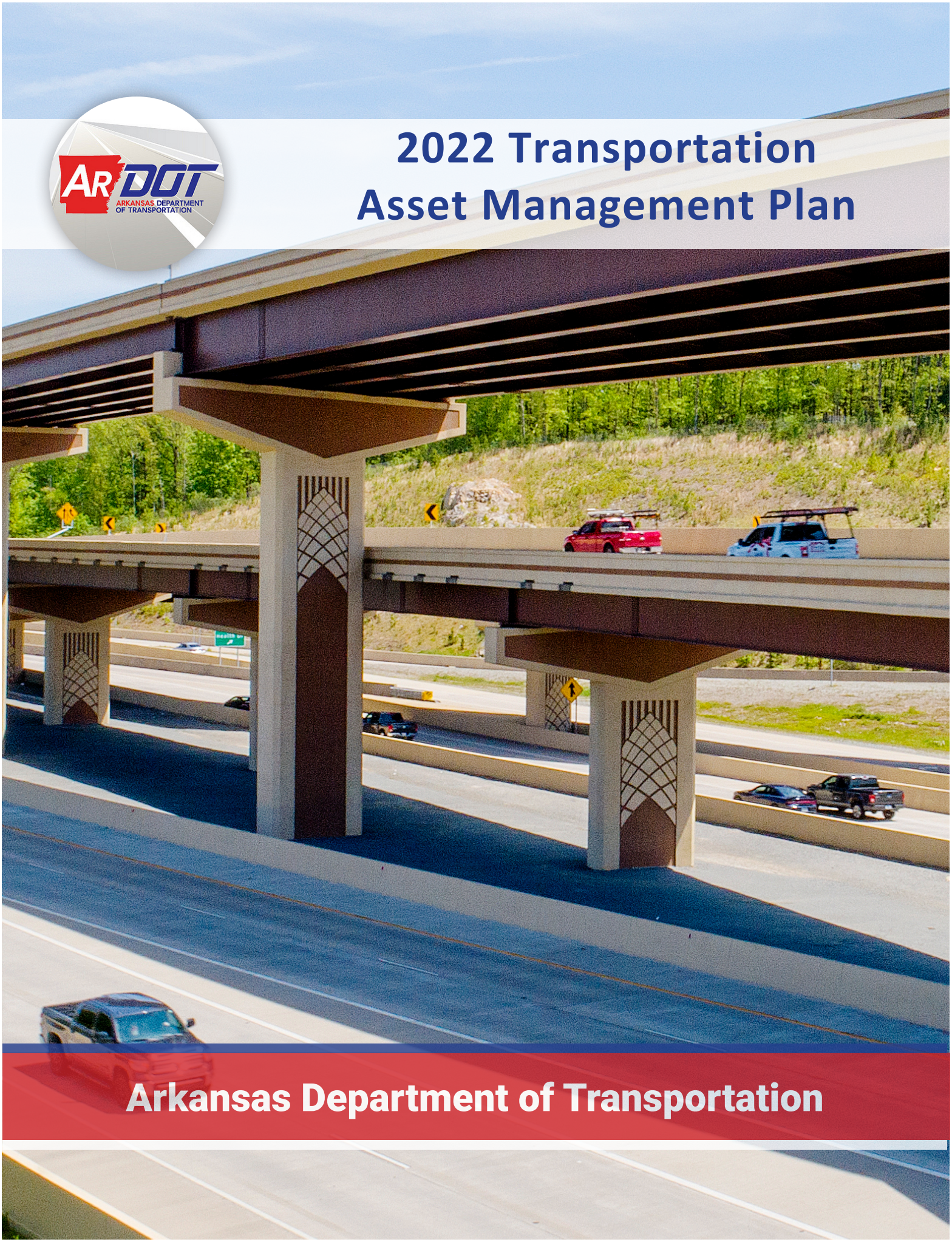
2022 Transportation Asset Management Plan



Arkansas Department of Transportation

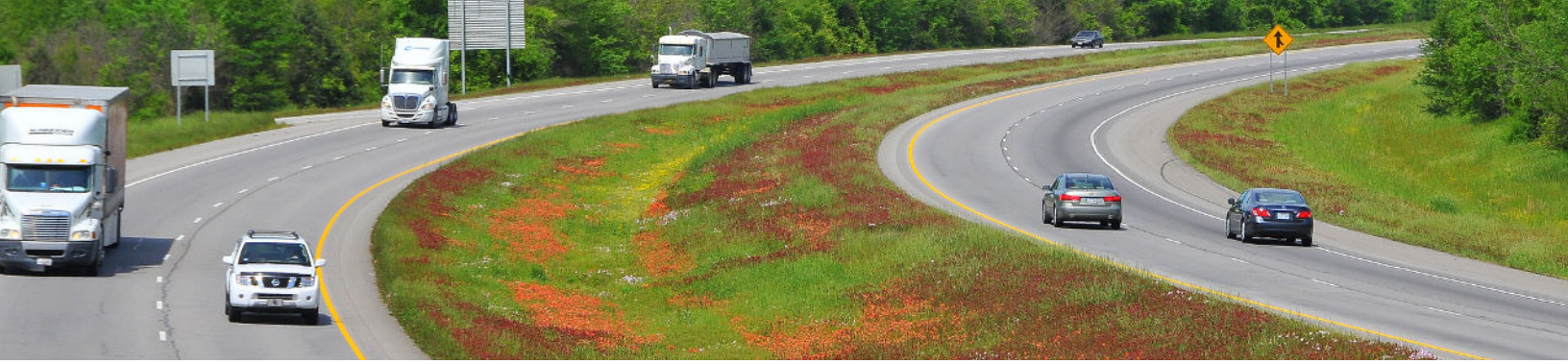


Table of Contents

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 1990s 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 nation. 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 uses multiple, overlapping roadway networks to assist with long-range planning. One of the roadway networks used by ARDOT is the Arkansas Primary Highway Network (APHN). It is a

system of approximately 7,900 miles that carries more than 90% of all travel in the State. ARDOT also manages approximately 8,500 miles not on the APHN.

All State-owned routes on the NHS are included on the APHN. 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 portion of the NHS in Arkansas is locally-owned. The locally-owned NHS includes 49 centerline miles of roadways and five bridges.

Inventory and Condition

Pavement

The table on the next page summarizes the current inventory and condition of all NHS pavements in Arkansas. The data reflects the pavement inventory and conditions as of December 31, 2020 and reported to FHWA in 2021. The table shows centerline and lane miles, and summarizes the condition for NHS roads using FHWA's pavement condition rating (PCR) system for evaluating pavement in terms of good, fair, and poor.

It is important to note that ARDOT uses a different PCR system than FHWA. ARDOT uses the Pavement Condition Index (PCI) as the primary tool to evaluate the condition of highway pavements. The PCI is calculated based on a weighted average of four types of pavement metrics including environmental cracking, structural cracking, roughness, and rutting. A letter grade is then assigned to a section of pavement based on the PCI. The letter grades used are A, B, C, D, and F, where A is excellent and F is failing. ARDOT's desired state of good repair is to maintain NHS pavements in a PCR of A or B.

Based on the FHWA PCR system, the NHS in Arkansas is predominantly in good or fair condition, with approximately 1 percent in poor condition.

Arkansas NHS Pavement Inventory and Condition Summary Based on FHWA Thresholds

Owner/System	Centerline Miles	Lane Miles	Good	Fair	Poor
NHS Total	3,366	11,159	45%	54%	1%
Interstate (All State Owned)	749	3,234	63%	36%	1%
Non-Interstate NHS	2,617	7,925	35%	62%	3%
State Owned	2,568	7,754	35%	62%	3%
Non-State Owned	49	171	19%	81%	0%

Bridges

The table below summarizes the current inventory and condition of all bridges on the NHS in Arkansas. The data reflects the inventory and conditions as of March 2020. It shows the number of bridges by owner, their corresponding deck area, and the percentage of bridges classified in good, fair, and poor condition based on FHWA definitions.

Arkansas NHS Bridge Inventory and Condition

Owner/System	Number of Bridges	Deck Area (ft^2)	Good	Fair	Poor
NHS Total	2,300	36,254,134	44%	52%	4%
State Owned	2,295	36,235,644	45%	51%	4%
Non-State Owned	5	18,490	40%	60%	0%

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 2022 to 2031. 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.

The desired state of good repair for NHS pavements is to maintain at least 95 percent at a Condition Rating of A or B and no more than 5 percent at a Condition Rating of F based on ARDOT's PCR system. Since Federal guidance requires the gap assessment to be calculated based on FHWA's PCR system, the desired state of good repair must be converted to FHWA's PCR system. By evaluating FHWA thresholds against the ARDOT pavement data, it has been determined that a 95 percent Condition Rating of A or B and a 5 percent Condition Rating of F are approximately 82 percent Good and 4 percent Poor in FHWA's PCR system, respectively. Therefore, the gap assessment for Good and Poor ratings will be calculated based on a desired state of good repair for NHS pavements at 82 percent and 4 percent, respectively.

The desired state of good repair for NHS bridges is 48 percent deck area in Good condition based on FHWA National Bridge Inventory standards. For the purposes of this gap assessment, 10 percent Poor NHS bridge deck area will be used. The goal is to maintain all bridges in Good or Fair condition, but ARDOT recognizes that even if all bridge needs are addressed as they arise, a small percentage of bridges will be in Poor condition at any given time. ARDOT used dTIMS to simulate achieving the desired state, and then tabulated the overall percentage of NHS bridges in Good, Fair, and Poor condition when the desired state of good repair is achieved.

The following tables show the gaps between current performance and the desired state of good repair for both pavements and bridges. These tables document that ARDOT will make progress towards achieving its desired state of good repair for NHS pavements and bridges.

Gap Assessment for NHS Pavement Assets Based on the FHWA Good and Poor Measures

Category	Good	Poor	Gap* (Good)	Gap* (Poor)
Desired State of Good Repair	82%	4%		
Interstate				
Current Performance	63%	1%	19%	-3%
10-Year Projected Performance	78%	0%	4%	-4%
Non-Interstate NHS				
Current Performance	35%	3%	47%	-1%
10-Year Projected Performance	36%	0%	46%	-4%

**Difference when compared to the Desired State of Good Repair.*

Gap Assessment for NHS Bridges Based on the FHWA Good and Poor Measures

Category	Good	Poor	Gap* (good)	Gap* (poor)
Desired State of Good Repair	48%	10%		
Current Performance	45%	4%	3%	-6%
10-Year Projected Performance	46%	10%	2%	0%

**Difference when compared to the Desired State of Good Repair.*

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 risks, and then defined potential mitigation strategies for high and very 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 details ARDOT's 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 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.

ARDOT Asset Management Funding Sources

Funding Sources	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
Federal Funds with State Match	$544	$559	$570	$596	$632	$657	$683	$710	$738	$768	**$6,457**
State Funds - Act 1	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	**$500**
State Funds - Act 416	$93	$100	$102	$102	$102	$103	$104	$105	$106	$107	**$1,024**
State Funds - Amendment 101	$0	$50	$244	$246	$249	$251	$254	$257	$260	$263	**$2,074**
Total	**$687**	**$759**	**$966**	**$994**	**$1,033**	**$1,061**	**$1,091**	**$1,122**	**$1,154**	**$1,188**	**$10,055**

ARDOT Asset Management Funding Projections

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
Asset Management Uses											
Pavement											
NHS											
Construction	$251	$269	$354	$365	$379	$390	$401	$411	$423	$435	**$3,678**
Preservation	$75	$80	$106	$109	$114	$116	$119	$123	$126	$130	**$1,098**
Rehabilitation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
Total NHS Pavement	**$326**	**$349**	**$460**	**$474**	**$493**	**$506**	**$520**	**$534**	**$549**	**$565**	**$4,776**
Non-NHS											
Total Non-NHS Pavement	**$266**	**$285**	**$377**	**$387**	**$403**	**$414**	**$426**	**$438**	**$450**	**$463**	**$3,909**
Total Pavement	**$592**	**$634**	**$837**	**$861**	**$896**	**$920**	**$946**	**$972**	**$999**	**$1,028**	**$8,685**
Bridge											
NHS											
Construction	$19	$26	$27	$27	$28	$29	$30	$31	$32	$33	**$282**
Preservation	$4	$5	$5	$6	$6	$6	$6	$6	$6	$6	**$56**
Rehabilitation	$6	$6	$7	$7	$7	$7	$7	$8	$8	$9	**$72**
Total NHS Bridge	**$29**	**$37**	**$39**	**$40**	**$41**	**$42**	**$43**	**$45**	**$46**	**$48**	**$410**
Non-NHS											
Total Non-NHS Bridge	**$66**	**$88**	**$90**	**$93**	**$96**	**$99**	**$102**	**$105**	**$109**	**$112**	**$960**
Total Bridge	**$95**	**$125**	**$129**	**$133**	**$137**	**$141**	**$145**	**$150**	**$155**	**$160**	**$1,370**
Totals											
NHS											
Construction	$270	$295	$381	$392	$407	$419	$431	$442	$455	$468	**$3,960**
Preservation	$79	$85	$111	$115	$120	$122	$125	$129	$132	$136	**$1,154**
Rehabilitation	$6	$6	$7	$7	$7	$7	$7	$8	$8	$9	**$72**
Total NHS	**$355**	**$386**	**$499**	**$514**	**$534**	**$548**	**$563**	**$579**	**$595**	**$613**	**$5,186**
Non-NHS											
Total Non-NHS	**$332**	**$373**	**$467**	**$480**	**$499**	**$513**	**$528**	**$543**	**$559**	**$575**	**$4,869**
Total Pavement & Bridge	**$687**	**$759**	**$966**	**$994**	**$1,033**	**$1,061**	**$1,091**	**$1,122**	**$1,154**	**$1,188**	**$10,055**

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 1990s and have been formalized in federal transportation funding legislation.

Building on the initial ARDOT Transportation Asset Management Plan (TAMP) published in April 2018, 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]

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

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 identifying 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 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), continued in the Fixing America's Surface Transportation (FAST) Act, and added to by the Infrastructure Investment and Jobs Act (IIJA). 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
- Financial plan
- Investment strategies

ARDOT's TAMP addresses all of the above subjects.

Asset Management Goals and Objectives

This TAMP supports ARDOT's strategic goals and objectives, as well as national goals established in MAP-21, the FAST Act, and the IIJA. 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 Long Range Intermodal Transportation Plan Goals and Objectives and 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.
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.	Improving infrastructure condition is a critical focus area of TAM.
Congestion Reduction, Mobility and System Reliability	• Contribute toward predictable, reliable travel times. • Plan and prepare for autonomous and connected vehicles. • Identify potential freight corridors within which special attention is given to preempt commercial vehicle bottlenecks.	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	• 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 nation. 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). ARDOT also works in cooperation with many partners 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 employees.

Organizational alignment and support for TAM is a key element of TAM program success. In late 2021, ARDOT established an asset management organizational structure in order to better implement asset management principles across the Department and to help ensure that anticipated performance outcomes are met. The initial step in creating this structure consisted of the establishment of 1) an Asset Management Governance Committee to provide high-level direction and oversight and 2) an Asset Management Program Team to coordinate asset management planning and implementation across the Department. Asset management workgroups consisting of departmental subject matter experts will be formed as needed.

The Asset Management Governance Committee membership consists of the Deputy Director & Chief Engineer, Assistant Chief for Administration, and the Assistant Chief Engineers of the Planning, Design, and Operations branches.

The responsibilities of the Governance Committee include:

- Provide strategic direction for the Department's asset management efforts
- Facilitate resources and organizational support for agreed-upon changes
- Oversee the incorporation of risk management in the project prioritization process
- Establish asset management performance targets and associated funding
- Promote asset management agency-wide

The Asset Management Program Team membership consists of the Assistant Chief Engineers of the Planning and Operations branches, Chief Fiscal Officer, Division Engineers from Program Management, System Information & Research, and Transportation Planning & Policy division; State Maintenance Engineer, and the FHWA Arkansas Division Transportation Engineer – Pavement.

The responsibilities of the Program Team include:

- Coordinate asset management initiatives across the agency
- Oversee development of the Transportation Asset Management Plan
- Provide input to critical plan development efforts
- Propose performance targets and associated funding levels
- Identify recommendations for advancing the implementation of asset management
- Facilitate the implementation of approved recommendations
- Establish subcommittees or task forces to address specific needs
- Promote best practices in asset management
- Ensure compliance with asset management rules and regulations

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 Systems Section is responsible for

maintaining the roadway inventory data on the 16,400 plus centerline miles of State-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 almost 7,400 State highway bridges. The Maintenance Division also provides information on transportation assets repeatedly damaged by emergency events. The Program Management Division supplies the financial plan and investment strategy data.

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 Conditions** – 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 updated 2022 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 has been and will again be updated as needed 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.

This version of the TAMP is 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.

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, identifying and developing projects, and monitoring asset performance. This chapter details ARDOT's inventory of pavement and bridge assets, and their condition. The data reflects the pavement inventory and conditions as of December 31, 2020 and reported to FHWA in 2021 and the bridge inventory and conditions as of March 2020.

Federal Requirements

Federal requirements for the 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 of pavements and bridges on the NHS, the TAMP must use FHWA's pavement condition rating (PCR) system for evaluating pavement in terms of good, fair, and poor. These requirements set thresholds for measures of good, fair, and poor condition for pavements and bridges calculated using data reported to the FHWA.

It is important to note that ARDOT uses a different PCR system than FHWA. ARDOT uses the Pavement Condition Index (PCI) as the tool to evaluate the condition of highway pavements. The PCI is calculated based on International Roughness Index, rutting, and cracking. A letter grade is then assigned to a section of pavement based on the PCI. The letter grades used are A, B, C, D, and F, where A is excellent and F is failing.

The bridge condition rating system used by ARDOT and FHWA are the same which classifies bridges in good, fair, and poor condition.

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 pavements and bridges on the NHS, consistent with federal requirements.

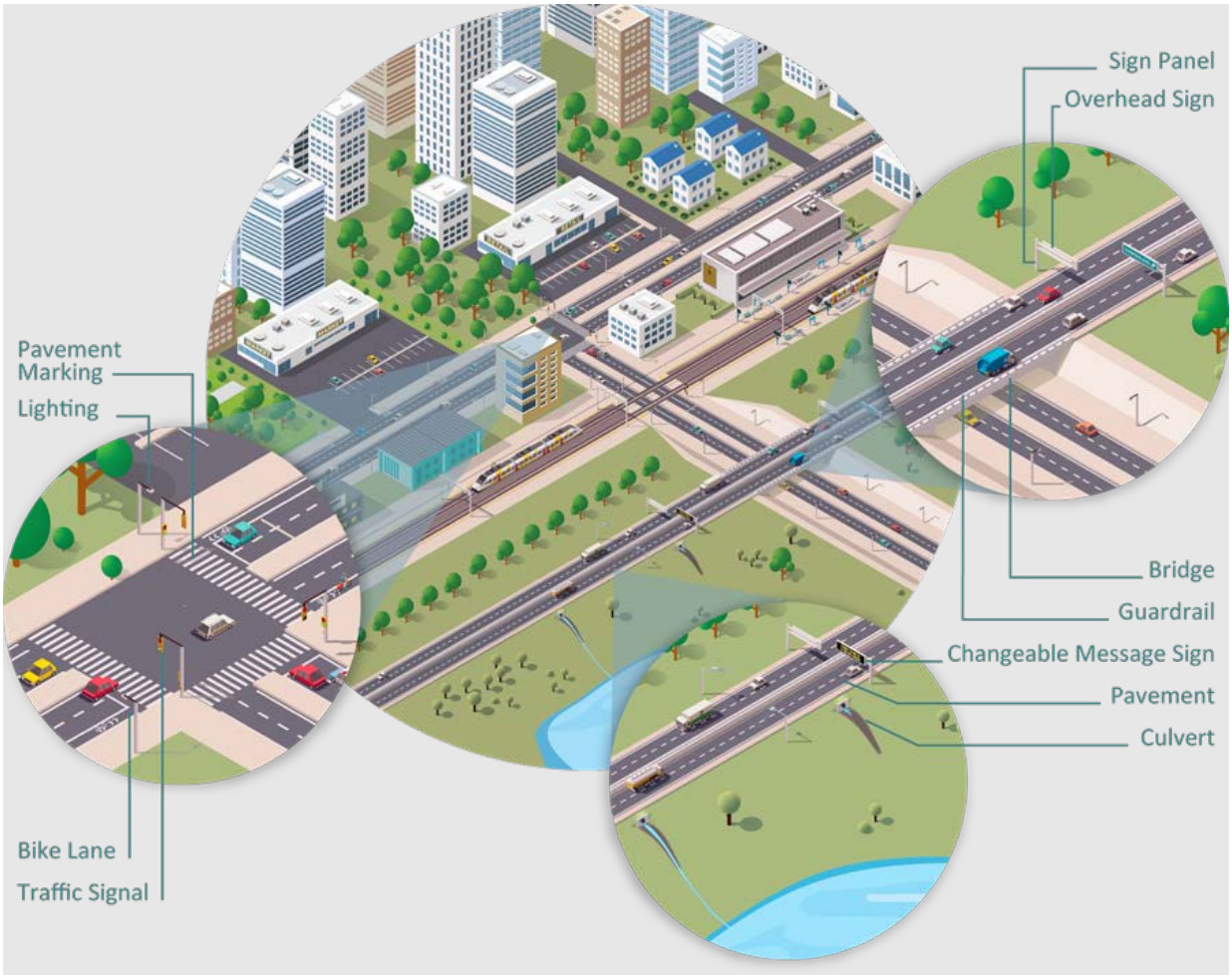


Figure 2-1. Typical Highway Assets

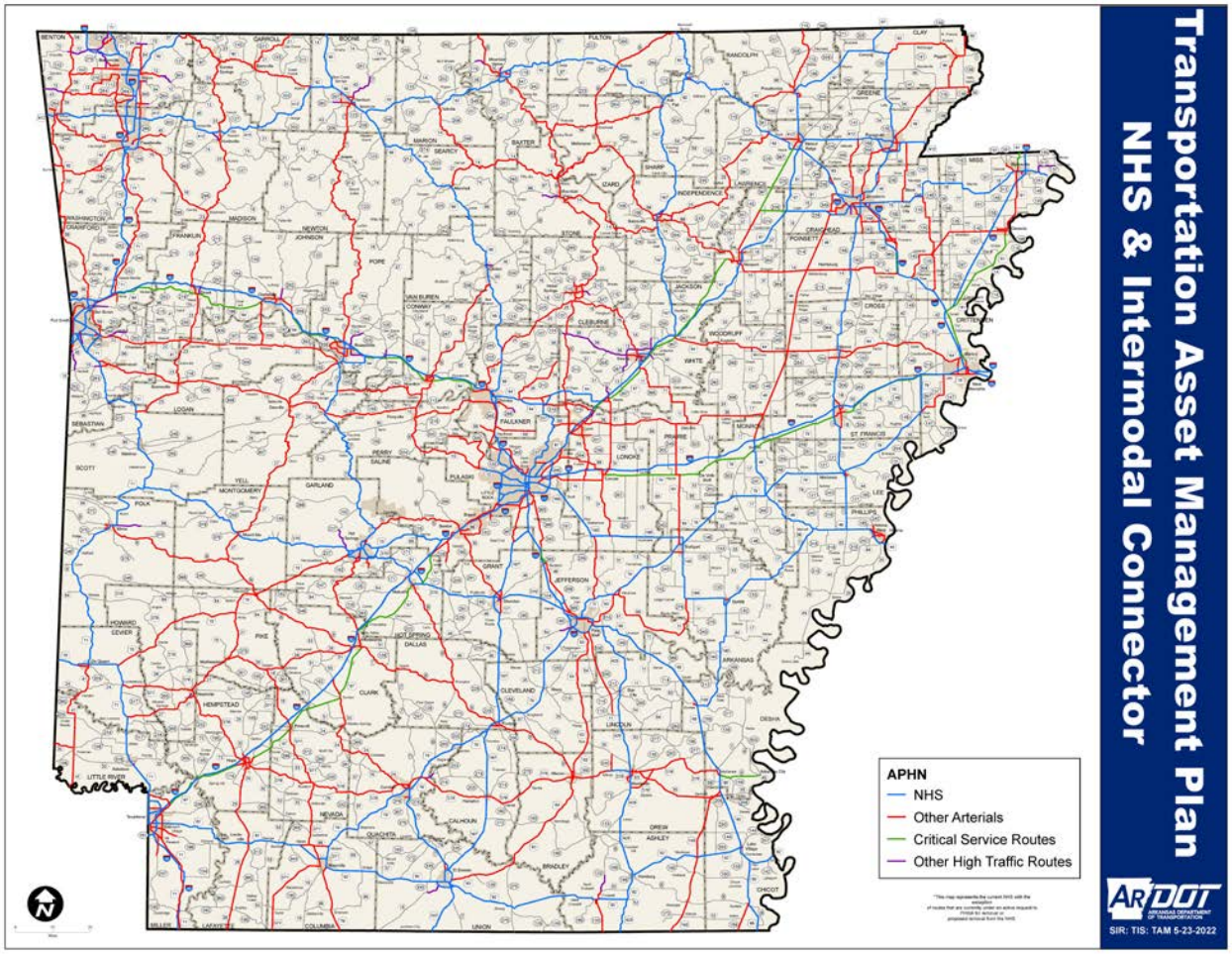


Figure 2-2. Arkansas Primary Highway Network

ARDOT uses multiple, overlapping roadway networks to assist with long-range planning. One of the roadway networks used by ARDOT is the Arkansas Primary Highway Network (APHN). It is a system of approximately 7,900 miles that carries more than 90% of all travel in the State. 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

The APHN includes state-owned roads on the NHS. The NHS has been defined by 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
- All principal arterials
- Selected major strategic highway connectors
- Selected intermodal connectors

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

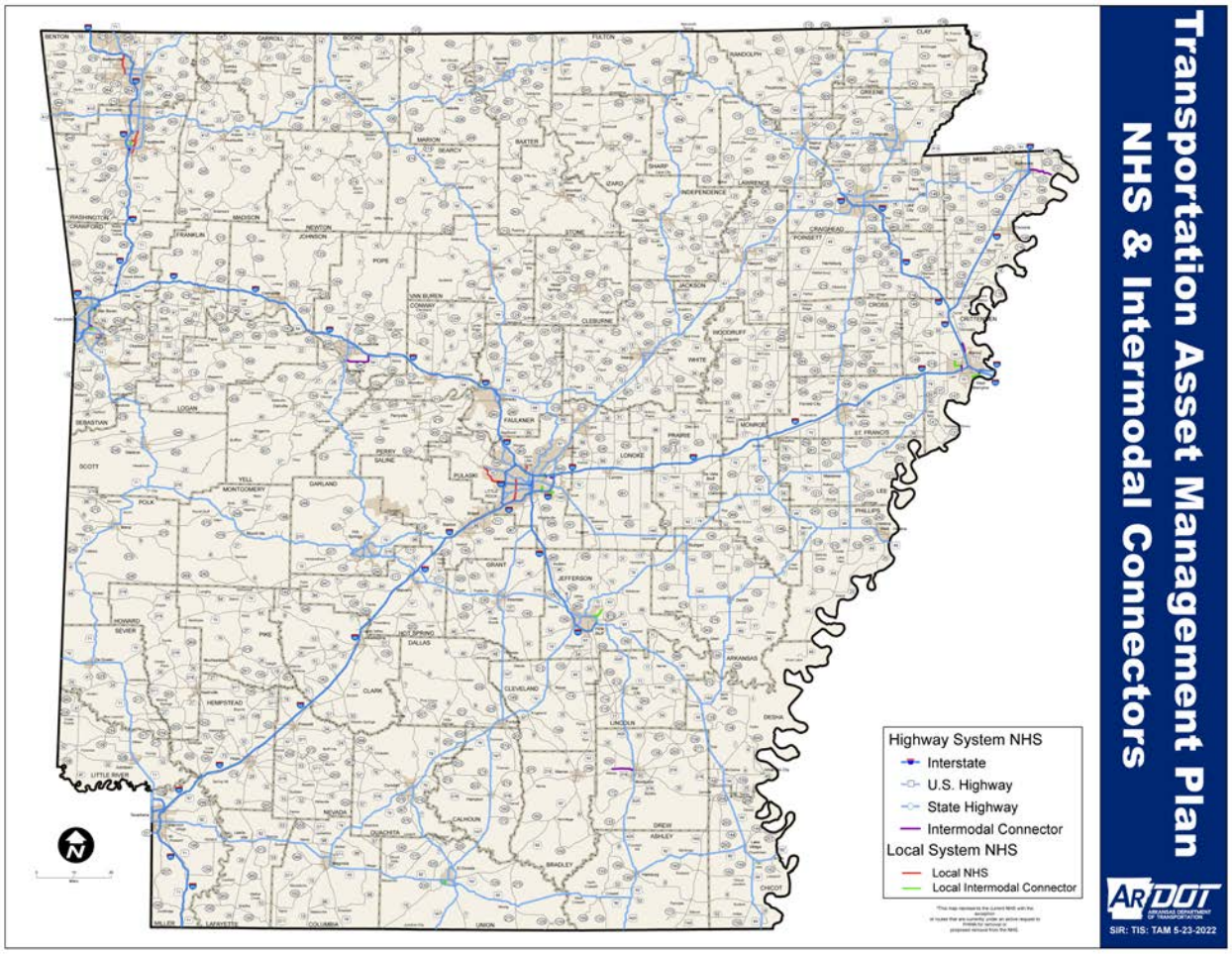


Figure 2-3. Arkansas National Highway System

A portion of the NHS in Arkansas is locally-owned. The locally-owned NHS includes 49 centerline miles of roadways and five bridges with a total deck area of 18,491 square feet.

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 five 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, in some cases, also reduce mobility.

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 equipped 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 2020 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, particularly on wet pavement, and captures the depth of the crack, which enhances data accuracy. ARDOT began the implementation of this new detection technology in late 2017 through contract data collection. ARDOT took posession of a new pavement data collection vehicle with three-dimensional imaging technology in 2020.

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 including environmental cracking, structural cracking, roughness, and rutting. PCI is then used to assign a PCR using letter grades A to F to describe overall pavement conditions of highways on the state system.

In addition to PCR, this TAMP also reports conditions for NHS pavements using the required FHWA PCR system that includes:

- 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, or warping.

For each of the above metrics, FHWA has established thresholds for good, fair, and poor conditions. 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 the metrics are rated as good, and poor when two or more are rated as poor. All other pavement sections 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 conditions. 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**

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

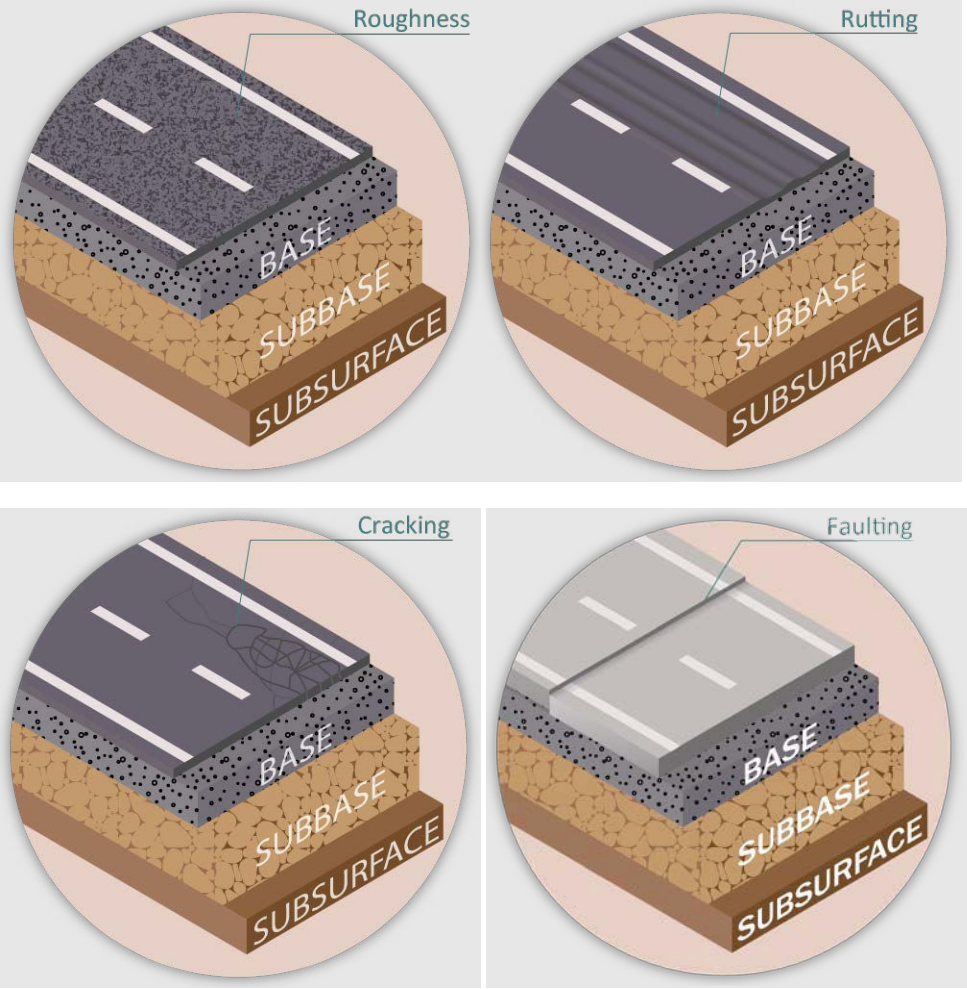


Figure 2-4. Pavement Condition Metrics

Inventory and Condition

Table 2-2 on the next page summarizes the current inventory and condition of all NHS pavement in Arkansas. The table breaks the NHS down into Interstate and Non-Interstate pavements and further breaks the Non-Interstate NHS into state owned and non-state owned pavement. The condition shown uses the FHWA good, fair, and poor conditions described above. As shown in the table, large portions of Interstate and Non-Interstate NHS pavements are classified as good or fair. Less than 1 percent of Interstate pavement and approximately 3 percent of Non-Interstate NHS pavement are classified as poor.

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

Owner/System	Centerline Miles	Lane Miles	Good	Fair	Poor
NHS Total	3,366	11,159	45%	54%	1%
Interstate (All State Owned)	749	3,234	63%	36%	1%
Non-Interstate NHS	2,617	7,925	35%	62%	3%
State Owned	2,568	7,754	35%	62%	3%
Non-State Owned	49	171	19%	81%	0%

Bridges

Overview

Bridges are a critical element of transportation infrastructure which provide a way across water bodies or valleys. Just as importantly, they provide access by spanning 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 expensive 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. This benefits both transportation agencies and the traveling public.

Data Collection

Condition data of bridges is collected through on-site 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 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*. 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 submitted to the NBI in March of 2020.

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.

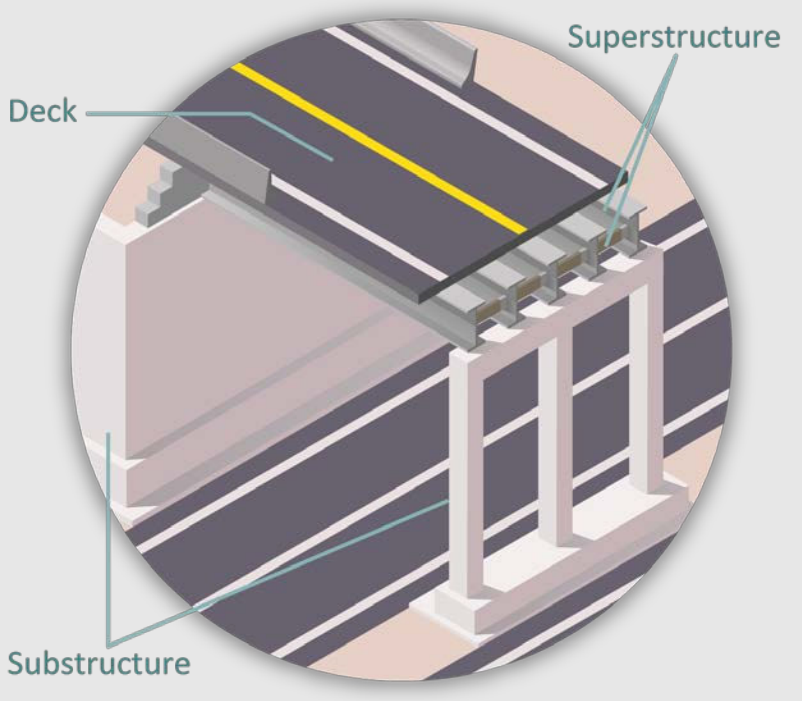


Figure 2-5. Bridge Components

Inventory and Condition

Table 2-3 summarizes the current inventory and condition of NHS 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 identifies the following information for state-owned and non-state-owned NHS bridges:

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

For all NHS bridges, 44% are in good condition with 4% in poor condition by deck area.

Table 2-3. Bridge Inventory and Condition (Good, Fair, Poor by Deck Area)

Owner/System	Number of Bridges	Deck Area (ft^2)	Good	Fair	Poor
NHS Total	**2,300**	**36,254,134**	**44%**	**52%**	**4%**
State Owned	**2,295**	**36,235,644**	**45%**	**51%**	**4%**
Non-State Owned	**5**	**18,490**	**40%**	**60%**	**0%**

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

Life cycle 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 life cycle 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 life cycle 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.

This system 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 or 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 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 April 2019 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 seven miles in length). The pavement analysis performed in dTIMS includes separate analyses of Interstate, Non-Interstate APHN, and Non-APHN systems. Pavement types, or asset sub-groups, 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 NBI inspection data for each structure. The bridge analysis includes all ARDOT-owned bridges, including bridges on and off the NHS. The asset sub-groups include culverts, decks, superstructures and substructures. 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 previously, ARDOT evaluates overall pavement condition using PCI and summarizes PCI into PCR letter grades. ARDOT's objective for its pavements is to maintain pavements 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 at least 95 percent of NHS pavements at a condition rating of A or B and to maintain at least 95 percent 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*.

Deterioration Models

The *Pavement Management System Configuration* report prepared by Deighton details ARDOT's pavement deterioration models. A total of 76 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.

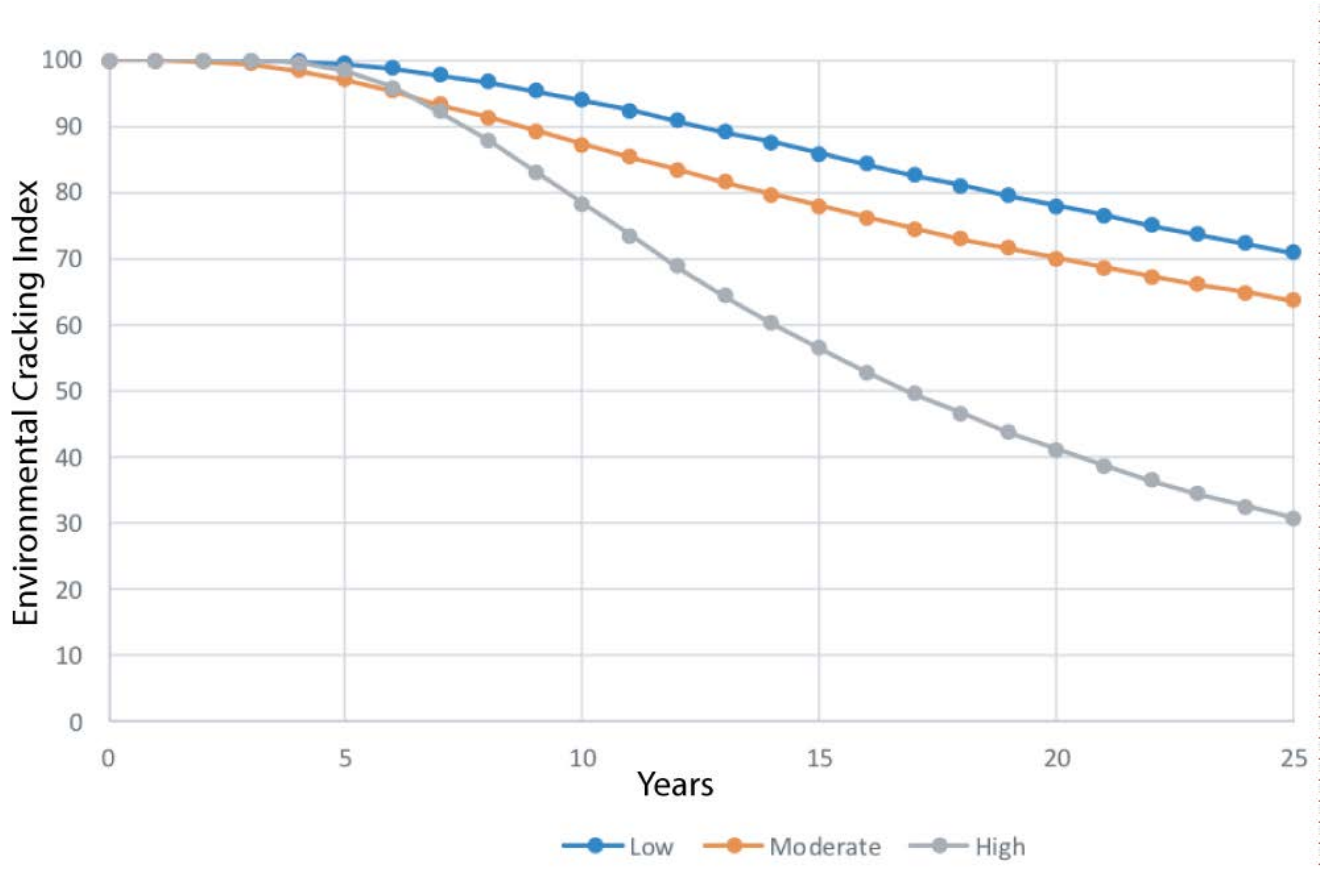


Figure 3-1. Example Pavement Deterioration Models – Environmental Cracking: Thin Pavement on Strong Soil

Treatments

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, 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 Treatments

Treatment	Cost Per Lane Mile			Treatment Life (years)
	Interstate	APHN	Non-APHN	
Asphalt crack seal	$ 30,000	$ 30,000	$ 30,000	8
Asphalt surface treatment	N/A	$ 20,000	$ 20,000	6
Micro surface	N/A	$ 40,000	$ 40,000	10
UTBWC	$ 120,000	$ 120,000	$ 120,000	8
Functional overlay	$ 150,000	$ 145,000	$ 140,000	10
Structural overlay	$ 300,000	$ 290,000	$ 280,000	18
Mill & Inlay	$ 170,000	$ 170,000	$ 170,000	12
Reconstruction	$ 3,300,000	$ 2,400,000	$ 2,100,000	20
Concrete grinding and joint rehab	$ 51,000	$ 51,000	$ 51,000	8
Concrete joint resealing	$ 20,000	$ 20,000	$ 20,000	8
Concrete grinding and spot patching	$ 115,000	$ 115,000	$ 115,000	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.

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 previously, 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 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. For the purposes of this TAMP, the desired state of good repair is defined as bridges that are in good condition as determined by FHWA NBI standards. Based on this definition and projected bridge conditions, the desired state of good repair for ARDOT's NHS bridges is 48 percent. These criteria support and are consistent with the goals and objectives described in Chapter 1.

Deterioration Models

The *Bridge Management System 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.

Treatments

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 $8 per square foot of deck area (in 2022 dollars).
- **Rehabilitation** restores all ratings to a value of 8 and costs approximately $50 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 $370 per square foot of existing bridge 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

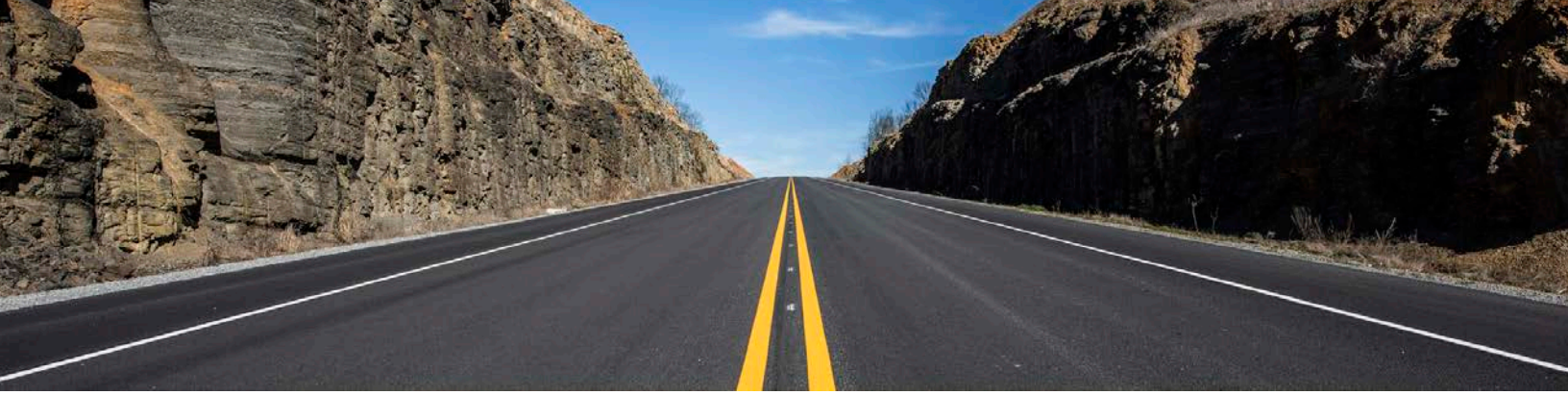
The life cycle strategy for bridges is established in dTIMS by specifying when different treatments are feasible and what their effects are. The system then simulates selection of the set of treatments that will maximize conditions subject to the constraints. In addition, ARDOT specifically constrains 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 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
- **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)

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 expensive 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 agreement with FHWA for use of federal funds for bridge preservation, described further in Chapter 6.



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 2022 to 2031. 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.

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 six percent. The most recent data reported to FHWA (representing conditions as of January 1, 2021) was used for the analysis.

As discussed in Chapter 2, 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.

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 PCR 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 PCR and the good, fair, and poor condition for each 1/10-mile section.

Bridges

For the bridge analysis, runs were performed for all State-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 six percent. As noted in Chapter 3, the budget was specified by treatment type, with 83 percent of the budget reserved for replacements, 10 percent for rehabilitation, and 7 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.

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.

Scenario Results

Pavements

Table 4-1 summarizes the predicted pavement conditions in 2031 based upon the expected level of funding documented in Chapter 6. The table shows the percentage of each system in good, fair, and poor conditions according to FHWA guidance.

Table 4-1. Predicted FHWA Good/Fair/Poor Conditions for NHS Pavement in 2031

	2031 FHWA Condition Rating		
System	**Good**	**Fair**	**Poor**
NHS	**51%**	**49%**	**0%**
Interstate	**78%**	**22%**	**0%**
Non-Interstate NHS	**36%**	**64%**	**0%**

Bridges

Table 4-2 summarizes the predicted NHS bridge conditions in 2031 based upon the expected level of funding documented in Chapter 6. The table shows predicted good, fair, and poor conditions according to FHWA guidance.

Table 4-2. Predicted FHWA Good/Fair/Poor Conditions for NHS Bridges in 2031

	2031 FHWA Condition Rating		
System	Good	Fair	Poor
NHS	46%	44%	10%

Gap Assessment

Pavements

As stated in Chapter 3, the desired state of good repair for NHS pavements is to maintain at least 95 percent at a Condition Rating of A or B and no more than 5 percent at a Condition Rating of F based on ARDOT's PCR system. Since Federal guidance requires the gap assessment to be calculated based on FHWA's PCR system, the 95 percent PCR of A or B and the 5 percent PCR of F must be converted to FHWA's PCR system. By evaluating FHWA thresholds against the ARDOT pavement data, it has been determined that a 95 percent Condition Rating of A or B and a 5 percent Condition Rating of F are approximately 82 percent Good and 4 percent Poor in FHWA's PCR system, respectively. Therefore, the gap assessment for Good and Poor ratings will be calculated based on a desired state of good repair for NHS pavements at 82 percent and 4 percent, respectively.

This assessment requires the gaps to be calculated for Interstate and Non-Interstate NHS roadways between the Desired State of Good Repair versus the Current Performance and the 10-Year Projected Performance, for both Good and Poor ratings.

The following gaps are noted in Table 4-3:

Interstate

- A gap of **19 percent** exists between the **Desired State of Good Repair** versus the **Current Performance** for **good pavements** (82% vs. 63%).
- No performance gap (**-3 percent**) exists between the **Desired State of Good Repair** versus the **Current Performance** for **poor pavements** (4% vs. 1%). We are exceeding our stated targets.
- A gap of **4 percent** exists between the **Desired State of Good Repair** versus the **10-Year Projected Performance** for **good pavements** (82% vs. 78%).
- No performance gap (**-4 percent**) exists between the **Desired State of Good Repair** versus the **10-Year Projected Performance** for **poor pavements** (4% vs. 0%). We are exceeding our stated targets.

Non-Interstate NHS

- A gap of **47 percent** exists between the **Desired State of Good Repair** versus the **Current Performance** for **good pavements** (82% vs. 35%).
- No performance gap (-**1 percent**) exists between the **Desired State of Good Repair** versus the **Current Performance** for **poor pavements** (4% vs. 3%). We are exceeding our stated targets.
- A gap of **46 percent** exists between the **Desired State of Good Repair** versus the **10-Year Projected Performance** for **good pavements** (82% vs. 36%).
- No performance gap (**-4 percent**) exists between the **Desired State of Good Repair** versus the **10-Year Projected Performance** for **poor pavements** (4% vs. 0%). We are exceeding our stated targets.

While wider gaps exist between the Desired State of Good Repair versus the Current Performance for good pavements, this gap is expected to drop significantly over the next 10 years due to increased funding from Amendment 101 referenced in chapter 6.

Table 4-3. Gap Assessment for NHS Pavement Assets Based on the FHWA Good and Poor Measures

Category	Good	Poor	Gap* (Good)	Gap* (Poor)
Desired State of Good Repair	**82%**	**4%**		
Interstate				
Current Performance	**63%**	**1%**	**19%**	**-3%**
10-Year Projected Performance	**78%**	**0%**	**4%**	**-4%**
Non-Interstate NHS				
Current Performance	**35%**	**3%**	**47%**	**-1%**
10-Year Projected Performance	**36%**	**0%**	**46%**	**-4%**

Difference when compared to the Desired State of Good Repair.

Bridges

As stated in Chapter 3, the desired state of good repair for NHS bridges is 48 percent deck area based on FHWA NBI standards. For the purposes of this gap assessment, 5% Poor NHS bridge deck area will be used. The goal is to maintain all bridges in good or fair condition, but ARDOT recognizes that even if all bridge needs are addressed as they arise a small percentage of bridges will be in poor condition at any given time. ARDOT used dTIMS to simulate achieving the desired state, and then tabulated the overall percentage of NHS bridges in good, fair, and poor condition when the desired state of good repair is achieved. The good and poor values from this analysis are shown in the table.

This assessment requires the gaps to be calculated for both good and poor ratings for NHS bridges between the desired state of good repair versus the current performance and versus the 10-Year Projected Performance.

The following gaps are noted in Table 4-4:

- A gap of **3 percent** exists between the **Desired State of Good Repair** versus the **Current Performance** for **good structures** (48% vs. 45%).
- A gap of **2 percent** exists between the **Desired State of Good Repair** versus the **10-Year Projected Performance** for **good structures** (48% vs. 46%).
- No performance gap (**-6 percent**) exists between the **Desired State of Good Repair** versus the **Current Performance** for **poor structures** (10% vs. 4%). We are exceeding our stated targets.
- No performance gap (**0 percent**) exists between the **Desired State of Good Repair** versus the **10-Year Projected Performance** for **poor structures** (10% vs. 10%). We are exceeding our stated targets.

Table 4-4. Gap Assessment for NHS Bridges Based on the FHWA Good and Poor Measures (by Deck Area)

Category	Good	Poor	Gap* (good)	Gap* (poor)
Desired State of Good Repair	**48%**	**10%**		
Current Performance	**45%**	**4%**	**3%**	**-6%**
10-Year Projected Performance	**46%**	**10%**	**2%**	**0%**

**** Difference when compared to the Desired State of Good Repair.***

In 2017, ARDOT completed a detailed study on the gap between current funding and funding needed to achieve the desired state of good repair titled *Arkansas State Highway 2016 Needs Study*. This report incorporates 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*. 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.

Since publication of the needs study there have been changes in ARDOT's finances, in part as a result of the State Legislature's response to the study. Chapter 6 describes expected funding levels considering these changes. Given its additional funding, ARDOT expects that the gap between available and needed funds has narrowed. The current dTIMS analysis suggests that increased pavement and bridge funding of $177 million per year would be required to achieve the desired goals, or $1.77 billion over 10 years. Although the gap assessment is specific to the NHS, the increased estimate of funding applies to all APHN pavements and all state-owned bridges. ARDOT nonetheless seeks to reduce the projected gaps where possible. Chapter 6 includes a discussion of ARDOT's investment strategies for addressing these gaps and supporting progress toward achieving our performance targets.

Performance Targets

Pursuant to 23 U.S.C. 150 and 23 CFR 490, State DOTs are required to submit biennial performance reports for recurring four-year performance periods starting in 2018. In the 2022 Baseline Performance Period Report for the period 2022-2025, ARDOT established 2-year and 4-year performance targets for NHS pavements and bridges. For Pavement, federal guidance has directed the use of IRI plus full distresses to establish the good, fair, and poor ratings.

Table 4-5. Performance Targets in the Baseline Performance Period Report submitted in October 2022.

Category	2-Year (2023)	4-Year (2025)
Percent of Interstate Pavements in Good Condition	**54%**	**48%**
Percent of Interstate Pavements in Poor Condition	**5%**	**5%**
Percent of Non-Interstate NHS Pavements in Good Condition	**41%**	**45%**
Percent of Non-Interstate NHS Pavements in Poor Condition	**4%**	**4%**
Percent of NHS Bridges by Deck Area Classified as Good Condition	**39%**	**40%**
Percent of NHS Bridges by Deck Area Classified as Poor Condition	**6%**	**8%**

5. Risk Management & Resiliency

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, building resiliency in transportation asset management (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).

In the context of risk management, resiliency is defined by FHWA as "The ability to anticipate, prepare for, or adapt to changing conditions or withstand, respond to, or recover rapidly from disruptions." Building resiliency into the transportation system helps protect assets against these greater risks by limiting disruptions and eliminating significant downtimes and closures.

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.

Infrastructure Investment and Jobs Act (IIJA) places a greater importance on building resiliency in our infrastructure systems. Specifically, Section 11105 requires State DOTs to consider extreme weather and resilience as part of the life-cycle planning and risk management analyses within a State TAMP resulting from changes to Title 23, United States Code (U.S.C), Section 119€(4) that took effect on October 1, 2021.

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 Procedures for Compliance with the National Bridge Inspection Standards* provides guidance for local agencies in complying with national bridge inspection standards. 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* and the 2014 *Standard Specifications for Highway Construction* provide material testing and acceptance requirements for controlling materials quality.

- **State of Arkansas Hazard Mitigation Plan (HMP)**: This 2018 plan is one of many planning tools utilized in order to make Arkansas more resilient to natural and man-made hazards. The information contained in the 2018 HMP continues to serve as a guide toward community sustainability and the reduction of the state's vulnerability to hazards. Each hazard that poses a significant risk to the State of Arkansas has been assessed using the same methodology, providing historical background, vulnerability, exposure and potential loss. A multi-agency team is currently working on developing the next iteration of the HMP. This update will have heavy focus on resilience, climate issues, equity, and built-infrastructure environments.

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

- **Project risk management:** ARDOT uses the AASHTOWare Project system to help manage its construction projects and minimize risks of cost and schedule overruns. The Department is also examining the feasibility of incorporating the AASHTO Construction and Materials system into its procedures.
- **Consideration of seismic risk in bridge design and inspection:** the northeastern portion of the state lies in the vicinity of the New Madrid fault. This fault subjects the eastern half of the State to seismic risk. ARDOT addresses seismic risk and resiliency in the design process as existing bridges are reconstructed or replaced. All bridges are designed according to seismic provisions in the AASHTO LRFD Bridge Design Specifications or the AASHTO Guide Specifications for LRFD Seismic Bridge Design. The State includes areas in all four Seismic Performance Zones (Categories). In addition, ARDOT developed and published its Earthquake Response Plan, dated April 20, 2015. The purpose of this document is to present the mitigation, preparation, and response plans of the Department in anticipation of a catastrophic earthquake.
- **Geotech Hazards Database:** ARDOT maintains a statewide database of geotechnical hazards. ARDOT Maintenance forces submit information to the Materials Division which is then reviewed and documented by staff geologists. These hazards are assigned a score as part of this review and this database is consulted during the project development phase when the Roadway Design Division submits a soil survey request to the Materials Division. This database is also consulted after emergency events to document changes in the geologic hazard.
- **Geotech Hazard Response:** ARDOT currently has multiple on-call contracts with firms that specialize in stabilization and repair of landslides. These firms specialize in techniques such as drilled rail, soil nails, and other advanced methods and they can respond quickly when needed.
- **LIDAR data:** ARDOT, in cooperation with the Arkansas Geological Survey, is reviewing LIDAR data for landslide hazards across the state.
- **Scour plan of action:** For structures rated to be scour critical, a scour plan of action (POA) is created. Typically, a scour POA has an event (high-water level, design storm, etc.) that triggers a special evaluation of the structure to ensure it is still stable.
- **Robust QC/QA program for bridge design:** ARDOT's Bridge division has a very robust QC/QA program to greatly reduce the chance of a bridge design or detailing error actually being built and put into service. After bridge/structure contracts are let, the Concrete & Steel Fabrication section reviews material invoices and fabricated structural elements to make sure they meet or exceed contract requirements. The Bridge division routinely hosts supplemental training, from outside experts, that is applicable to their structural responsibilities.
- **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 increase its resiliency by distributing 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.

- **Hydraulic Design:** ARDOT's Roadway Design division is currently developing a plan to incorporate adjustment factors for rainfall and average surface temperatures output from the FHWA's CMIP (Coupled Model Intercomparison Project) tool into the design of hydraulic structures. These adjustment factors should allow for consideration of rainfall changes and increased resiliency after future extreme weather events. The Roadway Design Division currently evaluates the 2, 5, 10, 25, 50, 100 and 500 -year design flows on all existing and proposed bridge class structures (greater than 20 feet). If the route is known to be critical, Roadway Design can provide design alternatives for larger than our normal 25-year or 50-year events. The Roadway Design Division's Hydraulics Section, with the cooperation of the ten Districts, collect road closing data, along with flooding reports. This allows the Department to establish histories to justify drainage improvement projects. Some of these drainage improvement projects have been designed to operate at the 500-year storm event or matched the highest recorded flood elevation at the location of the structure. The Hydraulics Section also participates in the re-evaluation of the Department's scour monitoring, modeling, and inspection processes. This is an ongoing activity that seeks to ensure the existing inventory of structures properly are assessed for vulnerability. This is a multidisciplinary effort across several Divisions and Districts. The Department meets all NFIP minimum standards and exceeds these standards with a no-rise requirement to all hydraulic modeling where insurable buildings are inundated during the 100-year flood event.
- **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.
- **Resilience research:** In 2018, ARDOT was aware of the increasing importance of incorporating resiliency into the departments activities and solicited research problem statements to that affect. This process led to the funding of a research project called *TRC2003: Data-Driven Methods to Assess Transportation System Resilience in Arkansas*. This research project is complete, and the final report is expected to be published in late 2022. Building upon a method developed by the Colorado DOT, this report proposes a foundational and repeatable resiliency assessment methodology to identify the most critical and vulnerable highway infrastructure assets in Arkansas. This study developed resiliency metrics that measure the overall network resiliency as a combination of the probability of disruptions in one or more of the network links (threats) and the importance of the link to mobility (criticality). Six criteria were used to estimate system criticality: traffic volume (annual average daily traffic [AADT]), roadway classification, freight output, tourism output, Social Vulnerability Index (SoVI), and redundancy. Three threat types were used to estimate system vulnerability: floods, landslides, and earthquakes.
- **Resiliency Funding:** Funding made available under IIJA for Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Program is included in ARDOT's draft STIP for 2023-2026. This funding will be used to fund projects that will improve the resiliency of the transportation system throughout the state. Eligible projects include evacuation routes, increasing resiliency of existing infrastructure, and efforts to move infrastructure to nearby locations not continuously impacted by extreme weather and natural disasters.
- **Auditing:** ARDOT performs and is subject to a number of types of audits. These help to 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.

- **After-Action Report/Improvement Plans:** After natural disasters, e.g., 2019 flooding on the Arkansas river, ARDOT conducts after-action reviews of the Department's response and compiles the findings into an improvement plan. The goal of the improvement plan is to highlight areas of strength and areas for improvement. This self-review leads to better preparedness for future events and increases the Department's resiliency.

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. This register was most recently updated in March 2022 through another Risk Management Workshop.

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 initial 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

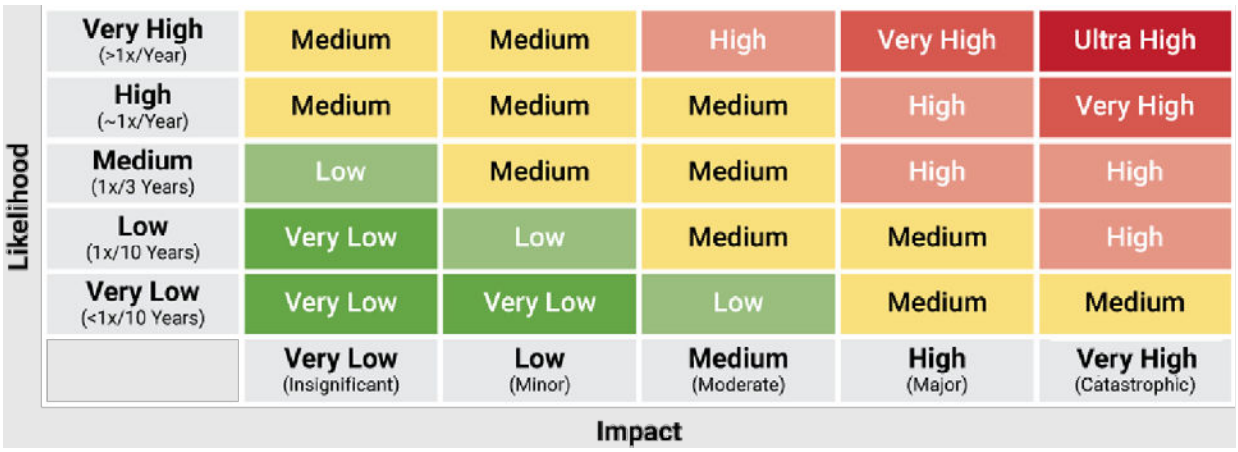


Figure 5-3. Categorization of Risk Likelihood and Impact (Consequence)

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 • Emerging technologies (e.g., autonomous vehicles)	• 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 • Awareness of 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	Risk related to proper project documentation.	• Many programs and products exist here – extensive discussion of these risks and related programs, policy and procedure is likely not necessary

Of the risks identified through the Risk Management Workshops, 18 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 two 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	Pavement Materials Quality	If the materials used on projects are not of sufficient quality then lifecycle costs may increase and performance targets may not be achieved.	Medium	Very High	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	Federal Funding Uncertainty	Uncertainty of future federal funds compromise decisions concerning the prioritization of work.	High	High	High
5	Finances	State Funding	If sufficient state matching funds are not available then some federal funding may not be available.	Low	Very High	High
6	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
7	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
8	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
9	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.	Medium	Very High	High
10	Business Operations	Lack of Maintenance Staff	If we lack experienced maintenance staff we may not be able to perform needed work.	Medium	Very High	High
11	Business Operations	Lack of Engineering Staff	If we lack experienced engineering staff we may not be able to perform needed work.	Medium	Very High	High
12	Business Operations	Lack of Construction Inspection Staff	If we lack capable construction inspection staff, then the quality of work accepted may be substandard.	Medium	Very High	High
13	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.	Medium	Very High	High

ID	Category	Description	Risk Statement	Likelihood	Impact	Risk Priority
14	**Information and Decision Making**	Opportunity to Leverage Technology	If we invest in new technology/software then we can make better data-driven decisions	High	High	High
15	**Asset Performance**	Opportunity for Intersection Innovation	If we use more innovative intersections, then the intersections will have improved capacity/throughput.	High	High	High
16	**Asset Performance**	Declining Asset Condition	If too many assets reach end-of-life at the same time, then available funding may not allow for needed repairs.	Very High	High	Very High
17	**External Threats/**	Cyberterrorism	If IT systems are hacked, then we could see impacts to data loss, business operations, safety, and/or funding,	High	High	High
18	**Business Operations**	Leadership Changes	If leadership (National, State, ARDOT) changes, then investment decisions may change.	Very High	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, 16	Low
D	Work at the Federal and State levels to help resolve challenges related to funding for transportation.	4, 5, 18	High
E	Improve the tracking of what treatments are performed on roads and bridges.	6, 7, 8	High
F	Explore the potential for improving the quality of asset condition data, such as through increased use of non-destructive evaluation.	6, 7, 8, 16	High
G	Articulate the budget needed for pavement data collection and establish a dedicated budget for this function.	6, 7, 8, 16	High
H	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).	9, 12, 13	Low
I	Increase the use of part-time employment to help retain experienced staff members who need employment flexibility.	9, 10, 11, 12, 13	High
J	Improve staff training to build needed skills within ARDOT.	9, 10, 11, 12, 13, 14, 15, 17	High

ID	Description	Addresses Risk(s)	Action Priority
K	Work with Human Resource to define employment incentives that can help staff key roles.	9, 10, 11, 12, 13, 17, 18	Medium
L	Expand use of software to help staff make data-driven decisions.	14, 17	High

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 Associated Mitigation Action: D (Table 5-3) Associated High Priority Risk: 4, 5 (Table 5-2)	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 Associated Mitigation Action: E (Table 5-3) Associated High Priority Risk: 6, 7, 8 (Table 5-2)	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 Associated Mitigation Action: F (Table 5-3) Associated High Priority Risk: 6, 7, 8 (Table 5-2)	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 Status: Completed	• Develop a business plan for pavement data collection activities with an initial focus on an automated pavement data collection vehicle and support staff

Action	Owner	Completion Date	Initial Activities
Review ARDOT employment practices to help recruit and retain needed staff Associated Mitigation Action: H, I, J, K (Table 5-3) Associated High Priority Risk: 9, 10, 11, 12, 13 (Table 5-2)	Human Resources Division	2020 Status: Ongoing	• 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 TAMP Risk Management 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 Information Technology Division, the Program Management Division, the Construction Division, the Human Resources Division, the Materials Division, the Environmental Division, the Roadway Design Division, the Right of Way Division, and the FHWA – Arkansas Division.

The TAMP Risk Management Committee's approach for asset-management related risks is as follows:

- The Committee will maintain an electronic version of the mitigation plan on ARDOT's intranet that will be accessible by ARDOT and FHWA staff.
- The 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 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 2022 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 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.

Work type is defined in 23 CFR 515.5 as construction, maintenance, preservation, rehabilitation, and reconstruction.

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

- Achieving and sustaining a desired state of good repair for the NHS pavements and bridges.
- Improving or preserving asset conditions and the performance of the NHS.
- 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 reviews of *We Move Arkansas*, the Arkansas STIP, and analyses of the projected revenue from Act 1 of 2016, Act 416 of 2019, and Amendment 101 of 2020. 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, which are derived from historical 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.

Statewide Transportation Improvement Program

ARDOT's 2021-2024 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.

Act 1

Act 1 was signed into law in 2016, and thus was not included in the *We Move Arkansas* revenue estimate. It provides approximately $50 million annually for Arkansas' highway system. The revenue comes primarily from interest earned from the securities reserve fund and 25 percent of Arkansas' general revenue surplus or the Governor's rainy-day fund.

Act 416

Act 416 was signed into law in March of 2019, and thus was not included in the *We Move Arkansas* revenue estimate. According to the legislation, the act is meant to "provide additional revenue to maintain and repair highways, streets, and bridges in the state." It provides approximately $95 million annually for Arkansas' highway system. The increases in revenue come primarily from motor fuel tax increases, additional fees for hybrid and electric vehicles, and new casino tax revenues.[1]

[1] A constitutional amendment was approved in November 2018 allowing for four casinos to operate in Arkansas.

Amendment 101

Amendment 101 was approved by voters in November 2020, and thus was not included in the *We Move Arkansas* revenue estimate. This legislatively referred constitutional amendment made permanent a 0.5% sales tax, authorized in 2012, with revenue directed to state and local transportation, including highways, roads, and bridges. The sales tax was temporarily authorized by voters in 2012 and set to expire in 2023. It is expected to generate $205 million annually for Arkansas' highway system.

TAM Funding Sources

The funding that ARDOT anticipates could reasonably be used for asset management purposes is detailed in Table 6-2 below.

Table 6-2. ARDOT Asset Management Funding Sources

Funding Sources	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
Federal Funds with State Match	$544	$559	$570	$596	$632	$657	$683	$710	$738	$768	**$6,457**
State Funds - Act 1	$50	$50	$50	$50	$50	$50	$50	$50	$50	$50	**$500**
State Funds - Act 416	$93	$100	$102	$102	$102	$103	$104	$105	$106	$107	**$1,024**
State Funds - Amendment 101	$0	$50	$244	$246	$249	$251	$254	$257	$260	$263	**$2,074**
Total	**$687**	**$759**	**$966**	**$994**	**$1,033**	**$1,061**	**$1,091**	**$1,122**	**$1,154**	**$1,188**	**$10,055**

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

ARDOT funding sources are projected to rise from $687 million in 2022 to $1,188 million in 2031. The State Funds - Amendment 101 amounts represent the projected increases in state revenue beginning in 2023 from Amendment 101. Over the 10-year period, funding sources are projected to provide a total of $10,055 million for asset management purposes.

Funding Uses

Funding for asset management purposes was established relative to other uses in the development of *We Move Arkansas* and the STIP. 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*.

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 (including resiliency and extreme weather) described in Chapter 5 that are not explicitly addressed in the scenario analysis.

Federal guidance regarding the TAMP establishes the use of Federal work types of initial construction, maintenance, preservation, rehabilitation, and reconstruction. ARDOT uses different terms to describe the work type of projects. Some of the terms used by ARDOT include intersection improvement, major widening, new interchange, new location, passing lane, structures and approaches, and system preservation. At this time, ARDOT work types do not correlate with the Federal work types. However, an attempt was made to project funding allocations for pavement and bridge improvements based on Federal work types. Table 6-3 shows the relationship between ARDOT and Federal work types. Table 6-4 shows the results of this effort.

Table 6-3. ARDOT Work Types

Federal Work Type	ARDOT Work Type
Construction	Intersection Improvements, Major Widening, New Interchange, New Location, Noise Abatement, Passing Lane(s), RR Grade Separation, Structure(s) & Approaches
Reconstruction	Reconstruction
Rehabilitation	Rehabilitation
Preservation	System Preservation
Maintenance	Maintenance projects/work is not programmed in the STIP.

In order to determine the projected funding allocations shown below, totals for NHS and Non-NHS projects were calculated from all projects in the 2021-2024 STIP. These amounts were then broken out by pavement and bridge totals. Projects on the NHS were then further broken down by federally mandated work types. The percentage of these amounts were then used to allocate the yearly totals from Table 6-2 into the different categories shown in Table 6-4.

It is important to note that Table 6-4 does not establish funding levels for future STIPs. The funding distribution shown identifies a potential scenario for the next 10 years based on how the 2021-2024 STIP was allocated. Future funding allocations often require adjustments to respond to the needs and priorities of yet to come events. The information contained in this TAMP is to be used as a planning tool and does not constrain ARDOT to future commitments.

Table 6-4. ARDOT Asset Management Funding Projections

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
Asset Management Uses											
Pavement											
NHS											
Construction	$251	$269	$354	$365	$379	$390	$401	$411	$423	$435	**$3,678**
Preservation	$75	$80	$106	$109	$114	$116	$119	$123	$126	$130	**$1,098**
Rehabilitation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
Total NHS Pavement	**$326**	**$349**	**$460**	**$474**	**$493**	**$506**	**$520**	**$534**	**$549**	**$565**	$4,776
Non-NHS											
Total Non-NHS Pavement	**$266**	**$285**	**$377**	**$387**	**$403**	**$414**	**$426**	**$438**	**$450**	**$463**	$3,909
Total Pavement	**$592**	**$634**	**$837**	**$861**	**$896**	**$920**	**$946**	**$972**	**$999**	**$1,028**	**$8,685**
Bridge											
NHS											
Construction	$19	$26	$27	$27	$28	$29	$30	$31	$32	$33	**$282**
Preservation	$4	$5	$5	$6	$6	$6	$6	$6	$6	$6	**$56**
Rehabilitation	$6	$6	$7	$7	$7	$7	$7	$8	$8	$9	**$72**
Total NHS Bridge	**$29**	**$37**	**$39**	**$40**	**$41**	**$42**	**$43**	**$45**	**$46**	**$48**	$410
Non-NHS											
Total Non-NHS Bridge	**$66**	**$88**	**$90**	**$93**	**$96**	**$99**	**$102**	**$105**	**$109**	**$112**	$960
Total Bridge	**$95**	**$125**	**$129**	**$133**	**$137**	**$141**	**$145**	**$150**	**$155**	**$160**	**$1,370**
Totals											
NHS											
Construction	$270	$295	$381	$392	$407	$419	$431	$442	$455	$468	**$3,960**
Preservation	$79	$85	$111	$115	$120	$122	$125	$129	$132	$136	**$1,154**
Rehabilitation	$6	$6	$7	$7	$7	$7	$7	$8	$8	$9	**$72**
Total NHS	**$355**	**$386**	**$499**	**$514**	**$534**	**$548**	**$563**	**$579**	**$595**	**$613**	$5,186
Non-NHS											
Total Non-NHS	**$332**	**$373**	**$467**	**$480**	**$499**	**$513**	**$528**	**$543**	**$559**	**$575**	$4,869
Total Pavement & Bridge	**$687**	**$759**	**$966**	**$994**	**$1,033**	**$1,061**	**$1,091**	**$1,122**	**$1,154**	**$1,188**	**$10,055**

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

Funding for pavements include investments for Interstates, APHN, and Non-APHN. Total funding for pavements is projected to be $592 million in 2022, rising to $1,028 million in 2031. While investments in both NHS and Non-NHS pavement benefit from the projected increases in revenue from Act 416 starting in 2020, the anticipated retirement of the GARVEE bonds in 2025 only impacts NHS pavement as these funds are allocated for Interstate improvements.

Funding for bridges is projected to be $95 million in 2022, rising to $160 million in 2031.

Asset Valuation

As noted above, for financial reporting, ARDOT calculates asset value based on the standard approach described in Governmental Accounting Standards Board (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 Standards 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 documented 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 $370 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 0 (worst condition).
  - 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. NCHRP Report 898 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 funding level described above is expected to result in improved pavement conditions. Thus, no additional investment is required to maintain asset value. For NHS bridges, the additional cost required to restore value is assumed to be equal to the cost of reducing the predicted percentage of bridges in poor condition in 2031 to the current value.

Table 6-5 summarizes the asset value calculations for NHS pavements and bridges. As indicated in Table 6-5, the GRC of NHS pavements and bridges is approximately $29.3 billion. The DRC of these assets is approximately $15.5 billion. No additional investment is required to maintain asset value for pavements beyond that shown in Table 6-4. An increase in investment of $143 million is required over the 10-year period from 2022 to 2031 to maintain asset value for bridges.

Table 6-5. NHS Asset Valuation Summary

Asset	Gross Replacement Cost	Current Depreciated Replacement Cost	Additional Investment Required to Restore Value (2022-2031)
	(x $1 Million)		
Interstate	$5,457	$3,329	$0
Non-Interstate	$10,897	$4,577	$0
Pavement Totals	**$16,354**	**$7,906**	**$0**
Bridge Totals	**$12,982**	**$7,642**	**$143**
Grand Total	**$29,336**	**$15,548**	**$143**

Note: all values are shown in 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 both the State and Federal goals and targets, along with the desired state of good repair as well as closing any performance gaps. The strategies incorporate asset modeling, treatments, and impacts, as well as risks (including extreme weather and resiliency) and financial constraints.

It is important to note that the investment strategy discussed below identifies a scenario based on how the 2021-2024 STIP was programmed. Future funding allocations often require adjustments to respond to the needs and priorities of future events. The investment strategy discussed here is to be used as a planning tool and does not constrain ARDOT from making adjustments to future TAMPs or STIPs.

As outlined in Chapter 6, ARDOT has approximately $687 million available for asset management purposes in FFY 2022. See Table 6-2 for a listing of the sources of this amount.

Pavements

In order to break these funds down to the level needed for the implementation demonstration, previous STIPs were examined and it was found that approximately 51% of the funds were allocated to the NHS as shown in Table 6-6. It is anticipated this will continue for FFY 2022.

- **Pavement Preservation** – ARDOT set a goal to allocate $304 – $354 million in FFY 2022 for pavement preservation projects.
- **Capital and Capacity** – ARDOT set a goal to allocate $188 – $238 million in FFY 2022 for capital and capacity projects.
- **Interstates** – ARDOT has historically allocated $100 million annually for improvements of our Interstates. Bond or debt payments for the Interstate Rehabilitation Program will continue until 2025. The bond or debt payment for FFY 2022 is $50 million. The amount available for projects to improve the Interstates in FFY 2022 is $50 million. All of these funds will be spent on the NHS since all Interstates are on the NHS.

Table 6-6. Summary of ARDOT Pavement Investment Strategy

FFY 2022 Pavement Investment Strategy	Available Funding	NHS	Non-NHS
	(x $1 million)		
Pavement Preservation (51% NHS – 49% Non-NHS)	$275 – 325	$140 – 165	$135 – 160
Capital and Capacity (51% NHS – 49% Non-NHS)	$217 – 267	$110 – 135	$107 – 132
Interstates (100% NHS)	$50	$50	$0
Total of Pavement Investment	$592	$326	$266

Bridges

As mentioned in Chapter 1 of the TAMP, ARDOT is responsible for almost 7,400 state-owned bridges, of which only 2300 (31%) are on the NHS. The Bridge funding component of ARDOT's investment strategy has historically dedicated $95 million for bridge construction, replacement, rehabilitation, and preservation. These funds are further allocated into approximately $72 million for construction or replacement, $14 million for rehabilitation, and $9 million for preservation. This allocation is based on the needed improvement to the structure. Therefore, the actual amounts can and do vary.

As mentioned earlier, ARDOT uses the APHN and Non-APHN networks to plan its investment strategies. To estimate the NHS funding levels for the TAMP, recent spending was analyzed and ARDOT estimates the NHS funding levels for bridges as follows.

- For construction or replacement, analysis of recent spending revealed that 67% of this funding was spent on the Non-NHS.

This breakdown, shown below in Table 6-7, provides ARDOT with planned NHS bridge expenditures of $29 million for FFY 2022.

Table 6-7. Summary of ARDOT Bridge Investment Strategy

FFY 2022 Bridge Investment Strategy	Available Funding	NHS	Non-NHS
	(x $1 million)		
Bridge Funding	$95		
Construction/Replacement		$19	$53
Rehabilitation		$6	$8
Preservation		$4	$5
BRIDGE TOTALS	$95	$29	$66

Total Investment

Therefore, the following table identifies the total investment in the Arkansas State Highway System.

Table 6-8. Summary of Total Investment

FFY 2022 Investment Strategy	Available Funding	NHS	Non-NHS
	(x $1 million)		
Pavement	$592	$300	$242
Bridge	$95	$29	$66
Total Investment	$687	$329	$308

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 highway funding program relies heavily on federal funds, 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 pavement conditions, such as the international roughness index (IRI),

rutting, and cracking for asphalt pavements, while IRI, faulting, and fractured slabs are applied to concrete pavements. 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.

- **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.