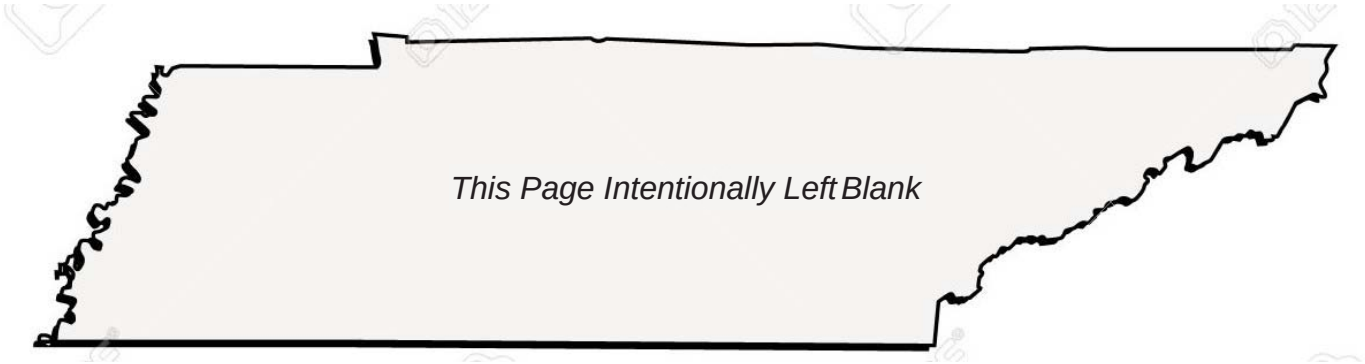
TDOT
Department of Transportation

Tennessee Department of Transportation
Transportation Asset Management Plan
2019



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STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
COMMISSIONER'S OFFICE
SUITE 700, JAMES K. POLK BUILDING
505 DEADERICK STREET
NASHVILLE, TENNESSEE 37243-1402
(615) 741-2848

CLAY BRIGHT
COMMISSIONER

BILL LEE
GOVERNOR

June 21, 2019

Pamela M. Kordenbrock
Tennessee Division Administrator
Federal Highway Administration
404 BNA Drive
Building 200, Suite 508
Nashville, TN 37217

Re: Submission of Final Transportation Asset Management Plan (TAMP)

Dear Ms. Kordenbrock:

In accordance with 23 CFR Part 515, the Tennessee Department of Transportation is pleased to present the enclosed submittal of our Final Transportation Asset Management Plan (TAMP). As stipulated in 23 CFR Part 515.11(a)(2), TDOT has produced a Final TAMP document which describes the State DOT's processes for developing its risk-based asset management plan, including the policies, procedures, documentation, and implementation approach that satisfy the requirements of this part.

Also accompanying the Final TAMP document is TDOT's documentation demonstrating the implementation of the TAMP, which compares the planned versus actual investment amounts by the following four different work types: Construction/Reconstruction, Rehabilitation/Repair, Preservation, and Maintenance. Any significant deviations from the planned investment amounts have been acknowledged, and justification for those deviations has been provided, as required in 23 CFR Part 515.11(a)(2).

TDOT looks forward to receiving feedback and guidance from FHWA regarding the certification of the processes which have been presented in this Final TAMP. TDOT has already begun to integrate asset management into our organizational mission, culture and capabilities at all levels; as stipulated in 23 CFR Part 515.19(a) thru (d); however, we will continue to assess our ability to implement the goals, objectives, and meet the established targets that are outlined in our Transportation Asset Management Plan.

If you have any questions, please contact me at 741-2848 or by email at Clay.Bright@tn.gov.

Sincerely,

Clay Bright
Commissioner

CB/cch

Enclosures

cc:
Mr. Paul D. Degges, P.E.
Ms. Lyndsay Botts
Mr. Joe Galbato
Mr. Toks Omishakin
Mr. Jeff Jones, P.E.
Mr. Matt Barnes
Ms. Sabrina David (FHWA)
Mr. John Steele (FHWA)
Ms. Pam Heimsness (FHWA)
Mr. Jerry Hatcher, P.E.
Mr. Will Reid, P.E.
Mr. Chris Harris, P.E.

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Acronyms

BMS - Bridge Management System

CRCP – Continuously Reinforced Concrete Pavement

FAST Act– Fixing America's Surface Transportation Act

FHWA – Federal Highway Administration

GASB 34 – Governmental Accounting Standards Board, Statement Number 34

IMPROVE Act – Improving Manufacturing, Public Roads and Opportunities for a Vibrant Economy Act

IRI – International Roughness Index

LCC – Life cycle cost

M&R – Maintenance & Repair

MAP-21 Act– Moving Ahead for Progress in the 21st Century Act

NBI – National Bridge Inspection

NBIS – National Bridge Inventory System

NHS – National Highway System

PMS – Pavement Management System

PPR – Pavement Performance Rating

PQI – Pavement Quality Index

RSL – Remaining Service Life

SIP – 10-Year Strategic Investment Plan

SOG – Standard Operating Guidelines

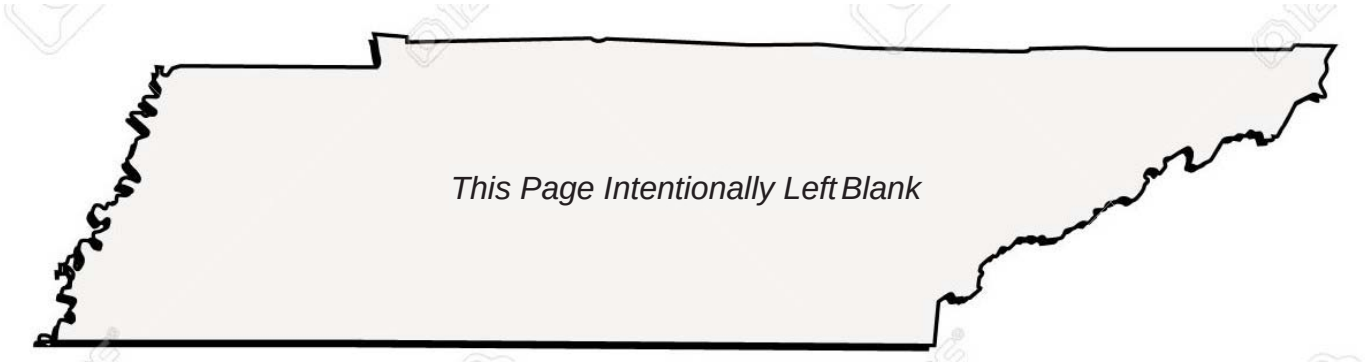
SOGR – State of Good Repair

STIP – State Transportation Improvement Program 2017-2020

TAMP – Transportation Asset Management Plan

TDOT – Tennessee Department of Transportation

TPM – National Transportation Performance Measures



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Chapter 1

Asset Management Objectives & Measures

What is a TAMP and Why is it Needed?

A Transportation Asset Management Plan (TAMP) is a strategic framework that positions agencies to consider the full life-cycle cost when evaluating, managing, and investing in transportation assets and infrastructure. It establishes a business-like mindset within an agency that looks to limit long-term costs, while extending the overall life-cycle and boosting the system-wide performance of the transportation network. The purpose of a TAMP is to document transportation assets that fully encompass Tennessee's transportation network in order to maintain and preserve that network. It will also serve as a strategic document supporting the overall Tennessee Department of Transportation (TDOT) Vision, established in 2013, "To serve the public by providing the best multimodal transportation system in the nation."

TAMP PURPOSE STATEMENT

Document all transportation assets that fully encompass Tennessee's transportation network i n order to maintain and preserve that network, as TDOT strives to provide the best multimodal transportation network in the United States.

The goal of a TAMP process is to create proactive approaches to management of transportation assets with methodical processes that considers the strategic management of the overall transportation network. This is achieved by maintaining assets in order to extend their life cycle.

Tennessee's TAMP will satisfy the requirements of the Moving Ahead for Progress in the 21st Century (MAP-21) Act and the Fixing America's Surface Transportation (FAST) Act by developing a risk-based

asset management plan for pavement and bridges on the National Highway System (NHS) and all state routes. Its purpose is to improve or preserve the condition of assets and the performance of the system, along with strategies to program projects that will help TDOT meet targets for asset condition and performance of the NHS consistent with national goals. The TAMP, as presented, is not a fix for short-term, emergency situations. It establishes TDOT's plan for doing business not only day-to-day, month-to-month, or even year-to-year, but decade-to-decade. The TAMP process, when utilized effectively, is a powerful budgeting and management methodology that can prevent major problems by prolonging the life-cycle of critical assets, while also planning for the future investments in the transportation network.

How Does Asset Management Planning Fit With TDOT's Guiding Principles?

TDOT established seven guiding principles, as part of the 25 year Long Range Transportation Policy Plan, that align with the overall department vision. These principles express the major priorities of TDOT and provide tangible actions to achieve the department's vision. Development of the TAMP carries out two of the guiding principles:

Preserve and Manage Existing System

Protect existing assets and maintain efficiency of the system through cost-effective management and new technologies.

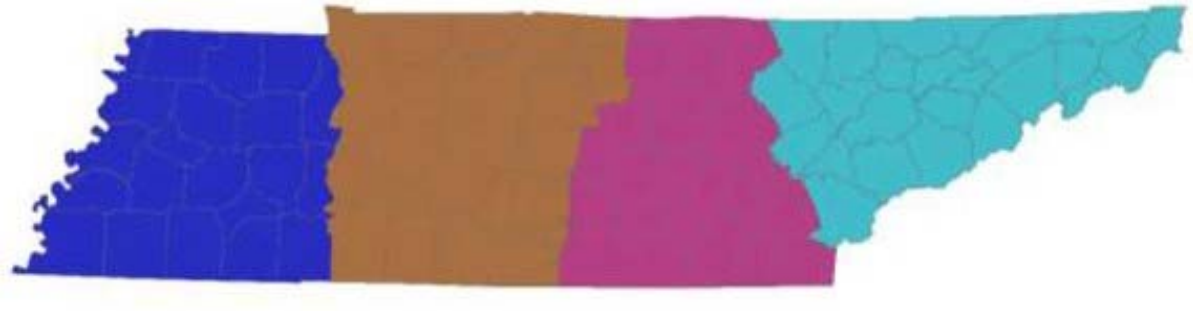
Emphasize Financial Responsibility

Maximize Tennessee's share of federal transportation funding; select projects based on identified regional needs; allow flexibility in local management of projects where feasible.

Which Assets Does TDOT Maintain and Evaluate?

TDOT is responsible for infrastructure along interstates and state routes throughout the State of Tennessee and, therefore, is responsible for the reliability and mobility of the customers it serves. Thetransportation system includes over 95,000 miles of roadways, over 20,000 bridges, 79 airports, 120 miles of Class I railroads, two (2) short line railways, 949 miles of

Map 1-1: Four Regions of Tennessee Department of Transportation



navigable waters, and two (2) passenger ferries. Although the Tennessee transportation system includes all modes (railroad, air, water, and roadway), the final TAMP focuses on two key roadway assets: over 14,000 miles of pavement and over 8,000 bridges. TDOT relies on the central bureaus and the four (4) regions as depicted in Map 1-1 to accomplish its mission. Chapter 2 includes a breakdown of pavement and bridge assets by responsible agencies. The customers served by the roadway network include a wide variety of stake-holders: citizens of the state, travelers driving through the state, trucking companies, military installations, and many more.

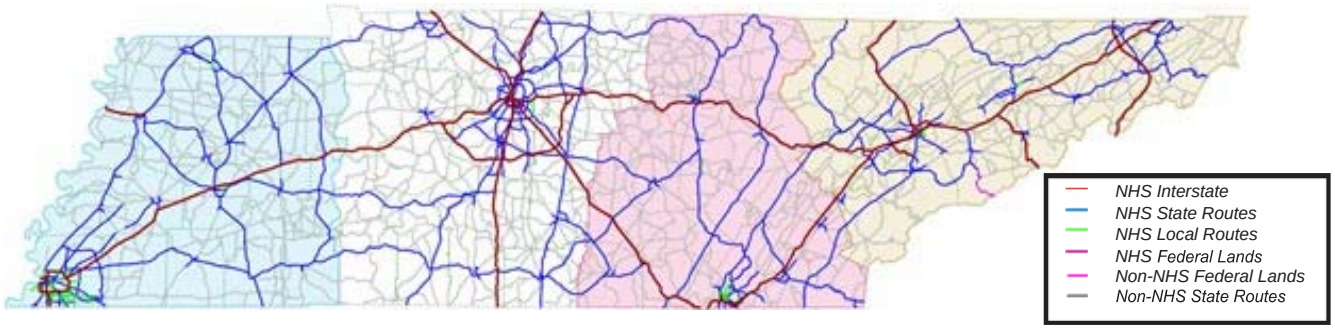
An examination of the types of trips made by the citizens and the freight companies demonstrates how important the reliability of the system is to the economic vitality and mobility of the state. The trip purposes for citizens range from business, school, church, and shopping to recreational activities. This wide range of trips shows how critical the reliability of the system is for daily business to occur. The products that travel the Tennessee roadway network also serve a wide range from agriculture to military equipment to groceries to electronic equipment. These entities expect a reliable transportation network from origin to destination.

The TAMP will assist TDOT in creating the best transportation system in the country by maintaining a reliable roadway network that serves its customers' needs. Through annual pavement evaluation and bi-annual bridge evaluations, the state can identify present areas of concern as well as future problem areas. By addressing the problems found by the evaluation process, the department can extend the life cycle of the asset and help stretch the funding dollars further. This gives the department a strategic planning document for a 10-year horizon to help identify large and small projects that will contribute to the performance goals established by TDOT.

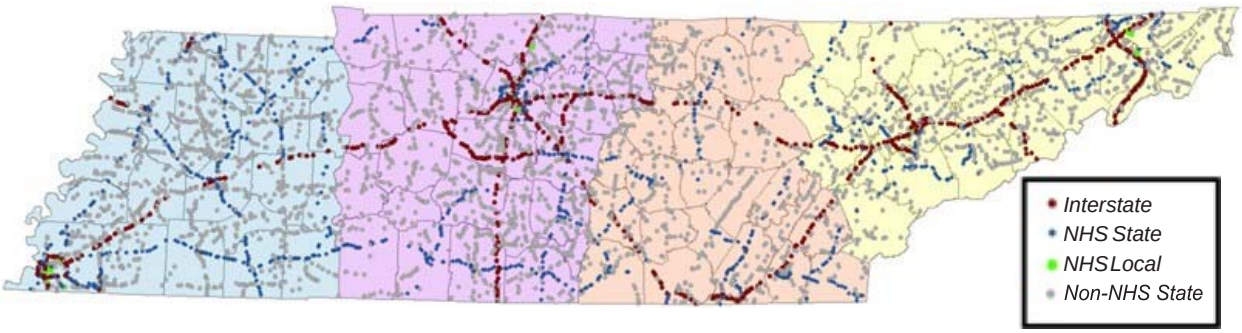
Which Assets Will Be Included in the TAMP?

TDOT has a wide array of assets as part of its multimodal transportation network. For this TAMP, we are focused on the pavement and bridges on the interstates, state and locally owned NHS routes, and non-NHS state routes. Reviewing the historical condition of these assets is important to understanding current trends. This information is utilized, along with the projected needs of the system, to budget for the current year of expenditures through the next ten (10) years. The department can develop an investment strategy for these assets to extend their life cycle and stretch funding dollars, while providing a safe and reliable roadway network. Maps 1-2 and 1-3 below are a depiction of the roadways and bridges evaluated and included as part of the TAMP.

Map 1-2: Roadways on Interstates, NHS, and Non-NHS State Routes



Map 1-3: Bridges on Interstates, NHS, and Non-NHS State Routes



Process and Content of the TAMP

Both the Initial and the Final TAMP is comprised of the following information:

Chapter 1: Asset Management Objectives & Measures

Included in this chapter is the purpose and foundation of preparing the TAMP. It explains how the TAMP helps the department reach the goals and objectives established in other reports.

Chapter 2: Asset Inventory & Condition

This chapter will provide the historical and baseline information tracked by TDOT to determine the inventory and condition of the pavement and bridges on the interstates, state and locally owned NHS routes, and non-NHS state routes.

Chapter 3: Performance Goals & Targets

Maintaining and prolonging the life of the transportation network assets helps TDOT stretch funding dollars while providing a reliable transportation network to the users. This chapter will define the performance measures for the pavement and bridges included in the TAMP, establish TDOT's performance targets for pavement and bridges to ensure the preservation of these assets, identifies where performance gaps exist when a target is not met, and discuss the prioritization of projects based on the evaluation criteria. The performance measure targets will be included in the Final TAMP.

Chapter 4: Life Cycle Cost

The amount of time that pavement and bridges which are part of the statewide transportation network can remain in a state of good repair depends on several factors including the number of trips the asset experiences, the number of trucks that use the asset, and the weather. While the weather cannot be predicted very far into the future, the department does utilize sophisticated software systems to predict future condition of pavements and bridges based on factors such as asset age, Average Daily Traffic counts (ADT), and the percentage of traffic made by heavy trucks. The focus of this chapter is on the processes that TDOT uses to consider the results from the analyses of the Pavement Management System (PMS) and Bridge Management System (BMS) to minimize whole life costs.

Chapter 5: Risk Management Analysis

Risk Management is a systematic process of identifying, analyzing, and prioritizing risks with the development of strategies to respond to potential threats and opportunities. This chapter discusses Risk Management and provides an overview of how risks are taken into account and managed in order to minimize impacts to the department's mission of providing a safe and reliable transportation system for the state and to meet the requirements of MAP-21. Additionally, the chapter looks at historical data from past natural disasters to identify locations that have received recurring federal emergency relief funding and the potential to add to the State Transportation Improvement Program (STIP) to eliminate future damage.

Chapter 6: Financial Plan

Over the last century, Tennesseans have invested a tremendous amount of dollars on their transportation system. This chapter will summarize historic funding levels for the bridge and pavement programs, describe the amount of funds expected to be available for these assets, identify various sources of transportation funding, describe how these funds will be allocated over the 10-year plan horizon, present funding levels in terms of the financial sustainability of the highway system, and document the process for developing the financial plan.

Chapter 7: TDOT TAMP Investment Strategies

This chapter will discuss investment strategies based on current practices and the results from the activities documented in previous sections, i.e. performance gap analysis, life-cycle cost considerations, risk assessment, financial analysis, etc. It will document the process used for consideration of various investment strategies.

Chapter 8: TAMP Process Improvement

This chapter will discuss opportunities for improvements to the asset management strategies being implemented by TDOT, describe the approach taken by TDOT to communicate to internal and external stakeholders about how the TAMP will be used to ensure the most efficient management of the transportation infrastructure, and provide a prioritized list of additional assets beyond pavement and bridges to be included in future versions of the TAMP.

The TAMP's Relation to Other TDOT Planning Documents

The TAMP is not meant as a replacement to any other TDOT planning process or priorities; rather, the TAMP builds upon the existing plans, processes, and priorities, as identified by TDOT in this document. The following documents were essential to the creation of this TAMP by outlining goals and objectives for the plan.

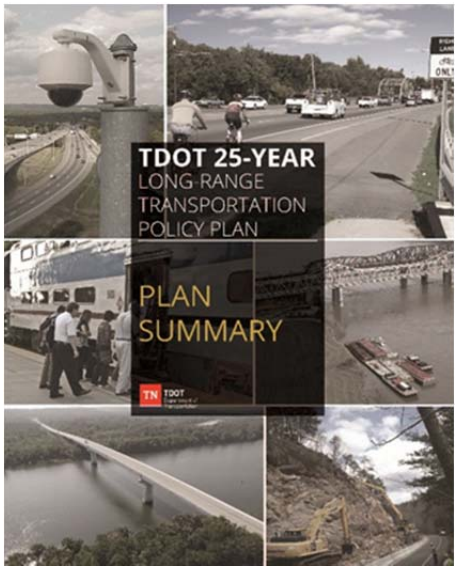
25-Year Long-Range Transportation Policy Plan

The 25-Year Long-Range Transportation Policy Plan consists of eight policy papers each with recommendations. Preparation of the plan included an extensive public engagement process that included citizens, advocates, industries, commerce, and transportation experts. The need to maintain and preserve assets of the system is reflected in the guiding principles and recommendations established in the papers. Creating the TAMP carries out two of the seven guiding principles of the 25-year Long-Range Plan which will be discussed in more detail later in this chapter. The department is guided by a programmatic approach with three emphasis areas – efficiency, effectiveness, and economic competitiveness. Effectiveness deals with the success of the department's investments which directly influences maintaining a state of good repair.

Travel Trends and System Performance – Policy Paper

One of the key parts of the TAMP is to set performance measures and targets for the condition of the roadway pavements and bridges on interstates, state and locally owned NHS routes, and non-NHS state routes. The purpose of the Travel Trends and Systems Performance Policy Paper is to assist with the prioritization of TDOT's projects. The measures identified in the paper are meant to be dynamic based on the revisions of the federal transportation legislation guidance.

Evaluation of the system through specific metrics and targets helps TDOT measure the effectiveness of programs and policies and helps prioritize projects. Measuring the existing condition of the transportation system in a way that provides system performance helps identify project needs and guide the department's funding. The performance measure and targets can help the department prioritize projects that will benefit the transportation system and possibly extend the life cycle of the asset. The performance measures and targets are discussed further in the next chapter.



TDOT Actions from the 25-Year Plan the TAMP Can Build Upon:

Advancement of TDOT's current practices in the area of sustainability as a means of maximizing return on investment

Make Planning data and tools available to a variety of local and national planning partners and agencies (Metropolitan Planning Organizations, Regional Planning Organizations, Economic Community Developement)

Promote asset management as a means of maintaining and preserving Tennessee's transportation infrastructure in a state of good repair

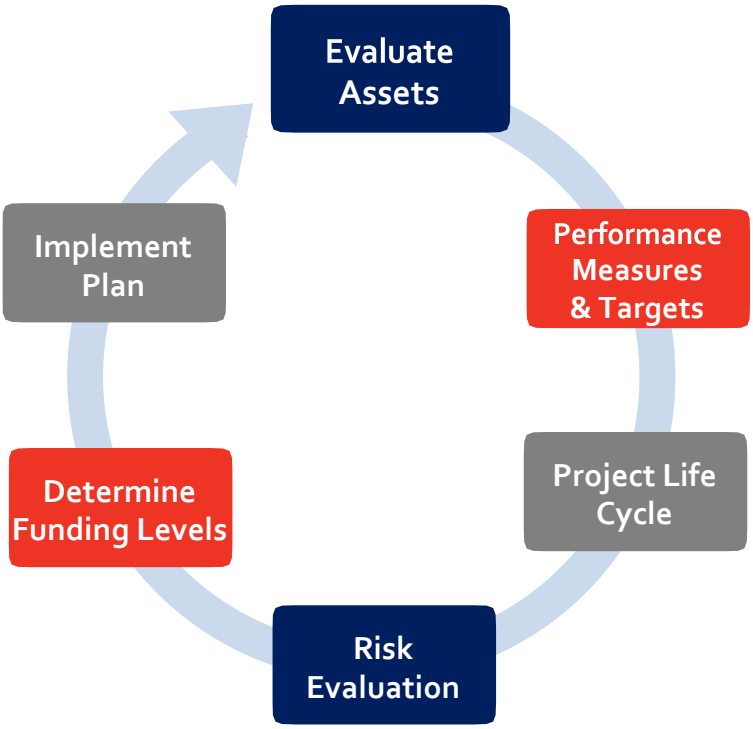
Increase capabilities and technical resources in asset management to advance understanding and investments in Tennessee's transportation infrastructure

Tennessee's State Transportation Improvement Program (STIP)

The STIP is developed with the purpose of carrying out the Department's Long Range Transportation Plan and the metropolitan transportation plans. The plan is fiscally constrained which means money must be designated and expected to be available for each of the projects listed. The STIP plans for transportation projects over a four-year time frame based on the reasonably expected funding levels. This must be prepared as a condition of federal funding for regionally significant highway and public transit transportation projects under Title 23, United States Code for highways and Title 49, United States Code for transit. TDOT reevaluates the STIP every three (3) years.

How Will TDOT Create, Implement, & Update the TAMP?

The TAMP was prepared by a team of TDOT staff and consultants, working together to research the historical data and predict the conditions of the assets and funding expected to be available over the next ten (10) years. The idea was to build upon the foundation that TDOT has established for evaluating the performance measures and to create procedures that can be used to prioritize projects based on the funding available. Implementation of the plan relies on close communication and collaboration with Metropolitan and Rural Planning Organizations (MPO & RPO), local agencies, federal agencies, and various divisions within TDOT. An objective in the creation of this document is to establish an easily repeatable process for future updates to be conducted.



Who is Responsible for TAMP Development and Implementation?

While it is expected the entire TDOT agency will in some way contribute to the development and implementation of the TAMP, TDOT has identified three (3) groups who will provide the oversight, input, and leadership necessary to the TAMP's creation, development and implementation; Executive Leadership, TAMP Steering Committee, and TAMP Core Team. In addition to these three (3) committees, two (2) specific roles have been identified for the management of the TDOT TAMP effort: Agency Sponsor/Champion, who is responsible for ensuring the appropriate resources of the agency are provided, and a Project Leader who is responsible for coordinating activities and day-to- day development of the TAMP. TDOT has identified the following champion and project leader for the TAMP development effort:

- Agency Sponsor/Champion – Jerry Hatcher, Director of Maintenance Division
- Project Leader – Chris Harris, Maintenance Division

Executive Leadership - the TAMP development and implementation is supported by TDOT's Executive Leadership Team consisting of Commissioner Bright and other senior managers within the agency. This team will provide overall guidance, direction, resource commitment, and approval.

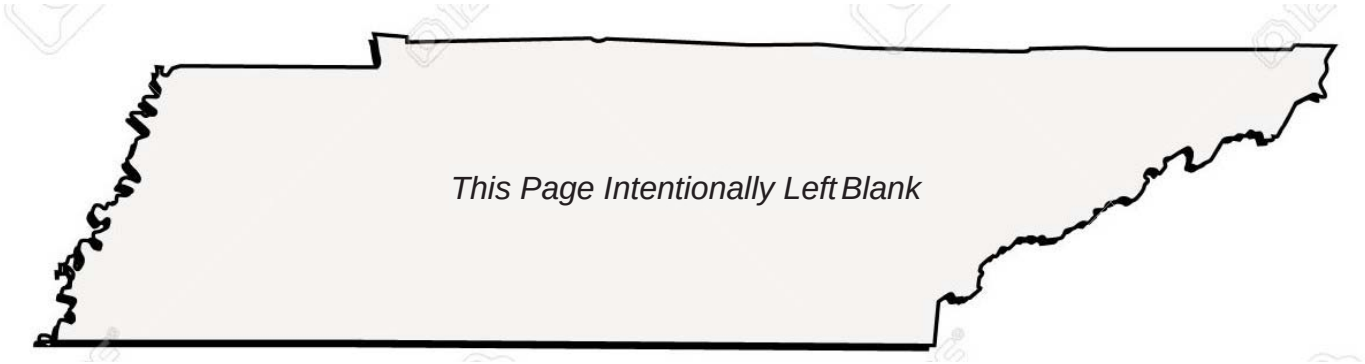
TDOT Executive Leadership Team	
Clay Bright	Commissioner
Lyndsay Botts	Deputy Commissioner & Chief of Staff
Paul Degges	Deputy Commissioner & Chief Engineer – Bureau of Engineering
Toks Omishakin	Deputy Commissioner – Bureau of Environment & Planning
Joe Galbato	Deputy Commissioner & Chief Financial Officer – Bureau of Administration
Will Reid	Assistant Chief Engineer of Operations
Jeff Jones	Assistant Chief Engineer of Design

The **TAMP Steering Committee** consists of TDOT Directors who are key managers of the agency's business units that will provide the data, reports, analysis, and documents that will form the core information in the creation of the TAMP. This team will provide the resources and analysis required to support the development of the TAMP and provide oversight to ensure the components of the plan are coordinated and accurately reflect TDOT's processes.

TAMP Steering Committee	
Jerry Hatcher	Director of Maintenance Division
Larry McGoogin	Director of Long Range Planning Division
Patsy Mimms	Director of Office of Strategic Planning
Steve Borden	Assistant Chief Engineer/Director of Region 1 - Knoxville
Joe Deering	Assistant Chief Engineer/Director of Region 2 – Chattanooga
David Layhew	Assistant Chief Engineer/Director of Region 3 – Nashville
Jason Baker	Assistant Chief Engineer/Director of Region 4 – Jackson
Steve Allen	Director of Strategic Transportation Investments
Brad Freeze	Director of Traffic Operations Division
Ted Kniazewycz	Director of Structures Division
Ronnie Porter	Director of Program Development & Administration
Jennifer Herstek	Director of Finance Division
Joe Kirk	Director of Information Technology
BJ Doughty	Director of Community Relations
Chris Harris	Maintenance Division - TAMP Project Lead
Mark Woods	Maintenance Division – Pavement Management Lead
John Steele	FHWA - Pavement and Materials Engineer

TAMP Core Team consists of members of the Maintenance Division and have direct oversight, guidance, and responsibility for coordination of the TAMP effort within TDOT. This team is responsible for working with the various TDOT business units to assemble data, reports, and documents that will be used in the creation of the various sections of the TAMP.

TAMP Core Team	
Jerry Hatcher	Director of Maintenance Division
Chris Harris	Maintenance Division - TAMP Project Lead
Christopher Starr	Maintenance Division – Asset Management Lead
Mark Woods	Maintenance Division – Pavement Management Lead
Ted Kniazewycz	Director of Structures Division
Tom Quinn	Structures Division - Bridge Management Lead
Amos Pulley	Maintenance Division – Technical Support
Austin Holliman	Maintenance Division – Technical Support
Morgan Ballard	Maintenance Division - Administrative Support



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Chapter 2

Asset Inventory & Condition

What Does TDOT Maintain and Improve?

The purpose of the TAMP is to document the assets used to provide Tennesseans with a reliable transportation network and to maintain and preserve the system as TDOT works towards providing the best transportation network in the nation. This section of the report will provide an inventory and assessment of the current condition of the existing roadways and bridges that are part of the National Highway System (NHS). In addition, the inventory includes the state highways maintained by TDOT and roadways maintained by federal and local authorities that are part of the NHS. NHS bridges maintained by federal and local authorities will also be part of the inventory.

The condition of the roadway pavement and bridges on the network maintained by TDOT are classified into three (3) categories: good, fair, or poor. The report will show the historical values of the Pavement Quality Index (PQI) and the Pavement Performance Rating (PPR) which is determined from the International Roughness Index (IRI), rutting, fatigue cracking and faulting (concrete only). Bridges

are inspected throughout the state of Tennessee on a two-year cycle. The sufficiency rating of the bridge is tracked to determine the maintenance needs. This rating consists of the condition rating of the bridge deck, superstructure, and substructure.

How Much Pavement Does TDOT Own and Maintain?

Tennessee has more than 95,000 centerline miles of publicly owned highways; however, only about 14,000 of those miles are maintained by the department. Only those on the NHS will be included in the TAMP. Map 2-1 shows the centerline miles and lane miles of the roadways included in the TAMP inventory, and Table 2-1 lists the centerline miles and lane miles for each highway system category that TDOT will be including as part of the TAMP. Between 2010 and 2018, TDOT added on average, approximately 0.27% additional lane miles to the state network of highways each year. It is anticipated that this average rate of increase will continue over the next ten year period.

How Many Bridges are on TDOT's Transportation Network?

TDOT inspects over 20,000 publicly owned bridges statewide; however, less than half of those bridges are owned by TDOT. Map 2-2 shows the bridges that are reported as part of the TAMP and categorized by each of the highway systems used to define the TAMP Roadway Network in Table 2-1, below. The number of bridges in each highway system category is shown below in Table 2-2, and displayed, in a similar manner, graphically in Map 2-2. Between 2014 and 2018, TDOT added on average, approximately 0.58% additional square feet of bridge deck to the National Highway System (NHS) bridge network. It is anticipated that this average rate of increase will continue over the next 10 year period.

Map 2-1: TAMP Roadway Inventory

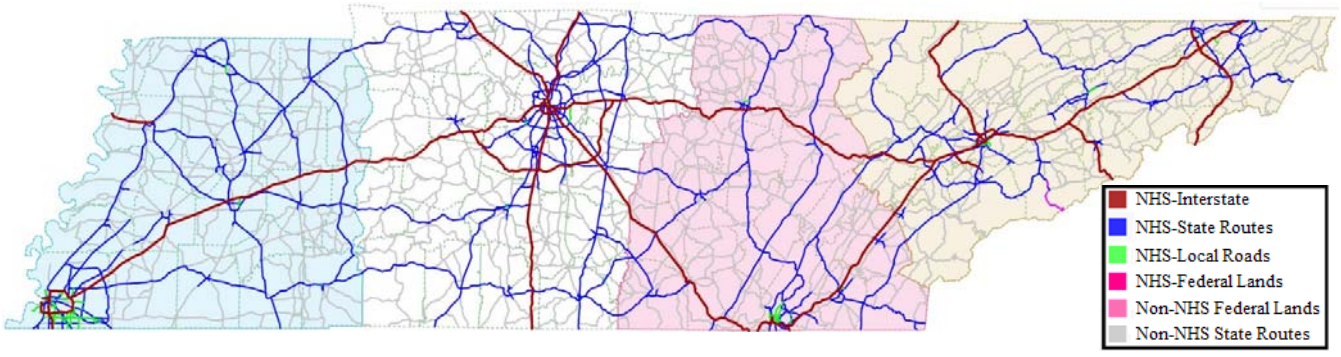


Table 2-1: TAMP Roadway Inventory (as of 2/13/2019)

Highway System	Centerline Miles	Lane Miles
NHS Interstates	1,201	5,813
NHS State Routes	3,656	12,636
NHS Local Roads*	163	709
NHS Federal Roads*	4	17
Total NHS	**5,024**	**19,175**
Non-NHS State Routes	9,016	19,213
Grand Total	**14,040**	**38,388**

**TDOT does not maintain NHS Local Roads or NHS Federal roads*

Map 2-2: TAMP Bridge Inventory

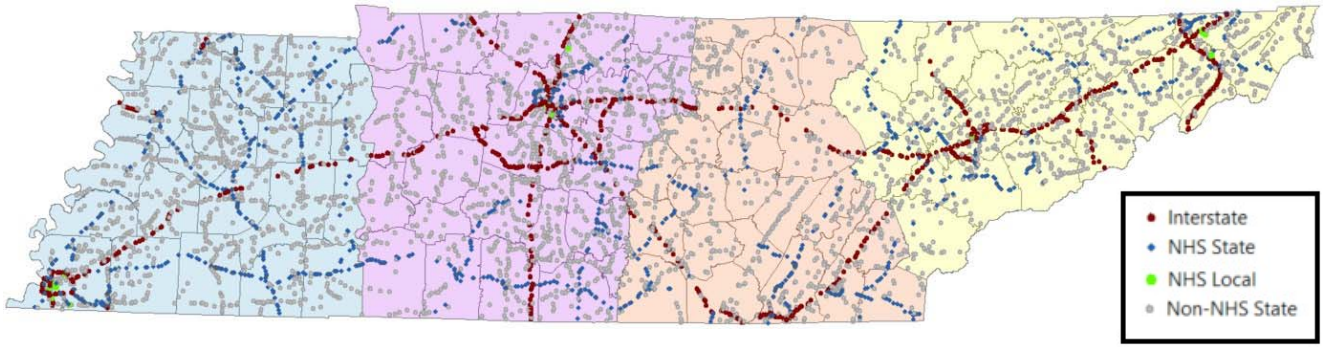


Table 2-2: Bridge Inventory (2019 NBI Data)

Highway System	Number	Deck Area (Sq. Feet)	Deck Area (Sq. Meters)
NHS Interstates	1,618	25,586,902	2,377,101
NHS State Routes	2,443	30,563,532	2,839,445
NHS Local*	101	1,835,882	170,559
NHS Federal*	5	322,035	29,918
Total NHS Bridges	**4,167**	**58,308,351**	**5,417,023**
Non-NHS State Routes	4,332	26,644,112	2,475,319
Total TAMP Bridges	**8,499**	**84,952,463**	**7,892,342**

**TDOT does not maintain NHS Local or NHS Federal Bridges*

What is the Condition of TDOT's Roadway Pavements?

Pavement Condition – Using Pavement Quality Index (PQI)

Historically, to help identify the roadways needing rehabilitation or maintenance, TDOT collects pavement condition data and calculates a Pavement Quality Index (PQI) for the Interstate, NHS State Routes, and non-NHS State Routes. The PQI scale ranges from 0 (needs resurfacing) to 5 (not a priority for maintenance). The PQI is calculated based on aspects of the pavement that affect ride quality and pavement distress. Figures 2-1 through 2-4 show the historic PQI ratings for the Interstate, NHS State Routes, NHS Local Routes, and non-NHS State Routes.

Figure 2-1: Historical Pavement Performance Rating on Interstates

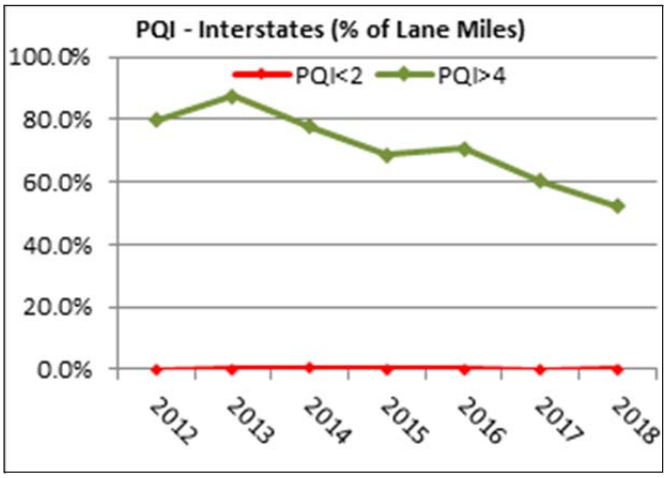


Figure 2-2: Historical Pavement Performance Rating on NHS State Routes

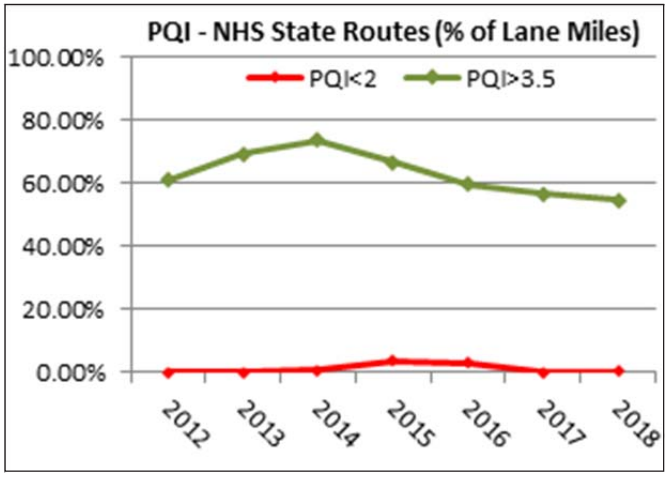


Figure 2-3: Historical Pavement Performance Rating on Local NHS Routes

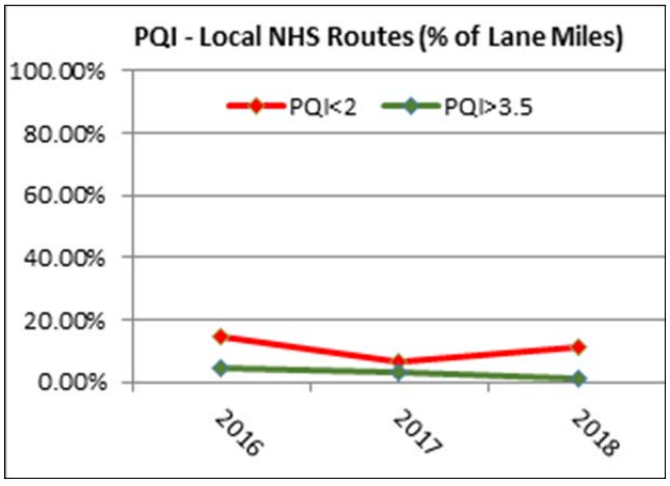
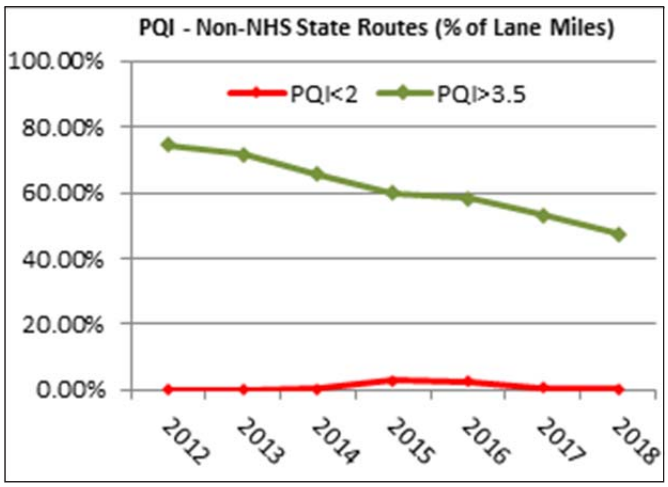


Figure 2-4: Historical Pavement Performance Rating on Non-NHS States Routes



Pavement Condition – Using National Transportation Performance Measures (NTPM)

In addition, TDOT tracks several pavement metrics to determine the condition of the roadways. Each of these metrics, shown in the following Table 2-3, is evaluated for each segment of roadway to determine the applicable performance rating (Good, Fair, Poor). For concrete pavements, the metrics that are included in determining the performance rating are roughness (International Roughness Index - IRI), fatigue cracking, and faulting. For asphalt pavements, it is roughness (IRI), fatigue cracking, and rutting. For each segment, the overall condition rating is determined using the values in Table 2-4.

Table 2-3: Pavement Condition Thresholds

Metric	Good	Fair	Poor
Roughness (IRI)	<95	95-170	>170
Rutting	<0.20	0.20 - 0.40	>0.40
Fatigue Cracking	<5	5 - 10	>10
Faulting	<0.05	0.05 - 0.15	>0.15

Table 2-4: Overall Pavement Condition Rating

Metric Ratings	Overall Condition Rating
All 3 metrics "Good"	**Good**
All other combos	**Fair**
2 or more metrics "Poor"	**Poor**

Performance results are then calculated by reporting the total number of lane miles in each condition category (Good, Fair, Poor) on each of the highway systems. To comply with the National Transportation Performance Measures (NTPM) reporting requirements established by Federal Highway Administration (FHWA) for pavements, states must report the percentage of lane miles that are rated as good and poor condition on the Interstate System. To align with how we have inventoried, assessed the condition, and budgeted for pavement management historically, TDOT has elected to also collect pavement condition data for state routes on the NHS, local NHS routes, and non-NHS state routes in the state. TDOT will share the pavement condition data with local NHS owners on an annual basis to make them aware of the condition of their NHS paved system.

The performance rating for pavements on each highway system is calculated by adding up all of the lane miles in each condition state on that highway system and calculating the percentage of each.

Historical performance rating data for the interstate system, state routes on the NHS, local NHS routes, and non-NHS state routes on TDOT maintained roadways are shown below in Figures 2-5 through 2-10, respectively. TDOT has been collecting pavement condition data for decades; however, in 2014 the method for collecting and rating fatigue cracking was changed by FHWA. Therefore, only data back to 2015 will be presented in Figures 2-5 through 2-10.

Figure 2-5: Historical Pavement Performance Rating on Interstates

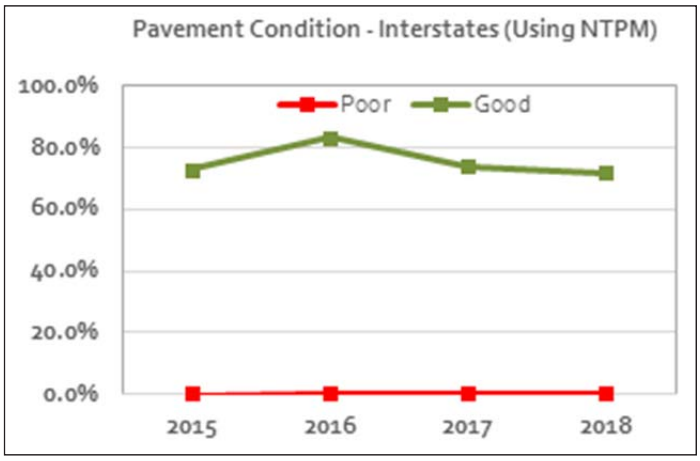


Figure 2-6: Historical Pavement Performance Rating on All NHS Routes

Because Local NHS route data was not able to be readily produced for 2018, the combined state and local NHS routes was not able to be produced at the time of preparation of the TAMP. Figure 2-6 has been retained for reporting of this data in future versions of the TAMP.

Figure 2-7: Historical Pavement Performance Rating on NHS State Routes

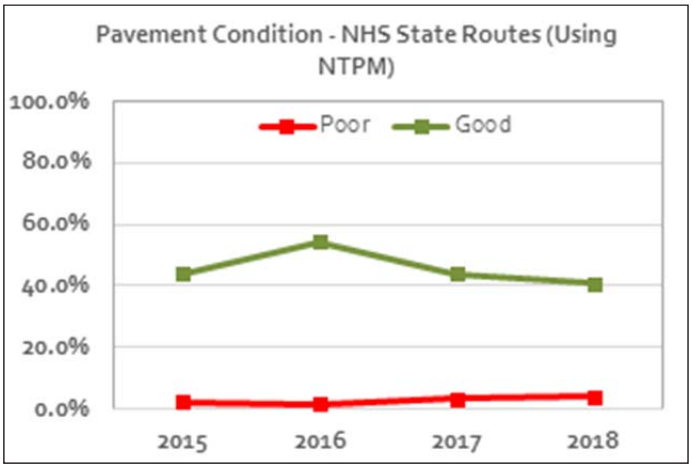


Figure 2-8: Historical Pavement Performance Rating on NHS Local Routes

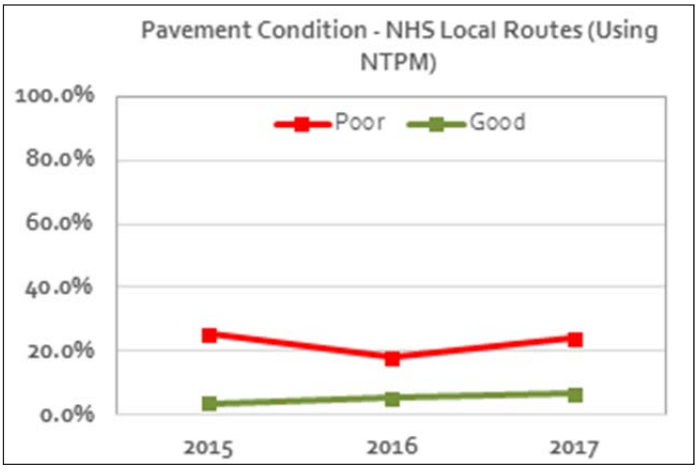


Figure 2-9: Historical Pavement Performance Rating on Non-NHS Routes

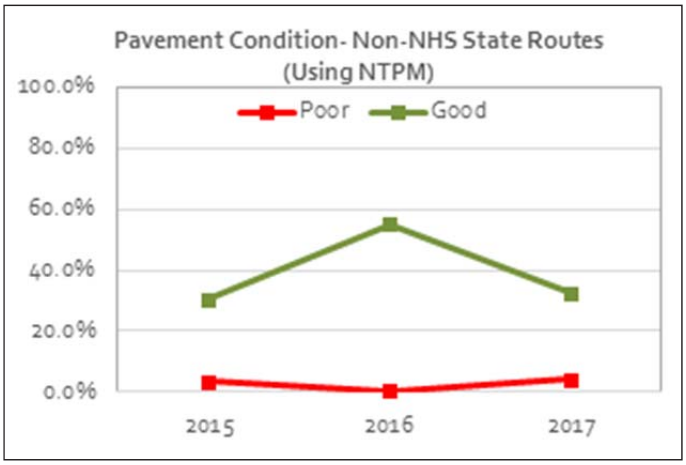
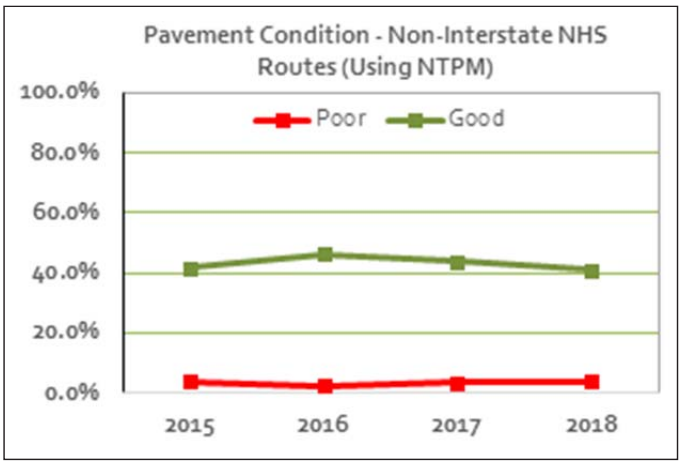


Figure 2-10: Historical Pavement Performance Rating on Non-Interstate NHS Routes



What is the Condition of TDOT's Bridges?

Bridge Condition – Using Structural Deficiency

TDOT conducts bridge inspections on all of the publicly owned highway bridges in the state every two (2) years except for federally owned bridges. The department follows the guidelines established by the National Bridge Inspection (NBI) reporting process, using the NBI rating for deck, superstructure, and substructure. Culverts are assessed on the culvert score. Also, as part of the NBI reporting process, bridges can be identified as structurally deficient. Structurally deficient is a term used consistently by all Departments of Transportation. These bridges are not unsafe; instead they are usually functionally adequate. They do, however, require significant maintenance and repair to remain open to traffic with eventual rehabilitation or replacement. Figures 2-11 and 2-12 below show the structurally deficient bridges from 1992 to 2016 based on the number of bridges and percent of bridge deck area, respectively.

Bridge Condition – Using National Transportation Performance Measures (NTPM)

From the NBI inspections, Table 2-5 shows the bridge metric levels that are used for the deck, superstructure, substructure, and culverts. Any metric that is evaluated as 7 or higher is considered to be in good condition. Any bridge metric that is evaluated as 4 or less is considered to be in poor condition, and also receives the designation as "Structurally Deficient". For each bridge, the overall condition rating of good, fair, and poor is determined using the values in Table 2-6.

Figure 2-11: Historical # of Structurally Deficient Bridges (All publicly-owned and all NHS)

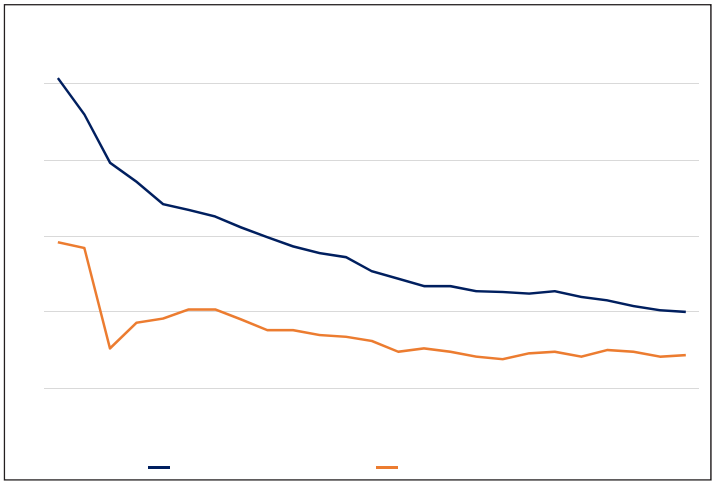


Figure 2-12: Historical Percent of Structurally Deficient Bridge Deck Area (All publicly-owned and all NHS)

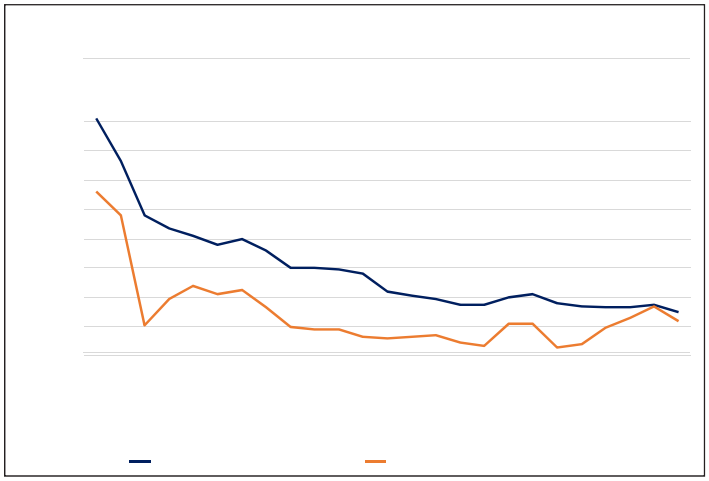


Table 2-5: Bridge Condition Thresholds

Components	Good	Fair	Poor
Deck	≥ 7	5 or 6	≤ 4
Superstructure	≥ 7	5 or 6	≤ 4
Substructure	≥ 7	5 or 6	≤ 4
Culvert	≥ 7	5 or 6	≤ 4

Table 2-6: Overall Condition Rating for Bridges

Metric Ratings	Overall Condition Rating
All metrics "Good"	Good
All other combos	Fair
1 or more metrics "Poor"	Poor

To comply with the National Transportation Performance Measures (NTPM) reporting requirements established by FHWA, states must report the percentage of bridge deck area that is rated as good and poor on all bridges on the Interstate and National Highway System. To align with how TDOT has historically evaluated the condition of bridges and budgeted for preservation, TDOT has elected to also include condition data for bridges on non-NHS state routes. TDOT will also include locally-owned and federally owned bridges on the NHS and state highways; however, TDOT does not perform inspections on any federally owned structures. Inventory and condition data for federally owned bridges has been provided by the FHWA through the National Bridge Inventory System (NBIS). TDOT will share the bridge condition information with local NHS owners on an annual basis to make them aware of the condition of their NHS structures.

The performance rating for bridges on each highway system is calculated by adding up all of the bridge deck area in each condition on that highway system and calculating the percentage of each. Historical performance rating data for the interstate system, state and locally owned bridges on the NHS, and state-owned bridges not on the NHS has been calculated back to 2012, and are shown in Figures 2-13 through 2-18, respectively.

Figure 2-13: Historical Bridge Performance Rating on All NHS Routes

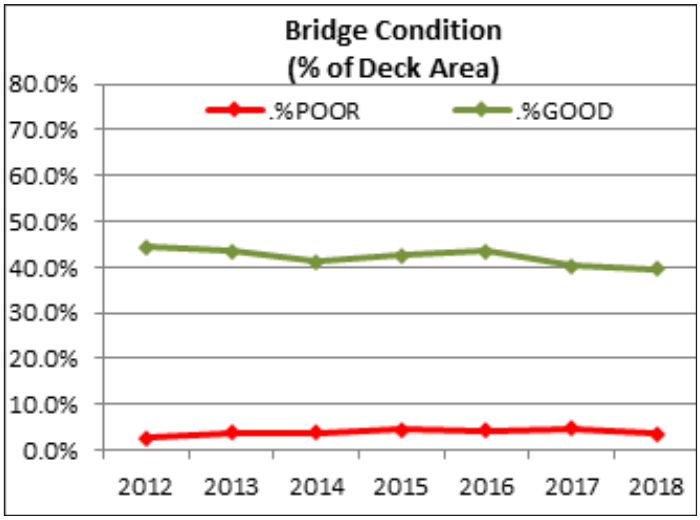


Figure 2-14: Historical Bridge Performance Rating on Interstates

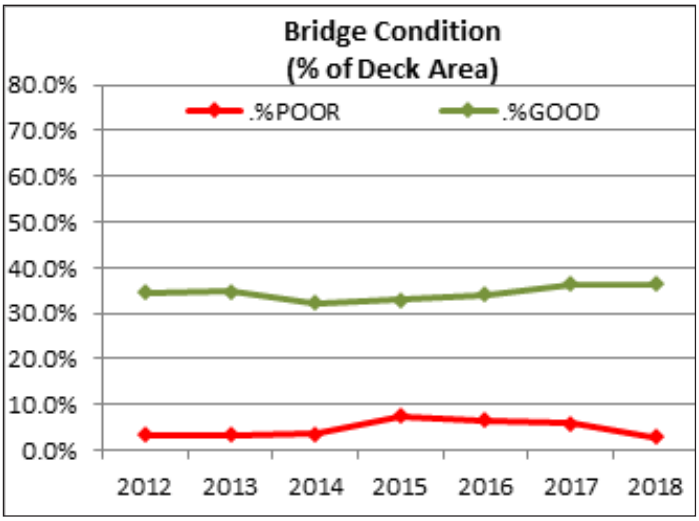


Figure 2-15: Historical Bridge Performance Rating on NHS State Routes

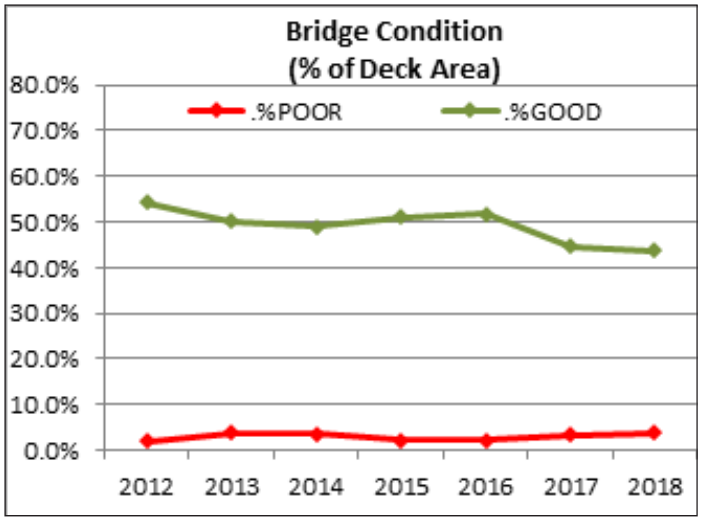


Figure 2-16: Historical Bridge Performance Rating on Non-NHS State Routes

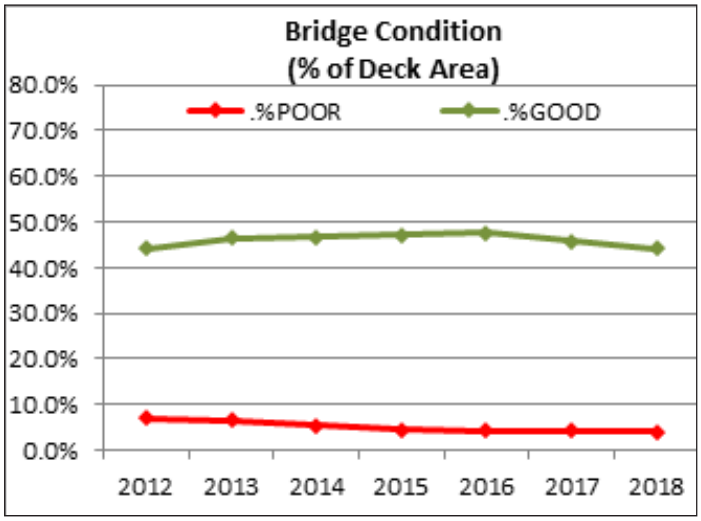


Figure 2-17: Historical Bridge Performance Rating on NHS Local Routes

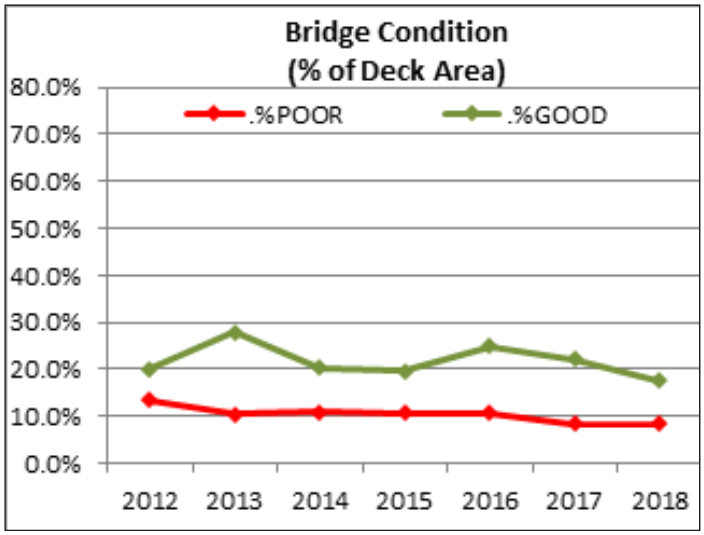
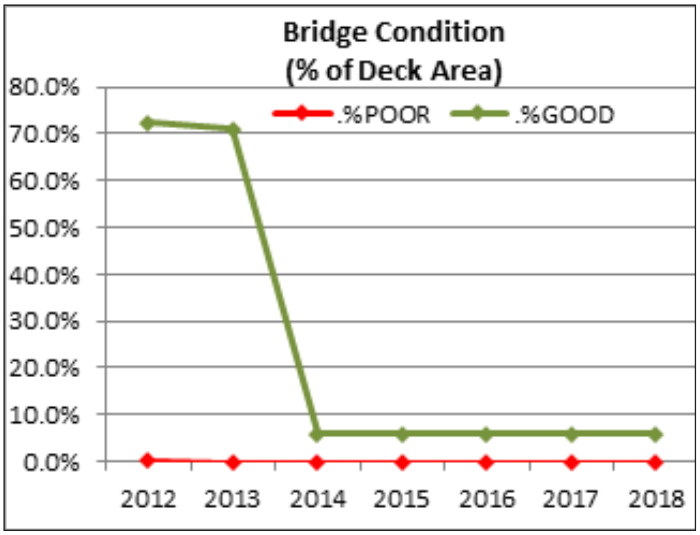


Figure 2-18: Historical Bridge Performance Rating on NHS Federal Routes



Chapter 3

Performance Goals & Targets

What are Performance Goals & Targets?

TDOT has historically tracked the condition of pavements and bridges throughout the state in order to evaluate the transportation system's performance. Performance measures and targets were established based on the operations, future conditions, and maintenance of the roadway system in conjunction with customer input. These performance measures have served as a good basis for TDOT to determine investment strategy, funding amounts, and project identification and provide a good foundation for the TAMP.

The national performance management measures and targets required by MAP-21 to address the condition of pavements and bridges on both the interstate system and the NHS are discussed in this chapter. TDOT has defined specific performance targets that constitute the agency's state of good repair (SOGR) for pavement and bridges on the NHS. In addition to these requirements, TDOT has established performance measures and targets for state-owned pavement and bridges not on the NHS.

Establishing performance measures and targets is fundamental to creating an asset management plan that supports the management and performance of the NHS, as well as to identify the need for preservation, maintenance, rehabilitation, or construction of new facilities. Tracking measurable conditions for pavements and bridges in relation to targets is a useful tool for TDOT to determine if the agency's goals for performance are being achieved at a network level as well as at a regional or a local level. It is also a transparent tool for TDOT to identify where funds benefit the NHS both on and off interstates.

TDOT tracks pavement and bridge conditions in a pavement management system and a bridge management system. The historic condition for each of the measurable conditions tracked are shown in Chapter 2. For pavement metrics, TDOT collects data based on ride quality (Pavement Serviceability Index) and condition (Pavement Distress Index). These two indexes are consolidated to calculate a Pavement Quality Index (PQI) which is used to gauge the overall condition of pavements. The schedule for pavement evaluation is annually on the interstate and NHS state routes and bi-annually on non-NHS state routes. For bridges, TDOT tracks the sufficiency rating of the bridge which is determined from the condition of the bridge deck, superstructure, and substructure. For large culverts (greater than 20' along the centerline of the highway), TDOT tracks the overall condition. Bridges (including large culverts) are inspected biennially.

It is important to note that TDOT historically meets or exceeds the national performance minimum standards established by MAP-21 for pavement and bridge conditions, as will be shown in the following sections of this chapter.

What are the National Performance Management Measures & Minimum Standards for Pavements & Bridges?

PAVEMENTS

Through MAP-21, national performance goals have been established for pavements and bridges to maintain the condition of these assets in a state of good repair. The National Performance Management Measures for pavements identified in 23 CFR Part 490 have established four (4) measures to assess pavement condition:

1. Percentage of pavements (Lane Miles) on the interstate system in Good condition,
2. Percentage of pavements (Lane Miles) on the interstate system in Poor condition,

3. Percentage of pavements (Lane Miles) on the NHS (excluding the interstate system) in Good condition, and
4. Percentage of pavements (Lane Miles) on the NHS (excluding the interstate system) in Poor condition.

Within the national rule, performance ratings of good, fair, and poor condition for pavements have been established by FHWA based on a combination of several metrics typically collected by every state DOT including TDOT. FHWA will use these metrics to quantify the condition of pavements in terms of roughness (IRI), cracking, rutting (asphalt) and faulting (concrete). Table 3-1 below summarizes the metrics and the performance ratings, as identified by FHWA.

Table 3-1: FAST Act Pavement Metrics and Performance Ratings

METRIC	PAVEMENT TYPE	GOOD	FAIR	POOR
IRI	ALL	<95	95 to 170	>170
Cracking	Asphalt	<5%	5% to 20%	>20%
Cracking	Jointed Concrete	<5%	5% to 15%	>15%
Cracking	CRCP	<5%	5% to 10%	>10%
Rutting	Asphalt	<0.20"	0.20" to 0.40"	>0.40"
Faulting	Jointed Concrete	<0.10"	0.10" to 0.15"	>0.15"

Using this criterion, an asphalt pavement is considered to be in good condition only if all three (3) metrics, consisting of IRI, percent cracking, and rutting, meets the criteria for good. The pavement is considered to be in poor condition if any two (2) of the three (3) metrics (IRI, percent cracking, and rutting) are determined to be in poor condition. Finally, the pavement is classified as fair if it doesn't meet the criteria of the good or poor conditions.

Similarly, a jointed concrete pavement is considered to be in good condition only if all three (3) metrics, consisting of IRI, percent cracking, and faulting, meets the criteria for good. The pavement is considered

to be in poor condition if any two (2) of the three (3) metrics (IRI, percent cracking, and faulting) are determined to be in poor condition. Finally, the pavement is classified as fair if it doesn't meet the criteria of the good or poor classification.

Continuously Reinforced Concrete Pavement (CRCP) is evaluated only on two (2) metrics; IRI and cracking. CRCP is considered to be in good condition if both metrics of IRI and cracking is determined to meet the criteria for good. It is considered to be in poor condition if both IRI and cracking is determined to meet the criteria for poor. It is considered to be in fair condition if it doesn't meet the criteria of the good or poor classification. The following Table 3-2 provides a summarization of this information along with the applicable federal rule, and the minimum standard for interstate pavements.

Table 3-2: FAST Act Good/Fair/Poor Determination for Interstate Pavements and Minimum Standard

Rule	23 CFR Part 490.313 (c)				23 CFR Part 490.315(a)
Pavement Type	Metrics	Good	Poor	Fair	Minimum Standard (Interstate)
Asphalt	IRI, Cracking, Rutting	All 3 = Good	2 of 3 = Poor	All other combinations	<5% in Poor condition
Jointed Concrete	IRI, Cracking, Rutting	All 3 = Good	2 of 3 = Poor	All other combinations	<5% in Poor condition
CRCP	IRI, Cracking	All 2 = Good	2 of 2 = Poor	All other combinations	<5% in Poor condition

In order to give state and local agencies time to modify the way they collect pavement condition data to meet these collection standards, the national rule provides for a transition period. State DOTs will only be measured based on IRI rating until after the data collection cycle ending December 31, 2018 for interstate highways and December 31, 2020 for the non-interstate NHS. After these dates, state DOTs will be evaluated based on the metrics identified in Table 3-2, and will also be required to limit the portion of their inventory data that is missing, invalid, or unresolved to no more than five (5) percent.

BRIDGES

The process for determining the condition of bridges is similar in concept to that for pavements. The national performance management measures for bridges identified in 23 CFR Part 490 have established three (3) classifications for the purpose of assessing bridge condition (based on square foot of deck area):

1. Percent of NHS bridges classified as in good condition,
2. Percent of NHS bridges classified as in fair condition, and
3. Percent of NHS bridges classified as in poor condition.

Within the national rule, performance ratings of good, fair, and poor condition for bridges have been established by FHWA based on a combination of three (3) metrics that are collected by every state DOT including TDOT. FHWA will use these metrics on a 0 to 9 condition scale to quantify the condition of bridges in terms of bridge deck, superstructure, and substructure. Culverts will be evaluated based on their overall condition. The following Tables 3-3 and 3-4 summarize the metrics and the performance ratings.

Condition is determined by the lowest rating of deck, superstructure, substructure, or culvert. If the lowest rating is greater than or equal to 7, the bridge is classified as good; if the lowest rating is less than or equal to 4, the classification is poor. Bridges rated below 7 but above 4 will be classified as fair; there is no related performance measure.

Table 3-3: FAST Act Components and Performance Ratings

Component	GOOD	FAIR	POOR (Structurally **Deficient)**
Deck	7 to 9	5 to 6	0 to 4
Superstructure	7 to 9	5 to 6	0 to 4
Substructure	7 to 9	5 to 6	0 to 4
Culverts	7 to 9	5 to 6	0 to 4

Table 3-4: FAST Act Good/Fair/Poor Determination for NHS Bridges and Minimum Standard

Rule	23 CFR Part 490.409(b)				23 CFR Part 490.411(a)
Structure Type	Component	Good	Poor (Structurally Deficient)	Fair	Minimum Standard (NHS bridges)
Bridge	Deck, Superstructure, Substructure	All Components = Good	1 or more Components = Poor	All other combinations	< = 10% of total deck area rated as POOR (Structurally Deficient)
Culvert	Overall Condition Rating	Rating = Good	Rating = Poor	Rating = Fair	

What are TDOT's Targets for the National Performance Management Measures for Pavements and Bridges?

TDOT has established performance targets for the National Performance Management Measures identified in 23 CFR Part 490 as indicated in Table 3-5. An Oversight Committee consisting of key TDOT managers was established to provide oversight and coordination for implementation of all MAP-21 and FAST Act final rules, including development of performance targets.

Table 3-5: TDOT National Performance Management Targets

Asset	System	% Good			% Poor		
		2-year	4-year	Baseline	2--year	4-year	Baseline
Pavements	Interstate	N/A	>60%	N/A	N/A	<1%	N/A
	Non-Interstate NHS	>40%	>40%	44.8%	<4%	<4%	3.2%
Bridges*	NHS (Interstate and non-Interstate)	>36%	>36%	39.5%	>36%	>36%	39.5%

Basis for Non-Interstate National Highway System (NHS) Pavement in Good Condition:

Non-interstate targets are based on the "full measure" as defined in 23 CFR 490.313(c), not IRI alone as defined in paragraph e of the same section. Targets were established per the full measure on time in accordance with the law as defined in 23 CFR 490.105(e). Using the "full measure", TDOT estimated a baseline value of 44.8%. Performance projections of the full measure at current funding levels extended below what TDOT considers an acceptable state of good repair, so a minimum target was selected within range of TDOT's historical state of good repair.

Performance projections using IRI alone, in which projected decline is much less severe, indicate non-interstate NHS % Good will be 72.8% at the mid-performance period and 72.2% by the end of the performance period.

Basis for Non-Interstate National Highway System (NHS) Pavement in Poor Condition:

Non-interstate targets are based on the "full measure" as defined in 23 CFR 490.313(c), not IRI alone as defined in paragraph e of the same section. Targets were established per the full measure on time in accordance with the law as defined in 23 CFR 490.105(e) and may be adjusted during the mid-performance period. Using the "full measure", TDOT estimated a baseline value of 3.2%. Based on network analysis of the full measure using pavement management data, it is expected that values for % Poor will stay within reasonable range of recent historical observations. Thus, targets were set within a similar range.

Historical calculations of using IRI alone indicate a gradual increase in %Poor. Projects for 2019 and 2021 % Poor using IRI alone are 7.0 and 7.3%, respectively.

How has TDOT Defined State of Good Repair for Pavement and Bridges?

TDOT has a long-standing history of maintaining the state's pavement and bridges in good condition, which are serviceable to Tennesseans based on the traffic they serve. The agency's long-term goals are to maintain pavement and bridges in a state of good repair throughout the asset's life time at the lowest possible cost.

TDOT has established long-term performance targets for pavements and bridges based on their importance and functional need. For example, interstate highways are the most important facilities since they provide the backbone for the movement of people, freight, and commerce within the state as well as across the nation. Historically, TDOT has not differentiated between state routes that are on the NHS and those that are not part of the NHS; however, this will change in the near future, and TDOT will ensure that NHS routes are meeting the established targets for that system. The following Tables, 3-6 and 3-7, provide the state of good repair performance measures and targets for the agency's pavements and bridges based on highway system. It should be noted that for bridges, TDOT has established the same performance measures and targets for the state's SOGR as for the national performance management measures.

Table 3-6: State of Good Repair Performance Measures

Asset	System	Performance Measure	Good	Poor
Pavements	Interstate	PQI	PQI >4.0	PQI <2.0
	Non-Interstate NHS	PQI	PQI >3.5	PQI <2.0
	Non-NHS State	PQI	PQI >3.5	PQI <2.0
Bridges*	Interstate	Condition ratings for Deck, Superstructure, Substructure	All three ≥7	One or more ≤4
	Non-Interstate NHS	Condition ratings for Deck, Superstructure, Substructure	All three ≥7	One or more ≤4
	Non-NHS State	Condition ratings for Deck, Superstructure, Substructure	All three ≥7	One or more ≤4

*Based on square feet of bridge deck

Table 3-7: TDOT State of Good Repair Targets

Asset	System	Good	Poor
Pave-ments	Interstate	>50%	<0.5%
	Non-Interstate NHS	>45%	<0.5%
	Non-NHS State	>45%	<0.5%
Bridges*	Interstate	>36%	<6%
	Non-Interstate NHS	>36%	<6%
	Non-NHS State	>36%	<6%

*Based on square feet of bridge deck

What is the Gap Between Pavement Performance and Targets?

As described previously, TDOT tracks Pavement Quality Index (PQI) for asphalt and concrete to determine the condition of the roadways. The PQI is a composite index number based primarily on the ride quality of the pavement, (Pavement Smoothness Index), and the condition of the pavement, (Pavement Distress Index), and is measured on a 0 to 5 scale. A pavement on the interstate system with a PQI greater than 4.0 is in good condition, while a pavement with a PQI of less than 2.0 is in poor condition. Similarly, pavements on non-interstate NHS and non-NHS state routes with a PQI greater than 3.5 are considered to be in good condition and pavements with a PQI less than 2.0 is in poor condition.

Using these characteristics, pavement performance is calculated and reported per number of lane miles. These results are used to assist the department in determining funding amounts, allocations to the four TDOT regions, and choosing the appropriate work types to minimize whole-life cost, i.e. a combination of maintenance, preservation, rehabilitation, or reconstruction needed for the roadways.

Figures 3-1 through 3-4 below show the PQI rating for each system of roadway from 2012 to 2018. As shown, in 2018, 52% of lane miles on the interstates had a PQI >4.0, which is above the SOGR target of 50%. In 2018, 54.7% of NHS state routes and 47.3% of non-NHS state routes had a PQI >3.5, which are both above the SOGR target of 45% for non-interstate state routes. Local MPO's who own routes on the NHS have agreed to accept TDOT's targets for State of Good Repair, thus the same target has been shown in Figure 3-3 for locally owned NHS routes.

Figure 3-1: Historical Pavement Performance Rating and Target on Interstates

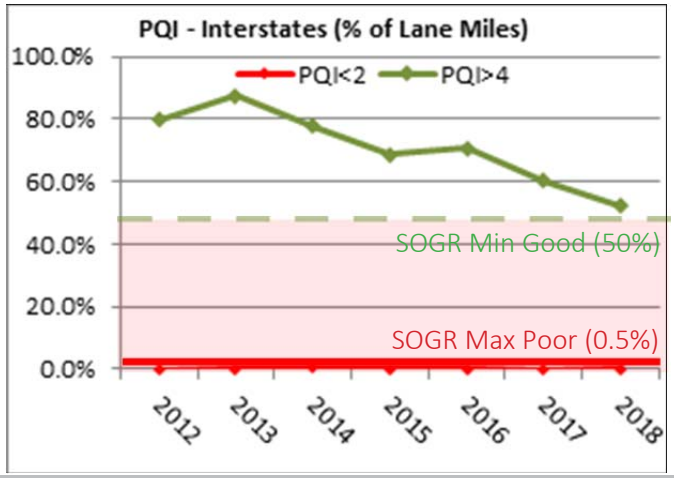


Figure 3-2: Historical Pavement Performance Rating and Target on NHS State Routes

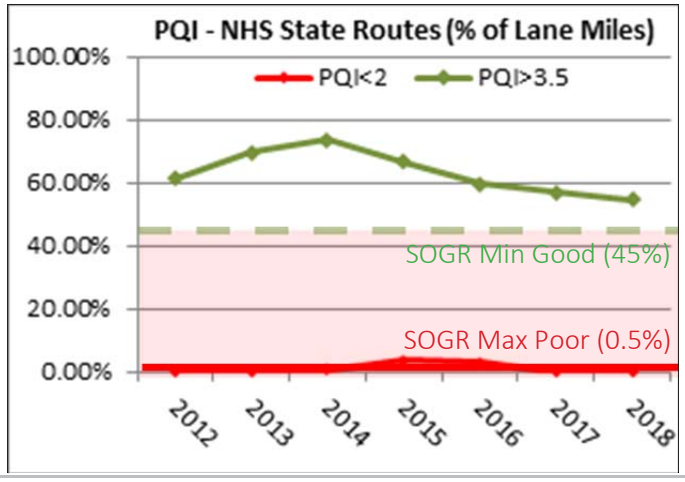


Figure 3-3: Historical Pavement Performance Rating and Target on NHS Local Routes

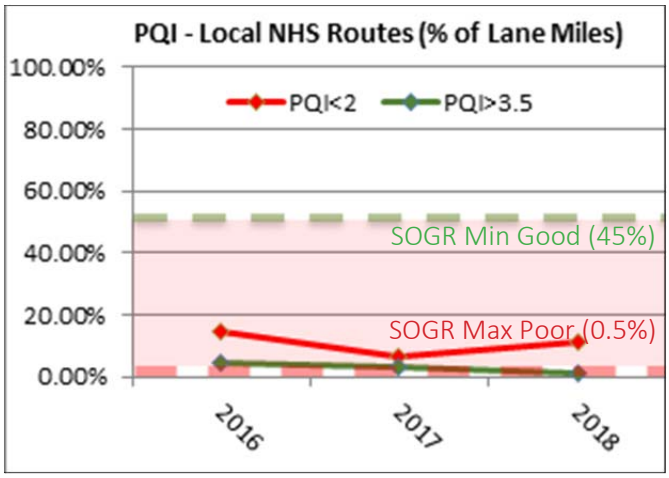
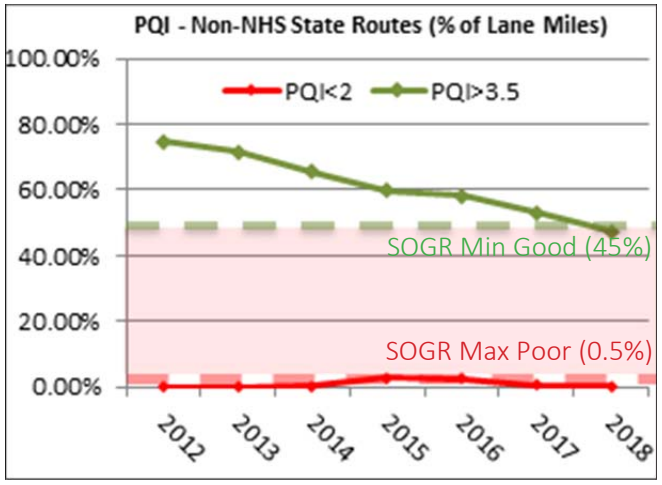


Figure 3-4: Historical Pavement Performance Rating and Target on Non-NHS State Routes



What is the Gap Between Bridge Performance and Targets?

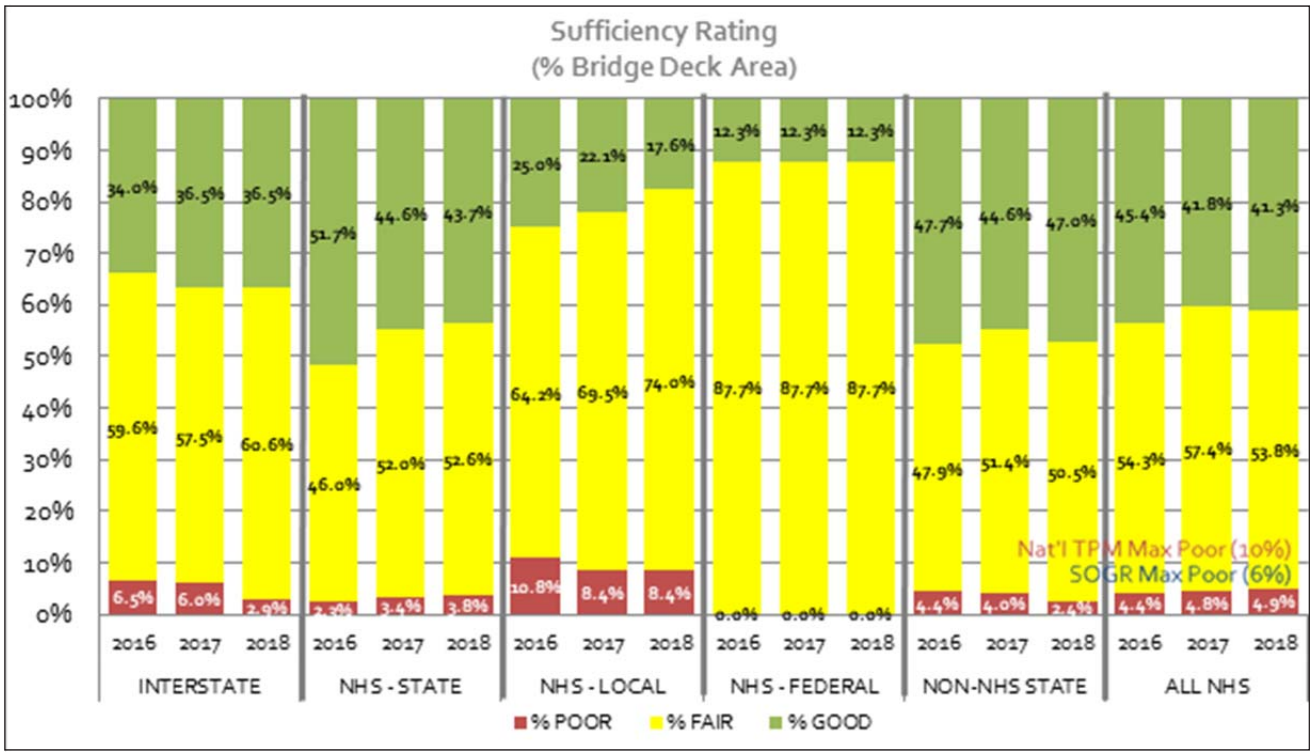
Since TDOT has established a dependable bridge management process using the NBIS inspection reports to determine program and project needs, the department will be able to make a smooth transition to the TAMP requirements. The inspection program requires an in-depth evaluation of the deck, substructure, and superstructure for bridges, and key features of large culverts based on the national bridge inspection standards. The results from the inspections are used to determine the type of work activity required for the bridge or large culvert, i.e. maintenance, preservation, rehabilitation, or replacement.

Although the overall condition of the bridge is reported in the sufficiency rating, the condition of the deck, substructure, and superstructure may trigger work needed to preserve the bridge and extend the life cycle of the structure. The target value for each of the metrics is six (6) or higher. If it is lower than a six (6), the bridge becomes a candidate for a preservation treatment or some type of maintenance plan to address the deficiency. If the condition is less than a five (5), other major work type is considered such as rehabilitation or even replacement of the entire structure.

The sufficiency rating which reflects the compilation of the deck, substructure, and superstructure evaluation or the large culvert evaluation is used to determine the maintenance or preservation method needed for the bridge or large culvert. The following Figure 3-5 shows the sufficiency rating for the

bridge inspections conducted in 2016-2018 on each system. As shown, in 2018 there were 2.9% of interstate bridges rated as poor, 3.8% on the non-interstate NHS state routes, 8.4% on the NHS local routes, 0% on federal routes, and 2.4% on non-NHS state routes. TDOT's bridges are within the agency's SOGR targets of 36% in good condition with no more than 6% of all state-owned bridges in poor condition. TDOT has not previously set any targets for federal or locally-owned bridges, thus no target is shown for those systems. In terms of how Tennessee's bridges compare with the national performance minimum standard (<= 10% of deck area rated poor), it is noted that only 4.9% of all bridges on the NHS are rated poor and well within the agency's targets of 36% in good condition and no more than 6% in poor condition.

Figure 3-5: Bridge Condition Rating



How Does TDOT Stay Ahead of the Performance Targets?

As described by the performance measures and targets, TDOT is currently meeting or exceeding the federal minimum performance standards for NHS pavements and bridges. To enhance TDOT's ability to maintain this high standard of bridge conditions that have been historically established, the agency has recently implemented a new bridge management system (BMS). The new BMS will assist the agency in predicting the future needs to preserve the system and maximize the use of their assets at minimum cost. The BMS is used to track the metrics of the bridges and large culverts as described in Chapter 2. This same system can be used to evaluate future needs through life cycle analysis. Similarly,

the Pavement Management System (PMS) is the engine that stores the results of the pavement condition survey and provides the analysis to assist TDOT managers with the information and data to develop pavement management programs to meet TDOT's goals and objectives using life cycle cost processes discussed more detail in Chapter 4.

It is difficult to predict what will happen over the course of the next ten (10) years and even more difficult to predict future traffic growth on a statewide level. While there is no perfect method for prediction of the future growth, traffic models are used to provide the best possible information for growth scenarios. The industry standard for a small study area is to review the historical growth in an area and assume the same amount of growth continues for the foreseeable future. However, to predict traffic growth for a ten-year horizon statewide, the statewide model was reviewed to predict growth for specific metropolitan areas in the state and for the remaining rural areas of Tennessee. The percentage of growth expected to be seen in the next ten (10) years is shown in the table below:

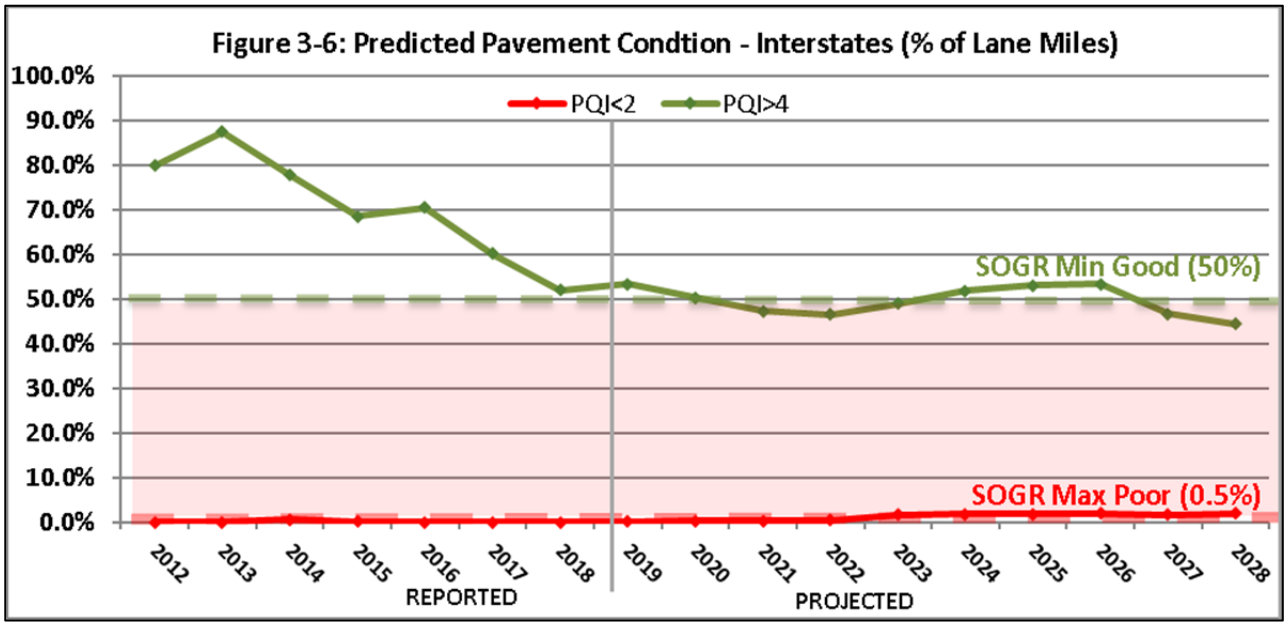
Table 3-8: Growth Rate Table

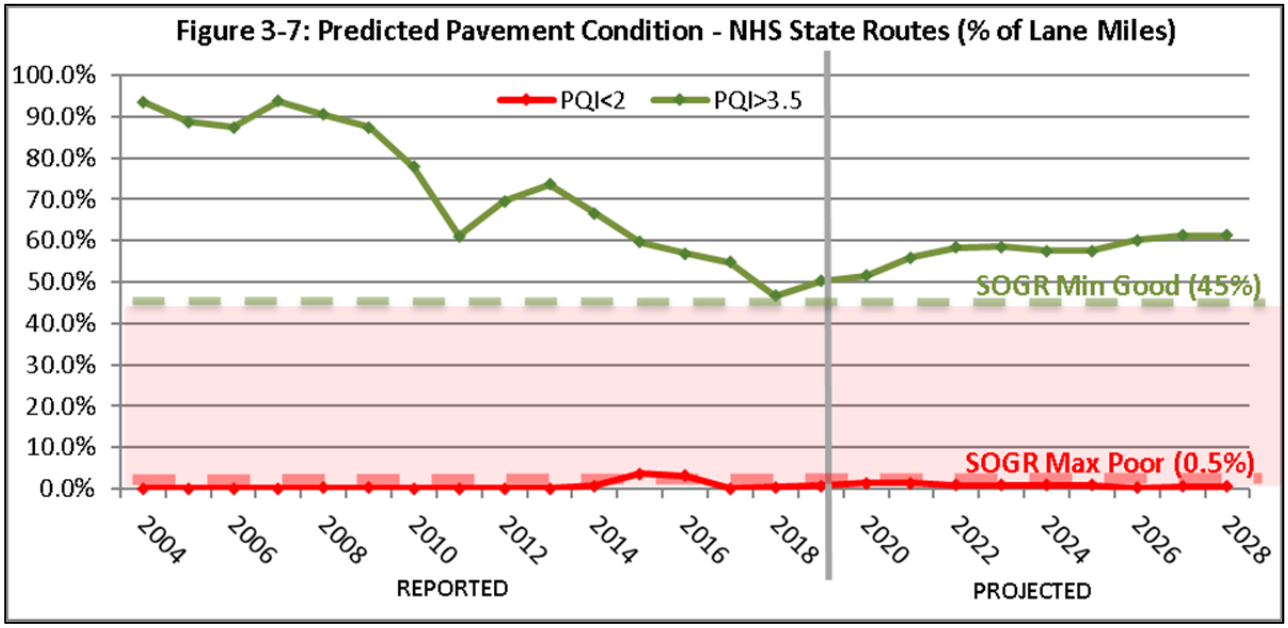
Area	10 Year Growth Rate (Statewide Model)
Greater Chattanooga	0.9%
Greater Knoxville	1.1%
Jackson	1.0%
Memphis	0.9%
Middle TN	1.5%
Tri-Cities	0.8%
Areas Outside MPO's	1.1%

These growth rate factors can be applied to each area of Tennessee using the PMS and BMS to help with the future analysis of the pavement and bridge conditions. The department can use this analysis to plan for maintenance and repair of the pavement and bridges over the next ten (10) years.

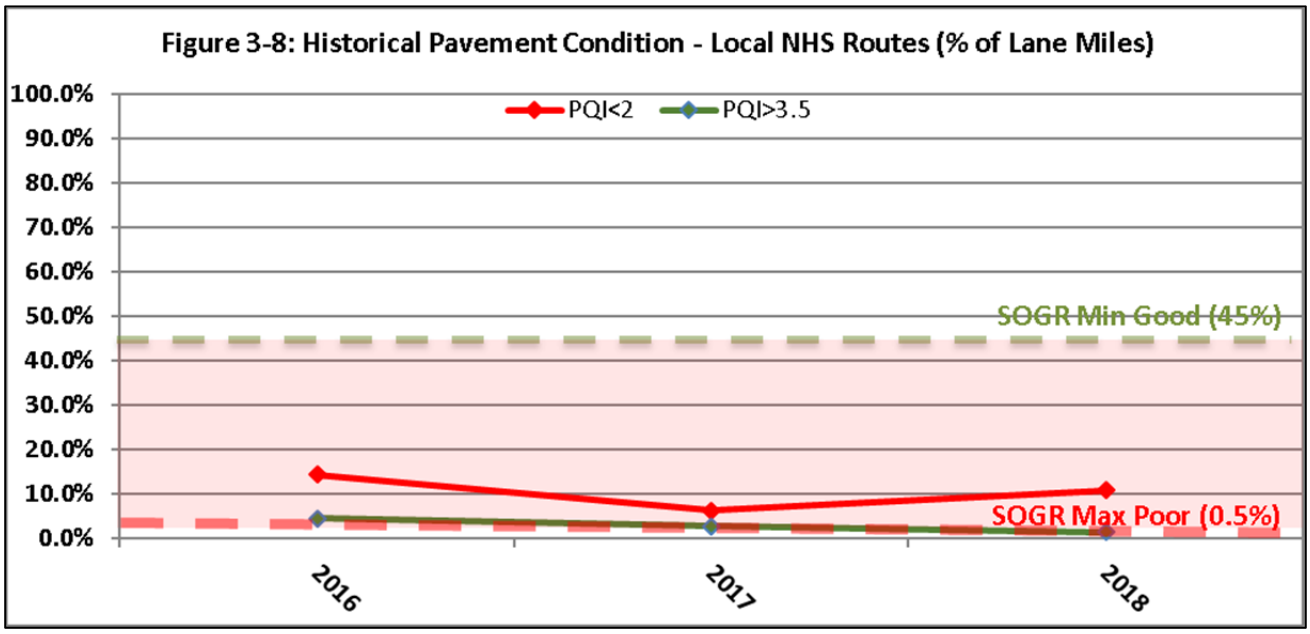
What is TDOT's Predicted Pavement Condition (10 years)?

Using the PMS, TDOT has projected the percentage of lane miles in good and poor condition for the years 2018 – 2028 on each of the route systems shown in Figures 3-6 through 3-9 below. Figure 3-6 shows that, with current available funding levels ($66 million), the pavement conditions for the interstate system are expected to dip slightly below TDOT's target of at least 50% of lane miles with a PQI > 4.0 over the next 10 years. Figure 3-7 shows how the pavement condition is predicted to remain above the minimum of 45% of lane miles with a PQI > 4.0 over the next 10 years.





PROJECTED



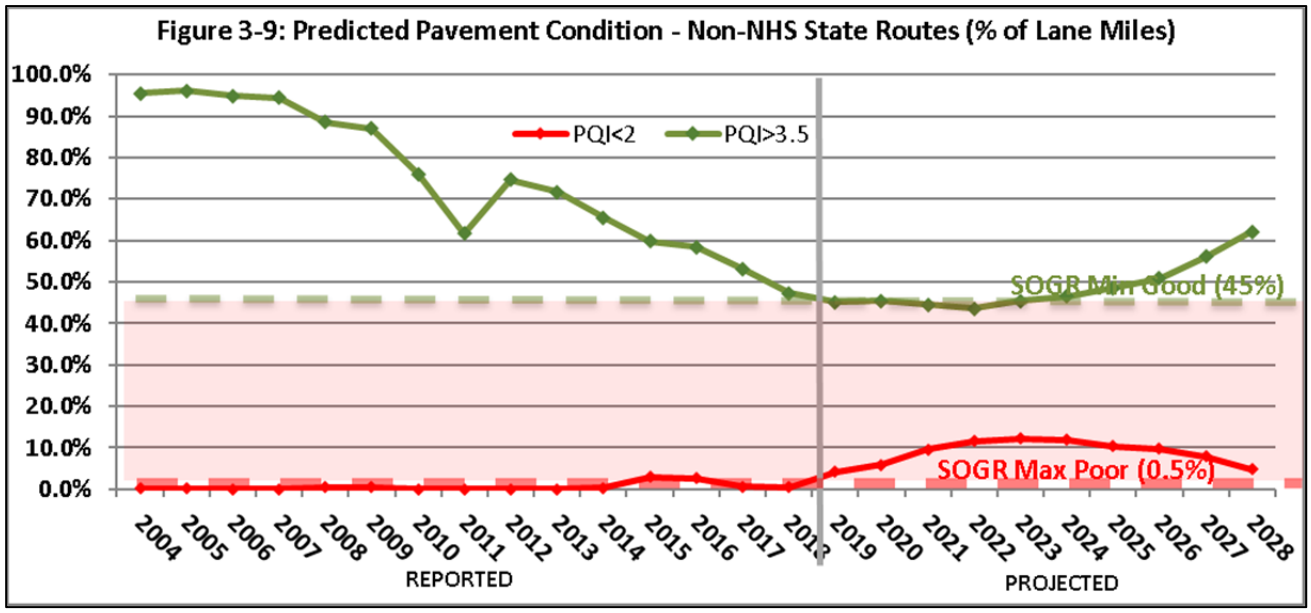


Figure 3-8 shows historical pavement condition on the local NHS routes, but does not include any prediction for future years. This is because TDOT does not have access to construction history on local NHS routes, which is required for predicting performance. TDOT is working with MPOs to gather this information and will project future performance in later versions of the TAMP.

Figure 3-9 contains a projection of the performance of pavements on state routes that are not part of the NHS. Although this group makes up the majority of the lane miles in TDOT's inventory (64%), this data indicates that the condition has historically been well above the target and is expected to

remain at or above the target for the majority of years within the analysis period. The percentage of non-NHS state routes with a PQI<2.0 is projected to get as high as 12% at current funding, which is far above TDOT's target of 0.5%.

Pavement management analyses can be conducted many different ways, each with their own particular benefits and inaccuracies. The figures shown in this chapter are designed to maximize cost-effectiveness of treatment selections. By the analysis shown, TDOT's interstate and NHS routes are projected to remain within the SOGR targets for % Good with current funding, but projections indicate targets may likely not be met for % Poor on non-NHS routes. An alternative analysis adjusted to meet % Poor targets, known as a "worst first" approach, produces projections where TDOT does not meet its targets for % Good. A more likely reality is that a combination of the two selection approaches – maximizing cost-effectiveness while minimizing the percentage of "Poor" roads – will result, but a combined analysis such as this is not currently possible. The Department is currently working to improve analyses in an effort to generate realistic output that confidently assesses whether increased funding is required. Concurrently, processes are being implemented to ensure pavement management predictions are properly being utilized as a resource for project selection. An assessment will be made annually on the Department's confidence with performance prediction. Once enough confidence is gained in performance predictions and those analyses properly verify the Department is efficiently selecting projects, a funding needs assessment will be made.

While those state routes that are not part of the NHS may not carry as much traffic as those designated as NHS routes, they still carry a fairly substantial portion of vehicular traffic in the state, and are an important part of our transportation network. While this decision may not have implications regarding TDOT's ability to comply with MAP-21 requirements, it is still an important investment decision for the agency going forward, which could impact how state dollars are invested in other areas of concern (safety, bridges, capacity, transit, etc.).

What is TDOT's Predicted Bridge Condition (10 years)?

Since TDOT's BMS does not yet have the capability of forecasting bridge condition, the department has chosen to predict the condition of the bridges, from 2019 to 2028, using a straight-line projection. TDOT continues to refine the condition forecasting capabilities of its BMS to improve their ability to predict the condition of the bridges over time, based on various funding scenarios. The

results of the current straight-line average forecast are broken down for each facility type in Figures 3-10 through 3-15.

Figure 3-10 shows that the percentage of interstate bridges in poor condition is projected to remain below 4% over the next ten (10) years, which is well below the national performance minimum standard of no more than 10% in poor condition and also meeting TDOT's SOGR target of less than 6% poor and at least 36% good. Figure 3-11 shows that all NHS bridges are also expected to meet these targets, coming in at under 6% poor each year.

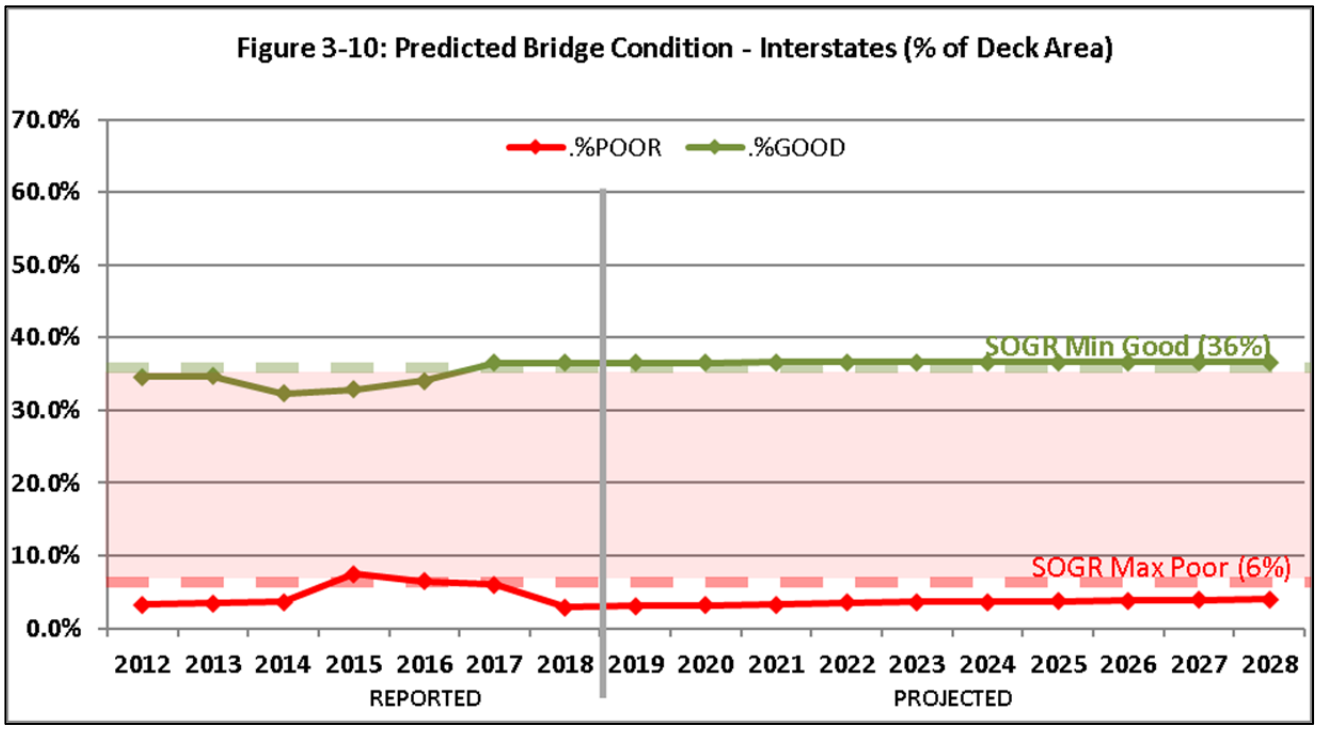


Figure 3-10: Predicted Bridge Condition - Interstates (% of Deck Area)
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
.%POOR
.%GOOD
SOGR Min Good (36%)
SOGR Max Poor (6%)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028
REPORTED
PROJECTED

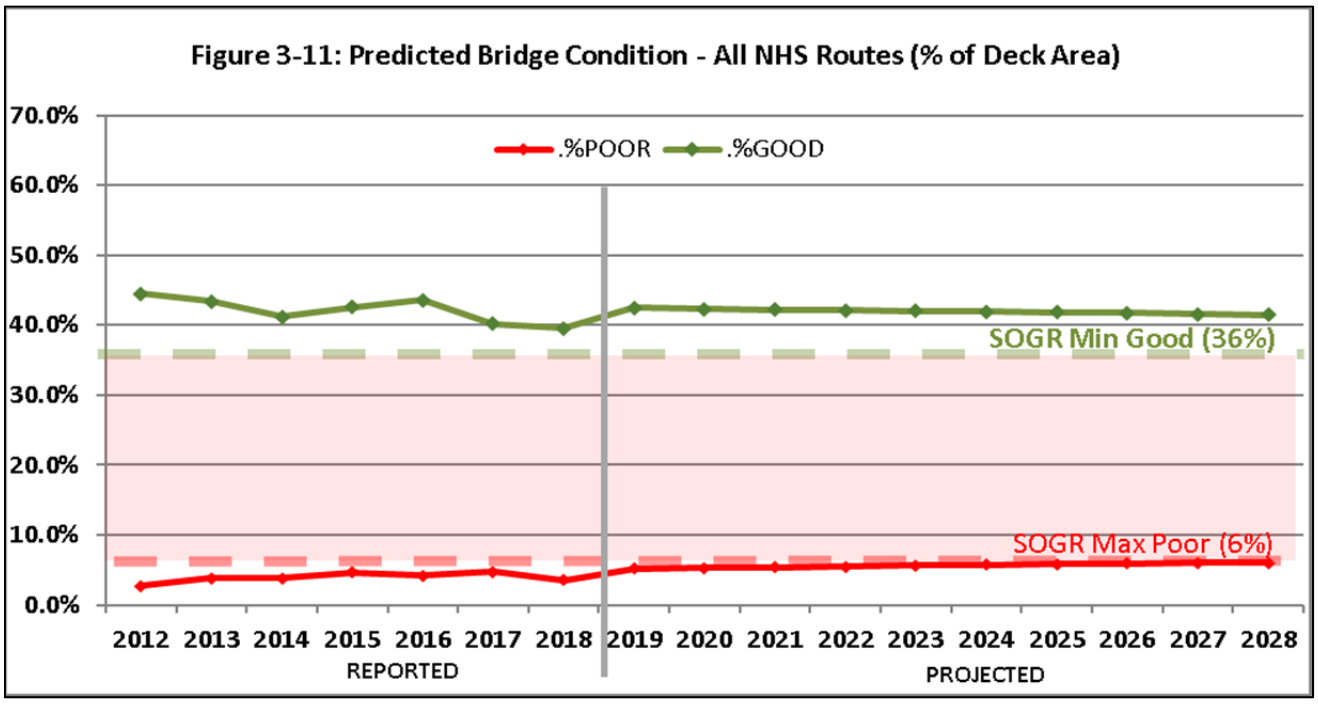
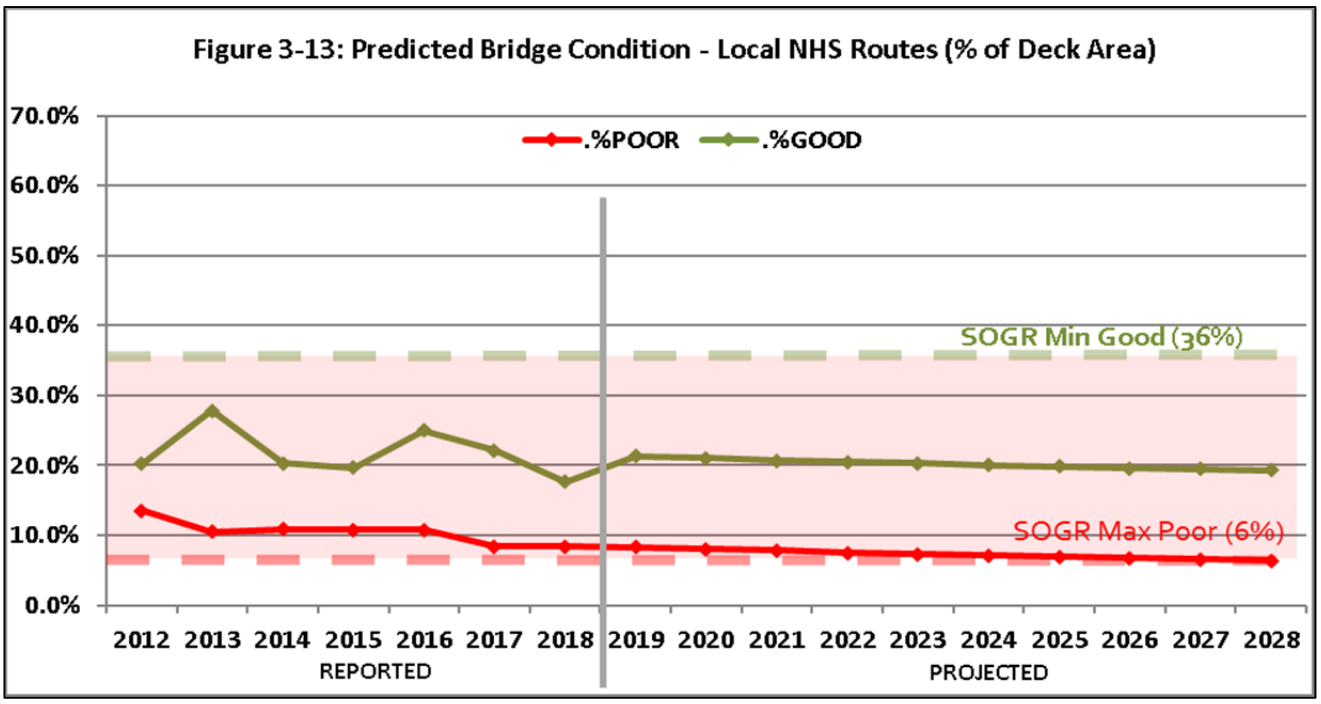
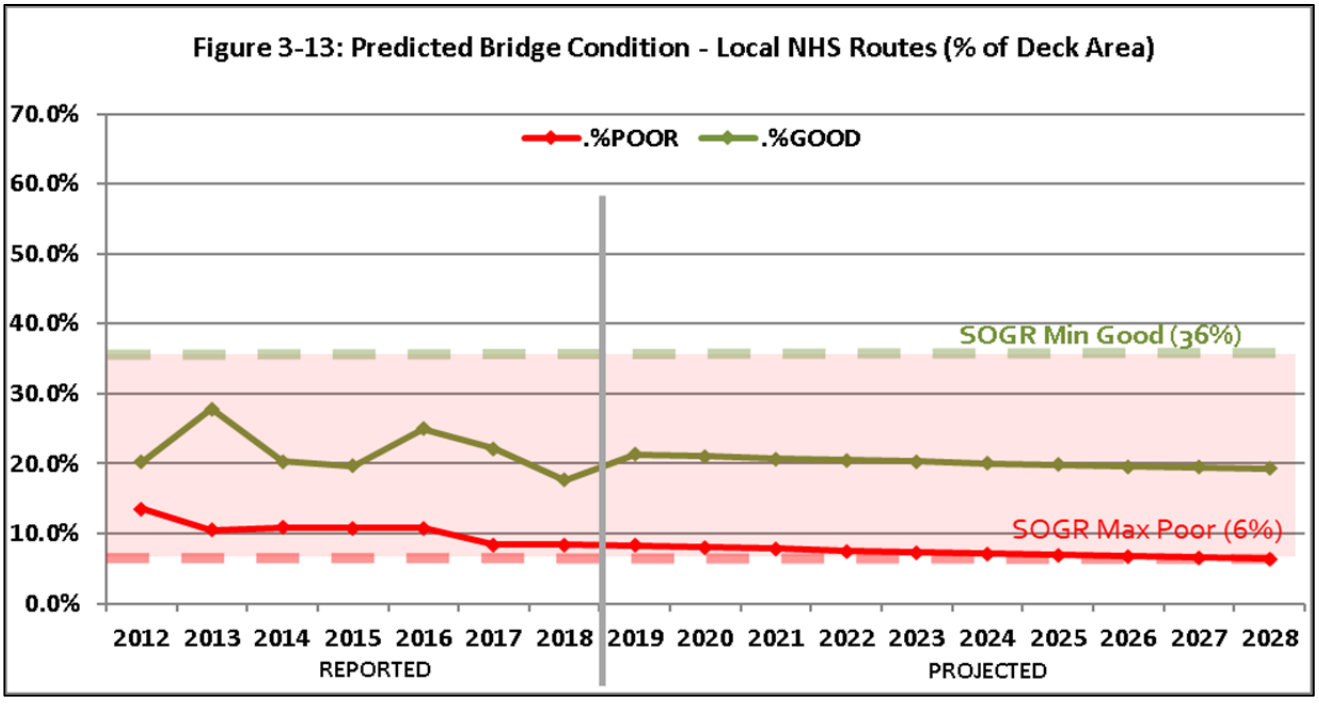


Figure 3-11: Predicted Bridge Condition - All NHS Routes (% of Deck Area)
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
.%POOR
.%GOOD
SOGR Min Good (36%)
SOGR Max Poor (6%)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028
REPORTED
PROJECTED



In Figure 3-12, state-owned Non-NHS bridges are predicted to remain below 4% poor, while in Figure 3-13, local NHS bridges are anticipated to decrease from 8.4% to 6.4% over the same ten (10) year period. Local agencies have elected to accept the state DOT's state of good repair targets of 36% good and 6% poor bridge deck area.



The estimated funding to achieve these SOGR targets for bridges is approximately $136 million per year. Around $85 million per year is expected to fund construction of replacement of deficient bridges, while approximately $40 million will be used for design and construction costs for rehabilitation and repair projects, and $4.4 million will be reserved for bridge preservation treatments. The remaining $5 million will fund the bridge maintenance program.

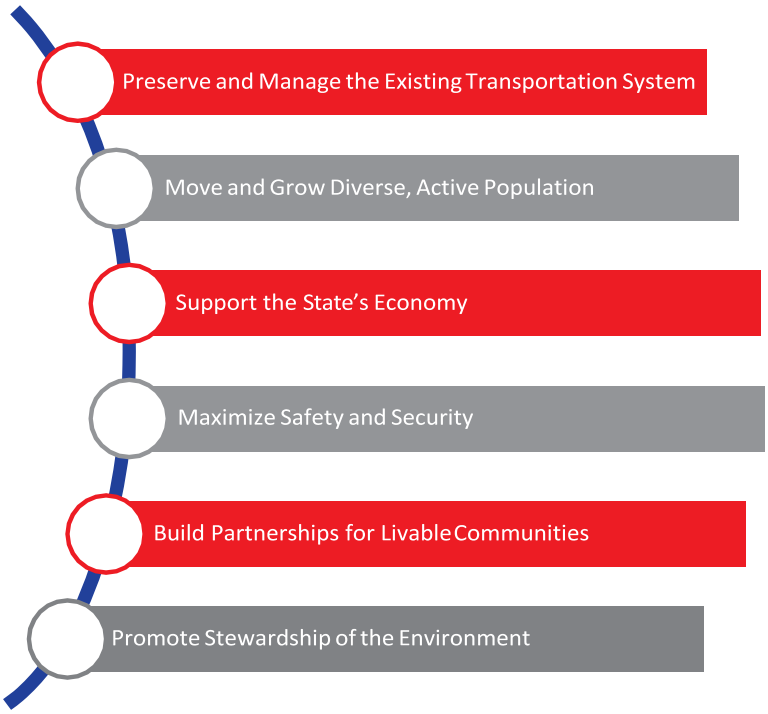
The bridge management budget has been relatively flat over the past several years; however, TDOT expects to increase funding by about $1 million annually to keep up with inflation and to allow for additional projects to be completed each year. Although TDOT does not assign funding for bridges by system, certain factors are considered during the project selection process, which impacts where those bridges carrying higher volumes of traffic will end up on the priority list. Since the interstate and NHS routes tend to carry the most traffic, they tend to be prioritized for repair/rehabilitation/replacement before the lower volume bridges. This ensures that the NHS and interstate bridges continue to remain in a state of good repair and keeps Tennessee's bridges among the best in the nation.

What Factors Outside of Physical Condition Affect TDOT's Gap Analysis?

TDOT plans for the operations of the transportation system in multiple ways. Many factors affecting the operations are part of the project selection process for the State Transportation Improvement Plan (STIP). Locations that commonly experience bottleneck or congestion problems, that see heavy truck traffic, or that experience traffic growth due to new developments are all issues that receive priority as part of the selection process.

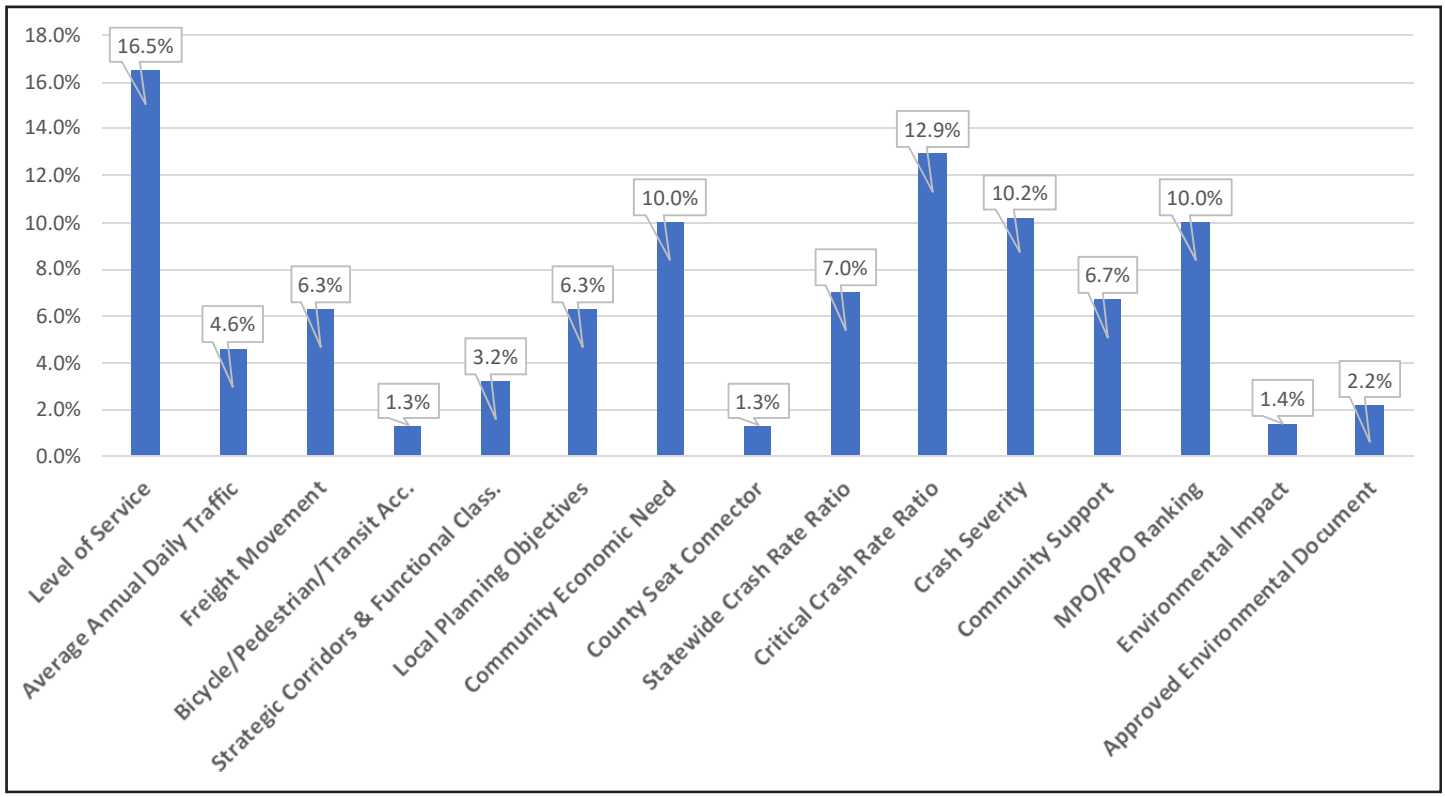
The items included in the project selection process are categorized to align with the Guiding Principles (see Figure 3-14) established as part of TDOT's Long Range Policy Plan. Each of the categories has several time frames that

Figure 3-14: TDOT's Guiding Principles for Developing the STIP



determine the scoring for that goal. Under the goal to Preserve and Manage the Existing Transportation System, the evaluated items include level of service (LOS), average annual daily traffic (AADT), and freight movement (see Figure 3-15 below). The LOS is weighted the most and will see the impacts of the traffic growth discussed earlier. It is important to note that the goals of the matrix are established in order to address the operations of the transportation system and currently don't include a score for the asset condition.

Figure 3-15: STIP Project Selection Prioritization Matrix Weighting



Several of the goals include weighted scores for roadways that are determined by evaluating an aspect used to measure the effectiveness of the NHS operations for providing safe and efficient movement of people and goods. The list below includes the goal and the specific characteristic evaluated that relate to the effectiveness of the NHS system.

- Move a Growing, Diverse, Active Population
    - Strategic Corridors and Functional Classification – the score is based on the roadway classification and also if it is part of the NHS
- Support the State's Economy
    - Community Economic Need – highways that are identified as a route for industrial or office park locations receive high scores in this category

- Maximize Safety and Security
    - o Statewide Crash Rate Ratio
    - o Critical Crash Rate Ratio
    - o Crash Severity

In order to account for the condition of the pavement and bridges and to ensure that TDOT is able to continue to meet the state of good repair targets, TDOT is considering revising the project selection matrix. Options under consideration are to revise the matrix to establish appropriate criteria and weighting of the PMS and BMS results. Additional options are to give roadways that are part of the NHS an appropriate weighted score to reflect the routes' importance. This addition to the matrix would help address the pavement and bridge condition deficiencies by creating a weighted score which addresses roadways in poor condition.

How Will TDOT Monitor the Performance of Pavement and Bridges?

As explained in earlier portions of this section, TDOT has a number of processes in place to monitor the condition of pavements and bridges and determine if the investment strategy and program of projects are in line with the objectives of the agency and the long-term state of good repair targets. Below is a summary of TDOT processes to identify potential problems, gaps, and development of strategies to head-off issues.

- On an annual basis, pavement condition results will be extracted from the pavement condition survey and reported to TDOT senior management. Additionally, pavement condition performance will be estimated based on current condition and budgetary amounts. Results will be compared to TDOT's long-term state of good repair targets and the targets TDOT will establish as a part of 23 USC 150(d) for the NHS. As described in Chapter 7, the results of the annual pavement performance report will be used to identify issues in TDOT's pavement management program, determination of funding amounts, or other gaps. Adjustments in program strategy and funding will be considered by senior management within the context of the overall vision and funding needs of the department.

- On an annual basis, bridge condition results will be extracted from the bridge management system and reported to TDOT senior management. Additionally, bridge performance will be estimated based on current conditions and budgetary amounts. Results will be compared to TDOT's long-term state of good repair targets and the targets TDOT will establish as a part of

23 USC 150(d) for the NHS. As described in Chapter 7, the results of the annual bridge performance report will be used to identify issues in TDOT's bridge management program, determination of funding amounts, or other gaps. Adjustments in program strategy and funding will be considered by senior management within the context of the overall vision and funding needs of the department.

- TDOT will also evaluate funding needs and effectiveness of the programming of projects, services, and efforts to meet the performance requirements of other sections of MAP-21 on safety, system performance/congestion, freight movement, and congestion mitigation and air quality. All of these various performance expectations will be considered by TDOT's senior management as annual budgets are developed in conjunction with the STIP and 3-Year construction program. With well-defined pavement and bridge programs and systems in place to evaluate the condition and future performance based on life-cycle cost planning, TDOT will be able to make informed decisions based on reliable data and state-of-the-practice analysis.

Chapter 4

Life Cycle Cost

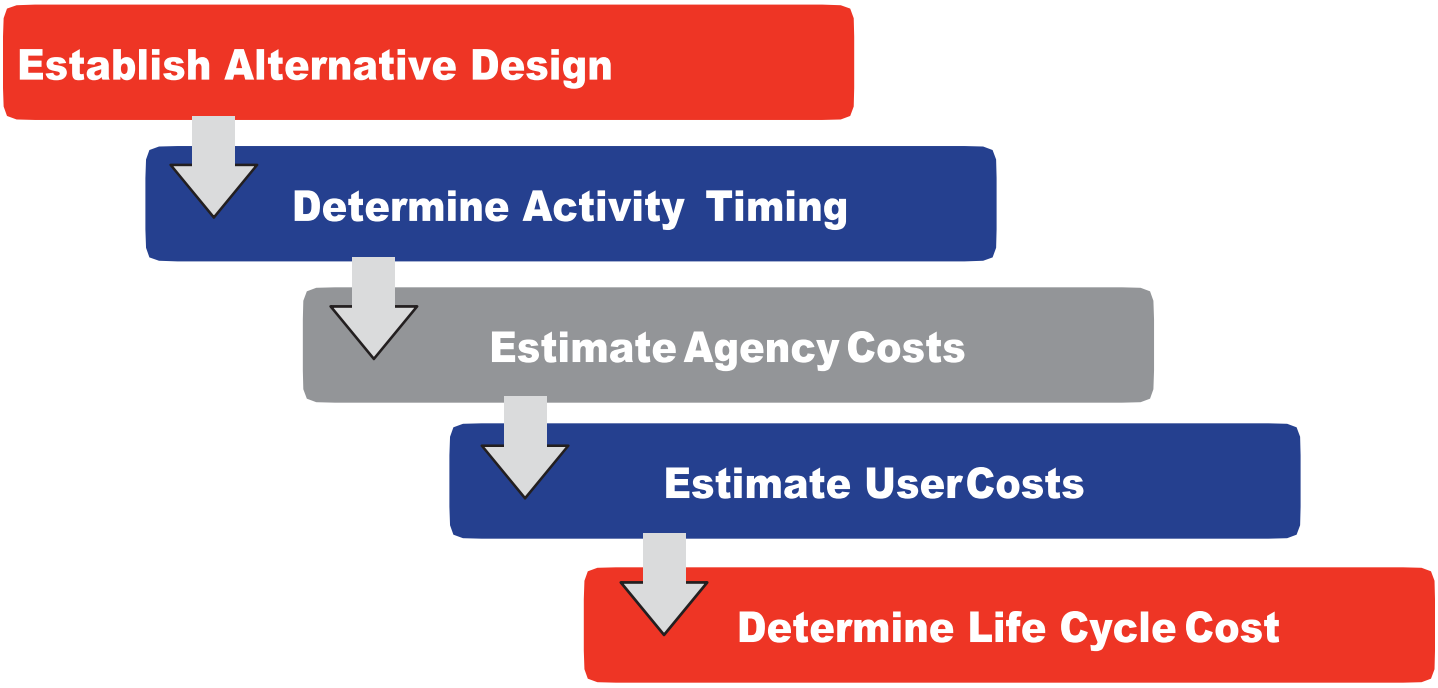
What is Life Cycle Cost Analysis?

TDOT has a long history of providing a well-maintained roadway system for its users. The interstates and state routes have high quality pavement as a result of the state's commitment to preservation methods that extend the life of the pavement. These pavement preservation methods are embedded within the PMS analysis, and the department has solidified its commitment to extending the asset's useful life through a life cycle cost analysis and through policies which promote pavement management principles. TDOT also has a regular bridge inspection program to identify preservation and maintenance needs in a timely manner on its bridges that extend the life cycle. TDOT has recently implemented a modern BMS which provides the capability to perform in-depth life cycle cost analysis to ensure the state's bridges are managed as cost effectively as possible within funding constraints. As required by the federal rules, the following section identifies the process TDOT uses to satisfy the requirements of MAP-21 for life cycle cost (LCC) planning.

In general, LCC analysis considers all the relevant costs incurred throughout the whole life of an asset, not just the initial construction cost. In order to keep an asset functioning adequately, achieve the performance targets established by the agency, and provide users with the level of service that meets their expectation, there are certain actions that must be performed throughout its life. The LCC process begins with the development of different alternatives to fulfill the structural and performance objectives of an asset. A key component of this analysis is the use of deterioration modeling tools to estimate an asset's condition as it ages. This estimation is based on factors such as environment, weather, and, in the case of pavements and bridges, the size and number of vehicle loadings over the life of the asset. The schedule of initial and future activities to maintain an asset's condition at a

predetermined performance level is defined and the costs of these activities are estimated. Direct agency expenditures (i.e. construction, maintenance, preservation, and rehabilitation activities) as well as cost to facility users that result from agency activities are typically included. The predicted schedule of activities and their associated agency and user costs form the projected LCC. Considering all of these costs during the service life of an asset helps the agency to select the lowest cost options to maintain a desired condition at a minimum practicable cost.

Figure 4-1: Life Cycle Cost Analysis Methodology Steps



What are the MAP-21 and Final Rule Requirements?

Life cycle cost and life cycle planning is defined in 23 CFR Part 515.5 as follows:

LIFE CYCLE COST

- The cost of managing an asset class or asset sub-group for its whole life, from initial construction to its replacement.

LIFE CYCLE PLANNING

- A process to estimate the cost of managing an asset class, or asset sub-group over its whole life with consideration for minimizing cost while preserving or improving the condition.

And in 23 CFR Part 515.7, state DOTs are required to develop a risk-based asset management plan to include specific minimum processes including the following section on life cycle planning identified in subsection (b):

> A State DOT shall establish a process for conducting life cycle planning for an asset class or asset subgroup at the network level (network to be defined by the State DOT). As a State DOT develops its life cycle planning process, the State DOT should include future changes in demand; information on current and future environmental conditions including extreme weather events, climate change, and seismic activity; and other factors that could impact whole-life costs of assets. The State DOT may propose excluding one or more asset sub-groups from its lifecycle planning if the State DOT can demonstrate to FHWA the exclusion of the asset sub-group would have no material adverse effect on the development of sound investment strategies due to the limited number of assets in the asset sub-group, the low level of cost associated with managing the assets in that asset sub-group, or other justifiable reasons. A life cycle planning process shall, at a minimum, include the following:
>
> (1) The State DOT targets for asset condition for each asset class or asset sub-group;
> (2) Identification of deterioration models for each asset class or asset sub-group, provided that identification of deterioration models for assets other than NHS pavements and bridges is optional;
> (3) Potential work types across the whole life of each asset class or asset sub-group with their relative unit cost; and
> (4) A strategy for managing each asset class or asset sub-group by minimizing its life-cycle costs, while achieving the State DOT targets for asset condition for NHS pavements and bridges under 23 U.S.C. 150(d).

What is TDOT's Process for Performing Life Cycle Cost Analysis?

TDOT performs a thorough and systematic LCC analysis on all state-owned pavement and bridge assets, regardless of highway system class, using the agency's PMS and BMS. The agency has established performance targets for the National Performance Management Measures identified in 23 CFR Part 490. An Oversight Committee consisting of key TDOT managers was established to provide oversight and coordination for implementation of all MAP-21 and FAST Act final rules including development of performance targets. Additionally, TDOT developed other performance

measures and targets, (State of Good Repair (SOGR) measures and targets), which are supplemental to the National Measures and Minimum Standards. These are based on historical agency practice and more applicable to the way TDOT manages.

A key component of asset management is the creation and institution of a performance management culture within all levels of an organization. The performance management program identifies performance measures and targets which link the overall goals and objectives of the agency to the available funds. Modern computerized management systems allow agencies to perform multiple "what-if" scenarios to analyze the future condition of an asset. These scenarios are based on different funding levels and investment strategies, i.e. strategies based on preservation, maintenance, rehabilitation, reconstruction, or a combination of all work types. Within the core functionality of both a PMS and BMS is the presence of complex computer algorithms, deterioration models, and the ability to predict the future condition of a pavement or bridge based on a number of variables such as weather, climate, environment, age, traffic loading, treatments, funding, etc. Another core function is a LCC analysis component whereby tailored treatments are applied to a pavement or bridge based on their condition. The concept behind this approach is to minimize whole-life cost by applying low cost treatments to an asset early in its life and extending the service life while minimizing investments.

Performance targets provide the benchmark to determine if the asset's condition is meeting the expectations of TDOT. TDOT has adopted a tiered approach based on the highway classification and its importance. For instance, interstate pavements have a higher performance target than state routes. SOGR performance measures and targets are listed in Chapter 3 and in the following Tables 4-1 and 4-2.

Table 4-1: TDOT State of Good Repair Performance Measures

Asset	System	Performance Measure	Good	Poor
Pavements	Interstate	PQI	PQI >4.0	PQI <2.0
	Non-Interstate NHS	PQI	PQI >3.5	PQI <2.0
	Non-NHS State			
Bridges*	Interstate	Condition ratings for Deck, Superstructure, Substructure	All three ≥ 7	One or more ≤ 4
	Non-Interstate NHS			
	Non-NHS State			

*Based on square feet of bridge deck

Table 4-2: TDOT State of Good Repair Performance Targets

Asset	System	Performance Measure	Good	Poor
Pavements	Interstate	% Lane Miles	> 50%	<0.5%
	Non-Interstate NHS		> 45%	<0.5%
	Non-NHS State		> 45%	<0.5%
Bridges*	Interstate	% Deck Area	> 36%	<6%
	Non-Interstate NHS		> 36%	<6%
	Non-NHS State		> 36%	<6%

*Based on square feet of bridge deck

With the establishment of performance measures and targets for pavements and bridges, TDOT performs an evaluation using the PMS and BMS. At the network level, the PMS and BMS provides several output reports to enable TDOT managers to gauge success in meeting the agency's goals. Examples of the type of reports are:

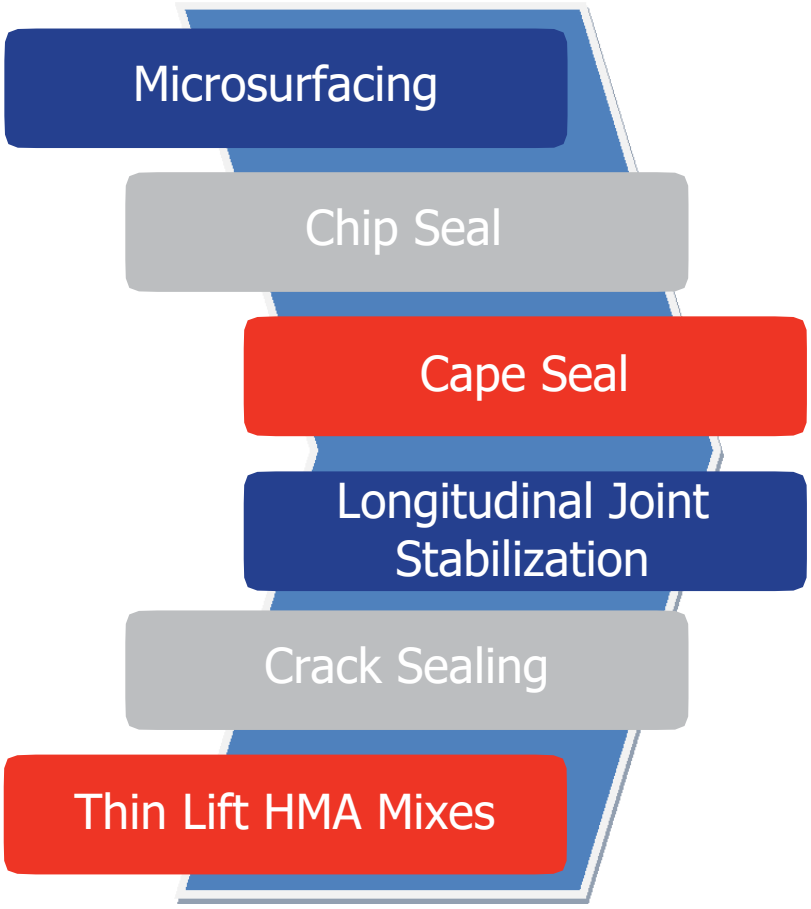
- Historical reports of expenditures, type of treatments (work types), resulting performance by highway system (interstate, non-interstate NHS, non-NHS state routes)
- Condition by highway system (interstate, non-interstate NHS, non-NHS state routes)
- Estimated funding levels to achieve specific condition, by highway system, 10-year projection
- Estimated condition based on various funding scenarios by highway system, 10-year projection
- Treatment work types (preservation, maintenance, rehabilitation, reconstruction), by highway system, 10-year cost and quantity projections

TDOT continues to meet their targets for pavement and bridge condition year after year and has typically been satisfied with its network performance. The Department strives for continual process improvement in the cost-effective management of the state's pavement and bridge assets. TDOT has historically used a combination of formal and informal processes, including LCC analysis, in the allocation of funds. While the Department's PMS is a mature system and has provided reliable analysis for a number of years, the BMS (formerly Pontis) was upgraded in 2018 to the new AASHTO BrM software program and will take time to calibrate the analysis the Department is looking for to perform reliable life cycle cost analysis.

This TAMP will use the best information available to address LCC analysis for the bridge program realizing that additional process improvements will be achieved as staff gains more experience and confidence in the BMS's analysis functionality. The BMS is a complex computerized software system and requires significant amounts of input data to run the models that perform the LCC analysis. As with any new system, it requires several iterations by staff and a review of the outputs to understand and validate the results. It is anticipated it will take a few months of performing the analysis, reviewing and refining the input variables to achieve the confidence required to make investment and program decisions necessary for a large bridge program of TDOT's size. The TAMP will help to solidify the process to provide greater transparency, consistency, and clarity. The following outline is a generalization of TDOT's process in using LCC in the development of their annual pavement and bridge management programs.

- Pavement condition survey results are uploaded to the PMS as segments are completed.
- The PMS Network Maintenance & Rehabilitation (M&R) Optimization/Work Program Development function is run to determine feasible maintenance, preservation, and rehabilitation strategies for each pavement section. (Pavement work types examples and typical costs are listed in Table 4-3.) The PMS will also perform network optimization based on performance and funding constraints. This process provides a life cycle analysis of costs and performance based on decision trees for treatment selection and performance prediction models. The system has the capability to perform multiple optimization scenarios based on user defined constraints. Optimization scenarios are capable of suggesting work plans that include multiple treatments on a given section within the analysis period. A theoretical best treatment is identified when the greatest projected benefit is achieved.
- Once the TDOT Maintenance Division is satisfied with the M&R output, the results are provided to TDOT's senior management for review and funding consideration. These analyses along with other records and reports on accomplishments, network pavement conditions, historical funding allocations, expenditures, type of pavement treatments, regional allocations and results, etc. provide a comprehensive overview of TDOT's pavement management program effectiveness. The outcome of this review is a proposed funding allocation for the annual pavement management program.
- Funds for the pavement management program come from the federal aid highway apportionment and from TDOT state funds. The federal aid portion is included in the STIP as a part of the National Highway Performance Program (NHPP) while the state funded portion is included in the State budget. The estimated amount for the pavement management program is shown in Chapter 6 Financial Plan of this document.
- Once the statewide pavement management program funding amount is determined, funds are allocated to each TDOT region based on their respective lane miles. Each region, in concert with their district management, develops an annual pavement management work program to address as many pavement needs as the funding will allow.
- Each of TDOT's four (4) regions is responsible for achieving TDOT's goals for pavement condition, treatment percentages, and remaining service life. The region submits their proposed program to the Programming Office and Pavement Management Office for final approval before project development is permitted to begin.

Figure 4-2: A Sample of Pavement Preservation Methods Used by TDOT



BRIDGE MANAGEMENTPROGRAM

As mentioned earlier, TDOT has recently implemented a new BMS, AASHTO's BrM, and is optimistic that it will provide greater analytical and optimization capability than the previous Pontis BMS. The BrM satisfies all the MAP-21 requirements and provides enhanced features such as deterioration modeling, life cycle cost analysis, asset valuation forecasting, and funding value modeling.

This edition of the TAMP for the bridge management program will be a blend between TDOT's historical process and their new efforts to interject as much analysis from the new BMS as possible.

- Bridge inspections are performed in accordance with the federal National Bridge Inspection Standards (NBIS) and results are uploaded to the BMS upon completion of each bridge inspection.
- The BMS program is used to determine feasible maintenance and rehabilitation strategies and performing network optimization based on performance and funding constraints. This analysis provides life cycle analysis of costs and performance based on TDOT's defined strategies. The system has the capability to perform multiple optimization scenarios based on user defined constraints.
- The Structures Division uses the results from the BMS analysis in conjunction with information contained in the bridge inspection reports to develop short-term and long-term bridge management programs. Bridges are placed on a repair list, if needed, and are given a priority rating of 1 thru 4 (1 is highest priority). The repair list is used to determine which bridges receive the highest priority for repair. Bridge candidates are considered for replacement if the sufficiency rating is less than 50 (1 (low) to 100 (high) scale) and it is structurally deficient. Other bridges may get replaced if they are within the limits of a large roadway improvement project.
- Risks such as scour, long term maintenance, Average Daily Traffic (ADT), seismic vulnerability, bridge type, approach alignment, and detour routes are all considered during the evaluation of the bridge replacement list by the Structures Division. Seismic vulnerability is a concern in West Tennessee, and is taken into consideration during the evaluations.
- Approximately 70% of the budget is dedicated to bridge replacement, while the remaining 30% is spent on bridge preservation and repairs. For the past several years, the annual budget for bridge management has held steady around $100 million, and has produced a steady incremental decrease in the total area of deficient bridge decks.
- Once the Structures Division is satisfied with the output of the reports, the results are provided to TDOT's senior management for review and funding consideration. These analyses along with other records and reports on accomplishments, network bridge conditions, historical funding allocations, expenditures, etc. provide a comprehensive overview of TDOT's Bridge Management Program effectiveness. The outcome of this review is a proposed funding allocation for the bridge management program.
- Generally, funds for bridge maintenance and repair come from TDOT state funds and are included in the State budget whereas bridge replacements and major rehabilitation projects are funded using federal dollars. The estimated amount for the bridge management program is shown in Chapter 6 Financial Plan of this document.

- Once the statewide bridge management program funding amount is determined, the Structures Division is responsible for finalizing the annual work plan and developing contracts to accomplish the work.

What are TDOT's Treatments for Pavements and Bridges?

PAVEMENT TREATMENTS

TDOT uses a systematic approach in developing the annual pavement management program consisting of a multitude of treatments (work types). The suite of treatments is a key input into the PMS's optimization program using life cycle cost analysis. Typical work types can be classified into four (4) major categories: Preventive Maintenance, Preservation, Rehabilitation, and Reconstruction as identified in Table 4-3 and as follows:

i. **Preventive Maintenance** — Preventive Maintenance is the day-to-day pavement maintenance activities that are scheduled or whose timing is within the control of maintenance personnel. This includes routine maintenance activities such as shallow patching and concrete joint replacement.
ii. **Rehabilitation** — Rehabilitation occurs when the pavement section deteriorates to a fair to poor condition in terms of both ride quality and structural condition. At this point, structural damage has occurred, and the objective of rehabilitative treatment is to repair that damage and restore the pavement. Thus, the approach is reactive and can be a costly and time-consuming process. This is accomplished with full-depth patching, or concrete slab replacement.
iii. **Preservation** — A proactive or preventive approach entails the application of a series of low-cost, preservation treatments that individually last for a few years and extends the life cycle. This is accomplished with chip seals, thin asphalt overlays, microsurfacing, crack sealing, concrete joint sealing, and cape seals, and mill and fill overlays less than 1.5 inches in depth. This is typically the most cost effective approach.
iv. **Reconstruction** — Reconstruction of a pavement is rarely done at TDOT and only in extreme circumstances where a pavement's structure is not sufficient to carry the design loads. This is typically done through the replacement or recycling of the existing pavement structure. This is by far the most costly approach to manage the pavement assets.

It should be noted that less than 5% of interstate lane miles and less than 1% of state routes currently have a concrete riding surface and are not currently included in the LLC analysis. A need for inclusion of proper concrete pavement maintenance within the state resurfacing program has been identified,

but has not yet been incorporated into the program. The pavement office and the regional resurfacing staff are in the process of identifying potential work types and proper timing of each. Potential work types being discussed include resealing joints, partial depth repair, full-depth repair, and diamond grinding. Historical cost data for each is minimal and considered to be non-representative. A draft program will be developed based on national recommendations from industry and academia and incorporated on a trial basis over the next few years with the intention of eventually including in pavement analysis decision trees.

It should also be noted that approximately 666 lane miles, less than 4 % of the NHS system, are non-TDOT assets and are the responsibility of either local or federal governments and are not included in the LLC analysis.

Table 4-3: Typical Pavement Work Types, Treatments, and Unit Costs

WORK TYPES	TREATMENTS	UNIT COST PER LANE MILE
Preventive Maintenance	Shallow patching	Asphalt: $110/ton to $376/ton Concrete: $442/CY
	Skin patching	
	Partial-depth patching	
	Repair concrete corner breaks	
	Concrete joint repair	
	Other thin patching	
Preservation	Thin asphalt overlay (1.5” or less)	State Routes: $21,100 to $122,300 Interstates: $164,100 to $168,000
	Microsurfacing	
	Chip seals	
	Cape seals	
	Crack sealing	
	Concrete joint sealing	
	Mill and fill asphalt overlays (1.5” or less)	
Rehabilitation	Full-depth patching	$248,100
	Repair/replacing concrete slabs	
Reconstruction	Rubblization and overlay of concrete pavement	$622,200 to $1,554,700
	Full-depth replacement of asphalt pavement	

BRIDGE TREATMENTS

Similar to pavement management, TDOT uses a systematic approach in developing the annual bridge management program consisting of a multitude of treatments (work types). The suite of treatments is a key input into the BMS's optimization program using life cycle cost analysis. Typical treatments can be classified into four (4) major categories: Preventive Maintenance, Preservation, Rehabilitation, or Reconstruction. These are identified in Table 4-4 and as follows:

i. **Preventive Maintenance** — Filling potholes in decks, minor structure repairs (minor spall repairs, cleaning expansion joints), and major structure repairs (parapet wall repairs).

ii. **Preservation** — Repainting structural steel, vegetation removal, sweeping, deck repairs and waterproofing deck surface (with membrane, thin epoxy overlay, polymer modified concrete, or a 4.5" reinforced concrete overlay), navigation light maintenance/replacement, guardrail protection at bridge ends, object marker replacement, cleaning and sealing or replacement of expansion joints.

iii. **Rehabilitation** — Bridge deck and expansion joint repairs, spall repairs and steel repairs on superstructure, scour prevention, bearing replacements, and preventative measures such as waterproofing the deck or repainting structural steel. A repair project may also include the replacement of the full superstructures of bridges.

iv. **Reconstruction** — Bridge candidates are considered for replacement if the sufficiency rating is less than 50 and it is structurally deficient. Other bridges may get replaced if they are within the limits of a large roadway improvement project.

It should be noted that 106 bridges, less than 3 % of bridges on the NHS, are non-TDOT bridges which are the responsibility of either local or federal governments and are not included in the LLC analysis.

Table 4-4: Typical Bridge Work Types, Treatments, and Unit Costs

Category	Treatments	Average Unit Cost Per Sq. Ft.
Preventive Maintenance	Filling potholes in deck	$20
	Minor structure repair	
	Major structure repair	
	Cleaning structure	
Preservation	Repainting structural steel	$70
	Sweeping	
	Deck repairs	
	Deck waterproofing	
	Deck epoxy overlay	
	Polymer modified concrete deck overlay	
	Cleaning and resealing expansion joints	
Rehabilitation	Replacement of expansion joints	$140
	Concrete spall repairs	
	Structural steel repairs	
	Scour prevention	
	Bearing replacement	
Reconstruction	Replace entire bridge	$165

What are TDOT's Strategies to Manage Assets?

TDOT has a long history of effectively managing state-owned assets to extend service life, especially of pavement and bridges. A key feature of the success of using asset management principles is understanding the connection between funding and maintaining asset performance at an established target. In order to successfully manage the agency's assets, formal and informal practices have been implemented that rely on quality data, systematic processes, and analytical evaluation that complement the technical expertise in the Maintenance and Structures Divisions. Below are examples of strategies TDOT uses to effectively manage the pavement and bridge assets:

PAVEMENT

i. **Standard Operating Guidelines (SOG)** – TDOT has developed a SOG manual for pavement management which establishes the vision, objectives, and procedures for managing the agency's pavements. The SOG provides guidance in the selection of candidates for maintenance, preservation, resurfacing, and rehabilitation projects for both rigid (concrete) and flexible (asphalt) pavement with an emphasis on employing preventive maintenance treatments until repair costs exceed the benefit, i.e. using LCC concepts. Visit https://www.tn.gov/tdot/maintenance/pavement-office/project-selection-and-development.html for more information.

ii. **Remaining Service Life (RSL) & Lane-Mile-Year analysis** – RSL is defined as the life of a pavement from the present time (or initial construction date if a new pavement) until it deteriorates to a specific condition which would trigger a significant costly repair treatment. The basic concept behind this metric is a quick evaluation to determine if the agency is programming a suite of projects that at a minimum offset the annual loss in pavement life. Each Region is required to perform this quick analysis to ensure that the type of projects recommended for the annual program will satisfy budget allocations, treatment options by type and percentage, and the remaining service life concept.

iii. **Pavement Quality Index (PQI)** – The PQI is a composite number based primarily on the ride quality of the pavement (Pavement Serviceability Index) and the condition of the pavement (Pavement Distress Index) and is measured on a 0 to 5 scale. An interstate pavement with a PQI of 4.0 or greater would be classified in the good condition category, while one with a PQI of less than 2.0 would be in poor condition. For state routes, pavements with a PQI of 3.5 or greater would be classified in the good category, while one with a PQI of less than 2.0 would be classified as poor. TDOT tracks this number for the Regional and Statewide network conditions to monitor the health of the system and to ensure the Department is meeting its performance goals and targets discussed in Chapter 3.

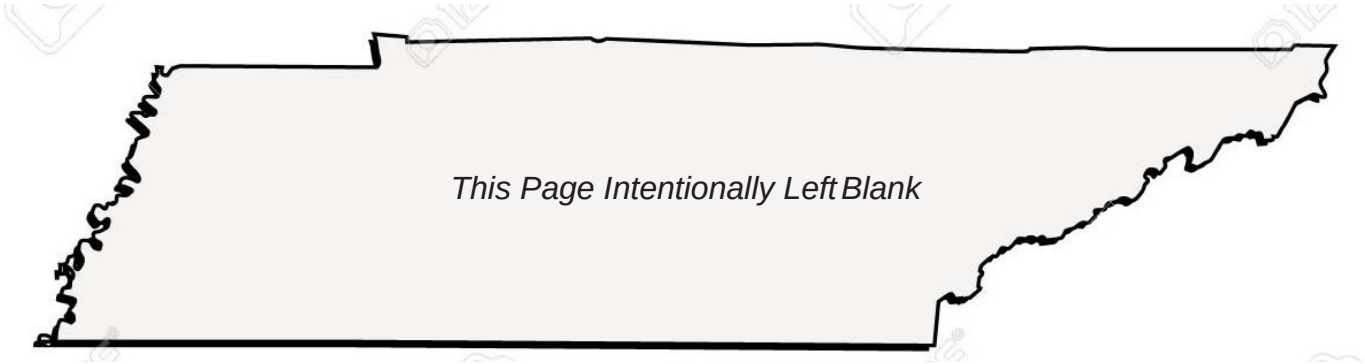
BRIDGES

i. **Review of NBIS Inspection Reports** – The Structures Division conducts bridge inspections on all the bridges in the state, with the exception of federally owned bridges, on a two-year schedule and reviews each bridge inspection report to identify potential candidates for improvement. Identified bridges are included on a repair list and given a priority rating of 1 thru 4 (1 is highest priority) for funding consideration. Once funding is determined, bridges with the highest priority are programmed for improvement. The review and creation of the repair list ensures that no bridge is overlooked.

ii. **Smart Project Scoping and Selection** – If a bridge is a candidate for replacement within the next ten (10) to twenty (20) years, the Structures Division reviews the project repair scope and costs. If a bridge is scheduled for repair but is also in a program to be replaced in the future, the repairs are scaled appropriately to match the projected life of the bridge (replacement letting plus two (2) years for construction) to the life cycle of the repair(s).

iii. **Hold the Line** – In recent years, TDOT has placed an emphasis on holding the number of structurally deficient bridges down to less than 6% on the state maintained system by programming enough funds to maintain the low percentage target.

iv. **Not a Worst-First Program** – Approximately 65% of the budget for Bridge Management is allocated to bridge replacement, while the remaining 35% is spent on bridge repairs and preservation. The new BMS will provide the complex LCC analysis to identify the most cost effective treatments for the whole life of the structure.



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Chapter 5

Risk Management Analysis

What is TDOT's Plan for Risk Management Analysis?

TDOT's risk management analysis process will be discussed in this chapter. It will describe the requirements of the final rule and identify the process TDOT used to satisfy the requirements of MAP-21 for risk management analysis.

What are the MAP-21 and Final Rule Requirements?

Risk management analysis requirements are identified in 23 CFR Part 515.7 (c) as follows:

A State DOT shall establish a process for developing a risk management plan. This process shall, at a minimum, produce the following information:

(1) 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, seismic activity, and risks related to recurring damage and costs as identified through the evaluation of facilities repeatedly damaged by emergency events carried out under part 667 of this title. Examples of other risk categories include financial risks such as budget uncertainty; operational risks such as asset failure; and strategic risks such as environmental compliance.

(2) An assessment of the identified risks in terms of the likelihood of their occurrence and their impact and consequence if they do occur;

(3) An evaluation and prioritization of the identified risks;

(4) A mitigation plan for addressing the top priority risks;

(5) An approach for monitoring the top priority risks; and
(6) A summary of the evaluations of facilities repeatedly damaged by emergency events carried out under part 667 of this title that discusses, at a minimum, the results relating to the State's NHS pavements and bridges.

Risk Management Definitions

For the purposes of this section, the following definitions are listed to provide the framework and context for the discussion of risk and risk management, as it applies to the TAMP at TDOT.

Risk – The impact of uncertainty upon TDOT's ability to deliver its programs, projects, and services. Risk is an event that is a deviation from the expected outcome. Risk can either be positive or negative and is measured in terms of a combination of the likelihood of an event occurring and the consequence if the event did occur.

Risk Management – A systematic process of identifying, analyzing, and prioritizing risks with the development of strategies to respond to potential threats and opportunities.

Risk Identification – The process of finding, recognizing, and describing risks.

Risk Register – A formal listing of risks identified by the department, which may include such information as priority, type, likelihood, consequence, impact, and mitigating actions.

Risk Context – The social, cultural, legal, regulatory, economic, and natural environment in which an entity operates that is unique to the department.

Risk Analysis – A process to understand the potential impact of various risks, in terms of likelihood and consequence.

Risk Assessment – The process of identifying risks, analyzing risks, and evaluating risk.

Risk Evaluation – The process of reviewing the results from the Risk Analysis and comparing the impact with the department's risk tolerance.

Risk Tolerance – The capacity of the department to accept or tolerate risk.

Risk Treatment – A process to determine how a department will respond to an identified risk.

Likelihood – The probability that a specific event might occur.

Consequence – The outcome of an event impacting the department's objectives.

Mitigation – Actions taken to address or reduce risk. Generally, it refers to the entire process of responding to risks.

Risk Levels – The different levels of risk which can be categorized into three major risk areas: Agency/Enterprise, Programmatic, and Project/Asset. They can be distinct or overlapping from one level to the next.

Agency/Enterprise Risk – Risks that are high-level issues and can impact the achievement of the agency's goals and objectives involving a multitude of issues, i.e. budgets, legislative requirements, regulatory reforms, public sentiment, broad managerial and personnel decisions.

Programmatic Risk – Risks that are typically a collection of related projects or program delivery issues that may be attributed to an entire sub-unit or business unit, e.g., bridge program, preservation program, maintenance program, program budgets.

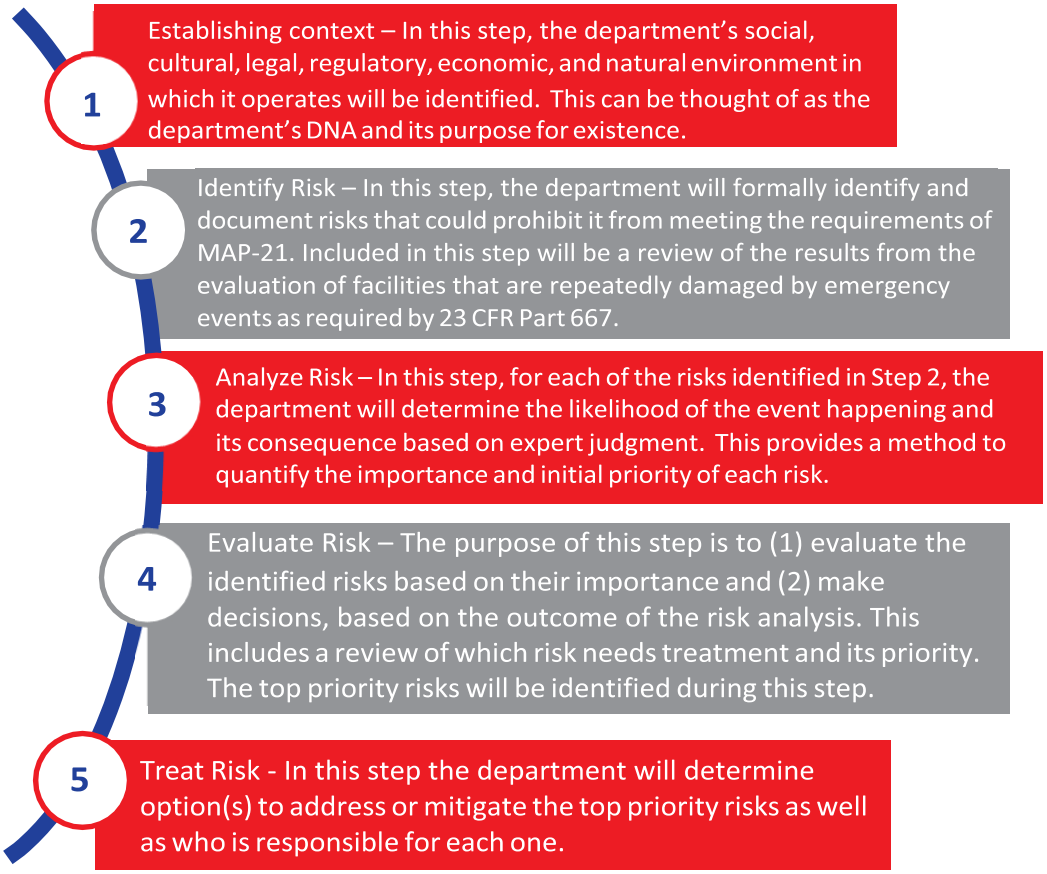
Project/Asset Risk – Risks that are associated with an individual project, location, or individual asset class; can be associated with providing continuity of service of a bridge or highway and system resilience and asset failure.

What Steps Has TDOT Taken Toward Risk Management?

With the passage of MAP-21, TDOT has taken this opportunity to initialize a more comprehensive approach to assess risk across the agency in accordance with asset management concepts. TDOT has selected a group of managers to serve on the risk management committee and perform a risk assessment and make recommendations to senior management on managing risk. In addition, many of the divisions consider risk within their area of responsibility on an annual basis.

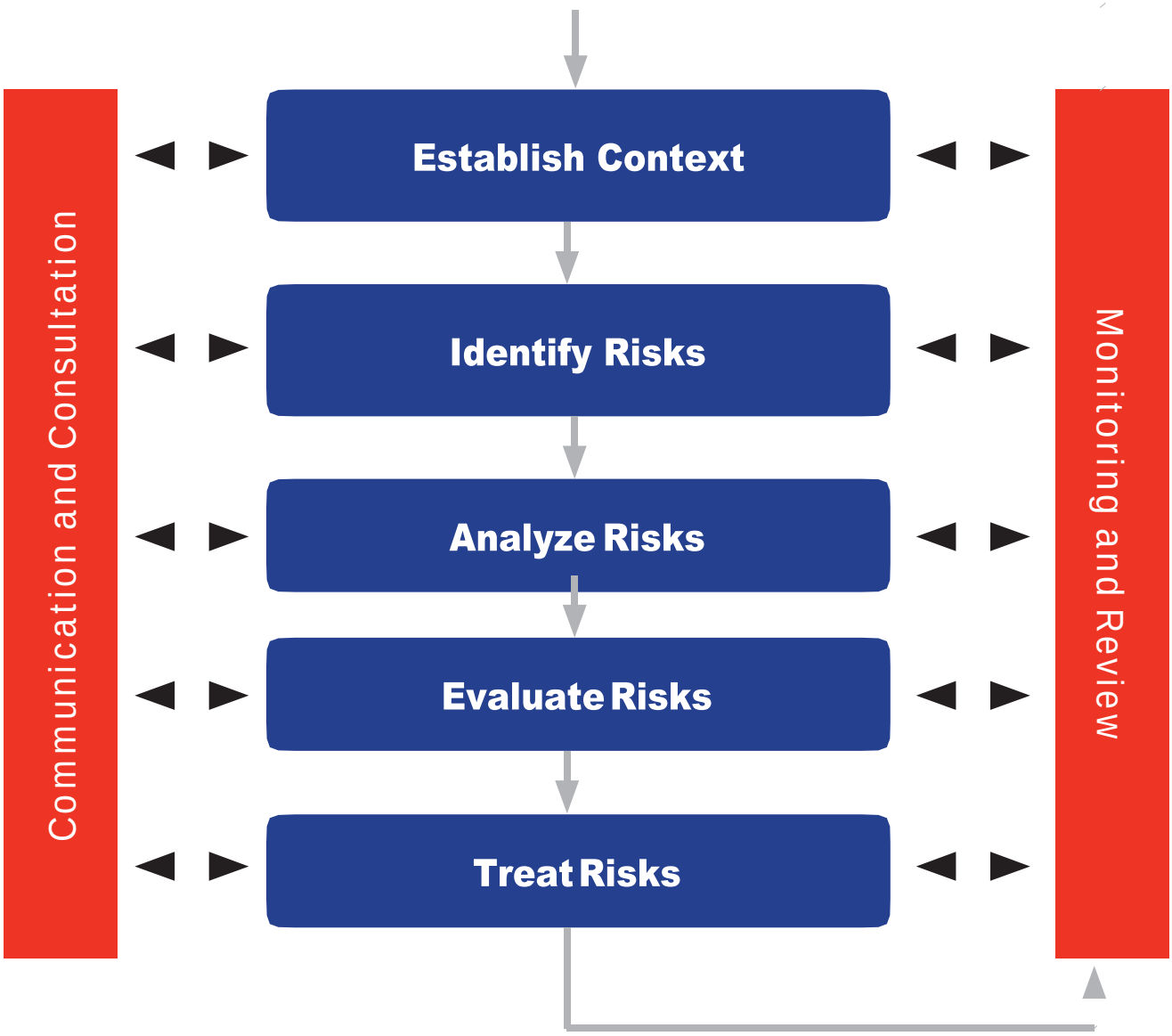
In January 2015, the risk management committee came together for a one-day workshop to kick-off the formal risk management effort and establish processes for identifying, evaluating and analyzing risks.

As part of this one-day workshop, the department adopted the framework identified by ISO 31000 on "Risk Management – Principles and Guidelines" and FHWA publication, "Risk-Based Transportation Asset Management Report 1: Evaluating Threats, Capitalizing on Opportunities." Based on these two (2) documents, the risk management process framework consists of a five-step methodology, as follows:



Two additional components are identified as a part of the framework: 1) Monitoring and Review, and 2) Communication and Consultation. Monitoring and Review is a planned part of the process that is accomplished on an established frequency, as determined by the Risk Management Committee and identification of who is responsible for monitoring each risk. Communication and Consultation provides an avenue to keep internal and external stakeholders abreast of the issues where risk problems and events are known throughout the department. This information is then shared with the public, legislature, media, and oversight bodies. The five-step process, as depicted in ISO literature, is illustrated in Figure 5-1.

Figure 5-1: Risk Management Framework, ISO 31000:2009



As mentioned previously, TDOT has selected a broad-based group of managers to serve on the risk management committee who represent each of the major business units within the department that contribute to the vision and guiding principles of the asset management plan for pavement and bridges. The members of the committee were selected based on their position in the department. As the individuals change positions or leave the department, replacement members will be appointed to represent the identified areas and positions. Additional members may be added to the committee, based on the needs of the department or to address additional areas of risk. Representatives from each of the following divisions and regions are members of the committee:

Maintenance Division	Structures Division	TDOT Region 1
Office of Strategic Planning	Long Range Planning	TDOT Region 2
Strategic Transportation Investments Division	Finance Division	TDOT Region 3
Information Technology	Environmental Policy Office	TDOT Region 4
Program Development Division	FHWA-Tennessee Division	Assistant Chief Engineer's Office

Establishing the Context

TDOT has a number of documents that describe the department's philosophy and its fundamental core values. These documents help provide the context for TDOT's risk management efforts, including the Vision, Mission, and Guiding Principles.

Vision - *To serve the public by providing the best multimodal transportation system in the nation*
Mission - *To provide a safe and reliable transportation system for people, goods, and services that supports economic prosperity in Tennessee*

Guiding Principles: PIERCE

Professional
Innovative
Efficient
Responsible
Communicate
Expeditious

In addition, TDOT has established a number of Strategic Goals and Operational Goals that provide further guidance and organizational direction. Some key themes from these documents are also fundamental principles of asset and risk management. These include a reliance on data-driven decisions, a strong emphasis on safety, and methods to sustain the infrastructure.

STRATEGIC GOALS

1. Implement improvements and initiatives that will increase safety for travelers and workers on Tennessee's transportation network

2. Increase and enhance economic development opportunities across the state

3. Dramatically change the paradigm for delivery of transportation products and services to improve efficiency and effectiveness of Tennessee's transportation system

4. Expand organizational strategies and resources to strengthen and support continuing education, training and development of TDOT employees

OPERATIONAL GOALS

1. Deliver transportation projects on schedule and within budget

2. Maintain the state transportation system to protect the long-term investment in our infrastructure

3. Operate and manage Tennessee's transportation system to provide a high level of safety and service for our customers and workers

4. Expand mobility choices to maximize access

Risk Identification

At the January 2015 risk workshop, the committee followed the risk management framework listed in Figure 5-1 in identifying and evaluating risks that would affect the ability of TDOT to meet the MAP-21 requirements for pavement and bridges. The initial effort produced a list with 53 different risks of which 18 were identified as high priority to be analyzed and evaluated. However, with the delay in the final rule determination, the risk management analysis was put on hold until finalization of the MAP-21 rule requirements.

In April 2019, a follow up risk management workshop was held with the committee with the purpose of reviewing the product that was generated from the 2015 risk management identification and analysis workshop and update as necessary. Additionally, several of the previous committee members are no longer with TDOT and the replacement members needed an opportunity to have an understanding and input into the risk management process.

The process the department used to compile the Risk Register consisted of a brainstorming session with the Risk Management Committee in which each member was asked to compile a list of risks within their respective areas of responsibility, along with any broader area that could potentially affect the department. The individual risks offered by each member were recorded in a master list and an open discussion was facilitated to understand the context of each risk. Risks that were similar or duplicative in nature were combined and consolidated into a revised risk register. The members also categorized each risk into the following three (3) types:

- Agency or Enterprise
- Programmatic
- Project or Asset

Risk Analysis

Once the risk register was compiled, the Risk Management Committee was asked to individually evaluate each risk in terms of likelihood and impact. The committee was provided with guidance on how to evaluate the likelihood of the risk happening, shown in Figure 5-2, along with its impact, shown in Figure 5-3. The process is a method to quantify the importance of each risk, based on expert opinion of the committee members. It was accomplished by reviewing each risk and assigning a numerical value for each variable (likelihood and impact) and multiplying them together to get an overall score. Each member individually determined a value (0 to 9) for the likelihood and impact for each risk, and the raw scores from each member were averaged together to calculate a composite score for each risk. The risks were ranked based on their score (high to low) and provided a preliminary prioritized list for consideration. It should be noted that the scores did not explicitly determine the final ranking of each risk. The scores only identified those risks that the committee gave greater consideration to during their evaluation process.

Figure 5-2: Risk Likelihood Guidance

Enterprise Risk Management Plan

Risk Assessment Scorecard: Likelihood

LIKELIHOOD: Likelihood or Probability of the Event Happening

RANK	SCORE	Probabilty %	DESCRIPTION OF LIKELIHOOD RANK
High HIGH	9	90%	Event Fully Expected to Occur
Medium HIGH	8	80%	Event Very Likely to Occur / Event Occurs Repeatedly
Low HIGH	7	70%	Event Likely to Occur / Event Likely to Occur Frequently
High MEDIUM	6	60%	Event Will Probably Occur / Event Will Probably Occur Periodically or Randomly
Medium MEDIUM	5	50%	Event Could Occur
Low MEDIUM	4	40%	Event May Occur / Event May Occur Periodically / Event May Occur Randomly
High LOW	3	30%	Event Might Happen / Event Might Happen Infrequently
Medium LOW	2	20%	Event Not Likely to Occur / Event Would Seldom Occur
Low LOW	1	10%	Event Not Expected to Occur
N/A	0	0%	Will Never Happen

Figure 5-3: Risk Impact Guidance

Enterprise Risk Management Plan

Risk Assessment Scorecard: Impact

IMPACT: The Potential Consequences or Results of the Event

Types of Impacts to Consider:

- Inability to Achieve Mission or Objectives
- Threat to Health & Safety / Loss of Life
- Regulatory / Compliance
- Damage to the Environment
- Regulatory / Compliance
- Financial / Safeguarding Assets
- Public Trust & Perception
- Fraud, Waste or Abuse

DESCRIPTION OF IMPACT RANKING	SCORE	RANK
Perilous / Catastrophic	9	High HIGH
Critical / Very Serious	8	Medium HIGH
Serious / Substantial	7	Low HIGH
Major / Significant	6	High MEDIUM
Important / Moderate	5	Medium MEDIUM
Of Concern	4	Low MEDIUM
Small	3	High LOW
Minimal	2	Medium LOW
Very Small / Negligible	1	Low LOW
None	0	N/A

Risk Evaluation

Using the initial risk register as a starting point, each committee member was asked to review the results from the risk analysis and provide recommendations to the Asset Management Core Team for prioritization adjustments based on their background and experience, with the caveat that the ranking should be in alignment with the priorities and needs of the department. Based on the outcome of this step, the Core Team re-prioritized the list of risks and sent it back to the committee for comments and recommendations. The final revised list, shown in Table 5-1 later in this chapter, was submitted to TDOT senior management for consideration and adjustment. It should be noted that the ranking of the risks does not strictly follow the numerical score determined by earlier steps.

Treating Risk

Based on the reprioritized list of risks, the TAMP Core Team, in consultation with senior leadership, selected the top 9 to evaluate in more detail and developed potential mitigating strategies for each. Table 5-1 lists the top risks, the team's designation of the type of risk, mitigation activities, and a designated point of contact for each one. The results of the risk management effort can be summarized in the following:

1. **Flooding** – Historically, most costs for major flooding events have been covered by either FHWA's Emergency Relief (ER) Program or Federal Emergency Management Agency (FEMA) on a reimbursable basis and are anticipated to do so in the future. Neither agency's program covers the total cost of the event and the state covers the cost share amount which can range from 10% to 25% of the total cost. Costs not covered by federal funds would be deducted from the same budget that funds capital projects, which could result in project delays or rescheduling.

2. **Rock Slides/Slope Failure** – In 2007, TDOT implemented a Rockfall Management Program to address potential hazardous sites where materials may fall into the roadway. Subsequently, in November 2017, a 5-year Rockfall Mitigation Project plan was developed to prioritize projects to be completed and funding was included in the FY2018-2020 Comprehensive Multimodal Program. The program is currently budgeted at $10M per year to address these risks for the 3-year period. However, this only covers rock slopes that fall into the roadway and does not address potential slope failures that occur below the roadway. A separate program to address those "landslide" slope failures is an organizational gap, and something the

agency should consider funding. A risk assessment and prioritization process would identify potential slope failure areas and estimated cost for funding consideration. The 2017 Rockfall Mitigation Project plan can be found at: https://www.tn.gov/content/dam/tn/tdot/hq-materials-tests/geotech/2017-11-03-RockfallManagementProgram.pdf.

3. **Reduction of Federal Funds** – TDOT can only tolerate this risk and take the necessary steps to be prepared should this take place. Potential mitigation strategy, in addition to delays of projects/programs, would be to set aside state funds in case a federal fund rescission takes place in the near future.

4. **Pipe Culvert Failures (pipe sizes less than 48")** – TDOT currently has a Small Structures Program to address replacement/repairs to large culverts between the size of four (4) feet and twenty (20) feet in length, measured along the roadway centerline. This program is currently funded at $2 million per year and routine inspections of these structures are conducted by TDOT's bridge inspectors on a recurring schedule. A statewide inventory and condition assessment program to address pipes and culverts that are smaller than four (4) feet in length along the roadway centerline is currently being developed. Funding for this program has not yet been assigned; however, a potential funding source for the assessment and repair of these culverts is in the routine maintenance budget.

5. **Inflation** – It is expected that TDOT's Finance Office will assist with predicting future inflation patterns so that the department can proactively plan for it in the budget. It has been a practice to include an inflation factor as annual budget analysis and requests are prepared.

6. **Deferred Maintenance** – Deferring maintenance is always a challenge to asset managers since it involves making a decision on what work is not going to be done. TDOT will use their PMS and BMS to help prioritize work. The agency has identified a need to upgrade the Maintenance Management System (MMS) to allow more robust analysis and management. Funding for system upgrades is made available by the IT Division as required.

7. **Higher Cost Due to Lack of Bidder Competition** – TDOT continues to review in-house vs. contract unit costs to determine the most cost effective and efficient way to accomplish their work programs. Based on historical costs, maintenance budgets may need to be adjusted to account for either higher contract costs or would need to be reflected as in-house routine maintenance.

8. **Competing Priorities/Trade-Off Analysis** – TDOT has recognized the need to upgrade their MMS. An Enterprise Asset Management System is planned for development as part of the agency's replacement of the Maintenance Management System. The IT Division is funding the system development. The new system would provide an enhanced trade-off analysis to allow senior leadership to make data-driven decisions on how to distribute funding to the various competing programs to maximize performance results with minimum investment.

9. **Inability to Track Annual Financial Obligations by Work Type** – The current financial and programming systems are unable to track annual financial obligations by the new MAP-21 work types. For this edition of TAMP, TDOT is using the best information available to estimate the financial information to satisfy MAP-21 requirements. While this is adequate for now, it is anticipated that FHWA will be expecting a more accurate accounting for the various work types in future updates to the TAMP. Failure to do so could reduce the federal share for NHPP funding down to 65%, which would have a significant impact on the agency's budget. Both the Financial Office and the Programming Office have key roles in improving the capability to track budgets, obligations, and expenditures.

Table 5-1: TDOT Risk Register

Risk		Type	Avg. Likelihood	Avg. Consequence	2019 Score	If	Then	Mitigation	Points of Contact
1	Flood	Project	6.1	6.9	41.7	If major flooding occurs which impacts critical roadway corridors or major bridges,	1. Road closure and damage may occur 2. Decreased mobility is likely 3. Long-term impact by saturation of subgrade 4. Injury/Death may occur 5. Increased maintenance/reconstruction costs 6. Litigation from private property owners	1. Emergency response protocols in place 2. Quick response on damage assessment/repair 3. Inspect impacted bridges for possible scour ASAP 4. Request federal Emergency Relief for catastrophic events 5. Increase pipe/culvert inspections and maintenance	WILL REID
2	Rock Slides/ Slope Failure	Project	6.1	6.7	41.3	If rock slides occur,	1. Road closure and damage may occur 2. Decreased mobility is likely 3. Long-term impact by saturation of subgrade 4. Injury/Death may occur 5. Increased maintenance/reconstruction costs 6. Litigation from private property owners	1. Continue with the Rockfall Mitigation Program that has been established and continue to update the list as more sites present themselves. 2. Continue to prioritize the list utilizing the risk-based approach. 3. Continue to fund the program to ensure priority sites are being mitigated. 4. Establish a new Landslide Mitigation Program to address potential slope failures below the roadway. 5. Identify annual funding for Landslide Mitigation Program.	ROBERT JOWERS Jerry Hatcher
3	Reduction of Federal Funds	Agency / Program / Project	5.1	7.5	37.8	If Federal Funding continues to be at current levels or reduced,	1. Number of new projects will be reduced 2. Capacity projects will be delayed 3. TDOT will enter a maintenance - only mode 4. Program priorities could change 5. System performance may be degraded 6. Reduction of maintenance funding 7. Public out-cry	1. Continue to monitor and manage funding 2. Adjust performance goals/targets 3. Manage public expectation 4. Identify priorities for state funds	JOE GALBATO Jennifer Herstek

Final Rank	Risk	Type	Avg. Likelihood	Avg. Consequence	2019 Score	If	Then	Mitigation	Points of Contact
4	Pipe Culvert Failures (<48" Cross-Drains)	Project	6.1	5.7	34.8	If pipe culverts are not properly inspected and maintained and ultimately fail,	1. Road closure and damage is possible 2. Decreased mobility may be observed 3. Long-term impact to pavement by saturation of subgrade 4. Increased maintenance/reconstruction costs 5. Litigation from private property owners 6. Increased risk of flooding is likely	Prevention: 1. Implement an improved inventory, inspection, condition assessment, and maintenance program of pipes/culverts 2. Repair pipe culverts where appropriate or replace when necessary 3. Maintain unrestricted flow line at inlet/outlet Response: 1. Following a failure, ensure quick response for damage assessment/repair	JERRY HATCHER Timothy Colvett
5	Inflation	Program	7.4	4.8	35.5	If the resource costs inflate,	1. Less work can be programmed 2. Authorized budgets cover less program 3. Overruns will increase	1. Develop inflation projection process 2. Monitor trends for major resource items (Labor, Equipment, Materials) 3. Provide 2-5 year projection of expected cost increases	JENNIFER HERSTEK
6	Deferred Maintenance	Project / Agency	6.0	5.9	35.2	If maintenance work is deferred,	1. Future maintenance costs will increase 2. Potential for significant infrastructure failures	Take a data-driven approach to prioritization of work (Bridge Maintenance System / Pavement Management System	JERRY HATCHER Ted Kniazewycz
7	Higher Cost due to Lack of Bidder Competition	Program	5.9	5.9	34.4	If higher cost due to lack of bidders occur,	1. Future construction (including resurfacing) projects may be limited. 2. Out-sourced maintenance projects may have to decrease level of service or be removed entirely. May also affect the level of service on in-house maintenance work by limiting in-house budget.	1. Review in-house capabilities and costs to determine if work can be done internally. 2. Review contracts to determine changes that are likely to increase competition, such as bundling projects or increasing quantities.	LORI LANGE Tim Colvett

	Risk	Type	Avg. Likelihood	Avg. Consequence	2019 Score	If	Then	Mitigation	Points of Contact
8	Competing Priorities /Trade-Off Analysis	Program / Agency	5.7	4.8	27.2	If competing priorities exist,	1. Reduction of maintenance funding 2. Deterioration of pavement and bridges	1. Formalized data-driven trade off analysis 2. Condition forecasting based on funding scenarios 3. Implement an Enterprise Asset Management System	PAUL DEGGES Joe Kirk
9	Inability to Track Annual Obligations by Work Type	Program / Project	5.1	5.7	29.4	If budget and obligations data cannot be classified into work type categories (Maintenance, Preservation, Rehabilitation/Re-pair, Reconstruction, Construction), classify projects that contribute to the condition of pavement or bridges, and track work on/off the National Highway System (NHS),	1. The department cannot determine the level of investment in pavements and/or bridges on/off the NHS 2. Targets/goals cannot be accurately established for pavements and bridges 3. Expenditures for pavements and bridges cannot be compared to the program budgets to determine if the department is meeting its objectives 4. The current value of the existing pavement/bridge infrastructure cannot be determined 5. FHWA could reduce the federal pro-rata share to 65% if TDOT does not report budgets and obligations by work type in the TAMP.	1. Evaluate Needs 2. Identify shortcomings of current programs 3. Update PPRM to allow for categorization of projects by work type, asset type, and NHS/Non-NHS 4. Ensure that project data is being properly categorized in PPRM.	RONNIE PORTER Joe Kirk

Evaluation of Facilities Repeatedly Damaged by Emergency Events

In order to meet the requirements for Part 667 – TDOT performed an evaluation of facilities repeatedly requiring repair and reconstruction due to emergency events by employing 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
- Evaluation of the risk of recurring damage at same site and cost of future repairs
- Identification of reasonable alternatives to avoid or eliminate the need for federal funds
- Sites identified through this process will be considered for inclusion in the STIP

The results of this evaluation were compiled and sent to the Tennessee Division Administrator of the Federal Highway Administration on October 26, 2018 and are included in Table 5-2 and the appendix. Based on the evaluation, TDOT was unable to identify any specific locations that have had two or more disaster repairs during the evaluation period of January 1, 1997 to December 31, 2017.

Table 5-2: Summary of Data for Declared Disaster Sites (Re: 23 CFR Part 667)

Event Dates	Type of Event	Number of Counties Affected	Number of Sites
January 28, 2009	Ice storm	2	12
November 10, 2009	Rockslide	1	1
January 19, 2010	Rockslide	1	1
January 25, 2010	Rockslide	1	1
March 14, 2010	Rockslide	1	1
Apr 30 to May 2, 2010	Flooding/Slides	41	24
February 20, 2011	Rockslide	1	1
April 5, 2011	Rockslide	1	1
April 19, 2011	Flooding	17	17
January 31, 2012	Rockslide	1	1
March 8, 2012	Landslide	1	1
February 10, 2016	Rockslide	1	1
February 26-29, 2016	Rockslide	1	1
April 23, 2017	Rockslides	3	3
May 13, 2017	Rockslide	1	1

Chapter 6

Financial Plan

What is TDOT's Financial Plan?

The Tennessee Department of Transportation has its own budget separate from the state's General Fund. Tennessee's annual State budget identifies sources of revenue and estimated amounts to contribute to TDOT's Highway Fund. Budgetary control is maintained by the Department, working in conjunction with the Department of Finance and Administration.

As required by the final rule, the following section identifies the process TDOT will use to satisfy the requirements of MAP-21 for the financial plan.

What are the MAP-21 and Final Rule Requirements?

Definitions as they apply to this section are found in 23 CFR Part 515.5 and repeated here as follows:

- Financial Plan means a long-term plan spanning ten (10) years or longer, presenting a State DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets for asset condition during the plan period, and highlighting how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies.

- Investment strategy means a set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risk.

- Work type means initial construction, maintenance, preservation, rehabilitation, and reconstruction.

And in 23 CFR Part 515.7, state DOTs are required to develop a risk-based asset management plan to include specific minimum processes. The following section on financial plan is identified in subsection (d):

- A State DOT shall establish a process for the development of a financial plan that identifies annual costs over a minimum period of 10 years. The financial plan process shall, at a minimum, produce:
  (1) The estimated cost of expected future work to implement investment strategies contained in the asset management plan, by State fiscal year and work type;
  (2) The estimated funding levels that are expected to be reasonably available, by fiscal year, to address the costs of future work types. State DOTs may estimate the amount of available future funding using historical values where the future funding amount is uncertain;
  (3) Identification of anticipated funding sources; and
  (4) An estimate of the value of the agency's NHS pavement and bridge assets and the needed investment on an annual basis to maintain the value of these assets.

What is TDOT's Process for Developing a Financial Plan?

The State of Tennessee is a fiscally conservative state where annual budgets are prepared based on a pay-as-you-go philosophy. The Governor is required to present a proposed budget to the General Assembly on an annual basis. The General Assembly, in consideration of the Governor's recommendations, passes an appropriation act which is the financial plan for all state agencies. The annual fiscal year budget begins on July 1 and ends on June 30. Once the fiscal year begins, budget staff starts making plans for the next fiscal year.

At TDOT, the process for creating an annual budget has been refined over the last few years and evolved to a systematic methodology based on historical information and performance data. The current process estimates the amount of funds available to the department by funding source and allocation of these funds to agency programs. Table 6-1 is TDOT's budget for fiscal year 2018-2019.

In order to satisfy the requirements of MAP-21 and the final rule, TDOT will expand on their current process to:

- Cover a 10-year period,
- Include cost estimates to implement the investment strategy, by year and work type,
- Estimate funding levels by revenue sources for the 10-year period, and
- Determine asset valuation for NHS pavement and bridges and annual investment to keep in a state of good repair.

In order to develop a financial plan that covers a 10-year period, TDOT will rely on work that has already been done, such as the 25-Year Long-Range Transportation Policy Plan, the 10-Year Strategic Investment Plan, State Transportation Improvement Program 2017-2020, the Fiscal Year 2019 Budget for the State of Tennessee, and the TDOT TAMP Investment Strategy. These documents, along with subsequent State Budgets, will provide the basis for developing a 10-year estimate of the funds available to TDOT to implement the TAMP investment strategy. Each of the major revenue sources which contribute to TDOT's annual budget will be analyzed to estimate future dollars.

Table 6-1: TDOT Fiscal Year 2018-2019 Budget

Recommended Budget by Program and Funding Source				
Fiscal Year 2018-2019				
Program Area	**State**	**Federal**	**Other**	**Total**
Administration	$92,536,400			$92,536,400
Headquarters Operations	$37,218,100			$37,218,100
Field Operations	$78,386,600			$78,386,600
Garage & Fleet Operations	$40,474,500		$5,500,000	$45,974,500
Highway System Maintenance	$315,149,900		$0	$315,149,900
Sub-Total Program Area	**$563,765,500**		**$5,500,000**	**$569,265,500**
State-Funded Programs				
Betterments	$800,000		$100,000	$900,000
State Aid	$30,622,000		$625,000	$31,247,000
State High Priority Bridges	$18,645,800			$18,645,800
State Industrial Access	$35,000,000		$200,000	$35,200,000
Local Interstate Connectors	$2,000,000		$2,000,000	$4,000,000
Sub-Total State-Funded Programs	**$87,067,800**		**$2,925,000**	**$89,992,800**
Federally Funded Programs				
Planning & Research	$6,647,000	$17,606,000		$24,253,000
Interstate System	$18,472,000	$166,252,000		$184,724,000
Highway Construction	$341,524,500	$794,732,800	$27,659,000	$1,163,916,300
Mass Transit	$67,161,200	$92,477,900		$159,639,100
Air, Water & Rail	$15,100,000	$13,500,000	$2,000,000	$30,600,000
Aeronautics Econ Dev Fund	$20,000,000	$0	$0	$20,000,000
Sub-Total Federally Funded Programs	**$468,904,700**	**$1,084,568,700**	**$ 29,6590,000**	**$1,583,132,400**
Total Appropriations	**$1,119,738,000**	**$1,084,568,700**	**$ 38,084,000**	**$2,242,390,700**
State Funding Sources				
Highway User Taxes	$923,200,000			
Miscellaneous Revenue	$25,938,000			
Fund Balances and Reserves	$8,000,000			
Bond Authorization	$127,000,000			
General Fund transfers	$20,500,000			
Transportation Equity Fund	$15,100,000			
Total State Funding Sources	**$1,119,738,000**			

The FY 2018-2019 budget represents an approximately 8% increase in funds available to the department over the FY 2017-2018 budget, due primarily to increases in federal funds (9%) and highway user fees based on fuel consumption and the 2017 IMPROVE (Improving Manufacturing, Public Roads and Opportunities for a Vibrant Economy) Act (6%). With these new numbers, TDOT's investment strategy for pavements and bridges identified in Table 7-4 of chapter 7 of the TAMP, represented as the following Table 6-2, have been updated from the ones identified in the initial TAMP as necessary to reflect changes in subsequent budgets or revenue forecasts.

During the process, TDOT reached out to local governments who are responsible for NHS pavements and bridges within their jurisdiction to obtain financial information on historical expenditures and estimated budgets for these two assets. Unfortunately, they were unable to provide any financial information on anticipated expenditures on the NHS system within their jurisdictions.

Table 6-2: TDOT 10-Year Estimated Program Funding (Dollars in Millions)

Year	Pavement Management	Bridge Management
2019	$1,197.6	$123.8
2020	$1,206.4	$118.2
2021	$1,212.5	$136.7
2022	$1,218.6	$137.2
2023	$1,224.6	$137.7
2024	$1,230.7	$138.7
2025	$1,236.9	$140.7
2026	$1,243.3	$142.2
2027	$1,249.5	$143.7
2028	$1,255.7	$145.2
Total	$12,275.8	$ 1,364.1

One of the requirements of the final rule is to estimate the cost of expected future work by the MAP-21 work types, i.e. by construction, maintenance, preservation, rehabilitation, and reconstruction. It should be noted that TDOT's pavement and bridge treatment types are slightly different from those identified in the MAP-21 final rule. To provide clarity between the two, Table 6-3 is provided to show how TDOT's treatment types align with the MAP-21 work types.

Table 6-3: Crosswalk Between TDOT Treatment Types and FHWA Work Types

MAP-21 Work Types	TDOT Pavement Treatments	TDOT Bridge Treatments
Preventative Maintenance	Maintenance Activities, including: Shallow patching Skin patching Partial-depth patching Repair concrete corner breaks Concrete joint repair Other thin patching	Preventive Activities, including: • Filling potholes in deck • Minor Structure repair • Major structure repair • Cleaning Structure
Preservation	Preservation Activities, including: • Thin asphalt overlay (1.5" or less) • Microsurfacing • Chip seals • Cape seals • Crack sealing • Concrete joint sealing • Mill and fill asphalt overlays (1.5" or less)	Preservation Activities, including: • Repainting structural steel • Sweeping • Deck repairs • Deck waterproofing • Deck epoxy overlay • Polymer modified concrete deck overlay • Cleaning and resealing expansion joints
Rehabilitation	Rehabilitation Activities, including: • Full-depth patching • Repair/replacing concrete slabs • Hot-in-Place recycling with 1.25" overlay	Rehabilitation Activities, including: • Replacement of expansion joints • Concrete spall repairs • Structural steel repairs • Scour prevention • Bearing replacement
Reconstruction	Reconstruction Activities, including: • Rubblization and overlay of concrete pavement • Full-depth replacement of asphalt pavement	Reconstruction Activities, including: • Bridge Replacement
Construction	Construction Activities, including: • Highway Widening • Highway Realignments • New Highway Construction	Construction Activities, including: • Bridge Widening • New Bridge Construction

In Table 6-4, TDOT's estimated budget for pavements is shown by work type over the next ten (10) years. The fund type that has a significant impact on the health of TDOT pavements is the annual resurfacing allocation. While TDOT does not currently budget resurfacing funds by specific work type, each region in the state is expected to optimize the paving program in their area by utilizing a minimum of 10% of their resurfacing funding for preservation treatments such as microsurfacing, thin-lift overlays, and chip seals. Going forward, the process of specifying treatment options for each roadway segment will be done by the PMS and confirmed by the resurfacing coordinators in each region. The increases in budget in this table are estimated to coincide with the revenue increase estimation of 0.5% per year.

Table 6-4: TDOT 10-Year Estimated Budget for Pavements by Work Type (Dollars in Millions)

Year	Construction & Reconstruction	Repair/ Rehab	Preservation	Maintenance	Total
2019	$943.0	$223.5	$7.3	$23.8	$1,197.6
2020	$947.7	$224.6	$7.3	$26.8	$1,206.4
2021	$952.5	$225.7	$7.4	$26.9	$1,212.5
2022	$957.2	$226.9	$7.4	$27.1	$1,218.6
2023	$962.0	$228.0	$7.4	$27.2	$1,224.6
2024	$966.8	$229.1	$7.5	$27.3	$1,230.7
2025	$971.6	$230.3	$7.5	$27.5	$1,236.9
2026	$976.5	$231.4	$7.6	$27.8	$1,243.3
2027	$981.4	$232.6	$7.6	$27.9	$1,249.5
2028	$986.3	$233.8	$7.6	$28.0	$1,255.7
Total	$9,645.0	$2,286.0	$74.7	$270.3	$12,275.8

Table 6-5 presents TDOT's bridge management budget projections over the next ten (10) years, broken down by the various work types. TDOT does not currently budget by system for bridges. Instead, each bridge is treated equally regardless of system and the priority for repairs is based upon the sufficiency ratings. Budget increases for bridge management are as follows:

- **Construction / Reconstruction** – Based on three (3) year plan for bridge replacements with 0.5% inflation index
- **Repair / Rehab** - $1 million increase per year with 0.5% inflation index
- **Preservation** – $5 million per year with 0.5% inflation index on 80 large bridges w/ 6.75M SF of deck
    - $2 million for 50,000 SY of deck seals per year (15 year life)
    - $2 million for other maintenance items based on historic trends
    - $1 million for traffic control

- **Maintenance** - $5 million per year for deck preservation & maintenance that fall within paving projects
    - These are done in conjunction with the resurfacing projects when they are let

TDOT does not currently break down its construction and reconstruction budgets to indicate what portion of the budget will be for pavement and bridges; thus, the budget amounts shown for construction & reconstruction in Table 6-4 and Table 6-5 have been combined and represent the total project obligations and do not represent dollars that are specifically allotted for pavements and bridges. Likewise, Repair and Rehabilitation activities are not currently separated in TDOT's budget process for pavement and bridges, so those budget amounts have been combined as well; however, these amounts are specific to repair and rehabilitation on pavement and bridges.

Table 6-5: TDOT 10-Year Estimated Bridge Management Budget by Work Type (Dollars in Millions)

Year	Construction & Reconstruction	Repair/ Rehab	Preservation	Maintenance	Total
2019	$67.6	$42.3	$9.4	$4.5	$123.8
2020	$67.7	$40.5	$5.0	$5.0	$118.2
2021	$89.7	$37.0	$5.0	$5.0	$136.7
2022	$89.7	$37.5	$5.0	$5.0	$137.2
2023	$89.7	$38.0	$5.0	$5.0	$137.7
2024	$89.7	$39.0	$5.0	$5.0	$138.7
2025	$89.7	$40.0	$5.5	$5.5	$140.7
2026	$90.2	$41.0	$5.5	$5.5	$142.2
2027	$90.7	$42.0	$5.5	$5.5	$143.7
2028	$91.2	$43.0	$5.5	$5.5	$145.2
Total	$855.9	$400.3	$56.4	$51.5	$1,364.1

What is the Value of TDOT's NHS Pavements and Bridges?

A quick gauge to determine if an agency is maintaining an asset at a steady, declining, or improving state is to look at the monetary value of the asset over a defined time frame. If the value of the asset is increasing or staying the same year to year, the agency's investment in the asset is large enough to offset any decline in condition, i.e. depreciation. This type of strategy is typically consistent with maintaining an asset in a state of good repair. Likewise, if the value of the asset is

declining, it is depreciating faster than the agency's investment in that asset. Based on TDOT's current investment amounts and strategy, it is anticipated that the current condition of the pavement and bridge network on the NHS system will remain approximately the same over the 10-year period.

There are many different ways to determine the monetary value of an asset. Based on the current data available to TDOT, the agency has decided to use two different methods to estimate the value of its pavements and bridges. For this edition of the TAMP, the agency is using GASB (Governmental Accounting Standards Board) methodology to estimate the value of its pavements. For bridges, TDOT has chosen to use an approach termed Depreciated Replacement Cost (DRC) as outlined in "A Guide to Developing Financial Plans and Performance Measures for Transportation Asset Management"[1]. The basic approach in using this method is to estimate the total replacement cost of an asset in current dollars and then reduce the value based on depreciation or lost value due to use or obsolescence. These approaches are described in detail as follows.

PAVEMENT VALUATION

To properly calculate total pavement network replacement costs, information on existing asphalt and aggregate base thicknesses would be required. For most state pavement assets, historical construction data is available in paper form but not currently in a database format. Thus, network-level data for original construction dates and pavement layer thicknesses is not available. The department is in the process of reviewing and entering these historical records into the PMS database. The Pavement Management Office has also commissioned ground penetrating radar (GPR) testing on ~3,500 centerline miles of state routes which were converted from county roads into state routes in the early 1980's. This GPR data provides an accurate assessment of as-built pavement layer thicknesses and is currently being transferred into the PMS. The TDOT Pavement Management Office intends to eventually commission collection of similar data on all other routes. Since these current layer thickness values are not available in network form, a records assessment was conducted on samples of each functional classification to facilitate a reasonable assessment of total pavement network replacement cost. Multiple samples were selected from the network for each functional class and records were reviewed to assess the average individual layer thicknesses. Average asphalt and aggregate layer thicknesses were established for each functional class and initial total replacement costs were established based on the 5-year average unit price per ton of each material type using an 11-foot lane, the network average. Since this value only considers material costs, unit prices were adjusted by a factor of 2.5 to factor all other additional costs such as mobilization and traffic control. This ratio is what was determined to be the typical ratio of total cost to material cost on recent historical projects.

1 Spy Pond Partners, LLC, KPMG, and University of Texas at Austin. NCHRP 19-12: A Guide to Developing Financial Plans and Performance Measures for Transportation Asset Management. TRB, 2018.

Replacement cost unit values and total network replacement cost values by facility type are included in Table 6-6.

Table 6-6: Asphalt Replacement Cost Values

Functional Class	Cost/11' Lane Mile		
	Total	Cost Adjustment	Adjusted Total Cost per Lane Mile
Rural Interstate	$584,787	2.5	$1,461,968
Rural Principal Arterial	$502,154	2.5	$1,255,386
Rural Minor Arterial	$389,054	2.5	$972,635
Rural Major Collector	$409,667	2.5	$1,024,167
Rural Minor Collector	$389,054	2.5	$972,635
Rural Local*	NA	NA	$972,635
Urban Interstate	$621,892	2.5	$1,554,731
Other Freeway - Exp.	$584,787	2.5	$1,461,968
Urban Principal Arterial	$422,038	2.5	$1,055,096
Urban Minor Arterial	$389,412	2.5	$973,531
Urban Major Collector	$487,998	2.5	$1,219,995
Urban Minor Collector	$248,884	2.5	$622,211
Urban Local*	NA	NA	$622,211
*Due to lack of data on the local system, Rural Local is estimated to be the same as Rural Minor Collector and Urban Local is estimated to be the same as Urban Minor Collector.			

Typically, it is uncommon for pavement assets in Tennessee to be completely rehabilitated full depth. The total network replacement cost is hypothetical. The average TDOT pavement maintains acceptable condition full depth and is maintained by means of resurfacing in the top 1-1/4". In calendar year 2018, resurfacing projects averaged $83,000 and $180,000 per lane mile on state routes and interstates, respectively. Using these values, maintenance cost values were established and are shown in Table 6-6.

The TDOT PMS maintains a record of recent resurfacing project history such as the age of the pavement surface since last resurfacing. Additionally, using current pavement condition and prediction models, the remaining service life (RSL) can be estimated for any given segment based on a trigger pavement quality index (PQI) value of 2.5.

Maintenance values were depreciated using the Governmental Accounting Standards Board (GASB) depreciation model, which depreciates based on the "Life Ratio". The Life Ratio is calculated by dividing the predicted remaining service life by the total surface life. Remaining service life values were determined using the PMS based on a trigger PQI value of 2.5. Total service life is determined by adding the age since last resurfacing and the remaining service life. For each individual pavement segment, the average resurfacing unit cost per lane mile was depreciated by this approach. This information for 2018 GASB-depreciated maintenance cost is shown below in Table 6-7. Greater than 95% of TDOT interstates and 99% of state routes are surfaced with asphalt. Thus, valuation methods are currently based on total replacement and maintenance costs of asphalt pavements. It is considered beneficial to eventually consider actual concrete rehabilitation and maintenance costs in this valuation process. This will be done in future years as maintenance costs are gathered for concrete-surfaced pavements.

Currently, asset valuations are only available using 2018 data. Using the GASB methodology, it is estimated that the current value of all TDOT pavements on the NHS is $10 billion. The Pavement Management Office is working on processing data for previous years to report similar asset valuations for previous years. Based on knowledge of historical pavement network depreciation, it is expected that this output will illustrate historically decreasing asset valuations for pavements.

Table 6-7: 2018 Valuation of TDOT Pavements on the NHS system (M=Millions of Dollars)

System	Lane Miles	Total Replacement Cost (M)	Total Maintenance Cost (M)	Total GASB Straight line Maintenance Cost (M)	Current Value(M)
Interstate	5,682.4	$8,588.7	$1,022.8	$465.4	$3,908.1
NHS State routes	12,456.7	$14,507.0	$1,033.9	$434.2	$6,092.3
Total NHS	18,139.1	$23,095.7	$2,056.7	$899.6	$10,000.4

BRIDGE VALUATION

The value of TDOT's bridges is determined based on the replacement value in current dollars then discounted using the bridge's condition (sufficiency rating). Since the agency has a variety of different types and sizes of bridges, the replacement value is based on a weighted average of the various bridge types in the TDOT inventory according to the main type of material and span length. The average unit prices are based on 2018 cost data that have been inflation adjusted for prior years. The replacement value is calculated using the area of the deck in square feet, multiplied by the current

construction replacement unit cost. The replacement value is discounted based on the bridge's sufficiency rating. The sufficiency rating is a nationally recognized numerical value from 1 to 100, where 100 is the best condition rating. According to FHWA's Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges, "The sufficiency rating formula…is a method of evaluating highway bridge data…to obtain a numeric value which is indicative of bridge sufficiency to remain in service." The following formula is used to calculate the current bridge value.

Current value (CV) = Replacement Value (RV) X Sufficiency Rating/100

Using this methodology, it is estimated that the current value of all TDOT bridges on the NHS is $7.822 billion. Table 6-8, Figure 6-1 and Figure 6-2 provide a historical look at how the value of TDOT's NHS bridges has changed over the last 5 years. It should be noted that the value of the agency's bridge assets has increased each year and the current value of the NHS bridges has been consistently retained at a high percentage of the replacement cost, which serves as an indicator that TDOT's Financial Plan and Investment Strategy is adequately funding the bridge program to meet their performance targets and offset any lost in value based on condition.

Table 6-8: 2014-2018 Valuation of TDOT Bridges on the NHS System (M=Millions of Dollars)

Year	2014	2015	2016	2017	2018
Area (SqFt)	56,704,224	57,165,119	57,254,406	57,792,286	58,024,288
Bridge Count	4,106	4,112	4,119	4,148	4,175
Replacement Cost (M)	$ 7,712	$ 8,175	$8,588	$9,073	$9,574
Cost per SqFt	$ 136	$ 143	$ 150	$ 157	$ 165
Current Value (M)	$ 6,233	$ 6,645	$7,008	$7,393	$7,822
% of Replacement Cost	80.8%	81.3%	81.6%	81.5%	81.7%

Figure 6-1: Historical Value of TDOT Bridges on the NHS System

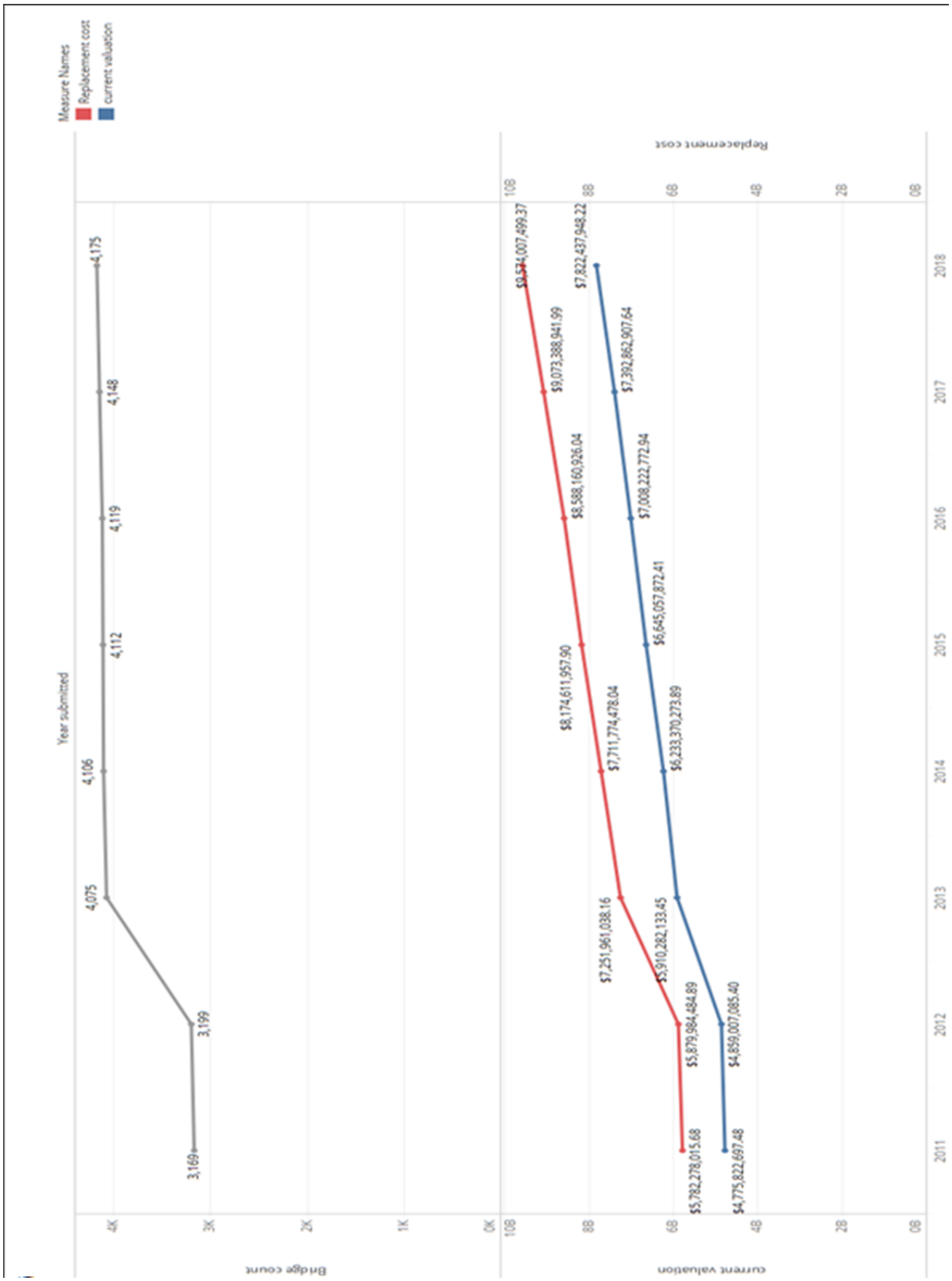
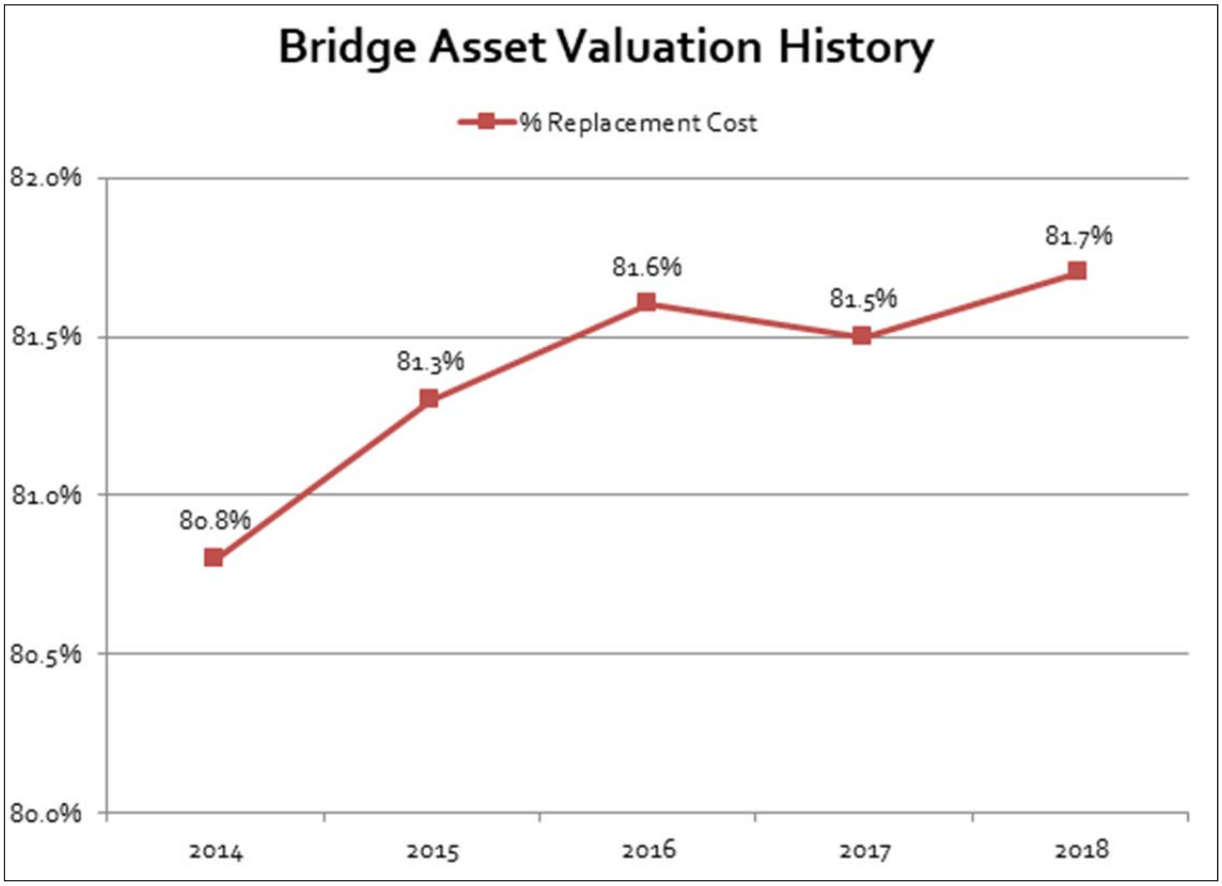


Figure 6-2: Historical % of Replacement Cost for Bridges on the NHS System

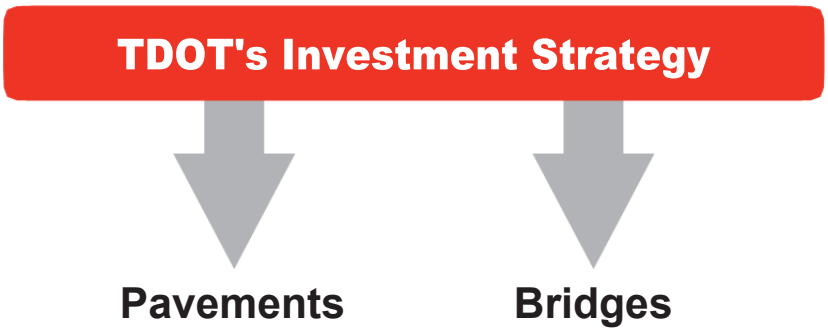


Chapter 7

TDOT TAMP Investment Strategies

What is TDOT's Investment Strategy?

TDOT's process for developing an investment strategy will be covered in this chapter. It includes a discussion on how the agency takes a holistic approach by reviewing and analyzing historical performance based on expenditures to determine future funding needs and projected performance of all modes of transportation that fall under TDOT's purview. While the TAMP focuses mainly on NHS pavement and bridges, the remaining six national goals identified in 23 USC 150(b): Safety, Congestion Reduction, System Reliability, Freight Movement and Economic Vitality, Environmental Sustainability, and Reduced Project Delivery Delays are being addressed by TDOT through other bureaus. This chapter discusses how TDOT uses historical data to develop an investment strategy that meets their needs and sustains a state of good repair for pavement and bridge assets. As required by the final rule, the following sections identify the process TDOT will use to satisfy the requirements of MAP-21 for investment strategy.



What are the MAP-21 and Final Rule Requirements?

Investment strategy is defined in 23 CFR Part 515.5 as follows:

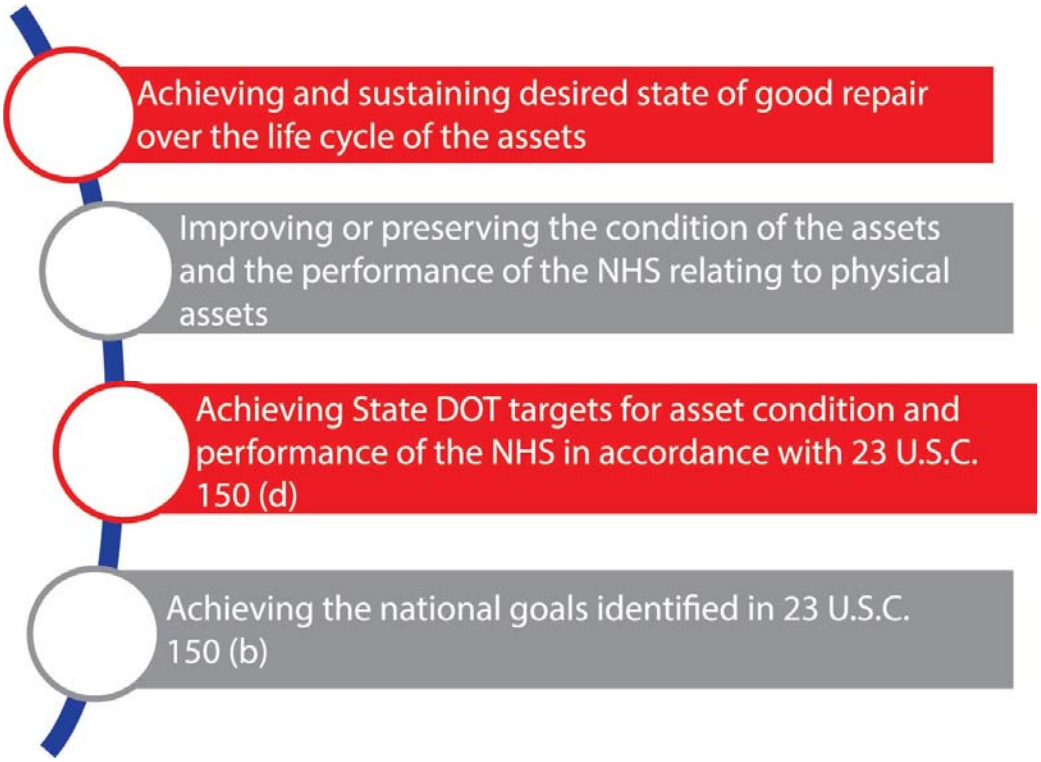
A set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks.

State DOTs in 23 CFR Part 515.7(e) and 515.9(f), are required to develop a risk-based asset management plan to include specific minimum processes for developing an investment strategy as listed in the following subsections:

515.7(e): A State DOT shall establish a process for developing investment strategies meeting the requirements in § 515.9(f). This process must result in a description of how the investment strategies are influenced, at a minimum, by the following:

- Performance gap analysis required under paragraph (a) of this section
- Life Cycle Planning for asset classes or asset sub-groups resulting from the process required under paragraph (b) of this section
- Risk management analysis resulting from the process required under paragraph (c) of this section
- Anticipated available funding and estimated cost of expected future work types associated with various candidate strategies based on the financial plan required by paragraph (d) of this section

515.9(f) An asset management plan shall discuss how the plan's investment strategies collectively would make or support progress toward:



What is TDOT's Process for Investment Strategies?

TDOT has recently adopted a 25-Year Long-Range Transportation Policy Plan that provides guidance and recommendations to help accomplish the agency's vision "to serve the public by providing the best multimodal transportation system in the nation." The Plan consists of two main components, a 25-Year Policy Plan and a 10-Year Strategic Investment Plan (SIP). The 25-Year Policy Plan provides recommendations to guide the department towards the vision statement and guiding principles over the next 25 years while the SIP provides a framework for the projection and allocation of the dollars available to the agency. It should be noted that these documents were prepared prior to the enactment of the IMPROVE Act (Improving Manufacturing, Public Roads and Opportunities for a Vibrant Economy

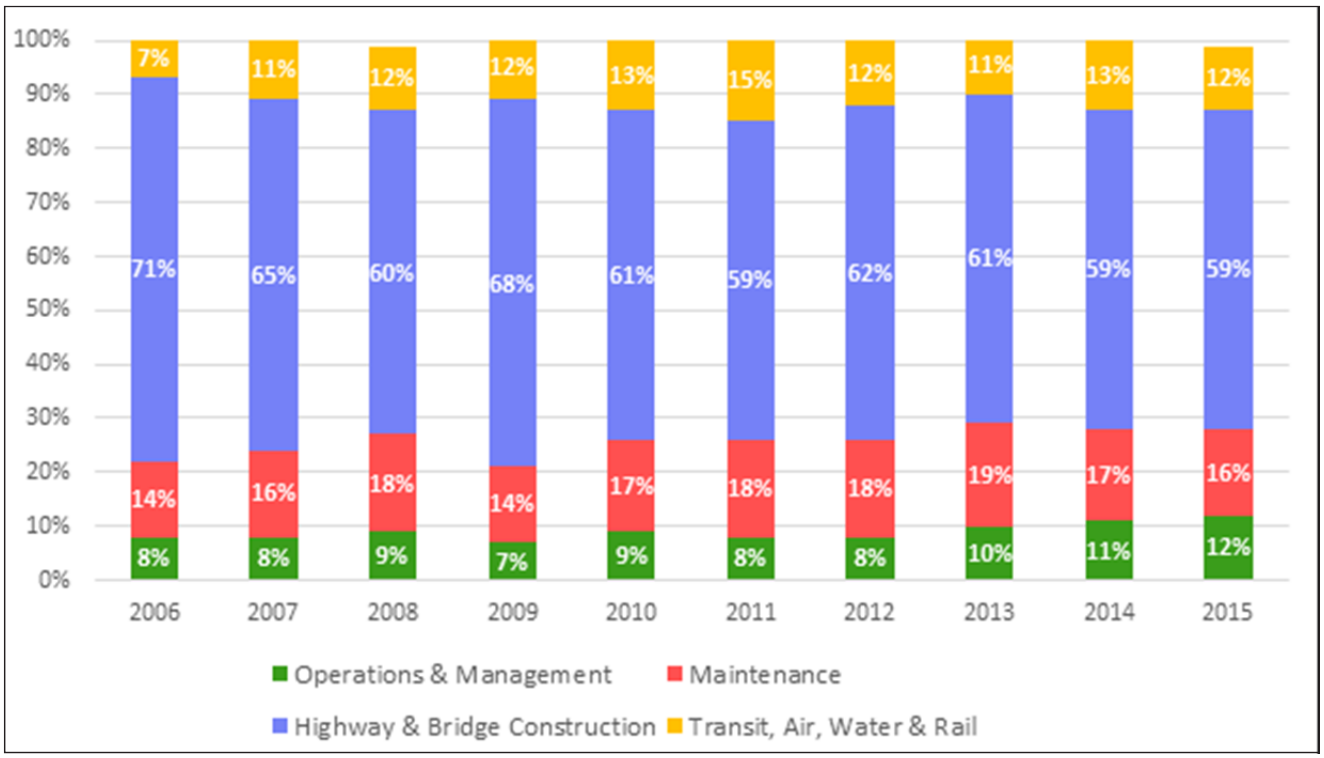
TDOT'S Vision Statement

"To serve the public by providing the best multi-modal transportation system in the nation"

Act), and the revenue projections do not reflect the additional funds generated through this legislation.

According to the SIP, from 2006 to 2015, TDOT's accumulated budget was over $18.76 billion. Looking at the budget in greater detail reveals four general budgeting areas: Operation & Management; Maintenance; Highway & Bridge Construction; and Transit, Air, Water, & Rail. Figure 7-1 provides a snapshot of the historical funding allocations by these categories and the percent of the budget for each one.

Figure 7-1: TDOT Historical Funding Over a 10-Year Horizon (FY 2006-2015) by Funding Area



Source: TDOT 10-Year Strategic Investment Plan

During this same time period, TDOT has made significant investments in pavements and bridges. Table 7-1 shows the historical investment amounts as part of the strategy TDOT has adopted to achieve the high national rankings in infrastructure condition. The Pavement Management program area provides the funds for TDOT's highest valued asset, pavements. These funds are used to sustain the condition of the paved system using a comprehensive pavement management treatment philosophy. Some examples of the type of activities funded through this program are hot-mixed asphalt resurfacing, mill and overlay, microsurfacing, surface seals, and crack and joint sealing. Because TDOT does not

currently break down budgets for capital projects to show what portion will be spent on pavements and bridges, the Construction and Reconstruction work types for pavements have been excluded from the values shown in Table 7-1, but are included in Table 6-2, in Chapter 6, and Table 7-4, later in this chapter.

The bridge management program area funds the activities that maintain and keep TDOT's bridges in a state of good repair. The work types under this program area include bridge replacements, rehabilitation, and preservation. Some example treatments in these work types are repainting steel beam bridges, deck overlays, expansion joint replacement, concrete repairs, steel repairs, and bridge replacements.

Table 7-1: TDOT Historical Funding for Pavements & Bridges (Dollars in Millions)

Program Area	2014	2015	2016	2017	2018	2019
Pavement Management	$205.0	$205.0	$205.	$227.0	$227.0	$230.8
Bridge Management	$111.0	$111.0	$111.	$116.0	$116.4	$122.2

The results from this funding strategy have kept TDOT's pavement and bridge conditions above the national average and high in the national rankings as indicated in Chapter 3, Performance Goals & Targets. The process TDOT utilizes for life cycle cost analysis and to determine funding allocations for pavements and bridges is discussed in Chapter 4, Life Cycle Cost Process. TDOT utilizes an analytical approach using the agency's PMS and BMS (relying on NBIS bridge inspection reports) along with historical reports on accomplishments, network pavement and bridge conditions, funding allocations, expenditures, pavement treatments/costs, structural capacity, bridge repair cost by type, etc. to determine funding allocations for pavements and bridges. Additionally, the agency uses well proven strategies to manage pavement and bridge assets as identified in Chapter 4 Life Cycle Cost and listed below.

There are three (3) main strategies TDOT has in place to identify investments on the roadway network involving annual pavement improvements. The three (3) strategies, discussed in more detail on the following page, include Standard Operating Guidelines (SOG), Remaining Service life (RSL) and Lane-Mile Year Analysis, and PQI.

Pavement Management Strategies

Standard Operating Guidelines (SOG)

TDOT has developed a SOG manual for the Pavement Management Program which establishes the vision, objectives, and procedures for managing the agency's pavements. The SOG provides guidance in the selection of candidates for maintenance, preservation, resurfacing, and rehabilitation projects for both rigid (concrete) and flexible (asphalt) pavement with an emphasis on employing preventive maintenance treatments until repair costs exceed the benefit, i.e. using LCC concepts.

Remaining Service Life (RSL) & Lane-Mile-Year Analysis

RSL is defined as the life of a pavement from the present time (or initial construction date of a new pavement) until it deteriorates to a specific condition which would trigger a significant costly repair treatment. The basic concept behind this metric is a quick evaluation to determine if the agency is programming a suite of projects which, at a minimum, offset the annual loss in pavement life. Each Region is required to perform this quick analysis to ensure that the type of projects recommended for the annual program will satisfy budget allocations, treatment options by type and percentage, and the remaining service life concept.

Pavement Quality Index (PQI)

The PQI is a composite number based primarily on the ride quality of the pavement (Pavement Serviceability Index) and the condition of the pavement (Pavement Distress Index) and is measured on a 0 to 5 scale. An interstate pavement with a PQI of 4.0 or greater would be classified in the good condition category, while one with a PQI of less than 2.0 would be in poor condition. For state routes, pavements with a PQI of 3.5 or greater would be classified in the good category, while one with a PQI of less than 2.0 would be classified as poor. TDOT tracks this number for the Regional and Statewide network conditions to monitor the health of the system and to ensure the Department is meeting its performance goals and targets discussed in Chapter 3.

The Bridge Management Program has four (4) strategies to determine where to allocate funding. The four (4) programs TDOT is currently using for funding allocation strategies are explained in more detail below and include Review of NBIS Inspection Reports, Smart Project Scoping and Selection, Hold the Line, and Not a Worst-First Program.

Bridge Management Strategies

Review of NBIS Inspection Reports

The Structures Division conducts bridge inspections on all the bridges in the state (except federally owned bridges) on a two-year schedule and reviews each bridge inspection report to identify potential candidates for improvement. Identified bridges are included on a repair list and given a priority rating of 1 thru 4 (1 is highest priority) for funding consideration. Once funding is determined, bridges with the highest priority are programmed for improvement. The review and creation of the repair list ensures that no bridge is overlooked.

Smart Project Scoping and Selection

If a bridge is a candidate for replacement within the next 10 to 20 years, then the Structures Division reviews the project repair scope and costs. If a bridge is scheduled for repair but is also in a program to be replaced in the future, the repairs are scaled appropriately to match the projected life of the bridge (replacement letting plus two (2) years for construction) to the life cycle of the repair(s).

Hold the Line

In recent years, TDOT has placed an emphasis on holding the number of structurally deficient bridges down to less than 4% on the state maintained system by programming enough funds to maintain the low percentage target.

Not a Worst-First Program

Approximately 70% of the budget for Bridge Management is allocated to bridge replacement, while the remaining 30% is spent on bridge repairs and preservation.

How Does TDOT Define State of Good Repair for Pavement and Bridges?

The results of these processes and strategies have produced a highway system that meets TDOT's state of good repair (SOGR) targets as described in Chapter 3 Performance Goals & Targets and listed below.

The SOGR targets for pavements are:

- Interstate – more than 50% of pavements are in Good condition (have a PQI greater than 4.0)
- All State Routes and Local NHS Routes (NHS and Non-NHS) – more than 45% of pavements are in Good condition (have a PQI greater than 3.5%)
- All routes – no more than 0.5% of pavements are in Poor condition (have a PQI less than 2.0).

The SOGR targets for bridges are:

- All systems – more than 36% of bridges are in Good condition
- All systems – no more than 6% of bridge are in Poor condition.

Figures 7-2 thru 7-8 provide a historical snapshot and 10-year projection of the condition of TDOT's pavements and bridges. Local NHS pavement data collection was not started by TDOT until 2016, which is not sufficient historical data on which to base an accurate projection; thus, only historical values are shown. Based on this data, in 2018, both pavements and bridges met the SOGR targets. For pavements, 52.0%, 46.6%, and 47.3% were rated at the Good level, for the interstate, NHS state routes and non-NHS state routes, respectively, and no more than 0.45% were rated at the Poor level. In 2018, 40.9% of all TDOT bridges were rated at the Good level and only 3.7% were in Poor condition.

Additionally, Figures 7-3 and 7-7 represent the condition of TDOT's pavements and bridges on the NHS and, similar to the other figures, over 97% of TDOT's pavements and over 96% of the bridges are found to be in the Good or Fair categories. The historical data of the pavement and bridge conditions demonstrates that TDOT has a good investment strategy in place for these assets and is expected to be maintained to meet the minimum standards required by MAP-21 as well as TDOT's SOGR targets.

Figure 7-2: TDOT Interstate Pavement Condition – SOGR

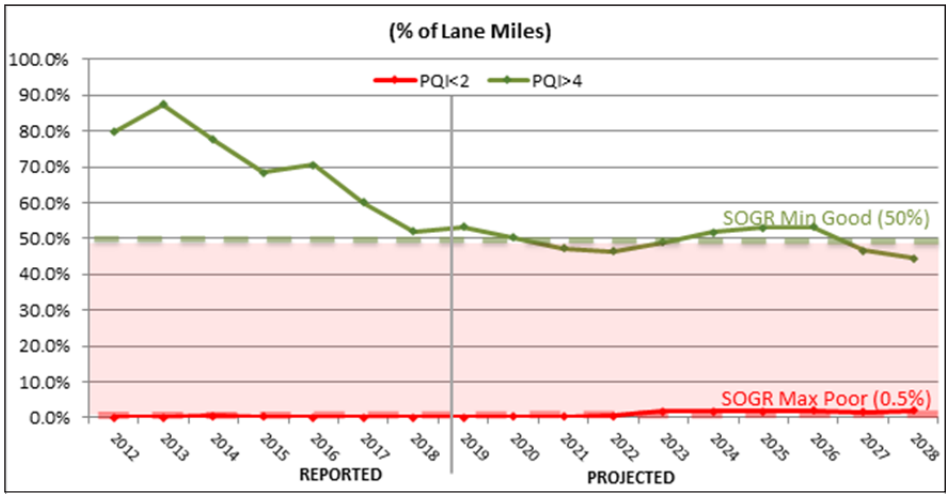


Figure 7-3: TDOT NHS State Routes Pavement Condition – SOGR

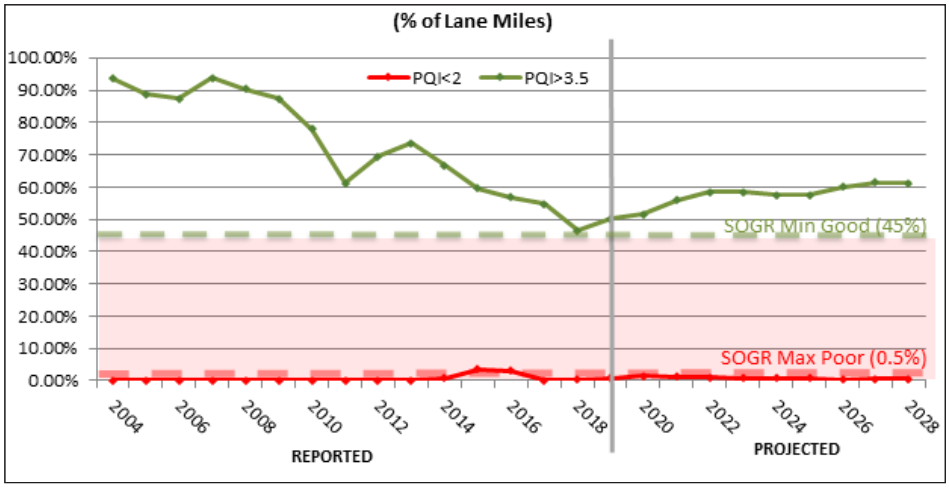


Figure 7-4: TDOT Non-NHS State Routes Pavement Condition – SOGR

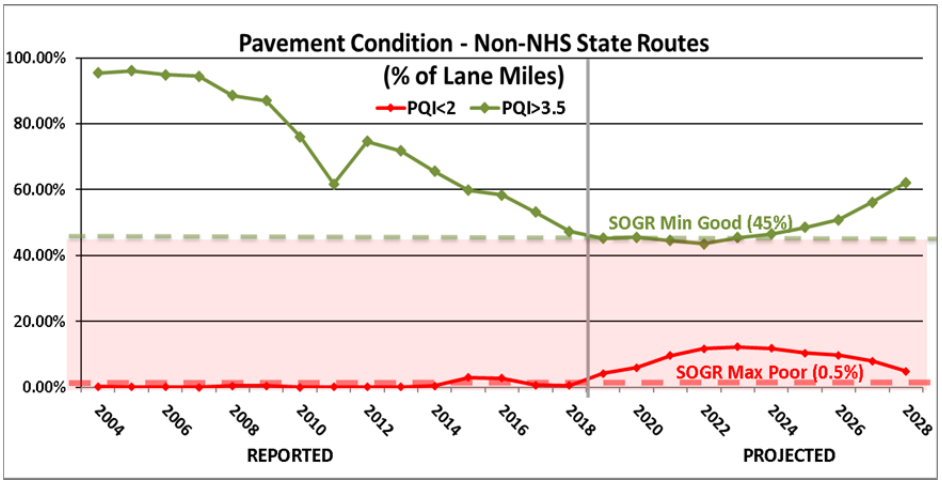


Figure 7-5: Local NHS Routes Pavement Condition - SOGR

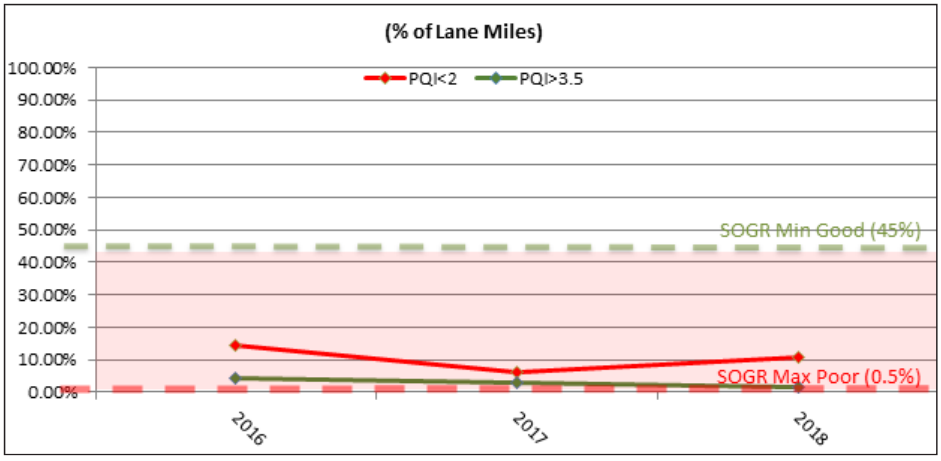


Figure 7-6: TDOT Interstate Routes Bridge Condition – SOGR

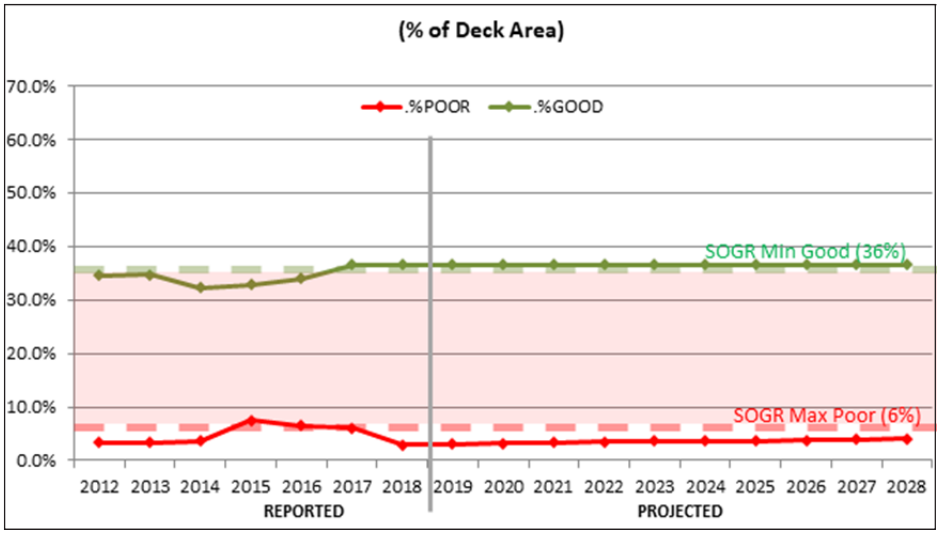


Figure 7-7: All NHS Routes Bridge Condition - SOGR

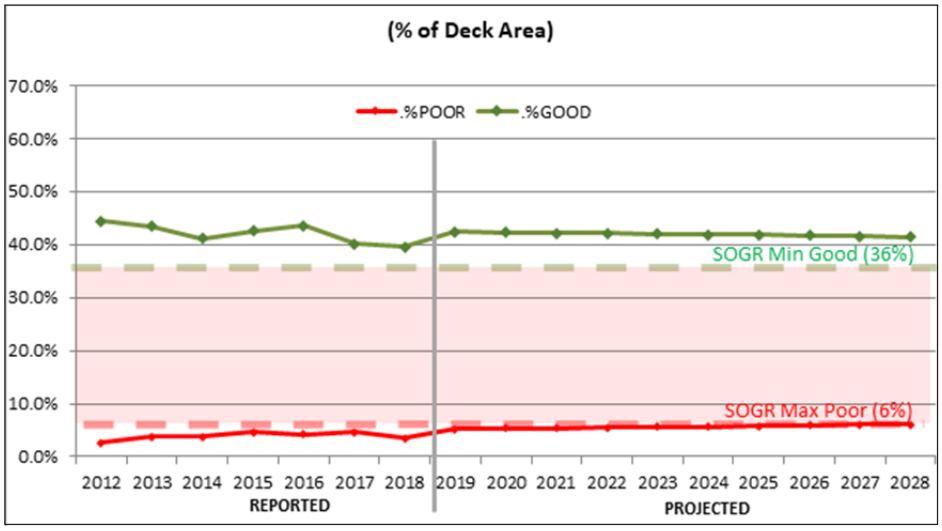


Figure 7-8: Non-NHS State Routes Bridge Condition - SOGR

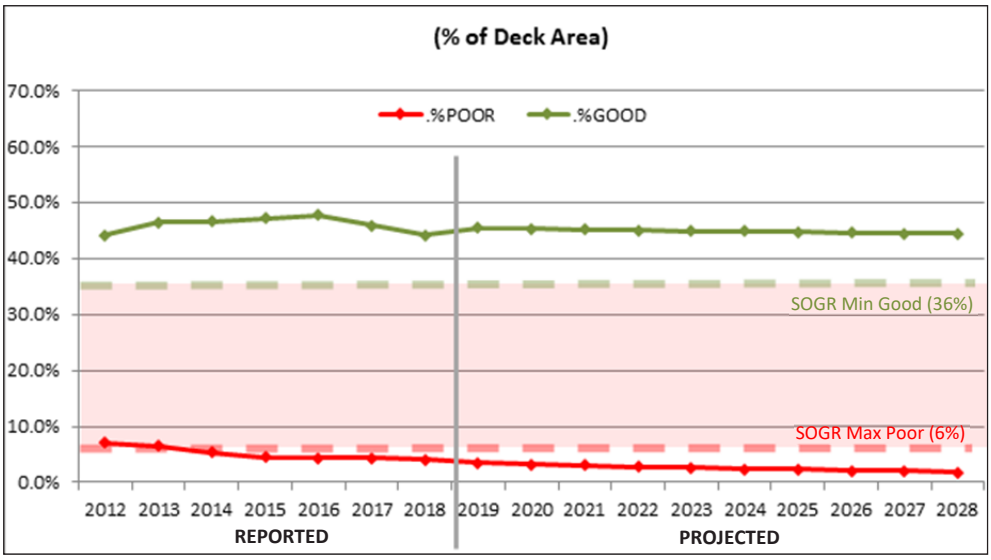
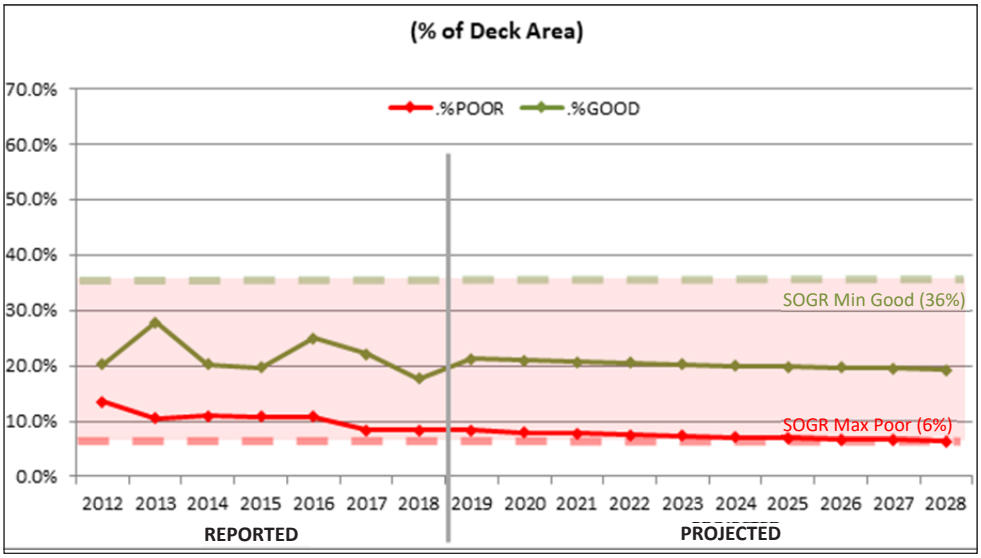


Figure 7-9: Local NHS Routes Bridge Condition - SOGR



It should be noted that the pavement and bridge conditions achieved as depicted in Figures 7-2 through 7-7 were based on TDOT's historical investment strategy shown in Figure 7-1 and Table 7-1 and the agency's "fix it first" philosophy using life cycle cost concepts and practices.

What is TDOT's Revenue Forecast?

The SIP that was prepared as a part of the TDOT 25-Year Long-Range Transportation Policy Plan performed an in-depth analysis of TDOT's revenue streams and developed a 10-year forecast. According to the SIP, revenue forecasts were developed using statistical analysis in looking at the economic models and demographic relationships that influence revenue sources, which generate funds for the TDOT budget. The 10-year forecast from Table 7-2 of the SIP provides an estimate of the state revenues generated by motor fuel taxes and registration fees for the 2017-2026 time frame as indicated below.

Table 7-2: TDOT 10-Year State Revenue Forecast (Dollars in Millions)

	Gasoline & Petroleum Special Products	Motor Vehicle Fuel (Diesel)	Motor Vehicle Registration	Total State Highway Fund Revenue
2017	$425.5	$127.1	$217.3	$769.9
2018	$426.6	$130.9	$220.2	$777.7
2019	$427.6	$134.5	$222.8	$784.9
2020	$428.1	$137.9	$225.5	$791.5
2021	$428.3	$141.0	$228.2	$797.5
2022	$428.2	$144.1	$230.6	$802.9
2023	$427.5	$147.1	$232.9	$807.5
2024	$426.8	$150.0	$235.2	$812.0
2025	$425.6	$152.8	$237.9	$816.3
2026	$422.3	$155.2	$240.7	$818.2
Total	$4,266.5	$1,420.6	$2,291.3	$7,978.4

Source: UTCBER and UTCTR TDOT, 2015

It should be noted that revenue forecasting is dependent on many external variables and can fluctuate from year to year. While the SIP forecast provides useful information on the future outlook of revenue sources, its projections become less accurate when economic factors change. Using this information as an indicator of revenue projections along with more recent TDOT budgets developed after the publication of the SIP, including revenue generated through the IMPROVE Act, Table 7-3 was created to provide a 10-year forecast. With the uncertainty in the growth of the various revenue sources which

generate funds for the TDOT budget and in consultation with the Finance Division, a conservative growth rate of 0.5% has been used to calculate the total budget for each year following 2019.

Table 7-3: TDOT 10-Year Revenue Forecast (Dollars in Millions)

	State Funds Plus Other Funds	Federal Funds	Total TDOT Funds
2019	$1,157.8	$1,084.6	$2,242.4
2020	$1,163.6	$1,090.0	$2,253.6
2021	$1,169.4	$1,095.4	$2,264.8
2022	$1,175.3	$1,100.9	$2,276.2
2023	$1,181.2	$1,106.4	$2,287.6
2024	$1,187.1	$1,112.0	$2,299.1
2025	$1,193.0	$1,117.5	$2,310.5
2026	$1,199.0	$1,123.1	$2,322.1
2027	$1,205.0	$1,128.7	$2,333.7
2028	$1,211.0	$1,134.4	$2,345.4
Total	$11,842.4	$11,093.0	$22,935.4

TDOT's historical budgeting practice, prior to the IMPROVE Act, reveals that approximately 10.6% of the agency's total budget has been allocated to pavement management and 5.2 % to bridge management. Using this as a guide to estimate future allocations starting in 2019, inflating the pavement budget each subsequent year by 0.5%, and increasing the bridge management budget based on explanations provided in Chapter 6 provides the estimated budget numbers in Table 7-4.

Table 7-4: TDOT 10-Year Estimated Program Funding (Dollars in Millions)

Year	Pavement Management	Bridge Management
2019	$1,197.6	$123.8
2020	$1,206.4	$118.2
2021	$1,212.5	$136.7
2022	$1,218.6	$137.2
2023	$1,224.6	$137.7
2024	$1,230.7	$138.7
2025	$1,236.9	$140.7
2026	$1,243.3	$142.2
2027	$1,249.5	$143.7
2028	$1,255.7	$145.2
Total	$12,275.8	$1,364.1

As indicated in Chapter 4 Life Cycle Cost, TDOT has historically had an effective process for determining allocation of funds and resources to meet the agency's vision and guiding principles. The following outline is a summarization of TDOT's process in the development of their annual pavement and bridge management programs.

Risk is also taken into consideration each year as TDOT's senior management develops the annual budget that is submitted to the Governor. Risks which are anticipated to occur on an annual basis but require a significant financial outlay such as snow/ice storms, flooding, and minor rock slides, are identified and budgeted in the Maintenance budget based on historical expenditures and are considered normal standard operational procedures. Other risks that cannot be absorbed by routine budgeting are identified in the STIP or other program areas. An example of a risk assessment TDOT has in place is the consideration of seismic vulnerability and flood prone areas as they develop the bridge management program. Additionally, TDOT has programmed funds for rockfall mitigation in the Three-Year Comprehensive Multimodal Program 2018-2020 to address problem areas.

TDOT's Process to Develop Pavement Management Program

Pavement condition survey results are uploaded to the PMS.

The PMS is used to determine feasible maintenance and rehabilitation strategies for each pavement section and create suggested work plans with associated budgetary needs to meet system performance requirements.

The results of these analyses, along with other records and reports, are provided to TDOT's senior management for review and funding consideration. The outcome of this review is a proposed budget for the annual pavement management program.

Funds are allocated to each TDOT region to develop an annual pavement management work program. Regional work plans are submitted to the state Programming office and central Pavement Office for final approval.

Each of TDOT's four regions complete their annual work plan.

TDOT's Process to Develop Bridge Management Program

Bridge inspection results are uploaded to the BMS upon completion of each bridge inspection.

The BMS program will be used to determine feasible maintenance and rehabilitation strategies and performing network optimization based on performance and funding constraints.

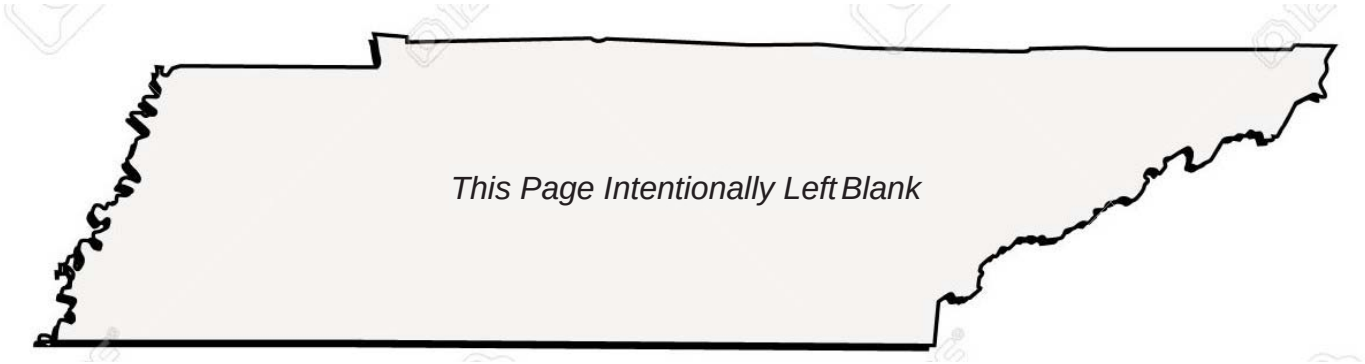
The Structures Division will use the results from the BMS analysis in conjunction with information contained in the bridge inspection reports to develop short-term and long-term bridge management programs.

As the Structures Division goes through the bridge replacement list, scour, long-term maintenance, ADT, seismic vulnerability, bridge type, approach alignment, and detour routes are all considered. Seismic vulnerability is a concern in West Tennessee, and is taken into consideration during the evaluations.

The results are provided to TDOT's senior management for review and funding consideration. The outcome of this review is a proposed funding allocation for the bridge management program.

Once the statewide structures management program funding amount is determined, the Structures Division is responsible for finalizing the annual work plan and developing contracts to accomplish the work.

As Tennessee is a "pay-as-you-go" state, and not handicapped by heavy bonding repayments, TDOT has the flexibility to adjust budgets and allocations to meet the vision and guiding principles of the agency. TDOT will continue to evaluate maintenance of pavement and bridge assets each budget year and tweak the investment strategy as needed.



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Chapter 8

TAMP Process Improvement

How Will TDOT Enhance the TAMP Process?

As TDOT has developed the Initial and Final versions of the 2019 TAMP, there have been various aspects of the process that the department has identified which would streamline the methodology to simplify the development, analysis, implementation, and updates to the asset management plan. The TAMP team has discovered gaps and potential enhancements to their current processes which would improve the department's ability to meet the requirements of MAP-21, the Federal Rules, and foster an asset management culture within the agency. In order for the department to expand on the foundational principles and concepts created through the TAMP development process, the following key process improvements have been identified for consideration in future updates to the TAMP.

Coordination with Structures

Since the development of the initial TAMP document was completed, the TAMP Core Team has coordinated with the TDOT Structures Division to gather bridge condition data, life cycle analyses, evaluate risk, and project future funding projections. The Structures Division now is an integral part of the TAMP Core Team.

Life Cycle Analysis

- The Structures Division has replaced the Bridge Management System with a newer version with the capability to establish a life cycle analysis process to determine the best approach for life cycle planning for structures. Additional tweaking of the deterioration models and financial forecasting capabilities will be done to fine tune the process going forward. The life cycle analysis will help the division determine the most cost effective preservation, rehabilitation, replacement, and maintenance methods needed. In addition, the process will evaluate the projected 10 year bridge management program required to keep the structures at or above the established targets.

Coordination with Finance

- The TAMP team will coordinate with the TDOT Finance Division to develop investment strategies for preserving TDOT's pavement and bridges. This step will follow the life cycle analysis to determine if gaps in the future asset condition and targets exist due to funding levels.
- The process used to determine the asset valuation will be adjusted to better reflect the depreciated current pavement and bridge value.

Incorporation into STIP

- Preservation and maintenance projects are included in the STIP as a lump sum portion per region. Identification of pavement projects are done on a regional level and the budget is distributed among all four regions by formula. A prioritization process that will incorporate pavement and bridge projects where the condition does not meet the target will be considered for implementation.

Annual Risk Management Process

- TDOT will work to formalize the risk assessment on a yearly basis. The risk assessment process will involve a method to obtain information from members of the risk management committee on a yearly basis so that new risks are added in a timely manner and risks that have been resolved are removed.

How Often Will the TAMP be Updated?

The federal rule has established the time frame for updating the TAMP. The Final TAMP must be submitted to FHWA by June 30, 2019. The rule also requires that the DOT update the TAMP at least once every four years as stated in the following:

23 CFR Part 515.13 Process certification and recertification, and annual plan consistency review

a) *Process certification and recertification under 23 U.S.C. 119(e)(6).* Not later than 90 days after the date on which the FHWA receives a State DOT's processes and request for certification or recertification, the FHWA shall decide whether the State DOT's processes for developing its asset management plan meet the requirements of this part. The FHWA will treat the State DOT's submission of an initial State-approved asset management plan under § 515.11(b) as the State DOT's request for the first certification of the State's DOT's plan development processes under 23 U.S.C. 119(e)(6). As provided in paragraph (c) of this section, State DOT shall update and resubmit its asset management plan development processes to the FHWA for a new process certification at least every 4 years.

(c) *Updates and other amendments to plans and development processes.* A State DOT must update its asset management plan and asset management plan development processes at least every 4 years, beginning on the date of the initial FHWA certification of the State DOT's processes under paragraph (a) of this section. Whenever the State DOT updates or otherwise amends its asset management plan or its asset management plan development processes, the State DOT must submit the amended plan or processes to the FHWA for a new process certification and consistency determination at least 30 days prior to the deadline for the next FHWA consistency determination under paragraph (b) of this section. Minor technical corrections and revisions with no foreseeable material impact on the accuracy and validity of the processes, analyses, or investment strategies in the plan do not constitute amendments and do not require submission to FHWA.

Although, as stated above, the federal ruling requires an update every four years, TDOT will be reviewing the TAMP on an annual basis. Part of the annual review will include determination of additional assets to be considered for inclusion in the plan. The processes used to prepare the TAMP, such as life cycle cost, risk management, and investment strategies, will be updated based on current methodologies, federal requirements and available data. TDOT will also update the inventory and condition data annually and report the required conditions per federal requirements.

What Assets Will TDOT Include in the Future?

The transportation system that TDOT is responsible for maintaining contains assets ranging from pavement and bridges to the small drainage structures, overhead structures and signs used to guide vehicular movement. Once the department has a complete inventory and assessment of other assets that are part of the transportation system, these may be incorporated into future versions of TDOT's Transportation Asset Management Plan.

Overhead Structures

Small Structures
(Drainage Structures Between 4' to 20')

Overhead and Ground Mounted Signs

ADA Ramps

Retaining Walls

Sidewalks

REFERENCES

TAMP Federal Ruling, 23 CFR Part 515:
https://www.gpo.gov/fdsys/pkg/CFR-2017-title23-vol1/xml/CFR-2017-title23-vol1-part515.xml

NBIS Regulations:
https://www.gpo.gov/fdsys/pkg/FR-2004-12-14/pdf/04-27355.pdf

25 Year Long Range Transportation Policy Plan:
https://www.tn.gov/tdot/long-range-planning-home/25-year-transportation-policy-plan.html
(This link takes you to all the policy papers.)

10-year Strategic Investment Plan:
https://www.tn.gov/content/dam/tn/tdot/documents/10-YearSIP_022316.pdf

Travel Trends and System Performance – Policy Paper:
https://www.tn.gov/content/dam/tn/tdot/documents/Travel_Trends_022316.pdf

State Transportation Improvement Program 2017-2020:
https://www.tn.gov/content/dam/tn/tdot/programdevelopment/stateprograms/stip2017-2020/STIP2017-2020_Final.pdf

Fiscal Year 2017-2018 Budget for the State of Tennessee:
https://www.tn.gov/content/dam/tn/tdot/finance/TDOTWorkProgramFY2017-18.pdf

IMPROVE Act:
https://www.tdot.tn.gov/projectneeds/spot#/

TDOT's Pavement Standard Operating Guideline:
https://www.tn.gov/tdot/maintenance/pavement-office/project-selection-and-development.html

Tennessee's MPO/RPO/TPO boundary areas:
https://www.tn.gov/content/dam/tn/tdot/long-range-planning/maps/MPO_RPO_Map.pdf

TDOT's 2017 Rockfall Mitigation Project plan can be found at:
https://www.tn.gov/content/dam/tn/tdot/hq-materials-tests/geotech/2017-11-03-RockfallManagementProgram.pdf

TDOT Transportation Asset Management Plan (TAMP):
https://www.tn.gov/tdot/maintenance/asset-management-office/transportation-asset-management-plan.pdf

TDOT TAMP Consistency Determination:
https://www.tn.gov/tdot/maintenance/asset-management-office/TDOT-TAMP-Consistency-Determination.pdf

TDOT TAMP Fact Sheets:
https://www.tn.gov/tdot/maintenance/asset-management-office/TDOT-TAMP-Fact-Sheet.pdf

APPENDIX

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
COMMISSIONER'S OFFICE
SUITE 700, JAMES K. POLK BUILDING
505 DEADERICK STREET
NASHVILLE, TENNESSEE 37243-1402
(615) 741-2848

JOHN C. SCHROER
COMMISSIONER

BILL HASLAM
GOVERNOR

October 26, 2018

Pamela M. Kordenbrock
Tennessee Division Administrator
Federal Highway Administration
404 BNA Drive
Building 200, Suite 508
Nashville, TN 37217

Re: 23 CFR Part 667 - Periodic evaluation of facilities repeatedly requiring repair and reconstruction due to emergency events.

Dear Ms. Kordenbrock:

In accordance with 23 CFR Part 667, the Tennessee Department of Transportation (TDOT) has completed an evaluation to identify roads, highways and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events. A thorough search was conducted to obtain data for this evaluation by examining TDOT work orders relative to disaster sites, data from the Financial Information Management System (FIMS) and reaching out to our FEMA partners for past emergency relief funds provided to the state of Tennessee. The time period for the evaluation was from January 1, 1997 to December 31, 2017.

A total of 15 disaster events meeting criteria of 23 CFR Part 667 were identified. These events occurred between January 2009 and May 2017. Most were flood events, but also included are rockslides, landslides, and an ice storm. A total of 439 sites located in 52 counties were identified as sites requiring repair and construction due to disaster events. All of the sites identified were distinct locations identified by mile postings or, in some cases as entire routes. There were no specific locations that were found to have had two or more disaster repairs during the aforementioned period of time. Please find the attached summary of the Department's findings. A complete data set for this analysis will gladly be provided upon request.

TDOT will continue to review and update this evaluation as events occur to determine if there are reasonable alternatives for sites at risk for repeated emergency repairs and/or reconstruction due to disaster events. Please advise if you need additional information on this matter.

Sincerely,

John C. Schroer
Commissioner

enclosure

cc: Mr. Paul D. Degges, P.E.
Mr. Will Reid, P.E.
Mr. Jerry Hatcher, P.E.
Ms. Sabrina David (FHWA)
Mr. John Steele (FHWA)

Summary of Data for Declared Disaster Sites (Re: 23 CFR Part 667)

Event Dates	Type of Event	Number of Counties Affected	Number of Sites
January 28, 2009	Ice storm	2	12
November 10, 2009	Rockslide	1	1
January 19, 2010	Rockslide	1	1
January 25, 2010	Rockslide	1	1
March 14, 2010	Rockslide	1	1
Apr 30 to May 2, 2010	Flooding	41	242
February 20, 2011	Rockslide	1	1
April 5, 2011	Rockslide	1	1
April 19, 2011	Flooding	17	171
January 31, 2012	Rockslide	1	1
March 8, 2012	Landslide	1	1
February 10, 2016	Rockslide	1	1
February 26-29, 2016	Rockslide	1	1
April 23, 2017	Rockslides	3	3
May 13, 2017	Rockslide	1	1

Consistency Determination Checklist

Consistency Determination Checklist

Required Elements	Indicators Element Meets the Requirements	How Requirements is Addressed in this Document	Required Elements Addressed on these Pages
TAMP approved by head of State DOT (23 CFR 515.9(k))	1. Does the TAMP bear the signature of the head of the State DOT?	Signature of TDOT Commissioner is on the transmittal letter to FHWA	Transmittal letter to FHWA
State DOT has developed its TAMP using certified processes (23 CFR 515.13(b))	2. Do the process descriptions align with the FHWA-certified processes for the State DOT? [If the process descriptions do not align with the FHWA-certified processes, the State DOT must request recertification of the new processes as amendments unless the changes are minor technical corrections or revisions with no foreseeable material impact on the accuracy and validity of the processes, analyses, or investment strategies. State DOTs must request recertification of TAMP development processes at least 30 days prior to the deadline for the next FHWA TAMP consistency determination as provided in 23 CFR 515.13(c).]	TDOT followed the requirements of 23 CFR 515.13(b) in developing the TAMP	Entire TAMP document
	3. Do the TAMP analyses appear to have been prepared using the certified processes?	TDOT followed the requirements of 23 CFR 515.13(b) in developing the TAMP	Entire TAMP document

Required Elements	Indicators Element Meets the Requirements	How Requirements is Addressed in this Document	Required Elements Addressed on these Pages
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	4. Does the TAMP include a summary listing of NHS pavement and bridge assets, regardless of ownership?	Table 2-1 and Table 2-2 in Chapter 2 provide a summary listing of NHS pavement and bridge assets including Federal and Local ownership.	Chapter 2, page 2-2 and 2-3
	5. Does the TAMP include a discussion of State DOT asset management objectives that meets requirements?	Chapter 1 provides a discussion on asset management objectives and measures.	Chapter 1
	6. Does the TAMP include a discussion of State DOT measures and targets for asset condition, including those established pursuant to 23 U.S.C. 150, for NHS pavements and bridges, that meets requirements?	TDOT established national performance measurement targets and state of good repair measures and targets for pavements and bridges.	Chapter 3, pages 3-5, & 3-6; Table 3-5, Table 3-6, & Table 3-7
	7. Does the TAMP include a summary description of the condition of NHS pavements and bridges, regardless of ownership, that meets requirements?	Document discusses condition of pavement and bridge assets on the NHS regardless of ownership in Chapter 2.	Chapter 2, pages 2-5 thru 2-9, Figures 2-5 thru 2-17
	8. Does the TAMP identify and discuss performance gaps?	Gaps affecting TDOT's condition of NHS pavements and bridges are discussed in Chapter 3	Chapter 3, pages 3-6 thru 3-13; Figures 3-1 thru 3-13
	9. Does the TAMP include a discussion of the life-cycle planning that meets requirements, including results?	Discussion on life-cycle planning is described in Chapter 4. Results from analysis is described in Chapter 3.	Chapter 4, entire chapter on life-cycle planning; Chapter 3, pages 3-9 thru 3-13 and Figures 3-6 thru 3-13 show results of analysis
	10. Does the TAMP include a discussion of the risk management analysis that meets requirements?	Discussion on risk management process and analysis is described in Chapter 5.	Chapter 5, pages 5-1 thru 5-12
	11. Does the TAMP include the results of the evaluations of NHS pavements and bridges pursuant to 23 CFR part 667?	Evaluation discussion in Chapter 5.	Chapter 5, page 5-13 & 5-14, Table 5-3

Required Elements	Indicators Element Meets the Requirements	How Requirements is Addressed in this Document	Required Elements Addressed on these Pages
	12. Does the TAMP include a discussion of a 10-year Financial Plan to fund improvements to NHS pavements and bridges?	Discussion on 10-year Financial plan in Chapter 6.	Chapter 6, pages 6-2 thru 6-7, Tables 6-1 thru 6-5
	13. Does the TAMP identify and discuss investment strategies the State intends to use for their NHS pavements and bridges?	For Pavement Management, three strategies are discussed in detail in this document that address achieving and sustaining a state of good repair. These include Standard Operating Guidelines (SOG), Remaining Service life (RSL) and Lane-Mile Year Analysis, and Pavement Quality Index. For the Bridge Management Program, four strategies are discussed: Review of NBIS Inspection Reports, Smart Project Scoping and Selection, Hold the Line, and Not a Worst-First Program	Chapter 7, pages 7-5 thru 7-12, and Figures 7-2 thru 7-9
	14. Does the TAMP include a discussion as to how the investment strategies make or support progress toward achieving and sustaining a desired state of good repair over the life cycle of the assets?	This document shows the results of current processes and strategies in Chapter 7 for managing pavement and bridge assets that have produced a highway system that is in a state of good repair as described in Chapter 3 Performance Goals & Targets.	Chapter 7, pages 7-5 thru 7-12, and Figures 7-2 thru 7-9
	15. Does the TAMP include a discussion as to how the investment strategies make or support progress toward improving or preserving the condition of the assets and the performance of the NHS related to physical assets?	This document shows historical condition data for pavements and bridges exceeding national performance goals.	Chapter 2, pages 2-5 thru 2-9, Figures 2-5 thru 2-17; Chapter 7, pages 7-5 thru 7-12, and Figures 7-2 thru 7-9
	16. Does the TAMP include a discussion as to how the investment strategies make or support progress toward achieving the State's targets for asset condition and performance of the NHS in accordance with 23 USC 150(d)?	This document shows the results of current processes and strategies for managing pavement and bridge assets that have produced a highway system that is meeting the state targets for the national performance measures as described in Chapter 2 & 3.	Chapter 7, pages 7-5 thru 7-12, and Figures 7-2 thru 7-9; Chapter 2, pages 2-5 thru 2-9, Figures 2-5 thru 2-17

Required Elements	Indicators Element Meets the Requirements	How Requirements is Addressed in this Document	Required Elements Addressed on these Pages
	17. Does the TAMP include a discussion as to how the investment strategies support progress toward achieving the national goals identified in 23 USC 150(b)?	This document shows the results of current processes and strategies for managing pavement and bridge assets that have produced a highway system that is meeting the state targets for the national performance measures as described in Chapter 2 & 3.	Chapter 7, pages 7-5 thru 7-12, and Figures 7-2 thru 7-9;
	18. Does the TAMP include a discussion as to how the TAMP's life-cycle planning, performance gap analysis, and risk analysis support the State DOT's TAMP investment strategies?	TDOT has historically had an effective process for determining allocation of funds and resources to meet the agency's vision and guiding principles. This document outlines a summarization of TDOT's process in the development of their annual pavement and bridge management programs. TDOT's risk analysis has identified top priority risk and those that require financial resources are identified and where applicable, funding has been programmed to mitigate the risk. An example of a risk assessment TDOT has in place is the consideration of seismic vulnerability and flood prone areas as they develop the bridge management program. Additionally, TDOT has programmed funds for rockfall mitigation in the Three- Year Comprehensive Multimodal Program 2018-2020 to address problem areas.	Chapter 7, pages 7-5 thru 7-15, Tables 7-1, 7-4, Figures 7-2 thru 7-9

Required Elements	Indicators Element Meets the Requirements	How Requirements is Addressed in this Document	Required Elements Addressed on these Pages
Inclusion of Other Assets in the TAMP:	19. If applicable, does the TAMP include a summary listing of other assets, including a description of asset condition?	Not applicable	Not applicable
	20. If applicable, does the TAMP identify measures and State DOT targets for the condition of other assets?	Not applicable	Not applicable
	21. If applicable, does the TAMP include a performance gap analysis for other assets?	Not applicable	Not applicable
	22. If applicable, does the TAMP include a discussion of life cycle planning for other assets?	Not applicable	Not applicable
	23. If applicable, does the TAMP include a discussion of a risk analysis for other assets that meets requirements in 23 CFR 515.9(I)(5)?	Not applicable	Not applicable
	24. If applicable, does the TAMP include a financial plan to fund improvements of other assets?	Not applicable	Not applicable
	25. If applicable, does the TAMP include investment strategies for other assets?	Not applicable	Not applicable

CONSISTENCY DETERMINATION

What is Consistency Determination?

TDOT strongly believes in operating as an open and transparent governmental body that serves the people of Tennessee in a beneficial manner to provide a safe and reliable transportation system for people, goods, and services that supports economic prosperity in Tennessee. TDOT's guiding principles - Professional, Innovative, Efficient, Responsible, Communicate, and Expeditious (PIERCE) - empower the agency to "say what you'll do, and do what you say" in meeting the transportation needs of the state. This TAMP exemplifies TDOT's commitment to plan, design, build, maintain, and manage one of the best transportation systems in the nation. The consistency determination is TDOT's proof that it is managing the state's NHS pavement and bridge assets in accordance with a strategic plan to be as efficient and effective as possible with the federal and state dollars and achieve their performance goals and objectives.

What are the MAP-21 and Final Rule requirements?

Consistency Determination requirements are identified in 23 CFR Part 515.13 (b) (2) as follows:

(b) Annual determination of consistency under 23 U.S.C. 119(e)(5). Not later than August 31, 2019, and not later than July 31 in each year thereafter, FHWA will notify the State DOT whether the State DOT has developed and implemented an asset management plan consistent with 23 U.S.C. 119. The notice will be in writing and, in the case of a negative determination, will specify the deficiencies the State DOT needs to address. In making the annual consistency determination, the FHWA will consider the most recent asset management plan submitted by the State DOT, as well as any documentation submitted by the State DOT to demonstrate implementation of the plan. The FHWA determination is only as to the consistency of the State DOT asset management plan and State DOT implementation of that plan with applicable requirements, and is not an approval or disapproval of strategies or other decisions contained in the plan. With respect to any assets the State DOT may elect to include in its plan in addition to NHS pavement and bridge assets, the FHWA consistency determination will consider only whether the State DOT has complied with § 515.9(l) with respect to such discretionary assets.

> (1) Plan development. The FHWA will review the State DOT's asset management plan to ensure that it was developed with certified processes, includes the required content, and is consistent with other applicable requirements in this part.

(2) Plan implementation. The State DOT must demonstrate implementation of an asset management plan that meets the requirements of 23 U.S.C. 119 and this part. Each State DOT may determine the most suitable approach for demonstrating implementation of its asset management plan, so long as the information is current, documented, and verifiable. The submission must show the State DOT is using the investment strategies in its plan to make progress toward achievement of its 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). The State DOT must submit its implementation documentation not less than 30 days prior to the deadline for the FHWA consistency determination.

(i) FHWA considers the best evidence of plan implementation to be that, for the 12 months preceding the consistency determination, the State DOT funding allocations are reasonably consistent with the investment strategies in the State DOT's asset management plan. This demonstration takes into account the alignment between the actual and planned levels of investment for various work types (i.e., initial construction, maintenance, preservation, rehabilitation and reconstruction).

(ii) FHWA may find a State DOT has implemented its asset management plan even if the State has deviated from the investment strategies included in the asset management plan, if the State DOT shows the deviation was necessary due to extenuating circumstances beyond the State DOT's reasonable control.

What is TDOT's Process for Documenting Consistency?

TDOT will submit to FHWA a summary of how the agency's annual investment strategy planned allocations are in alignment and reasonably consistent with actual expenditure amounts based on the various MAP-21 work types. Should the amounts significantly deviate, TDOT will provide documentation to justify the deviation.

Fiscal Year 2019	Bridges		Pavements	
Work Type	TAMP Investment ($M)	Actual Investment ($M)	TAMP Investment ($M)	Actual Investment ($M)
Maintenance	4.5	2.8	23.8	27.5
Preservation	9.4	8.9	223.5	264.9
Rehabilitation/Repair	42.3	41.0	7.3	25.0
Reconstruction	67.6	93.9	943.0	772.4
Total	123.8	143.3	1,197.6	1,089.8

Does the Actual Investment amount significantly deviate from the TAMP Investment amount? Yes

If yes, provide documentation below on why the deviation(s) were necessary due to extenuating circumstances beyond TDOT's reasonable control.

Documentation: TDOT has historically adopted a "pay-as-you-go" and "fix-it-first" strategy for annual transportation budgeting. Additionally, TDOT has taken an aggressive approach when it comes to promoting the preservation for pavement and bridge assets before they deteriorate to the point where they must be reconstructed. As a result of this strategy, TDOT has been ranked nationally as one of the best transportation infrastructure networks in the country.

Although TDOT's approach to managing its two most valuable assets has been successful to date, the approach that has been used to program budgets and to track project obligations is not consistent with the reporting requirements that have been established in 23 CFR Part 515.13(b)(2). While TDOT does execute projects which directly correlate to the four work types listed in the table above, the budgets that we establish each year have not been programmed into these specific work types and the actual investment amounts have not been tracked in that manner.

Additionally, TDOT's PPRM system does not have the capability to easily identify specific amounts which have been budgeted or expended on the National Highway System. Therefore, attempting to provide meaningful TAMP Investment and Actual Investment amounts broken down into these categories was painstakingly difficult, and the amounts shown above are our best estimate as to how we have executed projects within each work type.

The amounts shown for Maintenance, Preservation, and Rehabilitation/Repair were the easiest to determine. Our Pavement Office and Structures Division program managers typically have these amounts readily available, and were primarily responsible for producing the investment amounts and budgets for those work types.
The deviation in Rehabilitation/Repair investments for Pavements is attributed to the fact that the Pavement Management System recommended three interstate rehab projects this year instead of the typical one project.

The challenge was determining the portion of the Reconstruction projects that contribute to pavement and bridge condition. Many assumptions had to be made to split the amounts for this work type, because our system does not contain enough granularity in the data to produce these splits. That is why the deviation between the TAMP Investment and Actual Investment amounts for Reconstruction are so large.

Going forward, TDOT will work to develop new strategies to generate budget amounts which target the work types listed above for pavements and bridges. Additionally, the department will strive to split those budget amounts in a way that makes it clearer as to how much will be invested on and off the National Highway System. Likewise, TDOT will work to enable our financial and asset management systems to break down the actual investment amounts in a way that makes providing this consistency determination by work type and system much more simple and straightforward. Deviations from the budgeted TAMP investment amounts will require specific documentation to explain why they occurred; however, it will be important to recognize that project overruns and shifts in priority from year to year are inevitable.

This Consistency Determination document will be updated and posted on TDOT's website annually. It will also be referenced in the appendix of each version of TDOT's Transportation Asset Management Plan using the URL web address of the updated Consistency Determination document.

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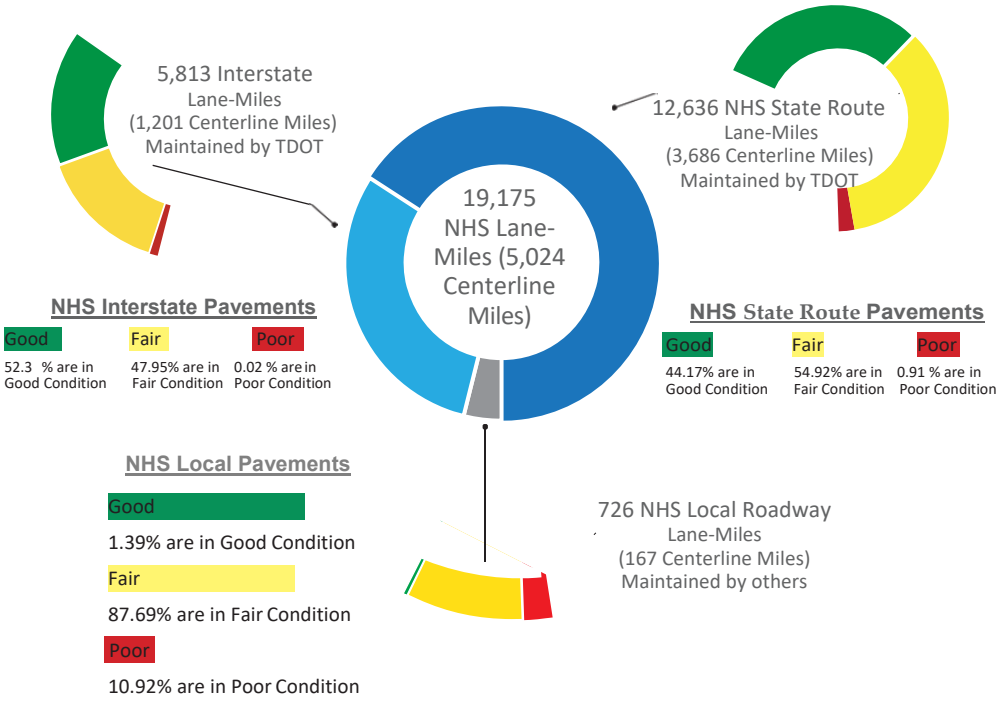
TAMP ASSET FACT SHEETS



Description

- There are 19,175 National Highway System (NHS) lane miles (5,024 center-line miles) in the State of Tennessee, of which 18,449 lane miles (4,857 centerline miles) are maintained by TDOT, 709 lane miles (163 centerline miles) are maintained by the local governments and 17 lane miles (4 centerline miles) are maintained by the federal government.
- Out of the 18,449 NHS lane miles that are maintained by TDOT, 5,813 lane miles (1,201 centerline miles) are on the interstate and 12,636 lane miles (3,656 centerline miles) are on the state routes.
- There are another 19,213 Non-NHS lane miles (9,016 centerline miles) that are maintained by TDOT.
- 98.9% of TDOT maintained pavements are flexible (asphalt) pavements, and 1.1% are rigid (concrete) pavements.

NHS Roadways Inventory and Condition



State of Good Repair (SOGR)

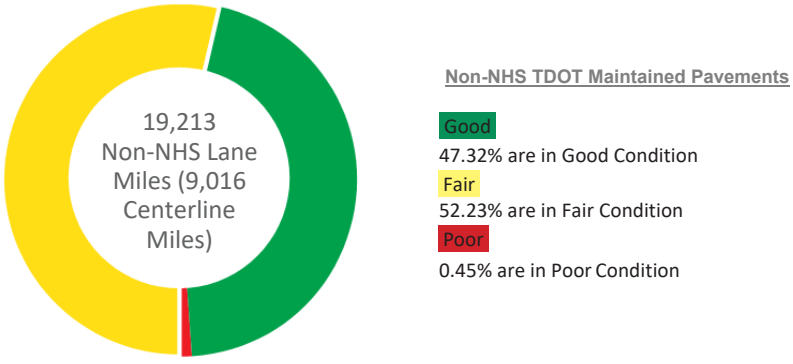
To help identify the roadways needing rehabilitation or maintenance, TDOT collects pavement condition data and calculates a Pavement Quality Index (PQI) for the Interstate, NHS State Routes, and Non-NHS State Routes.

The PQI is a composite index number based primarily on the ride quality of the pavement, (Pavement Smoothness Index), and the condition of the pavement, (Pavement Distress Index), and is measured on a 0 to 5 scale.

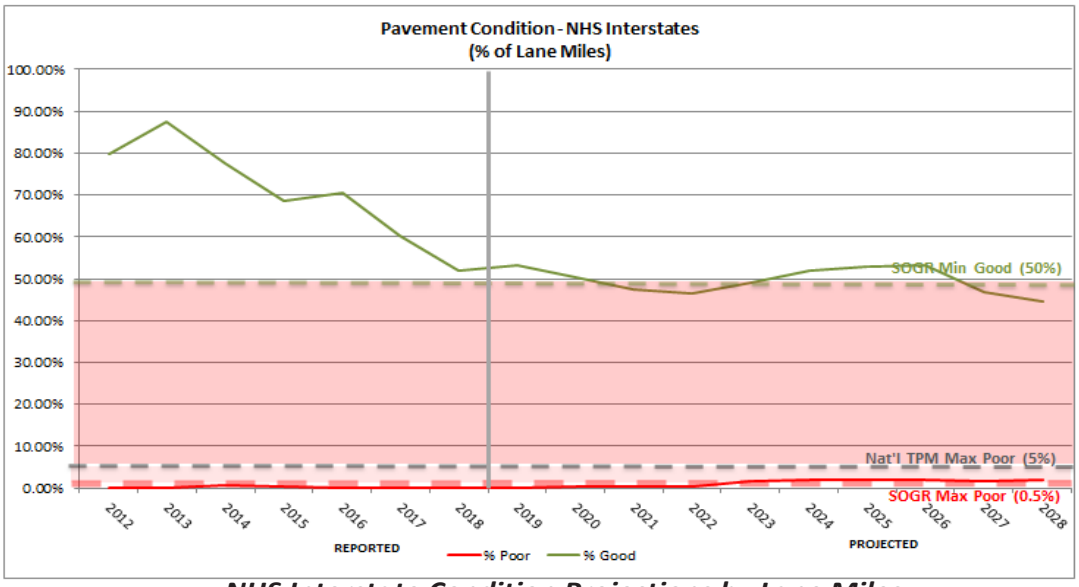
TDOT also tracks several pavement metrics to determine the condition of the roadways including:

- Roughness
- Rutting
- Fatigue Cracking
- Faulting

Non-NHS State Routes Inventory and Condition

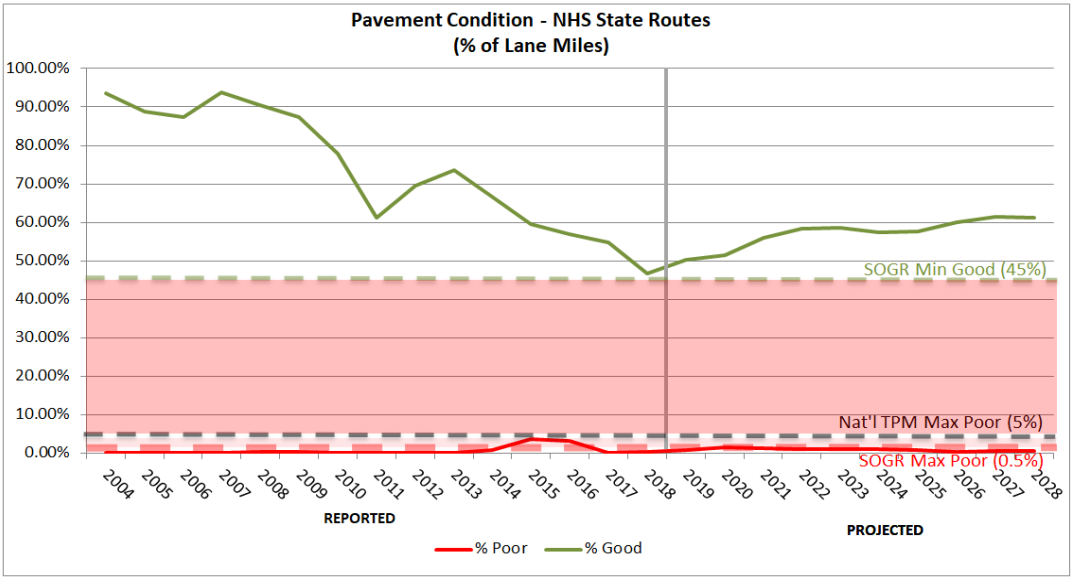


NHS Pavement Condition Projections



NHS Interstate Condition Projections by Lane Miles

Year	2019	2020	2021	2022	2023	Goal
% Good	53.4%	50.3%	47.3%	46.5%	48.9%	>50%
% Poor	0.2%	0.2%	0.3%	0.4%	0.4%	<0.5%



NHS State Route Condition Projections by Lane Miles

Year	2019	2020	2021	2022	2023	Goal
% Good	50.2%	51.5%	55.9%	58.4%	58.5%	>45%
% Poor	0.7%	1.4%	1.3%	0.9%	0.9%	<0.5%

Performance Projections

The charts on the left depict pavement condition for the current funding level of approximately $230M/year. These were developed through an analysis program using TDOT pavement deterioration curves as of May 2019.

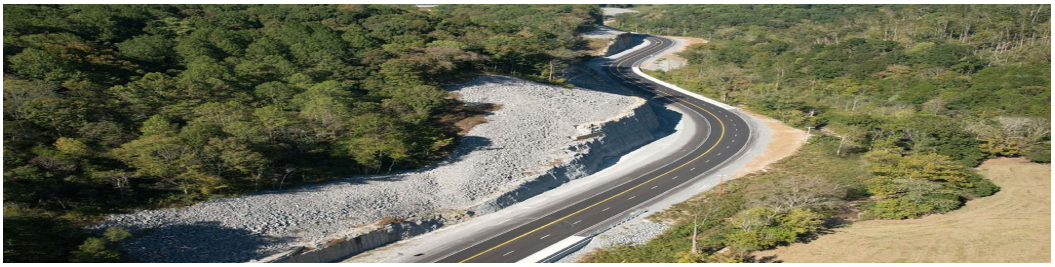
Asset Valuation

$10,000,400,000

Maintenance values were depreciated using the Governmental Accounting Standards Board (GASB) depreciation model, which depreciates based on the "Life Ratio". The Life Ratio is calculated by dividing the predicted remaining service life by the total surface life.

Using the GASB methodology, it is estimated that the current value of all TDOT pavements are as follows:

- NHS Interstate: $3.91B
- NHS State Routes: $6.09B
- Total NHS System: $10B



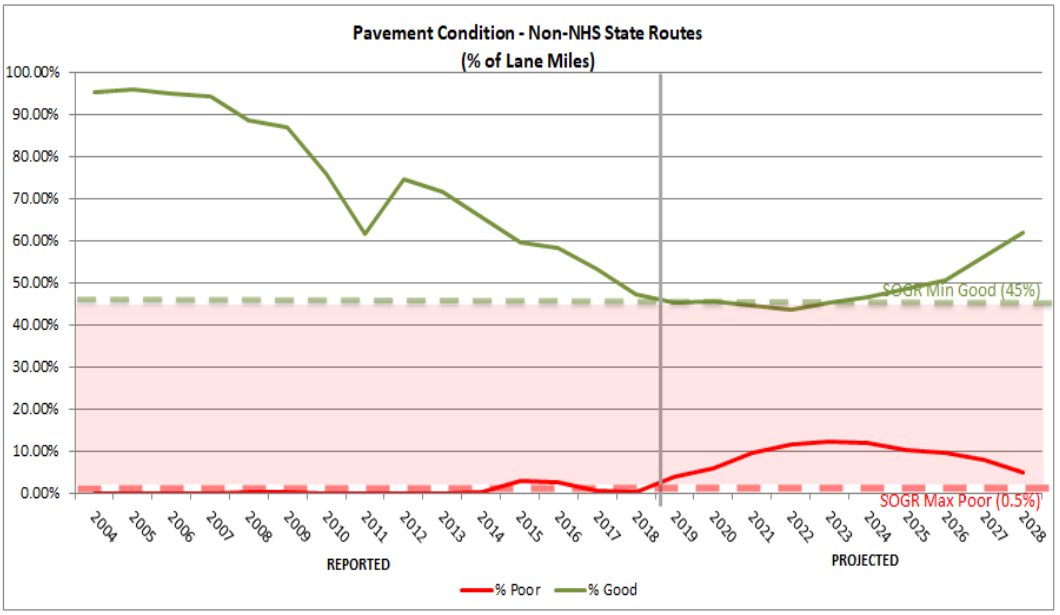
Measures & Targets

TDOT has set the following pavement condition goals (which is more stringent than the federal requirements that were established by 23 CFR Part 490.313(c) and 23CFR Part 490.315(a)):

State Goal

- Interstate: >50% good condition and less than 0.5% poor condition.
- Non-Interstate NHS: >45%good and less than 0.5%poor condition.
- Non-NHS State: >45% good and less than 0.5% poor condition.

Non-NHS State Route Pavement Condition Projections



Non-NHS State Route Condition Projections by Lane Miles

Year	2019	2020	2021	2022	2023	Goal
% Good	45.2%	45.5%	44.6%	43.6%	45.4%	>45%
% Poor	4.1%	5.9%	9.5%	11.6%	12.2%	<0.5%

Growth Rate Projections

These growth rate factors can be applied to each area of Tennessee using the PMS and BMS to help with the future analysis of the pavement and bridge conditions. The department can use this analysis to plan for maintenance and repair of the pavement and bridges over the next ten years.

Growth Rate Projections utilized in Pavement Management System (PMS) and Bridge Management System (BMS)

Area	10 Year Growth Rate (Statewide Model)
Greater Chattanooga	0.9%
Greater Knoxville	1.1%
Jackson	1.0%
Memphis	0.9%
Middle TN	1.5%
Tri-Cities	0.8%
Areas Outside MPO's	1.1%

Description

- TDOT inspects over 20,000 roadway bridges, 8,393 of these bridges are state maintained.
- Of the state maintained bridges, 4,061 are structures on the National Highway System (NHS); there are an additional 106 NHS bridges that are maintained by federal and local agencies.

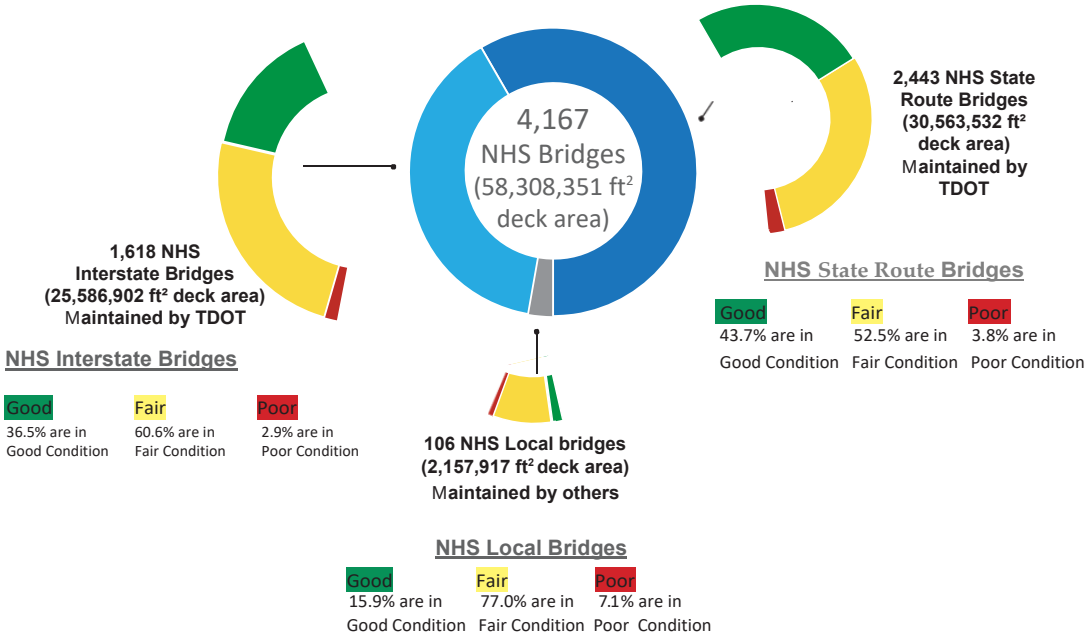
State of Good Repair (SOGR)

A bridge for which the condition rating for each of the three major components for a span bridge (Substructure, Deck, and Superstructure) or the structural condition of a culvert is rated at least a 7 on a 0-9 condition scale is classified as being in a Good condition.

Bridge Age

The average age of all Tennessee highway bridges is 42 years old. This is slightly less than the National Average which is 44 years old based upon a 2018 analysis of National Bridge Inventory data. Bridges on the State Highway System (On-System) tend to be larger and slightly older than those on local highways. The percentage of Structurally Deficient Highway Bridges has been reduced from about 20%, in 1992, to less than 5% in 2018.

NHS Bridge Inventory and Condition



NHS Interstate Bridges

Good	Fair	Poor
36.5% are in Good Condition	60.6% are in Fair Condition	2.9% are in Poor Condition

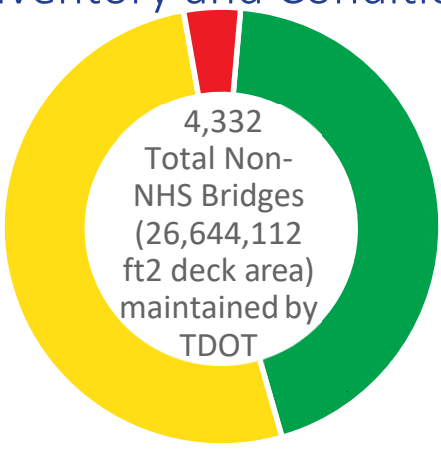
NHS State Route Bridges

Good	Fair	Poor
43.7% are in Good Condition	52.5% are in Fair Condition	3.8% are in Poor Condition

NHS Local Bridges

Good	Fair	Poor
15.9% are in Good Condition	77.0% are in Fair Condition	7.1% are in Poor Condition

Non-NHS State Route Bridge Inventory and Condition



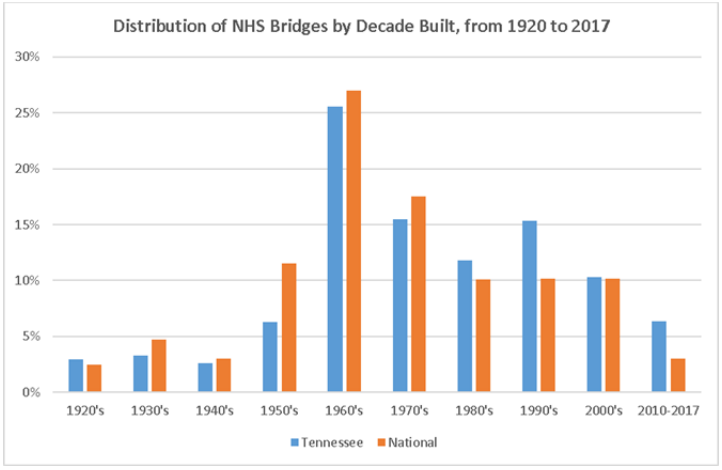
Non-NHS State Route Bridges

Good
44.2% are in Good Condition

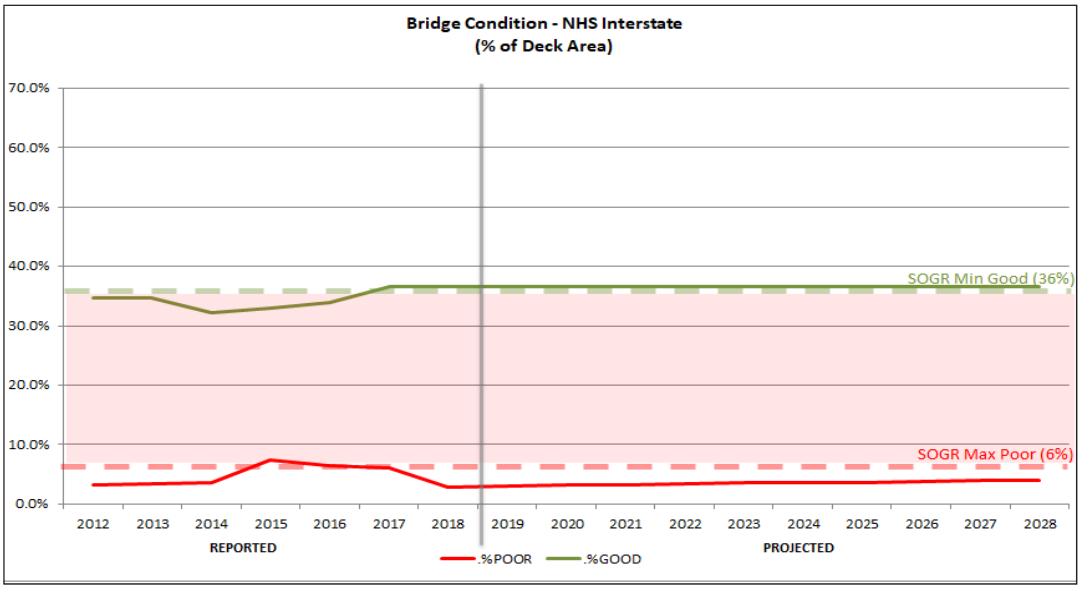
Fair
51.8% are in Fair Condition

Poor
4.0% are in Poor Condition

History

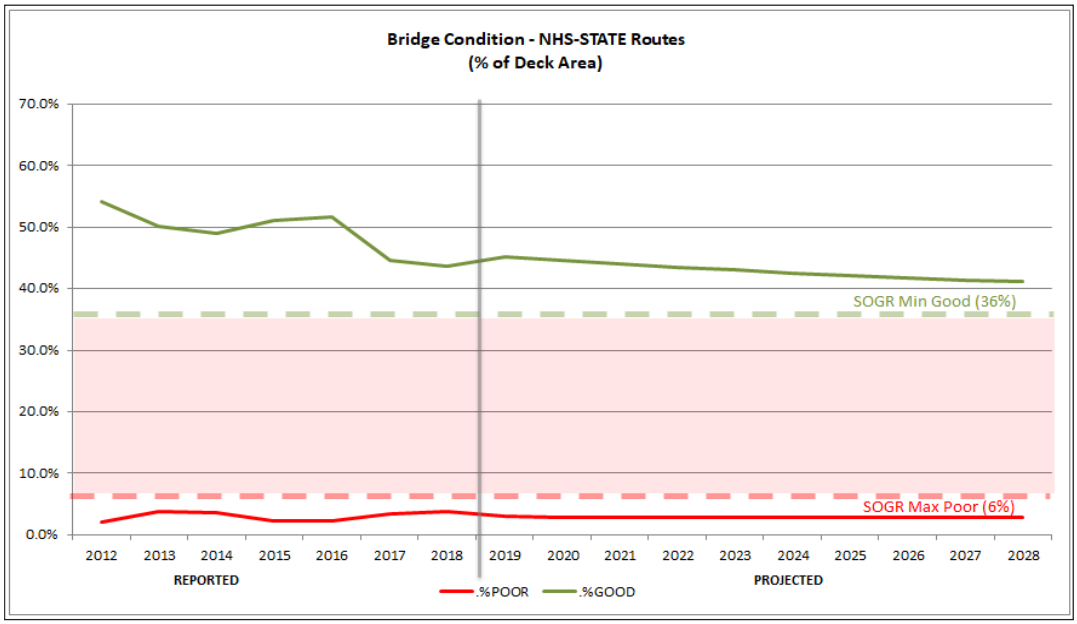


NHS Bridge Condition Projections



NHS Interstate Condition Projections by Deck Area

Year	2019	2020	2021	2022	2023	Goal
% Good	36.5%	36.5%	36.6%	36.6%	36.6%	>36%
% Poor	3.1%	3.2%	3.3%	3.5%	3.6%	<6%



NHS State Route Condition Projections by Deck Area

Year	2019	2020	2021	2022	2023	Goal
% Good	45.2%	44.6%	44.0%	43.5%	43.0%	>36%
% Poor	3.0%	2.9%	2.9%	2.9%	2.9%	<6%

Performance Projections

The chart to the left depicts bridge condition for the current funding level of approximately $122M/year. These were developed through an analysis using TDOT bridge condition data as of May, 2019.

Asset Valuation

$7,822,000,000

The value of TDOT's bridge is determined based on the replacement value in current dollars then discounted using the bridge's condition rating.

Measures & Targets

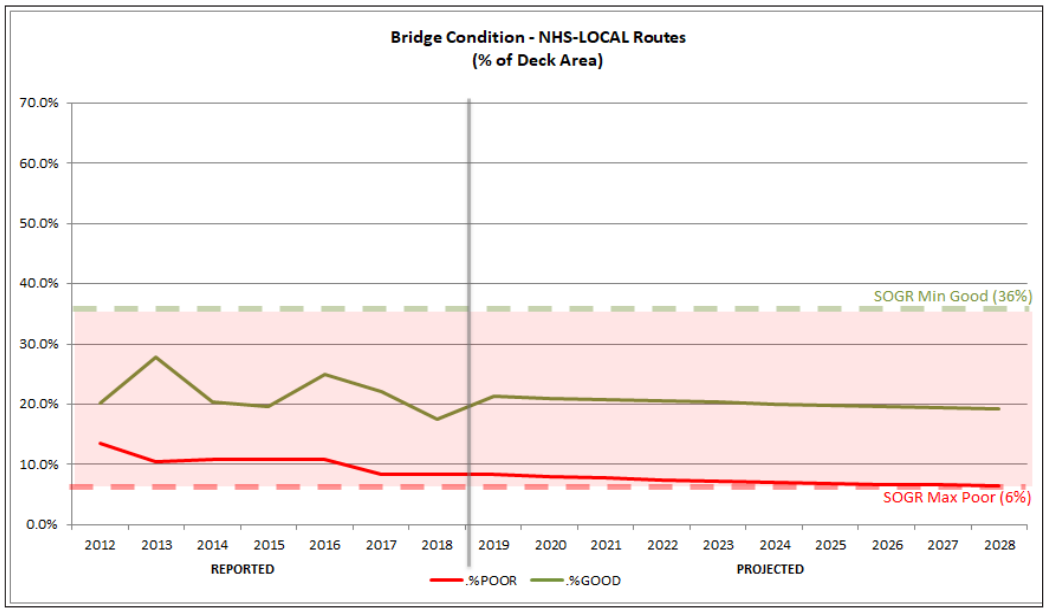
TDOT has set the following bridge condition goal:

- 36% or more Good by deck area on NHS bridges
- Less than 6% poor

Predicted Bridge Condition

Currently, TDOT's BMS does not yet have the capability of forecasting bridge condition as the BrM software is relatively new. The department has chosen to predict the condition of the bridges, from 2019 to 2028, using a straight-line projection. TDOT will continue to refine the condition forecasting capabilities of its bridge management system to improve our ability to predict the condition of the bridges over time, based on various funding scenarios.

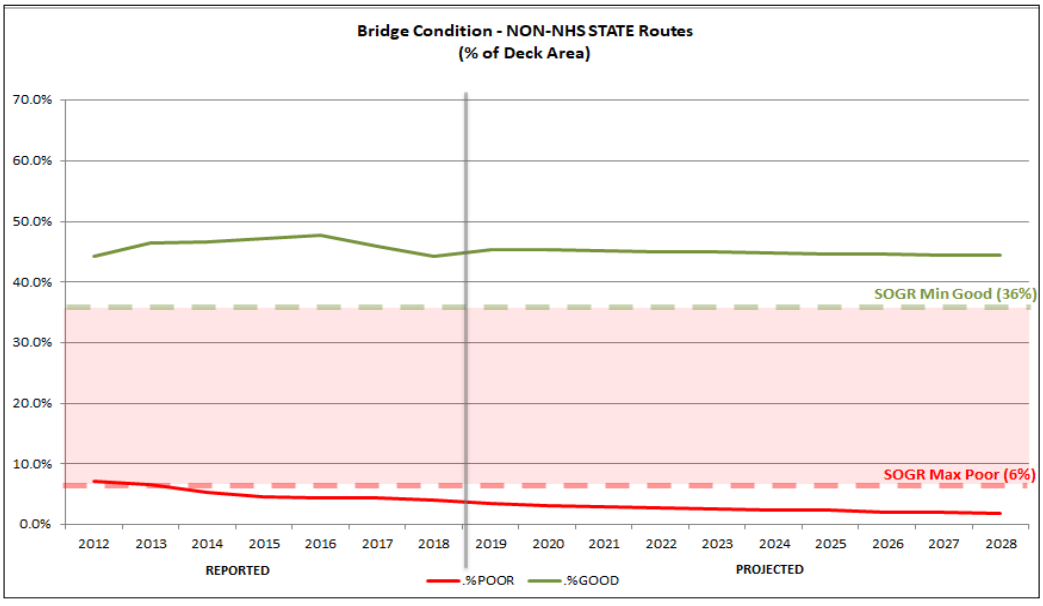
NHS Local Route Bridge Condition Projection



NHS Local Route Condition Projections by Deck Area

Year	2019	2020	2021	2022	2023	Goal
% Good	21.3%	21.0%	20.7%	20.5%	20.3%	>36%
% Poor	8.3%	8.0%	7.8%	7.5%	7.3%	<6%

Non-NHS State Route Bridge Condition Projection



Non-NHS State Route Condition Projections by Deck Area

Year	2019	2020	2021	2022	2023	Goal
% Good	45.4%	45.3%	45.1%	45.0%	44.9%	>36%
% Poor	3.5%	3.2%	3.0%	2.8%	2.6%	<6%