obsolescence, and congestion on approaching routes. As stated previously, these factors are used to assess the performance of bridges in the system.

Table 10 summarizes bridge needs by system classification. Of the system's 1,188 Interstate bridges, 21 (2 percent) are 50 years old or older and will be scheduled for replacement during the study period. A total of 43 Interstate bridges (4 percent) do not currently meet sufficiency rating standards or are either functionally obsolete or structurally deficient. In addition, 229 Interstate bridges (19 percent) either currently have congested roadways for approaches or are forecast to have congested approaches by 2008.

Table 10
Bridge Deficiencies by System Classification

System	Total Bridges	Age (<=1958)	Age (1959-1968)	2003 Sufficiency Rating or Status Deficiency	2003-2008 Volume/ Capacity Deficiency
Rural Interstate	619	19 (3%)	353 (57%)	4 (less than 1%)	73 (12%)
Urban Interstate	569	2 (less than 1%)	125 (22%)	39 (7%)	156 (27%)
Rural State Route	3,739	2,017 (54%)	375 (10%)	44 (1%)	13 (less than 1%)
Urban State Route	759	298 (39%)	162 (21%)	22 (3%)	46 (6%)

Figure 7 graphically depicts the status of the Interstate system's bridges.

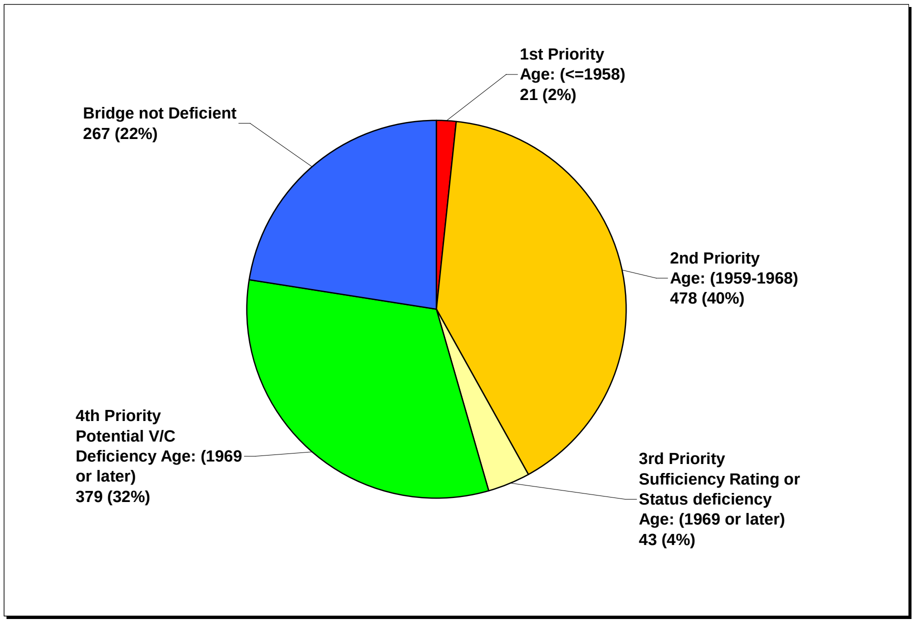

Figure 7
Interstate Bridge Needs

Figure 8 graphically depicts percentages of state route bridges. Over one-third of the state route bridges will not become deficient during the study period.

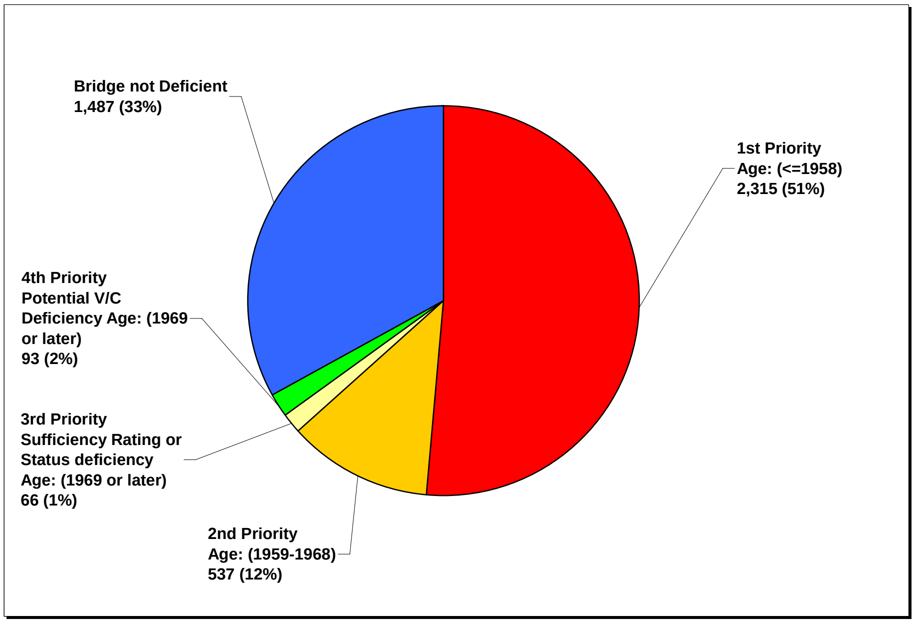

Figure 8
State Route Bridge Needs

Bridge replacement costs are significant and over half of the system's bridges will become deficient during the study period. As a result, it is expected that by 2018 the financial need to correct bridge deficiencies will exceed projected funding levels by approximately $3.7 billion.

The CPMS for 2004 to 2008 has $250 million programmed to address bridge improvements for Interstates and $308 million for state routes. The bridge improvements will preserve the system investment for future generations.

Bridge needs identified show a significant percentage of bridges statewide requiring replacement during the study period. Based on historic costs, bridge needs were identified and estimates of the cost for addressing needs is provided in Table 11. CPMS programs for all bridge improvement projects total $558 million, 22 percent of the total program for 2004 to 2008.

Table 11
Bridge Investments*

Based on 2004-2008 Five-Year CPMS

Bridge	Interstates	State Routes
2004-2008 Total Need	$296 million	$3.9 billion
2004 – 2008 Post CPMS Needs	$71 million	$3.6 billion
2004 – 2008 Funding Not Overlaying Needs	$25 million	$14 million
Unmet Needs	$46 million	$3.6 billion

* In current dollars

Pavement Analysis

Pavement ratings are part of the HYDRA (Highway Yearly Data Reduction and Analysis) system maintained by the University of Alabama for ALDOT. The study applied the University of Alabama's methodology and protocols to assessing the level of pavement needs.

The state's pavement is mostly flexible, with asphalt paving on the majority of the 10,851 mile state network. To meet growing travel demand and the public's expectations for safety, ride quality, and traffic flow, ALDOT has put a premium on activities and strategies that preserve and maintain existing highway systems instead of the typical strategy of fixing the worst first. Accomplishing that requires a change of philosophy from reactive maintenance to preventive maintenance. The proactive approach of preventive maintenance, known as pavement preservation, cuts the need for costly, time-consuming rehabilitation and reconstruction projects and reduces associated traffic disruptions. As a result, the public is seeing improved mobility, reduced congestion, and safer, smoother, longer-lasting pavements.

In comparison, the aim of pavement rehabilitation work is to repair structural damage and restore pavement conditions – a costly, time-consuming activity. This "worst first" scenario came about for many reasons, including the requirements of federal-aid funding and maximization of capital growth. But now, the pavement's service life can be extended by applying a series of low-cost preventive maintenance treatments, each of which lasts a few years. This translates into a better investment and a better ride quality.

ALDOT prioritizes pavement rehabilitation for sections with a HYDRA rating of below 80-83 (Figure 9). Between 2003 and 2008, 66 percent of the Interstate system (2,532 lane miles) and 51 percent of the state route network (11,354 lane miles) will require resurfacing to maintain the desired HYDRA rating. Figure 10 shows the pavement projects identified through 2008. A total of $584 million is forecast to be programmed for pavement improvements, which is approximately 23 percent of the total forecast funding for 2004 to 2008. If the State of Alabama maintains that same rate of investment, 2008 pavement investments will require $541 million. Between 2009 and 2018, 5,065 lane miles of the Interstate system and 22,079 lane miles of the state route network will require resurfacing to maintain the desired HYDRA rating. If the State of Alabama maintains that same rate of investment, 2018 pavement investments will require $2.3 billion.

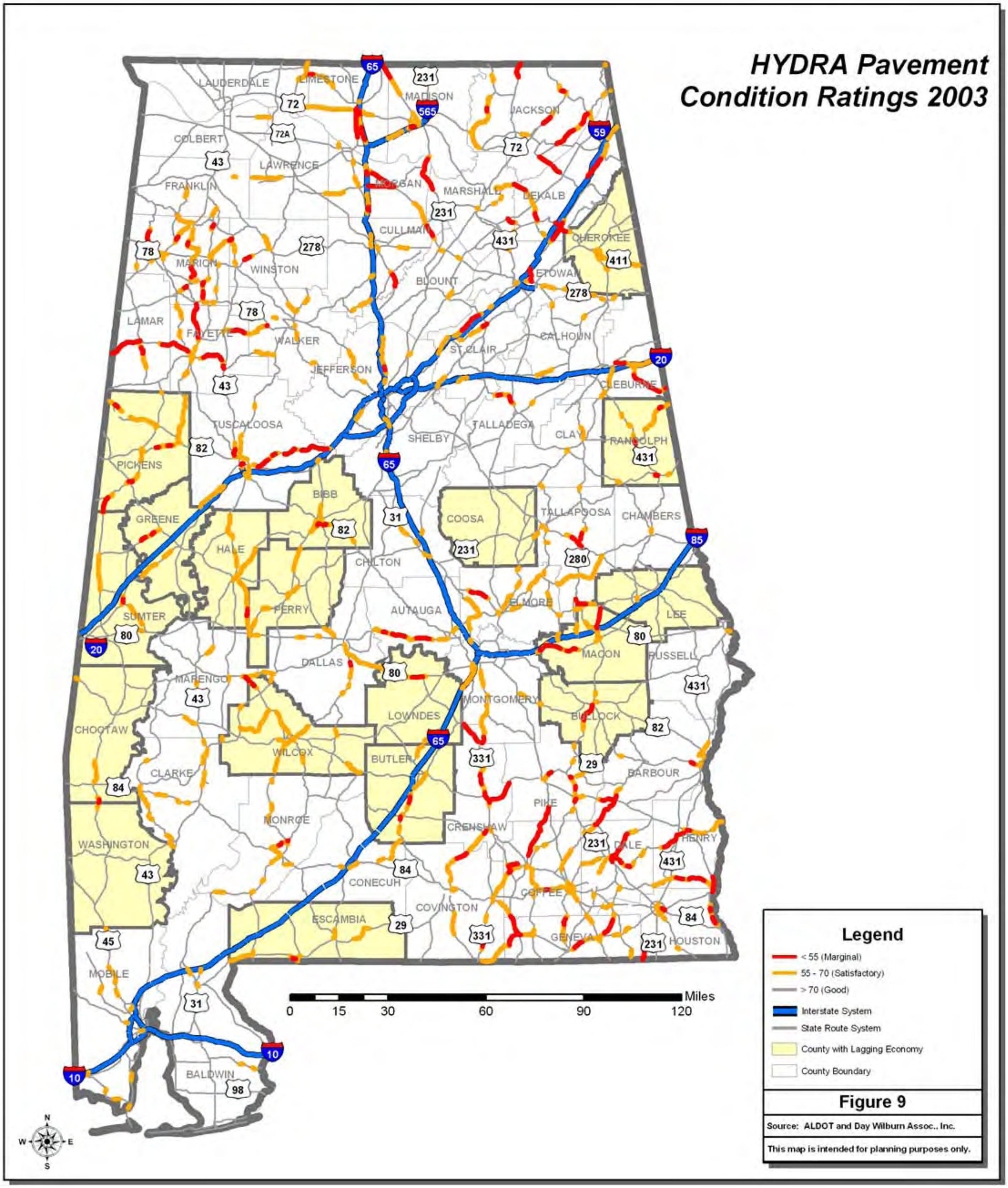

Figure 9 – HYDRA Pavement Condition Ratings 2003

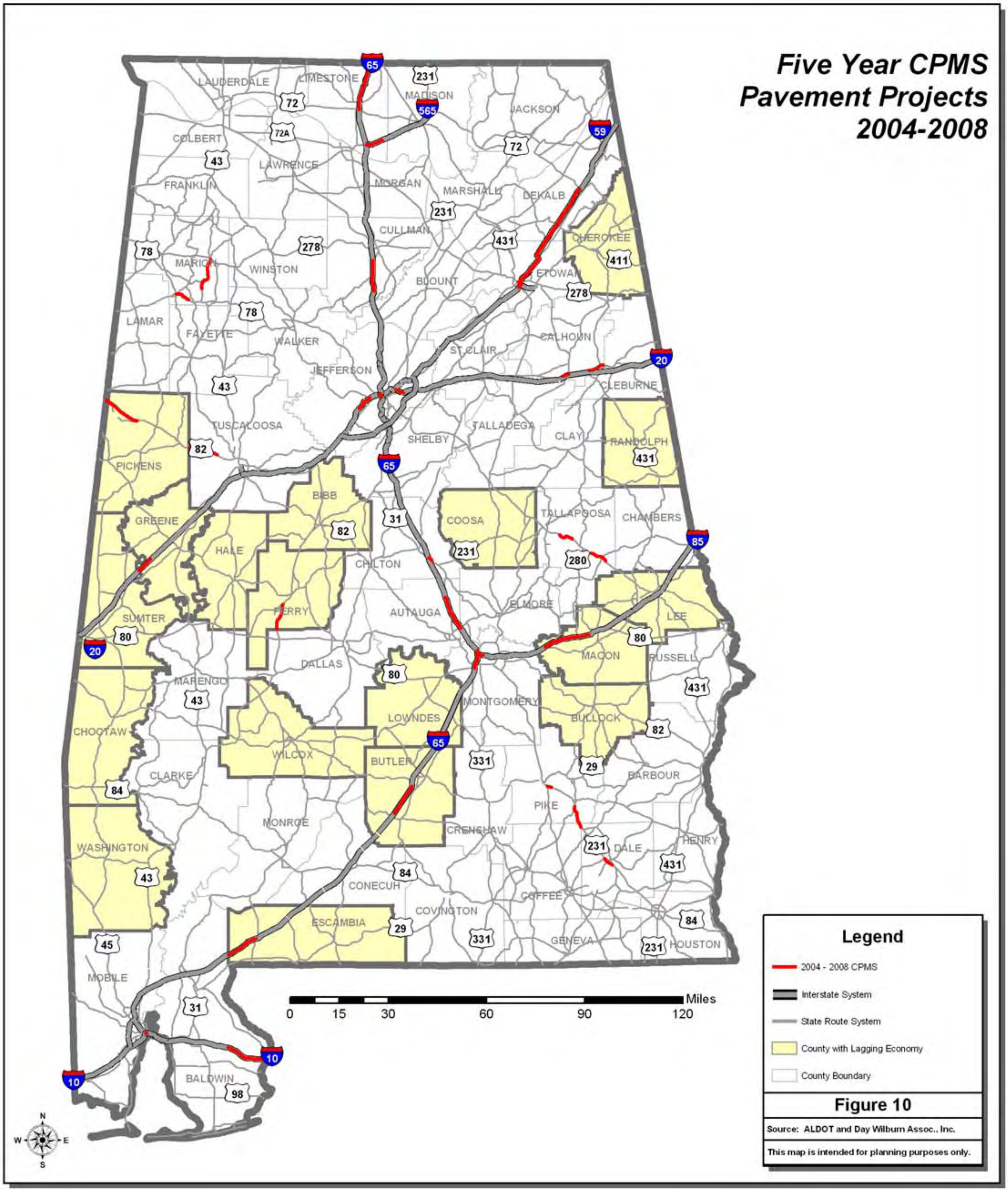

Figure 10 – Five Year CPMS Pavement Projects 2004-2008

6. 2009-2018 Deficiency Analysis

The Part Two analysis focused on the ten-year period beyond the current CPMS. Potential deficiencies were determined based on analyses similar to those employed in Part One.

As shown in Table 1, vehicle miles of travel (VMT) will increase 22 percent from 2008 to 2018, with the more aggressive growth occurring on the Interstate network. Annual average daily traffic (AADT) will grow at a similar pace, experiencing increases of 18 percent for state routes and 24 percent for Interstates from 2008 to 2018. Using projected VMT and AADT, the study projected expected conditions to 2018.

The capacity of the road system to accommodate 2018 travel is shown in Table 12. The table shows that approximately 23 percent of Interstate system miles will be at unacceptable levels of service in 2018.

Table 12
Volume to Capacity Ratio for 2018 by System Classification

Functional Class		2009-2018 V/C Deficiency (Miles)
Rural Interstate		136
Urban Interstate		73
Total		209
Rural State Route	Arterial	45
	Collector	16
Urban State Route	Arterial	38
	Collector	2
Total		101

*Shoulder analysis was not done as part of this study. This evaluation would be valuable and is recommended in a future enhancement

Needed capacity improvements are shown for 2018. The projections are separated for rural and urban systems, in lane mile units and by system classification. The need for capacity improvements varies depending on the relative proportion of congestion on that part of the system versus the total system. The larger the percentage of deficient lane miles in a given part of the system, such as Interstates or state route arterials, the greater the impact of capacity needs on that part of the network. Table 13 shows the percentage of the total system in need of capacity improvements.

Table 13
Percent of Total Centerline Miles Deficient by Functional Class

System	Centerline Miles	2018 Deficient Centerline Miles
Rural Interstate	606	136 miles (22%)
Urban Interstate	298	73 miles (24%)
Rural State Route	8,488	61 miles (1%)
Urban State Route	1,459	40 miles (3%)
Total	10,851	310 miles (3%)

Table 14 shows the 2018 capacity needs for Interstates and state routes based on current average cost per lane mile for capacity improvements. The level of investment for Interstates reflects the importance of the Interstate system in Alabama's mobility.

Table 14
Congestion Relief Investments*

Based on 2004-2008 Five Year CPMS

Capacity	Interstates	State Routes
2009 – 2018 Needs	$947 million	$175 million

* In current dollars

Table 15 shows the 2018 safety needs for Interstates and state routes based on current average cost per lane mile for capacity improvements. Although crashes cannot be projected, the growth in VMT was used to anticipate 2018 level of safety needs.

Table 15
Safety Investments*

Based on 2004-2008 Five-Year CPMS

Safety	Interstates	State Routes
2009 – 2018 Needs	$182 million	$240 million

*In current dollars

Table 16 summarizes bridge needs by system classification. Of the system's 1,188 Interstate bridges, 478 (40 percent) are 35 to 50 years old and will be scheduled for replacement during the study period. A total of 47 Interstate bridges (four percent) do not currently meet sufficiency rating standards or are either functionally obsolete or structurally deficient. In addition, 379 Interstate bridges (32 percent) either currently have congested roadways for approaches or are forecast to have congested approaches during the study period.

Table 16
Bridge Deficiencies by System Classification

System	Total Bridges	2009-2018 Volume/ Capacity Deficiency
Rural Interstate	619	47 (8%)
Urban Interstate	569	103 (12%)
Rural State Route	3,739	7 (less than 1%)
Urban State Route	759	27 (4%)

Bridge needs identified show a significant percentage of bridges statewide requiring replacement prior to 2018. Based on historic costs, bridge needs were quantified and identified in Table 17.

Table 17
Bridge Investments*

Based on 2004-2008 Five-Year CPMS

Bridge	Interstates	State Routes
2009 – 2018 Needs	$735 million	$862 million

* In current dollars

Appendix B: CBER Economic Index Data

The Two Economies of Alabama
Prepared by:

Center for Business and Economic Research
Culverhouse College of Commerce

The University of Alabama

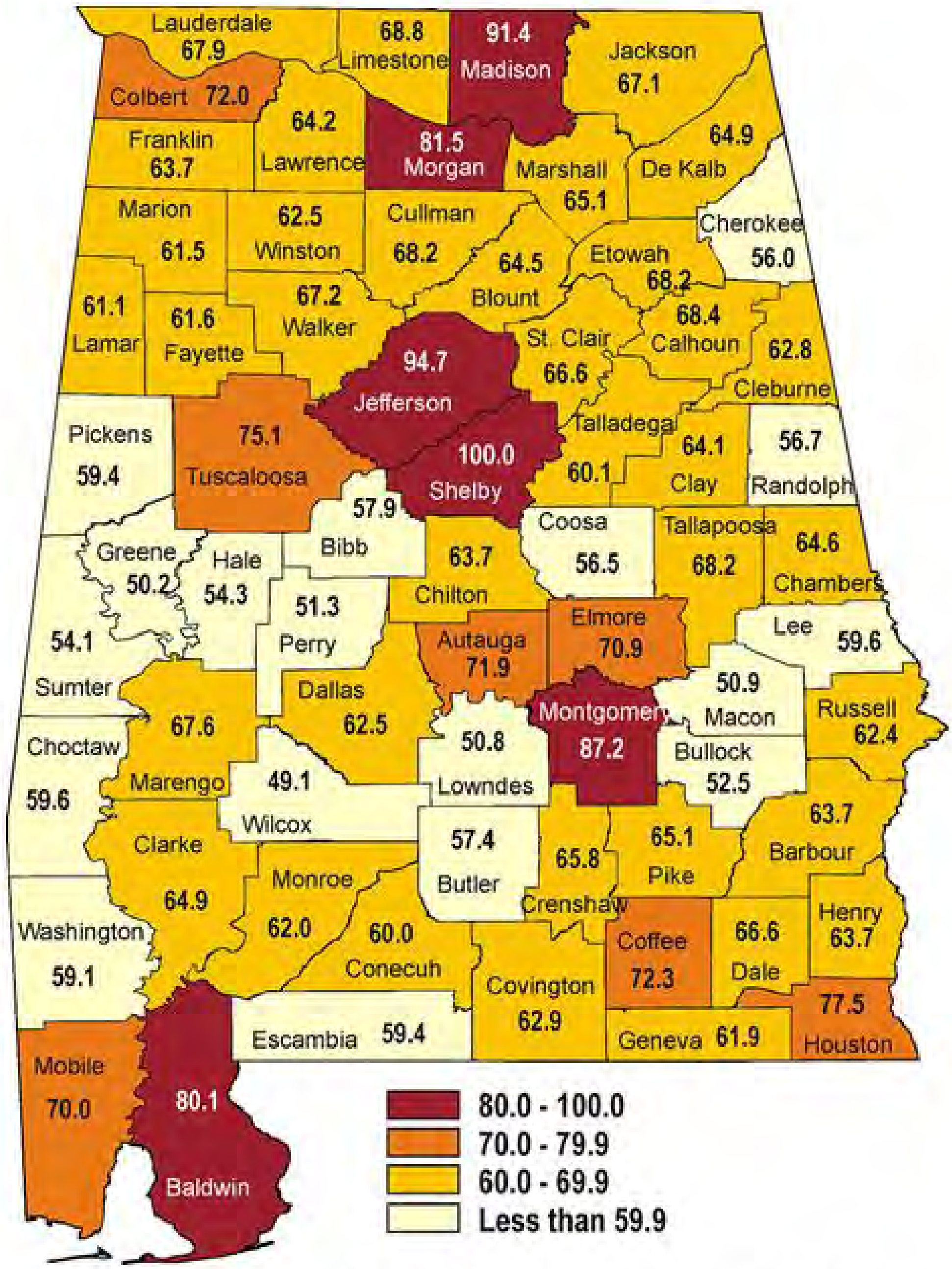

Figure 11 – Alabama County Economic Index

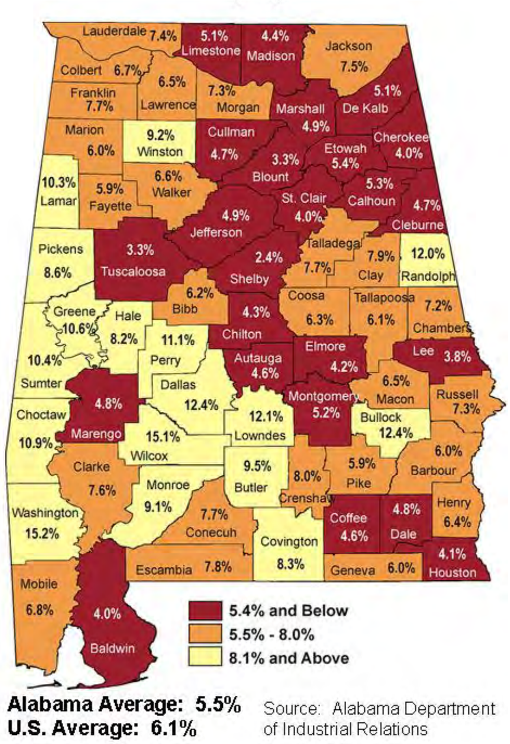

Figure 12 – Alabama Unemployment Rates, September 2003

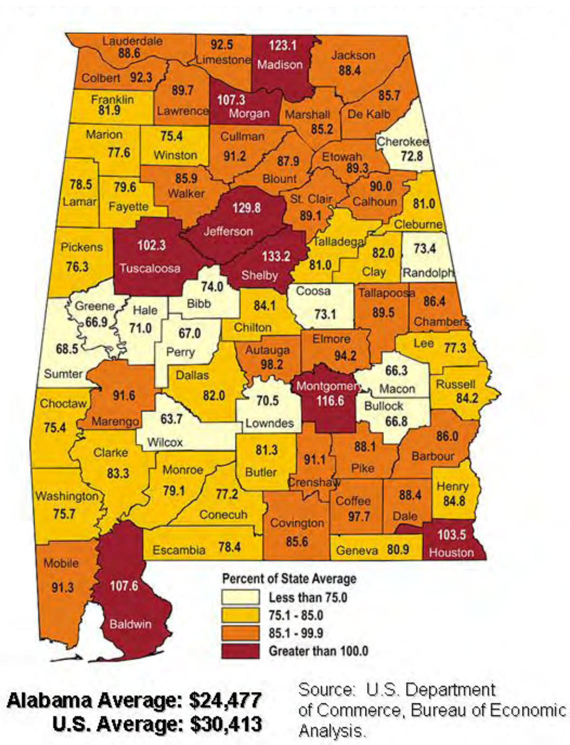

Figure 13 – Per Capita Income: Percent of State Average, 2001

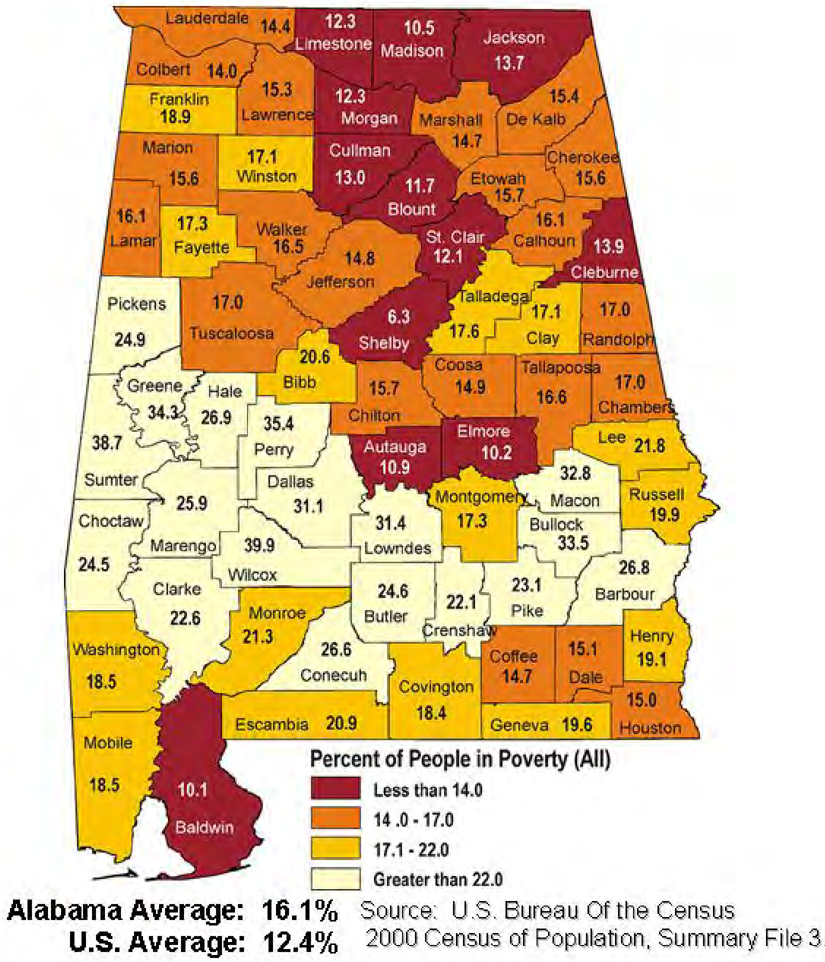

Figure 14 – Percent of People of All Ages in Poverty, 2001

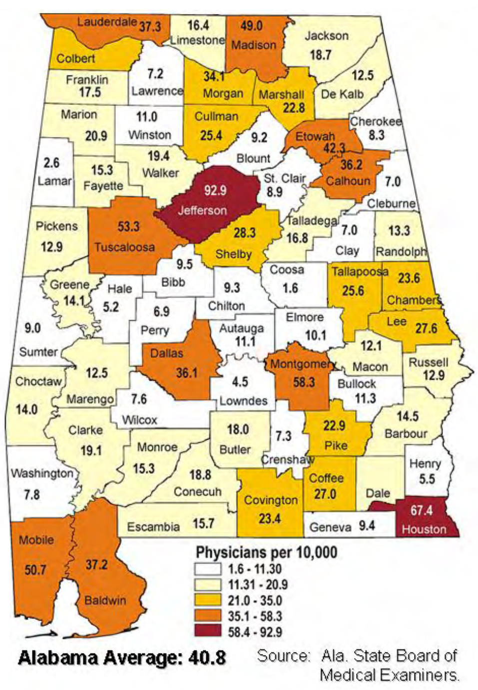

Figure 15 – Licensed Physicians Per 10,000 Population, 2002

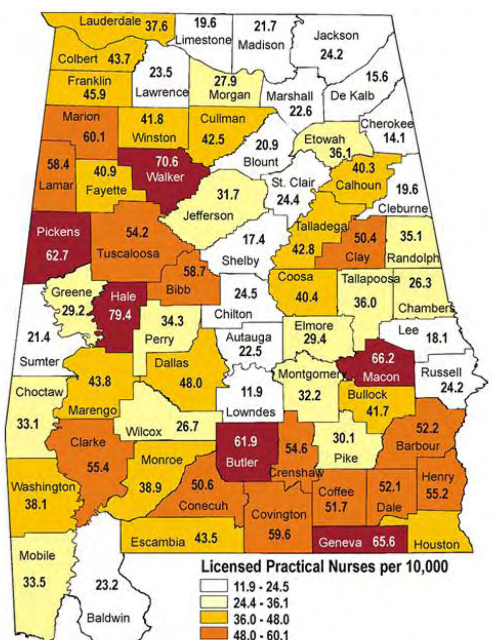

Figure 16 – Licensed Practical Nurses Per 10,000 Population, 2002

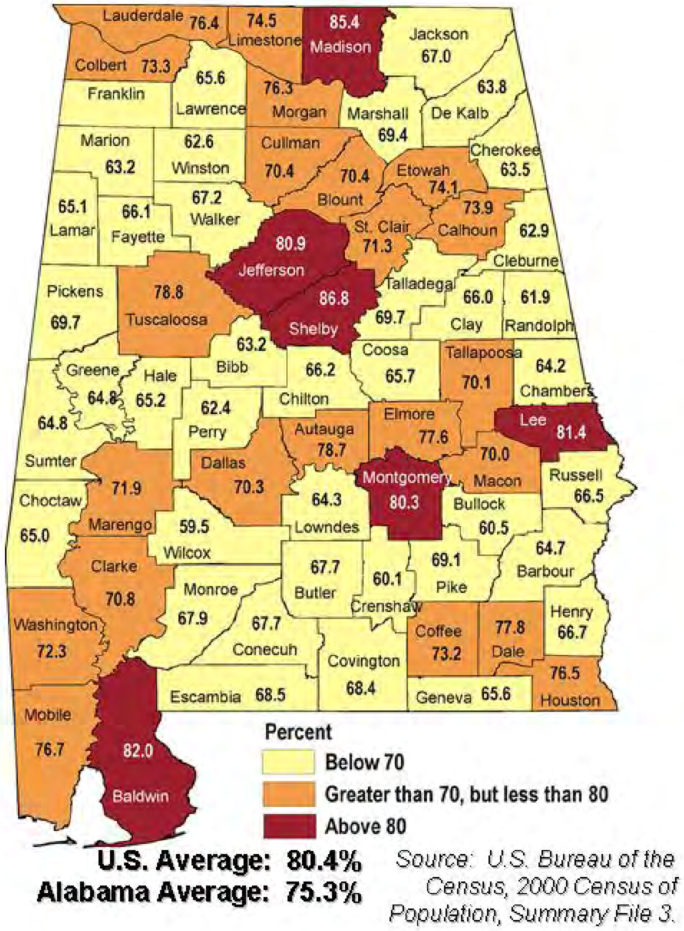

Figure 17 – Educational Attainment by County, 2000
(% of Population 25 years and older with a High School Diploma or Higher)

Appendix C: Alabama County Economic and Healthcare Metrics

Table 18: Summary of Counties with Economic and Health Indices Below 60

County	Minority %	Unempl %	PerCap Inc	Poverty %	Physicians /10,000	Nurses /10,000	Education	Index	Population	Persons in Poverty	Minority Population	Unemployed	No diploma
Wilcox	73	15.1	63.7	39.9	7.6	26.7	59.5	49.1	13183	5260	9624	1991	5339
Greene	81	10.6	66.9	34.3	14.1	29.2	64.9	50.2	9974	3421	8079	1057	3501
Lowndes	75	12.1	70.5	31.4	4.5	11.9	64.3	50.8	13473	4231	10105	1630	4796
Macon	87	6.5	66.3	32.8	12.1	66.2	70	50.9	24105	7906	20971	1567	7232
Perry	70	11.1	67	35.4	6.9	34.3	62.4	51.3	11861	4199	8303	1317	4460
Bullock	78	12.4	66.8	33.5	11.3	41.7	60.5	52.5	11714	3924	9137	1453	4627
Sumter	75	10.4	68.5	38.7	9	21.4	64.8	54.1	14798	5727	11099	1539	5209
Hale	61	8.2	71	26.9	5.2	79.4	65.2	54.3	17185	4623	10483	1409	5980
Cherokee	7.2	4	72.8	15.6	8.3	14.1	63.5	56	23988	3742	1727	960	8756
Coosa	36.1	6.3	73.1	14.9	1.6	40.4	65.7	56.5	12202	1818	4405	769	4185
Randolph	23.6	12	73.4	17	13.3	35.1	61.9	56.7	22380	3805	5282	2686	8527
Butler	42	9.5	81.3	24.6	18	61.9	67.7	57.4	21399	5264	8988	2033	6912
Bibb	23.3	6.2	74	20.6	9.5	58.7	63.2	57.9	20826	4290	4852	1291	7664
Washington	35	15.2	75.7	18.5	7.8	38.1	72.3	59.1	18097	3348	6334	2751	5013
Escambia	35.6	7.8	78.4	20.9	15.7	43.5	68.5	59.4	38440	8034	13685	2998	12109
Pickens	44.1	8.6	76.3	24.9	12.9	62.7	69.7	59.4	20949	5216	9239	1802	6349
Lee	25.9	3.8	77.3	21.8	27.6	18.1	81.4	59.6	115092	25090	29809	4373	21407
Choctaw	44.9	10.9	75.4	24.5	14	33.1	65	59.6	15922	3901	7149	1735	5573
State Avg	30.6	5.5	100	16.1	40.8	34.3	75.3	65.5	4447100	715983	1360813	244591	1098434
US Avg	24.9	6.1	124	12.4	Na	na	80.4	Na	281421906	34896316	70074055	17166736	55158694

Counties with Economic Indices Below 60

Population	425,588	Population unemployed	33,360	
% of State Population	9.57%	% of Statewide unemployment	13.60%	
Population in Poverty	103,799	Population with no HS diploma	127,636	These 18 counties have 9.57% of the state's population yet comprise 24.3% of its population in poverty, 13.6% of its unemployed, 11.6% of its population, with no diploma and 42.12 of the state's minority population.
% Statewide Population in Poverty	24.30%	% of Statewide pop with no HS dipl	11.60%	
Minority Population	179,268			
% Statewide Minority Population	42.12%			

LEGEND

Category	Description
Minority	Percentage of county population that is minority
Unempl	Percentage of county unemployed-Sept 2003
PerCapInc	County's percentage of Alabama State average per capita income-2001 ($24,447, US $30,413)
Poverty	Percentage of population in poverty-1999
Physicians	Licensed physicians per 10,000 population-2002
Nurses	Licensed practical nurses per 10,000 population-2002
Education	Percentage of population 25 years and older with a high school diploma or higher
Index	University of Alabama's Alabama County Economic Index

Appendix D: Project Methodology Report

Transportation needs identified in the planning process have a specific significance in establishing eligibility for federal funding. Potential projects undergo an evaluation to determine whether they address a transportation need and their implementation satisfies a specific public purpose. Projects in the CPMS were carefully evaluated during the planning process and found to have a “purpose and need.” Any project that shows “purpose and need” is considered a needed roadway improvement with federally justifiable reasons for implementation.

This study grouped transportation needs into the following categories: capacity, safety, and system preservation (pavement condition and bridges). The CPMS project implementation schedule was analyzed to determine whether projects address specific needs to improve the safety, operations, and/or condition of the transportation network. The analysis also considered whether there were unmet needs that required additional transportation investments beyond those programmed in the CPMS.

Data Sources

Using a variety of Alabama Department of Transportation (ALDOT) data resources, the study focused on a review and assessment of the system’s capacity, safety and system preservation. Table 1 lists the study’s data sources, including ALDOT’s Comprehensive Project Management System (CPMS) and State Road Network and the University of Alabama’s Critical Analysis Reporting Environment (CARE) and Highway Yearly Data Reduction and Analysis (HYDRA) database. These sources, plus the National Bridge Inventory (NBI), provided a wealth of data to demonstrate the service the transportation system is providing. They were also used to forecast future conditions and quantify future needs and funding.

Table 19 - Data Sources and Format

Analysis Category	Data Source	Format
Funding	Comprehensive Project Management System (CPMS)	Oracle database converted to GIS shapefile format by ALDOT GIS team
Capacity	RoadStateNetwork	Oracle database converted to GIS shapefile format by ALDOT GIS team
	Traffic Count Database	Oracle database converted to GIS shapefile format by ALDOT GIS team
Safety	Critical Analysis Reporting Environment (CARE)	Access database converted to GIS shapefile format by ALDOT GIS team
	Traffic Count Database	Oracle database converted to GIS shapefile format by ALDOT GIS team
Bridge	Alabama Bridge Inventory Management System (ABIMS)	Oracle database converted to GIS shapefile format by ALDOT GIS team
	National Bridge Inventory (NBI)	Oracle database converted to GIS shapefile format by ALDOT GIS team
	ALDOT Bridge Replacement Projections	Excel spreadsheet produced by ALDOT Maintenance Office
Pavement	Highway Yearly Data Reduction and Analysis (HYDRA)	Access database produced by Univ. of Alabama and converted to GIS shapefile format by ALDOT GIS team

Volume to capacity (v/c) ratios on state routes and Interstates were calculated to measure current and forecast future congestion. Crash and fatality rates were developed for roadways throughout the system to identify and analyze safety concerns. Current and future state route and Interstate bridge conditions were determined through existing and forecast sufficiency rating, functional obsolescence, and structural deficiency. Pavement condition measures were developed from the University's HYDRA database and ALDOT's maintenance schedule.

The ALDOT Transportation System Review and Assessment used a broad array of data resources to analyze existing system conditions and forecast future conditions. Transportation conditions that fell short of state and federal standards were identified and their impact on transportation network operations, safety and infrastructure was documented. Operations threshold measures were used to determine where improvements were needed. Using Geographic Information Systems (GIS), projects in the CPMS were mapped to show the correlation between identified transportation needs and CPMS initiatives.

After needs and projects were compared, costs were analyzed. Project costs vary by type of project and location (urban or rural areas). For instance, a construction project in a rural area may cost less than in an urban area, largely because the cost of right of way in an urban area is usually more. Projects in the CPMS are programmed to reflect the best cost estimates at the time. As projects are developed and progress from preliminary engineering to concept and final plans, cost estimates are revised. Current ALDOT cost estimates were used to calculate an average cost of projects to determine future 2018 financial requirements.

The level of transportation need was measured using operations and conditions thresholds for capacity, safety, pavement and bridges. System capacity as measured by v/c ratios is indicative of traffic operations in congested conditions. Capacity adding CPMS projects were assessed to determine their potential to address identified capacity transportation demands. Likewise, CPMS safety projects were examined against identified safety needs to see how well the CPMS program addressed this area. Pavement and bridge CPMS projects were similarly reviewed against needs on the system.

The methodology and approach developed to identify transportation demands and determine the impact of CPMS projects on improving system operations and condition can be replicated by ALDOT staff developing future year CPMS programs. The same methodology can be applied to prioritize projects as a group or evaluate the benefits of a given project on transportation needs.

Condition Measurement Methodology

Table 2 (Measures of Condition and Recommended Thresholds) identifies standards for determining transportation need and level of transportation demand. The following measures of condition were used:

- Capacity: Volume to capacity (v/c) ratio is a standard measure used to quantify capacity. The ratio of actual vehicle volume to the road's capacity is graded for rural and urban areas. A ratio of 0.75 or greater in rural areas identifies a deficient condition (approximately equivalent to a Level of Service C). In an urban area, a ratio of 0.90 or greater was categorized as deficient (approximately equivalent to a Level of Service D). The K Factor, the percentage of traffic in peak hour from ALDOT traffic count database (field name-K), was used in a formula to compute capacity.

$$\frac{(X)\ (\#\ \text{of lanes})}{\text{K Factor}}$$

X= 2200 passenger car per hour per lane for Interstates
= 1800 passenger car per hour per lane for 6 lane State Routes
= 1800 passenger car per hour per lane for 4 lane State Routes
= 1600 passenger car per hour per lane for 2 lane State Routes
# of lanes from ALDOT traffic count database (field name-LANECNT).

A factored percentage was added to the volumes to reflect truck traffic and ensure an accurate calculation. The Highway Capacity Manual 2000 passenger car volume adjustment formula:

$$\frac{\text{AADT}}{(\text{number of lanes})\ \text{X}\ (\text{heavy vehicle factor})}$$

was used to convert mixed Annual Average Daily Traffic (AADT) to the equivalent passenger vehicle AADT.

Future congestion was forecast by projecting volume based on a trend line of historic AADT.

$$\text{Heavy vehicle factor} = \frac{1}{1 + (\text{truck percent}) \times (Et - 1)}$$

Et = Passenger car equivalents for truck
Et = 1.5 (level terrain); 2.5 (rolling terrain); and 4.5 (mountainous terrain)

- Crash and Fatality Rates: The CARE (Critical Analysis Reporting Environment) database includes crashes and fatalities for the Alabama road network. Crashes are geocoded and can be shown on a GIS map. The standard measure for crashes and fatalities is computed based on a rate per 100 million vehicle miles of travel. Locations with crash rates that exceed one standard deviation above the state average are considered in need of improvement. Crash data for this assessment was evaluated through two screening processes. The first screen identified general crash and fatal crash trends across variables by examining the aggregate data. A second screen permitted comparison of locations against each other by calculating normalized crash and fatal crash rates. The normalized annual rates are derived by the following equations:

  Crash Rate = (annual # crashes * 100 million) / (section length * AADT * 365)
  Fatality Rate = (annual # fatalities * 100 million) / (section length * AADT * 365)

  For the most meaningful comparison, only like-type facilities are compared against each other. For example, crash locations on the Interstate system are only compared against other Interstate sections. Projections of future crash and fatality rates were calculated using the percentage growth rate of vehicle miles traveled (VMT).

- Bridges: Bridge data from the ABIMS (Alabama Bridge Inventory Management System) and federal NBI (National Bridge Inventory) system was used to identify bridges with problems associated with age, sufficiency ratings, structural deficiency and functional obsolescence, or congestion on approaching routes. Details related to the data and thresholds applied are provided below.
  - *Age:* Alabama DOT replaces bridge structures using a 50-year life cycle.
  - *Sufficiency Rating:* A composite score calculated based on separate factors that include structural adequacy and safety, serviceability and functional obsolescence, and essentiality for public use. Each of these factors contributes to a numeric value indicative of a bridge's fitness for service. The result of this formula is a composite score in which 100 percent represents an entirely sufficient bridge and 0 percent represents an insufficient or deficient bridge. ALDOT has set a threshold of equal to or less than 60 percent as the point at which bridges are considered for replacement or improvement.

- *Functional Obsolescence and Structural Deficiency:* Not related to the safety of the bridge structure, this is a measure of the structure's ability to operate under current traffic conditions. Older bridges designed and constructed to meet a given level of traffic ultimately will be overwhelmed by the state's growth and increased traffic volumes. This measure addresses the functionality of the bridge and its ability to serve traffic demands.
- *Congestion on Approaching Routes:* Bridge structures on roads with v/c ratios in excess of 0.9 in urban areas or 0.75 in rural areas are candidates for bridge replacement from congestion relieving measures, such as roadway and bridge widening.

- <u>Pavement:</u> Pavement condition was measured using the University of Alabama's HYDRA (Highway Yearly Data Reduction and Analysis) pavement databases for Alabama roads. The cost calculation methodology follows:
  - *Step 1: Determine Lane Mile Resurfacing Costs*
    - Split CPMS data into Interstate and non-interstate roads.
    - Determine pavement costs over a three-year period from 2001 to 2003 from the CPMS.
    - Allocate costs across number of lanes.
    - Annualize pavement costs.
  - *Step 2: Determine Statewide Deterioration Rate of Pavement*
    - Determine all road segments improved (in 2000, 2001, 2002).
    - For all road segments that were not improved, determine pavement condition rating for 2000 and 2002.
    - Calculate the system-wide decrease average rating.
    - Result (four percent deterioration rate).
  - *Step 3: Create a Pavement Calculator Forecaster Using the Above Data*
    - Assumption: Maintain the roads at the current rating level of 83 for Interstates and 80 for non-Interstate routes.
    - The calculation does not include changes in cost or inflation.
    - Because rigid (concrete) segments constitute less than four percent of all pavement, the calculation includes only flexible (asphalt) road segments.