2023-2032

Wisconsin Department of Transportation

TAMP

Transportation Asset Management Plan

APRIL 2023

Prepared in accordance with
23 USC Section 119 and 23 CFR Part 515

CONTENTS

Appendices

Tables

Figures

List of Acronyms

3R	Resurfacing, Restoration, Rehabilitation
AC	Asphaltic Concrete
APLP	Advanceable Program Letting Plan
BHM	Bureau of Highway Maintenance
BIL	Bipartisan Infrastructure Law
BMNG	Bridge Management Next Generation
BOS	Bureau of Structures
BPPG	Bridge Preservation Policy Guide
BSHP	Bureau of State Highway Programs
CFR	Code of Federal Regulations
CMAQ	Congestion Mitigation and Air Quality Improvement Program
CP	Composite Pavement
DMSL	Desired Minimum Service Level
DOT	Department of Transportation
DTIM	Division of Transportation Investment Management
DTSD	Division of Transportation Systems Development
EA	Environmental Assessment
EIS	Environmental Impact Statement
ER	Environmental Report
FFY	Federal Fiscal Year
FHWA	Federal Highway Administration
FIIPS	Financially Integrated Improvement Program
FTA	Federal Transit Administration
GAMA	Geographic Asset Management Application
GE	greater than or equal to
GIS	geographic information system
GTA	General Transportation Aids
HCM	Highway Capacity Manual
HCSB	High Cost State Bridge
HMA	Hot Mix Asphalt
HMM	Highway Maintenance Manual
HPMS	Highway Performance Monitoring System
HSIS	Highway Structures Information System
IH	Interstate Highway
IIJA	Investment and Jobs Act
IRI	International Roughness Index
ITS	Intelligent Transportation System
LCM	Location Control Management
LE	less than or equal to
LOS	Level of Service
LRIP	Local Road Improvement Program
Majors	Major Highway Development Program
MAPSS	Performance Improvement Program (Mobility, Accountability, Preservation, Safety, Service)
MIB	Major Interstate Bridge
MMS	Meta-Manager Highway Asset Management System
M&O	Maintenance and Operations
MPA	Metropolitan Planning Area
MPO	Metropolitan Planning Organization
N/A	Not Applicable
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NEPA	National Environmental Policy Act
NHPP	National Highway Performance Program
NHS	National Highway System

NOAA National Oceanic and Atmospheric Administration

OAPM Office of Asset Management and Performance Management

PASER Pavement Surface Evaluation and Rating

PbM Performance Based Maintenance

PBPD Performance Based Practical Design

PCC Portland Cement Concrete

PCI Pavement Condition Index

PEM Program Effectiveness Measure

PIF Pavement Information File

PMDSS Pavement Management Decision Support System

PS&E Plans, Specifications, and Estimates

PV Present Value

RMA Routine Maintenance Agreements

RPC Regional Planning Commissions

SAS Statistical Analysis System

SCT Structures Certification Tool

SEF Southeast Wisconsin Freeway Megaprojects

SFY State Fiscal Year(s)

SHR State Highway Rehabilitation

SLE Service Life Extension

STH State Trunk Highway

STIP Statewide Transportation Improvement Program

STP Surface Transportation Program

TAFIS Traffic Analysis Forecasting and Information System

TAMP Transportation Asset Management Plan

TAP Transportation Alternative Program

TPC Transportation Projects Commission

TPM Transportation Performance Management

TPP Typical Past Practice

TRC Traffic Count Segments

USH United States Highway

VMT Vehicle Miles of Travel

WEPA Wisconsin Environmental Policy Act

WisDOT Wisconsin Department of Transportation

WISLR Wisconsin Information System for Local Roads

YOE Year of Expenditure

YTD Year to Date

Executive Summary

Purpose

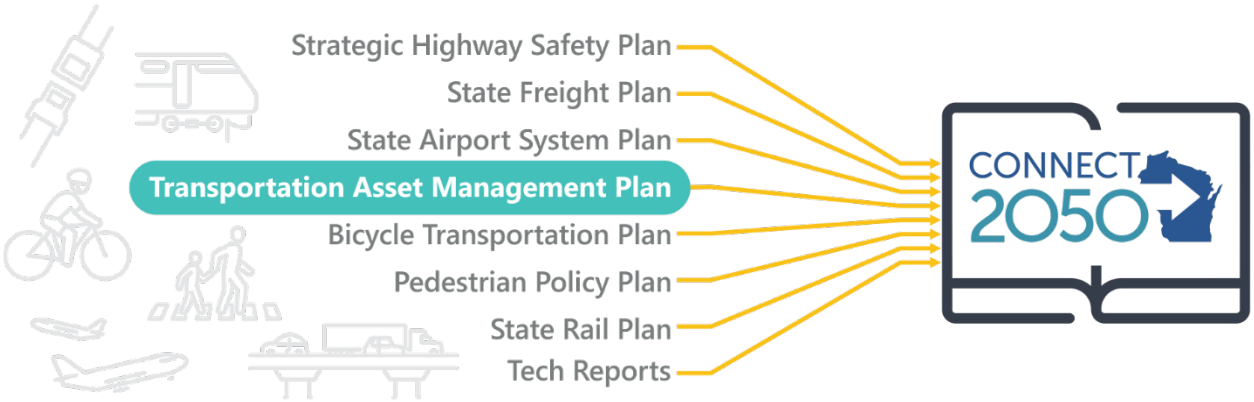
The Transportation Asset Management Plan (TAMP), required by 23 U.S.C. 119(e)(1), outlines the Wisconsin Department of Transportation's (WisDOT's) efforts to keep Wisconsin's portion of the National Highway System (NHS) safe, efficient, resilient and in a state of good repair at minimal practicable cost. The TAMP is the result of applying robust asset management principles over an analysis period extending from 2023 through 2032. It is an operational document that focuses its analysis, options development, programs, delivery mechanisms, and reporting mechanisms on ensuring that strategic objectives are achieved over time. Asset management is more than just analysis of financial and performance data; it also relies on models that incorporate material science and asset deterioration information. Asset management is at play when determining project scopes such as perpetuation, rehabilitation, or modernization. Asset management and data-driven decision-making ensure that the transportation system is operated, maintained, and improved in the most efficient and effective way possible, so that the right project is implemented in the right place, and at the right time.

WisDOT has a long history of using the principles of asset management to inform investment decisions through the MAPSS Performance Improvement Program, which are combined with Federal Transportation Performance Measures to set targets, and track progress for pavement and bridge performance. WisDOT also uses performance based practical design techniques (PBPD) and other performance analysis tools to ensure the development of cost-effective solutions that increase net system benefit of improvement projects.

The TAMP and the policy direction within it supports the vision and goals for Wisconsin's transportation system as stated in Connect 2050, WisDOT's multimodal long-range transportation plan. Connect 2050's vision statement serves as WisDOT's guiding vision for the transportation system as it is developed and maintained over time:

> *WisDOT envisions an integrated multimodal transportation system that maximizes the safe and efficient movement of people and products throughout the state in a way that enhances economic productivity, transportation accessibility and the quality of Wisconsin's communities while minimizing impacts to the natural environment and socioeconomic, historic, and cultural resources.*

Connect 2050's vision is the desired destination; how we get there is identified in a complex series of plans and programs that are guided by the plan's goals and objectives with the TAMP being one such plan. For more information, please see the Connect 2050 website.

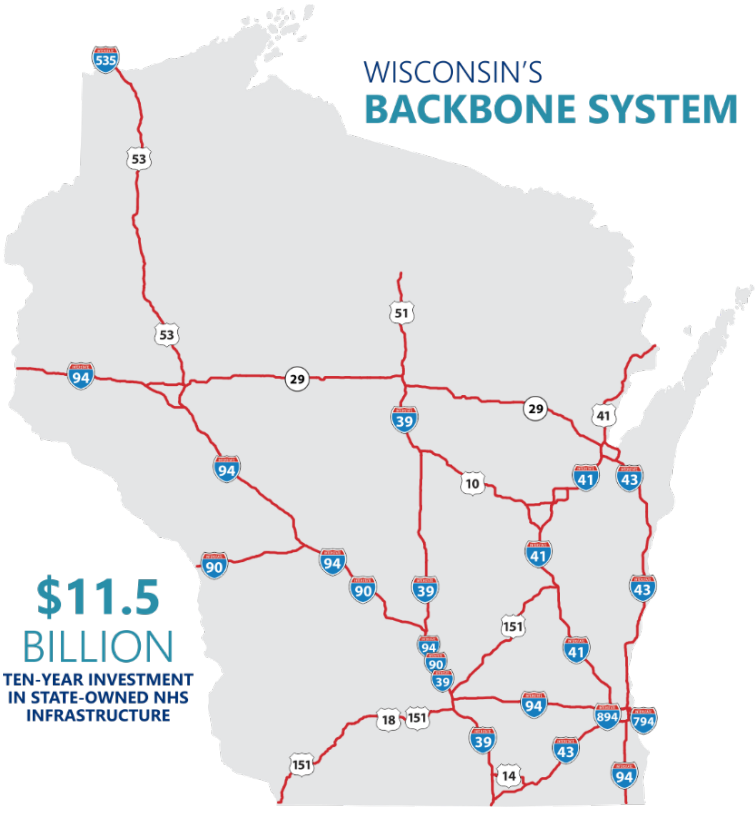


TAMP Overview

This TAMP presents WisDOT's investment plan for the NHS for the 10 years beginning with state fiscal year 2023 and extending through 2032. The investment plan adopts the transportation funding components of Governor Evers' 2021-2023 Biennial Budget as well as the federal transportation funding available through the Infrastructure Investment and Jobs Act (IIJA) also known as the federal Bipartisan Infrastructure Law (BIL). Beyond the sunset dates of the biennial budget and the BIL, WisDOT assumes that purchasing power will decrease gradually over the course of the ten-year analysis period. However, the TAMP is a dynamic document and will be updated over time with new strategies and the most current budget assumptions available.

The TAMP reports the impact WisDOT's investment plan is expected to have on pavement and bridge conditions on the NHS and explains the rigorous, data-based, asset management principles and processes underlying WisDOT's NHS investment plan. The TAMP describes each of the Biennial Budget programs available for making investments in Wisconsin's State Trunk Highway (STH) system infrastructure, along with the asset management principles and processes underlying the investment strategies in each program area. The processes WisDOT has in place to ensure the agency's NHS investment plan is implemented are also presented.

Federal law requires each state department of transportation (DOT) to document its 10-year investment plan for the NHS in a TAMP. The NHS investment plan presented in the TAMP must be constrained by the level of funding expected to be reasonably available. Each state DOT must also develop targets for NHS pavement and bridge condition, demonstrate their NHS investment plan was developed using sound asset management processes, and document whether the plan will allow their NHS pavement and bridge targets to be met.



WisDOT develops the investment strategies and sets priorities for the entire STH system, which incorporates a majority of the NHS subset, since the two systems are mostly aligned. The agency's top priorities are safety, regardless of STH sub-system, the condition of all STH bridges, and the pavement and other roadway conditions on the STH system. WisDOT has higher pavement condition performance targets for its 1,597 mile Backbone system, which includes all Interstate highways (879 center line miles) plus an additional 718 center line miles of other high-volume STH roadways; all of them multi-lane, divided highways, and many built to freeway standards. Backbone highways are all part of the WisDOT-owned NHS, and form Wisconsin's premier highway system that interconnects all regions and major state economic centers, with links to the national system outside Wisconsin.

The investments in NHS infrastructure reported in the TAMP are drawn mostly from the State Highway Rehabilitation (SHR) program, which funds a range of pavement and bridge perpetuation and rehabilitation projects. There is also the Major Highway Development and Southeast Wisconsin Freeway Megaprojects (SEF) programs, which fund costly infrastructure reconstruction and modernization projects across Wisconsin. Over the 10-year TAMP analysis period, WisDOT anticipates investing $11.5 billion in state-owned NHS infrastructure.

System Overview

Wisconsin's STH system includes just 10% of the total highway and local road mileage in the state, but those miles are heavily used. Almost 60% of all vehicle miles traveled occur on the state highway system. These simple statistics underscore the critical importance of the system to Wisconsin's economy and to the mobility and quality of life of Wisconsin's citizens. A safe, efficient, resilient, reliable network of high-quality STH roads and bridges links Wisconsin's industrial, agricultural, tourism, and other businesses to the world. It provides access to jobs, educational opportunities, and the host of social and recreational activities that make Wisconsin a great place to live, work and play.

The NHS is a strategic system of roads and bridges important to the nation's economy, defense and mobility. The NHS includes the Interstate Highway System and other important state and local highways. The STH system includes 5,323 center line miles of NHS roadway and 3,278 NHS bridges. The WisDOT-owned NHS carries more than 85% of the vehicle miles traveled on the STH system. This makes the condition of WisDOT's NHS roadways and bridges important to both WisDOT and the Federal Highway Administration (FHWA).

WisDOT STH SYSTEM INCLUDES:

5,323
CENTER LINE MILES OF WI NHS ROADWAY

3,278
WI NHS BRIDGES

WisDOT OWNED NHS CARRIES:

85%
VEHICLE MILES TRAVELED ON STH

The locally-owned NHS in Wisconsin is composed of 648 center line miles of highway. 129 local governments contain some NHS mileage, with 75 of those localities containing less than two miles of NHS. Overall, 64% of local NHS roadway miles are in 11 localities having 10 miles or more. Six of these 11 localities are in the greater Milwaukee area and the remainder are in the Madison, Fox Cities and Green Bay areas. WisDOT has communicated pavement condition information with all local agency NHS owners in preparation for this 2022 TAMP update.

Managing the maintenance, operation and improvement of the STH system is the responsibility of the WisDOT. The agency's goal for Wisconsin is to keep all STH roads and bridges in a state of good repair, delivering a high-quality STH system at minimal practicable cost. To achieve this goal, WisDOT committed itself to the pursuit of efficiency and to the use of performance-based asset management principles. WisDOT's asset management systems reflect the agency's commitment to continuous improvement in its project planning and programming processes. WisDOT will always strive to sustain the highest quality system of STH roads and bridges possible within the funding made available through Wisconsin's Biennial Budget.

The pavement and bridge condition data collected in 2021 and reported in the TAMP demonstrate Wisconsin highway users currently utilize high-quality pavement and bridge conditions on the NHS. Over the prior decade,

however, the funds available for investment in the maintenance and improvement of the STH system have not kept up with increases in construction costs. During this period, strong emphasis on improved efficiency and on sound asset management processes and priorities allowed WisDOT to sustain high-quality pavement and bridge conditions on the NHS and other critical STH roadways. Adequate funding is critical to long-term pavement and bridge conditions on the NHS and across the non-NHS portion of the STH system. For Wisconsin to make long overdue improvements to the state's highways, funding must continue to keep pace with the increasing system needs and construction costs over the coming decade.

Governor Evers' 2019-2021 Biennial Budget provided a 20% increase in base-year funding for the SHR Program, while also structurally enhancing continuing sources of state transportation revenues. The Governor's 2021-2023 Biennial Budget further strengthened this commitment by maintaining "real dollar" purchasing power in transportation programs. These actions, combined with increased federal funding provided through the federal BIL and continued implementation of the 10-year NHS investment strategy, will continue to provide high-quality NHS pavement and bridge conditions in the coming years.

Chapter 1 Highway Network Conditions and Targets

Pavement and Bridge Performance on the National Highway System: Current Conditions and Condition Targets

Overview

Wisconsin's STH system continues to evolve to support the state's economy, the mobility needs of Wisconsin citizens and the broader public good. The STH system currently encompasses 11,750 center line miles and 5,315 bridges. While the STH system represents only 10% of all highway and local road mileage in the state, its critical importance is underscored by the fact that it has carried almost 60% of the annual vehicle miles of travel occurring on Wisconsin highways since the year 2000.

WisDOT is responsible for managing the maintenance, improvement and operation of the STH system, and its decisions rely on performance-based asset management principles. The investment strategies resulting from WisDOT's commitment to efficient and effective asset management are reviewed and updated as necessary to optimize STH system performance. Flexible and responsive planning, budgeting and project delivery processes ensure WisDOT makes the best possible use of the resources available.

A subset of the highways within the United States are designated as comprising the NHS. The NHS is made up of highways important to the nation's economy, defense, and mobility. Nationally, the NHS is the highest priority portion of the highway system for FHWA. The WisDOT-owned portion of the NHS makes up 45% of STH center line miles and carries 85% of STH vehicle miles. For this reason, the WisDOT-owned portion of the NHS is a priority WisDOT shares with FHWA.

This TAMP is prepared in response to federal law requiring each state DOT to document its plans for the NHS, in support of the broad national goals shown in Table 1-1. The TAMP describes WisDOT's investment strategies as they relate to the NHS. Consistent with both WisDOT and FHWA priorities, the TAMP describes the quality pavement and bridge performance currently experienced on the NHS. It also presents WisDOT's two and four-year targets for NHS pavement and bridge performance in Wisconsin. WisDOT believes meeting these targets will maintain Wisconsin's NHS pavements and bridges in a state of good repair.

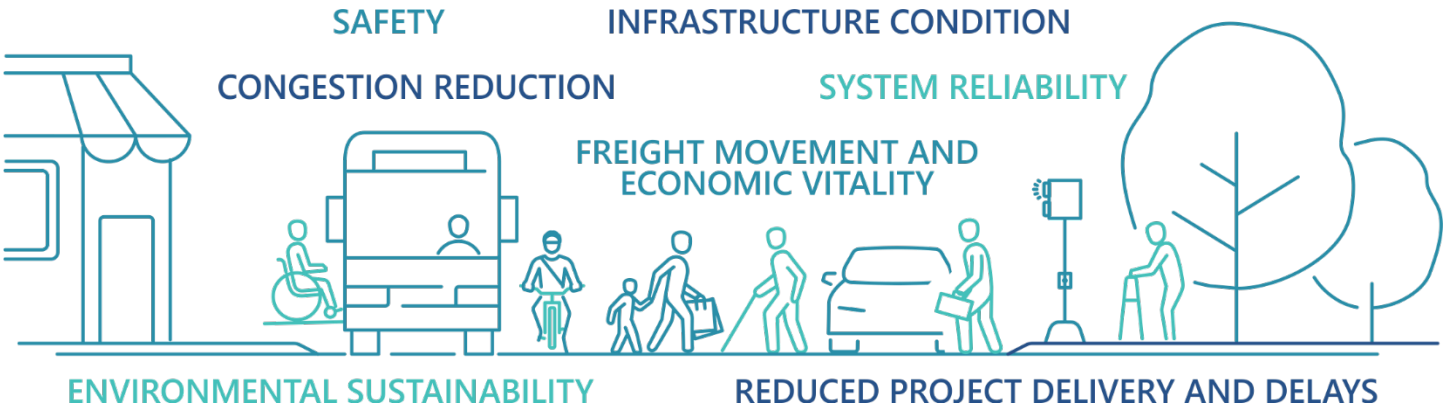


Table 1-1: National Goals for the Federal-Aid Highway Program

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

23 USC 150 (b)

The TAMP covers the 10-year period consisting of state fiscal years 2023 through 2032. By implementing the TAMP using a combination of state and federal funds, WisDOT believes those who rely on the NHS will continue to benefit from quality pavement and bridge conditions well into the future.

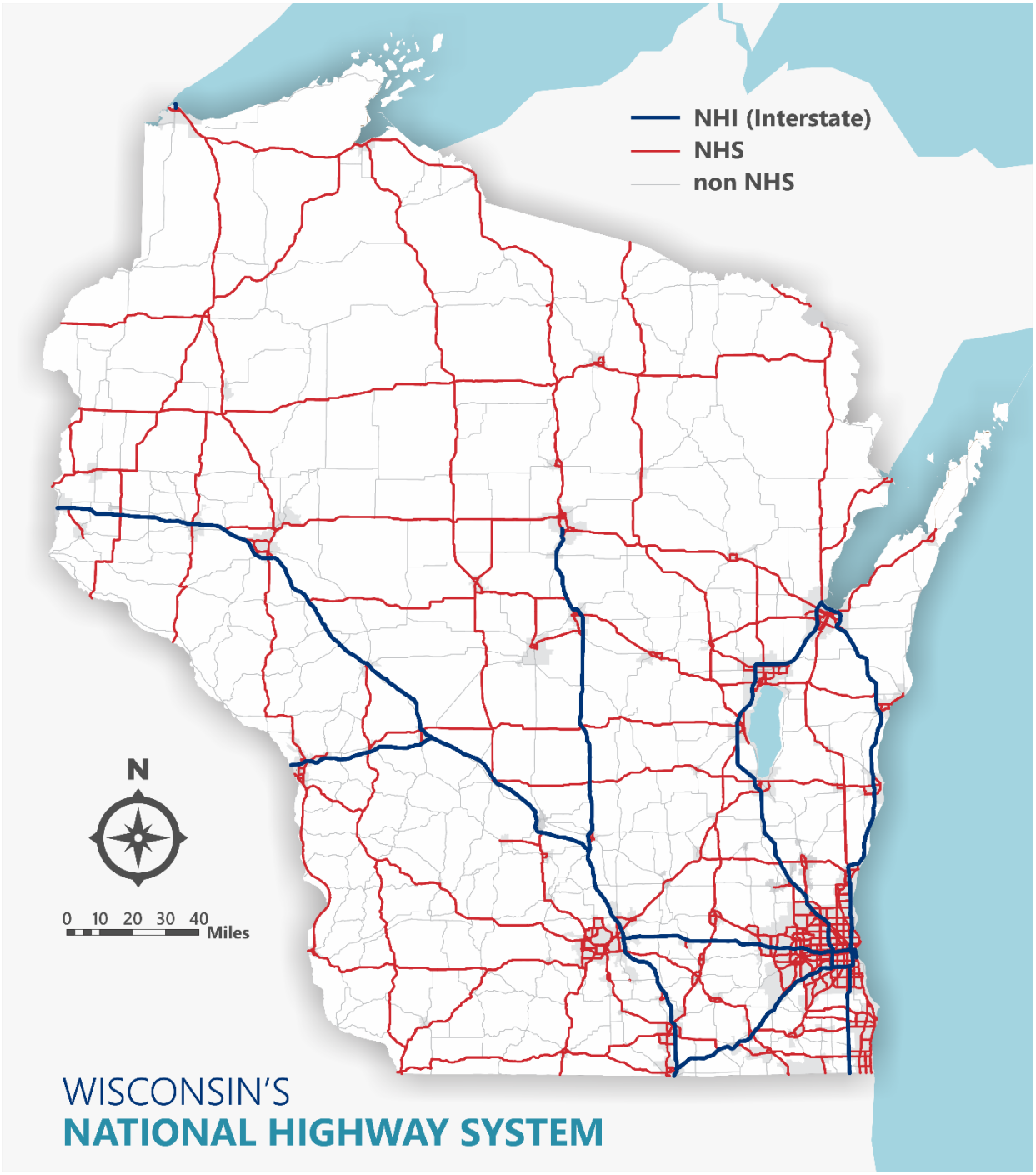
The Inventory of NHS Pavements and Bridges

Wisconsin's portion of the NHS totals approximately 5,971 center line miles of roadway and includes the following:

- NHS Interstate – Formally known as the Dwight D. Eisenhower National System of Interstate and Defense Highways, these highways retain a separate identity within the NHS
- NHS Secondary Routes – These highways are secondary to the NHS Interstate, but remain important to the national economy, defense, and mobility
- NHS Intermodal Connectors – These highways provide access between major intermodal facilities and other portions of the NHS.

Most of Wisconsin's NHS mileage, including the entire NHS Interstate, is WisDOT-owned, but some of the mileage is locally-owned and outside WisDOT's jurisdiction. Chapter 9 discusses Wisconsin's locally-owned NHS and provides a more detailed summary of the programs that support the maintenance, operations, and improvements of the locally-owned highway and bridge system, including the locally-owned NHS. Figure 1-1 shows a map of Wisconsin's NHS.

Figure 1-1: National Highway System in Wisconsin



https://wisconsindot.gov/Pages/projects/data-plan/plan-res/nhs.aspx

Table 1-2 summarizes the current inventory of Wisconsin's NHS pavements and bridges. NHS center line miles can differ in terms of their number of lanes, making pavement lane miles the single best measure of the amount of pavement making up the NHS. By their nature, bridges vary by both length and width, making square feet of bridge deck the single best measure for the extent of the bridges needing to be managed on the NHS. For simplicity, Table 1-2 shows the inventory of pavements and bridges on NHS Secondary Routes and NHS Intermodal Connectors together, labeling them Non-Interstate NHS.

Table 1-2: Current Inventory of WisDOT and Locally-Owned NHS Pavements and Bridges

NHS Sub-System	Pavements[1]		Bridges[2]	
	Center Line Miles	Lane Miles	Bridges	Sq. Ft. of Bridge Deck (Millions)
Total WisDOT-Owned NHS	5,323	16,781	3,278	40.2
Interstate	879	4,079	1,315	18.5
Non-Interstate NHS	4,444	12,702	1,963	21.7
Total Locally-Owned NHS	648	1874	314	3.4
Total Wisconsin NHS	**5,971**	**18,655**	**3,592**	**43.6**

[1] For divided highways, one center line mile equals two roadway miles. Roadway and center line miles are equal for undivided highways. The pavement data is for 2021.
[2] The bridge data is for 2021. Consistent with national definitions: a) only bridges more than 20 feet long (between abutments) are included in Table 1-2, and b) culverts more than 20 feet in width (length in the direction of travel) are counted as bridges.

The Value of NHS Pavements and Bridges

The large inventory of NHS lane miles and bridges reflects the extensive financial commitment made when constructing Wisconsin's NHS pavements and bridges. A rudimentary estimate of the value of NHS pavement and bridge assets totals almost $60.2 Billion and is shown in Table 1-3.

Table 1-3: Estimated Value of Wisconsin's NHS Pavement and Bridge Assets

NHS PAVEMENTS	**18,655** LANE MILES	**$2,034,779** PER LANE MILE[1]	**$38.0 Billion** ESTIMATED REPLACEMENT COST	ESTIMATED VALUE OF NHS PAVEMENT AND BRIDGES **$60.2 Billion**
NHS BRIDGES	**43.6** SQ FT OF BRIDGE DECK	**$510** PER SQ FT[2]	**$22.2 Billion** ESTIMATED REPLACEMENT COST	

[1] The estimated replacement cost per lane mile reflects a weighted average for differing types of pavement in rural and urban areas.
[2] The estimated replacement cost per square foot reflects the weighted average of the replacement costs for differing bridge configurations.

The Performance of NHS Pavements and Bridges

Given the importance of the NHS as a national system, FHWA has defined performance measures for assessing NHS pavement and bridge conditions as part of their National Highway Performance Program (NHPP). FHWA's NHPP performance measures are intended to allow NHS pavement and bridge conditions to be meaningfully compared state to state, and states are required to develop targets for the NHS pavement and bridge conditions they are trying to achieve (23 CFR Part 490). The NHPP performance measures are described in Table 1-4.

Using NHPP definitions, the categorization of individual pavements and bridges (not including culverts counted as bridges) as being in either "good" or "poor" condition depends on three condition factors assessed as part of the regular pavement and bridge inspection processes. For each pavement lane mile, the three condition factors are the International Roughness Index (IRI), the degree of cracking and the degree of either pavement rutting or faulting (rutting for asphalt pavements and faulting for jointed concrete pavements). For each bridge, the three factors are the National Bridge Inventory (NBI) ratings for bridge deck, bridge superstructure and bridge substructure. The NBI rating for each factor is an integer value between 0 (failed condition) and 9 (excellent condition). Categorizing the performance of the culverts included in Table 1-2 depends on the NBI rating factor for culvert condition, which is also an integer value ranging between 0 and 9.

Table 1-4: NHPP Pavement and Bridge Performance Measures

Pavement Performance Measures	Bridge Performance Measures
1. "Good" lane miles on the NHS Interstate (%)	**1.** "Good" NHS bridge deck area (%)
2. "Poor" lane miles on the NHS Interstate (%)	**2.** "Poor" NHS bridge deck area (%)
3. "Good" lane miles on the non-Interstate NHS (%)	
4. "Poor" lane miles on the non-Interstate NHS (%)	

Consistent with national definitions: a) only bridges more than 20 feet long (between abutments) are included, and b) culverts more than 20 feet in width (length in the direction of travel) are counted as bridges.

FHWA has defined the range of inspection values it believes determines whether the performance of an individual pavement is rated "good", "fair" or "poor". If all three condition factors for a given pavement are "good", based on the latest inspection, FHWA rates the pavement as "good". If two or more of the condition factors are "poor", the pavement is rated as "poor". Pavements not falling into either of these categories are rated "fair".

Bridge performance (not including culverts counted as bridges) is classified as "good", "fair" or "poor" based on the lowest NBI rating for FHWA's three bridge condition factors. If the lowest rating among the three factors is a 7, 8 or 9, the bridge is rated as "good". If the lowest rating is a 5 or 6, the bridge is rated as "fair". If the lowest rating among the three condition factors is less than 5, the bridge is rated as "poor". Culverts counted as bridges are classified as "good", "fair" or "poor" based on the NBI rating factor for culvert condition using the same logic. A rating of 7, 8 or 9 means the culvert is classified as "good", and a rating less than 5 means the culvert is classified as "poor", with "fair" falling between these two extremes.

The current condition of NHS pavements and bridges is shown in Table 1-5. The data demonstrates that the pavements and bridges on the NHS are performing well. This positive outcome is a direct result of WisDOT's long-standing highway asset management approach. Since the late 1990's, WisDOT has used its asset management tools to help guide resource allocations and investment strategies relating to the STH system. WisDOT's investment strategy has consistently given high priority to investment needs relating to STH bridges and to pavements on Backbone routes. Backbone highways comprise the portion of the STH system of greatest

importance to Wisconsin's economic health and mobility. Backbone highways are Wisconsin's premier highway sub-system, making up 30% of the lane miles on the WisDOT-owned portion of the NHS. WisDOT regularly updates its investment policies as part of its ongoing commitment to asset management, as discussed in Chapter 3. Recent updates have had a significant positive impact on the future pavement and bridge conditions experienced on the WisDOT-owned NHS.

Table 1-5: Current Pavement and Bridge Conditions on the NHS

NHS Infrastructure Component	Current Conditions (FHWA Performance Measures)		
	% Good	% Fair	% Poor
All NHS **Pavement** Lane Miles*	42.9%	53.7%	3.4%
Interstate NHS Lane Miles**	65.9%	33.8%	0.3%
Non-Interstate NHS Lane Miles**	36.3%	59.5%	4.2%
NHS **Bridge Deck** Area**	52.2%	45.2%	2.6%

**This data reflects 2021 HPMS inspection data calculated using WisDOT's calculations*
***This data reflects 2021 HPMS inspection data available on the FHWA Transportation Performance Management*

WisDOT's investment strategy for the WisDOT-owned NHS has consistently given high priority to safety needs, the investment needs on STH bridges, and pavements on Backbone routes. The positive impacts of this strategy are reflected in the current high-quality condition of WisDOT's NHS infrastructure. This is especially true for WisDOT's Interstate pavements and state-owned NHS bridges.

WisDOT's continued commitment to its long-standing asset management priorities is reflected in the pavement and bridge targets set for the Wisconsin portion of the NHS. In 2022, in compliance with 23 CFR Part 490 and 23 CFR Part 515, WisDOT set two and four-year targets for both the minimum percentage of "good" pavements and bridges and the maximum percentage of "poor" pavements and bridges on Wisconsin's Interstate and Non-Interstate NHS. These targets are shown in Table 1-6. A comparison with Table 1-5 demonstrates that the current condition of WisDOT's NHS pavements and bridges satisfies these target percentages.

The assessment of WisDOT's ability to continue meeting these targets will be based on Highway Performance Monitoring System (HPMS) and NBI data submitted to FHWA in 2024 and 2026, respectively. This data will reflect pavement and bridge condition surveys undertaken in calendar years 2023 and 2025.

Table 1-6: NHPP Pavement and Bridge Condition Targets for Wisconsin

	2024 Condition Targets (Two-year Targets)		2026 Condition Targets (Four-year Targets)	
	% Good	% Poor	% Good	% Poor
Interstate Pavements	≥ 60%	≤ 4%	≥ 60%	≤ 4%
Non-Interstate NHS Pavements	≥ 30%	≤ 10%	≥ 30%	≤ 10%
All NHS Bridges	≥ 49%	≤ 3%	≥ 48%	≤ 3%

Given the priority WisDOT places on STH bridges generally, Wisconsin has set the two and four-year targets for the percentage of "poor" NHS bridge deck area at a maximum of 3%. The two and four-year targets for "poor" Interstate lane miles both call for a maximum of 4%, while the targets for the maximum percentage of "poor" Non-Interstate NHS lane miles are set at 10%. The two and four-year targets for the minimum percentage of "good" NHS pavement lane miles and bridge deck area reflects Wisconsin's emphasis on bridges and its commitment to high-quality NHS infrastructure, maintained in a state of good repair.

WisDOT's Pavement Performance Using PCI

WisDOT has a rich database containing reliable measurements on numerous pavement distress types for all STH pavements. The data is gathered and used leveraging principles and practices from rigorous national standards and measures (ASTM-D6433) to express the condition of WisDOT's STH pavements using the Pavement Condition Index (PCI). WisDOT compared PCI-derived performance measures for NHS concrete pavements with the NHPP pavement performance measures for the same pavements and found that a significant percentage of the lane miles rated in "good" condition using the NHPP metric were rated "fair" using the more comprehensive PCI measuring standard. Some were even rated "poor" using the PCI approach.

WisDOT understands the NHPP pavement performance metrics were created to allow national comparisons of pavement condition using inspection data it is reasonable for all states to collect. Moving forward, WisDOT will continue to make detailed engineering decisions on STH pavement improvements using PCI and the individual distress items WisDOT tracks and incorporates.

As part of WisDOT's strong commitment to using PCI-derived information to inform the many decisions necessary to effectively manage Wisconsin's investment in the STH system, WisDOT has long-standing PCI-based targets for STH pavement condition in addition to the NHPP targets reported in Table 1-6. WisDOT's PCI-based targets are reported as part of WisDOT's MAPSS Performance Improvement Program Scorecard and are shown in Table 1-7.

Table 1-7: WisDOT's PCI Performance Goals and 2021 Actual results for the STH System

	% Goals for Fair and Above	% Actual for Fair and Above
Backbone Pavements	≥ 90%	99%
Non-Backbone Pavements	≥ 80%	84%
Total System Pavements	≥ 85%	85%

Source: MAPSS

Interstate highways within Wisconsin comprise approximately 55% of Backbone roadway miles, and all Backbone highways are designated as part of the NHS. Non-Backbone highways make up the remainder of the STH system and consist of both NHS and non-NHS routes.

Recent Backbone and non-Backbone pavement performance has exceeded these PCI targets and has been holding steady above the target values, reflecting WisDOT's strategic use of highway improvement funding and reliance on asset management principles to assure the long-term health of the STH and NHS system.

In what follows, Chapter 2 - Chapter 6 describe the funding programs available to manage the maintenance, improvement, and operation of the STH system, including the WisDOT-owned NHS. WisDOT's performance-based asset management investment strategies are described in Chapter 3, along with a summary of the investments anticipated on the WisDOT-owned NHS over the 10-year period from state fiscal year 2023 through 2032. Chapter 3 also compares the NHS pavement and bridge conditions expected to result from those investments to

Wisconsin's two and four-year NHPP pavement and bridge targets. As noted earlier, Chapter 9 discusses Wisconsin's locally-owned NHS pavements and bridges in more detail.

Chapter 2 WisDOT Program Funding

The Funding Programs Impacting the WisDOT-Owned Portion of the National Highway System

Overview

The WisDOT funding for maintenance, improvement, and operation of Wisconsin's STH system is contained in a set of budget appropriations approved during the State's Biennial Budget process occurring during odd-numbered calendar years. Each new state fiscal year begins on July 1. The types of highway and bridge work that can be paid for using funds contained in each budget appropriation is defined by Wisconsin law.

WisDOT is committed to working with the Governor and Legislature to allocate available funding across STH-related budget appropriations in a flexible manner, consistent with addressing the highest priority investment needs on the STH system. The following budget appropriations are available for the maintenance, improvement and operation of Wisconsin's STH system:

- State Highway Rehabilitation (SHR);
- Major Highway Development (Majors);
- Southeast Wisconsin Freeway Megaprojects (SEF);
- Major Interstate Bridge (MIB);
- High Cost State Bridge (HCSB); and
- State Highway Maintenance and Traffic Operations (M&O).

State law provides SHR funding for the improvement of existing state trunk highways and bridges. MIB and HCSB funding is provided for stand-alone bridge projects with costs exceeding limits set by state law. Majors funding is provided for high-cost projects typically involving reconstruction and expansion of the STH system, where "high-cost" is statutorily defined. Projects on the southeast Wisconsin freeway system, with a cost exceeding a statutory minimum, are defined as "megaprojects" and must be paid for using SEF funding.

WisDOT cannot unilaterally select projects for Majors, SEF, MIB and HCSB funding. The processes involved in developing these programs are described in Chapter 4 and Chapter 5. The state M&O program is discussed in Chapter 6.

As noted in Chapter 1, the locally-owned roadway and bridge infrastructure in Wisconsin is extensive. Recognizing the pervasive needs on the local system, both NHS and non-NHS, WisDOT recently directed 70%, or $159 million out of $228 million, in additional federal (fiscal year 2022) funding from the federal BIL to local roads and bridges. The programs available for locally-owned roads and bridges are additionally discussed in Chapter 9.

The SHR Program

The SHR program funds a broad range of improvements on the STH system. It cannot, in general, be used for M&O-type activities; however, preservation projects that provide at least a four-year service life extension are eligible. A partial list of typical SHR improvements includes the following: bridge preservation and rehabilitation activities such as deck overlays, deck replacements and bridge painting; pavement preservation and rehabilitation activities such as pavement resurfacing and pavement replacement; improvements to safety through the redesign of dangerous intersections and the modification of roadway curvature or grade in high crash locations; and roadway and bridge reconstruction, when appropriate. SHR projects can include funding for some M&O-type activities, such as the installation or replacement of highway signs, traffic control signals, ITS (intelligent

transportation system) infrastructure, highway lighting and lane marking, if those activities are incidental to the other SHR-eligible improvement activities being performed in conjunction with the project.

WisDOT has the flexibility to allocate SHR funding to the specific set of highway and bridge improvement projects it believes best fulfills the agency's asset management mission. The policies guiding identification of these projects are expressed through WisDOT's SHR investment strategy. Development of the SHR investment strategy is overseen by the Division of Transportation Investment Management (DTIM), with critical input from the Division of Transportation Systems Development (DTSD), Regions, and Central Office staff. The process for developing the SHR investment strategy is described in Chapter 3. M&O funded activities are coordinated with SHR to preserve STH highway and bridge infrastructure in a cost-effective manner.

The improvements funded by the SHR program are primarily managed through two sub-programs. The Backbone Program covers SHR improvements on Backbone routes. The Region 3R Program (resurfacing, restoration, and rehabilitation) covers SHR improvements on the remainder of the STH system. Management of the Backbone Program is centralized, with critical input from staff in each DTSD Region. Management of the Region 3R Program occurs at a Region level. 3R projects are identified and scheduled by staff in each DTSD Region under funding and policy guidance from DTIM and the DTSD Central Office.

The Major Highway Development and SEF Programs

Majors projects currently cost a minimum of $49.5 million and reconstruct or recondition an existing highway while adding lanes five or more miles in length to improve safety and traffic flow. Projects meeting this $49.5 million threshold that build new or relocate existing highways for 2.5 miles or more are also defined as Majors, as are projects that improve at least 10 miles of an existing multi-lane divided highway to freeway standards. In addition, any project currently costing a minimum of $123.7 million is also defined as a "non-traditional" Majors project unless it is otherwise defined as a MIB, HCSB or SEF project. The cost thresholds listed above are adjusted annually to reflect increases in highway construction costs due to inflation, as stated in s. 84.013.

SEF projects are defined as any project on a southeast Wisconsin freeway having a total cost exceeding $828.3 million. The latter cost threshold is adjusted annually to reflect increases in highway construction costs due to inflation. For this purpose, a southeast Wisconsin freeway is defined as a freeway-type facility located on the STH system in Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington or Waukesha counties. Southeast Wisconsin freeways are all part of the WisDOT-owned NHS. See s. 84.0145 for more details about SEF project enumeration.

The Major Interstate Bridge and High Cost State Bridge Programs

Bridge projects within the MIB program are defined as projects involving the construction or reconstruction of an STH bridge, including approaches, that crosses a river forming a boundary of Wisconsin where WisDOT's estimated cost share is at least $100 million, as stated in s. 84.016 (1) and (2). Bridge projects within the HCSB program are defined as projects involving the construction or rehabilitation of an STH bridge, including approaches, that does not cross a river forming a boundary of Wisconsin where the estimated cost exceeds $150 million, as stated in s. 84.017 (1) and (2). Currently, there are no provisions to adjust the dollar amounts in s. 84.016 (1) and s. 84.017 (1).

The Funding Assumptions Underlying the TAMP

Table 2-1 presents the funding levels assumed for this TAMP, representing the funds WisDOT expects to be reasonably available to support the management and operation of Wisconsin's STH system, including the state-owned NHS. As stated previously, the programs available for locally-owned roads and bridges, including the NHS, are discussed in Chapter 9.

Table 2-1: Assumed Funding for State Highway Programs, by Fund Source (YOE$ in Millions)

State Fiscal Years 2023-2027

Program/Fund Source	SFY 2023	SFY 2024	SFY 2025	SFY 2026	SFY 2027
SHR Total	**$1,144.0**	**$1,166.9**	**$1,190.2**	**$1,214.0**	**$1,238.3**
State	*$567.3*	*$578.7*	*$590.2*	*$602.0*	*$614.1*
Federal	*$576.7*	*$588.2*	*$600.0*	*$612.0*	*$624.2*
Majors and SEF Total	**$282.5**	**$282.5**	**$282.5**	**$282.5**	**$282.5**
State	*$84.7*	*$84.7*	*$84.7*	*$84.7*	*$84.7*
Federal	*$197.8*	*$197.8*	*$197.8*	*$197.8*	*$197.8*
MIB and High Cost State Bridge*	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
State	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Federal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Maintenance and Operations	**$289.7**	**$289.7**	**$289.7**	**$289.7**	**$289.7**
State	*$288.5*	*$288.5*	*$288.5*	*$288.5*	*$288.5*
Federal	*$1.2*	*$1.2*	*$1.2*	*$1.2*	*$1.2*
TOTAL	**$1,716.2**	**$1,739.1**	**$1,762.4**	**$1,786.2**	**$1,810.5**
State	**$940.5**	**$951.9**	**$963.4**	**$975.2**	**$987.3**
Federal	**$775.7**	**$787.2**	**$799.0**	**$811.0**	**$823.2**

**The MIB/HCSB programs are likely to fund the upcoming Lake Interchange and Blatnik Bridge projects discussed in Chapter 5; however, these are not included due to uncertainty regarding estimates and schedules. These projects, along with I-94 East-West, will be included in future TAMP updates.*

Table 2-1: Assumed Funding for State Highway Programs, by Fund Source (YOE$ in Millions) – (continued)

State Fiscal Years 2028-2032

Program/Fund Source	SFY 2028	SFY 2029	SFY 2030	SFY 2031	SFY 2032
SHR Total	**$1,263.1**	**$1,288.3**	**$1,314.1**	**$1,340.3**	**$1,367.1**
State	*$626.4*	*$638.9*	*$651.7*	*$664.7*	*$678.0*
Federal	*$636.7*	*$649.4*	*$662.4*	*$675.6*	*$689.2*
Majors and SEF Total	**$288.2**	**$288.2**	**$293.9**	**$293.9**	**$299.8**
State	*$86.5*	*$86.5*	*$88.2*	*$88.2*	*$89.9*
Federal	*$201.7*	*$201.7*	*$205.7*	*$205.7*	*$209.9*
MIB and High Cost State Bridge*	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
State	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Federal	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Maintenance and Operations	**$295.5**	**$295.5**	**$301.4**	**$301.4**	**$307.4**
State	*$294.3*	*$294.3*	*$300.2*	*$300.2*	*$306.2*
Federal	*$1.2*	*$1.2*	*$1.2*	*$1.2*	*$1.2*
TOTAL	**$1,846.8**	**$1,872.0**	**$1,909.4**	**$1935.6**	**$1,974.3**
State	**$1,007.2**	**$1,019.7**	**$1,040.1**	**$1,053.1**	**$1,074.1**
Federal	**$839.6**	**$852.3**	**$869.3**	**$882.5**	**$900.2**

**The MIB/HCSB programs are likely to fund the upcoming Lake Interchange and Blatnik Bridge projects discussed in Chapter 5; however, these are not included due to uncertainty regarding estimates and schedules. These projects, along with I-94 East-West, will be included in future TAMP updates.*

For state fiscal years 2024 and beyond, Table 2-1 incorporates the following funding assumptions regarding the level of funding reasonable available for state highway programs:

- Funding totals do not reflect IIJA/BIL increases that were directed by WisDOT to Local Program, Carbon Reduction, and TAP/CMAQ projects.
- SFY 2023 SHR Total equals Chapter 20 funding amounts for State and Federal. The Federal total includes $25 million Redistribution and $68.6 million FFY (federal fiscal year) ’22 BIL funding.
- SHR Totals in SFY ’24, ’27, ’29 and ’32 also include SHR Large Bridge projects that are assumed to be funded at 70% Federal/30% State funding split.
- SHR is increased by 2% annually for State funding and 2% annually for Federal funding, based on current projections.
- Majors and SEF assumes maintaining current funding levels through the ’25-’27 State Biennial Budget process, and then a 2% increase per biennium thereafter.
- Majors and SEF assumes 70% Federal/30% State funding split; actual fund splits will vary based on State biennial budget actions.
- M&O assumes maintaining current funding levels through the ’25-’27 State Biennial Budget process, an then a 2% increase per biennium thereafter.

While WisDOT believes these assumptions are reasonable for use in developing the TAMP, future biennial budgets approved through the legislative process will determine the actual mix of state, federal and bond funding in each program area. Wisconsin state law prohibits the current state legislature from committing future legislatures to any specific course of action; therefore, 2021-2023 Biennial Budget funding amounts must be used as the baseline to establish forward-looking funding projections.

Chapter 3 SHR Investment Strategy and Resiliency

Developing the State Highway Rehabilitation Program Investment Strategy Including Facilities Repeatedly Requiring Repair and Reconstruction (F4R)

Overview

WisDOT's NHS investment strategy is one component of its overall investment strategy for the STH system. WisDOT's goal in defining its overall STH investment strategy is to provide for safe and efficient travel, over STH pavements and bridges kept in a state of good repair. As noted in Chapter 2, the maintenance, improvement, and operation of the STH system is accomplished using funds contained in legislatively determined budget appropriations. The SHR program is for the preservation and rehabilitation of existing state trunk and connecting highways and bridges.

SHR funding cannot be used for M&O activities, SEF, high-cost MIB spanning a river forming a state border, other HCSB projects, or major highway projects (Majors). SHR funding can be used for a limited number of specific M&O-type activities, but only if those activities are incidental to the improvement of an existing state trunk or connecting highway or bridge or preservation projects that add a four-year service life extension.

Within these limits, WisDOT allocates SHR funding to the set of highway and bridge projects it believes best meets WisDOT's policy and performance goals. The policies guiding identification of these projects are expressed through WisDOT's SHR investment strategy. Development of the SHR investment strategy is overseen by DTIM, with critical input from DTSD Regions and Central Office staff. Development of WisDOT's SHR investment strategy relies heavily on the Meta-Manager Highway Asset Management System (MMS) and WisDOT's pavement and bridge asset management systems. Appendices A, B and C provide additional information on these systems. These systems help WisDOT identify highway and bridge improvement needs and understand the longer-term performance impacts of alternative SHR investment strategies over time.

Selection of the "optimal" SHR investment strategy defines the appropriate scope and priority for SHR investments addressing highway and bridge improvement needs on the STH system. It also helps define the appropriate split of SHR funding into WisDOT's SHR sub-programs. SHR sub-programs are defined for Backbone highways and bridges (the Backbone Program) and non-Backbone highways and bridges (the Region 3R Program). There is also a sub-program called SHR Large Bridge, for bridges that are too large to be easily accommodated within the Region 3R Program.

Table 3-1 provides a breakdown of the NHS and non-NHS roadways and bridges located on the Backbone and Region 3R systems. A map of the Backbone and Region 3R systems is shown in Figure 3-1. Note that the entire Backbone system is part of the NHS.

Management of the Backbone Program is centralized, with critical input from staff in each DTSD Region. Management of the Region 3R Program occurs at the Region level. 3R projects are identified and scheduled by staff in each DTSD region under funding and policy guidance from DTIM and the DTSD Central Office. Regardless of program management responsibility, the SHR projects selected for funding are heavily influenced by the highway and bridge projects identified as priorities by the MMS under the optimal SHR investment strategy. The optimal SHR investment strategy is, in turn, influenced by any gaps between WisDOT's pavement and bridge performance goals and the actual and anticipated performance of the STH system. Implementation of the Backbone and Region 3R Programs consistent with WisDOT's SHR investment strategy is critical to achieving acceptable STH system performance over time. By implementing these programs, WisDOT will achieve its pavement and bridge performance goals. Chapter 8 includes a discussion of WisDOT's SHR program effectiveness measures (PEM) and their use in managing the Region 3R Program.

WisDOT's Approach to Defining Alternatives for SHR Highway and Bridge Projects

The MMS is discussed in detail in Appendix C Meta-Manager. For highways, the MMS contains data for approximately 22,000 +/- one-mile roadway segments. For bridges, MMS data is defined at the individual bridge level. This section describes the scoping concepts reflected in the asset management tools developed for SHR highway and bridge projects. WisDOT's optimal SHR investment strategy uses a strategic combination of "Best Value" and "Reduced Cost" treatments to maximize system health given a funding constraint. It should be noted that all NHS roadways receive a Best Value treatment recommendation. Some SHR treatment limits are allowed on pavements and bridges within the termini of projects already scheduled within the Majors, SEF, MIB and HCSB programs. For such segments, the optimal SHR strategy provides for the minimum SHR investment required to keep those pavements and bridges in acceptable condition until the more extensive improvements, typically reconstruction, are completed through the modernization occurring in those programs. Chapter 4 provided a discussion of the process used in developing the Majors and SEF projects included in the TAMP. Chapter 5 discussed the potential for future MIB and HCSB projects on the WisDOT-owned NHS.

Highway Project Scoping

Once constructed, pavement conditions and ride deteriorate due to the cumulative impact of traffic, weather and other factors including the pavement's design and its maintenance and pavement section (reference Appendix A for additional details). The detailed distress information is summarized into an overall measure of pavement condition called the PCI. PCI and detailed distress information forms the starting point for scoping highway projects.

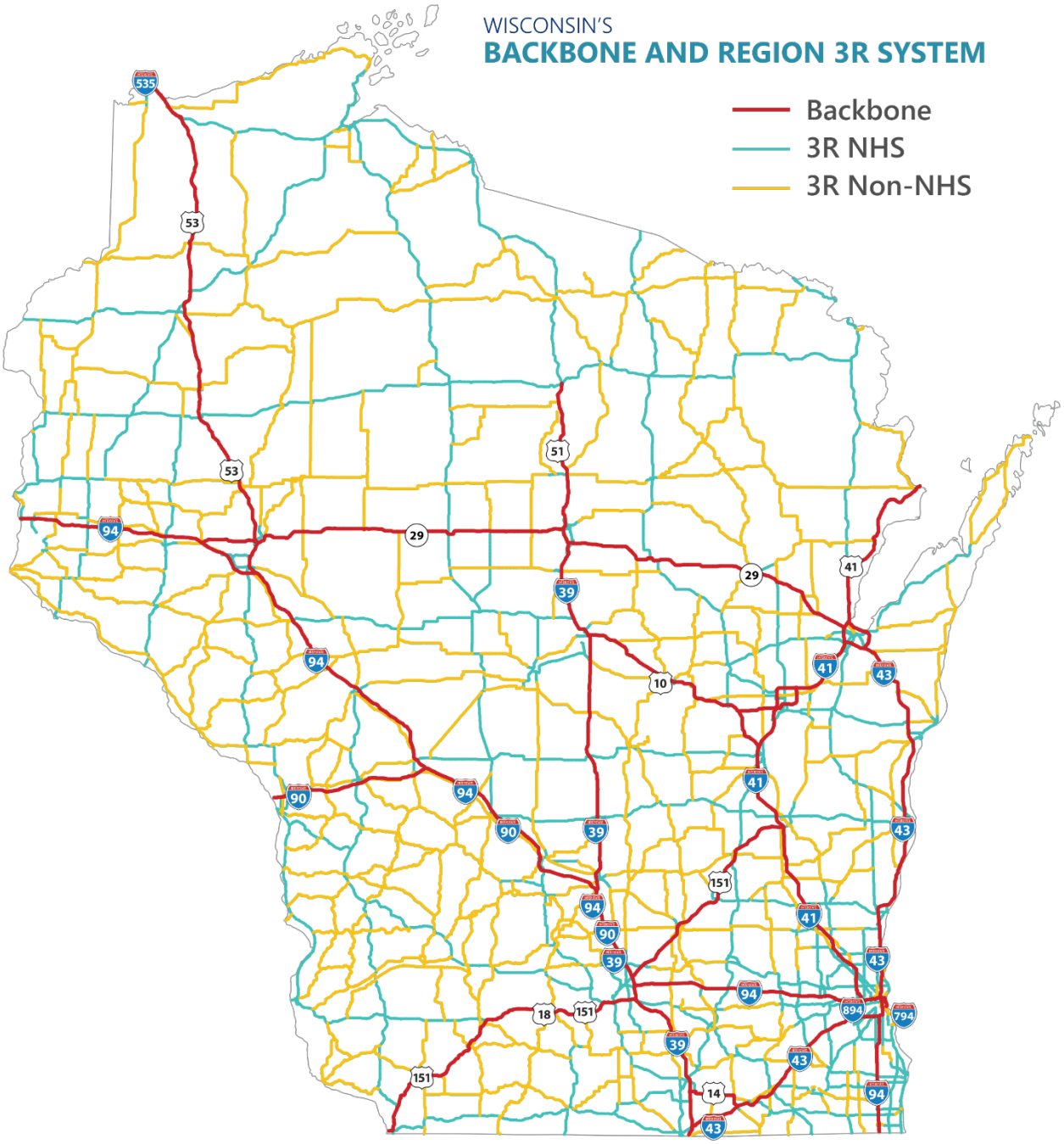
Table 3-1: NHS and Non-NHS Roadways and Bridges Located on the STH Systems

	NHS			
	Roadway		Bridge	
	Center Line Miles	Lane Miles	Count of Bridges	Sq. Ft. of Bridge Deck (Millions)
Backbone System				
Interstate	879	4,079	1,315	18.5
Non-Interstate	718	2,873	764	9.3
Total Backbone	1,597	6,952	2,079	27.8
Region 3R System				
Principal Arterial	3,647	9,666	1,078	11.3
Minor Arterial	80	163	90	0.8
Collector	0	0	31	0.4
Total Region 3R	3,726	9,829	1,199	12.4

Table 3-1: NHS and Non-NHS Roadways and Bridges Located on the STH Systems (continued)

	Non-NHS			
	Roadway		Bridge	
	Center Line Miles	Lane Miles	Count of Bridges	Sq. Ft. of Bridge Deck (Millions)
Backbone System				
Interstate	0	0	0	0.0
Non-Interstate	0	0	0	0.0
Total Backbone	0	0	0	0.0
Region 3R System				
Principal Arterial	273	717	29	0.2
Minor Arterial	4,737	9,576	1,156	7.4
Collector	1,410	2,825	523	3.4
Local	8	15	329	3.3
Total Region 3R	6,428	13,133	2,037	14.3

Figure 3-1: STH Roadways on the Backbone and Region 3R Systems



WisDOT's Pavement Management Decision Support System (PMDSS) bases its assessment of alternative pavement treatments on the type and amount (density) of distress present on each PIF (pavement information file) segment. Generally, two pavement treatments are identified by PMDSS. The "Best Value" treatment is the treatment having the lowest cost per year of service life extension (i.e. longest service life extension (SLE) per dollar invested). Typically, implementation of the "Best Value" alternative is consistent with the goal of minimizing pavement costs over time and maximizing the "health" of the WisDOT-owned highway system. Budget constraints, however, create situations where less expensive "Reduced Cost" treatments can assist in maximizing the system "health." PMDSS identifies "Reduced Cost" alternatives where appropriate, as described in Appendix A
.

The "Best Value" and "Reduced Cost" treatments identified by PMDSS are not always distinctly different pavement treatment options and sometimes a single treatment satisfies both criteria. The most straightforward situation creating this outcome is when PMDSS identifies a single treatment as appropriate for addressing all the distresses present on a pavement. Specific combinations of distress also increase the likelihood that the "Best Value" and "Reduced Cost" treatments will be the same even though more than one potential treatment is identified. For example, if an asphaltic concrete (AC) pavement has a minor amount of low severity alligator cracking and a moderate amount of low severity longitudinal and transverse cracking, PMDSS will suggest two potential treatments. The first would be patching, and the second would be an overlay. Given the cost difference between these treatments, and WisDOT's experience regarding the SLE's that can be expected, patching will likely be identified as both the "Best Value" and "Reduced Cost" option because it has the lower cost per year of SLE.

As described in Appendix A , WisDOT uses historical data to develop statistical relationships predicting changes in individual pavement distresses, PCI and IRI over time. To ensure they accurately represent actual field experience, these relationships are reevaluated as newly collected pavement condition ratings become available. After identifying "Best Value" and "Reduced Cost" pavement treatments based on existing conditions, PMDSS determines how the treatments will change over time if work is not undertaken when required. The result is a series of pavement conditions and treatment recommendations over an analysis period covering 10 years. This information is the starting point for the analysis of alternative SHR investment strategies within the TAMP.

The complete menu of potential pavement treatments identified by PMDSS vary in intensity. Certain treatments are classified as routine maintenance and, by law, can only be funded using the M&O appropriation. Details regarding needed M&O pavement treatments is made available to the DTSD Bureau of Highway Maintenance to help guide ongoing pavement maintenance activities. WisDOT currently collects the updated pavement condition on an annual basis. Annual data collections allow PMDSS to assume a larger and more formal role in influencing pavement maintenance activities. WisDOT is currently considering ways to more formally integrate PMDSS into pavement maintenance decision making.

Following WisDOT policy, pavement treatments undertaken with SHR funds must have a SLE of at least four years. Treatments with an SLE of less than four years must be undertaken using M&O funds. The SLE of a pavement treatment is expressed as the expected number of years before the PCI of the improved pavement will again deteriorate and reach a desired minimum service level (DMSL). The DMSL sets a lower bound for the desired PCI and varies by highway functional class, with better pavement conditions being a priority on higher functional systems. WisDOT's historic DMSL's for assessing SLE are 70 for Backbone highways, 65 for other Principal Arterials and 60 for all Minor Arterial and Collector highways.

WisDOT recently adopted lower threshold DMSL's for use when defining "Reduced Cost" treatments on non-NHS Minor Arterial and Collector highways already functioning in a degraded state and where costly major rehabilitation or replacement would otherwise be required. The lower threshold concept defines an "acceptable", as opposed to "desirable", service level for these highways, which carry the lowest traffic volumes on the STH system. Under the lower threshold concept, the DMSL is reduced to a PCI of 55 whenever the PCI is already below 60 before a treatment can be implemented (otherwise, the DMSL would have been a PCI of 60). In other words, if a pavement segment is already functioning at a PCI level below 60 on these highways, the lower threshold concept tests the SLE of improvement alternatives by allowing the post-treatment PCI to deteriorate to a PCI of 55.

By adopting the lower threshold concept, WisDOT is temporarily balancing lower pavement performance on a limited number of low volume non-NHS highways with greater pavement performance across the entire STH system. Projects subject to "downshifting" will not be permanently subject to lower cost levels of improvement. In time, only a higher level of improvement will provide the required SLE, even with a DMSL of 55. By allowing slightly reduced pavement conditions for a relatively short period (but not significantly lower than recently experienced), the lower threshold concept creates a limited number of situations where lower cost, otherwise ineligible, treatments become eligible because their revised SLE's are four years or more using the lower threshold DMSL. This allows lower cost treatment to be implemented instead of the significantly more expensive major rehabilitation or pavement replacement treatment otherwise required. The funding freed up through this process is then used to improve needy pavements that would otherwise have deteriorated due to a lack of funds. Eventually, all lower cost pavement treatments will fail to provide an SLE of at least four years using even a lower threshold DMSL, and more extensive treatments will be applied.

At this point in the process PMDSS has defined two alternatives for each PIF segment in need of a pavement treatment: "Best Value" and "Reduced Cost". As noted, the alternatives will be the same in some cases. The next step is to combine information at the PIF segment level (i.e. short sections to facilitate pavement inventory and condition assessment) into treatments at the project analysis level (i.e. longer project analysis segments). The starting and ending points (termini) of project analysis segments approximate historic STH improvement project termini. Identifying these termini is accomplished by aggregating adjacent PIF segments possessing the same type and age of pavement into a single project analysis segment.

Information on the "Best Value" and "Reduced Cost" alternatives at the PIF segment level is aggregated to develop "Best Value" and "Reduced Cost" alternatives at the project analysis level. If 50% or more of a project analysis segment requires treatment, the entire segment is defined as needing improvement. The treatment selected as "Best Value" at the project analysis level is the lowest level "Best Value" treatment (from among those called for on the PIF segments) that "undertreats" no more than 30% of the length of the project analysis segment. The same process is used to define the "Reduced Cost" alternative at the project analysis level.

When considering the scope for a highway project, WisDOT considers more than the appropriate pavement treatment. Safety, geometric and traffic deficiencies are also considered. The MMS evaluates the nature and extent of each of these deficiencies and identifies treatments to address them. This information, together with the pavement alternatives, results in an expanded set of mutually exclusive treatment options at the project analysis level. Each of the options will have a differing cost estimate. Costs increase, sometimes substantially, with the number of deficiencies addressed.

Given the high priority WisDOT places on the safety of the STH system, potential SHR projects are also identified where crash data indicates there are significant safety issues even though pavement conditions are acceptable. The scope of projects in these cases might include an intersection improvement or "spot" safety improvement.

Bridge Project Scoping

Like pavements, bridges are subjected to repeated traffic loadings and environmental factors such as heat, cold, snow and road salt. These factors all lead to progressive deterioration of bridge elements. Bridge maintenance, repair and rehabilitation activities are required to counter the effects of loadings and the environment. Some activities (such as deck sweeping and crack sealing) are performed using M&O funds. Other activities (concrete overlays, new decks, painting, etc.) are more extensive, require significant design efforts, and are let to contract using SHR funds. The scope of the work required on each bridge is determined by its current condition and where it is in its lifecycle. Safe, well-maintained bridges are critical to the functionality of the STH system, and for this reason, bridge improvements are a high priority in WisDOT's optimal SHR investment strategy.

The Wisconsin Structures Asset Management System (WiSAMS) is described in Appendix B. The bridge treatments called for by WiSAMS reflect Chapter 42 - Bridge Preservation in WisDOT's Bridge Manual. Two of the primary goals of bridge preservation by WisDOT are as follows:

- Keep bridges in a state of good repair using effective, low-cost treatments; and
- Implement timely preservation treatments on structurally sound bridges to promote optimal lifecycle costs, extend service life and lengthen the time between major rehabilitation and replacement activities.

WiSAMS identifies optimal treatments for each STH bridge, along with their estimated cost. Certain treatments will be funded through M&O and others through SHR.

The current condition of each STH bridge is based on the most recent bridge inspection. Forecasting the need for future treatments relies on forecasts of future bridge conditions. WiSAMS condition forecasts are based on deterioration curves developed using historic information on Wisconsin's bridges. Starting with the current condition of each bridge, the deterioration curves predict the condition of each bridge in future years, and those conditions define the timing and scope of the needed bridge treatments following the policies in the BPPG.

WisDOT's Process for Defining the Optimal Investment Strategy for SHR Funds

Discussion of the Fundamental Concepts Involved in WisDOT's Policy Analysis

Development of the "optimal" SHR investment strategy requires all SHR highway and bridge investment needs to be identified along with a determination regarding how to best address them. Alternative SHR investment strategies are evaluated by comparing their expected performance outcomes. The performance outcomes for STH

pavements and bridges are compared to WisDOT's performance goals, and any performance gaps are quantified. The estimated number of years of pavement service life added to the STH system by alternative strategies is also considered, along with the backlog of pavement and bridge needs remaining unaddressed at the end of the analysis period and the cost of addressing those backlog needs. Each alternative investment strategy produces a unique set of performance outcomes. Clear tradeoffs are involved when comparing one set of outcomes to another. The alternative strategy with the preferred mix of performance outcomes becomes WisDOT's "optimal" SHR investment strategy.

The "optimal" SHR investment strategy described below addresses WisDOT's bridge and safety priorities and provides the best overall pavement conditions (best long-term system health) for the STH system. The "optimal" SHR investment strategy also produces pavement and bridge performance consistent with WisDOT's STH and NHS pavement and bridge performance targets.

In developing the "optimal" SHR investment strategy, the outcomes of the alternative strategies were simulated over a 10-year period using WisDOT's pavement and bridge management systems. Each strategy contained a different set of policies guiding the highway and bridge treatments chosen for funding within the SHR resources available each year. Differing strategies answered the following policy questions in differing ways:

- Should the pavement treatment be based on "Best Value" or "Reduced Cost"?
- If a pavement treatment is necessary, should safety, geometric or traffic needs also be addressed?
- Do the safety needs call for treatment even though the pavement is in acceptable condition?
- What is the relative priority of each potential highway and bridge treatment?

Each alternative strategy contained a set of policies to be applied to the following STH sub-systems: Backbone routes, Connector routes and the individual functional systems making up non-routes.

For each alternative, the highway and bridge treatments called for during any given year were determined by their priority. The total cost of the treatments allowed in any given state fiscal year could not exceed the SHR resources available. The analysis assumed treatments were implemented when called for, improving pavement and bridge conditions in those locations. The improved conditions associated with varying highway and bridge treatments reflect WisDOT's experience with those treatments in the field. Once improved, those pavement and bridges began to deteriorate once again during the remaining years of the simulation. Conditions also deteriorated year to year for the pavements and bridges not selected for treatment. This process resulted in each alternative strategy having a unique set of STH system performance outcomes at the end of the 10-year analysis period.

Defining WisDOT's SHR Investment Strategy for the Backbone Program

The Backbone Program is WisDOT's highest priority for the use of SHR funds. Backbone highways are all part of the NHS. They are Wisconsin's most intensively used highways, carrying 54% of all STH vehicle miles of travel and 84% of all STH freight ton-miles on just 22% of STH roadway miles. A high functioning Backbone system is essential to passenger and freight mobility and to a strong Wisconsin economy. Backbone highways are also Wisconsin's safest highways.

WisDOT is committed to ensuring this high level of performance. As evidence of WisDOT's commitment, SHR funding is reserved for the Backbone Program after allowing for "first draws" from the annual SHR appropriation to fund design and construction engineering and a limited number of change orders affecting ongoing construction contracts. WisDOT's "optimal" SHR investment strategy for the Backbone Program has been consistently and successfully applied for many years. The proportion of SHR funding dedicated to the Backbone Program is reviewed regularly. WisDOT's asset management tools are used to help identify the level of funding necessary to address all priority SHR needs on the Backbone system.

In addition to ensuring appropriate funding, the priority placed on the condition and operation of the Backbone

system is reflected in the policies guiding the roadway and bridge treatments called for on the Backbone system. WisDOT's roadway and bridge treatment policies for the Backbone system are summarized in Table 3-2. The policies emphasize the preservation of Backbone pavements and bridges at the lowest practicable cost over time, while effectively addressing all safety deficiencies. As noted in Table 3-2, only limited capacity improvements (project lengths less than five miles) are made using SHR funding, and typically only if they are essential to highway safety. More extensive capacity improvement can only be implemented through the Majors and SEF programs. Recall that all Backbone routes are part of the NHS.

The Backbone Program is managed centrally by the Backbone Committee. The committee is led by the Bureau of State Highway Programs (BSHP), with membership from DTSD Region and Central Office staff. Developing the projects implemented within WisDOT's 10-year SHR investment strategy for the Backbone begins by using WisDOT's MMS analysis tools to identify highway and bridge projects (treatments) consistent with Table 3-2. The treatments are thoroughly reviewed by the Backbone Committee and the respective DTSD Regions before being finalized and approved. This process ensures all deficiencies deemed a priority are addressed within the scope of each Backbone project.

When available funding will not cover all approved projects, a prioritization process is applied. This process represents a second important part of WisDOT's Backbone investment strategy. The adjusted schedule is again reviewed by the Backbone Committee and DTSD Region staff prior to final approval. Backbone Program priorities are shown in Table 3-3 and reflect the emphasis WisDOT's Backbone investment strategy places on improving safety, maintaining excellent bridge conditions, and following a balanced approach when implementing cost-effective pavement treatments. These priorities have guided the Backbone Program for many years. WisDOT is confident they make the best possible use of the SHR funds dedicated to the Backbone system.

Table 3-2: Policies Guiding SHR Project Scoping within the Backbone Program

Functional System	Projects Scoping Policies
Backbone	• Address all warranted bridge and safety treatments (non-M&O funded) • Address pavement deficiencies using the "Best Value" treatment (non-M&O funded) • Address all safety deficiencies as part of any pavement or bridge treatment • Address safety deficiencies using stand-alone projects when more extensive work to address pavement or bridge conditions is not required • Address highway capacity deficiencies, to the extent possible, when a safety deficiency is the direct result of inadequate capacity. (Under current state statute, only very limited capacity expansion can be performed using SHR funds. Most capacity improvements on the Backbone system are funded through the Majors and SEF programs.)

Defining WisDOT's SHR Investment Strategy for the Region 3R Program

WisDOT's ability to accomplish its goals for the pavements and bridges managed through the Region 3R Program depends on two primary factors: the effectiveness of the 3R investment strategy and the level of funding available for the program. The 2021-2023 Biennial Budget and the federal BIL increase the long-term funding available for 3R investments, as shown in Table 2-1. Using the increased funding, WisDOT's asset management systems and 3R investment strategy allows the department to maintain or slightly improve system conditions of the state highway system at the end of the 10-Year TAMP analysis period.

Table 3-3: Backbone Program Priorities

Priority Class	Type of Project
Class 1	Projects where a significant share of project costs are covered by federal Highway Safety Improvement Program (HSIP) funding
Class 2	Projects addressing intersections with significant safety issues
Class 3	Projects addressing critical bridge and pavement needs
Class 4	Pavement and bridge preservation treatments
Class 5	Pavement resurfacing and reconditioning projects with a projected IRI GE 2.45
Class 6	Remaining pavement resurfacing and reconditioning projects
Class 7	Remaining pavement replacement and reconstruction projects
Class 8	Interchange projects or projects to improve operations

Asset management at WisDOT provides the best system health given available funding. The system prioritizes safety and bridge needs and then prioritizes pavement needs such that long term conditions are the best that available funding can provide. Additionally, this approach ensures that the magnitude of unmet need at the end of an analysis period is minimized. This investment stewardship approach maintains a state of good repair at the least practicable life cycle cost by using investment strategy incorporates a strategic combination of "Best Value" and "Reduced Cost" treatments to maximize system health given a funding constraint. It should be noted that all NHS roadways receive a Best Value treatment recommendation.

The asset management strategy incorporates a lower threshold into the scoping process for non-NHS Minor Arterials and Collectors (as highlighted in Table 3-4). Allowing slightly reduced pavement conditions for a relatively short period, the use of this lower threshold can sometimes result in less expensive "Reduced Cost" treatments for certain pavements in the short run. Using these cost savings, WisDOT can improve more miles of pavement using 3R funds, resulting in better long-term system conditions.

To complete the definition of WisDOT's optimal 3R investment strategy, a project prioritization process is required, just as it was for the optimal Backbone investment strategy.

WisDOT's Region 3R Program priorities are shown in Table 3-5. The priorities place added emphasis on safety and prioritize pavement preservation while allowing pavements to function at a lower tolerance level if costly pavement replacement is required.

Taken together, the policies implementing WisDOT's optimal 3R investment strategy make more cost-effective use of 3R funds and result in better STH system performance. The policies in Table 3-4 and Table 3-5 were used to define the specific projects included in WisDOT's optimal 3R investment strategy covering the 10-year TAMP analysis period.

Table 3-4: Policies Guiding SHR Project Scoping within the Region 3R Program

Functional System	Project Scoping Policies
Connectors	• Address all warranted bridge and safety treatments (non-M&O funded) • Address pavement deficiencies based on "Best Value" treatment (non-M&O funded) • Address all combinations of pavement, safety, geometric and capacity deficiencies, although no geometric improvements unless there is a safety deficiency at the same or greater scope, and no capacity improvement for urban projects unless the level of service (LOS) score is 5.0 or greater [1]
Other Principal Arterials	• Address all warranted bridge and safety treatments (non-M&O funded) • Address pavement deficiencies based on "Best Value" treatment (non-M&O funded) • Address all combinations of pavement, safety, geometric and capacity deficiencies, although no geometric improvements unless there is a safety deficiency at the same or greater scope, and no capacity improvement unless the pavement or safety deficiencies call for highway reconstruction
Minor Arterials	• Address all warranted bridge and safety treatments (non-M&O funded) • Address NHS pavement deficiencies based on "Best Value" treatment (non-M&O funded) and non-NHS pavement deficiencies based on "Reduced Cost" treatment (non-M&O funded), or using a lower threshold where applicable • Address all combinations of pavement, safety and geometric deficiencies, although no geometric improvements unless there is a safety deficiency at the same or greater scope
Collectors	• Address all warranted bridge and safety treatments (non-M&O funded) • Address pavement deficiencies based on "Reduced Cost" treatment (non-M&O funded), or using a lower threshold where applicable and with the maximum treatment being an overlay unless there is a safety deficiency • Address all combinations of pavement, safety and geometric deficiencies, although no geometric improvements unless there is a safety deficiency at the same or greater scope

[1] *The LOS score relates directly to Highway Capacity Manual (HCM) level of service codes A - F, where A represents free flow, B is reasonably free flow, C is stable flow, D is approaching unstable flow, E is unstable flow and F is breakdown flow. HCM codes A - F are assigned LOS scores of 1.0 - 6.0. The LOS score of each project level analysis segment is based on its traffic volume relative to the volumes defining the cut-points between the HCM codes for that type of highway. For example, if the traffic volume is halfway between the cut-points for E and F the LOS score would be 5.5, halfway between 5.0 and 6.0.*

Using this asset management strategy, definition of the optimal Region 3R Program begins by reducing each year's 3R funds by the cost of the bridge treatments warranted in that year, consistent with bridges having the highest priority within the 3R priority process. The remainder of the funding becoming available for the set of eligible highway projects identified using the data and analysis processes of the MMS. Eligible highway projects are funded in descending priority order until all available 3R funds are exhausted. Projects in Class 2 are funded before projects in Class 3, and so on, with the projects within each priority class being sorted by their traditional

3R priority index. This process ensures the highest priority set of 3R projects is selected for funding each year.

Table 3-5: Region 3R Program Priorities

Priority Class	Type of Project
Class 1	All warranted bridge projects
Class 2	Highway projects addressing a stand-alone safety priority
Class 3	Pavement preservation-only projects
Class 4	Highway projects where the PCI GE 70
Class 5	Remaining highway projects with a safety B/C of 1.75 or higher
Class 6	Remaining highway projects with a safety B/C between 1.0 and 1.75
Class 7	Remaining pavement-only projects with a minimal safety B/C
Class 8	Remaining pavement-only projects where lower thresholds are applicable
Class 9	Remaining highway projects calling for a critical pavement replacement on a Principal Arterial having a daily traffic volume GE 10,000 and a PCI LE 45 [1/]
Class 10	Remaining highway projects calling for an overlay where the 50 < PCI < 70
Class 11	Remaining highway projects calling for less than a pavement replacement, allowing for capacity expansion only if there is a safety deficiency
Class 12	Remaining highway projects calling for a critical pavement replacement on a Principal Arterial where the PCI LE 45
Class 13	Remaining highway projects calling for a critical pavement replacement where the PCI LE 45
Class 14	Remaining highway projects

[1] A critical pavement replacement is defined as a situation where a) no pavement treatment other than replacement or reconstruction would result in a SLE of more than four years, and b) an interim overlay test (short-term overlay) fails to provide five years of life extension.

During each year of the TAMP analysis period, the pavement and bridge conditions relating to the highway and bridge projects selected for treatment are reset to reflect the improved conditions that will result from the project. The improved conditions associated with varying highway and bridge treatments reflect WisDOT's experience with those treatments in the field. In subsequent years, those conditions begin to deteriorate once again. Meanwhile, conditions on the project analysis segments and bridges remaining unimproved are deteriorated to represent the conditions expected in the following year. Those conditions then help define the highway and bridge projects that

become eligible for funding in that year, and the iterative process repeats. This process captures cost increases that can occur due to a delay in a warranted treatment.

While all warranted 3R pavement needs cannot be fully funded each year, these "backlog" needs cannot simply be ignored as some will require treatment. Instead of leaving "backlog" needs totally unaddressed, WisDOT's optimal 3R investment strategy reserves funding for judicious "low cost" pavement fixes that maintain acceptable service until a major rehabilitation or replacement can occur. Backlog segments considered high-risk may also be good candidates to have designs "on the shelf" ready for project advancement in the event of unexpected funding availability or rapid deterioration in conditions. Additional information provided in Appendix G Risk Register.

Implementing WisDOT's Optimal SHR Investment Strategy

The ongoing development and implementation of the projects identified using WisDOT's optimal SHR investment strategy will be managed differently depending on whether the project is part of the Backbone Program or the Region 3R Program. As noted earlier, the projects and project schedules within the Backbone Program are managed centrally by the Backbone Committee. Within the Region 3R Program, each DTSD Region is given an annual allocation of 3R funds. The funding allocated to each DTSD Region is reviewed regularly to reflect shifts in the proportion of optimal 3R investment needs in each Region.

Within its 3R allocation, each DTSD Region manages their own projects and project schedules. This allows each Region to incorporate project-level information and considerations that cannot be captured in the MMS planning-level analysis process. There is, however, a clear expectation that the 3R project locations identified in the TAMP will receive strong consideration and that the policies inherent in WisDOT's optimal 3R investment strategy will be followed unless there are specific, credible, reasons for any deviation. DTSD Region accountability for their program of 3R projects is monitored using WisDOT's PEM, which is described in Chapter 8 and reported as a corporate performance measure as part of MAPSS, WisDOT's public-facing performance improvement program. To further assist Region staff, DTSD recently dedicated additional staff resources to streamlining the use of data-driven asset management programming, practical design concepts and performance measures related to planning and design. More detail on this effort is also provided in Chapter 8.

The Impact of WisDOT's Investment Strategy on Maintaining a State of Good Repair

Using WisDOT's investment strategy for both State and Locally-owned pavement and bridges, it is anticipated that all NHS assets will be kept in a state of good repair. Below are the current and 10-year analysis results using the pavement and bridge condition management systems that are available. WisDOT believes continuing to meet these targets will maintain NHS pavements and bridges in a state of good repair.

Using PCI, Table 3-6 reports current WisDOT-owned NHS conditions and evaluates the long-term pavement performance expected. The analysis assumed projects currently scheduled in the first 5 years of the SHR program will be constructed as scheduled and the remaining 5 years of the projects in the improvement program are identified based on asset management strategy described above. Using "poor" lane miles as a measure, Table 3-6 demonstrates the SHR funding assumed here is expected to maintain current pavement conditions in a State of Good Repair on the WisDOT-owned NHS at the end of the 10-year analysis period, post 2032.

Table 3-6: Impact of WisDOT's Investment Strategy on Long-Term WisDOT-Owned NHS Pavement

	Target "Fair & Above"	"Fair & Above"	"Poor"
2022 NHS Pavement Conditions (lane miles)*	87.0%	89.8%	10.2%
Proposed SHR Budget (post-SFY 2032 conditions)**	87.0%	90%	10.0%

**Projected conditions assuming all SFY '22 projects have been constructed and deterioration occurring on segments without work being completed.*
***Conditions assuming alternative SHR funding levels using PCI*

Similarly in Table 3-7 using local pavement data in the Wisconsin Information System for Local Roads (WISLR) system, the locally-owned NHS conditions are reported for current conditions and the anticipated performance expected of the 10-year analysis period. WisDOT uses the historical Pavement Surface Evaluation and Rating (PASER) pavement data to determine locally owned NHS pavement condition targets. This process is completed by evaluating each PASER score, type of pavement and age of pavement for each individual pavement information segment. These scores are combined by pavement type (ex. Asphalt, Concrete etc.) to determine annual average pavement deterioration rates. WisDOT deteriorates each individual pavement information segment over a 10-year analysis period to determine future predicted system conditions assuming no pavement improvements. WisDOT then evaluates the average number of local NHS miles that have been improved historically. Conservatively assuming similar funding is present for the future analysis period, a prediction of miles improved for the system is made. Combining the unimproved pavement conditions with anticipated improved miles provides the predicted pavement condition of the local NHS system at the end of the analysis period.

Table 3-7: Impact of WisDOT's Investment Strategy on Long-Term Locally-Owned NHS Pavement

	Target "Fair & Above"	"Fair & Above"	"Poor"
2022 NHS Pavement Conditions (lane miles)	90%	94.6%	5.4%
Proposed Locally Owned NHS (post-SFY 2032 conditions)*	90%	94.5%	5.5%

*Projected conditions are based on annual average deterioration rates and average annual improvements to local roadways

Table 3-8 combined State and Locally-owned NHS bridge deck area to determine condition. Historic trends and WisDOT's WiSAMS system are used to analyze bridge conditions over the 10-year analysis period and determined that conditions are projected to change from 2.3% to 3.3% poor. As listed in Table 3-5, WisDOT prioritizes and funds all warranted bridge projects and is still maintaining system conditions in a state of good repair. Bridge conditions and the scheduling of projects is closely monitored; however, there are times when a few large bridges are anticipated to go from fair to poor condition and remain there for a few years prior to the improvement project occurring, which could cause some year to year variability. Also, WisDOT is investing an additional $225M of federal funds from the BIL into the Local Bridge system to help maintain and potentially improve conditions.

Table 3-8: Impact of WisDOT's Investment Strategy on Long-Term NHS Bridges

	Target "Fair & Above"	"Fair & Above"	"Poor"
2022 NHS Bridge Conditions (bridge deck area)	97.0%	97.7%	2.3%
Proposed NHS Bridge Conditions (post SFY-2032)	96.5%	96.7%	3.3%

Flood Resiliency Management Practices

Per 23 CFR 515.7, the TAMP must summarize evaluations conducted under 23 CFR 667. Known as F4R at WisDOT, this program identifies and conducts evaluations of roadways and bridges that have experienced catastrophic damage resulting in state emergency declarations on two or more occasions. These efforts identify and consider alternatives that will mitigate, or partially or fully resolve, the root cause of the recurring damage.

There are currently no F4R facilities on the NHS. As of July 2022, there is one evaluation underway on a non-NHS project in the Southwest Region. Any projects in the Statewide Transportation Improvement Program (STIP) that meet the F4R criteria and are on identified F4R facilities will include an F4R Evaluation as a part of the project's scoping process. For more information on F4R, including an interactive map and the most up-to-date list of Wisconsin's F4R facilities, please see WisDOT's F4R webpage.

WisDOT has also developed a system risk assessment and asset prioritization for flood resiliency design guidance consideration. WisDOT is developing procedural guidance on how to manage the uncertainty of rainfall prediction. Managing the inherent statistical uncertainty of making future predictions based on past occurrences is consequentially linked to asset management infrastructure investment decision-making.

WisDOT's first considerations are the existing major drainage considerations for which we have available data. Bridges, culverts, and roadway topping elevation are the primary initial considerations. Parallel roadways, alternate routes, local roadways, harbors, airports, and other key facilities are the next iteration considerations.

Risk scoring definitions were established from pertinent existing roadway data sources. These risk elements include roadway elevation/floodplain elevation, frequency of flooding events, duration of flood events, pavement condition, scour critical bridge status, culvert pipe condition, traffic volume, truck volume, functional classification, dam shadow status, and interstate detour status. Each scoring definition was given a point range to represent the condition related to flooding events. Weightings were then established to represent the exposure, sensitivity, and consequence of flooding. Risk scoring definitions were broken down into those weighting categories.

The results of the system prioritization will be displayed in WisDOT's internal Geographic Asset Management Application (GAMA). WisDOT staff users will identify the highest priority assessment point total areas within the asset management segments within GAMA. Those highlighted segments are associated with areas of upcoming improvement project consideration. Each high priority area will move to project scoping when roadway treatments are due to be considered. The drainage design consideration in identified areas will utilize the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 90th percentile confidence interval limit for the 24hr 100-year flood rainfall depth for design. This will help more conservatively consider drainage design in high-risk locations

by ensuring rain events predictions aren't too low.

WisDOT believes the use of NOAA Atlas 14 and the 90th percentile confidence interval rainfall depth provides a solid basis for high-risk locations, as a recent study supports with information showing the NOAA Atlas 14 and the 90th percentile confidence interval rainfall depth is not exceeded until the year 2100 in the Midwest, when compared with the most recent climate models. While higher resolution models are being considered and developed, WisDOT remains open to evaluating GCM (general circulation models) data and tools to supplement or replace NOAA Atlas 14 data if deemed appropriate for a given situation[1].

The department's approach assures a conservative approach for resiliency design consideration at high priority locations while allowing for continued evaluation of the appropriateness and accuracy of the use of low-resolution global climate models in the prediction of rainfall uncertainty for resiliency infrastructure investment decision-making.

By maintaining this flood risk assessment and prioritization approach, WisDOT is both reactively dealing with areas of previous concern that fall below the above thresholds for F4R, and proactively attaching design considerations to key areas of greatest potential flood impact risk. This will lead to a more resilient roadway network system and will do so in a manner that is responsible to the stewardship goals of maintaining conditions.

[1] Gustavo de A. Coelho, et al. "Potential Impacts of Future Extreme Precipitation Changes on Flood Engineering Design Across the Contiguous United States." Water resources research, v. 58,.4 pp. e2021WR031432. doi: 10.1029/2021WR031432

Chapter 4 Majors and SEF Highway Investment Strategy

Developing the Major Highway Development and Southeast Wisconsin Freeway Megaprojects Program Investment Strategies

Overview

WisDOT is committed to ongoing and effective stewardship of the financial resources Wisconsin's Biennial Budget provides for the maintenance, operation, and improvement of the STH system. The Biennial Budget provides funding to WisDOT through a set of legislatively determined budget appropriations. The three largest improvement appropriations fund investments within the SHR, Major Highway Development (Majors) and SEF programs. The projects undertaken using Majors and SEF funding are WisDOT's largest and most costly. These projects not only rehabilitate and rebuild aging highway infrastructure, they enhance safety, resiliency and increase the ability of the infrastructure to effectively handle growing traffic volumes through modernization of the STH system.

Because of their significant costs, there are relatively few Majors and SEF projects approved for funding at any given time. Unlike projects in the SHR program, Majors and SEF projects require the specific approval of the Governor and the Legislature through the Biennial Budget or approval from the Transportation Projects Commission (TPC). Processes have been developed to ensure all Majors and SEF projects are thoroughly vetted, and well-justified before being approved. WisDOT works together with the Governor, Legislature and TPC to ensure only the highest priority projects are brought forward and that those projects have strong public support. The processes used to assess proposed projects are fully consistent with WisDOT's commitment to responsible data-driven stewardship of the STH system.

The TPC and Major Projects

The TPC was created in 1983 to review potential Majors projects and make recommendations to the Governor and Legislature regarding Majors that should be enumerated (i.e. authorized, by name, in state law). Many factors define what is and is not a Majors project, but Majors requiring enumeration typically reconstruct an existing highway while adding lanes for through traffic for more than five miles. See Chapter 2 for further discussion of how Majors projects are defined.

The TPC has 15 members, including five state Senate members, five state Assembly representatives and three citizen members. The Governor serves as TPC Chairman, the WisDOT Secretary serves as a non-voting member, and WisDOT managers serve as staff to the TPC. The commission is authorized to consider potential Majors projects for enumeration on a two-year cycle and meets only as necessary; however, the TPC has held annual meetings since 2019.

In fall of odd-numbered years, the TPC is authorized to review and approve potential Majors projects to advance to environmental study. WisDOT will only recommend potential high priority projects for TPC consideration and only after completing a thorough, data-driven analysis of potential Majors across Wisconsin. In recommending a potential project for environmental study, WisDOT considers the relative urgency of its current and anticipated safety and traffic congestion needs, the condition of its pavement and bridge infrastructure and the benefits the potential project would provide to highway users as well as to state and regional economic development.

WisDOT cannot perform an environmental study on a potential Majors project until a study is approved by the TPC. The type of environmental study required is dictated by state and federal environmental law. In most cases, this involves a full Environmental Impact Statement (EIS), although in some cases a less extensive Environmental Assessment (EA), or Environmental Report (ER) may be appropriate. The cost of performing an environmental document is significant and is funded within the budget for the Majors program. Potential studies compete for

funding with the construction of already enumerated projects, so the TPC only approves study candidates they consider to be the highest priority. Completing the National Environmental Policy Act (NEPA) process typically requires several years and involves extensive public input.

In the fall of even-numbered years, the TPC is authorized to review and recommend potential Majors projects for enumeration. The TPC cannot recommend enumeration until a final environmental document is approved by FHWA. The TPC may not recommend projects for enumeration unless construction on the projects can begin within six years.

WisDOT assists the TPC in their consideration of candidate enumerations by conducting an analysis and ranking of the candidates using a process defined in Administrative Rule (Trans 210). When potential enumerations are under review, the TPC has until December 15th to report its recommendations to the Governor (and Governor-Elect, if applicable), the Legislature and the Joint Committee on Finance. This allows time for the Governor (or Governor-Elect) to consider whether to include recommended enumerations in their proposed Biennial Budget, which is submitted to the Legislature the following January. WisDOT is not authorized to begin construction on an enumerated Majors project until the Biennial Budget containing the enumeration is signed into law.

The TPC also reviews and approves "non-traditional" Major projects. These are projects that begin development within the SHR program. During project development, the cost of the appropriate infrastructure solution is found to be unusually large, meaning construction of the project within SHR would compromise the ability of SHR to function effectively in meeting its goals. The TPC has authority to approve such projects for construction as Major projects; enumeration in the Biennial Budget is not required. WisDOT may request TPC review and approval of these projects immediately after the completion of a draft environmental document.

WisDOT currently has nine active Major projects that are in various stages of final design or construction as shown in Table 4-1. Final design and construction for Major projects are scheduled over many years, reflecting their cost and complexity.

Majors funding is allocated to specific projects on an annual basis consistent with an appropriate staging of construction and other activities. Costs are closely monitored at the project level to keep project costs within the overall project estimate. Costs are also managed at the program level to ensure the sum across all projects in each year remains within the total funding available. Once a Majors project is complete, the ongoing maintenance, operation and rehabilitation of the infrastructure is funded using Maintenance and Operations (M&O) and SHR funds.

Table 4-1 lists the nine Major projects currently in final design or construction. With the exception of USH 51 (IH 39/90 to USH 12/18), these projects are all located on the NHS and are part of WisDOT's NHS investment strategy.

Table 4-1: Approved/Enumerated Major Projects

Project	Highway Number	Project Limits
1	STH 15	STH 76 – New London
2	STH 23	STH 67- USH 41
3	IH 39/90	USH 12 to Illinois
4	IH 41	STH 96 to Scheuring Road
5	IH 43	Silver Spring Drive to 43rd Avenue
6	STH 50	IH 41 to 43rd Avenue
7	IH 39/90/94	Bridges over Wisconsin River
8	USH 51	IH 39/90 to USH 12/18
9	USH 53	La Crosse Corridor

Enumerating Southeast Wisconsin Freeway Megaprojects

The SEF is designed to fund improvement projects on the southeast Wisconsin freeway system currently costing more than $828.3 million. Authorization to proceed with the construction of a SEF megaproject can only occur after the enumeration of the project in the Biennial Budget.

The SEF program was created in 2011 (an earlier version was created in 2001). Although SEF projects are defined solely in terms of location and cost, they share similarities with Majors projects that modernize and enhance the safety of aging highway infrastructure.

The enumeration process for SEF projects does not involve the TPC. However, as with Majors, WisDOT reviews a broad array of factors to develop priorities for future southeast Wisconsin freeway megaprojects. Among the list of factors considered are infrastructure conditions, safety and capacity needs, corridor resiliency, state and regional economic development trends, public preferences, and potential benefits to highway users. With priorities in place, WisDOT works with the Governor and Legislature in seeking enumeration of each SEF project and ongoing funding for its construction.

Currently, three SEF megaprojects are enumerated for construction; the Zoo Interchange, the IH 94 East-West Corridor and the IH 94 North-South Corridor; however, the IH 94 North-South Corridor construction has been completed. The IH 94 East-West project is still in design and costs are not included as part of WisDOT's NHS investment strategy. Future TAMP updates will include costs and schedule information for this project when appropriate.

Inclusion of Majors and SEF in the TAMP

WisDOT has a total of nine Major projects currently under design or construction that are located on the NHS. WisDOT's investment plan for funding the projects is summarized in Chapter 7. The investment plan is consistent with the Wisconsin Department of Transportation Report to the Transportation Projects Commission on the Status of Major Highway Projects and Southeast Wisconsin Freeway Megaprojects, dated August 2022.

The construction schedules for enumerated Majors and SEF projects limit improvements called for as part of WisDOT's optimal SHR investment strategy is described in Chapter 3. If a pavement segment or bridge deck

requires rehabilitation prior to its replacement by an enumerated Majors or SEF project, the required pavement and bridge work is performed for minimum possible cost. If the need is within five years of the scheduled infrastructure replacement, it is assumed the need will be addressed through the State Highway M&O program, thereby deferring the capital improvement until the Majors or SEF project occurs. This helps ensure the financial and system performance information in the TAMP is fully consistent with both the schedule for completing Majors and SEF projects and with WisDOT's SHR and M&O policies.

Chapter 5 MIB and HCSB Investment Strategy

Developing the Major Interstate Bridge and High-Cost State Bridge Program Investment Strategies

Overview

WisDOT typically funds individual bridge projects on the STH system through the SHR program. Exceptions exist for bridges funded as part of larger projects within either the Major Highway Development (Majors) or SEF programs, and for high-cost bridges that cannot be reasonably accommodated within SHR. Bridges in the latter category are funded through either the MIB or HCSB programs. The eligibility criteria for these programs are defined by state law and were summarized in Chapter 2. Bridge projects funded through these programs occur infrequently. When they do arise, WisDOT works with the Governor and Legislature to obtain funding through the Biennial Budget.

Identifying Major Interstate Bridge and High Cost State Bridge Projects

Bridge projects funded through the MIB and HCSB programs are identified using the same data-driven asset management processes used to identify SHR-funded bridge projects on the STH system. Bridges are inspected on a regular cycle and the data is used by the Wisconsin Structures Asset Management System (WiSAMS) to help determine the need for and timing of bridge maintenance, rehabilitation, and reconstruction projects. See Appendix B for a more complete discussion of WiSAMS.


Stillwater Bridge

To date, the only bridge funded through the MIB program has been the Stillwater Bridge (also called the St. Croix Crossing) carrying STH 64 over the St. Croix River between Wisconsin and Minnesota in northwest Wisconsin. The only HCSB project funded to date has been the Hoan Bridge, carrying IH 794 over the Milwaukee harbor. Both bridge projects were on the NHS and work on them is complete.

WisDOT's TAMP covers state fiscal years 2023 through 2032. Two significant bridge replacement projects, the Blatnik and Lake Interchange Freeway Bridges, are currently under study and may need to be funded by the MIB and HCSB programs within this time-period. Program eligibility will depend on the combined cost of the improvements required to the bridges and their approaches. Both projects are located on the NHS.


Blatnik Bridge

The Blatnik Bridge carries USH 53 and IH 535 over the St. Louis River between Wisconsin and Minnesota in Duluth/Superior. Options for replacement of the Blatnik are currently under study through a joint effort led by Minnesota DOT (MnDOT). The preliminary engineering estimate for the Wisconsin portion of the bridge replacement will likely qualify the project for the MIB program. Development, screening, and evaluation of alternatives is currently underway. The screening and evaluation process will identify a more specific scope for the project, clarify the timeline of the main span replacement and evaluate the need for approach work.

The Lake Interchange Freeway carries IH 794 between the Marquette Interchange and the Hoan Bridge in Milwaukee and options for replacement of the Lake Interchange are currently under study. The preliminary engineering estimate for the bridge replacement will likely qualify the project for the HCSB program.

Given the current level of uncertainty surrounding the estimated costs and timing of both bridge replacement projects, the estimated costs for replacing the Blatnik and Lake Interchange bridges are not included as part of the NHS investment plan presented in Chapter 7. As project development efforts continue, and these uncertainties are resolved, WisDOT will work with the Governor and Legislature to ensure these important projects are appropriately funded. Future TAMP updates will include costs and schedule information for these projects when appropriate.

Chapter 6 Highway Maintenance and Operations Program

The Maintenance Program Impacting the WisDOT-Owned Portion of the National Highway System

Overview

The WisDOT Highway M&O Program plays a critical role in performing early-life pavement preservation, late-life pavement preservation, and serviceability improvement treatments by appropriate use of crack filling, patching, chip sealing, rut-filling, and short overlays. These activities fit well with the workforce capacity and capabilities of the County Highway Departments, and WisDOT contracts with the counties to perform maintenance activities on the WisDOT-owned highway system consistent with the mission of the M&O Program. State maintenance engineers work cooperatively with the county highway departments to direct the state highway maintenance activities. County personnel familiar with the condition of the STH system can be a valuable resource throughout the pavement assessment process.

Investments in pavement health made by the Highway Maintenance Program and the Highway Improvement Program must harmonize with each other. This is accomplished by ensuring early and late-life maintenance treatments are well-coordinated with a strategic combination of low-cost and best-value improvements in WisDOT's 6-year improvement program. Well-timed maintenance activities complement WisDOT's comprehensive pavement strategy.

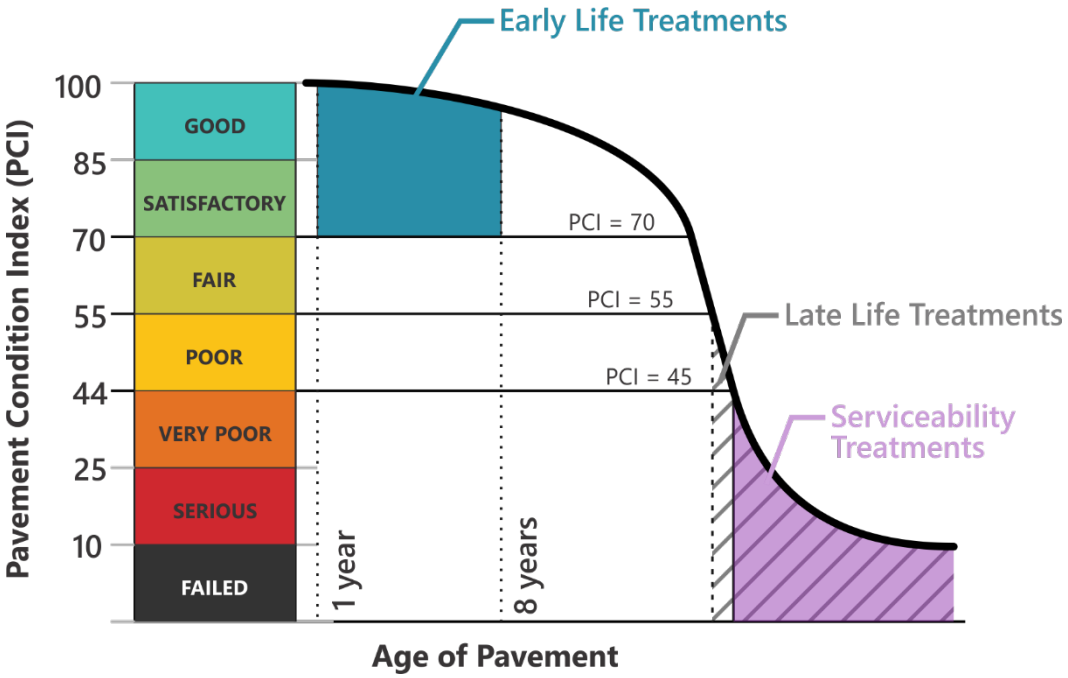
Pavement Maintenance by WisDOT Highway Maintenance Program

WisDOT M&O Program can positively affect statewide system pavement health in three key areas:

- **Early-Life Treatment:** Treatments such as crack fills and chip seals can be cost beneficial, life extending pavement treatments when applied early in the life of pavements with the appropriate deficiencies.
- **Late-Life Treatment:** Treatments such as chip seals with crack fills or patching with chip seals can also provide cost beneficial, late-life extensions on reasonably performing pavement where age-related distresses are occurring, but which are not leading to any serviceability issues.
- **Serviceability Treatments:** Serviceability issues are when distresses can negatively affect normal driving conditions and begin to create risk of potential safety concerns from handling or hydroplaning. Examples would be short segments or spot locations of rutting, potholes or severe tenting. Serviceability issues have higher probability to occur on pavement segments with a PCI below 45 with a segment IRI above 170 inch/mile or on pavement segments that have significant levels of medium or high severity rutting (greater than 4%).

Figure 6-1 shows how the relationship of pavement condition and age can be depicted graphically to help identify where appropriate Early-Life, Late-Life or Serviceability treatments would typically occur.

Figure 6-1: PCI and Pavement Age



Highway Maintenance Programs

There are two main sub-programs within the M&O Program used to fund the various early-life, late-life, and serviceability treatments. These sub-programs are Routine Maintenance Agreements (RMA) and Performance based Maintenance (PbM).

The RMA program is primarily associated with late-life and serviceability treatments and involves the daily or periodic repair and upkeep of the STH system. Most of these activities are implemented using a work force and equipment made available through Wisconsin's counties. Counties are reimbursed for their work based on their labor and machinery costs and any materials supplied. A partial list of routine maintenance activities includes the following: roadway surface, base, and shoulder repair; minor bridge repair; drainage and culvert repair; repair of guard rails, traffic signs and other safety measures; and the maintenance of rest areas, information centers, waysides and similar roadside facilities.

Besides funding routine maintenance activities, the RMA program also funds winter maintenance (plowing and deicing) and traffic operations. Traffic operations activities are designed to improve safety, manage congestion, mitigate delays, enable emergency response, warn, and guide motorists, and optimize the operational performance of the STH system. The operation and maintenance of traffic control and ITS are integral to traffic operations.

The PbM program primarily funds early-life and some late-life treatments. These projects are primarily based off asphalt pavement projects completed within the 6-Year Improvement Program. These treatments include:

- Crack filling
- Asphalt patching
- Chip seals

Candidate pavement maintenance projects under the PbM program are developed by the WisDOT's DTSD Regions and submitted to the Bureau of Highway Maintenance (BHM) according to annual program submittal

deadlines established by BHM. Candidate pavement maintenance projects must include the following information for approval consideration.

- The pavement design or typical section of the most recent paving project on the candidate segment.
- The pavement and maintenance history prior to the last improvement treatment.
- The treatment type being proposed and its relevance to the current deficiencies.
- Analysis and recommendation of how these deficiencies meet the need criteria for the eligible treatment types.
- Identification of any Improvement Projects on the segment and evidence the proposed work does not conflict with upcoming Improvement Program work.

Coordination with Counties for Highway Maintenance

BHM holds monthly meetings with DTSD Region Chief Maintenance Engineers, Region Maintenance Supervisors, the Wisconsin County Highway Association, and other stakeholders. These meetings are used to guide policy decisions and provide updates to the DTSD Regions and counties. Also, it provides an open and active line of communication about issues that are being seen statewide that may need to be addressed with updated policy guidelines.

DTSD Region maintenance staff engage with county highway departments on a daily basis to coordinate ongoing maintenance activities. Each county highway department has a commissioner and patrol superintendent whose job in part is to coordinate activities with WisDOT. Each DTSD Region has supervisors, engineers, and technicians whose role is to guide the maintenance activities that the counties perform. Each county has a RMA that contractually outlines the funding and function of each category of maintenance activity (pavement maintenance, structures maintenance, roadside maintenance, vegetation management, winter maintenance, etc.). WisDOT staff coordinate work on a daily and weekly basis and then review invoices monthly to validate the expenditures.

Bridge Maintenance Activities

Bridge maintenance funded through the M&O Program are discussed in Chapter 6 in the Bridge Project Scoping section. Maintenance, as well as improvement activities, are detailed in Chapters 42 and 43 of the WisDOT bridge manual.

Maintenance for Locally-owned portions of the NHS

Maintenance for the locally-owned portions of the NHS is the responsibility of the local municipality for pavement and bridge preservation operations. Chapter 9 discusses Wisconsin's locally-owned NHS and provides a summary of the programs that support the local maintenance, operations, and improvements.

Funding for the Highway Maintenance Programs

M&O has a total yearly budget as defined in Table 2-1. WisDOT invests an average of $180 million a year in state highway maintenance related activities. This includes the routine maintenance for pavement and bridges, plowing and salting and mowing through the RMA and PbM programs. Preventive maintenance activities that provide a four-year service life extension are also funded out of the highway improvement programs and are let to contract. This is consistent with the WisDOT and FHWA Preventive Maintenance Agreement.

The RMA budget in each county is based on the WisDOT-owned mileage they are tasked with maintaining. The RMA program funds a variety of activities including road and bridge maintenance and non-roadway items, such as winter related activities, mowing, and roadside facilities. Road and bridge activities make up approximately 30% of

all RMA program funding with the rest going to non-roadway activities. The largest expense is winter related activities at approximately 40% and all other items utilizing the remaining 30% of the RMA budget.

The PbM Program is variable year to year, but typically comprises 8-10% of the $180 million maintenance budget on an annual basis. The work being done through this program is all road and bridge maintenance activities. These projects prioritize performance-based maintenance opportunities to lower life cycles costs of pavement sections. An analysis was completed to include costs from this program into the funds being counted towards NHS routes.

The other portion of the M&O budget supports statewide operations activities such as traffic monitoring, salt purchases, and staffing. Salt purchasing makes up the largest portion of this budget and is coordinated through a centrally managed contract. The salt inventories are closely monitored and managed over the course of an entire season. DTSD Region staff routinely inspect salt shed inventories and conditions and usage is managed and monitored through specific use policies that prescribe standards of practice that help assure effectiveness for a winter event scenario yet manage the reasonableness of overall use.

The maintenance programs do not track their spending by NHS and Non-NHS routes, but the majority of NHS routes are considered "24-hour coverage" routes for the level of service that they received from the maintenance programs. WisDOT calculated each county's NHS vs Non-NHS lane mileage and used that percentage of the County's RMA budget to assume what amount of funds that are going towards NHS routes.

WisDOT's strong commitment to and support for maintenance activities as part of its asset management strategy were demonstrated by a 12% increase in maintenance funding in the 2017-2019 Biennial Budget. That funding level continued in Governor Evers' 2019-2021 and 2021-2023 Biennial Budget, and WisDOT assumes a similar funding level throughout the 10-year analysis period of this TAMP.

Chapter 7 The TAMP for Wisconsin's NHS

The Transportation Asset Management Plan for the Wisconsin's National Highway System

Overview

The WisDOT TAMP summarizes the investments the agency intends to implement on Wisconsin's NHS during the 10-year period beginning in state fiscal year 2023 and extending through 2032. WisDOT's STH system investments over this period are consistent with the program development processes discussed in Chapter 3 through Chapter 5 and with WisDOT's goals for safe, reliable and efficient travel, resilient infrastructure in a state of good repair, and an optimal mix of pavement and bridge conditions on the STH system. The Wisconsin's NHS is a high priority portion of the total system, and WisDOT's management systems are used to estimate the pavement and bridge conditions that will exist on the Wisconsin's NHS after the planned TAMP investments are implemented though state fiscal year 2032.

Expected Investments in Wisconsin's NHS

The investments in Table 7-1 reflect WisDOT's currently scheduled state highway improvement program for Majors and SEF, MIB and HCSB, SHR, Maintenance, and State-Let Local NHS Projects. All projects in the currently scheduled Backbone program are reflected in Table 7-1, along with 3R and Local NHS projects scheduled in 2023 through 2028. Given the current level of uncertainty surrounding the estimated costs and timing, the Blatnik Bridge project, IH 794 Lake Interchange and the I-94 East-West project are not included as part of the NHS investment plan. The expected level of SHR investment, shown in Table 2-1, in the NHS reflects the increased SHR funding provided by Governor Evers' Biennial Budgets in 2019-2021 and 2021-2023 and WisDOT's SHR Investment Strategy. SHR funding also recently increased due to the Infrastructure Investment and Jobs Act / Bi-partisan Infrastructure Law which was enacted in November 2021. A large portion of this funding increase from the BIL was dedicated to the Local Programs, as described in Chapter 9.

The investments in Table 7-1 are expressed in year of expenditure dollars (YOE$) and include estimated engineering. Estimated YOE$ are obtained by applying a multiplier for construction inflation to current market prices. Using the Chained Price Index for State and Local Gross Investment in Highways and Streets, provided by IHS Markit (formerly IHS Global Insight), WisDOT calculates inflation factors for highway facility construction costs. The forecasted inflation factors are shown in Table 7-2. WisDOT expects its NHS investment plan to result in spending (obligating) $11.5 billion (year of expenditure dollars) on the WisDOT-owned NHS during state fiscal years 2023 through 2032.

Consistent with 23 CFR Part 667 and Part 515, WisDOT is committed to identifying and implementing cost-effective design elements as part of projects on NHS roadway segments that have required repeated repair and reconstruction due to emergency events. Currently there are no such segments on the WisDOT-owned NHS.

The Pavement and Bridge Condition Benefits of the TAMP on Wisconsin's NHS

Without the NHS investments shown in Table 7-1, the pavements and bridges on the NHS will deteriorate over time due to traffic, weather, and other factors. WisDOT's pavement and bridge management systems predict that the percentage of "poor" NHS lane miles would triple, and the percentage of "poor" NHS bridge deck area would increase by approximately five times if all pavement and bridge investments were suspended through state fiscal year 2032. The investment strategies contained in this TAMP play an essential role in avoiding these unsatisfactory results, just as WisDOT's past policies and investment strategies have been essential to the quality NHS pavement and bridge conditions seen today.

Table 7-1: WisDOT's Investment Plan for Wisconsin's NHS (Millions of YOE$)

State Fiscal Years 2023-2027

FHWA Work Type	2023	2024	2025	2026	2027
Maintenance	$94.0	$95.9	$96.0	$97.9	$98.0
Preservation	$132.1	$177.7	$199.6	$106.9	$176.2
Rehabilitation	$492.7	$415.7	$484.7	$474.3	$490.2
Reconstruction	$345.9	$368.5	$302.8	$395.0	$416.4
New Construction	$10.9	$0.0	$1.7	$2.7	$0.0
Total NHS	$1,075.5	$1,057.7	$1,084.7	$1,076.8	$1,180.8

State Fiscal Years 2028-2032

FHWA Work Type	2028	2029	2030	2031	2032
Maintenance	$99.9	$100.0	$102.0	$102.1	$104.1
Preservation	$139.7	$147.8	$148.6	$144.3	$164.9
Rehabilitation	$545.2	$491.4	$494.4	$481.5	$547.5
Reconstruction	$387.5	$450.6	$459.7	$467.8	$482.0
New Construction	$2.7	$0.0	$0.0	$0.0	$0.0
Total NHS	$1,175.0	$1,189.8	$1,204.6	$1,195.7	$1,298.6

Table 7-1 incorporates the following assumptions regarding the level of funding being committed for the NHS:

- SFY '23 – '28 accounts for projects on the NHS from WisDOT's Six Year Highway Improvement Program and enumerated Majors and SE Mega projects that are on the NHS.
- SFY '29 – '32 utilizes modeled projects for the NHS and an assumed funding levels based off of historic data trends.
- Future TAMP updates will include costs and schedule information for IH 94 East-West, Blatnik Bridge and the IH 794 Lake Interchange when appropriate.

WisDOT uses the IHS Markit Chained Price Index for State and Local Gross Investment in Highways and Streets to calculate inflation factors for highway facility construction costs. IHS Markit (an economic consulting firm) creates a 30-year economic forecast for the index using econometric models and the department uses their forecasts to calculate inflation factors for highway facility construction costs. The inflation values derived from these forecasts are shown in Table 7-2.

Table 7-2: Forecast of Highway Construction Cost Inflation from IHS Markit By State Fiscal Year

2024	2025	2026	2027	2028	2029	2030	2031	2032
3.88%	3.13%	3.03%	3.14%	3.07%	3.14%	3.16%	3.14%	3.27%

Source: IHS Markit May 2022, 30-Year Focus-Trend Forecast (2nd Q.)

Table 7-3 compares WisDOT's two and four-year NHS pavement and bridge condition targets with estimated conditions post-2024 and post-2026. Estimated future conditions were developed using WisDOT's management systems and assume the NHS investments summarized in Table 7-1 are implemented. Expected NHS pavement and bridge conditions are consistent with WisDOT's targets in both time periods.

Table 7-3: The Impact of the TAMP on Pavement and Bridge Conditions on Wisconsin's NHS

	Condition Targets		HPMS and NBI Conditions Expected to Meet Targets [1]	
	% Good	% Poor	% Good	% Poor
Interstate Pavements	≥ 60%	≤ 4%	Yes	Yes
Non-Interstate NHS Pavements	≥ 30%	≤ 10%	Yes	Yes
All NHS Bridges	≥ 49% (2024) ≥ 48% (2026)	≤ 3%	Yes	Yes

[1] *HPMS and NBI are both are national databases maintained by FHWA using data provided by state transportation agencies.*

Chapter 8 Relationship of the TAMP, PEM, and STIP

The Relationship Between the Transportation Asset Management Plan, Program Effectiveness Measures and the Statewide Transportation Improvement Program

Overview

WisDOT's optimal investment strategy for the SHR program was discussed in detail in Chapter 3. Simply put, the strategy is designed to allocate SHR funding to the "right" place, at the "right" time, and for the "right" type of improvement. To ensure whether WisDOT's decentralized management of its 3R investment strategy is being effectively implemented, WisDOT created a set of Program Effectiveness Measures (PEM). The PEM process captures whether the 3R Program funded by each DTSD Region is reasonably consistent with WisDOT's SHR investment strategy, and by extension, with the TAMP.

Through the concept of "reasonable consistency", the PEM process balances WisDOT's commitment to data-driven decision-making with the reality that all data and management systems are imperfect and often need to be supplemented with information made available only through project-level design engineering conducted by DTSD Region staff. The PEM process also provides a mechanism for identifying the need for enhancements in existing data and management systems. In this way, the process supports WisDOT's commitment to the effective stewardship of SHR resources.

The STIP is a federally required listing of capital and non-capital highway and transit projects that are federally funded or considered regionally significant in both urban and rural areas. The projects in the STIP must demonstrate fiscal constraint or show that enough federal funding is expected to be reasonably available to cover project costs. The STIP is maintained in consultation with Metropolitan Planning Organizations (MPOs), tribal governments, and other local officials, and is made available for public review. Both the STIP and the TAMP include the projects scheduled for future years in WisDOT's Financially Integrated Improvement Program (FIIPS), providing further assurance that the TAMP will be implemented over time.

The PEM Process and the TAMP

The PEM process is based on the roadway projects contained in the first six years of WisDOT's scheduled 3R Program. Bridge projects are not currently included in the PEM process, but the goal is to add them in the future. The question the PEM answers is whether the roadway projects in the 3R Program are "reasonably consistent" with the projects called for under WisDOT's optimal 3R investment strategy. Consistency encompasses three factors: location, timing and type of improvement.

The "hybrid" segmentation of the STH system in the MMS is derived by "overlapping" segments from the following corporate databases. More detail is provided in Appendix C Meta-Manager:

1. STH pavement conditions (PIF);
2. Scheduled STH highway and bridge projects (FIIPS); and
3. STH traffic counts (TRC).

In developing the optimal 3R investment strategy presented in Chapter 3, the project treatments (scopes) and priorities under alternative 3R investment strategies were evaluated using project level analysis segments. The starting and ending points (termini) of the project level analysis segments approximated historic STH improvement project termini. Identifying these termini was accomplished by aggregating adjacent PIF segments possessing the same type and age of pavement into a single project level analysis segment. The optimal 3R

investment strategy resulted in a set of priority work-types in specific locations during specific years of the TAMP analysis period (call them TAMP work-types). The optimal 3R investments occurring on the NHS were included as part of the SHR investments presented in Table 3-1 for state fiscal years 2023 through 2032.

The PEM process defines its analysis segments in a somewhat different manner called "PEM segments". First, a subset of PEM segments is defined using the starting and ending points of the actual projects making up each Region 3R Program. These segments will only cover the portion of the STH system being treated within the program. PEM segments covering the remainder of the STH system are defined using historic STH improvement project termini.

The PEM process then analyzes 3R improvement needs using the network of PEM segments and the data contained in the MMS. The process applies the same policies and financial constraints used in defining WisDOT's optimal 3R investment strategy, and results in a second set of priority 3R work-types consistent with WisDOT's optimal 3R investment strategy (known as PEM projects). Each of the PEM projects is tied to a specific location on the STH system and to a specific year.

By comparing the projects in the actual Region 3R Program to the PEM projects, the PEM process identifies where the two sets of projects agree and where they disagree. If there is complete agreement, the program of 3R projects is totally consistent with WisDOT's optimal 3R investment strategy.

As noted above, PEM projects are developed using data from the MMS. Although this is the best set of data available for consistent policy analyses, more information needs to be considered when programming and designing projects in the field. Recognizing this, the PEM process does not expect 100% consistency between actual 3R projects and simulated PEM projects. For work-type and timing, the process determines whether the two sets of projects are "reasonably consistent." For project location, the PEM process uses a more rigorous standard of consistency.

The first step in determining reasonable consistency between actual 3R and PEM projects assigns scores between 1 and 6 to specific work-types: the higher the score, the more extensive the work. Scores are assigned to actual and simulated work occurring on PEM segments. The second step calculates the difference between the two scores. A positive difference indicates the 3R work is more extensive than the PEM work-type. A negative difference implies the opposite. If the difference is between -1 and 1, the actual 3R work-type is considered "reasonably consistent" with the optimal 3R investment strategy (i.e. the PEM work-type).

Reasonable consistency in timing is determined by calculating the difference between the year when the 3R project is scheduled to occur and the year when a PEM project is called for. A negative difference (2020 - 2022 = -2) indicates the 3R project is "early" (2020 instead of 2022). For pavement preservation work, a difference between -3 and 3 years implies "reasonably consistent" timing. For other work-types, the standard for "reasonable consistency" is a difference of between -4 and 4 years.

The PEM process expects actual 3R projects to be scheduled in areas where a PEM project is prioritized for improvement following WisDOT's optimal SHR investment policies and consistent with annual 3R funding.

Standards have been set to rate 3R Program effectiveness as either "poor", "acceptable" or "good" in terms of location, work-type and timing. The standards are as follows:

1. Location Measure
    a. Poor – 0 to 64% of actual 3R $ in locations with improvement need
    b. Acceptable – 65 to 79% of actual 3R $ in locations with improvement need
    c. Good – 80 to 100% of actual 3R $ in locations with improvement need;

2. Work-Type (Scope) Measure
    a. Poor – 0 to 44% of actual 3R $ on a "reasonably consistent" scope
    b. Acceptable – 45 to 64% of actual 3R $ on a "reasonably consistent" scope
    c. Good – 65 to 100% of actual 3R $ on a "reasonably consistent" scope; and
3. Timing Measure
    a. Poor – 0 to 44% of actual 3R $ at a "reasonably consistent" time
    b. Acceptable – 45 to 64% of actual 3R $ at a "reasonably consistent" time
    c. Good – 65 to 100% of actual 3R $ at a "reasonably consistent" time.

The resulting percentages are used to evaluate the performance of the Region 3R Program, both statewide and by DTSD Region. The results are reported as part of WisDOT's MAPSS Performance Improvement Program Scorecard. Each DTSD Region is held accountable for their 3R Program decisions. Program performance categorized as "poor" or marginally "acceptable" on any measure triggers a review of the reasons for this result. Information from the review may identify 3R Program adjustments required to improve performance. It can also indicate where enhancements are needed to the data, management systems and analysis tools used within the MMS, as shown on the PEM within MAPSS.

WisDOT's goal is for each DTSD Region to maintain all three of its PEM percentages in the "good" category. Specific goals are 80% for the location measure, 65% for work-type, and 65% for timing. These goals reflect WisDOT's commitment to implementing the optimal 3R investment strategy, a key component of the TAMP. The latest reported PEM results for 2021, both statewide and by DTSD Region, are shown in Table 8-1. The information demonstrates that WisDOT is meeting its statewide goals for the PEM, although individual Regions vary in their relative performance. As WisDOT becomes more proficient in implementing its optimal SHR investment strategies, the PEM scores in Table 8-1 are expected to improve.

Table 8-1: 3R Program Performance by DTSD Region – 2021

DTSD Region	Location Measure	Work-Type Measure	Timing Measure
North Central	Good (92%)	Good (94%)	Acceptable (64%)
Northeast	Good (81%)	Good (100%)	Good (65%)
Northwest	Good (90%)	Good (96%)	Good (66%)
Southeast	Good (88%)	Good (95%)	Good (75%)
Southwest	Good (92%)	Good (89%)	Good (76%)
Statewide 3R	Good (89%)	Good (93%)	Good (71%)
Statewide Goal	80%	65%	65%

Source: MAPSS

WisDOT's ongoing commitment to asset management principles, process improvement and performance measures is further underscored by the creation of DTIM's Office of Asset Management and Performance Management (OAPM). OAPM was created to ensure WisDOT's asset management initiatives are fully implemented

at the project level in order to maximize the benefits of WisDOT's ongoing investments in the STH system. OAPM spearheaded significant changes to WisDOT's FDM, standardizing the use of asset management protocols in project programming. These changes include inserting performance based practical design concepts into FDM protocols for standard highway improvements, pavement preservation treatments and safety projects. OAPM also revised WisDOT's Highway Maintenance Manual (HMM) to directly link the decision logic for pavement maintenance activities with WisDOT's SHR investment strategy. This ensures strategic use of highway maintenance dollars as an integral part of WisDOT's effort to optimize pavement health.

In addition to standardizing best practices in the FDM and HMM, OAPM is focused on ongoing tool development, education, and training to increase knowledge and instill asset management best practices into the fabric of WisDOT's project development culture. Through the development of asset-based resource models and the analysis of project delivery processes and costs, OAPM has refocused DTSD staff resourcing efforts to ensure use of internal and external resources align with effective system asset management.

In short, OAPM provides stewardship and oversight for streamlining project level asset management implementation using asset management programming concepts, practical design, and performance measures related to project development and design.

The STIP Process and the TAMP

The STIP includes both capital and non-capital highway and transit projects that are federally funded or considered regionally significant in both urban and rural areas. There is a direct relationship between the TAMP and the STIP, ensuring that the TAMP will be implemented as projects are programmed and constructed.

The list of state highway improvement programs was discussed in Chapter 2 and includes SHR, Majors, SEF, and two special bridge programs. For Majors, SEF, the special bridge programs, SHR Large Bridge, and the Backbone Program within SHR, projects in WisDOT's STIP are selected based on the TAMP investment strategies described in Chapter 3 through Chapter 5. For the 3R Program, the PEM process ensures the WisDOT's optimal 3R investment strategies are reflected in the scheduled program of projects, which are included in the STIP.

Total federal funding represented by the projects in the STIP is constrained by expected federal funding in each federal program area. Federal programs and funding levels are authorized by law and can change over time. Typically, federal programs are defined in a five-year "reauthorization" bill, which also authorizes the level of federal funding over the period.

WisDOT's Biennial Budget authorizes spending specific annual amounts of state, federal, local, and bond funds on projects financed through specific state highway appropriations (state programs). The Biennial Budget does not specify the federal program(s) to be used as the source of the federal funds authorized for each state appropriation. Over the four-year period covered by the STIP, WisDOT assumes future Biennial Budgets will provide funding at currently approved levels.

Federal highway programs often focus on either certain highway systems (e.g., the NHS) or certain types of work (e.g., Bridge Replacement and Rehabilitation). The Program Finance Section within DTIM assigns state and federal funding from specific federal programs to projects scheduled across the state highway appropriations authorized by WisDOT's Biennial Budget. Projects must meet the eligibility requirements for the federal program(s) providing funds, and total federal funding for the projects financed from a given federal program cannot exceed expected federal funding authority for that program. In addition, the total federal funding assigned to projects in a state program (e.g., SHR) cannot exceed the amount of federal funding authorized for that program in WisDOT's Biennial Budget. Biennial Budget limitations on other types of funding are also observed.

There are many stages, or lifecycles, involved in the development and implementation of every highway and bridge improvement project. Within WisDOT's FIIPS, projects early in the development process are assigned to

FIIPS Life Cycle 00. Projects are assigned to FIIPS Life Cycle 10 when their planning level scope, schedule, and budget have been identified. Although it may be some time before projects at FIIPS Life Cycle 10 can be constructed, these projects are included in the STIP if the staging of the project calls for funds to be obligated within the four-years covered by the STIP.

Federal regulations require WisDOT to develop the STIP cooperatively with local officials and tribal governments, while providing effective opportunities for public comment. The WisDOT Coordination Document provides additional information.

The project development process is ongoing and dynamic. To stay in sync with the State Highway Improvement Program, the STIP is updated regularly. Small changes are processed as administrative modifications, and larger changes are processed as amendments requiring public involvement and a showing that the STIP remains consistent with expected funding (or "fiscally constrained"). For more information, please see WisDOT's STIP webpage.

Chapter 9 Local Facilities and WisDOT Program Support

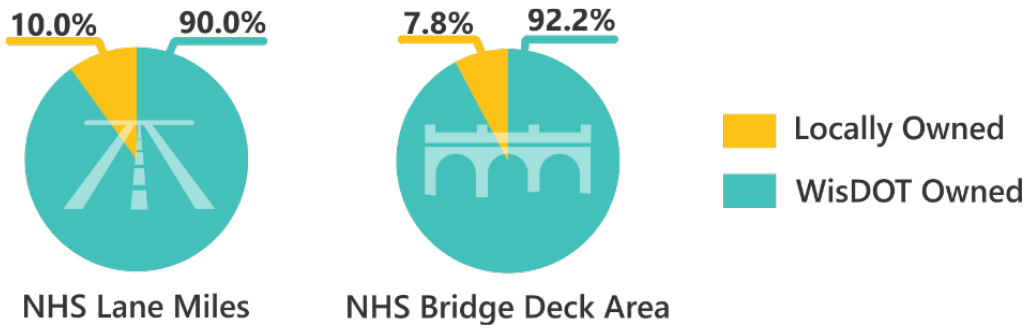
Pavement and Bridge Conditions on Wisconsin's Locally-owned National Highway System and WisDOT Programs to Support Effective Asset Management at the Local Level

Overview

WisDOT owns and manages a substantial majority of the NHS pavements and bridges in Wisconsin. As shown in Figure 9-1, 90.0% of NHS lane miles in Wisconsin are WisDOT-owned, with the rest being owned by local governments. 91.3% of the NHS bridges and 92.2% of the NHS bridge deck area in Wisconsin are also owned by WisDOT, with the remainder being locally-owned. This chapter will discuss the current condition of locally-owned NHS pavements and bridges in Wisconsin and WisDOT's efforts to help local governments effectively implement cost-effective NHS investment strategies.

WisDOT is committed to helping local governments manage their highway and bridge infrastructure using sound asset management principles and will continue efforts to make high-quality information from pavement and bridge management systems available to all local governments in Wisconsin. The most recent Biennial Budget and the federal Infrastructure Investment and Jobs Act / Bi-partisan Infrastructure Law increased the funding available to local governments for their highway programs, and WisDOT has also implemented ways to increase funding flexibility and reduce project delivery costs for local governments. Recognizing the pervasive needs on the local system, NHS and beyond, WisDOT directed 70%, or $159M out of $228M, of the additional FFY '22 BIL funding to Local Programs, primarily directed to local roads and bridges.

Figure 9-1: WisDOT-Owned vs. Locally-owned NHS Pavement Lane Miles and Bridge Deck Area Within Wisconsin



An Inventory of the Pavements and Bridges on the Locally-owned NHS

The local NHS in Wisconsin is composed of 648 center line miles of highway. 129 local governments contain some local NHS mileage, with 75 of those localities contain less than two miles of local NHS. Overall, 64% of local NHS roadway miles are in 11 localities having 10 miles or more. Six of these 11 localities are in the greater Milwaukee area and the remainder are in the Madison, Fox Cities and Green Bay areas.

Wisconsin's local NHS also contains 314 bridges, which are distributed across the state differently than roadway miles. While the Southeastern Wisconsin MPO contains 64% of the locally-owned NHS roadway miles, it contains 53% of the locally-owned bridges. Meanwhile, 47% of local NHS bridges are in other MPO's or non-MPO areas, compared with only 36% of the locally-owned NHS roadway miles.

Table 9-1 provides an inventory of the locally-owned NHS center line miles and bridges in Wisconsin.

Table 9-1: Inventory of Pavement Miles and Bridges on the Locally-owned NHS in Wisconsin

	Pavements [1]		Bridges [2]	
	Center Line Miles	Lane Miles	Bridges	Sq. Ft. of Bridge Deck (Millions)
Wisconsin's Locally-owned NHS	648	1874	314	3.4

[1] For divided highways, one center line mile equals two roadway miles. Roadway and center line miles are equal for undivided highways. The pavement data is for 2021.
[2] The bridge data is for 2021. Consistent with national definitions: a) only bridges more than 20 feet long (between abutments) are included in Table 9-1*, and b) culverts more than 20 feet in width (length in the direction of travel) are counted as bridges.*

The Condition of the Pavements and Bridges on the Locally-owned NHS

Table 9-2 summarizes the condition of Wisconsin's locally-owned NHS pavements and bridges using the most recently available PASER data for pavement and NBI data for bridges. The "fair and above" and "poor" percentages for bridges are based on inspections of all locally-owned NHS bridges, and demonstrate that NHS bridges are a priority at both the state and local level in Wisconsin.

Table 9-2: Condition of Locally-owned NHS Pavements and Bridges in Wisconsin

	Based on Lane Miles	
	% Fair & Above	% Poor
Wisconsin's Locally-owned NHS Pavements	94.6%	5.4%
	Based on Deck Area	
	% Fair & Above	% Poor
Wisconsin's Locally-owned NHS Bridges	97.6%	2.4%

The pavement and bridge conditions in this table reflect most recent inspection data.

As noted above, WisDOT is committed to supporting local pavement and bridge asset management and is working to improve the usefulness of the information and tools it provides to assist local governments. These efforts are directed at all local pavement and bridge infrastructure, not just the locally-owned NHS.

WisDOT Data Collection and Management Systems for Pavements and Bridges on the Locally-owned NHS

WisDOT manages bridge inspection data on all public use bridges in Wisconsin. Inspections occur on a minimum two-year cycle, regardless of ownership, as required by the National Bridge Inspection Standards (NBIS). This provides bridge inspection information of uniform quality on all NHS bridges in Wisconsin. Using this information, WisDOT can assess bridge conditions on the entire NHS using the condition metrics required by FHWA. Inspection data on local bridges is available to local governments through the Highway Structures Information System (HSIS).

WisDOT provides bridge asset management assistance to local governments by sharing recommended bridge treatments from the Wisconsin Structures Asset Management System (WiSAMS), as discussed in Appendix B .

Pavement condition information using the PASER system is collected on a two-year cycle by local governments for all locally-owned pavements and accessed within WISLR. To assist local governments in developing cost-effective pavement maintenance and improvement strategies using this information, WisDOT developed the WISLR Pavement Analysis Tool and provides training to local governments in its use.

WISLR data does not allow WisDOT to assess locally-owned NHS pavements using the condition metrics defined by FHWA. To fill this gap, WisDOT goes beyond WISLR and gathers the detailed information on pavement roughness, cracking, rutting and faulting required for the FHWA condition metric on locally-owned NHS pavements. WisDOT is sharing this information with local governments to supplement the information contained within WISLR.

WisDOT Coordination with Metropolitan Planning Organizations Regarding NHS Pavement and Bridge Performance

WisDOT coordinates with Wisconsin's 14 MPOs on a variety of highway and transit planning requirements through development of long-range transportation plans (LRTPs), Transportation Improvement Programs (TIPs), Unified Planning Work Programs (UPWPs), and federal performance measures. DTIM and DTSD Region Planning and Programming staff participate in the MPOs' Technical Advisory Committee (TAC) meetings and coordinate state, regional, and local project selection and delivery schedules. WisDOT meets with MPO staff at the quarterly Directors meeting which also includes participation from the Regional Planning Commissions (RPC), FHWA, and the Federal Transit Administration (FTA). Federal Transportation Performance Management (TPM) requirements, including pavement and bridge performance targets, have been a reoccurring topic on the Directors meeting agendas since TPM target setting requirements were codified in the FAST Act in 2015. WisDOT shares available performance measure data at the Metropolitan Planning Area (MPA) level with the MPOs. MPOs set performance targets for all federally required performance measures in their MPA in coordination with local officials and WisDOT. WisDOT will continue to leverage this critical partnership with the MPOs to ensure performance measures reflect current system performance and help guide investments and financial resources in efficient and effective program decision-making.

On an annual basis, WisDOT distributes PM2 Pavement data from the NHS in the form of GIS (geographic information system) shapefiles to Wisconsin's MPOs and the few RPCs that have requested them. WisDOT distributes the NHS PM2 Pavement data to the MPOs and RPCs for use with asset management decisions and target setting initiatives. The PM2 Pavement data contained in the shapefiles includes IRI, Rutting, Faulting, Cracking Percent, along with other relevant physical attributes, and is representative of the dataset that WisDOT submits annually to the FHWA for the HPMS program. To further assist MPOs and RPCs with their target setting initiatives, in 2022 WisDOT will begin including a "good", "fair", and "poor" rating at a roadway segment level based on FHWA's Transportation Performance Management thresholds.

WisDOT has also taken efforts to distribute pavement data to all local municipalities and counties that own and maintain any portion of the NHS. The same HPMS data, along with locally submitted WISLR data, was distributed in an easy to read excel format along with a questionnaire. From the results of that questionnaire, WisDOT was able to gather that while there are different approaches being taken all over the state, asset management principles are being implemented to provide maintenance, preservation, and rehabilitation projects at the local level.

WisDOT's Programs Providing Support for Local Highways and Bridges

WisDOT provides support for local pavement and bridge asset management through the provision of funding assistance for the maintenance and improvement of Wisconsin's local road system. Funding is provided through the Biennial Budget, and for a summary of WisDOT's local highway and bridge programs see WisDOT's Road and Bridge Assistance Programs.

The local road system plays an important role in supporting Wisconsin's economy and the mobility of its citizens. As such, WisDOT's funding increased markedly during the 2021-23 Biennial Budget. Funding for core local programs was also bolstered by the passage of the federal BIL in November 2021. Local pavement and bridge asset management is utilized in the following programs:

Local Road Improvement Program (LRIP) – LRIP is a program that assists local governments in improving seriously deteriorating county highways, town roads and city and village streets using state funds. The 2020-2021 and 2022-2023 program cycles both saw increased funding to the program due to the creation of the Local Roads Improvement Program-Supplement (LRIP-S). LRIP-S was a funding supplement to LRIP that began in the 2020-21 Wisconsin state biennium, which added an additional $90 million in discretionary funding to further assist local government in repairing their deteriorating roads. The LRIP-S funding supplement was continued in the 2021-23 biennial budget, which included a $100 million allocation. The 2021-2023 biennial budget also included an additional $25 million made available through the department's federal plan. Overall, LRIP increased roughly 189% from the 2017-2019 biennium to the 2021-2023 biennium.

General Transportation Aids (GTA) – GTA is a program that distributes $500 million annually to help local governments cover the costs of constructing, maintaining, and operating roads and streets also using state funds. This program increased by 10% during the 2019-2021 biennium. The budget further increased during the 2021-2023 biennium by an additional 4.6% starting with calendar year 2022 payments. The program also created a sum-certain appropriation up to $1,000,000 each year that provides adjusted payments to towns receiving mileage aid where costs are affected by the timing of when reimbursement payments (i.e., LRIP or Disaster Damage Aid reimbursements) are reported as revenue to compensate the town for the diminished payments.

Surface Transportation Program (STP) – STP is a program that allocates federal funds to complete a variety of improvements to federal-aid-eligible rural and urban highways, roads, and streets. The department was able to increase FFY 2022-2026 STP program funding by roughly 90%, to an annual amount of $127.2 million, due to the BIL. WisDOT implemented a federal BIL management plan and began to deliver federal funds for projects in FFY 2022.

Local Bridge – The Local Bridge Improvement Assistance Program helps rehabilitate and replace the most seriously deficient existing local bridges, using federal funds that share costs on a local match basis. Counties, cities, villages, and towns are eligible for rehabilitation funding on bridges with sufficiency ratings of 80 or less, and replacement funding on bridges with sufficiency ratings less than 50. WisDOT increased FFY 2022-2026 local bridge funding by roughly 106%, to an annual amount of approximately $88.6 million, leveraging additional funding made available through the BIL. WisDOT implemented a federal BIL management plan for the allocation of these additional funds in early 2022.

Congestion Mitigation and Air Quality Improvement Program (CMAQ) – The CMAQ program allocates federal funds to complete a variety of eligible project activities targeted at reducing criteria pollutant emissions within the surface transportation network of Wisconsin's identified air quality and non-attainment areas. These activities include both infrastructure and non-infrastructure improvements such as trail projects, alternative fuel vehicle acquisition/conversion, and traffic signalization improvements to help alleviate congestion on roadways. FFY 2022-2026 annual CMAQ funding increased roughly 40%, to an annual amount of $15 million. Projects were

awarded beginning in FFY 2022.

Although not targeted specifically to local NHS routes, WisDOT's increased funding support will allow local governments to better care for the roadways and bridges making up this important part of Wisconsin's overall highway network.

WisDOT Initiatives to Improve Local Program Flexibility and Reduce Costs

Wisconsin's local governments are responsible for prioritizing investments in Wisconsin's local road system using available state and federal funding.

STP funding amounts are based on population and WisDOT has implemented funding in the following categories:

- Rural roadways in the STP-Rural program
- STP-Urban (5k to 20k)
- STP-Urban (20k to 50k), and
- Large, urbanized area funding.

WisDOT has a new sub-program to fund projects on minor collectors and local streets called STP-Local. Up to 15% of the funds allocated to certain STP categories are used for functionally classified minor collectors and functionally classified local roads. In addition, the roadway must lie wholly outside of an urbanized area (i.e., the roadway must be in a rural or urban area less than 50,000 in population). STP-Local projects must be state-let and local improvement projects on connecting highways are not eligible for STP-Local funds.

Appendix A PMDSS

Pavement Management Decision Support System

Introduction and Overview

WisDOT places a high priority on data-driven pavement management. WisDOT's first pavement management system was developed in the late 1980's. Since that time, the data, functionality, and analytic capabilities of the system have continually improved. Today, the PMDSS is WisDOT's methodology for evaluating current and future pavement performance to identify cost-effective pavement treatment options. PMDSS relies on WisDOT's extensive history of high-quality data on pavement performance.

PMDSS is based on the PCI. PCI is part of a national standard (ASTM D6433) WisDOT uses to conduct visual surveys quantifying and classifying pavement distress. Currently all of WisDOT-owned pavement segments are being surveyed each year collecting data on pavement distresses, roughness, faulting and rutting.

Whenever pavement condition indicates a pavement segment needs attention, PMDSS identifies a range of pavement treatment options addressing its deficiencies. Treatments can range from routine pavement maintenance to complete roadway reconstruction. PMDSS estimates the cost of each treatment alternative and its ability to extend the service life of the pavement.

The "Best Value" pavement treatment is defined as the treatment alternative providing the longest extension in service life per dollar invested. In most situations, implementation of the "Best Value" alternative is consistent with the goal of maximizing the "health" of the WisDOT-owned highway system and maintaining pavements in a state of good repair. Budget constraints, however, can create situations where "Reduced Cost" treatments are an effective way to assist in maximizing system "health". PMDSS identifies "Reduced Cost" alternatives where appropriate. Given the importance of the NHS to the state and nation, "Best Value" treatments are selected to address the pavement needs on the WisDOT-owned NHS.

Moving beyond current conditions, PMDSS forecasts future pavement conditions year by year. The forecasts assume routine pavement maintenance continues to be performed consistent with past practice on each segment. Moving year by year through the forecast period, PMDSS reevaluates expected pavement conditions and revises pavement treatment recommendations as necessary. This process provides essential information to support the TAMP, other short-to-long range planning efforts, and the development of WisDOT's highway maintenance and improvement programs.

WisDOT certifies that PMDSS exceeds the minimum standards for developing and operating pavement management systems in 23 CFR Part 515, section 515.17.

PMDSS Pavement Condition Data

Current Pavement Condition Data, Collection and Evaluation

WisDOT maintains a staff of pavement inspection experts who collect and evaluate pavement distress information collected on an annual basis. This reflects the priority WisDOT places on pavement management and helps ensure timely, consistent, data collection and analysis. The WisDOT-owned highway system is divided into a series of pavement segments (nominally, one mile in length). In the case of divided highways, separate pavement segments are defined in both directions. Precise survey sections are selected within each pavement segment, and care is taken to ensure the survey sections are representative. Rutting and faulting measurements are continuous across the entire pavement segment (laser measured).

The pavement surveys are done using high resolution digital imagery. The stored images are carefully reviewed in

a laboratory environment where the distresses are classified by type, which is listed in the table below. Data on the severity (low, medium, high) and the extent (length or area) of each distress is also recorded. Appendix Table A-1 lists the types of distress evaluated by pavement type.

Appendix Table A-1: ASTM-D6433 Pavement Distress Items, by Pavement Type

Jointed Portland Cement Concrete Pavement	Asphaltic Concrete And Composite Pavement
1. Blowup/buckling	1. Alligator cracking
2. Corner breaks	2. Bleeding
3. Divided slabs	3. Block cracking
4. Durability (“D”) cracking	4. Bumps and sags
5. Faulting	5. Corrugation
6. Joint seal damage	6. Depression
7. Lane/shoulder drop off	7. Edge cracking
8. Linear cracking	8. Joint reflection cracking
9. Patching (large)	9. Lane/shoulder drop off
10. Patching (small)	10. Longitudinal and transverse cracking
11. Polished aggregate	11. Patching and utility cut patching
12. Pop outs	12. Polished aggregate
13. Pumping	13. Potholes
14. Punchouts	14. Railroad crossings
15. Railroad crossings	15. Rutting
16. Scaling, map cracking, and crazing	16. Shoving
17. Shrinkage cracks	17. Slippage cracking
18. Spalled corners	18. Swell
19. Spalled joints	19. Weathering and raveling

The pavement distress data in Appendix Table A-1 is supplemented with laser measured faulting and pavement roughness information (using the IRI) across the entire length of each pavement segment. The data is stored in the pavement information file (PIF). PMDSS combines the PIF data with information on the history of each segment and the functional classification of the roadway to evaluate the condition and integrity of the existing pavement structure and assess the effectiveness of potential pavement treatments.

While pavement data is routinely collected in the spring and summer months, a supplemental collection occurs late each calendar year to capture changes in pavement condition and IRI resulting from improvement projects completed earlier in the year. This ensures that PMDSS accurately captures and reflects field measured distress and IRI values for the entire STH system. PCI is derived from the measured severity and extent of each type of distress.

Forecasting Pavement Condition

PMDSS forecasts pavement conditions iteratively, year by year, beginning with the year following the most recent data collection. Using the rich set of pavement condition data stored in a PIF, WisDOT has developed models expressing the rate of deterioration in PCI and IRI as functions of pavement type and age. Generally, deterioration accelerates later in the life of a pavement. Future forecasts of PCI and IRI for each pavement segment are developed by estimating annual deterioration rates and applying them to the latest field measurements. The pavement distresses expected on each segment are forecast in a manner ensuring consistency with the PCI

projections. For each observed distress item, the projected increase in the extent of the distress is developed using an annual growth factor. Transition points between differing categories of distress severity are recognized as the projected extents reach thresholds appropriate for the differing distress types. Using historic data as a guide, new types of distress are introduced as relatively new pavements age over the forecast period.

In summary, the basic data elements used in PMDSS are the following:

- Pavement segment location;
- Functional classification;
- Pavement type;
- Number of overlays in place;
- Current and forecast values for roughness (IRI); and
- Current and forecast values for severity and extent (density) of each type of distress, including faulting for jointed Portland cement concrete (PCC) pavements and rutting for asphaltic concrete (AC) and composite pavements (CP).

The Range of Potential Pavement Treatments

As noted above, the types of distress data gathered differ between PCC and AC pavements. It is not surprising, therefore, that potential pavement treatments also differ by pavement type. PMDSS associates the severity and extent of a distress type with the treatment recommended to correct the problem. This is done for all the distresses exhibited on each pavement segment. For example, if a PCC pavement displays low severity durability cracking over 30% of its surface area, the recommended treatment would be spot repair. If the severity of the durability cracking were a degree higher (medium), and of the same extent, the recommended treatment would become a slab replacement. High severity durability cracking over 30% of the surface area would increase the recommended treatment still further, to a pavement replacement. Similar associations are made for all combination of distress, severity, and extent.

The associations made by PMDSS between specific pavement problems and recommended pavement treatments were developed using intensive data analysis supplemented by expert judgment and experience. The associations were thoroughly reviewed and confirmed by WisDOT engineering staff with extensive field experience. The potential pavement treatments considered by PMDSS are listed in Appendix Table A-2. Visual examples of pavements where PMDSS would call for certain treatment alternatives are shown in Appendix Table A-3 and Appendix Table A-4.

Appendix Table A-2: PMDSS Pavement Treatment Alternatives, by Pavement Type

Jointed Portland Cement Concrete Pavement	Asphaltic Concrete and Composite Pavement
1. Do nothing 2. Grind* 3. Spot repair* 4. Crack repair* 5. Patch* 6. Slab replacement* 7. Patch or slab replace plus an overlay 8. Pavement replacement (includes rubblization plus an overlay, and cracking and seating plus an overlay, as additional options) 9. Reconstruction	1. Do nothing 2. Crack seal* 3. Seal coat 4. Patch* 5. Mill (roughness issues)* 6. Overlay 7. Mill and overlay 8. Structural overlay 9. Patch and overlay (if over jointed concrete, then mill, patch and overlay) 10. Patch and structural overlay (if over jointed concrete, then mill, patch and structural overlay) 11. Pavement replacement 12. Reconstruction

* *Lower-level treatments are considered in combination with each other and with overlay and structural overlay treatments. There are 26 potential combination treatments for AC pavements and 36 for PCC treatments.*

Appendix Table A-3: Visual Examples of Treatments Needed on Portland Cement Concrete Pavements

Treatment Needed: Patch	Treatment Needed: Slab replacement
 designation: USH route: 151N county: COLUMBIA date: 07/07/2015 plm: 069.900 Lat: 43.34879169 Long: -89.03211358 Elev: 749.73 ft.	 designation: STH route: 019E county: DODGE date: 05/28/2015 plm: 054.607 Lat: 43.19770026 Long: -88.74744983 Elev: 733.52 ft.

Appendix Table A-3: Visual Examples of Treatments Needed on Portland Cement Concrete Pavements (continued)

Treatment Needed: Patch plus an overlay	Treatment Needed: Reconstruction
 designation: USH route: 053S county: WASHBURN date: 08/14/2013 plm: 069.433 Lat: 45.68190766 Long: -91.79942542 Elev: 1210.37 ft.	 designation: STH route: 011E county: RACINE date: 09/14/2015 plm: 049.600 Lat: 42.69717042 Long: -87.84754894 Elev: 595.38 ft.

Appendix Table A-4: Visual Examples of Treatments Needed on Asphaltic Concrete and Composite Pavements

Treatment Needed: Crack seal	Treatment Needed: Overlay
 designation: STH route: 032N county: MILWAUKEE date: 05/13/2014 plm: 025.922 Lat: 42.85163622 Long: -87.85345524 Elev: 583.81 ft.	 designation: STH route: 016W county: WAUKESHA date: 04/12/2016 plm: 007.670 Lat: 43.10978596 Long: -88.33639957 Elev: 815.28 ft.

Appendix Table A-4: Visual Examples of Treatments Needed on Asphaltic Concrete and Composite Pavements (continued)

Treatment Needed: Structural overlay	Treatment Needed: Reconstruction
	

Service Life Extensions Associated with Potential Pavement Treatments

The purpose of any pavement treatment is to extend the life of the pavement, where "life" is defined as the amount of time the pavement provides satisfactory service to the traveling public. PMDSS estimates the SLE made possible by each alternative pavement treatment. This information plays a critical role in developing pavement treatment recommendations. It also helps in defining whether the recommended treatment is appropriate for WisDOT's highway improvement program or routine maintenance.

The SLE of a potential pavement treatment relies on the concept of a "desired" minimum service level (DMSL) for pavements on the WisDOT-owned highway system. DMSL is expressed in terms of PCI and varies by the functional class of the roadway. The DMSL for Backbone highways and Non-Backbone Principal Arterials are set at PCIs of 70 and 65, respectively (100 reflects "like new" condition). The DMSL for highways functionally classified as Minor Arterial or below is set at a PCI of 60. In other words, the estimated SLE of a pavement treatment reflects WisDOT's goal for better pavement conditions on higher function, higher volume roadways.

To calculate the SLE of a potential pavement treatment, PMDSS begins by estimating the impact the treatment will have on the distresses of the pavement. Each combination of distress type, distress severity and distress extent impacts PCI through a unique "deduct" value (a positive number), with PCI being computed as 100 minus the maximum corrected deduct value, which is derived from individual "deduct" values for the distresses present. PMDSS estimates the reduction in "deduct" values caused by each potential treatment, and this reduction results in an increase in the post-treatment PCI for that alternative. Generally, the more substantial the treatment the greater the increase in PCI will be. Overlays and higher order treatments, for example, have a PCI of 100 immediately after implementation since they treat all types of distress, reducing the sum of the "deduct" values to 0.

Once a treatment is performed, the PCI of the pavement will begin to deteriorate. PMDSS estimates the rate of deterioration in PCI based on pavement type and pavement history. The SLE of each potential pavement treatment is the estimated number of years it will take for the expected post-treatment PCI to deteriorate to the DMSL for that pavement segment.

WisDOT Costs Associated with Potential Pavement Treatments

In 2022, WisDOT has improved its planning level cost model predictions from a static improvement cost per mile model to a more sophisticated machine learning algorithm to predict improvement costs. More precise planning level costs allow the department to more accurately predict project improvements resulting in a superior system health analysis.

The process for development of the cost model included using machine learning to analyze over 100 different variables that could impact the cost of an improvement project. That analysis identified 10 features that most accurately predicted the cost of an improvement project using a random forecast model. Those features included: project length, pavement thickness of treatment, type of improvement, average annual daily traffic, divided or undivided highway, number of lanes, location of improvement, signal density, posted speed and right shoulder type.

WisDOT will continue to update the model as new improvement projects are constructed. This will allow the department to stay up-to-date on market changes as new projects are awarded to contract.

Defining "Best Value" and "Reduced Cost" Pavement Treatments

PMDSS identifies both "Best Value" and "Reduced Cost" pavement treatments to support WisDOT's improvement program decision-making. If budget constraints did not exist, the long-term system "health" of the WisDOT highway system would be maximized by only selecting "Best Value" pavement treatments. However, with a constrained budget, adopting less extensive, and less costly, "Reduced Cost" pavement treatments in some circumstances, allows WisDOT's improvement budget to responsibly address more of the improvement needs that exist on the WisDOT-owned highway system.

PMDSS begins the process of identifying the "Best Value" and "Reduced Cost" treatments for each pavement segment by developing a list of potential treatment alternatives. The alternatives are developed by considering the severity and extent of individual distresses, one by one, and identifying the most appropriate treatment for each distress item. Pavement roughness is also considered. Following WisDOT policy, only treatments with an estimated SLE greater than four years are eligible for improvement program funding. By excluding treatments with an estimated SLE less than four years, PMDSS produces a list establishing a range of improvement alternatives (i.e. non-routine maintenance) for a given pavement segment.

As an example, assume an AC pavement segment has low severity alligator cracking over 3% of its surface area, low severity longitudinal and transverse cracking over 22% of its surface area and raveling affecting 50% of its surface. In this case, the list of treatment alternatives evaluated would include a seal coat for the raveling, an overlay for the longitudinal and transverse cracking, and a structural overlay for the alligator cracking.

In some cases, the list of alternatives for improvement program consideration is modified by the need for base patching, crack and joint repairs, and other routine maintenance type activities even though these lower-level treatments have SLE's of less than four years on their own. Assume, for example, that an AC pavement has a small amount of low severity alligator cracking (calling for patching) and extensive block cracking (calling for mill and overlay). In this example, the only treatment on the initial list of alternatives would be a mill and overlay. Patching would have been dropped since it has an SLE less than four years on its own. Still, addressing the need for patching prior to the mill and overlay would benefit future pavement performance, so PMDSS modifies the treatment on the final list to a patch, mill and overlay.

Once the range of the final treatment alternatives is set for each pavement segment, PMDSS estimates the cost and SLE of each treatment on the list. The "Best Value" pavement treatment is defined as the treatment alternative providing the longest SLE per dollar invested (i.e. the maximum (SLE/Cost)). The tentative "Reduced Cost"

treatment is defined as the alternative having the lowest dollar cost.

One of the goals of WisDOT's "optimal" SHR investment strategy is to be sure that smart, effective, pavement treatments are considered when a pavement requires extensive, and costly, treatment. To ensure this occurs, PMDSS re-evaluates the tentative "Reduced Cost" treatment when the "Best Value" treatment is equal to one of several specific alternatives. The combinations of "Best Value" and "Reduced Cost" treatments considered are shown in Appendix Table A-5. If the SLE conditions reflected in the column labeled the Final "Reduced Cost" Alternative are met, the treatment in that column becomes the recommended "Reduced Cost" treatment. If those SLE conditions do not hold, the final "Reduced Cost" treatment is set equal to the "Best Value" treatment to ensure limited improvement funds are used wisely.

There are cases where the "Best Value" and "Reduced Cost" treatments identified by PMDSS are the same. Sometimes a single treatment type satisfies both criteria. The most straightforward situation creating this outcome is when the distresses present on a pavement can only be addressed using a single type of treatment. An overlay may, for instance, be the only response PMDSS identifies as appropriate for some patterns of distress. In other situations, the specific combination of distresses increases the likelihood that the "Best Value" and "Reduced Cost" treatments will be the same even though more than one potential treatment is identified.

One example where this is likely to occur is with an AC pavement experiencing a minor amount of low severity alligator cracking and a moderate amount of low severity longitudinal and transverse cracking. In this situation, PMDSS will suggest two potential treatments. The first would be patching, and the second would be an overlay. Given the cost difference between these treatments, and WisDOT's experience regarding the SLE's that can be expected from them, patching will be identified as both the "Best Value" and "Reduced Cost" option because it has the lowest cost overall and the lower cost per year of SLE.

Once all "Reduced Cost" alternatives are finalized, both the "Best Value" and "Reduced Cost" treatments are input to the MMS to support WisDOT improvement programming decisions and guide the development of WisDOT's optimal SHR investment strategy.

Newer pavement segments may require only routine maintenance (or perhaps, no action at all) since pavement conditions have yet to deteriorate to the point where an improvement project (or preventive maintenance) is called for. In these cases, PMDSS information can be used to help guide decisions regarding WisDOT's routine maintenance program.

Appendix Table A-5: Criteria for the Re-Evaluation of "Best Value" and "Reduced Cost" Alternatives

Pavement Type	"Best Value" Treatment	Final "Reduced Cost" Alternative
Jointed Portland Cement Concrete Pavement	1. Pavement Replacement 2. Reconstruction	Patch, Repair and Overlay, if it provides an SLE greater than four years
	Patch, Repair and Overlay	Least expensive of the following if any provide an SLE greater than four years: 1. Patch 2. Spot Repair 3. Crack Repair

Asphaltic Concrete or Composite Pavement	1. Pavement Replacement 2. Reconstruction	Overlay, if it provides an SLE greater than four years
	1. Structural Overlay 2. Patch and Overlay 3. Patch and Structural Overlay	Overlay, if it provides an SLE greater than four years

Special PMDSS "Flags"

PMDSS produces two "flags" to assist in setting highway program priorities. The first programming flag is a "critical pavement" flag. In situations where the "Best Value" treatment is a pavement replacement or reconstruction, and the less extensive "Reduced Cost" alternative in Appendix Table A-5 does not provide an SLE of at least four years, PMDSS assigns a "critical pavement" flag to the pavement segment. The presence of this flag means the pavement replacement or reconstruction on the segment has high priority.

The second flag is a "pavement preservation" flag. The most cost-effective method for maintaining acceptable pavement performance over time is through early intervention, when distresses are minor, and the actions needed to address them are less expensive. PMDSS identifies pavement segments in this category and flags them as candidates for early intervention. Pavement segments qualifying for the "pavement preservation" flag have a PCI of 80 or more and the SLE's for lower-level pavement treatments, up to and including patch and overlay, are at least four years.

Lowered Threshold for the Desired Minimum Service Level

As described earlier, the SLE of a pavement treatment must be at least four years for it to be considered for inclusion in the improvement program (and the TAMP). In response to WisDOT's constrained funding environment, a lower threshold concept was developed to lower the DMSL used in computing SLE's in certain circumstances. A lower DMSL increases the SLE of a pavement treatment beyond what it would be using a higher DMSL.

The lower threshold concept is only considered on lower function roads (Minor Arterials and below) located off the NHS. These roadways typically have the lowest traffic volumes on the STH system. The lower threshold concept defines an "acceptable" as opposed to "desirable" service level for these roadways if certain conditions exist. Specifically, the lower threshold concept reduces the DMSL from a PCI of 60 to a PCI of 55 if the roadway is already functioning with a PCI below 55.

With a budget constraint, pavement treatments providing an SLE of at least four years using the lower threshold concept are an effective programming response on lower function roads. When lower threshold conditions apply, the "Reduced Cost" calculations within PMDSS are run using the lower threshold DMSL. If a potential pavement treatment provides an SLE of four years or more using the lower DMSL, PMDSS recommends it for consideration. This results in "acceptable" pavement performance on the roadway in question, while freeing budget dollars for use on other roadways that would otherwise not be improved.

Appendix B WiSAMS

Wisconsin Structures Asset Management System

Introduction and Overview

Since the 1980's, the data and analytic processes underlying WisDOT's bridge management efforts have continually improved. The Wisconsin Structures Asset Management System (WiSAMS) reflects WisDOT's latest policies for assessing bridge condition and recommending cost-effective treatments needed to maintain acceptable bridge conditions over time.

WiSAMS relies on an extensive set of bridge inventory and inspection data contained in WisDOT's HSIS. HSIS bridge inventory data describes the unique characteristics of each bridge on the STH system. Example inventory items include the date the bridge was constructed, its rehabilitation history and current load rating, the number of spans, as well as span length and deck width. The HSIS bridge inspection data collected by WisDOT covers the broad array of bridge elements necessary to assess detailed bridge conditions.

WiSAMS uses HSIS data to track bridge condition, perform analyses and create management reports for individual bridges and for the STH system. HSIS data is used to anticipate future bridge conditions and predict bridge maintenance, rehabilitation and replacement needs over time. The TAMP relies on this information to ensure NHS bridge needs are funded appropriately. The information also guides decisions on the specific bridge investments made through WisDOT's highway maintenance and improvement programs.

WisDOT certifies that WiSAMS exceeds the minimum standards for developing and operating bridge management systems in 23 CFR Part 515, section 515.17.

The HSIS Database

The HSIS database is maintained by DTSD and Bureau of Structures (BOS). BOS is responsible for the design, inspection, and maintenance of all 5,300+ STH bridges. The collection and storage of STH bridge information in the HSIS has evolved over time. Example HSIS inventory items include the following:

- Owner
- Municipality
- Original construction date
- Superstructure/Substructure type
- Number of spans
- Span length
- Deck width
- Feature carried (roadway ID)
- Feature under (roadway, waterway)
- Vertical clearance
- Average daily traffic
- Construction/rehabilitation history
- Design loading
- Load ratings (capacity measures)

HSIS inventory data is collected after the initial construction of a bridge and updated, as appropriate, after all rehabilitation or repair efforts. The inventory data collected goes beyond the requirements for the NBI, which is submitted to FHWA on an annual basis.

FHWA created NBIS during the 1970's in response to the collapse of the Silver Bridge on the Ohio-West Virginia border. The initial NBIS standards took effect in 1978 and were limited in scope. Inspectors were required to report bridge superstructure, substructure and deck condition using a 0-9 scale (0 = failed condition, 9 = excellent condition). Recent revisions to the NBIS require the collection of much more detailed data. WisDOT began

collecting more detailed data on select bridge elements beginning in the early-1990s, putting it ahead of the curve. WisDOT implemented detailed NBIS element-based bridge inspections in 2014, providing the sort of granular condition information needed to support detailed asset management efforts. Typically, bridge condition inspections occur every two years.

Due to long bridge service life, and the continual evolution of bridge inventory and inspection standards, WisDOT does not have a complete data record going back to the original construction of many STH bridges. HSIS inspection records typically go back to the mid-1990s, at best.

Early on, BOS utilized a mainframe database to store bridge inventory and inspection data. The ability to enter and access bridge data was limited and time-consuming. The internet made a truly connected and accessible database possible. BOS developed the HSIS to take advantage of these developments in the early 2000's and has continued to enhance the system to meet business needs. Notable features of the HSIS include the following:

- A web-based interface so HSIS is widely accessible internally and externally;
- Live updates, meaning new inventory information and new inspection data are available for immediate access;
- The ability for bridge inspectors to upload inspections directly to the HSIS site;
- Compatibility with multiple internet browsers and mobile devices (tablets, smartphones);
- The ability for the user to select parameters from drop-down menus and query information from the database;
- The presence of customized reports to meet business needs;
- A portal to access bridge plans and other contract design documents; and
- Compatibility with other applications used by WisDOT for easy transfer of data.

Creation of the HSIS was a necessary and critical step along WisDOT's bridge asset management path. HSIS gives BOS the capability to collect, store, and manipulate all the data necessary for asset management activities.

Early Bridge Management at WisDOT

Even before the development of HSIS, BOS understood the need for a bridge asset management system that can provide guidance on bridge maintenance, rehabilitation and replacement needs to WisDOT planning and programming engineers. The goal of a bridge asset management system is to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that achieve and sustain a desired state of good repair, at minimum practicable cost, over the lifecycle of the stock of bridge assets. In the late 1990s, BOS partnered with the BSHP in DTIM to provide six-year rehabilitation and replacement projections for every WisDOT-owned bridge in Wisconsin. There were obvious limitations: condition data was not as detailed as modern element-based inspection data, the equations used to extrapolate future deterioration were rudimentary, and the treatment recommendations were limited. The development of HSIS and the move to element-based bridge inspections presented an opportunity to develop a more robust bridge asset management process. To take advantage of the opportunity, BOS recognized that a rigorous set of bridge preservation and rehabilitation policies was required.

WisDOT BOS Bridge Preservation Policy Guide and WisDOT Bridge Manual Chapter 42 – Bridge Preservation

To develop the required set of bridge preservation and rehabilitation policies, BOS created the Bridge Management Next Generation (BMNG) team in 2011. The BMNG team represented a collaborative effort among members of the BOS Development and Maintenance sections and the bridge inspection program managers in each DTSD Region. The BMNG also incorporated input from WisDOT's FHWA liaison and an expert engineering consultant. The goals of the BMNG team included the following:

- Establish specific bridge preservation objectives;
- Establish performance measures for the objectives; and
- Identify the bridge preservation treatments (both the M&O and SHR funded treatments) that allow the objectives to be met and establish data-based criteria defining when each treatment is to be performed.

Completed in the summer of 2015, the BOS BPPG serves as the basis for optimal treatment decisions regarding STH bridges. The BPPG offers a statewide baseline for planning and scoping bridge preservation treatments over the lifecycle of each bridge. The goals of the WisDOT bridge preservation program include the following:

- Maintain bridges in a state of good repair using low-cost yet effective strategies;
- Implement timely preservation treatments on structurally sound bridges to promote optimal lifecycle costs, extend service life and lengthen the time between major rehabilitation and replacement activities;
- Limit adverse impacts to traffic operations and various affected stakeholders;
- Promote and support budgeting of preventive maintenance activities;
- Establish program performance goals and monitor progress toward meeting them; and
- Optimize the benefits and effectiveness of long-term maintenance investments in achieving a state of good repair for WisDOT's bridge inventory.

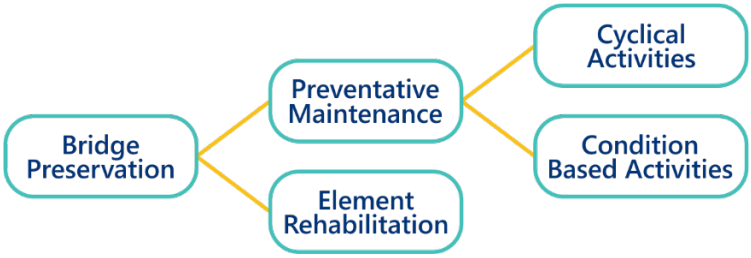
The BPPG became Chapter 42 – Bridge Preservation in the WisDOT Bridge Manual in 2019. This was done to facilitate updating the document regularly.

Effective bridge preservation requires the identification of actions (treatments) that accomplish the following:

- Prevent, delay or reduce the deterioration of bridges or bridge elements;
- Restore the functionality of existing bridges;
- Keep bridges in good condition; and
- Extend useful bridge life.

Bridge preservation actions encompass both maintenance and rehabilitation. They may also be either preventative in nature or condition driven. This breakdown is shown in Appendix Figure B-1.

Appendix Figure B-1: WisDOT Bridge Preservation Actions



The bridge preservation activities in Bridge Manual relate to bridge deck, superstructure and substructure elements. Appendix Table B-1, taken from the Bridge Manual, lists the most common preservation activities.

Appendix Table B-1: Common Bridge Preservation Activities

Bridge Component	Bridge Preservation Type	Activity Description	Preventive Maintenance Type	Action Frequency (Years)
All	Preventive Maintenance	Sweeping, power washing, cleaning	Cyclical	1-2
Deck	Preventive Maintenance	Deck washing	Cyclical	1
		Deck Sweeping		1
		Deck Sealing/Crack Sealing		3-5
		Thin polymer (Epoxy) overlays		7-15
		Drainage cleaning/repair	Condition Based	As needed
		Joint cleaning		
		Deck Patching		1- 2
		Chloride extraction		1 -2
		Asphalt overlay with membrane		5-15
		Polymer modified Asphalt overlay		10-15
		Joint seal replacement		10
		Drainage cleaning/repair		1
	Repair or Rehab Element	Rigid concrete overlays	Condition Based	As needed
		Structural reinforced concrete overlay		
		Deck joint replacement		
		Eliminate joints		

Appendix Table B-1: Common Bridge Preservation Activities (continued)

Bridge Component	Bridge Preservation Type	Activity Description	Preventive Maintenance Type	Action Frequency (Years)
Super	Preventive Maintenance	Bridge approach restoration	Cyclical	2
		Seat and beam ends washing		2
	Repair or Rehab Element	Bridge rail restoration	Condition Based	As needed
		Retrofit rail		
		Painting		
		Bearing restoration (replacement, cleaning, resetting)		
		Superstructure restoration		
		Pin and hanger replacement		
		Retrofit fracture critical members		
Sub	Preventive Maintenance	Substructure Restoration	Condition Based	As needed
		Scour Counter Measure		
		Channel Restoration		

Following the hierarchy shown in Appendix Figure B-1, Appendix Table B-1 lists preservation activities falling into either preventive maintenance or element rehabilitation for each major bridge component. Appendix Table B-1 also indicates whether the need for the activity is cyclical in nature or based on a condition survey. It also lists the frequencies with which cyclical and some condition-based activities are typically performed.

Saying the need for a bridge preservation activity is based on condition begs the question of what conditions are relevant. To address this, the Bridge Manual contains specific criteria establishing when various bridge elements are eligible for select condition-based (and some cyclical) preservation activities. These criteria are shown in Appendix Table B-2 and Appendix Table B-3.

The WiSAMS Bridge Management System

With the HSIS and BPPG in place, the next step in developing WisDOT's improved bridge management system was the creation of new bridge management software (WiSAMS). Developed in-house, WiSAMS relies on the bridge inventory and condition inspection data stored in the HSIS. WiSAMS represents a strategic, systematic process for operating, maintaining, and improving WisDOT's bridge assets, focusing on engineering and economic analyses based on quality information.

WiSAMS Background Logic

WiSAMS relies on a set of decision rules applied consistently to a set of HSIS data. Each decision rule takes the form of an "if-then" statement derived from the policies in the Bridge Manual. If the evaluation criteria contained in an "if-then" statement are met, a specific work action (bridge treatment) is assigned to the bridge. This ensures the bridge treatments recommended by WiSAMS will be consistent with Bridge Manual policy.

To illustrate, decision rules #1 and #10 are as follows:

WiSAMS Rule #1

- If the following criteria are met…
    - The current NBI rating for substructure is less than or equal to 3, and
    - The structure is scour critical,
- …then the recommended work action is "REPLACE STRUCTURE."

WiSAMS Rule #10

- If the following criteria are met…
    - The current NBI rating for superstructure is less than or equal to 3, and
    - The structure is > 50 years old, and
- …then the recommended work action is "REPLACE STRUCTURE."

These decision rules are simple in nature and rely largely on NBI condition data. As the history of element-based inspection data continues to develop, WiSAMS will be able to apply ever more sophisticated decision rules. Some current rules are more complex and already use element-based condition data. An example of one of these rules is as follows:

Appendix Table B-2: Concrete Deck/Slab Eligibility Matrix

	NBI Item 58	Top Deck Element Distress Area (%)	Bottom Deck Element Distress Area (%)	Preservation Activity	Benefit to Deck from Action	Application Frequency (in years)
Concrete Deck/Slab	≥7	-	-	Deck Sweeping/Washing	Extend Service Life	1 to 2
		5% < 3220 < 25%	-	Crack Sealing	Extend Service Life	3 to 5
		3220 CS3 + CS4 > 0%	-	Deck Sealing	Service life extended	3 to 5
		-	1080 < 5%	Full Depth Deck Patching	Service life maintained	As needed
		3210 CS3 + CS4 < 5%	1080 < 5%	Wearing Surface Patching	Service life maintained	As needed
		>20% (3220 OR 8911 CS3 + CS4) OR	(1140 OR 1150) < 20% for timber deck	Polymer Modified Asphalt Overlay	Service life extended	10 to 15
		>15% 3210 (applied to bare deck)				
		>20% (3210 OR 8911 CS3 + CS4) OR	1080 < 5% for concrete deck			
		>50% 3220 (reapplication)				
		>20% (3220 OR 8911 CS3 + CS4) OR	(1140 OR 1150) < 20% for timber deck	HMA w/ membrane	Service life extended	5 to 15
		>15% 3210 (applied to bare deck)				
		>20% (3210 OR 8911 CS3 + CS4) OR	1080 < 5% for concrete deck			
		>50% 3220 (reapplication)				
		3210 < 5%	1080 < 1%	Polyester Polymer Concrete	Service life extended	20 to 30
		3210 < 2% (applied to bare deck)	1080 < 1%	Thin Polymer Overlay	Service life extended	7 to 15
		8513 CS3 + CS4 > 15% (reapplication)				
	6	-	-	Deck Sweeping/Washing	Extend Service Life	1 to 2
		5% < 3220 < 25%	-	Crack Sealing	Extend Service Life	3 to 5
		3220 CS3 + CS4 > 0%	-	Deck Sealing	Service life extended	3 to 5
		-	1080 < 5%	Full Depth Deck Patching	Service life maintained	As needed
		3210 CS3 + CS4 < 5%	1080 < 5%	Wearing Surface Patching	Service life maintained	As needed
		>20% (3220 OR 8911 CS3 + CS4) OR	(1140 OR 1150) < 20% for timber deck	Polymer Modified Asphalt Overlay	Improve NBI (58) ≥ 7	10 to 15
		>15% 3210 (applied to bare deck)				
		>20% (3210 OR 8911 CS3 + CS4) OR	1080 < 5% for concrete deck			
		>50% 3220 (reapplication)				
		>20% (3220 OR 8911 CS3 + CS4) OR	(1140 OR 1150) < 20% for timber deck	HMA w/ membrane	Improve NBI (58) ≥ 7	5 to 15
		>15% 3210 (applied to bare deck)				
		>20% (3210 OR 8911 CS3 + CS4) OR	1080 < 5% for concrete deck			
		>50% 3220 (reapplication)				
		8513 CS3 + CS4 > 15% (reapplication)	1080 < 1%	Thin Polymer Overlay	Service life extended	7 to 15
		>20% (3220 OR 8911 CS3 + CS4) OR	1080 < 5% OR 1130 CS3 + CS4 < 25%	Concrete Overlay	Improve NBI (58) ≥ 7	12 to 20
		>15% 3210 (applied to bare deck)				
		>20% (3210 OR 8911 CS3 + CS4) OR				
		>50% 3220 (reapplication)				
	5	5% < 3220 < 25%	-	Crack Sealing	Extend Service Life	3 to 5
		3220 CS3 + CS4 > 0%	-	Deck Sealing	Service life extended	3 to 5
		-	1080 < 5%	Full Depth Deck Patching	Service life maintained	As needed
		3210 CS3 + CS4 < 5%	1080 < 5%	Wearing Surface Patching	Service life maintained	As needed
		>20% (3220 OR 8911 CS3 + CS4) OR	1080 < 5% OR 1130 CS3 + CS4 < 25%	Concrete Overlay	Improve NBI (58) ≥ 7	12 to 20
		>15% 3210 (applied to bare deck)				
		>20% (3210 OR 8911 CS3 + CS4) OR				
		>50% 3220 (reapplication)				
	4	>20% (3220 OR 8911 CS3 + CS4) OR	1080 < 5% OR 1130 CS3 + CS4 < 25%	Concrete Overlay	Improve NBI (58) ≥ 7	12 to 20
		>15% 3210 (applied to bare deck)				
		>20% (3210 OR 8911 CS3 + CS4) OR				
		>50% 3220 (reapplication)				
	≤ 4	-	1080 > 15% OR 1130 CS3 + CS4 > 50%	Deck Replacement	Improve NBI (58) = 9	25 to 45

Appendix Table B-3: Other Bridge Elements Eligibility Matrix

NBI Item	Element	NBI Criteria	Defect	Element Defect Condition State Criteria	Repair Action	Potential Benefits to NBI or CS	Anticipated Service Life Years
Deck	Joints	Item 58 ≥ 5	2350	CS2, CS3, or CS4	Joint Cleaning	CS1or CS2	
			2310	CS3 + CS4 ≥ 10%	Joint Seal Replacement/Restoration	CS1	5 to 8
			2360	CS3 + CS4 ≥ 25%	Joint Replacement④⑦	CS1	10 to 20
				All Condition State	Joint Elimination ④	Elimination	15 to 25
	Railing	Item 58 ≥ 5		CS3 or CS4	Railing Restoration	CS1 or CS2	3 to 10
				CS3 or CS4	Railing Replacement/Retrofit ⑧	CS1	10 to 20
Super	Steel Elements	Item 59 ≥ 5		N/A	Superstructure Washing/Cleaning	NA	1 to 2
			3440	CS2 + CS3 Area> 5% ⑥	Painting - Spot	CS1	1 to 5
				CS3 Area ≤ 25% ⑥	Painting - Zone	CS1 ①	5 to 7
				CS3 Area ≥ 25% ⑥	Painting - Complete	CS1 ②	15 to 20
		Item 59 ≥ 4		CS2, CS3, or CS4	Superstructure Restoration ③	NBI ≥ 7	5 to 20
	Bearings	Item 59 ≥ 5		CS3 or CS4	Bearing Reset/Repair	CS1 or CS2	1 to 5
				CS2 or CS3	Bearing Cleaning/Painting	CS1 or CS2	5 to 7
				CS3 + CS4 ≥ 25% or CS4 > 5%	Bearing Replacement	CS1	10 to 15
Sub	Miscellaneous	Item 60 ≥ 5		N/A	Substructure Washing/Cleaning	NA	1 to 2
			3440	CS2+CS3+CS4 Area > 5% ⑥	Painting - Spot	CS1	1 to 5
			3440	CS3 Area > 25% ⑥	Painting - Complete	CS1 ②	10 to 20
				CS2 or CS3 or CS4	Substructure Restoration ⑤	NBI ≥ 7	5 to 20
			9290	CS1 or CS2	Pier Protection ⑨	NBI ≥ 7	5 to 20
				CS3 or CS4	Scour Counter Measure⑩	NBI ≥ 7	5 to 20

① Increase NBI only if combine with structural steel repairs.

② Complete painting only if combined with structural steel repairs to improve the component NBI ≥ 7.

③ Superstructure restoration includes all work related to the superstructure including but not limited to strengthening, pin and hanger replacement, retrofit FC member, etc.

④ Combined with deck overlay or replacement project.

⑤ Substructure restoration includes all work related to the substructure including but not limited to fiber wrapping, strengthening, crack injection, encapsulation, etc.—regardless of material type.

⑥ Element condition state for steel protective coating.

⑦ Includes but is not limited to end block/paving block replacement.

⑧ Must bring railing to current standards or have an approved exception to standards.

⑨ Examples are pier protection dolphins and fender systems.

⑩ Provide scour countermeasures after repairing any other substructure defects.

WiSAMS Rule #24

- If the following criteria are met…
    - The number of previous overlays (concrete or asphalt) is less than 3, and
    - The current NBI rating for substructure is greater than or equal to 4, and
    - The current NBI rating for deck is less than 6.5, and
    - The current NBI rating for deck is greater than 3.5, and
    - The total quantity of deck area in CS-2, CS-3, and CS-4 for defect 1080 (de-laminations, spalls, and patches) is less than 5% of the total deck area, and
    - The total quantity of deck area in CS-3 and CS-4 for defect 1130 (cracking and efflorescence) is less than 25% of the total deck area, and the total quantity of deck area in CS-2, CS-3, and CS-4 for defect 3210 (de-bonding, spalls, patched area, pothole – wearing surface) is greater than 20% of the total deck area, or
    - The total quantity of deck area in CS-3 and CS-4 for defect 3220 (crack – wearing surface) is greater than 50% of the total deck area, or
    - The total quantity of deck area in CS-3 and CS-4 for defect 8911 (abrasion, wear, rutting, or loss of friction – wearing surface) is greater than 20% of the total deck area,
- …then the recommended work action is "CONCRETE OVERLAY."

Each of the WiSAMS decision rules is evaluated in sequential order using relevant inventory and condition data from HSIS. When the criteria for a rule are met, the work action associated with that rule is reported as the optimal bridge treatment. If a bridge is currently in good condition, there may be no treatment recommended.

Forecasting Future Work Actions

As described above, the process for identifying optimal bridge treatments depends on the condition data contained in HSIS. The current condition of each bridge is based on the most recent inspection, which, as noted above, typically takes place on a two-year cycle. Forecasting the need for future treatments relies on forecasts of future bridge condition. These condition forecasts are developed using condition deterioration curves. Based on the current condition of an individual bridge, the deterioration curves predict the condition of that bridge in future years. Then, applying the decision rules discussed above, WiSAMS recommends a series of future bridge treatments. Taken across the entire STH bridge inventory, the set of current and future treatment recommendations forms the basis of effective bridge asset management. The recommendations give DTSD Region engineers the insights necessary to preserve their bridge inventory in the most cost-effective manner possible using available M&O and SHR program funding.

Structures Certification Tool

The Structures Certification Tool (SCT) is a tool used to provide the WiSAMS recommendations to DTIM and DTSD Region staff. Region staff are able to use the work recommended in SCT to create projects. If region staff believe a work recommendation should be different, they are able to provide reasons and supporting documentation for the scope change in SCT. BOS Asset Management staff are able to review the proposed scope and supporting materials and decide if a change in scope is appropriate.

SCT facilitates discussion and provides information beyond just current and future recommended work actions. Some of this information includes:

- A comparison between WiSAMS recommended bridge treatments and bridge projects currently scheduled

for construction in WisDOT's FIIPS – FIIPS is independent of WiSAMS, and the comparison between the two systems on a bridge-by-bridge basis helps ensure optimal bridge treatments are being implemented.

- Cost estimates – WiSAMS uses actual cost data from recent projects to provide cost estimates for all recommended bridge treatments.

The information available through WiSAMS and SCT will continue to be modified and enhanced as necessary to improve the ability of the system to effectively aid WisDOT in identifying and implementing cost-effective STH bridge investment strategies.

WiSAMS, SCT and the WisDOT Bridge Asset Management Program

As noted earlier, BOS houses the bridge expertise for WisDOT, but DTIM and the DTSD Regions are the primary entities responsible for funding allocations, project selection, planning, scoping, and project delivery. Successful bridge asset management depends on effective communication, coordination, and collaboration between all involved.

WiSAMS is a key component of WisDOT's bridge asset management program. The reports produced by WiSAMS allows BOS to supply accurate, refined information to DTIM and the DTSD Regions via SCT. The format of WiSAMS reports and the information contained in them, along with the functionality of SCT, will continue to evolve to meet ever-changing customer needs.

BOS Asset Management produces and distributes reports twice annually to planning and scoping staff in the DTSD Regions. Here the collaborative process is key. BOS Asset Management depends on feedback from the Regions and BOS maintenance engineers to help assess the quality of the recommendations produced by WiSAMS. Constructive critiques of WiSAMS output help identify refinements needed to produce treatment recommendations more in line with actual observed bridge condition and deterioration.

Implementing WiSAMS recommendations represents a major step forward from past practice, but WiSAMS is only part of a larger asset management effort within BOS. To that end, the Bridge Rating and Management unit is tasked with ongoing asset management support. This support takes many forms, including the following:

- Maintaining, updating, and improving the WiSAMS application to provide more accurate work recommendations and additional information to help inform planning and scoping decisions;
- Answering questions and supplying data to DTSD Region planning and project scoping staff as necessary;
- Attending DTSD Region planning and project scoping meetings to offer bridge expertise; and
- Coordinating with DTIM and attending related meetings, including the monthly Backbone Committee meeting;
- Maintaining, updating, and improving the SCT application to provide all the information necessary to help planning and scoping decisions.

Appendix C Meta-Manager

WisDOT Meta-Manager Highway Asset Management System

Overview

WisDOT has long embraced a "data-driven" asset management approach to the development of projects and programs that improve the STH system. In conjunction with reliance on data for decision-making, WisDOT is also committed to a process of continual improvement in data quality (e. g. standards for data collection and storage, leveraging of technology, and data integration strategies).

As a central part of its commitment to data-driven decisions, WisDOT developed the MMS. The MMS provides WisDOT staff with a comprehensive suite of data and analysis tools to support development, monitoring and management of the highway improvement program for the STH system. The MMS combines information from WisDOT's pavement and bridge management systems (PMDSS and WiSAMS, discussed in Appendices A and B, respectively) with detailed information on the physical and safety characteristics of STH highways, the level and composition of traffic using the STH system, and the schedule of programmed projects from WisDOT's FIIPS.

The information in the MMS database can be divided into the following general categories:

- Current STH pavement and bridge conditions;
- Geometric characteristics and other physical attribute information for STH highways and bridges;
- Highway crashes, highway capacity, traffic volumes (auto and truck), traffic forecasts, and other information related to current and future performance of STH system;
- The currently scheduled program of STH highway and bridge improvement projects; and
- Predicted rates of deterioration in the physical condition of the individual STH pavements and bridges, along with the positive effects scheduled improvement projects will have on those conditions.

The MMS database is updated regularly and is readily available to all planning, programming and engineering staff in WisDOT's DTSD Regions and Central Office.

The suite of analysis tools developed for the MMS is tailored to address the following program management issues:

- Future highway and bridge investment needs and the alternative improvement projects to consider in responding to those needs;
- Estimated costs for alternative improvement projects;
- Improvement program priorities; and
- Impacts of varying budget constraints on the highway improvement program and resulting STH system performance.

Taken together, the MMS database and analysis tools provide significant insights relating to current and future conditions, improvement needs, and priorities on the STH system. The MMS helps ensure consistent policies underlie the development of the statewide highway improvement program, and WisDOT relies on it to help optimize highway program performance, which is summarized in Chapter 3. Enhancements to the MMS are made on an ongoing basis, consistent with WisDOT's emphasis on continuous process improvement.

The MMS Database

One of the fundamental functions of the MMS is to bring data together from the many independent databases relating to the STH system. WisDOT has a long history and its corporate databases have evolved over time. Typically, the information contained in any specific database is intended to address only a limited number of issues. By themselves, each database provides only a partial, limited, view of the condition, use and performance of the STH system. By integrating information from differing databases, MMS brings together a comprehensive set of information essential to developing, monitoring and managing the STH highway improvement program.

The MMS integrates information from differing databases using WisDOT's Location Control Management (LCM) system. WisDOT's LCM system allows data in each database to be tied to precise locations along the STH system. Using LCM, the MMS divides the overall STH system into short segments. Data representing pavement and bridge conditions, traffic, crashes and other attributes for those segments is then assembled into a single, comprehensive, database.

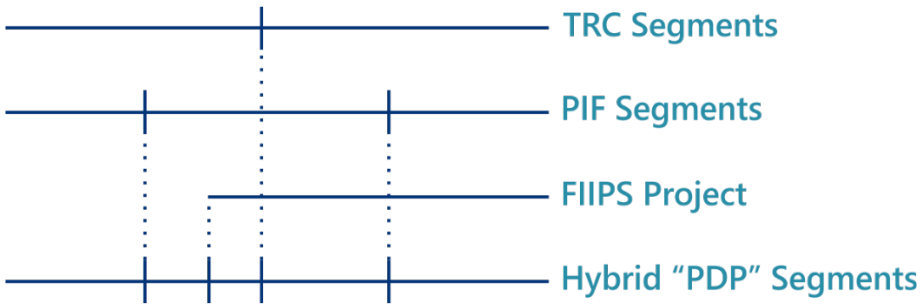
Location information defining the roadway segments contained in three corporate databases is used to derive the STH system segmentation used in the MMS. These databases are as follows:

1. STH pavement conditions (PIF);
2. Scheduled STH highway and bridge projects (FIIPS); and
3. STH traffic counts (TRC).

The beginning and ending points for the roadway segments in these databases are "overlapped" using special GIS tools, producing a new set of "hybrid" segments for the MMS. Appendix Figure C-1 provides an example where the overlap of two TRC segments, three PIF segments and one FIIPS segment produces five hybrid segments.

The segments in the PIF database average one mile in length. These are the shortest among the three databases used to create the hybrid segments underlying the MMS. The overlap process produces approximately 22,000 hybrid segments representing the entire STH system.

Appendix Figure C-1: Visual Representation of the MMS "Overlap" Process



Each direction of a divided highway is represented separately within the MMS database. With over 22,000 segments, the MMS database provides a finely grained picture of the condition, use and performance of the STH system.

Once the hybrid segments are defined, a relationship is created between each segment and data in WisDOT's STH "inventory" tables, which contain geometric design information relating to the STH system. The inventory data values "fitting" within each hybrid segment are identified. When more than one data value "fits" within a segment, the "predominant" data value is chosen to represent the hybrid segment.

Data on pavement conditions, traffic volumes, and scheduled STH improvement projects can be directly tied to

hybrid segments because of the overlap process. Information on STH bridges can be tied to the hybrid segments where they are located, and data on motor vehicle crashes can be tied to the specific points along the segments where the crashes occur.

At the corporate level, MMS data is stored as a Statistical Analysis System (SAS) database since SAS effectively supports analysis and reporting at the statewide level. For ease of use by staff in each DTSD Region, the MMS data for the highways and bridges located in each Region is provided as a Microsoft Excel workbook. To facilitate geographic analysis, comprehensive data mapping is facilitated through the provision of GIS shape files. Portions of the data are also made available within internal web-mapping platforms and is used within other systems as a trusted source of highway data.

The MMS Analysis Tools

The MMS analysis tools provide WisDOT managers with an understanding of current and future STH performance and investment needs. The budget available for the state highway improvement program is limited, making it impossible for all STH deficiencies to be addressed. A process is needed to assess the impact of alternative investment priorities on STH performance. The basic questions that must be analyzed include the following:

1. Which current and future STH deficiencies should be addressed within the funds available?
2. How should they be addressed?
3. When should they be addressed?

WisDOT has developed a set of policy-driven MMS analysis tools for answering these questions. The "optimal" answers are derived by simulating the impacts of alternative policies on STH system performance. The data needed to perform these policy simulations is contained in the MMS database.

Working together, staff from WisDOT's DTIM, BSHP, and DTSD have developed analytic tools that identify alternative improvement projects for addressing deficiencies on STH roadways and bridges. Deficient roadway segments are usually composed of several hybrid MMS segments, providing for logical project beginning and end points. For each deficient segment, a range of alternatives is defined. One alternative improves all the roadway deficiencies that exist on a roadway segment: pavement, safety, geometric, congestion, etc. Other alternatives address individual and select groupings of deficiencies. Taken together, these alternatives create a range of potential improvement projects for each segment. The cost of implementing each alternative is estimated based on the best information available on actual WisDOT costs. Alternatives and costs for addressing bridge deficiencies are also identified, independent of any deficiencies that may exist on the roadway segments where they are located.

MMS analysis tools developed for performing budget constrained policy analyses are used to evaluate alternative state highway improvement policies over analysis periods ranging from 5 to 10 years. Estimated STH roadway and bridge conditions coming into the analysis period reflect implementation of the actual state highway improvement program through that point in time.

Each policy analysis unfolds iteratively, year by year. During the initial iteration, STH roadway and bridge conditions in the first year of the analysis are evaluated and deficiencies are identified. The range of alternatives for treating those deficiencies is defined as described above. From this range of improvements, a single alternative (project scope) is selected for each deficient bridge and roadway segment. This selection process is policy driven, reflecting a consistent process for defining which deficiencies will be addressed (and won't be addressed) during project scoping. Bringing together the total budget available and the estimated cost of the selected alternatives, policy priorities then determine which alternatives (i.e. projects) should be undertaken in that year versus being delayed to a future period. The scope (and cost) of needed improvements may increase

over time if work is not made when first called for.

Prior to moving to the next year of the analysis, conditions on roadways and bridges not selected for improvement are deteriorated to reflect an additional year of wear and tear, and conditions on the roadways and bridges selected for improvement are reset to reflect the positive effects of the improvements made. Future iterations of the analysis then proceed in the same manner as the first, reflecting the same policies for defining project scope and prioritizing projects for funding. When complete, the policy analysis will have defined the year-by-year program of projects consistent with the policies being evaluated, and the resulting STH system performance over the analysis period.

Chapter 3 describes the policies defining the WisDOT's "optimal" SHR investment strategy. The MMS analysis tools were essential in the development this strategy, and the results of the analysis are an essential component of WisDOT's TAMP.

As this discussion makes clear, the MMS database and analysis tools provide essential, data-driven, support for defining and managing the state highway improvement program. WisDOT planning and programming staff regularly uses the MMS to:

- Estimate future STH roadway and bridge conditions and improvement needs;
- Identify, scope and prioritize potential STH improvement projects;
- Allocate available funding to sub-programs within the SHR Program and to DTSD Regions;
- Establish highway improvement program goals and performance measures; and
- Evaluate highway improvement program performance (e. g. Before/After analyses).

Appendix D Traffic Forecasts

Future Traffic Volumes Expected on the State Trunk Highway System

Overview

WisDOT has produced traffic forecasts and analyses for many years. For more than 25 years, WisDOT has refined techniques, developed policies, and standardized procedures that have guided transportation analyses. Today, several tools and sophisticated models exist to forecast traffic on Wisconsin's STH system. These tools and models are discussed in Chapter 9 of WisDOT's Transportation Planning Manual which outlines WisDOT's forecasting process, from the input assumptions to the final forecasts.

This appendix summarizes the STH system traffic forecasts contained in the latest release (July 2022) of the MMS database. These forecasts were produced by the current version of WisDOT's Traffic Analysis Forecasting and Information System (TAFIS) for 7,100+ traffic count segments (TRC). As noted in Appendix C Meta-Manager, TRC are a direct input used to develop the MMS segmentation for the STH system. This helps to ensure the validity of assigning forecasts to specific segments within the MMS.

The MMS contains forecasts of the average annual daily traffic and the average daily truck percentage for all highway segments comprising the STH system. Forecasts are included for a base year (currently 2023) and four future years (currently 2027, 2032, 2037 and 2042). Well established and consistent protocols are used so that enterprise-based information systems across WisDOT are consistent with one another.

The TAFIS traffic forecasts underlying the TAMP accurately capture recent traffic volumes and growth trends on the STH system. The average annual growth rate is approximately 0.4%, with only a handful of TRC demonstrating annual growth rates exceeding 2%. This level of expected traffic growth is much lower than that seen during the 1980's and 1990's, when average traffic growth on the STH system was almost 3% per year. Traffic growth has moderated significantly over the last 20 years, and WisDOT's TAFIS forecasts expect these moderate growth rates to continue.

TAFIS forecasts are used to develop level-of-service (LOS) projections and safety metrics within the MMS. LOS is a measure used to describe the quality of travel on a transportation facility, and the future LOS of a given highway is calculated using forecasted daily traffic volume and data on roadway geometry. LOS thresholds are defined for different classes of highway and are considered during the highway design process. If the forecast LOS for a highway exceeds its class threshold, traffic on the highway has slowed below the desirable level and flow will degrade over time unless highway improvements are undertaken. MMS crash rate metrics are developed using historical TAFIS information. Crash rates are an important indicator of the need to improve a highway and the type of improvement considered during the design process. TAFIS forecasts also influence the safety analysis underlying the optimal State Highway Rehabilitation (SHR) Investment Strategy, as discussed in Chapter 3.

TAFIS Forecasts of the Total Vehicle Miles of Travel Expected on the STH System

TAFIS forecasts are produced for each of the 7,100+ traffic count segments covering the STH system. Traffic counts are made at varying time frequencies, depending on the importance of the highway. Some counts are continuous, while others are taken over much shorter periods every few years.

Plotting historic traffic counts over time for any given count segment typically shows a significant degree of variation around a trend. One count may exceed the trendline while the next may be below trend. TAFIS forecasts are designed to capture traffic count trends and are conservative in nature. The MMS links TAFIS data to specific

highway segments, each with a defined mileage. This information can be used to estimate annual VMT. During the 20-year period from 1999 through 2019, total STH system VMT increased at a compound annual growth rate of 0.59%. The TAFIS forecasts underlying the TAMP show slightly lower average growth in the future, as shown in Appendix Table D-1. Due to the COVID-19 pandemic, total STH system VMT decreased by 15.7% in 2020, however, travel in Wisconsin rebounded in 2021 and total STH system VMT increased by 13.3% based on preliminary analysis.

Consistent with historic trends, forecast VMT growth is expected to be slightly stronger on the C2030 Backbone and C2030 Multilane Connectors than on the two-lane portion of the STH system. Taken together, C2030 Backbone and C2030 Multilane Connector routes account for approximately 60% of the annual VMT on the STH system. This reflects the important role these STH sub-systems play in linking Wisconsin's regional economies together and to the rest of the world. The rate of growth in TAFIS VMT forecasts (and in the average daily traffic forecasts underlying VMT) declines over time. This relates to the TAFIS methodology used to capture historic trends and is explained further in Chapter 9 of the Transportation Planning Manual.

Appendix Table D-2 provides forecast annual growth rates for the Interstate and the Non-Interstate NHS routes on the STH system. Growth rates for each NHS sub-system are very similar, with growth slightly below that expected on C2030 Backbone and C2030 Multilane Connector routes. The forecast growth rates for the Interstate and state-owned Non-Interstate NHS routes are close to one another and to the overall growth expected on the STH system. The similarity to the overall STH system is to be expected since approximately 80% of overall STH VMT takes place on state-owned NHS routes.

Appendix Table D-1: Forecast Annual Growth in VMT by STH Sub-System (Compound Annual Growth Rates)

STH Sub-System	2023-2027	2027-2032	2032-2037	2037-2042	2023-2042
Corridors 2030 (C2030) Backbone	0.62%	0.58%	0.54%	0.51%	0.56%
C2030 Connector – Multilane	0.64%	0.59%	0.55%	0.51%	0.57%
C2030 Connector – Two-Lane	0.32%	0.30%	0.28%	0.27%	0.29%
Non-C2030	0.40%	0.38%	0.36%	0.35%	0.37%
Total STH System	0.53%	0.50%	0.47%	0.44%	0.48%

Appendix Table D-2: Forecast Annual Growth in VMT by State-Owned NHS Sub-System (Compound Annual Growth Rates)

NHS Sub-System	2023-2027	2027-2032	2032-2037	2037-2042	2023-2042
Interstate	0.58%	0.54%	0.51%	0.48%	0.52%
Non-Interstate NHS	0.53%	0.50%	0.46%	0.44%	0.48%

Variations in Forecast Growth Rates for Travel on Individual Traffic Count Segments

Appendix Table D-3 shows the distribution of traffic count segments with forecasts of average annual growth within the following ranges: less than 1.0% growth; 1.0%-1.25% growth; 1.25%-1.5% growth; and greater than 1.5% growth. The table also reports the maximum growth rate across all traffic count segments within each STH sub-system.

Appendix Table D-3 demonstrates that 97% of all traffic count segments have expected average annual growth rates less than 1.0%, including 94% of the count segments on the C2030 Backbone. About 2% of all count segments have average annual growth rates between 1.0% and 1.25%. The C2030 Backbone has expected annual growth rates above 1.25% on about 0.6% of its count segments, and Non-C2030 routes and two-lane C2030 Connector also have less than 1% of their count segments showing annual growth in this range. The largest annual growth rate for any traffic count segment is on the Non-C2030 sub-system, but it represents an extreme outlier. Only 4 of the 5098 count segments on Non-C2030 routes have expected annual growth rates above 2%.

Appendix Table D-3: Distribution of Traffic Count Segments by Average Annual TAFIS Traffic Growth Rate and STH Sub-System (Compound Annual Growth Rates Through 2042)

Average Annual Traffic Growth Rates	C2030 Backbone	C2030 Connector Multilane	C2030 Connector Two-Lane	Non-C2030	Total STH System
Less than 1.0%	606	516	857	4954	6933
1.0-1.25%	37	14	11	103	165
1.25-1.5%	4	8	2	30	44
Greater than 1.5%	0	2	1	11	14
Total Segments	647	540	871	5098	7156
Maximum Growth on Any Segment	1.32%	1.53%	1.67%	2.71%	2.71%

Compared to the C2030 Backbone, a slightly greater proportion of Interstate and state-owned Non-Interstate NHS count segments have growth rates less than 1.0% (97% for the NHS vs. 94% for C2030 Backbone routes). This is consistent with the slightly lower VMT growth rate on the WisDOT-owned NHS.

Implications of Latest TAFIS Forecasts for Expected STH Traffic Congestion

As noted earlier, traffic growth has moderated significantly from the 1980's and 1990's. Information from the MMS indicates that several hundred C2030 Backbone and Connector miles currently exceed WisDOT LOS thresholds, suggesting additional travel lanes (capacity expansion) should be considered due to the traffic congestion being experienced. Most of these miles are on the NHS. Using the TAFIS forecasts summarized in Appendix Table D-1 through Appendix Table D-3, congested miles on the C2030 Backbone and Connector systems will increase significantly over the next 20 years unless investments beyond the already approved STH capacity expansion projects continue to be made. WisDOT will continue to analyze congestion, safety and other factors impacting these roadways and will bring priority capacity expansion needs forward for enumeration within the Major Highway Development and Southeast Wisconsin Freeway Megaprojects programs as appropriate.

Appendix E Performance Gap Process

Process Used in the Analysis of Performance Gaps

Overview

WisDOT's performance targets for the STH system reflect WisDOT's asset management priorities and the level of resources available for highway investment. Performance targets are set for future STH pavement and bridge conditions, including those on the WisDOT-owned NHS. The key to achieving these targets on a consistent basis is making sure that WisDOT resources are directed toward highway and bridge projects scheduled in the right places, with the right scope, and at the right time.

To design and deliver the "right" highway investments at the "right" time, WisDOT needs to both anticipate future system performance and have the "right" set of projects in the project delivery pipeline. Design, real estate acquisition and utility coordination activities all require long lead times.

Predicting STH pavement and bridge performance is subject to uncertainty. Given this reality, WisDOT continually monitors STH performance and refines the agency's highway investment strategies as required. By using this process to adjust the specific projects in the project delivery pipeline, WisDOT increases the likelihood that STH performance targets will be achieved. The process is accomplished using the database and analysis tools of THE MMS.

Estimating Future System Performance and Identifying Potential Performance Gaps

As described in Appendix C Meta-Manager, the MMS database integrates information from WisDOT's pavement and bridge management systems (PMDSS and WiSAMS, respectively, as described in Appendices A and B) with data from many other WisDOT sources. Information on traffic volumes, highway and bridge design characteristics and traffic crashes is included, along with detailed information on the STH highway and bridge projects currently in the project delivery pipeline from FIIPS.

Using this rich database, WisDOT can summarize current STH pavement and bridge conditions and forecast them into the future. Future pavement and bridge conditions will be influenced by both physical deterioration and the scope and timing of future STH improvement projects. Since this information is available from PMDSS, WiSAMS and FIIPS, WisDOT can use the MMS database to forecast STH pavement and bridge conditions both with and without the projects scheduled for future construction.

Depending on the underlying budget appropriation, STH highway and bridge projects are scheduled for a minimum of six years into the future and can extend for 10 years or more. The program of projects is adjusted and extended an additional two years at the start of each biennium (July of odd-numbered years). The resulting program update reflects WisDOT's investment strategies, consistent with agency priorities and funding expectations.

WisDOT's targets for future STH and WisDOT-owned NHS pavement and bridge conditions are set using the same priorities, funding expectations and investment strategies. This means the updated program of projects (the projects in the project delivery pipeline) at the start of each biennium is expected to meet WisDOT's STH pavement and bridge targets.

Many risk factors influence whether WisDOT's condition targets are met two, four or more years in the future. The physical deterioration rates experienced by individual pavements and bridges will differ from historic average rates. The final bid costs for individual projects will differ from their early program estimates, impacting the number of projects that can be constructed using available program funds. Unexpected delays will mean some projects originally scheduled in the early years of the program are shifted back in time while others are shifted

forward to make use of available construction dollars. The impact of these and other risk factors will become clear as pavement and bridge condition data continues to be gathered over time.

Throughout each fiscal year, WisDOT updates the MMS database and analyzes the impact updated condition data and the shifting program of projects has had on expected STH pavement and bridge performance. This analysis may uncover a performance gap, where actual performance lags what had been expected. By monitoring actual vs. expected performance on an ongoing basis, WisDOT can quickly respond to emerging performance gaps.

Closing Potential Performance Gaps by Adjusting the Project Schedule and Revising the SHR Investment Strategy

WisDOT responds to information on emerging STH and WisDOT-owned NHS pavement and bridge performance gaps in three ways: two occurring on an ongoing basis and the third occurring as the program of projects is updated at the start of each new biennium.

As noted above, one of the risk factors contributing to unexpected performance gaps is a difference between the projects planned for construction and the projects that ultimately occur. The greater the difference between the projects planned for a fiscal year and the projects delivered, the greater the chance for unexpected performance gaps to emerge. One of the ways used by WisDOT to minimize this risk on an ongoing basis is by monitoring internal performance measures that place high priority on meeting planned project delivery schedules and minimizing differences between estimated and actual project costs. Appendix G Risk Register provides a discussion of these and other aspects of WisDOT's risk management processes.

Ultimately, delays are unavoidable for some projects due to the complexities of designing and delivering projects for construction. In response to this reality, WisDOT's risk management process calls for a limited set of projects to be ready for construction well before construction is scheduled. These projects are referred to as being on the "shelf." As delays occur, WisDOT helps minimize future performance gaps by using information on emerging gaps while choosing projects to take off the "shelf" and move forward in the program. Projects are preferred if they help close emerging performance gaps, although there are other policy considerations as well.

At the start of each new biennium, the Biennial Budget presents WisDOT with a revised set of funding realities. The total funding the budget provides, and its distribution across program appropriations, may differ from WisDOT's expectations as the existing schedule of projects was updated at the start of the previous biennium and managed over the intervening two years. To adjust to these new realities, WisDOT uses the MMS database and analysis tools to reevaluate, and potentially adjust, the optimal investment strategy for the SHR Program. The analysis process is described in detail in Chapter 3.

The process of reevaluating the optimal investment strategy for SHR might, for example, indicate a larger share of available funding must be allocated to NHS bridges and to the Backbone system if WisDOT is going to continue meeting its performance targets for these STH sub-systems. If this were the case, the investment strategies used when responding to pavement needs on non-Backbone highways might also need to be revised if WisDOT is to continue meeting its pavement targets for these highways. WisDOT might also choose to adjust some of its performance targets due to the new funding realities. Whatever the exact outcome, this process provides WisDOT with the ability to use the latest information on STH pavement and bridge conditions, the latest pavement and bridge deterioration rates from PMDSS and WiSAMS, the current schedule of construction projects and other updated information to reconsider its investment policies and performance targets.

Appendix F Process Used in Lifecycle Planning

Overview

WisDOT is committed to asset management principles as part of its efforts to preserve the STH system at minimum practicable cost. WisDOT's PMDSS and Wisconsin Structures Asset Management System (WiSAMS) identify investment strategies for addressing pavement and bridge deficiencies. The investment strategies called for during the lifecycles of pavement and bridge assets are responsive to current asset conditions and consider both current and future costs. Strategies having lower costs today may have higher costs over time due to their impact on future asset condition. WisDOT's asset management policies focus on identifying and implementing investment strategies that minimize infrastructure costs over the lifecycles of the pavements and bridges making up Wisconsin's STH system.

Pavement Investment Strategies

WisDOT's pavement management system (PMDSS) is described in some detail in Appendix A . Based on pavement type, pavement history and current pavement condition, PMDSS identifies two options for treating pavements in need of rehabilitation: a "Best Value" option and a "Reduced Cost" option. To derive the "Best Value" option, PMDSS identifies alternative pavement rehabilitation treatments and divides the service life extension by their cost. The "Best Value" option is the pavement treatment having the maximum SLE per dollar. The "Reduced Cost" option is derived after considering the same set of alternative rehabilitation treatments, and is the pavement treatment having the lowest cost, regardless of the SLE it provides (subject to a minimum SLE of four years, per WisDOT policy).

Implementing "Best Value" pavement treatments is consistent with minimizing the lifecycle costs of preserving STH system pavements over time. Appendix Table F-1 provides two general examples demonstrating this point. Each example represents an existing pavement on the STH system, and in each case, pavement conditions call for a pavement treatment. Appendix Table F-1 compares the present value of life cycle costs resulting from implementation of each pavement's "No Preservation" treatments over time with the present value life cycle cost associated with implementing each pavement's "Best Value" treatments. In each case, the "No Preservation" option is a do-nothing scenario. Comparing dollar weighted average present values, the "Best Value" strategies provide a cost savings versus "No Preservation" approach.

Comparing the present value of costs for a stream of "Best Value" pavement treatments with the present value of costs for a stream of "Reduced Cost" pavement treatments does not provide a reliable comparison of the two strategies because the pavement service they provide to the traveling public varies due to overall pavement quality and the level of travel disruption caused by differences in the frequency of treatments. "Reduced Cost" treatments achieve a minimum level of pavement service at low cost. This makes them appropriate to consider when funding is limited, but they are not intended to provide a high level of pavement service at lowest lifecycle cost.

WisDOT's optimal SHR investment strategy calls for implementing "Best Value" pavement treatments on the Backbone and Connector systems and all Principal Arterial highways as discussed in Chapter 3. Since these highways make up the majority of roadway miles on the WisDOT-owned NHS, the lifecycle planning process underlying WisDOT's optimal SHR investment strategy manages WisDOT-owned NHS pavements at lowest lifecycle cost.

Appendix Table F-1: Comparison of "Best Value" and "No Preservation" Pavement Treatments

	Concrete Pavement Life Cycle						
	Treatment Stream	Treatment Type	Concept	Year	PCI Before	PCI After	Cost / Lane Mile
"Best Value"	Initial Construction	New Construction	-	0	-	100	$2,000,000
	First Rehabilitation	Concrete Repair	PSRS20	25	85	92	$150,000
	Second Rehabilitation	Concrete Repair	PSRS20	33	80	88	$150,000
	Third Rehabilitation	Concrete Repair & Overlay	RSRF20	41	71	100	$400,000
	End of Life	Pavement Replacement	PVRPLA	56	65	100	$2,000,000
Average Annual Life Cycle Cost per Lane Mile							$48,214
50-Year Life Cycle Cost Per Lane Mile							$2,410,714
"No Preservation"	Initial Construction	New Construction	-	0	-	100	$2,000,000
	Pavement Replacement	Pavement Replacement	PVRPLA	36	65	100	$2,000,000
Average Annual Life Cycle Cost per Lane Mile							$55,556
50-Year Life Cycle Cost Per Lane Mile							$2,777,778
% Change from "Best Value" vs "No Preservation"							-13.2%

	Asphalt Pavement Life Cycle						
	Treatment Stream	Treatment Type	Concept	Year	PCI Before	PCI After	Cost / Lane Mile
"Best Value"	Initial Construction	New Construction	-	0	-	100	$800,000
	First Rehabilitation	Resurface	RSRF10	18	55	100	$250,000
	Second Rehabilitation	Resurface	RSRF20	30	60	100	$400,000
	Third Rehabilitation	Resurface	RSRF10	42	60	100	$250,000
	End of Life	Pavement Replacement	PVRPLA	54	60	100	$800,000
Average Annual Life Cycle Cost per Lane Mile							$31,481
50-Year Life Cycle Cost Per Lane Mile							$1,574,074
"No Preservation"	Initial Construction	New Construction	-	0	-	100	$800,000
	Pavement Replacement	Pavement Replacement	PVRPLA	18	55	100	$800,000
	Pavement Replacement	Pavement Replacement	PVRPLA	36	55	100	$800,000
Average Annual Life Cycle Cost per Lane Mile							$44,444
50-Year Life Cycle Cost Per Lane Mile							$2,222,222
% Change from "Best Value" vs "No Preservation"							-29.2%

The treatment streams and years (SLE's) for the "Best Value" alternatives follow guidance on pavement lifecycles and service lives in WisDOT's Facilities Development Manual (FDM 14-15, Pavement Type Selection). This guidance is reviewed regularly and updated as needed to reflect current WisDOT experience. A review will be completed by 2024.

Bridge Investment Strategies

The Wisconsin Structures Asset Management System (WiSAMS) is described in Appendix B WiSAMS. WiSAMS is consistent with Chapter 42 – Bridge Preservation in WisDOT's Bridge Manual, which promotes optimal lifecycle costs, as shown in Appendix Table F-2.

Appendix Table F-2 contains four examples demonstrating the cost-effectiveness of WiSAMS and the Bridge Preservation chapter in the Bridge Manual: two relating to pre-stressed concrete girder bridges and two relating to steel girder bridges. For each bridge type, the first example relates to a bridge already in-service and the second relates to a newly constructed bridge. Lifecycle costs for the sequence of bridge treatments recommended by preservation policy are compared to the lifecycle costs of treatments consistent with typical bridge preservation practices from the 1980's and 1990's.

WisDOT's optimal SHR investment strategy implements WiSAMS recommended bridge treatments on all STH system bridges as summarized in Chapter 3. This policy is consistent with the priority placed on STH bridges and means WisDOT's lifecycle planning process manages the performance of the NHS bridges on the STH system at lowest lifecycle cost.

Appendix Table F-2: Comparison of WiSAMS and "Typical Past Practice" Bridge Treatments[1]

	WiSAMS[3]					Typical Past Practice (TPP)[2]			
	Treatment Stream	Year	Cost per 10,000 Sq. Ft.	Deck NBI Before	Deck NBI After	Treatment Stream	Year	Cost per 10,000 Sq. Ft.	Deck NBI After
Pre-tressed Concrete Girder – In-Service	Concrete Overlay	28	$378k	5	7	New Deck	33	$959k	9
	New Deck	48	$959k	4	9	Replace Bridge	50	$1,647k	9
	Reseal Deck	52	$5k	8	8				
	Reseal Deck	56	$5k	8	8				
	Polymer Overlay	60	$62k	7	8				
	Polymer Overlay	70	$62k	6	8	New Deck	83	$959k	9
PV Costs			$195k			PV Costs		$352k	
% Change From "TPP"			-44.7%						
Pre-stressed Concrete Girder – New	New Construction w/ Polymer Overlay	0	$1,647k	-	9	New Construction	0	$1,647k	9
	Reseal Deck	4	$5k	8	8	New Deck	33	$959k	9
	Reseal Deck	8	$5k	8	8				
	Polymer Overlay	12	$62k	7	8				
	Polymer Overlay	22	$62k	6	8				
	Concrete Overlay	47	$378k	5	7				
	New Deck	67	$959k	4	9				
	Reseal Deck	71	$5k	8	8				
	Reseal Deck	75	$5k	8	8				
	Polymer Overlay	79	$62k	7	8	Replace Bridge	50	$1,647k	9
	Polymer Overlay	89	$62k	6	8	New Deck	83	$959k	9
PV Costs			$1,788k			PV Costs		$1,999k	
% Change From "TPP"			-10.6%						

Appendix Table F-2: Comparison of WiSAMS and "Typical Past Practice" Bridge Treatments[1] (continued)

	WiSAMS[3]					Typical Past Practice (TPP)[2]			
	Treatment Stream	Year	Cost per 10,000 Sq. Ft.	Deck NBI Before	Deck NBI After	Treatment Stream	Year	Cost per 10,000 Sq. Ft.	Deck NBI After
Steel Girder – In-Service	Concrete Overlay	26	$378k	5	7	New Deck	32	$961k	9
	New Deck, Paint	46	$1,189k	4	9				
	Reseal Deck	50	$5k	8	8				
	Reseal Deck	54	$5k	8	8				
	Polymer Overlay	58	$62k	7	8				
	Polymer Overlay	68	$62k	6	8	Replace Bridge	58	$2,760k	9
	Concrete Overlay	93	$378k	5	7	New Deck	92	$961k	9
PV Costs			$243k			PV Costs		$375k	
% Change From "TPP"			-35.2%						
Steel Girder – New	New Construction	0	$2,760k	-	9	New Construction	0	$2,759k	9
	Reseal Deck	4	$5k	8	8				
	Reseal Deck	8	$5k	8	8				
	Polymer Overlay	12	$62k	7	8				
	Polymer Overlay	22	$62k	6	8				
	Concrete Overlay, Paint	47	$607k	5	7	New Deck	34	$961k	9
	New Deck	67	$961k	4	9	Replace Bridge	60	$2,759k	9
	Reseal Deck	71	$5k	8	8				
	Reseal Deck	75	$5k	8	8				
	Polymer Overlay	79	$62k	7	8				
	Polymer Overlay	89	$62k	6	8	New Deck	94	$961k	9
PV Costs			$2,923k			PV Costs		$3,100k	
% Change From "TPP"			-5.7%						

[1] Present value (PV) calculated at a discount rate of 5%. Costs are expressed in current base year $. 2022 is the base year for calculating PV. For the in-service bridges, 2024 is "24", and so on. For the newly constructed bridges, 2052 is "30", and so on.

[2] "Typical Past Practice" work was usually based on structure age and not condition. The "year" shown for each action is when that action was historically done.

[3] NBI deck values shown are average values, based on network-wide analysis. Values for a specific bridge will vary. Deck resealing does not result in an increase to deck NBI. The benefit provided is an increased amount of time at the current NBI value. The trigger for new construction is shown as deck NBI = 3, but construction occurs prior to reaching NBI = 3 and is influenced by other condition data.

Appendix G Risk Register

Process for Developing the Risk Management Plan

Overview

WisDOT is fully committed to effective asset management. This commitment requires WisDOT to systematically consider the many uncertainties impacting the STH system, management of the state highway improvement program and the design of the projects it contains. A robust risk management process is needed to identify and mitigate these risks. Failure to do so would compromise WisDOT's ability to reach its performance objectives for the STH system.

Appendix Table G-1 summarizes the risks identified by WisDOT's risk management process using a TAMP Risk Register. For each risk identified, the TAMP Risk Register summarizes its likelihood and potential impact, along with the mitigation strategy in place and the organizational area(s) responsible for implementing and monitoring the effectiveness of the strategy. Several strategies relate directly to the priorities and project-level treatments inherent in the investment strategies developed as part of the TAMP. Others relate to ensuring the TAMP is effectively implemented within the financial and staff resources available for the state highway program. Strategies have also been put in place to ensure environmental, traffic and other factors are adequately considered in the project design process, minimizing the risk that projects will not perform as anticipated over time.

The development and implementation of WisDOT's risk management plan is the responsibility of the Administrators of DTIM and DTSD. The risk management plan will continue to evolve. The Director of the BSHP and staff from BSHP's Program Development and Program Finance sections work closely with staff in the DTSD Regions, the DTSD Central Office to develop and implement program-level risk mitigation strategies as part of WisDOT's overall investment strategy. Development and implementation of project-level risk mitigation strategies are led by DTSD, with input from the DTSD Regions and several Central Office Bureaus, including the Bureaus of Project Development, Structures, Traffic Operations and Technical Services.

Appendix Table G-1: Risk Register

Risk Event, Likelihood, Impact, Priority	Mitigation Strategy	Responsible for Strategy	Status
Risk Event: Projects are not ready for letting to contract in the year originally scheduled. **Likelihood:** High **Impact**: Delayed infrastructure improvements at higher cost due to inflation. **Priority:** High	Monitor and adjust the projects in the letting schedule to meet the annual "let goal."	DTIM, DTSD	Ongoing
	Monitor the Advanceable Program Letting Plan (APLP) and Delivery Risk Report throughout the project development process to identify and address schedule risks.	DTIM, DTSD	Ongoing
	Maintain close coordination between project design and project scheduling staff.	DTSD	Ongoing
	Maintain an adequate number and variety of "shelf" projects ready to take the place of projects that slip from the letting schedule.	DTSD	Ongoing
	When possible, design projects to be eligible for both state and federal funding and meet both NEPA and WEPA (Wisconsin Environmental Policy Act) requirements.	DTSD	Ongoing
Risk Event: Actual state or federal funds are below the levels assumed in the Biennial Budget, or actual YTD let contract costs are above YTD PS&E estimates. **Likelihood**: Medium **Impact**: Potential delays to higher priority projects instead of lower priority projects. **Priority**: High	Monitor state revenue collections, federal highway apportionments and "let savings".	DTIM, DTSD	Ongoing
	Schedule work associated with higher priority projects early in the state fiscal year. Monitor the MAPSS measure related to "timely scheduling of contracts".	DTIM, DTSD	Ongoing
	Adjust the projects in the schedule to avoid exceeding available funding, typically later in the state fiscal year	DTIM, DTSD	Ongoing
	When possible, design projects to be eligible for both state and federal funding and meet both NEPA and WEPA requirements.	DTSD	Ongoing

Appendix Table G-1: Risk Register (continued)

Risk Event, Likelihood, Impact, Priority	Mitigation Strategy	Responsible for Strategy	Status
Risk Event: Actual state or federal funds are above the levels assumed in the Biennial Budget, or actual YTD let contract costs are below YTD PS&E estimates. **Likelihood:** High **Impact**: Missed opportunity to complete projects on an accelerated schedule and improve longer term infrastructure conditions unless the funds can be spent and there are projects available to bring forward in the schedule. **Priority**: High	Monitor state revenue collections, federal highway apportionments and "let savings".	DTIM	Ongoing
	If required, develop a Federal Plan (for federal $) or 13.10 request (for state $) for approval by the Joint Committee on Finance.	DTIM	As Needed
	Maintain an adequate number and variety of "shelf" projects ready to quickly advance into the letting schedule.	DTSD	Ongoing
	Adjust the projects in the schedule to make use of all available state and federal funding.	DTIM, DTSD	Ongoing
	When possible, design projects to be eligible for both state and federal funding and meet NEPA and WEPA requirements.	DTSD	Ongoing
Risk Event: Staffing resources are not available to fully deliver the state highway program. **Likelihood**: High **Impact**: Delayed infrastructure improvements at higher cost due to inflation. **Priority:** High	Assess the level of staff resources needed to deliver the program, compare the needed resources with available WisDOT staffing, and identify the level of consultant resource necessary to ensure project/program delivery.	DTSD. DTIM	Annual
Risk Event: Future Biennial Budgets and infrastructure conditions differ from assumptions made when structuring the highway program. **Likelihood**: High **Impact**: Projects scheduled beyond the first two years of the program may need to be adjusted to attain infrastructure condition targets. **Priority:** High	Adjust SHR programming guidelines, project schedules and the TAMP on a 2-year cycle consistent with the latest Biennial Budget and the latest information on infrastructure condition.	DTIM, DTSD	Biennially

Appendix Table G-1: Risk Register (continued)

Risk Event, Likelihood, Impact, Priority	Mitigation Strategy	Responsible for Strategy	Status
Risk Event: The projects contained in the long-range highway program are not fully consistent with WisDOT's highway investment strategy. **Likelihood**: High **Impact**: Increased average project costs, leading to the completion of fewer projects within available funds and unmet infrastructure condition targets. **Priority:** High	Monitor the MAPSS measure related to "program effectiveness" to ensure reasonable progress in programming improvement projects in the right place, at the right time, and at the right level of improvement, as called for by WisDOT's highway investment strategy.	DTIM, DTSD	Annual
Risk Event: Funding negatively impacts safety and infrastructure condition on the Backbone and other NHS routes. **Likelihood**: Medium **Impact**: Backbone routes and other NHS highways are unable to efficiently serve the mobility needs of individuals and businesses. **Priority:** High	Design preservation and improvement projects on the Backbone and other NHS routes to minimize lifecycle costs.	DTIM, DTSD	Ongoing
	Consider investment policy tradeoffs on lower volume and lower function highways when developing WisDOT's highway investment strategy	DTIM, DTSD	Biennially
Risk Event: Unexpected bridge deterioration requires the imposition of bridge closures or weight restrictions. **Likelihood**: Medium **Impact**: The STH system is unable to efficiently serve the mobility needs of individuals and businesses. **Priority:** High	Give bridges high priority within WisDOT's highway investment strategy and allocate resources consistent with WiSAMS bridge preservation and improvement needs.	DTIM, DTSD	Ongoing
	Adjust SHR programming guidelines and the TAMP on a 2-year cycle consistent with the latest Biennial Budget and the latest information on infrastructure conditions.	DTIM, DTSD	Biennially

Appendix Table G-1: Risk Register (continued)

Risk Event, Likelihood, Impact, Priority	Mitigation Strategy	Responsible for Strategy	Status
Risk Event: Unique environmental, traffic or other project level risks are either overlooked or not adequately considered within the project design process. **Likelihood**: Medium **Impact**: The project does not perform as planned over time, increasing costs and potentially limiting the ability of the infrastructure to serve the mobility needs of individuals and businesses. **Priority:** High	Regularly review and update project design standards to ensure they adequately provide for environmental, traffic and other project level risks.	DTSD	Ongoing
	Provide effective oversight of the "project scoping process" to ensure the unique risks impacting individual projects are not overlooked and are adequately considered in the project design process.	DTSD	Ongoing
Risk Event: Natural disasters or catastrophic infrastructure failures leading to the declaration of emergency or disaster declarations. **Likelihood**: Low **Impact**: Roadways and bridges impacted by emergency events provide unreliable service and past investment is significantly compromised, greatly increasing long-term infrastructure costs and sacrificing reliability. **Priority:** High	Conduct regular evaluations of roadways and bridges subject to repeated emergency events consistent with 23 CFR Part 667. Identify and consider alternatives that will mitigate, or partially or fully resolve the root problem, including their cost impact of the risk of recurring damage.	DTIM, DTSD	Ongoing
	Ensure the findings of these evaluations are fully considered prior to the moving a project to FIIPS LC 11 and are reexamined before the completion of the Design Study Report.	DTSD	Ongoing
	Implement flood resiliency design guidance considerations during the programming and scoping process	DTIM, DTSD	Ongoing

Appendix H Federal Work Type Table

The Assignment of WisDOT's Detailed Improvement Types to the Work Classifications Reported in the TAMP

Overview

Appendix Table H-1 provides a list of FIIPS Concept Codes, used to categorize improvement types, to their respective FHWA Work Types. It should be noted that WisDOT does not have a standalone concept code for "New Construction" in regard to roadways and any expansion projects that add lane capacity are included in Reconstruction, Expansion (RECSTE) which is included into the FHWA Work Type; Reconstruction.

Appendix Table H-1: FHWA Work Type to WisDOT Concept Code Crosswalk Table

FHWA Work Type	WisDOT Improvement Concept Code (FIIPS)	WisDOT Improvement Concept Description
Preservation	PSRS10	Seal Coat /Crack Fill/Join, Crack or Spot Repair
	PSRS20	Patch/Rut Fill/Repair and Grind/Slab Replace
	PSRS30	Some Combo of Patch/Rut/Repair/Seal/Crack/Grind
	RSRF10	Resurfacing (Overlay< 2.5 inches)
	RSRF15	Resurfacing (Overlay < 2.5 Inches w/ some full depth patch)
	COLD10	Partial Depth CIR with <= 2.5 Inch Cap
	COLD20	Partial Depth CIR with > 2.5 Inch Cap
	MISC	Work that isn't otherwise classified, including ancillary roadway
	BRPVTV	Bridge Preservation
Rehabilitation	PSRS40	Short Term Overlay (Mill & Overlay)
	RSRF20	Resurfacing (Overlay >= 2.5 Inches and < 4 inches)
	RSRF25	Resurfacing (Overlay >= 4 inches & doesn't increase profile)
	RSRF30	Resurfacing (Overlay >= 4 inches)
	PVRPLA	Pavement Replacement
	COLD30	Full Depth CIR
	RCND10	Resurfacing and intersection/shoulder/pavement widen
	RCND20	Resurfacing and improve curve/grade/sight/intersect
	BRRHB	Bridge Rehabilitation
Reconstruction	RECST	Reconstruction
	RECSTE	Reconstruction with Expansion
	PVRP_O	Pavement Replacement w/ Operational Improvement
	BRELIM	Elimination of Bridge
	BRRPLE	Replacement and expansion of existing Bridge
	BRRPL	Replacement of existing Bridge
New Construction	BRNEW	Construction of New Bridge