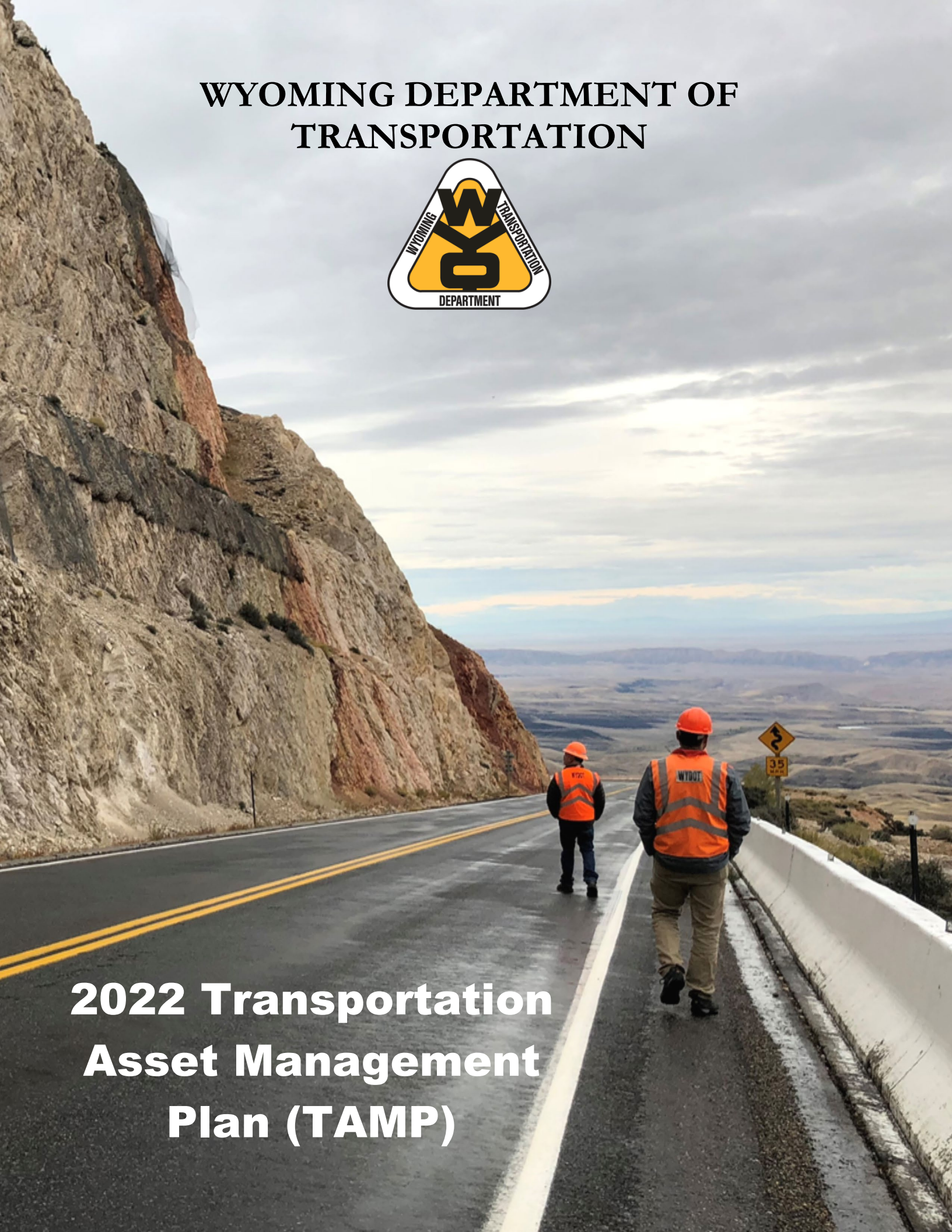
WYOMING DEPARTMENT OF TRANSPORTATION



2022 Transportation Asset Management Plan (TAMP)

Mark Gordon
Governor

WYOMING Department of Transportation

"Provide a safe and effective transportation system"

5300 Bishop Boulevard, Cheyenne, Wyoming 82009-3340

K. Luke Reiner
Director

July 13, 2022

Monica Gourdine, Interim Division Administrator
Federal Highway Administration
2617 E. Lincolnway, Suite D
Cheyenne, WY 82001-5671

Dear Ms. Gourdine:

In compliance with Federal Law 23 U.S.C. 119(e), the Bipartisan Infrastructure Law (BIL), and in conjunction with the Moving Ahead for Progress in the 21st Century Act (MAP-21), the Wyoming Department of Transportation is pleased to submit our 2022 Transportation Asset Management Plan (TAMP) to the Federal Highway Administration.

If you have any questions or comments, please let us know.

Sincerely,

K. Luke Reiner
Director, WYDOT

TABLE OF CONTENTS

1. INTRODUCTION 6

1.1 Transportation Asset Management 6
1.2 Objectives and Measures 8

2. ASSET INVENTORY 11

2.1 Pavement Inventory and Condition Assessment 11
2.1.1 Pavement Inventory 11
2.1.2 Pavement Conditions 11
2.2 Bridge Inventory and Condition Assessment 18
2.2.1 Bridge Inventory 18
2.2.2 Bridge Conditions 19

3. LIFE-CYCLE PLANNING 22

3.1 Life-Cycle Cost Analysis 22
3.2 Pavement LCCA 23
3.2.1 PMS Performance and Cost Models 25
3.2.2 Pavement Work Types 26
3.2.3 Pavement Maintenance 28
3.2.4 Traffic Demand 29
3.3 Bridge LCCA 30
3.3.1 BMS Performance, Cost, and Structure Improvement Models 30
3.3.2 Bridge Work Types 32

4. PERFORMANCE MANAGEMENT 34

4.1 Performance Measures and Gap Analysis 34
4.2 Pavement Performance Targets 36
4.3 Bridge Performance Targets 40

5. FINANCIAL SUMMARY 43

5.1 Financial Plan 43
5.2 Transportation Funding 44
5.3 Highway Construction Expenditures 46
5.4 Investment Strategies 48

6. RISK MANAGEMENT 53

6.1 Risk Analysis 53
6.1.1 Agency Risks 53
6.1.2 Program Risks 54
6.1.2.1 Risks to Pavements 55
6.1.2.2 Risks to Bridges 55
6.1.3 Project Risks 56
6.2 Risk Management Plan Development Process 56
6.3 System Resiliency 61
6.4 Evaluation of Emergency Events 63

7. ASSET MANAGEMENT IMPROVEMENT PROCESS 65
7.1 Evolving TAM Practices 65
7.2 Trade-Off Analysis 65
8. APPENDICES 67
8.1 Appendix A: Programming Investment Summary 67
8.2 Appendix B: Evaluation of Emergency Events 69

List of Tables

TABLE 1 TAMP Working Group 7
TABLE 2 WYDOT Pavement Inventory 11
TABLE 3 Pavement Condition Metrics 12
TABLE 4 FHWA Pavement Condition Thresholds 13
TABLE 5 FHWA Pavement Measure Calculation 13
TABLE 6 Statewide Pavement Conditions 17
TABLE 7 WYDOT Bridge Inventory 19
TABLE 8 NHPP Bridge Performance Condition Ratings 20
TABLE 9 WYDOT Bridge Conditions 21
TABLE 10 PMS Modeling Costs 25
TABLE 11 Annual Maintenance Costs for Pavements 29
TABLE 12 BMS Cost Models 31
TABLE 13 Structure Replacement Costs 32
TABLE 14 National Performance Measures 34
TABLE 15 Asset Category Descriptions 52
TABLE 16 Top Rated Risks 59
TABLE 17 Risk Register 59

List of Figures

FIGURE 1 TAMP Development Process 7
FIGURE 2 WYDOT Mission 8
FIGURE 3 National Transportation System Goal Areas 9
FIGURE 4 Visual Example of Pavement Conditions 13
FIGURE 5 Current Interstate Pavement Conditions 14
FIGURE 6 Current Non-Interstate NHS Pavement Conditions 15
FIGURE 7 Current Non-NHS Pavement Conditions 16
FIGURE 8 PQR Index 17
FIGURE 9 Statewide Pavement Condition Performance History 18
FIGURE 10 Example of Bridge Schematic 20
FIGURE 11 Statewide Bridge Condition Performance History 21
FIGURE 12 Pavement Life-cycle Model 24
FIGURE 13 Wyoming Interstate Pavement Conditions Utilizing FHWA Standard Criteria 36
FIGURE 14 Wyoming Non-Interstate NHS Pavement Conditions Utilizing FHWA Standard Criteria 37
FIGURE 15 Wyoming Non-NHS Pavement Conditions Utilizing WYDOT's Composite Index 37
FIGURE 16 Percent of Pavement Miles in Poor Condition & Preservation Effects 39
FIGURE 17 Interstate Pavement Condition Projections 39
FIGURE 18 Non-Interstate NHS Pavement Condition Projections 39
FIGURE 19 Non-NHS Pavement Condition Projections 40
FIGURE 20 Effects of Bridge Funding on NHPP Performance Ratings 41
FIGURE 21 All NHS Structures Predicted NHPP Performance Ratings 41
FIGURE 22 Wyoming Interstate Structures Predicted NHPP Performance Ratings 42
FIGURE 23 Wyoming Non-Interstate NHS Structures Predicted NHPP Performance Ratings 42
FIGURE 24 Wyoming Non-NHS Structures Predicted NHPP Performance Ratings 42
FIGURE 25 Historic & Projected STIP Expenditures Statewide 47
FIGURE 26 Annual Pavement & Bridge Program Expenditures 47
FIGURE 27 2022 Transportation Commission Funding Allocations 48
FIGURE 28 Investment Planning Process 49
FIGURE 29 Statewide Significant Corridors 50
FIGURE 30 Example of Landslide Roadway Hazard 54
FIGURE 31 Risk Management Plan Development 57
FIGURE 32 Risk Ratings Matrix 58

List of Acronyms

AADT	Annual Average Daily Traffic
BIL	Bipartisan Infrastructure Law (BIL)
BIRM	Bridge Inspection Reference Manual
BMS	Bridge Management System
CFR	Code of Federal Regulation
CMAQ	Congestion Mitigation & Air Quality
DOT	Department of Transportation
ERP	Enterprise Resource Program
FAST ACT	Fixing America's Surface Transportation (FAST) Act
FDR	Full Depth Reclamation
FHWA	Federal Highway Administration
FMIS	Federal Management Information System
GASB	Governmental Accounting Standards Board
HPM	Hot Plant Mix
HTF	Highway Trust Fund
HPMS	Highway Performance Monitoring System
HSIP	Highway Safety Improvement Program
IRI	International Roughness Index
LCCA	Life-Cycle Cost Analysis
LCP	Life-Cycle Planning
LRTP	Long-Range Transportation Plan
LTPP	Long-Term Pavement Performance
MAP-21	The Moving Ahead for Progress in the 21st Century (MAP-21) Act
MBEI	Manual for Bridge Element Inspection
MERRA-2	Modern-Era Retrospective Analysis for Research and Applications
NEPA	National Environmental Protection Agency
NBI	National Bridge Inventory
NHPP	National Highway Performance Program
NHS	National Highway System
PMP	Plant Mix Pavement
PMS	Pavement Management System
PPD	Presidential Policy Directive
PRR&R	Preservation, Repair, Rehabilitation, and Replacement program
PQR	Pavement Quality Rating
SOGR	State of Good Repair
SMS	Safety Management System
STBG	Surface Transportation Block Grant
STIP	Statewide Transportation Improvement Program
TAM	Transportation Asset Management
TAMP	Transportation Asset Management Plan
USC	United States Code
WYDOT	Wyoming Department of Transportation

1. INTRODUCTION

1.1 TRANSPORTATION ASSET MANAGEMENT

Transportation infrastructure assets such as pavements and bridges form the basis for a safe and reliable transportation system. Infrastructure assets represent a substantial public investment, and continuous investments must be infused into the network to maintain a fully functioning and operationally sound system. The purpose of this risk-based Transportation Asset Management Plan (TAMP) is to establish the strategic and systematic processes the Wyoming Department of Transportation (WYDOT) intends to use for maintaining and improving its transportation infrastructure assets over the next 10 years.

Due to its aging transportation system and relatively flat funding levels, WYDOT has adopted a preservation strategy of asset management, which prioritizes maintenance and preservation of the State's existing pavement and bridge assets over system modernization and expansion. The objective of this plan is to develop the set of principles and investment strategies that will achieve desired service levels across Wyoming's transportation network. This plan serves to outline the processes through which the agency intends to align its asset management objectives with overarching national performance goals to facilitate a sustainable program for managing Wyoming's roads and bridges. Transportation asset management (TAM) is a long-term, multi-disciplinary approach to managing infrastructure assets cost effectively, which dictates the timely, systematic implementation of preservation and maintenance activities to keep assets functioning at their desired level of service, while preventing conditions from deteriorating to an extent where more expensive rehabilitation treatments are required.

MAP-21 Definition of Asset Management

Asset management is defined 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." [23 USC, Sec. 101 (a) (2)].

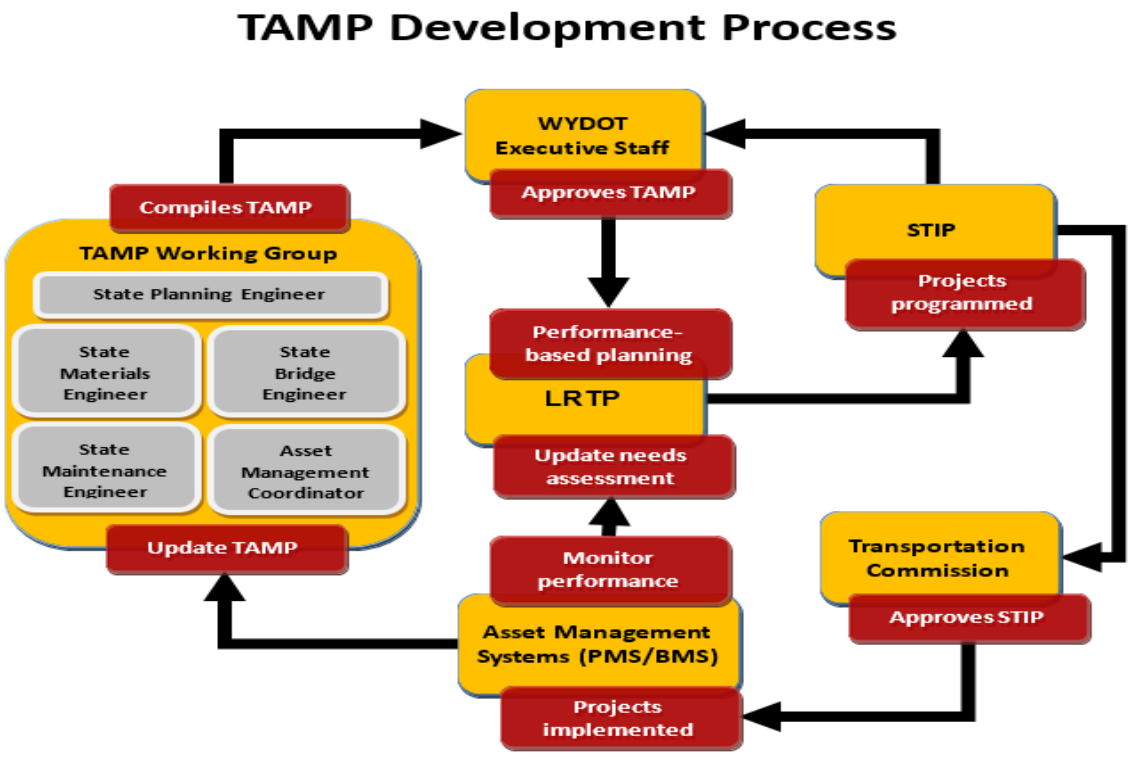
WYDOT's Planning Program coordinates and compiles the TAMP in conjunction with the TAMP Working Group. The processes formulated in this TAMP were developed with the assistance of the agency's program managers, subject matter experts, and various data stewards. Members of the TAMP Working Group include the State Planning Engineer, Systems Planning Engineer, State Materials Engineer, State Bridge Engineer, and the State Maintenance Engineer. Executive staff provided additional guidance regarding the long-term strategic direction of the agency, target setting, and the Financial Plan.

TABLE 1: TAMP WORKING GROUP

TAMP Working Group	Role in TAMP Development
State Planning Engineer	Serves as executive of the TAMP Working Group
State Materials Engineer	Compiles statewide pavement inventory, conditions & life-cycle costs
State Bridge Engineer	Compiles statewide bridge inventory, conditions & life-cycle costs
State Maintenance Engineer	Compiles statewide maintenance costs
State Systems Planning Engineer	Coordinates financial plan and investment strategies
Asset Management Coordinator	Generates draft document; coordinates between programs
WYDOT executive staff provides guidance and approval of final TAMP.	

The TAMP is considered a "living" document, which is regularly reviewed and updated in coordination with the implementation of WYDOT's asset management systems. Development of the TAMP required input from a number of program sources, including outputs from the management systems, district needs assessment, corridor studies, and cohesion with the agency's strategic vision and long range plan. Final review and approval of the TAMP is made by executive staff. WYDOT has incorporated its asset management policies into internal operating procedures and planning processes to further strengthen and support its national performance management objectives. Figure 1 provides an overview of WYDOT's TAMP development process.

FIGURE 1: TAMP DEVELOPMENT PROCESS



1.2 OBJECTIVES AND MEASURES

Federal Law 23 U.S.C. 119(e), in conjunction with the Moving Ahead for Progress in the 21st Century (MAP-21) Act and the Fixing America's Surfacing Transportation (FAST) Act, mandated that all State DOTs develop and implement a risk-based asset management plan for the National Highway System (NHS) to improve or preserve the condition and performance of the NHS. TAMP requirements were further amended by the Bipartisan Infrastructure Law (BIL) (§ 11105), which was signed into law on November 15, 2021. In order to meet the federal requirements, WYDOT has developed a TAMP that includes the following elements:

1. Inventory and condition of pavement and bridge assets on the NHS,
2. Asset management objectives and measures,
3. Performance-gap analysis between goals and condition,
4. Life-cycle cost and risk-based management analyses,
5. Financial plan for the future, and
6. Investment strategies

The primary objective of WYDOT's asset management program is to implement timely preservation and maintenance activities that facilitate and best maintain an acceptable level of service, thereby minimizing the effects of deterioration to existing assets. A preservation-based approach to asset management aligns with WYDOT's overall mission of providing a safe and effective transportation system. The guiding principles listed in Figure 2 were established with a focus on WYDOT's purpose, mission, vision, and agency goals, all of which are intended to support Wyoming's economy, while safely connecting communities and improving quality of life. WYDOT's guiding principles are listed in order of importance, and are tied to the MAP-21 TAMP elements for stewardship and resource management. Compared to past transportation legislation, MAP-21 required more performance analysis and overall administration; however, MAP-21 reduced category-specific funding areas (from 13 to six), allowing more flexibility in how states direct available funding. The Fixing America's Surface Transportation (FAST) Act passed in December 2015 added a seventh funding area but did not change the TAMP and performance requirements previously defined in the MAP-21

FIGURE 2: WYDOT MISSION

	WYDOT MISSION
	Provide a safe and effective transportation system
	AGENCY GOALS
	Ensure a vibrant, safe and competent workforce
	Acquire and responsibly manage resources
	Provide safe, reliable and effective transportation systems
	Provide essential public safety services and effective communication systems
	Create and enhance partnerships with transportation stakeholders
	Encourage and support innovation
	Preserve our history and heritage
	GUIDING PRINCIPLES
1	Align type of expenditures with appropriate and available revenue source
2	Address identified critical life safety issues
3	Preserve WYDOT assets
4	Improve operational effectiveness and efficiency
5	Minimize activities that negatively impact the public
6	Address mobility and capacity through system improvements and enhancements

Source: WYDOT 2021-2023 Strategic Plan

legislation. The recently passed BIL legislation further required State DOT TAMPs to take into consideration extreme weather and resilience as part of the TAMP life-cycle cost and risk management analyses.

The basis for this legislation was to promote consistency across the national transportation system, and to strengthen accountability and transparency in the stewardship of public transportation resources. MAP-21 funding areas are intended to facilitate resource allocations to those areas where improvements are most needed, and aid in monitoring the performance of the NHS system. The national performance measures relate to infrastructure management, safety enhancements, congestion mitigation, system reliability, freight movement and economic vitality, environmental sustainability, and reduced project delivery delays.

FIGURE 3: NATIONAL TRANSPORTATION SYSTEM GOAL AREAS

Increase Safety	Infrastructure Conditions	Congestion Reduction	System Reliability	Freight Movement & Economic Vitality	Environmental Sustainability	Reduced Project Delivery Delays
						
Reduce traffic fatalities & serious injuries on all public roads	*Maintain the NHS in a state of good repair*	*Reduce congestion on the NHS*	*Improve the efficiency of the surface transportation system*	*Improve the national freight network*	*Enhance performance of the transportation system while protecting the natural environment*	*Reduce project costs, accelerate project completion through eliminating delays in the project development and delivery process*

Source: 23 U.S.C. 150

Furthermore, should a state fail to meet the minimum conditions for bridges or pavements as outlined in the federal requirements, or if asset conditions deteriorate below federal minimum performance thresholds, and significant progress has not been made toward rectifying the deficiencies, then federal funding penalties may occur:

> *(f) INTERSTATE SYSTEM AND NHS BRIDGE CONDITIONS.—*
>
> *(1) CONDITION OF INTERSTATE SYSTEM.—*
>
> *(A) PENALTY—If a State reports that the condition of the Interstate System, excluding bridges on the Interstate System, has fallen below the minimum condition level established by the Secretary under section 150(c)(3), the State shall be required, during the following fiscal year—*
>
> *(i) to obligate, from the amounts apportioned to the State under section 104(b)(1), an amount that is not less than the amount of funds apportioned to the State for fiscal year 2009 under the Interstate maintenance program for the purposes described in this section (as in effect on the day before the date of enactment of the MAP-21), except that for each year after fiscal year 2013, the amount required to be obligated*

under this clause shall be increased by 2 percent over the amount required to be obligated in the previous fiscal year; and

(ii) to transfer from the amounts apportioned to the State under section 104(b)(2) (other than amounts sub allocated to metropolitan areas and other areas of the State under section 113(d)) to the apportionment of the State under section 104(b)(1), an amount equal to 10 percent of the amount of funds apportioned to the State for fiscal year 2009 under the Interstate Maintenance program for the purposes described in this section (as in effect on the day before the date of enactment of MAP-21).

(B) RESTORATION.—The obligation requirement for the Interstate System in a State required by subparagraph (A) for a fiscal year shall remain in effect for each subsequent fiscal year until such time as the condition of the Interstate System in the State exceeds the minimum condition level established by the Secretary.

(2) CONDITION OF THE NHS BRIDGES.—

(A) PENALTY—If the Secretary determines that, for the 3-year-period preceding the date of the determination, more than 10 percent of the total deck area of bridges in the State on the National Highway System is located on bridges that have been classified as structurally deficient, an amount equal to 50 percent of the funds apportioned to such State for fiscal year 2009 to carry out section 144 (as in effect the day before enactment of MAP-21) shall be set aside from amounts apportioned to a State for a fiscal year under section 104(b)(1) only for eligible projects on bridges on the National Highway System.

(B) RESTORATION—The set-aside requirement for bridges on the National Highway System in a State under subparagraph (A) for a fiscal year shall remain in effect for each subsequent fiscal year until such time as less than 10 percent of the total deck area of bridges in the State on the National Highway System is located on bridges that have been classified as structurally deficient as determined by the Secretary. [§1106; 23 USC 119(f)]

2. ASSET INVENTORY

2.1 PAVEMENT INVENTORY AND CONDITION ASSESSMENT

2.1.1 Pavement Inventory

Wyoming's highways are divided into three systems: Interstate, Non-Interstate NHS, and Non-NHS. Interstates are high-speed, controlled-access four-lane highways that carry the highest traffic volumes and the most freight load. Non-Interstate NHS routes are federally designated roadways that are functionally classified as Principal Arterials, and have been designated as important to the nation's economy, defense and mobility. Non-NHS highways encompass all other roadways managed by the State. The Wyoming roadway network consists of 24,068 centerline miles (including NHS mileage owned or controlled by federal or local governments), of which 6,735 miles are managed by WYDOT. Pavement assets also include other roadway segments such as interstate ramps, service roads, frontage roads, and turnouts, which are not measured or actively managed as part of its pavement network. WYDOT's Pavement Inventory Mileage has been summarized by ownership and district in the following table:

TABLE 2: WYDOT PAVEMENT INVENTORY

Wyoming Pavement Inventory (Ownership based on Centerline Miles)							
	District 1	District 2	District 3	District 4	District 5	Yellowstone	Total
NHS							
Interstate	257	241	187	237	-	-	922
Non-Interstate NHS	100	514	390	316	757	-	2,077
Non-WYDOT NHS	-	-	55	-	1	6	62
Total NHS	357	755	632	553	758	6	3,061
Non-NHS							
State	774	798	814	745	605	-	3,736
Non-WYDOT	3,212	4,399	2,781	3,457	3,181	241	17,271
Total Non-NHS	3,986	5,197	3,595	4,202	3,786	241	21,007
TOTALS	4,343	5,952	4,227	4,755	4,544	247	24,068

Source: WYDOT 2021 HPMS Submittal

2.1.2 Pavement Conditions

The Pavement Management Section within the Materials Program manages the inventory and condition of all WYDOT-maintained roads using the Pavement Management System (PMS), which is a highly specialized asset management software hosted by Agile Assets in an Oracle database. The PMS houses the comprehensive collection of WYDOT's historical and current pavement condition data, and stores the various pavement section analyses used for performance modeling. The objective of the PMS is to estimate future predicted pavement conditions, provide relevant asset condition information to facilitate effective project selection and design of pavement preservation and rehabilitation activities, and display

condition analysis results in an understandable format for WYDOT executive staff and Wyoming's legislators to interpret pavement condition funding requirements. The PMS uses historical data along with current conditions to predict future deterioration and prioritize pavement asset needs based on given funding scenarios. WYDOT uses the results of the PMS data analyses to produce the list of recommended pavement section candidates and associated treatment strategies.

To assess current and projected pavement conditions, WYDOT uses its PMS to fulfill the requirements for FHWA's Highway Performance Monitoring System (HPMS) for annual reporting on pavement conditions. HPMS reporting consumes a large part of WYDOT's activities and ongoing pavement condition analysis efforts. HPMS reporting pavement condition ratings are based on the combination of ride quality (International Roughness Index, i.e. IRI), rutting, faulting, and cracking.

TABLE 3: PAVEMENT CONDITION METRICS

Metric	Description
IRI	International Roughness Index is a method for measuring the smoothness or roughness of pavements, with higher values indicating greater distress.
Cracking	A fissure or discontinuity in the pavement surface measured in terms of the total percentage of cracked pavement surface, due to or accelerated by excessive loading, poor drainage, frost heaves or temperature changes.
Rutting	Lengthwise surface depressions within the wheel path that result in permanent deformation of the pavement and/or subgrade, caused by heavy traffic loads and heavy vehicles.
Faulting	Distress quantified for concrete pavements, which occurs when adjacent pavement slabs are vertically misaligned, due to slab settlement, curling, or warping.

WYDOT utilizes a third-party consultant for statewide pavement data collection. All NHS roadways in Wyoming are measured for asset condition under WYDOT's pavement data collection contract. Non-Interstate NHS roads that are federally or locally owned are measured for performance under WYDOT's data collection contract, but not actively managed by the PMS. Data collected on non-WYDOT owned roadways are shared with other NHS owners. Since the proportion of NHS controlled by other NHS owners represents such a small proportion of total Wyoming roadways (approximately 62 total miles), WYDOT tracks and maintains the asset conditions on behalf of these other NHS owners. WYDOT works with the other NHS owners on any work that is required to maintain these small sections, by providing recommendations on work treatment types when they are needed. No other sub-groups are excluded in the PMS analysis.

WYDOT collects annual data on the Interstate System and biennial data on the Non-Interstate NHS and Non-NHS routes (alternating years between NHS and non-NHS collection). Data is stored and available for decision makers and pavement designers to assess current and projected roadway needs. Pavement condition data includes ride quality (IRI), rut depth, cracking, faulting, and friction of each section. WYDOT measures the condition of each pavement management segment annually or biennially (depending on the system), and a detailed history of the construction treatments is continuously maintained within the PMS. Pavement condition ratings are classified as good, fair, or poor relative to each condition threshold (Table 4), and then combined for an overall section condition rating (Table 5). WYDOT's pavement data has been collected in this manner since 2016.

Table 4: FHWA Pavement Condition Thresholds

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

Table 5: FHWA Pavement Measure Calculation

Pavement Type			
	Asphalt and Jointed Concrete	Continuous Concrete	
Overall Section Condition Rating	3 metric ratings (IRI, cracking & rutting/faulting)	2 metric ratings (IRI & cracking)	Measures
Good	All 3 metrics rated "Good"	Both metrics rated "Good"	% of lane-miles in "Good" condition
Poor	≥ 2 metrics rated "Poor"	Both metrics rated "Poor"	% of lane-miles in "Poor" condition
Fair	All other combinations	All other combinations	

Figure 4: Visual Example of Pavement Conditions

Interstate, Non-Interstate NHS, and Non-NHS pavement condition data were collected and analyzed in accordance with HPMS reporting requirements. The following maps depict Wyoming's pavement conditions for routes by system (Interstate, Non-Interstate NHS, and Non-NHS) based on the 2021 HPMS submittal.

FIGURE 5: CURRENT INTERSTATE PAVEMENT CONDITIONS

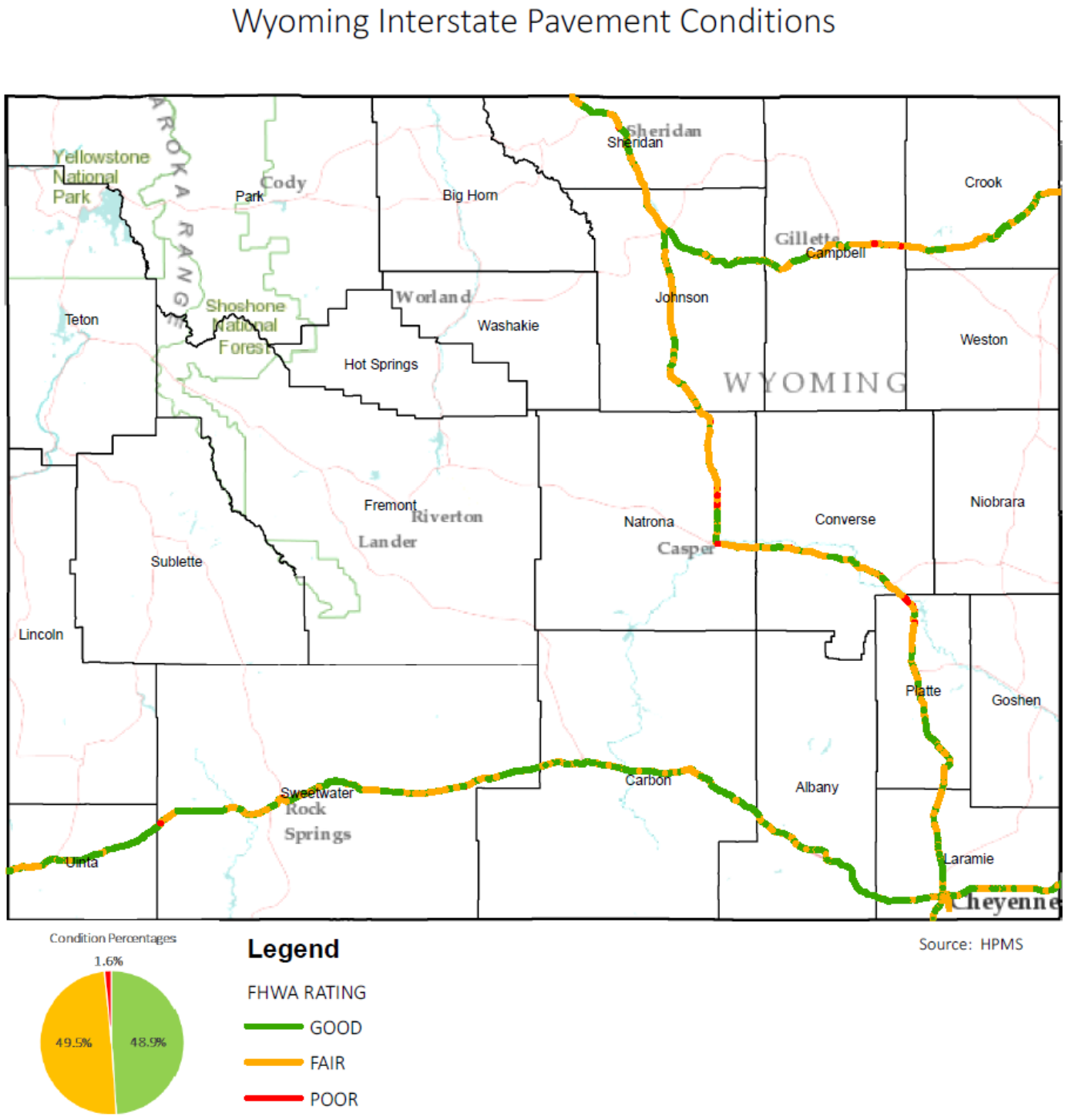


FIGURE 6: CURRENT NON-INTERSTATE NHS PAVEMENT CONDITIONS

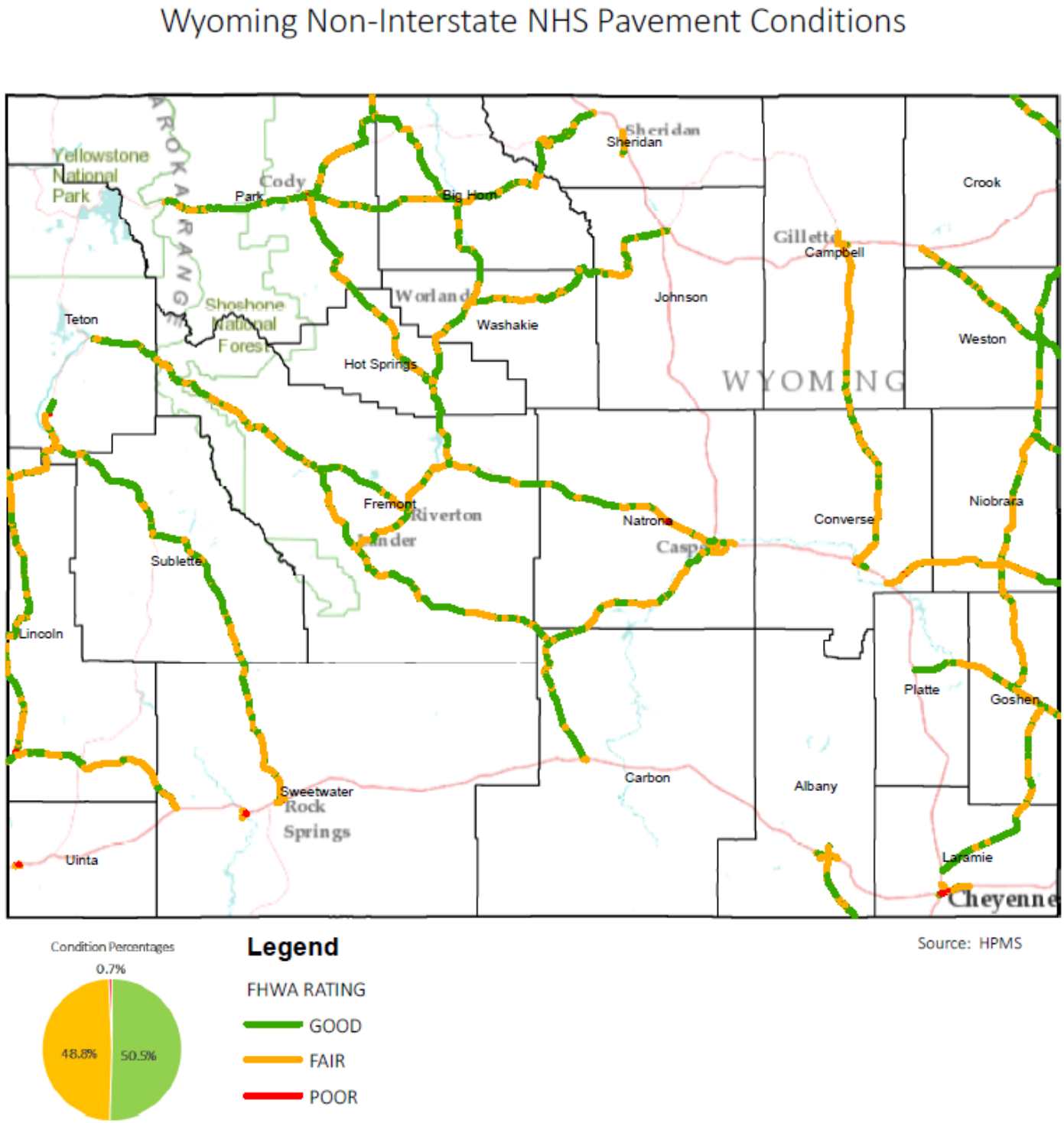
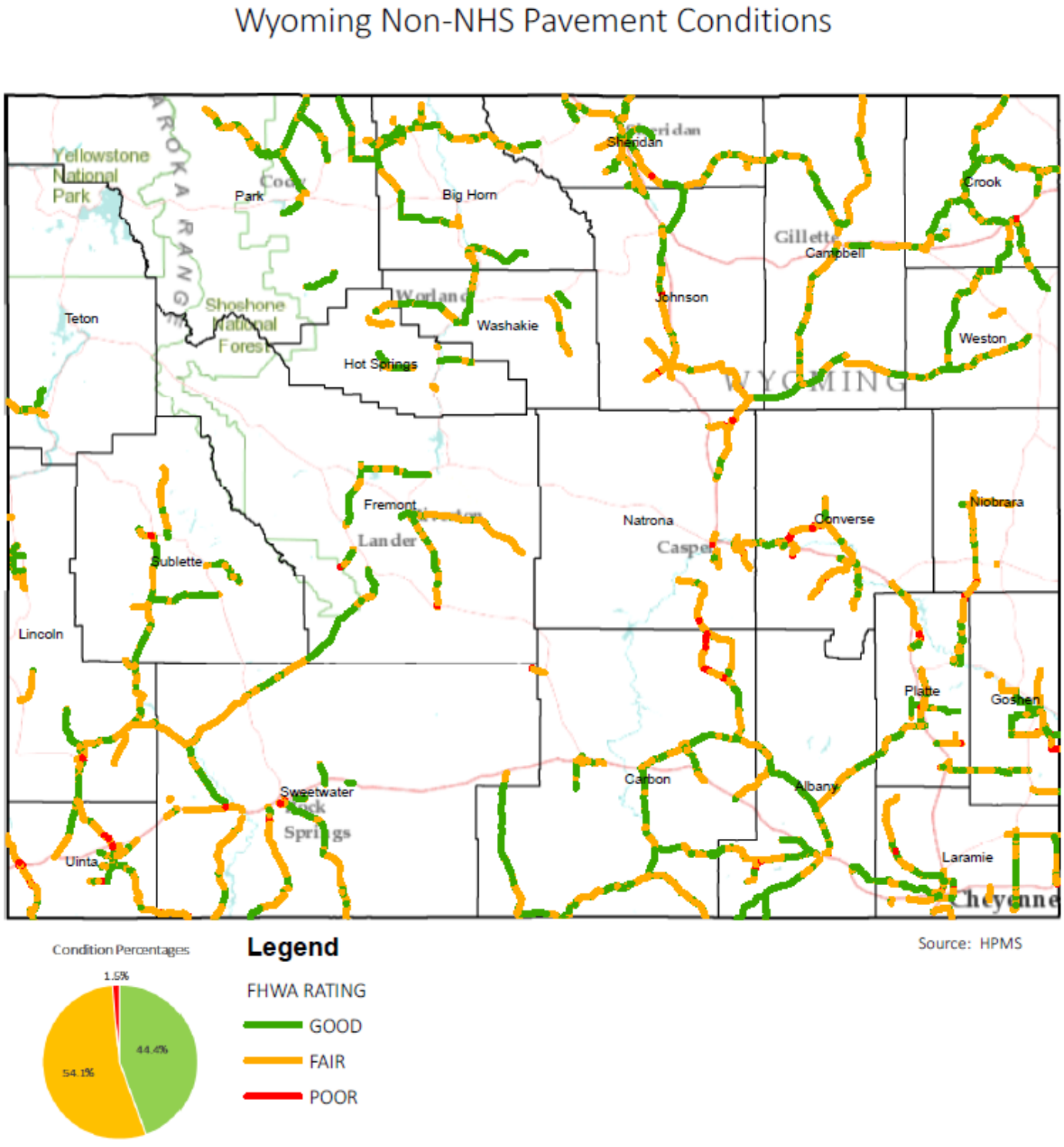


FIGURE 7: CURRENT NON-NHS PAVEMENT CONDITIONS



Prior to FHWA's standard condition criteria, WYDOT's pavement condition ratings were based on a Present Serviceability Rating composite condition index rating. WYDOT recently reformulated its composite index to more closely align with FHWA's criteria for assessing pavement conditions. The new composite index, or Pavement Quality Rating (PQR), is used to evaluate surfacing conditions and provide a relative comparison between roadway sections, and to optimize network conditions. The PQR is calculated using the Ride Rating (RR), Rutting or Faulting (depending on the surface type), and percent cracking. The Ride Rating (RR) uses the smoothness variable (IRI). PQR condition ratings are classified as good, fair, or poor relative to each condition threshold. PQR conditions splits are as follows: good condition has a PQR greater than 3.5; fair condition has a PQR greater than or equal to 2.5 and less than or equal to 3.5; and poor condition has a PQR less than 2.5.

FIGURE 8: PQR INDEX

Additionally, WYDOT has also converted its pavement management sections to HPMS tenth-mile (0.1) increments, along with the continuation of managing the existing sections. WYDOT believes these changes will prove beneficial and effective for future analyses and management purposes, and should ultimately help converge long-term pavement projections and available funding with HPMS targets.

As a business practice, WYDOT continues to manage pavement sections based on the PQR condition ratings rather than the FHWA ratings, since this allows for the management of existing roadway sections and suggests treatments based on an optimization of the overall conditions from target ranges set by WYDOT's Materials Lab and Executive Staff. The PMS will continue to suggest treatment candidates based on optimization of the overall network conditions based on PQR target ranges.

Based on outputs from the PMS, the percentage of Interstate currently shown in "Poor" condition is approximately 1.6 percent. A summary of Wyoming's current roadway conditions (as expressed in percentages of total mileage) by functional system, are summarized below.

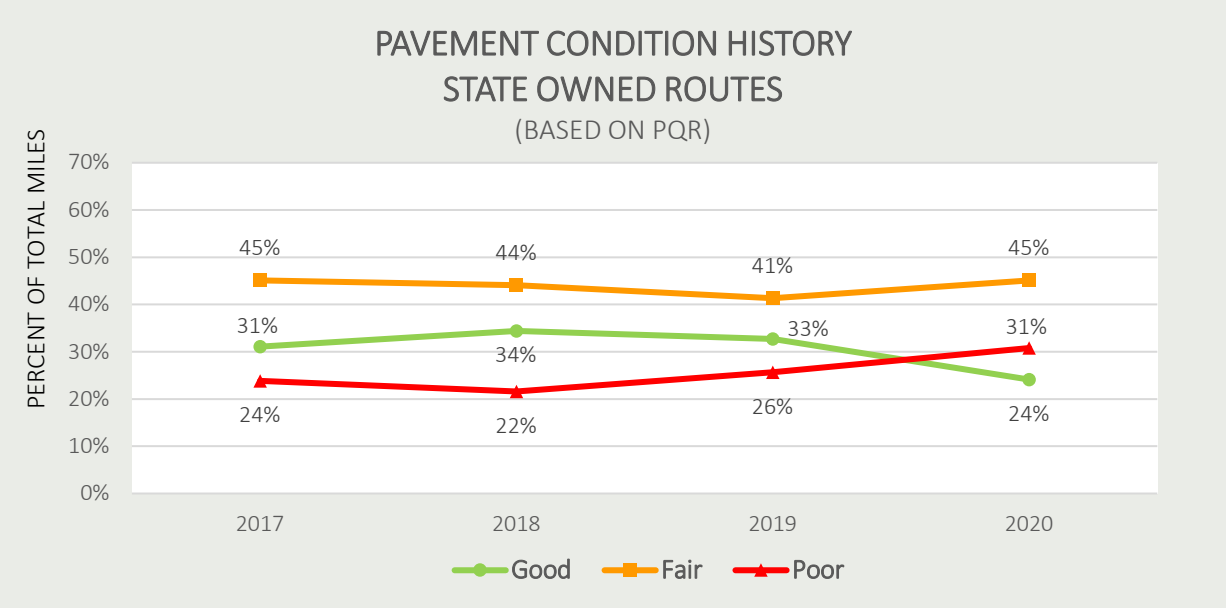
TABLE 6: STATEWIDE PAVEMENT CONDITIONS

Average Statewide Pavement Conditions Based on 2021 HPMS Submittal			
System	**Good**	**Fair**	**Poor**
Interstate	48.9%	49.6%	1.6%
Non-Interstate NHS	50.5%	48.7%	0.7%
Non-NHS	44.4%	54.1%	1.5%
Overall	45.1%	53.8%	1.1%

*Note: Pavement Condition averages do not include locally owned NHS pavement data.

Current and historical Statewide PQR pavement conditions are shown in the graph below.

FIGURE 9: STATEWIDE PAVEMENT CONDITION PERFORMANCE HISTORY



WYDOT's annually produced *Wyoming Transportation Facts Book* contains information on the current conditions of all Wyoming roadway networks, which can be found at the following link): http://www.dot.state.wy.us/home/administration/strategic_performance/fact_book.html.

A complete interactive map depicting statewide pavement conditions can be found at the following link: https://apps.wyoroad.info/itsm/map.html.

2.2 BRIDGE INVENTORY AND CONDITION ASSESSMENT

2.2.1 Bridge Inventory

WYDOT manages 1,951 structures, including 1,635 bridges and 316 culverts. Bridges are structures erected over a depression or an obstruction (such as a waterway, highway, or railway) having a passageway for carrying traffic and an opening, measured along the center of the roadway, of twenty feet or more. This definition includes multiple pipe culvert installations where the clear distance between openings is less than half of the smaller opening and the extreme ends of openings is twenty feet or more. WYDOT also inventories or inspects 3,199 structures not meeting the definition of a bridge, including 564 other structures such as tunnels, overhead sign structures, high mast light towers, and earth retaining walls. WYDOT's bridge asset inventory, based on the National Bridge Inventory (NBI) Submittal for 2022, excluding federally owned bridges, has been provided in the following table.

TABLE 7: WYDOT BRIDGE INVENTORY

Wyoming Bridge Inventory		
	Number of Bridges	Total Deck Area (ft^2)
NHS		
Interstate	915	5,051,859
Non-Interstate NHS	411	2,757,473
Cities, Counties and Railroads	4	10,876
Total NHS	**1,330**	**7,820,208**
Non-NHS		
State Owned	625	3,122,910
Cities, Counties and Railroads	834	2,071,655
Total Non-NHS	**1,459**	**5,194,565**
Totals	**2,789**	**13,014,773**

Source: WYDOT 2022 NBI Submittal

The Bridge Management System (BMS) only addresses State-owned bridges. Bridge sized pipes and box culverts are excluded, since when they need work, replacement is typically the only option. Federally or locally owned bridges are not included in the BMS recommendations. The data for locally owned bridges within NHS segments is shared with the asset owners. Federally owned bridges are inspected and managed by the federal government and WYDOT retrieves the data from the federal NBI submittals. Additionally, bridges having certain levels or types of deterioration or with specific details that may affect the safe usage of the structure receive special inspections designed to monitor their unique condition. These include In-depth, Damage, Fracture Critical, Underwater, and Non-destructive Pin inspections.

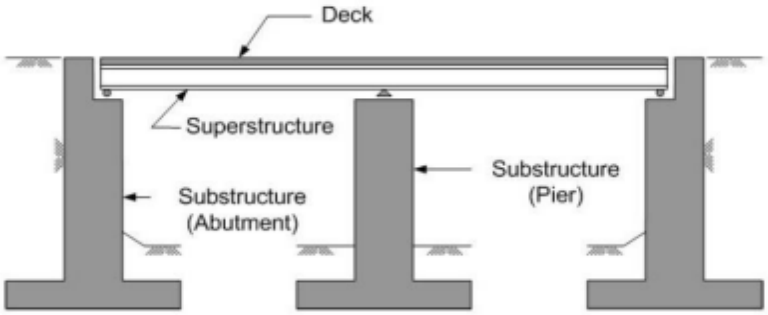
2.2.2 Bridge Conditions

WYDOT's Bridge Program utilizes a comprehensive BMS to assist with managing the State's bridges. The BMS is a set of tools comprised of the following elements: AASHTOWare™ Bridge Management software BrM (formerly Pontis), Wolfram Mathematica software, Oracle database, WYDOT Bridge Program developed BRASS™ Suite of Programs, and customized spreadsheets and reports. The objective of the BMS is to quantify the State's current bridge needs and forecast future structure conditions.

The BMS uses historical data along with current in-service conditions to predict the future deterioration and structure conditions, and to develop its preservation, repair, rehabilitation, or replacement candidate lists & targets, prioritize bridge asset needs, and select bridge projects based on given funding scenarios. WYDOT uses the results of the BMS data analyses to produce the list of recommended candidate structures and associated treatment strategies.

National Highway Performance Program (NHPP) performance ratings, derived from the most recent Inspection Reports, constitute the basis for the BMS optimizations that are used to predict future bridge performance. Bridge inspectors utilize the FHWA Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (Coding Guide), FHWA Bridge Inspection Reference Manual (BIRM), AASHTO Manual for Bridge Element Inspection, and AASHTO Manual for Bridge Evaluation as guidance in evaluating the current structural condition of all State-owned bridges within its asset inventory. Each bridge is composed of three components: (1) deck (NBI Item 58), (2) superstructure (NBI Item 59), and (3) substructure (NBI Item 60). A separate component condition rating exists for culverts (NBI Item 62).

FIGURE 10: EXAMPLE OF BRIDGE SCHEMATIC



Source: US DOT Bridge Inspector's Reference Manual

Inventory data is collected on the conditions of bridge components, namely decks, superstructures, substructures, and culverts, which are assessed in accordance with the Coding Guide. Inventory data and bridge condition assessments are summarized in the Inspection Reports, as well as the overall performance rating of the structure. Inspection Reports are generated for each state-owned structure on two-year basis. 23 CFR 650, Subpart C requires the inspection of all public structures in the state defined as bridges on a minimum twenty-four-month cycle by qualified bridge inspectors. WYDOT policy requires the annual inspection of load posted bridges both on and off system, which also includes NHS segments not owned by WYDOT. Internal policy also requires that qualified bridge inspection team leaders must be present at each inspection.

The condition of individual bridge elements (such as slabs, girders, abutments, piers, etc.) are assessed in accordance with the Manual for Bridge Element Inspection (MBEI). Bridge inspectors assess all elements of a bridge across four condition states (CS1 - Good, CS2 - Fair, CS3 - Poor, and CS4 - Severe) using the guidance provided in the MBEI. Portions of each element may be allocated amongst the four condition states depending on the asset condition. For example, if an element is examined and seventeen linear feet out of the total eighty linear feet has experienced some deterioration, the conditions can be allocated based on the unit of measure (for example, linear feet) for the applicable element. Using the bridge element conditions as a basis, the inspector then provides an overall condition rating for each bridge component based on a rating scale of 9 (Excellent) to 0 (Failed) in accordance with the Coding Guide.

The overall NHPP performance rating for a structure is based on the minimum condition state of the three primary bridge components. For culverts, the NHPP performance rating is based on the culvert condition rating. Component condition ratings of 7 – 9 are considered "Good"; component ratings 5 - 6 are considered "Fair"; and component ratings of 4 or less indicate a "Poor" condition.

TABLE 8: NHPP BRIDGE PERFORMANCE CONDITION RATINGS

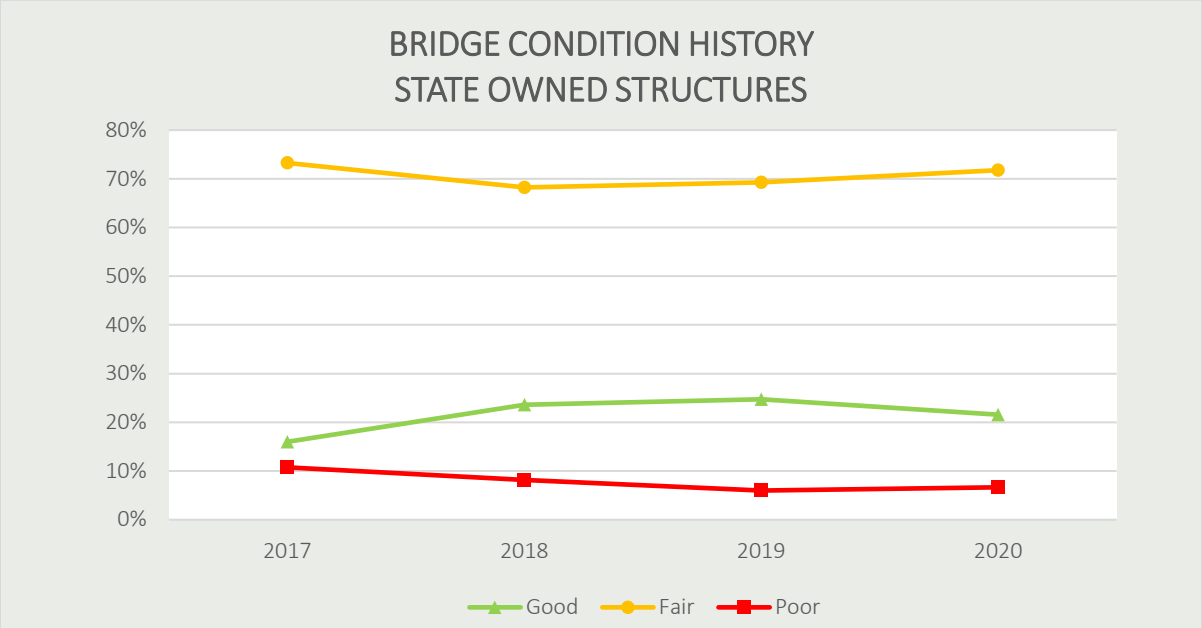
NHPP Bridge Performance Classification	
Classification	**NBI Condition Rating**
Good	9-7
Fair	6-5
Poor	≤ 4

Bridges may be classified as "Poor" based on an assessment of their physical condition. This federal classification indicates that bridge components have experienced a level of deterioration that could reduce the structure's ability to carry design loads. Designating a bridge as such does not imply that it is likely to collapse or is unsafe, but indicates that maintenance or rehabilitation of various components is necessary to improve its condition. The following table shows the percentage of structures (based on square footage of deck area) that are classified by NHPP Rating, and the designated "Poor" rated structures.

TABLE 9: WYDOT BRIDGE CONDITIONS

2021 NHPP Bridge Performance Ratings (Based on Deck Area)							
	Total Deck Area	Good		Fair		Poor	
		Area	%	Area	%	Area	%
NHS							
Interstate	5,163,126	1,157,350	22.42%	3,732,021	72.28%	273,755	5.3%
Non-Interstate NHS	2,861,355	742,698	25.96%	1,972,772	68.95%	145,885	5.1%
Non-WYDOT NHS	10,876	10,876	100.00%	0	0%	0	0.0%
Total NHS	8,035,357	1,910,924	23.78%	5,704,793	71.00%	419,640	5.22%
Non-NHS							
State	3,266,791	992,745	30.39%	1,990,646	60.94%	283,400	8.68%
Total Non-NHS	3,266,791	992,745	30.39%	1,990,646	60.94%	283,400	8.68%
TOTALS	11,302,148	2,903,669	25.69%	7,695,439	68.08%	703,040	6.22%

FIGURE 11: STATEWIDE BRIDGE CONDITION PERFORMANCE HISTORY



3. LIFE-CYCLE PLANNING

3.1 LIFE-CYCLE COST ANALYSIS

States are required by 23 CFR 515.7 to use a lifecycle planning process in their TAMP. WYDOT conducts network level lifecycle planning for two asset classes: pavements and bridges. Life-Cycle Planning (LCP) is the network-level analysis used to determine the most cost-effective way of managing an agency's infrastructure assets. As an asset is consumed (i.e. deteriorates), the future economic value automatically declines. Proper management over the lifespan of an asset helps prolong service life, reduces the rate of asset consumption (thereby lessening the impacts of usage), and lowers long-term operating costs (proactive versus reactive maintenance). By applying the proper treatment at the correct time, WYDOT is able to effectively minimize the rate of asset consumption and mitigate the impacts of deterioration and usage, while simultaneously maximizing funding resources, prolonging the useful life of its assets, and sustaining desired service levels.

The goal of WYDOT's asset management program is to minimize the life-cycle cost of preserving infrastructure while maximizing its value given constrained fiscal funding.

WYDOT's LCP scenario analysis is an iterative process based on the department's established performance targets (goals) and funding constraints. It is necessary to examine a number of alternative scenarios according to the desired level of service, funding constraints and inflation assumptions. Accurate predictions require high-quality data, valid forecasting models, and a defined methodology for analyzing and evaluating the long-term consequences (costs) for choosing amongst different treatment scenarios. The various funding scenarios are then used to generate the department's future long-term investment strategies, which may differ from a strategy that reduces costs in the short term. Outputs from the management systems at the network level feed the life-cycle cost analyses and assist decision makers in determining how much funding should be allocated between asset classes based on performance targets.

This section includes an explanation of how WYDOT uses its asset management systems to conduct the life-cycle cost analyses for each roadway segment or bridge to determine the best set of treatments that yield the lowest total cost for the network. LCP is a structured methodology that assesses the total long-term maintenance liabilities and preservation strategies for managing transportation infrastructure assets. The AASHTO TAM Guide defines life-cycle cost as, "the net present value or equivalent uniform annual cost of the sequence of monetary costs and benefits in a life-cycle activity profile" from initial construction to the end of service life. Life-cycle cost analysis (LCCA) is an engineering and economic analysis that examines the entire cost stream inherent in managing an asset, and quantifies the differential costs of alternative investment options (treatments) for each given asset class or asset subgroup. The analysis takes into account the costs incurred over the serviceable life of the asset (or portfolio of assets), from initial construction to replacement, and generates the investment strategies that yield the lowest total cost over time, which may differ from a strategy that reduces costs in the short term.

Timely investments in preventive and rehabilitative treatments help keep infrastructure assets operating in the best possible condition. Regular planned investments are the optimal way to extend the service life of roadways and bridges at the least cost to the agency. WYDOT's LCCA process compares cost alternatives to determine the sequence of treatments that accrue the lowest total life-cycle cost over the course of an asset's entire service life. The technique takes into account the opportunity costs associated with choosing one treatment option over another based on a benefit/cost analysis of treatment alternatives. The process helps guide resource allocation decisions, and improves decision-making by optimizing the cumulative set of treatments across asset classes for the entire transportation network.

To conduct its LCCA, WYDOT utilizes a set of sophisticated software technologies to predict and identify the structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions (or treatments) that will sustain a state of good repair (SOGR) of infrastructure assets at the lowest practicable cost. For the purposes of asset management, WYDOT considers a SOGR to be a condition in which its transportation infrastructure assets are functioning according to their design standards and expected service life, and being continually sustained through a systematic program of maintenance, preservation, and replacement. In general, WYDOT considers the serviceable life of an asset to be the period of time over which the asset is expected to remain in use before replacement is required. For bridges, WYDOT considers the useful life of a bridge to be between 50 to 75 years. The average lifespan of asphalt pavements is assumed to last 20 years, while concrete pavements can be expected to last up to 30 years.

Asset classes are assessed individually based on the various funding scenarios and rehabilitation strategies within the management systems. Optimization algorithms and decision trees within each of the respective management systems calculate the series of treatment strategies for maintenance, preservation, rehabilitation/repair, and replacement, taking into account the entire cost stream incurred throughout an asset's useful life for each roadway segment or bridge. The lowest life-cycle cost is calculated and compared against numerous other preservation, maintenance, repair and rehabilitation treatments, the aggregated results of which yield the optimal network-level investment strategies for managing each asset class. The network level LCP results are then used to generate recommended candidate treatments that yield the overall maximum benefit based on the greatest return on investment. By directing investments in this way, WYDOT effectively seeks to minimize the overall network life-cycle cost of preserving its existing infrastructure asset portfolio, while maximizing asset value given constrained fiscal funding.

3.2 PAVEMENT LCCA

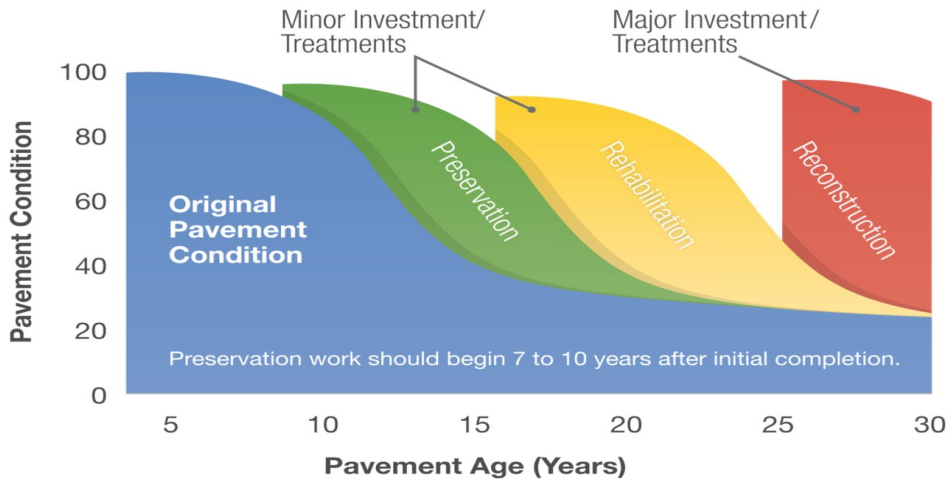
WYDOT's pavement management strategy seeks to maintain current pavement conditions and levels of service, with the goal of preserving its pavements through timely rehabilitation to prevent pavements from reaching a "Poor" condition state, which ultimately requires costlier repairs. Accordingly, WYDOT's PMS program seeks to manage the existing pavements through timely preservation and rehabilitation strategies, thereby limiting costlier reconstruction that occurs near the end of a roadway's life. The philosophy is to complete the right treatment at the right time to prolong the pavement's service life.

WYDOT's PMS was developed through an analysis of over 300 computer simulations or scenarios in the pavement module, which predicts the future condition of the highway network. The PMS stores data and performs analyses and evaluations on the pavement management sections. PMS sections are based on a detailed construction history and pavement type. Each pavement section is identified by location, direction (if Interstate), and functional classification. Pavement management sections are analyzed based on data derived from contracted third-party data collection, which feed the PMS and form the basis for a determination of predicted future ride quality, rut depth, cracking level, faulting (concrete slab rocking), and skid resistance of each pavement section.

Life-cycle costing is incorporated into WYDOT's PMS performance modeling software by calculating future conditions. Historic condition versus age data forms the backbone of the PMS performance models. Grouping similar pavement types and traffic levels provides a detailed set of data points, which are used to create deterioration curve models. While the PMS does not explicitly account for extreme weather and resilience, these factors are addressed during the project design phase to minimize life-cycle cost for the life of pavements. Pavements are designed based upon climate input options including Modern-Era Retrospective Analysis for Research and Applications (MERRA-2), Long-Term Pavement Performance (LTPP) sites, or user defined data. These inputs will capture climate-related data as it changes over time and allow for accurate design and selection of performance graded asphalt binders to account for average low and high temperatures.

Pavement treatments are selected to optimize the total life of Wyoming's road sections while giving consideration to minimizing construction activity and the corresponding inconvenience to the driving public. With regard to lowest life-cycle cost, WYDOT has determined preventive treatments provide the lowest cost per added year of life. Treatment costs are lower when applied earlier in a pavement's life-cycle. However, preventive repairs are not as effective once a road has deteriorated into the "Fair" or "Poor" rating; therefore, a blend of strategies optimizes the health of the highway network. The following figure depicts the life-cycle cost of pavement repair over its lifespan.

FIGURE 12: PAVEMENT LIFE-CYCLE MODEL



The basic PMS optimization allows for major rehabilitation work on extremely poor, higher traffic roadways, minor rehabilitation work on "Poor" and "Fair" roadways, and preventive maintenance work on roadways in "Good" condition. This preservation strategy is optimized to maximize future network

conditions based on anticipated pavement funding levels. All of the current pavement funding scenarios use an optimized system that incorporates a mixture of treatments to maximize the benefit to cost ratio for the Interstate, Non-Interstate NHS, and Non-NHS systems. Based on the optimal scenario that provides the best condition results in future years, each year a minimum number of project miles must be completed using preventive, minor and major rehabilitation strategies for each of the three roadway categories.

3.2.1 PMS Performance and Cost Models

The PMS uses inventory conditions, deterioration and performance models, traffic demand, inflation assumptions, and a set of system hierarchies (decision trees) to make the appropriate recommendations for maintenance & rehabilitation intervals for pavements. The PMS analyzes current and projected asset conditions via scenario planning, which uses various funding level inputs and established performance targets to optimize network-level system performance. Currently 37 PQR pavement performance models are utilized within the PMS based on the different highway systems, pavement types (asphalt versus concrete), and traffic level categories. The PMS performance models predict the annual change in PQR for each section as existing conditions are projected into the future. Six different decision trees within the PMS are utilized to make rehabilitation recommendations for each of the 1,668 PMS sections. A different decision tree was developed for each highway system and for each pavement type (asphalt and concrete) to allow for different pavement condition thresholds. Grouping similar pavement types and traffic levels provides a detailed set of data points used to create deterioration curve models.

The PMS Pavement Module in Agile Assets uses these performance models to calculate predicted annual changes in asset conditions for future years based on a system-wide, incremental cost methodology. The system uses average costs per square yard for the different treatment types; the costs are continually reviewed for accuracy. The management system selects project candidates using decision trees and benefit-cost analysis. Table 10 below shows the PMS treatment descriptions and costs associated with the pavement treatment levels utilized by WYDOT.

TABLE 10: PMS MODELING COSTS

PMS Treatment Costs		
Pavement Treatment	**Treatment Description**	**Treatment Cost**
1S Preventive Maintenance	Microsurfacing, chip seal, contract patches, thin overlays (PMP< 2”); partial/full-depth repairs, slab replacement with joint seal, cross-stitching, spall repair	$10/SY
2S Minor Rehabilitation	2”≤PMP<3” asphalt overlay; isolated slab replacement with joint seal, diamond grinding and/or grooving with joint seal (entire length of project)	$18/SY
2S Minor Rehabilitation on I-80	2”≤PMP<4” asphalt overlay; isolated slab replacement with joint seal, diamond grinding and/or grooving with joint seal (entire length of project)	$27/SY
3S Major Rehabilitation	≥4” pavement resurfacing on I-80, ≥3” pavement resurfacing on other State owned routes, FDR, whitetopping; complete slab replacement of all broken slabs within a PMS section (including joint sealing & diamond grinding and/or grooving entire section length), thin concrete overlays, HPM level/overlay and seal coat with or without crack and seat	$40/SY

The management system outputs depend on the financial constraints (anticipated budget levels) that are used, as well as average expected treatment costs for each treatment type. The pavement module in Agile Assets uses these models to calculate annual changes in condition for future years based on a system-wide, incremental cost methodology. The system allows entry of annual budget amounts for various future treatment types.

The PMS uses a pavement module in Agile Assets to determine future pavement conditions for various preventative maintenance and rehabilitation strategies that integrate budget data into the analysis to determine the best ratio of project types based on given monetary constraints. Inventory condition data, performance models, and inflation assumptions are utilized in conjunction with system hierarchies (decision trees) to determine the optimal set of treatments based on maintenance and rehabilitation intervals against the defined set of budgetary constraints. Additional factors incorporated into the management system performance models also include treatment strategies and costs, remaining service life of the asset, predicted deterioration rates, traffic counts and composition (AADT, percentage of truck volume, etc.), and traffic distribution patterns.

The PMS analysis accounts for the current highway construction projects and budget projections—including inflation, preservation treatment type, current road conditions, and performance modeling. The system allows entry of annual budget amounts for various future treatment types. Pavement funds are split among the five Transportation Districts according to a number of different considerations that primarily emphasize asset distress and greatest return on investment. District funding splits are based on ranking the districts by truck traffic, vehicle traffic, and total pavement mileage. After the initial funding allocations are divided by need amongst the five districts, the allocated pavement funds are further split up by the different treatment categories (1S, 2S, and 3S), and estimated treatment costs, to determine optimal treatment splits within each of the districts. This method allows WYDOT to tie district asset needs directly to district candidate lists. Project selections are based on WYDOT's pavement preservation strategy, which recommends roadway "candidate" selections for each district.

3.2.2 Pavement Work Types

WYDOT's preservation strategy for pavements involves "completing the right treatment at the right time", which focuses on improving or preserving the condition of existing assets. Pavement treatments are selected to optimize the total life of Wyoming's road sections while giving consideration to minimizing construction activity and the corresponding inconvenience to the driving public. In each district, a minimum number of miles per year must be completed using preventative maintenance and minor and major rehabilitation strategies set up in the recommended pavement preservation funding strategy.

The applied treatment type, i.e. the depth of pavement repair/rehabilitation, affects the models in a wide arrange of ways, such as steepening the deterioration rate for short-term rehabilitation strategies (i.e. 1S treatments), and lengthening of the performance curve for more robust treatments. The average lifespan of new pavements is typically assumed to last twenty years for asphalt, and thirty years for concrete. Although the expected surface life is no longer included in the design plans, the assumed expected lifespan assumption for pavement treatments is incorporated into the PMS models. Reconstruction (3S) treatments assume an average extension to the serviceable life of the pavements by 10 years for asphalt, and 15-20 years for concrete pavements. Rehabilitation (2S) treatments assume an average extension to service life of approximately 8-10 years for asphalt, and 10-13 years for concrete.

Maintenance/Preservation (1S) treatments, including chip seals and contract patching, are generally assumed to extend the serviceable life of pavements for 4 years for asphalt, and 5 to 7 years for concrete.

WYDOT's PMS includes a feature where actual data condition points may be compared to the performance models. In most cases, the performance model is conservative compared to the actual data points (the data points lie underneath the curve). All of the PMS performance curves use the general form of steepening rates of deterioration with age. The pavement performance models are set up intentionally in this way to account for annual maintenance activities that are not directly accounted for in the pavement module. When a preventive or rehabilitation treatment is applied to a given section, the PQR index is reset to a pre-determined, post-construction level until the collection of new data.

The Pavement Candidate List produced by the PMS suggests the recommended roadway sections and treatment type, which is used to develop projects for inclusion in the STIP. Pavement mileage goals are set by treatment type for each district, and mileage credit is received for the total mileage of candidate rehabilitation sections completed on a six-year rolling average. Pavement work types are described in further detail for each of the treatment types:

Pavement Maintenance ("M" Treatments) – Typical pavement maintenance strategies include crack sealing, chip sealing, and contract patching. While WYDOT's maintenance dollars are not directly incorporated in the funding strategies that the PMS produces (Pavement Candidate List), the PMS performance models do account for undetermined maintenance that could potentially occur, and the effects of which are incorporated into the deterioration models reflecting WYDOT's long-term pavement investment needs.

For the purpose of mileage goal calculation, certain pavement maintenance treatments may be eligible to receive 1S mileage credit, depending on the treatment applied and whether the pavement section was listed as an "S" candidate. In order to receive credit for pavement maintenance work, Districts provide a list of maintenance locations to the Materials Program annually for review of 1S credit. For asphalt pavements, chip seals must cover entire PMS section lengths and will provide full-length credit for application to 1S candidates, and 50% length credit when applied to 2S or 3S candidates. Patching provides a 50% credit of patched length if applied to 2S and 3S candidates. If patching length exceeds 50% of PMS section length on a 2S or 3S candidate, then 50% PMS length 1S credit will be allowed.

For concrete pavements, 1S treatment, excluding slab repair, will provide 50% section length credit if applied to a 1S candidate or 25% section length credit on 2S and 3S candidates. Slab replacement, 1S or 2S treatment will provide 50% section length credit on a 1S or 2S candidate, respectively. For concrete pavement; if one or more lesser treatments (1S and/or 2S) is applied in addition to a greater treatment (2S or 3S), credit will be calculated taking into account the greater treatment being applied. Pavement candidates without a required "S" treatment do not receive the 1S credit.

Pavement Preventative Rehabilitation/Preservation ("1S" Treatments) – The effects of pavement preventative rehabilitation treatments vary according to the surfacing type (bituminous versus concrete), as well as by the existing age of the pavements and the type of treatment being applied; however, in general it is assumed that maintenance and preservation (1S) treatments (including contract patching and crack sealing) will extend the expected life of the pavements by approximately 4 years for asphalt, and approximately 5-7 years for concrete. These treatments include microsurfacing, chip seals, thin asphalt

overlays of less than 2" for asphalt pavements. For concrete pavements, treatments include slab replacement, partial/full-depth repairs, cross-stitching and spall repair.

MINOR PAVEMENT REHABILITATION ("2S" TREATMENTS) – WYDOT's minor pavement rehabilitation 2S treatments are designed to extend the life of the pavement for approximately 8-10 years for asphalt, and 10-13 years for concrete. For asphalt pavements, 2S treatments include surface prep (mill, level, or combo), greater than or equal to 2" and less than 4" pavement resurfacing and seal coat on Interstate 80, greater than or equal to 2" and less than 3" pavement surfacing and seal coat on all other State owned routes. For concrete pavements, 2S treatments include isolated slab replacement with grinding on all new slabs and diamond grinding and/or grooving with sealing all joints for the entire length of the project.

MAJOR PAVEMENT REHABILITATION ("3S" TREATMENTS) – WYDOT's major pavement rehabilitations 3S Treatment is designed for approximately 10 years for asphalts, and approximately 15-20 years for concrete. For asphalt pavements, this treatment includes anything greater than or equal to 4" of pavement resurfacing and seal coat on Interstate 80, greater than or equal to 3" pavement resurfacing and seal coat on all other State owned routes, full depth reclamation (FDR) and overlay. For concrete pavements, 3S treatments include thin concrete overlay, HPM level/overlay and seal coat with or without crack and seat, and concrete rehabilitation including each of the following three procedures; slab replacement, diamond grinding and/or grooving the entire length of the project and re-sealing all joints.

PAVEMENT CONSTRUCTION (NEW CONSTRUCTION/RECONSTRUCTION "4S" TREATMENTS) – WYDOT's New Construction and Reconstruction 4S projects are not currently being recommended by the PMS. However, WYDOT has recently begun consideration of 4S treatments as a means of preserving the system rather than enhancing the system. After the PMS analyzed WYDOT's system with regards to base age, it was determined that prolonged preservation type treatments will lead to further subgrade issues if not treated properly. Historically, WYDOT performed these types of construction projects more for mobility purposes not related to preserving the existing system. Reconstruction is defined as roadways that are rebuilt primarily along existing alignment. Reconstruction normally involves full-depth base repair and pavement replacement. Other work that would fall into the category of reconstruction would be adding lanes adjacent to an existing alignment, changing the fundamental character of the roadway (e.g. converting a two-lane highway to a multi-lane divided arterial) or reconfiguring intersections and interchanges.

3.2.3 Pavement Maintenance

Preventive maintenance functions form the base of WYDOT's pavement preservation philosophy. Proactive maintenance activities such as crack sealing, culvert cleaning, or maintaining sign reflectivity must continue in order for the asset models to work. Preventive maintenance is the most cost effective way to extend the life of pavements by preventing the onset or acceleration of surface distress. As part of WYDOT's asset management strategy, maintenance crews actively perform routine repairs on all WYDOT maintained roadways. Maintenance work is performed by contract and in-house forces and includes crack sealing, short patches (patches less than a pavement management segment in length), chip seals, and slab repair and replacement. Without this work, pavements would have shorter life

Pavement maintenance consists of just-in-time repairs, which help ensure a serviceable system and is critical in maintaining the lowest life-cycle costs for pavements.

expectancies, and the PMS pavement deterioration models would need to be modified to show steeper deterioration curves; consequently, maintaining the current level of the maintenance budget is critical.

While the pavement deterioration models do not directly account for the effects of the surface maintenance that WYDOT performs, maintenance is considered a critical component in minimizing life-cycle cost for pavements. Maintenance dollars are not incorporated into the funding strategies that the PMS produces. Current annual maintenance costs for pavements, by highway system, are presented in the table that follows.

TABLE 11: ANNUAL MAINTENANCE COSTS FOR PAVEMENTS

Average Annual Maintenance Costs	
Roadway Category	**Annual Maintenance Cost per Year**
Interstate	$2.6 million
Non-Interstate NHS	$4.3 million
Non-NHS	$6.5 million
Total	$13.4 million

Note: This amount only includes WYDOT's contracted annual maintenance costs.

3.2.4 Traffic Demand

Traffic demand and vehicle mix (truck/car ratio) influences the deterioration rate and future conditions of highway infrastructure, specifically pavements. Higher traffic volumes, and trucks in particular, can dramatically increase pavement and bridge deterioration rates. Accelerated deterioration caused by increased traffic volumes affects the funding level needed to maintain the system and can affect future rehabilitation strategies. A lack of sufficient funding can cause increased (steeper) deterioration rates and worsening pavement conditions that will have lasting, long-term implications for Wyoming's roadways. Accurately estimating current and projected traffic levels and vehicle types is a critical factor in understanding current and future demands on Wyoming's transportation systems.

The Traffic Surveys Program within WYDOT's Planning Division collects, analyzes and continuously monitors traffic data to predict future traffic growth. Approximately 125 permanent automated traffic counter installations are placed at various locations throughout the state along designated traffic routes, which continuously gather 160 daily traffic counts. The collected traffic count data affects the pavement performance models and predicted deterioration that will occur.

Over the past several years, traffic counts have remained fairly static throughout the state with very little growth (except in a few limited areas, specifically related to areas of the oil and gas field development in the vicinity of Sublette County and the Highway 59 corridor from Douglas to Gillette). The Pinedale anticline area saw significant traffic increases in the early 2000s during the development of the Jonah field and other natural gas fields, with increases in total vehicular traffic and truck traffic. Traffic levels have since decreased after the completion of field development, but has not returned to previous levels. The oil and gas field development now occurring in Converse County (north of Douglas) is expected to follow the same trend (a sharp increase in traffic as the field is developed followed by a moderate to slight decline once development is completed).

Interstate 80 passes through Wyoming carrying traffic from California to New York while serving as a major truck route for the United States. The percentage of truck traffic on Wyoming's portion of I-80 is

among the highest in the nation, and constitutes approximately 47 percent of all traffic along I-80. Traffic volumes along I-80 average somewhere between 7,500 to 26,000 vehicles per day. Traffic on I-80 has increased by 1.6 percent annually over the past twenty years, while truck traffic has increased by 1.8 percent annually, and this trend is expected to continue. The continued increase in Interstate truck traffic has significantly impacted pavement deterioration rates on I-80, which has created a substantial drain on funding.

3.3 BRIDGE LCCA

WYDOT continues to develop and refine its Bridge Management System (BMS) to assist with its Preservation, Repair, Rehabilitation, and Replacement (PRR&R) program, the objective of which is to maximize the useful life of its bridge assets. WYDOT developed its BMS deterioration, cost, and improvement models utilizing historical WYDOT data in addition to an optimization algorithm. These three types of models are used in conjunction with the optimization algorithm to determine the best PRR&R actions and associated allocation of funds to best meet various performance measures and given budget scenarios and reduce network-level life-cycle cost.

In general, WYDOT strives to manage its bridge assets using a balanced approach to preservation and replacement. The Bridge Program initially focused its PRR&R actions on structures that were classified as "Poor"; however, as the percentage of "Poor" square footage began to fall, the BMS recommendations shifted focus primarily to preventative maintenance and preservation measures. Delaying preservation will result in worsening condition and costlier repairs in the future, or may accelerate the need for replacement down the line. However, as the cost of rehabilitation begins to approach the cost of full replacement, replacement becomes a more economical alternative. WYDOT has also recently begun to incorporate bridge replacement square footage targets into its BMS recommendations.

Currently, the BMS does not take into account user or risk-related costs; however, WYDOT does account for extreme weather and resilience in the project design phase to minimize life-cycle cost for the life of the asset. WYDOT recognizes there are uncertainties relating to the prediction of future deterioration, estimation of unit costs associated with PRR&R actions, and the prediction of the effects of PRR&R actions; therefore, these models employ a probabilistic, rather than deterministic approach, as discussed below. These models are continually evaluated, refined, and updated as necessary.

3.3.1 BMS Performance, Cost, and Structure Improvement Models

WYDOT's BMS is utilized to predict future bridge performance. BMS recommendations are based on a constrained analysis that optimizes a single objective function (function to be minimized or maximized). Most optimization modeling only optimizes a single objective function. The objective function can be the total PRR&R costs based on an established performance measure, or as in our case, the objective function can be set as the performance measure itself (i.e. minimizing NHPP "poor" rating percentage by square footage deck area) within a constrained budget. The BMS algorithm uses deterioration, cost, and improvement models to set targets (percentage of the budget that should be allocated) for specific preservation, repair, rehabilitation, and replacement actions.

There are many uncertainties pertaining to bridge deterioration, as well as variability related to cost estimation. WYDOT also recognizes that inspection data is inherently subjective, which constitutes a risk element as well. Thus, the decision was made to develop WYDOT's BMS models using a probabilistic rather than a deterministic approach, allowing the BMS to recognize levels of uncertainty or risk in predicting bridge conditions. A probabilistic model allows the BMS to incorporate levels of uncertainty or risk in changing condition states using a probability matrix. The probable distributions of the durations in which NBI condition ratings remained unchanged were used to build the final stochastic deterioration models. The BMS models and optimization algorithm are continually evaluated, refined, and updated as necessary, and performance measures are tracked in order to ensure the BMS is performing as expected.

Deterioration modeling predicts the future conditions of bridge decks, superstructures and substructures without PRR&R actions. The BMS deterioration curves were developed by monitoring conditions over time, and analyzing the expected benefits for bridge treatment types, as well as analyzing historical structure inspection data, namely the Deck, Superstructure, Substructure, and Culvert NBI condition ratings. These NBI ratings compared existing in-place conditions to original as-constructed conditions to provide a way of quantifying levels of deterioration over time.

BMS Structure Improvement Models predict the effects of PRR&R actions in ensuring the structural integrity of bridges and extending the useful life of the bridge before replacement is required. Structure Improvement Models simulate the effects associated with typical PRR&R actions. These models were developed by analyzing historical WYDOT rehabilitation data, namely PRR&R actions and associated NBI condition ratings before and after application of rehabilitative treatments.

The BMS cost models estimate the costs associated with each of the respective treatment actions (typical PRR&R actions). Bridge cost models were developed by analyzing historical WYDOT preservation, repair, rehabilitation, and new construction cost data. These cost models were also developed using a probabilistic approach, and are continually evaluated, refined, and updated as necessary to ensure that current costs are being captured in the BMS prediction models.

TABLE 12: BMS COST MODELS

BMS Modeling Costs (Based on Deck Area Square Footage)			
NBI Condition Rating	Deck Unit Cost per SF	Superstructure Unit Cost per SF	Substructure Unit Cost per SF
8	$0.00	$0.00	$0.00
7	$18.00	$0.00	$0.00
6	$27.00	$0.00	$0.00
5	$45.00	$7.00	$7.00
4	$57.00	$8.00	$8.00
3	$85.00	$10.00	$10.00
2	$85.00	$98.00	$295.00
1	$85.00	$98.00	$295.00

TABLE 13: STRUCTURE REPLACEMENT COSTS

Bridge Replacement Costs		
Structure Type	**Unit Cost per SF**	**Unit Cost/Perimeter FT/FT**
Bridge	$197.00	N/A
Culvert	N/A	$80.00

The BMS optimization algorithm quantifies the state's bridge needs and predicts the future bridge conditions based on various funding inputs. The optimization algorithm compares deterioration without PRR&R actions to improvements made with PRR&R actions and their associated costs. The algorithm then uses the financial constraints (i.e. the percentage of the budget allocated) for specific PRR&R actions. A list of candidate bridges is then provided to each district for use in developing projects to meet the PRR&R targets set within the BMS. Bridge treatment options are evaluated based on the benefit-cost ratios and predicted condition states, and the BMS recommends "candidates" for treatments that optimize network performance over time compared to other alternatives.

3.3.2 Bridge Work Types

WYDOT's bridge work types are defined as follows:

BRIDGE MAINTENANCE Bridge maintenance activities include: deck cleaning, minor pothole patching, expansion joint cleaning, minor expansion joint repair, minor bridge rail painting, drainage system cleaning, superstructure cleaning, minor damage repair, or other specific work required to maintain functional capacity in response to conditions or events that temporarily affect the operational performance of a structure. These activities typically do not improve the existing condition of the structures, but are of critical importance in sustaining the operational efficiency of the asset. Maintenance work is not incorporated in the funding strategies developed by the BMS. WYDOT does not have bridge maintenance costs programmed into its BMS investment plan as these activities are typically performed by field maintenance personnel.

BRIDGE PRESERVATION - WYDOT's Bridge Preservation Work activities include, but are not limited to: asphalt overlays with waterproof membranes, berm, riprap or slope paving repair, superstructure and substructure painting, concrete/crack sealing, culvert repair, debris removal from channel, drainage system repair, expansion joint repair/replacement, epoxy deck overlays, epoxy injection of concrete cracks, concrete repair, painting bridge rail, scour countermeasure installations, spot painting of steel girders, bearings, cross frames, rigid deck overlays, bridge deck repair, approach slab repair/replacement, substructure repair, superstructure repair, or bearing device modifications. Preservation work is incorporated in the funding strategies developed by the BMS.

BRIDGE REHABILITATION - Bridge Rehabilitation Work activities include: bridge widening, partial or complete deck replacement, strengthening of superstructures and substructures. Often these activities can be included in Bridge Preservation Work activities. In addition, Bridge Rehabilitation Work activities are not predicted and not included in the BMS funding model. Rehabilitation work is not incorporated in the funding strategies developed by the BMS.

BRIDGE REPLACEMENT – Bridge Replacement Work activities include: removal and replacement of existing structures, and roadway work required to tie-in the new structure. Replacement work that is not condition based, is not directly incorporated in the funding strategies developed by the BMS.

BRIDGE CONSTRUCTION - Bridge Construction Work activities include: construction of new structures along alignments without existing structures and roadway work required to tie-in the new structures. New bridge construction work is not incorporated in the funding strategies developed by the BMS.

4. PERFORMANCE MANAGEMENT

4.1 PERFORMANCE MEASURES AND GAP ANALYSIS

National Performance Measures are used to assess the health of the nation's transportation network. These measures allow FHWA to evaluate progress on the condition of NHS roadways and bridges, and are used to evaluate and monitor the progress a State DOT has made towards achieving performance targets. These performance measures are intended to communicate to stakeholders (i.e. the traveling public, local lawmakers, government officials) the condition of a state's transportation infrastructure assets, and help convey the requisite funding levels that will needed to sustain the State's transportation network at current or desired service levels. The national transportation performance measures, as well as the metrics used to assess these measures, are summarized in the next table.

TABLE 14: NATIONAL PERFORMANCE MEASURES

MAP-21 National Performance Areas and Measures
A. Safety Performance Measures
1. Number of Fatalities
2. Number of Serious Injuries
3. Rate of fatalities per 100 million VMT
4. Rate of serious injuries per 100 million VMT
5. Number of non-motorized fatalities and non-motorized serious injuries
B. Pavement Condition Performance Measures
1. % of Interstate Pavements in Good Condition
2. % of Interstate Pavements in Poor Condition
3. % of non-Interstate NHS Pavements in Good Condition
4. % of non-Interstate NHS Pavements in Poor Condition
C. Bridge Condition Performance Measures
1. % of NHS bridges (by deck area square footage) classified in Good condition.
2. % of NHS bridges (by deck area square footage) classified in Poor condition.
D. System Performance Measures
1. % of reliable person-miles traveled on the Interstate
2. % of reliable person-miles traveled on the non-Interstate NHS
E. Freight Performance Measures
1. Truck travel time reliability on the Interstate system (average TTTR)
F. CMAQ Performance Measures
1. Traffic Congestion Peak Hour Excessive Delay (PHED) measure - annual hours of PHED per capita
2. On-road mobile source emissions

Transportation performance targets are reported to FHWA on a 4-year cycle, and may be adjusted at the 2-year midpoint. Reporting the national performance measures improves an agency's accountability to the public, and allows state transportation agencies to better communicate to lawmakers the necessary funding levels that will be required to sustain the State's transportation network at the current, or desired

level of service. This section is used to evaluate the various funding scenarios that will be required to obtain the desired SOGR for the State's infrastructure assets.

Target setting for asset performance is centralized in Cheyenne at WYDOT Headquarters, and directed by the Assistant Chief Engineer for Engineering and Planning and the Assistant Chief Engineer for Operations. Performance targets are set based on current conditions, and indicate the degree of asset condition improvements required to achieve the established performance levels the agency intends to achieve with its investment decisions. The targets were established using defined funding levels, and the network level trade-off between WYDOT's two primary asset classes: bridges and pavements. Targets are broken out between functional system, i.e. Interstate, Non-Interstate NHS, and Non-NHS, and based on the most recent condition data available, baseline performance and historical trends, and forecasted asset condition projections. WYDOT tracks progress towards attainment of these goals through the STIP project portfolio.

Performance targets were defined for each of WYDOT's highway systems (Interstate, Non-Interstate NHS, and Non-NHS). Since WYDOT has a moderately fixed funding stream that is not indexed to inflation, these performance targets are not intended to maintain the system in the existing condition forever, but rather the targets have been based on maintaining minimum acceptable levels of service to ensure a safe and effective transportation system. The system should be able to maintain the existing conditions in the short-term (over the next 10 years), but the impacts of inflation begin to compound in the mid- to longer-term projections. WYDOT also works in conjunction with other NHS owners, and Wyoming's two Metropolitan Planning Organizations (MPO's), on integrating transportation improvement projects into the STIP to meet performance measures within the respective MPO planning areas, to direct resource allocations to those areas where improvements are most needed, and which facilitate progress towards meeting performance targets for the NHS. Funding is distributed to maximize asset longevity, while still balancing the State's transportation needs in the other goal areas.

A performance gap assessment is also included as part of this asset management plan per the requirements of 23 CFR Part 515. The performance gap analysis helps determine the best usage of future available funds, and helps communicate the unfunded transportation need to lawmakers and the general public. In order to conduct the gap analysis, the set of performance targets must first be defined, and requisite funding levels established, so that the difference between the two can be objectively evaluated. This section evaluates the variance between WYDOT's current and projected funding levels, and the resultant performance of asset conditions based on desired levels of service. The performance gap compares actual versus projected asset conditions against stated performance goals and target measures based on anticipated funding levels. When a difference exists between an infrastructure's desired condition level (target) and actual projected condition as determined by projected funding availability, then a performance gap is said to exist. The difference between projected funding and desired performance levels are evaluated through various funding scenarios, the difference of which constitute the performance gap.

In 2020, WYDOT commissioned a statewide transportation needs study with Dye Management Group, Inc. to help identify the agency's budgeted and unbudgeted surface transportation needs, the results of which were used in the State's performance gap evaluation. The gap analysis estimated the necessary funding levels that will be required to preserve or maintain WYDOT's transportation infrastructure assets in a SOGR, rehabilitate those that are aging or in poor condition, and replace those that have come to the

end of their useable service life. Based on the conclusions of that study and the latest forecasts from the bridge and pavement models, an additional $104 million is needed annually to maintain WYDOT's pavements and bridges in their current condition. Fully funding pavement preservation and rehabilitation at the levels necessary to maintain SOGR pavement performance will reduce taxpayers' costs to operate and maintain the network throughout its life-cycle, enhance safety, and improve mobility throughout the state. The performance gap analysis did not take into consideration future increases in traffic levels that will cause increased deterioration rates and decreased levels of service. WYDOT increased its annual funding levels for pavement and bridges as a result of the Dye Management Report; however, WYDOT continues to face major challenges maintaining the condition of the transportation system, and deteriorating roadways will cost taxpayers more in the long run.

4.2 PAVEMENT PERFORMANCE TARGETS

Federal legislation requires State DOTs to submit condition data to the HPMS annually. Based on this data, FHWA assesses whether states have met the minimum condition level requirements for pavement condition. FHWA also makes significant progress assessments based on biennial performance reports. State DOTs are required to set pavement performance targets for the following measures: (1) the percentage of pavements in good condition on the interstate system; (2) the percentage of pavements in poor condition on the interstate system; (3) the percentage of pavements in good condition on non-interstate NHS; and (4) the percentage of pavements in poor condition on non-interstate NHS. Pavement condition levels are based on the annual HPMS data submitted to FHWA. Figures 13 through 15 below show a graphical representation of WYDOT's current pavement conditions and performance targets based on FHWA's standard reporting criteria.

FIGURE 13: WYOMING INTERSTATE PAVEMENT CONDITIONS UTILIZING FHWA STANDARD CRITERIA

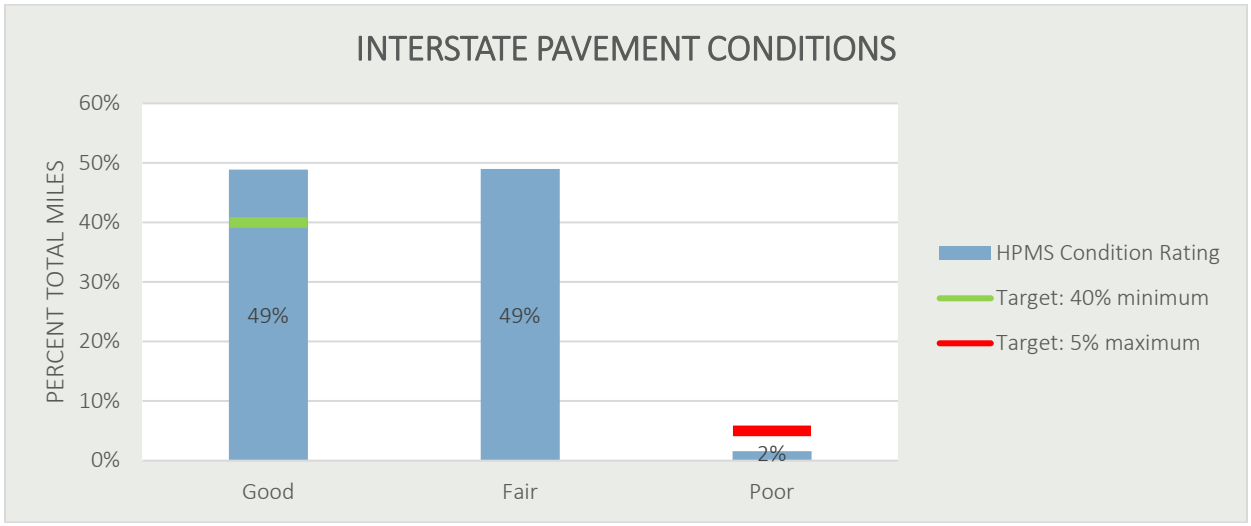


Figure 14: Wyoming Non-Interstate NHS Pavement Conditions Utilizing FHWA Standard Criteria

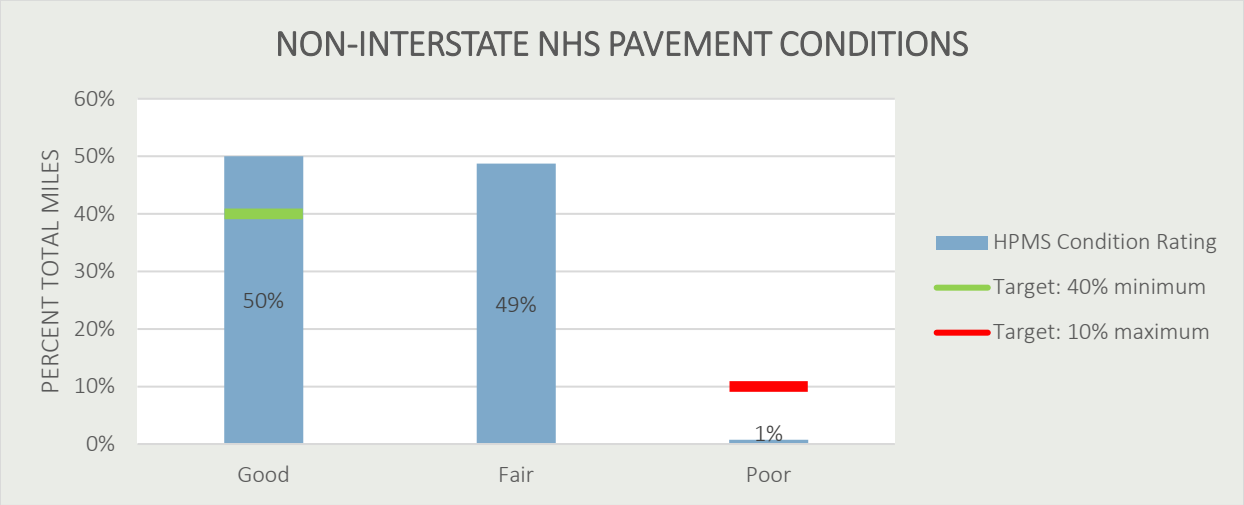
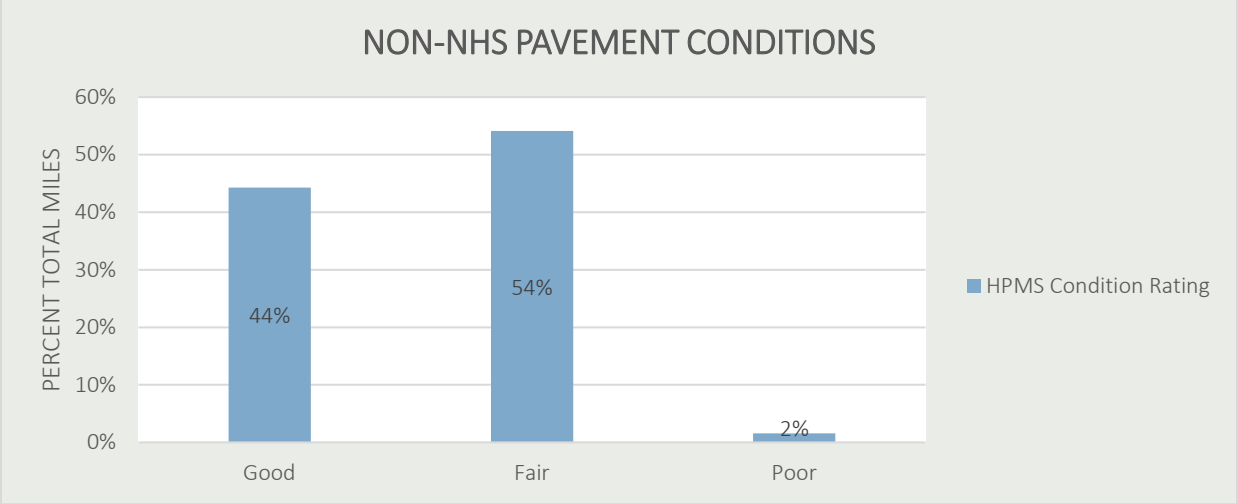


Figure 15: Wyoming Non-NHS Pavement Conditions Utilizing WYDOT's Composite Index



Pavement targets were established by analyzing International Roughness Index, Rutting, Faulting, and Percent Cracking Data in accordance with FHWA's standard criteria for reporting pavement condition. Targets were established based on the most recent available data collected on Interstate and Non-Interstate NHS routes and submitted to the FHWA HPMS. Historical targets were set internally based on the PQR rating system; however, these targets only loosely correlate to FHWA's MAP-21 performance metrics. In comparison to WYDOT's previous target setting methodology, new relative targets have been established for Wyoming's pavements based on the FHWA reporting criteria and the revised PQR metric.

For pavement conditions analyzed by FHWA's standard criteria, WYDOT has set performance targets for its Interstate system at greater than 40% in good condition, and less than 5% in poor condition. FHWA has set a minimum requirement for state DOTs to maintain no more than 5 percent of a state's pavements on the Interstate System in "Poor" condition. Based on outputs from the PMS, the percentage of the WYDOT's Interstate currently shown in "Poor" condition is 2 percent. For the Non-Interstate NHS system, WYDOT's pavement performance target is to have greater than 40% of roadways in good condition, and

less than 10% in poor condition. Effective as of FY 2021, WYDOT established network level targets based on PQR values. The goal is to maintain overall PQR conditions at the following values: for Interstates, the overall PQR shall be greater than or equal to 3.0, for Non-Interstate NHS the overall PQR shall be greater than or equal to 2.5, and for Non NHS the overall PQR shall be greater than or equal to 2.0.

Pavement conditions are continuously analyzed to provide the best data for selecting STIP construction projects, and WYDOT plans will continue to monitor and refine its pavement targets. Pavement Management's goal is to maintain current conditions within all functional classifications, but current funding levels are insufficient to accomplish this goal for pavements. WYDOT's PMS projected that at past spending levels all road systems would deteriorate, so in 2012, WYDOT increased pavement preservation funding to $125 million. In 2013, Wyoming increased the gas tax by ten cents per gallon and began using a portion of the additional tax revenue to increase its pavement funding level to $160 million per year; however, even with the increase to annual pavement spending, Wyoming's transportation system continues to face major challenges and inadequate funding has led to declining conditions, which will cost more to repair in the long term.

To meet its pavement performance targets, WYDOT has increased funding for pavements from $160 million to $185 million annually. Past pavement funding levels were not sustainable for WYDOT to continue delivering the level of service citizens have come to expect. Pavement preservation and rehabilitation needs were calculated by forecasting the required funding amount to maintain the system in its 2017 state of performance. This performance level was selected because it maintains and preserves the percentage of WYDOT pavements classified as "Good", while reducing the percentage of "Poor" pavements on the network. This performance level requires an average annual funding of nearly $235 million as compared with the prior funding $160 million funding level, which reflected a gap of $77 million. After accounting for the new adjusted pavement funding level of $185 million, the pavement performance gap is reduced to $52 million annually for pavements.

WYDOT continues to seek an additional $79 million annually to maintain pavements in current conditions and replace bridges on a 100-year service life.

Since two-thirds of WYDOT's pavement funds are expected to come from Federal Aid highway funding and one-third from state funding, and with anticipated funding splits between functional classifications into future years, WYDOT's PMS estimates near stable pavement conditions over the next fifteen years for Non-Interstate NHS, but deteriorating conditions on the Interstate highways and Non-NHS routes. The Interstate System is not being ignored; rather, the substantially higher number of trucks, especially on I-80, causes a deterioration rate that is much steeper than the other systems. There are insufficient funds to keep 922 centerline miles of Interstate in the same condition without completely sacrificing the other WYDOT maintained system's 5,608 centerline miles of pavement. Deterioration of the Interstate pavements beyond ten years was considered an acceptable risk trade-off. Additionally, there is a significantly high deterioration rate on the Non-NHS routes due to insufficient state funds. WYDOT continues to seek additional funding of $52 annually to maintain pavements in their current conditions.

The following charts represent Wyoming's projected pavement conditions for each functional system (Interstate, non-Interstate NHS, and Non-NHS systems) using a 4 percent annual inflation rate. The projections in Figures 16 through 19 represent pavement conditions based on WYDOT's PQR measures, which are used for standard business practice rather than the federal measures.

Figure 16: Percent of Pavement Miles in Poor Condition & Preservation Effects

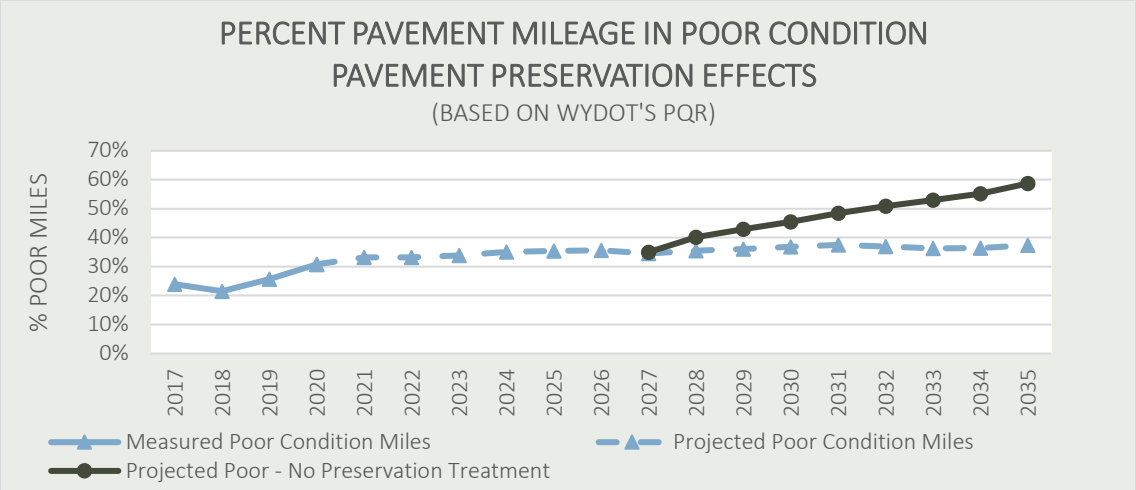


Figure 17: Interstate Pavement Condition Projections

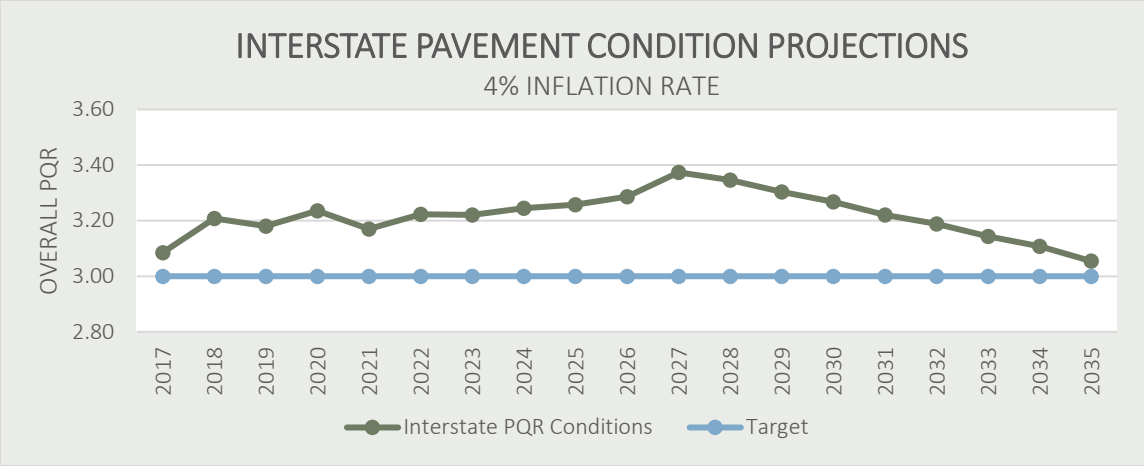


Figure 18: Non-Interstate NHS Pavement Condition Projections

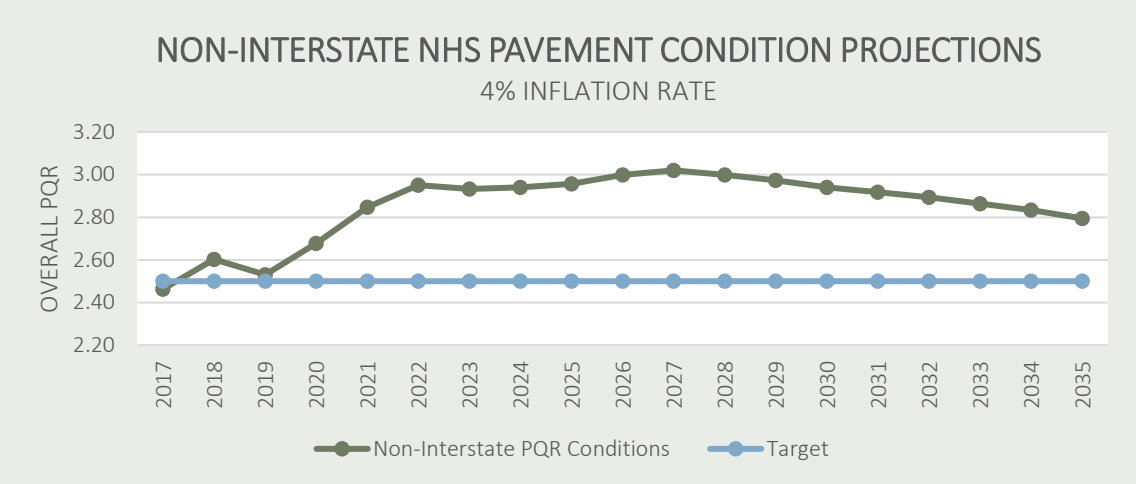
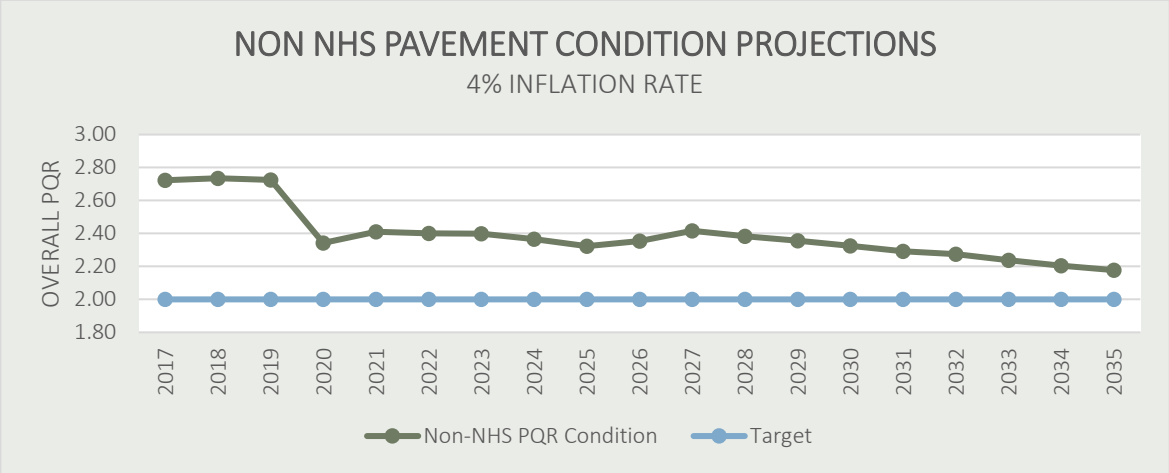


FIGURE 19: NON-NHS PAVEMENT CONDITION PROJECTIONS



4.3 BRIDGE PERFORMANCE TARGETS

WYDOT utilizes its BMS to identify needs and best allocate funds to meet WYDOT bridge performance goals. Once the funding level has been established, rehabilitation and replacement targets and candidate lists are developed for each district and provided for use in developing STIP projects. WYDOT's performance target for state-owned bridges, on and off of the NHS, has been set to at least 10 percent designated as "Good" (by area of deck square footage), and less than 10 percent designated as "Poor" in accordance with NHPP performance ratings to meet FHWA's performance measures. To meet its targets, WYDOT plans to invest an average of $35 million annually for bridges (including traffic control and mobilization). Based on current funding levels and implementation of the BMS, WYDOT expects to be able to meet its bridge performance targets for the next twenty years. The current investment plan allots adequate funds to maintain WYDOT's bridge targets for the next ten years; consequently, no gaps exist between the desired targets and projected conditions for the time being.

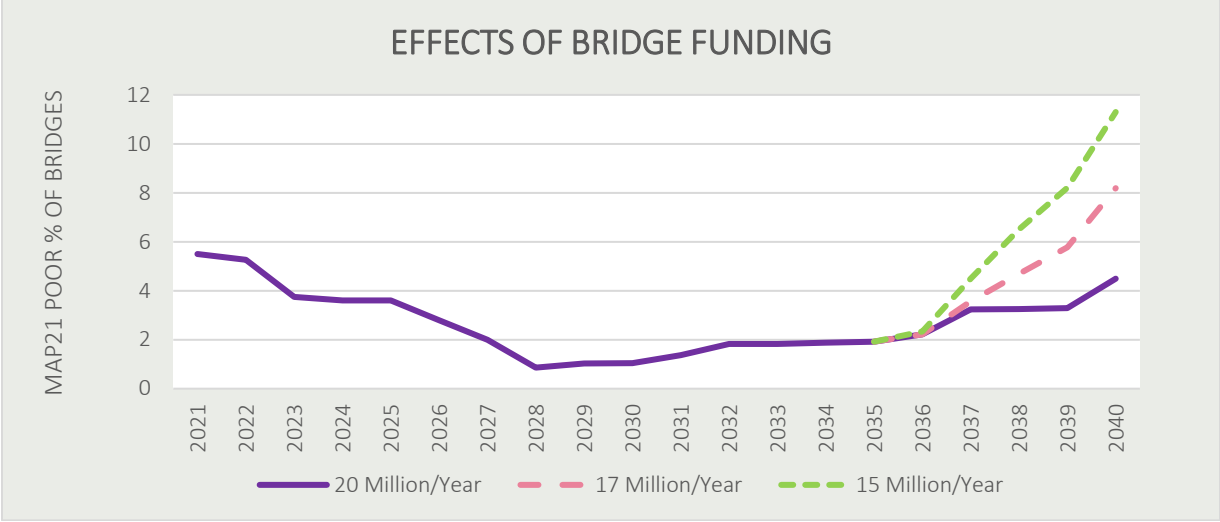
Bridge measures and conditions were covered in more detail in Section 2 of this document. Per the latest federal NBI submittal, WYDOT's bridge conditions were within the target range. State DOTs are required to submit bridge condition data to the NBI annually. FHWA assesses compliance with minimum condition levels based on this reported data. The percentage of the deck area of bridges located on the NHS classified as "Poor" must not exceed 10 percent. FHWA also makes significant progress assessments based on biennial performance reports, wherein State DOTs are required to set targets pertaining to the following performance measures: (1) the percentage of NHS bridges in good condition; and (2) the percentage of NHS bridges in poor condition.

WYDOT's goal is to maintain the condition of Wyoming's transportation infrastructure at its current service levels, and believes the current bridge funding levels are expected to be sufficient to meet its MAP-21 bridge performance targets over the next 10 years. To meet its bridge performance targets, WYDOT previously increased the funding allocated to bridge preservation, repair, and rehabilitation to $25 million per year. The $25 million represents the amount that will be spent on actual bridge preservation, repair, and rehabilitation work, less traffic control and mobilization costs. Additionally,

WYDOT plans to spend an average of $10 million annually for bridge replacements. The Dye Management report identified $62 million in annual bridge needs to maintain WYDOT's bridge performance levels, and meet FHWA minimum condition requirements for bridges. This amount included an annual estimated need of $50.5 million for bridge replacements, to replace structures past their life expectancy, which reflects a performance gap of $27 million annually for bridge replacements. Current design specifications are based on a 75-year design life, so additional funding for future bridge replacements is necessary to establish a replacement cycle based on design service life. The $10 million per year that WYDOT currently allocates for bridge replacements equates to a rate of replacement that is greater than 300-year service life for bridges. Eventually, preservation, repair, and rehabilitation actions will no longer be cost effective or possible, and bridges will need to be replaced as the cost to rehabilitate approaches replacement cost.

WYDOT's bridge performance projections are covered in the charts that follow.

Figure 20: Effects of Bridge Funding on NHPP Performance Ratings



Note: The $20 million is for actual bridge preservation, repair, and rehabilitation work, less traffic control and mobilization costs.

Figure 21: All Structures Predicted NHPP Performance Ratings

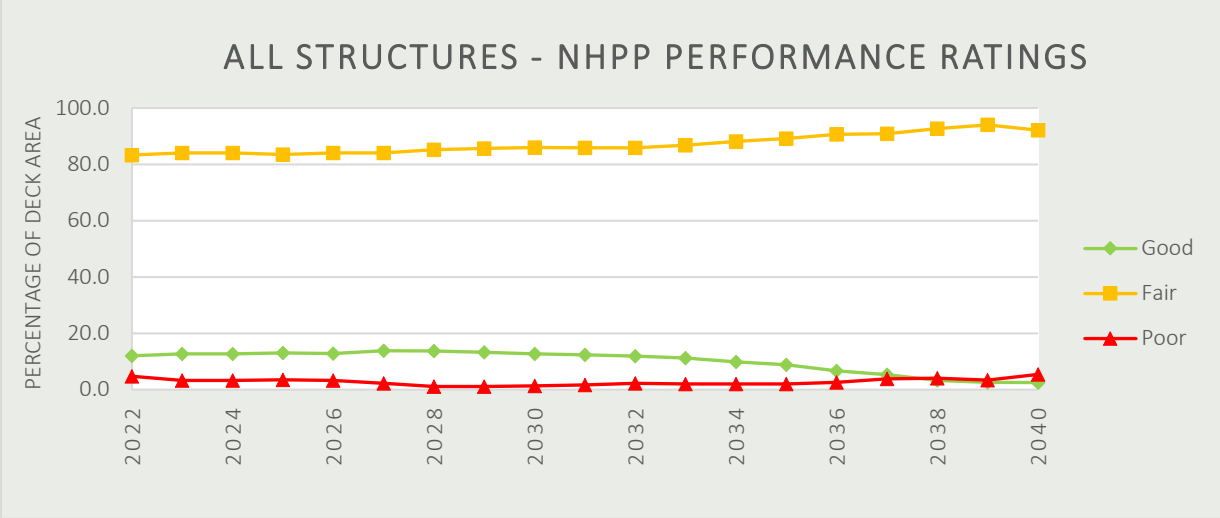


Figure 22: Wyoming Interstate Structures Predicted NHPP Performance Ratings

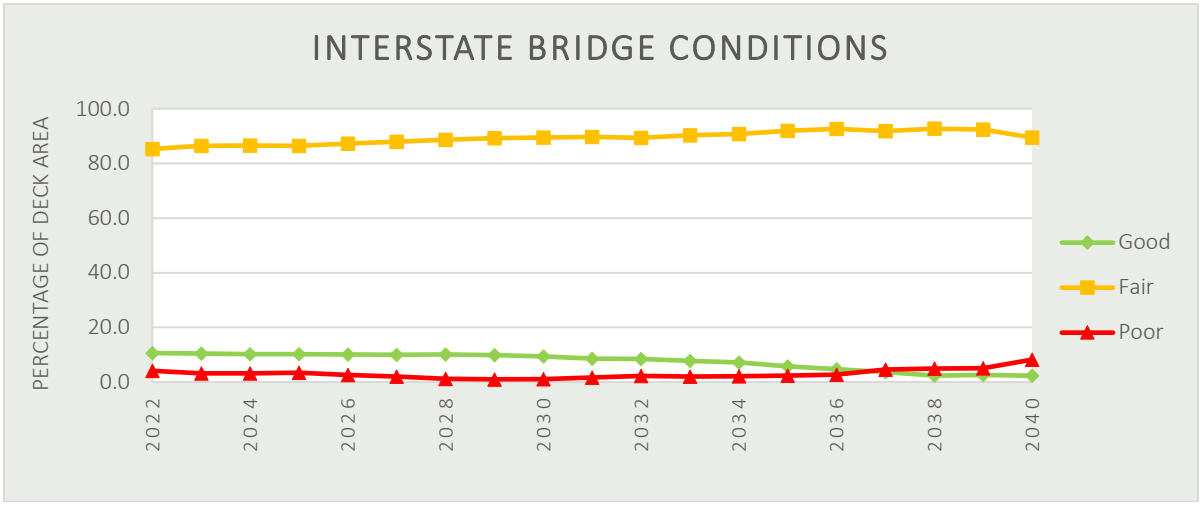


Figure 23: Wyoming Non-Interstate NHS Structures Predicted NHPP Performance Ratings

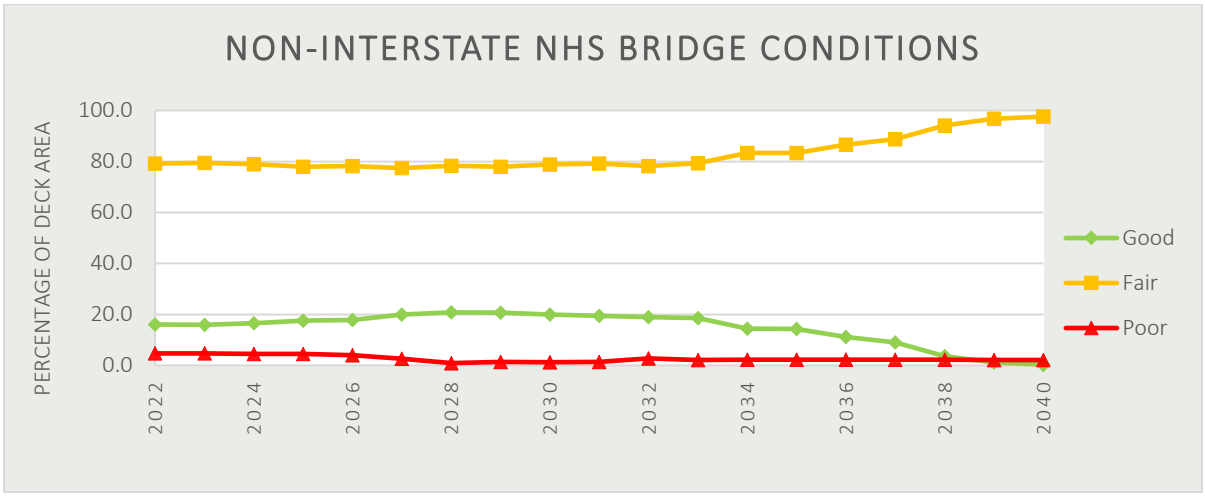
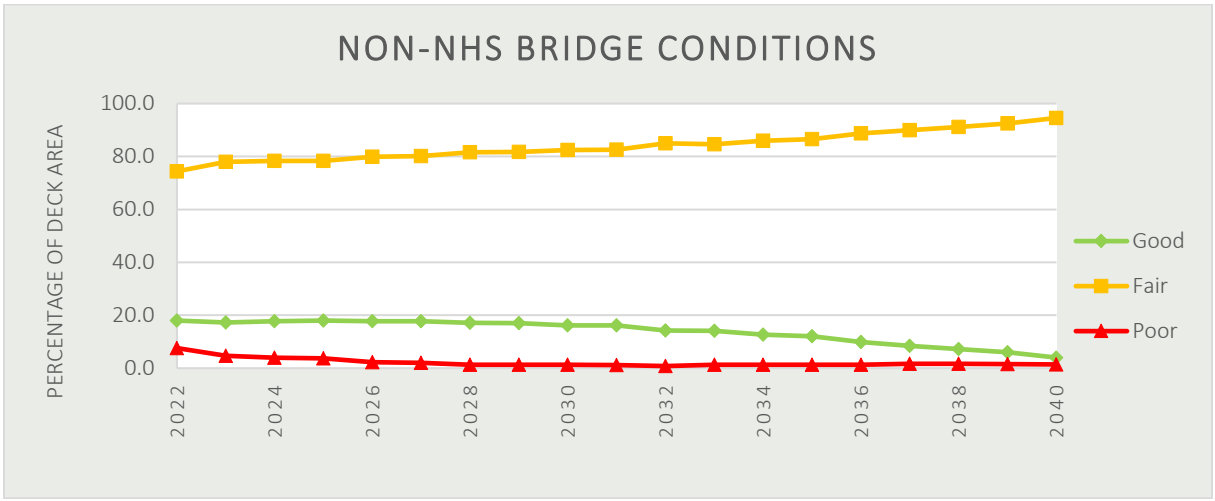


Figure 24: Wyoming Non-NHS Structures Predicted NHPP Performance Ratings



5. FINANCIAL SUMMARY

5.1 FINANCIAL PLAN

WYDOT utilizes a comprehensive financial planning process to support its asset management objectives and meet national performance requirements. The financial plan establishes how WYDOT intends to manage its highway infrastructure assets over a 10-year time period (at a minimum), and constitutes the basis for the investment strategies that will be implemented. 23 CFR 515.5 defines a financial plan as, "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."

Financial planning is used to estimate the projected funding that will be available to WYDOT, and illustrates the agency's ability to sustain the state's critical infrastructure assets. WYDOT's Financial Plan depicts the agency's overall projected future financial health, and helps communicate what condition performance targets can be reasonably achieved given the available funding. It also provides the basis for the investment strategies that will be adopted in order to sustain asset conditions and system performance. This section addresses the revenue sources and anticipated expenditures that will be used to meet established performance targets, and includes the estimated cost of future work types that will be necessary to implement the investment strategies defined in this plan. This section also contains an estimation of WYDOT's total infrastructure asset value, and the investment levels needed to maintain the value of these assets into the future.

WYDOT's Planning Program works in conjunction with the Budget Office to develop the TAMP Financial Plan, as well as in constructing the 6-year fiscally constrained STIP budget. As a whole, WYDOT strives to ensure that the financial future is reasonably predicted with a funding split that adequately maintains Wyoming's infrastructures assets in a SOGR. The financial plan helps to communicate realistic asset conditions and associated service levels that can be achieved using the available funding. It is an important component in helping quantify planned resource allocations for long-term asset management practices, and addresses the operational and maintenance needs required to maintain existing assets, in addition to any capital investments required to meet future travel demand. WYDOT's Financial Plan also demonstrates whether any financial sustainability gaps exist, the extent to which expenditures will not exceed revenues, and ties budgetary expectations to long-term asset condition needs. Appendix A: Programming Investment Summary provides a detailed account of WYDOT's Financial Plan projected revenues and expenditures.

Governmental Accounting Standards Board (GASB) Statement 34 infrastructure valuation offers additional insight into whether an agency's overall financial position has improved or deteriorated from previous years, and whether an agency's revenues are sufficient to pay for services in regards to the maintenance and preservation of its assets. GASB-34 demonstrates the value of public investment and highlights the impacts of neglected maintenance and repair on asset valuation/infrastructure. While GASB-34 values are based on historical acquisition and construction costs and do not reflect current

market valuation or replacement cost; they do clarify the extent to which an agency has already invested in its infrastructure assets, i.e. roads and bridges.

While WYDOT reports GASB-34 information to FHWA as required by law, WYDOT's asset management systems (PMS, BMS) use actual or expected replacement costs for calculating LCCAs and managing its infrastructure. WYDOT utilizes the GASB-34 Modified Approach to value its infrastructure assets. Official Financial Statements (dated September 30, 2020) reflect total infrastructure assets valued of $5,582,054,559 and Infrastructure Work in Progress (W.I.P) valued at $214,847,042. Infrastructure Assets are broken down into the following categories: land (right-of-way) - $69,246,068; bridges - $871,942,363; roadways - $4,576,481,962; communication systems - $60,089,438; and permanent easements - $4,294,728.

5.2 TRANSPORTATION FUNDING

This section establishes the transportation funding levels that will be needed to preserve or maintain WYDOT's infrastructure assets. WYDOT anticipates steady funding levels over the next 10 years. WYDOT derives its transportation funding from a variety of sources, including from the Federal Aid Highway Program funds, State Highway Fund, and local governments. Funding estimates are based on relatively conservative growth rate assumptions for each funding source, taking into consideration historic revenue trends and motor fuel consumption trends. While actual funding levels may vary due to changes in Congressional and State appropriations, planned expenditures are based on projected federal and state funding availability.

Based on the BIL legislation, which was recently signed into law, WYDOT anticipates receiving approximately $1.8 billion for federal-aid highway apportionment for fiscal years 2022 through 2026, in addition to $225 million for bridge replacement and repairs over the same five-year period, which equates to about a 29% increase in contract authority. The new infrastructure authorization bill ensures national funding stability for fiscal years 2022 through 2026, and is projected to provide WYDOT with an additional $80 million in federal funding for roads and bridges on an annual basis. Apart from the additional funding that will be made available pursuant to the BIL legislation for years beyond 2026 WYDOT projects that the available federal funding will grow at a conservative rate of 1% annually, which is in alignment with the average annual historic growth rate of federal funding under the terms of the FAST Act.

Two-thirds of WYDOT's transportation revenues come from the Federal-Aid Highway Program in the form of reimbursable grants. Discretionary grant funding is not included in the TAMP financial planning, as these funds are obtained through a competitive grant process, with no guarantees as to the amount of funding that will actually be received by the agency. All revenue assumptions and projections used in the TAMP Financial Plan are based on the continuation of current funding levels, so as minimize the impacts of funding uncertainties.

Wyoming is a grant recipient state for funds made available in accordance with 23 U.S.C., which provides a formula-based calculation for the Federal Aid apportionment for each state. Apportionments from the Highway Trust Fund (HTF) are computed based on prescribed formulas as set forth in law or federal legislation. The Federal Aid program provides states with financial assistance for the construction,

preservation, and operation of state and local highway systems through a "pay-as you-go" account, which involves reimbursement to the State DOT as highway construction projects are completed. Eligible roadways are designated based on functional classification, and include higher-level public roads, such as arterial roadways, urban collector roads, and other major rural collector roads. Congressional Authorization and Appropriations bills are required to fund the individual programs within the Federal-Aid Highway Program, and ultimately determine the federal revenues that will be available to WYDOT for each federal fiscal year. The new BIL legislation provided additional funding for eligible projects on the Federal Aid system (NHS), and congressional appropriations increased the program fund amount for WYDOT by approximately 23.6% in 2022.

The majority of WYDOT's federal funding is obtained through the following Federal Aid programs:

NATIONAL HIGHWAY PERFORMANCE PROGRAM (NHPP) - Provides support for the condition and performance of the NHS (including construction of new facilities), to ensure that investments of Federal-Aid funds in highway construction support progress towards the achievement of the national performance targets stipulated in a State's asset management plan for the NHS. These federal funds may only be obligated for a project on an eligible facility or for an activity that supports progress toward the achievement of national performance goals for improving infrastructure condition, safety, congestion reduction, system reliability, or freight movement on the NHS. Projects must be identified in the Statewide Transportation Improvement Program (STIP) and be consistent with the Long Range Statewide Transportation Plan.

SURFACE TRANSPORTATION BLOCK GRANT (STBG) - Provides greater flexibility in State and local transportation decisions to help State's best addresses State and local transportation needs.

CONGESTION MITIGATION/AIR QUALITY (CMAQ) - A flexible funding source to state and local governments for transportation projects that help meet requirements of the Clean Air Act.

HIGHWAY SAFETY IMPROVEMENT PROGRAM (HSIP) - Safety funding intended to facilitate a significant reduction in traffic fatalities and serious injuries on all public roads, including non-state-owned public roadways.

State funds are primarily used to provide the state match for WYDOT's federally funded projects. State funds are also used for annual highway maintenance and operations, or for highway improvements to non-NHS roadways and bridge projects that are not eligible for federal funds. The amount of local funding that will be available is project-dependent, and varies from year-to-year. State funds are comprised of revenues derived from motor fuel taxes, motor vehicle registration fees, mineral royalties and severance taxes, and occasionally from legislatively appropriated state general funds. Like most states, Wyoming levies excise taxes on gasoline, diesel fuel, and special fuels used by motor vehicles that use public highways. Registration fees include not only vehicle registration fees but also driver's licenses, permits, and other roadway-related licensing. Vehicle registration fees are based on a vehicle's classification and are renewed annually. Driver's licenses and learner's permit fees are paid by persons licensed to operate a motor vehicle. In 2013, WYDOT began receiving dedicated state funding from a ten cent per gallon fuel tax increase, which was projected to bring in $56.2 million in additional revenue annually. However, that increase in funding was partially offset by a reduction in previously received legislative general funds. WYDOT's Highway Fund receives approximately 57.5% of the 24¢ gasoline tax, and 75% of the diesel tax

per Wyoming §39-17. The additional fuel tax funds are being split between highways on and off the NHS based on traffic levels.

WYDOT developed multiple funding scenarios in conjunction with the LRTP to illustrate the total annual funding required for Wyoming's transportation network. The LRTP provides a 20-year vision of statewide transportation system goals, including a financial assessment of system needs and the resources that will be required to carry out the department's strategic plan. The analyses used the current trend as a base case scenario, compared with the amount needed to maintain the system at today's performance levels, and the amount needed to achieve necessary improvements for today and into the future. TAMP funding scenarios were built around the assumption that WYDOT's historical average annual Highway Improvement Program funding amount will be available to invest in the system (base scenario).

Revenue forecasting is an iterative process that involves a number of variables and changing assumptions. Accurately predicting future funding can be challenging for a number of reasons, not least of which include right-of-way acquisitions, environmental issues, and cost volatility for construction materials. (e.g. oil, steel, cement and some sources of aggregate). WYDOT attempts to account for cost volatility by calculating an annual inflation rate when developing STIP project costs. Many of these funding challenges are outside of the Department's ability to predict or control at the time a project is initially programmed. Any significant changes in either revenues or expenses will result in adjusting the schedule of projects. See WYDOT's Programming Investment Summary in Appendix 8.1 for the comprehensive revenue projections that will be available broken out by federal fiscal year.

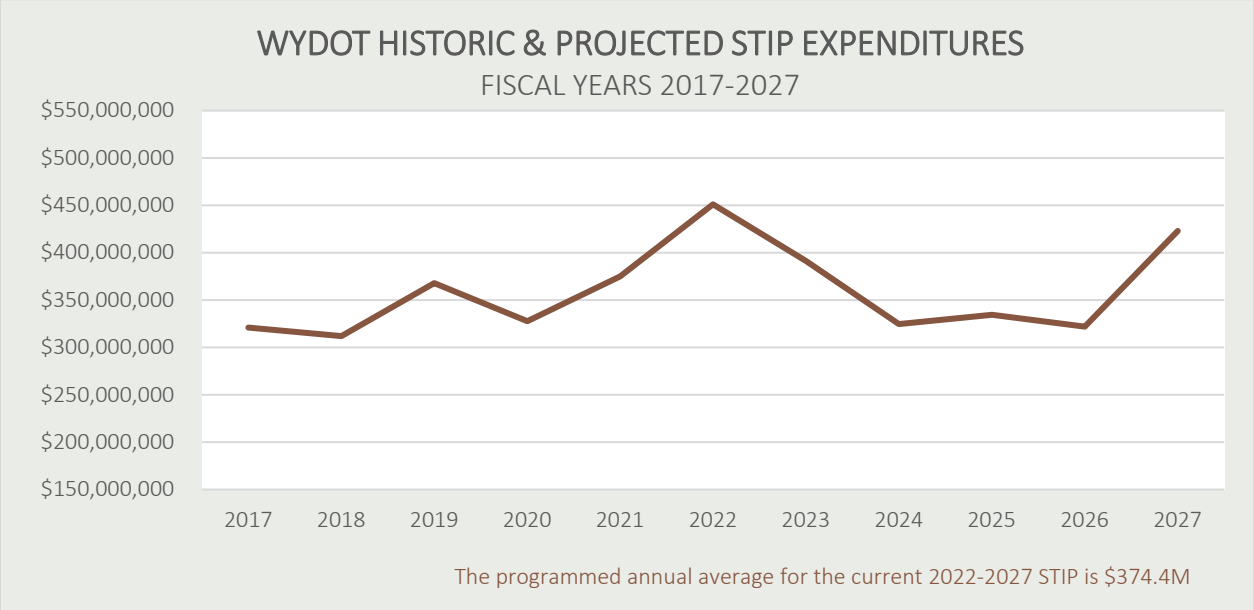
5.3 HIGHWAY CONSTRUCTION EXPENDITURES

Highway construction projects are intended to facilitate the implementation of WYDOT's transportation improvements that best allow the agency to address its stated mission of providing a safe and effective transportation system. WYDOT's highway construction program, the State Transportation Improvement Program (STIP), is a 6-year, fiscally constrained improvement plan that serves as a forecast of WYDOT's future transportation expenditures. The STIP is the mechanism through which WYDOT implements the investment strategies developed in the TAMP Financial Plan. The STIP is not merely an accounting document, but rather a snapshot of expected projects and their anticipated completion timeframes. Since both the nature of the projects and the funding sources are dynamic and subject to change, the STIP is inherently fluid.

Annual Pavement Program funding has been set at $185 million annually, while the Bridge Program funding has been set at $35 million annually (with $10 million set aside for bridge replacement). The majority of WYDOT STIP projects are developed based on the management system outputs to address Wyoming's transportation needs. These preservation-type projects are undertaken to maintain the viability of the existing transportation network. They are also intended to facilitate progress towards federal transportation performance targets regarding asset condition. The STIP should optimally contain an appropriate mix of preservation and modernization projects, which includes a limited number of capital improvement projects that are not related to the PMS and BMS candidate recommendations. Some additional funding may become available on a limited basis for reconstruction projects and those projects whose need is not related to condition improvements (i.e. safety, mobility, capacity, etc.),

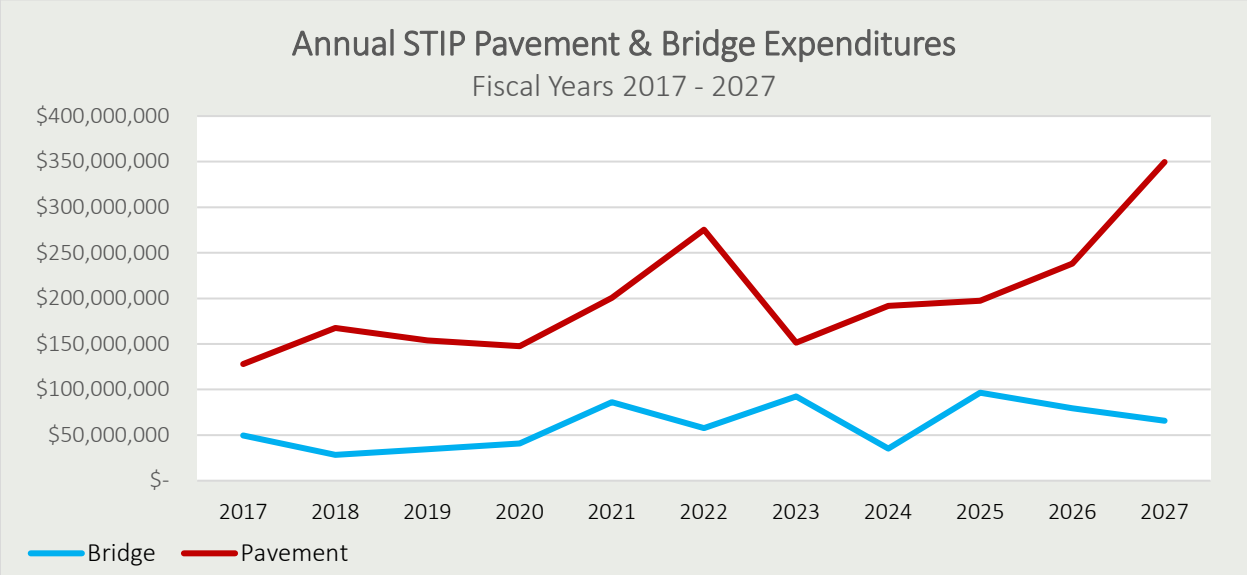
typically through the awarding of Federal grants. Annual historic average expenditure levels and projected future STIP expenditures are displayed in the following graphs.

Figure 25: Historic & Projected STIP Expenditures Statewide



Source: STIP expenditures based on WYDOT's ERP as of 7/7/2022. FY2027 contains additional COVID stimulus funds.

Figure 26: Annual Pavement & Bridge Program Expenditures



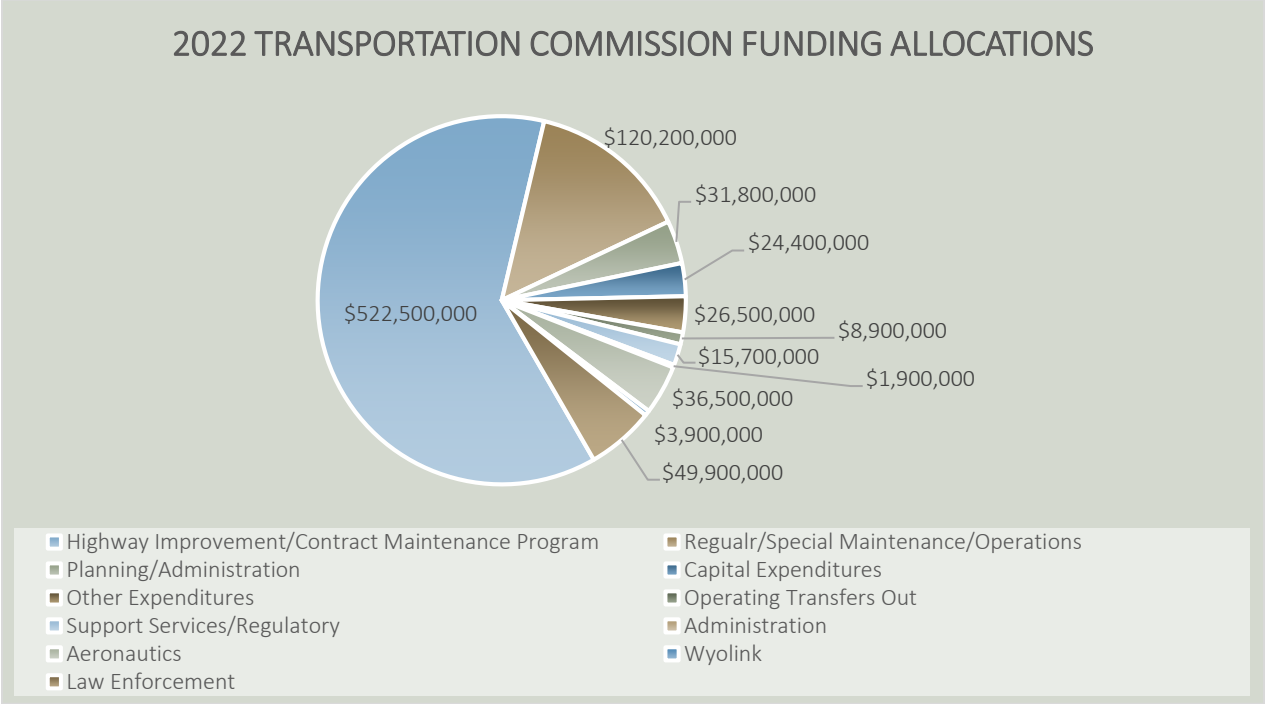
Source: STIP expenditures based on WYDOT's ERP as of 7/7/2022. FY2027 contains additional COVID stimulus funds.

The Planning Program, in consultation with the Budget Office, analyzes the statewide transportation needs and ultimately determines the funding allocations for each area of Wyoming's transportation network. To construct the STIP budget, the total statewide dollar amount available for highway construction contracts is reduced by the statewide designated funds, and the remainder of available funds are distributed amongst the five districts based on a combination of overall asset condition and

network-level system needs. Project costs are adjusted for inflation for future years, which allows for greater uniformity in planning over the life of the STIP. It also provides more consistency for longer-term asset management strategies, and increased budgetary controls for project selection and scheduling. STIP projects are linked to WYDOT's system level investment plan, and demonstrate the specific commitments WYDOT has made towards maintaining the state's transportation network, and reflect how the agency intends to achieve its stated transportation performance targets. In general, expenditures need to remain consistent with the agency's corridor plans, LRTP, and other strategic planning documents.

For fiscal years 2022 through 2026, WYDOT anticipates an annual average highway construction funding of approximately $523 million annually. After costs for project modifications, state infrastructure bank reimbursements, preliminary engineering, right-of-way acquisitions, utilities, and other dedicated program funding are deducted, approximately $436 million remains for actual highway improvements and contract maintenance (including preliminary engineering and construction engineering costs). The following graph illustrates the typical Wyoming Transportation Commission funding allocations.

Figure 27: 2022 Transportation Commission Funding Allocations



The Programming Investment Summary in Appendix 8.1 at the back of this report contains the detailed breakdown of WYDOT's anticipated expenditures by fiscal year for the 10-year time period covered in this asset management plan.

5.4 INVESTMENT STRATEGIES

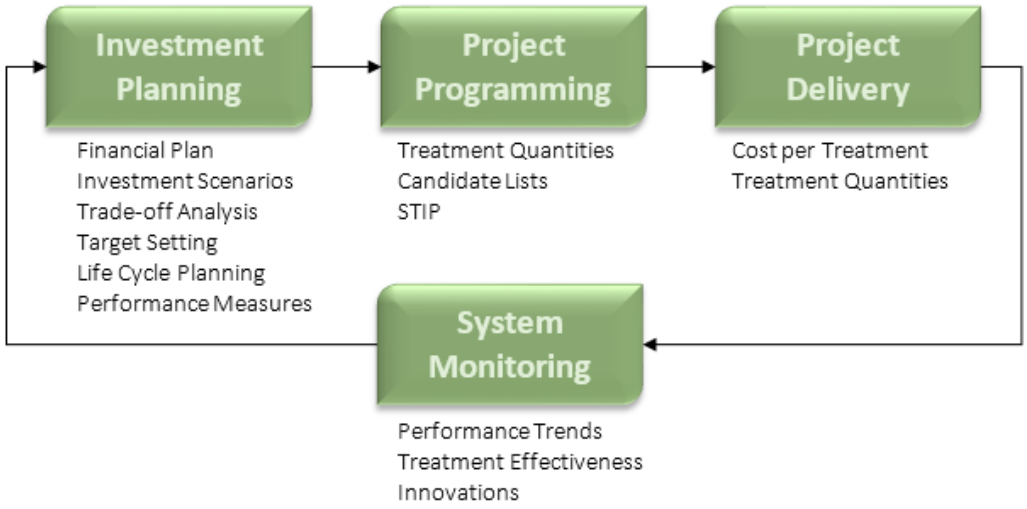
WYDOT's asset management strategy links investment decisions to anticipated asset condition improvements through performance-based planning. By identifying and implementing highway construction projects that contribute towards the agency's strategic goals, WYDOT can ensure that it

achieves progress with respect to meeting its established performance measures. WYDOT's investment priorities reflect the value Wyoming places on its transportation network. The investment strategies outlined in this section establish the methodology WYDOT employs for resource allocation to generate the greatest return on investment, while promoting system-wide asset condition sustainability, and facilitating progress towards the achievement of transportation performance goals. These investment strategies are based on a comprehensive system-level investment level trade-off between asset classes and system areas, and aimed at optimizing network-level conditions that best preserve the system. For the time being, most of WYDOT's transportation funding will be directed towards system preservation in alignment with the agency's stated asset management philosophy.

FHWA defines an investment strategy as the "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 risk." The focus of WYDOT's investment strategies will be to select and develop projects associated with areas of greatest need, which provide the most benefit to travelers and the State economy. Funding is distributed to the various asset categories based on the management system recommendations. As projects progress through the design process and then construction, the asset categories are tracked and updated regularly as these changes occur. This tracking is done to monitor and update the asset management recommendations as projects evolve, and to ensure that established performance targets are being actively achieved.

WYDOT's investment planning process identifies the funding allocation and likely overall focus for each program given the state's funding constraints. The investment plan describes the necessary trade-offs across system program areas and provides a system-level understanding of the size and mix of investments in a given area. A graphical representation of WYDOT's investment planning process is presented below in Figure 28.

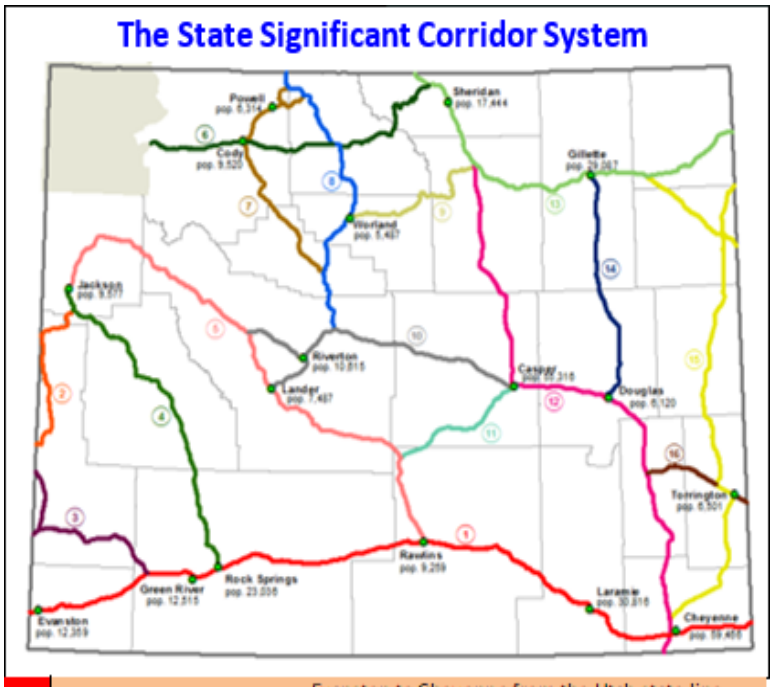
FIGURE 28: INVESTMENT PLANNING PROCESS



WYDOT focuses its investments on "preserving the system" using the outputs produced by the management systems, while recognizing that some instances of system modernization or expansion may be required to ensure the continued reliability and safety of the transportation network. Specifically, where major safety or mobility concerns have been identified and the deficiencies need to be addressed.

Mobility performance measures are mostly applicable to congested urban corridors; however, WYDOT is in the process of developing a mobility measure (using defined congestion levels combined with accessibility), with the recognition that increasing investment above current projections will undoubtedly yield improvements to general mobility, congestion, and access to all modes of transportation. While some projects may include minor mobility elements that modernize existing facilities, those improvements are typically limited in scope, and are considered on a case-by-case basis in accordance with WYDOT's standard business practices. For the most part, major capital expansion projects (new roadways, additional lanes, etc.) have been delayed until future years, since these type of projects incur future maintenance liabilities.

Figure 29: Statewide Significant Corridors



1	I-80	Evanston to Cheyenne from the Utah state line east to Nebraska state line
2	US 89	Geneva to Hoback Jct
3	US 30	Border Junction to Jct I-80 (Exit 66)
4	US 191 and US 189	Rock Springs to Jackson
5	US 287	Rawlins to Jackson
6	US 14 / 16 / 20	Yellowstone to Sheridan
7	WYO 120 and US Alt 14	Thermopolis to US 310
8	US 20 / 16 and US 310	Shoshoni to Lovell (Montana state line)
9	US 16	Worland to Buffalo
10	US 20 / 26 and WYO 789	Wind River/Lander to Casper
11	WYO 220	Muddy Gap to Casper
12	I-25 / US 87	Cheyenne to Buffalo
13	I-90	Montana state line (Sheridan) to S. Dakota state line (Sundance)
14	WYO 59	Douglas to Gillette
15	US 85 / 18	Cheyenne to Newcastle to Moorcroft
16	US 26	I-25 (exit 92) to Nebraska state line (Torrington)

WYDOT uses a corridor-based system planning process in conjunction with the LRTP to develop investment strategies that best maintain Wyoming's transportation network. The LRTP provides a 20-year vision of statewide transportation system goals to inform needs prioritization, including the financial assessment to fund the goals to carry out the department's vision. The LRTP identifies 16 key multimodal routes that form the vital links within the state, and shape the agency's long-range vision and investment strategies (Figure 29). A wide range of improvements will be needed across the transportation system in coming years to address system preservation needs, safety deficiencies, mobility and capacity concerns, etc.

WYDOT's corridor vision focuses system planning around the idea of creating a uniform and consistent experience when traveling from one location to another. The asset management process is used to optimize individual rehabilitation strategies within the corridor analysis based on the identified infrastructure needs within each corridor. Major connecting routes (Rawlins to Jackson or Evanston to Pine Bluffs, for example) are analyzed as contiguous routes, to determine the deficiencies and needs of each individual sub-segment or corridor, the results of which are used to determine all the items within a given segment that may be causing an impediment to the safe, efficient flow of traffic in the state. Generally,

WYDOT prioritizes its investments into system preservation, safety, and mobility along State Significant Corridors that exhibit the greatest need and provide the greatest overall benefit to the travelling public and state economy.

The majority of WYDOT's infrastructure spending is concentrated on bridge, pavement and safety, as these are the areas with defined measures both internally and at the Federal level. WYDOT expends approximately $185 million annually on its pavement preservation program, and $35 million on bridge preservation and replacements. The investment analysis quantified the effects of different funding scenarios on network asset conditions, based on the asset class tradeoffs across program areas to provide the optimal size and mix of investment required in each area. WYDOT's primary investment areas are defined as follows:

PRESERVATION - Work intended to maintain, preserve, rehabilitate and repair the existing transportation network at current condition levels, or desired levels of service. The majority of STIP projects fall into this category.

SYSTEM MODERNIZATION - Involves upgrades to the existing state highway system, including shoulder improvements, passing lanes, and intersection reconstruction. These types of highway construction projects do not increase the capacity of the system, rather are intended to bring existing facilities into conformity with current design and functional standards. These projects may impact the maintenance activities or physical asset inventory, and improve long-term system performance and safety of the existing system.

CAPITAL EXPANSION - Improvements to add capacity to the existing roadway network, construction of additional lanes on existing roadways or bridges, new bridges, and new interchange construction. These projects add additional infrastructure assets to the existing asset inventory, and may create future maintenance responsibilities/additional financial burdens.

LOCAL CONSTRUCTION **-** Construction on county and city roads (including those located on the NHS) that are primarily safety-oriented, preservation projects. Some minor expansion to accommodate local mobility needs may be included. Funding to support local construction is derived from a combination of federal, state, and local governments.

The investment strategies outlined in the TAMP and implemented in the STIP are those that maximize resource allocations by promoting long-term asset sustainability and facilitating progress towards achieving national performance targets. STIP projects are based on considerations of the State's system-wide asset needs. The comprehensive portfolio of projects outlined in the STIP are those that yield the greatest return on investment based on a systematic approach to maintenance, preservation, rehabilitation and replacement. WYDOT relies on recommendations from its management systems (PMS, BMS) to develop STIP projects that achieve progress toward meeting designated performance targets, as well as conform to the investment strategies established in the TAMP. These investment strategies are aimed at maximizing resource allocations to promote long-term asset sustainability.

The Planning Program analyzes transportation needs and intended funding, in consultation with the Budget Program, for all projects that are entered into the STIP. The STIP represents those projects WYDOT expects to construct in the upcoming fiscal year, and those projects being designed for

construction in the following five fiscal years. STIP projects are selected based on the performance of the statewide highway system, including pavement and bridge conditions and asset management systems recommendations. Highway safety and mobility are evaluated on a project-by-project basis. These projects are intended to meet WYDOT performance goals and are measured against those goals. The basis for the STIP is a fiscally constrained list of roadway projects, with an appropriate mix of preservation and rehabilitation projects. Additionally, funding is available to complete a limited number of reconstruction projects and also those projects whose need is not pavement related.

WYDOT tracks the planned and actual expenditure of construction funds by calculating the percentage of each project falling into defined asset categories and subcategories, depending on the nature of the work each project entails. STIP projects may have multiple asset categories and/or subcategories assigned, depending on the work to be completed. An example of this might be a project intended for pavement rehabilitation, but which will also have shoulder widening to decrease crashes, and passing lanes installed to improve traffic flow. The portion of the work for paving, such as plant mix, asphalt binder, hydrated lime, etc. would be categorized as pavement, whereas the portions of the work intended to solve safety and/or mobility issues would be allocated to safety or mobility. The Planning Program uses relevant planning and engineering documents to estimate the percentage of a project's anticipated construction costs that should be allocated to the pavement, safety and mobility categories. For projects located within urban boundaries, the work would be categorized as Urban.

Table 15: Asset Category Descriptions

Asset Category	Category Description
Pavement	All roadway surfacing work not associated with system expansion or mobility improvements.
Bridge	All bridges on or off the State-owned highway system.
Mobility	Capacity increases, additional lanes, intersection improvements for traffic flow, turn lanes, etc.
Safety	Items affecting the safety of the transportation network, including guardrail, rumble stripes, chevron striping, grading side slopes, epoxy striping, and signage upgrades.
Environmental Sustainability	Air quality Improvements, wetland banking, vehicle-animal collision mitigation, archeological and historical preservation.
Maintenance	Work for general maintenance of the roadway, including fencing, sign replacement, crack sealing, pothole patching, snow removal, etc.
Urban	Transportation-related improvements within an urban boundary.
Community Development	Enhancements to community livability, such as sidewalks, ADA upgrades, bicycle pathways, aesthetic improvements, etc.
Other	Other non-defined transportation items.

6. RISK MANAGEMENT

6.1 RISK ANALYSIS

Federal legislation requires State DOT's to develop and implement a risk-based asset management plan (23 CFR 515.7(c)) for the NHS to improve or preserve its condition and performance. The Bipartisan Infrastructure Law (BIL) (§ 11105) further amended the TAMP requirements to include consideration extreme weather and resilience within their risk management analysis. As a result, State DOTs are required to consider extreme weather and resilience as part of the risk management analyses within a State TAMP (23 U.S.C. 119(e)(4)(D)).

AASHTO defines risk management as "the formal and systematic effort to control uncertainty and variability on an organization's strategic objectives by managing risks at all levels of the organization."

The TAMP final rule defines risk management as the processes and framework for managing potential risks, including identifying, analyzing, evaluating, and addressing the risks to assets and NHS system performance. WYDOT used AASHTO and FHWA's guidance on defining and managing risks to formulate it's TAMP risk process. Within the context of TAM, risk is generally defined as the probability or threat of damage, injury, liability, loss, or any other negative occurrence caused by external or internal vulnerabilities that could have a potential impact on the transportation network, and which may be avoided through preemptive action. FHWA defines risk as "the positive or negative effect of uncertainty or variability on agency objectives." Risk management is incorporated into WYDOT's decision-making process to address existing and potential risks to its transportation network. The risk portion of this asset management plan focused on three levels of risk: agency risk, program risk, and project risk, which are defined as follows:

AGENCY RISKS – Risks affecting more than one major program, or having the ability to affect agency objectives or strategic progress.

PROGRAM RISKS – Risks common to clusters of projects, programs, or entire business units. These risks are typically addressed during the project design and development process. Programmatic risks usually fall into one or more of three broad categories: natural, environmental, and man-made. Each of these program risks categories is discussed in more detail in the sections that follow.

PROJECT RISKS - The third and lowest risk level are those that relate to bringing individual projects to contract. Numerous risks exist during an individual project's design and development process that can prevent a project from going to contract as scheduled or budgeted.

6.1.1 Agency Risks

The greatest known risk to Wyoming's transportation network is agency risk. Specifically, the lack of adequate funding to preserve and maintain the existing infrastructure, combined with an inability to modernize or expand the system to meet future needs. Financial risks, in particular, can hinder an

agency's ability to implement the investment strategies identified in this asset management plan. Financial risks include scope growth and project cost increases, labor and material price volatility, revenue uncertainty, political pressure, and environmental or right-of-way acquisition issues.

Another consideration affecting the agency risk of inadequate funding is inflation. Long-range projections predict relatively flat future funding levels. The anticipated average annual funding increases for the next 10 years are not expected to keep up with inflation. WYDOT has compared the region's Construction Price Index with other factors and has set a 5% annual inflation. While in the short-term this has little impact on the agency's ability to meet its performance targets, long-term projections (ten years or more into the future) show a growing funding shortfall compared to the expected pavement and bridge preservation needs.

6.1.2 Program Risks

WYDOT primarily addresses risk at the programmatic level. Programmatic risk is considered to be an event that prevents the traveling public, commerce, or both from successfully moving from one location to another across Wyoming's transportation network. The majority of threats and hazards to Wyoming highways are naturally occurring hazards, as opposed to man-made, and fall into two main categories: (1) extreme weather (environmental risks) and (2) geological hazards (natural risks). Extreme weather events include flooding, blizzards, high wind, and snow slides. Geological events include earthquakes, ground subsidence, landslides, and rock falls. Accordingly, WYDOT focuses on three broad categories of programmatic risk: natural, environmental, and man-made. Programmatic risk categories are described in more detail below:

Figure 30: Example of Landslide Roadway Hazard

NATURAL RISKS – Consists of earthquakes or seismic events, avalanches, forest fires, landslides, and rock falls. These risks tend to disrupt the traveling public for longer periods and are very random and unpredictable. Natural risks are considered and mitigated during each project's design phase using industry and national design standards. Historical data is also considered and used to determine the frequency or likelihood of re-occurrence.

ENVIRONMENTAL RISKS – Typically due to climate-related events, such as extreme wind hazards, blizzards, blowing snow, flooding or storm water runoff. These risks have the potential to disrupt the traveling public for an extended length of time, but are most often shorter-lived events that disrupt traffic for a brief period of time before service is fully restored. Environmental risks tend to occur more often (cyclically) than natural risks. These risks are predictable in that their occurrence is considered in the cost-benefit analysis during each project's design; for example, structures are designed (sized) to pass a flood event of a given design frequency (i.e. 25-year, 50-year, or 100-year flood levels) and the possibility of a larger flood occurring during the structure's life is considered an acceptable risk trade-off.

MAN-MADE RISKS - Road closures caused by accidents, fires, fuel spillage, or other errors in judgment made by the driving public and commercial carriers. Historically, these road closures have been reasonably short and/or easy to route traffic around. Man-made events rarely cause significant damage to the transportation infrastructure. Local emergency response agencies have historically managed such incidents.

6.1.2.1 Risks to Pavements

FHWA recommends a risk-based approach to managing networks, corridors and critical infrastructure by classifying routes based on varying levels of importance, and using metrics that encompass economic generators, traffic counts, or distance from population centers. WYDOT makes risk trade-offs for pavement conditions based on system classification of the roadway (i.e. Interstate, Non-Interstate NHS, and Non-NHS), with the recognition that more risk is being taken on lower trafficked Non-NHS roads, which allows for the overall condition on less-travelled roadways to be lower than for higher volume roadways. A secondary risk to WYDOT's pavement preservation program is based on the concept that it is less expensive to keep good pavements in "Good" condition than to repair them once they have fallen into "Poor" condition. This translates into the accepted risk that some roads in "Poor" condition will technically remain poor and will often continue to decline and become rougher, with deepening ruts, and increased cracking.

Beyond this, WYDOT's approach to monitoring other pavement risk is relatively reactive. Some areas have higher than usual natural and environmental risks, and receive additional monitoring through WYDOT's Geology Program. Unfortunately, WYDOT is unable to address a significant percentage of these existing risks with preventative measures whilst still maintaining a functioning transportation system due to the funding challenges the agency faces. For example, it is simply not feasible or economical to pre-emptively stabilize all possible rock fall slopes or landslide areas within the state. For these more remote and uncommon risks, WYDOT has determined that by reacting quickly and effectively to operational failures as soon they occur, funding can be utilized more effectively than by proactively attempting to prevent such failures from occurring. In turn, WYDOT responds effectively and efficiently after an event occurs causing a roadway closure, in an effort to minimize the duration and inconvenience to the travelling public.

6.1.2.2 Risks to Bridges

There are numerous risks associated with bridges, particularly for bridges located in seismic zones, over flood-prone waterways, or on foundations susceptible to scour. As bridge infrastructure assets age, their serviceability and structural integrity may be reduced due to the effects of deterioration. Some structures may contain fracture critical members or have fatigue prone details. Failure of key elements (such as protective coating systems, expansion joints, and bearings), along with bridge deck cracking may rapidly reduce structural integrity making it necessary to load post or close the bridge. Bridges with substandard vertical and horizontal clearances may also be at risk from impacts of oversize loads. These risks, along with many others, are identified and assessed through WYDOT's bridge inspection program. Appropriate actions are taken when inspections identify items or areas of concern. Resilience in bridges is addressed by the risk analysis performed during the design process, including seismic probability and scour potential.

6.1.3 Project Risks

A third level of risk relates to project risks, which pertains to bringing individual projects to contract and completion. Project risks are only considered to the extent that their accumulated effect may impair the agency's ability to implement the STIP. There are a number of risk factors that may prevent a project from successfully going to contract as scheduled, including, but not limited to, right of way acquisition, environmental clearances and permits, NEPA compliance, construction funding constraints, and project cost increases.

6.2 RISK MANAGEMENT PLAN DEVELOPMENT PROCESS

The final Federal rule defines risk management as the processes and framework for managing potential risks, including identifying, analyzing, evaluating, and addressing the risks to assets and NHS system performance. WYDOT's risk management process focuses on identifying, analyzing, evaluating, and prioritizing the effects of risk or uncertainty on the operational ability of the transportation system to continue functioning at intended service levels. WYDOT's Risk Management Plan focuses on four main risk areas: (1) operational, (2) strategic, (3) environmental, and (4) financial.

OPERATIONAL RISKS – risks include asset and maintenance failures, staff turnover, and internal procedural breakdowns.

STRATEGIC RISKS – include public opinion, stakeholder demands, and changing standards and regulations.

ENVIRONMENTAL RISKS – include rock slides, landslides, flooding, and seismic events.

FINANCIAL RISKS – These types of risk are not limited to a lack of funding, but can also include budget uncertainty, price volatility, price increases (inflation), and negative economic conditions.

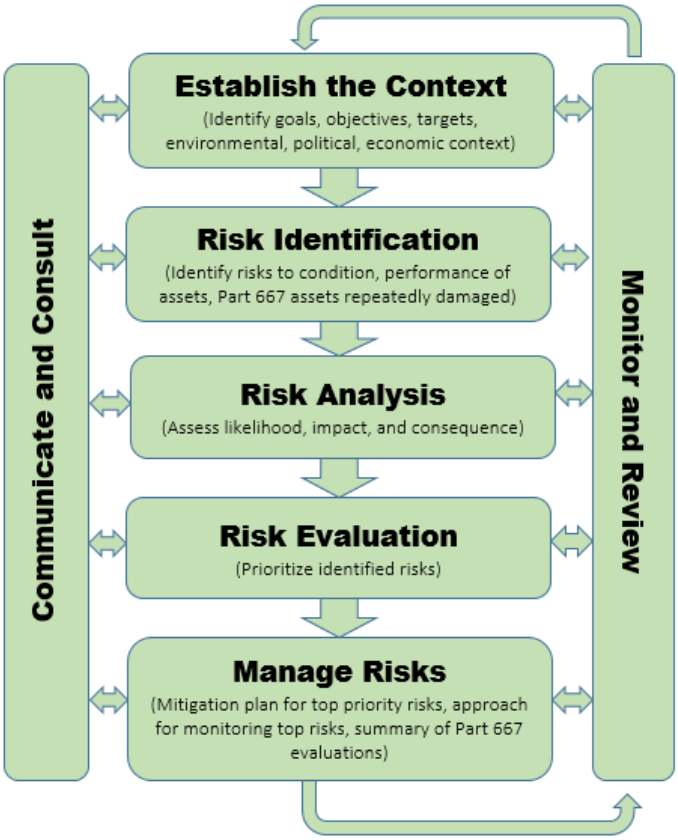
For the purposes of the Risk Management portion of this plan, WYDOT's risk process was used to assess scenarios of "if-and-when" an identified risk event occurs, what potential impacts it might have on the transportation network, and whether pre-emptive action should be taken to mitigate possible failures when necessary. It is critical for the transportation network to maintain operational continuity and functionality when a risk event occurs, and to effectively manage or adapt to changed conditions resulting from an unexpected risk occurrence.

Risks to the State's transportation network are identified by the magnitude of disruption and the likelihood or probability of occurrence. Although it can be difficult to quantify the exact cost or consequence of a risk event, WYDOT uses the risk mitigation strategies outlined in this document to prepare for and withstand service disruptions should they occur. This includes the potential for loss of service or harm to the transportation network due to unforeseen circumstances resulting in adverse consequences for the agency or the travelling public. Deteriorating roadways, bridges nearing the end of design life, capacity concerns, safety objectives, supporting rural communities, inadequate infrastructure to support economic growth or industry needs, and underfunded transportation alternatives all

contribute to the challenges WYDOT faces in regards to maintaining the state highway system at its current level.

To develop the risk management plan, WYDOT used the framework illustrated below in Figure 31 to identify, assess, evaluate, and prioritize program-level risks that could potentially impact Wyoming's transportation network. Risk management is a continual process that requires identified risks to be re-evaluated on a regular basis.

FIGURE 31: RISK MANAGEMENT PLAN DEVELOPMENT



WYDOT's risk management framework consists of different approaches depending on the type and nature of the risk identified. Possible risk response options include:

- TREAT THE RISK – by taking an action, and providing an explanation of the risk mitigation measures that will be undertaken.
- TOLERATE THE RISK – by accepting and monitoring the risk potential because it cannot be feasibly addressed.
- TERMINATE THE RISK – By ending the practice that causes it.
- TRANSFER THE RISK – on to contractors or design consultants.
- TAKE ADVANTAGE OF THE RISK – capitalizing on the risk.

A Risk Matrix is the tool WYDOT used to assess risks to the transportation system based on asset criticality, likelihood of occurrence, and a prioritization of identified risks and related vulnerabilities. To conduct its risk assessment, WYDOT personnel participated in a risk management survey to identify risk to which the agency is susceptible. Members of executive staff, program managers and relevant data stewards, district staff, and planning personnel utilized the following Risk Rating Matrix (Figure 32) to identify, assess, evaluate, and prioritize risks to the transportation network. The risk survey was sent to various WYDOT employees with different areas of expertise and varying degrees of institutional knowledge. The risk ratings rubric was used to assess the impacts and probability of each risk event occurring, the results of which were aggregated into a single score for each risk element. The average risk scores were then ranked to ascertain the agency's top priority risks.

FIGURE 32: RISK RATINGS MATRIX

Risk Matrix								
Risk Impact Matrix				Likelihood of Occurrence				
				Rare	Unlikely	Likely	Very Likely	Almost Certain
				1	2	3	4	5
Consequence	Catastrophic	Potential for multiple deaths & injuries; substantial public & private cost.	5	Medium	Medium	High	Very High	Very High
	Major	Potential for multiple injuries, substantial public or private cost and/or foils agency objectives.	4	Low	Medium	Medium	High	Very High
	Moderate	Potential for injury, property damage, increased agency cost and/or impedes agency objectives.	3	Low	Medium	Medium	Medium	High
	Minor	Potential for moderate agency cost and impact to agency objectives.	2	Low	Low	Low	Medium	Medium
	Insignificant	Potential impact low and manageable with normal agency practices.	1	Low	Low	Low	Low	Medium

Risk ratings from nine to ten were considered "very high risk," ratings of eight were considered "high risk," ratings from six to seven were considered "medium risk," and ratings from two to five were

considered "low risk." Sixteen major risks were identified, four of which were determined to be the agency's top-priority. The agency's top risks have been summarized in the table below.

TABLE 16: TOP RATED RISKS

Risks Identified	Avg Risk Rating
Prolonged Preservation Strategy	8.21
Workforce Attrition	8.17
Supply Availability/Contractor Constraints	7.69
Increase Fuel Efficiencies/EV's	6.86
Lack of Funding/Funding Uncertainty	6.79
Inflation/ Commodity Price Volatility	6.69
Inadequate Maintenance Budget	6.59
Congestion/Increased Travel Demand	6.17
Climate Change/Natural Disasters	5.86
Accuracy of BMS/PMS Models	5.76
Landslides/Slope Failure	5.72
Rock Falls/ Geohazards	5.66

WYDOT's risk framework evaluates the probability of potential hazards occurring in order to formulate the set of strategies and resources that will be needed to address identified risks to NHS infrastructure assets and system performance (i.e. minimize, monitor, and control their likelihood and impact). Mitigation strategies identified for those risks deemed "treatable", and the parties responsible for each of the top priority treatable risks have been addressed in the following Risk Management Register. Some of the agency's top rated risks from the table above are not treatable, and therefore must be tolerated. These risks include: funding deficits, supply availability/contractor constraints, increased fuel efficiency, inflation and commodity price volatility. The remainder of the risks are considered treatable, and are addressed in the Risk Register below, along with their mitigation strategies.

TABLE 17: RISK REGISTER

Top-Priority Risks	Mitigation Strategies	Responsible Parties
Prolonged Preservation Strategy o Falling behind on improvement, which increases the likelihood of responding reactively as opposed to being pro-active. o Aging infrastructure o Lack of reconstruction and added capacity and safety measures o Masking deep-rooted deterioration, which increases the likelihood of responding reactively as opposed to being pro-active.	Analyze planned versus actual project selection with system management plans to determine results of meeting or not meeting PMS/BMS model deterioration curves.	State Planning Engineer
	Develop trade-off analysis procedure/methodology to determine appropriate funding levels for preservation vs. replacement and reconstruction. • Determine proper annual funding levels for system-wide preservation, reconstruction, modernization/system expansion, and modal improvements per year.	Assistant Chief Engineer, Engineering and Planning
	Communicate the need to incorporate reconstruction projects as part of a system preservation strategy. Ensure there are sufficient funds to maintain any improvements into the future.	State Planning Engineer
	Use LRTP to assist the legislature in determining funding levels to meet system requirements.	System Planning Engineer

Workforce Attrition/Loss of Institutional Knowledge o Lack of trained personnel (resources to recruit, train, retain, changing expectations) o Retirement of workforce (back fill and training) o Lack of experienced workforce (WYDOT and external) o Decreasing quality of workforce (recruitment, retention, education, training, institutional knowledge, lack of experience)	Continue developing succession planning, defining critical positions, and improving knowledge transfer. • Develop contingency plans for decreased staffing levels that explore reallocating staff and contracting alternatives. • Standardize internal training procedures	Support Services Administrator
	Standing Committee on Training for technical and behavioral training made available to all WYDOT personnel. • On-the-job training (OJT) • WYDOT University provides professional training opportunities through instructor-led courses, distant learning options, and the WYDOT eLearning library.	Support Services Administrator
	Update recruitment strategies to reflect changing workforce needs. • Communicate to the legislature the need for a competitive compensation package.	Human Resources Manager
Inadequate Maintenance Budget o Premature asset failure due to lack of routine maintenance activities.	Analyze annual maintenance expenditures to determine the actual maintenance levels required to sustain and/or optimize the model deterioration curves.	State Maintenance Engineer
	Evaluate true costs of infrastructure maintenance activities and their effects upon asset life-cycle cost.	State Pavement Engineer
	Research mechanisms to incorporate maintenance expenditures into the performance models.	State Pavement Engineer
Congestion, Mobility Changes/ Increased Traffic Demand o Changing commerce and demand on the system o Economic/energy development (unknown changes in demand and traffic) o Population growth and/or migration	Develop an objective process to determine which mobility projects provide the greatest long-term benefit, and realign management system models to optimize strategies if economic drivers change.	State Planning Engineer
	Place more emphasis on corridor plans for mobility planning, and review the LRTP and verify needs are aligned.	System Planning Engineer
	Monitor traffic volumes and truck counts.	System Planning Engineer
	Monitor Bureau of Land Management /Forest Service Environmental Impact Statements.	System Planning Engineer
	Monitor automated/connected vehicle usage.	System Planning Engineer
Climate Change/Natural Disasters o Earthquakes or seismic events, avalanches, forest fires, flooding, extreme wind hazards, blizzards, blowing snow, storm water runoff	Implement risk mitigation strategies during project design phase using industry and national design standards, and historical data to determine the frequency or likelihood of re-occurrence. • Bridges are designed to pass a flood event of a given design frequency (i.e. 25-year, 50-year, or 100-year flood levels) with the possibility of a larger flood event occurring considered an acceptable risk trade-off. • Seismic retrofitting bridges. • Pavements are designed utilizing a 98%	Project Design Engineers

	reliability high average pavement temperature based upon FHWA supported climate data.	
	Incorporate resiliency analyses to identify critical assets prone to seismic events or other natural hazards associated with climate change.	Systems Bridge Engineer
	Utilize geospatial analysis to assess areas with greater susceptibility to extreme climate events.	Systems Planning Engineer
Accuracy of BMS/PMS Models o Assets deteriorating slower or more quickly than predicted.	Continue to refine data collection practices and BMS/PMS models to ensure that the model predictions are accurate and allocations are appropriate.	State Pavement Engineer, State Bridge Engineer
Landslide/Slope Failures o Loss of existing roadway or embankment due unstable slopes.	Identify unstable areas and create geodatabase of unstable slopes and active landslides. • Install monitoring devices at vulnerable locations; remediate storm water infiltration, re-contour or preemptively stabilize slopes when able.	Geology Program
Rock Fall/Geo-hazards o Rock fall hazards affecting the safety of the travelling public	Expand use of GIS database to map and monitor geo-hazard locations throughout the state. Mitigate hazardous areas where possible by removing lose rock.	Geology Program

6.3 SYSTEM RESILIENCY

System resiliency is the ability to keep the transportation open and operational in the face of unexpected risk events. Resiliency within a transportation network is a function of system-wide preparedness and planning for prevention, protection, mitigation, response, and recovery. In other words, it a measure of a system's adaptability, or ability to recover and return to full operational efficiency following a disaster. It is important for critical infrastructure to be secure and able to withstand and rapidly recover from all risk hazards. *Presidential Policy Directive 21 (PPD-21): Critical Infrastructure Security and Resilience* defines resilience as the ability to prepare for and adapt to changing conditions, and withstand and recover rapidly from disruptions—deliberate attacks, accidents, or naturally occurring threats or incidents. Critical infrastructure must be secure and able to withstand and rapidly recover from all hazards. While Wyoming's highway network was not defined as a critical infrastructure as defined in the PATRIOT Act and PPD-21, WYDOT recognizes that the fundamentals of resiliency apply to all levels of infrastructure. Due to the State's large, geographically dispersed land area, there is a heavy reliance on the state's highway system, and an individual failure may result in severe economic hardship for rural and small populations that are not served by other modes of transportation.

WYDOT periodically conducts system resiliency analyses to ascertain system vulnerabilities in conjunction with its risk management plan. Resiliency analyses are used to evaluate the robustness, reliability, elasticity, and adaptability of the transportation network by identifying elements of critical infrastructure with greater susceptibility to potential threats and hazards, extreme weather events, or environmental

disasters. Part of the risk management process entails incorporating the proper resiliency measures (when needed) to mitigate or offset the effects of any potential service disruptions when they do occur.

WYDOT relies on the following mechanisms to enhance or improve system resiliency within the State's transportation system:

HARDEN THE SYSTEM - Improve the condition and resiliency of the asset or corridor to withstand more severe climate events.

CREATE REDUNDANCY - Identify or build flexible alternative routes and/or modes.

OPERATIONAL SOLUTIONS - Repair and/or mitigate the undesirable conditions during and after the extreme event.

SYSTEMS PLANNING - Establish advanced decisions and processes to effectively address the potential for future risk events.

Resiliency efforts that "harden" the system are based off an evaluation of network-level transportation vulnerabilities, developing preparedness plans, and constructing necessary transportation improvements to enhance the network's ability to withstand and recover from hazard events. The network-level evaluation identifies critical facilities, such as roadways, bridges, airports, intermodal access, and redundant facilities, identifying or building alternative routes helps to harden the network, and ensuring that drivers have an alternative way to get from Point A to Point B should infrastructure become damaged or removed from service due to a risk event, such as an instance when a flood event takes a bridge out of service. Incorporating redundancy elements into network system can also help circumvent disruptions when they do occur.

Once critical assets have been identified, WYDOT determines the optimal mitigation strategy, and implements remediation efforts when required. Mitigation strategies are based on benefit-cost analysis of reducing network vulnerability to potential threats. An example of a resilience strategy might be incorporating structural design elements to take into account the threat of natural disasters, such as in seismic areas or areas prone to flooding. For example, when riprap on a bridge is washed away due to a flooding event, this creates a hazard that needs to be addressed; however, based on a cost-benefit analysis, WYDOT has determined that it is more feasible to simply replace the riprap when such an event occurs. So in this instance, the riprap would be considered a "sacrificial element" that is cheaper to repair or replace when an extreme weather event occurs.

Redundancy elements are incorporated into Wyoming's transportation network by constructing highway improvements that reduce network vulnerabilities to potential threats from environmental and man-made hazards (particularly hazards resulting from extreme weather conditions and climate change), incorporating structural design elements into highway construction projects that take into account the threats of natural disasters/events, such as in seismic of flood-prone areas, proactively monitoring high risk locations, and seismic retrofitting of bridges in areas with known seismic activity. Resiliency is further addressed in WYDOT's Freight Resilience Plan, which prioritizes the State's critical highway freight facilities based on criticality rating, condition/performance and risk analysis. A more thorough and comprehensive resiliency analysis process is applied to higher priority critical assets. WYDOT's primary

resiliency risks include: bridge flooding, bridge strikes, winter weather-related road closures, light high-profile vehicle blow-overs, and environmental non-attainment areas.

6.4 EVALUATION OF EMERGENCY EVENTS

In addition to addressing risk management, 23 CFR 515.7 requires State DOTs to include an identification of risks that could adversely affect the condition or performance of NHS pavements and bridges, an evaluation and prioritization of those risks, as well as to develop a mitigation plan for monitoring the severity and likelihood of occurrence of those identified risks. 23 CFR Part 667 further requires an evaluation of facilities repeatedly damaged by emergency events (at a minimum on the NHS), as well as any proposed mitigation alternatives for those locations. WYDOT conducted a statewide evaluation of the state's existing roads, highways, and bridges eligible for funding under Title 23 of the United States Code (U.S.C.) to meet the MAP-21 Evaluation of Emergency Events requirement and to better equip WYDOT to mitigate potential natural and environmental risks.

To comply with the federal regulations, State DOTs are required to conduct a statewide evaluation of existing network roads, highways, and bridges applicable under Title 23 that, "have required repair and reconstruction activities on two or more occasions due to emergency events, to determine if there are reasonable alternatives to any of these roads, highways, and bridges; evaluation should consider the risk of recurring damage and cost of future repair under current and future environmental conditions." An emergency event is defined as, "a natural disaster or catastrophic failure due to external causes resulting in an emergency declared by the Governor of the State or an emergency or disaster declared by the President of the United States." To determine the historical incidences of Presidential Disaster Declarations or Wyoming State Executive Orders – Declarations of Emergency, WYDOT referenced records from multiple agencies, including the Governor's Office, Wyoming State Library, Wyoming Secretary of State, Wyoming State Archives, Wyoming Legislative Service Office, and the Wyoming Office of Homeland Security. WYDOT utilized the information from these agencies' websites to obtain the relevant emergency events data.

In Wyoming, fourteen Governor and/or Presidential Declarations of Emergency or Disaster Declarations were identified as having been issued since January 1, 1997 that affected NHS highways and bridges. WYDOT conducted further research into the fourteen events to determine specific damage locations and the extent of damage to NHS highways and bridges, type and extent of work required to mitigate the damage, and geo-locating infrastructure assets directly impacted by these emergency events. WYDOT compiled a list of all projects related to emergency repair, damage repair, or emergency from internal databases, and including Federal Management Information System (FMIS), to ascertain which projects had emergency relief designations. These projects were cross-referenced to locations where infrastructure damage occurred as a result of an emergency declaration, WYDOT created a summary table of locations affected by emergency events (see Appendix 8.2 at the end of this document for the full table of emergency events and respective locations).

Three locations were identified as needing repair or reconstruction (or both) on two occasions due to emergency events since January of 1997. Two separate bridges located over the Little Wind River were identified as requiring riprap repair resulting from damages sustained in an emergency on two separate

occasions. WYDOT considers riprap to be a sacrificial element that protects the Substructures. No real mitigation strategies exist to protect the riprap at these locations in an instance of an emergency event. The cost to fully mitigate or eliminate the risk of damage to riprap at these locations would be cost prohibitive and environmentally unsound; therefore, WYDOT has elected to "tolerate" the risk of riprap damage to these structures. The third location was situated in the Wind River Canyon, which is a designated scenic highway canyon with Class 1 water in areas up to 2,500 feet deep, exposed rock and very steep slopes. During heavy rainfall and flooding events, large rock falls or erosion may occur; however, protecting the entire eleven miles of canyon is cost prohibitive and beyond the scope of reasonable risk mitigation measures.

Based on this evaluation of emergency events, a determination was made that no repairs or reconstruction activities have occurred on two or more occasions on any given section of state roadway in Wyoming due to emergency events as decreed by the Governor of Wyoming or by the President of the United States. Emergencies that did not affect the state's transportation system or use Title 23 funding were not considered in this evaluation. Appendix 8.2 Evaluation of Emergency Events contains the full details of the analysis.

7. ASSET MANAGEMENT PROCESS IMPROVEMENT

7.1 EVOLVING TAM PRACTICES

WYDOT continues to refine and improve its asset management practices through a data-driven approach to managing and preserving infrastructure assets. TAM enables an agency to make better investment decisions, with the goal of optimizing the project selection process, and achieving national performance targets. As such, WYDOT is committed to implementing TAM fundamentals into its standard business practice, and to refining its project selection process in accordance with this concept.

WYDOT's asset management process began in 2006 with the purchase of an Enterprise Resource Program (ERP), consisting of an Oracle database, to facilitate a more detailed tracking of project-related cost expenditures. The State Planning Engineer was appointed the primary Asset Management Program Manager, and the Planning Program was reorganized to include an Asset Management Coordinator within the Programming Section. WYDOT released its first PMS Candidate List to the five districts in 2013, with the first candidate projects coming to completion in 2016. WYDOT's initial BMS Candidate list was disseminated to the districts beginning in 2018. The Planning Program also began setting and tracking mileage goals for pavement and bridge for each of the districts to evaluate progress towards meeting its asset management objectives. WYDOT continually refines its internal asset management processes to keep pace with the evolving principles of asset management, and as new knowledge and practices are developed and implemented on the national level.

WYDOT has also been working to improve its internal asset management processes through an emphasis on data governance and performance management. WYDOT is currently in the process of implementing a new Scope Statement process, which will allow the agency to address other deficiency areas that have been identified by district personnel, while still prioritizing asset condition needs. Scope Statements will help integrate relevant asset management data earlier into the decision-making process, with the aim of minimizing scope creep and preventing unexpected delays that may arise during project development. Oftentimes unaddressed deficiencies will remain outside of funding limitations or project scope (or funding is focused on fixing a higher priority elsewhere); however, it is important to document where unfunded needs still exist on the network, so that those issues can be addressed in the future.

7.2 TRADE-OFF ANALYSIS

Good TAM practices recognize that decision makers must be given the resources and authority to perform to the standards required by the organization, while also being held accountable for meeting those standards. Wyoming's aging transportation infrastructure requires some costly repairs just to bring the system up to expectations for today and tomorrow. Given the costs to preserve the existing system at current service levels, little remains for new capital improvements or system expansion. With limited resources, multiple worthy transportation needs vie for the same funds, and WYDOT must make tradeoffs between various components of the transportation system to optimize the condition of the

transportation system. The balance of core transportation needs at the system level needs to be maintained so as to ensure the public has basic mobility access throughout the state. System-level needs currently being weighed against each other in the construction budget are pavement condition, bridge condition, and critical crash reduction for safety.

The District Engineers perform the required tradeoff analysis between individual projects within their designated geographical area. The tradeoff between competing transportation needs should vary between geographical areas of the state. For example, the desire for increased mobility in the Gillette area has a different weight than wildlife protection in the Jackson area. However, there are core transportation needs at the system level that must be maintained in order to ensure the public has basic mobility access throughout the state. There are also functions such as maintenance that form a base of preservation, such as crack sealing pavements, cleaning bridges, or maintaining sign reflectivity. These base functions must continue in order for the management system models to work. WYDOT recognizes that its current trade-off practice may lead to suboptimal project selection, so the agency recently commissioned a study to explore more advanced methodologies for trade-off analysis between asset classes, with the eventual goal of developing a trade-off tool that could be used to evaluate the agency's competing priorities through benefit-cost analysis. Optimized trade-offs would significantly benefit the agency in determining the appropriate funding allocations for the remainder of highway construction needs beyond system preservation.

WYDOT spends approximately two-thirds of the contract construction budget on three asset categories: (1) pavement, (2) bridge, and (3) safety. Safety infrastructure has an effect on reducing fatalities and serious injuries, and is another of WYDOT's goal areas. Although this document does not address the infrastructure deterioration and improvement plan for safety-related items, WYDOT has been in the process of developing a network-level Safety Management System (SMS). The SMS is a data driven strategic approach to improving highway safety, which will ultimately recommend specific safety treatments based on of benefit-cost calculations within the SMS. Additionally, mobility and capital improvements are not currently incorporated into the asset management system recommendations, and it is not possible to weigh competing priorities such as the construction of additional travel lanes to alleviate capacity concerns, or expanding bridges to accommodate more travel lanes against the value derived from simply preserving the existing infrastructure in its current condition state.

Mobility improvements and capital expansion are areas where stronger trade-off decision-making capabilities could advance the asset management process. WYDOT maintains the highway system such that it can facilitate the economical movement of people and goods within the state, and has identified roads in need of additional capacity to maintain economical movement of goods. Most of the identified roadways are either beyond the desired capacity now or will be so within the next five years; however, capacity improvements such as constructing additional travel lanes may be delayed if not justified within the first ten years of a project's 20-year design life. Capacity concerns and freight movement within the state relates to commercial truck parking. A lack of truck parking spaces closely coincides with road closures due to inclement weather and weather-related crashes and/or delays. WYDOT intends to investigate the need for additional truck parking improvements along the Interstate, particularly since winter weather issues will invariably aggravate any parking shortages. I-80 is one of the most highly used interstates corridors in the nation for the transport of goods across the nation, and is therefore considered a high priority in regards to providing adequate commercial truck parking facilities.

8. APPENDICES

8.1 APPENDIX A: PROGRAMMING INVESTMENT SUMMARY

Programming Amounts by Fiscal Year (Amounts shown in $ millions)										
Revenue Sources	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
State Sources	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8
Federal Revenues	438.3	447.1	456.0	465.1	474.4	438.3	438.3	438.3	438.3	438.3
Local Revenues	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1
TOTAL REVENUES	842.2	851.0	859.9	869.0	878.3	842.2	842.2	842.2	842.2	842.2
Agency Expenditures	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
State Transportation Improvement Program (STIP)	522.5	531.3	540.2	549.3	558.6	522.5	522.5	522.5	522.5	522.5
Regular-Special Maintenance/Operations	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2	120.2
Planning/Administration	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8
Capital Expenditures	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4	24.4
Other Expenditures	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5
Operating Transfers Out	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
Support Services/Regulatory	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7
Administration	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Aeronautics	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5
WyoLink	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Law Enforcement	49.9	49.9	49.9	49.9	49.9	49.9	49.9	49.9	49.9	49.9
TOTAL EXPENDITURES	842.2	851.0	859.9	869.0	878.3	842.2	842.2	842.2	842.2	842.2
Project Expenditures	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Highway Improvement/Contract Maintenance Program	436.9	444.9	453.0	461.3	469.7	436.9	436.9	436.9	436.9	436.9
Project Modifications	5	5	5	5	5	5	5	5	5	5
State Infrastructure Bank (SIB) Reimbursements	20	20	20	20	20	20	20	20	20	20
ROW/Utilities/Misc.	21	21	21	21	21	21	21	21	21	21
Indirect Cost Allocation Plan (ICAP)	39.6	40.4	41.2	42.0	42.9	39.6	39.6	39.6	39.6	39.6
Projected STIP Expenditures	522.5	531.3	540.2	549.3	558.6	522.5	522.5	522.5	522.5	522.5

Programming Investment Summary for Asset Management (Amounts shown in $ Millions)										
Asset Funding Strategies	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Bridge Maintenance	2.7	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bridge Preservation	42.6	36.7	28.8	35.7	25.7	8.5	14.6	25.8	25.0	25.0
Bridge Repair/Rehabilitation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bridge Replacement (New Construction/Reconstruction)	12.6	56.4	5.3	60.8	53.7	58.2	52.9	7.1	10.0	10.0
Pavement Maintenance	21.8	9.5	13.6	13.3	14.4	8.7	6.5	10.0	10.0	10.0
Pavement Preservation (1S)	18.2	9.8	9.1	6.8	6.7	16.8	10.0	10.0	10.0	10.0
Pavement Rehabilitation (2S+3S)	235.2	132.1	168.7	177.4	228.3	212.0	198.0	187.8	188.0	185.0
Pavement Construction (New Construction/Reconstruction)	9.1	59.1	52.5	19.2	0	2.3	2.9	77.3	5.0	10.0
Dedicated Programs**	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0
Other Asset Categories	56.7	103.3	135.9	110.1	102.9	92.4	114.0	80.9	150.9	148.9
Total Program Funding Available to Manage Assets	**436.9**	**444.9**	**453.0**	**461.3**	**469.7**	**436.9**	**436.9**	**436.9**	**436.9**	**436.9**

Source: Expenditures based on WYDOT's ERP as of 7/7/2022.
**Note: $38M is reserved out of the Highway Improvement/Contract Maintenance Program for dedicated programs. Funds to other agencies includes Industrial Road Program, Recreational Trail, Enhancements, Congestion Mitigation Air Quality, Transportation Alternatives, State Urban Programs, etc.

8.2 APPENDIX B: EVALUATION OF EMERGENCY EVENTS

Summary of Emergency Events							
Event Code/Type	Incident Period/ (Event)	Results	Projects	Route/Location	Project Type	Project Cost	Obligated Funds ($)
E.O. 1997-2	5/29/97 (Mud slides)	No information	None	N/A	N/A	N/A	No relevant projects
FEMA-1268	10/5/98-10/9/98 (Severe Storm Weather)	Federal disaster to Niobrara Co. to recover from effects of a severe winter storm; declaration authorized payment of 75% of approved costs for restoring public facilities damaged as a result of storm; funding available to the state on a cost-shared basis for approved projects that reduce future disaster risk.	None	N/A	N/A	N/A	$721,772 (incl. $43,722 for emergency work)
E.O. 2000-FEMA-1351	10/31/00-11/20/00 (Winter Storm)	Declaration covers damage to public property from storm for affected counties (Ibid); federal funds available to state and affected local gov'ts in 4 counties, to pay 75% of eligible cost for repairing or replacing damaged public facilities; funding available to the state on a cost-shared basis for approved projects that reduce future disaster risk.	None	N/A	N/A	N/A	$682,635 (incl. $4,604 for emergency work)

Summary of Emergency Events							
Event Code/Type	Incident Period/ (Event)	Results	Projects	Route/Location	Project Type	Project Cost	Obligated Funds ($)
FEMA-1599-DR	Tornado	Federal disaster aid to help tornado victims in Campbell Co.; funding available on cost-shared basis for approved projects that reduce future disaster risk.	None	N/A	N/A	N/A	$474,304
FEMA-1923-DR	6/4/10 - 6/18/10 (Flooding)	Public Assistance available to State on a cost-sharing basis for emergency work and repair/ replacement of damaged facilities in Fremont Co. and portions of the Wind River Indian Reservation within Fremont Co. & Statewide Hazard Mitigation.	CN10099	CR 20 RM 2.20	Bridge Replace	$1,099,646	$3,004,023 (including $1,728,655 for emergency work)
			CN10100	CR 20 RM 2.00	Erosion Control	$15,782	
			N151025	ML15B RM 16.13	Erosion Repair	$120,878	
			N151024	ML15B RM 5.14	Erosion Repair	$111,664	
			N151026	ML15B RM 0.17	Erosion Repair	$67,165	
			N203067	ML20B RM102.93	Erosion Repair	$218,862	
			CN10097	CR 334 RM 9.04-9.25	Temporary Bridge	$840,712	
E.O. 2011-4; FEMA-4007-DR	5/18/11 - 7/8/11 (Flooding; Severe Weather; Landslides)	Public Assistance available to State, etc. on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the severe storms, flooding, and landslides in affected counties (Ibid), and the Wind River Indian Reservation.	DR50911	ML34B RM 114.43-128	Rock Fall/scaling	$559,837	$5,554,880 (including $1,667,953 for emergency work)
			P351029	ML35B RM 73.4-73.45	ER/Slide Repair	$257,350	
			DR50915	ML37B RM 20.44-21.5	Rock Fall/scaling	$448,047	
			DR50926	ML37B RM 26.9	ER/Slide Repair	$201,513	
			DR41305	ML37B RM 75.60	Landslide	$264,116	
			0607037	ML607B RM184.86-197.5	Slide Repair [2]	$740,794	
			DR41320	ML607B RM 187.8	Slide Repair [2]	$78,667	
E.O. 2014-2	Flooding; Severe Weather	Gubernatorial Declaration of Emergency	DR33142	ML11B RM 80.83	Flood damage & erosion repair	$592,725	
			DR41810	ML302B RM 13.0	Slide Repair	$1,253,566	
E.O. 2015-1 D.D. #14368 & #14369,	5/24/15 - 6/6/15 (Flooding;	Gubernatorial Declaration of Emergency;	DR51575	ML34B RM 118.0 - 125.0	Landslide repair [1]	$899,832	$2,561,407 (including $426,876
			DR23431	ML85B RM	Bridge repair		

Summary of Emergency Events							
Event Code/Type	Incident Period/ (Event)	Results	Projects	Route/Location	Project Type	Project Cost	Obligated Funds ($)
FEMA-4227-DR	Severe Weather)	Presidential Disaster Declaration. Work on Lusk bridge using STIP funding)		150.01		$2,566,894	for emergency work)
			DR23462	ML1401B RM 132.65	Erosion repair [3] [4]	$789,147	
				ML85B RM 173.74			
				ML85B RM 185.55			
			DR23463	ML1401B RM 99.77-133.34	Drainage repair [3] [4]	$531,442	
				ML39B RM 41.39-43.0			
				ML40B RM 30.0-40.88			
				ML85B RM 149.77-187.0			
			DR50911	ML34B RM 114.43-128.0	Slide Repair [1]		
E.O. 2017-1; FEMA-4306-DR	2/6/17 - 2/7/17 (Severe winter storm; flooding; high winds)	Gubernatorial Declaration of Emergency; Presidential Disaster Declaration	None	N/A	N/A	N/A	
FEMA-4327-DR	Flooding		None	N/A	N/A	N/A	

Evaluation of Locations Repeatedly Damaged During Emergency Events				
Location	Damage Description	Projects	Route	Agency Response
1	Point location located within roadway segment - rock fall/scaling/landslide due to flooding and severe weather.	DR50911 DR51575 DR50911	ML34B RM 187.7	The damage that occurred in this location was to the riprap of the canyon bridges. Since riprap is considered a sacrificial element of a structure, no changes were made to the facilities damaged in the events. It would not be economically feasible, nor cost effective to protect all 11 miles of the Wind River Canyon that are susceptible to an extreme flooding event.

Evaluation of Locations Repeatedly Damaged During Emergency Events				
Location	Damage Description	Projects	Route	Agency Response
2	Point location located within roadway segment damaged during the same emergency event - Landslide caused by severe storms and flooding.	0607037 DR41320	ML607B RM 187.8	The duplicate repairs and/or reconstruction activities occurred during the same emergency event; therefore, a write-up of reasonable alternatives was not required.
3	Point location located within roadway segment damaged during the same emergency event - Landslide caused by severe storms and flooding.	DR23462 DR23463	ML1401B RM 132.65	The duplicate repairs and/or reconstruction activities occurred during the same emergency event; therefore, a write-up of reasonable alternatives was not required.
4	Various Bridge and drainage locations along US 85.	DR23431 DR23462 DR23463	ML85B RM 150.01, 173.74, 185.55, 197.77 - 187.0	The duplicate repairs and/or reconstruction activities occurred during the same emergency event; therefore, a write-up of reasonable alternatives was not required.