Mississippi's Unified Long-Range Transportation Infrastructure Plan

FINAL REPORT

Appendix D: Highway and Bridge Needs Assessment

MAY 2011

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1. INTRODUCTION

This report presents an estimate of highway and bridge needs over the period from 2008 to 2035. Full needs are estimated assuming the availability of all necessary funds (unconstrained funding scenario), as well as for two projected funding scenarios, namely a conservative projection (Level 1) and an aggressive or more optimistic projection (Level 2) that had more funds available to address highway and bridge needs than the conservative scenario.

2. HIGHWAY NEEDS METHODOLOGY

Needs for highways on the state's Federal Aid System were assessed using FHWA's HERS-ST – Highway Economics Requirements System, State Version. The HERS-ST model[1] is designed to analyze the effects of alternative funding levels on highway performance. The model simulates highway conditions and performance levels and identifies deficiencies through the use of engineering principles. In selecting improvements for implementation, the model is designed to select only those projects whose benefits exceed initial costs.

2.1 Highway Needs Analysis Process

The needs analysis process included several procedural steps:

- **Highway System Data Base** - The purpose of the data base was to define the existing characteristics of roadway sections and bridges that comprise the highway system. These data included information about the geometric, structural and operational features of the existing infrastructure. Additionally, projections were made of future conditions. These projections take into account the changes anticipated in traffic volumes and in the structural conditions of pavements. The input for this step was the state's Highway Performance Monitoring System (HPMS) database.
- **Determine Deficiencies** - Inventory data were compared to Minimum Tolerable Conditions considered acceptable by MDOT. Acceptability reflected judgment about the level of congestion and safety and the minimum structural conditions for pavements that the public should have to tolerate. Minimum tolerable conditions also reflect cost effectiveness principles. Criteria were defined for different types of facilities reflecting their functional classification, traffic volume, and location (as defined by terrain and rural/urban characteristics). Any condition below the minimum tolerable criteria was classified as a deficiency. This was done for existing conditions (as of 2008) and for future conditions forecasted through the year 2035.
- **Determine Needed Improvements** - Based on the types of deficiencies and the year in which the deficiencies occur, improvements that would correct the problem(s) were identified by the HERS-ST model. Improvements to overcome existing deficiencies constitute "backlog" needs, while those that address future deficiencies are considered as "future" or accruing needs. Projects identified by HERS-ST were improved to design standards as identified by MDOT for each functional classification of facility, the traffic volume it will serve in the future design year, and its location characteristics.

1 HERS-ST, Version 4.x, Highway Economic Requirements System State Version, Users Guide, U.S. Department of Transportation, FHWA. July 2009.

- **Estimate Costs** - The cost of each improvement was estimated using unit costs that reflect practices and cost experience in the state of Mississippi for each functional class of highways. Costs were expressed in constant 2008 dollars.

2.2 Types of Highway Needs

The highway needs are presented in terms of three categories:

- **Preservation** – the improvement of pavement only - actions that do not change roadway geometry;
- **Modernization** – includes improvements to pavement that change the roadway characteristics and/or the structural integrity of the pavement base; and
- **Expansion** – capacity increasing projects, which add lane(s) and change the roadway characteristics for existing lanes along the same segment.

HERS-ST defines various types of roadway improvements. For summary purposes, these improvements have been grouped into the three construction categories of Preservation, Modernization, and Expansion, as shown in **Table 2-1**.

Table 2-1: Roadway Improvement Types

HERS-ST Improvement Types	Categories
Reconstruction with High-Cost Lanes	Expansion
Reconstruction with Normal-Cost Lanes	Expansion
Reconstruction with Wider Lanes	Modernization
Reconstruction	Modernization
Resurface with High-Cost Lanes	Expansion
Resurface with Normal-Cost Lanes	Expansion
Resurface with Wider Lanes	Modernization
Resurface with Shoulder Improvements	Modernization
Resurface	Preservation

The improvement types within HERS-ST refer to actions or combinations of actions to improve roadways. All improvements involve resurfacing or reconstruction of the existing roadway in some capacity. However, other actions can be taken along with the initial improvement based on need. For example, "Reconstruction with High-Cost Lanes" basically means some of the existing roadway is being reconstructed, but more importantly that lanes are being added. The groupings are based on the dominate action being taken. As lanes are being added this is primarily a capacity adding project and so would be classified as an Expansion project. Similarly, "Resurfacing with Wider Lanes" is a modernization effort because the lanes are increasing in width while being resurfaced and changing the performance and safety of the roadway.

The difference between a Normal Cost action and a High Cost action has less to do with the actual cost of improvement and more as a deterrent based on a benefit/cost ratio. Widening Feasibility for a roadway dictates the maximum number of lanes a given functional classification

is allowed to add. The feasibility coded within the HPMS dataset is compared to the policy values within the model software. If both match or the HPMS expansion is lower, then the added lanes are allowed at normal costs. If the HPMS value is higher than the model value, then any expansion of lanes beyond the policy value is added at the high cost value. If the existing facility has a number of lanes beyond the maximum allowed in the policy value, any additional lanes will be added at a high cost (depending on the widening variable coded within the HPMS).

For construction needs, the analyses involved determining existing deficiencies in the study's base year (2008), called backlog needs. Then the analyses developed forecasts of future needs to 2035 by considering traffic growth, deterioration rates and other factors.

Roadway maintenance needs are not considered as capital construction needs and are not included in the Highway Needs described herein. Roadway maintenance needs include:

- General roadway maintenance such as drainage, traffic control and roadside; and
- Routine pavement maintenance such as patching.

For unpaved roads, maintenance costs represent the annualized rehabilitation and reconstruction costs (re-gravelling for example), as well as routine maintenance. Resurfacing is considered a construction need, not a maintenance need.

2.3 Roadway Improvement Costs

HERS-ST uses unit cost tables to determine a planning level cost estimate for the improvements determined within the model. These costs are shown by category, roadway classification, and size of urban setting or terrain type. **Table 2-2** shows the rural roads unit cost table by terrain type and **Table 2-3** shows the unit cost for urban roadways by size of the urbanized area. Both tables were established for this MULTIPLAN study using cost data provided by MDOT. The dollar amounts are in 2008 dollars on a per lane mile basis.

2.4 Minimum Tolerable Conditions

Deficiencies in HERS-ST refer to roadway characteristics based on the traffic level and terrain that fail to meet the Minimum Tolerable Conditions. If the roadway is identified as deficient, then HERS-ST triggers an improvement action. The Minimum Tolerable Conditions Table allows HERS-ST to define a "deficiency level" for pavement condition and other engineering and design variables, as shown in **Table 2-4**. These threshold levels are a product of conversations with experts within MDOT and related back to the HERS-ST formatting.

In Table 2-4, flat interstate pavement conditions are assumed to be "deficient" and require resurfacing at a PSR (pavement serviceability rating) of 3.4 or less. Additionally, if no action is taken and the PSR reaches the "reconstruction level" of 1.8, it is assumed that the segment is so deficient that it cannot be repaired by resurfacing and will require reconstruction. This may occur because on a constrained budget it is not possible to maintain all roads immediately they need resurfacing. The higher the deficiency and reconstruction levels for pavement conditions, the greater the overall need for resurfacing and reconstruction will be required to maintain these levels.

Table 2-2: Rural Unit Costs

2008 Improvement Costs ($Thousands per Lane Mile)		Reconstruction		Resurface		Shoulder Improve-ments	Add Lanes		New Alignment	
		Lane Widening	Pavement	Lane Widening	Pavement		Normal Cost	High Cost	Normal Cost	High Cost
Interstate	Flat	1,764	1,566	719	472	78	2,079	3,339	2,530	3,790
	Rolling	1,764	1,566	719	472	78	2,097	3,427	2,565	3,895
Principal Arterials	Flat	1,494	1,333	523	401	67	1,809	3,069	2,056	3,316
	Rolling	1,494	1,333	523	401	67	1,826	3,156	2,091	3,421
Minor Arterials	Flat	1,257	1,130	405	300	50	1,572	2,832	1,981	3,241
	Rolling	1,257	1,130	405	300	50	1,590	2,920	2,016	3,346
Major Collectors	Flat	1,370	1,235	412	306	79	1,540	2,800	1,698	2,958
	Rolling	1,370	1,235	412	306	79	1,540	2,870	1,698	3,028

Table 2-3: Urban Unit Costs

2008 Improvement Costs ($Thousands per Lane Mile)		Reconstruction		Resurface		Shoulder Improve-ments	Add Lanes		New Alignment	
		Lane Widening	Pavement	Lane Widening	Pavement		Normal Cost	High Cost	Normal Cost	High Cost
Interstates/ Expressways	Small Urban	1,764	1,566	719	472	78	2,099	3,439	2,570	3,910
	Small Urbanized	1,764	1,566	719	472	78	2,099	4,739	2,570	5,210
	Large Urbanized	2,205	1,958	899	590	98	2,424	7,044	3,220	7,840
Principal Arterials	Small Urban	1,494	1,333	523	401	67	1,829	3,169	2,099	3,439
	Small Urbanized	1,494	1,333	523	401	67	1,829	4,469	2,099	4,739
	Large Urbanized	1,868	1,666	654	501	84	2,154	6,774	2,748	7,368
Arterials/ Collectors	Small Urban	1,314	1,183	409	303	65	1,893	3,233	2,105	3,445
	Small Urbanized	1,314	1,183	409	303	65	1,900	4,540	2,105	4,745
	Large Urbanized	1,642	1,478	511	379	81	2,221	6,841	2,754	7,374

Table 2-4: Minimum Tolerable Conditions

		PSR	Recon-struction	Surface Type[2]	V/C Ratio	Lane Width[1]	Right Shoulder[1]	Shoulder Type[3]	Horizon Align[4]	Vertical Align[4]
Rural	Interstate	3.4	1.8	3	1.04	11	11	2	2	3
	Principal Arterials AADT > 6000	3.1	1.8	3	0.88	11	7	1	2	3
	Principal Arterials AADT < 6000	3.1	1.8	3	0.88	11	7	1	2	3
	Minor Arterials AADT > 2000	3.1	1.8	3	0.88	11	7	3	2	3
	Minor Arterials AADT < 2000	3.1	1.8	3	0.88	11	5	3	2	3
	Major Collectors AADT > 1000	2.8	1.8	3	0.64	10	4	3	2	3
	Major Collectors AADT > 400	2.8	1.8	3	0.64	10	4	3	2	3
	Major Collectors AADT < 400	2.8	1.8	3	0.64	9	1	3	2	3
Urban	Interstate	3.4	1.8	3	1.23	11	9	1	2	
	Expressway	3.4	1.8	3	1.13	11	9	1	2	
	Principal Arterial	3.1	1.8	3	1.17	9	5	1	2	
	Minor Arterial	3.1	1.8	3	1.17	9	5	1	2	
	Collector	2.8	1.8	3	1.12	9	0	4	2	

Notes:
(1) Widths are in feet
(2) Surface Type is 2 = High, 3 = Intermediate, 4 = Low, 5 = Unpaved
(3) Shoulder Type is 1 = Surfaced, 2 = Stabilized, 3 = Earth, 4 = Curbed
(4) Alignment (Curves/Grades) is 1 = All Appropriate, 2 = All Accepted, 3 = Some Reduced Speed, 4 = Some Unacceptable

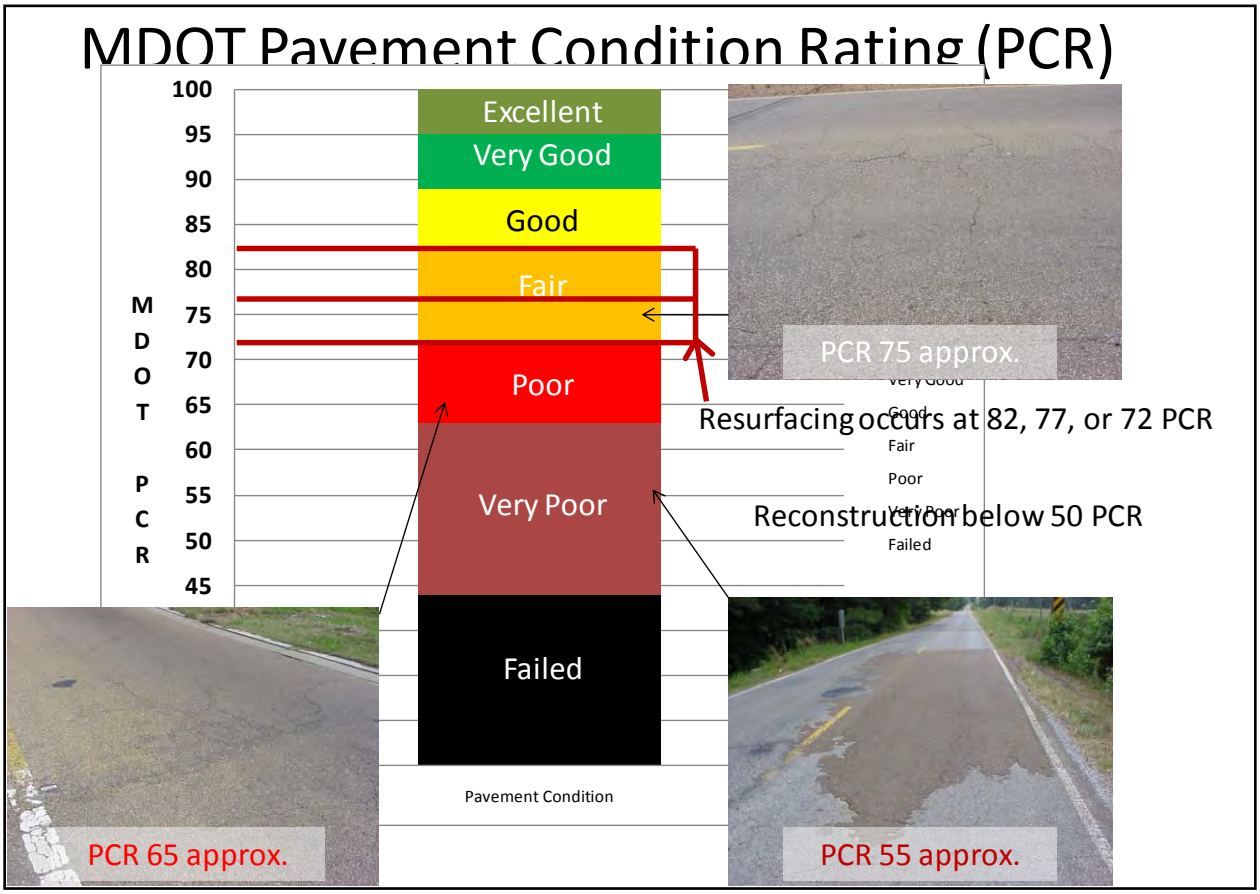
2.4.1 Pavement Condition Rating

MDOT uses a Pavement Condition Rating (PCR) to assess pavement condition. This rating has a value in the range of 1 to 100 as shown in **Figure 2-1**.

This rating system is used to determine the need for resurfacing or reconstruction of a road's pavement. The value at which a road is resurfaced is dependent upon the road's functional class:

- Interstates (existing and future) – when PCR less than 82
- Principal and Minor Arterials – when PCR less than 77
- Collectors and below – when PCR less than 72

Figure 2-1: MDOT Pavement Condition Rating



FHWA's HERS-ST software uses the Pavement Serviceability Rating (PSR) to assess pavement conditions. This rating uses a scale of 0 to 5, with 5 as the highest (best) possible value. The following is a description of the PSR scale[2]:

2 U.S. Department of Transportation, Federal Highway Administration, Highway Performance Monitoring System Field Manual, Washington, D.C. May 2005.

PSR	Condition	Description
4.0 - 5.0	Very Good	Only new (or nearly new) superior pavements are likely to be smooth enough and distress free (sufficiently free of cracks and patches) to qualify for this category. Most pavements constructed or resurfaced during the data year would normally be rated in this category.
3.0 - 4.0	Good	Pavements in this category, although not quite as smooth as those described above, give a first class ride and exhibit few, if any, visible signs of surface deterioration. Flexible pavements may be beginning to show evidence of rutting and fine random cracks. Rigid pavements may be beginning to show evidence of slight surface deterioration, such as minor cracks and spalling.
2.0 - 3.0	Fair	The riding qualities of pavements in this category are noticeably inferior to those of new pavements, and may be barely tolerable for high-speed traffic. Surface defects of flexible pavements may include rutting, map cracking, and extensive patching. Rigid pavements in this group may have a few joint failures, faulting and/or cracking, and some pumping.
1.0 - 2.0	Poor	Pavements in this category have deteriorated to such an extent that they affect the speed of free-flow traffic. Flexible pavement may have large potholes and deep cracks. Distress includes raveling, cracking, and rutting and occurs over 50 percent of the surface. Rigid pavement distress includes joint spalling, patching, cracking, scaling, and may include pumping and faulting.
0.0 - 1.0	Very Poor	Pavements in this category are in an extremely deteriorated condition. The facility is passable only at reduced speeds, and with considerable ride discomfort. Large potholes and deep cracks exist. Distress occurs over 75 percent or more of the surface.

For purposes of this study, MDOT's PCR values were converted to equivalent PSR values for use in HERS-ST according to **Table 2-5**.

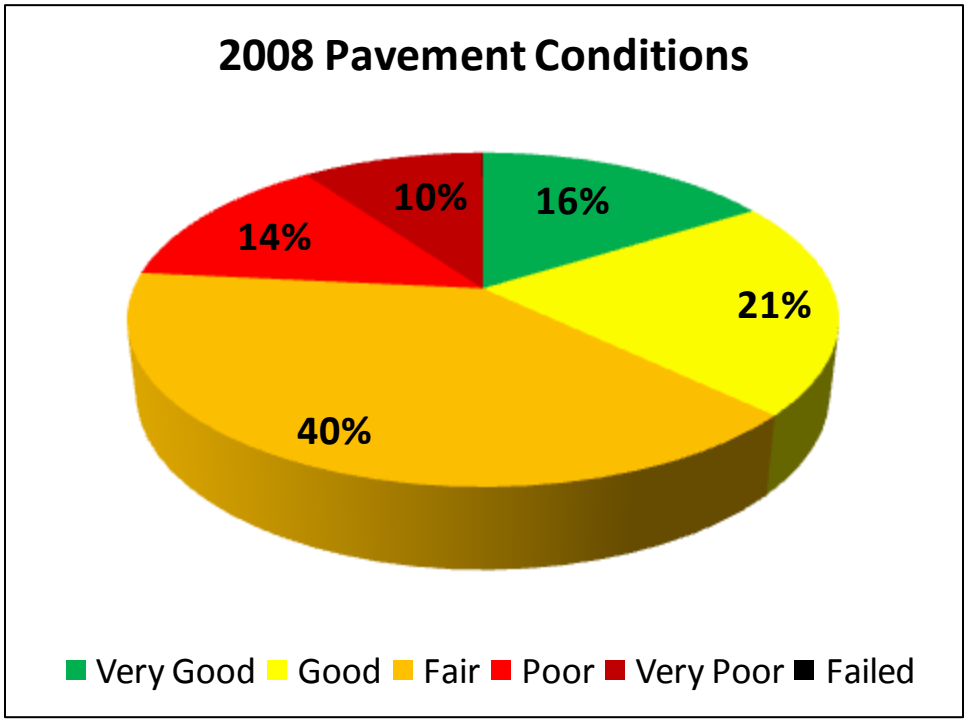
2.4.2 2008 Pavement Condition

Based upon pavement condition information contained in Mississippi's 2008 HPMS database, 37 percent of roads were in good or very good condition, with 40 percent in fair condition, and 23 percent in poor or very poor condition, as shown in **Figure 2-2**.

Table 2-5: Relationship between MDOT's PCR and HERS's PCR Ratings

Pavement Condition		MDOT PCR Value Range	Equivalent HERS-ST PSR
7	Excellent	95-100	4.6 - 5.0
6	Very Good	89-95	3.8 - 4.6
5	Good	82-89	3.4 - 3.8
4	Fair	72-82	2.8 - 3.4
3	Poor	63-72	2.3 - 2.8
2	Very Poor	44-60	1.1 - 2.3
1	Failed	25-44	0.0 - 1.1

Figure 2-2: 2008 Pavement Conditions



3. PROJECTED HIGHWAY NEEDS

For purposes of estimating highway needs, roads in Mississippi were considered in two groups:

- **Tier I** – existing interstates, plus the Mississippi portion for the planned I-269 around the Memphis urban area and U.S. 78 (future I-22).
- **Tier II** – all other roads.

Tier I roads are illustrated in **Figure 3-1**.

A total of nine scenarios were analyzed:

- Unconstrained Funding

  A. Full needs: Preservation, Modernization, and Expansion
  B. Preservation and Modernization needs only
  C. Preservation and Modernization needs plus Expansion needs on Tier I roads and on US 49, between the Gulf Coast and Jackson

- Conservative Funding Projection (Level 1 funding)

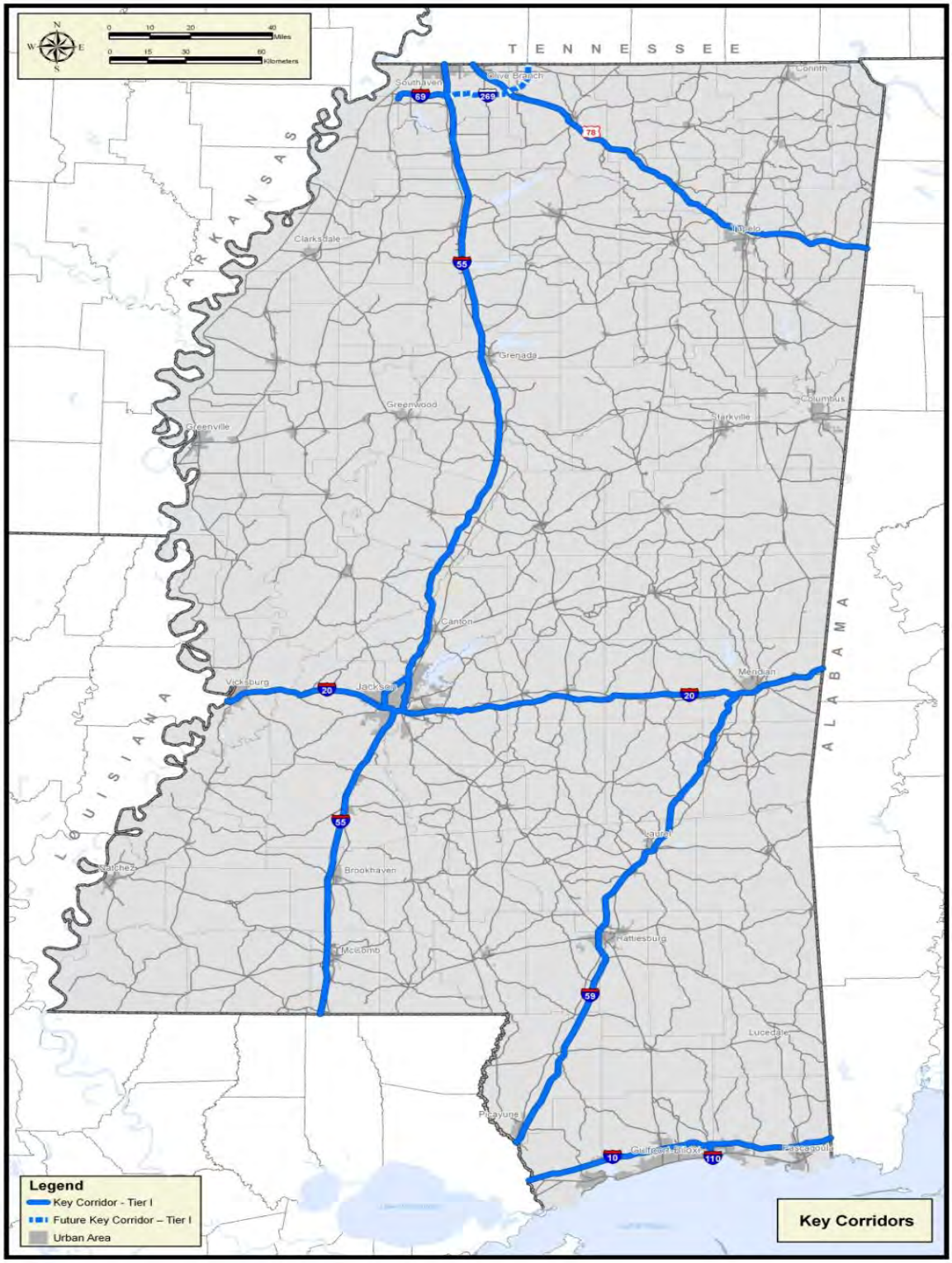
  D. All types of needs: Preservation, Modernization, and Expansion
  E. Preservation and Modernization needs only
  F. Preservation and Modernization needs plus Expansion needs on Tier I roads and on US 49, between the Gulf Coast and Jackson

- Aggressive Funding Projection (Level 2 funding)

  G. All types of needs: Preservation, Modernization, and Expansion
  H. Preservation and Modernization needs only
  I. Preservation and Modernization needs plus Expansion needs on Tier I roads and on US 49, between the Gulf Coast and Jackson

Description and discussion of results for scenarios A through I are contained within this chapter. All roads were assessed in each scenario.

Figure 3-1: Tier I Roads



3.1 Unconstrained Funding Projections

3.1.1 Full Highway Needs (A)

Full highway needs based on unconstrained levels of funding being available are projected in Scenario A to amount to $25,185 million, of which $5,495 million (or 21.8 percent) are estimated to be Backlog needs – the cost to bring all existing Federal Aid Roads up to Minimum Tolerable Conditions.

Full highway needs by functional class are shown in **Table 3-1**. If the period from 2008 to 2035 is divided into seven four-year periods, the distribution of needs by funding period is projected to be as shown in **Table 3-2**.

With unconstrained funding it is projected that by 2035 pavement conditions would be as shown in **Figure 3-2**. The 2008 pavement conditions are also shown for comparison. The 2035 projected pavement conditions by type of roads are shown in **Figure 3-3**.

3.1.2 Omitting Expansion Needs (B)

If the highway construction program were to be solely focused on Modernization and Preservation needs and there were unconstrained levels of funding available, the needs are projected in Scenario B to amount to $20,622 million, of which $4,995 million (or 24.2 percent) are estimated to be Backlog needs.

Full Modernization and Preservation needs in the absence of improvements that add capacity (Expansion) are shown in **Table 3-3** by functional class.

3.1.3 Expansion Needs on Selected Highways (C)

In Scenario C, full expansion needs are met on Tier I highways and on US 49 between the Gulf Coast and Jackson, as well as full Modernization and Preservation needs to all roads on the state's Federal Aid System.

These needs, shown by functional class in **Table 3-4**, are projected to amount to $23,089 million, of which $5,243 million, or 22.7 percent, are Backlog needs.

3.1.4 Full Highway Needs Summary

The needs projections for Scenarios A, B and C with unconstrained funding are summarized in **Table 3-5**.

Table 3-1: Full Highway Needs by Functional Class (A)

Type of Roadway Need	Roadway Pavement Needs by Functional Class [1] ($ millions)					
	Interstate and Other Freeways	Other Principal Arterials	Minor Arterials	Collectors	Total	Percent of Total
	Backlog Needs Only					
Rural						
Preservation	$245	$71	$443	$933	$1,692	45%
Modernization	$13	$1,035	$691	$96	$1,836	49%
Expansion	$114	$10	$0	$78	$202	5%
Total Rural	**$371**	**$1,116**	**$1,135**	**$1,107**	**$3,730**	**100%**
Urban						
Preservation	$77	$139	$6	$9	$232	13%
Modernization	$245	$468	$173	$283	$1,168	66%
Expansion	$158	$185	$22	$0	$365	21%
Total Urban	**$481**	**$792**	**$201**	**$292**	**$1,765**	**100%**
Rural + Urban						
Preservation	$322	$210	$450	$942	$1,924	35%
Modernization	$258	$1,502	$864	$379	$3,004	55%
Expansion	$272	$196	$22	$78	$567	10%
Total Needs	**$852**	**$1,908**	**$1,336**	**$1,399**	**$5,495**	**100%**
	2008 to 2035 (including Backlog Needs)					
Rural						
Preservation	$2,150	$224	$2,645	$4,600	$9,619	54%
Modernization	$67	$4,163	$1,327	$211	$5,768	32%
Expansion	$969	$640	$189	$655	$2,453	14%
Total Rural	**$3,186**	**$5,026**	**$4,162**	**$5,465**	**$17,840**	**100%**
Urban						
Preservation	$1,610	$560	$56	$129	$2,355	32%
Modernization	$518	$1,636	$416	$283	$2,852	39%
Expansion	$1,266	$777	$94	$0	$2,138	29%
Total Urban	**$3,394**	**$2,974**	**$566**	**$412**	**$7,345**	**100%**
Rural + Urban						
Preservation	$3,760	$784	$2,701	$4,728	$11,974	48%
Modernization	$585	$5,798	$1,743	$494	$8,620	34%
Expansion	$2,236	$1,417	$284	$655	$4,591	18%
Total Needs	**$6,581**	**$8,000**	**$4,728**	**$5,877**	**$25,185**	**100%**

Notes: (1) Expressed in base year 2008 Dollars.

Table 3-2: Full Highway Needs by Funding Period

Improvement Category	FP 1	FP 2	FP 3	FP 4	FP 5	FP 6	FP 7	Total
Expansion	$960	$628	$861	$664	$483	$557	$438	$4,591
Modernization	$4,182	$631	$612	$298	$477	$1,813	$608	$8,620
Preservation	$3,405	$892	$571	$878	$2,375	$2,612	$1,241	$11,974
Total	**$8,546**	**$2,151**	**$2,045**	**$1,840**	**$3,335**	**$4,982**	**$2,287**	**$25,185**
Per Year	$2,137	$538	$511	$460	$834	$1,245	$572	$899

Figure 3-2: 2035 Pavement Conditions with Unconstrained Funding

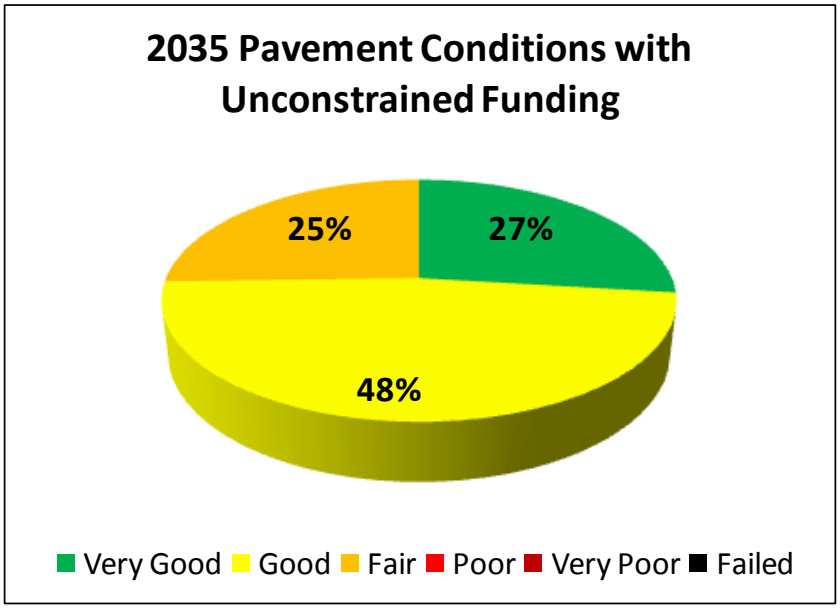


Figure 3-3: 2035 Pavement Conditions by Road Type with Unconstrained Funding

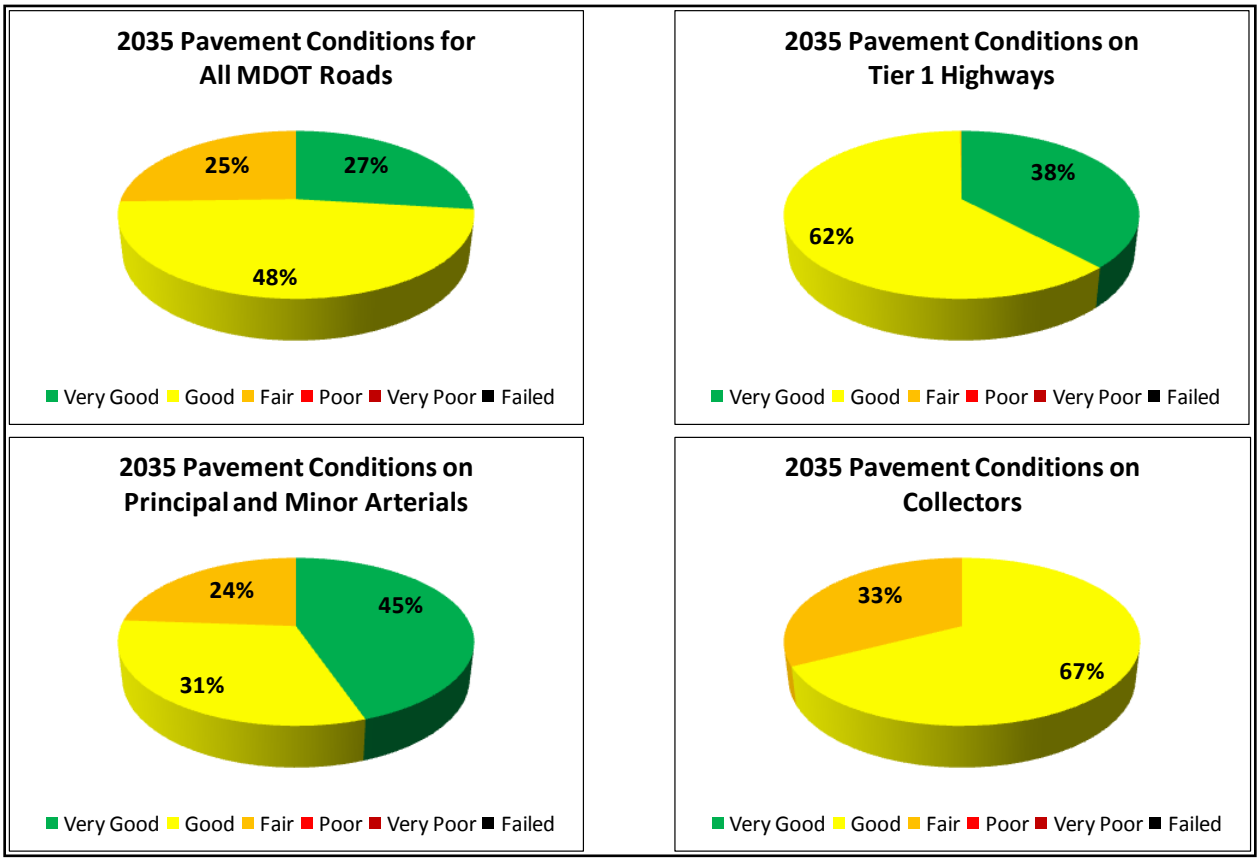


Table 3-3: Full Needs for Modernization and Preservation, with No Expansion (B)

Type of Roadway Need	Roadway Pavement Needs by Functional Class [1] ($ millions)					
	Interstate and Other Freeways	Other Principal Arterials	Minor Arterials	Collectors	Total	Percent of Total
	Backlog Needs Only					
Rural						
Preservation	$243	$72	$443	$939	$1,697	48%
Modernization	$13	$1,010	$730	$96	$1,850	52%
Expansion	$0	$0	$0	$0	$0	0%
Total Rural	**$256**	**$1,082**	**$1,174**	**$1,035**	**$3,547**	**100%**
Urban						
Preservation	$88	$143	$8	$9	$247	17%
Modernization	$246	$496	$176	$283	$1,201	83%
Expansion	$0	$0	$0	$0	$0	0%
Total Urban	**$334**	**$639**	**$184**	**$292**	**$1,449**	**100%**
Rural + Urban						
Preservation	$331	$214	$451	$948	$1,944	39%
Modernization	$259	$1,506	$907	$379	$3,051	61%
Expansion	$0	$0	$0	$0	$0	0%
Total Needs	**$590**	**$1,721**	**$1,358**	**$1,327**	**$4,995**	**100%**
	2008 to 2035 (including Backlog Needs)					
Rural						
Preservation	$2,085	$234	$2,659	$4,677	$9,656	62%
Modernization	$68	$4,225	$1,327	$211	$5,831	38%
Expansion	$0	$0	$0	$0	$0	0%
Total Rural	**$2,153**	**$4,459**	**$3,986**	**$4,888**	**$15,486**	**100%**
Urban						
Preservation	$1,474	$597	$56	$129	$2,256	44%
Modernization	$527	$1,688	$423	$283	$2,920	56%
Expansion	$0	$0	$0	$0	$0	0%
Total Urban	**$2,001**	**$2,285**	**$478**	**$412**	**$5,176**	**100%**
Rural + Urban						
Preservation	$3,560	$831	$2,715	$4,806	$11,911	58%
Modernization	$595	$5,912	$1,750	$494	$8,751	42%
Expansion	$0	$0	$0	$0	$0	0%
Total Needs	**$4,155**	**$6,744**	**$4,465**	**$5,299**	**$20,662**	**100%**

Notes: (1) Expressed in base year 2008 Dollars.

Table 3-4: Full Needs with Expansion Only on Selected Highways (C)

Type of Roadway Need	Roadway Pavement Needs by Functional Class [1] ($ millions)					
	Interstate and Other Freeways	Other Principal Arterials	Minor Arterials	Collectors	Total	Percent of Total
	Backlog Needs Only					
Rural						
Preservation	$228	$72	$443	$939	$1,682	46%
Modernization	$13	$1,010	$730	$96	$1,850	51%
Expansion	$114	$0	$0	$0	$114	3%
Total Rural	**$355**	**$1,082**	**$1,174**	**$1,035**	**$3,646**	**100%**
Urban						
Preservation	$77	$142	$8	$9	$236	15%
Modernization	$247	$495	$176	$283	$1,201	74%
Expansion	$158	$32	$0	$0	$190	12%
Total Urban	**$483**	**$669**	**$184**	**$292**	**$1,627**	**100%**
Rural + Urban						
Preservation	$306	$214	$451	$948	$1,918	36%
Modernization	$260	$1,505	$907	$379	$3,051	58%
Expansion	$272	$32	$0	$0	$304	6%
Total Needs	**$838**	**$1,750**	**$1,358**	**$1,327**	**$5,273**	**100%**
	2008 to 2035 (including Backlog Needs)					
Rural						
Preservation	$2,150	$227	$2,659	$4,677	$9,713	58%
Modernization	$67	$4,214	$1,327	$211	$5,820	35%
Expansion	$969	$138	$0	$0	$1,107	7%
Total Rural	**$3,186**	**$4,579**	**$3,986**	**$4,888**	**$16,640**	**100%**
Urban						
Preservation	$1,610	$590	$56	$129	$2,384	36%
Modernization	$518	$1,677	$423	$283	$2,901	43%
Expansion	$1,266	$119	$0	$0	$1,386	21%
Total Urban	**$3,394**	**$2,386**	**$478**	**$412**	**$6,670**	**100%**
Rural + Urban						
Preservation	$3,760	$817	$2,715	$4,806	$12,097	52%
Modernization	$585	$5,891	$1,750	$494	$8,720	37%
Expansion	$2,236	$257	$0	$0	$2,493	11%
Total Needs	**$6,581**	**$6,965**	**$4,465**	**$5,299**	**$23,310**	**100%**

Table 3-5: Highway Needs for Three Unconstrained Funding Scenarios

Improvement Category	Unconstrained Funding Scenario		
	A	B	C
Expansion	$4,591	$0	$2,493
Modernization	$8,620	$8,751	$8,720
Preservation	$11,974	$11,911	$12,097
Total	**$25,185**	**$20,662**	**$23,310**
Average Per year	$899	$738	$833

Note: Needs in Constant 2008 Dollars (millions)
A. Full needs: Preservation, Modernization, and Expansion
B. Modernization and Preservation needs only
C. Modernization and Preservation needs plus Expansion needs on Tier 1 and US 49

3.2 Highway Needs with Conservative Funding Projection

It is recognized that funding to satisfy all of the state's highway needs identified above will not be available. While future funding levels cannot be known with any certainty, the issues impacting future Federal and State funding for transportation have been addressed in Appendix C: Baseline Revenue Forecasts. That report identified two potential scenarios for funding of MDOT's Construction Program for highways and bridges, referred to as the:

- Conservative (Lower) Funding Projection, and
- Aggressive (Higher) Funding Projection.

This section evaluates the consequences on the condition of Mississippi's highways of three scenarios for using the limited funds available under the Conservative Funding Projection (Level 1 funding). HERS-ST was used to determine the most cost-effective use of funds in each of the seven four-year periods between 2008 and 2035. These funds, in Constant 2008 dollars, were based on the following considerations:

- Information from MDOT on typical levels of funding available for the Construction Program from recurring sources of federal and state funding;
- Information on short term funding sources that will be available only in the first funding period, such as funds from the American Recovery and Reinvestment Act of 2009 (ARRA) and Bonds (for new construction);
- MDOT's allocation of flexible funds between highway and bridge needs; and
- Growth projections for recurring funding sources of 1 percent per year for state and federal sources, determined in the Baseline Revenue Forecasts for the conservative funding projections.

Note that the HERS analysis of future conditions spans a 28-year period starting from 2008, as does the bridge analysis discussed later. Consequently, the total dollar value assumed in this report to be spent with Level 1 funding on MDOT's Construction Program through 2035 is higher than the figure shown in the Baseline Revenue Forecasts, which used a base year of 2010. However, as noted above, the key assumptions on growth rates for funding sources were the

same as used in the revenue forecasts. The funding available in each 4-year period for the Conservative Funding Projection is show in **Table 3-6**.

Table 3-6: Conservative Funding Allocated to Highway Needs

	Seven 4-year Funding Periods						
Projected Funding	**08-11**	**12-15**	**16-19**	**20-23**	**24-27**	**28-31**	**32-35**
Funding Level 1	$1,704	$1,380	$1,325	$1,271	$1,220	$1,171	$1,124
Average per year	$426	$345	$331	$318	$305	$293	$281
	Total Funds over 28 years			**$9,195**	**(36 % of Full Needs)**		

Funds in Millions of Constant 2008 Dollars

3.2.1 Level 1 Funding: Preservation, Modernization, and Expansion (D)

With the conservative funding projection and HERS allocating funding as cost-effectively as possible among all three categories of needs, the allocation of funds by type of roads, category of needs and backlog/accruing is shown in **Table 3-7**. Modernization needs would use the highest share of funds at 40 percent, with preservation and expansion accounting for 36 and 24 percent, respectively.

With this allocation of funds 2035 pavement conditions by road type are projected to be as shown in **Figure 3-4.** The deterioration of pavement condition by 4-year period is shown in **Figure 3-5**.

3.2.2 Level 1 Funding: Preservation and Modernization Only (E)

With the conservative funding projection and HERS allocating funding to meet preservation and modernization needs, the allocation of funds is as shown in **Table 3-8**. With no funds being used for expansion needs, funds would be evenly split between preservation (51 percent) and modernization needs (49 percent).

With this allocation of funds, by 2035 pavement conditions are projected to be as shown in **Figure 3-6**. The deterioration of pavement condition by 4-year period is shown in **Figure 3-7**.

Table 3-7: Conservative Funding Level Allocated to Needs of All Types (D)

Type of Roadway Need	Roadway Pavement Needs by Functional Class [1] ($ millions)					
	Interstate and Other Freeways	Other Principal Arterials	Minor Arterials	Collectors	Total	Percent of Total
	Backlog Needs Only					
Rural						
Preservation	$85	$18	$107	$34	$244	43%
Modernization	$0	$188	$101	$0	$289	52%
Expansion	$28	$0	$0	$0	$28	5%
Total Rural	**$113**	**$206**	**$208**	**$34**	**$560**	**100%**
Urban						
Preservation	$49	$84	$3	$0	$136	27%
Modernization	$119	$165	$13	$0	$297	60%
Expansion	$43	$17	$4	$0	$64	13%
Total Urban	**$210**	**$266**	**$19**	**$0**	**$496**	**100%**
Rural + Urban						
Preservation	$134	$102	$109	$34	$379	36%
Modernization	$119	$353	$114	$0	$586	55%
Expansion	$71	$17	$4	$0	$91	9%
Total Needs	**$323**	**$472**	**$227**	**$34**	**$1,056**	**100%**
	2008 to 2035 (including Backlog Needs)					
Rural						
Preservation	$1,021	$90	$993	$491	$2,596	46%
Modernization	$0	$1,804	$507	$0	$2,311	41%
Expansion	$653	$86	$28	$5	$772	14%
Total Rural	**$1,674**	**$1,981**	**$1,528**	**$496**	**$5,679**	**100%**
Urban						
Preservation	$388	$291	$9	$11	$699	20%
Modernization	$452	$682	$202	$0	$1,337	38%
Expansion	$943	$484	$52	$0	$1,479	42%
Total Urban	**$1,783**	**$1,457**	**$264**	**$11**	**$3,515**	**100%**
Rural + Urban						
Preservation	$1,409	$381	$1,003	$502	$3,295	36%
Modernization	$452	$2,486	$710	$0	$3,648	40%
Expansion	$1,596	$570	$80	$5	$2,251	24%
Total Needs	**$3,457**	**$3,438**	**$1,792**	**$507**	**$9,194**	**100%**

Notes: (1) Expressed in base year 2008 Dollars.

Figure 3-4: 2035 Pavement Conditions with Conservative Funding Projection Funds Allocated to Preservation, Modernization and Expansion Needs

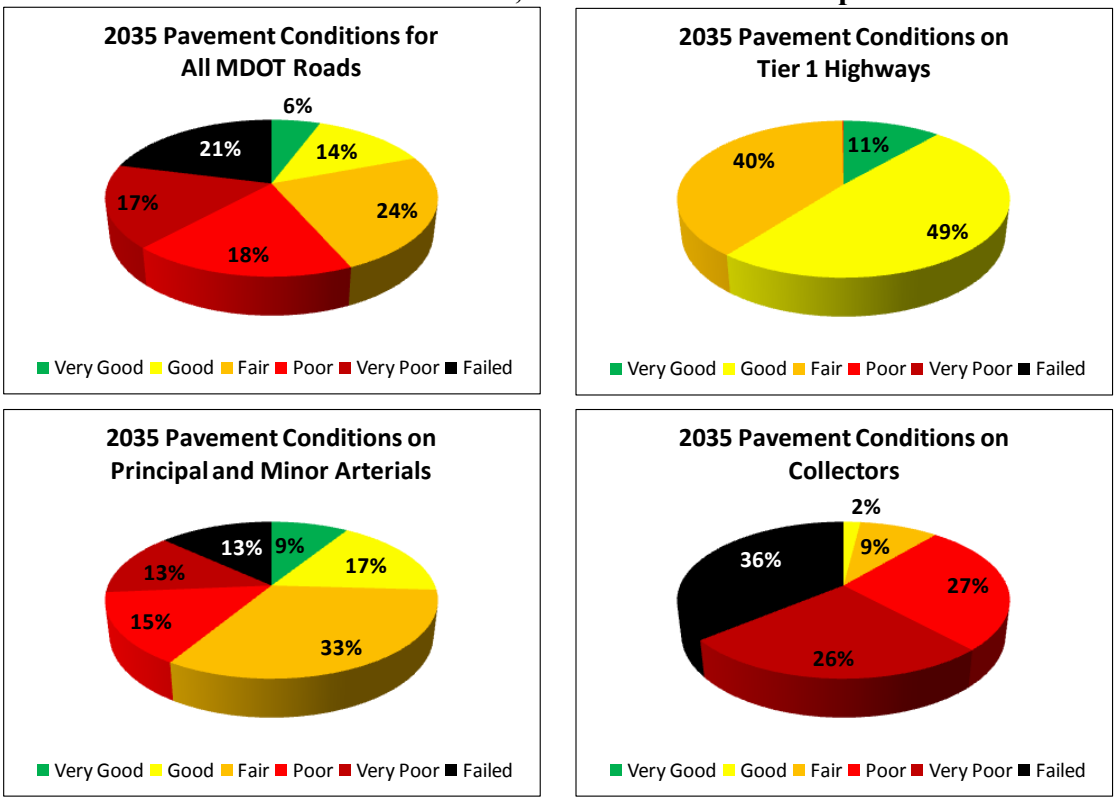


Figure 3-5: Pavement Deterioration with Scenario D

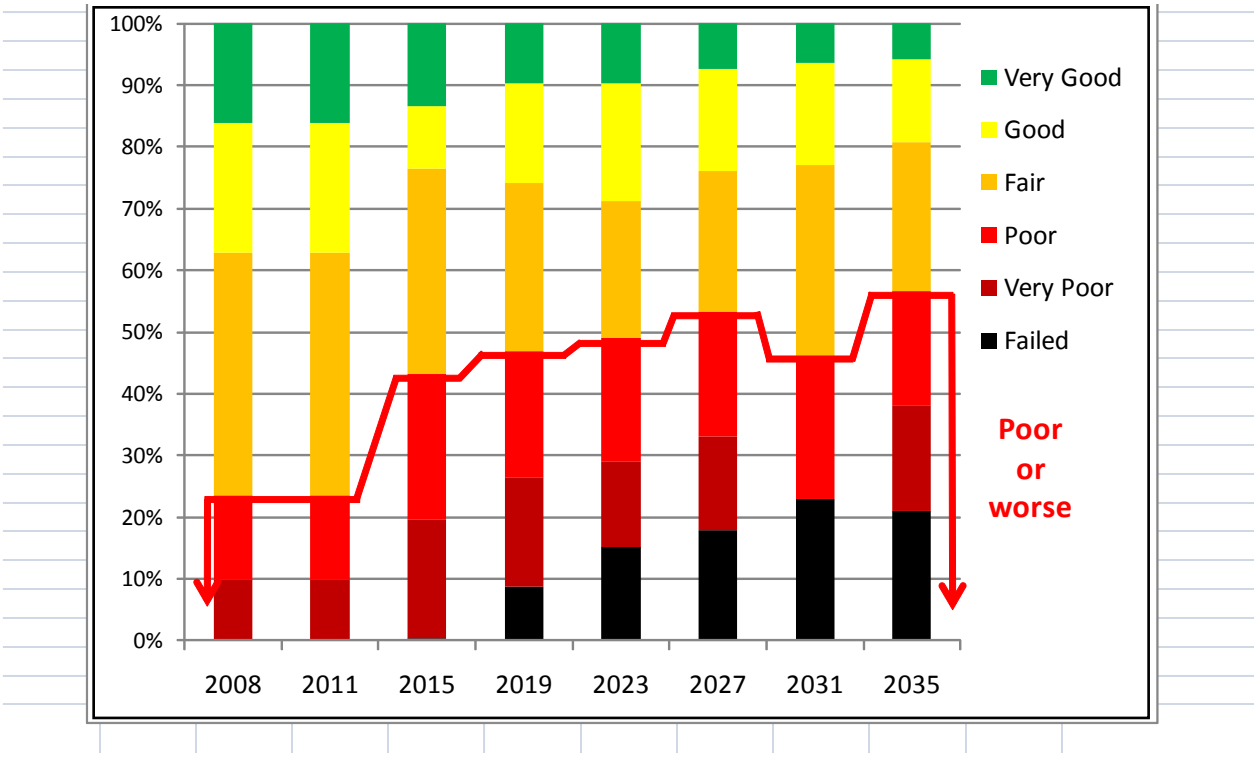


Table 3-8: Conservative Funding Allocated to Preservation and Modernization (E)

Type of Roadway Need	Roadway Pavement Needs by Functional Class [1] ($ millions)					
	Interstate and Other Freeways	Other Principal Arterials	Minor Arterials	Collectors	Total	Percent of Total
	Backlog Needs Only					
Rural						
Preservation	$108	$18	$164	$37	$327	53%
Modernization	$0	$192	$101	$0	$293	47%
Expansion	$0	$0	$0	$0	$0	0%
Total Rural	**$108**	**$210**	**$265**	**$37**	**$620**	**100%**
Urban						
Preservation	$58	$82	$3	$0	$143	32%
Modernization	$112	$175	$14	$0	$301	68%
Expansion	$0	$0	$0	$0	$0	0%
Total Urban	**$170**	**$256**	**$17**	**$0**	**$444**	**100%**
Rural + Urban						
Preservation	$166	$100	$167	$37	$469	44%
Modernization	$112	$367	$115	$0	$594	56%
Expansion	$0	$0	$0	$0	$0	0%
Total Needs	**$278**	**$466**	**$283**	**$37**	**$1,064**	**100%**
	2008 to 2035 (including Backlog Needs)					
Rural						
Preservation	$1,447	$172	$1,231	$864	$3,714	57%
Modernization	$0	$2,319	$530	$0	$2,849	43%
Expansion	$0	$0	$0	$0	$0	0%
Total Rural	**$1,447**	**$2,491**	**$1,761**	**$864**	**$6,563**	**100%**
Urban						
Preservation	$597	$350	$19	$11	$976	37%
Modernization	$486	$898	$260	$0	$1,645	63%
Expansion	$0	$0	$0	$0	$0	0%
Total Urban	**$1,083**	**$1,248**	**$279**	**$11**	**$2,621**	**100%**
Rural + Urban						
Preservation	$2,043	$523	$1,250	$875	$4,691	51%
Modernization	$486	$3,217	$791	$0	$4,494	49%
Expansion	$0	$0	$0	$0	$0	0%
Total Needs	**$2,530**	**$3,739**	**$2,040**	**$875**	**$9,184**	**100%**

Notes: (1) Expressed in base year 2008 Dollars.

Figure 3-6: 2035 Pavement Conditions with Conservative Funding Scenario E Funds Allocated to Preservation and Modernization Only

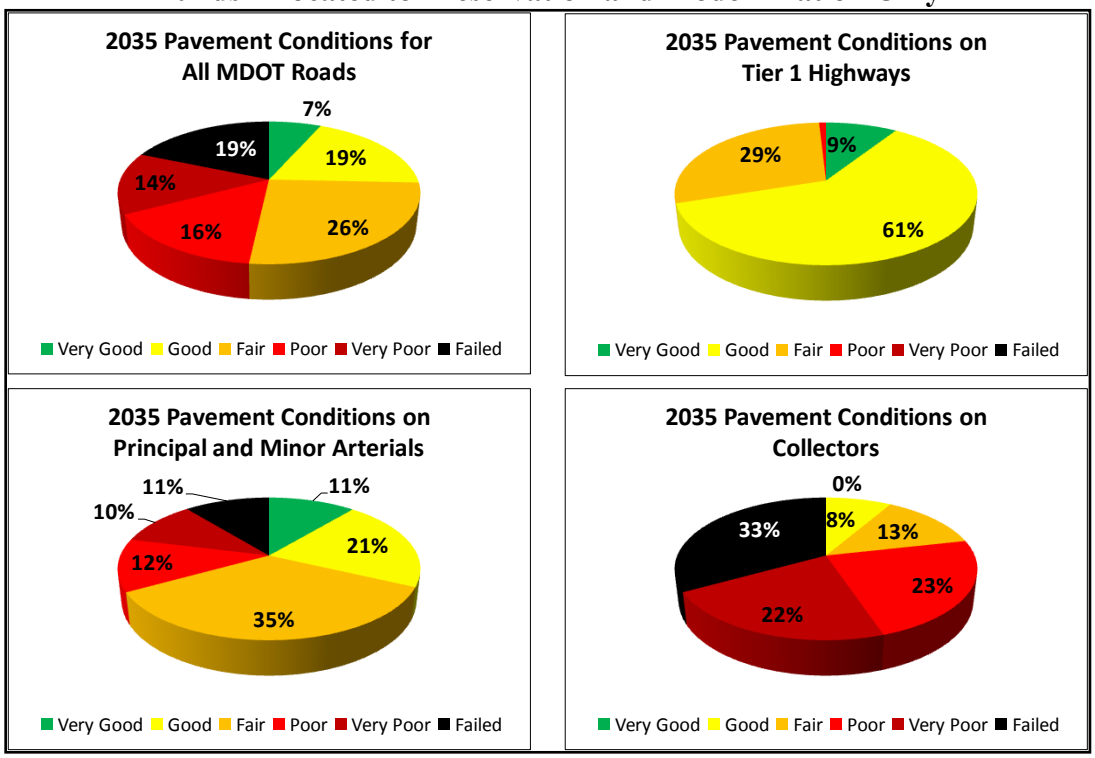
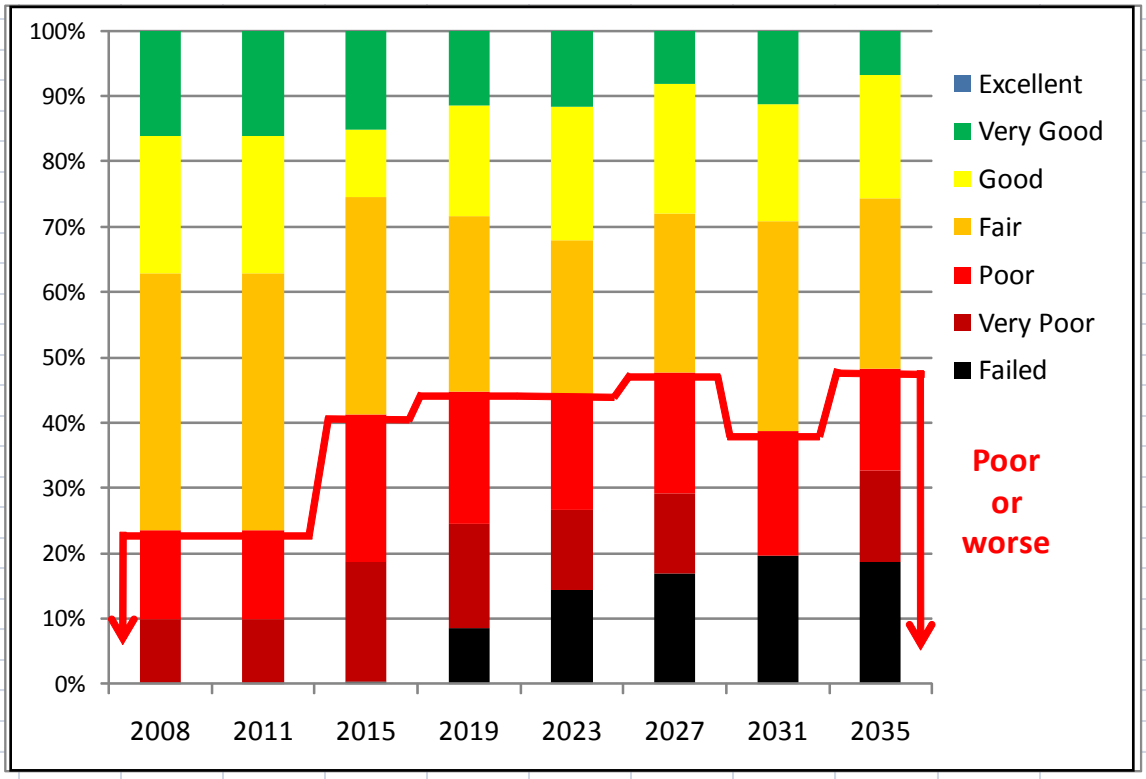


Figure 3-7: Pavement Deterioration with Scenario E



3.2.3 Level 1 Funding: Expansion on Tier I and U.S. 49 Only (F)

With the conservative funding projection and HERS allocating funding to preservation and modernization needs on all roads, as well as expansion needs on Tier I roads plus U.S. 49 between the Gulf Coast and Jackson, the allocation of funds is as shown in **Table 3-9**.

Pavement conditions in 2035 under this scenario (F) are shown in **Figure 3-8**. The deterioration of pavement condition by 4-year period is shown in **Figure 3-9**.

Table 3-9: Conservative Funding with expansion Only on Selected Highways (F)

Type of Roadway Need	Roadway Pavement Needs by Functional Class [1] ($ millions)					
	Interstate and Other Freeways	Other Principal Arterials	Minor Arterials	Collectors	Total	Percent of Total
	Backlog Needs Only					
Rural						
Preservation	$85	$18	$107	$37	$246	43%
Modernization	$0	$192	$101	$0	$293	52%
Expansion	$28	$0	$0	$0	$28	5%
Total Rural	**$113**	**$210**	**$208**	**$37**	**$567**	**100%**
Urban						
Preservation	$49	$81	$3	$0	$133	28%
Modernization	$119	$169	$13	$0	$301	63%
Expansion	$43	$0	$0	$0	$43	9%
Total Urban	**$210**	**$251**	**$16**	**$0**	**$477**	**100%**
Rural + Urban						
Preservation	$134	$99	$109	$37	$379	36%
Modernization	$119	$361	$114	$0	$594	57%
Expansion	$71	$0	$0	$0	$71	7%
Total Needs	**$323**	**$461**	**$223**	**$37**	**$1,044**	**100%**
	2008 to 2035 (including Backlog Needs)					
Rural						
Preservation	$1,052	$110	$1,028	$796	$2,986	49%
Modernization	$0	$1,900	$507	$0	$2,407	40%
Expansion	$653	$0	$0	$0	$653	11%
Total Rural	**$1,705**	**$2,010**	**$1,535**	**$796**	**$6,046**	**100%**
Urban						
Preservation	$388	$290	$13	$11	$702	22%
Modernization	$452	$824	$213	$0	$1,489	48%
Expansion	$943	$0	$0	$0	$943	30%
Total Urban	**$1,783**	**$1,114**	**$226**	**$11**	**$3,134**	**100%**
Rural + Urban						
Preservation	$1,440	$400	$1,041	$806	$3,687	40%
Modernization	$452	$2,723	$720	$0	$3,896	42%
Expansion	$1,596	$0	$0	$0	$1,596	17%
Total Needs	**$3,488**	**$3,124**	**$1,761**	**$806**	**$9,179**	**100%**

Notes: (1) Expressed in base year 2008 Dollars.

Figure 3-8: Pavement Conditions with Scenario F

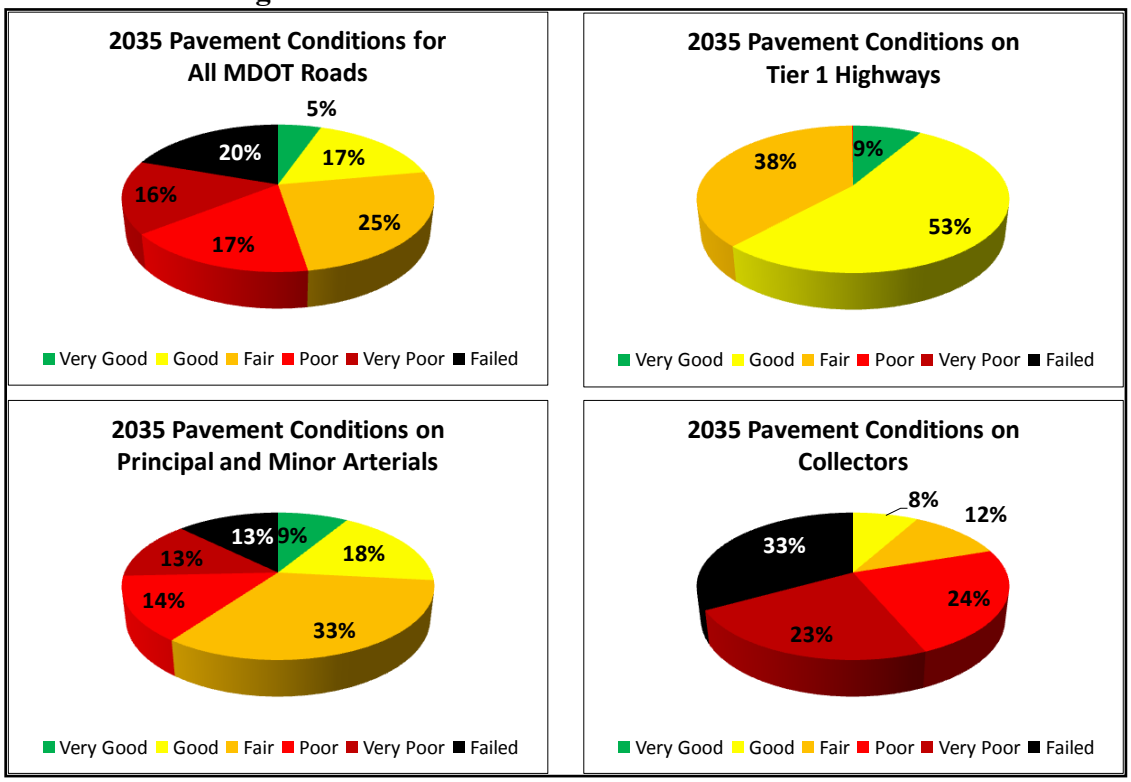
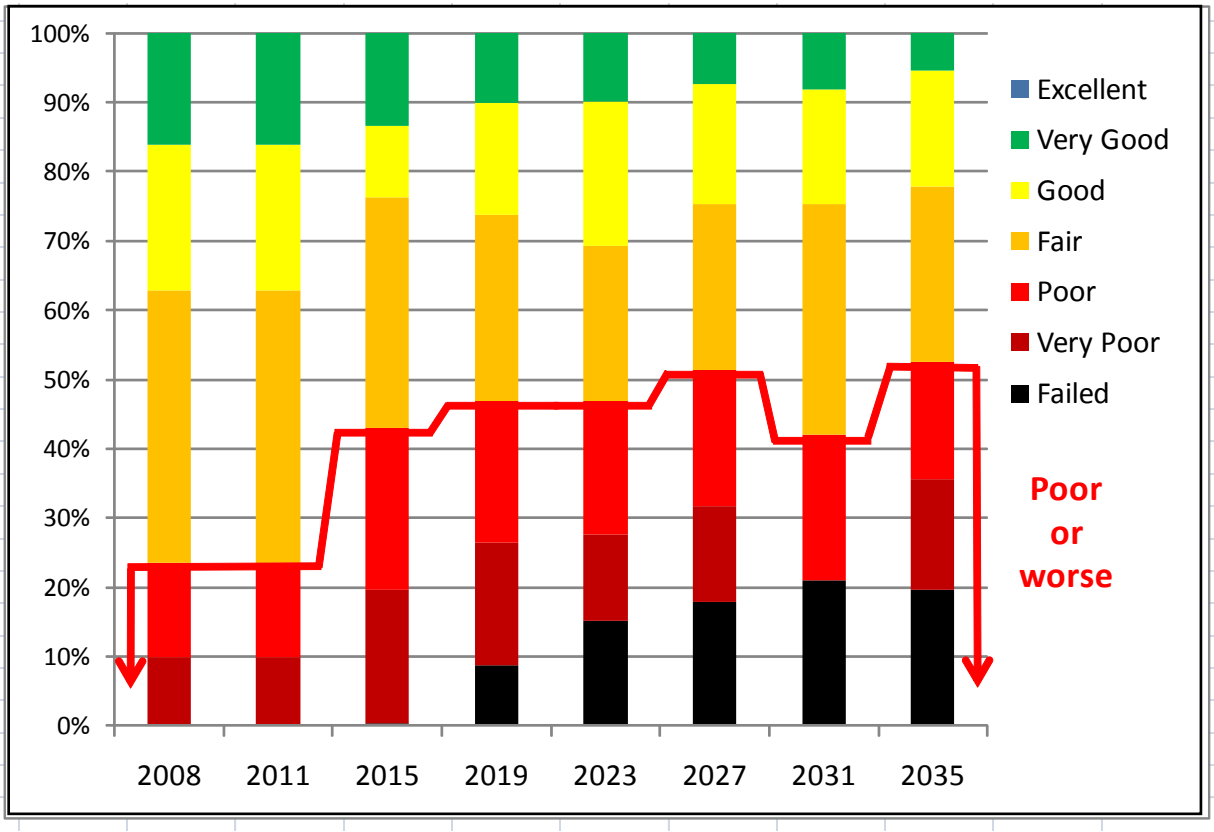


Figure 3-9: Pavement Deterioration with Scenario F



3.2.4 Conservative Funding Scenarios Summary

The estimated allocation of funds for Scenarios D, E, and F with the conservative level of projected funding is summarized in **Table 3-10.**

Table 3-10: Highway Expenditures with Three Conservative Funding Scenarios

Improvement Category	Conservative Funding Scenarios		
	D	E	F
Expansion	$2,251	$0	$1,596
Modernization	$3,648	$4,494	$3,896
Preservation	$3,295	$4,691	$3,687
Total	**$9,194**	**$9,184**	**$9,179**
Average Per year	$328	$328	$328

Note: Needs in Constant 2008 Dollars (millions)

D. All Types of needs: Preservation, Modernization, and Expansion

E. Modernization and Preservation needs only

F. Modernization and Preservation needs plus Expansion needs on Tier 1 and US 49

3.3 Highway Needs with Aggressive Funding Projection

The funding available in each 4-year period for the Aggressive Funding Projection is show in **Table 3-11**.

Table 3-11: Aggressive Funding Allocated to Highway Needs

Projected Funding	Seven 4-year Funding Periods						
	08-11	12-15	16-19	20-23	24-27	28-31	32-35
Funding Level 2	$1,739	$1,512	$1,557	$1,609	$1,668	$1,734	$1,808
Average per year	$435	$378	$389	$402	$417	$433	$452
	Total Funds over 28 years			**$11,627**	**(46 % of Full Needs)**		

Funds in Millions of Constant 2008 Dollars

3.3.1 Level 2 Funding: Preservation, Modernization, and Expansion (G)

With the aggressive funding projection and HERS allocating funding as cost-effectively as possible among all three categories of needs, the allocation of funds by type of roads, category of needs and backlog/accruing is shown in **Table 3-12**. Modernization needs would use the highest share of funds at 40 percent, with preservation and expansion accounting for 36 and 24 percent, respectively.

With this allocation of funds 2035 pavement conditions by road type are projected to be as shown in **Figure 3-10.** The deterioration of pavement condition by 4-year period is shown in **Figure 3-11**.

Table 3-12: Aggressive Funding Level Allocated to Needs of All Types (G)

Type of Roadway Need	Roadway Pavement Needs by Functional Class [1] ($ millions)					
	Interstate and Other Freeways	Other Principal Arterials	Minor Arterials	Collectors	Total	% of Total
	Backlog Needs Only					
Rural						
Preservation	$85	$18	$131	$34	$268	46%
Modernization	$0	$188	$101	$0	$289	49%
Expansion	$28	$0	$0	$0	$28	5%
Total Rural	**$113**	**$206**	**$232**	**$34**	**$584**	**100%**
Urban						
Preservation	$49	$84	$3	$0	$136	27%
Modernization	$119	$166	$14	$0	$299	60%
Expansion	$43	$17	$4	$0	$64	13%
Total Urban	**$210**	**$267**	**$21**	**$0**	**$499**	**100%**
Rural + Urban						
Preservation	$134	$102	$134	$34	$404	37%
Modernization	$119	$354	$115	$0	$588	54%
Expansion	$71	$17	$4	$0	$91	8%
Total Needs	**$323**	**$473**	**$253**	**$34**	**$1,083**	**100%**
	2008 to 2035 (including Backlog Needs)					
Rural						
Preservation	$1,395	$167	$1,201	$803	$3,565	49%
Modernization	$0	$2,422	$530	$37	$2,989	41%
Expansion	$512	$117	$60	$5	$693	10%
Total Rural	**$1,907**	**$2,707**	**$1,791**	**$844**	**$7,248**	**100%**
Urban						
Preservation	$520	$389	$15	$22	$946	22%
Modernization	$473	$973	$277	$0	$1,723	39%
Expansion	$1,007	$625	$72	$0	$1,704	39%
Total Urban	**$1,999**	**$1,987**	**$364**	**$22**	**$4,373**	**100%**
Rural + Urban						
Preservation	$1,914	$557	$1,215	$825	$4,511	39%
Modernization	$473	$3,395	$807	$37	$4,712	41%
Expansion	$1,518	$742	$132	$5	$2,397	21%
Total Needs	**$3,906**	**$4,694**	**$2,155**	**$866**	**$11,621**	**100%**

Notes: (1) Expressed in base year 2008 Dollars.

Figure 3-10: 2035 Pavement Conditions with Aggressive Funding Projection Funds Allocated to Preservation, Modernization and Expansion Needs

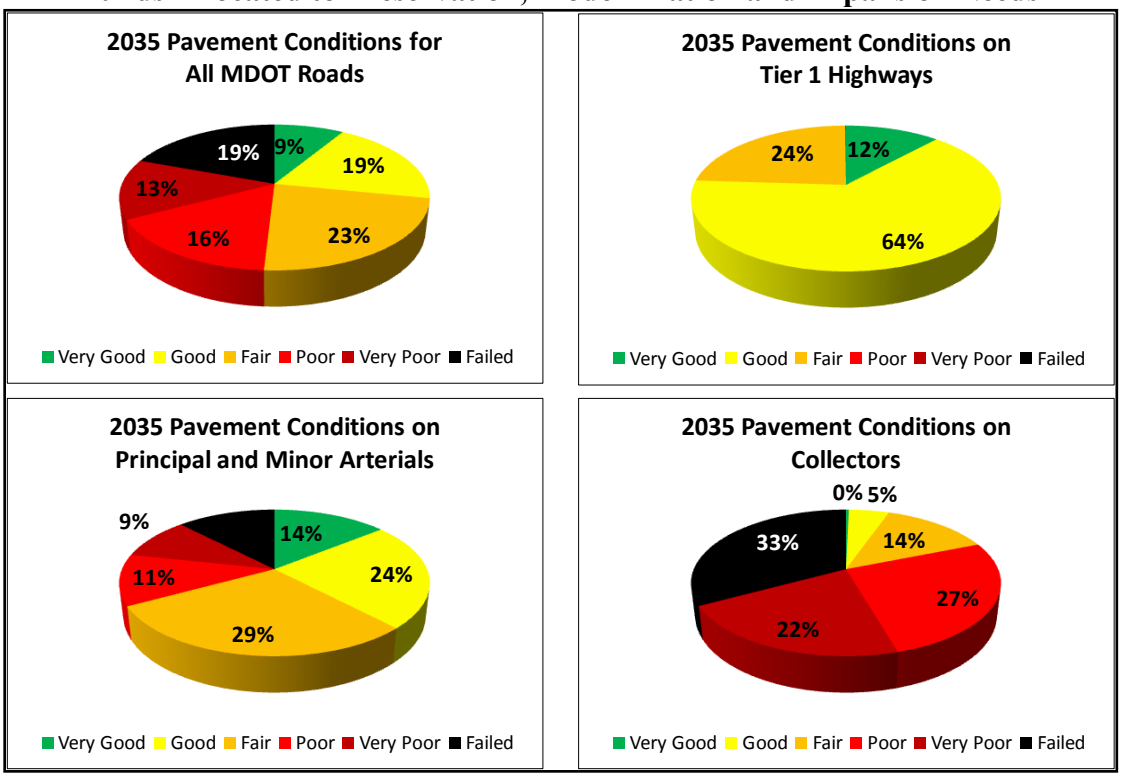
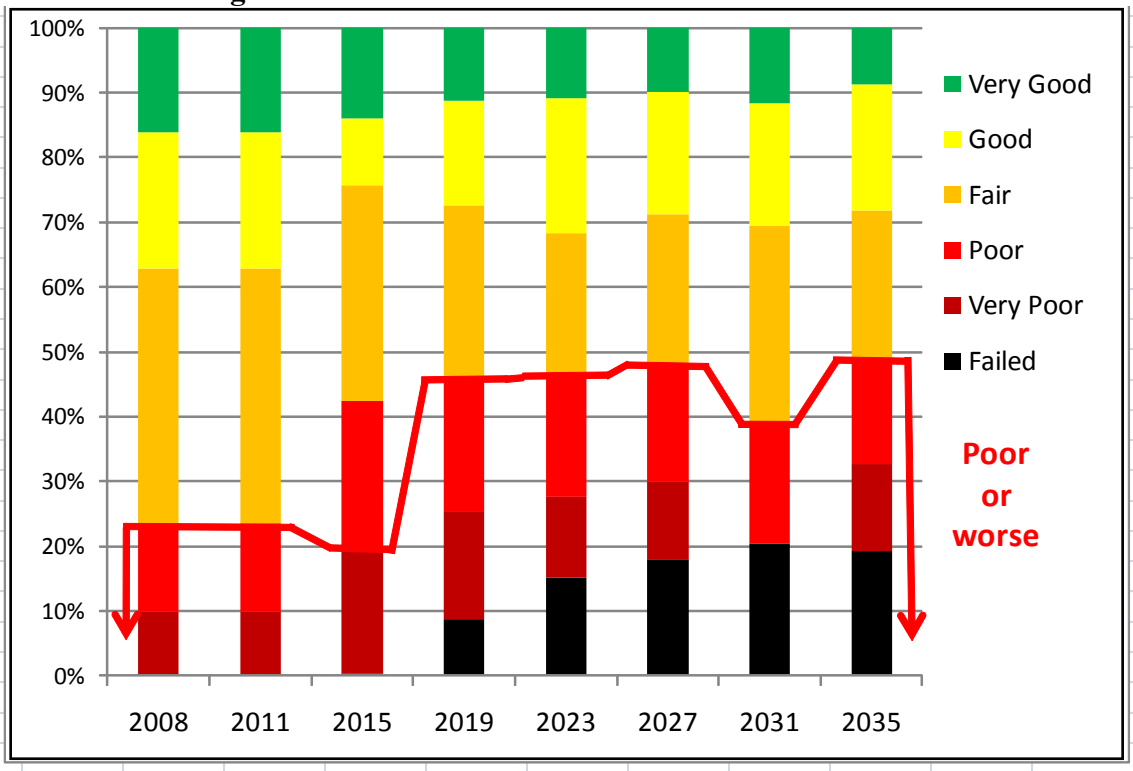


Figure 3-11: Pavement Deterioration with Scenario G



3.3.2 Level 2 Funding: Preservation and Modernization Only (H)

With the aggressive funding projection and HERS allocating funding to meet only preservation and modernization needs, the allocation of funds is as shown in **Table 3-13**. With no funds being used for expansion needs, funds would be evenly split between preservation (52 percent) and modernization needs (48 percent).

With this allocation of funds, by 2035 pavement conditions are projected to be as shown in **Figure 3-12**. The deterioration of pavement condition by 4-year period is shown in **Figure 3-13**.

Table 3-13: Aggressive Funding Allocated to Preservation and Modernization (H)

Type of Roadway Need	Roadway Pavement Needs by Functional Class [1] ($ millions)					
	Interstate and Other Freeways	Other Principal Arterials	Minor Arterials	Collectors	Total	% of Total
	Backlog Needs Only					
Rural						
Preservation	$112	$18	$181	$37	$348	54%
Modernization	$0	$198	$101	$0	$299	46%
Expansion	$0	$0	$0	$0	$0	0%
Total Rural	**$112**	**$216**	**$282**	**$37**	**$647**	**100%**
Urban						
Preservation	$58	$82	$3	$0	$143	32%
Modernization	$112	$175	$14	$0	$301	68%
Expansion	$0	$0	$0	$0	$0	0%
Total Urban	**$170**	**$256**	**$17**	**$0**	**$444**	**100%**
Rural + Urban						
Preservation	$170	$100	$184	$37	$491	45%
Modernization	$112	$372	$115	$0	$600	55%
Expansion	$0	$0	$0	$0	$0	0%
Total Needs	**$282**	**$472**	**$299**	**$37**	**$1,090**	**100%**
	2008 to 2035 (including Backlog Needs)					
Rural						
Preservation	$1,646	$187	$1,581	$1,264	$4,678	56%
Modernization	$0	$2,931	$637	$37	$3,605	44%
Expansion	$0	$0	$0	$0	$0	0%
Total Rural	**$1,646**	**$3,118**	**$2,218**	**$1,300**	**$8,282**	**100%**
Urban						
Preservation	$771	$474	$23	$22	$1,291	39%
Modernization	$505	$1,194	$307	$0	$2,006	61%
Expansion	$0	$0	$0	$0	$0	0%
Total Urban	**$1,276**	**$1,669**	**$331**	**$22**	**$3,297**	**100%**
Rural + Urban						
Preservation	$2,417	$662	$1,604	$1,286	$5,969	52%
Modernization	$505	$4,125	$944	$37	$5,611	48%
Expansion	$0	$0	$0	$0	$0	0%
Total Needs	**$2,922**	**$4,787**	**$2,548**	**$1,323**	**$11,580**	**100%**

Notes: (1) Expressed in base year 2008 Dollars.

Figure 3-12: 2035 Pavement Conditions with Aggressive Funding Scenario H Funds Allocated to Preservation and Modernization Only

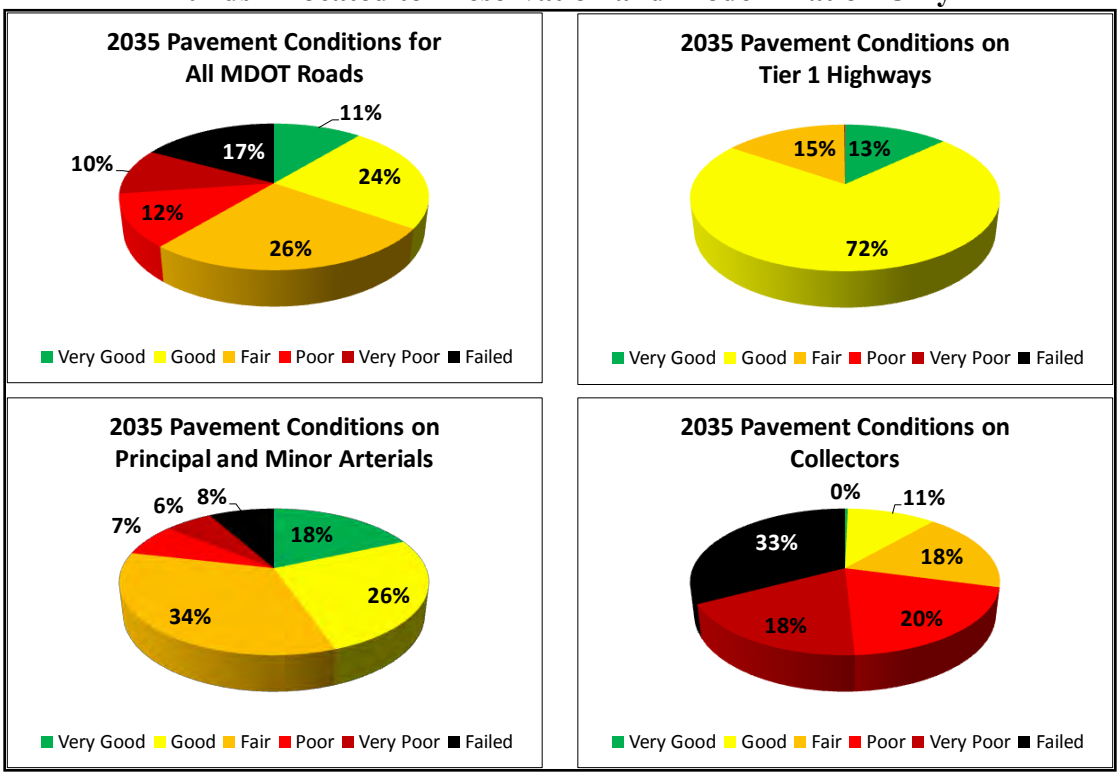
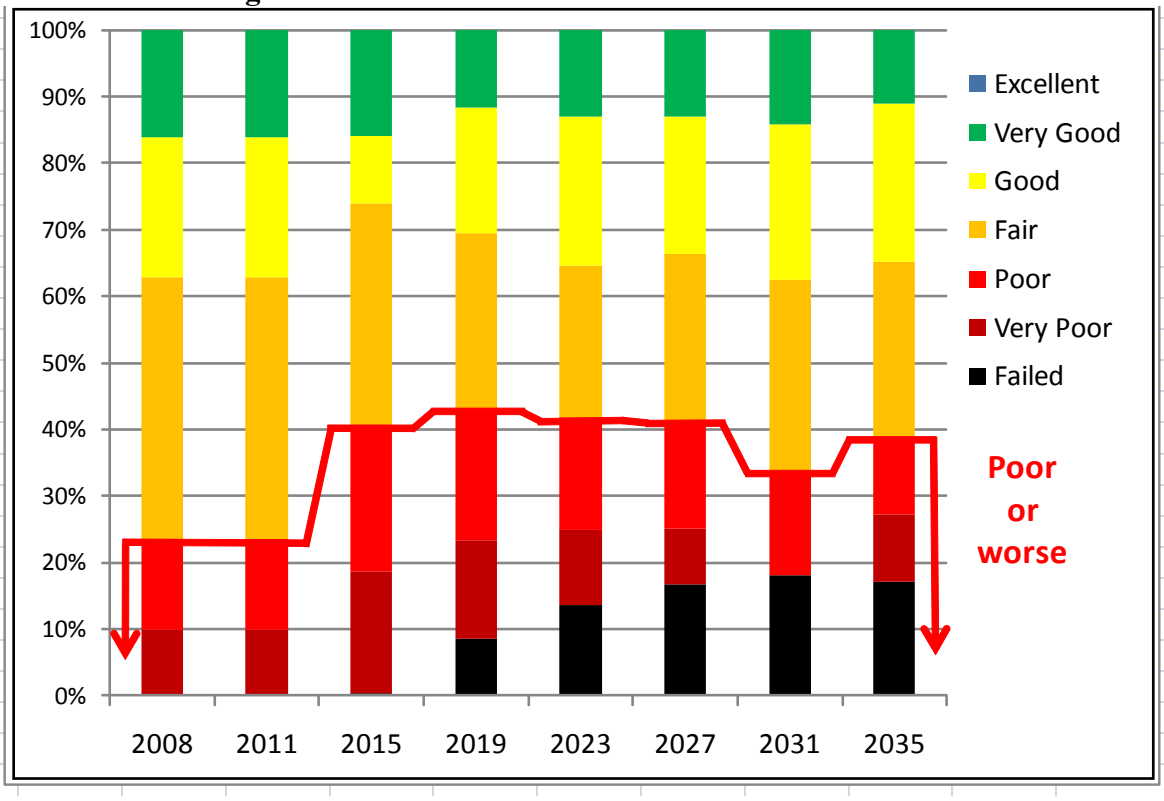


Figure 3-13: Pavement Deterioration with Scenario H



3.3.3 Level 2 Funding: Expansion on Tier I and U.S. 49 Only (I)

With the aggressive funding projection and HERS allocating funding to preservation and modernization needs on all roads, as well as expansion needs on Tier I roads plus U.S. 49 between the Gulf Coast and Jackson, the allocation of funds is as shown in **Table 3-14**.

Pavement conditions in 2035 under this scenario (I) are shown in **Figure 3-14**. The deterioration of pavement condition by 4-year period is shown in **Figure 3-15**.

Table 3-14: Aggressive Funding with Expansion Only on Selected Highways (I)

Type of Roadway Need	Roadway Pavement Needs by Functional Class [1] ($ millions)					
	Interstate and Other Freeways	Other Principal Arterials	Minor Arterials	Collectors	Total	% of Total
	Backlog Needs Only					
Rural						
Preservation	$85	$18	$131	$37	$271	46%
Modernization	$0	$192	$101	$0	$293	50%
Expansion	$28	$0	$0	$0	$28	5%
Total Rural	**$113**	**$210**	**$232**	**$37**	**$591**	**100%**
Urban						
Preservation	$49	$82	$3	$0	$133	28%
Modernization	$119	$170	$14	$0	$303	63%
Expansion	$43	$0	$0	$0	$43	9%
Total Urban	**$210**	**$252**	**$17**	**$0**	**$480**	**100%**
Rural + Urban						
Preservation	$134	$100	$134	$37	$404	38%
Modernization	$119	$362	$115	$0	$596	56%
Expansion	$71	$0	$0	$0	$71	7%
Total Needs	**$323**	**$462**	**$249**	**$37**	**$1,071**	**100%**
	2008 to 2035 (including Backlog Needs)					
Rural						
Preservation	$1,439	$187	$1,295	$948	$3,869	51%
Modernization	$0	$2,595	$530	$37	$3,162	42%
Expansion	$588	$0	$0	$0	$588	8%
Total Rural	**$2,027**	**$2,782**	**$1,825**	**$985**	**$7,619**	**100%**
Urban						
Preservation	$600	$458	$23	$22	$1,104	28%
Modernization	$473	$1,132	$298	$0	$1,903	48%
Expansion	$989	$0	$0	$0	$989	25%
Total Urban	**$2,062**	**$1,591**	**$321**	**$22**	**$3,996**	**100%**
Rural + Urban						
Preservation	$2,039	$646	$1,318	$971	$4,973	43%
Modernization	$473	$3,727	$828	$37	$5,065	44%
Expansion	$1,577	$0	$0	$0	$1,577	14%
Total Needs	**$4,089**	**$4,373**	**$2,146**	**$1,007**	**$11,615**	**100%**

Notes: (1) Expressed in base year 2008 Dollars.

Figure 3-14: Pavement Conditions with Scenario I

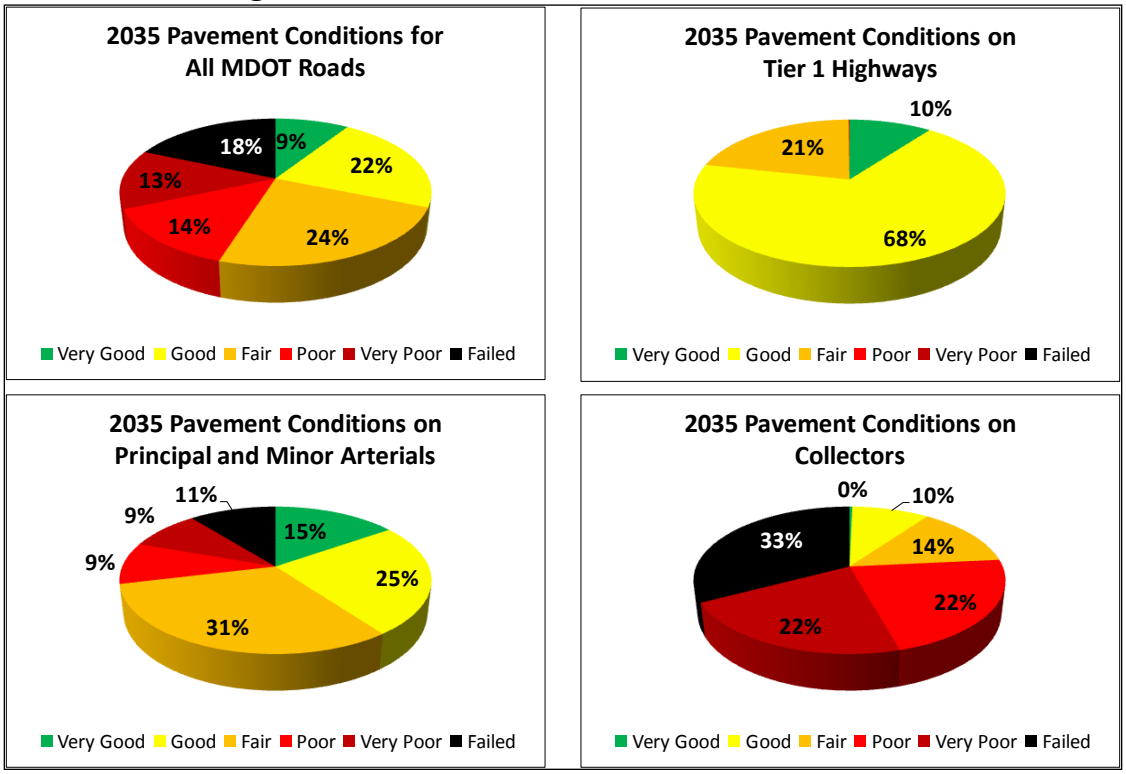
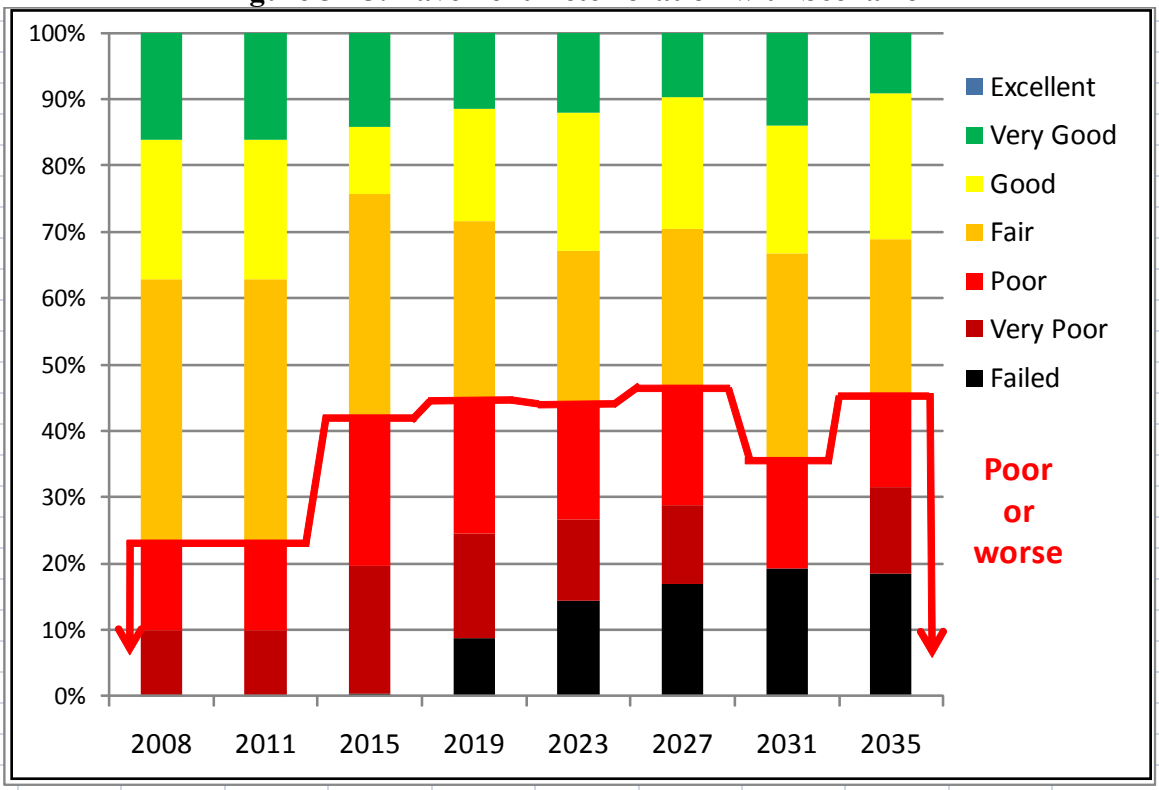


Figure 3-15: Pavement Deterioration with Scenario I



3.3.4 Aggressive Funding Scenarios Summary

The estimated allocation of funds for Scenarios D, E, and F with the conservative level of projected funding is summarized in **Table 3-15.**

Table 3-15: Highway Expenditures with Three Aggressive Funding Scenarios

Improvement Category	Aggressive Funding Scenarios		
	G	H	I
Expansion	$2,397	$0	$1,577
Modernization	$4,712	$5,611	$5,065
Preservation	$4,511	$5,969	$4,973
Total	**$11,621**	**$11,580**	**$11,615**
Average Per year	$415	$414	$415

Note: Needs in Constant 2008 Dollars (millions)

G. All Types of needs: Preservation, Modernization, and Expansion

H. Modernization and Preservation needs only

I. Modernization and Preservation needs plus Expansion needs on Tier 1 and US 49

4. BRIDGE NEEDS METHODOLOGY

Needs for bridges on the state's highway system were assessed using FHWA's NBIAS Tool – National Bridge Investment Analysis System.

The NBIAS is an investment analysis tool used to analyze bridge repair, rehabilitation, and functional improvement investment needs. The system can be used to examine the backlog of needs, in dollars and number of bridges; distribution of work done, in dollars and number of bridges; aggregate and user benefits; benefit-cost ratios for work performed; and physical measures of bridge conditions. Outcomes can be presented by type of work, functional classification, whether the bridges are part of the National Highway System (NHS), and/or whether the bridges are part of the Strategic Highway Network.

NBIAS is based on the same analytical framework as the Pontis bridge program first developed by the Federal Highway Administration (FHWA) in 1989 and subsequently taken over by the American Association of State Highway and Transportation Officials (AASHTO). AASHTO now owns and licenses Pontis to over 50 State transportation departments and other agencies. Pontis provides the bridge engineer with the tools to conduct detailed analysis of the performance of bridges. In order to perform analysis at such a detailed level, Pontis requires data on over 100 elements pertaining to each individual bridge.

NBIAS incorporates economic forecasting analysis tools to provide budget and planning staff with the ability to forecast the multiyear funding needs required to meet user-selected performance metrics over the length of a user specified performance period. NBIAS is modified

to work with bridge conditions as reported by the States for the National Bridge Inspection System as well as the element/condition state inspection regime used in Pontis.

4.1 Identifying Bridge needs

Bridge needs were identified through the analysis of the National Bridge Inventory (NBI) dataset. This dataset contains all bridges within a given state that are longer than 20 feet. NBIAS analyzes bridge structures only and removes culvert records from the NBI dataset. NBIAS can only predict and maintain needs for existing bridges. New bridge location analysis has to be performed outside of NBIAS and added to NBIAS results.

NBIAS uses a parameter table to determine if a bridge is under the minimum tolerable conditions for a structure based on roadway functional class, NHS status, or traffic level. If the bridge is deemed to be deficient by falling below any given level, then an action is required. This action will be given a cost to improve, determined from unit cost data. Based on the available funds and the project's ranking related to the cost/benefit ratio, an action will be implemented or passed over to the next year of analysis.

While sufficiency rating is not a deficiency level found in the minimum tolerable conditions, it is a valuable measure of the bridges well-being. The sufficiency rating is a calculated numerical value that is used to determine eligibility of a structure for Federal funding. Results from the sufficiency rating formula are percentages between 0 and 100:

- A bridge with a sufficiency rating of 80 or less is eligible for Federal bridge rehabilitation funding.
- A bridge with a sufficiency rating of 50 or less is eligible for Federal bridge replacement funding.

The sufficiency rating doesn't necessarily indicate a bridge's ability to accommodate certain loads or traffic volumes, but it does help determine which bridges may need repair or replacement.

The objective of NBIAS is to elevate the maximum number of bridges above the sufficiency rating of 50, year by year. This will give a state the most efficient and reliable system for the investment dollar. NBIAS uses the Pontis model to help determine the deterioration of the bridge over time, thus lowering the sufficiency rating, and if the bridge falls into a structurally deficient or functionally obsolete status.

Like the sufficiency rating, both structurally deficient and functionally obsolete classifications are used as a priority status for Federal bridge rehabilitation and replacement funding. According to the FHWA:

- A bridge is **structurally deficient** if the load-carrying elements are in diminished condition due to deterioration and/or damage. A bridge may also be structurally deficient, for example, if the waterway opening is "extremely insufficient" or causes "intolerable traffic interruption". Structurally deficient bridges are not unsafe, but could require traffic limitations.
- The term **functionally obsolete** deals with geometric deficiencies (lane width, clearances, etc.) when compared to current design standards and traffic levels.

A bridge can be both structurally deficient and functionally obsolete, but in this case will be classified by NBIAS as just structurally deficient. A bridge is not dangerous simply because it is either structurally deficient or functionally obsolete, but it will be more likely to receive an improvement to correct any deficiencies.

4.2 NBIAS Parameters

In order to identify those bridges in need of improvement, the NBIAS relies on input tables from the user. These include the improvement policy criteria for when a bridge should be:

- Widened,
- Raised, or
- Strengthened.

The criteria, also referred to as Minimum Tolerable Conditions (MTC), are specific to each state and contain the legal standards for each bridge type, as defined by roadway functional class, National Highway System (NHS) status, and Annual Average Daily Traffic (AADT) class. The deficiency (MTC) values trigger NBIAS to take an improvement action when a bridge falls below the respective structural standard, while design values are the new bridge dimensions NBIAS will use for a replacement bridge. Design standards are the engineering specifications for a new bridge.

Values addressed in the table include design and legal standards for lane and shoulder widths, as well as the swell factor, which is a cost-increase coefficient during bridge replacement to account for additional costs that accompany a replacement. These may include reconstructing approach roadway or improving the support columns. All values shown in **Table 4-1** (rural bridges) and **Table 4-2** (urban bridges) can be modified by the user to reflect state specific preferences. The measurement values in these tables are feet, although NBIAS stores all values using the metric system.

Table 4-1: Rural Bridge Parameters (feet)

Functional Class	AADT Class	Deficiency					Design			
		Right		Left						
		Lane Width	Shlder Width	Lane Width	Shlder Width	Vert Clear	Lane Width	Shlder Width	Vert Clear	Swell
Rural Interstates	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
Rural Principal Arterials	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	6.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
Rural Minor Arterials	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	6.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
Rural Major Collectors	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	8.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	8.0	16.5	1.5
Rural Minor Collectors	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	8.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	8.0	16.5	1.5
Rural Local Roads	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5

Source: Mississippi Department of Transportation

Table 4-2: Urban Bridge Parameters (feet)

Functional Class	AADT Class	Deficiency					Design			
		Right		Left						
		Lane Width	Shlder Width	Lane Width	Shlder Width	Vert Clear	Lane Width	Shlder Width	Vert Clear	Swell
Urban Interstates	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
Urban Freeway	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	9.0	16.5	1.5
Urban Principal Arterials	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	6.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
Urban Minor Arterials	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	6.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	10.0	16.5	1.5
Urban Collectors	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	8.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	8.0	16.5	1.5
Urban Local Roads	<= 400	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	401-1000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	1001-2000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	2001-4000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5
	> 4000	11.0	1.0	11.0	1.0	14.1	12.0	4.0	16.5	1.5

Source: Mississippi Department of Transportation

4.3 Unit Costs

Bridge unit costs are used to determine the improvement cost total for each action taken (or potentially taken) by NBIAS. **Table 4-3** contains user cost information required for the improvement models. These values include activities such as widening, raising, strengthening, and replacing a bridge. MDOT applied the same costs independent of the functional class of the roadway. An improvement cost within NBIAS is determined by multiplying the unit cost for the improvement type by deck area that will be improved, considering the change in dimensions that may result from the improvement for widening or replacing a bridge. These costs do not necessarily include sub-structure improvements, utility relocation, or right-of-way acquisition.

Table 4-3: Unit Cost per Improvement Type

Unit Cost per Square Foot of Deck ($2008)			
Replace	**Widen**	**Raise**	**Strengthen**
$ 126.00	$ 126.00	$ 63.00	$ 63.00

Source: Mississippi Department of Transportation, Bridges Division

4.4 Types of Bridge needs

As with highway needs, for the purpose of this report, bridge needs have been presented in terms of three categories. These categories are comparable, though not identical, to those for highways.

Highway Needs	Bridge Needs	Description of Bridge Needs
Preservation	Rehabilitation	Federally eligible maintenance, repair, and rehabilitation
Modernization	Improvement	Raising, widening, and strengthening
Expansion	Replacement	Replacement of Bridge

The bridge needs types for rehabilitation and improvement are clearly similar in nature to their highway counterparts of preservation and modernization. However, while the bridge need for replacement is the appropriate type of improvement required when the existing bridge is insufficiently wide to handle an expanded roadway with additional travel lanes, bridges may need to be replaced in other circumstances as well. When the age and reoccurring maintenance of a given bridge overshadows the cost to replace it, a new bridge will be recommended since the long-term benefit/cost ratio of the replacement is better. This applies also to improvement needs. When a potential improvement action is determined, for example raising a bridge that has clearance deficiencies, NBIAS will consider the long-term impacts and the potential benefits that could be realized if the bridge were to be replaced. If the long-term benefit/cost ratio of

replacement is just as viable (or better) than the long-term benefit/cost for the respective rehabilitation or improvement action, NBIAS will replace the bridge.

4.5 Existing Bridge Conditions

The condition of existing bridges in Mississippi is defined by the 2008 NBI database, which contains records for 13,627 bridges. **Table 4-4** shows the number of bridges throughout the state by functional classification of the roadway it carries.

Table 4-4: Number of Bridges Statewide by Functional Class

Functional Classification		Count		
Rural	Interstate	346	12,399	13,627
Rural	Principal Arterial	1,052		
Rural	Minor Arterial	926		
Rural	Major Collector	3,038		
Rural	Minor Collector	640		
Rural	Local	6,397		
Urban	Interstate	259	1,224	
Urban	Expressway	96		
Urban	Principal Arterial	270		
Urban	Minor Arterial	132		
Urban	Collector	201		
Urban	Local	266		
Undefined		4	4	

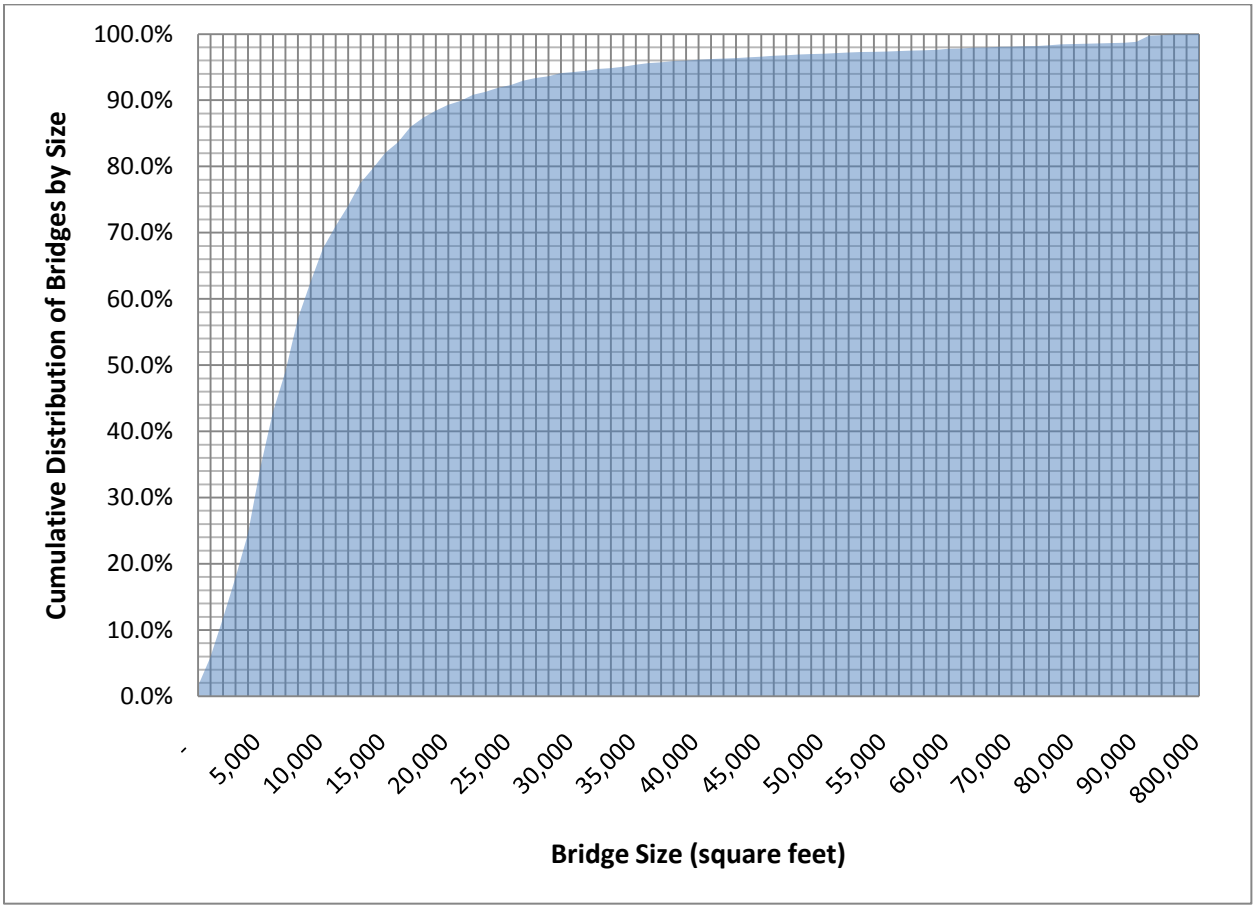
For this study, the state owned bridges were extracted from the NBI file. Only those bridges owned by the state highway agency, MDOT, were analyzed. These bridges totaled 4,227 or 31 percent of all Mississippi bridges in the 2008 NBI database. **Table 4-5** shows the number of MDOT bridges by functional classification.

Table 4-5: Number of State Owned Bridges by Functional Class

Functional Classification		Count		
Rural	Interstate	346	3,518	4,227
Rural	Principal Arterial	1,050		
Rural	Minor Arterial	916		
Rural	Major Collector	995		
Rural	Minor Collector	37		
Rural	Local	174		
Urban	Interstate	259	709	
Urban	Expressway	96		
Urban	Principal Arterial	229		
Urban	Minor Arterial	52		
Urban	Collector	40		
Urban	Local	33		

These bridges vary in size of deck area from 440 sq. ft. to more than 900,000 sq. ft. The largest of these is a 4-mile long bridge along I-10, for both eastbound and westbound lanes, that crosses the Pascagoula River. The great majority of bridges lie towards the lower end of this size range, with 74 percent of bridges being less than 12,000 sq. ft. in deck area, as shown in **Figure 4-1**.

Figure 4-1: Distribution of Bridge Sizes



Existing bridge conditions are summarized in **Table 4-6**. The 356 bridges considered structurally deficient represent 8.4 percent of the total, but only 3.2 percent of the deck area of all bridges. This implies that many of these bridges are among the smaller bridges in the State. On the other hand, the 779 functionally obsolete bridges represent 18.4 percent of all bridges and 12.1 percent of total deck area. This means the functionally obsolete bridges are on average almost twice the size of the structurally deficient bridges.

Table 4-6: Existing Bridge Conditions

Bridge Condition	Number of Bridges	Percent of Bridges	Percent of Deck Area
Sufficiency Rating (1-100)			
80 to 100	2,739	64.8%	78.4%
50 to 80	1,049	24.9%	17.3%
25 to 50	298	7.0%	2.9%
0 to 25	141	3.3%	1.4%
Total Bridges	**4,227**	**100.0%**	**100.%**
Structurally Deficient	356	8.4%	3.2%
Functionally Obsolete	779	18.4%	12.1%

As stated previously, bridges can be both structurally deficient and functionally obsolete, but will be classified by NBIAS as just structurally deficient. A bridge is not dangerous simply because it is either structurally deficient or functionally obsolete, but that bridge will be more likely to receive an improvement action to correct any deficiencies.

Over three-fourths of the bridges (75.1 percent) have a sufficiency rating (SR) of 75 or better, while 10.4 percent have an SR less than 50. The percentage of deck area within the top sufficiency rating category is 85.8 percent. This can be interpreted that larger bridges are in better condition, on average, than the universe of all bridges.

This inference is better illustrated by graphing the individual bridges. The existing sufficiency rating and bridge size for individual bridges are shown in **Figure 4-2** for bridges with a deck area up to 200,000 sq ft and in **Figure 4-3** for larger bridges (200,000 sq ft to 1,000,000 sq ft). The maximum possible value of sufficiency rating is 100.

Figure 4-2 shows the distribution of bridges and how most increase in sufficiency rating as they increase in size. This is understandable as the larger bridges are likely important connectors along frequently traveled roadways that regularly see improvements and maintenance to insure reliability. From this graphic, only a few points stand out and have been highlighted as red points. Those points are bridges that are approaching or below the sufficiency rating of 50 and above 40,000 sq ft. in size.

The existing sufficiency ratings are shown in two separate figures in order to highlight some of the larger bridges in Mississippi. These bridges, the largest eleven in the state, are above 200,000 sq ft in total bridge area. As Figure 4-3 shows, these bridges are in good condition with all eleven at or above a 74 percent sufficiency rating. The two largest bridges are the I-10 bridges across the Pascagoula River in Jackson County. The east and west bound bridges each represent an independent structure in the NBI file and both have a sufficiency rating of 92 in the initial year. Therefore, the points fall on top of each other in the chart and appear to be a single point.

Figure 4-2: Sufficiency Rating and Bridge Size of Individual Bridges

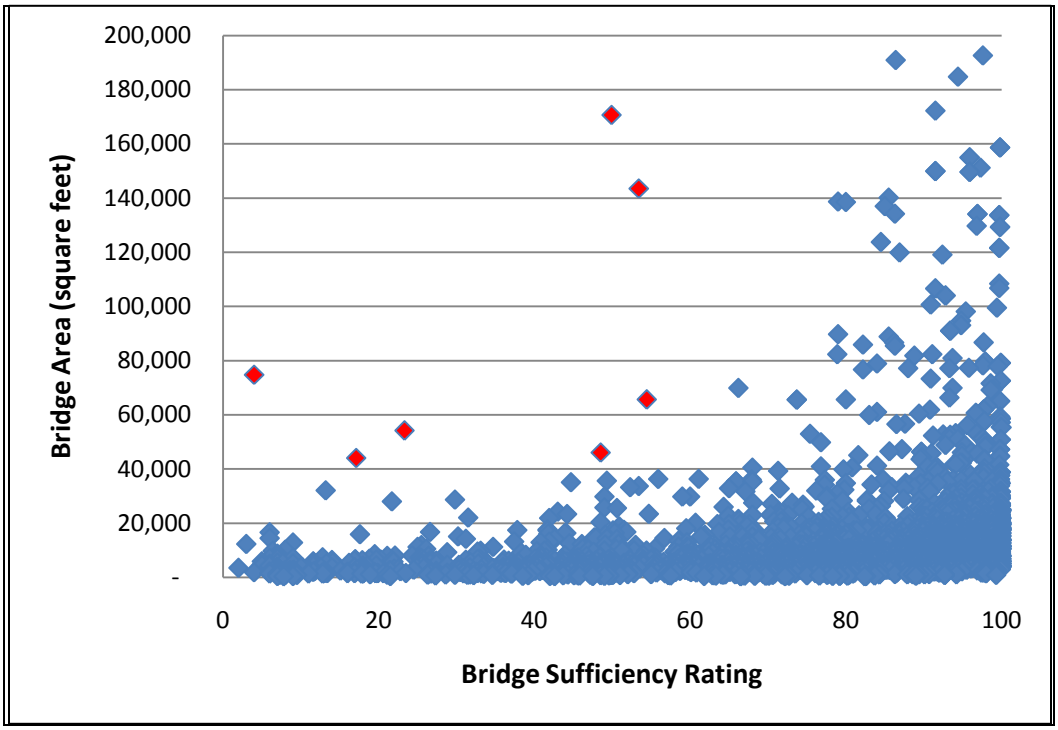
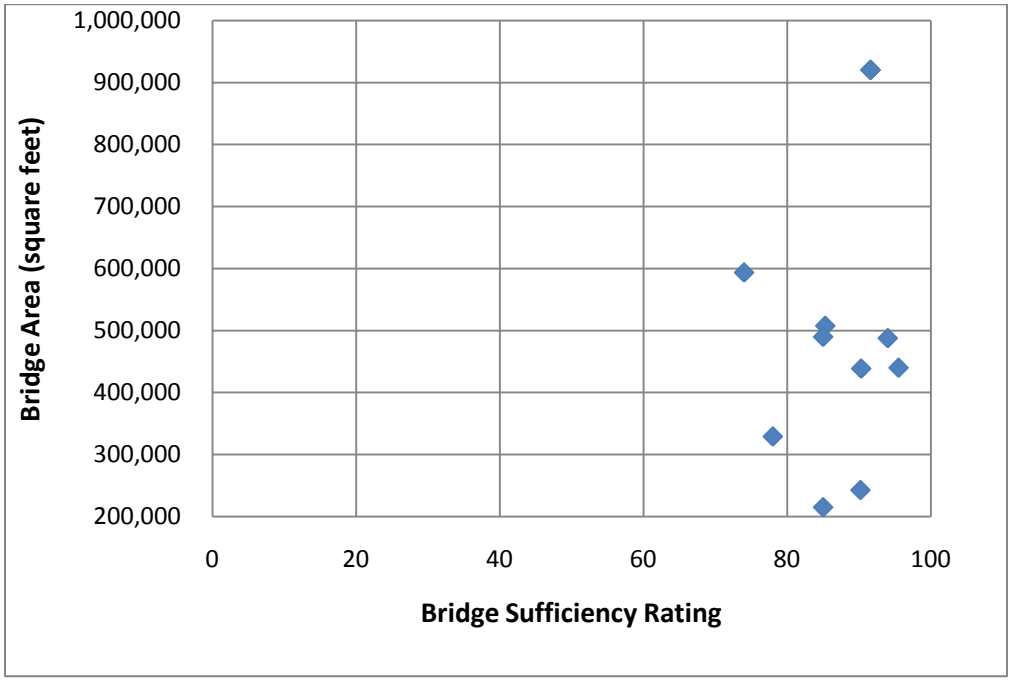


Figure 4-3: Sufficiency Rating and Bridge Size of Individual Bridges



5. BRIDGE NEEDS

5.1 Unconstrained Bridge Needs

Total financially unconstrained bridge needs are projected to be approximately $4.6 billion in 2008 dollars for the 28-year period spanning 2008 to 2035, of which $1.7 billion are backlog needs (38 percent). These needs are shown in **Table 5-1**, broken down by functional class, urban/rural and category of need.

Table 5-1: Total Bridge Needs

Type of Bridge Need	Bridge Needs by Functional Class [1] ($ millions)						
	Interstate and Freeways	Other Principal Arterials	Minor Arterials	Collectors	Local	Total	% of Total
	Backlog Needs Only						
Rural							
Rehabilitation	$2	$1	$1	$4	$0	$8	0.7%
Improvement	$71	$55	$70	$19	$27	$242	19.5%
Replacement	$85	$210	$516	$159	$26	$995	79.9%
Total Rural	**$158**	**$266**	**$586**	**$181**	**$53**	$1,245	100.0%
Urban							
Rehabilitation	$1	$1	$0	$0	$0	$3	0.5%
Improvement	$68	$38	$9	$6	$5	$126	26.0%
Replacement	$202	$108	$31	$9	$6	$357	73.4%
Total Urban	**$272**	**$146**	**$41**	**$16**	**$11**	$486	100.0%
Rural + Urban							
Rehabilitation	$4	$2	$1	$4	$0	$11	0.6%
Improvement	$139	$93	$80	$25	$32	$369	21.3%
Replacement	$287	$318	$547	$168	$31	$1,351	78.1%
Total Needs	**$430**	**$412**	**$627**	**$197**	**$64**	**$1,731**	**100.0%**
	2008 to 2035 (including Backlog Needs)						
Rural							
Rehabilitation	$74	$263	$137	$115	$22	$610	27.5%
Improvement	$71	$55	$70	$21	$27	$245	11.0%
Replacement	$186	$331	$600	$180	$71	$1,368	61.5%
Total Rural	**$332**	**$649**	**$807**	**$315**	**$120**	**$2,222**	**100.0%**
Urban							
Rehabilitation	$71	$68	$8	$3	$6	$154	6.5%
Improvement	$68	$38	$9	$7	$5	$127	5.3%
Replacement	$535	$708	$645	$92	$129	$2,109	88.2%
Total Urban	**$674**	**$813**	**$662**	**$101**	**$140**	**$2,390**	**100.0%**
Rural + Urban							
Rehabilitation	$145	$330	$145	$117	$28	$765	16.6%
Improvement	$140	$93	$80	$27	$32	$371	8.1%
Replacement	$721	$1,039	$1,245	$271	$200	$3,476	75.4%
Total Needs	**$1,006**	**$1,462**	**$1,470**	**$416**	**$259**	**$4,612**	**100.0%**

Notes: (1) Expressed in base year 2008 Dollars.

The distribution of needs by backlog and analysis period is shown in **Table 5-2**. This table breaks down needs by the rehabilitation, improvement, and replacement categories. The improvement category includes widening, raising, and strengthening.

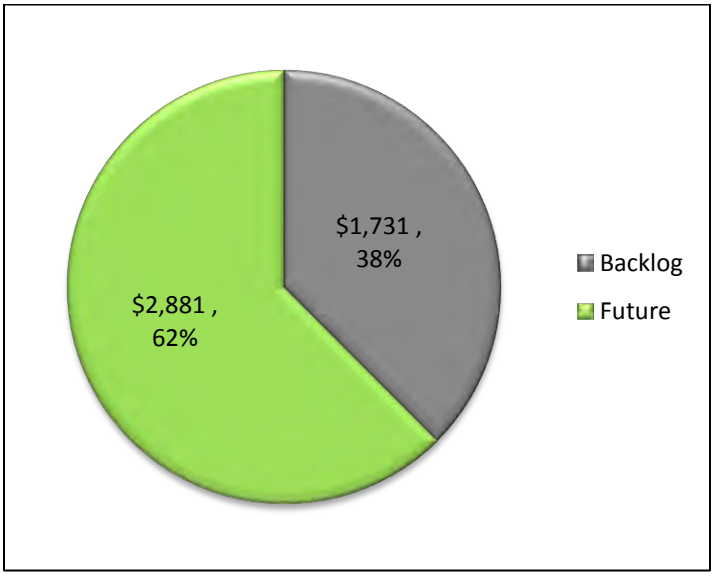
Table 5-2: Total Bridge Needs by Category and Analysis Period

	Seven 4-year Funding Periods							28 Year
Improvement Type	**08-11[(1)]**	**12-15**	**16-19**	**20-23**	**24-27**	**28-31**	**32-35**	**Total**
Rehabilitation	$37	$75	$104	$123	$135	$143	$148	$765
Improvement	$369	$1	$0	$1	$0	$1	$0	$371
Replacement	$1,813	$323	$295	$276	$263	$255	$251	$3,476
Total Needs	$2,218	$399	$399	$400	$398	$399	$399	$4,612

Note: 1. Includes $1,731 million in Backlog Needs

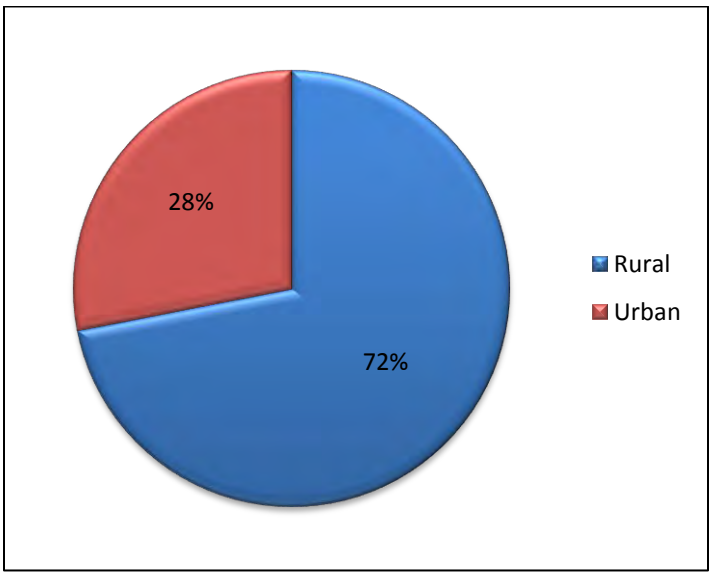
Most of the needs accrue in the future years during the 28-year period. Of the $4.6 billion total needs, 62 percent are future needs. **Figure 5-1** shows the percentage and total cost ($M) for backlog needs and future needs.

Figure 5-1: Backlog versus Future Needs ($Millions)



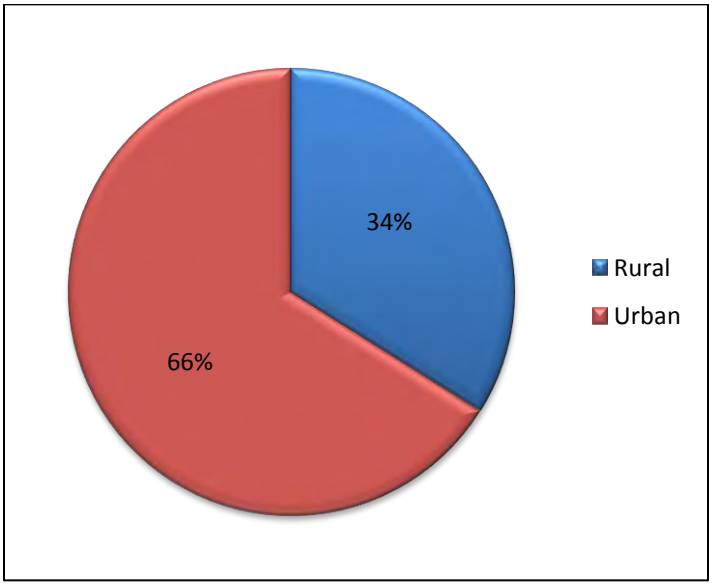
There are more rural bridges (3,518) than urban bridges (709) in the state system. The backlog needs reflect this disparity as $1.2 billion of the total $1.7 billion backlog needs occur on rural bridges. When compared to urban bridges, the allocation shows 72 percent of the backlog needs are on rural bridges while 28 percent are on urban bridges. **Figure 5-2** shows the percentage breakdown.

Figure 5-2: Backlog Needs – Rural versus Urban



The results are reversed for accruing needs. Most of the future needs are projected to occur on urban bridges. As shown in **Figure 5-3**, total urban needs are $1.9 billion (66 percent) of the future needs. Bridges on urban principal arterials and minor arterials accrue the most future needs. Rural bridges only total $977 million, or 34 percent of the total $2.8 billion for future needs.

Figure 5-3: Future Needs – Rural versus Urban



Total needs (backlog and future) during the 28-year needs scenario is equally distributed between urban and rural bridge. Urban bridges total $2.4 billion, or 52 percent of the $4.6 billion in total needs. Rural bridges equal $2.2 billion (48 percent of total needs).

5.1.1 Maintaining 85 Percent of Bridges to MTCs

A goal expressed by MDOT is to maintain the integrity of 85 percent of state bridges. To ensure 85 percent of the 4,227 MDOT bridges are at or above Minimum Tolerable Condition (MTC) levels (not deficient) some 3,593 bridges must be maintained at this level throughout the 28-year analysis period. According to NBIAS, based on existing conditions in the base year, 1,583 bridges or 37 percent failed to meet one or more MTC criteria and 2,644 bridges or 63 percent were at or above MTC levels. Therefore an additional 949 bridges (3,593-2,644) would need to be brought up to MTC levels to achieve the 85 percent goal.

NBIAS estimates the cost to achieve this goal at $1.04 billion in backlog needs to bring an additional 949 bridges up to MTC levels and a further $1.01 billion in accruing needs to rehabilitate the bridge network during the analysis periods to maintain these levels.

This amounts to an estimated $2.05 billion overall to maintain 85 percent existing bridges to minimum tolerable conditions.

5.1.2 Repair of Structurally Deficient Bridges

Structurally deficient bridges have damage or deterioration to the structure that affects its load-carrying capabilities. The goal of replacing structurally deficient bridges when they arise is to maintain a reliable network and limit the number of bridges that have load restrictions, which may cause rerouting of traffic.

Using NBIAS to estimate the cost of achieving this objective is not straightforward. If no improvements were made during the 28-year period, then all bridges would become structurally deficient. A bridge's deficiency status is a function of regular maintenance and life-cycle of the bridge. Therefore, the scenario settings would influence the number of structurally deficient bridges that occur and the resulting cost to improve those bridges would also vary.

The cost to improve existing deficient bridges can be calculated though. Initially, structurally deficient bridges totaled 356. That is 8.4 percent of all state bridges and 3.2 percent of deck area for all bridges. Through the use of the replacement cost and NBIAS methodology, it can be determined that the cost to improve these structurally deficient bridges would be $2.9 billion over 28 years. This would address the existing structurally deficient bridges, as well as the estimated 580 bridges that will become deficient during this time. The replacement rule used focuses NBIAS to take action on structurally deficient bridges by giving the bridge priority as long as funds are available.

5.2 Bridge Needs with Conservative Funding Projection

This section evaluates the consequences on the condition of Mississippi's bridges using the limited funds available under the Conservative Funding Projection (Level 1 funding) for MDOT's Construction Program. NBIAS was used to determine the most cost-effective use of

funds in each year between 2008 and 2035. These funds, aggregated in seven four-year periods and shown in **Table 5-3**, were based on the following:

- Information from MDOT on typical levels of funding available for the Construction Program from recurring sources of federal and state funding;
- Information on short term funding sources that will be available only in the first funding period, such as funds from the American Recovery and Reinvestment Act of 2009 (ARRA) and Bonds (for bridges);
- MDOT's allocation of flexible funds between highway and bridge needs; and
- Growth projections for recurring funding sources of 1 percent per year for state and federal sources, determined in the Baseline Revenue Forecasts for the conservative funding projections.

Table 5-3: Conservative Funding Allocated to Bridge Needs

	Seven 4-year Funding Periods						
Projected Funding	**08-11**	**12-15**	**16-19**	**20-23**	**24-27**	**28-31**	**32-35**
Funding Level 1	$537	$378	$363	$348	$334	$321	$308
Average per year	$134	$95	$91	$87	$84	$80	$77
	Total Funds over 28 years			**$2,589**	**(56 % of Full Needs)**		

Funds in Millions of Constant 2008 Dollars

5.2.1 Allocation of Conservative Bridge Funds

With the conservative funding projection a total of $2,589 million is allocated to bridge projects, amounting to 56 percent of full needs. With this level of funding, NBIAS allocated funds between improvement types as shown in **Table 5-4**. Almost 60 percent would be allocated to bridge replacement projects, with 30 percent used for rehabilitation and the balance on bridge improvements.

Table 5-4: Allocation of Conservative Bridge Funding

	Seven 4-year Funding Periods							28 Year
Improvement Type	**08-11**	**12-15**	**16-19**	**20-23**	**24-27**	**28-31**	**32-35**	**Total**
Rehabilitation	$55	$89	$113	$126	$136	$139	$143	$800
Improvement	$19	$24	$21	$26	$61	$39	$53	$243
Replacement	$464	$264	$228	$197	$137	$143	$111	$1,545
Total Needs	$537	$378	$362	$349	$334	$321	$308	$2,589

5.3 Bridge Needs with Aggressive Funding Projection

With the aggressive funding projection, available funds for bridge projects would amount to approximately $3,684 million, or 80 percent of full needs, as shown in **Table 5-5**. With this level of funding, NBIAS allocated funds between improvement types as show in **Table 5-6**. Approximately 70 percent would be allocated to bridge replacement projects, with 22 percent used for rehabilitation.

Table 5-5: Aggressive Funding Allocated to Bridge Needs

Projected Funding	Seven 4-year Funding Periods						
	08-11	12-15	16-19	20-23	24-27	28-31	32-35
Funding Level 1	$553	$438	$468	$500	$536	$574	$616
Average per year	$138	$109	$117	$125	$134	$144	$154
	Total Funds over 28 years			**$3,684**	**(80 % of Full Needs)**		

Table 5-6: Allocation of Aggressive Bridge Funding

Improvement Type	Seven 4-year Funding Periods							28 Year Total
	08-11	12-15	16-19	20-23	24-27	28-31	32-35	
Rehabilitation	$55	$91	$114	$126	$131	$138	$144	$798
Improvement	$23	$37	$46	$84	$75	$17	$0	$283
Replacement	$476	$309	$307	$290	$329	$405	$420	$2,537
Total Needs	$554	$437	$468	$500	$535	$560	$563	$3,618

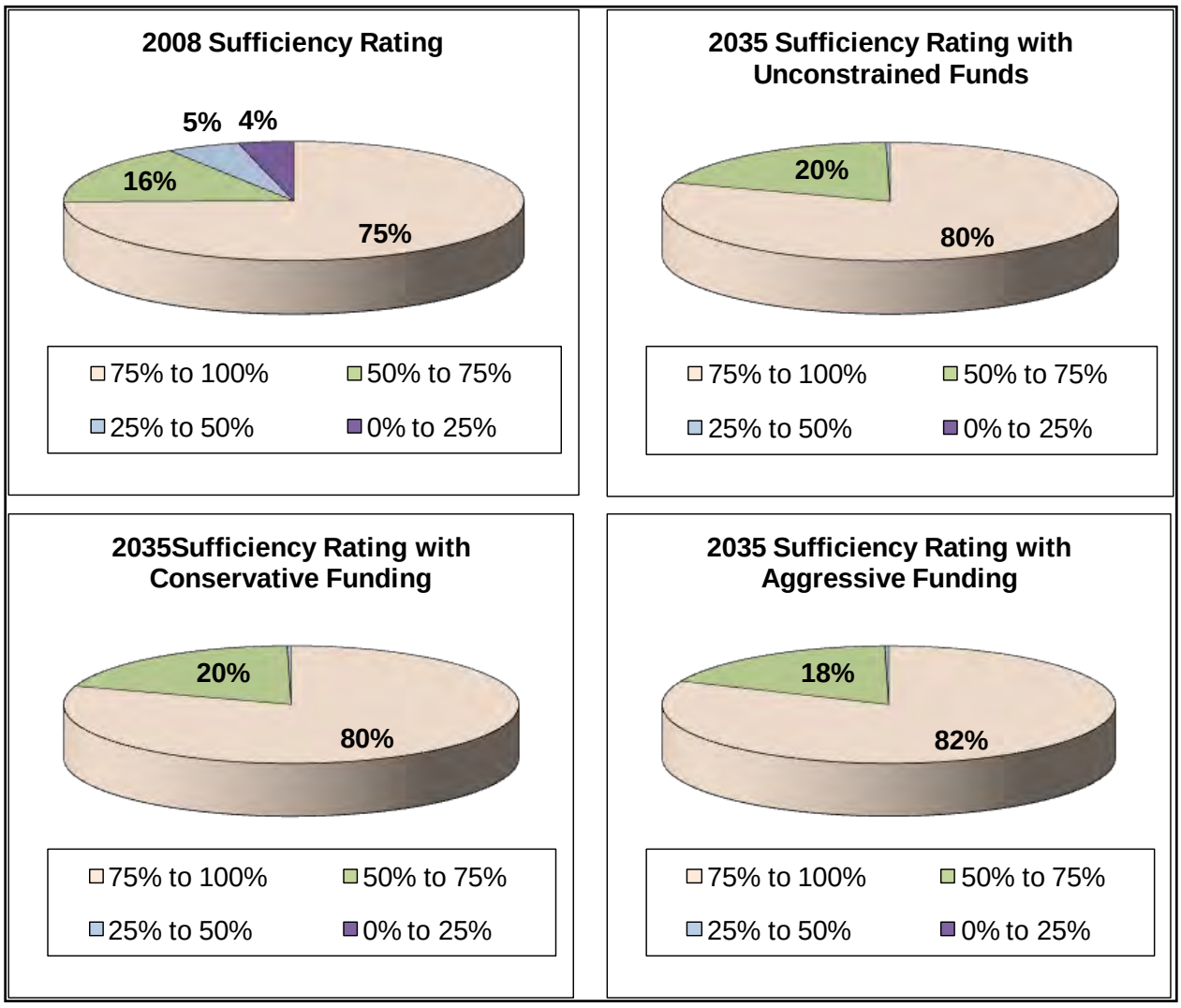
5.4 Impact of Funding on Projected Bridge Conditions

The impact of funding levels for bridge projects on the projected 2035 Sufficiency Rating is shown in **Table 5-7** for unconstrained funding levels, the conservative funding projection and the aggressive funding projection. These impacts are also illustrated in **Figure 5-4**. Initial 2008 conditions are also included for comparison.

Table 5-7: Projected Impacts of Funding on Bridge Sufficiency Ratings

Bridge Sufficiency Rating	Start 2008		2035 by Funding Scenario					
			Unconstrained		Conservative		Aggressive	
	Number	%	Number	%	Number	%	Number	%
75% to 100%	3,158	75%	3,388	80%	3,384	80%	3,446	82%
50% to 75%	686	16%	826	20%	831	20%	769	18%
25% to 50%	218	5%	13	0%	12	0%	12	0%
0% to 25%	165	4%	0	0%	0	0%	0	0%
Total	4,227	100%	4,227	100%	4,227	100%	4,227	100%
Total Funding	**N/A**		**$4,612 Million**		**$2,589 Million**		**$3,618 Million**	

Figure 5-4: Projected Impacts of Funding on Bridge Sufficiency Ratings



The impacts of funding levels on the Functionally Obsolete and Structurally Deficient status of bridges is shown in **Tables 5-8** and **5-9** by number of bridges and by bridge deck area, respectively.

Table 5-8: Impacts of Funding on Bridge Status by Number of Bridges

Bridge Status	2008	2035 by Funding Scenario		
		Unconstrained	Conservative	Aggressive
Percentages of Bridges by Bridge Status				
Functionally Obsolete	19%	5%	6%	5%
Structurally Deficient	7%	0%	0%	0%
Neither	74%	95%	94%	95%

Table 5-9: Impacts of Funding on Bridge Status by Bridge Deck Area

Bridge Status	2008	2035 by Funding Scenario		
		Unconstrained	Conservative	Aggressive
Percentages of Bridge Deck Area by Bridge Status				
Functionally Obsolete	3%	0.0%	0.0%	0.0%
Structurally Deficient	11%	2.2%	3.1%	2.2%
Neither	86%	97.7%	96.9%	97.8%

6. HIGHWAY AND BRIDGE FUNDING SUMMARY

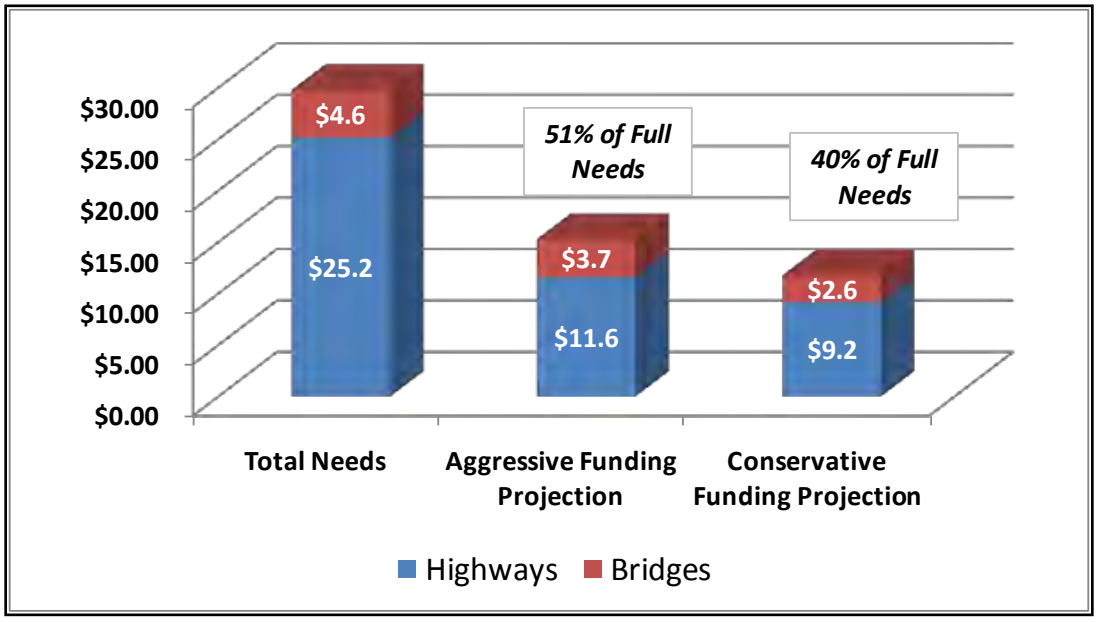
Total needs for MDOT highways and bridges amount to $29.8 Billion over the 28-year analysis period from 2008 to 2035 in Constant 2008 Dollars, averaging $1.1 Billion per year. This amount and the amounts expected to be available under the conservative and aggressive funding projections are shown in **Table 6-1** and illustrated in **Figure 6-1**.

Table 6-1: Total Highway and Bridge Needs with Funding Projections

Construction Program Component	Full Needs	Conservative Funding Projection	Aggressive Funding Projection
Highways	$25,185	$9,195	$11,627
Bridges	$4,612	$2,589	$3,684
Total	**$29,797**	**$11,784**	**$15,311**
Per Year	**$1,064**	**$421**	**$547**

Values are in Million Constant 2008 Dollars

Figure 6-1: Full Needs Compared to Projected Funding for Highways and Bridges



2035

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THE FUTURE IN MOTION