MoDOT’s National Highway System Transportation Asset Management Plan

April 2018
Missouri’s transportation system is a tremendous asset. Built by our parents and grandparents and funded by $55 billion in user fees (it has a $125 billion replacement value today), it is the nation’s seventh largest state highway system – a system that is larger than neighboring states Kansas and Illinois combined.

Missouri’s transportation system plays a vital part in the lives of its citizens. It is counted on to safely and reliably connect people with family, jobs and services, businesses with suppliers and customers, students with schools and visitors with destinations.

Missourians have consistently told us that maintaining our transportation assets is their highest priority, and the Missouri Department of Transportation (MoDOT) has a well-established history of maintaining our highways and bridges. Recently we were ranked ninth in the nation in highway performance and cost-effectiveness in the Reason Foundation’s 23rd Annual Highway Report.

We are steadily losing ground on our number of poor bridges with the count approaching 900. Some progress has been made on reducing the number of weight restricted bridges; however there are still over 1,200 structures with a restriction.

We are committed to providing a state transportation system that is safe, efficient and reliable. Our emphasis on preservation and maintenance is a major part of that commitment.

Missouri consistently makes sound investment decisions to protect our transportation system. Good use of analytical tools and formal policies allow the state to support investment decisions and try to meet targets for performance and infrastructure condition.

Our Transportation Asset Management Plan establishes the formal approaches to meeting evolving federal guidance with respect to National Highway System pavements and bridges. The plan demonstrates the clear linkages between maintenance and planning efforts and documents our financial planning, risk management, inspection and budgeting processes in a clear manner. This plan will also assist our agency in making the right decisions about where and when to invest funds in infrastructure improvements to sustain the system we have invested in over the years. Maintaining a state of good repair over the life cycle of the assets at a minimum practicable cost is good business practice, helping our state attract new investment and economic growth.

This Transportation Asset Management Plan also identifies potential risks our agency faces related to pavement and bridge condition and how to prevent or mitigate these risks. Doing so will help to allow us to meet our performance targets for years to come.

Working together, we can ensure the department provides a safe transportation system that ensures the mobility of people and goods, enhances economic prosperity and preserves the quality of our environment and communities.

Sincerely,

Patrick K. McKenna
MoDOT Director
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Introduction

Transportation asset management is a strategic framework for making cost-effective decisions about allocating resources and managing infrastructure. It is based on a process of monitoring the physical condition of assets, predicting deterioration over time and providing information on how to invest in order to maintain or enhance the performance of assets over their useful life. MoDOT’s Transportation Asset Management Plan is a crucial element in achieving MoDOT’s strategic goal of keeping roads and bridges in good condition. The TAMP ensures MoDOT is using taxpayer money wisely by:

- Minimizing life cycle costs,
- Maximizing system performance,
- Supporting an objective decision making process, and
- Balancing public expectations with limited funding to create a sustainable plan.

An initial plan was developed by department asset experts and planning statisticians based on statewide cost and life-cycles assumptions. That plan was shared with regional staff to adjust those assumptions to actual regional costs and life cycles. Refining and adjusting the TAMP will be a continuous process.

Purpose

MoDOT has adopted a transportation asset management approach to make the best decisions with transportation investments. The TAMP also keeps the department in compliance with the requirements put forth in the federal surface transportation act, known as the Fixing America’s Surface Transportation Act or the FAST Act. The details of those requirements can be found in the appendix of this document.

Background

The Missouri Department of Transportation is focused on preserving Missouri’s state highways and bridges so they are safe and reliable today and for future generations. This is a daunting task as Missouri has the seventh largest state highway system in the nation totaling 33,856 miles. The state highway system, which includes 10,403 bridges, is critical to Missouri’s economic competitiveness and quality of life.
Successful management of the state highway system relies on sound investment planning that considers constituent input, engineering needs and fiscal constraints. MoDOT’s inaugural transportation asset management plan provides direction for preserving this essential transportation system.

MoDOT has a bi-partisan, six member commission that is appointed by the state’s governor, but acts independently to provide overall direction and oversight to department leadership.

MoDOT created a performance management system in 2005 that has become a national model. Numerous performance measures are organized around seven Tangible Results Missouri citizens expect from its department of transportation. These results were established based on customer surveys and the department’s long-range planning outreach efforts:

- Keep Customers and Ourselves Safe
- Keep Roads and Bridges in Good Condition
- Provide Outstanding Customer Service
- Deliver Transportation Solutions of Great Value
- Operate a Reliable and Convenient Transportation System
- Use Resources Wisely
- Advance Economic Development

MoDOT also tracks its progress through completion of its annual Statewide Transportation Improvement Program (STIP) and other operational plans for individual functions and initiatives.

**Goals and Objectives**

The department’s asset management plan has been designed to align with MoDOT’s Tangible Results. Its objective is keep the state’s transportation assets in a state of good repair over the life cycle of those assets at the most practical cost. Specific organizational measures tied to this plan can be found in Chapter 2 of this asset management plan. Missourians continue to place the highest priorities on structurally sound bridges and smooth roads, as does this plan.
Chapter 1: Asset Inventory and Condition

Missouri’s state highway system includes 33,856 centerline miles of roads and 10,403 bridges. The system is divided into four roadway categories, each of which has its own unique characteristics regarding size, condition and use:
1) Interstates
2) Non-Interstate NHS Routes (Major Routes)
3) Minor routes
4) Low volume routes (less than 400 vehicles per day).

The National Highway System (NHS) includes the Interstate Highway System as well as other roads important to the nation’s economy, defense and mobility. The NHS was developed by the Department of Transportation (DOT) in cooperation with the states, local officials and metropolitan planning organizations (MPOs). The interstates and major routes make up Missouri’s portion of the NHS.

The final rule in 23 CFR 515 states “a state DOT shall develop a risk-based asset management plan that describes how the NHS will be managed to achieve system performance effectiveness and State DOT targets for asset condition.” The final rule also states “An asset management plan shall include, at a minimum, a summary listing of NHS pavement and bridge assets, regardless of ownership.”

This asset management plan will focus only on the NHS, which are the interstates and major routes. Of the 33,856 centerline miles of Missouri’s state highway system, 1,380 miles are classified as interstates, and 4,137 miles are major routes. In addition to the state highway system’s interstate and major routes, the local system in Missouri also accounts for 265 miles of the NHS. Missouri’s is comprised of 5,782 NHS miles with 95 percent of it being on the state system.

Ownership of the NHS System

- State NHS
- Local NHS

5517 miles

265 miles
System at a Glance
Pavements

MoDOT administers a transportation management system (TMS) to store pavement and bridge asset data, which includes a location referencing system, condition data and videos. Pavement data for all state owned NHS routes and locally owned NHS routes are collected annually. MoDOT uses an Automatic Road Analyzer (ARAN) vehicle (inset photo) to collect the pavement condition data and video of each route. This information is critical to managing MoDOT’s pavement and bridge assets. A screenshot of the ARAN viewer software is shown below.

MoDOT has historically analyzed pavement data and tracked progress of pavement by smoothness. Smoothness is measured by international roughness index (IRI), the lower the IRI, the smoother the road. Shown below are the MoDOT rating categories for NHS pavements for smoothness:

**NHS Pavement Smoothness Condition Categories**

<table>
<thead>
<tr>
<th>IRI Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRI &lt;100</td>
<td>Good Condition</td>
</tr>
<tr>
<td>IRI &gt; 100</td>
<td>Not Good Condition</td>
</tr>
</tbody>
</table>

The *interstate system*, (e.g., I-70, I-44, I-55) currently has 93 percent of the miles in good condition for smoothness. **Major routes** (e.g., U.S. 36, U.S. 50, U.S. 60 and U.S. 63) currently have
90 percent of the miles in good condition for smoothness. **Total NHS System** currently has 91 percent of the miles in good condition for smoothness.

On May 20, 2017 the Federal Highway Administration (FHWA) released the final rule establishing performance measures for State DOTs and MPOs to assess the condition of pavements on the NHS. The performance measures will report good and poor condition based upon the metric thresholds identified in the final rule as depicted below. To be considered “good” the pavement must rate good in all categories. To be considered “poor” the pavement must rate poor in at least two categories. All other combinations of ratings are considered “fair”.

<table>
<thead>
<tr>
<th>Metric Thresholds for Pavement Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rating</strong></td>
</tr>
<tr>
<td>IRI (inches/mile)</td>
</tr>
<tr>
<td>PSR* (0.0-5.0 value)</td>
</tr>
<tr>
<td>Cracking Percent (%)</td>
</tr>
<tr>
<td>Rutting (inches)</td>
</tr>
<tr>
<td>Faulting (inches)</td>
</tr>
</tbody>
</table>

*Present Serviceability Rating (PSR) may be used only on routes with posted speed limit <40mph.

** CRCP – Continuous Reinforced Concrete Pavement

Beginning in calendar year 2017, MoDOT began collecting additional pavement data in order to be in compliance with the FHWA final rule for managing pavement condition. The data collected for all NHS routes in 2017 included data for rutting, cracking and faulting in addition to the IRI data MoDOT historically collected. With the new data, MoDOT will be able to rate and analyze pavement not only on smoothness but also on the structural integrity of the pavement.

After analyzing the NHS system in Missouri based on the metrics identified by FHWA in the final rule, the following conditions resulted.

<table>
<thead>
<tr>
<th>Current Condition of Missouri NHS Routes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>State Owned</strong></td>
</tr>
<tr>
<td>% of Interstate in Good Condition</td>
</tr>
<tr>
<td>% of Interstate in Poor Condition</td>
</tr>
<tr>
<td>% of Non-Interstate NHS Pavements in Good Condition</td>
</tr>
<tr>
<td>% of Non-Interstate NHS Pavements in Poor Condition</td>
</tr>
</tbody>
</table>

For further information on the performance measures and targets for Missouri’s NHS Routes, see Chapter 2 of this asset management plan.
Bridges

Missouri’s NHS system includes 3,643 bridges which can be categorized as either a major bridge or typical bridge. A major bridge is any bridge that has a length greater than 1,000 feet, while a typical bridge has a length less than 1,000 feet. Missouri’s state system includes 207 major bridges and 7,043 typical bridges. Of these totals, Missouri has 166 major bridges on the NHS and 3,477 typical bridges on the NHS, for a total of 3,643 bridges on the NHS.

<table>
<thead>
<tr>
<th>Number of NHS Bridges (Source: 2016 NBI Data)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Major</td>
</tr>
<tr>
<td>State Owned</td>
</tr>
<tr>
<td>165</td>
</tr>
<tr>
<td>Locally Owned</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>166</td>
</tr>
<tr>
<td>Typical</td>
</tr>
<tr>
<td>State Owned</td>
</tr>
<tr>
<td>3,392</td>
</tr>
<tr>
<td>Locally Owned</td>
</tr>
<tr>
<td>85</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>3,477</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Square Foot of Bridge Deck on NHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
</tr>
<tr>
<td>State Owned</td>
</tr>
<tr>
<td>20,162,605</td>
</tr>
<tr>
<td>Locally Owned</td>
</tr>
<tr>
<td>113,520</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>20,276,125</td>
</tr>
<tr>
<td>Typical</td>
</tr>
<tr>
<td>State Owned</td>
</tr>
<tr>
<td>33,771,566</td>
</tr>
<tr>
<td>Locally Owned</td>
</tr>
<tr>
<td>979,617</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>34,751,183</td>
</tr>
</tbody>
</table>

The average length of an NHS major bridge in Missouri is 2,235 feet, over ten times the length of a typical bridge, which averages 205 feet. In total, the length of Missouri’s span-type bridges on the NHS is over one million feet.

All bridges are inspected regularly in accordance with federal law, typically every two years. If a bridge has known problems, it is inspected more frequently. According to the National Bridge Inspection Standards (NBIS), condition ratings are used to describe an existing bridge or culvert compared with its condition if it were new. The ratings are based on the materials, physical condition of the deck (riding surface), the superstructure (supports immediately beneath the driving surface) and the substructures (foundation and supporting posts and piers).

A condition rating is assigned for the bridge’s deck, superstructure and substructure. The lowest rating of the three components is considered the bridge rating.

The rating scale is:

- **9** – Excellent
- **8** – Very Good
- **7** – Good
- **6** – Satisfactory
- **5** – Fair
- **3 or 4** – Poor
- **2 or less** – Closed

<table>
<thead>
<tr>
<th>NBIS</th>
<th>Thresholds for Bridge Condition</th>
<th>Number of NHS Bridges</th>
<th>Square Foot of Bridge Deck on NHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td></td>
<td>1407</td>
<td>19,794,713</td>
</tr>
<tr>
<td>8</td>
<td>Good</td>
<td>2087</td>
<td>31,260,698</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>149</td>
<td>3,971,898</td>
</tr>
<tr>
<td>6</td>
<td>Fair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Poor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>3,643</td>
<td>55,027,309</td>
</tr>
</tbody>
</table>

For further information on the performance measures and targets for Missouri’s NHS Bridges, see Chapter 2 of this asset management plan.
Chapter 2: Performance Measures & Targets

The final rule in 23 CFR 515 states that “a state DOT shall develop a risk-based asset management plan that describes how the NHS will be managed to achieve system performance effectiveness and State DOT targets for asset condition...” This rule targets the performance of the NHS infrastructure of pavements and bridges. Chapter 1 of this Asset Management Plan outlines the current inventory and condition of Missouri’s NHS infrastructure and how the data is collected.

The performance measures for road and bridge condition are:
1) Percent Poor Interstate Pavement
2) Percent Good Interstate Pavement
3) Percent Poor Non-Interstate NHS Pavement
4) Percent Good Non-Interstate NHS Pavement
5) Percent of Good Deck Area on NHS
6) Percent of Poor Deck Area on NHS

Pavements

Historical performance of the NHS pavements has been monitored by the smoothness of the pavement. Chapter 1 of this Asset Management Plan explains how MoDOT captures and reports the data for smoothness. The historical information provided in the charts below is strictly based on smoothness data known as IRI. In 2017 MoDOT began to capture and report on smoothness and rutting, cracking and faulting. For all four pavement targets the goal is to maintain current conditions and the state of good repair.
Bridges
Bridges condition is monitored through routine inspections. The inspection rating information is outlined in Chapter 1 of this asset management plan. The historical information provided in the charts below is based on past inspection data. Moving forward there will be no change in the way MoDOT captures bridge information as the national performance measures use the same process of capturing bridge data.

The future bridge targets for percent poor deck area on the NHS were set at the current percent poor to maintain current conditions and the state of good repair. This target remains below the
FHWA ten percent penalty threshold. The bridge targets for percent good deck area on the NHS were established based on five years of historical data. The future targets are based on the declining trend in the short term and stay flat for future years to maintain the state of good repair.
Overall Performance

The targets established for both NHS pavements and NHS bridges can be achieved with the current baseline revenue dollars shown in Chapter 4 of this asset management plan. Therefore, the targets are considered fiscally constrained without a performance gap. Asset management costs in Missouri address non-NHS pavements and bridges as depicted in Chapter 4.

In future years, additional data will become available for rutting, cracking and faulting. The performance targets will be re-evaluated over time as more trend information becomes available.
Chapter 3: Lifecycle Planning

Ideally every mile of pavement and every bridge in the state would be in good condition. Unfortunately, funding is not available to improve and maintain Missouri’s entire transportation system in good condition, so priorities must be established. Significant investments have been made to improve pavement and bridge conditions over the last decade.

A previous significant investment known as The Smooth Roads Initiative (SRI) improved 2,200 miles of Missouri’s most heavily traveled roads. This program was completed in late 2006 and was mostly comprised of very thin resurfacing treatments to improve the smoothness of the pavement. Missouri’s system went from approximately 45 percent good pavements to 85 percent good pavements with this initiative and other strategic investments. The goal is to maintain these improved smooth surfaces. As you can see from the chart above, when road smoothness increases so does customer satisfaction.

The underlying goal of MoDOT’s asset management plan is to maintain the current condition of pavements and bridges (e.g. maintain the current state of good repair). The most cost effective method to preserve pavements and bridges is to use preventive maintenance treatments while the assets are still in good/fair condition. The chart on the next page shows the basic strategy for MoDOT’s TAMP – focused on less expensive preservation treatments more often than expensive rehabilitation and reconstruction treatments less often. The objective is to slow down the rate of deterioration and provide a smooth, durable and safe roadway for users at the lowest cost.

Smooth Roads = Happy Customers

MoDOT Customer Satisfaction
NHS Roads in Good Condition

A previous significant investment known as The Smooth Roads Initiative (SRI) improved 2,200 miles of Missouri’s most heavily traveled roads. This program was completed in late 2006 and was mostly comprised of very thin resurfacing treatments to improve the smoothness of the pavement. Missouri’s system went from approximately 45 percent good pavements to 85 percent good pavements with this initiative and other strategic investments. The goal is to maintain these improved smooth surfaces. As you can see from the chart above, when road smoothness increases so does customer satisfaction.

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Lifecycle planning should not be confused with life cycle cost analysis (LCCA). LCCA is performed at the project level and compares specific treatment options against each other, for example, concrete vs. asphalt on a pavement project. Lifecycle planning is performed at the network level where the needs of all roads and structures within that particular network are considered.

**Pavements**

Keeping good roads in good condition is the basic premise of MoDOT’s TAMP. The pavement treatment costs for this approach are slightly different for interstates and non-interstate NHS routes. Predicting the future costs to keep roadways in good condition involves estimating the type of treatment work needed for each roadway category, when those treatments will be needed and how long those treatments will be effective. The effective life of pavement is most commonly impacted by the traffic volume, preventive maintenance activities, ground support and quality of the materials used in the pavement. For example, interstate routes require a more expensive, heavy-duty pavement to withstand higher traffic volumes and truck traffic.

MoDOT’s approach to pavement preservation is applying a thin, preventive maintenance treatment on a routine cycle. This is the most cost effective way to keep the roads in good condition for the traveling public and preserve the investments made over the last decade. In rare instances, pavements will need a full depth replacement, but properly designed and maintained pavements should only require a preventive maintenance treatment to extend its full life. In addition to the cyclical preventive maintenance treatments, other preventive maintenance treatments such as crack sealing and pavement repairs are performed to further extend the pavements useful life.

The following charts provide the treatment assumptions, treatment life and average cost for interstate and non-interstate NHS roadway categories. These charts are the average of all seven MoDOT districts and represent a statewide average pavement treatment and associated cost.

The estimated preventive maintenance cost for **interstate routes** is $110,900 per lane mile. The average treatment cycle for this investment is eight years. These estimates are based on the following treatments: 70 percent 1¾” stone mastic asphalt (SMA), 20 percent 3¾” SMA and 10 percent a combination of unbonded asphalt wearing surface (UBAWS) and diamond grinding.
The estimated preventive maintenance cost for non-interstate NHS routes is $86,300 per lane mile. The average treatment cycle for this investment is nine years. These estimates are based on the following treatments: 70 percent 1¾” superpave asphalt, 10 percent 3¾” superpave asphalt, 10 percent 2¾” superpave asphalt and 10 percent a combination of UBAWS and diamond grinding.
Pavement Lifecycle and Performance Measures

As described in Chapter 2, MoDOT’s pavement performance goal is to sustain the state of good repair by maintaining current conditions. The lifecycle of each pavement treatment was derived by analyzing several past investments used throughout the state and at several locations. In particular the previous investments explained earlier in this chapter used an asset management approach of applying a thin lift of pavement to preserve the underlying structure. This program yielded data that supports the eight year lifecycle on Missouri’s NHS routes.

Bridges

Since Missouri has a large number of poor condition bridges, as outlined in Chapter 1, a preventive maintenance approach alone will not be sufficient to maintain current conditions. A combination of a preventive maintenance approach to prolong the useful life of Missouri’s existing bridges and an aggressive bridge repair/replacement program is needed to maintain current bridge conditions.

Bridge Preventive Maintenance

MoDOT also performs preventive maintenance activities for bridges. These activities are crucial to providing the lowest lifecycle costs and include:

- Bridge cleaning and flushing to remove dirt and debris and to allow proper drainage and drying of the deck. The dirt and debris holds moisture and chlorides that cause deterioration. Deck flushing is done in the fall and spring with a thorough cleaning of entire bridge done in the spring following snow season and again in the fall prior to snow season. This cleaning includes the bridge deck, piers, abutments and lower chords of truss bridges. The goal is to flush all bridges each year.
- Bridge joint and deck sealing is done to prevent dirt, debris and chlorides from deteriorating the deck and supporting bridge members. Sealing activities are performed on a cyclic basis as well as condition basis.
- Spot painting of bearings and pilings is done to protect from rusting and is performed on an as-needed basis.

Typical Bridges on the NHS—Bridge Work

For the 3,477 typical bridges on the NHS in Missouri, MoDOT will do a combination of replacements, redecks, rehabilitation and preventive maintenance treatments to maintain current conditions. The 3,477 typical bridges on the NHS equate to over 30 million square feet of bridge deck. The chart on the next page depicts the work type planned for bridges on the NHS.
The bridge work represented above varies in price per bridge and type of work being performed. The overall weighted cost per square foot of bridge deck is approximately $104/square foot and represents approximately 80 bridges each year getting work performed on them. This work is needed to keep each bridge in a state of good repair on the NHS, with much more work needed on non-NHS bridges to keep MoDOT’s entire bridge network in a state of good repair.

Even though approximately 80 bridges (approximately 944,000 square feet) on the NHS each year are getting improvements to maintain the state of good repair, MoDOT still sees approximately 20 bridges each year fall into the poor category. The number of bridges in the poor category on the NHS is currently 131 and represents approximately 1.7 million square feet of bridge deck and 1,983 bridges in the fair category on the NHS that equates to approximately 18.5 million square feet of bridge deck.

Historically, MoDOT has approached bridge work by the “worst first” method. Asset management has changed the focus from a “worst first” approach to a multi-focused approach including not only full replacements of poor bridges, but also on preventive maintenance of fair condition bridges. The preventive maintenance can be rehabilitation work or traditional type preventive maintenance such as flushing. The focus on preventive maintenance allows MoDOT to keep more bridges in a fair condition much longer.

**Major Bridges on the NHS – Bridge Work**

As described in Chapter 1, a major bridge is greater than 1,000 feet in length. The map on the next page shows MoDOT’s ten year major bridge needs, which represent over $700 million worth of construction costs. The concept of preventive maintenance to maintain the state of good repair is also used on the major bridges in Missouri. Unfortunately, several of the major bridges in Missouri are also well over their useful life and are in need of a full costly replacement. MoDOT currently has 166 major bridges on the NHS (207 total Major Bridges including non-NHS bridges) that represent over 20 million square feet of bridge deck. Of the
overall square foot of bridge deck, 11 percent are categorized as poor condition and are in need of replacement, and 63 percent are in the fair condition category.

Bridge Lifecycle and Performance Measures
As described in Chapter 2, MoDOT’s bridge performance goal is to sustain the state of good repair by staying flat on future bridge condition targets. Lifecycles of bridges are quite a bit different than pavements. Bridges newly replaced tend to last 50+ years while those repaired or rehabilitated will have an extended life that varies in years.

Lifecycle Summary
Overall MoDOT’s investment strategies (see Chapter 4) are being developed and led by pavement and bridge lifecycles.
Chapter 4: Financial Plan and Investment Scenario

Missouri’s transportation system has a replacement value today totaling $125 billion. A significant piece of that system is Missouri’s NHS system and it is a critical asset to the state with a replacement value totaling $53 billion.

![Missouri’s NHS Replacement Cost](image)

**Funding Overview**

Missouri’s state-owned NHS routes are funded from a combination of state and federal sources. The state funding available to maintain these routes includes the state fuel tax, motor vehicle and driver licensing fees, motor vehicle sales taxes and miscellaneous revenue.

The federal revenues are based on formulas prescribed by federal law through transportation funding acts. The majority of federal revenue is dedicated to pay for a share of eligible highway improvement costs. The federal share for the eligible costs is typically 80 percent, with the state providing a 20 percent match.
From fiscal years 2013 to 2017, the revenues have remained relatively stable as shown in the chart below.

The chart below provides MoDOT’s revenue forecast estimates for fiscal years 2019-2028.
The forecasted revenues are available for road and bridge investments across the state. Missouri’s road and bridge funding is allocated to local governments, other state agencies and MoDOT. The local government funding includes a share of state taxes and fees, and funding for locally-sponsored federal programs. These funds can be used to maintain locally-owned roads and bridges. MoDOT’s share of Missouri’s road and bridge funds are dedicated to improvements for state-owned routes. MoDOT’s investment areas include the construction program and other investments for engineering, debt payments, maintenance, fleet, facilities, information systems and administration. From fiscal years 2013 to 2017, the total investments have ranged from $2.3 billion to $2.5 billion as shown on the chart below.

MoDOT’s construction program investments are the primary funding source for maintaining NHS assets. MoDOT’s 10-year financial forecast assumes construction program investments will average $963 million annually, as shown on the following chart.
Based on the pavement and bridge assumptions from Chapter 3, MoDOT has estimated the cost to maintain existing conditions for all state-owned NHS routes. MoDOT’s asset management plan assumes annual inflation costs of three percent, resulting in an annual cost range from $335 million to $552 million per year. The year-to-year fluctuations are due to the significant cost for major bridge replacements that are included as specific bridges need to be replaced. The average cost of a major bridge replacement totals $49 million.

The remaining funds available range from $413 million to $633 million per year. These funds are available for improvements to non-NHS routes throughout the state, along with non-preservation improvements on the NHS routes, such as safety, congestion reduction and economic development.

For locally-owned NHS routes, each city or county receives state and federal funding that can be used to maintain the pavements and bridges. As shown in previous charts, these amounts range from $440 million to $501 million per year. In addition, many cities and counties have local taxes and fees dedicated for transportation purposes totaling approximately $800 million each year.

*Represents Total Funding Available for all state-owned roads and bridges (except low volume routes), not just NHS routes.
Chapter 5: Risk Management

Enterprise Risk Management (ERM) is a process designed to identify potential events that may affect the entity, manage risk to be within an acceptable level, and to provide reasonable assurance regarding the achievement of entity objectives. The existence of an ERM process within an organization is recognized as an example of good governance and is important to strategic management of organizational risk. MoDOT incorporated the ERM process into the organization in 2012. MoDOT’s senior leadership team collaborates yearly to examine and rate the organization’s risk areas.

MoDOT has identified the following top ten areas as potential areas of risk:

1. Workforce
2. Financial
3. Political
4. Public Opinion and/or Support
5. Transportation System Failures
6. Natural Disasters
7. Safety and Security
8. Information Technology
9. Legal and Regulatory Changes
10. Fraud and/or Theft

Out of the top ten areas being monitored for risk, three areas specifically are related to MoDOT’s TAMP which are: Financial, Transportation System Failures and Natural Disasters. Each year MoDOT evaluates the risk areas for impact, likelihood and readiness. Below is a table that outlines the January 2018 findings for the three risk areas associated with MoDOT’s TAMP. The yellow highlighted numbers represents the average score from MoDOT’s senior leadership team.

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Impact</th>
<th>Likelihood</th>
<th>Readiness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little Impact Devastating</td>
<td>Little Chance Fairly Certain</td>
<td>Plans in Place and Tested Unprepared</td>
</tr>
<tr>
<td>Financial</td>
<td>1 2 3 (3.3) 4</td>
<td>1 2 3 (3.0) 4</td>
<td>1 2 (2.2) 3 4</td>
</tr>
<tr>
<td>Transportation System Failures</td>
<td>1 2 3 (3.0) 4</td>
<td>1 2 (2.0) 3 4</td>
<td>1 (1.9) 2 3 4</td>
</tr>
<tr>
<td>Natural Disasters</td>
<td>1 2 3 (3.2) 4</td>
<td>1 2 (2.3) 3 4</td>
<td>1 (1.6) 2 3 4</td>
</tr>
</tbody>
</table>

**Financial Risk**

Financial risk includes items such as uncertainty of federal funds, viability of fuel tax as a revenue source, an unstable economy, the inability to match federal funds, inflation in commodities and/or contract prices and rising benefit costs. The financial risk is rated to have a high impact with a medium likelihood and a readiness rating nearing plans in place and tested. To aid in mitigating this risk MoDOT has put several processes in place to monitor the financial risk. Those processes include preparing an annual financial forecast, not fully programming the fourth and fifth year of the STIP, annual project estimate updates and bid letting review each month. In addition, maintaining the asset management plan was identified to ensure the existing system is maintained before new infrastructure is added.
Transportation System Failures

Transportation system failure risk includes items such as a bridge collapse, condition and capacity issues with interstates and traffic congestion in the metropolitan areas. The transportation system failure risk impact is rated to have a fairly high impact with a lower likelihood and a readiness rating nearing plans in place and tested. To aid in mitigating this risk MoDOT has several processes in place to monitor the transportation system failure risk such as, inspecting bridges on a routine cycle, emergency contracting authority, dedicated interstate and major bridge funding, and use of an asset management plan.

Natural Disasters

Natural disaster risk includes items such as earthquakes, blizzards, flooding, tornadoes, nuclear power plant events and pandemics. The natural disaster risk impact is rated to have a fairly high impact with a lower likelihood and a readiness rating nearing plans in place and tested. To aid in mitigating this risk MoDOT has put several processes in place to monitor the natural disaster risk, such as activating MoDOT’s Emergency Operations Center during weather events, creating and updating an Incident Response Plan and use of the National Incident Management System (NIMS).

Within this risk category is extreme weather vulnerabilities that could potentially affect assets. MoDOT has identified assets vulnerable to extreme flooding with some very recent flooding events occurring throughout the state. The assets vulnerable to flooding include several NHS bridges and pavements (some located on interstates) all of which have been identified. To mitigate this risk strategic assets were added to MoDOT’s STIP for improvement to reduce risk.
Chapter 6: Process Improvements

Monitoring and improving the TAMP is an evolving and iterative process. MoDOT continues to evaluate the successes of the TAMP through the various methods described below.

History of Asset Management

In 2006, MoDOT completed improvements to 2,200 miles of Missouri’s most heavily traveled roads with a program called the Smooth Roads Initiative (SRI). This program was the start of the current asset management approach in Missouri. The SRI program was mostly comprised of very thin resurfacing treatments to improve the smoothness of the pavement on the NHS system. This is the very same concept that MoDOT’s TAMP is built upon, which is focused on less expensive preservation treatments on a routine cycle instead of expensive rehabilitation and reconstruction treatments.

In early 2016, MoDOT began moving toward full asset management for pavements and bridges. To begin this effort, MoDOT engaged planning partners throughout the state in the discussions to set the framework for asset management. The preservation concept is applied so pavements and bridges can remain in a state of good repair. By late 2016, MoDOT developed statewide lifecycles, cost assumptions, projected funding and treatment types for all pavements and bridges. These efforts were further developed by customizing the statewide asset management assumptions into MoDOT district specific inputs.

While MoDOT has sufficient funds to maintain a state of good repair on the NHS system (see Chapter 4), the district asset management plans identified a funding shortfall for non-NHS assets. After realizing this funding deficit, the Missouri Highways and Transportation Commission established an Asset Management Deficit Program in 2017 to ensure adequate funding for a state of good repair for non-NHS assets.

Monitoring Asset Management

MoDOT established a TAMP Steering Committee in 2015 made up of MoDOT senior leadership positions and the Federal Highway Administration. The purpose of this committee is to set the direction of the TAMP, monitor the success of the TAMP and to make improvements to the process.
Each year districts work with regional partners to update the STIP using asset management plans as a guide to program projects. At the end of each programming cycle, MoDOT evaluates the STIP to ensure the projects programmed meet the objectives of the TAMP. MoDOT’s 10-year rolling TAMP is reviewed and refined each year with the latest information.

MoDOT also monitors results and adjusts strategies through a performance management system called Tracker. The Tracker has performance measures that monitor the condition of MoDOT’s pavements and bridges.

In addition to MoDOT’s performance measures, there are federal performance measures (see Chapter 2) that monitor the condition of Missouri’s pavement and bridge conditions. These are national measures established and reported on each year. MoDOT coordinates a monthly webinar with regional planning partners to discuss national performance requirements, including asset management.
<table>
<thead>
<tr>
<th>#</th>
<th>Section</th>
<th>Requirement</th>
<th>How this Requirement is Addressed in this Document</th>
<th>Requirement Addressed on these Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>515.9 (a)</td>
<td>A State DOT shall develop and implement an asset management plan to improve or preserve the condition of the assets and improve the performance of the NHS in accordance with the requirements of this part.</td>
<td>This document outlines how MoDOT will manage its NHS pavements and bridges over the asset management period of 10 years. MoDOT intends for asset conditions to hold steady.</td>
<td>Entire Document</td>
</tr>
<tr>
<td>2</td>
<td>515.9 (a)</td>
<td>Asset management plans must describe how the State DOT will carry out asset management as defined in § 515.5.</td>
<td>This document outlines how MoDOT plans to implement asset management practices for pavements and bridges over the next 10 years.</td>
<td>Entire Document</td>
</tr>
<tr>
<td>3</td>
<td>515.9 (b)</td>
<td>An asset management plan shall include, at a minimum, a summary listing of NHS pavement and bridge assets, regardless of ownership.</td>
<td>This document outlines all NHS bridges and pavements by ownership either state owned or locally owned.</td>
<td>Chapter 1 – Asset Inventory and Condition</td>
</tr>
<tr>
<td>4</td>
<td>515.9 (c)</td>
<td>In addition to the assets specified in paragraph (b) of this section, State DOT’s are encouraged, but not required, to include all other NHS infrastructure assets within the right-of-way corridor and assets on other public roads. Examples of other NHS infrastructure assets include tunnels, ancillary structures, and signs. Examples of other public roads include non-NHS assets in its asset management plan, or to include assets on other public roads, the State DOT, at a minimum, shall evaluate and manage those assets consistent with paragraph (1) of this section.</td>
<td>This document addresses all NHS bridges and pavements by ownership either state owned or locally owned. This document does not address non-NHS infrastructure.</td>
<td>Entire Document</td>
</tr>
<tr>
<td>5</td>
<td>515.9 (d)</td>
<td>The minimum content for an asset management plan under this part includes a discussion of each element in this paragraph (d).</td>
<td>See below</td>
<td>See below</td>
</tr>
<tr>
<td>6</td>
<td>515.9 (d)</td>
<td>(1) Asset management objectives. The objectives should align with the State DOT’s mission. The objectives must be consistent with the purpose of asset management, which is to achieve and sustain the desired state of good repair over the life cycle of the assets at a minimum practicable cost.</td>
<td>Introduction</td>
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<tr>
<td>7</td>
<td>515.9 (d)</td>
<td>(2) Asset management measures and State DOT targets for asset condition, including those established pursuant to 23 U.S.C. 150, for NHS pavements and bridges. The plan must include measures and associated targets the State DOT can use in assessing the condition of the assets and performance of the highway system as it relates to those assets. The measures and targets must be consistent with the State DOT’s asset management objectives. The State DOT must include the measures established under 23 U.S.C. 150(c) (3) (A) (ii) (I)–(III), once promulgated in 23 CFR part 490, for the condition of NHS pavements and bridges. The State DOT also must include the targets the State DOT has established for the measures required by 23 U.S.C. 150(c) (3) (A) (ii) (I)–(III), once promulgated, and report on such targets in accordance with 23 CFR part 490. The State DOT may include measures and targets for NHS pavements and bridges that the State DOT established through pre-existing management efforts or develops through new efforts if the State DOT wishes to use such additional measures and targets to supplement information derived from the pavement and bridge measures and targets required under 23 U.S.C. 150.</td>
<td>Chapter 1 – Asset Inventory and Condition and Chapter 2 – Performance Measures and Targets</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>515.9 (d)</td>
<td>(3) A summary description of the condition of NHS pavements and bridges, regardless of ownership. The</td>
<td>Chapter 1 – Asset Inventory</td>
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<tr>
<td>9</td>
<td>515.9 (d)</td>
<td>(4) Performance gap identification.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>515.9 (d)</td>
<td>(5) Life-cycle planning.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>515.9 (d)</td>
<td>(6) Risk management analysis, including the results for NHS pavements and bridges, of the periodic evaluations under part 667 of this title of facilities repeated damaged by emergency event.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>515.9 (d)</td>
<td>(7) Financial plan.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>515.9 (d)</td>
<td>(8) Investment planning.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>515.9 (e)</td>
<td>An asset management plan shall cover, at a minimum, a 10-year period.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>515.9 (f)</td>
<td>An asset management plan shall discuss how the plan’s investment strategies collectively would make or support progress toward: (1) Achieving and sustaining a desired state of good repair over the life cycle of assets,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>515.9 (g)</td>
<td>A State DOT must include in its plan a description of how the analyses required by State processes developed in accordance with § 515.7 (such as analyses pertaining to life cycle planning, risk management, and performance gaps) support the State DOT’s asset management plan investment strategies.</td>
<td>Entire Document</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>515.9 (h)</td>
<td>A State DOT shall integrate its asset management plan into its transportation planning processes that lead to the STIP, to support its efforts to achieve the goals in paragraphs (f) (1) through (4) of this section.</td>
<td>Chapter 6 – Process Improvement</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>515.9 (i)</td>
<td>A State DOT is required to make its asset management plan available to the public, and is encouraged to do so in a format that is easily accessible.</td>
<td>Entire Document</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>515.9 (j)</td>
<td>Inclusion of performance measures and State DOT targets for NHS pavements and bridges established pursuant to 23 U.S.C. 150 in the asset management plan does not relieve the State DOT of any performance management requirements, including 23 U.S.C. 150(e) reporting, established in other parts of this title.</td>
<td>Chapter 2 – Performance Measures and Targets</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>515.9 (k)</td>
<td>The head of the State DOT shall approve the asset management plan.</td>
<td>See by MoDOT Director after cover page</td>
<td></td>
</tr>
</tbody>
</table>
If the State DOT elects to include other NHS infrastructure assets or other public roads assets in its asset management plan, the State at a minimum shall address the following, using a level of effort consistent with the State DOT’s needs and resources:

1. Summary listing of assets, including a description of asset condition;
2. Asset management measures and State DOT targets for asset condition;
3. Performance gap analysis;
4. Life-cycle planning;
5. Risk analysis, including summaries of evaluations carried out under part 667 of this titles for the assets, if available, and consideration of those evaluations;
6. Financial plan; and
7. Investment strategies.

The asset management plan of a State may include consideration of critical infrastructure from among those facilities in the State that are eligible under 23 U.S.C. 119(c).

### 515.11 Deadlines and phase-in of asset management plan development

1. Not later than April 30, 2018, the State DOT shall submit to FHWA a State-approved initial asset management plan meeting the requirements in paragraph (b) of this section. The FHWA will review the processes described in the initial plan and make a process certification decision as provided in § 515.13(a).
2. Not later than June 30, 2019, the State DOT shall submit a State approved asset management plan meeting all the requirements of 23 U.S.C 119 and this part,
including paragraph (c) of this section, together with
documentation demonstrating implementation of the
asset management plan. The FHWA will determine
whether the State DOT’s plan and implementation meet
the requirements of 23 U.S.C. 119 and this part as
provided in § 515.13(b).

| 24  | 515.11 (b) | The initial plan shall describe the State DOT’s processes
for developing its risk-based asset management plan,
including the policies, procedures, documentation, and
implementation approach that satisfy the requirements of
this part. |
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>515.11 (b)</td>
<td>The plan also must contain measures and targets for assets covered by the plan. The investment strategies required by § 515.7(e) and § 515.9(d) (8) must support progress toward the achievement of the national goals identified in 23 U.S.C. 150(b). This initial plan must include and address the State DOT’s 23 U.S.C. 150(d) targets for NHS pavements and bridges only if the first target-setting deadline established in 23 CFR part 490 for NHS pavements and bridges is a date more than 6 months before the initial plan submission deadline in paragraph (a)(1).</td>
</tr>
<tr>
<td>26</td>
<td>515.11 (b)</td>
<td>The initial asset management plan may exclude one or more of the necessary analyses with respect to the following required asset management processes: (1) Life-cycle planning required under § 515.7(a) (2); (2) The risk management analysis required under § 515.7(a) (3); and (3) Financial plan under § 515.7(a) (4).</td>
</tr>
<tr>
<td>27</td>
<td>515.11</td>
<td>The State-approved asset management plan submitted</td>
</tr>
</tbody>
</table>

Entire Document

Chapter 2 – Performance Measures and Targets

N/A

N/A
(c) not later than June 30, 2019, shall include all required analyses, performed using FHWA-certified processes, and the section 150 measures and State DOT targets for the NHS pavements and bridges. The plan must meet all requirements in § 515.7 and 515.9. This includes investment strategies that are developed based on the analyses from all processes required under §515.7, and meet the requirements in 23 U.S.C. 119(e) (2).

| 28  | §515.17 | Pursuant to 23 U.S.C. 150(c) (3) (A) (i), this section establishes the minimum standards States must use in developing and operating bridge and pavement management systems that are not subject to FHWA certification under § 515.13. Bridge and pavement management systems shall include, at a minimum, documented procedures for:
|     |        | (a) Collecting, processing, storing, and updating inventory and condition data for all NHS pavement and bridge assets.
|     |        | (b) Forecasting deterioration for all NHS pavement and bridge assets;
|     |        | (c) Determining the benefit-cost over the life cycle of assets to evaluate alternative actions (including no action decisions), for managing the condition of NHS pavement and bridge assets;
|     |        | (d) Identifying short- and long-term budget needs for managing the condition of all NHS pavement and bridge assets;
|     |        | (e) Determining the strategies for identifying potential NHS pavement and bridge projects that maximize overall program benefits within the financial constraints.; and

Entire Document
|   | (f) Recommending programs and implementation schedules to manage the condition of NHS pavement and bridge assets within policy and budget constraints. |   |