MoDOT's National Highway System Transportation Asset Management Plan

August 2019

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 over 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.

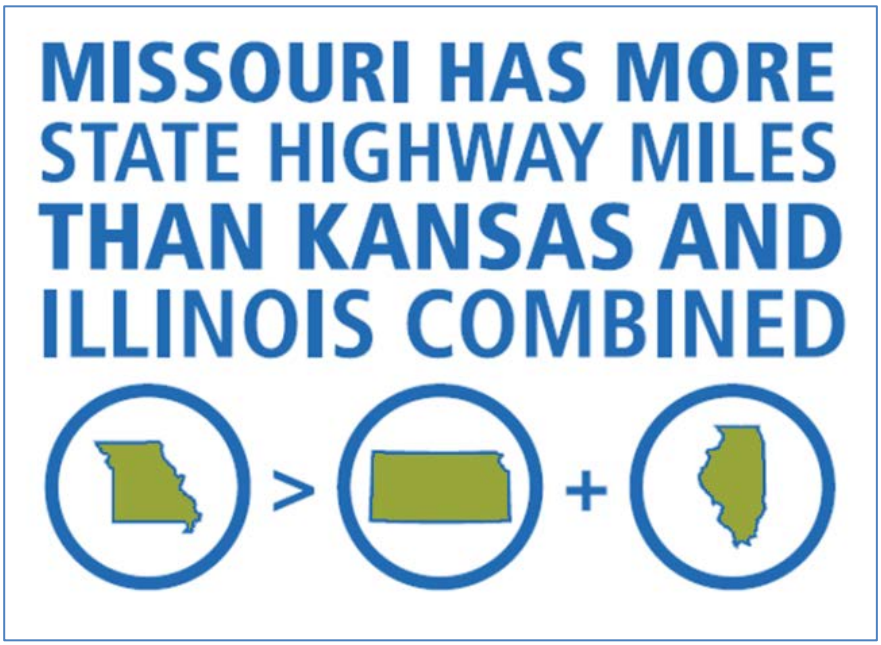
An initial plan was developed by department asset experts and planning statisticians based on statewide cost and life-cycles assumptions. That plan was shared with regional staff to adjust those assumptions to actual regional costs and life cycles. Refining and adjusting the TAMP will be a continuous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

Who We Are: 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 33,859 miles. The state highway system, which includes 10,385 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.

TAMP Process: MoDOT's current asset management strategies have been in place since 2005. In 2016, MoDOT's asset management planning evolved from a statewide plan to individual district models. Since 2016, each of MoDOT's seven districts maintain an asset management plan for pavements and bridges. These plans have been developed and updated annually by multi-disciplinary teams including bridge, pavement, mobility and maintenance experts along with input from senior leadership, FHWA and regional planning partners. The TAMP was developed by summarzing the latest district asset management plans. More information on the TAMP process can be found in Chapter 6.

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. Missourians continue to place the highest priorities on structurally sound bridges and smooth roads, as does this plan. The state of good repair for this TAMP is defined as maintaining current pavement and bridge conditions for the six federal pavement and brige performance measures over the next ten years. Specifically, the state of good repair goal throughout this document is defined as:

Federal Performance Measure	Targeted Condition to Maintain State of Good Repair for TAMP
Percent Poor Interstate Pavement	0.0%
Percent Good Interstate Pavement	77.5%
Percent Poor Non-Interstate NHS Pavement	1.0%
Percent Good Non-Interstate NHS Pavement	61.1%
Percent Poor Deck Area on NHS	7.1%
Percent Good Deck Area on NHS	30.9%

The targeted conditions shown in the table above are based on maintaining 2017 conditions with the exception of Percent Good Deck Area on the NHS. In 2017, the Percent Good Deck Area on the NHS was 34.0 percent. Based on deterioration trends, we anticipate the percentage to decline to 30.9 percent in 2020, then remain flat throughout the TAMP. Additional information for performance measures and targets can be found in Chapter 2.

The TAMP supports progress in achieving the national goals in 23 USC 150(b) as shown in the following table.

National Performance Goals	Strategies to Achieve Goal
(1) Safety	The TAMP supports the goals and objectives of Missouri's Highway Safety Improvement Program (HSIP) and Highway Safety Plan (HSP). Implementing these plans will reduce traffic fatalities and serious injuries.
(2) Infrastructure condition	TAMP strategies directly support the infrastructure condition goal by maintaining infrastructure in a state of good repair.
(3) Congestion reduction	The TAMP informs the congestion reduction goal by identifying available funding for congestion improvements after asset management needs are met.
(4) System reliability	Maintaining highway infrastructure in a state of good repair supports system reliability.
(5) Freight movement and economic vitality	Maintaining highway infrastructure in a state of good repair supports freight movement and economic vitality.
(6) Environmental sustainability	TAMP strategies are designed to support existing environmental, project development and STIP processes that protect the natural environment.
(7) Reduced project delivery delays	Implementing the TAMP reduces project delivery delays by guiding project delivery goals and results.

Chapter 1: Asset Inventory and Condition

Missouri's state highway system includes 33,859 centerline miles of roads and 10,385 bridges. The system is divided into four roadway categories, each of which has its own unique characteristics regarding size, condition and use:

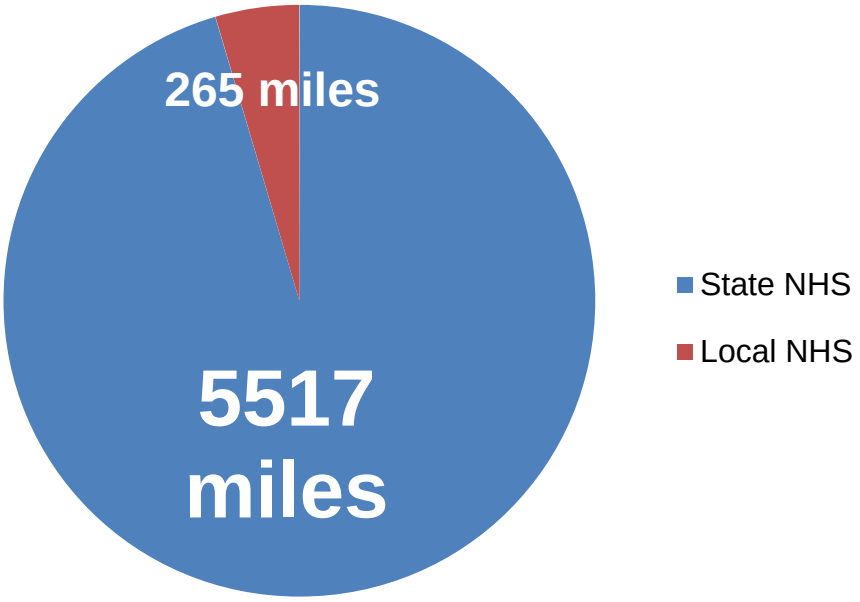
1) Interstates
2) Non-Interstate NHS Routes (Major Routes)
3) Minor routes
4) Low volume routes *(less than 400 vehicles per day)*.

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 U.S. 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.

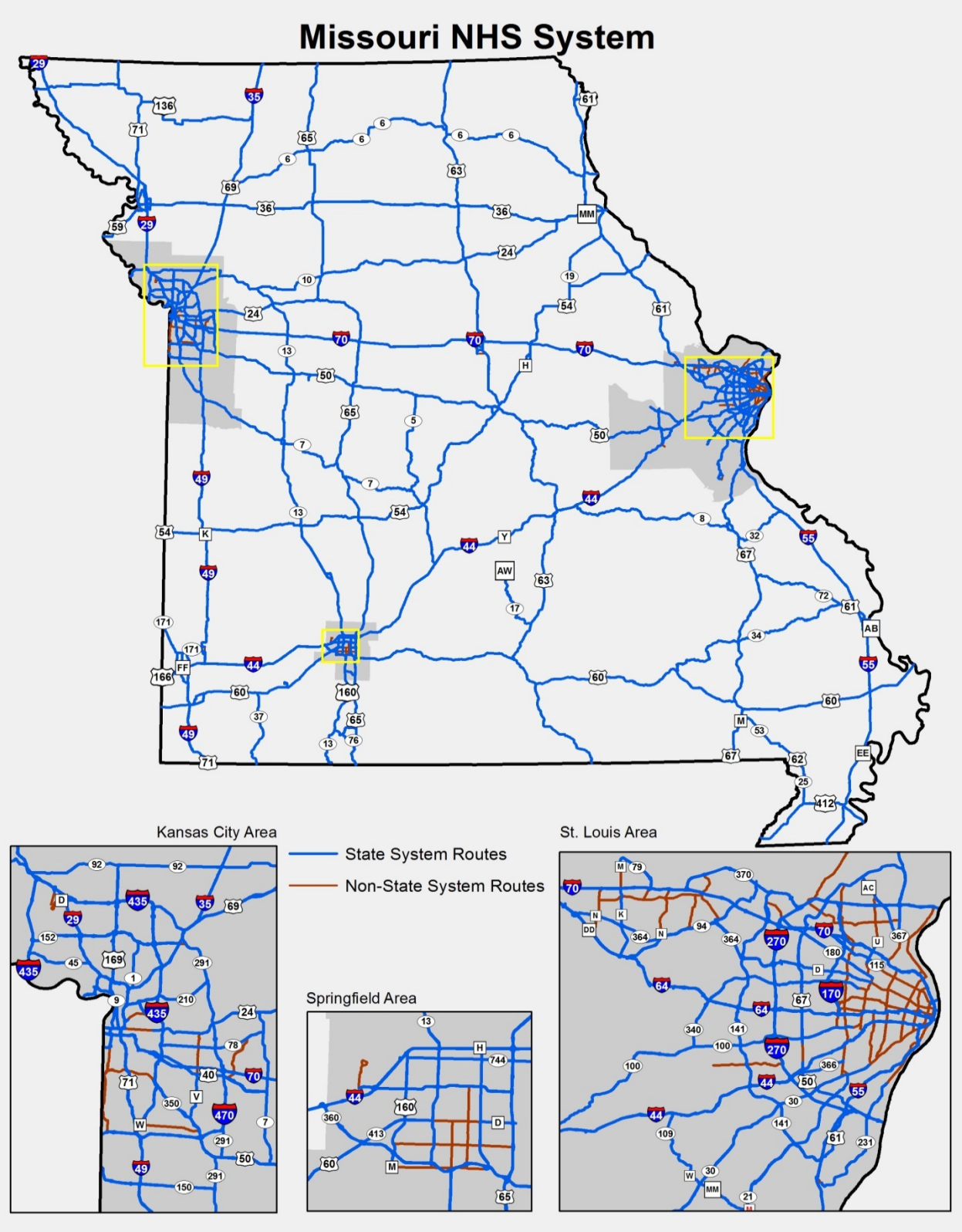
The final rule in 23 CFR 515 states "a state DOT shall develop a risk-based asset management plan that describes how the NHS will be managed to achieve system performance effectiveness and State DOT targets for asset condition..." The final rule also states "An asset management plan shall include, at 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 33,859 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



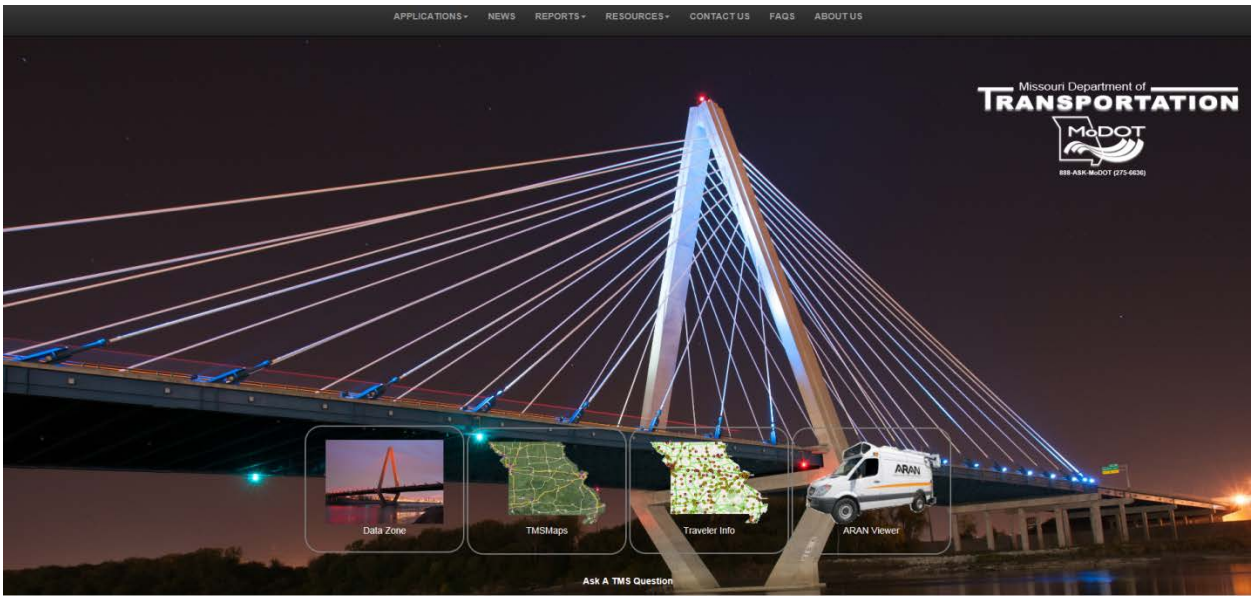
System at a Glance



Asset Management System

Transportation Management System (TMS) is the system that houses the Pavement Management System (PMS) and the Bridge Management System (BMS) information used in asset planning. When TMS was implemented in 1998, it only presented information for travelways (routes), safety, traffic and pavement. TMS is now comprised of client/server applications, web-based applications, ReportNet/ Crystal Reports and ArcGis tools and products. Over the years, the number of applications, reports and mapping products has exploded. There is also a component that allows for the addition of photos and documents related to certain inventory items.

MoDOT's TMS applications can be found at http://tms/home/



TMS is ever evolving and improving to aid in taking care of the large highway system in Missouri. The graphic below shows the TMS News that is sent out to keep information up to date and to show those who manage assets the new tools available within the applications.

TMS News

Transportation Management System

Missouri Department of Transportation

TMS Maps

Now able to search for bridges that have multiple bridge numbers associated to it..

Traveler information System

Added new applications of Traffic Bypass and Traffic Bypass Maintenance. These are new applications that activates bypass routes if needed for incidents on IS 70 and IS 44.

Updated:

June 26, 2018

TMS Reports

New Traffic Impact History Report. New report created for traffic impact history.

Did You Know:

- *TMS updates will occur July 13, 2018.*
- *Travelway maintenance will occur July 13, 2018.*
- *Click here for the most recent travelway maintenance.*
- *Fatal Crashes Report is updated monthly.*
- *MoDOT Property Damage Crashes Report is updated weekly.*
- *The MoDOT Maintenance Building layer has been updated in TMS. You can view this layer using the TMS Viewer or ArcGIS. To add the layer. Click on Add TMS Data icon, click on Area, click on MoDOT Locations and click on MoDOT Maintenance Buildings.*

TMS Modernization and New Applications To Date

The following applications have been modernized:

Asset Management	Travelway Overlapping Browser
LRS (Travelway Selection)	Adopt A Highway
Outdoor Advertising	Travelway Features
Travelway Lane	Traffic Management System
Routine Maintenance	Inventory Validation
Code Tables	Stormwater
Intelligent Transportation System	Emergency Operations Map
Data Zone	Safety Management System
Bridge Management System	Striping Inventory System
Maintenance Agreement	Routine Maintenance
Traffic Impact	Winter Road Cond
Data Zone-Crash Prediction Tool	Memorial Map
Traffic Bypass	Traffic Bypass Maintenance
ADA Compliance (PROW)	Data Zone—External

For questions regarding TMS or for training needs, please contact the TMS Help Desk at:
573-526-8055 Jeannemarie Lebeau 573-522-8464 Yvonne Wilbers

Missouri Department of Transportation

Transportation Planning
105 West Capitol Ave.
PO Box 270
Jefferson City, MO 65102

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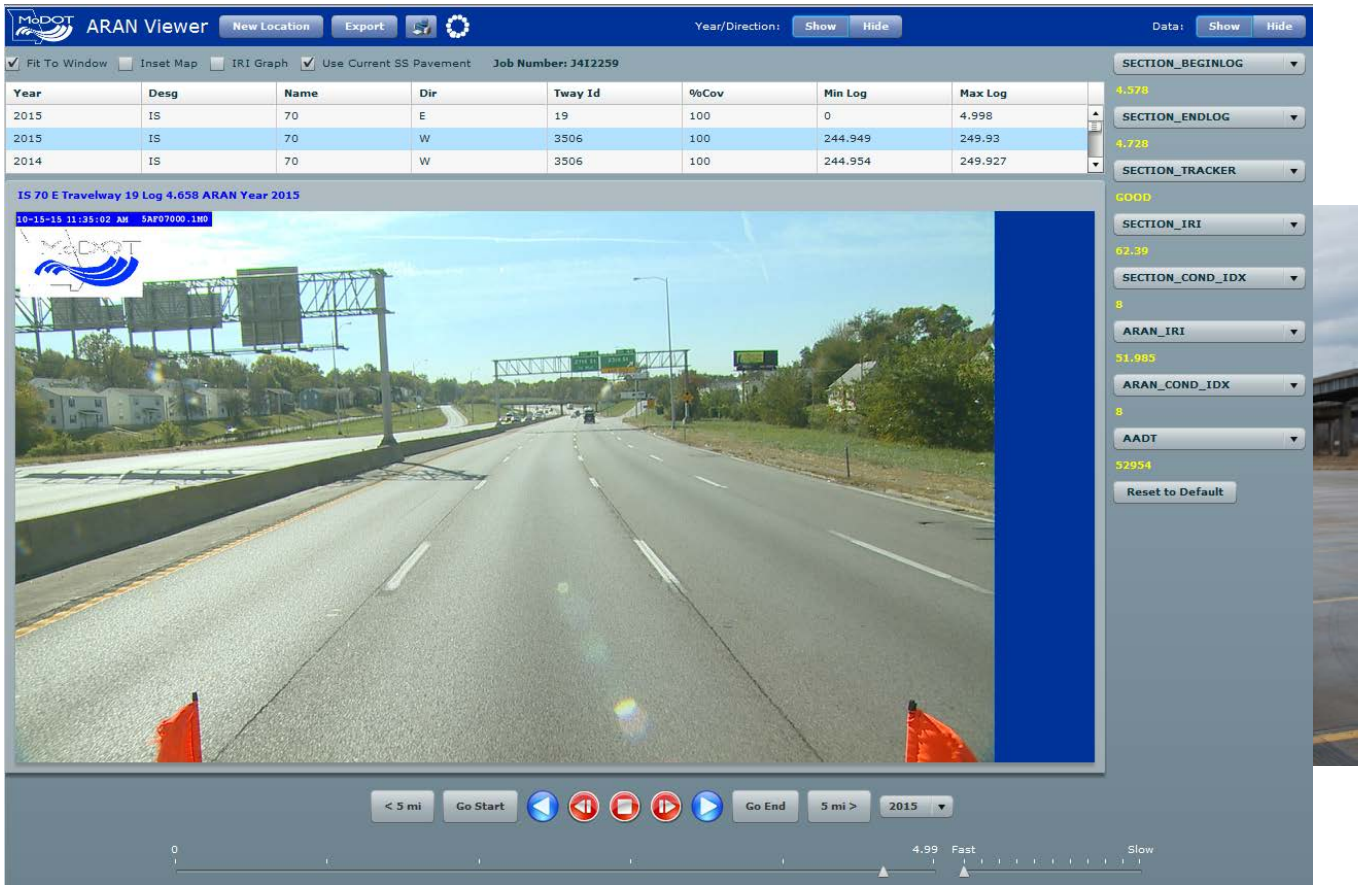
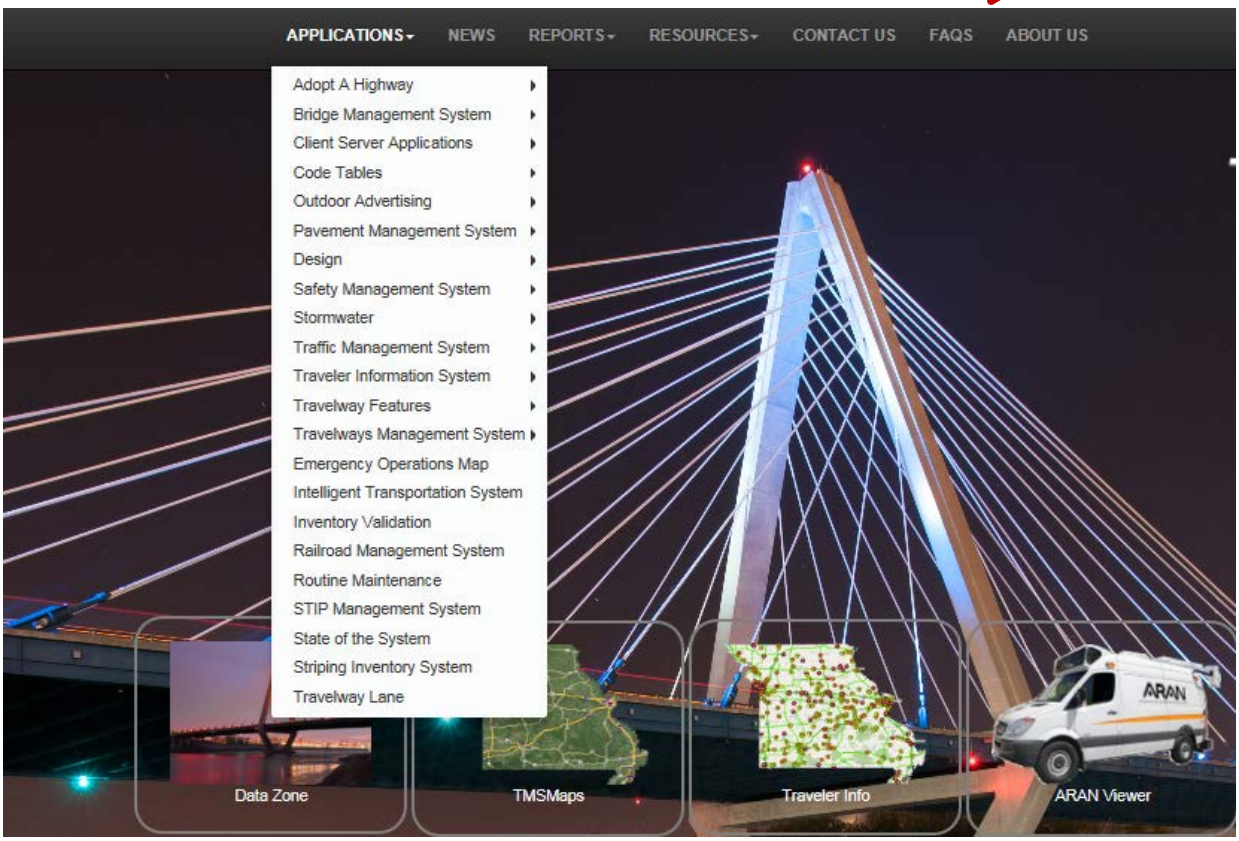
Our Mission is to provide a world-class transportation system that is safe, innovative, reliable and dedicated to a prosperous

Pavements

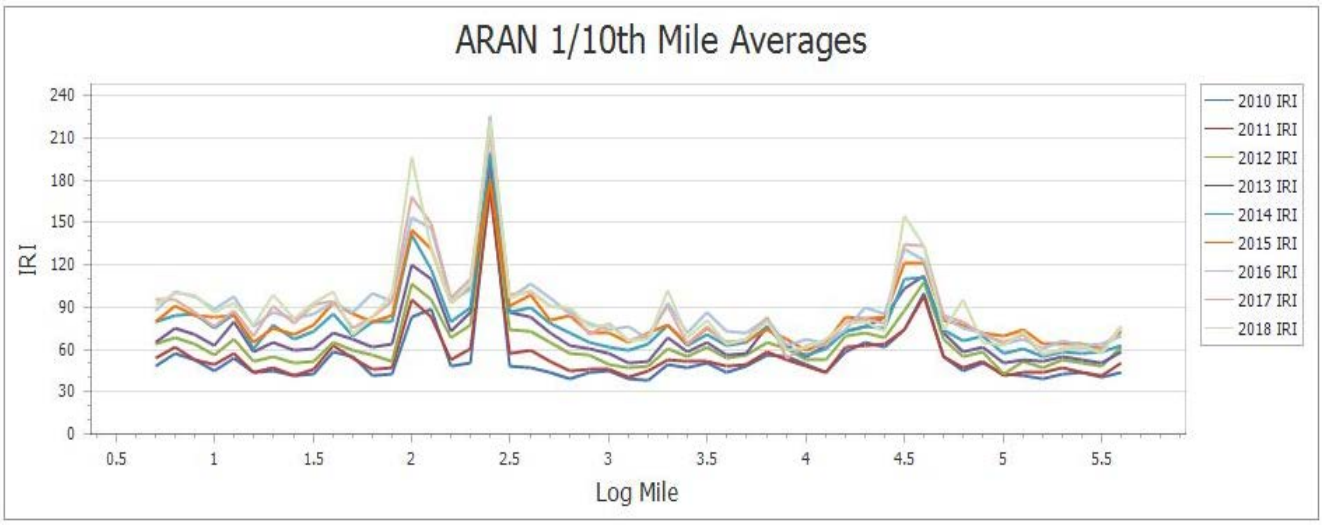
MoDOT administers a transportation management system (TMS) to store pavement and bridge asset data, which includes a location referencing system, condition data and videos. Pavement data for all state owned NHS routes and locally owned NHS routes are collected annually. MoDOT uses an Automatic Road Analyzer (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.



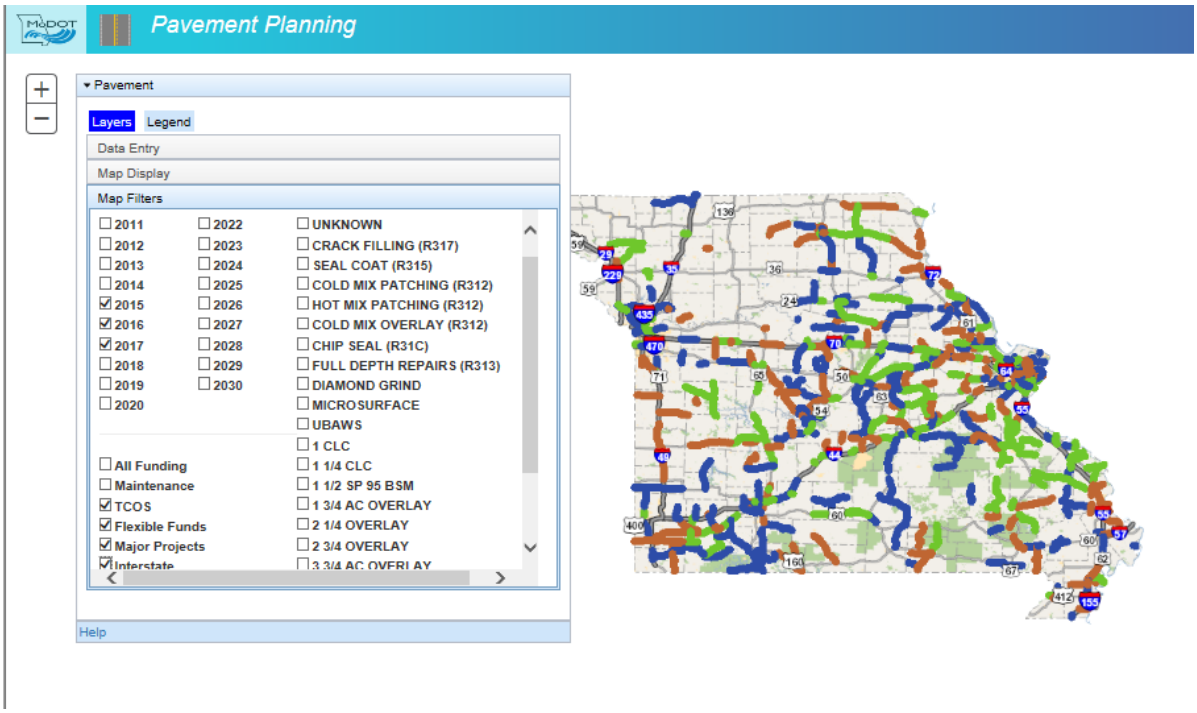
TMS applications (as shown on the following page) capture and store all historical pavement data. MoDOT pavement experts then query this historical information and analyze the data using spreadsheets to determine how well the pavement has performed and to establish future pavement deterioration rates for pavement sections. TMS is MoDOT's Pavement Management System (PMS) as it has multiple applications that aid in establishing the deterioration rate of pavements.



TMS provides historic condition data that is used to forecast future deterioration for pavements. The data on the following chart illustrates the data used to develop future deterioration forecasts.



The pavement planning tool within TMS (as shown below) has the ability to indicate pavement sections that need attention by year. These identified pavement sections are then further analyzed by MoDOT pavement engineers to determine right treatment for the condition. These pavement sections are then considered for programming in the 5-year STIP.



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

IRI <100 = Good Condition
IRI > 100 = Not Good Condition

The **interstate system**, *(e.g., I-70, I-44, I-55)* currently has 92 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 91 percent of the miles in good condition for smoothness. **Total NHS System** currently has 92 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".

Metric Thresholds for Pavement Condition			
Rating	**Good**	**Fair**	**Poor**
IRI (inches/mile)	**<95**	**95-170**	**>170**
PSR* (0.0-5.0 value)	**>4.0**	**2.0-4.0**	**<2.0**
Cracking Percent (%)	**<5**	****CRCP: 5-10, Jointed: 5-15, Asphalt: 5-20**	**>10, >15, >20**
Rutting (inches)	**<0.20**	**0.20-0.40**	**>0.40**
Faulting (inches)	**<0.10**	**0.10-0.15**	**>0.15**

*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.

Current Condition of Missouri NHS Routes			
	State Owned	Local Owned	Total
% of Interstate in Good Condition	78%	n/a	78%
% of Interstate in Poor Condition	0%	n/a	0%
% of Non-Interstate NHS Pavements in Good Condition	65%	12%	61%
% of Non-Interstate NHS Pavements in Poor Condition	0%	11%	1%

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

Bridges

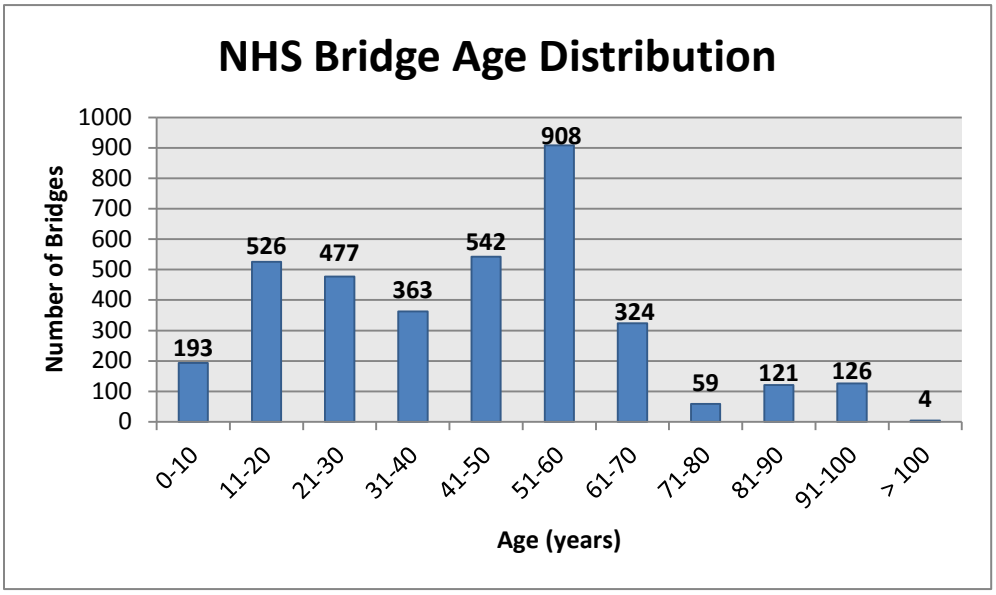
Missouri's NHS system includes 3,643 bridges which can be categorized as either a major bridge or typical bridge (including culverts). A major bridge is any bridge that has a length greater than 1,000 feet, while a typical bridge has a length less than 1,000 feet. Missouri has 166 major bridges on the NHS and 3,477 typical bridges on the NHS, for a total of 3,643 bridges on the NHS. The NHS bridges range in age from one to +100 years old.

Number of NHS Bridges (Source: 2016 NBI Data)

	State Owned	Locally Owned	Total
Major	165	1	166
Typical	3,392	85	3,477
Total	3,557	86	3,643

Square Foot of Bridge Deck on NHS

	State Owned	Locally Owned	Total
Major	20,162,605	113,520	20,276,125
Typical	33,771,566	979,617	34,751,183
Total	53,934,171	1,093,137	55,027,308



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

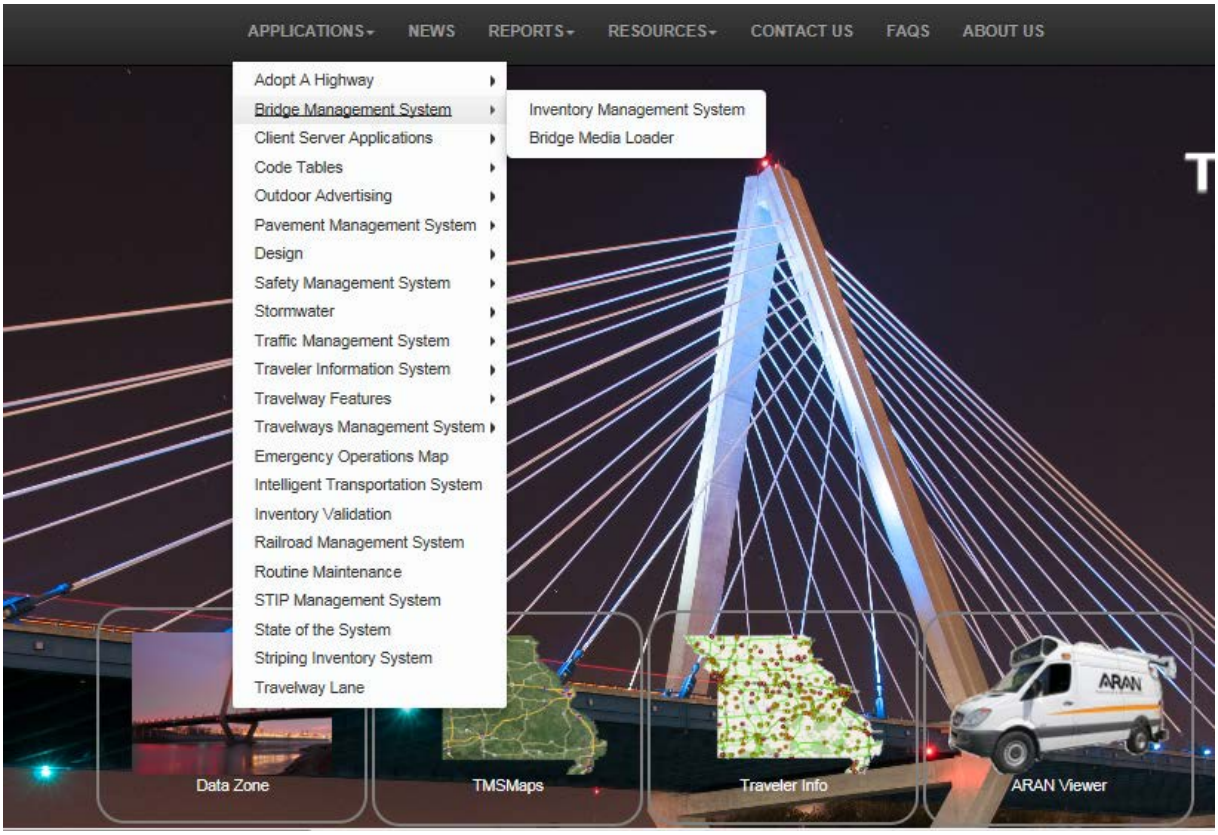
condition of the deck (riding surface), the superstructure (supports immediately beneath the driving surface) and the substructures (foundation and supporting posts and piers).

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. This also applies to culvert condition rating – item 62.

The rating scale is:
9 – Excellent; **8** – Very Good; **7** – Good; **6** – Satisfactory; **5** – Fair; **3 or 4** – Poor; **2 or less** – Closed

NBIS	Thresholds for Bridge Condition	Number of NHS Bridges / Material Type	Square Foot of Bridge Deck on NHS
9	Good	Concrete: 1,255 Steel: 832	19,794,713
8			
7			
6	Fair	Concrete: 958 Steel: 449	31,260,698
5			
4	Poor	Concrete: 63 Steel: 86	3,971,898
3			
2		0	0
1		0	0
0		0	0
Total		3,643	55,027,309

TMS applications house each bridge location and data as shown below.

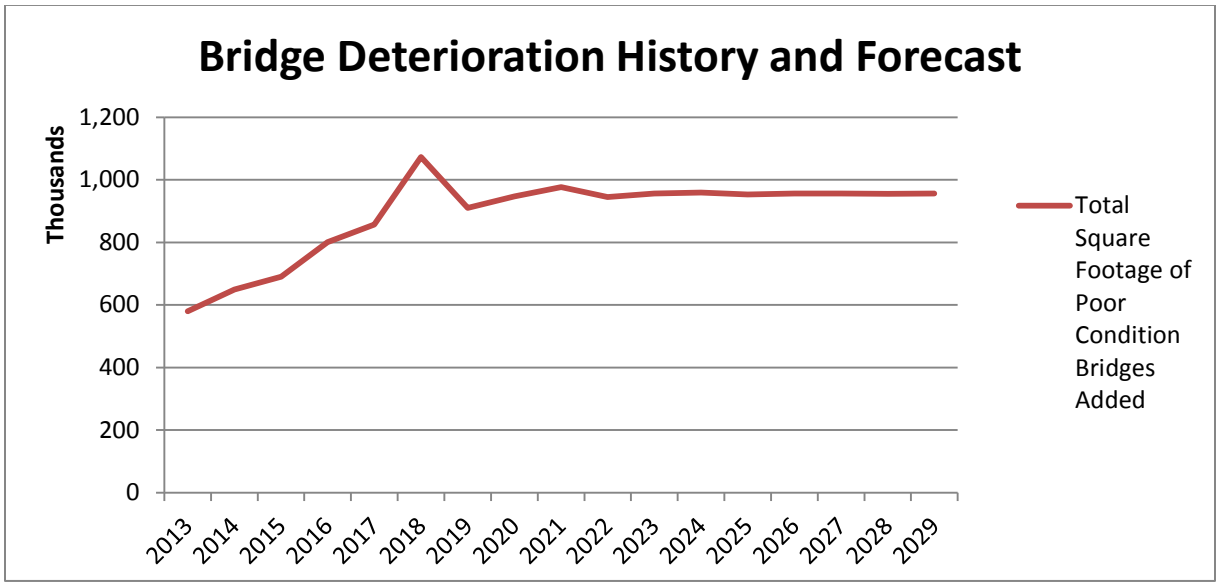


The bridge TMS applications with the bridge NBIS data gathered from field inspections make up the Bridge Management System (BMS). MoDOT has collected and maintained inventory and condition information on National Bridge Inventory (NBI) structures since 1971. An NBI structure is defined as a bridge or culvert that has an opening of at least 20 feet along the centerline of the roadway, is open to the public, and carries vehicular traffic as per 23 CFR 650. MoDOT uses our Transportation Management System to manage our bridge data including inventory and inspection information.

The vast majority of bridges in Missouri are inspected by MoDOT personnel with a small number inspected by consultants or by the local bridge owner. Most are inspected on a two year frequency while a few are done more frequently. MoDOT has worked with FHWA to develop criteria for inspecting some lower risk structures on a 48 month frequency. This is a tool available to our District Bridge Engineers to help reduce the bridge inspection workload.

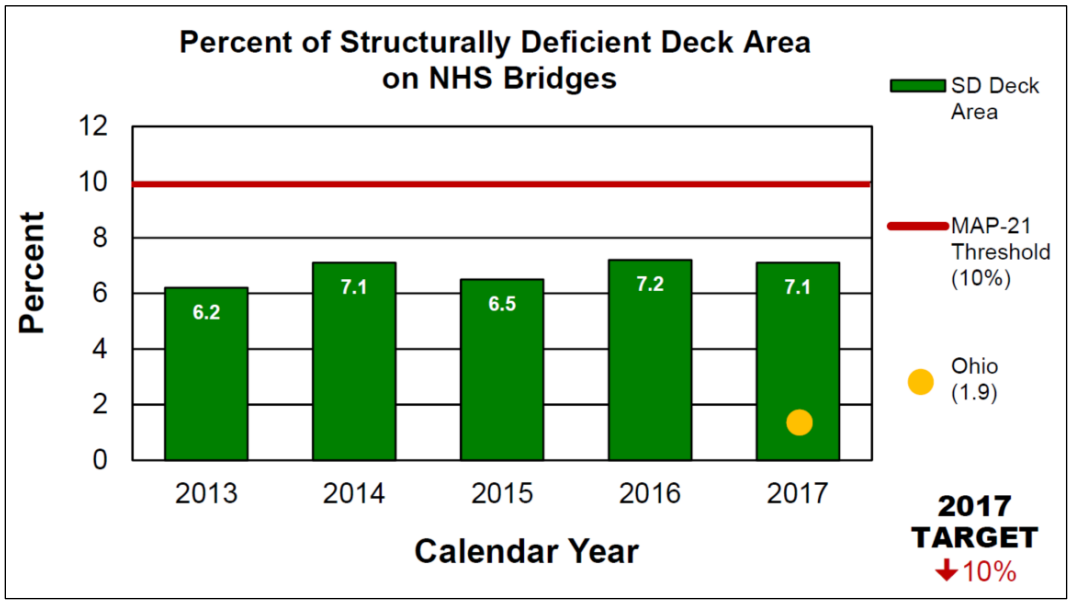
Historic deterioration rates for all bridges, as shown in the tables on the following page, are available in TMS. Similar to the pavement management system, TMS provides historic condition data that is used to forecast future deterioration for bridges. The data on the following chart illustrates the historic data used to develop future deterioration forecasts. The future deterioration

forecasts are used to establish targeted annual bridge repairs needed, by work type, for each MoDOT district.



Historically, a 50-year service life was anticipated for bridges; however, starting in 2010, structures are anticipated to have a 75-year service life. Major bridges designed since 2000 are anticipated to have a 100-year service life. One of the challenges with managing our bridge assets is we have a wave of bridges built in the 1950's and 1960's that are all reaching the end of their service life at about the same time.

As required by MAP 21, we also track the square feet of bridge deck of bridges on the NHS that are Structurally Deficient:



When programming bridge work, MoDOT takes a multi-pronged approach with varying work types. With the amount of poor bridges in Missouri, several replacements or redecks are needed per year; however, it is more cost effective to spend a portion of the limited funds on keeping Fair bridges Fair and Good bridges Good. This is done through a combination of rehabilitations and preventive maintenance projects. The expected life is 7 – 20 years for bridge rehabilitation.

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

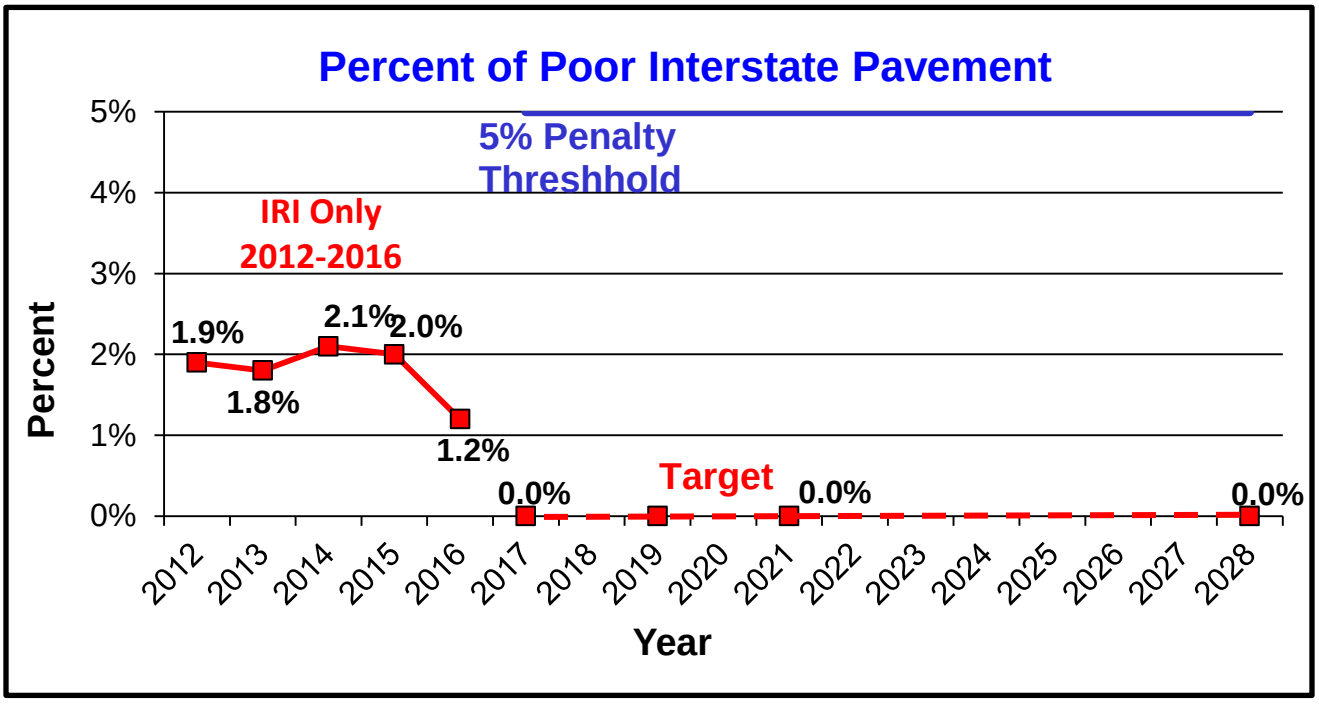
Chapter 2: Performance Measures & Targets

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 NHS Bridges classified as in Good condition
6) Percent of NHS Bridges classified as in Poor Condition

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.


Percent of Poor Interstate Pavement
5%
4%
3%
2%
1%
0%
Percent
5% Penalty Threshhold
IRI Only 2012-2016
1.9%
1.8%
2.1%
2.0%
1.2%
0.0%
Target
0.0%
0.0%
2012
2013
2014
2015
2016
2017
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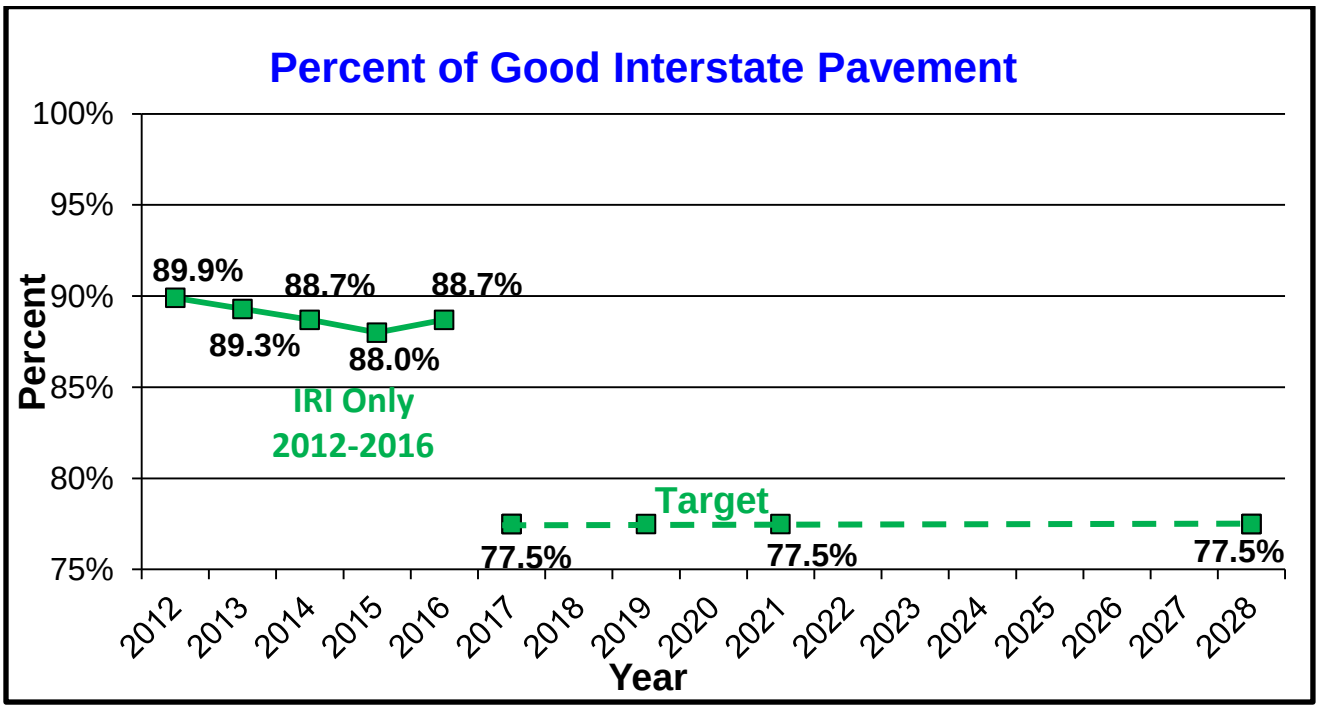
2028
Year


Percent of Good Interstate Pavement
100%
95%
90%
85%
80%
75%
Percent
89.9%
89.3%
88.7%
88.0%
88.7%
IRI Only 2012-2016
Target
77.5%
77.5%
77.5%
2012
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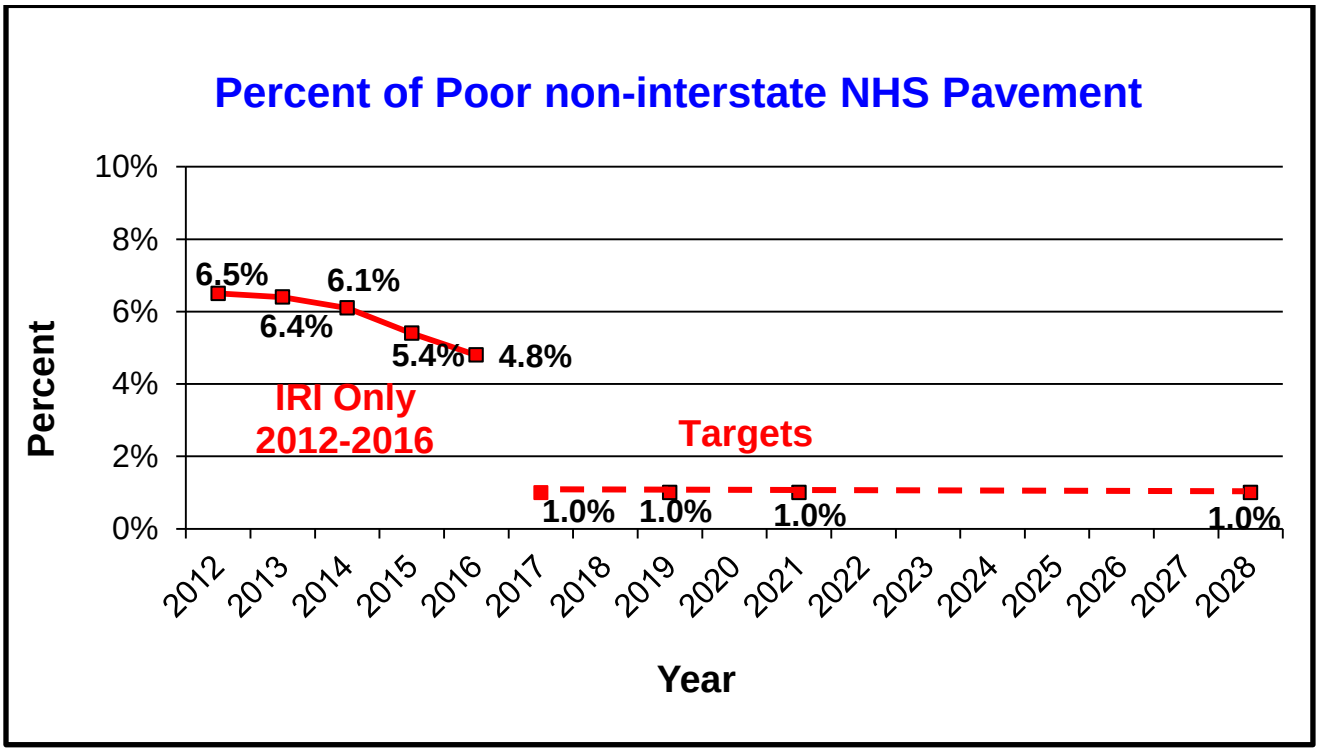
2028
Year


Percent of Poor non-interstate NHS Pavement
Percent
10%
8%
6%
4%
2%
0%
6.5%
6.4%
6.1%
5.4%
4.8%
IRI Only
2012-2016
Targets
1.0%
1.0%
1.0%
1.0%
2012
2013
2014
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2016
2017
2018
2019
2020
2021
2022
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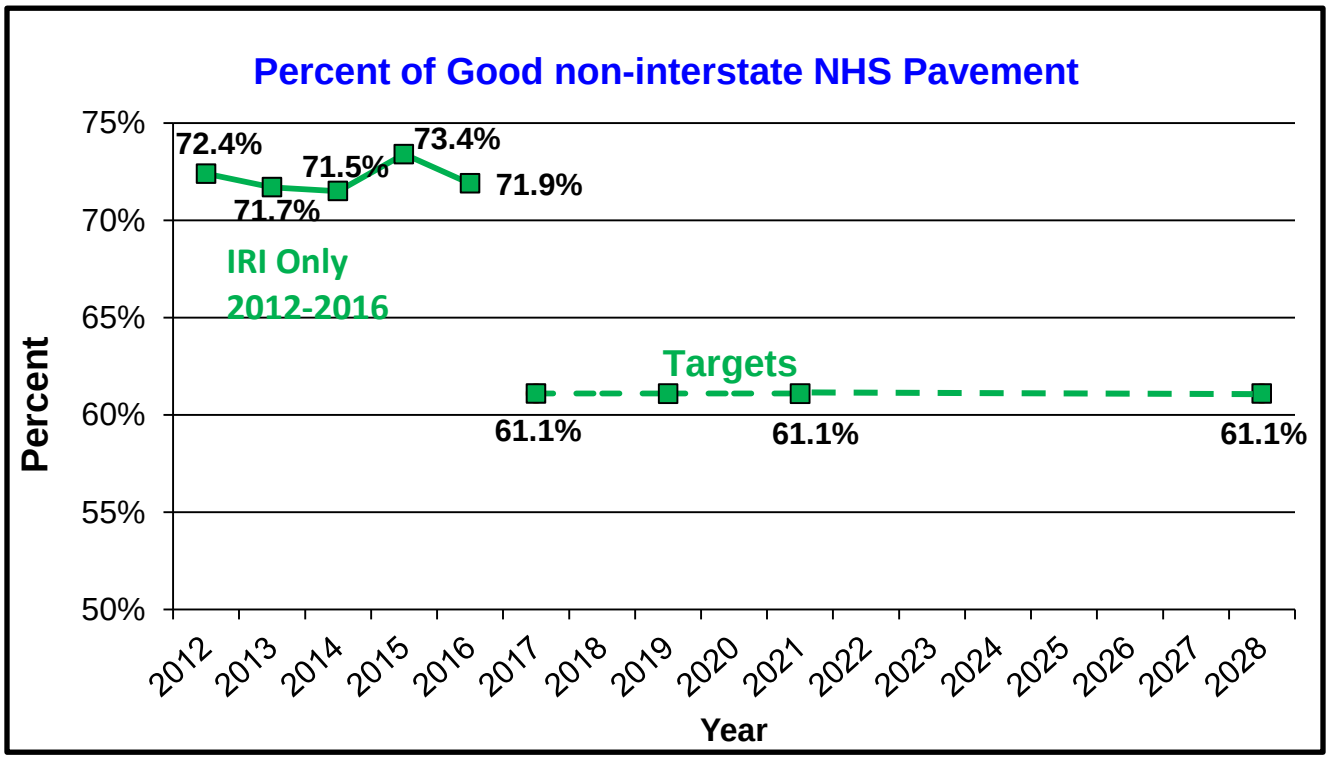
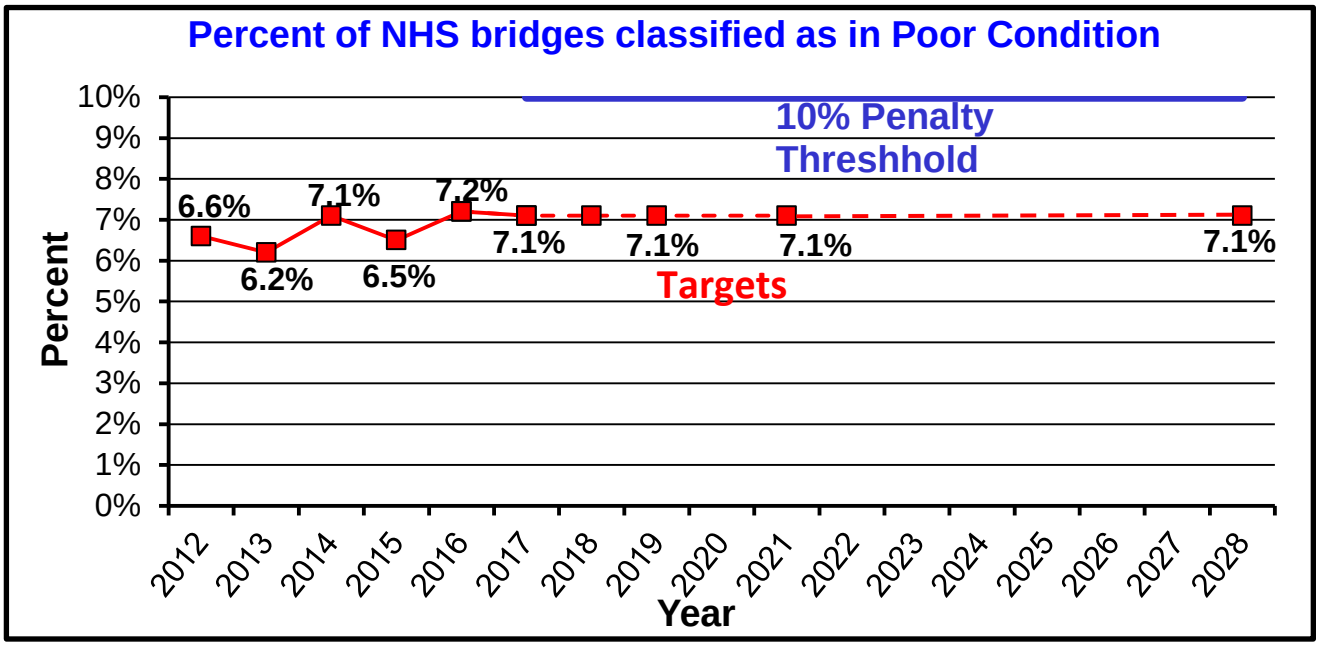
2027
2028
Year

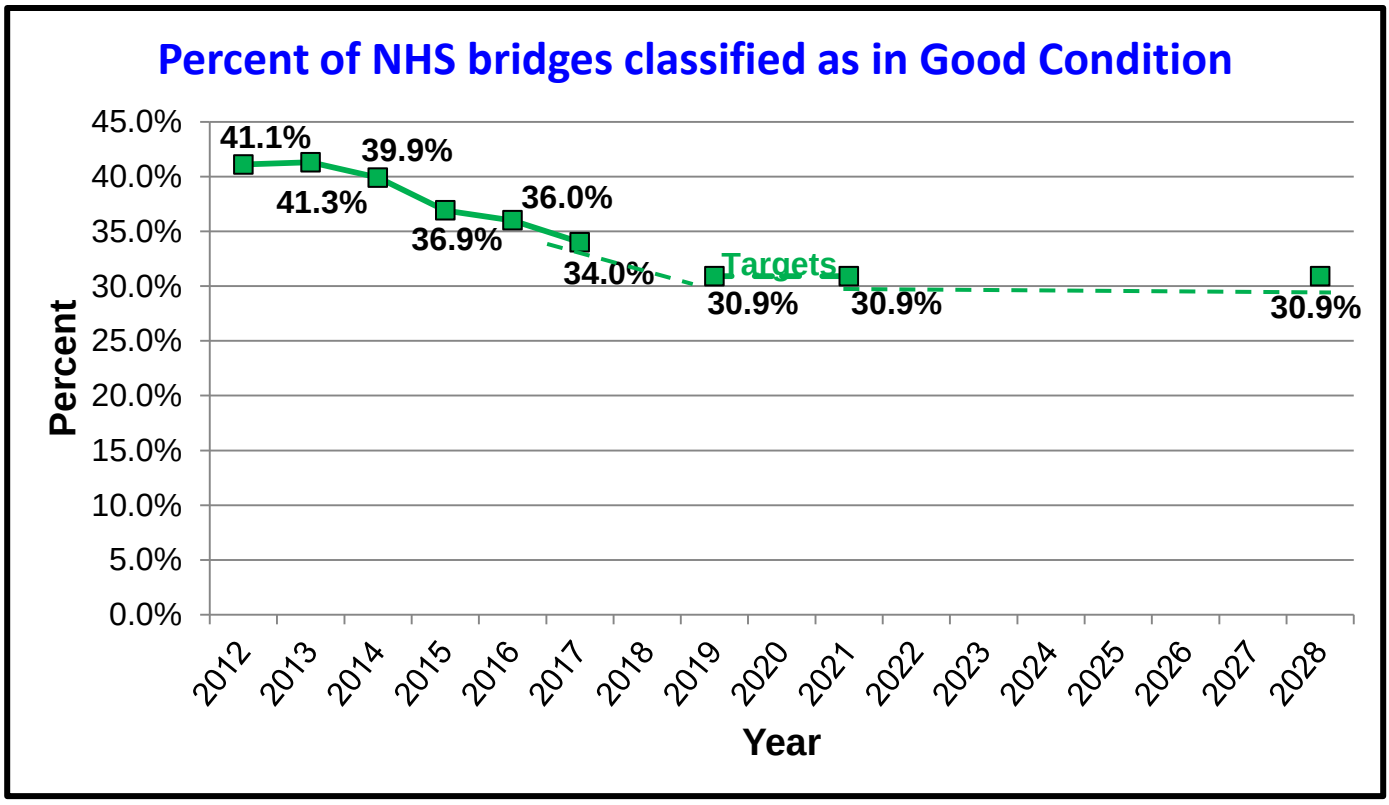

Percent of Good non-interstate NHS Pavement
Percent
75%
70%
65%
60%
55%
50%
72.4%
71.7%
71.5%
73.4%
71.9%
IRI Only
2012-2016
Targets
61.1%
61.1%
61.1%
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
Year

Bridges

Bridge 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 of bridges on the NHS classified as in poor condition 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 of bridges on the NHS classified as in good condition 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.





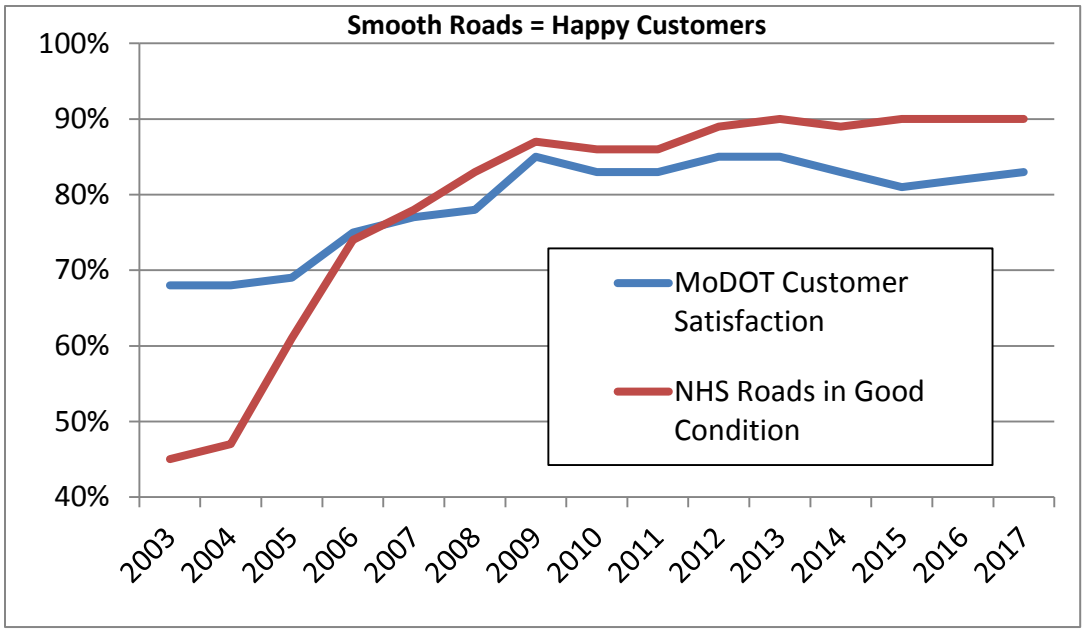
Overall Performance

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

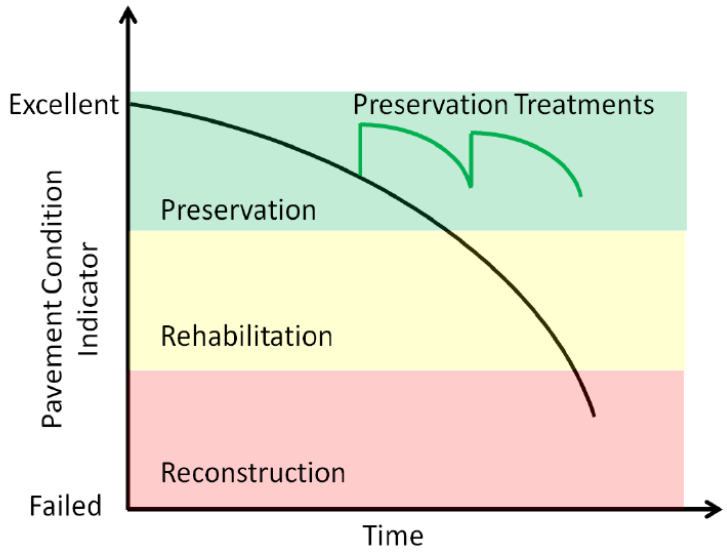
Ideally every mile of pavement and every bridge in the state would be in good condition. Unfortunately, funding is not available to improve and maintain Missouri's entire transportation system in good condition, so priorities must be established. Significant investments have been made to improve pavement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

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.



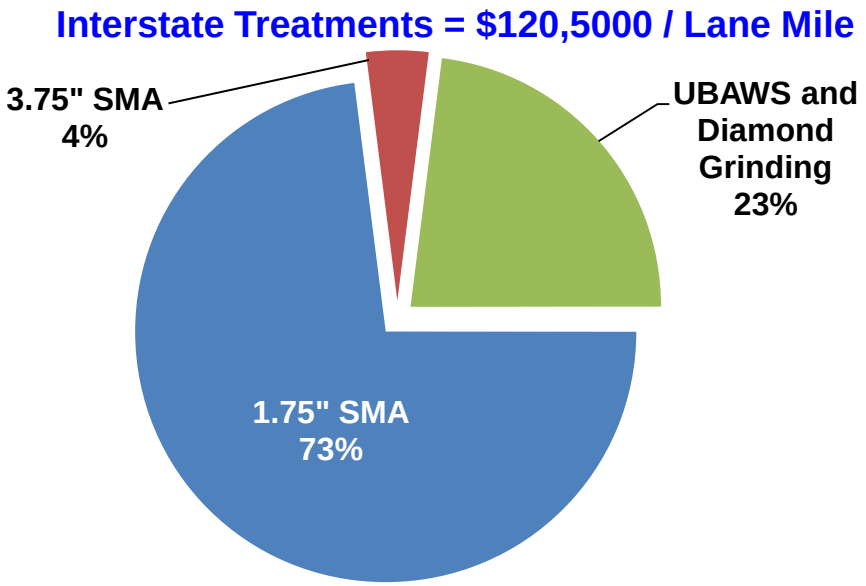
Pavements

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.

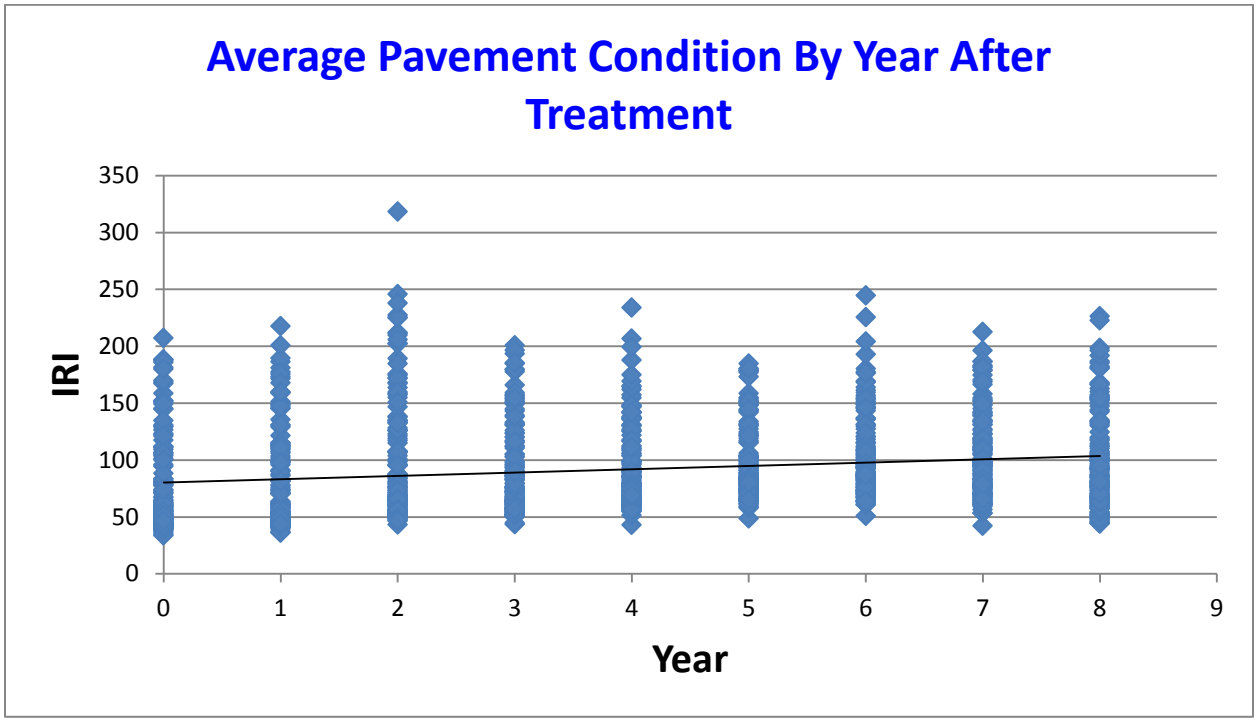
MoDOT's approach to pavement preservation is applying a thin, preventive maintenance treatment on a routine cycle. This is the most cost effective way to keep the roads in good condition for the traveling public and preserve the investments made over the last decade. In rare instances, pavements will 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 and reflect the analysis of existing pavement deterioration. These charts are the average of all seven MoDOT districts and represent a statewide average potential pavement treatment and associated cost for the 10 year asset management window i.e. each year the given work type may fluctuate but the overall 10 year average is shown in the chart.

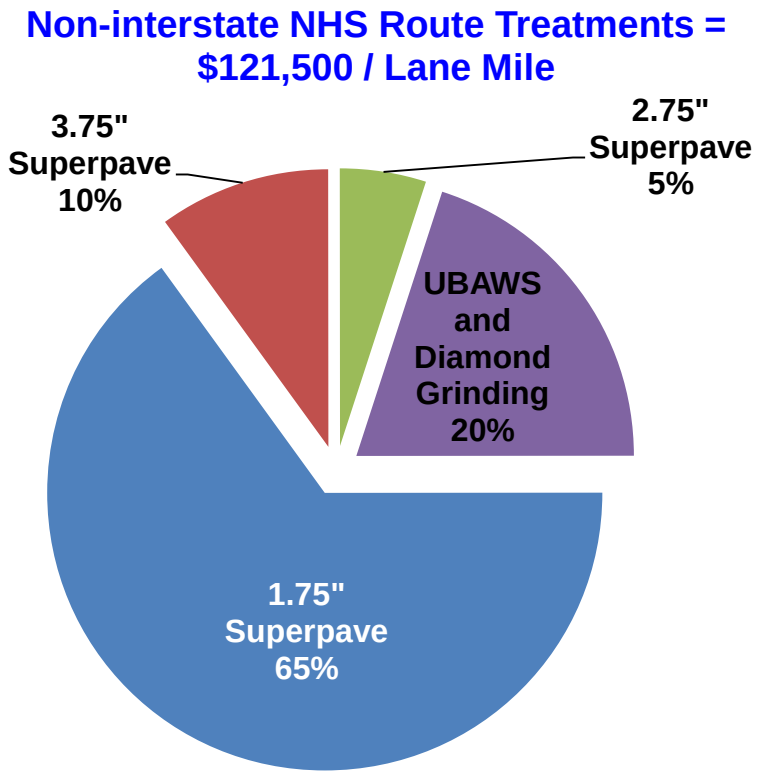
The estimated preventive maintenance cost for **interstate routes** is $120,500 per lane mile. The average treatment cycle for this investment is eight years. These estimates are based on the following treatments: 73 percent 1¾" stone mastic asphalt (SMA), 4 percent 3¾" SMA and 23 percent a combination of unbonded asphalt wearing surface (UBAWS) and diamond grinding.



Using the Asset Management System described in Chapter 2, MoDOT can determine the life cycle for assets. For example, the treatments assumed for interstates are expected to keep the pavement in good condition for 8 years. The following chart shows how interstate treatment data is used to confirm pavements remain in good condition for an average of 8 years.



The estimated preventive maintenance cost for **non-interstate NHS routes** is $121,500 per lane mile. The average treatment cycle for this investment is nine years. These estimates are based on the following treatments: 65 percent 1¾" superpave asphalt, 10 percent 3¾" superpave asphalt, 5 percent 2¾" superpave asphalt and 20 percent a combination of UBAWS and diamond grinding.



The pavement treatments identified in this chapter can be defined by the following federal work types.

Federal Work Type	MoDOT Work Type
Initial Construction	Limited – identified in STIP
Maintenance	UBAWS
Preservation	1.75" SMA 1.75" Superpave Diamond Grinding
Rehabilitation	2.75" Superpave 3.75" SMA 3.75" Superpave
Reconstruction	Limited – identified in STIP

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

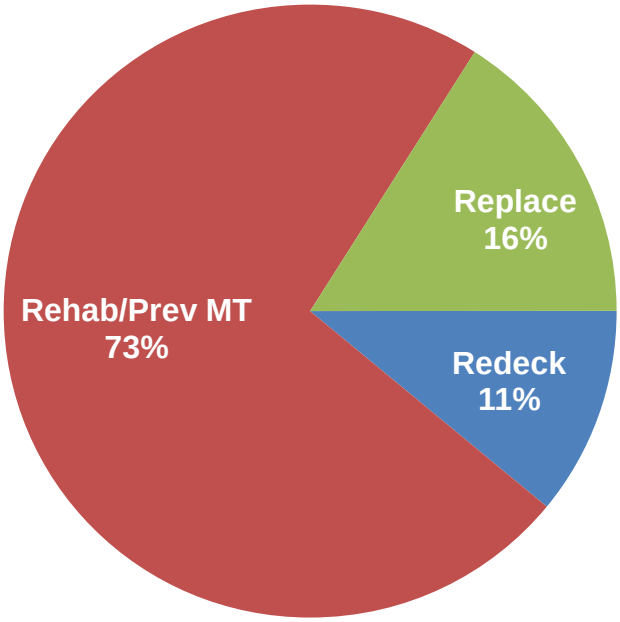
MoDOT also performs preventive maintenance activities for bridges. These activities are crucial to providing the lowest lifecycle costs and include:

- 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 an 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 cyclical 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. After evaluating historical deterioration on existing bridges, it was determined that on average 80 bridges need work on them each year to maintain the state of good repair. 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 potential work type planned for bridges on the NHS for the next ten years on average i.e. each year the given work type may fluctuate but the overall 10 year average is shown in the chart.

Planned Bridge Work by Work Type



The bridge work represented above varies in price per bridge and type of work being performed. The overall costs are as follows: Replacements - $279/sf; Redeck - $89/sf; Rehab/Preventive Maintenance $35/sf 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 worked needed on non-NHS bridges to keep MoDOT's entire bridge network in a state of good repair.

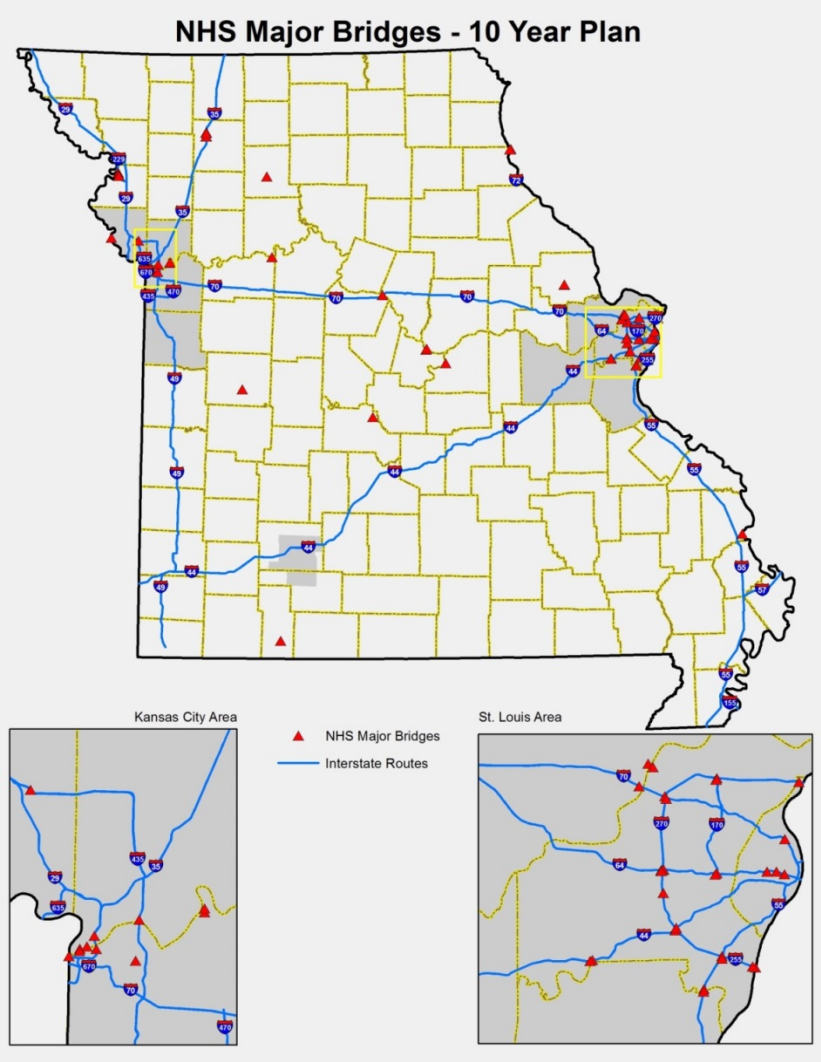
Even though approximately 80 bridges (approximately 944,000 square feet) on the NHS each year are getting improvements to maintain the state of good repair, MoDOT still sees approximately 20 bridges each year fall into the poor category. The number of bridges in the poor category on the NHS is currently 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 (208 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.



The bridge treatments identified in this chapter can be defined by the following federal work types.

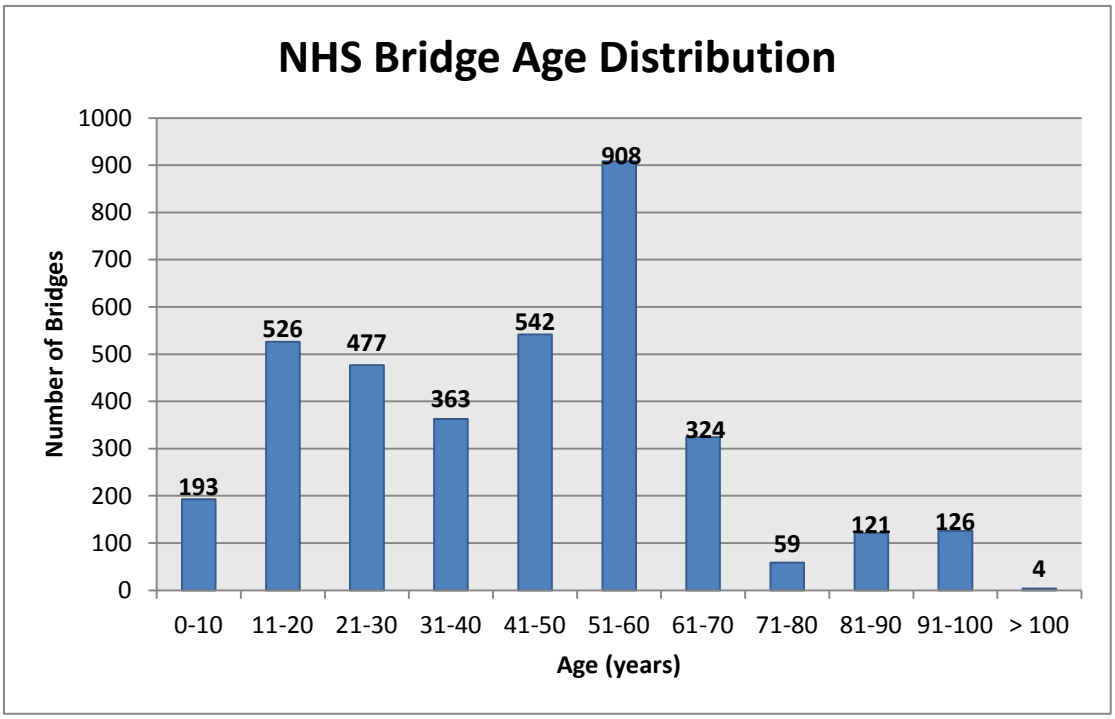
Federal Work Type	MoDOT Work Type
Initial Construction	Replacements
Maintenance	Prev MT
Preservation	Rehab/Prev MT
Rehabilitation	Rehab
Reconstruction	Redeck

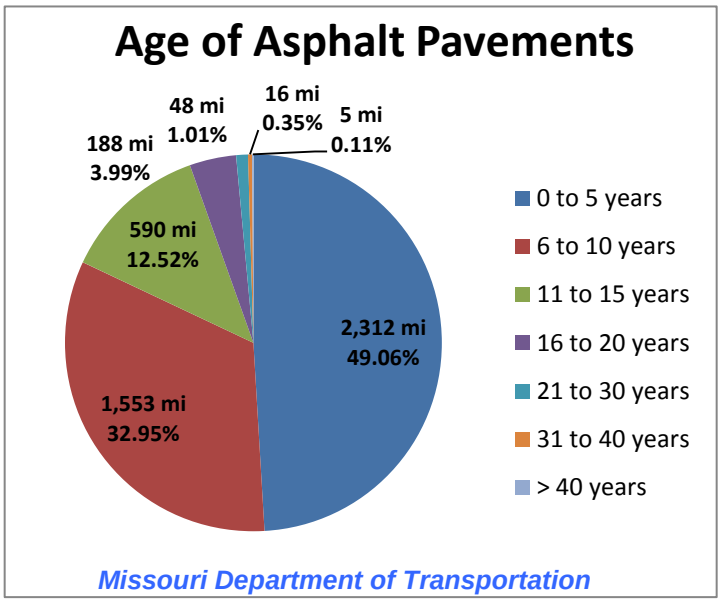
Bridge Lifecycle and Performance Measures

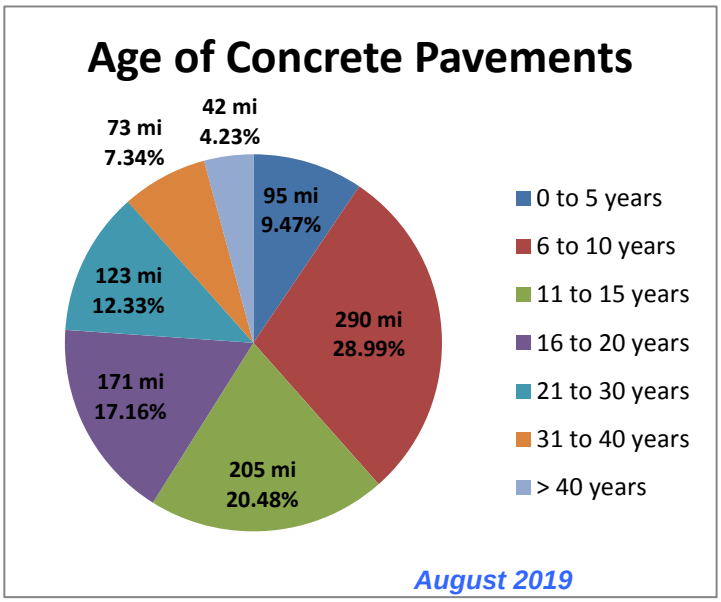
As described in Chapter 2, MoDOT's bridge performance goal is to sustain the state of good repair by staying flat on future bridge condition targets. Lifecycles of bridges are quite a bit different than pavements. Bridges newly replaced tend to last 50+ years while those repaired or rehabilitated will 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. To summarize the existing assets by age, the charts below were created for evaluating the system in addition to the condition data outlined in Chapter 1.

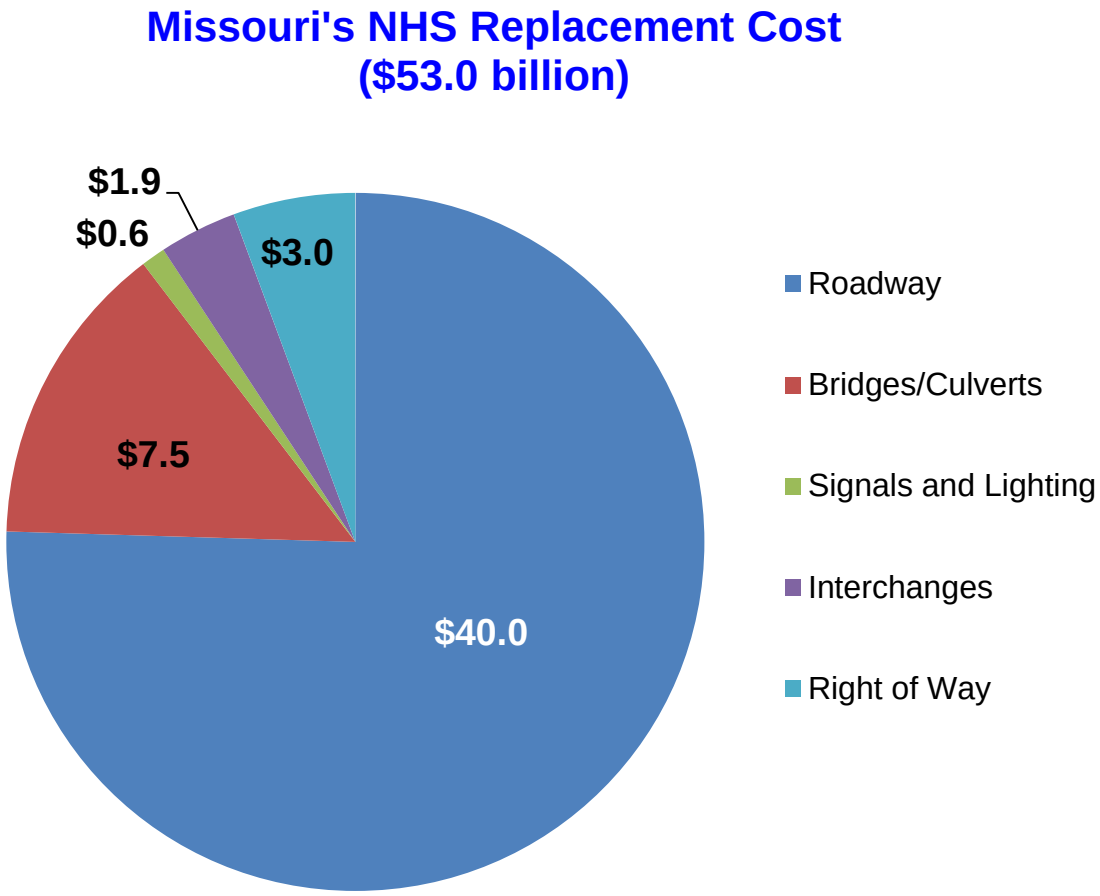






Chapter 4: Financial Plan and Investment Scenario

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. Detailed assumptions for the replacement cost calculation can be found in Appendix B.

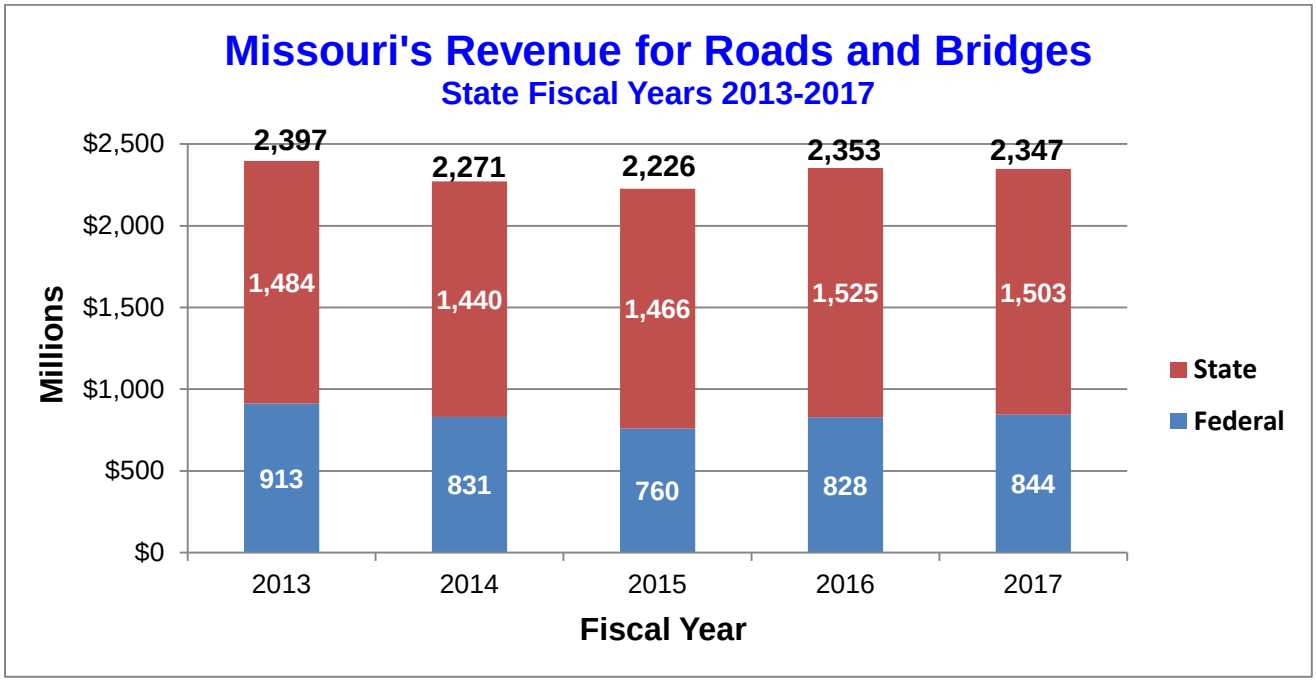


Funding Overview

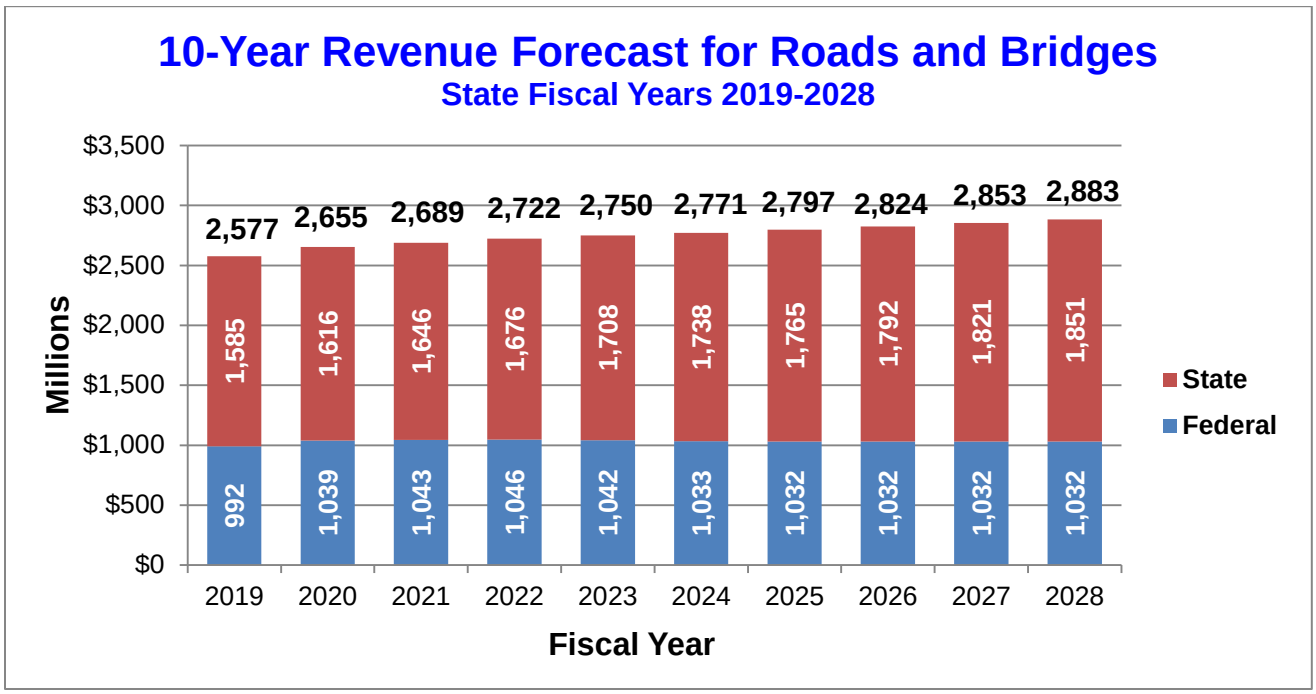
Missouri's state-owned NHS routes are funded from a combination of state and federal sources. The state funding available to maintain these routes includes the state fuel tax, motor vehicle and driver licensing fees, motor vehicle sales taxes and miscellaneous revenue.

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.

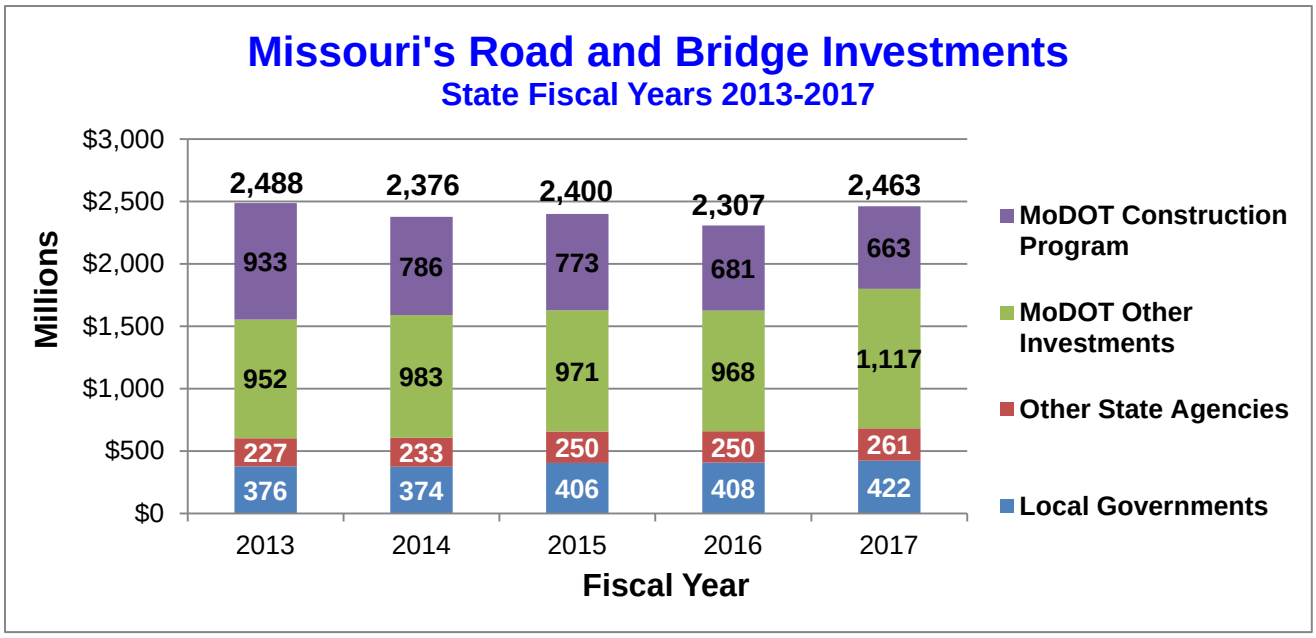
From fiscal years 2013 to 2017, the revenues have remained relatively stable as shown in the chart below.



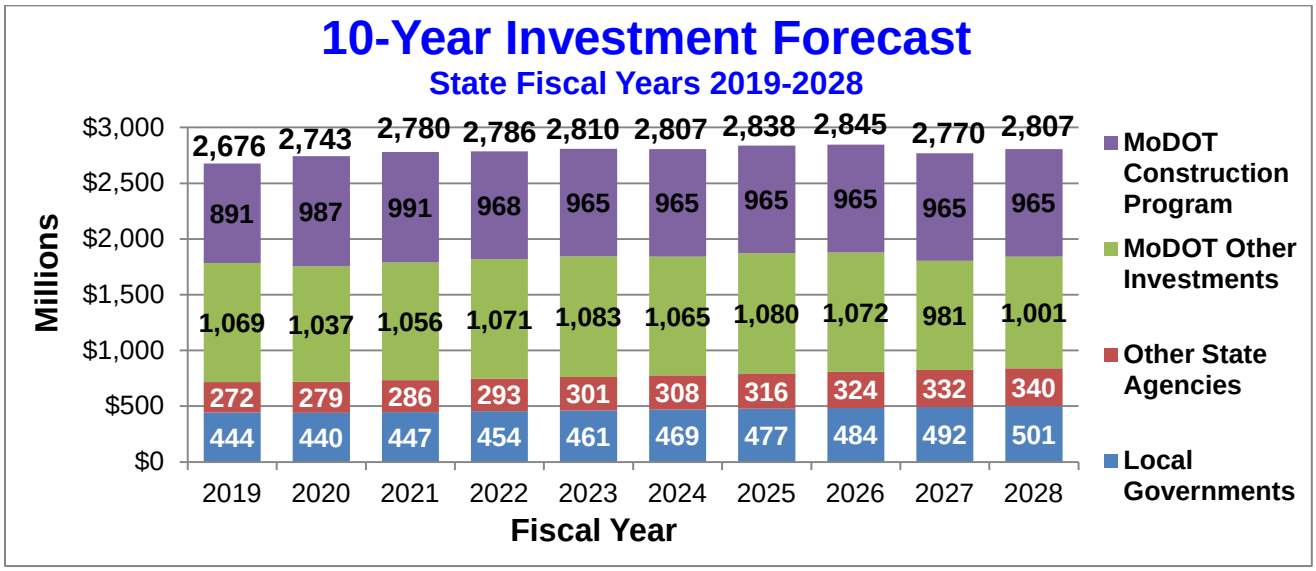
The chart below provides MoDOT's revenue forecast estimates for fiscal years 2019-2028.



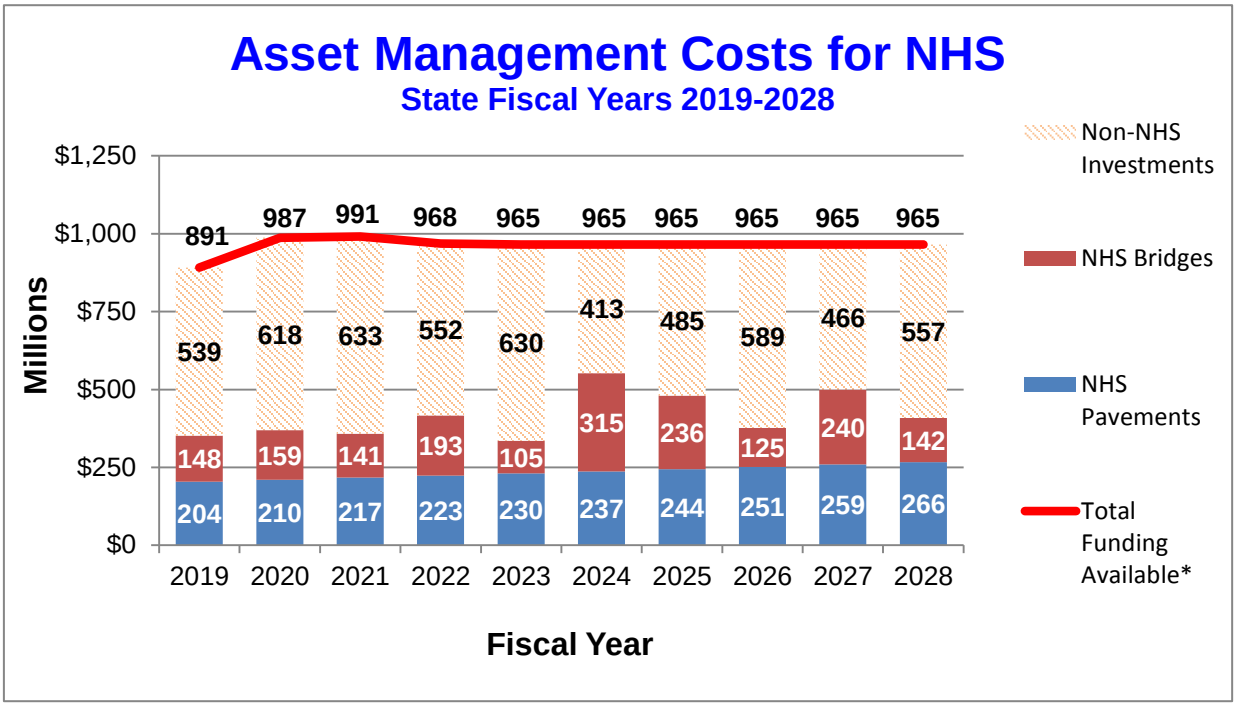
The forecasted revenues are available for road and bridge investments across the state. Missouri's road and bridge funding is allocated to local governments, other state agencies and MoDOT. The local government funding includes a share of state taxes and fees, and funding for locally-sponsored federal 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.



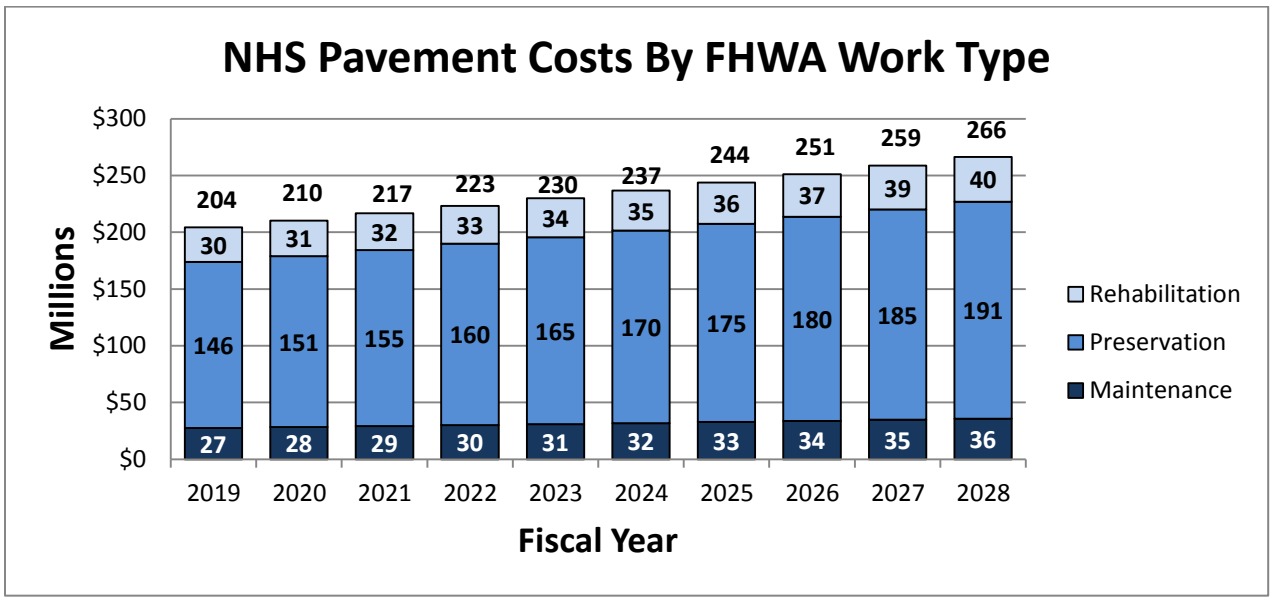
MoDOT's construction program investments are the primary funding source for maintaining NHS assets. MoDOT's 10-year financial forecast assumes construction program investments will average $963 million annually, as shown on the following chart.

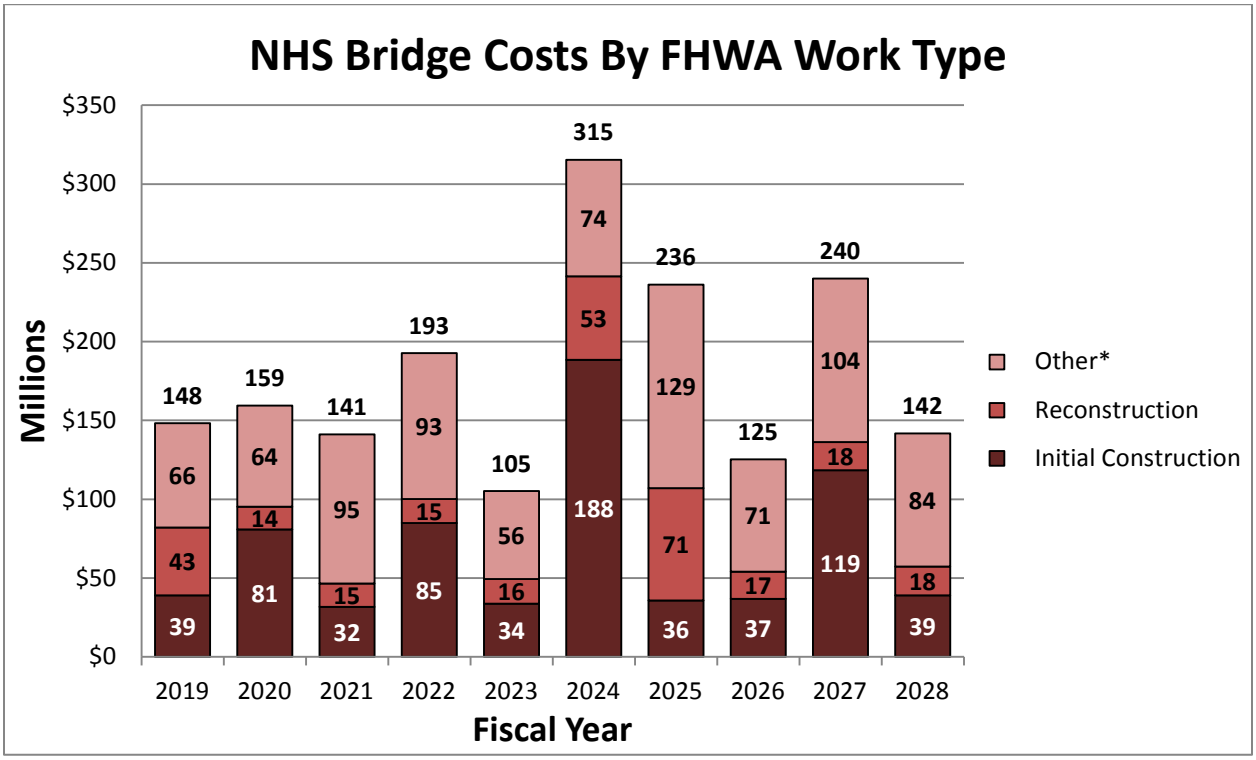


Based on the pavement and bridge work type assumptions from Chapter 3, MoDOT has estimated the cost to maintain existing conditions for all state-owned NHS routes. MoDOT's asset management plan assumes annual inflation costs of three percent, resulting in an annual cost range from $335 million to $552 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.



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





*Other includes maintenance, preservation and rehabilitation.

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. Therefore, MoDOT does not have a funding gap associated with maintaining the NHS system.

Performance Gaps

MoDOT focuses the majority of funding on asset management with the goal of maintaining existing conditions. Unfortunately, current available funding leaves a performance gap in system performance for reliability and congestion reduction improvements. MoDOT seeks and implements cost-effective, innovative solutions to close performance gaps, but results in these areas are expected to worsen going forward based on current funding, as shown in the following table.

System Performance Measure	2017 Baseline	2019 Target	2021 Target
Interstate Travel Time Reliability Measure: Percent of Reliable Person-Miles Traveled on the Interstate	91.6%	88.9%	87.1%
Non-Interstate Travel Time Reliability Measure: Percent of Reliable Person-Miles Traveled on the Non-Interstate NHS	92.3%		87.8%
Freight Reliability Measure: Truck Travel Time Reliability Index	1.25	1.28	1.30

In total, MoDOT's outreach and long range planning activities have identified an annual funding gap totaling $825 million for the following areas that are beyond maintaining the system:

- $95 million to improve state-owned bridge conditions
- $50 million to improve road conditions
- $25 million to stabilize the level of MoDOT's maintenance and operations efforts to keep pace with inflationary cost increases
- $275 million to invest in projects that increase economic growth and improve safety
- $300 million for major interstate reconstruction
- $80 million to improve multimodal transportation options

Additional information regarding unfunded transportation needs, including future expectations of demographics, employment, freight, travel and advanced technology can be found in MoDOT's 2018 long range transportation plan at http://www.modot.org/LRTP/.

Locally-Owned NHS Routes

Missouri's NHS system includes 265 miles of locally-owned routes, including 86 bridges with 1,093,137 square feet of bridge deck. MoDOT has processes in place to collect the pavement data each year for these routes and inspects all the bridges on these routes. This data is shared with local planning agencies and officials.

To fund asset management needs on 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 for the 10-year TAMP planning horizon. In addition, many cities and counties have local taxes and fees dedicated for transportation purposes totaling approximately $800 million each year.

While MoDOT does not dictate how these local funds are invested, MoDOT works collaboratively with local officials to share data, expertise and guidance to ensure these routes are properly maintained in a state of good repair. A listing of local owners is provided on page 4-6.

Cities

Aurora	Kirkwood
Cape Girardeau	Liberty
Carthage	Monroe City
Clayton	Neosho
Columbia	New Madrid
Cottleville	O'Fallon
Dardenne Prairie	Park Hills
Edina	Springfield
Excelsior Springs	St. Charles
Fulton	St. Joseph
Independence	St. Louis
Jennings	St. Peters
Joplin	Trenton
Kansas City	University City
	Wentzville

Counties

Boone
Greene
Jackson
St. Charles
St. Louis

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. See Appendix C for specific risks under each of these categories.

Risk Category	Impact				Likelihood				Readiness				
	Little Impact			Devastating	Little Chance			Fairly Certain	Plans in Place and Tested			Unprepared	
Financial	1	2	**3 (3.3)**	4	1	2	**3 (3.0)**	4	1	**2 (2.2)**	3	4	
Transportation System Failures	1	2	**3 (3.0)**	4	1	**2 (2.0)**	3	4	1	**(1.9)**	**2**	3	4
Natural Disasters	1	2	**3 (3.2)**	4	1	**2 (2.3)**	3	4	1	**(1.6)**	**2**	3	4

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 reduce 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 vulnerablities that could potentially affect assets. MoDOT has identified assets vulnerable to extreme flooding with some recent flooding events occuring 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. In the future, further evaluations of assets prone to natural disasters will be analyzed and considerations will be given to address the recurrent issues through projects programmed in MoDOT's STIP. MoDOT maintains records of all locations affected by natural disasters, and further documents if any repairs were made, and if those repairs were emergency repairs or permanent repairs. Under 23 CFR Part 667 requirements, MoDOT has identified two sites that have had damage and required permanent repairs repeatedly. Those sites and the correponding repairs are listed below.

- Platte County, Route 92 in Tracy near the Platte River.
  Event MO-07-01, Maintenance repaired the aggregate shoulders that had been washed out due to water overtopping the roadway.
  Event MO-11-02, Contract repair of eroded bank and installation of guardrail (4P3003, 4P1914)

- Maries County, US 63 at Gasconade River, Bridge A3760
  Event MO-08-02, Maintenance repaired and reshaped the fill slopes after shoulders and fill slopes were eroded due to water overtopping the roadway.
  Event MO-17-01, Contract scour repair at pier 7. (5P3298)

Although MoDOT has identified only two locations with repeated damaged that required permanent repairs, several other locations have experienced repeated damage but have only required emergency repairs. These emergency repairs are documented and kept on file along with the permanent repair locations.

Chapter 6: TAMP Process and Implementation

Developing, 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.

Missouri taxpayers have responded favorably to this approach as MoDOT's customer satisfaction scores have increased from 68 percent in 2004 to over 80 percent every year since this approach was implemented.

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.

In 2017, these efforts were further developed by customizing the statewide asset management assumptions into MoDOT district specific inputs. Each of the seven MoDOT districts have teams that evaluate treatment types, treatment life cycles, costs and the average annual number of treatments needed to maintain a state of good repair.

District plans also include 10-year funding projections based on the Missouri Highways and Transportation Commission's funding distribution policy. Districts receive STIP funds based on formulas that use the amount of highway travel, bridge size, highway miles, population and employment. Districts use asset management models to run various treatment type scenarios to determine the optimal treatment options that could be accomplished with the limited funding available.

An example of a district asset management's summary model is shown below. Each district uses this Excel-based model to develop assumptions and various investment scenarios to ensure current pavement and bridge conditions can be maintained with existing funding. The model provides a tool to manage the condition of pavement and bridge assets by allowing quick what-if analysis to determine the benefit-cost over the life cycle of assets for alternative actions, and identifies short- and long-term budget needs for managing the condition of pavement and bridge assets. Each MoDOT district uses the model to recommend optimal programs and implementation schedules to manage the condition of pavement and bridge assets within policy and budget constraints. The model includes the following sections:

- Pavement assumptions: This section includes the inventory of lane miles, current condition, planned condition for investment scenarios, treatment cost per mile, average treatment life, number of miles treated per year and estimated annual spending. Each of these items are identified for interstates, other major routes (non-interstate NHS), and all other state routes.

- Non-Major Bridge Assumptions: This section includes the bridge inventory for interstates, other major routes (non-interstate NHS) and all other state routes. The cost per square foot is included for the bridge repair options (replacement, redeck, rehabilitation and preventive maintenance) to arrive at an average cost per square foot.

- Major Bridge Assumptions: Listing of major bridges, which are greater than 1,000 feet, to be repaired over the 10-year time frame. This list is maintained by MoDOT's bridge division in a separate database.

- Estimated Funding Summary: A key component of MoDOT's asset management planning is ensuring each district's plan is fiscally constrained. This section identifies the expected funding available and uses the pavement and bridge assumptions information to develop 10-year cost estimates.

- Results: High-level summary of the expected pavement and bridge conditions at the end of the 10-year planning horizon.

A snapshot of the model for the St. Louis district is shown on the following page.

St. Louis District

($ Millions) - Amounts Do Not Include Engineering

Annual Cost Inflation: 3.0%

Pavement Assumptions:

	Lane Miles[1]	Current Percent Good	Planned Percent Good	Treatment Cost Per Lane Mile	Avg Treatment Life (Years)	Number of Miles Treated Per Year	Estimated Annual Spending
Interstates	1,694	85%	85%	$103,800	8	180	$18.7
Other Major Routes	1,806	90%	90%	$81,300	8	203	$16.5
Minor Routes (>400 ADT)	2,102	73%	73%	$32,600	9	170	$5.6
Low Volume Routes (<400 ADT)	*138*	*48%*	*Maintained by MoDOT Operations*				
							$40.8

[1] *Does not include ramps, which total 1% additional miles statewide.*

Major Bridge Assumptions:

	Year Needed	Inflated
Major Bridge - Replacements		
I-44 bridge over Meramec River in Fenton (A2643,L0623)	2020	$69.8
I-64 bridge over railroads/ramps in St. Louis City (A1523)	2021	$13.9
I-270 bridge over Mississippi River at Chain of Rocks (A0890)	2021	$144.9
Major Bridge - Repairs		
I-70 bridge over Missouri River at Blanchette (A3292)	2021	$23.2
I-255 bridge over Mississippi River in St. Louis (A1850,A4936)	2022	$11.9
Rte 799 bridge over Mississippi River (MLK) in St. Louis City (A4856)	2023	$36.9
I-64 bridge over Vandeventer in St. Louis City (L0667)	2025	$26.1
	Total:	$326.7

Non-Major Bridge Assumptions[2]:

Overall Weighted Cost Per Square Foot: $42

11%	3	Replacements - Critical Condition ($194 sq ft)
3%	1	Redecks - Critical Condition ($81 sq ft)
37%	11	Rehabs - Fair Condition ($30 sq ft)
49%	15	Prev. Maintenance - Fair Condition ($14 sq ft)
100%	30	

	Total Number of Bridges	Number of Critical Condition Bridges	Number of Fair Condition Bridges	Avg Critical/Fair Bridge Sq Ft	Avg Cost Per Bridge	Avg Annual Number to Repair (GOAL)	Avg Annual Number to Repair (PLANNED)	Estimated Annual Spending
Non-Major Bridges								
On Interstates	318	19	180	14,945	$0.6	12	12	$7.5
On Other Major Routes	279	8	118	16,600	$0.7	8	8	$5.5
On Minor Routes (>400 ADT)	280	9	145	12,537	$0.5	9	9	$4.7
Low Volume Routes (<400 ADT)	21	2	9	6,074	$0.3	1	1	$0.3
	898	38	452			30	30	$18.0

[2] *Includes only span-type bridges.*

Estimated Funding Summary:

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Distributed Funding Available[3]	$193.9	$148.5	$210.3	$194.2	$194.2	$194.2	$194.2	$194.2	$216.1	$216.1
Estimated SWIMB Allocation	$10.6	$10.6	$10.6	$10.6	$10.6	$10.6	$10.6	$10.6	$10.6	$10.6
Transp. Alternatives Funds	$2.3	$2.4	$2.5	$2.5	$2.5	$2.5	$2.5	$2.5	$2.5	$2.5
Operations and Other Funds	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Potential Funding Available	**$206.8**	**$161.5**	**$223.4**	**$207.3**	**$207.3**	**$207.3**	**$207.3**	**$207.3**	**$229.2**	**$229.2**
Pavement Costs	$43.2	$44.5	$45.9	$47.3	$48.7	$50.1	$51.6	$53.2	$54.8	$56.4
Non-Major Bridge Costs	$19.1	$19.7	$20.2	$20.9	$21.5	$22.1	$22.8	$23.5	$24.2	$24.9
Major Bridge Costs	$0.0	$0.0	$69.8	$182.0	$11.9	$36.9	$0.0	$26.1	$0.0	$0.0
ADA Transition Plan	$3.1	$3.2	$3.3	$3.4	$3.5	$3.6	$3.7	$3.8	$3.9	$4.1
Guardrail Updates	$2.6	$2.7	$2.8	$2.9	$3.0	$3.1	$3.1	$3.2	$3.3	$3.4
Other TCOS Costs	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total Costs	**$68.1**	**$70.1**	**$142.0**	**$256.4**	**$88.6**	**$115.8**	**$81.3**	**$109.8**	**$86.2**	**$88.8**
Annual Funds Remaining	**$138.7**	**$91.4**	**$81.4**	**($49.1)**	**$118.7**	**$91.5**	**$126.0**	**$97.5**	**$143.0**	**$140.4**
Cumulative Funds Remaining	**$138.7**	**$230.2**	**$311.6**	**$262.5**	**$381.2**	**$472.7**	**$598.8**	**$696.2**	**$839.2**	**$979.6**

[3] *Based on 2017-2021 STIP Targets. Amounts have been reduced by GARVEE payments.*

Results:

	Goal	Plan
Pavement Conditions - % Good		
Interstate	85%	85%
Majors	90%	90%
Minors (>400ADT)	73%	73%
# of Critical/Fair Condition Bridge Repairs/Year		
Interstates	12	12
Major Routes	8	8
Minor Routes (>400ADT)	9	9
Low Volume Routes (<400ADT)	1	1
Total	30	30
Funds Remaining in 2027		$979.6

There are additional assumption tabs for pavements and bridges as shown below. The pavement assumptions include treatment types, lane miles costs for each treatment, percentage of each treatment and years of treatment life to determine the averages used on the summary tab.

Asset Management Plan - Pavement Treatment Assumptions

Costs Per Lane Mile

	Treatment	Lane	Shoulder	Mill	Stripes	Rumbles	Mobilization (4.5%)	Total Cost	% of Treatments	Weighted Cost	Years	Cost Per Year	Wgt Cost Per Year	Weighted Years
Interstate	1.75 sma has 1/2 scratch on 50%*	67,500	33,750	6,400	1,200	1,000	4,943	114,793	35.0%	40,178	8.0	14,349	5,022	2.8
	3.75	111,700	55,850	6,400	1,200	1,000	7,927	184,077	10.0%	18,408	9.0	20,453	2,045	0.9
	1.75 sma has 1/2 scratch on 50%*	67,500	0	6,400	1,200	1,000	3,425	79,525	35.0%	27,834	8.0	9,941	3,479	2.8
	3.75	111,700	0	6,400	1,200	1,000	5,414	125,714	10.0%	12,571	9.0	13,968	1,397	0.9
	Diamond and ubaws*	30,000	0	14,100	1,200	1,000	2,084	48,384	10.0%	4,838	7.0	6,912	691	0.7
									100.0%	103,829		13,125	12,635	8.1
									* Preventive Maintenance Treatments	91,062				
Other Major Roads	1.75 SP 70	48,100	24,050	6,400	1,200	1,000	3,634	84,384	30.0%	25,315	7.0	12,055	3,616	2.1
	3.75	93,000	46,500	6,400	1,200	1,000	6,665	154,765	10.0%	15,476	10.0	15,476	1,548	1.0
	3	68,500	34,250	6,400	1,200	1,000	5,011	116,361	5.0%	5,818	8.0	14,545	727	0.4
	1.75 SP 70	48,100	0	6,400	1,200	1,000	2,552	59,252	40.0%	23,701	8.0	7,406	2,963	3.2
	3.75	93,000	0	6,400	1,200	1,000	4,572	106,172	5.0%	5,309	10.0	10,617	531	0.5
	3	68,500	0	6,400	1,200	1,000	3,470	80,570	5.0%	4,028	8.0	10,071	504	0.4
	ubaws	30,000	0	0	1,200	1,000	1,449	33,649	5.0%	1,682	7.0	4,807	240	0.4
									100.0%	81,330		10,711	10,129	8.0
Minor Roads	1 clc	30,500	2,440	0	1,200	0	1,536	35,676	25.0%	8,919	12.0	2,973	743	3.0
	Chip	9,900	0	0	1,200	0	500	11,600	40.0%	4,640	5.0	2,320	928	2.0
	Cold mix	17,500	1,400	0	1,200	0	905	21,005	5.0%	1,050	10.0	2,100	105	0.5
	1 clc	30,500	2,440	6,400	1,200	0	1,824	42,364	10.0%	4,236	12.0	3,530	353	1.2
	1.75 sp	37,200	18,600	6,400	1,200	1,000	2,898	67,298	10.0%	6,730	10.0	6,730	673	1.0
	ubaws	30,000	0	0	1,200	1,000	1,449	33,649	5.0%	1,682	7.0	4,807	240	0.4
	3.75	93,000	0	6,400	1,200	1,000	4,572	106,172	5.0%	5,309	15.0	7,078	354	0.8
									100.0%	32,566		4,220	3,397	8.8

The bridge assumptions tab includes the type of bridge work, number of bridges to be repaired each year and cost assumptions to determine an average cost per square foot.

Asset Management Plan - Typical (<1,000 ft) Bridge Assumptions

Cost Per Square Foot Assumptions:

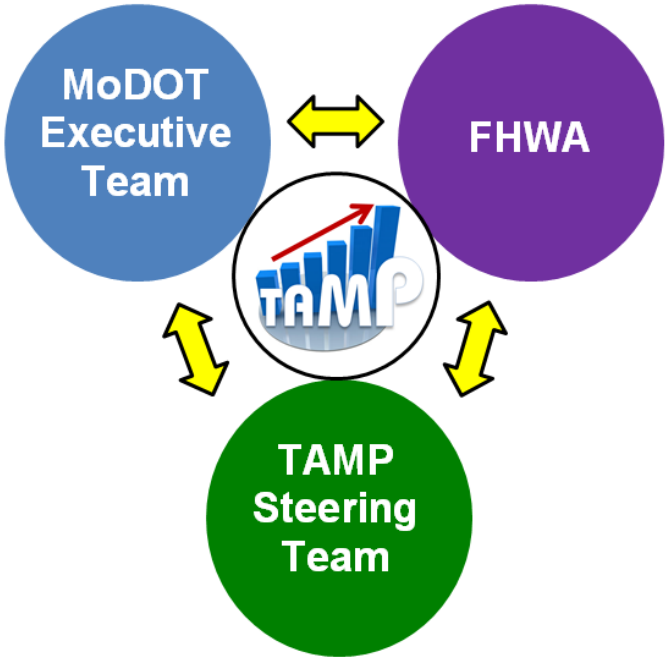
Type of Bridge Work	% of Type of Work	Number Per Year	Increase Existing Br.	Bridge Cost Per	Roadway Items	Total Unit Price
Replacements	22%	55	10%	$110	1.6	$194
Redecks	10%	25	5%	$55	1.4	$81
Rehab	28%	70	0%	$25	1.2	$30
Preventive Maintenance	40%	100	0%	$12	1.2	$14
	100%	250				

MoDOT districts use asset management models to guide project selection decisions for the STIP. These project programming decision are done in collaboration with planning partners, that include members responsible for the locally-owned NHS.

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 performance gap (funding shortfall) for non-NHS assets. After realizing this funding gap, the Missouri Highways and Transportation Commission (MHTC) established an Asset Management Deficit Program in 2017 to ensure adequate funding for a state of good repair for non-NHS assets. The MHTC took action again in February 2019 to align MoDOT's funding distribution with its asset management plan. These actions included, funding these categories at a level necessary to maintain the system condition and renaming the funding categories as Asset Management and System Improvement. These changes increase transparency with customers regarding the amount of funding required to maintain such a large system.

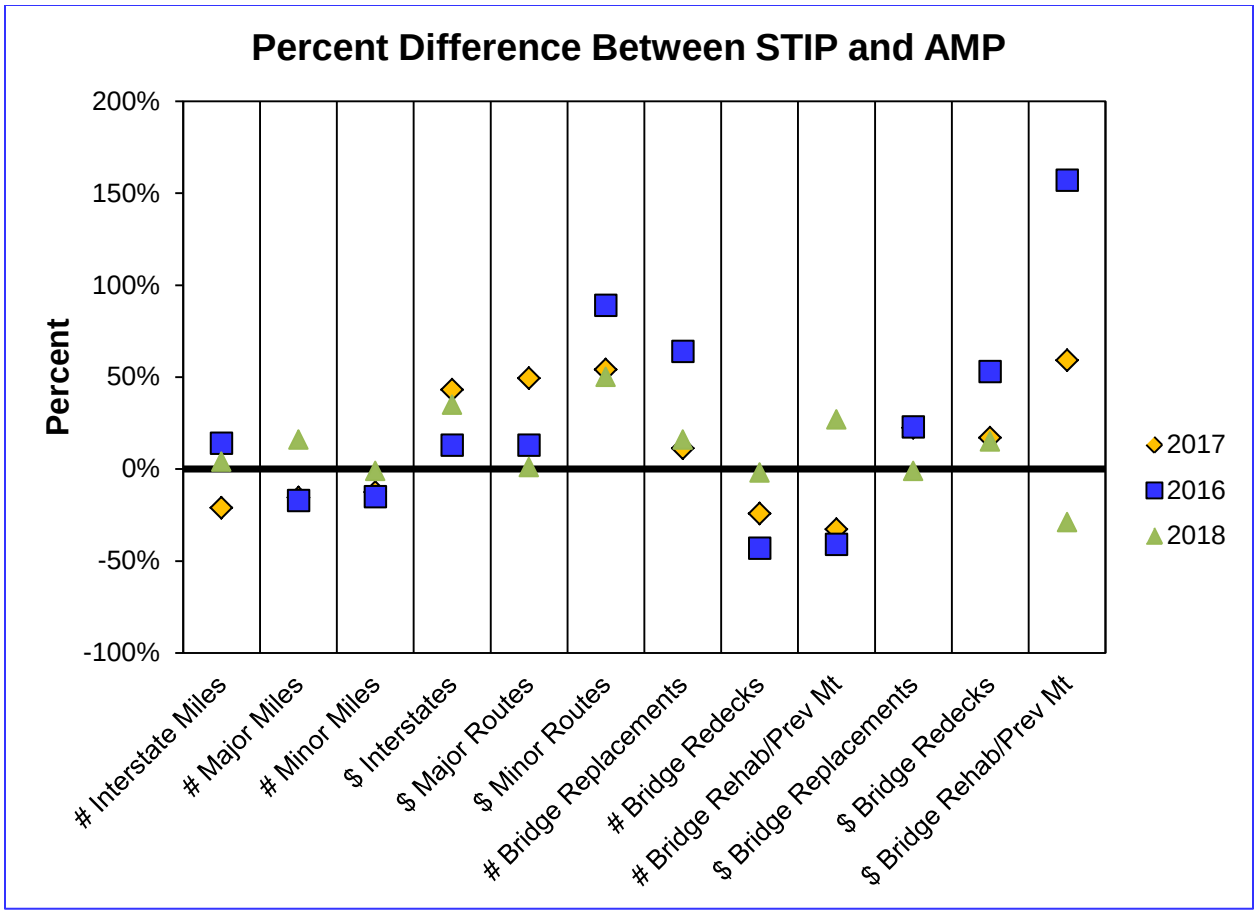
Implementing Asset Management

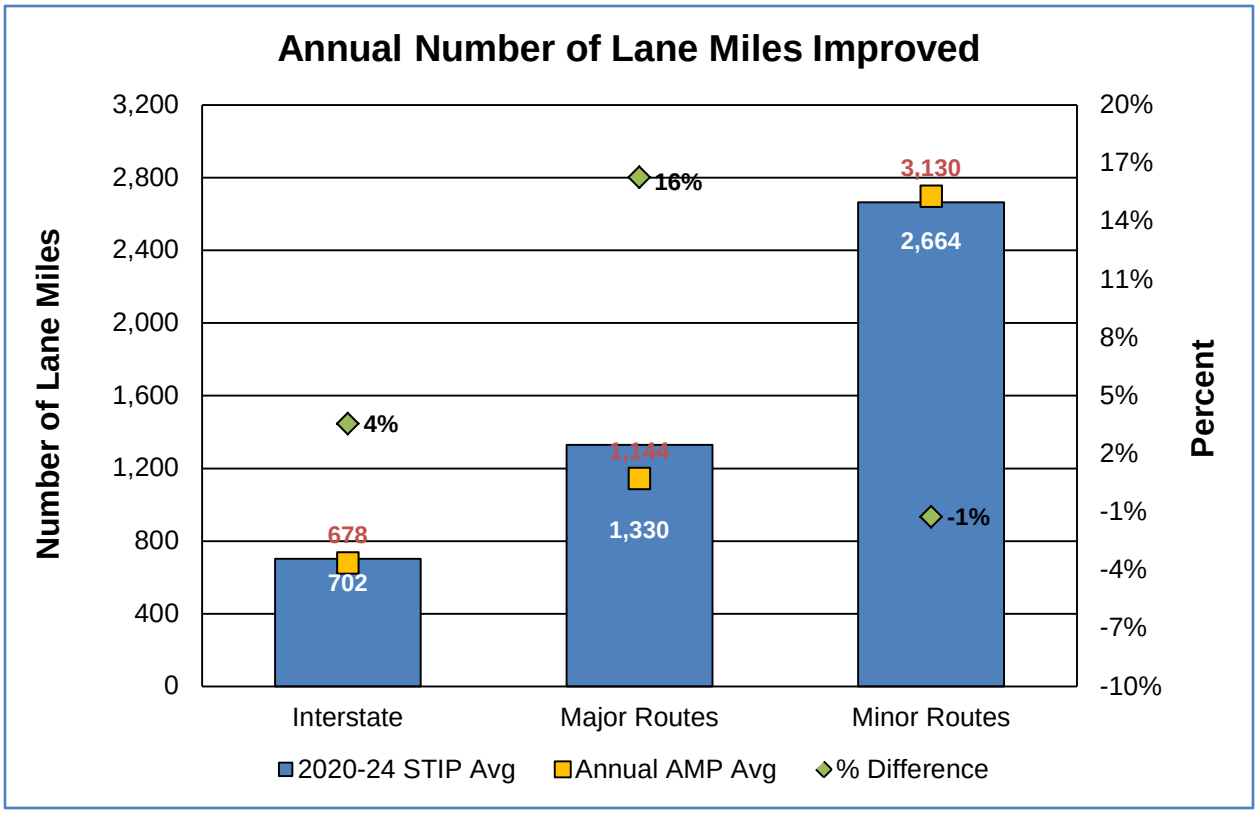
MoDOT established a TAMP Steering Committee in 2015 made up of MoDOT senior leadership positions and the Federal Highway Administration. The purpose of this committee is to set the direction of the TAMP, monitor the success of the TAMP and to make improvements to the process.

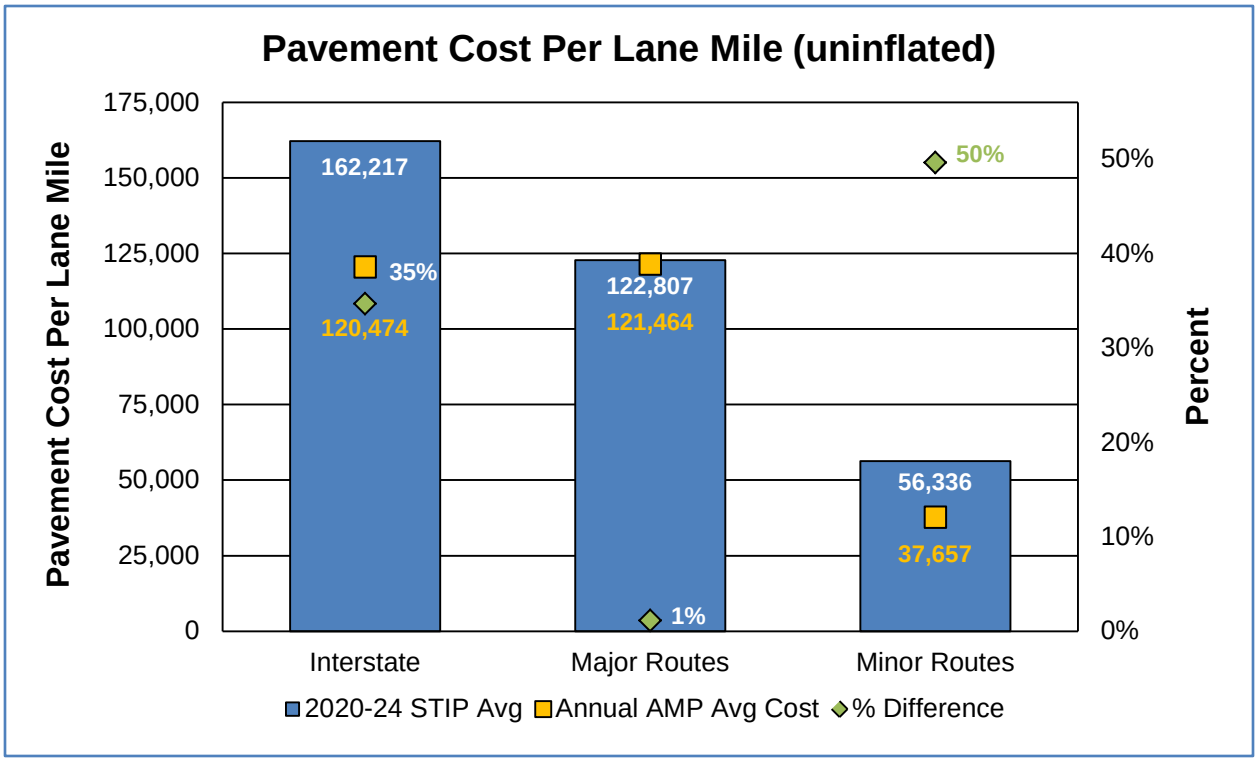


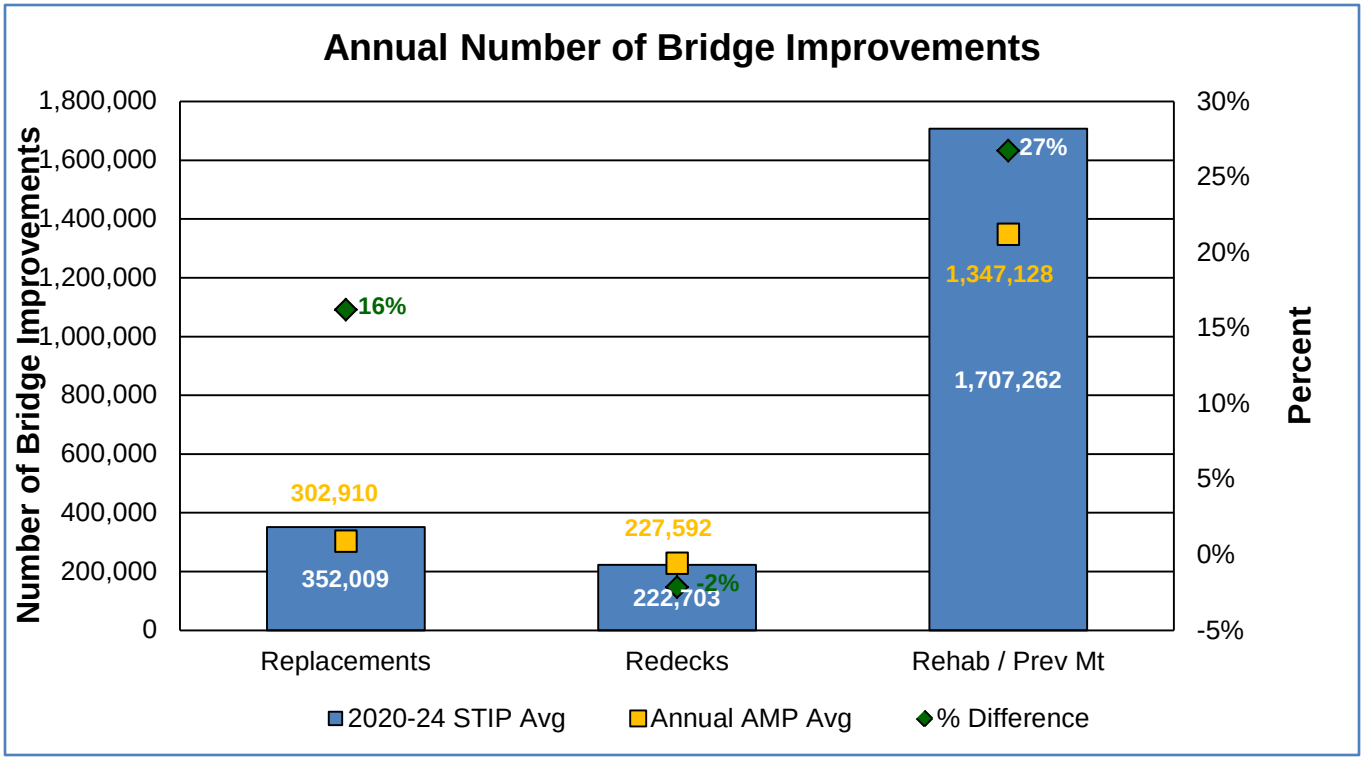
Each year districts work with regional partners to update the STIP using asset management plans as a guide to program projects. At the end of each programming cycle, MoDOT evaluates the STIP to ensure the projects programmed meet the objectives of the TAMP. MoDOT's 10-year rolling TAMP is reviewed and refined each year with the latest information.

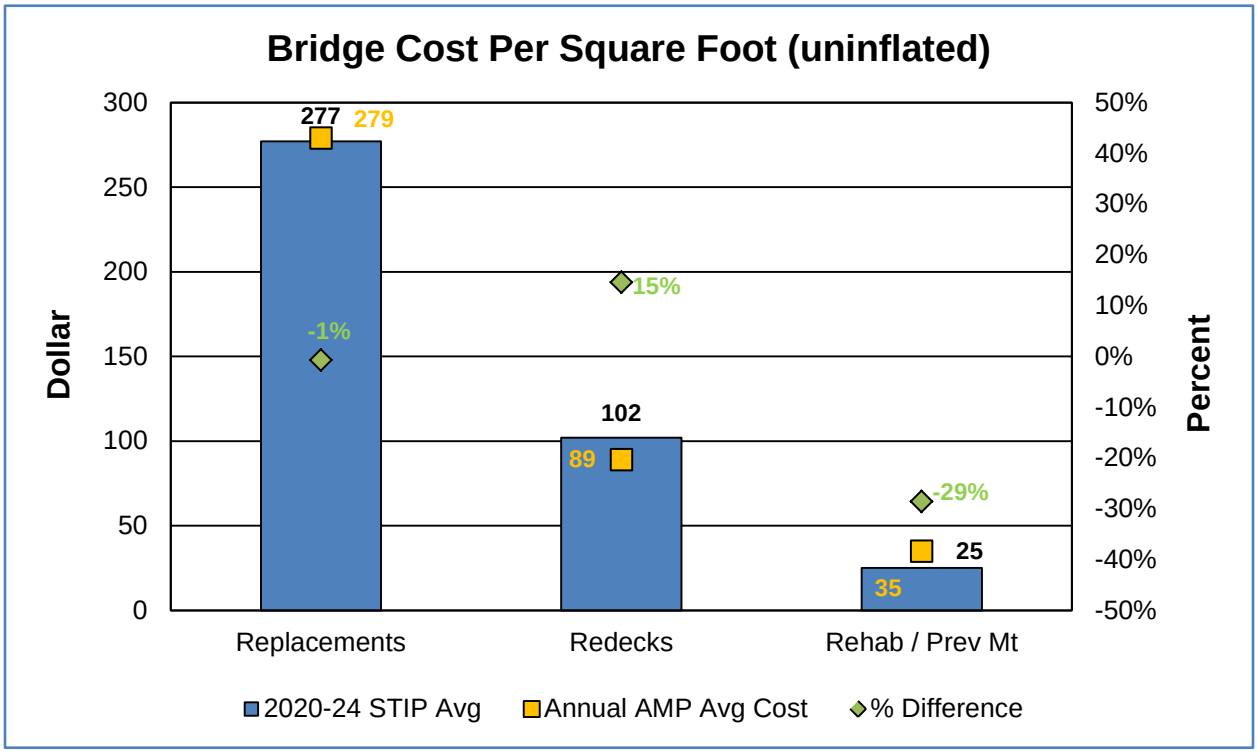
MoDOT also monitors results and adjusts strategies through a performance management system called Tracker. The Tracker has performance measures that monitor the condition of MoDOT's pavements and bridges. See below for Tracker information relating the STIP and the asset management plans.


Percent Difference Between STIP and AMP
Percent
200%
150%
100%
50%
0%
-50%
-100%
Interstate Miles
Major Miles
Minor Miles
$ Interstates
$ Major Routes
$ Minor Routes
# Bridge Replacements
# Bridge Redecks
# Bridge Rehab/Prev Mt
$ Bridge Replacements
$ Bridge Redecks
$ Bridge Rehab/Prev Mt
2017
2016
2018


Annual Number of Lane Miles Improved
Number of Lane Miles
Percent
3,200
2,800
2,400
2,000
1,600
1,200
800
400
0
20%
17%
14%
11%
8%
5%
2%
-1%
-4%
-7%
-10%
4%
678
702
16%
1,144
1,330
3,130
2,664
-1%
Interstate
Major Routes
Minor Routes
2020-24 STIP Avg
Annual AMP Avg
% Difference


Pavement Cost Per Lane Mile (uninflated)
Pavement Cost Per Lane Mile
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
50%
40%
30%
20%
10%
0%
Percent
162,217
35%
120,474
122,807
121,464
1%
50%
56,336
37,657
Interstate
Major Routes
Minor Routes
2020-24 STIP Avg
Annual AMP Avg Cost
% Difference


Annual Number of Bridge Improvements
Number of Bridge Improvements
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
30%
25%
20%
15%
10%
5%
0%
-5%
Percent
16%
302,910
352,009
227,592
-2%
222,703
27%
1,347,128
1,707,262
Replacements
Redecks
Rehab / Prev Mt
2020-24 STIP Avg
Annual AMP Avg
% Difference



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 has been coordinating a monthly webinar since 2015 with planning partners to discuss national performance requirements, including asset management.

It's imperative that the asset management plans get implemented in order to keep the system operating in the condition that it presents today. To ensure the asset management plans are implemented, each year MoDOT compares the asset management plan investment assumptions to the actual investment levels proposed to be programmed in the 5-year STIP prior to finalizing the draft STIP. Any significant deviations are reviewed and addressed if deemed appropriate. In the tables on the following page, the investment levels and amount of work in MoDOT's asset management plans is compared to the most recent 5-year STIP and reflects what is shown in the Tracker measures that monitors the implementation success. From the Tracker Measure, you can see that percent difference between the asset management assumptions and the actual investment levels in the STIP have dialed in considerably over the past two years. The charts below compare the treatment type assumptions from the asset management plan to the actual treatment types programmed in the STIP.

For pavements on Interstates and Other Major Routes, preservation is any treatment that is 1.75" or less including UBAWS and diamond grinding, rehabilitiation treatments are those 1.75" and greater and maintenance is chip seal only. For pavements on Minors Route that have an average daily traffic greater than 400, preservation is a treatment that is 1" or less, rehabilitation treatments are those 1" and greater and maintenance is chip seal only.

Pavements	STIP 3yr Avg # of lane miles	AMP Miles per year	STIP 3 year avg cost/lane mile	AMP cost/lane mile	STIP Investment (millions)	AMP Investment (millions)
Interstate	702	678	$162,217	$120,500	$113	$83
Other Majors	1330	1144	$122,807	$121,500	$157	$131
Minors >400 ADT	2664	2698	$56,336	$37,700	$134	$99
Totals	*4696*	*4520*			*$404*	$*313*

Bridges	STIP 3yr Avg # of sq. ft.	AMP sq ft per year	STIP 3 year avg cost/sq ft	AMP cost/sq ft	STIP Investment (millions)	AMP Investment (millions)
Replacement	352,009	302,910	$277	$279	$54	$85
Rehabilitation (incl. redeck, rehab & preventive MT)	1,929,965	1,574,720	$102* $25**	$89* $35**	$132	$67
Totals	*2,281,974*	*1,877,630*			*$186*	*$152*

*Redeck only **Rehab/PM only

Moving Forward

For the next update of asset management plans, MoDOT is focused on the following improvement areas:

- Evaluating bridge targets: Historically, asset management plans determined the number of bridge repairs needed each year. MoDOT will begin re-examining deterioration trends to identify the square footage of bridges to improve each year. Establishing annual square footage targets for replacements, redecks and rehabilitations will better align with performance measures and cost information.
- Updating bridge and pavement costs: Asset management plans are used to guide STIP investment decisions. For the previous two STIP update cycles, the STIP pavement costs per mile and bridge costs per square foot were significantly higher than asset management plan assumptions. Even though the most current STIP dialed in on these costs considerably, these costs will be analyzed each year to ensure the STIP and asset management plans are better aligned.
- Bridge-sized culverts: Previous asset management plans did not include bridge-sized culvert replacements. The majority of culverts are not in poor condition and many poor condition culverts can be improved by fixing scour, which can be accomplished by MoDOT's maintenance forces. These assets will be analyzed to ensure adequate repairs, if needed, are included in asset management plans.

#	Section	Requirement	How this Requirement is Addressed in this Document	Requirement Addressed on these Pages
1	515.9 (a)	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.	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.	Entire Document
2	515.9 (a)	Asset management plans must describe how the State DOT will carry out asset management as defined in § 515.5.	This document outlines how MoDOT plans to implement asset management practices for pavements and bridges over the next 10 years.	Entire Document
3	515.9 (b)	An asset management plan shall include, at a minimum, a summary listing of NHS pavement and bridge assets, regardless of ownership.	This documents outlines all NHS bridges and pavements by ownership either state owned or locally owned	Chapter 1 – Asset Inventory and Condition
4	515.9 (c)	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.	This document addresses all NHS bridges and pavements by ownership either state owned or locally owned. This document does not address non-NHS infrastructure.	Entire Document
5	515.9 (d)	The minimum content for an asset management plan under this part includes a discussion of each element in this paragraph (d).	See below	See below

6	515.9 (d)	(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.		Introduction
7	515.9 (d)	(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.		Chapter 1 – Asset Inventory and Condition and Chapter 2 – Performance Measures and Targets
8	515.9 (d)	(3) A summary description of the condition of NHS pavements and bridges, regardless of ownership. The		Chapter 1 – Asset Inventory

		summary must include a description of the condition of those assets based on the performance measures established under 23 U.S.C. 150(c) (3) (A) (ii) for condition, once promulgated. The description of condition should be informed by evaluations required under part 667 of this title of facilities repeated damaged by emergency events.		and Condition and Chapter 2 – Performance Measures and Targets
9	515.9 (d)	(4) Performance gap identification.		Chapter 4 – Financial Plan and Investment Scenario
10	515.9 (d)	(5) Life-cycle planning.		Chapter 3 – Life Cycle Planning
11	515.9 (d)	(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.		Chapter 5 – Risk Management
12	515.9 (d)	(7) Financial plan.		Chapter 4 – Financial Plan and Investment Scenario
13	515.9 (d)	(8) Investment planning.		Chapter 6 – TAMP Process
14	515.9 (e)	An asset management plan shall cover, at a minimum, a 10-year period.		Entire Document
15	515.9 (f)	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, (2) Improving or preserving the condition of the assets		Chapter 6 – TAMP Process and Introduction

		and the performance of the NHS relating to physical assets, (3) Achieving the State DOT targets for asset condition and performance of the NHS in accordance with 23 U.S.C. 150(d), and (4) Achieving the national goals identified in 23 U.S.C 150(b).		
16	515.9 (g)	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.		Entire Document
17	515.9 (h)	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.		Chapter 6 – TAMP Process
18	515.9 (i)	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.		Entire Document
19	515.9 (j)	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.		Chapter 2 – Performance Measures and Targets
20	515.9 (k)	The head of the State DOT shall approve the asset management plan.		See by MoDOT Director after cover page
21	515.9 (l)	If the State DOT elects to include other NHS infrastructure	Not applicable	Not applicable

		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.		
22	515.9 (m)	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).		N/A
515.11 Deadlines and phase-in of asset management plan development				
23	515.11 (a)	(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		Entire Document

		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.		Entire Document
25	515.11 (b)	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).		Chapter 2 – Performance Measures and Targets
26	515.11 (b)	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).		N/A
27	515.11 (c)	The State-approved asset management plan submitted not later than June 30, 2019, shall include all required		N/A

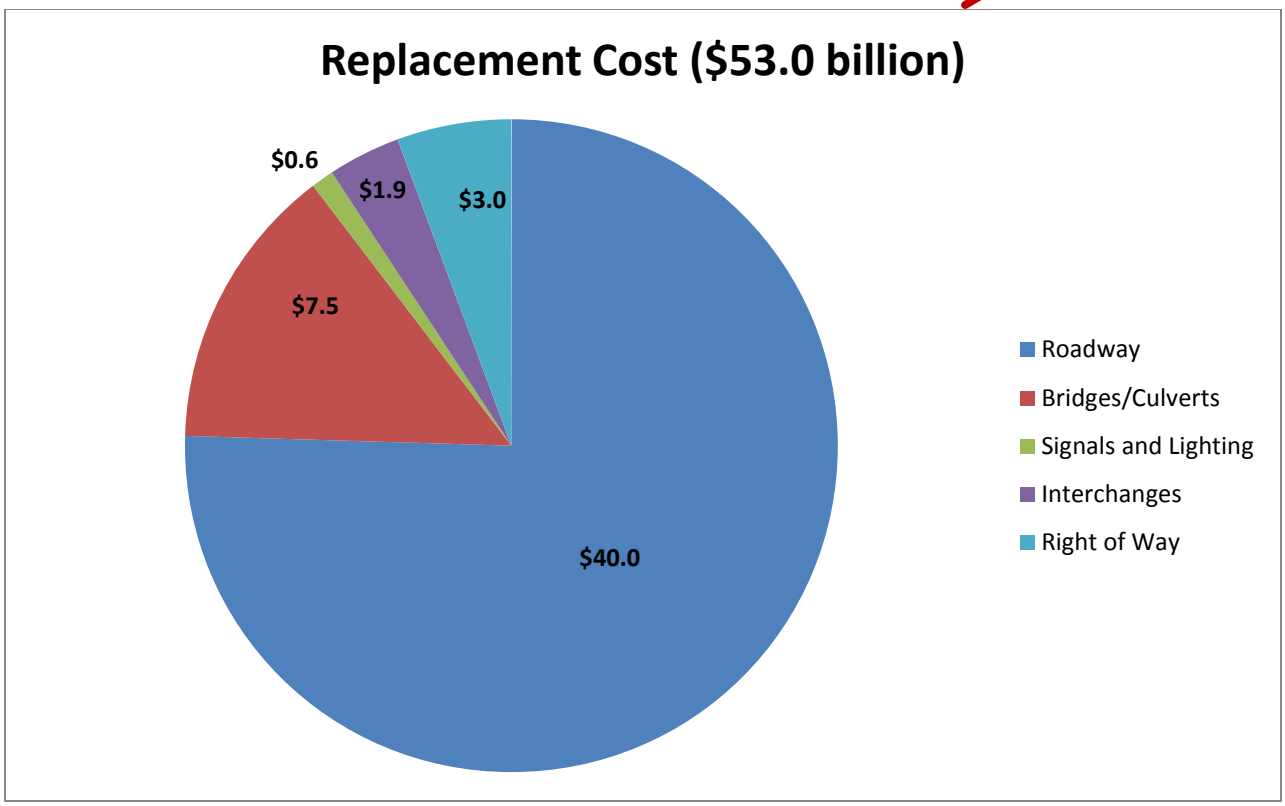
		analyses, performed using FHWA-certified processes, and the section 150 measures and State DOT targets for the NHS pavements and bridges. The plan must meet all requirements in § 515.7 and 515.9. This includes investment strategies that are developed based on the analyses from all processes required 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 (f) Recommending programs and implementation		Entire Document

		schedules to manage the condition of NHS pavement and bridge assets within policy and budget constraints.		

Replacement Cost of the National Highway System

To estimate the replacement cost of MoDOT's transportation system, an inventory of MoDOT's largest assets was analyzed. This inventory consisted of roadway, bridges, signals and lighting, interchanges, and right of way. The inventory was then broken down further to take into account various items that could impact cost. For example, an interchange in an urbanized area would have a different cost than one in a rural area. Costs were gathered from the design division based on previous awards. Cost was obtained by the type of facility (i.e. 2 lane, 4 lane, add lanes, etc.) The costs that were provided by design reflect what it would take to build the facility new. By combining the inventory data with the established cost data, the replacement cost for each of the assets was determined. The sum of the assets together resulted in a total replacement cost of $124.8 billion dollars.

System	Replacement Cost (billions)
Roadway	**$40.0**
Missouri has almost 21,000 lane miles of pavement in its inventory.	
Bridges/Culverts	**$7.5**
Missouri has over 55 million square feet of bridges on the National highway system.	
Signals and Lighting	**$.6**
Missouri has over 21,000 lights and signals on the National Highway System.	
Interchanges	**$1.9**
Missouri has more than 900 interchanges on the National Highway System. Approximately 400 of these are interchanges other than the standard diamond.	
Right of Way	**$3.0**
Missouri has approximately 60,000 acres of right of way along the National Highway System	
Total Replacement Cost	**$53.0**



Detailed Cost Assumptions:

Roadway	Cost per lane mile (millions)
Urbanized Interstate	$2.6
Urbanized Freeway	$2.3
Urbanized Divided	$2.3
Urbanized Undivided greater than Collector	$1.6
Urbanized Undivided Collector and below	$1.2
Urban Interstate	$2.3
Urban Freeway	$1.6
Urban Divided	$1.4
Urban Undivided greater than Collector	$1.6
Urban Undivided Collector and below	$1.2
Rural Interstate	$1.2
Rural Freeway	$1.2
Rural Divided	$1.1
Rural Undivided greater than Collector	$1.2
Rural Undivided Collector and below with an AADT greater than 400	$0.875
Rural Undivided Collector and below with an AADT less than 400	$0.650
Ramps	$1.0

Signals and Lighting	Cost each

Flashers	$5,000
Lights	$4,000
Signalized intersections	$250,000

Bridges/Culverts	**Cost**
Major Bridges	$317 per sq. Ft.
Bridges	$110 per sq. Ft.
Culverts (over 20 feet in length)	$250,000 each

Interchanges	**Cost each (millions)**
Cloverleaf	$1.0
Diamond	$1.0
Directional	$10.0
Diverging Diamond	$2.0
Folded Diamond	$1.0
Other	$5.0
Partial Cloverleaf	$1.0
Partial Diamond	$1.0
Single Point	$10.0
Slip Ramps	$1.0
Trumpet	$5.0

Processes in Place to Monitor and Mitigate Risk FINANCIAL	Process Owner	Monitoring and Reporting	Cycle
The Financial risk category was identified by the Senior Management Team as the category with the 2nd highest impact to MoDOT. It includes risks 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.			
Prepare an annual financial forecast	**Financial Services**	**Approved by Executive Team and provided to Commission**	**Annual**
Innovative project delivery, including Practical Design; Design-Build; value engineering; alternative technical concepts; add alternates; and use of commodity indexes to mitigate contractor risk of price increases, thereby improving bids	**Chief Engineer, Design and Districts**	**Monitoring through bid process and Staff Bid Review**	**Monthly**
Do not fully program years 4 and 5 of the STIP	**Transportation Planning and Districts**	**Reviewed by Executive Team and approved by Commission**	**Annual**
Build operating budget and STIP based on results of financial forecast	Financial Services and Transportation Planning	Budget is reviewed by Executive Team and approved by Commission. Financial Forecast is presented to the Commission.	Annual
Maintain updated Asset Management Plan (statewide and district specific) to ensure existing system is maintained before new elements are added. STIP is developed in unison with Asset Management Plan.	Districts and Transportation Planning	Reviewed with Executive Team during Draft STIP development.	Annual
Prepare monthly cash basis financial statements	Financial Services	Provided to Senior Management Team and Commission	Monthly
Prepare quarterly GAAP basis financial statements	Financial Services	Provided to Senior Management Team and Commission	Quarterly
Prepare monthly comparison of state highway user revenues to projections	Financial Services	Provided to Executive Team and Commission	Monthly
Monitor status of/changes to federal funding	Financial Services and Governmental Relations	Update SMT and Commission as necessary	As necessary

Processes in Place to Monitor and Mitigate Risk FINANCIAL	Process Owner	Monitoring and Reporting	Cycle
Maximize use of federal funds on projects and approved operations functions	**Financial Services and Transportation Planning**	**Report changes to Senior Management Team**	**As necessary**
Educate the public, legislators and employees on limitations of fuel tax as an adequate ongoing source of revenue, uncertainty of federal funding, and looming problem of matching federal funds. Includes the periodic Long Range Transportation Plan	Governmental Relations, Community Relations and Transportation Planning	Discussed as necessary for inclusion in public outreach	As necessary
Internal audit function exists and performs assessments of internal controls	Audits and Investigations	Reports audit results to Commission's Audit Committee and prepares annual report to Commission	As necessary and Annual
Use of competitive bidding to get best price	Design and General Services in Central Office and Districts	Monthly review by management and reporting and approval by Commission for STIP projects. No specific reporting for non-STIP procurement	Monthly
Wellness program and active management of health care program to lower medical costs	Risk and Benefits	Risk and Benefits TRACKER measures	Quarterly
"Federalizing" more work types to provide additional match	Design, Maintenance, Transportation Planning and Financial Services	Review by Federal Aid program staff as projects are entered in the federal aid computer system	Ongoing
Cost share program to leverage state resources for on-system projects	Cost Share Committee	Meeting materials and STIP amendments	Ongoing - Reactivated January 2017
Conservative approach to debt management	Financial Services	Annual debt report and debt workshops prior to debt issuance. Monitoring for any opportunities to call or refund debt.	Annual and as needed

Processes in Place to Monitor and Mitigate Risk FINANCIAL	Process Owner	Monitoring and Reporting	Cycle
GAPS			
Growing appropriations to Missouri State Highway Patrol			
Rapidly increasing cost of retirement and health care			
Note - The strategies in **BOLD** font have been identified by management as those most critical to mitigating this risk.			

Processes in Place to Monitor and Mitigate Risk - NATURAL DISASTER	Process Owner	Monitoring and Reporting	Cycle
The Natural Disaster risk category was identified by the Senior Management Team as the category with the 6th highest impact to MoDOT. It includes items such as an earthquake, a blizzard, flooding, tornadoes, a nuclear power plant event, and a pandemic.			
MoDOT has an Incident Response Plan containing subplans to address continuity of operations and specific risks such as severe weather, a pandemic, radiological response, and an earthquake.	**Maintenance**	**Update by Incident Response Plan Team**	**Annual**
Use of the National Incident Management System (NIMS) model, developed by the Federal Emergency Management Agency, to manage incidents. Training in and use of this scalable incident management framework allows a consistent response to incidents.	**Maintenance**	**Drills conducted periodically, alone or in cooperation with other agencies, including disaster drills**	**As needed**
For snow and other weather events, Emergency Operations Centers at Central Office and in each district are activated based on need. Statewide conference calls (multiple per day) are used to communicate weather predictions, evaluate resource needs and availability of those resources, and when necessary, mobilize crews and equipment to other parts of the state.	**Maintenance**	**As needed**	**As needed**
Inventory maintained around the state to respond to natural disaster (e.g. traffic control devices, fuel, steel girders, chemicals to fight snow, sand, sand bags, big bags) Contracts are in place to replenish supplies.	Maintenance	Inventories monitored in the financial accounting system	As needed
Employees receive Red Cross CPR/First Aid training	Risk and Benefits Management	Tracked for employees in MoDOT U	As needed
Maintain a radio system and train personnel in its use as a communication system in addition to phones and email	Maintenance	On-going	As needed

Processes in Place to Monitor and Mitigate Risk - NATURAL DISASTER	Process Owner	Monitoring and Reporting	Cycle
Three Mobile Emergency Response Operations Center (MEROC) trailers allow interoperable communication.	Maintenance	On-going	As needed
GAPS			
None noted.			
Note - The strategies in **BOLD** font have been identified by management as those most critical to mitigating this risk.			

Processes in Place to Monitor and Mitigate Risk - MAJOR TRANSPORTATION SYSTEM FAILURE	Process Owner	Monitoring and Reporting	Cycle
The Major Transportation System Failure risk category was identified by the Senior Management Team as the category with the 5th highest impact to MoDOT. It includes items such as a bridge collapse, condition and capacity issues with I-70 and I-44, and system gridlock in the metropolitan areas.			
All bridges are inspected in accordance with an FHWA approved risk based set of criteria. Inspection frequencies are typically 24 months; however, they may go as high as 48 months for simple/newer bridges. Bridges in worse condition are inspected more frequently. Employees trained in bridge inspection are empowered to immediately close an unsafe bridge.	**Bridge**	**Monthly status checks with report to FHWA each April 1**	**Annual**
Emergency contracting authority allows for fast contractor mobilization	**Design**	**Approved by Chief Engineer and reported to Commission at the next Commission meeting following award**	**As needed**
Use of the National Incident Management System (NIMS) model, developed by the Federal Emergency Management Agency, to manage incidents. Training in and use of this scalable incident management framework allows a consistent response to incidents.	**Maintenance**	**Drills conducted periodically, alone or in cooperation with other agencies**	**As needed**
Dedicated interstate/major bridge funding within Commission funding distribution formula	**Transportation Planning and Districts**	**Statewide Transportation Improvement Plan approved by Executive Management and Commission**	**Annual**
Development and Implementation of an Asset Management Plan that strategically identifies the best use of very limited resources in maintaining the transportation system.	**Transportation Planning and the Asset Management Steering Committee**	**Plan development with annual tracker measures**	**Annual**

Processes in Place to Monitor and Mitigate Risk - MAJOR TRANSPORTATION SYSTEM FAILURE	Process Owner	Monitoring and Reporting	Cycle
Motorist Assist program and Intelligent Transportation System technology mitigate congestion	Districts and Highway Safety and Traffic	Tracker mobility measure and programming improvements in Statewide Transportation Improvement Program	Quarterly and Annual
Dynamic message boards and traveler information map inform customers to mitigate impact on the traveling public	Districts and Highway Safety and Traffic	On-going	As needed
Aviation inspections every 3 years of public use airports that do not have scheduled service, to determine asset condition. FAA annually inspects airports with scheduled service	Multimodal	Data on one third of airports provided to FAA by September 30. Inspection results also provided to airport sponsor and used to develop Statewide Transportation Improvement Program	Annual
Note - The strategies in **BOLD** font have been identified by management as those most critical to mitigating this risk.			
GAPS			
Insufficient resources to rebuild I-70 and then I-44			
641 critical condition bridges with no identified funding to address			