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BUTCH ELEY
DEPUTY GOVERNOR &
COMMISSIONER OF TRANSPORTATION

BILL LEE
GOVERNOR

March 23, 2023

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

Re: Submission of TDOT's BIL-Compliant Transportation Asset Management Plan (TAMP) for Recertification

Dear Ms. Kordenbrock,

To meet the recertification requirements, per 23 CFR 515.13(c), A TAMP which complies with BIL requirements as outlined in 23 CFR 515.7(b) and 23 CFR 515.7(c)(1) is being resubmitted to your office with the requested revisions. TDOT looks forward to coordinating with your office to obtain recertification of TDOT's TAMP.

If you have any questions regarding this request, please contact me at 615-741-2848 or by email at Butch.Eley@tn.gov.

Sincerely,

Butch Eley
Deputy Governor & Commissioner

BE/ch
Enclosure

cc: FHWA - Mr. Gilberto DeLeon, Mr. Greg Simmons, Mr. Rich Casalone, Mr. Fawaz Saraf
TDOT - Mr. Will Reid, Mr. Preston Elliott, Mr. Joe Galbato, Mr. Paul Degges, Mr. Matt Barnes, Mr. Ben Price, Mr. Joe Deering, Ms. Lori Lange, Ms. Jamie Waller, Mr. Ted Kniazewycz, Ms. Jennifer Herstek, Mr. Ronnie Porter, Ms. Julie J. Carmean, Mr. Chris Harris, Mr. Tom Quinn, Mr. Xiaoyang Jia, Mr. Brian Hurst, Mr. John Kahle, Mr. Austin Holliman, Mr. Amos Pulley

TN TDOT Department of Transportation

TENNESSEE DEPARTMENT OF TRANSPORTATION

TRANSPORTATION ASSET MANAGEMENT PLAN (TAMP) 2022

March 2023 (BIL-Compliant)

Version 3.0

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CHAPTER 1
ASSET MANAGEMENT OBJECTIVES & MEASURES

What is a TAMP and Why is it Needed?

TAMP PURPOSE STATEMENT

The TAMP establishes a 10-year plan for asset investments that preserve our investment in our transportation network, as TDOT strives to provide a safe and reliable transportation system that supports economic growth and quality of life.

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 asset needs and outline planned investments that maintain and preserve our significant investment in the transportation network. It will also serve as a strategic document supporting the overall Tennessee Department of Transportation's (TDOT) Mission, established in 2019, "To provide a safe and reliable transportation system that supports economic growth and quality of life."

The TAMP documents proactive approaches to managing transportation assets with systematic, data-driven processes that consider the strategic objectives for the overall transportation network. This is achieved by using cost-effective treatment strategies that extend an asset's useful life and defer the need for more costly repairs.

Tennessee's TAMP satisfies the requirements of the Moving Ahead for Progress in the 21st Century (MAP-21) Act and the Fixing America's Surface Transportation (FAST) Act. In 2021 the Infrastructure Investment and Jobs Act (IIJA) (Public Law 117-58, also known as the Bipartisan Infrastructure Law (BIL)) was passed. IIJA introduced additional TAMP requirements that will be addressed in 2022.

The legislation requires that TDOT develop a risk-based asset management plan for pavement and bridges on the National Highway System (NHS) and all state routes. The TAMP's purpose is to improve or preserve the condition of assets and the performance of the system by presenting 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.

What is the TAMP 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 Transportation Asset Management (TAM) efforts, including the Vision, Mission, and Values.

Vision - Commitment to excellence in managing and improving the state's transportation system, promoting the success of our employees, and strengthening the trust of our customers.

Mission - To provide a safe and reliable transportation system that supports economic growth and quality of life.

Values:

- Stewardship: TDOT takes the best possible care of the state's assets.
- Integrity: TDOT is professional, honest, and strives to do the right thing.
- Safety: TDOT identifies and mitigates hazardous conditions for employees, contractors, and the traveling public.
- Consistency: TDOT is reliable and uniform in actions and words.
- Development: TDOT continually grows and shares knowledge, expertise, and experience.
- Innovation: TDOT looks for new and emerging ways to serve customers.
- Collaboration: TDOT works together internally and with partners to share ideas, skills, and insights to get the best results.
- Family: TDOT promotes a culture of caring, concern for others, and pride in what it does.

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

Operational Goals

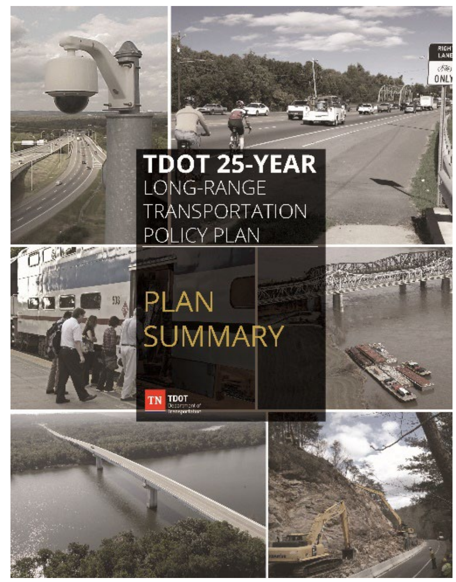
- Deliver transportation projects on schedule and within budget
- Maintain the state transportation system to protect the long-term investment in our infrastructure
- Operate and manage Tennessee's transportation system to provide a high level of safety and service for our customers and workers
- Expand mobility choices to maximize access

What is the TAMP's Relation to Other TDOT Planning Documents

The TAMP is not meant as a replacement to any other TDOT planning processes or priorities; rather, the TAMP builds upon the existing plans, processes, and priorities described in this document to efficiently manage system performance. The following documents were essential to the creation of this TAMP by outlining goals and objectives that set the direction for the TAMP investment strategies.

25-Year Long-Range Transportation Policy Plan

The *25-Year Long-Range Transportation Policy Plan*[1] (LRTPP) consists of eight policy papers, each with recommendations. Preparation of the Plan included an extensive public engagement process that involved citizens, advocates, industries, commerce, and transportation experts. The need to maintain and preserve system assets is reflected in the guiding principles and recommendations established in the papers. The strategic investments outlined in the TAMP addresses two of the seven guiding principles in the LRTPP, which is 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. The TAMP development fulfills four actions called for in the LRTPP (see figure 1-1).



[1] TDOT Long Range Planning Division. *25-Year Long-Range Transportation Policy Plan*. Accessed June 2022. https://www.tn.gov/tdot/long-range-planning-home/25-year-transportation-policy-plan.html

Figure 1-1. TAMP related actions called for in the LRTPP

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*[2] is to assist with the prioritization of TDOT's projects. The measures identified in the paper are meant to accompany those used throughout the Department for strategic and tactical management.

Evaluation of the system through specific metrics and targets helps TDOT measure the effectiveness of programs and policies for project prioritization. Measuring the existing condition and performance of the transportation system helps TDOT identify project needs and guides the Department's planned investments. The performance measures and targets help the Department prioritize projects that will

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[2] TDOT Long Range Planning Division. *Travel Trends and Systems Performance Policy Paper*. Accessed June 2022. https://www.tn.gov/content/dam/tn/tdot/documents/Travel_Trends_022316.pdf

benefit the transportation system and possibly extend an asset's life cycle. The performance measures and targets are discussed further in the next chapter.

How Does Asset Management Planning Fit with the LRTPP Guiding Principles?

TDOT established seven guiding principles (listed in figure 1-2), as part of the LRTPP, that align with the overall Department vision. These principles express TDOT's major priorities and provide tangible actions to achieve the Department's vision. The TAMP's development links to two of the guiding principles:

Figure 1-2. TDOT's Guiding Principles from the 25-year LRTPP

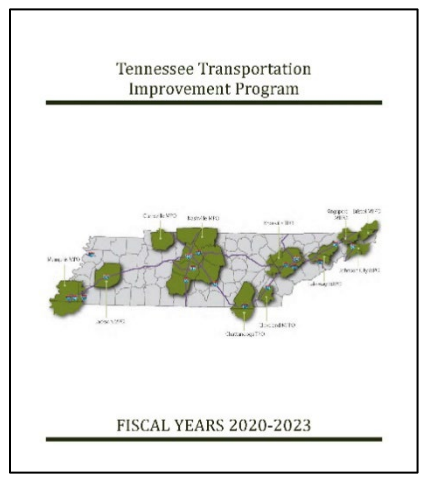
- Preserve and Manage Existing System -- Protect existing assets and maintain efficiency of the system through cost-effective management and new technologies.
- Emphasize Financial Responsibility-- Maximize Tennessee's share of federal transportation funding; select projects based on identified regional needs; allow flexibility in local management of projects where feasible.

TDOT implemented an asset management framework within the organization that enables it to show responsibility for public funds, meet agency goals and objectives and strengthen effective management strategies. This framework is shown in figure 1-3.

Figure 1-3. TDOT's Asset Management Framework

Tennessee's State Transportation Improvement Program (STIP)[3]

The STIP is developed with the purpose of carrying out the Department's LRTPP, the metropolitan transportation plans, and the planned TAMP investments. The plan is fiscally constrained, which means money must be designated and expected to be available for each of the projects listed. The STIP includes 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.



Which Assets Does TDOT Maintain and Evaluate?

TDOT is responsible for managing infrastructure assets along Interstates and state routes throughout the State of Tennessee to keep traffic moving safely and reliably. The transportation system includes over 96,000 centerline miles of roadways, over 20,000 bridges, 79 airports, 2100 miles of Class I railroads, 23 short line railways, 976 miles of navigable waters, and two (2) passenger ferries. Although the Tennessee transportation system includes all transportation modes (e.g., railroad, air, water, and roadway), this TAMP focuses on two key roadway assets: 14,032 centerline miles of pavement and over 8,494 bridges. TDOT relies on the central bureaus and the four (4) regions, as depicted in figure 1-4, to accomplish its

---

[3] TDOT Programming Division. *Tennessee Transportation Improvement Plan: Fiscal Years 2020-2023*. Accessed June 2022. https://www.tn.gov/content/dam/tn/tdot/programdevelopment/stip-amendments/1.5.21_Tennessee%20STIP%202020-2023%20Final_R.pdf

mission. A variety of customers are served by the transportation network TDOT maintains, including citizens of the state, travelers driving through the state, trucking companies, military installations, and other stakeholders.

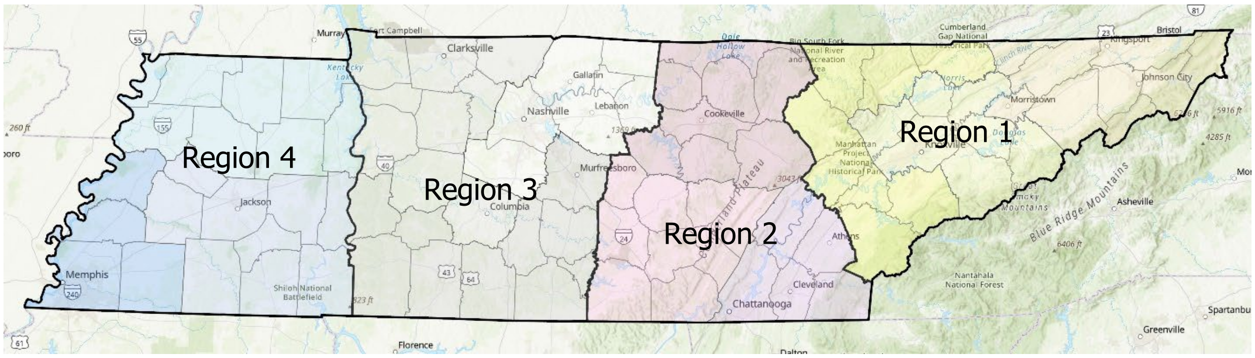


Figure 1-4: Four TDOT Regions

An examination of the types of trips made by the citizens and the freight companies demonstrates how important system reliability is to the economic vitality of the state. Citizens depend on the transportation system to travel to important day-to-day activities involving businesses, schools, churches, medical facilities, shopping centers, and recreational activities. In addition to people, products travel over the Tennessee roadway network, providing a wide range of services to agriculture, military, commercial, and other businesses. These entities expect a safe and reliable transportation network from origin to destination.

The TAMP outlines TDOT's plans for maintaining its pavements and bridges to support economic growth and quality of life. Through annual pavement evaluation and bi-annual bridge evaluations, current and future problem areas can be identified. By addressing the problems found through the evaluation process, the Department can extend the life cycle of the asset and help stretch available funding further. The TAMP outlines a strategic investment plan for a 10-year horizon that will contribute to TDOT's performance goals and objectives.

Which Assets Will Be Included in the TAMP?

TDOT manages a wide array of assets as part of its multimodal transportation network. This TAMP is 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 performance trends. This information is utilized, along with the projected system needs, to budget improvements for the next ten (10) years. The Department has developed an investment strategy for its pavements and bridges to extend their life cycle, while providing a safe and reliable roadway network. Figures 1-5 and 1-6 display the roadways and bridges included as part of the TAMP.

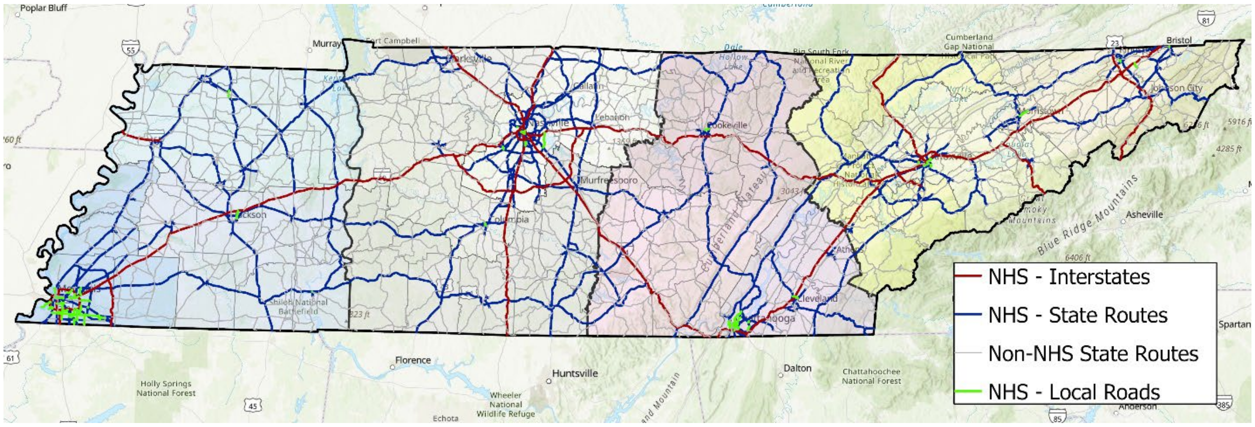


Figure 1-5: Roadways on Interstates, NHS, and Non-NHS State Routes

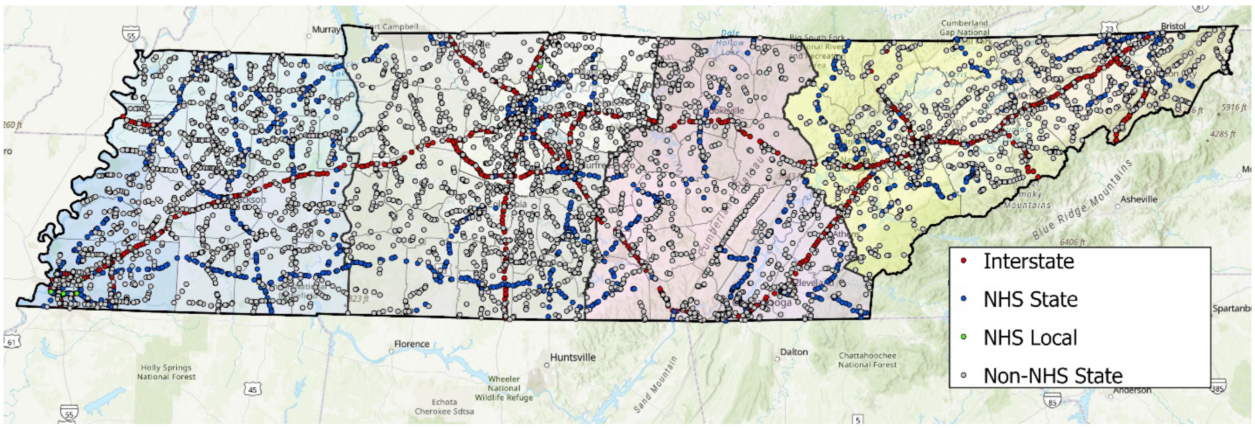


Figure 1-6: Bridges on Interstates, NHS, and Non-NHS State Routes

TAMP Development Process and Content

The process used to develop the TAMP involves several divisions of TDOT. As shown in figure 1-7, conditions are used with forecasting models from the pavement and bridge offices and combined with project funding priorities and financial resources to predict future conditions in relation to desired performance outcomes and targets. The TAMP resulting from using this process is organized into the eight (8) chapters described below.

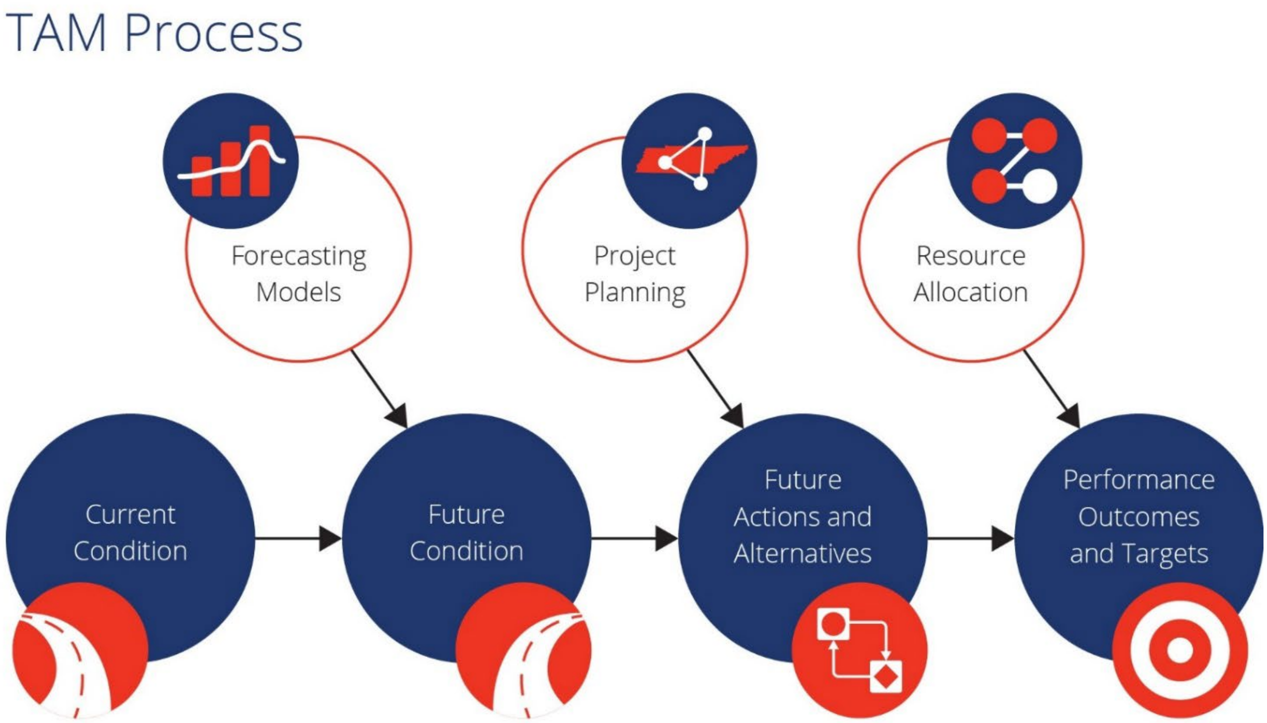


Figure 1-7. TDOT TAM Process

Chapter 1: Asset Management Objectives & Measures

Included in this chapter is the purpose and foundation for preparing the TAMP. It introduces the TAMP and explains how it helps the Department reach the goals and objectives established in other reports.

Chapter 2: Asset Inventory & Condition

This chapter provides the historical and baseline information tracked by TDOT to determine pavement and bridge inventory and condition information 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 defines the performance measures for the pavement and bridges included in the TAMP, establishes 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 discusses the prioritization of projects based on the evaluation criteria. The performance measure targets included in this TAMP reflect targets set in 2022.

Chapter 4: Life Cycle Planning

The amount of time that pavement and bridges can remain in a state of good repair depends on several factors, including the volume and types of vehicles that use the asset, the types of materials used to build the asset, and the climate where the asset is located. Over an asset's life cycle, different types of repairs are needed to address the deterioration that can occur, as depicted in figure 1-8. The Department uses sophisticated software systems to predict the future condition of pavements and bridges based on factors such as asset age, Average Daily Traffic (ADT) counts, and the percentage of heavy trucks using the facility. This chapter focuses on the processes that TDOT uses to consider the results from the life cycle planning analyses conducted using the Pavement Management System (PMS) and Bridge Management System (BMS) to minimize whole life costs.

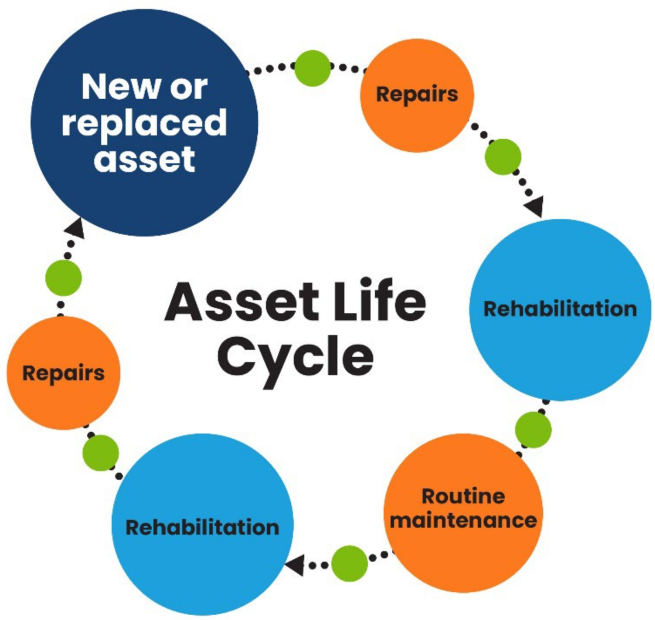


Figure 1-8. Asset Life Cycle Example

Chapter 5: Managing Risk and Resilience

Risk management is a systematic process of identifying, analyzing, and prioritizing risks so that strategies can be developed that mitigate potential threats and opportunities. This chapter discusses risk management and provides an overview of how risks are considered and managed to minimize impacts to the Department's mission. Additionally, the chapter looks at historical data from past emergency events to identify locations that have qualified for repeated federal emergency relief funding or have been addressed in the State Transportation Improvement Program (STIP) to prevent future damage.

Chapter 6: Financial Plan

Over the last century, TDOT has invested significant resources toward managing its transportation system. This chapter documents TDOT's historic funding levels for the bridge and pavement programs and its processes for allocating funding to address pavement and bridge needs. The chapter describes the amount and source of funding expected to be available for these assets over the next 10 years and describes how these funds will be allocated over the 10-year plan horizon.

Chapter 7: TDOT TAMP Investment Strategies

This chapter presents the planned 10-year investment strategies for managing pavements and bridges with planned investments. In addition, it describes funding needed to address any gaps between desired and expected performance.

Chapter 8: TAMP Process Improvement

This chapter presents opportunities for improvements to the asset management strategies being implemented by TDOT, describes the approach taken by TDOT to better align life cycle planning models to ensure the most efficient management of the transportation infrastructure, and provides a list of additional assets, beyond pavement and bridges, that are being considered for future versions of the TAMP.

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

The TAMP was prepared by a team of TDOT staff and consultants, working together to use available data and tools to develop planned 10-year investments. The idea was to build upon the foundation that TDOT has established for evaluating asset performance and to use available tools to prioritize projects based on the funding available. Implementation of the TAMP relies on close communication and collaboration with Metropolitan and Rural Planning Organizations (MPOs & RPOs), 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 agency will in some way contribute to the development and implementation of the TAMP, TDOT has identified the following 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
- TAMP Core Team

In addition to these three (3) groups, two (2) specific roles have been identified for the management of the TDOT TAMP effort:

- Agency Sponsor/Champion —responsible for ensuring the appropriate resources of the agency are provided.
- Project Leader —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 —Will Reid, Acting Assistant Chief Engineer of Program Delivery
- Project Leader —Chris Harris, Maintenance Operations Division, Asset Management Section

Executive Leadership —The TAMP development and implementation is supported by TDOT's Executive Leadership Team, consisting of Commissioner Eley and other senior managers within the agency. The members of the Executive Leadership Team are listed in Table 1-1. This team provides overall guidance, direction, resource commitment, and approval.

Table 1-1. TDOT's Executive Leadership Team Members

TDOT's Executive Leadership Team	
Butch Eley	Commissioner
Steve Townsend	Deputy Commissioner & Chief of Staff
Paul Degges	Chief Policy Advisor
Will Reid	Deputy Commissioner & Chief Engineer – Bureau of Engineering
Preston Elliott	Deputy Commissioner & Chief of Environment and Planning
Joe Galbato	Deputy Commissioner & Chief Financial Officer – Bureau of Administration
Joe Deering	Assistant Chief Engineer of Program Delivery
Ben Price	Assistant Chief Engineer of Operations
Lori Lange	Assistant Chief Engineer of Engineering

The **TAMP Steering Committee** consists of TDOT Directors who are key managers of the agency's business units that will provide the data, reports, analyses, and documents that form the core information in the creation of the TAMP. This team, listed in Table 1-2, provides the resources and analyses required to support the development of the TAMP and oversight to ensure the components of the plan are coordinated and accurately reflect TDOT's processes.

Table 1-2. TAMP Steering Committee Members

TAMP Steering Committee	
Jamie Waller	Director of Maintenance Operations Division
Matt Meservy	Director of Long-Range Planning Division
Julie Carmean	Director of Strategic Planning
Steve Borden	Assistant Chief Engineer/Director of Region 1 – Knoxville
Vacant	Assistant Chief Engineer/Director of Region 2 – Chattanooga
Jay Norris	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
Lee Smith	Interim Director of Traffic Operations Division
Ted Kniazewycz	Engineering Division – Bridge Management Lead
Ronnie Porter	Director of Program Development & Administration
Jennifer Herstek	Director of Finance Division
Jermaine Scales	Chief Information Officer and Director of Information Technology
Beth Emmons	Director of Community Relations
Chris Harris	Maintenance Operations Division – TAMP Project Lead
Xiaoyang Jia	Maintenance Operations Division – Pavement Management Lead
Vacant	FHWA – Technical Services Team Leader
Gregory Simmons	FHWA – Program Management Analyst
Richard Casalone	FHWA – Area Engineer
Vacant	FHWA – Bridge Engineer

The **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, whose members are listed in Table 1-3, 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.

Table 1-3. TAMP Core Team Members

TAMP Core Team	
Jamie Waller	Director of Maintenance Operations Division
Chris Harris	Maintenance Operations Division – TAMP Project Lead
Xiaoyang Jia	Maintenance Operations Division – Pavement Management Lead
Ted Kniazewycz	Engineering Division – Bridge Management Lead
Tom Quinn	Engineering Division – Bridge Management Lead
Christopher McDonald	Engineering Division – Bridge Management Technical Support
Brian Hurst	Program Development and Administration Division – Programming Lead
John Kahle	Program Development and Administration Division – Programming Lead
Amos Pulley	Maintenance Operations Division – Technical Support
Austin Holliman	Maintenance Operations Division – Technical Support
Morgan Ballard	Maintenance Operations Division – Technical Support

CHAPTER 2
ASSET INVENTORY & CONDITION

What Assets Are Included in This Chapter?

The TAMP documents inventory and condition information for pavement and bridge assets used to provide Tennesseans with a reliable transportation network. That information is used to identify cost-effective investment strategies to maintain and preserve the system as TDOT works towards providing the best transportation network in the nation. This chapter summarizes the inventory and condition assessment procedures used to manage pavement and bridge assets and incudes pavements and bridges on both the NHS and non-NHS, regardless of ownership.

How Much Pavement Does TDOT Own and Maintain?

Tennessee has more than 96,000 centerline miles of publicly owned highways; however, only about 14,000 of those miles are maintained by the Department. Figure 2-1 shows the pavement network on a map and Table 2-1 lists the pavement centerline and lane miles by highway system. Between 2011 and 2020, TDOT added, on average, approximately 0.12% additional lane miles to the state pavement network. It is anticipated that this average rate of increase will continue over the next 10-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. Figure 2-2 shows the bridges that are included in the TAMP and Table 2-2 summarizes the information by highway systems. Between 2017 and 2021, TDOT added, on average, approximately 0.36% additional square feet of bridge deck to the NHS bridge network each year. It is anticipated that this average rate of increase will continue over the next 10-year period.

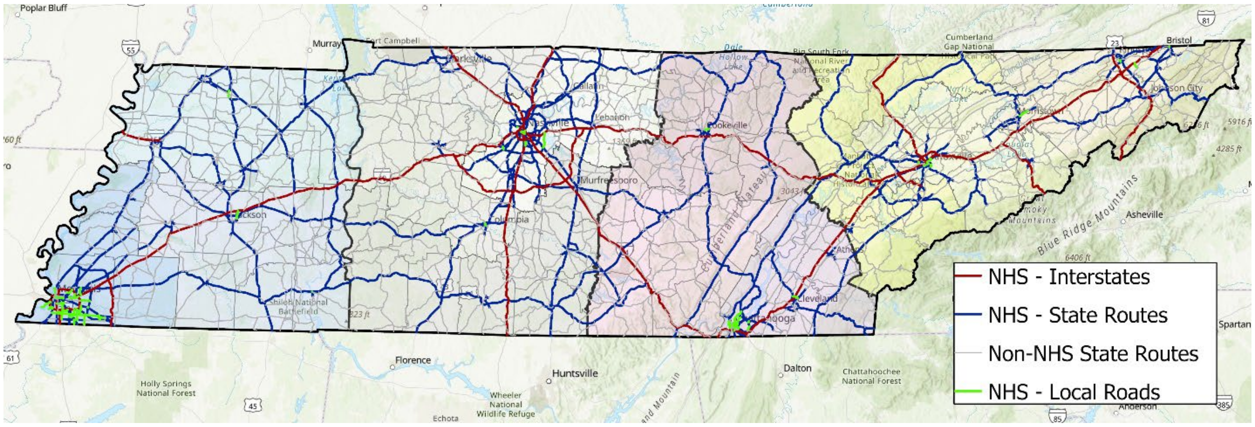


Figure 2-1: TAMP Roadway Inventory

Table 2-1: TAMP Roadway Inventory (as of 5/25/2022)

Highway System	Centerline Miles	Lane Miles
NHS Interstates	1,202	5,813
NHS State Routes	3,655	12,688
NHS Local Roads*	160	697
Total NHS	***5,017***	***19,198***
Non-NHS State Routes	9,015	19,216
Grand Total	***14,032***	***38,414***

**TDOT does not maintain NHS Local Roads*

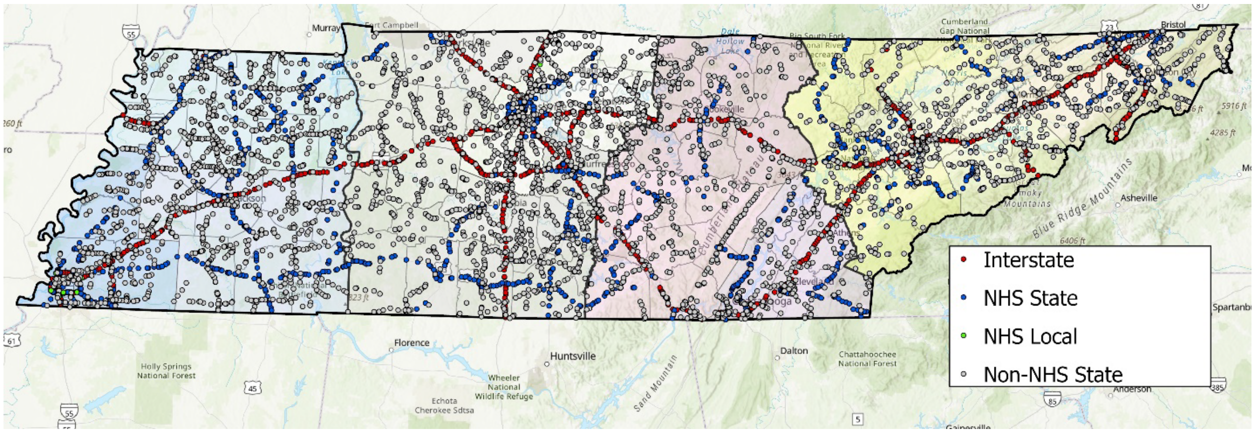


Figure 2-2: TAMP Bridge Inventory

Table 2-2: Bridge Inventory (2021 NBI Data)

Highway System	Number	Deck Area (by Sq. Ft.)
NHS Interstates	1,631	25,790,000
NHS State Routes	2,466	30,731,000
NHS Local*	96	1,814,000
NHS Federal*	18	300,000
Total NHS Bridges	**4,211**	**58,635,000**
Non-NHS State Routes	4,283	26,705,000
Total TAMP Bridges	**8,494**	**85,340,000**

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

What Factors Influence Asset Performance?

Pavement Performance Factors

Pavement condition deteriorates over time because of exposure to factors such as traffic volumes and configurations, environmental and weather impacts, construction quality, asphalt concrete and aggregate material properties, subgrade soil quality, maintenance magnitude and frequency, and human factors. TDOT considers the impacts of these factors in pavement life cycle planning and performance forecasting to determine the most cost-effective investment strategies to maximize pavement life.

Bridge Performance Factors

Bridge performance depends on a variety of factors including traffic magnitude and configuration, weather impacts, maintenance magnitude and frequency, construction quality, material properties, maintenance cycles, and use of deicing salts. TDOT considers the impacts of these factors in bridge life cycle planning and performance forecasting to determine the most cost-effective investment strategies to maximize bridge life.

How Does TDOT Measure Asset Performance?

Pavement and bridge are classified into three (3) categories: *Good*, *Fair*, or *Poor*. Pavement conditions are determined based on a Pavement Quality Index (PQI) and a Pavement Performance Rating (PPR), Bridges are inspected throughout the state of Tennessee on a two-year cycle. A bridge rating is used to determine maintenance needs from National Bridge Inventory (NBI) inspections of the bridge deck, superstructure, and substructure.

In addition to state measures, federal measures are also required to be reported to the Federal Highway Administration (FHWA). Both the state and federal measures for pavements and bridges are summarized in this section.

Measuring Pavement Conditions

Pavement Quality Index (PQI)

TDOT collects pavement condition data and calculates a Pavement Quality Index (PQI) for the Interstate, NHS state routes, and non-NHS state routes for use in identifying maintenance and rehabilitation needs. The PQI scale ranges from 0 (needs resurfacing) to 5 (not a priority for maintenance). The PQI is a function of the Pavement Smoothness Index (PSI) and Pavement Distress Index (PDI). The PSI represents road roughness using a scale from 0 to 5, with 5 representing a smooth road. TDOT defines roughness as the deviations of a pavement surface from a true planar surface with characteristic dimensions that affect vehicle dynamics, ride quality, dynamic loads, and drainage (e.g., longitudinal profile, transverse profile, and cross slope). PSI is a function of the International Roughness Index (IRI), as shown in equation 1.

$$\mathbf{PSI = 5 * e^{(-0.0055*IRI)}} \qquad \mathbf{(1)}$$

PDI is also reported on a scale of 0 to 5, with 5 representing a road in perfect condition. TDOT considers the following distresses in the PDI calculation: fatigue, rutting, longitudinal cracks in the wheel path, patching, block cracking, transverse cracks, and longitudinal cracks (non-wheel path). Each individual distress is assigned a deduct value (DV) based on the severity and extent on a given stretch of road surface. All the DVs are given a weight and subtracted from 5 to calculate the PDI.

TDOT determines PQI as a function of PSI and PDI on a scale from 0 to 5 with 5 being a road in perfect condition. As shown in equation 2, PDI encompasses the largest portion of this index because pavement distresses are most representative of current and future deterioration. TDOT's defines *Good, Fair,* and *Poor* for pavements using the PQI, as shown in Table 2-3.

$$\mathbf{PQI = PDI^{0.7} * PSI^{0.3}} \qquad \mathbf{(2)}$$

Table 2-3: Pavement *Good*, *Fair*, and *Poor* Definitions Using the PQI

System	Good	Fair	Poor
Interstate	> 4.0 PQI	4.0 >PQI>2.0	< 2.0 PQI
State Routes	> 3.5 PQI	3.5 >PQI>2.0	< 2.0 PQI

National Transportation Performance Measures (TPM) For Pavements

In addition to its state performance measures, TDOT calculates several federally required pavement metrics to report NHS pavement conditions to FHWA. The federal metrics, shown in Table 2-4, are used to assign a *Good*, *Fair*, and *Poor* rating to each 1/10-mile roadway segment. For concrete pavements, the metrics that are used include roughness (IRI), fatigue cracking, and faulting. For asphalt pavements, is the rating is based on roughness (IRI), fatigue cracking, and rutting. For each segment, the overall condition rating is determined using the values in Table 2-5.

Table 2-4: Federal Pavement Condition Thresholds

Metric	Good	Fair	Poor
Roughness (IRI)	<95 in/mi	95-170 in/mi	>170 in/mi
Rutting (HMA Only)	<0.20 inch	0.20 -0.40 inch	>0.40 inch
Fatigue Cracking	<5% (All)	5% - 20% (HMA) 5% – 15% (JPCP) 5% - 10% (CRCP)	>20% (HMA) > 15% (JPCP) >10% (CRCP)
Faulting (JPCP & CRCP only)	<0.05 inch	0.05 -0.15 inch	>0.15 inch

Table 2-5: Overall Pavement Condition Rating

Overall Metric Rating Condition	Rating
All 3 metrics “Good”	Good
All other combinations	Fair
2 or more metrics “Poor”	Poor

Performance results are then summarized and reported based on the total number of lane miles in each condition category (*Good, Fair, Poor*) on each of the highway systems. To comply with the TPM reporting requirements established by FHWA for pavements, states must report the percentage of lane miles that are rated in *Good* and *Poor* conditions on the Interstate and Non-Interstate NHS Systems.

To align with historical data collection and pavement management processes, 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.

Measuring Bridge Conditions

TDOT conducts bridge inspections on all publicly owned highway bridges in Tennessee, except those that are federally owned, every two (2) years. The Department follows the guidelines established by the NBI reporting process, using the NBI rating for deck, superstructure, and substructure. The NBI uses a scale from 1 to 9, with a rating ≤4 indicating a bridge in *Poor* condition, 5 or 6 indicating a bridge in *Fair* condition, and a rating of ≥7 representing a bridge in *Good* condition, as shown in Table 2-6. Culverts greater than 20 feet along the roadway centerline are assessed using the same NBI ratings.

Table 2-6: 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

As part of the NBI reporting process, bridges can be rated as *Good*, *Fair*, or *Poor*. A *Poor* rating 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 2-3 and 2-4 below show the *Poor* rated bridges in Tennessee from 2016 to 2021 based on the number of bridges and percent of bridge deck area, respectively.

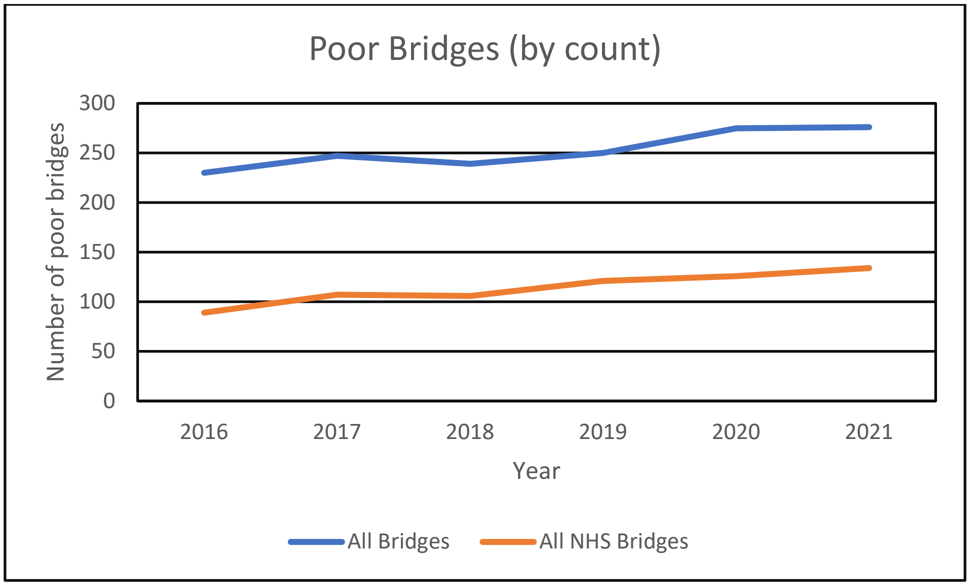


Figure 2-3: Historical Number of Poor Bridges in Tennessee (All publicly-owned and all NHS)

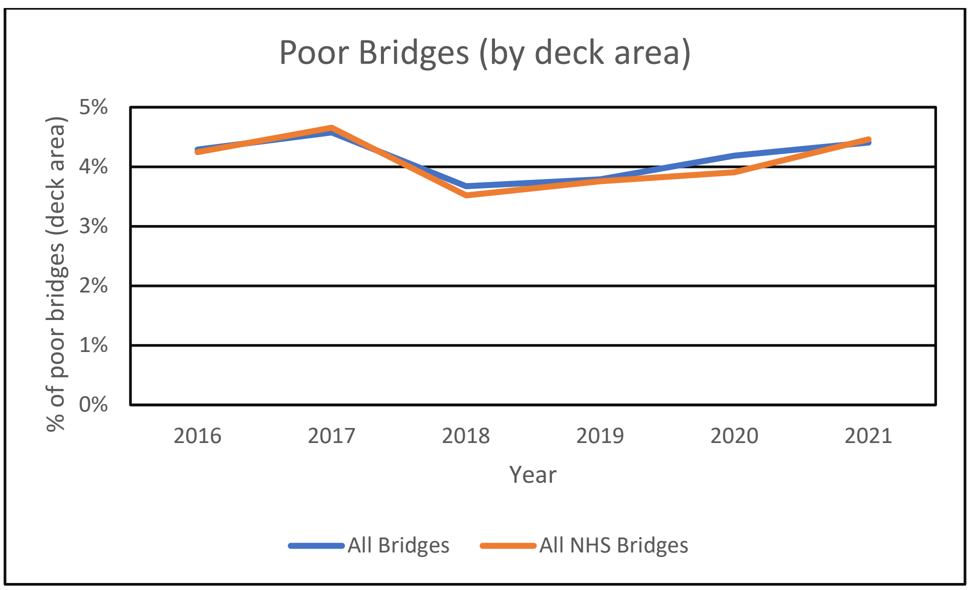


Figure 2-4: Historical Percent of Poor Bridge Deck Area in Tennessee (All publicly-owned and all NHS)

National Transportation Performance Measures for Bridges

The TPM for bridges use the same NBI ratings used by TDOT for reporting conditions. For federal reporting purposes, each bridge is assigned an overall condition rating of *Good*, *Fair*, or *Poor* using the values shown in Table 2-7.

Table 2-7: Overall Condition Rating for Bridges

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

To comply with the TPM 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 Non-Interstate NHS. 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.

What Are TDOT's Data Quality Control Measures?

Pavement Condition Data

TDOT developed an extensive guide to provide Quality Management (QM) procedures for pavement condition data collection at the network-level. This guide presents roles and responsibilities for administering QM procedures as well as the acceptance criteria used by the Pavement Management Engineer to accept or reject the data deliverables from the service provider. The QM guide specifies the types of pavement condition data that need to be collected, the required activities that will ensure data quality during production, the tasks that data inspection will cover, and the requirements that the data delivery will fulfill. It also specifies the content and scope of a Quality Management Report. As part of these QM procedures, TDOT performs the following steps to ensure pavement data quality:

- Personnel training
- Equipment calibration and validation processes
- Data format and completeness checks
- Sensor data checks
- Distress data checks
- Image checks
- Control and verification sites
- Time-series comparisons
- Estimation of corrective activities

Bridge Condition Data

TDOT follows the NBIS procedures as per 23 CFR, Part 650 C for bridge data quality control purposes. Each inspection team leader has completed the 2-week comprehensive bridge inspection course through the National Highway Institute. Team leaders are generally required to have at least 5 years of bridge inspection experience prior to taking responsible charge of a bridge inspection team. The team leader is required to review and sign each inspection report following the inspection. Over 85 percent of the bridge inspection reports are reviewed by an evaluator in the headquarters bridge inspection and repair section to ensure accuracy and consistency and to prioritize evaluations based on condition and inspection type.

What is the Condition of TDOT's Pavements?

Pavement Condition Trends – Using Pavement Quality Index (PQI)

Figures 2-5 through 2-8 show the historic and current PQI ratings for the Interstate, NHS state routes, NHS local routes, and non-NHS state routes, respectively.

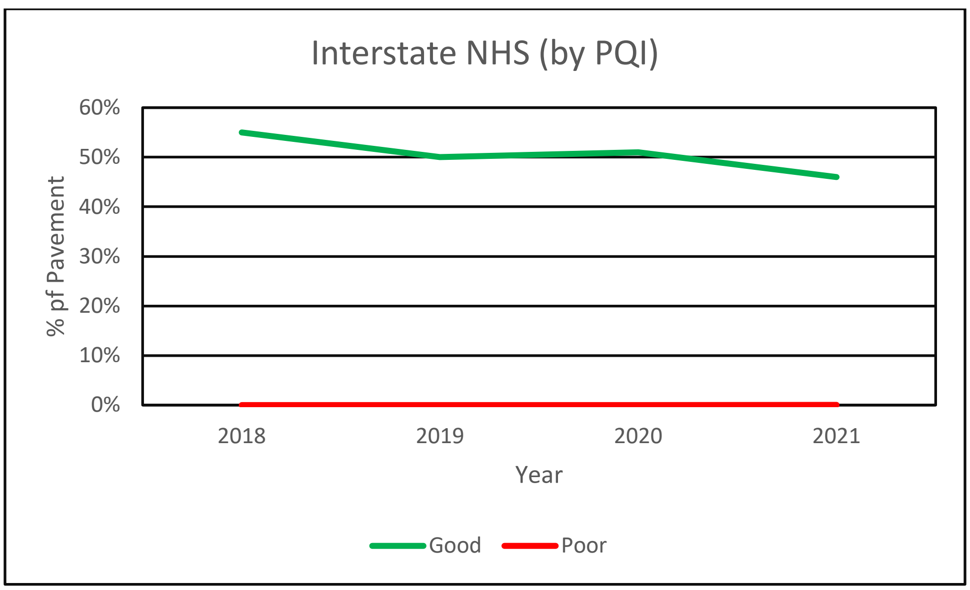


Figure 2-5: Historical Pavement Performance Rating on Interstates based on PQI

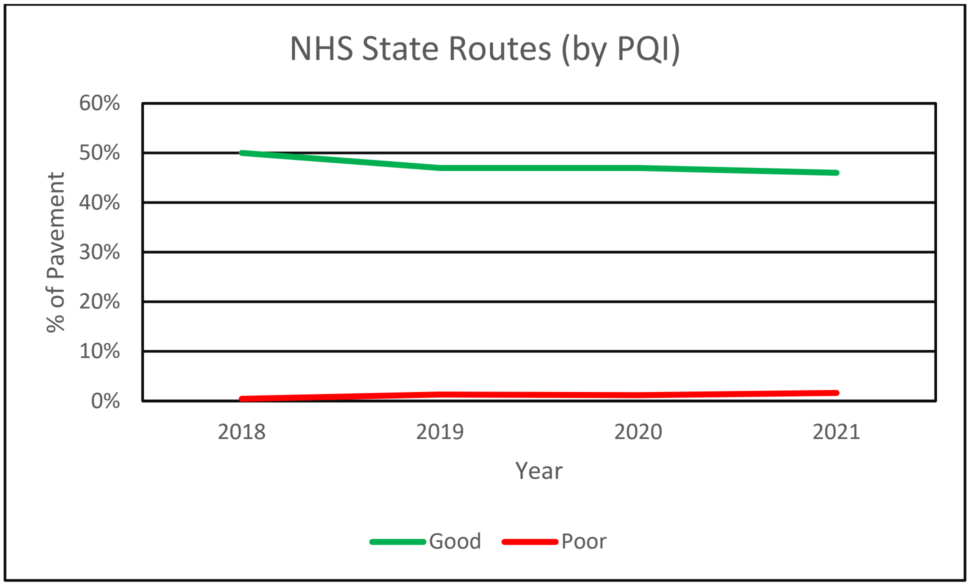


Figure 2-6: Historical Pavement Performance Rating on NHS State Routes based on PQI

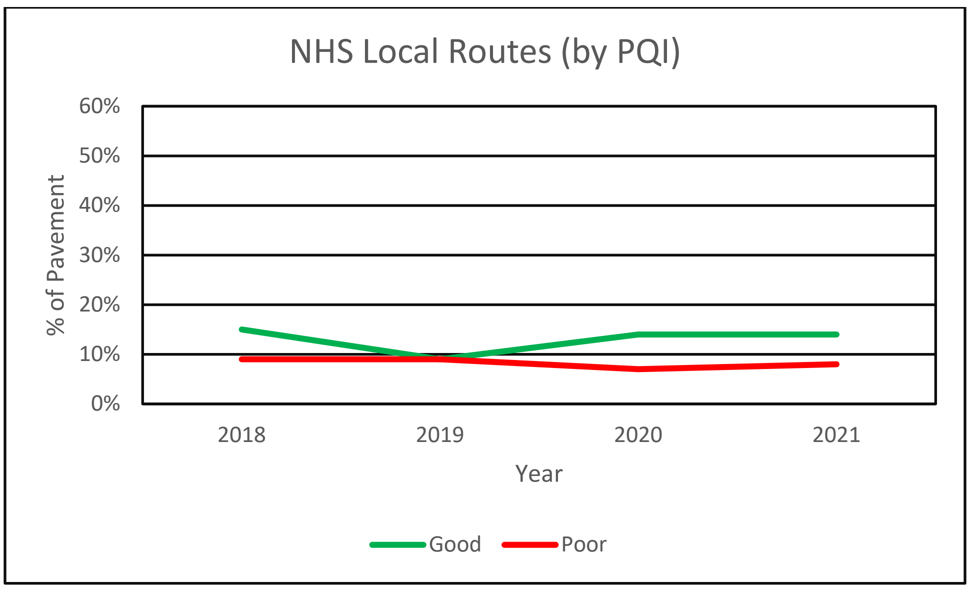


Figure 2-7: Historical Pavement Performance Rating on Local NHS Routes based on PQI

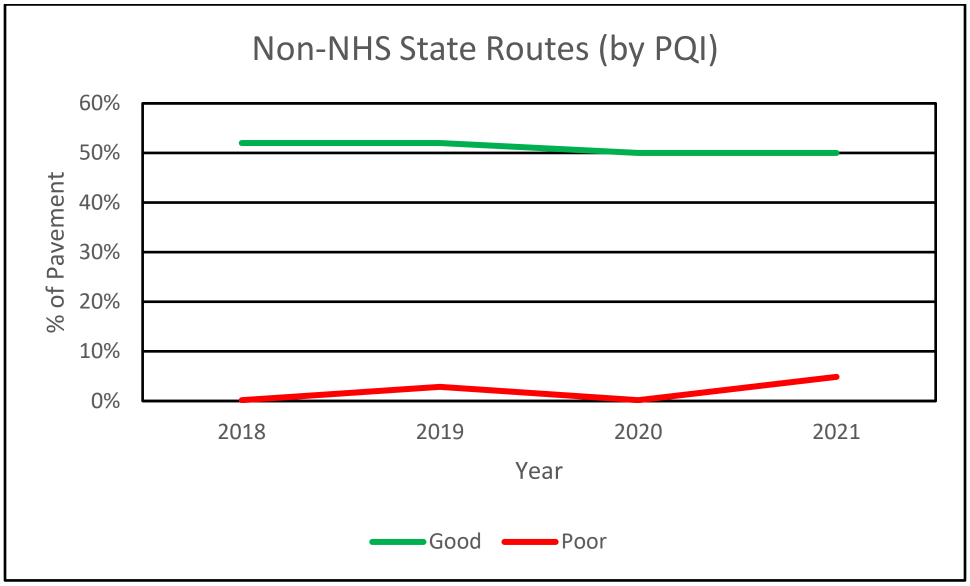


Figure 2-8: Historical Pavement Performance Rating on Non-NHS States Routes based on PQI

Pavement Condition Trend– Using TPM

Historical performance rating data for the federal ratings on the Interstate system, state NHS routes, local NHS routes, and non-NHS state routes are shown below in figures 2-9 through 2-14, respectively. Interstate and Non-Interstate NHS pavement information was obtained from highway performance monitoring system (HPMS) report card provided by FHWA. Non-NHS and local NHS pavement condition was calculated from raw data. TDOT collects non-NHS pavement condition information every other year with only half of the state included. Historical condition data showed a steep jump in 2016 which might be due to anomalies from data collection and federal metric calculation.

TDOT has been collecting and reporting pavement condition data to FHWA for decades; however, in 2014 the method for collecting and rating fatigue cracking was changed by FHWA. Therefore, only data from 2015 - 2020 is presented in the figures.

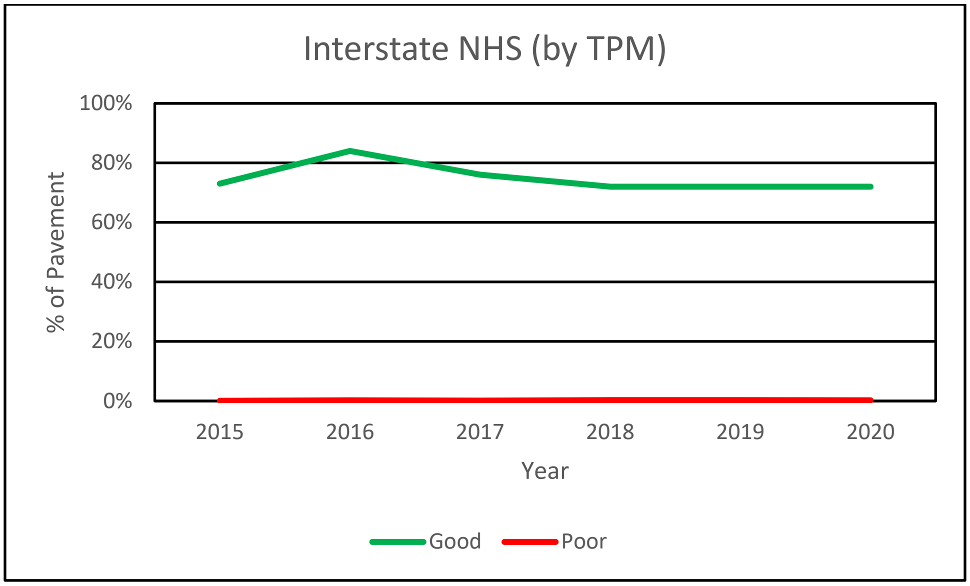


Figure 2-9: Historical Pavement Performance Rating on Interstates based on TPM

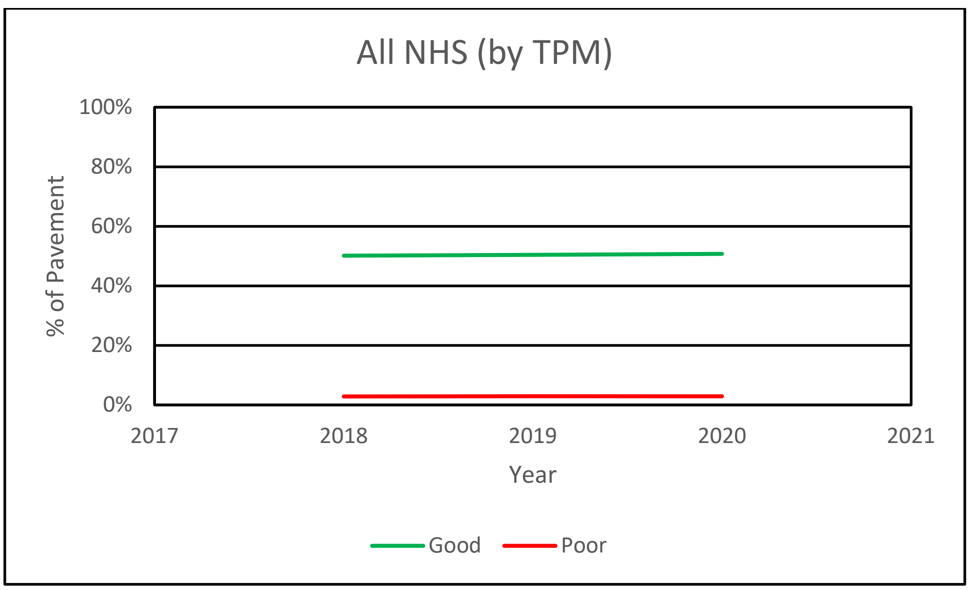


Figure 2-10: Historical Pavement Performance Rating on All NHS Routes based on TPM

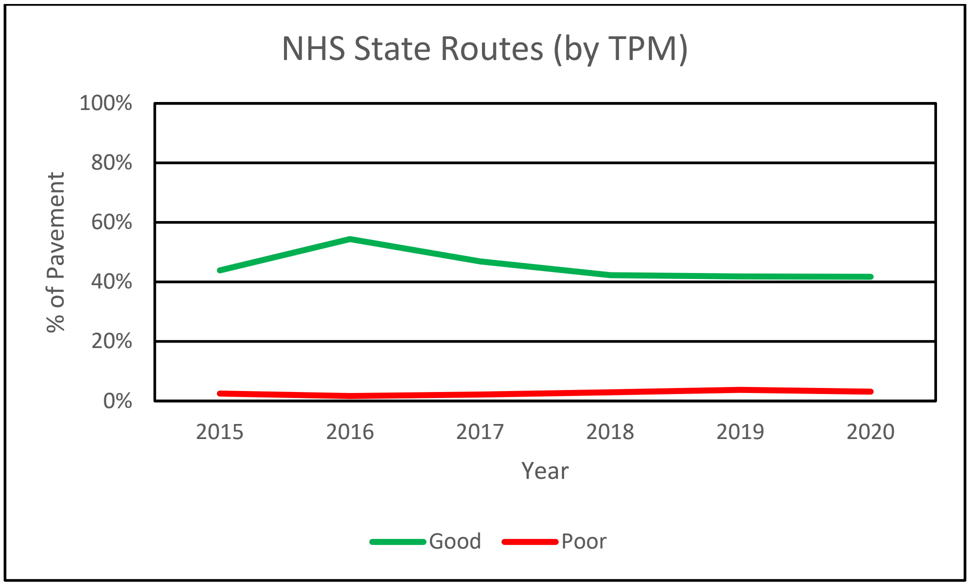


Figure 2-11: Historical Pavement Performance Rating on NHS State Routes

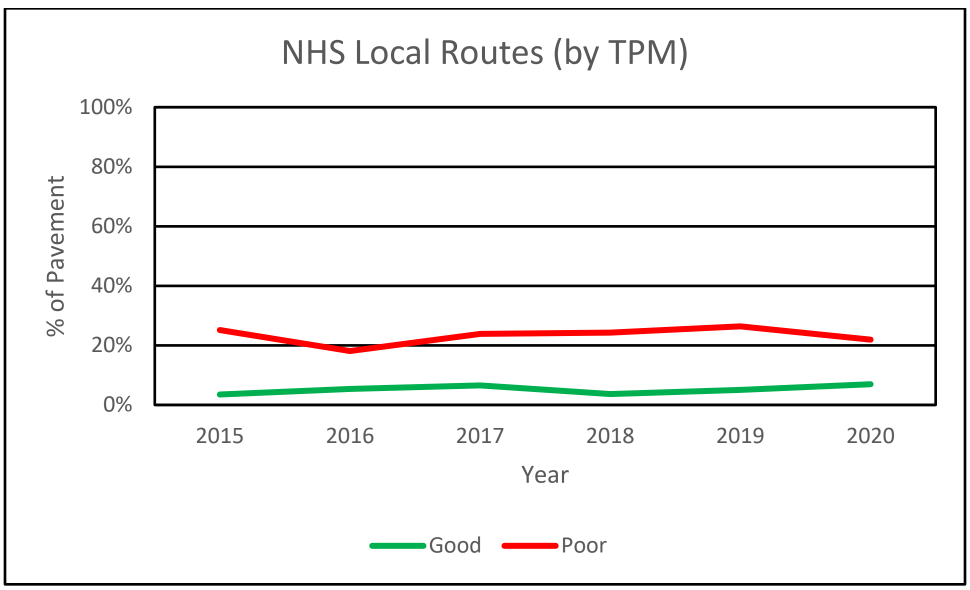
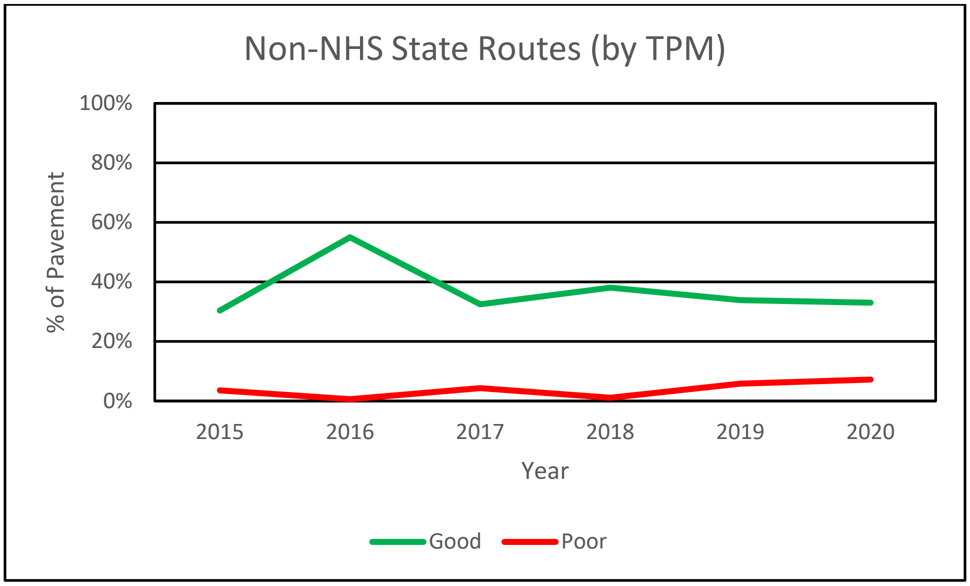


Figure 2-12: Historical Pavement Performance Rating on NHS Local Routes



*Just half of the state routes are collected each year. During 2020, Regions 1 and 2 were rated (33% *Good*) and during 2019, Regions 3 and 4 were rated (34% *Good*)

Figure 2-13: Historical Pavement Performance Rating on Non-NHS State Routes

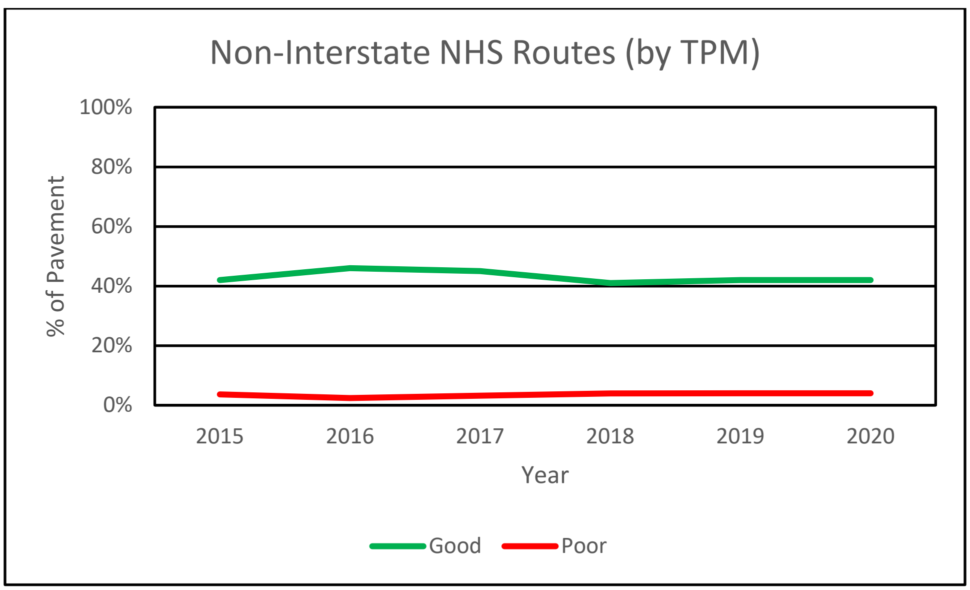


Figure 2-14: Historical Pavement Performance Rating on Non-Interstate NHS Routes

Current Pavement Conditions

Table 2-8 summarizes the current pavement conditions using both the state and federal performance measures.

Table 2-8: Current pavement conditions

2021 Pavement Condition Based on PQI		
Network	**%Good**	**%Poor**
Interstate NHS		
• Statewide	46	0.0
• Region 1	45	0.0
• Region 2	54	0.0
• Region 3	49	0.0
• Region 4	30	0.2
Non-Interstate NHS State Routes		
• Statewide	46	1.6
• Region 1	56	0.4
• Region 2	68	0.3
• Region 3	46	0.5
• Region 4	24	4.9
Non -NHS State Routes		
• Statewide	50 (2021)	4.9 (2021)
• Region 1	54 (2020)	0.3 (2020)
• Region 2	60 (2020)	0.0 (2020)
• Region 3	62 (2021)	0.2 (2021)
• Region 4	19 (2021)	10.4 (2021)
2020 Pavement Condition Based on TPM		
Network	**%Good**	**%Poor**
Interstate	72	0.2
Non-Interstate NHS	42	4.0
All NHS Routes	51	2.9
NHS State Routes	42	3.2
Local NHS	7	22.0
Non-NHS State Routes	33	7.2

What is the Condition of TDOT's Bridges?

Bridge Performance Trends

The overall condition for bridges on each highway system is calculated based on the total bridge deck area in each condition and calculating the percentage. Historical performance ratings from 2016 for all NHS routes, Interstate system, NHS state routes, non-NHS state routes, locally-owned NHS bridges, and federally-owned NHS bridges are shown in Figures 2-14 through 2-20, respectively.

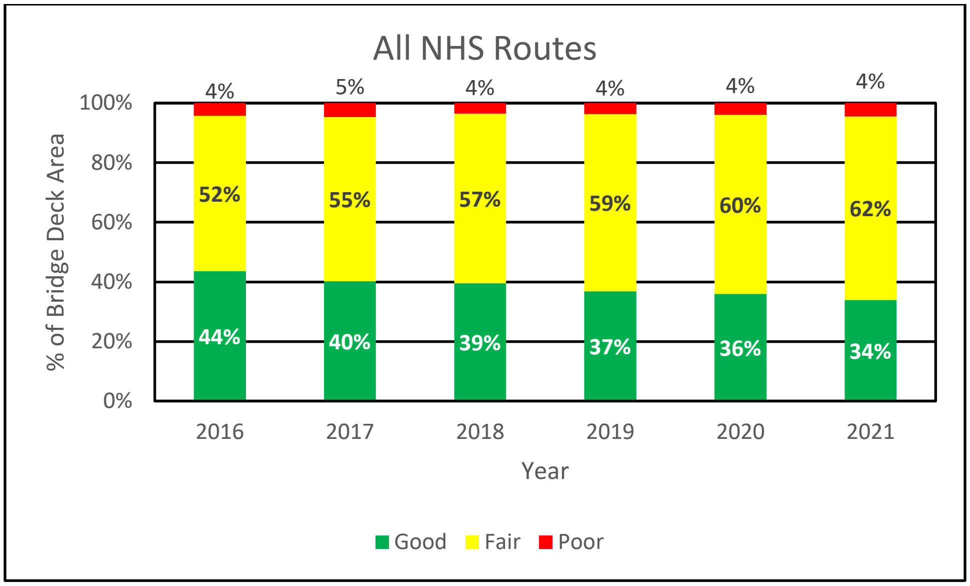


Figure 2-15: Historical Bridge Performance Rating on All NHS Routes

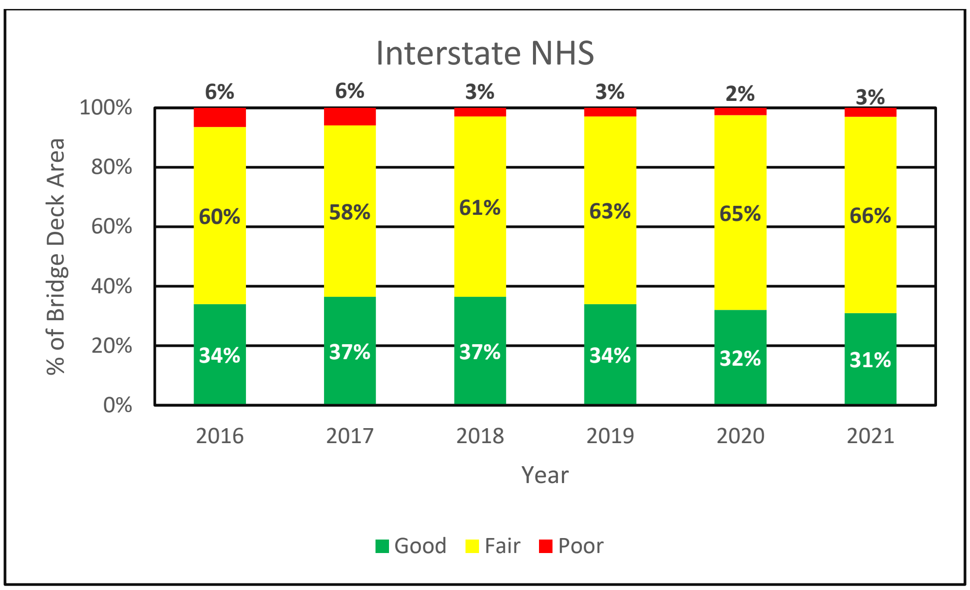


Figure 2-16: Historical Bridge Performance Rating on Interstates

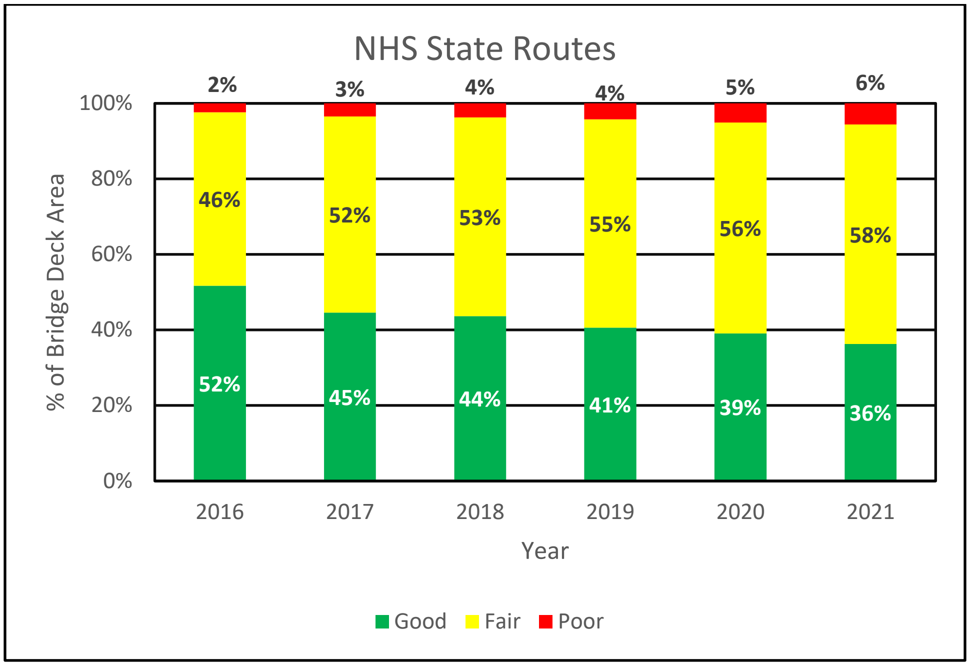


Figure 2-17: Historical Bridge Performance Rating on NHS State Routes

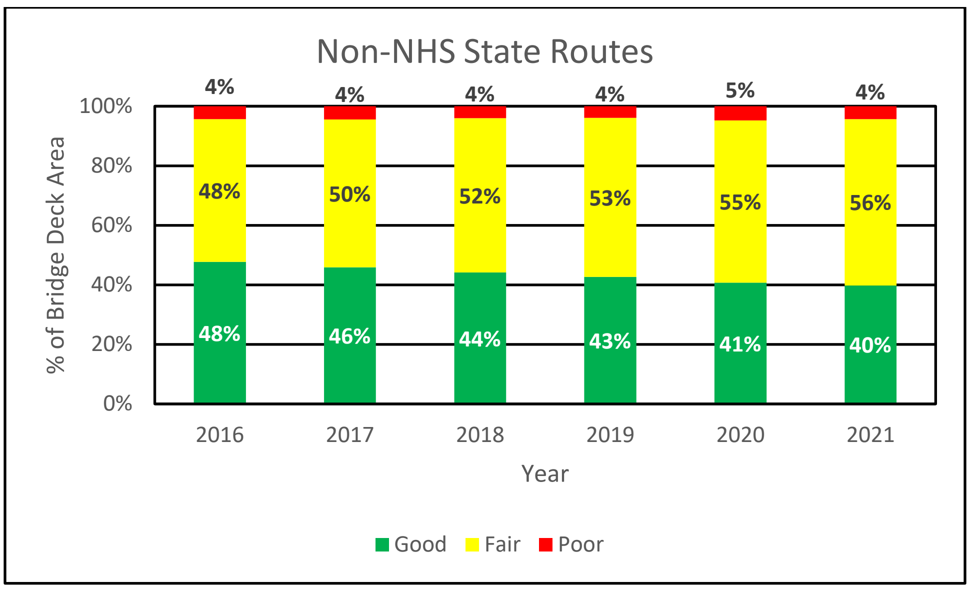


Figure 2-18: Historical Bridge Performance Rating on Non-NHS State Routes

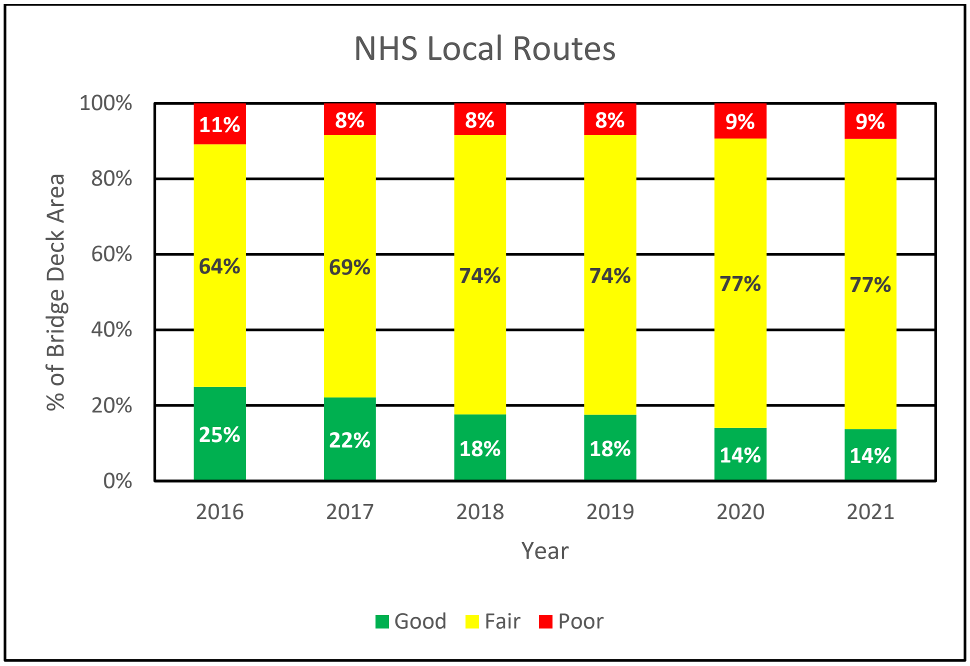


Figure 2-19: Historical Bridge Performance Rating on NHS Local Routes

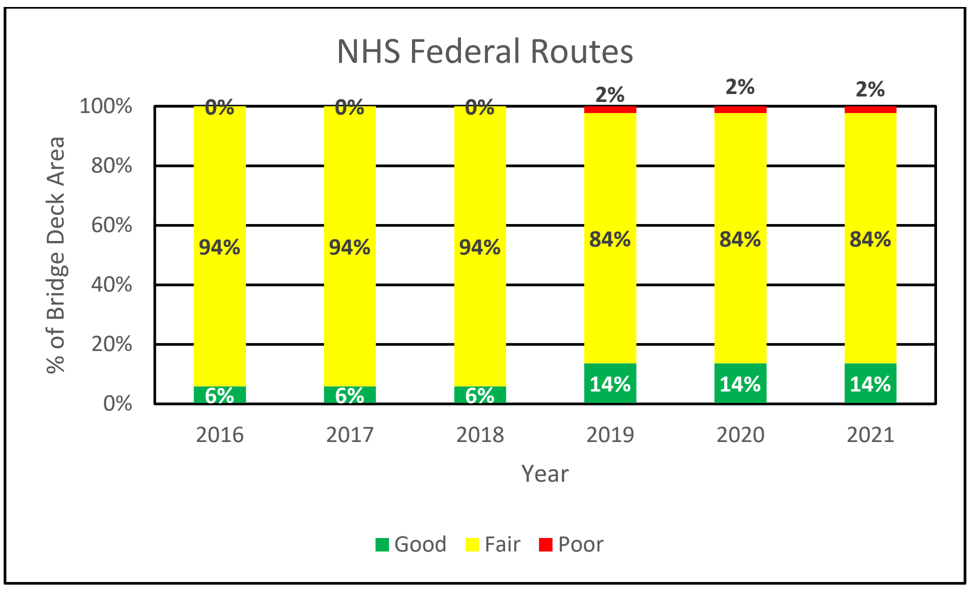


Figure 2-20: Historical Bridge Performance Rating on NHS Federal Routes

Current Bridge Conditions

Table 2-9 summarizes the current bridge conditions.

Table 2-9: Current bridge conditions

2021 Bridge Condition based on NBI			
Network	**%Good**	**%Fair**	**%Poor**
Interstate NHS	31	66	3
All NHS Routes	34	62	4
NHS State Routes	36	58	6
Federal NHS	14	84	2
Local NHS	14	77	9
Non-NHS State Routes	40	56	4

CHAPTER 3
PERFORMANCE GOALS AND TARGETS

What are Performance Goals and 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 Non-Interstate 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 transportation system, 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 PQI that is used to gauge the overall condition of pavements. The schedule for pavement evaluation is annually on the Interstate and Non-Interstate NHS state routes and biennially 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, and uses it for prioritization of bridge repairs and replacement. For large culverts (greater than 20 feet 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 Minimum Standards for Pavements & Bridges?

Pavements

Through MAP-21 and the FAST Acts, 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 (≤5% of Interstate Pavements in *Poor* Condition).
3. Percentage of pavements (Lane Miles) on the NHS (excluding the Interstate system) in *Good* condition.
4. Percentage of pavements (Lane Miles) on the NHS (excluding the Interstate system) in *Poor* condition.

Within the national rules, 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 uses 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: TPM 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 in.	0.20 in. to 0.40 in.	>0.40 in.
Faulting	Jointed Concrete	<0.10 in.	0.10 in. to 0.15 in.	>0.15 in.

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 does not 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, meet 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 does not 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 are determined to meet the criteria for *Good*. It is considered to be in *Poor* condition if both IRI and cracking are determined to meet the criteria for *Poor*. It is considered to be in *Fair* condition if it does not 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: TPM *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

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.
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 are 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*. Federally mandated standards require ≤10% *Poor* NHS deck area. Bridges rated below 7 but above 4 will be classified as *Fair* but is not reported to FHWA.

Table 3-3: TPM Components and Performance Ratings

Component	GOOD	FAIR	POOR
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: TPM *Good/Fair/Poor* Determination for NHS Bridges and Minimum Standard

<table>
<tr><th>Rule</th><th colspan="4">23 CFR Part 490.409(b)</th><th>23 CFR Part 490.411(a)</th></tr>
<tr><th>Structure Type</th><th>Component</th><th>Good</th><th>Poor</th><th>Fair</th><th>Minimum Standard (NHS bridges)</th></tr>
<tr><td>Bridge</td><td>Deck, Super-structure, Sub-structure</td><td>All Components = Good</td><td>1 or more Components = Poor</td><td>All other combinations</td><td rowspan="2">≤ 10% of total deck area rated as POOR</td></tr>
<tr><td>Culvert</td><td>Overall Condition Rating</td><td>Rating = Good</td><td>Rating = Poor</td><td>Rating = Fair</td></tr>
</table>

What are TDOT's Targets for the TPM for Pavements and Bridges?

TDOT has established performance targets for the National Transportation Performance Management Measures identified in 23 CFR Part 490 as indicated in Table 3-5. An Oversight Committee consisting of key TDOT managers and senior leadership 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 displays Pavement and Bridge targets for the 2022-2025 performance period.

Table 3-5: TDOT National Transportation Performance Management Targets

Asset	System	% Good		% Poor	
		4-year	Baseline	4-year	Baseline
Pavements	Interstate	>58%	70.8%	<1%	0.2%
	Non-Interstate NHS	>36%	40.3%	<6%	4.1%
Bridges*	NHS (Interstate and Non-Interstate)	>32%	33.2%	<6%	4.6%

*Based on square feet of bridge deck

Basis for Interstate and Non-Interstate NHS Pavement Targets

The national TPM pavement targets represent anticipated performance outcomes for the full extent of the Interstate and Non-Interstate NHS regardless of ownership. Target development included building models to predict specific pavement conditions, conducting network analysis based on FY23 funding levels (including 3% budget growth and 7% inflation), draft performance targets, and the feasibility/probability of achieving targets with current funding. Target considerations included baseline data, trend analysis, and an assessment of influencing factors. Identified target projections place a heavier emphasis on cost-effective projects that are expected to maximize *Good* condition ratings. However, a worst first approach was also considered and integrated into target selection in order to minimize *Poor* conditions on high-priority routes. An additional strategy identified to meet targets included assessing the structural condition of pavements and utilizing this information in decision making.

TDOT has projected a continued decline in % *Good* on both the Interstate and Non-Interstate NHS systems. Factors contributing to this decline include the current economic forecast, which continues to anticipate high inflation and increased costs.

How has TDOT Defined State of Good Repair (SOGR) 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 lifetime at the lowest possible cost.

TDOT has established long-term performance targets for pavements and bridges based on their im-portance 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. Tables 3-6 and 3-7 provide the SOGR 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. For pavements, the SOGR is based on the PQI.

Table 3-6: Pavement and Bridge SOGR 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 SOGR Targets

Asset	System	Good	Poor
Pavements	Interstate	>45%	<1.0%
	Non-Interstate NHS	>40%	<2.0%
	Non-NHS State	>40%	<2.0%
Bridges*	Interstate	>32%	<6%
	Non-Interstate NHS	>32%	<6%
	Non-NHS State	>32%	<6%

*Based on square feet of bridge deck

What is the Gap Between Pavement Performance and SOGR Targets?

TDOT calculates and reports pavement performance per number of lane miles using the PQI. These results are used to assist the Department in determining funding amounts, allocations to the four TDOT regions, and appropriate work types to minimize whole-life costs, which include 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 roadway system from 2018 to 2021. As shown, in 2021, 46% of lane miles on the Interstates had a PQI >4.0, which is above the SOGR target of 45%. In 2021, 46% of NHS state routes and 50% of non-NHS state routes had a PQI >3.5, which are both above the SOGR target of 40% for Non-Interstate state routes. During the 2018-2021performance cycle for TPM, local MPO's that own routes on the NHS agreed to accept TDOT's targets for State of Good Repair. The MPOs have not yet reviewed their TPM targets for the new performance period; however, for consistency, the SOGR targets shown in figure 3-3 for locally-owned NHS routes also reflect TDOT's newly established targets.

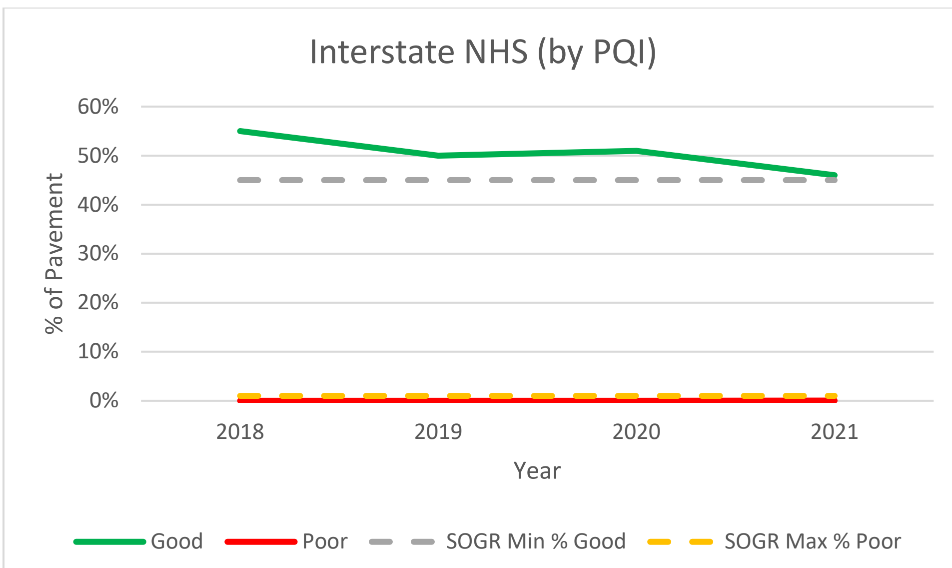


Figure 3-1: Historical Pavement Performance Rating and Target on Interstates

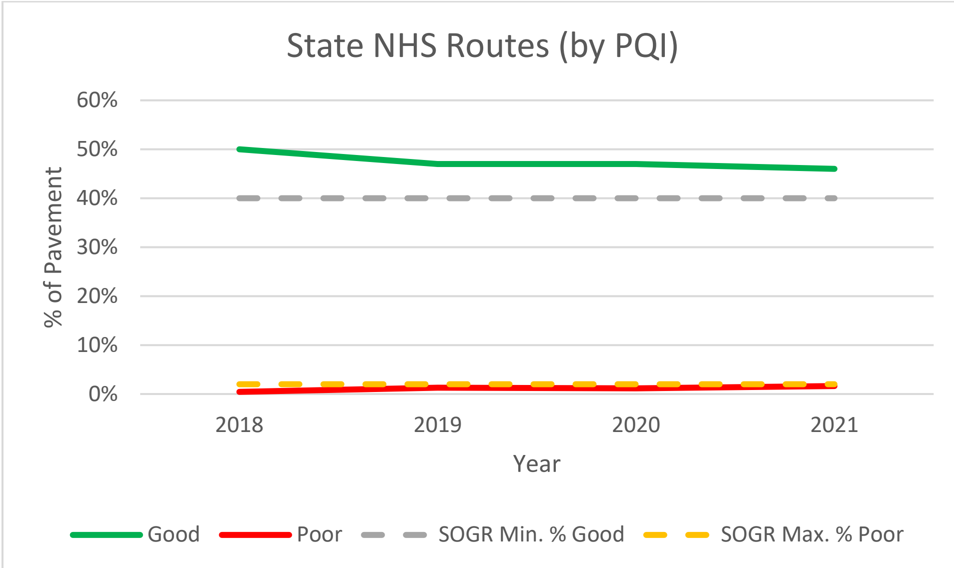


Figure 3-2: Historical Pavement Performance Rating and Target on Non-Interstate NHS State Routes

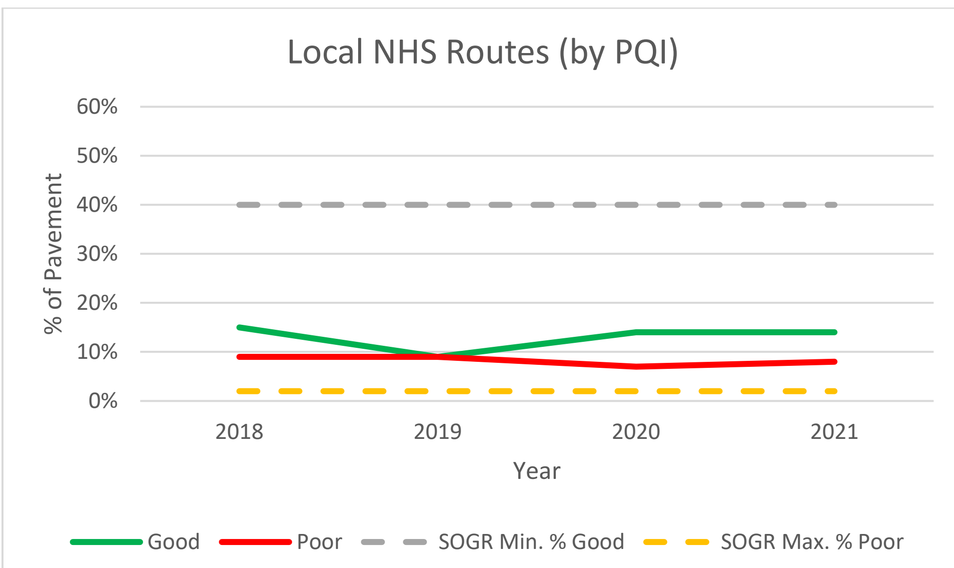


Figure 3-3: Historical Pavement Performance Rating and Target on NHS Local Routes

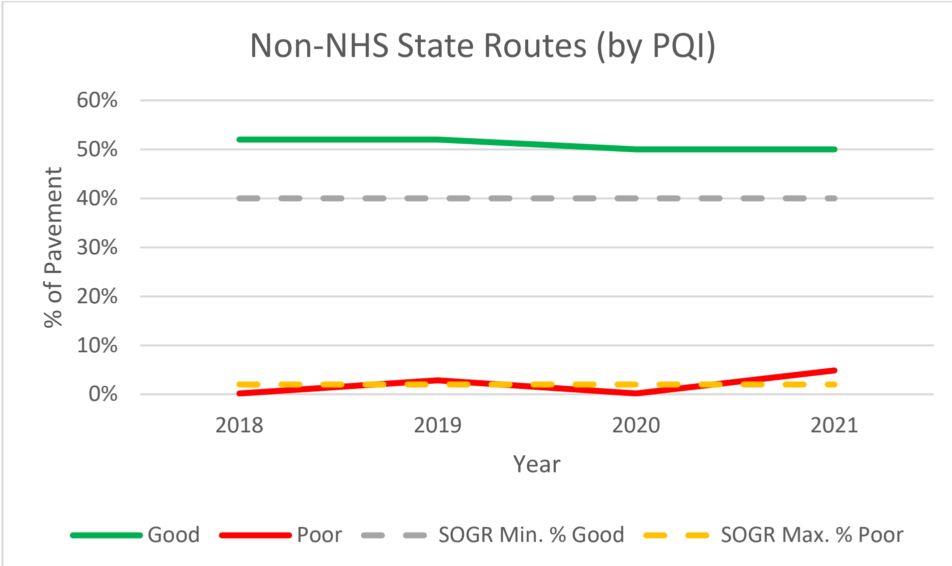


Figure 3-4: Historical Pavement Performance Rating and Target on Non-NHS State Routes

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 has made 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 NBI standards. The results from the inspections are used to determine the type of work activity required for the bridge or large culvert, including maintenance, preservation, rehabilitation, or replacement.

Figure 3-5 shows the *Poor* rating for the bridge inspections conducted in 2016-2021 on each system. For 2021, there were 3% of Interstate bridges, 6% on the Non-Interstate NHS state routes, 9% on the NHS local routes, 2% on federal routes, and 4% on non-NHS state routes rated as *Poor*. TDOT's NHS bridges are within the agency's SOGR targets of 32% in *Good* condition with no more than 6% of all state-owned bridge decks 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% of all bridges on the NHS are rated *Poor* and well within the agency's targets of 32% in *Good* condition and no more than 6% in *Poor* condition.

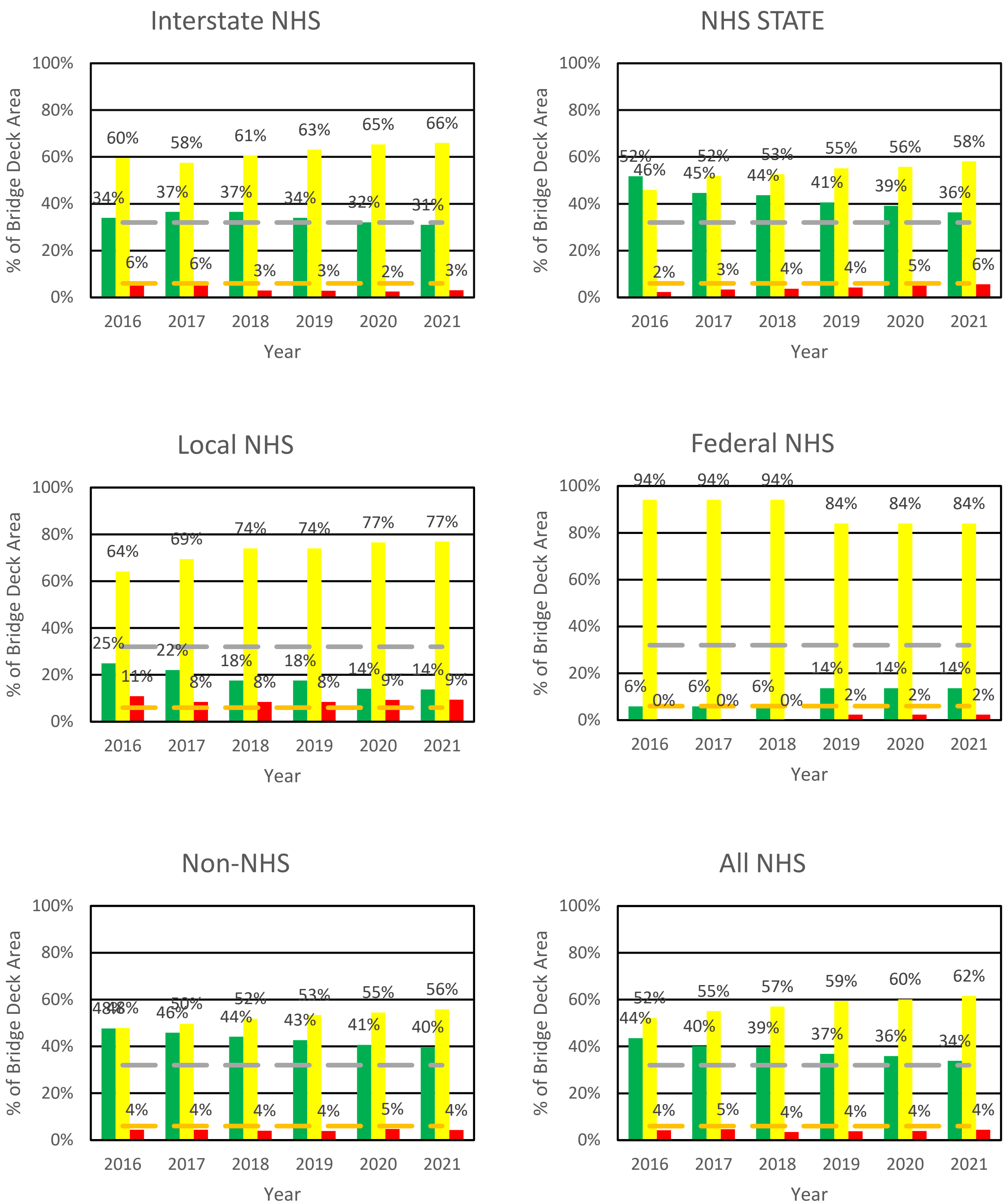


Figure 3-5: Bridge Condition Rating (Green-Good; Yellow-Fair; Red-Poor)

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 assists 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 bridge and large culvert metrics as described in Chapter 2. This same system was 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 vehicle miles travelled (VMT) growth expected to be seen in the next ten (10) years is shown in the table below:

Table 3-8: Estimated Annual VMT Growth Rate

Area	VMT Growth Rate, percent (Tennessee Statewide Model v_4)
Greater Chattanooga	0.5
Greater Knoxville	0.7
Jackson	0.3
Memphis	0.5
Middle TN	1.3
Tri-Cities	0.3
Statewide	0.9

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 the maintenance and repair of the pavement and bridges over the next ten (10) years.

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

Based on PQI Measures

Using the PMS, TDOT has projected the percentage of lane miles in *Good* and *Poor* condition for the years 2022 – 2031 on each of the systems shown in figures 3-6 through 3-8. Figure 3-6 shows that, with current available funding levels ($89.1 million), the pavement conditions for the Interstate system are expected to dip slightly below TDOT's target of at least 45% of lane miles with a PQI > 4.0 over the next 10 years. Figure 3-7 shows how the Non-Interstate NHS pavement condition is predicted to remain above the target of 40% of lane miles with a PQI > 4.0 over the next 10 years. The percentage of Interstate and Non-Interstate NHS state routes with a PQI<2.0 is projected to get as high as 19% and 25% at current funding, which is far above TDOT's target of 1% and 2%, respectively.

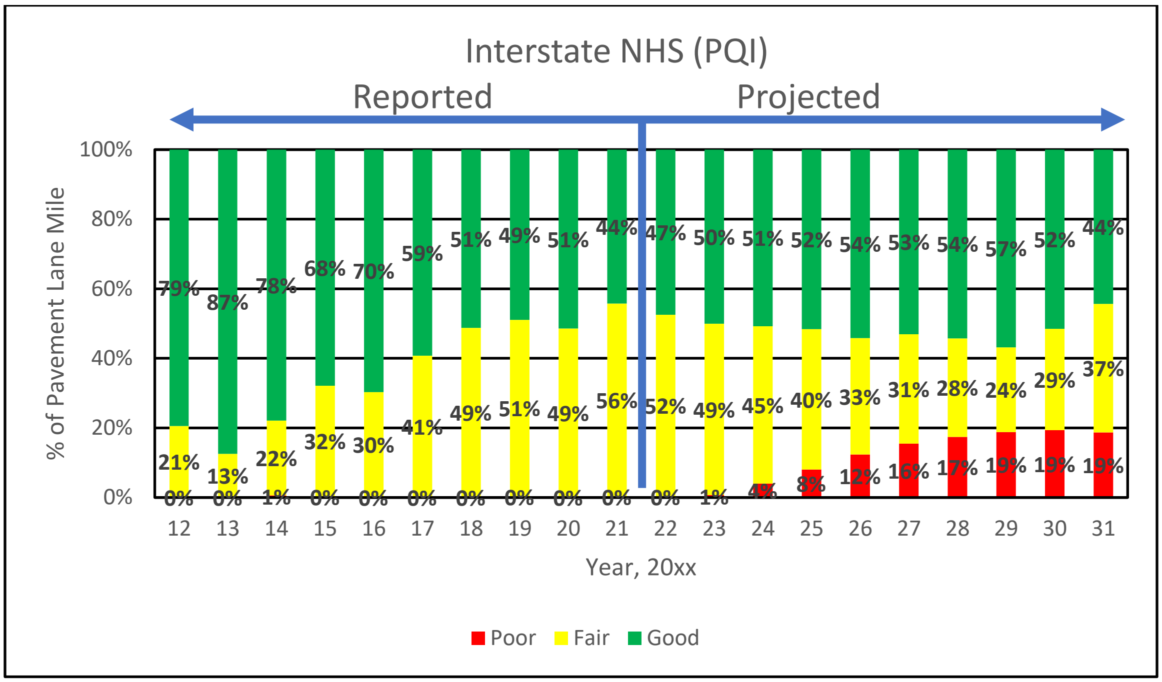


Figure 3-6: Pavement Condition (based on PQI)– Interstates (% of Lane Miles)

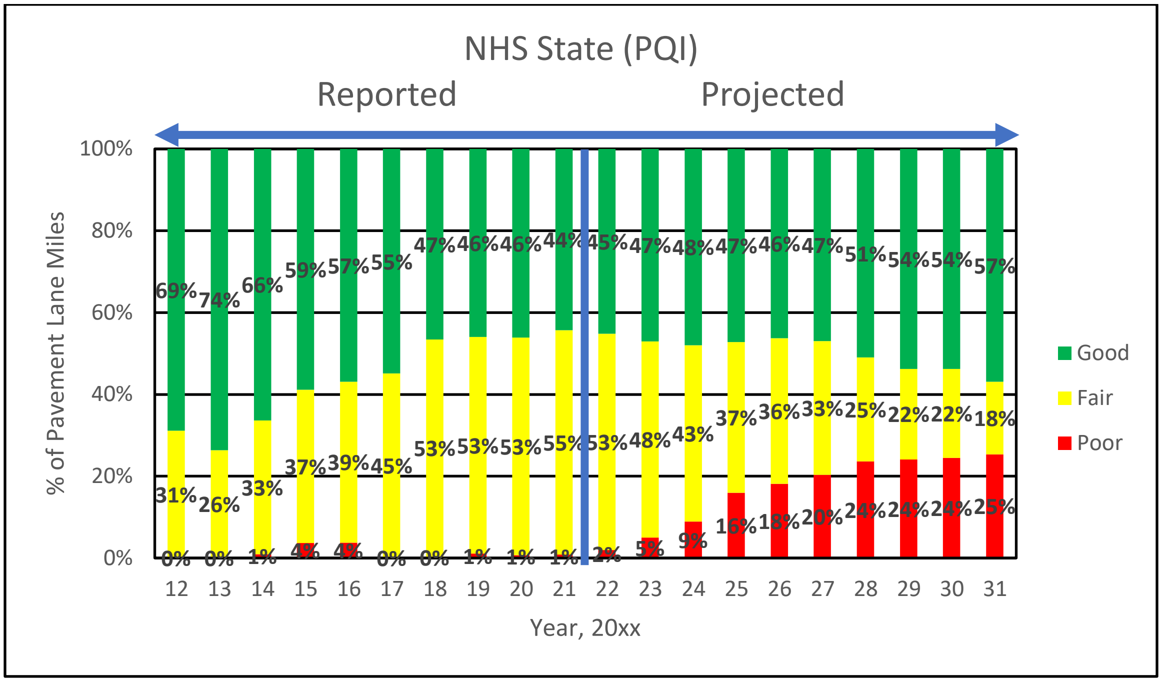


Figure 3-7: Pavement Condition (based on PQI) – Non-Interstate NHS State Routes (% of Lane Miles)

Figure 3-8 shows the projection of pavement performance 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 (69%), this data indicates that the condition has historically been well above the target and is expected to remain at or above the target for many of the years within the analysis period. The percentage of Non-NHS state routes with a PQI<2.0 is projected to get as high as 19% at current funding levels, which is far above TDOT's target of 2%.

In the TAMP, TDOT did not include the prediction for local NHS routes; however, TDOT worked with MPOs to gather this information and developed models to predict the future performance for this portion of the network. Currently, TDOT is coordinating with MPOs to enhance the model prediction and expecting to include local NHS performance prediction in 2026 TAMP.

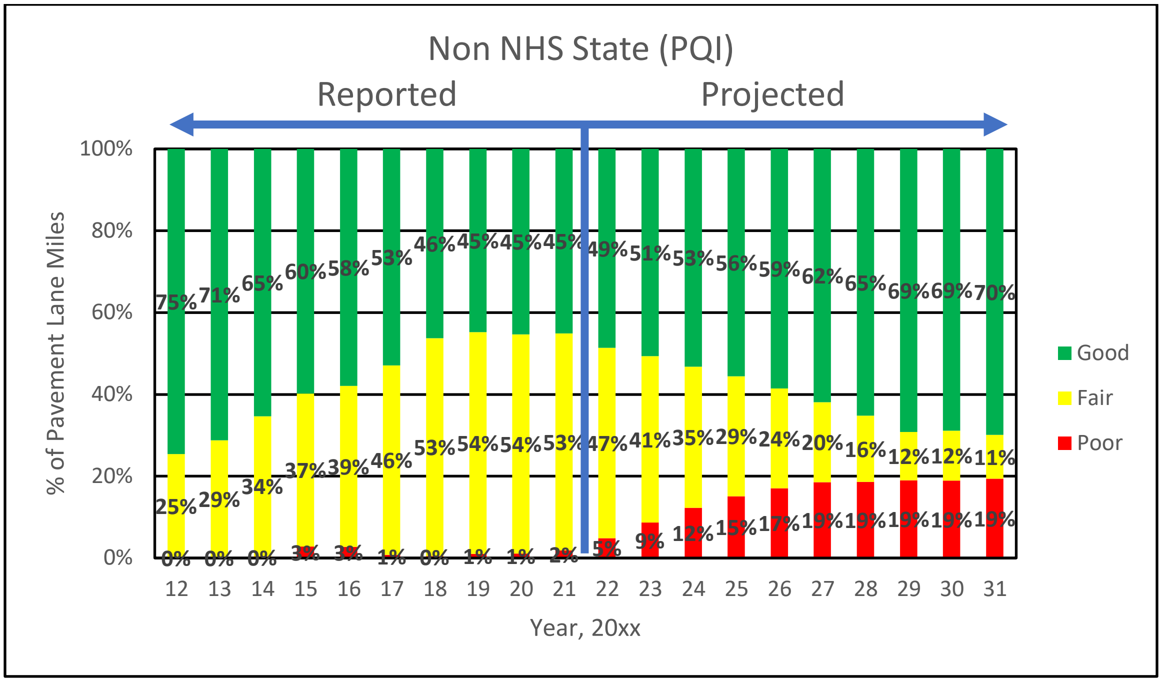


Figure 3-8: Pavement Condition (based on PQI) – Non-NHS State Routes (% of Lane Miles)

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 Non-Interstate 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 its analyses to generate realistic output that confidently assess 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. A confidence assessment of the prediction models is also planned to be conducted annually. 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 substantial portion of vehicular traffic in the state and are an important part of our transportation network. While this may not have implications regarding TDOT's ability to comply with MAP-21 requirements, it is still an important consideration for the agency going forward, which could impact how state dollars are invested in other areas of concern (safety, bridges, capacity, transit, etc.).

Based on TPM Measures

Recently, TDOT updated the PMS to project the percentage of lane miles in *Good* and *Poor* condition for the years 2022 – 2031 on each of the systems based on the TPM measures, as shown in figures 3-9 through 3-11. Based on current funding levels, by 2031 52%, 40%, and 46% TDOT's interstate NHS, Non-Interstate NHS state routes, and non-NHS state routes, respectively, will have *Good* ratings based on TPM measures, respectively. In addition, by 2031, 5%, 6%, and 6% of TDOT's Interstate NHS, Non-Interstate NHS state routes, and non-NHS state routes pavement network will be marked as *Poor* based on TPM projections.

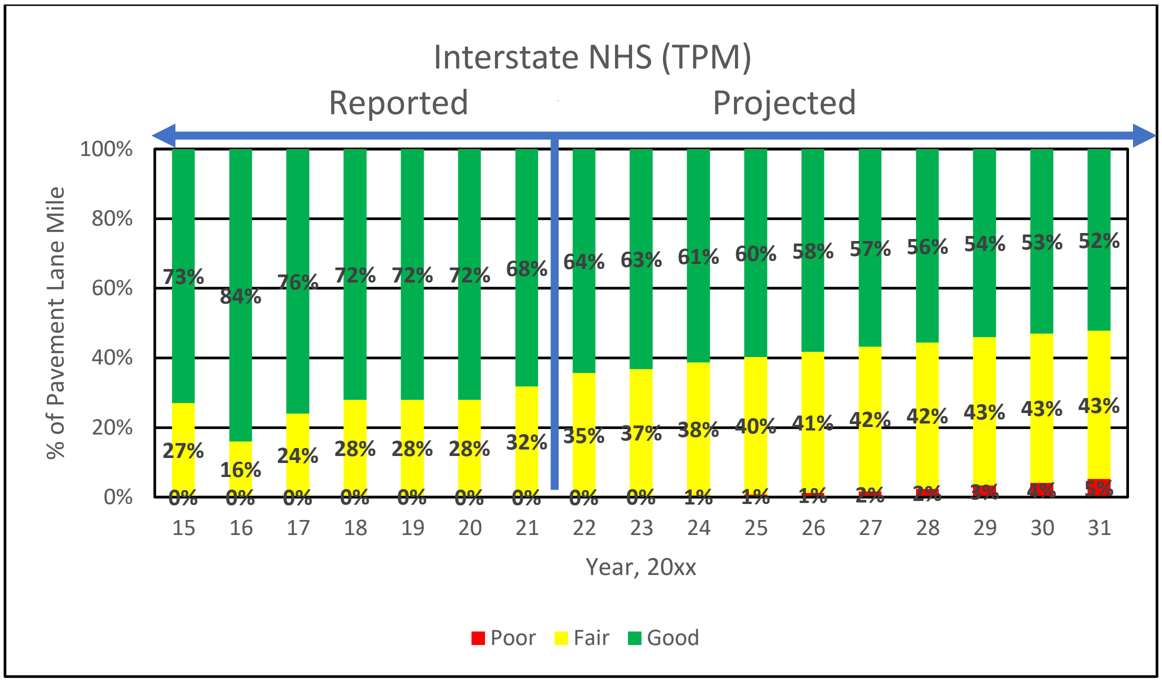


Figure 3-9: Pavement Condition (based on TPM) – Interstates (% of Lane Miles)

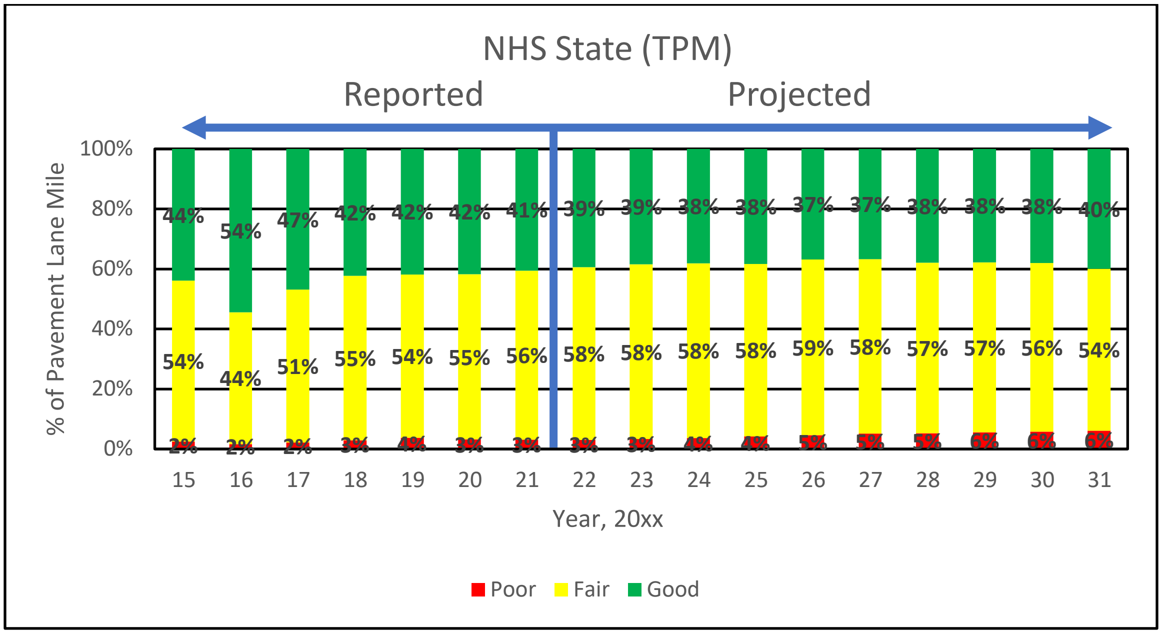


Figure 3-10 Pavement Condition (based on TPM) – Non-Interstate NHS State Routes (% of Lane Miles)

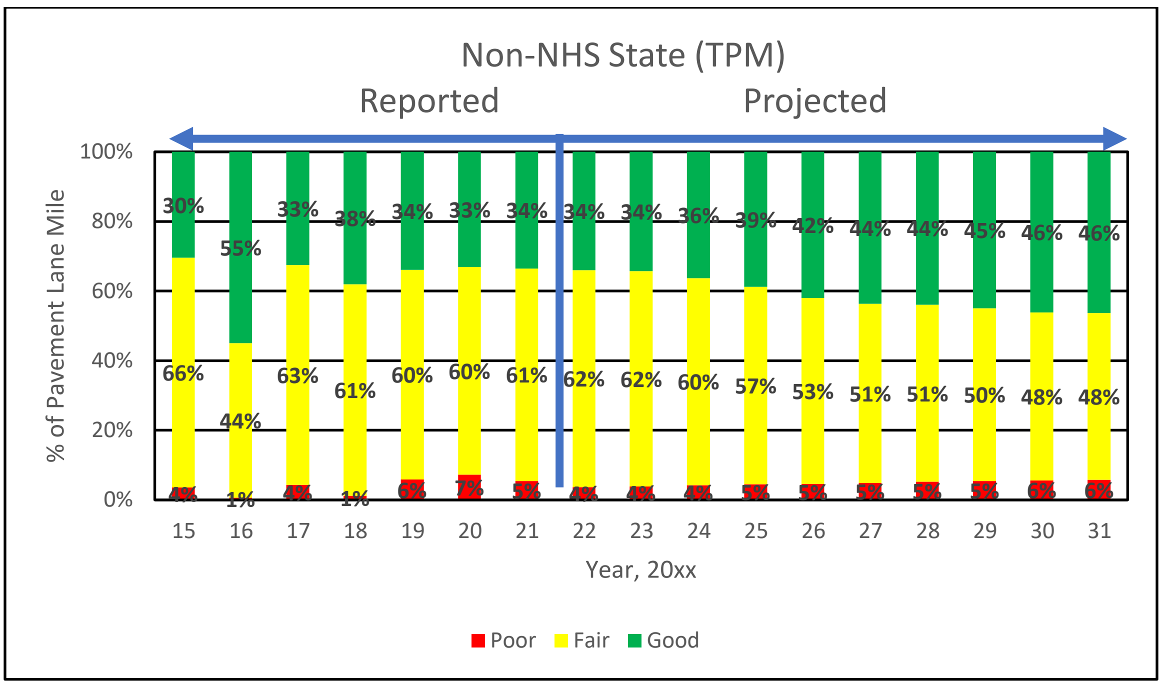


Figure 3-11: Pavement Condition (based on TPM) – Non-NHS State Routes (% of Lane Miles)

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

Since funding decisions for bridges are based on the entire state-owned bridge network rather than being broken down by system to prioritize repairs and replacements, the Department has chosen to show predicted condition of the bridges, from 2022 to 2031, using a straight-line projection of past condition results for each system of bridges. TDOT continues to refine the condition forecasting capabilities in its BMS to improve the 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 3-12 through 3-15.

Figure 3-12 shows that the percentage of Interstate bridges in *Poor* condition is projected to remain below 3% over the next ten (10) years, which is well below the national performance minimum standard of no more than 10% in *Poor* condition. It also meets TDOT's SOGR target of less than 6% *Poor* while falling a little below at least 32% *Good*. Figure 3-13 shows that all NHS bridges are also expected to meet these targets, coming in at under 6% *Poor* each year.

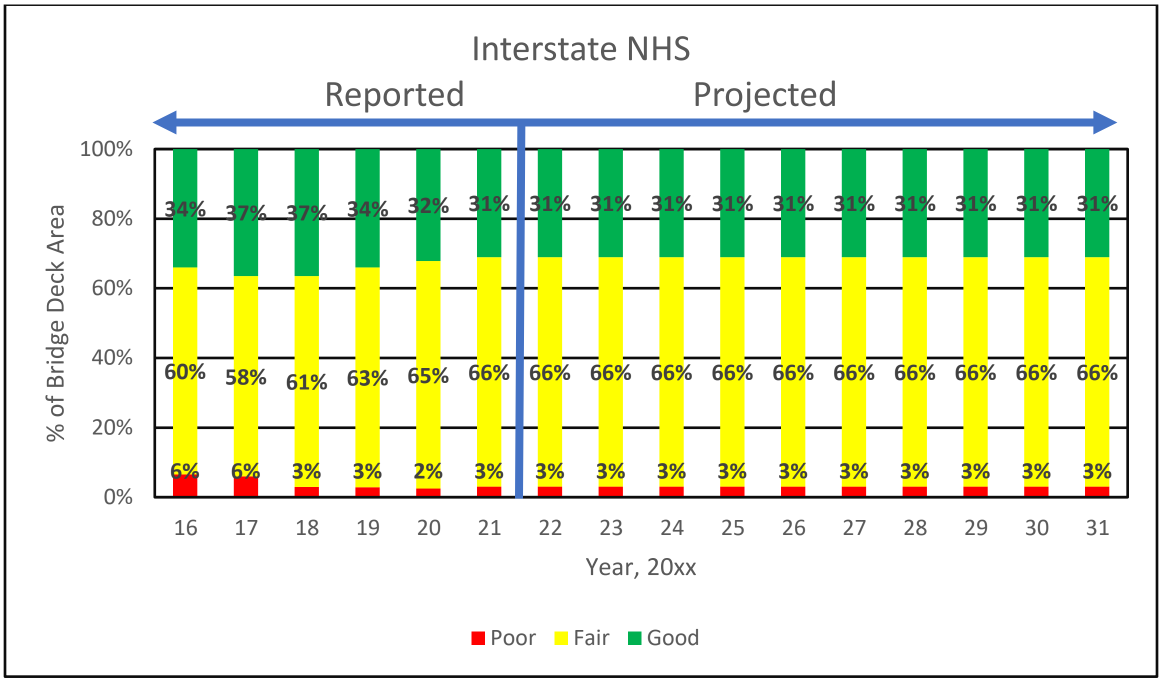


Figure 3-12: Predicted Bridge Condition – Interstates (% of Deck Area)

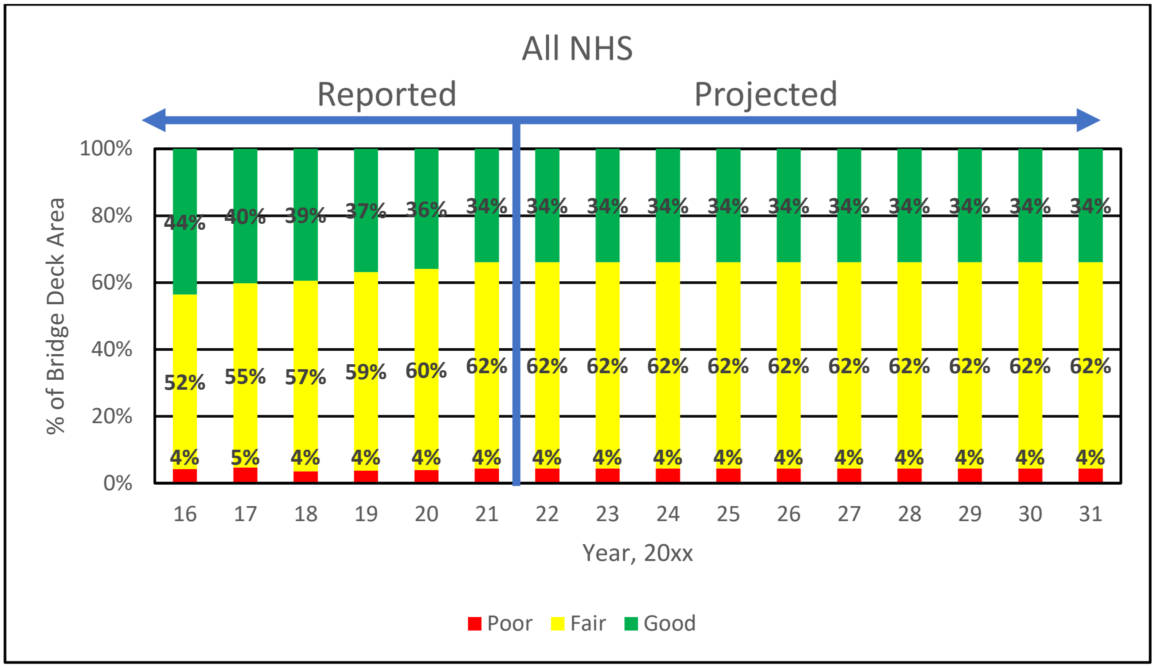


Figure 3-13: Predicted Bridge Condition – All NHS (% of Deck Area)

In Figure 3-14, state-owned non-NHS bridges are predicted to remain below 4% *Poor*, while in figure 3-15, local NHS bridges are anticipated to decrease from 11% to 9% from 2016 to 2031. Local agencies have elected to accept the state DOT's State of Good Repair targets of 32% *Good* and 6% *Poor* bridge deck area for the 2018-2021 performance cycle.

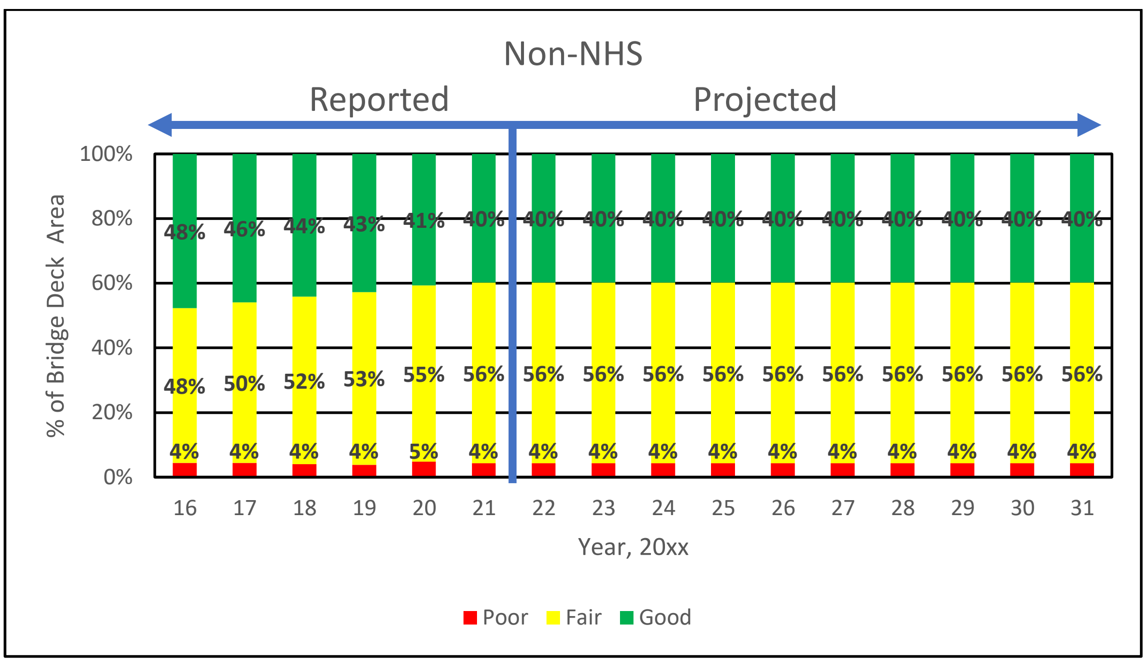


Figure 3-14: Predicted Bridge Condition – Non-NHS (% of Deck Area)

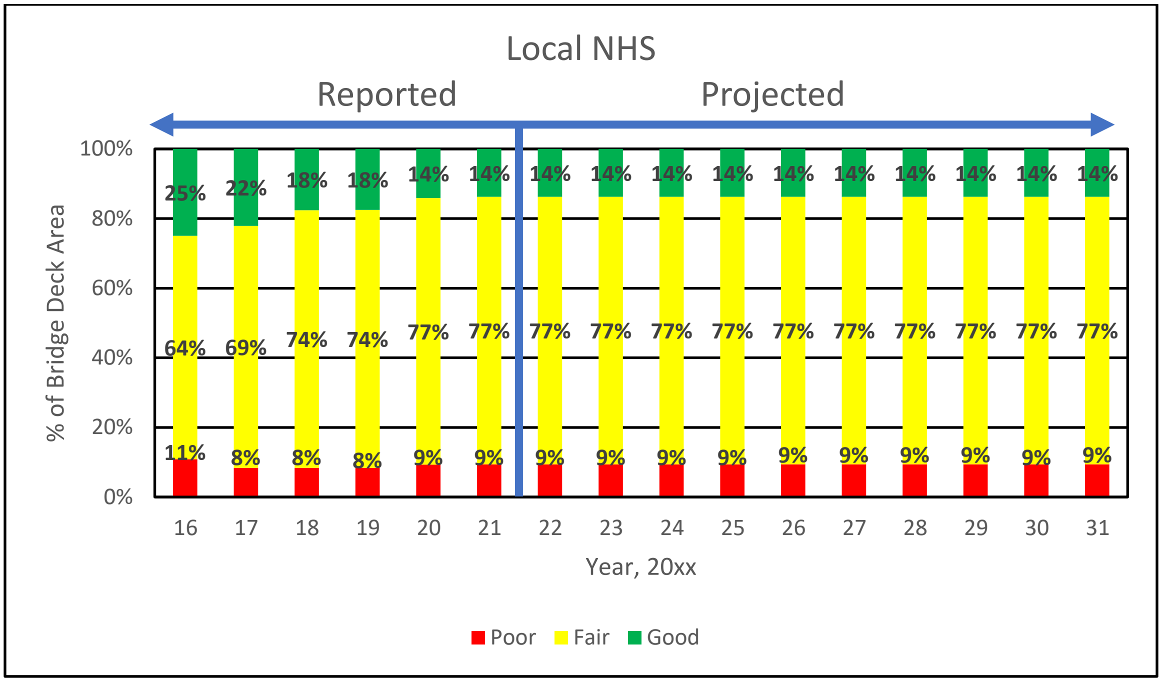


Figure 3-15: Predicted Bridge Condition – Local NHS (% of Deck Area)

The estimated funding to achieve these SOGR targets for bridges is approximately $165 million per year with an assumed 75 percent dedicated to NHS facilities. Around $104 million per year is expected to fund reconstruction of deficient bridges, and approximately $48 million will be used for rehabilitation projects with $8 million 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 plans to increase funding 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 3-16) established as part of TDOT's LRTPP. Each of the categories has several time frames that 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 3-17 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 scoring weights are established to address the operations of the transportation system and currently do not include a score for the asset condition.

Figure 3-16: TDOT's Guiding Principles for Developing the STIP

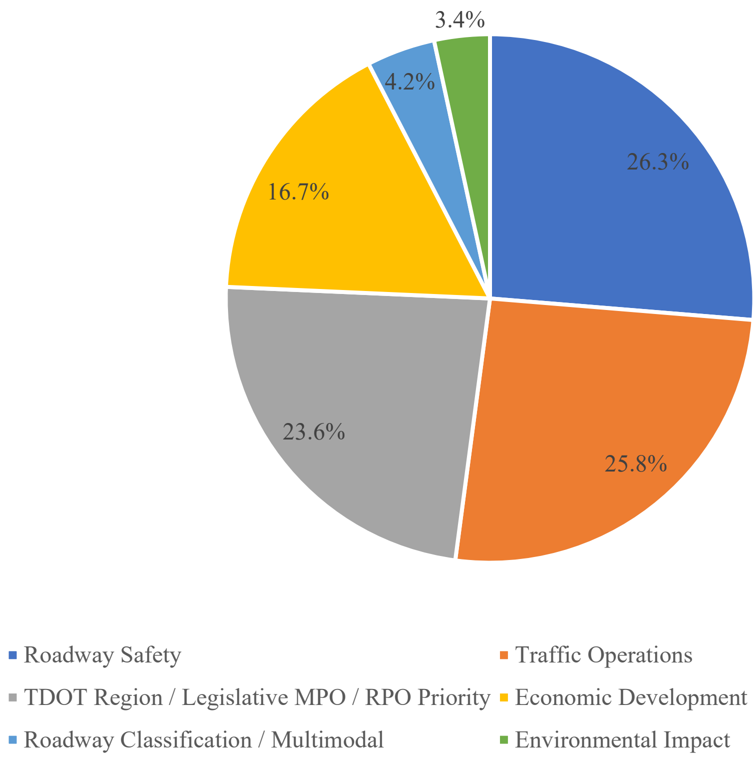


Figure 3-17: STIP Project Selection Prioritization Matrix Weighting

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 goals 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.
  - Statewide Crash Rate Ratio.
  - Critical Crash Rate Ratio.
  - Crash Severity.

In order to account for the condition of the pavement and bridges and to ensure that TDOT is able 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 to 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 PLANNING

What is Life Cycle Planning (LCP)?

TDOT has a long history of providing a well-maintained roadway system for its users. The Interstates and state routes have high-quality pavement resulting from the state's commitment to preservation practices that extend the life of the pavement network. These pavement preservation methods are embedded within the pavement management system (PMS) analysis, and the Department has solidified its commitment to extending the asset's useful life through policies that 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 that provides the ability 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 planning (LCP).

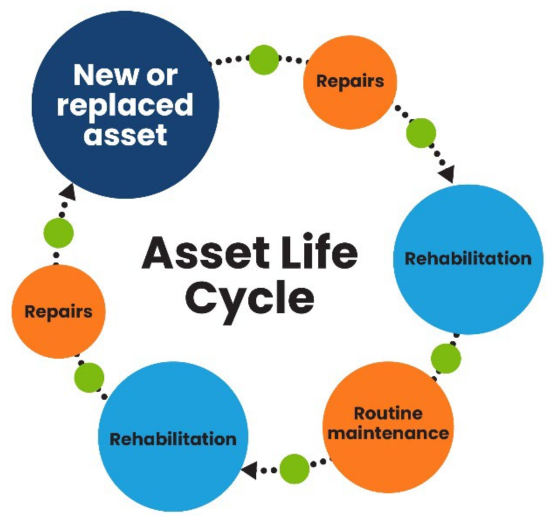


Figure 4-1: Typical asset life cycle stages

In general, an LCP analysis considers all the relevant costs incurred throughout the whole life of an asset (as illustrated in figure 4-1), not just the initial construction cost. 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 expectations, there are certain actions that must be performed throughout its life. The LCP process begins with the development of different alternatives to fulfill the structural and performance objectives for 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 (e.g., construction, maintenance, preservation, and rehabilitation activities) are typically included in the analysis. The predicted schedule of activities and their associated costs form the projected life-cycle cost of managing the asset network over the selected analysis period.

A key goal of an LCP analysis is to maintain a desired condition at a minimum practicable life-cycle cost. Conceptually, this "happy medium" point (illustrated in figure 4-2) exists where maintenance expenditures are neither too frequent nor delayed too long. Typically, a properly maintained pavement or bridge, when maintained at a level that minimizes costs in the long term, is continuously kept in relatively *Good* condition. Over the life of these assets, preservation activities that are optimally timed are estimated to cut long-term life cycle costs roughly in half, compared to a policy where no preservation activities are performed at all.

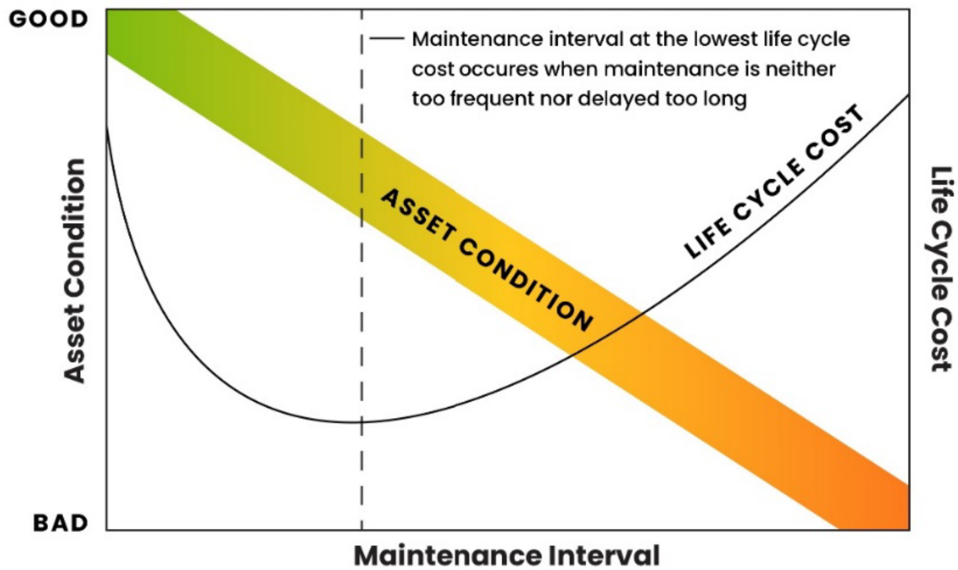


Figure 4-2: Ilustration of the life-cycle cost analysis concept.

What are the MAP-21 and BIL Requirements?

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

Life-Cycle Cost (LCC): The cost of managing an asset class or asset sub-group for its whole life, from initial construction to its replacement.

Life Cycle Planning (LCP): 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.

Per 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.
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).

Additionally, State DOTs are required to consider extreme weather and resilience as a part of the LCP analyses within the TAMP (resulting from Section 11105 of the BIL changes to Title 23, USC 119(e)(4) that took effect on October 1, 2021).

What is TDOT's Approach to Managing Transportation Infrastructure 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 Operations and Structures Divisions. Below are examples of approaches used by TDOT to effectively manage the pavement and bridge assets:

Pavements

1. **Standard Operating Guidelines (SOG)** – TDOT has developed a SOG manual for pavement management that 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 LCP concepts). Visit Pavement Project Selection for more information.

2. **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.

3. **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 is classified in the *Good* condition category, while one with a PQI of less than 2.0 are in *Poor* condition. For state routes, pavements with a PQI of 3.5 or greater are classified in the *Good* category, while one with a PQI of less than 2.0 is 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

1. **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 3 (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. The overall process is illustrated in figure 4-3.

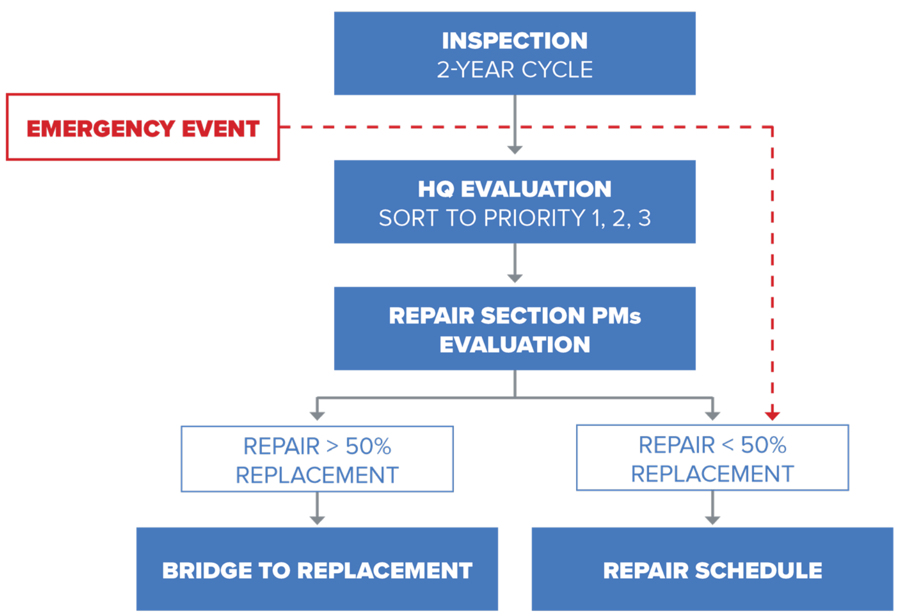


Figure 4-3: Bridge inspection and evaluation process.

2. **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).

3. **Focus on Preservation** – TDOT has placed an emphasis on holding the number of *Poor* bridges down to less than 6% on the state maintained system by a program of preservation that emphasizes the maintainence of bridge decks and joints. These elements tend to deteriorate more quickly and lead to other maintainence concerns.

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 4-1 and as follows:

1. **Preventive Maintenance** — Preventive Maintenance includes 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.

2. **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 extend 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 when applied to pavements in *Good* or *Fair* condition to delay the need for rehabilitation.

3. **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 the 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.

4. **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 costliest approach to manage the pavement assets.

Table 4-1: Typical Pavement Work Types, Treatments, and Unit Costs

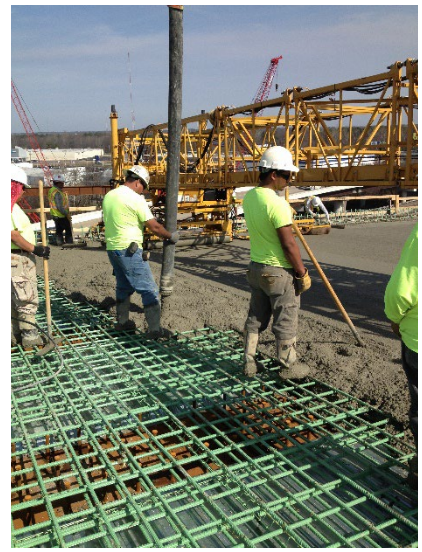
WORK TYPES	TREATMENTS	UNIT COST PER LANE MILE*
Maintenance	Shallow patching Skin patching Partial-depth patching Repair concrete corner breaks Concrete joint repair Other thin patching	Asphalt: $60 to $215/ton Concrete: $442 to $895/CY
Preservation	Thin asphalt overlay (1.5 in. or less) Microsurfacing Scrub Seals Chip seals Cape seals Crack sealing Concrete joint sealing Mill and fill asphalt overlays (1.5 in. or less) Open Graded Friction Course	$15,000 to $350,000
Rehabilitation	Full-depth patching Repair/replacing concrete slabs Cold in-place Recycling and Overlay Thick asphalt overlay (2 to 4 in.)	$110,000 to $435,000
Reconstruction	Rubblization and overlay of concrete pavement Full-depth replacement of asphalt pavement	$557,000 to $1,554,700

*Note: Unit cost values reported in the table are typical statewide ranges. Actual treatment cost will vary based on scope of the work, region, contractor, and other site-specific conditions.

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 LCP 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 for 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 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 LCP analysis.

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, and Reconstruction. These are identified in Table 4-4 and as follows:

1. **Preventive Maintenance** — Preventive Maintenance includes the day-to-day bridge maintenance activities that are scheduled or whose timing is within the control of maintenance personnel. This includes routine maintenance activities such as filling potholes in decks, minor structure repairs (minor spall repairs, cleaning expansion joints), and major structure repairs (parapet wall repairs).

2. **Preservation** — Preservation is a proactive or preventive approach that entails the application of a series of low-cost, preservation treatments that individually last for a few years and extend the life cycle. This is accomplished with repainting structural steel, vegetation removal, sweeping, deck repairs and water- proofing 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.

3. **Rehabilitation** — Rehabilitation occurs when structural damage has occurred, and the objective of the rehabilitative treatment is to repair that damage and restore the bridge. Rehabilitation includes 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 super-structures of bridges.

4. **Reconstruction** — Bridge candidates are considered for replacement if it is rated *Poor*. Other bridges may get replaced if they are within the limits of a large roadway improvement project.

It should be noted that 96 bridges (as of April 2022), 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 LCP analysis.

Table 4-2: Typical Bridge Work Types, Treatments, and Unit Costs

Category	Treatments	Average Unit Cost Per Sq. Ft.*
Maintenance	Filling potholes in deck	$25
	Minor structure repair	
	Major structure repair	
	Cleaning structure	
Preservation	Repainting structural steel	$90
	Sweeping	
	Deck repairs	
	Deck waterproofing	
	Deck epoxy overlay	
	Polymer modified concrete deck overlay	
	Cleaning and resealing expansion joints	
Rehabilitation	Replacement of expansion joints	$160
	Concrete spall repairs	
	Structural steel repairs	
	Scour prevention	
	Bearing replacement	
Reconstruction	Replace entire bridge	$200
	Widen the bridge	

** Includes only bridge item costs without ancillary project costs*

What is TDOT's Process for Conducting an LCP Analysis?

TDOT performs a thorough and systematic LCP 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 TPM identified in 23 CFR Part 490. An Oversight Committee consisting of key TDOT managers and senior leaders was established to provide oversight and coordination for implementation of all MAP-21, FAST Act, and BIL final rules including development of performance targets. Additionally, TDOT developed other performance measures and targets for pavements that are supplemental to the National Measures and Minimum Conditions. These are based on historical agency practice and more applicable to the way TDOT manages its transportation infrastructure assets.

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 agency's overall goals and objectives to the available funds. Modern computerized management systems allow agencies to perform multiple "what-if" scenarios to analyze the future condition of an asset network. These scenarios are based on different funding levels and investment strategies, (e.g., 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, and funding. Another core function is a cost effectiveness 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.

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 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) and 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, for a 10-year period.
- Estimated condition based on various funding scenarios by highway system, for a 10-year period.
- Treatment work types (preservation, maintenance, rehabilitation, reconstruction), by highway system, with 10-year cost and quantity projections.

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 LCP 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 has taken time to calibrate the analysis the Department desires to perform reliable life cycle cost analysis.

This TAMP uses the best information available to address LCP 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 LCP 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 LCP in the development of their annual pavement and bridge management programs.

Pavement Management Program

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 4-1). 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 Pavement Office 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.

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 regions submit their proposed program to the Programming Office and Pavement Management Office for final approval before project development is permitted to begin.

Bridge Management Program

TDOT is utilizing AASHTO's BrM for bridge life cycle planning. 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 reflects a blend between TDOT's historical process and their 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.

It should be noted that the BrM analysis includes only bridge item costs for estimating bridge needs. This is done to maintain the integrity of the treatment selection and prioritization analyses regardless of the location of the structure, final project scope, or funding source. For instance, the majority of NHS bridges are replaced as part of much larger widening projects and including the entire cost of a widening project into the unit cost for bridge replacement work would not be appropriate for other bridge projects. Ancillary costs vary significantly by location and do not contribute to improving the bridge condition. Similar issues arise on bridge rehabilitation and preservation projects. Keeping the unit treatment costs isolated to bridge items allows BrM to determine bridge needs based on bridge condition and the estimated cost to improve those specific conditions. If other items are added to a bridge project when it is programmed, funding for those additional costs is acquired to supplement the bridge budget.

The Structures Division uses the results from the BMS analysis in conjunction with information contained in the bridge inspection reports to develop short- and long-term bridge management programs. Bridges are placed on a repair list, if needed, and are given a priority rating of 1 thru 3 (1 is highest priority). Repair section engineers (project managers) review repair lists and further prioritize bridges for projects. If repairs costs are estimated to be more than 50% of the replacement cost, they are recommended for inclusion on the replacement list. This may require a repair project to keep the bridge operational until replacement. If repairs are feasible, the bridge is added to the repair schedule. These projects include minor repairs, major repairs, and complete rehabilitations. Other repair projects due to vehicle collision, flood damage or other unanticipated events are added to the repair schedule as necessary. Emergency projects often take precedence over other schedules and are delivered in a shorter time span.

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 hovered around $135 million. This funding level has maintained a general steady-state of the square feet of bridge deck area on the NHS in *Poor* condition between 2016 and 2021, demonstrating that the funding is being used effectively to preserve conditions. 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, and expenditures 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. 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 the Results of the LCP Analysis?

Pavement LCP Analysis

TDOT evaluated the impact of two LCP strategies using its PMS:

- **Current Strategy**: This strategy represents TDOT's existing preservation-focused approach for managing its pavement network. Pavements in generally good condition are candidates for maintenance and preservation activities. Pavements that exhibit more structural distresses are candidates for rehabilitation or reconstruction actions.

  This strategy uses a cost-effectiveness analysis approach in which the effectiveness of a treatment strategy is measured in terms of the area between the treated and untreated performance curves. The effectiveness divided by the total present worth represents the cost-effectiveness (C-E) ratio. The optimization routine within the PMS seeks to maximize the C-E ratio for the funding level specified for the analysis.
- **Worst-First Strategy**: This strategy represents a traditional "worst-first" approach in which pavements in *Poor* condition are prioritized for funding.

TDOT's PMS has configured treatment decision trees that are used to determine the right type of treatment based on current and projected conditions over the chosen analysis period. In addition to pavement condition, other factors such as age of rehabilitation treatment, speed limit, and roadway classification are also used to determine suitable treatment actions.

For the pavement LCP analysis, a 10-year analysis period was used. While TDOT's PMS is capable of conducting the analysis over longer time periods, TDOT elected not to do it for this TAMP due to the uncertainty associated with the long-term condition projections using the performance models. The performance models were developed by TDOT using approximately 10 years of data and utilizing the same models to extrapolate performance over a longer timeframe could potentially result in unrealistic outcomes. TDOT recently updated its pavement performance models and will continue making routine updates to the models in the future as more performance data becomes available through future pavement condition inspection cycles.

Table 4-5 summarizes LCP scenarios evaluated by TDOT. LCP Scenario #1 does not consider annual treatment cost increases over the analysis period. While this scenario is not realistic, it provides a basis for comparing the expected impacts of treatment cost increase over time. Since 2016, TDOT has been closely monitoring treatment unit costs and has observed an average annual unit cost increase of 7% for the major treatments used in each region. This observation was the basis for LCP Scenario #2 that considers annual treatment cost increases over the analysis period. LCP Scenario #3 represents an optimistic scenario where the baseline budget is increased by 25%. All the LCP scenarios evaluated consider a 3% increase in annual budget.

Table 4-5. LCP scenarios evaluated

LCP Scenario	Scenario Detail	LCP Strategies Evaluated
1	Current budget with 3% annual budget increase	Current Strategy and Worst-First
2	Current budget with 3% annual budget increase and 7% annual treatment cost increase	Current Strategy
3	Current budget with 25% increase in baseline budget, 3% annual budget increase, and 7% annual treatment cost increase	Current Strategy

Figure 4-4 presents the annual budget levels used for the analysis. For the first year of the analysis (2022), all the committed projects (totaling approximately $339 million) were included. For 2023 onwards, the baseline budget was assumed to be $337 million, and a 3 percent annual budget increase was assumed.

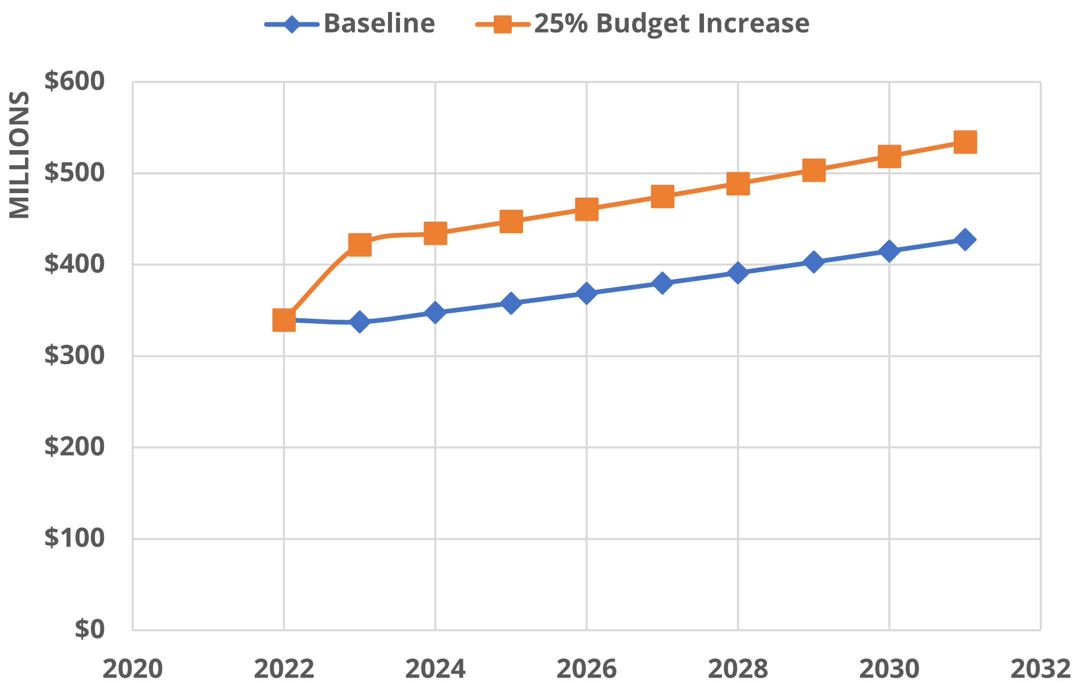


Figure 4-4. Annual budged levels used in the pavement analysis

Figure 4-5 illustrates the budget distribution across Interstates and state routes in each region. For the state routes in each region, the budget is allocated based on the total lane-miles.

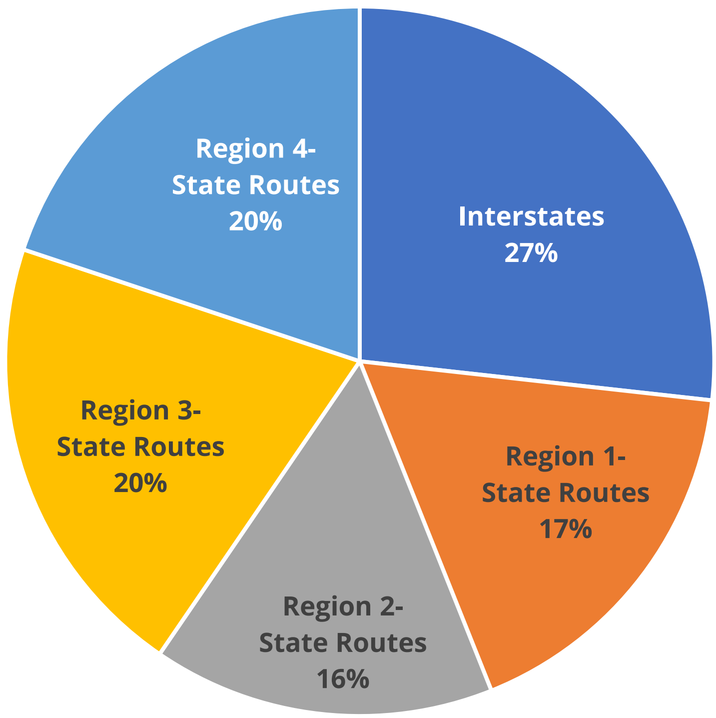


Figure 4-5. Budget allocation across Interstates and State Routes in each TDOT region.

How Does TDOT's Current Pavement Strategy Compare to the Worst-First Strategy?

LCP Scenario #1 (current budget with 3% annual increase) was used to illustrate the benefits associated with TDOT's existing preservation-centric strategy of managing its pavement network over the worst-first strategy. As seen in figure 4-6, TDOT's current strategy results in a higher fraction of the network in *Good* condition since the preservation-focused approach prioritizes treatments based on maximizing the cost-effectiveness ratio at the network level. On the other hand, while the worst-first scenario results in a lower fraction of pavements in *Poor* condition, it is evident that this strategy is not financially sustainable in the long-term as the fraction of pavements in *Good* condition experiences a steady decline over time. Hence, this strategy was not evaluated under LCP Scenarios #2 and #3.

Figure 4-6. Pavements — Current Strategy vs. Worst-First Strategy

What is the Impact of Each Pavement LCP Scenario on Projected Pavement Conditions?

The current pavement condition and 10-year projected pavement conditions for each LCP scenario evaluated are illustrated in figures 4-7 through 4-9.

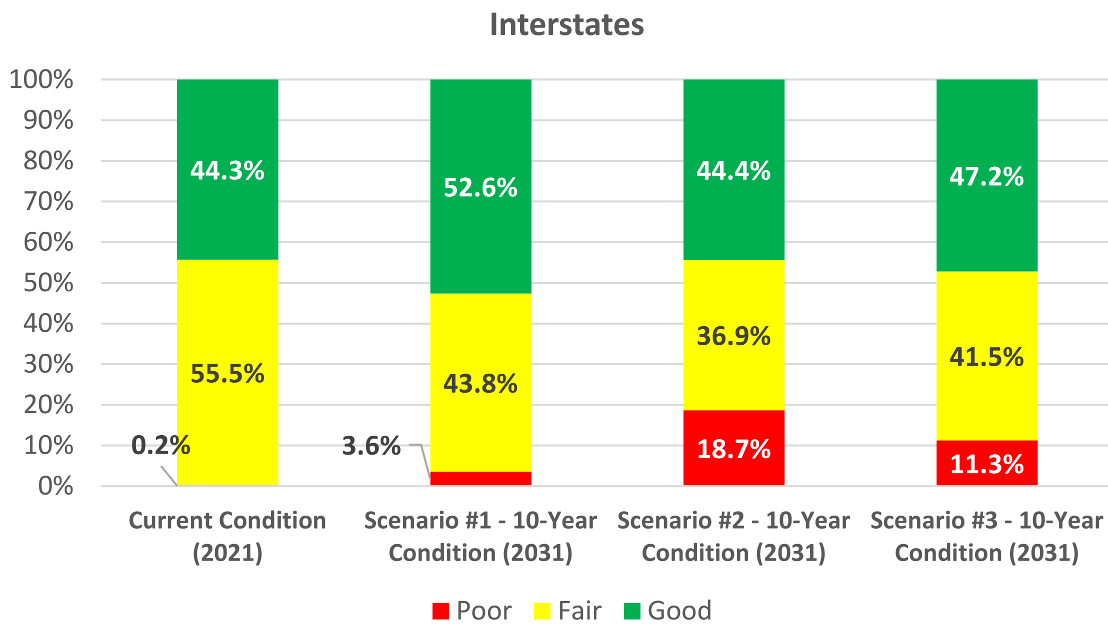


Figure 4-7. Initial and projected pavement condition––Interstates

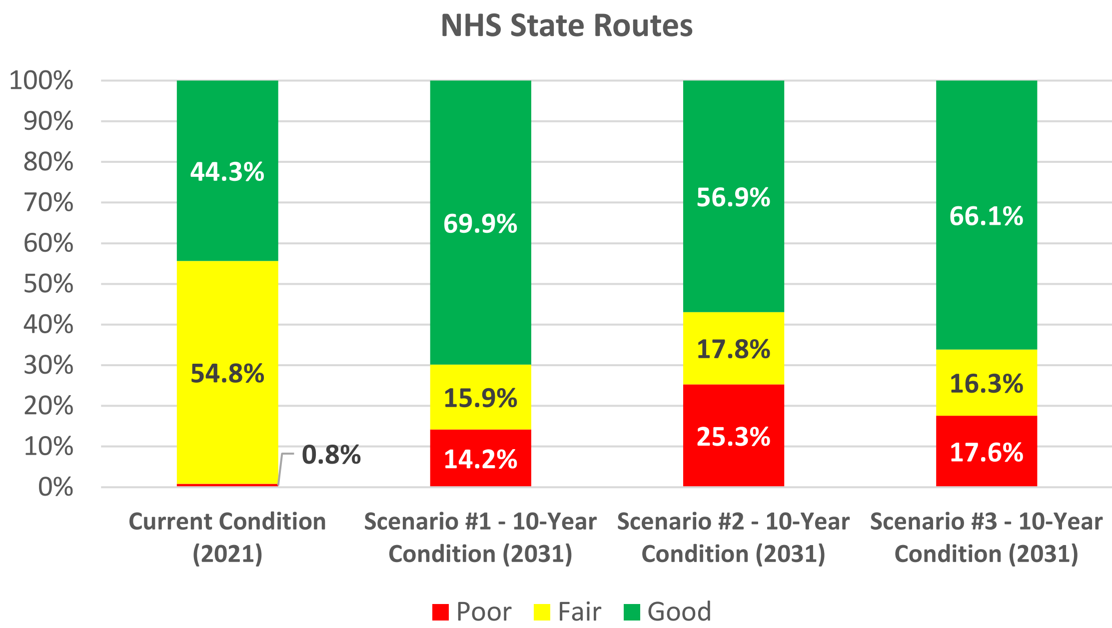


Figure 4-8. Initial and projected pavement condition––Non-Interstate NHS State Routes

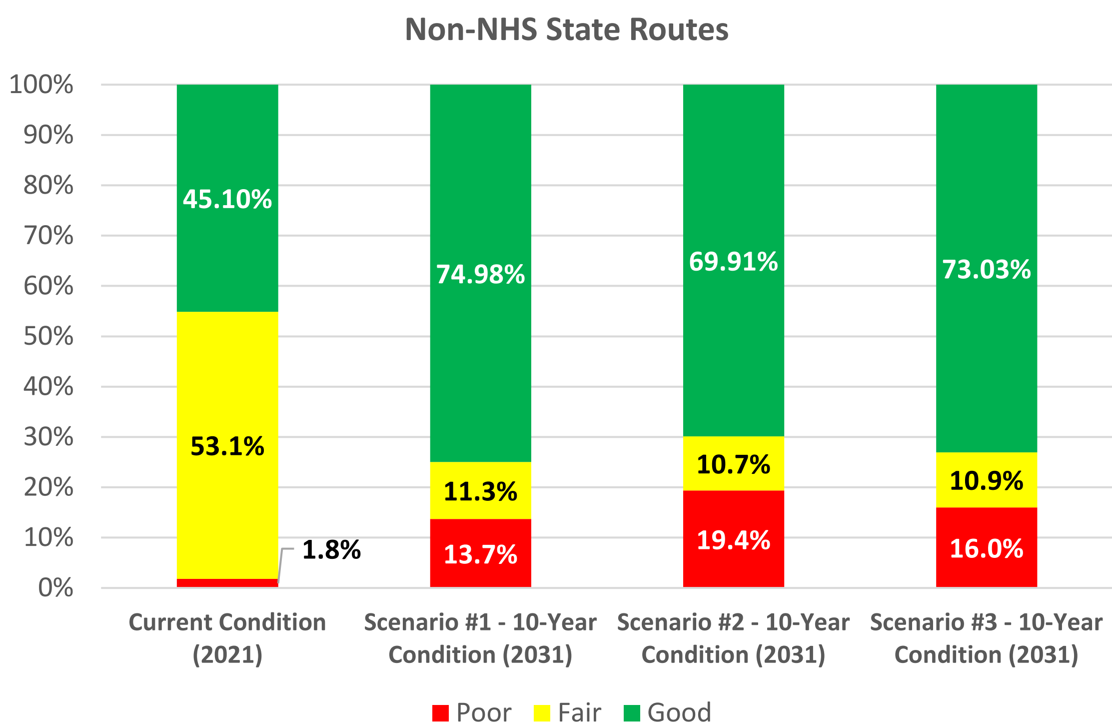


Figure 4-9. Initial and projected pavement condition–Non-NHS State Routes

Key takeaways from figures 4-7 through 4-9 are summarized below:

- Scenario #1 results in the best condition outcomes at the end of the analysis period. However, it is important to note that this scenario is not a realistic one since it does not consider treatment cost increases over time.
- If the trend in the annual treatment cost increase that TDOT has been experiencing over the last 5 years continues, the current budget level, even with a 3 percent annual increase, is not adequate to offset loss in purchasing power that TDOT is expected to experience over the next 10 years.
- As seen from the 10-year performance outcomes for LCP Scenario #3, even a 25 percent increase over the baseline budget (along with a 3 percent annual budget increase) and a 7 percent annual increase in treatment cost) is not expected to be adequate in sustaining current pavement conditions over the 10-year period.

With higher-than-expected inflation rates, TDOT's pavement network will continue to decline in condition under the current economic climate unless the available funding is able to offset the projected treatment cost increase over time.

Are there Significant Differences in Pavement Performance in each TDOT region?

TDOT also investigated performance differences by region, and the results of the pavement condition outcomes under LCP Scenario #2 for the NHS and non-NHS state routes are illustrated in figures 4-10 and 4-11, respectively.

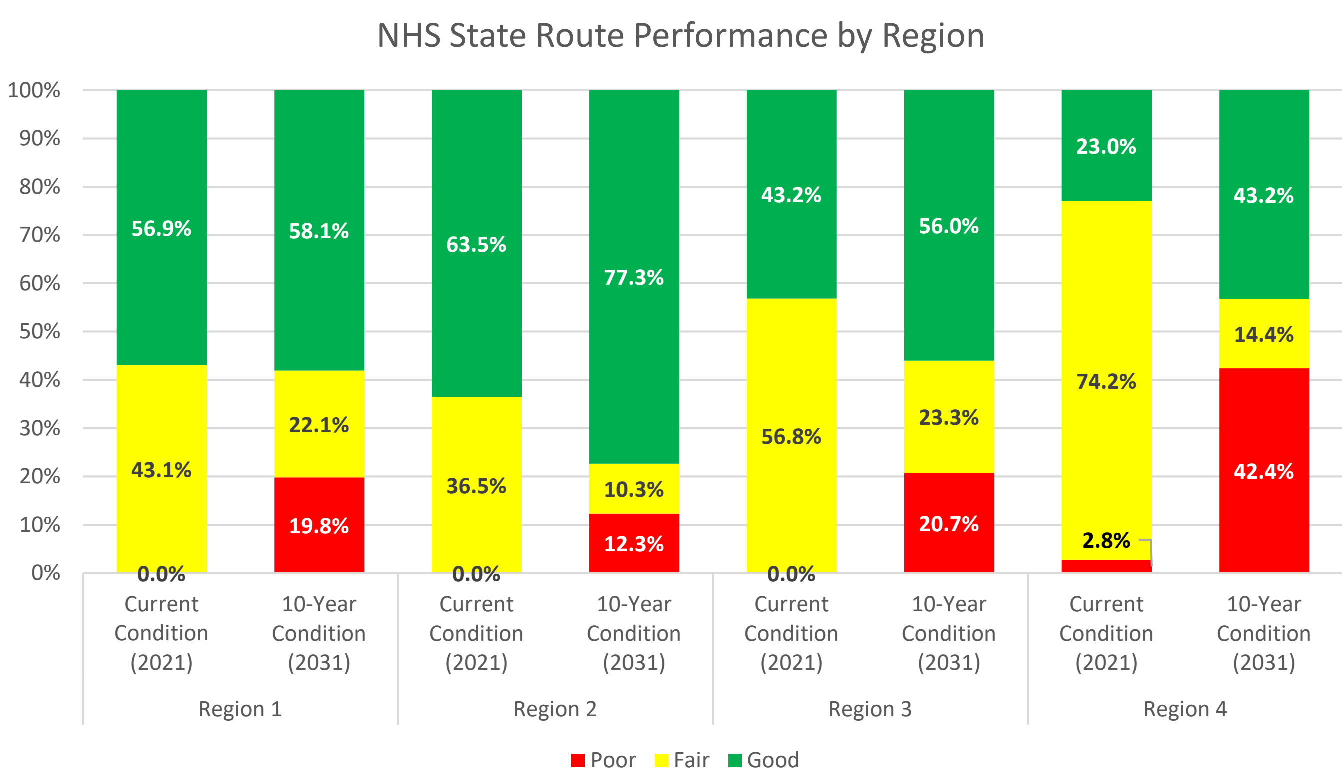


Figure 4-10. NHS State Routes––Performance by TDOT Region

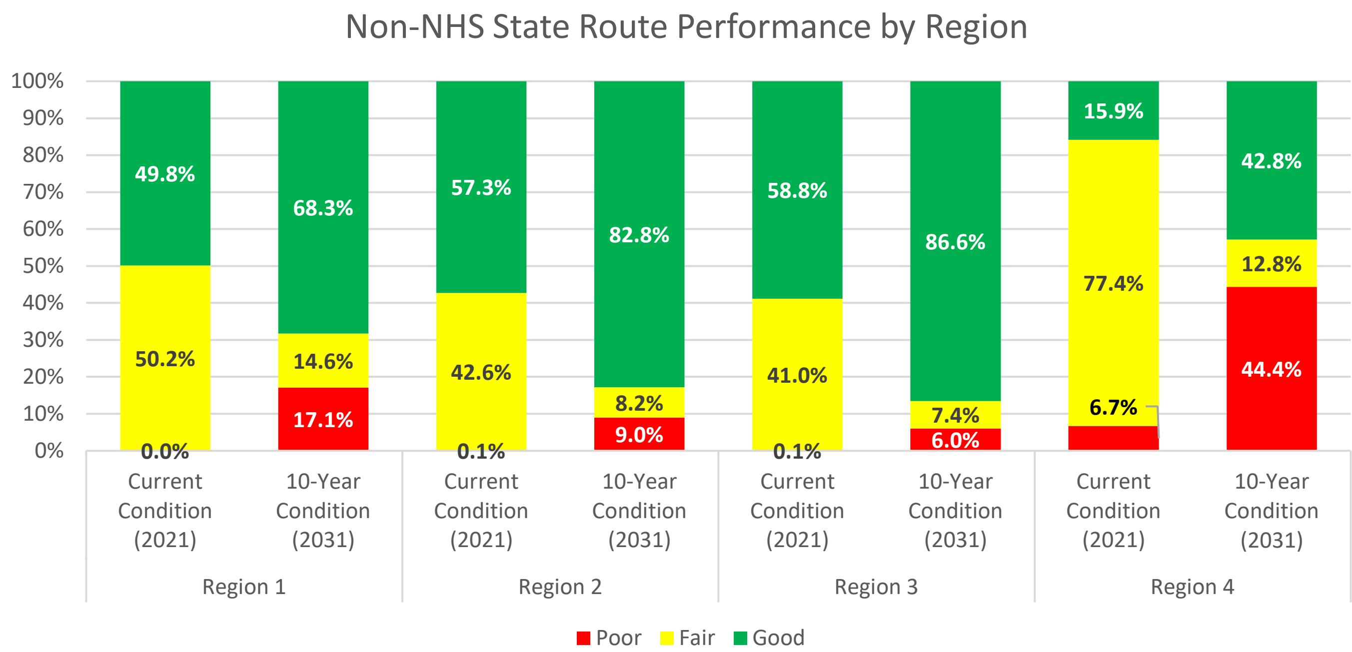


Figure 4-11. Non-NHS State Routes––Performance by TDOT Region

It is evident from figures 4-10 and 4-11 that pavements in Region 4 are projected to be in significantly worse condition when compared to the pavements in the other TDOT regions. As noted earlier, TDOT recently undertook an effort to update the pavement performance models used in the PMS. During this effort, it was observed that the deterioration rate of the main treatments used by TDOT is significantly higher in Region 4 when compared to Regions 1 through 3. As an example, the PQI deterioration curves for TDOT's primary resurfacing treatment, a 1.25-inch mill and inlay, is shown in figure 4-12. The performance curve represents treatments on Non-Interstate urban routes.

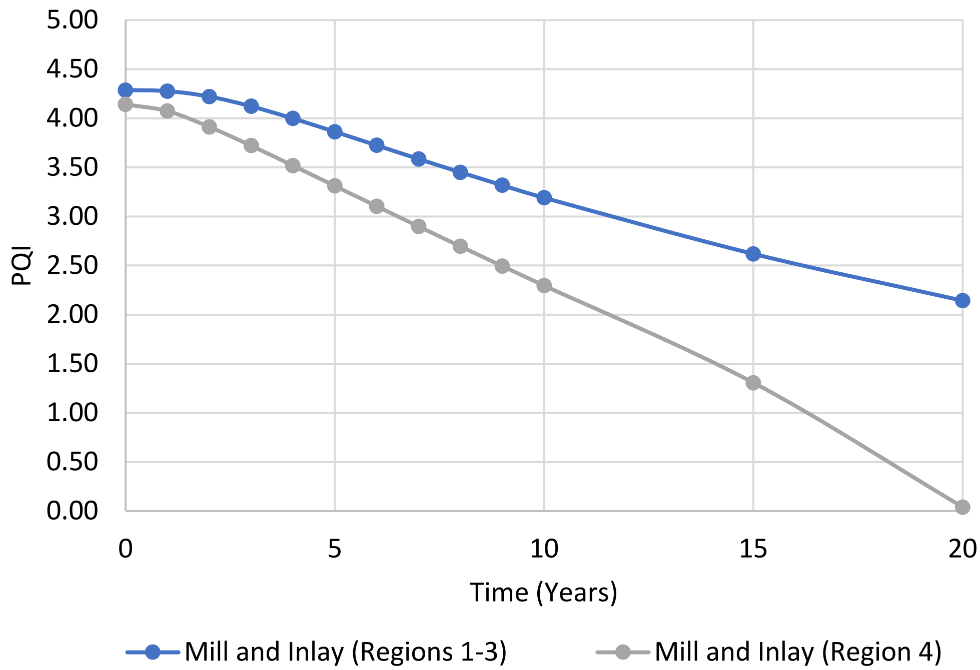


Figure 4-12. PQI Performance Curves for Mill and Inlay Treatment

The higher rate of pavement deterioration in Region 4 cannot be addressed just through repeated application of preservation treatments since the fundamental cause of the deterioration is in the underlying pavement layers. Investments in heavier rehabilitation treatments that include the strengthening of the subgrade and/or the base layers will be needed to enhance the structural capacity of the pavement structure and reduce the rate of deterioration. TDOT is in the process of developing suitable life-cycle treatment strategies for areas of concern in Region 4. TDOT is also investigating the use of traffic speed deflection (TSD) testing for assessing the structural condition of pavements. In the coming years, TDOT is looking to integrate the structural condition data within the PMS and enhance the treatment decision trees to consider structural condition in addition to other pavement condition parameters currently being assessed.

Bridge LCP Analysis

An LCP analysis was conducted using TDOT's BMS to identify the best opportunities for long-term cost savings and to prioritize investments appropriately to ensure that the right amount of preservation work is completed in a timely manner.

The analysis is based on an overall rating for each bridge and uses historical data in modeling deterioration rates to forecast future needs for preservation, rehabilitation, and replacement. The model that most closely follows the preservation strategy employed by TDOT weights the 50-year look-ahead life cycle cost analysis at 25% and condition at 75% percent and allows the program to choose the distribution of funds by project type.

As an illustration of the analysis, a strategy that implements TDOT's preservation policy can be compared to a traditional worst-first strategy, in which bridges are allowed to deteriorate to the lowest tolerable condition before being rehabilitated or replaced. Given the current economic climate, both analyses include an 5% annual treatment cost inflation.

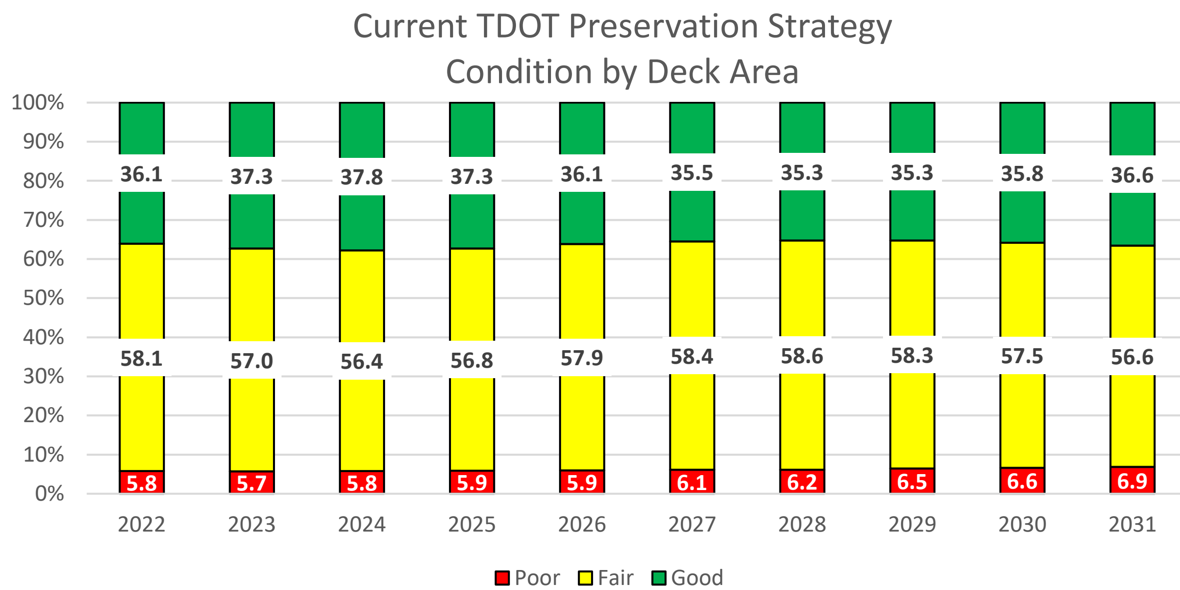


Figure 4-13. Projected systemwide (NHS and non-NHS) bridge conditions based on TDOT's preservation strategy

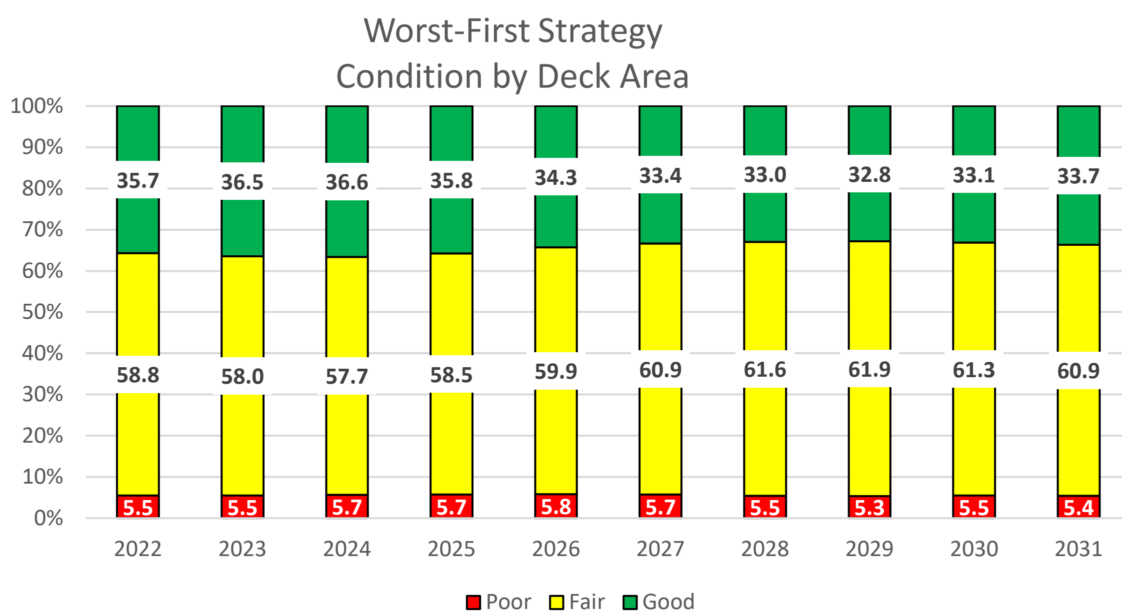


Figure 4-14. Projected systemwide (NHS and non-NHS) bridge conditions based on a worst-first strategy

Figures 4-13 and 4-14 compare current (2022 National Bridge Inventory submittal of 2021 inspections) systemwide bridge conditions with forecasts of 2031 conditions under either an optimized preservation scenario or a worst-first scenario. This worst-first scenario contains no preservation work, only rehabilitation and replacement, and gives no consideration to future costs. It results in the number of bridges in *Poor* condition at 5.4% by deck area (compared to 5.0% today) and maintains the percent of bridges in *Good* condition at 33.7% (compared to 33.2% today). In contrast, the TDOT preservation strategy with the same funding sees the number in *Poor* condition go to 6.9% and improves *Good* condition to 36.6%, a gain of about 3.0% over the worst-first scenario.

What is TDOT's Approach to Improving System Resilience?

Improving Pavement System Resilience

The main environmental risks that impact the resilience of TDOT's pavement assets include:

- Temperature extremes (high and low)
- Snow and ice storms
- More extreme rainfall events
- Increased number of flooding events
- Droughts

For the key risks identified, some of the main pavement vulnerabilities include the following:

- Increased rate of asphalt binder aging
- Reduced pavement structural capacity of unbound base layers and subgrade
- Reduced surface friction

TDOT considers a range of adaptation strategies that can be implemented at various stages of the pavement life cycle. These strategies include adaptations to:

- **Material selection**: Use of pavement materials that are less susceptible to extreme temperature and moisture variations. TDOT recently completed the following studies that developed procedures to improve performance of asphalt and concrete materials used by TDOT:
    - **Mitigating Stripping in Asphalt**. This study investigated the mechanism of moisture damage, evaluated moisture resistance of different asphalt-aggregate combinations, and assessed the effect of asphalt aging and antistripping agents on moisture susceptibility.
    - **Enhancing Freeze-Thaw Resistance of Tennessee Concrete Mixes through Improved Air Void Testing**. This study investigated the applicability of Super Air Meter (SAM) to TDOT concrete mixes and the suitability of SAM number as a QC/QA tool for freeze-thaw resistance and determines the acceptance criterion for the SAM number if it can be adopted for QC/QA purposes.
- **Design approaches**: Use of design standards that result in improved structural support and drainage.

- **Construction procedures**: Provision of flexibility in construction schedule to accommodate precipitation events that may impact overall project schedule and improvement of finishing and curing practices.
- **Maintenance and operation activities**. Increased efforts to seal cracks and joints in existing pavements, adjustment of spring thaw load restrictions, use of asphalt pavement preservation techniques that reduce surface course binder aging (e.g., chip seals, fog seals, Microsurfacing), maintenance of high friction pavement surfaces, and employment of nondestructive methods to determine pavement structural adequacy in inundated/flood condition to determine structural loading restrictions after inundation events.

In addition to agencywide resilience initiatives (discussed in Chapter 5), TDOT is currently working on the following research activities to help improve the resilience of pavement systems:

- **Understanding the effects of extreme climate shifts on pavement infrastructure in Tennessee**. The overall goal of this study is to help identify a comprehensive approach to evaluate the status of pavement conditions and maintenance needs for smooth operation of transportation infrastructure. Specific objectives of this study are to:
  - Quantify historic weather and projected weather parameters for pavement design parameters.
  - Recommend criteria for use of pavement materials that are resilient to projected weather.
  - Recommend weather parameters and maintenance plans for design, implementation, and maintenance future pavement infrastructure.
- **Development of a Balanced Mix Design (BMD) Procedure for Tennessee Asphalt Mixtures**. TDOT's implementation of BMD tests and specification criteria is expected to improve mixture performance and extend the service life of asphalt pavements. This is also expected to contribute to reduced maintenance and rehabilitation costs.
- **Improving Winter Maintenance for Open-Graded Friction Course (OGFC) Pavements in Tennessee**. This study will develop specific recommendations on winter maintenance practices for OGFC pavements that are expected to improve overall treatment performance and expected service life.
- **Evaluation of Traffic Speed Deflectometer for Collecting Network-Level Pavement Structural Data in Tennessee**. The purpose of this study is to develop traffic speed deflectometer data collection and analysis guidelines for pavement structural evaluation. The study will also develop a methodology for incorporating TSD data into TDOT's PMS. Finally, this study will help TDOT establish a pavement structure database in the PMS and make network-level treatment decisions that considers structural capacity.

- **Mechanistic-Empirical Pavement Design Guide (MEPDG) Climate Data Input for the State of Tennessee**. The goal of this study is to select candidate sites and collect related climate data sources and predict pavement performance on the selected sites with different pavement structures, materials, and traffic levels. This study will provide TDOT with climate data source inputs for the MEPDG method and enable TDOT to develop pavement designs that consider climate indicators.

Improving Bridge System Resilience

In the past 30 years, TDOT has been active in developing programs to enhance the resiliency of its bridge system. In the 1990's, TDOT developed a scour assessment program. All state & local bridges had a scour analysis or assessment performed to determine scour vulnerability. Bridges determined to be scour critical had countermeasures installed or were placed on a monitoring program. BRIDGEWATCH is a program that TDOT uses to monitor storm events and alert to threshold events at bridge locations. The program generates email alerts to the bridge owners (with TDOT receiving all alerts) to indicate a scour inspection is needed based on predicted flows from the storm event. Evidence of scour is also checked for and noted during regular bridge inspections, and scour repair and countermeasure projects are developed as needed as part of the repair program. All new bridges are designed for calculated scour based on generally accepted hydraulic analysis methods, including HEC-18.

In the 1990's, TDOT also initiated a seismic retrofit program for bridges. Beginning with bridges identified in TDOT's Earthquake Preparedness Plan as critical for recovery after an event, bridges deemed vulnerable were retrofitted with seismic restrainers and other modifications such as column strengthening. This was later expanded to all Interstate and state route bridges in areas of high seismic vulnerability (mainly in western part of state). All new bridges are designed for anticipated earthquake events in accordance with AASHTO guidelines.

The policy for TDOT bridge designs includes several elements that lead to more resilient structures, as well as structures that minimize long term maintenance concerns. These elements include:

1. Continuous structures and integral abutments (elimination of superstructure joints preferred wherever possible)
2. Use of epoxy steel in bridge decks and other elements
3. Design for earthquake loads
4. Design for calculated scour
5. Use of concrete sealers on substructures (especially under superstructure joints)

CHAPTER 5
RISK MANAGEMENT ANALYSIS

What is TDOT's Plan for Risk Management Analysis?

During the development of the 2018 and 2019 TAMPs, the context for risk management was established. This involved determining the types of risks that would be considered in the TAMP, the individuals who would participate in the workshops, and the methods used to analyze and evaluate risks. This chapter describes the requirements of the Federal requirements for risk management analysis, the process TDOT used to satisfy those requirements, and the results of the analysis. The chapter also describes TDOT's ongoing practices for monitoring and addressing risk, including risks posed by extreme weather, and TDOT's ongoing efforts to improve infrastructure resilience.

What are the MAP-21 and BIL 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.

Additionally, State DOTs are required to consider extreme weather and resilience as a part of the risk management analysis within the TAMP (resulting from Section 11105 of the BIL changes to Title 23, USC 119(e)(4) that took effect on October 1, 2021).

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.

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, (e.g., budgets, legislative requirements, regulatory reforms, public sentiment, broad managerial and personnel decisions).

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

Likelihood – The probability that a specific event might occur.

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

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.

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

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

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

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

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 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.

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.

What Steps Has TDOT Taken Toward Risk Management?

Following the passage of MAP-21, in 2012, TDOT initializes a comprehensive approach to assess risk across the agency in accordance with asset management concepts. This overall approach has remained in place and supported development of this TAMP. 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 February and March 2022, the risk management committee came together for two half-day workshops to kick-off the formal risk management effort and establish processes for identifying, evaluating and analyzing risks.

As part of this workshop, the Department adopted the framework based on ISO 31000 on "Risk Management – Principles and Guidelines" and FHWA publication, "Risk-Based Transportation Asset Management Report 1: Evaluating Threats, Capitalizing on Opportunities." TDOT's risk management process consists of the five-steps shown in Figure 5-1.

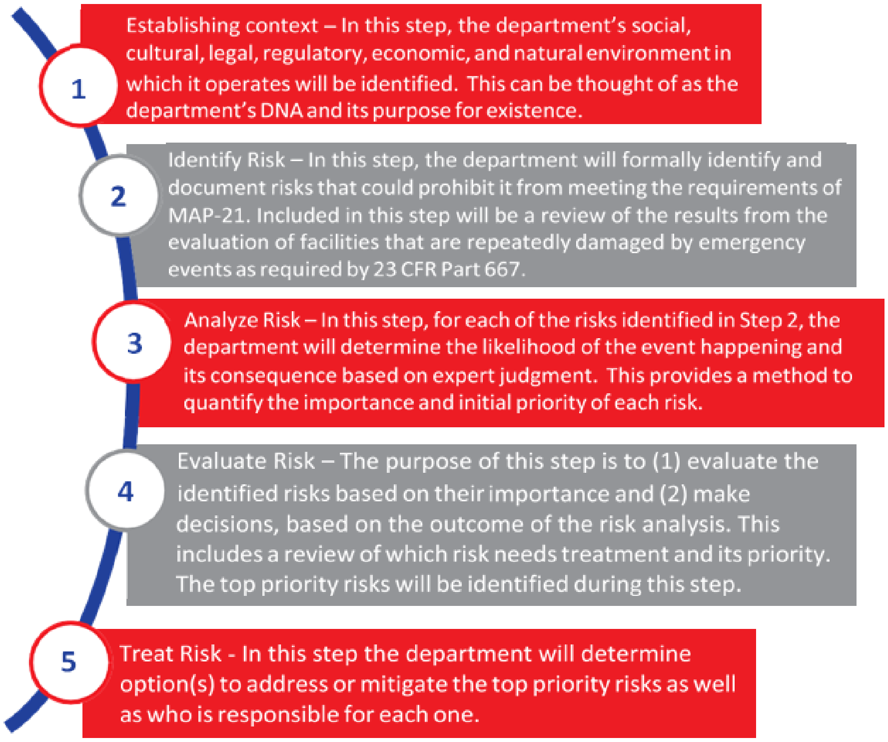


Figure 5-1. TDOT's risk management process

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 5-2.

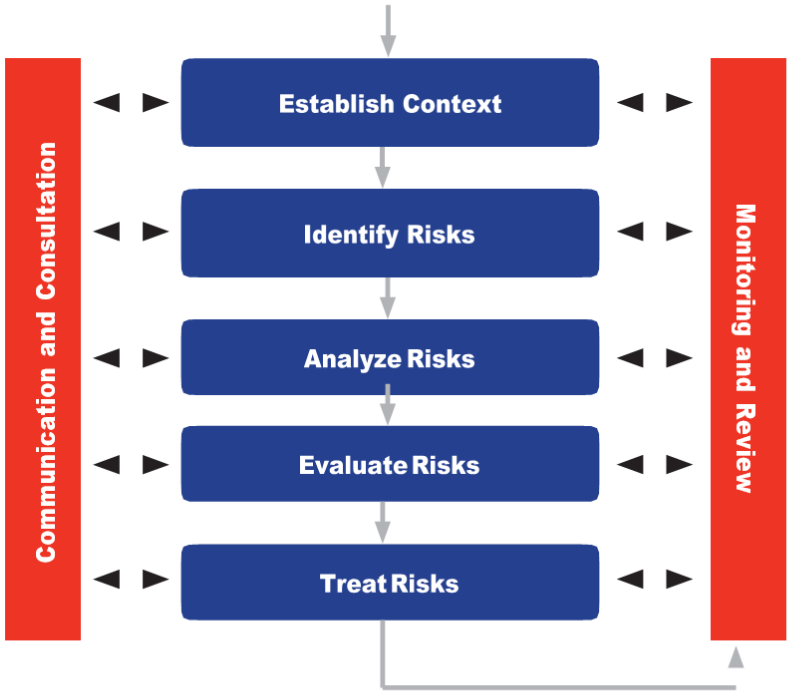


Figure 5-2: Risk Management Framework, ISO 31000:2009

Collectively, the TDOT Risk Management Committee represents each of the major business units within the Department that contribute to the TAMP's vision and guiding principles 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 are 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 the divisions and regions presented in table 5-1 are members of the committee.

Table 5-1. Risk Management Committee Representation

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

How Was the Risk Management Framework Applied?

Risk Identification

At the 2022 risk workshop, the committee followed the risk management framework listed in figure 5-2 in identifying and evaluating risks that would affect the TDOT's ability to meet the federal requirements. During an initial brainstorming session with the Risk Management Committee, 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 as a whole. To help participants consider a broad range of risks they were asked to consider each of the following six (6) risk categories:

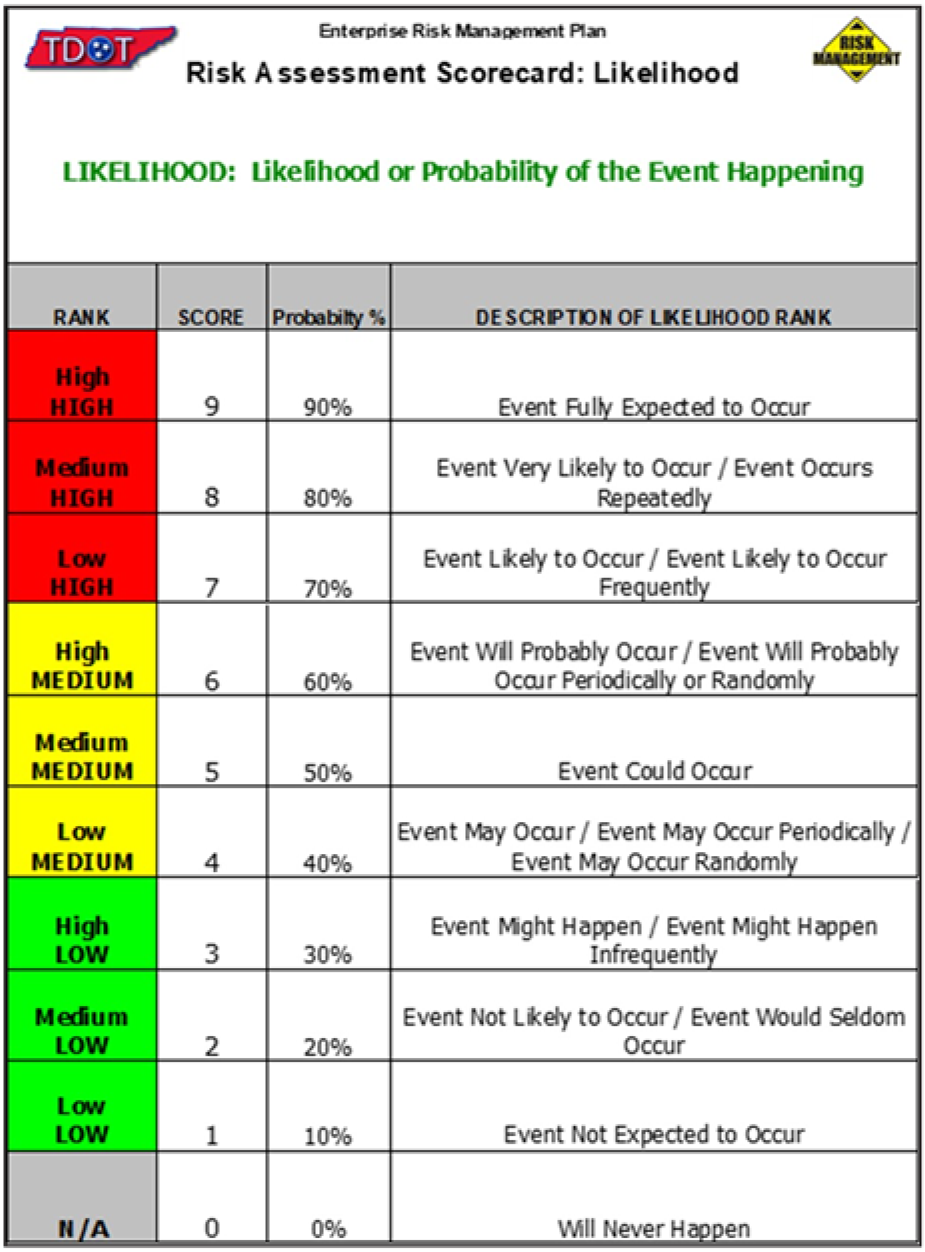
- Agency
- Bridge
- Financial
- Pavement
- Programming
- Extreme Weather/Emergency

The initial effort produced a list with 100 different risks. Risks that were similar or duplicative in nature were combined and consolidated into an initial risk register containing 85 unique risks.

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, using the values shown in figure 5-3, and its potential impact, using the values shown in figure 5-4. The likelihood and impact scales are based on the Department's enterprise risk management guidance.

Once the likelihood and impact were assessed, the values were multiplied together to get an overall risk score. The risks were ranked based on their score (high to low) so a preliminary prioritized list could be generated for consideration. It should be noted that the scores did not explicitly determine the final ranking for each risk. The initial scores only reflected the individual ratings provided by each committee member during the evaluation process.



Enterprise Risk Management Plan

Risk Assessment Scorecard: Likelihood

LIKELIHOOD: Likelihood or Probability of the Event Happening

RANK	SCORE	Probability %	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 Likelihood Guidance

TDOT

Enterprise Risk Management Plan

Risk Assessment Scorecard: Impact

RISK MANAGEMENT

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

Figure 5-4: Risk Impact Guidance

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 TAMP 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.

Risk Mitigation

Based on the reprioritized list of risks, the TAMP Core Team, in consultation with senior leadership, selected the top 12 risks to evaluate in more detail and developed potential mitigation 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.

Risk mitigation is intended to make Tennessee's highway infrastructure more resilient. This can be accomplished through hardening assets to withstand extreme weather or other natural events. Resilience may also be addressed through enhancing TDOT's ability to respond to and recover to emergencies or changing trends. The following bullets summarize TDOT's primary mitigation and resilience strategies to reduce the likelihood and/or impact of uncertainty that may occur.

- **Accountability to Avoid Project Postponement / Priority Changes** – TDOT has emphasized accountability for project delivery and is connecting project delivery to management performance appraisals. Project delays cause disruptions to staff efforts and reduce efficiency in delivering the capital program.
- **Consideration of Inflation/Project Cost Uncertainty** – 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 performance analysis and budget requests are prepared.
- **Addressing OGFC Performance Issues** – While TDOT has recognized significant reductions in wet-weather crashes on sections of roadway surfaced with OGFC, this special asphalt mixture requires special maintenance considerations for use in winter weather. Additionally, exceptional damage to the roadways has occurred during the recent winter calling into question the life expectancy of the treatment as compared to previous assumptions. TDOT is evaluating how best to apply OGFC treatments, preserve them for a longer life, and prevent widespread winter-weather failures.
- **Proactive Events During Snow and Ice Storms** – Significant travel delays often accompany winter weather. Tennessee usually experiences snow events beginning with freezing rain or ice making pre-treatment impractical or less effective than pre-treating for a purely snow event. Public expectations are that winter weather does not impair their individual mobility or commercial delivery process. TDOT operations has multiple strategies to employ based on weather predictions to make cost-effective decisions for treatment. Maintenance operations has also improved situational awareness during storms with stationary and on-truck weather sensors to adjust strategies to match storm conditions.
- **Flood** – 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 are deducted from the same budget that funds capital projects, which could result in project delays or rescheduling.

- **Recognizing Pavement Base and Subbase Issues** – TDOT has observed increasing rates of pavement distresses indicative of deep pavement fatigue or deformation. These pavement distresses require more invasive repair strategies which are more expensive than TDOT's typical preservation and resurfacing treatments.
- **Identifying Pavement Drainage and Underdrain Issues** – As with pavement base issues, TDOT is finding that drainage systems and underdrains are often failing in aging systems. Failing drainage systems often cause weaker subgrade and base conditions. Weaker pavement layers deflect more under traffic and cause significant pavement distresses to develop. As mentioned previously, these repairs cost significantly more than preferred preservation or resurfacing treatments. TDOT is investigating ways to retrofit underdrain systems and improve drainage on roadway sections with vulnerable pavements.
- **Monitoring Supply Chain Issues** – Recent economic uncertainty and the COVID-19 pandemic has created significant supply chain issues which affect delivery of transportation projects. TDOT is experiencing rapidly increasing prices and contractors are communicating that project schedules are slowed because of material and equipment supply issues. TDOT is working with industry representatives to maintain awareness of critical deficiencies and assist in mitigation as much as possible.
- **Rockfall Management Program Funding** – In 2007, TDOT implemented a Rockfall Management Program to address potential hazardous sites where materials could 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 FY2020-2023 Comprehensive Multimodal Program. The program is currently budgeted at $10M per year to address these risks for the 3-year period.

What Risks Emerged from the Process?

Table 5-2 summarizes the results from the risk workshops. The risks are ranked based on their overall score and potential consequences are identified. Suggested mitigation strategies are also presented with a point of contact listed to monitor changes in risk likelihood or consequence over time.

Table 5-2: TDOT Risk Register

Rank	Risk	Type	Score	IF	THEN	MITIGATION	Point(s) of Contact
1	Project Postponement/ Priority Changes (3-year plan not being firm)	ALL	64.6	Projects are postponed or there are changes in priority	1.TDOT would need to reprogram projects, and that may lead further away from a Transportation Asset Management (TAM) strategy and may not achieve targets for State of Good Repair (SOGR). 2. Maintenance needs and expenditures would increase until the project could be delivered. 3. Project cost would likely increase, potentially reducing TDOT's program capacity.	1. If a project is postponed due to changes in priority, then that project may be reprogrammed instead of impacting the available funds for other projects. 2. Maintain enough projects in the pipeline of similar work type. 3. Develop realistic project schedules. 4. Ensure successful Integrated Program Delivery (IDP) implementation.	Program Development & Administration Division Director
2	Inflation	Bridge / Pavement	63.4	Resource costs increase due to inflation	1. TDOT would be able to deliver fewer projects and there would be a reduction in the overall program delivery. 2. Less work would likely be accomplished by TDOT. 3. Authorized budgets would cover less program. 4. Overruns will increase.	1. If projects have a significant cost increase, that project may need to be reprogrammed instead of impacting the available funds for other projects. 2. Develop a process to predict inflation trends. 3. Monitor trends for major resource items such as labor, equipment, and materials. 4. Provide a 2 to 5-year projection of expected project cost increases.	Construction Division Director

Rank	Risk	Type	Score	IF	THEN	MITIGATION	Point(s) of Contact
3	Open-Graded Friction Course (OGFC) Issues Snow/Ice Storms	Bridge / Pavement / Weather	62.7	Construction materials are not designed and/or utilized appropriately to withstand extreme weather events	1. Excessive use of calcium chloride-based deicers and inadequate deck cover above reinforcement causes premature failure of bridge decks. 2. Poor quality construction materials and construction techniques causes premature failure of Open-Graded Friction Course (OGFC) surfaces. 3. More extensive costs to maintain bridge decks and Open-Graded Friction Course (OGFC) pavements is required due to premature failures.	Bridge Decks: 1. Reduce the use of calcium chloride-based deicers. 2. Use thin epoxy overlays to seal decks (on a 10-to-15-year cycle) to provide additional protection. 3. Use epoxy coated rebars in bridge decks. 4. Provide additional thickness above reinforcement (than required by design). 5. With Asphalt Concrete overlay, use deck sealers to mitigate chloride penetration (as a preventive maintenance approach). Pavements: 1. Consider different replacement cycle for Open-Graded Friction Course (OGFC) based on historical performance data. 2. Implement mix design and construction specification revisions for Open-Graded Friction Course (OGFC) mixtures. 3. Utilize preservation treatments like fog seals and microsurfacing to reduce permeability and binder aging. 4. Consider restricted use of underbelly snowplows on Interstate routes.	Bridges: State Engineering Division Director Pavement: Maintenance Operations Division Director
4	Subbase Pavement Failure Improper Pavement Drainage	Pavement	62.0	TDOT is unable to identify pavement rehabilitation projects in a timely manner	1. May result in (work type) consistency determination issues as a part of the TAMP review process. 2. TDOT will be unable to identify imminent base/subbase issues. 3. Repairs cannot be implemented in a timely fashion. 4. Project scope changes/postponement are more likely to occur. 5. Project cost escalation is likely to occur.	1. Use PMS data to identify potential projects early and commission early testing. 2. Implement use of network-level Traffic Speed Deflection Device (TSDD) testing to evaluate pavement structural capacity and determine suitable treatment needs.	Maintenance Operations Division Director

Rank	Risk	Type	Score	IF	THEN	MITIGATION	Point(s) of Contact
5	Flood	Weather/ Emergency	61.8	Major flooding occurs that impacts critical roadway corridors or major bridges	1. Catastrophic roadway damage and extended road closures may occur. 2. Decreased mobility is likely. 3. Long-term impact by saturation of subgrade is likely. 4. Injury/Death may occur. 5. Increased maintenance/reconstruction costs may result. 6. Litigation from private property owners could occur.	1. Ensure that emergency response protocols are in place. 2. Provide quick response on damage assessments and repairs. 3. Inspect impacted bridges for possible scour as soon as possible. 4. Request federal Emergency Relief (ER) reimbursement for eligible catastrophic events. 5. Increase pipe/culvert inspections and maintenance to ensure that drainage structures are able to handle the increased flow of water during flood events. 6. Consider how an evaluation of previously damaged facilities can best inform the preparation of the Transportation Asset Management Plan (TAMP) and State Transportation Improvement Plan (STIP).	Maintenance Operations Division Director Regional Directors
6	Project Cost Uncertainty	Financial	61.4	Projects cost estimates are inaccurate due to circumstances outside of TDOT's control, like Right-of-Way (ROW) cost, or utility cost	1. May lead to project delays, reprogramming, and change orders. 2. TDOT may be forced to reprogram projects and that may lead further away from a Transportation Asset Management (TAM) strategy and may not achieve targets for State of Good Repair (SOGR).	1. Consider reprogramming of delayed projects in a future year to minimize the impact to the available funds for other projects. 2. Monitor schedules, budgets, and market trends. 3. Ensure successful Integrated Program Delivery (IDP) implementation.	Assistant Chief Engineer of Program Delivery Program Development & Administration Division Director
7	Supply Chain Issues	Agency	60.1	Supply chain restricts availability to construction materials	1. Delivery dates may be extended and could affect construction and maintenance schedules. 2. The ability to provide services such as fleet operations and management may be impacted causing a disruption to mobility on the network. 3. May lead to project delays or increase budget needs beyond available revenue and threaten the agency's ability to meet TAM objectives and performance targets.	1. Monitor material supply shortages. 2. Predict accurate project costs and schedules. 3. Maintain adequate stockpiles of critical items.	Construction Division Director Maintenance Operations Division Director

Rank	Risk	Type	Score	IF	THEN	MITIGATION	Point(s) of Contact
8	Rockslides and Land Slides	Weather/ Emergency	60.0	Rockslides or landslides occur	1. Road closure and damage may occur. 2. Decreased mobility is likely to occur. 3. Long-term impacts to roadway stability due to the saturation of the subgrade may be possible. 4. Injury/Death may occur 5. Maintenance/reconstruction costs may increase. 6. Litigation from private property owners may occur.	1. Continue with the Rockfall Mitigation Program that has been established and continue to update the list as more sites are identified. 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 the Landslide Mitigation Program.	Materials and Tests Division Director Maintenance Operations Division Director
9	Increased Weight Limits on TDOT Bridges and Pavements	Bridge / Pavement	49.6	Legal weight limits are increased or the number of illegally overweight trucks increases	1. Premature failure is more likely to occur on pavements 2. Bridges can be expected to deteriorate at a more rapid pace 3. Maintenance cost will increase 4. Asset service life will reduce and the short- and long-term cost of maintaining the pavement and bridge networks will increase 5. Ability to project and plan for deterioration will be impacted 6. Additional workload for bridge inspection staff and repair teams may increase. 7. There may be an increased need to maintain appropriate signage on impacted roads and bridges.	1. Monitor policy changes proposed by Federal and State governments to express concerns on changing load limits. 2. Increase enforcement and enhanced signage across the state. 3. Impose fines based on estimated/calculated damage for overweight permits. 4. Implement Weigh-in-Motion Program to obtain load spectra data to enhance asset condition deterioration forecasting capabilities and improve design procedures.	Bridges: State Engineering Division Director Pavement: Maintenance Operations Division Director
10	Higher Program Cost vs Estimated Cost	Programming	57.0	Project costs increase after the selection for the program or if the planning is developed with limited information	Program costs will increase causing other project delays and reprogramming projects in a future year.	1. Consider reprogramming projects, which are postponed due to changes in priority, in a future year to reduce the impact to available funds for other projects. 2. Ensure successful Integrated Program Delivery (IDP) implementation.	Assistant Chief Engineer of Program Delivery Program Development & Administration Division Director

Rank	Risk	Type	Score	IF	THEN	MITIGATION	Point(s) of Contact
11	High Staff Turnover/ Lack of Qualified Personnel/ Lack of Proper Training	Agency	52.8	Significant staffing risks become evident	1. Staff turnover may result in inexperienced TDOT staff in place to respond to emergency situations 2. Institutional knowledge may not be shared between stakeholders. 4. Ensuring proper inspection and monitoring of contractor work becomes more difficult. 5. More alternative delivery projects may be necessary.	1. Maintain continuous technical training series for new departmental staff and contractors. 2. Continue emergency preparedness drills - locally and statewide. 3. Implement knowledge transfer systems. 4. Consider use of consultants to supplement departmental resources. 5. Consider using consultants to provide mentoring training. 6. Provide cross-training among operations staff with consideration for utility players who can do a little bit of everything. 7. Maintain flexibility where possible for an alternative work schedule for employee retention.	Chief Engineer Assistant Chief Engineer of Operations Human Resources Division Director

What Considerations Are Being Made for Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events?

TDOT provides support for responding to and recovering from emergency events that impact the operation and condition of the highway network. This work commonly involves repair or reconstruction of highways and bridges that are damaged during an event. TDOT records information for each location where repairs or reconstruction are performed including the specific location, the type of work performed and the costs to deliver the work. The costs for these response and recovery activities are funded through a combination of state and federal funds, depending on the size and location of each emergency.

To comply with federal requirement 23 CFR Part 667, *Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Event*s, TDOT periodically evaluates its emergency response data to identify any locations have that have required repair or reconstruction on two or more occasions from emergency events declared by the Governor or the President of the United States since January 1, 1997. This process is outlined in table 5-3.

Table 5-3. Business process to support 23 CFR Part 667 requirements

Step	NHS Highways and Bridges	Non-NHS Highways and Bridges
Documentation	After a qualifying emergency event has been declared, the TDOT Regional and District Operations staff will assess the situation and evaluate the damage on roads, highways, and bridges on the Federal Aid Highway System. Once the situation has been assessed, a Detailed Damage Assessment Form (DAF) will be completed for each site and submitted to the FHWA. The DAFs will be input into a GIS system for documenting the location, asset(s) damaged, and extent of damage.	
Evaluation	Following the qualifying event TDOT will perform a statewide evaluation of the NHS, using the GIS database, to identify recurring incidents of repair or reconstruction particular locations. If recurring events (more than two events at a given location) are identified for a location on the NHS, TDOT will develop an action plan for addressing the issue.	Prior to requesting federal aid for any highway or bridge project, TDOT will compare all locations included in the project with its records of locations damaged by qualifying emergency events, using the GIS database.

Step	NHS Highways and Bridges	Non-NHS Highways and Bridges
Implementation	Asset managers will meet with subject matter experts to evaluate the most suitable repair and rehabilitation strategies. A funding request will be submitted to the appropriate authorities. The selected repair and rehabilitation strategy will be communicated to the responsible parties. The permanent repairs will be documented in the GIS database for future assessments.	TDOT considers the outcomes of these evaluations during the development of transportation plans and programs, including TIPs and STIPs, and during the environmental review process under 23 CFR Part 771.

The listing of emergency events evaluated are listed in Table 5-4. More information is available for review by FHWA upon request. During the evaluation, TDOT identified 3 (three) specific locations that have had two or more disaster repairs during the evaluation period of January 1, 1997 to June 30, 2022. These locations are listed in Table 5-4 and shown in figure 5-5.

Table 5-4: Summary of Data for Declared Disaster Sites (Re: 23 CFR Part 667)

Event Dates	Type of Event	Number of Counties	Number of Sites Affected
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
March 2, 2018	Bridge Strike	1	1
April 27, 2018	Bridge Strike	1	1
November 27, 2018	Rockfall	1	1
February 26 - March 2, 2019	Statewide Flooding	83	229
July 11, 2019	Slope Failure	1	1
February 6 - March 10, 2020	Slope Failures, Flooding, Tornado Damage	13	19
August 21, 2021	Flooding	4	13
April 18, 2022	Slope Failure	1	1

Table 5-5. Locations identified as repeated ER repairs

Date Damaged	Event Name	Region	District	County	Route	Begin LM	End LM	Begin Lat	Begin Long	End Lat	End Long	Type Damage
4/30/2010	ER-TN10-5-9	3	38	Hickman	SR230	11.47	11.47	35.870211	87.500464	35.870211	87.500464	Bridge Damage
8/21/2021	ER-TN21-1	3	38	Hickman	SR230	11.514	11.514					Bridge Damage
1/28/2009	ER-TN09-1	4	47	Lake	SR021	0.00	7.63	36.368718	89.504436	36.352228	89.405201	Snow Storm
4/19/2011	ER-TN11-3	4	47	Lake	SR021	0.00	0.154					Storm Damage to Highway
1/28/2009	ER-TN09-1	4	47	Obion	SR157	0.00	5.30	36.444114	89.295121	36.506701	89.280303	Snow Storm
2/27/2019	ER-TN19-2	4	47	Obion	SR157	3.5	3.5					Slope Failure - Above Road

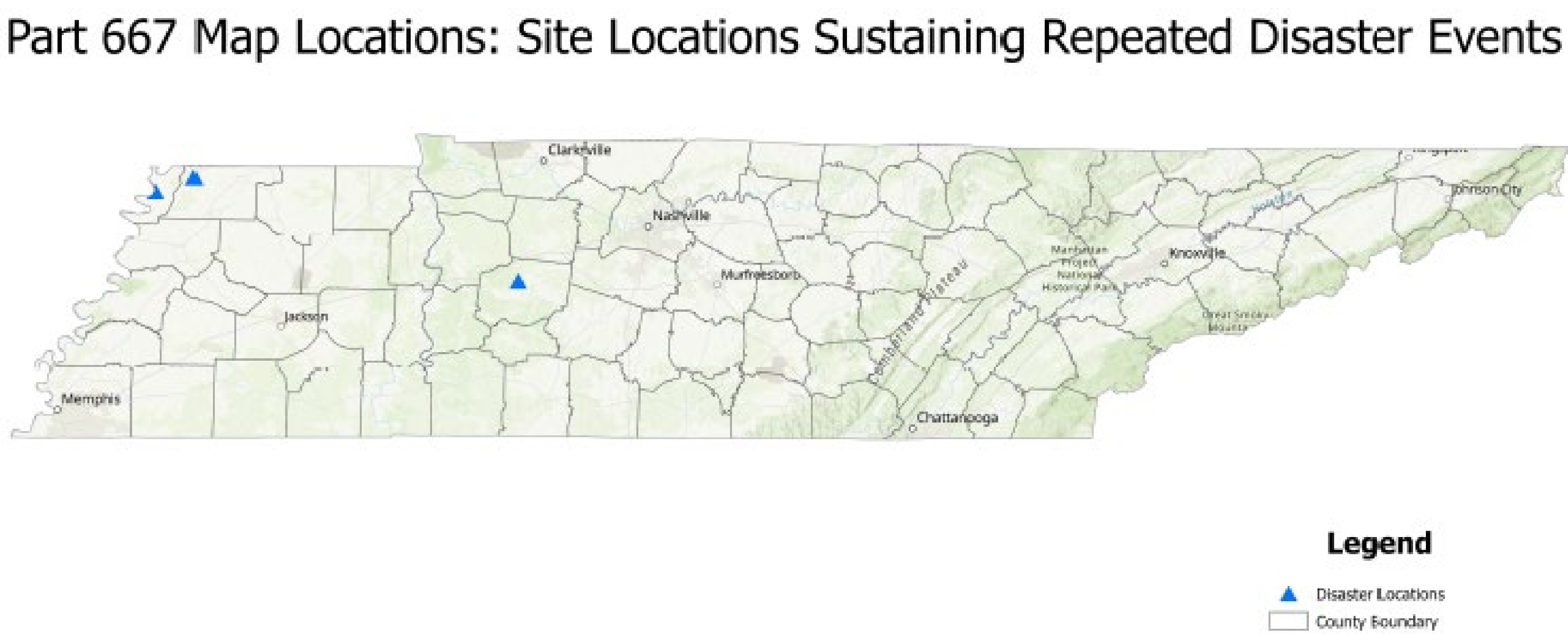


Figure 5-5. Locations in Tennessee with two or more disaster repairs

The locations identified were in Hickman, Lake, and Obion Counties. The site in Hickman County is a bridge on SR230 that has been repeatedly damaged by flooding. This location is being replaced with a new structure. The location on SR021 in Lake County was initially included in a snow and ice event over 7.6 mi. in 2009 and then 0.15 mi. was damaged most recently in 2011 during a flooding event. Similarly, the Obion County location on SR157 extended over 5.3 mi. and was included in the 2009 snow and ice event. The second event occurred in 2019 at log mile 3.5 where a landslide occurred on a slope above the roadway. These second two locations seem to have been damaged in unrelated events rather than repeated damage of the same type.

How Does TDOT Consider Extreme Weather and Resilience in Risk Management?

In 2015, TDOT completed an extreme weather vulnerability assessment that included all major transportation infrastructure assets located within the State. This vulnerability assessment served as a screening tool to better understand the impacts of extreme weather on the State's transportation assets. It also served as a foundation that TDOT could build upon by performing follow-on activities based on study results.

As a second phase of this effort, sixteen critical assets identified as highly vulnerable to extreme weather were selected for more site-specific study, with a goal of providing recommendations for adaptation strategies worthy of potential consideration. Although roads make up a significant portion of the identified list, site selection criteria included consideration of different transportation asset types and geographical locations. Detailed information was collected about the physical asset and its location, utilizing site-specific maps, photos, published literature, and conversations with persons knowledgeable about the site. For each location, a variety of candidate adaptation strategies worthy of consideration were identified, ranging from lower-cost solutions to initiatives that require more substantial investment. The attractiveness of these alternative strategies depends on resource availability, estimated benefit/cost associated with strategy implementation, and the expected lifetime of strategy effectiveness.

These considerations are made extremely challenging by the uncertainty associated with future forecasts of the frequency and severity of extreme weather events, although there are strong indications that one can expect an upward trend in the likelihood of such events. While these case studies are limited to sixteen specific locations in Tennessee, addressing the threats of future extreme weather just in these locations alone would prove challenging from a transportation planning perspective. Such a challenge becomes far more difficult, however, when one considers the number of critical transportation assets within the state whose operability must be maintained in order to provide adequate mobility to satisfy societal needs.

TDOT is in the process of facilitating the integration of resilience into agency decision-making processes and operating procedures. To achieve this objective, four specific activities are considered:

- Form a TDOT Extreme Weather Resilience Task Force for the purpose of maintaining an ongoing engagement to encourage adoption and collaboration across TDOT's offices and divisions.
- Design and administer a resilience self-assessment survey for TDOT senior management to complete.

- Analyze survey results, identify needs, and begin facilitating development of resilience activities to address identified needs, and
- Develop and operate a Resilience web site to serve as a knowledge resource for TDOT and its stakeholders.

The process of integration can be impactful on several levels within the TDOT organization. Of particular interest are opportunities to bring extreme weather resilience into agency decision-making involving:

- Selection of capital and operating transportation investments.
- Development of the State Transportation Improvement Program (STIP).
- Implementation of maintenance plans and procedures.
- Design, construction, and repair of roads and bridges.
- Selection of materials for use in building roads and bridges.
- Hazard mitigation planning and emergency management.
- Informing the environmental review process.
- Data collection activities to characterize and monitor the condition of vulnerable assets.
- Collaboration with MPOs in updates to their Long-Range Transportation Plans.

During June 2022, a project is underway at the I-40 Rockwood Mountain site identified and evaluated in the *Understanding the Effects of Extreme Climate Shifts on Pavement Infrastructure in Tennessee* report. To stabilize the potential landslide, soil nails have been deployed beneath the west bound lanes of the freeway (See figure 5-6).

Figure 5-6. Soil nails installed as a landslide stabilization

As described previously, TDOT is in the process of implementing the results of the research project titled *Integration of Resilience Into TDOT Agency Practices: Phase III*. TDOT has also initiated a number of other research projects that could provide additional insight into strategies for addressing risk, resilience, and impacts of extreme weather and climate change. More information on each study is available in the project abstracts accessible through the links below.

- Advancing Urban Stream Restoration/Enhancement Practices for Compensatory Mitigation Credits (Resiliency)
- Best Practices for Bridges with Pipe Piles (Resiliency)
- Assessment of Site Conditions and Improvement of Ground-motion Prediction Equations in the Central United States (Resiliency)
- Design and Application of Stormwater Conveyance from Bridge Decks (Climate Change)
- Updating Equations for Peak Flow Estimation in Urban Creeks and Streams of Tennessee (Climate Change)
- Considerations for Landslide and Debris Flow Monitoring (Climate Change)

CHAPTER 6
FINANCIAL PLAN

What is TDOT's Financial Plan?

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

According to 23 CFR Part 515.7(d), State DOTs are required to establish a process for developing a Financial Plan that, at a minimum, produces:

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.
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?

In order to satisfy the requirements of MAP-21 and the final rule, TDOT uses information from the annual budget process and the STIP development process to:

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

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 time 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. 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 2020-2023,* the *Fiscal Year 2022 Budget for the State of Tennessee*, and the TDOT TAMP Investment Strategy. These documents, along with subsequent State budgets, 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.

What is TDOT's Revenue Forecast?

Tennessee passed the current highway funding bill in 2022. TDOT's budget has been bolstered by transfers from general funds in 2023 ($623 million). Given all the recent uncertainty in the State's revenue trends, TDOT cannot expect to receive similar transfers in the future. However, the Tennessee Governor and Legislature have made it clear that funding transportation needs is a priority. Based on these assumptions, TDOT expects state revenue to increase approximately 0.5 percent per year during the 10-year period of this TAMP through slight increases in the user fees collected. Table 6-1 provides an overview of the current and forecasted State highway funding by major revenue source.

Table 6-1: TDOT 10-year State revenue forecast (dollars)

State Fiscal Year	Gasoline & Petroleum	Motor Fuel Tax (Diesel)	Gasoline Inspection Tax	Motor Vehicle Registration Tax	Additional Revenue and General Fund Transfers	Total Estimated Revenue
2022	$437,900,000	$217,300,000	$36,300,000	$278,925,000	$528,791,200	$1,499,216,200
2023	$455,200,000	$233,500,000	$37,800,000	$302,500,000	$878,436,000	$1,907,436,000
2024	$457,476,000	$234,667,500	$37,989,000	$304,012,500	$153,416,180	$1,187,561,180
2025	$459,763,380	$235,840,838	$38,178,945	$305,532,563	$153,597,261	$1,192,912,987
2026	$462,062,197	$237,020,042	$38,369,840	$307,060,225	$153,779,247	$1,198,291,551
2027	$464,372,508	$238,205,142	$38,561,689	$308,595,526	$153,962,143	$1,203,697,008
2028	$466,694,370	$239,396,168	$38,754,497	$310,138,504	$154,145,954	$1,209,129,493
2029	$469,027,842	$240,593,148	$38,948,270	$311,689,197	$154,330,684	$1,214,589,141
2030	$471,372,981	$241,796,114	$39,143,011	$313,247,643	$154,516,337	$1,220,076,086
2031	$473,729,846	$243,005,095	$39,338,726	$314,813,881	$154,702,919	$1,225,590,467
2032	$476,098,496	$244,220,120	$39,535,420	$316,387,950	$154,890,434	$1,231,132,420

Revenue forecasting is dependent on many external variables and can fluctuate from year to year. While the forecast in Table 6-1 provides useful information on the outlook of revenue sources, its projections become less accurate when economic factors change.

What Level of Funding Will be Available to Address Pavement and Bridge Conditions?

State highway funds are used to support many functions in addition to the needs of infrastructure assets. Table 6-2 provides a breakdown of the uses of State revenue from fiscal year 2022 and forecasted for fiscal year 2023. This is used as the basis for determining the amount of State revenue expected to be available for addressing the needs of NHS pavements and bridges during the TAMP period.

Table 6-2: Revenue available for asset management (dollars)

	2022	2023
Total State Revenue	**$1,499,216,200**	**$1,907,436,000**
Less:		
Admin	$99,476,700	$122,553,600
HQ Operations	$45,818,400	$49,031,000
Field Operations	$84,578,100	$88,358,300
Garage & Fleet Operations	$25,185,400	$29,412,800
Capital Improvements	$16,250,000	$10,065,000
Mass Transit	$59,578,900	$59,578,900
Planning & Research	$6,873,000	$6,873,000
Multimodal Access Grant	$18,000,000	$18,000,000
Air, Water & Rail	152,100,000	$113,800,000
Beer & Bottle Dedicated Rev.	$5,800,000	$7,500,000
General Fund Transfer for Non-Road/Bridge	$337,000,600	$102,200,000
State Revenue Available for Project Development and Delivery, including TAM	**$648,555,100**	**$1,300,063,400**

While the amount of State funding shown in table 6-2 is available for use to improve asset conditions, most of that funding will be used on assets located off the NHS. This is because federal NHPP funds must be spent on the NHS while other sources of federal and state funding may be spent on any type of highway. In 2021, the Federal government passed the Bipartisan Infrastructure Law which provides a significant increase in Federal aid for NHS and other assets. Table 6-3 shows the total State and Federal funding estimated for establishing the investment strategies for NHS pavements and bridges. The 2023 estimate for State and Other funds is bolstered by a one-time investment of $719,000,000 for three high-priority economic development projects that will not have a significant impact on statewide asset conditions. As a conservative estimate, TDOT is assuming the level of investment will remain flat from 2025 through 2032.

Table 6-3: TDOT 10-year transportation program funding (dollars)

Year	State Funds Plus Other Funds	Federal Funds	Total TDOT Funds
2023	$1,097,277,810	$916,880,350	$2,014,158,160
2024	$236,810,111	$827,930,972	$1,064,741,083
2025	$239,827,582	$842,930,449	$1,082,758,031
2026	$239,827,582	$842,930,449	$1,082,758,031
2027	$239,827,582	$842,930,449	$1,082,758,031
2028	$239,827,582	$842,930,449	$1,082,758,031
2029	$239,827,582	$842,930,449	$1,082,758,031
2030	$239,827,582	$842,930,449	$1,082,758,031
2031	$239,827,582	$842,930,449	$1,082,758,031
2032	$239,827,582	$842,930,449	$1,082,758,031
Total	**$3,252,708,577**	**$8,488,254,914**	**$11,740,963,491**

The totals shown in Table 6-3 are reflective of the agency's current transportation program. This funding is distributed between projects to implement TDOT's investment strategies, as described in Chapter 7 and the capital projects, which do not substantially contribute to the state of good repair of TDOT's pavement and bridge assets. These totals do not include maintenance funding that is used for routine repairs such as pothole patching of pavements. Expected levels of maintenance funding are included in the investment strategies described in Chapter 7.

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

A quick gauge to determine if an agency is maintaining its assets at a steady, declining, or improving state is to look at the monetary value of the asset inventory over a defined time frame. If the value of the assets is increasing or staying the same from year to year, it is an indication that the agency's level of investments has been large enough to offset any decline in condition such as depreciation. This type of strategy is typically consistent with maintaining an asset in a state of good repair. Likewise, if the value of the assets is declining, it is an indication that investment levels are not sufficient to account for deterioration.

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 pavements, TDOT has opted to use the process established for development of the Governmental Accounting Standards Board (GASB) Statement Number 34, commonly referred to as "GASB-34."
- For bridges, TDOT has chosen to use a depreciated replacement cost (DRC) approach, as outlined in *A Guide to Developing Financial Plans and Performance Measures for Transportation Asset Management*[4].

Pavement Valuation

GASB-34 is a set of requirements aimed at making government financial statements consistent between agencies. Included in the standard is a method for estimating asset value based on the total replacement value minus depreciation based on the "Life Ratio". The Life Ratio is calculated by dividing the predicted remaining service life by the total service 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. The information for 2021 GASB-depreciated maintenance cost is shown below in Table 6-4.

Greater than ninety-five percent of TDOT Interstates and ninety-nine percent 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.

Using the GASB methodology, it is estimated that the current value of all TDOT pavements on the NHS is $8.637 billion, which is 36.1% of the cost to replace the pavement assets, down from $10 billion and 43.3% in 2018.

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[4] 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

Table 6-4: 2018 & 2021 Valuation of TDOT pavements on the NHS system (M=millions of dollars)

System & Year	Lane Miles	Total Replacement Cost (M)	Total Maintenance Cost (M)	Total GASB Straight line Maintenance Cost (M)	Current Value (M)	% of Replacement Value
NHS - Interstate						
2018	5,682.4	$8,588.7	$1,022.8	$465.4	$3,908.1	45.5%
2021	5,645.0	$8,991.6	$1,183.8	$475.9	$3,396.3	37.8%
NHS - State Routes						
2018	12,456.7	$14,507.0	$1,033.9	$434.2	$6,092.3	42.0%
2021	12,321.0	$14,958.8	$1,330.6	$482.0	$5,241.1	35.0%
Total NHS (2018)	**18,139.1**	**$23,095.7**	**$2,056.7**	**$899.6**	**$10,000.4**	**43.3%**
Total NHS (2021)	**17,966.0**	**$23,950.4**	**$2,514.4**	**$957.9**	**$8,637.4**	**36.1%**

Bridge Valuation

The basic approach in using the method described below is to estimate the total replacement cost of an asset in current dollars and then reduce that value based on lost value due to deterioration of the bridge. This approach is described in detail as follows.

The value of TDOT's bridges is determined based on the replacement value in current dollars and then discounted using a weighted value for each component of the bridge – 30% for substructure condition, 30% for superstructure condition, and 40% for deck condition – based on each component's condition rating (0-to-9-point scale). 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 2021 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 component condition rating. The condition rating of each component of the structure is a nationally recognized numerical value from 0 to 9, where 9 is the best condition rating. The following formula is used to calculate the current bridge value.

$$\text{Current Value (CV)} = \text{Deck Area (in Sq Ft)} \times \text{Unit Cost Per Sq Ft} \times \left[(0.4) \times \text{Deck Condition Rating}/9 + (0.3) \times \text{Superstructure Condition Rating}/9 + (0.3) \times \text{Substructure Condition Rating}/9\right] \quad (3)$$

Using this methodology, it is estimated that the current value of all TDOT bridges on the NHS is $8.892 billion, which is 71.54% of the total replacement value of $12.431 billion for all TDOT bridges. Table 6-5 provides an overview of how the value of TDOT's NHS bridges has changed over the last 7 years.

The current strategy is losing an average of 0.39% of the replacement value of the NHS bridges per year; however, the value of the agency's NHS 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. This 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 significant loss in value based on condition.

Table 6-5: 2017-2021 Valuation of TDOT bridges on the NHS system ($M=millions of dollars)

Year	2017	2018	2019	2020	2021
Area (millions of Sq Ft)	57.794	58.026	58.286	58.414	58.635
Bridge Count	4,148	4,175	4,180	4,187	4,211
Replacement Cost ($M)	$9,247	$9,864	$10,608	$11,391	$12,431
Cost per Sq Ft	$ 160	$ 170	$182	$195	$212
Current Value ($M)	$6,760	$7,182	$7,691	$8,231	$8,892
% of Replacement Cost	73.11%	72.81%	72.50%	72.26%	71.54%
% Change	N/A	-0.30%	-0.29%	-0.24%	-0.72%

CHAPTER 7
TDOT TAMP INVESTMENT STRATEGIES

This chapter discusses TDOT's process for developing investment strategies and the expected outcomes of that process. 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 is TDOT's Investment Strategy?

TDOT's investment strategies are developed using historical investment and performance data to evaluate the impact of different investment scenarios on asset conditions and system performances. This holistic approach allows TDOT to establish funding needs for all modes of transportation that fall under TDOT's purview (see figure 7-1). 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's capital program.

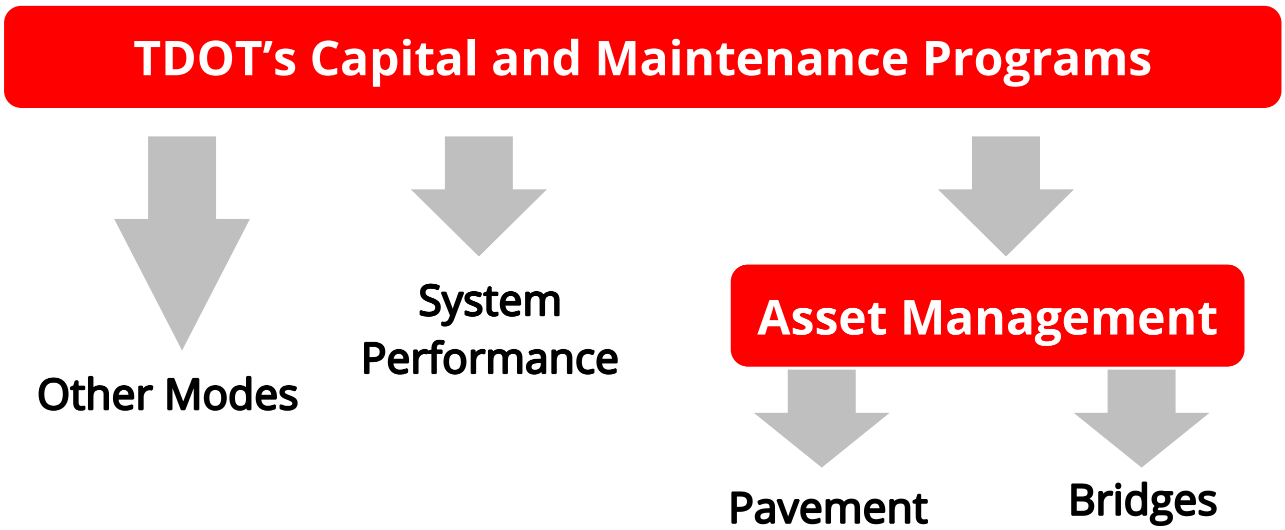


Figure 7-1. Funding breakdown for TDOT's major financial commitments

With an understanding of funding needs, TDOT can identify investment strategies and funding levels that meet system needs and sustain a state of good repair for pavement and bridge assets. The investment strategy drives the allocation of funding between programs. Within each asset management program, life cycle plans drive the project identification and selection process. This approach ensures funding is adequate to achieve performance goals and projects are selected to provide the best long-term solutions to Tennessee's infrastructure needs.

What are the MAP-21 and Final Rule Requirements?

Investment strategy is defined in 23 CFR Part 515.5 as 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.

23 CFR Part 515.7(e) and 515.9(f) requires each State DOT to develop a risk-based asset management plan that includes 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 those items listed in figure 7-2.

Figure 7-2. Influences for investment strategies

- 515.9(f) An asset management plan shall discuss how the plan's investment strategies collectively would make or support progress toward items listed in figure 7-3.

Figure 7-3. TAMP investment strategies support progress towards these values

What is TDOT's Process for Developing an Asset Management Investment Strategy?

TDOT's investment strategy is based on the policies established in the 25-Year Long-Range Transportation Policy Plan, which 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 for the first 10 years of the plan. It should be noted that these documents were prepared prior to the enactment of Tennessee's Improving Manufacturing, Public Roads and Opportunities for a Vibrant Economy (IMPROVE) Act, and the Federal Bipartisan Infrastructure Law (BIL), so the revenue projections do not reflect the additional funds generated through this legislation.

To develop asset management investment strategies, TDOT applies the overall system goals established in the 25-year LTTPP along with analyses described in earlier chapters of this TAMP to determine how best to allocate funding between asset classes and programs.

Life Cycle Planning

Life cycle plans developed for pavement and bridges are used to configure the asset management systems. Using similar processes as described in Chapter 4, TDOT staff evaluate different funding scenarios to determine the best balance of work types to achieve and sustain the desired state of good repair with available funding. 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. The agency uses well proven strategies to manage pavement and bridge assets as identified in Chapter 4 Life Cycle Cost and listed below.

Risk Management Analysis

Risks identified in Chapter 5, Risk Management, are considered when establishing TDOT's investment strategies. Additionally, engineering and operations staff contribute to identifying system and location-specific vulnerabilities when identifying, prioritizing, and developing projects. This helps ensure that construction projects lead to a more resilient highway infrastructure.

Anticipated Available Funding

Investment strategies are based on the funding that is expected to be available during the TAMP period. The first 4 years of funding are based on estimates established through the STIP development process. These are updated annually and may vary from the revenue forecasts. The revenue projections described in Chapter 6, Financial Plan, are used to establish budgets for the years beyond the 4-year STIP.

Pavement Management Strategies

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, micro surfacing, surface seals, and crack and joint sealing.

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 include:

1. Standard Operating Guidelines (SOG).
2. Remaining Service life (RSL).
3. Lane-Mile Year Analysis and PQI.

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.

Bridge Management Strategies

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. TDOT’s bridge management strategies combine network level goals with evaluation of the individual needs of each bridge. The bridge management program area funds the activities that maintain and keep TDOT's bridges in a state of good repair (see figure 7-4). The work types under this program area include bridge reconstruction, 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.

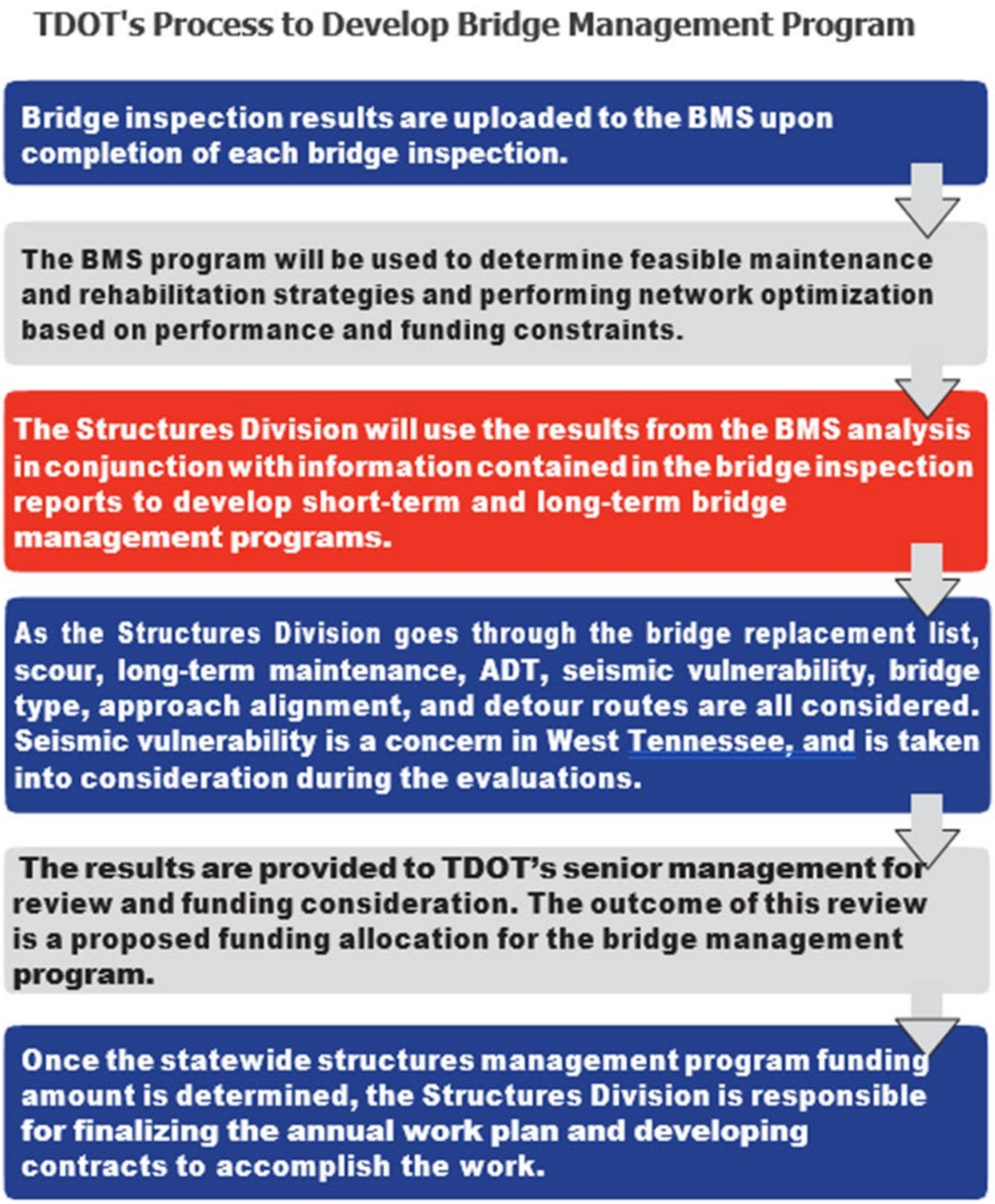


Figure 7-4. Bridge management process

Review of NBIS Inspection Reports

The Structures Division conducts bridge inspections on all the bridges in the State (except Federally owned bridges) on a 2-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 through 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 *Poor* bridges down to less than four percent on the State maintained system by programming enough funds to maintain the low percentage target. TDOT has historically directed approximately 75 percent of bridge funding to the NHS network. Condition data reflects that this approach has maintained NHS and non-NHS bridges in a similar condition with very similar condition trends.

Focus on Preservation

Approximately seventy percent of the budget for bridge management is allocated to bridge replacement, while the remaining thirty percent is spent on bridge repairs and preservation.

How Much Will TDOT Invest in Pavements and Bridges Over the Next Ten Years?

The TDOT asset management program for pavements and bridges is fully supported by available revenue, as shown in table 7-1. The capital funding beyond the pavement and bridge needs will be used to support other program needs, including system enhancements. As can be seen in table 7-1, the funding available for these other purposes is expected to decline as the annual cost increases for addressing pavement and bridge needs is expected to grow faster than available revenue. Without changes to the current 10-year program, this will lead to a future funding gap.

Table 7-1: TDOT 10-year estimated program funding ($ millions)

Year	Pavement Management	Bridge Management	Capital Projects	Total TDOT Funds (from table 6-3)
2023	$274	$157	$1,583 *	$2,014
2024	$283	$158	$624	$1,065
2025	$291	$160	$632	$1,083
2026	$300	$162	$621	$1,083
2027	$309	$164	$610	$1,083
2028	$318	$166	$599	$1,083
2029	$327	$167	$589	$1,083
2030	$337	$169	$577	$1,083
2031	$347	$171	$565	$1,083
2032	$358	$174	$551	$1,083
Total	**$3,144**	**$1,648**	**$5,368**	**$11,743**
Average	**$314**	**$165**	**$596**	**$1,174**

** - includes a one-time investment of $719 million in state funds for three high-priority projects which will not contribute to the condition of the pavement and bridge assets.*

How will TDOT Invest its Funding in Pavements and Bridges?

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 7-2 is provided to show how TDOT's treatment types align with the MAP-21 work types.

Table 7-2: Crosswalk between TDOT treatment types and FHWA work types

FHWA Work Types	TDOT Pavement Treatments	TDOT Bridge Treatments
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 in. or less) • Microsurfacing • Chip seals • Cape seals • Crack sealing • Concrete joint sealing • Mill and fill asphalt overlays (1.5 in. 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 in. 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 • Bridge widening
Construction	**Construction Activities, including:** • Highway widening • Highway realignments • New highway construction	**Construction Activities, including:** • New bridge construction

In Table 7-3, TDOT's estimated budget for pavements is shown by work type over the next 10 years. The fund type that has a significant impact on the health of TDOT pavements is the annual resurfacing program allocation. While TDOT does not currently budget resurfacing funds by specific work type, treatment selection is driven by recommendations from the PMS that follow the life cycle strategy described in Chapter 4.

TDOT prioritizes management of the existing system over enhancement and expansion. Therefore, the expected expenditures on initial construction are highly dependent on the needs of pavements, bridges, and other assets. The programming of system enhancement projects is beyond the scope of asset management investment strategies and is therefore not addressed in this document. TDOT will work through existing planning and Federal aid authorization processes to balance the full capital program with available revenue, while delivering the commitments to pavement and bridge state of good repair summarized in tables 7-3 and 7-4.

Table 7-3: TDOT 10-year estimated budget for pavements by work type (dollars in millions)

Year	Construction	Reconstruction	Maintenance	Preservation	Rehabilitation	Total
2023	N/A	N/A	$26	$221	$27	$274
2024	N/A	N/A	$27	$228	$28	$283
2025	N/A	N/A	$28	$234	$29	$291
2026	N/A	N/A	$28	$242	$30	$300
2027	N/A	N/A	$29	$249	$31	$309
2028	N/A	N/A	$30	$256	$32	$318
2029	N/A	N/A	$31	$263	$33	$327
2030	N/A	N/A	$32	$271	$34	$337
2021	N/A	N/A	$33	$279	$35	$347
2032	N/A	N/A	$34	$288	$36	$358
Total	**N/A**	**N/A**	**$298**	**$2,531**	**$315**	**$3,144**
Average	**N/A**	**N/A**	**$30**	**$253**	**$32**	**$314**

Table 7-4 presents TDOT's bridge management budget projections over the next 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 bridge condition ratings. The treatment selection process leads to a balance of project types based on the preferred life cycle plan established in Chapter 4.

Table 7-4: TDOT 10-year estimated bridge management budget by work type (dollars in millions)

Year	Construction	Reconstruction	Maintenance	Preservation	Rehabilitation	Total
2023	N/A	$100	$4	$8	$45	$157
2024	N/A	$100	$4	$8	$46	$158
2025	N/A	$102	$4	$8	$46	$160
2026	N/A	$103	$4	$8	$47	$162
2027	N/A	$104	$5	$8	$47	$164
2028	N/A	$105	$5	$8	$48	$166
2029	N/A	$106	$5	$8	$48	$167
2030	N/A	$106	$5	$9	$49	$169
2031	N/A	$108	$5	$9	$49	$171
2032	N/A	$110	$5	$9	$50	$174
Total	**N/A**	**$1,044**	**$46**	**$83**	**$475**	**$1,648**
Average	**N/A**	**$104**	**$5**	**$8**	**$48**	**$165**

The expected expenditures shown in table 7-3 reflect an expected annual increase of three percent for pavement preservation and pavement maintenance, while the values shown in table 7-4 reflect an expected annual increase of one percent for bridges. This increase is included to account for expected cost increases and not to increase the overall accomplishments. The rate of increase for pavement is greater than what is assumed for revenue, as described in Chapter 6, which is 0.5 percent for State revenue and 2 percent for Federal revenue. As a result, the funding available for major capital improvements is expected to decline by this same amount unless additional revenue is identified.

Will TDOT's Investment Strategies Achieve the Desired State of Good Repair for Pavement and Bridges?

Figures 7-5 thru 7-10 provide a 10-year projection of the condition of TDOT's pavements and bridges. Based on this data, bridges are expected to continue to meet SOGR targets. However, pavements are at risk of not meeting targets if conditions deteriorate as these forecasts indicate. These forecasts deviate significantly from TDOT's historical conditions. TDOT will continue to monitor conditions and may adjust allocations between SOGR and system enhancement projects as needed to maintain conditions.

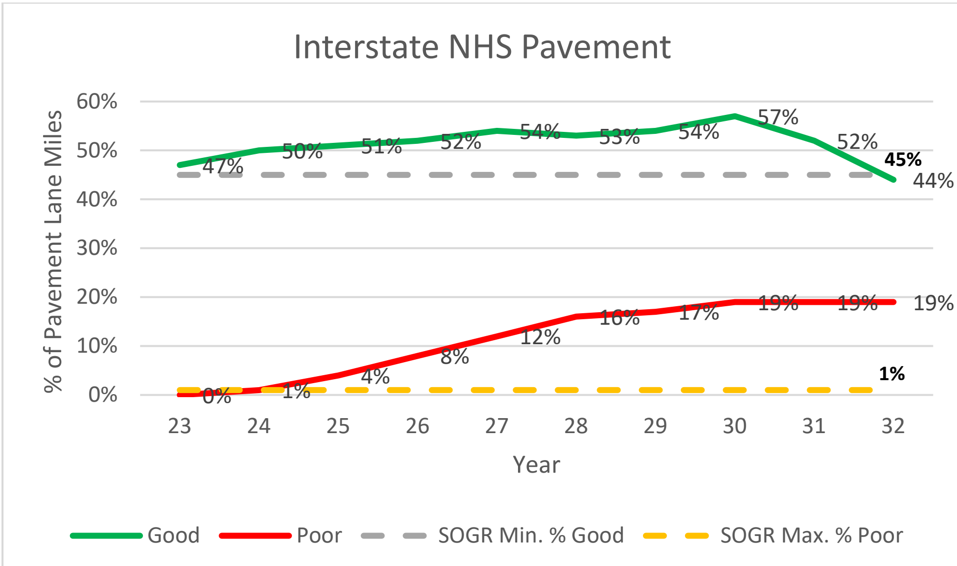


Figure 7-5: TDOT Interstate NHS pavement condition – SOGR

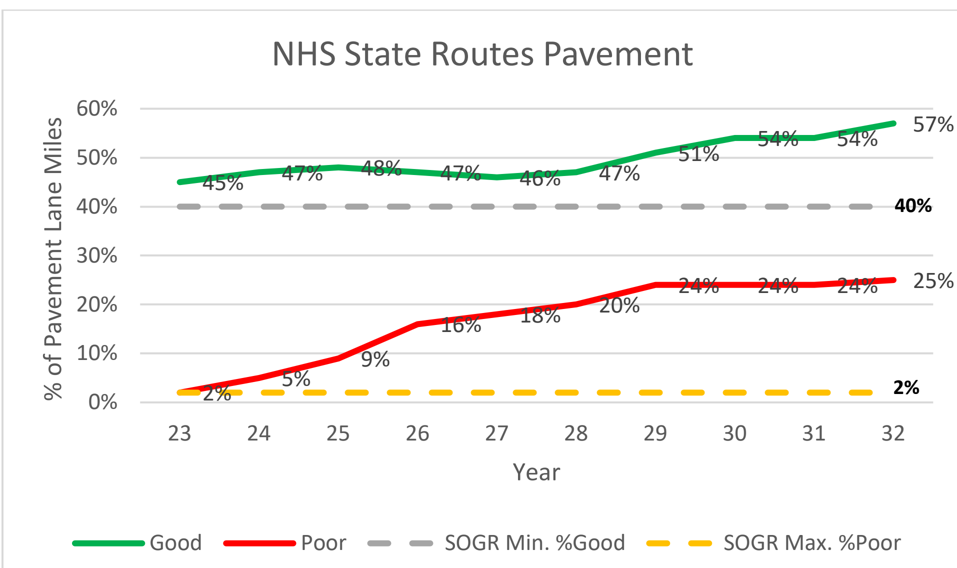


Figure 7-6: TDOT NHS State Routes Pavement Condition – SOGR

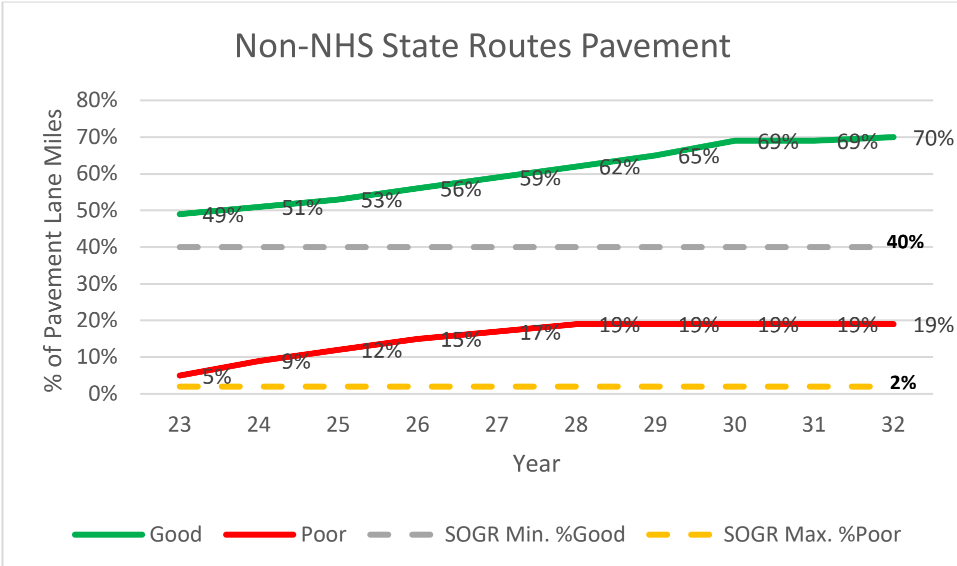


Figure 7-7: TDOT Non-NHS State Routes Pavement Condition – SOGR

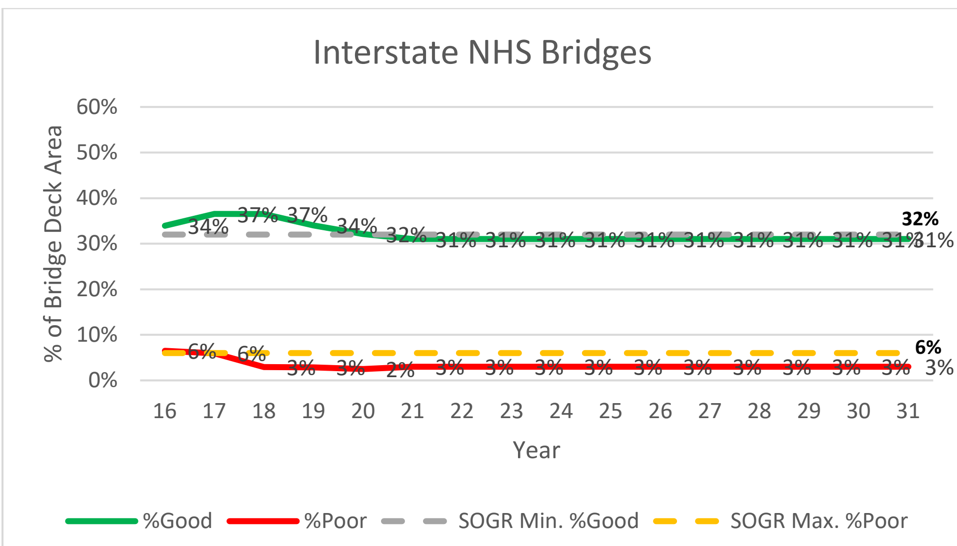


Figure 7-8: TDOT Interstate Bridge Condition – SOGR

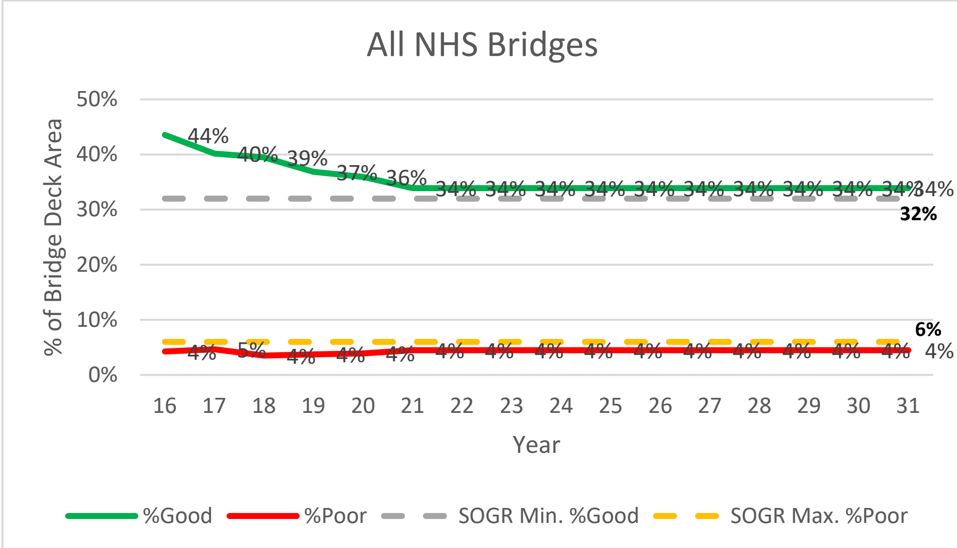


Figure 7-9: All NHS Routes Bridge Condition – SOGR

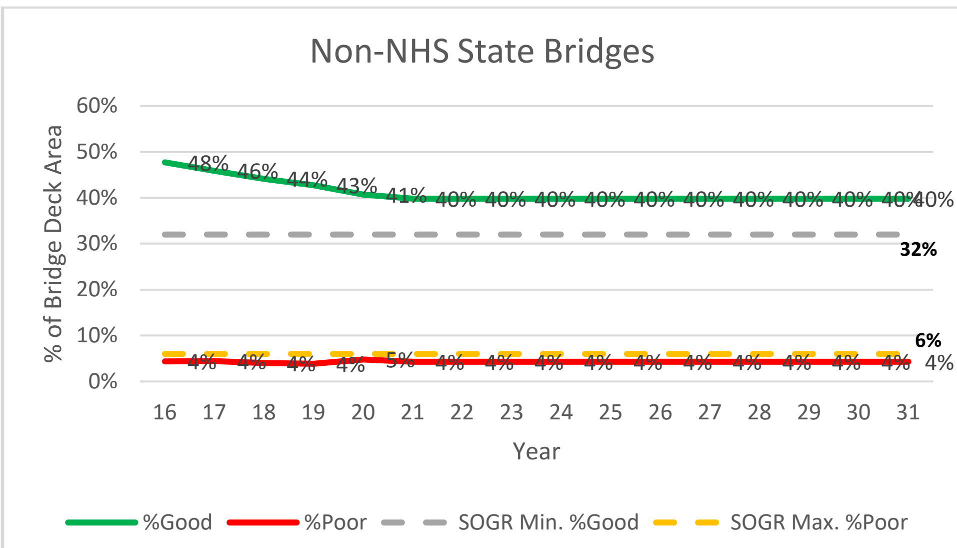


Figure 7-10: Non-NHS State Routes Bridge Condition – SOGR

The pavement and bridge conditions achieved, as depicted in figures 7-5 through 7-10, are based on TDOT's "fix it first" philosophy using life cycle cost concepts and practices described in Chapter 4. Current programming is expected to maintain bridge conditions above the threshold of the desired state of good repair. However, pavement conditions are expected to decline.

The declining pavement conditions are primarily due to the impact of escalating paving project costs. As explained in Chapter 4, paving projects have been increasing in cost at an annual rate of approximately 7 percent. With budgets increasing at only 3 percent annually, this is leading to fewer miles of paving each year. Additionally, TDOT has a significant number of lane miles that, without treatment, will transition from *Fair* to *Poor* condition in the next five years. These factors combine to put TDOT's pavement system at risk of a rapid decline in condition over the next 10 years.

TDOT will continue to monitor conditions and adjust investment priorities as needed to protect the State's investment in highway infrastructure. There is a chance, and historic precedence, that paving costs stabilize after the past few years of significant increases. As Tennessee is a "pay-as-you-go" State, and not handicapped by heavy bond repayments; and thus, TDOT has the flexibility to adjust budgets and allocations to meet the vision and guiding principles of the agency. If costs continue to rise, TDOT will adjust investment priorities accordingly to support infrastructure conditions that support delivery of the agency's mission and facilitate the safe and effective transport of goods and people within and across the state.

CHAPTER 8
TAMP PROCESS IMPROVEMENT

What TAMP Components have been Improved since 2018?

Each TAMP development is an opportunity to evaluate how the process works within the agency and with the stakeholders. Improvements have taken place since the previous TAMP was produced in 2019, and additional enhancements are planned during the next cycle. Enhancements that have been achieved since 2019 include the following:

- The Structures Division has gotten more proficient with the BrM Bridge Management System and has used it to establish a life cycle analysis process to determine the best approach for life cycle planning for structures. The inspection data is current and reflects expected deterioration rates that the Tennessee network experiences with the current balance of preservation, rehabilitation, reconstruction, and maintenance methods. However, the process has not been used enough to develop a high degree of reliability for the Structures Division. Traditional budgeting processes continue to be the primary way to estimate budget needs over the projected 10-year bridge management program horizon.
- The TAMP team has fully integrated the TDOT Finance Division into the TAMP development process for funding estimates for preserving TDOT's pavement and bridges using both state and federal funding estimates.
- The pavement and bridge LCP teams have documented project selection processes for choosing appropriate treatments for maintenance, preservation, rehabilitation, and reconstruction. Pavement projects are identified using a regional budget distributed among all four regions by formula. However, a prioritization process that incorporates pavement projects where the atypical treatments are ineffective is being considered for implementation. This may result in additional resources being applied to Region 4 pavements that have been shown to deteriorate more rapidly than those in the other regions.
- TDOT conducts an enterprise risk assessment on a yearly basis. The risk assessment process involves 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 Will TDOT Enhance the TAMP Process?

As TDOT has developed the 2022 TAMP, there have been various aspects of the process that the Department has identified 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 current federal requirements and foster an asset management culture within the agency. 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.

Including Ancillary Assets

- TDOT has initiated a process for developing supplemental documents covering several families of ancillary assets operated by stakeholder units within the agency. The process will likely follow the FHWA guidance document *Handbook for Including Ancillary Assets in Transportation Asset Management Programs* (FHWA-H IF-19-068). These assets include:
  - ITS components
  - Culverts and small structures
  - Geohazards (Rockfall & Landslides)
  - Signs
- Supplemental documents may also be developed for additional asset families in the future based on the maturity and availability of the data required to manage the assets. These may include underdrains, guardrails, sidewalks, curb ramps, retaining walls and overhead sign structures.

Pavement Model Update

- The State Pavement Office has just completed a revision of its pavement treatment models included in the PMS. A corresponding treatment selection decision tree has also been updated to include the most cost-effective and beneficial timing for preservation and rehabilitation treatments. It is anticipated that process improvements will continue to produce more reliable treatment selection decisions and that those recommendations will be provided to the regional resurfacing coordinators and included in the construction program.

Local NHS Pavement Modeling

- A weakness was identified during the life cycle planning analysis for pavements because no construction history for locally-owned NHS routes is included in the TDOT PMS. An opportunity exists as local agencies in metropolitan areas (e.g., Nashville, Knoxville, and Memphis) are investing in pavement management systems to better manage pavement assets under their jurisdiction. TDOT will approach agencies owning local NHS segments and coordinate with them to include locally owned NHS system components in the next analysis. The data translation may not be congruent with the TDOT PQI system; however, construction history and pavement condition information can assist in developing condition predictions.

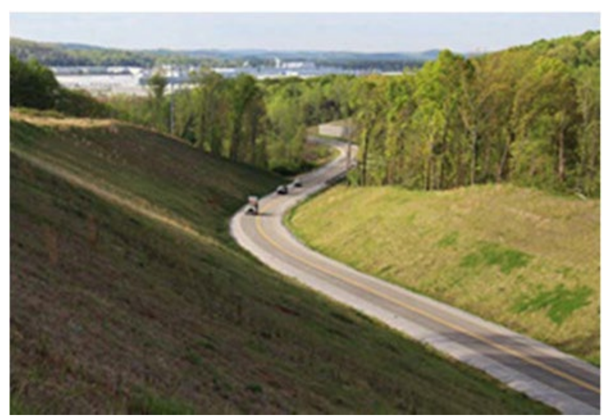
Consistency Determination Integration

- Process improvements are continuing in how TDOT gathers information for the consistency determination. This requires filtering the data by system location, asset type, and type of work in accordance with the five federal types of work. The agency has adapted programming practices to identify the system where the work will take place, and the specific type of work that will be done during the allotment process. Additionally, the asset type for the project and allotment line is being identified. Changing this process takes multiple iterations of communication and training involving both the TAMP Core Team and the TDOT Programming Office. It is hoped that the process to develop the consistency determination will continue to be streamlined and result in reliable information produced in a timely manner. Currently, significant quality assurance efforts are required within the one-month period between the end of the data collection cycle on May 31 and the consistency determination being submitted to the FHWA Tennessee Division office on June 30.
- TDOT intends to separate investments for capital projects from the resurfacing and bridge management programs. Capital projects require significant funding but have an insignificant impact on improving the overall network asset condition levels compared to the resurfacing and bridge management programs. This strategy will also improve consistency between the way unit costs are considered in the bridge management system and the bridge program funding.

Bridge Management System Refinements

- Significant improvements have occurred during the 2022 TAMP development in BMS implementation. The staff assigned to administer the BrM BMS have developed policies and decision trees within the system to partially replicate the business processes that TDOT currently uses. As stated previously however, the administrators do not yet have a high degree of confidence in the management system outputs. To improve TDOT's confidence in the BMS, staff will continue to refine the policy considerations and decision trees within the model to reflect conditions in Tennessee.

How Often Will the TAMP be Updated?



TDOT's first TAMP was certified by FHWA in 2018. Based on that certification date, the 2022 TAMP must be submitted to FHWA by July 19, 2022 for recertification. DOTs are required to update the TAMP at least once every four years. The TAMP must be updated more frequently if there are changes to the processes described in the certified TAMP.

The most recent legislation introduced additional requirements for considering extreme weather and resilience in LCP and risk management. As the rules for implementing these requirements are being developed by FHWA, a one-time extension was offered to state DOTs. This extension must be requested of the Division Office no later than July 1, 2022. If granted, it allows state DOTs until December 31, 2022 to submit a TAMP that complies with the new BIL requirements. TDOT has requested this extension but must submit this draft non-BIL compliant TAMP by July 19, 2022 to satisfy federal legislation. The draft non-BIL compliant TAMP will not be formerly reviewed by the FHWA Division Office.

Although the TAMP is required to be updated every four years, TDOT will be reviewing the TAMP on an annual basis. Part of the annual review will include the determination of additional assets to be considered for inclusion in the plan. The processes used to prepare the TAMP, such as life cycle planning, risk management, and investment strategy development, will be updated based on current methodologies, federal requirements, and available data.