2022

MoDOT's National Highway System Transportation Asset Management Plan

DATA DRIVEN DECISIONS FOR CRITICAL TRANSPORTATION ASSETS

MISSOURI DEPARTMENT OF TRANSPORTATION

Missouri's transportation system is the nation's seventh largest state highway system and is larger than neighboring states Kansas and Illinois combined. It's a tremendous asset, built by $55 billion in user fees (it has a $145 billion replacement value today) and plays a vital part in the lives of its citizens. This system is counted on to connect people safely and reliably with family, jobs and services, businesses with suppliers and customers, students with schools and visitors with destinations.

Maintaining our transportation assets comes as Missourian's highest priority, and the Missouri Department of Transportation (MoDOT) has a well-established history of maintaining our highways and bridges. Over the last few decades, Missouri citizens have communicated that they expect MoDOT to maintain the transportation system and services as their number one goal. Missouri is 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.

With this focus on maintaining the system, MoDOT has reduced the number of poor bridges from 922 to 823 statewide with 147 being on the National Highway System (NHS), our most heavily traveled roadways. However, in that same timeframe, a significant number of bridges that are in good condition have slipped to fair. This trend is expected to continue as approximately 6% are expected to fall into fair condition over the next 4 years. Balancing the bridge needs with pavement needs, MoDOT expects to hold their own on good condition interstates and non-interstate NHS pavements by maintaining current performance.

Consistent, sound investment decisions protect our transportation system. Good use of analytical tools and formal policies places Missouri in a position to support investment decisions and try to meet targets for performance and infrastructure condition. MoDOT was recently ranked third in the nation in highway performance and cost-effectiveness in the Reason Foundation's 26th *Annual Highway Report*.

Our Transportation Asset Management Plan (TAMP) 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. Managing the condition over the entire life cycle of the assets at a minimum practicable cost is good business practice, helping our state attract new investment and economic growth.

This 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, 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.

The MoDOT's TAMP 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.

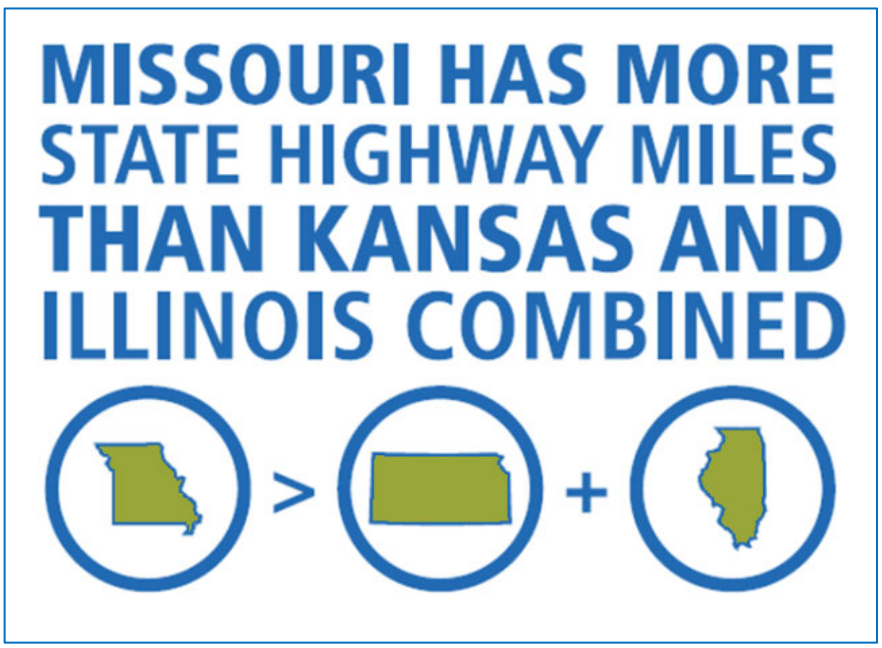
An initial plan was developed by department asset experts and planning statisticians based on statewide cost and life cycle assumptions. That plan was shared with regional staff to adjust those assumptions to actual regional costs and life cycles. Refining and adjusting the TAMP will be a continuous 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 (FAST Act) and continues through the Bipartisan Infrastructure Law. The details of those requirements can be found in the appendix A of this document.

Background

Who We Are: MoDOT 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 33,825 miles. The state highway system, which includes 10,387 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. This second iteration of MoDOT's TAMP provides direction for preserving this essential transportation system.

MoDOT has maintained a nationally recognized performance management system since 2005 that is a national model. Based on customer surveys and long-range planning outreach efforts, the department identified seven tangible results that Missouri citizens expect of their transportation network and those that provide support:

- Moving Missourians Safely
- Providing Outstanding Customer Service
- Delivering Efficient and Innovative Transportation Projects
- Operating a Reliable Transportation System
- Managing Our Assets
- Stabilizing Resources and Engaging our Workforce
- Building a Prosperous Economy for All Missourians

Numerous performance measures were established to meet these expectations. MoDOT also tracks its progress through completion of its annual Statewide Transportation Improvement Program (STIP) and other operational plans for individual functions and initiatives.

Goals and Objectives

The department's asset management plan has been designed to align with MoDOT's tangible results. Its objective is to 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. For the purposes of this TAMP, good repair is defined as having a condition rating for a performance metric rated as good. MoDOT's focus is on maintaining current pavement and bridge conditions for the six federal pavement and bridge performance measures over the next 10 years. Specific goals are illustrated below:

Federal Performance Measure	Draft 2025 Targeted Condition to Maintain State of Good Repair for TAMP
Percent Poor Interstate Pavement	0.1%
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	7.8%
Percent Good Deck Area on NHS	19.2%

The targeted conditions in the preceding table are based on maintaining 2021 conditions with the exception of Percent Good Deck Area on the NHS. Additional information for performance measures and targets may 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 may 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

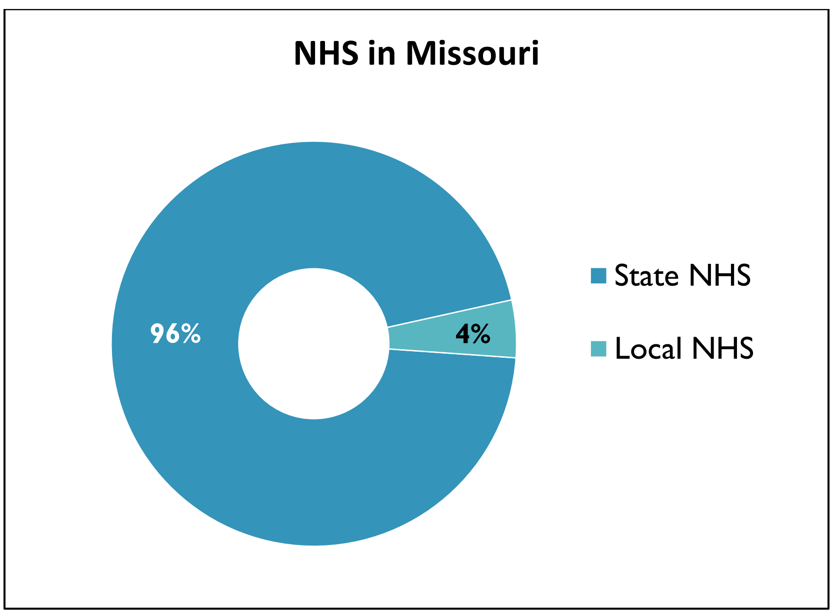
Missouri's state highway system includes 33,825 centerline miles of roads and 10,387 bridges. The system is divided into the following four roadway categories, each of which has its own unique characteristics regarding size, condition, and use:

1) interstates
2) non-interstate NHS routes (major routes)
3) minor routes
4) low volume routes *(less than 400 vehicles per day)*

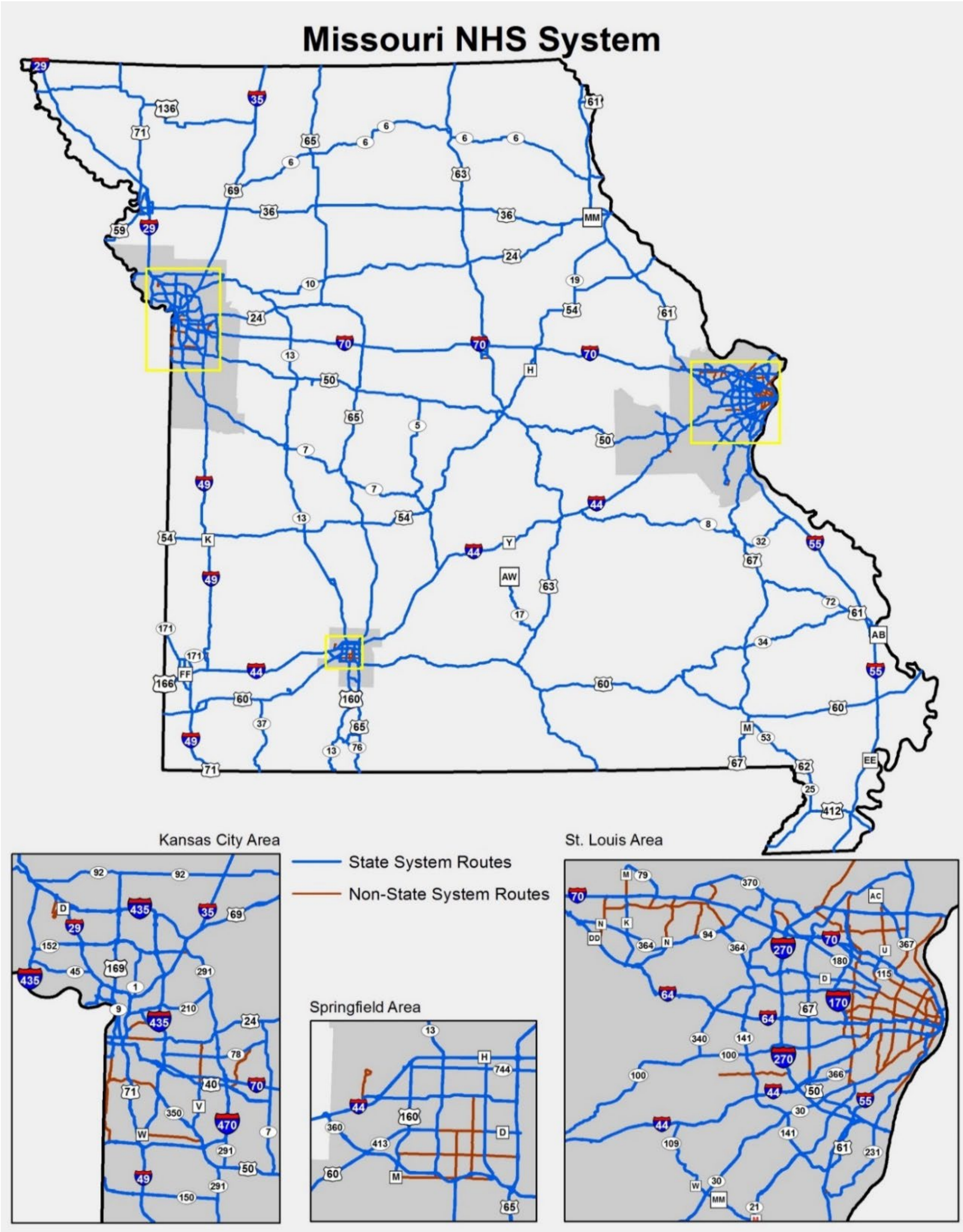
The NHS includes the interstate highway system as well as other roads important to the nation's economy, defense and mobility. The NHS was developed by the U.S. Department of Transportation (DOT) in cooperation with the states, local officials and Metropolitan Planning Organizations (MPOs). The interstates and major routes generally align with 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. Of the 33,825 centerline miles of Missouri's state highway system, 1,385 miles are classified as interstates, and 4,101 miles are other major routes. In addition to the state highway system's interstate and major routes, the local system in Missouri also accounts for 233 miles of the NHS. Missouri's transportation system includes 5,723 NHS miles with 96% of it being on the state system.



System at a Glance:

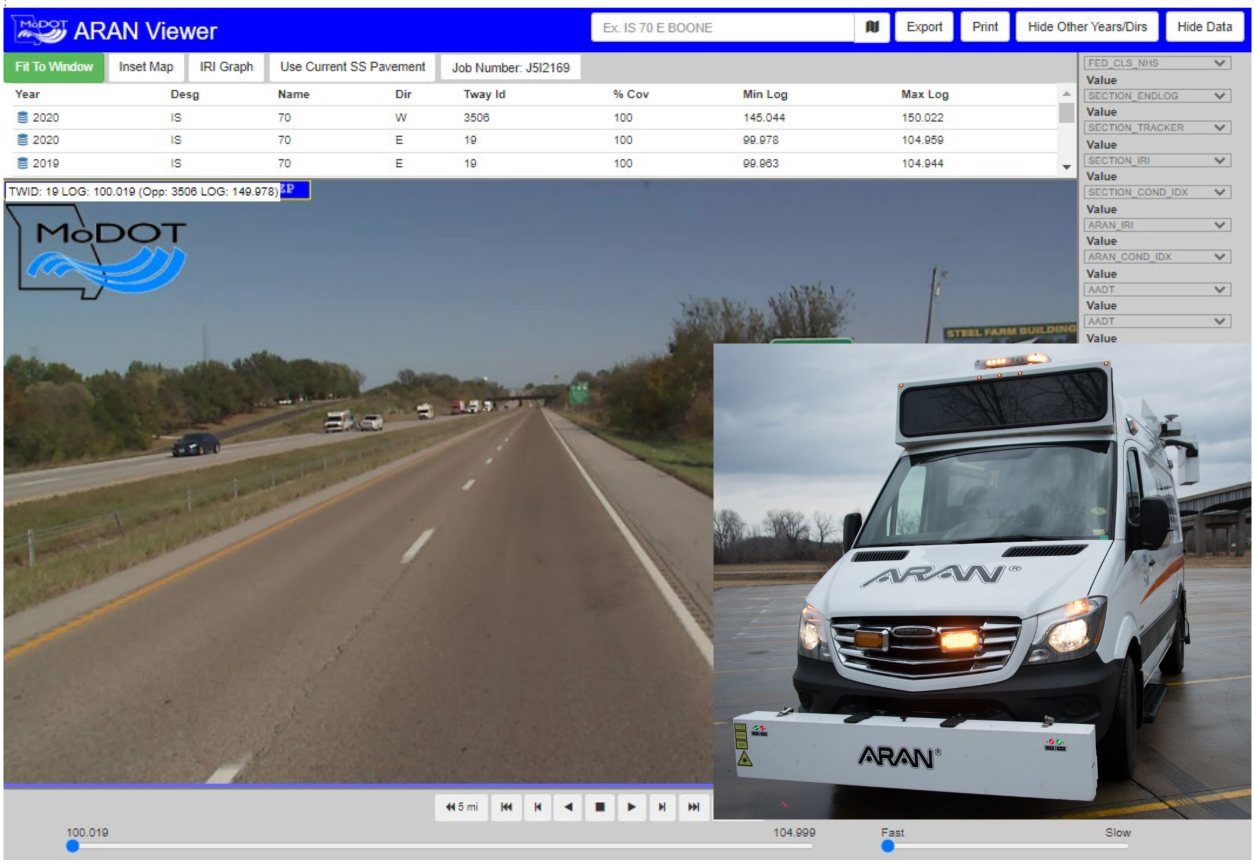


Transportation Management System

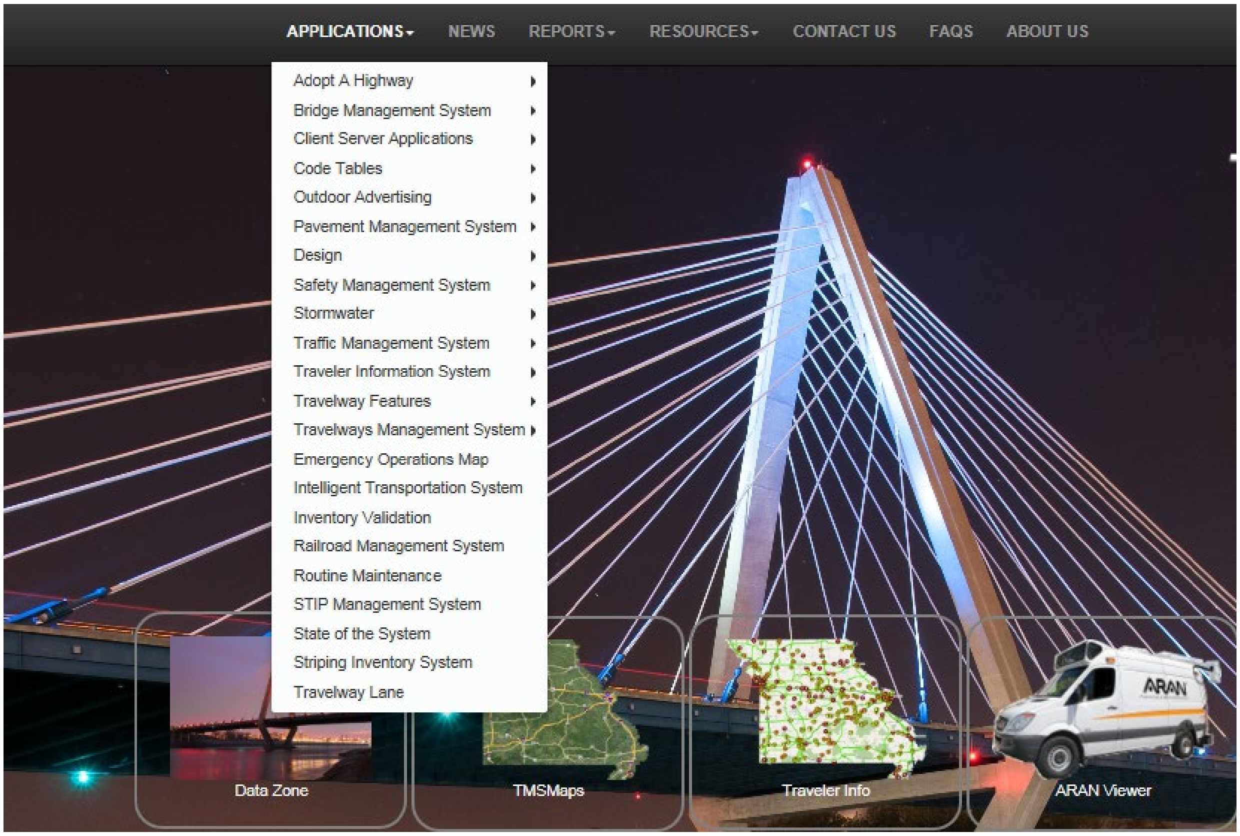
The Transportation Management System (TMS) houses the Pavement Management System (PMS) and the Bridge Management System (BMS) information used in asset planning. When TMS was implemented in 1998, it only presented information for travelways (routes), safety, traffic and pavement. TMS is now comprised of web-based applications, Cognos/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.

TMS is ever evolving and improving to aid in taking care of the large highway system in Missouri.

Pavement and bridge asset data is collected and stored, including location referencing, condition data and videos. Pavement data for all NHS routes (i.e., for both state and locally-owned routes) are collected annually. MoDOT uses an Automatic Road Analyzer (ARAN) vehicle 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.



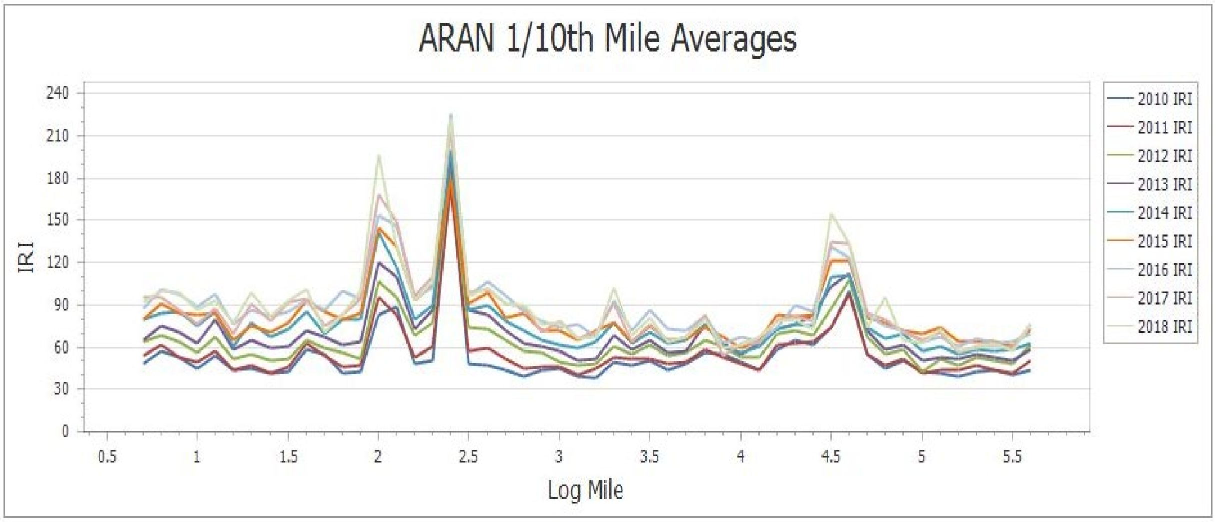
TMS applications (as shown on the following page) not only are used to capture conditions and data, they serve as the archive for all historical pavement data and currently contain over 20-years of pavement performance history. This data is used with the PMS, along with additional tools and processes, to analyze and determine the pavement performance and deterioration rates for pavement sections. This allows MoDOT the ability to optimize the treatments based upon performance over time.



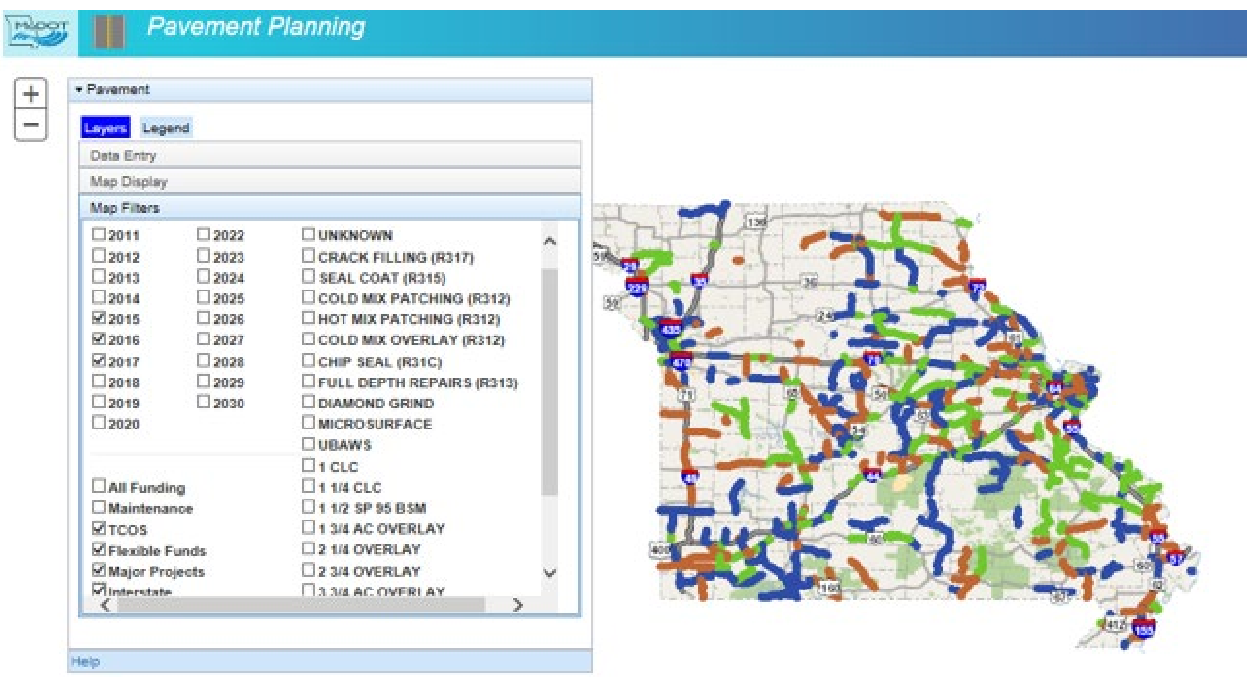
Pavements

MoDOT staff use the data from the PMS to manage pavement. The PMS houses each district's anticipated pavement strategies for all routes to be addressed for a minimum of the next two treatments (typically 10 – 20 years). This cumulative data set allows for analysis of future conditions using the overall improvement strategies as well as providing feedback for the potential outcomes for each region's approach. These can then be compared to the established statewide approach and goals to validate the pavement component of the asset management plan. Further, the pavement plan allows for condition assessment, which provides an opportunity to adjust strategies, both at the macro (systemwide approach) level and the micro (individual pavements and treatments) level. This ensures continued focus on making the right decision organizationally in MoDOT's approach to pavements while also positioning MoDOT to make the right decision for each pavement treatment as each route is moved towards construction.

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



The PMS (as shown below) allows future statewide pavement treatments, funding categories and locations to be viewed by year. These identified pavement sections are then further analyzed by MoDOT pavement engineers for condition and performance to validate the appropriate treatment for the condition. These pavement sections are then considered for programming in the five year STIP.



MoDOT has historically captured the international roughness index (IRI), rutting, cracking and structural integrity information for pavements. Beginning in calendar year 2017, MoDOT tweaked the data collection to align with the Federal Highway Administration (FHWA) final rule for managing pavement condition and all categories. MoDOT continues to monitor pavement performance for all required metrics. Potential pavement treatment strategies are analyzed and the system performance is predicted based upon the strategies implemented.

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 <40 mph.
** CRCP – Continuous Reinforced Concrete Pavement

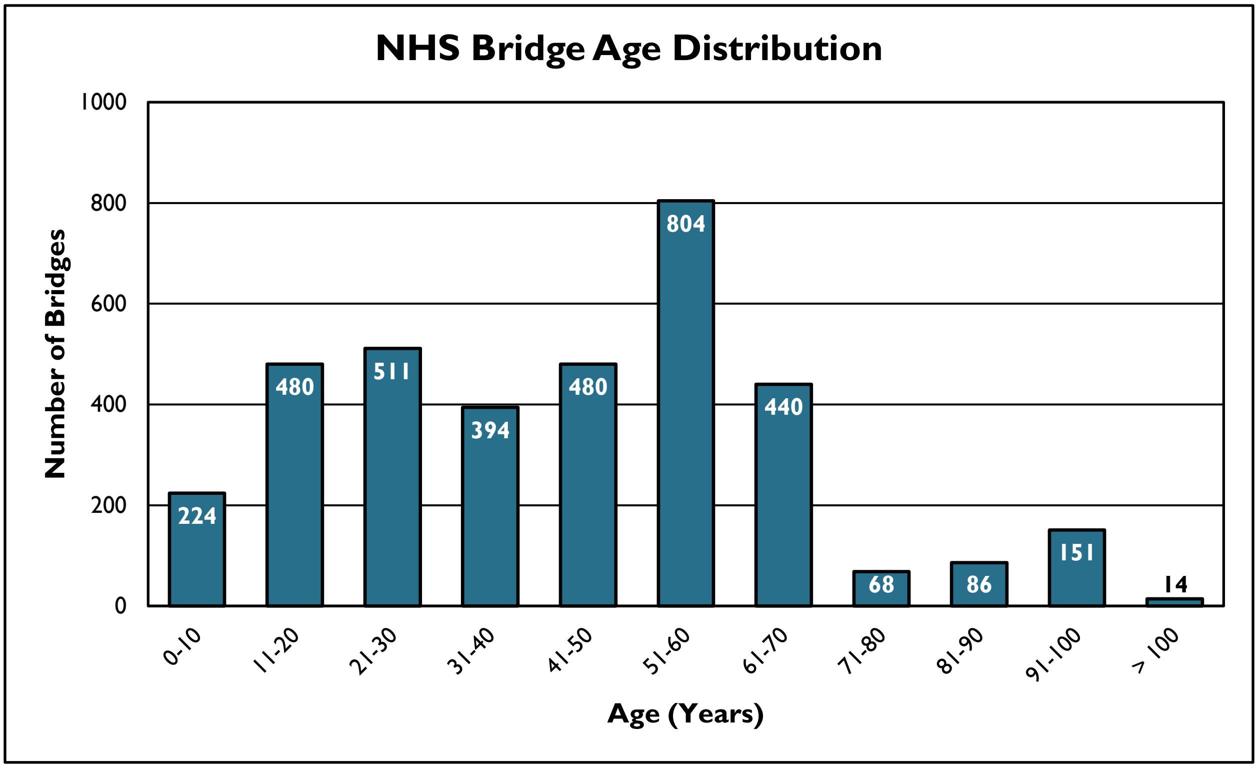
The following conditions were identified as a result of analyzing the NHS based on the metrics identified by FHWA in the final rule.

2021 Condition of Missouri NHS Routes			
	State Owned	Local Owned	Total
% of Interstate in Good Condition	79.9%	n/a	79.9%
% of Interstate in Poor Condition	0.0%	n/a	0.0%
% of Non-Interstate NHS Pavements in Good Condition	63.3%	12%	60.9%
% of Non-Interstate NHS Pavements in Poor Condition	0.8%	11%	1.3%

Note: For further information on the performance measures and targets for Missouri's NHS routes, see Chapter 2 of this document.

Bridges

Missouri's NHS includes 3,652 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 169 major bridges on the NHS and 3,483 typical bridges. The NHS bridges have a wide age span as illustrated below.



2021 Number of NHS Bridges			
	State Owned	**Locally Owned**	**Total**
Major	167	2	169
Typical	3,395	88	3,483
Total	3,562	90	3,652

2021 Square Foot of Bridge Deck on NHS			
	State Owned	**Locally Owned**	**Total**
Major	20,331,415	182,026	20,513,441
Typical	33,776,905	990,694	34,767,599
Total	54,108,320	1,172,720	55,281,040

The average length of an NHS major bridge in Missouri is 2,216 feet. This is over 10 times the length of a typical bridge, which averages 204 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 as compared with its new condition. The ratings are based on the materials, physical condition of the deck (riding surface), superstructure (supports immediately beneath the driving surface) and substructures (foundation and supporting posts and piers).

A condition rating is assigned for the bridge's deck, superstructure and substructure. This also applies to culvert condition rating.

The condition rating scale assess each of the three-bridge element's condition from Excellent to Poor. The lowest rating of the three components is considered the bridge rating. The rating scale is as follows:

Rating	Description
9	Excellent
8	Very Good
7	Good
6	Satisfactory
5	Fair
4 or less	Poor

<table>
<tr><th colspan="4">2021 NHS Bridges</th></tr>
<tr><th>NBI Rating</th><th>Classification</th><th>Number of NHS Bridges by Material Type</th><th>Square Foot of Bridge Deck on NHS</th></tr>
<tr><td>9</td><td rowspan="3">Good</td><td rowspan="3">Concrete: 802
Steel: 331</td><td rowspan="3">15,039,044</td></tr>
<tr><td>8</td></tr>
<tr><td>7</td></tr>
<tr><td>6</td><td rowspan="2">Fair</td><td rowspan="2">Concrete: 1448
Steel: 924</td><td rowspan="2">36,302,553</td></tr>
<tr><td>5</td></tr>
<tr><td>4</td><td rowspan="5">Poor</td><td rowspan="5">Concrete: 61
Steel: 86</td><td rowspan="5">3,939,443</td></tr>
<tr><td>3</td></tr>
<tr><td>2</td></tr>
<tr><td>1</td></tr>
<tr><td>0</td></tr>
<tr><td>Total</td><td></td><td>3,652</td><td>55,281,040</td></tr>
</table>

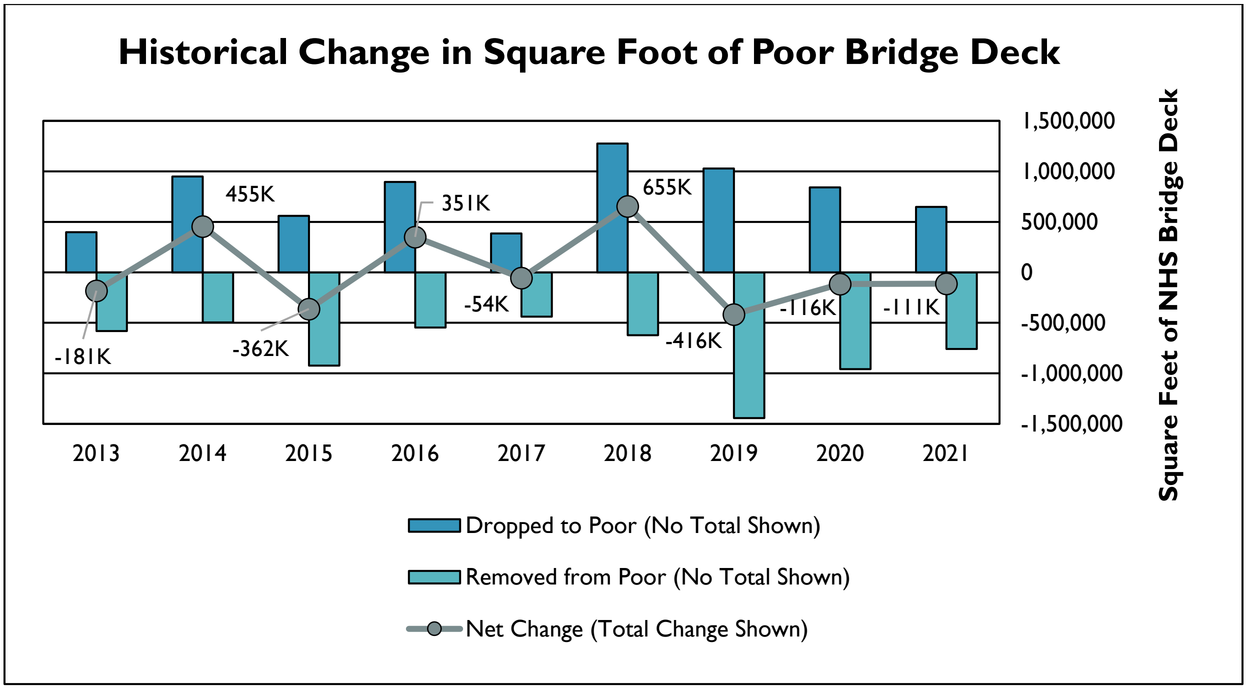
2021 NHS Major Bridges		
Condition	**Area**	**Percentage of Total**
Good	3,675,361	17.9%
Fair	14,276,351	69.6%
Poor	2,561,729	12.5%
Total:	20,513,441	100%

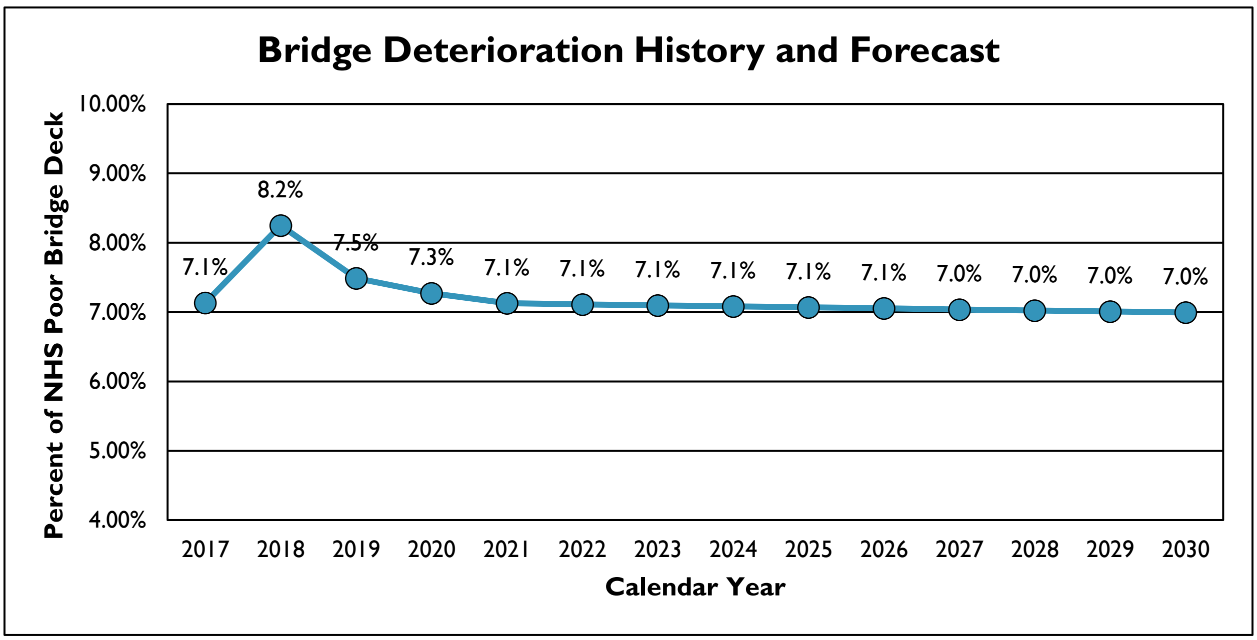
MoDOT uses the TMS to manage bridge data including inventory and inspection information. The TMS bridge application and the NBIS data gathered from field inspections, make up the BMS. MoDOT has collected and maintained inventory and condition information on National Bridge Inventory (NBI) structures 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.

Most bridges in Missouri are inspected by MoDOT personnel with a small number inspected by consultants or by the local bridge owner. Most are inspected every two years 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 district bridge engineers to help reduce the bridge inspection workload.

Historic deterioration rates for all bridges are available in TMS. Like the PMS, 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 forecast which are used to establish targeted annual bridge repairs needed by work type for each MoDOT district.

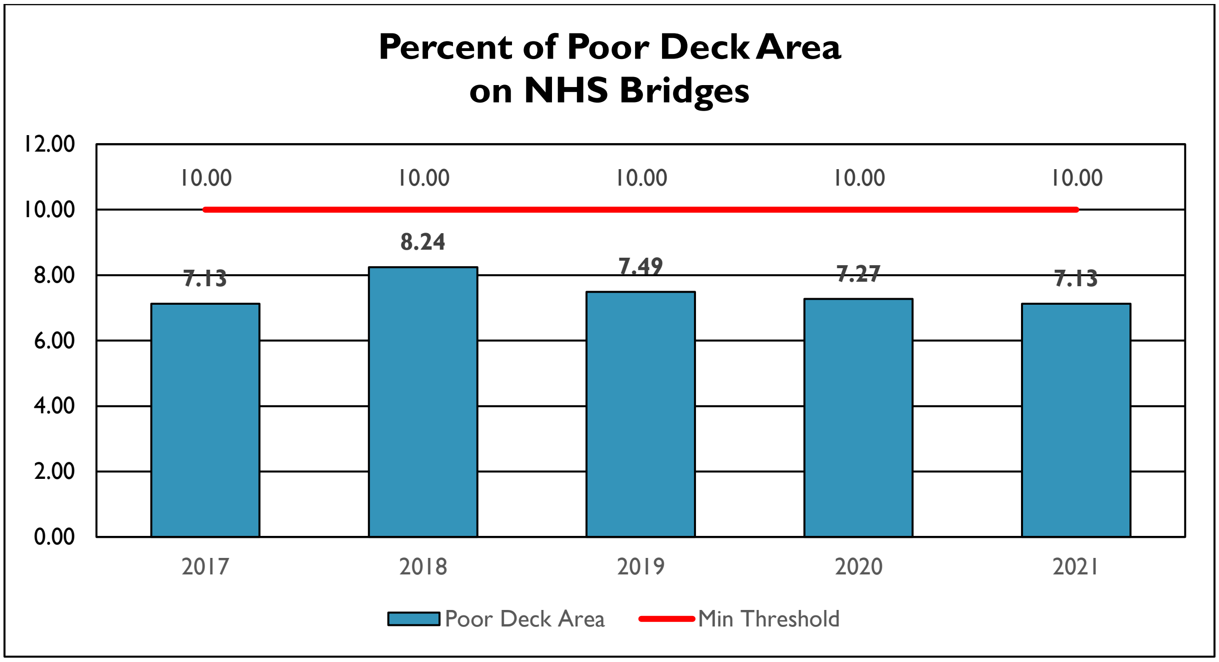
One of the challenges with managing bridge assets is that there is a wave of bridges built in the 1950's and 1960's that are all reaching the end of their service life at about the same time. This will significantly increase the square foot of bridge deck that moves from fair to poor when the wave hits.





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.

MoDOT also tracks the percent of square feet of bridge decks on the NHS that are poor deck area.



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 deck replacements 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 seven – twenty 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 and 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.

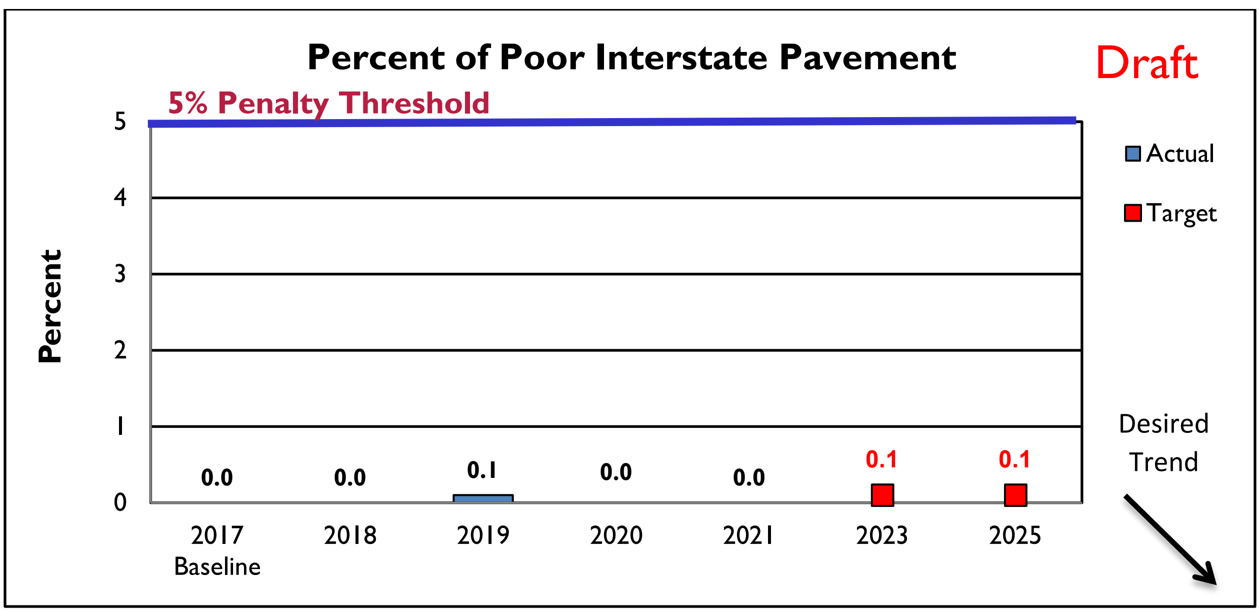
MoDOT performance measures for road and bridge condition are as follows:

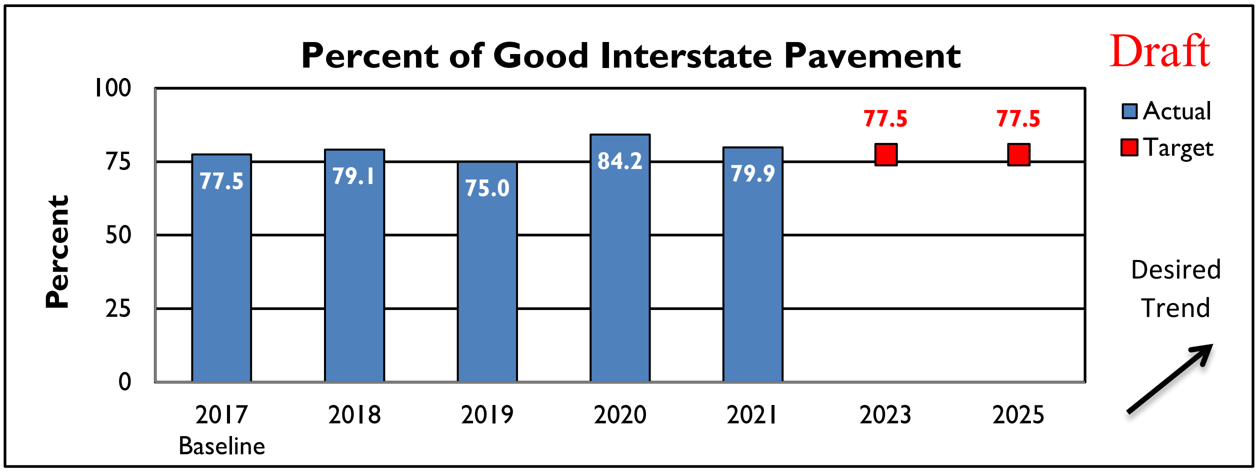
1) Percent Poor Interstate Pavement
2) Percent Good Interstate Pavement
3) Percent Poor Non-Interstate NHS Pavement
4) Percent Good Non-Interstate NHS Pavement
5) Percent of NHS Bridges Classified as in Poor Condition
6) Percent of NHS Bridges Classified as in Good Condition

It should be noted, due to the timeline associated with TAMP development and performance goal setting, all performance goals are considered "Draft".

Pavements

Historical performance of the NHS pavements has been monitored by the smoothness of the pavement. Chapter 1 of this AMP explains how MoDOT captures and reports the data for smoothness. For all four pavement targets, the goal is to maintain or manage the current conditions and the state of good repair.




Percent of Good Interstate Pavement
Draft
Percent
100
75
50
25
0
77.5
79.1
75.0
84.2
79.9
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77.5
2017
Baseline
2018
2019
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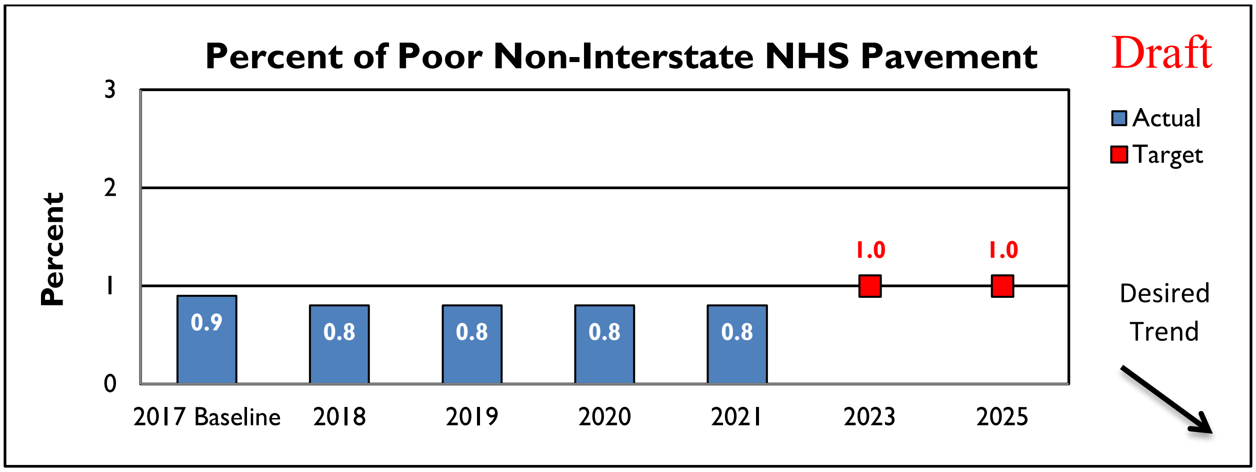
2025
Actual
Target
Desired
Trend


Percent of Poor Non-Interstate NHS Pavement
Draft
Percent
3
2
1
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0.9
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0.8
0.8
1.0
1.0
2017 Baseline
2018
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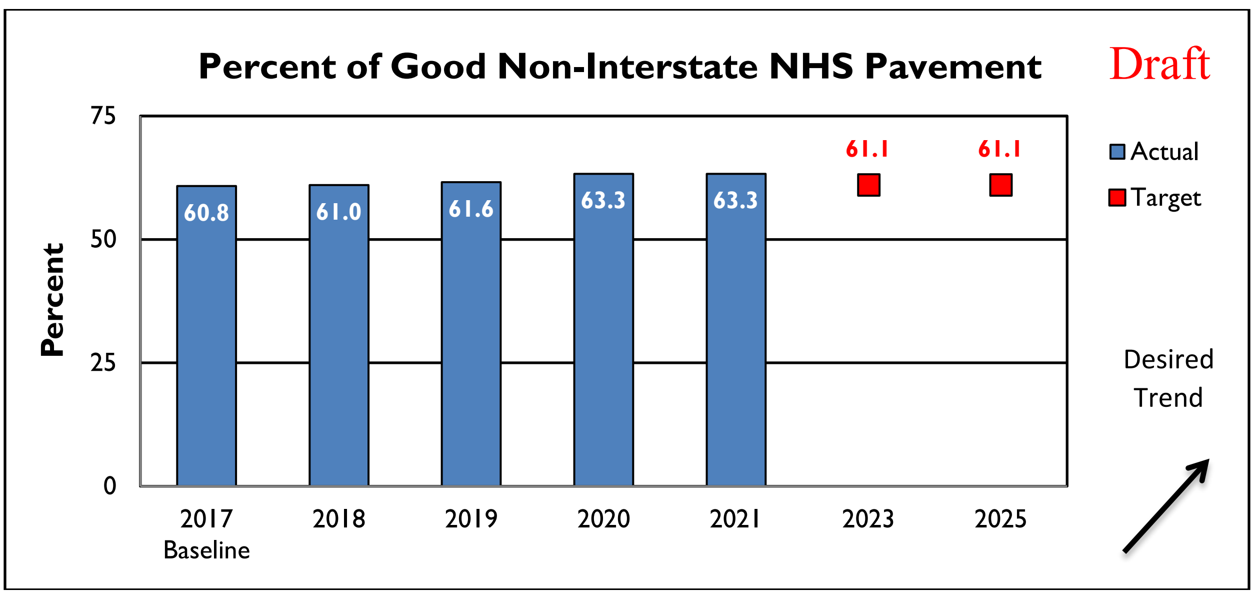
Actual
Target
Desired
Trend


Percent of Good Non-Interstate NHS Pavement
Draft
Percent
75
50
25
0
60.8
61.0
61.6
63.3
63.3
61.1
61.1
2017
Baseline
2018
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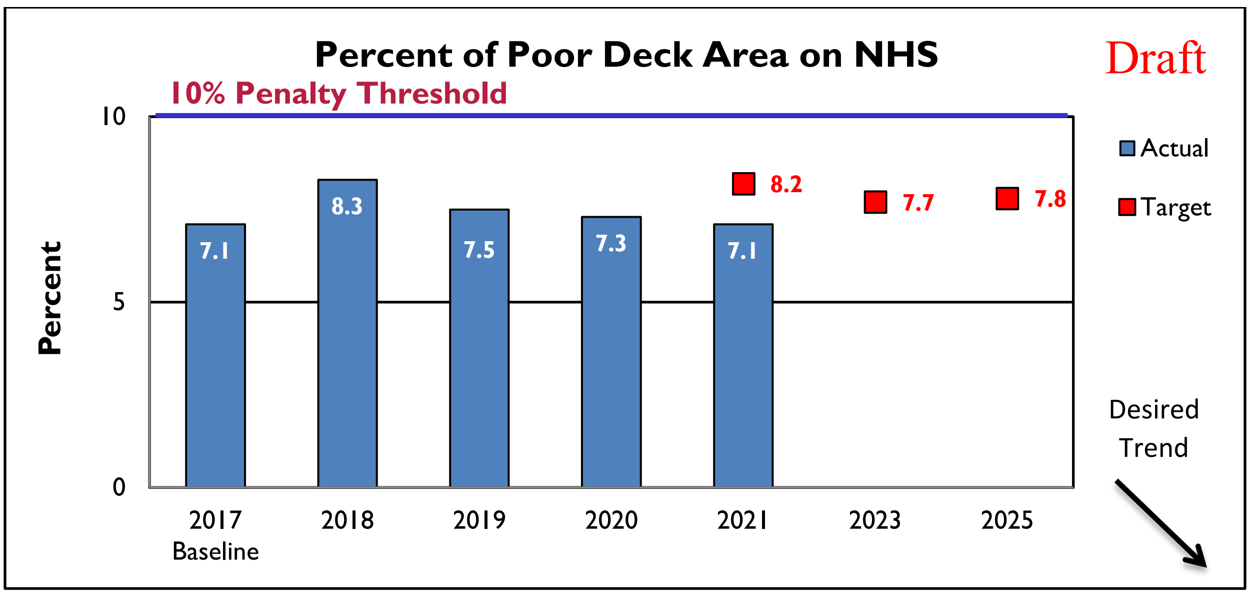
2020
2021
2023
2025
Actual
Target
Desired
Trend

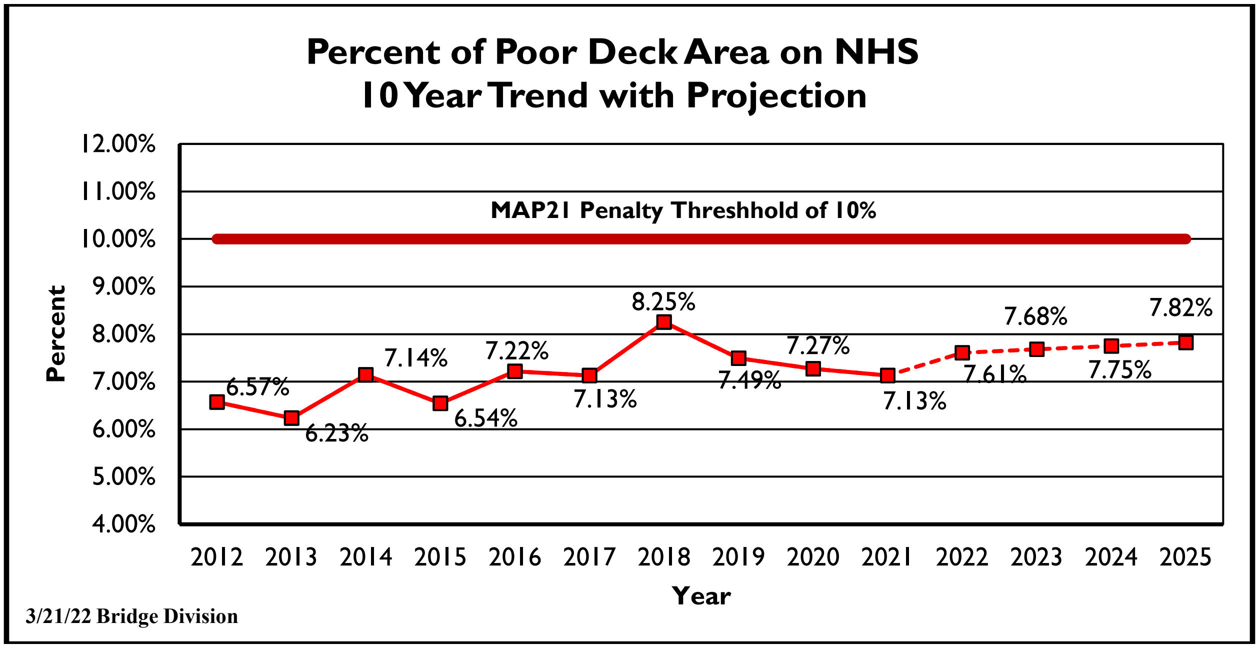
Bridges

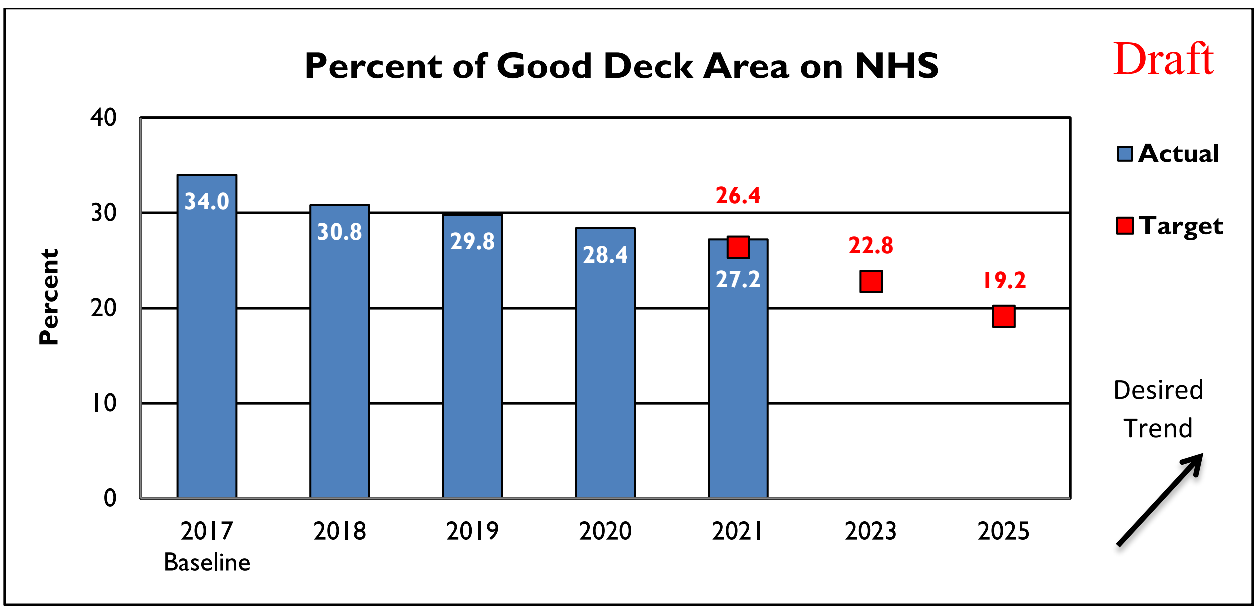
Bridge condition is monitored through routine inspections. The inspection rating information is outlined in Chapter 1 of this asset management plan. The historical information provided in the charts below is based on past inspection data.

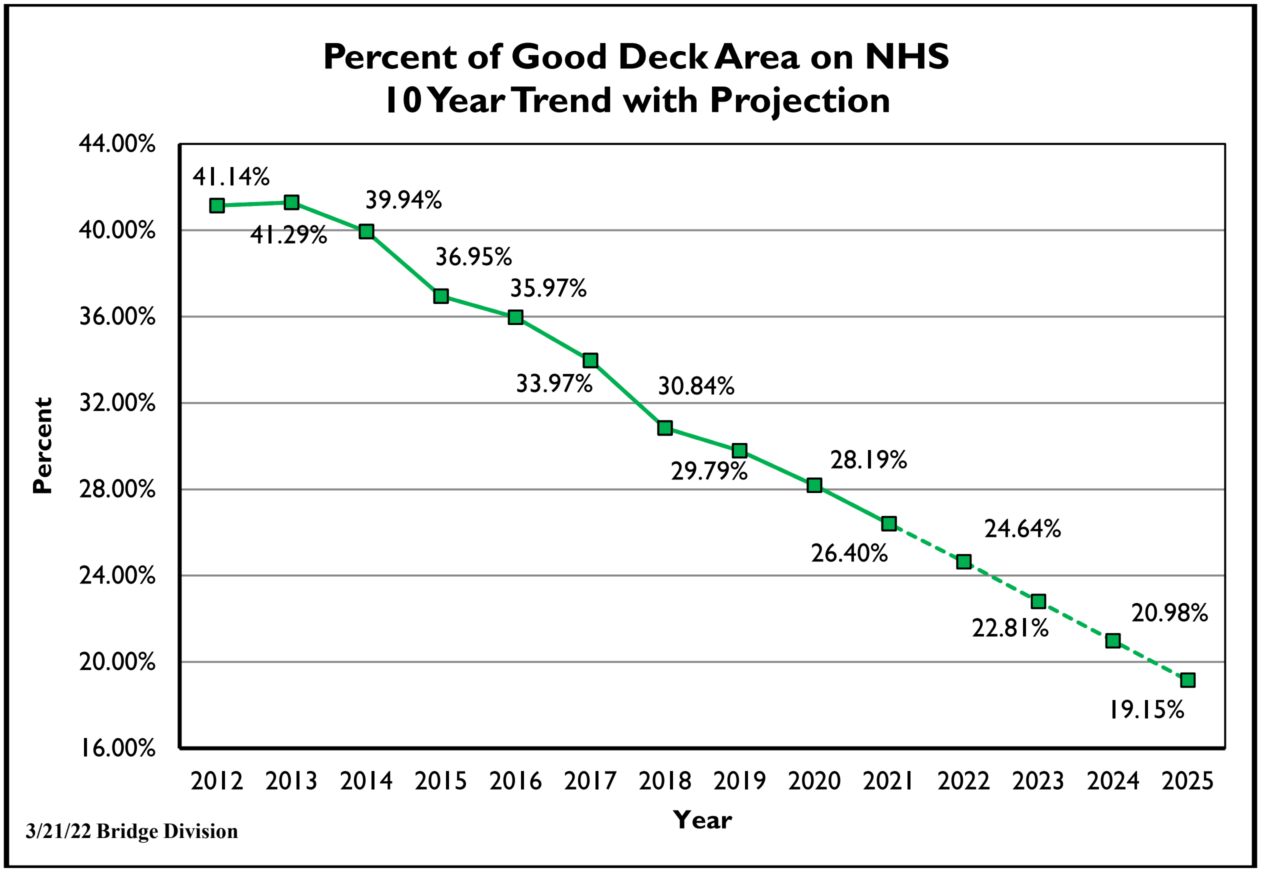
The future bridge targets for percent of bridges on the NHS classified as in poor condition were set based on a trend line from the last eight years. The goal is to maintain current conditions and keep bridges in a state of good repair. This target remains below the FHWA 10% penalty threshold. The bridge targets for percent of bridges on the NHS classified as in good condition were established based on a trend line from the last eight years. They are projected to decline in the coming years.

Fluctuations in overall percentage are common, and a major bridge falling into the poor category can impact the overall percentage as much as 0.5%. The Rocheport and Buck O'Neal bridges are both under reconstruction, but it will take approximately two to three years to complete and have the new structures open to traffic. Three other NHS major bridges are programmed for replacement in the STIP: Rt 51 Perry "Chester" (poor) in the Southeast District, IS 270 St. Louis City "Chain of Rocks" (fair) in the St. Louis District and IS 29 Clay "Courtney" (poor) in the Kansas City District.




Percent of Poor Deck Area on NHS
10 Year Trend with Projection
12.00%
11.00%
10.00%
9.00%
8.00%
7.00%
6.00%
5.00%
4.00%
Percent
MAP21 Penalty Threshhold of 10%
6.57%
6.23%
7.14%
6.54%
7.22%
7.13%
8.25%
7.49%
7.27%
7.13%
7.61%
7.68%
7.75%
7.82%
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025
Year
3/21/22 Bridge Division


Percent of Good Deck Area on NHS
Draft
40
30
20
10
0
Percent
34.0
30.8
29.8
28.4
27.2
26.4
22.8
19.2
2017 Baseline
2018
2019
2020
2021
2023
2025
Actual
Target
Desired Trend



Overall Performance

The targets established for NHS pavements and bridges can be achieved with the current baseline revenue dollars shown in Chapter 4 of this asset management plan. If additional revenues are received for this use, such as being awarded discretionary grants for specific projects on an NHS corridor, outperforming the target is possible and would be the desired outcome.

Although MoDOT is in a position to achieve the goals, those goals do include a slightly ascending target for NHS bridges in poor condition and slightly descending target for percent of good deck area on NHS. Due to a large wave of structures of similar age coming up for treatment, it is anticipated that the rate of transition from good to fair will exceed the transition of poor to good through replacement or deck replacement and the rate of fair to good through robust rehabilitation. Additionally, with some significant major bridges coming up in this TAMP window, the goal for percent of poor bridge deck on NHS anticipates the potential for a major bridge to fall from fair to poor within this time frame.

Chapter 3: Lifecycle Planning

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 resurfacing treatments targeted to improve pavement smoothness. MoDOT also invested in the Better Roads, Brighter Future initiative which followed on the heels of SRI. Ultimately, the series of strategic initiatives for investing in MoDOT's most important roadways moved Missouri's major highway system from approximately 45% good pavements to 85% good pavements. It also put MoDOT in a position to establish its asset management approach of maintaining the good condition of these smooth pavements.

For much of the last 20 years, customer satisfaction and road smoothness were closely aligned because as road smoothness increased, so did customer satisfaction. This clearly indicated the public desire to have smooth roads. However, over the last few years, the connection between smooth roads and customer satisfaction has declined. This demonstrates that customer satisfaction is evolving, and it is likely smooth roads alone are not enough to ensure satisfied customers. This places greater emphasis on the need to manage assets in the most cost-effective manner possible, ensuring that funds are available for the other goals established by the Long-Range Transportation Plan (LRTP).

Life cycle 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 – e.g. concrete vs. asphalt on a pavement project. Life cycle planning is performed at the network level where the needs of all roads and structures within those particular networks are considered.

Pavements

Keeping good roads good is at the heart of MoDOT's approach to asset management. 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 based upon applying preventive maintenance treatments 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 two decades. 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 them to the maximum foreseeable life. In addition to the cyclical preventive maintenance treatments, other contract type maintenance treatments, such as crack sealing and pavement repairs, are performed to further extend the pavement's useful life.

Pavement Life Cycle Scenarios

For pavement life cycle evaluation, MoDOT considered three strategies to maintaining pavements over the long term, a worst first replacement approach, a preservation approach and a hybrid of the two. For convenience, the typical project specific LCCA timeline of 45 years was used to evaluate each scenario.

Worst First Replacement:

The approach to replace all NHS pavement assumes that over the next 45 years, all NHS pavements would be replaced at approximately 448 lane miles per year. Throughout the 45-year cycle, it is assumed that current asset management practices would continue for pavement not yet replaced and that the anticipated LCCA treatment cycle would occur as scheduled in the LCCA for all replaced pavements. This approach would align all NHS pavement with the LCCA cycle and would essentially repeat on 45-year cycles. The anticipated total 45-year cycle cost with inflation would be $82 billion. This scenario would require approximately 75%, on average, of all anticipated funds for construction awards for this 10-year TAMP window.

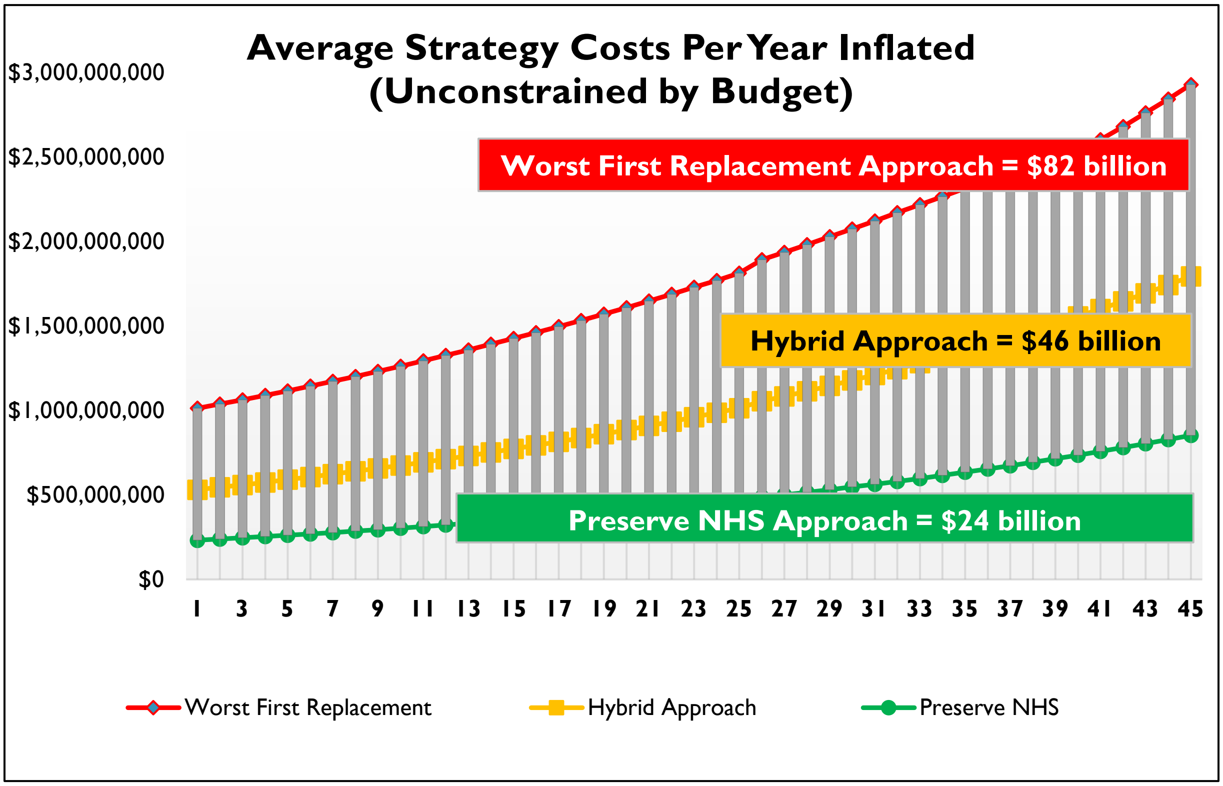
Hybrid Approach - Worst First Replacement on Interstate, Preserve Remaining NHS:

The second approach would replace all interstate pavement while taking a preservation approach to the remaining NHS. It assumes that over the next 45 years, all interstate pavements would be replaced at approximately 147 lane miles per year. Throughout the 45-year cycle, it is assumed that current asset management practices would continue for all NHS pavement and interstate pavement not yet replaced. It is also assumed that the anticipated LCCA treatment cycle would occur as scheduled in the LCCA for all replaced pavements. This approach would align all interstate pavement with the LCCA cycle and would essentially repeat on 45-year cycles. The anticipated total 45-year cycle cost with inflation would be $46 billion. This scenario would require approximately 35%, on average, of all anticipated funds for construction awards for this 10-year TAMP window.

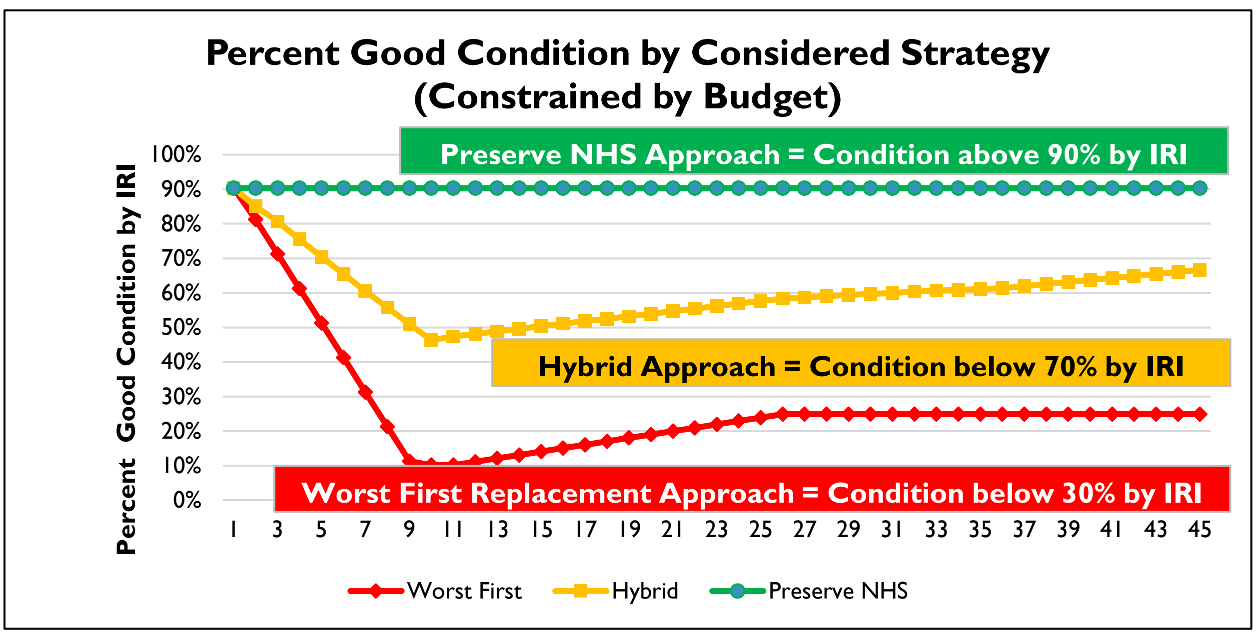
Preserve NHS, with Consideration to Replace Segments with Lagging Performance:

The third approach, which is the current asset management focused approach, assumes that MoDOT would continue using a variety of treatments to maintain pavement condition performance. It is further assumed that reconstruction is used to replace those segments where lagging performance is identified. This is anticipated to be a nominal amount each year for the sake of comparison. Treatments would consist of MoDOT's current asset management practices for all pavements. The anticipated total 45-year cycle cost with inflation would be $24 billion. This scenario would require approximately

19%, on average, of all anticipated funds for construction awards for this 10-year TAMP window.

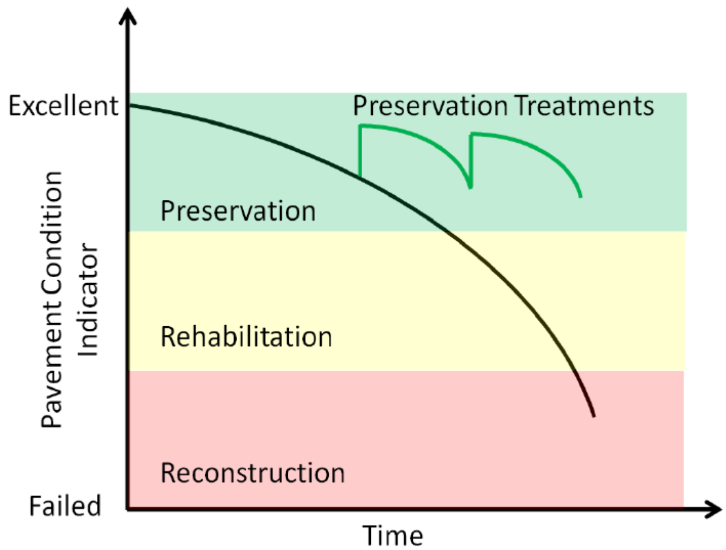


When the cost of treatment and inflation are considered, the worst first and hybrid approaches required significantly more funds over the time frame, costing 3.5 and 2 times more respectively.



Additionally, with both alternative strategies, the NHS condition would fall to nearly 30% and 70% respectively.

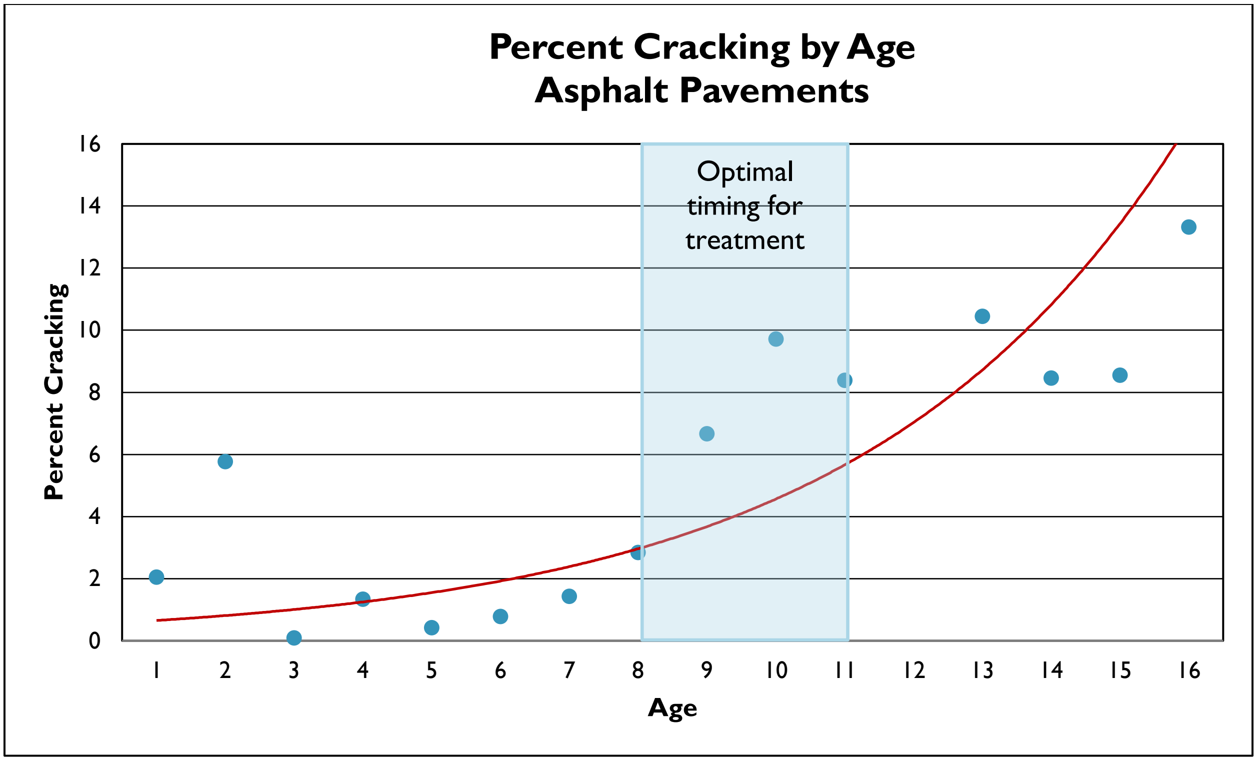
MoDOT's asset management approach to maintain the current condition of pavements and bridges is the most cost-effective method to preserve pavements and bridges. It is based upon the strategic use of preventive maintenance and rehabilitation treatments to maintain assets in their current condition, while the assets are already in good/fair condition. The diagram below shows the basic strategy for MoDOT's TAMP – focusing on less expensive preservation treatments more often than expensive robust rehabilitation and reconstruction treatments. These less expensive preservation treatments keep the pavement and bridge conditions at a higher level throughout the cycles than is possible using the more involved and more expensive treatments less frequently. The objective is to slow down the rate of deterioration and provide a consistently smooth, durable, and safe roadway for users at the lowest cost.

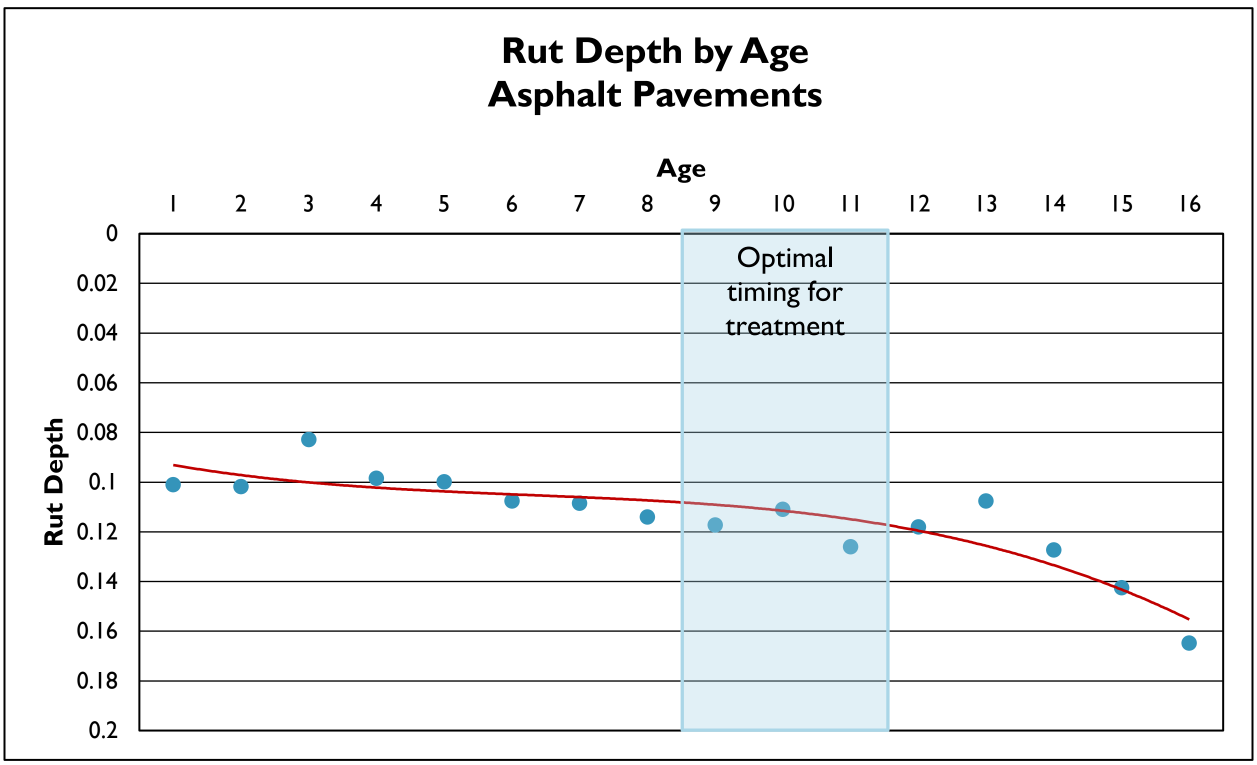


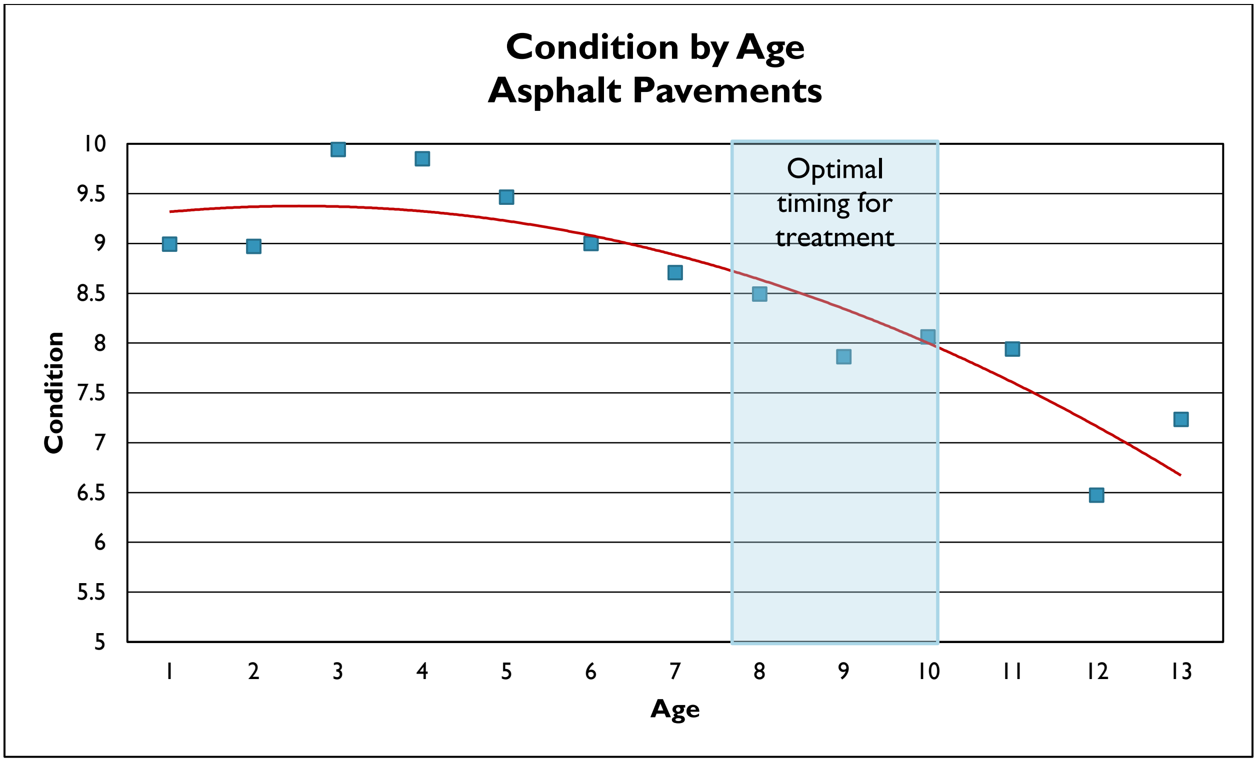
Pavement Treatment Service Life and Performance Measures

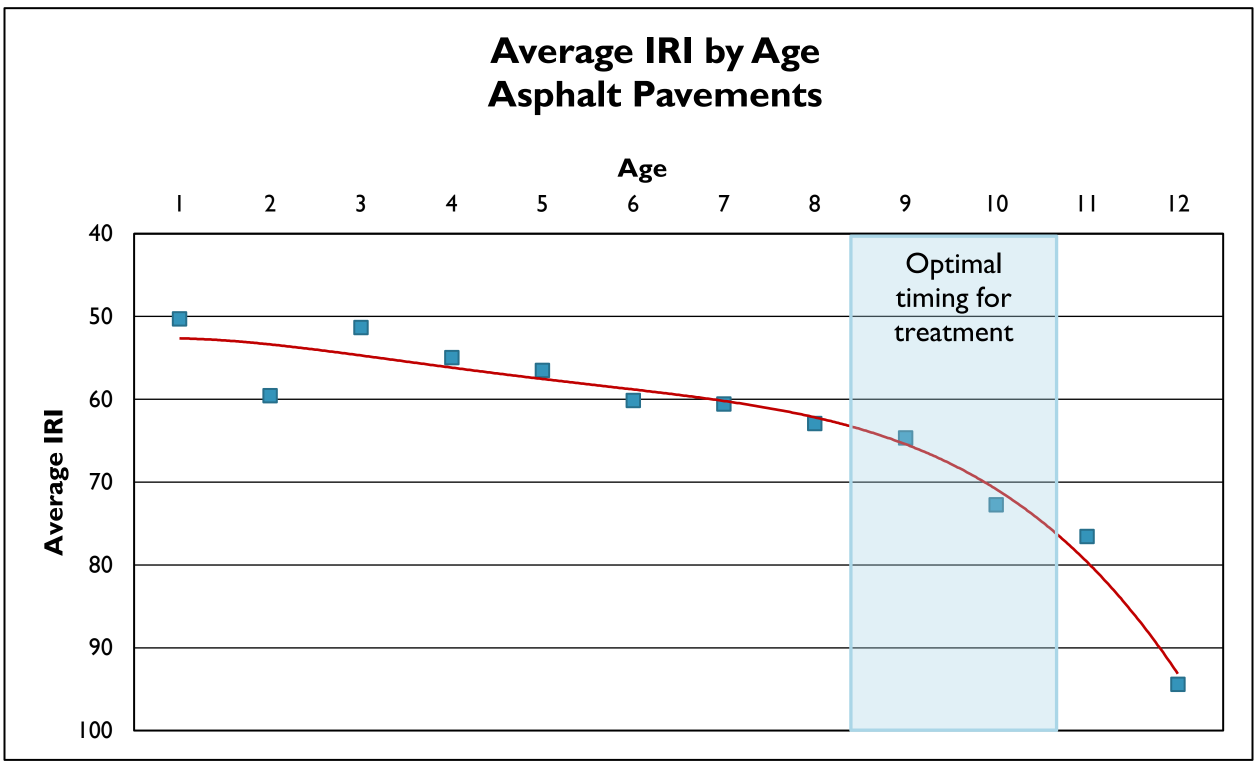
As described in Chapter 2, MoDOT's pavement performance goal is to sustain the state of good repair by maintaining current conditions. The associated service life of the applicable pavement treatments is derived by analyzing the condition over time of several previously placed treatments used throughout the state. The combination of treatments used within a region is then considered to develop a region-specific treatment service life for each district. This research and the district-based approach yields data that supports an eight-to-nine-year treatment cycle on Missouri's NHS routes.

The following graphs demonstrate the deterioration rates for asphalt pavements by age for each of the primary pavement condition metrics, with an indicated optimized treatment window for each.


Percent Cracking by Age
Asphalt Pavements
Optimal timing for treatment
Percent Cracking
0
2
4
6
8
10
12
14
16
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Age


Rut Depth by Age
Asphalt Pavements
Age
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Optimal timing for treatment
Rut Depth
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2





MoDOT uses a variety of pavement treatments to best obtain the desired treatment service life based upon the existing conditions while addressing the specific needs at the time of treatment. The work types identified in this chapter can be defined by the following typical pavement treatments.

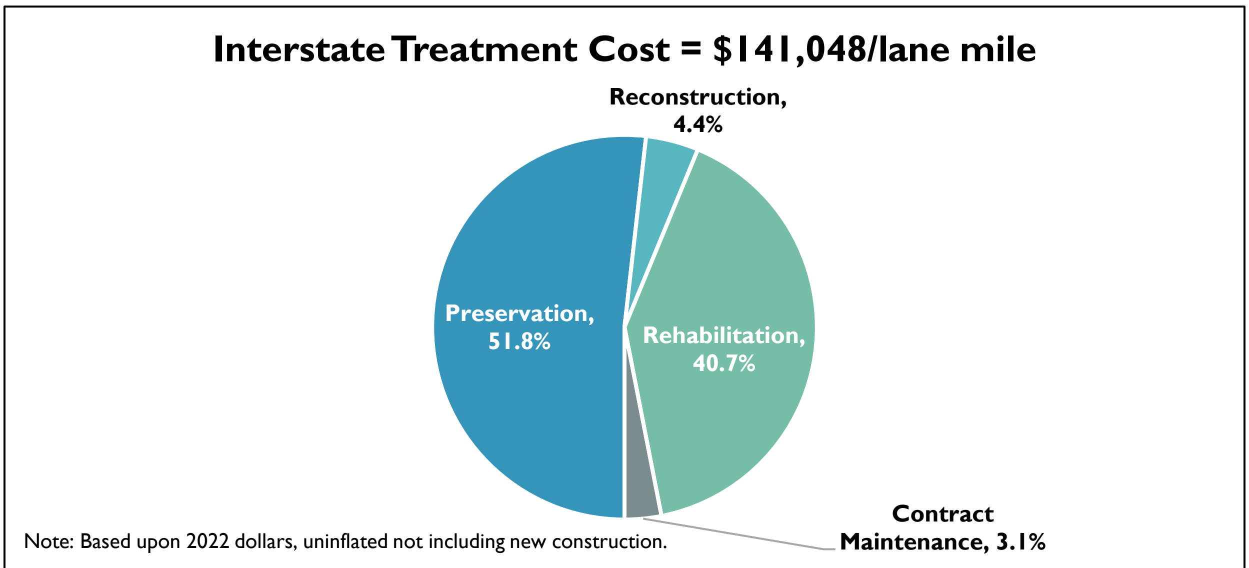
Federal Work Type	MoDOT Work Type
Initial Construction	New Construction (Capital Improvement)*
Reconstruction	Hot Mix Asphalt (HMA) or Portland Cement Concrete Pavement (PCCP) roadway replacement, Unbonded Portland Cement Overlay (or Rubbilization with HMA Overlay)
Rehabilitation	HMA Overlay (2" or greater), PCC Overlay (<6")
Preservation	HMA Thin-Lift Overlay (less than 2"), Diamond Grinding, Unbonded Asphalt Wearing Surface, Chip Seal/Scrub Seal
Maintenance	Full-Depth Pavement Repair, Patching, Crack Filling/Sealing, Slurry Leveling, Joint Repair, Fogging

*Note – Initial Construction is estimated based upon current STIP and is not considered by MODOT to be an area of asset management focus.

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).

Interstate Pavement

The estimated interstate average treatment cost for interstate routes is $141,048 per lane mile based upon the asset plans. The combination of treatments used to create the cost above results in an average treatment cycle length of eight to nine years.



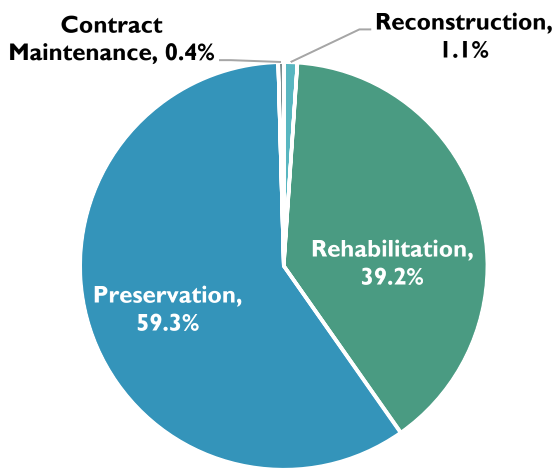
These estimates are based on the following treatments: 51.8% preservation treatments such as diamond grinding, thin lift overlays, unbonded asphalt wearing surface placement, microsurfacing placement or other preventive maintenance strategies, 40.7% rehabilitation treatments including high type asphalt overlays 2-inch or greater, 4.4% reconstruction, and 3.1%

contract maintenance such as pavement repair projects, crack filling and sealing operations. The percentages and the chart above are based upon the planned work for interstates 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).

Non-Interstate Pavement

The estimated average non-interstate NHS pavement treatment cost is $116,289 per lane mile based upon the asset plans. The combination of treatments used to create the cost above results in an average treatment cycle length of eight to nine years.

Non-Interstate Treatment Cost = $116,289/lane mile



Note: Based upon 2022 dollars, uninflated not including new construction.

These estimates are based on the following treatments: 59.3% preservation treatments such as diamond grinding, thin lift overlays, unbonded asphalt wearing surface placement, microsurfacing placement or other preventive maintenance strategies, 39.2% rehabilitation treatments including high type asphalt overlays 2-inch or greater, 1.1% reconstruction, and 0.4% contract maintenance such as pavement repair projects, crack filling and sealing operations. The percentages, and the chart above, are based upon the planned work for non-interstate NHS pavement for the next 10 years on average (i.e., each year the given work type may fluctuate, but the overall 10-year average is shown).

Pavement Lifecycle Planning

With the wide range of variables that impact pavement life and performance, MoDOT's approach to pavement life cycle is purposefully flexible to accommodate the complex circumstances of each region. The treatments considered and the associated frequency of application are determined by the region to account for material availability and performance and costs. In general, MoDOT's pavement life cycle consists of construction, a series of preventive maintenance strategies, appropriately timed rehabilitation strategies, and when pavement performance lags beyond what should reasonably be expected, reconstruction or heavy rehabilitation.

Each district maintains a pavement plan, which details the anticipated pavement work over the next 20 years. This pavement plan serves as a tool to ensure staff are considering all roadways within their network, are considering the long-term needs of the system, and have opportunity to identify those facilities for which performance is lagging so that they can move forward in a consistent manner with their asset management plan.

Each year, districts are provided updated information on the current condition of the facilities within their region and the district's available funding in each category of distributed funds, including asset management. Districts work to update their asset management plan to reflect necessary changes, demonstrate the strategic approach will maintain their target conditions and address the new 10th year of the rolling 10-year cycle.

MoDOT's pavement preservation approach is focused on the treatment cycles which help extend the length of time between more exhaustive and costly rehabilitation treatments. As the conditions of a given route and the treatments used to preserve that route over time can vary significantly, the complete life cycle of each pavement can vary. In addition, the timing at which pavement performance through the use of preventive treatments will begin to lag. It is at this point of lagging performance that significant rehabilitation or replacement is considered.

Bridges

Since Missouri has many 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.

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

Federal Work Type	MoDOT Work Type
Initial Construction/Capacity Improvement	New Bridge Construction, Bridge Replacement
Reconstruction	Deck Replacement, Superstructure Replacement
Rehabilitation	Deck Overlay, Rehabilitation
Preventive Maintenance	Painting, Washing, Sealing, Epoxy Injection, Epoxy Overlay
Maintenance	Bridge Miscellaneous, Seal Replacement, Expansion Joint Replacement, Deck Patching, Substructure Repair, Scour Repair

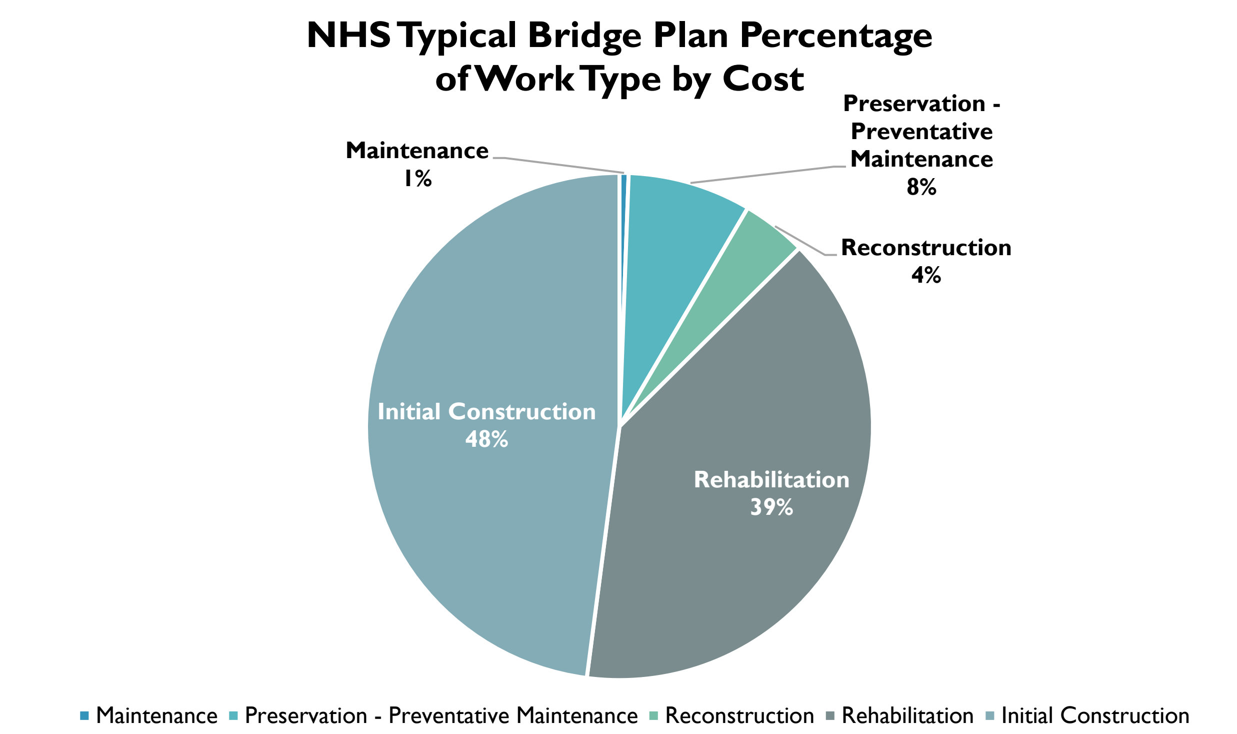
Bridge Preventive Maintenance

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

- Bridge cleaning and flushing to remove dirt and debris and to allow proper drainage and drying of the deck. The dirt and debris hold moisture and chlorides that cause deterioration. Deck flushing is done in the fall and spring. A thorough cleaning of an entire bridge is 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 3,483 typical bridges on the NHS in Missouri, MoDOT will do a combination of replacements, deck replacements, rehabilitation, preventive maintenance treatments and 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 3,483 typical bridges on the NHS equate to over 30 million square feet of bridge deck. The chart below depicts the potential work type planned for bridges on the NHS for the next 10 years on average (i.e., each year the given work type may fluctuate, but the overall 10-year average is shown in the chart).



Note: Based upon 2022 dollars, uninflated

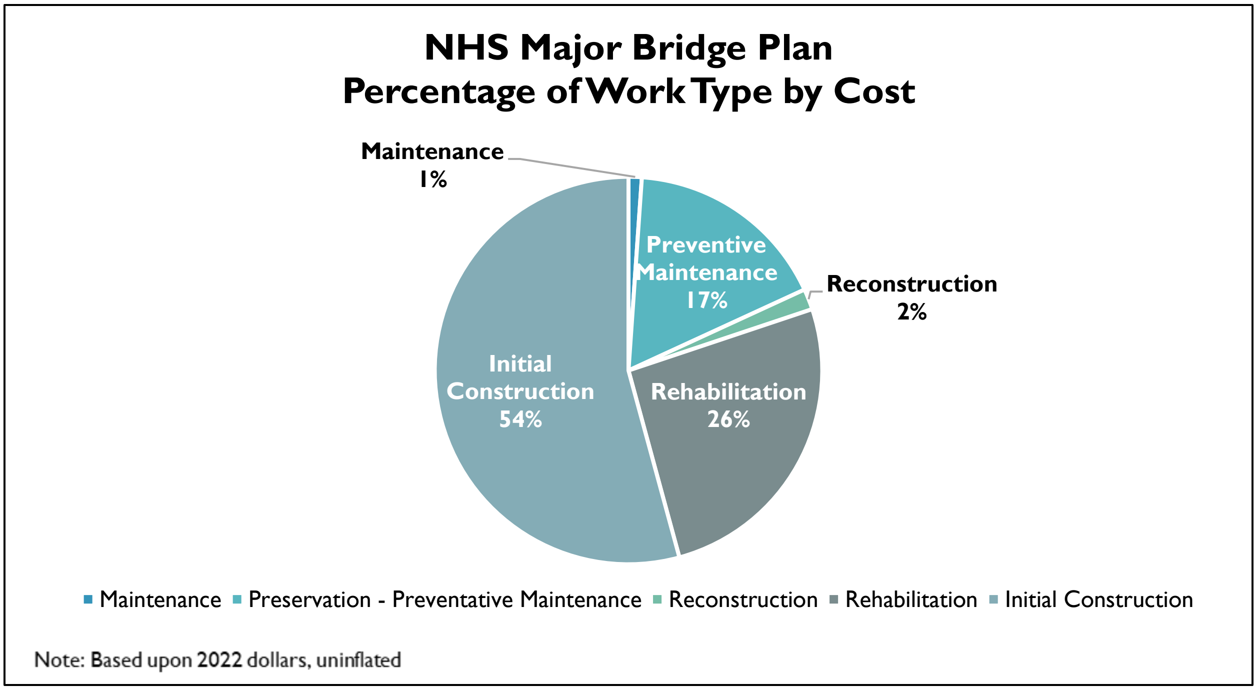
The bridge work represented above varies in price per bridge and type of work being performed. The overall costs are as follows: initial construction - $299/square foot; reconstruction - $105/square foot; rehabilitation/preventive maintenance $27/square foot. This represents approximately 80 bridges each year having substantive work performed on them. This work is needed to keep bridges in good and fair condition on the NHS, with much more work needed on non-NHS bridges to maintain the state of good repair of MoDOT's entire bridge.

Even though about 80 bridges (2.5 million square feet) on the NHS each year are receiving treatments to maintain good and fair conditions, MoDOT still sees roughly 28 bridges fall into the poor category each year. The number of bridges in the poor category on the NHS is currently 127 and represents approximately 1.4 million square feet of bridge deck. There are 2,255 NHS bridges in the fair category which is approximately 22.0 million square feet of bridge deck.

There was a time in which MoDOT approached bridge work using a focus on worst first method. MoDOT's efforts on asset management has shifted the effort from the worst first approach to a multi-focused approach that includes not only full replacements of poor bridges, but also preventive maintenance of good and 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 good and fair condition for a much longer term.

Major Bridges on the NHS – Bridge Work

As described in Chapter 1, a major bridge is greater than 1,000 feet in length. MoDOT's 10- year major bridge needs have an estimated cost of construction that is over $1.1 billion. Preventive maintenance to maintain the state of good repair is also a focus area on the major bridges in Missouri. Unfortunately, several major bridges in Missouri are well beyond their design life and may be in poor condition or have significant functional issues that necessitate a costly replacement versus other treatments. Missouri currently has 169 major bridges on the NHS that represent about 20.5 million square feet of bridge deck. Of the overall square foot of bridge deck, 12.5% is categorized as poor condition requiring replacement or a major rehabilitation, and 69.6% is categorized as fair condition.



Bridge Lifecycle and Performance Measures

As described in Chapter 2, MoDOT's bridge performance goal is to maintain a level percentage of poor deck area on the NHS through replacement and major rehabilitation projects. Due to the relative age of Missouri's interstate roadways, the percentage of good deck area is expected to drop. The goal is to reduce the rate of decline by doing early preventive maintenance treatments to lengthen the period a structure stays in good condition. MoDOT will also focus resources on bridges in the fair category by doing more significant rehabilitation work to reduce the amount of deck area, moving from fair to poor condition. The life cycles of bridges are different than pavement, as bridge condition changes are generally slow and pavement condition can transition between conditional categories quickly. New bridges take many years to progress to a point of being in poor condition. Early intervention through preservation actions, timely repairs, and moderate rehabilitations should result in bridges staying in the good and fair condition categories for longer periods of time.

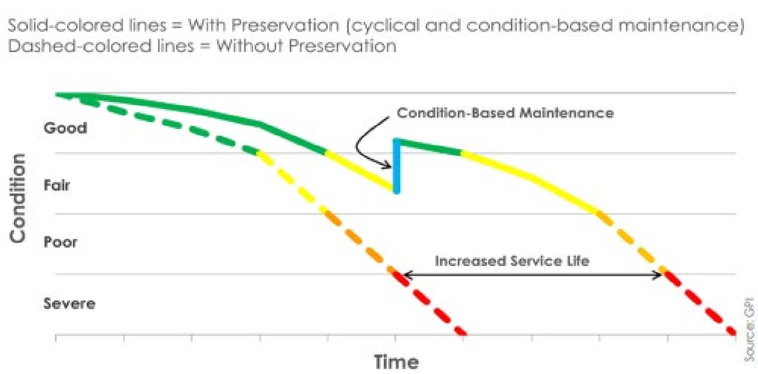


Figure 17. A comparison of bridge condition over time with and without bridge preservation.

Extreme Weather and Resiliency in Life Cycle Planning

As MoDOT has considered natural disasters in its enterprise risk assessment over the last several years, focus has been placed upon the potential impacts of weather-related issues to the transportation system. MoDOT's general approach, which is focused on preservation of the transportation system, provides routine opportunities to address emerging issues that have been identified. With a relatively short frequency of eight-to-nine-years between projects at most locations, there is less risk of having to make a replacement decision on a non-performance related basis, such as extreme weather and resiliency, at locations where significant investment has recently been made.

MoDOT monitors the rate of deterioration of the NHS, watching closely for changes over time in the time frame associated with the primary pavement condition metrics. This effort provides a real time understanding of the service life of treatments over time and through the changing environment. With a rolling 10-year asset management window, any changes to service life experienced each year can be reflected in the adjustment process to ensure that extreme weather concerns are routinely accounted for within the life cycle assumptions.

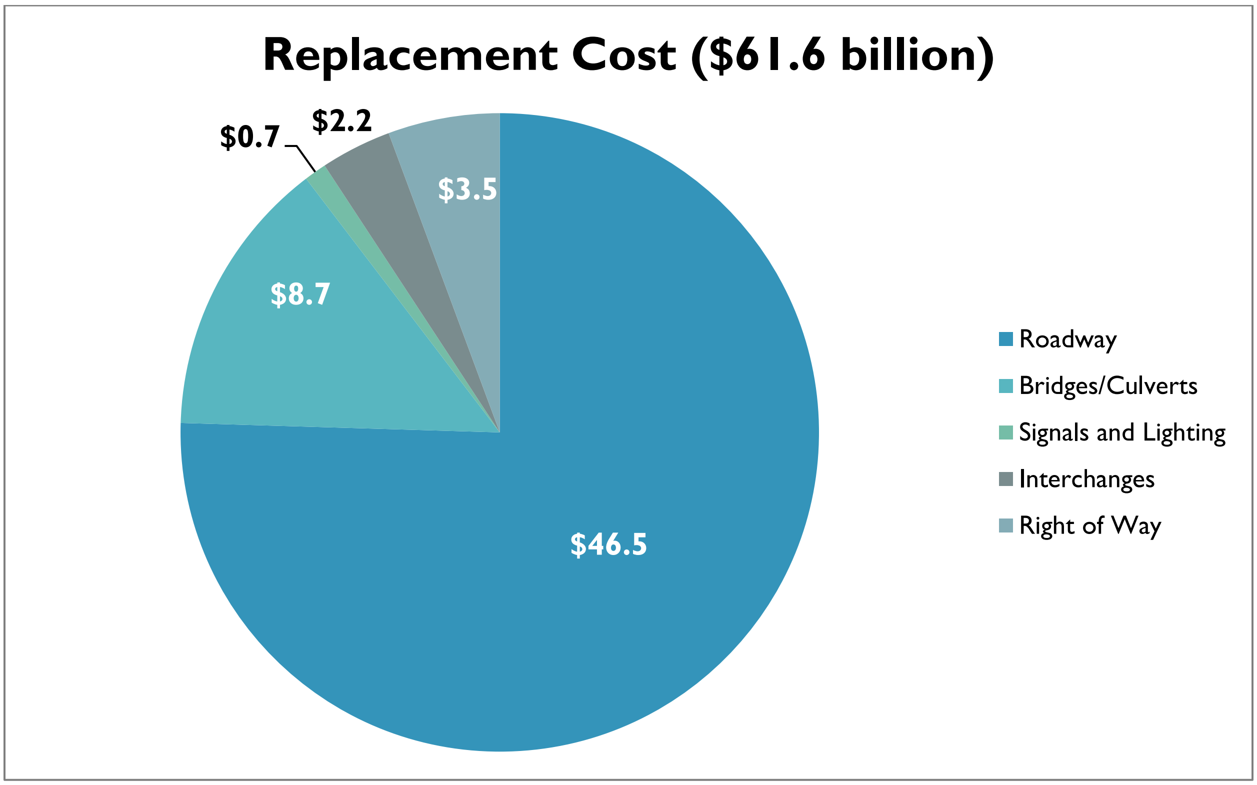
As a routine product of the planning and project delivery processes, MoDOT reviews each specific location for all applicable needs with each iteration, considering items such as safety needs, functional needs, corridor consistency and potential impacts due to extreme weather and resiliency. Although the necessary project scope to address these needs may exceed the scope for the asset management plan projects, the concerns, issues, and emerging needs for the location are documented for consideration with future projects.

By integrating the small changes associated with weather changes over time, MoDOT is actively engaged in long-term accommodation of the change and considers the impacts of extreme weather and resiliency in the life cycle planning process.

Chapter 4: Financial Plan and Investment Scenario

Missouri's transportation system has a replacement value today totaling $145 billion. A significant piece of that system is Missouri's NHS, which is a critical element in the transportation network. It has a replacement value totaling nearly $62 billion. Detailed assumptions for the replacement cost calculation can be found in appendix B. As MoDOT maintains a robust, geospatially located inventory of roadway, bridges, and right of way, along with detailed inventories of signs, signals and lighting and interchanges, the replacement cost for the NHS is readily available. The cost is, therefore, easy to update for changes in inventory, changes to costs and current inflation.

MoDOT's valuation of assets, using the replacement cost approach, serves as a valuable communication tool. It ensures transportation stakeholders understand the investment made to date and the relative expense to maintaining such a vast and valuable resource.

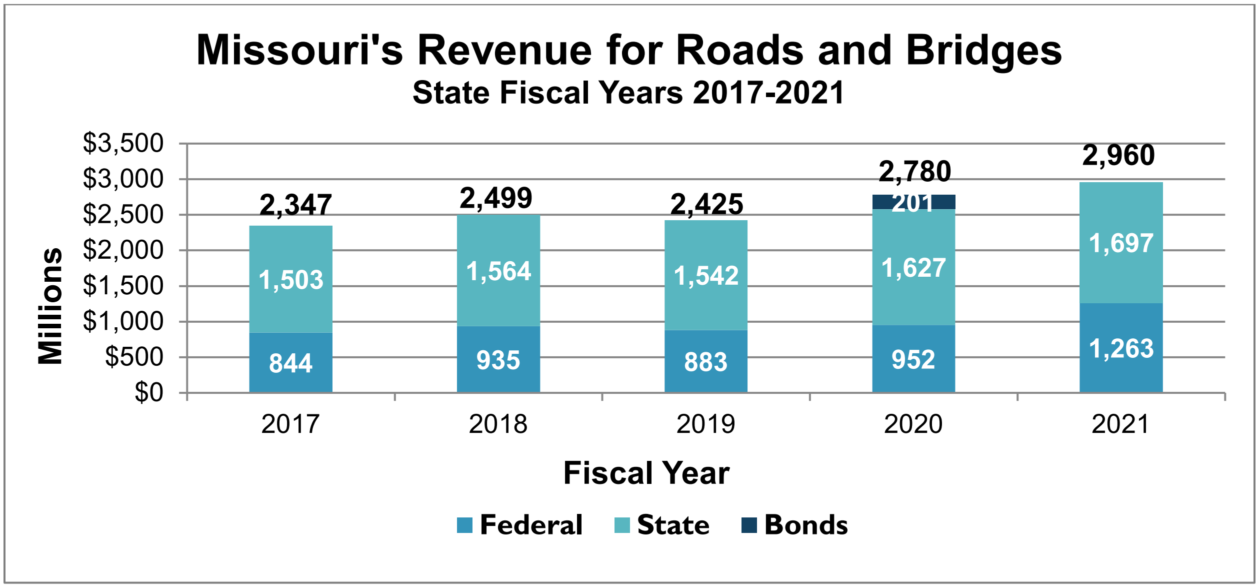


Funding Overview

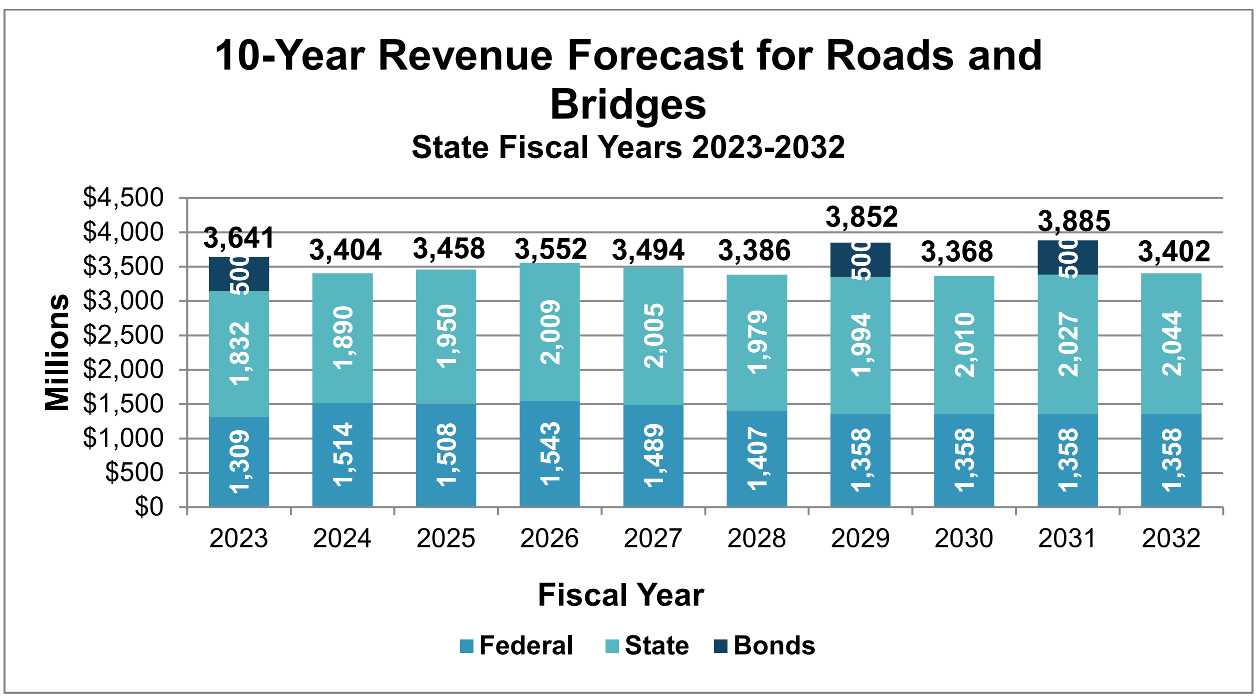
Missouri's state-owned NHS routes are funded from a combination of state and federal sources. The state funding available to maintain these routes includes the state motor fuel tax, motor vehicle and driver licensing fees, motor vehicle sales taxes and miscellaneous revenue.

The federal revenues are based on formulas prescribed by federal law through transportation funding acts. Most federal revenue is dedicated to pay for a share of eligible highway improvement costs. The federal share for the eligible costs is typically 80%, with the state providing a 20% match.

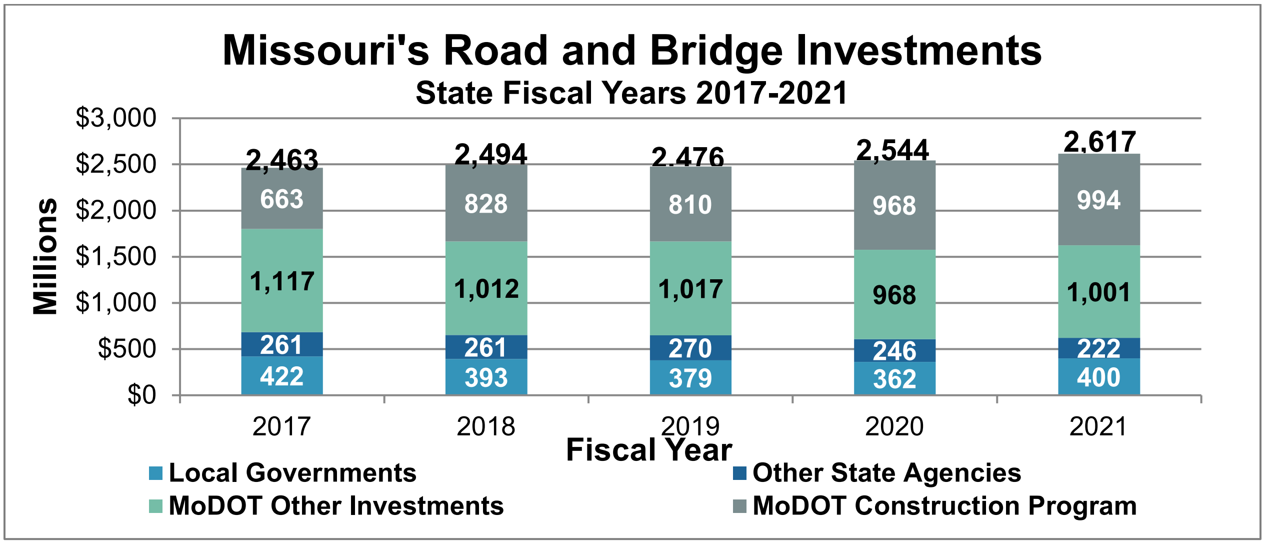
From fiscal years 2017 to 2021, the revenues increased as shown in the chart below. The FY 2021 federal revenue includes COVID-19 relief funds.



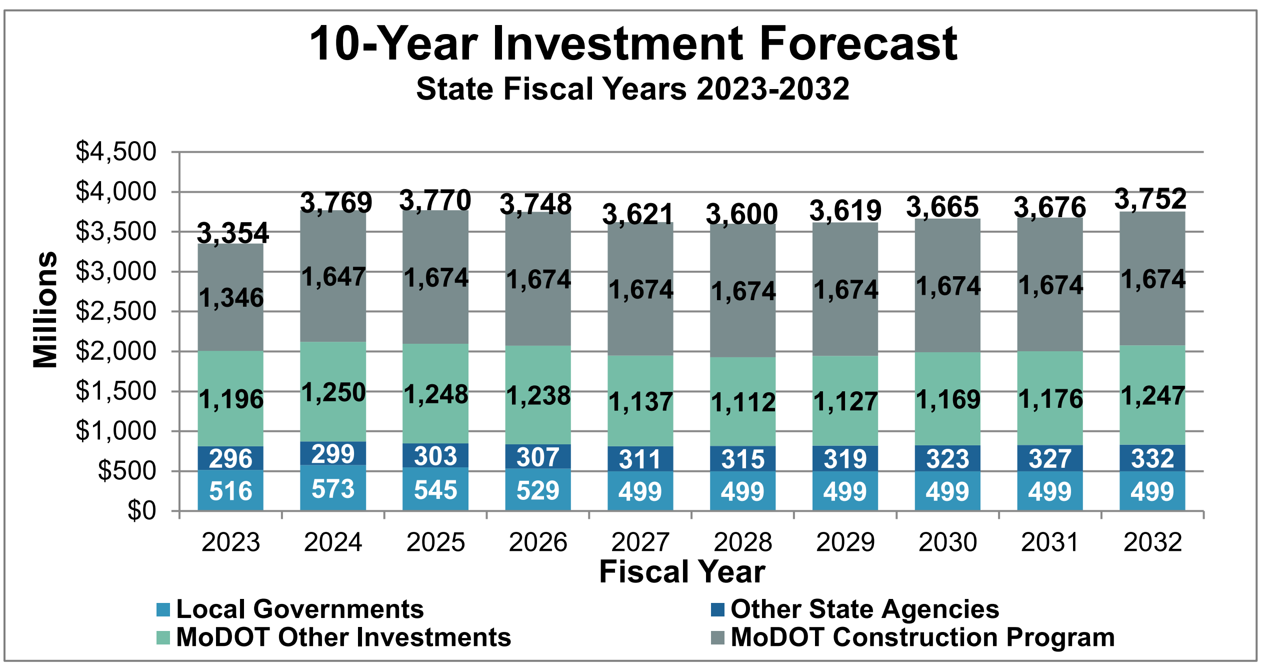
The chart below provides MoDOT's revenue forecast estimates for fiscal years 2023-2032.



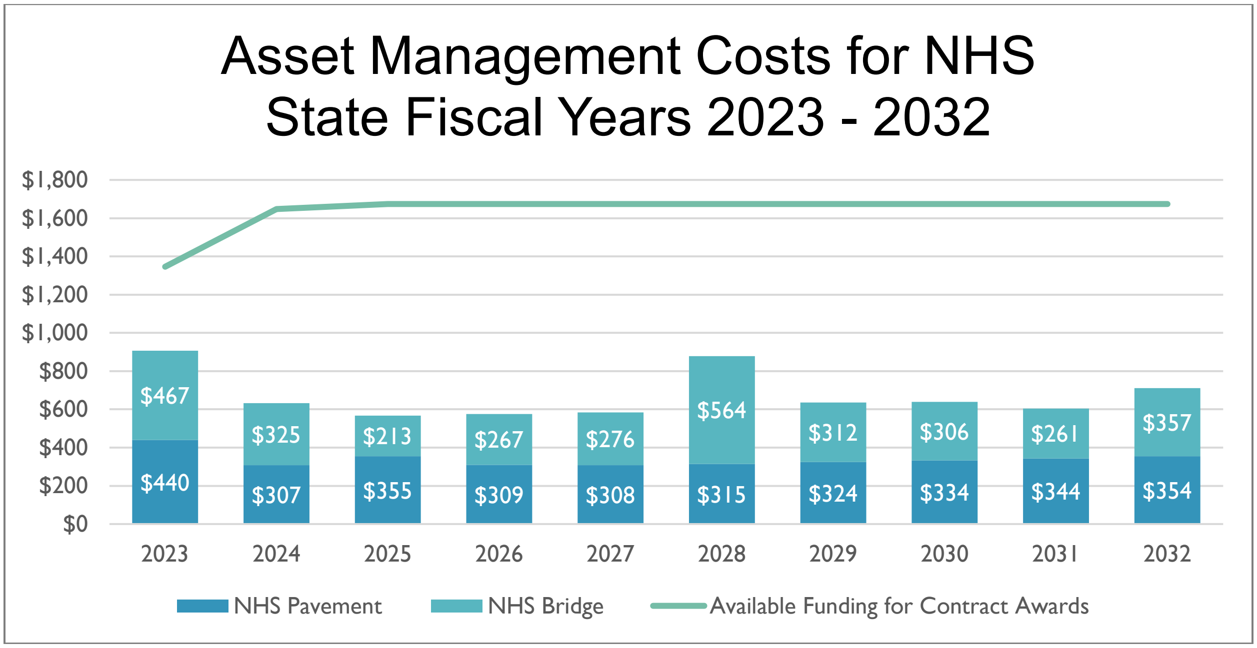
The forecasted revenues are available for road and bridge investments across the state. Missouri's road and bridge funding is shared with local governments and other state agencies, with the rest remaining with MoDOT. Local government funding includes a share of state taxes and fees and funding for locally-sponsored federal programs. These funds can be used to maintain locally-owned roads and bridges. MoDOT's share of Missouri's road and bridge funds is 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 2017 to 2021, the total investments have ranged from $2.5 billion to $2.6 billion as shown on the chart below.

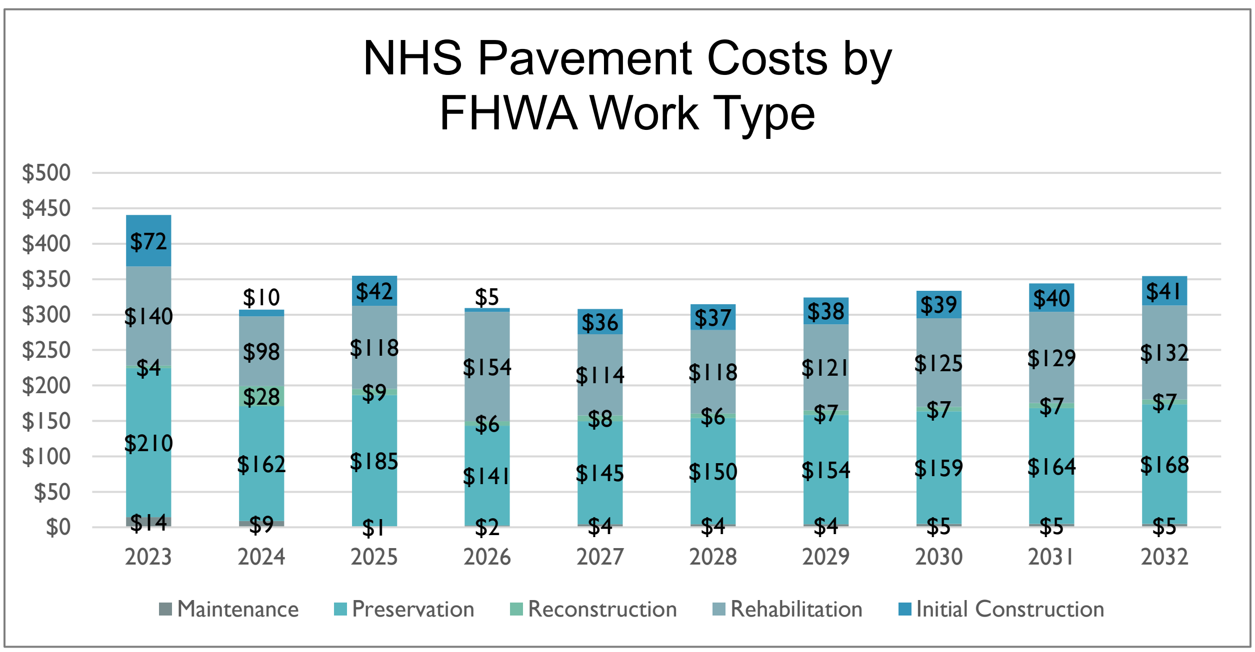


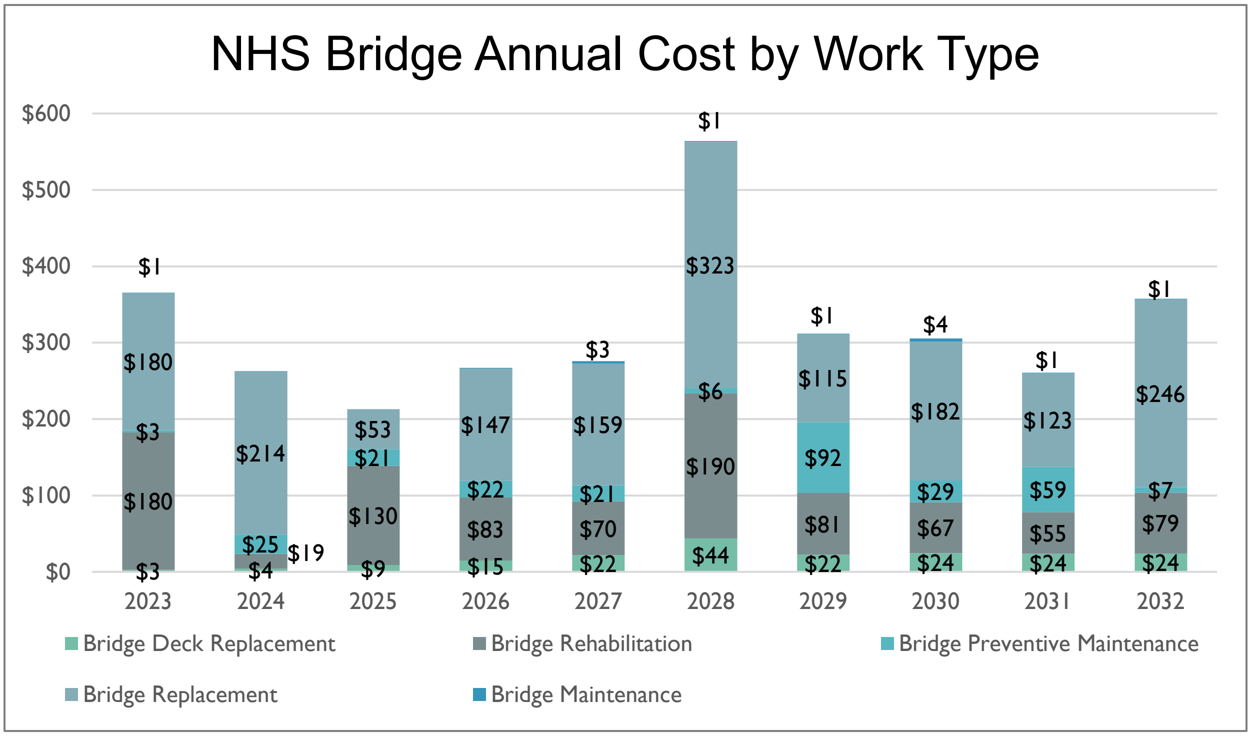
MoDOT's construction program investments are the primary funding source for maintaining NHS assets. The 10-year financial forecast assumes construction program investments will average $1,639 million annually, as shown on the following chart.

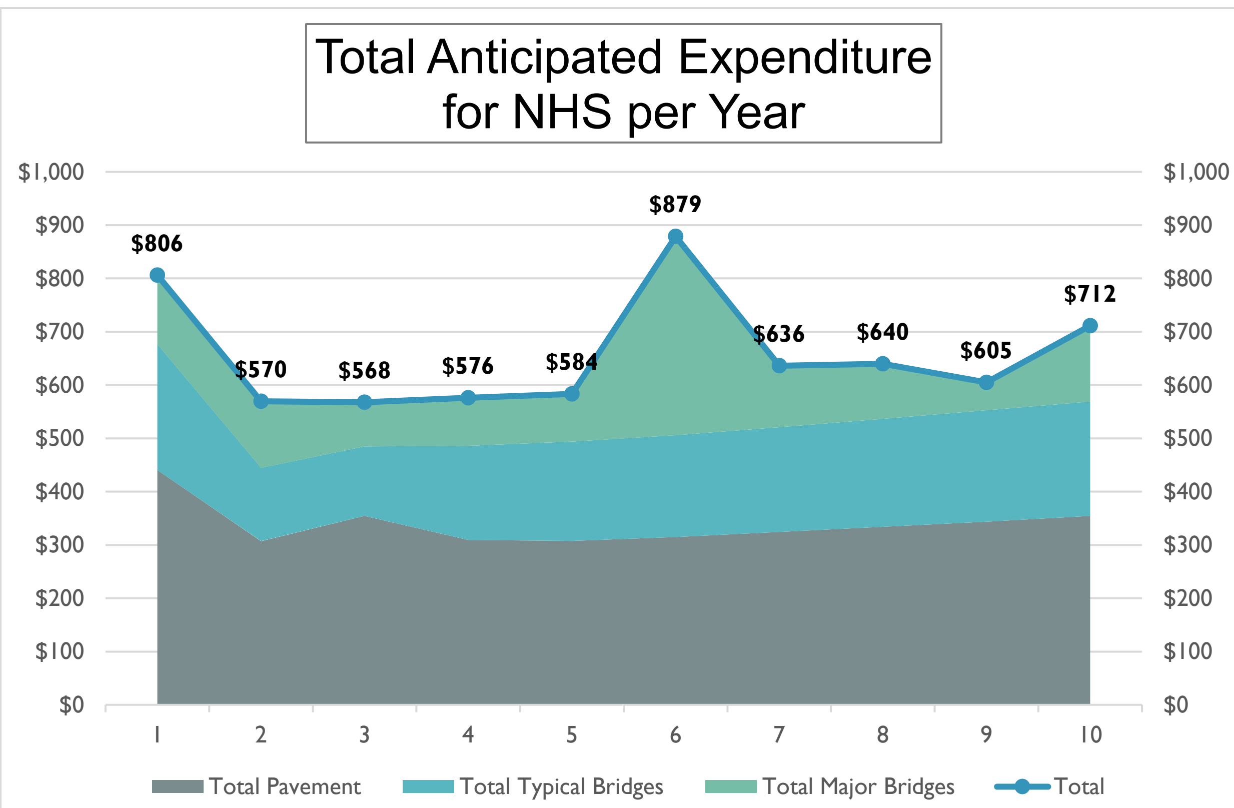


Based on the pavement and bridge work type assumptions from Chapter 3, MoDOT has estimated the cost to maintain existing conditions for all state-owned NHS routes. MoDOT's asset management plan assumes annual inflation costs of 3%, resulting in an annual cost range from $556 million to $902 million per 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, however, it is not uncommon for a major bridge replacement to cost over $250 million.






NHS Bridge Annual Cost by Work Type
$600
$500
$400
$300
$200
$100
$0
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
$1
$180
$3
$180
$3
$214
$25
$4
$19
$53
$21
$130
$9
$147
$22
$83
$15
$3
$159
$21
$70
$22
$1
$323
$6
$190
$44
$1
$115
$92
$81
$22
$4
$182
$29
$67
$24
$1
$123
$59
$55
$24
$1
$246
$7
$79
$24
Bridge Deck Replacement
Bridge Rehabilitation
Bridge Preventive Maintenance
Bridge Replacement
Bridge Maintenance


Total Anticipated Expenditure for NHS per Year
$1,000
$900
$800
$700
$600
$500
$400
$300
$200
$100
$0
1
2
3
4
5
6
7
8
9
10
$806
$570
$568
$576
$584
$879
$636
$640
$605
$712
Total Pavement
Total Typical Bridges
Total Major Bridges
Total

The remaining funds available between anticipated contractor awards and the yearly anticipated NHS expenditures range from $540 million to $1.1 billion 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. As a result, MoDOT does not have a funding gap associated with maintaining the NHS.

Potential Additional Funds

MoDOT continues to seek additional funds through discretionary or competitive federal grant programs, additional state funds, cost share programs and other similar approaches. MoDOT looks for opportunities to leverage these additional funds for asset management focused projects to make further progress towards asset management goals, often using major bridges, a package of typical bridges or statewide priority corridor improvements as the basis of grant requests. By addressing these existing needs with funds not previously committed, MoDOT is able to advance other priority assets to create positive improvement in the condition of the system.

Performance Gaps

MoDOT focuses a significant amount of resources and funding on asset management with the goal of maintaining existing conditions. Unfortunately, current available funding leaves a gap in system performance for reliability and congestion reduction improvements. With the sheer volume of construction activities planned over the next five years, including extensive work on interstate and NHS corridors, and those routes most relied upon for freight, travel time impacts are likely.

Additionally, although MoDOT's desire is to maintain the state of good condition for all assets, the anticipated investment in bridges will likely see a decline in the percentage of good deck on the NHS. Although considerable effort is being made, a portion of the bridge deck in good condition will fall to fair condition, as the work is balanced to maintain the entire system. This decline is demonstrated in the performance targets. However, as identified earlier in this chapter, if additional unanticipated funds are received, this is an area that MoDOT would anticipate augmenting the investment to slow or eliminate the decline.

In 2018, MoDOT's outreach and long-range planning activities identified an annual funding gap totaling $825 million for several areas, which extends beyond simply maintaining the system. In 2022, the associated costs of those areas were updated to reflect the inflation that had occurred. The areas and funding amounts may be found below.

- $115 million to improve state-owned bridge conditions
- $60 million to improve road conditions
- $105 million to stabilize the level of MoDOT's maintenance and operation efforts to keep pace with inflationary cost increases
- $300 million to invest in projects that increase economic growth and improve safety
- $325 million for major interstate reconstruction
- $95 million to improve multimodal transportation options

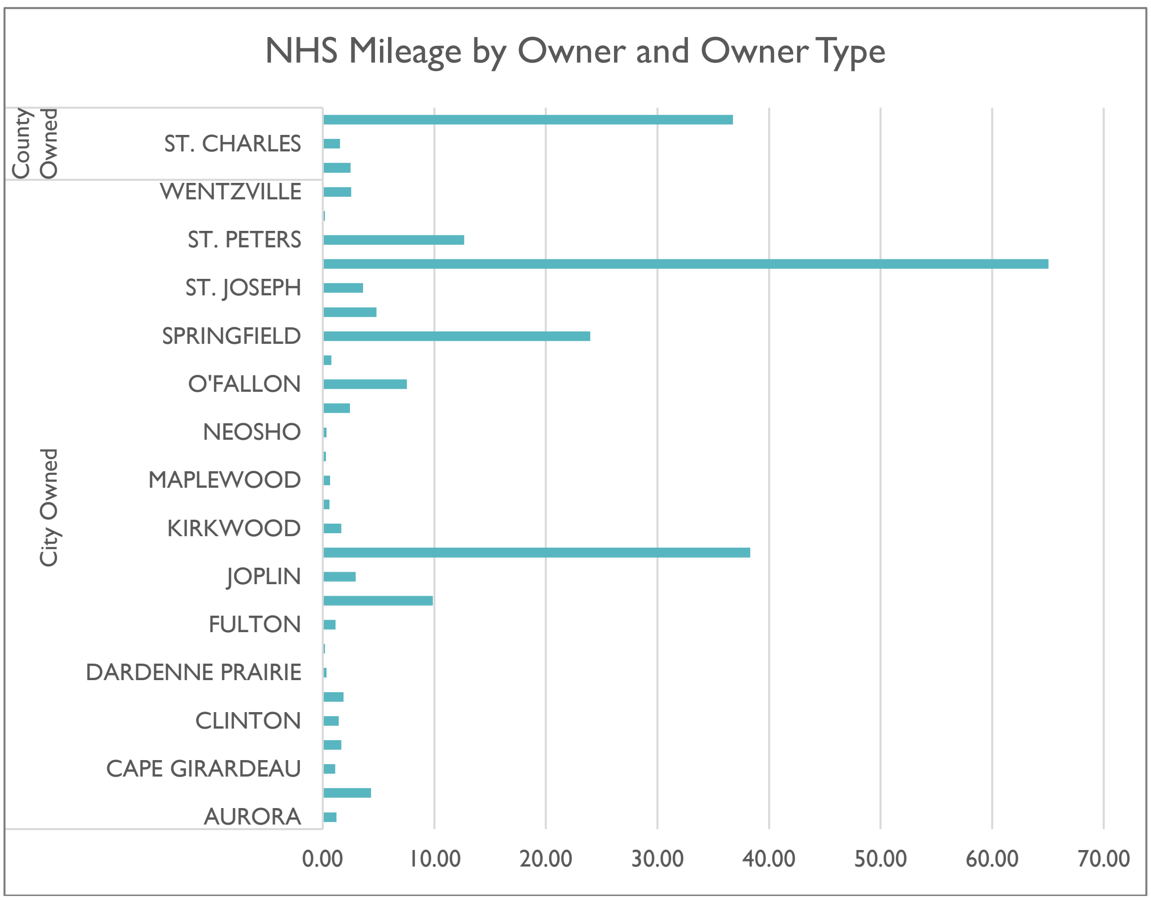
Additional information regarding unfunded transportation needs, including future expectations of demographics, employment, freight, travel and advanced technology, may be found in MoDOT's 2018 LRTP at https://www.modot.org/long-range-transportation-plan.

Recent funding increases associated with the Bipartisan Infrastructure Law (BIL) (federal) and Senate Bill 262 (state) have marginally closed this funding gap for some of the most critical unfunded needs, allowing some progress on projects with goals outside of the asset management.

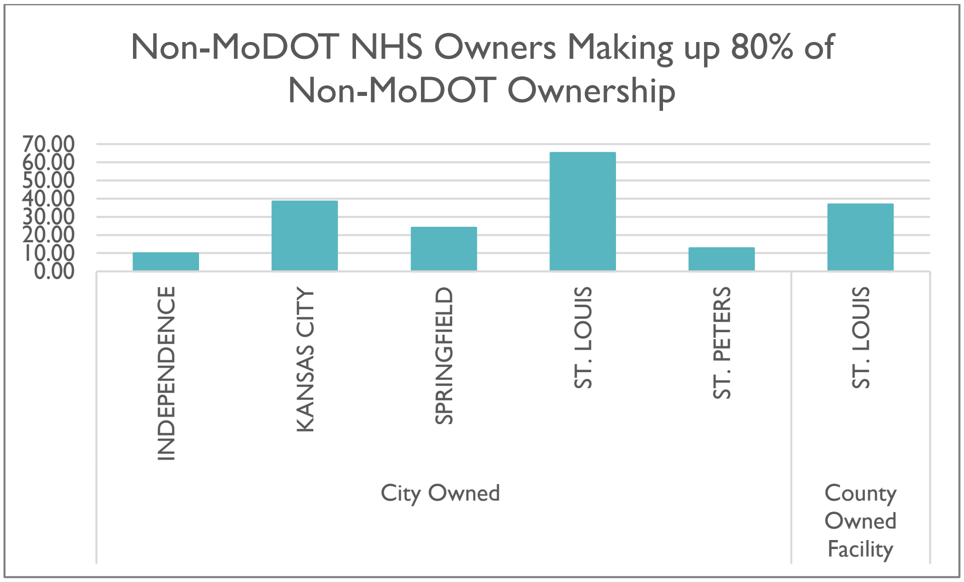
MoDOT continues to consider potential unanticipated funding streams, such as discretionary grants. When successful, MoDOT may use these funds to address NHS asset improvement as part of addressing identified capital improvement projects or existing issues, such as safety or functional concerns.

Locally-Owned NHS Routes

Missouri's NHS includes 233 miles of locally-owned routes. This accounts for 4% of the total miles of NHS roadways in Missouri, and it is associated with a total of 3.8% of the Vehicle Miles Traveled for all NHS routes. These roadways include 90 bridges with 1.2 million square feet of bridge deck. As MoDOT already has the expertise, equipment, and ability to collect pavement data and to inspect bridges, this work is proactively performed for all locally-owned NHS. MoDOT shares this information with the facility owners and the applicable local planning agencies and officials.



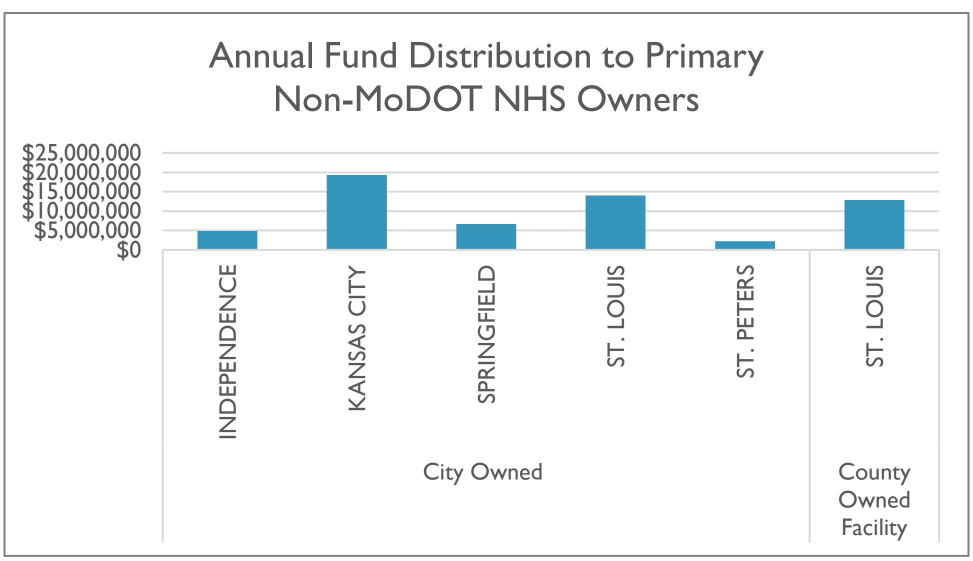
Note: Excludes owners with less than 0.1 mile.



To fund asset management needs on locally-owned transportation systems including the locally-owned NHS routes, cities and counties responsible for transportation networks in the state of Missouri receive state and federal funding that can be used to maintain the pavements and bridges. A local share of the state highway user fees is distributed. The user fees are composed of motor fuel tax, vehicle sales tax and motor vehicle fees.

For reference, the following graph shows the distribution to entities responsible for the bulk of the non-MoDOT owned NHS routes in Missouri. To those six entities alone, MoDOT distributed nearly $60 million in 2021 to maintain their transportation systems.

MoDOT also hosts a collaborative monthly meeting to discuss federal performance measures and other related information. This meeting with MPO and Regional Planning Commission's staff provides an opportunity for MoDOT to stay engaged with area transportation planning partners and maintain a conversation regarding performance goals.



MoDOT does not dictate how these local funds are invested, but works collaboratively with local officials to share data, expertise and guidance to ensure these routes are properly maintained. The need for the system to be held in a state of good repair is then actively communicated.

Entity Type	City/County	Centerline Miles
City Owned	AURORA	1.23
	BRANSON	4.32
	CAPE GIRARDEAU	1.12
	CARTHAGE	1.65
	CLINTON	1.43
	COTTLEVILLE	1.87
	DARDENNE PRAIRIE	0.35
	EDINA	0.20
	FULTON	1.14
	INDEPENDENCE	9.86
	JOPLIN	2.96
	KANSAS CITY	38.31
	KIRKWOOD	1.68
	LIBERTY	0.59
	MAPLEWOOD	0.65
	MONROE CITY	0.28
	NEOSHO	0.35
	NEW MADRID	2.43
	O'FALLON	7.55
	PARK HILLS	0.78
	SPRINGFIELD	23.97
	ST. CHARLES	4.82
	ST. JOSEPH	3.61
	ST. LOUIS	65.05
	ST. PETERS	12.67
	TRENTON	0.20
	WENTZVILLE	2.56
County Owned	GREENE	2.48
	ST. CHARLES	1.55
	ST. LOUIS	36.76

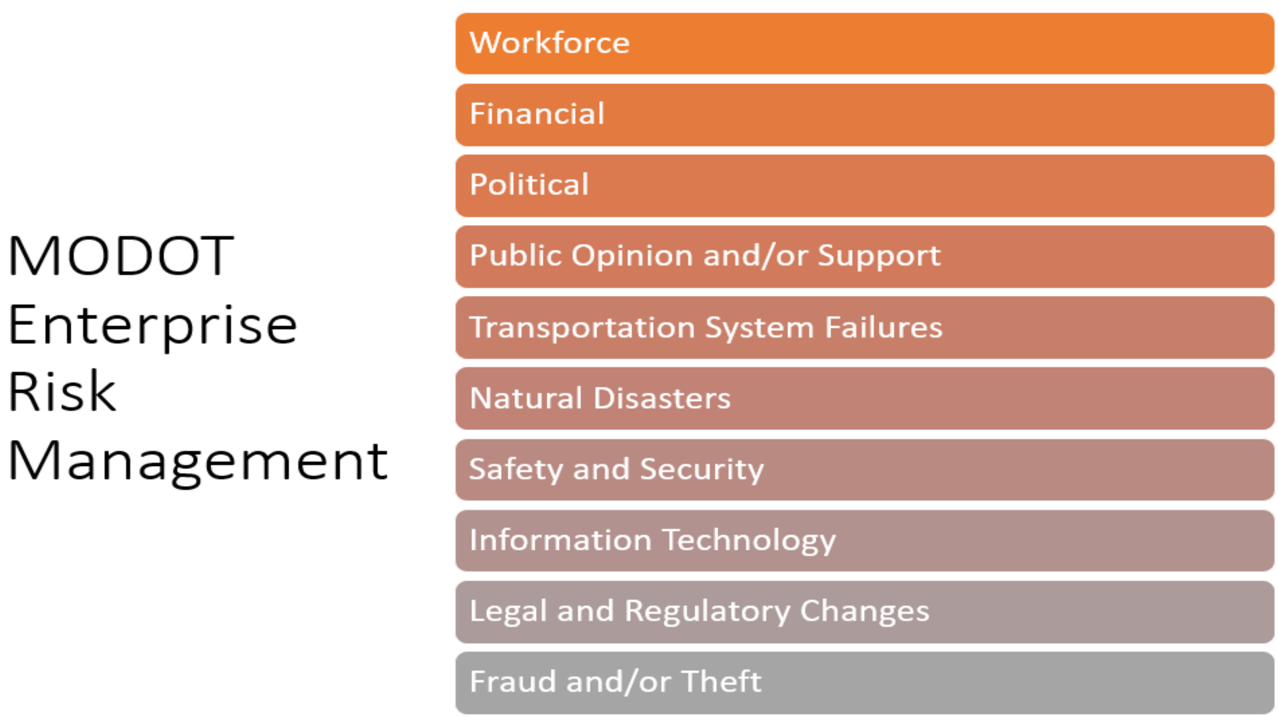
Chapter 5: Risk Management and Resiliency

When compared to other states, Missouri's transportation system has similar challenges and associated risks, many of which have a potential to impact the ability to operate the system safely and reliably. MoDOT works diligently to be aware of these risks, understand the likelihood of impact, and have reasonable strategies in place to help eliminate or mitigate the potential for occurrence and to respond to the impacts if the risk area is experienced.

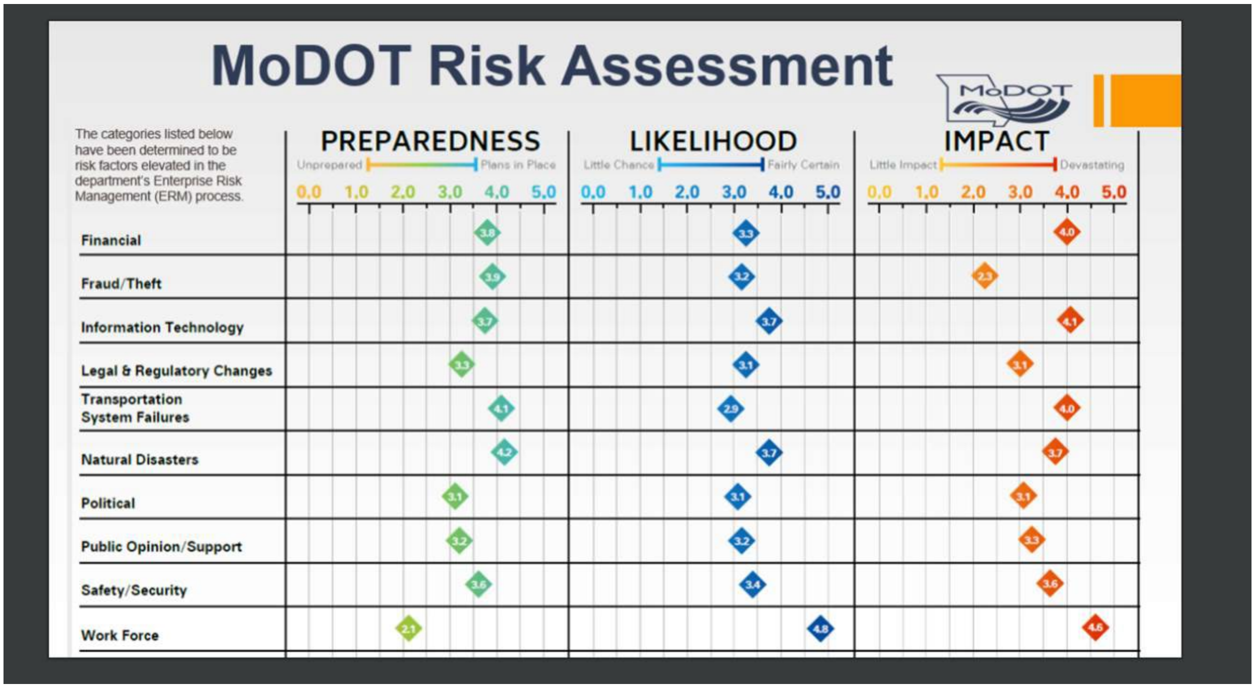
Enterprise Risk and how it Relates to Asset Management

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 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. The senior leadership team collaborates yearly to examine and rate the organization's risk areas while considering any changes from the previous evaluation and any emerging trends.

MoDOT has identified the following top 10 areas as potential areas of risk:



Each year MoDOT evaluates these risk areas for impact, likelihood and readiness. Below is a table that outlines the February 2022 findings for all risk areas.



Risk Area Discussion

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 slightly lower likelihood and a readiness rating. To aid in mitigating this risk, MoDOT has several processes in place. These processes include:

- preparing an annual financial forecast
- not fully programming the fourth and fifth year of the STIP
- identifying projects within the STIP which may be impacted by funding changes
- implementing a new STIP Information Management System (SIMS) to better align individual projects to funding categories and work types
- completing annual project estimate updates
- conducting monthly letting analysis and review, and
- implementing the Missouri Highways and Transportation Commision (MHTC) commitment to the asset management funding needs ahead of system improvement to ensure the existing system is maintained before new infrastructure is added.

MoDOT continues to maintain a conversation with federal, state and local partners to impress upon all stakeholders the potential impacts to the transportation system performance and condition related to funding uncertainty. A Citizen's Guide to Transportation Funding is published yearly, to demonstrate where transportation funds are used and the needs of the system. MoDOT also works with planning partners, using the planning framework to identify unmet needs throughout all regions and to develop the unfunded needs list, a listing of critical projects throughout the state for which funds have not been allocated. The planning framework is a transportation decision-making process that engages the right stakeholders at the right levels to lift up transportation needs. This process ensures that transportation decision-making represents the system users, who are key stakeholders involved in establishing our LRTP goals.

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 fairly high with a slightly lower likelihood and a readiness rating. To aid in mitigating this risk, MoDOT has several processes in place to monitor the transportation system failure potential for critical system elements. These include inspecting bridges on a routine cycle, emergency contracting authority, dedicated major bridge funding, and use of an asset management plan.

Natural Disasters and Extreme Weather

Natural disasters and extreme weather risk include items such as earthquakes, blizzards, flooding, tornadoes, nuclear power plant events and pandemics. The natural disaster risk impact is rated fairly high with a lower likelihood and a readiness rating that is fairly high. To aid in mitigating this risk, MoDOT has 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). MoDOT has worked diligently to prepare organizationally for the logistical impacts of system element failures by conducting drills to simulate potential scenarios and preparing materials and guidance to facilitate expediant response to nearly any potential scenario, including both natural disasters and instances of extreme weather.

This risk category includes extreme weather vulnerablities that could potentially affect assets. MoDOT has identified assets vulnerable to extreme flooding as a result of recent flooding events occurring throughout the state. The assets vulnerable to flooding include several NHS bridges and pavements, some of which are located on interstates. Locations that have been identified as having a risk due to natural disaster or extreme weather events are documented. There is consideration of potential mitigation strategies with each project programmed within those identified locations. When appropriate and reasonable, resiliency projects are added to MoDOT's STIP to construct improvements that will eliminate or reduce the associated risk.

Public Opinion and Support

As a public agency, it is critical that MoDOT understands customer expectations and operates with transparency. Public opinion and support are directly related to how well customers and transportation stakeholders think MoDOT listens and responds to their interests and concerns. Communication is key in ensuring customers and transportation stakeholders are informed about MoDOT's operations, funding and the decisions that are made. MoDOT is committed to ensuring that critical information related to these areas is readily available. MoDOT maintains the Citizen's Guide for Transportation Funding to communicate details related to the system, system conditions, operational costs and MoDOT performance.

MoDOT also conducts the Report Card Survey, the results of which are published and measured in a MoDOT Tracker performance measure. There is a continual focus on public opinion, including the public's perception regarding how MoDOT is performing. Additionally, MoDOT works with one of the most inclusive and engaging planning frameworks in the nation. Proactively working with local planning partners ensures that MoDOT makes informed decisions, which consider local sentiment for the projects and services delivered. This framework serves as the basis for prioritization of the unfunded needs list. This framework also serves as the basis for prioritization of the STIP, ensuring local interests, transportation stakeholders and area leaders are involved in the transportation decisions in each region.

Work Force

Of all ERM categories, work force was determined to be the most impactful and most likely, while being the category for which the organization is the least prepared. MoDOT's ability to deliver the necessary asset management projects could be greatly impacted if the ability to employ, train and maintain employment of qualified, dedicated staff does not continue. Recent increases to the state gas tax and the federal funding provided by BIL of 2021, increase the anticipated volume of work that must be designed and constructed in all areas of STIP delivery, not just the asset management associated projects. The turnover rate the last two years has been higher than previously experienced and the trend is anticipated to continue. MoDOT has been working on strategies to improve employee retention and new employee interest.

Resiliency and Periodic Evaluation

In 2018, MoDOT completed an evaluation of all NHS facilities, which had been impacted by natural disasters and required permanent repair. In 2020, MoDOT updated TMS to include records of all locations (NHS and all other routes) affected by natural disasters which resulted in repair. An automated process was developed to advise staff when projects were proposed within the limits of those locations. If a proposed project is located in an applicable previously repaired location, district planning staff are notified of the instance and are advised to upload the associated assessment into the document storage area for the project in SIMS. As of January 2022, MoDOT has identified seven sites that have had damage and required permanent repair, two or more times.

- Platte County, Route 92 in Tracy near the Platte River

  Event MO-07-01, 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).

  An assessment reviewed the potential mitigation activities and the relative cost for future consideration. See appenix C for assessment.

- 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)

  An assessment reviewed the potential mitigation activities and the relative cost for future consideration. See appendix C for assessment.

- Carroll County, US 24/65 near Waverly

  Event MO-07-01, Flooding related damage due to the Missouri River

  Event MO-19-02, Flooding related pavement and ditch repair.

  An assessment reviewed the potential mitigation activities and the relative cost for future consideration. See appendix C for assessment.

- Atchinson County, Rte 136 Missouri River to I-29 – Resolved by Resiliency Project

  Event MO-11-02, Flooding related damage

  Event MO-19-01, Flooding related damage.

  An assessment reviewed the potential mitigation activities and the relative cost for future consideration. See appendix C for assessment.

- Carroll County, US 24 near Chariton County line

  Event MO-07-01, Flooding related pavement repair.

  Event MO-10-01, Scour at Bridge A4613

  Event MO-19-02, Flooding related pavement and ditch repair.

  An assessment reviewed the potential mitigation activities and the relative cost for future consideration. See appendix C for assessment.

- Wayne County, US 67 through county limits

  Event MO-11-01, Slide repairs due to heavy rains.

  Event MO-17-02, Slide repairs due to heavy rains.

  An assessment of the location determined that the previously repaired locations have permanently addressed the slope failures. With the exception of potentially unnecessarily disturbing all of the remaining area of slope to replace existing soil with stone, no reasonable mitigation strategies are identified. Upon investigation, it was determined that only one specific location within the broader established limits for the events was affected twice. The remaining locations being affected by only one or the other of the events. The repair at station 665+00 was affected by the event in 2011 and 2017. In 2017, the permanent repair included more extensive rock replacement and the addition of a geotextile fabric, which is expected to mitigate the need for future repair. See appendix C for assessment.

Although MoDOT identified six NHS 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.

In addition to the SIMS application applying restrictions for identifying overlap between proposed work and these locations, all of the applicable location limits are shared with the district planning managers. This coordinates the assessment process and keeps district staff mindful of the potential solutions when assessing future needs. In some instances alternative strategies associated with eliminating the risk of future natural disaster impacts would require complete replacement or reconstruction, which may not align with MoDOT's asset management first approach. Addressing the underlying issues will likely require an end-of-life replacement of the facility; however, significant rehabilitation projects for these areas will be weighed against the potential for eliminating a location of repeated concern.

Chapter 6: TAMP Process Development and Implementation

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 that include 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, the STIP and the LRTP.

The process of managing transportation assets requires continual refinement to practices and procedures. This is to ensure decisions are based on the best available information and the process itself has the flexibility necessary to ensure continual improvement. With each iteration, additional information, knowledge, tools and resources are available, providing greater clarity and certainty to details that may have been previously assumed. MoDOT's process which affirmation of previous decisions and provides the opportunity for each region to review progress with each cycle. This ensures that minor adjustments are made concurrently with each STIP cycle to maintain the course and direction toward the goals.

History of MODOT's Approach to Asset Management

For some time now, MoDOT customers and transportation stakeholders have clearly communicated a priority on maintaining the transportation system and services that are available today. As a result, MoDOT has long been focused on maintaining its assets.

In 2006, MoDOT completed improvements to 2,200 miles of Missouri's most heavily traveled roads with SRI. This program, which consisted mostly of thin resurfacing treatments to improve the smoothness of the pavement on the NHS, established the foundation of MoDOT's asset management philosophy. This focus on the condition and performance is the very concept that MoDOT's TAMP is built upon. The NHS performance is prioritized over other routes, and a wide range of treatment options are strategically considered to balance all the needs across the system.

Missouri taxpayers responded favorably to this approach as MoDOT's customer satisfaction scores increased from 68% in 2004 to over 80% for most years 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 was applied so pavements and bridges are held in the best condition possible. By late 2016, MoDOT developed statewide life cycles, 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 MHTC 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. This allows each district to achieve the performance goals for pavement and bridges.

Then in 2021, each district developed district-wide long-term pavement plans. Using their current asset management direction the districts were able to establish the next two likely pavement treatments, the desired timing, and the anticipated cost for every route in the district. These plans provided a starting point for each district's asset management scenarios, giving context to the potential benefits and impacts of changing from their current course. This effort better integrates the project delivery timeline and processes into the asset management plan and also helps to align the STIP development process with the asset management plan. These pavement plans are a snapshot-in-time perspective of the current asset management plan, and also provide a long-term outlook of the actual projects. This allows for greater opportunity to validate and align the asset performance assumptions, the associated planning processes and the project delivery processes. Aligning these provides greater opportunity to make individual project adjustments to ensure that the results for each project have a positive impact and support the asset management goals.

An example of a district's asset management 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 analyses to determine the benefit cost over the life cycle of assets for alternative actions. It also identifies short and long-term budget needs for managing the condition of pavement and bridge assets. Each district uses the model to recommend optimal programs and implementation 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 (predominately non-interstate NHS), and all other state routes.
- Non-Major Bridge Assumptions: This section includes the bridge inventory for interstates, other major routes (predominately 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: A listing of major bridges, anticipated work, cost and timing for major bridges likely to be addressed 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: A 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 below.

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.

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
[2] Includes only span-type bridges.	898	38	452			30	30	$18.0

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

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 mile 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

<u>Cost Per Square Foot Assumptions:</u>

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				

For nearly all projects, MoDOT districts are the lead for project identification, development, and delivery. The associated project programming decisions are made in a collaborative environment with MoDOT's planning partners, including members responsible for the locally-owned NHS. MoDOT's commitment to asset management, and the priority placed upon it by Missouri's citizens during the development of the LRTP, is constantly at the forefront of these conversations. This ensures alignment of the planning processes with MoDOT's asset management plan and STIP

Even with the investment made to maintain the state of good repair on the NHS (see Chapter 4), some ground is being lost. The issue has been even more impactful to the non-NHS assets.

Throughout this process, and as iterations of the asset management plans have occurred, the MHTC proactively took steps to fully support the maintenance of all of these critical assets over time. These steps include the following:

- In 2017, the MHTC established the Asset Management Deficit Program to ensure adequate funding for a state of good repair for non-NHS assets.
- In 2019, the MHTC aligned MoDOT's funding distribution with its asset management plan, by creating the safety, asset management and system improvement funding categories and then committing the necessary funds to maintain current assets.
- In 2021, the MHTC augmented the Asset Management Deficit Program with additional funds to support those regions struggling with low volume route conditions. This effort also included adjusting internal rules to allow MoDOT STIP projects on the low-volume routes.
- In 2022, the MHTC again augmented the Asset Management Deficit Program with additional funds to further support the condition of these routes.
- In 2022, the Governor and the legislature appropriated $100 million for low-volume routes around the state in order to continue to improve these critical facilities for rural citizens.

These changes increase transparency with customers regarding the amount of funding required to maintain such a large system.

Connecting Asset Management to other Documents

Successful asset management cannot occur without being integrated into organizational operations and implemented within the necessary processes and practices. It is important that the organization's strategic documents align with the commitments necessary for asset management implementation. As identified throughout this document, MoDOT has worked diligently to create obvious and succinct connections between the asset management program and other significant plans.

Long-Range Transportation Plan

MoDOT's LRTP identified taking care of the transportation system and services available today as the primary goal. MoDOT's approach to asset management is built upon this foundation, that customers and stakeholders expect MoDOT to support the investment that has already been made in the transportation system by keeping roads smooth and bridges safe. With a focus on this expectation, many additional communication tools were developed to ensure citizens and stakeholders had available information about all that goes into providing the system and services and what it takes to appropriately maintain them.

Statewide Transportation Improvement Plan

MoDOT and its planning partners have agreed with the importance of maintaining the existing transportation system and services here in Missouri and have committed to funding the necessary projects to do so before funding other work. This focus on asset management is the starting point for STIP programming. Prior to the start of the programming cycle, district staff refresh their district asset management plans, which are then reviewed to ensure that the plans will place districts in a position to successfully maintain the condition of the roads and bridges. The programming approval process to generate the STIP then includes an executive team review of the asset management plans and the alignment of each district's programming with the strategies included in the plan. It moves forward only after receiving executive team approval. Ultimately, MoDOT's STIP mirrors the asset management program, addressing system condition maintenance before considering capital improvement.

Citizen's Guide to Transportation Funding

The Citizen's Guide to Transportation Funding is a communication tool used to educate and inform Missourians on the status and future direction of their transportation system. The guide takes the complex issues of the state's transportation revenue, expenditures, system condition and unfunded needs and explains them in easy-to-understand terms. Clearly demonstrating MoDOT's commitment to maintain and manage the assets, the Citizen's Guide to Transportation funding highlights the efforts that MoDOT undertakes to meet the long-range transportation goals, including the commitment to maintain the current system and services.

In combination with asset management plans and MoDOT's performance management documentation, these documents work in concert to establish a cycle of commitment and accountability. Transitioning through the documents, it is clear that stakeholders want MoDOT to maintain assets, and that MoDOT has a plan to maintain the assets and is committed to doing so. The projects needed to maintain these assets are being programmed and delivered and MoDOT is monitoring progress and making necessary adjustments to ensure success, and then communicating to the public the decisions and the progress being made.

Implementing Asset Management

MoDOT established the TAMP Steering Committee in 2015 made up of MoDOT senior leadership positions and FHWA. The committee's purpose is to set the direction of the TAMP, provide guidance on TAMP development and 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 align with the objectives of the asset management plans and therefore with the TAMP. MoDOT's 10-year rolling asset management plans are reviewed and refined each year with the latest information.

In addition to MoDOT's performance measures, there are federal performance measures (see Chapter 2) that monitor Missouri's pavement and bridge conditions. These are national measures established and reported on every other year. MoDOT has been coordinating a monthly webinar since 2015 with planning partners to discuss national performance requirements, including asset management.

It is imperative that the asset management plans get implemented to keep the system operating at or above the current condition. To ensure the asset management plans are implemented, each year MoDOT's executive team is presented a comparison of the asset management plan investment assumptions with the actual investment levels proposed to be programmed in the five-year STIP prior to finalizing the draft STIP. Any significant deviations are reviewed and addressed if deemed appropriate prior to MHTC action on the 5-year STIP.

Chapter 7: Potential TAMP Improvement

A good asset management approach is flexible to ensure continued success as conditions, priorities, funding or other impactful areas change. MoDOT's asset management process is fully intended to adapt over time to ensure MoDOT's ability to maintain a state of good repair. In addition to yearly reviews of costs, conditions, performance, and other areas of focus, MoDOT understands the need to look long term for opportunities to improve the asset management processes.

Looking Ahead to Potential Future Improvements

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

- Asset management tools and SIMS identified category/sub-categories for project work type descriptions will continue to be updated to better align the specific federal work types required in the TAMP to the STIP programming data. This adjustment will aid data collection, data analysis and reporting while reducing the necessary analysis and research of the associated planned and committed projects.

- Improved Bridge Deterioration Model: MoDOT is currently working with the University of Missouri on a research project to better predict the deterioration rates of bridges based upon a variety of factors. The new models will improve MoDOT's ability to quantify and predict the anticipated deterioration over time and provide improvements in establishing deterioration trends to identify the square footage of bridges to improve each year. Improved accuracy in the required annual square footage targets for replacements, deck replacements and rehabilitations will better align MoDOT's performance with its goals.

- The continued development and refinement of the 20-year pavement plans will be critical in understanding the practical implementation of the strategies around the state as STIP programming occurs. Pavement plan analysis and the ability to compare the projected treatment types with the programmed treatment types, through comparison with the STIP programming, will allow MoDOT to potentially improve statewide consistency.

- 20-Year Bridge Plan: The development of location specific bridge work plans for each district will improve the 20-year outlook and will strengthen the long-term alignment capabilities. The 20-year plan will provide a more detailed account of the specific bridges, locations, and anticipated work types to provide a greater understanding of the specific upcoming needs and anticipated costs. As a transitionary element clearly demonstrating the path between management practices and programming, the bridge plan will improve scenario planning and performance management.

#	Section	Requirement	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.	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.	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.	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.	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
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),	Chapter 1 – Asset Inventory and Condition and Chapter 2 – Performance Measures and Targets

		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.	
8	515.9 (d)	(3) A summary description of the condition of NHS pavements and bridges, regardless of ownership. The 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.	Chapter 1 – Asset Inventory 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:	Chapter 3 – Life Cycle Chapter 4 – Financial Planning

		(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 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).	Chapter 6 – TAMP Process and Introduction
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 letter by MoDOT Director after cover page
21	515.9 (l)	If the State DOT elects to include other NHS infrastructure assets or other public roads assets in its asset management plan, the State at a minimum shall address the following, using a level of effort consistent with the State DOT's needs and resources: (1) Summary listing of assets, including a description of asset condition; (2) Asset management measures and State DOT targets for asset condition; (3) Performance gap analysis; (4) Life-cycle planning;	Not aplicable

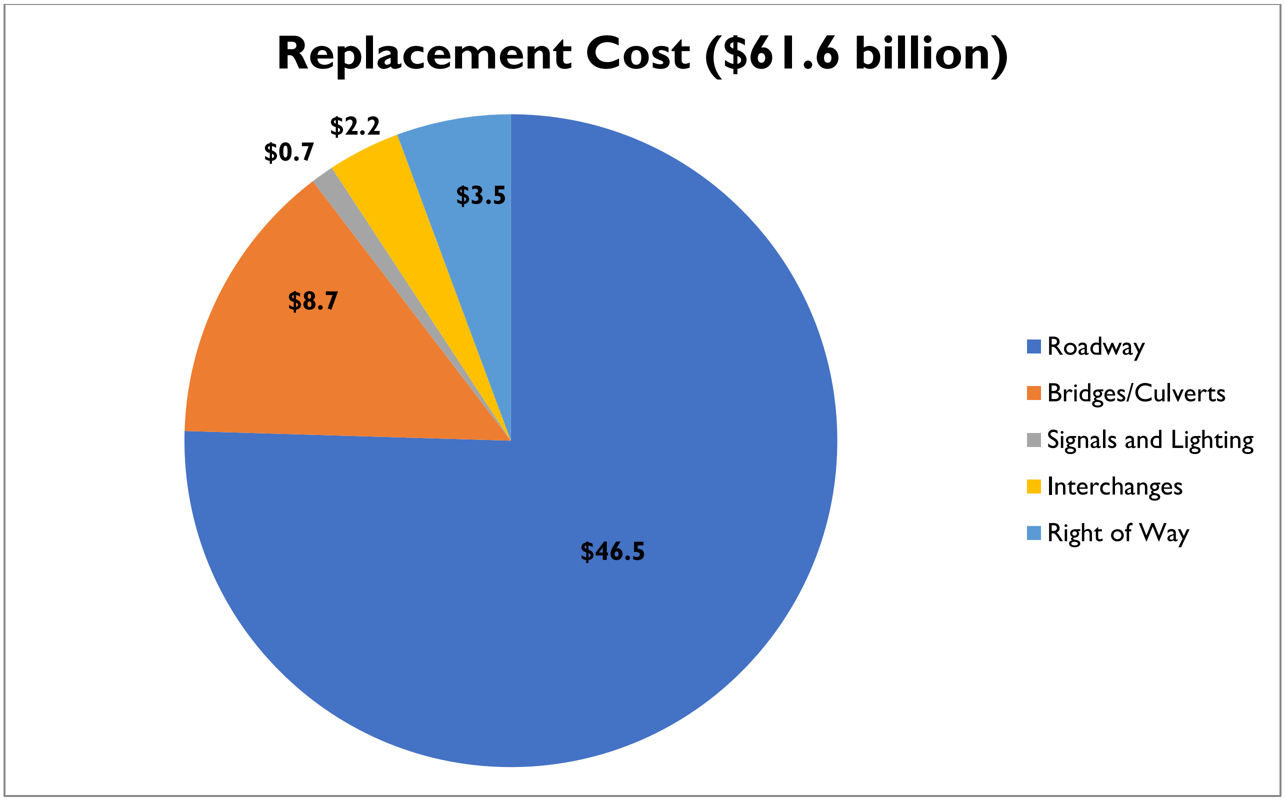
		(5) Risk analysis, including summaries of evaluations carried out under part 667 of this titles for the assets, if available, and consideration of those evaluations; (6) Financial plan; and (7) Investment strategies.	
22	515.9 (m)	The asset management plan of a State may include consideration of critical infrastructure from among those facilities in the State that are eligible under 23 U.S.C. 119(c).	N/A
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 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).	Entire Document
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:	N/A

		(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).	
27	515.11 (c)	The State-approved asset management plan submitted not later than June 30, 2019, shall include all required analyses, performed using FHWA-certified processes, and the section 150 measures and State DOT targets for the NHS pavements and bridges. The plan must meet all requirements in § 515.7 and 515.9. This includes investment strategies that are developed based on the analyses from all processes required under §515.7, and meet the requirements in 23 U.S.C. 119(e) (2).	N/A
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 schedules to manage the condition of NHS pavement and bridge assets within policy and budget constraints.	Entire Document

Appendix B: 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 consider 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 lanes, add lanes, etc.). The costs that were provided by design reflect what it would take to build the facility new and include inflation. 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 $145.0 billion dollars.

System	Replacement Cost (billions)
Roadway	**$46.5**
Missouri has almost 21,000 lane miles of pavement in its inventory.	
Bridges/Culverts	**$8.7**
Missouri has over 55 million square feet of bridges on the National highway system.	
Signals and Lighting	**$.7**
Missouri has over 21,000 lights and signals on the National Highway System.	
Interchanges	**$2.2**
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	**$3.5**
Missouri has approximately 60,000 acres of right of way along the National Highway System	
Total Replacement Cost	**$61.6**



Detailed Cost Assumptions:

Roadway	**Cost per lane mile (millions)**
Urbanized Interstate	$3.0
Urbanized Freeway	$2.7
Urbanized Divided	$2.7
Urbanized Undivided greater than Collector	$1.9
Urbanized Undivided Collector and below	$1.4
Urban Interstate	$2.7
Urban Freeway	$1.9
Urban Divided	$1.6
Urban Undivided greater than Collector	$1.9
Urban Undivided Collector and below	$1.4
Rural Interstate	$1.4
Rural Freeway	$1.4
Rural Divided	$1.3
Rural Undivided greater than Collector	$1.4
Rural Undivided Collector and below with an AADT greater than 400	$1.0
Rural Undivided Collector and below with an AADT less than 400	$0.8
Ramps	$1.2

Signals and Lighting	**Cost each**
Flashers	$5,810
Lights	$4,650
Signalized intersections	$290,000

Bridges/Culverts	**Cost**
Major Bridges	$368 per sq. Ft.
Bridges	$128 per sq. Ft.
Culverts (over 20 feet in length)	$290,000 each

Interchanges	**Cost each (millions)**
Cloverleaf	$1.2
Diamond	$1.2
Directional	$11.6
Diverging Diamond	$2.3
Folded Diamond	$1.2
Other	$5.8
Partial Cloverleaf	$1.2
Partial Diamond	$1.2
Single Point	$11.6
Slip Ramps	$1.2
Trumpet	$5.8

Appendix C: Part 667 Assessments

1) Carroll County, US 65
2) Carroll County, US 24
3) Atchison County, Rte 136
4) Maries County, Rte 63
5) Platte County, Rte 92
6) Various Counties (SE District), US 67

23 CFR Part 667 Report - Carroll US 65

In accordance with CFR 667, Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, the following is an evaluation for a 4.99-mile segment of Route 24/65, in Carroll County, Missouri. This evaluation is being conducted to determine if there are reasonable alternatives to mitigate or minimize future instances of similar repair. Route 24/65 has required repair and reconstruction activities on two occasions due to emergency events.

Emergency Events:

- Event MO-07-01 – Records for this event are not available. It is assumed that repairs involved repairing shoulders, establishing side slopes and ditch grading work.

- Event MO-19-02 – Rebuild 0.5 miles of roadway shoulder reconstruction, re-establish side slopes and diches. The total cost of this work was $458,734.

Alternatives that will mitigate, or partially or fully resolve, the root cause of the recurring damage:

- The root cause of the shoulder repair work was due to flooding of the Missouri River. Back water from the Missouri River and nearby streams rose and overtopped the roadway. The shoulders and side slopes were damaged as the waters receded by wave action eroding away the soil. There was no damage to the pavement as the floodwaters had no significant flow.

- To prevent future roadway overtopping, the roadway profile would need to be raised 2.5 feet. Raising the roadway to this level will result in the roadway remaining open during significant flooding events, therefore minimizing future detours. Raising the roadway will also include the reconstruction of 2 bridges.

Risk of recurring damage: The levees along the Missouri River have been strengthened since this last event, therefore the frequency of future flooding events may be reduced. We believe there is a low probability that this same type of damage will result from future flooding.

Cost of future repair under current and future environmental conditions:

- Without any resiliency measures taken, future repairs are anticipated to be of the same nature as the previous flooding events, with repair costs estimated in the range of $700,000 to $1 million per event.

- The future repairs to prevent overtopping of the roadway, involving raising the roadway profile, are estimated to be $38.9 million
  - Earthwork/Pavement – $19.9 million
  - Bridges/culverts – $12.7 million
  - Right of Way – $130,000
  - Utilities - $0 (assuming non-reimbursable)
  - PE – $3.9 million
  - CE - $2.3 million

Likely duration of the solution: Assuming the corridor would be closed during construction with a detour provided, the reconstruction of the roadway and 2 bridges and roadway would take 2 construction seasons.

Assessment: The repairs performed do not address the overtopping of the roadway. The anticipated costs to repair the shoulders and side slopes for future events is not that costly as compared to raising the roadway profile. The detour for this segment when the roadway is closed is 57 miles. Detour length does play a factor in considering the solution. However, with the recent repairs and strengthening of the levee along the Missouri River, the likelihood of reoccurring events is minimal and therefore make raising the roadway unfeasible.

23 CFR Part 667 Report - Carroll US 24

In accordance with CFR 667, Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, the following is an evaluation for a 4.0-mile segment of Route 24, in Carroll County, Missouri. This evaluation is being conducted to determine if there are reasonable alternatives to mitigate or minimize future instances of similar repair. Route 24 has required repair and reconstruction activities on a few occasions due to emergency events.

Emergency Events:

- Event MO-10-01 – Contract scour repair to piers on bridge no. A4613 over the Grand River. The cost for this repair was $2.1 million.
- Event MO-19-02 – Water overtopped the roadway, but only slight damage was observed to the shoulders. Repairs to the shoulders were done by maintenance forces to allow traffic back onto the roadway. There were no permanent repairs performed via contract after this event. Initial estimate for the proposed contract repair work was $400,000.

Alternatives that will mitigate, or partially or fully resolve, the root cause of the recurring damage:

- The root cause of the shoulder repair work was due to flooding of the Grand River and the Missouri River. Flooding of the Missouri River caused the Grand River to back up and overflow its banks. This backwater from the Grand River and nearby streams rose and overtopped the roadway. The shoulders were damaged as the waters receded. There was no damage to the pavement as the floodwaters had no significant flow.
- To prevent future roadway overtopping, the roadway profile would need to be raised 2 feet. Raising the roadway to this level will result in the roadway remaining open during significant flooding events, therefore minimizing future detours. Raising the roadway will also include the reconstruction of one major bridge and two large box culverts.

Risk of recurring damage:

- The 2010 event resulted in the need for scour repairs to the bridge over the Grand River. Repairs were completed by placing a large amount of rock fill to remedy the scour areas. After the 2019 event it appears there was no scour damage, therefore the previous remedy was sufficient. We anticipate the risk for recurring damage is low.
- The levees along the Missouri River have been strengthened since this last event, therefore the frequency of future flooding events may be reduced. This segment of roadway has been overtopped in the past, yet only minor shoulder damage has been experienced. The risk of future damage to the roadway is low.

Cost of future repair under current and future environmental conditions:

- Without any resiliency measures taken, future repairs are anticipated to be of the same nature as the previous flooding events involving shoulder repairs. Future costs for shoulder repairs are estimated to be in the range of $500,000 to $1 million per event.
- The future repairs to prevent overtopping of the roadway, involving raising the roadway profile, are estimated to be $68.2 million

Earthwork/Pavement – $17.9 million	Right of Way – $190,000	Grand River Bridge - $33.7 million
Drainage /Culverts – $5 million	Utilities - $0 (assuming non-reimbursable)	PE – $7.5 million
CE - $3.9 million		

Likely duration of the solution: Assuming the corridor would be closed during construction with a detour provided, the reconstruction of the roadway and major bridge would take 2-3 construction seasons.

Assessment: The repairs by the maintenance forces do not address the overtopping of the roadway. The anticipated costs to repair the shoulders and side slopes for future events is not that costly as compared to raising the roadway profile. In addition, the recent work on the river levees should help to reduce the frequency of these events. Based on these factors, raising the roadway profile is unfeasible.

23 CFR Part 667 Report – Atchison Rte. 136

In accordance with CFR 667, Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, the following is a summary of disaster repairs and resiliency measures performed for a 5.21-mile segment of Route 136 from the Missouri River to I-29, in Atchison County, Missouri. This summary is being submitted to illustrate the repair measures taken from previous reconstruction activities, and the recent measure to provide resiliency on this segment of roadway.

Emergency Events:

- Event MO-11-02 – Filling in 3 scour holes, new full depth pavement in areas of the scour holes, shoulder shaping to match existing roadway and pavement resurfacing. Total cost of this work was $6.707 million.

- Event MO-19-01 – Filling in one scour hole, new full depth pavement in area of the scour hole, shoulder repair, shaping slopes and pavement resurfacing. Total cost of this work was $5.119 million.

Alternatives that will mitigate, or partially or fully resolve, the root cause of the recurring damage:

- The root cause of the damage to the roadway, shoulders and fill slopes was due to flooding of the Missouri River overtopping the roadway. During the floods of 2011 and 2019, levees to the north were not able to handle the volume of water in the Missouri River. As the levees broke to the north US 136, the floodwaters had high velocities through this area. As the high velocity water overtops the roadway, the combination of flow and relatively steep side slopes undermined the leeward side shoulder and eroded away at the fill slopes causing the large scour holes and subsequent failures of the roadway.

- To prevent future overtopping of this roadway, the profile would need to be raised approximately 5 feet. Raising the roadway to this level will result in the roadway remaining open during significant flooding events, therefore minimizing future detours. Raising the roadway will also include the reconstruction of one existing bridge and the bridge over the Missouri River. Raising the profile will also call for additional drainage structures under the roadway to prevent floodwaters from backing up to the north.

- To prevent future scour holes and shoulder damage, a solution to protect the leeward shoulders and side slopes has been considered. This solution will not address the overtopping of the roadway but should limit the damage to the roadway resulting in reduced periods of road closure. Plans for this alternative involve full depth shoulder reconstruction on the leeward side, then flattening the side slopes (6:1) and reinforcing with a grid-tied concrete block mat. This concrete mat, anchored into the side slope, is designed to help reduce the velocity and erosion of these side slopes.

Risk of recurring damage: Both above noted flooding events resulted in the same type of damage for this roadway segment. We believe there is a high probability that this same type of damage will result from future flooding.

Cost of future repair under current and future environmental conditions:

- Without any resiliency measures taken, future repairs are anticipated to be of the same nature as the previous flooding events, with repair costs estimated in the range of $5 million to $8 million per event.
- The alternate to raise the roadway has an estimate of $144.7 million:
    - Earthwork/Pavement – $25.6 million
    - Bridges/culverts – $15 million
    - Missouri River Bridge $80 million
    - Right of way – $500,000
    - Utilities – $500,000
    - PE – $14.6 million
    - CE - $8.5 million

- The proposed resiliency project to rebuild the leeward shoulders, flatten and armor the side slopes has an estimate of $10.8 million.
  - Shoulder & side slope grading - $1.8 million
  - Resurfacing - $1.2 million
  - Grid-tied concrete block mat - $4.5 million
  - Utilities - $275,000
  - Miscellaneous items – $1.5 million
  - PE - $928,000
  - CE - $637,000

<u>Assessment:</u> The repairs performed over the past two events do not address the overtopping of the roadway, or the continued damaged caused to the shoulders and side slopes from flood waters. The cost to continue repairing the roadway after these events is high when comparing to the potential alternate solutions. In reviewing the alternates, the project to rebuild the leeward shoulders, flatten and armor the side slope has been selected as the best solution at this time. This solution will reduce the road closure time as the resiliency measures will reduce the damage and time to repair. The proposed resiliency project is anticipated to be a long-term solution with a service life of 30 years or more.

<u>Likely duration of the solution</u>: The work to construct the proposed solution will take two construction seasons. Work will be done under lane closures to keep traffic moving along the corridor.

<u>NOTE:</u> The solution to rebuild the leeward shoulders, flatten and armor the side slope was recently bid in May 2022 with the low bid being $7.2 million. Project will begin in the summer of 2022.

23 CFR Part 667 Report – Maries Rte. 63

In accordance with CFR 667, Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, the following is an evaluation of a 1.34-mile segment of Route 63 and bridge number A3760 over the Gasconade River, in Maries County, Missouri. This evaluation is being conducted to determine if there are reasonable alternatives to Route 63 and bridge A3760 which have required repair and reconstruction activities on two occasions due to emergency events.

Emergency Events:

- Event MO-08-02, maintenance repairs and fill slope reshaping after shoulders and fill slopes were eroded due to flood waters overtopping the roadway. The cost for these repairs were $51,279.50.
- Event MO-17-01, contract scour repairs to pier 7. The cost for this repair was $262,000 (project J5P3298).

Alternatives that will mitigate, or partially or fully resolve, the root cause of the recurring damage:

- Project J5P3298 performed scour repairs to pier 7 with large stone designed to prevent future scour.
- The root cause of the damage to the fill slopes was due to flooding. To prevent future overtopping of the roadway, the profile of the roadway would have to be raised approximately 2.85'. Due to the geometry of the existing bridge and roadway, raising the profile 2.85' would result in the construction of a new bridge, approximately 1010' in length to improve hydraulic performance (15 feet longer than the existing bridge) and the reconstruction of the existing roadway for approximately 556' north of the existing bridge and approximately 6523' south of the bridge for a total length of roadway reconstruction of 7079'.

Risk of recurring damage:

- Event MO-08-02 was the first and only recorded event to date that overtopped Route 63. Currently the risk of recurring damage to Route 63 is low.
- The risk to recurring scouring at pier 7 is moderate. Typically scour repairs are only anticipated to last for 25-years, and due to an error, the rock used for project J5P3298 was not as large as originally specified by the design.

Cost of future repair under current and future environmental conditions:

- Future scour repairs at pier 7 are estimated to be $319,948.00.
- Future repairs to fill slopes due to overtopping of roadway are estimated to be $66,908.00.

Costs of achieving the solution:

- Bridge: $10,200,000.00
- Roadway Grading and Drainage: $1,384,220.00
- Roadway Base & Surface: $2,098,440.00
- Miscellaneous: $696,532.00
- Estimated Contract Total: $14,379,192.00
- Construction Cost: $14,666,775.84
- Utilities: $0.00
- Right-of-Way: $10,000.00
- PE Costs: $1,464,000.00
- CE Costs: $1,891,000.00
- Program Estimated Total: $18,031,775.84

Likely duration of the solution:

Assuming Route 63 would be closed, and traffic would be detoured to other state routes, the bridge replacement and roadway improvements would likely be constructed simultaneously in one construction season.

23 CFR Part 667 Report – Platte Rte. 92

In accordance with CFR 667, Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, the following is an evaluation of a 0.3-mile segment of Route 92 in Platter County, Missouri. This evaluation is being conducted to determine if there are reasonable alternatives to mitigate or minimize future instances of similar repair. Route 92 has required repair and reconstruction activities on two occasions due to emergency events.

Emergency Events:

- Event MO-07-01, repairs and fill slope reshaping after shoulders and fill slopes were eroded due to flood waters overtopping the roadway. The cost for this repair is assumed to be reasonably close to the MO-11-02 event. Cost records were not found.
- Event MO-11-02, repairs and fill slope reshaping after shoulders and fill slopes were eroded due to flood waters overtopping the roadway. Guardrail was added. The cost for these repairs were $317,000.

Assessment

Due to proximity to the town of Tracy, MO, it is not feasible or realistic to raise the road substantially through the limits of the area.

Alternatives that will mitigate, or partially or fully resolve, the root cause of the recurring damage:

- The root cause of the damage to the fill slopes was due to flooding. To prevent future damage, the existing slope and shoulder need to be removed and replaced with an erosion resistant material, such as concrete or large stone.

Risk of recurring damage:

- Due to proximity to the adjacent river, there is reasonable likelihood of a future flooding event, however each such event has not caused similar damage.
- The existing repairs from 2011/2012 have performed well but are likely to need re-addressed to prevent increased likelihood of damage.

Cost of future repair under current and future environmental conditions:

- The future repairs to fill slopes due to overtopping of roadway are estimated to cost approximately $500,000, based upon previous repairs and inflation. Since the permanent repair and the future potential emergency repair are essentially the same, the anticipated cost of the alternate is the same.
- PE Costs: $35,000
- CE Costs: $35,000
- Program Estimated Total: $570,000

Likely duration of the solution:

Work may impact the travel way during construction, which may require short- or long-term closures. The work would be anticipated to be performed over a few months.

This assessment will be considered along with the other needs throughout the district. MoDOT will consider the appropriate scope of work, whenever work is programmed on Rt 92 through these limits.

MoDOT completed permanent repairs for events MO-11-01, Wayne County, Route 67 under project J9P3000 and MO-17-01, Wayne County, Route 67 under project J9P3501.

There was only one specific location at which work was performed under both projects, at approximately station 665+00. The original project consisted of mostly aggregate placement at the location of the slide repair. The second project (J9P3501) involved more significant repairs such as permanent geotextile and rock fill.

MoDOT believes that the work performed under the second project will permanently address the root issue at these repaired locations, including at station 665+00. Furthermore, MoDOT does not anticipate any future repetition failures at any location at which work was performed.

We therefore believed the repairs to date have adequately mitigated the root cause.