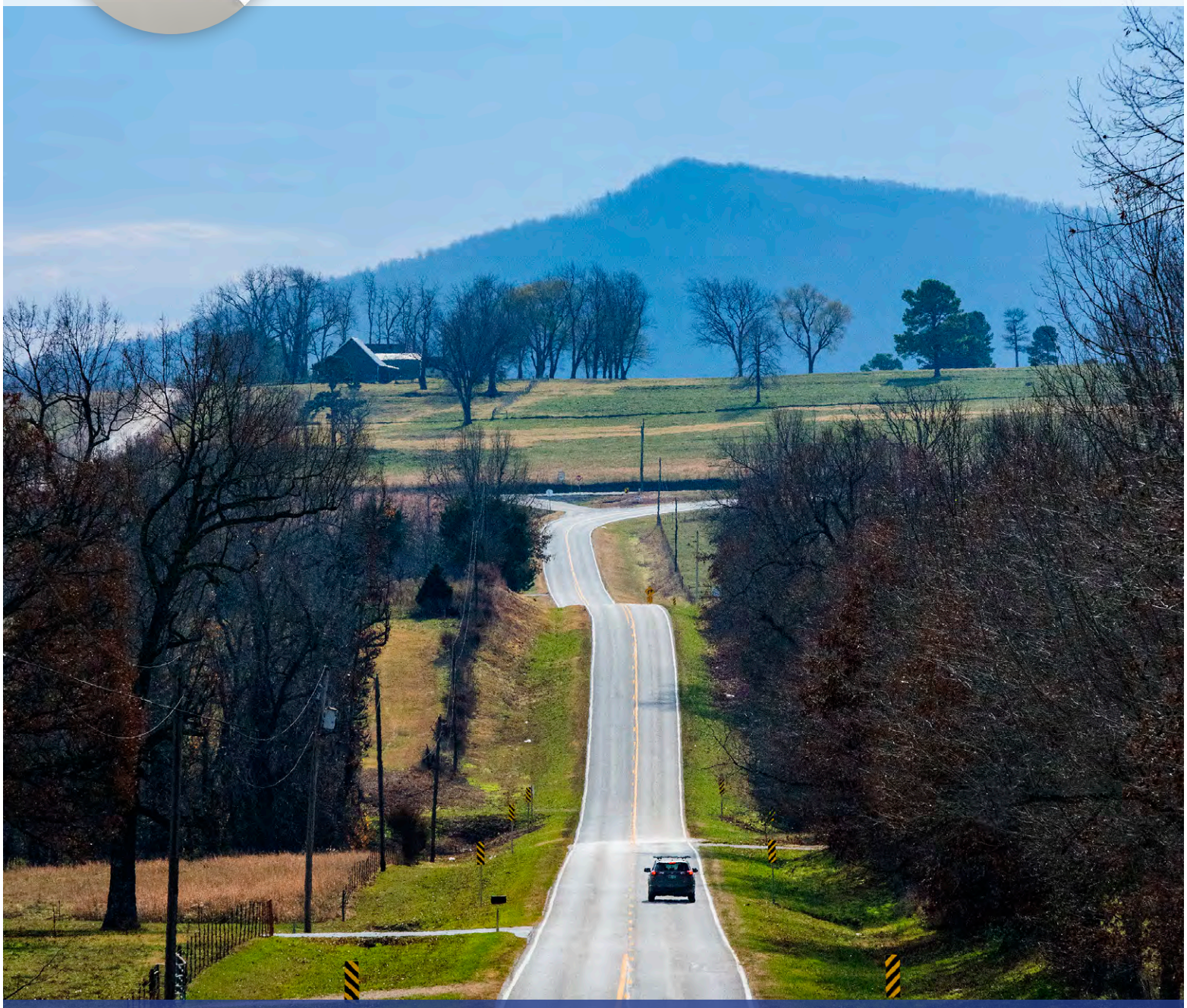
Risk-Based Transportation Asset Management Plan



Arkansas Department of Transportation

Table of Contents

Executive Summary

Overview

The mission of the Arkansas Department of Transportation (ARDOT) is to provide safe and efficient transportation solutions to support Arkansas' economy and enhance the quality of life for generations to come. Transportation Asset Management (TAM) provides ARDOT a process to use in managing the transportation system of Arkansas given currently available funding levels. TAM principles have been formally discussed in the transportation industry since the 1990's and were formalized in recent and current federal transportation funding bills.

A Transportation Asset Management Plan (TAMP) documents a State Department of Transportation's (DOT) assets and approach to applying TAM principles. The Federal Highway Administration (FHWA) has developed specific requirements for the subjects a TAMP should contain (23 CFR Part 515). This TAMP has been prepared to comply with Federal Highway Administration (FHWA) requirements. It describes the inventory and condition of the highways and bridges located on the National Highway System (NHS) in Arkansas. It also describes how ARDOT is managing these assets using TAM principles.

Arkansas' Transportation System

ARDOT owns and maintains the 12th largest State Highway System in the U.S. ARDOT's physical assets include pavements, bridges, culverts, rights of way, facilities, and many additional traffic and safety features, such as retaining walls, signs, and guardrails. All of these assets are needed to support the transportation system and require a significant level of ongoing investment. However, the large majority of ARDOT's investments in the State's transportation system assets are dedicated to two asset classes: pavements and bridges (including bridge-length culverts).

Therefore, this TAMP is focused on these two asset classes, consistent with federal requirements.

ARDOT's system includes multiple, overlapping roadway networks. The Arkansas Primary Highway Network (APHN) was developed for use in long-term planning. This is a system of 7,920 miles that carries more than 90% of all travel on the State Highway System. ARDOT also manages 8,520 miles of roads not on the APHN.

A portion of the routes on the APHN are also on the NHS. The NHS has been defined by FHWA to include roads deemed important to the nation's economy, defense, and mobility, including the Interstate Highway System, most principal arterials, and selected other routes. A small portion of the NHS in Arkansas is locally-owned, including 35 centerline miles of road and 6 bridges.

Inventory and Condition

Pavement

The table below summarizes the current inventory and condition of all pavements on the State Highway System in Arkansas. The table shows centerline and lane miles of road, and the percentage of lane miles in each of five condition rating categories, labeled using A to F letter grades. Condition Rating is established using a process developed by ARDOT and based on ARDOT's Pavement Condition Index (PCI). ARDOT's desired state of good repair is to maintain APHN pavement in a Condition Rating of A or B and Non-APHN pavements in a Condition Rating of A, B or C.

ARDOT Pavement Inventory and Condition Summary

			Condition Rating				
System	Centerline Miles	Lane Miles	A	B	C	D	F
Total	**16,432**	**37,332**	**4%**	**14%**	**26%**	**32%**	**24%**
APHN	**7,920**	**20,719**	**7%**	**21%**	**32%**	**27%**	**13%**
Interstate	**749**	**3,203**	**32%**	**39%**	**19%**	**7%**	**3%**
Non-Interstate APHN	**7,171**	**17,516**	**2%**	**18%**	**34%**	**31%**	**15%**
NHS Only	2,608	7,675	3%	25%	35%	25%	12%
Non-APHN	**8,512**	**16,613**	**1%**	**4%**	**19%**	**38%**	**38%**

Note: The Non-Interstate NHS is a subset of the Non-Interstate APHN.

The table below summarizes the inventory and condition for NHS roads only using thresholds for evaluating pavement in terms of good, fair and poor established by FHWA. Based on the FHWA thresholds, the NHS in Arkansas is predominantly in good or fair condition, with approximately 1 percent in poor condition. ARDOT's desired state of good repair is to maintain NHS pavements in good or fair condition based on the FHWA thresholds.

Arkansas NHS Pavement Inventory and Condition Summary Based on FHWA Thresholds

Owner/System	Centerline Miles	Lane Miles	Good	Fair	Poor	
Interstate	**749**	**3,203**	**70%**	**29%**	**1%**	
Non-Interstate NHS	**2,643**	**7,776**	**38%**	**61%**	**1%**	
State Owned	2,608	7,675				
Non-State Owned	35	101				

Note: Condition data for the Non-State Owned routes has not been collected. For the purposes of this TAMP, the condition data of these routes is assumed to be comparable to those of other NHS routes.

Bridges

The table below summarizes the current inventory and condition of all bridges in Arkansas. It shows the count of bridges by owned and whether they are on or off the NHS, their corresponding deck area, and the percentage of bridges classified in good, fair and poor condition based on FHWA definitions.

Arkansas Bridge Inventory and Condition

Owner/System	Number of Bridges	Deck Area (ft^2)	Good	Fair	Poor	
State Owned						
Total	**7,306**	**60,205,283**	**50%**	**45%**	**5%**	
NHS	2,362	36,100,852	50%	46%	4%	
Non-NHS	4,944	24,104,431	50%	44%	6%	
Non-State Owned						
Total	**5,391**	**10,653,964**	**62%**	**33%**	**5%**	
NHS	6	23,381	52%	23%	25%	
Non-NHS	5,385	10,630,583	62%	33%	5%	
Total						
Total	**12,697**	**70,859,247**	**52%**	**43%**	**5%**	
NHS	2,368	36,124,233	50%	46%	4%	
Non-NHS	10,329	34,735,014	54%	40%	6%	

Life Cycle Planning

Asset life cycle planning is an essential component of asset management. An asset life cycle plan describes what investments are required in an asset's maintenance, preservation, and rehabilitation as a function of the asset's age and/or condition. It helps predict the condition of an asset over time, and helps an agency determine what asset investment to make given limited available funding to maximize performance and use of agency resources.

ARDOT uses the commercial off-the-shelf management system Deighton Total Infrastructure Management System (dTIMS), developed by Deighton Associates Limited (Deighton), to support life cycle planning for pavements and bridges. In dTIMS, the life cycle strategy consists of a set of treatments, triggers that specify when the treatment may be considered, and details on the effectiveness of the treatment.

Performance Scenarios and Gap Assessment

An important facet of asset management is projecting future asset conditions to help establish the appropriate allocation of existing funding, prioritization of improvements, and realistic expectations concerning future performance. ARDOT uses dTIMS to support development of performance scenarios and assess performance gaps. The analysis resulted in the set of conditions predicted for pavements and bridges over the 10-year period from 2018 to 2027. Results from this analysis were then used to perform a gap assessment for NHS pavements and bridges, as required by FHWA. The tables below summarize the gap assessment results. For pavements separate tables are shown based on the ARDOT Condition Rating and FHWA good/fair/poor thresholds. Each table shows the desired state of good repair, current performance, and projected performance, as well as the gap between the desired state of good repair and current and projected conditions.

Gap Assessment for NHS Pavement Assets Based on Condition Rating

	Condition Rating		
	A-B	C-F	Gap
Interstate			
Desired State of Good Repair	100%	0%	N/A
Current Performance	77%	23%	23%
10-Year Projected Performance	97%	3%	3%
Non-Interstate NHS			
Desired State of Good Repair	100%	0%	N/A
Current Performance	44%	56%	56%
10-Year Projected Performance	35%	65%	65%

Gap Assessment for NHS Pavement Assets Based on FHWA Good/Fair/Poor Thresholds

	Good	Fair	Poor	Gap
Interstate				
Desired State of Good Repair	100%		0%	N/A
Current Performance	8%	91%	1%	1%
10-Year Projected Performance	66%	33%	1%	1%
Non-Interstate NHS				
Desired State of Good Repair	100%		0%	N/A
Current Performance	6%	93%	1%	1%
10-Year Projected Performance	22%	74%	4%	4%

Gap Assessment for NHS Bridges

	Good	Fair	Poor	Gap
Desired State of Good Repair	96%		4%	N/A
Current Performance	49%	47%	4%	0%
10-Year Projected Performance	56%	33%	11%	7%

Risk Management

Transportation agencies often spend significant resources responding to and/or mitigating unforeseen events. These include, but are not limited to, damage to the transportation system from natural disasters and other events; unexpected changes in available funding that impact capital plans; and defects in designs, materials, or construction that require further investment to address. ARDOT staff continually manage a wide variety of transportation-related risks, using both formal and informal risk management approaches. Consistent with FHWA requirements, as part of developing the TAMP, ARDOT assessed risks that may impact the condition and performance of NHS pavements and bridges. Also, ARDOT analyzed facilities repeatedly damaged as a result of emergency events. Through the risk assessment ARDOT identified a set of 36 risks, and then defined potential mitigation strategies for high priority risks. This TAMP presents a mitigation plan ARDOT will use to help monitor risks going forward, and help mitigate risks to the transportation system.

Financial Planning

Developing an asset management financial plan is important for identifying the resources needed to invest in preserving and improving asset conditions. The TAMP financial plan

describes funding sources and uses for asset management over the next 10 years (Federal Fiscal Years 2018 to 2027) and includes an estimate of projected funding sources that can be used for asset management and the planned uses of those funds. The financial plan also includes an estimated valuation of NHS bridge and pavement assets.

As part of the financial plan ARDOT has implemented three key investment strategies. The first strategy is to establish a dedicated funding stream for interstate pavements through the Interstate Rehabilitation Program (IRP). The second investment strategy is to shift funds to asset preservation through adoption and implementation of agreements with FHWA for use of federal funds for asset preservation. ARDOT's third investment strategy for achieving its asset management objectives is to allocate funds to districts using a state-wide needs-based approach.

1. Introduction

About this Plan

The mission of the Arkansas Department of Transportation (ARDOT) is to provide safe and efficient transportation solutions to support Arkansas' economy and enhance the quality of life for generations to come. Managing the transportation system of Arkansas becomes more challenging as it ages and demands of the traveling public increase. This situation is made more difficult by expected funding levels that are insufficient to meet identified needs. These factors place greater weight on decisions involving the allocation of available funding to accomplish our mission.

Transportation Asset Management (TAM) provides ARDOT a process to use in managing the transportation system of Arkansas given currently available funding levels. TAM principles have been formally discussed in the transportation industry since the 1990's and were formalized in recent and current federal transportation funding bills.

This TAM plan describes the inventory and condition of the highways and bridges located on the National Highway System (NHS) in Arkansas. It also describes how ARDOT is managing these assets using TAM principles.

What is Transportation Asset Management?

Transportation asset management is defined in U.S. law (23 U.S.C. § 101 (a)(2)) as a "strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the life cycle of the assets at minimum practicable cost."

Fundamentally, asset management is focused on how best to maintain infrastructure over time to support resource allocation decisions. The American Public Works Association Asset Management Task Force highlighted this aspect of

asset management with its 1998 definition of asset management as "…a methodology needed by those who are responsible for efficiently allocating generally insufficient funds amongst valid and competing needs."[1]

Supporting an asset management approach requires first determining what physical assets an agency owns and establishing their condition. With this information, an agency can then determine how to invest available funds in the right place, at the right time, to produce the most cost-effective, life cycle performance for the given investment.

Figure 1-1. Asset Management Components

Figure 1-1 provides a schematic identification of the various overall asset management components. TAM business processes are shown in the bracketed center portion of the figure. Key enablers of TAM are shown on the outside of the figure. These include "Organization & People" and "Information & Systems".

What is in a Transportation Asset Management Plan?

A Transportation Asset Management Plan (TAMP) documents a State Department of Transportation's (DOT) assets and approach to applying TAM principles. The Federal Highway Administration (FHWA) has developed specific requirements for the subjects a TAMP should contain (23 CFR Part 515). These requirements were originated by Congress in the "Moving Ahead for Progress in the 21st Century Act" (MAP-21) and were continued in the Fixing America's Surface Transportation (FAST) Act. FHWA requires each DOT to prepare a TAMP for its NHS roads and bridges. The TAMP should include discussion of the following:

- Asset management objectives
- Asset management measures and State DOT targets for asset condition
- A summary description of the condition of NHS pavements and bridges
- Performance gap identification
- Life cycle planning
- Risk management analysis

[1] FHWA Office of Asset Management, Asset Management Primer, December 1999

- Financial plan
- Investment strategies

ARDOT's TAMP addresses all of the above subjects. The plan includes pavements and bridges on the NHS.

Asset Management Goals and Objectives

This TAMP supports ARDOT's strategic goals and objectives, as well as the national goals established in MAP-21 and the FAST Act. ARDOT's strategic goals are to:

- Provide a Safe and Efficient Intermodal Transportation System
- Accomplish Our Mission with a Focus on Stewardship
- Champion Transportation Solutions that Promote Quality of Life and Economic Development
- Continually Improve Transportation Services and Solutions Through Employee Engagement
- Maximize External and Internal Customer Satisfaction

The national goals established in MAP-21 include:

- **Safety** - To achieve a significant reduction in traffic fatalities and serious injuries on all public roads
- **Infrastructure Condition** - To maintain the highway infrastructure asset system in a state of good repair
- **Congestion Reduction** - To achieve a significant reduction in congestion on the National Highway System
- **System Reliability** - To improve the efficiency of the surface transportation system
- **Freight Movement and Economic Vitality** - To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development
- **Environmental Sustainability** - To enhance the performance of the transportation system while protecting and enhancing the natural environment
- **Reduced Project Delivery Delays** - To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices

In developing its 2017 Long Range Intermodal Transportation Plan (LRITP) ARDOT defined a comprehensive set of goals and objectives that supports both ARDOT's strategic goals and the national goals listed above. Table 1-1 below lists these and describes how ARDOT's TAM program supports each of them.

Table 1-1. ARDOT LRITP Goals and Objectives and Their Relationship to TAM

Goal	TAM-Related Objectives from the LRITP	Relationship to TAM
Safety and Security	• Align safety goals with the goals of the Strategic Highway Safety Plan. • Identify roadways and bridges that are vulnerable to extreme weather events and other natural phenomena. • Improve the resiliency of the transportation system to meet travel needs in response to extreme weather events.	The TAMP includes a risk mitigation plan for identifying risks to the NHS and recommended mitigation actions. Further, in improving its highway and bridge conditions ARDOT seeks to incorporate targeted safety improvements.

Goal	TAM-Related Objectives from the LRITP	Relationship to TAM
Infrastructure Condition	• Enforce weight and size restrictions to protect roads and bridges. • Improve ride quality on NHS roads. • Follow asset management principles to optimize preservation strategies on the State Highway System. • Identify potential freight corridors within which special attention is given to preempt commercial vehicle bottlenecks.	Improving infrastructure condition is a critical focus area of TAM.
Congestion Reduction, Mobility and System Reliability	• Provide predictable, reliable travel times. • Plan and prepare for autonomous and connected vehicles.	Through improving conditions of existing highways and bridges TAM helps maximize performance of existing assets.
Economic Competitiveness	• Support the maintenance and operation of state highways, bridges, transit, rail, ports, locks, and dams.	TAM helps determine how best to maintain existing highways and bridges.
Environmental Sustainability	• Identify and reduce barriers to reduce delays and improve the project delivery process. • Minimize impacts to natural, historic, and cultural resources.	TAM involves defining the life cycle strategy for maintaining roads and bridges to minimize life cycle costs and help achieve other agency goals.
Multimodal Transportation System	• Develop and sustain efficient intermodal connections to allow for more efficient transfer of goods between modes.	TAM helps address how best to maintain roads and bridges, which are critical components of the multimodal transportation system.

Agency Overview

ARDOT owns and maintains the 12th largest State Highway System in the U.S. that is comprised of roads, bridges, and a wide variety of other physical assets. ARDOT also works in cooperation with many partner and governmental agencies to oversee assets such as ports and waterways, railways, public transit, bicycle and pedestrian facilities, and aviation access. ARDOT is centrally organized with ten districts across the state, and more than 3,600 full-time, regular employees.

Organizational alignment and support for TAM is a key element of TAM program success. The System Information and Research Division has responsibility for preparing the TAMP. Two sections within this division are directly involved in the TAM program. The Traffic Information Section is responsible for maintaining the roadway inventory data on the 16,400 plus centerline miles of ARDOT-owned roads. The Asset Management Section is responsible for collecting, processing, and analyzing pavement performance data, as well as for developing cost-effective strategies for maintaining and preserving the State's highways. Other divisions within ARDOT help support development of the TAMP. In particular, the Heavy Bridge Section within the Maintenance

Division supplies the analysis of bridge investment needs and preservation strategies for ARDOT's inventory of over 7,200 highway bridges.

Document Organization

The TAMP consists of the following six chapters:

1. **Introduction** – This chapter outlines the purpose of the TAMP, gives an agency overview, and presents the organization of the document.
2. **Asset Inventory and Condition** – This chapter contains inventory and condition information for Arkansas' pavements and bridges.
3. **Life Cycle Planning** – This chapter describes ARDOT's strategies for managing pavement and bridges over their life cycle to minimize agency and user costs.
4. **Performance Scenarios and Gap Assessment** – This chapter details a set of scenarios predicting future conditions of Arkansas' pavements and bridges over a ten-year period, detailing the gap between current and predicted conditions and ARDOT's desired state of good repair.
5. **Risk Management** – This chapter discusses risks to Arkansas' pavement and bridges that could impact the achievement of TAM goals and objectives. It presents a mitigation strategy for addressing ARDOT's highest priority risks.
6. **Financial Plan and Investment Strategies** – This chapter weighs detailed projected future revenues and expenditures for asset management-related uses. It also describes ARDOT's investment strategies for best achieving its goals and objectives given available resources.

Updating the TAMP

TAMPs are intended to evolve over time as changes in conditions, budgets, risks, constraints, targets or strategic priorities are identified. Throughout the development of this initial TAMP for Arkansas, opportunities for improvement were identified. Federal regulations require that TAMPs be reviewed and updated periodically to incorporate improvements and re-evaluate conditions, targets, and performance. Therefore ARDOT's TAMP will need to be updated to reflect changes and improvements realized in the future. It should be noted that the FHWA will make ongoing consistency determinations to certify that the TAMP is fully implemented by ARDOT.

Future versions of the TAMP will likely be influenced by ongoing work related to establishing targets in other federal performance management areas. Companion federal requirements for safety, congestion, freight, and air quality will be completed in the coming years and may need to be integrated into the ARDOT TAMP.

The TAMP presents a coordinated plan by ARDOT and its partner MPOs to maintain Arkansas' highway infrastructure assets today and into the future. This TAMP meets the federal requirements for TAM and provides a solid foundation to build upon and improve the management of transportation assets in Arkansas moving forward.

This page is intentionally blank.

2. Asset Inventory and Conditions

Introduction

Asset inventory and condition data are the foundation for Transportation Asset Management. Inventory and condition data communicate the required vital information about the current condition of the State's assets. Accurate inventory and condition data are needed for supporting asset management processes, such as life cycle planning, calculating funding needs, developing projects, and monitoring asset performance. This chapter details ARDOT's inventory of pavement and bridge assets, and their condition.

Federal Requirements

Federal requirements for Transportation Asset Management Plans (TAMP) are detailed in 23 CFR Part 515. To meet these requirements, a TAMP must include all pavements and bridges in the State on the NHS. The TAMP must also incorporate a summary listing of the assets included and describe the conditions of those assets. In reporting conditions for pavements and bridges on the NHS, the TAMP must include the federally-defined performance measures detailed in 23 CFR Part 490. These requirements describe measures of good, fair and poor condition for pavements and bridges calculated using data reported to the FHWA.

TAMP Scope

Transportation agencies manage a wide variety of physical assets, as depicted in Figure 2-1. ARDOT's assets include pavements, bridges, culverts, rights of way, facilities, and many additional traffic and safety features, such as retaining walls, signs, and guardrails. All of these assets are needed to support the transportation system and require a significant level of ongoing investment. However, the large majority of ARDOT's investments in the State's transportation system assets are dedicated to two asset classes: pavements and bridges (including bridge-length culverts). Therefore, this TAMP is focused on these two asset classes, consistent with federal requirements. In addition to addressing pavements and bridges on the NHS, this TAMP includes information on all ARDOT-owned pavements and bridges, as well as other pavements and bridges on the NHS.

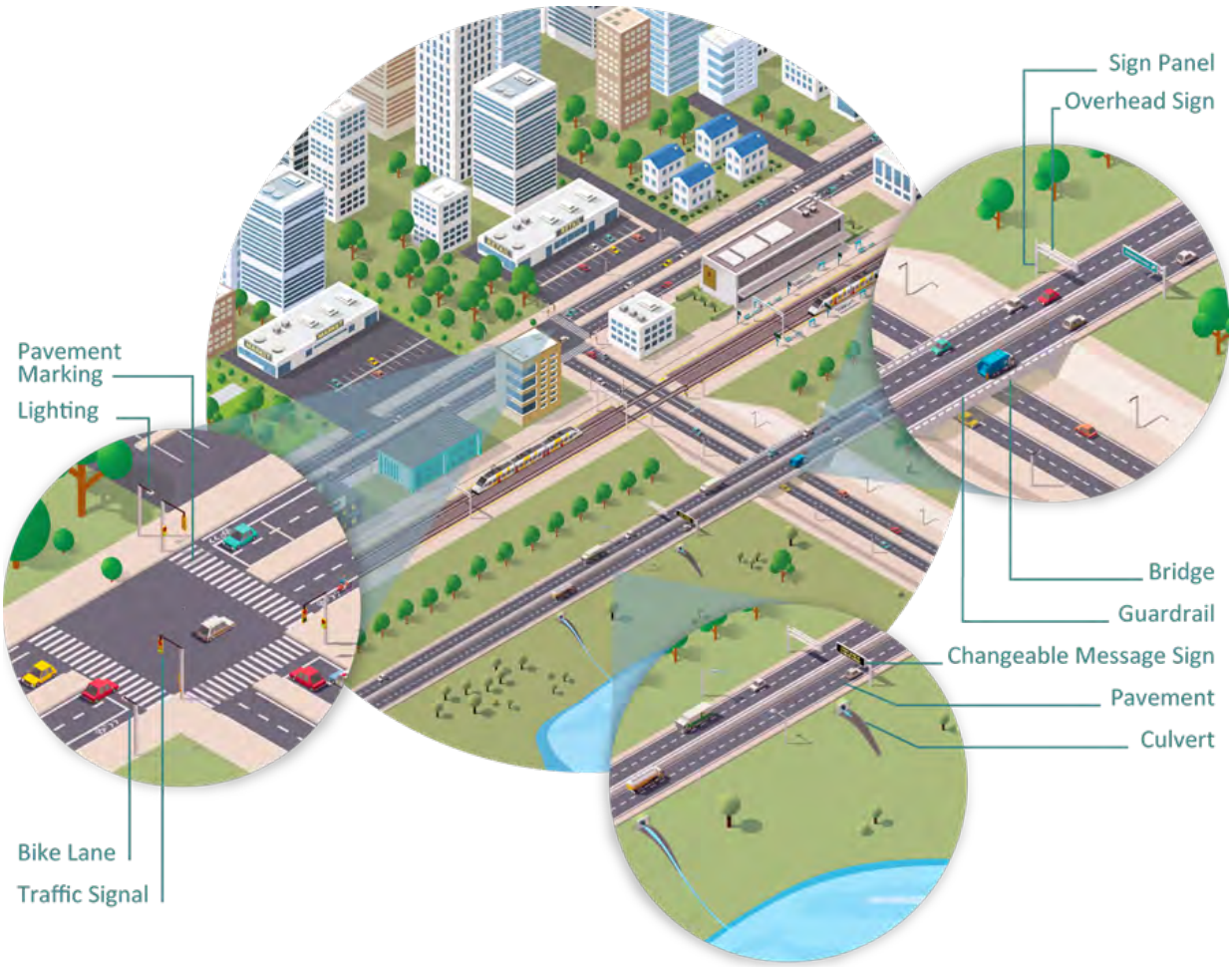


Figure 2-1. Typical Highway Assets

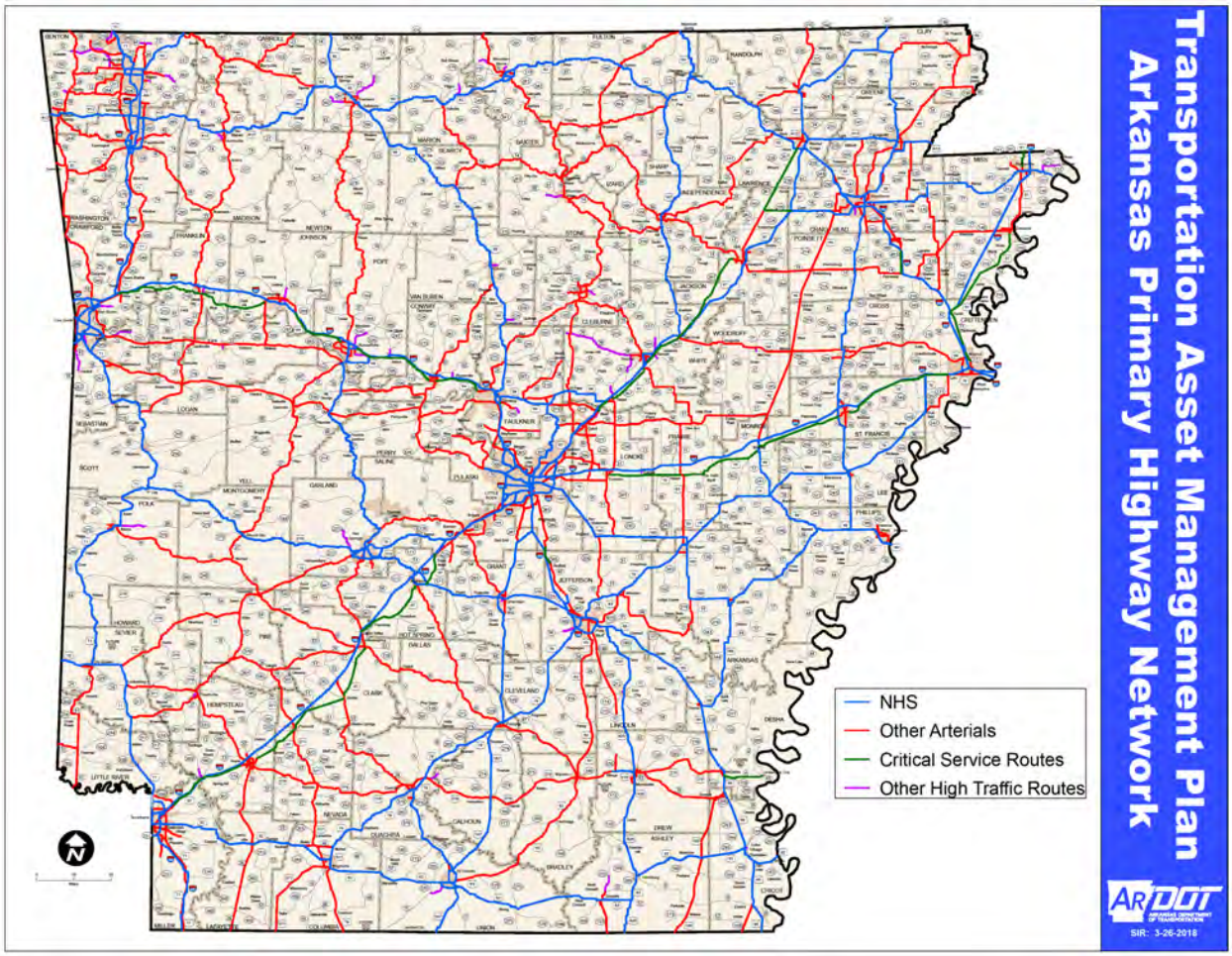


Figure 2-2. Arkansas Primary Highway Network

The Arkansas Primary Highway Network (APHN) was developed for use in long-term planning. This is a system of 7,920 miles that carries more than 90% of all travel on the State Highway System. It accounts for nearly 50% of the total State Highway System. It was adopted by the Arkansas Highway Commission by Minute Order 2004-049 on April 14, 2004, as a system that provides interstate and regional movement, linkage to population centers, and critical services.

The APHN is comprised of:

- National Highway System (NHS)
- Other Arterials
- Critical Service Routes
- Other High Traffic Routes

Part of the APHN is the NHS. The NHS has been defined by the Federal Highway Administration (FHWA) to include roads deemed important to the nation's economy, defense, and mobility, including:

- All Interstates
- All roads in the Strategic Highway Network (STRAHNET), another federally-defined network
- Most principal arterials

- Selected major strategic highway connectors
- Selected intermodal connectors

Figure 2-3 is a map of the state showing NHS routes highlighted.

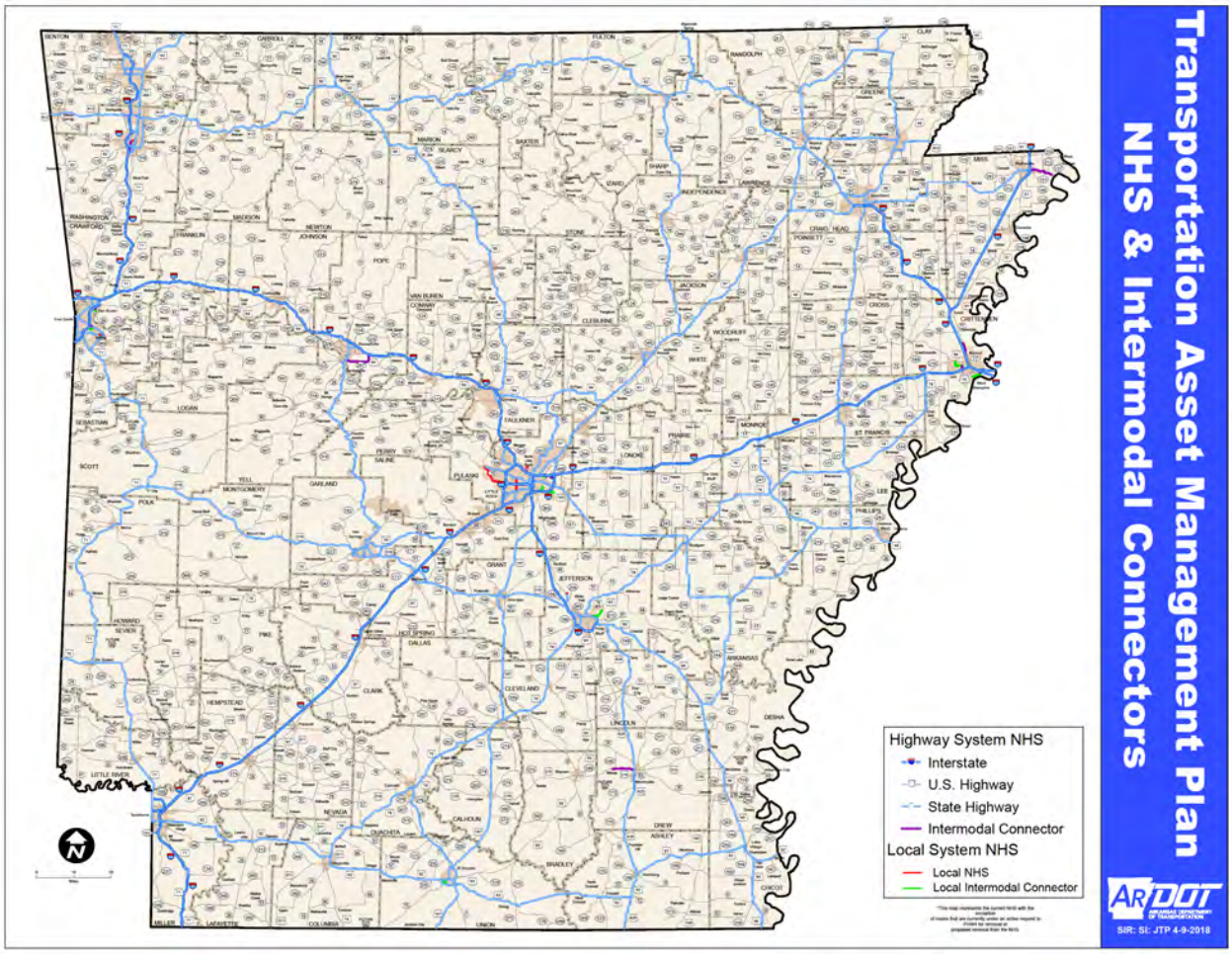


Figure 2-3. Arkansas National Highway System

A small portion of the NHS in Arkansas is locally-owned. Locally-owned NHS assets include approximately 101 lane miles of pavement (of more than 7,700 total Non-Interstate NHS lane miles) and 6 bridges with a total deck area of 23,360 square feet (out of over 33 million square feet in NHS deck area).

Condition data on the state- and locally-owned NHS pavements are included in this TAMP. Condition and inventory data on state-owned NHS bridges and on six locally-owned NHS bridges are also included.

Pavement

Overview

In Arkansas, pavement work represents the single largest investment of public dollars in existing transportation assets. Keeping pavements in good condition lengthens their useful life, enhances safety, minimizes user operating costs, and reduces vehicle emissions. Rough roads not only increase wear and tear on vehicles, but can also reduce mobility in some cases.

National Cooperative Highway Research Program (NCHRP) Report 859 discusses the potential consequences of delaying needed work on pavements and other highway assets. As detailed in this report, delaying needed work on pavements can result in degraded pavement condition, more significant treatments, higher costs, and a reduction in Level of Service (LOS). In addition, the report identifies lower condition ratings and LOS as factors that contribute to user discomfort, exposure to crashes and increased fuel usage. Insufficient funding is the most common cause for delayed maintenance or preservation activities.

Data Collection

Since 1993 ARDOT has used state-of-the-art technolgy to collect pavement inventory and condition data using automated collection methods. Specially-equiped vehicles are used to capture video data of the road network at highway speeds, and at the same time measure key indices of pavement condition, such as rougness, rutting and cracking. Pavement data in this TAMP was collected in 2016 for ARDOT's submission to the Highway Performance Monitoring System (HPMS).

Technology for pavement data collection is constantly evolving, and ARDOT has made periodic enhancements to its data collection approach to leverage new technology while complying with changes in standards of data collection. One recent change in data collection has been the implementation of three dimensional imaging for pavement cracking. This newer technology improves the detection of cracks and captures the depth of the crack, reducing the number of "false positives" reported previously. ARDOT began the implementation of this new detection technology in late 2017. Future versions of the TAMP will include three dimensional imaging of pavement cracking.

Performance Measures

ARDOT collects data on a variety of pavement metrics, including roughness, cracking, rutting, and faulting of concrete pavements.

In order to provide a summary measure of pavement condition, ARDOT has developed an index termed the Pavement Condition Index (PCI) that represents the general condition of a pavement section on a scale of 0 (worst condition) to 100 (best condition). PCI is calculated as a weighted average of four types of pavement metrics, which are environmental cracking, structural cracking, roughness, and rutting. PCI is then used to assign a Pavement Condition Rating using letter grades A to F which describe the overall

pavement condition of the state highway system as good, fair, or poor. This is accomplished by grouping "A" and "B" PCI grades as good, "C" and "D" PCI grades as fair and "F" PCI grades as poor.

In addition to PCI and Pavement Condition Ratings, this plan also reports conditions for NHS pavements using the measures required by FHWA:

- Percentage of pavements on the Interstate System in good condition
- Percentage of pavements on the Interstate System in poor condition
- Percentage of pavements on the NHS (excluding the Interstate System) in good condition
- Percentage of pavements on the NHS (excluding the Interstate System) in poor condition

The above measures are calculated using HPMS data as specified in 23 CFR Part 490.309. Based on these regulations, the overall condition of a given pavement section is classified using the following metrics:

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

For each of the above metrics, FHWA has established thresholds for good, fair and poor condition. Conditions are assessed using these threshold criteria for each 1/10-mile long pavement section. An individual section is rated as being in good condition, if all of the metrics are rated as good, and poor when two or more are rated as poor. All other combinations are rated as fair. The lane miles in good, fair and poor condition are tabulated for all sections to determine the overall percentage of pavements in good, fair and poor condition. These thresholds are summarized in Table 2-1 below.

Table 2-1. FHWA Pavement Condition Thresholds

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

It is important to mention there are differences between the good, fair and poor ratings based on FHWA guidance as compared to ARDOT's guidance. The reason for the differences is due to how each agency establishes the breakpoints in condition ratings.

A graphic depiction of the four pavement condition metrics is shown below in Figure 2-4.

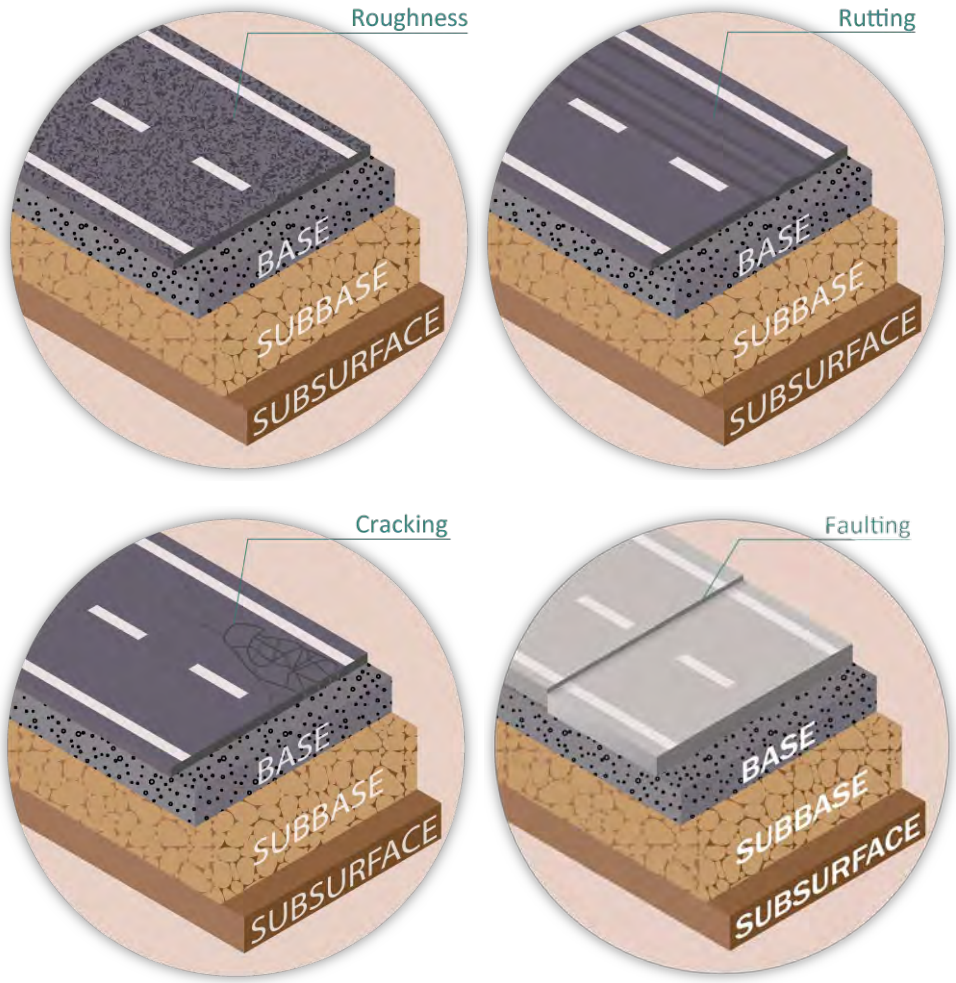


Figure 2-4. Pavement Condition Metrics

Inventory and Condition

Table 2-2 below summarizes the current inventory and condition of all pavements on the State Highway System in Arkansas. This table is based on the process developed by ARDOT which uses the PCI and Pavement Condition Rating.

The table divides all pavements on the State Highway System into five categories.

- APHN
- Interstate
- Non-Interstate APHN
- NHS Only
- Non-APHN

The table identifies the following information for each of the five categories.

- Centerline miles
- Lane miles
- Percentage of lane miles in each Condition Rating for each category.

Overall conditions are best for the Interstates, which carry the most traffic on a mile-by-mile basis, and are the worst for the Non-APHN, which carries the least. For the Interstate System approximately 77 percent of pavements have a Condition Rating of A or B. In contrast for Non-Interstate NHS pavements approximately 34 percent have a Condition Rating A or B. For the Non-APHN fewer than 10 percent of pavements have a Condition Rating of A or B.

Table 2-2. ARDOT Pavement Inventory and Condition Summary

			Condition Rating				
System	Centerline Miles	Lane Miles	A	B	C	D	F
Total	**16,432**	**37,332**	**4%**	**14%**	**26%**	**32%**	**24%**
APHN	7,920	20,719	7%	21%	32%	27%	13%
Interstate	749	3,203	32%	39%	19%	7%	3%
Non-Interstate APHN	7,171	17,516	2%	18%	34%	31%	15%
NHS Only	2,608	7,675	3%	25%	35%	25%	12%
Non-APHN	8,512	16,613	1%	4%	19%	38%	38%

Note: The Non-Interstate NHS is a subset of the Non-Interstate APHN.

Table 2-3 below summarizes the current inventory and condition of the NHS using the FHWA good/fair/poor measure described above. As shown in the table, large portion of Interstate and Non-Interstate NHS pavements are classified as good or fair. Approximately 1 percent of pavements in each category are classified as poor. Condition data were not collected for the locally-owned NHS pavements, but the value for state-owned pavements is assumed to be representative of the total.

Table 2-3. Arkansas NHS Pavement Inventory and Condition Summary Using FHWA Thresholds

Owner/System	Centerline Miles	Lane Miles	Good	Fair	Poor	
Interstate	**749**	**3,203**	**70%**	**29%**	**1%**	
Non-Interstate NHS	**2,643**	**7,776**	**38%**	**61%**	**1%**	
State Owned	2,608	7,675				
Non-State Owned	35	101				

Note: Condition data for the Non-State Owned routes has not been collected. For the purposes of this TAMP, the condition data of these routes is assumed to be comparable to those of other NHS routes.

Bridges

Overview

Bridges are a critical element of transportation infrastructure. These engineering feats provide passage across water bodies and other obstacles without impeding travel underneath or substantially altering the landscape. Just as importantly, they provide access by spanning over other infrastructure elements such as rail lines and intersecting roadways. While pavement can deteriorate in quality without fully losing its most basic function, a bridge must be safely constructed and adequately maintained to remain a viable travel option. Research shows that bridges in good condition allow access to essential services and have a positive impact on the economy, making their construction and maintenance worthwhile.

New bridges are designed to last at least 75 years. However, the majority of bridges in Arkansas were designed for a 50-year design life. In reality, a significant number of bridges remain in service for much longer. Just like any other feature, a bridge requires periodic preservation activities to extend its useful life. If bridge preservation work is delayed or deferred, the deterioration will quickly reach a point where more costly repairs are needed. Delays in preservation activities result in accelerated deterioration. Upon discovery that a bridge is in an advanced deteriorated condition, load restrictions may be necessary. These bridges are generally referred to as load posted bridges. In extreme cases, the bridge may require closing until needed repairs can be completed, which would result in costly detours for the traveling public.

There is significant research, based on historical data that clearly shows how proper maintenance and preservation of bridges in a state of good repair prolonged useful life. These benefits are felt by both transportation agencies and the traveling public.

Data Collection

Condition data of bridges is collected through visual inspections. ARDOT inspects most of its bridges on a two-year cycle, and inspects selected bridges more frequently. FHWA has specified data to be collected as part of a bridge inspection through the National Bridge Inspection Standards (NBIS). ARDOT collects bridge data according to these standards and reports data annually to the National Bridge Inventory (NBI). The NBI is an FHWA database that includes data on all bridges and culverts on public roads in the nation that are more than 20 feet long. Additionally, ARDOT supplements its routine bridge inspections with more detailed visual inspections of bridge structural elements. Prior to 2015, ARDOT collected element-level data for all bridges, state and local, using the American Association of State Highway and Transportation Officials (AASHTO) specification for Commonly Recognized (CoRe) Elements. Since 2015 element-level inspections have been required for bridges on the NHS using an updated set of element definitions specified in the AASHTO Manual for Bridge Element Inspection (MBEI). ARDOT currently performs element inspections for all state-owned bridges and locally owned NHS bridges based on this standard. The bridge data presented in this TAMP was collected in 2017 for submittal to the NBI.

Performance Measures

FHWA has established two measures of bridge condition:

- Percentage of NHS bridges classified in good condition (weighted by deck area)
- Percentage of NHS bridges classified in poor condition (weighted by deck area)

FHWA requires that states use these measures in their TAMPs to describe condition, set targets, and analyze performance gaps of NHS bridges.

ARDOT follows the FHWA NBI standards for inspection of all Arkansas bridges. ARDOT performs inspections for all Arkansas bridges. Inspectors record overall ratings for a bridge's deck, superstructure, and substructure components on a scale from 0 (worst condition) to 9 (best condition). Structures classified as culverts are included in the inventory if they are longer than 20 feet. For the culvert structures, a single culvert rating is recorded using the same 0-9 scale.

Bridge condition ratings are used to classify the bridge as being in good, fair or poor condition. The lowest of the three ratings for deck, superstructure and substructure determines the overall rating of the bridge. If this value is 7 or greater, the bridge is classified as being in good condition. If it is 5 or 6, the bridge is classified as being in fair condition, and if it is 4 or less, the bridge is classified as being in poor condition. A graphic depiction of the three bridge components is shown below in Figure 2-5.

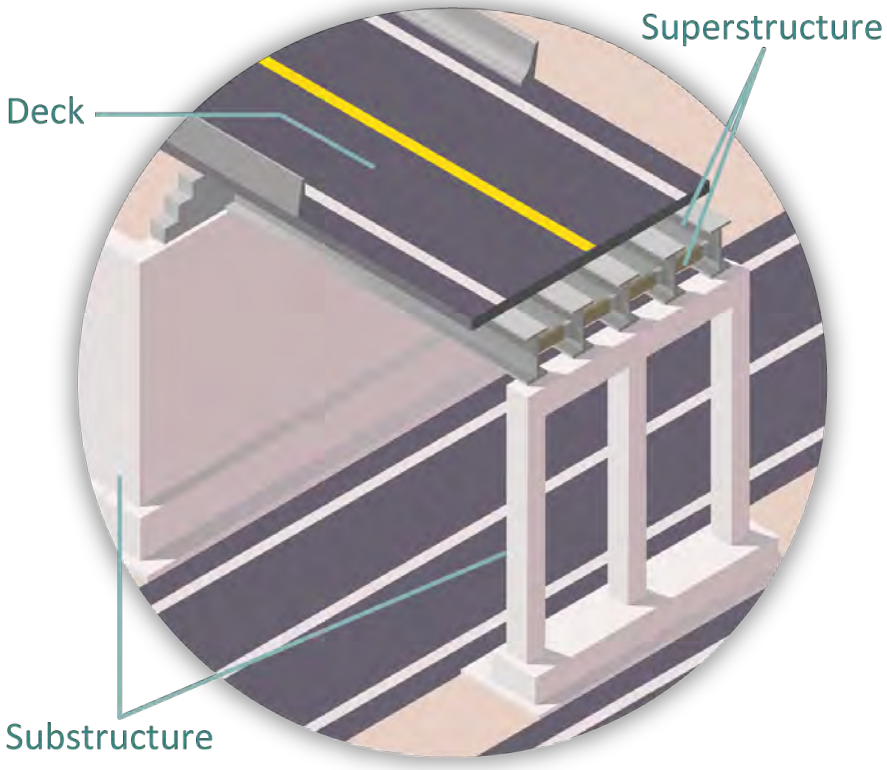


Figure 2-5. Bridge Components

Inventory and Condition

Table 2-4 below summarizes the current inventory and condition of all bridges in Arkansas. This table is based on FHWA's NBI standards for identifying bridges that are in good, fair and poor condition.

The table divides all bridges into two main categories, State Owned and Non-State Owned. Each of these categories is further divided into NHS and Non-NHS bridges.

The table identifies the following information for each of the categories.

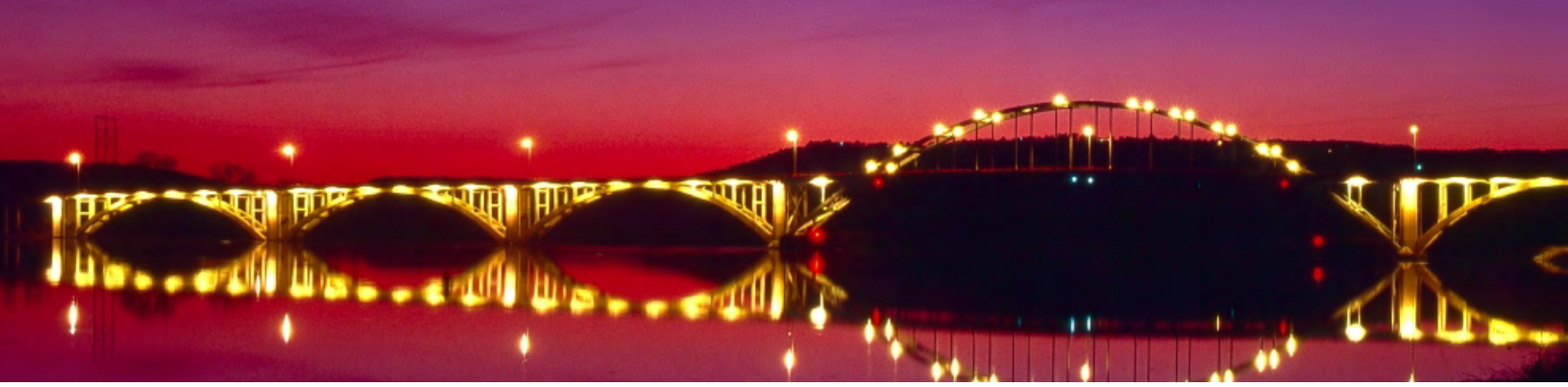
- Number of Bridges
- Deck area in square feet
- Percentage of bridges in good, fair and poor condition

For all NHS bridges, over 50% are in good condition with less than 4% in poor condition. For all Non-NHS bridges, over 54% are in good condition with less than 6% in poor condition.

Table 2-4. Bridge Inventory and Condition

Owner/System	Number of Bridges	Deck Area (ft^2)	Good	Fair	Poor	
State Owned						
Total	**7,306**	**60,205,283**	**50%**	**45%**	**5%**	
NHS	2,362	36,100,852	50%	46%	4%	
Non-NHS	4,944	24,104,431	50%	44%	6%	
Non-State Owned						
Total	**5,391**	**10,653,964**	**62%**	**33%**	**5%**	
NHS	6	23,381	52%	23%	25%	
Non-NHS	5,385	10,630,583	62%	33%	5%	
Total						
Total	**12,697**	**70,859,247**	**52%**	**43%**	**5%**	
NHS	2,368	36,124,233	50%	46%	4%	
Non-NHS	10,329	34,735,014	54%	40%	6%	

This page is intentionally blank.



3. Life Cycle Planning

Introduction

Transportation asset management is fundamentally concerned with determining how best to manage a physical asset over its life cycle. The process of developing a strategy for managing an asset to achieve a target level of performance while minimizing life cycle costs is termed "life cycle planning." An asset life cycle plan describes what investments are required in an asset's maintenance, preservation, and rehabilitation as a function of the asset's age and/or condition. Life cycle planning is supported by management systems, including pavement and bridge management systems, which help model asset deterioration, simulate the effect of different treatments, and determine the optimal mix of treatments to perform for individual assets and networks of assets.

Generally, an effective life cycle plan emphasizes performing timely maintenance activities to keep an asset in good condition, while avoiding, where possible, assets deteriorating to poor condition. Once an asset deteriorates to poor condition treatment options are more expensive. The benefit of such a strategy is that it has the potential to reduce long-term costs to the transportation agency and road users. Life cycle planning also provides the information needed to determine how best to prioritize asset investments when funding levels are insufficient to meet all of the transportation system's needs.

This chapter summarizes the federal requirements for life cycle planning in TAMP development, describes ARDOT's overall approach, and details life cycle planning for pavements and bridges.

Federal Requirements

Lifecycle planning is defined in 23 CFR 515.5 as "a process to estimate the cost of managing an asset class, or asset sub-group, over its whole life with consideration for minimizing cost while preserving or improving condition."

The federal regulations stipulate that a lifecycle planning process shall, at a minimum, include:

- State DOT targets for asset condition for each NHS asset class or asset sub-group
- Identification of deterioration models for each NHS asset class or asset sub-group
- Potential work types, or treatments, across the whole life of each asset class or asset sub-group with their relative unit cost
- A strategy for managing each NHS asset class, or asset sub-group by minimizing its lifecycle costs, while achieving the State DOT targets for asset condition for NHS pavements and bridges

The federal regulations also stipulate that States should have pavement and bridge management systems for supporting life cycle planning and other related processes. 23 CFR 515.17 describes required pavement and bridge management system functionality, which includes:

- Collecting, processing, storing, and updating inventory and condition data for all NHS pavement and bridge assets
- Forecasting deterioration for all NHS pavement and bridge assets
- 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
- Identifying short- and long-term budget needs for managing the condition of all NHS pavement and bridge assets
- Determining the strategies for identifying potential NHS pavement and bridge projects that maximize overall program benefits within the financial constraints
- Recommending programs and implementation schedules to manage the condition of NHS pavement and bridge assets within policy and budget constraints

Approach Overview

ARDOT uses the commercial off-the-shelf management system Deighton Total Infrastructure Management System (dTIMS), developed by Deighton Associates Limited (Deighton), to support life cycle planning for pavements and bridges and to meet the management system requirements outlined above.

dTIMS includes functionality for managing asset inventory and condition data, defining treatments, specifying treatment triggers and other business rules, and simulating conditions over time given a budget and other constraints. The dTIMS simulation selects what treatments to perform on each asset to most efficiently improve asset conditions subject to constraints. The system supports specification of simulation constraints including, but not limited to, budget constraints by asset class/sub-class and by treatment type. The simulation can be used to predict future conditions, determine funding required to meet a given set of performance targets, and/or recommend specific treatments to perform on a given asset.

ARDOT has configured dTIMS to analyze both its pavements and bridges. Under contract to ARDOT, Deighton has prepared configuration documents detailing the models implemented in the system and how the system is used. The most recent pavement configuration document is dated August 2017 and the most recent bridge configuration document is dated September 2016.

Pavement data loaded into dTIMS includes detailed distress data reported every 1/10 mile. The distress data are aggregated by management section, where a management section is homogenous in pavement type and

functional characteristics, and represents a typical length of pavement over which a treatment is applied (typically two to five miles in length). The pavement analysis performed in dTIMS includes separate analyses of Interstate, Non-Interstate APHN (including all Non-Interstate NHS pavements), and Non-APHN systems. Pavement types defined in the system include Asphalt, Jointed Concrete, and Continuously Reinforced Concrete. The pavement analysis is run separately for the three systems listed above.

Bridge data loaded into dTIMS includes National Bridge Inventory (NBI) inspection data for each bridge. The bridge analysis includes all ARDOT-owned bridges, including bridges on and off the NHS. When simulating bridge conditions and work types, a mix of spending for bridge replacement, deck overlays, and rehabilitation is used to achieve the best overall performance.

The following sections provide additional details on the life cycle plans developed in dTIMS for pavements and bridges, respectively.

Pavement Life Cycle Planning

Performance Objectives

As discussed in Chapter 2, ARDOT characterizes overall pavement condition using PCI and summarizes PCI into Condition Rating letter grades. ARDOT's objective for its pavements is to maintain pavement at the desired state of good repair at minimum life cycle cost. The desired state of good repair for ARDOT's pavements is to maintain all NHS pavements at a Condition Rating of A or B and to maintain other non-NHS pavements on the APHN at a Condition Rating of A, B, or C. These criteria were established through a statewide needs assessment in 2016 and described in the Arkansas Legislative Audit report titled *Review of Sources and Uses of Funds: Arkansas Department of Transportation for the Period July 1, 2009 through June 30, 2016 and Projected for Fiscal Years 2017 through 2020*. Furthermore, the criteria supported are consistent with the goals and objectives described in Chapter 1.

Deterioration Models

The Pavement Management System (PMS) Configuration report prepared by Deighton details ARDOT's pavement deterioration models. A total of 72 models have been developed and are detailed in this document. These vary by the following:

- **Pavement indices -** separate deterioration models are established for environmental cracking, structural cracking, roughness and rutting
- **Pavement thickness** - separate models are defined for thin and thick pavements
- **Soils strength -** separate models are defined for weak, moderate, and strong soil strength
- **Truck traffic -** separate models are defined for low, moderate, and high truck traffic

Figure 3-1, reproduced from the configuration document, shows a representative set of deterioration models. In this case, models for the three different truck traffic levels are shown for environmental cracking of thin pavements on strong soil. The uppermost line shows predicted deterioration for pavements with a low level of

truck traffic, while the lowest line, reflecting the most rapid deterioration, shows predicted deterioration for pavements with a high level of truck traffic.

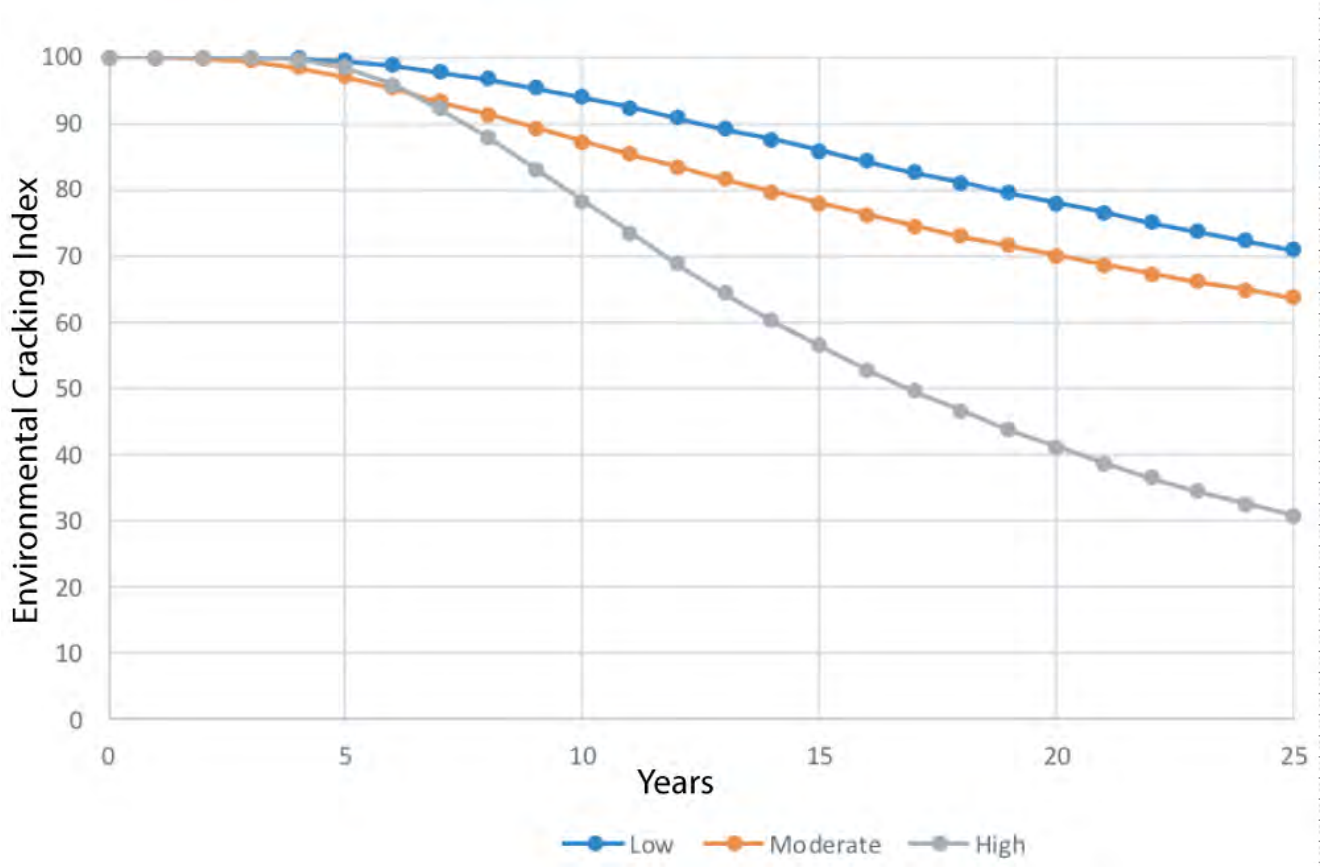


Figure 3-1. Example Pavement Deterioration Models – Environmental Cracking: Thin Pavement on Strong Soil

Work Types

Table 3-1 shows the treatments simulated by dTIMS for pavements. For each treatment, the table shows a description, the cost per lane mile for Interstates, the Non-Interstate APHN, and Non-APHN systems, and the approximate treatment life in years. Additional treatments performed by ARDOT include asphalt crack sealing and concrete joint repair, which are projected to occur following a major treatment such as an overlay.

Table 3-1. Pavement Work Types

Treatment	Cost Per Lane Mile ($)			Treatment Life (years)
	Interstate	APHN	Non-APHN	
Asphalt crack seal	$17,250	$17,250	$17,250	8
Asphalt surface treatment	N/A	14,500	14,500	6
Micro surface	N/A	39,424	39,424	10
Ultra-Thin Bonded Wearing Course	65,000	65,000	65,000	8
Thin overlay	98,000	98,000	98,000	10
Structural overlay	365,000	365,000	325,000	18
Hot in place recycle	250,000	250,000	250,000	12
Reconstruction	1,687,500	1,375,000	1,250,000	20
Concrete grinding	26,048	26,048	26,048	8
Concrete joint repair	5,000	5,000	5,000	8
Concrete pavement repair	57,000	57,000	57,000	8

Strategy

In dTIMS, the life cycle strategy consists of a set of treatments, triggers that specify when the treatment may be considered, and details on the effectiveness of the treatment. Using this information, the system then determines the specific treatment strategy to perform for a given section based on the budget and other constraints. Absent a budget constraint, the system attempts to maximize pavement condition as measured using PCI. With constraints, the system attempts to identify the strategy that provides the greatest benefit (in terms of improved pavement condition) given the available budget.

Figure 3-2, reproduced from the configuration document, shows a hypothetical example in which two treatments are possible. On this graph pavement condition is depicted on the vertical axis and age is depicted on the horizontal axis. The predicted condition in the absence of a treatment is shown in black. The blue and red lines depict two different strategies. The blue line shows the approximate effect of performing a surface treatment, while the red line shows the effect of an overlay. A surface treatment is less expensive than overlaying the pavement, but it must be performed more frequently to achieve the same pavement life extension as an overlay. Thus, in this hypothetical example, which is not based on true pavement preservation practice, dTIMS would likely program an overlay if sufficient funds were available. Otherwise repeated surface treatments would likely be recommended.

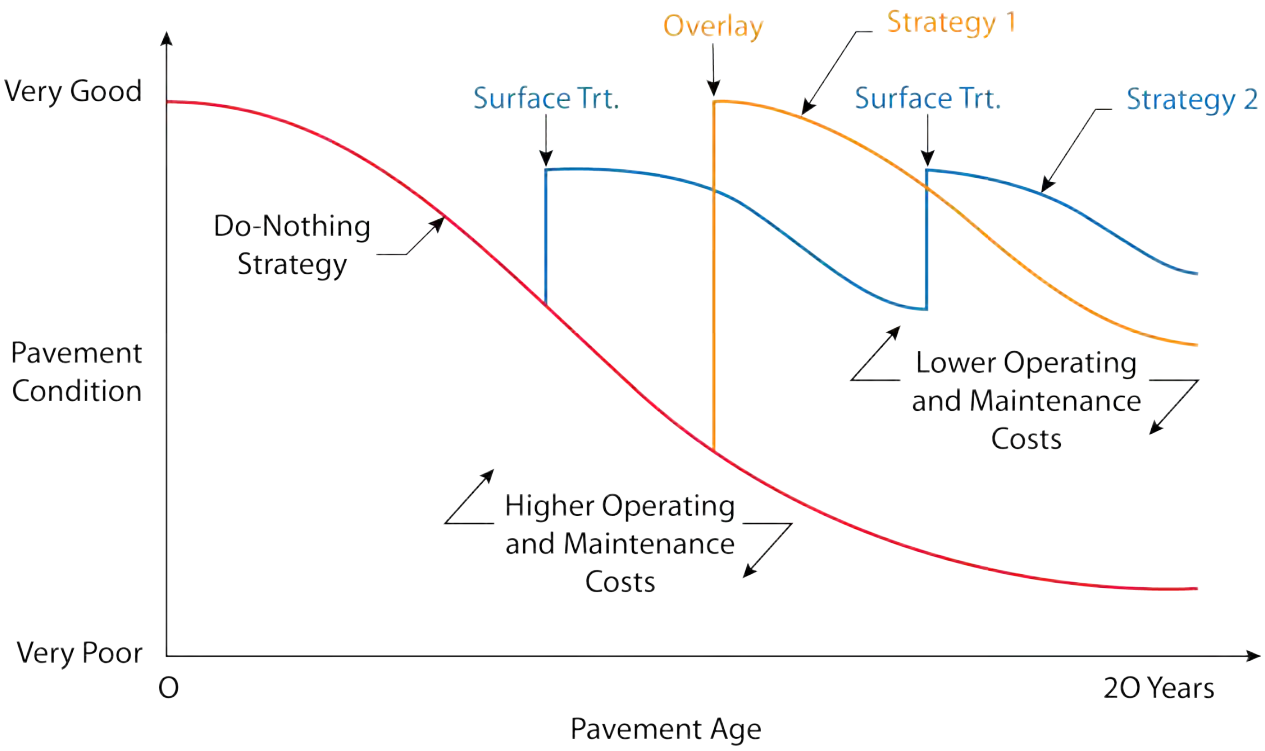


Figure 3-2. Example Pavement Strategies

For each of the 11 treatments listed in Table 3-1 ARDOT has defined the following parameters to support identification of the optimal life cycle strategy:

- **Treatment Triggers** specify the ranges over which the treatment is deemed feasible for the four condition indices described previously (environmental cracking, structural cracking, roughness, and rutting). These triggers may vary by system.
- **Treatment Resets** describe, for each of the four condition indices, whether the treatment resets the index, extends pavement life, or leaves the index unchanged. Life extension is specified in terms of the additional number of years added to pavement life for the specified index.
- **Subsequent Treatments** are treatments that can be performed following a previous treatment. For example, following micro-surfacing it is possible to perform a thin or functional overlay, but not to repeat the micro-surfacing treatment.

Bridge Life Cycle Planning

Performance Objectives

As discussed in Chapter 2, ARDOT characterizes bridge conditions using the deck, superstructure, substructure, and culvert ratings. A condition index term, Bridge Condition Index, combining these ratings is used internally in dTIMS as a trigger for replacement and to help prioritize work.

ARDOT's objective for its bridges is to maintain all bridges in good or fair condition at minimum life cycle cost. However, ARDOT recognizes that even in an ideal setting some bridges will be in poor condition, if only because

of the time required for design and construction once a bridge is identified as being in poor condition. Further, the funds to replace all poor bridges as soon as they become poor are simply not available. Thus, for this TAMP, the desired state of good repair for ARDOT's bridges is, as stated in Chapter 2, approximately 4 percent of NHS bridges in poor condition. Note that without an infusion of additional funding ARDOT's bridge management system is projecting an increase in the percentage of bridges in poor condition to approximately 11% by 2027. These criteria support and are consistent with the goals and objectives described in Chapter 1.

Deterioration Models

The Bridge Management System (BMS) Configuration report prepared by Deighton details the development of ARDOT's bridge deterioration models. A total of 18 models have been developed and are detailed in this document. These include:

- **Culvert deterioration -** concrete and steel
- **Deck deterioration -** concrete deck on concrete cast-in-place deck structure, bituminous deck on concrete cast-in-place deck structure, concrete deck on concrete precast panel deck structure, bituminous deck on concrete precast panel deck structure, other
- **Superstructure deterioration -** concrete, concrete continuous, steel, steel continuous, pre-stressed concrete, pre-stressed concrete continuous, timber, aluminum/iron
- **Substructure -** scour critical, timber, other

For each deterioration curve, the time for transition from one condition rating to another was determined by analysis of historic bridge data. Separate analyses were performed for bridges with unusually fast, unusually slow, and normal deterioration patterns. This resulted in upper, middle, and lower transit curves which are applied at different stages of the bridge life cycle.

Figure 3-3 is an example of the middle curve transitions for a bituminous deck on a concrete cast-in-place deck structure. The figure shows condition on the vertical axis and age on the horizontal axis. Each series on the figure is the curve for a different initial condition rating showing the average time until the rating deteriorates to the next lower value.

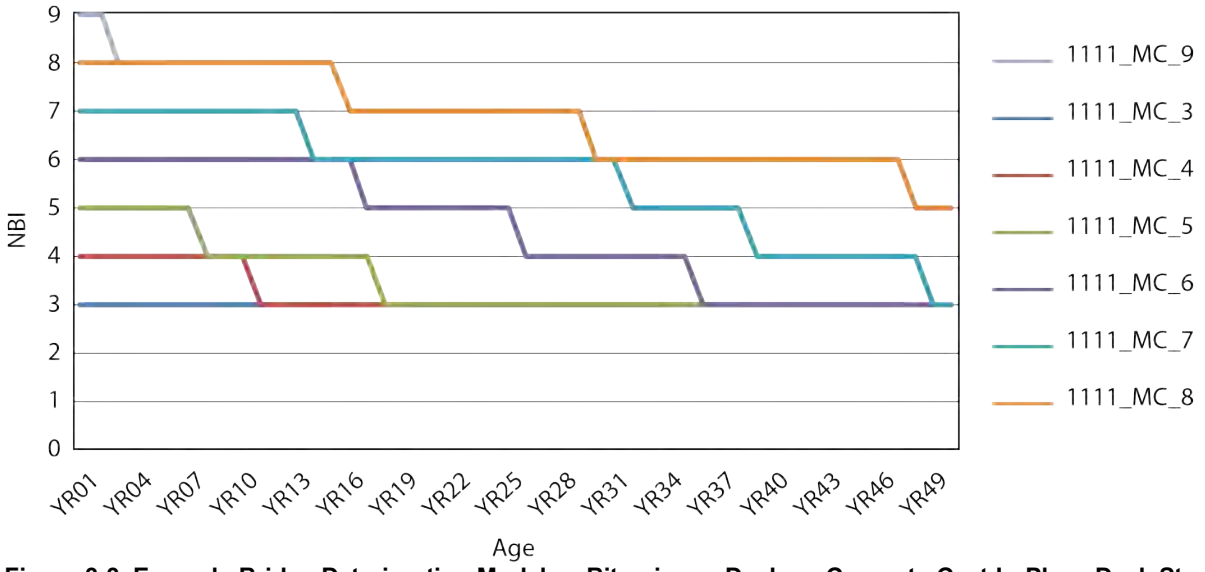


Figure 3-3. Example Bridge Deterioration Models – Bituminous Deck on Concrete Cast-In-Place Deck Structure

Work Types

Similar to the case for pavements, a number of bridge treatments were initially defined in dTIMS. However, the analysis performed for the TAMP was restricted to the three predominant treatments performed by ARDOT. These are as follows:

- **Polymer overlay** has the effect of maintaining the deck rating for approximately 12 years. This treatment costs approximately $7 per square foot of deck area (in 2017 dollars).
- **Rehabilitation** restores all ratings to a value of 8 and costs approximately $33 per square foot of deck area.
- **Bridge or culvert replacement** has the effect of restoring all bridge conditions to a value of 8. The cost of the treatment is approximately $120 to $180 per square foot of deck area. However, ARDOT explicitly calculates the replacement cost of each bridge considering the likely dimensions of a replacement bridge. The unit cost for the replacement depends upon the maximum span length and bridge length for the current bridge.

Strategy

The life cycle strategy for bridges is established in dTIMS by specifying when different treatments are feasible and what their effects are. The system then simulates selection of the set of treatments that will maximize conditions subject to the constraints. In addition, ARDOT specifically constrains the total percentage of work for each of the three treatments. These constraints have been set through analysis of a range of scenarios to maximize overall performance. The treatments' triggers and constraints are as follows:

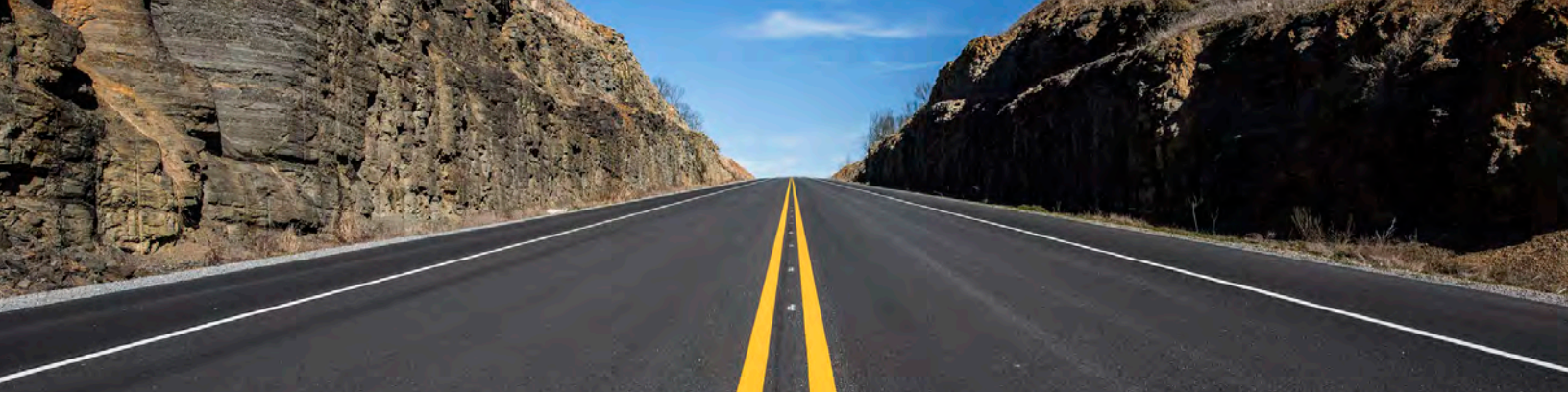
- **Polymer overlays** are feasible when all of the following are true:
  - NBI Deck rating is ≥ 7
  - There is no current overlay whose lifespan has not expired (12 years)
  - There is no current bituminous overlay
  - NBI Superstructure rating is ≥ 6
  - NBI Substructure rating is ≥ 5
  - It is not a timber structure
  - NBI item 43b (Design Type, Main) is not 22, 05, or 06
  - NBI item 108a (Deck Surface Type) is either 1, 2, 3, or 4
  - Nine percent of the total budget may be spent on overlays
- **Rehabilitation** is feasible when all of the following are true:
  - NBI Deck rating is 5 or 6
  - NBI Superstructure rating is ≥ 6
  - NBI Substructure rating is ≥ 5
  - It is not a timber structure
  - NBI item 43b (Design Type, Main) is not 22, 05, or 06
  - NBI item 108a (Deck Surface Type) is either 1, 2, 3, 4, 5, or 6
  - The bridge is more than 12 years old
  - Thirteen percent of the total budget may be spent on rehabilitation
- **Replacement** is feasible:
  - when the structure is a bridge and at least one of the following is true:

    - Bridge Condition Index ≤ 60
    - NBI rating ≤ 4
    - Timber structure
    - It is posted (for load or otherwise)
  - when the structure is a culvert and either of the following is true:
    - NBI Culvert rating ≤ 4, or
    - It is posted (for load or otherwise)
  - Seventy-eight percent of the total budget may be spent on replacement

Based on these criteria, the system typically recommends an overlay for decks with a rating of 6 and rehabilitation for bridges with a deck rating of 5 or greater to avoid triggering the need for a more costly replacement. This approach is consistent with a life cycle cost minimizing approach.

The above paragraphs describe the life cycle strategy as modeled in dTIMS. When determining what work to perform on a given bridge, ARDOT staff review the dTIMS recommendations and verify or change the recommendations based on the inspection report of each bridge. Staff may also visit each bridge to gain additional information prior to making a project recommendation. Through this process ARDOT may confirm the system recommendations or, based on the available information, identify a more effective strategy. Also, in determining preservation treatments, ARDOT staff considers a broader range of treatments than those modeled in dTIMS. The full set of treatments, their costs, and the circumstances under which they may be recommended are detailed in ARDOT's proposed agreement with FHWA for use of federal funds for bridge preservation, described further in Chapter 6.

This page is intentionally blank.



4. Performance Scenarios and Gap Assessment

Introduction

An important facet of asset management is projecting future asset conditions to help establish the appropriate allocation of existing funding, prioritization of improvements, and realistic expectations concerning future performance. Management systems allow an agency to define a performance scenario in which future conditions for a given asset class are projected, taking into account the effect of deterioration and scheduled investments along with potential future investments that are based on expected funding levels. The ingredients for developing such a scenario include information on the current asset inventory and its conditions, summarized in Chapter 2; the products of asset life cycle planning described in Chapter 3; and assumptions regarding potential future funding described in Chapter 6.

This chapter presents the results of a set of performance scenarios developed for the 10-year period from 2018 to 2027. These have been developed for pavements and bridges to predict future conditions given potential funding. This chapter also includes a gap assessment performed to identify the difference between current and projected asset conditions in achieving the desired state of good repair.

Federal Requirements

A requirement of the federal regulations for TAMPs in 23 CFR Part 515 is that States should establish a process for conducting a performance gap analysis. 23 CFR Part 515.5 defines performance gaps as "…gaps between the current asset condition and State DOT targets for asset condition, and the gaps in system performance effectiveness that are best addressed by improving the physical assets." 23 CFR Part 515.7 stipulates the purpose of the gap assessment is to "…identify deficiencies hindering progress toward improving or preserving the NHS and achieving and sustaining the desired state of good repair." It further stipulates that the process should address:

- State targets for asset conditions for NHS pavements and bridges based on performance management rule 23 CFR Part 490.
- Gaps in the performance of the NHS that affect NHS pavements and bridges regardless of their physical condition.
- Alternative strategies to close or address the identified gaps.

ARDOT performs the following steps as part of TAMP development to support compliance with the above requirements:

- Defining the desired state of good repair for NHS pavements and bridges
- Establishing existing conditions
- Simulating future conditions
- Comparing existing and projected future conditions to the desired state of good repair and the two- and four-year targets for NHS pavements and bridges established separately
- Calculating the one-time investment that would be required to close any gaps projected to occur between the targets and projected conditions, as well as between the desired state of good repair and projected conditions
- Incorporating the identification of strategies to address the gaps as part of the investment strategies development process discussed in Chapter 6

An important input to the gap assessment process is the setting of two- and four-year targets for NHS pavements and bridges established in accordance with 23 CFR Part 490. However, given that the deadline for initial development of these targets is after the submission date for this initial TAMP, the two- and four-year targets were undefined as of the time of TAMP development. These targets will be included in future gap assessments and detailed in future versions of this TAMP.

Analytical Approach

ARDOT uses dTIMS to support development of performance scenarios and assess performance gaps. dTIMS is a software decision support tool which performs modeling capabilities that can deliver future projections on infrastructure condition for an agency's transportation network based on information of definable funding scenarios. Key parameters used in the system are developed through the life cycle planning process described in Chapter 3. Both pavement and bridge analyses were performed for ARDOT owned assets only. The following sections further detail the approach used for pavements and bridges, respectively.

Pavements

For the pavement analysis, ARDOT performed runs for three different road systems: Interstates, Non-Interstate APHN, and Non-APHN. A separate budget was established for each of these systems, as detailed in Chapter 6. Scenarios were run at the expected budget level, as well as at other budgets above and below the expected levels. Budgets are specified in the system in current dollars, with an assumed annual inflation rate of two percent. The most recent dataset available as of November 2017 was used for the analysis.

As mentioned before, Non-Interstate NHS pavements are included in the Non-Interstate APHN system. For this Tamp, no particular constraint is placed on spending for the NHS versus other APHN pavements. Instead, the system simulates allocation of funds to achieve best results for the entire APHN. If needed, future TAMPs will include NHS specific evaluations.

For each run, dTIMS predicts what work will occur, as well as the conditions resulting from pavement deterioration and the simulated treatments. Results are expressed in terms of average PCI and the percentage

of pavement lane miles in each Condition Rating: A, B, C, D, and F. To further refine the results from dTIMS, a supplemental analysis is performed to calculate PCI, Pavement Condition Rating and the good, fair and poor condition for each 1/10-mile section.

Bridges

For the bridge analysis, runs were performed for all ARDOT owned bridges. Scenarios were run at the expected budget level, as well as at other budgets above and below the expected levels. Budgets are specified in the system in current dollars, with an assumed annual inflation rate of two percent. As noted in Chapter 3, the budget was specified by treatment type, with 78 percent of the budget reserved for replacements, 13 percent for rehabilitation, and 9 percent for deck treatments. As with pavements, no particular constraint is placed on spending for the NHS versus other bridges. Instead, the system simulates allocation of funds to achieve best results for the entire state owned inventory. If needed, future TAMPs will include NHS specific evaluations.

For each run, dTIMS predicts what work will occur, as well as the conditions resulting from bridge deterioration and the simulated treatments. Results are expressed in terms of percentage of bridges in good, fair, and poor condition, by deck area, as well as average Bridge Condition Index, a measure used internally to the system to combine the different condition ratings for a bridge. For bridges, in contrast to the case of pavements, dTIMS directly predicts the good, fair and poor rating as required by FHWA.

As noted previously, the desired state of good repair for NHS bridges is to maintain current conditions in terms of the percent of bridges classified as being in poor condition. As detailed in Chapter 2, for NHS bridges, 96 percent of the inventory is in good or fair condition, while 4 percent is in poor condition.

Scenario Results

Pavements

Figures 4-1 to 4-6 show predicted conditions for pavements. Each graph shows the distribution of lane miles by Pavement Condition Rating for each year of the analysis. Time is depicted on the horizontal axis and the percentage of lane miles in each Pavement Condition Rating is shown on the vertical axis. Values for 2018 to 2027 are predicted based on current level of funding discussed in Chapter 6.

The figures below include:

- Figure 4-1, **Predicted Pavement Conditions – All Pavements**
- Figure 4-2, **Predicted Pavement Conditions – APHN**
- Figure 4-3, **Predicted Pavement Conditions – Interstates**
- Figure 4-4, **Predicted Pavement Conditions – Non-Interstate APHN**
- Figure 4-5, **Predicted Pavement Conditions – Non-Interstate NHS**
- Figure 4-6, **Predicted Pavement Conditions – Non-APHN**

Figure 4-1, Predicted Pavement Conditions – All Pavements, points out that currently there is not adequate funding available to maintain the entire State Highway System in a state of good repair. In 2027, it is projected that 66% of the system will be in poor condition.

Figure 4-2, Predicted Pavement Conditions – APHN, shows that the condition of some of the APHN will improve over the 10-year period. It also shows that more of the APHN will reach a poor condition by 2027. It is important to remember that this portion of the State Highway System carries more than 90% of all travel in the State.

Figure 4-3, Predicted Pavement Conditions – Interstates, shows that the condition of the Interstates will continue to improve over the 10-year period. This graph also points out the benefit of the Interstate Rehabilitation Program to the condition of the Interstate System in Arkansas.

Figure 4-4, Predicted Pavement Conditions – Non-Interstate APHN, shows that, due to inadequate funding levels, the majority of Non-Interstate APHN pavements in fair condition decline into poor condition while there is some increase in the percentage of pavements in good condition over the 10-year period.

Figure 4-5, Predicted Pavement Conditions – Non-Interstate NHS, shows that the condition of some of the Non-Interstate NHS will improve over the 10-year period. However, it also shows that more of the Non-Interstate NHS will reach a poor condition by 2027. This is due to an inadequate level of available funding.

Figure 4-6, Predicted Pavement Conditions – Non-APHN, shows that the condition of the Non-APHN will worsen significantly over the 10-year period. It is predicted that 94% of the Non-APHN will be rated as poor in 2027 if there is not a significant increase over the current level of funding.

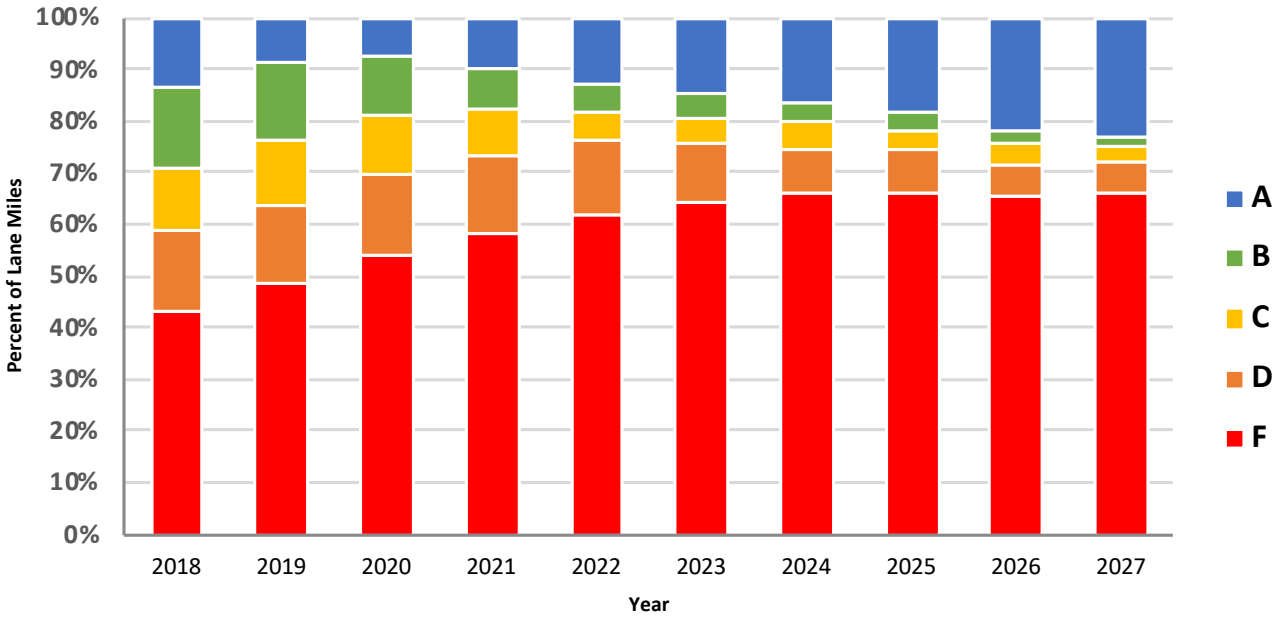


Figure 4-1. Predicted Pavement Conditions – All Pavements

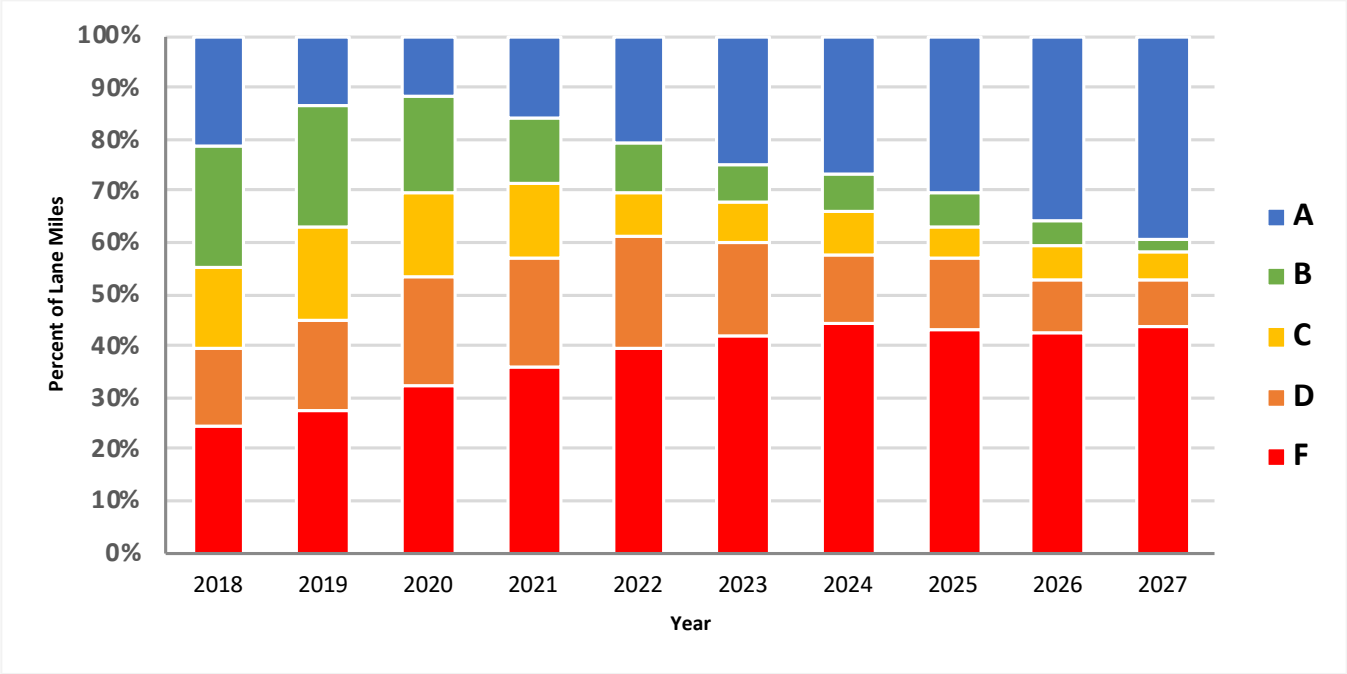


Figure 4-2. Predicted Pavement Conditions – APHN

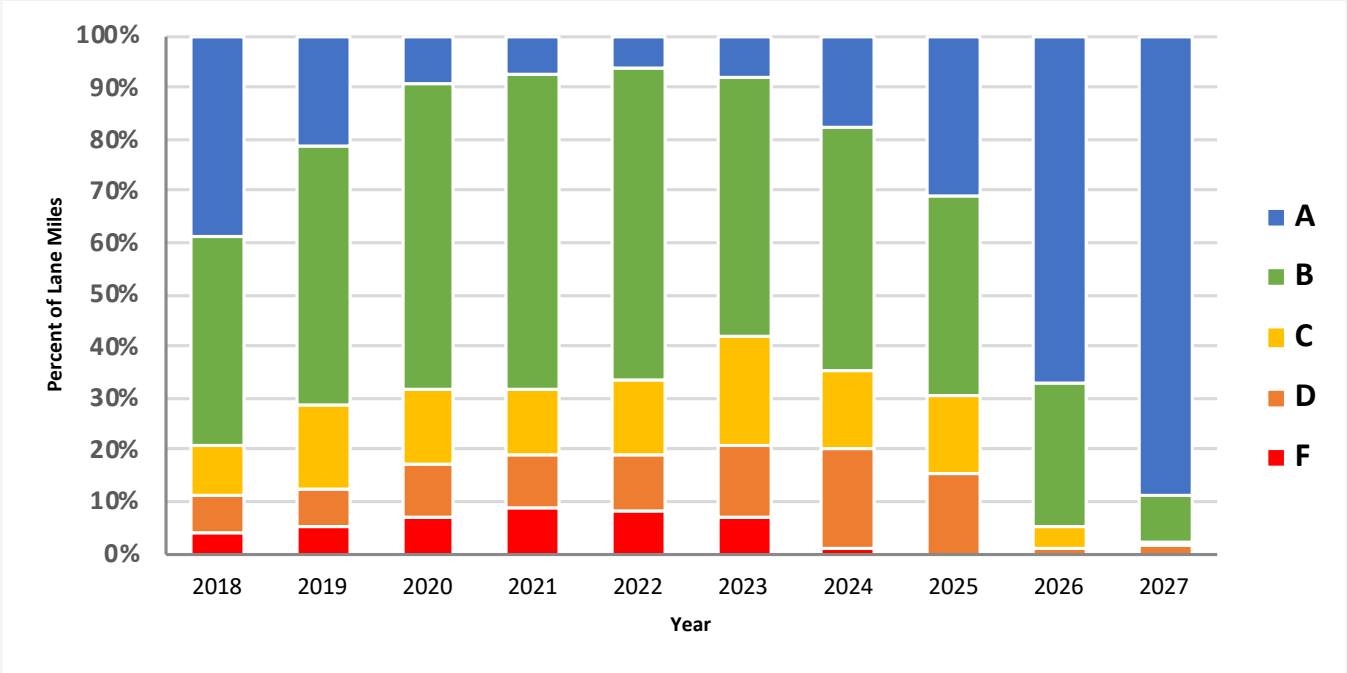


Figure 4-3. Predicted Pavement Conditions – Interstates

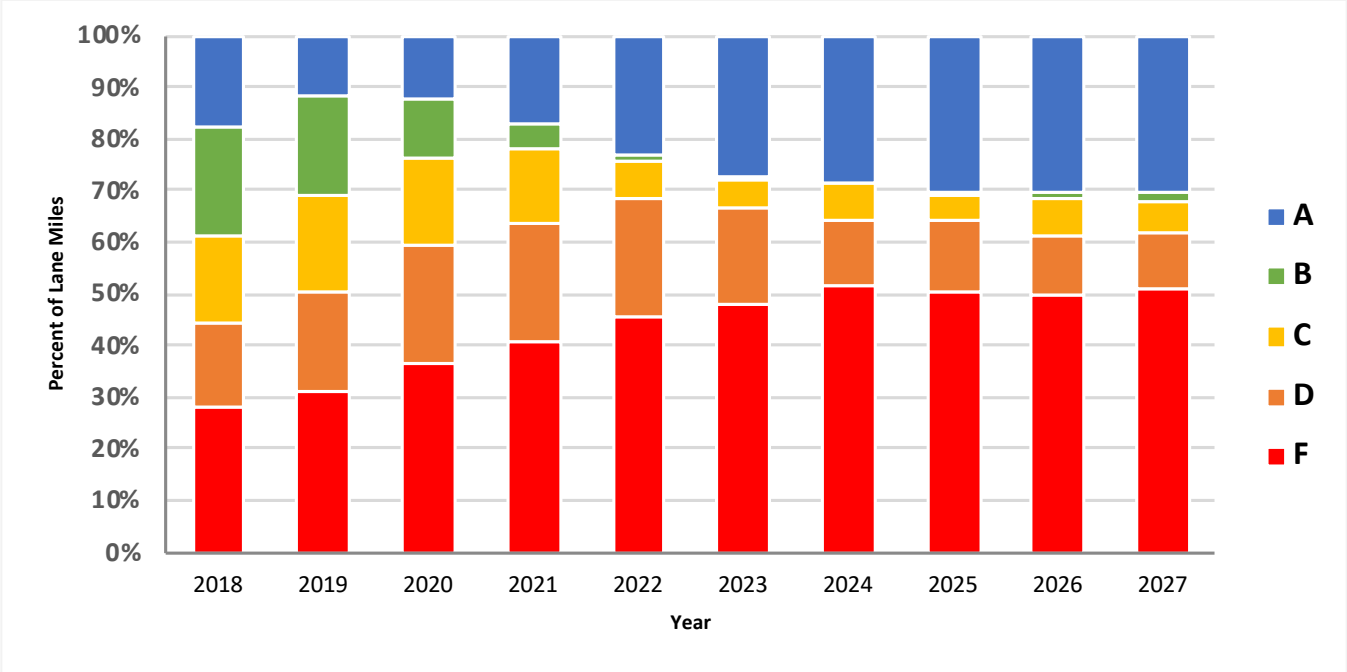


Figure 4-4. Predicted Pavement Conditions – Non-Interstate APHN

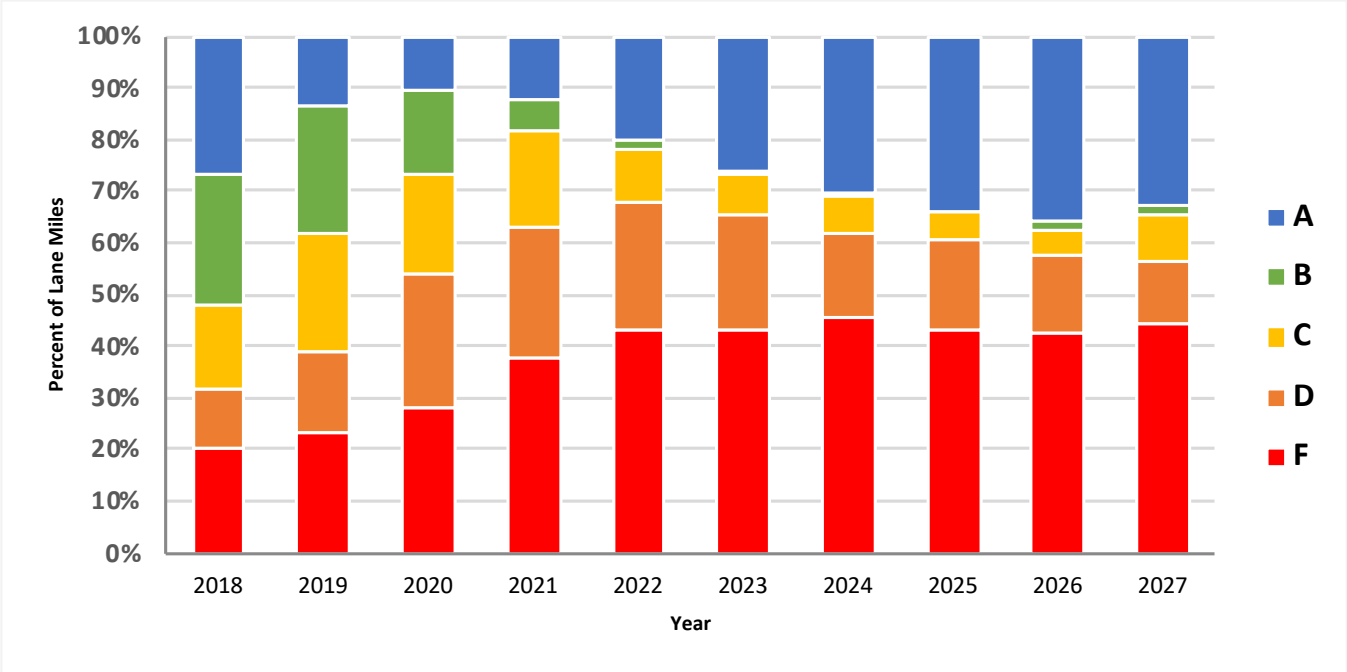


Figure 4-5. Predicted Pavement Conditions – Non-Interstate NHS

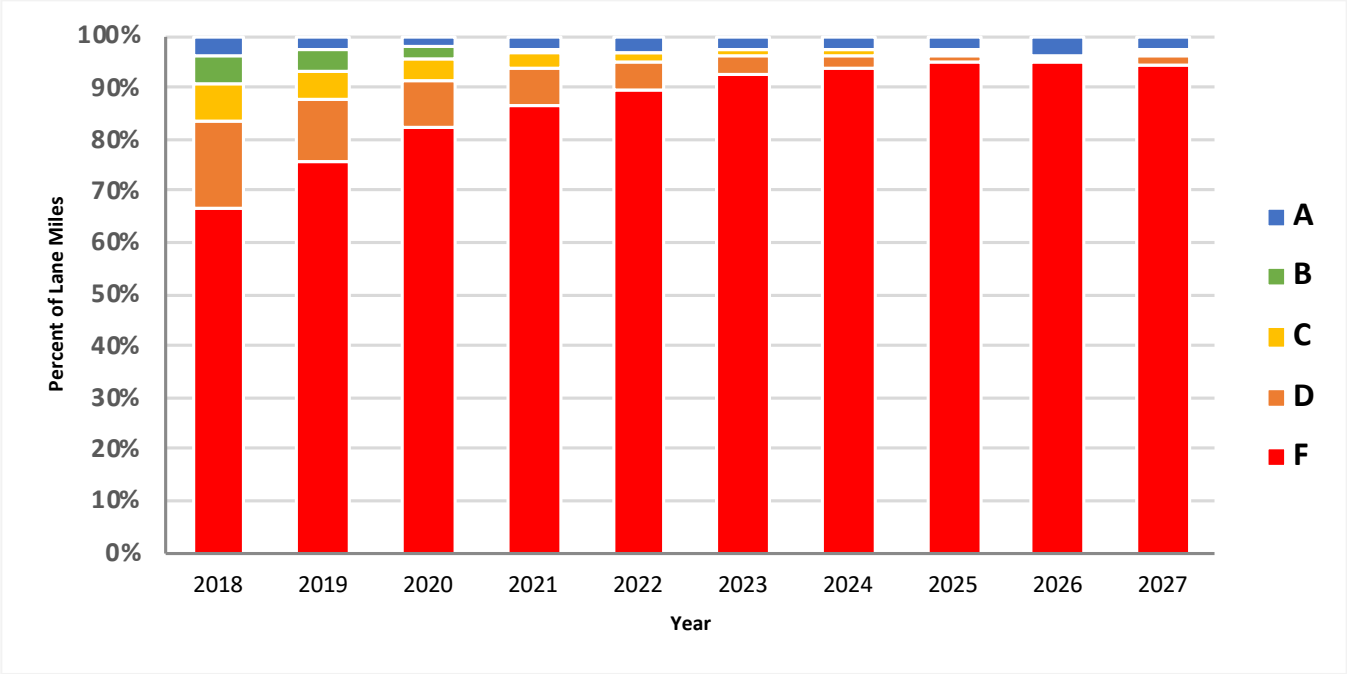


Figure 4-6. Predicted Pavement Conditions – Non-APHN

Table 4-1 summarizes the predicted conditions in 2027 based upon the current level of funding. The table shows the percentage of each system predicted for each Pavement Condition Rating, quantifying the values shown for the final bar in Figures 4-1 to 4-6. Table 4-2 shows predicted good, fair and poor conditions according to FHWA guidance.

Table 4-1. Predicted ARDOT Pavement Condition Level by System in 2027

	2027 ARDOT Condition Rating				
System	A	B	C	D	F
Total	23%	2%	3%	6%	66%
APHN Total	39%	3%	6%	9%	43%
Interstate	89%	9%	1%	1%	0%
Non-Interstate APHN	31%	1%	6%	11%	51%
Non-Interstate NHS	33%	2%	9%	12%	44%
Non-APHN	3%	0%	1%	2%	94%

Table 4-2. Predicted FHWA Good/Fair/Poor Conditions for NHS Pavement in 2027

	2027 FHWA Condition Rating		
System	**Good**	**Fair**	**Poor**
Interstate	**66%**	**33%**	**1%**
Non-Interstate NHS	**22%**	**74%**	**4%**

Bridges

Figures 4-7 and 4-8 show predicted conditions for bridges. Each graph shows the distribution of good, fair, and poor deck area for each year of the analysis. Time is depicted on the horizontal axis and the percentage of deck area in each category is shown on the vertical axis. The predicted values shown in the graphs are based on the current level of funding discussed in Chapter 6.

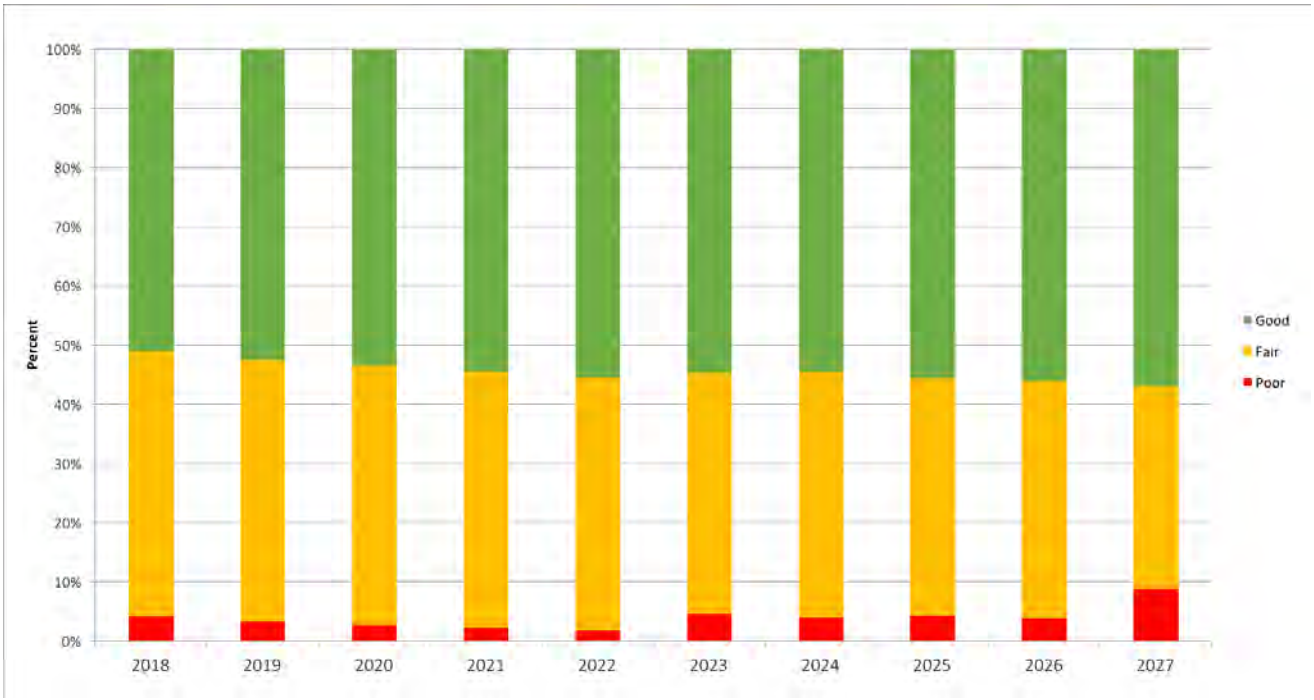


Figure 4-7. Predicted Bridge Conditions – All Bridges

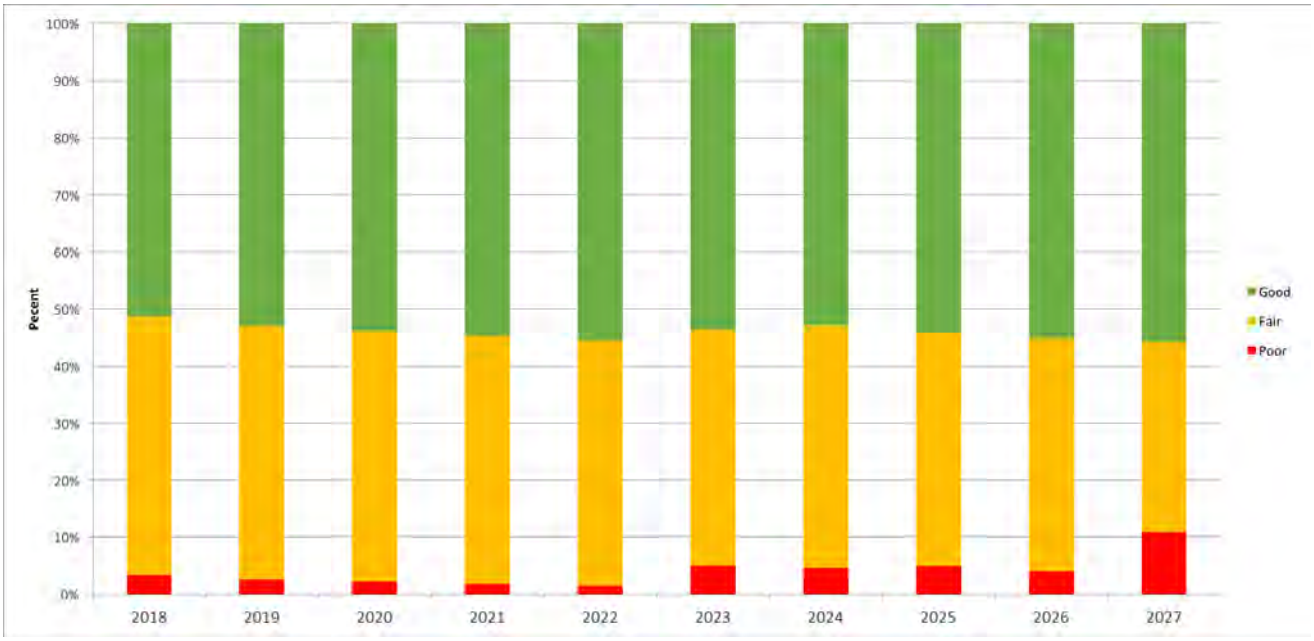


Figure 4-8. Predicted Bridge Conditions - NHS

As indicated in the figures, bridge conditions are projected to worsen over time, with the percentage of bridges in poor condition generally held constant or declining until this value increases in 2027. As of 2027, 55.8 percent of bridges on the NHS are projected to be in good condition, 33.2 percent are projected to be in fair condition, and the remaining 11 percent are projected to be in poor condition.

Gap Assessment

Tables 4-3 to 4-5 detail the gap assessment performed for NHS pavements and bridges.

Table 4-3 shows the gap assessment for NHS pavements based on pavement condition. ARDOT's desired state of good repair for NHS pavements is to maintain these with a Pavement Condition Rating of A or B. For Interstates, approximately 77 percent of the system is currently maintained with a Pavement Condition Rating of A or B. Based on current funding levels, this figure is expected to rise to approximately 97 percent by 2027. In the future, only 3 percent of lane miles are estimated to fall below this threshold.

For Non-Interstate NHS pavements, only 44 percent of the system is currently maintained in the desired state of good repair, and this figure is expected to drop to 35 percent by 2027 based on expected funding. Currently 56 percent of Non-Interstate NHS lane miles fail to meet the desired state of good repair, and in the future 65 percent of lane miles are projected to fall below this threshold.

Table 4-3. Gap Assessment for NHS Pavement Assets Based on Condition Rating

	Condition Rating		
	A-B	C-F	Gap
Interstate			
Desired State of Good Repair	100%	0%	N/A
Current Performance	77%	23%	23%
10-Year Projected Performance	97%	3%	3%
Non-Interstate NHS			
Desired State of Good Repair	100%	0%	N/A
Current Performance	44%	56%	56%
10-Year Projected Performance	35%	65%	65%

Table 4-4 presents the results of the NHS pavement gap assessment using the FHWA good, fair and poor measure. Based on this measure the projected gap in 2027 is 1 percent of lane miles for Interstates and 4 percent of lane miles for the Non-Interstate NHS. However, these figures are misleading, as a large percentage of ARDOT pavements are forecasted as being in fair condition even when the Condition Rating is C or worse, which is outside of ARDOT's definition of the desired state of good repair.

Table 4-5 shows the gap assessment for NHS bridges based on the FHWA good, fair and poor measure. ARDOT's desired state of good repair for NHS bridges is to maintain the percentage of bridges in poor condition at or below the current value of 4 percent. Given this definition, there is no gap between the desired state of good repair and current conditions. However, the percentage in poor condition is expected to rise to 11 percent in 2027, creating a 7 percent gap equivalent for bridges (by deck area).

Table 4-4. Gap Assessment for NHS Pavement Assets Based on the FHWA Good/Fair/Poor Measure

	Good	Fair	Poor	Gap
Interstate				
Desired State of Good Repair	100%		0%	N/A
Current Performance	8%	91%	1%	1%
10-Year Projected Performance	66%	33%	1%	1%
Non-Interstate NHS				
Desired State of Good Repair	100%		0%	N/A
Current Performance	6%	93%	1%	1%
10-Year Projected Performance	22%	74%	4%	4%

Table 4-5. Gap Assessment for NHS Bridges Based on the FHWA Good/Fair/Poor Measure

	Good	Fair	Poor	Gap
Desired State of Good Repair	96%		4%	N/A
Current Performance	49%	47%	4%	0%
10-Year Projected Performance	56%	33%	11%	7%

Recently ARDOT completed a detailed study on the gap between current funding and funding needed to achieve the desired state of good repair. In September 2017 ARDOT published the report *Arkansas State Highway 2016 Needs Study – Draft*. This report incorporates the Arkansas Legislative Audit report discussed previously titled *Review of Sources and Uses of Funds: Arkansas Department of Transportation for the Period July 1, 2009 through June 30, 2016 and Projected for Fiscal Years 2017 through 2020*. The Needs Study concludes that over the next 10 years system preservation needs for ARDOT owned roads total $9.25 billion. This figure includes $5.04 billion for system preservation for pavements and bridges. The Legislative Audit report further details that an additional $277 million would be required per year, equal to $2.77 billion over 10 years, to meet pavement and bridge system preservation needs for the entire State Highway System.

The projections shown here reflect ARDOT's best estimate of NHS pavement and bridge performance given expected funding. Nonetheless, ARDOT seeks to reduce the projected gaps where possible. Chapter 6 includes a discussion of ARDOT's investment strategies for addressing these gaps.

This page is intentionally blank.

5. Risk Management

Introduction

Transportation agencies often must spend significant resources responding to and/or mitigating unforeseen events. These include, but are not limited to, damage to the transportation system from natural disasters and other events; unexpected changes in available funding that impact capital plans; and defects in designs, materials, or construction that require further investment to address.

Where it is possible to anticipate upcoming needs and potential events, it is important to consider these in future plans, both to improve the accuracy of those plans, and, where possible, reduce costs to ARDOT and the public. The process of identifying and responding to these issues is termed risk management. Risk management strengthens asset management by identifying strategies to either reduce uncertainty or manage its effects. Being proactive rather than reactive in managing risk, and avoiding management by crisis, helps an agency to best use available resources, builds public trust, and reduces risk. Many of the activities ARDOT undertakes on a daily basis, such as inspecting bridges, testing materials, and overseeing project schedules, were first instituted to help reduce or mitigate risk.

This section describes the federal requirements pertaining to risk management in TAM, as well as ARDOT's risk management process and asset risk mitigation plan. Additionally, this section summarizes an assessment of NHS pavements and bridges repeatedly damaged by emergency events, consistent with federal requirements.

Federal Requirements

Requirements for consideration of risk in a TAMP are detailed in 23 CFR Part 515. This section of the federal regulations defines risk as "the positive or negative effects of uncertainty or variability upon agency objectives" (23 CFR Part 515.5).

The regulations further define risk management as "the processes and framework for managing potential risks, including identifying, analyzing, evaluating, and addressing the risks to assets and system performance" (23 CFR Part 515.5).

Based on the regulations, a state TAMP should include a description of its risk management process. The process should include the following:

- Identification of risks that can impact the condition and performance of NHS pavements and bridges
- Assessment of the identified risks in terms of the likelihood of their occurrence and their impact and consequence if they do occur
- Evaluation and prioritization of the identified risks
- Mitigation plan for addressing the top priority risks
- Approach for monitoring the top priority risks
- Summary of the evaluation of NHS pavements and bridges repeatedly damaged by emergency events

Generally, the risk management process required by the regulations follows the idealized process described in International Standards Organization (ISO) Standard 31000 and in the literature, as depicted in Figure 5-1 below.

Source: adapted from the Contractor's Final Report for NCHRP Project 20-24(74), 2011.

Figure 5-1. Risk Management Process

While describing an overall process consistent with that outlined in the figure, the regulations include specific provisions regarding risk identification and evaluation of facilities repeatedly damaged by emergency events. The regulations provide examples of risks that should be identified, including: current and future environmental conditions, such as extreme weather events, seismic activity, and risks related to recurring damage from emergency events; financial risks such as budget uncertainty; operational risks such as asset failure; and strategic risks such as environmental compliance.

The requirements for evaluation of facilities repeatedly damaged by emergency events are described in a separate section of the federal regulations, 23 CFR Part 667. This section requires each state to perform an evaluation of roads, highways, and bridges damaged repeatedly through emergency events since January 1, 1997. An "emergency event" is defined as "…a natural disaster or catastrophic failure resulting in an

emergency declared by the Governor of the State or an emergency or disaster declared by the President of the United States." The evaluation should be performed on a statewide basis, and a summary of the evaluation for NHS roads and bridges should be included in the TAMP.

Risk Management Process and Assessment

Existing Controls

ARDOT staff continually manage a wide variety of transportation-related risks, using both formal and informal risk management approaches. ARDOT's formal controls for mitigating risk are captured in the agency's manuals, guidelines, and specifications available on the ARDOT web site (www.ArDOT.gov). These incorporate approaches for mitigating known risks in the following areas:

- **Design/Specifications:** The documents *Geometric Design Criteria for Non-freeway Resurfacing, Restoration and Rehabilitation Projects, Roadway Design Drainage Manual, List of Frequently Used Standard Bridge Drawings*, *Roadway Design Plan Development Guidelines, Arkansas 2014 Standard Specification for Highway Construction*, and others provide guidance for road and bridge design reflecting best practices and additional guidance on specific design issues, such as bridge design details and guidance for culvert selection.
- **Design-Build Project Risks:** The manual *Design-Build Guidelines and Procedures* helps mitigate project-level risk by detailing the design-build process and clarifying the allocation of risk for these projects.
- **Bridges:** Routine bridge inspections help to manage bridge risks. The manual *Local Government Procedure for Compliance with the National Bridge Inspection Standards* provides guidance for local agencies in performing bridge inspections. The "*Bridge Scour Plan of Action"* form is used to detail scour events and mitigate risks related to bridge scour. The *ARDOT Earthquake Response Plan* itemizes the mitigation, preparation, and response plans in anticipation of a catastrophic earthquake.
- **Storm Water:** The documents *2016 Erosion and Sediment Control Design and Construction Manual* and *Statewide Storm Water Management Program* specify best practices for storm water pollution prevention and plan development in design, construction and maintenance.
- **Materials:** The *Manual of Field Sampling and Testing Procedures* catalogs best practices for controlling materials quality.

In addition to developing and maintaining these resources, ARDOT has worked to reduce risk through a number of other initiatives, including:

- **Project risk management:** ARDOT uses the AASHTO SiteManager system to help manage its construction projects and minimize risks of cost and schedule overruns.
- **Consideration of seismic risk in bridge design and inspection:** the northern portion of the state lies in the vicinity of the New Madrid fault and is subject to seismic risk. ARDOT addresses seismic risk in the design process as existing bridges are reconstructed or replaced. In addition, ARDOT is developing a plan for performing special inspections in response to seismic activity.
- **Improved winter maintenance:** in recent years there have been multiple winter storms that have challenged ARDOT's resources for snow and ice removal, and consequently created significant, albeit short-term, safety and mobility impacts. To meet winter maintenance needs, ARDOT has established winter weather stockpiles (salt, sand, and de-icing chemicals) in protected shelters around the state, and

has pre-staged snow removal equipment in strategic locations. ARDOT has recently expanded its inventory of snow removal equipment and added GPS and live cameras to this equipment for tracking and observation. ARDOT has developed a plan to distribute resources in advance of and in response to severe weather events, and has developed revised policies related to personnel assignments, chains of command, and equipment usage outside their normal operating areas.

- **Analysis of funding scenarios:** ARDOT routinely analyzes impacts of potential changes in funding and transportation-related policies that may impact needs or available funds. This information is provided to ARDOT managers, state legislators and other stakeholders to help inform their decision-making. The subsection on mitigation actions discusses ongoing and future analyses of different funding levels needed to help address impacts of changes in funding.
- **Auditing:** ARDOT performs and is subject to a number of types of audits. These help reduce risk through verifying that established rules, regulations, policies, and procedures are followed. For example, ARDOT conducts desk audits of its planning contracts and railroad agreements. ARDOT also has an internal audit division that conducts audits of individual business units. Furthermore, the Arkansas Legislative Audit periodically audits ARDOT (most recently in August 2017).

Risk Register Development

To address the requirements for consideration of risk in developing its TAMP, ARDOT supplemented its pre-existing processes through development of a risk register. The initial version of the register was developed through the ARDOT TAMP Risk Management Workshop conducted on December 14, 2017. Participants in the workshop included staff from ARDOT, Metropolitan Planning Organizations (MPOs) from across the State, and FHWA.

The risk register identifies risks in seven categories. These categories are illustrated in Figure 5-2 and are defined in Table 5-1. Through the Risk Management Workshop, ARDOT identified a total of 36 risks, classifying them into these categories. Subsequently, workshop participants performed a qualitative assessment of each risk, using expert judgment to assess the likelihood of each one occurring and the impact or consequence of each one if it were to occur. Figure 5-3 shows the approach used for classifying risks in terms of likelihood and impact, and the resulting initial priority established based on these values.

Figure 5-2. Risk Categories

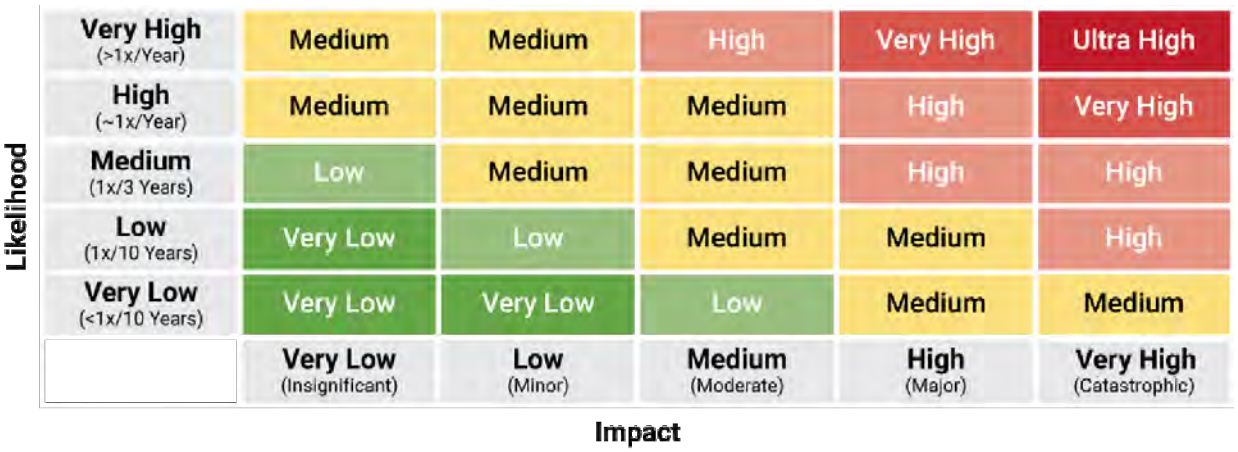


Figure 5-3. Categorization of Risk Likelihood and Impact (Consequence)

Table 5-1. Risk Category Definitions and Examples

Risk Category	Description	Elements of Risk Management
Asset Performance	Risks associated with asset failure, which can include: • Structural • Capacity or Utilization • Reliability or Performance • Obsolescence • Maintenance or Operation	• Consistently perform and document inspection programs • Allocate funding for repair and maintenance • Evaluate competing resource demands • Establish intervention levels • Prioritize actions and document processes
Highway Safety	Risks to highway safety related to the asset management program: • Highway crash rates, factors, and countermeasures • Safety performance of assets, maintenance, and rehabilitation treatment options • Safety in project selection, coordination, and delivery	• Safety focused asset management programs • Network screening for consideration of safety hotspots within asset maintenance and rehabilitation • Consideration of safety benefits/costs in asset management decision making • Incorporating consideration of potential safety improvements in developing projects
External Threats	External threats include both human-induced and naturally occurring threats, such as: • Extreme weather • Seismic events • Terrorism or accidents • Paradigm shifting technologies	• Incorporate potential impacts of environmental conditions and new technologies into long term planning • Identify and inventory external risks to existing infrastructure • Infrastructure inspection, replacement or retrofit programs to mitigate risks • Operational and emergency response programs • Processes to incorporate resiliency into design standards
Finances	Risks to the long term financial stability of the asset management programs, including: • Unmet needs in long-term budgets • Funding stability • Exposure to financial losses	• Projection of available funds for asset management programs • Analysis of factors that may impact funding levels • Continued communications at the Federal and State levels regarding need for adequate funding

Risk Category	Description	Elements of Risk Management
Information and Decision Making	Risks related to the asset management program include: • Lack of critical asset information • Quality of data, modeling or forecasting tools for decision making • Security of information systems	• Enterprise data management programs and strategies • Robust information technology solutions emphasizing risk prevention, preparedness and recovery • Programs to address model risks (e.g. premature failure of pavement due to underestimation of truck loading)
Business Operations	Risks due to internal business functions associated with asset management programs, such as: • Employee safety and health • Inventory control • Purchasing and contracting	• "Safety first" culture within asset management programs – routine safety meetings, documented safety and standard operating procedures, workforce training, etc. • Robust systems and tools for work force, equipment, inventory, and contract management to reduce risks of theft, misuse, unnecessary storage or inaccurate estimates of program costs
Project and Program Management	Project and program management is a very mature area in U.S. transportation sector	• Many programs and products exist here – extensive discussion of these risks and related programs, policy and procedure is likely not necessary

Of the 36 initial risks identified through the Risk Management Workshop, 14 were assessed as a high or very high priority. These risks are listed in Table 5-2. The table has a short description of each risk, a risk statement describing what will occur if the risk is realized, the likelihood and impact of the risk, and the initial priority established based on Figure 5-3.

The initial priorities listed in Table 5-2 were used to determine which risks to evaluate further to determine potential mitigation actions. Potential mitigation actions were formulated for all of the risks listed in Table 5-2. Each action was then classified in terms of its priority using the following criteria:

- An action was classified as being of high priority if it is recommended, even if it requires additional staff time or investment to implement.
- An action was classified as being of medium priority if it is recommended to the extent it can be performed given existing resources.
- An action was classified as being of low priority if it is not recommended for further implementation, at this time, considering available resources and competing priorities.

Table 5-3 lists the potential mitigation actions defined through this process, describing the action, the risks in Table 5-2 it would help mitigate, and action priority. As indicated in the table, six high priority potential mitigations actions are identified, in addition to three medium priority actions and three low priority actions.

Note the priorities indicated in Tables 5-2 and 5-3 are the product of an initial assessment of potential asset management-related risks and mitigation actions established through expert judgment by a cross section of ARDOT staff and other NHS stakeholders. These priorities are provided to help document ARDOT's risk management process and are not a statement of agency policy.

Table 5-2. High Priority Asset Management-Related Risks

ID	Category	Description	Risk Statement	Likelihood	Impact	Risk Priority
1	Asset Performance	Truck Volumes/ Weights	If truck traffic and/or weights increase at a greater rate than anticipated, this may cause accelerated pavement and bridge deterioration.	High	Very High	Very High
2	Asset Performance	Materials Quality (pertains to ASR and asphalt)	If the materials used on projects are not of sufficient quality then lifecycle costs may increase and performance targets may not be achieved.	Very High	High	Very High
3	External Threats	Earthquakes	If there is an earthquake, the resulting damage to roads and bridges may require diversion of funds.	Low	Very High	High
4	Finances	Funding Uncertainty	Uncertainty of future funds compromise decisions concerning the prioritization of work.	High	High	High
5	Finances	Increased Fuel Efficiency	Improvements in fuel efficiency may reduce available funds in the future.	Very High	Medium	High
6	Finances	Inability to Match Federal Funds	If sufficient state matching funds are not available then some federal funding may not be available.	High	Very High	Very High
7	Information and Decisions	Performance Models	If we do not have reliable asset performance models then we may not correctly predict future conditions and needs.	High	High	High
8	Information and Decisions	Quality of Asset Condition Data	If we have incomplete or poor quality data on asset condition we may not correctly predict future conditions and needed work.	Medium	High	High
9	Information and Decisions	Data on an Asset Over Its Lifecycle	If we lack data on assets over their life cycle we may not correctly predict future conditions and needed work.	Medium	High	High
10	Business Operations	Knowledge Transfer	If we lack appropriate knowledge management and succession planning, then future staff may not have sufficient knowledge to perform needed work.	High	High	High
11	Business Operations	Lack of Maintenance Staff	If we lack experienced maintenance staff we may not be able to perform needed work.	Medium	High	High
12	Business Operations	Lack of Engineering Staff	If we lack experienced engineering staff we may not be able to perform needed work.	High	High	High
13	Business Operations	Lack of Construction Inspection Staff	If we lack capable construction inspection staff, then the quality of work accepted may be substandard.	High	Very High	Very High
14	Business Operations	Poor Quality Construction Work	If the work performed on construction projects is not of good quality, then the desired results may not be achieved.	High	Very High	Very High

Table 5-3. Potential Mitigation Actions for Asset Management-Related Risks

ID	Description	Addresses Risk(s)	Action Priority
A	Educate legislators regarding concerns related to impacts of potential changes in truck size/weights limits and special permits.	1	Medium
B	Explore the use of warranty specifications for improving materials quality.	2	Medium
C	Target selected bridges for replacement to mitigate seismic risk (e.g., critical bridges to sustain mobility along identified corridors).	3	Low
D	Work at the Federal and State levels to help resolve challenges related to funding for transportation.	4, 6	High
E	Evaluate the potential for a VMT and/or alternative fuels tax.	5	Low
F	Improve the tracking of what treatments are performed on roads and bridges.	7, 8, 9	High
G	Explore the potential for improving the quality of asset condition data, such as through increased use of non-destructive evaluation.	7, 8, 9	High
H	Articulate the budget needed for pavement data collection and establish a dedicated budget for this function.	7, 8, 9	High
I	Develop targeted retirement incentives to help facilitate the process of knowledge transfer (through allowing better planning around the timing of bringing in new staff to supplement or replace experienced staff).	10, 13, 14	Low
J	Increase the use of part-time employment to help retain experienced staff members who need employment flexibility.	10, 11, 12, 13, 14	High
K	Improve staff training to build needed skills within ARDOT.	10, 11, 12, 13, 14	High
L	Work with Human Resource to define employment incentives that can help staff key roles.	10, 11, 12, 13, 14	Medium

Risk Mitigation

Mitigation Plan

Following the development of the risk register as described above, ARDOT prepared a mitigation plan to implement risk mitigation actions that were determined by ARDOT to be most feasible and effective for mitigating ARDOT's high priority asset management-related risks. Table 5-4 summarizes the resulting TAMP risk mitigation plan.

Table 5-4. Risk Mitigation Plan

Action	Owner	Completion Date	Initial Activities
Provide information to ARDOT management and stakeholders regarding potential funding scenarios and challenges	Asset Management Steering Committee and member Divisions	2019	• Define alternative scenarios for analysis, including scenarios with reduced funding • Analyze scenarios in which additional needs are generated through increased truck size/weights • Perform analysis of future pavement and bridge conditions, and funding gap for each scenario • Prepare analysis summary for review by ARDOT management and stakeholders • Determine needed follow-up activities in consultation with ARDOT management
Implement maintenance management system for improved tracking of maintenance actions	Maintenance Division	2019	• Evaluate available Maintenance Management Systems with a focus on compatibility with other business management systems
Explore potential for improving the quality of asset condition data, such as through increased use of non-destructive evaluation	System Information & Research and Materials Divisions	2019	• Develop methodology to utilize Ground Penetrating Radar for collecting and evaluating asset condition data • Evaluate alternative methods and technology for use in non-destructive evaluation
Establish future pavement data collection budget requirements	System Information & Research Division	2018	• Develop a business plan for pavement data collection activities with an initial focus on an automated pavement data collection vehicle and support staff
Review ARDOT employment practices to help recruit and retain needed staff	Human Resources Division	2020	• Evaluate the performance of the recently implemented Achieving Career Excellence (ACE) Program on employee retention, training, and recruitment

Risk Monitoring

The risk mitigation plan summarized above is intended to be a living document. Moving forward ARDOT will maintain the plan, adding additional actions as conditions change and other actions are completed. Responsibility for monitoring the plan will lie with the Asset Management Steering Committee. This ad-hoc committee is chaired by the Division Head of the System Information & Research Division and includes staff from the System Information & Research Division, the Transportation Planning & Policy Division, the Bridge Division, the Maintenance Division, the Computer Services Division, the Program Management Division, and the FHWA – Arkansas Division.

The Steering Committee's approach for asset-management related risks is as follows:

- The Steering Committee will maintain an electronic version of the mitigation plan on ARDOT's intranet that will be accessible by ARDOT and FHWA staff
- The Steering Committee will meet as needed to review the plan for what actions have been performed to mitigate top priority risks, what actions are planned, and what additional actions should be added to the mitigation plan
- On an annual basis, the Steering Committee will convene a workshop to review the risk register and mitigation plan, and re-evaluate according to ARDOT's asset management risk mitigation strategy

Summary of Transportation Assets Repeatedly Damaged by Emergency Events

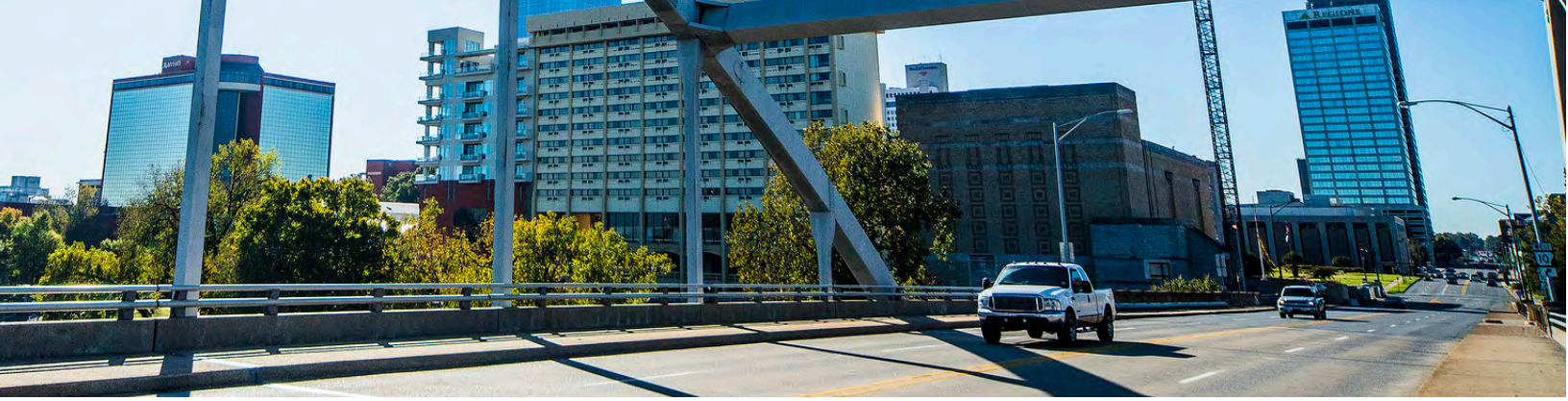
As noted above, FHWA requires state DOTs to perform periodic evaluation of facilities repeatedly requiring repair and reconstruction due to emergency events. The analysis should identify alternatives that will mitigate or resolve the root cause of the recurring damage, the costs of achieving the solution, and the likely duration of the solution.

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

- Reduce the need for Federal funds to be expended on emergency repair and reconstruction activities
- Better protect public safety and health and the human and natural environment
- Meet transportation needs as described in the relevant and applicable Federal, State, local, and tribal plans and programs

While the evaluation described above is separate from the TAMP, FHWA further requires that a summary of the evaluations for NHS bridges and pavements be included in this TAMP as part of the risk management process.

However, a review of available data did not identify any NHS pavement or bridge assets that required repeated repair or reconstruction due to an emergency event.



6. Financial Plan and Investment Strategies

Introduction

Developing an asset management financial plan is important for identifying the resources needed to invest in preserving and improving asset conditions. This chapter details ARDOT's TAM financial plan and describes the investment strategies ARDOT is using to make progress toward achieving its goals and objectives. The financial plan describes funding sources and uses for asset management over the next 10 years (Federal Fiscal Years 2018 to 2027) and includes an estimate of projected funding sources that can be used for asset management and the planned uses of those funds. The financial plan also includes an estimated valuation of bridge and pavement assets and is accompanied by a description of ARDOT's specific investment strategies.

Federal Requirements

In the context of TAM, the term "financial plan" is defined in 23 CFR Part 515.5 to mean "…a long-term plan spanning 10 years or longer, presenting a State DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets for asset condition during the plan period, and highlighting how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies." Further, an investment strategy is defined as "…a set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks."

In 23 CFR 515.7, states are required, as part of the development of their TAMPs, to establish processes for developing a financial plan and investment strategies. The regulations require the financial plan to include:

- Estimated cost of expected future work to implement investment strategies contained in the asset management plan, by fiscal year and work type
- Estimated funding levels expected to be reasonably available, by fiscal year, to address the costs of future work types
- Identification of anticipated funding sources
- Estimate of the value of the agency's NHS pavement and bridge assets and the needed investment on an annual basis to maintain the value of these assets

Regarding investment strategies, these should help make or support progress toward:

1) Achieving and sustaining a desired state of good repair for the NHS pavements and bridges;
2) Improving or preserving asset conditions and the performance of the NHS; and,
3) Achieving targets for asset condition and performance.

The process description should address how the strategies are influenced by the following:

- Life cycle planning described in Chapter 3
- Performance gap analysis described in Chapter 4
- Risk management described in Chapter 5
- Financial plan described in this chapter

ARDOT already supports a number of the TAMP requirements related to financial planning and investment strategy development in whole or in part. Table 6-1 describes existing practices and key documents detailing those that correspond to the federal requirements.

Table 6-1. TAMP Requirements and Corresponding ARDOT Practices

Federal TAMP Requirements	ARDOT Practices
10 year minimum time horizon	Financial projections are included in *We Move Arkansas*, a 25-year long range intermodal transportation plan, a statewide needs assessment, and in the State Transportation Improvement Program (STIP).
Estimate cost of future work, by work type and state fiscal year	Both *We Move Arkansas* and the statewide needs assessment estimate the costs of various treatment strategies for highways and bridges. The STIP details specific project investments in the near term.
Estimate funding levels and sources that are expected to be reasonably available by fiscal year	*We Move Arkansas* includes a 25-year revenue estimate, while the statewide needs assessment includes a 10-year revenue forecast.
Estimate asset value and the needed annual investment to maintain asset value	Calculations of asset value are developed for ARDOT's financial statements using the standard approach described in General Accounting Standards Board (GASB) Statement 34. These calculations are not, however, made for specific asset types or systems.
Develop investment strategies	*We Move Arkansas* includes a general description of ARDOT's investment strategies. Two agreements between ARDOT and FHWA further detail ARDOT's approach to asset preservation for pavements and bridges.

Funding Sources

The funding sources in the TAMP are based on those described in *We Move Arkansas* and the Arkansas STIP. Together these resources, described below, serve as the basis for identification of asset management funding sources and the resulting financial plan.

We Move Arkansas

We Move Arkansas, Arkansas' most recent long-range intermodal transportation plan, includes a revenue estimate of ARDOT's funding for infrastructure investment from Federal Fiscal Year 2016 through 2040. The estimate is based on specific growth rate assumptions for each revenue and funding source considering historic trends and projections of major indicators such as motor fuel consumption and population.

The revenue estimate includes state revenues, federal funding, and local matching funds for investment in surface transportation infrastructure over the 25-year forecast period. Federal funding is assumed to grow 2.0 percent annually, which aligns with the average annual growth rate of federal funding under the five-year term of the FAST Act. State funds come primarily from motor fuel tax revenues, motor vehicle registration fee revenues, and natural gas severance tax revenues.

State Transportation Improvement Program

ARDOT's STIP includes projects for which authorization may be requested for any phase of development. For urban areas greater than 50,000 in population, projects listed in Transportation Improvement Programs (TIPs) developed by the State's various Metropolitan Planning Organizations (MPOs) are included as part of the overall federal-aid highway program and the federal-aid transit program.

The STIP includes both the federal-aid and state portions of the State's overall highway construction program and is fiscally constrained in accordance with federal regulations.

TAM Funding Sources

Based upon existing plans and programs, ARDOT anticipates available funding that could reasonably be used for asset management purposes as detailed in Table 6-2 below. ARDOT funding sources, after debt service on existing obligations, are projected to total $392 million annually through 2025 and $450 million annually in 2026 and 2027, following final debt repayment. Over the 10-year period, funding sources are projected to total $4,036 million. Figure 6-1 provides a breakdown of the major funding sources over the 10-year period (excluding debt service).

Table 6-2. ARDOT Asset Management Funding Sources

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total
Sources											
Federal Funds	360	360	360	360	360	360	360	360	360	360	**3,600**
State Funds	90	90	90	90	90	90	90	90	90	90	**900**
Debt Service	(58)	(58)	(58)	(58)	(58)	(58)	(58)	(58)	0	0	**(464)**
Total	**392**	**392**	**392**	**392**	**392**	**392**	**392**	**392**	**450**	**450**	**4,036**

Note: All values are shown in millions of current year dollars by fiscal year.

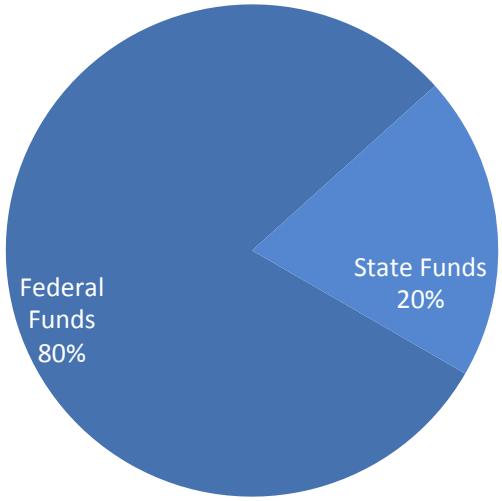


Figure 6-1. ARDOT Asset Management Funding Sources, 2018-2027

Funding Uses

Overall funding for asset management was established, relative to other uses, in development of *We Move Arkansas* and the STIP described above. Asset management funding was established by consideration of available funds, historical expenditures, planned work, and different investment scenarios for achieving the broad range of objectives articulated in *We Move Arkansas*.

The TAMP further details how the funds for asset management could be used, distinguishing these by system and asset class. To develop the projections of asset management funding allocation, ARDOT staff reviewed a range of investment scenarios for pavements and bridges assuming different budget levels and treatment strategies. These investment scenarios were developed using the life cycle planning assumptions detailed in Chapter 3. In some cases alternative treatment strategies were used to test these assumptions, such as testing a "replacement only" strategy for bridges. The investment scenario analyses were performed in dTIMS, as described in Chapter 4, and tested a range of budget levels for pavements and bridges. Ultimately, ARDOT established the projected allocations considering projected conditions and performance as well as the risks described in Chapter 5 that are not explicitly addressed in the scenario analysis.

Table 6-3 provides the resulting projection of funding allocations for asset management. Note that Table 6-3 includes funds spent on other system preservation uses besides pavement and bridges (e.g., preserving system capacity) to provide a full accounting of the sources identified in Table 6-2. As shown in Table 6-3, from 2018 to 2027, the projected investment totals $4,036 million. This investment includes $1,736 million in pavements, $900 million in bridges, and $1,400 million in other system preservation activities.

The investment in pavements includes capital investments for Interstates, the APHN, and Non-APHN. Funding for pavements is projected to be $89 million per year from 2018 to 2025 and $147 million per year in 2026 and 2027. The change in funding for the final two years of the plan reflects that ARDOT is budgeting $100 million annually for the duration of the 10-year period for Interstate pavements. During the 2018 to 2025 period, a portion of these funds will be used to repay bonds, the proceeds of which were previously used to improve the condition of Interstate pavements. In 2025 these bonds will be fully repaid and, as shown in Table 6-2, allow the full $100 million to fund current year investments in Interstate pavements. Capital funding for Non-NHS pavements is estimated at $73 million per year. It should be noted that additional funds not shown here are expended on district maintenance. District maintenance funds are not included in the dTIMS simulation. Instead, the deterioration curves developed through the life cycle planning process incorporate the effects of District maintenance activities.

Funding for capital investments in bridges is projected to total $90 million per year. Of this total, funding for NHS bridges is expected to be approximately $46 million per year, and funding for Non-NHS bridges is projected to be approximately $44 million. As in the case of pavement, additional funds not shown here are expended on district maintenance. District maintenance funds are not included in the dTIMS simulation. Instead, the deterioration curves developed through the life cycle planning process incorporate the effects of District maintenance.

Table 6-3. ARDOT Asset Management Funding Projections

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total
Uses											
Pavement											
NHS	89	89	89	89	89	89	89	89	147	147	**1,006**
Non-NHS	73	73	73	73	73	73	73	73	73	73	**730**
Total	**162**	**162**	**162**	**162**	**162**	**162**	**162**	**162**	**220**	**220**	**1,736**
Bridge											
NHS	46	46	46	46	46	46	46	46	46	46	**460**
Non-NHS	44	44	44	44	44	44	44	44	44	44	**440**
Total	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**900**
Pavement and Bridge Subtotals by System											
NHS	135	135	135	135	135	135	135	135	193	193	**1,466**
Non-NHS	117	117	117	117	117	117	117	117	117	117	**1,170**
System Preservation - Other	**140**	**140**	**140**	**140**	**140**	**140**	**140**	**140**	**140**	**140**	**1,400**
Total	**392**	**392**	**392**	**392**	**392**	**392**	**392**	**392**	**450**	**450**	**4,036**

Note: all values are shown in millions of current year dollars by fiscal year.

Figure 6-2 shows the expected distribution of pavement and bridge funding from 2018 to 2027. As shown in Figure 6-2, 66 percent of asset management funds are targeted for pavements and 34 percent are allocated to bridges. A total of 55 percent of the asset management funds are projected to be spent on the NHS including 38 percent for NHS pavements (Interstate and Non-Interstate NHS) and 17 percent for NHS bridges.

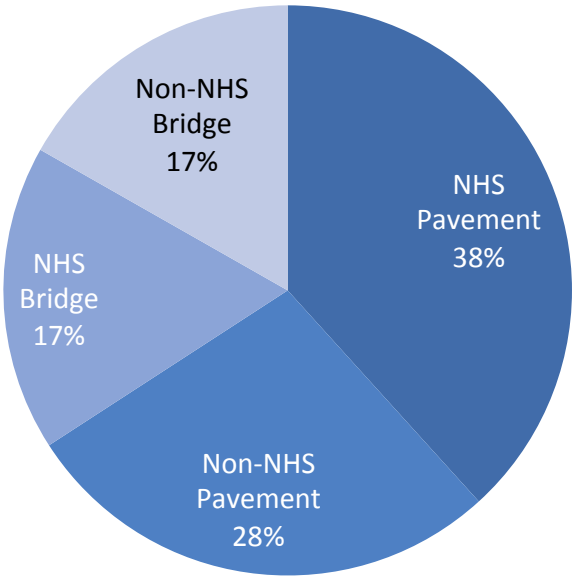


Figure 6-2. ARDOT Asset Management Funding Projections, 2018-2027

Asset Valuation

As noted above, for financial reporting, ARDOT calculates asset value based on the standard approach described in GASB Statement 34. This calculation is performed at an aggregate level using historic cost data and assuming straight-line depreciation. The GASB 34 calculation, though performed in a manner consistent with financial reporting requirements, is of limited value for use in asset management. The calculation is performed at an aggregate level and is thus not specific to asset classes or systems (e.g., NHS pavements). In addition, the methodology uses historic cost data and, therefore, the resulting asset value tends to understate the cost of replacing assets.

As an alternative to the GASB 34 approach, to support asset management applications, ARDOT calculates asset value based on Depreciated Replacement Cost (DRC), where the replacement cost is based on the current cost of replacing an asset. This method is consistent with the fair value approach described in International Accounting Standard 16 (IAS 16) which involves the following steps:

- Gross Replacement Cost (GRC) is calculated for each NHS pavement section and bridge based on the cost of asset reconstruction or replacement in current dollars.
  - For NHS pavements, the reconstruction cost listed in Chapter 3 is applied ($1,687,500 per lane mile for Interstates; $1,375,000 for the Non-Interstate NHS). These are the values specified for reconstruction in dTIMS, and were originally derived from ARDOT's document Estimated Costs Per Mile, with adjustments for inflation and the percentage of roads in the different categories listed in that document (e.g., freeway versus non-freeway, urban versus rural).
  - For NHS bridges, a separate calculation is made for each bridge considering the projected dimensions of a replacement bridge. The replacement cost averages $187 per square foot, accounting for the cost of replacing the existing bridge and the additional size of a replacement bridge.
- Asset Consumption (AC) is calculated by determining the replacement value lost due to deterioration of an asset. This value is estimated based on asset condition.

  - For pavements, asset consumption is projected to grow from 0 to the replacement cost of the section as PCI drops from 100 (best condition) to the threshold value for a Condition Rating of F.
  - For bridges, asset consumption is projected to grow linearly from 0 to the replacement cost of the bridge as the bridge reaches the end of its useful life. ARDOT uses dTIMS to project the remaining life and useful life for each bridge. Note that a bridge in poor condition is deemed to be at the end of its useful life.
- DRC is calculated as the difference between GRC and AC.

Although it may seem counterintuitive to develop separate estimates of asset value for different purposes, this approach is consistent with the conclusions of other agencies. NCHRP Report 608, published in 2008, reviews transportation agency experience implementing GASB Statement 34 and concludes that, absent significant changes in the calculation approach, asset valuation results developed based on the GASB 34 standard approach are unlikely to play a substantial role in asset management and decision-making. Ongoing research on asset valuation currently underway through NCHRP Project 19-12 on financial planning for asset management further supports this conclusion and recommends the use of the DRC methodology applied by ARDOT.

Once asset value is determined, additional calculations are performed to determine the investment required to maintain asset value over time. For pavement, the asset value is computed as of 2027 based on expected funding. The cost to maintain asset value over the 10-year period is equal to the project expenditures summarized in Table 6-3, in addition to the difference in asset value between the beginning and end of the analysis period. This difference represents the cost in today's dollars to restore value by performing additional reconstruction or replacement work on assets that have reached the end of their useful life and thus have been fully depreciated. For NHS bridges, the additional cost required to restore value is assumed to be equal to the cost of closing the gap for NHS bridges reported in Chapter 4, as the desired state of good repair is to maintain current conditions and thus, value.

Table 6-4 summarizes the asset value calculations for NHS pavements and bridges. As indicated in Table 6-4, the GRC of NHS pavements and bridges is approximately $26 billion. The DRC of these assets is approximately $13 billion with an average annual investment of approximately $198 million required to maintain value, which is approximately 35% more than the expected spending of approximately $147 million per year.

Table 6-4. NHS Asset Valuation Summary

Asset	GRC	Current DRC	Projected Capital Expenditure	Additional Investment Required to Restore Value	Average Annual Investment to Maintain Value
Pavement	**15,677**	**9,124**	**1,006**	**76**	**109**
Interstate	5,309	2,515	536	0	54
Non-Interstate	10,368	6,609	470	76	55
Bridges	**10,752**	**4,050**	**460**	**434**	**89**
Total	**26,429**	**13,174**	**1,466**	**510**	**198**

Note: all values are shown in millions of current year dollars by fiscal year.

Investment Strategies

Asset management investment strategies are the policies for resource allocation that will deliver the best asset performance given available funds and the agency's goals. Generating an asset management investment strategy involves assessing various funding scenarios designed to achieve and sustain a desired state of repair and deliver the program efficiently.

The investment strategies presented in this chapter build a foundation for TAM financial decisions by connecting the TAMP to ongoing funding and programming processes. They support progress toward achieving the State's goals and targets, as well as closing any performance gaps. The strategies incorporate asset modeling, treatments, and impacts, as well as risks and financial constraints.

ARDOT has implemented three primary investment strategies. The first strategy is to establish a dedicated funding stream for Interstate pavements through the Interstate Rehabilitation Program (IRP). The second investment strategy is to shift funds to asset preservation through adoption and implementation of agreements with FHWA for use of federal funds for asset preservation. ARDOT's third investment strategy for achieving its asset management objectives is to continue allocating funds to districts using a statewide needs-based approach. These strategies are described in more detail below.

Interstate Rehabilitation Program

In 2011, the citizens of Arkansas voted to help finance enhancements to existing Interstates by authorizing the Arkansas Highway Commission to issue up to $575 million in GARVEE bonds. The bond proceeds combined with funds equal to those previously allocated by FHWA for Interstate Maintenance have provided ARDOT with a dedicated stream of funding for Interstates. Current funding for the program is $100 million per year. The GARVEE bonds were issued before December 31, 2015. Consequently, the bulk of the program ($58 million per year) is dedicated to bond repayment through 2025, leaving $42 million for new investments. After 2025, all of the bonds will have been repaid and annual investments in Interstate pavements will increase to at least $100 million per year.

System Preservation

A critical area of emphasis for improving asset conditions is to focus additional funds on system preservation. In recent years, ARDOT has shifted funds away from pavement reconstruction and bridge replacement that would have addressed assets in poor condition to invest in preventing asset deterioration through preservation treatments. This focus is reflected in recent project decisions for pavements and bridges. In the case of bridges, a portion of the program is now set aside for preservation work such as deck overlays and rehabilitation.

ARDOT's capital program relies heavily on federal funding, therefore, an important step in supporting this strategy is the establishment of agreements with FHWA allowing the usage of federal funds for preventive maintenance and other preservation activities. Both of the agreements, described below, outline procedures by which investment decisions for federal funding are made for pavement and bridge preventive maintenance and preservation.

- **Agreement for the Use of Federal Funds for Preventive Maintenance of Pavement.** ARDOT and FHWA developed the Pavement Preventative Maintenance Agreement to outline procedures to determine, evaluate, and implement preventive maintenance strategies for pavement assets. Preventive maintenance projects may be identified by ARDOT staff, based on engineering observation or performance data, or comments from local agencies and the general public. The Agreement outlines the attributes used to determine asphalt pavement and concrete pavement conditions, such as the international roughness index (IRI), rutting, and cracking for asphalt pavement and IRI, faulting, and fractured slabs for concrete. The Agreement also defines categories of treatment strategies and pavement condition classification. All preventive maintenance projects must consider appropriate ways to maintain or enhance the current level of safety and accessibility and outlines safety enhancements to be considered for inclusion in preventive maintenance projects.
- **Proposed Agreement for the Use of Federal Funds for Preventive Maintenance and Preservation of Bridges.** ARDOT and FHWA developed the Bridge Preventive Maintenance and Preservation Agreement to further implement the use of federal funding for preventive maintenance and preservation activities authorized in 23 USC 116(e) and the FHWA memorandum dated February 25, 2016, titled "Guidance on Highway Preservation and Maintenance". The Agreement is based on bridge inspection data to improve bridge condition through systematic preservation and assist ARDOT in making decisions related to bridge preservation, repair, rehabilitation, and replacement. At the time this document was being developed, this agreement had not yet received final approval.

Needs-Based District Allocation

ARDOT used to allocate funding to its districts based on historical spending patterns and generally equal distributions of available revenue. The TAM initiative has provided ARDOT with a greatly improved assessment of its pavement and bridge investment needs for use in its allocation of capital funds to districts based on the consideration of statewide investment needs. The adoption of statewide targets for pavement and bridge condition, required under 23 CFR Part 490, will help facilitate this transition by establishing targets that districts can use in identifying investment needs and determining funding priorities.