

Transportation Asset Management Plan



December 2015

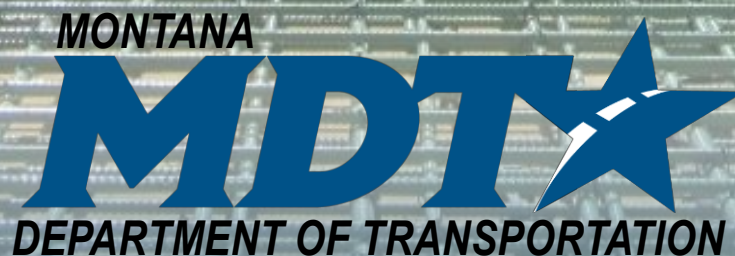




Table of Contents

1. Managing Our Assets.....	3
Transportation Asset Management Overview	5
2. Managing Pavements	6
Pavement Inventory.....	6
Measuring Pavement Condition	6
Pavement Condition Trends	7
Pavement Goals and Performance Targets	9
Identifying and Selecting Pavement Projects	9
Pavement Life Cycle Cost Considerations	11
Projecting Future Pavement Conditions	12
3. Managing Bridges	13
Bridge Inventory.....	13
Measuring Bridge Condition	13
Bridge Condition Trends	14
Bridge Goals and Performance Targets	16
Identifying and Selecting Bridge Projects	16
Bridge Life Cycle Cost Considerations	17
Projecting Future Bridge Conditions	18
4. Managing Risk	20
Risk and Risk Management Definitions.....	20
Identifying, Assessing, and Prioritizing Risks	20
Risk Management.....	21
5. Financial Plan.....	23
Valuing Montana's Assets	23
Funding Sources.....	23
Balancing Needs and Funding	23
Allocating Funds for Asset Management.....	24
Anticipated Funding Levels	25
Performance Gap Assessment.....	26
6. TAMP Investment Strategies	27
7. Future TAMP Enhancements.....	28

Photo: MDT, Two Medicine Bridge Project

1. Managing Our Assets

In an era of constrained resources, effective management of transportation assets is an increasingly important function of transportation agencies. The Montana Department of Transportation (MDT) is committed to managing assets as a key business practice. MDT strives to maintain transportation assets in a state of good repair over the long-term with the most efficient investment of resources.

Beginning in 1999, MDT began the annual Performance Programming Process (P3) to develop an optimal investment plan and measure progress towards strategic transportation goals established by TranPlan 21 - MDT's statewide long range transportation plan. Through P3, MDT sets condition targets, tracks progress, and evaluates network level conditions for pavements and bridges to maintain consistent conditions throughout the state. As part of P3, MDT allocates funds based on scenario analyses with consideration of budget and work type tradeoffs. These analyses are a fundamental part of a comprehensive asset management program and MDT continues to build technical capacity to actively manage our transportation infrastructure assets.

This Transportation Asset Management Plan (TAMP) is MDT's first formal plan that builds from the foundation established by P3 and describes how MDT manages pavements and bridges to fulfill the requirements of MAP-21. The 2015 TAMP extends beyond federal compliance and positions MDT as a leader in managing assets for performance. The plan emphasizes:

- ★ **Communicating asset management objectives** and outcomes to MDT's internal and external stakeholders;
- ★ **Documenting a management approach** for transportation assets that align strategic policy goals with project selection and budgeting decisions;
- ★ **Synthesizing information** to develop a complete story of the state of transportation assets in Montana and how condition is expected to change over time with available funding;
- ★ **Identifying potential investment strategies** that will help MDT achieve performance goals in a fiscally constrained environment;
- ★ **Assessing risks affecting transportation** assets in Montana and MDT's ability to manage these risks; and
- ★ **Documenting current gaps** in MDT's asset management framework and identifying the activities and resources needed to close those gaps and enhance asset management practices.

The 2015 TAMP was developed throughout 2014 and finalized December of 2015. MDT staff and a TAMP Steering Committee, composed of managers from various agency functions, guided the effort and contributed significantly to identifying risk management and mitigation activities, examining current gaps and potential enhancements, and developing investment strategies.

What is Asset Management?

Transportation Asset Management is a process to strategically manage transportation systems in a cost-effective, safe, efficient, and environmentally sensitive manner. This approach focuses on performance to manage systems for optimal results.

The previous federal transportation reauthorization legislation Moving Ahead for Progress in the 21st Century Act (MAP-21) further institutionalized asset management by requiring that all state departments of transportation develop a risk-based transportation asset management plan (TAMP) for pavements and bridges on the National Highway System.

MDT's TAMP meets current federal requirements and positions MDT to respond to expected future guidance on asset management rules and performance guidelines.



MDT's 2015 TAMP aligns with MAP-21 requirements to develop a risk-based asset management plan. The TAMP includes detailed analysis and reporting of current pavement and bridge conditions; identifies strategies to manage risks; provides a 10-year financial plan and investment scenarios; and, describes current gaps and future enhancements to MDT's asset management framework. The document is organized into the following chapters:

- ★ **Chapter 2: Managing Pavement** – Provides an overview and trends in MDT's pavement condition and details how MDT manages pavement decisions. This section defines the goals of the pavement program, discusses life cycle cost considerations, describes MDT's pavement project selection process, and discusses how future pavement conditions will be addressed.
- ★ **Chapter 3: Managing Bridges** – Describes trends in MDT's historical bridge conditions and defines bridge program goals. This section provides an overview MDT bridge project selection process and discusses expected future bridge conditions.
- ★ **Chapter 4: Managing Risk** – Presents MDT's initial asset management risk register, which is a consensus scoring of risks based on likelihood and consequences. This section identifies mitigation strategies to address major risks that could impact MDT's ability to meet asset management goals.
- ★ **Chapter 5: Financial Plan** – Summarizes MDT's funding outlook and documents expected MDT funding for asset management activities over the next 10 years. This section describes future condition levels and potential performance levels MDT can achieve with projected funding.
- ★ **Chapter 6: Investment Scenarios** – Introduces the investment strategies MDT will employ to achieve asset management goals and targets.
- ★ **Chapter 7: Asset Management Enhancements** – Describes how MDT intends to enhance asset management practices in the future.

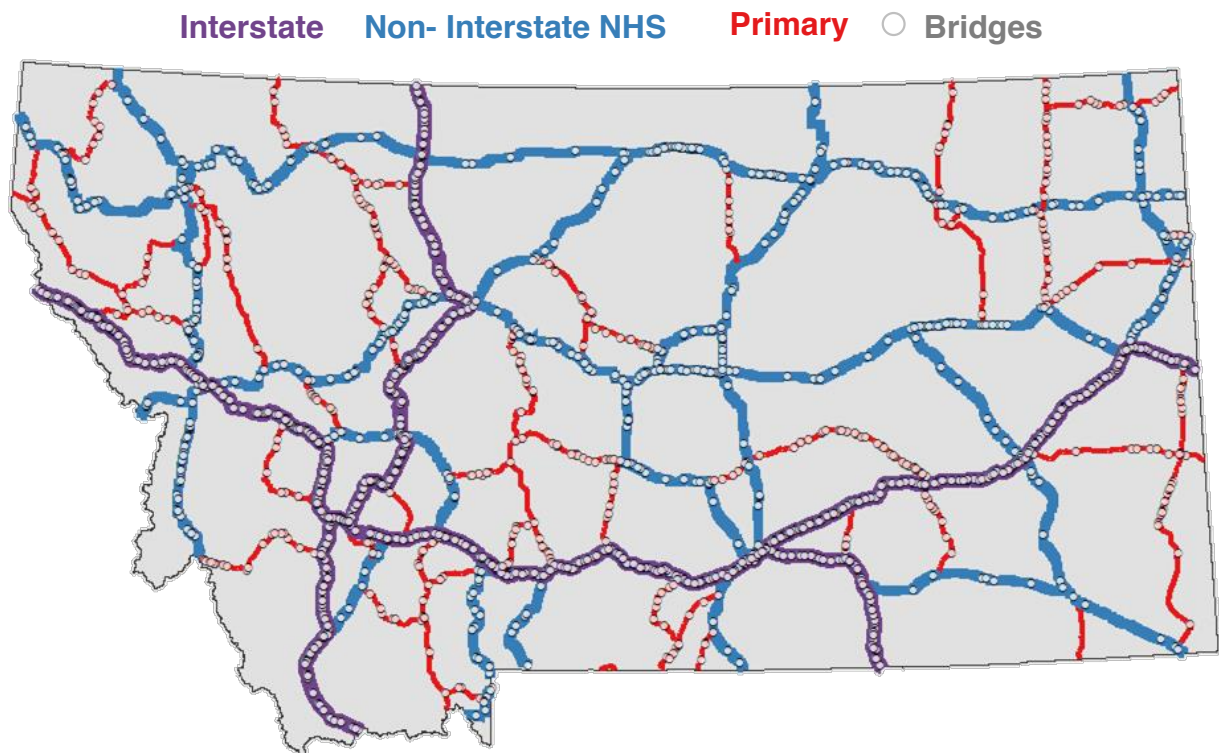
Transportation Asset Management Overview

MDT's 2015 TAMP covers a historical period from 2005 through 2014 and looks ahead from 2015 through 2024. The plan addresses pavements and bridges on the National Highway System including both Interstate and Non-Interstate roadways as well as MDT's Primary Highway System.

The National Highway System (NHS) includes the Interstate Highway System as well as other non-Interstate highways important to the nation's economy, defense, and mobility. The U.S. Department of Transportation (US DOT) in cooperation with state, regional, and local officials developed the NHS. MAP-21 expanded the system to include additional Principal Arterials in Montana.

MDT designates a strategic system of Primary, Secondary, and Urban highways that are critical to state and local economies and interregional travel. The Primary Highway System consists of a system of connected roads important to interstate, statewide and regional travel, including rural arterial routes and their extensions in urban areas. This system includes routes functionally classified as principal or minor arterials and others selected by the Montana Transportation Commission. This TAMP focuses on the NHS and state Primary Highway System (Primary).

MDT is responsible for over 16,583 lane miles of paved roadways and 1,660 bridges on Interstate, Non-Interstate NHS and Primary roadways. Roads and bridges that are owned and maintained exclusively by Federal agencies or tribal governments and locally-owned roads and bridges are not covered in this TAMP. The map below illustrates the extent of the three main highway systems and bridge structures addressed under the asset management program.



2. Managing Pavements

Pavement Inventory

There are approximately 75,000 centerline road miles open to public travel in Montana which carry over 12 billion vehicle miles of travel annually. The majority of miles travelled (over 60 percent) occur on just 9 percent of the roadway system – the Interstate, Non-Interstate-NHS and Primary road networks. For the purposes of this TAMP, MDT focuses on these three major highway systems. Table 2.1 shows the breakdown of pavement centerline (single roadway) and lane miles (individual lanes on a roadway) by system.

TABLE 2.1 MDT PAVEMENT INVENTORY, 2014

	System	Centerline Miles	Lane Miles
Assets Included in TAMP	Interstate	1,192	4,770
	Non-Interstate NHS	2,990	6,625
	Primary	2,575	5,188
	Total	6,757	16,583

Source: MDT TIS Roadlog

Measuring Pavement Condition

MDT collects pavement condition data on a regular basis using road profiling systems, lasers, and 3D cameras. MDT manages pavement condition data using a Pavement Management System (PvMS) and analyzes data collected to calculate the following condition rating metrics.

- ★ **Ride Index (RI)** – A measure of traveler perception of ride smoothness. Ride Index is based on the International Roughness Index (IRI), which is the international standard for smoothness. MDT calculates RI by converting IRI to a 0-100 scale and assigning Good, Fair, Poor categories using the thresholds outlined in the table below. These thresholds are consistent with those used by MDT for P3 performance measures. Further condition performance measure guidance from FHWA is pending and, until that guidance is updated, MDT will use the thresholds defined below throughout this TAMP.

RIDE INDEX COMPARED TO INTERNATIONAL ROUGHNESS INDEX

State of Repair	P3 Designation	Ride Index	IRI
Good	Superior	≥80	<75
Fair	Desirable	≥60 and <80	76-150
Poor	Undesirable	<60	>150

- ★ **Rut Index (Rut)** - A measure of rutting in the wheel path, reported on a 0-100 scale.
- ★ **Alligator Crack Index (ACI)** - A measure of the amount of cracking caused by repeated traffic loading (also known as fatigue cracking), reported on a 0-100 scale.
- ★ **Miscellaneous Crack Index (MCI)** - A measure of the amount of cracking caused by environmental changes or material or design deficiencies (also known longitudinal or transverse cracking) reported on a 0-100 scale.



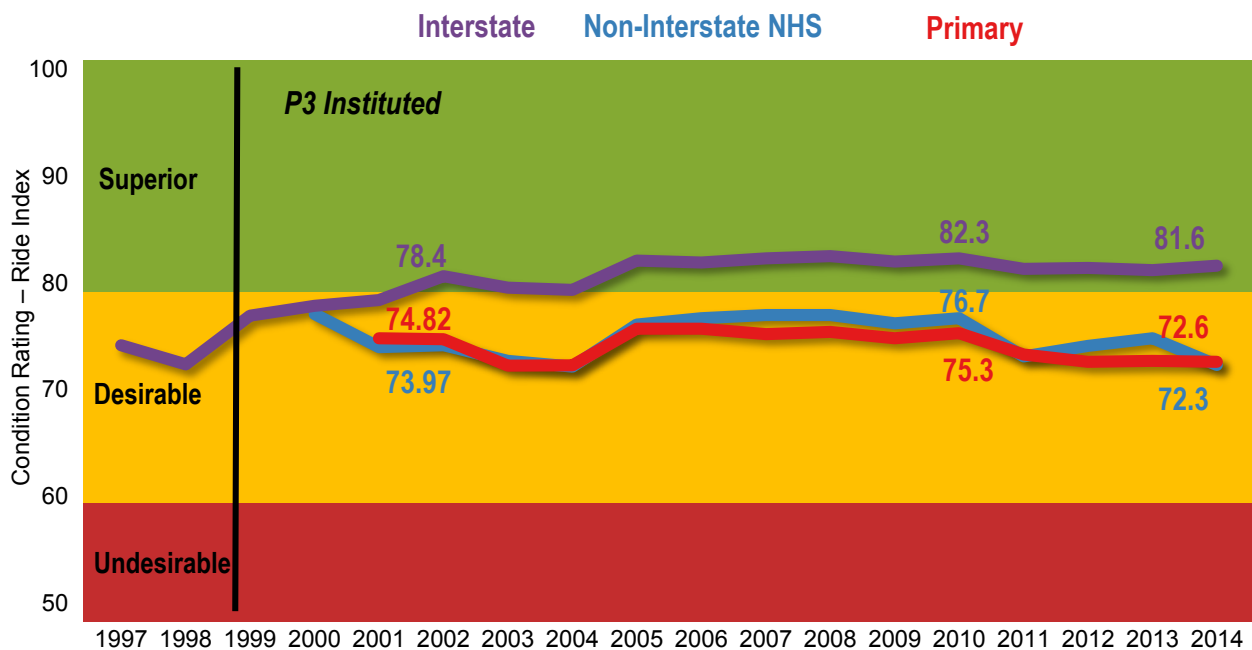
MDT uses each of these measures for different purposes. For instance, Ride Index (RI) is used as the main performance measure for pavements in P3. MDT establishes RI performance targets by roadway system to achieve consistent pavement conditions throughout the state. RI, Rut, and both ACI and MCI measures are used to identify potential pavement project treatments. MDT engineering staff utilizes pavement condition data along with traffic and truck volumes as well as in-place materials to select appropriate projects to preserve pavement condition while addressing safety, capacity, and additional needs.

Pavement Condition Trends

Beginning in 1999, MDT began to utilize the annual Performance Programming Process (P3) to develop an optimal investment plan and measure progress towards statewide strategic transportation goals. Through P3, MDT establishes condition targets, tracks progress, and evaluates network level conditions for pavements to maintain consistent conditions throughout the state. MDT sets a P3 performance target of maintaining the Interstate, Non-Interstate NHS and Primary systems in the Desirable to Superior range.

Figure 2.1, below, illustrates the impact of MDT's performance management approach to maintaining and improving the condition of Montana roadways. The figure depicts average pavement condition ratings for MDT's three roadway systems along with RI-defined performance categories of Superior, Desirable, and Undesirable. Over the past 15 years, pavement conditions in Montana are generally remaining stable with slight deterioration.

FIGURE 2.1 HISTORICAL PAVEMENT CONDITION - RIDE INDEX

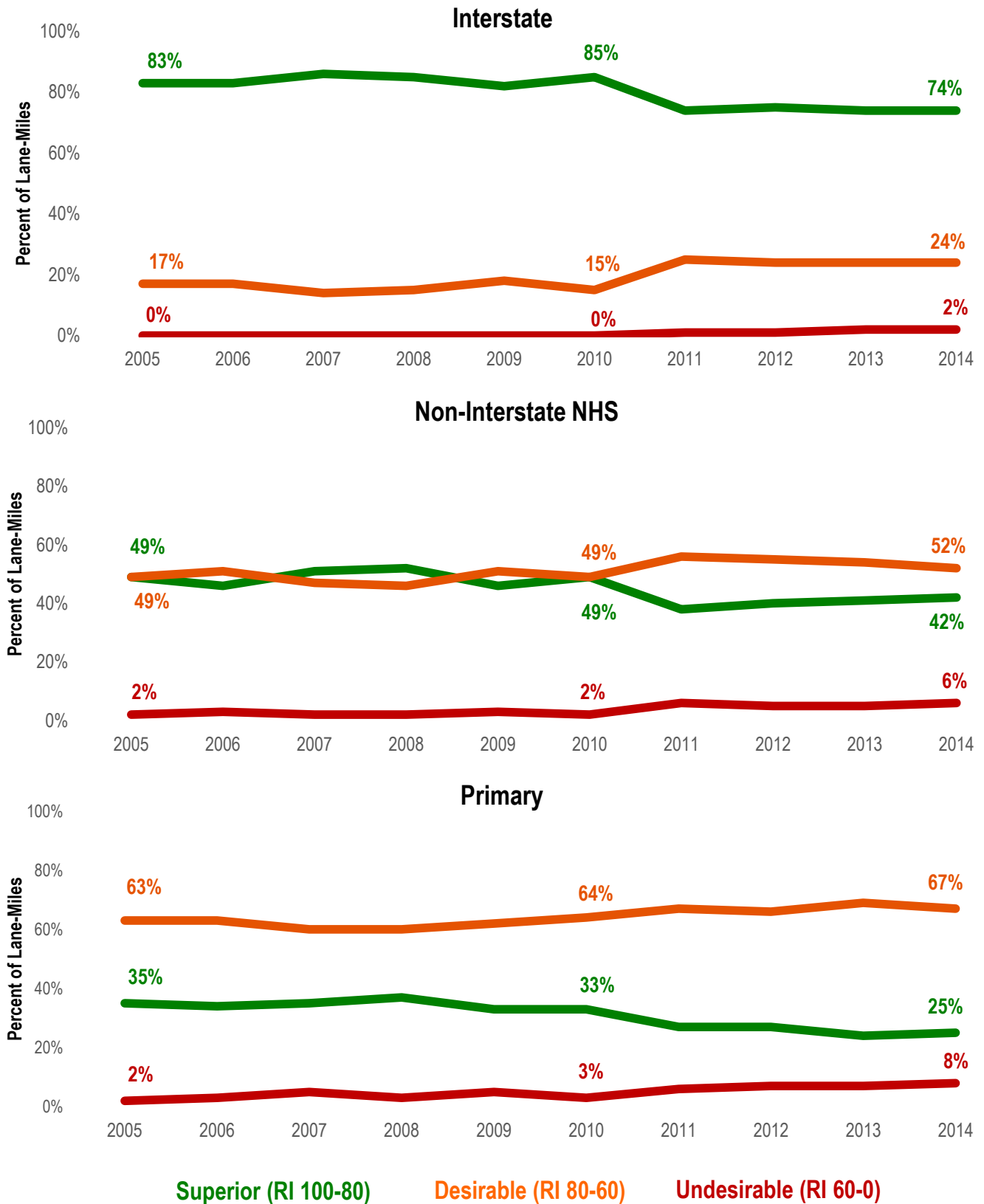


Source: MDT, Materials Bureau, PvMS data

The series of graphics in Figure 2.2, on following page, illustrates changes in pavement condition over the past ten years for MDT's major highway systems. The following charts appear to show large changes in condition between 2010 and 2011. However, these shifts are the result of a combination of events including: extensive flooding, increased lapsed time between treatments, and updated data collection equipment that improved data quality. Overall, the majority of Interstate and Non-Interstate NHS roadway lane miles remain in Superior condition, but are declining and will likely continue to do so. Primary system lane miles largely remain in Desirable condition but could worsen over time.



FIGURE 2.2 HISTORIC PAVEMENT CONDITION BY SYSTEM (PERCENT LANE MILES)





Pavement Goals and Performance Targets

MDT's Pavement Program directly supports the statewide goals established by TranPlan 21. MDT's system wide asset management priorities focus on implementing the right pavement treatments in the right places at the right times. MDT continues to implement the following activities and actions in support of strategic statewide goals:

- ★ **Preservation of the existing system** – provide the “right treatment at the right time” to actively manage pavements using cost-effective treatments. Activities include crack seal, seal and cover, rut fill, mill/fill, overlay, micro-surfacing, cold-in-place recycle, and hot-in-place recycle treatments.
- ★ **Capacity expansion and mobility improvements** – improving the roadway network when the current roadway can no longer support continued growth using current geometrics. Activities include major rehabilitation and reconstruction treatments to address level of service deficiencies by adding lanes and/or shoulder width.
- ★ **Safety and other improvements** – maintaining pavement condition to ensure safety for the traveling public. Activities related to safety include rut-fill, chip seal, concrete diamond grind.

Pavement Preservation Strategic Goal

MDT also defines a specific pavement goal through P3. This goal is to “*preserve highway pavement condition at existing or higher levels on the Interstate, Non-Interstate NHS, and Primary Systems.*” MDT also establishes the following performance target corresponding to this goal:

- ★ **Average Ride Index Desirable or Superior (RI \geq 60)**

Identifying and Selecting Pavement Projects

MDT's PvMS divides highways into segments that are similar in structure, number of lanes, and traffic volumes for the purposes of identifying pavement treatments. PvMS calculates average condition for each segment using measures of ride, rut, fatigue cracking and miscellaneous cracking. The system forecasts future condition for each condition metric and then applies decision tree logic in order to determine appropriate pavement treatment types. Pavement treatment types consist of the following maintenance and preservation activities:

- ★ **Preventive Maintenance** – MDT considers both scheduled maintenance and pavement preservation activities as preventive maintenance. Preservation work applies to pavements in good condition and can slow deterioration rates. Typical preventative treatments include crack seals, chip seals, overlays and microsurfacing. Crack seals are generally completed between three and six years after project completion or as needed. Chip seals are initially completed with pavement resurfacing projects and then reapplied between six and twelve years after project completion. MDT generally uses overlays and microsurfacing on roads over twelve years old to address observed pavement distresses.
- ★ **Minor Rehabilitation** - MDT applies minor rehabilitation activities to rehabilitate existing pavement surfaces through an engineered approach that considers observed pavement distress and in-place materials. This treatment extends the life of the pavement structure by rehabilitating the wearing surface only. Typical treatments include: thin overlays, mill-fills, hot in-place recycle, or cold in-place recycle with overlay.



- ★ Major Rehabilitation - MDT applies major rehabilitation activities to extend the life of the pavement, improve ride quality, and/or enhance capacity. The majority of major rehabilitation work is on existing alignments, but may include rebuilding substandard horizontal or vertical curves. Typical treatments include milling and overlay and recycle pulverization with overlay.
- ★ Reconstruction - MDT applies reconstruction treatments at the end of a pavement's serviceable life or when geometric improvements are required.

MDT's Materials Bureau provides recommended pavement treatments from PvMS to District Offices and District Engineering staff, through the annual Pavement Performance and Condition Report. This report is a resource used by the Districts when selecting the best mix of projects to address needs while also meeting performance and funding targets established by P3. Districts also consider other factors when selecting pavement projects including: level of service, safety, environmental impacts, and maintenance activities to determine appropriate projects. Districts follow guidance provided in the Guidelines for Nomination and Development of Pavement Projects Joint Agreement. These pavement project guidelines are summarized in Table 2.2.

TABLE 2.2 GUIDELINES FOR NOMINATION AND DEVELOPMENT OF PAVEMENT PROJECTS

Category	Preventative Maintenance		Rehabilitation		Reconstruction
	Scheduled Maintenance	Pavement Preservation	Minor	Major	
Surface Engineering	None < 0.20 ft Overlay	None < 0.20 ft Overlay	Engineered	Engineered	Engineered
Environmental Documentation	NEPA/MEPA	NEPA/MEPA	NEPA/MEPA	NEPA	NEPA
Geometric Standards	As-Built	As-Built	As-Built	As-Built to Current Standards	Current Standards
Safety and Capacity Considerations	Crash Cluster and ADA Evaluations	Treatable Trends, Clusters, Clear Zone, Signage, Guardrail Criteria, ADA Evaluations	Treatable Trends, Clusters, Clear Zone, Signage, Guardrail & ADA Criteria, Width, Slope, and Geometric Evaluations		Full Safety and Capacity
Applied Treatments	Seal & Cover, Crack, Joint, Fog, & Sand Seal, Micro Surfacing Overlay	Seal and Cover, Crack, Sand, & Fog Seal, Rut Fill, Mill OGFC, Micro Surfacing Overlay, Mill & Fill, Cold In-Place Recycle with Chip Seal	Overlay, Mill & Fill, with Overlay, Cold In-Place Recycle with Overlay, No Exposure of Base Gravel	Overlay, Mill, Overlay, Recycle Pulverize with Overlay, If Base Gravel Exposed Treat/Modify Gravels	Full Surfacing Standards
How Needs Are Identified	Scheduled Treatments	Observed Distress PvMS Recommendations	Observed Distress PvMS Recommendations	Observed Distress Geometrics, Safety Considerations	Operational Factors, Geometrics
Eligible Funding Source	Maintenance Funds	Maintenance Funds	----	----	----
	State Construction	State Construction	State Construction	----	----
	Federal Aid	Federal Aid	Federal Aid	Federal Aid	Federal Aid

Source: MDT Guidelines for Nomination and Development of Pavement Projects

Pavement Life Cycle Cost Considerations

In 1999, MDT implemented a pavement preservation program after analyzing and comparing the effectiveness of worst-first and pavement preservation strategies. The objective of the pavement preservation program is to slow the rate of deterioration, while providing a smooth, safe, and durable roadway at the lowest lifecycle cost. This strategy includes establishing funding “plugs” or allocations for preservation treatments - a practice that continues today.

Pavement deterioration results from environmental factors and traffic volumes. As pavements deteriorate they lose structural and/or functional capacity. Preventative maintenance and rehabilitation improves pavement condition, extends pavement service life, postpones major reconstruction needs, and provides a safe driving surface.

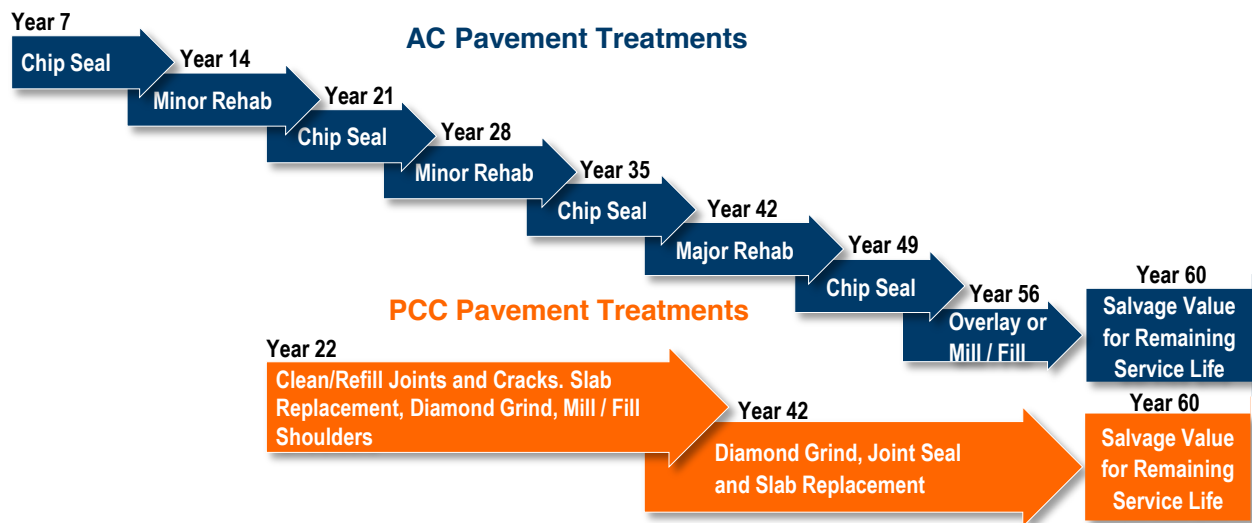
MDT manages pavement assets in a strategic and proactive way by:

- ★ Aggressively applying preventive maintenance solutions such as chip seals with each new surfacing project.
- ★ Deploying trained maintenance personnel and advanced technology to apply needed maintenance actions at the right place at the right time.
- ★ Designing new facilities for durability and longer life using state-of-the-art materials and methods.

PvMS recommends treatments based on a series of decision trees that reflect life-cycle cost considerations MDT provides these recommendations for MDT engineering staff to use in minimizing pavement’s life cycle costs. MDT also conducts detailed life cycle cost analysis for major rehabilitation and reconstruction projects. As part of this analysis, design staff evaluate multiple design alternatives and estimate the cost of future activities over a life cycle of 40 or more years.

The goal of this process is to select a design alternative that leads to the lowest life cycle cost and not necessarily the one that has the lowest initial construction cost. The activities and timings assumed for the life cycle cost analysis in the design phase are provided in Figure 2.3 below.

FIGURE 2.3 PAVEMENT LIFE CYCLE TREATMENTS



Projecting Future Pavement Conditions

MDT is currently upgrading its pavement management system with improved analytics. Additionally, MDT will further review the system's performance models (ride and rut) and verify accuracy after completing a software upgrade that is expected early 2016.

Using the existing analytics and based on flat growth P3 analysis, MDT expects the condition of the Interstate, Non-Interstate NHS and Primary systems to decline slightly over the next 10 years, while remaining within the current performance target thresholds. MDT's confidence in these projections is based on years of experience projecting future conditions and monitoring progress towards specific targets through P3. The previously noted effort to update PvMS analytics will address gaps in this analysis and ensure MAP-21 compliance. Current gaps and future enhancements are detailed below.

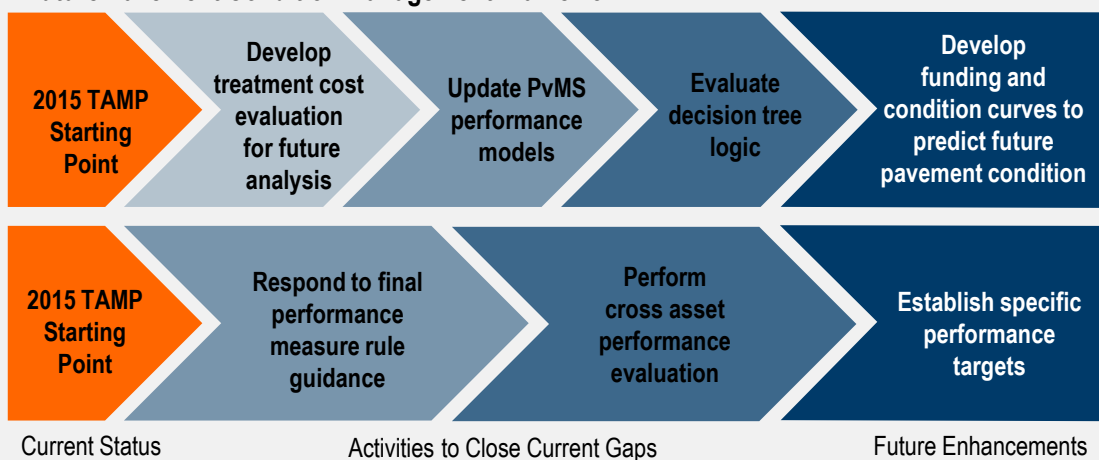
Current Pavement Management Gaps and Future Enhancements

MDT's 2015 TAMP provides the starting point for developing a robust pavement management framework. However, there are current gaps in MDT's analytical capabilities, data systems, and evaluation processes that must be closed.

- To better predict future pavement conditions, MDT is working on developing enhanced funding and condition curves. This analysis requires that MDT analyze potential treatment costs, update PvMS performance models and continually evaluate decision tree logic.
- To establish realistic and attainable statewide pavement condition performance measures, MDT is developing capabilities to perform cross-asset performance evaluations and is awaiting final guidance on MAP-21 performance measures from U.S DOT.

MDT is currently working on these activities. Additional resources may be required to fully move MDT toward an enhanced pavement management framework. An action plan is being developed to address the gaps identified here.

Future Pavement Condition Management Framework



3. Managing Bridges

Bridge Inventory

MDT inspects the status and condition of Montana's bridges every year and reports to the Federal Highway Administration. This annual reporting includes inventory and inspection data for bridges and culverts that are 20 or more feet in length and located on public roads. In 2014, there were over 4,168 bridges and 280 culverts throughout the state that met these criteria.

Not all of those structures are addressed by the guidelines and processes in MDT's TAMP. This plan focuses on bridges and culverts on Montana's Interstate, Non-Interstate NHS, and Primary Systems and does not cover bridges that are federally maintained – for example some bridges in national parks or on tribal lands. Table 3.1 shows a breakdown of structures by highway system. Overall, 1,660 bridges (40 percent of statewide total) and 149 culverts (53 percent of total) are covered by the TAMP.

TABLE 3.1 BRIDGES AND CULVERTS IN MONTANA, 2014

	System	Bridges (#)	Bridge Deck Area (ft ²)	Culverts (#)	Culvert Deck Area (ft ²)
Assets Included in TAMP	Interstate	799	7,178,463	32	63,453
	Non-Interstate NHS	444	3,944,726	79	95,422
	All NHS	1,243	11,123,189	111	158,875
	Primary	417	2,202,522	38	33,110
	TAMP Total	1,660	13,325,711	149	191,985

Measuring Bridge Condition

MDT inspects bridges every two years consistent with the requirements of the National Bridge Inventory (NBI) program. MDT also conducts additional routine maintenance inspections every six months to identify debris, scour, cracking, and other deterioration of major bridge components. These regular inspections occur in between the standard federal inspection cycle to proactively identify issues.

Three major components of bridges are individually inspected and rated. These primary components include: the deck surface which vehicles drive on; the superstructure supporting the deck; and, the substructure which transfers the load of the bridge to the foundation. These components are evaluated with the following rating systems:

- ★ **Structure condition:** MDT assigns a condition rating of Good, Fair, or Poor based on the minimum NBI condition rating for a bridge superstructure and substructure. MDT considers all structurally deficient bridges to be in poor condition.

Structure Condition Rating System

Minimum Super / Substructure Condition Rating	Structure Condition
> 5 (and bridge is not Structurally Deficient)	Good
= 5 (and bridge is not Structurally Deficient)	Fair
< 5 (or bridge is Structurally Deficient)	Poor



- ★ **Deck condition:** MDT evaluates deck condition based on NBI ratings and assigns a rating of Good, Fair, or Poor based on the thresholds provided in the table below. To support internal decision-making, MDT further divides the Fair category into “Fair-1” and “Fair-2”. These rating scales are used to determine appropriate preservation treatments for bridges.

Deck Condition Rating System		
Deck NBI Condition Rating	Deck Condition (for reporting)	Deck Condition (for decision making)
> 6	Good	Good
6	Fair	Fair-1
5		Fair-2
< 5	Poor	Poor

- ★ **Structural deficiency:** NBI condition ratings are assessed on a scale of 1 to 9. A bridge is considered structurally deficient if any of the deck, superstructure or substructure has a NBI condition rating of less than 5. This term is not meant to imply that a bridge is unsafe. Rather, it is used to identify bridges that require significant repair work to remain in service and will eventually require more substantial work such as rehabilitation or replacement to address underlying deficiencies.

Bridge Condition Trends

Figure 3.1, below, displays the percent of structurally deficient bridges by roadway system over the past decade. Historic trends appear to indicate an increase in deficient bridges between 2009 and 2010. This increase is not necessarily a reflection of actual conditions, but a result of MDT’s effort to improve quality assurance and coverage in its bridge inspection program. With better inspection data a more accurate picture of the bridge network became available.

FIGURE 3.1 PERCENT OF STRUCTURALLY DEFICIENT BRIDGES BY SYSTEM

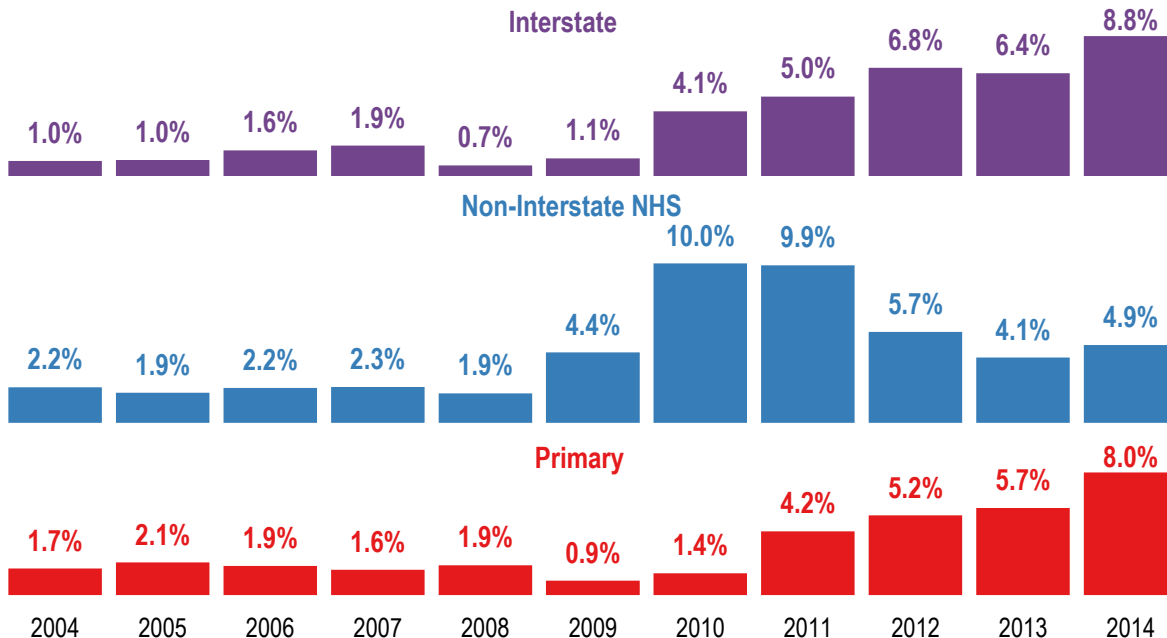
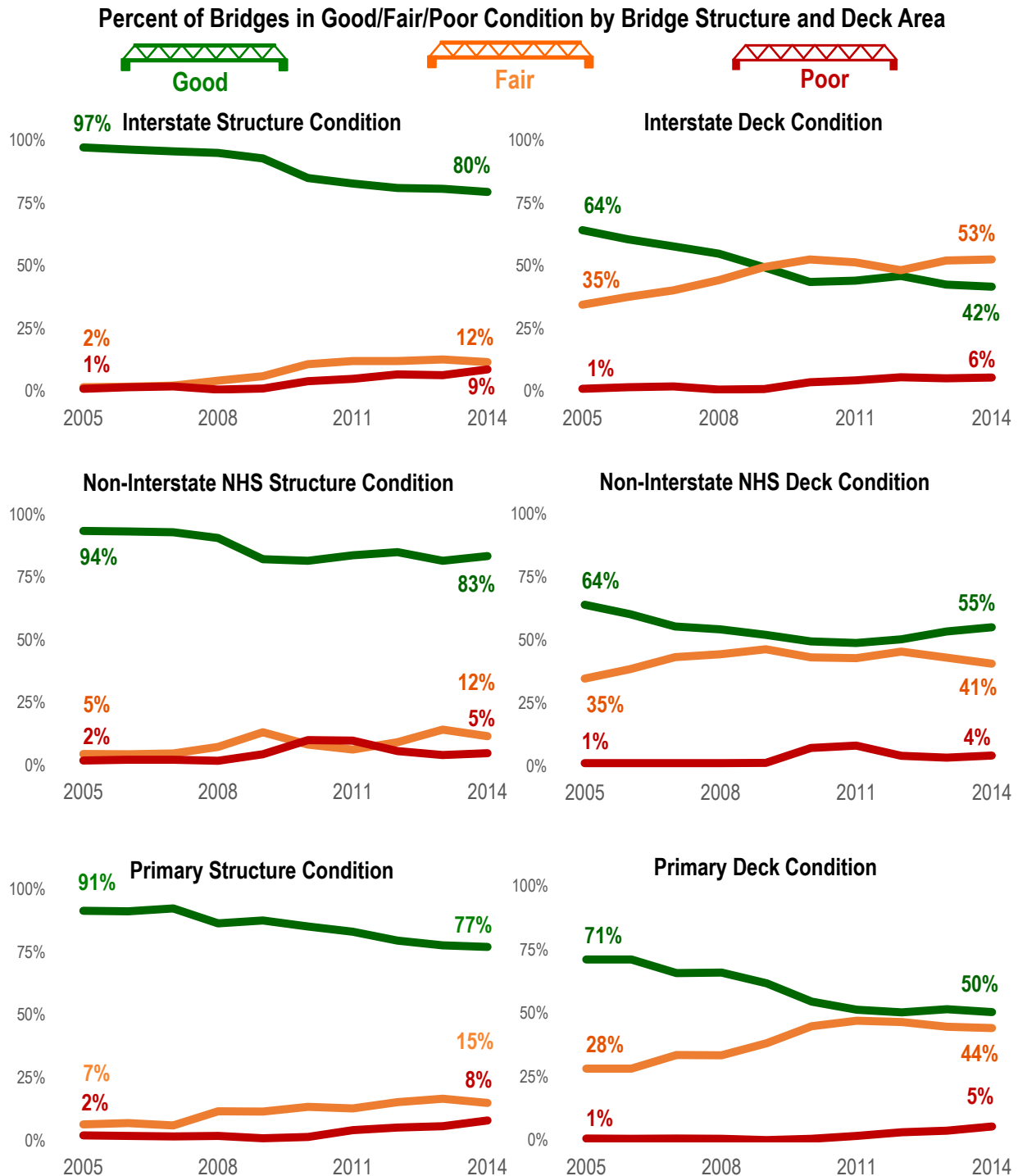




Figure 3.2, below, illustrates bridge structure and deck conditions over the past 10 years. These data demonstrate that the condition of MDT's bridges are steadily declining. While the percent of bridges rated in poor condition remain relatively stable, over time more and more good condition bridges are deteriorating into fair condition.

FIGURE 3.2 HISTORIC BRIDGE CONDITIONS



Bridge Goals and Performance Targets

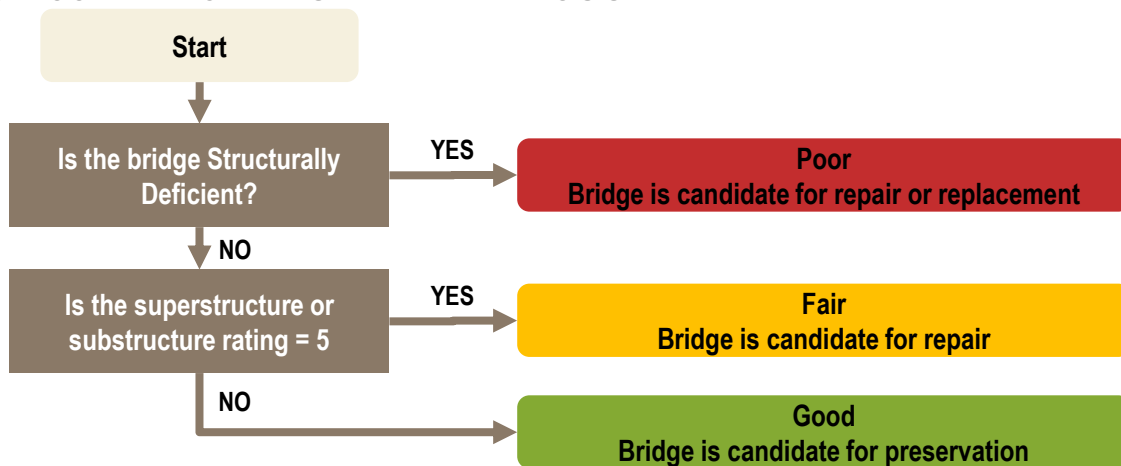
MDT's Bridge Program supports the goals established in, TranPlan 21, through the following priorities:

- ★ **Preservation of the existing system** – providing the “right treatment at the right time” in order to manage pavements using cost-effective treatments. Activities include bridge deck rehabilitation, corrosion mitigation, joint repair or replacement, and bridge rail upgrades.
- ★ **Capacity expansion and mobility improvements** – improving the roadway network when the current roadway can no longer support continued growth using current geometrics. Activities include full replacements on new alignments with increased traffic capacity
- ★ **Safety and other improvements** – maintaining bridge condition to ensure safety for the traveling public. Activities related to traffic safety range from simple skid treatments to full replacements or new alignments. Other activities cover seismic retrofitting of vulnerable bridges and installation of scour countermeasures on susceptible bridges.

Identifying and Selecting Bridge Projects

MDT applies a series of decision trees when selecting bridge maintenance and preservation treatments. Utilizing the bridge improvement type decision process illustrated in Figure 3.3, below, MDT determines if a bridge is a candidate for repair, replacement, or preservation.

FIGURE 3.3 BRIDGE IMPROVEMENT TYPE DECISION TREE

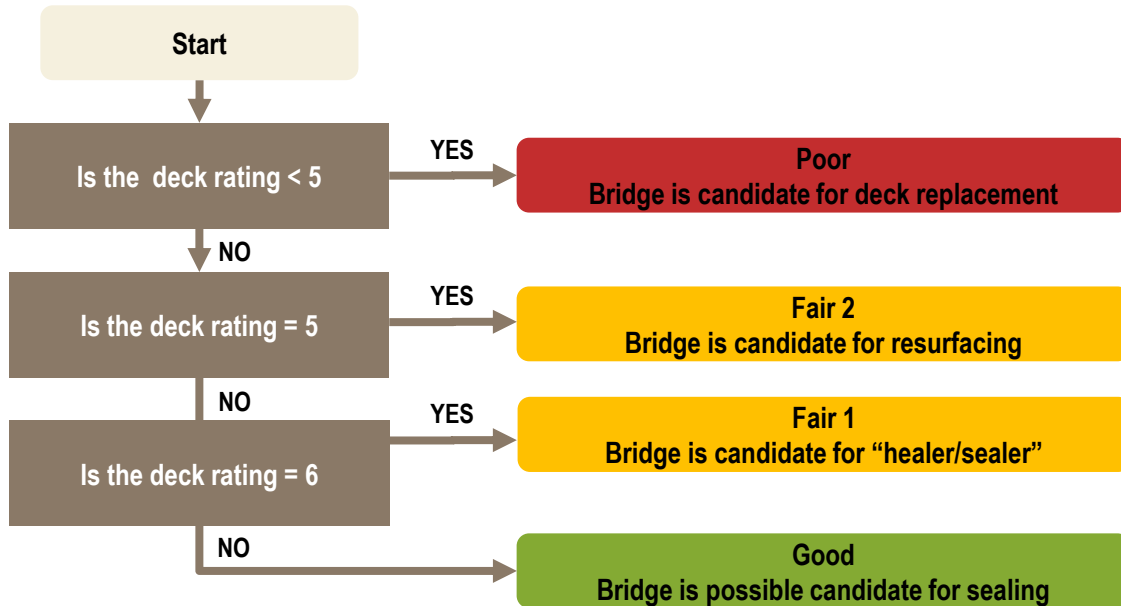


Based on NBI ratings, bridges are grouped by overall condition. Overall rating identify trends in the condition of critical elements of bridge structures. Trends help show common types of deterioration or may highlight repair or preservation needs that are applicable across all bridges, regardless of condition. This analysis helps develop cost effective strategies to address bridge needs and the decision process helps ensure that appropriate bridge projects are selected.

MDT considers preservation activities for bridges in Fair or Good condition based on the potential of these activities to reduce life-cycle costs and delay the time at which more substantial and expensive bridge improvements are required. Decision tree logic provides a simple and quick determination of whether preservation is likely to be cost-effective for a particular bridge given its condition. MDT uses this rationale to identify when preservation treatments should be considered from a life-cycle cost perspective.

Bridge decks generally deteriorate at a faster rate than other key bridge elements. MDT uses a bridge deck preservation decision process, illustrated in Figure 3.4, below to select deck work. Deck condition ratings determine appropriate treatments. Once MDT selects a bridge for deck work, the condition of other bridge elements is reviewed and other structural work can be included if appropriate.

FIGURE 3.4 BRIDGE DECK PRESERVATION DECISION TREE



Life cycle cost implications of specific preservation treatments are also evaluated in order to assess their cost effectiveness relative to more substantial treatments. For example, the service life of a bridge deck is significantly less than other major bridge components and deck condition often drives structural deficiency status. Assessing deck condition separately from overall bridge condition and considering deck improvements as standalone activities enables MDT to defer the need for more costly bridge rehabilitations and replacements when a bridge is otherwise in good condition.

Individual bridge improvements are also considered from a life-cycle cost perspective. MDT selects bridges for preservation work or may combine multiple bridges along a route or in a geographic area. If similar needs are identified in an area the work can be bundled into one project to be cost-effective. MDT's Bridge Bureau reviews recommended bridge improvement type with input from Districts, MPOs, and local governments.

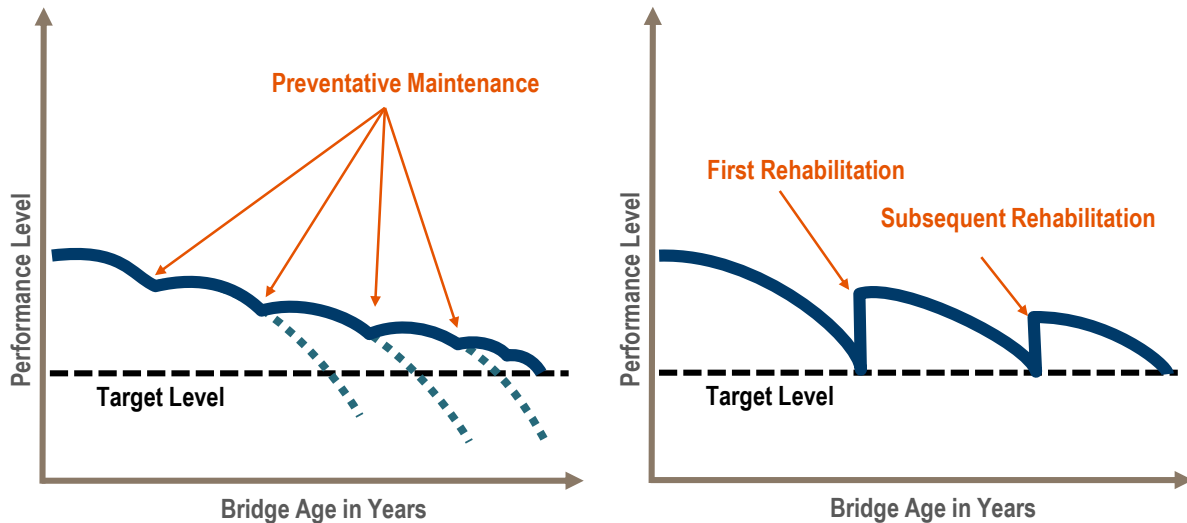
Bridge Life Cycle Cost Considerations

Historically, federal funds could not consistently be used for proactive, preservation-focused bridge improvements. Restrictions on federal bridge funds tended to promote a "worst-first" philosophy in project selection. A defined set aside for bridge improvements also further restricted the ability to transfer funds. These requirements incentivized the selection and implementation of bridge improvements regardless of their cost-effectiveness.

Under current federal legislation, MDT now has more flexibility to determine an appropriate budget level for the bridge program and to consider a greater array of preservation activities. These changes enable MDT to move from a "worst-first" approach to a "right treatment at the right time" approach. One of the main goals of a right-time approach is minimizing bridge life cycle costs. This philosophy also cost-effectively improves bridge conditions and the overall safety of the system.

Figure 3.5, below, illustrates the life-cycle activity profile of two differing bridge investment strategies. The left-hand graph illustrates the effect of bridge preservation. Preservation activities are typically assumed to be relatively small investments that do not result in an immediate improvement to the condition of a bridge but rather slow bridge deterioration and extend bridge service life. The right-hand graph illustrates a routine maintenance, rehabilitation and repair strategy. Bridge rehabilitation and repair result in an immediate condition improvement but are typically more expensive than preservation activities. It is important to consider the costs and benefits of each of these investment profiles over the full life of an asset to determine which approach is most cost-effective.

FIGURE 3.5 LIFE CYCLE COST CONSIDERATIONS IN BRIDGES



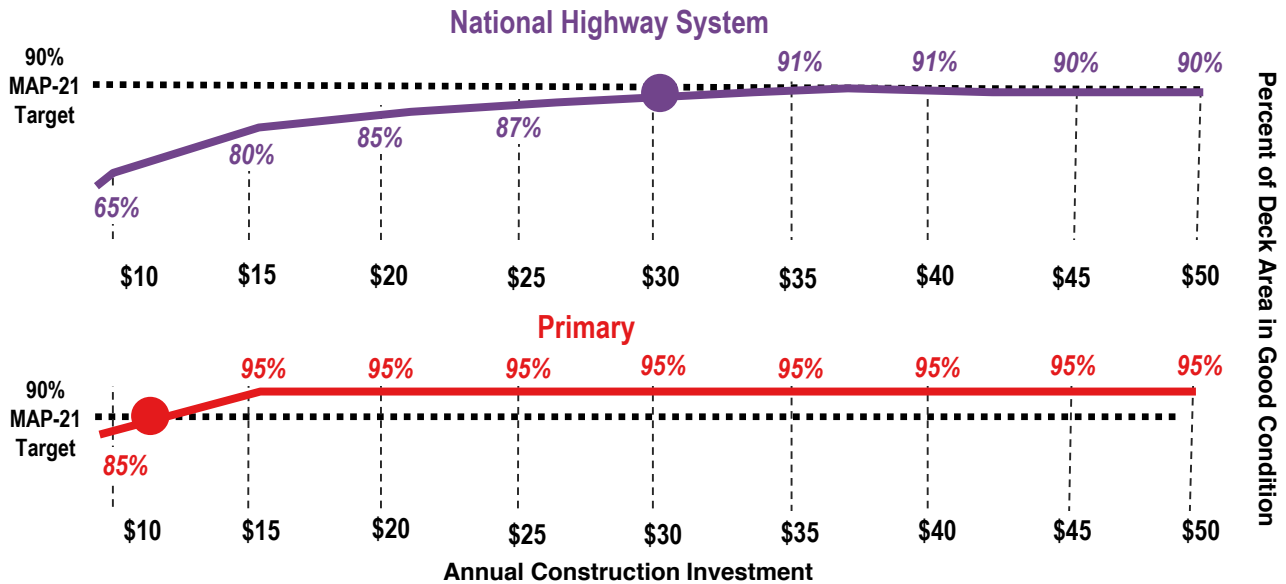
Projecting Future Bridge Conditions

MDT identifies potential bridge projects that balance competing needs and minimize life cycle costs. However, the actual impact of these projects on the condition of Montana's bridges depends on how much of this work MDT can afford. There is direct relationship between funding levels, bridge conditions, and overall performance levels in the state.

MAP-21 and current federal legislation establishes a national measure of bridge condition calculated as the percent of bridge deck area on structurally deficient bridges. MAP-21 also establishes a minimum standard for NHS bridge conditions. If more than 10 percent of the total deck area of NHS is on structurally deficient bridges for three consecutive years, the state must reallocate funding to address those issues.

Figure 3.6, on the following page, illustrates how different funding levels could impact bridge conditions ten years in the future. MDT develops these performance curves using the National Bridge Investments Analysis System (NBIAS) bridge analysis tool developed by FHWA. For MDT to meet national performance standards on all NHS bridges requires an annual construction budget of approximately \$32 million. An additional \$12 million annually is required to achieve the same standard for Montana's Primary system bridges. These future estimates are provided for informational purposes and as a planning aid for the TAMP. Based on historic trends and an understanding of bridges in Montana, the condition values on this chart are conservative and it may be possible to exceed expected performance over the next 10 years with the projected level of funding.

FIGURE 3.6 RELATIONSHIP BETWEEN FUNDING AND FUTURE BRIDGE CONDITIONS



Moving forward, MDT will develop a performance curve using a tool calibrated to Montana historical bridge data. This is a critical current gap in the current bridge management process, as the NBIAS tool uses national default data for key assumptions. MDT will incorporate refined versions of this analysis in future versions of the TAMP. These activities and other enhancements are detailed below.

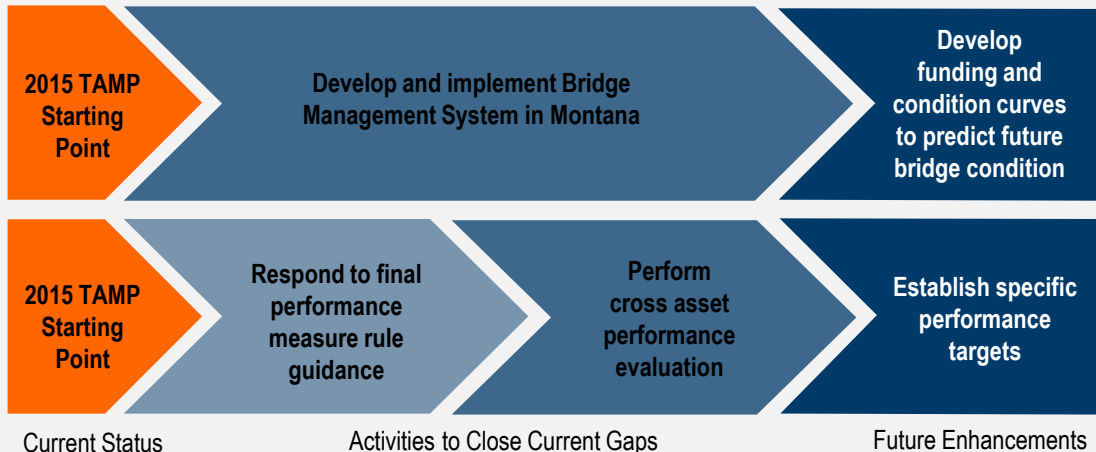
Current Bridge Management Gaps and Future Enhancements

MDT's 2015 TAMP provides a starting point for developing a robust bridge management framework. However, there are gaps in MDT's current analytical capabilities, data systems, and evaluation processes. Over the near-term, these gaps must be closed.

- To explore options for a fully functional statewide Bridge Management System.
- To establish realistic and attainable statewide bridge condition performance measures, MDT is working to perform cross-asset performance evaluations.

Additional activities and resources may be required to fully implement an enhanced bridge management system. An action plan is being developed to address the gaps identified here.

Future Bridge Management Framework



4. Managing Risk

Risk and Risk Management Definitions

The U.S. DOT defines risk as the positive or negative effects of uncertainty or variability upon agency objectives. Risk management is a process and framework for managing potential risks, including identifying, analyzing, evaluating, and addressing the risks to assets and system performance.

Major risk management elements within the context of MDT's asset management program are as follows:

- ★ **Risk identification** – identifies events that could impact MDT's ability to effectively manage Montana's bridges and pavements.
- ★ **Risk assessment** – assesses the likelihood of an event happening and the consequences if that event does occur.
- ★ **Risk prioritization** – determines, based on risk assessment, where to focus attention and resources.
- ★ **Risk treatment** – identifies and implements a treatment or mitigation activity for each priority risk.
- ★ **Risk monitoring** – monitors and responds to possible events, evaluates the effectiveness of treatments, and periodically updates risk priorities.

Identifying, Assessing, and Prioritizing Risks

During the TAMP development process, MDT Executive, Engineering, IT, Planning, and Administration, staff assessed the likelihood and impacts of risks related to asset management. An online survey was distributed to agency staff across these functional areas to help identify, assess, and prioritize potential risks and provide valuable insights in the following areas:

- ★ Identifying top three asset management risks;
- ★ Describing potential consequences of risks with respect to safety, mobility, asset damage, financial impact, and agency reputation;
- ★ Specifying the assets impacted by these risks (i.e., bridge, pavement, or both);
- ★ Assessing the likelihoods of these risks occurring; and,
- ★ Evaluating the consequences of these risks should they occur.

The survey resulted in set of risks evaluated by the TAMP Steering Committee at a risk workshop. Using the risks identified in the survey as a starting point, the Steering Committee finalized a list of 13 risks to include in the 2015 TAMP and assessed each through a formal evaluation process. As part of this process, the participants evaluated and scored each risk in the following categories:

- ★ **Risk Likelihood** – Risks are assigned a likelihood level based on their probability of occurrence. Steering Committee members assessed risk likelihood on a 1 (low) to 5 (high) scale and responses were averaged to determine the overall score.

★ **Risk Consequence** – Risks are assigned a consequence level based on their assumed impacts should they occur. Steering Committee members assessed these consequences related to the following factors:

- *Safety* - the impact of the risk on fatal or serious injury crashes;
- *Mobility* - the impact of the risk on people and freight movement between locations;
- *Asset damage* – the impact of the risk on the physical and/or functional condition of an asset; and
- *Financial* – the impact of the risk on agency or other costs pertaining to asset management.

Steering Committee values were averaged for each category of impacts to determine overall safety, mobility, asset damage, and financial scores. MDT then calculates the overall consequence level for each risk as the weighted average of the safety, mobility, asset damage, and financial scores. For the purpose of determining a risk score, MDT considers all impact areas to be of equal importance and assigned each a weight of 25 percent.

★ **Risk Level** – As shown in Figure 4.1, below, MDT calculates an overall risk level for each identified risk as the product of the risk likelihood score and risk consequence score. MDT uses these scores to assign a priority level to each risk that is included in an overall risk register.

FIGURE 4.1 EVALUATING RISK LIKELIHOOD AND CONSEQUENCE

<i>Consequence Level</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
	<i>Negligible</i>	<i>Minor</i>	<i>Major</i>	<i>Critical</i>	<i>Catastrophic</i>
Likelihood Level					
1					
Low	1	2	3	4	5
2					
Medium Low	2	4	6	8	10
3					
Medium	3	6	9	12	15
4					
Medium High	4	8	12	16	20
5					
High	5	10	15	20	25

Risk Management

MDT's initial risk management register is presented in Table 4.1 on the following page. This register identifies a prioritized set of risks and defines mitigation strategies for each. The risk register is a living document and MDT will continue to monitor the risk landscape as well as the effectiveness of mitigation strategies and will periodically update this risk register. MDT is already conducting several of these mitigation strategies; these strategies are highlighted in the risk management table on the following page.

TABLE 4.1 RISK MANAGEMENT REGISTER

Priority	Risk	Mitigation Strategy
1	A. Purchasing power decreases by more than 3% due to inflation, price volatility, mandates, etc.	<ul style="list-style-type: none"> Educate lawmakers on importance of asset management Coordinate with FHWA and AASHTO to address funding uncertainty at the national level Revert to TranPlan 21 policy of preservation first and reassess programmatic funding levels
2	B. Extreme weather event	<ul style="list-style-type: none"> Document emergency response protocol Set aside funds for routine emergency response Work with federal partners to streamline emergency response process in terms of public involvement, environmental review, and right-of-way acquisition
	C. Change in political climate	<ul style="list-style-type: none"> Educate lawmakers on importance of asset management Formalize and document asset management processes so they are not easily disrupted Improve IT resources to enable scenario analysis and response to legislative inquiries
	D. Transportation funding is reduced by 20% in real dollars	<ul style="list-style-type: none"> Revert to TranPlan 21 policy of preservation first and reassess funding levels
	E. Bubble in asset replacement needs due to uneven asset age distribution	<ul style="list-style-type: none"> Quantify and communicate the problem Implement a Bridge Management System and assess opportunities to delay replacement by investing in bridge preservation, repair, and rehabilitation Finalize and implement asset management plan Address longer term asset management needs (beyond 10-year) in long range plan
	F. Increased ongoing, seasonal weather events	<ul style="list-style-type: none"> Update hydraulic standards Clean major culverts to ensure uninhibited flow
3	G. Suboptimal project prioritization and selection	<ul style="list-style-type: none"> Document and formalize repeatable and defensible method for prioritizing projects Compare planned projects to actual projects implemented Improve ability of management systems to recommend optimal strategies
	H. Catastrophic infrastructure failure for reasons other than deterioration or scour (e.g., vehicle impact, natural disaster, etc.)	<ul style="list-style-type: none"> Implement seismic retrofit program Implement, update as needed, and ensure compliance with the Business Continuity Plan and Emergency Response Plan
	I. A freight-intensive market sector or unexpected development changes traffic volumes/patterns or negatively impacts infrastructure	<ul style="list-style-type: none"> Conduct impact reviews as part of permitting process Track and make adjustments to traffic data so that management systems reflect impacts on bridge and pavement infrastructure
	J. Reduced flexibility with federal funding	<ul style="list-style-type: none"> Revert to TranPlan 21 policy of preservation first and reassess programmatic funding levels
4	L. Data, management systems, and other IT infrastructure are unable to support decision, analysis or business needs.	<ul style="list-style-type: none"> Implement a Bridge Management System and enhance Pavement Management System Enhance Financial Management Suite and Program & Project Management System Develop and implement a data governance plan
	M. Lack of internal or external staffing resources	<ul style="list-style-type: none"> Conduct succession planning throughout agency Update recruitment strategy to reflect changing workforce needs
	N. Significant increase in federal funding	<ul style="list-style-type: none"> Keep backlog of federal funding eligible projects "on shelf" and ready for implementation Investigate strategies to increase Highway State Special Funds available for match.
MDT is already conducting several of these mitigation strategies; these strategies are highlighted in orange .		

5. Financial Plan

Valuing Montana's Assets

MDT's completes an infrastructure valuation to ensure compliance with Montana Operations Manual, Chapter 335: Capital Asset Accounting. Under Section III.B.3 of this manual, infrastructure is required to be capitalized at its historical cost and depreciated over its useful life. MDT uses the Government Accounting Standards Board Statement No. 34 (GASB-34) depreciation approach to determine the value of state infrastructure assets annually.

MDT estimates the value of the state's surface transportation infrastructure at nearly \$3.75 billion in 2014. This value covers all existing assets within the state, primarily completed roadway projects, and includes many more roads, bridges, and structures than are covered by this TAMP. In addition, this figure represents a book value based on depreciation and nationally accepted accounting standards. *It does not represent replacement value of those assets and should not be confused with other estimates of needs and value for the state's multimodal transportation system.* This accounting book value does represent a significant portfolio and illustrates the importance of MDT's ability to manage the system for performance and cost-effectiveness.

Infrastructure is defined as long-lived assets that are stationary in nature and can be preserved for a significantly greater number of years than most capital assets. Examples of infrastructure assets include roads, bridges, tunnels, drainage systems, water and sewer systems, dams, and lighting systems. Approximately one quarter of the total valuation is attributable to unfinished projects (e.g. construction work in progress). Assets used mainly for the purpose of MDT to gather information or conduct enforcement and maintenance are considered capitalized assets.

Funding Sources

MDT's budget is a combination of federal and state funds provided through federal authorization. The majority of federal funds that support asset management activities in Montana are provided through two key federal funding programs and state revenues:

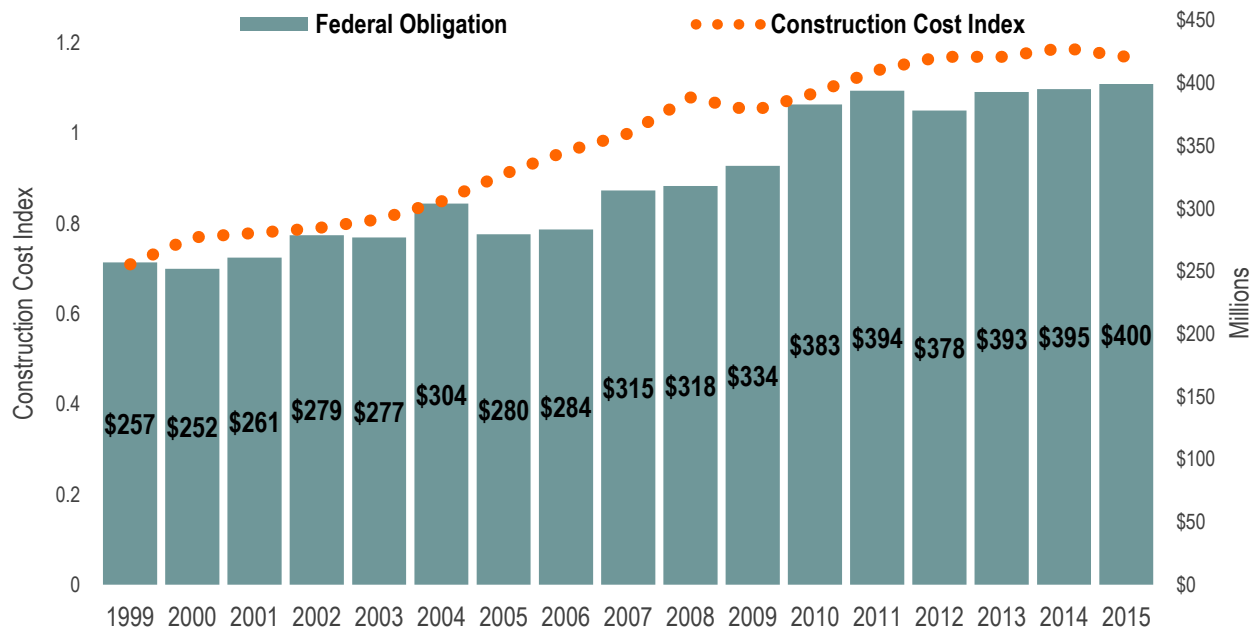
- ★ Federal National Highway Performance Program (NHPP) provides funding to improve the condition and performance of bridges and pavements on the NHS. With the introduction of MAP-21, and more recently the FAST act, bridge funds now compete with other eligible activities within the NHPP funding pot.
- ★ Federal Surface Transportation Program (STP) funds may be used to preserve or improve conditions and performance on the federal-aid highway system.
- ★ State Highway Special Revenue funds are generated by state fuel taxes and vehicle weight permits and fees. The majority (87 percent) of Highway State Special Revenue funds are constitutionally restricted for the construction, reconstruction, repair, operation, and maintenance of Montana's federal, state, and local highway roadway systems.

Balancing Needs and Funding

TranPlan 21, sets the direction and vision and establish priorities for how the statewide transportation system is managed and developed. To meet statewide priorities, MDT performs P3 tradeoff analyses and

develops a performance-based Funding Distribution Plan. The aim of P3 is to balance available funding against needs and develop an optimal budget that delivers the best possible highway system performance outcomes. However, achieving targeted performance outcomes with increasingly limited funding is challenging. According to Bureau of Labor Statistics inflation data, the cost of construction rose over 60 percent between 1999 and 2015. This reflects the increasing cost of key construction inputs, including labor, fuel, materials, and equipment. When construction costs and inflation increase at a faster pace than funding levels, the purchasing power of federal and state funds decreases. As shown in Figure 5.1, below, federal obligations to Montana continue to grow. Yet, the value of those funds in real terms is not keeping pace with rising construction costs or overall statewide investment needs.

FIGURE 5.1 FEDERAL FUNDING FLOWS AND INFLATION INDICES



Source: MDT, Bureau of Labor Statistics

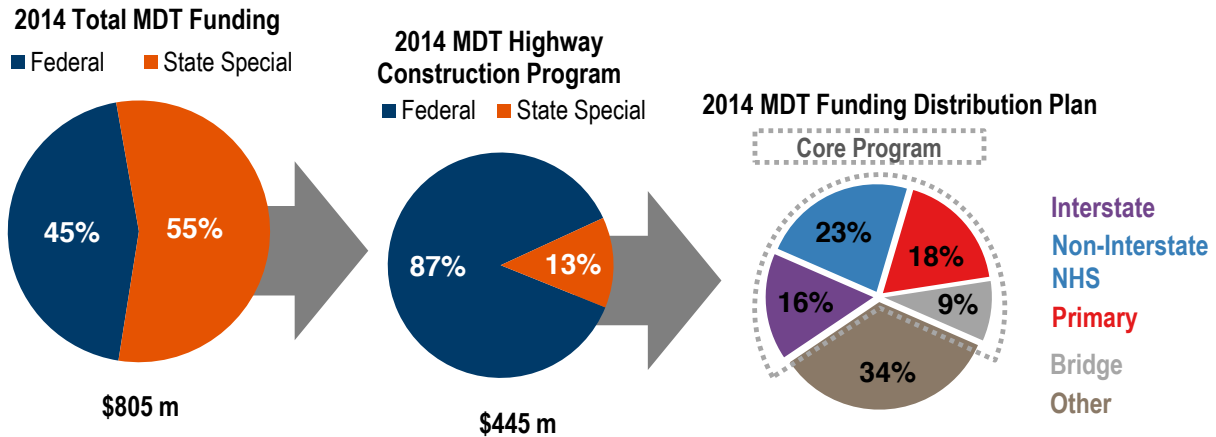
Allocating Funds for Asset Management

MDT managed approximately \$805 million in total funding in 2014. Total funding available is a combination of Federal and State Highway Special funds. Not all of these funds are available for asset management activities.

MDT allocates \$360 million (45 percent) of available federal and state funds for general operations, planning, maintenance, multimodal activities, and for distribution to other state agencies and tribal and local governments. The remaining \$445 million is directed to the Highway Construction Program, which is then further broken down into the Funding Distribution Plan. Typically, P3 utilizes approximately 70 percent of the Highway Construction Program for Core Program allocations. P3 driven Core Program consists of Interstate, Non-Interstate NHS, Primary and Bridge categories. The remaining distributions provided through state statute or federal programs are included in the “Other” category for purposes of the TAMP.

Figure 5.2, on the following page, illustrates how MDT’s funds are allocated from total funding allocations to the Core Program. This allocation by system is based on need as determined in P3.

FIGURE 5.2 MDT FUNDING ALLOCATION



Anticipated Funding Levels

MDT allocates construction funds to the Core Program each year as part of the annual P3. The outputs from this process include recommended funding for the Bridge Program as a whole and Pavement by MDT District, System (Interstate, Non-Interstate NHS, and Primary), and type of work (Preservation, Rehab, or Reconstruction). MDT allocates funding to bridge and pavement programs in order to maintain target condition levels and based on an analysis of the relationships between funding and performance. Table 5.1 displays anticipated funding levels for the TAMP assets over the next 10 years.

TABLE 5.1 ESTIMATED FUNDS FOR CONSTRUCTION IMPROVEMENTS TO TAMP ASSETS BY MDT FUNDING PROGRAM, 2015-2024

Year	Pavement			Bridge
	Interstate	Non-Interstate NHS	Primary	Statewide
2015	\$57.8 m	\$83.2 m	\$84.4 m	\$41.5 m
2016	\$55.3 m	\$89.9 m	\$85.3 m	\$42.7 m
2017	\$55.0 m	\$90.9 m	\$93.3 m	\$44.0 m
2018	\$54.6 m	\$91.8 m	\$101.7 m	\$45.3 m
2019	\$58.8 m	\$109.5 m	\$98.8 m	\$46.7 m
2020	\$60.8 m	\$113.3 m	\$102.2 m	\$48.1 m
2021	\$62.8 m	\$117.1 m	\$105.6 m	\$49.6 m
2022	\$64.9 m	\$121.0 m	\$109.2 m	\$51.0 m
2023	\$67.1 m	\$125.1 m	\$112.9 m	\$52.6 m
2024	\$69.4 m	\$129.3 m	\$116.7 m	\$54.1 m

Source: MDT 2015 Funding Distribution Plan. Millions of 2015 Dollars

For the purposes of this TAMP, MDT makes the following adjustments to estimate funds available for construction activities:

- ★ Reducing distribution values by 10 percent to account for Federal obligation limitation;



- ★ Further reducing distribution values by 28 percent to adjust for obligation limits and account for non-construction phases;
- ★ Reducing adjusted values by 10.37 percent to account for Indirect Cost Allocation Plan; and,
- ★ Increasing adjusted values to account for the state match of 8.76 percent for the Interstate program and 13.42 percent for all other programs.

MDT presents P3 recommended funding levels to the Montana Transportation Commission for concurrence and uses P3 funding levels to develop a Funding Distribution Plan. Not all of the federal allocations in the distribution plan are available to improve assets covered in this TAMP

Performance Gap Assessment

The difference between MDT's performance targets and expected performance levels - given projected funding levels - is the state's performance gap. MDT is in the process of updating its pavement management system capabilities and exploring options for implementing a bridge management system. As pavement and bridge modelling improves, MDT anticipates eliminating any significant performance gap by more accurately projecting future conditions based on available funding. The graphic below details current activities and actions to enhance MDT's capabilities and close current gaps in the process.

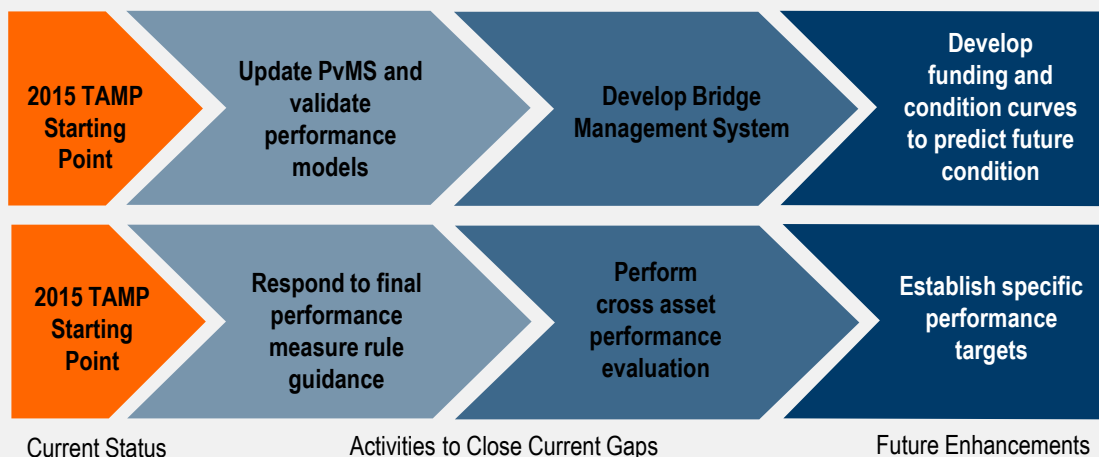
Current Financial Planning Gaps and Future Enhancements

MDT's 2015 TAMP provides the starting point for developing a detailed financial plan to actively manage Montana's roads and bridges. However, there are current gaps in MDT's current analytical capabilities, data systems, and evaluation processes that must be closed.

- To better predict future bridge and road conditions, MDT is implementing a statewide Bridge Management System and will continue to update PvMS and validate performance models.
- To establish realistic and attainable statewide performance measures, MDT is working to perform cross-asset evaluations and better define funding and performance relationships.

Additional resources may be required to move MDT forward and to fully close future performance gaps. An action plan is being developed to address the gaps and activities identified here.

Future Financial Plan Framework





6. TAMP Investment Strategies

Asset management investment strategies are defined by the U.S. DOT in a recent asset management rulemaking notice, as strategies that result from evaluating various levels of funding to achieve a desired level of condition that sustain state of good repair and system performance at a minimum practicable cost while managing risks.

TranPlan 21 sets policy goals and actions that guide how MDT manages, operates, improves, and maintains Montana's transportation system. MDT's asset management investment strategies support statewide goals and performance objectives through the following key focus areas:

- ★ **Funding levels.** MDT conducts analyses of performance and tradeoffs between competing needs to develop funding levels that meet targets. These funding levels reflect the relative priority of MDT's assets and systems.
- ★ **Guidelines for identifying projects.** Chapters 2 and 3 of this document describe how MDT allocates funds to specific work activities. To support the overall objective of doing the right work at the right place at the right time, and to minimize life cycle costs, MDT uses the logic described to select appropriate treatments.
- ★ **Risk mitigation activities.** Chapter 4 presents MDT's initial risk register. This table identifies risks that could impede MDT's ability to achieve its asset management objectives, and defines a series of risk mitigation strategies for each risk.

Taken collectively, projected funding levels, project identification guidelines, and risk mitigation activities will enable MDT to achieve its asset management goals and performance targets.

7. Future TAMP Enhancements

This section of the TAMP presents potential enhancements that can improve asset management practices moving forward. A comprehensive gap assessment undertaken during the TAMP development process identified a set of enhancements to strengthen the asset management program.

To support the TAMP development process, MDT staff completed the asset management self-assessment survey from Volume I of the AASHTO Asset Management Guide. The purpose of this survey is to assess MDT in terms of state-of-the-art asset management practices. MDT managers also participated in detailed interviews to describe existing practices and discuss potential opportunities for improvement. MDT staff convened a self-assessment workshop that provided insights and established consensus on priorities for improvement.

Based on MDT input, priorities for enhancing the asset management program include:

- ★ **Clarify Alignment between P3 and the 5-year Tentative Construction Program.** This initiative addresses the potential disconnect between the program-level funding decisions made during P3 and the final allocation of funds. MDT will address this issue by:
 - Further documenting the Tentative Construction Program development process;
 - Clarifying the impact of how transfers between programs and District-specific factors impede the agency's ability to meet the goals, objectives, and targets established through P3; and,
 - Further documenting the process used to verify that the Tentative Construction Program is consistent with P3 results.
- ★ **Implement a Bridge Management System.** MDT currently uses a bridge information system for storing and managing inventory and condition data. MDT is in the process of exploring options for implementing a more comprehensive bridge management system that:
 - Forecasts bridge deterioration;
 - Evaluates life-cycle costs;
 - Identifies short and long-term budget needs; and,
 - Recommends optimal work strategies and implementation schedules.
- ★ **Enhance the Pavement Management System.** MDT's PvMS currently recommends treatments based on an analytical approach that relies on pavement ride quality. MDT is currently working to improve modeling capabilities in order to more accurately forecast future pavement conditions. MDT is also investigating how to address other elements of pavement performance upon future guidance. The pavement management system can then be used to recommend treatments based on a comprehensive view of pavement life cycle costs.
- ★ **Improve Coordination Between Maintenance and Capital Activities.** This initiative is aimed at taking a comprehensive view of potential asset treatments and minimizing budget and organizational constraints to implement them. The initiative involves the following activities:
 - Identifying a tool kit of strategies for effectively managing pavements throughout their life.
 - Determining the most efficient way to implement each strategy. For example, with maintenance forces or through a capital project; or with internal forces or contractor forces.



- For strategies flagged for implementation through the maintenance program, pursuing funding and ensuring that MDT has the training, equipment, and staffing capacity to implement them.

★ **Develop a Transportation Asset Management Information System (TAMIS).** MDT is making significant advancements in data and information systems to support asset management decisions. A TAMIS can help ensure that MDT implements future systems and system updates in a way that maximizes the ability to support asset management. TAMIS is a set of software and business processes that help turn data from multiple systems into useable information. Potential elements of MDT's TAMIS include:

- An enterprise data dictionary that defines core data items;
- A data governance plan that identifies responsibility for collecting and managing core data items, defines a source of record for each item, and documents a data QA/QC process;
- Linear Referencing System standards that enable data from multiple systems to be integrated efficiently via Geographic Information System;
- Dashboards, mapping systems, and other applications that enable staff to quickly query and obtain data from multiple sources; and
- A system architecture that illustrates how core systems interact with one another now, and provides a vision for how they should interact in the future.

★ **Integrate Risk Management into the Asset Management Process.** The risk register provided in this document is an important first step in managing asset management risks. MDT will use this register to communicate priority risks and track the implementation of mitigation strategies. Longer term, MDT will investigate how to develop a more comprehensive approach for considering risk in the asset management process. For example, risk analysis could be considered in the prioritization of potential bridge and pavement projects.

★ **Address Additional Assets in the Asset Management Program.** MDT focuses initial asset management efforts on bridges and pavements. Longer term, MDT will work to develop formal asset management programs for other assets. In determining priorities for additional assets, MDT will:

- Assess the relative risk for asset groups (e.g. likelihood of a failure and consequences of failure);
- Assess the degree to which MDT could/should proactively mitigate the risk of failure;
- Estimate the costs of implementing and sustaining each asset management element; and
- Compare the implementation costs to the costs of potential asset failure, and determine which elements, if any, should be implemented.



For more information on MDT's TAMP visit: <http://www.mdt.mt.gov> or contact:

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