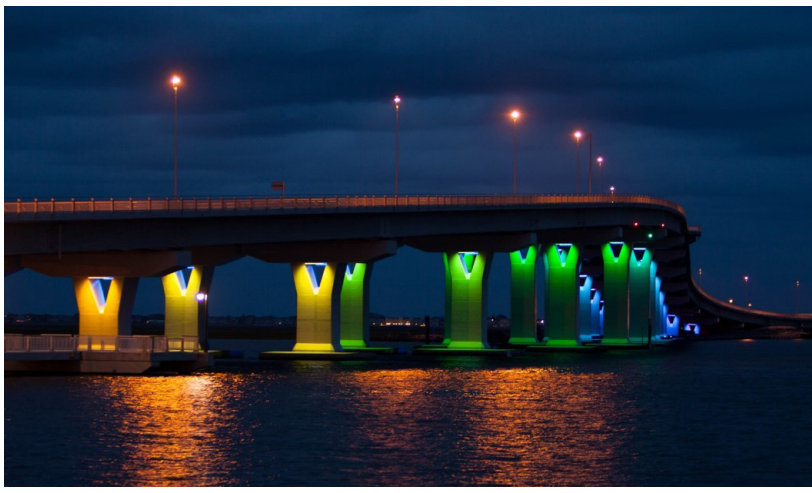
NEW JERSEY

TRANSPORTATION ASSET MANAGEMENT PLAN



AUGUST 2019

Governor Phil Murphy | Lieutenant Governor Sheila Oliver | NJDOT Commissioner Diane Gutierrez-Scaccetti

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Cover Images

Top Center: NJ Route 36 Highlands Bridge

Bottom Left: NJ Route 18

Bottom Right: NJ Route 52 Causeway

Message from the Commissioner

I am pleased to present the Final Transportation Asset Management Plan (TAMP) for New Jersey in fulfillment of the requirements set forth in 23 CFR 515, the Asset Management Plan Final Rule, as established by the Fixing America's Surface Transportation (FAST) Act. The New Jersey Final TAMP provides a risk-based, performance-driven process that informs and guides the transportation investment decisions for the state.

The Department developed the Final TAMP in coordination with the state's transportation agencies that own and operate portions of the National Highway System. Partners in this effort include transportation authorities and commissions, county and municipal governments, and Metropolitan Planning Organizations. Engagement with these entities consisted of various forms of communication, meetings and web-conferences, in addition to data collection activities to acquire best available data for the Final TAMP. The Department will continue these activities on a systematic basis as it continues implementation of the Final TAMP.

New Jersey's TAMP will assist the State's decision-makers with their transportation investment choices and help inform and educate all of its transportation partners, stakeholders and citizens about the needs, goals and objectives of its critical transportation infrastructure and highway network. The New Jersey Department of Transportation (NJDOT) greatly appreciates the support of the FHWA New Jersey Division Office. The two agencies will continue to cultivate TAMP processes and incorporate Transportation Performance Management (TPM) and Performance Based Planning and Programming (PBPP) as required by 23 USC 150.

A well-maintained, efficient transportation system is fundamental to the health of New Jersey's economy. Transportation is a service used by nearly every citizen every day. New Jersey has made a pledge to its constituent communities embodied in five core values: Inform, Innovate, Collaborate, Empower and Evolve. These values guide the Department's new mission and its "*Commitment to Communities*" initiative. New Jersey's TAMP is the performance-driven framework for achieving resilient and sustainable highways, pavements and bridges, as well as to ensure the safe and efficient movement of people and goods. The TAMP framework aligns with NJDOT's business practices and new mission, and will surely foster regular improvement to the NJDOT and the state's transportation system.

Sincerely,

Diane Gutierrez-Scaccetti

Diane Gutierrez-Scaccetti
Commissioner of Transportation

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Table of Contents

TAMP

Appendices

Executive Summary

The New Jersey Transportation Asset Management Plan (TAMP) is a risk-based plan for highway asset preservation. The TAMP describes the policies, procedures, data, and tools used to preserve pavement and bridge assets on the National Highway System (NHS) for various asset owners and the State Highway System (SHS) managed by New Jersey Department of Transportation (NJDOT). It establishes objectives and investment strategies to manage the condition of New Jersey's pavements and bridges. The NJDOT pavement and bridge management systems are used in the TAMP process to determine the most cost-effective allocation of resources among different types of preservation and rehabilitation approaches across the lifecycle of pavement and bridge assets.

The TAMP, at the planned level of investment, predicts that the condition of pavement and bridge assets will improve by the year 2029. To make progress toward the TAMP's objectives, NJDOT must follow the strategies outlined in this TAMP.

What is Transportation Asset Management?

Transportation asset management is the risk-based process through which highway assets are managed across their whole lifecycle to most cost-effectively serve the needs of roadway users. Asset managers rely on data-driven decisions to ensure that the right work is done at the right time to minimize the costs of ownership while providing safe and reliable roads.

The New Jersey TAMP

The TAMP describes New Jersey's ongoing asset management process, establishing a data-driven, risk-based framework that guides the preservation of pavement and bridge assets in New Jersey with a primary focus on the NHS. Additionally, the TAMP addresses federal asset management and performance management reporting requirements regarding pavement and bridge assets. The TAMP sets policy goals and objectives for these assets, and outlines investment plans for their accomplishment.

TAMP Policy Goals

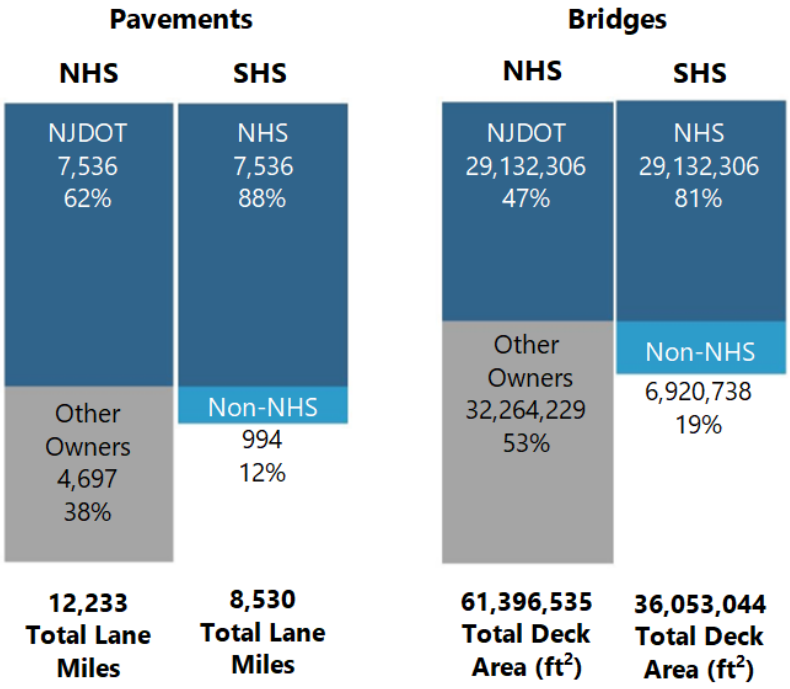
The TAMP is the planning-level document detailing NJDOT's plan to keep the State's infrastructure in a State of Good Repair. The TAMP is an important foundation for NJDOT's mission to provide a world class transportation system. It provides the strategies that will keep infrastructure in a State of Good Repair. The TAMP sets the following asset management policies to advance the NJDOT mission:

- Provide a safe, reliable roadway system.
- Achieve and maintain a State of Good Repair for transportation infrastructure assets.
- Manage the roadway system to reduce lifecycle costs.
- Increase resilience of the system to the impacts of extreme weather events.
- Codify ongoing asset management as a data-driven process linking targets to outcomes through NJDOT performance-based planning and programming processes.

The TAMP Addresses the National and State Highway Systems

The TAMP addresses the management of all New Jersey's NHS pavements and National Bridge Inspection Standard (NBIS) bridges, regardless of ownership. Federal law and rulemaking have set specific requirements for the assets included in a TAMP. New Jersey's 2019 TAMP also includes pavement and bridges assets on the SHS that are not on the NHS because this is the network that NJDOT manages. Exhibit ES-1 shows the assets addressed in the TAMP, which are also summarized by highway system and owner. As shown, the majority of SHS assets are also on the NHS.

Exhibit ES-1: TAMP Asset Inventory



State of Good Repair Objectives

State of Good Repair Objectives for the measured physical condition of pavement and bridge assets are set through the TAMP. The TAMP specifies the lifecycle planning approach and the investment strategies that support the accomplishment of the Policy and State of Good Repair Objectives.

The objectives are expressed in terms of percent of the asset in a State of Good Repair. Assets in a State of Good Repair are those that are in *Good* or *Fair* condition.

The TAMP establishes the following State of Good Repair Objectives:

- 80 percent of pavements on SHS roadways (by lane miles) in a State of Good Repair.
- 94 percent of NBIS bridges on SHS roadways (by deck area) in a State of Good Repair.
- 95 percent of NBIS bridges on NHS roadways (by deck area) in a State of Good Repair.

Performance Measures

The conditions of NHS assets are reported to the Federal Highway Administration (FHWA) in measures established through the National Highway Performance Program (NHPP) along with a set of statewide targets for pavement and bridge assets on the NHS. Additionally, for pavement assets, the TAMP reports NJDOT's Condition Status metric. This is a more refined metric that NJDOT uses for managing pavements and allocating resources because it is better-suited to model and optimize pavement

network performance. These performance measures are used to provide a summary of highway asset conditions and State of Good Repair. Exhibit ES-2 provides a description of how the condition ratings manifest on these assets.

Exhibit ES-2: Condition Rating Descriptions by Asset Class

Asset	Good	Fair	Poor
Pavements	Pavement in Good condition has minimal deterioration. Road users experience a smooth ride without cracks/ruts/faults. Preserving the road optimizes performance.	Some deterioration, such as minor cracking, rutting or faulting. Road users experience acceptable ride. Preserving or repairing the road minimizes costs.	Advanced deterioration and poor ride that can damage vehicles. Requires significant reactive repairs until costlier road treatments can be programmed.
NBIS Bridges	Bridges in Good condition range from those with no problems to those having only minor deterioration.	Primary structural elements are sound; may have more noticeable deterioration. This is the most cost-effective time to rehabilitate.	Advanced deterioration or seriously affected structural components. Bridges are still safe to travel but require greater rehabilitation.

Baseline Conditions and Performance Projections

The asset condition and performance measure data contained in this TAMP are prefaced with a "Collection Year" (CY) to clarify what period the data represents. "CY" refers to information gathered in a given year. In the TAMP, data from a given CY is treated as the starting point, or baseline, for the following year. For instance, CY 2017 data (or collected during 2017), which is the best available data, becomes the baseline data for 2018.

Baseline asset conditions (CY 2017 data) and projected future asset conditions (through CY 2029) are reported in terms of the measures described above. In addition, two- and four-year statewide targets are established and reported as short-term benchmarks to measure progress toward achieving the TAMP State of Good Repair Objectives. Future asset conditions are projected using pavement and bridge management systems that forecast the combined impacts of the planned asset investments and treatments and predicted deterioration on the overall condition of the network. Baseline and projected asset conditions are compared against State of Good Repair Objectives to establish the performance gaps. Projected asset conditions at the planned level of investment are shown in Exhibit ES-3 for the SHS, and Exhibit ES-4 for the NHS.

The Performance Gap

While progress continues toward achieving the State of Good Repair Objectives, the SHS will come closer towards meeting its objectives at the planned investment level. The funding gap to meet the State of Good Repair Objectives for SHS assets is shown in Exhibit ES-3. There is an average annual funding gap for the SHS of approximately $256 million for pavements and $143 million for bridges.

Overall, TAMP analyses project that, under the planned level of investment, the condition of both pavements and bridges on the NHS and SHS will improve through the TAMP analysis period ending in CY 2029. However, the SHS will come closer towards meeting the TAMP State of Good Repair Objectives by CY 2029, while NHS bridges are predicted to meet and exceed the State of Good Repair Objective under the TAMP.

Exhibit ES-3: State of Good Repair (SOGR) Summary for SHS Pavement and NBIS Bridge Assets

Performance	Pavement		Bridge	
	CY 2017	CY 2029	CY 2017	CY 2029
	Good or Fair		Good or Fair	
SOGR Objective	80.0%		94.0%	
Planned Condition	64.7%	66.6%	89.2%	91.6%
Performance Gap	-15.3	-13.4	-4.8	-2.4
Average Annual Investment Fiscal Years 2019-2029				
To Achieve Objective	$657 million		$652 million	
Planned Funding	$401 million		$509 million	
Projected Funding Gap	-$256 million		-$143 million	

Note: Pavement data shown using NJDOT Condition Status measures. Bridge data shown using NHPP measures.

Exhibit ES-4: State of Good Repair (SOGR) Summary for NHS Pavement and NBIS Bridge Assets

Performance	Pavement (Interstate / Non-Interstate)		Bridge	
	CY 2017	CY 2029	CY 2017	CY 2029
	Good or Fair		Good or Fair	
SOGR Objective	N/A[1]		95.0%	
Planned Condition	98.6 / 98.8	99.3 / 99.4	94.1%	95.3%
Performance Gap	-	-	-0.9	+0.3

[1] No State of Good Repair Objective for NHS pavements has been defined.

Note: Pavement and bridge data shown using NHPP measures.

TAMP Risks

The two greatest risks to accomplishing this plan are:

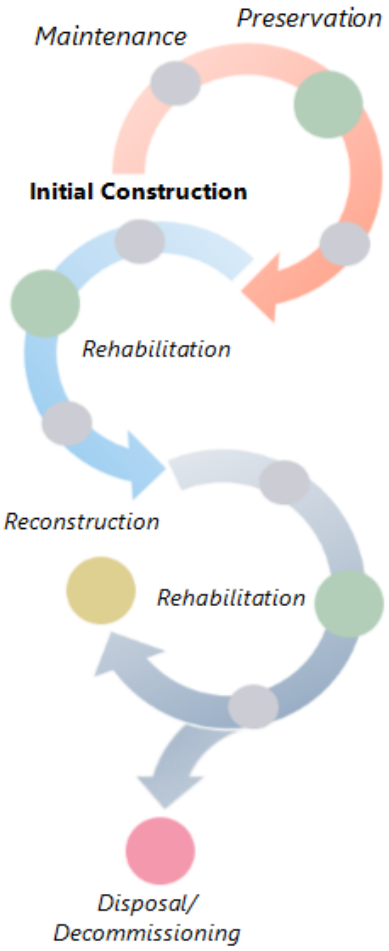
Firstly, that shortfalls in planned funding levels occur or investment levels by work type are less than established in the investment strategies. If the current levels of investment in pavement and bridge preservation continue over the plan period (as opposed to the planned level of investment established in the TAMP), the TAMP predicts that pavement conditions will deteriorate, and bridge conditions will improve, but to a lesser extent than planned.

Secondly, that the conditions of highway assets are adversely impacted through accelerated deterioration and damages caused by extreme weather events and climate change. Accelerated deterioration and damages to highway assets would require increased investment levels to accomplish the State of Good Repair Objectives.

Lifecycle Planning

Successful highway asset management applies a whole lifecycle approach to the maintenance, preservation, rehabilitation and eventual replacement or removal of assets. Lifecycle planning determines the best sequence of actions (or "treatments") across the network of assets to meet condition objectives for the lowest practicable cost. This approach incorporates engineering, economic, risk, and financial analysis into the whole lifecycle, as depicted in Exhibit ES-5.

Exhibit ES-5: Asset Lifecycle



Financial Plan

The 2018 Statewide Transportation Improvement Program (STIP) (Fiscal Years 2018-2027) serves as the basis for the TAMP's 11-year budget for the preservation of the SHS (which includes state-owned NHS). Additionally, the TAMP estimates the level of investment planned on non-NJDOT-owned NHS assets using the best available data collected from the owners. Together, these funding assumptions provide the budget for the TAMP analyses. Future 10-year STIP investment levels for infrastructure preservation will be informed by the 2019 TAMP. These analyses will enable NJDOT leadership to make trade-offs between the objectives in support of NJDOT's overall mission and other performance objectives.

Investment Strategies

The TAMP describes the funding amounts ("investment strategies") to be invested in different work types (i.e., maintenance, preservation, rehabilitation, and reconstruction) annually by asset class through the TAMP analysis period ending in CY 2029. They represent the optimal allocation of resources, identified through TAMP analyses, to pursue TAMP Policy and State of Good Repair Objectives. On an annual basis FHWA will conduct a consistency review to assess the compliance of NJDOT's expenditures to the investment levels outlined in the TAMP according to work type. While the level of detail for non-NJDOT owner expenditures does not support a breakdown by work type, the NHS investment strategy for pavement and bridge assets is presented in Exhibit ES-6.

Exhibit ES-6: Investment Strategy for NHS Pavement and NBIS Bridges

Asset	Investment by Fiscal Year ($ millions)											
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Average
Pavements	380	340	340	375	345	440	370	465	530	530	530	420
Bridges	730	730	745	860	960	840	930	900	885	885	885	850

Note: See *Chapter 8: Investment Strategies* for further details on the investment strategies for the SHS and NHS.

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1. Introduction

Background

New Jersey's highway system is critical to the economic and social well-being of the State's residents and is of strategic importance to the regional and national economy. The highway system moves people and goods through the state. Additionally, it provides a vital link to some of the busiest airports and ports in the United States. New Jersey's Transportation Asset Management Plan (the TAMP) plays a key role in the accomplishment of the New Jersey Department of Transportation's (NJDOT) mission of providing a world class transportation system. It addresses the safety and reliability of the transportation network through establishing investment strategies for the preservation of infrastructure assets in a State of Good Repair.

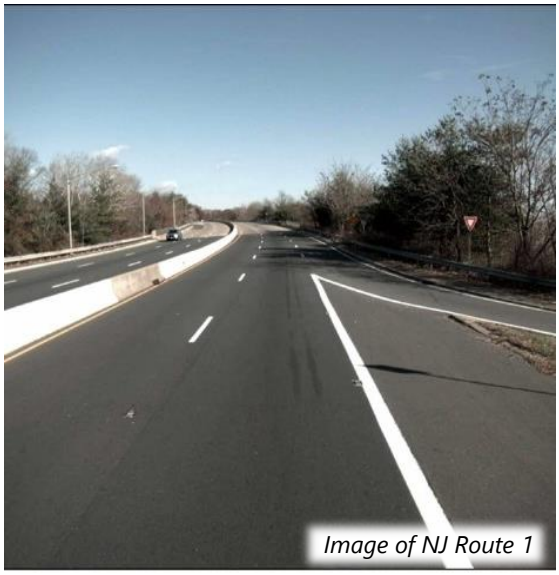


Image of NJ Route 1

Image of Bridge Deck Patching

In fact, NJDOT has five stated core missions related to transportation, including Infrastructure Preservation, Safety, Mobility and Congestion Relief, Operations and Maintenance, and Mass Transit, the last belonging to New Jersey Transit. The preservation of highway infrastructure includes the inspection, preventive maintenance, application of preservation treatments, repair, rehabilitation, and reconstruction of New Jersey's highway infrastructure assets. Managing these assets is a complex process that requires evaluating system safety, asset conditions, and performance risks in the context of available funding to make good lifecycle planning decisions. The TAMP positions NJDOT to employ technology and expertise to cost effectively achieve safety and reliability through the preservation of its highway infrastructure.

Highway infrastructure preservation requires a significant ongoing investment that must be balanced against funding needs for NJDOT's other objectives. In light of these competing needs, there is a strategic advantage to determining how actions can be taken in the near future to improve asset longevity and reduce total expenditures. The systematic projection of how assets will perform over time and the use of this information to plan for their cost-effective preservation is referred to as Transportation Asset Management.

New Jersey's Transportation Asset Management Plan (the TAMP) describes the ongoing asset management process and constitutes the plan for the preservation of New Jersey's highway assets.

1.1 Role of the TAMP

The Code of Federal Regulations (23 CFR 515.5) defines "asset management" as:

> *A strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired State of Good Repair over the life-cycle of the assets at minimum practicable cost*.

The TAMP provides a data-driven, risk-based framework guiding the management of National Highway System (NHS) assets within New Jersey consistent with federal regulatory guidelines. The TAMP also provides the foundation upon which NJDOT manages State Highway System (SHS) assets, fulfilling its mission to achieve consistent progress through focused investments toward keeping infrastructure in a State of Good Repair and supporting one of its core missions of Infrastructure Preservation.

The TAMP sets overall Policy and State of Good Repair Objectives for assets in the TAMP, and outlines investment plans for achieving the desired performance levels for each asset.

The TAMP formalizes and documents the following processes and key information:

- The desired State of Good Repair for highway assets.
- Current conditions (performance) of highway assets.
- Federal requirements for the TAMP.
- Risk-based tradeoff analysis[1] within and among selected asset types through the gap analysis process.
- Lifecycle planning strategies that reduce the total cost of ownership of highway assets over their lifecycle.
- Impact of investment scenarios upon asset performance for each asset type.
- Risk management to support the implementation of the TAMP and asset management activities.
- TAMP-related communication and collaboration among all owners of the NHS in New Jersey and in National Highway Performance Program (NHPP) target setting (23 CFR 490).
- Initiates the process to identify enhancements to strengthen NJDOT's organizational capabilities for asset management.

[1] Tradeoff analysis is also referred to as cross-asset allocation for TAMP purposes.

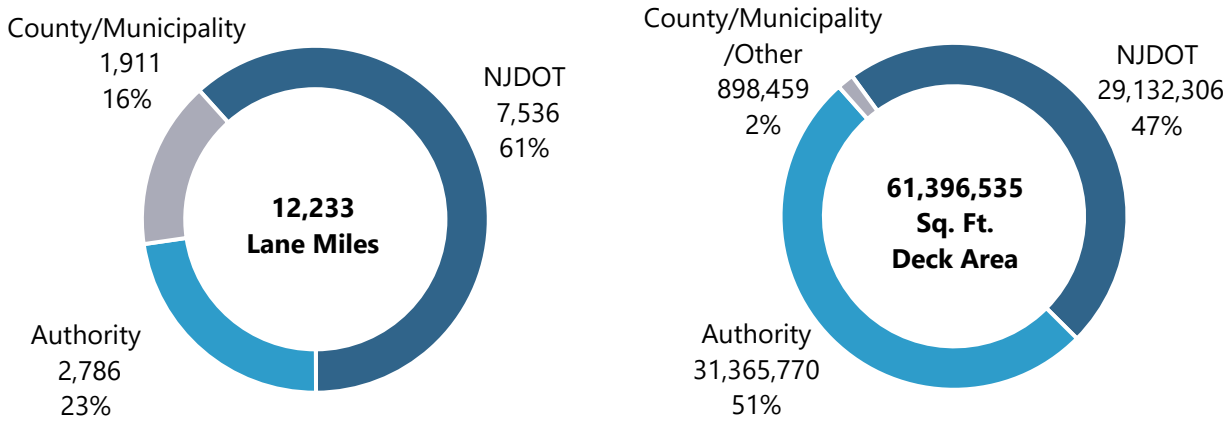
1.2 Federal Requirements

Two landmark pieces of federal transportation legislation created a performance-based approach to the management of federal highway programs. The Moving Ahead for Progress in the 21st Century Act (MAP-21) was enacted on July 6, 2012 and its asset management provisions were subsequently amended by the Fixing America's Surface Transportation Act (FAST Act) on December 4, 2015. The federal approach codified in this legislation, found at 23 U.S.C. 119, focuses on national transportation goals, increasing the transparency and accountability for federal highway programs, and improving transportation investment decision-making through performance-based planning and programming.

As part of this performance-based framework, federal law requires states to develop a risk-based TAMP to preserve or improve the condition of highway assets and the performance of the NHS. Federal requirements adopted to implement the legislation were added to the Code of Federal Regulations in 23 CFR Part 515 on October 2, 2017. This "Asset Management Rule" provides guidance on the process, contents and role of the TAMP.

Federal law for the TAMP requires that it includes, at a minimum, all NHS pavement and National Bridge Inspection Standard (NBIS) bridge assets, whether owned or maintained by NJDOT or by other entities. Accordingly, the TAMP process engages 83 non-NJDOT jurisdictional entities that have ownership and/or maintenance responsibilities for pavement and bridges on the NHS in New Jersey, briefly summarized in Exhibit 1-1. The communication and collaboration process through which these jurisdictions are involved in the TAMP is described in *Chapter 3: TAMP Governance, Policy, and Objectives*.

Exhibit 1-1: NHS Pavement (left) and NBIS Bridges (right) by Owner



Source: NJDOT Bureau of Transportation, Data and Support, Roadway Systems Section and NJDOT Bureau of Structural Evaluation and Bridge Management.
Note: "Other" includes NJ Transit and private entities.

The State of New Jersey, compared to other states has a substantial portion of NHS pavement and NBIS bridge assets that are owned and/or maintained by non-NJDOT entities, which requires NJDOT to collaborate with other jurisdictions to ensure it collects accurate data and describes the processes pertaining to the preservation of these assets.

The federal requirements and how they are achieved through the TAMP are listed in Exhibit 1-2. This exhibit shows the criteria the Federal Highway Administration (FHWA) uses to certify compliance (per 23 CFR 515.9) and where each criterion is addressed within the TAMP.

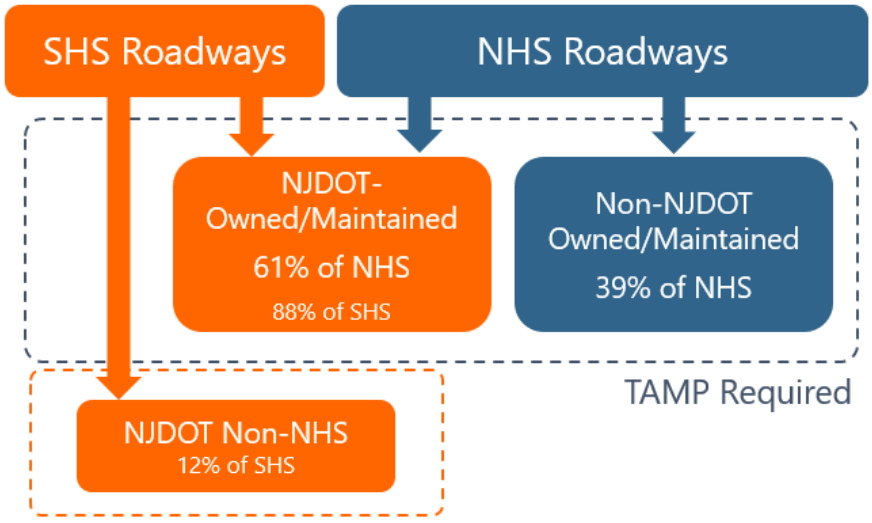
Exhibit 1-2: FHWA Asset Management Plan Requirements per 23 CFR 515.9

§	Requirements and Elements	Chapter /Date
A	A State DOT shall develop and implement an asset management plan to improve or preserve the condition of the assets and improve the performance of the NHS in accordance with the requirements of this part.	All
B	An asset management plan shall include, at a minimum, a summary listing of NHS pavement and bridge assets, regardless of ownership.	2
C	In addition to the assets specified in paragraph 515.9(b), State DOTs are encouraged, but not required, to include all other NHS infrastructure assets within the right-of-way corridor and assets on other public roads.	N/A
D	The minimum content for an asset management plan under this part includes a discussion of each element: • Asset management objectives. The objectives should align with the State DOT's mission. • Asset management performance measures and State DOT targets for asset condition for NHS pavements and bridges. • A summary description of the condition of NHS pavements and bridges, regardless of ownership. • Performance gap identification; lifecycle planning; risk management analysis; financial plan; and investment strategies.	2-8
E	An asset management plan shall cover, at a minimum, a 10-year period.	4-8
F	An asset management plan shall discuss how the plan's investment strategies collectively would make or support progress toward: • Achieving and sustaining a desired State of Good Repair over the life cycle of the assets; • Improving or preserving the condition of the assets and the performance of physical assets on the NHS; • Achieving the State DOT targets for asset condition and performance of the NHS; and, • Achieving the national goals.	4, 5, 8
G	A State DOT must include in its plan a description of how the analyses support the State DOT's asset management plan investment strategies.	5, 8
H	A State DOT shall integrate its asset management plan into its transportation planning processes that lead to the Statewide Transportation Improvement Program, to support its efforts to achieve the aims of the TAMP.	3, 8
I	A State DOT is required to make its asset management plan available to the public and is encouraged to do so in a format that is easily accessible.	Sep. 2019
J	Inclusion of performance measures and State DOT targets for NHS pavements and bridges in the asset management plan does not relieve the State DOT of other performance management requirements/reporting.	2-4
K	The head of the State DOT shall approve the asset management plan.	Jun. 2019
L	If the State DOT elects to include other NHS infrastructure assets or other public roads assets in its asset management plan, the State at a minimum shall address the following, using a level of effort consistent with the State DOT's needs and resources: • Summary listing of assets, including a description of asset condition; • Asset management measures and State DOT targets for asset condition; • Performance gap analysis; lifecycle planning; risk analysis; financial plan; and, investment strategies.	N/A
M	The asset management plan of a State may include consideration of critical infrastructure in the State.	All

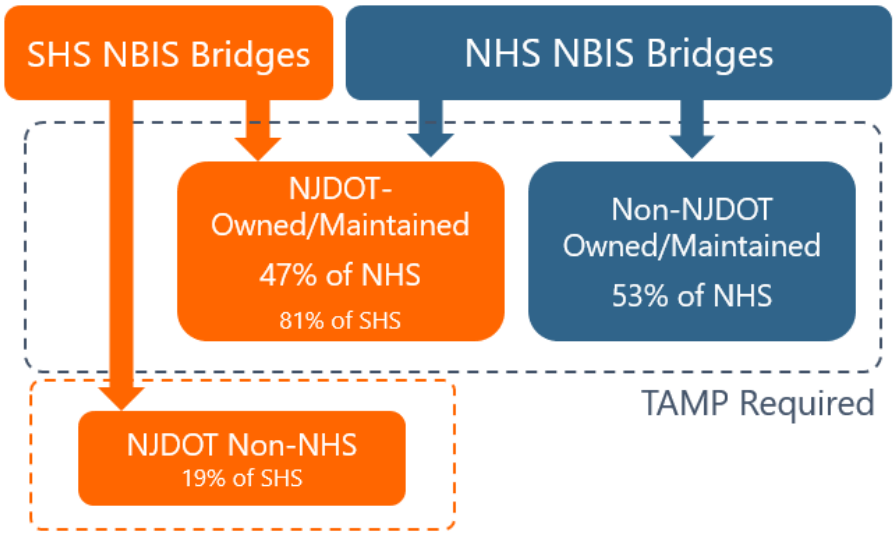
1.3 Scope of the TAMP

The TAMP addresses the management of all NHS pavement and NBIS bridge assets, regardless of ownership, consistent with federal requirements. Additionally, the TAMP process supports a data-driven capital planning process for NJDOT, which informs the New Jersey Transportation Capital Program and culminates in the development of the New Jersey's Statewide Transportation Improvement Program (STIP). The FY 2018-2027 STIP (2018 STIP) documents major transportation improvements planned in the State of New Jersey, identifying capital projects and programs, as well as funding allocations and sources for each of the STIP's 10 years. The categories of assets addressed by the TAMP are summarized below.

Pavements



Bridges



1.4 TAMP Organization

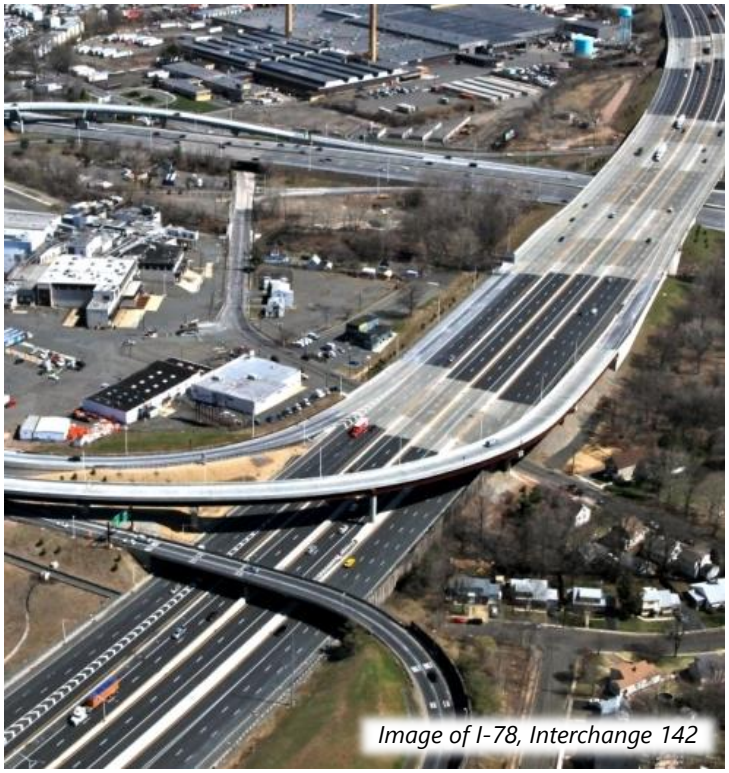
The TAMP is documented in the following chapters:

1. ***Introduction*** – provides an overview of the role of the TAMP in the management of the New Jersey SHS and in addressing federal requirements for the NHS. The chapter provides background information on the NHS in New Jersey, role of the TAMP, federal requirements, the scope of the TAMP, and organization of the TAMP.
2. ***Asset Inventory, Performance Measures, and Baseline Conditions*** – describes the asset classes addressed in the TAMP, the performance measures used to track their condition, as well as presents baseline asset conditions and historical progress toward State of Good Repair Objectives. The established two- and four-year NHPP targets are introduced and reviewed.
3. ***TAMP Governance, Policy, and Objectives*** – describes NJDOT's ongoing business practices and accountabilities for asset management. The chapter describes governance for the implementation of the TAMP, engagement of stakeholders, risk management, and the monitoring and reporting of asset conditions reporting. Additionally, NJDOT's asset management-related policies are outlined. These provide the policy context for the TAMP State of Good Repair Objectives, which are also presented.
4. ***Performance Gap Analysis*** – documents the analytical process and assumptions used to perform the TAMP gap analysis. This process documents the methods used to project the performance gaps over the two- and four-year horizons for the NHPP targets, and 11-year horizon for the State of Good Repair Objectives. The alternative investment scenarios for the TAMP analysis period are evaluated, compared, and presented.
5. ***Lifecycle Planning*** – describes NJDOT's whole-life planning strategies and business practices for the management of the different asset classes. This chapter describes and summarizes the plan for managing the assets to achieve the TAMP State of Good Repair Objectives while minimizing costs and risks. The preferred lifecycle strategies are also presented, which underlie the investment strategies.
6. ***Risk Management*** – describes the TAMP risk management process and presents the risk register. Responsibilities for risk management and the framework to ensure that risks are appropriately addressed and mitigated are also outlined.
7. ***Financial Plan*** – presents planned capital investments in highway infrastructure preservation over the TAMP analysis period, an 11-year period from FY 2019 through FY 2029, as well as details, key sources and uses of the investments, particularly those related to asset management. The chapter also discusses broader financial risks and opportunities.
8. ***Investment Strategies*** – describes investment strategy for each asset class that is derived from the preceding TAMP analyses and consists of the optimal allocation of resources across the asset portfolio. The investment strategies balance the funding amounts to be invested according to work type that enable NJDOT to pursue the TAMP Policy and State of Good Repair Objectives.

2. Asset Inventory, Performance Measures, and Baseline Conditions

Background

Effective asset management requires timely and accurate asset information. The asset management process measures and monitors the inventory, condition, and performance of the transportation assets to provide the foundation for the management of these assets across their lifecycle.



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2.1 Overview

This chapter describes the New Jersey Transportation Asset Management Plan (the TAMP) asset inventory, performance measures, baseline conditions, and National Highway Performance Program (NHPP) two- and four-year targets. It begins with a brief identification of the categories of assets that are included in the TAMP, including an explanation of the entities responsible for the various levels of roadway network in the state. The TAMP addresses assets within two category groupings, according to the two different roadway networks that are the subject of the TAMP: The National Highway System (NHS) and the State Highway System (SHS). It is important to note that these roadway networks are not mutually exclusive, a large portion of the SHS is comprised of NHS roadways.

The asset condition and performance measure data contained in this chapter are prefaced with a "Collection Year" (CY) to clarify what period the data represents. "CY" refers to information gathered in a given year. In the TAMP, data from a given CY is treated as the starting point, or baseline, for the following year. For instance, in this chapter, CY 2017 data (e.g., collected during 2017), which is the best available data, becomes the baseline data for 2018.

2.2 Scope of the TAMP

2.2.1 Assets Included in the TAMP

Pavements

- Pavements on the National Highway System (NHS)*
- Pavements on the State Highway System (SHS)**

Bridges

- National Bridge Inspection Standard (NBIS) Bridges on the NHS*
- NBIS Bridges on the SHS**

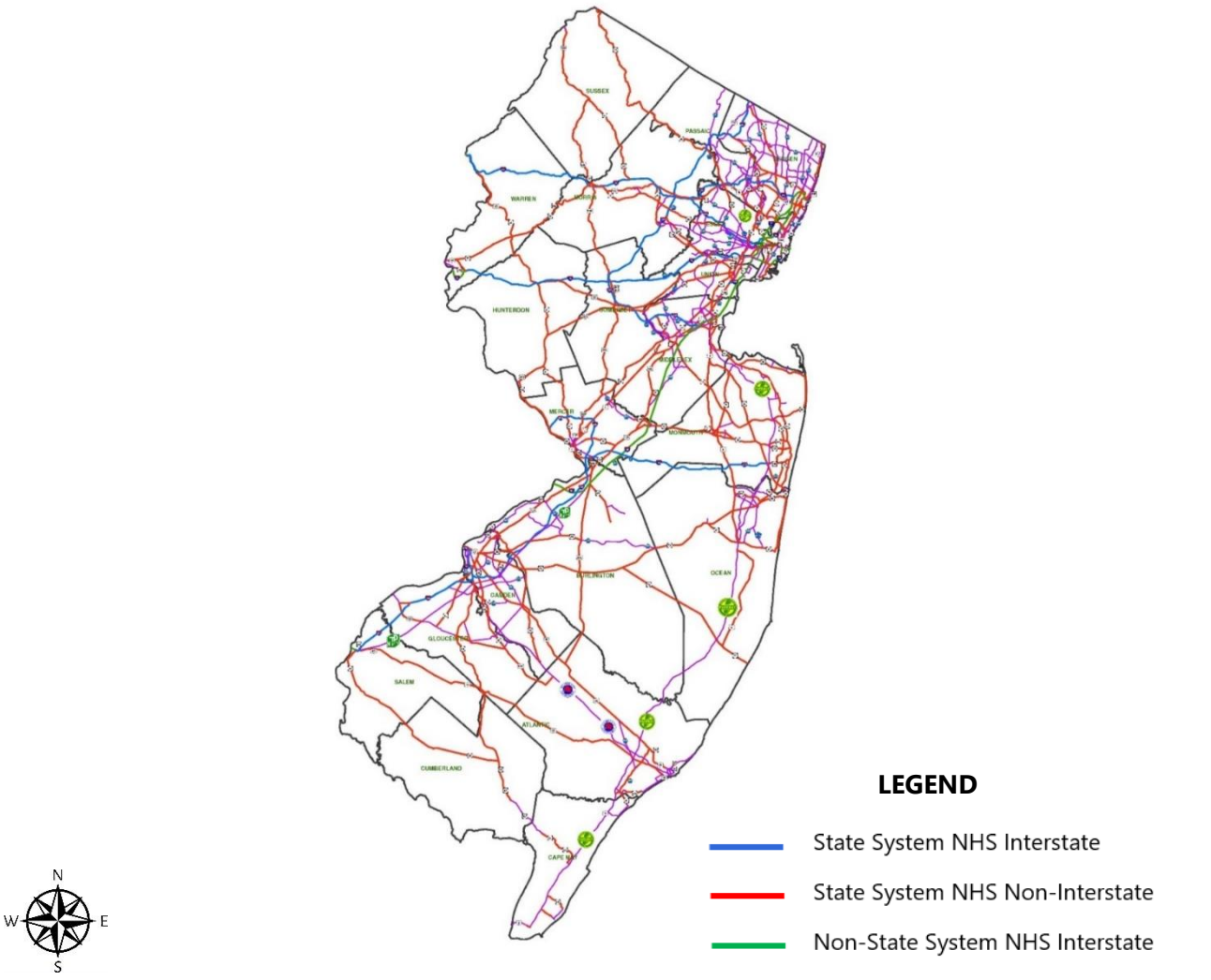
*Assets required in the TAMP per 23 CFR 515.
**Roadway assets that the New Jersey Department of Transportation (NJDOT) owns and/or maintains.

New Jersey Roadways – Networks and Jurisdictional Responsibilities

National Highway System

There are presently 12,233 pavement lane miles on the NHS in New Jersey. The NHS as defined by the Federal Highway Administration (FHWA) is broken down into two categories, interstate and non-interstate. Interstate NHS highways are controlled-access expressways designated by the United States Department of Transportation and signed as part of the interstate system. Non-interstate NHS highways handle significant traffic, long-distance travel, or provide connection between transportation facilities such as interstate highways, transit centers, airports, or ports. While the NHS in New Jersey is a single network, it is owned and maintained by 83 different agencies. Each entity is free to manage its portion of the system to meet its own objectives, and using its own resources, management approaches, measures, and tools. Each entity has its own funding streams which may also include federal aid through the National Highway Performance Program (NHPP).

Exhibit 2-1 NHS Roadways in New Jersey



Source: NJDOT Bureau of Transportation, Data & Safety.

State Highway System

The SHS includes all the approximately 8,530 pavement lane miles owned by the State of New Jersey (also referred to as NJDOT-owned and/or maintained). The SHS includes a significant amount of NHS roadways (7,536 pavement lane miles), both interstate and non-interstate, as well as 994 pavement lane miles of other high-speed limited-access freeways, principal arterials, and minor arterials.

Other Roadways

The remaining and largest portion of roadway mileage in New Jersey is comprised of non-NHS roadways under the jurisdiction of counties, municipalities, and parks. The roadways include minor arterials, major and minor collectors, and local roadways that are primarily intended to provide access from residential and commercial areas. While these roadways may handle significant levels of traffic for short distances, local roads typically have the lowest speed limits and carry the lowest traffic volumes. Assets on these roadways are not addressed in the TAMP.

2.2.2 New Jersey Highway Assets and Owners

This section presents the TAMP asset quantities by network and the categories of owner.

Exhibit 2-2: Required TAMP Assets – CY 2017

Asset Class	Network	Type	NHS Totals
NHS Pavements *(Lane Miles)*	**All**		**12,233**
		Interstate	2,982
		Non-Interstate	9,251
	SHS		**7,536**
		Interstate	1,976
		Non-Interstate	5,560
	Other*		**4,697**
		Interstate	1,006
		Non-Interstate	3,691
NHS NBIS Bridges *(Deck Area Sq. Ft.)*	**All**	-	**61,396,535**
	SHS	-	**29,132,306**
	Other*	-	**32,264,229**

*Other includes authorities/commissions, counties, municipalities, and others; all defined later.
Sources: NJDOT Bureau of Transportation, Data and Support, Bureau of Structural Evaluation and Bridge Management.
Notes: NHS = National Highway System. SHS = State Highway System. NBIS = National Bridge Inspection Standard.

Exhibit 2-3: Assets on SHS – CY 2017

Asset Class	Units	SHS Totals
Pavements	*Lane Miles*	**8,530**
NBIS Bridges	*Deck Area (Sq. Ft.)*	**36,053,044**

Note: Assets may be on the SHS and NHS. NBIS = National Bridge Inspection Standard.
Sources: Bureau of Transportation, Data and Support, NJDOT Bureau of Structural Evaluation and Bridge Management.

Pavements – The TAMP pavement inventory includes all mainline travel pavement on NHS roadways, regardless of owner. Shoulders are not included in pavement inventory totals. The TAMP inventory also includes all mainline travel pavement on SHS roadways regardless of whether on or off the NHS.

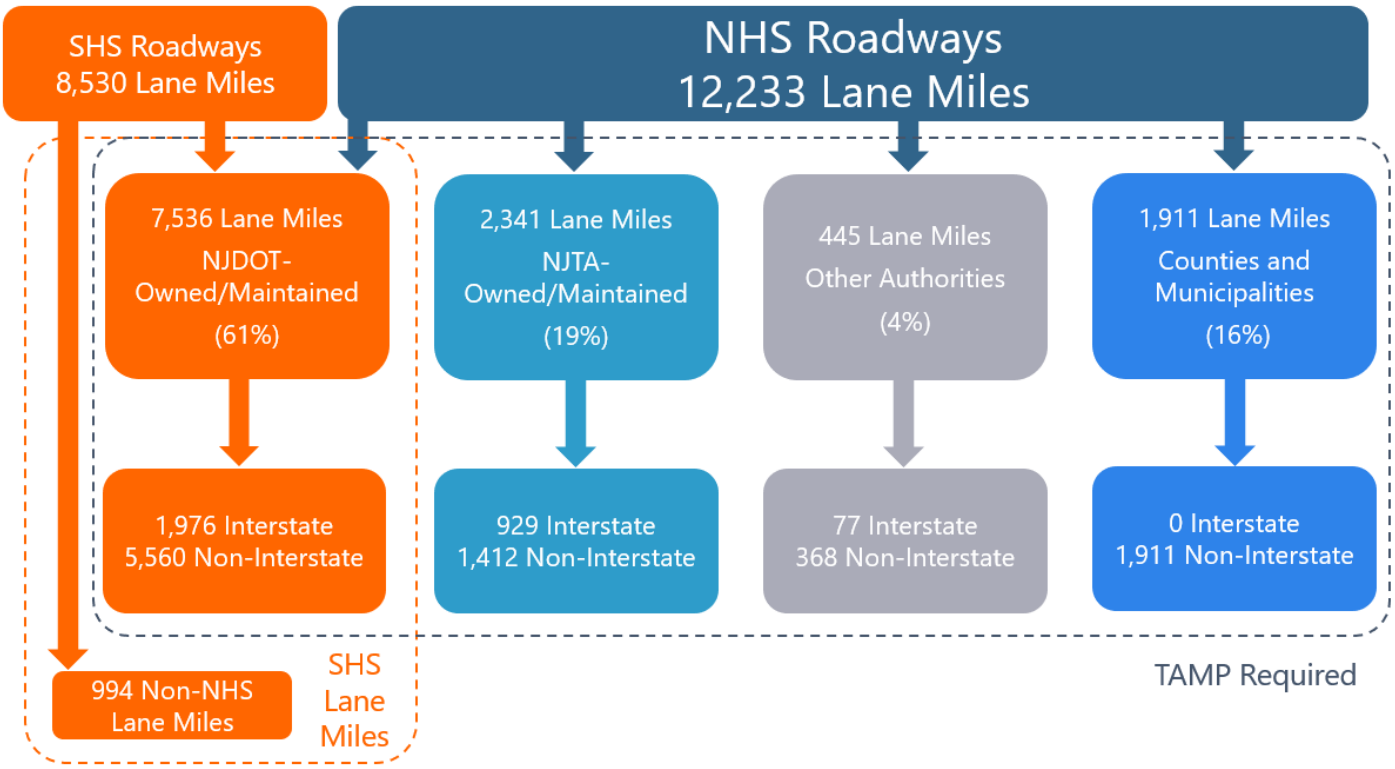
Bridges – The TAMP bridge inventory includes all National Bridge Inspection Standard (NBIS) bridges on the NHS, regardless of owner. NBIS Bridges are bridges carrying public roads with a span greater than 20 feet as measured along the centerline of the roadway. These bridges are inspected every two years, as required by federal law. The TAMP bridge inventory also includes all NBIS bridges maintained by NJDOT (SHS and NJDOT-maintained bridges), regardless of whether they are on or off the NHS.

Ownership of TAMP Pavement Assets

The summary asset inventory in Exhibits 2-2 and 2-3 lists New Jersey's inventory of pavement by lane miles and by system (NHS vs. SHS). Exhibit 2-4 portrays the breakdown in responsibility for these pavement assets. All of the pavement assets represented in Exhibit 2-4 are included in the TAMP.

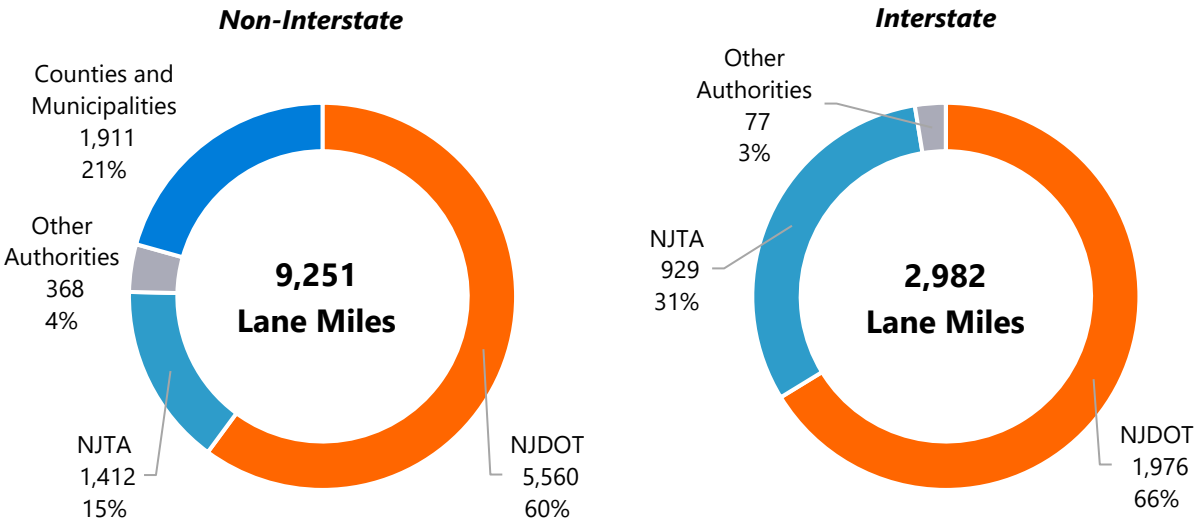
In total, there are 12,233 lane miles of pavement on the NHS, according to the best data available. As of CY 2017 data, NJDOT maintains approximately 61 percent (7,536) of these pavement lane miles, as well as 994 pavement lane miles as part of the SHS. The New Jersey Turnpike Authority (NJTA), which owns the New Jersey Turnpike and the Garden State Parkway, accounts for another 19 percent (2,341) of the NHS pavement lane miles. A more detailed breakdown of NHS pavement assets by county and jurisdiction is presented in Exhibit 2-6. Exhibit 2-5 provides a breakdown of NHS pavement assets by category of interstate and non-intestate, as well as by ownership.

Exhibit 2-4: NHS and SHS Pavements by Lane Miles and Category, by Owner – CY 2017



Source: NJDOT Bureau of Transportation, Data and Support, Roadway Systems Section.
Note: NJTA = New Jersey Turnpike Authority.

Exhibit 2-5: NHS Pavement Lane Miles by Owner and Category – CY 2017



Source: NJDOT Bureau of Transportation, Data and Support, Roadway Systems Section.
Note: NJTA = New Jersey Turnpike Authority.

Exhibit 2-6: NHS Pavement Lane Miles by Jurisdiction Type – CY 2017

MPO	County	Subtotal	NJDOT	County	Municipality	Authority
NJTPA	Bergen	1,086.8	506.5	339.5	9.6	231.2
	Essex	781.9	315.9	244.8	86.4	134.9
	Hudson	363.5	146.9	88.6	13.8	114.2
	Hunterdon	302.4	301.0	-	-	1.4
	Middlesex	1,271.5	610.9	146.9	8.4	505.4
	Monmouth	978.1	681.5	35.9	9.0	251.8
	Morris	780.9	725.9	50.9	4.1	-
	Ocean	739.5	368.5	134.0	-	237.1
	Passaic	461.4	282.6	132.8	18.9	27.0
	Somerset	463.5	449.5	14.0	-	-
	Sussex	168.7	167.7	-	-	1.0
	Union	555.9	310.4	37.5	21.5	186.5
	Warren	302.6	269.7	3.4	1.1	28.4
Subtotal	NJTPA	8,256.8	5,136.9	1,228.3	172.9	1,718.7
DVRPC	Burlington	963.0	569.4	130.0	-	263.6
	Camden	747.0	469.8	142.8	7.1	127.4
	Gloucester	488.7	355.4	53.9	6.6	72.8
	Mercer	654.9	442.1	30.6	33.7	148.5
Subtotal	DVRPC	2,853.6	1,836.8	357.2	47.4	612.3
SJTPO	Atlantic	624.2	267.9	46.8	19.3	290.2
	Cape May	205.5	53.0	20.0	7.9	124.6
	Cumberland	129.1	117.8	11.3	-	-
	Salem	163.6	123.5	-	-	40.1
Subtotal	SJTPO	1,122.3	562.2	78.0	27.2	454.9
	Totals	12,232.7	7,535.9	1,663.5	247.5	2,785.9

Authority Name	Type of Authority	Lane Miles
New Jersey Turnpike Authority	Authority	2,341.3
South Jersey Transportation Authority	Authority	265.0
Palisades Interstate Parkway Commission	Special Agency	46.6
Port Authority of NY & NJ	Authority	45.3
Delaware River Port Authority	Authority	35.7
Delaware River Joint Toll Bridge Commission	Commission	33.3
Delaware River & Bay Authority	Authority	15.9
Burlington County Bridge Commission	Commission	2.8
	Total	2,785.9

Source: NJDOT Bureau of Transportation, Data and Support.
Notes: Full list of municipal owners in Appendix B. MPO = Metropolitan Planning Organization. NJTPA = North Jersey Transportation Planning Authority. DVRPC = Delaware Valley Regional Planning Commission. SJTPO = South Jersey Transportation Planning Organization. NJDOT data includes owned and/or maintained assets.

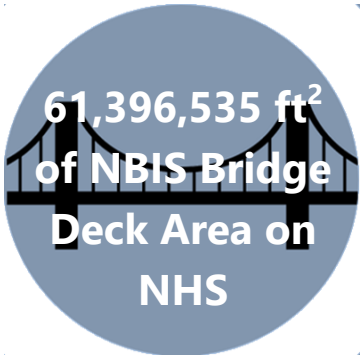
Ownership of TAMP NBIS Bridges

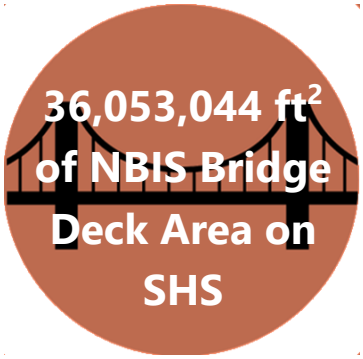
The summary asset inventory in Exhibits 2-2 and 2-3 lists New Jersey's inventory of highway carrying NBIS bridges by deck area and by system (NHS vs. SHS). Exhibit 2-7 portrays the breakdown in responsibility for these bridges. All of the bridges represented in Exhibit 2-7 are included in the TAMP.

In total, there is 61,396,535 ft^2 of bridge deck area on the NHS in New Jersey. Based on CY 2017 data, NJDOT maintains 36,053,044 ft^2 of deck area, of which 6,920,738 ft^2 is on the SHS but not on the NHS (Note: going forward, bridges referred to as SHS assets include non-SHS bridges that are maintained by NJDOT). NJDOT's maintenance responsibility represents about 47 percent of the total NHS deck area in New Jersey.

As presented in Exhibit 2-7, NJTA structures, including the New Jersey Turnpike and the Garden State Parkway, are tabulated separately since these represent a large part of the NHS ownership. Together, both NJTA roadways have 887 bridges on the NHS. Their NHS ownership represents about 34 percent of NHS bridges by deck area in New Jersey. This leaves about 19 percent of NHS bridges by deck area that is owned and maintained by others (approximately 17 percent other authorities and 2 percent various counties and municipalities and other owners). Therefore, in total approximately 53 percent of NHS bridges by deck area is not maintained by NJDOT as shown in Exhibit 2-8.

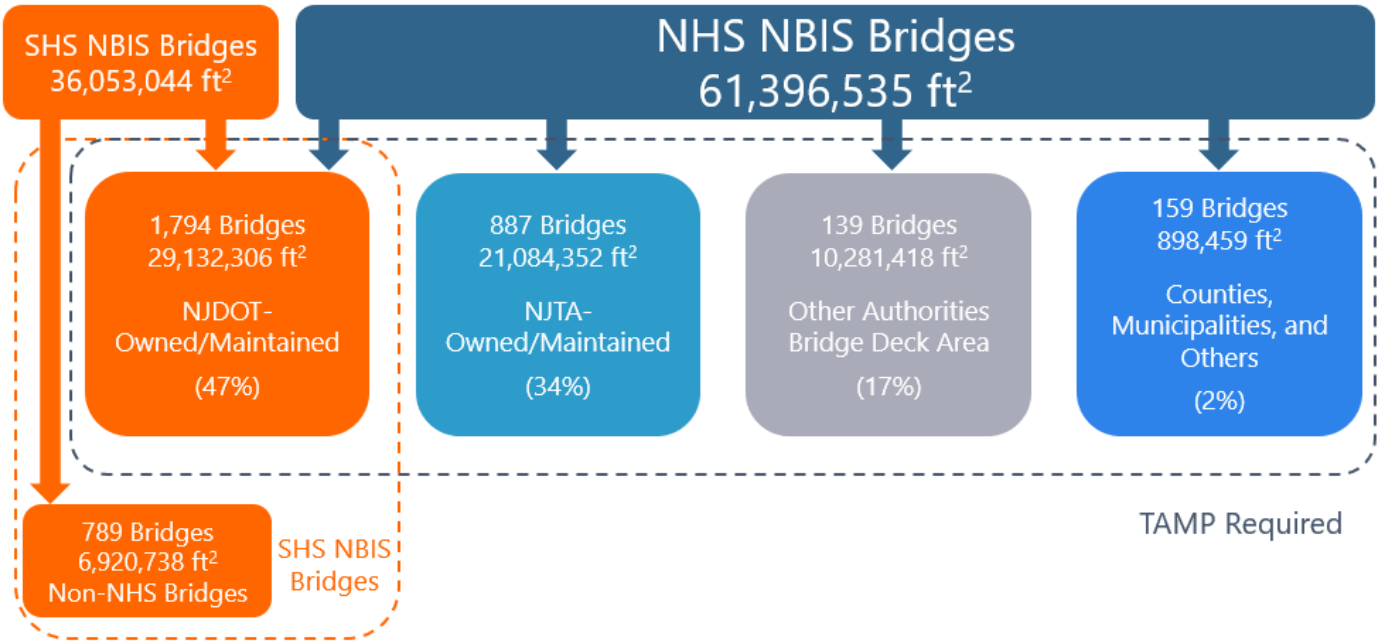
A more detailed breakdown of NHS bridges by county and jurisdiction is presented in Exhibit 2-9.





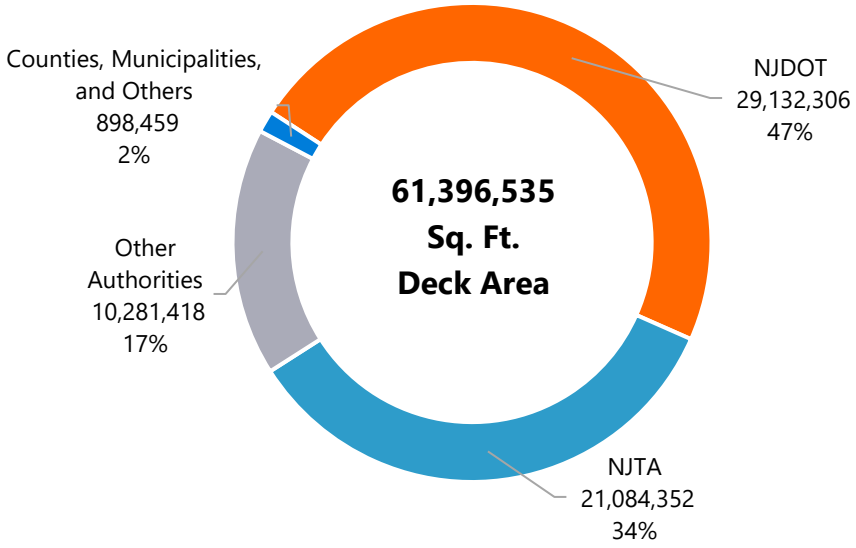
Included in the bridge inventory is a total of 38 border bridges, with 9,289,011 ft^2 deck area, that span between New Jersey and its neighboring states (New York, Pennsylvania, and Delaware). None of the border bridges are owned or maintained by NJDOT; they are owned and maintained by a variety of authorities and commissions. These bridges will also be included in the border states' TAMPs.

Exhibit 2-7: NHS and SHS NBIS Bridges by Count and Deck Area, by Owner – CY 2017



Source: NJDOT Bureau of Structural Evaluation and Bridge Management.
Notes: NJTA = New Jersey Turnpike Authority. Others (not "Other Authorities") include NJ Transit and private entities.

Exhibit 2-8: NHS NBIS Bridge Deck Area (ft²) by Owner – CY 2017



Source: NJDOT Bureau of Structural Evaluation and Bridge Management.
Notes: NJTA = New Jersey Turnpike Authority. Others (not "Other Authorities") include NJ Transit and private entities.

Exhibit 2-9: NHS NBIS Bridge Deck Area (ft^2) by Jurisdiction Type – CY 2017

MPO	County	Subtotal	NJDOT	County	Municipality	Authority	Other
NJTPA	Bergen	6,626,088	3,114,850	91,465	-	3,407,781	11,993
	Essex	8,479,889	3,811,092	84,991	21,235	4,553,513	9,058
	Hudson	6,817,933	2,621,849	113,237	-	4,082,846	-
	Hunterdon	748,160	601,123	-	-	147,037	-
	Middlesex	6,864,380	2,787,016	86,284	-	3,991,079	-
	Monmouth	2,228,997	1,407,573	17,035	-	804,388	-
	Morris	1,732,006	1,715,556	10,705	-	-	5,745
	Ocean	1,539,546	1,115,020	25,391	-	399,135	-
	Passaic	2,809,814	2,309,315	150,447	-	350,052	-
	Somerset	936,274	924,922	2,903	-	-	8,449
	Sussex	190,733	154,740	-	-	35,992	-
	Union	4,730,387	1,210,552	6,271	-	3,509,713	3,850
	Warren	768,264	347,830	2,709	-	412,201	5,524
Subtotal	**NJTPA**	44,472,472	22,121,441	591,439	21,235	21,693,737	44,619
DVRPC	Burlington	2,893,387	916,370	20,736	-	1,956,281	-
	Camden	4,422,729	1,365,271	32,314	-	3,005,006	20,139
	Gloucester	1,986,460	750,437	8,883	-	1,227,140	-
	Mercer	2,736,745	1,834,508	29,742	-	872,496	-
Subtotal	**DVRPC**	12,039,322	4,866,586	91,675	-	7,060,922	20,139
SJTPO	Atlantic	2,182,239	946,755	61,668	-	1,164,510	9,307
	Cape May	1,056,554	879,782	57,125	-	119,646	-
	Cumberland	182,478	181,226	1,252	-	-	-
	Salem	1,463,472	136,517	-	-	1,326,955	-
Subtotal	**SJTPO**	4,884,742	2,144,279	120,045	-	2,611,111	9,307
Total		**61,396,535**	**29,132,306**	**803,159**	**21,235**	**31,365,770**	**74,065**

Authority	Type of Authority	Deck Area
New Jersey Turnpike Authority	Authority	21,084,352
Delaware River Port Authority	Authority	3,737,698
Port Authority of NY & NJ	Authority	3,603,241
Delaware River & Bay Authority	Authority	1,263,078
Delaware River Joint Toll Bridge Commission	Commission	953,515
South Jersey Transportation Authority	Authority	390,070
Burlington County Bridge Commission	Commission	271,140
Palisades Interstate Parkway Commission	Special Agency	62,675
	Total	**31,365,770**

Source: NJDOT Bureau of Structural Evaluation and Bridge Management.
Notes: Full list of municipal and Other owners in Appendix B. MPO = Metropolitan Planning Organization. NJTPA = North Jersey Transportation Planning Authority. DVRPC = Delaware Valley Regional Planning Commission. SJTPO = South Jersey Transportation Planning Organization. NJDOT data includes owned and/or maintained assets. "Other" owners include NJ Transit and private entities.

2.3 Pavement Performance Metrics, Measures, and Baseline Conditions

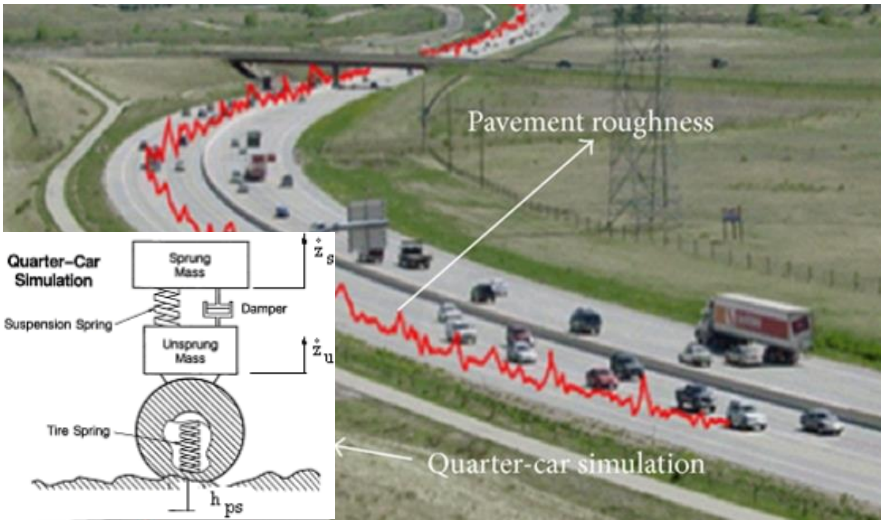
2.3.1 Pavement Condition Distresses, Data Collection, and Reporting

FHWA Rule, 23 CFR 490 Subpart C requires State DOTs to report condition information for each 1/10th mile segment of NHS pavement on the interstate system annually, and for non-interstate NHS pavement biennially based on the specific condition metrics. A metric is defined as a quantifiable indicator of performance or condition. The metrics established by FHWA to measure pavement condition and performance are described below and illustrated in Exhibits 2-10 through 2-13.

International Roughness Index (IRI)

International Roughness Index is a measure of ride quality, which represents the roughness felt by vehicle occupants driving over the pavement in a measure of inches of vertical movement per mile traveled.

Exhibit 2-10: International Roughness Index Data Collection Illustration



Cracking

FHWA requires that cracking is measured as the percent of the pavement surface area exhibiting cracking, within the wheel path, per 1/10th mile of pavement. The intent of this metric is to determine the amount of load-related cracking, indicating structural failure of the pavement. As SHS pavements do not exhibit significant wheel-path cracking that would indicate structural deficiency, NJDOT measures cracking over the full extent of the pavement surface in addition to the wheel path to also capture environmental, wear, and age-related cracking.

Exhibit 2-11: Block and Longitudinal Cracking

Rutting

Rutting is a measure of surface depression (in inches) in a pavement's wheel path, as demonstrated in Exhibit 2-12. It is reported as the average depression depth per 1/10th mile of pavement.

Exhibit 2-12: Rutting

Faulting

Faulting is a measure of difference in elevation (in inches) across a jointed concrete pavement's transverse joints or cracks. It is reported as the average difference in elevation across joints or cracks per 1/10th mile of pavement.

Exhibit 2-13: Faulting

NJDOT Condition Status Performance Metric

Condition Status is a composite performance metric determined from the following two indices, for each 1/10th mile segment of SHS pavement:

- International Roughness Index.
- Surface Distress Index – a composite index, developed by and for NJDOT, that considers structural and nonstructural distresses that can be observed at the pavement surface, including: cracking, patching, faulting, joint deterioration, and rutting.

Pavement Data Collection and Reporting

NJDOT uses automated equipment to collect data on pavement condition in accordance with AASHTO standard R 43-13. The data collection van, depicted in Exhibit 2-14, is outfitted with lasers, sensors, and cameras to collect information on cracking, ride quality, wheel path rutting, and faulting. The van also takes photos of the entire roadway during data collection.

Data are collected and reported for all SHS and all NHS roads through three separate efforts:

- NJDOT Pavement Management Unit collects data for all SHS, South Jersey Transportation Authority, and Palisades Interstate Parkway pavements.
- NJDOT Bureau of Transportation, Data and Support Unit manages collection of data for all remaining non-SHS pavements on the NHS except for the NJTA.
- The NJTA collects condition data for its own pavements.

Exhibit 2-14: Pavement Condition Data Collection Vehicle

NJDOT compiles and reports pavement condition data for all SHS pavements, as well as the full NHS in accordance with requirements for the FHWA Highway Performance Monitoring System.

2.3.2 Pavement Performance Measures

23 CFR 490 defines a performance measure as "an expression based on a metric that is used to establish targets and assess progress toward achieving the established targets." Many states including New Jersey have already established performance measures for their pavement assets to monitor and report asset condition and assist in planning and funding decisions. Described below are the federal performance measures for the NHS and NJDOT's performance measures for the SHS.

NHS Pavement Performance Measures – NHPP Measures

FHWA's Transportation Performance Management regulations (23 CFR 490 subpart C) define specific performance measures to be used in condition reporting and targets established for pavements on the NHS (see Section 2.5 for NHPP targets).

- The percentage of interstate pavement lane miles in *Good* condition.
- The percentage of interstate pavement lane miles in *Poor* condition.
- The percentage of non-interstate NHS pavement lane miles in *Good* condition.
- The percentage of non-interstate NHS pavement lane miles in *Poor* condition.

From NJDOT's annual NHS data submission, FHWA calculates and reports the performance of NHS pavements in New Jersey based on the NHPP metrics and the rating system in Exhibit 2-15.

Exhibit 2-15: Pavement Condition Metrics and Rating Criteria for NHPP Performance Measures

Metric	Units	Rating defined by 23 CFR 490 for each Performance Measure		
		Good	Fair	Poor
International Roughness Index	Inches/mile	<95	95-170	>170
Cracking	Percent	<5	Jointed: 5-15 Asphalt: 5-20	>15 >20
AND EITHER				
Rutting (Asphalt)	Inches	<0.20	0.20-0.40	>0.40
OR				
Faulting (Portland Cement Concrete)	Inches	<0.10	0.10-0.15	>0.15

FHWA has defined "Good" to mean that values for all three metrics for each pavement type must fall in the "Good" range for that 1/10th mile segment of pavement to be rated as "Good." For a pavement segment to be rated in "Poor" condition, two of the three metric values must fall within the "Poor" range. The results of the 1/10th mile segment evaluation are then accumulated for each condition category resulting in an overall percentage of each condition category, representing the overall performance, for the network. This methodology is very forgiving and results in the majority of the network being rated as *Good* or *Fair* with a limited ability to discern any differences between pavement conditions within these condition categories. Furthermore, the methodology makes it impractical to utilize this methodology to effectively manage the pavement network.

SHS Pavement Performance Measures – NJDOT Measures

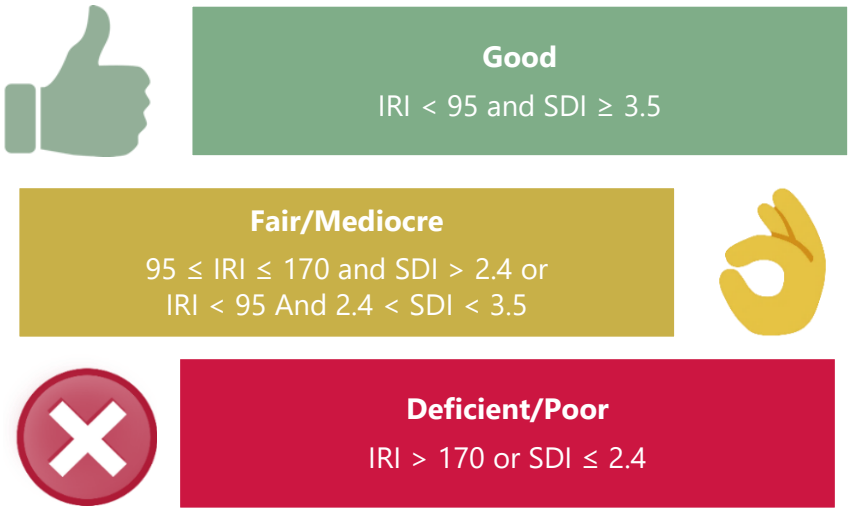
There are many means of measuring pavement condition, and few national standards. The pavement performance measures and metrics that were established by FHWA in 2017 for NHS performance reporting differ from those established by NJDOT for SHS pavement management and performance reporting. NJDOT has been collecting pavement condition data and using it to manage pavement since 2000.

Over that time NJDOT has developed and refined its performance metrics and rating criteria to best support pavement management, considering the types of pavement in its inventory, the traffic loading on its pavements, the types of distresses and modes of failure experienced, and the types of treatments proven effective for improving pavement condition within New Jersey. NJDOT uses these performance measures to report pavement condition, set State of Good Repair Objectives, identify appropriate treatments, and prioritize paving projects.

NJDOT's performance measure for the SHS is the percent of pavement in *Good* or *Fair* condition. Pavements meeting the threshold of *Good* or *Fair* condition are considered to be in a "State of Good Repair." The TAMP State of Good Repair Objectives for the SHS are described in *Chapter 3: TAMP Governance, Policy, and Objectives*.

Exhibit 2-16 indicates how the International Roughness Index and Surface Distress Index factor into the Condition Status performance metric ratings of *Good*, *Fair*, and *Poor*.

Exhibit 2-16: Pavement Condition Metrics and Rating Criteria for NJDOT's Performance Measures



Notes: SDI = Surface Distress Index. IRI = International Roughness Index.

Similar to FHWA's methodology, both International Roughness Index (IRI) and Surface Distress Index (SDI) values must fall within the "Good" range for a pavement segment to be considered "Good." Unlike FHWA, if either IRI or SDI values fall within the "Poor" range, the pavement segment is considered "Poor." Additionally, based on the IRI and SDI values, each pavement section is assigned a numerical benefit value that allows NJDOT to distinguish pavements within the *Good*, *Fair* and *Poor* categories to better identify treatment strategies and more effectively manage the network.

To further clarify the differences between NJDOT's performance measure for the SHS and the NHPP performance measure for the NHS, Exhibit 2-17 illustrates which underlying distress metrics are used in each performance measure.

Exhibit 2-17: NJDOT and NHPP Performance Measure Comparison

Distress	Measure	
	NHPP	NJDOT
IRI	●	●
HMA Rutting	●	●
HMA Wheelpath Cracking	●	●
HMA Cracking		●
HMA Cracking Outside Wheelpaths		●
HMA Patching		●
PCC Faulting	●	●
PCC Total Cracking/Spawling	●	●
PCC Joint Deterioration		●
PCC Patching		●

2.3.3 Baseline and Historic Pavement Conditions

Baseline Pavement Conditions

Pavement condition throughout New Jersey's highway systems are dynamic, changing over time due to a combination of factors including deterioration due to environmental aging and repeated loading of vehicular traffic, as well as continual improvements to the network through maintenance and capital investment activities. Furthermore, assets located in areas deemed to be vulnerable to extreme weather conditions (i.e., frequent flooding, storm surge, sea level rise, etc.) receive additional scrutiny beyond standard lifecycle planning practices to determine if advanced environmental aging occurs, and are appropriately managed through targeted, albeit still maturing, vulnerability mitigation programs at NJDOT[1], further detailed in *Chapter 5: Lifecycle Planning* and *Chapter 6: Risk Management*.

Effective management of SHS and NHS pavement assets requires timely, accurate, and complete data on baseline condition, as well historical data that helps to characterize condition trends. Exhibits 2-18 and 2-19 provide a summary of New Jersey's baseline pavement condition based on CY 2017 data. Exhibit 2-18 reports the baseline condition for pavement on the NHS using the NHPP performance measures.

Exhibit 2-18: NHS Pavement Baseline Condition by System (NHPP Measures) – CY 2017

Asset Class	System	Lane Miles		Condition (NHPP Measures by % of Lane Miles)	
		Total	Collected	% Good	% Poor
Pavements	Interstate*	2,982	2,710.838	55.02	1.36
	Non-Interstate NHS**	9,251	8,834.962	30.37	1.18

Source: FHWA Highway Performance Monitoring System 2017 Pavement Report Card.
* Total interstate pavement lane miles missing/invalid data or coded as bridge = 44.149 miles.
** Total non-interstate pavement lane miles missing/invalid data or coded as bridge = 153.378 miles.

Exhibit 2-19 presents the SHS pavement performance measured according to NJDOT's Condition Status performance metric. The exhibit indicates that approximately 65 percent of SHS pavement is in *Good* or *Fair* condition, or in a State of Good Repair, and 35 percent is rated *Poor*, when using the Condition Status performance metric.

[1] NJDOT's Asset Management, Extreme Weather and Proxy Indicators pilot study initiated a process that assesses the impacts of extreme or repeat weather events upon the conditions of New Jersey's highway assets.

Exhibit 2-19: SHS Pavement Baseline Condition (NJDOT's Condition Status) – CY 2017

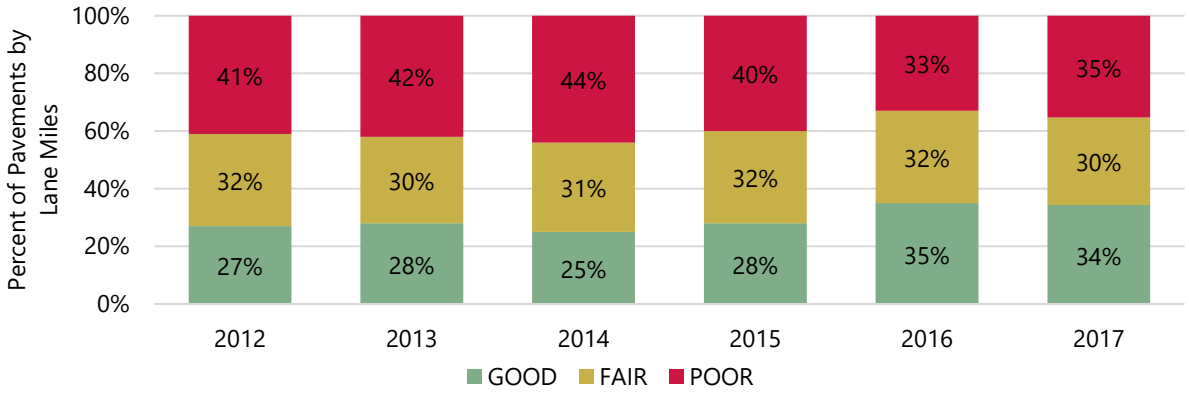
Asset Class	State System	Lane Miles	Condition (NJDOT Measures by % of Lane Miles)			
			% Good	% Fair	% Poor	
Pavements	SHS	8,530	34.32	30.38	35.30	

Source: NJDOT Pavement Management Unit.

Historic Pavement Condition

NJDOT has steadily improved pavement condition on the SHS over the past ten years through effective asset management practices. Exhibit 2-20 shows how pavement condition has improved from 59 percent of pavement lane miles in a State of Good Repair (*Good* or *Fair)* in CY 2012 and is approaching 65 percent in CY 2017.

Exhibit 2-20: SHS Pavement Historic Conditions (NJDOT's Condition Status) – CY 2012 to CY 2017



Source: NJDOT Pavement Management Unit.

2.4 Bridge Performance Measures and Baseline Conditions

This section summarizes the performance measures used, the baseline condition, and the targets established for New Jersey's bridges on the NHS (see Section 2.5 for NHPP targets) included in the TAMP. Unlike the case with pavements, the same performance measures are used for SHS reporting and NHS performance reporting to FHWA.

2.4.1 Bridge Components and Ratings, Data Collection, and Reporting

Bridge Components

Bridges serve as connections within the road network by providing passages over waterways, railroads, and other highways. NJDOT-owned bridges are presently designed for a minimum service life of 75 years. However, many bridges in the highway network are older than 75 years while some bridges have had to be taken out of service at earlier ages. If a bridge has deteriorated to the point where it cannot safely handle standard highway loads, it may need to be posted at lower weight limits or even be closed until it can be repaired or replaced.

Since the 1970s federal law has required that all bridges on public roads with a span over 20 feet be inspected at least once every two years. The three basic components of a bridge, shown in Exhibit 2-21, are the deck, superstructure, and substructure. Each component receives a condition rating, which will be described below.

Culverts are structures that allow water to flow under a road, railroad, trail, or similar obstruction from one side to the other side. Culverts with a total length greater than 20 feet (measured along the centerline of the roadway) are also subject to the federal NBIS requirements. Culverts have a single component ("Culvert") that receives a condition rating.

Exhibit 2-21: Bridge - Basic Components

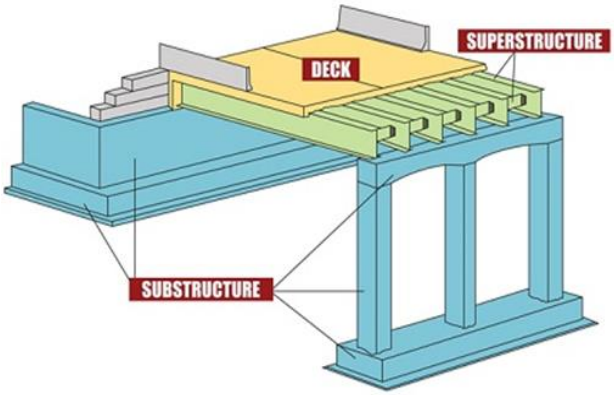


Exhibit 2-22: Culvert

Bridge Component Ratings

NBIS assigns ratings on a scale of 0 (*Failed* condition, not shown) to 9 (*Excellent* condition) to each component of a bridge (deck, superstructure, or substructure) or to the culvert based on physical conditions observed during inspections. Exhibit 2-23 displays the relationship between the ratings and the performance measures (*Good*/*Fair*/*Poor*).

Exhibit 2-23: NBIS Component Ratings and Corresponding Performance Measures

Rating Codes for Deck, Superstructure, and Substructure, or for Culvert		Performance Measures
Code	**Description**	
9	Excellent	Good
8	Very Good	
7	Good	
6	Satisfactory	Fair
5	Fair	
4	Poor	Poor
3	Serious	
2	Critical	
1	Imminent Failure	

Bridge Data Collection and Reporting

NJDOT collects information on all NBIS bridges that it owns or maintains for annual reporting to the FHWA. NJDOT also manages inspection contracts for the collection of data on county, municipal, and

some smaller entity bridges. Condition data for bridges owned by other agencies such as the NJTA, and others, is collected by those respective agencies. NJDOT receives the inspection data on these bridges for reporting to the FHWA. NJDOT is responsible for the maintenance of the bridges it owns, as well as orphan bridges, New Jersey Department of Environmental Protection bridges, and Delaware and Raritan Canal bridges that carry state highways.

2.4.2 Bridge Performance Measures

NHS and SHS Bridge Performance Measures – NHPP Measures

NJDOT is using the NHPP measures as the performance measures for NBIS bridges (23 CFR 490 Subpart D) in the TAMP. The NHPP measures set the overall condition of the bridge or culvert based on the lowest component rating [per 23 CFR 490.409(b)]. If all three of the deck, superstructure, and substructure components of a bridge or the culvert component is rated 7 or greater, the bridge is classified as being in *Good* condition. If the lowest component is rated 5 or 6, it is classified as *Fair* condition, and if the lowest component is 4 or less, it is classified as being in *Poor* condition.

FHWA Rule, 23 CFR 490.407(c) specifically states that the NHPP shall use two of the classifications (*Good* and *Poor*) to assess bridge condition on the NHS. A bridge in *Poor* condition is also sometimes referred to as "structurally deficient." A bridge that is flagged as "structurally deficient" does not imply that it is unsafe; this just means that deficiencies have been identified that require maintenance, rehabilitation, or replacement.

NJDOT uses these performance measures to report bridge condition, set State of Good Repair Objectives, identify appropriate treatments, and prioritize bridge projects. NJDOT's performance measure for bridges is the percent of bridges by deck area in *Good* or *Fair*. Bridges meeting the requirements to be rated as *Good* and *Fair* are in a "State of Good Repair." The TAMP State of Good Repair Objectives for bridges are described in *Chapter 3: TAMP Governance, Policy, and Objectives*.

2.4.3 Baseline and Historic Bridge Conditions

Baseline Bridge Conditions

The condition of bridges throughout New Jersey's highway systems is dynamic, changing over time due to a combination of factors including deterioration due to environmental aging and repeated loading of vehicular traffic, as well as continual improvements to the network through maintenance and capital investment activities. Furthermore, assets located in areas deemed to be vulnerable to extreme weather conditions (i.e., frequent flooding, storm surge, sea level rise, etc.) receive additional scrutiny beyond standard lifecycle planning practices to determine if advanced environmental aging occurs, and are appropriately managed through targeted, albeit still maturing, vulnerability mitigation programs at NJDOT, further detailed in *Chapter 5: Lifecycle Planning* and *Chapter 6: Risk Management*.

To effectively manage bridges, it is imperative to know the baseline condition of the structures and maintain historic data on the measured conditions. The TAMP baseline condition for bridges is presented using CY 2017 data. Exhibit 2-24 and Exhibit 2-25 describe bridge conditions.

Approximately six percent of the bridges by deck area on the NHS are in *Poor* condition. This meets the NHPP requirement of no more than 10 percent of NHS bridges by deck area in *Poor* condition. It should be noted that the percent *Poor* for authority-owned bridges averages less than one percent, while the percent *Poor* for SHS bridges is over 11 percent and the percent *Poor* for all other owners is over 15 percent.

Exhibit 2-24: NHS NBIS Bridge Baseline Condition by Owner – CY 2017

Asset Class	Owner	Deck Area (ft^2)	% of Total	Condition (NHPP Measures by % of Deck Area)			
				% Good	% Fair	% Poor	
NBIS Bridges	NJDOT	29,132,306	47.45	28.66	60.26	11.07	
	NJTA	21,084,352	34.34	16.68	82.10	1.22	
	Other Authorities	10,281,418	16.75	7.63	92.13	0.25	
	Others	898,459	1.46	12.26	71.46	16.29	
	NHS Total	**61,396,535**	**100.00**	**20.79**	**73.26**	**5.95**	

Source: NJDOT Bureau of Structural Evaluation and Bridge Management.
Notes: Other Authorities include the South Jersey Transportation Authority, the Burlington County Bridge Commission, the Delaware River Joint Toll Bridge Commission, Delaware River Port Authority, Delaware River & Bay Authority, Palisades Interstate Parkway Commission, and the Port Authority of New York and New Jersey. Others includes counties, municipalities, NJ Transit, and private entities.

Exhibit 2-25 reports the baseline condition for all SHS bridges. As of CY 2017, approximately 10.8 percent of SHS bridges by deck area are in *Poor* condition. When measured by percent *Good*, bridges on the NHS are in slightly better condition than bridges off the NHS. On the other hand, there is a higher percentage of SHS bridges on the NHS in *Poor* condition than SHS bridges off the NHS.

Exhibit 2-25: SHS NBIS Bridge Baseline Condition by System – CY 2017

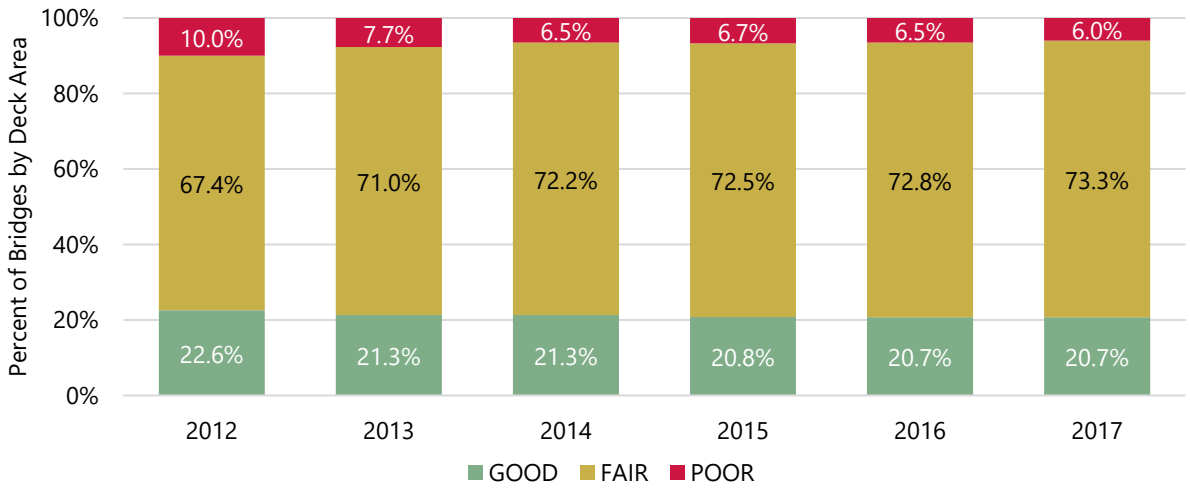
Asset Class	System	Deck Area (ft^2)	% of Total	Condition (NHPP Measures by % of Deck Area)			
				% Good	% Fair	% Poor	
NBIS Bridges	NHS	29,132,306	80.80	28.66	60.26	11.07	
	Non-NHS	6,920,738	19.20	25.53	65.05	9.42	
	NJDOT Total	**36,053,044**	**100.00**	**28.06**	**61.18**	**10.75**	

Source: NJDOT Bureau of Structural Evaluation and Bridge Management.

Historic NBIS Bridge Conditions

Through progressive asset management practices, owners of NHS bridges have been able to steadily improve conditions in New Jersey over the past five years. Exhibit 2-26 shows the improvement from 90 percent of NHS bridges by deck area in a State of Good Repair (*Good* or *Fair)* in CY 2012 to 94 percent in CY 2017. The recent trend shown in Exhibit 2-26 reflects steady progress towards more bridges by deck area rated as in a State of Good Repair, with a four percentage-point increase in the bridges by deck area in *Good* or *Fair* condition (and an equal percentage-point reduction in percent *Poor*).

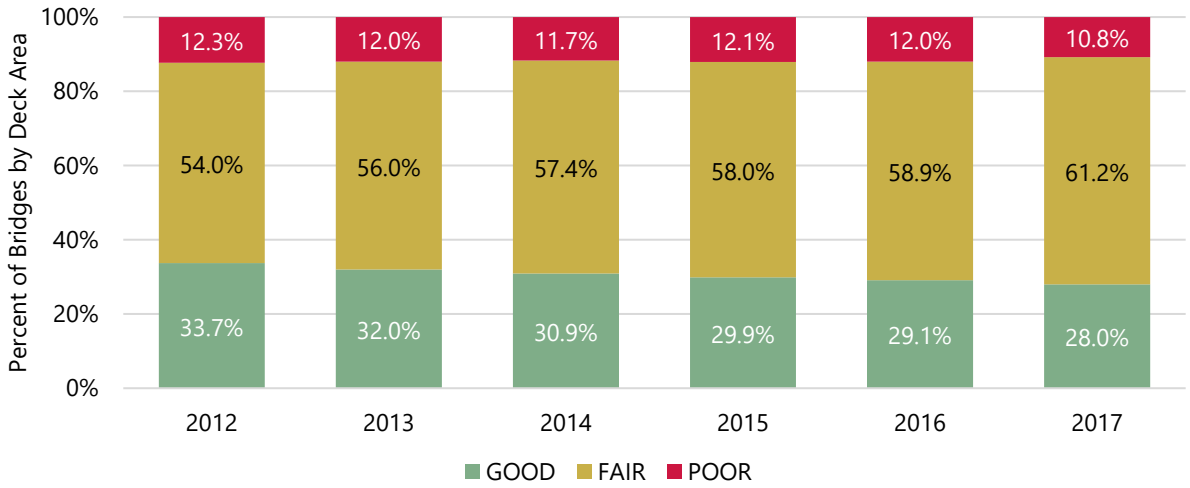
Exhibit 2-26: NHS NBIS Bridge Condition History – CY 2012 to CY 2017



Source: NJDOT Bureau of Structural Evaluation and Bridge Management.

Through progressive asset management practices, NJDOT has been able to steadily improve bridge conditions in New Jersey over the past five years. Exhibit 2-27 shows a steady improvement in the condition from 87.7 percent of SHS bridges by deck area in *Good* and *Fair* in CY 2012 data to 89.2 percent *Good* and *Fair* in CY 2017 data. This exhibit shows that the share of SHS bridges by deck area in a State of Good Repair has only increased by 1.5 percentage points in the six-year period. NJDOT plans to pursue this objective by implementing lifecycle strategies described in *Chapter 5: Lifecycle Planning* and continue improving the ongoing TAMP process.

Exhibit 2-27: SHS NBIS Bridge Condition History – CY 2012 to CY 2017



Source: NJDOT Bureau of Structural Evaluation and Bridge Management.

2.5 National Highway Performance Program Targets

Pursuant to 23 U.S.C. 150 to measure pavement and bridge conditions on the NHS, the TAMP includes the two- and four-year statewide targets established by NJDOT. The statewide targets are short-term benchmarks for making progress toward achieving the TAMP State of Good Repair Objectives (as detailed in *Chapter 3: TAMP Governance, Policy, and Objectives*).

Exhibit 2-28: NHPP Two- and Four-Year Targets for Pavements

	Two-Year (CY 2019)		Four-Year (CY 2021)	
NHS	**Good**	**Poor**	**Good**	**Poor**
Interstate Pavements Target (%)	Not Required		50.0	2.5
Non-Interstate Pavements Target (%)	25.0	2.5	25.0	2.5

Note: Targets set using NHPP performance measures. NHS includes all pavement assets regardless of ownership.

Exhibit 2-29: NHPP Two- and Four-Year Targets for NBIS Bridges

	Two-Year (CY 2019)		Four-Year (CY 2021)	
NHS	**Good**	**Poor**	**Good**	**Poor**
NBIS Bridges Target (%)	19.4	6.5	18.6	6.5

Note: Targets set using NHPP performance measures. NHS includes all NBIS bridge assets regardless of ownership.

3. TAMP Governance, Policy, and Objectives

Background

New Jersey's Transportation Asset Management Plan (the TAMP) is a product of the ongoing asset management process that the New Jersey Department of Transportation (NJDOT) has established over the past several years. The TAMP is governed by several policies, involves many key personnel, and is driven by an iterative process to improve transportation asset management.

The TAMP is the result of a collaborative and consultative process involving internal and external stakeholders that own National Highway System (NHS) and State Highway System (SHS) assets, as well as New Jersey's Metropolitan Planning Organizations (MPO). However, the contributions required of the various stakeholders involved require careful coordination and a clear delineation of the responsibilities within this process for the objectives established to be achieved.

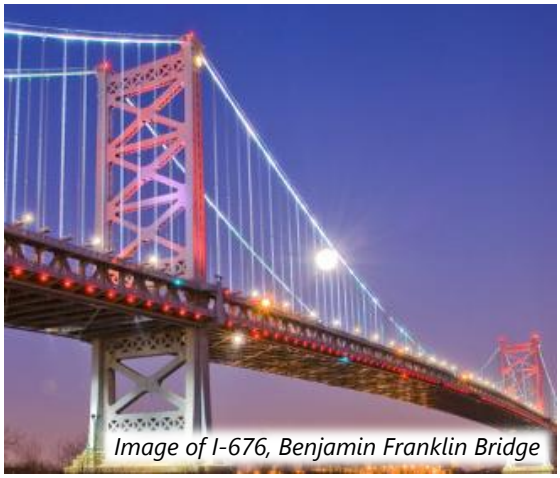


Image of I-676, Benjamin Franklin Bridge

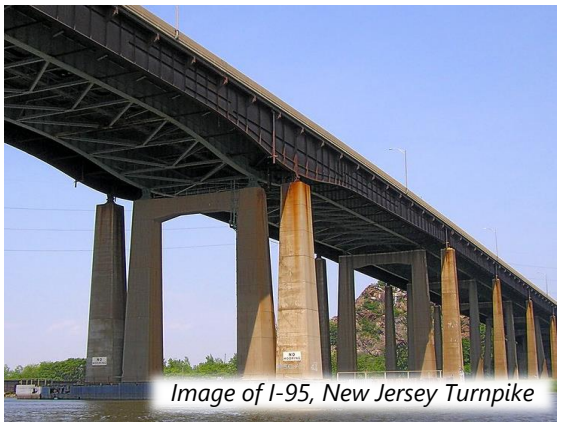


Image of I-95, New Jersey Turnpike

Image of I-295, Scudder Falls Bridge

Image of NJ Route 440, Bayonne Bridge

3.1 Overview

Chapter 3 introduces the ongoing governance structure that supports the TAMP and its objectives, including the responsibilities of the different committees and constituent team members. Next, the chapter discusses the results of the external stakeholder engagement efforts conducted to adequately address the entire NHS. Finally, the policy context for the TAMP as well as the TAMP Policy and State of Good Repair Objectives for the asset classes included in the TAMP are presented.

3.2 Asset Management Governance

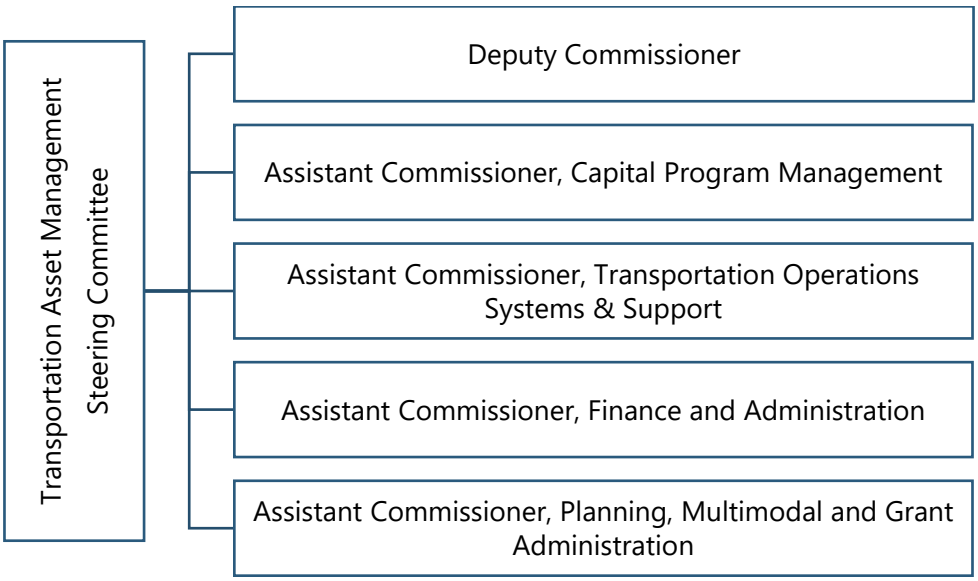
Asset management is central to the accomplishment of NJDOT's mission. Asset management is identified as infrastructure preservation at NJDOT and is one of five core missions for NJDOT, while the other four include Safety, Mobility and Congestion Relief, Operations and Maintenance, and Mass Transit, which belongs to New Jersey Transit. The transportation asset management process provides the mechanism to achieve progress toward keeping infrastructure in a State of Good Repair and achieve the Infrastructure Preservation core mission. The TAMP builds on existing business practices to establish the ongoing governance, technical and management processes, to meet federal asset management requirements, and established State of Good Repair Objectives.

The governance structure, responsibilities for the ongoing asset management process and TAMP implementation are described in the following sections.

3.2.1 Transportation Asset Management Steering Committee

The Transportation Asset Management Steering Committee is comprised of NJDOT senior leadership. The committee sets policy direction and provides executive oversight and leadership for the performance management of New Jersey's transportation system. The Committee provides general direction to the TAMP effort and assists in communicating the purpose and progress to other stakeholders. The composition of the Committee is displayed below in Exhibit 3-1.

Exhibit 3-1: Transportation Asset Management Steering Committee



Key Responsibilities

- Establish asset management Policy and State of Good Repair Objectives.
- Approve National Highway Performance Program (NHPP) targets addressing bridge and pavement preservation.
- Provide oversight in the management of enterprise-level risks to the accomplishment of asset management Policy and State of Good Repair Objectives.

- Monitor and review, on an annual basis, the performance and condition of NJDOT assets and the NHS to evaluate progress toward achieving NHPP targets and the TAMP objectives.
- Monitor and review, on an annual basis, the status of TAMP strategies and actions to improve NJDOT's asset management business practices.
- Communicate the investment strategies to Executive Management for consideration during New Jersey's Transportation Capital Program and Statewide Transportation Improvement Program (STIP) development processes.
- Communicates the implications of not addressing performance gaps, such as impacts on other performance areas, and consequences of not meeting NHPP targets.

3.2.2 Transportation Asset Management Directors Group

The TAMP Directors Group is comprised of NJDOT directors of the organizational units responsible for elements of the TAMP process. This group provides general direction to the TAMP effort, monitors progress, and supports resolution of issues requiring coordination across functional areas. The Directors Group supports change management, organizational development, and the implementation of the TAMP process as an agency-wide, enterprise-wide process, and provides guidance to both the Transportation Asset Management Steering Committee and the Transportation Asset Management Plan Team.

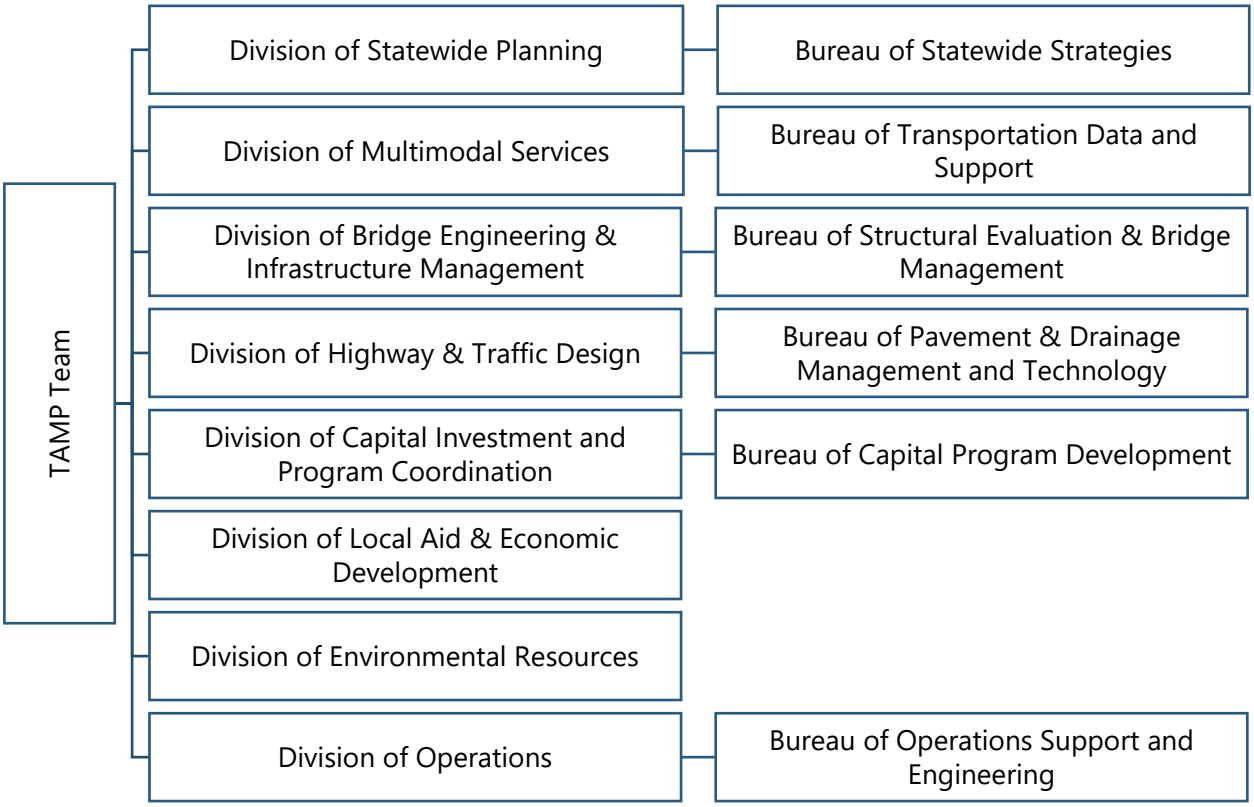
Key Responsibilities

- Review and support asset management Policy and State of Good Repair Objectives.
- Guide the TAMP effort, progress and resolutions requiring coordination among different units.
- Manage agency-wide decisions to implement asset management in business activities.
- Assist in communicating the purpose and progress of the TAMP to other stakeholders.
- Support risk management process and provide guidance on risk mitigation strategies.

3.2.3 Transportation Asset Management Plan (TAMP) Team

The TAMP Team is a cross-functional team of program managers with responsibilities for agency-wide asset management processes and asset management programs for specific asset classes identified within the TAMP. The Team establishes NJDOT's overall asset management approach to address federal requirements and NJDOT's business management needs. The Team coordinates the implementation of enhancements and other modifications to the TAMP process (documented separately from the 2019 TAMP). The composition of the Team is displayed below in Exhibit 3-2.

Exhibit 3-2: TAMP Team



Key Responsibilities

- Manage the TAMP process to meet federal and NJDOT business requirements.
- Propose, adopt, and manage technical procedures for the TAMP process.
- Evaluate investment scenarios to support the Transportation Asset Management Steering Committee in investment decisions for asset management in New Jersey's Transportation Capital Program and STIP development processes.
- Ensure that NJDOT asset managers are adopting and utilizing lifecycle planning and lifecycle planning strategies.
- Coordinate and collaborate with all non-NJDOT NHS owners and the MPOs.
- Manage the implementation of TAMP strategies and actions.
- Manage and maintain the TAMP risk register and risk management process.

Specific Responsibilities by Team Members

Division of Statewide Planning - Bureau of Statewide Strategies

The Bureau of Statewide Strategies provides overall project management for the TAMP process, including the work of the TAMP Team and the management of compliance with federal requirements.

Key Responsibilities

- Manage TAMP Team work required for compliance with federal TAMP requirements.
- Develop and deliver work required for compliance with federal TAMP requirements.

- Assist NJDOT pavement and bridge Subject Matter Experts (SME) with engagement of all non-NJDOT NHS owners and MPOs related to the process for establishing targets in conjunction with the other NHPP performance measures and targets.
- Report all statewide NHPP performance measures and targets established by NJDOT to the Federal Highway Administration (FHWA).
- Communicate and collaborate with all jurisdictions that own NHS assets and MPOs regarding the TAMP process.
- Incorporate asset management into the overall statewide performance-based planning and programming process and transportation performance management framework.

Division of Multimodal Services - Bureau of Transportation Data and Support

The Bureau of Transportation Data and Support is responsible for the management of data collection and completion of the NHS asset inventory.

Key Responsibilities

- Maintain the New Jersey transportation network definition and linear referencing system.
- Manage collection of pavement asset and roadway data from the county and municipal NHS owners.
- Collect and provide NHS pavement condition data for all jurisdictions other than NJDOT and the New Jersey Turnpike Authority.
- Coordinate data collection from the New Jersey Turnpike Authority.
- Ensure the completeness of the NHS and SHS roadway system attributes and pavement data quality compliance in accordance with FHWA requirements.
- Submit the Highway Performance Monitoring System/NHS data to FHWA.

Division of Bridge Engineering and Infrastructure Management - Bureau of Structural Evaluation and Bridge Management

The Bureau of Structural Evaluation and Bridge Management provides technical leadership for the management of bridge and structural assets in New Jersey and establishes the technical policies, procedures, and business practices for lifecycle planning of bridge and structural assets.

Key Responsibilities

- Provide all relevant National Bridge Inspection Standard (NBIS) bridge inventory data for the NHS and SHS for all jurisdictions.
- Monitor the condition of bridge and structural assets and conduct performance gap analysis to evaluate alternative investment and policy scenarios to support performance-based capital planning, program development, and performance target setting.
- Develop and manage the Bridge Management System (BMS) analytical procedures to enable analyses of investment scenarios and to optimize investments.
- Provide technical leadership to identify and drive implementation of business practices that increase the durability and remaining service life of New Jersey's bridge and structural assets.
- Conduct lifecycle planning and implement lifecycle planning strategies.

- Manage implementation of enhancements to asset management capabilities for bridge and structural assets.
- Identify and manage risks associated with the management of bridge and structural assets.

Division of Highway and Traffic Design - Bureau Pavement and Drainage Management and Technology

The Bureau of Pavement and Drainage Management and Technology provides technical leadership for the management of pavement assets in New Jersey and establishes the technical policies, procedures, and business practices for lifecycle management of pavement.

Key Responsibilities

- Monitor the condition of pavement and conduct performance gap analysis to evaluate alternative investment and policy scenarios to support performance-based capital planning, program development, and performance target setting.
- Develop and manage the Pavement Management System (PMS) and analytical procedures to optimize investments.
- Provide technical leadership to identify and drive implementation of business practices that increase the durability and remaining service life of New Jersey's pavement assets.
- Conduct lifecycle planning and implement lifecycle planning strategies.
- Manage implementation of enhancements to asset management capabilities for pavement.
- Identify and manage risks associated with the management of pavement assets.

Division of Capital Investment and Program Coordination - Bureau of Capital Program Development

The Division of Capital Investment and Program Coordination uses the TAMP process analyses to consider the impact of alternative investment scenarios on the TAMP State of Good Repair Objectives in the capital investment planning process.

Key Responsibilities

- Provide data on sources and uses of transportation funds for the TAMP financial plan.
- Conduct New Jersey's Transportation Capital Program development process. The Capital Program details the set of projects, which will be authorized by NJDOT in the given year, along with each project's funding source(s).
- Prepare the STIP on a biennial basis.
- Advance new projects into the project delivery process.

Division of Local Aid & Economic Development

The Division of Local Aid and Economic Development works with county and municipal government officials to improve the efficiency and effectiveness of the New Jersey's transportation system.

Key Responsibilities

- "Cradle to grave" administration and management of Local Public Agency projects funded under the Federal-aid and state aid programs.

- Provide technical leadership to identify and drive implementation of business practices that increase the durability and remaining service life of the local transportation system while providing technical guidance to Local Public Agencies.
- Facilitate federal and state programs including: management of solicitations, development of program criteria, as well as provision of project selection oversight, and grant announcements.
- Provide program-level quality assurance to ensure there is a unified approach to program administration of grants throughout the Division.

Division of Environmental Resources

The Division of Environmental Resources works to ensure that roadway projects comply with all environmental policies, State and federal environmental regulations, and commitments stemming from coordination with regulatory agencies and consultation with cultural resource agencies.

Key Responsibilities

- Perform and oversee the preparation of National Environmental Policy Act (NEPA) documents.
- Facilitate permit applications, soil erosion and sediment control certifications.
- Perform cultural resource studies.
- Monitor construction, wetland mitigation plans, and hazardous waste in New Jersey.
- Identify and manage external risks to mitigate extreme weather and climate change impacts on New Jersey's transportation system.

Division of Operations - Bureau of Operations Support and Engineering

The Division of Operations - Bureau of Operations Support and Engineering provides data on preventive maintenance and preservation projects for roadway and bridge assets in the State of New Jersey.

Key Responsibilities

- Support preventive maintenance and infrastructure preservation for roadway and bridge assets to achieve the State of Good Repair Objectives.
- Implement lifecycle planning strategies for management of roadways and bridges.
- Implement asset management TAMP Policy and State of Good Repair Objectives.
- Monitor the condition of pavement and bridge assets in New Jersey.
- Identify and manage performance risks within the framework of available funding associated with the management of roadways and bridges.

3.3 External Stakeholder Participation

The TAMP process includes an extensive communications and consultation program involving all 83 non-NJDOT NHS owners and the three MPOs in New Jersey.

3.3.1 Communication and Consultation with NHS Owners

The TAMP communications program informs and educates all 83 non-NJDOT NHS owners and three MPOs about the purpose and scope of the TAMP while encouraging their participation during the TAMP development. The TAMP communications program is designed to enable NHS owners to:

- ***Become informed*** on the TAMP at key milestones.
- ***Provide data*** for inclusion in the TAMP.
- ***Review and provide input*** to TAMP analysis.
- ***Participate in target setting*** for NHPP measures.

In this iteration of the TAMP, non-NJDOT NHS owners were surveyed to provide data and asked to validate information regarding the NHS assets in their jurisdiction.

The following are the broad aims of the communications and consultative process:

- ***Communication of Asset Management Purpose, Objectives, and Requirements*** – To enable meaningful input, communications and involvement including providing an overview of the TAMP, its purpose, objectives, and requirements, as well as the TAMP process and the role of non-NJDOT owners in the TAMP process. Communications are to afford non-NJDOT owners the opportunity to provide data on the NHS that they manage, to review and comment on TAMP analysis results, to provide input and comment on TAMP plan strategies, and to comment on and provide input on the TAMP document.
- ***Establish Ongoing Communications with NHS Owners*** – In the TAMP development process, non-NJDOT NHS owners receive project communications sent directly to a single point of contact within each organization. The point(s) of contact serve as the liaison between the TAMP Team and their respective agency. They are invited to participate in all stakeholder meetings; they direct project communications to applicable staff in their organization; they coordinate and manage the disposition of data requests; they coordinate their organization's review and validation of technical analysis; and they direct any input or comment from their organization on the TAMP to the TAMP Team.
- ***Ensure Direct Engagement*** – The TAMP Team project management (provided by Division of Statewide Planning - Bureau of Statewide Strategies) communicates plan processes and updates on the TAMP development to all stakeholders to ensure expedient and centralized transmissions related to the TAMP. Email correspondence from project management to stakeholders provides information on the progress of the TAMP development and how the stakeholders fit into the process. Direct engagement may take the following forms:
    - Face-to-face/telephone sub-group meetings.
    - Stakeholder workshops/web-conferences.
    - Periodic communication via email.
- ***Ensure Quality Data*** – The TAMP Team directly enlisted the support of the three MPOs to assist NJDOT during the TAMP communication process. Specifically, the MPOs assisted in the collection of data and information from the various jurisdictions for NHS assets.

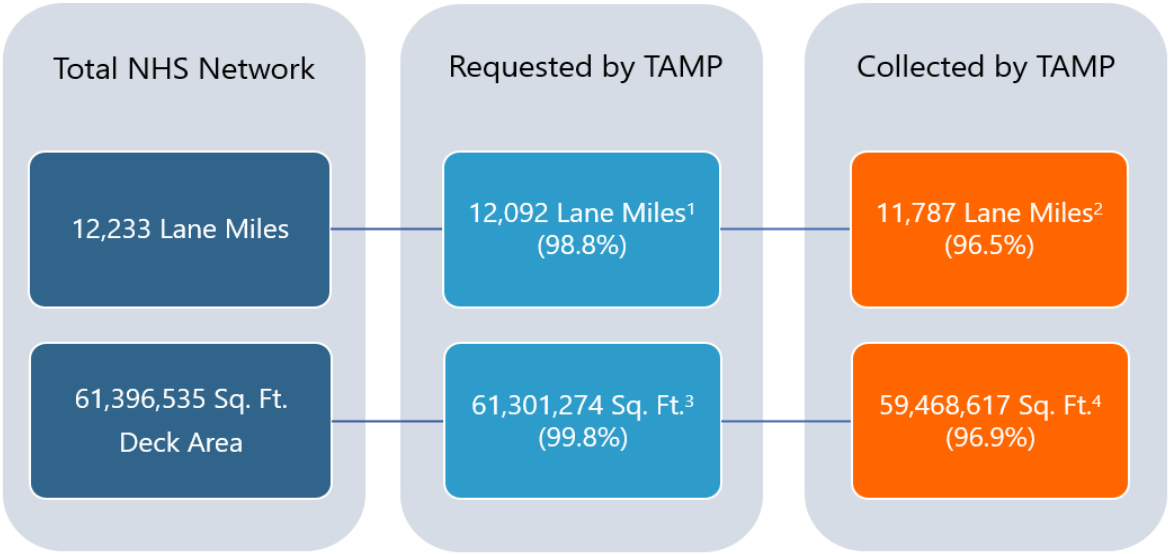
3.3.2 Data Collection

The TAMP process collects data from non-NJDOT NHS owners regarding their NHS asset inventory, including recent and planned expenditures on those NHS assets. The actions and data requested from each non-NJDOT NHS owner includes:

- ***Review and confirmation of*** the accuracy of NJDOT-provided maps and data relating to non-NJDOT NHS pavement and NBIS bridge assets, including roadway segment and bridge identifying information.
- ***Information relating to*** past project work, planned expenditures, and expected asset condition trends for non-NJDOT NHS pavement and NBIS bridge assets.

Exhibit 3-3 provides an overview of the data collection effort for the TAMP, representing the asset totals for which data was verified, and a more detailed summary is included in Appendix B.

Exhibit 3-3: Results from Data Collection Efforts with Non-NJDOT NHS Owners



[1] Data verification and expenditures for 141 pavement lane miles not requested from municipal owners.

[2] Data verification and expenditures for 446 pavement lane miles not collected from authority/commission (19 pavement lane miles) and county/municipal (427 pavement lane miles) owners.

[3] Data verification and expenditures for 95,261 square feet of deck area not requested from municipal owners.

[4] Data verification and expenditures for 1,927,918 square feet of deck area not collected from authority/commission (1,534, 217 sq. ft.), county/municipal (319,635 sq. ft.), and other (74,065 sq. ft.) owners.

3.3.3 Input to TAMP Development

All non-NJDOT NHS owners and MPOs are provided the opportunity to review and comment on analysis results, the draft TAMP, and updated TAMP documents. The TAMP Team conducted in-person and web-enabled workshops at key milestones in the development of the TAMP including:

- ***Stakeholder Workshop 1*** – Introduction to the TAMP, reviewed the purposes of the TAMP and data collection. Held on January 17, 2017.
- ***Stakeholder Workshop 2*** – Presentation of draft performance metrics and baseline conditions. Held on January 31, 2018.
- ***Stakeholder Workshop 3*** – Review of the Initial TAMP and planned performance targets and State of Good Repair Objectives. Held on November 27, 2018.
- ***Stakeholder Workshop 4*** – Review of analysis results from 2019 TAMP, as well as investment strategies for the SHS and NHS. Held on June 12, 2019.

3.3.4 Additional Engagement

NJDOT staff regularly engaged external stakeholders regarding several transportation asset management- and transportation performance management-related events, activities, and the sharing of subject matter, including but not limited to the TAMP. Additionally, MPO-sponsored events served as forums for directly engaging many of the stakeholders. Some of these events include National Highway Institute or FHWA training courses, webinars, and web conferences; NJDOT's quarterly MPO collaboration meetings, NJDOT Local Aid Division's New Jersey State Association of County Engineers quarterly meetings; and other local events.

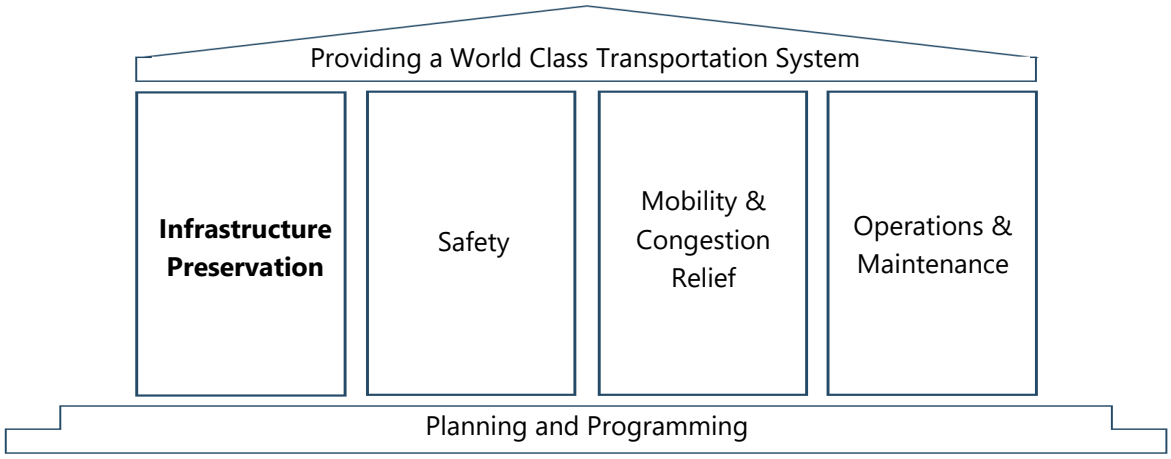
3.4 Policy and Objectives

The TAMP establishes NJDOT's asset management Policy and State of Good Repair Objectives, also known as the desired performance levels for each asset. These policies and objectives are intended to guide NJDOT's asset management activities and improve its ability to meet its mission of providing a world class transportation system to support the Infrastructure Preservation core mission. The TAMP is a living document and its analytical activities serve as an ongoing means for not only achieving its Policy and State of Good Repair Objectives, but also as a continual source of information for NJDOT's broader planning efforts.

3.4.1 Policy Context

The preservation of highway infrastructure is central to the accomplishment of NJDOT's overall mission of providing a world class transportation system. Infrastructure Preservation is one of four core missions owned by NJDOT that are addressed in New Jersey's Transportation Capital Program and STIP development processes, as outlined in Exhibit 3-4; the other core missions owned by NJDOT include Safety, Mobility and Congestion Relief, and Operations and Maintenance.

Exhibit 3-4: NJDOT Core Missions and Overall Mission



Note: Fifth core mission is "Mass Transit" and belongs to New Jersey Transit.

The TAMP provides the policy, measurable objectives, and implementation strategies that fulfill the Infrastructure Preservation core mission.

3.4.2 NJDOT Asset Management Policy

The TAMP recognizes that improving asset management practices and outcomes is a continuous process that requires top-down leadership, reinforced by policy direction and management actions in concert with bottom-up staff involvement that continually refines practices and processes. The TAMP acknowledges that funding the transportation improvements required to achieve and maintain a State of Good Repair for the State's roadway network competes with funding to accomplish NJDOT's other objectives.

The following proposed revision of NJDOT's Asset Management Policy provides executive-level direction on expectations and requirements. It communicates to NJDOT leadership and employees, business partners, and customers the agency's commitment to maintaining assets in a State of Good Repair.

> *Establish and maintain an industry-leading asset management process. Our policy is to employ asset management best practices and data-driven processes to manage New Jersey's infrastructure across the whole lifecycle to maintain assets in a State of Good Repair. In this way, our asset management process is the foundation for cost-effective infrastructure preservation and fulfills the mission of providing a world class transportation system."*
>
> *We employ our asset management process to manage and monitor State of Good Repair. Through the asset management process, we make transparent, cost-effective decisions in the acquisition, design, construction, operation, maintenance, rehabilitation, and/or reconstruction of NJDOT assets. Our asset management process addresses federal requirements and is the method to manage the performance of the National Highway System.*
>
> *The New Jersey Transportation Asset Management Plan is NJDOT's investment plan for fulfilling the Infrastructure Preservation core mission, and the plan for improving our asset management program and processes so that NJDOT "achieves consistent progress through focused investments in keeping infrastructure in a State of Good Repair." The TAMP is also the process through which strategies and plans are developed for the management of NJDOT assets across their lifecycle. In support of accomplishing NJDOT's mission and this asset management policy, the New Jersey Transportation Asset Management Plan includes strategies, implementation actions, and performance measures. The performance measures monitor NJDOT's success in accomplishing State of Good Repair Objectives for the National Highway System consistent with federal requirements and for the accomplishment of New Jersey's desired State of Good Repair for the State Highway System.*

Asset Management Policy Objectives

The following Policy Objectives have been established to support NJDOT's overall Asset Management Policy. These Policy Objectives are designed to help NJDOT achieve and maintain a desired State of Good Repair through their underlying asset management activities.

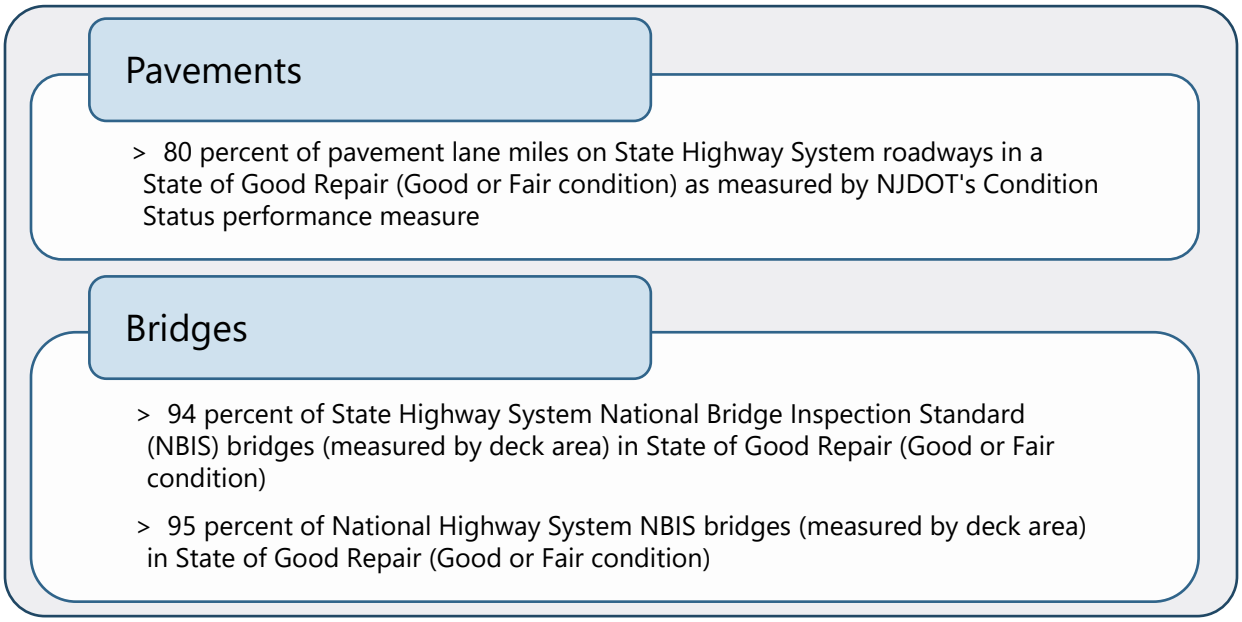
Policy Objectives	Provide a safe, reliable roadway system.
	Achieve and maintain a State of Good Repair for transportation infrastructure assets.
	Manage the roadway system to reduce lifecycle costs.
	Increase resilience of the system to the impacts of extreme weather events.
	Establish ongoing transportation asset management as data-driven process linking targets to outcomes through NJDOT performance-based planning and programing (e.g, New Jersey's Transportation Capital Program and 10-year STIP) processes.

The TAMP is NJDOT's plan for advancing these Policy Objectives. They are accomplished through the programs and projects that preserve New Jersey's infrastructure included in the TAMP. Central to advancing the policy is the development of NJDOT's organizational and analytical capabilities for asset management identified in the TAMP. Additional enhancements to the TAMP process and asset management integration at NJDOT will be identified through a separate process and integrated through the implementation of the TAMP and future updates to the TAMP.

State of Good Repair Objectives

The TAMP defines the desired State of Good Repair for select highway assets in New Jersey in terms of measurable objectives for their condition. To achieve these objectives, NJDOT will adopt the most cost-effective lifecycle and investment strategies, which will be detailed in later chapters. First, the performance measures that NJDOT uses as indicators of the State of Good Repair are described in *Chapter 2: Asset Inventory, Performance Measures, and Baseline Conditions*. Objectives in terms of these measures are outlined in Exhibit 3-5.

Exhibit 3-5: TAMP State of Good Repair Objectives



NJDOT developed a State of Good Repair Objective for SHS pavements in 2011 of achieving 80 percent of pavement lane miles in *Good* or *Fair* condition by CY 2021. This objective is being retained as the State of Good Repair Objective for SHS pavements in the TAMP, providing continuity between NJDOT's condition-tracking efforts, as well as lifecycle and investment strategy planning efforts.

As part of a strategic planning effort in 2011, NJDOT developed a State of Good Repair Objective that no more than six percent of NJDOT bridges by deck area should be in *Poor* condition (minimum 94 percent in *Good* or *Fair* condition). This objective is being retained as the State of Good Repair Objective for SHS bridges in the TAMP, thereby providing continuity between NJDOT's management processes and federal TAMP measurement and reporting requirements. A different State of Good Repair Objective, a minimum 95 percent of bridges by deck area in *Good* or *Fair* condition is set for the NHS.

3.4.3 TAMP Objectives Support the National Goal Areas

The TAMP enables NJDOT to assess its progress toward the infrastructure preservation national goal area, which is one of seven national goal areas. The full assessment of the national goal areas is addressed through multiple planning, programming, and project development processes. The Division of Statewide Planning coordinates these efforts as part of developing the following plans and programs:

- Statewide Long-Range Transportation Plan.
- Transportation Performance Management Plans, including the Strategic Highway Safety Plan and the Congestion Management and Air Quality Plan.
- Statewide Transportation Improvement Program (STIP).
- Statewide Freight Plan.

Priorities, strategies, objectives, and performance projections from the TAMP and each of the above-mentioned plans are used to develop the New Jersey Transportation Capital Program.

At present, because Transportation Performance Management has not yet been fully implemented in all national goal areas, the TAMP analyses are critical inputs when developing the New Jersey Transportation Capital Program. However, as plans for the other goal areas are established, their results will be considered by the Division of Statewide Planning and shared between department leads within each goal area alongside the results of the TAMP process (as discussed previously under Key Responsibilities).

4. Performance Gap Analysis

Background

Performance gap analysis is a federally-required part of the Transportation Asset Management Plan (TAMP) [23 CFR Part 515.7(a)(3)] defined as "the gaps between the current asset condition and state targets for asset condition, and the gaps in system performance effectiveness that are best addressed by improving the physical assets," (23 CFR 515.5). The TAMP gap analysis consists of developing future performance projections and evaluating gaps between current and projected performance and State of Good Repair Objectives.

Image of NJ Route 36, Highlands Bridge

4.1 Overview

Chapter 4 includes the following: (1) an overview of the gap analysis process, (2) a summary of performance gaps including a comparison of baseline performance versus projected performance against the TAMP State of Good Repair Objectives and (3) a comparison of projected performance in CY 2019 and CY 2021 versus NJDOT's two-and four-year National Highway Performance Program (NHPP) targets for the National Highway System (NHS). Detailed information on performance projections and gaps for pavement and bridges are provided after the gap summary.

The gap analysis includes projections of conditions for the following four investment scenarios:

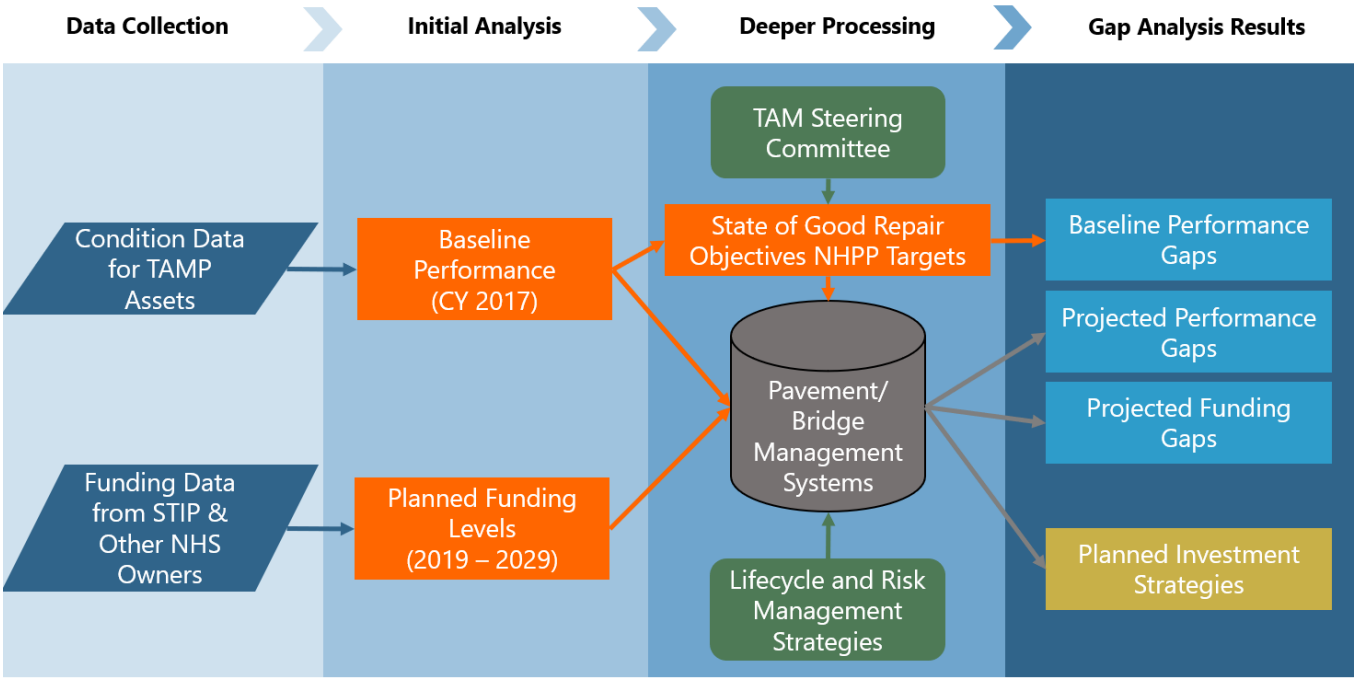
- ***Planned Funding*** – This scenario is based on the total funding for the particular asset's maintenance, preservation, rehabilitation, and replacement, by year, in the Fiscal Year (FY) 2018-2027 Statewide Transportation Improvement Program (2018 STIP) in the TAMP financial plan. The final STIP year (FY 2027) investment level is extended through FY 2028 and FY 2029.
- ***Funding to Achieve State of Good Repair Objectives*** – This scenario identifies funding required to accomplish the TAMP State of Good Repair Objectives for the State Highway System (SHS) by the end of the TAMP analysis period (CY 2029).
- ***Funding to Maintain CY 2017 Condition*** – This scenario determines the funding required to maintain the same level of performance of the SHS at the end of the TAMP analysis period as it is at the beginning of it, as of CY 2017.

- ***Continuation of FY 2018 Funding Levels*** – This scenario identifies what performance would be if funding levels at the beginning of the TAMP analysis period were extended throughout the TAMP analysis period. The term "FY 2018" is used for convenience in naming the scenario. Average funding in a multi-year period bracketing FY 2018 informed the determination of the funding levels used for this scenario.

The results of the gap analysis support the performance management of NJDOT capital investments and target-setting under the NHPP. The chapter concludes with a discussion of how the gap analysis results are used in planning and programming processes to improve investment decision-making.

The TAMP gap analysis process is depicted in Exhibit 4-1 below.

Exhibit 4-1: TAMP Gap Analysis Process for the SHS



1. ***Data Collection*** – Asset condition data are gathered using the data collection and reporting processes as described in *Chapter 2: Asset Inventory, Performance Measures, and Baseline Conditions*. Planned Funding for the SHS is from the 2018 STIP and is presented in *Chapter 7: Financial Plan*. Funding for non-NJDOT owners of NHS assets is collected through a communications outreach program with owners and is detailed in *Chapter 7: Financial Plan*.

2. ***Initial Analysis*** – Baseline asset performance is determined from CY 2017 condition data for both the SHS (NJDOT-owned and/or maintained assets) and the entire NHS, regardless of ownership. Planned funding is established in *Chapter 7: Financial Plan*. The initial analysis includes an examination of recent historical performance trends along with recent spending levels.

3. ***Deeper Processing*** – A review of historical performance and spending provided guidance in determining the TAMP State of Good Repair Objectives adopted by the Transportation Asset Management Steering Committee. Pavement and bridge management systems apply lifecycle and risk management strategies (see *Chapter 5: Lifecycle Planning*) to develop projected performance of SHS pavement and bridge assets under planned funding levels.

   NJDOT management systems are used to estimate the gaps in performance and/or funding under four investment scenarios.

   Funding projections developed through outreach with non-NJDOT owners of NHS assets (as discussed in Section 3.3) are applied in the context of historical performance trends to develop performance projections for the non-NJDOT owned NHS assets.

4. ***Gap Analysis Results*** – The gap analysis results identify (1) the difference between baseline performance and projected performance for each asset and the State of Good Repair Objectives, (2) the projected performance of select assets and NHPP targets, (3) the gaps in system performance revealed through the analysis, and, (4) the gaps in funding to achieve the State of Good Repair Objectives.

The TAMP analysis period extends from FY 2019 to FY 2029. The performance data for CY 2017 through CY 2029, shown in the following exhibits, includes the first two years for context only. Planned funding levels for NJDOT follow the federal fiscal year (October 1—September 30) as they are determined from the 2018 STIP that also follows the federal fiscal year. Asset performance is reported in collected year (calendar year) form, with a minimum one-year lag between spending in the fiscal year and impact on the asset condition (the lag between spending and impact on asset condition differs for pavement and bridge projects).

4.2 Gap Analysis Results Summary

4.2.1 Pavement Gap Summary

Exhibits 4-2 through 4-4 present a summary of the pavement gap analysis results. Notable findings from the analysis are as follows:

- SHS pavement performance will improve from 64.7 percent of pavement lane miles in a State of Good Repair in CY 2017 to 66.6 percent by CY 2029.
- For the SHS, a 13.4 percentage point shortfall from the State of Good Repair Objective remains by the end of the TAMP analysis period.
- For the SHS, planned funding results in performance condition improvements of 5.7 percentage points higher than current funding (FY 2018) performance condition.
- Interstate and non-interstate NHS pavement will meet the NHPP targets while improving performance over the TAMP analysis period.

The SHS pavement baseline (CY 2017) gap and planned CY 2029 performance gap are expressed in terms of NJDOT performance measures. The NHS gaps relative to NHPP two- and four-year targets are expressed in terms of the federal NHPP performance measures. Both sets of performance measures

are defined in detail in *Chapter 2: Asset Inventory Performance Measures, and Baseline Conditions*. Pavement gap analysis methods and SHS pavement performance projections under four investment scenarios are detailed in Sections 4.3.2 and 4.4.3.

The pavement gap analysis indicates that interstate pavements on the NHS in New Jersey will meet the additional condition requirement of 23 CFR 490 that no more than five percent of interstate pavements are in *Poor* condition during the entire TAMP analysis period.

Exhibit 4-2: SHS Pavement – State of Good Repair Gap Analysis Summary

Performance	**Baseline CY 2017**	**CY 2029 Planned**
NJDOT's Condition Status Measures	**Good or Fair**	**Good or Fair**
State of Good Repair Objective (%)	80.0	80.0
Condition (%)	64.7	66.6
Performance Gap[1] (percentage points)	**-15.3**	**-13.4**
Investment	**Average Annual Investment, FY 2019-2029**	
Investment Required to Achieve Objective	$657 million[3]	
Planned Funding[2]	$401 million[3]	
Funding Gap	**-$256 million**[4]	

Note: SHS includes all NJDOT-owned and/or maintained pavements.

[1] Gap exists. All targets are not met. Negative sign indicates extent of performance below target.

[2] Consistent with 2018 STIP.

[3] Total includes Design.

[4] Funding deficit exists. Indicates amount of funding required to close the funding gap and bring targets to a State of Good Repair.

Exhibit 4-3: NHS Interstate Pavement – Target Gap Analysis Summary

	Two-Year (CY 2019)		**Four-Year (CY 2021)**	
NHPP Measures	**Good**	**Poor**	**Good**	**Poor**
Target (%)	Not Required		50.0	2.5
Planned Condition (%)	55.3	1.3	62.1	1.1
Performance Gap[1] (percentage points)	**Not Applicable**		**+12.1**	**+1.4**

Note: NHS includes all pavement assets regardless of ownership.

[1] No Gap. All targets are met. Positive sign indicates extent of performance above target.

Exhibit 4-4: NHS Non-Interstate Pavement – Target Gap Analysis Summary

	Two-Year (CY 2019)		Four-Year (CY 2021)	
NHPP Measures	**Good**	**Poor**	**Good**	**Poor**
Target (%)	25.0	2.5	25.0	2.5
Planned Condition (%)	30.7	1.2	38.3	1.0
Performance Gap[1] (percentage points)	**+5.7**	**+1.3**	**+13.3**	**+1.5**

[1] No Gap. All targets are met. Positive sign indicates extent of performance above target.

4.2.2 Bridge Gap Summary

The following findings are summarized from the bridge gap analysis results shown in Exhibits 4-5 through 4-7:

- SHS bridge performance will improve from 89.2 percent of NBIS bridges by deck area in a State of Good Repair in CY 2017 to 91.6 percent by CY 2029.
- For the SHS, a 2.4 percentage point shortfall from the State of Good Repair Objective remains by the end of the TAMP analysis period.
- For the SHS, planned funding results in performance condition improvements of 1.4 percentage points higher than the "Continuation of FY 2018 Funding Levels" scenario.
- NHS bridges will meet the federal performance targets while:
    - The percentage of NJDOT NHS bridges by deck area that are in a State of Good Repair (*Good* or *Fair*) will increase from 88.9 percent in the baseline (CY 2017) to 91.6 percent in CY 2029.
    - The percentage of non-NJDOT NHS bridges by deck area in *Good* or *Fair* condition is assumed to remain the same as the baseline year (CY 2017) percentages.

All bridge gaps are expressed in terms of NHPP performance measures for bridges. These performance measures are defined in detail in *Chapter 2: Asset Inventory Performance Measures, and Baseline Conditions*. Bridge gap analysis methods and SHS bridge performance projections under the four investment scenarios are detailed in Sections 4.4.2 and 4.4.3.

The NHPP (23 CFR 490) includes an additional condition requirement that no more than ten percent of NHS National Bridge Inspection Standard (NBIS) bridges by deck area are "structurally deficient" (i.e., in *Poor* condition). The bridge gap analysis indicates this requirement will be met during the TAMP analysis period.

Exhibit 4-5: SHS NBIS Bridges – State of Good Repair Gap Analysis Summary

Performance	Baseline CY 2017	CY 2029 Planned
NHPP Measures[1]	**Good or Fair**	**Good or Fair**
State of Good Repair Objective (%)	94.0	94.0
Condition (%)	89.2	91.6
Performance Gap[2] (percentage points)	**-4.8**	**-2.4**
Investment	**Average Annual Investment, FY 2019-2029**	
Investment Required to Achieve Objective	$652 million	
Planned Funding[3]	$509 million[4]	
Funding Gap[5]	**-$143 million**[6]	

Note: SHS Bridges include all NJDOT-owned and/or maintained NBIS bridges.

[1] Using measures defined in 23 CFR 490.

[2] Gap exists. All targets are not met. Negative sign indicates extent of performance below target.

[3] Consistent with 2018 STIP.

[4] Includes funding for NBIS bridge maintenance, preservation, rehabilitation, replacement, and other bridge asset management items. Excludes funding for inspections, administration of the Bridge Management System and management of other structures (culverts, sign structures, etc.), which is about $51 million per year.

[5] See Section 4.4.3 for an important caveat about the size of the funding gap in light of the anticipated completion of the Pulaski Skyway Rehabilitation Project.

[6] Funding deficit exists. Indicates amount of funding required to close the funding gap and bring targets to a State of Good Repair.

Exhibit 4-6: NHS NBIS Bridges – Target Gap Analysis Summary

	Two-Year (CY 2019)		Four-Year (CY 2021)	
NHPP Measures[1]	**Good**	**Poor**	**Good**	**Poor**
Target (%)	19.4	6.5	18.6	6.5
Planned Condition (%)	19.4	6.5	18.6	6.5
Performance Gap[1] (percentage points)	**+0.0**	**+0.0**	**+0.0**	**+0.0**

Note: NHS bridges includes all NBIS bridges carrying the NHS, regardless of ownership.

[1] Using measures defined in 23 CFR 490.

[2] No Gap. All targets are met. Positive sign indicates extent of performance above target.

Exhibit 4-7: NHS NBIS Bridges – State of Good Repair Gap Analysis Summary

Performance	Baseline CY 2017	CY 2029 Planned
NHPP Measures[1]	**Good or Fair**	**Good or Fair**
State of Good Repair Objective (%)	95.0	95.0
Condition (%)	94.0	95.3
Performance Gap[2] (percentage points)	**-1.0**	**+0.3**

Note: NHS bridges includes all NBIS bridges carrying the NHS, regardless of ownership.

[1] Using measures defined in 23 CFR 490.

[2] All targets are not met. Positive sign indicates extent of performance above target. Negative sign indicates extent of performance below target.

4.3 Pavement Performance Gap Assessment

4.3.1 Pavement Performance Measures

NJDOT assesses pavement performance using the measures defined in *Chapter 2: Asset Inventory, Performance Measures, and Baseline Conditions*. NJDOT uses performance measures based on its Condition Status performance metric for the SHS, which provides the agency with more actionable information in setting and applying its pavement management strategies. This measure differs from the federally-required NHPP measures for the NHS. To address the difference in measures, NJDOT has developed processes that allow its Pavement Management System to correlate the Condition Status metrics to the NHPP measures for the NHS portion of the SHS.

4.3.2 Pavement Gap Analysis Methods

Pavement gap analysis has been a routine practice for NJDOT beginning in 2011 when State of Good Repair Objectives were first established. NJDOT has tracked the Condition Status of SHS pavements and compared the result to the (pre-TAMP) objective of achieving 80 percent of pavement lane miles in *Good* or *Fair* condition by CY 2021. The gap analysis data has been used to continually adjust pavement lifecycle planning and investment strategies.

The NJDOT Pavement Management Unit uses a Pavement Management System (PMS) (described in greater detail in *Chapter 5: Lifecycle Planning*) to forecast the performance of the SHS under various combinations of lifecycle strategies and funding scenarios. This helps to determine the best long-term investment approach to achieve and sustain the desired performance. The results of the gap analysis, risk analysis and the TAMP financial plan are used to establish investment strategies for pavements. Appendix C describes the technical approach used to support analysis using the NHPP measures for gap analysis of the full NHS pavement network.

Total planned funding for the four work types of pavement maintenance, preservation, rehabilitation, and replacement approximates $401 million per year for the TAMP analysis period FY 2019-2029. Actual funding levels for each year included in the 2018 STIP are used in the analysis as presented in *Chapter 7: Financial Plan*. The funding levels vary substantially from the $401 million average with early

years tending to have lower funding amounts and later years having considerably higher funding amounts than the average. The "Continuation of FY 2018 Funding Levels" scenario depicts pavement performance assuming funding is not increased in later years as per the 2018 STIP and the TAMP financial plan.

The pavement analysis uses the funding in aggregate and does not restrict project selection to amounts consistent with allocations in the 2018 STIP to each work type. The resulting optimized distribution of spending totals among work types is presented in *Chapter 8: Investment Strategies*.

4.3.3 Projected Pavement Performance and Gaps

The following sections further elaborate on the baseline and projected performance gaps for SHS and NHS pavements. Analysis results for the SHS are provided in terms of NJDOT's Condition Status performance measure, and the results for NHS pavements are provided in terms of NHPP measures.

Baseline SHS Performance

As of CY 2017 data, 64.7 percent of NJDOT pavements are in *Good* or *Fair* condition, as shown in Exhibits 4-8 and 4-9. While this is an improvement over historic performance, a sizeable gap (15.3 percentage points) remains between baseline (CY 2017) and desired performance of 80 percent *Good* or *Fair*.

Projected SHS Performance

The projected outcomes of the four investment scenarios described in Section 4.1 are summarized in Exhibits 4-8 and 4-9. Exhibit 4-8 presents a line graph depicting the year-by-year performance of pavement on the SHS for each of the four investment scenarios. Exhibit 4-8 illustrates both of the following: (1) the baseline context for the projected performance, and (2) the projected paths of each investment scenario. Exhibit 4-9 presents performance in the baseline and at the end of the analysis period for each investment scenario, providing for a comparison of the performance gaps for each scenario.

Exhibit 4-8: Projected SHS Pavement Performance under Investment Scenarios – CY 2017-2029

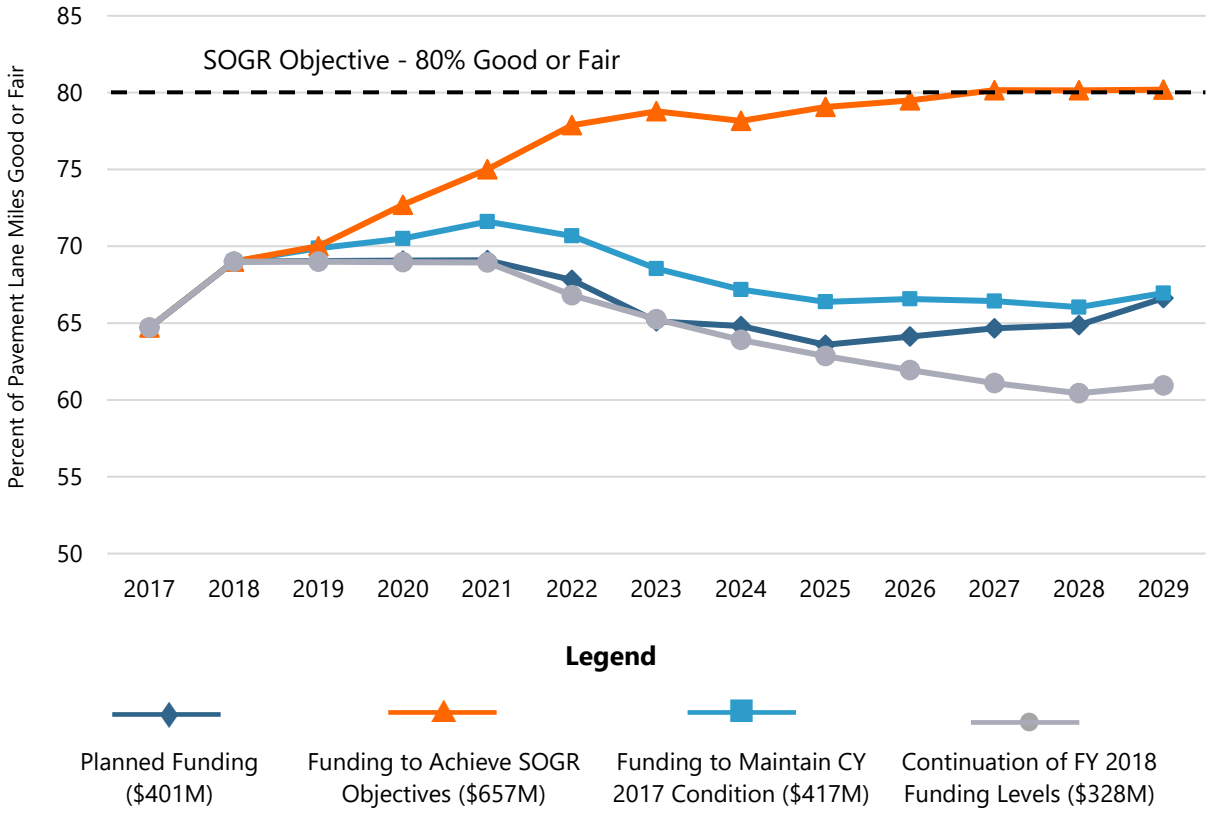
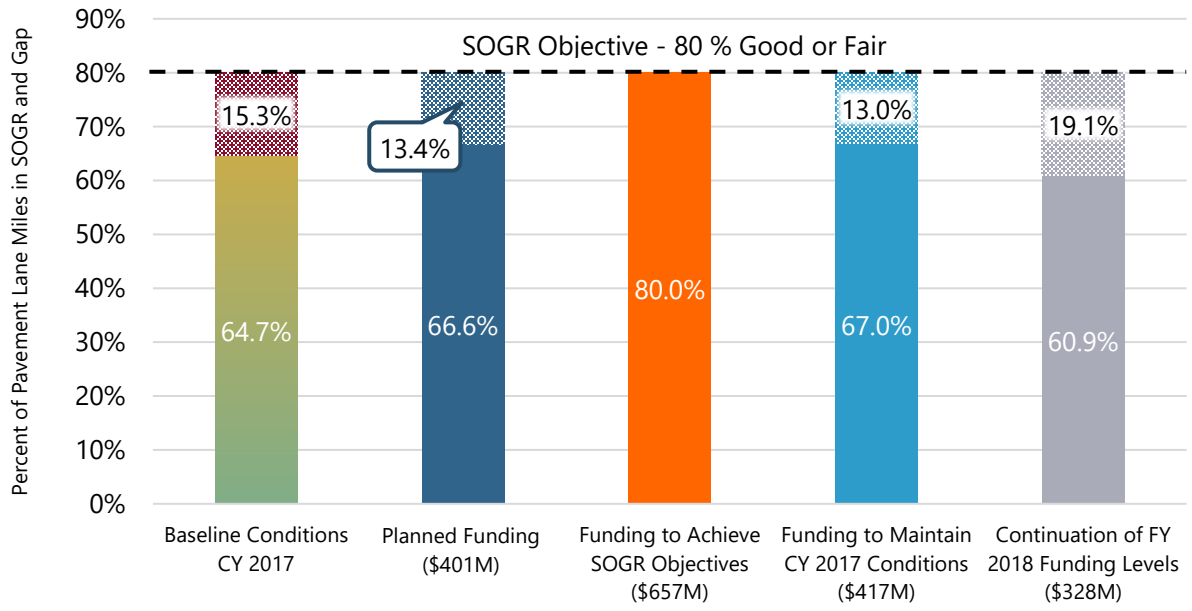


Exhibit 4-9: SHS Pavement Performance by Investment Scenario – CY 2029 and Baseline CY 2017



Notes: SOGR = State of Good Repair. SHS includes all NJDOT-maintained pavement assets. The "Funding to Maintain CY 2017 Conditions" scenario does not yield the exact same performance as CY 2017 conditions because of the way the PMS software works; funding must be input and adjusted iteratively until the condition percentage is met. 67.0% Good or Fair was regarded as sufficiently close to CY 2017 conditions.

The scenario analysis shown in Exhibit 4-9 reveals that a significant increase in investment is needed to achieve the TAMP State of Good Repair Objective for SHS pavements within the TAMP analysis period. An annual average of $657 million is required, which is 67 percent higher than the $401 million in planned funding. The Planned Funding scenario is projected to result in declining performance from baseline (CY 2017) levels until FY 2025, followed by increases in the latter years, eventually reaching a performance gap moderately smaller than the baseline gap. This performance time path reflects the planned funding path, in which funding in the latter years is higher than in the earlier years of the TAMP analysis period and is higher than the annual average funding amount. Sustained funding at higher levels than the "Planned Funding" scenario annual average will be required to continue performance increases and progress toward reducing the performance gap.

Projected NHS Performance

For NHS pavements, NJDOT is required to establish two- and four-year targets, with conditions reported utilizing NHPP measures, as described in *Chapter 2: Asset Inventory, Performance Measures, and Baseline Conditions*. The measures report pavement condition in terms of the percentage of pavements in *Good* and *Poor* condition on interstate and non-interstate NHS pavements. The reporting requirements are applicable to all pavements on the NHS, regardless of ownership. NJDOT has chosen conservative targets due to the unfamiliarity with the federal measures and the performance of the NHS by these measures. For the first reporting period (CY 2019 and CY 2021) the Federal Highway Administration (FHWA) is not requiring states to establish midpoint (CY 2019) targets for interstate pavement. Federal Transportation Performance Management regulations under 23 USC 490 establish that no more than five percent (5%) of lane miles of interstate pavement should be rated *Poor*.

Exhibits 4-10 and 4-11 present projected performance of interstate and non-interstate NHS pavements over the TAMP analysis period. An improvement over the TAMP analysis period is projected in the performance of both interstate and non-interstate NHS. The percentage of pavement rated *Good* is projected to increase on both interstate and non-interstate NHS, while the percentage rated *Poor* is projected to decrease on both interstate and non-interstate NHS. All targets are projected to be met. The projections shown in these exhibits represent a combination of investments planned to be made by NJDOT and non-NJDOT owners of NHS assets in the State of New Jersey, as described in *Chapter 7: Financial Plan*.

Exhibit 4-10: Projected Interstate NHS Pavement Conditions – CY 2017 to CY 2029

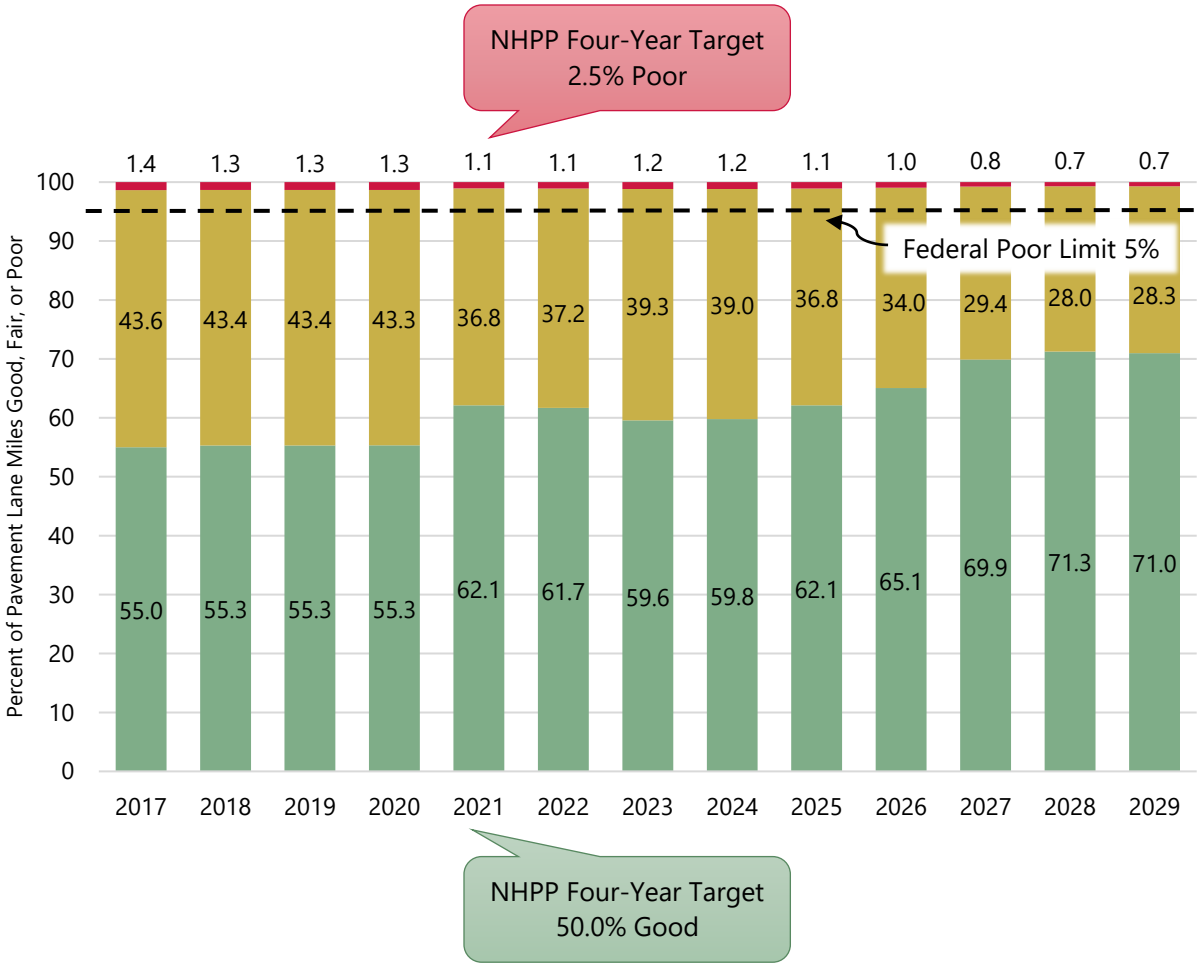
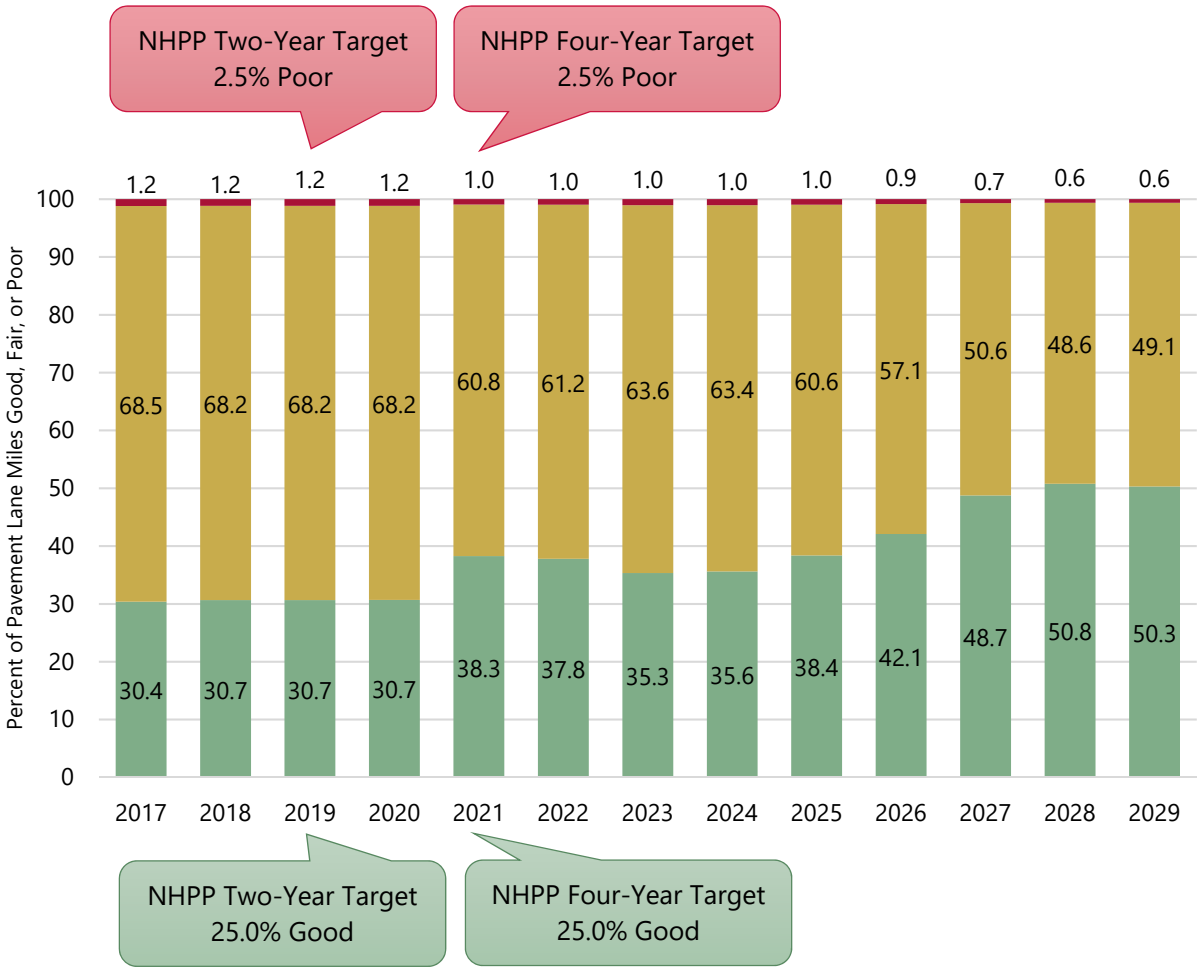


Exhibit 4-11: Projected Non-Interstate NHS Pavement Conditions – CY 2017 to CY 2029



4.4 NBIS Bridge Performance Gap Assessment

4.4.1 NBIS Bridge Performance Measures

NJDOT assesses bridge performance using the measures defined in *Chapter 2: Asset Inventory, Performance Measures, and Baseline Conditions,* identical to federal requirements by the NHPP for bridges. The NHPP requires biennial reporting of the percentage of NHS bridges by deck area in *Good* and *Poor* condition categories.

4.4.2 NBIS Bridge Gap Analysis Methods

The NJDOT Bureau of Structural Evaluation and Bridge Management (SEBM) uses various Bridge Management System (BMS) tools to implement lifecycle planning and formulate its investment strategy. The technical capabilities, details, and uses of the BMS tools are summarized in *Chapter 5: Lifecycle Planning.* Detailed information on one of the software tools, AASHTOWare BrM, is presented in Appendix D. NJDOT's BMS analyzed various combinations of funding allocations and deterioration models in support of the performance gap analysis for the TAMP.

Total expected funding for work types of maintenance, preservation, rehabilitation, and replacement approximates $509 million per year on average from FY 2019 to FY 2029. Actual funding levels in each year from the 2018 STIP are used in the analysis (and presented in *Chapter 7: Financial Plan*), which vary substantially from the $509 million average. Early years tend to have lower funding amounts with later years having considerably higher funding amounts than the average. As compared to the "Planned Funding" scenario, the "Continuation of FY 2018 Funding Levels" scenario depicts bridge performance if funding does not increase, whereas the "Planned Funding" scenario reflects expectations of funding increases in later years which is consistent with the 2018 STIP and the TAMP financial plan.

The BMS analysis considers funding in aggregate; it does not restrict project selection to amounts consistent with each of the individual STIP funding categories. The resulting optimized distribution of spending totals among work types is presented in *Chapter 8: Investment Strategies*.

There is a lag between funding and its effect on performance. Generally, funding in any given fiscal year is captured in bridge projected performance levels two collection years later.

4.4.3 Baseline and Projected NBIS Bridge Performance and Gaps

Section 4.4.3 elaborates on the baseline and projected performance gaps for SHS and NHS bridges. Exhibit 4-12 presents year-by-year performance of bridges on the SHS for each of the investment scenarios illustrating both the historic context for the projected performance and the projected paths of each investment scenario. Exhibit 4-13 presents baseline asset performance and the asset performance at the end of the TAMP analysis period for each investment scenario, permitting comparison of the performance gaps of each scenario.

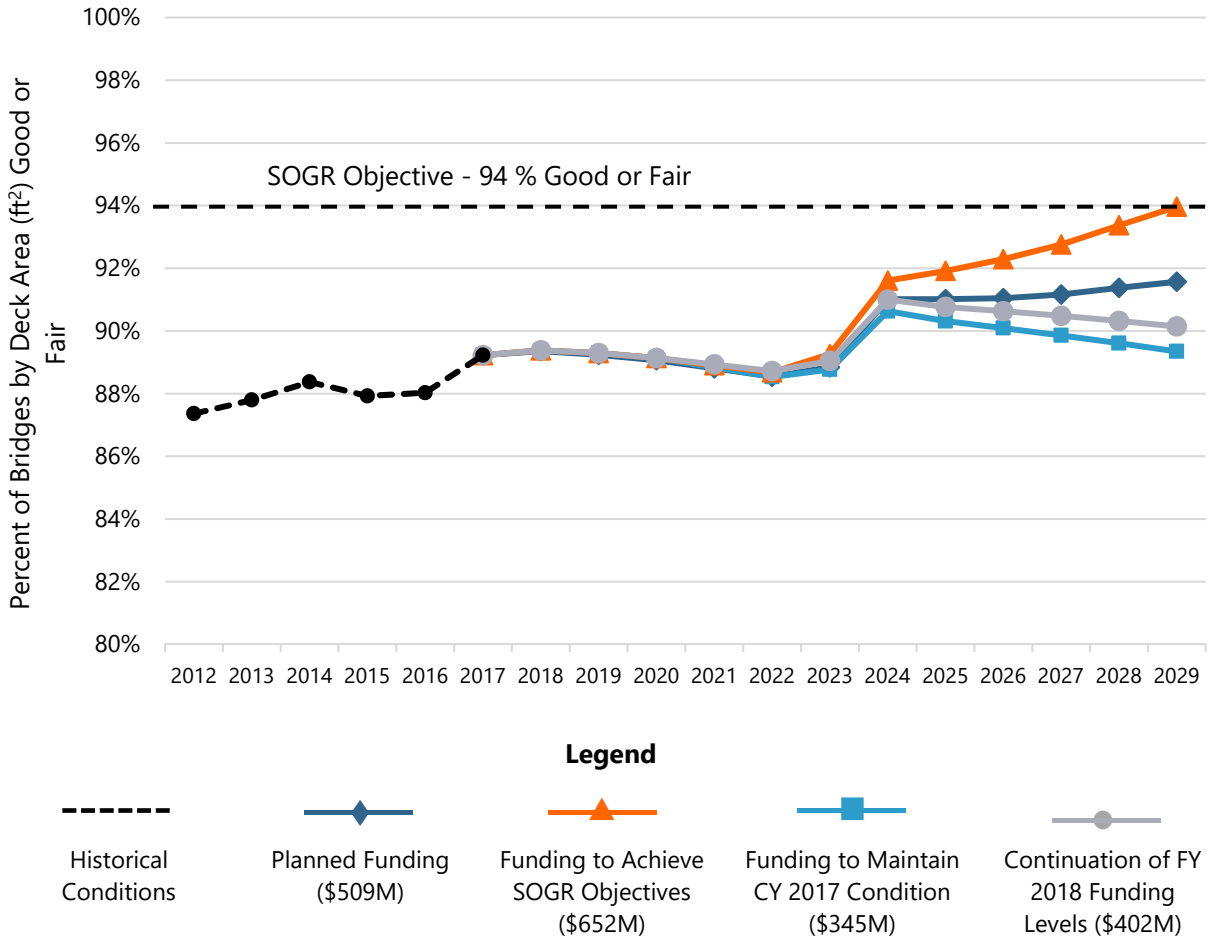
Baseline SHS Performance

Exhibit 4-13 reveals a performance gap between the CY 2017 baseline of 89.2 percent of SHS bridges by deck area in *Good* or *Fair* condition and the TAMP State of Good Repair Objective that at least 94 percent of bridges by deck area should be in *Good* or *Fair* condition. Exhibit 4-12 shows that the historic performance was marked by a generally increasing trend from CY 2012 to the baseline year.

Projected SHS Performance

All four investment scenarios include the Pulaski Skyway Rehabilitation Project. With costs exceeding one billion dollars, the rehabilitation of the Pulaski Skyway is one of NJDOT's largest construction projects. The rehabilitation work has been ongoing for several years prior to the TAMP analysis period and will continue into the mid-2020s. Completion of the work will result in the Skyway's very large deck area moving to a State of Good Repair, providing a substantial increase in network performance for a relatively modest investment in the TAMP analysis period.

Exhibit 4-12: Projected SHS NBIS Bridge Performance under Investment Scenario – CY 2012-2029



Notes: SOGR = State of Good Repair. SHS Bridges include all NJDOT-maintained NBIS bridges. The vertical scale begins at 80%; changes over time and differences are exaggerated by the shortened scale.

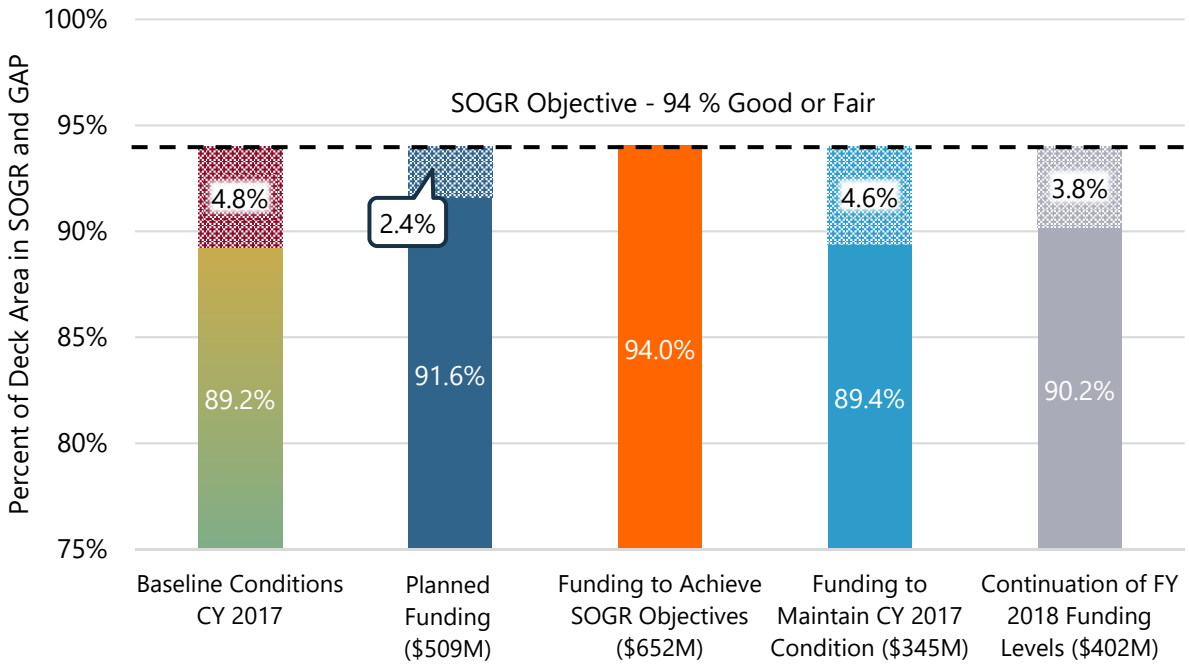
Because it takes several years to develop a bridge rehabilitation or replacement project, the early years of the TAMP analysis period are limited to projects that are already programmed. This limitation, combined with the two-year lag from funding to when the credit is taken for improved condition, is reflected in the overlap of the performance of the four investment scenarios in the earlier years of the TAMP analysis period. In the middle of the analysis period (CY 2024), the completion of the Pulaski Skyway Rehabilitation Project has a significant effect on performance of all scenarios.

Investment expenditures are greater in the latter years under the "Planned Funding" and "Funding to Achieve State of Good Repair Objectives" scenarios than the early years of the TAMP analysis period. The continued improvement shown for these two scenarios is dependent on sustaining the elevated investment levels of the latter years of the TAMP analysis period. It is notable that the "Continuation of FY 2018 Funding Levels" scenario results in a declining performance in the latter years. Additional discussion of the planned investment path is included in *Chapter 8: Investment Strategies*.

Exhibit 4-13 summarizes the baseline and projected performance gaps in achieving the TAMP State of Good Repair Objective for SHS bridges under the four investment scenarios. The "Planned Funding" scenario, while an improvement over the baseline, remains short of achieving the TAMP State of Good Repair Objective by the end of the TAMP analysis period. The "Planned Funding" scenario achieves a narrowing of the performance gap, and its upward slope in the latter years suggests a continued narrowing of the gap beyond CY 2029.

Exhibit 4-13 shows that a continuation of FY 2018 funding levels would result in a smaller performance gap than the baseline gap. As noted previously and as depicted in the trend projection in Exhibit 4-12, performance is on a declining path under this investment scenario. Continued deterioration of the aging bridge network will overtake the performance gains achieved with the completion of the Pulaski Skyway Rehabilitation Project.

Exhibit 4-13: SHS NBIS Bridge Performance by Investment Scenario – CY 2029 and Baseline CY 2017



Notes: SOGR = State of Good Repair. SHS includes all NJDOT-maintained bridges.

Projected NHS Performance

The planned NHS NBIS bridge conditions are based on the funding levels detailed in *Chapter 7: Financial Plan*, which reflect the 2018 STIP along with information reported by non-NJDOT owners of NHS assets. Projects for the NJDOT NHS that are already programmed in the 2018 STIP are assumed to be fixed.

Non-NJDOT NHS

The TAMP projects that the total deck area of non-NJDOT NHS bridges in *Good* or *Fair* condition will remain the same as it is in the baseline year (CY 2017). The rationale for this projection is a combination of historic trends and expenditure projections, as described below.

- Over the period between CY 2012-2017, more bridges moved out of *Poor* condition than the number of bridges that moved into *Poor* condition.
- The non-NJDOT NHS deck area in *Good* or *Fair* condition increased from 93.4 percent in CY 2012 to 98.7 percent in CY 2017.
- Spending on locally-owned NHS bridges is expected to increase compared to spending in the period CY 2012-2017. This increase is based on reported spending plans in questionnaire results and on the increased local system support allocations in the 2018 STIP.

NJDOT NHS

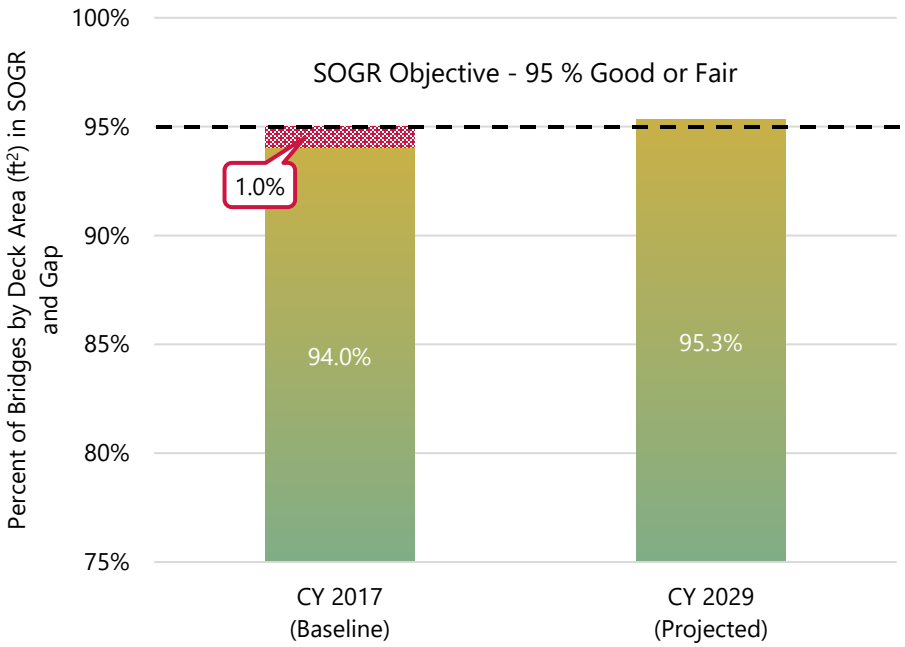
For NJDOT NHS, the percentage of bridges by deck area that are in a State of Good Repair (*Good* or *Fair*) will increase from 88.9 percent in the baseline (CY 2017) to 91.6 percent in CY 2029.

Combined NJDOT and Non-NJDOT NHS

The performance of the NHS is characterized by adding the quantity NJDOT NHS deck area in a State of Good Repair to that of non-NJDOT NHS owners. The resulting projection is that 95.3 percent of all NHS bridges (including border bridges) by deck area will be in a State of Good Repair in CY 2029. This projected performance slightly exceeds the 95 percent State of Good Repair Objective for NHS bridges.

Exhibit 4-14 displays the baseline and projected performance of NHS bridges. The Exhibit depicts a one percentage point performance gap in the baseline, with no performance gap at the end of the TAMP analysis period (CY 2029). The completion of the Pulaski Skyway Rehabilitation Project results in a substantial increase in bridge performance with modest expenditures over the TAMP analysis period. Sustained funding at higher levels is necessary to maintain the higher level of performance achieved by the completion of the Pulaski Skyway Rehabilitation Project.

Exhibit 4-14: Projected NHS NBIS Bridge Performance and Gaps – CY 2029 and Baseline CY 2017



Notes: SOGR = State of Good Repair. Includes NJDOT-owned and/or maintained NHS bridges and NHS bridges owned by others, including border bridges.

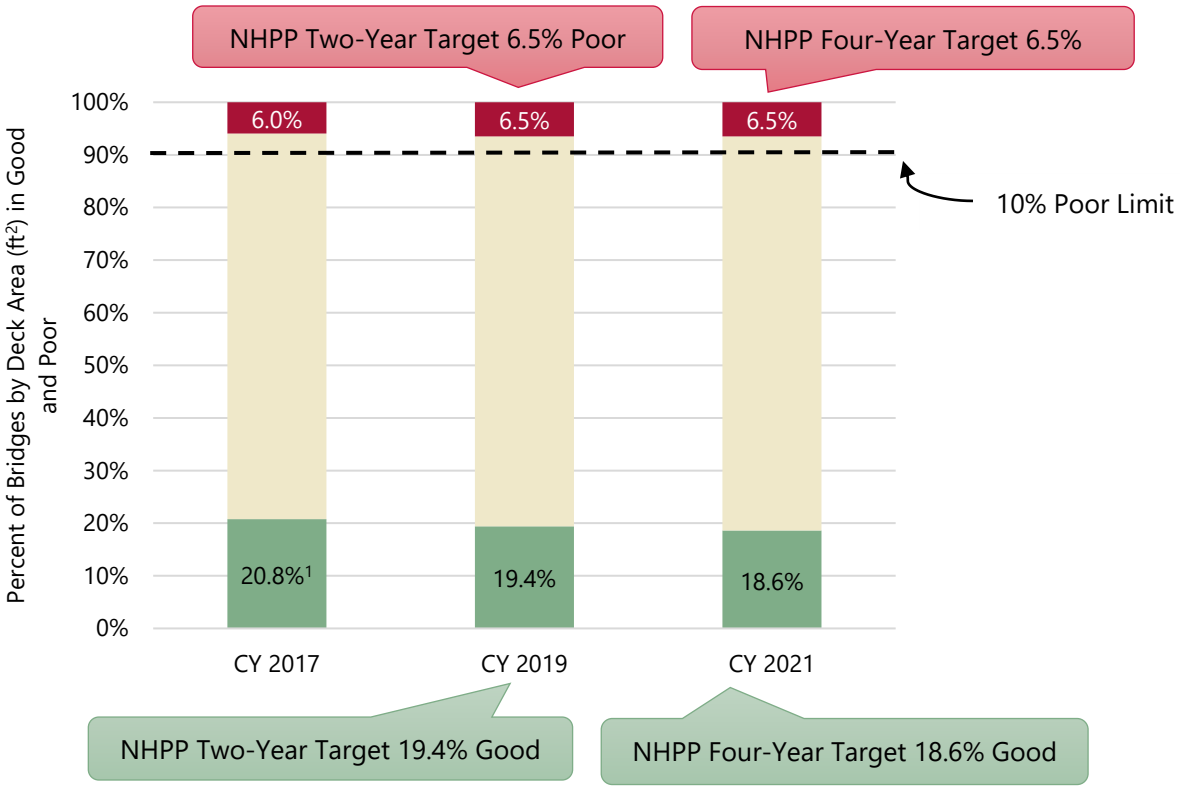
NHPP Two- and Four-Year Performance Targets for the NHS

NJDOT is required to set two-year and four-year performance targets for NHS bridges, regardless of ownership. The targets are stated in terms of the NHPP measures described in *Chapter 2: Asset Inventory, Performance Measures, and Baseline Conditions*. The measures express bridge performance in terms of the percentage of NHS bridges by deck area in *Good* and *Poor* condition. The NHPP performance targets and projected performance are depicted in Exhibit 4-15.

Because of the long timespan required to develop major bridge projects (for example, the Pulaski Skyway Rehabilitation Project), the four-year performance horizon can only be affected by projects that are already programmed. Bridge performance in a four-year horizon is incapable of meeting a higher performance level than the level projected for programmed projects. Accordingly, NJDOT determined projected NHS conditions in years CY 2019 and CY 2021 and set performance targets consistent with projected performance.

Programmed projects will convert some bridge conditions from *Poor* to *Good* over the next several years, but these programmed projects are not expected to offset the increasing pace of deterioration of the aging bridge population. NJDOT projects a slight decline in percent *Good* from baseline to CY 2019 and to CY 2021 and a slight increase in percent *Poor* from the baseline to CY 2019. Both near-term trends are driven by performance on the NJDOT NHS bridges. Non-NJDOT owners of the NHS are projected to have stable performance of their bridge populations. The longer-term performance of both the SHS and NHS is projected to improve after these initial years of the TAMP analysis period.

Exhibit 4-15: Projected NHS NBIS Bridge Conditions – CY 2017, CY 2019, and CY 2021



[1] The 20.8% Good in CY 2017 is the accurate baseline performance of the NHS. However, the figure is different than that reported by FHWA (21.7%) because data in the submission to FHWA was missing 36 border bridges.

4.5 Use of TAMP Gap Analysis Results to Inform Infrastructure Preservation Funding Levels

The TAMP process is a major component of the NJDOT performance management framework. The TAMP gap analysis identifies impacts of funding decisions made in New Jersey's STIP development process on achieving NJDOT's Infrastructure Preservation core mission and accomplishing NHPP targets for NHS bridges and pavement preservation. The gap analysis process results in projections of asset performance and recommended actions to improve or sustain asset performance for consideration by the Transportation Asset Management Steering Committee and NJDOT senior management.

4.6 Trade-Offs Between Performance Goals

As analytical capabilities mature, NJDOT will be better equipped to evaluate trade-offs among achieving a variety of different objectives. Trade-offs between infrastructure preservation objectives for different asset classes and also between Infrastructure Preservation and the other core missions will be evaluated in future capital planning processes after the submittal of the 2019 TAMP.

System performance is measured across the following seven national goal established by Congress for the Federal-Aid Program at 23 USC SS150(b):

- Infrastructure Condition
- Safety
- Congestion Reduction
- System Reliability
- Freight Movement and Economic Vitality
- Environmental Sustainability
- Reduced Project Delivery Delays

Recognizing that infrastructure conditions affect performance in other goal areas, and vice versa, the ongoing TAMP process supports efforts aimed at reducing performance gaps identified for other National Goal Areas by means of appropriately managing infrastructure asset conditions. The NJDOT performance management processes and analyses are currently being evaluated to determine methods for implementing all national goal areas.

NATIONAL GOAL AREAS

- SAFETY
- INFRASTRUCTURE CONDITION
- CONGESTION REDUCTION
- SYSTEM RELIABILITY
- FREIGHT MOVEMENT & ECONOMIC VITALITY
- ENVIRONMENTAL SUSTAINABILITY
- REDUCED PROJECT DELAYS

https://www.fhwa.dot.gov/tpm/about/goals.cfm

The overall process will involve outreach to external stakeholders regarding the performance of the NHS. A full gap assessment comparing the performance of the NHS against performance in all seven national goal areas cannot be performed until performance measures have been established, targets have been set for each goal area and at least one round of data collection has been completed after target setting. It is expected that a minimum of one to two years will be required for the implementation of this process. Additionally, data being collected in any given year reflects performance outcomes resulting from investments made in prior years that were in turn based on investment strategies established even earlier. As a result of the delay in tracking outcome-based performance measures, NJDOT expects several years of data collection, review, and utilization before data sets are fully validated and performance models are adequately calibrated.

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5. Lifecycle Planning

Background

Lifecycle planning is defined in the Federal Highway Administration (FHWA) Asset Management Rule as:

"A strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based on quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired State of Good Repair over the lifecycle of the assets at a minimum practical cost."

Image of NJ Route 206, Stony Brook Bridge

Image of NJ Route 206, Stony Brook Bridge

5.1 Overview

Chapter 5 provides an overview of lifecycle planning along with detailed information specific to the New Jersey Department of Transportation's (NJDOT) lifecycle planning for pavement and bridges. For each asset included in New Jersey's Transportation Asset Management Plan (the TAMP), the analytical tools and methods used in lifecycle planning are described, and the lifecycle planning practices of non-NJDOT National Highway System (NHS) asset owners are reported.

5.1.1 Managing Across the Whole Lifecycle

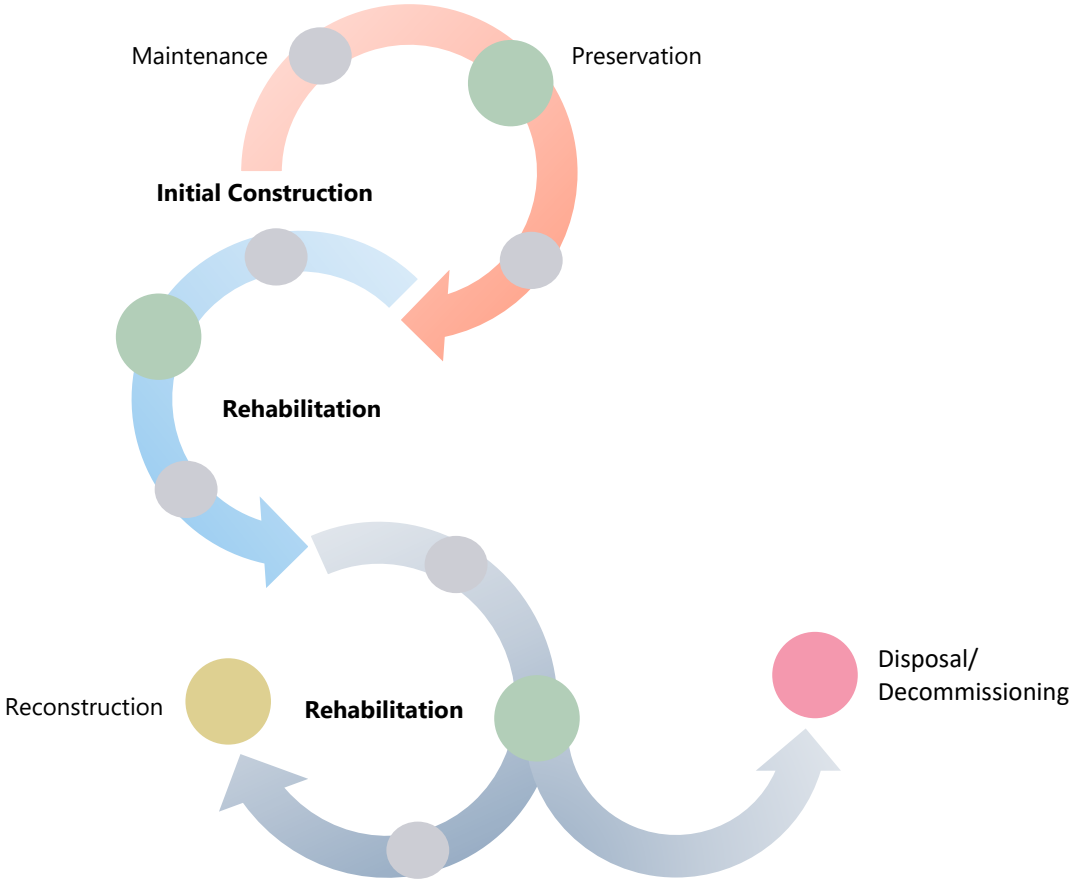
Lifecycle planning identifies whole life strategies for managing a network of assets to achieve a target performance level while accomplishing other performance objectives. These strategies are the best sequence of maintenance, preservation, rehabilitation and replacement (reconstruction) treatments for the TAMP assets over their lifecycle at the network level.

Lifecycle planning differs from lifecycle cost analysis. Lifecycle cost analysis is applied to a specific asset, comparing the costs of different sequences of actions over an asset's entire lifecycle. Agencies use project-level lifecycle cost analysis when comparing two or more design alternatives for a single

project, considering all agency expenditures and user costs throughout the life of each project alternative. In contrast, lifecycle planning is performed at the network level, considering the needs of all the assets in a system or a subset of the system over an analysis period sufficiently long to include at least one lifecycle for the asset class under consideration.

Lifecycle planning uses a whole life approach to manage assets, considering treatment needs from initial construction (e.g., new asset creation) through rehabilitation to replacement (reconstruction) or disposal/decommissioning. Assets sometimes undergo multiple cycles of rehabilitation before they require reconstruction. Exhibit 5-1 presents the various stages of an asset lifecycle.

Exhibit 5-1: Stages of Asset Lifecycle



5.1.2 Pavement and Bridge Management Systems

Performing lifecycle planning at the network level requires engineering, economic, and financial analyses, all supported by NJDOT's pavement and bridge management systems. The NJDOT pavement and bridge management systems are each a collection of databases, staff, software tools, institutional knowledge, and business processes that: (1) manage the variety of data on assets, (2) initiate projects, (3) develop lifecycle plans and investment strategies, and (4) provide information and reports to federal authorities, external stakeholders, and other business units. The pavement and bridge asset

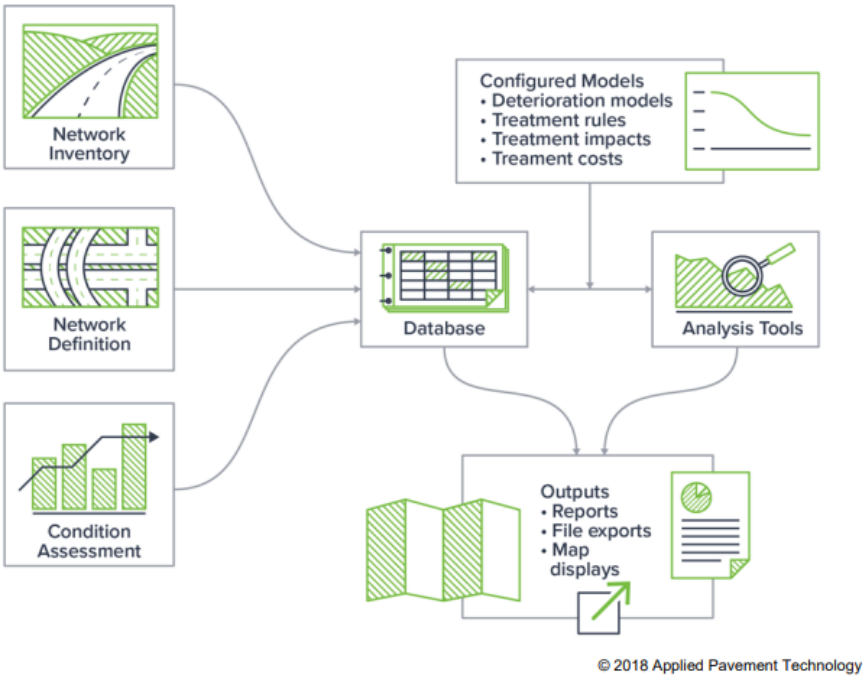
management systems, detailed later in this chapter, use inventory and condition data, performance objectives, deterioration models, financial information, and rules defining when different treatments should be applied, to determine the most cost-effective strategies for preserving or improving asset performance over the long term.

Recent advances in software tools have resulted in increased sophistication in lifecycle planning. Pavement and bridge management systems are increasingly relying upon computer modeling software to assist in developing asset management programs and associated investment strategies. The enhanced software develops recommended network asset management programs through the application of an algorithm that optimizes NJDOT's different policy objectives while incorporating the following:

- Deterioration modeling.
- Network policies that detail the conditions under which a treatment should become a work candidate.
- Action-benefit relationships that translate treatments to benefits in the form of changes in condition, changes in deterioration rates, or a change in another measure of value (e.g., change in a bridge's scour critical status).
- Unit costs of treatments.
- Lifecycle costing associated with work candidates.

A generalized, high-level schematic of the components of a pavement or bridge management system is displayed in Exhibit 5-2. The exhibit portrays the multiple layers of a management system and highlights that the management system is much more than the modeling software system, which is an analytical tool within the overall system.

Exhibit 5-2: Management System Components



5.2 Pavements

Lifecycle planning for pavements involves developing long-term treatment strategies from a roadway network perspective considering the role the roadway plays in meeting overall transportation objectives, as well as considering the engineering properties of different types of pavement and the factors that will impact future conditions. Rather than focus on the needs of each mile of pavement, lifecycle planning establishes treatment strategies for the full roadway network, using data aggregated from the entire asset population. The treatment strategies represent combinations of pavement management actions that keep pavements operational at the lowest practical cost.

Lifecycle planning is a core component of pavement management, as it establishes a cost-effective and practical approach to managing pavements. Lifecycle planning provides data-driven input to NJDOT's processes for prioritizing maintenance work, developing repair and rehabilitation plans, selecting projects for implementation, and allocating funds to pavement preservation.

5.2.1 Lifecycle Planning Considerations

All pavement in New Jersey, across all owners, is one of the following types:

- **Flexible pavement** is constructed with layers of hot mix asphalt concrete.
- **Composite pavement** is comprised of relatively thick slabs of Portland cement concrete, overlaid with an asphalt wearing surface.
- **Jointed Concrete pavement** is constructed with contraction joints between slabs of Portland cement concrete.

The vast majority of pavement in New Jersey is either flexible or composite, while the minority of NHS pavement is jointed concrete pavement. For all pavement types, lifecycle planning focuses on the most cost-effective means to preserve, maintain, and rehabilitate pavement assets (i.e., sealing or replacing the pavement surface to keep water from infiltrating and weakening the pavement structure). An effective lifecycle strategy can allow a pavement to provide 50 years or more of service life before the pavement structure requires full reconstruction.

Pavement Deterioration

All pavements decline in condition over time because of regular use and exposure to seasonal weather fluctuations. Pavement flexes under traffic conditions and over time the pavement weakens and loses structural integrity. Typical pavements, subjected to loading for which they were designed, should not expect structural failure to occur before 50 or more years of service, assuming proper maintenance is provided.

Additionally, several environmental factors cause pavements to deteriorate rapidly, including exposure to air, sun, and water. Exposure to air and the sun's rays causes asphalt pavement to oxidize, or dry out, becoming brittle. The result of the exposure is surface cracking which, if not addressed, can accelerate pavement deterioration. Water can infiltrate the pavement from surface cracks resulting from wear , oxidation, or joints, or from beneath, because of poor drainage.

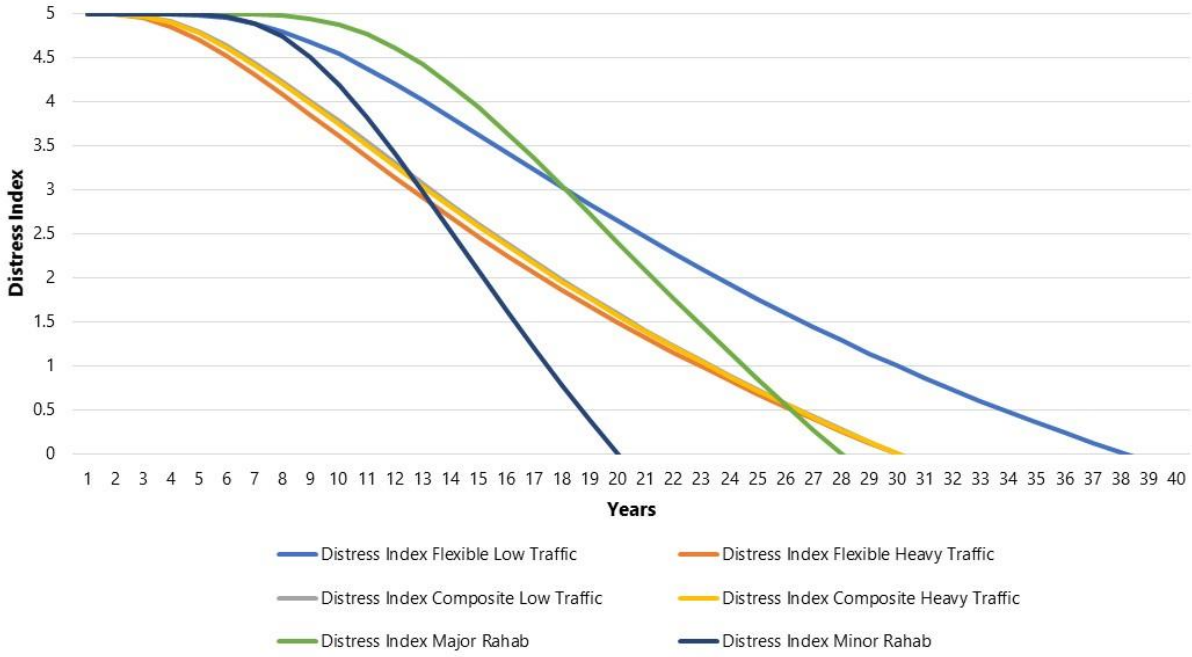
There are several factors that impact the rate at which pavements deteriorate. For New Jersey, the most relevant factors are:

- ***Pavement Type*** – As described previously, the two most common types of pavements found in New Jersey are flexible pavements and composite pavements. While each pavement is susceptible to deterioration from loading and exposure to the elements, they deteriorate in different ways, and require different treatments.
- ***Volume of Traffic*** – New Jersey as a densely populated state with much interstate traffic experiences high volumes of passenger and freight travel flows, the latter often with heavy loading on many pavements. These volumes can accelerate structural failure if pavements are not properly designed and maintained.
- ***Drainage*** – Pavement structures must be kept dry to avoid early structural failure. Water weakens the soil under the pavement which can lead to failure due to increased flexing under regular use. Freezing and thawing of water within or between the pavement layers can cause rapid deterioration and potholes.
- ***Environmental Factors*** – New Jersey has a relatively wet climate with a significant number of freeze-thaw cycles in a typical year. Roadside ditches and storm sewers must be maintained to support proper drainage, without this pavement lifecycle planning is not effective. New Jersey also has many low-lying and coastal areas which are prone to flooding. Flooding of pavement can weaken the pavement structure, or if the water is flowing, cause catastrophic failure. See *Chapter 6: Risk Management* (Section 6.4.2) for information on NJDOT's Asset Management, Extreme Weather and Proxy Indicators pilot study that assessed the impacts of extreme or repeat weather events upon the conditions of New Jersey's highway assets.

A significant challenge for New Jersey is the increased impact of these four factors on pavement deterioration. Economic growth and concentrated land development patterns have increased traffic volumes, while a trend of increasing frequency and severity of extreme weather events have increased environmental stresses on New Jersey's roadways.

Effective lifecycle planning for pavements requires reliable mathematical models of pavement deterioration, and of the effects of treatments to restore pavement condition and extend service life. NJDOT's models are developed based on historical data of NJDOT pavement conditions and treatment actions. Exhibit 5-3 shows an example, not specific to NJDOT, of mathematical models demonstrating the different time paths of pavement deterioration associated with different treatments.

Exhibit 5-3: Example Pavement Deterioration Models



Pavement Treatments

Pavement treatments may be grouped into five categories: maintenance, preservation, resurfacing, rehabilitation, and reconstruction. Exhibit 5-4 shows the typical treatments types, by category, and costs used by NJDOT to maintain or improve pavement conditions.

- ***Maintenance Treatments*** – Maintenance treatments are performed to prevent against or repair damage but do not significantly impact a pavement's measured condition. Examples of maintenance treatments include crack sealing and pothole repair. These treatments are typically performed by NJDOT maintenance personnel.
- ***Preservation Treatments*** – Preservation treatments are performed to address minor surface distresses and extend pavement service life. However, these treatments do not restore or improve a pavement's structural capacity. Examples of NJDOT preservation treatments include micro-surfacing, slurry seal, or thin asphalt overlays (less than 2 inches). These treatments are typically applied to pavements rated *Fair* or better by NJDOT's Condition Status performance metric (see *Chapter 2: Asset Inventory, Performance Measures, and Baseline Conditions* for more details). This is because the *Fair* category is largely made up of pavements with moderate surface distresses but little or no loss of pavement structural capacity.
- ***Resurfacing Treatments*** – Resurfacing treatments are performed to address more significant surface distresses and restore pavement condition. These treatments do not restore or improve a pavement's structural capacity; however, they remove the damaged portion of the existing pavement surface, typically 2 to 3 inches, through a milling operation and then replace it with an equal depth of new asphalt material. These treatments are typically applied to pavements in *Fair* condition by NJDOT's Condition Status performance metric but can also be used to

treat some *Poor* pavements. Resurfacing is included under the FHWA "rehabilitation" work type within the TAMP pavement investment strategy.

- ***Rehabilitation Treatments*** – Rehabilitation treatments restore pavement surface conditions and restore or improve a pavement's structural capacity. For flexible pavements, these treatments are comprised of overlays or mill and replacements where the resultant pavement thickness is increased. For rigid or composite pavements, these treatments also include repairs to the concrete slabs or the load-transfer devices between slabs. Rehabilitation is typically done to pavements that are at the low end of *Fair* or rated *Poor* by NJDOT's Condition Status performance metric.
- ***Reconstruction*** – Reconstruction is needed when a pavement has reached the end of its functional life, and its structural capacity is insufficient to carry the required traffic loads. Reconstruction typically requires complete removal of the pavement and replacement with new drainage assets. Reconstruction is only performed on pavements rated *Poor* by NJDOT's Condition Status performance metric.

Exhibit 5-4: Typical NJDOT Pavement Treatment Types and Costs

Category	Treatment Number and Type		Average Project Cost per Lane Mile
Maintenance	0	Crack Sealing and Pothole Repair	Varies
Preservation/ Resurfacing	1	Chip Seal	$166,000
	2	Cape Seal (Treatments # 1 + 3)	$200,000
	3	Micro-surfacing or Slurry Seal	$141,000
	4	High Performance Thin Overlay	$160,000
	5	Ultra-thin Friction Course	$170,000
	6	Treatments # 3 + 4 or 3 + 5	$250,000
	7	Resurfacing (2" or 3")	$250,000
Rehabilitation	8	Resurfacing (2 lifts of 3" or more)	$350,000
	9	Concrete Pavement Rehab	$400,000
Reconstruction	10	Reconstruction	$1,200,000

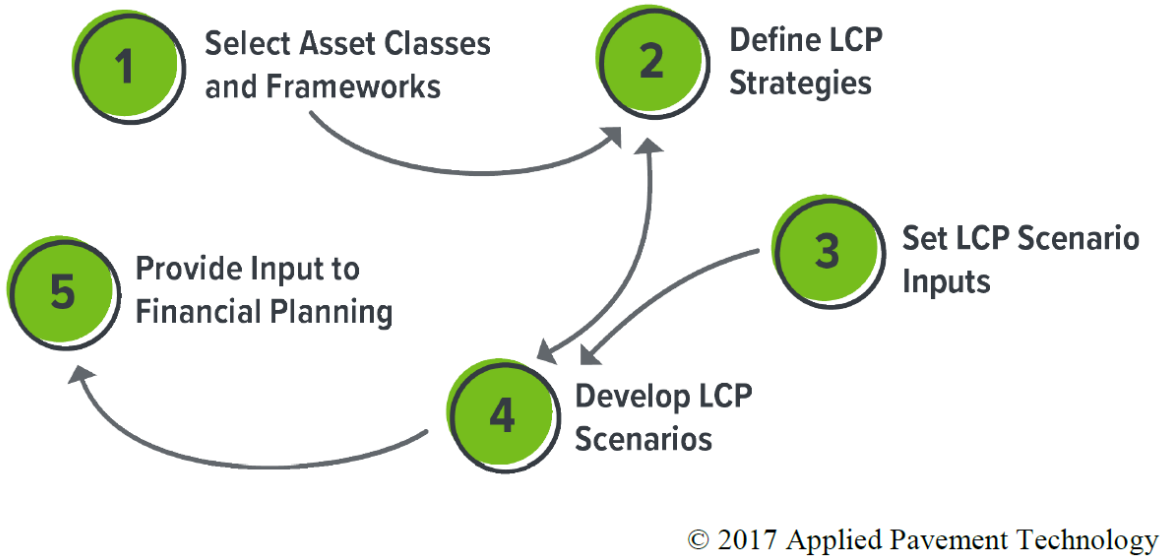
Source: NJDOT Pavement Management Unit, NJDOT Pavement Management Software February 2019.

Pavement Lifecycle Planning Process and Uses

The Lifecycle Planning Process

Exhibit 5-5 summarizes the NJDOT process for pavement lifecycle planning based on FHWA guidance, *Using a Life Cycle Planning Process to Support Asset Management*. The process described in this section is performed routinely by the Pavement and Drainage Management & Technology Unit as part of its regular responsibilities, and alternate strategies are evaluated at least annually. The frequency of these evaluations allows NJDOT to determine the impacts of changes in measured pavement conditions, treatment costs, available treatments, and other inputs that occur routinely and are reflected in the pavement management data and performance models.

Exhibit 5-5 Lifecycle Planning Process



Note: LCP = Lifecycle Planning

NJDOT's lifecycle planning for pavements is performed using NJDOT's Pavement Management Software (PMS) to evaluate the cost-effectiveness of different long-term strategies for managing pavements. NJDOT's PMS is a customized implementation of Deighton's Total Infrastructure Management System (dTIMS) pavement management software, that has been configured based on NJDOT's business practices and historic pavement performance to model and project future pavement conditions. The system uses data from the pavement condition database, as described in Section 2.3.1 to analyze the needs of all NJDOT pavements. The system contains data on cracking, rutting, ride quality, age, traffic volumes, and physical attributes. The system also contains expected treatment costs (see Exhibit 5-4), treatment impact rules, and treatment deterioration models. The data are applied to treatment trigger rules to determine the most appropriate treatment for each section of pavement in each year of an analysis.

Once the appropriate treatments, including a "do-nothing" alternative, are determined for each road section, the system calculates the benefit/cost ratio for each viable treatment to prioritize treatments with the greatest benefit. The benefits measure is primarily driven by the improvements in condition, treatment life, and traffic volume carried. For lifecycle planning, NJDOT's PMS is used to project pavement conditions 20 years or more into the future to cover needs over an entire lifecycle planning analysis period. The specific activities conducted at each step of the process are presented below.

- ***Step 1 Select Asset Classes and Frameworks*** – NJDOT applies this process on NJDOT pavements. NJDOT considers all pavements to be a single class of assets and does not evaluate performance separately for any subclasses of pavements because most NJDOT pavements have asphalt wearing surfaces, deteriorate similarly, and receive similar treatments. The processes followed by other owners of NHS pavements are described later in this chapter.
- ***Step 2 Define Lifecycle Planning Strategies*** – Strategies are described through the trigger rules and benefit calculations which prioritize treatments for inclusion within limited budgets.

Strategies are defined by varying these rules and evaluating the impact on future performance. The current set of trigger rules are used as a baseline strategy to which other strategies are compared. Alternative strategies can explore how different triggers or means of calculating benefits impact long-term pavement conditions.

NJDOT trigger rules that guide dTIMS in developing benefit/cost-based treatment strategies are as follows:

- Pavements that have a Surface Distress Index (SDI) between 2.4 and 3.6 are considered for various preservation treatments, depending on other factors such as the specific distresses and traffic level.
- Pavements with an SDI less than 2.4 are considered for resurfacing, rehabilitation, or reconstruction based on project-level pavement screening data and other factors including traffic level, structural integrity, and geometric constraints.

Using NJDOT-defined treatment costs, deterioration models, and condition reset values, dTIMS software develops multiple lifecycle treatment strategies for each pavement section and recommends preferred strategies based on optimized network performance and lifecycle cost.

- ***Steps 3 and 4, Set Lifecycle Planning Inputs and Define Lifecycle Planning Scenarios*** – Lifecycle planning scenarios are a combination of strategy and funding level. Additionally, the scenarios consider all the data contained in NJDOT's PMS. Pavement condition, attribute data, and traffic data are updated annually from the highway performance management data set. Other inputs, such as trigger values and budgets, are established as scenario considerations. NJDOT evaluates the effectiveness of different strategies holding the budget constant.

  NJDOT uses a 20-year analysis period. Using the current funding level (FY 2018) and trigger rules, the first scenario typically run is an unconstrained preservation budget to determine what level of preservation the system recommends annually. That information is then used to develop additional scenarios which consider risks such as the inability to deliver the optimum preservation program.

- ***Step 5 Provide Input to Financial Planning*** – The results of the lifecycle planning scenarios are used in the development of the New Jersey Transportation Capital Program and the Statewide Transportation Improvement Program (STIP). Additional model runs are performed as part of performance gap analysis, where combinations of investment levels and lifecycle planning strategies are used to project pavement asset performance under different investment scenarios.

Use of Lifecycle Planning Results

NJDOT's PMS is used to evaluate and recommend both short- and long-term strategies for pavements that inform programming processes such as the STIP. Based on these strategies, the system recommends programs (sets of projects) and delivery schedules that lead to desired levels of performance.

The gap analysis process uses NJDOT's PMS to evaluate potential outcomes of different lifecycle strategies and investment levels. The combinations of different strategies and investment levels, referred to as "scenarios," are analyzed over the TAMP analysis period. The results from each scenario are evaluated to determine the best means of achieving the TAMP State of Good Repair Objectives and asset management targets within available resources.

NJDOT's PMS software has the capability to collect, process and store pavement data necessary for lifecycle planning related to NJDOT pavements. The system can forecast deterioration to establish both short- and long-term pavement budget needs and strategies for addressing those needs. The system does not contain data on the non-NJDOT NHS pavements. To perform analyses on the entire NHS, NJDOT uses information gathered from other NHS owners regarding their lifecycle planning strategies, to estimate projected conditions on the non-NJDOT NHS, based on scenarios run in NJDOT's PMS. The derived analysis is currently performed in a separate spreadsheet tool and is expected to continue being performed outside of NJDOT's PMS for the foreseeable future.

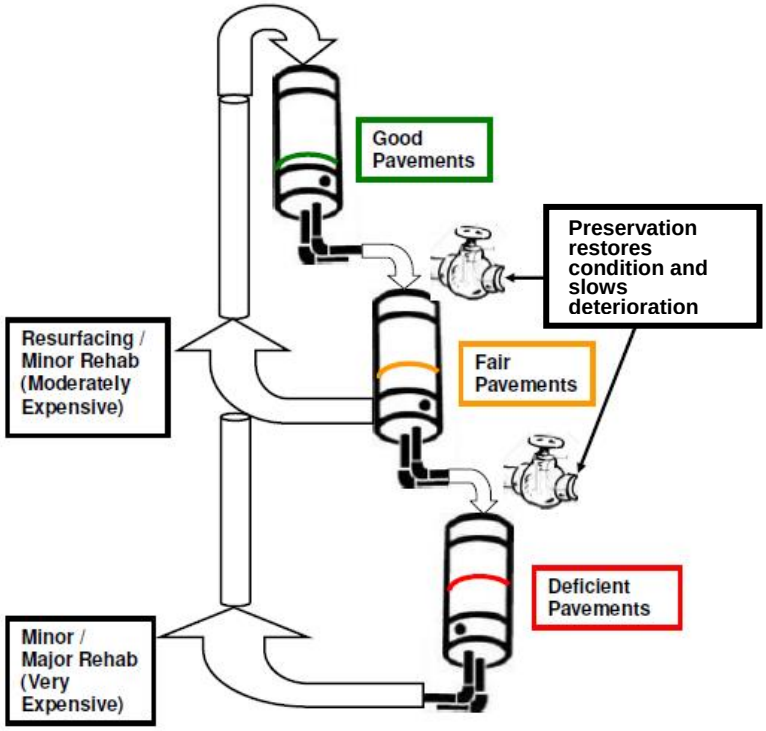
With the implementation of automated distress data collection, NJDOT is reevaluating the current trigger statements in dTIMS, particularly for preservation, to produce more refined preservation treatment recommendations. NJDOT is also evaluating the use of travel speed deflectometer data to better identify pavements that would require major rehabilitation or reconstruction. As NJDOT acquires more treatment performance information (through annual data collection efforts), particularly on preservation and specialty mixes, staff will continue to refine the deterioration models.

5.2.2 Pavement Lifecycle Strategy

NJDOT's lifecycle planning strategy for pavements maximizes the use of pavement preservation to the greatest extent possible. Based on analysis of historic pavement conditions, NJDOT has determined that the time required between preservation treatments is approximately 10 years for most of the treatment types listed in Exhibit 5-4. The treatments address surface distress resulting from regular use and exposure to the elements. Following new construction, or complete reconstruction, of an asphalt pavement, the surface will typically require a preservation overlay after 10 to 12 years of service. Approximately every 10 years, each section of pavement will need to receive an appropriate treatment (the exception would be treatment type #3, micro-surfacing and slurry seal, which is the thinnest, least expensive treatment and requires reapplication more frequently). Since preservation treatments are typically less than 20 percent of the cost of reconstruction, maximizing their application provides the most cost-effective means of maintaining and improving network-wide conditions.

Exhibit 5-6 shows how NJDOT's pavement lifecycle strategy extends service life by identifying the lowest-cost treatment for each pavement section and prioritizing preventive maintenance treatments on *Fair* and *Good* pavements.

Exhibit 5-6: NJDOT Pavement Lifecycle Planning Strategy

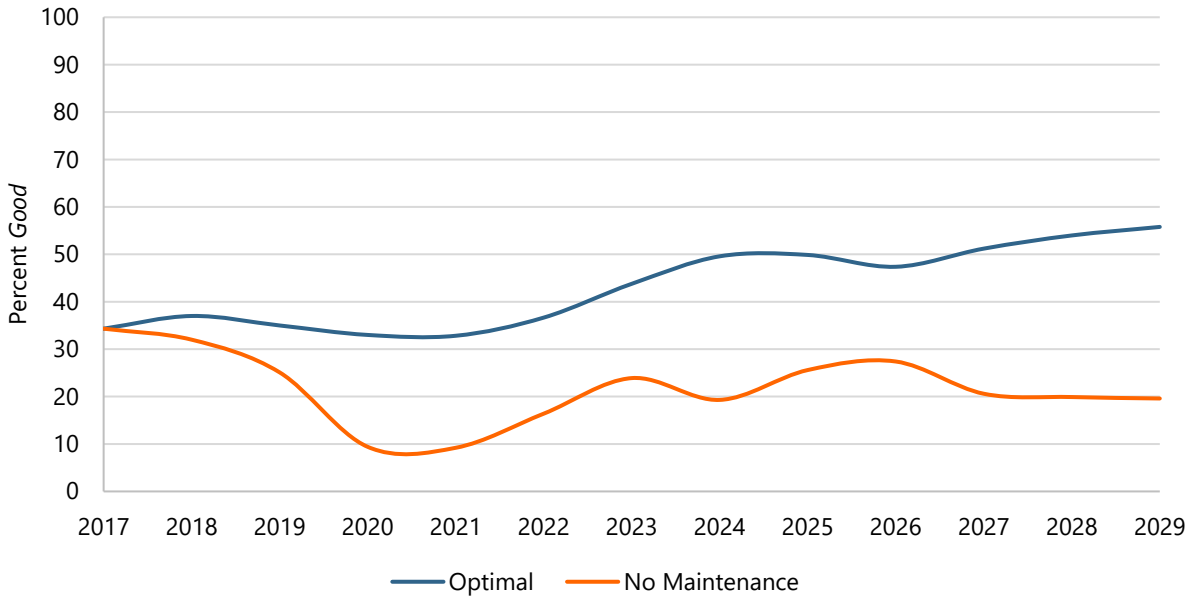


This strategy originated in 2011, when NJDOT began lifecycle planning for pavements. At that time, it was determined that in order to achieve the State of Good Repair Objective of 80 percent of pavements in *Good* or *Fair* condition by CY 2021, approximately 10 percent (840 pavement lane miles at the time) of the pavement network would need to be treated annually to maintain the current condition (CY 2017) and an additional two percent (170 pavement lane miles at the time) would need to be treated to achieve the State of Good Repair Objective by the target year of CY 2021. It would have been cost-prohibitive to pave that many lane miles each year using only resurfacing overlays or more significant treatments, so NJDOT began to investigate the use of less expensive, "preservation" treatments such as micro-surfacing and thinner asphalt overlays.

NJDOT has determined that the service life difference between preservation and traditional treatments is often minimal, provided that the preservation treatments are applied to appropriate pavements. This new understanding has led NJDOT to increase the priority of preservation treatments in developing annual paving programs.

Exhibit 5-7 shows the results of two analyses run in NJDOT's PMS to demonstrate the benefits of prioritizing preservation treatments. For this comparison, NJDOT's PMS evaluated two scenarios at the same level of annual investment. In the "Optimal" scenario, the system's decision tree applied the available funding to maximize the use of preservation treatments. In the "No-Maintenance" scenario, the system was unable to choose any thin preservation overlays and allowed pavements to deteriorate to the point of needing more-costly resurfacing overlays before being selected to receive work. Although neither strategy achieves the agency's pavement objective at the defined budget level, the results show consistently better network pavement conditions both in the short and long term using the "Optimal" strategy.

Exhibit 5-7: Comparison of Optimal and No-Maintenance Lifecycle Planning Strategies



Responsibility

The NJDOT Pavement Management Unit is responsible for establishing the pavement lifecycle strategy and using NJDOT's PMS to develop annual paving plans. The Pavement Management Unit develops lists of potential preservation sites that are then evaluated to determine the optimal treatment for each location. The Pavement Management Unit works closely with both Capital Program Management and Operations and Maintenance staff to ensure that selected projects receive cost-effective treatments that best fit the pavement lifecycle strategy, while accommodating the specific circumstances of each site.

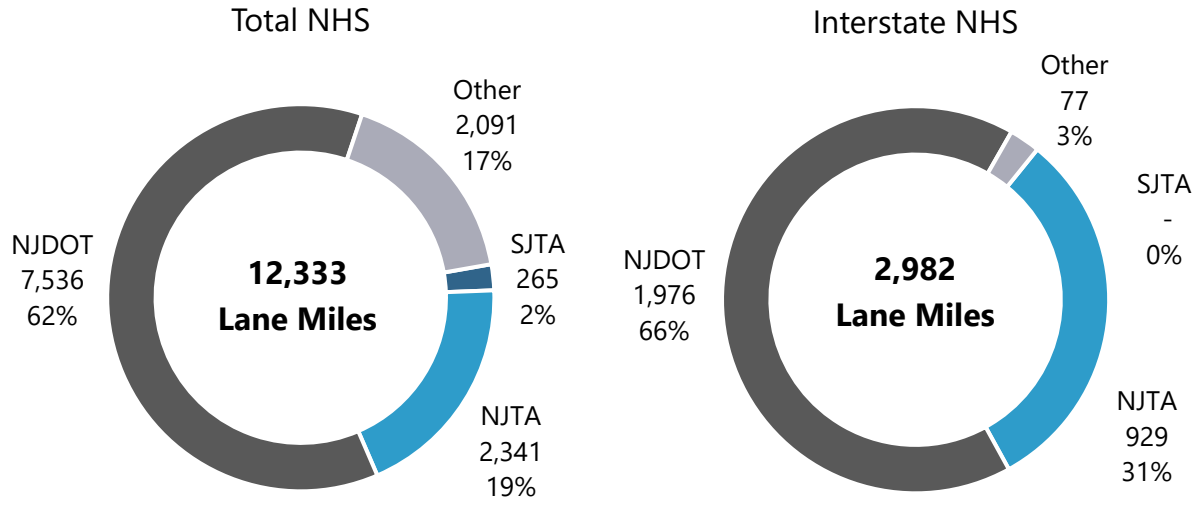
Minimizing User Impacts

To minimize the impact of pavement performance gaps on the traveling public, the NJDOT PMS treatment prioritization formula includes a factor for traffic volume. In addition to condition and lifecycle optimization, sites with greater traffic volumes are prioritized over sites with lower volumes. The adjustment to prioritization maximizes the number of vehicles traveling on recently paved roads, ensuring the greatest number of travelers benefit from the treatment.

5.2.3 New Jersey Turnpike Authority and South Jersey Transportation Authority Pavement Lifecycle Planning

A large portion of NHS pavement is owned and managed by the New Jersey Turnpike Authority (NJTA) (19 percent) and the South Jersey Transportation Authority (SJTA) (2 percent) as shown in Exhibit 5-8. When considering interstate pavement only, NJTA owns 31 percent of the interstate pavement lane miles in New Jersey. Both agencies have robust pavement preservation programs with mature lifecycle plans and are fully funded by toll revenue receiving no federal aid for pavement projects.

Exhibit 5-8: NJDOT, NJTA, and SJTA Ownership of Total and Interstate NHS Pavement (Lane Miles)



Source: NJDOT Bureau of Transportation, Data and Support, Roadway Systems Section.

NJTA Pavement Lifecycle Planning

NJTA owns and manages approximately 2,341 lane miles of NHS pavement on two major highway networks: the New Jersey Turnpike and the Garden State Parkway. Both roadways carry considerable travel volumes, with the New Jersey Turnpike carrying significant freight volumes. Presently, the majority of NJTA pavement is in *Good* condition. The NJTA pavement condition maintenance strategy consists of the following four components:

1. Condition assessments using collected pavement data
2. Prioritization of pavement needs based on condition assessments
3. Completion of projects to address pavements in *Poor* condition
4. Completion of projects to prevent pavements from reaching *Poor* condition

In recent years, NJTA has implemented a Pavement Management System (PMS) to manage collected data and condition assessment results. The PMS also provides information used to estimate needed treatments and their timing, based on projected condition.

Due to increased deterioration rates recorded as part of recent condition assessments, NJTA is presently revising lifecycle estimates and plans for various roadway sections. Life expectancies based on prior lifecycle practices ranged from 10 to 12 years. A follow-up evaluation comparing budgeted and expended amounts for pavement resurfacing projects with the PMS's estimates of lifecycle needs revealed that both were not keeping pace with levels of deterioration. Resurfacing projects are included in annual maintenance programs; however, based on the result of the evaluation of amounts budgeted versus expended on pavement resurfacing projects, additional capital funding was allocated to address pavement needs. Further details about NJTA funding for pavement resurfacing and capital projects are provided in *Chapter 7: Financial Plan*.

NJTA collects detailed distress data on all lanes of the New Jersey Turnpike and the Garden State Parkway every five years and annually on the heaviest-travelled lane of each. Visual observations augment the data to identify sections of each roadway for resurfacing projects (i.e., mill and overlay).

The current lifecycle strategy for the Garden State Parkway is to perform a mill and overlay every 10 to 12 years, although the NJTA is re-evaluating the timing of treatments. Additionally, NJTA has divided the Garden State Parkway into 15 sections for tracking conditions and identifying annual projects.

For the New Jersey Turnpike, the NJTA is transitioning the lifecycle strategy to a cyclical treatment plan, similar to that used on the Garden State Parkway. During the transition, estimated to take eight years, additional funding will be required to maintain pavements that are not scheduled for complete resurfacing until they are sectionalized. The additional funding will be required until the 23 sections of the New Jersey Turnpike can be fully transitioned to sectionalized resurfacing.

SJTA Pavement Lifecycle Planning

SJTA manages 265 lane miles of non-interstate NHS pavement on the Atlantic City Expressway. Presently, the SJTA is transitioning its lifecycle planning practices to a holistic transportation asset management-led approach Currently, the SJTA pavement lifecycle plan applies a traditional mill and hot mix asphalt overlay on a 10- to 11-year cycle. In addition to pavement condition metrics collected for PM2 requirements, the SJTA conducts annual visual inspections along with periodic International Roughness Index (IRI) testing. PM2 data is collected on all NHS pavements maintained by SJTA under a contract with a third-party consultant. These two datasets are combined for a complete picture to assist in managing the SJTA network. The SJTA data supports the effectiveness of the current approach, predicting that no SJTA pavement will be rated as *Poor* by CY 2023 and CY 2029. Additional improvements in SJTA pavement conditions are anticipated under the holistic transportation asset management approach.

5.2.4 Port Authority of New York and New Jersey Pavement Lifecycle Planning

Details for the Port Authority lifecycle planning practices are described within Section 5.3.4. Pavements are typically managed as part of a facility-based project and not separately by lane mile. Most of the Port Authority's facilities included in the TAMP are bridges. The Port Authority's share of NHS pavements (<0.1%, 45.3 lane miles) is considerably less than its share of NHS bridges by deck area (5.9%, 3,603,241 square feet).

5.2.5 Other Jurisdictions Pavement Lifecycle Planning

An additional 2,045 lane miles (17%) of NHS pavement in New Jersey is owned by a large number of other municipal, county, and authority owners. These pavements are managed in different ways by each owner. Much of the total 2,045 pavement lane miles is comprised of short sections managed as part of the management of other roadways. Typically, work done on these pavements responds to significant pavement distress and local priorities. Funding for work on these pavements is typically provided through Authority tolls, or a combination of federal, state, and local funding. As described in *Chapter 7: Financial Plan,* the average level of annual expenditures on NHS pavements is expected to increase beyond recent expenditure levels, suggesting that owners are taking the appropriate steps to

maintain the condition of their NHS pavements. NJDOT continues to refine its data collection process (described in *Chapter 3: TAMP Governance, Policies, and Objectives*) to improve the TAMP's consideration of NHS pavements.

5.3 Bridges

5.3.1 Lifecycle Planning Considerations

The key to lifecycle planning for bridges is to understand bridge performance over time and understanding which strategies ensure bridges remain in a State of Good Repair. There are several considerations unique to bridges that affect this planning:

- **Bridges are expensive and long-lived assets** with high construction and reconstruction costs.
- **A wide range of maintenance, preservation, and rehabilitation treatments exist** to extend the life of bridges. These treatments change over time, incorporating new materials and details developed to improve lifecycle performance.
- **Bridges are complex assets with multiple components** (deck, superstructure, and substructure) that affect each other.
- **Environmental conditions impact bridge components,** affecting the anticipated life span of bridges. For example, snow requires the use of de-icing salts, high water events can cause scour of bridge foundations.
- **Historic data on bridge deterioration must be continually reviewed.** Historic data indicates past performance that can be used to project future performance, but these trend projections must be modified as new materials and constructions details are developed.

Bridge Deterioration

Bridges deteriorate over time due to their use and exposure to seasonal weather fluctuations. Factors that contribute to more rapid bridge deterioration include the following:

- Use of de-icing salts.
- High-water events that cause scour–the removal of foundation material under the substructure.
- Large volumes of heavy vehicle traffic.
- Bridge design characteristics and materials – Older bridges tend to have characteristics that make them prone to more rapid deterioration, such as lack of coated rebar in concrete decks, insufficient load-bearing capacity, lack of scour-resistant foundations, or lack of resilient joints. The expected service life of older bridges (built before 1979) is approximately 50 years. The service life of NJDOT bridges using current design criteria and improved materials is in the 75- to 100-year range.

Factors including economic growth and increasingly concentrated land development patterns have led to increased traffic volumes, resulting in accelerated bridge deterioration. In addition, the increasing frequency and severity of extreme weather events have amplified environmental stresses on bridges.

Bridge Treatments

Bridge treatments may be grouped into four general categories or work types: maintenance, preventive maintenance/preservation, rehabilitation, and reconstruction.

Maintenance

Maintenance is a reactive approach to unforeseen situations that arise requiring immediate or prompt repairs. Examples include severe deck spalls, over-height trucks hitting the girders, or severe scour or undermining. In these cases, maintenance actions must be taken to keep the bridge in service and safe for use by the public. This work is typically performed by NJDOT maintenance forces or by Job Order Contracts for more complex repairs. On a unit cost basis, this work tends to be more expensive than planned preservation or rehabilitation activities.

Preventive Maintenance/Preservation

Bridge preservation is defined as actions or strategies that prevent, delay, or reduce the deterioration of bridges or bridge elements, restore the function of existing bridges, keep bridges in *Good* condition, and extend serviceability. Preservation actions may be cyclical or condition-driven, or a combination.

The Preservation work type in the TAMP bridge investment strategy includes actions that NJDOT refers to as preventive maintenance. The NJDOT Bridge Preventive Maintenance Program was developed in response to an October 8, 2004, FHWA memorandum stating that highway bridges will be eligible for federal aid for maintenance activities if NJDOT can demonstrate that the treatments are a cost-effective means of extending the useful life of a federal highway.

The Bridge Preventive Maintenance Program is updated regularly with treatments applied to all NJDOT National Bridge Inspection Standard (NBIS) bridges. NJDOT currently implements the program under several contracts.

The program's various treatments are identified in Exhibit 5-9. The treatments are only applied if the component is rated 5 (*Fair*) or higher. This threshold ensures that maintenance activities for an element are not performed if the overall component is deteriorated to the point where replacement is required soon. Also, some treatments are applied only if specific element rating criteria are met. For example, crack sealing of bare concrete deck is performed every two years on a deck, provided that the deck element ratings indicate that the deck is in reasonably good condition, namely: less than 25 percent of the deck area is in Condition State 2, and none of the deck is in Condition State 3 or 4.

NJDOT plans to integrate preventive maintenance treatments into AASHTOWare's Bridge Management software (BrM), the Bridge Management System's software tool. Until this integration is complete, the procedure for the selection and implementation of preventive maintenance work is as follows:

1. **Engineering staff perform a cursory review** of bridge inspection reports and element ratings to determine which structures are eligible for preventive maintenance treatments using federal funding. Bridges requiring preventive maintenance are grouped into geographic areas or highway corridors to minimize cost.

2. **Staff perform a detailed review** of the identified eligible bridges furthering their understanding of the bridge inspection reports, maintenance records, and preventive maintenance cycles.
3. **Field inspections are performed** for every structure and conditions are documented.
4. **Cost estimates are drafted** for each maintenance activity.
5. **Needed maintenance work that can be performed by** NJDOT maintenance crews **is forwarded** to state forces.
6. **The remaining preventive maintenance work is compiled** into a Bridge Preventive Maintenance Contract for public bidding.
7. **Completed work is documented** through the Work Order System, which acts as a liaison between Bridge Maintenance and Bridge Management. In the future, it is anticipated that documentation will be entered directly into the Bridge Management System (BMS) to aid in periodic re-evaluation of the program.

Exhibit 5-9: NJDOT Bridges – Preventive Maintenance Treatment Types

Bridge Component	Treatment Type	Cycle
Deck	Bridge Cleaning, Washing, Sweeping	Every 2 years
	Seal Cracks on Wearing Surface-Asphalt Overlay	Every 2 years
	Seal Cracks on Deck	Every 2 years
	Seal Cracks on Parapet	Every 2 years
	Seal Concrete Deck	Every 5 years
	Corrosion Inhibitor	Every 5 years
	Repair/Replace Joints	Every 10 years
	Repair Concrete Deck/Sidewalk	Every 10 years
	Repair Concrete Parapet	Every 10 years
	Re-Seal Base Plates & Curb	Every 10 years
	Repair Approach Slabs	As needed**
	Hot Mix Asphalt Patch	As needed**
	Safety Improvements	As needed**
Super-structure	Superstructure Concrete Repair	As needed
	Lubricate Bearings	Every 4 years**
Substructure	Seal Cracks on Substructure	Every 5 years
	Substructure Concrete Repair	Every 10 years
	Substructure Carbon Wrap	As needed
	Seal Substructure Concrete	As needed**
	Repair Erosion/Scour	As needed**

Source: NJDOT Bridge Preventive Maintenance Program, Revision IV, April 2016.
Note: ** Indicates that the treatment type is only applied if other work is being performed on the same structure.

The NJDOT Bridge Preventive Maintenance Program includes the schedule of painting treatments displayed in Exhibit 5-10. The first treatment displayed, painting only the deteriorated beam ends, is on the shortest cycle and is a common area of paint deterioration due to leaking deck joints. The other two treatments are more exhaustive and are on a longer cycle. These treatments are subject to certain criteria being met with respect to the condition of element 515 (protective coating).

Exhibit 5-10: NJDOT Bridge Painting Treatments

Activity	Cycle
SSPC SP-3 Tool Cleaning; Beam Ends	Every 5 years
SSPC SP-3 Tool Cleaning; Entire Bridge	Every 10 years
SSPC SP-10 Near White Blast; Entire Bridge	Every 20 years

Source: NJDOT Bridge Preventive Maintenance Program, Revision IV, April 2016

NJDOT maintains 18 movable bridges. NJDOT's Movable Bridge Engineering Group leads the design, analysis, inspection, investigation, construction support, and emergency response and assistance for these structures. Unlike standard bridge types, the movable bridges contain many mechanisms for the lift or pivot functions.

The various mechanisms require mechanical and electrical system maintenance that is more complex than a standard fixed bridge. Regular maintenance of the cables, motors, gates, and other warning devices must be performed to ensure that they function properly. Exhibit 5-12 identifies these preventive maintenance activities.

Exhibit 5-11: South Front Street Single-Leaf Bascule Bridge, Union County, New Jersey

Source: Bridgehunter.com.
Note: Bridge for illustration only, no longer in operation.

Exhibit 5-12: NJDOT Moveable Bridges – Preventive Maintenance Treatment Types

Activity	Selection Criteria	Cycle
Lubricate Span Lock	All operational bascule drawbridges	Monthly
Service Warning/Barrier Gate Mechanical Equipment	All drawbridges	Every 3 months
Service Louver Assembly	All drawbridges	Every 6 months
Steel Surface Preparation & Spot Painting	All drawbridges	Annually
Service Warning Gong	All drawbridges	Annually
Service Junction Box	All drawbridges	Annually
Service Span Lock Mechanical & Electrical Equipment	All operational bascule drawbridges	Annually
Service Machinery/Motor Brake Mechanical & Electrical Equipment	All drawbridges	Annually
Service Span Motor	All drawbridges	Annually
Service Control System Cabinetry	All drawbridges	Annually
Service Power Distribution Transformers	All drawbridges	Annually
Cleaning/Lubrication of Drawbridge Lift Cables	All operational lift drawbridges	Every 5 years
Cleaning/Lubrication of Drawbridge Sheave Assembly & Lift Cables	All operational lift drawbridges	Every 5 years
Drawbridge Pest Control Brush Replacement	All drawbridges	Every 5 years

Source: NJDOT Bridge Preventive Maintenance Program, Revision IV, April 2016.

Rehabilitation

Rehabilitation involves the major work required to restore the structural integrity of a bridge, as well as work necessary to correct major safety defects. Rehabilitation work may be done on one or multiple elements and/or components to restore them. These projects typically require significant engineering resources for design and are costly. Examples of bridge rehabilitation include but are not limited to: partial or complete deck replacement, superstructure replacement, and superstructure strengthening. Incidental widening is often associated with some of these activities. NJDOT has defined which rehabilitation treatments are warranted at specific Condition States across the lifecycle of different structure types.

Reconstruction

Reconstruction is the total replacement of a bridge with an entirely new structure. Reconstruction is needed when the bridge has reached the end of its functional life, and its structural capacity is insufficient to carry the required vehicular and permit loads. A bridge may also be replaced when several components have reached *Poor* condition and the bridge is limited by other shortcomings that will be remedied with a replacement project such as insufficient under-clearance or insufficient load capacity. Bridge reconstruction can also involve widening for a variety of possible purposes. For example, widening might be called for to bring the new bridge up to current standards, such as increased shoulder width requirements, or to accommodate increased traffic volumes.

Initial (new) Construction (not a part of bridge asset management)

Initial Construction is the construction of a new structure where none had existed before. Initial construction is not a part of the NJDOT BMS. New bridge construction projects originate from safety or congestion relief needs, which are initiated as part of other (i.e., non-asset management) NJDOT planning activities. While initial construction is not a part of bridge lifecycle planning, design to minimize lifecycle cost is an important factor in conceptual and final design for new bridge construction.

New Jersey is a densely developed state with a road network that is substantially built out. The great majority of NJDOT investment goes toward the management of this existing network rather than to the addition of capacity.

5.3.2 Bridge Management System Tools

NJDOT uses Bentley's AssetWise Asset Reliability Inspection (formerly called InspectTech) software version 7.5 (also called Combined Inspection System or CombIS) as the primary tool for data collection and data quality assurance. NJDOT intends to utilize AASHTOWare's Bridge Management software Version 6.0.0 (BrM 6) as the primary tool for data analysis, deterioration projection, and predictive modeling. The BMS team performed and compared the results of BrM 6 optimization runs prepared in support of the TAMP, and found skewed results due to a number of configuration settings and functions within the software. To understand these skewed results and enhance the BrM functionality, the BMS team has developed a plan of action as described under *BMS Enhancement Plan*. In order to meet the TAMP requirements, the BMS team has utilized Subject Matter Experts and current departmental practices to achieve data driven decision making.

A detailed presentation of BrM 6 capabilities is in Appendix D.

BMS Enhancement Plan

The NJDOT Bureau of Structural Evaluation and Bridge Management (SEBM) is working with the software developers to enhance BrM 6 functionality. Exhibit 5-13 summarizes the tasks required to implement BrM 6 software as it relates to deterioration modelling, lifecycle planning, and the prioritization of planned programs and projects. NJDOT SEBM has acquired Mayvue Solutions under AASHTOWare's Service Unit contract to assist in the completion of Tasks 1, 2 and 3, described below. The scope of work and the negotiation meetings were completed on July 31, 2019. In addition, the planned improvements in the next version of BrM by AASHTOWare will accomplish Task 8. The remaining Tasks 4, 5, 6, and 7 will be accomplished by Staff Augmentation contracts with selected consultants and in-house staff.

Exhibit 5-13: Plan of Action for Incorporating BrM 6 into the BMS

Task	Description	Progress to Date	Anticipated Completion Date
1	Work with AASHTOWare's BrM software developers to develop crystal reports for TAMP related reports and factsheets.	NJDOT has manually created factsheets in the spreadsheet and word format by utilizing historical data.	Dec 2019
2	Work with AASHTOWare's BrM software developers to review configuration settings and identify any outliers or issues	Initial settings and configuration completed. Correction possibly needed to utilize optimization within BrM.	Sep 2020
3	Work with AASHTOWare's BrM software developers to align NBI and NBE data conversion profiles	NJDOT has developed conversion profiles but they produce unwanted results.	Dec 2020
4	Include Work Candidates to evaluate alternative actions and short-term budget needs using BrM.	Initiated the enhancement of an action-benefit-cost model in BrM for additional treatments due to priority repairs. Development of manual and web services for data transfer of work completed.	June 2021
5	Create an Optimized Preservation Program within BrM to evaluate alternative actions for short- and long- term budget needs.	Initiated the development plan for the preservation program manual with Bridge Maintenance team, and our research partners.	Dec 2021
6	Enhance Optimized Rehabilitation and Replacement programs including realistic Budget Projections using BrM.	Attempted during 2019 Final TAMP implementation period, but skewed results noticed.	Dec 2021
7	Develop BMS Manual. Update Manual of Bridge Element Inspection and NBI Coding Guide.	Staff Augmentation is set. Consultants will assist in the development and update of these manuals.	Dec 2021
8	Upgrade BrM to the version that includes a new Life Cycle Planning (LCP) module.	AASHTOWare has accepted the final design specifications for LCP improvements.	June 2022

5.3.3 Bridge Lifecycle Strategy and Strategies for Improving Lifecycle Planning

NJDOT is enhancing its bridge lifecycle planning as follows:

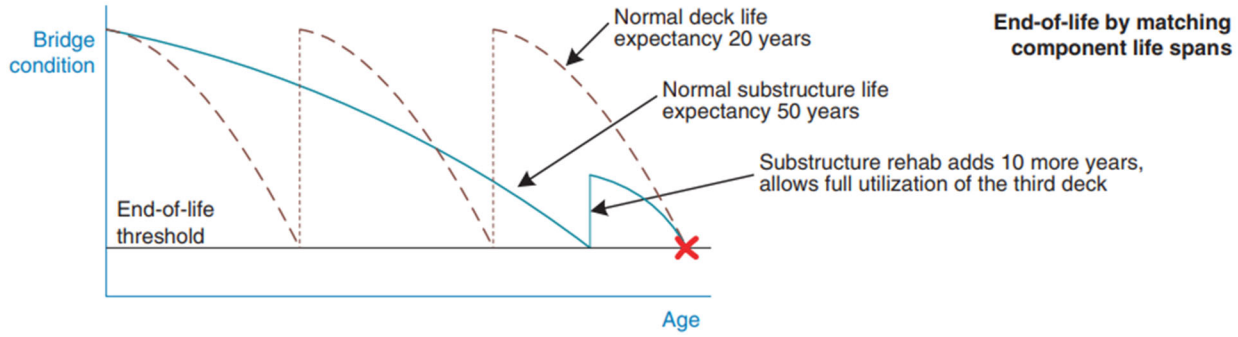
- Implement improved lifecycle planning tools to support project selection.
- Improve planning for routine maintenance and for preventive maintenance/ preservation programs.
- Use improved materials and systems.
- Adopt better design details.
- Incorporate innovative technologies.

Implement Improved Lifecycle Planning Tools to Make Better Project Selections

The full implementation of the BrM 6 software capabilities enables NJDOT to forecast future bridge conditions and to select the mix of bridges and treatments that optimize the weighted objectives of condition, lifecycle cost, risk, and mobility at the allocated funding levels.

Exhibit 5-14 illustrates how the actions for bridge deck, superstructure, and substructure can be selected over time to achieve full utilization of the components in the life of a bridge. Through implementation of various policies, the life of a bridge can be optimized. The use of BrM 6 allows the most effective lifecycle plan for a given funding level to be determined. *Chapter 4: Performance Gap Analysis* reports the performance level delivered by optimizing the lifecycle plans under the four different investment scenarios.

Exhibit 5-14: Example of Optimizing Components for Maximum Bridge Life

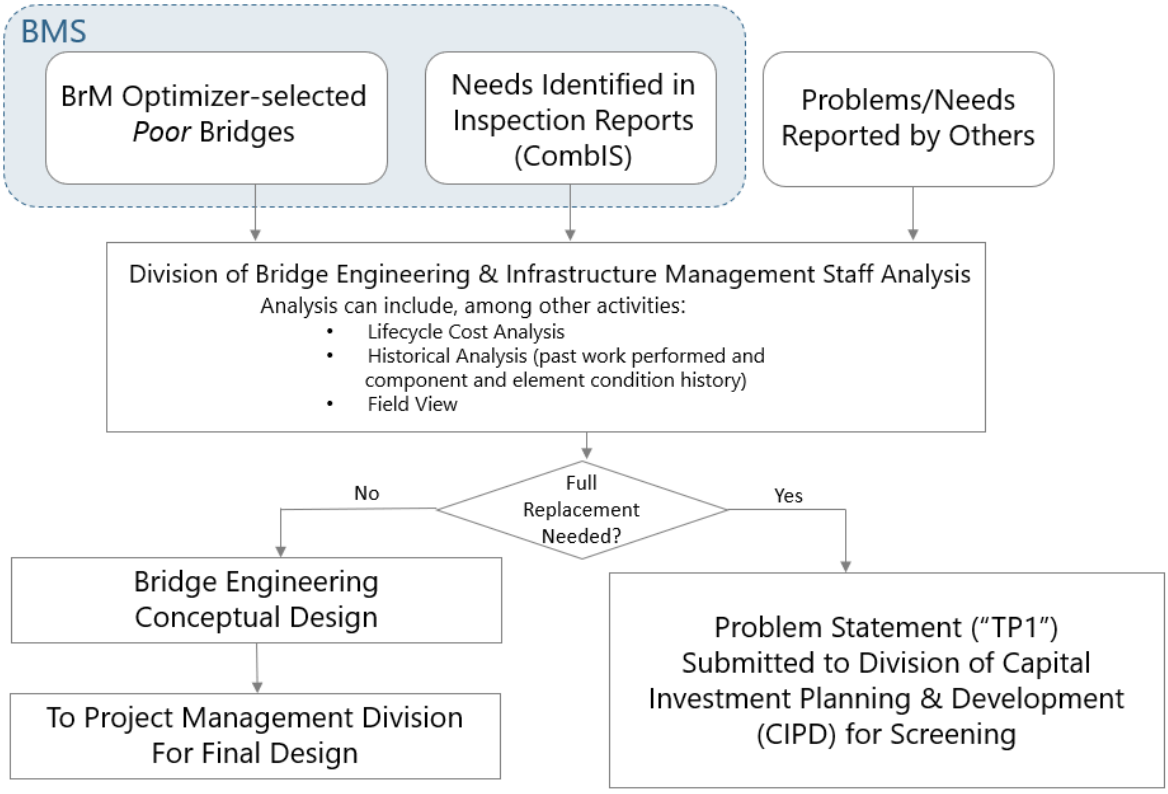


Source: NCHRP Report 713 – Estimating Life Expectancies of Highway Assets, Volume 1, page 26.

Using BrM 6 results in data-driven decisions, ensuring that the best lifecycle planning is implemented for the bridge network in New Jersey. The tool also enables NJDOT to project the costs for bridge treatments on a network level that are required to achieve a given performance objective.

Exhibit 5-15 depicts that the BrM optimizer is one source of the candidate bridge rehabilitation and replacement projects that are subject to further analysis by the Division of Bridge Engineering & Infrastructure Management. As BrM software functionality improves and as NJDOT calibration of the software continues to advance, NJDOT anticipates BrM to take on an increasingly greater role in project selection over time.

Exhibit 5-15: Bridge Project Initiation Process



Improve Planning for Preventive Maintenance Programs

NJDOT has implemented a Bridge Preventive Maintenance Program that undertakes actions to extend the life of a bridge component before reaching the point requiring major rehabilitation or replacement. This program is a key part of the lifecycle plan and a significant improvement over prior "worst first" approaches in which a component or the entire structure is replaced at the end of its service life without extending that life through maintenance and preservation treatments.

The NJDOT Transportation Operations Systems & Support (TOSS) is the owner of the Bridge Preventive Maintenance Program. TOSS plans preventive maintenance treatments after reviewing bridge inspection reports and then selecting projects based on the condition of bridge elements and components. TOSS and the Bureau of SEBM collaborate to improve the process and program results. As BrM 6 is fully implemented, NJDOT will develop a list of preventive maintenance and preservation projects for the near future based on the forecasting and project selection capabilities in the software.

The BrM 6 tool will choose the optimal preventive maintenance projects as a beginning point for further review with input from Subject Matter Experts.

Use of Improved Materials and Systems

Another strategy for improving the lifecycle of bridges is the use of improved materials and systems that are more durable, easier to install, reduce maintenance costs, and extend the useful life of the structure. NJDOT is currently identifying these material applications. Once identified, they will be added to the set of potential treatments with expected impact on future deterioration to be incorporated through a definition of action and benefit in the configuration of BrM. NJDOT continually reviews new materials and systems for potential addition to the list of treatments in BrM. A treatment is added to BrM by determining its benefit it terms of change in deterioration and the treatment's unit cost.

Examples of improved materials and systems include:

- ***Precast Concrete*** – Precast is increasingly common among the bridge industry and virtually every concrete component of a bridge can be built. Precast deck slabs, pre-fabricated superstructure units, girders, piers caps, arches, substructure units, moment slabs, approach slabs, etc. can be shipping and erected in the field within days with no curing wait time necessary. Precast pre-stressed concrete can be integrated with post-tensioned or pre-tensioned strands to increase the concrete capacity.
- ***Galvanized Steel Girders, Railings, and Rebars*** – To increase the durability of key structural components and prevent corrosion, NJDOT has employed hot dip galvanizing on steel girders, reinforcing bars, and metal railings (see Exhibits 5-16 and 5-17). While the steel is in the dipping kettle, the iron in the steel metallurgically reacts with the molten zinc to form a tightly-bonded alloy coating that provides superior corrosion protection to steel. The initial cost of this coating is greater than traditional painting for girders or epoxy-coating for rebar; however, the hot-dip galvanizing offers superior protection and results in an extended service life.

Exhibit 5-16: Galvanized Reinforcing Bars – NJ Route 139

Source: Gannett Fleming Photo - NJ Route 139 Reconstruction.

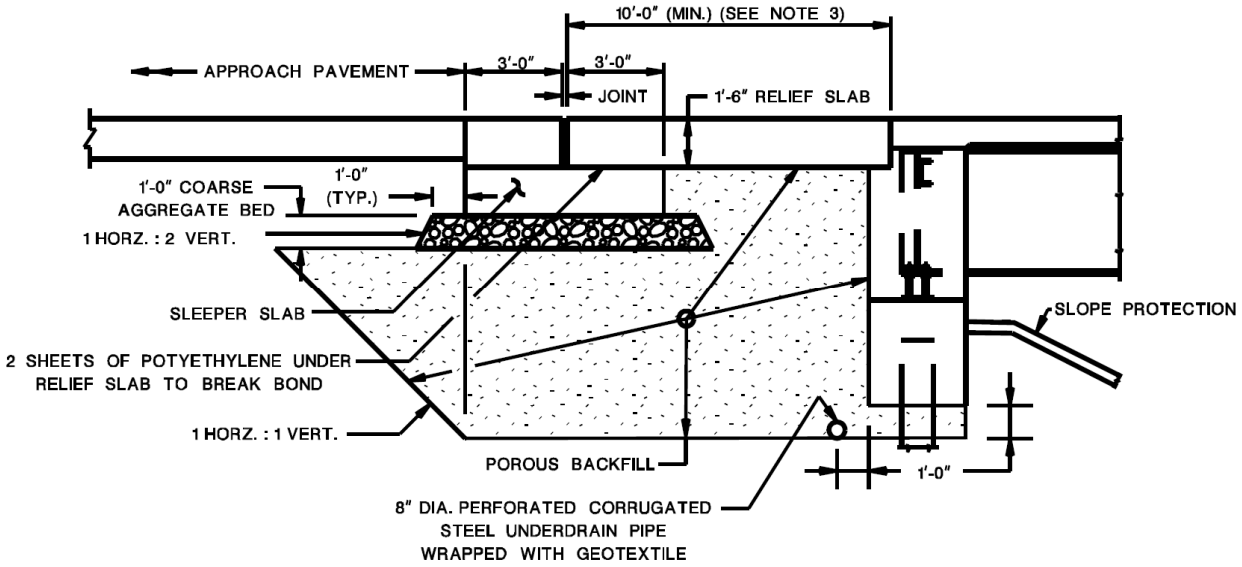
Exhibit 5-17: Galvanized Steel Girders with Painted Overcoat (Except at faying surfaces of the connections) – NJ Route 139

Source: Gannett Fleming Photo - NJ Route 139 Reconstruction.

Adopt Better Design Details

NJDOT regularly updates its design details to extend the service life of bridges and reduce lifecycle costs. Such design details include moving joints away from bridge decks using integral abutments (Exhibit 5-18), eliminating joints by using continuous superstructures, and introducing scour cut off walls.

Exhibit 5-18: Integral Abutment Detail from NJDOT Standard Drawing Plate 2.5-5



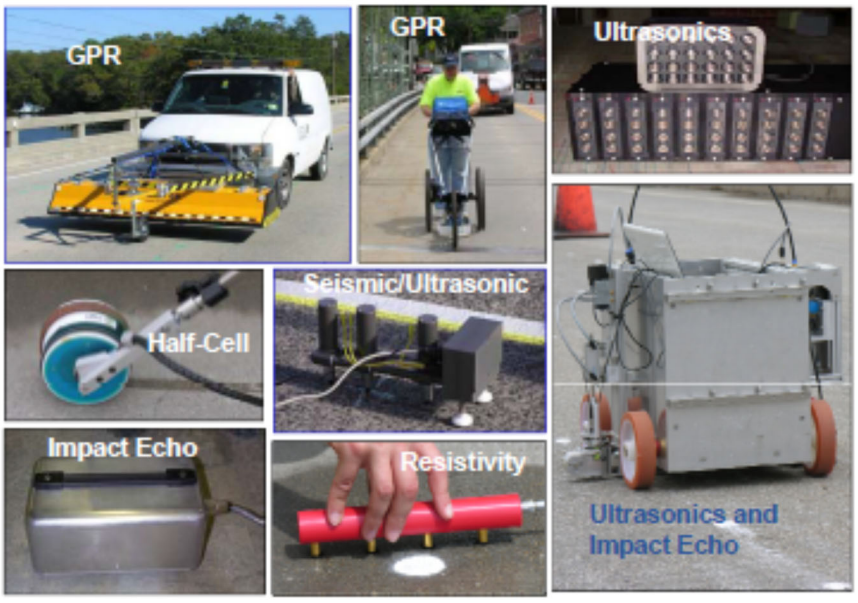
Source: NJDOT Design Manual for Bridges and Structures, 6th Edition, 2016.

Incorporate Innovative Technologies

NJDOT is investing in new technologies to perform inspections more efficiently and thereby identify distresses at earlier stages of deterioration. The efforts result in the implementation of preservation measures improving the service life of bridges before significant deterioration has occurred. These methods include the use of unmanned aerial vehicles (drones) for the inspection of inaccessible areas of bridges and the use LIDAR (Light Detection and Ranging, a scanning survey technique) to map out and measure the clearances around structures and subsurface cracking. Other technologies include advanced non-destructive evaluation (NDE) techniques such as RABIT. the Robotics Assisted Bridge Inspection Tool, which includes Ground Penetrating Radar (GPR), Ultrasonic, Impact Echo, Resistivity, and High Definition Imaging applications to determine the deterioration of bridge elements before they have reached the state of advanced deterioration. Exhibit 5-19 illustrates some non-destructive evaluation tools.

The NJDOT Bridge Resource Program investigates and implements innovative technologies. The Bridge Resource Program utilizes the extensive NJDOT laboratory and field-testing equipment and bridge engineering staff expertise to assist NJDOT. The Division of Bridge Engineering and Infrastructure Management develops: (1) lifecycle planning strategies, (2) innovative materials, (3) improved bridge design tools, (4) advanced laboratory and field data collection, (5) bridge monitoring strategies, (6) bridge inspection, (7) non-destructive evaluation, and (8) innovative technologies/equipment that enhance the conditions of NJDOT bridges by allocating available capital resources to bridges in a targeted and efficient manner.

Exhibit 5-19: State of the Art Bridge Deck Evaluation Tools

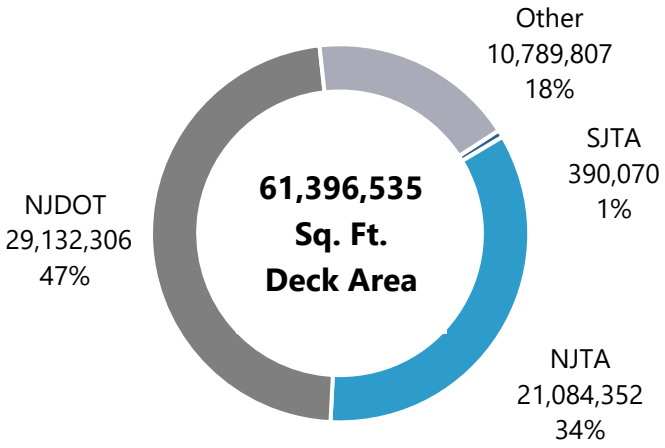


Source: Use of Robotics in Nondestructive Evaluation and Minimally Invasive Rehabilitation of Bridge Decks, Nenad Gucunski, Rutgers University Center for Advanced Infrastructure and Transportation (CAIT).

5.3.4 NJTA and SJTA Bridge Lifecycle Planning

The NJTA and SJTA together own a significant portion of the total NHS bridge deck area in New Jersey. As shown in Exhibit 5-20, the two authorities account for a combined total of nearly 35 percent of NHS bridges by deck area. Both agencies have robust bridge preservation programs with mature lifecycle plans. Both are fully funded from toll revenues and receive no federal aid for bridge projects.

Exhibit 5-20: NJDOT, NJTA, and SJTA Ownership of NHS NBIS Bridge Deck Area in Square Feet



Source: NJDOT Bureau of Structural Evaluation and Bridge Management.
Note: Other includes the Burlington County Bridge Commission, the Delaware River Joint Toll Bridge Commission, Delaware River Port Authority, Delaware River & Bay Authority, the Port Authority of New York and New Jersey, the Palisades Interstate Parkway Commission, NJ Transit, as well as county, municipality, and private owners.

NJTA Bridge Lifecycle Planning

NJTA owns and manages approximately 21,084,352 square feet of NHS NBIS bridge deck area. Presently, the majority of NJTA bridges by deck area are in *Good* condition. NJTA's strategy to maintain the condition of its bridges consists of four components:

1. Condition assessments using bridge inspection data
2. Prioritization of bridge needs based on inspection findings
3. Completion of projects to address bridges in *Poor* condition ("Structurally Deficient")
4. Completion of projects to prevent bridges from reaching *Poor* condition

The NJTA's lifecycle planning strategy for bridges programs repairs in response to bridge inspection findings. NJTA screens bridges based on routine inspection findings and includes any repairs in its annual maintenance program. The NJTA strategy develops capital programs encompassing several years to include structures scheduled to be rehabilitated or replaced. The effectiveness of the current NJTA approach is supported by data predicting that less than 10 percent of its bridges by deck area will be rated as *Poor* by CY 2023 and CY 2029. Considering the success of the current strategy, NJTA is not planning on any significant changes in how it maintains its bridges.

Historically, the annual NJTA maintenance program funding increases by approximately two percent per year. Between FY 2018 and FY 2019 the maintenance program funding was scheduled to increase by almost 15 percent, indicating that the current repair strategy provides a flexible approach. Bridge repairs include projects not only on bridges in *Poor* condition, but also includes repairs on bridges to prevent them from reaching *Poor* condition. A recently announced $500 Million per year capital program includes several bridge projects to address and prevent deterioration. The prior $7 Billion 10-year program included bridge projects on both the New Jersey Turnpike and Garden State Parkway roadways. Further details about NJTA funding and planned bridge repair and capital projects are provided in *Chapter 7: Financial Plan*.

SJTA Bridge Lifecycle Planning

SJTA manages approximately 390,070 square feet of NHS NBIS bridge deck area on the Atlantic City Expressway. Presently, SJTA is transitioning its lifecycle planning practices to a holistic transportation asset management led approach. Currently, the SJTA lifecycle plan for bridges utilizes biennial inspection program data to determine the deterioration rates of bridge elements. Bridges are repaired annually to address the findings from the biennial inspections. The SJTA annual repair budget varies from $0.5 million to $1.5 million. The SJTA also develops a capital program, as needed, to reconstruct and upgrade the condition of bridges. The consultant led effort prepares a five-year outlook into capital planning needs for the SJTA. The effectiveness of the current approach taken by the SJTA is supported by data predicting that none of its bridges by deck area will be rated as *Poor* by CY 2023 and CY 2029. The SJTA anticipates additional improvements in bridge conditions under an asset management approach.

5.3.5 Port Authority of New York and New Jersey Bridge Lifecycle Planning

The Port Authority of New York and New Jersey owns and manages 3,603,241 square feet (6%) of NHS NBIS bridge deck area in New Jersey. The Port Authority's lifecycle planning practices can be broadly divided into three phases of (1) Project Planning, (2) Project Initiation/Definition Scoping, and (3) Project Prioritization.

1. ***Project Planning*** – This first phase begins with the Engineering Department's Quality Assurance Division (QAD) completion of a biennial inspection for a facility, including the inspection report, summary of findings, and potential recommendations. Once completed, these reports are transmitted to the facility manager, Tunnels Bridges and Terminals Department (TB&T); and the Engineering and Architectural Design Division (EADD). The recipients review each of the reports as a team to identify the repairs that address the findings of the inspections.

   Led by TB&T, specific repairs are added to one of two lists: "Immediate & Miscellaneous Repairs Log" or the "Priority Repairs Log." Both lists track repairs from discovery to execution. Before a repair is formally added to one of the two lists, TB&T (along with QAD and EADD) reviews the current lists of repairs to ensure that any existing repair on the lists is not duplicated. This review affords TB&T the opportunity to identify any trends that may be developing among the logged repairs. QAD reviews the lists and potential additions to ensure

that the asset element/component requiring repair has at least two years of remaining service life.

2. ***Project Initiation/Definition Scoping*** – The second phase begins as TB&T and EADD (with support from QAD) group needed repairs by facility to form "projects" addressing the facility's needs either as a "Short-Term Priority Repair Project" or a "Comprehensive Long-Term Replacement/Rehabilitation Project." If there are few repairs for a given facility that are unrelated to each other, are not critical, or that can be completed in the short-term, the repairs will not be grouped into projects. The repairs simply remain in their respective repair lists. In the case of non-project repairs, the Capital Planning Office manages how and when the repairs are addressed. The repairs may be included in the Operating Major Works Program (OMWP), or accomplished through work requests with existing contractors, new work orders, or new RFPs. For repairs that are grouped into projects, TB&T and EADD develop a scope of work and magnitude of cost estimate for each of the proposed projects.

3. ***Project Prioritization*** – The third phase begins as a Project Initiation Request Form (PIRF) is developed for each project. A "State of Good Repair Scorecard" is completed by the project manager and lead engineer for the facility. The scorecard considers not only the physical condition of a facility but also considers the operational impact associated with its failure. Meetings are held with staff to review the various scores on the scorecard and to achieve consensus on the final score. Projects are ranked based on overall scores into categories based on pre-defined thresholds. Projects receiving an overall score equal to or higher than an established threshold are grouped with other projects of the same priority for potential funding as part of the Port Authority's Capital Plan or OMWP.

   If a facility has an overall rating of *Fair* or lower, the project may require the completion of a PIRF and "State of Good Repair Scorecard." If this trigger is met, EADD will complete a full lifecycle analysis for the facility ("Comprehensive Condition Assessment") outlining recommendations for the facility. As the Capital Planning Office develops the Port Authority's Capital Plan and OMWP, "High Priority" projects, any "Comprehensive Condition Assessments," and lower priority projects are subject to review.

5.3.6 Other Jurisdictions Bridge Lifecycle Planning

Twelve (12) percent (7,186,565 sq. ft.) of NHS NBIS bridge deck area in New Jersey is owned and maintained by a variety of other municipal, county, and authority owners. These bridges are managed with a condition-based strategy; repairs to the structures are based on the findings of biennial inspections. Presently, non-authority and non-commission bridge owners Preventive Maintenance Programs, or equivalent, are unknown to NJDOT.

Based on outreach results, the average level of annual expenditures on NHS bridges is expected to increase relative to recent expenditure levels, suggesting that owners are taking positive steps to maintain the condition of their NHS bridges, as detailed in *Chapter 7: Financial Plan*. NJDOT continues refining its data collection process (described in *Chapter 3: TAMP Governance, Policies, and Objectives*) resulting in improvements in the TAMP's consideration of NHS bridges.

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6. Risk Management

Background

Risk management involves addressing vulnerability, uncertainty, opportunities, and threats to the achievement of objectives. The risk management process outlined in the New Jersey Transportation Asset Management Plan (TAMP) is intended to provide the mechanism for the New Jersey Department of Transportation (NJDOT) to manage the effects of uncertainty on the TAMP Policy and State of Good Repair Objectives. It identifies critical risks to the accomplishment of these objectives and establishes an ongoing process to evaluate and address those risks to enhance the success of New Jersey's asset management program.

Image of I-287 after washout

Image of I-287 after repair

6.1 Overview

Risk management is not a new concept to NJDOT. NJDOT's project delivery process has incorporated risk management practices as integral features in its overall planning processes. The TAMP risk management process builds on the following guidelines to address risk as part of the ongoing TAMP process and implementation:

- NJDOT's *Risk Management Guidelines* (2017), provides NJDOT project managers with standardized procedural guidance on project-level risk assessment and management.
- ISO31000:2009, *Risk Management – Principles and Guidelines,* provides NJDOT management with standards of practice for Enterprise Risk Management that are applied to incorporate risk into the TAMP process.

The TAMP risk management process identifies and categorizes risks, evaluates risks, and provides a framework for addressing these risks within the context of the TAMP Policy and State of Good Repair Objectives. The evaluation identifies risks to achieving the State of Good Repair Objectives established

for the National Highway System (NHS) and State Highway System (SHS). The process results in a risk register, a tool used to monitor and manage high impact risks to the TAMP objectives.

6.2 Risk Management Framework and Process

6.2.1 Role of and Responsibilities for Risk Management

Role of Risk Management

Risk is the "effect of uncertainty on objectives[1]." The management of risk as a business practice prepares NJDOT for managing internal and external uncertainties regarding future events and conditions. The role of risk management is to develop a systematic approach to anticipating adverse and unexpected situations and responding effectively to these situations in the event they arise. The risk management process allows management to understand the risk and define actions that avoid, reduce, address, or accept the risk.

Risk management serves a critical role in the ability to fulfill the TAMP Policy and State of Good Repair Objectives. While there are multiple ways to use risk management information in asset management plans and processes, the role of risk management in the TAMP is outlined in the five steps below.

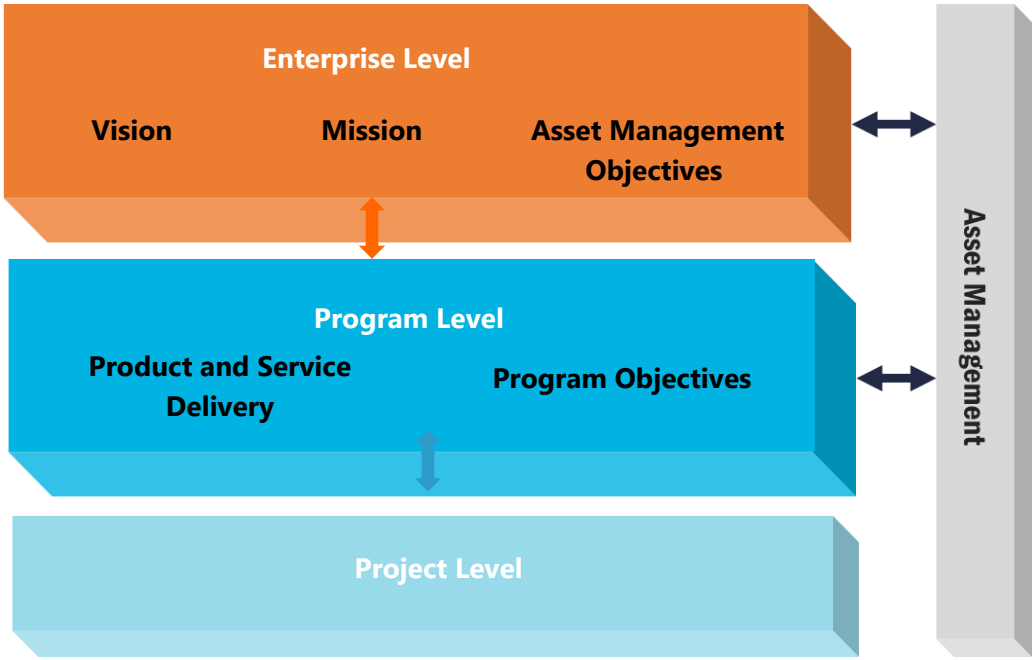
1. ***Provide Information*** – The identification of risks informs key players (Transportation Asset Management Steering Committee, Directors Group, Transportation Asset Management Plan Team (TAMP Team), and other stakeholders) that these risks could potentially obstruct the implementation and accomplishment of the TAMP as planned.
2. ***Reduce Risks to Performance*** – Through the use of risk information, NJDOT identifies and addresses internal and external risks to the likelihood of implementing the TAMP or achieving TAMP objectives.
3. ***Set Priorities for TAMP Enhancements*** – By utilizing the risk management process, NJDOT identifies specific staff needs to improve system-wide performance. Such needs may include increasing data-collection efforts, and providing training to improve modeling and forecasts for planning purposes.
4. ***Prioritize Capital Investments*** – NJDOT determines which at-risk transportation assets or networks merit increased investment or monitoring, as well as which high-value, high-risk assets merit closer administration.
5. ***Improve Resilience*** – Extreme weather events and their effects on the transportation system are risks considered in the TAMP risk management process. By utilizing the risk management process, NJDOT identifies mitigation strategies that can "harden" the system in the face of climate stressors, which makes the system more resilient.

[1] ISO 31000 definition.

Responsibilities for Risk Management

The TAMP process manages risk at the enterprise level and program level as shown in Exhibit 6-1.

Exhibit 6-1: NJDOT Manages Risk through an Enterprise Risk Management Approach in the TAMP



Enterprise-Level Responsibilities

Enterprise-level risk affects the ability of NJDOT to accomplish its overall mission and achieve its strategic goals and objectives. Enterprise-level risk is considered the highest level of risk within an organization and includes the management of overall policy objectives and investment priorities for asset management. The Transportation Asset Management Steering Committee manages risks that require policy-maker action and enterprise-level action. The Transportation Asset Management Steering Committee meets annually to review TAMP risks and monitor the status of the TAMP's implementation and risk management actions (see Section 6.4).

Program-Level Responsibilities

Program-level risks threaten the accomplishment of objectives for programs that manage a specific asset class (i.e., pavement, bridges, others). Accountability for the execution of risk management activities at the program-level is overseen by the TAMP Team. The TAMP Team is comprised of program managers and technical leaders with program management responsibilities for the accomplishment of the TAMP State of Good Repair Objectives. Risks are subsequently monitored and reviewed annually in a dedicated TAMP Team risk management workshop. The workshop is facilitated by reference to the TAMP risk register and the agenda is to monitor and refine risk mitigation and response actions or strategies (see Section 6.4).

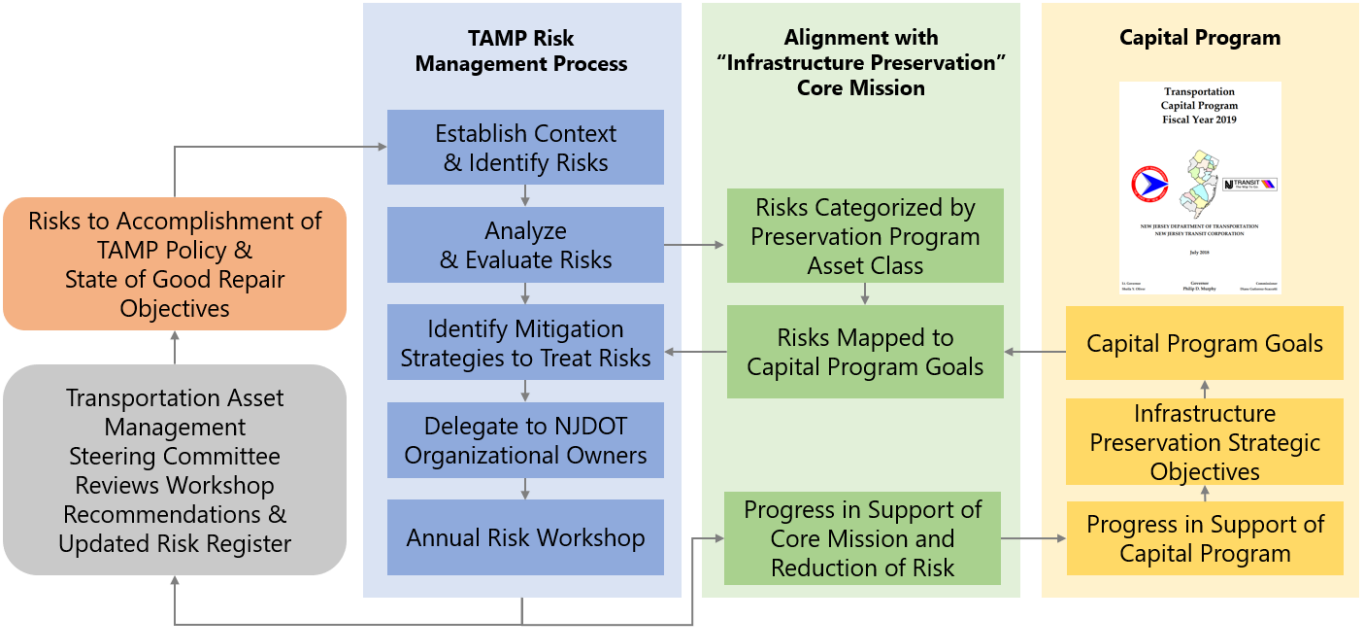
6.2.2 TAMP Risk Management Process

The TAMP risk management process identifies and addresses risks that may impact NJDOT's ability to fulfil its overall mission. The TAMP risk management process is consistent with industry best practices as outlined in the framework for managing risk (based on ISO 31000), AASHTO's Guide for Enterprise Risk Management, and FHWA's Risk-Based Transportation Asset Management Reports.

6.2.3 Risk Management and NJDOT's Broader Planning Process

The risk management process is closely tied to other TAMP processes, including lifecycle planning and financial planning, which influence the development of the investment strategies. The risks to the accomplishment of the TAMP Policy and State of Good Repair Objectives also influence other NJDOT planning processes, such as New Jersey's Transportation Capital Program development process. The relationship between the TAMP risk management process and NJDOT's broader planning processes is shown in Exhibit 6-2. The risk management mitigation strategies identified are to be followed through to avoid negative impacts upon other NJDOT processes.

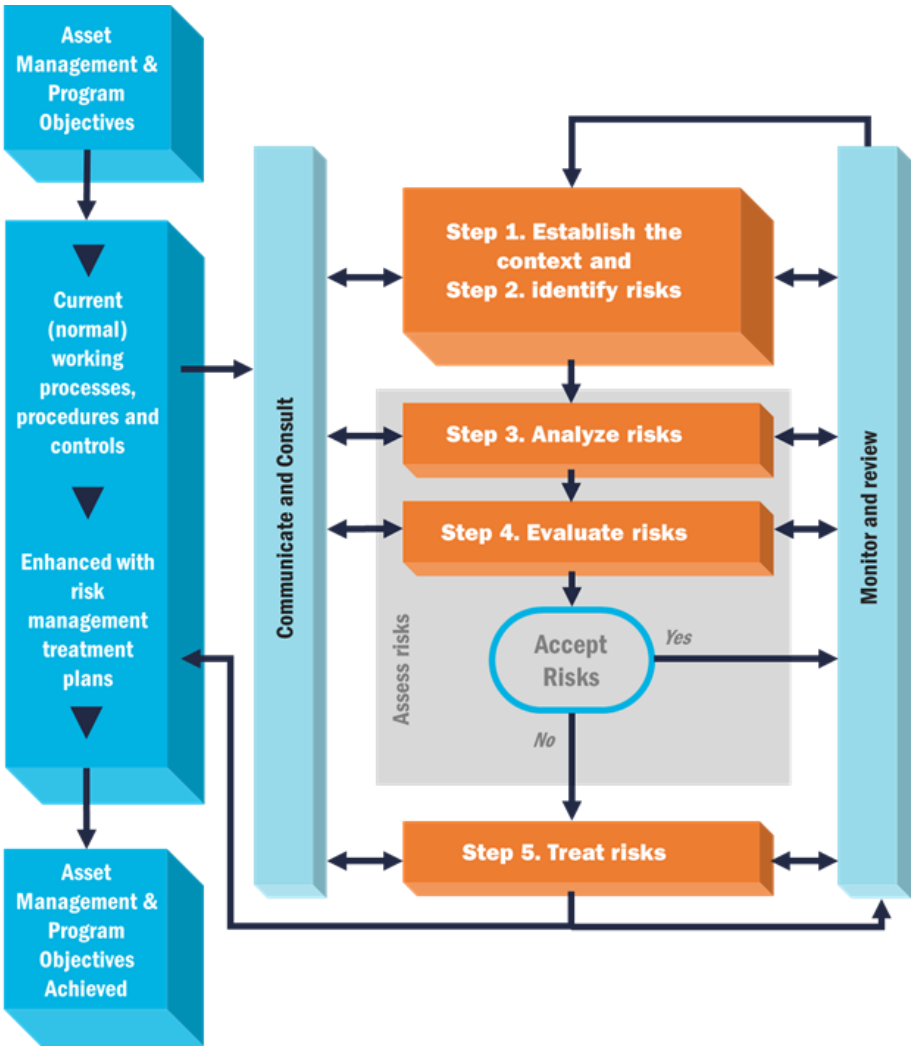
Exhibit 6-2: TAMP Risk Management Relationship to NJDOT's Planning Processes



6.2.4 Risk Management Process Steps

NJDOT's process to manage risks is shown in Exhibit 6-3 below. The exhibit depicts how asset management is an enterprise-wide activity and is central to NJDOT's overall mission. Program areas including bridge, pavement, and others are each responsible for the work activities and products required to accomplish the objectives set by the agency.

Exhibit 6-3: NJDOT ISO-Based Risk Management Framework



NJDOT's risk management process applies to the development of the TAMP and provides the foundation for the practice of risk management in future TAMP updates. The application of this process follows the steps outlined in the following sections.

Step 1. Establish the Context, and Step 2. Identify Risks

The first step establishes the context by identifying the circumstances that form the setting for asset management at NJDOT. Context includes the social, cultural, legal, regulatory, economic, and natural environments to which NJDOT must be sensitive.

For the TAMP, the context and the risks are closely related. For example, NJDOT must comply with the regulatory requirement for the TAMP to address the full NHS; however, because much of the NHS is owned by other jurisdictions within New Jersey, there are risks associated with data accuracy.

To adequately manage risks, NJDOT must first define the internal and external environments that comprise the context for asset management. NJDOT's internal environment is shaped by its internal

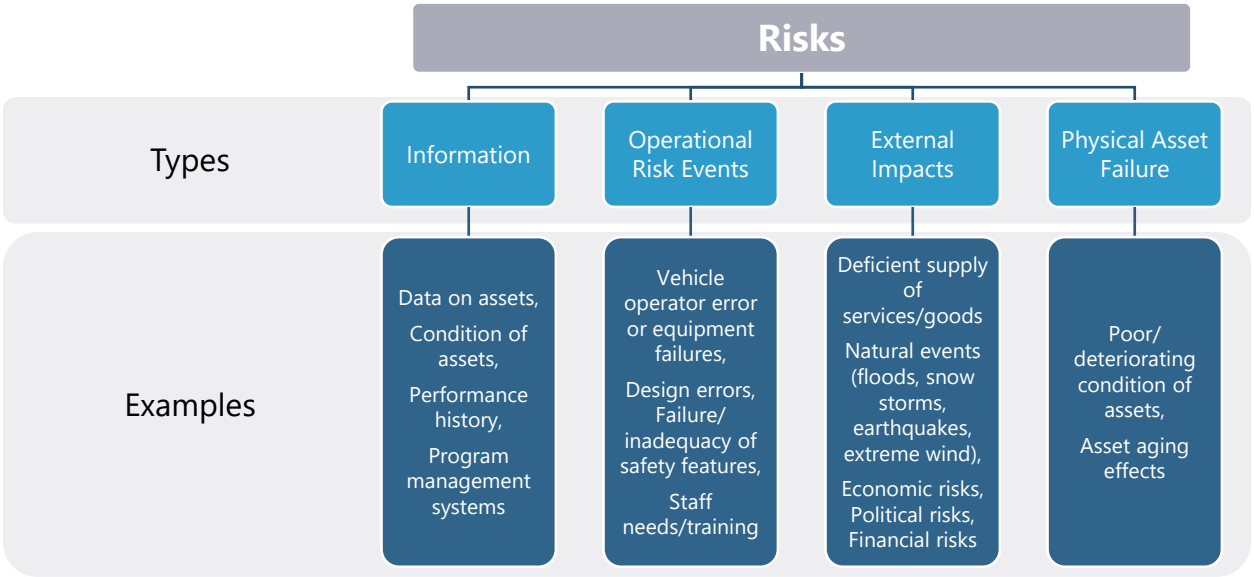
stakeholders, governance structure, capabilities, and overall objectives. The external environment is shaped by local, state, and federal policy environments, jurisdictional roles, and priorities. Once the full context is established, risk identification can take place. The risks that may affect the achievement of the TAMP Policy and State of Good Repair Objectives are identified, defined, and categorized according to their potential impact upon NJDOT and its different programs.

The TAMP risk management process combines these two steps in a collaborative effort consisting of the brainstorming of risks, identification of the associated impacts, and development of detailed risk statements to be analyzed and addressed. This collaborative effort takes place as part of the TAMP process during the TAMP Team risk management workshop. The key participants include TAMP Team members and representatives from key functional areas and NJDOT business units.

Types of Risk

The TAMP process groups risk by type. Risk types were identified through the first TAMP Team risk management workshop held in 2017 and are described below and shown in Exhibit 6-4. The risk types shown in this exhibit are now the foundation for the TAMP risk management process, with any additions being new or emergent. Each of the asset classes and systems that comprise the overall transportation network is susceptible to the sources and types of risks depicted in Exhibit 6-4. Additionally, the ownership of New Jersey's NHS roadway assets is distributed across many jurisdictions (a total of 83 non-NJDOT NHS owners), further complicating the risk management process. A detailed description of each of the risk types follows Exhibit 6-4.

Exhibit 6-4: NJDOT Identified Risks – Types and Examples



Information

Information plays a key role in effectively establishing, managing, and accomplishing TAMP objectives. Analyses, objectives, strategies, and decision guidance are all dependent on the quality of the data used to compute these items, which directly impacts the accuracy of the analytical processes used to prepare the TAMP.

Operational (Internal) Risk Events

Operational risks are internal to NJDOT and pose threats to the TAMP process in a variety of ways. Changes in staff, changes in program priorities, such as a reduction in funding for maintenance, a reduction in funding for design, or operational errors that result in project failures or changes to project schedule, all have the potential to negatively impact the implementation of the TAMP process and its recommended investment strategies.

External Impacts

External impacts (including those upon third parties that support NJDOT's operations) are risks beyond the control of NJDOT and include political, financial, environmental, fraud or malfeasance (security issues, terrorism, vandalism) and other risks. External risks have the potential to affect the accomplishment of the TAMP objectives. New Jersey has experienced several extreme weather events in recent years, spawning research efforts to better understand the specific risks posed by extreme weather events. Specifically, NJDOT's Asset Management, Extreme Weather and Proxy Indicators pilot study initiated a process that assesses the impacts of extreme or repeat weather events upon the conditions of New Jersey's highway assets. While most external risks cannot be controlled, NJDOT can prepare for and mitigate against the negative effects in advance.

Physical Asset Failure

The risk of physical asset failure is directly related to the TAMP's performance management efforts. The prevalence of assets in *Poor* condition along with continued deterioration increases the likelihood of asset failure resulting in disruptions to, and negatively impacting, the broader transportation system. A major goal of asset management is the development of analytical tools that predict how assets will perform over time. The lack of analytical tools or a lack of knowledge of their limitations can in turn become risks contributing to physical asset failure.

Step 3. Analyze Risks, and Step 4. Evaluate Risks

The identified risks are analyzed and evaluated as part of a facilitated discussion during a TAMP Team risk management workshop to determine their individual likelihoods and impacts upon the achievement of the TAMP objectives. Participants reach a consensus during the workshop on the likelihood and impact rating values assigned to each of the risks.

First, risks are evaluated according to their *impact* on the achievement of the TAMP objectives (ranging from 1 to 10, where 1 is low and 10 is high). Risks are then evaluated by their *likelihood* of occurrence (ranging from 1 to 5, where 1 is low and 5 is high). The *impact* rating is multiplied by the *likelihood* rating to compute an overall Risk Rating value, which represents the relative magnitude of the risk. Risk Rating values can range from as low as 1 to as high as 50 (for example, if the *impact* rating of Very High [rating of 10] is multiplied by a *likelihood* rating of Very High [rating of 5], this will result in the highest Risk Rating value of 50).

These resulting Risk Rating values are then used to rank the risks according to their relative ability to impede the fulfillment of the TAMP Policy and State of Good Repair Objectives. The risk evaluation is

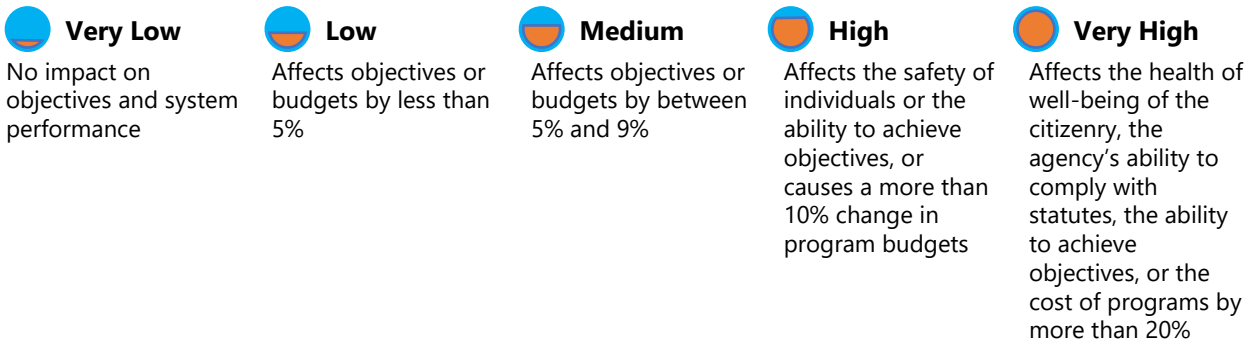
facilitated by the TAMP risk register tool, in the form of a spreadsheet, which has been calibrated to apply the TAMP process risk rating approach.

Risk Rating Approach

The TAMP risk rating process is consistent with the approach used at the project level at NJDOT. Risk is evaluated along the following dimensions:

Impact – Impact (or consequence) refers to the extent to which a risk event might affect NJDOT or the TAMP. Impacts are defined for each risk.

Exhibit 6-5: Impact Rating Approach

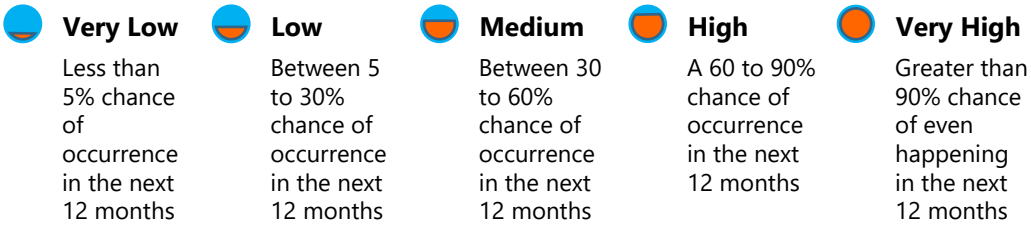


Likelihood – Risks are assigned a descriptor that represents the possibility that a given risk event will occur.

Exhibit 6-6: Likelihood Rating Definitions

Likelihood Rating	Definition	Probability
Very High – Almost Certain = 5	This event occurs frequently at NJDOT. Current controls or circumstances suggest a likely occurrence.	There is a greater than 90% chance of the event happening in the next 12 months. It is likely to occur at least once over the next 12 months.
High – Likely = 4	This event may occur at NJDOT on a regular basis. Current controls or circumstances suggest there is a distinct probability of occurrence.	There is between a 60 to 90% chance of the event happening in the next 12 months. It is likely to occur once in 1 to 4 years.
Medium – Possible = 3	This event may occur occasionally at NJDOT. Current controls or circumstances suggest there is a possibility of occurrence.	There is between a 30 to 60% chance of the event happening in the next 12 months. It is likely to occur once in 5 to 7 years.
Low – Unlikely = 2	This event may occur infrequently at NJDOT. Current controls and circumstances suggest the occurrence would be considered highly unusual.	There is between a 5 to 30% chance of the event happening in the next 12 months. It is likely to occur once in 8 to 20 years.
Very Low – Rare = 1	This event may have happened previously at NJDOT. However, in the absence of other information or exceptional circumstances, NJDOT would not expect it to happen in the foreseeable future.	There is less than a 5% chance of the event happening in the next 12 months. It is likely to occur less than once in 15 years.

Exhibit 6-7: Likelihood Rating Approach



Risk Rating – The risk rating is the result of the risk evaluation and is the mathematical product of a risk's likelihood rating and its impact rating. Risk Rating values range from 1 to 50, and are categorized as follows:

- **Critical** – Requires elevating decision-making to the Transportation Asset Management Steering Committee; requires prompt action to implement new enterprise-level controls. Values in this category, shown in red in Exhibit 6-8, range from 31 to 50.
- **High** – Affects the ability of the agency to carry out its mission or strategic plan. Existing controls may be effective; however, additional action and/or controls may be required. Values in this category, shown in orange in Exhibit 6-8, range from 16 to 30.
- **Medium** – Impacts completion of a critical agency function. Existing controls must be effective; however, additional actions may need to be implemented. Values in this category, shown in yellow in Exhibit 6-8, range from 6 to 15.
- **Low** – Managed with current practices and procedures. Impacts are addressed with routine operations monitored for effectiveness. Values in this category, shown in green in Exhibit 6-8, range from 1 to 5.

Risk Rating Matrix

The range of Risk Ratings is displayed as a heat map, ordered by their relative criticality, in Exhibit 6-8. The risk evaluation process uses a four-level rating system to characterize a risk's relative criticality: low, medium, high, and critical. For example, a risk rated with a "Moderate" degree of impact and "Possible" likelihood, would result in an overall criticality of "Medium."

Exhibit 6-8: Risk Rating Heat Map

Likelihood	Almost Certain = 5	Low = 5	Medium = 10	High = 20	Critical = 35	Critical = 50
	Likely = 4	Low = 4	Medium = 8	High = 16	High = 28	Critical = 40
	Possible = 3	Low = 3	Medium = 6	Medium = 12	High = 21	High = 30
	Unlikely = 2	Low = 2	Low = 4	Medium = 8	Medium = 14	High = 20
	Rare = 1	Low = 1	Low = 2	Low = 4	Low = 7	Medium = 10
Risk Heat Map		Insignificant = 1	Minor = 2	Moderate = 4	Major = 7	Severe = 10
		Impact				

Step 5. Treat Risks

The treatment of risks consists of developing response strategies and actions for addressing each risk using the risk register; those with the highest Risk Ratings are addressed first.

The risk register records the response to each risk and specifies the organizational ownership for the response. The selected risk management responses are accompanied by related implementation actions identified by the TAMP Team. Many risk responses can be expected to impact and alter current working processes at NJDOT. Responses for critical risks may initiate more significant shifts in business processes to ensure the achievement of the TAMP objectives. The range of risk responses that appear in the risk register are shown in Exhibit 6-9.

Exhibit 6-9: Risk Responses

Risk Type	Response	Explanation
Adverse Risks	**Avoid**	Terminating the risk by stopping a practice or eliminating the source of the risk.
	Transfer Threat	Shift the impact of a risk to a third party together with ownership of the response.
	Mitigate Threat	If treatment is possible and its benefits outweigh its costs, NJDOT could decide to act on and mitigate the risk.
	Accept Threat	Accepting the risk and providing regular monitoring or treatment of the risk.
Beneficial Risks	**Exploit Opportunity**	Aggressive response strategy to ensure opportunity is realized.
	Share Opportunity	Allocate risk ownership of an opportunity to another party to maximize its likelihood/impact, maximizing benefits.
	Enhance Opportunity	Aim to modify the "size" of the positive risk and increase risk likelihood/impact, maximizing benefits.
	Accept Opportunity	Accepting the risk and providing regular monitoring or treatment of the risk.

Monitor and Review

Risk responses are actionable items managed through the TAMP risk management process. As depicted in Exhibit 6-9, several risk response explanations involve modifying existing business processes so that a risk may be reduced or eliminated. Ideally, a risk can be retired from the risk register when the required response is implemented. However, it is expected that many responses, once implemented, will still require monitoring and review on a periodic basis.

The majority of the risks (e.g., those that are not retired from the risk register) are managed on an ongoing basis through the periodic review and update of the risk register. The TAMP Project Manager in the Division of Statewide Planning is presently responsible for reviewing the risk register on an annual basis with all the identified organizational owners to ensure that there has been progress in the

implementation of a risk response. Continuous communication between NJDOT divisions is critical during this ongoing process. This review is to be submitted to the Transportation Asset Management Steering Committee and Directors Group to report on the status of all risk responses.

As part of the risk register annual update, the TAMP Project Manager and the TAMP Team conduct the risk management process of review of information and updates after discussions with each of the organizational owners. Revisiting the risk identification, risk analysis, evaluation, and determination of risk responses (e.g., treating risks) allows the risk manager[2] to objectively update information within the risk register. Post-treatment Risk Ratings are incorporated into the risk register based on updates to the likelihood and impact ratings that result from implemented risk responses. Risks that have been addressed and are no longer considered "adverse" risks are taken off the risk register. An annual validation of the risk register by the Transportation Asset Management Steering Committee and Directors Group are part of the ongoing process to address risks elevated from the annual TAMP Team risk management meeting.

Risk Register

The full risk register is shown in Appendix E. The table breaks the risk management process into three broad workflows: (1) risk identification, (2) risk analysis, and (3) risk management. The achievement of the TAMP Policy and State of Good Repair Objectives is predicated upon the implementation of the risk management process culminating in the risk register tool being utilized as part of ongoing NJDOT business practices.

6.3 Ongoing TAMP Risk Management Process

The risk register is the managed report used to support risk management in the TAMP process. For the TAMP's ongoing risk management process, effective risk management has two elements:

1. Management accountability for the risk responses.
2. Regular monitoring of risks, including addressing new and emergent risks, and the annual assessment and review of TAMP risks.

Management accountability for risk management is embedded into the governance of the TAMP. *Chapter 3: TAMP Governance, Policy, and Objectives* describes the risk-related responsibilities for the following groups:

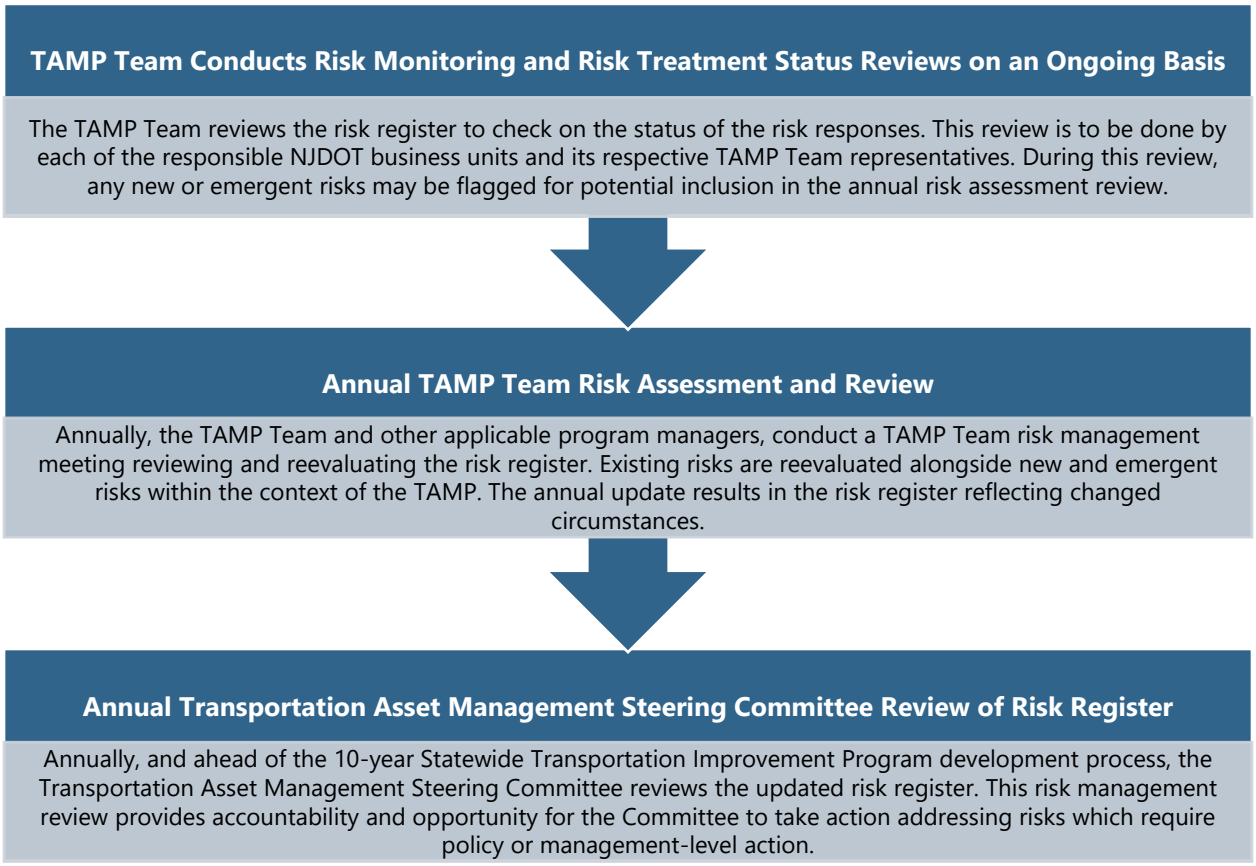
- ***Transportation Asset Management Steering Committee*** – The senior management team accountable for setting overall policy direction for the performance of New Jersey's transportation system.
- ***Transportation Asset Management Directors Group*** – The management team responsible for the different elements and implementation of the TAMP process.

[2] Risk manager varies depending on the risk level (enterprise, program, project levels) and the identified responsible division(s). The risk management process is overseen by NJDOT Statewide Strategies Division, which manages the development of the TAMP.

- ***TAMP Team*** – The management team responsible for managing the program that accomplishes the TAMP Policy and State of Good Repair Objectives.

The process through which these two groups use the risk register is outlined in Exhibit 6-10.

Exhibit 6-10: Ongoing TAMP Risk Management Process



6.3.1 Managing High and Critical Risks Going Forward

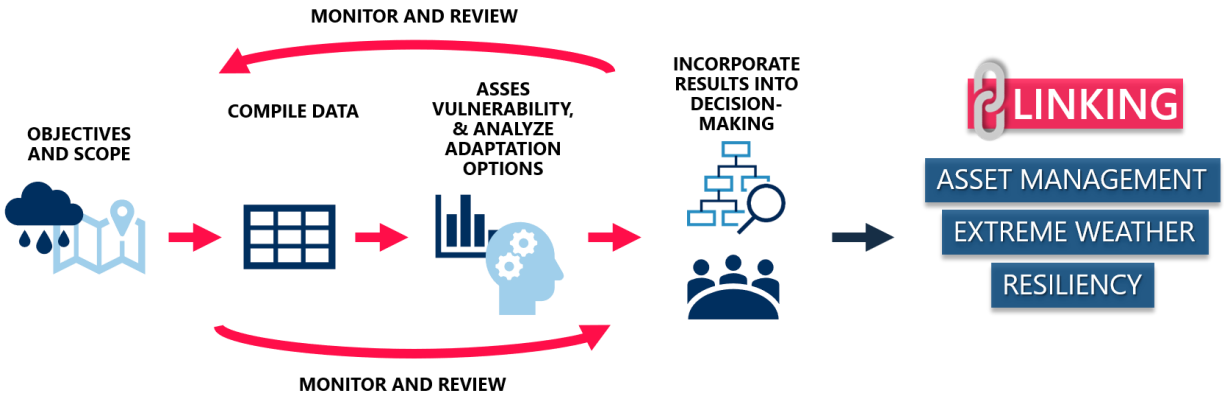
The use of the risk register is one part of the overall risk mitigation strategy established within the TAMP risk management process. The TAMP process allows for further training, executive-level support and commitment, collaborative TAMP Team risk management meetings, and encouraging employee participation during implementation of the TAMP process.

TAMP Team risk management meetings, one of the tools utilized in the risk management process, empower participants to collaborate and identify mitigation strategies for risks that may exist beyond NJDOT's traditional project-level risk assessment framework. The first TAMP Team risk management workshop was held in October 2017. Examples of highly-rated risks and associated management strategies identified through the workshop include the following:

- ***Risk – Extreme Weather Events*** – The impacts of extreme weather events on NJDOT's highway infrastructure, as experienced in recent years such as Hurricanes Sandy and Irene, are projected to increase. Additionally, the frequency and severity of rain events, excessive

temperatures and other stressors associated with climate change will continue to present challenges to maintaining a State of Good Repair for transportation assets. More importantly, factors related to extreme weather must be considered when conducting lifecycle planning efforts in asset management and in decision making to ensure adequate investments are made in the appropriate categories to achieve the desired objectives. Exhibit 6-11 shows the framework, recommended by FHWA, to guide efforts.

Exhibit 6-11: Framework – Linking Asset Management, Extreme Weather, and Resiliency



Consistent with this approach, the objective and scope to link extreme weather and asset management begins with the compilation of data, assessing vulnerabilities and analyzing adaptation strategies. NJDOT has committed to the full development of an ArcGIS vulnerability assessment tool to achieve this task, which consists of a Resiliency Management System[3] that will intersect various data layers such as flood hazard zones, topography, land use, and other environmental and socioeconomic factors that can identify vulnerable areas subject to extreme weather events. Transportation assets can then be added to perform GIS intersection analysis for the development of a resiliency rating score. This score can account for criticality of the asset, the likelihood of service disruption and can be considered in prioritizing further analysis of specific assets in vulnerable areas to understand the root cause(s), clarify the need for and extent of appropriate mitigation measures to reduce risk.

Finally, as improved or enhanced communications is often a key to success, NJDOT has also committed to establishing a Resiliency Working Group wherein asset owners will collaborate with their peers to first assess how extreme weather and climate change is currently addressed, identify gaps, and make specific recommendations to address shortfalls. This Resiliency Working Group will also be a forum for assessing the use of the Resiliency Management System and further refine it to meet the needs to manage risks associated with extreme weather. This effort is scheduled to begin in June 2019 with the establishment of a Resiliency Senior Advisory Group that will consist of directors and managers of various units in NJDOT to guide and react to efforts of the Resiliency Working Group. Through this enhanced communication effort, asset owners and others will be able to collaborate on cross-cutting

[3] The System is an outcome of NJDOT's Asset Management, Extreme Weather and Proxy Indicators pilot study.

issues related to extreme weather risks and establish sound business practices to address risks associated with climate change not only in asset management, but in day to day functions of NJDOT.

Although these approaches to linking asset management and extreme weather are focused on NJDOT, non-NJDOT NHS owners can benefit from the use of the Resiliency Management System in identifying vulnerable areas and can adopt similar approaches in addressing extreme weather risks in their respective organizations. Furthermore, the Resiliency Management System will inform the process for identifying assets repeatedly requiring repair and reconstruction due to emergency events, 23 CFR 667, outlined Section 6.4.

- ***Risk – Pavement Materials Specification*** – The continued reduction in the quality of asphalt binder material directly affects the timing of treatments as part of pavement lifecycle planning and results in the premature deterioration of the roadway network. NJDOT has decided to mitigate this risk and address the continued deterioration by developing performance related materials specifications on a number of high-performance treatments where the binder quality is most essential. This action has been initiated by NJDOT's materials group who have implemented a number of performance related specifications on NJDOT's most expensive mixes where the risk is the greatest to insure the investment results in the anticipated performance and value.

- ***Risk – Bridge Management System (BMS)*** – The BMS, described in *Chapter 5: Lifecycle Planning*, determines the National Bridge Inspection Standards (NBIS) bridge asset management investment priorities and project selection. There is a risk that the data quality, software tool configuration, or user application of the BMS can result in suboptimal project selection. The mitigation of this risk requires NJDOT to continue to work with research partners towards the implementation of AASHTOWare's Bridge Management software (BrM) in order to efficiently and accurately apply its models on the NJDOT network.

- ***Consideration of risk in NJDOT's Bridge Management System (BMS) –*** The NJDOT Bureau of Structural Evaluation and Bridge Management (SEBM) currently incorporates risk primarily by relying on bridge inspection reports. For instance, inspectors identify work needs and provide rough estimates of repair costs as part of bridge inspection reports. Any bridge with a component rated "4" or lower will result in a work recommendation. Historically, the Bureau of SEBM has analyzed and prioritized these work recommendation reports using the following criteria:

    - Scour critical bridge
    - Fracture critical bridge
    - Moveable bridge
    - Annual Average Daily Traffic (AADT)
    - An Emergency Management System (EMS) rating of 1-5
    - Sufficiency rating
    - Bridge carries an interstate highway
    - Two of the components are rated 4 or lower

The NBIS bridge projects that are programmed in the FY 2018-2027 Statewide Transportation Improvement Program (2018 STIP) were selected using these prioritization criteria. Going forward, the Bureau of SEBM is working towards a greater reliance on BrM for developing its overall bridge management program and for bridge project selection and development processes, and less on subject matter expert judgment, as noted in *Chapter 5: Lifecycle Planning*.

Risk is one of four criteria that BrM can apply in developing a recommended program of preservation, rehabilitation, and reconstruction projects. The other criteria are condition, mobility, and lifecycle cost. The data that go into computing a risk score, how that score is computed, and the relative weight of the risk criterion in project selection, are all configured by the user (SEBM). The current configuration of how BrM incorporates risk at NJDOT is depicted in Appendix D, Exhibit D-6.

6.4 Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events (Part 667)

As part of a separate FHWA rule (23 CFR 667 or "Part 667"), state departments of transportation evaluated facilities on the NHS that repeatedly require repair and reconstruction due to emergency events. The rule states that state departments of transportation "shall conduct statewide evaluations to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events since 1997."

The evaluation was the first of its kind and the TAMP process allows for the improvement of this evaluation process in future TAMPs.

6.4.1 Emergency Declarations in New Jersey

As part of its Part 667 evaluation, NJDOT conducted an analysis of the following:

- 8 Federal Emergency Declarations
- 22 Major Disaster Declarations
- 45 State of Emergency Declarations

The majority of damages and repairs to NHS infrastructure in New Jersey identified during this analysis and data collection phase have been attributed to six events including:

- Hurricane Floyd (September 1999)
- Tropical Depression Ivan (September 2004)
- Nor'easter (April 2007)
- Hurricane Irene (August 2011)
- Tropical Storm Lee (September 2011)
- Hurricane Sandy (October 2012)

The following section describes the process followed by NJDOT to obtain and evaluate data pertaining to the evaluation.

6.4.2 Part 667 Evaluation Process

Process to Identify Locations Subject to Part 667

To meet the mandated reporting deadline, NJDOT created a Part 667 Advisory Group consisting of Bridge and Pavement Asset Managers, along with NJDOT staff from the IT, Operations, Budget, and Local Aid offices, under the supervision of NJDOT Division of Statewide Planning, engaged in a multi-step process to identify "repeatedly repaired and reconstructed" assets affect by emergency events. The effort included:

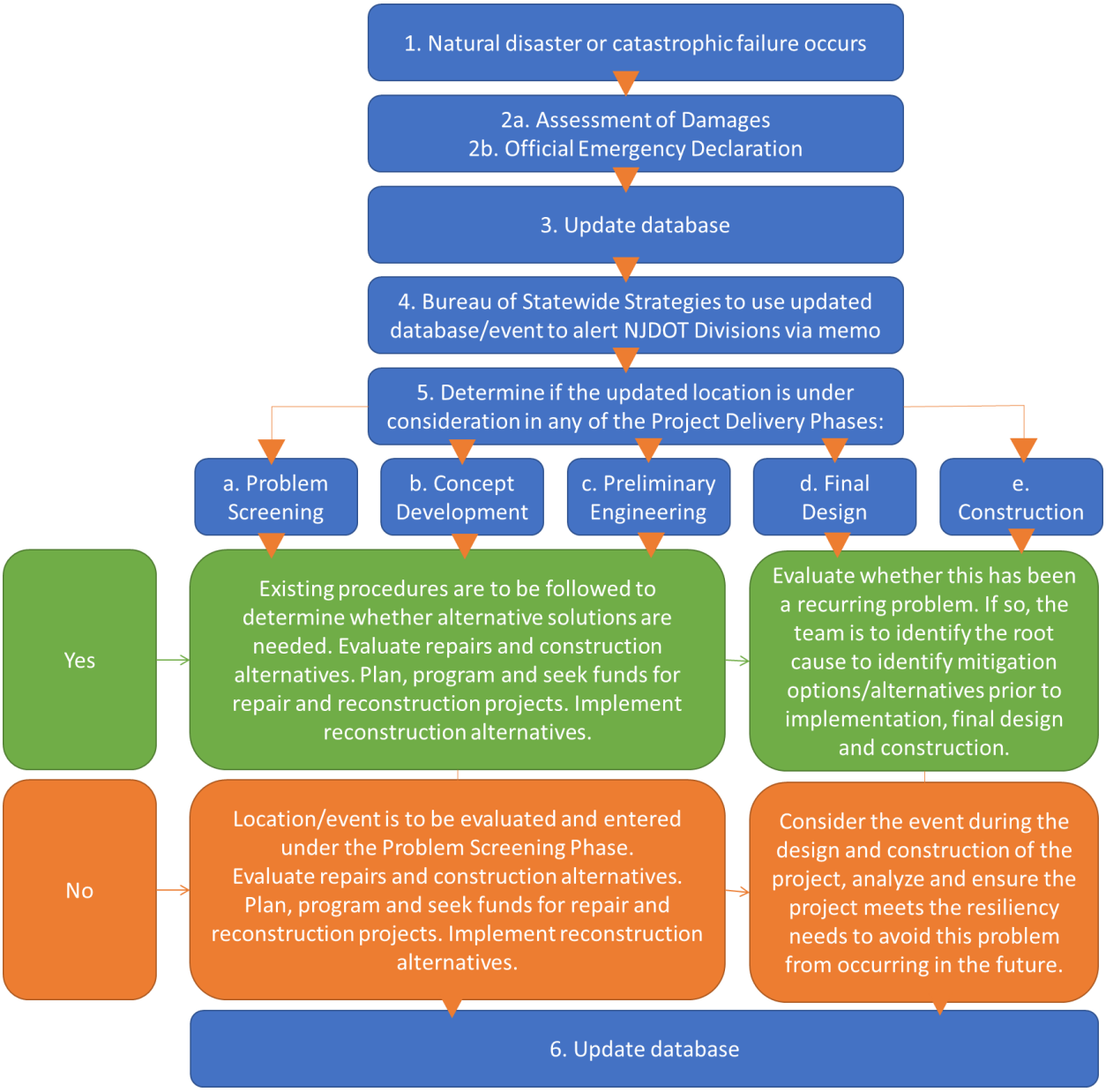
- Review of requirements for Part 667.
- Creation of a Federal Emergency Management Agency (FEMA) list of 75 emergency declarations in New Jersey since 1997 and organizing these into a "Emergency Declarations Database" (the majority of these declarations are related to severe storms and flooding).
- Creation of a separate "Events Database" to identify locations of frequently repaired and reconstructed facilities on the NHS by:
    - Communicating with non-NJDOT NHS owners to request data.
    - Reviewing paper and electronic records that corresponded to the list of emergency declarations in New Jersey since 1997. A total of 16 NJDOT Emergency Relief Program Field Reports were reviewed that included a total of 510 incidents or records. Each record contains a listing of bridge, culvert, and pavement projects, the repair and reconstruction work under the emergency declaration.
    - Reviewing the project locations listed in each emergency declaration record to determine highway and road segments, bridges, and culverts that are on the NHS. The effort was completed using two methods: (1) verification by the NJDOT Automated Straight-Line Diagram and, (2) verification by NJDOT spreadsheet containing NHS mileposts supplied by NJDOT Bureau of Transportation Data and Support.
    - Adding highway and road segments, bridges, and culverts that were verified to be on the NHS to the "Events Database" to compile a full listing of the individual repairs and their locations. Data collected included the location description, region, municipality, county, route, direction, milepost start and end, description of damage, structure ID number, and a description of the repair.
- Identification of assets with recurring damage that are subject to the Part 667 requirements. Using the data collected, NJDOT manually reviewed all repair locations to identify any assets that were damaged and subsequently repaired or reconstructed two or more times by emergency events. The following steps were followed:
    - Categorize and separate temporary repairs versus permanent repairs using FHWA Emergency Relief Manual (Updated May 31, 2013).
    - Organize list using the following fields: route, milepost begin, milepost end, and event code.
    - Review sorted list to check for facilities repaired or reconstructed two or more times.

This process revealed that multiple assets have been damaged in emergency events since 1997; however, none have been repeatedly repaired or reconstructed two or more times.

Process to Update Database and Evaluations

To establish a continuous process to integrate into NJDOT's business practices, NJDOT has identified the following steps shown in Exhibit 6-12 as the process to update the "Events Database" and perform future evaluations under Part 667. NJDOT Bureau of Statewide Strategies, as the Part 667 evaluation manager, is to follow this process for future evaluations.

Exhibit 6-12: Part 667 Evaluation Process



Description of Process Steps

1) Emergency Event or Catastrophic Failure Occurs

NJDOT defers to FHWA's definition of the following terms:

- *Emergency event* means a natural disaster or catastrophic failure resulting in an emergency declared by the Governor of the State or an emergency or disaster declared by the President of the United States.
- *Catastrophic failure* means the sudden failure of a major element or segment of a road, highway, or bridge due to an external cause. The failure must not be primarily attributable to gradual and progressive deterioration or lack of proper maintenance.

If either an emergency event or catastrophic failure occurs, as previously defined, the process shown in Exhibit 6-12 is initiated to evaluate assets repeatedly repaired or reconstructed, and evaluation of alternative measures.

2a) Assessment of Damages

NJDOT completes a FHWA required Detailed Damage Inspection Report (DDIR) documenting the extent of the damages from the emergency event or catastrophic failure. The assessment of damages is to be captured by the future developed report; therefore, the purpose of this form is to not only assess the damages and needed repairs but to integrate this information into the "Event Database." The current practice involves the documentation of damages and needed repairs made; however, these are not always a direct result of the event or failure.

If there are current contracts in place or ongoing projects, these are used to expedite the repair process, which is helpful for the agency and highway users, but it creates a challenge when attempting to relate events and failures to specific repairs. To improve the data collection and evaluation process, the NJDOT Part 667 Advisory Group will specify the fields to include in the Detailed Damage Inspection Report to keep the burden to a minimum and help tie repairs back to specific events and failures.

2b) Official Emergency Declaration

Only emergency events or catastrophic failures, as defined in Part 667, that are acknowledged by the Governor or President are to be considered for the remainder of the Part 667 evaluation.

3) Update Database

Data collected as part of the DIDR are integrated into the database of repairs and reconstructed assets.

4) & 5) NJDOT Bureau of Statewide Strategies to Alert NJDOT Divisions via Memo

This involves the sharing of information within different NJDOT business units. It serves to alert NJDOT business units of the current problem, and to determine whether this location is under review in any of the Project Delivery Process Phases.

- If the documented location is not found to be addressed during any current project phases, it is to be entered into the Problem Screening Phase, to be evaluated across all NJDOT

management systems for a decision to advance the location to the next phase, Concept Development, maintenance, or withdrawal. (The emergency is evaluated for repair and reconstruction alternatives to be planned, programmed, and funded, regardless of it being a repeated occurrence or not during the Concept Development phase; emergency repairs are to be expedited depending on the need).

- Repeated occurrences require a root cause analysis[4] for the identification of the most cost-effective mitigation or adaptation solution, while non-repeated occurrences require the process described previously to consider alternative repairs and reconstruction and determine a preliminary preferred alternative (PPA) prior to implementation.

6) Update Database

This ensures the most up-to-date information regarding the location is entered into the "Events Database" for future reference and evaluations. This update differs from the database update done in Step 3 by including actions taken past the initial identification of the event, including repairs, reconstruction, funding, etc.

Integration of Process into Asset Management Practices – Risk Register

The Part 667 Advisory Group plans to incorporate this evaluation and process into the TAMP risk management process by adding a detailed risk statement to the risk register for this database to be updated and managed as an ongoing risk. If a location is found to require repeated repairs or reconstruction, it will be added as a separate risk statement in the TAMP risk register.

Next Steps

To establish a continuous process to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events, the NJDOT Part 667 Advisory Group will take the following steps:

- Build additional logic into existing "Events Database" to identify assets that have been repaired or constructed two or more times based on the relevant NJDOT Standard Route Identifier (SRI).
- Develop a roles and responsibilities document for the management of risk and resiliency in NJDOT's asset management program.
- Develop a form or tool to collect a standardized set of data related to repairs and reconstruction due to emergency events.
- Develop process for the continuous coordination with non-NJODT NHS owners in meeting requirements of Part 667.
    - Develop a process to address or cover the evaluation, mitigation and identification of project alternatives by other owners (i.e., county, municipal), which also would involve

[4] The analysis is an outcome of NJDOT's Asset Management, Extreme Weather and Proxy Indicators pilot study.

the Metropolitan Planning Organizations (MPO) and the NJDOT Local Aid office, if an event resulted in damages to a county- or municipal-owned road or bridge.

- Add the fields of the Part 667 database as part of a layer in a "Resiliency Management GIS Database"[5] to expedite the review of the impacted locations and serve as a visual representation during the different Project Delivery Process Phases.

[5] The database is a recommendation from NJDOT's Asset Management, Extreme Weather and Proxy Indicators pilot study.

7. Financial Plan

Background

The financial plan describes the funding available to the New Jersey Department of Transportation's (NJDOT) Transportation Asset Management Plan (the TAMP) and identifies expected infrastructure preservation expenditures for pavement and bridge assets over the TAMP analysis period. The financial plan provides context for these expenditures by presenting the recent history and projections included within the 10-year Statewide Transportation Improvement Program (STIP). The financial plan also estimates the value of NJDOT pavement and bridge assets along with the investment required to maintain their asset value.

Image of NJ Route 3, over Passaic River

7.1 Overview

The TAMP financial plan uses the Fiscal Year (FY) 2018-2027 STIP (2018 STIP) as the basis for an 11-year budget for the preservation of the State Highway System (SHS). The 11-year analysis period for the TAMP (FY 2019-2029) provides for the alignment with the out-year in the next update to the 10-year STIP (FY 2020-2029). Financial plan dollar amounts for FY 2028 and FY 2029 are extrapolated from the amounts in the final year of the 2018 STIP. Additionally, the TAMP estimates the planned level of expenditure on non-NJDOT National Highway System (NHS) assets using the best available data collected from the other NHS owners. The planned SHS funding together with expenditure estimates provided by other NHS owners are used to project the condition of the NHS and SHS through the year FY 2029.

7.2 NJDOT Funding Sources

The New Jersey Transportation Capital Program is funded primarily through federal aid and appropriations from the New Jersey Transportation Trust Fund as described below.

7.2.1 New Jersey Transportation Trust Fund

Sources and Uses of Funds in the New Jersey Transportation Trust Fund

The New Jersey Transportation Trust Fund (TTF) is managed by the New Jersey Transportation Trust Fund Authority (TTFA). The Trust Fund Authority is an independent agency of state government whose sole purpose is to finance the annual New Jersey Transportation Capital Program. The principal revenue sources for the TTF are: (1) tax revenues and (2) proceeds from bond sales. The monies are used to fund NJDOT, New Jersey Transit (NJ Transit), and Local Aid projects, and to pay debt service on the bonds it has issued.

All Motor Fuels Tax and Petroleum Gross Receipts Tax revenues are constitutionally dedicated for transportation purposes and are ultimately directed by annual legislative appropriation to the TTF. The New Jersey State Constitution also requires the dedication of no less than $200 million of annual Sales and Use Tax revenues for transportation purposes.

Beyond the constitutional dedications of the tax revenues noted previously, the Trust Fund Authority also receives annual revenue from contributions authorized by contracts entered with the State's toll road authorities. Statutory dedications from certain motor vehicle violations and heavy truck registrations are also authorized; however, the legislature has not appropriated any of these latter fees to the TTF in the past several years.

Separate annual legislative actions are required to move funding into and out of the TTF. The TTF's annual spending authorization supporting NJDOT, NJ TRANSIT, and Local Aid is distinct from the legislature's appropriation of transportation revenues to the TTFA. The legislature's annual spending authorization enables NJDOT and NJ TRANSIT to issue contracts and purchase orders for projects. In contrast, the revenue appropriation *to* the Authority provides the funding source for debt service payments and pay-as-you-go appropriations. "Pay-as-you-go" refers to the spending that is funded by the tax revenue and bond sale proceeds that remain after paying debt service.

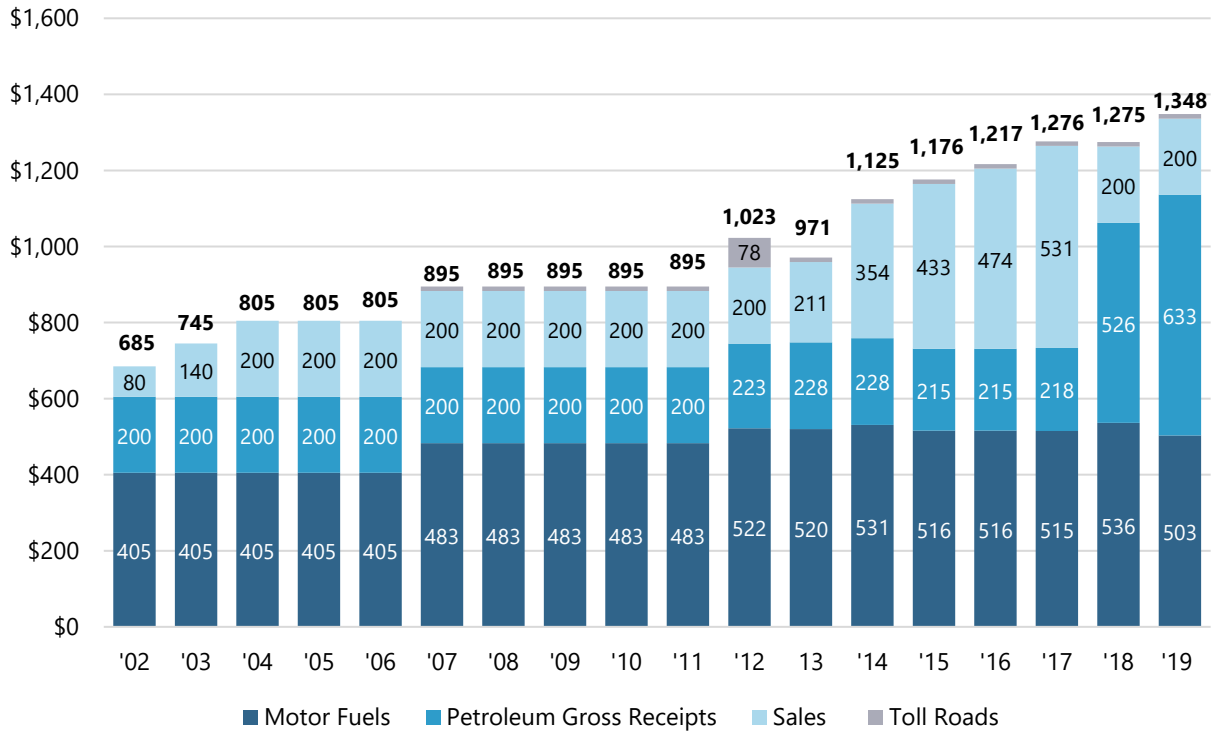
New Jersey Transportation Trust Fund Authority Act of 2016

In October 2016, the "New Jersey Transportation Trust Fund Authority Act" was reauthorized (P.L. 2016, c.56) to support New Jersey's annual Transportation Capital Program for FY 2017 through FY 2024. The reauthorization provides a total of $16 billion in capital spending over the eight-year period, supported by $12 billion in bonding authority and "pay-as-you-go" appropriations of motor fuels, petroleum gross receipts, and sales and use tax revenues. The excess fuel tax revenue over the amount needed for debt service is deposited into a newly-established TTF Sub-Account for Capital Reserves, from which it is available as needed for appropriation to the New Jersey Transportation Capital Program. The TTF anticipates that a total of $1.3 billion in new "pay-as-you-go" funding will be funded through this TTF Sub-Account through FY 2024.

Transportation Trust Fund Trends

Exhibit 7-1 presents the legislative appropriations of constitutionally and statutorily dedicated revenues to the TTF from FY 2002 through FY 2019. The exhibit illustrates the relatively flat trajectory of motor fuels tax-related appropriations to the fund through FY 2019. Exhibit 7-1 also illustrates that the increased appropriation of sales and use tax revenues was the main source of appropriations growth from FY 2013 to FY 2017. The fuel tax rate increases taking effect in FY 2018 resulted in the sales and use tax appropriations reverting to their statutory minimum of $200 million a year. The substantial increases in petroleum gross receipts tax revenues shown for FY 2018 more than offset the decline in sales and use tax appropriations to the TTF. The total appropriations for 2018 and 2019 do not reflect all dedicated tax revenues from those sources. Revenues in excess of the appropriations shown are deposited into the TTF Sub-Account for Capital Reserves (described above).

Exhibit 7-1: Appropriations to the Transportation Trust Fund (TTF) ($ millions) – FY 2002-2019



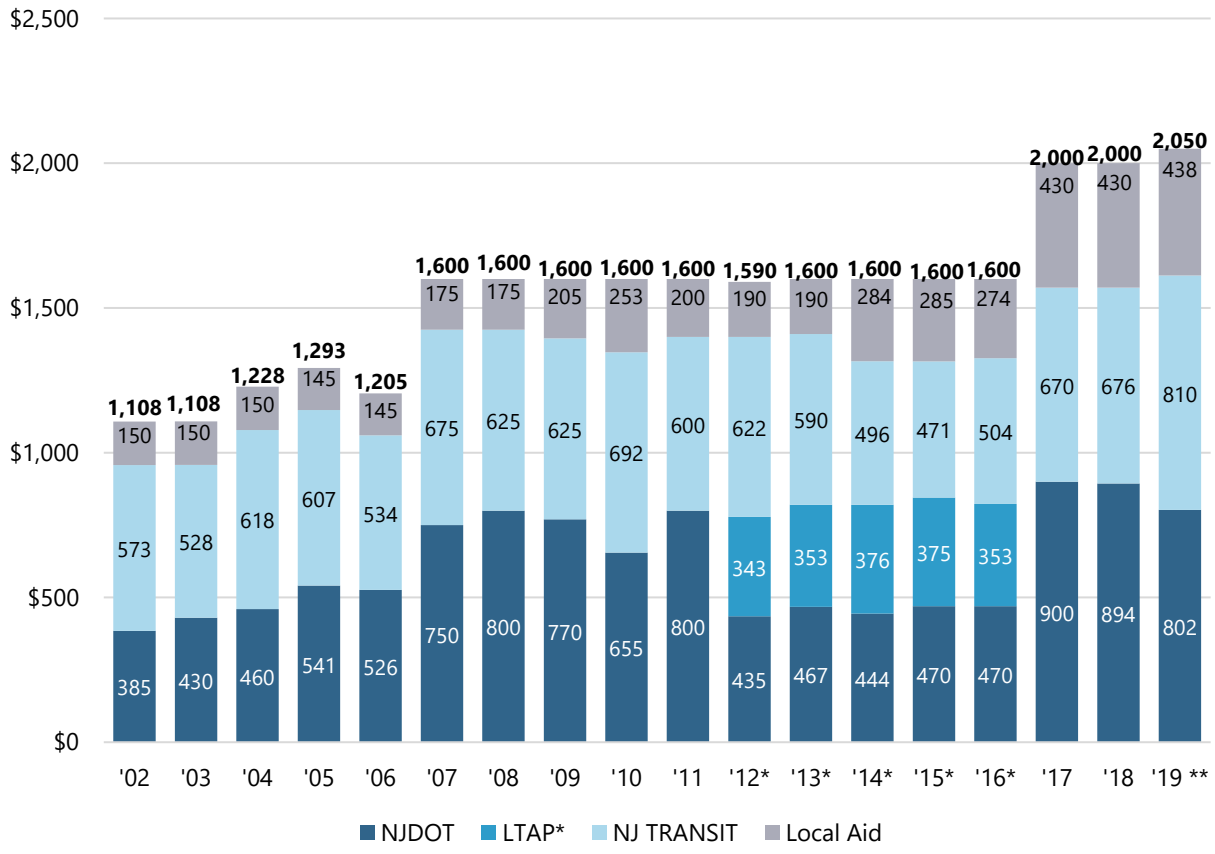
Source: New Jersey TTFA, 2019. https://www.state.nj.us/ttfa/financing/apprevenues.shtm
Note: Contribution from Toll Road Authorities has been $12 million per year since FY 2013.

Exhibit 7-2 presents the history of appropriations from the TTF to NJDOT, NJ TRANSIT, and Local Aid projects from FY 2002 through FY 2019. Exhibit 7-2 illustrates the significant increase in appropriations to NJDOT, NJ TRANSIT, and Local Aid resulting from the 2016 Trust Fund Reauthorization. Exhibit 7-2 also illustrates the critical role of the Port Authority of New York and New Jersey (PANYNJ) funding in supplementing funding from the TTF toward the Lincoln Tunnel Access Projects.

The annual appropriations *from* the Transportation Trust Fund shown in Exhibit 7-2 exceed the appropriations *to* the Transportation Trust Fund shown in Exhibit 7-1. This is made possible by the use

of the TTF Sub Account for Capital Reserves combined with the use of proceeds from the sale of Transportation Trust Fund bonds and notes. By funding the New Jersey Transportation Capital Program through a trust fund, empowered to issue debt and to hold dedicated funds in reserve, NJDOT enjoys greater stability and predictability in capital planning than would be possible if the state transportation funds available to NJDOT were limited to annual tax revenues. To be sustainable over the longer term, the New Jersey Transportation Capital Program must match long-term spending with long-term tax revenues.

Exhibit 7-2: Appropriations from the Transportation Trust Fund (TTF) ($ millions) – FY 2002-2019



Source: New Jersey TTFA, 2019. https://www.state.nj.us/ttfa/capital/

* Funding provided by the PANYNJ over FY 2012-2016 for the Lincoln Tunnel Access Projects (Pulaski Skyway, Wittpenn Bridge, etc.) was provided directly to the Transportation Capital Program. It was not appropriated from the TTF.

** Includes a $50 million supplemental appropriation for NJ TRANSIT preventative maintenance projects.

7.2.2 Federal Formula Funding

Federal transportation funding for FY 2016 through FY 2020 was established in the Fixing America's Surface Transportation Act (FAST). Under the FAST Act, the U.S. Department of Transportation plans to apportion to New Jersey an annual average of $1.058 billion from FY 2016 through FY 2020. Program exchange arrangements and transfers between NJDOT and NJ TRANSIT will reduce the aggregate

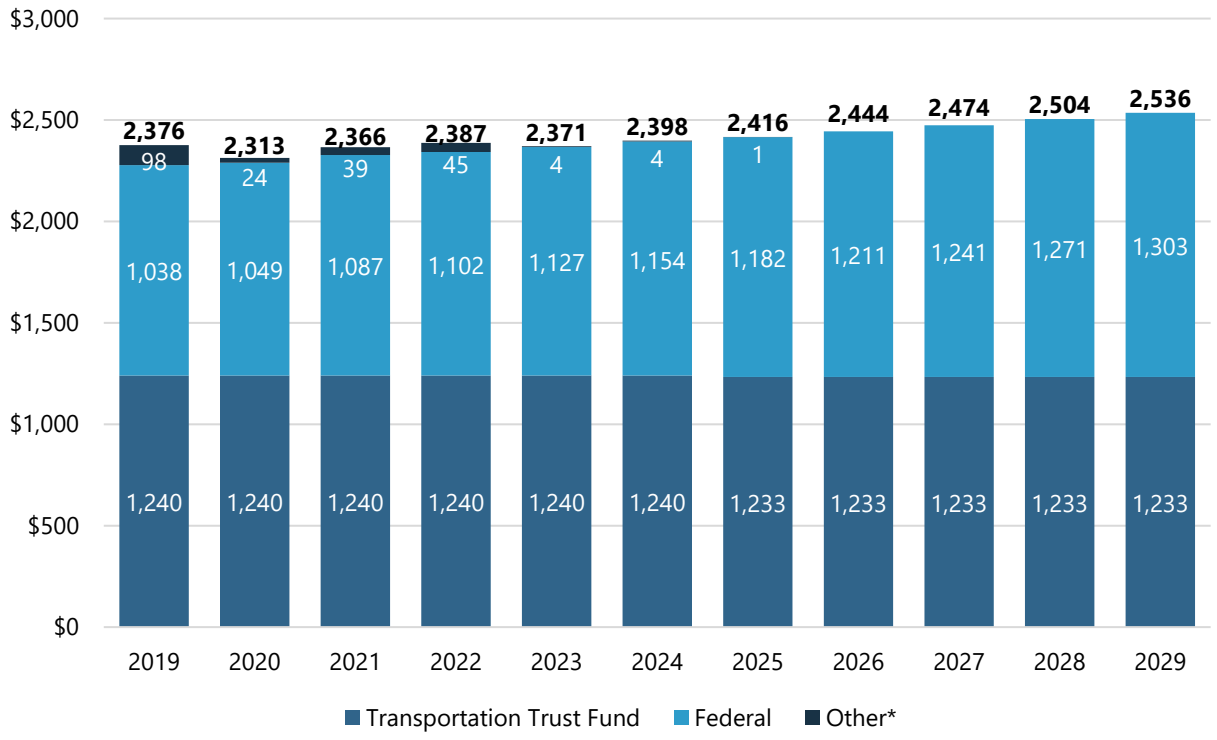
apportionment level to approximately $1 billion annually. Federal funding after FY 2020 was projected by assuming a continuation of the average annual growth rate of 2.4 percent.

The two FAST Act funding programs directly relevant to asset management are the National Highway Performance Program (NHPP) and the Surface Transportation Block Grant Program. The NHPP is available for interstates, state highways, and other facilities, provided these are on the NHS. The Surface Transportation Block Grant Program may be used for facilities on and off the NHS.

7.2.3 NJDOT Eleven-Year Funding Projections

Exhibit 7-3 displays New Jersey's annual Transportation Capital Program projected funding amounts by source from FY 2019 through FY 2029. The revenue estimates for the period FY 2018 to FY 2027 (from the 2018 STIP) were developed cooperatively by NJDOT, NJ TRANSIT, and New Jersey's three Metropolitan Planning Organizations, in full consultation with the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA). The cooperative consultation meeting among all entities was held on December 5, 2016. For FY 2028 and FY 2029, funding from the TTF is assumed to continue at the levels that were projected for FY 2025-2027. Federal funding is assumed to continue to grow at the rate of growth that it registered in the years FY 2025-2027.

Exhibit 7-3: Projected NJDOT Funding, by Source ($ millions) – FY 2019-2029



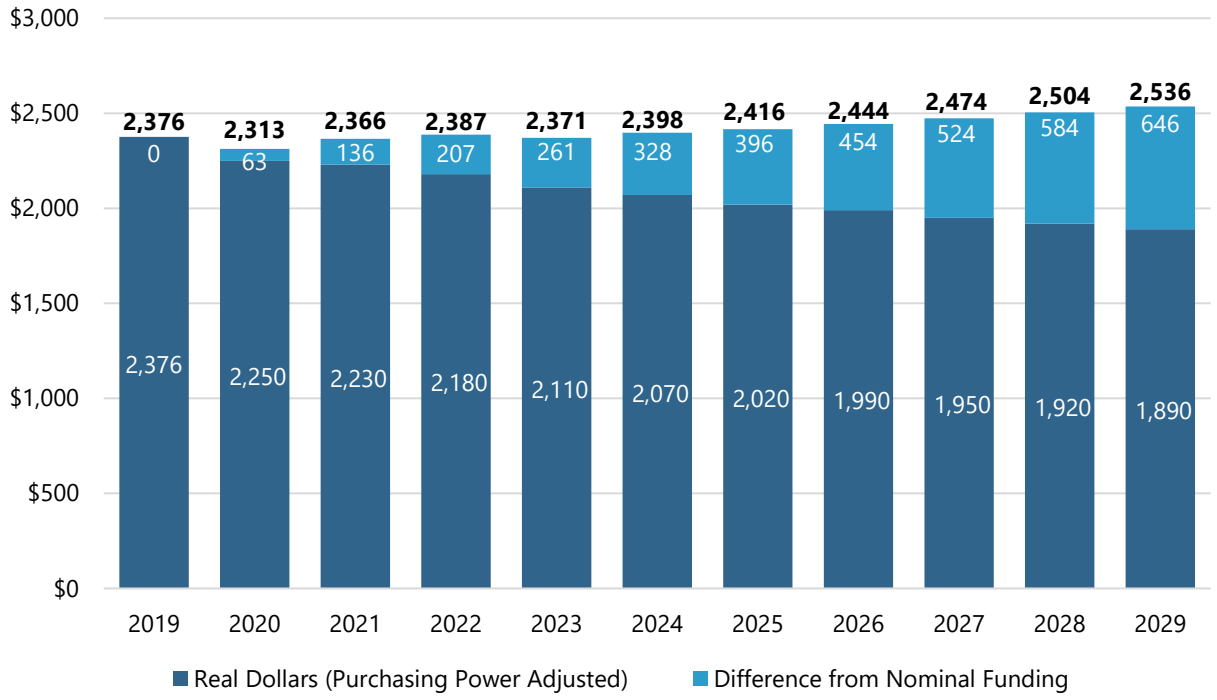
Source: New Jersey STIP, FY 2018-2027, Approved, January 2018. Projected to FY 2028 and FY 2029.
* "Other" funding sources can include authorities, private entities, and local governments.

The future funding stream is subject to considerable uncertainty. As shown in Section 7.2.1 NJDOT's share of the annual funding appropriated from the TTF can vary from year to year; however, as shown

in Exhibit 7-3, the annual appropriations have been consistent. Moreover, the current Trust Fund Authorization ends in 2024, with amounts to be authorized beyond that year unknown. The amount of federal funding beyond the FAST Act horizon (2020) is uncertain.

The erosion of future funding purchasing power resulting from cost escalation adds another degree of uncertainty. Exhibit 7-4 displays the effect of an assumed three percent rate of annual inflation on the real purchasing power of this funding stream. Three percent is the inflation rate currently specified in NJDOT guidance for use in its Construction Cost Estimating Guide (February 2019).

Exhibit 7-4: Projected NJDOT Capital Funding – Nominal and Real, Inflation-Adjusted Dollars ($ millions) – FY 2019-2029



Source: New Jersey STIP, FY 2018-2027, Approved, January 2018. Projected to FY 2028 and FY 2029.
Note: Real Dollars purchasing power incorporates the effects of an assumed three percent rate of annual inflation.

7.3 Projected Funding Allocations for Core Missions and Asset Program Categories

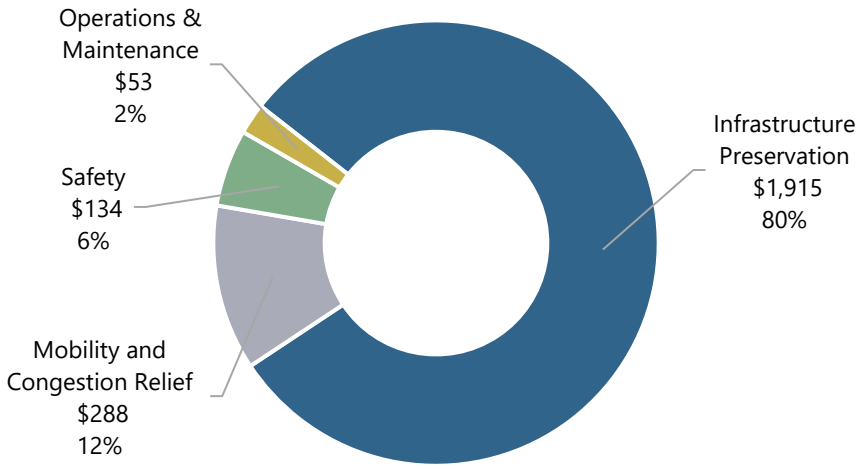
Total NJDOT spending is projected at an annual average of $2.42 billion per year (comprised of state and federal sources). This spending is divided among NJDOT's four core missions: Infrastructure Preservation, Mobility and Congestion Relief, Operations and Maintenance, and Safety. Infrastructure Preservation is the core mission that is the focus of transportation asset management planning and is the area where funds available to accomplish the TAMP State of Good Repair Objectives are allocated.

The spending breakdown information provided in this section is taken from the 2018 STIP, which ends in FY 2027. Because the TAMP does not develop funding projections for all of the core missions or

asset program categories for the full TAMP analysis period FY 2019-2029, it is not possible to present the breakdown among the core missions and asset program categories for the TAMP analysis period.

Exhibit 7-5 shows that for the period FY 2018-2027, the average annual expenditure for the Infrastructure Preservation core mission totals more than $1.93 billion. This amount is approximately 80 percent of total spending across NJDOT's core missions.

Exhibit 7-5: NJDOT Average Annual Expenditure by Core Mission ($ millions) – FY 2018-2027



Source: New Jersey STIP, FY 2018-2027, Approved, January 2018.
Note: Fifth core mission for the State of New Jersey of "Mass Transit" is excluded since it belongs to NJ Transit.

The other funding categorization that the New Jersey Transportation Capital Program uses is asset categories. These categories correspond to the nature of activity funded, regardless of the core mission. Exhibit 7-6 represents the annual average funding for each combination of core mission and category.

- ***Bridge Assets*** – This classification includes projects which are designed to keep existing bridges functioning and in a State of Good Repair, as well as the bridge inspection program and administration of the Bridge Management System (BMS). It also includes the management of other structures including minor bridges, dams carrying SHS roadways, overhead sign structures, and high mast light poles, and the New Jersey Route 29 Northbound tunnel.
- ***Road Assets*** – This classification includes projects to keep the existing roadways functioning and in a State of Good Repair. Assets funded under this category include not only pavement but also appurtenant assets such as drainage infrastructure, guiderails, and traffic signals.
- ***Airport Assets*** – This classification includes projects to preserve, maintain, and improve aviation facilities.
- ***Local System Support*** – This classification encompasses funding distributed to counties and municipalities for planning, infrastructure preservation, mobility improvements, and local safety improvements, among other dedicated purposes.

- ***Capital Program Delivery*** – The NJDOT salaries and other administrative expenses which directly relate to developing and delivering the New Jersey Transportation Capital Program are funded through this category. This classification includes efforts such as planning and research, environmental reviews, and right-of-way acquisition assistance.
- ***Multimodal Programs*** – This classification includes projects for Americans with Disabilities Act (ADA) compliance, pedestrian and bicycle, rail and maritime transportation, among others.
- ***Congestion Relief*** – This classification encompasses work that improves the flow of people and goods. Programs include highway operational improvements, bottleneck widening, missing links, major widening, intelligent transportation systems, and travel demand management.
- ***Transportation Support Facilities*** – This classification includes projects to preserve, maintain, and improve physical plant infrastructure including office buildings, rest areas, maintenance facilities, and park-and-ride locations.
- ***Safety Management*** – Examples of safety management projects and programs include rail highway grade crossings, traffic signal replacement, maintenance of crash records, rockfall mitigation, and intersection improvements.

Exhibit 7-6: Average Annual Expected Funding by Core Mission and Asset Category ($ millions) – FY 2018-2027

Asset Category ($ million)	Core Mission: Infra-structure Preservation	Core Mission: Mobility & Congestion Relief	Core Mission: Operations and Maintenance	Core Mission: Safety	Subtotal	Share of Category Total
Bridge Assets	543	-	-	-	**543**	23%
Road Assets	448	-	-	-	**448**	19%
Airport Assets	4	-	-	-	**4**	0%
Local System Support	574	22	-	25	**621**	26%
Capital Program Delivery	258	-	1	2	**261**	11%
Multimodal Programs	90	11	-	-	**101**	4%
Congestion Relief	-	254	-	-	**254**	11%
Transportation Support Facilities	-	-	52	-	**52**	2%
Safety Management	-	-	-	107	**107**	4%
Subtotal	**1,915**	**287**	**53**	**134**	**2,390**	100%
Share of Mission Total	80%	12%	2%	6%	100%	

Sources: New Jersey STIP, FY 2018-2027, Approved, January 2018.

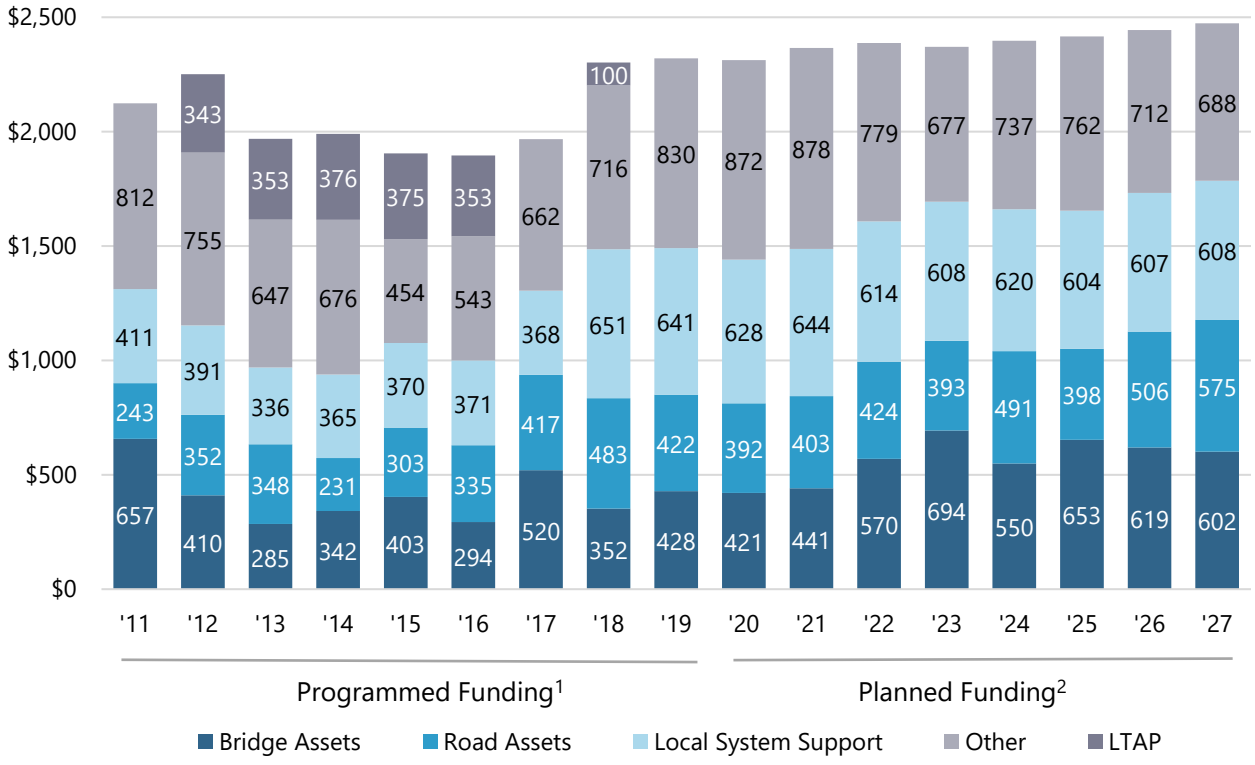
Note: Fifth core mission for the State of New Jersey of "Mass Transit" is excluded since it belongs to NJ Transit.

Exhibit 7-7 presents the historic funding levels and planned funding levels for each Transportation Improvement Program asset category for the period FY 2011 through 2027. Funding values for bridge assets, road assets, and local system support are displayed within the chart. The other categories are grouped together.

The data shown in Exhibit 7-7 indicates the following:

- The elevated spending for FY 2011 and FY 2012 was a result of federal stimulus funding under the American Reinvestment and Recovery Act.
- The category expected to experience the greatest increase in programmed expenditures is Local System Support. This increase will have a direct effect on the resources available for asset preservation, rehabilitation, and replacement on the locally-owned NHS roadways.
- Spending on SHS pavement and bridge assets is planned to increase from the levels in the preceding 5-year period (FY 2013-2017). The increase is more modest in the first 4 years (FY 2018-2021) of the 2018 STIP (the portion that has been approved by FHWA) than is projected for the latter 6 years of the 10-year 2018 STIP.

Exhibit 7-7: Annual Funding, by Asset Category ($ millions) – FY 2011-2027



[1] Source: New Jersey Transportation Capital Program, documents for each fiscal year.

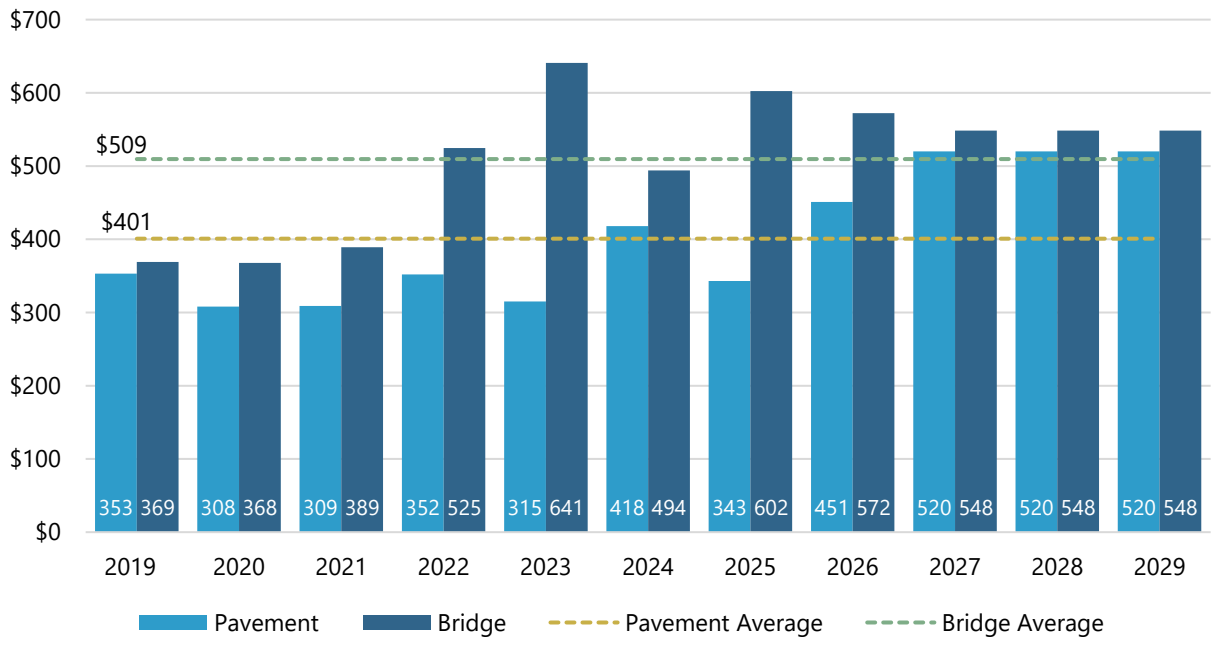
[2] Source: New Jersey STIP, FY 2018-2027, Approved, January 2018.

Notes: LTAP = the Lincoln Tunnel Access Projects (aka the PANYNJ-NJDOT Project Program), received $1.8 billion in funding from the PANYNJ between FY 2012 and FY 2016; the projects apply to the Bridge Assets category. "Other" category includes Airports, Capital Program Delivery, Congestion Relief, Multimodal Programs, Safety Management, and Transportation Support Facilities.

7.4 Projected Funding Allocations for SHS Asset Management

The TAMP uses the dollar amounts shown below in Exhibit 7-8 to establish the planned condition of NJDOT pavement and NBIS bridge assets. The dollar amounts form the budget constraints used in the performance gap analysis to project pavement and bridge conditions over the TAMP analysis period. The dollar amounts represent the portions of planned funding for pavement and bridge assets that are directly applicable to the asset management activities that directly affect the performance projections. The values shown in Exhibit 7-8 exclude funding for expenses (included in Exhibit 7-7) such as drainage management, structure inspections, and replacement of sign structures. Expenditure projections specific to assets on the NHS are not shown because the NJDOT capital planning and budgeting process does not distinguish between assets on and off the NHS, except for the allocation of federal NHPP funds that are only available for projects on the NHS. For a breakdown of the portions of planned funding for pavement and bridge assets by work type, see *Chapter 8: Investment Strategies*.

Exhibit 7-8: Projected Funding Available for NJDOT Pavement and Bridge Asset Management ($ millions) – FY 2019-2029



Sources: 2019 amounts are from New Jersey's annual Transportation Capital Program for FY 2019. FY 2020-2027 amounts are from New Jersey STIP, FY 2018-2027, Approved, January 2018. FY 2027 amounts are projected to FY 2028 and FY 2029.

Note: Only includes funding for maintenance, preservation, rehabilitation and reconstruction of pavements and NBIS bridges. Bridge data excludes funding for inspections, administration of the BMS and management of other structures (culverts, sign structures, etc.), which is about $51 million per year.

7.5 Projected Expenditures for Non-NJDOT NHS Assets

The responsibility for approximately 39 percent of pavement lane miles and approximately 53 percent of bridges by deck area on the NHS is dispersed across 83 non-NJDOT entities. Many of these jurisdictions do not distinguish in their business practices or fixed-asset accounting between their NHS and other roadway assets. Consequently, funds available for asset management-related expenditures for the owners of the balance of the NHS assets are challenging to identify. The TAMP, as part of its consultative process with other NHS owners, conducted a data collection survey and communications activities to assemble the data. This cooperative effort provides the best available data from which to predict the expenditures that will be applied to the non-NJDOT NHS pavement and bridge assets.

7.5.1 New Jersey Turnpike Authority

The New Jersey Turnpike and Garden State Parkway, both owned by the New Jersey Turnpike Authority (NJTA), account for 2,341 pavement lane miles (19%) and 21,084,352 square feet (34%) of NBIS bridges by deck area on the NHS in New Jersey. NJTA is fully funded by user fees (tolls). NJTA had produced a 10-year Capital Improvement Program to fund pavement and bridge projects and to maintain its assets in overall good condition. NJTA is nearing the completion of its 10-year, $7 billion Capital Improvement Program, and a new, approximately $500 million-per-year program has been announced.

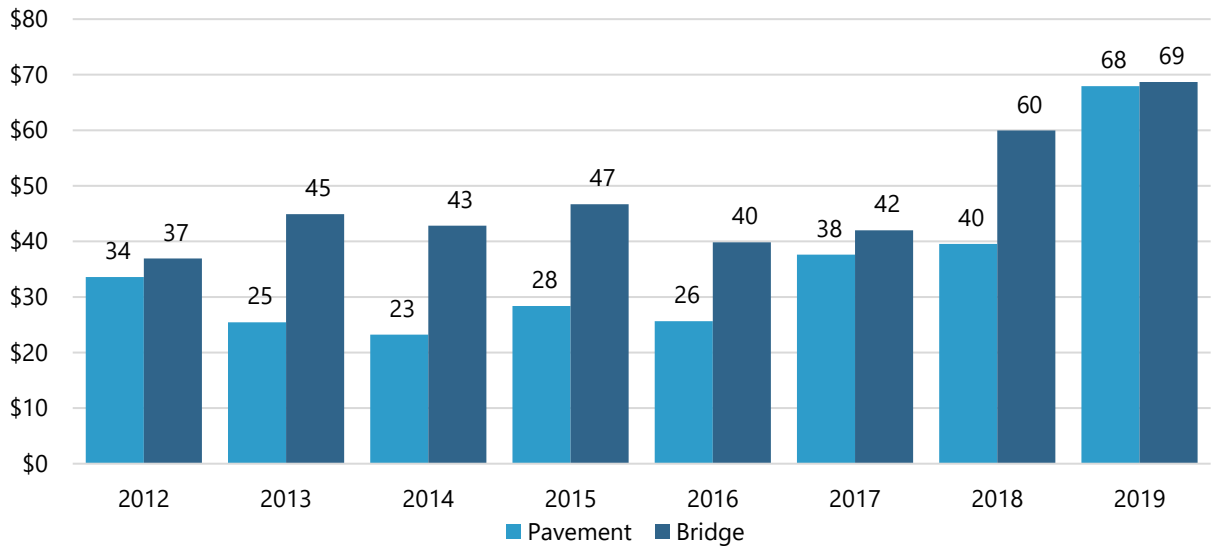
Funding for pavement resurfacing projects is primarily earmarked in the Authority's Maintenance Reserve Fund on an annual basis during the fall budget process. The allocation for pavement resurfacing projects, if not included in the Capital Improvement Program, has been based on historical information and projected need, for projects that are not included in the Capital Improvement Program. Increased pavement deterioration over the recent past has driven NJTA to revise its lifecycle estimates for various roadway sections (see *Chapter 5: Lifecycle Planning*). To address the increased deterioration, additional funds were allocated during FY 2018 (NJTA's FY align with calendar years). NJTA will incorporate data from its Pavement Management System to project pavement needs and project costs over the next five years re-establishing the historical basis and trend for projected needs. Projected funding to be allocated from the Authority's Maintenance Reserve Fund for pavement resurfacing projects for FY 2018 is approximately $69.5 million with $67.9 million projected for FY 2019. Of the 2018 total of $69.5 million, $30 million was allocated to address the increased pavement deterioration. NJTA expects that the FY 2019-dollar amount will increase in future years to avoid continued pavement deterioration.

Funding for bridge repair projects is primarily earmarked in the Authority's Maintenance Reserve Fund on an annual basis during the fall budget process. In prior years, the dollar amount allocated for bridge repair projects, if not included in the Capital Improvement Program, has been based on historical information and projected needs. Projected funding to be allocated from the Authority's Maintenance Reserve Fund for bridge repair projects for FY 2018 is approximately $60.0 million with approximately $68.7 million projected for FY 2019. Historically, the increase in funding for the bridge repair program has approximated two percent per year.

Annual expenditures for pavement resurfacing and bridge repair projects for the eight-year period spanning FY 2012-2019 are presented in Exhibit 7-9 (figures for FY 2019 are budget estimates). The

exhibit shows a long-term trend of increasing expenditures. The increase in pavement expenditures is approximately 11 percent, with bridge expenditures increasing approximately 15 percent over the FY 2012-2019 period.

Exhibit 7-9: NJTA Annual Expenditures for Pavement Resurfacing and Bridge Repair Projects ($ millions) – FY 2012-2019



Source: NJTA Annual Budget Reports FY 2012-2019.

The sum total of pavement and bridge allotments has increased substantially over the recent past. During the five-year period from FY 2012 through FY 2016, pavement resurfacing and bridge repair projects were approximately $69.5 million per year. Budget estimates for combined pavement and bridge projects in FY 2019 are nearly double the average for the period 2012-2016 ($136.6 million versus $69.6 million average per year).

Exhibit 7-10 presents the annual average spending levels for pavements and bridges during the FY 2012-2019 period. This financial data is also used to project pavement resurfacing and bridge repair expenditures in the TAMP analysis period.

Exhibit 7-10: Average and Estimated Annual Funding for the New Jersey Turnpike Pavement and NBIS Bridges

Asset Class	Average Annual Expenditure ($ millions)	
	Prior & Estimated (2012-2019)	Projected[1] (2019-2029)
Pavement	35.2	42.7
NBIS Bridges	47.7	52.6

Source: NJTA Annual Budget Reports FY 2012-2019.

[1] Average annual spending for the TAMP analysis period is estimated as equal to the average spending level in the four-year period (FY 2016-2019) based on NJTA's stated intent to increase spending greater than long-term averages.
Note: Pavement resurfacing and bridge repair projects only, excludes newly-announced, but not-yet-available Capital Improvement Program.

7.5.2 Port Authority of New York and New Jersey

The Port Authority owns 45 pavement lane miles (0.4%) and 3,603,241 square feet (5.9%) of NBIS bridges by deck area on the NHS. The Port Authority's Capital Plan for the 10-year period FY 2017-2026 includes $6.1 billion in bridge and tunnel projects, including approach roadways in New Jersey. Of the $6.1 billion total, approximately $3.7 billion is related to bridge deck, superstructure, and substructure components and roadway surfaces. Exhibit 7-11 shows the Port Authority's planned expenditures on pavements and bridges.

Exhibit 7-11: Average and Estimated Annual Funding for the PANYNJ Pavement and NBIS Bridges

Asset Class	Average Annual Expenditure ($ millions)	
	Planned (2017-2026)	Projected[1] (2019-2029)
NBIS Bridges & Pavements[2]	328.7	328.7

[1] Average annual spending for the TAMP analysis period is estimated as equal to the average spending level in the period (FY 2017-2026).

[2] NBIS bridge and pavement project expenditures are estimated by facility and not by bridge/pavement asset types.

7.5.3 South Jersey Transportation Authority

The South Jersey Transportation Authority (SJTA) owns 265 pavement lane miles (2.2%) and 390,070 square feet (0.5%) of NBIS bridges by deck area on the NHS. SJTA provided its six-year past and five-year projected spending plan for its NHS pavement and bridges as shown in Exhibit 7-12. Spending for the TAMP analysis period was estimated by calculating a simple average of the spending for the prior and planned periods. Because there is a risk that the increase in planned spending will not be sustained over the entire TAMP analysis period, giving equal weight to spending estimates for the prior and planned periods was used as a measure of conservatism.

Exhibit 7-12: Average and Estimated Annual Funding for SJTA Pavement and NBIS Bridges

Asset Class	Average Annual Expenditure ($ millions)		
	Prior (2012-2017)	Planned (2018-2022)	Projected[1] (2019-2029)
Pavement	1.7	2.6	2.2
NBIS Bridges	1.8	3.0	2.4

[1] Average annual spending for the TAMP analysis period is estimated as the average of the spending level in the prior period (FY 2012-2017) and the planned spending level for the immediate future period (FY 2018-2022).

7.5.4 Other Toll Authorities

The Delaware River Port Authority owns 3,737,698 square feet of NHS NBIS bridge deck area. This figure ranks third highest behind NJDOT and NJTA. During the TAMP data collection process, the Authority indicated that it spent nearly $77 million on these highway bridges during the FY 2012 to FY 2017 period with plans to spend an additional $75 million from FY 2018 to FY 2022.

The Delaware River Joint Toll Bridge Commission owns 953,515 square feet of NHS NBIS bridge deck area. During the TAMP data collection process, the Commission indicated that it spent nearly $107 million on these highway bridges during the FY 2012 to FY 2017 period with plans to spend an additional $16 million from FY 2018 to FY 2022.

The Palisades Interstate Parkway Commission owns approximately 47 lanes miles of NHS pavement and 62,675 square feet of NHS NBIS bridge deck area in New Jersey. The Commission is not a toll authority and does not collect user fees. During the TAMP data collection process, the Commission indicated that it spent nearly $203,000 on these assets during the FY 2012 to FY 2017 period with plans to spend an additional $490,000 from FY 2018 to FY 2022. These expenditures represent maintenance costs.

The Delaware River and Bay Authority owns 1,263,079 square feet of NHS NBIS bridge deck area. The total budget for the Authority's Five-Year Capital Plan for FY 2018-2022 is projected to be $67.2 billion. Of the total amount, $165.2 million in expenditures is projected for work on the bridge's deck, superstructure, and substructure components from FY 2019 to FY 2023.

The Burlington County Bridge Commission owns 271,140 square feet of NHS NBIS bridge deck area. The Commission's Five-Year Capital Plan for FY 2018-2022 is projected to be $149 million. Of the total amount, $110 million in expenditures is projected for work on bridge deck, superstructure, and substructure components.

7.5.5 Other Owners

The remaining assets on the NHS are owned predominantly by county agencies. A questionnaire requesting recent spending history and spending plans was sent to county and municipal NHS asset owners. Responses were received from 16 of the 18 county owners, representing more than 90 percent of NHS pavement lane miles and nearly half of NHS NBIS bridge deck area owned by counties and municipalities. Exhibit 7-13 presents the estimation of NHS pavement preservation spending by these agencies. Exhibit 7-14 presents the estimation of NHS NBIS bridge-related spending by these agencies.

The estimating procedure for county and municipal owners uses the responses received during the TAMP outreach program to estimate a unit spending rate to apply to the entire population of such owners. For example, the respondents accounted for 1,484 pavement lane miles and reported $15,113,500 average annual spending in the immediate five-year period ending in FY 2017. This produces an average annual spending per lane mile of $10,184, which is applied to the total pavement lane miles for the group, yielding a total estimated expenditure of $19,462,000.

The respondents provided their spending plans out to FY 2022. Spending for the TAMP analysis period was estimated by calculating a simple average of the spending for the prior and planned periods. Because there is a risk that the increase in planned spending will not be sustained over the entire TAMP analysis period, giving equal weight to spending estimates for the prior and planned periods was used as a measure of conservatism.

An additional, ongoing risk related to estimating the expenditures by county and municipal NHS owners is related to the requirement for NJDOT to collect accurate data on the spending plans of these

owners; moreover, the ability of these owners to accurately review records of completed projects and programmed projects related to NHS pavement and bridge assets.

Exhibit 7-13: Estimated NHS Pavement Management Expenditure by County and Municipal Owners

	Average per Year ($)		
	Prior (FY 2012-2017)	**Planned (FY 2018-2022)**	**Projected[1] (FY 2019-2029)**
Questionnaire Respondents			
Average Annual Spending	$15,113,500	$19,430,000	$17,272,000
Pavement Lane Miles	1,484	1,484	1,484
Average Annual Spending/Lane Mile	$10,184	$13,093	$11,639
All County and Municipal Owners			
Total Pavement Lane Miles	1,911	1,911	1,911
Estimated Total Spending of Group	**$19,462,000**	**$25,021,000**	**$22,242,000**

Source: Survey administered during early 2019. Note: For respondents, if the amount of spending specific to NHS assets was not provided, NHS spending was estimated to be proportional to the share of the asset that is on the NHS.
[1] Average annual spending for the TAMP analysis period is estimated as the simple average of the spending in the prior period (FY 2012-2017) and the planned spending for the immediate future period (FY 2018-2022).

Exhibit 7-14: Estimated NHS NBIS Bridge Management Expenditure by County and Municipal Owners

	Average per Year ($)		
	Prior (FY 2012-2017)	**Planned (FY 2018-2022)**	**Projected[1] (FY 2019-2029)**
Questionnaire Respondents			
Average Annual Spending	$3,909,055	$6,780,942	$5,344,999
Bridge Deck Area (Sq. Ft.)	504,759	504,759	504,759
Average Annual Spending/ Sq. Ft. Deck Area	$7.74	$13.43	$10.59
All County and Municipal Owners			
Total Bridges Deck Area (Sq. Ft.)	824,394	824,394	824,394
Estimated Total Spending of Group	**$6,384,000**	**$11,075,000**	**$8,730,000**

Source: Survey administered during early 2019. Note: For respondents, if the amount of spending specific to NHS assets was not provided, NHS spending was estimated to be proportional to the share of the asset that is on the NHS.
[1] Average annual spending for the TAMP analysis period is estimated as the simple average of the spending in the prior period (FY 2012-2017) and the planned spending for the immediate future period (FY 2018-2022).

7.5.6 Summary of Projected Expenditures for Non-NJDOT NHS Assets

Exhibit 7-15 presents the projected NHS asset management expenditures for each grouping of non-NJDOT asset owners. The projected totals for NHS pavement and bridge assets represent an increase from prior spending totals. This projected increase supports the conservative projection shown in the Performance Gap analysis that the performance of the non-NJDOT NHS pavement and bridge assets will remain at the same level as in the TAMP baseline (CY 2017).

The TAMP presents these estimates using the best available data, assumptions noted previously, and does not represent a complete set of financial plans for asset management by each of the other NHS owners. The pavement expenditure estimate accounts for 97 percent of all non-NJDOT NHS pavement lane miles. The bridge expenditure estimate accounts for 95 percent of all non-NJDOT NHS bridges by deck area.

Exhibit 7-15: Estimated NHS Expenditures by Non-NJDOT Asset Owners ($ millions)

Owner	Projected Average Annual Expenditure ($ millions) (FY 2019-2029)	
	Pavements	Bridges
NJTA	43	53
PANYNJ[1]	0	329
SJTA	2	2
Other Authorities	N/A[2]	24[3]
Counties & Municipalities	22	9
Total[4]	**67**	**417**

Source: See prior sections and exhibits for source information.

[1] Expenditures for PANYNJ pavements included with dollar amount for bridges.

[2] Expenditures for the five authorities in Section 7.5.4 excluded due to challenges in corroborating reported data, 2018 STIP data, and published Capital Programs. These authorities collectively own 1.1% of NHS pavements.

[3] Includes the Palisades Interstate Parkway Commission, Delaware River Joint Toll Bridge Commission, and Delaware River Port Authority. Expenditures for the Delaware River and Bay Authority and Burlington County Bridge Commission excluded because they did not respond to data request, and due to challenges in corroborating 2018 STIP data and published Capital Programs. These authorities collectively own 2.5% of NHS bridges by deck area.

[4] Estimates account for approximately 97 percent of all NHS pavement lane miles and approximately 95 percent of all NHS bridges owned by non-NJDOT owners.

7.6 The Value of NJDOT's SHS Pavement and NBIS Bridge Assets

7.6.1 Asset Valuation Method

The New Jersey SHS constitutes a massive investment of public resources. There are a variety of approaches to represent the value of this investment. The TAMP uses a modified depreciated replacement cost approach to valuation. For each category of asset valued (e.g., pavement), a unit cost

to replace the asset is estimated. For bridges the unit costs vary by the type of bridge. The unit cost multiplied by the number of units (e.g., lane miles) represents an approximation of what it would cost to replace all of the State's holdings of that asset. The replacement cost applies only to the non-depreciable portion of the asset. The value of right-of-way and off-site work costs for roadways are examples of items excluded from the asset valuation.

Transportation assets deteriorate with use and with exposure to harsh environmental conditions and eventually require replacement. Asset valuation incorporates the diminished service life of an asset resulting from accumulated depreciation. The TAMP uses asset condition ratings to estimate remaining service life. This method was selected rather than age-based depreciation to better reflect upcoming replacement needs.

Assets listed in *Good* condition are assumed to have 90 percent of their service life remaining; each unit of such assets is valued at 90 percent of the unit replacement cost. Assets in *Fair* condition are assumed to have 75 percent of their service life remaining. Assets in *Poor* condition are assumed to have 25 percent of their service life remaining.

Exhibit 7-16 presents the valuation of NJDOT SHS pavements and bridges.

Exhibit 7-16: Asset Valuation of NJDOT SHS Pavement and NBIS Bridge Assets ($ millions)

Asset Type	Unit Totals by Condition (Lane Miles and Deck Area 000 Sq. Ft.)				Unit Replace-ment Cost ($ millions)	Replacement Cost ($ millions)	
	Total	Good	Fair	Poor		Full, Un-depreciated	Depreciated
Pavement	8,530	2,928	2,592	3,010	1.200	10,236	6,398
Bridge Subtotal	36,053				NA	101,003	73,752
Significant Bridges	3,446	1,183	1,423	841	6.135	21,142	14,367
Movable Bridges	1,075	43	925	106	5.113	5,493	3,882
Large Scale Bridges	5,630	1,973	2,934	723	3.068	17,270	12,751
Medium Scale Bridges	8,191	2,746	4,857	588	2.556	20,938	16,004
Conventional Scale Bridges	17,121	4,048	11,569	1,505	2.045	35,012	25,962
Small Scale Bridges	591	126	351	114	1.943	1,148	786
					Pavement and Bridge Total	**111,239**	**80,150**

Notes: Unit replacement costs, and therefore the valuations, include only the depreciable portion of the assets and exclude items such as right-of-way.
Definitions: Significant Bridges: Deck Area ≥ 300,000 sq. ft. Moveable Bridges: Moveable Bridges. Large Scale Bridges: Deck Area ≥ 100,000 sq. ft. and < 300,000 sq. ft. Medium Scale Bridges: Deck Area ≥ 25,000 sq. ft. and < 100,000 sq. ft. Conventional Bridges: Deck Area ≥ 2,500 sq. ft. and < 25,000 sq. ft. Small Scale Bridges: Deck Area < 2,500 sq. ft.

7.6.2 Estimating Investment Required to Maintain Asset Value

In a conventional asset valuation, capital asset values are reduced by accumulated depreciation and increased by capital investment. For example, if the level of investment in a given year is equivalent to the depreciation charged for that year, the capital asset valuation would remain unchanged. Therefore, efforts to preserve a level of transportation asset valuation can consist of investing a sufficient amount to maintain the existing level of "accumulated depreciation."

Investments that maintain the current level of performance are the equivalent to investments that maintain the asset valuation as it is calculated for the TAMP, in which condition rating is used for measuring depreciation. The investment levels are defined in *Chapter 4: Performance Gap Analysis*. One of the four investment scenarios analyzed was "Funding to Maintain CY 2017 Condition," which is the investment required to maintain baseline (CY 2017) conditions. As noted in *Chapter 4: Performance Gap Analysis*, a $417 million annual average investment over the TAMP analysis period is required to maintain baseline pavement conditions for the SHS and $345 million annual average investment is required to maintain baseline NBIS bridge conditions.

For the NHS, the investment required to maintain value was estimated by applying the NHS share of the asset's depreciated value to the investment required to maintain the value for all of the assets on the SHS. Additional details on the levels of investments required to preserve the valuation of NJDOT's pavement and bridge assets is presented in the following section.

7.6.3 Value of the NJDOT State Highway System and Investment Required to Maintain Value

The values of all NJDOT pavement and NBIS bridge assets are presented in Exhibit 7-17. The total asset valuation exceeds $80 billion, with 85 percent of this valuation (over $68 billion) accounted for by the assets on the NJDOT NHS (88% of SHS pavement lane miles are on the NHS; 81% of SHS bridges by deck area are on the NHS). At more than $62 billion, NBIS bridges account for the overwhelming majority (92%) of the valuation of SHS pavement and bridge assets.

An estimated total exceeding $763 million per year in asset management investment is required to maintain the value of all NJDOT pavement and NBIS bridge assets. The investment required to maintain the value of all NJDOT pavement and bridge assets on the NHS assets is $663 million per year. The relatively short service life of pavement compared to bridges is evidenced in the comparison of relative asset valuations of the two types of assets versus the required investment to maintain their value. These investment levels do not include all required asset management expenditures. For example, the bridge asset category receives an annual average of approximately $51 million in funding for bridge inspection, administration of the BMS and management of other structures including minor bridges, tunnels, signs, and high mast light poles.

Exhibit 7-17: Asset Valuation of NJDOT SHS and NJDOT-NHS Assets ($ millions)

Asset Type	Unit Totals (Lane Miles and Deck Area 000 Sq. Ft.)		Total Depreciated Asset Value ($ millions)		Annual Investment Required to Maintain Asset Value ($ millions)	
	SHS	NJDOT NHS	SHS	NJDOT NHS	SHS	NJDOT NHS
Pavement	8,530	7,536	6,398	5,647	417	368
Bridge Subtotal	36,053	29,132	73,752	62,515	345	294
Significant Bridges	3,446	3,446	14,367	14,367	72	72
Movable Bridges	1,075	858	3,882	3,092	19	15
Large Scale Bridges	5,630	5,630	12,751	12,751	59	59
Medium Scale Bridges	8,191	7,481	16,004	14,556	72	65
Conventional Scale Bridges	17,121	11,365	25,962	17,265	120	80
Small Scale Bridges	591	353	786	484	4	2
Pavement and Bridge Total			**80,150**	**68,162**	**763**	**663**

Notes: Unit replacement costs, and therefore the valuations, include only the depreciable portion of the assets and exclude items such as right-of-way.
Definitions: Significant Bridges: Deck Area ≥ 300,000 sq. ft. Moveable Bridges: Moveable Bridges. Large Scale Bridges: Deck Area ≥ 100,000 sq. ft. and < 300,000 sq. ft. Medium Scale Bridges: Deck Area ≥ 25,000 sq. ft. and < 100,000 sq. ft. Conventional Bridges: Deck Area ≥ 2,500 sq. ft. and < 25,000 sq. ft. Small Scale Bridges: Deck Area < 2,500 sq. ft.

A continuation of FY 2018 pavement funding ($328 million per year) is insufficient to maintain the value of the NJDOT pavement assets. Planned funding of $401 million per year, although greater than current levels, is also insufficient to maintain pavement asset values.

Planned bridge funding of $509 million per year is greater than the amount needed to maintain asset values for the TAMP analysis period. This favorable result is attributed to the substantial prior investment in the Pulaski Skyway rehabilitation. That effort left only a fraction of the total investment remaining to complete the project and substantially improve the bridge condition (and associated valuation). To continue to maintain the bridge asset value, the investment reflected in the TAMP financial plan will need to be increased after the TAMP analysis period (FY 2030 and beyond), as deterioration continues to depreciate the value of bridges.

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8. Investment Strategies

Background

New Jersey's Transportation Asset Management Plan (the TAMP) describes investment strategies for pavement and bridge assets. The investment strategy for each asset class is derived from the preceding TAMP analyses and consists of the optimal allocation of resources across the asset portfolio. The investment strategies balance the funding amounts to be invested according to work type (i.e., maintenance, preservation, rehabilitation, and reconstruction) enabling the New Jersey Department of Transportation (NJDOT) to pursue TAMP Policy and State of Good Repair Objectives.

Image of NJ Route 7, Wittpenn Bridge

8.1 Overview

The TAMP investment strategies for the State Highway System (SHS) are the planned funding levels among asset management work types for each asset class. The strategies are derived from the application of each asset's preferred lifecycle strategy over the TAMP analysis period based on available funding, risk analysis, and asset condition. Chapter 8 includes the following:

- An overview of how NJDOT develops investment strategies.
- The NJDOT investment strategies for SHS pavement and National Bridge Inspection Standard (NBIS) bridge assets by year.
- A comparison of investment strategies to funding needed to achieve the TAMP State of Good Repair Objectives.
- Investment strategies for the National Highway System (NHS) pavement and NBIS bridge assets
- A description of how investment strategies are integrated into New Jersey's Transportation Capital Program and Statewide Transportation Improvement Program (STIP) development processes.

8.2 NJDOT Investment Strategy for the SHS

8.2.1 Development of Investment Strategies

The NJDOT pavement and bridge management systems use analytical software to support lifecycle planning to develop investment strategies. The investment strategies optimize planned funding and forecast expenditures to make progress toward the TAMP State of Good Repair Objectives at the lowest lifecycle cost, while incorporating the consideration of risk. The management systems and lifecycle planning processes are detailed in *Chapter 5: Lifecycle Planning*.

NJDOT is enhancing and expanding the use of modeling software in its pavement and bridge management systems. The modeling software develops recommended network asset management programs that optimize user-defined objectives, subject to funding constraints. The modeling software optimizes for the objective of asset (pavement or bridge) condition and allows for other objectives to be considered. For instance, NJDOT has configured AASHTOWare's Bridge Management software (BrM) to include certain risk characteristics (e.g., scour criticality) and mobility characteristics (e.g., approach roadway alignment) among the objectives to be optimized.

NJDOT plans to make use of management system software as an integral part of the overall investment strategy development and project selection processes over the coming years; however, the selection of projects from among the work candidates advanced by the software remains subject to review by NJDOT subject matter experts, as detailed in *Chapter 5: Lifecycle Planning*. Considerations include risk, ability to deliver the project, work history on the asset, implications of other work on the network in the vicinity, and significance of the asset to the transportation system.

The funding allocations by work type, presented in the following sections, summarize the TAMP pavement and bridge asset management investment strategies.

8.2.2 NJDOT Pavement Investment Strategy

The investment strategy for SHS pavements is to increase preservation expenditures that prevent pavement assets from deteriorating to a point of requiring even greater investment. The pavement investment strategy prioritizes pavement treatments to maximize the benefits in terms of long-term cost savings and network performance by improving pavement conditions. The overall investment strategy is driven by cost effectiveness, prioritizing funding for the most cost-effective treatments first, (preservation and resurfacing) and allocating the remaining funding based on individual project deliverability.

Exhibit 8-1 (following page) presents the allocation of planned pavement asset management funding among the work types identified in the Federal Highway Administration (FHWA) asset management rule. These work types are summarized in the following sections.

Exhibit 8-1: Investment Strategy for SHS Pavements

Work Type	Pavement Investment by Fiscal Year ($ millions)											
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Average
Maintenance[1]	-	-	-	-	-	-	-	-	-	-	-	**-**
Preservation	15	15	15	15	15	50	50	80	80	100	100	**50**
Rehabilitation	290	265	245	270	250	305	265	340	410	390	390	**310**
Reconstruction	50	30	50	65	50	65	30	30	30	30	30	**40**
Total	**355**	**310**	**310**	**350**	**315**	**420**	**345**	**450**	**520**	**520**	**520**	**400**

Source: NJDOT Pavement Management System.
[1] Pavement maintenance work is performed in-house by NJDOT staff, along with other work. As a result, it is not possible to isolate a pavement maintenance cost for purposes of modeling or developing of investment strategies.
Note: Dollar amounts are rounded to the nearest $5 million.

A planned investment level for initial (new) construction of pavement is not included because planning for construction of new pavement assets is beyond the purview of the Pavement Management Unit and its Pavement Management System (PMS). Projections for new pavement construction spending over the TAMP analysis period are unavailable. Moreover, NJDOT has not focused on new roadway expansion for many years; instead it continues to focus on maintaining its existing infrastructure.

Maintenance

Maintenance treatments are those which are performed to delay, prevent, or repair damage but do not significantly impact a pavement's measured condition. Examples of maintenance treatments include crack sealing and pothole repair. These treatments are typically performed in-house by NJDOT staff along with other work, making it problematic to isolate pavement maintenance cost for purposes of modeling or developing investment strategies; therefore, a planned investment level for pavement maintenance is not included in Exhibit 8-1.

Preservation

Treatments classified under the preservation work type are performed to address minor surface distresses, improve pavement surface conditions, and extend pavement service life without restoring or improving the pavement's structural capacity. Examples of NJDOT preservation treatments include micro-surfacing, slurry seal, and thin asphalt overlays (less than 2 inches).

The NJDOT investment strategy for pavements includes a substantial increase in expenditures on preservation treatments over the TAMP analysis period. This increase is in both dollar amount and in share of allocated pavement funding. As detailed in Exhibit 8-1, the preservation dollar amounts steadily increase during the TAMP analysis period, beginning at $15 million for FY 2019 and increasing to $100 million for FY 2029, a net increase of $85 million.

The NJDOT Pavement Management Unit has determined that increased use of preservation treatments reduces lifecycle costs. The increased emphasis on preservation aligns with the asset management

emphasis in the Moving Ahead for Progress in the 21st Century (MAP-21) legislation. Preservation treatments reduce the risk that assets will require more expensive major rehabilitation treatments in the future by protecting the integrity of the pavement structure from routine wear, water infiltration, and freeze thaw damage.

Rehabilitation

Treatments classified under the rehabilitation work type are those which restore a pavement's surface condition, such as resurfacing, and those that restore or improve a pavement's structural capacity typically in the top layers of the pavement structure. Pavement rehabilitation investment levels vary over the TAMP analysis period, fluctuating annually in the middle years (FY 2020-2025) and reaching the highest levels in later years (FY 2026-2029).

The bulk of the pavement program continues to be rehabilitation work. There is an annual Transportation Trust Fund (State funding) allocation of $100M for resurfacing to promptly restore pavement surface condition at critical locations. Federal funding allocations to rehabilitation are based on project deliverability and on the amount of federal funds remaining after allocation to preservation and reconstruction.

Reconstruction

Reconstruction projects renew or replace the entire depth of the pavement structure. Reconstruction projects are very involved with very long delivery schedules (10 to 15 years or longer). They are identified through rigorous project-level pavement condition, design, and cost-benefit analyses. They often include much more than just pavement work, as reconstruction offers the opportunity to consider correction of all roadway deficiencies, such as those relating to drainage, geometry, structures, safety, mobility, freight, etc. Due to its very high cost, reconstruction is typically the last resort. Such projects are fit into the program as they become deliverable. For this reason, funding for the reconstruction and rehabilitation categories tend to vary inversely to accommodate project schedules within the two work types.

8.2.3 NJDOT NBIS Bridge Investment Strategy

The investment strategy for SHS bridges consists of increasing expenditures on preservation treatments to prevent a bridge from deteriorating to a point of requiring even greater investment, as well as prioritizing rehabilitation and reconstruction treatments to improve the conditions of several key bridges, to reduce lifecycle costs, and to improve network conditions for travelers. Exhibit 8-2 (following page) presents the allocation of planned bridge asset management funding among the work types, summarized in the following sections, identified in the FHWA asset management rule.

Exhibit 8-2: Investment Strategy for SHS NBIS Bridges

Work Type	Bridge Investment by Fiscal Year ($ millions)											
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Average
Maintenance	70	70	70	70	70	70	70	70	70	70	70	**70**
Preservation	100	100	100	115	120	125	135	140	150	150	150	**125**
Rehabilitation	45	50	60	55	60	100	95	160	165	165	165	**100**
Reconstruction	155	150	160	285	390	200	300	200	165	165	165	**215**
Total	**370**	**370**	**390**	**525**	**640**	**495**	**600**	**570**	**550**	**550**	**550**	**510**

Source: NJDOT Bridge Management System.
Note: Dollar amounts are rounded to the nearest $5 million.

A planned investment level for initial (new) construction of bridges is not included because planning for construction of new bridges is currently beyond the purview of the Bridge Management Unit and its Bridge Management System (BMS). Projections of spending on construction of new bridges over the TAMP analysis period are currently unavailable.

Maintenance

Treatments classified under maintenance are those which are a reaction to unforeseen situations that arise and require immediate or prompt repairs. The maintenance dollar amounts remain at $70 million per year for the entire TAMP analysis period. After adjusting for an assumed three percent annual cost escalation, the purchasing power of the $70 million in FY 2029 would be $52 million. Besides inflation risk, there is a risk that the level of unforeseen repairs due to extreme weather or other events could be exceptionally high in one or more years.

The 2018 STIP funding allocation for maintenance is subtracted from the total 2018 STIP funding allocation to bridge asset management to provide the funding constraint for management system analysis. The BMS is used to determine the optimal allocation of the balance of bridge funding remaining among the other work types: preservation, rehabilitation, and reconstruction. The allocation among work types is constrained in the early years of the TAMP analysis period by the commitment of some of the funding to projects that are already programmed.

Preservation

Treatments classified under the preservation work type are those which prevent, delay, or otherwise reduce deterioration of bridge elements. NJDOT has adopted a bridge preventive maintenance program that specifies treatments, their cycle, and element condition criteria used to determine when each treatment should be applied. The Bridge Management Unit has determined that the dollar amounts for preservation should be increased relative to current levels and relative to the annual amounts in the 2018 STIP.

The investment strategy amounts for preservation reflect the increased emphasis on preservation spending recommended by the BMS, steadily increasing from $100 million in FY 2019 to $150 million in FY 2029. One of the main factors behind this gradual increase is that the increased emphasis on preservation aligns with the asset management emphasis in the MAP-21 legislation, and the projected condition benefits to the system that result from increased preservation investment amounts.

Rehabilitation

Treatments classified under the rehabilitation work type involve major work to restore a bridge's structural integrity and correct major safety defects. Dollar amounts remain relatively flat through FY 2019 to FY 2023, becoming greater in FY 2024 and FY 2025 than in prior years. The rehabilitation dollar amounts continue to increase from FY 2025 to FY 2026 and remain elevated throughout the remainder of the TAMP analysis period.

Reconstruction

Reconstruction dollar amounts increase during the period from FY 2022 to FY 2026 while ending the TAMP analysis period at a similar investment level as that expended in FY 2019. The Pulaski Skyway Rehabilitation Project is reflected in the elevated reconstruction spending in FY 2022 and FY 2023.

The BMS analysis finds that rehabilitation spending yields a higher benefit per dollar than reconstruction. Therefore, to offset the increased dollar amounts for preservation, the dollar amounts for reconstruction are reduced from the amounts in the 2018 STIP, while the amounts for rehabilitation are unchanged.

8.2.4 SHS Funding Needs and Gaps

The level of investment required to meet the TAMP State of Good Repair Objectives for the SHS are presented in Exhibit 8-3 and Exhibit 8-4 (following pages). Exhibit 8-3 shows that an average expenditure of $655 million per year is required to achieve the State of Good Repair Objective for SHS pavements by CY 2029. The planned investment of $400 million per year leaves an average annual gap of $255 million. Exhibit 8-4 shows that an average of $650 million per year is required to achieve the State of Good Repair Objective for SHS NBIS bridges by CY 2029. The planned investment of $510 million per year leaves an average annual gap of $140 million.

Exhibit 8-3: Investments and Gaps to Meet State of Good Repair Objective for SHS Pavements

	Pavement Investment by Fiscal Year ($ millions)											
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**Average**
Needed for SOGR	655	655	655	655	655	655	655	655	655	655	655	**655**
Investment Strategy	355	310	310	350	315	420	345	450	520	520	520	**400**
Gap	300	345	345	305	340	235	310	205	135	135	135	**255**

Source: NJDOT Pavement Management System.
Notes: "SOGR" = State of Good Repair, of which the objective is 80% of pavement lane miles in *Good* or *Fair* condition. The dollar amounts shown are from *Chapter 4: Performance Gap Analysis*; however, they are rounded here to the nearest $5 million.

Exhibit 8-4: Investments and Gaps to Meet State of Good Repair Objective for SHS NBIS Bridges

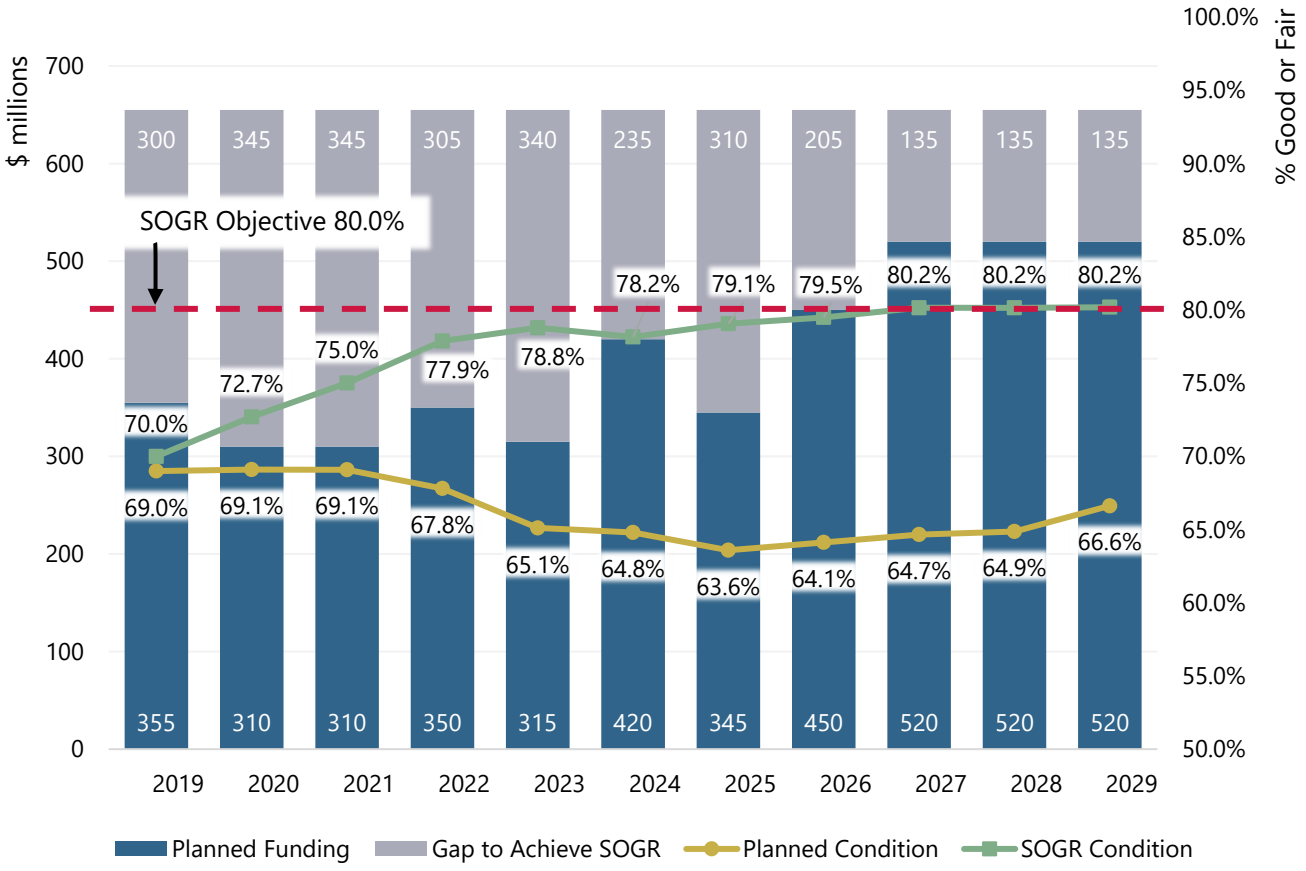
	Bridge Investment by Fiscal Year ($ millions)											
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**Average**
Needed for SOGR	370	380	530	675	800	665	780	760	740	740	740	**650**
Investment Strategy	370	370	390	525	640	495	600	570	550	550	550	**510**
Gap	0	10	140	150	160	170	180	190	190	190	190	**140**

Source: NJDOT Bridge Management System.
Notes: "SOGR" = State of Good Repair, of which the objective is 94% of bridges by deck area in *Good* or *Fair* condition. The dollar amounts shown are from *Chapter 4: Performance Gap Analysis*; however, they are rounded here to the nearest $5 million. Approximately $51 million per year funding for inspections, administration of the Bridge Management System, and management of other structures (culverts, sign structures, etc.) is additional to the dollar amounts shown here for both the SOGR needs and the Investment Strategy.

The State of Good Repair funding needs and gaps are based on an assumed three percent annual increase in unit costs of all pavement and bridge treatments. There is the risk that the funding gap could be greater than shown, if cost escalation exceeds this assumed rate, or if the legislature does not appropriate the funding projected in the TAMP financial plan used to formulate these investment strategies.

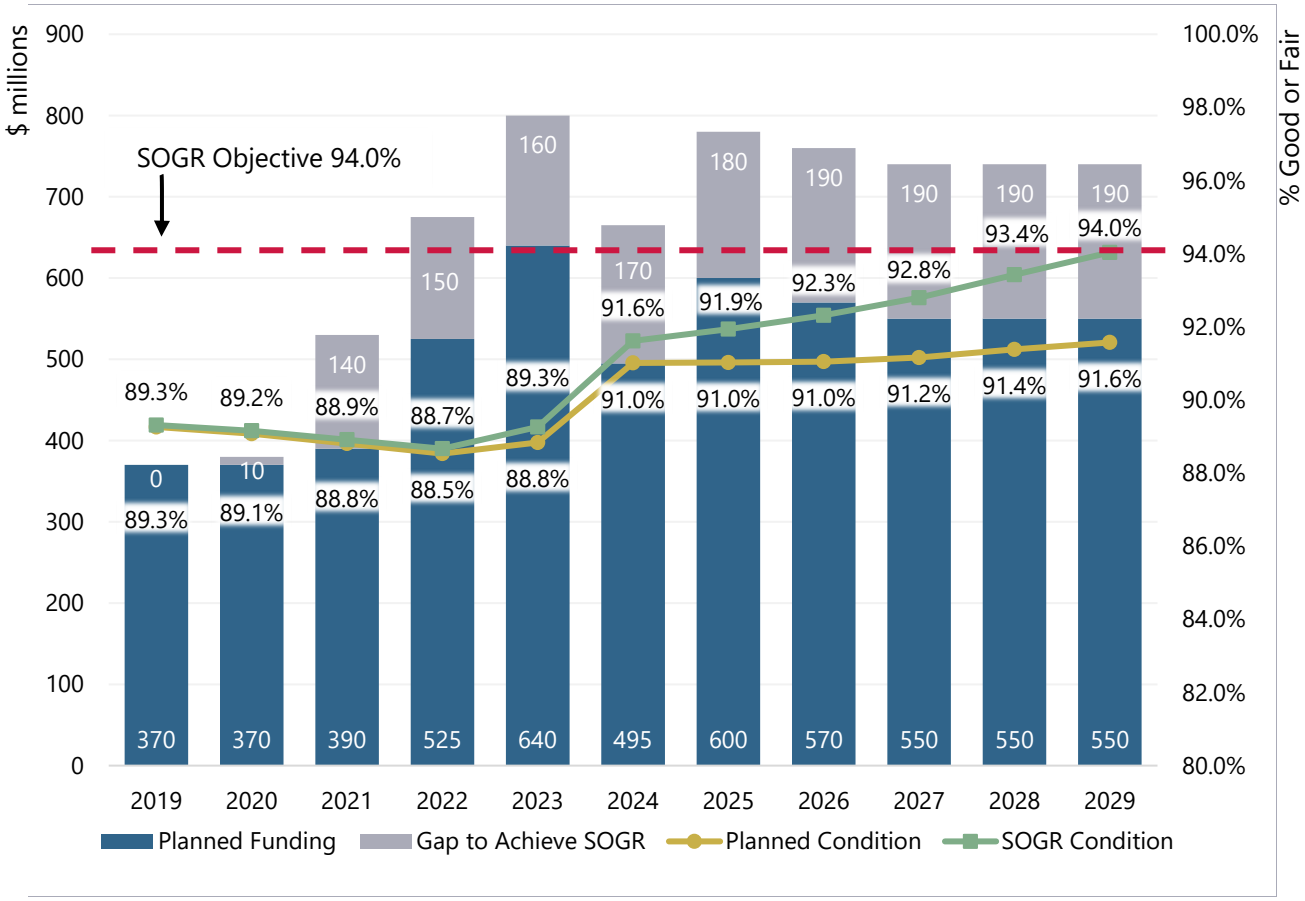
Exhibit 8-5 and Exhibit 8-6 (following pages) compare needed and planned total investments for each year of the TAMP analysis period, along with lines connecting performance in each year.

Exhibit 8-5: SOGR Funding Needs and Planned Investment for SHS Pavement Assets ($ millions) and Projected Performance (% Good or Fair)



Source: NJDOT Pavement Management System.
Note: Pavement performance reflects a one-year lag from spending to change in condition. SOGR = State of Good Repair (*Good* or *Fair* condition).

Exhibit 8-6: SOGR Funding Needs and Planned Investment for SHS NBIS Bridges ($ millions) and Projected Performance (% Good or Fair)



Source: NJDOT Bridge Management System.

Note: Bridge performance reflects a two-year lag between rehabilitation and replacement spending and change in condition. SOGR = State of Good Repair (*Good* or *Fair* condition).

8.3 Investment Strategy for the NHS

The NHS investment strategy is a compilation of NJDOT investment strategies and planned expenditures by non-NJDOT NHS owners. The NJDOT investment strategies for SHS pavement and bridge assets are noted in Section 8.2. The NJDOT investment strategy for the SHS is the foundation for the NHS investment strategy. NJDOT manages its pavement and NBIS bridge assets without distinguishing between assets on or off the NHS. The investment level on NJDOT NHS pavement is projected to be 88 percent of the total NJDOT pavement investment. That level of investment reflects the percentage of SHS pavement lane miles on the NHS. The level of investment on NHS bridges is projected to be 85 percent of the total NJDOT bridge investment. The 85 percent expenditure is slightly higher than the 81 percent of SHS bridges by deck area on the NHS.

The NJDOT investment levels are combined with estimates of expenditures from other NHS owners, as noted in *Chapter 7: Financial Plan* (see Section 7.5). Collected financial data from other NHS owners is used to estimate expenditures on the non-NJDOT NHS assets. The level of detail in the information

from other NHS owners does not support a breakdown of spending by work type for the NHS. The NHS investment strategy is presented in Exhibit 8-7.

Exhibit 8-7: Investment Strategy for NHS Pavement and NBIS Bridges

Asset	Investment by Fiscal Year ($ millions)											
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Average
Pavements	380	340	340	375	345	440	370	465	530	530	530	420
Bridges	730	730	745	860	960	840	930	900	885	885	885	850

Note: SHS data based on the Planned Funding scenario. NHS data gathered through the TAMP outreach program. Dollar amounts are rounded to the nearest $5 million.

8.4 Linking the TAMP to the 10-Year STIP

The TAMP is informed by, and will in turn inform, transportation planning and capital programming in New Jersey. The primary New Jersey program development products are the New Jersey STIP, the New Jersey Statewide Transportation Capital Program, regional Transportation Improvement Plans (produced by Metropolitan Planning Organizations), and the capital plans of authorities and commissions that own NHS pavement and bridge assets. The TAMP investment strategies are intended to guide funding allocations in New Jersey's STIP development process, with implementation through New Jersey's Transportation Capital Program development process.

The TAMP process provides asset performance projections and recommended actions to the Transportation Asset Management Steering Committee and to NJDOT Senior Leadership. The Transportation Asset Management Steering Committee and NJDOT Senior Leadership review the projections and recommended actions, along with information related to other NJDOT objectives regarding the other core missions of Safety, Mobility and Congestion Relief, and Operations and Maintenance, to determine the best balance of investments to achieve policy objectives across asset classes within the New Jersey STIP.

Exhibit 8-8 depicts the role of the TAMP process in the NJDOT statewide planning process. The TAMP provides the framework for data-driven scenario analysis used in New Jersey's STIP development process. The TAMP investment scenario analysis uses the 2018 STIP as a funding constraint after current and planned expenditures were allocated in the 2018 STIP. In the future, the New Jersey STIP will incorporate data from the TAMP process prior to allocating funding.

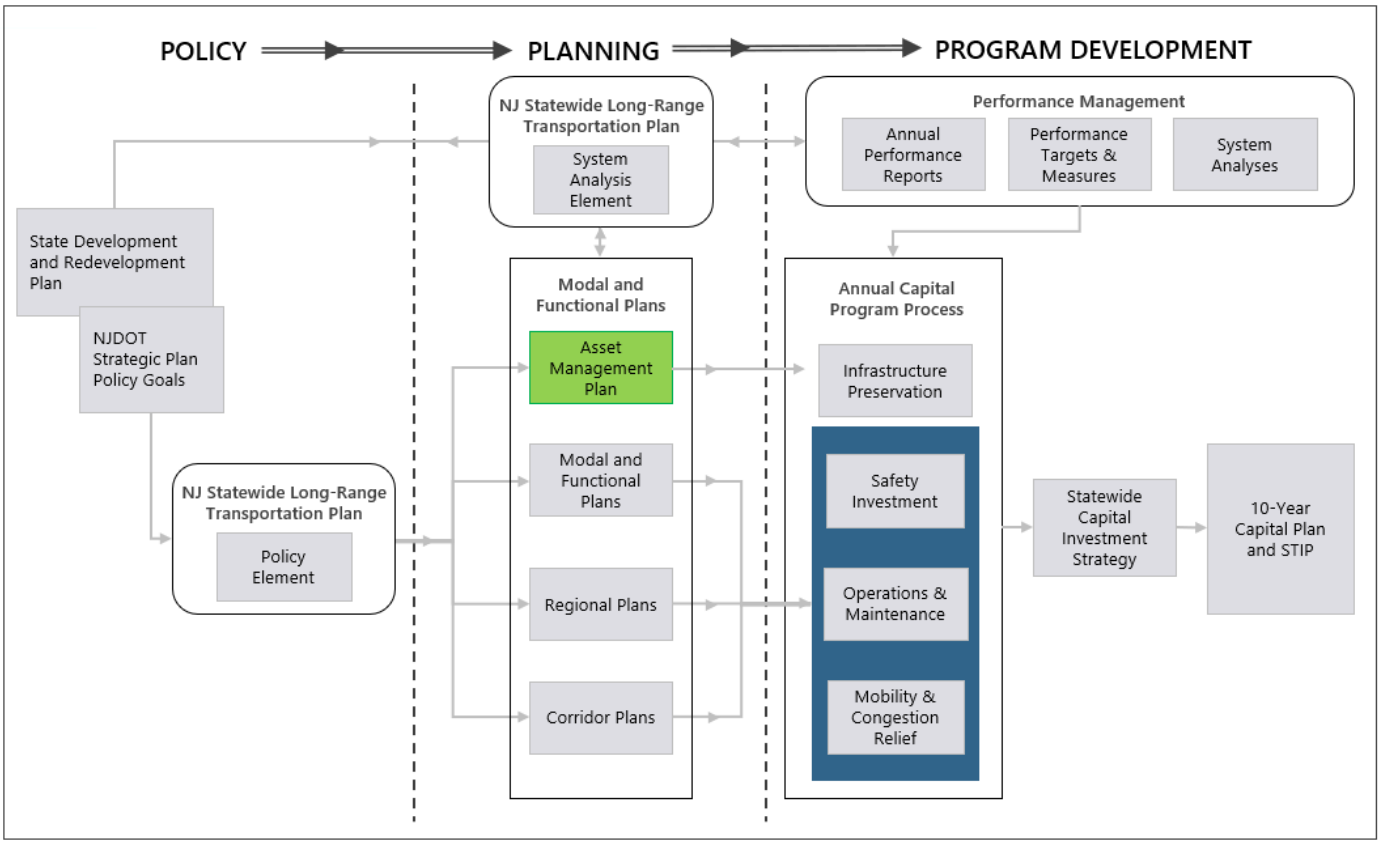
The development of future New Jersey STIPs will rely upon the collaborative effort of NJDOT Senior Leadership to determine funding priorities. The TAMP process offers the following support and guidance to NJDOT Senior Leadership:

- Describes current asset conditions by program category.
- Provides the source and use of funds by asset program category.

- Facilitates dialogue among NJDOT Senior Leadership about the current 2018 STIP level of performance, trade-offs among asset programs, and impact on core missions.
- Initiates transition to performance-based resource allocation.

Upon completion, future New Jersey STIPs become the funding plan for addressing bridge and pavement performance through the programmatic allocation of resources.

Exhibit 8-8: TAMP Process within NJDOT Integrated Planning Process



Note: Core Mission of "Mass Transit" not shown here under "Annual Capital Program Process" as it belongs to NJ Transit.

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Appendices

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Appendix A: Glossary of Acronyms and Definitions

Acronyms

AASHTO – American Association of State Highway and Transportation Officials
BMS – Bridge Management System
BrM – AASHTOWare Bridge Management software
CFR – Code of Federal Regulations
CY – Collection Year
dTIMS – Deighton's Total Infrastructure Management System
EADD – Engineering and Architectural Design Division
FAST – Fixing America's Surface Transportation
FHWA – Federal Highway Administration
FY – Fiscal Year
GIS – Geographic Information System
HPMS – Highway Performance Monitoring System
IRI – International Roughness Index
ISO – International Standards Organization
MAP-21 – Moving Ahead for Progress in the 21st Century
MPO – Metropolitan Planning Organization
NBI – National Bridge Inventory
NBIS – National Bridge Inspection Standard
NCHRP – National Cooperative Highway Research Program
NHPP – National Highway Performance Program
NHS – National Highway System
NJDOT – New Jersey Department of Transportation
NJTA – New Jersey Turnpike Authority
OMWP – Operating Major Works Program
PANYNJ – Port Authority of New York and New Jersey
PIRF – Project Initiation Request Form
PMS – Pavement Management System
QAD – Quality Assurance Division
SDI – Surface Distress Index
SEBM – Structural Evaluation and Bridge Management
SHS – State Highway System
SJTA – South Jersey Transportation Authority
SOGR – State of Good Repair
STIP – Statewide Transportation Improvement Program
TAMP – Transportation Asset Management Plan
TB&T – Tunnels, Bridges and Terminals
TTF – Transportation Trust Fund
TTFA – Transportation Trust Fund Authority

Definitions

The primary sources of information for this glossary are the AASHTO Transportation Asset Management Guide: A Focus on Implementation (AASHTO 2011), and the Code of Federal Regulations, Title 23, Chapter I, Subchapter F, Part 515.5.

Asset – All physical highway infrastructure located within the right-of-way corridor of a highway. The term asset includes all components necessary for the operation of a highway including pavements, highway bridges, tunnels, signs, ancillary structures, and other physical components of a highway.

Asset Class – Assets with the same characteristics and function (e.g., bridges, culverts, tunnels, pavements, or guardrail) that are a subset of a group or collection of assets that serve a common function (e.g., roadway system, safety, Intelligent Transportation (IT), signs, or lighting).

Asset Criticality – The importance of an asset and the level of risk that it may be exposed to.

Asset Management (AM) – The strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively throughout their life cycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well-defined objectives.

Asset Management Plan – A document that describes how a State DOT will carry out asset management, including how the State DOT will make risk-based decisions from a long-term assessment of the National Highway System (NHS), and other public roads included in the plan at the option of the State DOT, as it relates to managing its physical assets and laying out a set of investment strategies to address the condition and system performance gaps.

Baseline Condition – The initial condition of an asset at the start of an analysis period.

Capital Investment – Funds used by an agency to purchase assets, which generate revenue or value over the course of time.

Critical Infrastructure – Facilities of great importance, such that if they were to fail or be incapacitated, would have a debilitating impact on national or regional economic security, national or regional energy security, national or regional public health or safety, or any combination of those matters.

Condition – An indication of the physical state of the asset, which may or may not affect its performance.

Core Missions – NJDOT's mission has been broken up into five Core Missions. Performance data and expenditures are tied to the Core Missions: Infrastructure Preservation, Safety, Operations and Maintenance, Mobility and Congestion Relief, and Mass Transit.

Department of Transportation (DOT) – The agencies responsible for owning, maintaining, and improving transportation systems.

Depreciation – An expression of the consumption of the economic value of the asset through use. The value, capacity, or capability of the asset that is lost this way is restored through periodic replacement or reconstruction.

Deterioration Model – A model used to predict future asset condition and to estimate funding requirements.

Enhancement – When used in reference to the TAMP, an enhancement is defined as a significant modification or improvement that substantially changes a business practice or process, thus requiring an action plan and recertification upon implementation of the enhancement.

Financial Plan – A long-term plan spanning 10 years or longer, presenting a State DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets for asset condition during the plan period, and highlighting how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies.

Gap Analysis – The area of deviation between the current and desired states, which can be used to determine the areas of TAM that require improvement.

Inventory – Provides a data infrastructure to tie together the various data sets required for a comprehensive, mature asset management process. Additionally, the term can also apply to the identification and classification of the assets owned or maintained by an organization.

Investment Strategy – A set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks.

Level of Service (LOS) – Classifications or standards that describe the quality of service offered to road users, usually by specific facilities or services against which service performance can be measured.

Lifecycle – The phases of the life of an asset, which are planning, design, construction, operations, and disposal.

Lifecycle Cost – All the costs that an agency incurs in managing assets from the creation of the asset to its ultimate disposal.

Lifecycle Planning – A process to estimate the cost of managing an asset class, or asset sub-group over its whole life with consideration for minimizing cost while preserving or improving the condition.

Minimum Practicable Cost – The lowest feasible cost to achieve the objective.

Mobility – Origin-destination travel time.

National Highway System – The National Highway System (NHS) is a network of strategic highways within the United States, including the interstate highway system and other roads serving major airports, ports, rail or truck terminals, railway stations, pipeline terminals, and other strategic transport facilities.

Performance – The ability of an asset to provide the required level of service.

Performance Gap – The difference between the desired performance and the current or projected performance.

Performance Measure – Quantifies how well the agency is accomplishing its strategic goals and objectives as described in the TAM.

Periodic Maintenance – Activities that are done at a regular frequency to help preserve the inherent levels of service of an asset, including reliability and safety, at minimum cost.

Planned Maintenance – Activities that are planned and not done as a response to an event. Planned maintenance processes include condition monitoring, periodic maintenance, and preventive maintenance.

Preventive Maintenance – Activities that are regularly performed on an asset to lessen the likelihood of it failing. It is performed while the asset is still in acceptable condition so that it does not deteriorate unexpectedly.

Prioritization – The process of arranging work or maintenance to be done for assets in order of relative importance.

Reactive Maintenance – Activities that are done to maintain the level of service of an asset as a response to an event, such as emergency repair, routine maintenance, and corrective action.

Reconstruction – The process of rebuilding an asset after it has reached a condition where otherwise less extensive treatments would not be enough to restore it to a desired condition.

Rehabilitation – A type of corrective action that is done to restore the original condition of an asset.

Reliability – The standard deviation of origin-destination travel time.

Repair – Maintenance work that is done on an asset to improve the condition to acceptable levels.

Replacement – A type of corrective action that is done to renew an asset by completely replacing it with a new asset.

Resilience – The capacity to recover quickly from shocks and events.

Resurfacing – The process of installing a new layer of asphalt over the existing pavement, also known as an overlay.

Risk (of an asset) – The threat to transportation operations caused by extreme events, other external hazards, and from asset failure arising from any cause. Some examples of causes of asset failure are poor condition, unexpected loading, or poor work practices.

Risk Identification – The process of documenting and categorizing risks by considering its likelihood and consequences.

Risk Assessment – The process of evaluating risks that involves determining the likelihood of an extreme event occurring, the consequences to the asset if the event were to occur, and the effect on mission, life, property, and the environment of the damage to the asset or loss of function caused by the extreme event.

Risk Management – The process of identifying sources of risk, evaluating them, and integrating mitigation actions and strategies into routine business functions of the agency.

Risk Prioritization – The process of creating a list that determines the order for addressing risks, based on their potential negative impact to the agency's performance objectives.

Risk Treatment – How the agency plans to address the identified risks. This may be done through its operational program, asset preservation program, or the addition of new investments.

Risk Monitoring – Systems that are used to keep track of identified risks, residual risks, and new risks. It also monitors the execution of planned strategies for the already identified risks and evaluates their effectiveness.

Routine Maintenance – A type of reactive maintenance that is done at fixed intervals.

State of Good Repair (SOGR) – A targeted condition state for assets, typically within an asset management program, that is designed to help an organization maximize its use of resources to pursue the condition state given a set of planning processes.

Statewide Transportation Improvement Program (STIP) – A statewide prioritized listing/program of transportation projects covering a period of four years that is consistent with the long-range statewide transportation plan, metropolitan transportation plans, and TIPS.

Strategic – The highest level of goals or objectives in an agency that affect the entire agency.

Tactical – The actions aimed at achieving a specific goal within an agency.

Targets – Predicted performance outcomes for specific measures that are typically synonymous with the goals and objectives of the TAMP.

Utility – Establishes a unit-less common scale for each performance measure and then combines them.

Work Type – Classification of asset treatments defined by FHWA which include: initial (new) construction, maintenance, preservation, rehabilitation, and reconstruction.

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Appendix B: Local NHS Owner Outreach Program

This appendix summarizes the NHS pavement and NBIS bridge assets for which NJDOT's outreach program was able to verify inventory and condition data, as well as related expenditures. As described in *Chapter 3: TAMP Governance, Policy, and Objectives* the TAMP process conducts a data collection program with non-NJDOT NHS owners regarding their inventory of NHS assets, including condition data from some owners, and recent and planned projects and expenditures on those NHS assets. The actions and data requested from each non-NJDOT NHS owner includes:

- ***Review and confirmation of*** the accuracy of NJDOT-provided maps and data relating to the inventory of non-NJDOT NHS pavement and NBIS bridge assets, including roadway segment and bridge identifying information.
- ***Review and/or provision of information relating to*** past project work, planned expenditures, and expected asset condition trends (for some owners) for non-NJDOT NHS pavement and NBIS bridge assets.

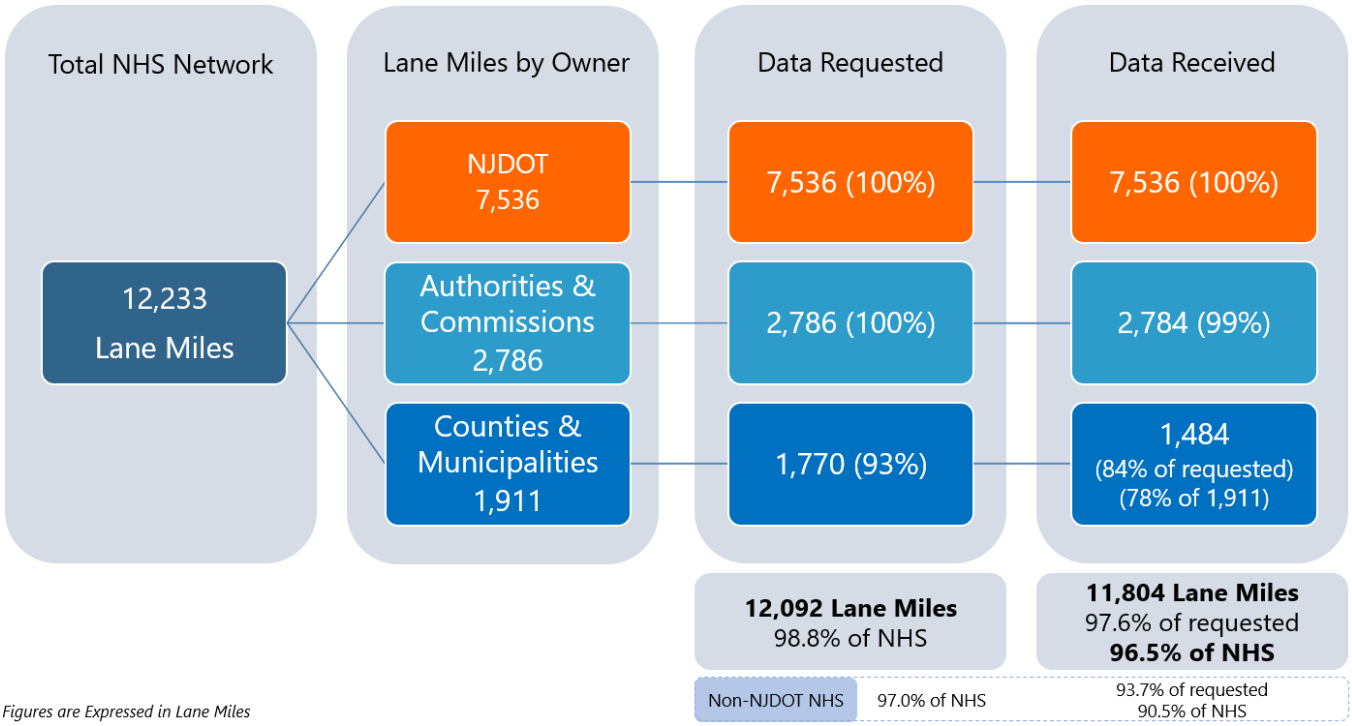
NHS Pavements

Outreach for NHS pavement data collection and verification involved 18 counties, 8 authorities/commissions, and 5 of the 53 municipalities that have responsibility for part of the NHS, as well as NJDOT's internal departments that provided data and verification for NJDOT-owned and/or maintained assets. In sum, a total of 35 out of 83 owners were contacted which represents approximately 12,092 out of 12,233 lane miles (98.8%) on the NHS. NJDOT will continue to work on improving data collection efforts to obtain best available data from the municipalities initially excluded in this 2019 New Jersey TAMP, which are summarized in Exhibit B-3. The results are further described in Exhibits B-1 and B-3. Ultimately, data was collected and verified for approximately 96.5 percent of NHS pavements.

NHS NBIS Bridges

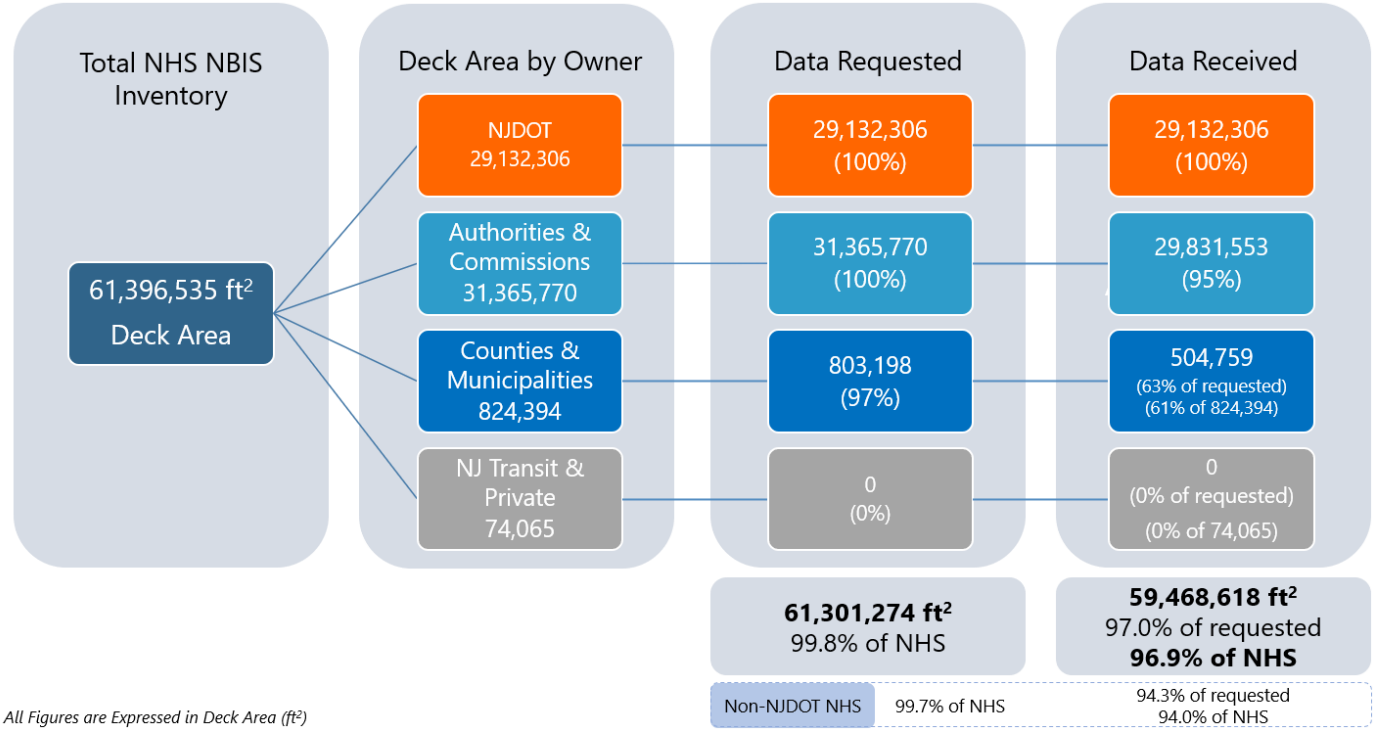
Outreach for NHS NBIS bridge data collection and verification involved 18 counties 8 authorities/commissions, and 1 municipality with responsibility for part of the NHS (as shown in Exhibit B-4), as well as NJDOT internal departments that provided data and verification for NJDOT-owned and/or maintained assets (Note: NJ Transit and private entities were not contacted; instead, data from the NBIS database was utilized). In sum, 28 out of 30 owners were contacted which represents approximately 61,301,274 out of 61,396,535 square feet of deck area (99.8%) on the NHS. The results are further described in Exhibits B-2, B-4, and B-5. Ultimately, data was collected and verified for approximately 96.9 percent of NHS NBIS bridges.

Exhibit B-1: NHS Pavement TAMP Data Collection Summary



All Figures are Expressed in Lane Miles

Exhibit B-2: NHS NBIS Bridge TAMP Data Collection Summary



All Figures are Expressed in Deck Area (ft²)

Exhibit B-3: NHS Pavement Lane Miles Owned by Municipalities & Counties

County	Municipality	Lane Miles
Atlantic	Atlantic City	16.4
	Egg Harbor Township	0.2
	Somers Point City	1.3
	Ventnor City	1.4
Bergen	Englewood City	4.8
	Fair Lawn Borough	0.1
	Fort Lee Borough	0.2
	Franklin Lakes Borough	0.3
	Lyndhurst Township	3.1
	Ramsey Borough	0.6
	River Edge Borough	0.1
	Tenafly Borough	0.3
Camden	Camden City	6.0
	Gloucester City	1.1
Cape May	Ocean City	6.9
	Wildwood City	1.0
Essex	East Orange City	4.6
	Maplewood Township	5.7
	Millburn Township	1.3
	Newark City	72.3
	Orange City	1.6
	West Orange Township	0.9
Gloucester	Deptford Township	1.2
	Washington Township	1.6
	Woodbury City	3.8
Hudson	Bayonne City	0.4
	Harrison Town	0.5
	Jersey City	9.8
	Weehawken Township	1.6
	West New York Town	1.6
Mercer	Hamilton Township	7.3
	Princeton Township	0.8
	Trenton City	21.3
	West Windsor Township	4.3
Middlesex	East Brunswick Township	0.2
	Edison Township	3.9
	Metuchen Borough	1.1
	New Brunswick City	1.4
	Woodbridge Township	1.7
Monmouth	Atlantic Highlands Borough	0.5
	Freehold Borough	2.6
	Freehold Township	0.1
	Highlands Borough	0.4

County	Municipality	Lane Miles
	Middletown Township	5.4
Morris	Madison Borough	0.9
	Morris Township	1.2
	Morristown Town	2.0
Passaic	Paterson City	12.3
	Wayne Township	6.7
Union	Elizabeth City	21.0
	Union Township	0.5
	Westfield Town	0.1
Warren	Phillipsburg Town	1.1

Note: All pavement lane miles owned by municipalities are non-interstate.

County	Lane Miles
Atlantic	46.8
Bergen	339.5
Burlington	130
Camden	142.8
Cape May	20
Cumberland	11.3
Essex	244.8
Gloucester	53.9
Hudson	88.6
Mercer	30.6
Middlesex	146.9
Monmouth	35.9
Morris	50.9
Ocean	134
Passaic	132.8
Somerset	14
Union	37.5
Warren	3.4

Note: All pavement lane miles owned by counties are non-interstate.

Exhibit B-4: NHS NBIS Bridge Deck Area Owned by Municipalities & Counties

County	Municipality	Deck Area (ft^2)
Essex	Newark City	21,235

County	Deck Area (ft^2)
Atlantic	61,668
Bergen	91,465
Burlington	20,736
Camden	32,314
Cape May	57,125
Cumberland	1,252
Essex	84,991
Gloucester	8,883
Hudson	113,237
Mercer	29,742
Middlesex	86,284
Monmouth	17,035
Morris	10,705
Ocean	25,391
Passaic	150,447
Somerset	2,903
Union	6,271
Warren	2,709

Exhibit B-5: NHS NBIS Bridge Deck Area Owned by Others

Owner	Deck Area (ft^2)
New Jersey Transit	65,616
Private Entities	8,449

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Appendix C: NHS Pavement Gap Analysis Technical Approach

This appendix describes the process for forecasting the conditions of interstate and non-interstate National Highway System (NHS) pavements in terms of the National Highway Performance Measures, as described in *Chapter 2: Asset Inventory, Performance Measures, and Baseline Conditions*, using output from the NJDOT pavement management system.

To support target setting as required by the Performance Management Rule and performance gap analysis as required by the Asset Management Rule, NJDOT needs to forecast pavement conditions in terms of the metrics and measures defined in 23 CFR 490. For this reason, the following methodology was developed and used to estimate future NHS pavement conditions in terms of the NHPP measures to support two- and four-year target setting and gap analysis.

The procedures for forecasting conditions in terms of the NHPP measures are as follows:

1. NJDOT compiles a data set using base year pavement condition data, from the pavement management database, which includes the following data elements for each segment of pavement for which NJDOT collects data (includes NJDOT-owned and/or maintained pavements, as well as those on the Atlantic City Expressway and Palisades Interstate Parkway) in the pavement management system:
    a. NJDOT's Condition Status (Percent *Good*/*Fair*/*Poor*).
    b. International Roughness Index.
    c. Rutting
    d. Wheel Path Cracking
    e. Slab Cracking
    f. Joint Faulting
2. The data set is analyzed to determine the relationship between the NJDOT Condition Status rating of *Good*/*Fair*/*Poor*, and the NHPP measures of *Good*/*Fair*/*Poor* to determine the best means of correlating the measures.
3. A determination is made as to the statistical correlation between the measures. Exhibit C-1 shows an example of factors used to correlate NJDOT's Condition Status to the NHPP measures in the 2019 TAMP.

Exhibit C-1: Example Conversion of NJDOT's Condition Status to NHPP Measures

NHPP Measure Rating	Condition Status Rating		
	Good	Fair	Poor
Good	0.94	0.06	0.00
Fair	0.23	0.77	0.00
Poor	0.08	0.85	0.07

These conversion factors provide a statistically valid correlation between the system-wide average of NJDOT's Condition Status (CS) and the system-wide average of the NHPP measures on the state-maintained system.

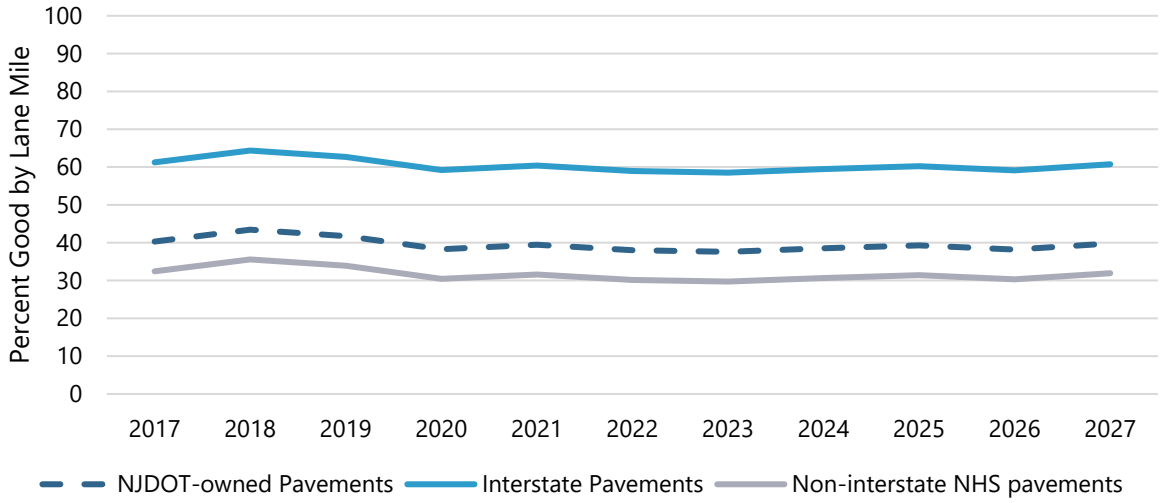
4. The above analysis is performed for pavement segments contained in the pavement management system and applied to outputs from the pavement management system. As described in *Chapter 4: Performance Gap Analysis*, the pavement management system only includes pavements owned and/or maintained by NJDOT and does not contain the entire NHS. As a result, the initial year of any prediction scenarios will not align with baseline NHS conditions, (i.e. SHS is not in the same condition as the NHS). To account for this and allow the pavement management system data to be used to estimate the condition of the NHS, the converted data must be aligned to the base year conditions for interstate and non-interstate NHS pavements. Exhibit C-2 show and example of the SHS-to-NHS correction factors.

Exhibit C-2: Example Correction Factors to Correlate NJDOT Pavement Performance with NHS Pavement Performance

Rating	Calculated NHPP Measure (SHS)	Baseline NJ Interstate NHPP Measure	Interstate Correction Factor	Baseline Non-interstate NHS NHPP Measure	Non-Interstate NHS Correction Factor
Good	40.3	61.25	20.94	32.45	-7.86
Fair	57.1	37.74	-19.32	65.17	8.11
Poor	2.6	1.01	-1.61	2.38	-0.24

The correction factors, calculated on the baseline year, are added to each year of the analysis scenarios, resulting in a shifting of each predicted performance curve along the Y-axis, while preserving the shape of the performance curves in subsequent years of the analysis. Exhibit C-3 shows how the results of converting NJDOT's Condition Status percent *Good* to NHPP measure percent *Good* for interstate pavements from a single analysis run.

Exhibit C-3: Example of Conversion of NJDOT's Condition Status to NHPP Measures



5. For years beyond the base year, a final adjustment must be made to account for differences in the expected performance of interstate and non-interstate NHS pavements based on the investment strategies of different system owners. To support this adjustment NJDOT made the following assumptions. Exhibit C-4 shows the breakdown of the interstate and non-interstate NHS pavement inventory used for this adjustment of forecast conditions.

   - Because NJDOT does not prioritize or select pavement projects based on functional class the future performance of the NHS (interstate and non-interstate) will be the same as the performance of the SHS relative to baseline conditions.
   - Investment on the non-NJDOT-owned NHS will largely follow historic trends. This is supported by *Chapter 7: Financial Plan*.
   - Because the STIP indicates that NJDOT, and local owners (counties and municipalities) are largely reliant on federal aid, for preserving and improving interstate and non-interstate pavement conditions, these pavements will perform the same regardless of ownership.
   - Because the of the current conditions, life cycle strategies, and financial resources of the New Jersey Turnpike Authority and South Jersey Transportation Authority, the performance of their pavements are expected to remain constant over the analysis period.

Exhibit C-4: Breakdown of NHS Pavements by Anticipated Performance

Owner	Interstate (Lane Miles)	Non-Interstate NHS (Lane Miles)
NJDOT & Local Owners	1,976	7,471
Authorities	1,006	1,780
Total	2,982	9,251
Percentage[1]	66.26%	80.76%

[1] Defined as the percentage of each network that we assume will perform the way NJDOT pavements will behave. Calculated as: [1,976 ÷ 2,982 = 0.6626] and [7,471 ÷ 9,251 = 0.8076]

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Appendix D: Supplementary Information on AASHTOWare Bridge Management Software (BrM)

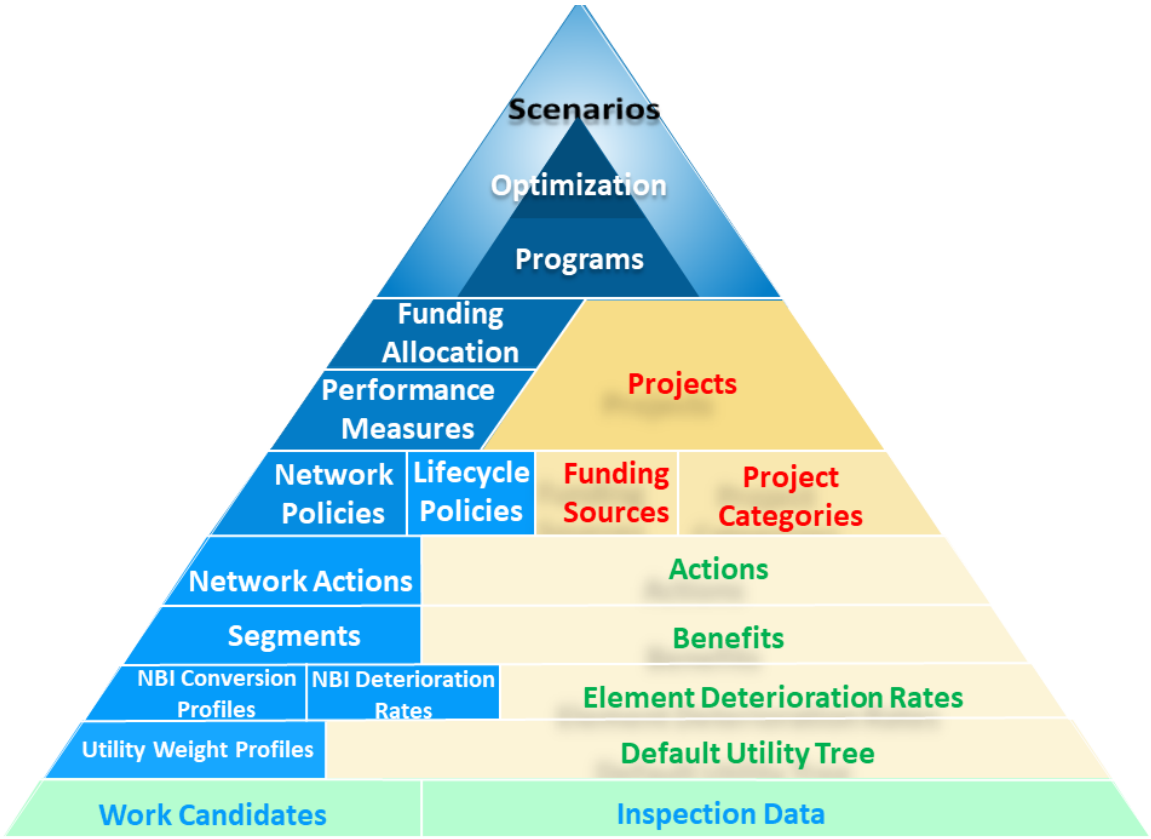
D.1 Overview

AASHTOWare Bridge Management (BrM) is a comprehensive bridge management system originally developed in 1989 (as Pontis) for the Federal Highway Administration (FHWA). The software is licensed through the American Association of State Highway and Transportation Officials (AASHTO) to over 50 State Departments of Transportation and other agencies. According to the BrM user manual, BrM specializes in:

- Allocating scarce resources to protect infrastructure investments, ensuring safety and maintaining mobility.
- Storing inventory and inspection information about an agency's bridges and other structures.
- Supplying a rich set of modeling and analysis tools to support project development, budgeting, and program development.
- Formulating network-wide preservation and improvement policies for evaluation of each structure in a network, making recommendations for the projects an agency should include in their capital plan.
- Providing the capability to analyze the impact of different project alternatives on the performance of individual structures or of an entire network of structures.
- Defining and scheduling projects for individual structures or for groups of structures.

The BrM 6 software pyramid presented in Exhibit D-1 displays the various modules that make up the software system. Select modules are described below, beginning with the base and working upwards. Module names are highlighted in bold the descriptive paragraphs that follow the exhibit.

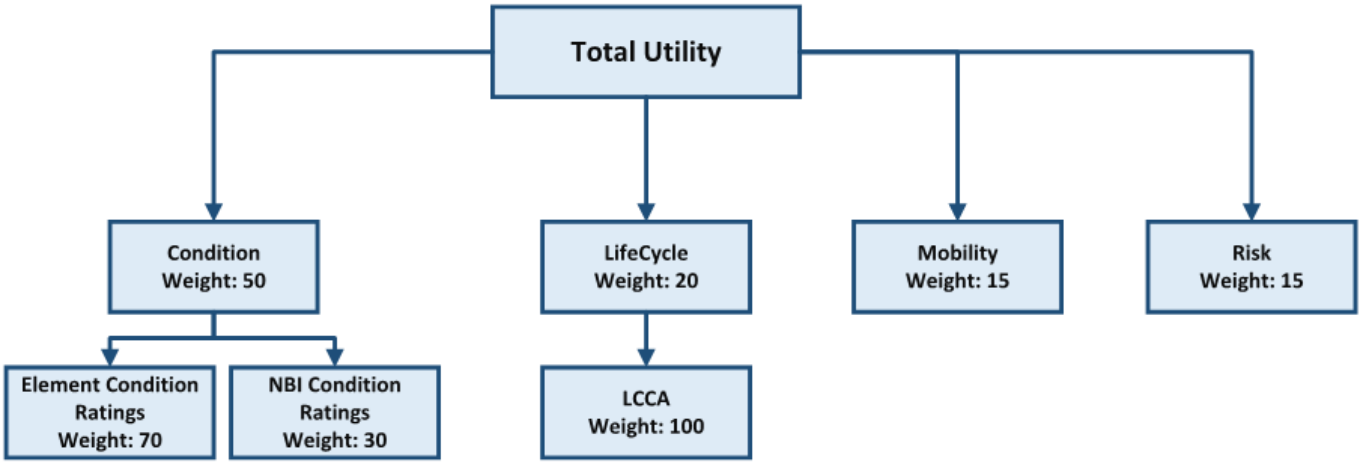
Exhibit D-1: AASHTOWare BrM 6.0 Pyramid



D.1.1 BrM Optimizer – The Utility Score

BrM 6 can be used to perform constrained optimization to recommend a set of bridge projects that maximize utility subject to a funding constraint. The utility score is the heart of this BrM optimization function. The BrM utility score can incorporate four objectives (criteria): (1) bridge condition, (2) lifecycle cost, (3) mobility, and (4) risk. For each bridge work candidate, BrM calculates a score for each of the four criteria. Default Utility Tree refers to the default scheme through which a set of weights is used to compile various utility criteria scores into a single utility score. A utility score ranges from 1 to 100 and is assigned to each bridge. A utility tree (or function) is made up of four criteria: condition, lifecycle cost, mobility, and risk. Exhibit D-2 presents the modified, default utility tree with various Utility Weight Profiles configured by the New Jersey Department of Transportation (NJDOT) for conducting the performance gap analysis for the Transportation Asset Management Plan (TAMP). BrM executes an optimization algorithm that considers, for each year, all the possible work candidates and associated utility scores for each bridge and selects the work candidates that maximize the utility score. This is done for each year of the TAMP analysis period.

Exhibit D-2: Utility Tree with Weight Profiles

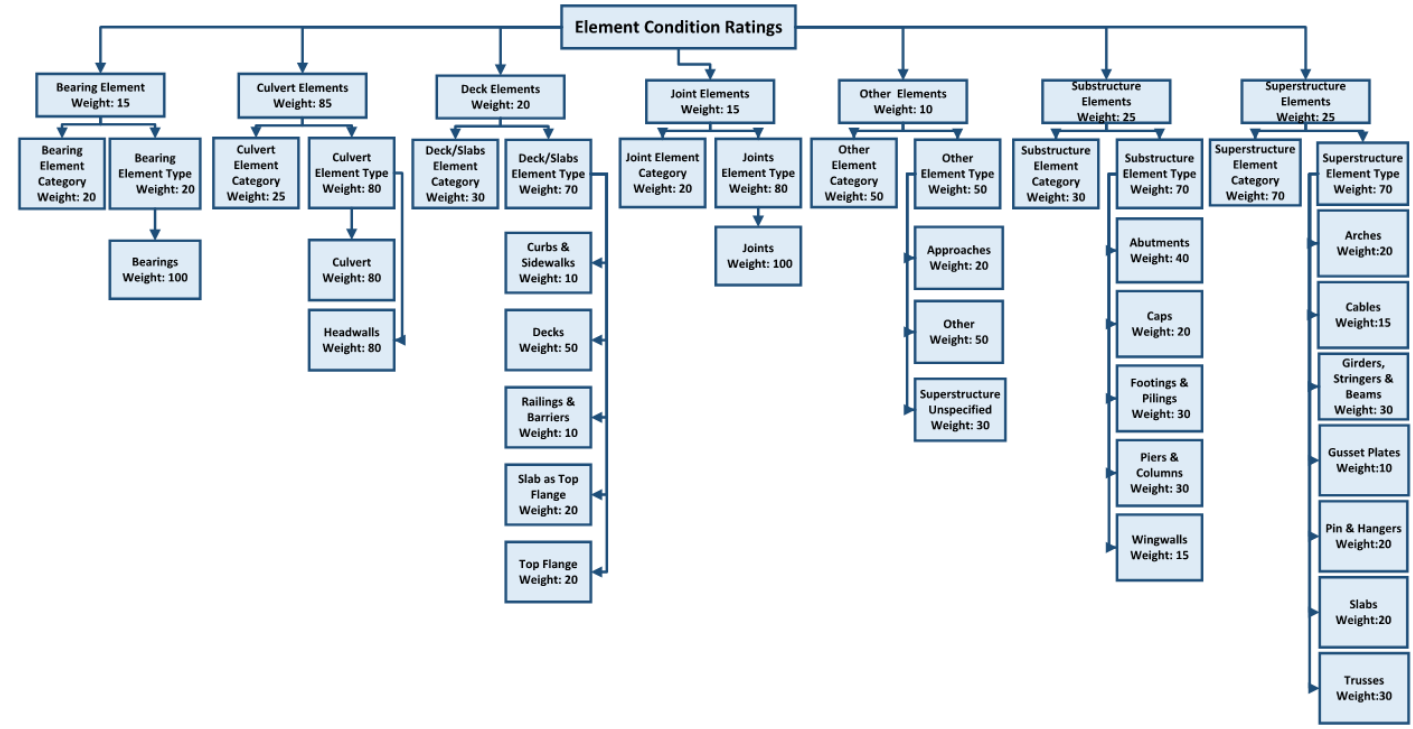


Source: NJDOT Bureau of Structural Evaluation and Bridge Management.

Exhibit D-2 shows that the condition objective was given the highest weighting (50 out of 100 weighting points). The bridge condition score is a composite of the bridge "Element Ratings" (expressed as a health index) and the bridge components' National Bridge Inventory ratings. Bridge inspectors rate each bridge element (concrete deck, metal railing, steel girder, concrete column, etc.) in terms of the percentage of the element that is in each of four progressively worse Condition States (CS) from CS1 to CS4. The health index is a composite of the condition state percentages that expresses the element health on a scale from 1 to 100.

Detailed branches for each node (condition, lifecycle, mobility, and risk) are presented in Exhibits D-3 through D-6.

Exhibit D-3: Utility Tree Condition Nodes



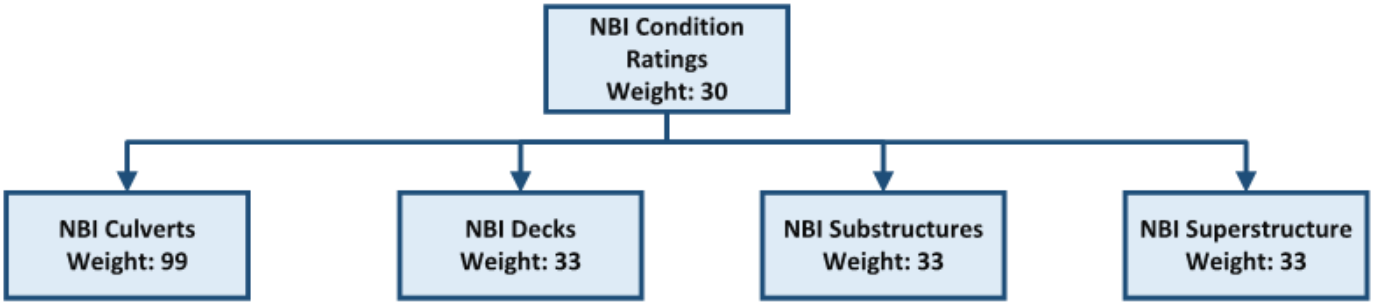


Exhibit D-4: Utility Tree Lifecycle Node

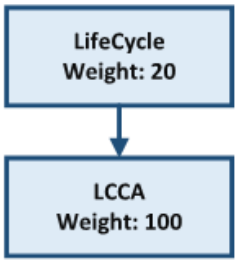


Exhibit D-5: Utility Tree Mobility Node

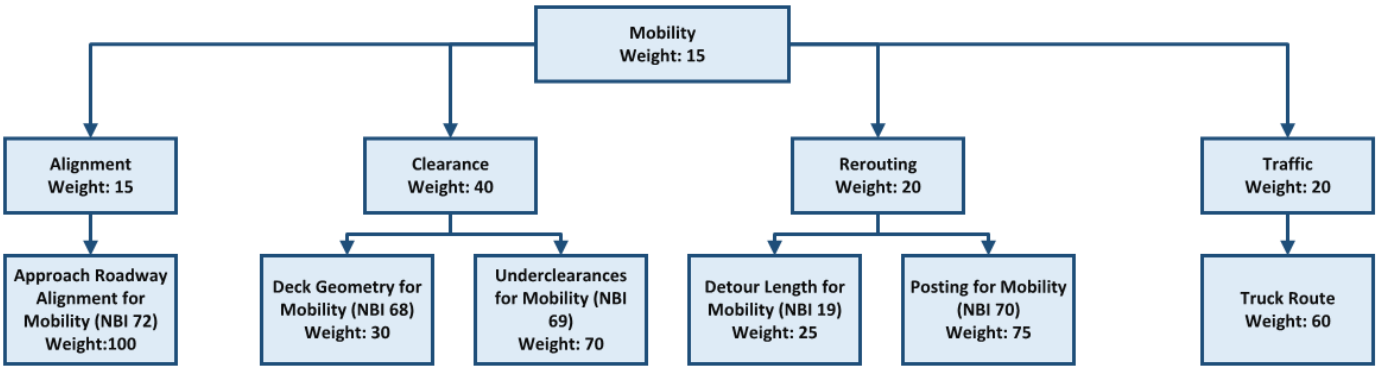
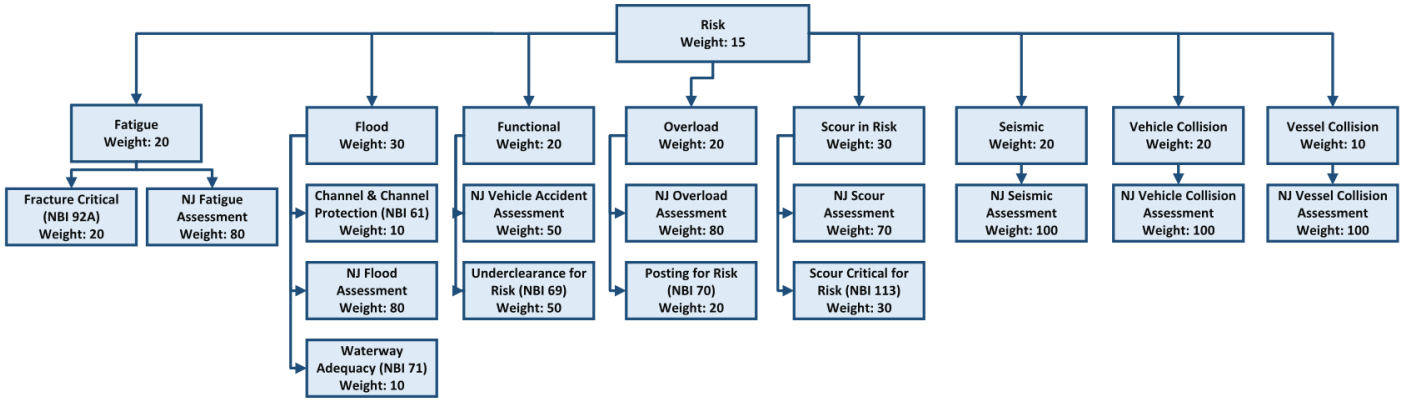


Exhibit D-6: Utility Tree Risk Node



Source: Bureau of Structural Evaluation and Bridge Management.

Exhibit D-2 shows that the condition objective was given the highest weighting (50 out of 100 weighting points). The bridge condition score is a composite of the bridge "Element Ratings" (expressed as a health index) and the bridge components' National Bridge Inventory ratings. Bridge inspectors rate each bridge element (concrete deck, metal railing, steel girder, concrete column, etc.) in terms of the percentage of the element that is in each of four progressively worse Condition States from CS1 to CS4. The health index is a composite of the condition state percentages that expresses the element health on a scale from 1 to 100.

The lifecycle cost score is calculated from the future stream of costs (the lifecycle costs) associated with the work candidate. The lifecycle cost score is calculated with the following formula:

$$\left(1 - \left(\frac{Short\ Term\ Costs + Long\ Term\ Costs - Residual\ Value}{(2 \times Replacement\ Cost)}\right)\right) \times 100$$

The formula for the lifecycle cost score gives a higher score to a work condidate that lowers the lifecycle costs. The lifecycle cost scoring uses the lifecycle policies input by the user (described below). The lifecycle policies are the "trigger rules" that state which treatments will be implemented under which conditions. These rules are applied over the specified period for lifecycle analysis, typically between 50 and 75 years. In the formula, the short-term and long-term costs are the costs that result from following the lifecycle policies that NJDOT has specified for the model.

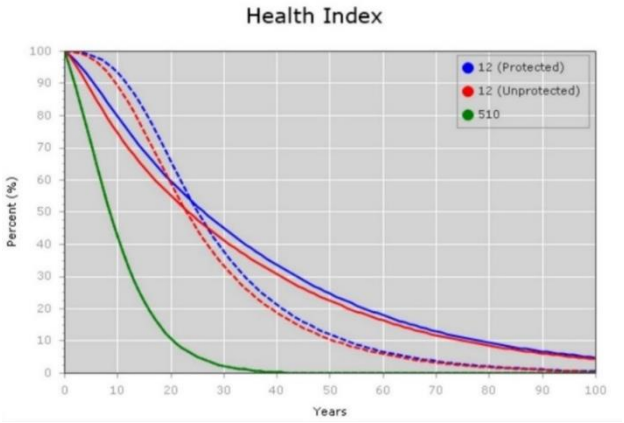
The mobility objective considers characteristics of the bridge that have implications for the mobility of travelers on or under the bridge. The existence of mobility restrictions lowers the score and treatments that remove an existing restriction raise the mobility score.

The risk objective includes several characteristics related to risk including scour critical status, vehicle collision risk, flood risks, and structural fatigue risks, among others. The lower the risk characteristics, the higher the risk score in the utility function. Treatments that lower risk will elevate the utility score for the bridge.

D.1.2 Deterioration Modeling

BrM projects the future health of bridge elements using probabilistic deterioration models. NJDOT's deterioration model parameters were established using expert elicitation. The NJDOT BrM model includes Element Deterioration Rates, NBI Component Deterioration Rates, and NBI Conversion Profiles that convert element ratings to NBI component ratings. on the component rating scale of one to nine. An illustrative set of deterioration curves is shown in Exhibit D-7. The graph shows alternative deterioration curves for Element 12 (reinforced concrete deck) with or without protective systems (Element 510) in place. Both the red (unprotected) and blue (with protective systems) lines show a decline in the health index over time, with the blue lines declining more slowly than the red lines. The solid versus dashed lines reflect different assumptions for the deterioration model parameters. The dashed lines represent a model in which the probability of deterioration from CS1 (*Good* condition) increases with the time spent in that condition. The solid lines represent a model in which there is no time component to the probability of deterioration. The green line charts the deterioration in Element 510, the protective system. As the protective system deteriorates, the difference between the protected (blue) and unprotected (red) curves narrows.

Exhibit D-7: Deterioration Curve for Reinforced Concrete Deck – Element 12



Source: 2018 Bridge Management Peer Exchange - Presentation by NJDOT on Initial Calibration of BrM 5.2.3 for NJDOT Initial TAMP, Bureau of Structural Evaluation and Bridge Management.

D.1.3 Treatments (Actions) and Their Lifecycle Benefits

BrM 6 includes actions and benefits that model the relationships between treatments and their benefits. The benefits are the changes that occur to a structure because of a treatment (action). Benefits are a change in the score of one or more of the utility modes. Benefits are measured as a change in the score of one or more of the utility nodes. In most instances, actions will change the utility score by shifting the deterioration curve, thus increasing the element rating in each future analysis year. The actions which yield these benefits have assigned unit costs that are used in the lifecycle cost analysis and in the constrained optimization runs.

For the TAMP, NJDOT has run BrM 6 with the seven actions and unit costs presented in Exhibit D-8. The unit costs were developed from recorded costs for various work on previous projects in the NJDOT Bid Express System. These costs include direct construction costs of a given element (concrete, rebar, and coatings) and indirect costs (mobilization, maintenance of travel flows), and other costs that are not part of the actual bridge element. Costs that are highly specific to a project such as right-of-way acquisition, permitting, and engineering, are not modeled within BrM. An annual escalation factor of three percent is applied to the unit costs shown in Exhibit D-8.

Exhibit D-8: NJDOT Actions and Unit Costs in BrM 6 for a Conventional National Bridge Inspection Standard (NBIS) Bridge

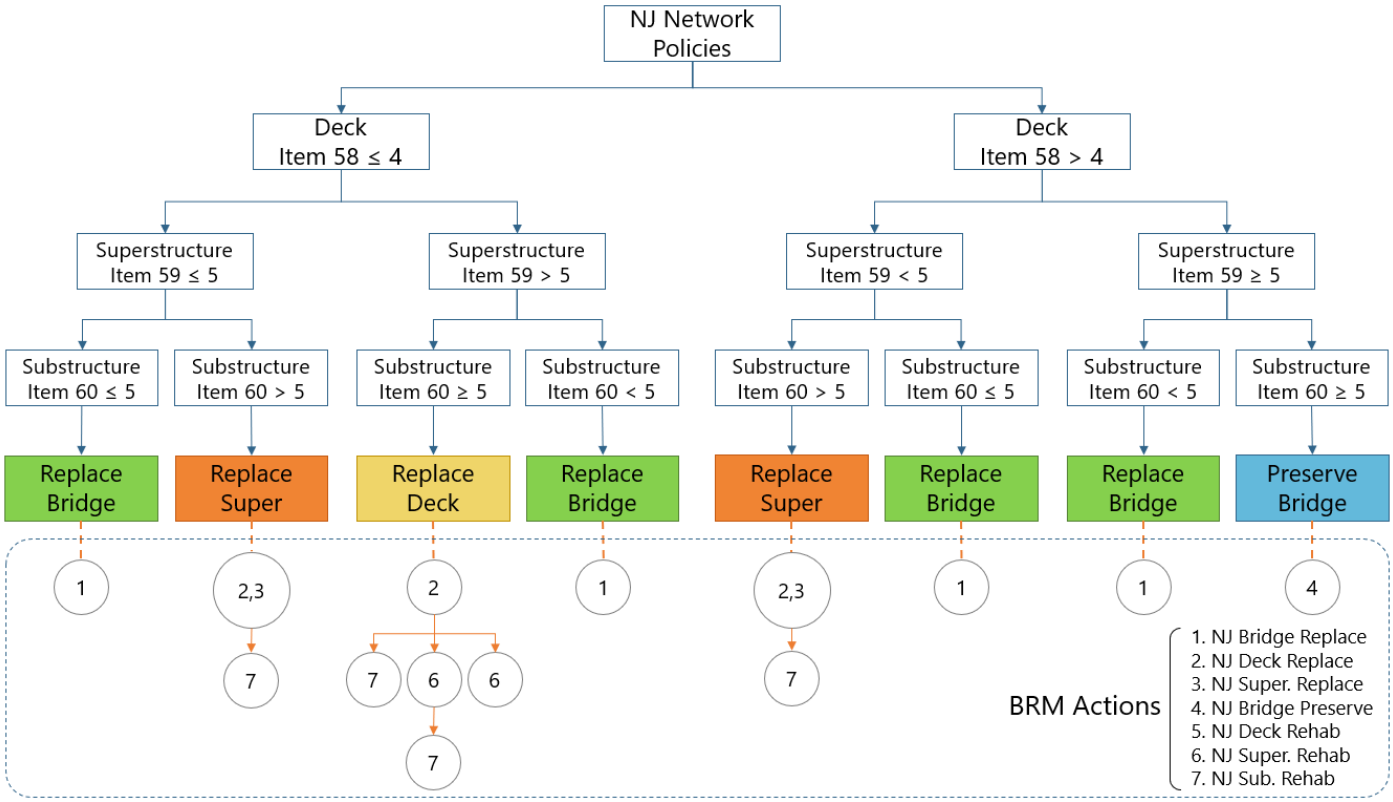
NJDOT Actions	Override Cost ($/SF)
Bridge Replace	$2,045
Deck Replace	$408
Superstructure Replace	$700
Bridge Preserve	$138
Deck Rehab	$ 86
Superstructure Rehab	$104
Substructure Rehab	$ 86

Source: Bureau of Structural Evaluation and Bridge Management.
Notes: Includes indirect costs (e.g., mobilization) and certain other costs not directly related to construction.

D.1.4 Network Policies

Within BrM 6, network policies serve as decision trees for actions or combinations of actions, along with the component conditions under which they would become work candidates. Network policies are analogous to "trigger rules" in the NJDOT Pavement Management System. The general purpose is to save computer run-time by ruling out actions that are not appropriate given the condition of the component. For example, a network policy would rule out preservation treatments when any component has a rating of four or lower. Exhibit D-9 presents the Network Policies for NBIS bridges that NJDOT has established in its current configuration of BrM.

Exhibit D-9: NJDOT Bridge Network Policies

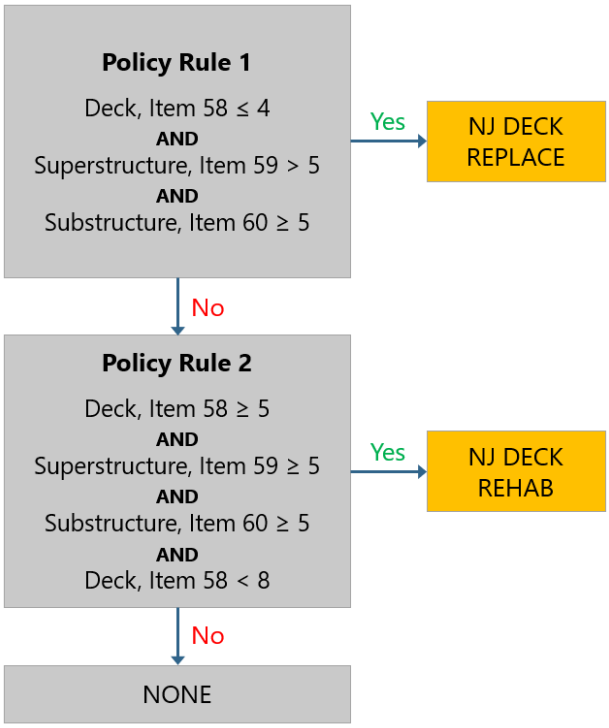


Source: 2018 Bridge Management Peer Exchange - Presentation by NJDOT on Initial Calibration of BrM 5.2.3 for NJDOT Initial TAMP, Bureau of Structural Evaluation and Bridge Management.

D.1.5 Lifecycle Policies

NJDOT has created and input five lifecycle policies in BrM 6. The lifecycle policies are used to compute the score for the lifecycle criterion of the Utility function. The lifecycle policies are also used to conduct lifecycle cost analysis in bridge-specific project analysis. Each policy includes multiple rules, and each rule is assigned to one resulting action. The policies are business rules that determine the conditions under which each possible treatment is applied. The example shown in Exhibit D-10 specifies under what conditions a deck should be replaced and under what conditions it should be rehabilitated (Deck Lifecycle Policy). Lifecycle policies look very much like network policies. Their uses in BrM differ, and they can have a different degree of detail from network policies.

Exhibit D-10: BrM Lifecycle Policy for Decks



Source: Bureau of Structural Evaluation and Bridge Management.

Lifecycle policy flowcharts have been developed for three other policies for NBIS bridges:

- Overall Bridge: replace or preserve
- Superstructure: replace or rehabilitate
- Substructure: rehabilitate or do nothing

D.1.6 Programs

A program in BrM is a set of selected BrM specifications that is run in the BrM optimizer to produce a set of recommended projects. A program is created by selecting the following (a partial list):

- Analysis start and end year.
- Bridge Subdivision (Segment)– a program can be run on a selected subset of the bridge network. There are many possible ways to filter the network: functional class of the road carried, District, NBI condition rating, type or scale of bridge, etc.
- Assigned Network Policies – choosing which policies are assigned is the means of limiting the treatments that BrM optimizer will consider. For example, a program aimed at determining the optimal way to invest a given preservation budget would assign only preservation network policies.
- Utility Weight Profile.
- Annual Funding Allocations for the specified period for lifecycle analysis.
- Performance Constraints – targeted levels of Performance Measures such as percent *Poor* by deck area.

The user can then run the created program in the BrM optimizer. If run in utility maximization mode, the BrM optimizer selects projects that maximize utility given a funding allocation. If the program is run in cost minimization mode, the BrM optimizer selects the projects that achieve the performance constraints at minimum cost.

D.1.7 Project Analysis ("Projects" in the BrM pyramid graphic)

Besides network optimization, BrM 6 can perform project analysis on individual bridges. For example, BrM can model the lifecycle cost effects of a superstructure repair project. It will calculate the lifecycle cost of the superstructure repair projects as follows:

- The cost of the repair project.
- Plus, the net present value of the stream of costs of the future projects that will be carried out on the bridge, given that the superstructure repair is undertaken (future projects are determined from the lifecycle policies).
- Minus the discounted present value of the bridge's residual value at the end of the specified period for lifecycle analysis (typically chosen from 50 to 75 years).

By slowing deterioration and deferring rehabilitation and replacement work further into the future, the candidate project would reduce the present value of that work and therefore reduce the net present value of the future stream of costs.

Appendix E: Risk Register

Risks to the accomplishment of the TAMP asset management policies and State of Good Repair Objectives are described on the following pages. Exhibit E-1 presents enterprise-level risks and Exhibit E-2 presents program-level risks.

Exhibit E-1: Risk Register – Enterprise-Level Risks

Risk Identification				Risk Analysis			Risk Management	
ID	**Assistant Commiss-ioner**	**Risk Type**	**Detailed Risk Statement**	**Impact**	**Likelihood**	**Risk Rating**	**Response**	**Response Action/Strategy Description**
1	Planning, Multimodal and Grant Administration	Information	If extreme weather hazards and their impact on the NJDOT/State Highway System (SHS) are not accounted for, Then NJDOT may lack resiliency efforts to mitigate the effects of extreme weather hazards on its system.	Very High	Medium (Possible)	30	Accept Opportunity	A. Finalize the GIS tool developed during the Federal Highway Administration's (FHWA) Extreme Weather, Proxy Indicators and Asset Management Pilot Program to visually identify vulnerable areas. Future work will consist of identifying process to use this tool and management of it, as well as additional information/data to be added. B. Establish a Senior Advisory Group and a Resiliency Working Group to determine ways to address resilience to climate change, current gaps, and collect input to address environmental risks in asset management and business practices within NJDOT.
2	Planning, Multimodal and Grant Administration	External Impacts	If funding shortfalls occur (or investment levels by work type are below those outlined in the investment strategies), Then NJDOT's planning efforts will be negatively impacted which may require trade-off decisions by lowering objectives and targets.	Very High	Medium (Possible)	30	Mitigate Threat	Continue to promote NJDOT/SHS needs through the TAMP, and the importance of adhering to the investment strategies.

Risk Identification				Risk Analysis			Risk Management	
ID	**Assistant Commiss-ioner**	**Risk Type**	**Detailed Risk Statement**	**Impact**	**Likelihood**	**Risk Rating**	**Response**	**Response Action/Strategy Description**
3	Transportation Operations Systems and Support	External Impacts	If NJDOT is unable to adequately communicate the how and why of asset management, Then the overall (capital) transportation program may not be adequately funded or properly implemented; Then the bridge vs pavement (capital) transportation program may not be adequately funded or properly implemented; Then the state vs others (capital) transportation program may not be adequately funded or properly implemented.	High	High (Likely)	28	Mitigate Threat	Develop a communication plan that includes outreach and education for necessary stakeholders.
4	Planning, Multimodal and Grant Administration	Information	If NJDOT continues to use metrics for the NJDOT/SHS network that are different from the metrics used for the National Highway System (NHS) network, Then there will be inconsistencies in asset management processes across the agency.	High	Medium (Possible)	21	Mitigate Threat	Clearly communicating the distinction between the networks, metrics, and goals/objectives within the TAMP.
5	Transportation Operations Systems and Support	External Impacts	If all roadway assets are not included in the TAMP, Then the system cannot be effectively managed, negatively affecting the overall agency objectives.	Moderate	Very High (Almost Certain)	35	Mitigate Threat	A. Programs are required to be developed for other assets to develop a mitigation strategy. B. Consider inclusion of additional asset types in future TAMPs.
6	Planning, Multimodal and Grant Administration	Information	If project/program deliveries are not met, Then project/program costs increase;Then the overall quality of the network decreases;Then there will be suboptimal treatments on assets;Then performance expectations will not accurately reflect the assumptions of original modeling.	Moderate	Very High (Almost Certain)	20	Mitigate Threat	Develop a dashboard/app to better manage program delivery according to the Statewide Transportation Improvement Program (STIP). Better delivery leads to better management.

Risk Identification				Risk Analysis			Risk Management	
ID	**Assistant Commiss-ioner**	**Risk Type**	**Detailed Risk Statement**	**Impact**	**Likelihood**	**Risk Rating**	**Response**	**Response Action/Strategy Description**
7	Planning, Multimodal and Grant Administration	Operational	If there is inadequate staffing and turnover of staff at NJDOT, Then the implementation of asset management practices at NJDOT will be prolonged due to additional onboarding needs and the time required to adequately replace subject matter experts with qualified staff.	Moderate	Very High (Almost Certain)	20	Mitigate Threat	Communicate needs based on deficiency. Elevate to department leadership as an enterprise issue extending beyond asset management.
8	Finance and Administration	External Impacts	If other jurisdictions do not complete any actions to implement processes outlined in the TAMP, Then the targets will not be met which will affect future funding needs.	Moderate	Very High (Almost Certain)	20	Accept Threat	Communicate the importance of the processes outlined in the TAMP with other agencies/jurisdictions.
9	Capital Program Management	Operational	If NJDOT is unable to adequately collect a complete set of financial data, Then this will hinder the ability to make good sound decisions regarding goals, performance measures, targets, program level prioritization, and negatively affect funding.	Moderate	High (Likely)	16	Mitigate Threat	A survey was developed to collect qualitative data on anticipated pavement funding and condition from other NHS pavement owners. For planned projects using funding from Bridge Assets, the Bridge Management System (BMS) will be kept in sync with the approved STIP. Anytime there is an update to the STIP (every 2 years), it will be reflected in the BMS and project information will be revised. The survey may be performed to collect planned information from other NHS NBIS bridge asset owners. For future projects, the anticipated funding and the condition information will be calculated based on NJDOT's current predictive capabilities, and survey performed to collect future projects by other NHS NBIS bridge assets owners.
10	Admin.	Operational	If other assets (including, but not limited to minor bridges, drainage, retaining walls, Intelligent Transportation System (ITS) assets, guiderail) are lacking clear and measurable goals, objectives and targets Then asset conditions cannot be effectively measured.	Moderate	High (Likely)	16	Mitigate Threat	Create policies and strategies to apply good asset management practices to the entire network.

Risk Identification				Risk Analysis			Risk Management	
ID	**Assistant Commiss-ioner**	**Risk Type**	**Detailed Risk Statement**	**Impact**	**Likelihood**	**Risk Rating**	**Response**	**Response Action/Strategy Description**
11	Capital Program Management	Information	If NJDOT's geospatial models are based on the outdated information, Then this will obstruct NJDOT's ability to make data-driven decisions due to its lack of ability to understand the interconnected geospatial relationships (GIS intersection analysis) over the lifecycle of each respective asset class.	Moderate	High (Likely)	16	Accept Threat	Address concerns of outdated geospatial data by continuing to improve the capabilities of the data warehouse and automatically update asset class data agency-wide.
12	Finance and Administration	Information	If there is no systematic prioritization process for all NHS owners/maintainers in New Jersey, Then NJDOT cannot effectively achieve its obligation to meet its set targets for the NHS.	Moderate	High (Likely)	16	Mitigate Threat	Share NJDOT's prioritization strategies with others and highlight the importance of applying a consistent method for the maintenance of NJ's transportation network.
13	Planning, Multimodal and Grant Administration	External Impacts	If human intentional threats and their impact on the NJDOT/SHS system are not accounted for, Then NJDOT may lack resiliency efforts to mitigate the effects of human intentional threats on its system.	High	Low (Unlikely)	14	Accept Threat	Incorporate human intentional threats as part of this and all future TAMPs by developing scenarios, mitigation strategies, and improving security measures that would minimize these threats.
14	Finance and Administration	External Impacts	If there is a change in federal transportation legislation requiring changes to the TAMP, Then the TAMP process will need to be re-evaluated based on any new legislation requirements; Then the cost of asset management projects may increase.	High	Low (Unlikely)	14	Accept Threat	A. Continue to stay up-to-date on legislation changes/updates/requirements. B. Monitor the cost of asset management projects as changes are published.
15	Planning, Multimodal and Grant Administration	External Impacts	If there is a need to compete for limited funding, Then State of Good Repair projects will be underfunded resulting in deterioration of the network condition and leading to increased lifecycle costs.	High	Low (Unlikely)	14	Accept Threat	Continue to monitor the availability of funds and apply AM plan for decision making regarding projects.
16	Capital Program Management	External Impacts	If a new administration (federal/states level) and/or policies is elected, Then NJDOT's priorities may shift.	Low	Very High (Almost Certain)	10	Accept Threat	Monitor any changes in administration and respective change of policies.

Risk Identification				Risk Analysis			Risk Management	
ID	**Assistant Commiss-ioner**	**Risk Type**	**Detailed Risk Statement**	**Impact**	**Likelihood**	**Risk Rating**	**Response**	**Response Action/Strategy Description**
17	Planning, Multimodal and Grant Administration	Operational	If costs escalate and cost estimating fluctuate, Then different agencies will determine costs in different ways, leading to inconsistent estimation; Then prices go up; Then cost estimating package accuracy will affect this risk differently; Then longer projections will lead to higher uncertainty; Then there is a risk of projects not being delivered, negatively affecting program objectives.	Low	Very High (Almost Certain)	10	Accept Threat	A. Continue to monitor/document any changes of costs. B. Consider best alternative to establish a reasonable consistent approach.
18	Capital Program Management	Operational	If technological hazards and their impact on the NJDOT/SHS system are not accounted for, Then NJDOT may lack resiliency efforts to mitigate the effects of technological hazards on its system.	Moderate	Low (Unlikely)	8	Accept Threat	A. Include cybersecurity as part of the developmental process of all technological advances/implementation in NJDOT's system to avoid dealing with these situations as an after-thought. B. Develop strategies, plans, and any training necessary to incorporate addressing technological threats as part of the TAMP.
19	Planning, Multimodal and Grant Administration	Information	If NJDOT lacks or has inadequate tools for lifecycle modeling, Then forecasts and expectations are going to be ineffective towards vital agency planning processes.	Low	High (Likely)	8	Accept Threat	Improve lifecycle modeling tools for asset classes and for managing across assets.
20	Capital Program Management	Information	If NJDOT is unable to adequately collect a complete set of condition and performance data, Then this will hinder the ability to make good sound decisions regarding goals, performance measures, targets, program level prioritization, and negatively affect funding.	Moderate	Low (Unlikely)	8	Mitigate Threat	Establish and implement a systematic approach to data collection.

Risk Identification				Risk Analysis			Risk Management	
ID	Assistant Commiss-ioner	Risk Type	Detailed Risk Statement	Impact	Likelihood	Risk Rating	Response	Response Action/Strategy Description
21	Finance and Administration	Information	If NJDOT is unable to standardize their architecture for data schemas, Then said datasets will reduce the reliability of the data being captured for each management system and result in the discouragement of communication with data between internal and external stakeholder silos.	Low	Medium (Possible)	6	Mitigate Threat	Enforce standardize schemas as a requirement to submit data into NJDOT's data warehouse.
22	Finance and Administration	Information	If NJDOT doesn't establish a data sharing process with external stakeholders, Then it will reduce the awareness and communication of issues between departments, stakeholders, and the public.	Low	Medium (Possible)	6	Mitigate Threat	Work with external stakeholder to develop a data sharing process to increase awareness and communication of ongoing data issues.
23	Planning, Multimodal and Grant Administration	Information	If NJDOT lacks a system to track programming for NHS roadways that are operated and maintained by external owners, Then NJDOT cannot accurately meet reporting requirements on the NHS as required by FHWA.	Low	Medium (Possible)	6	Accept Threat	Request external owners develop and implement method to track data and provide to NJDOT for TAMP reporting.
24	Planning, Multimodal and Grant Administration	Information	If it is unknown what type of roadways (NHS vs. non-NHS) receive non-federal expenditures, Then NJDOT will be unable to report on total expenditures for the entirety of the NHS.	Low	Low (Unlikely)	4	Mitigate Threat	Identify/implement method to track non-federal expenditures programmed by NJDOT-NHS vs Non-NJDOT NHS.
25	Planning, Multimodal and Grant Administration	Information	If the public comments negatively on the TAMP investment strategy, Then the desired investment may not occur.	Low	Low (Unlikely)	4	Accept Threat	Strengthen justification.
26	Planning, Multimodal and Grant Administration	Operational	If there is a delay in future TAMP submissions, Then NJDOT will have to incur costs of data collection or there will be gaps in reported condition data.	Low	Very Low (Rare)	2	Mitigate Threat	Make timely submission.
27	Planning, Multimodal and Grant Administration	Information	If condition and performance data are not provided by non-NJDOT NHS owners, Then NJDOT will have to incur costs of data collection or there will be gaps in reported condition data.	Very Low	Very Low (Rare)	1	Accept Threat	NJDOT will collect the data.

Exhibit E-2: Risk Register – Program-Level Risks

Risk Identification				Risk Analysis			Risk Management	
ID	Assistant Commissioner	Risk Type	Detailed Risk Statement	Impact	Likelihood	Risk Rating	Response	Response Action/Strategy Description
28	Finance and Administration	Operational	If NJDOT equipment and software is not properly maintained or upgraded due to obstacles in the procurement process or IT support, Then data required for Highway Performance Monitoring System (HPMS), asset management, and performance management regulations could be insufficient and/or incorrect leading to penalties for non-compliance.	High	High (Likely)	28	Enhance Opportunity	A. Implement management systems and strategies to maintain equipment and software needed for compliance. B. Develop contingency plan.
29	Capital Program Management	Physical Asset Failure	If we continue to see deterioration in asphalt binder as industry improves refinement process, Then treatment life/ performance will be greatly reduced resulting in pre-mature deterioration of the network.	High	High (Likely)	28	Mitigate Threat	Improve materials specifications.
30	Capital Program Management	Operational	If critical staff are lost or there is an obstacle to onboarding new staff due to the constraints of the civil servant system, Then data required for HPMS, asset management, and performance management regulations could be insufficient and/or incorrect leading to penalties for non-compliance.	High	Medium (Possible)	21	Mitigate Threat	Continue to train and grow expertise within the unit.
31	Capital Program Management	External Impacts	If we experience poor construction quality, Then treatment life/ performance will be greatly reduced resulting in pre-mature deterioration of the network.	High	Medium (Possible)	21	Mitigate Threat	A. Improve construction inspection process and specifications. B. Provide training to the industry and in-house staff.
32	Capital Program Management	External Impacts	If the number of contractors who can/will do pavement preservation treatments does not increase, Then preservation program cannot grow, and project costs are not optimized.	Moderate	Very High (Almost Certain)	20	Accept Threat	A. Continue to encourage competition within the industry through outreach and training. B. Demonstrate that NJDOT is increasing funding for its preservation program. C. Continue to explore alternate treatments that maybe more suitable for more contractors.

Risk Identification				Risk Analysis			Risk Management	
ID	Assistant Commiss-ioner	Risk Type	Detailed Risk Statement	Impact	Likelihood	Risk Rating	Response	Response Action/Strategy Description
33	Capital Program Management	Information	The Pavement Management System cannot accurately predict when major rehab and reconstruction is required. If many pavement projects require more costly treatments, Then the network pavement conditions predicted by the modeling software will not be correct and the recommended funding level will not be enough.	Very High	Low (Unlikely)	20	Mitigate Threat	Investigate new technology to perform structural evaluation at the network level.
34	Capital Program Management	Operational	If critical staff are lost or there is an obstacle to onboarding new staff due to the constraints of the civil servant system or a lack of subject matter expertise to run models, Then resources required to effectively run models could be insufficient and the model could become inaccurate.	High	Medium (Possible)	21	Accept Threat	Elevate to department leadership as an enterprise issue extending beyond asset management.
35	Capital Program Management	External Impacts	If the deterioration model is not configured accurately, or if the amount of benefit or credit for each treatment is not taken timely and accurately, Then future projects may not reflect the optimal treatment to be performed on the bridge assets in the given target year, resulting in BrM 6.0 creating projects in the future that may not happen at all in the given year (target year may get delayed).	Moderate	High (Likely)	16	Mitigate Threat	The initial models will be validated by our research partners. Any recommendation to calibrate/tweak such models to improve the efficiency of the models, specific to New Jersey needs, will be considered. Continue to train our BMS staff by using AASHTOWare's BrM 6.0 service units agreements, peer exchange meetings, and internal entities.
36	Capital Program Management	Information	If there is a lack of coordination between bridge maintenance and bridge management, Then lifecycle management strategies cannot be effectively implemented.	Moderate	High (Likely)	16	Mitigate Threat	Continue to improve the communication plan between Bridge Maintenance (custodian of Bridge Preventive Maintenance and Bridge Preservation) and BMS. Until Bridge Maintenance management system (called "Field book") is developed, we will be entering required information into BrM 6.0 manually to evaluate gap analysis and lifecycle planning for bridge assets.

Risk Identification				Risk Analysis			Risk Management	
ID	Assistant Commiss-ioner	Risk Type	Detailed Risk Statement	Impact	Likelihood	Risk Rating	Response	Response Action/Strategy Description
37	Capital Program Management	Information	If there is a lack of coordination of model data on planned bridge maintenance with data in the BrM 6.0 model, Then the model will be inaccurate and at risk of applying the wrong treatments at the wrong times/locations.	Moderate	High (Likely)	16	Mitigate Threat	Continue to improve the communication plan between Bridge Maintenance (custodian of Bridge Preventive Maintenance and Bridge Preservation) and BMS. If needed, some new models for Bridge Maintenance program will be developed and implemented in BrM 6.0 to properly apply credits for treatments performed. This TAMP will be utilized to validate the treatments' benefits applied to a bridge for both reactive and proactive actions taken.
38	Capital Program Management	Information	If we are applying new monitoring technologies, Then we can prolong the life of structures and reduce inspection costs.	Low	High (Likely)	8	Accept Opportunity	Continue to learn, train, and optimize new technologies to improve cost efficiencies and the life of assets.

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Appendix F: Part 667 Events

FHWA Final Rule 23 CFR 667 requires State DOTs to conduct a statewide evaluation to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events since January 1, 1997.

The statewide evaluation must include identification and consideration of any alternative that will mitigate, or partially or fully resolve, the root cause of the recurring damage, the costs of achieving the solution, and the likely duration of the solution. The evaluations must consider the risk of recurring damage and the cost of future repair under current and future environmental conditions.

As part of the evaluation, NJDOT conducted an analysis of the following:

- 8 Federal Emergency Declarations
- 22 Major Disaster Declarations
- 45 State of Emergency Declarations

The majority of damages and repairs to NHS infrastructure in the state of New Jersey identified during this analysis and data collection phase have been attributed to six (6) main events including:

- Hurricane Floyd (September 1999)
- Tropical Depression Ivan (September 2004)
- Nor'easter (April 2007)
- Hurricane Irene (August 201)
- Tropical Storm Lee (September 2011)
- Hurricane Sandy (October 2012)

There were no findings of repeated locations that have required repair and reconstruction activities on two or more occasions due to emergency events since January 1, 1997. The following exhibits list the identified Federal and State Emergency Declarations analyzed for this evaluation.

Exhibit F-1: Federal Emergency Declarations for New Jersey from January 1, 1997 to May 20, 2018

ID	Event	Incident Period	Date Declared
1	New Jersey Hurricane Sandy (EM-3354)	October 26, 2012 to November 08, 2012	October 28, 2012
2	New Jersey Hurricane Irene (EM-3332)	August 26, 2011 to September 05, 2011	August 27, 2011
3	New Jersey Hurricane Katrina Evacuation (EM-3257)	August 29, 2005 to October 01, 2005	September 19, 2005
4	New Jersey Power Outage (EM-3188)	August 14, 2003 to August 16, 2003	September 23, 2003

ID	Event	Incident Period	Date Declared
5	New Jersey Snowstorm (EM-3181)	February 16, 2003 to February 17, 2003	March 20, 2003
6	New Jersey Terrorist Attack Emergency Declaration (EM-3169)	September 11, 2001	September 19, 2001
7	New Jersey Virus Threat (EM-3156)	May 30, 2000 to November 01, 2000	November 01, 2000
8	New Jersey Hurricane Floyd (EM-3148)	September 16, 1999 to September 18, 1999	September 17, 1999

Exhibit F-2: Federal Major Disaster Declarations for New Jersey from January 1, 1997 to May 20, 2018

ID	Event	Incident Period	Date Declared
1	New Jersey Severe Winter Storm and Snowstorm (DR-4264)	January 22, 2016 to January 24, 2016	March 14, 2016
2	New Jersey Severe Storm (DR-4231)	June 23, 2015	July 22, 2015
3	New Jersey Hurricane Sandy (DR-4086)	October 26, 2012 to November 08, 2012	October 30, 2012
4	New Jersey Severe Storms and Straight-Line Winds (DR-4070)	June 30, 2012	July 19, 2012
5	New Jersey Severe Storm (DR-4048)	October 29, 2011	November 30, 2011
6	New Jersey Remnants of Tropical Storm Lee (DR-4039)	September 28, 2011 to October 06, 2011	October 14, 2011
7	New Jersey Severe Storms and Flooding (DR-4033)	August 13, 2011 to August 15, 2011	September 15, 2011
8	New Jersey Hurricane Irene (DR-4021)	August 27, 2011 to September 05, 2011	August 31, 2011
9	New Jersey Severe Winter Storm and Snowstorm (DR-1954)	December 26, 2010 to December 27, 2010	February 04, 2011
10	New Jersey Severe Storms and Flooding (DR-1897)	March 12, 2010 to April 15, 2010	April 02, 2010
11	New Jersey Severe Winter Storm and Snowstorm (DR-1889)	February 05, 2010 to February 06, 2010	March 23, 2010
12	New Jersey Snowstorm (DR-1873)	December 19, 2009 to December 20, 2009	February 05, 2010
13	New Jersey Severe Storms and Flooding Associated with Tropical Depression Ida and a Nor'easter (DR-1867)	November 11, 2009 to November 15, 2009	December 22, 2009
14	New Jersey Severe Storms and Inland and Coastal Flooding (DR-1694)	April 14, 2007 to April 20, 2007	April 26, 2007

ID	Event	Incident Period	Date Declared
15	New Jersey Severe Storms and Flooding (DR-1653)	June 23, 2006 to July 10, 2006	July 07, 2006
16	New Jersey Severe Storms and Flooding (DR-1588)	April 01, 2005 to April 03, 2005	April 19, 2005
17	New Jersey Tropical Depression Ivan (DR-1563)	September 18, 2004 to October 01, 2004	October 01, 2004
18	New Jersey Severe Storms and Flooding (DR-1530)	July 12, 2004 to July 23, 2004	July 16, 2004
19	New Jersey Severe Storms, Flooding and Mudslides (DR-1337)	August 12, 2000 to August 21, 2000	August 17, 2000
20	New Jersey Hurricane Floyd (DR-1295)	September 16, 1999 to September 18, 1999	September 18, 1999
21	New Jersey Coastal Storm (DR-1206)	February 04, 1998 to February 08, 1998	March 03, 1998
22	New Jersey Flooding (DR-1189)	August 20, 1997 to August 21, 1997	September 23, 1997

Exhibit F-3: State Emergency Declarations for New Jersey from January 1, 1997 to May 20, 2018

EO	Date	Governor	Explanation
73	8/22/97	Whitman	Declares State of Emergency due to torrential rainfall and resultant flooding and damages, etc., in counties of Atlantic, Burlington, Cape May, Cumberland and Ocean.
78	2/6/98	Whitman	Declares state of emergency existed and presently exists in Atlantic, Cape May, Monmouth and Ocean Counties.
98	8/5/99	Whitman	Declares state of water emergency exists throughout New Jersey.
101	9/15/99	Whitman	Declares a State of Emergency in the State of New Jersey due to flooding from Hurricane Floyd.
117	8/14/00	Whitman	Declares State of Emergency exists in Morris and Sussex Counties.
120	12/30/00	Whitman	Declares State of Emergency exists in New Jersey due to severe weather conditions caused by snow and blizzard conditions, including hazardous road conditions, high tides and coastal flooding.
124	3/4/01	DiFrancesco	Declares State if Emergency exists in New Jersey – Severe Winter Weather
130	7/3/01	DiFrancesco	Declares State of Emergency exists in Morris County – Accident leading to Bridge being unsound I-80
131	9/11/01	DiFrancesco	Declares State of Emergency in the State of New Jersey due to the Terroristic Attacks on the World Trade Center and the Pentagon.
11	3/4/02	McGreevey	Declares Water Emergency – Drought
27	8/14/02	McGreevey	Declares a state of emergency in Monmouth County – severe weather
28	8/28/02	McGreevey	Declares a state of emergency in Camden and Gloucester Counties – severe weather
48	2/16/02	McGreevey	Declares State of Emergency – severe winter weather
63	8/14/02	McGreevey	Declares State of Emergency – widespread power outages

EO	Date	Governor	Explanation
68	9/18/03	McGreevey	Declares State of Emergency – Hurricane Isabel
121	7/13/04	McGreevey	Declares that a State of Emergency presently exists in Burlington and Camden Counties – flooding and power outages.
15	1/22/05	Codey	Declares a State of Emergency presently exists throughout the State of New Jersey – Winter weather
59	10/14/05	Codey	Declares a State of Emergency presently exists throughout the State of New Jersey – severe weather
16	6/28/06	Corzine	Declares a State of Emergency presently exists throughout the State of New Jersey – severe weather
64	4/16/07	Corzine	Declares a State of Emergency presently exists throughout the State of New Jersey – Nor'easter
160	11/12/09	Corzine	Declares a State of Emergency for the counties of Cape May, Atlantic, Cumberland, Burlington, Ocean and Monmouth – Nor'easter
13	2/9/10	Christie	Declares and proclaim that a State of Emergency has existed in the aforesaid counties since 2/5/10 – Severe Winter Weather
18	3/12/10	Christie	Declares and proclaims that a State of Emergency exists – flooding and storm
55	1/25/11	Christie	Declare and proclaim that a State of Emergency exists within the Passaic Valley Sewerage District
57	3/9/11	Christie	Declares a Weather-Related State of Emergency – Flooding
73	8/25/11	Christie	Declare and proclaim that a State of Emergency exists in the State of New Jersey – Hurricane Irene
80	10/30/11	Christie	Declare and proclaim that a State of Emergency exists in the State of New Jersey – Strong winter-type storm
104	10/27/12	Christie	Proclaim that a State of Emergency exists in the State of New Jersey – Hurricane Sandy
106	11/1/12	Christie	Declares State of Water Emergency, Authorizes DEP to take steps to prevent water shortage
108	11/2/12	Christie	Declares a limited State of energy emergency with regard to the supply of motor fuel and implementing odd-even rationing for gasoline purchases in 12 New Jersey counties.
146	1/2/14	Christie	Declares a State of Emergency, authorizing the State Director of Emergency Management to active and coordinate the preparation, response and recovery efforts for the storm with all county and municipal emergency operations and governmental agencies. Governor Christie authorized the closing of state offices on Friday, January 3 for all non-essential personnel.
147	1/21/14	Christie	Declares a State of Emergency, authorizing the State Director of Emergency Management to active and coordinate the preparation, response and recovery efforts for the storm with all county and municipal emergency operations and governmental agencies. – Winter storm
148	2/3/14	Christie	Declares a State of Emergency, authorizing the State Director of Emergency Management to active and coordinate the preparation, response and recovery efforts for the storm with all county and

EO	Date	Governor	Explanation
			municipal emergency operations and governmental agencies. – Winter Storm
149	2/4/14	Christie	Governor Christie Declares State of Emergency in Preparation for Tuesday Night's Severe Winter Weather
150	2/12/14	Christie	Governor Christie Declares State of Emergency in Preparation for Wednesday Night's Severe Winter Weather
153	3/2/14	Christie	Governor Christie Declares State of Emergency in Preparation for Monday Morning's Severe Winter Weather
167	11/26/14	Christie	Governor Chris Christie today declared a State of Emergency, authorizing the State Director of Emergency Management to activate and coordinate the preparation, response and recovery efforts for the storm with all county and municipal emergency operations and governmental agencies. Commuters are asked to use extreme caution while traveling across the state. - Winter Weather
172	1/26/15	Christie	Declares and proclaims that a State of Emergency exists – Severe Winter Weather
175	3/4/15	Christie	Authorizes the State Director of Emergency Management to activate and coordinate the preparation, response and recovery efforts for the storm with all county and municipal emergency operations and governmental agencies. - Winter Weather
186	10/1/15	Christie	Governor Chris Christie today declared a state of emergency throughout the state as a result of severe weather conditions expected in the coming days. – Winds and Flooding
202	1/22/16	Christie	Governor Christie Declares State of Emergency Ahead of Arrival of Winter Storm
214	9/3/16	Christie	Governor Chris Christie Declares A State of Emergency for Ocean, Atlantic and Cape May Counties in Preparation for Tropical Storm Hermine
221	3/13/17	Christie	Governor Chris Christie declared a State of Emergency, authorizing the State Director of Emergency Management to activate and coordinate the preparation, response and recovery efforts for the storm with all county and municipal emergency operations and governmental agencies in preparation for Winter Storm Stella
14	3/6/18	Murphy	Declares the state emergency across all 21 counties in the state and allows for the extension of resources into other parts of the state as the storm continues to impact New Jersey. – Nor'easter
17	3/20/18	Murphy	Declares a State of Emergency exists throughout the State of New Jersey, effective at 7:00 p.m., Eastern Daylight Time, on March 20, 2018 – Nor'easter

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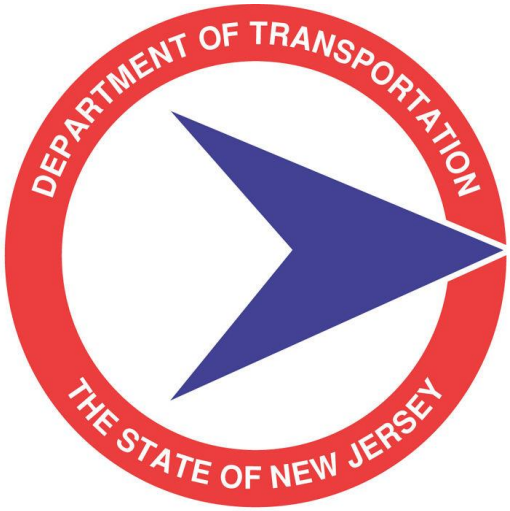
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