FINAL

TRANSPORTATION ASSET MANAGEMENT PLAN

SCDOT

South Carolina
Department of Transportation

Christy A. Hall, P.E.
Secretary of Transportation
803-737-0874 | 803-737-2038 Fax

August 5, 2019

Ms. Emily Lawton, Division Administrator Federal Highway Administration
Strom Thurmond Federal Building
1835 Assembly Street
Suite 1270
Columbia, SC 29201

Dear Ms. Lawton:

SCDOT submitted its Final TAMP to FHWA as required under 23 CFR Part 515.9 on June 30, 2019.

Upon initial review FHWA requested that our TAMP be revised to reflect the recent changes that were made to preservation funding for our Pavement Program. These changes were approved by the SCDOT Commission at the June 2019 meeting and the Engineering Directives supporting these changes were approved on July 25, 2019. Please accept this revised Final TAMP that includes these revisions requested by FHWA.

The SCDOT 2018-2020 Strategic Plan goals form the guiding principles of our 10-year Investment Strategies, which focus on the maintenance, preservation, and safety of the existing transportation infrastructure; directing investments based on a hierarchy of highway systems and priority networks; integrating risk-based prioritization; implementation of performance based planning and decision making processes; improving safety; advancing lifecycle cost in investment programming; and enhancing mobility. These goals and principles are reflected in this TAMP.

As we continue with our 10-year Investment Plan, we are beginning to see improvement in our state-maintained pavements, when measured by South Carolina's pavement quality index (PQI). Similarly, we are projecting an overall improvement in the condition of NHS bridges in South Carolina through implementation of our bridge investment strategies, and a significant reduction in the rates of fatalities and serious injuries through the use of targeted safety solutions. These projected asset conditions and system improvements are made possible by the enactment of Act 40 in 2017 by the South Carolina State Legislature, which provides dedicated funding to improve transportation infrastructure in South Carolina.

Respectfully Submitted,

Christy A. Hall, P.E.
South Carolina Secretary of Transportation

Post Office Box 191
955 Park Street, Room 309
Columbia, SC 29202-0191

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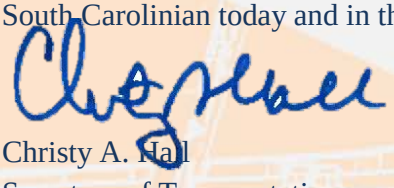
A Message from the Secretary

As the Secretary of Transportation, I am happy to present the SCDOT 2018-2027 Transportation Asset Management Plan (TAMP). This plan documents our commitment to the Governor, General Assembly, and the citizens of South Carolina that SCDOT will maintain the State Highway System in the highest state of good repair possible given the funding available. This is made possible through the acceptance and implementation of asset and performance management principles and practices that tie defined asset condition outcomes to specific levels of investment. This TAMP also describes the asset management practices that SCDOT has and is working to implement, to ensure that our pavement and bridge assets have the longest service life possible for the least practical cost. The plan includes the condition targets that were established as part of our 10-Year Plan that was made possible by Act 40, more commonly known as the Roads Bill, which was passed by the General Assembly and signed by the Governor in June of 2017. Without this additional funding, the goals and targets set for the improvement of our pavements, bridges, and the safety of our system would not be possible.

This TAMP goes beyond what is federally required by including the pavement and bridge assets on the entire State Highway System in South Carolina, not just the pavement and bridge assets on the National Highway System (NHS). We have also included our ten-year safety targets in the TAMP because safety is our top priority. SCDOT is committed to improving safety on our highway system, especially on our rural roads. We have developed the Rural Road Safety Program to specifically address safety on these roads that comprise only five percent of the system, but account for thirty percent of the fatal and serious injury crashes in the state.

In the future we will be adding additional assets to the TAMP and non-asset targets for mobility, such as travel time reliability targets on our interstates for trucks and passenger vehicles. And finally, we have described how the TAMP relates to our other planning documents. These include our Strategic Plan, our long range Multimodal Transportation Plan, and the Statewide Transportation Improvement Program (STIP), in an effort to show how these plans all work together to provide a clear vision of where we want to go with our transportation system, and how we are going to get there. Asset and Performance Management are a big part of the new way we conduct business at SCDOT. As we like to say, "This ain't your father's DOT". I hope you will find the information in this document helpful in understanding how we maintain and preserve the pavement and bridge assets on the state highway system, and how this will enable us to rebuild that system into one that will meet the needs of every South Carolinian today and in the future.

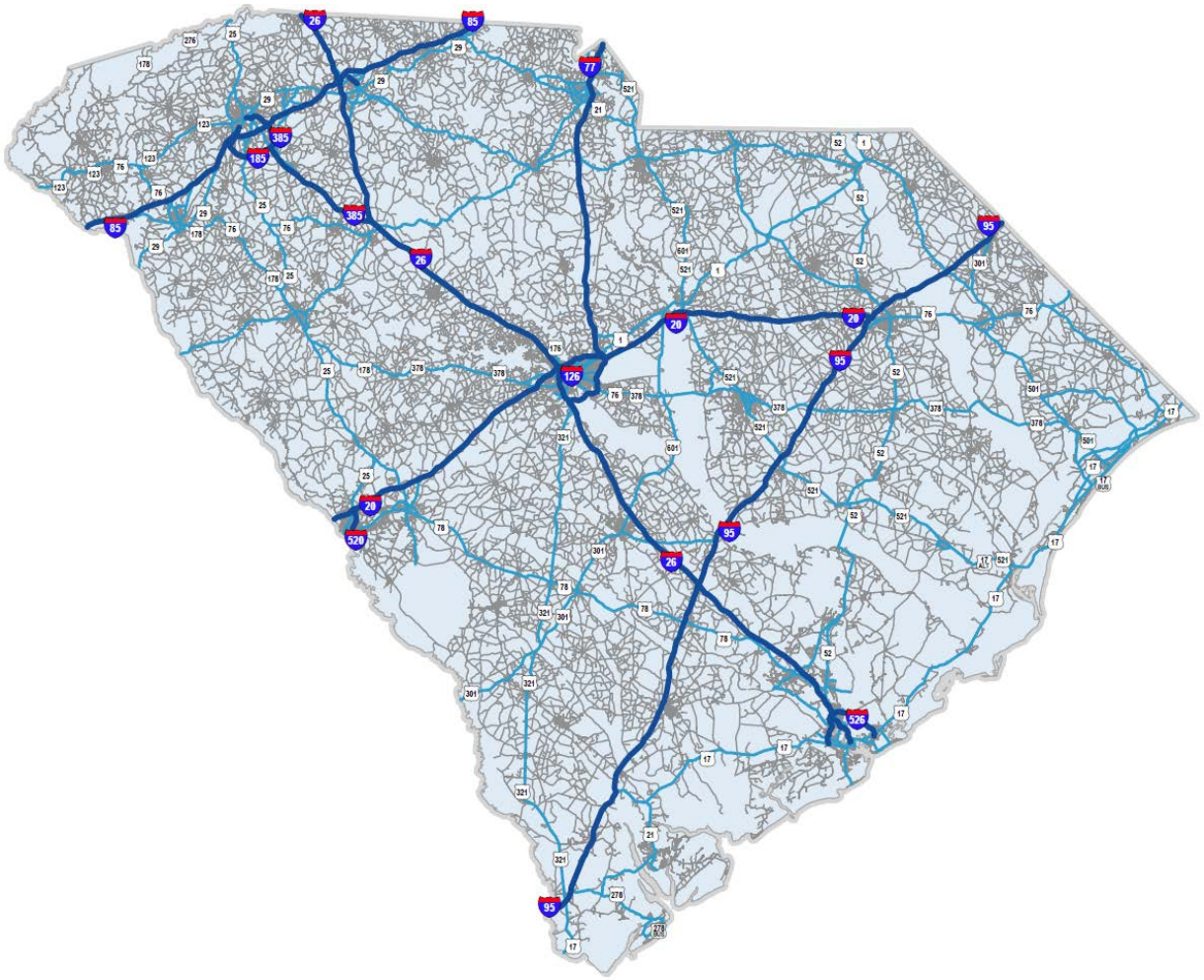


Christy A. Hall
Secretary of Transportation

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The South Carolina Department of Transportation (SCDOT) is the state agency in South Carolina responsible for planning, maintaining and operating 41,330 centerline miles of roadway and 8,451 bridges, which makes up the fourth largest state-owned system in the United States. The state-owned highway system in South Carolina is shown in the figure below.



The highway system is vital to the increasing growth of South Carolina's economy. In 2018, nonfarm employment grew by 1.6% according to Bureau of Labor Statistics data. In addition, South Carolina was 10th in the nation for population growth between 2000 and 2010 according to the US Census Bureau and the State's population increased by 15.3 percent over this period. South Carolina's population is expected to grow an additional 31 percent by 2040, with a corresponding household growth of 32 percent by the year 2040. Based on job and population growth, SCDOT is projecting a 0.9% average annual increase in total miles traveled on its highway system. South Carolina's highway system interconnects ports with major cities and commercial hubs and promotes the efficient transfer of both goods and people within the State and across interstate corridors.

Transportation Asset Management

At its core, transportation asset management is the process of operating, maintaining, and improving infrastructure through maintenance, preservation, repair, and rehabilitation during the assets' life. SCDOT has adopted transportation asset and performance management as a best management practice and has fully embraced the concept for all of its programs. The Secretary of Transportation and the governing board of the agency, the SCDOT Commission, have reaffirmed the importance of the transportation asset management plan (TAMP) for accountability and transparency regarding the use of tax payer funds especially in light of the 2017 legislation that dramatically increased state funding for infrastructure in South Carolina. Tying a planned investment level to a predicted outcome is a major shift in the way SCDOT manages its programs and is essential to earning the public's trust through the effective deployment of resources to achieving results. SCDOT's TAMP is all-inclusive by incorporating state and federal funding together for a more robust plan for the State.

SCDOT's Strategic Plan goals

The leadership team of SCDOT recently deployed a new Strategic Plan, which form the guiding principles of SCDOT's Investment Strategies, focusing on the maintenance, preservation, and safety of the existing transportation infrastructure, directing investments based on a hierarchy of highway systems and priority networks, integrating risk-based prioritization, improving safety, advancing lifecycle cost in investment programming, and enhancing mobility.

The five major goals of the SCDOT Strategic Plan are to:

- Improve safety programs and outcomes in high-risk areas;
- Maintain and preserve its existing transportation infrastructure;
- Improve program delivery to increase the efficiency and reliability of the road and bridge network;
- Provide a safe and productive work environment for SCDOT employees; and
- Earn public trust through transparency, improved communications, and audit compliance.

SCDOT's 10-year Performance Strategies

SCDOT has divided work on its transportation infrastructure into several major program categories: Safety, Pavements, Bridges, Interstate Upgrades, Metropolitan Planning Organization/Council of Governments (MPO/COG) Programs, and a Freight Program. In developing infrastructure investment priorities, SCDOT aligns the programs to the strategic plan and factors in other items such as applicable state and federal laws, asset condition and performance trendlines, revenue trends, industry capacity, public input, and asset management principles.

Over the past two years, SCDOT has fully migrated the Safety, Pavement, and Bridge programs, and travel time reliability to become elements within the TAMP. Additional elements will be added in the future to cover the remaining programs.

As part of the new Strategic Plan, SCDOT has identified some very specific goals for the next ten years for the Safety, Pavement, Bridge, and Interstate Upgrade (capacity and mobility) programs:

Safety

- Improve 1,000 miles of non-interstate rural roads with tailored safety solutions. South Carolina has the deadliest rural roads in the Nation. SCDOT has developed and implemented a targeted solution to address the “worst of the worst” rural roads in the State.

Pavements

- Use a performance-based approach to drive the recovery of South Carolina’s pavements through a blend of preservation, rehabilitation, and reconstruction projects.

Bridges

- Specifically target two bridge categories: 1. Load-restricted bridges; and, 2. Structurally Deficient bridges on the National Highway System. In 2016 (the baseline year for the 10-Year Plan), there were 348 load-restricted (Poor Condition) bridges in South Carolina, which impacted the movement of goods, school bus routing, and emergency response times in the State. Also, in 2016, there were 51 structurally deficient bridges not yet programmed for replacement or repair on the National Highway System that could significantly hamper South Carolina’s ability to move freight across the major routes in the State.

Capacity

- Widen 100+ centerline miles of interstate and address major freight pinch points at interstate-to-interstate interchanges.

Mobility

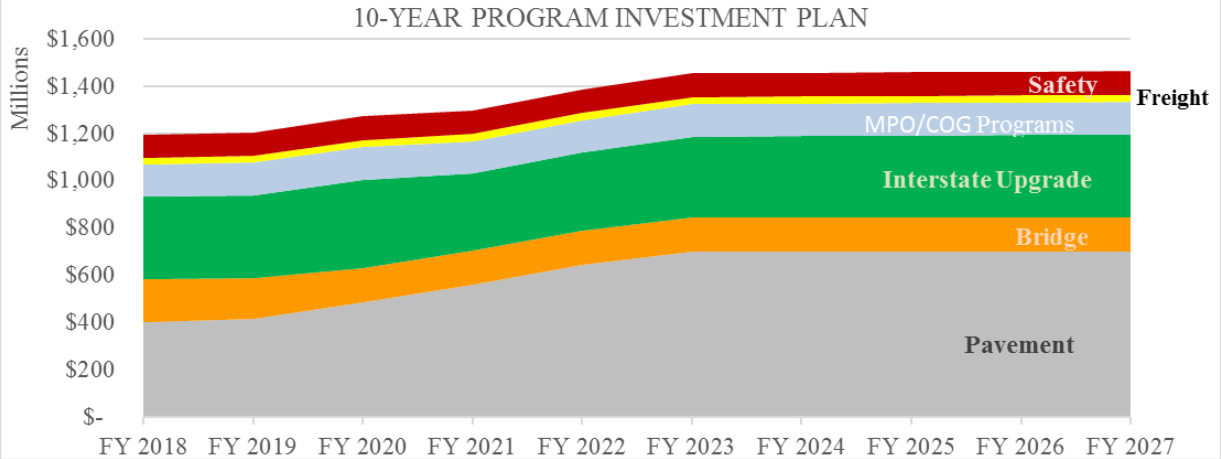
- Improve the percentage of reliable travel times for Interstate highways and improve truck (Freight) travel reliability.

SCDOT's Investment Plans

Based on the strategic plan and desired 10-year targets, SCDOT has aligned all available financial resources to fund the various programs at levels predicted to be necessary to achieve the desired results.

TAMP Ten Year Investment Plan

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Category	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027
Pavement*	$ 401,800,000	$ 417,000,000	$ 487,000,000	$ 562,000,000	$ 642,000,000	$ 702,000,000	$ 702,000,000	$ 702,000,000	$ 702,000,000	$ 702,000,000
Bridge	$ 180,000,000	$ 170,000,000	$ 145,000,000	$ 145,000,000	$ 145,000,000	$ 145,000,000	$ 145,000,000	$ 145,000,000	$ 145,000,000	$ 145,000,000
Interstate Upgrade	$ 350,493,227	$ 352,634,891	$ 373,079,163	$ 323,254,793	$ 332,239,411	$ 340,250,000	$ 340,950,000	$ 343,500,000	$ 346,550,000	$ 348,400,000
MPO/COG Programs	$ 138,000,000	$ 138,000,000	$ 138,000,000	$ 138,000,000	$ 138,000,000	$ 138,000,000	$ 138,000,000	$ 138,000,000	$ 138,000,000	$ 138,000,000
Freight	$ 24,606,774	$ 27,313,519	$ 30,044,871	$ 30,044,871	$ 30,044,871	$ 30,044,871	$ 30,044,871	$ 30,044,871	$ 30,044,871	$ 30,044,871
Safety	$ 97,704,024	$ 98,658,105	$ 99,631,267	$ 99,631,267	$ 99,631,267	$ 99,631,267	$ 99,631,267	$ 99,631,267	$ 99,631,267	$ 99,631,267
Total Annual Budget	$1,192,604,025	$1,203,606,515	$1,272,755,301	$1,297,930,931	$1,386,915,549	$1,454,926,138	$1,455,626,138	$1,458,176,138	$1,461,226,138	$1,463,076,138



The 10-year investment plan is projected to enable SCDOT to reduce fatalities and serious injuries on South Carolina's highways, substantially improve the percent of the State's pavements considered to be in good condition measured by its pavement quality index (PQI), reduce the number of load-restricted bridges in the State, and widen a substantial amount of the State's interstates. PQI is a metric specifically designed to measure road quality in South Carolina based on the State's unique characteristics.

SCDOT is projecting decreases in fatalities and serious injuries within South Carolina during the next ten years based on its strategic investment strategies. SCDOT is forecasting a 23 percent decrease in fatality rate and a 38 percent decrease in the rate of serious injuries on the state highway system by 2026. South Carolina has the highest fatality rate in the nation. Approximately 1,000 people are dying on our roads annually. SCDOT's rural roads are some of the deadliest roads in the State with approximately 30 percent of fatalities and serious injuries occurring on these roads, which represent only 5 percent of the network.

SCDOT's 10-Year Safety Performance Targets

	2016 Baseline Condition[1]	Ten-year Target[1]	% Change	Average 10-Year Allocation (in millions)
Safety				
Fatalities (Number)	890	886	(0.45)	$99.3
Fatalities (Rate)	1.75	1.34	(23.43)	
Serious Injuries (Number)	3,194	2,573	(19.44)	
Serious Injuries (Rate)	6.30	3.89	(38.25)	
Non-Motorized Fatalities and Serious Injuries (Number)	376	368	(2.13)	

[1] Based on a 5 year rolling average

The 10-year plan also will enable SCDOT to dramatically improve the condition and operation of the backbone of the State's infrastructure network, the National Highway System (NHS). NHS pavement condition and NHS bridge condition are both predicted to improve and the percent in poor condition is projected to decrease.

These projected asset condition improvements are made possible by the enactment of Act 40 (commonly referred to as the Roads Bill) in 2017 by the South Carolina State Legislature, which provides dedicated funding to improve transportation infrastructure in South Carolina through an incremental increase in the State's gas tax and other fees over a six year period. At full implementation, SCDOT is poised to receive nearly a doubling of state resources, which will outpace the federal funds coming to the State by 2:1. This increased funding presents a unique opportunity for SCDOT to turn around the downward trend in the condition of the state-owned highway system and further demonstrates the need for effective management of resources.

SCDOT's 10 Year Asset Condition Performance Targets*

	2016 (Actual) % Good	2016 (Actual) % Poor	Ten-year Target % Good	Ten-year Target % Poor	Average 10-Year Allocation (in millions)
Pavements					
Interstate[1]	65%	11%	92%	3%	$135.0
Non-Interstate NHS	28	45	72	16	86.5
Non-NHS Primaries	20	61	48	37	186.0
Federal Aid Secondary	19	52	40	35	112.5
Non-Federal Aid Secondary[2]	15	55	25	45	121.0
Bridges (by count)					
NHS	48	6	66	0	114.5
FA	46	11	41	11	18.0
Off System	40	9	36	10	18.5
Bridges (by deck area)					
NHS	42	4	60	0	114.5
FA	50	10	41	15	18.0
Off System	51	7	44	10	18.5

* Pavement condition based on PQI scale;. Bridge condition is based on the federal NBI scale.

[1] Includes approximately $20 million added value from planned interstate widening projects over the next ten years.

[2] Includes approximately $39 million projected added value from projects County Transportation Committees program on the State's Non-Federal Aid Secondary system annually.

Risk Management

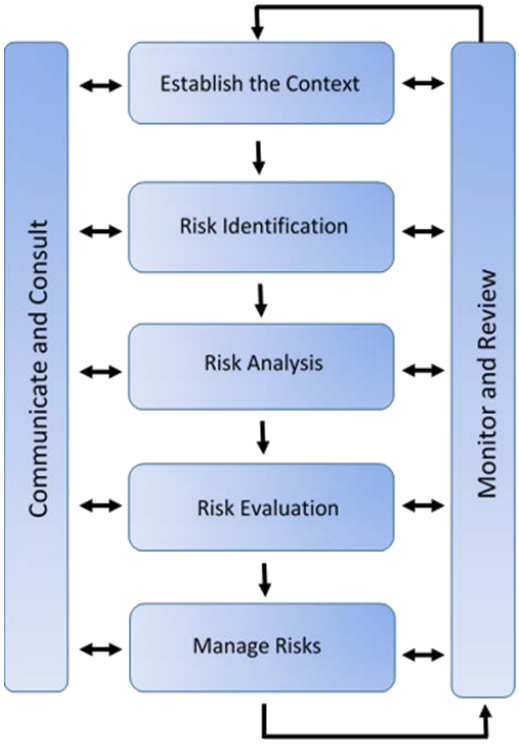
There are risks involved with every aspect of owning, managing, and maintaining a transportation system. There is the risk of damage to, or loss of assets due to extreme weather events, crashes, or acts of vandalism. Other risks include the loss of key personnel or shortfalls in expected revenue. SCDOT classifies risks into one or more of the following areas:

- Operational (Project delays, cost overruns, waste, inefficiency)
- Safety (Employee and public well-being)
- Financial threats (Funding, liquidity, credit, reporting)
- Strategic (Resources not aligned, unclear objectives)
- Reputational (Unintentional unwanted headlines that could destroy public trust)
- Ethical (Intentional fraud, abuse, mismanagement, conflict of interest)
- Legal (law suits)
- Regulatory (Noncompliance)

Enterprise risk management is the process of integrating the management of risk into all of an agency's key programs at every level within the organization. This includes managing the risks at the agency, program, project, and activity level.

SCDOT began the process of implementing an Enterprise Risk Management (ERM) program in spring of 2017. There are numerous ERM processes that have been developed, both for the public and private sector. SCDOT has chosen to follow the process developed by the International Organization of Standardization (ISO) in 2009, known as ISO 31000. The process uses a cyclical framework comprised of seven components and is used in many risk management guides. The components of this process are:

- Communication and Consultation – developing a communication structure within the organization to create an understanding of the risk management process and create continuous communication between the risk manager(s) and the risk owners.
- Establish the Context – what is the mission and challenges that may be faced. Is the environment changing? What resources are available to meet the identified objectives? Are there legal, political or social environments that may impact the success of the organization?
- Risk Identification – identifying the sources of risks and opportunities, areas of impacts, events and their causes and consequences.
- Risk Analysis – understanding the risk, its consequences and the likelihood of the risk occurring.



- Risk Evaluation – risks are evaluated and prioritized based on the impact to the organization and their likelihood of occurrence.
- Managing Risks – deciding whether to tolerate, treat, transfer, terminate, or take advantage of the risk.
- Monitoring and Review – evaluation of the results of the risk process. This is a cyclical process.

This approach is used to identify enterprise, program, project and activity level risks. SCDOT manages risk at multiple levels for several reasons. The strategic objectives of the agency cannot be achieved without the coordination of functions at many levels within SCDOT. Problems that arise at the activity or project level can affect the goals set at the program and enterprise level and could therefore become a strategic risk for the agency, thus the need to employ an enterprise risk management solution at SCDOT.

The Future of Transportation Asset Management at SCDOT

While SCDOT has embraced transportation asset management in its business practices, the agency constantly strives to improve its efficiency, transparency, and accountability. Particularly, SCDOT has identified areas—grouped under three broad areas: **culture, data, and tools**—that could be enhanced to improve the efficient use of transportation resources. SCDOT is working toward:

- Identifying communication strategies to disseminate transportation asset management information to key stakeholders;

- Increasing the use of Whole Life Management principles in the pavement, bridge, and maintenance management processes;
- Conducting a risk assessment of key assets;
- Creating a comprehensive inventory of transportation infrastructure assets;
- Developing a data governance plan for assets; and
- Evaluating securing analytical tradeoff decision-support tools to support transportation asset management decision making.

CHAPTER 1
INTRODUCTION

1. INTRODUCTION

1.1. OVERVIEW

Transportation asset management is defined as a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on engineering and economic analysis based upon quality information to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost.[1] Effective July 2012, state departments of transportation were required to develop a risk-based Transportation Asset Management Plan (TAMP) with an emphasis on performance-based management. This requirement is a result of both the 2012 surface transportation bill, Moving Ahead for Progress in the 21st Century (MAP-21), and the 2015 Fixing America's Surface Transportation Act (FAST Act). The State of South Carolina Legislature similarly emphasized the importance of transportation asset management and directed the South Carolina Department of Transportation (SCDOT) to develop a TAMP.

SCDOT has embraced the philosophies of performance and asset management as a management practice. This document supports SCDOT's 2018-2020 Strategic Plan, which serves as a roadmap by outlining the agency's vision, mission, values, and goals. SCDOT has developed this TAMP to document procedures in practicing transportation asset management and is implementing this Plan to achieve the condition targets established by SCDOT.

1.1.1. Vision

The vision of the agency is "to rebuild our transportation system over the next decade in order to provide adequate, safe, and efficient transportation services for the movement of people and goods in the Palmetto state." This statement captures the essence of SCDOT's focus of getting to a state of good repair for the existing state highway system and recognizing the unique opportunity to turn around the downward decay of the road network that has occurred over the past thirty years. SCDOT has adopted risk-based asset management principles to ensure efficient and cost-effective use of the resources entrusted to SCDOT in reaching its ten-year vision.

1.1.2. Mission

As outlined within its 2018-2020 Strategic Plan, "SCDOT connects communities and drives the economy through the systematic planning, construction, maintenance, and operation of the state highway system and the statewide intermodal transportation and freight system."

1.1.3. Values

[1] 23 U.S.C. 101(a)(2), MAP-21 § 1103.

SCDOT's values influence day-to-day activities, inform the decision-making process, and enable the agency to measure progress towards goals. The values are based on the concept of **TEAM** within the organization as One SCDOT and with its citizens and business stakeholders. In practicing asset management, SCDOT focuses on the following core values to make infrastructure investment decisions:

- **T**rust
- **E**xcellence
- **A**ccountability
- **M**ake a Difference

1.1.4. Goals

SCDOT's Strategic Plan goals are to:

- Improve safety programs and outcomes in high-risk areas;
- Maintain and preserve its existing transportation infrastructure;
- Improve program delivery to increase the efficiency and reliability of the road and bridge network;
- Provide a safe and productive work environment for SCDOT employees; and
- Earn public trust through transparency, improved communications, and audit compliance.

These goals directly reflect many aspects of transportation asset management. Specifically, transportation asset management focuses on preservation of existing infrastructure with a more cost-effective and efficient approach. SCDOT also utilizes transportation asset management principles to address mobility by planning for future demands on the system. These actions facilitate safe and efficient movement of citizens, goods, and services; thereby, enhancing the performance of state and national commerce.

1.2. Asset Management Drivers

Transportation asset management at SCDOT is aligned with the agency's vision, mission, values, and goals. SCDOT has long recognized the importance of applying and institutionalizing transportation asset management. For example, SCDOT utilizes transportation asset management principles in allocating transportation resources and delivering the Department's performance goals. SCDOT applauds the federal legislation requiring a systematic approach to managing transportation infrastructure, as it simply reinforces efforts already underway at the state level.

The main transportation asset management drivers include:

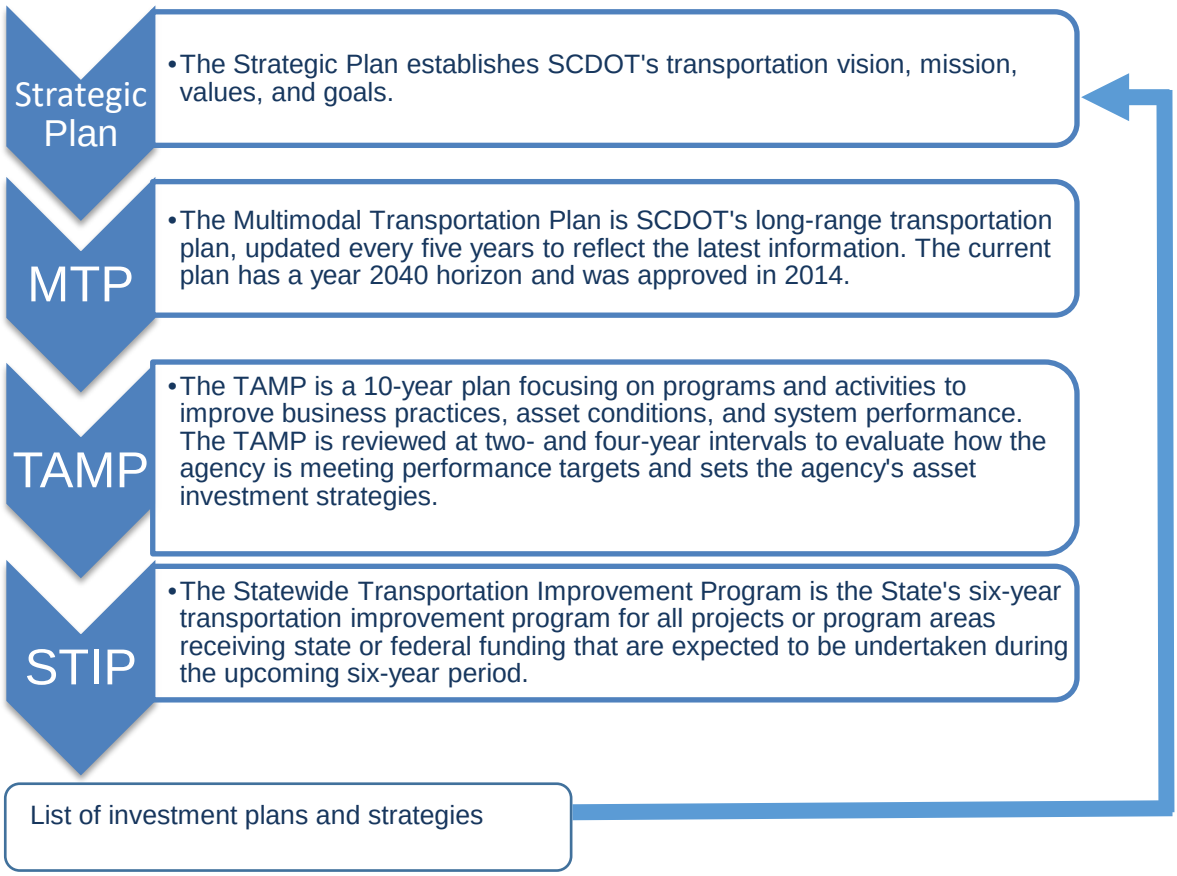
- **Extending asset life**: Adopting transportation asset management principles enables SCDOT to invest in cost-effective strategies that involve proactively maintaining, preserving, and improving the performance and conditions of transportation assets, which results in extending the productive life of transportation assets.
- **Optimizing available resources**: SCDOT's transportation assets have many competing needs for preservation and improvement with limited available resources. Transportation asset management principles are utilized to make informative decisions to balance competing needs and financial constraints to achieve defined performance targets, which enable SCDOT to make the best use of available resources.
- **Achieving customer expectations**: South Carolina citizens demand transparency in public investments. These demands drive SCDOT to adopt a systematic and formal approach to invest in transportation projects and programs that enable the agency to work towards meeting citizen expectations.
- **Complying with state and federal requirements**: SCDOT's commitment to meeting state and federal requirements demands the use of transportation asset management principles.
- **Meeting system demand**: demand for capacity continues to grow as the population and freight movement increases. For the State of South Carolina to maximize its economic competitiveness in a global economy, SCDOT must proactively plan to meet capacity and infrastructure needs.

1.3. TAMP Relationship to Other Planning Documents

As a strategic document, the TAMP is used as a supporting tool to improve business practices that lead to better asset preservation and system performance. The TAMP serves as a pivotal document that links other planning documents within the agency to improve organizational business performance.

SCDOT develops and implements different transportation planning documents, including the Strategic Plan, Statewide Multimodal Transportation Plan (MTP), and Statewide Transportation Improvement Program (STIP). The TAMP is a key document that bridges these other long- and short-term plans. For example, investment strategies outlined in the TAMP feed projects and programs included in the STIP. Figure 1-1 shows the relationships between the agency's other plans and the TAMP.

Figure 1-1. TAMP Relationship to SCDOT Planning Documents



1.4. Scope and Structure of the TAMP

The purpose of this TAMP is to provide a clear and transparent direction in managing the State's assets. This is achieved by outlining the approach SCDOT is using to effectively manage resources and add value to the highway transportation infrastructure.

SCDOT has adopted transportation asset and performance management as a best management practice and has fully embraced the concept for all of its programs. The Secretary of Transportation and the governing board of the agency, the SCDOT Commission, have reaffirmed the importance of the TAMP for accountability and transparency regarding the use of taxpayer funds especially with the passage of legislation in 2017 that dramatically increased state funding for infrastructure in South Carolina. Tying a planned investment level to a predicted outcome is a major shift in the way SCDOT manages its programs and is essential to earning the public's trust through the effective deployment of resources to achieving results.

SCDOT's TAMP is all-inclusive by incorporating state and federal funding together for a more robust plan for the state owned system. However, in accordance with the requirements of MAP-21 and FAST Act, this TAMP separately reflects road and bridge assets on the National Highway System.

The TAMP was developed through a systematic process, which was initiated with a gap assessment documenting and benchmarking transportation asset management within SCDOT. Results of this assessment helped shape the plan.

The remainder of the document is organized as follows:

- **Chapter 2** presents an overview of the practice of transportation asset management at SCDOT, including the agency's organizational structure and how it relates to the business structure that governs the asset management practices.
- **Chapter 3** reviews the principles of Whole Life Management of Assets at SCDOT and how this management technique is incorporated into the TAMP. The chapter describes the current state of the practice within the agency, potential enhancements, best practices, and the agency's asset management systems.
- **Chapter 4** reviews the state of SCDOT's highway transportation system. Specifically, the chapter discusses the demand for transportation, asset inventory, and asset condition trends.
- **Chapter 5** outlines the role of the financial plan as a key component of the agency's asset management framework. This chapter documents the agency's financial resources to manage the existing highway infrastructure.
- **Chapter 6** outlines SCDOT's Risk Management approach in order to identify and predict risks, both positive and negative, to the current transportation asset infrastructure.
- **Chapter 7** presents the investment approach to allocating asset management resources at SCDOT. The chapter defines system performance targets, establishes the hierarchy of investment decision making and outcomes, and highlights existing system performance gaps.
- **Chapter 8** documents potential opportunities the agency has identified to further enhance the transportation asset management process to support better utilization of resources.

CHAPTER 2

SOUTH CAROLINA ASSET MANAGEMENT

2. South Carolina Transportation Asset Management

2.1. Overview

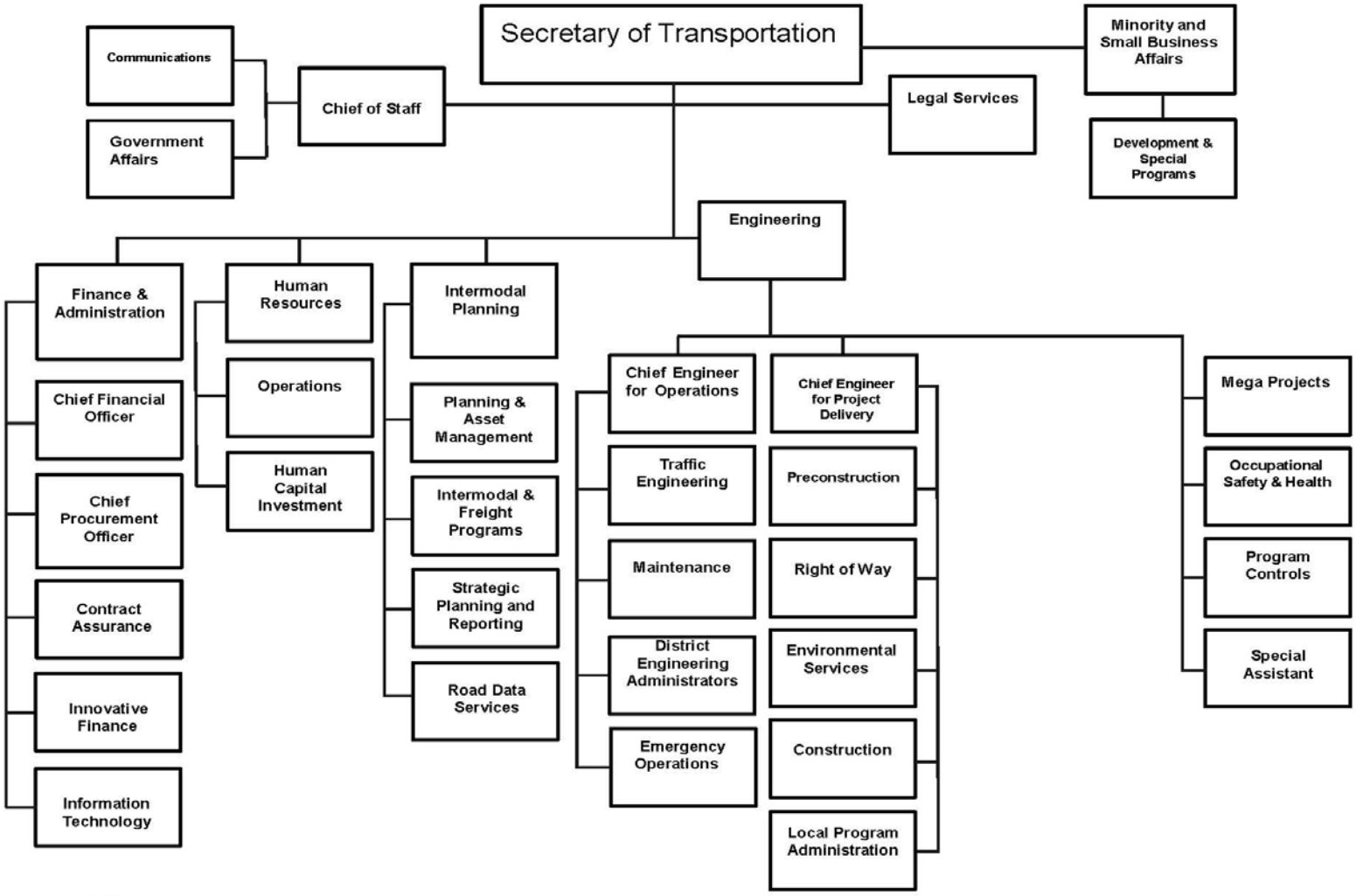
The overarching objective of asset management requires vital support from the executive level and all other strategic, technical, and operational units within an organization. How asset management is organized within SCDOT and general transportation asset management policies and principles are discussed in this chapter.

2.2. Organizational Structure

The Transportation Commission is the administrative and governing authority of the South Carolina Department of Transportation. The Commission is composed of nine members: one member from each Congressional District and two at-large members. The District members are appointed by the Governor, subject to approval of the legislative delegations of their respective Districts. The two at-large members of the Commission are also appointed by the Governor, subject to approval by a separate confirmation vote in both the Senate and the House of Representatives. In addition, the Commission, with the advice and consent of the Senate, appoints The Secretary of Transportation, who manages the day-to-day operations of SCDOT and carries out the policies of the Commission.

Figure 2-1 illustrates the organizational structure for SCDOT. SCDOT is divided into the following organizational units: Intermodal Planning, Finance and Administration, Engineering (including maintenance), Human Resources, Minority and Small Business Affairs, Chief of Staff, and Legal Services. Figure 2-1 shows further divisional offices under each organizational unit that support the operation of the transportation system in South Carolina.

Figure 2-1. SCDOT Organizational Structure



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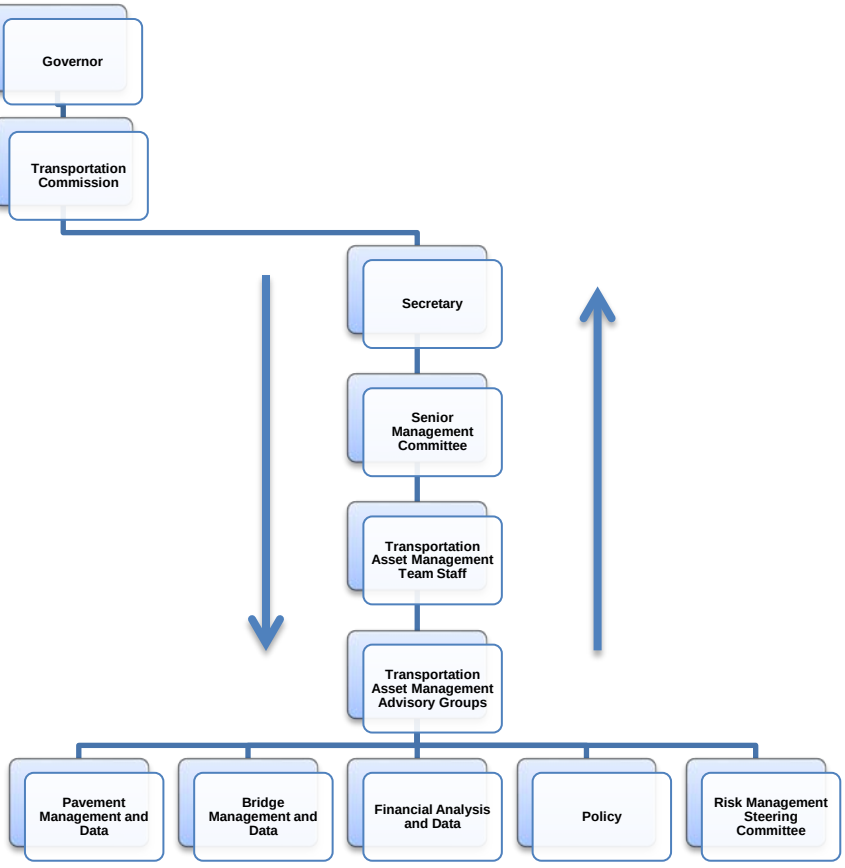
2.3. Asset Management Governance Structure

The Intermodal Planning Division is responsible for Planning and Asset Management at SCDOT. However, asset management is a business practice that pervades all divisions and units within SCDOT. SCDOT has implemented a transportation asset management governance structure that brings together diverse workgroups to champion the process, identify issues, provide inputs, and perform system-level analysis.

Figure 2-2 illustrates the transportation asset management governance structure and consists of the following functional tiers:

1. Governor
2. Transportation Commission,
3. Secretary of Transportation,
4. Senior Management Committee,
5. Transportation Asset Management Team Staff, and
6. Transportation Asset Management Advisory Groups.

Figure 2-2. SCDOT Transportation Asset Management Governance Structure



The specific functions of each tier are listed in the following subsections:

Governors Enterprise Strategic Priorities

South Carolina's Statewide Enterprise Strategic Objectives require state agencies to integrate Enterprise Strategic Objectives in their own strategic planning and identify the enterprise strategic objective that is linked to each agency-level goal. Below is the list of Statewide Enterprise Strategic Objectives:

- ***Education, Training and Human Development***

  Improve educational infrastructure to elevate the levels of educational preparedness of every South Carolinian to lead a healthy and productive life, including success in a job or career and in the community.

- ***Healthy and Safe Families***

  Enhance public well-being by delivering efficient and cost-effective public health and support services.

- ***Maintaining Safety, Integrity, and Security***

  Protect the safety, integrity, and security of statewide public resources, data, infrastructure and citizens including timely response to emergencies, disasters and emerging threats.

- ***Public Infrastructure and Economic Development***

  Build a world-class and safe public infrastructure to enhance the quality of life of our citizens and to promote the state in global competiveness as a location for business, investment, talent, innovation and visitors.

- ***Government and Citizens***

  Deliver a government that serves the needs of South Carolinians and achieves inter-agency collaboration to deliver highly effective, efficient, and innovative programs.

SCDOT Transportation Commission

The SCDOT Transportation Commission, as required by South Carolina Act 40 of 2017, approves any policy related to transportation asset management including the adoption of performance based targets by the request of the SCDOT Secretary of Transportation.

Secretary of Transportation

As required by 23 CFR §515.9, the Secretary of SCDOT approves the TAMP for submittal to FHWA. The Secretary directs all transportation asset management policy initiatives at SCDOT and recommends the appropriate policy approval by the Transportation Commission. In addition, the Secretary:

- Establishes the long-term strategic goals;
- Establishes the recommended targets, by program, to align to the long-term strategic goals;
- Recommends to the SCDOT Commission the required or adjusted investment levels, by program, to achieve the 10-year targets;
- Ensures asset management strategy and policy is in harmony with statewide policy;
- Directs transparency, accountability, and communication efforts relating to the TAMP; and
- Provides an annual report regarding progress towards achieving the targets outlined in the TAMP.

Senior Management Committee

The Senior Management Committee, led by the Deputy Secretary for Intermodal Planning, or his or her designee, provides strategic vision and executive leadership for asset management and consists of all SCDOT Deputy Secretaries and directors of Planning and Asset Management, Intermodal and Freight Programs, Maintenance, Road Data Services, Traffic Engineering, Strategic Planning and Reporting, and Program Controls. The committee is empowered to make large-scale cross-functional area recommendations to the Secretary. The mission of the committee is to:

- Ensure asset management strategy and policy is in harmony with long-term strategic plans and statewide policy;
- Foster an environment in which the most effective program of projects is selected and delivered on time and on budget;
- Define objectives and strategies for preservation, and preventive and corrective maintenance;
- Review all asset management policies that impact internal and external stakeholders and recommend them to the Secretary for approval;
- Review and decide on asset management standards, practices, and programs;
- Manage communications with external stakeholders; and
- Prepare an annual report regarding progress towards achieving the targets outlined in the TAMP.

Transportation Asset Management Team Staff

The Transportation Asset Management Team Staff consists of the Chief Asset and Performance Manager and his or her staff. The role of the Transportation Asset Management Team Staff is to:

- Bring leaders from across the agency together to direct asset management policies and effort;
- Recommend policy to achieve SCDOT's transportation asset management vision;
- Recommend deliverables for Senior Management Committee consideration;
- Develop and articulate an investment strategy, framework, and process to preserve and manage the multimodal transportation assets of the State in a manner that is economically, environmentally, and socially sustainable;
- Serve as a champion and provide guidance for the transportation asset management advisory groups;
- Recommend performance measures;
- Align the agency's asset-specific management efforts across the Divisions;
- Develop and share best practices across the advisory groups;
- Recommend policy and procedure modifications to improve project development and delivery; and
- Assist the Senior Management Committee in providing a liaison role with FHWA on policy and procedural matters relating to asset management.

Transportation Asset Management Advisory Groups

Each advisory group is selected by the Chief Asset and Performance Manager. The groups are made up of subject matter experts to provide knowledgeable inputs as well as undertake technical analyses required for transportation asset management. These advisory groups are formed and dissolved as needed. Some of the tasks the advisory groups undertake include pavement and bridge data analysis and programming, financial analysis and planning, policy setting, risk management and target setting.

2.4. Guiding Principles of SCDOT Asset Management Program

The primary purpose of SCDOT is to provide a safe and reliable transportation system for the movement of people and goods. This purpose requires SCDOT to ensure that transportation assets are effectively and efficiently operated, preserved, maintained, and expanded to meet future demands. Asset management at SCDOT is guided by the following principles:

- Providing quality transportation services to effectively meet the needs of South Carolina citizens;
- Maintaining public trust by being a transparent, effective, accountable, and cost-efficient organization in providing services to its citizens and other users of the system;
- Promoting economic efficiency and making use of performance data to optimize investments and reduce costs over assets' lifecycles; and
- Collaborating as a team and partnering with other stakeholders, such as Metropolitan Planning Organizations and Council of Governments, to meet infrastructure needs.

2.4.1. Current Practice

SCDOT has been practicing some level of asset management prior to the enactment of MAP-21. In fact, South Carolina Act 114 of 2007 introduced a strategic and systematic approach to transportation investment at SCDOT. Act 114 requires SCDOT to use objective data in prioritizing transportation projects for bridge replacement, interstate mainline capacity improvements, interstate interchanges, and resurfacing projects. Maintenance, preservation, expansion, and replacement or rehabilitation activities at SCDOT are guided by asset condition, traffic, economic development potential, district maintenance capabilities, the frequency and effectiveness of repairs, and funding availability. These inputs in the decision process enable SCDOT to invest in projects and programs that yield greater benefits on investment, as well as mitigate potential risks.

SCDOT has made notable advances in managing its roadway network. The agency continues to engage in efforts that balance resources and increased maintenance, preservation, and renewal needs. To maximize the utilization of available resources, SCDOT has adopted a three-part strategic approach to preserve its pavements: Preservation, Rehabilitation, and Reconstruction. These interventions are recommended for qualifying asset categories or systems using well-documented inventory and condition information. SCDOT employs programs, such as the Maintenance Assessment Program (MAP), to evaluate maintenance performance on primary and secondary roadways by assessing the maintenance level of service (LOS) being provided with the funding available.

The MAP is capable of estimating the cost associated with moving from the current LOS to a desired LOS. Based upon this information, resources can be targeted at areas requiring improvements. The MAP system evaluates seven different elements to determine the LOS of a road segment: pavement, shoulders/ditches, drainage structures, roadside, signs,

pavement markings, and guardrail. As a result, transportation investment decision-making at SCDOT has been in harmony with many aspects of the MAP-21 and FAST Act provisions.

2.4.2. Continual Process Improvement

Continual process improvement at SCDOT encompasses many different strategies. The agency continues to seek insights from regional, national, and international best practices and standards in transportation asset management to improve its way of doing business and serving the citizens of South Carolina and roadway users. SCDOT uses transportation asset management principles to plan investment decisions, implement strategic decisions, create a knowledge base for informed decision-making, and determine whether the effects of its strategies are moving toward its goals and objectives. SCDOT uses results from these processes to make flexible, effective, and efficient improvements in programmatic, contractual, and financial management in the agency. Some other efforts to ensure continual process improvement at SCDOT include, but are not limited to, peer-to-peer exchanges, webinars, National Highway Institute trainings, and workshops. Specifically, SCDOT has targeted the following strategies to improve transportation asset management practices:

- Collaborate with local transportation and transit operators to enable a broader functionality of the transportation system;
- Develop robust deterioration models for pavement and bridge assets to better predict asset condition and inform treatment selection;
- Develop analytical tools capable of performing scenario and cross-assets/program tradeoff analysis to inform decision-making;
- Develop effective methods to incorporate other assets beyond pavements and bridges;
- Improve the dissemination of information to the general public on the state of asset condition and system performance, including highlighting performance through dashboards on SCDOT's webpage; and
- Engage with Metropolitan Planning Organizations, Council of Governments, and County Transportation Committees by hosting and facilitating regional transportation forums with agency headquarter and district staff.

2.5. Benefits to Citizens of South Carolina

SCDOT's overall goals with transportation asset management are to preserve its transportation infrastructure at a minimum practicable cost over the service life of the assets, incorporate risk analyses to ensure the risks that jeopardize projects are mitigated, and perform tradeoff analyses in decision making to achieve greater benefits. For South Carolina citizens and its economy to be competitive now and in the future, the State must maintain a functional and resilient transportation system. Good asset management practices help SCDOT explore strategies to efficiently carry South Carolina's transportation system through the 21st century.

SCDOT understands that reliable transportation is the backbone of a robust and thriving economy, and investments in transportation must be made effectively to improve the economic and social quality of life for the citizens of the State. The benefits and importance of asset management impact every citizen of the State. A well-maintained and preserved transportation system helps revitalize business districts. Furthermore, individual citizens save time and money from reduced congestion and vehicle maintenance costs. Asset management enables SCDOT to identify future demands and strategize for long-term planning and maintenance of the State's transportation system.

CHAPTER 3

WHOLE LIFE MANAGEMENT OF ASSETS

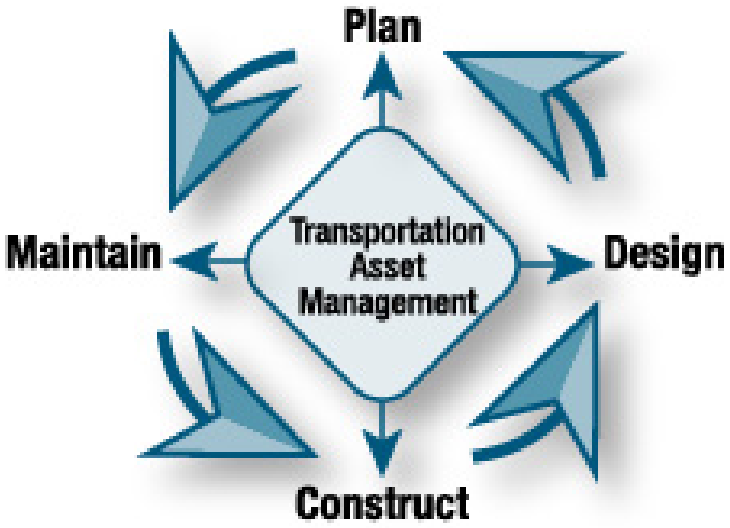
3. Whole Life Management of Assets

3.1. Overview

This chapter reviews the practice of Whole Life Management (WLM) of assets at SCDOT. WLM embodies quality management of physical infrastructure. It is a practice that utilizes the principles of engineering economics to evaluate the overall long-term economic efficiencies between competing alternative investments. The practice allows for cost comparison of alternatives across an extended time horizon needed to achieve defined levels of performance. WLM is analogous with the concept of Life-Cycle Cost Analysis (LCCA), as it considers costs associated directly with constructing and operating an asset, as well as other costs over the full service life of the asset, such as preservation, repair, and preventative maintenance costs.

As shown in Figure 3-1, the transportation asset management lifecycle spans four distinct stages: planning, design, construction, and maintenance. In each phase of the lifecycle, a variety of treatments, analysis methodologies, data, and assumptions impact the specific asset. As a result, WLM practices will differ across these phases.

Figure 3-1. The Asset Life Cycle



WLM promotes the proactive management of physical infrastructure assets across their lifespans. Incorporating WLM principles can replace the ”worst-first” approach of transportation infrastructure decision-making in favor of a realistic, informed, long-term series of actions that extend the life of the asset. Taking a worst-first approach results in an ever-increasing number of pavements in poor condition because focusing on resource-intensive reconstruction projects diverts resources from more cost-effective preservation treatments that maintain pavements in a good condition. Worst-first is a never-ending cycle and creates a heavy financial burden that most state transportation agencies cannot bear. SCDOT therefore developed its pavement program to include funding dedicated to preservation

activities targeted toward pavements in an existing good condition rather than follow a strict "worst-first" approach.

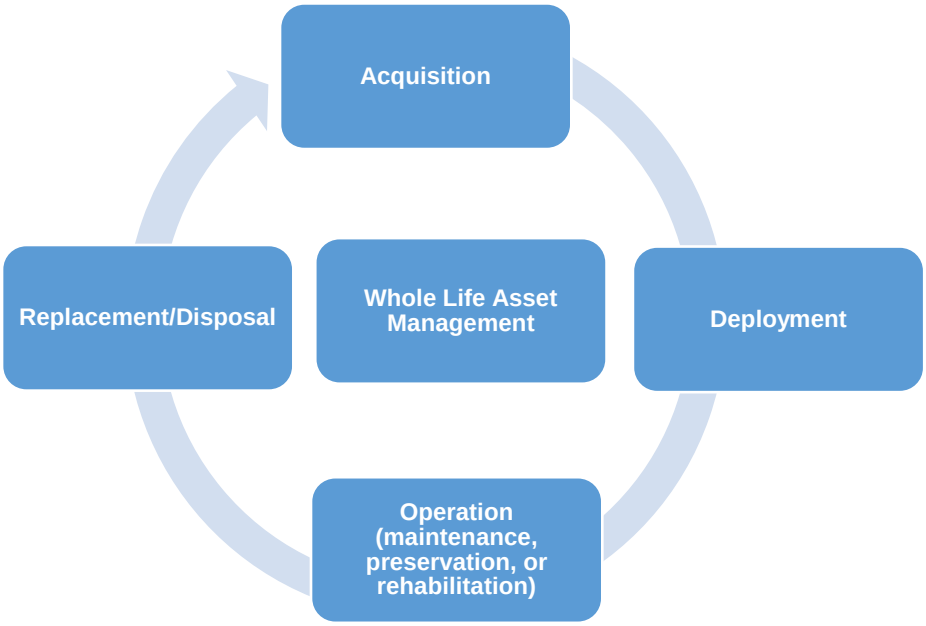
The outcome of this planning facilitates the development of investment options that address key strategic issues, including:

- Enhanced safety,
- Improved asset conditions,
- Enhanced reliable transportation system, and
- Reduced risks at the minimum practicable cost extending the life of the asset.

Life-Cycle Cost Basics

Figure 3-2 shows a graphical representation of the WLM of a physical infrastructure asset from Acquisition, when an asset is conceived, scoped, designed, and constructed, to Replacement/Disposal, when an asset is replaced or retired, decommissioned, or demolished. The time period between deployment and replacement/disposal can be envisioned as the actual service life of an asset. Information gathered throughout these phases provides relevant insight to the timing and selection of appropriate interventions. It should be noted that while this figure accurately depicts the life cycle of bridge assets, it is SCDOT's goal to strategically prolong its other assets' lives by optimizing a combination of preservation and rehabilitation activities to achieve the best asset conditions possible.

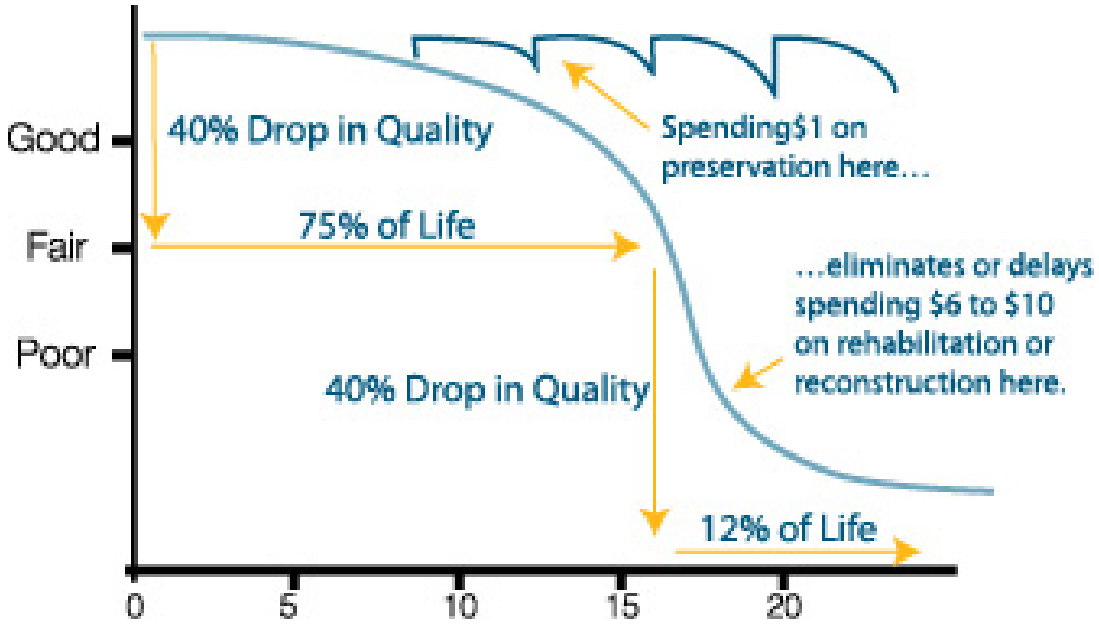
Figure 3-2. Representation of Whole Life Asset Management Approach



The relationship between age and intervention type in achieving a targeted or desired operation condition is vital to WLM. Each time SCDOT undertakes a particular intervention method, such as maintenance, preservation, or rehabilitation, during the operation phase the remaining service life (RSL) of the asset is improved or the asset is delayed from moving into

the disposal stage. Furthermore, Figure 3-3 (adopted from Galehouse et al. 2003) shows that each time a timely intervention is applied, the RSL of the asset is extended. On the other hand, if an asset is allowed to deteriorate past specific trigger points, by delaying maintenance or intervention for example, the results in cost can increase significantly.

Figure 3-3. Deterioration Curve of a Pavement Asset



FHWA report FHWA-SA-98-079, *LCC Analysis in Pavement Design*, defines LCCA as:

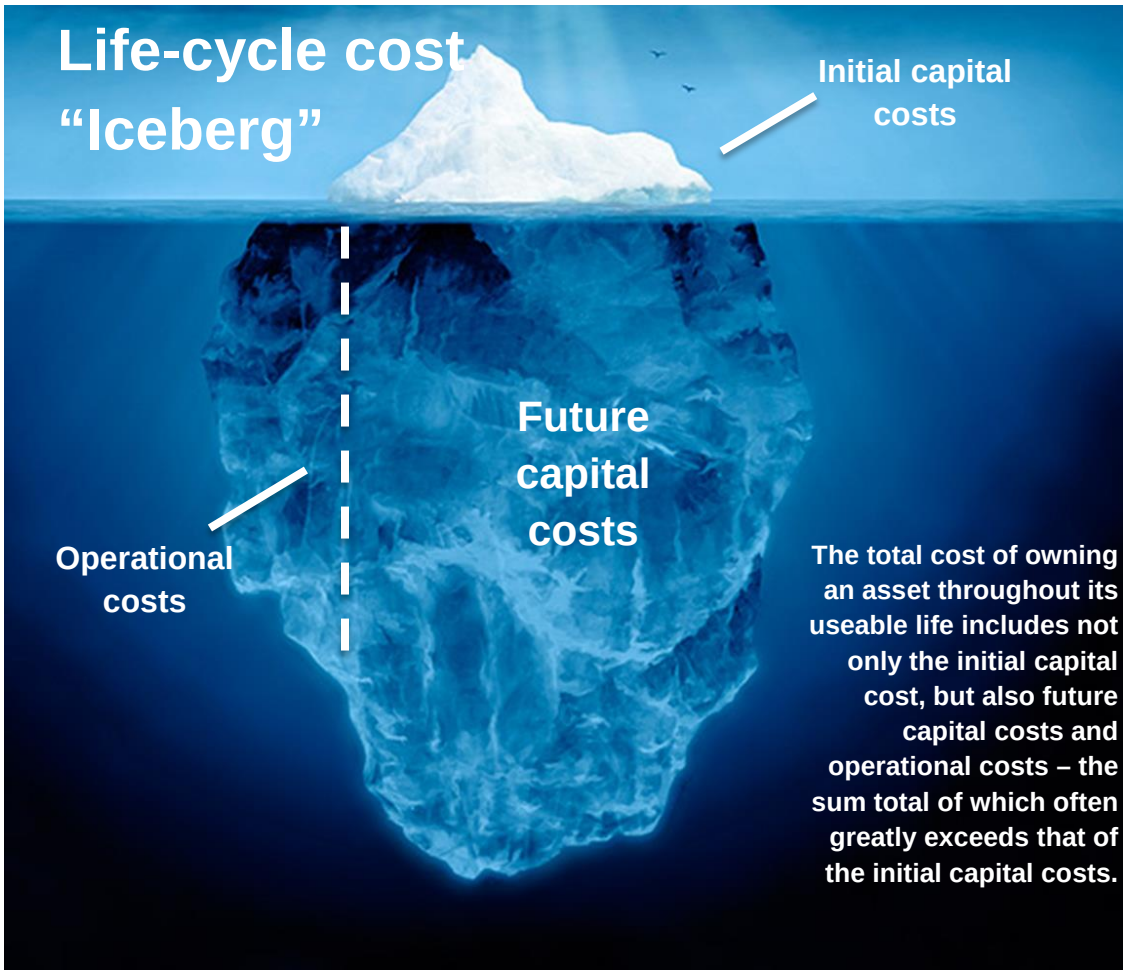
"[A]n analysis technique that builds on the well-founded principles of economic analysis to evaluate the over-all-long-term economic efficiency between competing alternative investment options." The report further states that "[LCCA] does not address equity issues. It incorporates initial and discounted future agency, user, and other relevant costs over the life of alternative investments. It attempts to identify the best value (the lowest long-term cost that satisfies the performance objective being sought) for investment expenditures."

To estimate LCC, an agency has to account for how the value of money changes over time, including:

- Discounting: A dollar today is worth more than a dollar next year because it can be invested and earn interest;
- Inflation: The costs of materials tend to increase over time; and
- Depreciation: The value of an asset tends to decline over time.

Estimating LCC requires the tracking of all asset operational costs (maintenance, preservation, and rehabilitation); the change in asset condition over time based on geography, climate, substructure, and vehicle loading; and the impact of operational costs on condition. LCC resembles an iceberg; the vast majority of cost is in the future, or "below the surface", as shown in Figure 3-4.

Figure 3-4. The Iceberg Concept in Lifecycle Cost



Multiple data sources are used to compare alternatives by expressing each alternative using a common metric that rolls the entire LCC into a single number such as Net Present Value or Benefit-Cost Ratio, allowing for an "apples to apples" comparison. Based on this analysis, an alternative with better cost-effectiveness may be chosen over the initial design. In addition, life cycle approaches not only provide for a justified selection between competing alternatives, but also provide for a greater understanding of the factors that influence cost effectiveness, including design, construction, maintenance, and operational costs.

3.2. CURRENT APPLICATION OF LCC CONSIDERATIONS AT SCDOT

LCCA relies on complete, consistent, and quality data to generate useful information. SCDOT makes the best use of limited available data in conjunction with expert knowledge to generate a fair estimate of long-term costs required for asset sustainability.

Once a project has been selected, such as adding capacity or reconstructing an existing asset, SCDOT engineers explore a variety of pavement design options, which includes the type of pavement materials. For most pavement projects on non-National Highway System (NHS) Primary and Secondary systems, SCDOT engineers look at a variety of factors, giving high weight to lowest initial cost and constructability. This includes such factors as the practical use of the pavement and the design and material of adjacent pavements. Choosing the same pavement design utilized for an adjacent road reduces future maintenance costs by allowing SCDOT to use the same pavement treatment methods on both road segments. Based on conditions in South Carolina, the main pavement type on Primary and Secondary systems is asphalt pavement.

For interstate widenings and reconstruction projects, in addition to calculating initial construction costs, the engineers calculate the cost of managing an asset over a period of 50 years under each design option. The analysis incorporates the present value of future costs associated with asset maintenance and preservation, modeling its projected deterioration based on forecast traffic conditions and proposed treatment types.

For cases in which different designs are projected to cost similar amounts in terms of present value, the engineers also consider user costs under each scenario associated with projected delay during periods of maintenance and reconstruction. After performing this scenario analysis, an advisory committee consisting of representatives from offices of the Directors of Construction and Maintenance convene to determine what design should be bid for contract. Engineering Directive (ED) 15 outlines the pavement selection process described above and is included as Appendix A.

The Division of Maintenance and Office of Construction are required to use WLM principles to select asset preservation projects in a given budget year. To help inform their decision, they use a table of expected service life of pavement treatments for planning analysis. Current service life expectations for selected rehabilitation and preservation treatments are shown in Table 3-1, which also highlights the wide range of treatments and their performance for planning purposes. SCDOT continues to refine the expected life characteristics of several treatments to better inform decision making. For example, SCDOT is working with researchers from Clemson University and the National Center for Asphalt Technology to develop more accurate deterioration curves for different treatment types.

Table 3-1. Expected Service Life of Selected Treatments

Treatment	Years (Pavement Service Life)	
	Low	High
Crack Seal	2	3
Chip Seal	4	6
Microsurfacing	5	7
Open Graded Friction Course	6	8
General Rehab	7	20
Mill & Replace 1”- 2”	8	10
Overlay < 200 PSY	9	12
Mill & Replace 2”- 4”	10	12
Overlay 400 PSY	10	30
Overlay > 400 PSY	10	30
Reconstruction	10	30
Mill & Replace 2”- 4” + Overlay 200 PSY	11	15
Section Reclamation	12	15
Mill & Replace 1”- 2” + Overlay 400 PSY	17	20
Mill & Replace 2”- 4” + Overlay 400 PSY	17	20
IC 2”- 4” + Overlay 150-200 PSY	17	20
IC 4”- 6” + Overlay 150-200 PSY	17	20

Note: PSY = pound per square yard; IC = Intermediate Course

Ideally, SCDOT would apply preservation treatments to assets in good condition to maintain their level of service. However, there are times when SCDOT must balance selecting projects using WLM principles with the need to fix some roadways or bridges that are in such disrepair that they may become a safety hazard to the traveling public. In other instances, the routes that are important to the State as a strategic corridor or freight network may require higher prioritization to ensure the efficient movement of goods. As a result, SCDOT implements a balanced approach that considers risks and asset performance in selecting projects for preservation, rehabilitation, or reconstruction.

3.3. Impact of Adding Capacity and Design Characteristics

Effective asset management practice and transportation planning take into consideration future demands and system needs. However, with added capacity come increased maintenance costs. This presents a continuous business challenge that requires SCDOT to balance between competing demands, needs, and associated risks.

The Agency realizes that by adding capacity future maintenance costs increase in kind, however, it is not a significant determinant whether or not the agency moves forward with a capacity building project. Factors such as rapid growth in the major urban centers, emerging land use patterns, public safety, mobility level of service, air quality, and freight needs play a greater role in the agency's determination as to whether or not it will pursue a capacity project.

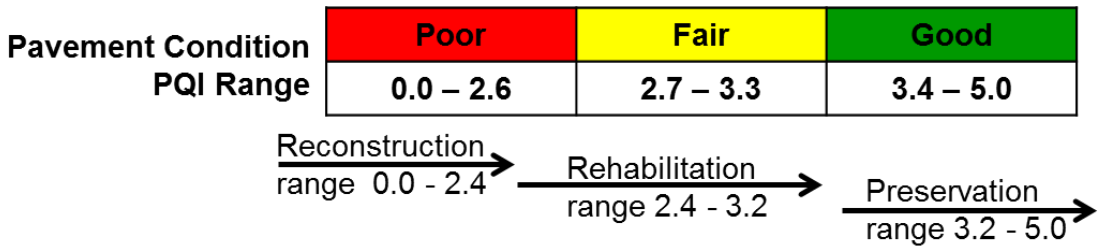
3.4. PAVEMENT MANAGEMENT

SCDOT developed a dedicated Pavement Management Office and began the collection of pavement condition data in the early 1990s. The Road Data Services Department within SCDOT's Division of Intermodal Planning includes the Pavement Management, GIS Collection, and Inventory sections. These sections are responsible for the collection, processing, analyzing, and reporting of pavement condition and traffic counts for over 41,000 centerline miles of interstate, non-interstate NHS, non-NHS primary, Federal Aid secondary, and Non-Federal Aid secondary roads within the State.

SCDOT uses a semi-automated methodology for pavement data collection and a proprietary system (Highway Pavement Management Application) for its pavement management software. Observed pavement conditions and computer-assisted programs combined with the data recorded through profiling equipment produce a representation of the pavement surface condition. Pavement condition is reported in a pavement quality index (PQI), incorporating roughness, rutting, cracking, patching, and raveling, which was developed for South Carolina to reflect the types of pavement deterioration typically found within the State.

The PQI consists of two components: Pavement Serviceability Index (PSI) and Pavement Distress Index (PDI) – the former measures rutting and roughness and the latter measures pavement distress (cracking, raveling). PQI is first used to determine pavement treatment candidates based on the scale shown in Figure 3-5. However, project selection for interstate rehabilitation projects is based on approved criteria and the components that make up the PQI, which is outlined in Appendix B.

Figure 3-5. PQI Ranges Suitable for Treatment Types



The treatment types are defined as:

- Reconstruction – usually involves the complete replacement of the pavement structure.
- Rehabilitation – structural enhancements to improve a pavement's load carrying capability – e.g., adding additional layers of asphalt.
- Preservation – low cost treatments such as chip seal, crack sealing, or ultrathin asphalt overlays placed on a pavement asset to sustain it at or improve it to a good condition.

The current pavement management system (PMS) has 15 to 20 years of collected data on the interstate system. Since 2007, a dedicated effort to improve the quality of data on the other tiers of the state-maintained system has been underway. Data are updated quarterly to reflect completed construction projects that changed pavement conditions. The SCDOT Pavement Management System provides a three-year outlook on its pavement inventory. It uses decision trees to determine the appropriate pavement treatment based on standard decision cycles accounting for typical deterioration, which may vary by system tier and pavement type.

Along with using PMS to manage its pavement asset inventories, SCDOT uses PMS to make recommendations on potential project candidates and to project future conditions based on specific funding levels. Current pavement condition data is collected and modeled for future performance based on historic pavement performance trends. The costs associated with pavement treatments are derived from SCDOT's bid history of construction lettings and updated annually. These costs are entered into the PMS and used to model an expected performance level over different periods using predefined levels of funding, which are adjusted 2.2% annually for inflation.

The goal of any pavement management effort is to systematically address the majority of roads before they deteriorate to the point that reconstruction is required. Pavement management preferred practices and the influence of WLM start with strong pavement design principles. SCDOT has outlined a primary goal for its pavement design activities: *to provide the most cost-effective pavement structure while optimizing the level of service provided to road users*. This goal considers multiple factors, including: construction considerations, initial cost, adjacent existing pavement, and ease of maintenance.

As noted, SCDOT uses a 50-year analysis period for benefit cost analysis for selected pavement design projects. Engineering Directives 52, 63, 64, and 65 (attached as Appendices B and C), which outline the pavement improvement project prioritizations for Interstates, Primary, federal-aid Secondary, and non-federal aid Secondary routes, allow for a point system to be used in ranking candidate projects. For non-interstate pavement projects, points are assigned based on various criteria that receive different weights, including: the condition of the pavement based on PQI and IRI, the average daily traffic, the percentage of the road that has been patched or is in need of patching, the average daily truck traffic, whether the road is part of the state freight and/or strategic corridor networks, the functional classification

of the road, and whether the road is part of the state safety program. For interstates, ranking is based on:

- Pavement condition (65%);
- Average daily traffic (10%);
- Average daily truck traffic (10%);
- Pavement Maintenance costs (10%); and
- Location and significance to the community or local businesses (5%).

SCDOT applies a proactive approach in preserving its highway system by employing planned pavement maintenance strategies. SCDOT periodically reviews the number of miles that fall into preservation, rehabilitation, and reconstruction activities to ensure that funding is being allocated to each treatment category appropriately. Currently a minimum of ten percent of the funding is allocated for preservation with the remaining funding allocated for rehabilitation and reconstruction based on the percentage of lane miles in each category for each road system. The preservation allocation is reviewed periodically to ensure that there is adequate funding to preserve the pavements that have been reconstructed or rehabilitated. The PMS aids SCDOT in this process by helping determine how funding should be distributed among the categories and then by incorporating WLM principles in determining what projects SCDOT should undertake.

3.5. Bridge Management

Bridge inspections are conducted in accordance with the National Bridge Inspection Standards (NBIS), which were established as part of the Federal-Aid Highway Act of 1970.

SCDOT classifies bridge deficiencies identified during inspections according to work priority based on the impact the deficiency has on the load carrying capacity of the bridge or the safety of the motoring public. Bridgework priorities identified during inspections are entered and tracked in the Highway Maintenance Management System (HMMS) Bridge Deficiency Module. Since these bridge safety inspections capture all of the various maintenance needs that a bridge may have, the deficiencies discovered determine the preservation and rehabilitation work needed to sustain a desired state of good repair over the lifecycle of the bridge at minimum practical cost. These priorities consist of:

1. Priority A – Identify any deficiencies that would require posting a reduction in load carrying capacity or a closure of the structure. These repairs are to be performed immediately.

2. Priority B – Any structure condition that adversely affects the safety of the traveling public or one that may require a reduction in the load capacity or may require closure. Work should be performed within a reasonable time frame. If not, posting or closure may be recommended.

3. Priority C – Maintenance items that do not immediately affect the load carrying capacity of the bridge or the safety of the traveling public but, if left unattended,

progresses to Priority A or B condition. Work to correct these deficiencies should be completed within one year of discovery.

For bridge replacements, SCDOT prioritizes the selection of bridges following Act 114 criteria. Engineering Directives 68, 69, and 70 (attached as Appendix D), which outline bridge replacement project prioritization processes for NHS, non-NHS, and load restricted bridges, allow for a point system to be used in ranking candidate projects. Points are assigned based on objective data, including structural condition, traffic status, Average Daily Traffic, Average Daily Truck Traffic percentage, detour length, and whether the bridge is on the Strategic or Freight networks. Points are also allocated using engineering judgment, including district repair feasibility and future industrial and housing development. Only bridges that are rated as structurally deficient based on the National Bridge Inventory (NBI) scale are considered as replacement candidates. Targeting structurally deficient bridges and closed or load restricted bridges is a strategic priority of SCDOT. Prioritization and ranking is considered every two years for approval by the Transportation Commission.

Upon Commission approval, a prioritized list is created for structurally deficient bridges on the NHS and load restricted bridges, and is sent to the Office of Preconstruction, which determines project cost and looks at other factors, such as if the potential bridge replacement would conflict with other projects under design or development. Projects are developed through various implementation strategies that best suit the characteristics and needs of the project based on local input. The proposed project delivery plan is submitted to the planning office to determine financial availability and then inserted into the STIP.

SCDOT is currently reevaluating its process and incorporating additional life cycle planning processes in its bridge management practices. Traditionally SCDOT's Bridge Management Program has focused primarily on bridge replacements. In 2014, the Commission approved a multi-year bridge rehabilitation program that included deck replacements, and major repairs to over 50 bridges. Completion of this program has been delayed due to emergency weather events that have occurred each year since 2015. SCDOT has utilized significant resources to repair and replace bridges damaged or destroyed by these events. However, SCDOT realizes that a complete bridge management approach must include not only replacement, but also rehabilitation and preservation in order to get the longest service life possible from its bridge investment. The bridge preservation program has traditionally included deck repair, joint replacement, and painting of structural steel. SCDOT is looking for ways to move to a more WLM approach with the bridge program. This will be aided by using the latest version of the BrM bridge management software to expand the rehabilitation and preservation programs using the software's modeling capabilities to ensure the right bridges are selected for rehabilitation and preservation at the most appropriate time. SCDOT continues to look for ways to move away from a reactive Bridge Asset Management Program to one that is more proactive.

Management of Coastal Bridges

To assist in management of SCDOT's complex bridges, an asset management contract is in place to inspect and maintain select fixed and movable coastal bridges in Beaufort, Berkeley,

Charleston, and Horry County. Work under this contract includes sweeping, routine inspections and repairs approved by the SCDOT's Feasible Action Review Committee.

Use of Consultant Services

SCDOT has expanded its use of consultant services in the areas of bridge inspection and load rating in order to balance its internal workload and improve the bridge inspection program. Contracts have been awarded to a team of consultants to assist in completing required load ratings and inspections as necessary. This includes load rating the entire bridge inventory, the results of which could have significant impacts on this plan should the results require load restriction on a large number of bridges. Tasks in their scope of work include:

- Load Rating & Load Testing
- AASHTO Ware BrM & BrR – Specialized Programming & Training
- SCDOT Load Rating and Inspection Guidance Documents
- Hexagon iHaul Oversize/Overweight Routing System
- Bridge Inspections

The SCDOT works closely with the FHWA to ensure that its bridge inspection program meets all federal requirements.

3.6. Maintenance Decision Making and Whole Life Management

The Director of Maintenance is responsible for the development and implementation of policy for maintenance of roads and bridges. Historically, funding for maintenance activities has been the largest obstacle for addressing maintenance in a more proactive manner using WLM. Due to past funding levels, traditionally, SCDOT reacted to pressing maintenance concerns by addressing conditions in the order of the worst first and did not have available funding to proactively maintain its assets in better condition.

By showing the needs of its existing assets, SCDOT secured additional funding from a historic 12-cent increase in the state gas tax, of which a majority is being allocated to preserving its existing assets. This process included developing "performance curves" (which are included in the Investment Strategies Chapter), that project asset conditions in 10-years for SCDOT's different pavement and bridge systems based on outputs from the agency's pavement and bridge management systems.

Using results of this life-cycle planning process, the SCDOT Secretary of Transportation presented potential investment strategies to the legislature. The presentation outlined projected conditions of the state-maintained pavement and bridge systems if the agency were to receive additional revenue compared with condition targets without an increase in revenue. This life-cycle planning process was the basis for the investment strategies detailed in the

Investment Strategies Chapter of this TAMP that lead to the agency's ten-year condition targets. These ten-year investment strategies will help move the agency's assets toward a state of good repair.

In addition, SCDOT is currently pursuing a request for proposals for enterprise-level asset management software that will allow it to perform more robust analyses and more thoroughly involve life cycle planning at the network and agency level. Further discussion about the future of transportation asset management at SCDOT is included in Chapter 8.

CHAPTER 4
STATE OF THE SYSTEM

4. State of the System

4.1. Overview

This chapter reviews the state of SCDOT's highway transportation system. In a broader transportation asset management context, the State of the System provides information regarding the trend of system demands, physical infrastructure inventory, and existing condition. This information is vital in system and financial planning to meet current and future needs of the State's highway system. The subsections in this chapter review the demand for transportation, asset inventory, and condition.

4.2. Demand—Past, Present, Future

Continual changes in demographics and socioeconomic characteristics in South Carolina, coupled with aging transportation infrastructure, have increasingly overburdened the State's highway transportation system. In times of declining and limited resources, the issue is amplified. These trends inform the process of forecasting future system demands and planning for these demands. For enhanced decision making as it relates to transportation infrastructure investment, SCDOT relies upon quality information derived from important historic trends, such as population, employment, and traffic growth. South Carolina was 10th in the nation for population growth between 2000 and 2010 according to the US Census Bureau and the State's population increased by 15.3 percent over this period. South Carolina's population is expected to grow an additional 31 percent by 2040, with a corresponding household growth of 32 percent over that same period.[2] In addition, South Carolina experienced 1.6% job growth in 2018 according to the Bureau of Labor Statistics Quarterly Census of Employment and Wages.

Table 4-1 shows a breakdown of population growth in South Carolina. A correlation exists between household and employment growth and trip generation. As population and the number of households increase, more trips are generated through commuting, shopping, and other day-to-day activities. SCDOT considers these forecasted growth numbers on future demands on the system and accordingly plans to manage the impacts on the transportation network.

[1] Per the 2014 South Carolina Multimodal Transportation Plan

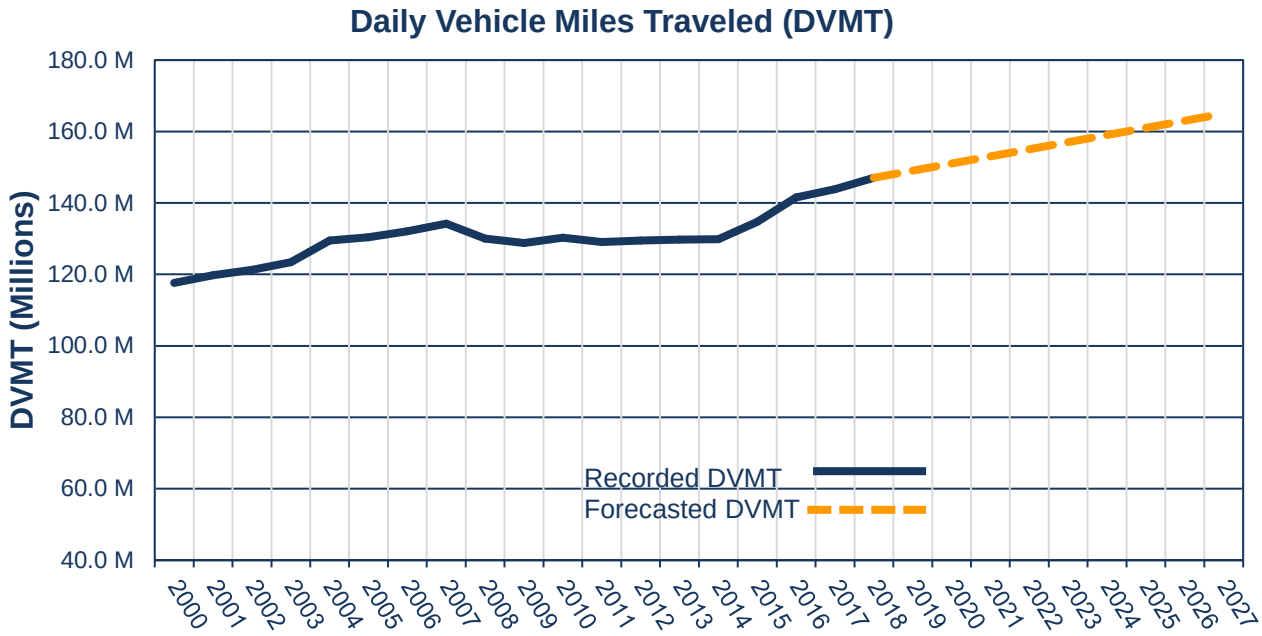
Table 4-1. South Carolina Demographic and Socioeconomic Projections

Demographic	Base Year (2010)	Forecast Year (2040)	Forecast Growth (%)	Annual Growth (%)
Population	4,625,000	6,061,000	31.0	0.91
Household	1,801,000	2,379,000	32.1	0.93
Employment	2,037,000	2,758,000	35.4	1.02

[2] Source: South Carolina Multimodal Transportation Plan, 2014

The change in Daily Vehicle Miles Traveled (DVMT) over the years in South Carolina is similar to trends exhibited nationwide. DVMT in South Carolina stayed consistent between 2009 and 2013, which was largely attributable to the recession between 2007 and 2009. Figure 4-1 shows the DVMT trends in South Carolina between 2009 and 2017 and forecast out to 2027. The figure shows that DVMT has sharply risen since 2013 and peaked in the year 2017 with over 152 million DVMT, which is the most daily miles traveled since SCDOT began tracking the measure. DVMT is projected to increase one percent annually through 2027.

Figure 4-1. DVMT Trend in South Carolina[3]



In addition to traffic growth demands, SCDOT will experience system demands due to factors such as aging infrastructure and extreme weather conditions. SCDOT has enhanced its practice of keeping good inventory and condition data for the system in order to facilitate efficient and effective asset management practices. Examples include: more frequently

[3] Road Data Services, Office of Planning, Traffic Engineering, SCDOT

collecting pavement data beginning in 2017, incorporating new pavement data collection technologies on the federal aid system in 2018 and on the non-federal aid system beginning in 2019, implementing new traffic counters that have the ability to classify vehicle types, and employing sensors that monitor the structural health of key bridges and bridge components. SCDOT understands that undertaking these efforts in collecting and analyzing highway and bridge data to inform business decisions is not just good for business, but it is the right thing to do as a steward of public resources.

4.3. ASSET REGISTRY

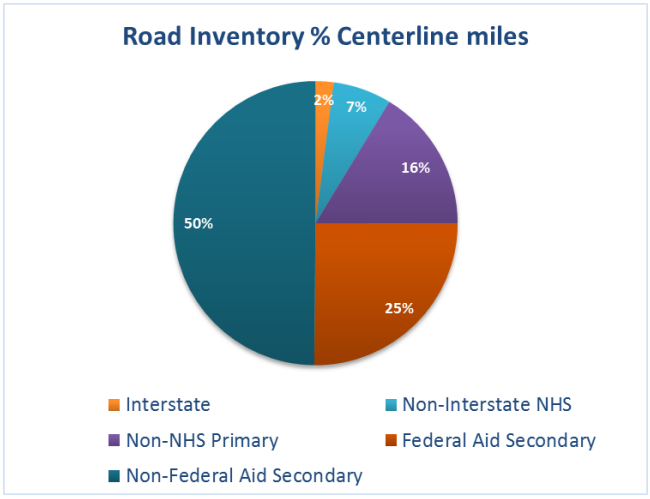
SCDOT's current transportation asset management efforts focus on its pavement and bridge infrastructure assets. South Carolina's transportation system includes the NHS, which includes the interstate system, and other important roadways that are not necessarily a part of the NHS. It is also important to note that SCDOT does not manage certain sections of the non-interstate NHS, totaling approximately 0.2 percent of the non-interstate NHS mileage within the State, or 4.2 centerline miles. SCDOT does collect condition data on these locally owned NHS sections and their condition values are incorporated into the data presented in this report. Even though SCDOT maintains almost all of the interstate and non-interstate NHS in the State, ensuring the smooth operation and better preservation of the NHS requires effective coordination and efficient collaboration with the MPOs and the COGs, who typically program capacity, access management, and similar projects on the non-interstate NHS system.

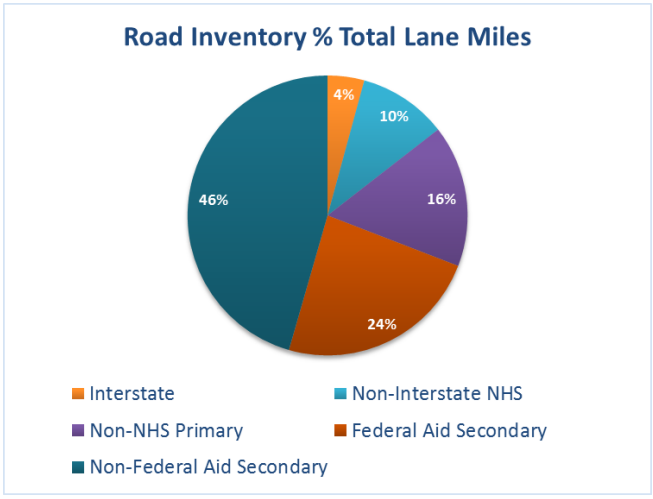
SCDOT owns and maintains over 41,000 centerline miles encompassing over 90,000 lane-miles of roadway. This inventory of roadway mileage makes SCDOT's highway system the fourth largest state-owned system in the United States. Over half of the state-maintained system is not eligible for federal funds. For the purpose of efficient asset management, SCDOT categorizes the State's highway system into five different tiers: Interstate, Non-Interstate NHS, Non-NHS Primary (U.S. highways and SC designated routes), Federal Aid Secondary, and Non-Federal Aid Secondary highways. Table 4-2 shows a breakdown and description of each category maintained by the State. By centerline miles, the NHS accounts for 8.7 percent of the road network maintained by SCDOT.

Table 4-2. SCDOT Road Inventory

System Functional Tier	State-maintained Centerline-miles	State-maintained Lane-miles
Interstate	851	3,846
Non-Interstate NHS	2,747	9,354
Non-NHS Primary	6,761	14,901
Federal Aid Secondary[4]	10,359	21,266
Non-Federal Aid Secondary	20,598	41,309
Total	**41,315**	**90,676**

Figures 4-2 and 4-3 display the percentage breakdown of roadway centerline and lane miles of the SCDOT Roadway inventory.





4.4. Pavement Inventory

SCDOT owns, operates, and maintains a mixture of asphalt, concrete, and composite pavement assets. Pavement assets form the core part of the highway transportation system. As such, SCDOT invests adequate time, human, and financial resources in tracking the quantity and conditions of these core assets.

4.4.1. Pavement Condition Metric

SCDOT understands the importance of maintaining a functional highway system. The agency measures the performance and tracks the condition of its highway infrastructure assets using metrics it has selected to align with its long-term goals. SCDOT tracks asset conditions by using these metrics, which it incorporates into its Pavement Quality Index (PQI) measure. With the move toward a unified national metric reporting standard, SCDOT has also begun measuring pavements by International Roughness Index (IRI), cracking percentage, rutting (for asphalt only), and faulting (for jointed concrete only).

SCDOT tracks and maintains pavement conditions using a pavement management system (PMS) and the Road Inventory Management System (RIMS). These systems support the agency in making informed, strategic investment decisions relating to pavement maintenance and programming. Figure 4-4 through Figure 4-11 show SCDOT's pavement condition trend by functional class based on PQI. PQI scales are shown in Figure 3-5 in the preceding chapter. SCDOT generates these results using the Department's PMS. Figure 4-4 shows that SCDOT is incrementally improving its interstate pavements. Beginning in 2011, SCDOT has kept the percentage of interstate pavements in poor condition around ten percent, while maintaining the percentage of interstate pavements in good condition has risen to 74 percent. SCDOT has managed these conditions through the use of risk-oriented planning and programming by focusing its maintenance efforts on preservation and maintaining mileage quantified as good. The data reveals the returns on the agency's efforts to provide quality ride experiences on the most traveled portions of the pavement network. While interstate pavements comprise 4.2 percent of the road network system, measured by lane miles, they carry approximately 30.1 percent of the DVMT as of 2018.

Figure 4-4. Interstate Pavement System Condition Trend

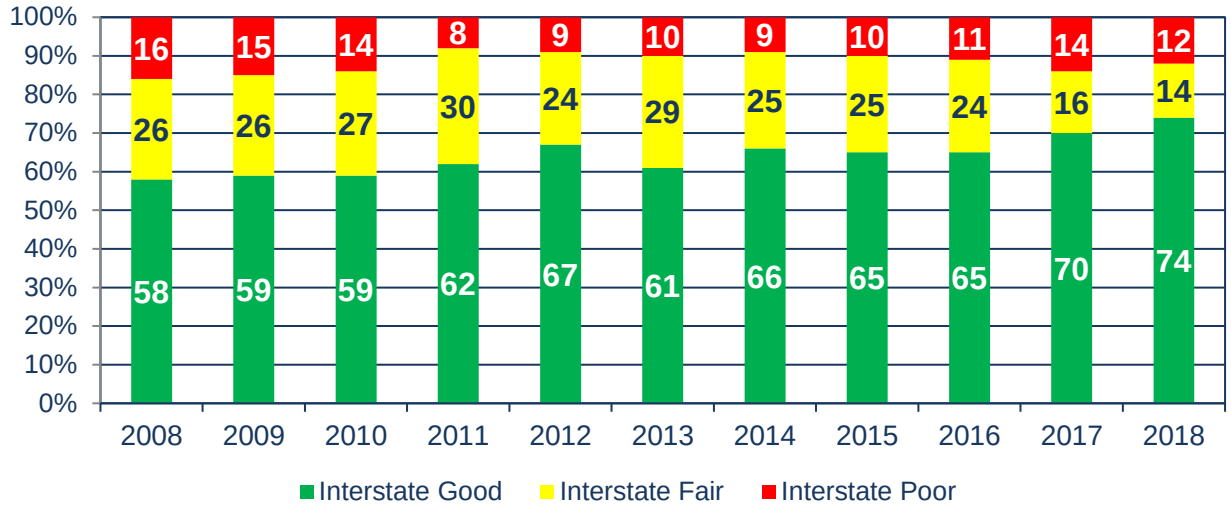


Figure 4 5. Interstate Pavement System Condition Map

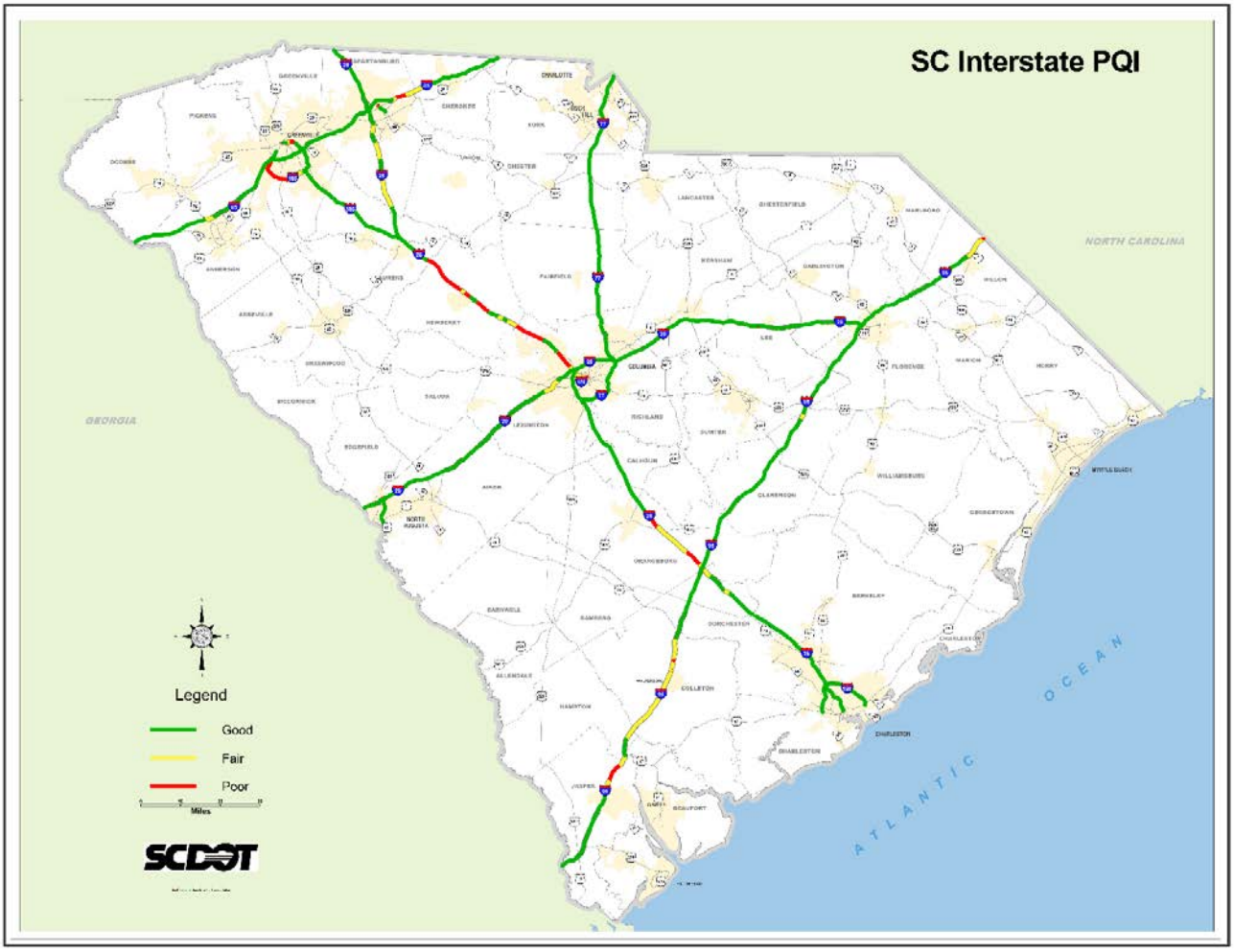


Figure 4-6 through Figure 4-11 show a different story for the other state-maintained systems. All of these systems experienced a double-digit percentage point increase of pavements considered poor using the PQI measure between 2008 and 2018. This is primarily from pavements quantified as fair deteriorating into poor condition. As will be discussed in the Financial and Investment Strategies chapters, these systems have deteriorated because SCDOT historically has had insufficient funds to maintain its system and has had to strategically focus its maintenance projects on certain areas. With increased state revenues, SCDOT intends to prevent further deterioration in its pavement system and begin improving overall pavement condition across all of the systems it maintains.

Figure 4-6. Non-Interstate NHS Primary Pavement System Condition Trend

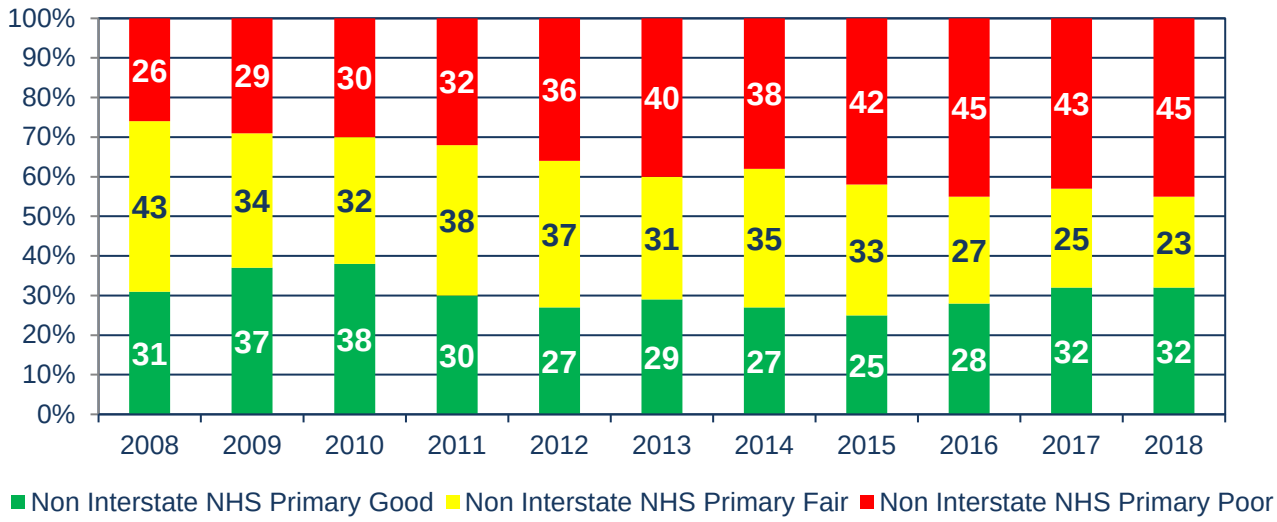


Figure 4-7. Non-Interstate NHS Primary Pavement System Condition Map

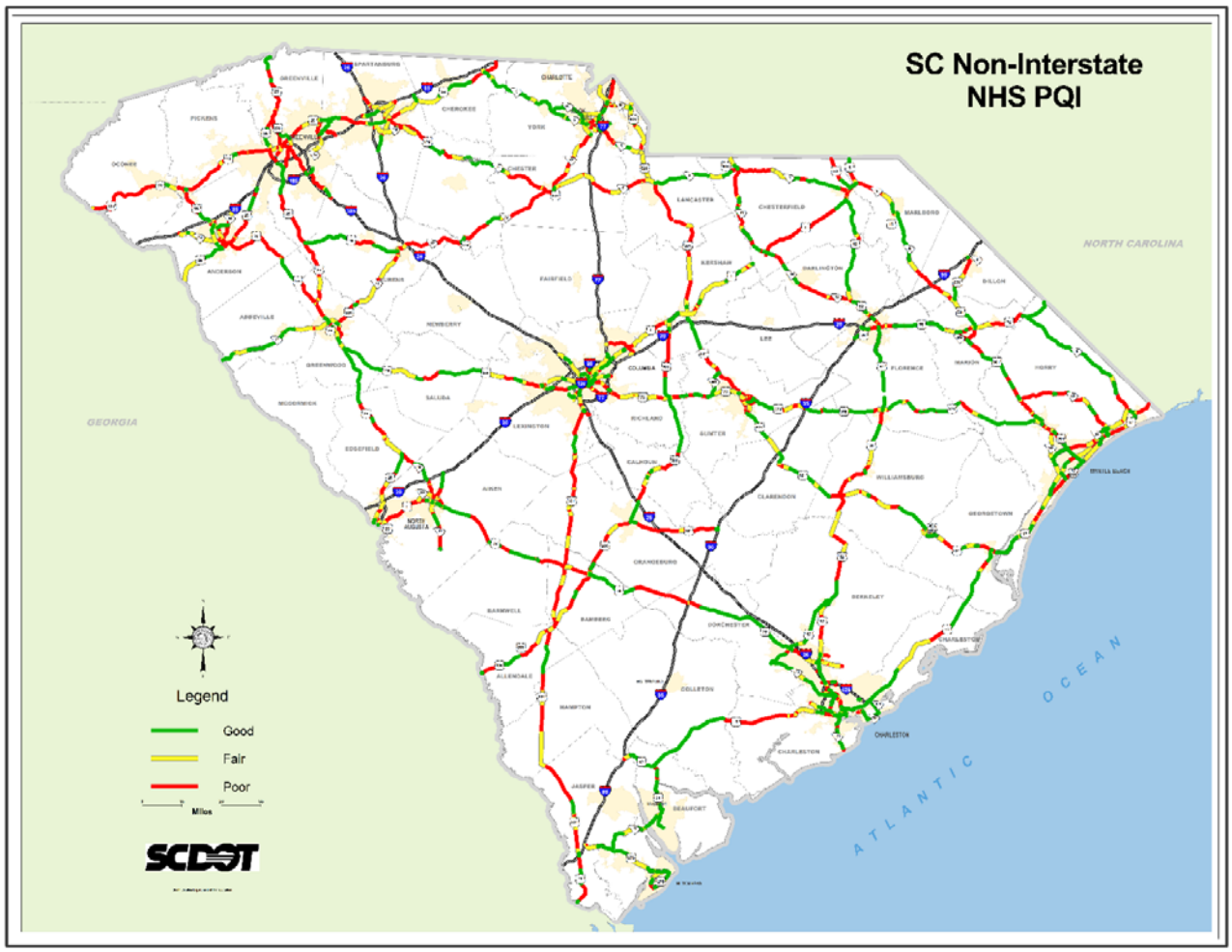


Figure 4-8. Non-NHS Primary Pavement System Condition Trend

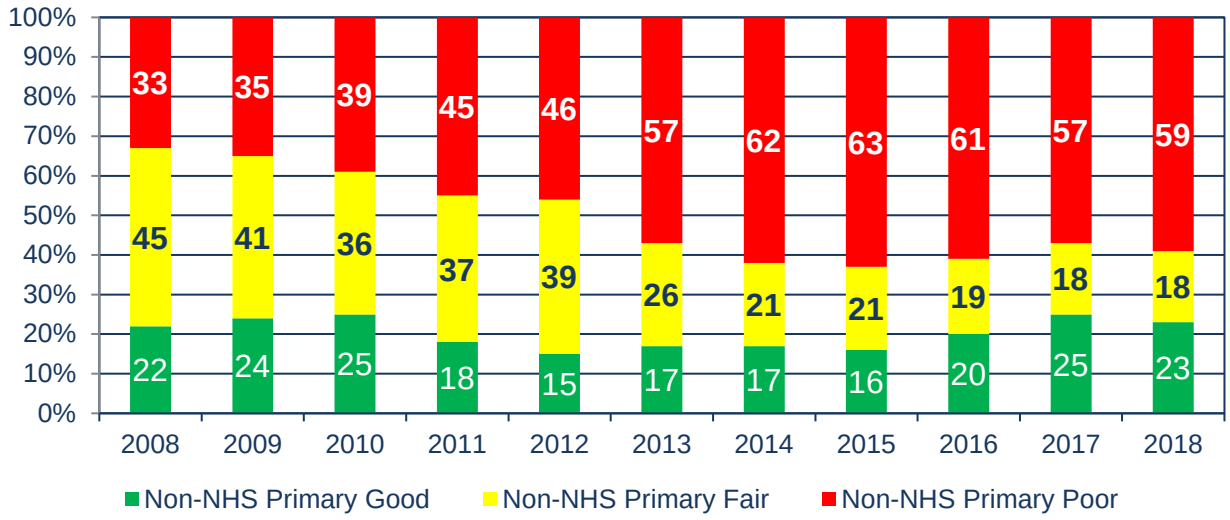


Figure 4-9. Non-NHS Primary Pavement System Condition Map

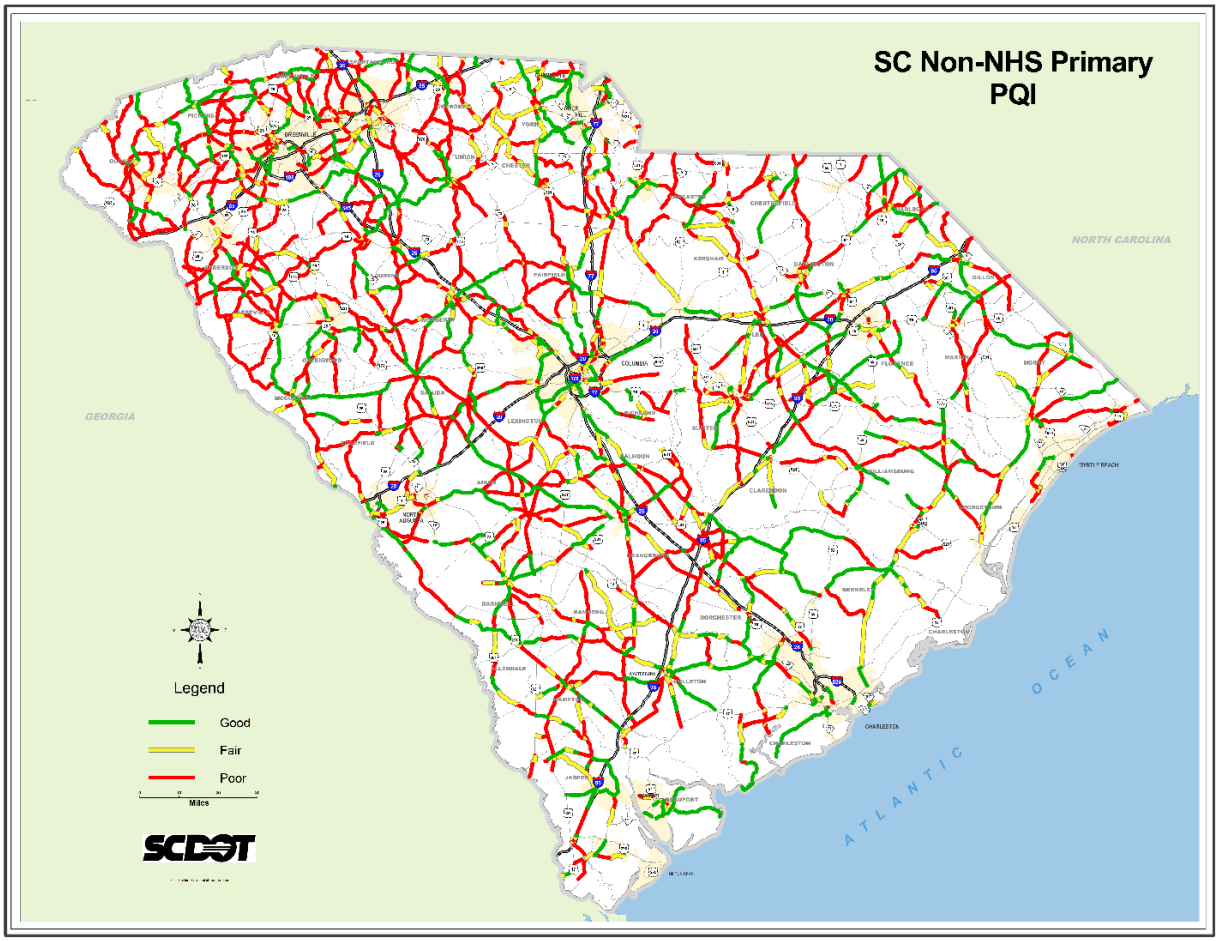


Figure 4-10. Federal Aid Secondary Pavement System Condition Trend

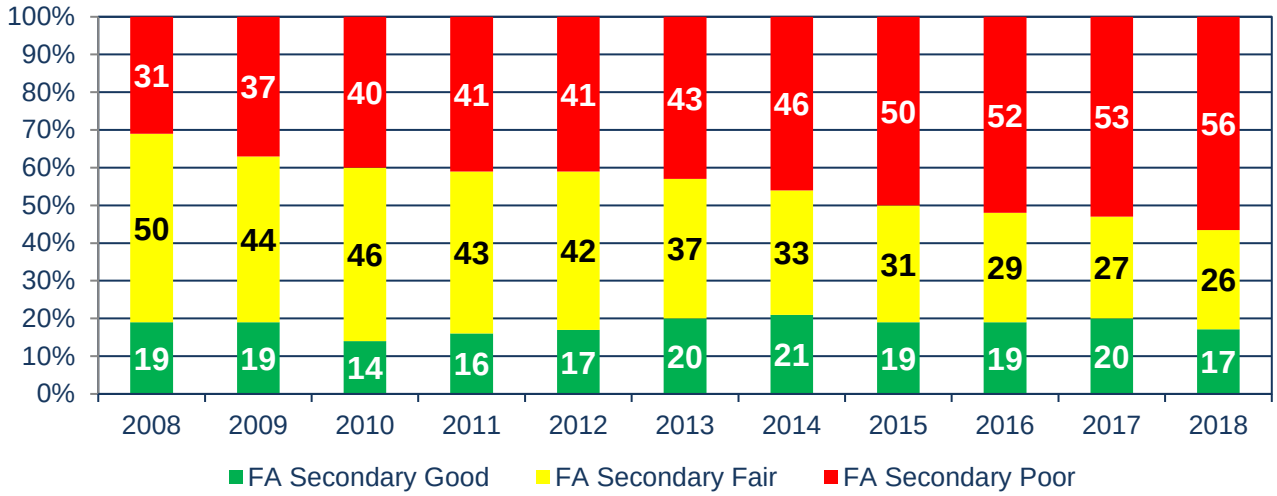


Figure 4-11. Federal Aid Secondary Pavement System Condition Map

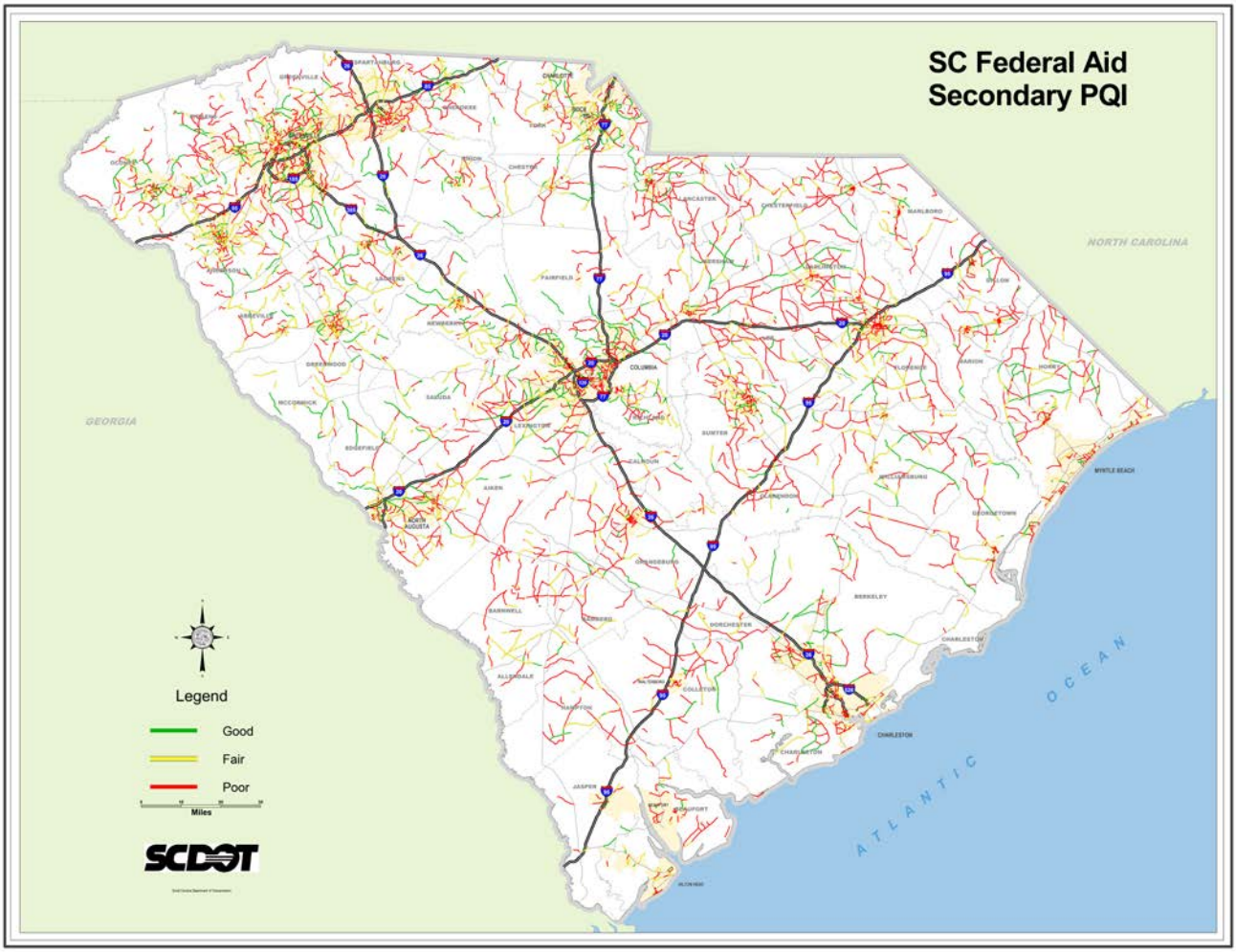


Figure 4-12. Non-Federal Aid Secondary Pavement System Condition Trend

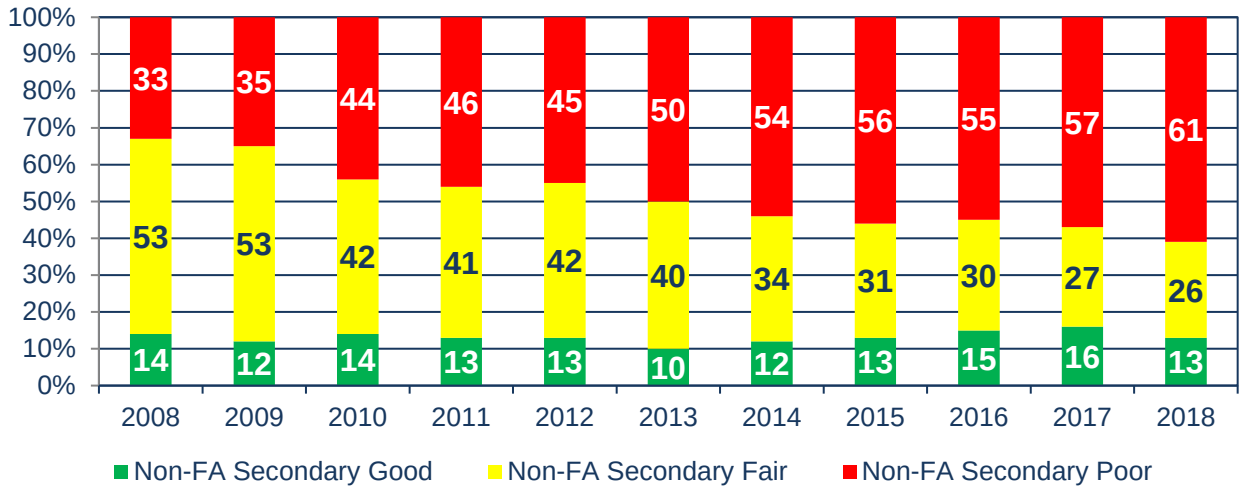
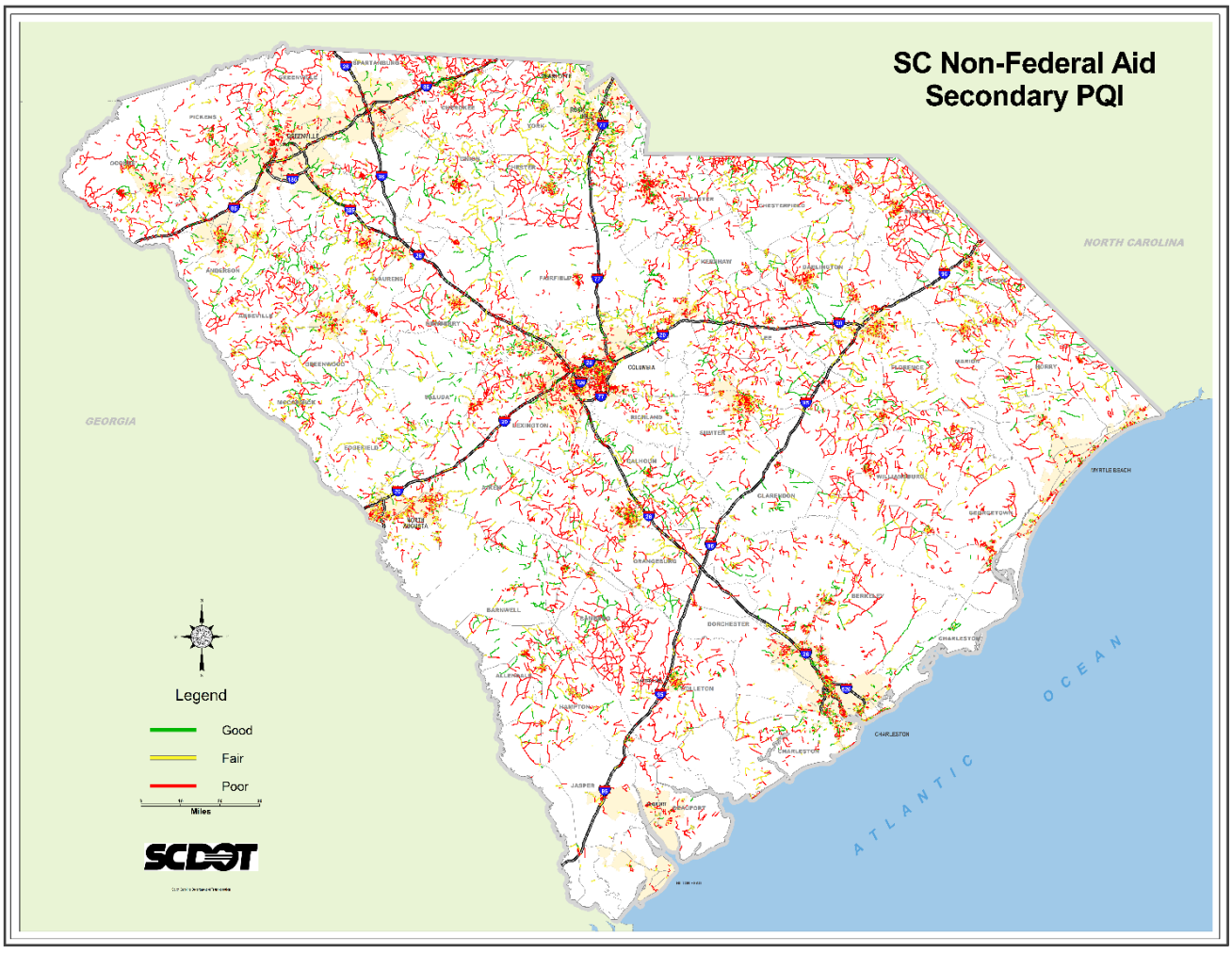


Figure 4-13. Non-Federal Aid Secondary Pavement System Condition Map



4.4.2. Remaining Service Life

Because SCDOT maintains approximately 90,000 lane miles, it has limited resources to adequately maintain its entire system. For example, if all of its pavement assets were maintained once on a ten-year cycle, SCDOT would need to treat 9,000 lane miles annually, which with its historical funding levels has been prohibitive.

Another useful metric to illustrate this principle is remaining service life. Each pavement asset has an initial service life based on its design. As each year passes, every pavement loses one year of service life unless the pavement has been treated, in which case additional service life is added. Figure 4-14 shows the aggregate service life for SCDOT maintained pavements from 2008 to 2018 for the interstate, primary, and secondary systems. In any given year, SCDOT's pavements lose service life equal to the number of lane miles in the system. However, service life is also gained by performing preventative maintenance, rehabilitation, or reconstruction treatments or adding capacity, such as interstate widening projects. Figure 4-15 demonstrates that funding for pavements has increased since 2015 and will continue to increase until 2023. This increase in pavement investments is positively reflected within Figure 4-14 by the consistently decreasing deterioration rates (Improving conditions) of pavements. Should this rate of improvement continue over the next several years, a state of equilibrium could ultimately be achieved. This would result in an even exchange of every mile loss of service life with a mile gained with maintenance, rehabilitation, reconstruction treatments or adding capacity. The goal is to eventually add more years of service life than are lost each year, thus indicating that the condition of the system is improving.

Figure 4-14. Net Change in Pavement Service Life

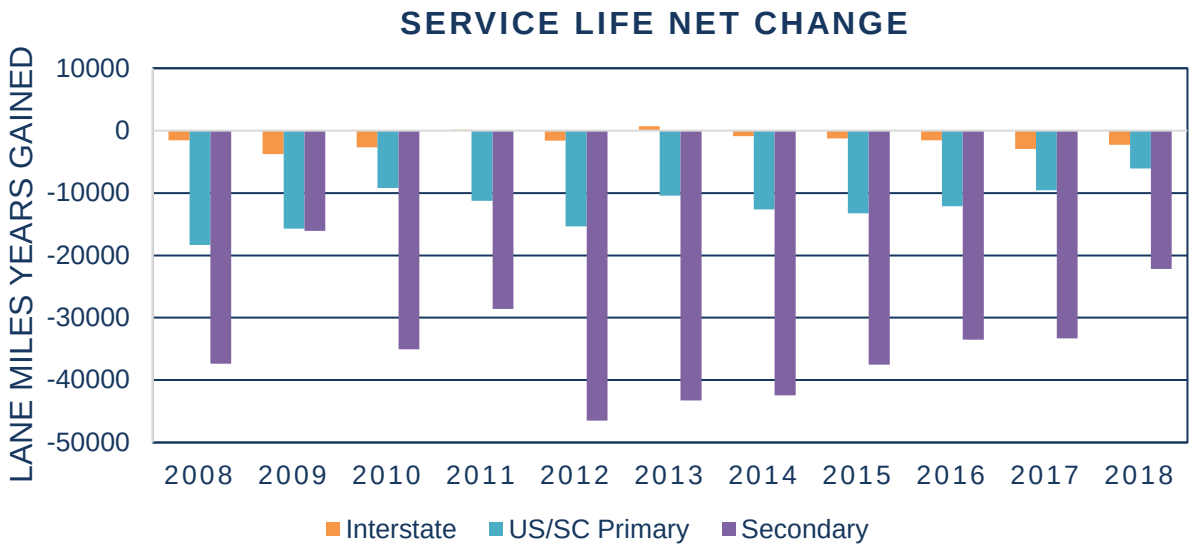
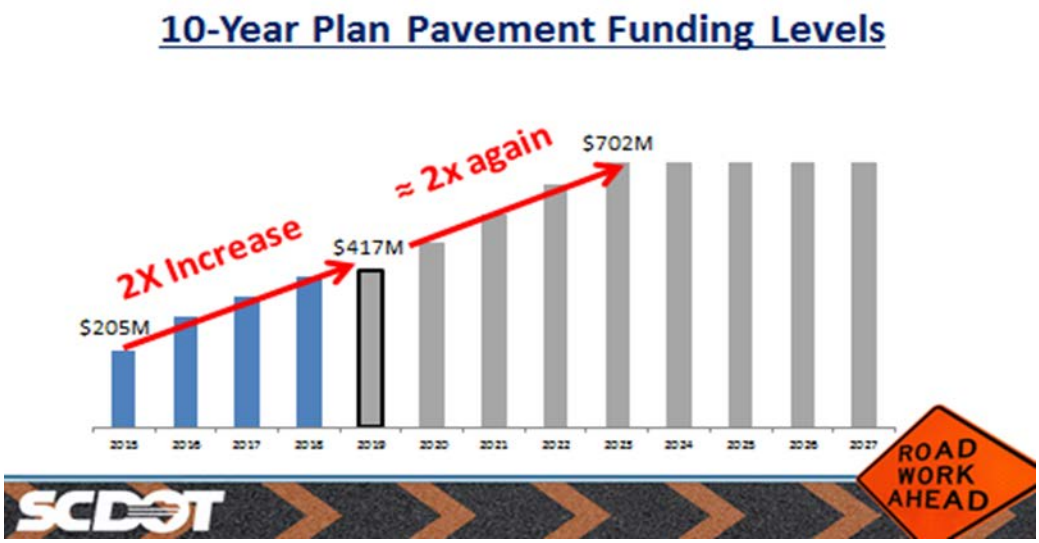


Figure 4-15. Year Pavement Funding Levels



[1] SCDOT began tracking this metric in 2008.

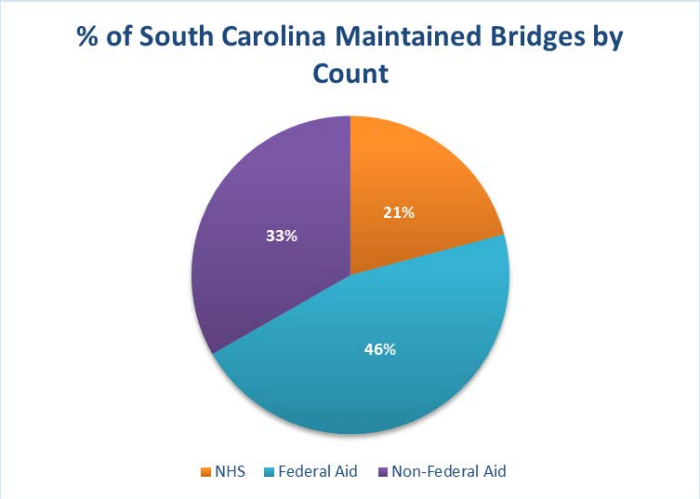
4.5. BRIDGE INVENTORY

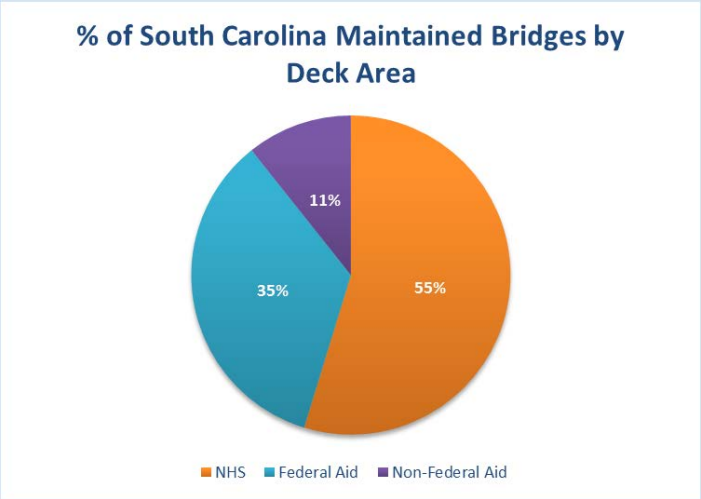
As shown in Table 4-3, SCDOT owns, operates, and maintains 8,451 bridge structures with an average age of about 40 years. These structures include over 1,000 large culverts, defined as bridges with a span greater or equal to 20ft. SCDOT inspects all bridges, including locally-owned bridges, which are located on public roads. The inspection frequency is based on both the National Bridge Inspection Standards (NBIS) and SCDOT policy. Inspection data collected includes both the NBI and the National Bridge Elements (NBE). The Off System category shown in Table 4-3 refers to bridges that are not federal aid eligible. These bridges are a part of the state highway system.

Table 4-3. 2018 South Carolina State-maintained Bridge Inventory

Functional Class	Count	Bridge Deck Area (square feet)
NHS	1,765	39,508,348
Federal Aid	3,875	24,950,318
Off System	2,811	7,716,380
Total	**8,451**	**72,175,046**

Figures 4-16 and 4-17 display the percentage of inventory by count and by deck area assigned to each functional class.





4.5.1. Bridge Condition Metric

SCDOT monitors progress in maintaining and preserving bridges using the following set of metrics: percentage of state-owned bridges classified as good, fair, and poor. They are defined as:

- Good – Under the NHPP standards a bridge is considered to be in good condition if the deck, superstructure, and substructure all are rated 7 or higher using the NBI rating scale of 0 to 9.
- Fair – Under the NHPP standards a bridge is considered to be in fair condition if the condition of the deck, superstructure, and substructure are all rated less than 7, but greater than 4 using the NBI rating scale of 0 to 9.
- Poor - Under the NHPP standards a bridge is considered to be in poor condition if the deck, superstructure, or substructure are rated a 4 or lower using the NBI rating scale of 0 to 9.

These metrics are compared to the agency's goals and targets to evaluate the effectiveness and efficiency of resource allocation and utilization processes. These metrics align with the National Highway Performance Program (NHPP) recommended reporting metrics, which is the percentage of NHS bridge deck area classified as good or poor based on the NBI scale of 0 - 9. The collective use of these measures and metrics enhances SCDOT's transportation asset management processes and influences decisions about program budgets and priority setting.

4.5.2. Bridge Condition Trends

SCDOT tracks and maintains bridge conditions using the Bridge Inspection Online (BIO) and BrM software. In addition, the SCDOT Highway Maintenance Management System (HMMS) complements the BrM in tracking maintenance activities on bridges. The BrM facilitates the annual NBI reporting requirements and in the future will support the agency in making informed decisions relating to bridge maintenance and programming. The BIO is a software program specifically developed for the SCDOT. The tablet compatible program is used to update NBI data, take notes, upload photos and other documentation during inspections. It also routes the report to the appropriate staff for qualitative review; stores the historic inspection data; and can be used to aid in the scheduling of inspections.

To ensure public safety, SCDOT has adopted a bridge inspection policy that sets standards for training, inspection frequencies, data collection, and reporting. The bridge program policy is used in conjunction with the national bridge inspection standards. SCDOT uses both in-house inspectors and consultants to perform routine bridge inspections and ensure bridge inspection deadlines are met. Additionally, SCDOT uses consultants to perform all underwater inspections.

Figure 4-18 through Figure 4-21 show the historic trend of bridge performance by measuring the number of load restricted, number of structurally deficient, and percentage of structurally deficient bridges by deck area for its entire system and NHS, respectively. The data indicates that the agency has reduced the number of load restricted bridges in addition to structurally deficient bridges as measured by count and percentage of total deck area over the past five years.

Per NHPP requirements, SCDOT cannot allow the deck area of structurally deficient NHS bridges to exceed 10 percent of the total NHS bridge deck area without facing penalties. SCDOT is well below this target, with approximately 4.8 percent of NHS bridge deck area classified as poor in 2018.

Figure 4-18. Number of Load Restricted Bridges on State Highway System (2012-2018).

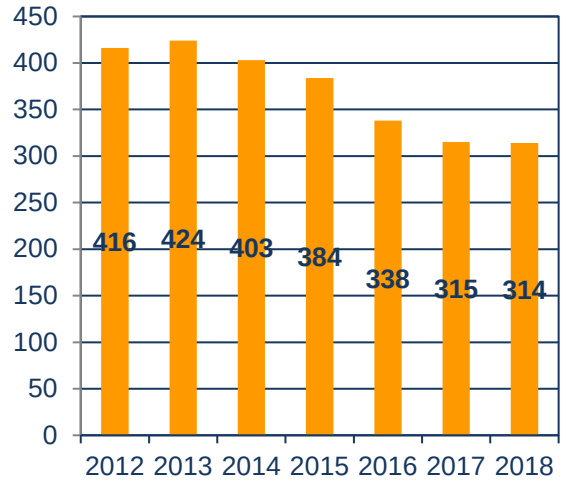
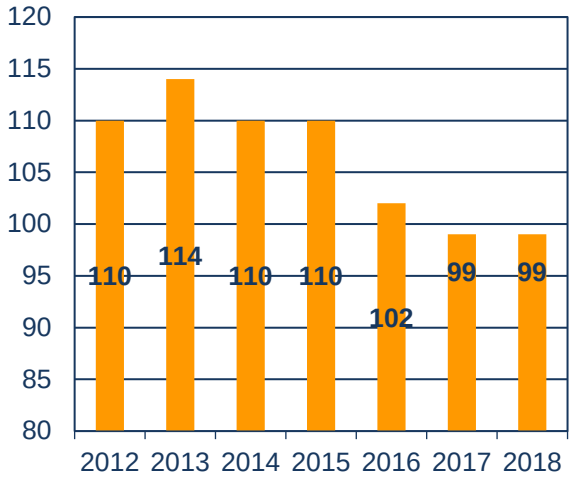


Figure 4-19. Number of Bridges rated as Poor (Structurally Deficient) on the NHS (2012-2018).



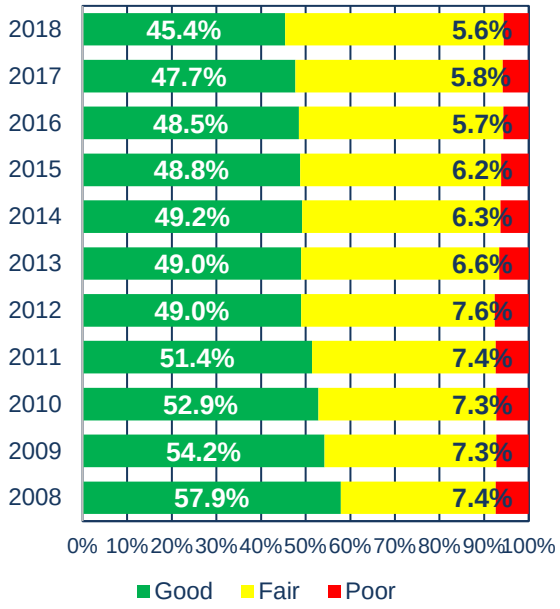


Figure 4-20. NHS Bridge Condition Based on Federal Metrics Percent by Count

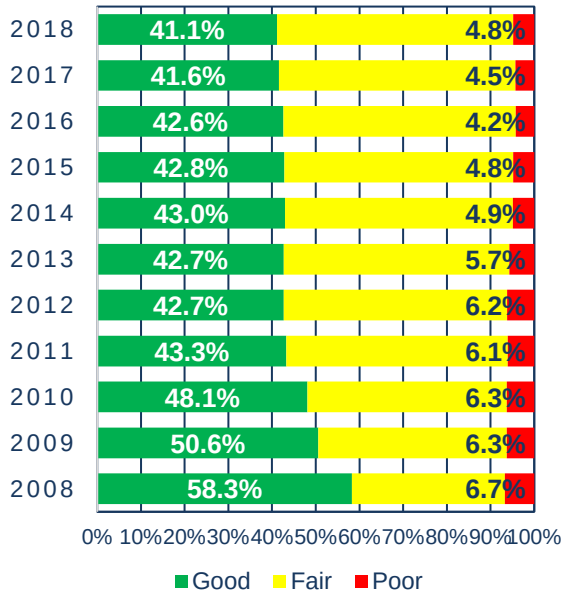
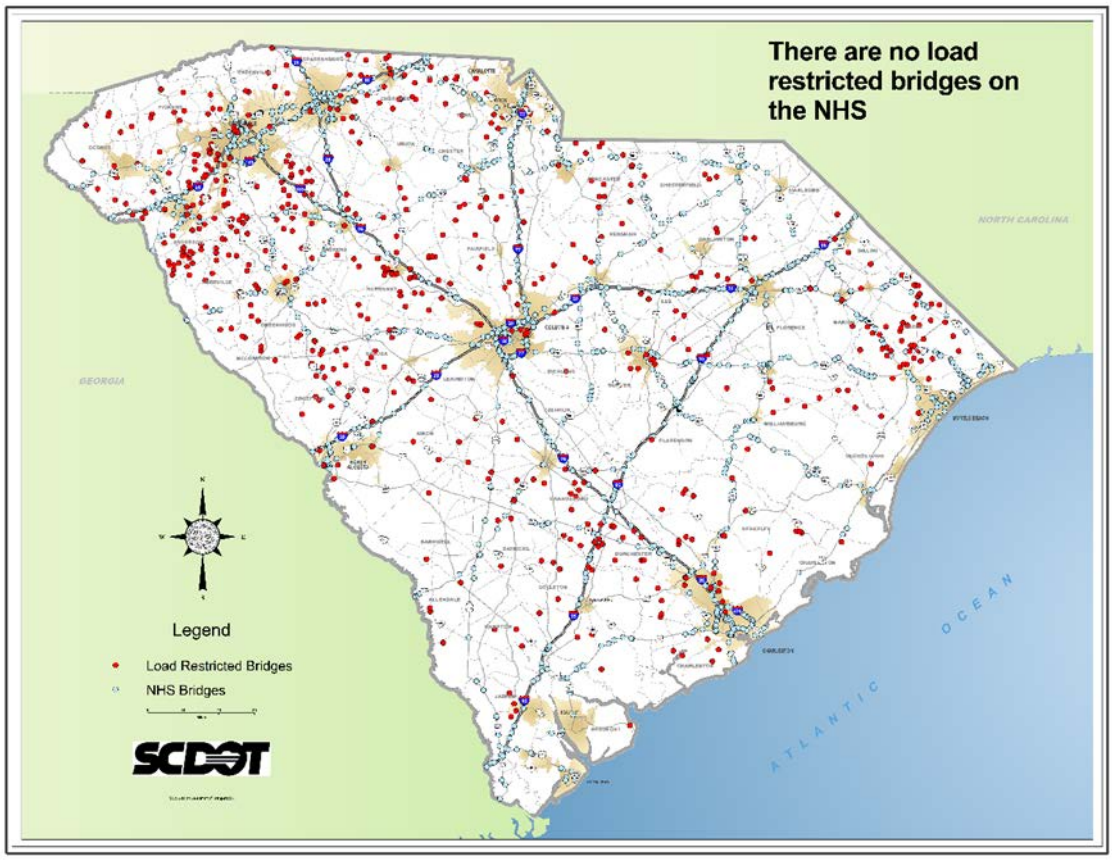


Figure 4-21. NHS Bridge Condition Based on Federal Matrix Percent By Deck Area

Figure 4-22. Load restricted bridges as of February 12, 2019.
(There are no load restricted bridges on the NHS system.)



4.6. ASSET VALUATION

SCDOT uses a modified Governmental Accounting Standards Board (GASB) Statement No. 34 approach to value its pavement and bridge assets, using a straight-line method, which assumes an asset life of 75 years for roads and 50 years for bridges. Currently, these values are reported in South Carolina's Combined Annual Financial Report (CAFR), but the level of detail is not by functional class. As of June 30, 2018, SCDOT's road and bridge networks are valued at $10.5 billion net of depreciation according to the CAFR. The agency is revising its process of estimating the value of its assets by functional class and will include valuation estimates in future revisions to its TAMP, which will also detail the annual investment needed to maintain the value of these assets over a ten-year period.

CHAPTER 5

FINANCIAL PLAN OVERVIEW

5. Financial Plan Overview

The financial plan chapter outlines SCDOT's financial planning efforts in funding its pavement and bridge assets, safety, capacity, MPO/COG, and freight programs, including documenting current and future financial capacity. SCDOT's financial goal is to provide its customers a safe and quality transportation system while maintaining financial and asset sustainability.

5.1. Development of Financial Plan

SCDOT develops its asset management financial plan for a ten-year period by state fiscal year. Staff from Finance and Administration and Program Controls provide financial data inputs over this period, which consider known and reasonably available revenue and project costs based on the agency's investment strategies. The current structure of SCDOT's 10-year budget and investment strategies is to allocate funding by investment area, such as safety and Interstate System Upgrade, and pavement and bridge subsystems.

Annual funding allocations for each pavement system are designed to achieve specific targets outlined in the agency 10-year plan as determined by the pavement condition/funding model. Funding for preservation is currently set at ten percent, with the remaining funding allocated for rehabilitation, and reconstruction work types based on the percentage of assets eligible for that type of work determined by asset condition. Pavement programs are managed on a network basis. The interstate pavement program is prioritized on a statewide basis. For the other pavement networks, funding is allocated on a county-by-county basis, determined by the counties' share of the statewide pavement assets eligible for preservation, rehabilitation, or reconstruction from the agency's annual budget. Bridge funding is allocated annually based on the agency's financial projections to meet its strategic bridge program goals, such as reducing the number of structurally deficient bridges on the NHS towards zero by FY 2027. All projects for the various program categories are prioritized using objective and quantifiable criteria and presented to the SCDOT Commission for approval. More information about the processes is included in Appendices B, C, and D, and a breakdown of funding allocation by pavement subsystem and work type is included in Chapter 7.

5.2. Funding Sources

SCDOT receives funding from both the State and federal government in financing eligible transportation programs. Each fund category has restrictions, and the governing authority of the agency over these funds varies accordingly. Certain funding the agency receives is on a recurring basis, such as revenue from state and federal gas taxes. Other funding the agency receives is through one-time appropriations enacted in law by the State or federal government. The following are the main funding sources that support the management of the South Carolina highway system:

- **State Highway Fund (SHF):** the SHF is supported largely by state motor fuel taxes, also known as the highway user fee or gas tax, which in the recent past has generated approximately $500 million annually from a combination of gasoline and diesel fuel sales. The gas tax remains the most common source of revenue for the SHF, historically accounting for approximately one third of the SHF revenue. The SHF is also supported by revenue from the Department of Motor Vehicles through provisions in Act 275 of 2016, which amount to approximately $86 million annually.

- **Infrastructure Maintenance Trust Fund (IMTF):** Act 40 of 2017 requires SCDOT to establish the IMTF. The IMTF must be used exclusively for the repairs, maintenance, and improvements to the existing transportation system. The new fund consists of the incremental increase in the gas and diesel tax of $0.02 per year through FY 2023, when it reaches $0.12, fees from vehicle purchases, and certain fees collected by the Department of Motor Vehicles.

- **Non-Federal Aid Highway Fund (NFAHF):** the NFAHF is used strictly for maintenance and preservation purposes on roadways that do not qualify for federal funds. The NFAHF is primarily financed by revenue from the Department of Motor Vehicles, an electric power tax, and gas taxes. In FY 2018, the NFAHF provided approximately $48 million for maintenance and preservation of non-federal aid roads.

- **Federal-Aid Highway Program (FHP):** the FHP funds programs that support federal aid eligible transportation goals, which includes specific highways and activities allowed by federal legislation. Not all state-owned highways are eligible to benefit from federal funds and in South Carolina, about half of the highways maintained by SCDOT are eligible. Federal funds require a match, which is typically 10 or 20 percent. Federal funds are provided on a reimbursement basis. As the SCDOT must spend state dollars first, then it is reimbursed, minus the match. SCDOT projects to receive $ 629.6 million from the Federal-Aid Highway Program for use to program on its assets in 2019 an expected 3.74% increase from FY 2018.

- **General Fund:** in addition to the above funds, SCDOT also periodically receives one-time appropriations as stipulated by the South Carolina State Legislature for specific projects or activities.

- **Emergency Management Grant:** Additional one-time grants include federal emergency grants for recovery programs during natural disasters. These funds require a state match; however, the percentage of match can be reduced.

In addition to the above funding sources, SCDOT administers the “C-Fund,” which historically has primarily been funded by a portion of the state gas tax and is distributed by formula to South Carolina’s 46 counties. By law, counties must spend at least 25 percent of their C-Fund allocations on the state highway system for construction, improvements, and maintenance; however, in practice, the counties spend closer to 60 percent of their C-Fund allocations on the state highway system. For FY 2017, the C-Fund received $75.3 million.

5.3. CURRENT FUNDING LEVELS

In 2018, SCDOT programmed approximately $1.1 billion for its assets, of which 88% came from the Infrastructure Maintenance Fund and the Federal-Aid Highway Program. Figure 5-1 outlines the funding sources and associated amounts SCDOT programmed for its assets for the fiscal year ending June 30, 2018.

Figure 5-1. Revenues by Funding Source for FY 2018 (in millions)

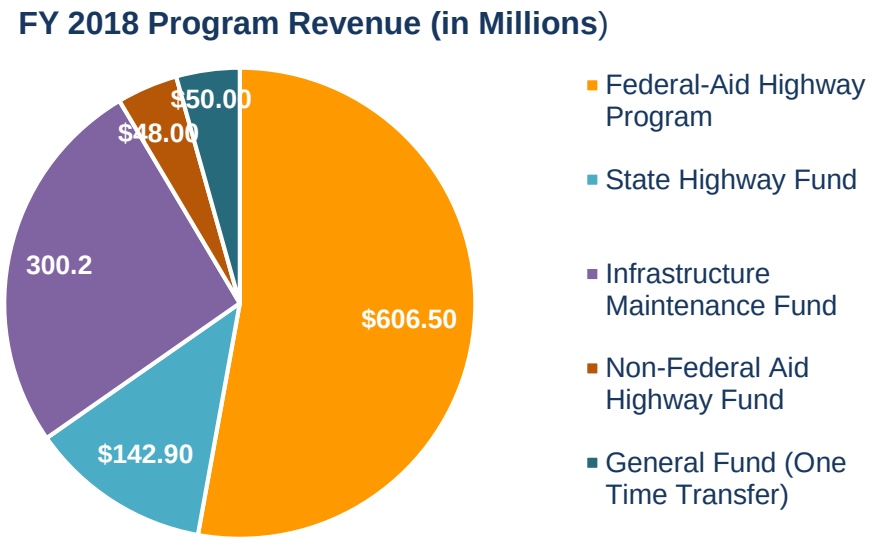


Figure 5-2. Revenues by Funding Source for FY 2019 -FY 2021 (in millions)

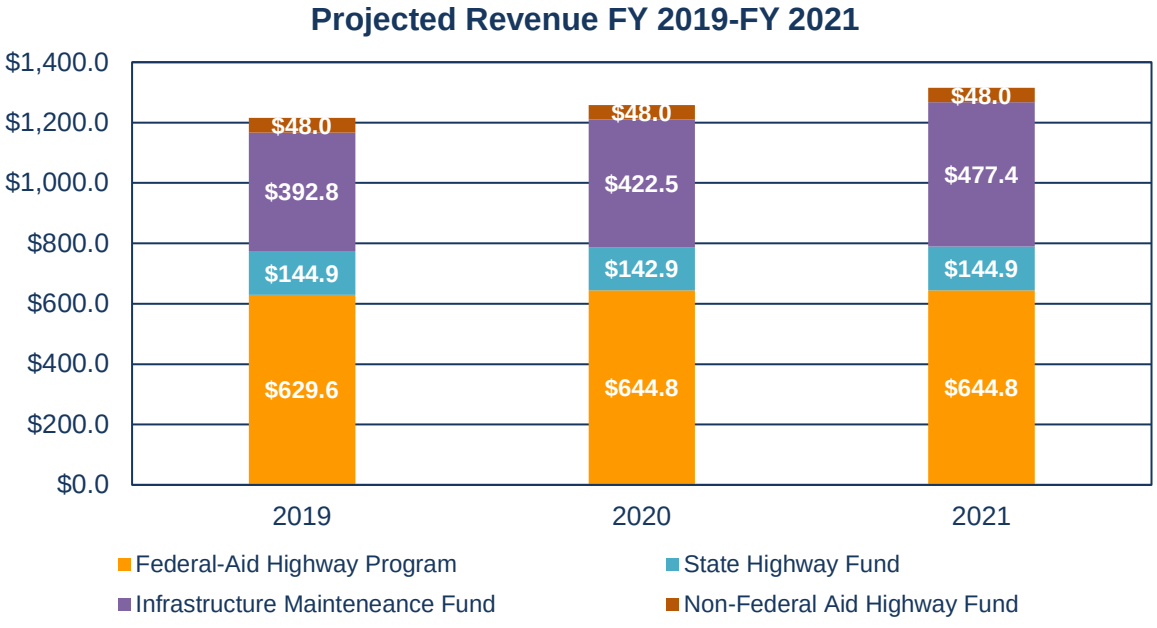


Figure 5-2 summarizes the total projected program revenue dedicated to asset management from the Federal Aid Highway Program, State Highway Fund, Infrastructure Maintenance Fund (Act 40) and the Non-Federal Aid Highway Fund for fiscal years 2019 – 2021. As the chart illustrates funding for asset management programs is projected to increase from approximately $1.21 Billion in FY 2019 to $1.31 Billion in FY 2021, a projected 12% increase. This has translated to more work on the street as can be seen in Figure 5-3, which shows that the SCDOT Construction Program has more than tripled in the last five years. For a full description of 10-year projected revenues for the asset management program, see Table 5-1 on page 67.

A consistent pattern of increased investments is further demonstrated in Figure 5-4. Figure 5-4 illustrates the sharp increase in investments directed towards maintenance and system preservation over the last 4 fiscal years increasing by 68% in total investments between FY 2015 and FY 2018. Moreover, the percentage of Maintenance versus the total transportation expenditures has increased growing from 46% to a steady 50%.

Figure 5-3. SCDOT Construction Program History

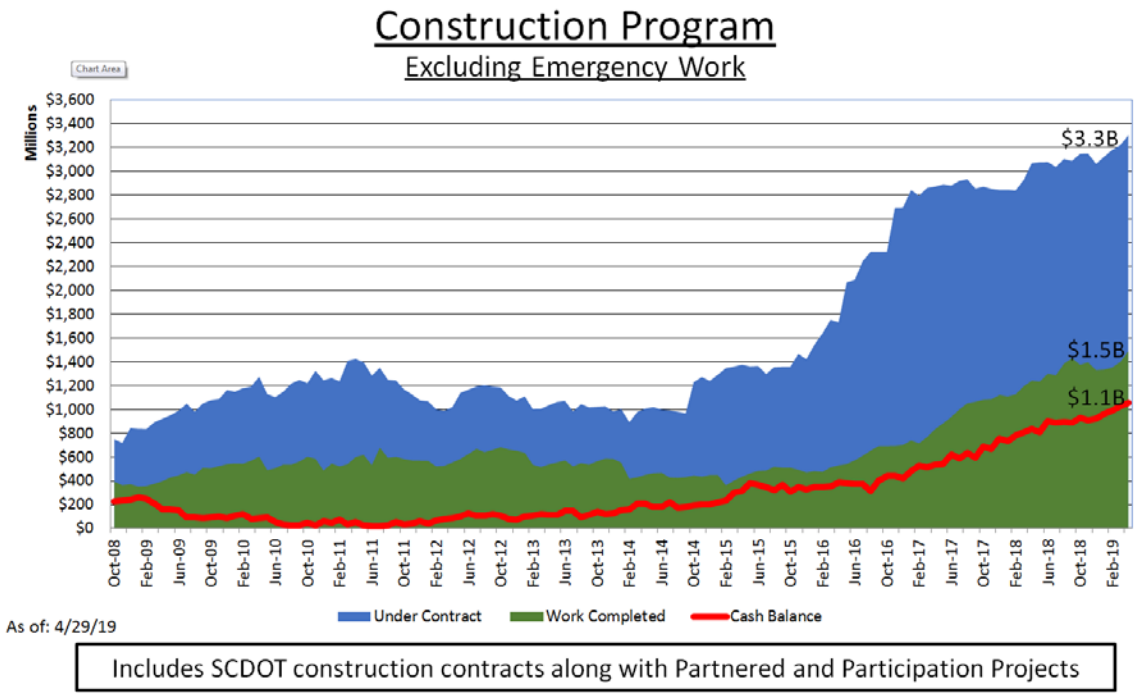
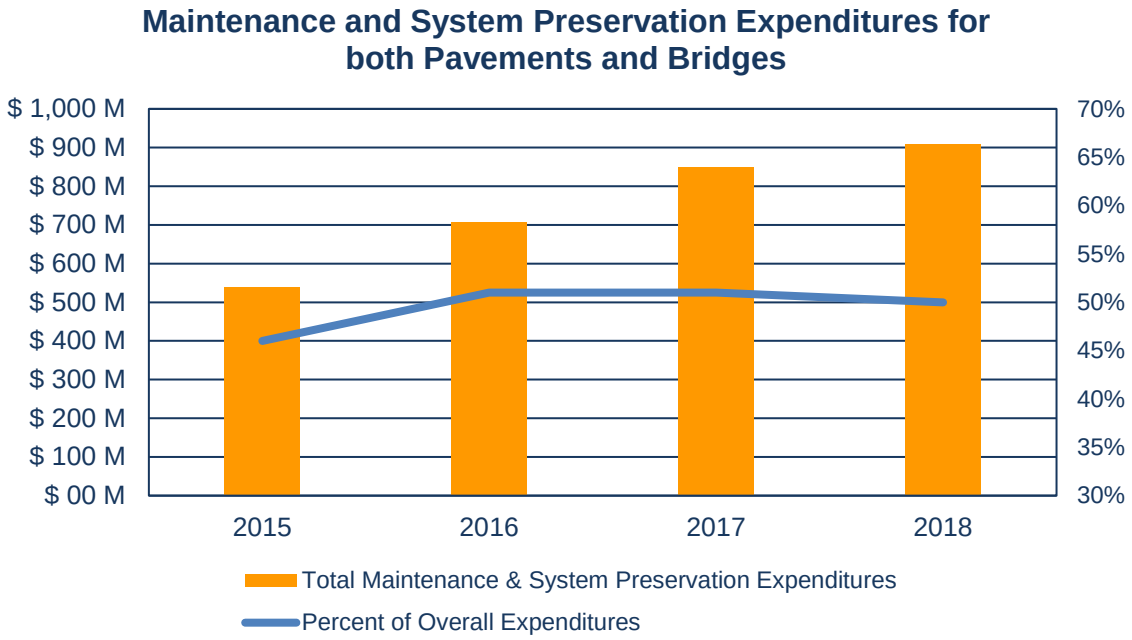


Figure 5-4. SCDOT Total Maintenance & System Preservation Expenditures.



5.4. INVESTMENT IN HIGHWAY INFRASTRUCTURE

Highway maintenance in South Carolina is under the Division of Maintenance, which has the responsibility of developing and implementing maintenance policies for roads and bridges under the jurisdiction of SCDOT. The office ensures the State's bridges and pavements are functionally capable to handle traffic and maintains and improves the quality of bridges and pavements by doing preventative, routine, and reactive maintenance, such as patching potholes, cleaning catch basins, regrading shoulders, and performing vegetation management.

In addition to routine highway maintenance, SCDOT invests in the performance of its transportation system through treatment programs, such as preservation, rehabilitation, or reconstruction of pavements and bridges, and by adding capacity to its interstate system. Other investments in pavement and bridge assets include investments related to safety, funding distributed to MPOs and COGs, and SCDOT's freight program. Figure 5-5 represents SCDOT's $581 million program for the fiscal year ending June 30, 2018, related to all SCDOT's bridge and highway assets.

Figure 5-5. Asset Management Program for FY 2018

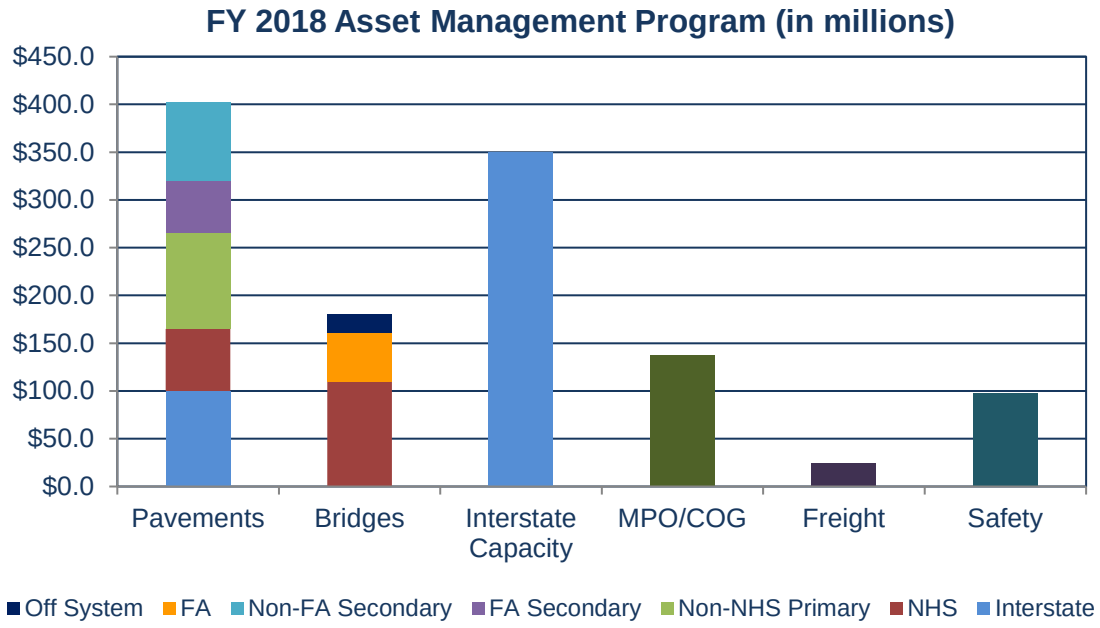


Figure 5-6. Asset Management Program for FY 2019

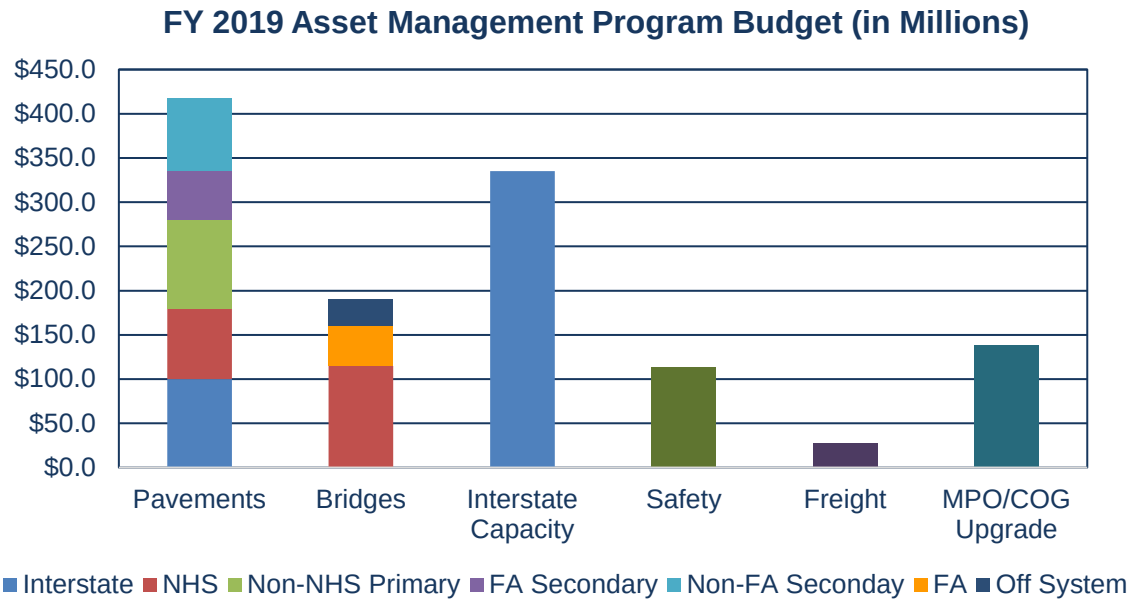
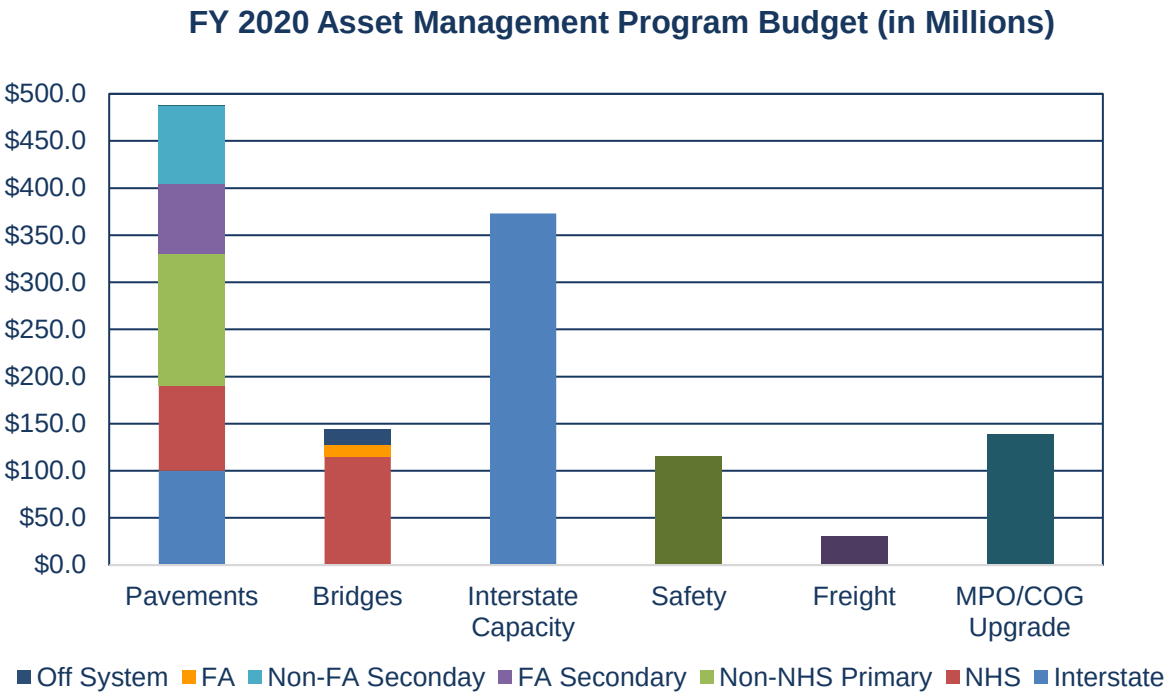


Figure 5-6 and 5-7 shows the agency's forecasted program related to pavements and bridges on the state highway system for the FY 2019 and FY 2020 program. The SCDOT programed $604 million in 2019, a 3.96% increase in spending from FY 2018. Figure 5-7 shows a forecasted budget of $632 Million for FY 2020, an increase of 4.6%. Approximately half of SCDOT's funding goes to maintenance of its existing assets,

indicating the agency's commitment to maintaining the value of the highway transportation network. The expenditures displayed in Figures 5-5 to 5-7 can be found in Figure 7-2.

Figure 5-7. Forecasted Asset Management Program for FY 2020



5.5. Future Funding Levels

This section presents the program level revenue projections for SCDOT's transportation assets. The projections are based on historical revenue trends for both state and federal appropriations, inflation numbers, and forecast revenue from Act 40 in May 2017.

With the passage of Act 40 of 2017, revenue from the gas tax is expected to increase over the 10-year period by approximately 75 percent, as the gas tax will increase in 2-cent annual increments from $0.1675 to $0.2875 by July 1, 2022. Along with increasing the fees collected for vehicle purchases from a ceiling of $300 to $500 and price changes to registration fees, the Act is forecasted to increase annual revenues for SCDOT's assets by approximately $600 million once the increases are fully phased in beginning in FY 2023 compared to the FY 2017 funding level. Table 5-1 represents the Department's asset management revenue forecast for FY 2018 to FY 2027. SCDOT projects $13.6 billion over the 10-year period will be available to program for its transportation assets.

Table 5-1. Forecasted Asset Management Program Funding Level Sources for FYs 2018-27 (in millions)

Revenue Source	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	10-year average
Federal-Aid Highway Program	$606.5	$629.6	$644.6	$644.8	$652.6	$654.1	$652.5	$652.7	$652.5	$652.7	$644.2
State Highway Fund	142.9	144.9	142.9	144.9	142.9	144.9	144.9	144.9	144.9	144.9	144.3
Infrastructure Maintenance Fund[1]	300.2	392.8	422.5	477.4	527.6	609.1	611.8	614.1	617.4	619.0	519.2
Non-Federal Aid Highway Fund	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
General Fund One-time Transfers	50.0	--	--	--	--	--	--	--	--	--	5.0
Total	**$1,147.5**	**$1,215.3**	**$1,257.9**	**$1,315.0**	**$1,371.0**	**$1,456.0**	**$1,457.1**	**$1,459.6**	**$1,462.7**	**$1,464.5**	**$1,360.7**

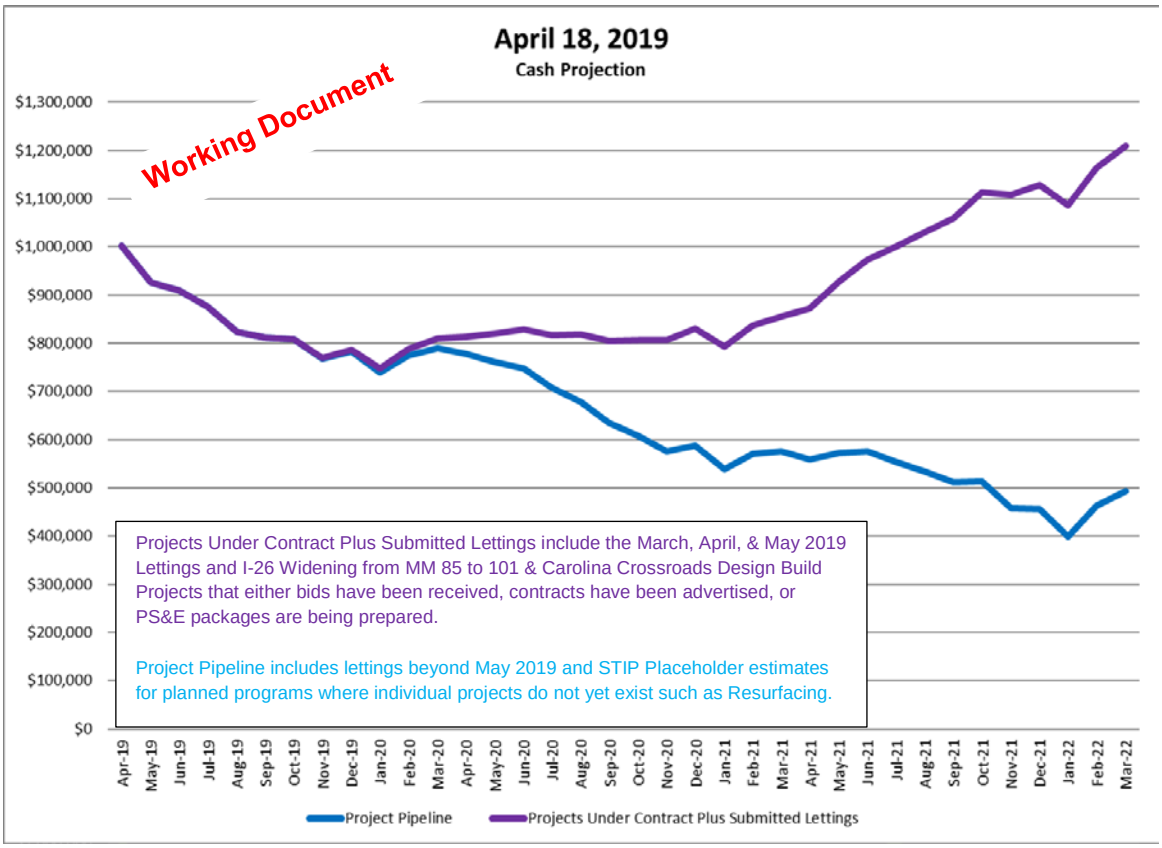
[1] Excludes $57 million in FY 2023 and $114 million annually thereafter based on the potential sunset of a vehicle preventative maintenance tax credit.

5.6. Cash Flow Monitoring

SCDOT leadership holds regular Program and Resource Analysis Meetings (PRAM) to review cash flow projections, monitor the delivery of special projects, and the Department's ability to meet its future financial obligations. Figure 5-8 shows the cash flow projection for projects under contract and in the development phase. These meetings provide timely and relevant information to the Secretary and senior leadership that facilitates communication regarding resource utilization and to ensure that the agency is on track to meet asset condition targets. These meetings also provide SCDOT the opportunity to enact changes to resource allocation in a timely manner in order to meet program goals.

Additionally, the Agency has created a Chief of Financial Planning (CFP) positon with the sole responsibility of ensuring the effective management of the transportation programs through responsible short and long-term planning of all financial resources including cash; federal, state, and local revenues; and bond proceeds, in order to ensure all activities remain in budget.

Figure 5-8. Cash Flow Projection Curves



CHAPTER 6

RISK MANAGEMENT AND MITIGATION APPROACHES

6. Risk Management and Mitigation Approaches

6.1. Overview

SCDOT has embraced asset and performance management and is in the process of weaving these principals into everyday business practices, a process that will take time to fully implement. In simple terms, performance management is a strategic approach that requires the practitioner to use system information to set specific goals and objectives and allocate the resources necessary to achieve them. There are risks as well as opportunities involved with the achievement of all goals and objectives. Federal regulation 23 CFR part 515.5 defines risk as "the positive or negative effects of uncertainty or variability upon agency objectives". The longer the time horizon, the more uncertainties, and risks there are. It defines risk management as "the processes and framework for managing potential risks, including identifying, analyzing, evaluating, and addressing the risks to assets and system performance". Therefore, asset management, performance management and risk management are used together to allow SCDOT to achieve its strategic objectives.

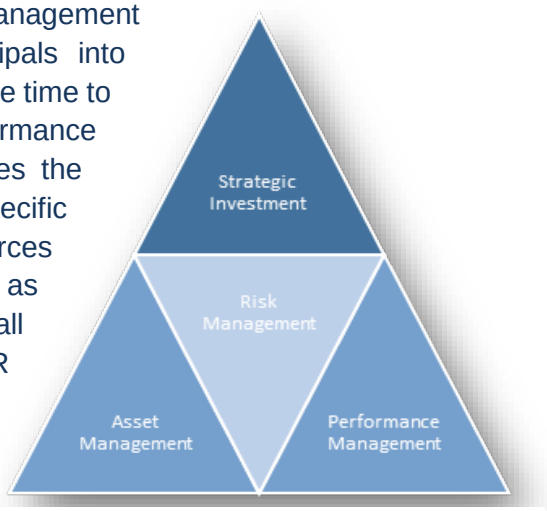


Figure 6-1. Role of Risk Management

Risk Management Planning Process Requirements of 23 CFR 515.7

- Identification of risks that can affect condition of NHS pavements and bridges and the performance of the NHS, including risks associated with current and future environmental conditions such as extreme weather events, climate change, and seismic activities;
- An assessment of the identified risks in terms of likelihood of their occurrence and their impact and consequence if they do occur;
- An evaluation and prioritization of the identified risks;
- A mitigation plan for addressing the top priority risks;
- An approach for monitoring the top priority risks;
- Evaluation of risks related to reoccurring damage and costs as identified through the evaluation of facilities repeatedly damaged by emergency events (addressed in 23 CFR 667), and alternatives to mitigate or resolve their root causes;

6.2. Background and Purpose of the Risk Management Plan

There are risks involved with every aspect of owning, managing, and maintaining a transportation system. There is the risk of damage to, or loss of assets due to extreme weather events, crashes, or acts of vandalism. Other risks include the loss of key personnel or shortfalls in expected revenue. SCDOT classifies risks into one or more of the following areas:

- Operational (Project delays, cost overruns, waste, inefficiency)
- Safety (Employee and public well-being)
- Financial threats (Funding, liquidity, credit, reporting)
- Strategic (Resources not aligned, unclear objectives)
- Reputational (Unintentional unwanted headlines that could destroy public trust)
- Ethical (Intentional fraud, abuse, mismanagement, conflict of interest)
- Legal (law suits)
- Regulatory (Noncompliance)

Enterprise risk management is the process of integrating the management of risk into all of an agency's key programs at every level within the organization. This includes managing the risks at the agency, program, project, and activity level.

Figure 6-2. Structure of Enterprise Risk Management

SCDOT began the process of implementing an Enterprise Risk Management (ERM) program in spring of 2017. There are numerous ERM processes that have been developed, both for the public and private sector. SCDOT has chosen to follow the process developed by the International Organization of Standardization (ISO) in 2009, known as ISO 31000. The process uses a cyclical framework comprised of seven components and is used in many risk management guides. The components of this process are:

- Communication and Consultation – developing a communication structure within the organization to create an understanding of the risk management process and create continuous communication between the risk manager(s) and the risk owners.

- Establish the Context – what is the mission and challenges that may be faced? Is the environment changing? What resources are available to meet the identified objectives? Are there legal, political or social environments that may impact the success of the organization?

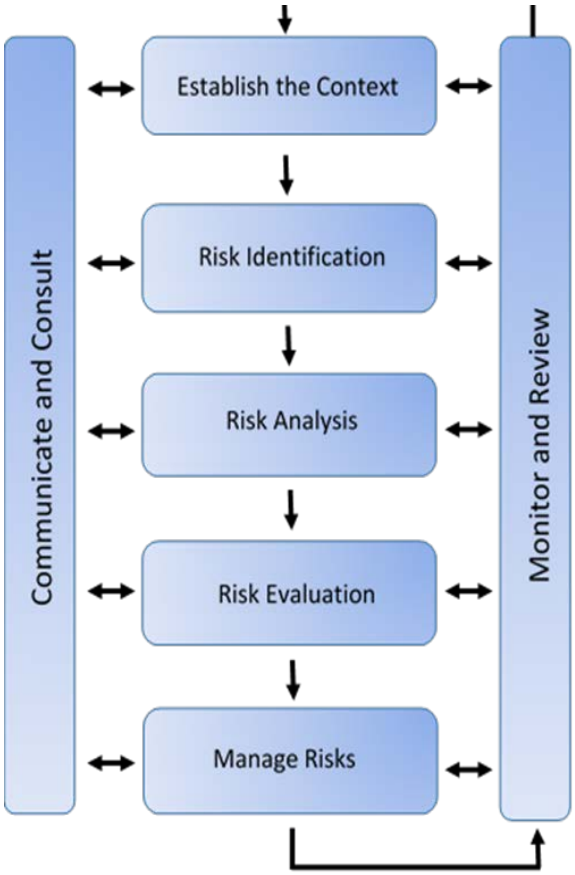
- Risk Identification – identifying the sources of risks and opportunities, areas of impacts, events and their causes and consequences.

- Risk Analysis – understanding the risk, its consequences and the likelihood of the risk occurring.

- Risk Evaluation – risks are evaluated and prioritized based on the impact to the organization and their likelihood of occurrence.

- Managing Risks – deciding whether to tolerate, treat, transfer, terminate, or take advantage of the risk.

Figure 6-3. SCDOT Risk Management Process Framework



- Monitoring and Review – evaluation of the results of the risk process. This is a cyclical process.

This approach is used to identify enterprise, program, project and activity level risks. SCDOT manages risk at multiple levels for several reasons. The strategic objectives of the agency cannot be achieved without the coordination of functions at many levels within SCDOT. Problems that arise at the activity or project level can affect the goals set at the program and enterprise level and could therefore become a strategic risk for the agency, thus the need to employ an enterprise risk management solution at SCDOT. Each area is discussed in detail in the following sections.

6.3. ESTABLISHING THE CONTEXT

To establish the overall risk management approach, it is essential to identify and understand the context in which SCDOT operates. Per FHWA, this process involves understanding and documenting the social, cultural, legal, regulatory, economic, political and natural environmental characteristics that could create risks or opportunities affecting an agency's goals and objectives. Developing a deep understanding of the context allows the preferred risk management approach to be tailored to the Department's specific needs and circumstances. This understanding enables SCDOT to develop and approve internal and external risk management communication processes to facilitate the flow of information through the Department and to key external stakeholders.

6.4. RISK IDENTIFICATION

Risk identification is the process of determining pertinent threats or uncertainties that can potentially impact the achievement of SCDOT's mission, goals or objectives. SCDOT undertakes this task by establishing risk teams comprised of subject matter experts and conducts workshops guided by the Department's Risk Manager. The Risk Manager facilitates the workshop by conducting exercises such as brainstorming, scenario reviews or other group techniques to stimulate thinking. This qualitative screening process is meant to cast as wide a net as possible in order to capture all potential risks to the goal or objective under review, taking into account the categories of risk identified in section 6.2. Ultimately, through the screening of risk events, SCDOT identifies a comprehensive set of risks that are context sensitive, aligned with the strategic direction of TAM, and that address the objectives of the risk management process. SCDOT's risk identification process is continuous, which allows for inclusion of new emerging risks or opportunities, and the development of strategies to mitigate these risks or take advantage of the opportunities.

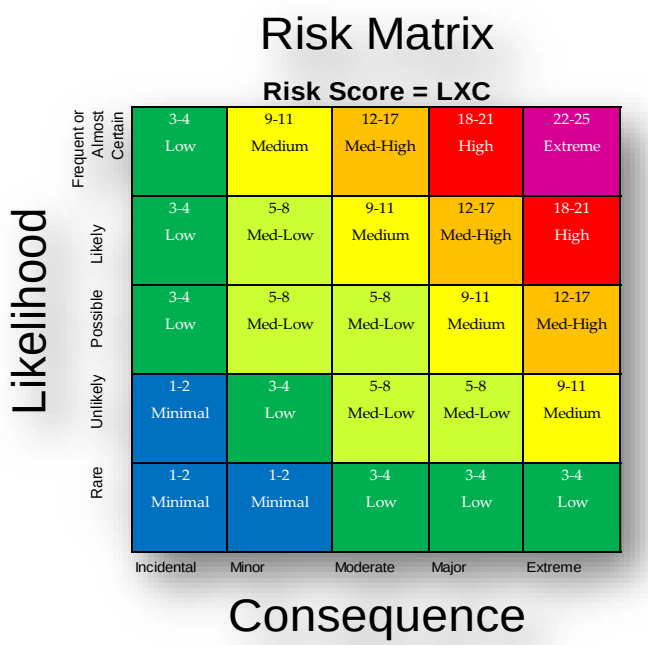
Table 6-1, contains the comprehensive list of bridge and pavement priority risks identified through two, half-day, workshops held with SCDOT and FHWA leadership staff. The risks are further designated into risk type categories based on the nature of the risk. A more detailed description of the risks is further provided in Section 6.10, Risk Register and Appendix E.

Table 6-1. SCDOT Risks identified at the Risk Management Workshops

Risks Identified for Bridges Program	
Operational Risks	Costs inflate substantially on a program level
	Additional bridges are added to the load-restricted or structurally deficient lists
	Ability to deliver projects impacted by lack of qualified internal workforce
	Ability to deliver projects impacted by lack of qualified external contractors
Financial Risk	Low-priority bridges consume resources disproportionately
	Opportunity: Receipt of additional State funding
	Opportunity: Receipt of additional Federal funding
	State Funding Cuts
	Federal Funding Cuts
External Risk	Ability to deliver projects impacted by material shortage
	Bridges are damaged by extreme weather events
	Bridges are damaged or destroyed by Earthquakes
	Bridges are damaged or destroyed by vehicle impacts/fires
Risks Identified for Pavement Program	
Operational Risks	Project costs inflate substantially
	Ability to deliver projects impacted by lack of qualified contractors
	Loss or lack of Institutional Knowledge
Financial Risk	Opportunity: Receipt of additional State funding
	Opportunity: Receipt of additional Federal funding
	State Funding Cuts
	Federal Funding Cuts
External Risk	Ability to deliver projects impacted by material shortage
	Pavements are damaged by extreme weather events (hurricane, floods, snow/ice
	Pavements are damaged or destroyed by Earthquakes
	Pavements are destroyed by vehicle impacts/fires
Information Risk	Inaccurate pavement condition prediction models
	Inaccurate pavement condition data

6.5. Risk Analysis

Figure 6-4. SCDOT Risk Matrix that shows the expected value of likelihood and impact.



SCDOT estimates the probability and consequences of each identified threat or vulnerability to determine the magnitude of the resulting risk. This process is referred to as risk analysis. SCDOT uses a mixed process (quantitative and qualitative) in assigning probability and consequence values/ratings to each identified risk event. Specifically, the process is done during the workshop to solicit expert opinion and historic information, and then develop key indicators to estimate risk likelihood and consequence values. An overall risk score is estimated from these two risk components. The higher the risk score, the more important it is to develop risk mitigation strategies to deal with the risk (or formalize any existing strategy at the activity, asset/project, program, or agency level).

6.6. Risk Evaluation and Prioritization

SCDOT risk teams evaluate the identified risks and establish risk appetites to determine high-impact risks for prioritization. Defining the risk appetite can be a subjective or qualitative process. SCDOT has a very low risk appetite for safety and ethics related risks and a higher appetite for risks in the area of external threats and business operations. Risk evaluation and prioritization offer SCDOT the opportunity to alleviate the impact of likely threats that present higher consequences. The overall process informs resource allocation decisions with inputs from the risk information. The result of these preceding processes is a risk register, which is presented in Section 6.9 of this chapter. Each risk owner compares the magnitude of the risks with the Department's risk tolerance for prioritization and development of mitigation strategies.

6.7. MANAGING RISKS

Once the risk teams have scored each of the risks, they determine if and how the risk can be managed. SCDOT uses five options to manage risks known as the "the five T's" of risk management, which are to tolerate, treat, transfer, terminate, or take advantage of the risk.

Tolerating the risk means taking no action to mitigate the risk. The risk score is low enough to be within SCDOT's established risk appetite.

Treating the risk is the most common response to risk assessment. Many processes and business practices of SCDOT and other state transportation agencies were put in place to treat some type of risk. One example is the National Bridge Inspection Program that was established by FHWA in the early 1970's in response to a bridge collapse. The purpose of the program is to reduce the risk of future collapse and improve the safety of the traveling public. All risks cannot and should not be treated. SCDOT weighs the cost to the benefit when deciding on which risks to treat.

Figure 6-5. "T's of Managing Risk

Transferring the risks shifts the responsibility for the risk to another party, but this may not always be possible. SCDOT uses performance contracts for the inspection and maintenance of its largest bridge systems. This is one of the ways that SCDOT can transfer some of the risk to another party. Once again, SCDOT considers the cost to the benefit when establishing performance contracts for the maintenance of assets.

Terminating the risk is the practice of stopping the activity or practice that is the source of the risk. An example of this would be to discontinue using a product with a questionable safety record or replacing a high-risk product with a lower risk one.

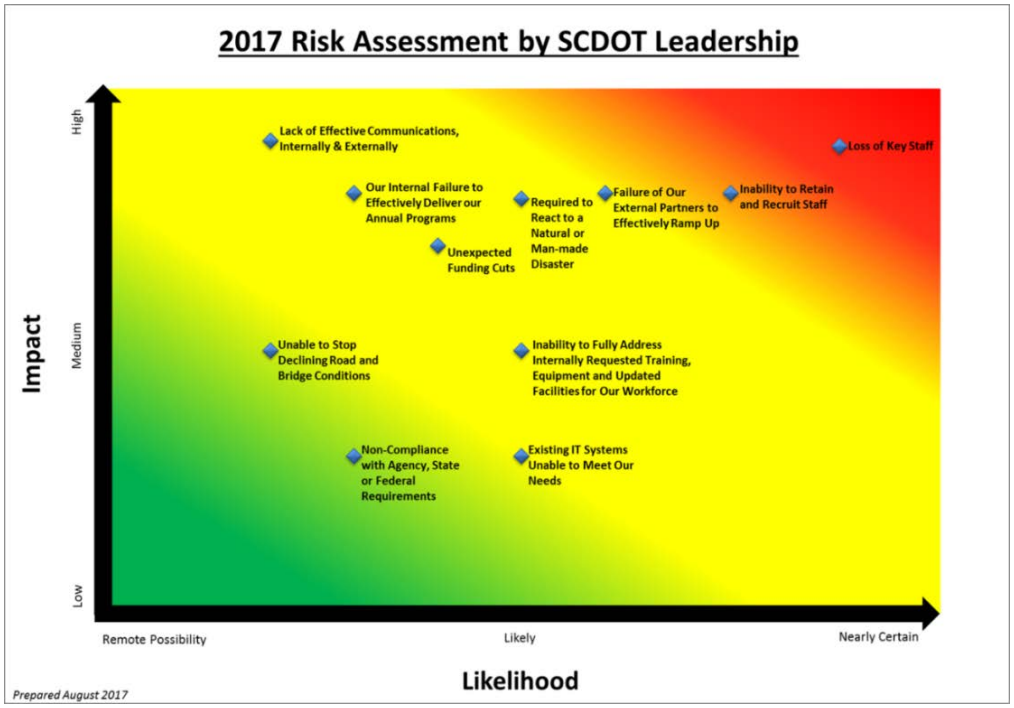
Taking advantage of an opportunity presented by the risk can take many forms such as using a new product or process that can save the agency money. Without taking well-reasoned risks, SCDOT cannot take advantage of innovation and the opportunity to maximize the return on investment for the taxpayer. One way to measure the success of an enterprise risk management system is to look at the number of innovations it produces.

6.8. SOURCES AND TYPES OF RISK

All SCDOT activities contain risk. Risk pervades every unit, program, or project within the Department. The characterization or stratification of risks allows SCDOT to better scope the risks, identify ownership, develop mitigation strategies, allocate resources, and manage and monitor the risk. Generally, SCDOT deals with both internal and external risks. Internal risks are those risks within the control of the Department and, as such, SCDOT has the capability to plan and mitigate their occurrences and impacts. While SCDOT does not have control over the occurrence of external risks, identifying these risks facilitates the development of response plans to alleviate the risk impacts upon their occurrence.

SCDOT identifies both internal and external risks that can be further classified at four different levels of operations:

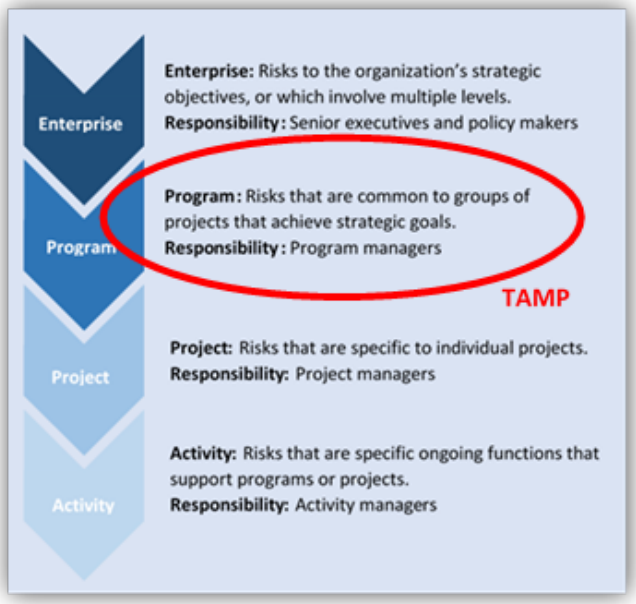
Figure 6-6. "SCDOT Enterprise Level Risks



- **Agency or Enterprise-level risks**: These are risks associated with SCDOT goals and objectives. They originate from threats and uncertainties that can hinder SCDOT from realizing its short and long-term goals and are dealt with at the executive level. A heat map of the 2017 risk assessment conducted by SCDOT leadership is shown above. Agency risks are reviewed on a two-year cycle.

- **Program-level risks**: These are risks associated with the different programs or units within the Department. Program-level risks originate from threats and uncertainties that can hinder achievement of program goals and objectives, or lead to the inefficient operation of business units within SCDOT. Usually, program managers and unit administrators or their designees are responsible for risks at this level.

Figure 6-7. Levels of Risk Management.



- **Asset/**Project**-level risks**: These are risks inherent in individual projects undertaken by the Department. Project-level risks are the most common type of risks usually managed by State DOTs. Because federal legislation (MAP-21) includes mandates to develop risk-based transportation asset management plans, SCDOT approaches risk management in a more comprehensive manner. Thus, the Department's TAM processes incorporate all levels of risks that can hinder SCDOT's asset management goals.

- **Activity-level risks**: These are risks associated with conducting daily work activities that support programs or projects. Activity-level risks are identified in action plans prepared by every unit in support of the SCDOT Strategic Plan. Activities that support one of the strategic goals or objectives are listed along with the associated risks, risk owner, and actions taken to mitigate the risks. Action plans are reviewed every six months by the directors in conjunction with the Risk Managers to identify obstacles in the way of success in achieving the objectives described in the action plans, identify potential solutions to address those obstacles and share success stories. Each division holds meetings every six months to review the progress made by the directors and Division Heads and Direct Reports review their progress with the Secretary annually.

6.9. Risk Register

The purpose of the risk registers is to provide SCDOT with a list of priority risks identified, stated clearly and assessed as to their importance to meeting agency objectives. The risk register leads directly to managing the severity and impacts of the risk, such as risk mitigation/treatment. In the register below, we have identified the top three priority risks, risk consequences, risk severity score, policy control measures, risk management plan action items, and risk owners for each asset. The risk severity is color coded to correspond to the risk matrix (Figure 6-4). The complete Risk Register can be viewed in Appendix E.

Note: The final adjusted risk severity score was derived through an iterative scoring process, which began with the assignment of an initial risk score (Column 3). The assessed score was based on the likelihood and severity of the risk to the agency as illustrated in Figure 6.4. Policy control measures, which include existing agency policies and practices, as well as proposed risk management action plan items (Columns 4 and 5) were applied to the risk. Following the application of the mitigation measures, the risk was then rescored. The results from this exercise are displayed in the final adjusted risk score (Column 6).

Type of Risk or Opportunity	Risk Consequences/Impacts	Original Risk Severity Score	Policy Control Measures (Primary (P) and Secondary (S))	Possible Risk Management Action Plan Items	Final Adjusted Risk Severity Score	Risk Owner
Bridge Risk Registry						
Additional bridges are added to the load-restricted or structurally deficient lists	Delays in program; Increase in cost.	**Extreme (25.0)**		Explore increase in rehab options; Robust Preservation Program.	High (20.0)	Maintenance
Costs inflate substantially on a program level	Delays in project delivery due to scope expansion and requests for additional funds; Unmet agency goals and customer expectations.	**Extreme (25.0)**	(P) Agency Policies, Procedures, Design Criteria; (P) Develop contingencies for the successful delivery of projects considering many different scenarios of cost inflation; (S) Partner with contractors, manufacturers, and industry to develop long-term material needs and supply plan for Bridge program.	Allowance for increased risk of low-volume bridge design manual; Growing District in-house Bridge capabilities; Explore increase in rehab options.	Medium-High (17.5)	Planning Finance Maintenance Preconstructio n
Ability to deliver projects impacted by lack of qualified internal workforce	Can delay project and program delivery times; Can lead to unmet system performance.	**Extreme (22.5)**	(P) HR Retention; Outsourcing Labor	Research on Technology and Efficiency Assessments to reduce staff workload; More Flexible HR Programs.	Medium (9.0)	HR
Pavements Risk Registry						

Type of Risk or Opportunity	Risk Consequences/Impacts	Original Risk Severity Score	Policy Control Measures (Primary (P) and Secondary (S))	Possible Risk Management Action Plan Items	Final Adjusted Risk Severity Score	Risk Owner
Loss or lack of Institutional Knowledge	Loss of productivity, quality of work, delays, increase in cost.	**High (20.0)**	Recruitment and Retention Plans; Workshops and Trainings for Internal Staff and Contractors; Outsourcing.		Medium-High (16.0)	HR
Project costs inflate substantially	Delays in project delivery due to scope expansion and requests for additional funds; Unmet agency goals and customer expectations.	**High (18.0)**	(P) Develop contingencies for the successful delivery of projects considering many different scenarios of cost inflation.	Optimize the blend of investment; Corridor Management; Increasing daytime work; Lower standards for low-volume and low-speed roads; Prioritize OGFC to risky assets based on safety data; Substitute with SMA	Medium (13.5)	Planning Finance Maintenance Preconstruction
Inaccurate condition prediction models	Will impact the pavement program financial plan and target setting process.	Medium-High (16.0)	(P) Regularly Update Cost in Models; Deterioration Curves Development; (S) Develop Pavement Management Data Quality Management Plan.	Add age of concrete; Add a structural evaluation; Ongoing research project to update deterioration curves; Add a construction history (going forward)	Medium-Low (6.0)	Road Data Services

6.10. RISK MONITORING

The SCDOT recognizes that the risk management process is a cyclic process that requires continuous monitoring and evaluation, serving as a feedback loop, to achieve risk based agency goals (Figure 6.3). An effective implementation of a risk based decision-making practice must include evaluation and monitoring of the priority risks by the risk owners on a periodic basis.

Risk owners or their designees assigned with the responsibility of tracking and evaluating the status of their assigned risks periodically determine what additional mitigation measures/treatments may be required to reduce the overall risk severity. Risk owners report findings back to the TAMP Risk Management Steering Committee and the risks are reevaluated and rescored on an annual basis. The annual review of the Risk Management Plan corresponds with the review schedule of the SCDOT Strategic Plan.

6.11. SUMMARY OF PART 667 EVALUATION

As part of its risk management process, in accordance with 23 CFR 667, SCDOT evaluated its pavement and bridge assets on the NHS to determine if repair and reconstruction activities occurred at least twice due to the effects of events that resulted in an emergency or disaster declaration by the Governor of South Carolina or President of the United States.

Between 1998 and 2018, there were 22 emergency weather related events resulting in either a gubernatorial or presidential declaration for the State of South Carolina. SCDOT began maintaining detailed records on whether a specific asset was affected by these emergency events resulting in a declaration beginning in 2005. Prior to then, the records only show that various repairs were needed on roadways in a particular area without defining the specific asset.

Based on an extensive analysis conducted by the SCDOT it was determined that no discernable damage had occurred to facilities more than once during the review period.

SCDOT staff determined that several NHS road assets required repair and/or replacement first during the historic flood in October 2015; from Hurricane Matthew in October 2016; and from Hurricane Florence in 2018. Based on financial data maintained by the Office of Program Controls, the most expensive repair was approximately $5.4 million on a grouping of multiple projects as a result of the 2015 major flood; $2.2 Million on US 521 (2015 Major Flood); and $2.2 Million on a segment of I-95 during Hurricane Florence. Most of the damage encountered during the storm events resulted in less than $1 million. A detailed list of the gubernatorial and presidential declared emergency events; a detailed list of NHS roadways damaged through events declared as an emergency; and a memo summarizing the SCDOT periodic evaluation of facilities repeatedly requiring repair and reconstruction due to emergency events, is provided in Appendix H.

Based on historic funding levels and frequency of events, it has been the agency's practice to tolerate the risk to its NHS assets resulting from emergency events. In situations where an asset is damaged for the second time, a cost benefit analysis will be conducted to determine the return on investment for repairs that will mitigate the risk of recurring damage from future events.

CHAPTER 7

INVESTMENT STRATEGIES

7. Investment Strategies

7.1. Overview

This chapter outlines SCDOT's investment approach to allocating resources to its assets. The investment strategies focus on areas important for SCDOT and align with the agency's strategic goals. The strategies result in statewide ten-year targets for SCDOT's safety, pavement, bridge, and interstate mobility programs (See Appendix I). This chapter incorporates federally-required measures and targets where appropriate, but primarily focuses on state-specific transportation asset management targets.

7.2. Guiding Principles of SCDOT Investment Strategies

SCDOT's 2018-2020 Strategic Plan has five stated goals with underlying objectives:

- Improving safety programs and outcomes in high-risk areas.
  - Reduce fatalities by 6% by end of calendar year 2020
  - Reduce fatalities on roads in rural areas
- Maintaining and preserving existing transportation infrastructure.
  - Increase responsiveness regarding customer service requests for routine maintenance items
  - Increase the % Good Pavements on the road network across the State
  - Decrease the number of structurally deficient bridges across the State
  - Improve the level of service of day-to-day maintenance of the State Highway System for key safety-related items
  - Decrease the number of mass transit vehicles in poor condition
  - Enhance the network of small businesses that are ready, willing and able to assist the Department in meeting its infrastructure goals
- Improving program delivery to increase the efficiency and reliability of the road and bridge network.
  - Improve the reliability of the movement of people and goods across the major portions of the road network
  - Ensure projects proceed on schedule and within budget in accordance with SCDOT's 10-year Program Delivery Plan
  - Expedite the environmental permitting process for road and bridge projects
- Providing a safe and productive work environment for SCDOT employees.
  - Increase the public's awareness of highway worker safety in work zones
  - Establish programs to provide unit and individual safety awards and incentives
- Earning public trust through transparency, improved communications, and audit compliance.
  - Launch an updated Customer Service Training
  - Increase responsiveness

The seven National Goals, which are in harmony with SCDOT's goals, are:

- Safety – To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.
- Infrastructure Condition – To maintain the highway infrastructure asset system in a state of good repair.
- Congestion Reduction – To achieve a significant reduction in congestion on the National Highway System.
- System Reliability – To improve the efficiency of the surface transportation system.
- Freight Movement and Economic Vitality – To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets and support regional economic development.
- Environmental Sustainability – To enhance the performance of the transportation system while protecting and enhancing the natural environment.
- Reduced Project Delivery Delays – To reduce project costs, promote jobs and the economy and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.

The goals of the Department's Strategic Plan form the basis of the guiding principles of SCDOT's Investment Strategies, which focus on the maintenance, preservation, and safety of the existing transportation system, directing investments based on a hierarchy of highway systems and priority networks, integrating risk-based prioritization, improving safety of the roadways, advancing lifecycle cost in investment programming, and enhancing mobility. The application of these principles is supplemented by accurate and quality data, inputs from experts, and collaboration among local government representatives. In developing its Investment Strategies, SCDOT considers the results of its life cycle planning efforts and internal risk assessment with the objective of closing its performance gap and moving toward a state of good repair for its assets. Through these processes, SCDOT programs suitable investment strategies that drive progress towards performance targets.

7.3. Selection of Investment Strategies

A key step in a risk-based asset management business approach is selecting investment strategies that link agency goals and system performance targets with SCDOT's risk assessment. SCDOT's objective in undertaking transportation asset management is to provide a properly maintained and safe transportation network at a minimum practicable cost over the life of its assets. As such, SCDOT has identified uncertainties that threaten the achievement of its objectives and mitigates those associated risks while taking advantage of arising opportunities.

The agency's risk assessment outlines the threats to which SCDOT is exposed, as well as the number of risks, types of risk, and potential impacts of the risk events. The consideration of risk allows SCDOT to estimate the consequences and/or opportunities to agency or network operations for a given or an implemented investment strategy.

SCDOT considers tradeoff analysis as an important component in selecting investment strategies. The tradeoff analysis component enables SCDOT to evaluate the effectiveness of each strategy on the performance of the system and the cost involved in foregoing other investment strategies. This is done by presenting various alternative funding scenarios for consideration and the corresponding projected system condition. These strategies are further shaped by performance targets, which consider agency and national goals, funding constraints, and the agency's risk profile.

Chapter 8 of the TAMP includes further discussion on the agency's action plan.

7.3.1. Safety Investment Strategies

While the majority of SCDOT's TAMP addresses its pavement and bridge assets, it is also important to note other priorities of the agency. Historically, South Carolina has had one of the highest traffic fatality rates in the nation. Most recently, in 2014 and 2015, South Carolina was worst in the nation for the number of deaths per 100 million vehicle miles traveled, with 1.65 and 1.89 deaths respectively. The rate in 2015 is 6 percent higher than the national rate and 40 percent higher than other states in the southeastern region.[5] In total, approximately 1,000 people die on South Carolina public roads annually. Many of these fatalities occur on the State's rural road system, which encompasses many of the state-maintained roads located within rural areas that link communities. According to the most recent data as of publishing, 30 percent of the rural traffic-related fatalities and serious injuries occur on just five percent of SCDOT's system.

With the additional funding available from Act 40 of 2017, SCDOT is directing $50 million annually through FY 2027 into its Rural Road Safety Program, a plan that was first presented to the Transportation Commission in June of 2017. With the funding influx, SCDOT initially will be targeting nearly 1,000 miles of non-interstate rural roads with safety solutions particularly tailored for those corridors based on crash data compiled by the Department's Traffic Engineering Office. Those safety solutions include rumble strips, raised pavement markings, highly reflective signs, wider pavement markings, guardrail, specialized pavement treatments, wider shoulders, paved shoulders, wider clear zones adjacent to roadways, and relocating drainage ditches further away from the roadways.

Other safety emphasis areas for the agency include limiting roadway departures, improving intersections and other high-risk locations, and protecting non-motorized roadway users. SCDOT's 10-year Safety Targets will be discussed in Section 7.5.2.

7.3.2. Pavement Investment Strategies

Investment in pavement assets reflects a whole life management approach and emphasizes the strategies listed below. The strategies listed here are not in an order of implementation priorities. Rather, SCDOT selects and implements a combination of strategies based on

[5] National Highway Traffic Safety Administration, Traffic Safety Facts, Report # DOT HS 812 412, (June 2017)

system conditions, funding, and risk. The current policy of SCDOT is to allocate dedicated levels of funding to the different pavement strategies.

- **Pavement preservation:** SCDOT is committed to preserving and extending the service life of the existing transportation network. Under the pavement preservation investment strategy, emphasis is placed on performing preventive maintenance activities that keep "good" roads "good" for an extended period of time. These activities involve the timely application of lower-cost surface maintenance treatments that delay pavement assets declining from a state of good repair into a state that will require rehabilitation or reconstruction. Preservation of the existing system and keeping a majority of the NHS in a good condition is a priority of SCDOT. Pavements in good condition require relatively low maintenance costs; consequently, requiring minimum resources to maintain the pavements over their remaining service life while the pavements remain in good condition. Based on research, for every dollar spent on preservation, SCDOT saves six to ten dollars that would have been spent on rehabilitation or reconstruction in the future. Table 7-1 lists the average pavement treatment costs per lane mile for the most common preservation, rehabilitation, and reconstruction treatments used by SCDOT.

- **Pavement rehabilitation:** SCDOT is committed to utilizing strategies that enhance pavements that have structural or functional deficiencies. The rehabilitation strategy is implemented to enhance pavement structure and restore heavily deteriorated pavements. SCDOT adopts the rehabilitation strategy to extend the service life of pavements that have moved beyond the minimum threshold for preservation. Restoration, resurfacing, and recycling rehabilitation strategies are implemented to modernize and extend the pavements' service life and return the pavements to a state of good repair.

- **Pavement reconstruction/replacement:** SCDOT will utilize the reconstruction strategy for roads with heavily deteriorated pavement structures. Reconstruction involves the replacement of the entire existing pavement structure with an equivalent or increased pavement structure. Pavement reconstruction is the most expensive of the pavement investment strategies. For the purpose of effective utilization of resources, some roads may be strategically allowed to deteriorate to this level for reconstruction at a later date, especially if there are other planned construction activities for the roads, such as widening projects or safety improvements, which reduce overall cost by eliminating duplication of certain construction activities.

- **Routine Maintenance:** Routine maintenance as defined by the AASHTO Subcommittee on Maintenance is work that is planned and performed on a routine basis to maintain and preserve the condition of the highway system or to respond to specific conditions and events that restore the highway system to an adequate level of service. This includes pavement work such as patching potholes and broken pavement edges to minor leveling and strengthening of localized areas.

Table 7-1. Average pavement treatment costs per lane mile for the various preservation treatments used by SCDOT and for rehabilitation and reconstruction.

2018 Pavement Improvement Program (Award Amounts)		
Treatment	**LM Average**	**SY Average Cost**
Chip Seal (Preservation)	$ 29,705.19	$ 4.29
Crack Seal (Preservation)	$ 6,117.62	$ 0.49
Ultra Thin Lift Asphalt (Preservation)	$ 64,155.62	$ 9.09
Micro Surface (Preservation)	$ 38,349.24	$ 5.41
Average for all Preservation	$ 31,562.40	$ 6.26
Heavy Rehabilitation	$ 206,828.44	$ 29.28
Rehabilitation	$ 136,846.71	$ 19.49
Average for all Rehabilitation	$ 147,949.09	$ 24.38
Reconstruction	$ 196,009.20	$ 28.10
***** These are average contract costs based on all of the included pay items for each specific treatment. LM amounts based on 12' lane. Values are a weighted average of 2018 Federal and State Programs		

7.3.3. Bridge Investment Strategies

With the agency's needs-based approach, bridge investment strategies include a combination of routine maintenance, preservation, rehabilitation, and replacement activities. The most common routine maintenance activities include concrete spall repairs, repairs to bridge rail, cleaning of bearing assemblies, pile repairs, debris removal, and cleaning drainage weep holes. Preservation strategies include painting, deck patching, and sealing expansion joints. Rehabilitation activities include deck replacements, bearing replacements, and other major repairs. This approach enables SCDOT to address structurally deficient bridges while ensuring that bridges in good condition are effectively preserved to delay the higher cost of rehabilitation or replacement. SCDOT implements these investment strategies with the objective of achieving the following:

- **Identify and Inventory structurally deficient bridges:** SCDOT staff conducts continual assessment of its bridge inventory and monitors its progress. As bridge preservation, rehabilitation, and replacement investment strategies are implemented, the structurally deficient bridge list can change periodically as new data is provided from field inspections and bridges are added or subtracted. The agency reports the status of the list by publishing quarterly and annual progress in its online performance viewer.

- **Extend the life of the State's bridge system:** SCDOT's commitment to stop the deterioration of the overall bridge system is the highest priority when developing bridge investment strategies for preservation, rehabilitation, and reconstruction.

- **Reduce the number of structurally deficient bridges[6]:** Structurally deficient bridges present uncertainty in the smooth operation of a transportation system. The Department's 10-year fiscally-constrained target is to replace or upgrade all of the structurally deficient bridges on the interstate and NHS primary systems that were identified in May 2016. These networks carry about 56 percent of all the daily vehicle miles traveled in the State. In addition, including bridges already programmed, SCDOT projects to replace or upgrade a total of 465 bridges statewide through FY 2027 that are classified as closed, load restricted, or structurally deficient throughout its system. This includes 51 structurally deficient bridges in 2016 that were not yet programmed for replacement or repair on the NHS. These deficient bridges could significantly hamper South Carolina's ability to move freight across the major routes in the State if not repaired or replaced.

- **Target closed and load-restricted bridges[6]:** This strategy will direct Investments towards structurally deficient bridges designated as load restricted. Most of these bridges are currently located on the primary and secondary roadway system. These load-restricted bridges negatively impact system operation. SCDOT understands that some of these bridges are located on strategic freight routes leading to adverse impacts on business operations in South Carolina. SCDOT intends to replace 348 load-restricted bridges as part of the 465 bridges mentioned above.

7.3.4. Interstate Capacity Investment Strategies

The interstate system within South Carolina carries 29% of the annual traffic in the State, but consists of just 4 percent of the state-maintained system by mileage. To help relieve congestion, reduce delay, and prevent freight bottlenecks, SCDOT is targeting certain interstate corridors for widening over the next 10 years. This includes the Rural Interstate Freight Corridor Mobility Improvement Program that was approved by the SCDOT Commission in October 2018. In addition to solving the above issues, this strategy will improve pavement conditions on the interstate as existing pavements will be resurfaced when lanes are added. SCDOT has targeted 100 + centerline miles of interstate to be widened through 2027.

7.4. The Role of Performance Targets in Investment Decision Making

Performance-based investment decision-making is a strategic approach SCDOT uses to link department goals, objectives, and risks in allocating resources effectively. Performance-based resource allocation is effective with the use of well-defined performance measures and the establishment of practical and achievable performance targets. Performance targets are vital elements in the SCDOT's performance and risk-based asset management program. SCDOT uses 10-year projected performance conditions as benchmarks in evaluating

[6,6] These lists are not mutually exclusive. Certain load-restricted bridges are also structurally deficient and vice versa.

progress made from baseline performance after the implementation of an investment strategy. These state targets are used to assess the effectiveness of selected investment strategies. The use of targets in performance management allows for accountability to decision makers and the public by communicating the effectiveness of investment actions.

SCDOT's asset performance targets are aligned with performance measures to ensure that resources are utilized efficiently and investments are prioritized effectively, such as percent of pavement miles or bridge structures in "Good" or "Poor" condition. In effect, performance targets enable SCDOT to make investment recommendations based on objective, data-driven results by tracking asset condition performance measures.

SCDOT's performance measures for pavements were established prior to FHWA's final rulemaking in May 2017, and are based on agency-specific performance measures, which do not align with the promulgated national measures. SCDOT uses the pavement quality index (PQI) to determine whether a pavement is in good, fair, or poor condition. The national measures are based on rideability, rutting, cracking percentage, and faulting, all of which are components of PQI. However, using the federal metrics does not produce the same results of good, fair, and poor. For bridge assets, SCDOT tracks conditions using the FHWA NBI rating criteria.

MAP-21 has given State DOTs the flexibility to establish their own targets. Based on this flexibility, SCDOT has established fiscally constrained targets, also referred to as the 10-year performance estimates, which are based on projected state and federal funding for the next 10 years. The establishment of these targets is driven by unique factors used to assess system performance over a selected timeframe defined by the TAMP. As a result, the targets are dynamic and may evolve over the next ten years.

7.5. System 10-Year Projected Performance Outcome

SCDOT's approach to managing its system involves the development of investment strategies that optimize system performance with the existing and future budget allocations. SCDOT investigates different investment scenarios and recommends target-achieving strategies or options that minimize the agency's risks at the lowest practical cost. The results of this scenario analysis enables SCDOT to better estimate system financial needs and manage resources effectively.

As noted, SCDOT uses a pavement management system to forecast system conditions and make investment and policy decisions to achieve pavement performance goals. Using an investment strategy that allocates funding within each system proportionate to the percentage of those system pavements in good, fair, or poor condition, Figure 7-1 shows the annual funding level required to achieve a desired percentage of good pavements for each system over the next ten years. Using this model, the funding needed to maintain the system at its 2016 percent good condition levels through 2027, would be approximately:

- $105 million for interstate (65.0% good);
- $38 million for non-interstate NHS (28.0% good);
- $85 million for non-NHS primary (20.0% good);
- $60 million for federal-aid secondary (19.0% good); and
- $85 million for non-federal aid secondary (15.0% good).

The model assumes that if any system were to receive no funding over the next ten years, all or almost all of the pavement segments classified as being in good condition in 2016 within that system will deteriorate to either fair or poor condition. It should also be noted that the model does not account for any programmed projects on the state system financed by local option sales taxes due to inherent variability in project timelines and local project selection processes.

Figure 7-1. Ten-Year Projected Performance and Funding Levels for Pavement Systems

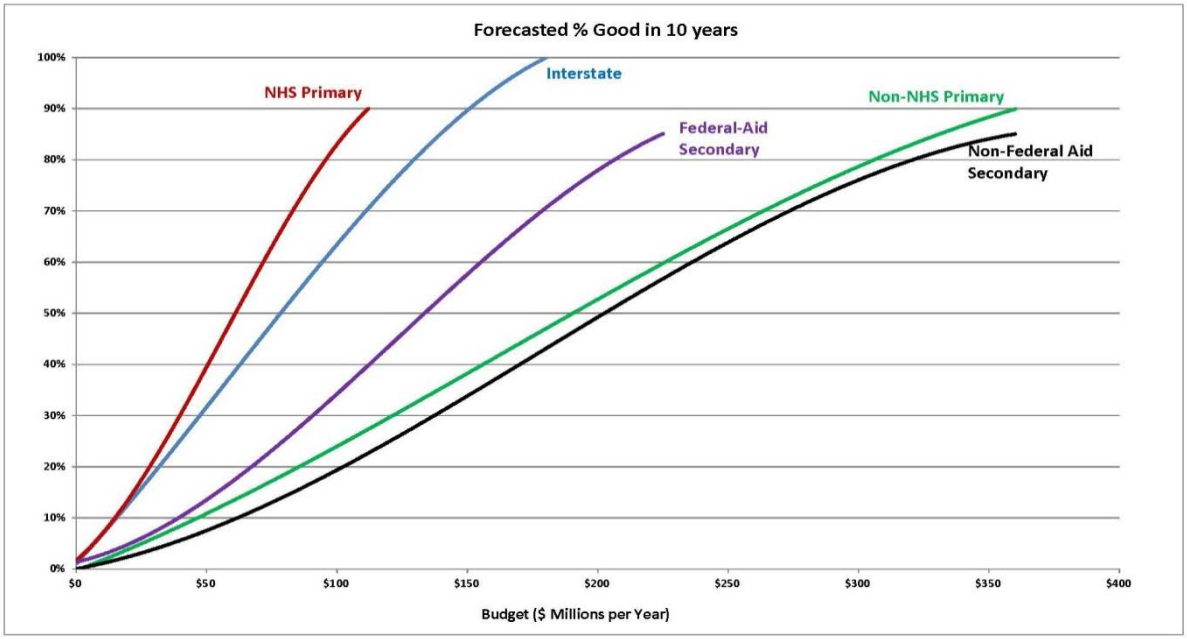
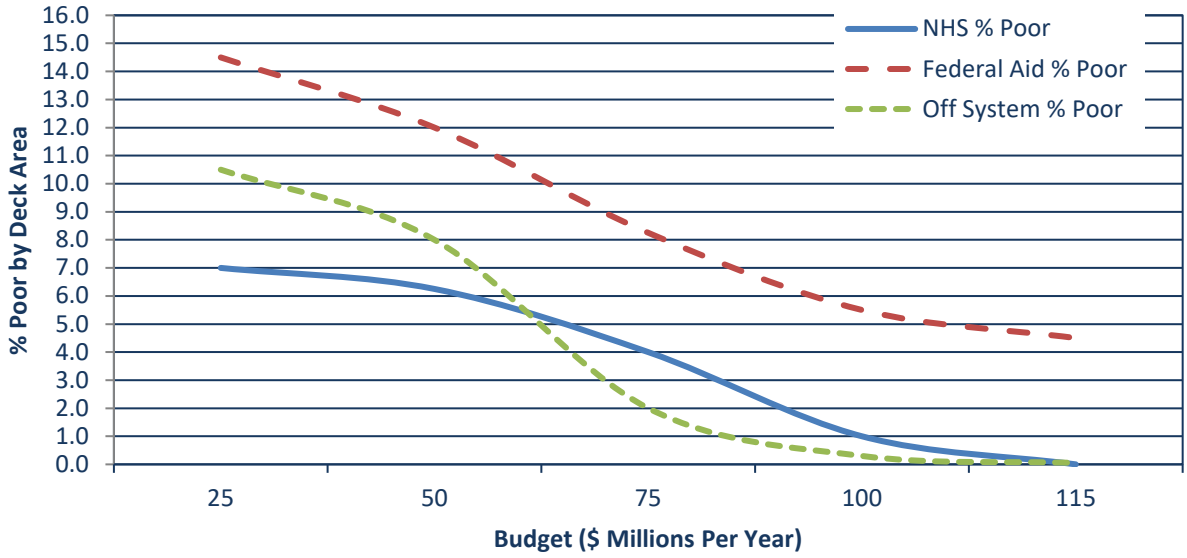


Figure 7-2 likewise shows the average annual funding level required to maintain the three SCDOT-maintained bridge systems at a desired percentage of poor bridges for each system over the next ten years. This model shows the funding necessary to maintain the system at its 2016 percent poor levels through 2027, would be approximately:

- $75 million for NHS bridges (4.0% poor);
- $70 million for federal aid bridges (9.5% poor); and
- $55 million for off-system bridges (7.4% poor).

Figure 7-2. Ten-Year Projected Performance and Funding Levels for Bridge Systems



As noted in the Financial Chapter, SCDOT will have available for its assets approximately $1.36 billion on average annually through FY 2027. Deducting $610 million per year for its interstate capacity, MPO and COG, freight, and safety programs leaves approximately $750 million on average per year over the ten-year period for pavement and bridge preservation, rehabilitation, and reconstruction. Table 7-2 outlines SCDOT's projected Investment Strategies for the next ten years. Due to the inherent variability in construction prices, the allocations among asset classes may change based on what the Transportation Commission approves in future years. This table is based on the funding provided within the ten-year consolidated funding plan.

Table 7-2. Projected Program Category Allocations to Assets FYs 2018 – 2027 (in millions)

Asset Budget Category	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	10-year avg.
Pavements	$401.8	$417.0	$487.0	$562.0	$642.0	$702.0	$702.0	$702.0	$702.0	$702.0	$602.0
Interstate	100.0	100.0	100.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	135.0
NHS	65.0	80.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	86.5
Non-NHS Primary	100.0	100.0	140.0	140.0	180.0	240.0	240.0	240.0	240.0	240.0	186.0
Federal Aid Secondary	55.0	55.0	75.0	100.0	140.0	140.0	140.0	140.0	140.0	140.0	112.5
Non-Federal Aid Secondary	81.8	82.0	82.0	82.0	82.0	82.0	82.0	82.0	82.0	82.0	82.0
Bridges	180.0	170.0	145.0	145.0	145.0	145.0	145.0	145.0	145.0	145.0	151.0
NHS	110.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	114.5
Federal Aid	50.5	25.5	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	18.0
Off System	19.5	29.5	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	18.5
Assets Subtotal	581.8	587.0	632.0	707.0	787.0	847.0	847.0	847.0	847.0	847.0	753.0
Interstate System Upgrade	350.5	352.6	373.1	323.3	332.2	340.3	341.0	343.5	346.6	348.4	345.1
MPO/COG Programs	138.0	138.0	138.0	138.0	138.0	138.0	138.0	138.0	138.0	138.0	138.0
Freight	24.6	27.3	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	29.2
Safety	97.7	98.7	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.3
Total	$1,192.6	$1,203.6	$1,272.8	$1,297.9	$1,386.9	$1,454.9	$1,455.6	$1,458.2	$1,461.2	$1,463.1	$1,364.6

7.5.1. Initial TAMP Implementation

The Initial SCDOT TAMP was approved in April 2018. Since Its adoption, the SCDOT has implemented TAMP investment strategies consistent with 23 CFR 515.13(b)(2)). This is demonstrated through Table 7-3 thru Table 7-5. These tables provide a current detail of planned and actual expenditures for FY 2018 and FY 2019. Also included are longer-range planned projections for FY 2020 to FY 2027 showing funding allocations for preservation, rehabilitation, and reconstruction; and planned and routine maintenance work types for FY 2018 to FY 2027. The following provides a more detailed explanation of how planned and actual funding levels were determined and why they may not always align.

- The total planned program budget amounts for each system were used for the 10-Year Plan Program budget amounts.
- The planned budget amounts for 2020-2027 were determined using 10% of the allotment for preservation, and the average percentages of the 2018 and 2019 actual award amounts for rehabilitation and reconstruction.
- Interstate System - The 2018-2019 Interstate actual amounts were determined by subtracting the amount of funding awarded to contract for preservation from the total funding authorized to arrive at the amount for rehabilitation. No preservation funding was allocated in 2019 due to cost overruns in 2018.

- Non-Interstate NHS and Non-NHS Primary Systems - Planned amounts are based on the percentage of good, fair and poor corresponding to preservation, rehabilitation, and reconstruction. In 2018 and 2019, the NHS Program was a statewide program that has since reverted back to a county distribution program for year 2020 and beyond, with each county receiving an NHS award allotment. Therefore, the actual award amounts are lower than planned (Non-NHS Primary) due to funding from the non-NHS Primary program being redirected towards the highest priority routes on the Non-Interstate NHS.

- FA Secondary and Non-FA-Secondary Systems – Planned expenditures were consistent with the amounts provided within Table 7-2. Actual expenditures were generally consistent with planned amounts.

- In Tables 7-3 and 7-4, the total planned program budget amounts for each system were taken from the Consolidated Funding Spreadsheet, Table 7-2.

In Tables 7-3 and 7-4, planned amounts for preservation, rehabilitation, and reconstruction/replacement in years 2020-2027 are averages taken from actual award amounts for 2018 and 2019, and from the construction-letting database.

The Agency is using the investment strategies in its plan to make progress toward achievement of its pavement and bridge performance targets for asset condition and performance of the NHS and to support progress toward the national goals identified in 23 U.S.C. 150(b). As noted in Table 7-2, SCDOT programs and develops its 10-year investment strategies at the network level.

Table 7-3. Pavement Budget Allocations by Work Type (in Millions) FY 2018-2027

Planned Pavement Budget Allocations by Work Type (In Millions)												
Pavement Asset Budget Category	2018		2019		2020	2021	2022	2023	2024	2025	2026	2027
	Planned	Actual	Planned	Actual	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned
Interstate	$100.00	$167.56	$100.00	$77.76	$100.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00	$150.00
Preservation	$10.00	$43.97	$10.00	$	$10.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00
Rehabilitation	$90.00	$123.59	$90.00	$77.76	$90.00	$130.00	$130.00	$130.00	$130.00	$130.00	$130.00	$130.00
Reconstruction	$	$	$	$	$	$	$	$	$	$	$	$
Non-Interstate NHS	$65.00	$128.07	$80.00	$105.03	$90.00	$90.00	$90.00	$90.00	$90.00	$90.00	$90.00	$90.00
Preservation	$14.99	$26.24	$25.46	$21.78	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00
Rehabilitation	$14.16	$97.99	$19.92	$76.69	$75.81	$75.81	$75.81	$75.81	$75.81	$75.81	$75.81	$75.81
Reconstruction	$35.85	$3.84	$34.62	$6.56	$5.19	$5.19	$5.19	$5.19	$5.19	$5.19	$5.19	$5.19
Non-NHS Primary	$100.00	$71.54	$100.00	$67.94	$140.00	$140.00	$180.00	$240.00	$240.00	$240.00	$240.00	$240.00
Preservation	$23.06	$18.65	$31.67	$16.71	$14.00	$14.00	$18.00	$24.00	$24.00	$24.00	$24.00	$24.00
Rehabilitation	$21.78	$41.58	$25.11	$37.03	$92.76	$99.67	$128.14	$170.86	$170.86	$170.86	$170.86	$170.86
Reconstruction	$55.16	$11.31	$43.22	$14.20	$33.24	$26.33	$33.86	$45.14	$45.14	$45.14	$45.14	$45.14
FA Secondary	$55.00	$65.68	$55.00	$53.14	$75.00	$100.00	$140.00	$140.00	$140.00	$140.00	$140.00	$140.00
Preservation	$10.60	$13.12	$11.14	$10.08	$7.50	$10.00	$14.00	$14.00	$14.00	$14.00	$14.00	$14.00
Rehabilitation	$15.65	$34.12	$14.92	$22.78	$39.76	$53.01	$74.21	$74.21	$74.21	$74.21	$74.21	$74.21
Reconstruction	$28.75	$18.44	$28.94	$20.28	$27.74	$36.99	$51.79	$51.79	$51.79	$51.79	$51.79	$51.79
NFA Secondary**	$81.80	$101.06	$68.00	$63.71	$68.00	$82.00	$82.00	$82.00	$82.00	$82.00	$82.00	$82.00
Preservation	$12.37	$14.55	$11.00	$9.86	$6.80	$8.20	$8.20	$8.20	$8.20	$8.20	$8.20	$8.20
Rehabilitation	$24.63	$52.23	$18.37	$24.65	$34.78	$41.94	$41.94	$41.94	$41.94	$41.94	$41.94	$41.94
Reconstruction	$44.80	$34.28	$38.63	$29.20	$26.42	$31.86	$31.86	$31.86	$31.86	$31.86	$31.86	$31.86
Totals Actual	$401.80	$533.91	$403.00	$367.58	$473.00	$562.00	$642.00	$702.00	$702.00	$702.00	$702.00	$702.00

*** Zero dollars spent for interstate preservation in 2019 due to over programming in 2018**

**** NFA Secondary Budget reduced by $14M in 2019 & 2020 due to program overruns in 2018**

Note: 2018 & 2019 represent actual contract award amounts

Table 7-4. Bridge Budget Allocations by Work Type (in Millions) FY 2018-FY2027

Planned Bridge Budget Allocations by Work Type (In Millions)												
Bridge Asset Budget Category	2018		2019		2020	2021	2022	2023	2024	2025	2026	2027
	Planned	Actual	Planned	Actual	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned
NHS	$110.00	$25.56	$115.00	$43.99	$115.00	$115.00	$115.00	$115.00	$115.00	$115.00	$115.00	$115.00
Preservation	$10.75	$0.91	$11.25	$4.28	$11.24	$11.24	$11.24	$11.24	$11.24	$11.24	$11.24	$11.24
Rehabilitation	$20.75	$6.60	$21.69	$8.27	$21.69	$21.69	$21.69	$21.69	$21.69	$21.69	$21.69	$21.69
Replacement	$78.50	$18.05	$82.06	$31.44	$82.07	$82.07	$82.07	$82.07	$82.07	$82.07	$82.07	$82.07
Non-NHS	$50.50	$115.63	$25.50	$111.20	$13.00	$13.00	$13.00	$13.00	$13.00	$13.00	$13.00	$13.00
Preservation	$1.68	$0.39	$0.85	$3.70	$0.43	$0.44	$0.44	$0.44	$0.44	$0.44	$0.44	$0.44
Rehabilitation	$4.50	$8.20	$2.27	$9.90	$1.16	$1.19	$1.19	$1.19	$1.19	$1.19	$1.19	$1.19
Replacement	$44.32	$94.19	$22.38	$97.60	$11.41	$11.36	$11.36	$11.36	$11.36	$11.36	$11.36	$11.36
New Location	$	$12.85	$	$								
Off System	$19.50	$9.63	$29.50	$9.53	$ 17.00	$17.00	$17.00	$17.00	$17.00	$17.00	$17.00	$17.00
Preservation	$0.28	$0.77	$0.42	$0.14	$0.24	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26
Rehabilitation	$	$	$	$								
Replacement	$19.22	$8.86	$29.08	$9.39	$16.76	$16.74	$16.74	$16.74	$16.74	$16.74	$16.74	$16.74
Totals	$180.00	$150.82	$170.00	$164.72	$145.00	$145.00	$145.00	$145.00	$145.00	$145.00	$145.00	$145.00

Note: 2018 & 2019 represent actual contract amounts

Table 7-5. Planned Routine Maintenance for Pavements and Bridges (in Millions) FY 2018-FY2027

Planned Routine Maintenance for Pavements and Bridges (In Millions) FY 2018-FY2027												
Routine Maintenance	2018		2019		2020	2021	2022	2023	2024	2025	2026	2027
	Planned	Actual	Planned	Actual	Planned	Planned	Planned	Planned	Planned	Planned	Planned	Planned
Pavements	$7.63	$9.57	$11.89	$11.75	$12.43	$12.15	$12.15	$12.15	$12.15	$12.15	$12.15	$12.15
Interstate	$0.04	$0.05	$0.09	$0.09	$0.09	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08
Non-Interstate NHS	$0.14	$0.18	$0.30	$0.29	$0.31	$0.27	$0.27	$0.27	$0.27	$0.27	$0.27	$0.27
Non-NHS Primary	$0.23	$0.29	$0.48	$0.47	$0.50	$0.43	$0.43	$0.43	$0.43	$0.43	$0.43	$0.43
FA Secondary	$1.53	$1.92	$2.33	$2.31	$2.44	$2.41	$2.41	$2.41	$2.41	$2.41	$2.41	$2.41
NFA Secondary	$5.69	$7.13	$8.69	$8.59	$9.09	$8.97	$8.97	$8.97	$8.97	$8.97	$8.97	$8.97
Bridges	$0.53	$0.75	$0.56	$0.33	$0.56	$0.55	$0.55	$0.55	$0.55	$0.55	$0.55	$0.55
NHS	$0.05	$0.07	$0.06	$0.03	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06
Non-NHS Primary	$0.07	$0.10	$0.22	$0.13	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22
Off System	$0.40	$0.57	$0.28	$0.17	$0.28	$0.27	$0.27	$0.27	$0.27	$0.27	$0.27	$0.27

Note: Maintenance Costs are for Materials only and do not include labor and equipment, since this is how these activities are budgeted.

7.5.2. PQI and the Federal Pavement Performance Measure

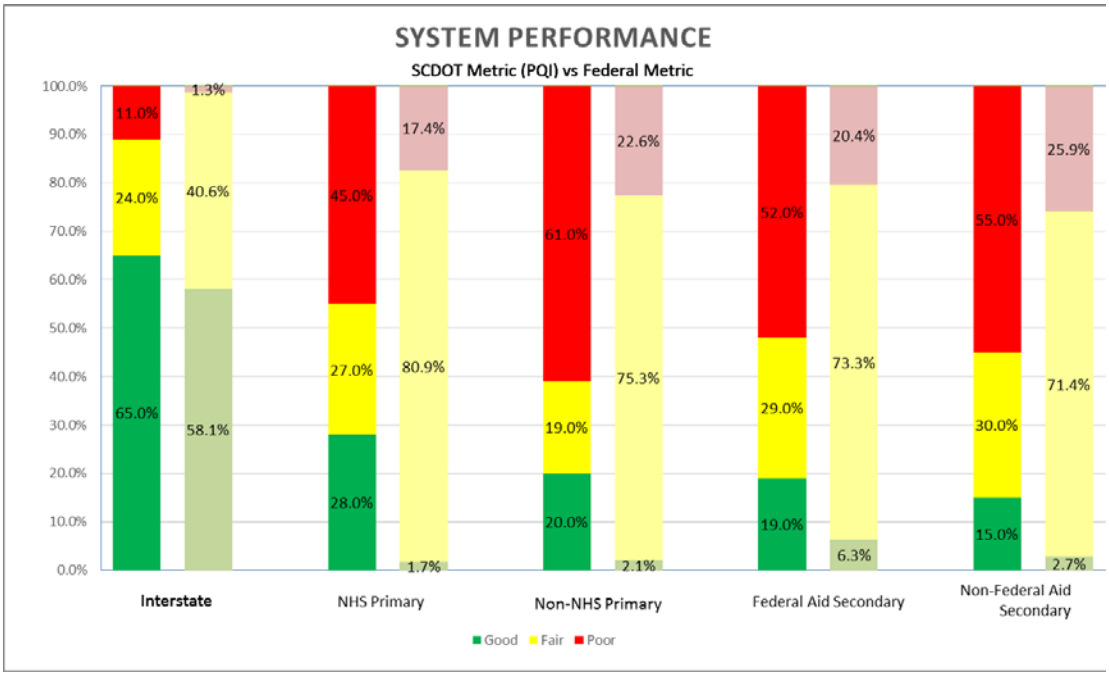
Beginning in 2018, states were required to collect and report pavement data to FHWA based on the federal pavement performance measure, which uses rideability, cracking percentage, rutting, and faulting condition data. While SCDOT has historically collected these types of data, the collection method was not aligned with new federal standards. Table 7-6 lists the measurement thresholds that determine whether a pavement is good or poor under the federal pavement performance measure. For Jointed Plain Concrete Pavement and Asphalt, IRI, Cracking, and Rutting/Faulting must all be good to warrant a good rating. If at least two of the three categories qualify as poor, then the pavement is considered poor. For Continuously Reinforced Concrete Pavement, the pavement is considered good if both IRI and Cracking are good and the pavement is considered poor if both IRI and Cracking are poor.

Table 7-6. Federal Performance Measure Pavement Condition Thresholds

Federal Performance Measures	Good	Poor
IRI (inches/mile)	< 95	> 170
Cracking Percent (%)		
Continuously Reinforced Concrete Pavement (CRCP)	< 5	> 10
Jointed Plain Concrete Pavement (JPCP)		> 15
Asphalt		> 20
Rutting (Asphalt only) (inches)	< 0.20	> 0.40
Faulting (JPCP only) (inches)	< 0.10	> 0.15

In the process of changing its pavement condition data collection, SCDOT staff approximated pavement condition data using the federal measures for 2016, which is outlined in Figure 7-3 in comparison with PQI. Based on the data, the PQI measure shows a higher percentage of pavements in good and poor condition than the federal measure across all pavement systems; however, the percentage of interstate pavements in good condition is comparable using either the PQI or the federal measure.

Figure 7-3. 2017 Pavement Condition Measure Comparison



Based on a number of factors, including decades of historical pavement condition data, which includes patching and raveling, SCDOT staff believe presenting 10-year pavement condition targets using PQI as the performance measure, rather than the federal metric, is currently the prudent choice for the agency. Once SCDOT has collected multiple years of pavement condition data using the newly-promulgated federal standards, the agency will reevaluate its methodology.

7.5.3. Fiscally-Constrained Targets

These are targets established by SCDOT based on observed financial and historic system performance trends, projected revenue, and industry capacity to deliver. Fiscally-constrained targets are assumed to be realistic in nature and emulate the existing and projected fiscal environment of the agency. Accordingly, key aims for establishing fiscally constrained targets are to:

- Communicate what is achievable with forecasted revenue streams to decision makers and system users;
- Pursue realistic investment strategies that can be financially supported by SCDOT and realistically delivered by the transportation industry in South Carolina; and
- Establish consistent and rational resource allocation policies that facilitate progress towards achieving performance targets and agency goals.

Due to limitations in its current pavement management software, SCDOT can only project the future percentage of good pavements on its system using the software. SCDOT is currently working on adding the capability for the projection of the percent of poor pavements over a ten-year or longer horizon. In lieu of using the pavement management software, SCDOT

pavement management engineers analyzed the 5-year historical relationship between the amount of fair and poor pavements and projected the percentage of poor pavements in ten years using that constant relationship.

As noted, pavement targets are represented using PQI. Based on a 0 to 5 scale, Good is greater than or equal to 3.4 and Poor is less than or equal to 2.6. Bridge targets are based on the 0-9 federal NBI measurement. Good bridges must have values of 7 or higher for the deck, substructure, and superstructure components and Poor bridges have values of 4 or less in one or more of the deck, substructure, or superstructure components (See Table 7-7). Culverts considered bridges follow the same rating values. See Table 7-8 for current conditions and ten-year fiscally-constrained targets by pavement system and bridge system. These targets were developed using models built into SCDOT's pavement management system and historical bridge condition data trends.

Table 7-7. National Bridge Inventory Measurement Rating Scale

NBI Rating Scale (from 0 – 9)	**9 8 7** **Good**	**4 3 2 1 0** **Poor**
Deck	≥ 7	≤ 4
Superstructure	≥ 7	≤ 4
Substructure	≥ 7	≤ 4
Culvert	≥ 7	≤ 4

Table 7-8. SCDOT Pavement and Bridge System Fiscally-Constrained Targets*

	2016 (Actual) % Good	2016 (Actual) % Poor	Ten-year Target % Good	Ten-year Target % Poor	Average 10-Year Allocation (in millions)
Pavements					
Interstate[1]	65	11	92	3	$135.0
Non-Interstate NHS	28	45	72	16	86.5
Non-NHS Primaries	20	61	48	37	186.0
Federal Aid Secondary	19	52	40	35	112.5
Non-Federal Aid Secondary[2]	15	55	25	45	121.0
Bridges (by count)					
NHS	48	6	66	0	114.5
FA	46	11	41	11	18.0
Off System	40	9	36	10	18.5
Bridges (by deck area)					
NHS	42	4	60	0	114.5
FA	50	10	41	15	18.0
Off System	51	7	44	10	18.5

* Pavement condition based on PQI scale. Bridge condition is based on the federal NBI scale.

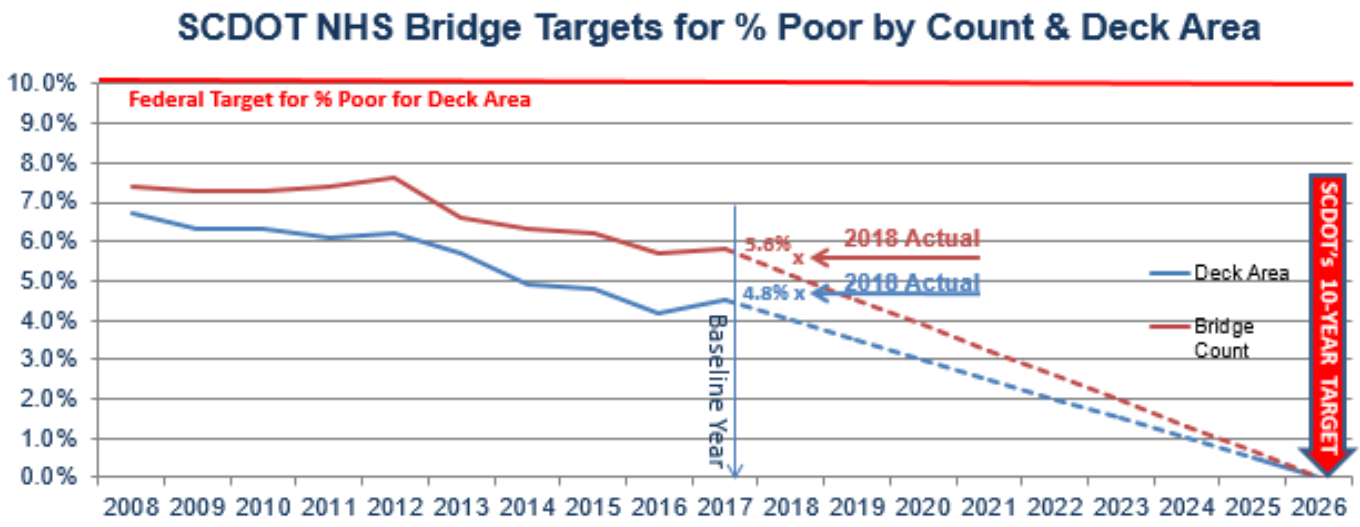
[1] Includes approximately $20 million added value from planned interstate widening projects over the next ten years.

[2] Includes approximately $39 million projected added value from projects County Transportation Committees program on the State's Non-Federal Aid Secondary system annually.

With the $602 million SCDOT is budgeting toward its pavement systems on average over the next 10 years, it is forecasting significant improvement in the percent good of its pavements.

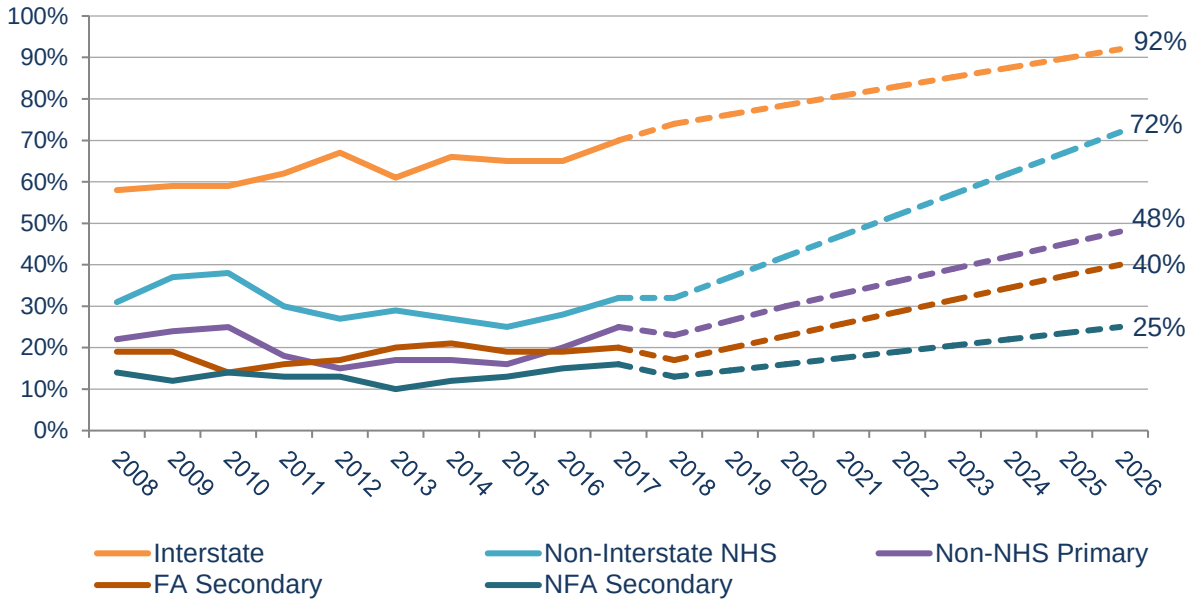
Investments in the NHS bridge system are projected to increase the percent good by 18 percentage points measured by both count and deck area. The ten-year target of decreasing the percentage of poor bridges by count and by deck area towards zero is illustrated in Figure 7-4. However, the projected percent good of the Federal Aid and Off System bridge networks, measured by both count and deck area, is projected to trend downward at the current level of funding.

Figure 7-4. NHS Bridges % Poor by Deck Count and Area



The 10-year fiscally constrained targets shown in Table 7-8 and Figure 7-5 below are based on current available data. SCDOT staff will annually monitor its pavement and bridge asset condition data to track its investment strategies against its 10-year targets. If the data trend results in a significant deviation from the 10-year asset condition targets, the agency will consider alternative strategies to close the performance gap, or consider amending its 10-year targets if analysis shows the gap cannot be closed.

Figure 7-5. SCDOT Pavement System Fiscally-Constrained Targets



The ten-year condition targets outlined in this plan are based on best available current data. Managing the fourth-largest highway system in the United States necessarily involves a careful analysis of competing priorities. For example, SCDOT's Interstate Capacity Program will impact its future pavement program budget by increasing the mileage that needs ongoing preservation. While it is likely that added capacity during this TAMP's ten-year timeframe will not need preservation treatments during that period, the agency is aware that it will need to increase the future amount budgeted to its pavement program budget to properly maintain its interstate system. However, the need for an increased future pavement program budget does not affect the agency's decision as to whether it will pursue added interstate capacity in the present, other factors such as mobility, level of service, and freight needs do.

Two and Four-Year Targets

Federal law requires states to set two- and four-year targets for their pavement assets on the interstate and non-interstate NHS and bridge assets on the NHS by May 2018 and every four years thereafter using the federal measures. SCDOT developed a detailed methodology, which included analyzing the deterioration of its pavement and bridge assets, determining the percentage of its pavement and bridge assets that were likely to move from fair to poor condition, and determining the percentage of its assets that are likely to move to good condition based on finished construction projects.

To maintain the highway infrastructure asset system in a state of good repair, the National goals are defined in MAP-21/FAST Act and require that within the TAMP, SCDOT address 6 pavement and bridge performance measures and develop 2 and 4 year targets. The required performance measures used in the development of the targets are as follows:

- Percent of Interstate pavements in Good condition;
- Percent of Interstate pavements in Poor condition;
- Percent of non-Interstate NHS pavements in Good condition;
- Percent of non-Interstate NHS pavements in Poor condition;
- Percent of NHS bridges by deck area in Good condition; and
- Percent of NHS bridges by deck area in Poor condition.

MPOs and COGs are required to either adopt and support the SCDOT statewide targets or set their own targets specific to their areas. SCDOT, MPOs, and COGs will have the opportunity to adjust their four-year targets after the initial two years. Below we describe the processes and data used to develop the two and four-year targets as well as the recommended targets displayed in Tables 7-9 and 7-10. A complete description for both the pavement and bridge target setting methodology is provided in Appendix G and Appendix H.

Pavement Target Setting Process

Pavement performance targets were established as required by 23 CFR Part 490. The target setting process started with a kick-off meeting with participants from Planning, Road Data Services, and Maintenance. The meeting discussed data collection cycles on different road

systems, as well as a comparison of the current SCDOT pavement-rating index's (PQI) vs. federal metrics.

SCDOT analysts used collected data for the International Roughness Index, Cracking Percent, Rutting, and Faulting based on whether the pavement was asphalt, continuously reinforced concrete pavement (CRCP), or jointed concrete pavement (JPCP). Using historical data, staff developed deterioration models for the different pavements by segment. Over the 4-year period, staff also examined whether there were any planned improvements made to the pavements that would be inspected and reported to HPMS within four years based on the agency's investment strategies.

The aggregated data was presented to a workgroup of internal experts. Based on the methodology, the workgroup chose a median deterioration model that resulted in a projected good and poor value, taking into account improvements made on the Interstate and non-interstate NHS, as described in the table below. For the initial reporting period, Interstates are only required to have 4 year targets [23 CFR 490.105(e)(7)] whereas non-interstate NHS system require both 2–year and 4-year targets. The table illustrates that it is anticipated that both the baseline and 4-year targets for the Interstate Pavements will remain below the maximum 5% poor rating.

Table 7-9. SCDOT's 2 and 4 year Interstate and Non-Interstate Targets

	2017 Baseline Condition*	2 – Year Targets	4 - Year Targets
Performance Measure			
% interstate pavements in good condition	56.5%	N/A	71.0%
% interstate pavements in poor condition	3.1%	N/A	3.0%
% non-interstate NHS pavements in good condition	7.2%	14.9%	21.1%
% non-interstate NHS pavements in poor condition	4.3%	4.3%	4.6%

*Taken from pavements target setting document

Bridge Target Setting Process

The National Bridge Inspection Standards (NBIS) apply to all publicly owned highway bridges longer than twenty feet located on public roads. NBIS are federal regulations (23CFR 650) establishing requirements for bridge inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and maintenance of bridge inventory. Information from these inspections is stored in the National Bridge Inventory (NBI) database, created in 1972. The NBI database contains condition information on five aggregate structural units (deck, superstructure, substructure, channel, and culvert) by assigning a condition rating to each of these components of a bridge on a scale from 9 (perfect) to 1 (severe deterioration/failure). Staff analyzed historic NBI submittal data from 1992 through 2017 and developed a Markov chain analysis to forecast the bridges that would move from Good to Fair or Fair to Poor during the 2 and 4-year target window. Staff then collected data from our

construction and maintenance offices to determine the number of bridges, and corresponding deck area that were to be improved in the same window of time. Table 7-10 clearly illustrates that both the 2017 baseline, 2 and 4-year targets are projected to fall below the maximum 10% of deck area that can be rated in poor condition for bridges on the NHS.

Table 7-10. SCDOT's 2 and 4 year NHS Bridge Asset Targets

	2017 Baseline Condition*	2 – Year Targets	4 - Year Targets
Performance Measure			
% NHS Bridges Deck Area in good condition	41.6%	42.2%	42.7%
% NHS Bridges Deck Area in poor condition	4.5%	4.0%	6.0%

*Taken from bridge target setting document

Safety Targets

As noted, the agency is also prioritizing improving safety in its investment strategies. Table 7-11 highlights SCDOT's 10-year safety targets compared with baseline data from 2016 based on its ten-year investment strategies. These targets are developed from FHWA's safety performance measures. SCDOT is forecasting a 23 percent decrease in fatality rate and a 38 percent decrease in the rate of serious injuries on its road and bridge systems by 2026. SCDOT developed its 10-year safety targets based on projected improvements from tailored safety initiatives, including its rural road safety program, and safety initiatives operated by the South Carolina Department of Public Safety. Additionally, SCDOT allocated $5M for safety projects related to non-motorized users. The Safety Office identified locations throughout the state that experienced the highest number of bike/ped related crashes, and will conduct Road Safety Audits (RSA) at the top locations. The results of the individual RSAs will be reviewed and evaluated for implementation.

Table 7-11. SCDOT's 10-year Safety Performance Targets

	2016 Baseline Condition*	Ten-year Target*	% Change
Safety			
Fatalities (Number)	890	886	(0.5)
Fatalities (Rate)	1.75	1.34	(23.4)
Serious Injuries (Number)	3,194	2,573	(19.4)
Serious Injuries (Rate)	6.30	3.89	(38.3)
Non-Motorized Fatalities and Serious Injuries (Number)	376	368	(2.1)

* Based on a five year rolling average.

7.5.4. Preventative Maintenance Tax Credit

Act 40 of 2017 includes a preventative maintenance tax credit for South Carolina residents that automatically sunsets after calendar year 2023 unless the Legislature extends it in law. SCDOT projects the value of the credit to be approximately $114 million per year. If the credit were to sunset, the SCDOT Commission, based on SCDOT staff recommendation, has directed that the additional revenue be invested in mobility on the State's freight network, bridges, mobility projects on the NHS in partnership with metropolitan planning organizations and council of governments, and safety-related routine maintenance. These investment strategies align with SCDOT's 2018-2020 Strategic Plan and the agency intends to use asset management and whole life management principles to select projects if the additional reoccurring funding were to become available.

7.5.5. State of Good Repair

With the passage of Act 40 in May of 2017, SCDOT projects it will receive an additional $600 million in state revenue when it is fully phased in, a near doubling of its state resources, which will also outpace the federal funds coming to the State by 2:1. This additional revenue will enable SCDOT to greatly improve the condition of its assets by 2027. However, even with this additional funding, due to the size of SCDOT's highway and bridge systems, SCDOT does not project for its system to reach a state of good repair during the TAMP's ten-year timeframe. It will likely take 20 years to recover the system that has decayed over the past 30 years. For the purposes of the TAMP, SCDOT defines its pavements and bridges to be in a state of good repair as the projected condition that can be achieved in 20 years utilizing the level of funding projected to be available through 2037. Table 7-12 lists the projected percentages of good and poor pavements and bridges using the data and prediction models currently available. SCDOT may update the state of good repair as data and deterioration models are updated, or if additional funding becomes available.

Table 7-12. SCDOT's Desired State of Good Repair

SCDOT Desired State of Good Repair										
Asset	Centerline Miles	% VMT	Current Condition (2018 Data)		10-Year Target		Desired State of Good Repair		Current Gap	
Pavements			% Good	% Poor	% Good	% Poor	% Good	% Poor	% Good	% Poor
Interstate	851	30%	74%	12%	92%	3%	95%	4%	21%	-8%
Primary (all)	9,571	46%	26%	54%	53%	30%	90%	10%	64%	-44%
Non-Interstate NHS	2,752	26%	32%	45%	42%	16%	90%	10%	58%	-35%
Non-NHS Primaries	6,765	20%	23%	59%	63%	37%	90%	10%	67%	-49%
FA Eligible Secondary	10,370	17%	17%	56%	40%	35%	50%	20%	33%	-36%
Non-Federal Aid Eligible Secondary	20,657	7%	13%	61%	25%	45%	40%	25%	27%	-36%
Asset	# of Structures	% VMT	Current Condition (2019 Q1 Data)		10-Year Target		Desired State of Good Repair		Current Gap	
Bridges by Count			% Good	% Poor	% Good	% Poor	% Good	% Poor	% Good	% Poor
NHS	1,745	56%	44%	6%	66%	0%	66%	0%	22%	-6%
Non-NHS	3,883	37%	39%	8%	41%	11%	46%	11%	6%	2%
Off-System	2,794	7%	44%	10%	36%	10%	40%	9%	-5%	-1%
Asset	Deck Area (square feet)	% VMT	Current Condition (2019 Q1 Data)		10-Year Target		Desired State of Good Repair		Current Gap	
Bridges by Deck Area			% Good	% Poor	% Good	% Poor	% Good	% Poor	% Good	% Poor
NHS	39,110,289	56%	40%	5%	60%	0%	60%	0%	20%	-5%
Non-NHS	24,903,895	37%	51%	6%	41%	15%	50%	10%	-1%	3%
Off-System	7,607,110	7%	48%	10%	44%	10%	51%	7%	2%	-2%

CHAPTER 8

THE FUTURE OF TRANSPORTATION ASSET MANAGEMENT AT THE SCDOT

8. The Future of Transportation Asset Management at SCDOT

8.1. Overview

This chapter documents the strategic areas and initiatives that SCDOT has identified as gaps or opportunities for improvement in applying and strengthening the principles of transportation asset management at SCDOT. Particularly, SCDOT has identified the following areas—grouped under three broad areas: **culture, data, and tools**—that could be enhanced to improve the efficient use of transportation resources, as well as to improve transparency and accountability. Table 8-1 shows the agency's action plan matrix for improving and strengthening transportation asset management practices at SCDOT. These enhancement opportunities are further expanded in the following paragraphs with accompanying action items to support identified strategies. SCDOT expects these action items to build upon its existing practices to increase the benefits transportation asset management offers.

Table 8-1. Opportunities for Improvements Action Plan Matrix

Strategic Area	Strategic Direction	Timeframe	Owner
Culture	Identify communication strategies to disseminate transportation asset management information to key stakeholders.	2-4 years	Secretary of Transportation and Deputy Secretaries for Intermodal Planning, Engineering, and Finance and Administration
	Increase the use of Whole Life Management principles in the pavement, bridge, and maintenance management processes.	2-4 years	Secretary of Transportation and Deputy Secretaries for Intermodal Planning and Engineering
	Conduct annual risk assessments of key assets.	Annual	Secretary of Transportation and Deputy Secretaries for Intermodal Planning, Engineering, and Finance and Administration
Data	Create a comprehensive inventory of transportation infrastructure assets.	5-10 years	Directors of Planning and Asset Management, Maintenance, and Information Technology
	Develop a data governance plan for assets.	5-10 years	Directors of Planning and Asset Management and Information Technology
Tools	Evaluate securing analytical tradeoff decision support tools to support transportation asset management decision making.	5-10 years	Directors of Planning and Asset Management and Maintenance

8.2. ACTION ITEMS

The focus of the action items is on improving the efficiency of transportation asset management and in supporting risk-based resource allocation at SCDOT. The matrix emphasizes the need for cultural change because even with the acquisition of asset data management systems and/or analytical tools, staff and leadership need to adopt an asset management philosophy. Instituting this philosophical change will facilitate the effective use of existing data and tools while the agency works to improve upon these areas. Areas of strategic interest include:

Identifying communication strategies to disseminate transportation asset management information to key stakeholders:

- Develop a transportation asset management communication plan that targets key transportation asset management stakeholders.
- Improve collaboration with local transportation and transit operators to improve efficiency of the transportation system.

Increasing the use of Whole Life Management principles in the pavement, bridge, and maintenance management processes:

- Continue and expand the use of advanced monitoring techniques to identify potential problems and minimize the need for future costly repair options on bridges.
- Develop a more accurate construction and maintenance history over time, as resources become available to yield long-term benefits for WLM approaches.
- Continue with the assessment of the service life of all pavement treatments and bridge components.

Conducting a risk assessment of key assets:

- Develop a resiliency plan to protect key assets from disasters or emergency events

Creating a comprehensive inventory of transportation infrastructure assets:

- SCDOT leadership team will evaluate and determine what additional assets should be included in the TAMP, such as the agency's drainage structures and signal systems.
- Develop performance measures and performance targets for each prioritized asset group in addition to pavements and bridges.
- Consider a holistic and systematic approach to asset management at the corridor level.

Developing a data governance plan for assets:

- Develop a consistent data management governance structure to guide divisional data gathering, reporting, and analysis.
- Coordinate the agency's data gathering and storage activities involving all divisions to follow a standard plan.
- Develop an implementation plan to integrate and utilize legacy systems to support decision making.

Evaluating securing analytical tradeoff decision-support tools to support transportation asset management decision making:

- Apply tradeoff analysis to support transportation asset management recommendations and decisions.
- Develop policies to guide the allocation of resources within and across different types of investments.
- Investigate alternative methods for cross-asset resource allocation, tradeoff analysis, and optimization to achieve system objectives.
- Consider risk assessment in cross-asset resource allocation, tradeoff analysis, and optimization procedures.

APPENDICES

APPENDIX A: ENGINEERING DIRECTIVE 15

South Carolina Department of Transportation

Engineering Directive

Directive Number:	**ED-15**	**Effective: July 15, 2014**
Subject:	**Pavement Type Selection Process**	
References:	**None**	
Purpose:	**Establish Procedure for Pavement Selection This**	
Directive Applies To:	**Construction**	

Requests for pavement design will be initiated by the design manager and sent to the Pavement Design Unit at the Office of Materials and Research. The Pavement Design Unit will use soil information provided by the Geotechnical Materials Unit at the Office of Materials and Research and estimates of future traffic provided by Traffic Engineering to derive the structural requirements for the pavement structure.

Once the pavement parameters are known, the Pavement Design Unit will analyze the project's pavement type requirements according to the process described in Figure 1. For existing pavements, the existing pavement type and its required rehabilitation will generally dictate the pavement type for widening or other improvements. In these cases, the State Pavement Design Engineer will select the pavement type without further approval, subject to the normal review process for all pavement design recommendations.

For pavements being constructed on new location or reconstructed, the pavement with the lowest initial cost will generally be the default selection without further approval when the required structural number is below 4.0. However, the State Pavement Design Engineer may choose to consider alternative pavement structures for any project if economic circumstances cause significant changes in the price of either pavement type or if consideration of alternative pavement structures is considered to potentially be in the best interest of the Department, even if the required structural number is below 4.0. If the State Pavement Design Engineer determines that an alternative pavement structure is desirable, review by the Pavement Advisory Committee and approval by the Directors of Preconstruction and Construction is required.

For ramps, parking areas, minor paving projects of less than 20,000 square yards, and projects officially designated "demonstration projects" by the Deputy Secretary for Engineering for the purposes of pavement research, the State Pavement Design Engineer may select any pavement type after consultation with the design manager and the Director of Construction and without regard to the required structural number. The State Pavement Design Engineer may also make pavement type recommendations directly to the Directors

of Construction and Preconstruction for their review or choose to consult the Pavement Advisory Committee. For other new location or reconstructed pavement projects not meeting the requirements given above and with a required structural number above 5.0 and for rehabilitation projects where the State Pavement Design Engineer has indicated that alternative pavement types may be advantageous, the Pavement Advisory Committee will be convened to make type selection recommendations.

The Pavement Advisory Committee will consist of the Materials and Research Engineer, and permanent representatives from Maintenance, Construction, Traffic Engineering, and FHWA. The design manager for the project and the District Construction Engineer where the project will be located will also be members. The State Pavement Design Engineer will provide preliminary design and cost information via e-mail to the committee for their review. The Materials and Research Engineer will then convene a meeting of the committee to discuss the information and make pavement recommendations. If the committee reaches a consensus, the recommendations will be forwarded to the Directors of Construction and Preconstruction for their review. The Directors may concur, request additional review by the Pavement Advisory Committee, or override the Pavement Advisory Committee recommendations. The recommendations will then be forwarded to the design manager for inclusion in the plans.

If the Pavement Design Committee is unable to reach a consensus, the Directors of Construction and Preconstruction will be consulted for a final decision. If in any instance the Directors of Construction and Preconstruction are unable to agree on the pavement type selection, the Deputy Secretary for Engineering will make the final decision.

Submitted by: Todd Steagall
Director of Construction

Recommended by: Kenneth B. Eargle, Interim
Chief Engineer for Operations

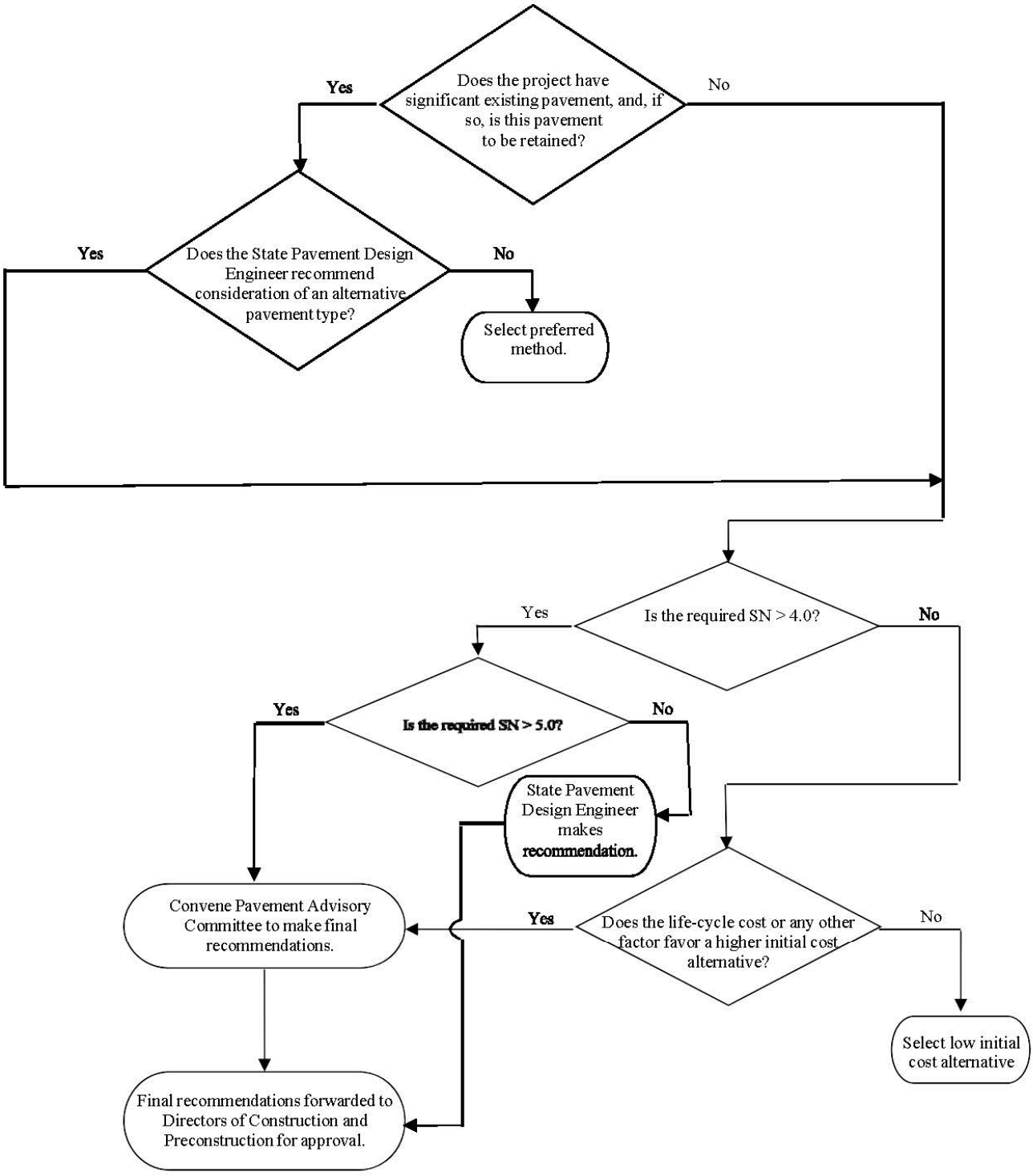
Approved: Christy A. Hall
Deputy Secretary for Engineering

Lead: Director of Construction

History: Issued December 8, 2003
First Revision on July 27, 2005
Second Revision on June 1, 2007
Third Revision on July 16, 2009
Fourth Revision on July 15, 2014

APPENDIX A
FOR ENGINEERING DIRECTIVE 15

Flowchart of Pavement Type Selection Process



APPENDIX B
FOR ENGINEERING DIRECTIVE 15

Appendix – Pavement Type Selection Factors

The selection of pavement type is not an exact, objective process, but one in which the pavement designer must make judgments on many varying factors. The pavement type selection may be dictated by an overriding consideration for one or more of these factors. The predominant factors in the selection process are given below.

The selection process may be facilitated by comparison of alternate structural designs for one or more pavement types using theoretical or empirically derived methods. However, such methods are not so precise as to absolutely guarantee a certain level of performance from any one alternate or comparable service for all alternates.

Comparative cost estimates can be applied to alternate pavement designs to aid in the decision-making process. The cost for the service of the pavement would include not only the initial cost but also subsequent costs to maintain the service level desired. It should be noted that these procedures are also imprecise due to the lack of information on costs attributable to future events such as maintenance, salvage value, and the value of reduced service to the road user.

Even if structural design and cost comparison procedures were perfected, by their nature they would not encompass all factors that should be considered in pavement type selection. Such a selection should properly be one of professional engineering judgment based on the consideration and evaluation of all factors applicable to a given highway section.

Beyond economic analysis, a variety of factors affect the pavement type selection process. These factors are:

1. Construction Considerations: Staged construction of the pavement structure may dictate the type of pavement selected. Other considerations such as speed of construction, accommodating traffic during construction, safety of traffic during construction, ease of replacement, anticipated future widening, seasons of the year when construction must be accomplished, and others might have a strong influence on paving type selections in specific cases.

2. Initial Cost: While it is desirable to compare pavement costs on the basis of the entire life- cycle, it must be recognized that available resources are finite. In cases where a pressing need for construction exists, deferring needs until adequate resources are available to build a more expensive structure may not be an option. In these cases, first cost becomes an overriding concern in the selection process.

3. Adjacent Existing Pavement: Provided there is no major change in conditions, the choice of a pavement type may be influenced by adjacent existing sections that have given adequate service. The resultant continuity of pavement type serves to simplify maintenance and rehabilitation activities.

4. Stimulation of Competition: It is desirable that monopoly situations be avoided and that improvement in products and methods be encouraged. These goals are aided by healthy competition among industries involved in the production of paving materials.

5. Ease of Maintenance: Certain pavement alternatives may provide a superior life-cycle cost, but may also entail frequent or complex maintenance activities. While SCDOT strives to provide excellent maintenance for its facilities, there is no assurance that additional resources may be available for options that require unusual levels of maintenance. Consequently, pavement designs should be considered realistically when their future performance is based on critical maintenance activities.

6. Local Preference and Recognition of Local Industry: While these considerations may seem to be outside the realm of pavement design, highway administrators cannot always ignore them. This is especially true when many other factors involved are indecisive with respect to the selection process.

7. Other: Unique or unusual factors not listed here may also influence or drive the selection process. It is important to retain the ability to select pavement type based on professional engineering judgment in special situations.

APPENDIX B: ENGINEERING DIRECTIVE 52

South Carolina Department of Transportation

Engineering Directive Memorandum

Number: 52

Primary Department: Chief Engineer for Planning, Location, and Design

Referrals: South Carolina Code of Laws Sections 57-1-370 and 57-1-460

Subject: Interstate Rehabilitation Project Selection Process

Act 114 of 2007 established changes to the South Carolina Code of Laws, adding Sections 57-1-370 and 57-1-460, which require the South Carolina Department of Transportation (SCDOT) to promulgate new regulations describing its project selection process. This directive provides details of the engineering ranking process for interstate rehabilitation using the criteria approved by the SCDOT Commission (Commission) at its July 18, 2007 meeting. The engineering ranking of projects may be considered by the Commission in developing a project priority list.

This engineering directive details the process for ranking interstate rehabilitation needs based on an engineering perspective. All projects ranked and presented to the Commission since June 27, 2007 were selected using this process.

SCDOT has approximately 842 centerline miles of interstate. The miles of interstate are segmented based on pavement condition and pavement type. These segments will be ranked individually.

The following commission approved criteria, with weightings as determined by engineering staff, will be used when establishing the engineering ranking for interstate rehabilitation projects:

- ***Pavement condition (65%).*** Pavement condition is determined by evaluating the pavement distress level, rideability, and remaining service life.

- ***Average daily traffic (ADT) (10%).*** ADT is the average traffic volume per day, including trucks.

- ***Average daily truck traffic (ADTT) (10%).*** ADTT is the percentage of ADT that is truck traffic.

- ***Pavement maintenance costs (10%).*** Pavement maintenance costs are the total maintenance costs from the previous state fiscal year for the segment being evaluated.

- ***Location and significance to the community/local businesses (5%).*** This is a measure of a road's overall functional value to the local area, provided by the engineering district.

Using the weighted criteria, an engineering ranking for segments of interstate in need of repair will be produced on a statewide basis. Under the Interstate Maintenance Program, the highest ranked segments will be grouped into proposed construction contracts that are intended to minimize traffic disruptions and provide efficient contract management opportunities for SCDOT staff. The proposed contracts will be submitted to the Commission for approval and inclusion in the Statewide Transportation Improvement Program (STIP).

In general, the number of projects submitted for Commission approval should be commensurate with the amount of funds available and the time required to advance the projects to construction. Once a project is approved by the Commission, it will retain its priority status until constructed or specifically addressed by the Commission.

Submitted by: *John V. Walsh*

Chief Engineer for Planning, Location, and Design

Submitted by: *J. C. Watson*

Chief Engineer for Operations

Approved: *Tony L. Chapman*

Deputy Secretary for Engineering

Effective Date: *January 13, 2009*

Original signed by Deputy Secretary for Engineering Tony L. Chapman, P.E. January 13, 2009. All original engineering directives maintained by the Office of the Deputy Secretary for Engineering.

APPENDIX C: ENGINEERING DIRECTIVES 63, 64, AND 65

South Carolina Department of Transportation

Engineering Directive

Directive Number:	**ED-63**	**Effective: July 25, 2019**
Subject:	**Primary Pavement Improvement Project Prioritization Process**	
References:	**Section 57-1-370 of South Carolina Code of Laws, 1976, as amended; S.C. Code of Regulations 63-10, as amended**	
Primary Department:	**Maintenance**	

In 2007, the South Carolina General Assembly enacted Act 114. One of the landmark items in Act 114 was the requirement that the South Carolina Department of Transportation (SCDOT) establish a project prioritization process. In 2016, the General Assembly enacted Act 275. Act 275 eliminated some of Act 114's requirements but it retained the requirement for project prioritization. This requirement is codified in Section 57-1-370 of the South Carolina Code of Laws, 1976, as amended. Additional detail on the process is found in S.C. Code of Regulations 63-10, as amended.

This engineering directive details the process for ranking **primary** pavement improvement needs using objective and quantifiable criteria and describes the distribution of funds to the counties. This process does not apply to the selection of roads for preservation. The goal of pavement preservation is to keep good roads in good condition through the timely application of the appropriate preventive maintenance treatment. Roads with a pavement quality index (PQI) range of 3.2 to 4.0 are selected for preservation by the resident maintenance engineer in accordance with the SCDOT Guidelines for Selecting Preventive Maintenance Treatments and approved by the district.

SCDOT has approximately 24,031 lane miles of primary routes. Available funding will be used for pavement improvement and preservation. Funding will be distributed to each county based on the county's percentage of primary lane miles compared to the statewide total of primary lane miles. A minimum of ten percent of the funding allocation will be used for the application of preservation treatments with the remaining funding used for rehabilitation and reconstruction.

The following **relevant** criteria and associated weightings will be used when calculating the scores to rank pavement improvement candidates on a scale of 0 to 1,000 points. The higher the point value a road segment receives, the higher the priority for pavement improvement.

- **Pavement Quality Index (PQI) (40% weight, 0 to 400 points)** – PQI is a numerical value representing the overall condition of the pavement surface based on observable and measurable data related to the road segment in question. PQI is based on a 5 point scale, with 0.0 being the worst and 5.0 being the best. Because PQI is the criterion that

primarily supports the purpose and need for pavement improvement projects, it has therefore received the highest weighting among the relevant criteria.

- **International Roughness Index (IRI) (15% weight, 15 to 150 points)** – IRI is a measured numerical value for the roughness of a pavement. A pavement can be structurally sound and have poor ride quality. This criterion has an effect on safety and the public's perception of the quality of the pavement and the need for resurfacing. The 15% weighting reflects this importance.

- **Average Daily Traffic (ADT) (15% weight, 15 to 150 points)** – ADT is the average traffic volume per day. Pavements are designed to carry loads expressed as equivalent single axle loads (ESALS). The higher the average daily traffic the faster a pavement will reach the end of its design life and need to be rehabilitated or reconstructed. Therefore, the amount of traffic a pavement carries directly affects its service life. The 15% weighting reflects this importance.

- **Percent Patching (5% weight, 5 to 50 points)** – This factor gives the estimated percentage of a road segment that has been patched or is in need of patching. This criterion is an indication of the corrective maintenance performed on the pavement and the need for overall resurfacing. It is also a factor included in the computation of PQI and therefore is given a lower weighting as a stand-alone criterion.

- **Average Daily Truck Traffic (ADTT) (5% weight, 5 to 50 points)** – ADTT is the percentage of ADT that is truck traffic, converted to truck volume. While an important contributor to the deterioration of a pavement, it is already a factor in the calculation of ADT. Therefore, it is given a lower weighting as a stand-alone criterion.

- **State Freight Network (5% weight, 0 to 50 points)** – This criterion is used to give some added emphasis to roads on the freight network. Recent federal funding legislation emphasizes improving the condition of the freight network. Because it is only a supplemental criterion, it is given a lower weighting. If the road segment is on the designated freight network, then it receives full value for this criterion. If not, it receives no value.

- **Strategic Corridor Network (5% weight, 0 to 50 points)** – This criterion is used as a supplemental criterion to give some added emphasis to roads on the strategic corridor network. Recent federal funding legislation emphasizes improving the condition of the strategic corridor network. Because it is only a supplemental criterion, it is given a lower weighting. If the road segment is on the strategic corridor network, then it receives full value for this criterion. If not, it receives no value.

- **Functional Classification (5% weight, 10 to 50 points)** – This criterion factors in the functional classification of the roadway. It is given a lower rating because functional class is also a function of the criteria used to designate routes on the freight and strategic corridor networks. More significant functional classifications are valued higher within this criterion than lower classifications.

- **State Safety Programs (5% weight, 0 to 50 points)** – This criterion is used to give emphasis to road segments that are also included in the safety program. Since it is a

supplemental criterion, it is given a lower weighting. If the road segment is included in a safety program, then it receives full value for this criterion. If not, it receives no value.

The weighted criteria are entered into a ranking formula that provides a numerical priority ranking score (PRS). Primary routes will be qualified based on a threshold score for inclusion in a pool of candidates. Once eligible candidates are identified, field engineers will use the following field review criteria, which are worth a maximum of 400 points, to complete the ranking process:

- **Relative Condition (minus 100 to 100 points)** – This criterion is used so that PQI data accurately reflects the current condition of the pavement due to localized improvements made by SCDOT maintenance forces or accelerated deterioration due to increased loads.

- **Corridor Continuity (0 to 100 points)** – This criterion is used for route segments that would complete the resurfacing of, or add to the completion of the resurfacing of, a route corridor through a county or a district.

- **Connectivity (0 to 100 points)** – This criterion is used for routes that provide connectivity to economic centers, schools, emergency facilities or other key points of public interest.

- **Contractibility (0 to 100 points)** – Contractibility can be the grouping of roads in a specific geographical area into one project to achieve economies of scale or group roads with like treatments into a single project to reduce project costs.

The following Act 114 criteria were considered but deemed **not relevant** as they relate to the pavement improvement program, as they do not support the **purpose and need** of this program category.

- **Financial Viability** – Not relevant as part of the prioritization process since rehabilitation and reconstruction are normal steps in the life cycle of a pavement.

- **Potential for Economic Development** – Not relevant as part of the prioritization process since these projects consist of the rehabilitation and reconstruction of existing routes.

- **Environmental Impact** – Not relevant as part of the prioritization process since these projects consist of the rehabilitation and reconstruction of existing pavements.

- **Alternative Transportation Solutions** – Not relevant to the Pavement Improvement Program category.

- **Consistency with Local Land Use Plans** – Not relevant to the prioritization process since this program category consists of the rehabilitation and reconstruction of existing roads.

Upon completion of the prioritization and pavement improvement project development process, the prioritized list of primary routes that fulfill each county's funding allocation will be presented to the SCDOT Commission for approval.

All raw data used by the districts to determine the final ranking of candidates selected from the pool must be included when the project packages are submitted to the Director of Maintenance for review. All data used for project prioritization will be kept on file as required by Departmental Directive 51 and SCDOT's record retention schedules.

Submitted by: David B. Cook, P.E.
Director of Maintenance

Recommended by: Andrew T. Leaphart, P.E.
Chief Engineer for Operations

Approved by: Leland Colvin, P.E.
Deputy Secretary for Engineering

History: Issued on January 13, 2017
First Revision on June 17, 2019
Second Revision on July 25, 2019

South Carolina Department of Transportation

Engineering Directive

Directive Number:	**ED-64**	**Effective: July 25, 2019**
Subject:	**Federal-Aid Secondary Pavement Improvement Project Prioritization Process**	
References:	**Section 57-1-370 of South Carolina Code of Laws, 1976, as amended; S.C. Code of Regulations 63-10, as amended**	
Primary Department:	**Maintenance**	

In 2007, the South Carolina General Assembly enacted Act 114. One of the landmark items in Act 114 was the requirement that the South Carolina Department of Transportation (SCDOT) establish a project prioritization process. In 2016, the General Assembly enacted Act 275. Act 275 eliminated some of Act 114's requirements but it retained the requirement for project prioritization. This requirement is codified in Section 57-1-370 of the South Carolina Code of Laws, 1976, as amended. Additional detail on the process is found in S.C. Code of Regulations 63-10, as amended.

This engineering directive details the process for ranking **federal-aid (FA) secondary** pavement improvement needs using objective and quantifiable criteria and describes the distribution of funds to the counties. This process does not apply to the selection of roads for preservation. The goal of pavement preservation is to keep good roads in good condition through the timely application of the appropriate preventive maintenance treatment. Roads with a pavement quality index (PQI) range of 3.2 to 4.0 are selected for preservation by the resident maintenance engineer in accordance with the SCDOT Guidelines for Selecting Preventive Maintenance Treatments, and approved by the district.

SCDOT has approximately 21,271 lane miles of FA secondary roads. Available funding will be used for pavement improvement and preservation. Funding will be distributed to each county based on the county's percentage of FA secondary lane miles compared to the statewide total of FA secondary lane miles. A minimum of ten percent of the funding allocation will be used for the application of preservation. treatments with the remaining funding used for rehabilitation and reconstruction

The following **relevant** criteria and associated weightings will be used when calculating the scores to rank pavement improvement candidates on a scale of 0 to 1,000 points. The higher the point value a road segment receives, the higher the priority for pavement improvement.

- **Pavement Quality Index (PQI) (40% weight, 0 to 400 points)** – PQI is a numerical value representing the overall condition of the pavement surface based on observable and measurable data related to the road segment in question. PQI is based on a 5 point scale, with 0.0 being the worst and 5.0 being the best. Because PQI is the criterion that

primarily supports the purpose and need for pavement improvement projects, it has therefore received the highest weighting among the relevant criteria.

- **International Roughness Index (IRI) (15% weight, 15 to 150 points)** – IRI is a measured numerical value for the roughness of a pavement. A pavement can be structurally sound and have poor ride quality. This criterion has an effect on safety and the public's perception of the quality of the pavement and the need for resurfacing. The 15% weighting reflects this importance.

- **Average Daily Traffic (ADT) (15% weight, 15 to 150 points)** – ADT is the average traffic volume per day. Pavements are designed to carry loads expressed as equivalent single axle loads (ESALS). The higher the average daily traffic the faster a pavement will reach the end of its design life and need to be rehabilitated or reconstructed. Therefore, the amount of traffic a pavement carries directly affects its service life. The 15% weighting reflects this importance.

- **Percent Patching (5% weight, 5 to 50 points)** – This factor gives the estimated percentage of a road segment that has been patched or is in need of patching. This criterion is an indication of the corrective maintenance performed on the pavement and the need for overall resurfacing. It is also a factor included in the computation of PQI and therefore is given a lower weighting as a stand-alone criterion.

- **Average Daily Truck Traffic (ADTT) (5% weight, 5 to 50 points)** – ADTT is the percentage of ADT that is truck traffic, converted to truck volume. While an important contributor to the deterioration of a pavement, it is already a factor in the calculation of ADT. Therefore, it is given a lower weighting as a stand-alone criterion.

- **State Freight Network (5% weight, 0 to 50 points)** – This criterion is used to give some added emphasis to roads on the freight network. Recent federal funding legislation emphasizes improving the condition of the freight network. Because it is only a supplemental criterion, it is given a lower weighting. If the road segment is on the designated freight network, then it receives full value for this criterion. If not, it receives no value.

- **Strategic Corridor Network (5% weight, 0 to 50 points)** – This criterion is used as a supplemental criterion to give some added emphasis to roads on the strategic corridor network. Recent federal funding legislation emphasizes improving the condition of the strategic corridor network. Because it is only a supplemental criterion, it is given a lower weighting. If the road segment is on the strategic corridor network, then it receives full value for this criterion. If not, it receives no value.

- **Functional Classification (5% weight, 10 to 50 points)** – This criterion factors in the functional classification of the roadway. It is given a lower rating because functional class is also a function of the criteria used to designate routes on the

freight and strategic corridor networks. More significant functional classifications are valued higher within this criterion than lower classifications.

- **State Safety Programs (5% weight, 0 to 50 points)** – This criterion is used to give emphasis to road segments that are also included in the safety program. Since it is a supplemental criterion, it is given a lower weighting. If the road segment is included in a safety program, then it receives full value for this criterion. If not, it receives no value.

The weighted criteria are entered into a ranking formula that provides a numerical priority ranking score (PRS). FA secondary routes will be qualified based on a threshold score for inclusion in a pool of candidates. Once eligible candidates are identified, field engineers will use the following field review criteria, which are worth a maximum of 400 points, to complete the ranking process:

- **Relative Condition (minus 100 to 100 points)** – This criterion is used so that PQI data accurately reflects the current condition of the pavement due to localized improvements made by SCDOT maintenance forces or accelerated deterioration due to increased loads.

- **Corridor Continuity (0 to 100 points)** – This criterion is used for route segments that would complete the resurfacing of, or add to the completion of the resurfacing of, a route corridor through a county or a district.

- **Connectivity (0 to 100 points)** – This criterion is used for routes that provide connectivity to economic centers, schools, emergency facilities or other key points of public interest.

- **Contractibility (0 to 100 points)** – Contractibility can be the grouping of roads in a specific geographical area into one project to achieve economies of scale or group roads with like treatments into a single project to reduce project costs.

The following Act 114 criteria were considered but deemed **not relevant** as they relate to the pavement improvement program, as they do not support the **purpose and need** of this program category.

- **Financial Viability** – Not relevant as part of the prioritization process since rehabilitation and reconstruction are normal steps in the life cycle of a pavement.

- **Potential for Economic** Development – Not relevant as part of the prioritization process since these projects consist of the rehabilitation and reconstruction of existing routes.

- **Environmental Impact** – Not relevant as part of the prioritization process since these projects consist of the rehabilitation and reconstruction of existing pavements.

- **Alternative Transportation Solutions** – Not relevant to the Pavement Improvement Program category.

- **Consistency with Local Land Use Plans** – Not relevant to the prioritization process since this program category consists of the rehabilitation and reconstruction of existing roads.

Upon completion of the prioritization and pavement improvement project development process, the prioritized list of FA secondary routes that fulfill each county's funding allocation will be presented to the SCDOT Commission for approval.

All raw data used by the districts to determine the final ranking of candidates selected from the pool must be included when the project packages are submitted to the Director of Maintenance

for review. All data used for project prioritization will be kept on file as required by Departmental Directive 51 and SCDOT's record retention schedules.

Submitted by: David B. Cook P.E..
Director of Maintenance

Recommended by: Andrew T. Leaphart, P.E.
Chief Engineer for Operations

Approved by: Leland Colvin, P.E.
Deputy Secretary for Engineering

History: Issued on January 13, 2017
First Revision on July 25, 2019

South Carolina Department of Transportation

Engineering Directive

Directive Number:	**ED-65**	**Effective: July 25, 2019**
Subject:	**Non-Federal Aid Secondary Pavement Improvement Project Prioritization Process**	
References:	**Section 57-1-370 of South Carolina Code of Laws, 1976, as amended; S.C. Code of Regulations 63-10, as amended**	
Primary Department:	**Maintenance**	

In 2007, the South Carolina General Assembly enacted Act 114. One of the landmark items in Act 114 was the requirement that the South Carolina Department of Transportation (SCDOT) establish a project prioritization process. In 2016, the General Assembly enacted Act 275. Act 275 eliminated some of Act 114's requirements but it retained the requirement for project prioritization. This requirement is codified in Section 57-1-370 of the South Carolina Code of Laws, 1976, as amended. Additional detail on the process is found in S.C. Code of Regulations 63-10, as amended.

This engineering directive details the process for ranking **non-federal aid (NFA) secondary** pavement improvement needs using objective and quantifiable criteria and describes the distribution of funds to the counties. This process does not apply to the selection of roads for preservation. The goal of pavement preservation is to keep good roads in good condition through the timely application of the appropriate preventive maintenance treatment. Roads with a pavement quality index (PQI) range of 3.2 to 4.0 are selected for preservation by the resident maintenance engineer in accordance with the SCDOT Guidelines for Selecting Preventive Maintenance Treatments and approved by the district.

SCDOT has approximately 41,393 lane miles of NFA secondary routes. Available funding will be used for pavement improvement and preservation. Funding will be distributed to each county based on the county's percentage of NFA secondary lane miles compared to the statewide total of NFA secondary lane miles. A minimum of ten percent of the funding allocation will be used for the application of preservation treatments with the remaining funding used for rehabilitation and reconstruction.

The following **relevant** criteria and associated weightings will be used when calculating the scores to rank pavement improvement candidates on a scale of 0 to 1,000 points. The higher the point value a road segment receives, the higher the priority for pavement improvement.

- **Pavement Quality Index (PQI) (40% weight, 0 to 400 points)** – PQI is a numerical value representing the overall condition of the pavement surface based on observable and measurable data related to the road segment in question. PQI is based on a 5 point scale, with 0.0 being the worst and 5.0 being the best. Because PQI is the criterion that primarily supports the purpose and need for pavement

improvement projects, it has therefore received the highest weighting among the relevant criteria.

- **International Roughness Index (IRI) (15% weight, 15 to 150 points)** – IRI is a measured numerical value for the roughness of a pavement. A pavement can be structurally sound and have poor ride quality. This criterion has an effect on safety and the public's perception of the quality of the pavement and the need for resurfacing. The 15% weighting reflects this importance.

- **Average Daily Traffic (ADT) (15% weight, 15 to 150 points)** – ADT is the average traffic volume per day. Pavements are designed to carry loads expressed as equivalent single axle loads (ESALS). The higher the average daily traffic the faster a pavement will reach the end of its design life and need to be rehabilitated or reconstructed. Therefore, the amount of traffic a pavement carries directly affects its service life. The 15% weighting reflects this importance.

- **Percent Patching (5% weight, 5 to 50 points)** – This factor gives the estimated percentage of a road segment that has been patched or is in need of patching. This criterion is an indication of the corrective maintenance performed on the pavement and the need for overall resurfacing. It is also a factor included in the computation of PQI and therefore is given a lower weighting as a stand-alone criterion.

- **Average Daily Truck Traffic (ADTT) (5% weight, 5 to 50 points)** – ADTT is the percentage of ADT that is truck traffic, converted to truck volume. While an important contributor to the deterioration of a pavement, it is already a factor in the calculation of ADT. Therefore, it is given a lower weighting as a stand-alone criterion.

- **State Freight Network (5% weight, 0 to 50 points)** – This criterion is used to give some added emphasis to roads on the freight network. Recent federal funding legislation emphasizes improving the condition of the freight network. Because it is only a supplemental criterion, it is given a lower weighting. If the road segment is on the designated freight network, then it receives full value for this criterion. If not, it receives no value.

- **Strategic Corridor Network (5% weight, 0 to 50 points)** – This criterion is used as a supplemental criterion to give some added emphasis to roads on the strategic corridor network. Recent federal funding legislation emphasizes improving the condition of the strategic corridor network. Because it is only a supplemental criterion, it is given a lower weighting. If the road segment is on the strategic corridor network, then it receives full value for this criterion. If not, it receives no value.

- **Functional Classification (5% weight, 10 to 50 points)** – This criterion factors in the functional classification of the roadway. It is given a lower rating because functional class is also a function of the criteria used to designate routes on the freight and strategic corridor networks. More significant functional classifications are valued higher within this criterion than lower classifications.

- **State Safety Programs (5% weight, 0 to 50 points)** – This criterion is used to give emphasis to road segments that are also included in the safety program. Since it is a supplemental criterion, it is given a lower weighting. If the road segment is included in a safety program, then it receives full value for this criterion. If not, it receives no value.

The weighted criteria are entered into a ranking formula that provides a numerical priority ranking score (PRS). NFA secondary routes will be qualified based on a threshold score for inclusion in a pool of candidates. Once eligible candidates are identified, field engineers will use the following field review criteria, which are worth a maximum of 400 points, to complete the ranking process:

- **Relative Condition (minus 100 to 100 points)** – This criterion is used so that PQI data accurately reflects the current condition of the pavement due to localized improvements made by SCDOT maintenance forces or accelerated deterioration due to increased loads.

- **Corridor Continuity (0 to 100 points)** – This criterion is used for route segments that would complete the resurfacing of, or add to the completion of the resurfacing of, a route corridor through a county or a district.

- **Connectivity (0 to 100 points)** – This criterion is used for routes that provide connectivity to economic centers, schools, emergency facilities or other key points of public interest.

- **Contractibility (0 to 100 points)** – Contractibility can be the grouping of roads in a specific geographical area into one project to achieve economies of scale or group roads with like treatments into a single project to reduce project costs.

The following Act 114 criteria were considered but deemed **not relevant** as they relate to the pavement improvement program, as they do not support the **purpose and need** of this program category.

- **Financial Viability** – Not relevant as part of the prioritization process since rehabilitation and reconstruction are normal steps in the life cycle of a pavement.

- **Potential for Economic Development** – Not relevant as part of the prioritization process since these projects consist of the rehabilitation and reconstruction of existing **routes**.

- **Environmental Impact** – Not relevant as part of the prioritization process since these projects consist of the **rehabilitation** and reconstruction of existing pavements.

- **Alternative Transportation Solutions** – Not relevant to the Pavement Improvement Program **category**.

- **Consistency with Local Land Use Plans** – Not relevant to the prioritization process since this **program** category consists of the rehabilitation and reconstruction of existing roads.

Upon completion of the prioritization and pavement improvement project development process, the prioritized list of NFA secondary routes that fulfill each county's funding allocation will be presented to the SCDOT Commission for approval..

All raw data used by the districts to determine the final ranking of candidates selected from the pool must be included when the project packages are submitted to the Director of Maintenance for review. All data used for project prioritization will be kept on file as required by Departmental Directive 51 and SCDOT's record retention schedules.

Submitted by: David E. Cook P.E.
Director of Maintenance

Recommended by: Andrew T. Leaphart, P.E.
Chief Engineer for Operations

Approved by: Leland Colvin, P.E.
Deputy Secretary for Engineering

History: Issued on January 13, 2017
First Revision on July 25, 2019

APPENDIX D: ENGINEERING DIRECTIVES 68, 69, AND 70

South Carolina Department of Transportation

Engineering Directive

Directive Number:	**ED-68**	**Effective: March 10, 2017**
Subject:	**NHS Bridge Replacement Project Prioritization Process**	
References:	**Section 57-1-370 of South Carolina Code of Laws, 1976, as amended; S.C. Code of Regulations 63-10, as amended**	
Primary Department:	**Maintenance**	

In 2007, the South Carolina General Assembly enacted Act 114. One of the landmark items in Act 114 was the requirement that the South Carolina Department of Transportation (SCDOT) establish a project prioritization process. In 2016, the General Assembly enacted Act 275. Act 275 eliminated some of Act 114's requirements but it retained the requirement for project prioritization. This requirement is codified in Section 57-1-370 of the South Carolina Code of Laws, 1976, as amended. Additional detail on the process is found in S.C. Code of Regulations 63-10, as amended.

This engineering directive details the process for ranking **NHS** bridge replacement needs using objective and quantifiable criteria.

SCDOT has approximately 1,740 bridges on the NHS system. Only bridges that are structurally deficient will be considered for replacement. NHS bridges will be ranked on a statewide priority basis.

The following **relevant** criteria along with the bridge management system (BrM) will be used when calculating the scores to rank bridge replacement candidates on a scale of 0 to 1,500 points. The higher the point value, the higher the priority for replacement. An initial candidate list will be generated from BrM using a scale of 0 to 1,000 points. The bridge with the highest cost benefit ratio will receive 1,000 points, with the remaining bridges receiving a percentage of points based on their cost benefit ratio compared to the bridge with the highest cost benefit ratio.

BrM uses the following criteria to rank bridges for replacement based on the cost benefit ratio calculated for each structure by the software. The output from BrM is the criterion that primarily supports the **purpose and need** of this program category. For that reason, this criterion received the highest weighting of 1,000 points among the relevant criteria.

- **Structural Condition** – Structural condition is the bridge's condition as compared to a new condition and is determined by detailed inspection data.
- **Traffic Status** – Traffic status is a reflection of the actual operational status of the structure (closed, load-restricted, or recommended for load restriction).

- **Average Daily Traffic (ADT)** – ADT is the average traffic volume per day.

- **Average Daily Truck Traffic (ADTT)** – ADTT is the percentage of ADT that is truck traffic, converted to truck volume.

- **Detour Length** – Detour length is the additional distance one would have to travel if the bridge must be closed or load-restricted.

Once the pool of prospective bridge candidates has been ranked by BrM, bridges will be sorted by engineering district and sent to the district engineering administrators for the completion of the field review criteria, which will be worth 0 to 500 points. The districts will score each bridge using the criteria listed below and return the results to the State Bridge Maintenance Engineer. The points from the field review will be added to the points received from the BrM prioritization, and bridges will be ranked from highest total score to the lowest total score.

- **Route Continuity and River Basin Upgrades (0 to 125 points)** – This criterion ensures that needed route upgrades are justified and provide both short and long-term benefit. It also provides a mechanism to ensure that our river basins receive additional consideration since these bridges are generally larger, carry more traffic, and also have significant detours if major work or restrictions are required. The 125 point maximum for this criterion reflects this importance.

- **District Repair Feasibility (0 to 75 points)** – This item is used to evaluate bridge repair history, needs, and effectiveness.

- **Improved Emergency Services and Emergency Evacuation Routes (0 to 75 points)** – This criterion ensures that emergency services such as fire and ambulance are considered and that interruptions are minimal. It also ensures that hurricane evacuation routes are maintained to a high level, as well as primary and secondary lifeline routes for seismic response.

- **State Freight Network (0 to 50 points)** – This criterion is used to give some added emphasis to roads on the freight network. Recent federal funding legislation emphasizes improving the condition of the freight network. If the road segment is on the designated freight network, then it receives full value for this criterion. If not, it receives no value.

- **Strategic Corridor Network (0 to 50 points)** – This criterion is used as a supplemental criterion to give some added emphasis to roads on the strategic corridor network. Recent federal funding legislation emphasizes improving the condition of the strategic corridor network. If the road segment is on the strategic corridor network, then it receives full value for this criterion. If not, it receives no value.

- **New Schools and/or Changes in Bus Routes (0 to 50 points)** – These developments should be analyzed in terms of how much impact new schools have when constructed. Since school bus routes are relative to the population and location of school-aged students and can change from year to year, close coordination with school districts

is necessary.

- **Known Commercial Routes (0 to 50 points)** – This criterion ensures that SCDOT considers the movement of goods and the impacts that structurally deficient bridges may have on known commercial routes.
- **Future Economic Development (Residential/Commercial) (0 to 25 points)** – This criterion is used to measure current and future needs and benefits provided to existing or future developments.

The following Act 114 criteria were considered but deemed **not relevant** as they relate to the bridge replacement program category priority list, as they do not support the **purpose and need** of this program category.

- **Financial Viability** – Not relevant as part of the prioritization process since rehabilitation and replacement are normal steps in the life cycle of a bridge. Replacement cost is considered when determining the type of replacement structure, but not in the ranking process.

- **Pavement Quality Index (PQI)** – Not relevant as part of the prioritization process since PQI is not calculated for, nor applicable to bridge decks.

- **Environmental Impact** – Not relevant as part of the prioritization process. The environmental permitting process is a part of every bridge replacement project and may have a large impact on the time it takes to develop the project, but it is not used to prioritize bridge replacements.

- **Alternative Transportation Solutions** – Not relevant to Bridge Replacement Program category.

- **Consistency with Local Land Use Plans** – Not relevant to the prioritization process since this program category consists of the rehabilitation and replacement of existing bridge structures.

Upon completion of the selection and vetting process, the prioritized list of bridge replacement candidates will be presented to the SCDOT Commission for approval.

All data used for project prioritization will be kept on file as required by Departmental Directive 51 and SCDOT's record retention schedules.

Submitted by: James J. Feda, Jr., P.E. Director of Maintenance

Recommended by: Andrew T. Leaphart, P.E.
Chief Engineer for Operations

Approved by: Leland Colvin, P.E.
Deputy Secretary for Engineering

History: Issued on March 10, 2017

MEMORANDUM OF RECORD

Date: October 31, 2017

Re: ED-69, Non-NHS Bridge Replacement Project Prioritization Process

Engineering Directive 69, Non-NHS Bridge Replacement Project Prioritization Process, has been canceled. Off-system bridges are addressed in the load-restricted program.

Leland Colvin, P.E.
Deputy Secretary for Engineering

South Carolina Department of Transportation

Engineering Directive

Directive Number:	**ED-70**	**Effective: March 10, 2017**
Subject:	**Load Restricted Bridge Replacement Project Prioritization Process**	
References:	**Section 57-1-370 of South Carolina Code of Laws, 1976, as amended; S.C. Code of Regulations 63-10, as amended**	
Primary Department:	**Maintenance**	

In 2007, the South Carolina General Assembly enacted Act 114. One of the landmark items in Act 114 was the requirement that the South Carolina Department of Transportation (SCDOT) establish a project prioritization process. In 2016, the General Assembly enacted Act 275. Act 275 eliminated some of Act 114's requirements but it retained the requirement for project prioritization. This requirement is codified in Section 57-1-370 of the South Carolina Code of Laws, 1976, as amended. Additional detail on the process is found in S.C. Code of Regulations 63-10, as amended.

This engineering directive details the process for ranking **load restricted** bridges for replacement using objective and quantifiable criteria.

The number of load restricted bridges varies from month to month, with the number usually ranging from 300 to 350 bridges. Load restricted bridges will be ranked on a statewide priority basis.

The following **relevant** criteria along with the bridge management system (BrM) will be used when calculating the scores to rank bridge replacement candidates on a scale of 0 to 1,500 points. The higher the point value, the higher the priority for replacement. An initial candidate list will be generated from BrM using a scale of 0 to 1,000 points. The bridge with the highest cost benefit ratio will receive 1,000 points, with the remaining bridges receiving a percentage of points based on their cost benefit ratio compared to the bridge with the highest cost benefit ratio.

BrM uses the following criteria to rank bridges for replacement based on the cost benefit ratio calculated for each structure by the software. The output from BrM is the criterion that primarily supports the **purpose and need** of this program category. For that reason, this criterion received the highest weighting of 1,000 points among the relevant criteria.

- **Structural Condition** – Structural condition is the bridge's condition as compared to a new condition and is determined by detailed inspection data.
- **Traffic Status** – Traffic status is a reflection of the actual operational status of the structure (closed, load-restricted, or recommended for load restriction).
- **Average Daily Traffic (ADT)** – ADT is the average traffic volume per day.
- **Average Daily Truck Traffic (ADTT)** – ADTT is the percentage of ADT that is truck traffic, converted to truck volume.

- **Detour Length** – Detour length is the additional distance one would have to travel if the bridge must be closed or load restricted.

Once the pool of prospective bridge candidates has been ranked by BrM, bridges will be sorted by engineering district and sent to the district engineering administrators for the completion of the field review criteria, which will be worth 0 to 500 points. The districts will score each bridge using the criteria listed below and return the results to the State Bridge Maintenance Engineer. The points from the field review will be added to the points received from the BrM prioritization, and bridges will be ranked from highest total score to the lowest total score.

- **Route Continuity and River Basin Upgrades (0 to 125 points)** – This criterion ensures that needed route upgrades are justified and provide both short and long-term benefit. It also provides a mechanism to ensure that our river basins receive additional consideration since these bridges are generally larger, carry more traffic, and also have significant detours if major work or restrictions are required. The 125 point maximum for this criterion reflects this importance.

- **District Repair Feasibility (0 to 75 points)** – This item is used to evaluate bridge repair history, needs, and effectiveness.

- **Improved Emergency Services and Emergency Evacuation Routes (0 to 75 points)**

– This criterion ensures that emergency services such as fire and ambulance are considered and that interruptions are minimal. It also ensures that hurricane evacuation routes are maintained to a high level, as well as primary and secondary lifeline routes for seismic response.

- **State Freight Network (0 to 50 points)** – This criterion is used to give some added emphasis to roads on the freight network. Recent federal funding legislation emphasizes improving the condition of the freight network. If the road segment is on the designated freight network, then it receives full value for this criterion. If not, it receives no value.

- **Strategic Corridor Network (0 to 50 points)** – This criterion is used as a supplemental criterion to give some added emphasis to roads on the strategic corridor network. Recent federal funding legislation emphasizes improving the condition of the strategic corridor network. If the road segment is on the strategic corridor network, then it receives full value for this criterion. If not, it receives no value.

- **New Schools and/or Changes in Bus Routes (0 to 50 points)** – These developments should be analyzed in terms of how much impact new schools have when constructed. Since school bus routes are relative to the population and location of school-aged students and can change from year to year, close coordination with school districts is necessary.

- **Known Commercial Routes (0 to 50 points)** – This criterion ensures that SCDOT considers the movement of goods and the impacts that structurally deficient bridges may have on known commercial routes.

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The following Act 114 criteria were considered but deemed **not relevant** as they relate to the bridge replacement program category priority list, as they do not support the **purpose and need** of this program category.

- **Financial Viability** – Not relevant as part of the prioritization process since rehabilitation and replacement are normal steps in the life cycle of a bridge. Replacement cost is considered when determining the type of replacement structure, but not in the ranking process.

- **Pavement Quality Index (PQI)** – Not relevant as part of the prioritization process since PQI is not calculated for, nor applicable to bridge decks.

- **Environmental Impact** – Not relevant as part of the prioritization process. The environmental permitting process is a part of every bridge replacement project and may have a large impact on the time it takes to develop the project, but it is not used to prioritize bridge replacements.

- **Alternative Transportation Solutions** – Not relevant to Bridge Replacement Program category.

- **Consistency with Local Land Use Plans** – Not relevant to the prioritization process since this program category consists of the rehabilitation and replacement of existing bridge structures.

Upon completion of the selection and vetting process, the prioritized list of bridge replacement candidates will be presented to the SCDOT Commission for approval.

All data used for project prioritization will be kept on file as required by Departmental Directive 51 and SCDOT's record retention schedules.

Submitted by: James J. Feda, Jr., P.E.
Director of Maintenance

Recommended by: Andrew T. Leaphart, P.E.
Chief Engineer for Operations

Approved by: Leland Colvin, P.E.
Deputy Secretary for Engineering

History: Issued on March 10, 2017

APPENDIX E: RISK REGISTER FOR BRIDGES AND PAVEMENTS

Type of Risk or Opportunity	Risk Consequences/Impacts	Original Risk Severity Score	Policy Control Measures (Primary (P) and Secondary (S))	Possible Risk Management Action Plan Items	Final Adjusted Risk Severity Score	Risk Owner
Bridge Risk Registry						
Additional bridges are added to the load-restricted or structurally deficient lists	Delays in program; Increase in cost.	Extreme (25.0)		Explore increase in rehab options; Robust Preservation Program.	High (20.0)	Maintenance
Costs inflate substantially on a program level	Delays in project delivery due to scope expansion and requests for additional funds; Unmet agency goals and customer expectations.	Extreme (25.0)	(P) Agency Policies, Procedures, Design Criteria; (P) Develop contingencies for the successful delivery of projects considering many different scenarios of cost inflation; (S) Partner with contractors, manufacturers, and industry to develop long-term material needs and supply plan for Bridge program.	Allowance for increased risk of low-volume bridge design manual; Growing District in-house Bridge capabilities; Explore increase in rehab options.	Medium-High (17.5)	Planning Finance Maintenance Preconstruction
Ability to deliver projects impacted by lack of qualified internal workforce	Can delay project and program delivery times; Can lead to unmet system performance.	Extreme (22.5)	(P) HR Retention; Outsourcing Labor	Research on Technology and Efficiency Assessments to reduce staff workload; More Flexible HR Programs.	Medium (9.0)	HR
Low-priority bridges consume resources disproportionately	Resources beyond risk appetite are consumed.	High (20.0)	(P) Agency Policies, Procedures, Design Criteria; (P) Develop contingencies for the successful delivery of projects considering many different scenarios of cost inflation; (P)Silo-prioritized Plans; (S) Partner with contractors, manufacturers, and industry to develop long-term material needs and supply plan for Bridge program.	Allowance for increased risk of low-volume bridge design manual; Growing District in-house Bridge capabilities; Agency-wide prioritized Plans; Focus on Strategic Alternative Corridors.	Low (4.0)	Planning Maintenance Preconstruction
The ability to deliver projects impacted by lack of qualified external contractors	Can delay project and program delivery times; Can lead to unmet system performance.	Medium-High (17.5)	(P) Meet with bridge contractors periodically to determine their capacity and their plans for capital improvements and increased workforce;	Agency-wide prioritized Plans; Automate Bridge List for Contractors from P2S List;	Medium (10.0)	Construction

Type of Risk or Opportunity	Risk Consequences/Impacts	Original Risk Severity Score	Policy Control Measures (Primary (P) and Secondary (S))	Possible Risk Management Action Plan Items	Final Adjusted Risk Severity Score	Risk Owner
			(S) Partner with contractors, manufacturers, and industry to develop long-term material needs and supply plan for Bridge program.	Strategic Contracting based on Market Sectors.		
Federal Funding Cuts	Reduce ability to complete program.	Medium-High (15.0)	(P) Communication with Congressional delegation.		Medium (12.5)	Finance
Bridges are damaged by extreme weather events	Disruption to system operations; Excessive costs in replacing or rebuilding bridges.	Medium-Low (8.0)	(P) Agency Policies, Procedures, Design Criteria; (P) SCDOT obtain ER Funds; Document events, develop a flood pattern and identify vulnerable regions, develop GIS base maps and identify scour critical bridges; (P) Identify vulnerable regions, develop heat maps within the state, and develop contingency plans for quick response, recovery, and rebuilding process; (P) Utilize existing NBI system and increase the frequency of inspections for at-risk bridges (scour critical); (P) Develop effective countermeasures and criteria for affected bridges to reduce the rate of scour and damage to bridges where practical.		Low (5.25)	Preconstruction Maintenance
Ability to deliver projects impacted by material shortage	Can delay project and program delivery times; Can lead to unmet system performance.	Low (5.0)			Low (5.0)	Construction
State Funding Cuts	Reduce ability to complete program.	(Low) (5.0)			Low (4.0)	Finance
Opportunity: Receipt of additional State funding	Reduces impact of lack of funding issues.	Low (4.0)			Low (4.0)	Finance

Type of Risk or Opportunity	Risk Consequences/Impacts	Original Risk Severity Score	Policy Control Measures (Primary (P) and Secondary (S))	Possible Risk Management Action Plan Items	Final Adjusted Risk Severity Score	Risk Owner
Opportunity: Receipt of additional Federal funding	Reduces impact of lack of funding issues.	Low (4.0)			Low (4.0)	Finance
Bridges are damaged or destroyed by Earthquakes	Disruption to system operations; Excessive costs in replacing or rebuilding bridges.	Minimal (2.5)	(P) Document events and develop emergency response plans that identify vulnerable zones, districts, or assets and prepare for prompt response actions; (P) Incorporate earthquake resistant designs in high risk areas to improve resiliency during earthquakes.		Minimal (2.5)	Preconstruction
Bridges are damaged or destroyed by vehicle impacts/fires	Congestion due to bridge posting or closures may cause significant traffic delays in movement of people, goods and services; Unplanned repair costs may affect scheduled programs or delivery of projects.	Minimal (2.5)	(P) Develop emergency response plans for affected routes to maintain safe traffic flow and traffic operations upon asset failure; (P) Identify vulnerable locations and build protective barriers, or delineate highly vulnerable assets.		Minimal (2.5)	Maintenance
Pavements Risk Registry						
Loss or lack of Institutional Knowledge	Loss of productivity, quality of work, delays, increase in cost.	High (20.0)	Recruitment and Retention Plans; Workshops and Trainings for Internal Staff and Contractors; Outsourcing.		Medium-High (16.0)	HR
Project costs inflate substantially	Delays in project delivery due to scope expansion and requests for additional funds; Unmet agency goals and customer expectations.	High (18.0)	(P) Develop contingencies for the successful delivery of projects considering many different scenarios of cost inflation.	Optimize the blend of investment; Corridor Management; Increasing daytime work; Lower standards for low-volume and low-speed roads; Prioritize OGFC to risky assets based on safety data; Substitute with SMA	Medium (13.5)	Planning Finance Maintenance Preconstruction

Type of Risk or Opportunity	Risk Consequences/Impacts	Original Risk Severity Score	Policy Control Measures (Primary (P) and Secondary (S))	Possible Risk Management Action Plan Items	Final Adjusted Risk Severity Score	Risk Owner
Inaccurate condition prediction models	Will impact the pavement program financial plan and target setting process.	Medium-High (16.0)	(P) Regularly Update Cost in Models; Deterioration Curves Development; (S) Develop Pavement Management Data Quality Management Plan.	Add age of concrete; Add a structural evaluation; Ongoing research project to update deterioration curves; Add a construction history (going forward)	Medium-Low (6.0)	Road Data Services
The ability to deliver projects impacted by lack of qualified contractors	Can delay project and program delivery times; Can lead to unmet system performance.	Medium (12.0)	(P) Diversify our pavement treatment types; (P) Meet with paving contractors periodically to determine their capacity and their plans for capital improvements and increased workforce.		Medium (10.0)	Construction
Pavements are damaged by extreme weather events (hurricane, floods, snow/ice)	Disruption to system operations; Excessive costs in replacing or rebuilding roads.	Medium (12.0)	(P) Identify vulnerable regions, develop heat maps within the state, and develop contingency plans for quick response, recovery, and rebuilding process; (P) Use of ER Funds.	Document events, develop a flood pattern and identify vulnerable regions, develop GIS base maps and implement consistent drainage inspection program to identify maintenance and upgrade needs.	Medium-Low (6.0)	Maintenance Construction
The ability to deliver projects impacted by material shortage	Can delay project and program delivery times; Can lead to unmet system performance.	Medium (9.0)	(P) Partner with contractors, manufacturers, and industry to develop long-term material needs and supply plan for pavement program.		Medium-Low (6.0)	Construction
Inaccurate pavement condition data	Will impact the pavement program financial plan and target setting process.	Medium-Low (8.0)	Develop Pavement Management Data Quality Management Plan.		Low (4.0)	Road Data Services
Opportunity: Receipt of additional State funding	Capacity of industry to match additional work.	Low (3.75)			Low (3.75)	Finance
Opportunity: Receipt of additional Federal funding	Adjustment of work type within current funding.	Low (3.0)			Low (3.0)	Finance

Type of Risk or Opportunity	Risk Consequences/Impacts	Original Risk Severity Score	Policy Control Measures (Primary (P) and Secondary (S))	Possible Risk Management Action Plan Items	Final Adjusted Risk Severity Score	Risk Owner
Pavements are damaged or destroyed by Earthquakes	Disruption to system operations; Excessive costs in replacing or rebuilding roads.	Minimal (2.5)	(P) Document events and develop emergency response plans that identify vulnerable zones, districts, or assets and prepare for prompt response actions; (P) Identify vulnerable regions, develop heat maps within the state, and develop contingency plans for quick response, recovery, and rebuilding process.		Minimal (2.5)	Maintenance Construction
Pavements are destroyed by vehicle impacts/fires	Congestion due to lane closures may cause significant traffic delays in movement of people, goods and services; Unplanned repair costs may affect scheduled programs or delivery of projects.	Minimal (2.5)	(P) Develop emergency response plans for affected routes to maintain safe traffic flow and traffic operations upon asset failure.		Minimal (2.5)	Maintenance
State Funding Cuts	Adjustment of programs.	Minimal (2.5)			Minimal (2.5)	Finance
Federal Funding Cuts	Adjustment of programs.	Minimal (2.5)			Minimal (2.5)	Finance

APPENDIX F: BRIDGES PERFORMANCE MEASURE TARGET SETTING METHODOLOGY

SCDOT PERFORMANCE MEASURES AND TARGET SETTING - BRIDGE

1. Federal Requirements

The Federal Highway Administration (FHWA) published in the Federal Register (82 FR 5886) a final rule establishing performance measures for State Highway Agencies (SHA)s to use in managing pavement and bridge performance on the National Highway System (NHS). The NHS is the Interstate Highway System plus additional roads important to the nation's economy, defense, and mobility. The National Performance Management Measures: Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program Final Rule addresses requirements established by the Moving Ahead for Progress in the 21st Century (MAP-21) Act and reflects passage of the Fixing America's Surface Transportation (FAST) Act. The rule is effective May 20, 2017. SHAs are required to:

- establish targets for all bridges carrying the NHS, which includes on- and off-ramps connected to the NHS within a State, and bridges carrying the NHS that cross a State border, regardless of ownership.
- Establish statewide 2- and 4-year targets by May 20, 2018, and report by October 1, 2018.
- Adjust targets at the Mid Performance Period Progress Report if necessary (October 1, 2020).

23 CFR 650.305 defines a bridge as "*a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.*"

Metropolitan Planning Organizations (MPOs) are required to support the SHA's 4-year target or establish their own, quantifiable target by 180 days after the SHA's target is established.

Bridge performance measures are detailed in 23 CFR Part 490 Subpart D: National Performance Management Measures for Assessing Bridge Condition. The regulation also establishes minimum condition requirements for NHS bridges.

Performance Measures	Penalties

- Percentage of NHS bridges classified as in Good condition
- Percentage of NHS bridges classified as in Poor condition

If more than 10% of total deck area of NHS bridges are classified as structurally deficient for three consecutive years then NHPP funds need to be obligated for eligible bridge projects on the NHS.

23 CFR Part 490.407 and 490.409 define the metric thresholds for each applicable bridge, the performance measures for determining condition are based on the minimum NBI rating values for deck, superstructure, substructure and culverts (as shown in Table 1.1). 23 CFR 490.411 provides the definition for Structurally Deficient bridge: "*…Beginning with calendar year 2018 and thereafter, a bridge will be classified as Structurally Deficient when one of its NBI Items, 58--Deck, 59--Superstructure, 60-- Substructure, or 62--Culverts, is 4 or less*."

Table 1.1 Bridge Condition Thresholds (§490.407, §490.409)

NBI Rating Scale (from 0 – 9)	**9 - 8 - 7 Good**	**6 - 5 Fair**	**4 - 3 - 2 - 1 - 0 Poor**
Deck (Item 58)	≥ 7	5 or 6	≤ 4
Superstructure (Item 59)	≥ 7	5 or 6	≤ 4
Substructure (Item 60)	≥ 7	5 or 6	≤ 4
Culvert (Item 62)	≥ 7	5 or 6	≤ 4

If:
Min ≥ 7 → **Good**
Min ≤ 4 → **Poor**

The condition values are weighted by the respective deck area of each bridge and express condition totals as a percentage of the total deck area of bridges in a state. Deck area for each bridge is calculated based on length from NBI item 49 (structure length) and width from NBI item 52(deck width) or item 32 (approach roadway width). This method for calculating bridge condition is illustrated below.

$$\text{Percent of NHS bridges in good condition} = 100 * \frac{\sum_{g=1}^{GOOD} [\text{Length} * \text{Width}]_{\text{Bridge } g}}{\sum_{g=1}^{Total} [\text{Length} * \text{Width}]_{\text{Bridge } t}} \text{(1-1)}$$

$$\text{Percent of NHS bridges in poor condition} = 100 * \frac{\sum_{g=1}^{Poor} [\text{Length} * \text{Width}]_{\text{Bridge } p}}{\sum_{g=1}^{Total} [\text{Length} * \text{Width}]_{\text{Bridge } t}} \text{(1-2)}$$

2. Bridge Inventory Data

The initial National Bridge Inspection Standards (NBIS) were established as part of the Federal-Aid Highway Act of 1970 that were limited to bridges on the Federal-aid highway system. Currently, the NBIS regulations apply to all publicly owned highway bridges longer than twenty-feet located on public roads. NBIS are federal regulations (23 CFR 650) establishing requirements for bridge inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and maintenance of bridge inventory. Information from these inspections is stored in the National Bridge Inventory (NBI) database, created in 1972. The NBI is the aggregation of structure inventory and appraisal data collected by each state to fulfill the requirements of NBIS. The NBI

database contains condition information on five aggregate structural units (deck, superstructure, substructure, channel, and culvert) by assigning a condition rating to each of these components of a bridge on a scale from 9 (perfect) to 1 (severe deterioration/failure) that are needed for bridge condition calculation using Equation 1-1 and 1-2.

The NBI database is maintained by the Federal Highway Administration (FHWA). These encoded alpha-numeric text files are available to download for program years beginning in 1992. SHAs are required to inspect bridges under their jurisdictions at regular intervals and to submit NBI data files with updated information to FHWA in March of each year. FHWA conducts annual reviews of state bridge inspection programs to ensure compliance with federal regulations.

SCDOT's bridge inspection program started in the 1970's. The SCDOT Bridge Maintenance Office manages the bridge inspection program. As required by NBIS, SCDOT performs inspection on non-load restricted bridges biennially and annually on load restricted bridges. SCDOT's bridge inspection data are stored in the Roadway Information Management System (RIMS) and in the SCDOT Bridge Management System (BrM).

3. Bridge Inventory

For this initial bridge performance target setting, South Carolina bridge inventory data files (1992–2017) in ASCII format were downloaded from FHWA's NBI website (https://www.fhwa.dot.gov/bridge/nbi/ascii.cfm). A data import script was created to import these text files into an Access table with fields as defined in the FHWA Recording and Coding Guide. Each year's data from 1992 to 2012 were imported into Access as separate tables. All data analyses in this report are based on the NBI dataset.

3.1 . Bridges in South Carolina

Table 3.1 shows bridges in South Carolina based on data submission to NBI in 2017, which include 909 local agency owned bridges. Table 3.2 shows the distribution of NHS bridges on interstate and non-interstate NHS by count and by deck area and Figure 3.1 shows the locations of the 1,739 NHS bridges.

Table 3.1. South Carolina Bridge Inventory*

Functional Class	Count	Bridge Deck Area (ft^2)
NHS	1,739 (18.6%)	38,985,499 (53.3%)
Non-NHS	7,602 (81.4%)	34,166,510 (46.7%)
Total	9,341	73,152,009

Table 3.2. NHS Bridges Distribution*

Route System	Bridge Type	By Deck Area (ft^2)		By Count	
Interstate	Bridge	16,491,965	43.5%	614	42.2%
	Culvert	479,090		120	
Non-interstate NHS	Bridge	21,424,183	56.6%	795	57.8%
	Culvert	590,261		210	
Total		38,985,499		1,739	

*: based on 2017 NBI data submission

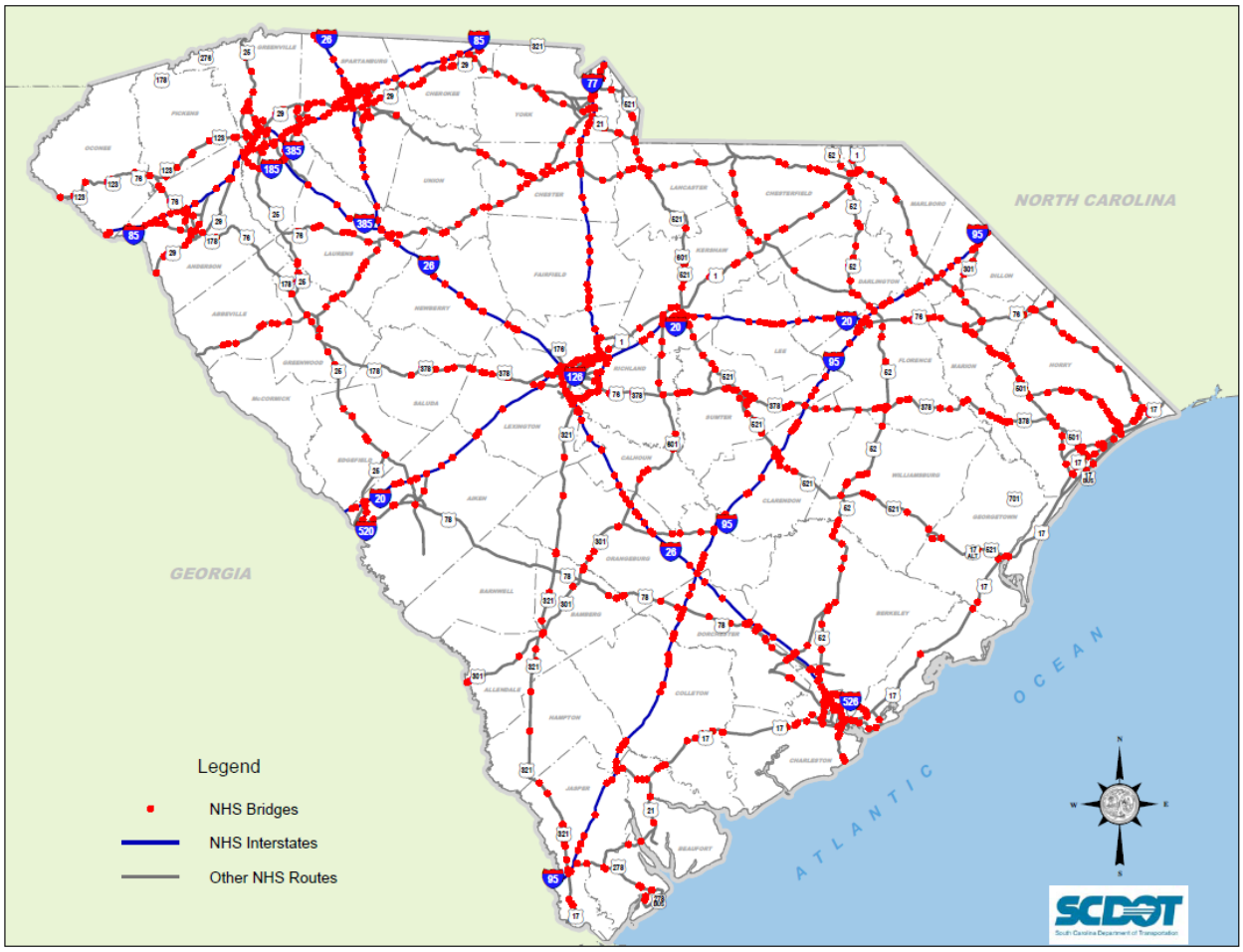

Figure 3.1. South Carolina Bridges on National Highway System

3.2. Border Bridges

The FHWA requires that SHAs coordinate with all relevant bridge owners, such as federal agencies that own NHS bridges and other state SHAs that share NHS bridges that cross state borders. South Carolina has twenty-six border bridges with Georgia and North Carolina (as shown

in Table 3.3). Eight bridges maintained by Georgia Department of Transportation (GDOT) are on the NHS. GDOT was contacted and verified its inventory information.

Table 3.3. Border Bridges between South Carolina and Georgia/North Carolina

Owner	NHS				Non-NHS		Total	
	Interstate		Non-Interstate					
	Count	Deck Area (ft^2)	Count	Deck Area (ft^2)	Count	Deck Area (ft^2)	Count	Deck Area (ft^2)
GA	4	335,876	4	417,330	4	157,389	12	910,595
NC					2	12,461	2	12,461
SC	3	219,642	2	93,117	7	325,616	12	638,376

3.3. SCDOT Maintained Bridge Conditions

Based on the 2017 NBI dataset, 48% of bridges by count and 30% by deck area were built or reconstructed from the 1960's to 1970's during the construction boom related to the development of the Interstate Highway System. About 35% of the bridges by count and 11% by deck area built or reconstructed prior to the 1970's were concrete bridges. Overall, about 47% of bridges by count and 69% by deck area were built or reconstructed since the 1980's (Figure 3.2 and Figure 3.3). A sizable proportion (40% by count and 23% by deck area) of the inventory is 45 years old or older. These structures have either exceeded or will soon exceed their originally anticipated design service life of 50 years. Border bridges are not included in the data analysis in this section.

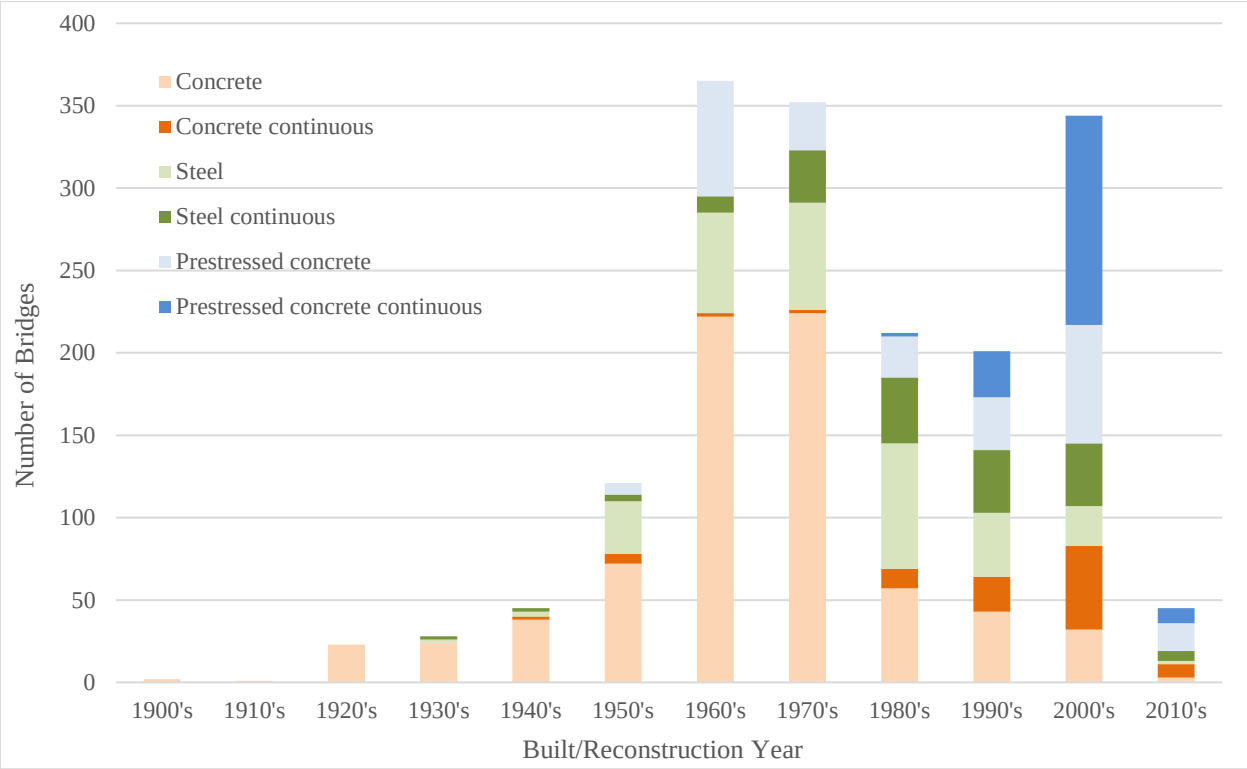

Figure 3.2. South Carolina NHS Bridges Count by Year Built/Reconstructed

With the development of high-strength steel wire technology in the 1950's, 24% of the bridges by count and 32% by deck area are prestressed concrete bridges. Steel continuous bridges account for about 30% of the NHS bridge deck area, but only 9.9% by count, or 172 bridges (Figure 3.4).

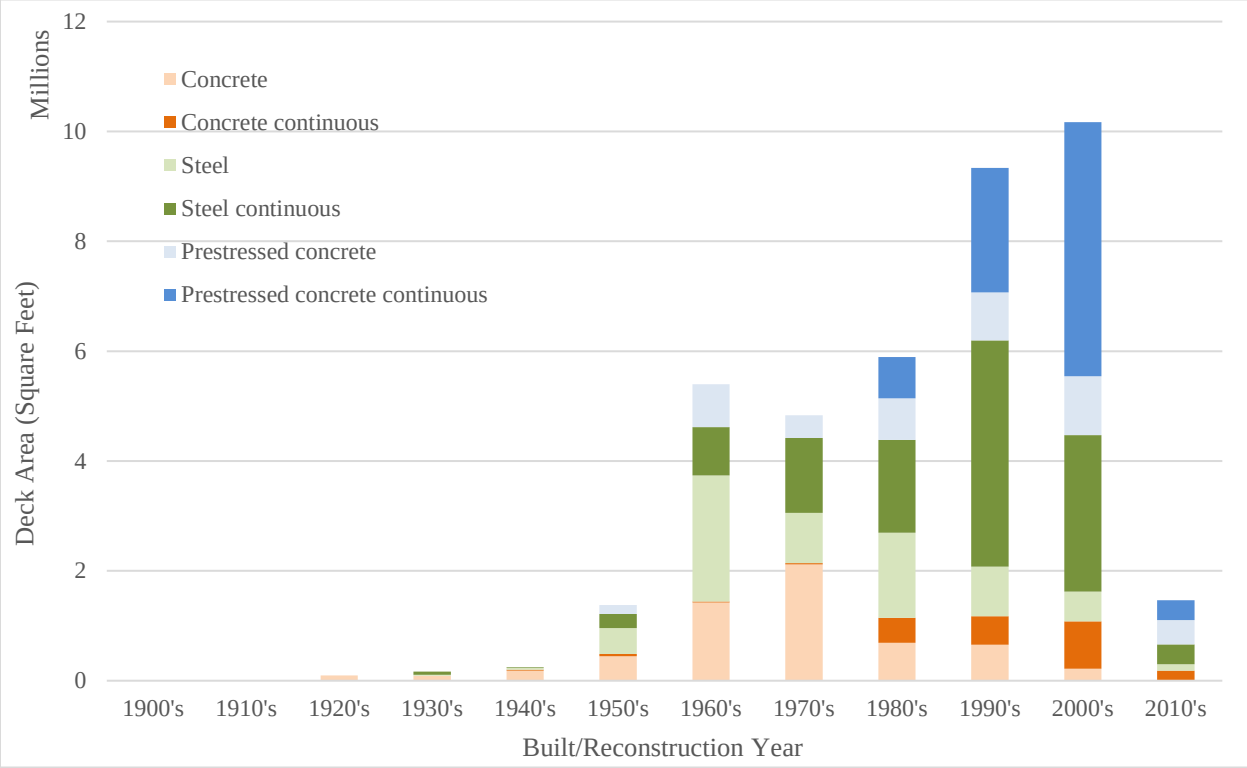

Figure 3.3. South Carolina NHS Bridges Deck Area by Year Built/Reconstructed

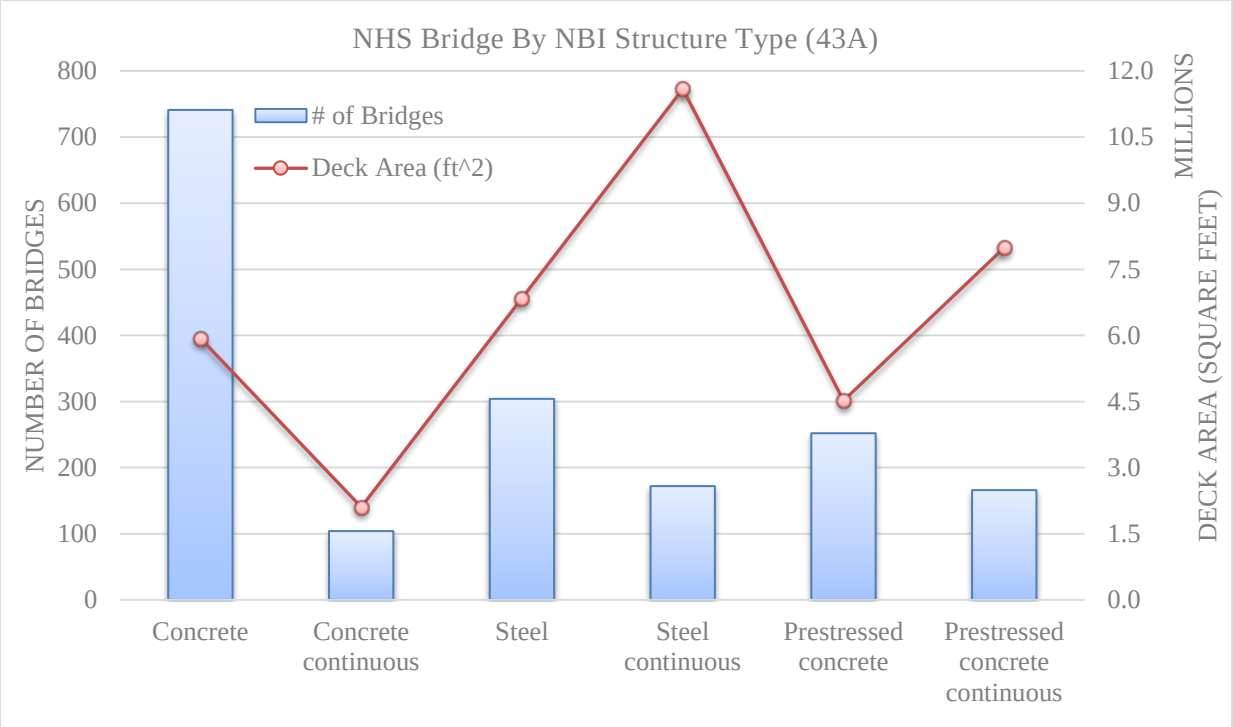

Figure 3.4. South Carolina NHS Bridges by Structure Type

Figure 3.5 and 3.6 show the NHS bridge conditions based on thresholds defined by §490.407 and §490.409 between 2007 and 2017. As shown in Figure 3.6, the percentage of poor bridges by deck area has been well below 10% over the past decade. Based on 2017 NBI data, 5.8% of NHS bridges by count (4.3% by deck area) were rated poor. The percentage of poor bridges was reduced by approximately 3 percentage points by count and by deck area between 2007 and 2017. However, the percentage of good bridges also decreased by 10 percentage points, both by count and by deck area, during the same time period.

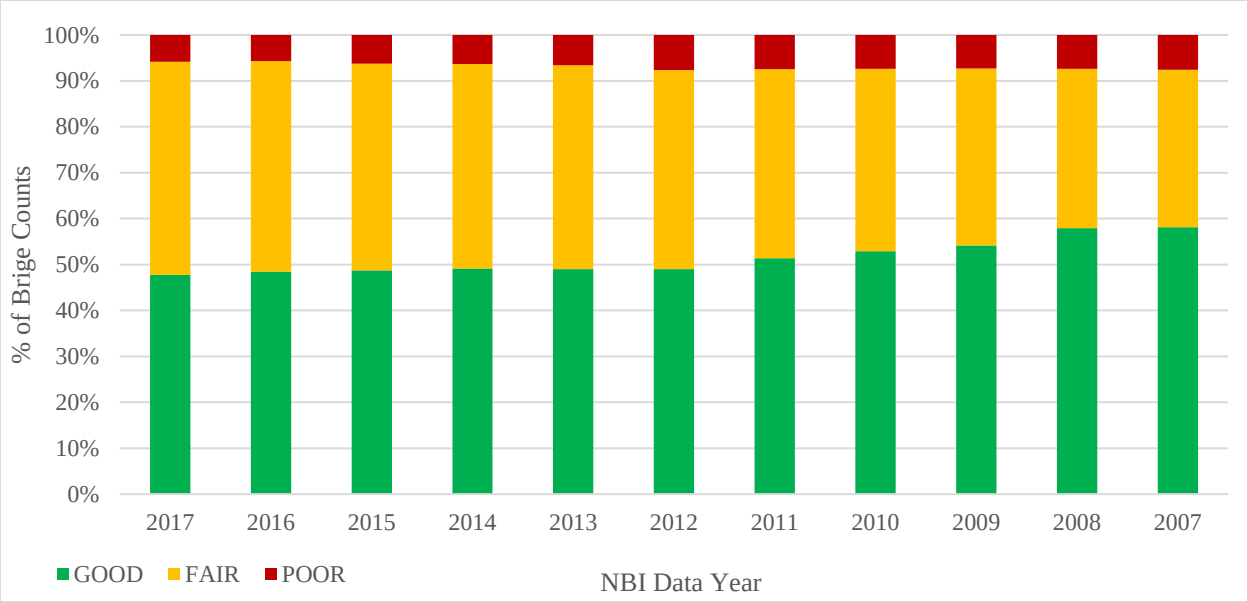

Figure 3.5. 2007 - 2017 NHS Bridge Condition Based on Federal Metrics – by Count

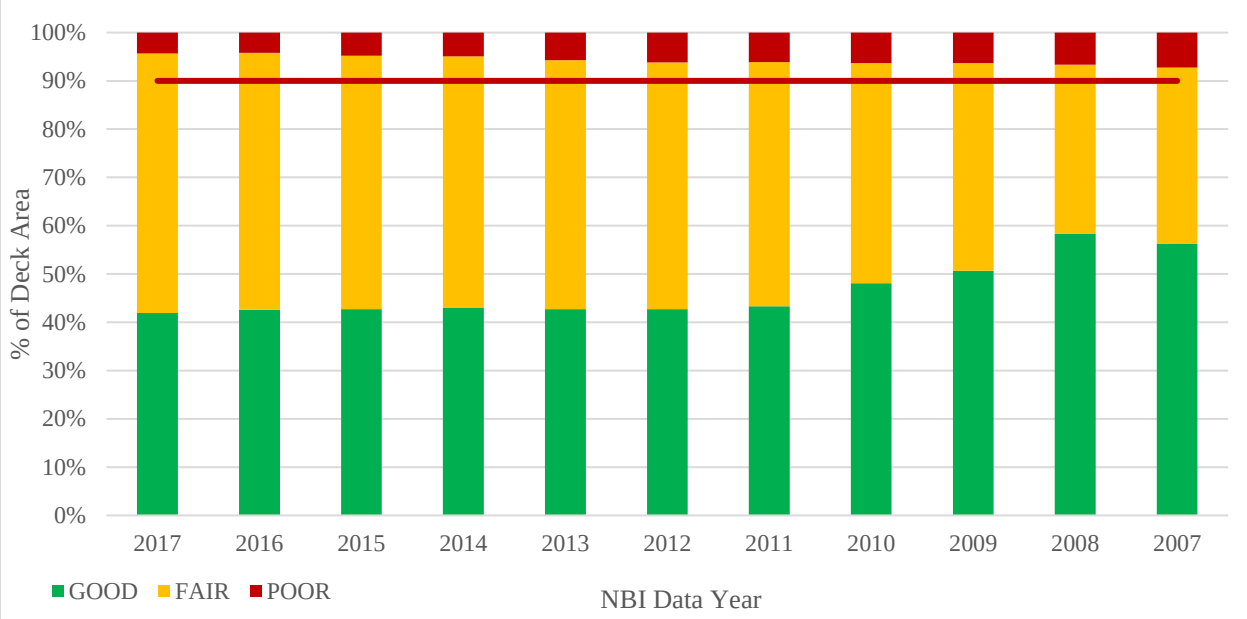

Figure 3.6. 2007 - 2017 NHS Bridge Condition Based on Federal Metrics – by Deck Area

Figure 3.7 and 3.8 shows the 2017 NHS bridge element condition ratings based on NBI data. For bridges in the "Fair" category, approximately 15% of the bridges by count and 17% by deck area have at least one minimum NBI rating of 5. These bridges therefore are the most likely to fall within the "Poor" category in the coming years.

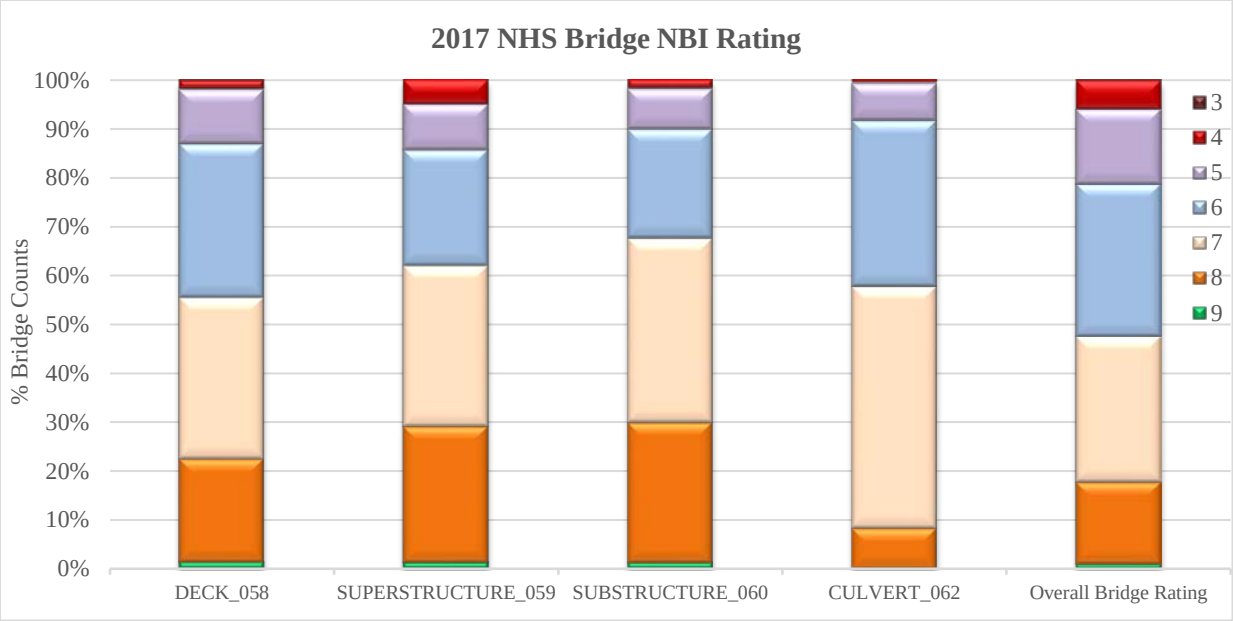

Figure 3.7. 2017 NHS Bridge Condition Based on Federal Metrics – by Count

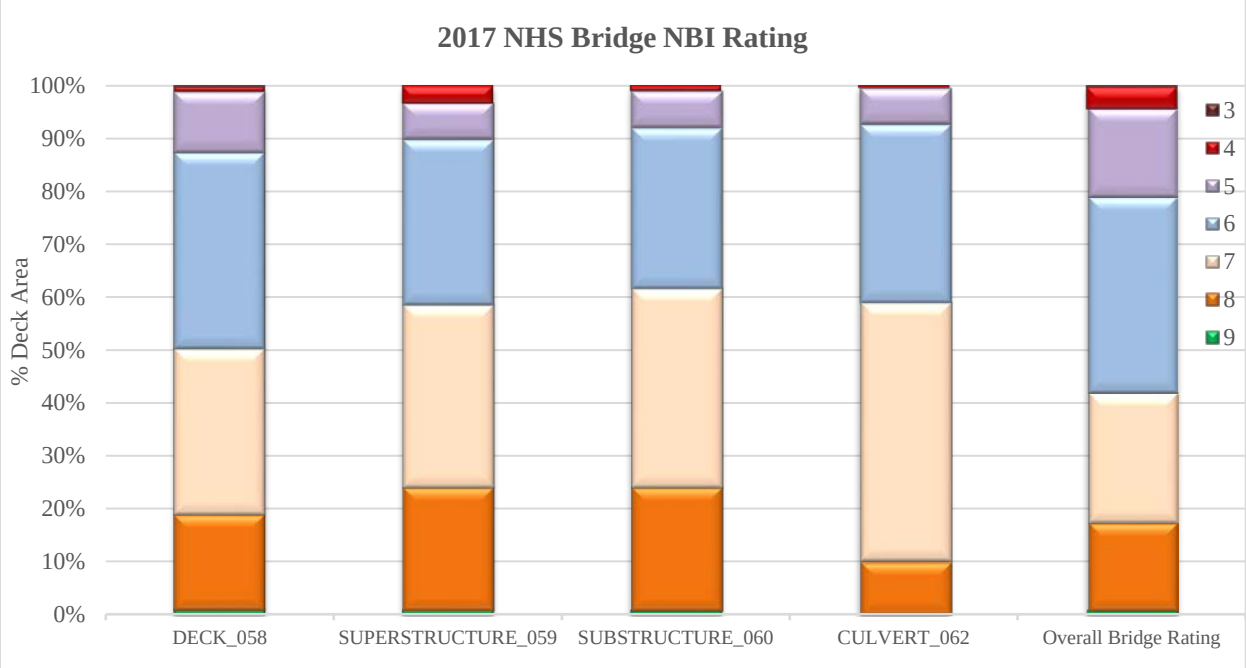

Figure 3.8. 2017 NHS Bridge Condition Based on Federal Metrics – by Deck Area

Table 3.4 and Figure 3.9 show the distribution of NHS bridges rated fair in 2017 by bridge structure type and by number of stay-the-same condition rating years. Overall, 46.5% of 2017 NHS bridges by count and 53.8% by deck area falls in the fair category. In addition, there are 6.7% of 2017 NHS bridges by count and 7.3% by deck area that had overall bridge rating of 5 and have stayed at condition state 5 for more than ten years.

Bridge Structure Type	By Count		By Deck Area (ft^2)	
	NBI Rating 5	NBI Rating 6	NBI Rating 5	NBI Rating 6
Concrete	125	271	1,151,154	2,343,610
Concrete Continuous	2	28	17,095	798,046
Steel	76	105	2,398,268	1,970,331
Steel Continuous	21	47	1,480,066	5,060,229
Prestressed Concrete	38	77	540,734	1,506,987
Prestressed Concrete Continuous	4	14	922,001	2,777,515
Σ	266	542	6,509,318	14,456,718

Table 3.4. NHS Bridge Rated Fair by Structure Types

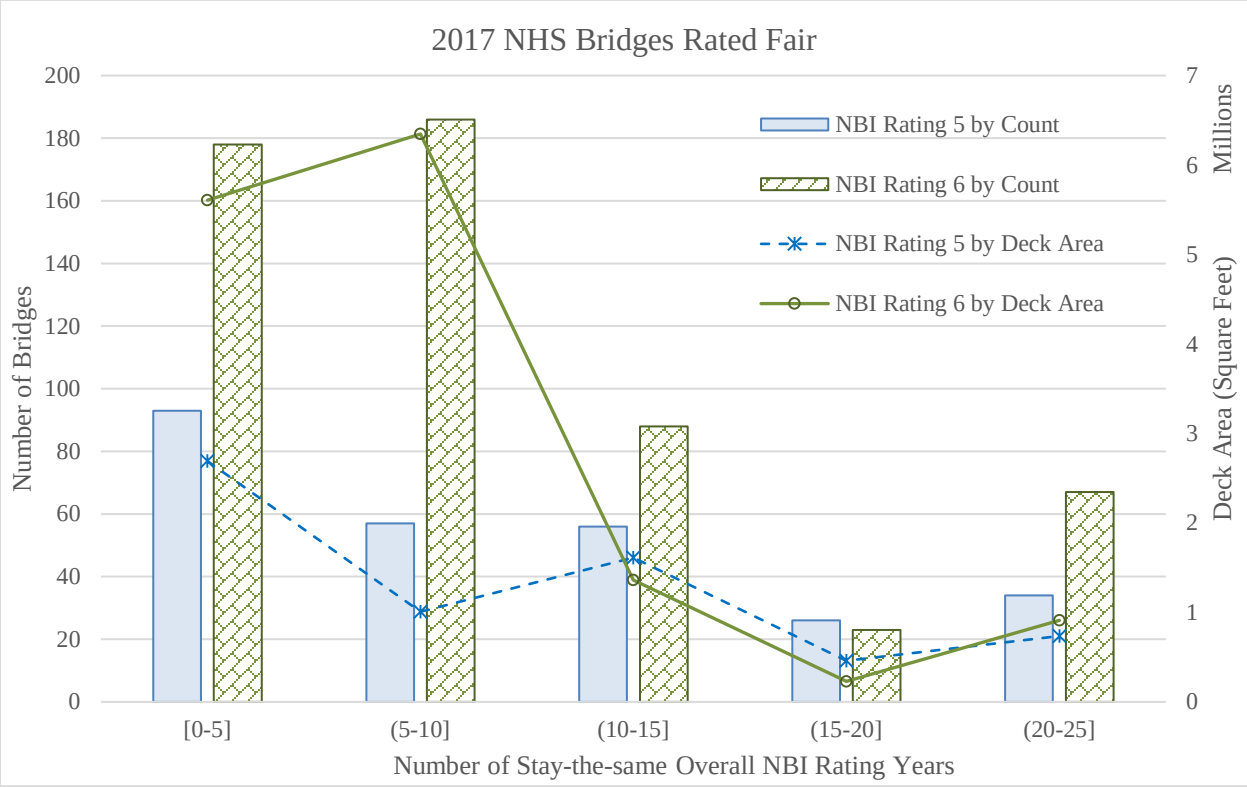

Figure 3.9. 2017 NHS Bridge Rated Fair – Number of Stay-the-Same Bridge Rating Years

4. Target Setting Process

SCDOT is faced with significant challenges in addressing the highway bridge preservation and replacement needs. As shown in Section 3, approximately 40% percent of NHS bridges by count

are approaching or have exceeded their theoretical design life and may need various levels of repairs, rehabilitation, or replacement. With limited resources and increasing travel demands, these circumstances require SCDOT to become more strategic by adopting and implementing performance and risk based approaches to address the bridge program needs.

The target setting process started with a kick-off meeting on January 19, 2018, with participants from Office of Planning and the Director of Maintenance Office. The meeting discussed data collection cycles on bridges, as well as historical SCDOT bridge rating practices vs. federal metrics. Office of Planning staff were tasked to develop the bridge performance targets as required by 23 CFR Part 490.

The bridge performance target setting process includes the following steps:

- Obtaining historical South Carolina NBI data from FHWA;
- Obtaining available data and data sources from Road Data Services, Construction, Preconstruction, Program Controls, and Maintenance offices;
- Reviewing data;
- Analyzing data;
- Reviewing data analysis results with working group members;
- Making necessary modifications; and
- Combining data analysis results and setting preliminary targets.

4.1. Data Source

To set performance targets, the following data sources were utilized:

- NBI: National Bridge Inventory – Managed by FHWA
- RIMS: Road Inventory Management System – Managed by Road Data Services
- P2S: Project Programming System – Managed by Program Controls
- SiteManager – Managed by Director of Construction Office
- Statewide Transportation Improvement Program – Managed by Planning
- Spreadsheets kept for potential project programming from Director of Maintenance Office

As stated in Section 3, historical NBI data for South Carolina bridges were downloaded and imported into a Microsoft Access database. Upon inspection, it was noted that there were two systematic changes in the unique bridge identifiers (NBI item 8 Structure Number) in the 25-years of data history. The first change occurred in the 2006 NBI data submission and the second in the 2013 NBI data submission. After consulting with staff in the Bridge Maintenance office and Road Data Services, it was determined that an additional byte prefilled as a “0” was added between the 3rd and 4th position of 2005’s structure number for 2006’s NBI data submission. For 2012-2013, 2013 NBI item Structure Numbers did not appear to have a pattern when they were updated to a sequential sequence when compared to the ordering of 2012 Structure Numbers. In addition, there was not an available translation table to correlate 2012 and 2013’s Structure Numbers. After

consulting with staff in the Bridge Maintenance office and Road Data Services, criteria used to correlate 2012's Structure_Number_008 to 2013's Structure_Number_008 were the following variables in addition to deck area:

YEAR_BUILT_027
ROUTE_PREFIX_005B
ROUTE_NUMBER_005D
DIRECTION_005E
FEATURES_DESC_006A
FACILITY_CARRIED_007
LOCATION_009

A total of 1,675 matches were found out of 1,719 NHS bridge records from 2013. Two translation tables were created for mapping 2005 to 2006 bridge data and 2012 to 2013 bridge data, respectively.

Queries were created to link available historical data such as structure type, deck area, element ratings to 2017 NHS bridges included in the dataset. Additional criteria used for the queries include:

- Only "On Route" records are included
- Only bridges with non-blank deck, superstructure, substructure rating fields
- Only culvert with non-blank culvert rating fields
- No duplicated records
- Structure length >0
- Deck width (or approach roadway width) >0

4.2 Data Analysis Method

To set targets for future bridge conditions, it is important to understand bridge deterioration. Deterioration is a long-term process of decline in bridge conditions due to environmental factors, degradation of material, and vehicular loading. Different structural types of bridges, such as concrete slab, steel, and prestressed concrete, may have similar response and loading mechanisms; however, no two bridges are the same in all respects, especially in their deterioration and aging characteristics. In the absence of a mechanistic-based bridge deterioration model that requires quantitative contribution of each structure element's physical property, environmental effects, and maintenance constraints, it is difficult to accurately predict deterioration for all types of bridges using the same condition analysis framework.

Most bridge deterioration models are based on statistical regression and/or stochastic modeling. Deterministic models are dependent on a mathematical regression formula for the relationship between the factors affecting bridge deterioration and the measure of a bridge's condition. The output of such models is expressed by deterministic values that represent the average predicted conditions. The models can be developed using straight-line extrapolation, regression, and curve-fitting methods. A Markovian process, which has been adopted in many bridge management

systems, is a stochastic process that takes the uncertainties involved in the bridge deterioration process into consideration.

The Markov chain is a special case of the Markovian process that takes on a finite number of possible discrete states. This can be modeled as a series of transitions between certain states. The Markov chain assumes that the future condition rating of a bridge or a bridge element depends on its last condition rating. The transition from one state to the other is characterized by transition probabilities, which can be determined from either expert judgment or empirical observation. The nine possible NBIS bridge condition ratings (from 1 to 9) can be defined as nine Markovian states. Without repair or rehabilitation, the bridge condition ratings are assumed to either stay the same or decrease with an increase in bridge age. As a result, a bridge element or a bridge with a condition state, say *i*, has a probability ($p_{i,i}$) to remain the same and a probability ($p_{i,j}$) to change to a lower condition state, *j*, during one inspection cycle. By knowing this probability for each of the condition states, the transition probability matrix *P*, can be developed as shown below:

$$P = \begin{array}{c} \\ 1 \\ 2 \\ . \\ . \\ n \end{array} \begin{array}{c} \begin{array}{cccc} 1 & 2 & \ldots\ldots & n \end{array} \\ \begin{bmatrix} p_{1,1} & p_{1,2} & \ldots\ldots & p_{1,n} \\ p_{2,1} & p_{2,2} & \ldots\ldots & p_{2,n} \\ . & . & \ldots\ldots & . \\ . & . & \ldots\ldots & . \\ p_{n,1} & p_{n,2} & \ldots\ldots & p_{n,n} \end{bmatrix} \end{array} \qquad (4\text{-}1)$$

Where:
$p_{i,i}$ is the probability for a bridge or a bridge to remain at condition i
$p_{i,n}$ is the probability for a bridge or a bridge to change from condition *i* to condition *n*

The sum of the probabilities for each row in matrix *P* in Equation 4-1 should be one. If the initial condition vector *P(0)* that describes the condition of a bridge or a bridge component is known, the future condition vector *P(t)* at any number of transition periods can be obtained as follows:

$$P(t) = P(0) * P^t \qquad (4\text{-}2)$$

Deriving the transition probabilities included in each transition probability matrix has been approached using different techniques. For this initial target setting process, a simple approach was used in defining the transition probability, $P_{i,}$, as the percentage or proportion of bridges or bridge elements in condition state *i* that deteriorated to condition state *j* in one inspection period (Scherer and Glagola, 1994, Wang et al., 1994):

$$P_{i,j} = \frac{n_{i,j}}{n_i} \qquad (4\text{-}3)$$

Where:
n_i is the total number of bridges in condition *i* at a given time
$n_{i,j}$ is the number of bridges whose condition state changes from *i* to *j* at a given time, where *i* could equal to *j*.

4.3 Data Analysis

For each NHS bridge in the 2017 NBI dataset, its inspection history from 1992 to 2017 was created based on queries described in Section 4.1. For each 2017 NHS bridge, its bridge type, deck area, condition ratings for deck, superstructure, substructure, or culvert, and number of years it took to decrease from one state to another were recorded if there were no changes in deck area, structure type, and built/reconstruction year. For each condition state, structure type, and possible stay-the-same condition year, the number of bridges that stayed the same or shifted to another condition was calculated for ratings of deck, superstructure, substructure, or culvert. Figures A.1 to A.5 show the duration distribution for the overall rating and individual deck, superstructure, substructure, or culvert items to shift from one condition state to another. Out of 1,798 condition shift cases recorded, about 85% of the cases dropped one condition state and 13% dropped two condition states during an inspection cycle (Figure 4.1). On average, it took most structures less than ten years to transit from a higher state to a lower state (Figure 4.2).

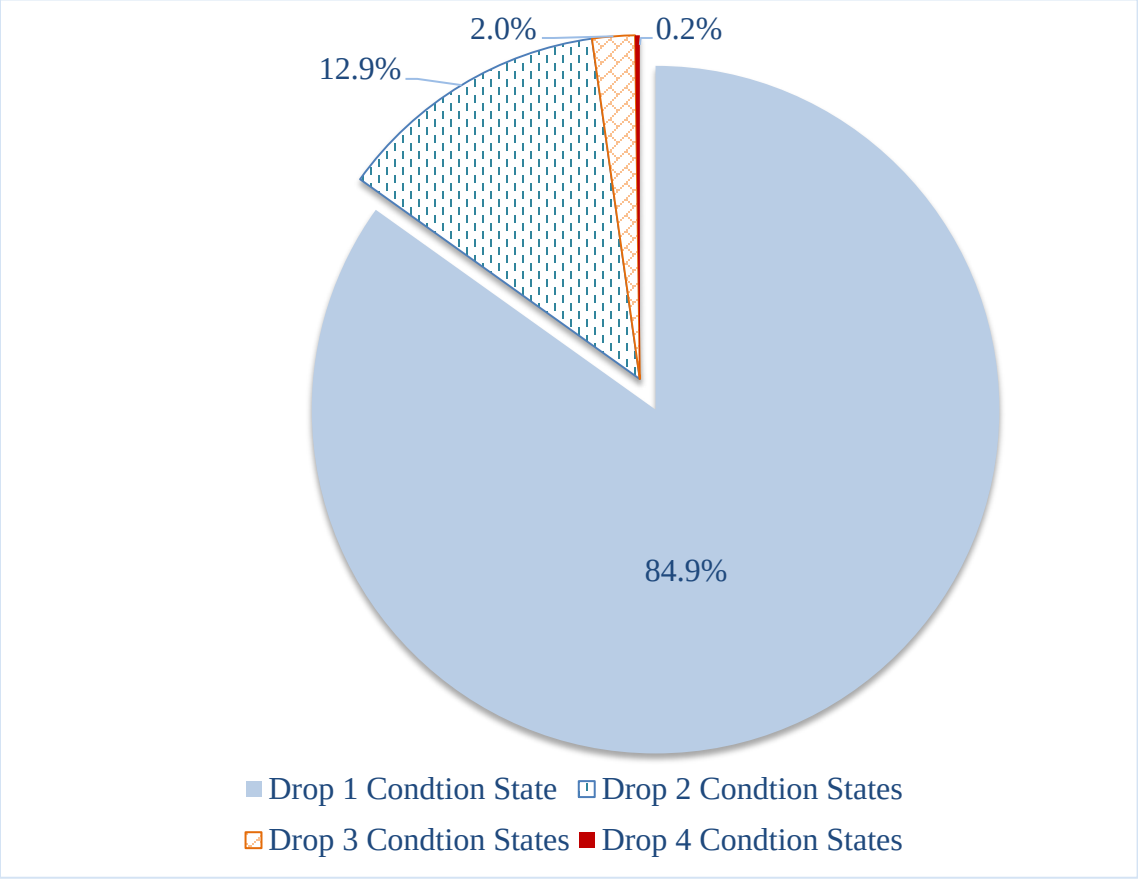

Figure 4.1. Bridge Condition Transition

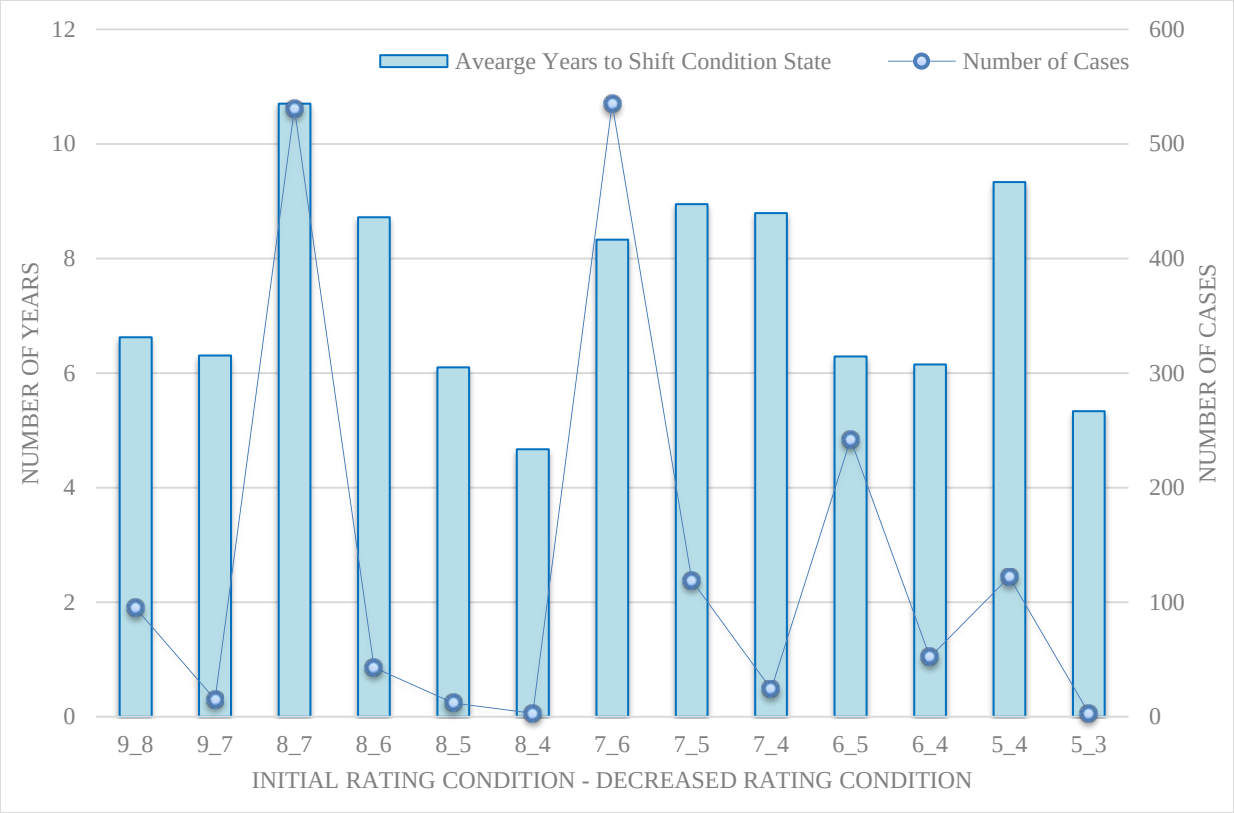

Figure 4.2. Bridge Condition Transition - Average Duration

The percentages of bridges, deck, superstructure, substructure, and culvert elements in condition states 9 to 4 that stayed at the same condition state or deteriorated one state condition were calculated for ten possible stayed-the-same years. Intuitively, the longer a bridge remains at the same condition rating, the higher probability it might transit to a lower condition state in the next inspection cycle. Four options were considered for predicting future bridge condition states:

Option 1: develop one probability matrix based on ten-year whole bridge ratings for each structure type.

Option 2: develop individual probability matrices based on ten-year deck, superstructure, substructure, and culvert ratings for each structure type. Whole bridge ratings will be calculated based on the lowest element rating.

Option 3: develop two probability matrices based on whole bridge ratings for the first and second five-year periods for each structure type. Future ratings will be calculated based on the numbers of years a bridge remains in the same state.

Option 4: develop individual probability matrices based on deck, superstructure, substructure, and culvert ratings for the first and second five-year periods for each structure type. Whole bridge ratings will be calculated based on the lowest element rating and the number of years a bridge remains in the same state.

For Option 3 and 4, bridges that remained in the same condition more than five years will use the second matrix that was developed based on the second five-year ratings because most bridges changed condition states within ten years and there are not enough data available beyond ten years. In addition, there are not enough rating data that are lower than 4. Therefore, results of transition probability matrices for condition 4 or lower are for reference only. In the matrices shown, probabilities for $p_{i,i}$ and $p_{i,i-1}$ are calculated based on 10- or 5-year average values. Probabilities for $p_{i,i-2}$ is calculated as:

$$p_{i,i-2} = 1 - p_{i,i} - p_{i,i-1} \qquad (4\text{-}4)$$

The transition matrices are included in Appendix B. The primary objective of deterioration modeling is to predict future condition ratings of bridges or bridge elements. To assess the accuracy of the models developed above, historical rating data from 2013, 2015, and 2017 are used to verify 2- and 4-year prediction accuracies. Due to construction activities, and NHS limit variations, the total number of NHS bridges is not the same for 2013, 2015, and 2017 data. Therefore, the same set of bridges was used to compare 2013 vs. 2017 and 2015 vs. 2017 data, respectively. It is assumed that all bridges rated as poor in 2013 and 2015 and rated as good in 2017 were due to bridge rehabilitation/replacement. Table 4.1 and 4.2 show predicted 2- and 4-year bridge conditions by count and by deck area based on 2013 and 2015 NBI data compared with 2017 data using the four options mentioned earlier. All options predict slightly higher percentages in good and poor than actual percentages. Option 2 seems to have the best predictions among the four options and is used for final target setting. Figure 4.3 and 4.4 show the predicted 2017 NBI rating versus actual 2017 NBI rating based on 2013 and 2015 actual rating data with improvements using with Option 2, respectively. In both cases, over 84% of the predicted values equal to actual values and over 98% of the predicted values are within ±1 condition state of actual values.

Table 4.1. Prediction Comparison by Count and Deck Area – 2013 vs. 2017

	Rating	By Count			By Deck Area		
		2013 w/o improvement	2013 w/ improvement	2017	2013 w/o improvement	2013 w/ improvement	2017
Option 1	Good	49.2%	50.4%	47.0%	42.8%	43.7%	42.6%
	Fair	44.1%	43.9%	47.1%	49.0%	48.9%	53.1%
	Poor	6.7%	5.7%	5.9%	8.1%	7.4%	4.4%
Option 2	Good	49.2%	50.4%	47.0%	42.8%	43.7%	42.6%
	Fair	43.9%	43.7%	47.1%	49.0%	48.9%	53.1%
	Poor	6.9%	5.9%	5.9%	8.2%	7.4%	4.4%
Option 3	Good	48.3%	49.5%	47.0%	41.8%	42.7%	42.6%
	Fair	44.9%	44.6%	47.1%	50.1%	49.9%	53.1%
	Poor	6.8%	5.8%	5.9%	8.2%	7.4%	4.4%
Option 4	Good	48.3%	49.5%	47.0%	41.8%	42.7%	42.6%
	Fair	42.6%	42.4%	47.1%	49.2%	49.1%	53.1%
	Poor	9.1%	8.1%	5.9%	9.0%	8.2%	4.4%

Table 4.2. Prediction Comparison by Count and Deck Area – 2015 vs. 2017

	Rating	By Count			By Deck Area		
		2015 w/o improvement	2015 w/ improvement	2017	2015 w/o improvement	2015 w/ improvement	2017
Option 1	Good	48.8%	49.3%	47.4%	42.7%	42.9%	41.6%
	Fair	44.8%	44.6%	46.8%	50.2%	49.9%	54.0%
	Poor	6.4%	6.0%	5.8%	7.1%	7.1%	4.5%
Option 2	Good	48.8%	49.3%	47.4%	42.7%	42.9%	41.6%
	Fair	44.9%	44.8%	46.8%	52.5%	52.5%	54.0%
	Poor	6.3%	5.8%	5.8%	4.8%	4.6%	4.5%
Option 3	Good	48.8%	49.3%	47.4%	42.7%	42.9%	41.6%
	Fair	44.9%	44.8%	46.8%	52.5%	52.3%	54.0%
	Poor	6.3%	5.8%	5.8%	4.8%	4.8%	4.5%
Option 4	Good	48.8%	49.3%	47.4%	42.7%	42.9%	41.6%
	Fair	44.9%	44.8%	46.8%	52.5%	52.5%	54.0%
	Poor	6.3%	5.9%	5.8%	4.8%	4.6%	4.5%

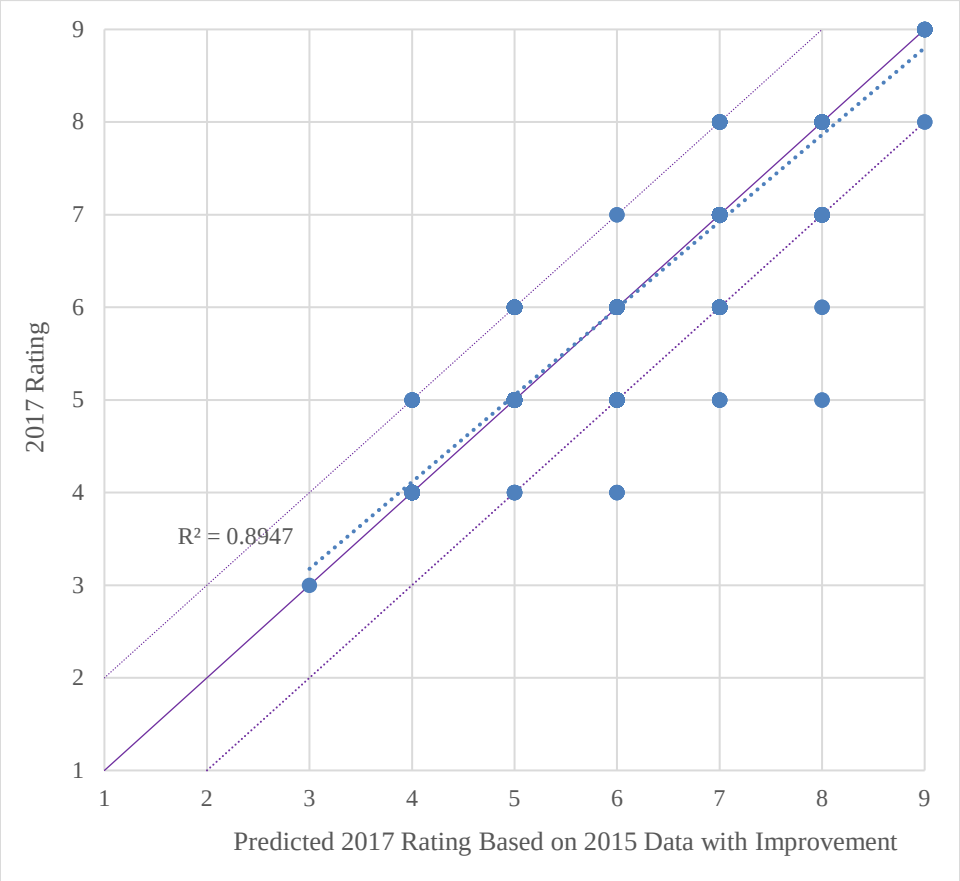

Figure 4.3. 2017 Rating vs. Predicted 2017 Rating Based on 2015 Data

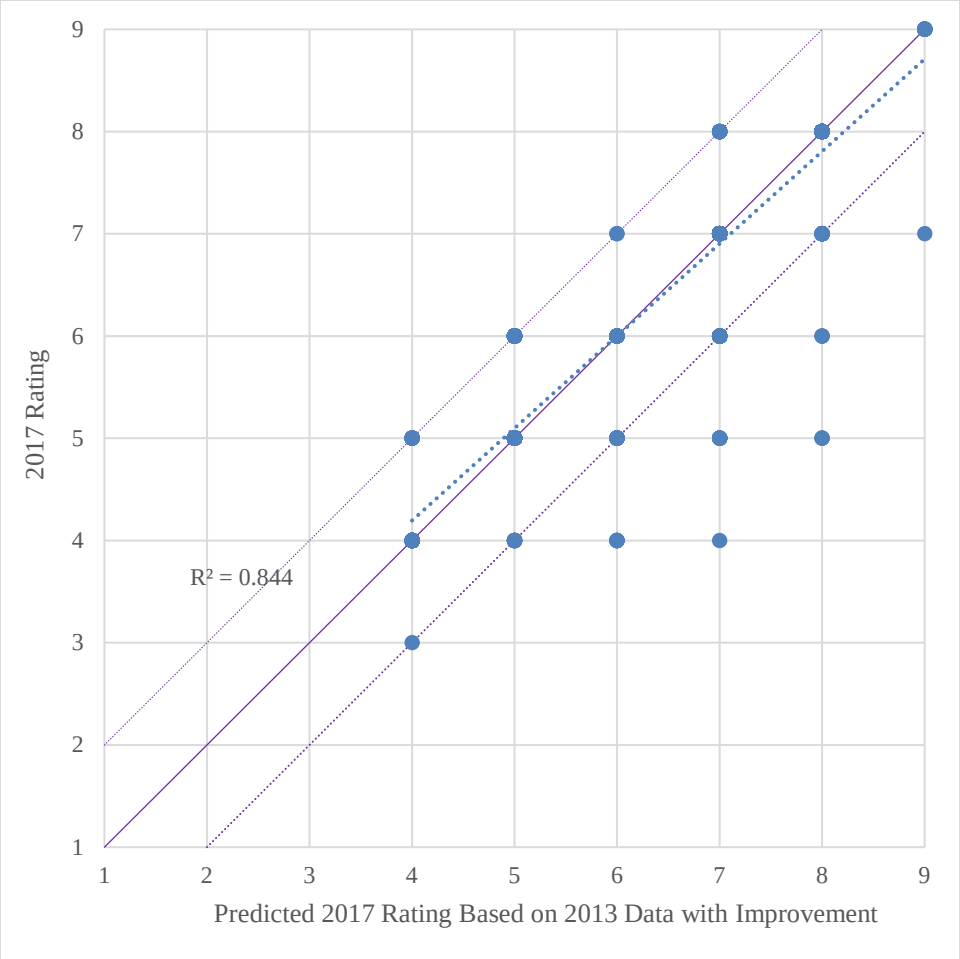

Figure 4.4. 2017 Rating vs. Predicted 2017 Rating Based on 2013 Data

5. Targets

5.1. NHS Bridges

For the 1st performance period (1/1/2018 – 12/31/2021), 2- and 4-year targets are required for NHS bridges. SCDOT is required to report data to FHWA annually on the condition and functional adequacy for all bridges statewide. As a result, bridge projects with potential completion dates between 12/31/2016 and 6/30/2019 need to be included for the 1st 2-year target. Projects with potential completion dates between 12/31/2016 and 6/30/2021 need to be factored into the 1st 4-year target, allowing time for inspection of new construction projects. Table 5.1 shows typical bridge preservation/rehabilitation/reconstruction project types and potential improvements for deck, superstructure, substructure, and culvert based on historical data and subject matter experts' opinions. Preservation projects, such as bridge painting, joint repair, spall repair, are not factored

in the target setting for the 1st performance period as it is hard to quantify how much improvement these types of project would make on a bridge.

Table 5.1. Potential Bridge Construction Project Improvements

Project Type	Potential Results			
	Deck	**Superstructure**	**Substructure**	**Culvert**
Bridge Replacement	Good	Good	Good	Good
Deck Overlay	Good	N/A	N/A	N/A
Deck full/partial depth repair	Some Improvement	N/A	N/A	N/A
Bridge Painting	N/A	N/A	N/A	N/A
Expansion Joint Repair	Some Improvement	N/A	N/A	N/A
Bearings, spalls on girders, joints repair	N/A	Some Improvement	N/A	N/A

Existing and planned NHS bridge rehabilitation and replacement project information was obtained from the eSTIP, P2S, and SiteManager. Active construction project scopes were compared to contracts and plans to determine contract time, new deck area, if available, and potential impacts to bridge condition for rehabilitation projects. Preconstruction and the Maintenance office were contacted to verify project scope and potential contract time for planned projects.

A total of 36 bridge construction projects that affect 70 bridges have been or are planned to be completed between 12/2016 and 06/2021. Among the 18 bridge replacement/removal projects, 24 bridges will be replaced and four will be removed. Of these 28 bridges, 22 bridges were rated as "poor" according to 2017 NBI data. For bridge replacement projects, the change in deck area is factored into the 2021 projections if bridge plans are available.

Table 5.2. NHS Bridge Construction Projects

Project Type	Planned Completion <06/2019		Planned Completion 06/2019 – 06/2021	
	Number of Bridges	Deck Area (ft^2)	Number of Bridges	Deck Area* (ft^2)
Replacement	7	147,993	17	214,493
Deck rehab	7	306,963	2	174,495

*: Estimated

It was noted that there are ten bridges identified in RIMS as NHS bridges that were not in the 2017 NBI dataset. The ten bridges have a total deck area of 187,702 ft^2 (approximately 0.5% of total deck area), six of which are in the "good" category and the other four in the "fair" category. These ten bridges are included in the 2- and 4-year target setting.

The bridge deterioration models developed in Section 4 were applied to each NHS bridge included in the 2017 NBI dataset, as well as the eight border bridges owned and maintained by GDOT and the ten bridges mentioned above. Table 5.3 shows the projected 2019 and 2021 bridge conditions using Option 2 described in Section 4. There are four bridges (Structure_Number_008: 2298, 2662, 9503, 9670) with total deck area of 922,000 ft^2, which count for approximately 2.3% of the deck area, which are projected to have deck ratings in the "poor" category and superstructure and substructure ratings in "good" or "fair" categories in 2021.

Table 5.3. Projected NHS Bridge Condition Based on Federal Metrics

		2017	2019 w/o improvement	2021 w/o improvement	2019 w/ improvement	2021 w/ improvement
By Count	Good	47.6%	47.6%	47.6%	47.9%	48.7%
	Fair	46.6%	46.6%	46.3%	46.8%	46.4%
	Poor	5.8%	5.7%	6.1%	5.2%	4.9%
By Deck Area	Good	41.6%	41.6%	41.6%	42.2%	42.7%
	Fair	54.2%	54.2%	51.8%	53.8%	51.3%
	Poor	4.2%	4.2%	6.6%	4.0%	6.0%

5.2 Minimum Threshold

Per 23 CFR part 490 subpart D, State DOTs are required to maintain a minimum condition level of NHS bridges. FHWA's Office of Bridges and Structures will determine annually if a State DOT meets the minimum threshold based on NBI data by July 1st of each year and notify the State DOT of its compliance by October 1st of the year. FHWA will make the 2018 annual determination whether States meet this threshold requirement by October 1 based on 2016, 2017, and 2018 NBI data submissions. Per 23 CFR 490.411 and 490.413, if for three consecutive years more than 10.0% of a State DOT's NHS bridges' total deck area is classified as Structurally Deficient, the State incurs a penalty the following fiscal year. If a State does not meet the minimum condition requirements in 23 CFR 490.411, an amount equal to 50 percent of the State's FY 2009 Highway Bridge Program apportionment will be set aside from the State's NHPP annual apportionment and obligated the same fiscal year the penalty is incurred for eligible projects. The obligation and set aside requirement is only for eligible projects on bridges on the NHS as described in 12 U.S.C. 144.

When setting its percent poor targets for NHS bridges, SCDOT will strive to ensure it meets the minimum condition rating as outlined in federal law.

5.3. MPO Condition Data

Within 180 days after the State DOT's target is established, MPOs can decide to adopt and support the State DOT's 4-year target or establish their own, quantifiable targets. For the first target setting process, SCDOT recommended to MPOs to adopt and support the State's 4-year target. Table 5.4 shows 2017 condition data by MPO using the federal metric.

Table 5.4. MPO 2017 NHS Bridge Condition Data

MPO	Bridge Counts	Deck Area (ft^2)	Condition	By Count	By Deck Area
ANATS	27	305,287	Good	22.2%	22.4%
			Poor	3.7%	1.3%
ARTS	43	601,494	Good	46.5%	63.8%
			Poor	14.0%	10.3%
CHATS	134	10,988,198	Good	18.7%	18.6%
			Poor	1.5%	1.2%
COATS	172	4,005,135	Good	67.4%	68.8%
			Poor	9.3%	7.2%
FLATS	58	730,346	Good	48.3%	28.4%
			Poor	0.0%	0.0%
GPATS	148	2,295,414	Good	62.8%	60.7%
			Poor	4.1%	3.6%
GSATS	91	2,977,532	Good	90.1%	79.4%
			Poor	0.0%	0.0%
LATS	45	2,073,757	Good	13.3%	2.4%
			Poor	8.9%	4.9%
RFATS	33	669,062	Good	15.2%	23.0%
			Poor	6.1%	1.3%
SPATS	91	1,132,331	Good	54.9%	65.1%
			Poor	7.7%	7.2%
SUATS	15	193,605	Good	53.3%	67.9%
			Poor	13.3%	10.7%

6. Recommendations

Based on the criteria and methodology outlined above, the Working Group met on April 18, 2018, and recommended the following NHS condition targets:

NHS Bridge Target	By Deck Area	
	%Good	%Poor
2-year	42.2%	4.0%
4-year	42.7%	6.0%

Table 6.1. NHS Bridge condition target recommendations

The chosen targets are based on the projected conditions using Markovian process in Option 2 for the respective structure type and assumptions that planned construction projects will be finished and inspected within the first performance period as outlined in the methodology above. The 4-year percent poor target for NHS bridges meets the FHWA's 10.0% maximum threshold requirement. The Working Group also recommended that MPOs adopt and support the statewide 4-year NHS bridge condition target.

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APPENDIX G: PAVEMENTS PERFORMANCE MEASURE TARGET SETTING METHODOLOGY

SCDOT PERFORMANCE MEASURES AND TARGET SETTING - PAVEMENT

1. Federal Requirements

The Federal Highway Administration (FHWA) published in the Federal Register (82 FR 5886) a final rule establishing performance measures for State Highway Agencies (SHA)s to use in managing pavement and bridge performance on the National Highway System (NHS). The NHS is the Interstate Highway System plus additional roads important to the nation's economy, defense, and mobility. The National Performance Management Measures: Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program Final Rule addresses requirements established by the Moving Ahead for Progress in the 21st Century (MAP-21) Act and reflects passage of the Fixing America's Surface Transportation (FAST) Act. The rule is effective May 20, 2017. SHAs are required to:

- Set targets for the full extent of the interstate and non-interstate NHS, regardless of ownership.
- Establish statewide 2- and 4-year targets for the non-interstate NHS and 4-year targets for the interstate by May 20, 2018, and report by October 1, 2018.
- Adjust targets at the Mid Performance Period Progress Report if necessary (October 1, 2020).

Metropolitan Planning Organizations (MPOs) are required to support the relevant SHA's 4-year target or establish their own quantifiable target within 180 days after the SHA's target is established.

Pavement performance measures are detailed in 23 CFR Part 490 Subpart C: Measures for Assessing Pavement Condition. The regulation also establishes minimum condition requirements for interstate pavements.

Performance Measures	Penalties
• Percentage of pavements of the Interstate System in Good condition • Percentage of pavements of the Interstate System in Poor condition • Percentage of pavements of the non-Interstate NHS in Good condition	If 5% of interstate pavements are in poor condition then the agency must obligate NHPP funds on interstate pavement.

- Percentage of pavements of the non-Interstate NHS in Poor condition

23 CFR Part 490.311 defines the metric thresholds for each 0.1-mile pavement segment, as well as the pavement measures calculation (as shown in Table 1.1 and Table 1.2).

	Table 1.1 - Pavement Condition Thresholds [23 CFR 490.313]		
	Good	Fair	Poor
IRI (in./mile)	<95	[95, 170]	>170
Cracking Percent (%)	<5	CRCP: [5, 10]	>10
		JPCP: [5, 15]	>15
		ASPHALT: [5, 20]	>20
Rutting (in.)	<0.20	[0.20, 0.40]	>0.40
Faulting (in.)	<0.10	[0.10, 0.15]	>0.15

Table 1.2 - Pavement Measures Calculation [23 CFR 490.313]

For each 0.1-1ane mile segment:	Pavement Type			Measure
	Asphalt and JPCP	CRCP		
Overall Section Condition Rating	3 Metric Ratings (IRI, Cracking, and Rutting/Faulting)	2 Metric Ratings (IRI, Cracking,)		
Good	All 3 metrics rated "Good"	Both metrics rated "Good"	→	Percentage of lane-miles in "Good" Condition
Poor	≥ 2 metrics rated "Poor"	Both metrics rated "Poor"	→	Percentage of lane-miles in "Poor" Condition
Fair	All other combinations	All other combinations		

Based on pavement condition and inventory data, which include facility type, through lanes, functional system, surface type, structure type, and urban code, the percentage of pavements in good and poor conditions are calculated as:

$$\% \text{ Pavements in Good condition} = 100 \times \frac{\sum_{g=1}^{Good}\{(End\_Point - Begin\_point) \times Though\_lanes\}_{section\ g}}{\sum_{g=1}^{Total}\{(End\_Point - Begin\_point) \times Though\_lanes\}_{section\ t}}$$

$$\% \text{ Pavements in Poor condition} = 100 \times \frac{\sum_{g=1}^{Poor}\{(End\_Point - Begin\_point) \times Though\_lanes\}_{section\ p}}{\sum_{g=1}^{Total}\{(End\_Point - Begin\_point) \times Though\_lanes\}_{section\ t}}$$

2. SCDOT Pavement Inventory

Figure 1.1 shows the centerline miles and lane-miles maintained by SCDOT. Figure 1.2 shows the NHS routes in South Carolina. The agency has developed its 10-year targets based on its Pavement Quality Index (PQI) prior to the promulgation of the federal metrics. Under MAP-21, about 8.7% of centerline miles and 14.5% of lane-miles are subject to the target setting requirements based on federal metrics.

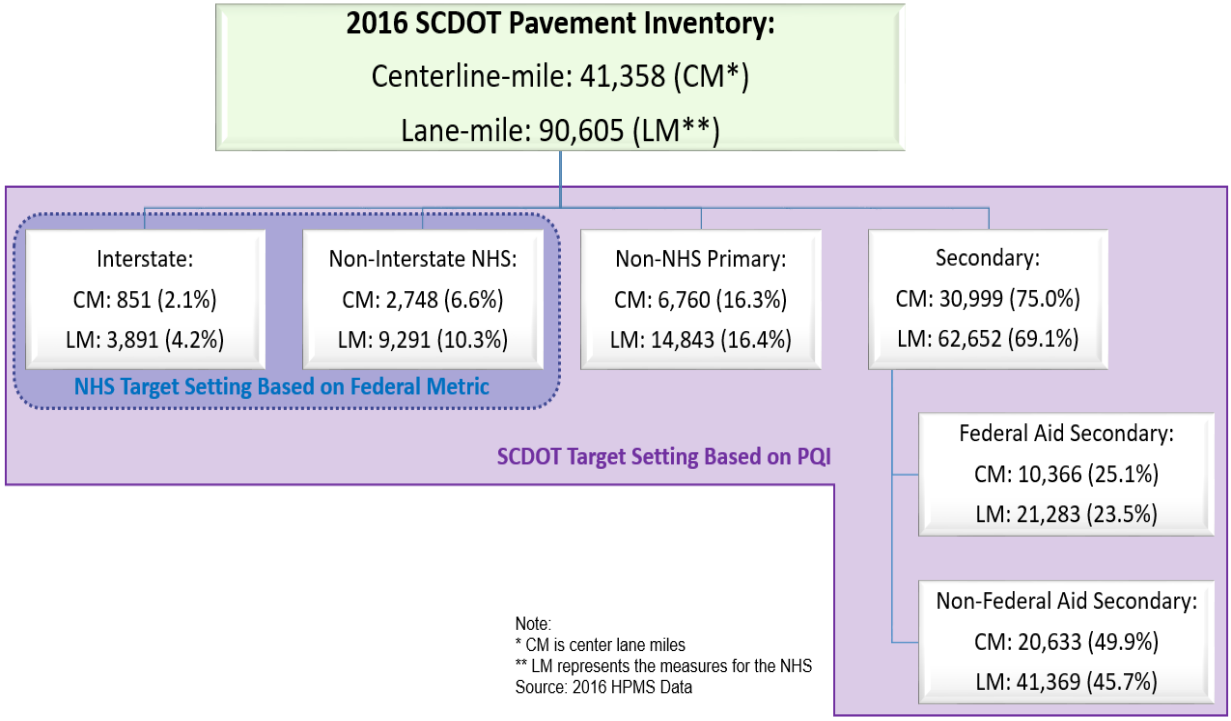

Figure 1.1. 2016 SCDOT Pavement Inventory

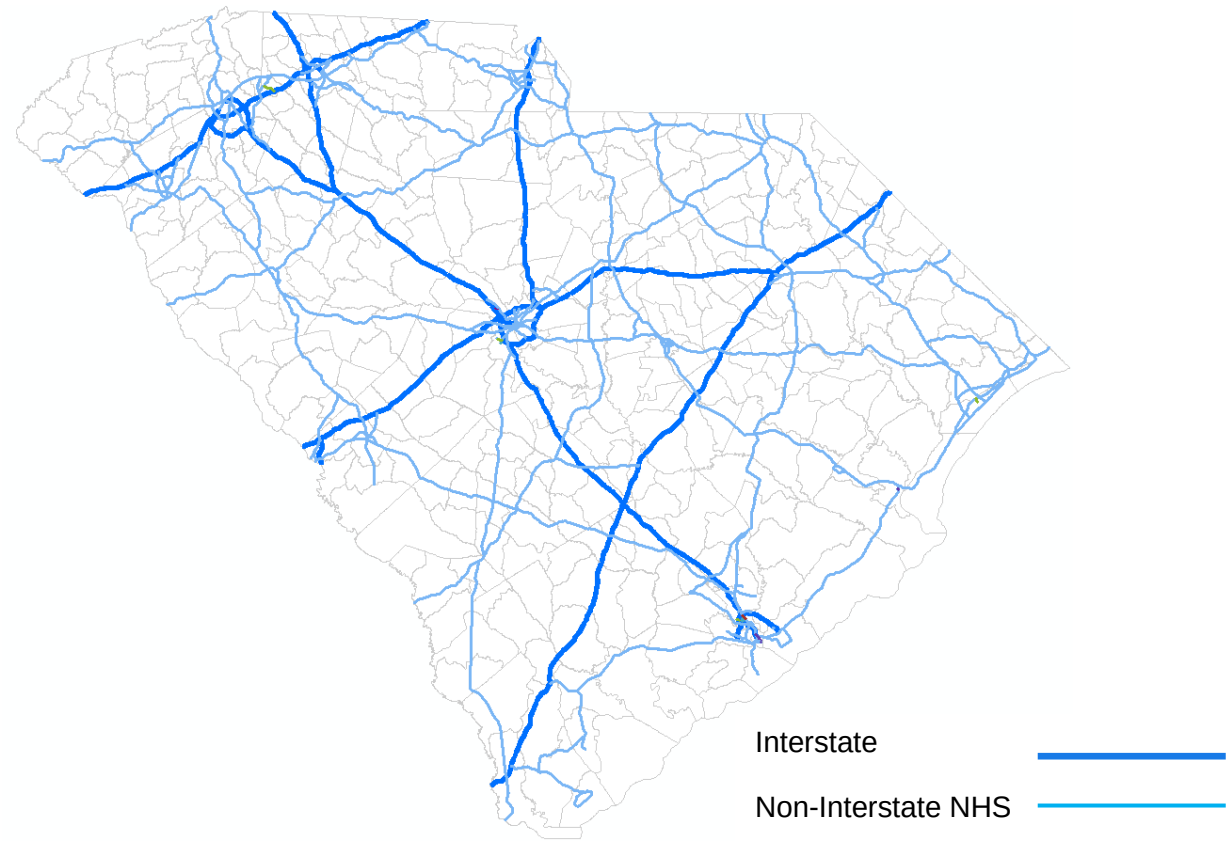

Figure 1.2. South Carolina National Highway System

3. Gaps and Challenges

3.1. PQI vs. Federal Metrics

Since its inception in 1978, FHWA's Highway Performance Monitoring System (HPMS) has evolved into a robust national repository of data on the extent, condition, performance, use, and operating characteristics of the nation's highways. States report a variety of pavement condition statistics to HPMS each year for roads on the NHS, including, but not limited to, International Roughness Index (IRI) information, cracking, rutting and faulting data. Prior to MAP-21, each State decided its own index on pavement quality measurement.

SCDOT started collecting pavement condition data in 2000. In the early 2000s, SCDOT began measuring its pavement condition using PQI, which is a unique pavement index developed for SCDOT.

PQI is calculated based on Pavement Serviceability Index (PSI) and Pavement Distress Index (PDI) into an overall index (Equation 1). PSI is used to represent roughness in the SCDOT HPMA Index models. PDI is used to convert distress measurements into a composite distress index. PDI is customized for SCDOT based on a modified version of the PCI Method (ASTM D 6433 Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys).

$$PQI = PDI^{0.76} \times PSI^{0.20} \quad (1)$$

Where:

$PSI = 5e^{-0.004(IRI)}$

PDI = 5 – ADV

IRI: International Roughness Index in inches/mile

Adjusted Deduct Value: $ADV = 10(0.0014 - 0.3958 \log10(NED) + 0.9565 \log10(TDV))$

Number of Equivalent Distresses (NED) is calculated by putting the sum of the deduct values (TDV) over DVmax.

Equivalent Distress: $ED = DVi / DVmax$

Deduct value: $DV = 10(a + b \log10(PDA))$

PDA: percent distressed area (extent value)

a and b: model coefficients

Both PQI and federal metrics are indices intended for evaluating pavement surface characteristics. SCDOT has traditionally used PQI to evaluate pavement surface conditions and as part of the pavement preservation/rehabilitation project programming selection criteria.

SCDOT chooses pavement preservation candidates based on the PQI of the roadway section. Once PQI is calculated, a candidate list of potential pavement preservation projects is developed. The type of treatment selected depends on several factors, including traffic condition, cost and location.

A set of trigger values used for selecting pavement preservation projects for each route system in South Carolina are as follows:

- US and SC Routes: PQI greater than or equal to 3.2 but less than 4.0
- Federal-aid Secondary Routes: PQI greater than or equal to 3.2 but less than 4.0
- Secondary Routes: PQI greater than or equal to 3.0

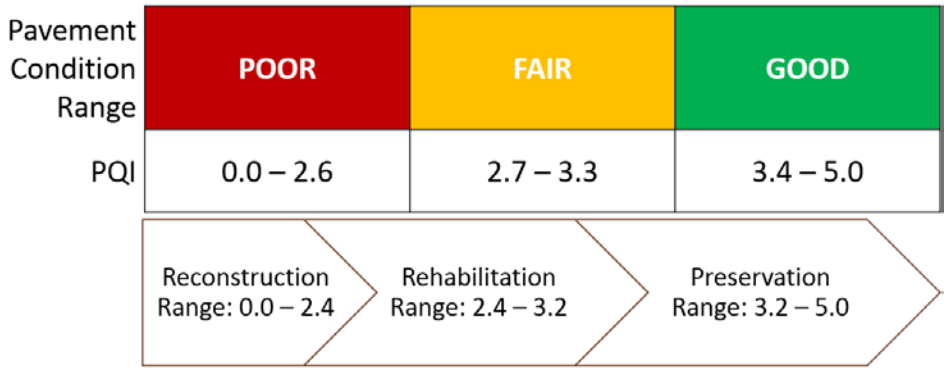

Figure 3.1. PQI Ranges and Trigger Values.

The national pavement condition measure requirements pose some challenges for the Department's data collection capabilities that require additional investment to meet the Federal requirements in terms of both data collection cycle and methods. Prior to 2018, only IRI data were collected biennially on non-interstate pavements, all other data were collected triennially. In addition, the Department did not process rutting, cracking and faulting in the same manner as identified in the federal rulemaking. Currently, the only metric identified in the Federal rules that the Department collects in a manner consistent with FHWA's definitions is IRI. The gaps in data collected and familiarity with new cracking, rutting, and faulting analysis approaches will need to be overcome in order to meet the federal requirements.

Differences between data collection required by 23 CFR 490.111 and SCDOT collection methods are shown in Table 3.1. Starting January 2018, SCDOT fully adopted all 23 CFR 490.111 data collection requirements for data collection on NHS routes.

Table 3.1 – Data Collection Method Differences

	Data Collection Method	
	23 CFR 490.111 Requirements	SCDOT Collection Prior to 2017
Equipment	AASHTO Standard M328-14	AASHTO Standard M328-14
IRI (in./mile)	AASHTO Standard R43-13 AASHTO Standard R57-14	AASHTO Standard R43-13 AASHTO Standard R57-14
Cracking Percent (%)	AASHTO Standard R 55-10 AASHTO Standard R67-10 AASHTO Standard PP 68-10	Visual observation
Rutting (in.)	AASHTO Standard R48-10 AASHTO Standard PP 69-10 AASHTO Standard PP 70-10	Used 3-sensors rather than 5-sensors
Faulting (in.)	AASHTO Standard R36-13	Visual observation

3.2. Data Consistency

Based on conversations with Road Data Service staff, equipment and data collection technology were changed several times over the past 18 years. This has led to some inconsistencies in the data that make it very difficult to accurately model the changes that have occurred in rutting and rideability during the periods of these procedural changes. For example, Figure 3.2 shows the asphalt pavement performance measure based on rutting on interstate routes. It can be observed that there are data shifts for the data collection years of 2004, 2011, and 2014. Road Data Services staff confirmed that there were equipment changes for those years.

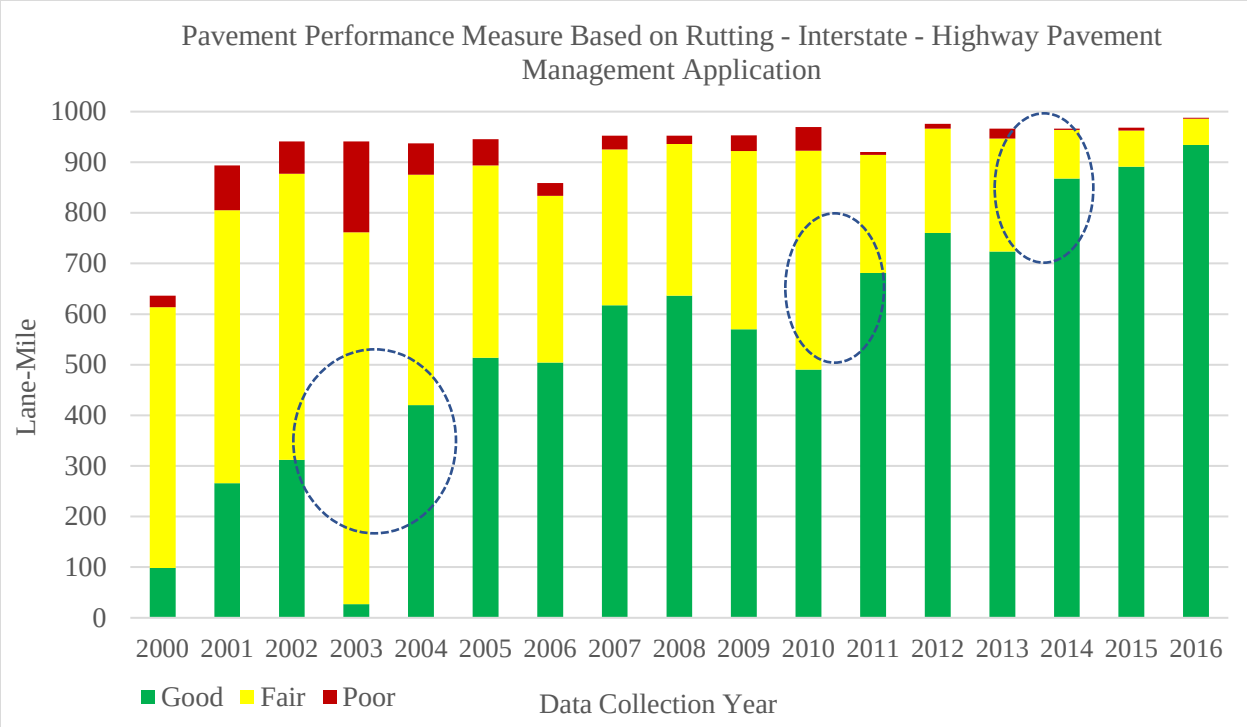

Figure 3.2. Pavement Performance Measure Based on Rutting - Interstate – Hot Mixed Asphalt Pavement

3.3. Target Setting

The National Highway Performance Program Final Rule requires DOTs to set statewide 2- and 4-year targets based on the national performance measures for the non-Interstate NHS and 4-year targets for the interstate by May 20, 2018, and subsequently report the targets to FHWA by October 1, 2018.

Ideally, the target setting process for pavement would be based on analyzing historical IRI, cracking, rutting/faulting data, pavement structure data, pavement preservation/rehabilitation history, traffic condition, historical construction costs, and potential funding. The process would provide the optimal preservation/rehabilitation choices and achievable targets within a defined period. However, the Department currently has the following gaps:

- Data collection issues as discussed in sections 3.1 and 3.2
- Lack of pavement structure data in a searchable format
- Lack of pavement preservation/rehabilitation history in a searchable format

SCDOT has committed to address the gaps identified above by seeking to establish an agency-wide enterprise database. However, it will take considerable resources and time to have sufficient data for a performance- and risk-based target setting analysis.

4. Target Setting Process

Due to environmental conditions and traffic loading, pavements deteriorate with age. Well-designed, constructed, and maintained roadways are a vital component of any transportation system. One of the main goals of performance-based planning is to apply the right preservation/rehabilitation method to the right pavement at the right time. Proper preventive maintenance treatments are a cost-effective means of obtaining the maximum life and performance from the pavement. Treatments applied too soon add little benefit and treatments applied too late are ineffective, failing to prolong the life of the pavement. The potential savings from following a cost-effective approach to meeting performance objectives for pavements could be significant.

The target setting process started with a kick-off meeting on January 4, 2018, with participants from Planning, Road Data Services, and Maintenance. The meeting discussed data collection cycles on different road systems, as well as a comparison of the current SCDOT pavement rating index (PQI) vs. federal metrics. Office of Planning staff were tasked to develop the bridge performance targets as required by 23 CFR Part 490.

The process includes the following steps:

- Query available data and data sources from the Road Data Services, Construction, Program Control, and Maintenance offices.
- Data review
- Data analysis
- Review data analysis results with working group members
- Make necessary modifications
- Combine data analysis results and set preliminary targets

4.1. Data Source

To set performance targets, the following data sources are utilized:

- HPMA: Highway Pavement Management Application – Managed by Road Data Services
- RIMS: Road Inventory Management System – Managed by Road Data Services
- P2S: Project Programming System – Managed by Program Controls
- SiteManager – Managed by Director of Construction Office
- Statewide Transportation Improvement Program – Managed by Planning
- SCDOT Rideability Quality Acceptance database – Managed by Office of Material and Research
- Spreadsheets kept for potential project programming from Director of Maintenance Office and Office of Material and Research

4.2 Data Analysis

After reviewing data from various data sources, the following analyses were performed:

- Number of total sections

  As required by 23 CFR 490.313 - Calculation of performance management measures, the total number of sections are defined as "*…total number of mainline highway Interstate System sections excluding bridges, unpaved surface and "other" surface types, and missing data sections, described in paragraph (f)(1) and (b)(4)(i) of this section…*"

  Based on information provided by the Pavement Management Engineer, data were collected on both directions for divided highways and one direction for un-divided highways. Bridges were not marked during the data collection. For 2016, a total of 4,901 miles of data were collected on NHS routes, which is approximately 91% coverage.

Table 4.1. Mileage of Divided and Undivided NHS

System	Divided (miles)	Undivided (miles)
Interstate	850.59	
Non-interstate NHS	938.17	1,813.44
Total = (850.59 + 938.17)*2 + 1,813.44 = 5,390.96 miles		

To remove bridges from the roadway condition data, bridge location data were obtained from RIMS. Bridge middle mile points were located to adjacent roadway section mile points. Out of the 1,745 NHS bridges, 448 bridges did not find matching adjacent sections. Bridge lengths were subtracted from sections where bridges were located. Pavement condition data were applied to the <0.1-mile sections adjacent to bridges as shown in Figure 4.1.

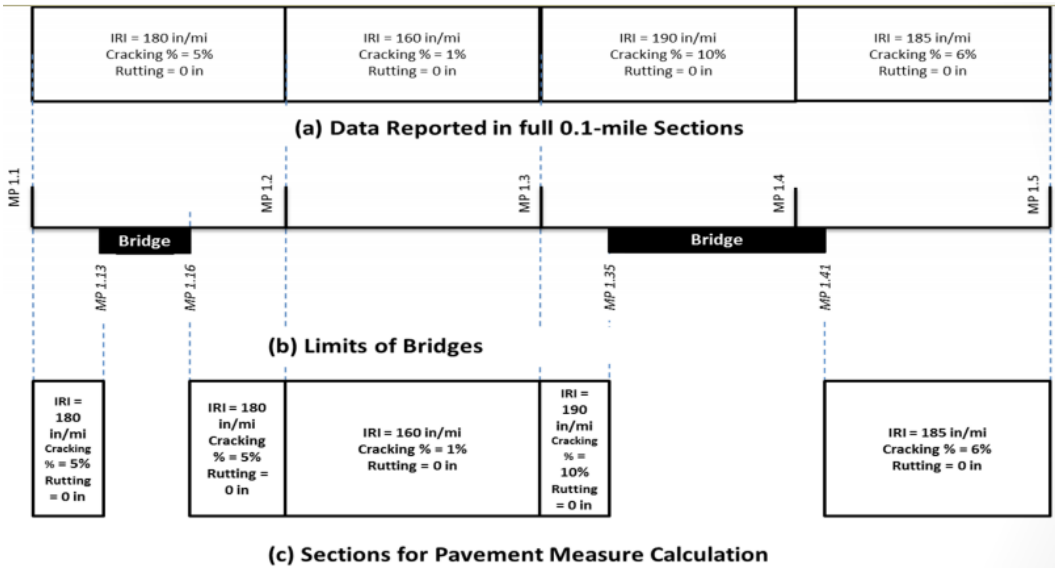

Figure 4.1 – Illustration of Bridge Exclusion on 0.1-Mile Pavement Sections

- Pavement deterioration rate

The Department currently has a deterioration model based on PQI. However, to set targets based on national performance measures outlined in 23 CFR Part 490 Subpart C, the agency needs to develop a deterioration model to project changes of the four pavement condition indices required in the federal regulations. With the gap and challenges discussed in Section 3, it will take considerable resources, time, and commitment to have enough data to establish a conforming model.

To estimate potential IRI, cracking, rutting, and faulting changes in 2- and 4-years, existing pavement condition data collected between the year of 2000 and 2016 were analyzed. For each index, the following steps were taken:

- Reviewed the percentage of good, fair, poor for each data collection year
- Estimated yearly change rate for each index. To estimate the changing rate:
  - Each index collected between 2000 and 2016 for each 0.1-mile segment was examined.
  - Assumed that each segment had no more than one rehabilitation or reconstruction between 2000 and 2016.
  - Recorded initial index value and collection year (could be year 2000 or later), then found the next index value and collection year for the same 0.1-mile segment that either had a significant change from the next collected value, had a phase change, or reached the last collection year for the segment. A phase is defined based on the good, fair, and poor condition ranges outlined in 23 CFR Part 490 Subpart C. It is assumed that if significant changes occurred, these changes are due to rehabilitation or reconstruction, which may result in a significant improvement in score. If the collection year of the second index is

less than 2016, then a second set of data were identified. After the data sets were identified, annual average rates of increase were calculated as:

$$\text{Annual Average Rate of Increase} = \frac{\text{Value2} - \text{Value1}}{\text{Year2} - \text{Year1}}$$

Where:
$Value_1$ is the index value collected at the beginning of a period
$Year_1$ is the collection year for $Value_1$
$Value_2$ is the index value collected at the end of a period
$Year_2$ is the collection year for $Value_2$

For rutting data, due to the data inconsistency noted in section 3.2, the annual average rates of increase were calculated for three time periods: 2004-2010, 2011-2013, and 2014-2016.

For cracking data, Appendix Figure C.4 shows the distribution of cracking data on interstate CRCP sections. The data showed all CRCP sections had 99% cracking during the last 12 years. Further inspection on interstate CRCP cracking data are needed. As a result, cracking data on CRCP sections will not be used.

For faulting data, Appendix Figure D.2 shows the distribution of faulting data on non-interstate NHS JPCP sections. The data showed nearly none of the non-interstate NHS JPCP sections had any faulting. As a result, faulting data on non-interstate NHS JPCP sections will not be used.

Visual Basic code was developed for data processing. Annual average rates of increase were calculated for each 0.1-mile segment and for IRI, rutting, estimated cracking, and estimated faulting. Negative rates were not included in further data analysis assuming that:

- ✓ Pavement generally deteriorates under traffic load and environment effects, resulting in poorer condition over time.
- ✓ Pavement sections may have had a preservation/rehabilitation/ reconstruction during the period; however, the change in value was not significant. For example, a pavement segment with IRI value of 80in./mile had an overlay project that improved the IRI values to 70in./mile. Without actual project data, it would be impossible to tell if the 10in./mile difference in IRI was due to error or construction improvement. However, the selection of construction projects was more than likely based on much more than just one pavement condition index. A pavement preservation/rehabilitation/reconstruction project often improves many

other pavement condition indices and extends pavement life that may not be directly reflected in the pavement condition indices.
  - ✓ There may be data errors that were either system, random, or human error.
- Generated box plots showing the distribution of averaged index rates of change with:
  - ✓ Different initial index values
  - ✓ Different route systems (i.e., interstate and non-interstate NHS)
  - ✓ Different pavement types (i.e. Hot Mix Asphalts (HMA), Bituminous over Concrete (BOC), JPCP, CRCP)

  Appendix A-D shows the summarized data and box plots.

- Calculated the mean, median, and 75th percentile values of the annual average rate of increase for each pavement type and each route system.
- Calculated an estimate of the deteriorated index value for each year from 2017 to 2020 based on the previous year's index value and the mean, median, and 75th percentile annual average rates of increase. Visual Basic codes were developed for data processing.
- Calculated pavement condition (i.e. good, fair, and poor) based on the calculated index values from the step above.

➢ Identify upcoming construction projects that might reach completion within the next 2 and 4 years.

Active roadway construction projects and their expected completion dates are extracted from SiteManager. Upcoming construction projects that are expected to be completed within the 2- and 4-year time frame are provided by Office of Materials and Research and Director of Maintenance office. Since these construction projects have not been completed, it is necessary to estimate how much improvement these construction projects will have. Staff also queried the Statewide Transportation Improvement Program for widening and rehabilitation projects on the non-Interstate NHS with expected construction completion within the 2- and 4-year target period.

o Rideability

SCDOT currently has two supplemental technical specifications, SC-M-403 (Rideability for Asphalt Mixtures) and SC-M-502 (PCC Pavement Rideability). SC-M-403 applies to sections with a minimum 45 mph speed limit and with more than 0.5 mile of pavement without interruptions or exclusions (such as, but not limited to, bridges, stop signs, railroad crossings, speed limit below 45 mph, signalized intersections, or sharp curves posted for less than 35 mph.). SC-M-403 and SC-M-502 require IRI to be collected on 0.1 lane-mile segments. Based on RIMS data, approximately 16.4% of non-interstate NHS routes have speed limits less than 45 mph. Based on SiteManager and P2S data, since 2014, there were 26 contracts with mill/fill or reconstruction on 33 NHS routes that has section lengths less than 0.5-mile. Additional analyses will be needed to identify the

percentage of rehabilitation/reconstruction routes that were subjected to the rideablitiy specifications.

Depending on the initial rideability of a pavement, the IRI after an overlay is completed may not be less than 95 and therefore not result in a rating of “good” based on the IRI ranges defined in 23 CFR 490.313. For example, under SC-M-403, contractors may still receive 100% of the contracted amount even if the IRI results in a “fair” or “poor” determination if the initial IRI was sufficiently high. Hypothetically, if all asphalt pavement segments on non-interstate NHS received overlays with application rates of 150psy or greater were to achieve an upper limit of 100% pay band defined in SC-M-403 within a short period of time, then the % of good NHS pavements would be about 70% and % of poor would be 0% based on IRI ranges defined in 23 CFR 490.313. If all asphalt pavement segments on non-interstate NHS received overlays with application rates of 150psy or less to achieve an upper limit of 100% pay band defined in SC-M-403 within a short period of time, then the % of good NHS pavements would be about the same as before the treatments and % of poor would be about 6% based on IRI ranges defined in 23 CFR 490.313.

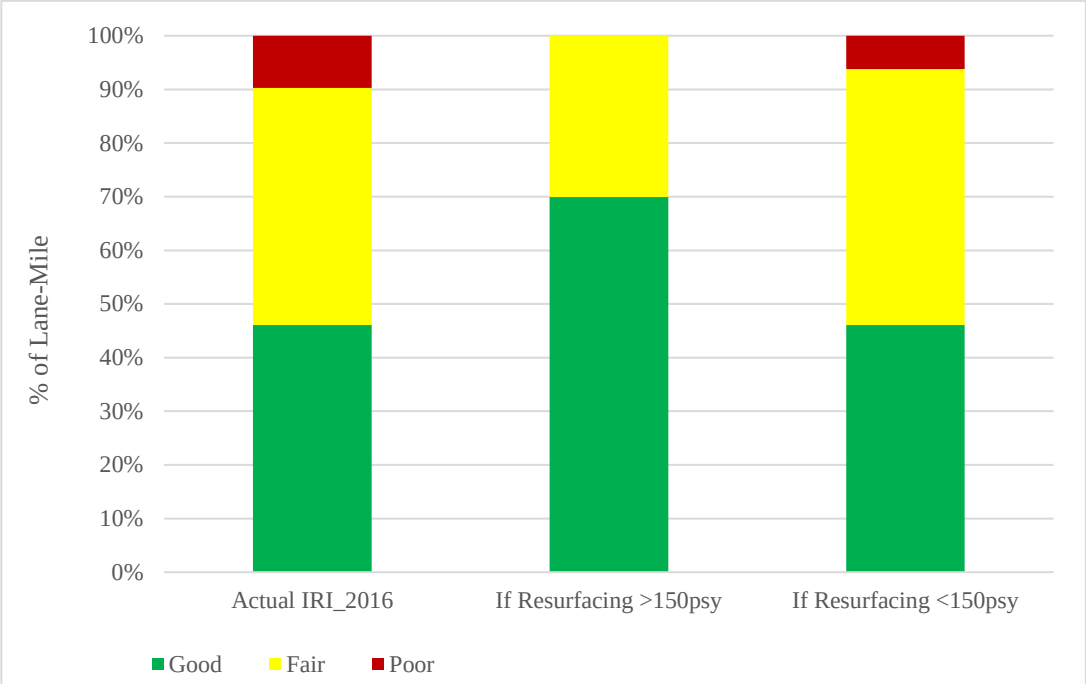

Figure 4.2. Hypothetical 100% Pay IRI Values on Non-Interstate NHS – HMAS

The Office of Material of Research (OMR) collects rideability data for construction projects for QA/QC purposes. OMR’s Rideability Quality Acceptance database contains data from 2009 with more than 14,000 miles of data. Figure 4.3 shows the final IRI values from new construction/rehabilitation/preservation construction projects on interstate

routes. Out of 1,920.9 lane-miles of data, 46.6 lane-miles (2.4%) falls in the fair category and 2.4 lane-miles falls in the poor category based on IRI ranges defined in 23 CFR 490.313. Figure 4.3 shows the distribution of the final IRI values from interstate HMAS pavement construction projects.

As discussed previously, only some of the construction segments are subjected to SC-M-403. Figure 4.4 shows the distribution of final IRI data from 3,978 lane-miles of primary routes (SC and US). Overall, 3,764 lane-miles (94.6%) falls in the good category and 24 lane-miles (0.1%) in the poor category based on IRI ranges defined in 23 CFR 490.313. The figure also shows the distribution of the final IRI values from pavement construction projects on primary routes.

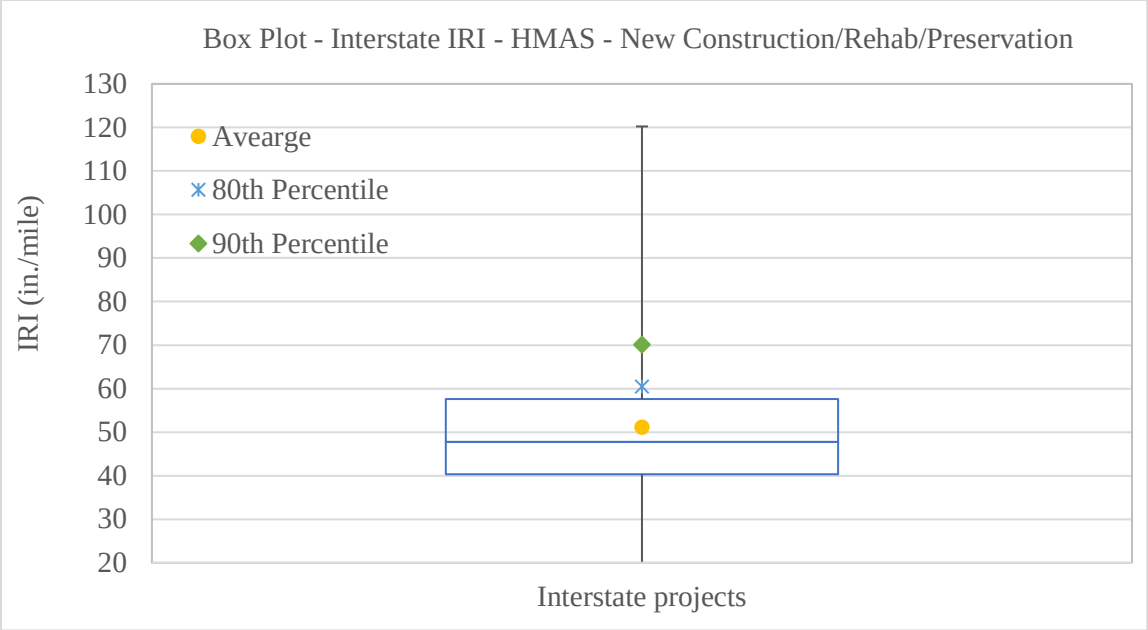

Figure 4.3. Final IRI Values on Interstate New Construction/Rehabilitation/Preservation Projects

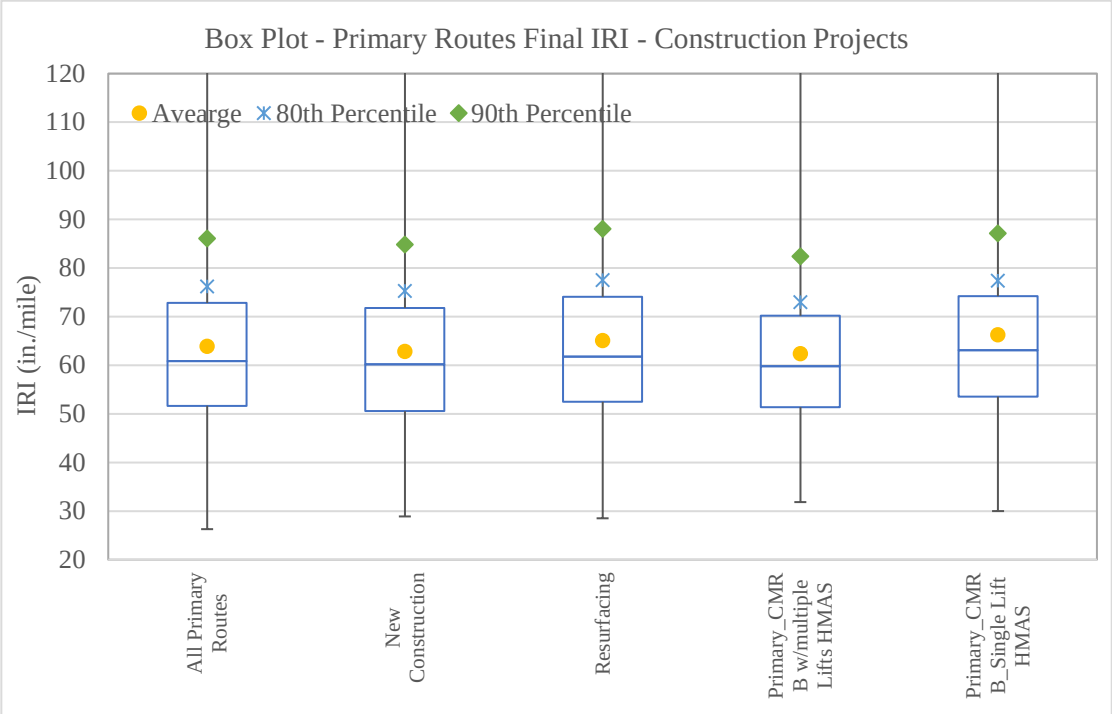

Figure 4.4. Final IRI Values on US- and SC-Routes

- Cracking

Almost all preservation/rehabilitation methods will improve percentage of cracking by some extent depending on the causes of cracking and the treatment method. Some of the typical causes of pavement cracking include: traffic loading; environment or climate influences; drainage deficiencies; materials quality problems; construction deficiencies; and external contributors, such as utility cuts. In general, it is expected that if proper treatment methods are prescribed at the right time, the pavement should remain in good to fair condition for an expected duration. The agency currently does not have enough historical pavement cracking data for further analyses.

- Rutting

Rutting is permanent deformation that could occur in one or more layers in a pavement structure due to: insufficient pavement structure, pavement material (e.g. mix design, angular aggregate), increasing traffic load, construction quality (e.g. compaction), and environmental conditions. To improve rutting, reasons for rutting need to be investigated so that proper methods may be prescribed. For example, wear rutting likely could be fixed with leveling and overlay because wear rutting generally occurs in the surface layer due to loss of aggregate particles. On the other hand, structural rutting typically needs to be corrected with reconstruction or heavy rehabilitation methods.

- Faulting

Faulting is a vertical displacement at the transverse joints creating an elevation difference in the adjacent concrete pavement slabs. Faulting is a concern because it results in incomplete and non-uniform slab support while creating an unpleasant ride. More importantly, it indicates a potential for future slab breakup at those joints. Typical treatment strategies for faulting include dowel bar retrofitting, full depth patching, diamond grinding, or reconstruction.

Table 4.2 shows typical pavement preservation/rehabilitation/reconstruction project types and potential improvement for IRI, cracking, rutting, and faulting based on historical data and subject matter experts' opinions.

Table 4.2. Potential Improvements

Project Type		Potential Results			
		IRI	Cracking	Rutting	Faulting
Interstate	HMAS: Reconstruction	Good	Good	Good	N/A
	JPCP: Reconstruction	Good	Good	N/A	Good
	HMAS: Mill/Fill	Good	Good	Good	N/A
	JPCP/CRCP: patching/diamond grinding	Good	Good	N/A	Good
NHS: HMAS	FD replacement	Good	Good	Good	N/A
	CMRB	Good/Fair	Good	Good	N/A
	Mill/Fill	Good/Fair	Good	Good	N/A
	Single lift overlay	Good/Fair	Good	Good	N/A
	Thin overlay	Good/Fair /Poor	Good/Fair	Good/Fair /Poor	N/A
	PMST	Good/Fair /Poor	Good/Fair	Good/Fair /Poor	N/A
	MicroSurfacing	No improvement	Some improvement	Some improvement	N/A
	Chip Seal	No improvement	Some improvement	No improvement	N/A
	Crack sealing	No improvement	Some improvement	No improvement	N/A
	FDP	No improvement or Worsen	Some improvement	Some improvement	N/A

- Estimate construction costs for non-interstate NHS routes since these construction projects have not been programmed in.
-

5. Target

5.1. Interstate

For the 1st performance period (1/1/2018 – 12/31/2021), a 4-year target is required for interstate pavement. Annual data collection is required on interstate pavements with a submission date of April 15. As a result, interstate pavement projects with potential completion dates of 12/31/2020 need to be factored in for the 1st 4-year target, assuming 2022 data submission will be from the 2021 data collection. Existing and planned interstate rehabilitation and reconstruction project information was extracted from P2S and Site Manager. Project scopes were compared to a tracking spreadsheet provided by the State Pavement Design Engineer, contracts, and plans to determine if a project would impact interstate pavement conditions. Based on historical data shown in Section 3.2 and subject matter experts' opinion, these interstate projects are expected to result in pavement in "good" status based on federal metrics after project completion. As shown in Table 5.1, a total of 23 projects that include 533 direction miles have completion dates after 12/31/2016. Visual Basic code was developed to match project data with pavement condition data. There is 0.92 direction miles that did not match corresponding segments in 2016 pavement data collection.

Table 5.1. Active and planned interstate pavement construction projects

Contract	I- 126	I- 20	I- 26	I- 385	I- 585	I- 77	I- 85	I- 95	Total
0205520		9.1							9.1
0205560		18.25							18.25
0405581							17.6		17.6
0408110							12.6		12.6
1412170								44.46	44.46
1784151								10	10
1805441			19.82					32.08	51.9
2384931				10.94					10.94
2705430								28.6	28.6
2712130								5.04	5.04
3012551				16.04					16.04
3184000		30.4							30.4
3205220		12.4							12.4
4205380			12.8		0.98				13.78
4208281							16		16
4210780			42.6						42.6
4283421							22.6		22.6
5105691	7.36		11.67						19.03
5106020						27.02			27.02
8805531								29.68	29.68
8808761						11.17		12.87	24.04
8812250		28.76							28.76
8812280		7.58				34.67			42.25
Total	7.36	106.49	86.89	26.98	0.98	72.86	68.8	162.73	**533.09**

Excluding bridge sections, a total of 1,065 interstate lane miles that were/will be under construction were matched with corresponding segments in the 2016 pavement condition data collection. Estimated 2016 pavement conditions based on federal metrics for these 1,065 lane miles are shown in Table 5.2.

Table 5.2. Estimated 2016 Pavement Condition for Construction Projects

Estimated 2016 Pavement Condition Based on Federal metrics	Construction Projects with completion dates after 12/31/2016 and before 12/31/2019	
	Lane-Miles	Percentage
Good	482.50	45.3%
Fair	550.96	51.7%
Poor	32.40	3.0%

Average, median, and 75th percentile pavement deterioration rates that were developed in Section 4.2 were applied to respective pavement types of interstate 0.1-mile segments. Table 5.3 and Figure 5.1 show potential pavement status with no improvement as well as with construction projects.

Table 5.3. Projected Interstate Pavement Condition Based on Federal Metrics

Deterioration Rates		2016	2017	2018	2019	2020	2021	2021 w/Improvements
Average	Good	61.4%	56.5%	52.5%	47.3%	4.6%	0.0%	30.6%
	Fair	36.9%	40.4%	43.2%	47.5%	87.8%	89.2%	63.8%
	Poor	1.7%	3.1%	4.2%	5.3%	7.6%	10.8%	5.6%
Median	Good	61.4%	58.0%	55.1%	53.2%	51.4%	49.2%	71.0%
	Fair	36.9%	38.8%	40.7%	42.0%	43.6%	45.4%	25.9%
	Poor	1.7%	3.1%	4.2%	4.8%	5.0%	5.4%	3.0%
75th percentile	Good	61.4%	54.1%	46.7%	4.8%	0.0%	0.0%	30.5%
	Fair	36.9%	42.3%	48.0%	88.4%	87.8%	74.5%	55.6%
	Poor	1.7%	3.6%	5.3%	6.8%	12.2%	25.5%	13.9%

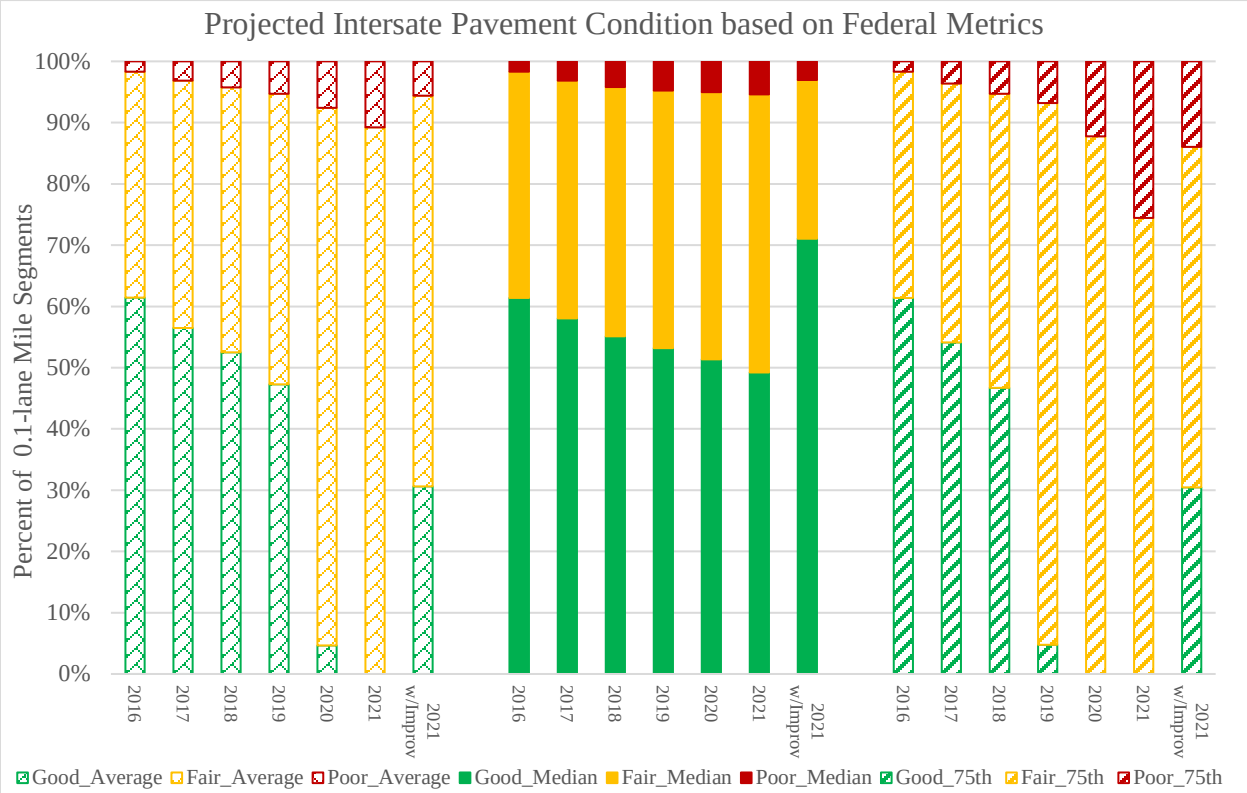

Figure 5.1. Projected Interstate Pavement Condition Based on Federal Metrics

5.2. Non-Interstate NHS

For the 1st performance period (1/1/2018 – 12/31/2021), 2- and 4-year targets are required for non-interstate NHS pavements. Biennial data collection is required with a submission date of Jun. 15 beginning in 2021. As a result, non-interstate pavement projects with potential completion dates between 12/31/2016 and 6/30/2019 need to be included for the 1st 2-year target, assuming the 2021 data submission will include data collected from mid-2019 through 2020. Projects with potential completion dates between 12/31/2016 and 12/31/2020 need to be factored into the 1st 4-year target, assuming the 2023 data submission will include data collected from 2021 through 2022.

Typical construction project types on non-interstate NHS pavement are shown in Table 5.4. Based on subject matter experts' opinion, preservation treatment types should be applied to pavement in "good" conditions in theory and would not have significant changes in pavement conditions in the short-term (2- to 4-years). As a result, preservation projects are not factored in the target setting for the 1st performance period. It is expected that these projects will have an impact on the 2nd and maybe 3rd performance period. In addition, more federal requirement compliant data will be available for the 2nd and 3rd performance period leading to better estimated impacts from preservation projects.

Table 5.4. Typical Pavement Preservation/Rehabilitation Types

Treatment		Project type
Rehab type	Reconstruction	Various depth CMRB; RCC; Full-Depth Asphalt replacement
	Heavy Rehab	Uniform mill with intermediate lift and overlay
	Rehab	Single lift asphalt overlay
	Light Rehab	Asphalt lift 125 psy< but <150 psy
Preservation	Chip Seal, Double Chip, Micro Surface, Crack Seal, FDP, PMST, Ultrathin Asphalt Overlay (<125psy)	

Active and recent non-interstate NHS rehabilitation and reconstruction project information was extracted from P2S and SiteManager. Project scopes were compared to a tracking spreadsheet provided by the Director of Maintenance Program Manager, contracts, and plans to determine if a project would impact non-interstate NHS pavement conditions. Based on historical data and subject matter experts' opinion, these non-interstate rehabilitation projects are expected to result in 94.6% pavement segments in "good" status, and 5.4% in "fair" status based on federal metrics. A total of 117 construction projects that cover 458 miles have substantial completion dates after 12/31/2016. Visual Basic code was developed to match project data with pavement condition data. There are 12.3 miles that did not match corresponding segment sections from the 2016 pavement data collection.

Excluding bridge sections, a total of 1,156 lane miles on non-interstate NHS that are/will be under construction were matched with corresponding segments from the 2016 pavement condition data collection. Estimated 2016 pavement conditions based on federal metrics for these 1,156 lane miles are shown in Table 5.5.

Table 5.5. Estimated 2016 Pavement Condition for Construction Projects

Estimated 2016 Pavement Condition Based on Federal metrics	Existing construction Projects with completion dates after 12/31/2016	
	Lane-Miles	Percentage
Good	12.7	1.1%
Fair	1073.0	92.8%
Poor	70.3	6.1%

Average, median, and 75th percentile pavement deterioration rates developed in Section 4.2 are applied to respective pavement types on 0.1-mile segments of the non-interstate NHS. In addition to projects shown in Table 5.5, 654.8 lane miles are currently programmed as either reconstruction or rehabilitation projects for fiscal year 2018-2019. These 654.8 lane miles are included in the calculation for the 4-year target. Table 5.6 and Figure 5.2 shows potential pavement status with no improvement compared with construction projects for 2019 and 2021.

Table 5.6. Projected non-Interstate NHS Pavement Condition Based on Federal Metrics

Deterioration Rates								w/Improvements	
		2016	2017	2018	2019	2020	2021	2019	2021
Average	Good	10.3%	7.2%	4.5%	0.0%	0.0%	0.0%	9.6%	21.0%
	Fair	87.0%	88.5%	89.4%	91.4%	73.5%	67.8%	83.4%	56.5%
	Poor	2.6%	4.3%	6.1%	8.6%	26.5%	32.2%	7.0%	22.5%
Median	Good	10.3%	8.8%	7.0%	5.4%	3.8%	0.0%	14.9%	21.1%
	Fair	87.0%	87.4%	88.6%	89.3%	89.8%	92.3%	80.8%	74.3%
	Poor	2.6%	3.8%	4.4%	5.3%	6.4%	7.7%	4.3%	4.6%
75th percentile	Good	10.3%	6.9%	0.1%	0.0%	10.1%	0.0%	9.6%	21.0%
	Fair	87.0%	88.6%	93.4%	90.2%	81.9%	70.3%	82.5%	51.5%
	Poor	2.6%	4.5%	6.6%	9.7%	7.9%	29.7%	7.9%	27.5%

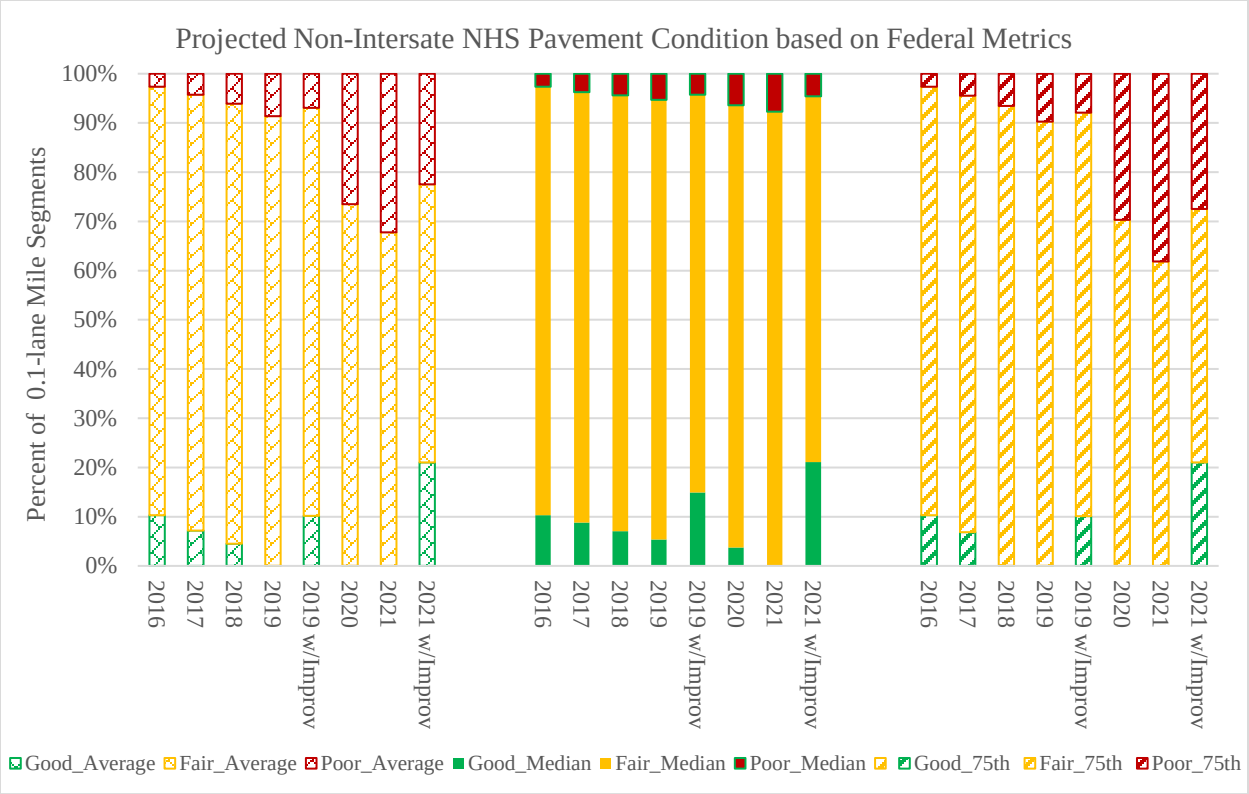

Figure 5.2. Projected Non-Interstate NHS Pavement Condition Based on Federal Metrics

5.3 Minimum Threshold

Per 23 CFR part 490 subpart B, State DOTs are required to maintain a minimum condition level of interstate pavements, defined as less than 5.0 percent poor. FHWA will make the first annual determination whether States meet this threshold requirement by October 1 beginning in 2019 based on the prior calendar year's data (2018 for the first determination). If a State's Interstate System condition rating is greater than 5.0% poor, then the State must obligate NHPP funds for Interstate Maintenance that is at least as great as the amount obligated in fiscal year 2009, plus an annual 2% inflationary adjustment from fiscal year 2013 onward and transfer an amount equal to 10% of its 2009 Interstate Maintenance apportionment from its Surface Transportation Program funding to fund interstate projects.

When setting its percent poor targets on the Interstate System, SCDOT will strive to ensure it meets the minimum condition rating as outlined in federal law.

5.4 MPO Condition Data

Within 180 days after the State DOT's target is established, MPOs can decide to adopt and support the State DOT's 4-year target or establish their own, quantifiable targets. For the first target setting process, SCDOT recommended to MPOs to adopt and support the State's 4-year target. Table 5.7 provides 2016 condition level data by MPO using the federal metric and the number of lane miles to which the condition data relates.

Table 5.7. MPO Condition Data

Study Area		2016 Interstate Condition	Interstate Lane Miles	2016 NHS Condition	NHS Lane Miles
ANATS	%Good	67.3%	39.0	11.0%	209.9
	%Poor	0.0%		9.4%	
ARTS	%Good	50.6%	120.2	19.2%	260.6
	%Poor	10.6%		1.0%	
CHATS	%Good	66.5%	239.4	25.1%	620.8
	%Poor	0.2%		3.8%	
COATS	%Good	64.1%	636.8	6.3%	651.4
	%Poor	2.3%		2.0%	
FLATS	%Good	56.4%	176.4	12.5%	205.5
	%Poor	3.5%		2.5%	
GPATS	%Good	55.1%	366.2	1.6%	671.3
	%Poor	0.3%		1.5%	
GSATS	%Good	N/A	N/A	13.3%	749.1
	%Poor	N/A		2.9%	
LATS	%Good	21.8%	59.9	24.1%	318.1
	%Poor	1.7%		1.3%	
RFATS	%Good	92.8%	144.5	13.3%	308.3
	%Poor	0.0%		5.1%	
SPATS	%Good	53.5%	256.5	0.0%	320.2
	%Poor	3.0%		0.7%	
SUATS	%Good	N/A	N/A	0.0%	202.4
	%Poor	N/A		2.6%	

6. Recommendations

Based on the criteria and methodology outlined above, the Working Group met on April 04, 2018, and recommended the following pavement condition targets:

Target	%Good	%Poor
Interstate 4 year	71.0%	3.0%
non-Interstate NHS 2 year	14.9%	4.3%
non-Interstate NHS 4 year	21.1%	4.6%

Table 6.1. Interstate and non-Interstate NHS pavement condition target recommendations

The chosen targets are the median projected conditions using average deterioration rates for the respective systems and planned completed construction projects that will be finished in time to be rated by the Department's pavement condition collection contractor as outlined in the methodology above. The 4-year percent poor target for interstate pavements meets the FHWA 5.0% minimum threshold requirement.

The Working Group also recommended that MPOs adopt and support the statewide 4-year interstate pavement condition target and 2- and 4-year non-Interstate NHS pavement condition targets. Particularly for the non-Interstate NHS, SCDOT staff do not have enough data on the location of construction projects during FYs 2019 and 2020 to incorporate that information by MPO planning area boundaries for MPO target setting purposes.

APPENDIX H: TABLE OF ASSETS DAMAGED BY CLIMATIC EMERGENCY EVENTS SINCE 1998 AND SUPPORTING DOCUMENTS

Year	Event Name	Declaration Type
8/25/1998	Hurricane Bonnie	Presidential
9/14/1999	Hurricane Floyd	Presidential
1/22/2000	Winter Storms	Presidential
2/2/2002	Ice Storm	Governor
10/25/2002	Tornado/Floods	Governor
12/4/2002	Ice Storm	Presidential
1/23/2003	Winter Weather	Governor
1/26/2004	Ice Storm	Presidential
8/14/2004	Hurricane Charley	Presidential
8/28/2004	Tropical Storm Gaston	Presidential
9/6/2004	Tropical Storm Frances	Presidential
8/29/2005	Hurricane Katrina	Presidential
12/15/2005	Ice Storm	Presidential
8/29/2006	Tropical Storm Ernesto	Governor
1/10/2011	Winter Storm	Governor
1/28/2014	Ice Storm	Governor
2/10/2014	Winter Storm	Presidential
10/1/2015	Major Flood	Presidential
10/4/2016	Hurricane Matthew	Presidential
1/6/2017	Winter Weather	Governor
9/6/2017	Hurricane Irma	Presidential
9/16/2018	Hurricane Florence	Presidential

NHS Roadways Damaged by Severe Weather Events Since 1998

NHS Route	Project Title	Total Cost Estimate of Damage	Event	Date
Multiple **US 1** **US 601** **US 17** **US 78** **US 521** **US 501** **SC 31** **US 601** **I-20** **US-21** **US-76** **SC 12** **SC 48** **SC 215** **SC 277**	Force Account Work - October 2015 Flood Event (DR-4241) (Grouping) MM 1 – 1.04, 21.85 -21.85, 0- 18.45 MM 8.56, 3.13 – 5.97 MM 57.23 – 64.93, 32.24 – 35.85 MM 22.4 – 23.47 MM 17.8 - 18.35, 21.57 – 27.41 MM 17.09 – 18.0 MM 9.0 - 9.09 MM 3.13 - 5.97, 3.0 - 23.480 MM 66.58 - 67.39 MM 2.290 - 21.27 MM 23.99 - 46.62, 11.05 - 12.44 MM 2.56 - 11.02 MM 2.16 - 22.990 MM 0.0 - 6.230 MM 0.0 - 8.140	$5,475,833.63	Major Flood	10/1/2015
I- 95	Emergency Repairs along I-95 from MM 119-131 - Clarendon County	$1,389,759.72	Major Flood	10/1/2015
SC 642	Emergency repairs on SC 642 (Dorchester Rd) in Dorchester Co	$136,752.90	Major Flood	10/1/2015
US 1	Emergency repair on US 1 near Old Mill in Lexington Co	$127,637.84	Major Flood	10/1/2015
I- 526	I-526 EB Roadway Repair MM 14.7	$167,268.87	Major Flood	10/1/2015
I- 26	I-26 EB/WB Roadway Repair MM 211.1	$171,949.89	Major Flood	10/1/2015
I- 526/I-26	I-526 EB Roadway Repair MM 16.0 /I-26 EB Roadway Repair MM 209	$89,904.47	Major Flood	10/1/2015
SC 12	SC 12 Roadway & Drainage Reconstruction /Reconstruct approximately 200' of US 21 (N. Main Street) between Wilkes Road (S-218) and Mason Road (S-219).	$379,638.00	Major Flood	10/1/2015
US 52	Emergency repair work on S-1139 (NFA), SC41 (NFA), SC41 (NFA), in Florence County and Emergency repair work on US 52 in Williamsburg County	$1,049,280.48	Major Flood	10/1/2015
US 76	US 76 BS(Broad Street) Roadway Repair (DR-4241)	$209,570.65	Major Flood	10/1/2015
US 521	Emergency repair work on US 521, US 301, S-40, R-8736 (I-95 ramp), S-28 at 1.09	$2,230,687.50	Major Flood	10/1/2015

	(NFA), and S-28 at 2.5 (NFA) in Clarendon Co			
I- 95	Emergency repair work on I-95 in Orangeburg County and S-265 (NFA) in Calhoun County.	$597,106.91	Major Flood	10/1/2015
I- 526	I-526 WB Roadway Repair MM 15.32 (DR-4241)	$29,999.06	Major Flood	10/1/2015
US 521	Emergency repair work on SC 51 in Georgetown County and on SC 377, US 521, and S-16 in Williamsburg County.	$574,677.87	Major Flood	10/1/2015
I- 26	I-26 WB Repair at MP 209.5 in Charleston (DR-4241)	$43,908.47	Major Flood	10/1/2015
US 52 (Bridge)	Inactive	$	Major Flood	10/1/2015
US 52	Emergency repair work on US 52 and on SC 41 in Florence Co and on SC 41/51 in Williamsburg Co	$443,871.99	Major Flood	10/1/2015
SC 31	SC 31 Roadway Repair at MP 19.69 & MP 1.91 in Horry County (DR-4241)	$257,996.11	Major Flood	10/1/2015
SC 642	SC 642 Emergency Repair (DR-4286)	$101,052.80	Hurricane Matthew	10/4/2016
I- 26/I-526	I-26 EB Emergency Slope Repair (DR-4286) and I-526 EB Emergency Slope Repair(DR-4286)	$361,071.55	Hurricane Matthew	10/4/2016
I- 95	Emergency Repairs along I-95 in Florence and Dillon Cos.(DR-4286)	$722,138.36	Hurricane Matthew	10/4/2016
I- 26	I-26 WB Emergency Slope Repair (DR-4286)	$173,351.26	Hurricane Matthew	10/4/2016
US 301	US 301 Culvert and Road Washout Repair MP 3.95 - MP 4.31 (DR-4286)	$870,041.52	Hurricane Matthew	10/4/2016
I- 95	I-95 SB Emergency Repairs at MM 186 in Dillon County	$367,047.70	Hurricane Matthew	10/4/2016
US 378 and US 501	Emergency Flood Control along US 378 in Florence County and US 501 in Horry	$500,000	Hurricane Florence	9/16/2018
US 76	US 76 Shoulder Repair in Marion County (DR-4394)	$145,852.78	Hurricane Florence	9/16/2018
SC 9	SC 9 Emergency Repair in Horry County (DR-4394)	$113,539.25	Hurricane Florence	9/16/2018
US 76	US 76 Emergency Roadway & Drainage Repairs in Marion County (DR-4394)	$1,089,982.19	Hurricane Florence	9/16/2018
I-95 (Road and Bridge)	I-95 over Great Pee Dee River Emergency Repair (DR-4394)	$2,200,000.00	Hurricane Florence	9/16/2018
I-95	I-95 NB - MP 192.2 - Dillon County Emergency Slope Repair I-95 SB - MP	$239,816.15	Hurricane Florence	9/16/2018

	173.2 to 174.8 - Florence County Emergency Slope Repairs (DR-4394)			
US-1	US 1 over Husbands Creek Emergency Box Culvert Replacement (DR-4394)	$736,592.25	Hurricane Florence	9/16/2018

South Carolina
Department of Transportation

November 23, 2018

Ms. Emily Lawton, Division Administrator
Federal Highway Administration
Strom Thurmond Federal Building
1835 Assembly Street
Suite 1270
Columbia, SC 29201

Dear Ms. Lawton:

This letter serves as notification that the South Carolina Department of Transportation (SCDOT)'s has completed its statewide evaluation for all NHS roads, highways and bridges as required by 23 CFR 667.7 (a), "Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction due to Emergency Events." The evaluation established that no facilities had been repeatedly repaired due to emergency events since 1997.

In order to meet the requirements for 23 CFR 667.7 (a), SCDOT will employ the following process:

- Conduct an evaluation using the best data available to determine if any road, highway or bridge has been damaged to the point which required repair or reconstruction activities on two or more occasions due to emergency events (Presidential or Governor declared event) since January 1, 1997.
- Produce a map and spreadsheet identifying areas that have been damaged on two or more occasions due to an emergency event.
- If reoccurring damage exist at the same site, the Department will evaluate its risk and the cost of future repairs.
- Identify reasonable alternatives to avoid or eliminate the need for federal emergency relief funds.
- Sites identified through this process will be considered for inclusion in the Statewide Transportation Improvement Program (STIP).

If you have any comments or concerns regarding the Department's evaluation, please feel free to give me a call at (803) 737-7903

Respectfully,

Brent L. Rewis

Director of Planning

Ec:

Jim Feda, SCDOT

Dan Hinton, FHWA

APPENDIX I: SCDOT TRANSPORTATION ASSET MANAGEMENT PLAN (TAMP) PERFORMANCE TARGETS

SCDOT Transportation Asset Management Plan (TAMP) Performance Targets

Updated October 18, 2018

Safety	2016 Baseline Condition		10-Year Target		Average Annual Funding Level	Commission Approval Date
Fatalities (Statewide)	890	5 Year Rolling Average	886	5 Year Rolling Average		September 2017
Fatality Rate	1.75	5 Year Rolling Average	1.34	5 Year Rolling Average		
Number of Serious Injuries	3194	5 Year Rolling Average	2573	5 Year Rolling Average	**$99M**	
Serious Injury Rate	6.30	5 Year Rolling Average	3.89	5 Year Rolling Average		
Non-Motorized Fatalities & Serious Injuries	376	5 Year Rolling Average	351	5 Year Rolling Average		
Emphasis Area: Roadway Departures					**$70M Emphasis Area Allocation**	
Rural Road Safety Program					$50M	September 2017
Interstate Safety Program					$11M	March 2018
Rumble Strips Installation Program					$9M	March 2018
Emphasis Area: Intersections & Other High-Risk Locations					**$22M Emphasis Area Allocation**	
Intersection Safety Projects					$13M	March 2018
RailRoad Safety Projects					$4M	March 2018
Workzone Enforcement					Included in Project Costs	
Target Zero Law Enforcement Teams					Previously Allocated	March 2018
Road Safety Assessments & Implementation					$5M	March 2018
Emphasis Area: Vulnerable Roadway Users					**$5M Emphasis Area Allocation**	
Pedestrian & Bicycle Safety Projects					$5M	March 2018
Safety Data Analytics					**$2M**	
Total Average Annual Funding					**$99M**	March 2018

Pavements	Centerline Miles	% VMT	2016 Baseline		10-Year Target		Average Annual Funding Level	Commission Approval Date
			% Good	% Poor	% Good	% Poor		
Interstate	851	30%	65%	10%	92%	3%	**$135M**	April 2018
Primary	9,517	46%	19%	56%	53%	30%	**$272.5M**	April 2018
Non-Interstate NHS	*2,752*	*26%*	*25%*	*42%*	*72%*	*16%*	***$86.5M***	April 2018
Non-NHS Primaries	*6,765*	*20%*	*16%*	*63%*	*48%*	*37%*	***$186M***	April 2018
FA Eligible Secondary	10,370	17%	19%	50%	40%	35%	**$112.5M**	April 2018
Non-Federal Aid Eligible Secondary	20,657	7%	13%	56%	25%	45%	**$121M**	April 2018
Total Average Annual Funding							**$641M**	

Bridges (by number)	# Structures	% VMT	2016 Baseline**		10-Year Target		Average Annual Funding Level	Commission Approval Date
			% Good	% Poor defined as % SD*	% Good	% Poor defined as % SD		
NHS	1,745	56%	48%	6%	66%	0%	**$114.5M**	April 2018
Non-NHS	3,883	37%	46%	11%	41%	11%	**$18M**	April 2018
Off-System	2,794	7%	40%	9%	36%	10%	**$18.5M**	April 2018

Bridges (by deck area)	Bridge Deck Area† (square feet)	% VMT	2016 Baseline**		10-Year Target		Average Annual Funding Level	Commission Approval Date
			% Good	% Poor defined as % SD*	% Good	% Poor defined as % SD		
NHS	39,110,289	56%	42%	4%	60%	0%	**$114.5M**	April 2018
Non-NHS	24,903,895	37%	50%	10%	41%	15%	**$18M**	April 2018
Off-System	7,607,110	7%	51%	7%	44%	10%	**$18.5M**	April 2018

Bridge Programs	2016 Baseline Condition	10-Year Target	Average Annual Funding	Commission Approval Date
Load Restricted Bridge Program	348 Bridges	0	**$36.5M**	April 2018
NHS Structurally Deficient Bridge Program	102 Bridges	0	**$114.5M**	April 2018
Total Average Annual Funding			**$151M**	April 2018

Mobility	2016 Baseline Condition	10-Year Target	Average Annual Funding Level	Commission Approval Date
Percentage of Interstate Segments with Reliable Travel Times	94.80%	86.00	**$345.1M**	October 2018
Truck Travel Time Reliability Index	1.34	1.53	**$110.0M*** **	October 2018
Total Average Annual Funding			**$454.3M**	October 2018

Pavement condition based on Pavement Quality Index (PQI).
NFA Secondary annual funding of $121M includes estimated $39M in CTC spending
**Bridge conditions based on Federal Metrics
* Structurally Deficient
***Funding available beginning in 2023