OKLAHOMA Transportation

OKLAHOMA DEPARTMENT OF TRANSPORTATION

# Transportation Asset Management Plan

## 2022-2031

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CHAPTER 1

# Introduction

Safe, reliable, and resilient transportation free of congestion strengthens human and economic connections. As stewards of the National Highway System (NHS) in Oklahoma, the Oklahoma Department of Transportation (ODOT) is responsible for the performance of highways and bridges deemed critical to the national economy. This Transportation Asset Management Plan (TAMP) describes ODOT's strategic approach to enhancing the movements of people and goods by cost effectively maintaining the state's transportation network at the best condition levels possible given available resources.

## INTRODUCTION

**Transportation Asset Management**

A strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis and risk assessment of current and future environmental conditions such as extreme weather events 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 which takes into consideration recurring damage from extreme and emergency events at minimum practicable cost.

The State Highway System (SHS) in Oklahoma represents a vital link in the national transportation network, helping connect the east and west coasts as well as facilitating the movement of international goods from the southern border to all points north. Many of these key routes have been designated as critical for national defense and interstate commerce, and as such have been classified as part of the National Highway System (NHS). This designation provides access to additional Federal funding resources pending proof of thoughtful stewardship. This state TAMP focuses solely on Oklahoma's NHS assets, as required by law, and demonstrates the strategic approach that ODOT applies to the preservation of NHS pavement and bridges.

A healthy transportation system is essential for forging a strong economy and improving quality of life. The transportation system managed by 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 cause ongoing deterioration of pavements and bridges that must be maintained, preserved, rehabilitated, or reconstructed to ensure 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 or not taking into consideration the frequency and damage from repeated events can result in higher long- term costs for repair and rehabilitation, funds being diverted more often to address emergency repairs, 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, performing the "right" treatment at the "right" time is crucial to continued long-term use at the lowest possible cost.

# DOCUMENT ORGANIZATION

The remainder of this TAMP focuses on how ODOT makes progress towards performance goals on the NHS over the following seven chapters.

**Chapter 2: Objectives and Measures** – Mission and objectives for Transportation Asset Management (TAM) in Oklahoma and performance measures for pavements and bridges.

**Chapter 3: Asset Inventory and Condition** – Summary listing of assets, including a description of asset condition of the NHS for pavements and bridges in Oklahoma, categorized by system and owner.

**Chapter 4: Life Cycle Planning** – ODOT's pavement and bridge data collection, evaluation, and life cycle planning methodologies.

**Chapter 5: Financial Plan** – 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.

**Chapter 6: Investment Strategies** – ODOT's general approach to investing in transportation assets as well as ODOT's specific strategies related to its assets.

**Chapter 7: Performance Gap Analysis** – How projected funding for pavements and bridges are expected to impact asset conditions in the next ten years, including a performance gap analysis and establishment of 2- and 4-year asset performance targets.

**Chapter 8: Risk Analysis** – Categories of risks ODOT faces, how ODOT prioritizes risks, and how ODOT plans to mitigate its top priority risks.

CHAPTER 2

# Objectives and Measures

ODOT works to achieve national and state asset goals through a data-informed framework based on Oklahoma's statewide vision and ODOT's transportation asset management mission.  Asset management objectives and measures allow ODOT to track its progress and stay on course.

## INTRODUCTION

Supporting ambitious state- and department-wide visions, ODOT has identified asset management goals and objectives in its long range and TAM planning. ODOT tracks performance and progress towards those asset management objectives using performance measures and key performance indicators (KPIs) related to asset condition on the NHS and more broadly, the Oklahoma SHS.  These measures align with statewide and national goals and objectives, and allow ODOT to identify how effective its TAM planning and strategies are at achieving its objectives.

Chapter 3 **Asset Inventory and Condition** describes existing Oklahoma NHS assets and their performance on federal measures.

# STRATEGIC CONTEXT

ODOT's TAM planning operates within the context of Oklahoma Governor Stitt's statewide vision and ODOT's vision and mission to achieve organizational, statewide, and national goals (Figure 1).

**Figure 1: Oklahoma Vision and Mission Statements**

## Oklahoma Vision and Mission Statements

### State Vision

Governor Stitt's Top 10 Plan calls for Oklahoma to be in the Top 10 in a range of areas including transportation. The Top 10 Plan is intended to improve Oklahoma's accountability, transparency, and measurable results.

### ODOT's Vision

- ODOT is an innovative and responsive leader in the Transportation Field.
- We value our people for individual and team contributions, empowering them to make decisions through productive partnerships.
- We are accountable in meeting the transportation needs of citizens, business and industry in the safest, most proficient manner possible.

### ODOT's Mission

Provide a safe, economical and effective transportation network for the people, commerce and communities of Oklahoma.

### TAM Mission

- 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

# GOALS AND OBJECTIVES

Seven national transportation goals apply to all states; the goal which is most impacted by TAM is Infrastructure Condition: "To maintain the highway infrastructure asset system in a state of good repair." By optimizing the use of available resources and improving asset conditions, TAM also plays a role in supporting other national goals including Safety, Congestion Reduction, System Reliability, Freight Movement and Economic Vitality, and Environmental Sustainability.

As part of its 2045 Long Range Transportation Plan (2045 LRTP), ODOT and its stakeholders identified long term goals and objectives for the Oklahoma transportation system:

- Safety and Security – Ensure a safe and secure transportation system for all users.
- **Infrastructure Preservation** – Preserve and maintain the condition of Oklahoma's multimodal transportation system in a state of good repair through risk-based, data-driven decision-making processes.
    - Relevant TAM Objectives:
        - Improve and maintain pavement condition levels on the state highway system
        - Improve and maintain bridge condition levels on the state highway system
        - Improve ride quality on the state highway system, including NHS facilities
        - Make more effective use of asset condition data to systematically approach asset management
        - Protect existing and design new transportation infrastructure to meet travel needs in response to extreme weather events and other environmental conditions
- Mobility and Accessibility – Facilitate the movement of people and goods, improve connectivity between regions and activity centers, and increase travel mode choices.
- Economic Vitality – Provide a reliable multimodal transportation system for people and goods that coordinates with land development patterns, strengthens communities, and supports a healthy and competitive Oklahoma economy.
- Environmental Responsibility – Minimize and mitigate transportation-related impacts to the natural and human environments.
- Efficient Intermodal System Management and Operation – Maximize system performance and operations.
- Fiscal Responsibility - Sustainably fund and efficiently deliver quality transportation projects while continuing to leverage additional resources in coordination with ODOT's partners.

In addition to the 2045 LRTP goals and objectives, ODOT also has established TAM-specific objectives which guide its asset management decisions:

- 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
- Assess and address risks from frequency of extreme weather events

ODOT's TAM program objectives directly support the 2045 LRTP's "Infrastructure Preservation", "Safety and Security", and "Fiscal Responsibility" goals. In addition, efficiently maintaining infrastructure in a state of good repair is a key component underlying each of the remaining goals. However, TAM is only one part of ODOT's work and navigating tradeoffs between goal areas.

# PERFORMANCE MEASURES

To track progress made toward achieving its TAM objectives, ODOT uses federal performance measures for NHS pavement and bridges, and Oklahoma KPIs for all SHS pavements and bridges.

## Federal Pavement Measures

FHWA uses pavement performance measures to determine the national network condition level of the Interstate and non-Interstate NHS pavements. Each state must report four pavement performance measures via the Highway Performance Management System (HPMS) (Table 1).

### Table 1: Federal Pavement Measures

| Pavement Condition Measures | |
|---|---|
| **Interstate** | **Non-Interstate NHS** |
| Percentage of pavements on the Interstate system in **Good** condition | Percentage of pavements on the non-Interstate NHS in **Good** condition |
| Percentage of pavements on the Interstate system in **Poor** condition | Percentage of pavements on the non-Interstate NHS in **Poor** condition |

The measures are calculated using quantitative data based on the following distresses:

- 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 in the wheelpath. 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.

FHWA has established criteria for each metric to classify pavement as in Good, Fair or Poor condition depending on the pavement type (Table 2). FHWA uses these pavement condition metrics to determine the pavement condition for each one-tenth mile pavement section.

### Table 2: Federal Pavement Condition Criteria

| Pavement | Good | Fair | Poor |
|---|---|---|---|
| **International Roughness Index (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 |
| **Asphalt Rutting (inches)** | <0.20 | 0.20 – 0.40 | >0.40 |
| **Jointed Concrete Faulting (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. The lane miles in Good, Fair, and Poor condition are tabulated for all NHS sections to determine an overall percentage of pavement conditions.

## Federal Bridge Measures

Similarly, FHWA uses two bridge performance measures to determine the network condition level of NHS bridges (Table 3).

### Table 3: Federal Bridge Condition Measures

| Bridge Condition Measures |
|---|
| **All NHS Bridges** |
| Percentage of NHS bridges classified as in **Good** condition |
| Percentage of NHS bridges classified as in **Poor** condition |

Bridge condition is assessed using minimum condition ratings for four National Bridge Inventory (NBI) items: deck, superstructure, substructure, and culvert data. Any structure with a rating of 4 or less on any NBI item is classified as Poor. Any structure with a rating of 7 or more for all applicable NBI items is classified as Good. All other structures are Fair. To obtain overall network performance, the federal measurement weights each NHS structure by its deck area.

## State Key Performance Indicators

In addition to the federal performance measures required for NHS highways and bridges, ODOT also tracks the following asset management KPIs for SHS pavement and bridge assets (Table 4):

- Achieve and sustain less than 1% structurally deficient (SD) bridges (68 of 6,796)
- Decrease miles of rural two lanes with deficient shoulders by 10% (530 miles) in four years
- Increase total lane miles in good condition by 10% (from 33% to 43%) (3,044 lane miles) in four years

The KPI baseline year was 2019 and ODOT set targets for 2020-2023. Updates on these KPIs are reported to Executive Leadership and the Field Districts quarterly to ensure that there is understanding of current conditions in each district.

### Table 4: State Key Performance Indicators

| KPI | Reported | | Targets | | | |
|---|---|---|---|---|---|---|
| | FY 2019 | FY 2020 | FY 2020 | FY 2021 | FY 2022 | FY 2023 |
| Achieve and sustain less than 1% structurally deficient (SD) bridges (68 of 6,796) | 1.27% | 0.99% | 1.00% | 1.00% | 1.00% | 1.00% |
| Decrease miles of rural two lanes with deficient shoulders by 10% (530 miles) in four years | 5,299 | 5,311 | 5,167 | 5,034 | 4,902 | 4,769 |
| Increase total lane miles in good condition by 10% (from 33% to 43%) (3,044 lane miles) in four years | 33.18% | 34.71% | 35.68% | 38.18% | 40.68% | 43.18% |

CHAPTER 3

# Asset Inventory and Condition

Oklahoma's TAMP addresses pavement and bridge assets on the National Highway System. This chapter presents summary information on asset inventory and identifies the current conditions for these assets.

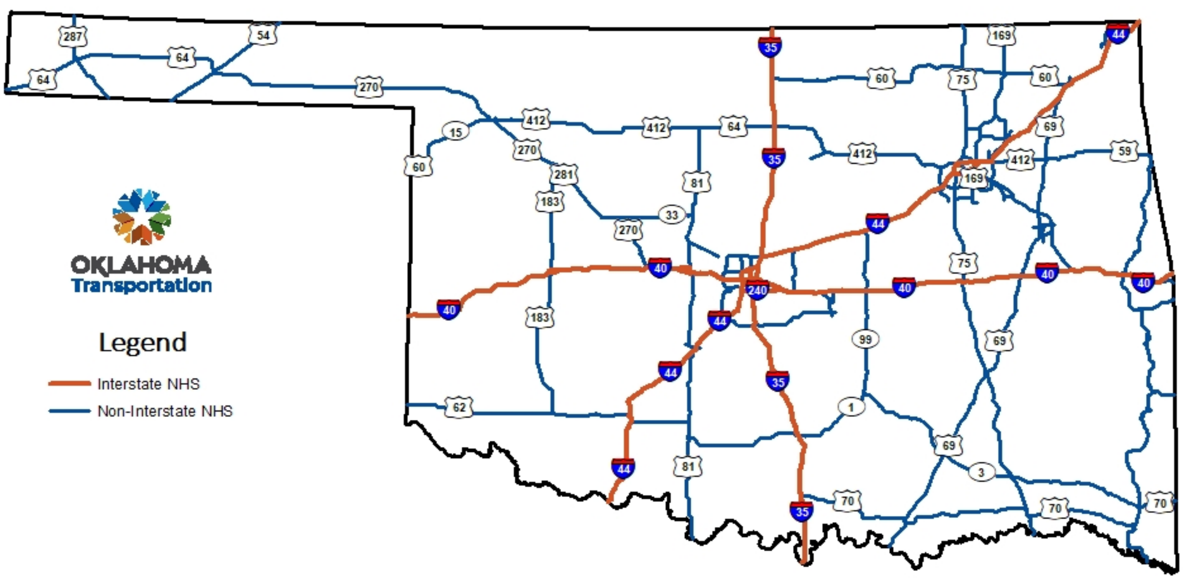
## INTRODUCTION

The Oklahoma transportation network provides critical connections that keep the national economy moving while providing safe, reliable travel for Oklahoma residents, businesses, and visitors. In addition to being stewards of the SHS, ODOT is responsible for reporting on the performance of the NHS within the state. This chapter details the extent, ownership responsibilities, and existing conditions of NHS pavement and bridge assets within Oklahoma. A foundational understanding of inventory and condition data is essential for effective life-cycle planning, financial need projections, project development, and asset performance monitoring.

# EXTENT OF THE NHS IN OKLAHOMA

The NHS is a roadway system established by Congress consisting of roads designated as being important to the national economy, defense, and mobility, including Interstates, the Strategic Highway Network, some Principal Arterials, and intermodal connectors. The NHS in Oklahoma spans 13,269 pavement lane miles and 3,422 bridges (Figure 2).

**Figure 2: Oklahoma National Highway System in 2022**

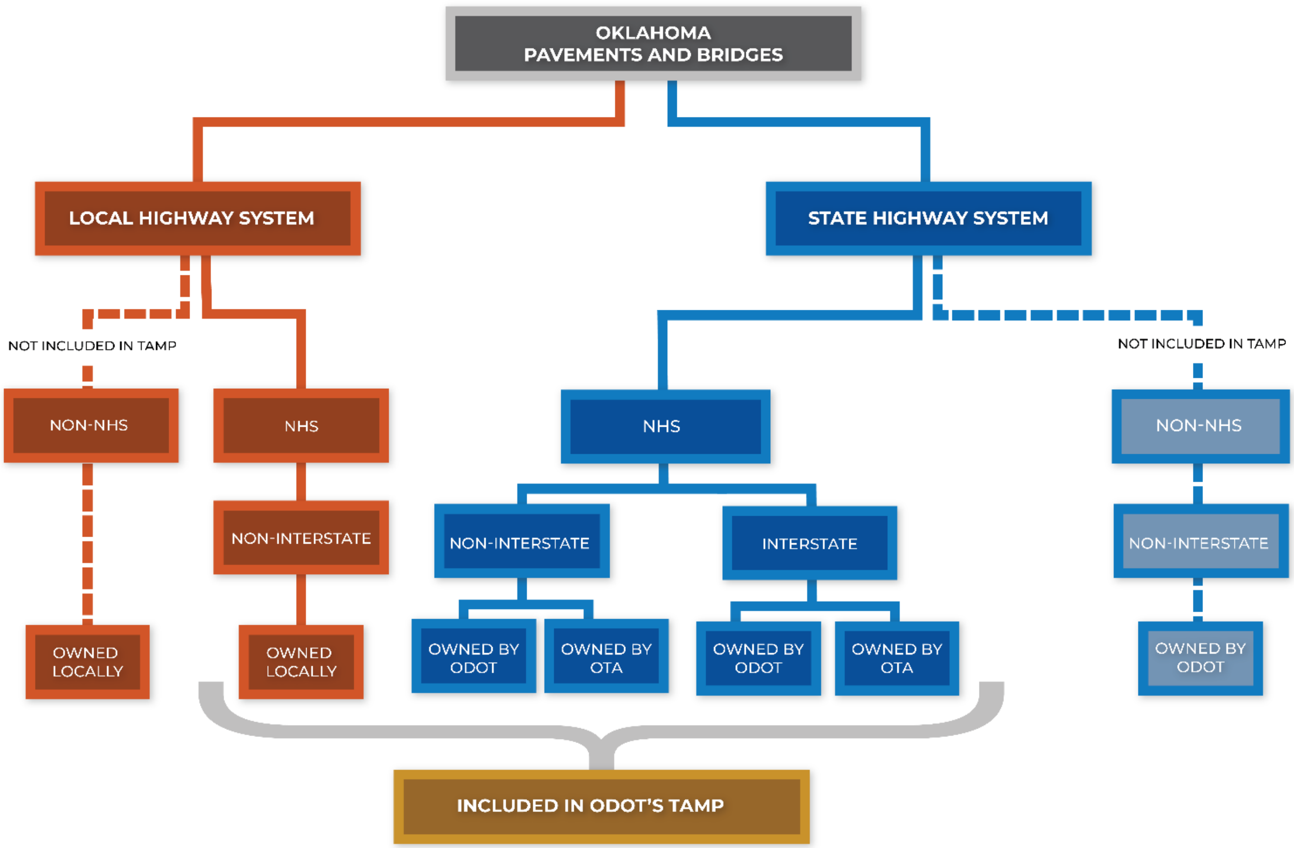



## NHS Ownership and Coordination

Consistent with the requirements for a federally compliant TAMP, this plan includes all NHS pavements and bridges in Oklahoma regardless of owner. Oklahoma's NHS pavement and bridge assets are collectively owned, maintained, and managed by the following entities (Figure 3):

- **ODOT** owns and maintains over three-quarters of Interstate and Non-Interstate NHS assets;
- **Oklahoma Turnpike Authority (OTA)** owns and operates the next largest share of the Interstate and Non-Interstate NHS assets; and
- **Local governments** own and operate small portions of the Non-Interstate NHS. Where municipalities overlap with metropolitan areas of 50,000 or more people, ODOT coordinates with the appropriate **Metropolitan Planning Organization (MPO)**.

### Figure 3: NHS Pavement and Bridge Asset Ownership



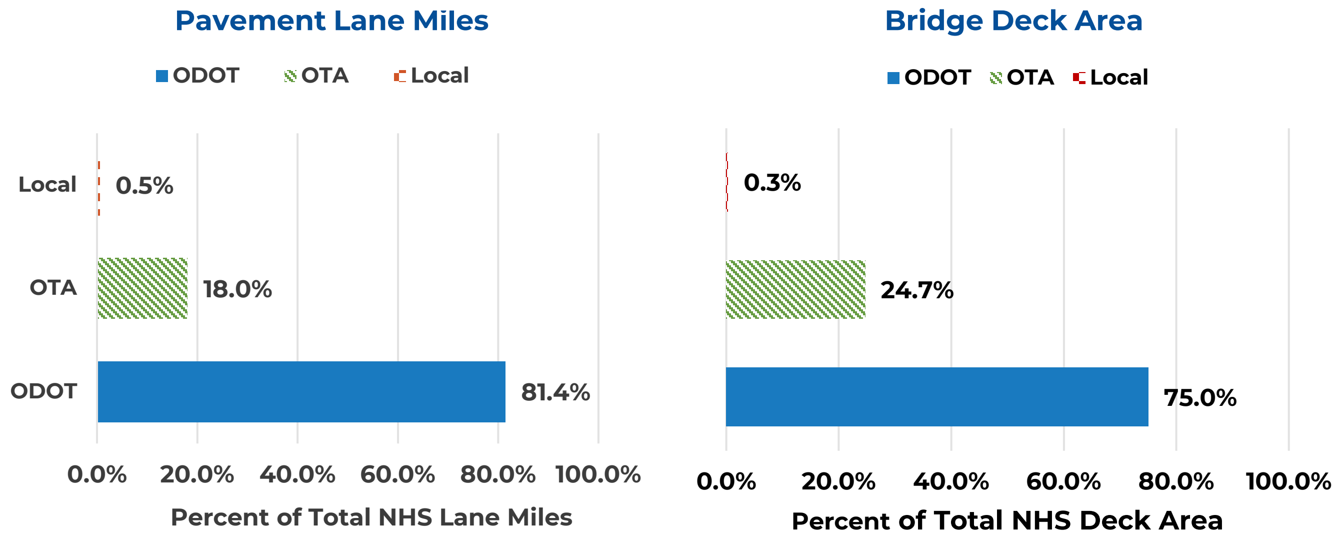

ODOT, OTA, local governments, and state MPOs coordinate planning and data collection activities on the NHS. For instance, ODOT:

- inspects all NHS bridges and other eligible structures in Oklahoma, regardless of ownership, as part of the state's National Bridge Inventory (NBI) data reporting and
- collects all NHS and SHS pavement inventory in Oklahoma, regardless of ownership, as part of the state's Highway Performance and Monitoring System (HPMS) data reporting.

## NHS Pavement and Bridge Asset Inventories

ODOT owns the majority of NHS pavement and bridge assets in Oklahoma, followed by the OTA and local governments (Figure 4). All inventory numbers presented in this section are current as of year-end 2020.

**Figure 4: NHS Pavement and Bridge Ownership**




### NHS Pavement Inventory

Of the 81.4% of the Oklahoma NHS pavement lane-miles that are owned by ODOT, nearly three-quarters of these are on the non-Interstate NHS, whereas nearly half of the NHS lane-miles owned by the OTA are on the Interstate system (Figure 5). OTA owns and maintains one of the largest inventories of lane miles of any toll authority in the United States, consisting of eleven turnpikes totaling 2,392 lane miles of NHS pavements. The local NHS pavements currently consist of 70 lane miles spread across five cities and one county (Figure 6).

**Figure 5: NHS Pavement Inventory by Ownership and Interstate Status**

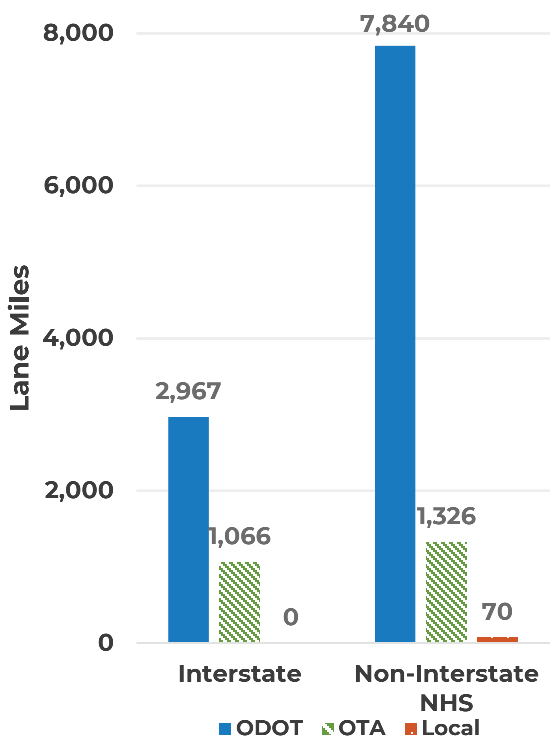
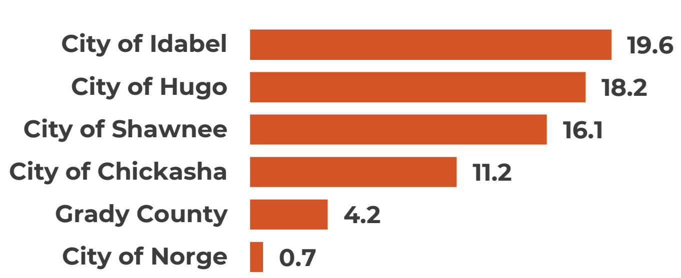


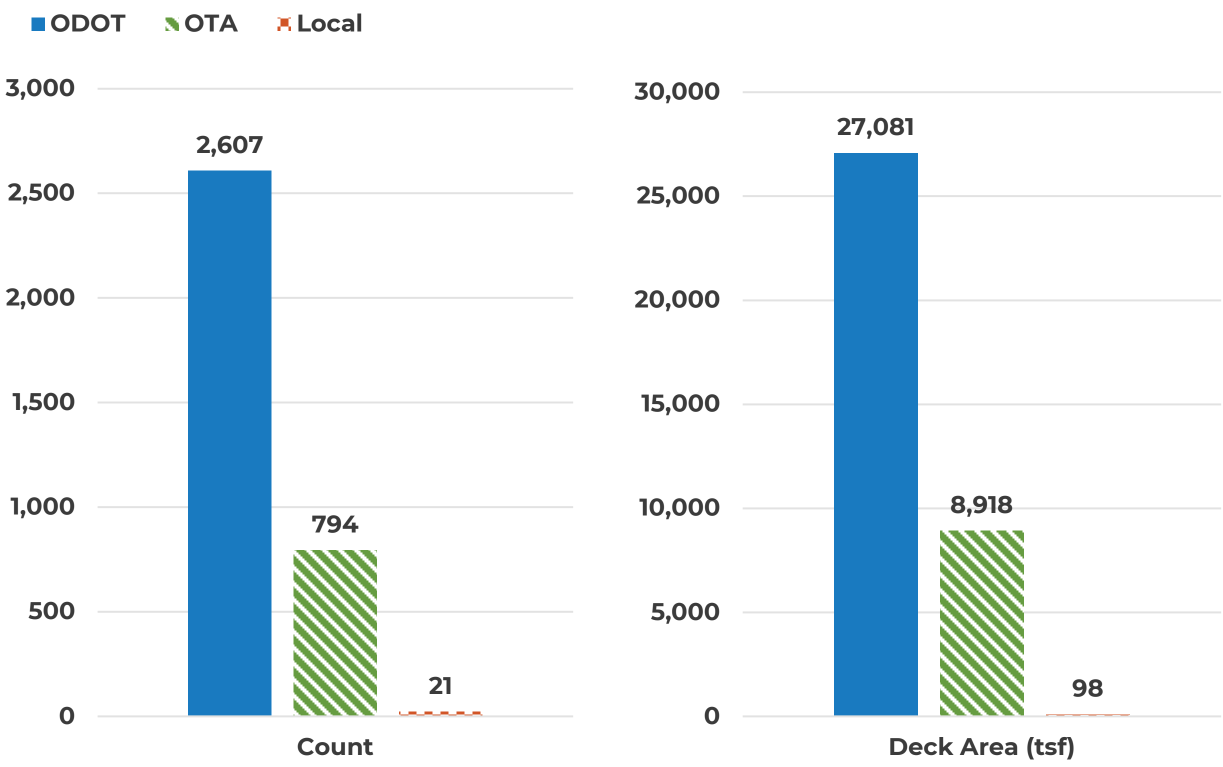

**Figure 6: Distribution of Local NHS Pavement Lane Mile Ownership**



## NHS Bridge Inventory

ODOT oversees approximately three-quarters of NHS bridges in Oklahoma both by count and deck area (Figure 7). With a larger share of NHS assets on the Interstate system, bridges owned by OTA are on average the largest in the state from a deck area perspective. By comparison, bridges owned by local governments are a little less than half of the size, on average.

**Figure 7: NHS Bridge Inventory by Ownership**

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# NHS PAVEMENT AND BRIDGE CONDITION

NHS pavement and bridge performance is categorized as Good, Fair, or Poor as defined by rulemaking under the Moving Ahead for Progress in the 21st Century Act and continued through subsequent federal legislation. Since the last TAMP, ODOT and its planning partners have made progress in increasing the share of Good NHS pavements and bridges as detailed in the following subsections. All existing condition data shown was collected as of year-end 2020 and reported to the Highway Performance Monitoring System (HPMS) in 2021.

## Existing NHS Pavement Condition

The federal definition for pavement condition (excluding PSR, which is an alternative performance indicator for lower speed roadways) is illustrated in Table 5. 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 metrics are rated as Poor. All other combinations are rated as Fair.

### Table 5: Federal Definition for Pavement Condition

| Pavement | Good | Fair | Poor |
|---|---|---|---|
| **International Roughness Index (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 |
| **Asphalt Rutting (inches)** | <0.20 | 0.20 – 0.40 | >0.40 |
| **Jointed Concrete Faulting (inches)** | <0.10 | 0.10 – 0.15 | >0.15 |

Between year-end 2018 and 2020, the percent Good lane miles on the NHS in Oklahoma increased from approximately 45% to 48%. Yet, the share of Poor NHS lane miles also increased from 2% to 3% over the same timeframe.

As detailed in Table 6, conditions on the Interstate system outperform those on the non-Interstate NHS. Due to its larger share of VMT and truck traffic, ODOT has targeted a higher performance level for the Interstate system. This has translated into having 65.6% Good (1.0% Poor) Interstate pavement lane miles as compared to 40.5% Good (3.5% Poor) non-Interstate NHS lane miles. With a larger share of Interstate lane-miles, OTA pavements are currently in better condition. Local NHS pavements are predominantly (more than 90%) in a Fair condition.

### Table 6: NHS Pavement Condition (Year End 2020)

| Pavement | Lane Miles | Good | Fair | Poor |
|---|---|---|---|---|
| ODOT Interstate | 2,869.6 | 63.9% | 35% | 1.2% |
| OTA Interstate | 1,031.0 | 70.2% | 29.3% | 0.1% |
| **Total Interstate** | **3,900.6** | **65.6%** | **33.5%** | **1.0%** |
| ODOT Non-Interstate NHS | 7,895.7 | 38.3% | 58.2% | 3.6% |
| OTA Non-Interstate NHS | 1,335.4 | 54.9% | 41.9% | 3.0% |
| Local Non-Interstate NHS | 70.5 | 9.1% | 91.3% | 0.5% |
| **Total Non-Interstate NHS** | **9,301.6** | **40.5%** | **56%** | **3.5%** |

**Numbers may sum to greater than 100% due to rounding*

## Existing NHS Bridge Condition

The federal performance measure which assesses bridge condition uses minimum condition ratings for a bridge's NBI deck, superstructure, and substructure data (Table 7). For NBI purposes, a culvert is classified as a bridge when it is 20 feet or longer. Any bridge or culvert 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 or culvert's NBI items must be 7 or greater. All other bridges and culverts are classified Fair.

### Table 7: Federal Definition for Bridge Condition

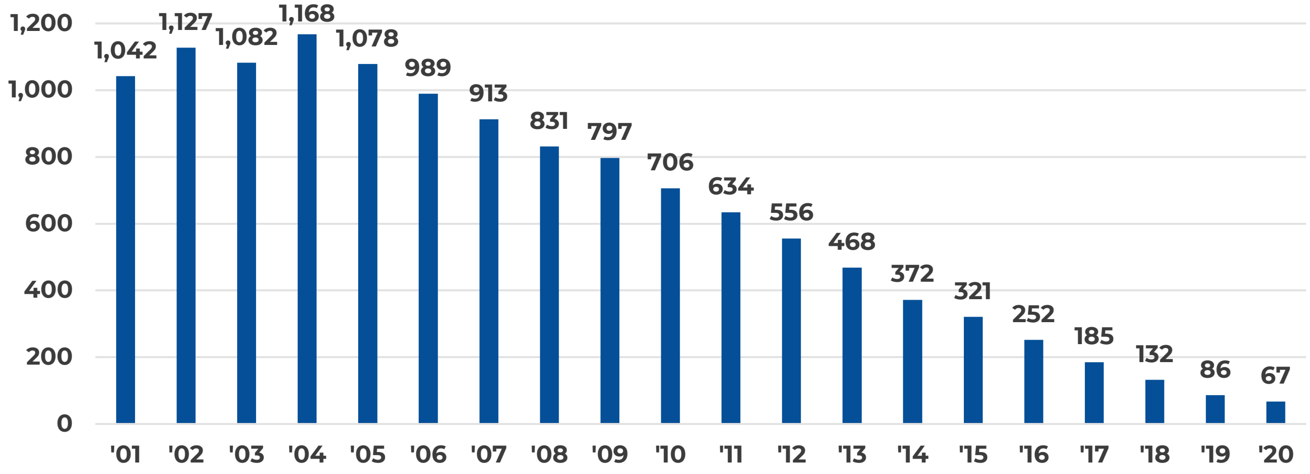
| Metric | Minimum NBI Component* Rating |
|---|---|
| **Good** | 7 or better |
| **Fair** | 5 or 6 |
| **Poor** | 4 or lower |

**NBI components consist of the deck, substructure, superstructure, and/or culvert*

While ODOT bridge managers consider multiple performance indicators when selecting improvement projects, a major initiative over the last two decades has been to reduce the number of Poor bridges. This is evidenced by ODOT having achieved a 94.3% reduction in Poor (i.e., structurally deficient) bridges on the Oklahoma SHS since 2004 (see Figure 8). This reduction has led

Oklahoma to move from ranking 49th in the nation for Poor bridge counts in 2005 to 7th as of 2020. A Poor bridge is not indicative of a structure being unsafe to travel on; if a Poor bridge is deemed to be unsafe, ODOT will close the bridge. Otherwise, ODOT may post a load restriction for large trucks as needed. As of year-end 2020, 47.9% of all NHS bridges are in Good condition and 1.3% are in Poor condition (Table 8).

### Figure 8: Count of Structurally Deficient Bridges on Oklahoma SHS Since 2001




### Table 8: Existing Bridge Condition by Deck Area (Year End 2020)

| Bridges | Deck Area (tsf) | Count | Good | Fair | Poor |
|---|---|---|---|---|---|
| ODOT NHS | 27,081 | 2,607 | 39.3% | 59.2% | 1.6% |
| OTA NHS | 8,918 | 794 | 74.5% | 25% | 0.6% |
| Local NHS | 98 | 21 | 20.3% | 77% | 2.7% |
| **Total NHS** | **36,097** | **3,422** | **47.9%** | **50.8%** | **1.3%** |

**Numbers may sum to greater than 100% due to rounding*

CHAPTER 4

# Life Cycle Planning

Life Cycle Planning (LCP) principles enable transportation agencies to maximize the return on transportation investments for system users and stakeholders. Through timely maintenance, preservation, and rehabilitation treatments, ODOT makes progress towards its performance goals and objectives at the lowest long-term cost. ODOT determines an optimal mix of treatments using predictive pavement and bridge management systems that evaluate the costs, benefits, and service life extensions of different funding options given site specific conditions. This whole-life approach helps to ensure that the 'right' treatment is funded at the 'right' time given available revenues and external risks such as extreme weather.

# INTRODUCTION

LCP reduces costs and maintains assets in better condition by implementing proactive preservation treatments as compared to a reactive maintenance strategy. Figure 9 and Figure 10 illustrate a representative example of applying the two life-cycle strategies to a one-mile segment of four-lane NHS highway. If that segment receives proactive preservation treatments, the asset remains in Good or Fair condition over 40 years (Figure 9). If the same asset instead only received reactive preservation (Figure 10), it would fall into Poor condition for several years and overall cost nearly $200 thousand dollars more than the proactive approach, not accounting for inflation. Translated to Oklahoma's full NHS pavement system, proactive preservation and LCP will save over half a billion dollars over 40 years.

**Figure 9: Proactive Preservation (1 mile segment of four-lane NHS)**

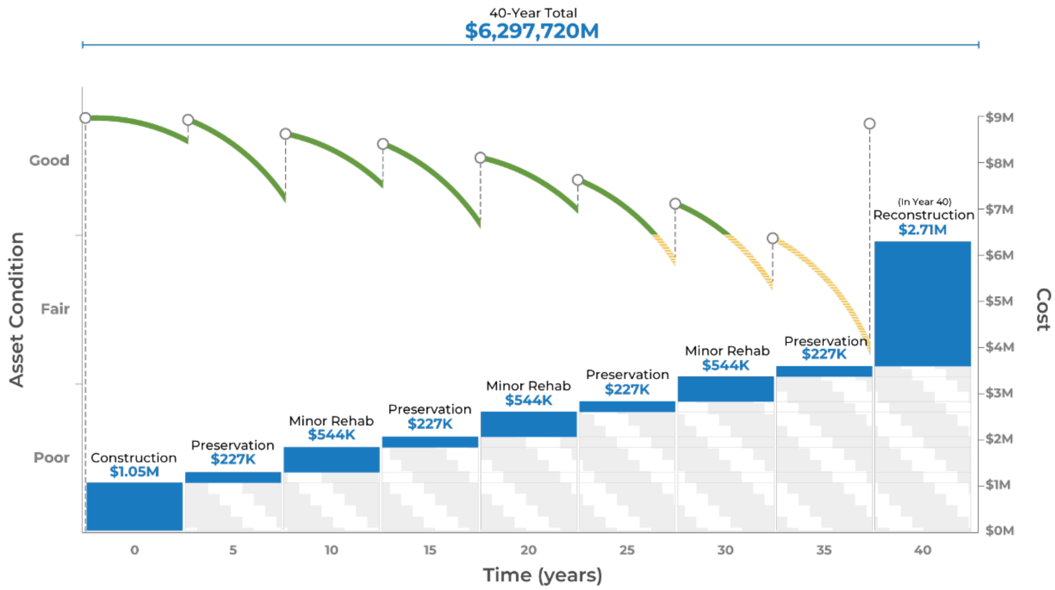
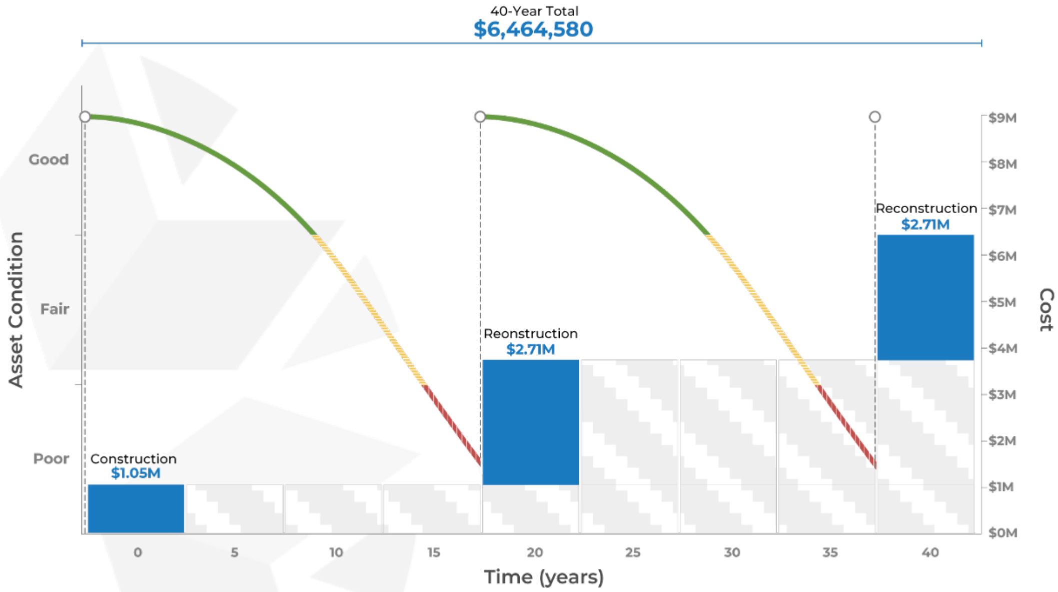



**Figure 10: Reactive Preservation (1 mile segment of four-lane NHS)**



This calls for a data-driven, forward-looking approach to investment decisions. As such, ODOT leverages predictive pavement and bridge management systems to understand the performance implications of different investment strategies (discussed in Chapter 6 **Investment Strategies**) and set achievable targets that are representative of progress towards agency goals. To ensure the asset forecasts are based on a solid foundation, ODOT implements a data quality management program. As a result of these efforts, ODOT can apply the "right" treatment at the "right" time to efficiently achieve performance goals at the lowest possible long-term cost, while balancing the need for any risk-mitigating or corrective actions, including those risks and actions related to extreme weather and their impacts (see Chapter 8 **Risk Management** for detailed discussion of extreme weather risks, impacts and risk management).

# ASSET MANAGEMENT SYSTEMS

ODOT's pavement and bridge management sections implement LCP principles through asset management systems which are used to:

1) collect, process, store, and update inventory and condition data for all State Highway System (SHS) and/or National Highway System (NHS) pavement and bridge assets,
2) forecast asset deterioration based on facility type and location, with conditional predictions updated after extreme weather events,
3) determine benefits and costs over the life cycle of assets to evaluate alternative actions (including no action decisions),
4) identify short- and long-term budget needs for managing condition,
5) determine strategies for identifying potential projects that maximize overall program benefits within financial constraints, and
6) recommend programs and implementation schedules to manage condition within policy and budget constraints.

The deterioration and improvement models leveraged in the management systems have been calibrated to historic ODOT data. The two primary asset management systems applied at ODOT are detailed as follows.

**Pavement** analysis is supported by the Deighton Total Infrastructure Management System (dTIMS) Pavement Management System (PMS). This system is used to analyze and report pavement surface. The PMS was first implemented in 2001 and has captured digital pavement data since 2004, employing third-party data collection vehicles using up-to-date pavement collection technology. 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.

**Bridge** management is supported by the AASHTOWare Bridge Management (BrM) software. This bridge management system (BMS) stores inspection and inventory data on bridges, their components (e.g., deck, superstructure, substructure, and culvert), and specific bridge elements (e.g., girder, pier, abutment) and reports pavement surface condition. ODOT is currently transitioning from using the predictive modules of National Bridge Investment Analysis System (NBIAS) to BrM which has more advanced modeling techniques and consolidates analyses into a single BMS. To date, ODOT has calibrated component-level models and is in the process of calibrating element-level predictive models. The resulting forecasts supported by BrM using ODOT data are detailed in Chapter 7 **Performance Gap Assessment**.

# DATA MANAGEMENT

To provide inputs to the asset management systems, ODOT collects, validates, and manages a wide variety of pavement and bridge information and aggregates it to meet different reporting requirements. A brief overview of pavement and bridge data management at ODOT is detailed in the following subsections.

## Pavement Data Management

Each year, ODOT oversees the collection of pavement surface condition data for the SHS and non-ODOT-owned NHS. ODOT pavement distress data is collected using a state-of-the-art 3D Laser Crack Measurement System (LCMS), which captures detailed road surface conditions via longitudinal and transverse profiling. In compliance with federal requirements for pavement data quality, ODOT has formalized the details of the existing quality assurance and quality control process into a Data Quality Management Plan.

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

Collected distress data extend beyond those required for the federal pavement performance measures as shown in Table 9. Distress data is reported for each 0.1-mile increment annually through the Highway Performance Monitoring System (HPMS). Summary data are further published annually in ODOT District Notebooks. Beyond reporting, pavement data is used for managing system conditions, assessing funding needs, and guiding the project-level decision making of Field District staff.

**Table 9: Pavement Distresses Collected Beyond Those Required for Federal Pavement Performance Measures**

| Asphalt Concrete Pavement | | Jointed Concrete Pavement | | Continuously Reinforced Concrete Pavement | |
|---|---|---|---|---|---|
| **Distress** | **Severity** | **Distress** | **Severity** | **Distress** | **Severity** |
| 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 | -- |
| Pavement Patching | -- | Transverse Cracking | 1-2 | | |
| Pothole Patching | -- | Multi-Cracked Slab | 1-2 | | |
| Raveling | -- | Joint Spalling | 1-2 | | |
| | | Joint Patching | -- | | |

## Bridge Data Management

ODOT bridge inspections comply with National Bridge Inspection Standards (NBIS) including the capturing of element-level conditions in support of NBI reporting. Beyond federal reporting requirements, ODOT also collects additional bridge data including paint type, expansion device type, and automated truck routing information, all of which are detailed in the ODOT Bridge Inspection Field Manual.

Structures are inspected either 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. As discussed in Chapter 2 **Objectives and Measures**, bridges are considered Poor when they have an inspection rating of 4 or less on a scale from 0-9 for any NBI component (deck, superstructure, substructure, or culvert).

NBI bridge inspections undergo a rigorous quality control process. Inspectors are required to verify all information available with assumptions and user error reporting available in the system of record, BrM. Additionally, multiple levels within ODOT conduct quality assurance reviews. 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.

# PAVEMENT LIFE CYCLE PLANNING

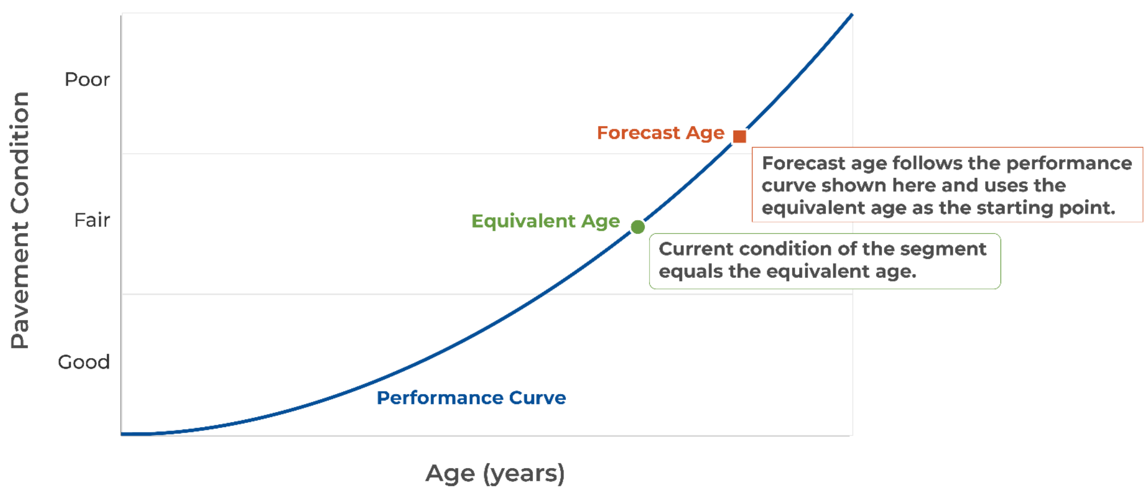
Pavement data maintained in the PMS serves as the starting point for forecasting future conditions, defining the most cost-effective life-cycle plan given any budget, assessing the minimum investment needs to achieve desired targets, and identifying the budget allocation needed to achieve realistic targets. Key steps in this forward-looking approach including applying deterioration and improvement models, evaluating life-cycle costs given site-specific assumptions related to extreme weather and resiliency, optimizing the scheduling of general work, then translating those work types into specific project treatments.

## ODOT Pavement Deterioration Models

The pavement distresses used to calculate the federal pavement performance measures, namely IRI, percent [wheelpath] cracking, rutting (for Asphalt Concrete Pavements – ACP), and faulting (for Jointed Concrete Pavements – JCP), are forecasted using models indicative of accelerating deterioration over time. In general, ODOT ACP are estimated to reach Poor condition in approximately 20 years and JCP in 35 years; both pavement types tend to become Poor due to the percent cracking and IRI distresses. Continuously Reinforced Concrete Pavements (CRCP) are estimated to become Poor in 30 years.

The Equivalent Age Technique is applied to predict future conditions based on the most recent inspection data to form a 'no build' forecast (Figure 11). This calls for identifying where each segment distress rating falls on the corresponding performance vs. age curve based on its most recent inspection. The 'no build' prediction for each distress is then normalized using linear interpolation on a scale from 0 (worst) to 100 (best).

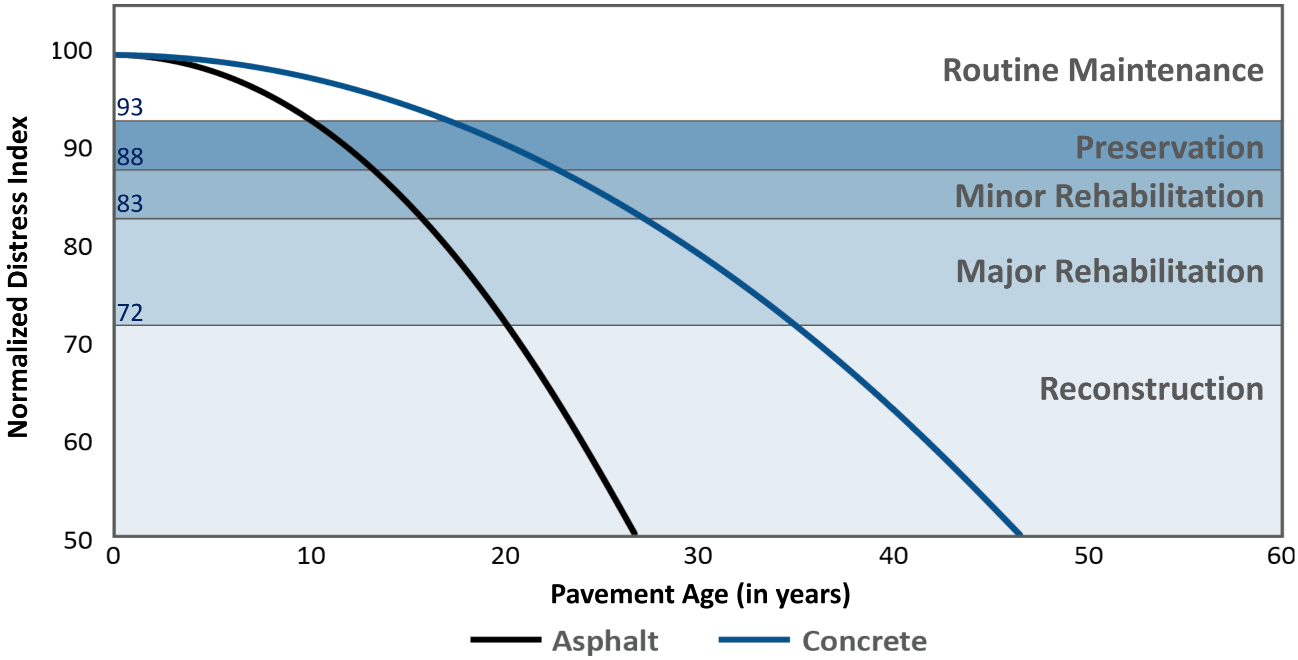
### Figure 11: Equivalent Age Technique



## ODOT Pavement Improvement Models

ODOT's PMS uses work codes correlated to five FHWA work types for life-cycle planning: i) Initial Construction, ii) Maintenance, iii) Preservation, iv) Rehabilitation, and v) Reconstruction. Each work type represents different categories of treatments which are specified based on site specific conditions once funds are programmed, including the risk of extreme weather events such as flooding. The deterioration models are used to determine viable work type based on the requisite treatment intensity to improve conditions at any specified point in the future (Figure 12). Improvement models are layered on top of the 'no build' forecast to form a 'build' prediction set, again using the Equivalent Age Technique. The ACP and JCP deterioration and improvement models are applied to all existing assets; needs related to new assets are processed outside of the PMS.

**Figure 12: Representative Deterioration Models and Corresponding Viable Work Types**




If and when emergency or extreme weather events occur which impact the condition of the NHS in Oklahoma, ODOT and its partners redirect funding as needed to respond, correct the issue, and restore performance. Life cycle planning principles are applied going forward after the event. See Chapter 8, **Risk Management** for further discussion of how ODOT designs for resiliency, responds to extreme weather events, and Oklahoma's assets damaged by emergency or extreme weather events.

The costs associated with each work type further vary by pavement type and anticipated traffic loadings. Typical costs for pavement preservation projects are $4.4 million; rehabilitation projects cost on average $9.2 million; and reconstruction projects typically cost $14.3 million. Average treatment benefits, reflective of before and after analysis of past ODOT treatments, are reported in terms of the typical performance jump in a normalized distress index (Table 10); in some cases, a reduced rate of deterioration may be observed without a corresponding jump in performance.

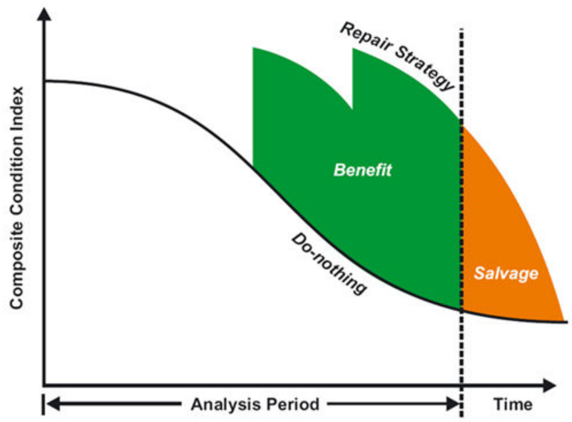
### Table 10: Modeled Pavement Treatment Benefits by Work Type

| Treatment | Typical Overall Service Life Extension (years) | Post-Treatment Performance Jump (Distress Index) | | | |
|---|---|---|---|---|---|
| | | % Cracking | IRI | Rutting | Faulting |
| **Preservation** | | | | | |
| Crack Sealing | 2 | -- | -- | -- | -- |
| Seal Coat | 4 | 2 | -- | -- | -- |
| Chip Seal | 5 | 8 | -- | -- | -- |
| Microsurface | 6 | 3 | 4 | 4 | -- |
| Ultra-Thin Bonded Wearing Course | 7 | 7 | 5 | 5 | -- |
| Cape Seal | 8 | 10 | 4 | 4 | -- |
| Resurface | 10 | 12 | 6 | 10 | 8 |
| In-Place Recycle | 15 | 15 | 12 | 15 | -- |
| Dowel Bar Retrofit & Diamond Grind | 15 | -- | 10 | -- | 15 |
| **Rehabilitation** | | | | | |
| Shoulder Improvement & Resurface | 10 | 12 | 6 | 10 | 8 |
| Pavement Rehabilitation | 15 | 15 | 15 | 15 | 10 |
| Fabric Reinforcement & Resurface | reset | reset | reset | reset | -- |
| **Reconstruction** | | | | | |
| Widen & Resurface | 15 | 15 | 15 | 15 | 10 |
| Reconstruct – No Added Lanes | reset | reset | reset | reset | reset |

## Pavement Life Cycle Evaluation

Based on the deterioration and improvement models, the dTIMS PMS evaluates the life cycle costs of scheduling work types at different points in time. Incremental Benefit Cost (IBC) techniques are built into the PMS to compare the costs and present value of benefits of any work profile relative to a 'no build' case. To capture the benefits over time, the ODOT PMS calculates the area between the improvement and "no-build" (i.e., do-nothing other than routine maintenance) curves and discounts the estimated benefit to calculate the economic internal rate of return and first year rate of return (Figure 13).

**Figure 13: Representative IBC Analysis**




Source: Deighton (n.d.). Budget Scenarios: What is IBC (Incremental Benefit Cost)?. Retrieved from https://demo.deighton.com/whitby/ba/help/Content/dTIMS/dt_budget_scen_ibc.htm. Last Accessed February 2022.

## Pavement Work Program Optimization

An optimization module built into the PMS facilitates financially constrained work planning. The PMS algorithms recommend work types over time that maximize the network-level IBC ratio each year subject to an annual overall budget.  The preservation work recommendations are then translated into specific project-level treatments by way of ODOT's Pavement Preservation Projects (3P) Decision Trees – as shown in **Appendix A**. This decision process factors in additional distresses collected by ODOT beyond those used for federal performance reporting.

Appropriate timing with respect to observed pavement distresses is important to avoid significant increases in costs associated with correcting additional deterioration.

# BRIDGE LIFE CYCLE PLANNING

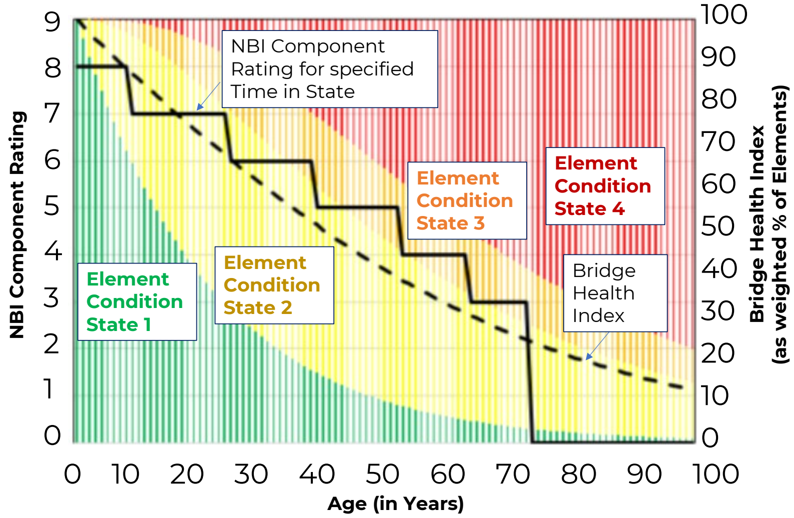
Bridge data maintained in BrM serves as the starting point for forecasting future conditions, defining the most cost-effective life-cycle plan given any budget, assessing the minimum investment needs to achieve desired targets, and identifying the budget allocation needed to achieve realistic targets. Like pavements, key steps in bridge life-cycle planning are to apply deterioration and improvement models, evaluate life-cycle costs, optimize the scheduling of general work, then translate those work types into specific project treatments.

## ODOT Bridge Deterioration Models

The BMS contains deterioration models for both structural component (i.e., deck, superstructure, substructure, and culvert) and element (e.g., girders and beams, columns, and pier walls). With the support of a strategic partner (Mayvue) of the American Association of State Highway and

Transportation Officials (AASHTO), ODOT has calibrated component deterioration models based on a "Time in State" report of the On-system bridges; for element forecasts, ODOT leverages the default parameters (i.e., Weibull survival function parameters to estimate the time until the first condition state transition and Markovian transition probabilities between each condition state) in the BMS (Figure 14). The BrM further calculates an overall health index by aggregating the total quantity of bridge elements in each of the four condition states. As element models are calibrated, this index will be of further use for guiding work type viability.

**Figure 14: Representative Bridge Deterioration Modeling**




Adapted from Source: AASHTOWare BrM 5.2.3 (April 26, 2017). Deterioration and LCCA. Retrieved from https://www.eiseverywhere.com/file_uploads/5e06bbe9f6b9c5cf3bcf6ec731081772_3DeteriorationandLCCA.pdf. Last Accessed March 2022

## ODOT Bridge Improvement Models

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 11 identifies treatments typically performed by ODOT. The default benefits in BrM associated with the work types aligned to these are applied. Bridge preservation projects typically cost ~$675 thousand; rehabilitation projects cost $3.0 million on average and reconstruction projects' average cost is around $12.3 million.

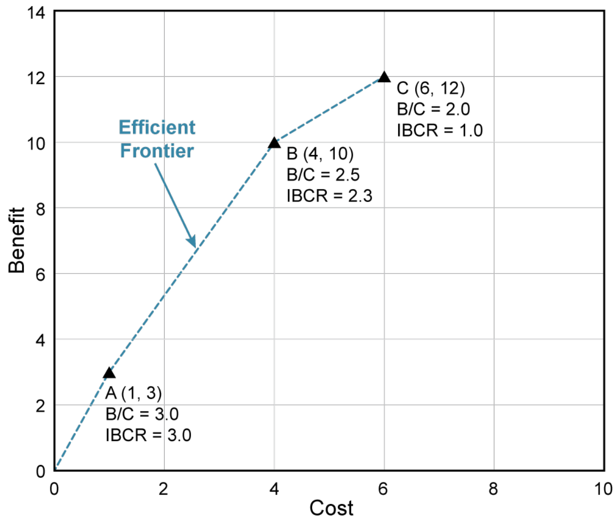
**Table 11: Bridge Treatments**

| Treatment |
| --- |
| **Maintenance** |
| Deck Washing |
| Drift Removal |
| **Preservation** |
| Steel Beam Paint |
| Deck Flood Coat & Silane |
| **Rehabilitation** |
| Joint Replacement |
| Bridge Rehab |
| Deck Overlay |
| Concrete Repair |
| **Reconstruction** |
| Deck Replacement |
| Bridge Replacement |

## Bridge Life Cycle Planning Approach

Similar to pavements, the bridge model leverages IBC to evaluate the efficacy of different treatments relative to the planned timing of their application. An efficiency frontier is used to shortlist treatments based on their IBC Ratio (Figure 15). Any alternative treatment not on this frontier is deemed not feasible for selection. As a result, ODOT is able to consider the most cost-effective treatments from a life-cycle perspective while optimizing treatment selections given shorter term financial constraints and site-specific assumptions related to extreme weather and resiliency.

**Figure 15: Representative IBC Efficiency Frontier**




## Bridge Work Program Optimization

An optimal bridge work program is generated in BrM by maximizing the system IBC Ratio. ODOT bridge engineers at each Field District are provided with these outputs, alongside an annual District Notebook as part of their final decision-making process which also incorporates known risks related to extreme weather and flooding and route or corridor redundancy.

# ASSET MANAGEMENT AND PROJECT PROGRAMMING

Results from annual pavement condition surveys and biennial bridge inspections are published in annual District Notebooks in map format. These District Notebooks, alongside recommended treatments from the PMS and BMS, serve as a critical communication and decision-making tool for Field District staff, ensuring not only that the most appropriate cost-effective LCP pavement management decisions are made, but that they are coordinated with ODOT's Construction Work Plan (CWP), Asset Preservation Plan (APP), and Bridge programs.

Once Field District staff review the provided information, they submit candidate projects to ODOT's Central Office which then conducts spatial analysis of proposed work improvement locations to help prioritize submittals based on the: i) extent of deficiency that is anticipated to be corrected by a project ii) opportunity to reduce long term costs, and iii) criticality of the location. A cloud-based project prioritization solution (Decision Lens) is used to score both pavement and bridge projects separately and together, in light of any cross-discipline scope items. Outputs further inform updates to the CWP, APP, and bridge project pipelines, cross-discipline resource allocation, and project programming processes.

## Resiliency Considerations

Due to its geology, rivers, and flood plains, ODOT has long recognized the vulnerability of its transportation assets to extreme weather and the risks it can present to the condition and performance of pavements and bridges; therefore, ODOT has integrated resiliency considerations into its life cycle planning and project programming. ODOT has developed well-regarded resiliency-focused design guidelines for bridges and roadways in flood-prone areas (see **Risk Management** for details) to reduce potential damage from extreme weather events and minimize overall life cycle costs, and is increasingly incorporating resiliency and redundancy considerations into its decision making.

In 2022, ODOT shifted from static District Notebooks to interactive digital district notebooks which allow Field District staff to layer multiple data sets for workplan rebalance and transparency. The digital District Notebooks include a Project Corridor feature which allows users to select and review multiple corridors at once. Using this function, staff have the ability to prioritize a more resilient transportation network by incorporating route redundancy in the event of road closures due to extreme weather considerations into corridor planning decisions.

In the event that an asset is damaged from an external threat such as extreme weather, ODOT prioritizes repairs or reconstruction ahead of the life cycle planning asset management schedule as necessary to ensure the safety and reliability of the transportation network.

ODOT expects to continue to incorporate additional resiliency considerations into its life cycle planning processes and other decision making frameworks.

CHAPTER 5

# Financial Plan

Financial planning enables ODOT to understand what reasonable revenues may be available for preserving pavement and bridge assets and the relative value of the Oklahoma highway system.

## INTRODUCTION

Understanding available revenue sources is essential for helping ODOT develop and assess the likely performance implications of different investment strategies. The Financial Plan of the TAMP provides

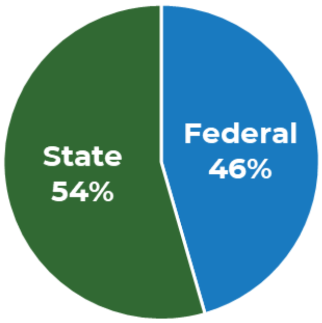
- an overview of the primary revenue sources used for highway preservation,
- a projection of likely revenues that will be available to ODOT and its partner agencies for preserving pavement bridge assets on the National Highway System (NHS),
- planned spending by project work type, and
- a financial assessment of NHS pavement and bridge asset value.

## PRIMARY REVENUE SOURCES

A combination of federal, state, and local funding is used to preserve ODOT owned NHS roadways.

The majority (54%) of ODOT's total revenues anticipated over the next ten federal fiscal years (FFY) is expected to come from state funds, with the remainder from federal programs (Figure 16).

**Figure 16: Anticipated ODOT Funding Distribution FFY 2022-2031**



Primary state revenue sources include income tax, motor vehicle tax, and motor fuel funds via the Rebuilding Oklahoma Access and Driver Safety (ROADS) fund, the State Transportation Fund, as well as other state sources (Table 12).

**Table 12: Primary State Revenue Sources for Highway & Bridge Preservation**

| State Funding Sources | Description |
|---|---|
| Rebuilding Oklahoma Access and Driver Safety (ROADS) Fund | The Oklahoma Legislature established the ROADS fund to address structurally deficient bridges and roads in disrepair. This funding bypasses the appropriations system and is sourced from income taxes, motor vehicle taxes, and motor fuel taxes. |
| Motor Fuel Taxes | Oklahoma levies excise taxes on gasoline and diesel at 20 cents per gallon. Rates were increased in 2018 (the first increase since 1987) from 16 cents per gallon of gasoline and 13 cents per gallon of diesel. |
| State Transportation Fund | The State of Oklahoma imposes a variety of fees, which include appropriations from the diesel fuel tax, gasoline tax, special fuel tax, motor vehicle taxes, and a motor vehicle collections fee, deposited in the State Transportation Fund. |

ODOT's primary federal funding sources include the National Highway Performance Program (NHPP) and the Surface Transportation Block Grant Program (STBG), but also includes apportionments for other Federal-Aid Programs such as the Bridge Formula Program established under the Infrastructure Investment and Jobs Act (IIJA) and National Highway Freight Program (NHFP) for assets on designated freight corridors. As opportunities arise, ODOT additionally seeks funding through competitive grant programs such as the federal Nationally Significant Multimodal Freight & Highway Projects (aka Infrastructure for Rebuilding America - INFRA) and Multimodal Project Discretionary Grant (MPDG).

# ANTICIPATED REVENUE LEVELS

Approximately $1.5 billion (after debt service and administration expenses) is anticipated to be available annually over the next ten years (FFY 2022 – 2031). This revenue forecast is based on a review of historically and/or categorically committed funding to State-Aid and Federal-Aid highway system improvements and does not address Department-initiated set asides or other mandated programs. The budgetary projections assume a continuation of Federal funding at FFY 2022 Obligation Limitation base levels, without growth; each year this benchmark is adjusted based upon the results of the annual Congressional budgeting process. The forecast further accounts for changes in vehicle fuel economy and forecasted traffic volumes - as it pertains to motor fuel taxes - and deducts debt service and agency administration expenditures.

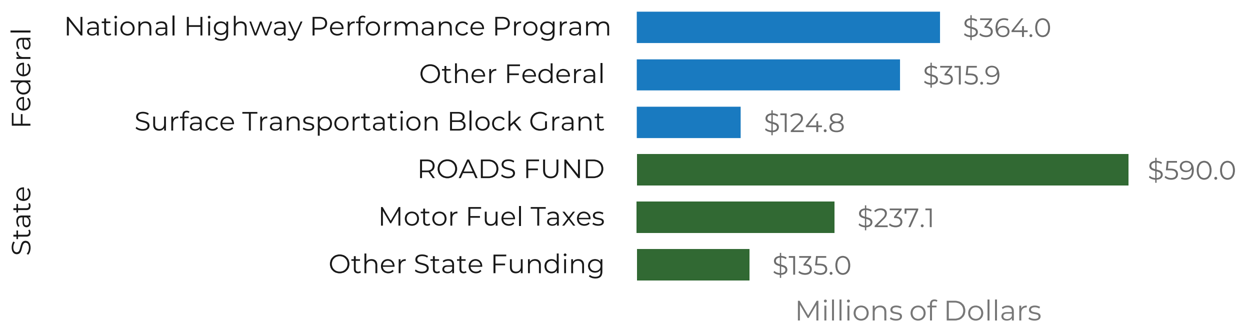
Nearly three quarters of ODOT funding is anticipated to come from the NHPP, STBG, ROADS Fund, and motor fuel taxes (Figure 17). This includes an increase in the ROADS fund cap from $575 million annually to $590 million annually (as of state FY 2023). All revenue sources are held constant at their

**State and Federal Fiscal Years**

- The Federal fiscal year begins October 1st and ends September 30th
- Oklahoma's fiscal year begins on July 1st and ends on June 30th

forecasted levels except for motor fuel taxes; motor fuel tax revenues are expected to be $240 million a year starting in state FY 2023 and then reduced by 1% every three years.

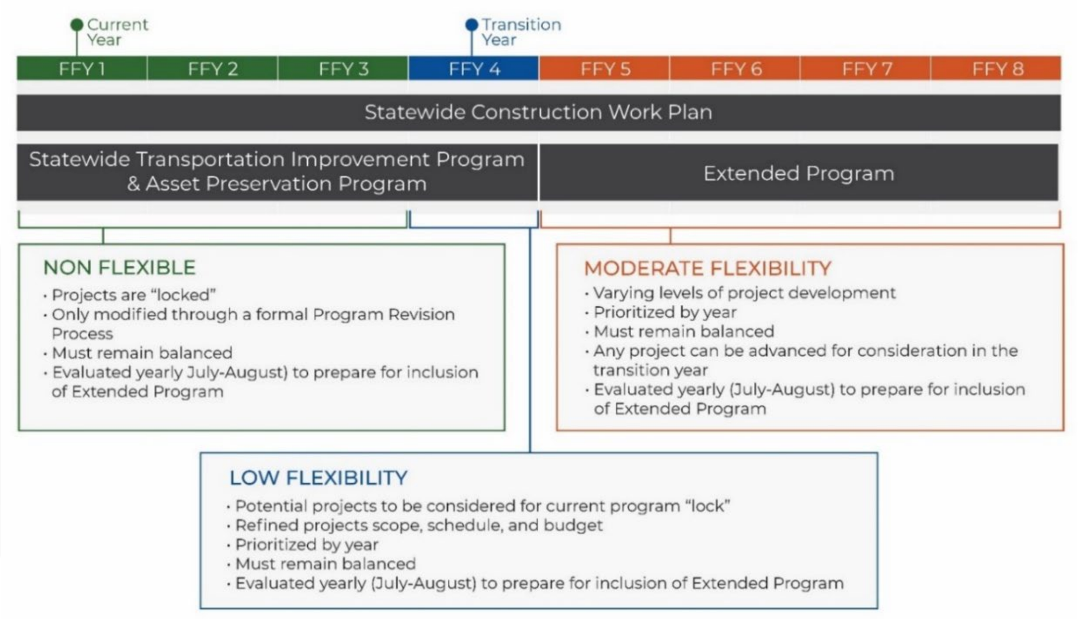
**Figure 17: Anticipated Average Annual ODOT Revenue by Funding Source FFY 2022-2031**




# PLANNED SPENDING

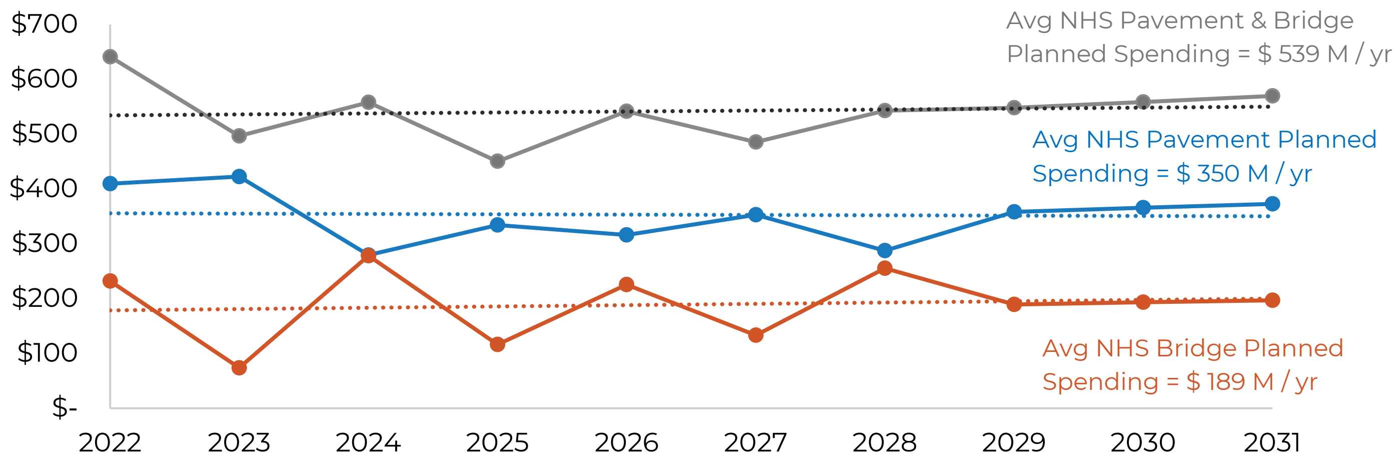
These projected revenue levels feed into the development of fiscally balanced and financially responsible ODOT plans and programs. Most notably this includes planned projects in the eight-year Construction Work Program (CWP) and four-year Asset Preservation Program (APP). As of 2022, the CWP contained ~$7.7 billion in estimated project costs and the APP contained ~ $483 million in estimated project costs. The first four years of the CWP is comprised of projects that are included in the federally mandated Statewide Transportation Improvement Program (STIP); all four years of the APP are included in the STIP (Figure 18 ). Projects selected for inclusion in the STIP are based on data driven decision making and are informed by the Pavement Management System, the Bridge Management System, and the Maintenance Management System.

**Figure 18: ODOT Work Plans and Programs**



Cost-effectively preserving NHS pavements and bridges in a good condition state is but one of multiple objectives that ODOT and its planning partners must balance as stewards of Oklahoma highway infrastructure. When looking at estimated costs of planned projects and extending the trendline of expenditures out to 10 years, ODOT and the OTA are anticipated to spend approximately $539 million annually on pavement and/or bridge treatment on NHS projects. When classified based on the primary NHS asset class improved, approximately 65% goes towards pavement with the remaining 35% going to bridges (Figure 19).

### Figure 19: Planned NHS Pavement and Bridge Spending FFY 2022-2031



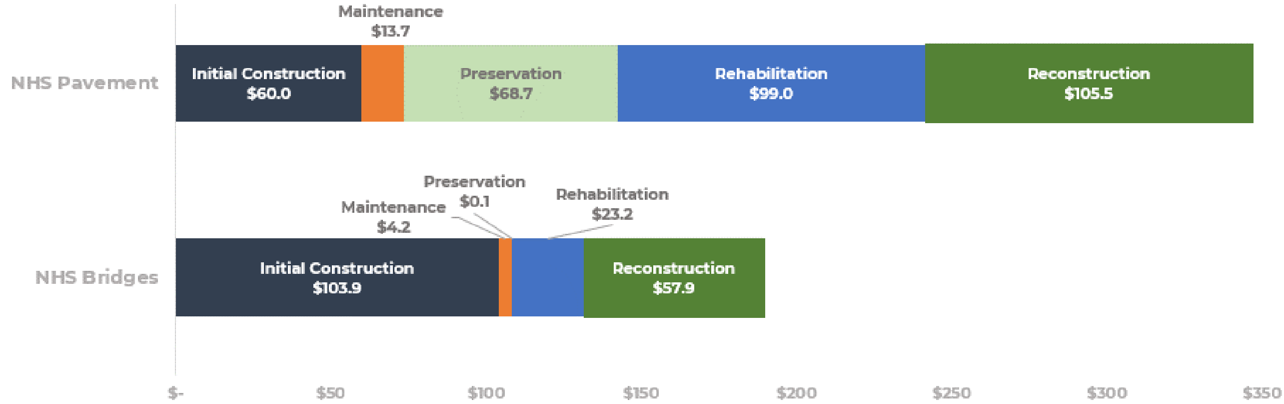

To estimate planned NHS pavement and bridge spending by FHWA work type, ODOT filters projects in the STIP, CWP, and APP based on the work codes most closely associated with the five pavement and bridge work types for Asset Management Plans referenced in 23 CFR Part 515.5: Maintenance, Preservation, Rehabilitation, Reconstruction, and Initial Construction. Based on the review of FHWA work types compared to ODOT project coding practices, only 'Drift Removal' satisfies the criteria for the 'Bridge Maintenance' FHWA section. That is not to imply that ODOT does not perform regular bridge maintenance, but instead shows a nomenclature difference where many project types that ODOT internally considers to be 'maintenance' instead fall under the FHWA 'Preservation' category.

### Table 13: ODOT Work Codes by FHWA Work Type

| Work Type | Pavement Work Code(s) | Bridge Work Code(s) |
|---|---|---|
| Maintenance | ITS Maintenance & Operations, Wireless Maintenance & Operation, Fiber Optic Maintenance & Operations, Signing, Illumination, Pavement Marking, Impact Attenuators | Drift Removal |
| Preservation | Resurface, Seal Coat, Micro surface, Ultrathin | Bridge Painting, Bank Protection, Joint Seal/Repair, Bridge Waterproof Seal |
| Rehabilitation | Shoulder Improvement & Resurface, Shoulder Improvement, Pavement Rehabilitation | Bridge Repair, Bridge Rehab |
| Reconstruction | Interchange: Widen & Resurface, Intersect Modification, Traffic Signals, Intersection Mod. & Traffic Signals, Reconstruct-Added Lanes, Reconstruct-No Added Lanes | Bridge & Approaches, Widen, Resurface & Bridge |
| Initial Construction | ITS Construction, Wireless Construction, Fiber Optic Construction, Grade, Drain, & Surface | Grade, Drain & Bridge, Grade, Drain, Bridge & Surface |

The majority (61%) of planned spending across NHS pavement and bridges is expected to coincide with the initial construction and reconstruction work types (Figure 20).

### Figure 20: Planned Annual NHS Pavement and Bridge Spending by Work Type FFY 2022-2031




For both NHS pavement and bridges, reconstruction accounts for ~30% of planned spending, however, unlike bridges nearly half of planned NHS pavement spending is anticipated to fall under the preservation and rehabilitation work types. All planned annual spending by NHS pavement and bridges by work type are presented in Table 14.

As discussed in Chapter 7 **Performance Gap Assessmen**t, using the dTIMS software, ODOT found that an 8% increase in Interstate preservation, rehabilitation, and reconstruction funding, in addition to currently planned non-Interstate NHS funding, in order to maintain system valuation.

### Table 14: Planned NHS Pavement and Bridge Spending by FFY and Work Type

In millions of dollars (share of NHS asset spending in each year)

| | Work Type | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NHS Pavement | Initial Construction | 176.6 | 68.8 | 69.3 | 53.7 | 108.7 | 69.2 | 20.0 | 51.0 | 52.0 | 53.1 | **722.5** |
| | | 43.1% | 16.3% | 24.8% | 16.1% | 34.4% | 19.6% | 7.0% | 14.2% | 14.2% | 14.2% | **20.7%** |
| | Maintenance | 74.5 | 78.3 | 21.2 | 9.7 | 3.8 | 3.8 | 3.9 | 4.0 | 4.1 | 4.1 | **207.3** |
| | | 18.2% | 18.5% | 7.6% | 2.9% | 1.2% | 1.1% | 1.4% | 1.1% | 1.1% | 1.1% | **5.9%** |
| | Preservation | 55.3 | 84.7 | 69.7 | 92.4 | 60.4 | 102.8 | 39.7 | 57.5 | 58.7 | 59.9 | **681.0** |
| | | 13.5% | 20.0% | 24.9% | 27.7% | 19.1% | 29.2% | 13.8% | 16.1% | 16.1% | 16.1% | **19.5%** |
| | Rehabilitation | 87.6 | 41.1 | 62.8 | 67.6 | 94.3 | 54.0 | 135.8 | 129.7 | 132.3 | 134.9 | **940.2** |
| | | 21.4% | 9.7% | 22.5% | 20.2% | 29.9% | 15.3% | 47.2% | 36.2% | 36.2% | 36.2% | **26.9%** |
| | Reconstruction | 15.4 | 149.8 | 56.6 | 110.6 | 48.7 | 122.8 | 88.1 | 116.1 | 118.4 | 120.8 | **947.2** |
| | | 3.8% | 35.4% | 20.2% | 33.1% | 15.4% | 34.8% | 30.6% | 32.4% | 32.4% | 32.4% | **27.1%** |
| | **Total** | **409.4** | **422.6** | **279.5** | **334.0** | **315.9** | **352.6** | **287.5** | **358.3** | **365.5** | **372.8** | **3,498.2** |
| NHS Bridges | Initial Construction | 94.0 | 10.4 | 140.1 | 79.4 | 116.7 | 99.6 | 143.6 | 116.2 | 118.5 | 120.8 | **1,039.3** |
| | | 40.6% | 14.1% | 50.3% | 68.4% | 51.8% | 74.8% | 56.2% | 61.3% | 61.3% | 61.3% | **54.9%** |
| | Maintenance | - | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 7.1 | 7.3 | **42.4** |
| | | 0.0% | 1.4% | 0.7% | 2.6% | 1.8% | 3.8% | 2.3% | 3.7% | 3.7% | 3.7% | **2.2%** |
| | Preservation | - | - | 0.5 | 0.8 | - | - | - | - | - | - | **1.3** |
| | | 0.0% | 0.0% | 0.2% | 0.7% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | **0.1%** |
| | Rehabilitation | 45.0 | 27.3 | 34.4 | 15.1 | 46.6 | 13.6 | 30.7 | 6.3 | 6.4 | 6.6 | **232.1** |
| | | 19.4% | 37.0% | 12.4% | 13.0% | 20.7% | 10.2% | 12.0% | 3.3% | 3.3% | 3.3% | **12.3%** |
| | Reconstruction | 92.7 | 35.1 | 101.2 | 17.8 | 58.2 | 15.0 | 75.2 | 60.0 | 61.2 | 62.4 | **578.8** |
| | | 40.0% | 47.5% | 36.4% | 15.3% | 25.8% | 11.3% | 29.4% | 31.7% | 31.7% | 31.7% | **30.6%** |
| | **Total** | **231.7** | **73.8** | **278.3** | **116.2** | **225.5** | **133.2** | **255.4** | **189.5** | **193.3** | **197.1** | **1,894.0** |

The resulting forecasted performance outcomes associated with this planning strategy is detailed in Chapter 7 **Performance Gap Assessment**.

# VALUE OF ODOT'S NHS ASSETS

ODOT defines the representative value of NHS pavement and bridge assets based on the extent of each system and estimated replacement costs. These costs were estimated using historical project costs and then multiplied against the federally reported NHS inventories: the Highway Performance Monitoring System (HPMS) for pavements and the National Bridge Inventory (NBI) for deck area.

Using this methodology, the estimated replacement value of NHS pavements is approximately $32.5 billion (Table 15). Interstate pavements represent only 30% of NHS lane miles but reflect over 64% of the NHS pavement value. Likewise, from a geography perspective, Urban NHS pavements make up nearly 30% of NHS lane miles but represent over 54% of NHS pavement value.

### Table 15: Estimated Replacement Value of NHS Pavement

| Geography | Roadway Type | Lane Miles | Replacement Value per Lane Mile | Asset Value |
|---|---|---|---|---|
| Urban | Interstate | 1,410 | $10.20 million | $14.38 billion |
| | Non-Interstate NHS | 2,551 | $1.25 million | $3.19 billion |
| Rural | Interstate | 2,622 | $2.50 million | $6.56 billion |
| | Non-Interstate NHS | 6,685 | $1.25 million | $8.36 billion |
| **Statewide** | **All NHS** | **13,269** | **$2.45 million** | **$32.49 billion** |

The average replacement cost of NHS bridges has been observed to be about $200 per square foot. Based on system extents, this translates to an NHS bridge valuation of over $7 billion (Table 16). ODOT is responsible for 77% of this NHS bridge value.

### Table 16: Estimated Replacement Value of NHS Bridges

| NHS Ownership | Square Feet | Asset Value |
|---|---|---|
| ODOT | 27.08 million | $5.42 billion |
| OTA | 7.92 million | $1.58 billion |
| Local | 0.10 million | $0.20 billion |
| **All NHS** | **35.1 million** | **$7.02 billion** |

Through continued investment, ODOT can maintain the overall value of its network. This can be achieved at a lower cost than the full system replacement value through implementing cost-effective life cycle planning principles (detailed in Chapter 4 **Life Cycle Planning**).

CHAPTER 6

# Investment Strategies

Investment strategies help ODOT return the best performance outcomes possible given limited, available resources. As stewards of NHS pavement and bridges, ODOT has identified proven policies and strategies that help make progress toward achieving and sustaining desired condition levels over the life cycle of the assets.

## INTRODUCTION

ODOT's identified investment strategies help advance the most impactful, cost-effective NHS pavement and bridge treatments recommended from asset management systems to the CWP, APP, and eventual Statewide Transportation Improvement Program (STIP). These strategies further ensure progress towards attaining State and Federal goals, objectives, and targets while minimizing performance gaps over time.

# INVESTMENT STRATEGIES

As part of the recently adopted Oklahoma 2045 Long Range Transportation Plan, ODOT identified policies and strategies to help prepare ODOT and its planning partners to manage and operate a modern, efficient transportation system; those policies and strategies most pertinent to highway and bridge asset management are detailed in Table 17.

### Table 17: ODOT's Asset Management Related Highway and Bridge Policies and Strategies

| **Reduce fatalities and serious injuries on Oklahoma highways through appropriate engineering solutions, systemic improvements, and educational policies.** |
|---|
| Improve safety of roadway infrastructure by:<br>• adding shoulders on portions of the state highway system that lack them or have deficient shoulders, and<br>• continuing to apply appropriate safety countermeasures to targeted locations. |
| **Improve safety and bridge conditions cost effectively by replacing or rehabilitating structurally deficient bridges on the state highway system and averting growth in the share of structurally deficient bridges.** |
| • Implement Bridge Management System (BMS) to inform the programming of replacement or rehabilitation treatments for bridges on the state highway system that might otherwise become structurally deficient.<br>• Continue to identify, rehabilitate, and replace at risk and fracture-critical bridges.<br>• Continue to follow a programmatic approach to identify and address potential preservation issues on historic bridges, working collaboratively with community partners. |
| **Preserve and improve the condition of highways and bridges while minimize life cycle costs.** |
| • Continue to invest in bridge preservation to achieve and maintain a share of state-system structurally deficient bridges no greater than 1 percent.<br>• Continue to invest in pavement preservation and use the Pavement Management System to enhance conditions on the state highway system, particularly to increase the share of "good" pavement by ~10 percent and meet state and federal performance targets.<br>• Implement the regulations outlined in the Federal transportation legislation as they pertain to performance measures and asset management. |
| **Identify, assess, and mitigate risks to highway assets.** |
| • Monitor risks to bridges and highway assets, including pavement and bridges, via the risk management process documented in Chapter 8 **Risk Management** of this TAMP.<br>• Collect data required for risk analysis, including collection of trends or forecasts related to seismic activity, extreme weather, and other risk categories identified in the Chapter 8 **Risk Management** of this TAMP.<br>• Consider new design standards to mitigate the risk associated with damage to bridges due to vehicle strikes.<br>• Lend ODOT's expertise to local governments to model seismic risks to local bridges and update design standards if necessary.<br>• Investigate the causes of past highway failures related to flooding and update design standards or hydraulic guidelines as needed. |

Source: ODOT (August 6, 2020). Oklahoma's 2020-2045 Long Range Transportation Plan.

These policies and strategies are indicative of ODOT's focus on enabling safe travel and finding a balance between corrective, risk mitigation and proactive, preventive maintenance treatments. The culmination of these strategies are cost-effective projects being programmed for construction, taking into account the risks identified in Chapter 8.

# PROJECT SELECTION PROCESS

Project selection at ODOT is a comprehensive and collaborative process designed to provide a safe, economical, resilient, and effective transportation network for the people, commerce, and communities of Oklahoma. One of the bedrock principles of this approach is the tacit agreement between the Oklahoma Transportation Cabinet – which governs ODOT and the OTA – and other NHS owners to share data via a cabinet-wide IT office. This includes the regional condition data packaged together as part of ODOT's Field District notebooks as well as software-generated recommendations for allocations and project recommendations.

The shared asset condition data is used along with local and site-specific knowledge to initiate the most effective preservation treatments which are then cross-checked with asset management system recommendations. This list of candidate projects is then further checked by applying a consistent and objective scoring process enabled through the Decision Lens prioritization and resource planning software.

The project selection process is fiscally constrained based on the expected funding amounts through federal and state transportation revenue sources. Using the Transportation Cabinet data, engineering judgment, and asset management principles such as performance gap analysis, asset life cycle planning, and risk management, projects are identified for inclusion in the CWP and APP through a comprehensive consideration process led by the eight field district engineers with continuous input from many stakeholders and approved by the Transportation Commission. These annual plans guide ODOT's project development and delivery strategies. The first four years of the CWP is comprised of projects that are included in the federally mandated STIP. All four years of the APP are included in the STIP. ODOT also supplies quarterly Key Performance Indicator and Transportation Performance Measure progress updates to all districts, which provide an up-to-date look at current and projected status. This includes Federal Good-Fair-Poor measures for pavements, two lane highways without shoulders, and bridges, as well as the performance measure targets associated with these metrics.

CHAPTER 7

# Performance Gap Assessment

ODOT uses asset management systems to predict the likely performance implications of different investment levels over time, which enables ODOT to allocate limited funding efficiently to maximize benefits over the entire system. It also helps ODOT understand potential funding gaps based on the difference between targeted condition levels and the anticipated conditions given available revenues.

## INTRODUCTION

ODOT uses predictive pavement and bridge asset management systems (detailed in Chapter 4 **Life Cycle Planning**) to forecast asset condition performance under different funding scenarios. These systems help ODOT develop optimal work programs within anticipated revenue constraints (detailed in Chapter 5 **Financial Plan**) and proactively assess whether expected funding levels will be sufficient to achieve performance targets. This section provides a performance and gap assessment for NHS pavement and bridges and establishes corresponding 2-, 4-year targets and a comparison of current performance to 10-year projections.

## FINANCIALLY CONSTRAINED PERFORMANCE LEVELS

ODOT forecasts future NHS pavement and bridge performance based on the optimized work program generated by its asset management systems. A key input to these systems is the anticipated revenues available for pavement and bridge spending,

## Pavement Forecast & Investment Strategy

For the pavement analysis, ODOT ran the anticipated NHS asset management spending (Table 19) through dTIMS.

To estimate planned NHS pavement and bridge spending by FHWA work type, ODOT filters projects in the STIP, CWP, and APP based on the agency's work codes most closely associated with the five pavement and bridge work types for Asset Management Plans referenced in 23 CFR Part 515.5: Maintenance, Preservation, Rehabilitation, Reconstruction, and Initial Construction (Table 18). OTA went through a similar exercise to map their work codes to FHWA work types. Differences in terminology and work codes may result in slight discrepancies when communicating the share of planned spending.

### Table 18: ODOT Work Codes by FHWA Work Type

| Work Type | Pavement Work Code(s) |
|---|---|
| Maintenance | ITS Maintenance & Operations, Wireless Maintenance & Operation, Fiber Optic Maintenance & Operations, Signing, Illumination, Pavement Marking, Impact Attenuators |
| Preservation | Resurface, Seal Coat, Micro surface, Ultrathin |
| Rehabilitation | Shoulder Improvement & Resurface, Shoulder Improvement, Pavement Rehabilitation |
| Reconstruction | Interchange: Widen & Resurface, Intersect Modification, Traffic Signals, Intersection Mod. & Traffic Signals, Reconstruct-Added Lanes, Reconstruct-No Added Lanes |
| Initial Construction | ITS Construction, Wireless Construction, Fiber Optic Construction, Grade, Drain, & Surface |

### Table 19: Planned NHS Pavement Spending by FFY and Work Type

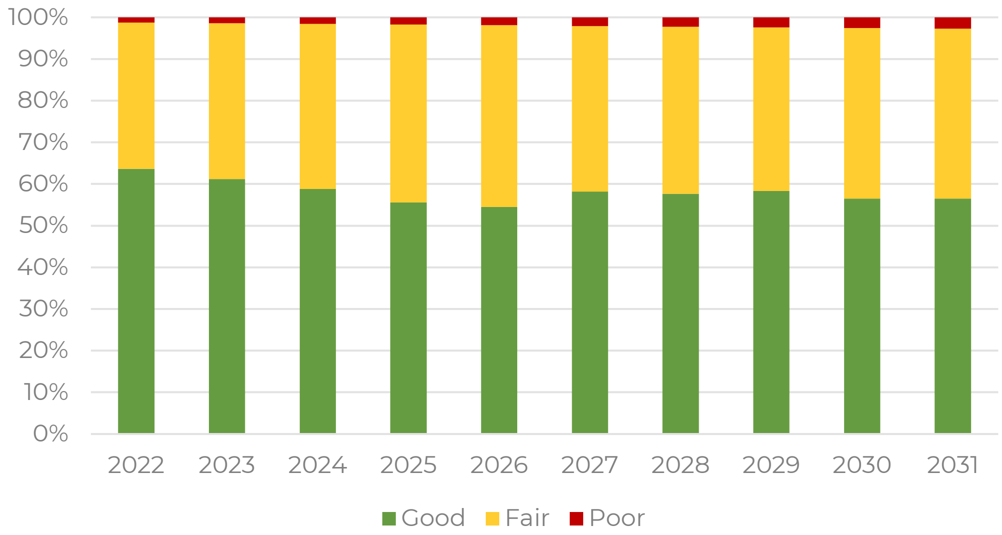
*In Millions of Dollars*

| | Work Type | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Interstate | **Initial Construction** | 91.4 | 10.0 | 4.5 | 21.6 | 28 | 21.3 | 0.0 | 30.0 | 30.6 | 31.2 | **268.6** |
| | **Maintenance** | 30.9 | 33.6 | 9.1 | 4.2 | 1.6 | 1.7 | 1.7 | 1.8 | 1.8 | 1.9 | **88.3** |
| | **Preservation** | 16.1 | 32.3 | 26.6 | 35.3 | 23.0 | 39.2 | 15.2 | 22.0 | 22.4 | 22.8 | **254.9** |
| | **Rehabilitation** | 69.7 | 11.5 | 17.5 | 18.8 | 26.3 | 15.0 | 37.9 | 36.2 | 36.9 | 37.6 | **307.4** |
| | **Reconstruction** | 14.2 | 28.5 | 10.8 | 21.1 | 9.3 | 23.4 | 16.8 | 22.1 | 22.6 | 23.0 | **191.8** |
| | **Total** | **222.3** | **115.9** | **68.5** | **101** | **88.2** | **100.6** | **71.6** | **112.1** | **114.3** | **116.5** | **1,111.0** |
| Non-Interstate NHS | **Initial Construction** | 85.2 | 58.8 | 64.8 | 32.2 | 80.7 | 47.9 | 20.0 | 21.0 | 21.4 | 21.8 | **453.8** |
| | **Maintenance** | 43.6 | 44.7 | 12.1 | 5.5 | 2.1 | 2.1 | 2.2 | 2.2 | 2.2 | 2.3 | **119.0** |
| | **Preservation** | 39.2 | 52.4 | 43.1 | 57.2 | 37.4 | 63.6 | 24.6 | 35.6 | 36.3 | 37.0 | **426.4** |
| | **Rehabilitation** | 17.9 | 29.7 | 45.3 | 48.8 | 68.0 | 38.9 | 98.0 | 93.5 | 95.4 | 97.3 | **632.8** |
| | **Reconstruction** | 1.2 | 121.2 | 45.8 | 89.5 | 39.4 | 99.4 | 71.3 | 94.0 | 95.9 | 97.8 | **755.5** |
| | **Total** | **187.1** | **306.8** | **211.1** | **233.2** | **227.6** | **251.9** | **216.1** | **246.3** | **251.2** | **256.2** | **2,387.5** |

** Numbers may not add exactly due to rounding*

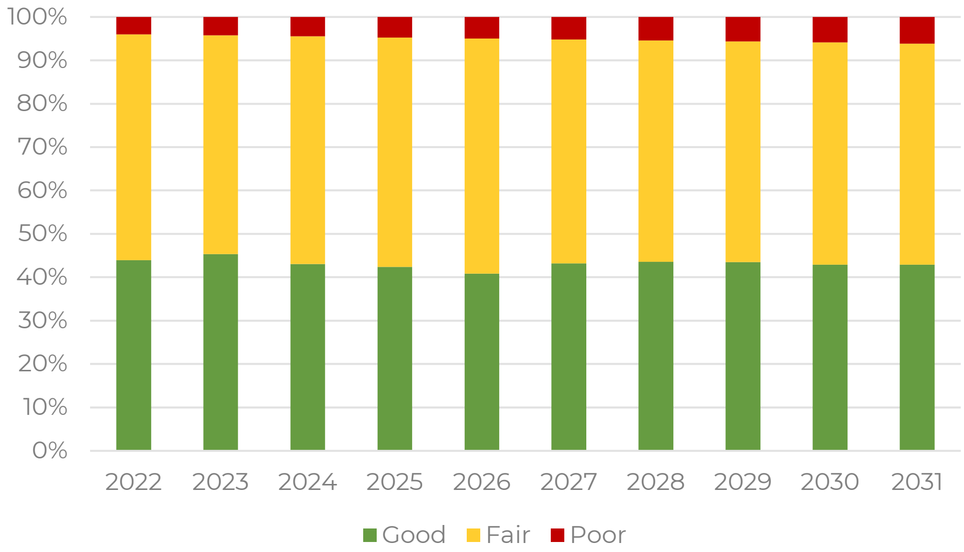
With approximately 32% of NHS pavement spending designated for the Interstate system, dTIMS forecasts that the Interstates will be in 56.5% Good and 2.7% Poor condition in 2031 (Figure 21). This represents a slight decline in performance from the most recent Highway Performance Monitoring System (HPMS) submittal in 2020.

**Figure 21: Forecasted Interstate Pavement Condition given Planned Investment**




Under planned spending, the non-Interstate NHS system would improve from 40.5% Good in 2020 to 42.9% Good in 2031; however, percent Poor pavement lane miles would also increase from 3.6% in 2020 to 6.1% in 2031 (Figure 22).

**Figure 22: Forecasted Non-Interstate NHS Pavement Condition given Planned Investment**




This allocation between the Interstate and non-Interstate NHS prioritizes higher performance standards for the Interstates, due to their economic importance and increased usage.

## Bridge Forecast & Investment Strategy

For the bridge analysis, ODOT ran its anticipated bridge investment allocation (Table 21) through ODOT's BrM.

To estimate planned NHS bridge spending by FHWA work type, ODOT filters projects in the STIP, CWP, and APP based on the work codes most closely associated with the bridge work types for Asset Management Plans referenced in 23 CFR Part 515.5: Maintenance, Preservation, Rehabilitation, Reconstruction, and Initial Construction (Table 20). Based on the review of FHWA work types compared to ODOT project coding practices, only 'Drift Removal' satisfies the criteria for the 'Bridge Maintenance' FHWA section. That is not to imply that ODOT does not perform regular bridge maintenance, but instead shows a nomenclature difference where many project types that ODOT internally considers to be 'maintenance' instead fall under the FHWA 'Preservation' category.

### Table 20: ODOT Bridge Work Codes by FHWA Work Type

| Work Type | Bridge Work Code(s) |
|---|---|
| **Maintenance** | Drift Removal |
| **Preservation** | Bridge Painting, Bank Protection, Joint Seal/Repair, Bridge Waterproof Seal |
| **Rehabilitation** | Bridge Repair, Bridge Rehab |
| **Reconstruction** | Bridge & Approaches, Widen, Resurface & Bridge |
| **Initial Construction** | Grade, Drain & Bridge, Grade, Drain, Bridge & Surface |

### Table 21: Planned NHS Bridge Spending by FFY and Work Type

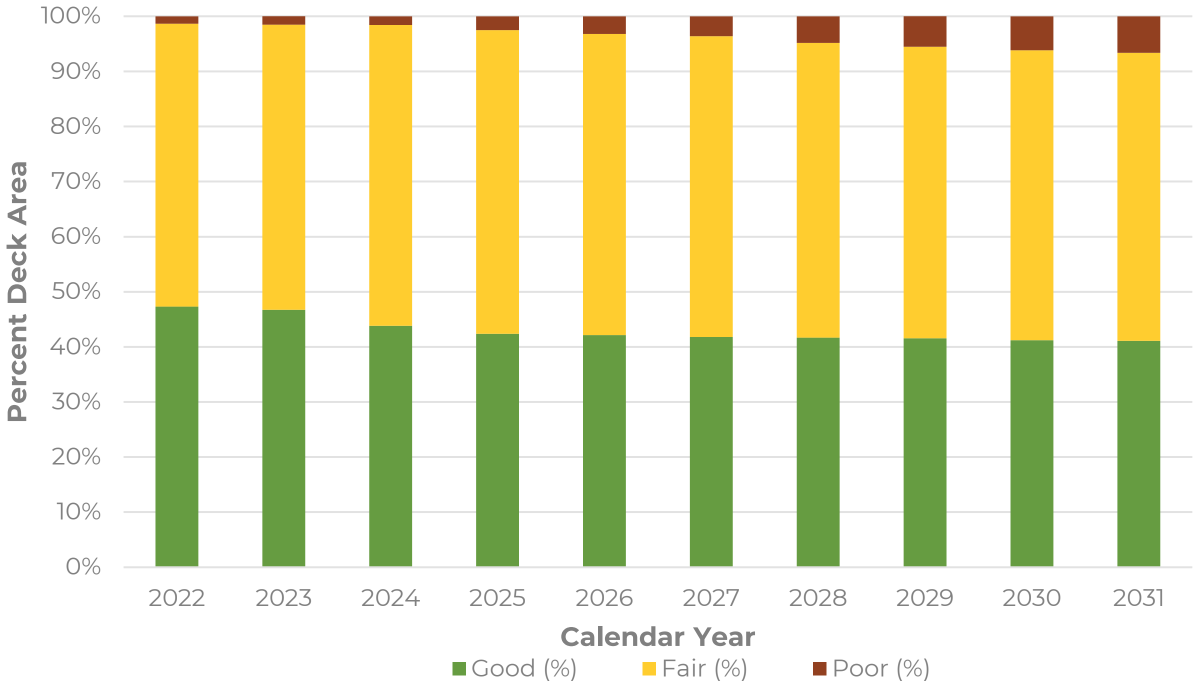
*In Millions of Dollars*

| | Work Type | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NHS | **Initial Construction** | 94.0 | 10.4 | 140.1 | 79.4 | 116.7 | 99.6 | 143.6 | 116.1 | 118.5 | 120.9 | **1,039.3** |
| | **Maintenance** | - | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 7.00 | 7.14 | 7.28 | **42.4** |
| | **Preservation** | - | - | 0.5 | 0.8 | - | - | - | - | - | - | **1.3** |
| | **Rehabilitation** | 45.0 | 27.3 | 34.4 | 15.1 | 46.6 | 13.6 | 30.7 | 6.3 | 6.4 | 6.6 | **232.1** |
| | **Reconstruction** | 92.7 | 35.1 | 101.2 | 17.8 | 58.2 | 15.0 | 75.2 | 60.0 | 61.2 | 62.4 | **578.8** |

** Numbers may not add exactly due to rounding*

With currently anticipated revenues, ODOT expects that NHS bridge deck area will experience a decline from 48.0% Good to 41.1% Good and an increase in Poor deck area from 1.3% to 6.7% by 2031 (Figure 23). This reduced performance level is associated with aging infrastructure: as noted in the 2020 update to ODOT's Bridges and Highways report, more than 1,250 state-owned bridges are over 80 years old; ODOT would have to replace or refurbish approximately 90 bridges annually to keep pace with this level of aging over the next 8 years.

**Figure 23: Forecasted NHS Bridge Condition Given Planned Investment**




# 10-YEAR GAP ASSESSMENT

ODOT has identified a funding level that could maintain NHS pavement and bridges at or near their 2021 condition state over a 10-year period. However, ODOT has established a reduced performance standard for non-Interstate NHS pavement due to strong current condition levels and importance of maintaining Interstate roadways for the national, state, and regional economies.

## Pavement Gap Assessment

Using the dTIMS software, ODOT found that increasing funding for Interstate preservation, rehabilitation, and reconstruction funding by 8%, in addition to currently planned non-Interstate NHS funding, would achieve targeted performance levels (Table 22). This approximately translates to an annualized need of an additional ~$6 M (in 2020 USD) to achieve desired 10-year performance levels.

### Table 22: NHS Pavement 10-year Performance Gap Assessment

| | Pavement | Good | Fair | Poor |
|---|---|---|---|---|
| Interstate | Reported Performance (2020) | 65.6% | 33.5% | 1.0% |
| | 10-Year Projected Performance (2031) | 56.5% | 40.8% | 2.7% |
| | **10-year Projected Performance Gap** | **9.1% worse** | **--** | **1.7% worse** |
| Non-Interstate NHS | Reported Performance (2020) | 40.5% | 56.0% | 3.6% |
| | 10-Year Projected Performance (2031) | 42.9% | 50.9% | 6.1% |
| | **10-year Projected Performance Gap** | **2.4% better** | **--** | **2.5% worse** |

## Bridge Gap Assessment

Based on anticipated revenues, the BrM software projects a 6.8% gap in Good and 5.4% gap in Poor deck area in 10 years (Table 23). This approximately translates to an annualized need of an additional ~$30 M (in 2020 USD) to achieve desired 10-year performance levels.

### Table 23: NHS Bridge 10-year Performance Gap Assessment

| | Bridges | Good | Fair | Poor |
|---|---|---|---|---|
| NHS | Reported Performance (2020) | 47.9% | 50.8% | 1.3% |
| | 10-Year Projected Performance (2031) | 41.1% | 52.3% | 6.7% |
| | **10-year Projected Performance Gap** | **6.8% Worse** | **--** | **5.4% Worse** |

# FEDERAL 2- AND 4-YEAR TARGETS

As compared to its previous targets, ODOT has made significant progress towards reducing the percentage of Poor pavement lane miles and bridge deck area. Due to ODOT's focus on reducing the amount of assets in Poor condition, a lower performance level than expected was realized for Good conditions (Table 24). 2-year targets were not required for Interstate pavements in the prior performance period.

### Table 24: Reported Performance vs. Prior 2-year (2020) Federal Targets

| | Metrics | Good | Fair | Poor |
|---|---|---|---|---|
| **Non-Interstate NHS** | Reported Performance (2020) | 38.4% | 57.8% | 3.6% |
| | Targeted Performance (2020) | 45.0% | -- | 5.0% |
| | **Observed Performance Gap** | **6.6%** | -- | **Attained** |
| **NHS Bridges** | Reported Performance (2020) | 46.6% | 51.8% | 1.6% |
| | Targeted Performance (2020) | 55.0% | -- | 5.0% |
| | **Observed Performance Gap** | **8.4%** | **--** | **Attained** |

To update its targets, ODOT leveraged its dTIMS and BrM predictive asset management systems to generate 2- and 4-year performance forecasts, then adjusted for recently observed model accuracy. 0.5% and 0.75% annually accumulating margins of error are assumed for all pavement and bridge forecasts respectively over a 4-year period. The target values were then rounded to the nearest integer indicative of worse condition. This adjustment is based on comparing the prior 2-year (2020) projections to observed conditions: the values were within 1% of each other for pavements and within 1.5% of each other for bridges.

## NHS Pavement 2- and 4-year Targets

As a result of this process, ODOT is targeting 59% Good and 3% Poor Interstate pavement lane miles for 2024 and 56% Good and 4% Poor for 2026 (Table 25).

### Table 25: Federal 2- and 4-year Interstate Pavement Targets

| Year | Interstate Pavement | Good | Fair | Poor |
|---|---|---|---|---|
| **2024** | **2 Year Target** | **59.0%** | -- | **3.0%** |
| **2026** | **4 Year Target** | **56.0%** | -- | **4.0%** |

For non-Interstate NHS pavement, ODOT is targeting 41% Good and 5% Poor pavement lane miles for 2024 and 40% Good and 6% Poor for 2026 (Table 26).

### Table 26: Federal 2- and 4-year Non-Interstate NHS Pavement Targets

| Year | Non-Interstate NHS Pavement | Good | Fair | Poor |
|---|---|---|---|---|
| 2024 | 2 Year Target | 41.0% | -- | 5.0% |
| 2026 | 4 Year Target | 40.0% | -- | 6.0% |

## NHS Bridge 2- and 4-year Targets

ODOT is targeting NHS bridge deck area to achieve 43% Good and 3% Poor for 2024 and 40% Good and 5% Poor for 2026 (Table 27).

### Table 27: Federal 2- and 4-year NHS Bridge Targets

| Year | NHS Bridges | Good | Fair | Poor |
|---|---|---|---|---|
| 2024 | 2 Year Target | 43.0% | -- | 3.0% |
| 2026 | 4 Year Target | 40.0% | -- | 5.0% |

## Challenges to Meeting or Exceeding Targets

ODOT has set performance targets based on planned spending; however, future transportation performance is inherently uncertain. ODOT leverages risk management processes (detailed in Chapter 8 **Risk Management**) to help mitigate a variety of known unknowns, be it project delivery delays, extreme weather events, shifting freight patterns, financing, or other hazards. ODOT regularly revisits observed performance to help recalibrate projections and establish more meaningful targets.

CHAPTER 8

# Risk Management

The future is inherently uncertain. Whether it be due to extreme weather, resource availability, modeling accuracy, or other risks, transportation performance outcomes may deviate from forecasts. By blending expert judgment with quantitative analysis, ODOT staff proactively integrate risk management strategies into their daily work to ensure continued progress towards attaining transportation goals.

## INTRODUCTION

Risk management is part of ODOT's culture, permeating through its daily operations and planning efforts. This section focuses on risks specifically related to asset management that could impact attainment of NHS preservation goals. Uncertainty around risk categories including highway safety, external threats, future funding, information and decision making, business and operations, and management risks - including cost or schedule overruns - all have the potential to affect the success of ODOT's asset management actions and strategies. However, ODOT has plans in place to manage and monitor these risks and reduce their potential impact.

This chapter discusses how ODOT identifies, prioritizes, mitigates, and monitors risks related to the TAMP to proactively address uncertainty and minimize potential adverse effects and costs.

## RISK MANAGEMENT APPROACH

Working together, ODOT staff throughout the organization comprehensively assess risk using the best available data. ODOT executives and senior-level staff provide strategic direction and ensure adherence to the following risk-based transportation asset management framework:

- identify & assess risks – collectively brainstorm risks to system performance with asset owners and stakeholders, identify assets with a history of being repeatedly damaged by extreme weather, and assess the likelihood and impact(s) of identified risks;
- evaluate & prioritize risks – evaluate the priority level associated with likelihood and impact;
- manage & mitigate risks – establish management strategies including development of mitigation plans for top priority risks; and
- monitor risks – assign monitoring responsibilities.

## Identifying & Assessing Risks

In an era of increasingly frequent and intense extreme weather, multinational conflicts and a pandemic disrupting the global supply chain, growing cybersecurity threats, and emerging vehicle technologies that may affect future motor fuel tax revenues, risk management is more pertinent than ever to transportation asset management. Within that broader context, ODOT asset managers have identified six core risk categories which have the potential to impact the success of ODOT's asset management objectives and strategies: i) safety, ii) external threats, iii) finances, iv) asset information and decision making, v) business and operations, and vi) projects and programs. The associated risks identified with each category and a corresponding assessment are provided in the following subsections.

### Safety

*Risks*

As ODOT's primary goal, safety considerations are pervasive throughout all transportation programs and operations. As pertaining to asset management, four types of highway safety risks exist: i) crashes necessitate the need for asset repairs (e.g., vehicle/barge collisions with bridge piers), ii) asset improvements inadvertently introduce new safety hazards (e.g., smoother pavements increase vehicle speeds leading to more severe crashes), iii) construction crews are exposed to traffic while delivering asset improvement projects, and iv) asset deterioration necessitates posting load restrictions or closing a facility.

*Assessment*

Beyond the tragic human toll of crashes, safety hazards can impact the state's economy and ODOT's ability to deliver the anticipated benefits of scheduled asset management activities. Design guidelines and policies may also shift over time necessitating new requirements to install safety countermeasures in conjunction with asset management activities and/or requiring adherence to new geometric standards and materials.

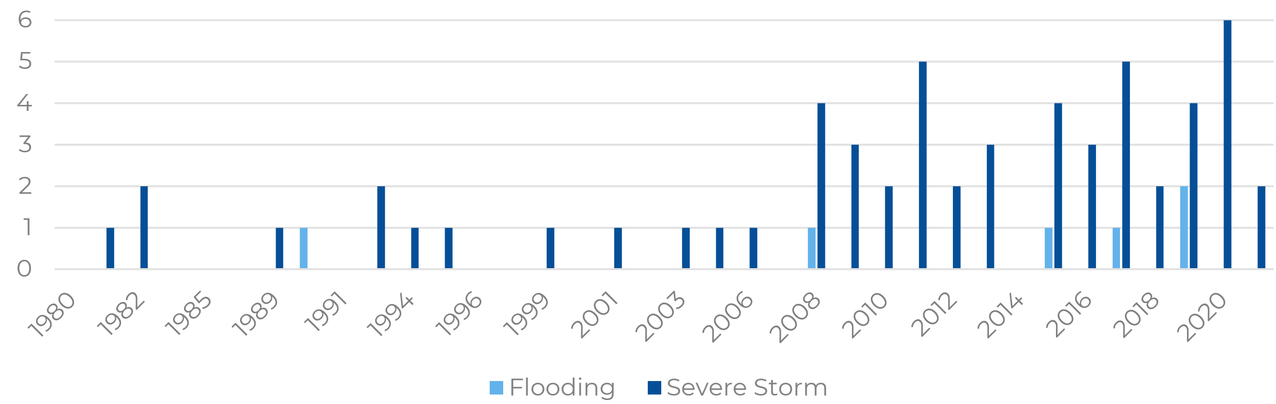
If asset management project selection and delivery processes do not adequately consider safety needs, potential impacts, and requirements, then ODOT risks leaving safety needs unaddressed or having project delivery delayed or interrupted by unexpected safety considerations or requirements.

# External Threats & Resiliency

*Risks*

Oklahoma has experienced increasingly frequent billion-dollar+ extreme weather events over the past decade (Figure 24), and the risk of such events including flooding and tornados is not expected to decrease in the near future.

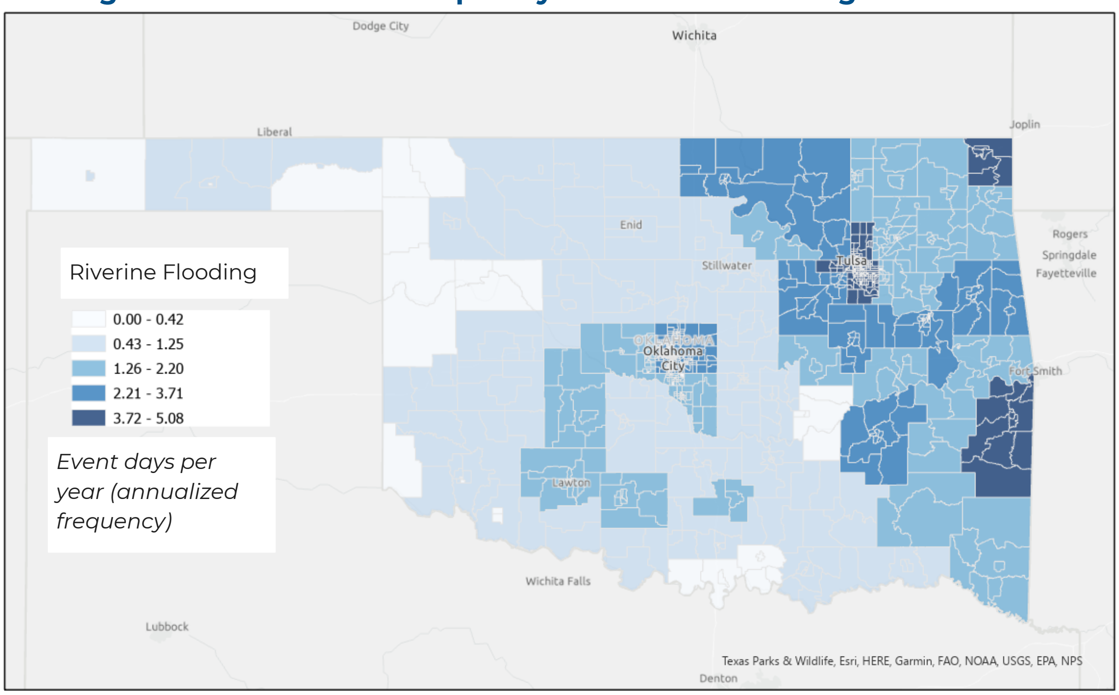
**Figure 24: Billion-Dollar Disaster Events in Oklahoma from Flooding and Severe Storms, 1980 to 2021 (Inflation Adjusted)**




*Source: National Oceanic and Atmospheric Administration (NOAA)*

Historically, different types of extreme weather events happen more frequently in some areas of Oklahoma and thus pose a higher risk to transportation assets in those regions. Central and Eastern Oklahoma experience more frequent flooding events than Western Oklahoma due to the Neosho, Arkansas, Oklahoma, and Canadian Rivers (Figure 25) based on data collected between 1996 and 2019.

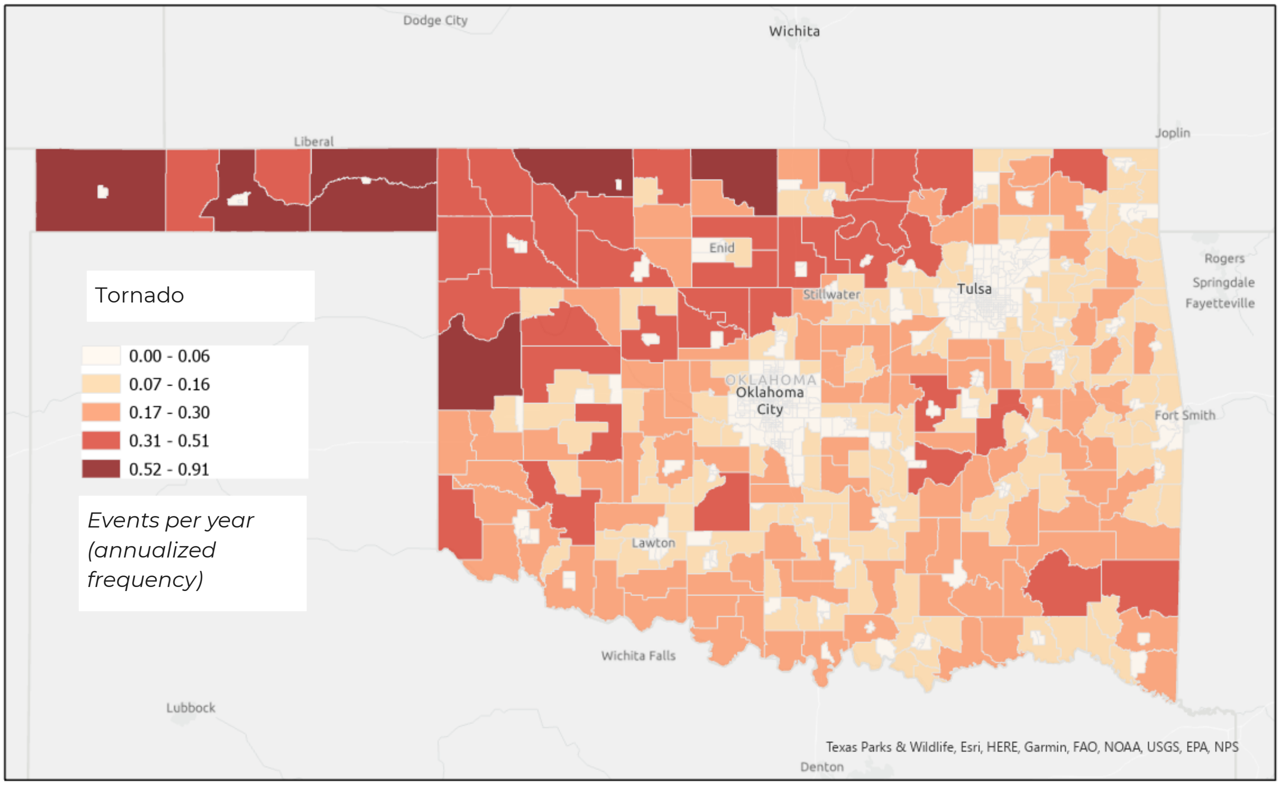
**Figure 25: Annualized Frequency of Riverine Flooding in Oklahoma**




*Source: FEMA National Risk Index*

On the other hand, Western Oklahoma is drier and has historically experienced little riverine flooding; however, the panhandle and northwest Oklahoma have had tornados more frequently than other areas of the state (Figure 26).

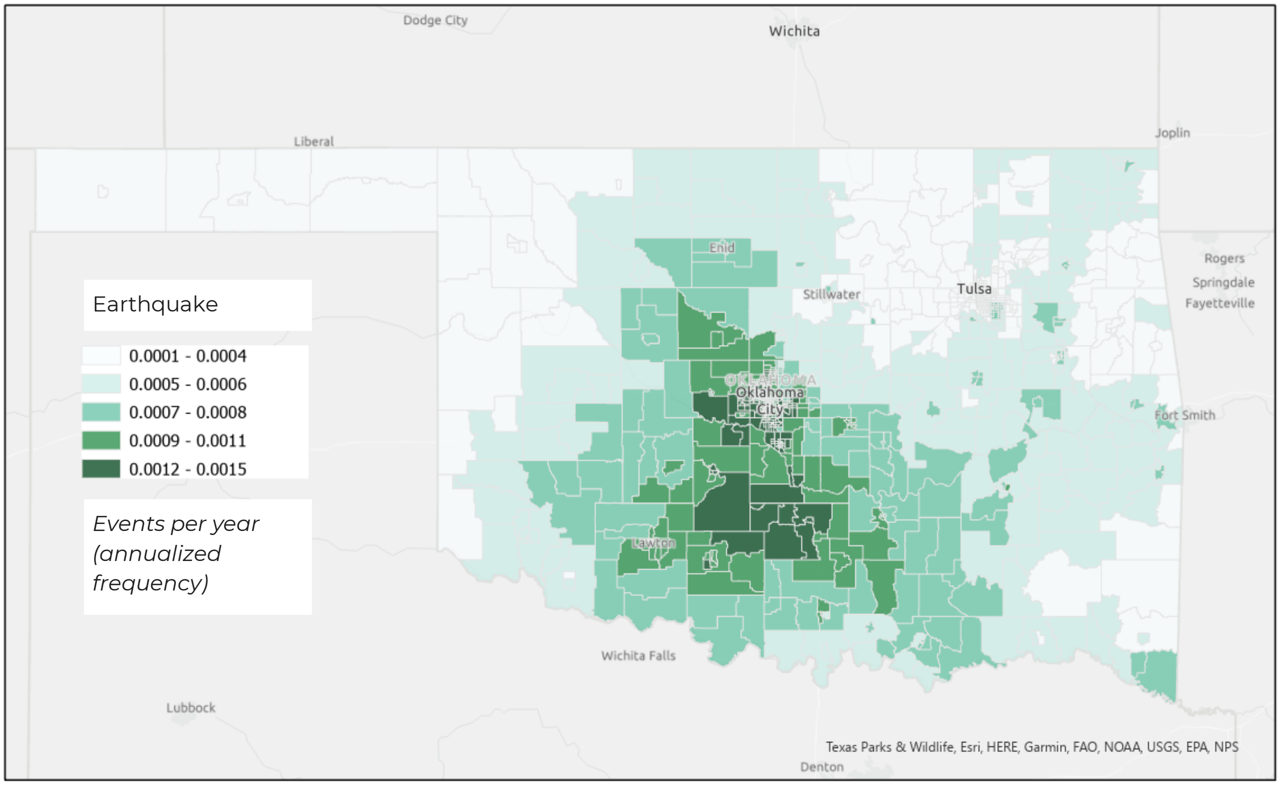
**Figure 26: Annualized Frequency of Tornados in Oklahoma**




*Source: FEMA National Risk Index*

In addition, seismic events are not uncommon in Oklahoma; while the number of seismic events with a magnitude greater than three has declined since a spike in 2016, they still pose a threat to ODOT's transportation assets.  Central Oklahoma, including Oklahoma City, has historically experienced the highest frequency of earthquakes (Figure 27).

### Figure 27: Annualized Frequency of Earthquakes in Oklahoma




*Source: FEMA National Risk Index*

In addition to natural disasters, other external threats such as terrorism or other security threats may cause unexpected damage to highways or bridges.

*Assessment*

If assets are damaged by extreme weather, seismic events, terrorism, or other security events, then ODOT may be required to divert funds from other planned investments to repair the damaged assets.  If funds are diverted from planned asset management projects, ODOT may not be able to achieve its forecasted asset condition targets.  In addition, assets damaged by external events may disrupt the movement of people and goods if redundant routes are not available or assets are not appropriately prioritized for repair.

## Finances

*Risks*

ODOT's long term budget is based on best-available information about future funding sources and revenue streams. However, the anticipated needs of the transportation system exceed the amount of funding that is expected to be available (see Chapter 7, **Performance Gap Assessment**).

Many factors out of ODOT's control can influence the amount of funding that ODOT receives for its programs (see Chapter 5, **Financial Plan** for additional details). For example, economic downturns may impact state and federal tax revenues and legislative decisions, or changes in travel behavior or increases in the amount of electric or hybrid vehicles could reduce fuel tax revenues. Future changes to state and/or federal regulations could result in funds being diverted away from transportation. In addition, cost inflation can reduce the buying power of future ODOT funding or revenue.

*Assessment*

If transportation funding needs are unmet and projects cannot be programmed to address all needs, then the performance or condition of transportation system assets may be negatively impacted. As asset conditions worsen, it becomes more expensive to correct an asset which has deteriorated into Poor condition than to proactively maintain an asset in good condition (see Chapter 4, **Life Cycle Planning**) so overall long-term costs may increase.

## Asset Information and Decision Making

*Risks*

High quality modeling, forecasting and project selection based on accurate and complete asset inventory and condition information is critical to the success of ODOT's asset management activities. Inaccurate or incomplete data could result from insufficient quality controls or data validation processes, outdated technology systems, among other causes. Additionally, the models used in bridge and pavement management systems must be calibrated over time.

In addition to data about ODOT's assets, forecast models must also have accurate and up-to-date assumptions about the factors impacting asset condition, such as the potential for increased damage from flooding or scour events, or increased truck loading.

*Assessment*

If asset management systems have incomplete or poor-quality data about assets and assumptions, or models are not calibrated properly, then ODOT's predictive models may not accurately forecast future conditions. Since ODOT uses future condition forecasts to prioritize and optimize needed asset management work, incomplete or inaccurate data may make it less likely for ODOT to achieve its predicted or planned asset condition improvements.

## Business and Operations

*Risks*

Effective business functions related to workers' safety and health, inventory, purchasing and contracting, and coordination and communication (both internal and external) are key to successfully implementing ODOT's asset management processes. Employees and contractors must be able to complete their work as safely and efficiently as possible, following clearly documented guidelines for safety, inventory control, purchasing and contracting. ODOT's divisions, asset groups, and work units have to effectively coordinate and communicate with each other and external stakeholders. Additionally, information technology systems and ODOT data could be at risk of cybersecurity incidents.

*Assessment*

If existing or new processes are not appropriately documented and communicated to employees or contractors, then ODOT may unintentionally deviate from its plans for worker safety and asset management activities and not be able to complete needed work safely and efficiently. If ODOT does not have a robust system for contract and inventory management, then theft, misuse, or inaccurate data about program costs may become more likely. Also, if internal and external stakeholders are not coordinated, ODOT may miss opportunities to improve efficiency, share important information or insights, or communicate its successes or needs. Finally, cybersecurity breaches of ODOT's technology systems could put critical information at risk of corruption.

## Projects and Programs

*Risks*

Selecting the 'right' project and delivering that project at 'right' time is imperative to maximizing the benefits of asset management projects. Scoped improvements have a limited window of viability lest a more intensive – and costly - treatment be necessitated due to delay. In addition to schedule delays, there is a risk of cost overruns due to unanticipated site conditions and increases in material prices due to inflation or other supply chain issues. On the programmatic side, risks include future revenue availability for asset treatments and sufficient contractor availability to deliver all scoped projects.

*Assessment*

If projects or programs experience cost/ time overruns or funding changes or restrictions, then ODOT may not be able to complete its asset management work on time or within expected costs, which could impact its ability to achieve asset condition targets within the specified time frame. In addition, restrictive designated funding can limit ODOT's flexibility to address needs optimally within existing programs. Inconsistent program sizes can further exacerbate the ability of contractors to prepare resources for bidding on and completing additional projects so as to realize anticipated performance improvements from asset treatments.

## Evaluating & Prioritizing Risks

ODOT has evaluated its identified risk categories by likelihood and impact, as shown in the risk matrix shown in Figure 28 to identify priority risks.

**Figure 28: Transportation Asset Management Risk Matrix**

**Likelihood**

| Impact | | 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 |
| **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 |

Finances were evaluated to be high risk priority, followed by highway safety, external threats, information and decision making, and projects and programs as medium risk priority. Business and operations risks were evaluated to be low risk priority (Figure 29).

**Figure 29: Prioritized Risk Categories**

| High | Medium | | | | Low |
|---|---|---|---|---|---|
| Finances | Highway Safety | External Threats | Information & Decision Making | Projects and Programs | Business & Operations |

## Managing Risks

ODOT leverages policies, programs, partnerships, data, and technology to manage the risks directly related to asset management performance and increase the likelihood that ODOT will achieve its asset management targets and objectives.

### Safety

Safety is ODOT's primary priority; therefore, ODOT has developed a safety-focused asset management program which proactively applies asset management techniques to ensure the safe operation of highway and bridge assets. This includes a network screening for safety hotspots for consideration within asset management, rehabilitation, or upgrade programs; posting bridges for load; ensuring proper skid resistance on road surfaces; and corrective actions as necessary to maintain assets' structural integrity. ODOT is also identifying priority corridors which may require more conservative design models. ODOT also considers safety-related benefits and costs as part of asset management decisions and project prioritization, and coordinates with safety analysts to identify and include appropriate safety countermeasures in asset management projects in the project development stage. To address risks related to vehicle or barge hits, ODOT is revising design standards including raised bridges and drilled shafts, as well as pursuing insurance reimbursement. In addition, ODOT evaluates new or equal products related to safety by assessing the likelihood and consequences of product failure, and by proposing conditional use demonstration or experimental projects for monitoring and evaluation. Finally, at the department level, ODOT is modernizing its crash data collection and analytics systems.

### External Threats & Resiliency

To reduce the impact of the risks posed by external environmental threats, ODOT has incorporated the potential impacts of environmental conditions and extreme weather into its long-term planning by assessing external risks to existing assets and developing infrastructure inspection, replacement and retrofit programs to mitigate identified risks. ODOT also has processes to incorporate resiliency into its design standards and can identify and validate redundant routes or detours using GIS software when identifying candidate projects.

When specific external threats occur, ODOT has identified several strategies to respond quickly and efficiently to restore reliable movement of goods and people. For example, ODOT utilizes ShakeMap Broadcast (ShakeCast) to prioritize its response to earthquakes or other seismic events in Oklahoma. In the event of seismic activity, ShakeCast automatically retrieves a ShakeMap from the U.S. Geological Survey (USGS) server and compares the measured shaking intensity against bridge fragility curves which estimate the probability of "exceeding a given damage state as a function of the ground-motion intensity." Within 20 minutes after a seismic event, ShakeCast alerts each of ODOT's District Response Lead and other designated personnel to each event's potential damage to state-owned bridges categorized as slight, moderate, extensive, or complete damage.

ODOT uses ShakeCast data to prioritize bridge inspections after seismic events, identify if additional inspection crews are required, and prioritize asset repairs. The primary goal of inspections is to evaluate the actual extent of damage to bridges and determine whether a bridge is safe and functional.

While Oklahoma has no locations of repeated emergency declaration, it does experience flooding somewhat regularly due to its geology, watersheds, and weather conditions. ODOT has a variety of policies, strategies, and practices in place to design assets with flooding in mind, monitor at-risk structures, ensure traveler safety and access during flooding events, inspect structures after flooding, repair or reconstruct damaged assets, and prepare for potential large-scale events.

ODOT has design standards to build resilient bridges; for example, drilled shafts with minimum elevations below the rock layer to maintain structural stability, and girders designed to maintain bridge alignment when floodwater puts pressure on the side of the bridge. In addition, ODOT designs appropriate roadways near bridges to include dips ("fuse plugs") in approach road or embankment to redirect floodwater to controlled locations before it overtops the bridge during flood events above design standards.

ODOT regularly inspects its bridges to monitor their condition and identify potential resiliency issues. ODOT conducts traditional "bridge and box" inspections every two years and performs underwater bridge inspections on a five-year cycle. Field Divisions are responsible for addressing issues such as debris buildup.

ODOT identifies which assets are most vulnerable to flooding impacts such as overtopping. When extreme weather or flooding is predicted, ODOT works with the U.S. Army Corps of Engineers (USACE) to identify and preemptively close locations where overtopping is likely to occur. ODOT alerts travelers to road closures and detours or redundant routes before the flood event and coordinates with evacuation routes, if necessary. Locations that are frequently closed due to flooding or designed overtopping are well-known to Field District Engineers, who are prepared to alert travelers with permanent signs and detours on redundant routes. Monitoring flooding locations and pre-emptively directing travelers to redundant detour routes helps ensure traveler safety during flood events.

After storm and flooding events, ODOT reviews how well assets performed in terms of resiliency and analyzes whether standards or processes should be updated in response to similar events.

Finally, ODOT works with partners including USACE to participate in Risk Mock Drills to prepare for other extreme yet infrequent events such as earthen dam failures.

In addition, ODOT participates in operational and emergency response programs designed to react and recover from vehicle accidents or terrorism events.

## Finances

ODOT works with the Oklahoma legislature to communicate the impact of potential changes in state revenues and has been developing dashboards to facilitate communications with the public and elected officials. To reduce the amount of uncertainty in future funding and finances, ODOT leverages programs which forecast changes in revenue and costs, and which optimize the impact of available funds for asset management. In addition, ODOT is exploring innovative financing opportunities for asset management programs.

## Information And Decision Making

ODOT and its contractors document and use robust quality control procedures for inspection programs to collect and validate asset inventory and condition data (see Chapter 4, **Life Cycle Planning** for details on data collection and management). In addition, ODOT periodically reviews and updates model assumptions, such as estimates of truck loading and flooding or scour events. ODOT utilizes a scour flag in its bridge management system which downgrades condition based on scour criticality. ODOT also uses USGS data related to historical flood levels to assess flood risk and identify appropriate design minimums for each project depending on cost and availability or robustness of detours. Finally, ODOT has specified intervention levels for asset management to ensure the appropriate treatments are applied at the right time to optimize costs and benefits. ODOT also uses cross-discipline information to continually improve its data-driven project selection processes based on comprehensive needs, which helps ensure that ODOT selects the appropriate projects to meet its objectives and targets.

To mitigate cybersecurity risks, ODOT uses enterprise data management programs, strategies, and IT solutions which emphasize risk prevention, preparedness, and recovery.

## Business And Operations

ODOT has established a "safety first" culture by holding routine safety meetings, documenting safety and standard operating procedures, and providing workforce and work site safety training.

ODOT also uses robust systems and tools to manage its workforce, equipment, inventory, and contracts. These programs reduce the risks of misuse, theft, unnecessary storage costs, all of which can lead to inaccurate estimates of program costs. ODOT is also reviewing and updating its internal business systems to increase efficiency.

## Projects And Programs

Project and program management are addressed through a variety of existing systems and processes, including contingencies built into project costs and project bundling. E-construction systems are also being updated and combined with paperless processes and management practices to improve the efficiency of project delivery. ODOT also applies realistic interest rate assumptions to its programs. In addition, ODOT is developing project status dashboards to transparently share project-related information.

### Monitoring Top Priority Risks

Risk management at ODOT is an enterprise-wide effort leveraging the unique knowledge and capabilities of diverse staff. Risk monitoring assignments are made based on each unit's subject matter expertise, as detailed in the following summary of staff responsibilities.

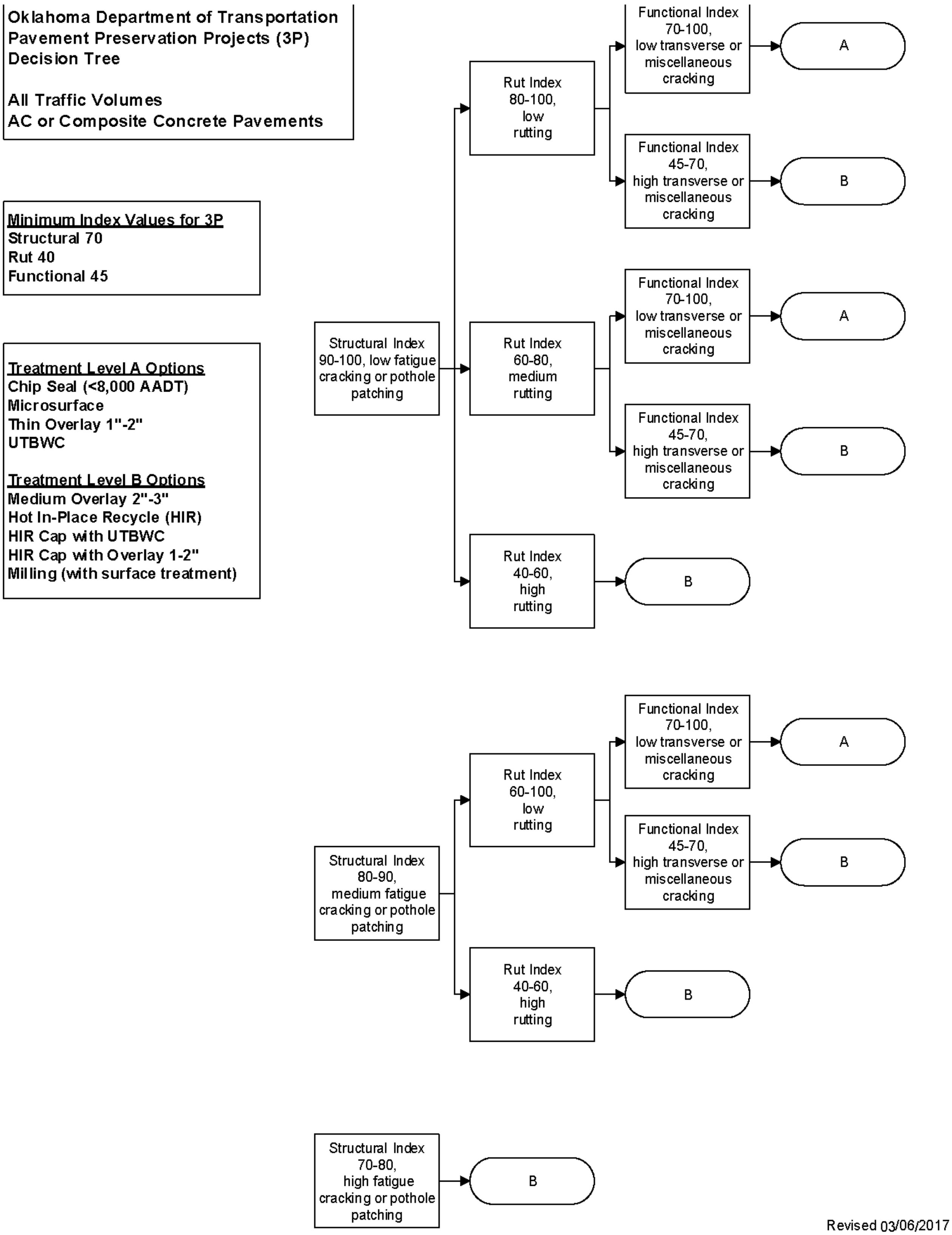
- Executive Leadership and management responsible for monitoring outreach, communication, and education efforts regarding regulatory changes and how they might change how funding is allocated within ODOT operations.
- The Oklahoma Transportation Cabinet created a Cabinet Level Strategic Communications team to communicate to stakeholders about the value of asset management to communicate the implications of funding being diverted to other uses. These staff will also educate the public about the financial consequences of vehicles hitting bridges, working to reduce the financial impacts of those collisions.
- Executive Leadership, financial leaders, and field districts 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 strengthen their relationships with other state offices (e.g., Office of Management and Enterprise Services) and with 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

Coinciding with risk monitoring activities, ODOT assigns special coding to FHWA Emergency Relief (ER) projects in effort to maintain a list of facilities that have been repaired and reconstructed due to a federally declared disaster event. ODOT and FHWA work together in tracking these federally declared disaster events while inspecting and addressing any site on the National Highway System that meet the criteria set forth in 23 CFR 667. For locations on the SHS and NHS, ODOT tracks (ER) projects performed on state-controlled facilities. Since 2008, ODOT has had no sites on the NHS that have repeatedly met the criteria to be reported for 23 CFR 667 as a result of a federally declared disaster event.

# Appendix A


Oklahoma Department of Transportation
Pavement Preservation Projects (3P)
Decision Tree
All Traffic Volumes
AC or Composite Concrete Pavements
Minimum Index Values for 3P
Structural 70
Rut 40
Functional 45
Treatment Level A Options
Chip Seal (<8,000 AADT)
Microsurface
Thin Overlay 1"-2"
UTBWC
Treatment Level B Options
Medium Overlay 2"-3"
Hot In-Place Recycle (HIR)
HIR Cap with UTBWC
HIR Cap with Overlay 1-2"
Milling (with surface treatment)
Structural Index 90-100, low fatigue cracking or pothole patching
Rut Index 80-100, low rutting
Functional Index 70-100, low transverse or miscellaneous cracking
A
Functional Index 45-70, high transverse or miscellaneous cracking
B
Rut Index 60-80, medium rutting
Functional Index 70-100, low transverse or miscellaneous cracking
A
Functional Index 45-70, high transverse or miscellaneous cracking
B
Rut Index 40-60, high rutting
B
Structural Index 80-90, medium fatigue cracking or pothole patching
Rut Index 60-100, low rutting
Functional Index 70-100, low transverse or miscellaneous cracking
A
Functional Index 45-70, high transverse or miscellaneous cracking
B
Rut Index 40-60, high rutting
B
Structural Index 70-80, high fatigue cracking or pothole patching
B
Revised 03/06/2017

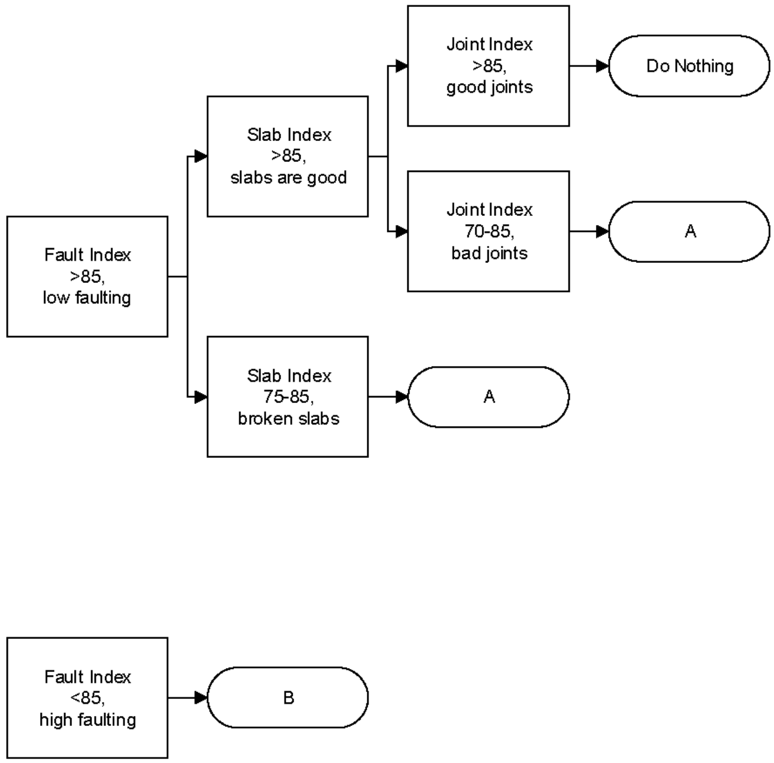
**Oklahoma Department of Transportation**
**Pavement Preservation Projects (3P)**
**Decision Tree**

**All Traffic Volumes**
**Jointed Concrete Pavements**

**Min. Index Values for 3P**
**Slab 75**
**Joint 70**

**Treatment Level A Options**
**Patching**

**Treatment Level B Options**
**Patching**
**Dowel Bar Retrofit**
**Diamond Grinding**




Revised 03/6/2017

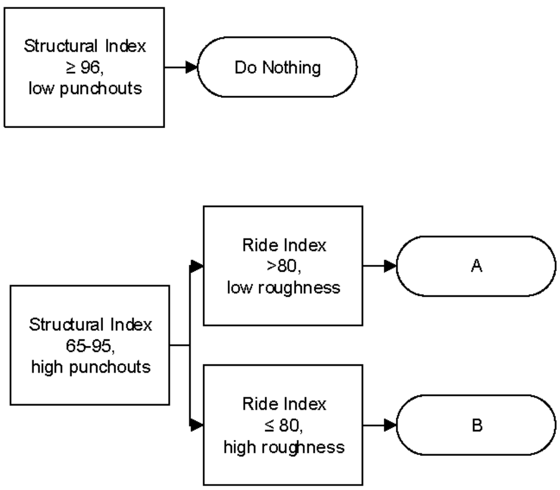
**Oklahoma Department of Transportation**
**Pavement Preservation Projects (3P)**
**Decision Tree**

**All Traffic Volumes**
**Continually Reinforced Concrete Pavements**

**Min. Index Values for 3P**
**Structural 65**

**Treatment Level A Options**
**Full-Depth Punchout Repair**

**Treatment Level B Options**
**Full-Depth Punchout Repair**
**Diamond Grinding**




Revised 03/06/2017