U.S. Department of Transportation
Federal Highway Administration

Oklahoma Division

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July 30, 2018

In Reply Refer To:
HDA-OK

J. Michael Patterson
Executive Director
Oklahoma Department of Transportation
200 NE 21st Street
Oklahoma City, OK 73105

Dear Mr. Patterson:

The Oklahoma Department of Transportation (ODOT) Initial Transportation Asset Management Plan (TAMP), that was submitted to the Division Office on April 30, 2018, has been reviewed and is hereby certified. The processes you followed to develop your TAMP, comply with the minimum requirements, set forth in 23 U.S.C. 119 (e) (6), 23 CFR 515.11(a) and 515.11(b).

We recommend that ODOT should consider advancement in the cross-asset analysis in its investment strategizes as well as full implementation of AASHTO's BrM 5.3 in bridge management program. ODOT must also provide all the required analysis set forth in 23 U.S.C. 119 and 23 CFR 515.11 in your fully compliant TAMP which is due June 30, 2019. We also recommend ODOT continue building up more systematic process and emergency events log data for all field offices. This will help ODOT to do a better analysis during periodic evaluation of its facilities repeatedly requiring repair and reconstruction due to emergency event as required in 23 CFR 667.

We would like to commend your staff of their diligence in developing the Initial TAMP and their continuous commitment in implementation of the TAMP.

If you have any further questions, please contact Waseem Fazal, Pavement & Materials Engineer at 405-254-3332, or by email at waseem.fazal@dot.gov.

Sincerely,

Basharat Siddiqi
Division Administrator

Oklahoma Department of Transportation

Transportation Asset Management Plan

2018-2027

Oklahoma's Transportation Asset Management Plan outlines a 10-year strategy for managing the state's pavements and bridges.

July 2018

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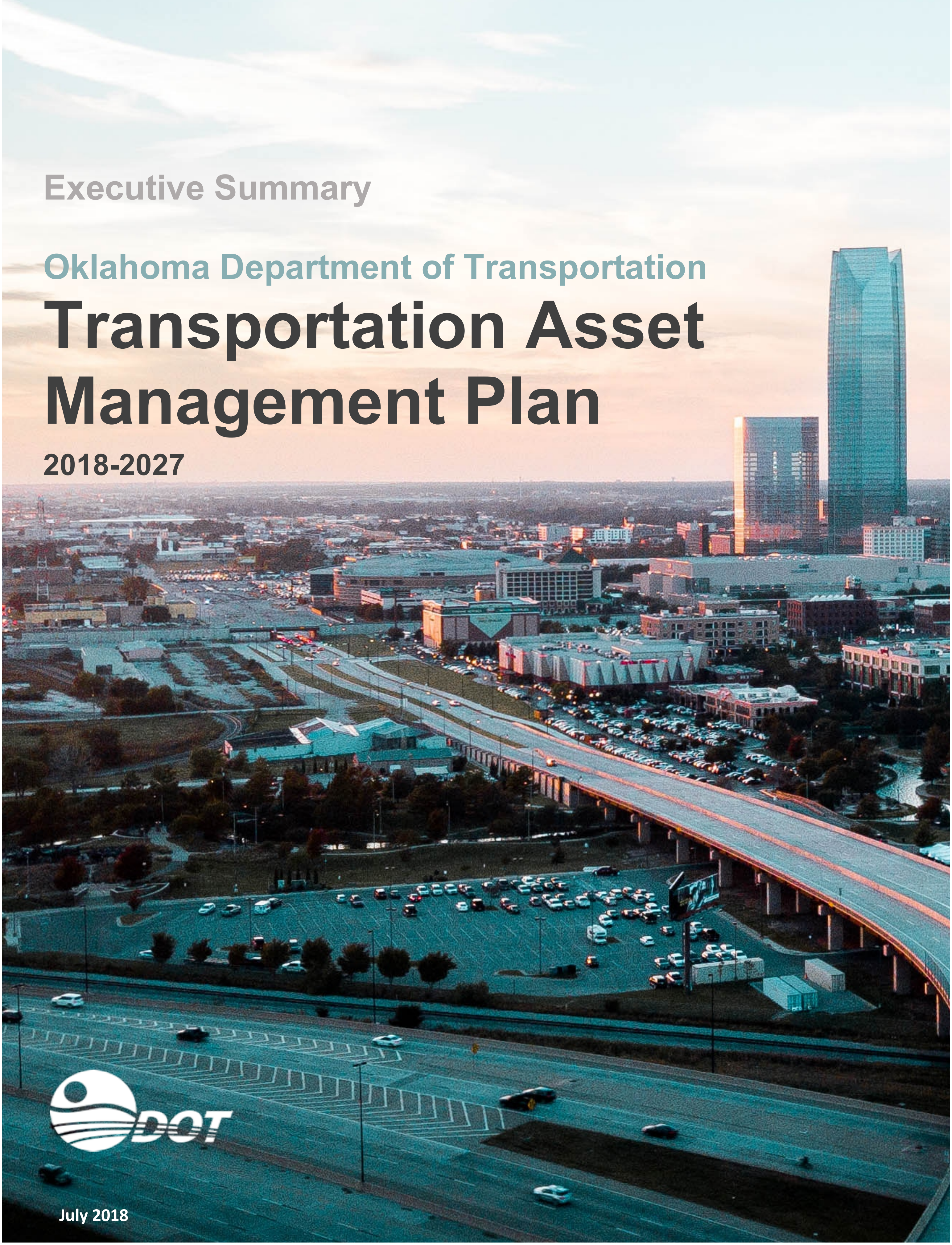
Executive Summary

Oklahoma Department of Transportation

Transportation Asset Management Plan

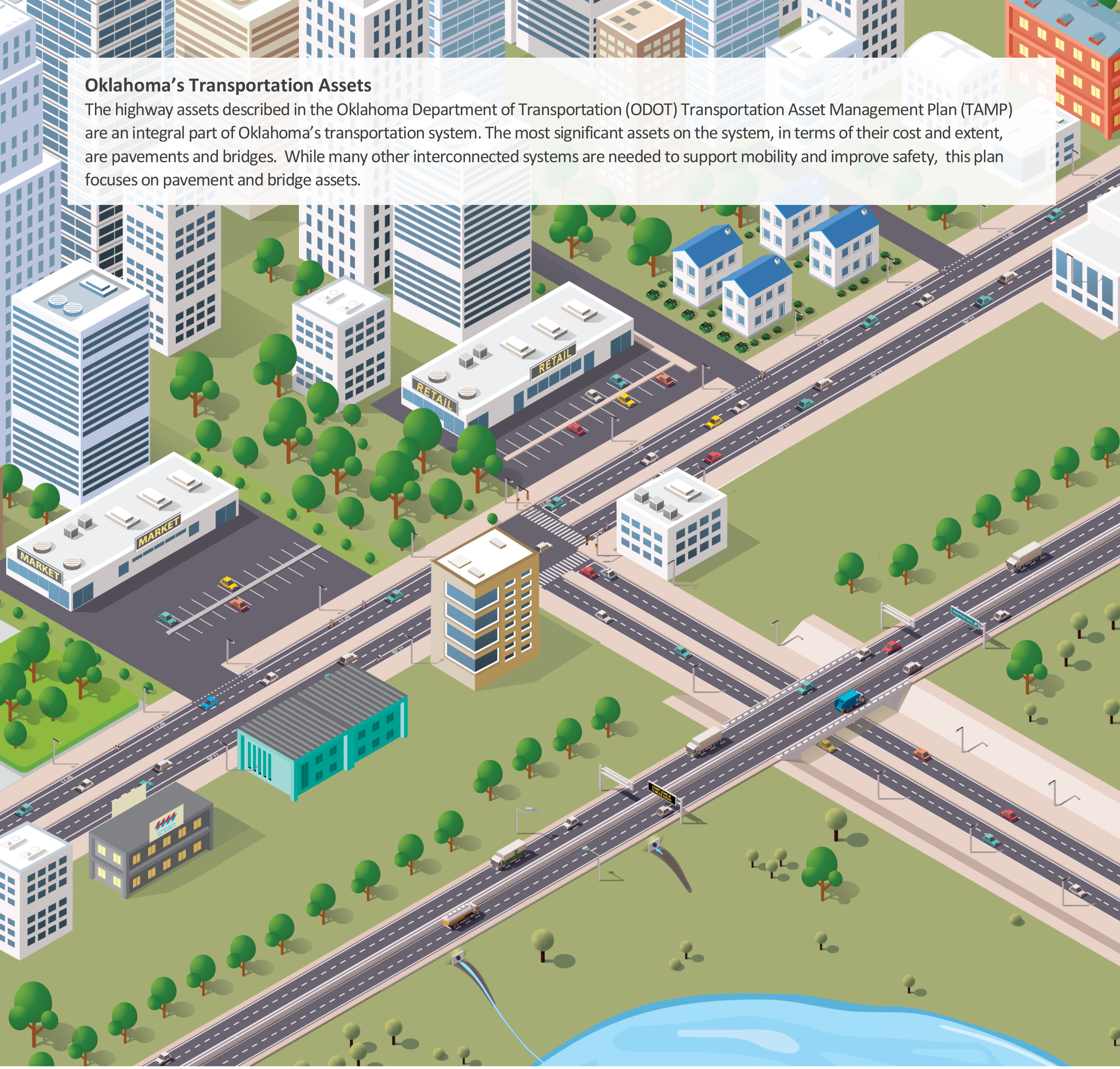
2018-2027



July 2018

Oklahoma's Transportation Assets

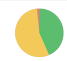
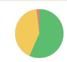
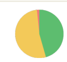
The highway assets described in the Oklahoma Department of Transportation (ODOT) Transportation Asset Management Plan (TAMP) are an integral part of Oklahoma's transportation system. The most significant assets on the system, in terms of their cost and extent, are pavements and bridges. While many other interconnected systems are needed to support mobility and improve safety, this plan focuses on pavement and bridge assets.

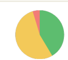
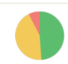
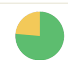
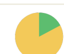
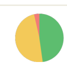


The ODOT TAMP outlines a 10-year strategy for managing the state's pavements and bridges. The strategy includes setting goals and objectives, reporting the current conditions of assets, and projecting conditions 10 years into the future. The TAMP also details life cycle planning, presents a financial plan, and discusses how to manage risk. Taken together, these elements give Oklahoma a path towards transparent and efficient use of taxpayer dollars.

Inventory and Conditions for Oklahoma Pavement and Bridge Assets

Whether based on age, condition, level of service, or simply frequency of repair, a performance measure is critical to actively manage the preservation of an asset. In the Oklahoma TAMP, asset performance is reported based on the percentage of the asset classes in Good, Fair, and Poor condition.

Pavements	Asset Inventory	Good	Fair	Poor	
ODOT Interstate	2,946 Lane Miles	62.8%	36.3%	0.9%	
OTA Interstate	1,039 Lane Miles	74.4%	25.6%	0.0%	
Total Interstate	3,985 Lane Miles	65.8%	33.5%	0.7%	
ODOT Non-Interstate NHS	6,684 Lane Miles	43.6%	54.8%	1.6%	
OTA Non-Interstate NHS	1,321 Lane Miles	56.8%	41.5%	1.7%	
Local NHS	127 Lane Miles	n/a	n/a	n/a	
Total Non-Interstate NHS	8,005 Lane Miles	45.7%	52.7%	1.6%	

Bridges	Asset Inventory	Good	Fair	Poor	
ODOT NHS	28,352 Square Feet (000s)	41.4%	53.9%	4.7%	
ODOT Non-NHS	24,121 Square Feet (000s)	48.9%	43.7%	7.4%	
OTA NHS	7,182 Square Feet (000s)	76.5%	23.5%	0.0%	
Local NHS	748 Square Feet (000s)	17.4%	82.6%	0.0%	
Total NHS	36,282 Square Feet (000s)	47.9%	48.5%	3.6%	

Oklahoma's Transportation System

Oklahoma's transportation system includes assets owned by ODOT as well as the Oklahoma Turnpike Authority (OTA) and local governments. Maintaining and improving the condition of these assets requires a statewide view, in order to serve Oklahoma travelers and meet national and state performance goals. A limited number of National Highway System (NHS) bridges and NHS pavements are not under the jurisdiction of ODOT.

Pavements

ODOT manages 30,373 lane miles of roads, with 9,630 lane miles of NHS pavements and 20,743 lane miles of non-NHS pavement. The ODOT-maintained NHS pavements make up 79.5% of the 12,117 total Oklahoma NHS lane miles. In the Initial TAMP, the condition of the 127 lane miles of locally-owned NHS pavement (about 1.05% of the Oklahoma NHS system) is unknown and is not factored into the condition totals. However, these lane miles are included in the inventory.

Bridges

There are 6,735 bridges maintained by ODOT, including 2,786 NHS bridges. The ODOT-maintained NHS bridges make up 84.3% of the 3,303 total Oklahoma NHS bridges.

Risks to the System

Managing risk is an everyday occurrence at ODOT. Risks may include threats to transportation assets, variability in travel behavior forecasts, changes in rules and regulations, uncertainty of extreme weather conditions, and opportunity for increased or decreased financial support for assets. ODOT continually manages a wide variety of transportation-related risks, using both formal and informal risk management approaches.

Asset Performance Goals

An important element of asset management is to allocate limited funding in the most efficient manner to maximize benefits over the asset life cycle. To help accomplish this, ODOT defines asset condition targets and uses management systems to predict future performance at projected funding levels and to identify potential performance gaps.

Asset Life Cycle Planning

Oklahoma's life cycle planning focuses on a proactive preservation approach to maintaining assets and works to significantly reduce a reactive maintenance approach. Performing preventative maintenance keeps assets in better condition at a lower cost over the long term. In contrast, higher cost reconstruction or replacement is needed when assets are not well maintained.

ODOT's Investment Strategies

ODOT is committed to a holistic approach to transportation asset management and strives to maintain as many assets as possible in a state of good repair. ODOT is guided in these efforts by the state's 2015-2040 Long Range Transportation Plan.

Oklahoma Pavement and Bridge Performance Targets

ODOT's Desired State of Good Repair for pavement and bridge assets is to maintain these assets at or near current condition levels, as measured by both state and federal measures.

Interstate Pavements	Good	Fair	Poor
Desired State of Good Repair	**65.3%**	**33.5%**	**1.3%**
Current Performance	**65.8%**	**33.5%**	**0.7%**
Current Performance Gap	*-0.5%*		*-0.6%*
10-Year Projected Performance	**59.7%**	**36.4%**	**3.9%**
10-Year Projected Performance Gap	5.6%		2.6%

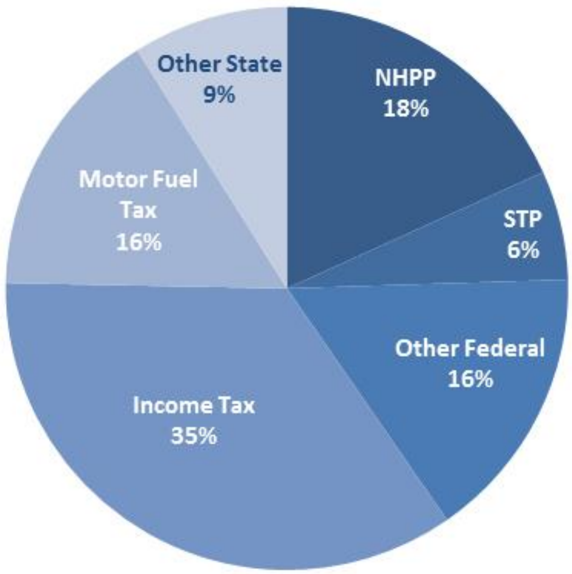
Non-Interstate NHS Pavements	Good	Fair	Poor
Desired State of Good Repair	**52.3%**	**42.0%**	**5.7%**
Current Performance	**45.7%**	**52.7%**	**1.6%**
Current Performance Gap	6.6%		*-4.1%*
10-Year Projected Performance	**48.4%**	**43.0%**	**8.6%**
10-Year Projected Performance Gap	3.9%		2.9%

NHS Bridges	Good	Fair	Poor
Desired State of Good Repair	**47.9%**	**48.5%**	**3.6%**
Current Performance	**47.9%**	**48.5%**	**3.6%**
Current Performance Gap	0.0%		0.0%
10-Year Projected Performance	**64.4%**	**28.1%**	**7.5%**
10-Year Projected Performance Gap	*-16.5%*		3.9%

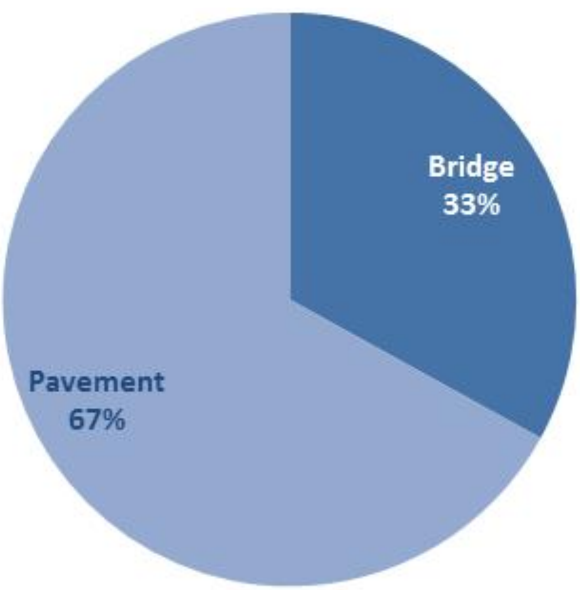
Making the Investment

Combined, ODOT and OTA funding sources are projected to average $1.7 billion annually and total $17.1 billion over the 10-year period of the plan (after deductions for debt service on existing obligations and administrative costs). Of this total, about $2.8 billion is planned for NHS pavement and bridge asset management investments, $6.8 billion planned for Non-NHS pavement and bridge asset management investments, and the remaining $7.6 billion for other investments such as congestion mitigation, air quality improvement, planning, safety, mobility, transit, research, and others. The planned investments in NHS asset management are weighted toward pavement (67 percent) over bridge (33 percent) over the ten-year period.

ODOT Funding Sources



ODOT and OTA NHS Pavement and Bridge Investment
2018-2027



Asset Management Mission and Objectives

ODOT held a workshop in January 2017 at the start of the TAMP development effort to determine its asset management mission and objectives and validated them at a follow-up workshop in February 2018.

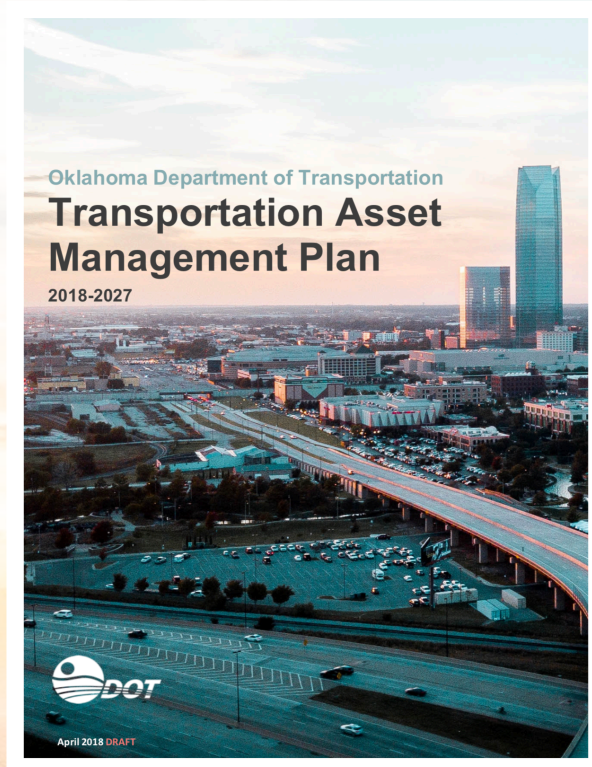
Mission

The Transportation Asset Management (TAM) Program will:

- Maximize available funding through a risk-based, data driven decision-making process
- Maintain and improves the state transportation assets
- Be transparent and accountable to partners and customers

Objectives

- Maintain (improve) the condition of the state's bridges and roadways
- Reduce risk associated with asset performance
- Make better data driven decisions about our assets
- Reduce costs and improve efficiency, including effectively delivering projects that support asset management
- Increase internal and external communications and transparency
- Improve customer service
- Improve safety on the state's transportation system
- Enhance mobility of people and goods



Download the full 2018-2027 Transportation Asset Management Plan at:

https://www.ok.gov/odot/Programs_and_Projects/Transportation_Programs/TAM-TAMP.html

Chapter 1

Introduction

Oklahoma's road and bridge network serves as the backbone of the state's economy, moving people to work and goods to market. The Transportation Asset Management Plan (TAMP) proposes a strategic approach to maintaining the state's transportation network that maximizes asset lifespans and makes the best use of the resources available.

Overview

A healthy transportation system is essential for forging a strong economy and improving quality of life. The transportation system managed by the Oklahoma Department of Transportation (ODOT) connects people to jobs, schools, healthcare, recreation, and their communities, as well as to the rest of the world. ODOT is responsible for operating, managing, maintaining and improving this transportation system to provide safe and convenient travel for citizens, visitors, and businesses.

The demands on the transportation system lead to ongoing deterioration of pavements and bridges that must be repaired, rehabilitated, or replaced to preserve the integrity and reliability of the transportation system. Transportation managers must continually evaluate system safety, performance, condition, and vulnerabilities in the context of available funding to make good transportation investment decisions. Deferring investments in infrastructure preservation can result in higher long-term costs for repair and rehabilitation and can mean added costs and delays for travelers due to rough roads and weight-restricted bridges.

The ongoing costs associated with preserving the condition and performance of existing transportation assets are significant. ODOT and its partner agencies spend millions of dollars each year to hold deterioration at bay so that the transportation system can continue to support its users reliably, safely, and with minimal disruption. Similar to maintaining a home or an automobile, doing the right preventative maintenance at the right time can significantly extend

Transportation Asset Management

A strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost.

service life and avoid costlier repairs in the long run. The need to efficiently manage transportation system investments has led to the recognition of the benefits of managing assets using a data-driven systematic approach generally referred to as Transportation Asset Management (TAM).

Guiding Principles of ODOT's Asset Management Program

Oklahoma's asset management goals are to:

- Build, preserve, and operate facilities more cost-effectively with improved asset performance. Manage assets throughout their lifecycles and for the long-term, considering growth forecasts, available funding and changes in user expectations.
- Deliver to customers the best value for the public tax dollar spent. Maximize the benefits delivered by the network while minimizing the costs of providing, maintaining, and using the network.
- Enhance the credibility and accountability of ODOT to its governing executive and legislative bodies. Deliver agreed-upon levels of service through financial programs and use of effective management and reporting systems.

Federal TAM requirements are centered on investing limited funding resources in the right place at the right time to produce the most cost-effective life cycle performance for a given investment (23 CFR 515.7 and 23 CFR 515.9). This vision is at the heart of ODOT's asset management philosophy, as shown by ODOT's early adoption of pavement and bridge management systems.

The TAMP is a living document. It is meant to evolve over time as changes in condition, budgets, risks, constraints, and priorities are identified as well as to incorporate any future modification in federal laws or requirements. Throughout the development of this initial TAMP, improvement opportunities were found (see Chapter 9). As those improvements are realized, the TAMP will be updated to reflect better information or improved processes.

Document Organization

The TAMP consists of nine chapters.

1. **Introduction** – This chapter gives an overview of Oklahoma's asset management goals and how the document is organized.
2. **Asset Inventory and Condition** – This chapter presents the inventory and current condition of both National Highway System (NHS) and state pavements and bridges in Oklahoma, categorized by system and owner.
3. **Objectives and Measures** – This chapter describes the mission and objectives for TAM in Oklahoma and performance measures for pavements and bridges.

4. **Performance Assessment** – This chapter describes how different funding scenarios for pavements and bridges would impact asset conditions in the next ten years. It includes a performance gap analysis of the ten-year projected performance with current performance and the ten-year forecast based on expected funding.
5. **Life Cycle Planning** – This chapter describes the implementation of life cycle management and ODOT's pavement and bridge asset life cycle plans.
6. **Risk Management** – This chapter discusses the categories of risks ODOT faces, how ODOT prioritizes risks, and how ODOT plans to mitigate its top priority risks.
7. **Financial Plan** – This chapter presents the funding sources for ODOT and the Oklahoma Turnpike Authority (OTA) for assets and how they will be used. A current valuation of pavement and bridge assets is also included.
8. **Investment Strategies** – This chapter presents ODOT's general approach to investing in transportation assets as well as ODOT's specific strategies related to its assets.
9. **Process Improvements** – This chapter presents the process improvement initiatives for improving TAM practices and results in the future.

This TAMP focuses on pavements and bridges on the NHS, which includes the Interstate system that is required by federal rules. It also includes all state-owned pavement and bridge assets to help ODOT improve asset management results.

Chapter 2

Asset Inventory and Condition

Oklahoma's TAMP addresses the required pavement and bridge assets on the NHS and also includes all pavements and bridges on the State Highway System (SHS). This chapter presents summary information on asset inventory and identifies the current conditions for these assets.

Overview

Asset inventory and condition data provide the basis for managing transportation assets. Inventory and condition data are valuable for communicating the extent of Oklahoma's assets and the current state of those assets. These data are also the building blocks for other asset management processes. Accurate inventory and condition data are needed for supporting asset management processes such as life cycle planning, projecting funding needs, developing projects, and monitoring asset performance

Oklahoma's pavement and bridge assets include the following systems:

- **Interstate Highways**, which are part of the nationwide Interstate Highway System.
- **The NHS**, a network of pavements and bridges that the federal government has designated essential for national connectivity. The NHS includes all Interstates.
- **The SHS**, which includes both NHS and Non-NHS routes.

Oklahoma's pavement and bridge assets are also classified by ownership:

- **ODOT** owns and maintains much of the Interstate and Non-Interstate NHS, as well as Non-NHS assets. Collectively, the assets owned by ODOT make up the SHS.
- **OTA** owns and operates portions of the Interstate and Non-Interstate NHS.
- **Local governments** own and operate small portions of the Non-Interstate NHS.

Federal Requirements

A state's TAMP must contain a description of asset inventory and condition of NHS bridges and pavements (23 CFR 515.9(b)). States are encouraged to include other assets on the NHS or other public roads in the TAMP (23 CFR 515.9(c)). If a state chooses to include additional assets, the TAMP must include information on those assets in the following sections: inventory and condition, performance measures, targets, performance gap analysis, life cycle planning, risk management, financial plan, and investment strategies. States are also required to obtain necessary data from other NHS owners in a collaborative and coordinated effort (23 CFR 515.7(f)). The ODOT TAMP includes the Non-NHS pavement and bridge assets maintained by ODOT. ODOT performed the same analysis for assets for both NHS and Non-NHS assets.

System Summary

ODOT and Non-ODOT Asset Categories

For the purposes of the federally compliant TAMP, ODOT-owned pavement and bridge assets, along with the Non-ODOT-owned NHS pavements and bridges, are displayed in Figure 2.1.

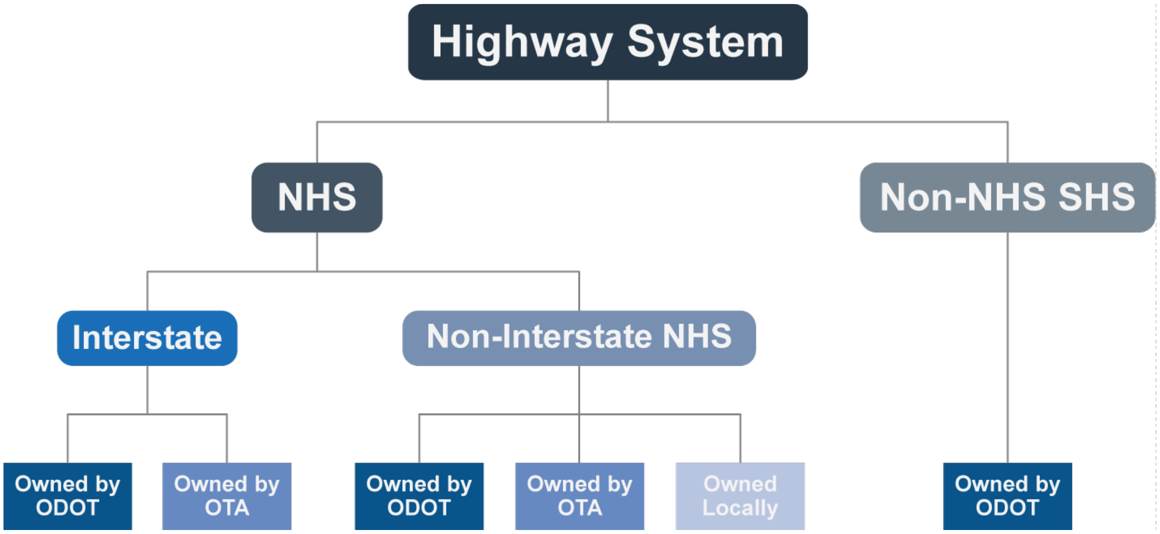


Figure 2.1 TAMP Asset Classifications

Pavement and Bridge Asset Inventories

The Oklahoma NHS is made up of 12,117 lane miles of pavements. ODOT maintains 9,630 NHS lane miles, which includes 2,946 lane miles of Interstate pavements and 6,684 lane miles of Non-Interstate NHS pavements. OTA maintains 2,360 NHS lane miles, while local governments maintain the remaining 127 NHS lane miles. The SHS has 30,373 lane miles of pavements, which includes 9,630 NHS lane miles and 20,743 Non-NHS lane miles. The combined pavement lane miles included in the TAMP are 32,860, which includes both the 30,373 lane miles of the SHS and the 2,487 lane miles of NHS that are maintained by OTA and local governments. All of the data in this TAMP were collected in 2016 and reported in 2017 (see Table 2.1) and represent the best available data.

The Oklahoma NHS is made up of 3,269 bridges. Of these, 2,786 are maintained by ODOT, 459 are maintained by OTA, and 24 are maintained by local governments. The SHS has 6,735 bridges, which include 2,786 NHS bridges and 3,949 Non-NHS bridges. The combined total of bridges in the TAMP is 7,218, which includes both the 6,735 bridges on the SHS and the 483 NHS bridges maintained by OTA and local governments (see Table 2.1).

Table 2.1 Pavement and Bridge Asset Inventory

		Pavements	Bridges	
Owner	**System**	**Lane Miles**	**Count**	**Deck Area** Thousands square feet (tsf)
ODOT	Interstate	2,946	2,786	28,352
	Non-Interstate NHS	6,684		
	Non-NHS	20,743	3,949	24,121
	Total	**30,373**	**6,735**	**52,473**
Other	OTA Interstate	1,039	459	7,182
	OTA Non-Interstate NHS	1,321		
	Local NHS	127	24	748
	Total	**2,487**	**483**	**7,930**
Total	NHS	12,117	3,269	36,282
	Total	**32,860**	**7,218**	**60,403**

Bridges Source: 2016 National Bridge Inventory, submitted June 2017, *updated version 1/3/2018 bridges*
Pavements Source: 2016 Pavement data reported in 2017

The NHS analysis in this document includes all categories except for the local NHS. Figure 2.2 shows the distribution NHS pavement lane miles by ownership.

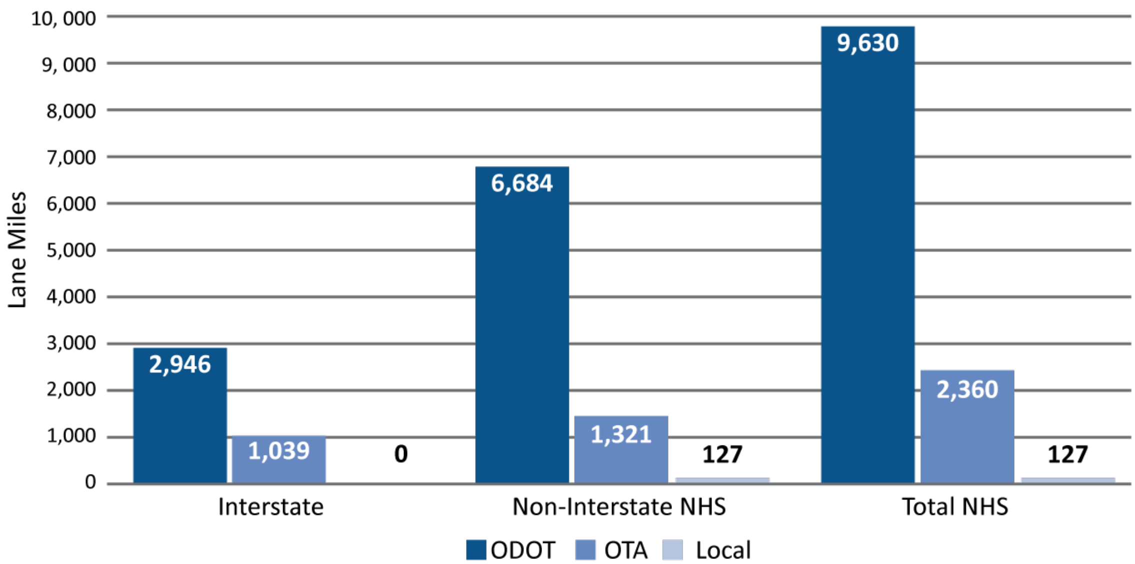


Figure 2.2 NHS Pavement Inventory

The charts in Figure 2.3 show the distribution of Oklahoma NHS pavement and bridge assets by ownership.

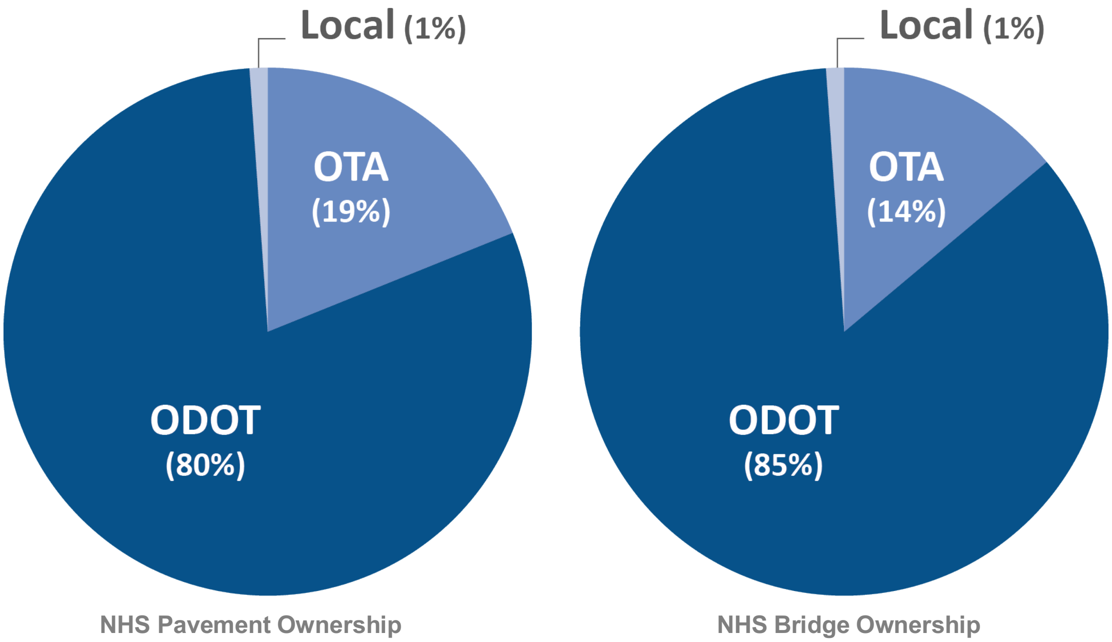


Figure 2.3 NHS Pavement and Bridge Ownership

OTA and MPO Coordination

ODOT, OTA, and the Metropolitan Planning Organizations (MPOs) have been working together on planning-related coordination. ODOT collects the inventory and condition data for all NHS bridges and has been responsible for providing the National Bridge Inventory (NBI) data for all Oklahoma bridges. ODOT collects the pavement inventory and condition data for OTA but in the past has not collected the pavement inventory and condition information for the 127 miles that is locally owned.

OTA owns and maintains one of the largest inventories of lane miles of any toll authority in the United States, consisting of ten turnpikes currently totaling 606 centerline miles, which includes 2,360 lane miles of NHS pavements. 1,039 of those lane miles are classified as Interstate pavement and the remaining 1,321 lane miles are classified as Non-Interstate NHS pavements. OTA maintains 459 bridges with 7,200 tsf of NHS bridge deck area.

The local NHS pavements currently consist of 127 lane miles or about 1% of all Oklahoma NHS pavement lane miles. Eight localities own a limited quantity of NHS pavements in Oklahoma. In some cases the ownership extent is extremely small; four localities –Tulsa, Muskogee, Grady County, and Tulsa County – each own fewer than eight NHS lane miles. Idabel, Shawnee, and Chickasha each own between 15 and 30 lane miles of NHS pavements, while Oklahoma City owns the largest share of Oklahoma's local NHS: over 40 lane miles.

In coordination with the local NHS owners, ODOT intends to expand its pavement surface condition data collection program to these pavements in future years. In this Initial TAMP, the condition of the 127 lane miles of NHS pavement that represents about 1.05% of NHS system is not factored into the condition total since the data is unknown, but the inventory is included. Local NHS ownership is shown in Figure 2.4

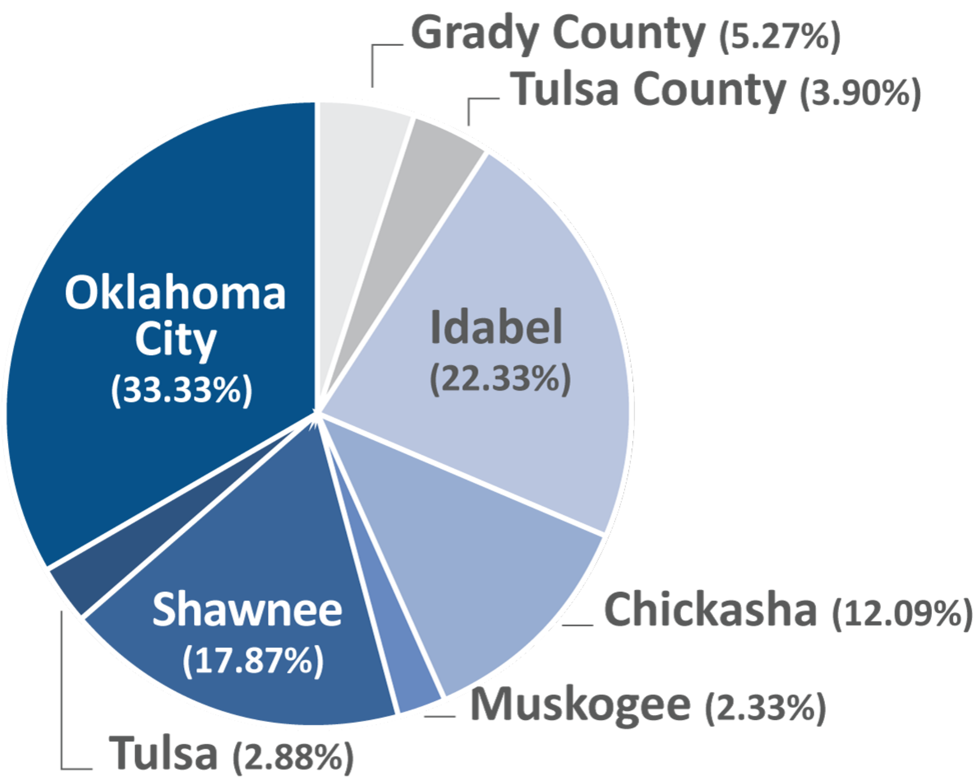


Figure 2.4 Local NHS Ownership as a Percentage of Total Local NHS Lane Miles

ODOT currently performs bridge inspections and maintains the NBI data for Local NHS bridges. There are 24 NHS bridges on the local NHS system comprising 748 tsf or 0.7% of the total NHS deck area.

Historically, there has not been the need for ODOT and local governments to share asset condition information or performance management information. As a result of the TAMP development requirements, ODOT is coordinating with representatives from OTA and MPOs to discuss the approach for Non-ODOT-managed assets. An improvement initiative to better coordinate and support Non-ODOT asset data on the NHS is described in Chapter 9.

Pavement Inventory and Condition

Table 2.2 shows the present condition of ODOT and OTA Interstate pavements. Currently 65.8% of Interstate pavements are in Good condition while only 0.7% are in Poor condition. Detailed definitions of these and other measures of asset condition are included in Chapter 3.

Table 2.2 Interstate Pavement Condition

Pavements	Lane Miles	Good	Fair	Poor
ODOT Interstate	2,946	62.8%	36.3%	0.9%
OTA Interstate	1,039	74.4%	25.6%	0.0%
Total Interstate	**3,985**	**65.8%**	**33.5%**	**0.7%**

Table 2.3 shows the present condition of ODOT Non-Interstate NHS pavements and OTA Non-Interstate NHS pavements. 45.7% of these pavements are in Good condition while only 1.6% are in Poor condition.

Table 2.3 Non-Interstate NHS Pavement Condition

Pavements	Lane Miles	Good	Fair	Poor
ODOT Non-Interstate NHS	6,684	43.6%	54.8%	1.6%
OTA Non-Interstate NHS	1,321	56.8%	41.5%	1.7%
All Non-Interstate NHS	8,005	45.7%	52.7%	1.6%
Local NHS*	127	n/a	n/a	n/a

* = Local NHS data is not available at this time

Table 2.4 shows the current condition of ODOT's Non-NHS pavements. 30% of these pavements are in Good condition, 68.5% are in Fair condition, and 1.5% are in Poor condition.

Table 2.4 Non-NHS Pavement Condition

Pavements	Lane Miles	Good	Fair	Poor
ODOT Non-NHS	20,743	30.0%	68.5%	1.5%

Federal rules allow states to choose whether or not to perform and report network-level federal Interstate pavement condition data in both directions of travel. ODOT chose to minimize the additional cost of this separate data capture and report the required Interstate data in the primary direction of travel for federal analysis purposes.

Bridge Inventory and Condition

ODOT is responsible for the federally mandated bridge inspections on all bridges in Oklahoma. For the 2017 annual submission of the federally required NBI, ODOT maintained 6,735 structures that met the criteria. The bridge data analysis included in this document is based on the data that is in the NBI. ODOT's current primary state-level performance measure for the ODOT Bridge Program is the number of structurally deficient bridges.

The primary performance measure for the ODOT Bridge Program has been to reduce the number of structurally deficient bridges it maintains. When a bridge is structurally deficient, it can still be safe to travel on, but in some cases ODOT will post a load restriction for large trucks. If a bridge is deemed to be unsafe, ODOT will close the bridge.

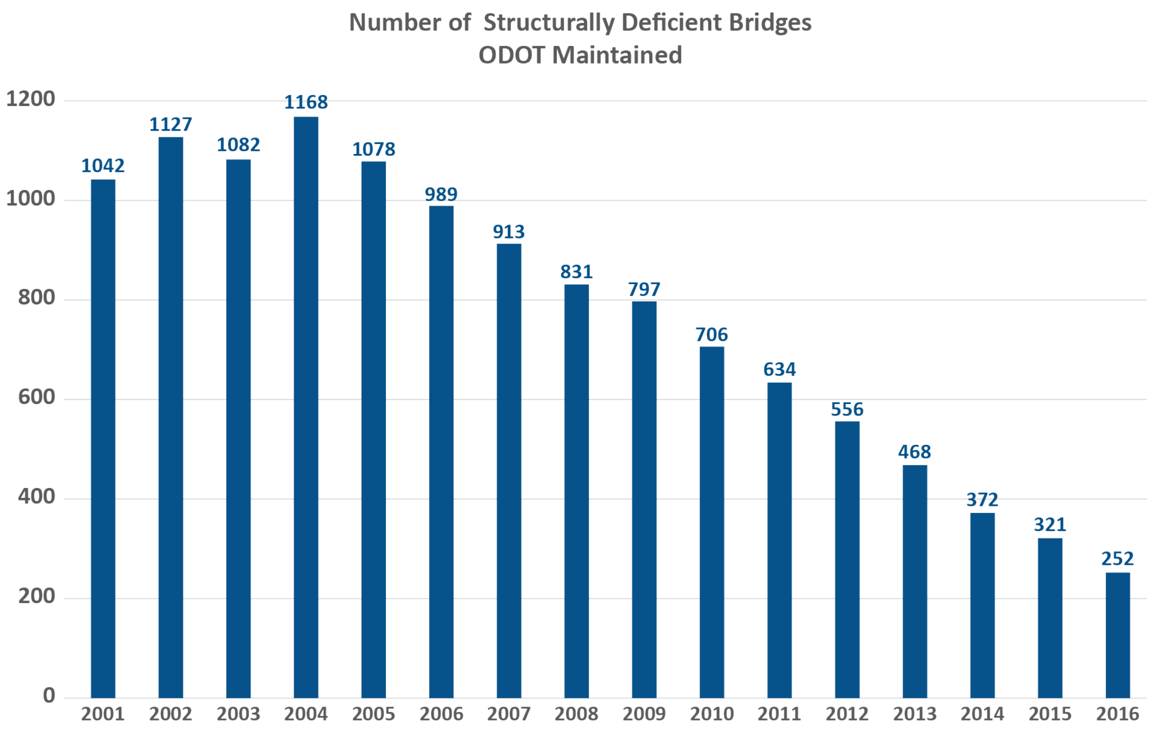


Figure 2.5 Structurally Deficient Bridges Maintained by ODOT

Following decades of minimal funding availability for ODOT-maintained bridges, the number of structurally deficient bridges reached a high of 1,168 bridges in 2004. A subsequent concentration on bridge condition resulted in an increase in funding that has enabled ODOT to renew their focus on eliminating state-maintained structurally deficient bridges. Since 2004, ODOT has been able to reduce the total number of structurally deficient bridges by 916, or a 74.8% reduction (see Figure 2.4).

Bridge Conditions

Table 2.5 shows present bridge conditions. Currently 47.9% of all NHS bridges are in Good condition and 3.6% are in Poor condition.

Table 2.5 Bridge Conditions

Bridge Type	Count	% Structurally Deficient by Deck Area			
		Good	Fair	Poor	
ODOT NHS	2,786	41.4%	53.9%	4.7%	
ODOT Non-NHS*	3,949	48.9%	43.7%	7.4%	
OTA NHS	459	76.5%	23.5%	0.0%	
Local NHS	24	17.4%	82.6%	0.0%	
Total NHS	**3,269**	**47.9%**	**48.5%**	**3.6%**	
Total Non-NHS*	**3,949**	**48.9%**	**43.7%**	**7.4%**	

* Only includes ODOT-maintained Non-NHS Bridges

Chapter 3

Objectives and Measures

ODOT's objectives and measures for TAM include maintaining and improving the performance and condition of pavement and bridges, delivering efficient and effective projects that preserve and advance existing infrastructure, and enhancing the ability to make data-driven decisions that improve investment decision making.

Overview

TAM best practices emphasize the use of performance management for transportation programs, shifting the decision-making framework towards data-driven, proactive, goal-oriented investment choices. Federal Highway Administration (FHWA) defines transportation performance management as "a strategic approach that uses system information to make investment and policy decisions to achieve national performance goals."

ODOT has been practicing TAM through the leadership of its Field Divisions. Using the guidance of the Moving Ahead for Progress in the 21st Century Act (MAP-21), ODOT is strengthening its TAM program through better use of its existing management systems, data, risk management, and life cycle planning. This chapter describes the TAM objectives and measures ODOT uses in the performance management of its pavement and bridge assets.

Federal Requirements

Federal rules establish the following national pavement performance measures for state DOTs to assess pavement condition (23 CFR 490.307(a)):

- Percentage of pavements of the Interstate System in Good condition
- Percentage of pavements of the Interstate System in Poor condition
- Percentage of pavements of the Non-Interstate NHS in Good condition
- Percentage of pavements of the Non-Interstate NHS in Poor condition

Federal rules also set network-level condition assessments that are calculated for each one-tenth mile pavement section (23 CFR 490.313). Pavement sections are assessed by measuring pavement roughness, faulting, rutting, and cracking. These measurements are aggregated and summarized as

Good, Fair, or Poor. ODOT used the data for the most recent Highway Performance Monitoring System (HPMS) data submittal and evaluated the new federal pavement measures for both ODOT Interstate and ODOT Non-Interstate NHS pavement management system (PMS) data.

A penalty will be imposed if the percentage of Interstate pavement lane miles is greater than 5% Poor condition.

The final ODOT TAMP (due in June 2019) is required to include 2-year and 4-year targets for Good and Poor pavement conditions under federal Performance Management rules for pavements and bridges (PM2). PM2 rules are meant to establish nationally consistent condition data for the NHS. ODOT is reporting its PM2 targets in this initial TAMP.

Federal rules also establish the following national bridge performance measures for state DOTs to assess bridge condition (23 CFR 490.407(c)):

- Percentage of NHS bridge deck area in Good condition
- Percentage of NHS bridge deck area in Poor condition

For bridges, the rules require the use of NBI data for bridges on the NHS. Bridge condition ratings are used to classify the bridge as being in Good, Fair or Poor condition. The lowest of the three ratings for deck, superstructure and substructure determines the overall rating of the bridge. If this value is 7 or greater, the bridge is classified as being in Good condition. If it is 5 or 6, the bridge is classified as being in Fair condition, and if it is 4 or less, the bridge is classified as being in Poor condition. Overall, the percentage of Good/Fair/Poor bridges is based on deck area.

A penalty will be imposed if the percentage of NHS bridges classified as structurally deficient exceeds 10%. As of 2018, the definition of structurally deficient has been simplified to be the same as Poor condition. If the penalty is triggered, ODOT must obligate a specified percentage of its funds to address the conditions.

TAM Mission and Objectives

A workshop was held in January 2017 at the start of the TAMP development effort to determine TAM mission and objectives. The following are the ODOT TAM mission and objectives from this workshop and validated at the TAMP Building Workshop in February 2018.

TAM Mission

The TAM Program will:

- Maximize available funding through a risk-based, data driven decision-making process
- Maintain and improve state transportation assets
- Be transparent and accountable to partners and customers

TAM Objectives

- Maintain the condition of the state's bridges and roadways
- Reduce risk associated with asset performance

- Improve data-driven decision making about transportation assets
- Reduce costs and improve efficiency, including effectively delivering projects that support TAM
- Increase internal and external communications and transparency
- Improve customer service
- Improve safety on the state's transportation system
- Enhance mobility of people and goods

The safety and mobility objectives at the end of the list represent overall transportation objectives that the TAM program will support and integrate in the investment decision-making and management of the assets.

Pavement Performance Measures

ODOT Measure

ODOT's primary performance measure for pavement condition is Pavement Quality Index (PQI). PQI is measured on a scale of 0 to 100, where higher numbers indicate higher quality. The PQI score is made up of pavement distress data such as ride, rutting, and structure. Each pavement type has several summary condition indices as well as an overall PQI that can be calculated based on aggregated subsection pavement distress data. These indices are then weighted and combined to calculate the PQI.

ODOT developed a methodology to correlate PQI to the federal pavement measures. The condition information presented in Chapter 2 used the federal performance measures for pavements.

Federal Measures

FHWA has selected four pavement performance measures to determine the network condition level of the NHS pavements. The pavement data supporting these measures will be reported to the HPMS. The four measures are calculated using quantitative data based on the following metrics:

- Ride is an indicator of discomfort experienced by road users traveling over the pavement, measured using the International Roughness Index (IRI).
- Cracking is measured in terms of the percentage of cracked pavement surface. Cracks can be caused or accelerated by excessive loading, poor drainage, frost heaves or temperature changes, and construction flaws.
- Rutting is quantified for asphalt pavement by measuring the depth of ruts along the wheel path. Rutting is commonly caused by a combination of heavy traffic and heavy vehicles.
- Faulting is quantified for concrete pavements. Faulting occurs when adjacent pavement slabs are vertically misaligned. It can be caused by slab settlement, curling, and warping.

For each of these metrics, depending on the pavement type, FHWA has established criteria for each metric to measure Good, Fair and Poor condition (see Table 3.1). FHWA uses these pavement condition metrics to determine the network-level pavement condition for each one-tenth mile pavement section.

Table 3.1 Federal Pavement Condition Criteria

Federal Pavement Condition Criteria			
Metric	Good	Fair	Poor
IRI (inches/mile)	<95	95 - 170	>170
Cracking (%)			
- Asphalt	<5	5 - 20	>20
- Jointed Concrete	<5	5-15	>15
- Continuously Reinforced Concrete	<5	5 - 10	>10
Rutting Asphalt (inches)	<0.20	0.20 - 0.40	>0.40
Faulting Concrete (inches)	<0.10	0.10 – 0.15	>0.15

An individual section of pavement is rated as being in Good overall condition if all of the metrics are rated as Good, and it is rated as Poor if two or more are rated as Poor. All other combinations are rated as Fair (see Table 3.2). The lane miles in Good, Fair, and Poor condition are tabulated for all sections to determine an overall percentage of pavement conditions.

Table 3.2. Pavement Section Ratings

If a pavement segment has:	It receives a rating of:
All metrics rated Good	Good
Two or more metrics rated Poor	Poor
Any other combination of ratings	Fair

ODOT and FHWA Pavement Performance Measures Correlation

ODOT has had an established PMS in place for a number of years. A key function of the PMS is to forecast pavement performance using PQI, anticipated funding levels, and detailed analytical models developed based on years of historical pavement condition and treatment performance data. Details of these processes will be described in further detail in Chapter 5.

ODOT can apply this approach to develop network-level estimates of future performance against state performance measures. However, it is not possible to report federal performance directly from these analysis results because of the differences between the state and federal measures.

The detailed distress information required to calculate federal performance ratings are not available as an output from ODOT's pavement condition forecasting tools. As a result, a process for mapping Oklahoma's PQI to federal Good and Poor pavement ratings was developed to support the TAMP performance targeting and gap analysis requirements. The ODOT-developed mapping process leverages results of a comparison of individual subsection PQI with overall federal Good, Fair, and Poor ratings from associated one-tenth-mile data. The analysis allows ODOT to correlate the PQI of the ODOT inventory subsection to the percentage of associated one-tenth-mile sections that would be rated in federal Good or Poor condition. With this mapping, ODOT is able to leverage outputs from PMS investment optimization and condition forecasting analysis to predict future federal performance.

ODOT will closely monitor federal measures each year and compare the PMS projections against the actual outcomes of the federal data to determine the adequacy of this process to meet federal TAMP and performance targeting requirements.

Bridge Performance Management

ODOT Bridge Performance Measures

ODOT uses the number of structurally deficient bridges as its primary performance measure for bridges. The structurally deficient bridge assessment is consistent with the federal rating system.

FHWA Bridge Performance Measures

Bridge condition is assessed using minimum condition ratings for a bridge's NBI deck, superstructure, and substructure data. For NBI purposes, a culvert is classified as a bridge when it is 20 feet or longer. The NBI condition rating is based on the NBI culvert item.

Any bridge with a rating of 4 or less on any NBI item (deck, superstructure and substructure) is classified as Poor. To be classified as Good, all three of a bridge's NBI items must be 7 or greater. All other bridges are Fair. If a bridge is classified as Poor, it is considered to be structurally deficient.

Likewise, for a culvert classified as a bridge, if the individual rating on the NBI item culvert is 4 or less, the culvert is classified as Poor, or structurally deficient. The same methodology applies to Good and Fair classifications as shown in Table 3.4.

The federal measurement (23 CFR 490.409(b)) requires weighting of each bridge by its deck area to represent the performance quantity.

Table 3.4 Federal Bridge Conditions Criteria

Federal Bridge Condition Criteria*	
Metric	**Range**
Good	9 - 7
Fair	6 - 5
Poor	4 - 0

*Applies to Deck, Substructure, Superstructure, and Culvert NBI Items

ODOT and FHWA Bridge Performance Measures

ODOT has historically used structurally deficient bridge count to report bridge performance, while the federal bridge performance measure requires reporting by bridge deck area. The relative differences between these approaches will depend on the number of large bridges in the inventory. ODOT has committed to using deck area in the future to be consistent with the federal measure. The TAMP presents bridge condition by deck area and uses the federal rating for the percentage of Good and Poor bridges.

Chapter 4

Performance Assessment

One of the most important requirements of asset management is to allocate limited funding in the most efficient manner to maximize benefits over the asset life cycle of the entire system. To accomplish this, ODOT must define asset condition targets and then use management systems to predict future performance based on projected funding levels to see whether these targets can be achieved or whether funding gaps will be encountered.

Overview

Gap analysis provides a method to predict how successful an agency will be in maintaining the maximum value of the assets over time. Gap analysis allows ODOT to move from a reactive model of "Where we are now?" to a predictive model of "Where will we be in the future?", allowing for informed preemptive resource allocation decisions.

Federal Requirements

States are required by law to meet a minimum performance level for the condition of Interstate pavements (23 U.S.C. 119(f)(1)). The law requires that the percentage of Interstate lane miles in Poor condition cannot exceed 5%. If this threshold is not met, ODOT will be required to obligate a portion of the National Highway Performance Program and transfer a portion of its Surface Transportation Program funds to address Interstate pavement conditions. Condition targets for the Non-Interstate NHS are set by the state.

Federal regulations also establish how a state's asset management objectives should relate to a desired state of good repair (23 CFR 515.9(d)(1)). The regulations require that a state's asset management objectives align with the DOT's mission. The objectives must be consistent with the purpose of asset management, which is to achieve and sustain the desired state of good repair over the life cycle of the assets at a minimum practicable cost.

Under federal law, states must meet a minimum performance standard for bridges that are part of the NHS. States must maintain bridges so that the total percentage of structurally deficient bridges weighted by deck area of all NHS bridges does not exceed 10% (23 U.S.C. 119(f)(2)). This requirement applies to NHS bridges, on- and off-ramps connected to those bridges, and NHS bridges that cross into another state. Similar to Interstate pavements, if more than 10% of NHS bridges by deck area are structurally deficient, ODOT will be required to allocate more of their federal funding to NHS bridges.

FHWA has said that a state's TAMP must include a performance gap analysis of the state's targets for NHS pavements and bridges. States may choose to perform performance gap analyses for other targets as well. The requirements indicate that a performance gap exists when there is a difference between current or projected conditions and condition targets.

The requirements specify that a performance gap analysis should include an estimate of the annual funding needed to achieve and sustain the targets being analyzed. The results of the performance gap analysis are then used to estimate funding needs. Gap analysis results will guide the Life Cycle Planning (LCP) scenarios required for investment strategies. ODOT is identifying any gaps affecting the state's targets for the condition of NHS pavements and bridges.

Additional Factors Impacting Future Performance

An important consideration in asset management planning is the relationship between growth and demand on the transportation system and the impact it will have on asset management. This will require balancing asset capacity, supporting economic development in Oklahoma, supporting other system performance needs, and delivering mobility. As the context for asset management in Oklahoma evolves and the TAM program matures, the ability to make better decisions and balance competing priorities will increase.

ODOT has sought to establish predictive models of future asset conditions in order to support informed proactive resource allocation decisions. There are many factors that will influence future demands on Oklahoma's pavements and bridges such as the health of the economy. A healthy economy will increase volumes on the system resulting in more rapid deterioration. The factor that is likely to have the greatest impact in performance gaps and deficiencies is increased freight traffic.

Increased Freight Traffic

The Oklahoma 2018-2022 Freight Transportation Plan presents an analysis showing total truck freight tonnage increasing 4% from 2018-2022. The results of this analysis are summarized in Table 4.1.

Table 4.1: Oklahoma Truck Freight Growth 2018-2022

Tonnage by Direction					
	Inbound	Outbound	Within	Pass-Through	Total
2018	48.1	80.7	123.6	234.3	486.7
2022	50.3	83.8	123.6	248.6	506.3
% Change 2018-2022	4.6%	3.8%	0.0%	6.1%	4.0%

Figure 4.1 maps the flow of trucks traveling over the Oklahoma state highway network.

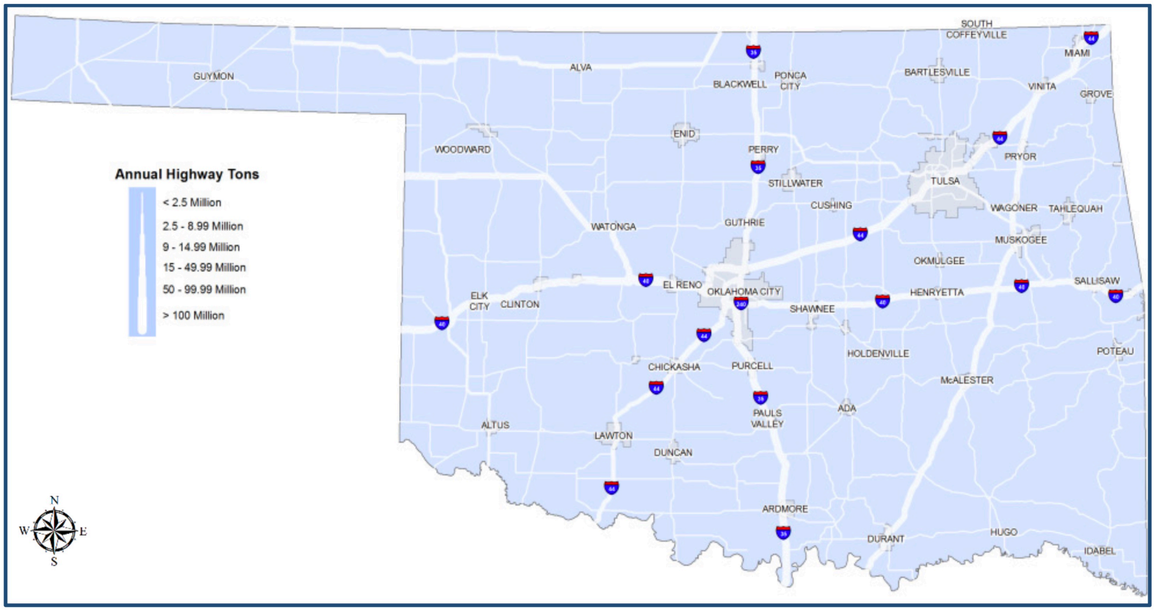


Figure 4.1 Annual Highway Freight Flows
Source: Oklahoma Freight Transportation Plan – Technical Report; IHS 2014 Transearch; Oklahoma DOT and WSP Analysis, 2017

The map shows that each of the top highest-volume truck routes are on the NHS system. Indeed, with the exception of SH-152 all of the top 10 non-Interstate truck routes by volume are on the NHS system. Additional detail is provided by Figure 4.2, showing high-volume truck corridors statewide.

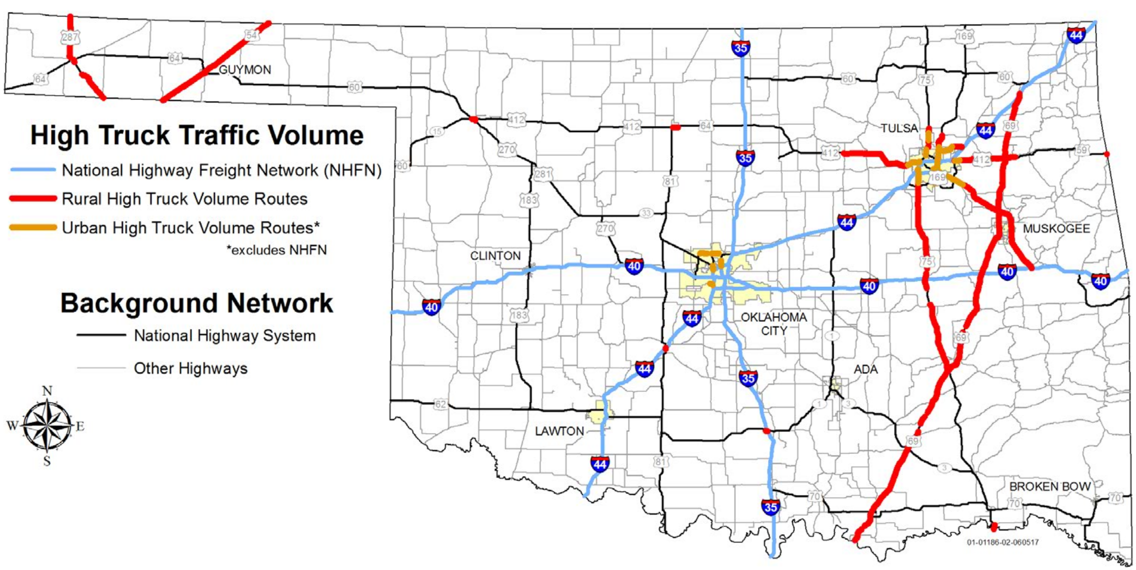


Figure 4.2 High Volume Truck Corridors
Source: Oklahoma Freight and Goods Movement Brochure, 2017

An increase in freight traffic over the period covered by the ODOT TAMP could impact ODOT's progress towards the desired performance goals presented in this chapter for the NHS as well as SHS pavements and bridges. An overall increase in truck traffic has the potential to lead to higher levels of deterioration in the condition of Oklahoma's pavements and bridges – possibly resulting in additional performance gaps or deficiencies with respect to ODOT's performance projections for those assets.

Oklahoma's transportation agencies seek to better meet future growth and demand to support the economy, managing assets in as efficient manner as possible while providing ease of movement. Understanding the best priorities given funding limitations is important to ODOT. A key consideration is determining if the economy and the transportation funding structure can sustain the assets that fulfill those purposes.

Corridor-specific asset management strategies will be explored as a means to integrate the freight plan with the TAMP. The transportation network in Oklahoma has capacity available but there are key locations where there are issues for assets. Many of these locations are near freight hubs where greater freight traffic is present and growing. ODOT is exploring mechanisms to relate the growth in freight traffic with impacts on asset condition. TAM supports Oklahoma's economy through analyses, financial planning, and investment strategies. As the information on growth and demand on the transportation system strengthens, TAM decisions will deliver a stronger transportation system in Oklahoma.

ODOT Future Performance Analysis Methodology

Projecting conditions allows ODOT to determine whether asset performance will meet desired performance goals. This requires a determination of the projected level of funding allocated to assets over the 10-year time frame of the TAMP. For this analysis, ODOT evaluated the following LCP scenarios:

- **Current Funding Scenario.** This scenario reflects performance that can be achieved with projected funding that is expected to be available to ODOT over the 10-year analysis period for pavements. More details on the sources of these funds can be found in Chapter 7.
    - It is important to note that the average annual investment levels described by these analyses are not reflective of the current distribution between Interstate, Non-Interstate NHS and Non-NHS pavements as documented within the Asset Preservation Plan and Construction Work Plan. This is because the PMS was used to optimize available funding independent of these network categorizations.
- **State of Good Repair Scenario.** ODOT has identified a funding level that is capable of maintaining pavements at or near the current condition state as measured by both state and federal measures. This scenario and the resulting projected 10-year conditions levels will be known as the ODOT State of Good Repair.

Pavement Performance Assessment

Although ODOT PMS analysis can directly forecast only the state PQI measure, ODOT has developed a process to correlate section specific forecasts of PQI to section specific federal performance. This process is described in detail in Chapter 2 and is used to provide the federal performance projections described within this section of the document.

Another challenge in forecasting Oklahoma pavement conditions are NHS pavements that are not maintained by ODOT. These present a challenge as funding and maintenance treatment selection are not directly under ODOT's control. As previously highlighted, the primary non-ODOT owner of NHS pavement in Oklahoma is OTA.

Federal condition and target setting requirements apply to the entire Oklahoma Interstate and Non-Interstate NHS systems, a significant portion of which are maintained by OTA. While ODOT cannot directly control OTA pavement maintenance investment, ODOT has worked with OTA to understand their anticipated pavement performance. Through these discussions, it is understood that OTA anticipates sufficient funding and adequate maintenance practice to maintain current pavement performance levels over the 10-year analysis period. Using this assumption, OTA pavement performance has been included in the performance projection provided below.

In addition to these other challenges, an increase in freight traffic could result in performance gaps and deficiencies, requiring additional asset management work activities in order to achieve the desired state of good repair.

Interstate Pavement Projections

Interstate Current Funding Scenario

At current total pavement investment levels for TAM, ODOT optimization analysis from the PMS projects an optimal Interstate investment level to be approximately $55.6 million per year over the next ten years (more details on projected funding are included in Chapter 7). At this funding level, ODOT predicts a decline in Interstate pavement condition over the ten-year analysis period of the TAMP. While the percentage of Good Interstate pavements is projected to increase slightly from 58.1% in 2018 to 59.7% in 2027, the percentage of Poor Interstate pavements is projected to increase from 1.1% in 2018 to 3.9% in 2027 (see Figure 4.3).

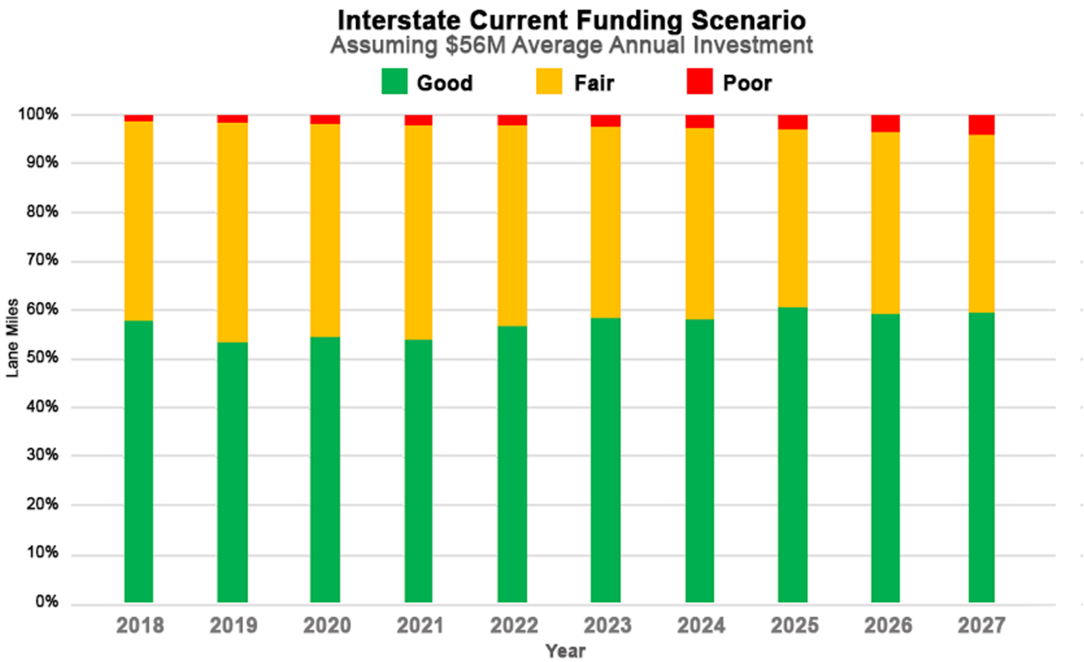


Figure 4.3 Interstate Current Funding Scenario

Interstate Desired State of Good Repair

ODOT identifies the maintaining of current performance of the Interstate system as the desired state of good repair. To inform this decision and support gap identification, the PMS was used to determine an annual investment level necessary to maintain Interstate pavements in their current condition. This analysis excluded maintenance costs of OTA-maintained Interstates, as it was already determined that OTA Interstates would be maintained to current performance levels.

Using the PMS, ODOT determined that an annual budget of $68 million would allow state-maintained Interstate pavements to remain as close as possible to the initial 2018 condition state over the 10-year analysis period.

An annual budget of $68 million for ten years would result in nearly constant pavement conditions as shown in Figure 4.4. The percentage of Good Interstate pavements would increase slightly from 63.4% in 2018 to 65.3% in 2027, the percentage of Fair pavements would decrease slightly from 35.6% to 33.5%, and the percentage of Poor Interstate pavements would increase slightly from 1.0% to 1.3%.

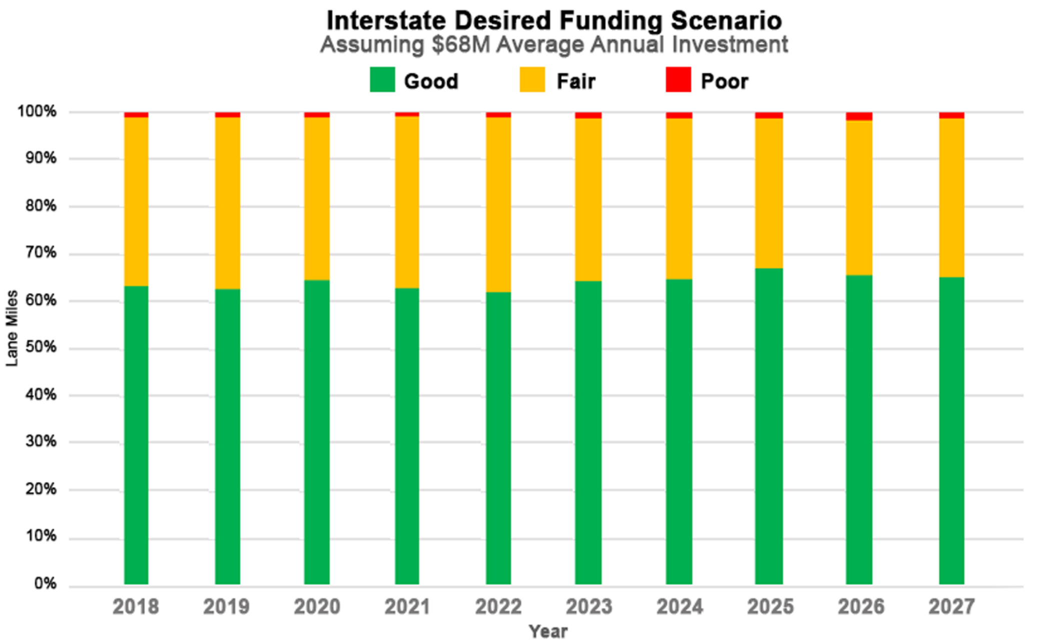


Figure 4.4 Interstate Desired Funding Scenario

Interstate 10-Year Pavement Targets

Due to the decrease in state-sponsored funding, ODOT has made the assumption that the current projected funding levels could be strained even further in the future. Based on current analysis, ODOT has projected the TAMP 10-year Interstate pavement condition targets as 59% in Good condition and 4% in Poor condition.

Non-Interstate NHS Pavement Projections

Non-Interstate NHS Current Funding Scenario

At current total pavement TAM investment levels, ODOT's PMS analysis identified an optimal investment level for Non-Interstate NHS pavements to be approximately $118 million per year over the next ten years. At this funding level, ODOT projects a mixed decline in non-Interstate NHS pavement condition over the 10-year analysis period of the TAMP. While the percentage of Good pavements would increase from 40.9% in 2018 to 48.4% in 2027, the percentage of Poor pavements would also increase from 2.5% in 2018 to 8.6% in 2027 (see Figure 4.5).

This trend in which both Good and Poor conditions increase over time is expected given an optimized investment of limited pavement management funds. The optimal investment strategies emphasize preservation activities such as preventative maintenance or minor rehabilitation which are very cost-effective in maintaining pavement in Good condition or improving Fair pavement to Good condition before it deteriorates and requires more costly rehabilitation or reconstruction activities.

Conversely, an optimized investment strategy avoids costly reconstruction activities, even in a capital program, where rehabilitation of Fair pavements is more cost-effective than attempting to address the worst performing pavement on the network. As a result, there is a tendency for the lowest performing pavements to deteriorate while a reconstruction backlog awaits funding.

It is important to note that while allowing for a backlog of reconstruction to develop is not ideal, under limited funding constraints, it is the most effective way to manage the network. In the long term, if ODOT took a "worst-first" approach, the total backlog of pavements in Poor condition would increase even more dramatically as Good and Fair pavements deteriorated to the point where cost-effective preservation and rehabilitation investment would no longer be effective.

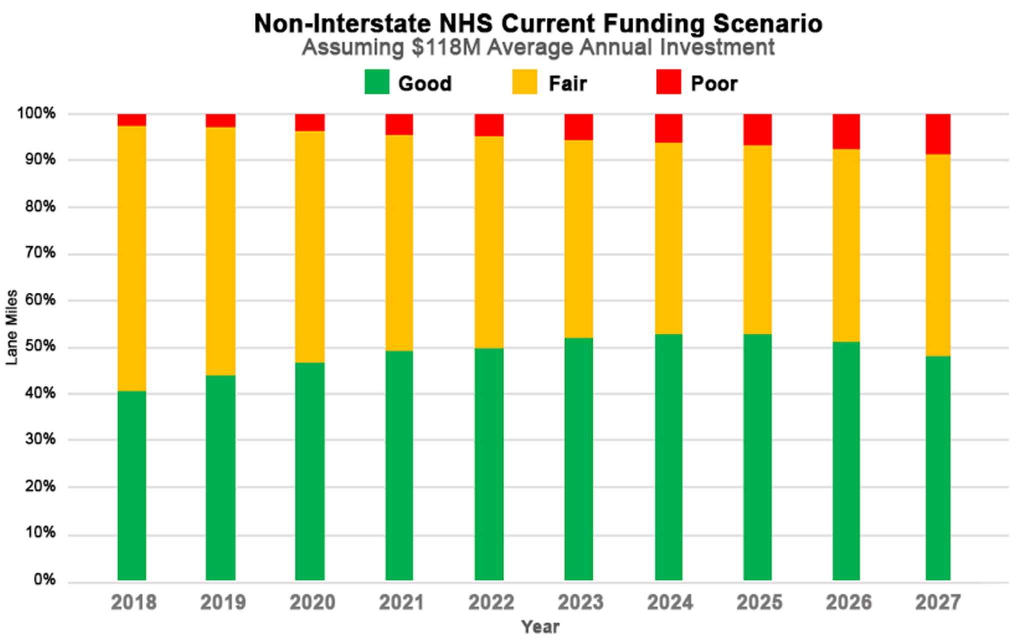


Figure 4.5 Non-Interstate NHS Current Funding Scenario

Non-Interstate NHS Desired State of Good Repair Scenario

ODOT identified the desired state of good repair for Non-Interstate NHS pavements as the maintenance of Non-Interstate NHS pavements in their current condition by the State's PQI-based Good, Fair, Poor metrics. Some decrease in performance by the federal Poor measure is acceptable, though this decline should occur through an understood and managed process.

Using the PMS, ODOT identified that an annual budget of $145 million would allow the Non-Interstate NHS pavement to maintain current state performance while managing federal performance so that there will be a minimal decrease in performance in the federal Poor measure. This annual budget excludes costs for Non-Interstate NHS pavement maintained by OTA.

Figure 4.6 shows that a $145 million annual budget would result in the following: the percentage of federal Good pavements would increase slightly from 47.5% in 2018 to 52.3% in 2027, the percentage of Fair pavements would decrease significantly from 50.1% to 42.0%, and the percentage of federal Poor pavements would increase from 2.4% to 5.7%.

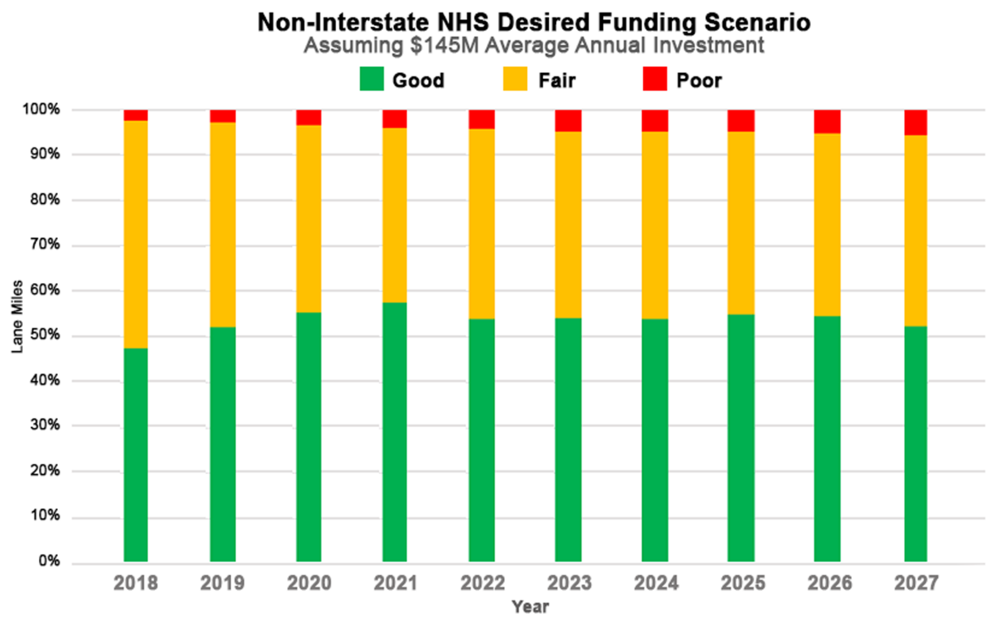


Figure 4.6 Non-Interstate NHS Desired Funding Scenario

Non-Interstate NHS 10-Year Pavement Targets

Based on current analysis, ODOT has projected the TAMP 10-year Non-Interstate NHS pavement condition as 49% in Good condition and 9% in Poor Condition. There is no federal minimum performance level for Non-Interstate NHS pavements. ODOT will set 2 and 4-year pavement condition targets by the federal deadline of May 20, 2018 and will update the TAMP accordingly.

Non-NHS Pavement Projections

Non-NHS Current Funding Scenario

Based on PMS investment optimization analysis of current 10-year pavement TAM funding forecasts, an optimal investment level for Non-NHS Pavement was determined to be approximately $332 million per year over the next ten years. Based on this projected funding, ODOT predicts a decline in Non-NHS pavement condition over the 10-year analysis period of the TAMP. The percentage of Good pavements would increase slightly from 31.3% in 2018 to 36.1% in 2027. Unfortunately, the percentage of Poor pavements would increase significantly from 2.9% in 2018 to 15.9% in 2027 (see Figure 4.7).

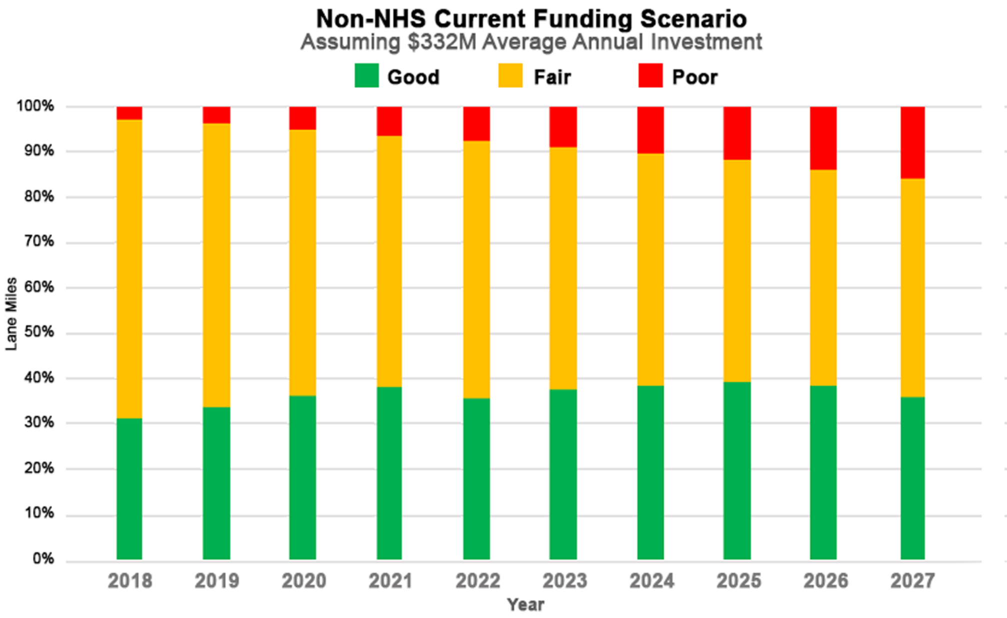


Figure 4.7 Non-NHS Current Funding Scenario

Non-NHS Desired State of Good Repair Scenario

The desired state of good repair identified by ODOT consists of maximizing performance through increased preservation investments while managing Poor pavement with an increased investment in major rehabilitation and reconstruction activities. However, it is recognized that for the Non-NHS pavements it is not practical to maintain existing performance levels with given funding.

Using the PMS, ODOT determined that an annual budget of $525 million would allow ODOT to maintain Good and Fair pavements at acceptable levels. However, even at this increased funding level, pavements requiring reconstruction would continue to deteriorate.

Figure 4.8 shows how under a $525 million annual budget, the percentage of Good pavements would increase from 37.7% in 2018 to 44.7% in 2027, the percentage of Fair pavements would decrease significantly from 59.5% to 44.0%, and the percentage of Poor pavements would increase from 2.8% to 11.3%.

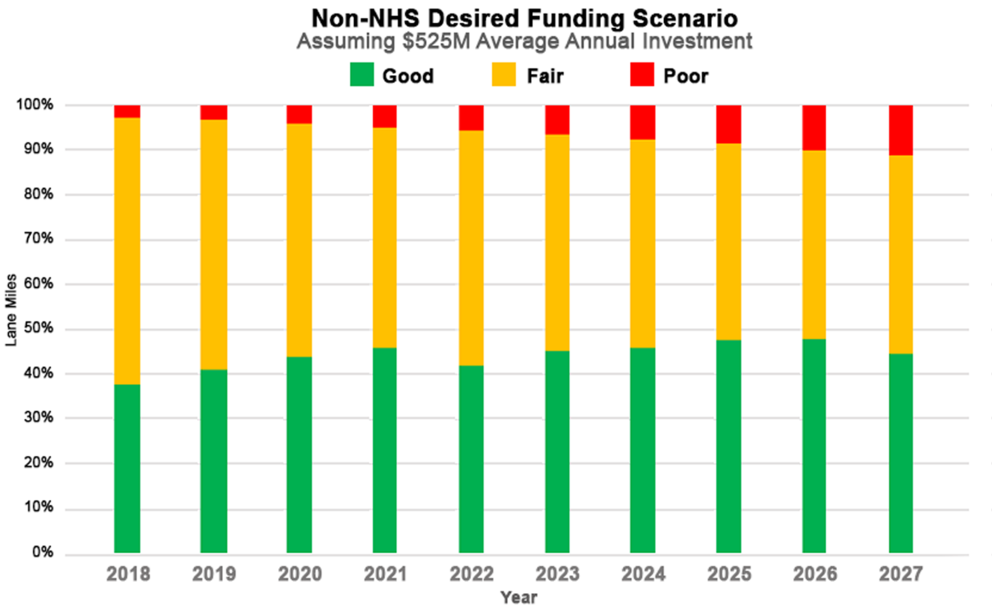


Figure 4.8 Non-NHS Desired Funding Scenario

Non-NHS 10-Year Pavement Targets

Based on the analysis, ODOT has identified the TAMP 10-year Non-NHS pavement condition targets as 35% or more in Good condition, representing a 5% increase in pavements rated in the highest condition state, and 16% or less in Poor Condition, representing almost a 15% increase in pavement rated in the lowest condition state.

Gap Assessment for All Pavements

Table 4.2 displays the gap assessment for Interstate pavements, Non-Interstate NHS pavements, and Non-NHS pavements. For each pavement type:

- The Current Performance is the Present Condition as reported in Chapter 2.
- The 10-year Expected Performance is the projected condition in 2027 based on the baseline funding scenarios presented earlier in this chapter.
- The 10-year Desired State of Good Repair is the projected condition from the desired funding scenarios presented earlier in this chapter.
- The Current Gap is the difference between the 10-year desired State of Good Repair and the Current Performance.
- The 10-year Projected Gap is the difference between the 10-year desired State of Good Repair and the 10-year Expected Performance.

A positive value for a Current Gap or a 10-Year Projected Gap indicates a need to improve conditions. A negative or zero value indicates that no gap currently exists.

Table 4.2 Pavement Gap Assessment

Interstate Pavements	Good	Fair	Poor
Desired State of Good Repair	**65.3%**	**33.5%**	**1.3%**
Current Performance	**65.8%**	**33.5%**	**0.7%**
Current Performance Gap	*(-0.5%)*		*(-0.6%)*
10-Year Projected Performance	**59.7%**	**36.4%**	**3.9%**
10-Year Projected Performance Gap	5.6%		2.6%

Non-Interstate NHS Pavements	Good	Fair	Poor
Desired State of Good Repair	**52.3%**	**42.0%**	**5.7%**
Current Performance	**45.7%**	**52.7%**	**1.6%**
Current Performance Gap	6.6%		*(-4.1%)*
10-Year Projected Performance	**48.4%**	**43.0%**	**8.6%**
10-Year Projected Performance Gap	3.9%		2.9%

Non-NHS Pavements	Good	Fair	Poor
Desired State of Good Repair	**44.7%**	**44.0%**	**11.3%**
Current Performance	**30.0%**	**68.5%**	**1.5%**
Current Performance Gap	14.7%	*(-24.5%)*	9.8%
10-Year Projected Performance	**36.1%**	**48.0%**	**15.9%**
10-Year Projected Performance Gap	6.1%	*(-20.5%)*	14.4%

Federal Performance Management Rule (PM2) 2 and 4-Year Targets

Federal Requirement

Separate from the TAMP, performance gaps relative to the 2-year and 4-year performance targets will be assessed as required by FHWA's PM2 rule. FHWA will assess agency progress towards performance targets biennially against reports submitted by ODOT.

NHS 2 and 4-Year Interstate Projections (Implied)

For the federal 2 and 4-year target requirement from PM2, ODOT will start with the projections derived from the Current Scenario analysis described previously. These targets are included in the Initial TAMP as implied 2 and 4-year targets. ODOT will set pavement condition targets by the federal deadline of May 20, 2018 and will update the TAMP accordingly.

Table 4.4 shows the Interstate projections to be 1.6% Poor in Year 2, rising to 2.0% Poor in Year 4. These short-term projected outcomes reflect recent budget cuts and ODOT's understanding of the managed decline.

Table 4.3: 2-Year and 4-Year Interstate Projections

2-Year and 4-Year Performance Projections			
Year	Good	Fair	Poor
2020 (2-Year Performance Projection)	54.7%	43.7%	1.6%
2022 (4-Year Performance Projection)	57.0%	41.0%	2.0%

Similarly, Table 4.3 shows a similar projection for Non-Interstate NHS pavements. The Year 2 projection is 3.5% Poor, and the Year 4 projection rises to 4.8% Poor.

Table 4.4: 2-Year and 4-Year Non-Interstate NHS Projections

2-Year and 4-Year Performance Projection Oklahoma Non-Interstate NHS (All)			
Year	Good	Fair	Poor
2020 (2-Year Performance Projection)	47.1%	49.4%	3.5%
2022 (4-Year Performance Projection)	50.1%	45.1%	4.8%

Bridge Performance Assessment

Methodology

Projecting conditions allows ODOT to determine whether asset performance will meet performance goals. This requires a determination of the projected level of funding allocated to assets over the 10-year time frame of the TAMP. To project federal bridge conditions, ODOT used the FHWA's NBIAS solution, based on the federal practice of measuring structurally deficient bridges by deck area, to show the differences in performance at different budget levels. For this analysis, ODOT evaluated the following LCP scenarios:

- A **Current Funding Scenario**, which reflects the funding ODOT is currently projecting over the 10-year analysis period for bridges.
- A **State of Good Repair Scenario**, that can maintain bridges at or near the current conditions levels, will be identified as the ODOT State of Good Repair.

Both scenarios may be impacted by factors – such as an increase in freight traffic – that could result in additional performance gaps and deficiencies. For example, even as additional asset management work activities may be required to address accelerated bridge deterioration on routes with a high volume and percentage of truck traffic, resources may also be needed to address issues such as limited vertical clearances or bottlenecks due to narrow bridge widths as increased freight traffic extends to new routes. ODOT's bridge projections will benefit in the future from increasing coordination with the ODOT Freight Transportation Plan to address these and other related issues.

NHS Bridge Projections

The federal analysis requirement applies to all NHS bridges and does not isolate bridges by category such as Interstate or Non-Interstate NHS.

ODOT performs inspections on every bridge in Oklahoma, so the OTA data and the Local NHS bridge data is available for analysis. ODOT does not have access to budget information for those agencies, so assumptions will be made in this projected analysis. This analysis includes all OTA bridges and assumes OTA bridge conditions will remain constant for this 10-year period. This assumption is based on the belief OTA will earn adequate toll revenues to provide sufficient funding levels to maintain OTA bridges.

NHS Bridges Current Funding Scenario

The current funding scenario projects spending $90.8 million per year on NHS bridges (more details on projected funding are included in Chapter 7). Figure 4.9 shows that under the current funding scenario there will be an increase in the percentage of bridges in Poor condition over the 10-year analysis period of the TAMP. While the percentage of Good bridges will increase from 56.2% in 2018 to 64.4% in 2027, the percentage of Poor bridges will also increase from 4.5% in 2018 to 7.5% in 2027.

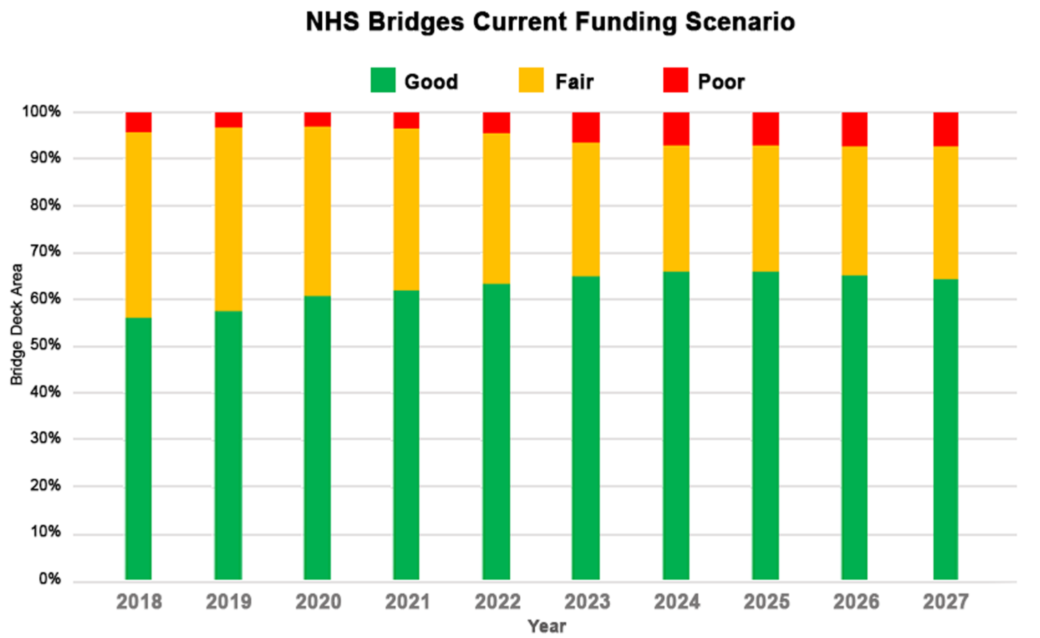


Figure 4.9 NHS Bridges Current Funding Scenario

NHS Bridges Desired State of Good Repair

As with pavements, ODOT identifies the desired state of good repair for the NHS bridges as the investment level necessary to maintain bridges in current conditions. For bridges, a state of good repair would require maintaining 47.9% of bridges in Good condition and keeping the percentage of Poor bridges under 3.6%.

NHS 10-Year Bridge Targets

The current funding scenario forecasts that the ten-year target for bridge performance will be 60% in Good condition and 8.5% in Poor Condition. Given recent funding cuts and the current fiscal outlook ODOT has concerns that the funding could be reduced further resulting in even more decline in the target condition.

Non-NHS Bridge Projections

Federal analysis is not required for Non-NHS bridges. ODOT made the decision to include these optional additional assets in the TAMP. ODOT performs the NBI bridge inspections for these assets and has sufficient data to fully perform this analysis.

Non-NHS Bridges Current Funding Scenario

The current funding scenario projects spending $282.8 million per year on Non-NHS bridges (more details on projected funding are included in Chapter 7). Figure 4.10 shows that under the current funding scenario there will be a decrease in the percentage of bridges in Poor condition over the 10-year analysis period of the TAMP. While the percentage of Good bridges will remain constant from 42.3% in 2018 to 42.4% in 2027, the percentage of Poor bridges, while experiencing some fluctuation, will decrease respectably from 8.3% in 2018 to 6.4% in 2027.

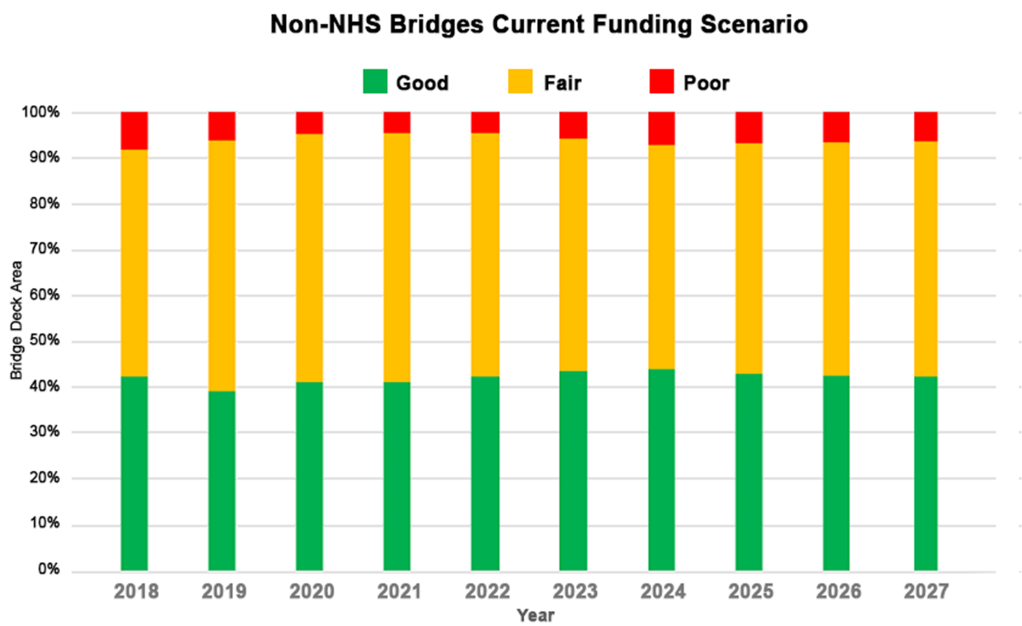


Figure 4.10 Non-NHS Bridges Current Funding Scenario

Non-NHS Bridges Desired State of Good Repair

As with NHS bridges, ODOT identifies the desired state of good repair for Non-NHS bridges as the investment level necessary to maintain bridges in their current condition. For bridges, a state of good repair would mean maintaining 48.9% of bridges in Good condition and keeping the percentage of Poor bridges under 7.4%.

Non-NHS 10-Year Bridge Targets

The recent funding cuts and political climate have influenced ODOT to assume that the current projected funding levels, while currently valid, could be strained even further in the future. Based on this analysis, ODOT has projected the TAMP 10-year Non-NHS bridge condition targets as 40% in Good condition and 7.5% in Poor condition.

Gap Assessment for NHS and Non-NHS Bridges

Table 4.5 displays the gap assessment for NHS and Non-NHS bridges. For each bridge type:

- The Current Performance is the Present Condition as reported in Chapter 2.
- The 10-year Expected Performance is the projected condition in 2027 based on the current funding scenarios presented earlier in this chapter.
- The 10-year Desired State of Good Repair is the projected condition from the desired funding scenarios presented earlier in this chapter.
- The Current Gap is the difference between the 10-year desired State of Good Repair and the Current Performance.
- The 10-year Projected Gap is the difference between the 10-year desired State of Good Repair and the 10-year Expected Performance.

A positive value for a Current Gap or a 10-Year Projected Gap indicates a need to improve conditions. A negative or zero value indicates that no gap currently exists.

Table 4.5 Bridge Gap Assessment

NHS Bridges (deck area)	Good	Fair	Poor
Desired State of Good Repair	**47.9%**	**48.5%**	**3.6%**
Current Performance	**47.9%**	**48.5%**	**3.6%**
Current Performance Gap	0.0%		0.0%
10-Year Projected Performance	**64.4%**	**28.1%**	**7.5%**
10-Year Projected Performance Gap	*(-16.5%)*		3.9%

Non-NHS Bridges (deck area)	Good	Fair	Poor
Desired State of Good Repair	**48.9%**	**43.7%**	**7.4%**
Current Performance	**48.9%**	**43.7%**	**7.4%**
Current Performance Gap	0.0%		0.0%
10-Year Projected Performance	**42.4%**	**51.2%**	**6.4%**
10-Year Projected Performance Gap	6.5%	*(-7.5%)*	*(-1.0%)*

NHS 2 and 4-Year Projections (Implied)

In a separate federal rule, Oklahoma is required to report 2 and 4-year targets for the federal performance measures. For this requirement ODOT will start with the projections derived from the Current Scenario analysis described previously. This is included in the Initial TAMP as implied 2 and 4-year targets. ODOT will set pavement condition targets by the federal deadline of May 20, 2018 and will update the TAMP accordingly.

Table 4.6 shows bridge performance projections to be 3.3% Poor in Year 2, rising to 4.7% Poor in Year 4.

Table 4.6 2-Year and 4-Year Bridge Condition Projections

2-Year and 4-Year Performance Projection Oklahoma NHS Bridges (All)			
Year	Good	Fair	Poor
2020 (2-Year Performance Projection)	**60.7%**	**36.0%**	**3.3%**
2022 (4-Year Performance Projection)	**63.3%**	**32.0%**	**4.7%**

Chapter 5

Life Cycle Planning

Life Cycle Planning (LCP) is a network-level adaptation of the principles of the project level life cycle cost analysis approach. The principle of LCP is that timely investments in an asset's maintenance, preservation, and rehabilitation result in improved condition and lower overall long-term costs. An optimal mix of treatments is best determined by advanced pavement and bridge management systems, using predictive modeling along with a fundamental understanding of the costs, benefits, and service life extensions for different treatment types.

Overview

LCP focuses on a proactive preservation approach to maintaining assets and works to significantly reduce a reactive maintenance approach. According to the federal definition, LCP is 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. Figure 5.1 shows the life cycle cost benefit of proactive preservation over reactive maintenance.

Federal Requirements

FHWA defines a LCP strategy as a collection of treatments that represent the entire life of an asset class or sub-group. A state's LCP process must include potential treatments across the life of each asset class or sub-group with their relative unit costs (23 CFR 515.7(b)). The following elements are required in a state's LCP process:

- Asset performance targets for each asset class or sub-group
- Deterioration models for each asset class or sub-group
- A strategy for managing each asset class or sub-group by minimizing its life cycle costs while achieving performance targets
- Using the best available data
- Implementation of both pavement and bridge management systems to help make data-driven investment decisions
- Development and use of a Data Quality Management Program

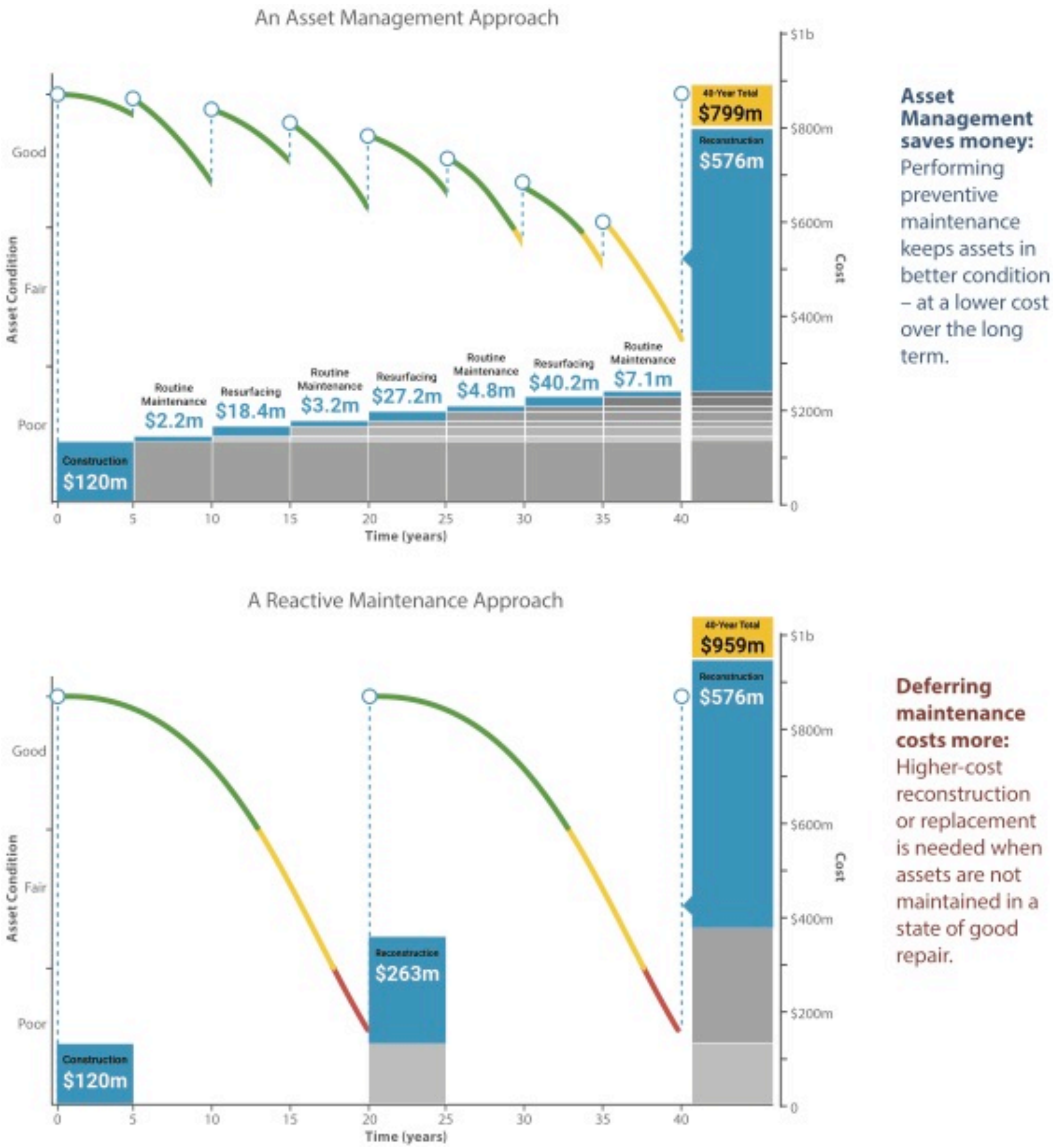


Figure 5.1 Proactive Preservation vs. Reactive Maintenance
Source: RIDOT – based on an analysis published by TXDOT, compiled for Caltrans

Benefits of Life Cycle Planning

As an example, consider how LCP applies to a bridge. Each time an element of a bridge deteriorates to a worse condition, one or more additional treatments such as repairs or rehabilitation become feasible. Many of these treatments have the potential to extend the service life of the bridge, but each also has a cost. The Bridge Management System (BMS) estimates the life cycle cost to keep the bridge in service with and without the treatments in order to see which alternative provides the maximum benefit while minimizing the long-term costs.

Certain kinds of preventive maintenance actions are highly cost-effective so long as they are performed at the optimal time. For example, repainting a steel bridge before it has extensive rust is highly effective in prolonging its life. If painting is delayed past the most effective application time, the steel structure will rust so much that painting will no longer be effective, requiring significantly more expensive rehabilitation or replacement options.

National Cooperative Highway Research Program (NCHRP) Report 859 quantifies the consequences of delayed maintenance or preservation, including degraded pavement conditions, more advanced and costly treatments, and a reduction in Level of Service. Additionally, the report describes how delayed maintenance can:

- Generate user discomfort
- Increase exposure to accidents
- Increase fuel usage
- Increase damage to vehicles
- Increase air pollution due to greater traffic congestion
- Increase harmful vehicle fuel emissions

Life Cycle Planning Methodology Summary

The following sections detail the methodology for ODOT's LCP for NHS pavement and bridge assets. ODOT's existing LCP practices are based on the long-term use of pavement and bridge management systems that process annual data collection and condition ratings (ODOT implemented Deighton's dTIMS PMS in 2001). These management systems use advanced deterioration modeling based on input developed over years of condition data and treatment history data.

Interstate pavements, Non-Interstate NHS pavements, and bridges make up the asset classes, while asset sub-groups for pavements include Asphalt, Jointed Concrete Pavement, and Continuously Reinforced Concrete Pavements. Bridge asset sub-groups include concrete bridges and steel bridges.

Pavement Life Cycle Planning

Pavement Modeling Approach

The PMS is the heart of pavement LCP at ODOT. The Pavement Management Branch uses the PMS to analyze the outcome of various budget scenarios to determine potential outcomes. This systematic process allows ODOT to determine the budget needed to achieve desired targets as well as the budget needed to achieve realistic targets. The PMS is then used to analyze the actual predicted budget for the analysis period. This actual budget helps to determine if ODOT can achieve either its desired or realistic targets.

The Pavement Management Branch has developed deterioration models based on historical condition data maintained within the PMS. Figure 5.2 is a graphical representation of the pavement deterioration models. It shows that if ODOT did not perform any sustaining pavement treatments based on ODOT deterioration curves and Pavement Management Data, a typical asphalt pavement would deteriorate from a perfect 100 PQI to a poor 72 PQI after approximately 20 years, while a concrete pavement is expected to last 35 years.

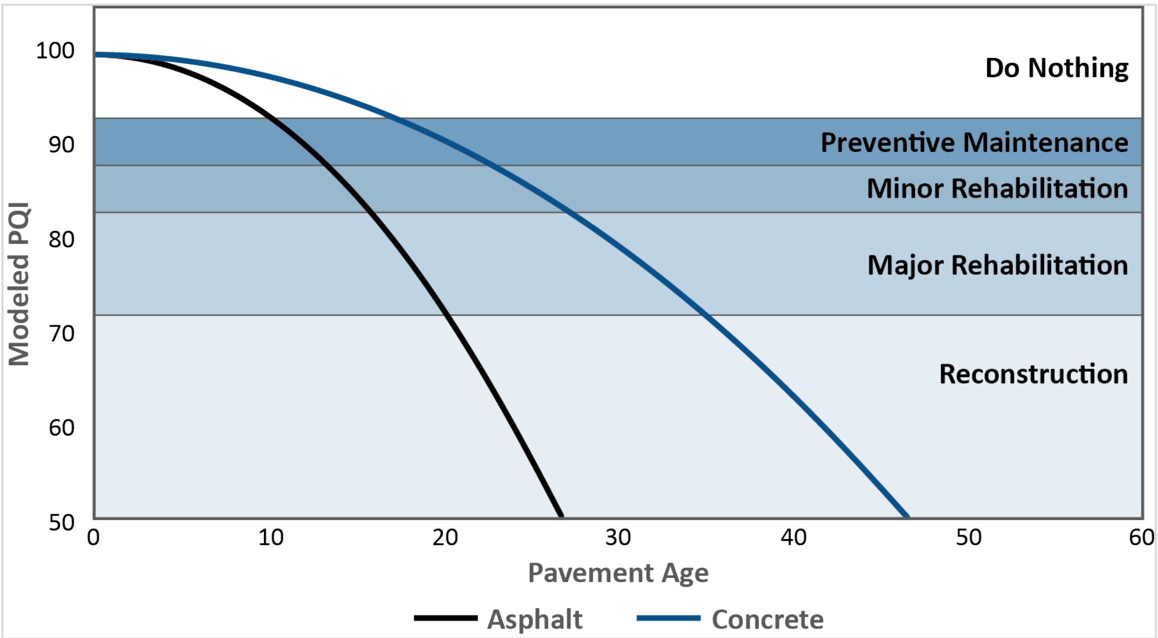


Figure 5.2 ODOT Network-Level Deterioration Models and Treatment Categories

Current pavement conditions are combined with condition deterioration models and modeled treatment benefits to project future pavement conditions. The resulting condition forecasts serve as the basis of ODOT's multi-year pavement needs and investment optimization analysis.

Pavement Treatments

ODOT Pavement Management has four network-level pavement maintenance treatment categories: Preservation, Minor Rehabilitation, Major Rehabilitation, and Reconstruction. Additionally, a shoulder reconstruction treatment category is applied on Major Rehabilitation projects when deficient shoulders are identified and on all Reconstruction projects.

Pavement treatment unit costs include a cost for pavement activities as well as a total project unit cost (excluding shoulder costs), which includes additives for non-paving-related expenses. These costs are modeled on anticipated traffic demand and pavement type, ensuring that changing demands on a given section of pavement will lead to adjustments in pavement maintenance needs. An example from ODOT's TAM current practices manual shows the impact of traffic volume on the cost and scope of a pavement intervention when performing major rehabilitation of an asphalt concrete pavement. Major Pavement Rehabilitation is modeled as a 4" mill and overlay for low-traffic sections, whereas a 7" mill and overlay is expected for high-traffic sections.

Table 5.1 provides a summary of typical costs and treatment descriptions for ODOT's network-level pavement maintenance treatment categories by pavement type, including asphalt concrete pavement (ACP), Jointed Concrete Pavement (JCP), and Continuously Reinforced Concrete Pavement (CRCP).

Table 5.1 ODOT Pavement Treatment Costs and Treatment Type Descriptions

ODOT Pavement Treatment Costs and Treatment Type Descriptions				
Treatment Category	**Pavement Type**	**Traffic Volume***	**Project Cost / LM**	**Treatment Type Description**
Preservation	ACP	Low	$22,333	Chip Seal
	ACP	Medium	$37,600	Ultra-Thin Bonded Wearing Course
	ACP	High	$61,519	1.5" AC Overlay
	JCP	Low	$27,973	Joint Seal, 2% Patching
	JCP	Medium	$30,515	Joint Seal, 2% Patching
	JCP	High	$33,049	Joint Seal, 2% Patching
	CRCP	-	$20,184	Joint Seal, 2% Patching
Minor Rehab	ACP	Low	$105,146	Cold Mill, 2.0" AC Overlay
	ACP	Medium	$126,259	Cold Mill, 2.5" AC Overlay
	ACP	High	$148,612	Cold Mill, 3.0" AC Overlay
	JCP	Low	$142,443	Joint Seal, 5% Patching, Diamond Grind, DBR
	JCP	Medium	$154,954	Joint Seal, 5% Patching, Diamond Grind, DBR
	JCP	High	$169,431	Joint Seal, 5% Patching, Diamond Grind, DBR
	CRCP	-	$80,744	Joint Seal, 5% Patching, Diamond Grind
Major Rehab	ACP	Low	$190,873	Cold Mill, 4.0" AC Overlay
	ACP	Medium	$229,171	Cold Mill, 5.0" AC Overlay
	ACP	High	$268,801	Cold Mill, 7.0" AC Overlay
	JCP	Low	$313,148	Joint Seal, 15% Patching, Diamond Grind, DBR
	JCP	Medium	$341,262	Joint Seal, 15% Patching, Diamond Grind, DBR
	JCP	High	$371,558	Joint Seal, 15% Patching, Diamond Grind, DBR
	CRCP	-	$199,634	Joint Seal, 15% Patching, Diamond Grind
Reconstruction	ACP	Low	$535,616	8" AC Pavement
	ACP	Medium	$621,870	10" AC Pavement
	ACP	High	$706,649	12" AC Pavement
	JCP	Low	$632,695	9" DJCP Pavement
	JCP	Medium	$694,189	11" DJCP Pavement
	JCP	High	$724,936	12" DJCP Pavement
	CRCP	-	$1,187,640	12" CRCP Pavement

*Low traffic volume is defined as 0 to 2000 annual average daily traffic (AADT), medium is between 2000 and 10,000 AADT, and high is above 10,000 AADT.

Investment in a selected treatment category benefits a pavement by reducing distresses and reducing the rate of pavement condition deterioration. ODOT has established network-level treatment models that characterize this benefit in the form of a reset or reduction of the pavement's effective age (see Table 5.2).

Table 5.2 Modeled Pavement Treatment Benefits

Modeled Pavement Treatment Benefits	
Treatment Category	Modeled Treatment Benefit
Preservation	Pavement Effective Age reduced by 5 Years
Minor Rehab	Pavement Effective Age reduced by 7 Years
Major Rehab	Pavement Effective Age reduced by 15 Years
Reconstruction	Pavement Effective Age reset to 0

Preservation Treatment Selection

ODOT identifies pavement preventative maintenance and minor rehabilitation needs based on the PQI approach. In addition, ODOT's Pavement Management Branch also provides detailed decision trees to support project-level decision making and treatment selection for preservation projects.

The project-level Pavement Preservation Projects (3P) Decision Trees ensure that the best candidate treatment is selected for a given pavement preservation intervention. (The 3P decision trees are included as Appendix A.) Appropriate timing with respect to observed pavement distresses is important because performance of preservation treatments is highly dependent on selecting "the right treatment on the right road at the right time," according to the National Center for Pavement Preservation. 3P Decision Trees are strictly project-level tools that are not applied to network-level forecasted condition assessments used for optimization analysis. The project-level 3P Decision Trees provide pavement preservation treatment recommendations based on pavement type and individual distress index values summarized for the pavement subsection. As an example, key criteria within the decision tree for asphalt pavement include:

1. Structural Index – extent of fatigue or wheel path cracking
2. Rut Index – extent of rutting
3. Functional Index – extent of transverse or block cracking

Preservation treatment selection is based on the actual pavement distresses. For example, appropriate preservation treatments for a segment of asphalt pavement can vary from a low-cost chip sealing when limited cracking is present to more substantial asphalt concrete overlays or hot in-place recycling activities when higher widths of rutting or cracking are present.

Pavement LCP Approach

The PMS determines the treatments or strategies for an asset class (such as Interstate or Non-Interstate NHS) and asset sub-class (such as Asphalt or Jointed Concrete Pavement) to be employed in any given year while maximizing cost-benefit decisions. The PMS performs this analysis for each homogeneous pavement section. Table 5.3 presents an example of potential treatments that might be used for different pavement types.

Table 5.3 Example Pavement Life Cycles

Pavement Life Cycles				
Treatment	**Pavement Type**	**Pavement**	**Project**	**Cost Description**
Preservation Preventative Maintenance	ACLV	$19,782	$22,333	Chip Seal
	ACMV	$32,820	$37,600	Ultra Thin Bonded Wearing Course
	ACHV	$53,698	$61,519	1.5" AC Overlay
	JCLV	$24,417	$27,973	Joint Seal, 2% Patching
	JCMV	$26,636	$30,515	Joint Seal, 2% Patching
	JCHV	$28,847	$33,049	Joint Seal, 2% Patching
	CRCP	$17,618	$20,184	Joint Seal, 2% Patching
Preservation Minor Rehab	ACLV	$87,428	$105,146	Cold Mill, 2.0" AC Overlay
	ACMV	$104,983	$126,259	Cold Mill, 2.5" AC Overlay
	ACHV	$123,570	$148,612	Cold Mill, 3.0" AC Overlay
	JCLV	$118,441	$142,443	Joint Seal, 5% Patching, Diamond Grind, DBR
	JCMV	$128,843	$154,954	Joint Seal, 5% Patching, Diamond Grind, DBR
	JCHV	$140,881	$169,431	Joint Seal, 5% Patching, Diamond Grind, DBR
	CRCP	$67,138	$80,744	Joint Seal, 5% Patching, Diamond Grind, DBR
Major Rehab	ACLV	$147,749	$190,873	Cold Mill, 4.0" AC Overlay
	ACMV	$177,394	$229,171	Cold Mill, 5.0" AC Overlay
	ACHV	$208,070	$268,801	Cold Mill, 7.0" AC Overlay
	JCLV	$242,397	$313,148	Joint Seal, 15% Patching, Diamond Grind, DBR
	JCMV	$264,160	$341,262	Joint Seal, 15% Patching, Diamond Grind, DBR
	JCHV	$287,611	$371,558	Joint Seal, 15% Patching, Diamond Grind, DBR
	CRCP	$154,530	$199,634	Joint Seal, 15% Patching, Diamond Grind
Reconstruction	ACLV	$374,578	$535,616	8" AC Pavement
	ACMV	$434,899	$621,870	10" AC Pavement
	ACHV	$494,189	$706,649	12" AC Pavement
	JCLV	$466,764	$632,695	9" DJCP Pavement
	JCMV	$512,131	$694,189	11" DJCP Pavement
	JCHV	$534,815	$724,936	12" DJCP Pavement
	CRCP	$872,392	$1,187,640	12" CRCP Pavement
Shoulder	ACLV	$294,823	$421,573	8" AC Pavement
	ACMV	$382,882	$547,489	10" AC Pavement
	ACHV	$490,359	$701,174	12" AC Pavement
	JCLV	$348,865	$472,883	9" JC Pavement
	JCMV	$382,890	$519,004	11" JC Pavement
	JCHV	$399,903	$542,065	12" JC Pavement
	CRCP	$399,903	$544,412	12" JC Pavement

Pavement Data Management

Pavement Surface Condition Data Collection

Each year ODOT collects pavement condition data and roadway geometric elements for the entire state-maintained highway system as well as the Non-ODOT-owned NHS. This data is used for a range of pavement management and reporting purposes, including managing system conditions, assessing funding needs, and guiding the project-level decision making of Field Division staff. This data is summarized and published in ODOT Division Notebooks which are provided for use by Field Division staff in combination with available field knowledge of system needs to identify the lowest life-cycle cost investment strategy to achieve ODOT performance goals.

ODOT Pavement Distress Data

ODOT's data collection contractor uses a state-of-the-art 3D Laser Crack Measurement System (LCMS) to capture detailed road surface distress, transverse profile, and rutting data. This LCMS data is processed according to ODOT specifications into various detailed distress classifications and severities for use in ODOT pavement condition rating and pavement management decision making. ODOT reports these distresses and IRI data in the HPMS on an annual basis. Table 5.4 provides a summary of those distress measurements.

Table 5.4 Detailed Pavement Distress Measures

Asphalt Concrete Pavement		Jointed Concrete Pavement		Continuously Reinforced Concrete Pavement	
Distress	**Severity**	**Distress**	**Severity**	**Distress**	**Severity (1-4)**
Fatigue Cracking	1-3	Corner Breaking	1-2	Longitudinal Cracking	1-2
Transverse Cracking	1-4	"D" Cracking	1-2	Punchouts	1-3
Misc. Cracking	1-3	Longitudinal Cracking	1-2	Patching	AC & PC
Pavement Patching	-	Transverse Cracking	1-2		
Pothole Patching	-	Multi-Cracked Slab	1-2		
Raveling	-	Joint Spalling	1-2		
		Joint Patching	AC & PC		
		Slab Patching	AC & PC		

Data Aggregation and Summarization

After data collection and validation, raw pavement surface condition data is aggregated from 0.01-mile collection sections into the ODOT inventory subsections by the Pavement Management Branch. These inventory subsections form the basis of ODOT pavement management decision making and reporting.

Pavement Condition Data Analysis

ODOT Project-Level Analysis

Each pavement type has several summary condition indices as well as an overall PQI that can be calculated based on aggregated subsection pavement distress data. Each index is calculated on a 0-100 scale based on associated distress information. These indices are then weighted and combined to calculate the PQI. Details of the PQI methodology are provided in Table 5.5.

Once finalized, all information is loaded into the PMS for analysis and reporting by Pavement Management Branch staff.

Table 5.5 PQI Construct by Pavement Type

PQI Construct by Pavement Type			
Pave Type	**Index**	**PQI Weight**	**Description**
Asphalt Concrete Pavement	Ride	40%	Based on average IRI: • 100 *(Average IRI ≤ 60)* • 0 *(Average IRI ≥ 310)*
	Rut	20%	Based on average transverse rutting (measured in inches): • 100 *(Average Rutting ≤ 0.1")* • 0 *(Average Rutting ≥ 0.66")*
	Functional	20%	Based on Transverse & Misc. Cracking and Raveling
	Structural	20%	Based on Fatigue Cracking, Patching and Potholes
Jointed Concrete Pavement	Ride	40%	Based on average IRI: • 100 *(Average IRI ≤ 60)* • 0 *(Average IRI ≥ 310)*
	Fault	30%	Based on faulting between slabs (measured in inches): • 100 *(Average Faulting = 0")* • 0 *(Average Faulting ≥ 0.25")*
	Joint	10%	Based on Joint Spalling, Cracking, and Patching
	Slab	20%	Based on Slab Transverse, Longitudinal and Multi-Cracking, Slab Patching, and Corner Breaks
Continuously Reinforced Concrete Pavement	Ride	40%	Based on average IRI: • 100 *(Average IRI ≤ 60)* • 0 *(Average IRI ≥ 310)*
	Structural	60%	Based on Punchouts, Longitudinal Cracking, and Patching

Results from annual pavement condition surveys are published in annual Division Notebooks in both tabular and map formats (see Figure 5.3 for an example). These Division Notebooks serve as a critical communication and decision-making tool for Field Division staff, ensuring not only that the most appropriate cost-effective LCP pavement management decisions are made, but that they are coordinated with the Construction Work Plan (CWP), Asset Preservation Plan (APP), and Bridge programs.

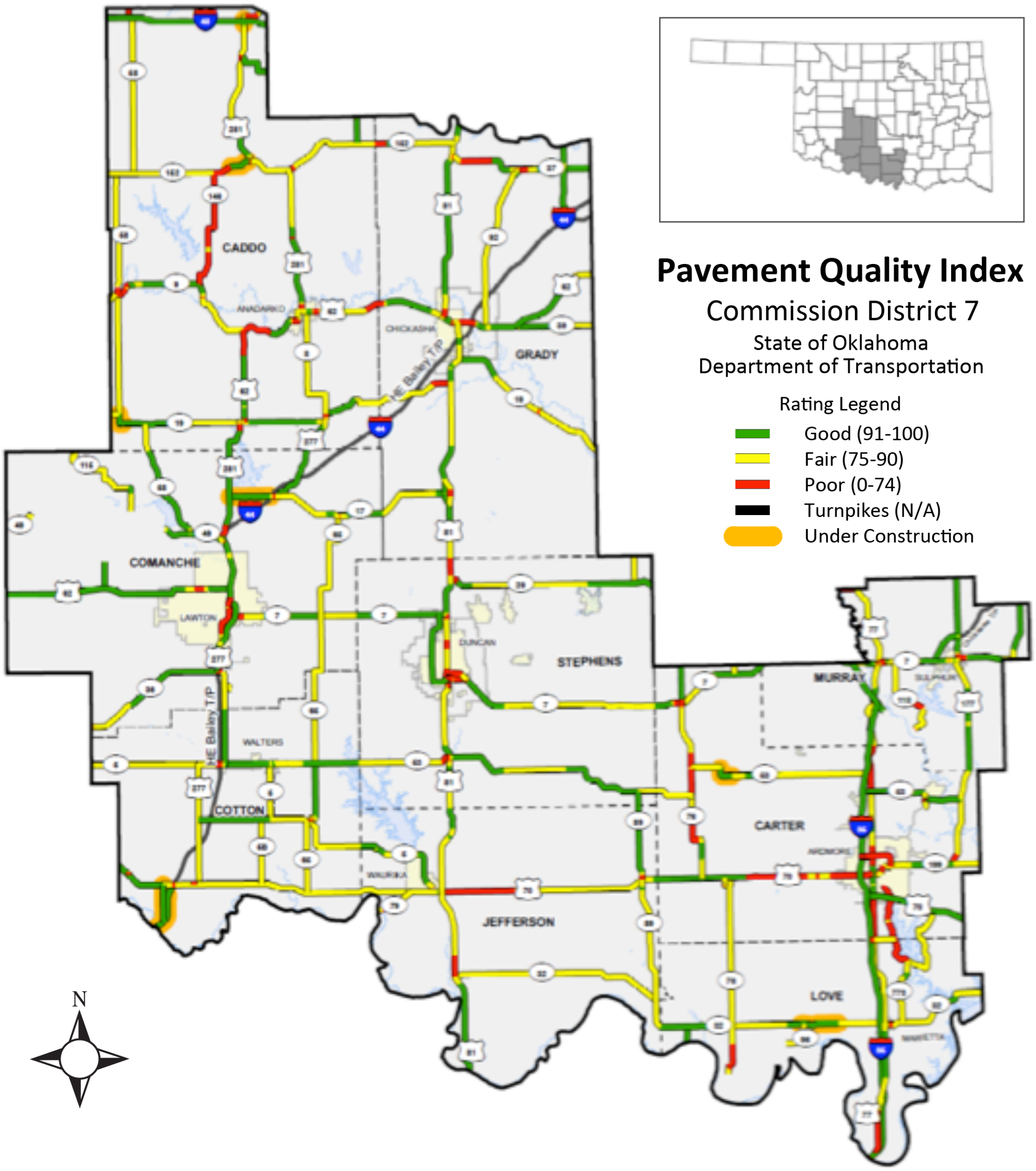


Figure 5.3 Example PQI Map (2017 Division 7 Notebook)

Data Quality Assurance and Quality Control

The Pavement Management Branch is confident in the accuracy of detailed road surface distress, transverse profile, and rutting data obtained in the data collection process. The data collection contractor uses an internal data quality control program, which includes weekly verification of system accuracy, and ODOT runs 40 internal checks for data validation prior to acceptance. In order to comply with federal requirements for pavement data quality, ODOT will formalize the details of the existing quality assurance and quality control process into a required Data Quality Management Plan (23 CFR 490.319(c)).

Bridge Life Cycle Planning

Bridge Modeling Approach

Similar to the PMS, the BMS is the heart of bridge LCP at ODOT and supports compliance with federal requirements. First, the BMS analyzes each bridge to predict the needs for that bridge. Next, the BMS identifies the most appropriate repair treatment at the right time, which provides the lowest life cycle cost over time.

The BMS is also used to analyze the outcomes of various budget scenarios. This process allows ODOT to determine the most appropriate budgets to achieve both desired and realistic targets. The BMS is also used to analyze the actual predicted budget for an analysis period.

ODOT currently uses two different systems that together meet FHWA's requirements for a BMS. The AASHTO BrM is used for maintaining inventory and inspection data. In addition, ODOT uses the FHWA National Bridge Investment Analysis System (NBIAS) to model bridge investment needs. FHWA uses NBIAS data to predict future bridge investment needs and performance for the biennial Conditions and Performance Report, which FHWA and the Federal Transit Administration provide to Congress on the status of the transportation infrastructure.

The basis of LCP is a deterioration model. The BMS contains deterioration models for each structural element on a bridge, including the bridge deck, superstructure elements such as girders and beams, and substructure elements such as columns and pier walls. The condition of each element is described using a set of condition levels, and a deterioration model is specified by describing the likelihood of transition from one condition state to another in a given year. The deterioration models in NBIAS are specified for nine different climate zones and were assembled by FHWA from element model provided by different states. These models were in turn developed through a combination of historical analysis and expert judgment.

Once a bridge inventory has been established, NBIAS predicts maintenance, repair, and rehabilitation needs along with functional improvement investment needs. It then simulates allocation of a given budget to the bridge inventory over time with the objective of maximizing user benefits and minimizing agency costs. When performing an analysis, the BMS executes a series of simulations with different annual budgets. The BMS presents its results through a series of reports and interactive views that allow for interpolating results between different budget scenarios.

Bridge Treatments

ODOT performs a range of treatments on its bridges. These include relatively low-cost preservation treatments that can extend the life of a bridge, rehabilitation treatments for bridges in Fair or Poor condition, and component or full bridge replacement.

Table 5.6 identifies treatments typically performed by ODOT and notes how these are modeled in NBIAS. Table 5.6 also shows a typical unit cost for each treatment. In NBIAS some of the treatments listed, including bridge replacement, deck replacement, deck flood coat, joint replacement and deck overlay, are explicitly modeled using the same units of measure as that shown in Table 5.6. In other cases, such as for painting and concrete repairs, NBIAS uses different unit costs for different bridge elements (such as girders, beams, and stringers), and the units of measure may be different from that shown in Table 5.6. Bridge rehabilitation is not specifically modeled by NBIAS but is accomplished by performing different actions to different bridge elements. Deck Washing and Drift Removal are not modeled in NBIAS. To the extent these activities impact deterioration, this needs to be incorporated in the deterioration models, and the cost for these activities need to be considered outside of the NBIAS simulation.

To compare ODOT costs with those in NBIAS, ODOT compared the default costs in the NBIAS 4.2 2014 database with those used by ODOT where the treatment is explicitly modeled in NBIAS and found a good match between the NBIAS default (which is adjusted state-by-state) and the ODOT cost. Further, ODOT performed a calibration run in NBIAS in which bridge conditions from 2008 were used as input to the system, and conditions from 2008 to 2017 were modeled using actual expenditures from this period. The result of this analysis is that predicted conditions closely matched actual conditions in terms of percentage of bridges in Poor condition (the predicted percent Poor different from the actual by 0.2%). Given the close agreement between directly comparable treatment costs and the modeled vs. actual conditions, ODOT elected to use the NBIAS default treatment assumptions for Oklahoma without further revisions.

Table 5.6 Typical ODOT Bridge Treatments

Treatment	Units	Unit Cost ($ per unit)	NBIAS Modeling Approach
Bridge Replacement	square foot	116	explicitly modeled
Bridge Rehab	square foot	80	modeled as a combination of treatments
Deck Replacement			explicitly modeled, but cost varies by type of deck rather than urban/rural environment
- Urban	square foot	90	
- Rural	square foot	42	
- Average	square foot	65	
Deck Flood Coat + Silane	square yard	25	modeled as deck repair
Steel Beam Paint	square foot	22	explicitly modeled, but cost is by linear foot and varies between elements

Treatment	Units	Unit Cost ($ per unit)	NBIAS Modeling Approach
Joint Replacement	linear foot	60	explicitly modeled
Deck Overlay	square yard	150	explicitly modeled
Deck Washing	square yard	1.25	not modeled
Drift Removal		varies	not modeled
Concrete Repair		varies	explicitly modeled, costs and units of measure vary by element

Bridge Life Cycle Planning Approach

The LCP approach used for bridges is based on a set of two basic models, both of which are implemented in NBIAS. First, NBIAS determines what treatments are most cost effective for each individual bridge element by solving a linear optimization to determine the treatments that, if performed, will minimize life cycle costs of maintaining the bridge element over time.

Table 5.7 shows an example of the life cycle strategy developed using this approach, in this case for reinforced concrete superstructure element. Table 5.7 lists the different condition states the element may be in, with State 1 being the best state and 4 the worst. Table 5.7 further lists the feasible treatments in each condition state, including a “do nothing” action in which treatment is deferred. For each treatment Table 5.7 shows the probability the element will transition to each other condition state over a one-year period given the treatment is performed, the unit cost of performing the treatment, and the discounted life cycle cost (labeled the “long-term cost”) of performing the treatment, assuming that in the future recommended treatments will be performed. The final column of Table 5.7 indicates which treatments are optimal in each condition state. In this example, the optimal strategy is to do nothing if the element is in State 1 or 2, Clean and Patch in State 3, and Rehabilitate in State 4.

Table 5.7 Example Life Cycle Strategy for a Reinforced Concrete Superstructure Element

Example of Life Cycle Strategy for a Reinforced Concrete Superstructure Element									
State	Action	Probability of Transition to State					Unit Cost	Long-Term	Optimal?
		1	2	3	4	Fail	($)	Cost ($)	
1	Do Nothing	92%	8%	0%	0%	0%	0.00	87.84	Y
2	Do Nothing	0%	98%	2%	0%	0%	0.00	161.48	Y
	Clean & Patch	86%	14%	0%	0%	0%	584.25	677.31	
3	Do Nothing	0%	0%	87%	13%	0%	0.00	984.32	
	Clean & Patch	53%	38%	10%	0%	0%	725.77	910.05	Y
4	Do Nothing	0%	0%	0%	87%	13%	0.00	2,127.88	
	Rehabilitate	33%	41%	17%	9%	0%	1,620.42	2,026.86	Y
	Replace	100%	0%	0%	0%	0%	3,953.51	4,035.60	

In the context of this modeling approach, the benefit of performing a recommended treatment is that it saves money relative to deferring action. For instance, in the above example, the savings from performing the Clean and Patch treatment when recommended relative to deferring action is $74.27, equal to the difference between the long-term cost of Do Nothing and Clean and Patch. This cost savings is used to prioritize what treatments to perform when there are insufficient funds for performing the recommended treatments.

The application of the LCP is simulated over time using the NBIAS program simulation model. This model determines what work should actually be performed in a given year considering the available budget, the optimal element-level life cycle strategy, and options for replacing or making functional improvements to a bridge. The objective of this model is to maximize total agency cost savings and user benefits, given a budget and other constraints. In this model, multiple project alternatives are considered for each bridge, including doing nothing, performing the recommended element-level preservation work, and making a functional improvement to the bridge. Functional improvements considered by the system include widening existing lanes and shoulders, raising the bridge, strengthening the bridge, or replacing the bridge. The functional improvements yield savings through improving bridge conditions and also yield additional user benefits. Widening existing lanes and shoulder is predicted to reduce crash costs, while raising or strengthening a bridge is predicted to save truck travel time and operating costs through reducing detours. Replacing a bridge potentially yields all of these benefits.

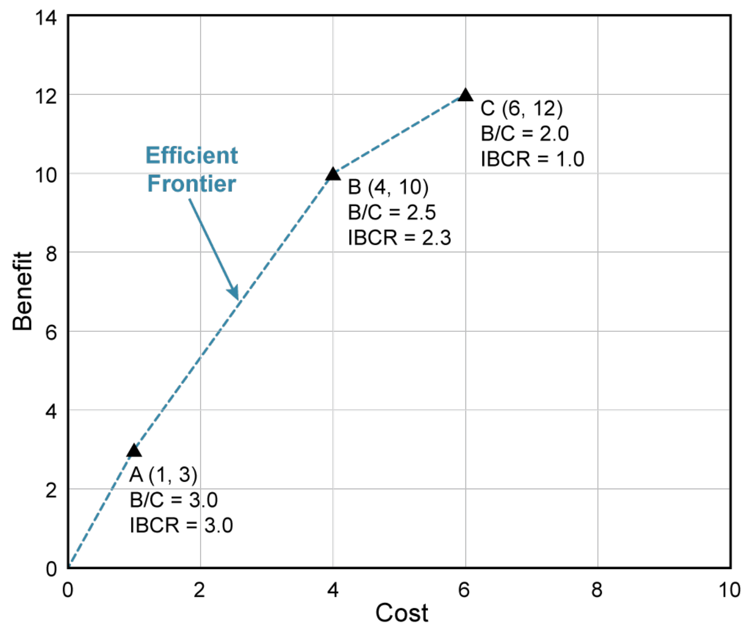


Figure 5.4 Example IBCR Calculation

To determine what work to perform given a limited budget, NBIAS uses the incremental benefit cost heuristic (IBC), which is used in many management systems to determine the best set of projects to perform to maximize benefits subject to a budget constraint. With this approach the incremental benefit cost ratio (IBCR) for each project alternative for a bridge is calculated by comparing the alternative to the next-cheapest alternative, dividing the difference in benefit by the difference in cost between the alternatives. Prior to performing the IBCR calculation inefficient alternatives are filtered out. The remaining alternatives thus form the “efficient frontier” of feasible project alternatives. Figure 5.4 shows an example of a benefits and costs for a hypothetical case of an asset with three project alternatives (A, B and C), and the IBCR for each.

Figure 5.5 depicts the program simulation process. When simulating allocation of funds NBIAS orders the list of alternatives in decreasing order of IBCR, combining results for all bridges, and then selects projects until funds are expended. Thus, in the hypothetical example show in Figure 5.4, if sufficient funds are available the model will select Alternative C, but if funds are limited it may only select A (or to do nothing). As depicted in Figure 5.5, the process of generating and selecting alternatives is repeated for each year of the analysis period. The end result of the model is a simulated set of project alternatives that maximizes overall agency and user benefits given the available budget.

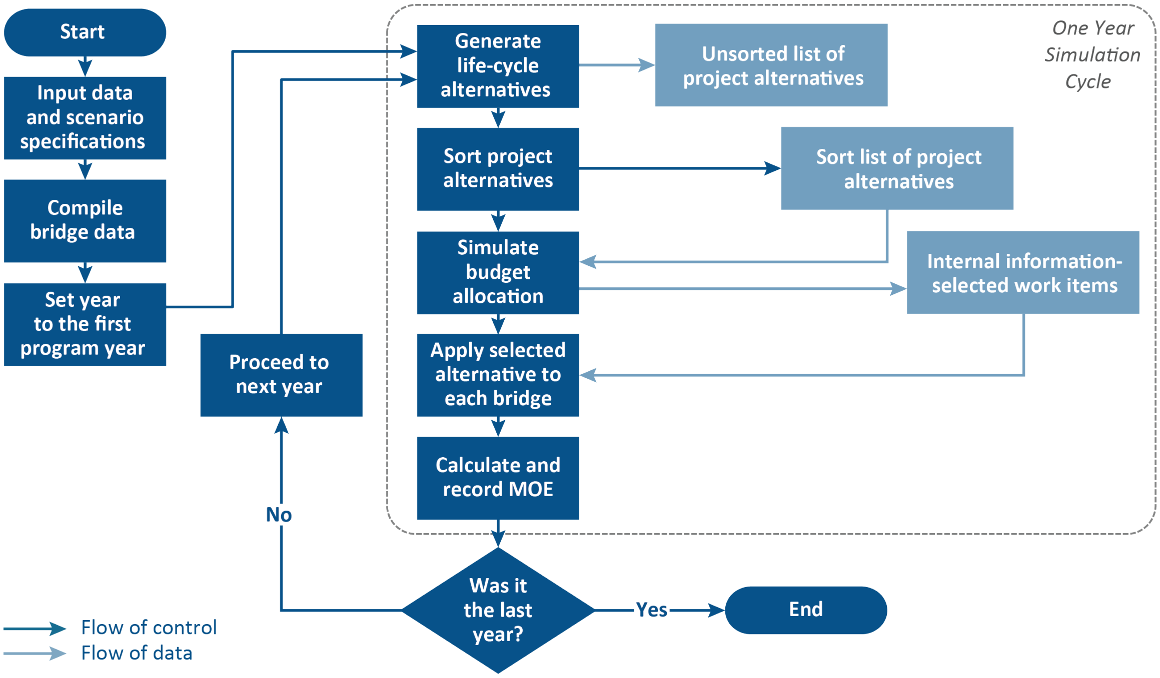


Figure 5.5 Program Simulation Process

Bridge Condition Data Management

Data Collection

ODOT manages its bridge inventory and inspection data in BrM. ODOT complies with requirements to collect and report NBI data, as well as with more recent requirements to capture element-level conditions.

ODOT includes additional specific bridge inventory and condition data elements in its data collection, such as scour critical ratings, load ratings, paint type, expansion device type, automated truck routing information, and channel profile items, all of which are detailed in the ODOT Bridge Inspection Field Manual.

Structures are inspected either by in-house staff or by consultants on a minimum cycle of two years, with limited exceptions. Structures in Poor condition are inspected more often, with some inspected as often as every six months. Bridges are considered Poor when they have an inspection rating of 4 or less on any NBI item (deck, superstructure and substructure). This is the federal definition of Poor bridges. As of January 1, 2018, the federal definition of Poor bridges is the same as structurally deficient bridges. ODOT follows the federal definitions in its bridge inspection program. A functionally obsolete bridge means that the bridge does not meet current functional standards. There is no relationship between functionally obsolete and a Poor designation for a bridge.

Individual inspection results are captured on a 0-9 rating scale, which then results in overall structural and functional ratings of the bridge. On the 0-9 scale, 9 represents a rating of excellent condition while 0 represents a failed condition.

Table 5.8 provides a list of the criteria, which can result in a bridge becoming rated as structurally deficient or functionally obsolete.

Table 5.8 Structural Deficiency and Functional Obsolescence Criteria

Structural Deficiency		Functional Obsolescence	
Inspection Item	**Rating**	**Inspection Item**	**Rating**
Deck	≤ 4	Deck Geometry	≤ 3
Superstructure	≤ 4	Underclearances	≤ 3
Substructure	≤ 4	Approach Roadway Alignment	≤ 3
*Structure Evaluation	≤ 2	Structural Evaluation	3
*Waterway Adequacy	≤ 2	Waterway Adequacy	3

* FHWA removed the NBI items from evaluation of structural deficiency after December 2017

ODOT also uses a sufficiency rating generated from bridge inspection reports. This rating utilizes four separate factors, which are calculated and subtracted from a perfect rating of 100 to obtain the sufficiency rating. This results in a 0-100 rating where 100 would represent an entirely sufficient bridge while 0 represents an entirely insufficient or deficient bridge.

The four factors involved in calculating the sufficiency rating are:

- Structural Adequacy and Safety (55%)
- Serviceability and Functional Obsolescence (30%)
- Essentiality for Public Use (15%)
- Special Reductions (up to 13%)

Quality Assurance and Quality Control

NBI bridge inspections include a process to ensure the quality of inspection results. This includes quality control requirements. For example, bridge inspectors must have verified all information available with assumptions and used error reporting available in the system of record, BrM. Additionally, quality assurance reviews are conducted at multiple levels within the agency.

ODOT also conducts annual Quality Assurance and Quality Control training workshops that cover routine inspections, fracture-critical inspections, and bridge load rating. These workshops are attended by all bridge inspection team leaders and load rating engineers.

Management Systems

ODOT uses Deighton's dTIMS as its PMS. ODOT implemented this system in 2001 and has captured digital pavement data since 2004, employing third-party data collection vehicles using the most up-to-date pavement collection technology. ODOT uses the systems BrM and NBIAS together as its BMS. ODOT began implementation of its BMS in the mid-1990's.

Both the PMS and the BMS as currently implemented are fully compliant with federal requirements as referenced by ODOT's PMS Guide and the BMS Guide. Table 5.9 summarizes the requirements for management systems, and describes how these are met for the PMS and BMS. Additional detail on each of these systems is provided below.

Recommending programs and implementation schedules to manage the condition of NHS pavement and bridge assets within policy and budget constraints

Table 5.9 Approach to Meeting Management System Requirements

Requirement	PMS	BMS
Collecting, processing, storing, and updating inventory and condition data for all NHS pavement and bridge assets	dTIMS collects, processes, stores and updates data consistent with HPMS requirements	BrM collects, processes, stores and updates data consistent with NBI bridge and element-level requirements
Forecasting deterioration	dTIMS predicts change in PQI by pavement section as depicted in Figure 5.2	NBIAS predicts change in condition by bridge element as illustrated in Table 5.7
Determining the benefit-cost over the life cycle of assets to evaluate alternative actions (including no action decisions)	dTIMS identifies the most cost-effective treatments as illustrated in Table 5.3	NBIAS identifies the most cost-effective treatments for each bridge element over its life cycle as illustrated in Table 5.3
Identifying short- and long-term budget needs for managing condition	dTIMS identifies budget needs in its simulation model described above	NBIAS identifies budget needs in its simulation model described above
Determining the strategies for identifying potential projects that maximize overall program benefits within the financial constraints	dTIMS identifies the most cost-effective projects within constraints in its simulation described above	NBIAS identifies the most cost-effective projects within constraints in its simulation described above
Recommending programs and implementation schedules to manage condition within policy and budget constraints	dTIMS recommends programs and program years within constraints in its simulation described above	NBIAS recommends programs and program years within constraints in its simulation described above

Pavement Management System

The Pavement Management Branch utilizes the PMS to analyze and report pavement surface condition and roadway geometry measurements. The PMS also provides project-level decision making support through an optimization analysis to select treatments based on pavement surface condition, pavement type, and available funding. This analysis is informed by PMS-modeled pavement deterioration, treatment cost, and benefits in conjunction with ODOT pavement management decision thresholds and pavement preservation project decision tree analysis.

The PMS uses PQI to determine the treatment eligibility of individual pavement inventory subsections. Pavement treatment recommendations are modeled in four general categories: Preventative Maintenance, Minor Rehabilitation, Major Rehabilitation, and Reconstruction (see Table 5.10).

Table 5.10 Pavement Treatment Categories by PQI

Pavement Treatment Categories by PQI	
Treatment Category	**PQI Range**
Preventative Maintenance	88 < PQI ≤ 93
Minor Rehabilitation	83 < PQI ≤ 88
Major Rehabilitation	72 < PQI ≤ 83
Reconstruction	0 < PQI ≤ 72

Bridge Management System

As described above, ODOT uses two systems together as its BMS: BrM and NBIAS. ODOT's system of record for bridge inspection and inventory data is BrM. This system stores data on bridges, their components, and specific bridge elements. ODOT is currently transitioning from Version 5.2.1 to Version 5.3.

For modeling bridge investment needs and future conditions, ODOT is using FHWA's NBIAS. The NBIAS modeling approach is detailed above in the description of ODOT's bridge life cycle planning approach. NBIAS provides a comprehensive modeling approach that identifies the optimal life cycle plan for each bridge element and simulates bridge conditions and work using economic analysis principles reviewed by FHWA.

In the future it may be possible for ODOT to utilize new bridge modeling functionality recently added to BrM in the latest version of the system (5.3). ODOT is in the process of exploring the feasibility of using the BrM modeling approach. If ODOT finds that this version of the system provides improved modeling capability and results, ODOT will explore use of the BrM modeling approach as a supplement to NBIAS for future TAMP updates.

Chapter 6

Risk Management

Managing risk is an everyday occurrence at ODOT, using both formal and informal approaches. Workers who are maintaining roads, operating the transportation system during extreme weather situations, or planning for the uncertainties of future funding are all performing risk-related activities.

Overview

ODOT has formal risk controls in place for managing project schedules and costs, using pavement and bridge management systems, and conducting bridge safety inspections, including additional episodic bridge inspections in response to increased seismic activity. There are also many safety-related activities such as replacing missing or damaged signs as they are needed.

Risks may include, but are not limited to, threats to transportation assets, variability in forecasted travel behavior, changes in rules and regulations, uncertainty of extreme weather conditions, and opportunity for increased or decreased financial support for assets.

Federal Requirements

Federal regulations require an expanded formal risk management program for ODOT TAM of NHS pavements and bridges (23 CFR 515.7(c)). The requirements include:

- Identification of risks that can affect the condition of NHS pavements and bridges
- Assessment of the risks associated with current and future environmental conditions that could affect NHS performance
- Assessment of the identified risks in terms of the likelihood of their occurrence and their impacts and consequence if they do occur
- Evaluation and prioritization of the identified risks
- Mitigation plan for addressing the top priority risks
- Approach for monitoring the top priority risks
- A summary of evaluations of NHS pavements and bridges that have been repeatedly damaged by emergency events.

Defining Risk

The International Standard 31000 defines risk as “the effect of uncertainty on objectives.” In the simplest terms, a risk is anything that could be an obstacle to the achievement of goals and objectives. However, risks are not just threats. They can be anything that may impede an objective or even create a new opportunity.

FHWA defines risk management as "the processes and framework for managing potential risks, including identifying, analyzing, evaluating, and addressing the risks to assets and system performance." This includes day-to-day concerns such as assets deteriorating faster than expected or projects going over budget, as well as potentially catastrophic risks of asset failure caused by natural disasters. Figure 6.1 depicts the risk management process and products as defined by FHWA's asset management rule.

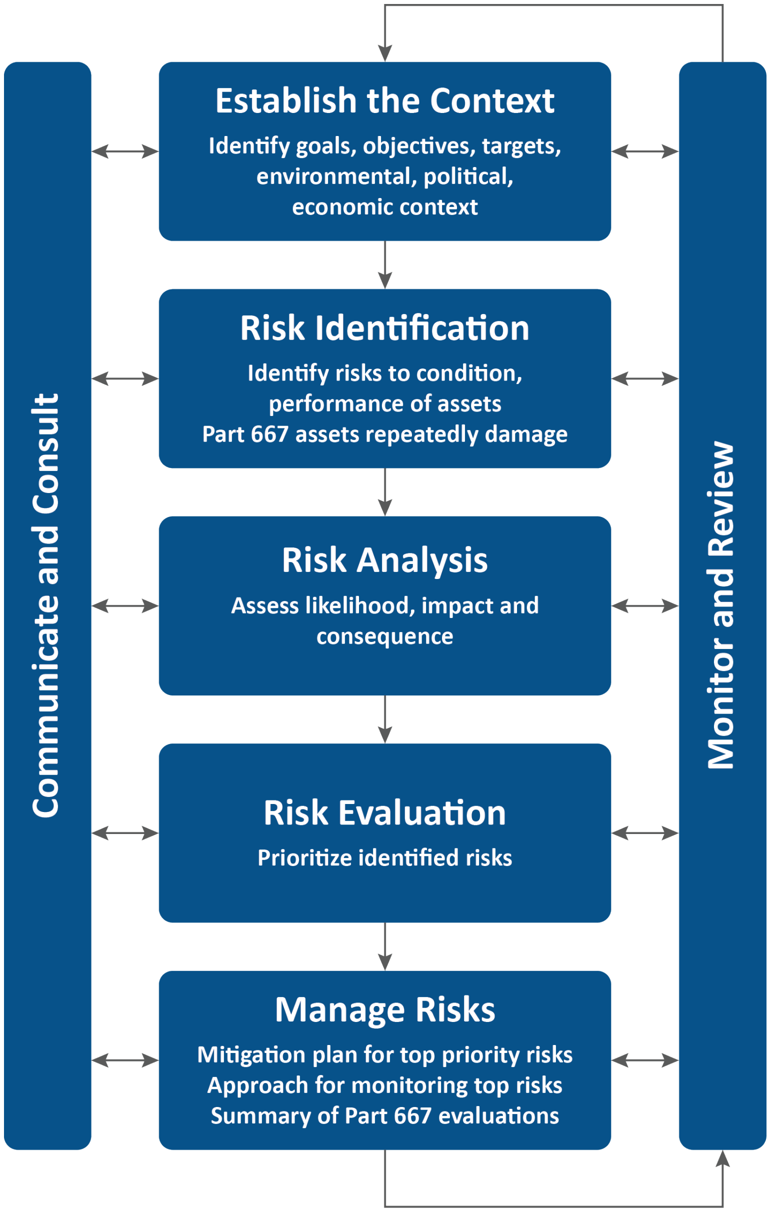


Figure 6.1 Risk Management Process and Products
Source: FHWA

Managing transportation assets entails managing risk. Risks must be considered in the day-to-day management process in order to successfully manage ODOT's assets with the most efficient and effective strategies and methods. In the context of asset management, FHWA defines risk as "the positive or negative effects of uncertainty or variability upon agency objectives."

Transportation agencies often must spend significant resources mitigating and responding to risks. Reacting to the uncertainty presented by risks can be more expensive and time consuming than proactive management.

Risk management strengthens asset management by identifying strategies to either reduce uncertainty or manage its effects. Being proactive rather than reactive in managing risk and avoiding "management by crisis" helps an agency to make best use of available resources to minimize and respond to risk. It also aids in building public trust.

Like every transportation agency, ODOT faces a range of general types of risks as well as risks specific to the individual system and state. ODOT has identified seven basic categories of risks that may impact the transportation system assets. Table 6.1 depicts this risk information.

Table 6.1 Oklahoma TAM Risk Categories

Source: ODOT

Oklahoma TAM Risk Categories		
Risk Category	**Description**	**Elements of Risk Management**
Asset performance	Risks associated with asset failure, which can include: • Structural • Capacity or Utilization • Reliability or Performance • Obsolescence • Maintenance or Operation	• Consistently documented inspection programs • Documented allocation of funding for repair and maintenance • Documentation of competing resource demands • Determined intervention levels • Prioritization actions and documented reasoning
Highway Safety	Risks to highway safety related to the asset management program: • Highway crash rates, factors and countermeasures • Safety performance of assets, maintenance and rehabilitation treatment options • Safety in project selection, coordination and delivery	• Safety-focused asset management programs • Network screening for safety hotspots for consideration within asset maintenance, rehabilitation or upgrade programs • Consideration of safety benefits/costs in asset management decision making • Safety-related product evaluation • Prioritization actions and documented reasoning
External Threats	External threats include both human-induced and naturally occurring threats, such as: • Extreme weather • Seismic events • Terrorism or accidents • Paradigm shifting technologies	• Incorporate potential impacts of environmental conditions and new technologies into long term planning • Identify and inventory external risks to existing infrastructure • Infrastructure inspection, replacement or retrofit programs to mitigate risks • Operational and emergency response programs • Processes to incorporate resiliency into design standards
Finances	Risks to the long term financial stability of the asset management programs, including: • Unmet needs in long-term budgets • Funding stability • Exposure to financial losses	• Enterprise data management programs and strategies • Robust information technology solutions emphasizing risk prevention, preparedness and recovery • Programs to address model risks (e.g. premature failure of pavement due to underestimation of truck loading)
Information and Decision Making	Risks related to the asset management program include: • Lack of critical asset information • Quality of data, modeling or forecasting tools for decision making • Security of information systems	• Enterprise data management programs and strategies • Robust information technology solutions emphasizing risk prevention, preparedness and recovery • Programs to address model risks (e.g. premature failure of pavement due to underestimation of truck loading)
Business and Operations	Risks due to internal business functions associated with asset management programs, such as: • Employee safety and health • Inventory control • Purchasing and contracting	• "Safety first" culture within asset management programs – routine safety meetings, documented safety and standard operating procedures, workforce training, etc. • Robust systems and tools for work force, equipment, inventory, and contract management to reduce risks of theft, misuse, unnecessary storage or inaccurate estimates of program costs
Project & Program	Project and program management is a very mature area in U.S. transportation sector	• Many programs and products exist here – extensive discussion of these risks and related programs, policy and procedure is likely not necessary

Federal regulations also specify that each state TAMP address a defined set of risk management requirements. The FHWA has provided interim guidance for integrating these risk management requirements into TAMPs and processes. The interim guidance states that, "the objective of a risk-based TAMP is not to avoid all risks. Rather, it is to acknowledge risks, assess and prioritize them, and allocate resources and actions based upon the agency's risk tolerance and how the risks could affect the asset management objectives."

The interim guidance provides seven keys to successfully integrating risk into TAM:

1. High-level or top-down support
2. Robust analysis that demonstrates the long-term consequences of investment scenarios
3. An asset management program that includes tradeoff scenarios illustrating which tradeoffs reduce the greatest risks
4. An asset management process that addresses resiliency by anticipating and mitigating external risks such as natural disasters
5. The integration of risk into asset and performance management processes
6. Communicating risks and engaging stakeholders in the process
7. Continuous improvement of risk management skills and processes

Risk Management Approach

Risk Management at ODOT

Prior to developing the TAMP, ODOT practiced both formal and informal risk management in many of its offices. These offices focus on specific categories of risk such as information technology risk, emergency risk, and safety risk. Table 6.2 summarizes those responsible for existing efforts.

Table 6.2 Risk Management at ODOT

Risk Management at ODOT	
Risk Type	**Responsible Office**
Enterprise Risk Management	Senior Staff
Asset Risk Management	Field Division Engineer and Maintenance Engineer
Project Risk Management	Project Management Division
Information Technology Security	Office Services Division
Emergency Risk Management	Maintenance and Operations
Safety Risk Management	Human Resources Division - Safety

Risk Methodology

To address the new formal risk management program requirements, ODOT conducted an initial Risk Management Workshop that included stakeholders from ODOT and FHWA. The ODOT document "Risk Management Workshop Summary" provides the complete details of this initial effort.

Over the course of the workshop participants reviewed risk management concepts; reviewed and augmented a working risk register; and performed an initial qualitative risk assessment based on likelihood, impact, and consequence as shown in the risk matrix shown in Figure 6.2.

Risk Matrix with Impact and Likelihood Definitions			Likelihood				
			Rare	Unlikely	Likely	Very Likely	Almost Certain
			Less than once every 10 years	Once in more than 3 but less than 10 years	Once between 1-3 years	Once a year	Several times a year
Impact	Catastrophic	Potential for multiple deaths & injuries, substantial public & private cost.	Medium	Medium	High	Very High	Very High
	Major	Potential for multiple injuries, substantial public or private cost and/or foils agency objectives.	Low	Medium	Medium	High	Very High
	Moderate	Potential for injury, property damage, increased agency cost and/or impedes agency objectives.	Low	Medium	Medium	Medium	High
	Minor	Potential for moderate agency cost and impact to agency objectives.	Low	Low	Low	Medium	Medium
	Insignificant	Potential impact low and manageable with normal agency practices.	Low	Low	Low	Low	Medium

Figure 6.2 Risk Matrix

These analyses included but were not limited to risks for pavement and bridge conditions and environmental conditions. Based on this assessment, participants identified potential mitigation strategies and actions. Finally, participants identified the highest priority risks and their respective mitigation strategies. This information is compiled and displayed in the Risk Register, included as Appendix B.

Mitigation Plan for Top Priority Risks

At the initial Risk Management Workshop, ODOT identified which risks were top priority. In order to develop a plan for mitigating these risks, ODOT conducted a second workshop that included stakeholders from ODOT and from FHWA. For each risk ODOT determined what actions need to be carried out, who would be responsible for the action, when the action would be carried out, and what the initial steps would be. ODOT's plan for mitigating top priority risks is shown in Table 6.3.

Table 6.3 Mitigation Plan for Top Priority Risks

Mitigation Plan for Top Priority Risks				
Risk	**Action**	**Owner**	**Completion Date**	**First Step**
Damage to bridges due to vehicle hits may require diversion of funds.	Industry education, consider new design standards, pursue insurance reimbursements	Bridge Division, Field Division, Media and Public Relations	ASAP	System review
If the public does not understand or support ODOT's asset management efforts, funding may be diverted.	Use personal messaging to communicate to each stakeholder how they are affected	Media and Public Relations, Strategic Asset and Performance Management, District Engineers	1/31/19	Identify stakeholders, use unified messaging, offer on-demand planning, use professional services
A reduction of state revenues due to falling energy industry revenues may result in a reduction in funding for transportation	Educate legislators about the risk, reduce non-essential costs	Senior Staff, Comptroller, Field Divisions	ongoing	Speak to legislators
Staff cannot perform needed work if they lack access to adequate technology, design tools, and training	Retake control of mission-critical work	Office Services Division	ongoing	Contact consultants and internal staff
	Get administrator access to computers	Office Services Division	2018	Improve relationship with Office of Management and Enterprise Services, inform senior staff how lack of administrator access hinders ODOT processes
	Find opportunities for new technology and removal of old software	Office Services Division	ASAP	Contact all divisions to determine current and projected technology needs
	ODOT staff need to seek expertise in new technologies under development such as autonomous vehicles	ODOT	ASAP	Acquire expertise on changes in the traveling public's demographics, trends, and technologies
Future changes in regulations may result in diversion of funds	Outreach, communication, education	Senior Staff	ongoing	Engage Congressional delegation and inform stakeholders
	Change how regulations are interpreted	ODOT	ongoing	Accept higher level of risk
	Predict how regulatory changes will affect ODOT processes	ODOT	2018	Strengthen partnerships with FHWA and other agencies

Monitoring Top Priority Risks

Different offices within ODOT will be responsible for monitoring different top priority risks. Some risks will be monitored by ODOT Senior Staff, some will fall to particular offices within ODOT, and others will be monitored throughout ODOT. The following is a summary of who will be responsible for what.

- **ODOT Senior Staff** will monitor ongoing outreach, communication, and education efforts regarding ongoing changes in regulations and how those changes might change how funding is allocated within ODOT operations.
- The **Media and Public Relations Division** (MPR) will communicate to stakeholders about the value of asset management in order to reduce the risk of funding being diverted to other uses. MPR will also educate the public about the financial consequences of vehicles hitting bridges, working to reduce the financial impacts of those collisions.
- The **Senior Staff, Comptroller** and **Field Divisions** will monitor ongoing communication with legislators to make them aware of how falling revenue from the energy industry could lead to falling revenue for ODOT operations.
- **Offices throughout ODOT** will strengthen their relationships with other state offices such as the Office of Management and Enterprise Services and their relationships with federal agencies such as FHWA. Offices will also work towards acquiring expertise in new technologies such as autonomous vehicles and work on replacing old technology.

Transportation Assets Repeatedly Damaged by Emergency Events

State DOTs are required to perform periodic evaluation of facilities that require repeated repair and reconstruction due to emergency events, including most projects that used Emergency Relief funds, per the federal Fiscal Management Information System, to resolve the emergency (23 CFR 667). The regulations require that state DOTs conduct statewide evaluations to determine if there are reasonable alternatives to pavements or bridges that have required repair or reconstruction more than once due to emergency events. Agencies are required to perform "an analysis that includes identification and consideration of any alternative that will mitigate, or partially or fully resolve, the root cause of the recurring damage, the costs of achieving the solution, and the likely duration of the solution."

Reasonable alternatives are defined as options that could partially or fully achieve the following:

1. Reduce the need for federal funds to be expended on emergency repair and reconstruction activities
2. Better protect public safety and health and the human and natural environment
3. Meet transportation needs as described in applicable federal, state, local, and tribal plans and programs

While the requirement for evaluation of assets that have repeat damage due to emergency events is a separate rule from the TAMP, the TAMP rules require that the risk management process include a summary of the evaluations for NHS bridges and pavements. Appendix C includes a list of some of the identified risk locations organized by division.

Chapter 7

Financial Plan

The financial plan for the Oklahoma TAMP summarizes ODOT and OTA funding sources and uses for asset management over the next 10 years (FY2018 to FY2027).

Overview

The Oklahoma TAMP financial plan includes an estimate of projected funding sources and the planned investments to achieve ODOT's desired condition and performance from existing pavement and bridge assets. The financial plan also includes an estimate of asset valuation for the bridge and pavement assets. Additionally, the financial plan includes funds available for NHS and Non-NHS pavement and bridge assets in Oklahoma.

Each state DOT is required by FHWA to develop a financial plan for their TAMP that spans at least 10 years and includes the following (23 CFR 515.7(d)):

- Estimated cost of expected future work to implement investment strategies contained in the TAMP, by state fiscal year and work type;
- Estimated funding levels that are expected to be reasonably available, by fiscal year, to address the costs of future work types;
- Identification of anticipated funding sources; and
- Estimated 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.

ODOT's existing planning and investment strategy practices are the basis for the TAMP financial plan and ODOT's compliance with federal TAMP requirements. These financial planning and investment strategy practices are outlined in Table 7.1.

Table 7.1 Financial Planning and Investment Strategy – Current Practice vs. Federal TAMP Requirements

Current Practice vs. Federal TAMP Requirements	
Federal TAMP Requirements	**ODOT Financial Planning and Investment Strategy Practices**
10-year minimum time horizon	Combination of 25-year long range transportation plan (*Moving Oklahoma Forward*), 8-year *Construction Work Plan* (CWP), and 4-year *Asset Preservation Plan* (APP)
Estimate cost of future work by work type and state fiscal year	*Moving Oklahoma Forward* projected costs of various treatment strategies for highways and bridges
Estimate funding levels and sources that are expected to be reasonably available by fiscal year	*Moving Oklahoma Forward* 25-year detailed revenue forecast
Estimate asset value and the needed annual investment to maintain asset value	Remaining service life multiplied by replacement cost

Funding Sources

The funding sources in the TAMP are based on revenue forecasts for Moving Oklahoma Forward, the CWP, the APP, and OTA revenue projections. Together, these resources serve as the basis for development of the TAMP funding sources and financial plan.

Moving Oklahoma Forward

Moving Oklahoma Forward, the state's most recent long-range transportation plan, includes a detailed revenue forecast of ODOT's funding for infrastructure investment from FY2016 through FY2040. The forecast is based on specific growth rate assumptions for each revenue and funding source considering historic trends and projections of major indicators, such as motor fuel consumption and population. The plan also includes scenario analysis of the revenue forecast that modified forecast assumptions and resulted in alternate revenue forecast scenarios.

The revenue forecast includes state revenues, federal funding, and local matching funds for surface transportation infrastructure investment over the 25-year forecast period. In brief, the following funds are included in the forecast: state and federal highway and bridge funds; state and federal transit funds; state and federal highway assistance to local governments, including counties, cities, and towns; state transit funds to urban transit systems; state and federal funds to rural and tribal transit systems; and state funds for passenger rail and for railroad improvements. ODOT's primary sources of state funding for transportation investment include motor fuel tax revenues, income tax revenues, and motor vehicle registration fee revenues.

The Moving Oklahoma Forward forecast does not include locally raised transportation revenues such as city transit subsidies, county taxes, or funds for public ports along the Arkansas River system; federal funding for the McClellan Arkansas River Navigation System; airport or aeronautics funding; or OTA funds.

Construction Work Plan and Asset Preservation Plan

The Moving Oklahoma Forward 25-year revenue forecast is utilized as a resource when ODOT develops the CWP and APP. The CWP provides forecasts of funding specifically available for the construction program for each year of the program. Similarly, the APP provides forecasts of funding specifically available for asset preservation for each year of the program. As depicted in Figure 7.1, the Statewide Transportation Improvement Plan (STIP) represents the first half of the CWP.

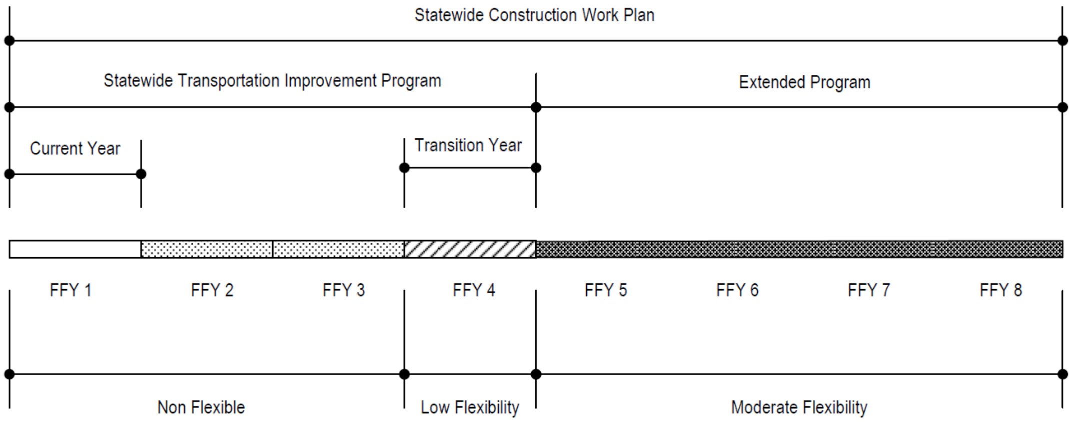


Figure 7.1 CWP and STIP

OTA Revenue Projections

OTA provided projections of their revenues for use in the TAMP. OTA's revenues are generated through toll revenues. Notably, OTA does not receive federal funding.

TAMP Funding Sources

Based upon existing plans and programs, ODOT and OTA provided anticipated funding over the period of FY2018 to FY2027. These funds exceed projected asset management uses (described later in this chapter) as they fund all of the transportation investments of ODOT and OTA including safety, mobility, planning, transit, and other programs.

Table 7.2 provides the projected ODOT funding available by major funding source by fiscal year. ODOT funding sources, after debt service on existing obligations and administration costs, are projected to average $1.38 billion annually and total $13.80 billion over the ten-year period. Figure 7.2 provides a breakdown of the major funding sources in the most recent fiscal year, 2018.

Table 7.2 ODOT Funding Sources (dollars in millions)

ODOT Funding Sources (dollars in millions)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total
Federal Funds											
National Highway Performance Program	280	280	280	280	280	280	280	280	280	280	2,796
Surface Transportation Program	96	96	96	96	96	96	96	96	96	96	961
Other Federal Funding	243	243	243	243	243	243	243	243	243	243	2,434
Total Federal Funding	**619**	**619**	**619**	**619**	**619**	**619**	**619**	**619**	**619**	**619**	**6,191**
State Funds											
Income Tax (ROADS Fund)	536	580	580	580	580	580	580	580	580	580	5,756
Motor Fuel Tax	242	241	240	240	239	238	237	232	229	228	2,365
Other State Funding	137	137	137	137	137	135	135	135	135	135	1,357
Total State Funding	**915**	**958**	**957**	**957**	**955**	**952**	**951**	**947**	**943**	**942**	**9,479**
Total	**1,534**	**1,577**	**1,577**	**1,576**	**1,574**	**1,572**	**1,571**	**1,566**	**1,563**	**1,562**	**15,670**
Deductions for Debt Service and Admin.											
Debt Service	(54)	(48)	(48)	(39)	(38)	(38)	(38)	(39)	-	-	(342)
Administration	(151)	(151)	(151)	(150)	(150)	(150)	(150)	(150)	(150)	(150)	(1,503)
Total	**(205)**	**(199)**	**(199)**	**(189)**	**(189)**	**(188)**	**(188)**	**(189)**	**(150)**	**(150)**	**(1,845)**
Funding Available	**1,329**	**1,378**	**1,378**	**1,387**	**1,386**	**1,383**	**1,383**	**1,378**	**1,413**	**1,412**	**13,825**

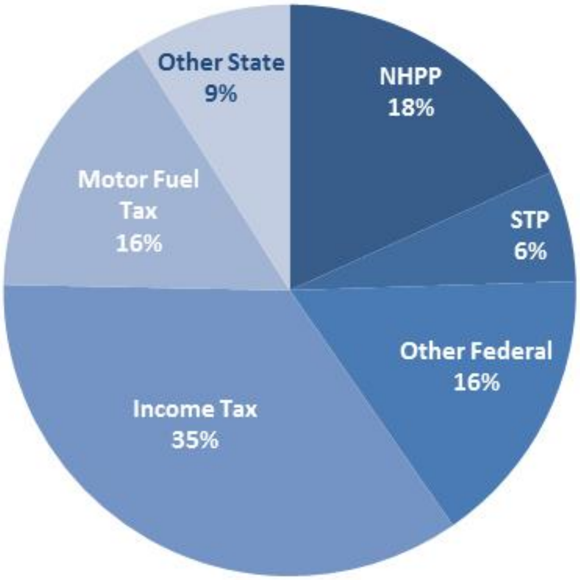


Figure 7.2 ODOT Funding Sources, 2018

Table 7.3 provides the projected OTA funding by fiscal year. These funding sources are primarily toll revenues. OTA revenues are projected to average $347 million annually and total $3.5 billion over the ten-year period. It should be noted that OTA does not receive federal funding.

Table 7.3 OTA Funding Sources (dollars in millions)

OTA Funding Sources (dollars in millions)											
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total
Sources											
Turnpike Revenues	311	320	328	342	348	355	360	365	370	374	3,473
Total Sources	**311**	**320**	**328**	**342**	**348**	**355**	**360**	**365**	**370**	**374**	**3,473**

Table 7.4 provides a summary of both ODOT and OTA funding sources. As noted previously, the funds exceed projected asset management uses (described later in this chapter) as they fund all of the transportation investments of ODOT and OTA. Combined, the projected ODOT and OTA funding sources are projected to average $1.7 billion annually and total $17.1 billion over the 10-year period, after deductions for debt service on existing obligations and administrative costs.

Table 7.4 ODOT and OTA Funding Sources – Summary (dollars in millions)

ODOT and OTA Funding Sources – Summary (dollars in millions)											
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total
Sources											
Federal Funds	619	619	619	619	619	619	619	619	619	619	**6,191**
State Funds	915	958	957	957	955	952	951	947	943	942	**9,479**
OTA Funds	311	320	328	342	348	355	360	365	370	374	**3,473**
Deductions for ODOT Debt Service and Admin.	(205)	(199)	(199)	(189)	(189)	(188)	(188)	(189)	(150)	(150)	**(1,845)**
Deductions for OTA Administration	(15)	(15)	(15)	(15)	(15)	(16)	(16)	(16)	(16)	(17)	**(155)**
Funding Total	**1,625**	**1,683**	**1,691**	**1,713**	**1,719**	**1,722**	**1,727**	**1,727**	**1,766**	**1,769**	**17,143**

Funding Uses

As discussed above, the TAMP presents funding uses based on Moving Oklahoma Forward, the CWP, the APP, and OTA's capital plans. The TAMP further refined the data in the CWP and APP by separating the asset management investments in bridge and pavement assets by NHS and Non-NHS assets. TAMP development included a Financial Planning and Investment Strategy Workshop designed to help establish ODOT objectives for redistribution of currently available TAM funding, establish priorities areas for any future additional funding, and establish areas for potential reduction should revenues fall short of forecasts.

Table 7.5 provides projection of funding uses for asset management and other investments from FY2018 through FY2027. These funding projections would result in the conditions projected in the Current Funding scenario discussed in Chapter 4 and would result in the 10-year expected performance shown in Table 4.1. As shown in Table 7.5, the projected average annual investment in NHS asset management (pavement and bridges) is $275 million and the total planned investment over the ten-year period is $2.75 billion. Non-NHS bridge and pavement asset management investment is projected to average $676 million annually and total $6.8 billion over the 10-year period. Combined investment in NHS and Non-NHS asset management, therefore, is projected to average $951 million annually and total $9.5 billion over the 10-year period. Other investments, including congestion mitigation, air quality improvement, planning, safety, mobility, transit, research, and others, exhaust the remaining projected funding sources averaging $764 million annually and totaling $7.6 billion over the 10-year period.

Table 7.5 Funding Uses (dollars in millions)

Funding Uses (dollars in millions)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total
Uses											
NHS											
ODOT Bridge Asset Management	138	101	142	27	127	77	71	8	8	8	**709**
ODOT Pavement Asset Management	125	128	137	156	192	61	96	162	162	162	**1,382**
OTA Bridge Asset Management	11	24	22	15	7	24	24	24	25	25	**199**
OTA Pavement Asset Management	18	18	52	54	49	53	54	54	54	54	**460**
NHS Total	**292**	**270**	**352**	**252**	**374**	**215**	**245**	**249**	**250**	**250**	**2,750**
Non-NHS											
ODOT Bridge Asset Management	409	301	310	314	291	323	323	185	185	185	**2,827**
ODOT Pavement Asset Management	194	251	288	376	331	515	500	491	491	491	**3,929**
Non-NHS Total	**603**	**551**	**598**	**690**	**622**	**838**	**824**	**676**	**676**	**676**	**6,756**
Other Investments*											
Other Investments Total	**729**	**862**	**741**	**771**	**722**	**669**	**658**	**801**	**840**	**843**	**7,637**
Uses Total	**1,625**	**1,683**	**1,691**	**1,713**	**1,719**	**1,722**	**1,727**	**1,727**	**1,766**	**1,769**	**17,143**

*Other Investments include congestion mitigation, air quality improvement, planning, safety, mobility, transit, research, other.

As shown in Figure 7.3, the planned investments in NHS asset management are weighted toward pavement (67 percent) over bridge (33 percent) over the ten-year period.

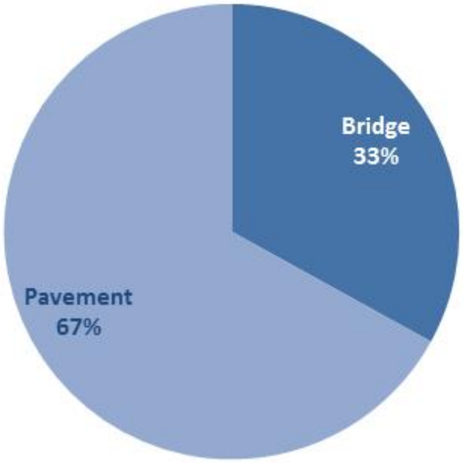


Figure 7.3 NHS Pavement and Bridge Investment (ODOT and OTA), 2018-2027

Summary of Funding Sources and Uses

Table 7.6 provides a summary of the projected sources and uses of funds for asset management and other investments in Oklahoma by ODOT and OTA over the 10-year period of FY2018 to FY2027. Table 7.6 combines the funding sources shown in Table 7.4 with the funding uses shown in Table 7.5. As shown, available funding is projected to total $17.10 billion over the 10-year period with $2.75 billion planned for NHS pavement and bridge asset management investments, $6.8 billion planned for Non-NHS pavement and bridge asset management investments, and the remaining $7.6 billion for other investments such as congestion mitigation, air quality improvement, planning, safety, mobility, transit, research, and others.

Table 7.6 Summary of Funding Sources and Uses (dollars in millions)

Summary of Funding Sources and Uses (dollars in millions)											
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total
Sources											
Federal Funds	619	619	619	619	619	619	619	619	619	619	**6,191**
State Funds	915	958	957	957	955	952	951	947	943	942	**9,479**
OTA Funds	311	320	328	342	348	355	360	365	370	374	**3,473**
Deductions for ODOT Debt Service and Admin.	(205)	(199)	(199)	(189)	(189)	(188)	(188)	(189)	(150)	(150)	**(1,845)**
Deductions for OTA Administration	(15)	(15)	(15)	(15)	(15)	(16)	(16)	(16)	(16)	(17)	**(155)**
Funding Total	**1,625**	**1,683**	**1,691**	**1,713**	**1,719**	**1,722**	**1,727**	**1,727**	**1,766**	**1,769**	**17,143**
Uses											
NHS											
ODOT Bridge Asset Management	138	101	142	27	127	77	71	8	8	8	**709**
ODOT Pavement Asset Management	125	128	137	156	192	61	96	162	162	162	**1,382**
OTA Bridge Asset Management	11	24	22	15	7	24	24	24	25	25	**199**
OTA Pavement Asset Management	18	18	52	54	49	53	54	54	54	54	**460**
NHS Total	**292**	**270**	**352**	**252**	**374**	**215**	**245**	**249**	**250**	**250**	**2,750**
Non-NHS											
ODOT Bridge Asset Management	409	301	310	314	291	323	323	185	185	185	**2,827**
ODOT Pavement Asset Management	194	251	288	376	331	515	500	491	491	491	**3,929**
Non-NHS Total	**603**	**551**	**598**	**690**	**622**	**838**	**824**	**676**	**676**	**676**	**6,756**
Other Investments*	**729**	**862**	**741**	**771**	**722**	**669**	**658**	**801**	**840**	**843**	**7,637**
Uses Total	**1,625**	**1,683**	**1,691**	**1,713**	**1,719**	**1,722**	**1,727**	**1,727**	**1,766**	**1,769**	**17,143**

*Other Investments include congestion mitigation, air quality improvement, planning, safety, mobility, transit, research, other.

Asset Valuation

ODOT uses the standard depreciation method under the Government Accounting Standards Board Statement 34 (GASB 34) for accounting for infrastructure assets. The 2008 NCHRP Report 608 concluded that significant changes to GASB 34 rules were needed if the asset valuation results were to play a substantial role in asset management and decision making. FHWA recognizes that GASB 34 rules disregard the upkeep and condition of the assets. The numbers produced under GASB 34 are far removed from, and often grossly understate, the true value of the assets.

ODOT has chosen to use Depreciated Replacement Cost (DRC), which according to the International Accounting Standard 16, represents the fair value of the asset. In this value determination, the Gross Replacement Cost (GRC) is reduced by the actual lost value due to asset consumption (AC), rather than in terms of reduced book value. In other words, the DRC approach calculates the consumption of the asset from its newly constructed state over time (age) and through wear and tear (condition). In principle, this provides the cost of replacing the assets to the level of service required by the DOT. In general, the DRC can be represented as:

$$DRC = GRC - AC$$

Pavement Asset Valuation

To calculate the DRC of each pavement section, current pavement condition information and ODOT pavement deterioration models are combined to establish an estimated age (EA) and remaining life (RL). The RL of the section is compared to the total expected life (EL) of the pavement to calculate a depreciation factor (DF) which is used to establish the DRC based on a modeled reconstruction cost (RCC).

Pavement-specific DRC calculations:

$$Remaining\ Life\ (RL) = Expected\ Life\ (EL) - Estimated\ Age\ (EA)$$

$$Depreciation\ Factor\ (DF) = \frac{Remaining\ Life\ (RL)}{Expected\ Life\ (EL)}$$

$$RCC = Reconstruction\ Unit\ Cost * Section\ Lane\ Miles$$

$$DCR = Depreciation\ Factor\ (DF) * Reconstructrion\ Cost\ (RCC)$$

The calculated DCR of each pavement section is then aggregated across the network to estimate a Total Asset Value of the pavement network.

$$Total\ Asset\ Value = \sum_{i=0}^{n} \mathrm{DCR}$$

ODOT models the EL of an asphalt pavement at approximately 38 years, while the EL of a concrete pavement is approximately 67 years.

As shown in Table 7.7, by this methodology, the Oklahoma NHS is valued at approximately $6.3 billion, while ODOT-maintained Non-NHS routes are valued at over $8.3 billion. In total, the value of Oklahoma pavements included within this TAMP exceeds $14.6 billion. The total replacement cost of the network approaches $21 billion.

Table 7.7 Pavement Asset Valuation

Pavement Asset Valuation				
Description	**Lane Miles**	**% Remaining**	**Replacement Value**	**Asset Value**
All NHS	**12,134**	**73%**	**$8,561,026,196**	**$6,291,364,688**
ODOT Interstate	2,949	76%	$2,282,369,467	$1,741,288,409
ODOT Non-Interstate NHS	6,825	71%	$4,624,954,249	$3,287,837,098
ODOT Non-NHS	21,001	68%	$12,345,170,327	$8,346,014,718
OTA Interstate	1,039	81%	$737,685,678	$595,437,162
OTA Non-Interstate NHS	1,321	73%	$916,016,802	$666,802,019
All ODOT and OTA	**33,135**	**70%**	**$20,906,196,522**	**$14,637,379,405**

It is important to note that locally maintained NHS routes were not included in this calculation as the detailed inventory and condition information necessary to support the calculation was not available. In the following pavement condition data collection cycle, local NHS condition information will be collected and local NHS will be included within the valuation. However, with less than 1% of Oklahoma NHS maintained locally, this is not a significant portion of the statewide NHS network value.

Bridge Asset Valuation

To calculate the bridge DRC, ODOT assigned a remaining life value based on the minimum value of the deck, superstructure, and substructure NBI rating values, as shown in Table 7.8.

Table 7.8 Remaining Life Assessment

NBI Range	0	1	2	3	4	5	6	7	8	9
Remaining Life	**0%**	**0%**	**0%**	**15%**	**30%**	**45%**	**60%**	**75%**	**90%**	**100%**

The deck area of each bridge, with the identified NBI value, was then determined. Using a weighted average method, based on this calculated NBI deck area and the associated remaining life, the Overall Percent Remaining Life was calculated for each bridge category.

The GRC was then determined by multiplying the total bridge deck area by the replacement cost of $188.03 per square foot for NHS bridges and $169.03 per square foot for Non-NHS bridges.

Finally, the Overall Percentage Remaining Life was multiplied by the GRC to determine the Asset Valuation.

Table 7.9 below shows the summary of those calculations by bridge classification. The NHS bridges in Oklahoma have a DRC Asset Valuation of $4.3 billion while the ODOT bridges total $6.2 billion.

Table 7.9 Bridge Asset Valuation

Bridge Asset Valuation					
Description	**Count**	**Area (Sq. Feet)**	**% Remaining**	**Replacement Value**	**DRC Asset Value**
All NHS	**3,269**	**36,282,158**	**64%**	**$6,822,060,137**	**$4,337,556,632**
ODOT NHS	2,786	28,352,096	61%	$5,330,986,760	$3,273,431,518
OTA NHS	459	7,182,236	73%	$1,350,461,180	$986,574,666
Local NHS	24	747,826	55%	$140,612,197	$77,550,449
ODOT Non-NHS	3,949	24,120,835	64%	$4,077,144,740	$2,608,009,407
All ODOT	**6,735**	**52,472,931**	**63%**	**$9,866,378,147**	**$6,174,565,560**

Chapter 8

Investment Strategies

The purpose of ODOT's TAMP is to ensure that both short-term and long-term funding allocation decisions are based on quality data and analysis that consider engineering, life-cycle cost, and risk analysis. Investment strategies are developed to best manage the physical assets with the limited funding available and anticipated in the future.

Overview

The focus of investment strategies is to identify potential opportunities to improve financial decisions based on directing funding resources to various assets in the most appropriate manner. It ties together the TAMP with the STIP and the CWP (Note: the STIP is the first four years of the CWP so when discussing the CWP, the STIP is part of the CWP). The investment strategies are designed to help ODOT continue to achieve federal and state goals and targets. They are also intended to prevent any potential performance gaps. The strategies incorporate asset modeling, treatments, and impacts, as well as risks and financial constraints.

Federal Requirements

FHWA requires that states include investment strategies as part of their TAMP (23 CFR 515.9(f)). FHWA defines investment strategies as "a set of strategies that results 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." The TAMP must discuss how the investment strategies make progress towards achieving a desired state of repair over the life cycle of the assets in the plan, improving or preserving asset condition, achieving 2- and 4-year state DOT targets for NHS asset condition and performance, and achieving national performance goals. The desired state of good repair means the desired asset condition over the 10-year period of the TAMP, also referred to as 10-year desired state of good repair in this plan.

FHWA also requires that states establish a process for developing investment strategies as part of the TAMP (23 CFR 515.7(e)). The process must describe how investment strategies are influenced, at a minimum, by:

- Performance gap analysis
- LCP

- Risk management analysis
- Anticipated available funding and estimated cost of future work

General Approach to Investments in Transportation Assets

As detailed in previous chapters, ODOT is committed to a holistic approach to TAM. ODOT strives to maintain as many assets as possible in a state of good repair.

State transportation funding reductions led ODOT to delay some projects and remove others from its CWP for federal fiscal years 2018-2025. In light of this reduced funding, ODOT will continue to prioritize preventative maintenance and the goals identified in the 2015-2040 Long Range Transportation Plan (Moving Oklahoma Forward), including safe and secure travel, infrastructure preservation, and economic vitality. The STIP and the CWP are strongly related and are the vehicles where the TAM goals and measures influence the investment of available resources to deliver the pavement and bridge targets in the TAMP. Additionally, ODOT continues to improve its TAMP processes through TAM and other programs that strengthen TAM results, as described in Chapter 9. Going forward, ODOT will continue to integrate performance assessment, LCP, and risk management analysis as described in previous chapters. ODOT will also employ process improvement strategies described in Chapter 9 in order to make the best use of taxpayer dollars.

In addition to these overarching strategies, ODOT will continue to use strategies specific to pavements and bridges as described below. At a department-wide level, ODOT has initiated the use of a multi-objective decision support tool that provides improved prioritization of the CWP.

ODOT Investment Strategies

Methodology

Many activities are supporting the development and refinement of investment strategies including the development of Moving Oklahoma Forward, the TAMP, the STIP, division decision-making processes, and the development of the CWP. As part of the development of Moving Oklahoma Forward, workshops were conducted to identify potential issues that would affect ODOT assets going forward. The effort then identified potential strategies to prevent or minimize the impact of these potential issues. As a part of these processes, the best available data has been used for the analyses and decision-making. ODOT continuously strives to improve data quality so that decision making is improved.

As ODOT moves forward, it will continue to solidify efforts to ensure that future investment strategies will collectively make progress toward achieving and sustaining a desired state of good repair over the life cycle of the assets and preserve the condition of the assets, with a focus on the performance of the NHS assets.

It is anticipated that by leveraging the following strategies, ODOT's TAM program will be able to continue to achieve both state and federal asset condition and performance requirements as well as maximize the impact towards state program objectives. The achievement of these strategies will rely on the alignment of the STIP, CWP, and TAMP. Each of these components are opportunities to improve TAM results and need coordination to make adjustments as time progresses and situations change. The TAMP document is an important input into the choices that are being made in the STIP and the CWP.

Continue to Advance a State of Good Repair

ODOT's priority is to invest in assets to maintain a state of good repair. This means maintaining ODOT pavement and bridge assets in a manner that ensures they stay in a good and working condition for as long as possible. A key priority embedded in the CWP is asset state of good repair, communicating to all stakeholders the importance of asset preservation. This investment strategy aligns perfectly with TAM practice in general and federal TAMP requirements. ODOT is moving towards a proactive, preservation-first approach, rather than a reactive, worst-first approach. This approach applies to bridge and pavement assets in this TAMP.

Focus on Statewide Transportation System Goals

Improving ODOT's ability to link asset-related decision-making with other transportation goals is an integral part of it multi-objective decision analysis initiative. The current CWP reflects an effort between ODOT leadership plus Project Management, Traffic Safety, GIS Management, and Maintenance Division Engineers. The selection, prioritization, and allocation of resources were done with a holistic view of system performance. This effort has led to an improvement of resource allocation processes in general that reflect the understanding from the pilot effort.

Pavement Specific Strategies

The following are pavement-related policies or strategies that are included in Moving Oklahoma Forward that could help to achieve ODOT's long-term vision for the state-maintained highway system. These strategies are based on utilizing the best data available. These include:

- Using the PMS as a tool to enhance pavement condition on the SHS
- Assessing the impact of increased truck size, weight, and axle configurations on the SHS
- Implementing MAP-21 regulations pertaining to performance measures and asset management for bridges and pavement

In addition to the long-term policies established in Moving Oklahoma Forward, ODOT has identified investment in pavement preservation as an area of emphasis for the pavement management program. ODOT currently dedicates about $75 million in annual funding to the APP, which is specifically invested in preventative maintenance and minor rehabilitation treatments. This program has proven to be very effective at maintaining pavement in Good to Fair condition, avoiding the need for more expensive treatments.

In an effort to provide maximum benefits from available funding across multiple ODOT program areas, ODOT has combined pavement maintenance and safety goals. ODOT now places an emphasis on both shoulder and roadway improvements during preservation activities and ensures that enhanced shoulders are part of all major rehabilitation or reconstruction efforts on two-lane highways.

Bridge-Specific Strategies

The following bridge-related policies and strategies from Moving Oklahoma Forward will help to achieve ODOT's long-term vision for the state-maintained bridges. These strategies are based on utilizing the best data available. These include:

- Implementing an adopted schedule for replacement or rehabilitation of structurally deficient bridges on the SHS
- Pursuing methods of rehabilitation and replacement of fracture-critical bridges
- Developing a programmatic approach to identifying and addressing potential preservation issues on noteworthy historic bridges
- Continuing to develop ODOT's BMS
- Continuing to use the bridge rating system as a tool to identify "at risk" structures and incorporating them into the bridge maintenance program
- Assessing the impact of increased truck size, weight, and axle configurations on the SHS
- Implementing MAP-21 regulations pertaining to performance measures and asset management for bridges and pavement

In addition to the policy established in Moving Oklahoma Forward, ODOT currently dedicates approximately $40 million in annual funding to bridge rehabilitation and another $5 million for the preventative maintenance program. These funds are specifically targeted for investment in lower-cost maintenance and rehabilitation treatments that have proven effective in slowing or stemming further bridge deterioration or functional decline in "at risk" bridges and maximizing the life-cycle of the bridge.

While bridge rehabilitation and preventative maintenance through the APP exemplify the wise investment of available resources, ODOT plans to continue the long-term annual bridge replacement commitments at a pace that will prevent the aging bridge inventory from reaching advanced stages of deterioration that adversely impact the public.

As discussed earlier, ODOT has significantly reduced the number of structurally deficient bridges to a level that might allow ODOT to redirect funds towards pavements. This funding trade-off analysis is at the heart of a TAMP effort and is a substantial goal of the federal asset management requirements.

Chapter 9

Process Improvements

TAM is a process of continuous improvement. Deeper partnerships, new data sources, and new approaches to data analysis allow ODOT to make ongoing improvements to how its assets are managed. This chapter offers ideas for how ODOT will improve its asset management process.

Overview

TAM is a continuously improving practice. Oklahoma has been improving TAM programs and data, making progress towards aligning them with state goals and targets. This chapter details how ODOT will implement TAM performance improvements in the TAMP and focus on specific initiatives to achieve a better TAM program that will lead to improved TAM performance. The improvements listed in this chapter were developed using input gathered during the TAMP workshops working collaboratively by a group of federal, state, and local stakeholders throughout Oklahoma.

Federal Requirements

FHWA requires that a state DOT update its TAMP and development processes every four years. FHWA recommends that state DOTs conduct periodic self-assessments of TAM capabilities (23 CFR 515.19(d)). As written in the federal rules, "based on the results of the self-assessment, the State DOT should conduct a gap analysis to determine which areas of its asset management process require improvement. In conducting a gap analysis, the State DOT should:

1. Determine the level of organizational performance effort needed to achieve the objectives of asset management
2. Determine the performance gaps between the existing level of performance effort and the needed level of performance effort; and
3. Develop strategies to close the identified organizational performance gaps and define the period of time over which the gap is to be closed."

ODOT is in the process of acquiring strategic modelling software that will help to manage TAM process improvements. Subsequent improvements to TAM processes will be documented in future updates to this TAMP.

TAM Process Improvements

Throughout the TAMP development process, stakeholders gathered to focus on specific aspects of the TAMP and provide input on ways to improve processes in the future. On February 7, 2018, a workshop was held with Oklahoma TAMP stakeholders to build agreement on potential TAM process improvements. Stakeholders included representatives from ODOT as well as from other federal, state, and local agencies. After the presentation of all of the building blocks in the TAMP, this interactive workshop included an exercise to finalize priorities for TAM improvement initiatives. A set of improvement initiatives from past workshops was provided for the participants to consider.

Oklahoma TAMP stakeholders identified priority TAM improvements that would support the defined objectives in the sections of the draft TAMP. Each workshop participant prioritized their top three improvement initiatives, as well as a single initiative that could be considered a "quick hit," meaning it could be relatively easy to accomplish in the short term. The results were compiled to help determine high priority initiatives and opportunities for near-term improvement.

The results of the workshop are shown below. They are organized into the following categories: Delivering on Targets, LCP, Risk Management, Data and Tools, Coordination with Partners, and Strategic and Organizational Management. A note is added when one or more workshop participants indicated that an action would be relatively easy to accomplish in the short term.

Delivering on Targets

Setting and delivering on performance targets gives ODOT measurable ways to demonstrate its progress towards serving the public. Setting performance targets is an iterative process, and so ODOT identified the following ways in which various divisions could work to continue to develop and refine the process.

- ODOT's Roadway Design Division and Bridge Division could collaborate with the Strategic Asset and Performance Management Division (SAPM) to implement a cross-asset allocation process.
- SAPM could improve roadway deterioration modeling by incorporating data on annual average daily traffic and pavement sections.
- SAPM and Field Divisions could rebalance their feedback process in order to model whether proposed investment strategies will meet goals.
- SAPM could compare projected asset conditions to measured asset conditions in order to improve projections *(*easy to accomplish in the short term).*

Life Cycle Planning

LCP is based on the principle that timely investments in an asset's maintenance, preservation, and rehabilitation result in improved condition and lower overall long-term costs. ODOT could further improve the LCP processes by compiling and analyzing data from new sources as detailed below.

- ODOT could capture data from the public in order to augment existing data collection and to involve the public in TAM in a proactive way *(*easy to accomplish in the short term).*
- ODOT could analyze economic growth data from housing and business activity to evaluate the economic impact of past roadway improvement projects.
- ODOT could create an economic growth prediction tool that could estimate the potential economic value of proposed road improvements.

Risk Management

Risk management is a daily activity at ODOT. The traveling public and ODOT workers face risks to health and safety from deteriorating assets and extreme weather, and ODOT faces financial and organizational risks such as reduced funding and loss of institutional knowledge. In order to improve the processes by which ODOT manages these risks, stakeholders proposed the following strategies.

- ODOT Senior Staff, SAPM, and ODOT's Legislative Liaison could work to educate legislators on the impacts of revenue changes. This initiative would involve creating talking points, proposing policy, and scheduling meetings *(*easy to accomplish in the short term).*
- All managers throughout ODOT could work on retaining institutional knowledge through cross-training and succession planning. Managers could write manuals of traditional precedents, standard operating procedures, and best practices.
- The Secretary of Transportation could champion the cause of managing ODOT's information technology rather than having it managed by the Office of Management and Enterprise Services.

Data and Tools

Quality data is essential to well-informed decision making. Stakeholders developed the following strategies to continue to improve how data is collected, stored, and used.

- Bridge Management and Pavement Management could continue to validate their models in order to improve accuracy. This validation could coincide with annual pavement and bridge condition data collection.
- Bridge Management and Pavement Management could improve data quality control processes by deciding which data items are essential, developing data samples to validate the remaining data, and consulting with other states *(*easy to accomplish in the short term).*
- ODOT could establish a central location for data with a site manager using Geographic Information Systems or Agile Assets.

Coordination with Partners

ODOT cultivates ongoing partnerships with OTA, FHWA, local authorities, and other transportation agencies to serve the traveling public. The following strategies are ways ODOT will continue to build on existing partnerships.

- Data owners throughout ODOT will work to improve how data is tracked and assembled in order to meet the needs of the TAMP. Relevant divisions could develop data platforms and responsibilities in order to ensure that the needed data is compiled.
- The TAMP committee and stakeholders from partner transportation agencies will define ongoing roles and responsibilities to ensure that TAMP process maintenance engages the appropriate entities.
- The TAMP committee and associated transportation agencies will develop a communication plan with agreed-upon messaging points in order to ensure that TAMP outreach is educational.

Strategic and Organization Management

By looking at strategic and organization management, ODOT can build on its strengths and continue to serve the public. Stakeholders suggested the following strategies for building on ODOT's organizational management.

- All division engineers and division managers could work to preserve institutional knowledge throughout ODOT by integrating succession training and cross training into overall hiring practices *(*easy to accomplish in the short term).*
- In collaboration with other state government agencies, Human Resources could work on recruitment by studying current market pay rates in both the public and private sectors *(*easy to accomplish in the short term).*
- The Office Services Division could work to regain ownership and internal knowledge of ODOT's information technology assets.

Glossary

3P	Pavement Preservation Projects
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ACP	Asphalt Concrete Pavement
APP	Asset Preservation Plan
BMS	Bridge Management System
BrM	AASHTOWARE Bridge Management Software
CRCP	Continuously Reinforced Concrete Pavement
CWP	Construction Work Plan
DOT	Department of Transportation
FHWA	Federal Highway Administration
GASB 34	Government Accounting Standards Board Statement 34
HPMS	Highway Performance Monitoring System
IBC	Incremental Benefit Cost
IBCR	Incremental Benefit Cost Ratio
IRI	International Roughness Index
JCP	Jointed Concrete Pavement
LCMS	Laser Crack Measuring System
LCP	Life Cycle Planning
MAP-21	Moving Ahead for Progress in the 21st Century
MPO	Metropolitan Planning Organization
MPR	Media and Public Relations Division of ODOT
NBI	National Bridge Inventory
NBIAS	National Bridge Investment Analysis System
NCHRP	National Cooperative Highway Research Program
NHS	National Highway System
ODOT	Oklahoma Department of Transportation
OTA	Oklahoma Turnpike Authority
PM2	Performance Management 2 Rules
PMS	Pavement Management System
PQI	Pavement Quality Index
SAPM	Strategic Asset and Performance Management Division of ODOT
SHS	State Highway System
STIP	State Transportation Improvement Plan
TAM	Transportation Asset Management
TAMP	Transportation Asset Management Plan
tsf	Thousand Square Feet

Appendix A. Pavement Preservation Projects (3P) Decision Trees

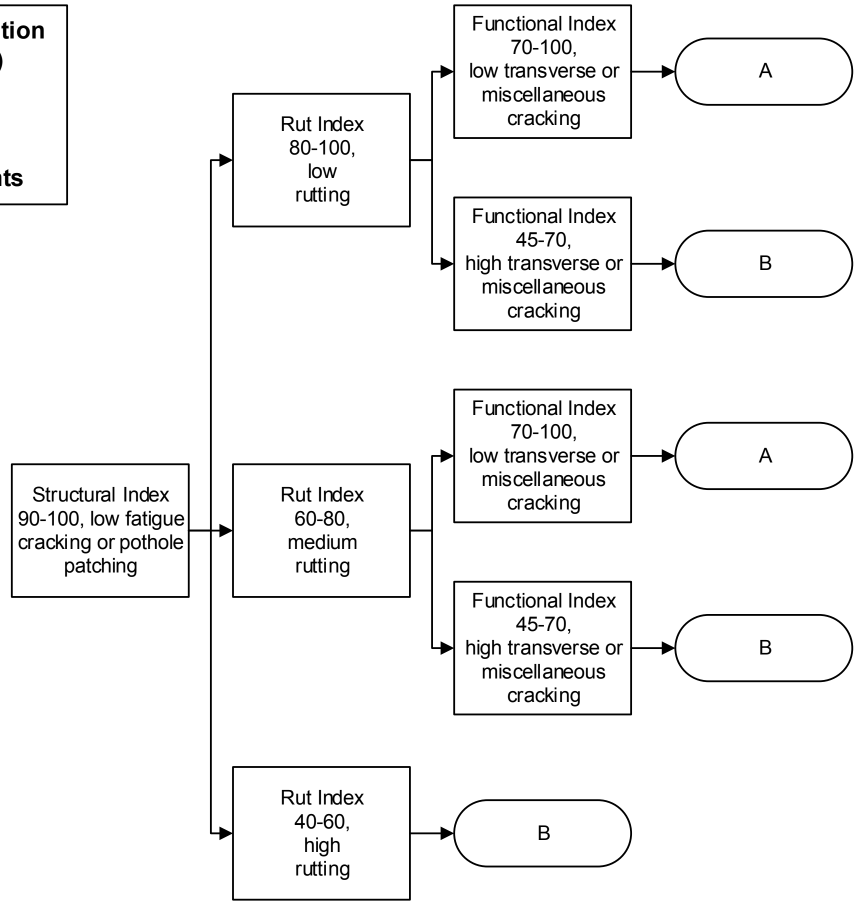
Oklahoma Department of Transportation
Pavement Preservation Projects (3P)
Decision Tree

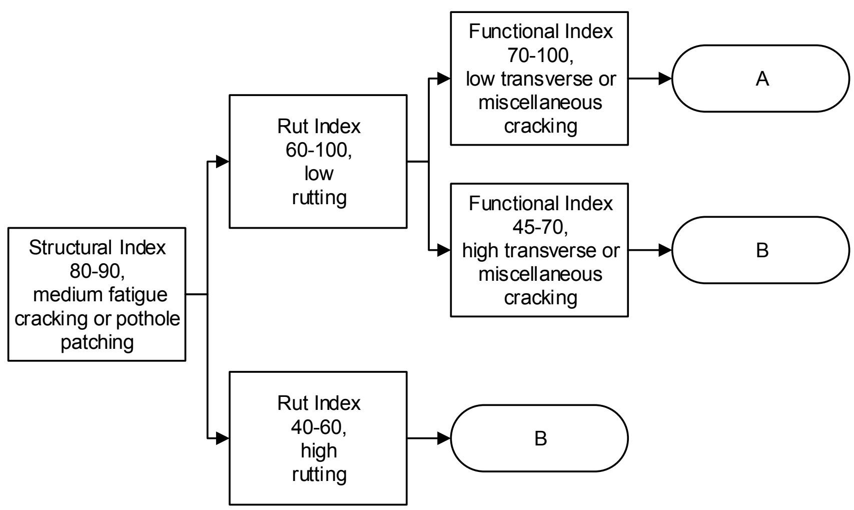
All Traffic Volumes
AC or Composite Concrete Pavements

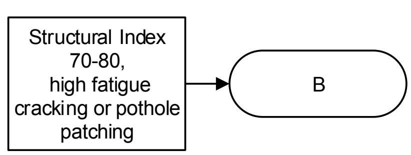
<u>Minimum Index Values for 3P</u>
Structural 70
Rut 40
Functional 45

<u>Treatment Level A Options</u>
Chip Seal (<8,000 AADT)
Microsurface
Thin Overlay 1"-2"
UTBWC

<u>Treatment Level B Options</u>
Medium Overlay 2"-3"
Hot In-Place Recycle (HIR)
HIR Cap with UTBWC
HIR Cap with Overlay 1-2"
Milling (with surface treatment)







Revised 03/06/2017

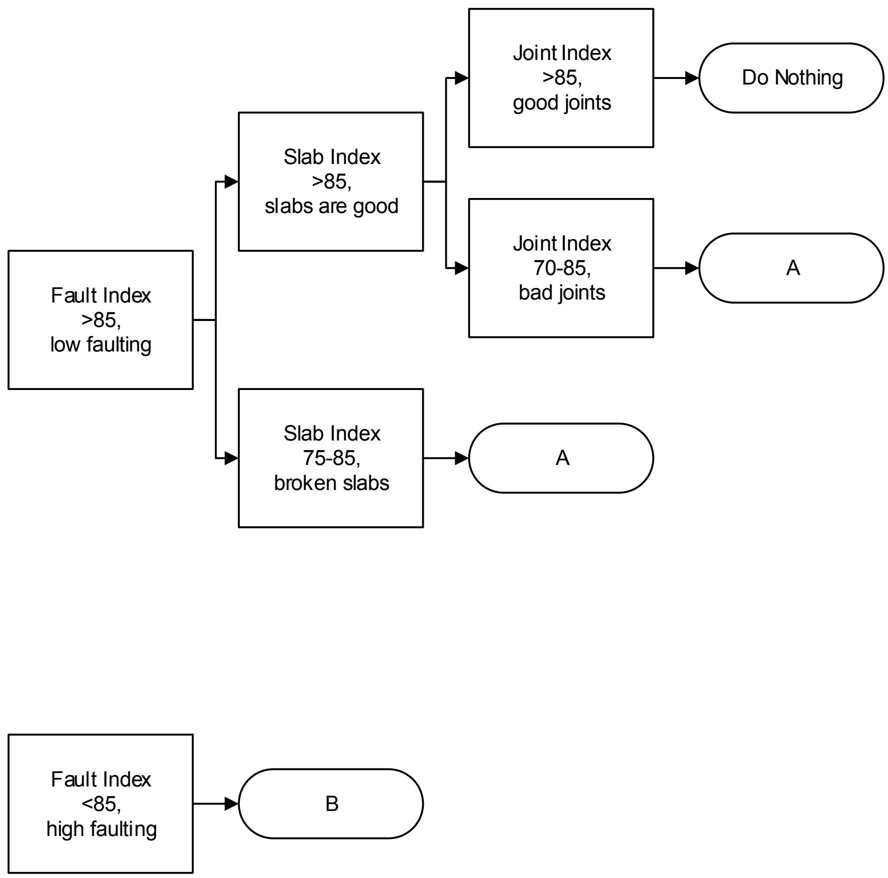
Oklahoma Department of Transportation
Pavement Preservation Projects (3P)
Decision Tree

All Traffic Volumes
Jointed Concrete Pavements

<u>Min. Index Values for 3P</u>
Slab 75
Joint 70

<u>Treatment Level A Options</u>
Patching

<u>Treatment Level B Options</u>
Patching
Dowel Bar Retrofit
Diamond Grinding



Revised 03/6/2017

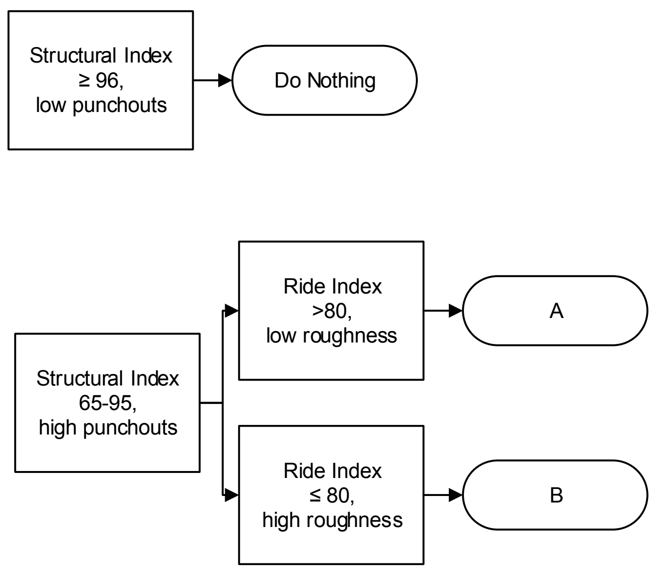
Oklahoma Department of Transportation
Pavement Preservation Projects (3P)
Decision Tree

All Traffic Volumes
Continually Reinforced Concrete Pavements

<u>Min. Index Values for 3P</u>
Structural 65

<u>Treatment Level A Options</u>
Full-Depth Punchout Repair

<u>Treatment Level B Options</u>
Full-Depth Punchout Repair
Diamond Grinding



Revised 03/06/2017

Appendix B: ODOT Risk Register

Identify				Respond and Monitor			Risk Mitigation Actions			
Category	**Title**	**Risk Statement**	**Current Controls**	**Mitigation Action**	**Priority**	**Additional Note**	**Action**	**Owner**	**Completion Date**	**First Step**
1-Asset Performance	Deterioration Models	If our deterioration models inaccurate we may not correctly predict future conditions, needed work, and future funding needs.	Bridge has developed models in new BrM (addressed - hopefully) Pavement in process of re-evaluating (want to improve project level decision making)	Validate models	Low	Need to define inaccurate in terms of deterioration modeling Current condition is very accurate	Validate models	Bridge Division, SAPM Division	Ongoing	Review past performance of models
1-Asset Performance	Modeling Flooding/Scour	If our models do not capture potential damage from increased flooding and scour events they may lead to incorrect predictions	Bridge has a scour flag and will downgrade condition based on scour criticality - big floods occurred recently (May 2015) so it has become a concern. USGS contract provides discharges for historical flood levels. These will vary as information changes 50-year design minimum for Interstate, 100 year is goal, but this is a project level decision and cost is considered Availability and robustness of detours	Update models based on periodic review (2-4 years)	Medium	Example of recent red river flooding - and difficult decision regarding keeping interstate bridge open when most other crossings were closed.	Develop scour models and utilize GIS information to assist in validating detour availability	Bridge Division	Ongoing	Investigate scour modeling

Appendix B: ODOT Risk Register

Category	Title	Risk Statement	Current Controls	Mitigation Action	Priority	Additional Note	Action	Owner	Completion Date	First Step
Identify				**Respond and Monitor**			**Risk Mitigation Actions**			
							Identify priority corridors and develop more conservative design models, make right lane thicker concrete, legislate for funding needs	ODOT Operations	Ongoing	Educate Legislators
							Develop and model corridors that would be susceptible to incoming truck traffic	SAPM Division	ASAP	Surveys the available models and products that demonstrate this
1-Asset Performance	Truck Size/Weights	If allowable configurations and weights increase, then bridge or pavement design conditions and deterioration may be impacted		See above + lobby against and screen network if change made	Medium	Port of entry program invested $8M in technology to track	Enforcement	OK Corp. Commission, OHP Size and Weight	Ongoing	Educate trucking industry; Educate legislation
							Enforcement	Senior Staff, OK Corp. Commission	1 year for outreach	Discussion with agencies and outreach
2-Highway Safety	Increased Focus on Safety	Increasing numbers of traffic fatalities may result in shifting focus from improving pavement and bridge conditions to further improving safety.		Develop four-year work plan detailing need for safety and funding above and beyond current funding	**Medium-High**	$12M in Traffic Safety Funding is already defined. National performance measure	Safety targets	Traffic Division	ASAP	Determine specific safety measures to use and review FARS

Appendix B: ODOT Risk Register

Identify				Respond and Monitor			Risk Mitigation Actions			
Category	**Title**	**Risk Statement**	**Current Controls**	**Mitigation Action**	**Priority**	**Additional Note**	**Action**	**Owner**	**Completion Date**	**First Step**
2- Highway Safety	Changes in Design Standards	Changes in design standards (e.g. MASH Standard Adoption) for traffic and safety features (e.g., guardrail) may require additional safety investments.		Maintenance - avoid due to inability to deliver new standard Construction- accept and update standards Get ODOT staff involved at national level	**Low**	**(Note: Disconnect between Analyze and Priority)**	Monitor trends	Design committee representatives	Ongoing	Continued attendance at committee meetings
2- Highway Safety	Inadvertent Introduction of Safety Issues	Work on rehabilitation of existing roads and bridges may inadvertently introduce new safety hazards, requiring additional resources to address within project/program			low		Attentiveness to design impacts	Roadway Division, Bridge Division, Traffic Division	Ongoing	Thorough review of project conditions
2- Highway Safety	New Safety Installation Requirements	Work on rehabilitation of existing roads and bridges may trigger requirements to install new safety countermeasures, requiring additional resources to address within project/program				Missing details	Design standards/new installation	ODOT Traffic	Ongoing	Integrate safety info into asset plan

Appendix B: ODOT Risk Register

Identify				Respond and Monitor			Risk Mitigation Actions			
Category	**Title**	**Risk Statement**	**Current Controls**	**Mitigation Action**	**Priority**	**Additional Note**	**Action**	**Owner**	**Completion Date**	**First Step**
3-External Threats	IT System Ownership	ODOT has limited control of their IT systems, which may result in difficulty in new IT programs and enhancements			**High**		Regain control of IT function and decisions	Senior Staff, Office Services Division	ASAP	Initiate discussions with OMES for latitude. Review statute/policy options.
3-External Threats	Theft of Components	If we do not secure our assets (e.g., copper, solar panels) the may fail prematurely due to theft of components.	Right now ODOT often leaves unaddressed, so if addressed may need to divert funding		low					
3-External Threats	Vehicle Accident Damage (Bridge Hits, spills, etc.)	Damage to structures due to vehicle hits may require diversion of funds.	15 Bridge hits / year - all require rehabilitation action Pavement damage and clean up Bridge strike by barges	New design standards (raise bridge, drilled shafts) Pursue insurance reimbursement	**High**	Using external consultant to improve collection process. Lots of spread on this High (6), Medium (3), Low (3)	Industry education	Bridge Division, Field Division, Media and Public Relations Division, Safety Branch	ASAP	System review
3-External Threats	Flooding	Damage to pavement or structures due to floods may require diversion of funds		Where possible, design for flooding and accept where not economically feasible	**Medium**	**(Note: Disconnect between Analyze and Priority)**	Design for it	ODOT	2018	Identify flood susceptible structures
3-External Threats	Geotechnical hazards (e.g. Rockfalls and landslides)	If rockfalls or landslides occur, damage and diversion of funding occurs		Construction consultant to address issues statewide - comes from	Low	Acceptable solution already in place				

Appendix B: ODOT Risk Register

Identify				Respond and Monitor			Risk Mitigation Actions			
Category	**Title**	**Risk Statement**	**Current Controls**	**Mitigation Action**	**Priority**	**Additional Note**	**Action**	**Owner**	**Completion Date**	**First Step**
				Maintenance Budget						
4-Finances	Politically Motivated Project Selection	If projects are selected based on political decisions, this may result in diversion of funds.	Limited concern due to 8-year plan process has already mitigated this risk		low		Correct detail info; Tech to support analysis; Securing system	ODOT	2019	Develop TAMP and Decision Lens to support 8-Year CWP
4-Finances	Public Support and Communicating Benefits	If the public does not understand or support our asset management efforts this may result in diversion of funds.		Education, Stakeholder outreach, Media awareness, Press releases	**High**		Communicate how each person will be affected personal message	MPR/SAPM/ DEs	1/31/19	Unified messaging; identify stakeholders – on demand planning; Professional service
4-Finances	Funding Uncertainty	Uncertainty of future funds may result in suboptimal decisions concerning what work to perform.			Medium	Different at report out	Education, Legislation, Public	Sr. Staff, Media and Public Relations Division	ASAP	Legislator Info packet, Senior Staff presentations
							Reduce budgeted program	Senior Staff, Field Division	2018	Rebalance 8-Year CWP to new funding level
							Keep public and legislature informed of the consequences of lowering funding and benefits of raising funding.	Senior Staff	2018	Current needs and current funding forecast
							Reserve fund	Legislature, ODOT	2018	Investigate Opportunity

Appendix B: ODOT Risk Register

Identify				Respond and Monitor			Risk Mitigation Actions			
Category	**Title**	**Risk Statement**	**Current Controls**	**Mitigation Action**	**Priority**	**Additional Note**	**Action**	**Owner**	**Completion Date**	**First Step**
							Present TAMP to legislature and show what happens with decreased funding	ODOT	Annually	Create TAMP report and formalize the presentation
							Education of legislature	Senior Staff, Field Division	1/31/19	Host new legislators for meet and greet showing consequences of action/inaction
4-Finances	Future State Revenues (e.g. Energy Industry Revenues)	Changes in revenues from the energy industry may result in reduction in funding	State doesn't tax at same rate as other states, also very dependent on sales tax income during energy industry	Educate legislature of impact, reduce non-essential costs, reduce constructio n program, toll credit	**High**		Reductions in revenue = reduced 8-Year CWP, Educate Legislature	Senior Staff, Field Division	Ongoing	Educate Legislators
4-Finances	Inflation	Changes in inflation may result in diversion of funds (overall)			Medium	Different at report out	Determine realistic interest rate to apply to program	Senior Staff	Ongoing	Determine realistic expectation and apply to program
4-Finances	Input Prices	Change in the price of inputs may result in reduction in the work we can perform (commodity specific)			Medium		Maintenance: Develop annual material contracts. Construction: Price adjustment special provision	Maintenanc e Division, Field Division	Ongoing	Develop longer term material contracts to minimize price spike impacts

Appendix B: ODOT Risk Register

Identify				Respond and Monitor			Risk Mitigation Actions			
Category	**Title**	**Risk Statement**	**Current Controls**	**Mitigation Action**	**Priority**	**Additional Note**	**Action**	**Owner**	**Completion Date**	**First Step**
4-Finances	Impacts of Incurring Debt	Decisions to increase debt (debt service, cost to borrow) may reduce available funds in the future.			Medium	Different at report out	Seek legislative relief	Senior Staff	Ongoing	Seek funding from legislators to finance debt service
4-Finances	Improvements In Fuel Efficiency	Improvements in fuel efficiency may reduce available funds on the future.		Use education to raise awareness of alternative approaches to taxing efficient/alternative fuel vehicles	**High**	Leave separate **(High but Not Addressed in TAM Building Workshop)**	Seek legislative relief	Senior Staff	Ongoing	Discuss potential for fuel tax revenue impact and support additional revenue from fuel sources - potential indexing of fuel tax
5-Information and Decisions	Need To Maintain State of Industry Practice	If we do not embrace new materials and equipment we may not be able to maintain our assets efficiently		Investigate new materials and equipment	Low	A lot of research funding already going into place	Continue existing research program	Senior Staff, SAPM Division	Ongoing	Continue to engage universities and industry
5-Information and Decisions	Lack Of Access To Technology	If staff lack access to adequate technology, design tools and training they may not be able to perform needed work		Work with OMES to improve relationship	**High**	Could be low cost with potential for big impact	Take back over mission critical work	Office Services Division	Ongoing	Internal staff discussions
							Get administrator access to our computers	Office Services Division	2018	Improve OMES relationship and inform Sr. Staff of how this hinders ODOT processes

Appendix B: ODOT Risk Register

Identify				Respond and Monitor			Risk Mitigation Actions			
Category	Title	Risk Statement	Current Controls	Mitigation Action	Priority	Additional Note	Action	Owner	Completion Date	First Step
							Find opportunity for new tech and removal of $1 for old software	Office Services Division with all divisions	ASAP	Identify outdated software
							We have a lack of expertise in new technologies coming out (self-driving vehicles)	ODOT	ASAP	Acquire the expertise on the changing traveling public
5-Information and Decisions	Incorrect Project Selection	If we select projects incorrectly we may not achieve predicted asset improvements.		Decision lens and review procedures	Medium	Decision lens is in place	Correct detail info; Tech to support analysis; Securing system	ODOT	2019	Decision Lens training
5-Information and Decisions	Quality of Asset Inventory & Condition Data	If we have incomplete or poor-quality data on asset condition we may not correctly predict future conditions and needed work.	Division Notebook process		Medium		Check data with 3rd party quality check and check with field data to make sure it lines up with what they see	ODOT SAPM	Continuous	Inventory of current system
5-Information and Decisions	Quality of Asset Inventory Data	If we have incomplete or poor-quality data on asset inventory we may not correctly predict future conditions and needed work.			Low		Maintain data integrity, accessibility, and collection methodology	SAPM Division	Ongoing	Continue data validation and reviews

Appendix B: ODOT Risk Register

Identify				Respond and Monitor			Risk Mitigation Actions			
Category	**Title**	**Risk Statement**	**Current Controls**	**Mitigation Action**	**Priority**	**Additional Note**	**Action**	**Owner**	**Completion Date**	**First Step**
5-Information and Decisions	Data on An Asset Over Its Life Cycle	If we lack data on assets over their life cycle we may not correctly predict future conditions and needed work		ESRI Roads & Highway to improve coordination and investigate new field collection tech	Medium		Maintain data integrity, accessibility, and collection methodology	SAPM Division	Ongoing	Continue data validation and reviews
5-Information and Decisions	Pavement and Bridge Management Systems Lack Certain Needed Functionality	If certain management system gaps are not addressed, we may not be able to maintain our assets efficiently		Periodic reviews of management systems	Medium	High - 4, Medium - 5, Low -2	Maintain Management Systems	Bridge Division, SAPM Division	2019	Review management system capabilities and functionality
6-Business Operations	Lack of External Coordination	If external coordination is lacking, we may not plan and deliver TAM programs efficiently			Medium		Engage stakeholders	Senior Staff, Media and Public Relations Division, Field Division	2019	Identify pertinent stakeholders
6-Business Operations	Lack of Maintenance Staff	If we lack experienced maintenance staff (e.g., for repair or installation of signals, signs, lights, and ITS) we may not be able to perform needed work			Medium	This is borderline High - lots of discussion	Agency-wide market study	Senior Staff, HR Division	ASAP	Perform and implement market study
6-Business Operations	Lack of Engineering Staff	If we lack experienced engineering staff we may not be able to perform needed work			Medium		Agency-wide market study	Senior Staff, HR Division	ASAP	Perform and implement market study

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Identify				Respond and Monitor			Risk Mitigation Actions			
Category	**Title**	**Risk Statement**	**Current Controls**	**Mitigation Action**	**Priority**	**Additional Note**	**Action**	**Owner**	**Completion Date**	**First Step**
6-Business Operations	Knowledge Transfer	If we lack appropriate knowledge management and succession planning future staff may not have sufficient knowledge to perform needed work. If policies are not well documented, then how can ODOT ensure these modeling considerations asre properly accounted for as staff turns over	Field should have final say due to subjective/unquantifiable data		Medium		Retain employees	Senior Staff, HR Division	Ongoing	Increase pay; Succession planning
							Educate or cross train younger employees	ODOT	2018	Document current practice
							Better documents, Procedure spelled out, set up mentor program	All DOT	2 years for docs then continual	Each push outlines their tasks/processes; Setup people who can learn those tasks or can be mentored
6-Business Operations	Process Documentation	If we lack appropriate documentation of existing processes future staff may not have sufficient knowledge to perform needed work.			Medium		Require process documentation	Senior Staff	2019	Require divisional or specialty area notebook that addresses methods and policies
6-Business Operations	Internal Coordination	If we do not coordinate across divisions, asset groups, and work units we may not be able to perform needed work.			Low		Encourage communication	All DOT	Ongoing	Encourage communication between all offices and areas; Intranet messaging

Appendix B: ODOT Risk Register

Identify				Respond and Monitor			Risk Mitigation Actions			
Category	**Title**	**Risk Statement**	**Current Controls**	**Mitigation Action**	**Priority**	**Additional Note**	**Action**	**Owner**	**Completion Date**	**First Step**
6-Business Operations	Construction Industry Capacity	If the construction industry lacks capacity to perform the needed volume of certain types of work we may not be able to perform needed work.			Medium	Different at report out	Ensure AOGC is aware of projected workload	Senior Staff	Ongoing	Continued engagement with AOGC
6-Business Operations	Changes in Regulations	Future changes to regulations (MUTCD, AASHTO, NESC, PURA, etc.) may result in diversion of funds.		Training of staff and educate Leadership role	Medium Low - training **High - leadership role**	Changed after discussion	Input, outreach, communication, education	Senior Staff, Committee Members	Ongoing	Committee Members to be attentive to proposed changes. Senior Staff to inform delegation of impacts
							Change in interpretation	ODOT	Ongoing	Accept higher level risk
							Predict how changes will affect ODOT process	ODOT	2018	Strengthen partnership with other agencies like FHWA
6-Business Operations	New Regulations	New regulations may create delay in and increase the cost of needed work.		See 34	Medium	Changed after discussion	Educate, identify, monitor	Senior Staff	Ongoing	Continue communication with regulators and delegation
							Predict how changes will affect ODOT process	ODOT	2018	Strengthen partnership with other agencies like FHWA

Appendix C: Emergency Events Log

Division	County	Control Section	Mile Point	Federal Aid Route Number (if applicable)	Lat/Long (if available)	Location Description	Event Type (flooding, earthquake, fire, tornado, etc)	Event Date	Damage Description	Repair Type (does not include emergency repairs)	Repair Location	Repair Date	Roadway (Y/N)	Bridge (Y/N)	DDIR (Y/N)	Notes
1	11 - Cherokee	82-11-20	2.65	SH-82	35°40'01.03"N 94°56'14.24"W	Southwest of RCB at Chicken Creek (NBI 12689) on S. side of SH-82 extending S. 1/4 mile	flooding		Ditch erosion and loss of embankment leading to shoulder and northbound lane damage due to plugged cross drains uphill of location	placed and compacted fill, reshaped shoulder and ditches, added rip rap	Southwest of RCB at Chicken Creek (NBI 12689) on S. side of SH-82 extending S. 1/4 mile	5/17/17	Y	N	N	
1	31 - Haskell	71-31-18	1.3	SH-71	35°10'34.11"N 95°23'08.85"W	Double pipe banks (3 HDPE pipes and 4 CGMP pipes) 1.3 miles north of the Pittsburg County line	flooding		Repetitive flooding, loss of fill around CGMP pipe bank due to corrosion, damage to northbound lane due to undermining	Replaced CGMP's with Polypropelyne pipe, add fill, replaced headwalls and roadway	Double pipe banks (3 HDPE pipes and 4 CGMP pipes) 1.3 miles north of the Pittsburg County line	9/14/16	Y	N	N	
1	31 - Haskell	82-31-21	2.35	SH-82	35°04'36.10"N 95°06'44.23"W	East side of SH-82 2.35 miles north of the Latimer County line	flooding		Slope failure on east side of SH-82, loss of embankment under shoulder and portion of northbound lane	constructed geosynthetically confined soil wall, replaced base and pavement	East side of SH-82 2.35 miles north of the Latimer County line	9/1/15	Y	N	Y	ERSTP-231C(018)ER, J/P 31686(04), GSI constructed retaining wall, state forces replaced base and placed asphalt shoulder/lane
1	56 - Okmulgee	75-56-11	8.45	US-75	35°43'18.45" N 95°59'50.63" W	East side of US-75 northbound lanes 1.4 miles south of SH-16 interchange	flooding		Repetitive slope failure on east side of US-75, loss of embankment	extended drainage structure, replaced fill on a flatter slope, replaced guardrail, sod	East side of US-75 northbound lanes 1.4 miles south of SH-16 interchange	2013	N	N	N	special maintenance project MX-256N(014), J/P 30232(04)
1	56 - Okmulgee	40-56-03	5.5	I-40	35°25'58.49"N 95°59'25.37"W	East side of eastbound (NBI 15795)and westbound (NBI 15794) I-40 bridges over railroad tracks near Henryetta	flooding		Repetitive slope failure on east side of eastbound (NBI 15795)and westbound (NBI 15794) I-40 bridges over railroad tracks near Henryetta	reworked slope in past, currently needs another repair	East side of eastbound (NBI 15795)and westbound (NBI 15794) I-40 bridges over railroad tracks near Henryetta	pending	N	Y	N	

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2	12 - Choctaw					US-271 south of Hugo on the Red River	Flooding									
2	12 - Choctaw					Crowder Creek on US-270, 1 mile west of US-70 and US-271	Flooding									
2	12 - Choctaw					US-70 near Frank Fodge Bridge (Muddy Boggy) between Soper and Boswell	Flooding									
2	12 - Choctaw					SH-109 at Muddy Boggy Bridge	Flooding									
2	7 - Bryan					US-70 at Bryan/Marshall county line (Roosevelt Bridge)	Flooding									
2	7 - Bryan					SH-78 at the Red River	Flooding									
2	7 - Bryan					SH-78 at Blue River North of Durant	Flooding									

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2	7 - Bryan					SH-22 West of Kenefic at Blue River	Flooding									
2	40 - Leflore					US-270 at Wister Lake	Flooding									
2	45 - McCurtain					US-259 at Red River	Flooding									
2	64 - Pushmataha					US-271 at Dry Creek approx. 8 miles East of junction of SH-2 and US-271	Flooding									
2	64 - Pushmataha					SH-3 at Kiamichi River between Antlers and Rattan	Flooding									
2	64 - Pushmataha					SH-43 at Sardis Lake north of Clayton	Flooding									
2	39 - Latimer					SH-2 at Sardis Lake near Yaunish	Flooding									

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2	61 - Pittsburgh					US-270 west of the Turnpike near Coal Creek	Flooding									
3	63-Pottawatomie	102-63-47	5.4		35*11'15.01" N 97*2'52.21"W	SH 102 - 5.4 miles South of SH 9	Flooding		CGMP failure; Ditch and shoulder erosion	Replaced CGMP;fill; reshape; Level Patch	SH 102 - 5.4 miles South of SH 9	5/28-5/29/15 8/17/15	Y	N	Y	In May the CGMP was replaced in August the Asphalt was laid.
3	63-Pottawatomie	102-63-47	5.33		35*7'15.92"N 97*2'7.05"W	SH 102 - 5.33 miles south of SH 9	Flooding		CGMP failure; Ditch and shoulder erosion	Replaced CGMP;fill; reshape; Level Patch	SH 102 - 5.33 miles south of SH 9	6/1-6/5/15 8/17/15	Y	N	Y	In June the CGMP was replaced in August the Asphalt was laid.
3	63-Pottawatomie	102-63-47	4.5		35*11'44.29" N 97*3'15.60"W	SH102 - 4.5 miles south of SH9	Flooding		CGMP failure; Ditch and shoulder erosion	Replaced CGMP;fill; reshape; Level Patch	SH102 - 4.5 miles south of SH9	6/8-6/12/15 8/18/15	Y	N	Y	In June the CGMP was replaced in August the Asphalt was laid.
3	63-Pottawatomie	102-63-47	0.73		35*15'0.24"N 97*3'13.88"W	SH102 - 0.73 miles south of SH9	Flooding		CGMP failure; Ditch and shoulder erosion	Replaced CGMP;fill; reshape; Level Patch	SH102 - 0.73 miles south of SH9	6/4/15 7/13/15&8/20	Y	N	Y	In June the CGMP was replaced in July & August the Asphalt was laid.
4	55 - Oklahoma					US 62 (NE 23rd) and Air Depot; Approx. 3 miles E of I-35	Flooding		Washout, loss of asphalt roadway and shoulders, loss of fill under roadway and shoulder, loss of embankment	JP 30314(05) Project # ERNHPP-255A(207)ER	US 62 (NE 23rd) and Air Depot; Approx. 3 miles E of I-35		Y	N	Y	
4	37 - Kindfisher			SH 33	35'50'31.32" N 97'43'31.09" W	SH 33 over Campbell Creek between NS 294 and 295; J/P 21855(04)	Flooding		Washed out of shoofly and riprap				Y	Y	Y	

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4	37 - Kingfisher			SH 33	35'51'39.40" N 97'55'27.14" W	SH 33 over Uncle John's Creek and overflow J/P 21856(04);NBI#:30 119 & 30118	Flooding		Rip Rap washed out and erosion in creek		SH 33 over Uncle John's Creek and overflow J/P 21856(04);NBI#:30 119 & 30118		Y	Y	Y	
4	37 - Kingfisher			SH 51		SH 51 over Turkey Creek	Flooding		Rip Rap wash out		SH 51 over Turkey Creek		N	N	Y	
4	27 - Grant			SH 11	36°48'39.01" N 97°59'03.49" W	SH11	Flooding		Detour Washout, reduced to one lane (built as 2-way detour)		SH11		Y	N	Y	
4	52 - Noble			SH 156	36°34'56.28" N 97°08'21.84" W	SH 156 over Deadman's Creek NBI# 30290	Flooding		Erosion on cross stream, needs bank protection and stabilization		SH 156 over Deadman's Creek NBI# 30290		N	N	Y	
4	9 - Canadian			0901C	35°25'11"N 97°41'21"W	SW 44th and Morgan Road	Flooding		Roadway washed out (repaired)		SW 44th and Morgan Road		Y	N	Y	
4	42 - Logan			SH 74	36°03'37"N 97°35'10.15" W	SH 74 over Skeleton Creek NBI# 30051	Flooding		Loss of Rip Rap		SH 74 over Skeleton Creek NBI# 30051		N	N	Y	
4	42 - Logan			0932C	36°06'56.66" N 97°33'39.91" W	SH 51 over Otter Creek NBI# 28670	Flooding		Side structure and rip rap washed out		SH 51 over Otter Creek NBI# 28670		N	N	Y	

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4	55 - Oklahoma			US-62	35'29'35.31" N 97'0940.70" W	Us 62 over the North Canadian River; NBI # 21129	Flooding		Bridge and roadway slopes threatened by river scour as it turns underneath the bridge		Us 62 over the North Canadian River; NBI # 21129		N	N	Y	
4	55 - Oklahoma			US-62		Us 62 over the North Canadian River NBI 21129 STR# 5504 1746x	Flooding		Debris Removal from Bridge		Us 62 over the North Canadian River NBI 21129 STR# 5504 1746x		N	N	Y	
4	55 - Oklahoma			I-44 EB to I-235 SB	35'31'40.38" N 97'30'57.03" W	I-44EB to I-235SB over NBI # 28686	Flooding		Loss of rip rap along the south abutment. Scour and bank failures on both banks of the creek.		I-44EB to I-235SB over NBI # 28686		N	N	Y	
4	9 - Canadian					Old SH-66 (EW-102) approx. 0.5 mi West of Red Rock Rd	Flooding				Old SH-66 (EW-102) approx. 0.5 mi West of Red Rock Rd				y	
4	9 - Canadian					Old SH-66 E of Karns Rd	Flooding				Old SH-66 E of Karns Rd				y	
4	9 - Canadian					SH-152 @ unnamed creek 6.5 mi W of SH-92 near Mustang	Flooding				SH-152 @ unnamed creek 6.5 mi W of SH-92 near Mustang				y	
4	9 - Canadian					SH-4 @ N. Canadian Overflow 2.0 mi N of SH-66 near Yukon	Flooding				SH-4 @ N. Canadian Overflow 2.0 mi N of SH-66 near Yukon				y	

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4	37 - Kingfisher					SH-3 Beg. Spprox 3.0 Mi E of Blaine C/L ext E 1.0 Mi	Flooding				SH-3 Beg. Spprox 3.0 Mi E of Blaine C/L ext E 1.0 Mi				y	
4	37 - Kingfisher					US-81 @ Kingfiher Creek Approx .9 Mi N of SH 33	Flooding				US-81 @ Kingfiher Creek Approx .9 Mi N of SH 33				y	
4	37 - Kingfisher					SH-33 @ Uncle John Creek	Flooding				SH-33 @ Uncle John Creek				y	
4	37 - Kingfisher					SH-33 @ campbell Creek E of Kinfisher	Flooding				SH-33 @ campbell Creek E of Kinfisher				y	
4	55 - Oklahoma					US-62 @ N. Canadian River 0.5 Mi E of SH-270 jct near Harrah	Flooding				US-62 @ N. Canadian River 0.5 Mi E of SH-270 jct near Harrah				y	
4	55 - Oklahoma					SH-74 @ NW220/Coffee Creek	Flooding				SH-74 @ NW220/Coffee Creek					
4	55 - Oklahoma					I-235 & 23rd Street	Flooding				I-235 & 23rd Street					

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4	55 - Oklahoma					Choctaw Rd @ NE 23rd street	Flooding				Choctaw Rd @ NE 23rd street					
4	27 - Grant					US81 between Jefferson and Medford	Flooding				US81 between Jefferson and Medford					
4	27 - Grant					Us60 between Lamont Pond Creek	Flooding				Us60 between Lamont Pond Creek					
4	37 - Kingfisher					SH33 West of 81 in Kingfisher	Flooding				SH33 West of 81 in Kingfisher					
4	37 - Kingfisher					US 81 North of 33 in Kingfisher	Flooding				US 81 North of 33 in Kingfisher					
4	37 - Kingfisher					SH 51 W of Hennesey around Turkey Creek and Turkey Creek Golf Course	Flooding				SH 51 W of Hennesey around Turkey Creek and Turkey Creek Golf Course					
4	42 - Logan					Cotton Wood Creek bottom	maybe mitigated with new cotton wood creek				Cotton Wood Creek bottom					

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4	52 - Noble					SH 15 West of the town of Red Rock	Flooding				SH 15 West of the town of Red Rock					
4	36 - Kay					SH 156 N of Salt Fork	Flooding				SH 156 N of Salt Fork					
4	36 - Kay					US 77 South of Tonkawa @ intersetion with Fountain Rd	flooding				US 77 South of Tonkawa @ intersetion with Fountain Rd					
4	36 - Kay					US 177 due north of 11 in Chickaskia river bottom	Flooding				US 177 due north of 11 in Chickaskia river bottom					
4	36 - Kay					North bound off ramp at Bender/Braman Rd	Flooding				North bound off ramp at Bender/Braman Rd					
7	7 - Carter	70-10-02	14.2	US 70	34 10'23.00", 97 18'50.03"	US 70 WB over Cottonwood Creek	Flood		Scour and erosion behind abutments, under approach slabs and piers, erosion of TBSC shoulders	Pier and approach repair	Both abutments and approach slabs, Pier 1 & 4, approach shoulders	6/15/16	Y	Y	Y	
7	17 - Cotton	53-17-24	1.76	SH 53	34:21:44, -98:16:58	SH 53 over E. Cache Creek	Flood		Severe debris accumulation on upstream side of bridge	Debris removal	Upstream side of bridge	July, 2015	N	Y	N	

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7	17 - Cotton	70-17-04	15.18	US 70	34:09:32; - 98:11:26	US 70 over Whiskey Creek	Flood		Drift and Debris	Debris removal	Upstream side of bridge	July, 2015	N	Y	N	
7	69 - Stephens	53-69-16	11.12	SH 53	34:20:50.61;- 97:46:55.62	SH 53 over Mud Creek	Flood		Drift and Debris	Drift removal	Upstream side of bridge	July, 2015	N	Y	N	
7	69 - Stephens	29-69=12	14.41	SH 29	34:38:16.02;- 97:42:33.74	SH 29 over Black Bear Creek	Flood		Drift and Debris	Drift removal	Upstream side of bridge	Aug, 2015	N	Y	N	
7	69 - Stephens	53-69-16	14.3	SH 53	34:20:50.47;- 97:43;35.45	SH 53 over Pine Creek	Flood		Silt and Debris	Silt Removal	Under bridge	Aug, 2015	N	y	N	
7	50 - Murray	77-50-02	6.42	US 77	34:27:19.33;- 97:08:00.04	US 77 over Washita River Southbound	Flood		Drift and Debris	Drift removal	Upstream side of bridge	Aug, 2015	N	Y	N	
7	50 - Murray	07-50-08	2.44	SH 7	34:30:17.5;- 97:08:35.06	SH 7 over Washita River Westbound	Flood		Drift and Debris	Drift removal	Upstream side of bridge	Nov, 2017	N	Y	N	
7	10 - Carter	53-10-30	8.98	SH 53	34:17:17.69;- 97:00:55.72	SH 53 over Washita River	Flood		Drift and Debris, pier scour	Drift removal, scour fill	Under bridge	2016	N	Y	N	

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7	43 - Love	77S-43-14	6.93	SH 77S	34.032967;-97.071372	SH 77S at Lake Murray Spillway	Flood		Erosion on South side of spillway	Riprap in erosion holes	South side of spillway	2017	Y	N	N	
7	43 - Love	76-43-16	6.66	SH 76	34:02:17.31;-97:25:18.77	SH 76 at Simon Creek	Flood		Abutment Scour and Approach Slab Undermined	Approach filled with Concrete and abutment wall	North Abutment	July, 2015	N	Y	Y	
8	49 - Mayes	20-49-10	11.95		36°23'19"/95°03'29"	11.95 miles east of the SH82 jct in Salina OK.	flooding		severe undermining at the east approach to Spavinaw Creek bridge	excavate, backfill, and surface east approach to Spavinaw Creek bridge	11.95 miles east of the SH82 jct in Salina OK.	5/1/17-6/29/17	y	y	n	
8	49 - Mayes	20-49-10	11.95		36°23'19"/95°03'29"	11.95 miles east of the SH82 jct in Salina OK.	flooding		Flooding undermined roadway	excavate, backfill, and surface roadway	11.95 miles east of the SH82 jct in Salina OK.	12/26/15-1/31/16	y	n	y	
8	49 - Mayes	82-49-32	2.84		36°26'42"/95°03'17"	2.06 miles south of the SH28 jct.	flooding		Flooding undermined shoulder	reshape shoulders	2.06 miles south of the SH28 jct.		y	n	n	Bridge project was still ongoing and the repair was made under the construction contract. JP 21911(04)
8	21 - Delaware	116-21-39	2.8		36°15'51"/94°43'03"	2.8 miles east of the US59 jct.	flooding		severe undermining of the east bank under the Cloud Creek bridge	rebuilt creek bank & slope, placed riprap to prevent further erosion	2.8 miles east of the US59 jct.	5/8/17-6/8/17	n	y	n	