NEW YORK STATE OF OPPORTUNITY. Department of Transportation

# Transportation Asset Management Plan

**December 2022**

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

# Transportation Asset Management Plan

December 2022

Marie Therese Dominguez, Commissioner

# Table of Contents

# List of Figures

# List of Tables

# Acknowledgments

New York State Department of Transportation (NYSDOT) has created a multidisciplinary and cross functional team to develop its Transportation Asset Management Plan (TAMP). The team includes NYSDOT staff from Policy and Planning, Maintenance, Budget and Finance, Structures, and Technical Services, as well as members from the New York State Thruway Authority (NYSTA) and the Federal Highway Administration (FHWA). Oversight and governance of TAMP development was provided through NYSDOT's asset management business structure with support from the FHWA New York Division Office.

# Executive Summary

## GUIDING PRINCIPLES OF NEW YORK STATE'S ASSET MANAGEMENT PROGRAM

The primary focus of the New York State Department of Transportation's (NYSDOT's) and the New York State Thruway Authority's (NYSTA's) asset management efforts is the preservation and safety of the existing infrastructure. The State's objective is to manage the highway system as effectively as possible in an environment that encourages updating infrastructure that is nearing the end of its service life with available funding that is significantly lower than the system's needs. To ensure that good decisions are made in its efforts to preserve and enhance the safety and condition of the transportation system, the NYSDOT has adopted four guiding principles known as the Forward Four, as shown in Figure ES.1. An additional principle is public safety, which is inherent in all NYSDOT's investment decisions.

*Figure ES.1 The Forward Four.*

# NEW YORK STATE'S TRANSPORTATION ASSET MANAGEMENT PLAN

New York State's Transportation Asset Management Plan (TAMP) provides a window into NYSDOT's and the NYSTA's asset management practices. The TAMP also establishes a blueprint that includes considerations of both risk and life-cycle management. The TAMP documents current practices in the areas where they exist and identifies gaps that the State will address in the future. The TAMP is an important step forward in furthering governmental transparency and accountability.

Specifically, the TAMP:

- Defines the NYSDOT's and the NYSTA's asset management objectives.
- Summarizes the inventory and condition of National Highway System (NHS) highways and bridges, along with travel trends on the system.
- Documents a realistic estimate of funding expected to be available for the system over the next 10 years.
- Documents NYSDOT's asset management business structure, policies, and practices.
- Illustrates how risk is managed and presents a list of priority risks and mitigation strategies for addressing them.
- Describes how NYSDOT and the NYSTA manage their pavement and bridge assets throughout their lifetimes.
- Defines investment strategies used to guide the allocation of available funds.
- Lays out an agenda for future improvements to asset management and the TAMP.

The TAMP also addresses the current Federal requirements. Federal statute 23 USC 119(e) requires all State DOTs to develop a risk-based TAMP that, at a minimum, addresses pavements and bridges on the NHS. Additional TAMP requirements are provided in Federal regulation 23 CFR 515. This TAMP has been developed in accordance with current guidance from the Federal Highway Administration (FHWA) and complies with all Federal requirements.

To provide a full understanding of the asset management strategies practiced by NYSDOT, the NYSTA, and other ancillary owners of the NHS, this TAMP addresses all bridges and pavements that are on the NHS, with special emphasis on the portions of the NHS that are eligible for funding from the NYSDOT comprehensive program. Because a portion of this infrastructure is not owned by NYSDOT, local agencies that maintain portions of the NHS do so by applying State and local investment strategies with available financial resources. Therefore, NYSDOT maintains close and collaborative relationships with toll authorities, counties, cities, and other municipalities who own and operate portions of the NHS as well as Metropolitan Planning Organizations (MPOs) who are essential partners in the asset management process.

Users of the transportation system should not be concerned with what entity owns the highway. They should perceive a consistent experience as they travel along a corridor, regardless of jurisdiction or political boundaries crossed. Similarly, all asset owners who are eligible to both receive and invest in New York State or Federal transportation funds need a clear understanding and consistent set of performance standards, investment strategies, and project selection criteria.

# KEY ELEMENTS OF THE TAMP

## Asset Register

NYSDOT managers over 38,000 lane-miles of highway and more than 7,500 bridges. Together with other owners, the NHS in New York State includes nearly 20,000 lane miles of pavement and over 5,500 bridges (with decks totaling nearly 100 million square feet of total area).

NYSDOT manages its pavements using a customized composite rating of surface distresses, called surface rating, which rates the overall condition of the pavement on a scale of 1-10. NYSDOT uses this rating scale to summarize pavement conditions in terms of Excellent (9-10), Good (7-8), Fair (6), or Poor (1-5). Federal regulations require NYSDOT to report pavement conditions on the NHS using specific measures defined in 23 CFR 490 Subpart C. Federal bridge measures are defined in 23 CFR 490 Subpart D. The Federal pavement and bridge measures summarize pavement and bridge conditions as the percentage of assets in Good, Fair, or Poor condition based on specific distress metrics.

Tables ES.1 to ES.6 summarize the inventory and condition of New York State's pavements and bridges, which is based on data collected in calendar year 2020. For conditions in terms of the NYSDOT measures, pavement conditions are summarized in terms of the percentage of lane miles in Excellent and Good condition, "7+," and Poor condition, "5-."

*Table ES.1 Pavement inventory in lane-miles.*

| Highway System | NYSDOT | NYSTA | Others | Subtotal |
|---|---|---|---|---|
| Interstate | 5,495 | 2,426 | 142 | 8,063 |
| Non-Interstate NHS | 14,170 | 39 | 4,775 | 18,984 |
| Total NHS | 19,665 | 2,465 | 4,917 | 27,047 |
| Non-NHS Federal Aid Highways | 17,489 | 5 | 23,636 | 41,130 |
| Total Federal Aid Eligible | 37,154 | 2,470 | 28,553 | 68,177 |
| Non-Federal Aid Eligible | 1,134 | 29 | 169,069 | 170,232 |
| Total Statewide | 38,288 | 2,499 | 197,622 | 238,409 |

*Table ES.2 Pavement conditions based on national measures.*

| Highway System | % Good | % Fair | % Poor |
|---|---|---|---|
| Interstate | 45.3% | 53.6% | 1.1% |
| Non-Interstate NHS | 18.9% | 73.5% | 7.6% |

*Table ES.3 Pavement conditions based on NYSDOT surface rating.*

| Highway System | NYSDOT % Lane-Miles Pavement Rated 7+ | NYSDOT % Lane-Miles Pavement Rated 5- | NYSTA % Lane-Miles Pavement Rated 7+ | NYSTA % Lane-Miles Pavement Rated 5- | Others % Lane-Miles Pavement Rated 7+ | Others % Lane-Miles Pavement Rated 5- |
|---|---|---|---|---|---|---|
| Interstate | 70.00% | 2.30% | 76.50% | 1.20% | 95.10% | 0.10% |
| Non-Interstate NHS | 62.10% | 7.50% | 39.80% | 0.00% | 60.60% | 8.90% |
| Non-NHS Federal Aid Highways | 48.40% | 14.30% | 100.00% | 0.00% | 47.30% | 0.30% |
| Total Federal Aid Eligible | 61.60% | 9.90% | 76.20% | 1.20% | 64.20% | 0.50% |
| Non-Federal Aid Eligible | 47.40% | 21.90% | NA | NA | 55.50% | 18.90% |

*Table ES.4 Bridge inventory (by count).*

| Highway System | NYSDOT (Count) | NYSTA (Count) | Others (Count) | Sub-total (Count) |
|---|---|---|---|---|
| Interstate | 1,743 | 446 | 113 | 2,302 |
| Non-Interstate NHS | 2,599 | 62 | 570 | 3,231 |
| Total NHS | 4,342 | 508 | 683 | 5,533 |
| Non-NHS Federal Aid Highways | 2,665 | 147 | 1,935 | 4,747 |
| Total Federal Aid Eligible | 7,007 | 655 | 2,618 | 10,280 |
| Non-Federal Aid Eligible[1] | 533 | 113 | 6,616 | 7,262 |
| Total Statewide | 7,540 | 768 | 9,234 | 17,542 |

*Table ES.5 Bridge inventory (millions of square feet of deck area).*

| Highway System | NYSDOT (Deck Area) | NYSTA (Deck Area) | Others (Deck Area) | Sub-total (Deck Area) |
|---|---|---|---|---|
| Interstate | 30.4 | 11.0 | 9.3 | 50.7 |
| Non-Interstate NHS | 30.6 | 1.2 | 16.4 | 48.2 |
| Total NHS | 61.0 | 12.2 | 25.7 | 98.8 |
| Non-NHS Federal Aid Highways | 16.1 | 1.5 | 10.6 | 28.1 |
| Total Federal Aid Eligible | 77.1 | 13.6 | 36.2 | 126.9 |
| Non-Federal Aid Eligible[1] | 3.2 | 0.9 | 13.1 | 17.2 |
| Total Statewide | 80.3 | 14.5 | 49.3 | 144.1 |

[1] Unlike pavements, all bridges are eligible for Federal Aid. The breakdown by deck area based on the Federal Aid eligibility of carried route is shown in figure 2.9.

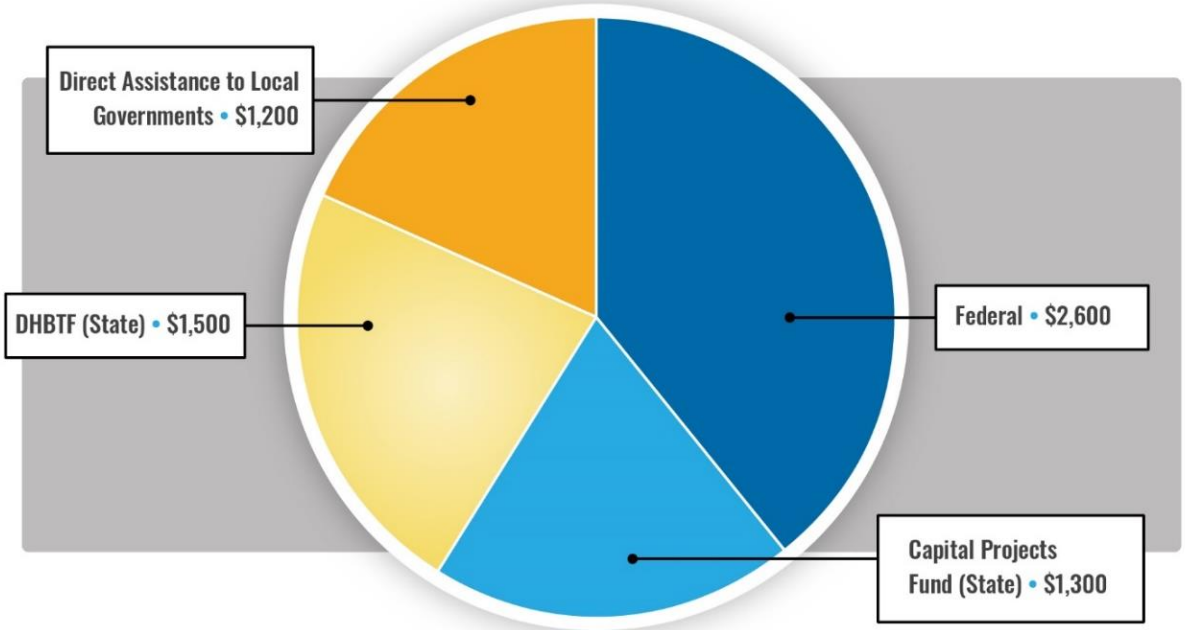
*Table ES.6 Bridge conditions weighted by deck area.*

| Owner Agency | NHS % Good | NHS % Fair | NHS % Poor |
|---|---|---|---|
| NYSDOT | 26.16% | 62.06% | 11.78% |
| NYSTA | 40.28% | 50.15% | 9.57% |
| Others | 16.38% | 74.33% | 9.29% |
| Total | 25.33% | 63.81% | 10.86% |

## Funding Available for Managing Highway Infrastructure

The State estimates that approximately $78 billion in funding will be available for highway infrastructure over the next 10 years between the NYSDOT and the NYSTA. The majority of that funding, approximately $65.6 billion, is managed by NYSDOT. Figure ES.2 shows the average annual funding forecasted for NYSDOT.

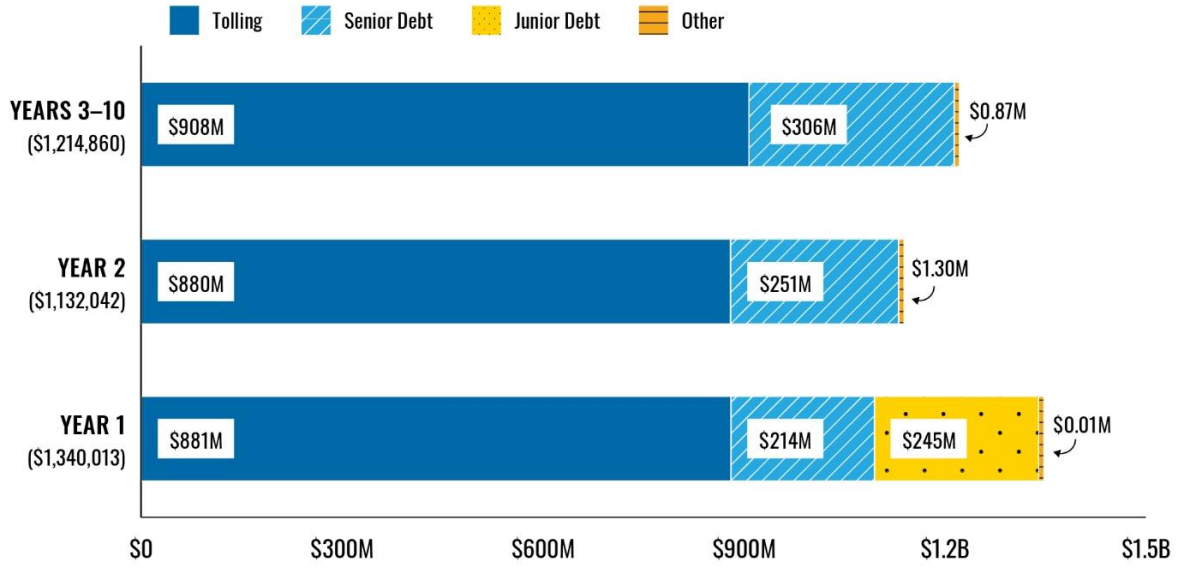
*Figure ES.2 Estimated average annual NYSDOT funding ($ millions)[2].*




[2] DHBTF is New York State Dedicated Highway and Bridge Trust Fund. For more information, see section 3.2.

The NYSTA expects to receive an additional $12.2 billion over the next 10 years, as shown in figure ES.3. However, this funding supports all aspects of the agency's missions, so not all of these funds are available for asset management of pavements and bridges on the NHS.

*Figure ES.3 NYSTA annual funding ($ thousands).*




Both agencies have many responsibilities that must be funded and some of the funds that are collected can only be used for certain functions. Table ES.7 shows NYSDOT's and NYSTA's current finance plan as it is distributed to these different missions. Only the core construction portion is available for asset management programming.

NYSDOT's current Capital Plan provides an average of nearly $6.6 billion in new capital program funding annually to improve the transportation system, enhance the system's resiliency, and create jobs. Of that amount, approximately $3.7 billion in new funding is provided annually to support NYSDOT's highway and bridge program including more than $2.8 billion in core construction funding for the repair, rehabilitation, and replacement of critical State and local infrastructure. In addition, approximately $1.3 billion in engineering, planning, right-of-way, inspections, administration, and other program delivery support is included. The capital program also provides $804 million in additional funding for traffic operations, safety, and routine maintenance, $430 million in additional funding for transit, modal projects, and transportation alternatives, and $1.2 billion in additional funding for direct assistance to local governments and off-system bridges. Of the $2.814 billion for core construction, an $830 million subset has been established for priority projects.

*Table ES.7 Total average annual funds available for core construction 2022-2031 ($ millions).*

| | |
|---|---|
| **NYSDOT Total Annual Funding (From Figure ES.2)** | **$6,560** |
| **Minus:** | |
| Engineering, planning, right-of-way (ROW), inspections, and administration | ($1,312) |
| Traffic operations, safety, and routine maintenance | ($804) |
| Transit, modal projects, and transportation alternatives | ($430) |
| Direct assistance to local governments and off-system bridges | ($1,200) |
| **Sub-total for NYSDOT core construction** | **$2,814** |
| **NYSTA Total Annual Funding (From Figure ES.3)** | **$1,132** |
| **Minus (From Fig. 3.6):** | |
| Thruway operating | ($382) |
| Debt service | ($360) |
| State police operating | ($67) |
| Arch, facilities, and equipment | ($47) |
| Other | ($1) |
| **Sub-total for NYSTA core construction funds** | **$275** |
| **Total Annual Average Core Construction Funds** | **$3,089** |

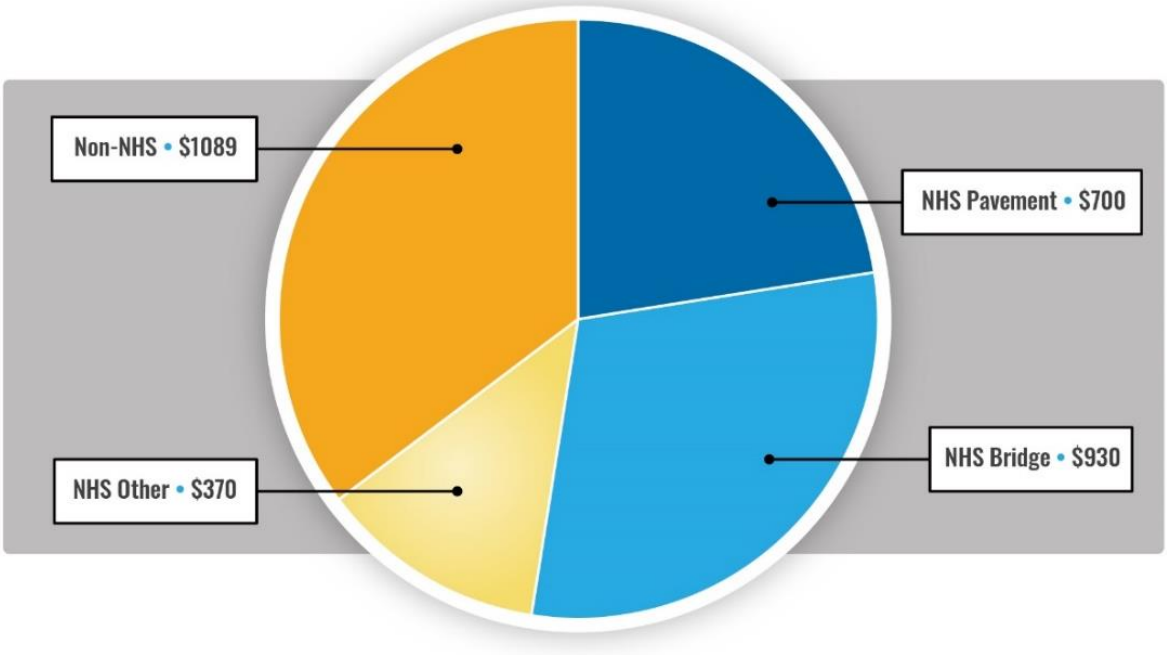
NYSDOT and NYSTA core construction funds are used for the construction of projects throughout the State transportation system, not just on the NHS (for reference, the NHS represents about one-third of the entire transportation system in the State). These funds are used to help local municipalities pay for construction projects as well. For the TAMP, it is assumed that all local funding of the NHS is reflected within the core construction category. In addition, not all core construction funds are used for pavement and bridge construction; a portion are used for other needs such as maintenance of ancillary assets and other improvements such as drainage repairs, pedestrian upgrades, or for large mobility projects or new construction. The "Other" category includes:

- Mobility improvements.
- Drainage improvements.
- Secondary assets, such as guiderail and signs.
- Overhead sign structures.
- Information technology services.
- Signal improvements.
- Noise and retaining walls.
- Truck and freight facilities.
- Rest area projects.
- Bicycle and pedestrian projects (including the Americans with Disabilities Act [ADA] mandates on paving projects).
- Park and ride work.
- Tree trimming.

The core construction program also includes priority projects such as the I-81 Viaduct in Syracuse, Hunts Point Interstate Access Improvements, and Van Wyck Expressway Capacity Improvements. While many of these projects will impact asset conditions, and are considered in forecasts of future asset conditions, they are not selected specifically for that purpose. The core construction fund addresses construction needs across the entire NYSDOT system, which includes assets other than pavements and bridges, as well as non-NHS assets.

Figure ES.4 shows the average amount of combined annual NYSDOT and NYSTA funding available for pavement and bridge work on the NHS over the next 10-year period. These funding amounts reflect the current Capital Program as discussed in chapter 3.

*Figure ES.4 Average annual funding available for NHS pavements and bridges 2022-2031.*




A substantial portion of this funding is dedicated to priority projects which address major transportation needs, but do not significantly impact Statewide conditions. For example, I-81 through Syracuse has an estimated construction cost of over $2.1 billion but only impacts less than 50 lane-miles of pavement. Because of the extremely high unit costs of such priority projects, they are not included in the investment strategies for managing pavement and bridge conditions through the TAMP period, as described in the TAMP investment strategies. While system enhancement projects will improve pavement and bridge conditions, a higher percentage of costs for these projects go to other work and appurtenances which include realignment and improvements to bicycle, pedestrian, safety, and intelligent transportation system (ITS) assets and functionality. All of these investments advance NYSDOT's mission. However, the full costs of these projects cannot be considered available for asset management. As a result, the average annual revenue available to sustain and improve NHS conditions is approximately $450 million for NHS pavements and $700 million for NHS bridges. The differences between these amounts and the core construction funds for pavements and bridges, shown in figure ES.4, is captured as "Initial Construction" funding in the investment strategies summarized in Chapter 7.

## NYSDOT's Asset Management Business Structure

NYSDOT's formal Statewide asset management business structure, which has been in place since 2011, enables consistent decision-making at all levels of the organization and sets consistent fiscal limits for performance across geographic boundaries through a governance process. It helps to manage expectations and allows NYSDOT, as steward of the transportation system, to facilitate the best investment for the system and the State, regardless of ownership.

NYSDOT's internal asset management business structure is illustrated in figure ES.5. The structure is functional rather than organizational. Currently these teams are not organizational units but are comprised of dedicated groups of staff from across program areas throughout the Department. The focus areas represented by the Statewide and Regional teams consist of the highest priority program areas for asset consideration.

*Figure ES.5 NYSDOT's internal asset management business structure.*


## Managing Risk and Building Resilience

### NYSDOT's Risk Register

As part of NYSDOT's Asset Management practices, the Comprehensive Program Team (CPT) and the Statewide Teams identified agency-level risks that could impact NHS assets or the agency's ability to manage those assets. The Capital Program Delivery Committee (CPDC) prioritized these needs and identified mitigation strategies for each. The following risks are included in the initial risk register:

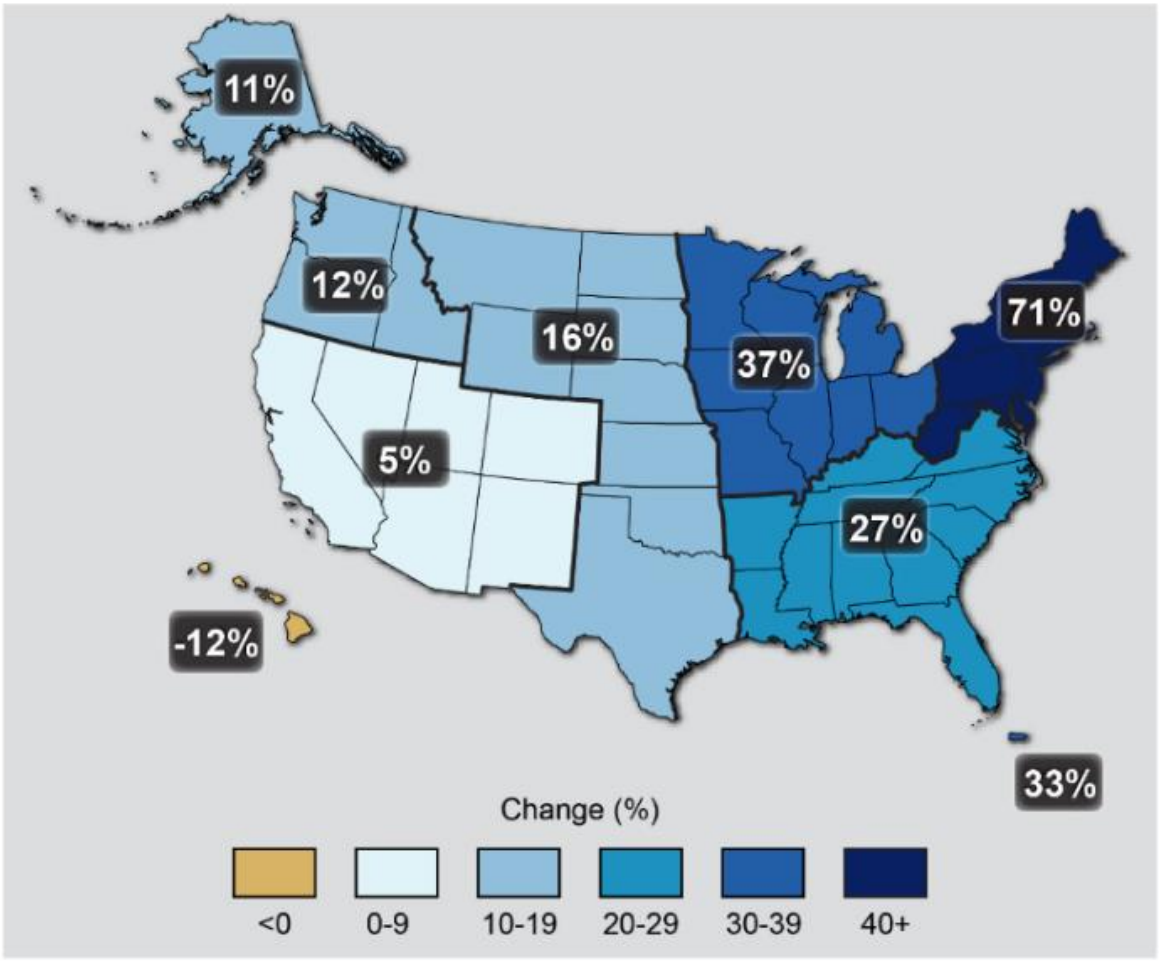
- Federal funding is increasingly limited to use on the NHS and is insufficient to address all system needs. Only twenty-seven percent of total Federal Aid may be used on non-NHS assets.

- Climate change continues to impart a wetter weather pattern on New York State with more intense storms (e.g., Tropical Storms Isaias and Fred, and Hurricanes Henri and Ida) and sea level rise.
- Improved software tools and new performance measures must be developed by NYSDOT to quantifiably optimize investment levels across programs (e.g., bridge, pavement, safety, mobility, access).

## Addressing Climate Change and Extreme Weather Risks

NYSDOT recognizes that the projected increase in the frequency and intensity of storm events remain high. Extreme events are a growing risk for NYS's transportation system as illustrated by storms that occurred in 2021 including named storms Ida, Henri, and Fred. As shown in figure ES.6, the amount of precipitation falling in very heavy events has increased for each region of the United States, except Hawaii.

*Figure ES.6 Observed increases in precipitation from heavy rain events, 1958 to 2012 (Source: U.S. Climate Resiliency Toolkit).*



The major impacts of concern associated with more extreme storm events include:

- More road closures.
- More culverts and block bridges clogged with debris.
- More tree debris removal from roadways.
- Depleted Operations resources (staff and contract).
- More repairs and replacements of damaged assets.
- More icing events.

Strategies to mitigate the risks include increasing the portion of the program dedicated to demand response contracts to improve the capacity to respond to these events. Strategies also include continuing to increase funding for the dedicated culvert and bridge programs. In addition, capital funds should be set aside to ensure that the critical maintenance fleet is adequate for response. Deployment of in-house maintenance forces has been proven to shorten response time and lower costs over demand response contracts.

## Flooding

Of particular concern is the transportation infrastructure's vulnerability to flooding, especially if the frequency and severity of flooding increases. Flood risks include increased damage to assets, more frequent overtopping of roadways, and having to divert staff from other priorities for response and recovery. Mitigation strategies include:

- Addressing known vulnerabilities.
- Conducting and regularly updating flood vulnerability assessments.
- Considering changes in future conditions due to climate change during design.
- Proactively clearing debris-prone bridges and culverts prior to storm events.
- Assessing repetitive damage sites.

### *Sea Level Rise*

Coastal flooding is of great concern, especially if sea level rises at an accelerated rate in the coming decades. As the century progresses and seas continue to rise, more State highways will be affected. NYSDOT's strategies to mitigate this emerging risk include:

- Develop an infrastructure hardening plan with prioritized locations.
- Continue to develop apps and models to analyze at-risk infrastructure and support prioritization efforts.
- Review critical evacuation and detour routes and design interventions to prevent flooding and closure of these routes.
- Review policies for potential improvements in how climate change and sea level rise are addressed.
- Regularly review engineering practices to identify robustness to future climate (projections).
- Continue to provide information on climate forecasts to support durable designs.

## Asset Management Investment Strategies

NYSDOT has developed the following investment strategy to guide the distribution of asset management funding:

- **Maintenance First** prioritizes activities that maximize the service life of existing infrastructure assets over expansion or enhancement of the highway network. This work is performed on assets that are in relatively good condition to keep them from slipping to more costly reconstruction treatments in the future.
- **System Renewal and Enhancement** addresses assets that have deteriorated beyond a state in which they can be preserved or that require improvements to address operational, sustainability, economic development, or other needs.

### NYSDOT's Commitment to Building a Resilient System

The STIP reflects a balance of many needs including resiliency. Resilience is a significant factor in selecting projects, but there are many considerations in developing the comprehensive program and statewide transportation improvement program (STIP). Every project in NYSDOT's comprehensive program considers extreme weather and climate change risk to incorporate NYSDOT's built-to resiliency standards. Prior to each comprehensive program and STIP update, NYSDOT issues guidance to its Regions and to the MPOs that includes consideration of resilience needs.

Through these investment strategies, NYSDOT anticipates investing an average of $450 million per year for NHS pavements and $700 million per year for NHS bridges, to sustain and improve asset conditions. These sums exclude investments in system renewal and enhancement. Figures ES-7 and ES-8 show how this investment will be divided between work types for pavements and bridges, respectively. These investments do not include major investments in priority projects. While some asset management projects may include the construction of additional lane-miles, this is typically occurring through actions such as minor realignments, the creation of turning lanes, or the extension of exit or entrance merge lanes, not through the construction of new centerline miles.

*Figure ES.7 annual NHS pavement construction spending by FHWA treatment type at **$450** average annual spending (Excludes major priority projects).*

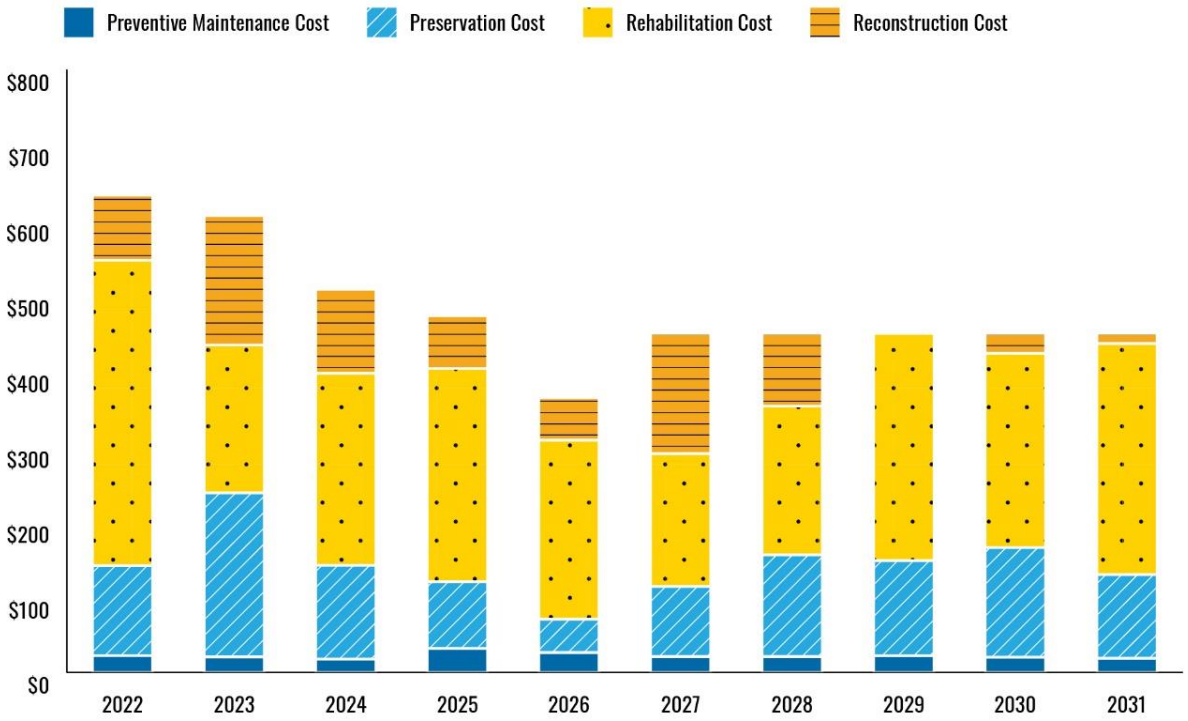
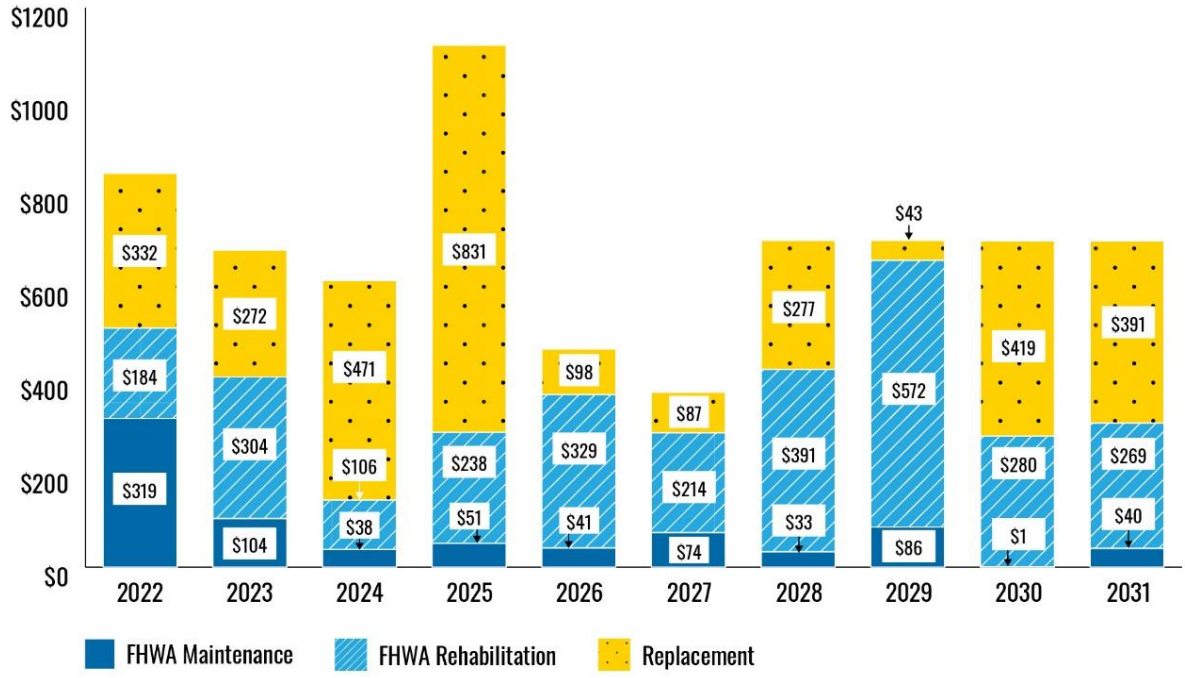



*Figure ES.8 Bridge construction spending by FHWA treatment type at $**700M** average annual funding (Excludes major priority projects).*



## Asset Management Performance and Targets

As part of its TAMP update efforts, NYSDOT recently established condition targets for pavements and bridges on the NHS. These targets are provided in table ES.8. These are not aspirational goals but reflect an effort to minimize deterioration of the existing highway and bridge infrastructure in an economic environment where available resources are about one-third of what is needed to achieve and maintain a state of good repair. The targets required by 23 CFR 450 (Subpart C for pavements and Subpart D for bridges) represent attainable conditions within the target-setting timeframe, established in 23 CFR 490 Subpart C. NYSDOT anticipated achieving the 2021 target; however, that determination is pending data to be released by FHWA which was not available in time for submittal of the TAMP to FWHA.

*Table ES.8 NYS NHS asset management performance gap.*

| System / Asset | Performance Measure | Baseline 2021 | Target 2023 | Target 2025 | Desired SOGR | 10-year Forecast | Projected Performance Gap* |
|---|---|---|---|---|---|---|---|
| Interstate Pavement | % Good | 45.3% | 53.2% | 54.3% | 83.0% | 50.7% | 32.3% |
| | % Fair | 53.6% | 45.6% | 44.0% | 16.7% | 45.1% | NA |
| | % Poor | 1.1% | 1.4% | 1.7% | 0.3% | 4.2% | 3.9% |
| Non-Interstate NHS Pavement | % Good | 18.9% | 22.3% | 20.7% | 95.1% | 23.1% | 72.0% |
| | % Fair | 73.5% | 68.4% | 68.4% | 2.0% | 39.4% | NA |
| | % Poor | 7.6% | 9.3% | 10.9% | 2.9% | 31.2% | 28.3% |
| NHS Bridges | % Good | 25.33% | 25.33% | 24.0% | 34.3% | 16.5% | 17.8% |
| | % Fair | 63.81% | 63.81% | 64.3% | 55.7% | 69.5% | NA |
| | % Poor | 10.86% | 10.86% | 11.7% | 10.0% | 14.0% | 4.0% |

*Calculated as the difference between baseline conditions and the desired SOGR.

Both NHS pavement and bridge conditions by deck area are projected to worsen over the next 10 years. As can be seen in table ES.8, the current investment strategy does not result in a state of good repair for either pavements or bridges. The state of good repair is the condition that the State system can be maintained in perpetuity at the lowest annual cost. NYSDOT's assets are not currently in a state of good repair and even with current funding the most efficient investment plan results in a widening gap between desired and actual conditions. To achieve a state of good repair on the NHS in 10 years, NYSDOT would require approximately $3.275[3] billion per year for pavements and bridges from all levels of government, as compared to the current annual funding level for these assets of $1.15 billion. Additional details on the funding needed to achieve the desired state of good repair can be found in appendix D.

[3] Excluding initial construction and major system enhancement projects.

## Asset Management Improvements and Next Steps

There are profound and practical challenges ahead for both New York State and much of the country due to the aging of the nation's transportation infrastructure, changing climate, and inadequate funding relative to the growing needs of the State's infrastructure assets. The TAMP includes 10-year projections of system conditions based on expected funding. Left unabated, the amount of poor pavement on the NHS will more than double in the next 10 years. Similarly, the amount of poor bridges by deck area on the NHS will increase by almost one-third, from 10.86 percent to 14 percent.

The State will continue to improve its investment strategy through improvements in data collection, modeling software, organizational efficiency, management of risks, and overall asset management capabilities to ensure that the State is making the best use of its available resources. To that end, NYSDOT has implemented an Enterprise Asset Management System (EAMS) suite of applications including Structures Manager, Structures Analyst, Pavement Analyst, Roadway Inventory System, Portfolio Analyst, and a Maintenance Management System. This system is built on one common linear referencing system and is linked to the Department's geospatial data warehouse. The warehouse is the system of record for the inventory of most critical secondary assets including point and linear drainage, guiderail, and signs. By having a mapped inventory of pavements, bridges, and secondary assets, maintenance activities can be recorded against these individual assets, enabling the generation of work histories for these assets. The warehouse also provides key source data for the agency's Maps and Apps portal, which is an agency-wide library of geospatially based applications that make these data widely available through this system of engagement.

Recognizing the difficult circumstances that States are facing in managing an aging highway infrastructure, there is still much to be done such as:

- Expand the asset management program to inform decision-making processes and develop life-cycle strategies for assets beyond pavements and bridges.
- Advance new technologies to make asset management systems easier to improve and adapt to changing priorities.
- Continue to expand the system of engagement to provide custom data input and access solutions that reduce staff time and improve data quality.
- Improve coordination of capital construction programs and State maintenance forces to ensure work is being delivered in the most efficient manner.
  - Understand the type, extent, and location of others' assets in the NYSDOT right-of-way (ROW), e.g., municipal sidewalks and utilities.
  - Integrate maintenance, planning, programming, and engineering data.
  - Use electronic as-built plans and Maintenance Management System (MMS) work reporting to update asset inventory & condition data.
- Establish full data sharing (collect once for the enterprise).
- Improve the way construction contracts are developed and managed.
- Improve the efficiency of program delivery.

These initiatives are prioritized, resourced, and tracked to completion through NYSDOT's asset management business structure. They will advance asset management processes and enable NYSDOT to manage the highway system as effectively as possible.

# ASSET SUSTAINABILITY INDEX

NYSDOT's current preservation-first investment strategy provides better end conditions than a traditional approach that prioritizes replacing assets in poor condition. However, as previously indicated, it does not result in a state of good repair for either pavements or bridges. If the pavement system were in a state of good repair, a vast majority of the system would be in good enough condition to only warrant a preventive maintenance treatment, with occasional heavier overlays. Only a small percentage of the system would be in bad enough shape to warrant major rehabilitation or reconstruction. Because the cost for the preventive maintenance treatments is much lower and more efficient than the heavier rehabilitation and renewal treatments, achieving the desired state of good repair would allow NYSDOT to maintain overall system conditions for the lowest practical annual cost.

NYSDOT's assets are not currently in a state of good repair and with current funding even the most efficient investment plan results still lead to a widening gap between desired and actual conditions. The ratio of actual funding to the funding level necessary to achieve the state of good repair for an asset class is called the Asset Sustainability Index (ASI). To achieve a state of good repair on the NHS in 10 years, New York State would require approximately $3.275 billion per year for pavements and bridges as compared to its current annual funding level for these assets of $1.15 billion. This results in a current ASI for State pavements and bridges of 0.35, indicating that the State receives approximately one-third of funding from all levels of government needed to achieve a state of good repair. Details can be found in Appendix D.

### NYSDOT's Commitment to Sustainability

NYSDOT will seek out and implement creative and low-cost ways to leverage funding to minimize costs over the life of the investments while fostering:

- **Economic competitiveness:** Improve efficiencies in work/business travel and freight movement, improve tourism access and intermodal connectivity, and develop investments which complement or enhance the strategic investments proposed by Regional Economic Development Councils.
- **Social equity/community:** Improve accessibility for transit, recreation, education, and health care; support smart growth, complete streets, and livability; increase safety; and weigh climate-associated risk to transportation infrastructure.
- **Environmental stewardship:** Increase energy efficiency and reduce greenhouse gas emissions; reduce resource consumption; limit impacts that encroach on the environmental footprint; not deplete, and where practicable, enhance resources for future generations; and improve air quality.

# 1. Introduction

The ability to move people and goods safely and efficiently through the State is dependent on a well-functioning transportation system. From construction of the nation's first railroads to the Erie Canal, to the Brooklyn Bridge, to the New York City elevated subway lines, and to the Interstate Highway System, New York State has been a world leader in the construction of multi-modal transportation infrastructure—transportation infrastructure that has transformed the State's economy into the global centers for the financial, insurance, real estate, and technology sectors. New York's transportation infrastructure, much of it built before or during the Eisenhower Interstate Era, is among some of the oldest and most heavily utilized in the nation and is subject to some of the harshest weather conditions. The repair, rehabilitation, efficient operation, and strategic replacement of existing transportation infrastructure are required for safety and mobility, and for the State to remain economically competitive.

Recognizing the challenges ahead, New York State Department of Transportation (NYSDOT) investments are focused on asset management and infrastructure preservation strategies. NYSDOT has implemented new strategies to select investments in projects that go beyond preservation to provide system renewal and enhancement, linking transportation with economic development, resiliency, and sustainability.

## 1.1 GUIDING PRINCIPLES OF NYSDOT'S ASSET MANAGEMENT PROGRAM

The primary focus of NYSDOT's asset management efforts is the preservation of the existing infrastructure and the safety of the travelling public. NYSDOT's objective is to manage the highway system as effectively as possible in an environment in which the available funding is significantly lower than the system's needs. To support effective decision making, NYSDOT has adopted four guiding principles, known as the Forward Four, shown in figure 1.1. An additional principle is public safety, which is inherent in all NYSDOT's investment decisions.

*Figure 1.1 Guiding principles of the asset management program.*

## Maintenance First

Expected financial resources are not sufficient to support a "build new" or "worst first" approach. Therefore, NYSDOT has chosen to adopt a "preserve what we have" approach. The Maintenance First strategy starts with Asset Management principles and data driven decision-making. The highest priority is to preserve the functionality and safety of the existing highway system. It is important to recognize that a Maintenance First strategy is a long-term strategy. The Agency must have patience to hold the course.

## System not Projects

To meet the needs of the entire system, NYSDOT requires a system-wide, program-driven approach instead of individual project solutions. Traditionally, a focus on projects led to high levels of investment that improved a relatively small portion of the highway and bridge infrastructure. This resulted in small sections being in excellent condition while the overall system deteriorated.

NYSDOT's current system-oriented strategy considers how to stretch available capital and maintenance resources to get the best overall conditions across the system. That means when the Agency considers an individual project, it must be examined in the context of the larger transportation system: Who does this asset serve? Is it in a corridor that is essential to move people or goods? Where does it fit within Regional and State priorities? Inherent in these decisions is the need to identify better ways to manage and operate the transportation system to use the capacity of the current system most effectively. System improvement projects that promote economic development, livability, and system connectivity must also be strategically advanced to provide the greatest benefit to the users of the system.

## Maximize Return on Investments

Even with the recent increase in Federal Aid, funding for transportation has been and will continue to be significantly less than the amount required to address all the State's recognized needs. Decades of insufficient investments have resulted in declining system conditions and a growing backlog of needs required to bring the system to a state of good repair.

Given the limited available resources, it is essential that a strategy be established to invest in a way that produces the greatest possible return on investment. The objective is to develop an approach that encourages good decision-making and allocation of funds in a manner that not only preserves the most important assets but also meets the needs of those who rely on the transportation system.

This has led NYSDOT to implement whole life management principles (explained in chapter 5), which emphasize investments in appropriate treatments, at appropriate times, and at appropriate locations. Highway construction is timed appropriately within the "window of opportunity" for the selected treatment while maintaining safety standards. Focused rehabilitation work will be performed, fixing only those elements in need of repair when it is determined that significant life can be bought with limited investment. Project scopes are constrained to include what is required to achieve the full remaining life of the asset while providing for a safe, accessible, resilient, and equitable highway system. Bridges and highways will be replaced when replacement provides the best return on investment. Mobility enhancement and modernization projects will be included when it makes strategic and economic sense.

## Make It Sustainable

NYSDOT has adopted an investment strategy that allows development of a sustainable program that maximizes the return on investment, extends the life of the assets, and provides users of the system with a safe, reliable, balanced, and environmentally sound transportation system. This sustainable approach to programming considers the relative and cumulative value of the assets as they benefit the public, economy, and environment. NYSDOT's decision-making process looks broadly at the benefits of the work done with each Comprehensive Program to preserve the existing transportation system and support opportunities for innovation, economic growth, and development. This is done in a fiscally responsible manner by considering life-cycle cost as well as fiscal cycles.

NYSDOT's focus on preservation supports sustainability because it seeks to optimize the condition of the existing infrastructure and limit the system's footprint on the environment. Resiliency in response to the impacts of climate change is also taken into consideration when making capital investments to ensure that those assets can function effectively in an environment of more intense storms, sea level rise, and temperature increases. NYSDOT's sustainable program also incorporates strategies to minimize transportation system disruptions resulting from routine incidents, planned events, and non-routine events such as natural disasters or security-related occurrences.

**NYSDOT's Commitment to Sustainability**

NYSDOT will seek out and implement creative and low-cost ways to leverage funding to minimize costs over the life of the investments while fostering:

- **Economic competitiveness:** Improve efficiencies in work/business travel and freight movement, improve tourism access and intermodal connectivity, and develop investments which complement or enhance the strategic investments proposed by Regional Economic Development Councils.
- **Social equity/community:** Improve accessibility for transit, recreation, education, and health care; support smart growth, complete streets, and livability; increase safety; and weigh climate-associated risk to transportation infrastructure.
- **Environmental stewardship:** Increase energy efficiency and reduce greenhouse gas emissions; reduce resource consumption; limit impacts that encroach on the environmental footprint; not deplete, and where practicable, enhance resources for future generations; and improve air quality.

# 1.2 COMPREHENSIVE PROGRAM UPDATE

NYSDOT's Comprehensive Program is the primary mechanism for delivering on its mission to provide safe and reliable transportation to its customers. NYSDOT typically develops a Comprehensive Program Update (CPU) every 2 years. The update establishes a program of projects for all infrastructure and delivery mechanisms for the subsequent 5 years. The Comprehensive Program is developed under the direction of the asset management structure and follows the asset management practices described in chapter 4. Projects are prioritized and selected according to the asset management investment strategies described in chapter 7. The program is fiscally constrained and includes expected budgets, accomplishments, and key

milestone dates for every project. The resulting program represents the mix of projects that provide the best progress towards the Department's goals.

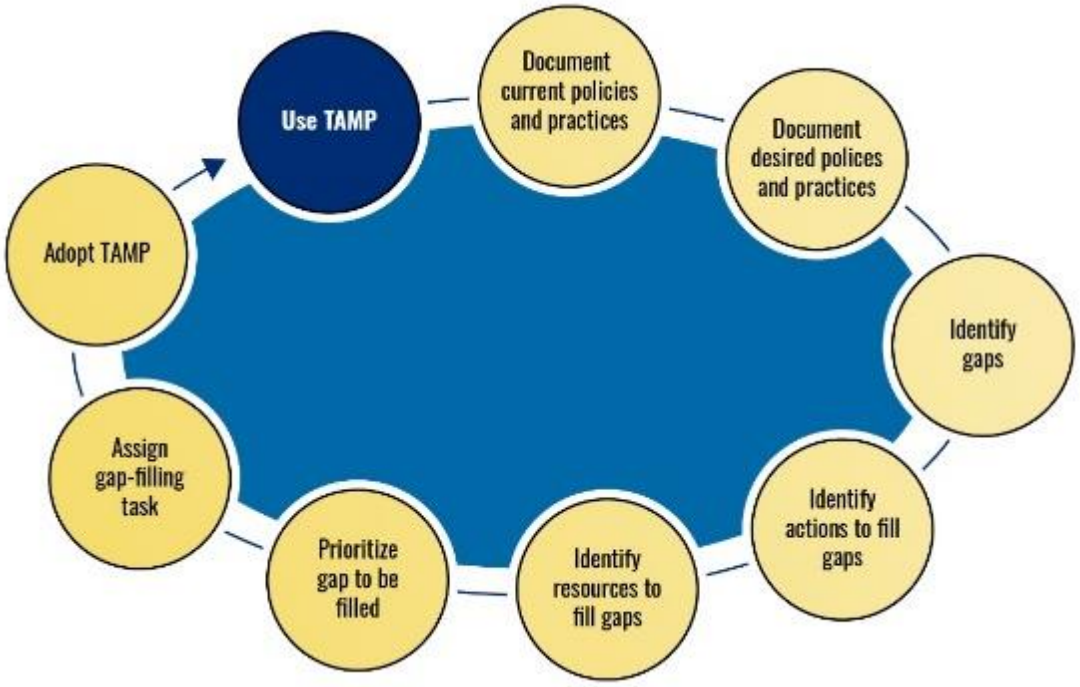
## 1.3 OBJECTIVES OF THIS DOCUMENT

This Transportation Asset Management Plan (TAMP) is a window into NYSDOT and New York State Thruway Authority (NYSTA) policies. It explains the roles, responsibilities, and processes related to establishing and executing transportation asset management (TAM) activities at NYSDOT and the NYSTA. The plan covers the breadth of asset management practices at NYSDOT and the NYSTA and was developed to achieve the following objectives:

- **Continue the implementation of asset management practices**. New York State has made great strides in modernizing its programming processes. The Federal Highway Administration (FHWA) certification of NYSDOT's process for developing this plan ensures that these strategies, processes, and tools will continue to shape future programming efforts.
- **Communicate asset management policy and strategy.** To date, NYSDOT's asset management policy has been scattered in numerous documents such as its State Transportation Improvement Program (STIP) update instructions and Statewide team charters. The TAMP pulls together all the relevant information from these sources to present internal and external stakeholders with a clear understanding of NYSDOT's vision and implementation of asset management.
- **Document and prioritize opportunities for improvement of business practices.** TAM is a continual improvement process. As described in the American Association of State Highway and Transportation Officials (AASHTO) *Transportation Asset Management Guide: A Focus on Implementation*, the development of a TAMP "is an ongoing process of communication with partners, self-evaluation, gap identification, prioritization, improvement, and adoption."[4] This plan lays out the process for continual improvement of TAM business practices and contains NYSDOT's current asset management improvement plan. Figure 1.2 illustrates this concept.

[4] *AASHTO Transportation Asset Management Guide: A Focus on Implementation*, Washington DC, 2019.

*Figure 1.2 Iterative TAMP development process.*




## 1.4 SCOPE OF THE TAMP

This TAMP describes the asset management strategies and processes employed by NYSDOT, the NYSTA, and other ancillary owners of the national highway system (NHS) to address all bridges and pavements that are on the NHS or managed by NYSDOT. Special emphasis is provided to the portions of the NHS that are eligible for funding from the NYSDOT Comprehensive Program. About seventy-three percent of the NHS is owned and maintained by NYSDOT, with the remainder of the NHS split between the NYSTA and local agencies. NYSDOT maintains close collaborative relationships with Metropolitan Planning Organization (MPO) members, toll authorities, counties, and municipalities who own and operate portions of the NHS. Because of this collaboration, the term "the State" will be used when the goals and strategies of the State, as encompassed by the actions of the NYSDOT, its local partners, and the NYSTA, are highlighted. In cases where the strategies differ, the particular agency will be called out in the document.

Transportation system users should not be concerned with what entity owns the highway. They should perceive a consistent experience as they travel along a corridor, regardless of jurisdiction or political boundaries. Similarly, all asset owners who are eligible to receive and invest in New York State or Federal transportation funds need a clear understanding and consistent set of performance standards, investment strategies, and selection criteria. Towards this end, this document addresses asset management practices followed by the NYSDOT and the NYSTA. NYSDOT cannot and does not dictate investment strategy to partner agencies; however, compatibility with the TAMP approach is encouraged for Federal Aid projects and Federal Aid eligible assets. More detail on how NYSDOT works with its partner infrastructure owners is provided in chapter 4.

There are several significant Federal funding sources that are not within the scope of pavement and bridge asset management including the Federal Congestion Mitigation and Air Quality (CMAQ) Program, Transportation Alternatives Program (TAP), Highway Safety Improvement Program (HSIP), and discretionary grant programs. These programs have organizational and procedural requirements that are different from the more mainstream highway funds. The integration of projects funded by these programs will evolve over time as the TAMP's scope expands to address priority assets other than bridges and pavements.

## 1.5 TAMP STRUCTURE

Federal statute 23 USC 119 and regulation 23 CFR 515 contain specific provisions for the content to be included in a TAMP. The requirements for TAMP contents include:

- A summary listing of the pavement and bridge assets on the NHS in the State, including a description of the condition of those assets.
- Asset management objectives and measures.
- Performance gap identification.
- Life-cycle cost and risk management analysis.
- A financial plan.
- Investment strategies.

In order to meet these requirements, this TAMP is presented as follows:

- **Chapter 1—Introduction (this chapter):** Provides an overview of asset management and the TAMP.
- **Chapter 2—State of the System:** Examines the overall demand on the New York State NHS system by the traveling public and summarizes the inventory and condition of the State's pavements and bridges.
- **Chapter 3—Financial Summary:** Documents the expected funding for the system over a 10-year period.
- **Chapter 4—Transportation Asset Management Practices:** Describes NYSDOT's and NYSTA's asset management business structure, policies, and practices.
- **Chapter 5—Life-Cycle Planning:** Presents the principles of life-cycle management used by the State and explains the process used to prioritize projects under this philosophy.
- **Chapter 6—Risk Management:** Outlines the process used to assess risk and presents a risk register that lists priority risks and associated mitigation activities.
- **Chapter 7—Investment Plan:** Illustrates how the available funds are provided for planning purposes and describes the State's investment strategies related to asset management.
- **Chapter 8—Asset Management Improvements and Next Steps:** Defines specific improvement areas the State will be pursuing in the near term and lays out an agenda for future improvements to asset management policy and practices as well as to the TAMP.

# 2. State of the System

Asset management takes a performance-based approach to managing the physical condition of infrastructure assets with available resources. This requires accurate data on the number, location, and condition of infrastructure assets. This chapter provides an overview of asset inventory conditions, performance, and demand for two specific agency assets: pavements and bridges both on the NHS in New York State, as well as the remaining pavements and bridges managed by NYSDOT.

## 2.1 SYSTEM DEMAND

New York State's highway infrastructure has evolved over decades to move people and goods safely and efficiently through and around the State. Over the years, the demands placed on the system have changed and highway owners have continually responded by modernizing the infrastructure. Figure 2.1 shows the number of vehicles miles traveled (VMT) on NYSDOT's highway system since 1920. The chart can be broken down into several key phases or epochs based on world events and sustained rates of VMT growth. Those epochs are:

- The Great Depression (1931-1939).
- World War II (1941-1945).
- Post-War Boom (1946-1978).
- Roarin' 80s, 90s, and 00s (1979-2006).
- Great Recession (2007-2011).
- Stabilization (2011-2019).
- COVID-19 Pandemic and Recovery (2020-present).

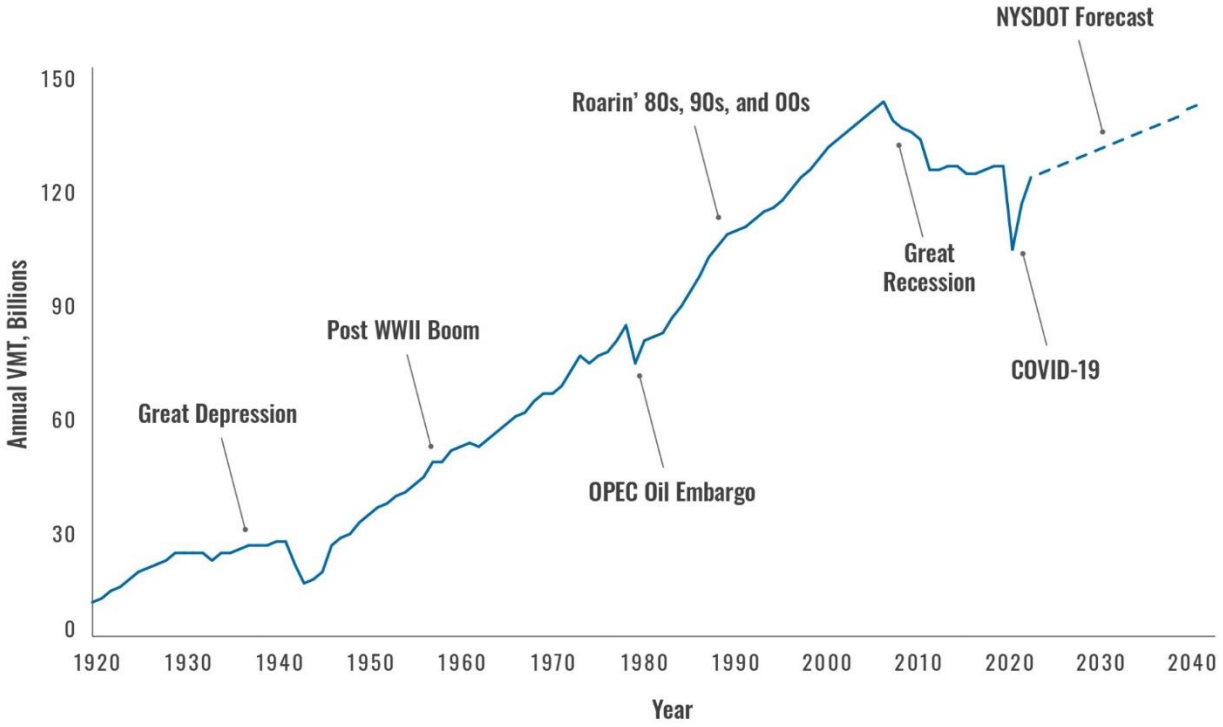
The chart shows that VMT growth was the lowest during the Great Depression, whereas it was the highest during the Roarin' 80s, 90s, and 00s period. This latter epoch captures transportation related to the coming-of-age life events such as marriages, family development, and career starts during the late 70s and early 80s of the Baby Boom generation (i.e., those born between 1946 and 1964). This also includes the beginnings of sunset events including grown children becoming independent, downsizing of family units, and retirements.

The graph also shows the dramatic impact that the Great Recession had on VMT in New York. The severe economic downturn of the 2007-2009 period dramatically shrank the economy and hence significantly reduced travel. The impact of the Great Recession on VMT appears to be larger than either of the two previous VMT downturn events, that of World War II and the Organization of the Petroleum Exporting Countries Oil Embargo of the late 1970s.

What looked in 2019 to be the beginning of a new period of growth was cut short by the COVID-19 Pandemic in 2020. Travel restrictions and stay-at-home guidance resulted in a VMT reduction of over 20 billion miles traveled during 2020. While recovery to near pre-pandemic values is expected to occur in just a few years, the mass adoption of remote work policies may have a lasting effect on VMT.

Figure 2.1 also shows that NYSDOT expects a steady two percent annual increase in VMT going forward, although at a lower growth rate than experienced in the past. To meet the expected increase in demand for the next 25 years, it is vitally important that NYSDOT effectively manage its existing highway system. This is at the heart of NYSDOT's asset management approach.

*Figure 2.1 Vehicle miles traveled on NYSDOT highways (1920-2040).*




## 2.2 CURRENT ASSET INVENTORY AND CONDITIONS

NYSDOT manages over 38,000 lane-miles of pavement and more than 7,500 highway bridges. Additionally, the NYSTA and other agencies (including the Port Authority of New York and New Jersey, Bridge and Tunnel Authorities, cities, counties, other authorities, and other local governments) manage tens of thousands of miles of pavement and thousands of bridges. NYSDOT's Comprehensive Program includes all available State and Federal highway funds and covers all NYSDOT owned assets as well as all Federal Aid eligible assets. Federal Aid assets are stratified in two tiers—NHS and non-NHS. The NHS is further stratified by Interstate and non-Interstate. This creates a four-tier hierarchy of:

- Interstates.
- Non-Interstate NHS.
- Non-NHS Federal Aid system.
- Non-Federal Aid eligible NYSDOT-owned assets.

# Pavement Inventory, Measures, and Condition

## Pavement Inventory

There are approximately 238,409 lane-miles of public roadways in New York State. Table 2.1 provides a breakdown of public roads in New York State by owner and functional class.

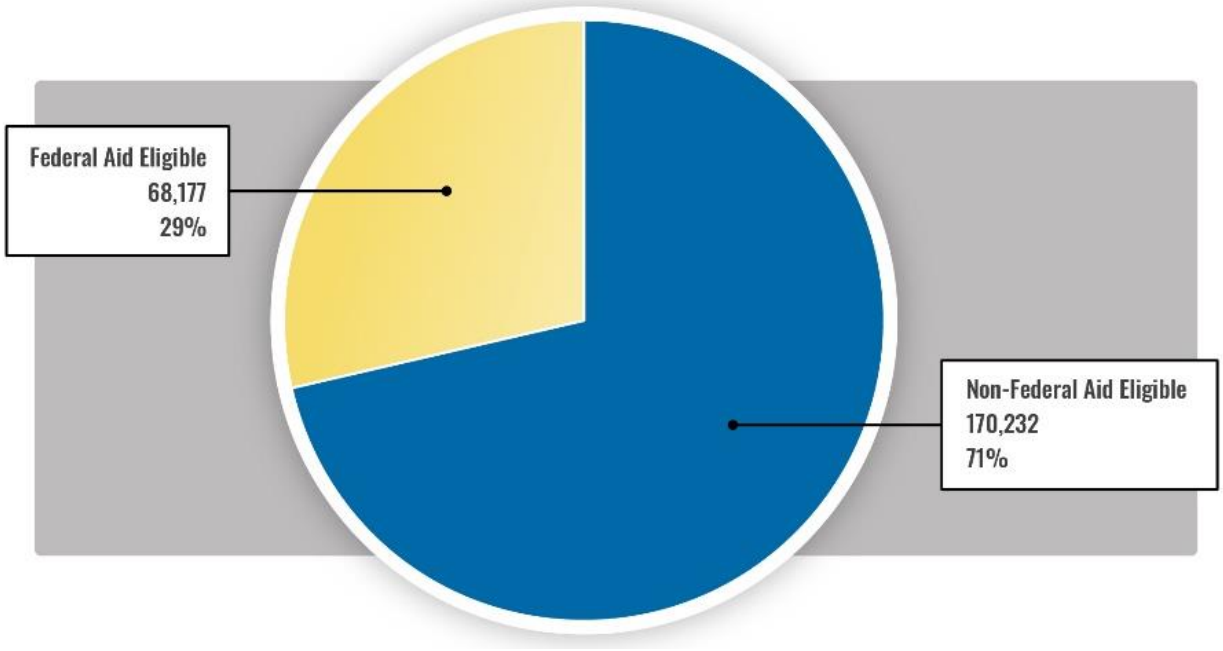
*Table 2.1 Pavement inventory in lane-miles.*

| Highway System | NYSDOT | NYSTA^ | Others | Subtotal |
|---|---|---|---|---|
| Interstate | 5,495 | 2,426 | 142 | 8,063 |
| Non-Interstate NHS | 14,170 | 39 | 4,775 | 18,984 |
| Total NHS | 19,665 | 2,465 | 4,917 | 27,047 |
| Non-NHS Federal Aid Highways | 17,489 | 5 | 23,636 | 41,130 |
| Total Federal Aid Eligible | 37,154 | 2,470 | 28,553 | 68,177 |
| Non-Federal Aid Eligible | 1,134 | 29 | 169,069 | 170,232 |
| Total Statewide | 38,288 | 2,499 | 197,622 | 238,409 |

All public roadways are assigned an FHWA functional class, which is a broad descriptor of the uses and configuration of the road. The roadway network can also be divided into roadways that are eligible for Federal Aid and roadways that are not. For a roadway to be eligible for Federal Aid, it must either be on the NHS or it must have a higher functional class including Interstates, Other Freeways and Expressways, Principal Arterials, Major Collectors, and Urban Minor Collectors. The distribution of the State roadway network between Federal Aid eligible and non-eligible roads is presented in figure 2.2.

As mentioned above, the most important roadways in the Federal Aid eligible roadway network are included on the NHS. The NHS is a network of nationally significant highways that consist of interconnected urban and rural principal arterials and highways (including toll facilities) serving major population centers, international border crossings, ports, airports, public transportation facilities, other intermodal transportation facilities, and other major travel destinations; meeting national defense requirements; and serving Interstate and interregional travel. All routes on the Interstate System are a part of the NHS. The TAMP is primarily focused on the NHS.

*Figure 2.2 Lane-miles of public roadways in New York State.*




As shown in figure 2.3, about thirty-nine percent of the Federal Aid eligible lane-miles of pavement in the State are on the NHS. However, the NHS carries sixty-eight percent of the total traffic on the Federal Aid eligible portions of the State highway system, as expressed by vehicle miles of travel, as shown in figure 2.4.

*Figure 2.3 Federal Aid eligible highways in New York State by lane-miles.*

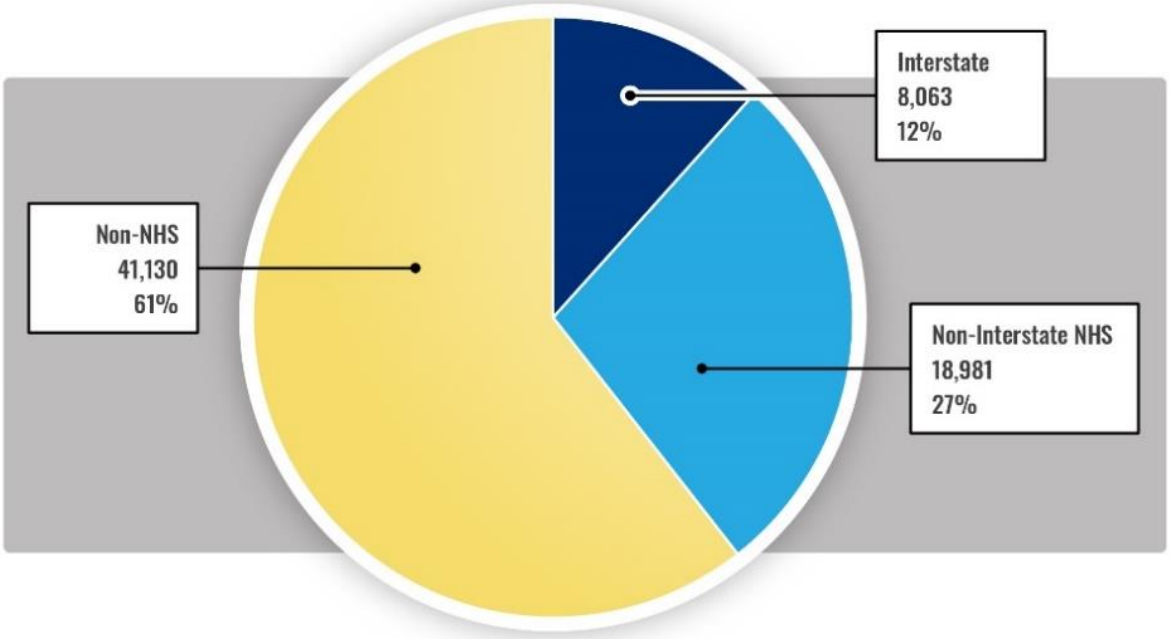
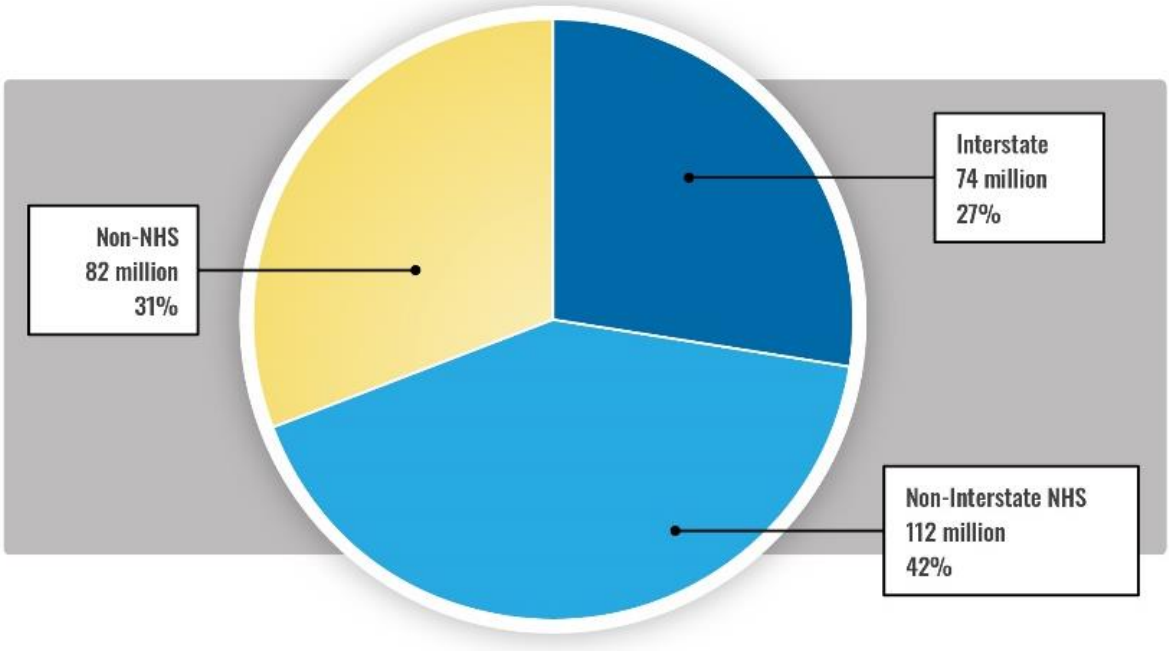
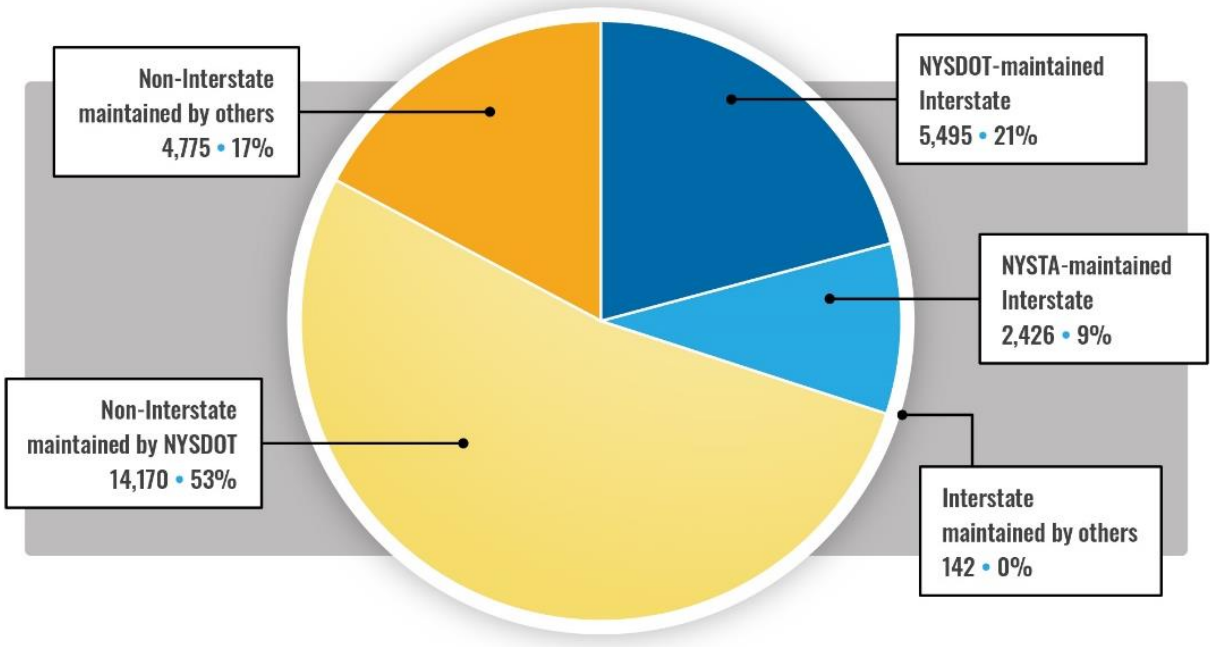


*Figure 2.4 Federal Aid eligible highways in New York State by VMT.*




The NHS in New York State consists of 27,047 lane-miles. Like most States, the NYSDOT doesn't bear sole responsibility for administration and maintenance of the NHS. Significant portions of the NHS are maintained by other agencies. Other owners of NHS facilities in New York State include the NYSTA, Mid-Hudson Bridge Authority, Triborough Bridge and Tunnel Authority, Port Authority of New York and New Jersey, counties, cities, and towns. In total, NYSDOT maintains 19,665 lane-miles of the NHS. Figure 2.5 shows a breakdown of the NHS by maintenance jurisdiction.

*Figure 2.5 NHS pavement lane-miles by maintenance jurisdiction.*



## Pavement Performance Measures

NYSDOT collects a wide variety of data relating to pavement condition and uses several performance measures as part of its pavement program. NYSDOT uses these measures for three purposes: reporting to State and Federal authorities, selecting projects, and managing the network. This section explores pavement data collected, the associated performance measures, and the applications for those measures.

NYSDOT has both State and Federal reporting requirements. The Department creates an annual Highway Mileage Report for pavement inventory that is distributed to the public on the NYSDOT website. NYSDOT also submits an annual Pavement Condition Report to the State legislature that includes a summary of the condition of the highway system using the New York State pavement condition metrics outlined below. For the Federal government, detailed pavement inventory, traffic, and condition information, primarily consisting of Federal cracking and roughness data, is submitted annually through FHWA's Highway Performance Monitoring System (HPMS).

As detailed below, NYSDOT collects cracking, rutting, faulting, and other types of pavement distress data for the entire NHS and shares that data with the NYSTA and other NHS partners, regardless of jurisdiction. Data for the Interstate system are collected annually, while data on the non-Interstate NHS and remainder of the State highway system are collected every other year. Even though other NHS owners such as the NYSTA may collect additional pavement data for their own purposes, NYSDOT does not ask for these additional data because they are not used for Federal reporting and are not used by NYSDOT to program projects. NYSDOT collects, processes, stores, and updates inventory and condition data for NHS pavement assets in its pavement management system in compliance with 23 CFR 515.17.

### *Measures Used for Treatment Selection*

**Surface Rating:** NYSDOT has traditionally expressed condition in terms of their pavement surface rating, which is an overall measure of pavement quality based on the severity, extent, and location of pavement cracking.

The Surface Rating is based on a 10-point scale and is reported as follows:

| | |
|---|---|
| 10-9 | Excellent (no work needed) |
| 8 | Very Good (crack seal candidate) |
| 7 | Good (preventative maintenance candidate) |
| 6 | Fair (corrective maintenance candidate) |
| <=5 | Poor (rehabilitation or reconstruction candidate) |

For reporting purposes, surface rating may be provided for an individual segment or reported as an average for a corridor, geographic area, any subset of pavements, or the entire network.

NYSDOT's surface scores have traditionally been generated through visual-based windshield surveys. In 2015 NYSDOT began phasing out windshield surveys and replaced them with an automated crack/distress detection system. This system uses 3D technology to more accurately identify and quantify the degree of distress exhibited by highway pavement. The new crack data are consistent with the latest Federal HPMS requirements and record the amount of cracking over five distinct zones within the pavement surface. In an effort to maintain consistency in monitoring the rate of deterioration over the life of the pavement, NYSDOT has developed an algorithm by which to convert the automated distress data back into the

traditional 10-point Surface Rating scale. NYSDOT's long-term approach to working with this new data stream will be further explored in chapter 8.

**International Roughness Index (IRI)**: IRI is a national standard measure of ride quality reported as in./mi. NYSDOT categorizes pavements as follows:

| | |
|---|---|
| ≤ 60 | Very Smooth |
| 60-119 | Smooth |
| 120-170 | Fair |
| 171-220 | Rough |
| >220 | Very Rough |

For reporting purposes, IRI may be provided for an individual segment or reported as an average for a corridor, geographic area, any subset of pavements, or the entire network.

**Dominant Distress:** There is another component of the surface rating that identifies the presence of a dominant distress on the pavement section. A pavement section with a dominant distress requires a more significant treatment to be applied than when that dominant distress is not present. These include:

- **Faulting:** The measure of elevation difference between sequential slabs in rigid pavements. Faulting indicates failure of the load transfer devices between slabs.
- **Spalling:** The loss of material from the surface of concrete pavement due to corrosion of reinforcing steel.
- **Alligator cracking:** Areas of interconnected cracks in flexible pavements occurring in the wheel path, identifying failure of the underlying pavement material.
- **Widening drop-off:** The measure of elevation difference between one longitudinal area of a paving lane and an adjacent area that was constructed at a different time.

Depending on the type of dominant distress, it will have a classification that tells whether its presence is "Isolated" (i) to < 20% of the pavement section, or "General" (g) on ≥20% of the pavement section, or if it is "Low Severity" (l) or "High Severity" (h).

Both surface rating and IRI are used along with the dominant distress to select appropriate treatments and to identify, prioritize, and select pavement projects. These measures are calculated for every pavement segment so treatments can be optimized to the specific conditions at each location.

### *Additional Measures Collected by the NYSTA for Treatment Selection*

The basis of the NYSTA's Pavement Management System (PMS) is the annual Pavement Distress Survey, data from which are used to generate a Pavement Distress Index (PDI) for each segment of the NYSTA pavement network. The Pavement Distress Survey is conducted each spring by two trained NYSTA employees driving on the shoulder at 10 to 15 mph and visually observing and recording pavement distresses. Conducting the survey in the spring takes advantage of longer days and allows the pavement to be evaluated after winter, provides time to program emergency repairs as needed before the construction season, and limits the number of miles not rated due to construction. Most importantly, it provides current condition data in time to be used in the development of the annual capital program.

The survey collects data in one-mile increments in each direction of travel along the entire length of the Thruway. Visible rutting is also identified for asphalt pavements; however, it is not included in the PDI calculation since it is not a predominant issue on Thruway pavements.

The PDI is a composite measure and is calculated from the five individual distress ratings collected for each pavement type. The PDI uses a weighted formulation and a deduct approach. Indices and sub-indices are calculated for each mile of road, in each direction. The distress indices are a non-dimensional measure that expresses the relative amount of surface damage. The distress survey has been conducted since 2012.

The PDI ranges from 0 to 100, with 100 representing a new pavement with no visible surface distresses and 0 representing a pavement that is severely distressed. Pavement with a PDI between 90 and 100 is classified as Excellent. Pavement with a PDI less than 60 is classified as Poor.

**NYSTA Pavement Condition Data**

Five different distresses are rated for both asphalt-overlaid and concrete pavements:

**Asphalt-Overlaid Pavement**

- Centerline Cracking
- Transverse Cracking
- Edge of Pavement/Shoulder Cracking
- Other Lane Cracking/Defects
- Shoulder Cracking/Defects

**Portland Cement Concrete (PCC) Pavement**

- Centerline Joint Cracking/Spalling
- Transverse Joint Cracking/Spalling
- Edge of Pavement/Shoulder Joint Cracking/Spalling
- Slab Surface Cracking/Defects
- Shoulder Cracking/Defects

For asphalt-surfaced pavements, the PDI, rater comments, contract work history, associated treatments, and service lives achieved for a particular segment are analyzed together to realistically infer the condition of the underlying concrete slabs without cores, falling weight deflectometer testing, or other testing. Accident history, traffic and truck volumes, drainage problems, and other relevant factors are also considered when determining the appropriate treatment and timing for each pavement section, subject to financial constraints and minimum performance criteria. NYSTA is exploring the use of automated or semi-automated survey methods including Laser Crack Measuring Software to replace the manual survey.

### *National Highway Performance Measures for Pavements*

Federal regulation 23 CFR Part 490 Subpart C—National Performance Management Measures for the Assessing of Pavement Condition, establishes the following Federal **performance measures** for State DOTs to use in managing pavement on the NHS:

- Percent of Interstate pavements in Good condition.
- Percent of Interstate pavements in Poor condition.
- Percent of non-Interstate NHS pavements in Good condition.
- Percent of non-Interstate NHS pavements in Poor condition.

FHWA has identified three **pavement metrics** for each type of pavement in order to assess these performance measures:

- IRI (Asphalt, Jointed Concrete Pavement).
- Cracking Percent (Asphalt, Jointed Concrete Pavement).
- Rutting (Asphalt Pavement).
- Faulting (Jointed Concrete Pavement).

The pavement metrics and rating thresholds used to determine the performance measures are identified in figure 2.6.

*Figure 2.6 Pavement condition metrics and thresholds.*

**§ 490.311 Metric Thresholds in Final Rule**

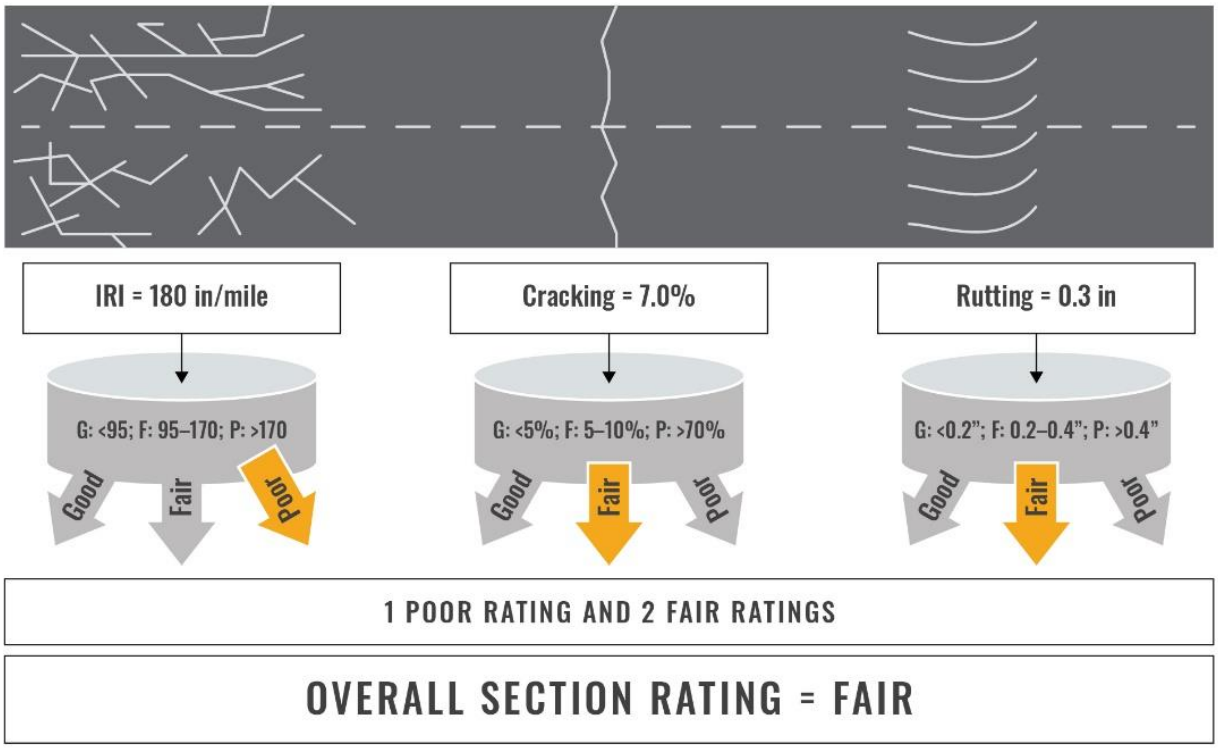
| Rating | Good | Fair | Poor |
|---|---|---|---|
| IRI • (inches / mile) | <95 | 95–170 | >170 |
| PSR* • (0.0-5.0 value) | ≥4.0 | 2.0–4.0 | ≤2.0 |
| Cracking Percent • (%) | <5 | CRCP: 5–10<br>Jointed: 5–15<br>Asphalt: 5–20 | >10<br>>15<br>>20 |
| Rutting • (inches) | <0.20 | 0.20–0.40 | >0.40 |
| Faulting • (inches) | <0.10 | 0.10–0.15 | >0.15 |

*PSR may be used only on routes with posted speed limit <40mph

The appropriate metrics are applied to each 0.1-mile section to determine the overall section rating. Figure 2.7 provides an example for rating a 0.1-mile section of asphalt pavement.

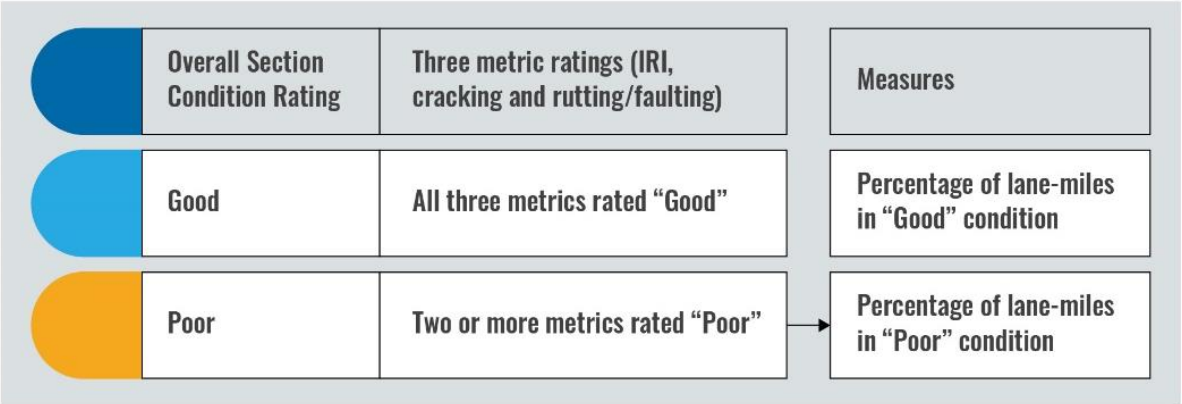
- Good = all three metrics rated "Good."
- Poor = two or more metrics rated "Poor."
- Fair = less than three metrics rated "Good" and less than two measures rated "Poor."

*Figure 2.7 Pavement section rating for 0.1-mile section of asphalt pavement.*




The individual segments are then combined into the Interstate or Non-Interstate NHS categories to determine the system-wide performance measures as shown in figure 2.8.

*Figure 2.8 Calculation of system-wide performance measures.*



**Present Serviceability Rating (PSR)** is a performance measure for pavement conditions on the NHS. This rating is calculated on NHS roadway sections where the posted speed limit is less than 40 mph and where actual IRI values are unable to be collected. When an IRI value is unavailable, the surface rating and dominant distress can be used to calculate PSR. The PSR can be determined by dividing the New York State surface rating by 2 and subtracting 0.5 if a dominant distress of General Alligator Cracking (Ag), General Spalling (Sg), or High-Severity Widening Dropoff (Wh) is present.

The calculation: (PSR = (Surface Score/2) — (0.5 if there is Ag, Sg, or Wh present).

Ex. Surface Rating = 5 Ag, so PSR = 2.0

PSR= 5/2 = 2.5, Ag = -5

PSR = 2.5 – .5 = **2.0 (Poor)**

The metric thresholds of 23 CFR 490.11:

| | |
|---|---|
| PSR > 4.0 | Good |
| PSR > 2.0 and < 4.0 | Fair |
| PSR < 2.0 | Poor |

The description of each PSR condition state is provided in table 2.2.

*Table 2.2 PSR condition states.*

| PSR | Description |
|---|---|
| 4.0–5.0 | Only new (or nearly new) superior pavements are likely to be smooth enough and distress free (sufficiently free of cracks and patches) to qualify for this category. Most pavements constructed or resurfaced during the data year would normally be rated in this category. |
| 3.0–4.0 | Pavements in this category, although not quite as smooth as described above, give a first-class ride and exhibit few, if any, visible signs of surface deterioration. Flexible pavements may be beginning to show evidence of rutting and fine random cracks. Rigid pavement may be beginning to show signs of slight surface deterioration, such as minor cracks and spalling. |
| 2.0–3.0 | The riding qualities of pavements in this category are noticeably inferior to those of new pavements and may be barely tolerable for high-speed traffic. Surface defects of flexible pavements may include rutting, map cracking, and extensive patching. Rigid pavements in this category may have a few joint failures, faulting and/or cracking, and some pumping. |
| 1.0–2.0 | Pavements in this category have deteriorated to such an extent that they affect the speed of free-flow traffic. Flexible pavement may have large potholes and deep cracks. Distress includes raveling, cracking, and rutting that occurs over fifty percent of the surface. Rigid pavement distress includes joint spalling, patching, cracking, scaling, and may include pumping and faulting. |
| 0.1–1.0 | Pavements in this category are in an extremely deteriorated condition. The facility is passable only at reduced speeds and with considerable ride discomfort. Large potholes and deep cracks exist. Distress occurs over seventy-five percent or more of the surface. |

### Measures Used for Network Management

NYSDOT uses the following performance measures to manage its pavement network:

- **Percent VMT on Good or Excellent Pavements** is a measure of how much of the customers' travel is on a good road. It also reflects the program's emphasis on prioritizing the high-volume roads for preservation work.
- **Percent Poor Pavement** is a measure of the extent of the system that has deteriorated to the point of requiring major rehabilitation or reconstruction.
- **Backlog** represents the funding needed to bring every pavement to a state of good repair today. A better system condition will have fewer needs and therefore a lower backlog. Since backlog is computed by the pavement models using condition trend data, it knows what the appropriate treatment is for each segment and will not recommend "band-aid" treatments that tend to cause a short-term bump in ratings.

NYSDOT tracks and evaluates these measures at the network level and uses them to support the setting of planning targets (i.e., planning level funding assumptions) between Regions and programs. It also establishes target values for Percent VMT on Good or Excellent Pavements and Percent Poor Pavement. These target values are provided in chapter 7. In addition, NYSDOT uses the Federal requirement of no more than five percent poor Interstate pavement as a further constraint in its modeling when developing its capital program.

## Pavement Conditions

NYSDOT and the NYSTA use the measures above to manage and report on pavement conditions. Table 2.3 provides a summary of pavement conditions in terms of NYSDOT's Pavement Surface Rating, showing both the VMT and lane-miles (LM) in each condition state. Table 2.4 provides a summary of conditions based on the National Highway Performance Measures for pavements (collection year 2020).

*Table 2.3 Pavement conditions based on surface rating.*

| Highway System# | NYSDOT % VMT on Pavement rated 7+ | NYSDOT % LMs Pavement rated 5- | NYSTA % VMT on Pavement rated 7+ | NYSTA % LMs Pavement rated 5- | Others % VMT on Pavement rated 7+ | Others % LMs Pavement rated 5- |
|---|---|---|---|---|---|---|
| Interstate | 70.00% | 2.30% | 76.50% | 1.20% | 95.10% | 0.10% |
| Non-Interstate NHS | 62.10% | 7.50% | 39.80% | 0.00% | 60.60% | 8.90% |
| Non-NHS Federal Aid Highways | 48.40% | 14.30% | 100.00% | 0.00% | 47.30% | 0.30% |
| Total Federal Aid Eligible | 61.60% | 9.90% | 76.20% | 1.20% | 64.20% | 0.50% |
| Non-Federal Aid Eligible | 47.40% | 21.90% | NA | NA | 55.50% | 18.90% |

*Table 2.4 Pavement conditions based on national measures.*

| Highway System | % Good | % Fair | % Poor |
|---|---|---|---|
| Interstate | 45.3% | 53.6% | 1.1% |
| Non-Interstate NHS | 18.9% | 73.5% | 7.6% |

## Bridge Inventory, Measures, and Condition

Similar to pavements, NYSDOT has both State and Federal reporting requirements pertaining to the structures on the highway network. NYSDOT submits the Graber Report containing inventory and condition information using the State condition metrics to the State legislature. This report is available to the general public on the NYSDOT website. For the Federal government, NYSDOT annually reports bridge inventory and condition information using the Federal metrics through FHWA's National Bridge Inventory System.

NYSDOT collects, processes, stores and analyzes data in their bridge management system meeting the minimum requirements of 23 CFR 515.17.

### Bridge Inventory

New York State has 17,542 highway bridges totaling 144,132,000 square feet of deck area, as shown in table 2.5. The table also shows the same inventory broken down by count.

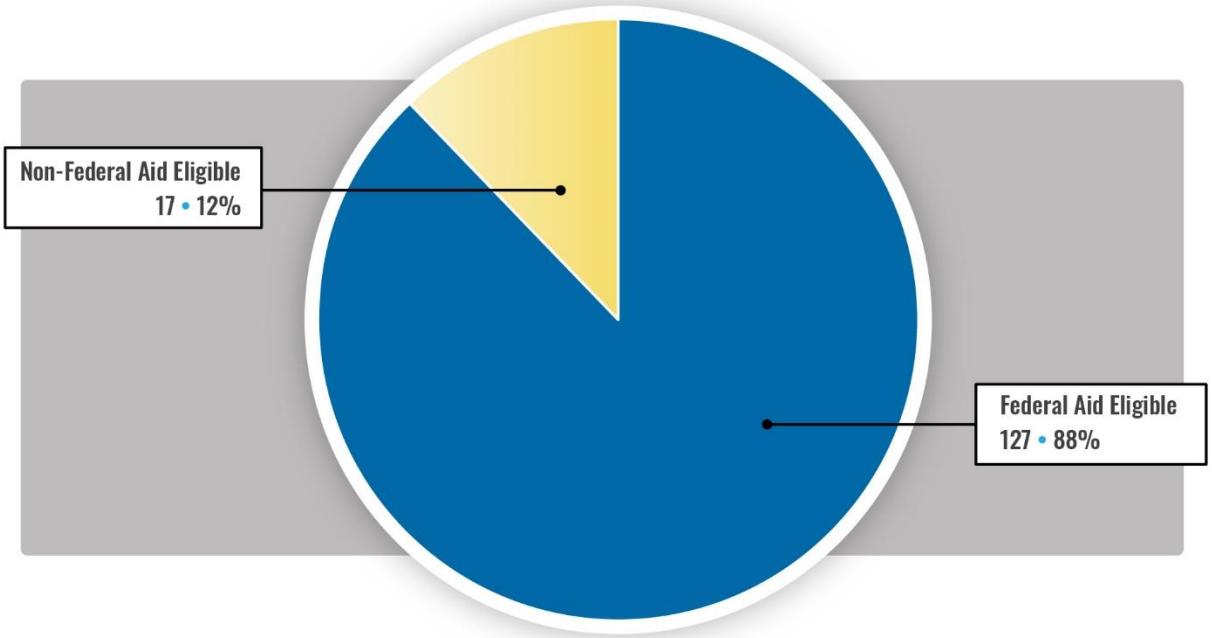
*Table 2.5 Bridge inventory.*

| Highway System | NYSDOT (Deck Area*) | NYSTA (Deck Area*) | Others (Deck Area*) | Sub-total (Deck Area*) | NYSDOT (Count) | NYSTA (Count) | Others (Count) | Sub-total (Count) |
|---|---|---|---|---|---|---|---|---|
| Interstate | 30.4 | 11.0 | 9.3 | 50.7 | 1,743 | 446 | 113 | 2,302 |
| Non-Interstate NHS | 30.6 | 1.2 | 16.4 | 48.2 | 2,599 | 62 | 570 | 3,231 |
| Total NHS | 61.0 | 12.2 | 25.7 | 98.8 | 4,342 | 508 | 683 | 5,533 |
| Non-NHS Federal Aid Highways | 16.1 | 1.5 | 10.6 | 28.1 | 2,665 | 147 | 1,935 | 4,747 |
| Total Federal Aid Eligible | 77.1 | 13.6 | 36.2 | 126.9 | 7,007 | 655 | 2,618 | 10,280 |
| Non-Federal Aid Eligible | 3.2 | 0.9 | 13.1 | 17.2 | 533 | 113 | 6,616 | 7,262 |
| Total Statewide | 80.3 | 14.5 | 49.3 | 144.1 | 7,540 | 768 | 9,234 | 17,542 |

* Millions of square feet.

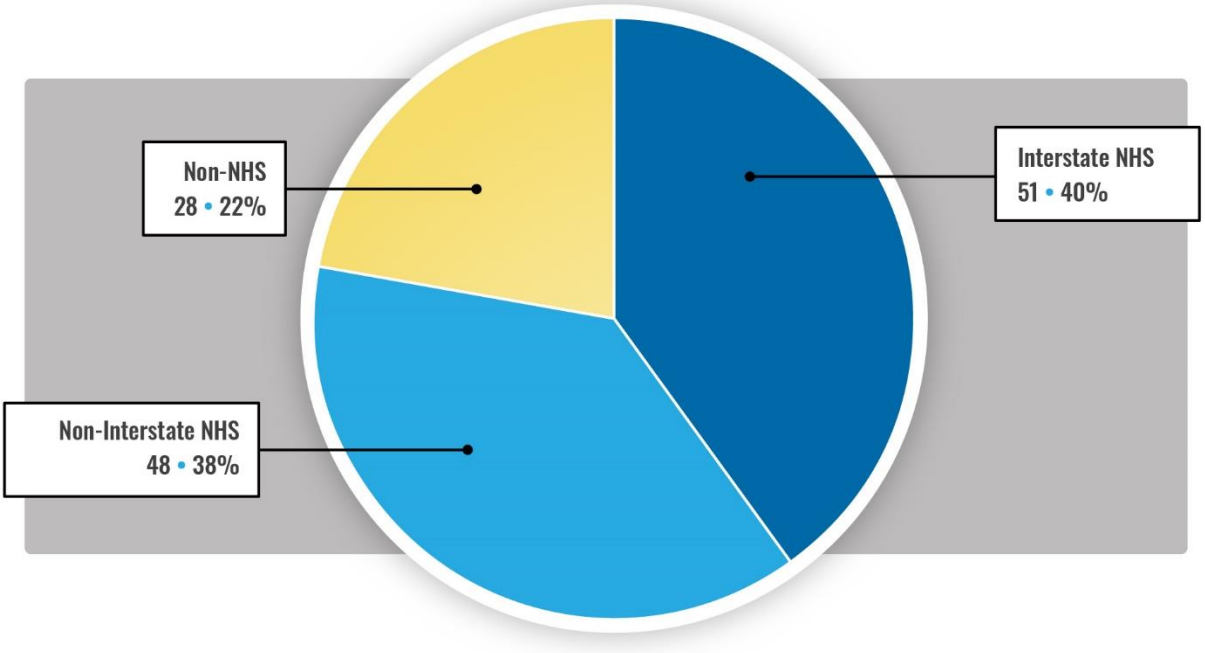
Unlike pavements, all bridges are eligible for Federal Aid and a majority (10,280) carry Federal Aid routes. And, as expected, bridges carrying Federal Aid routes make up a vast percentage of the total deck area in the State. The breakdown by deck area based on the Federal Aid eligibility of carried route is shown in figure 2.9.

*Figure 2.9 Total NYS Highway bridges by deck area (millions of sf).*



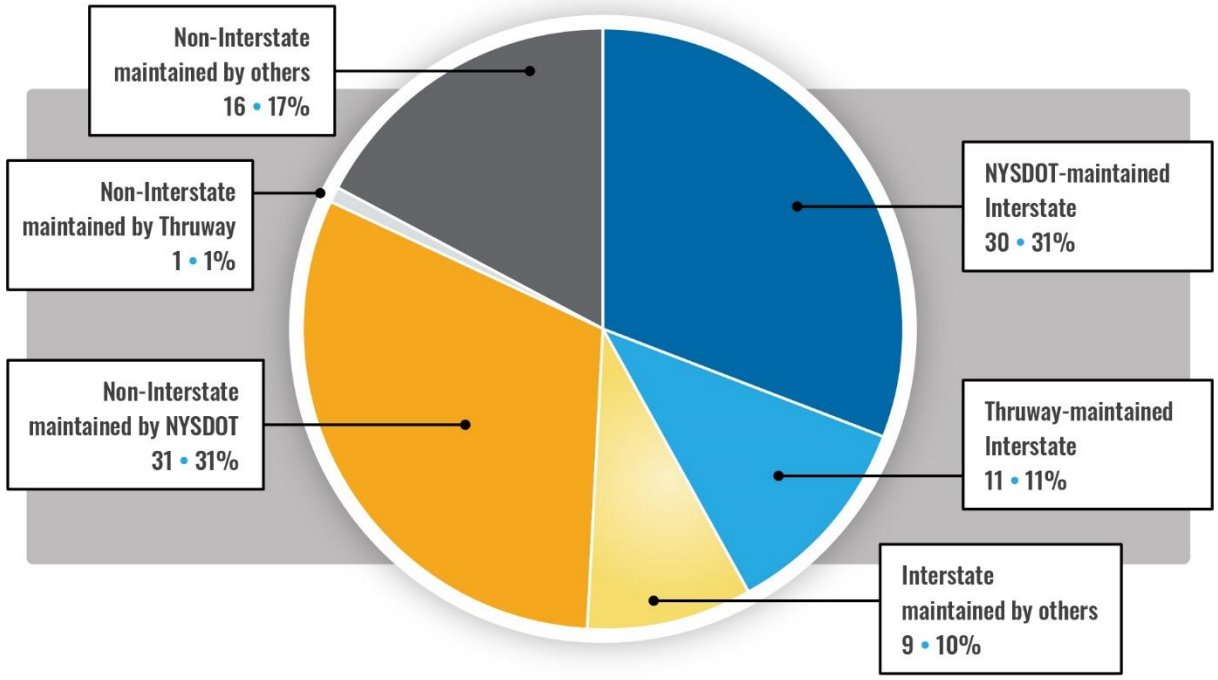

Over 10,200 structures in the State are on highways that are eligible for Federal Aid, with a small majority of these structures (5,533), on the NHS. Once again, the larger structures are on the NHS even though the number of NHS structures make up a slim majority (54%). The breakdown of these structures by total deck area skews heavily toward the NHS (78%), as shown in figure 2.10.

*Figure 2.10 Deck area (millions of sf) of Federal Aid eligible bridges, by system tier.*



Finally, both the structures located on the Interstate system and the non-Interstate portions of the NHS are administered by NYSDOT, the NYSTA, other bridge and tunnel authorities, counties, and other local governments. This breakdown is shown in figure 2.11.

*Figure 2.11 Deck area (millions sf) of NHS bridges, by system and jurisdiction.*




## Bridge Performance Measures

As part of its bridge program, NYSDOT uses performance measures for three purposes: State reporting, Federal reporting, and managing the network. The following is a summary of the performance measures in each of these categories.

Bridge condition data are collected through inspections performed in accordance with National Bridge Inventory (NBI) requirements. Inspections may be performed by NYSDOT staff or by consultants through the inspection program. The NYSTA and other tolling authorities perform their own bridge inspections, according to the NBI requirements. Regardless of who performs the inspection, all the bridge condition data are submitted to NYSDOT. Bridge inspections are performed for all structures at a maximum interval of 24 months. Interim inspections may be performed during the calendar year between required biennial inspections and are required for structures that meet specific criteria established in the NYSDOT Bridge Inspection Manual, Appendix A. NYSDOT is responsible for all Quality Assurance on the data for all bridges, regardless of ownership, and is responsible for all State and Federal reporting.

### *Measures Used for New York State Reporting*

New York State reports on bridge conditions in several reports using two different performance metrics. For individual highway structures, NYSDOT reports FHWA poor status in the Bridge Data Report, a public report that can be found on NYSDOT's website.

For highway bridge system reporting, NYSDOT reports average Condition Rating (CR) and percent good and excellent in two reports. First is in the Graber Report, a public report available

on NYSDOT's website, and second is in the Highway Pavement and Bridge Condition Report to the executive chamber.

Notably, NYSDOT system analysis and reporting is on a different population of structures (all NYSDOT and locally-owned/maintained highway structures, as opposed to NHS structures) using different condition data (AASHTO element inspection data, as opposed to NBI data) and lastly using a different metric (translated Condition Rating, as opposed to NBI rating).

Details of NYSDOT's collection of NBI, AASHTO, and (now historical) State ratings can be found in current and historical inspection manuals available on NYSDOT's website. Details on CR performance categories can be found in the reports referenced above.

### *Measures Used for Federal Reporting Requirements*

In New York State, bridge inspectors assess and record NBI ratings on a 0 to 9 scale for all bridges, in addition to the AASHTO Element rating data in a 4 to 1 scale, during field inspections. These data are used to determine the FHWA bridge classification as outlined below.

Details of NBI ratings can be found in FHWA's Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges.

National performance management measures for assessing bridge condition, based on NBI data, have three condition classifications. They are:

1. Percentage of NHS bridges classified in Good condition.
2. Percentage of NHS bridges classified in Fair condition.
3. Percentage of NHS bridges classified in Poor condition.

For span-type structures, this performance measure rating is based on the minimum of the NBI ratings of the bridge deck, substructure, or superstructure. For culvert-type structures, this is simply based on the NBI culvert rating. The Federally mandated reporting measure for NHS bridges is Structurally Deficient deck area—represented in terms of percent. Effective January 1, 2018, a Structurally Deficient (Poor) bridge is defined by FHWA as when the lowest rating of the three NBI items for a bridge is 4, 3, 2, 1, or 0. When the rating of an NBI item for a culvert is 4, 3, 2, 1, or 0, the culvert will be classified as Poor.

## Measures Used for Network Management

NYSDOT uses CR to manage its bridge network and is also exploring possible use of a new metric to replace CR. This CR metric is currently derived from AASHTO Element data, and historically was derived from the State's inspection recording system, as defined in 2014 and earlier inspection manuals available on NYSDOT's website.

The definitions of CR performance ranges are as follows:

- **Good:** Bridges in good condition generally require preventive and corrective maintenance actions such as bridge washing, deck sealing, and bearing lubrication (CR greater than 5.8).
- **Fair–Protective:** Bridges in fair condition generally require relatively minor preventive and corrective maintenance actions such as bearing repairs, joint repairs, zone and spot painting, and girder end repairs (CR between 4.9 [inclusive] and 5.8 [inclusive]).

- **Fair–Corrective:** Bridges in fair condition that generally require moderate preventive and corrective maintenance actions such as bearing replacement, deck replacement, and major substructure repairs (CR between 4.4 [inclusive] and 4.9).
- **Poor:** Bridges in poor condition that generally require major rehabilitation or replacement (CR less than 4.4).
- **Deficient:** NYSDOT defines a deficient bridge as one with a CR of less than five. A deficient CR indicates the presence of sufficient deterioration and/or loss of original function that requires corrective maintenance or rehabilitation to restore the bridge to its fully functional, non-deficient condition. It does not mean that the bridge is unsafe.

### Bridge Conditions

Table 2.6 provides an overview of the condition of bridges on the NHS in terms of the National Performance Measures, which is based on bridge deck area for data collection year 2020.

*Table 2.6 Bridge conditions.*

| Owner Agency | NHS % Good | NHS % Fair | NHS % Poor |
|---|---|---|---|
| NYSDOT | 26.16% | 62.06% | 11.78% |
| NYSTA | 40.28% | 50.15% | 9.57% |
| Others | 16.38% | 74.33% | 9.29% |
| Total | 25.33% | 63.81% | 10.86% |

## 2.3 SYSTEM PERFORMANCE AND ASSET CONDITIONS

Asset condition is only one performance area managed by NYSDOT. NYSDOT's CPU process coordinates between performance areas to ensure that New York State's transportation system can:

- Withstand the increasing intensity and frequency of extreme weather events.
- Facilitate the efficient movement of individuals and commerce.
- Support changing personal mobility and travel demands.

The CPU is a 5-year program that is updated every 2 to 3 years. The program draws from performance objectives established in NYSDOT's family of performance-based plans, as shown in figure 2.12. The CPU includes strategies to address asset condition and system performance needs in terms of pavement and bridge conditions, safety, and sustainability.

*Figure 2.12. NYSDOT's family of performance-based plans.*


Strategies for addressing pavement and bridge conditions emphasize engineering-based asset management principles as defined and described in this TAMP. Additionally, the CPU addresses system needs related to climate/resiliency vulnerabilities; operational enhancements and emergency response efforts through Traffic Systems Management and Operations (TSMO) activities; and overall safety measures to mitigate injuries/fatalities of motorists, bicyclists, and pedestrians. Additional details of the CPU update process are provided in chapter 7.

# 3. Financial Resources

This chapter discusses the value of the State's NHS assets and describes the funding expected to be available over the next 10 years to address pavement and bridge needs. NYSDOT and the NYSTA receive funding from multiple sources and are tasked with numerous missions, but only a portion of overall funding is available for asset management of pavements and bridges. This chapter describes NYSDOT's various revenue streams and explains how the Department arrives at an average annual core construction investment level for highway assets.

## 3.1 VALUATION OF NYSDOT ASSETS

NYSDOT uses the Government Accounting Standards Board Statement No. 34 modified method to determine the value of its assets on an annual basis. In this method, the collective original construction cost of all road and bridge assets is determined, then each year NYSDOT adds the value of all new construction and subtracts the depreciation. The valuation for roads includes the cost of pavement construction and all other assets necessary for the operation of the highway such as signs, striping, and drainage. The current value of assets on the NHS is:

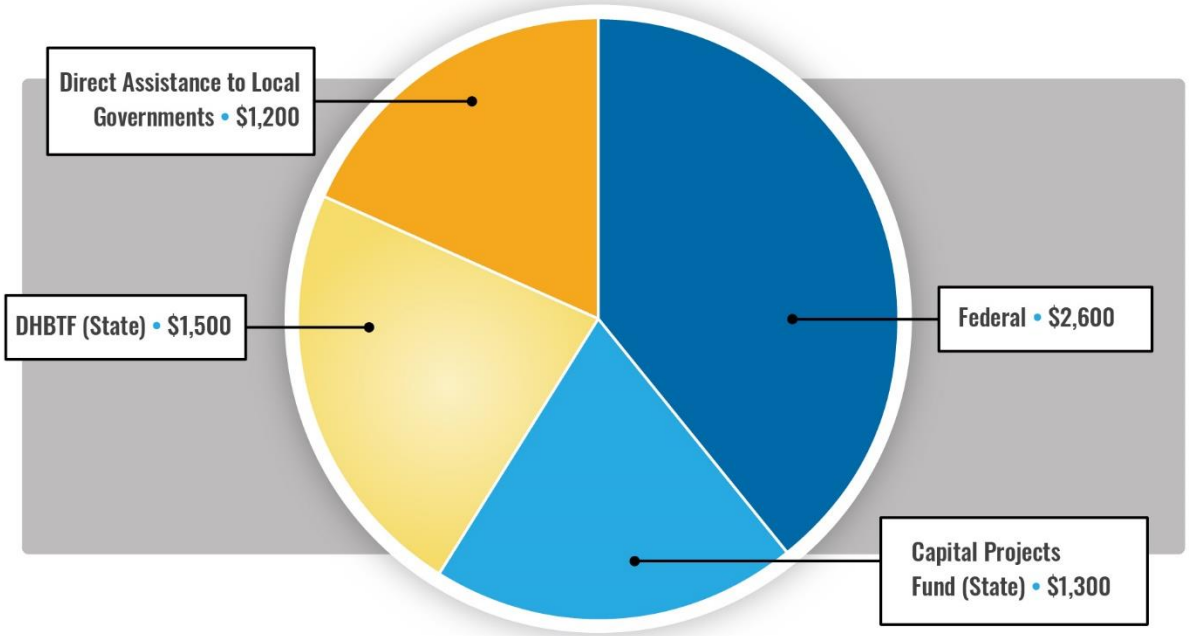
- Pavements: $38.02 billion or $38.02B/26,756 lane-miles = $1.42M/lane-mile.
- Bridges: $19.03 billion or $19.03B/5,485 bridges = $3.47M/bridge.

NYSDOT does not consider asset valuation when setting asset management strategies. Instead NYSDOT uses condition-based measures to determine annual financial need, as described in chapter 7. However, asset valuation is an important measure that indicates the soundness of NYSDOT's investment decisions and therefore NYSDOT is currently in the process of identifying ways to include asset valuation in the upcoming TAMPs.

## 3.2 CORE FUND SOURCES OVERVIEW

NYSDOT receives funding for use on the NHS, as well as on the wider State and local transportation system. In contrast, the NYSTA receives funding and collects revenues, but they are only to be used on the New York State Thruway, which is completely on the NHS. Based on the best available information from State and Federal sources, NYSDOT is forecasting flat funding beyond 2026, which is the final year of the current Federal highway funding bill. This section describes the sources of funding that are available annually for use on the transportation system in New York State, as shown in figures 3.1 for NYSDOT and 3.3 for the NYSTA. Figure 3.2 provides additional details on Federal fund sources. Each of these funding sources is further defined below.

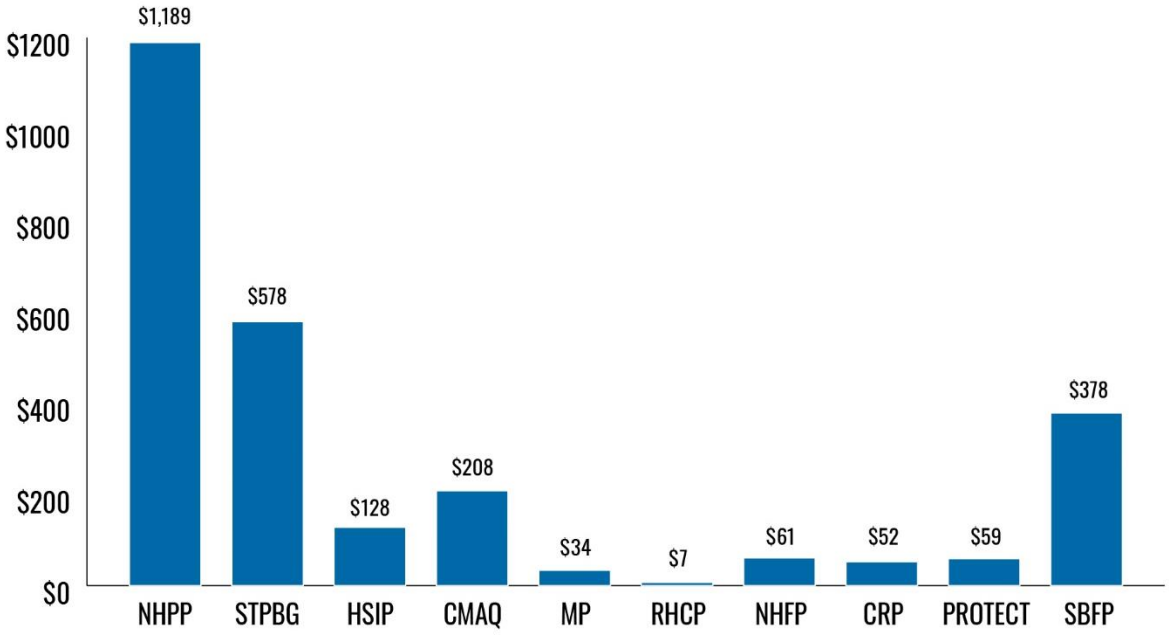
*Figure 3.1 NYSDOT funding sources ($ millions/yr).*




- **State funds** are comprised of funds from the New York State Dedicated Highway and Bridge Trust Fund (DHBTF). The fund sources are subsidized by the Petroleum Business Tax, motor vehicle fees, motor fuel taxes, and other taxes and fees. On average, budgets for the next 10 years are anticipated to include about $1.5 billion per year in State funds for support of NYSDOT's comprehensive program.
  - **Direct Assistance to Local Governments**. State aid to municipalities for highway infrastructure purposes primarily includes the Consolidated Local Street and Highway Improvement Program (CHIPS), Extreme Winter Recovery Program, and the Marchiselli Program.
  - **Capital Projects Fund**. Periodically, the State supplements transportation funding provided by dedicated sources such as the DHBTF. Whereas the core construction funds are funds gathered from dedicated State and Federal transportation funding streams, the Capital Projects Fund is primarily funded by personal income tax receipts and is used to provide funding for infrastructure investment as a means of job creation.
  - **Bonds.** Bond acts must be approved by voters. Bonds are currently not a significant source of revenue for NYSDOT.
- **Local Municipal Investments.** These investments vary widely across the State. Local funding is subsidized through local tax collections, which are primarily sales and property taxes. These funds are not collected, managed, or distributed by New York State or NYSDOT; rather, they are collected and remain in the municipalities in which they originate. Therefore, these revenues are not listed for the purposes of the TAMP.
- **Federal Aid** is comprised of Federal transportation funding and authorization programs. Total Federal funding is anticipated to be approximately $2.6 billion per year. Federal transportation funding is typically split into broad categories of eligible

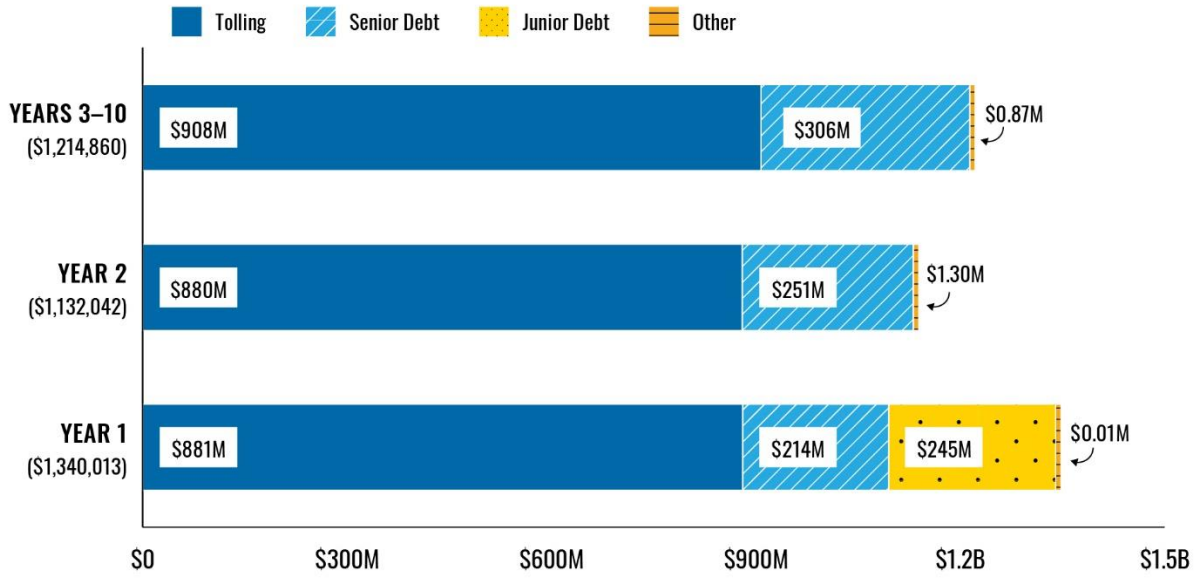
work. Figure 3.2 illustrates the mix of funds that is expected to be received annually by New York State by program, based on the Bipartisan Infrastructure Law (BIL) passed in 2021. In general terms, programs such as the HSIP; CMAQ; Railway-Highway Crossing Program; National Highway Freight Program (NHFP); Carbon Reduction Program; Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation Program; Supplemental Bridge Formula Program; and Metropolitan Planning Program have very specific goals. Meanwhile, the National Highway Performance Program and Surface Transportation Program Block Grants can be used to satisfy a range of core system, bridge, and highway needs.

*Figure 3.2 Expected Federal funding mix for NYSDOT ($ millions).*




- **Authority Funds**
  - **Tolling**. NYSDOT cannot raise revenue through tolling; however, several transportation authorities who are responsible for segments of the NHS in New York State can and do. These authorities include the NYSTA, Mid-Hudson Bridge Authority, Triborough Bridge and Tunnel Authority, and the Port Authority of New York and New Jersey. The NYSTA is the toll authority that owns the largest portion of NHS in the State and raises most of its revenue through the collection of tolls. NYSTA funding is shown in figure 3.3 below.
  - **The NYSTA Senior and Junior Debt.** Amounts shown in figure 3.3 represent proceeds (monies) of a prior or current year debt issuance (bonds) that would be planned to be available for use on capital projects. Senior debt (bond) proceeds are available for use for any Thruway capital project expenditures that are not Mario M. Cuomo Bridge Project-related.

*Figure 3.3 NYSTA annual funding ($ thousands).*




# 3.3 USES OF HIGHWAY INFRASTRUCTURE FUNDS

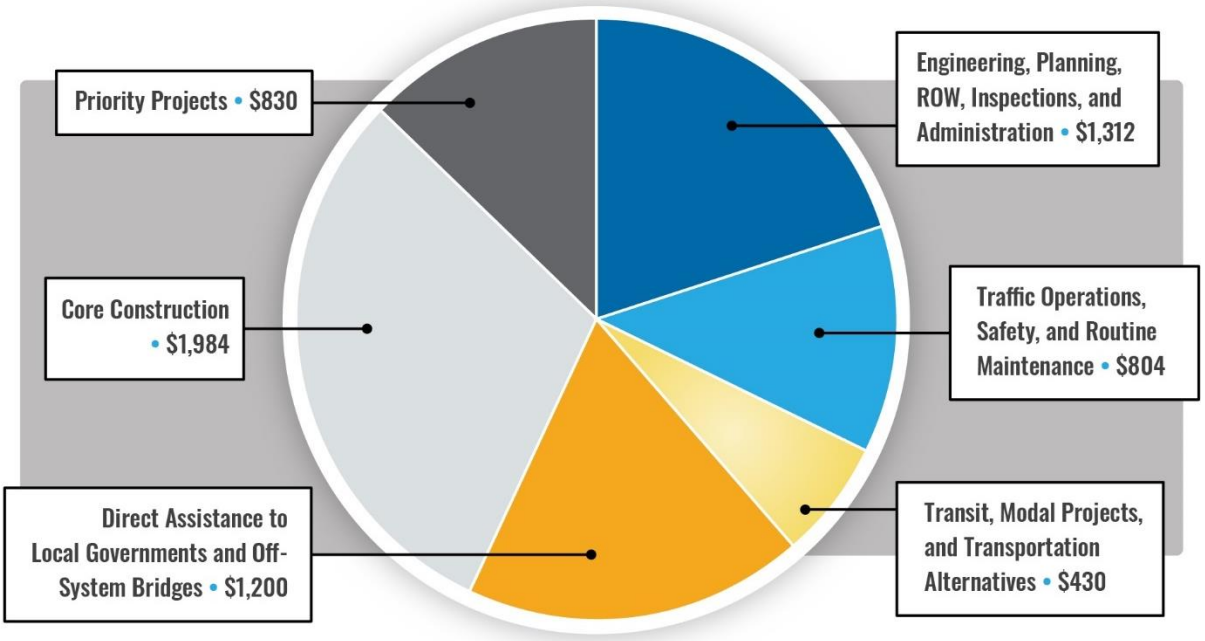
## Expected Annual NYSDOT Expenditures

NYSDOT's current Capital Plan[1], as shown in figure 3.4, provides an average of $6.56 billion in new capital program funding annually to improve the transportation system, enhance the system's resiliency, and create jobs. However, not all funds are available for asset management of pavements and bridges on the NHS. NYSDOT has many responsibilities that must be funded and some of the funds that are collected can only be used for certain functions. These include, for example, safety initiatives that are managed through the HSIP, the CMAQ, and spending on multimodal facilities.

Of the total revenue received, approximately $2.8 billion in new funding is provided annually to support NYSDOT's highway and bridge program through construction funding for the repair, rehabilitation, and replacement of critical State and local infrastructure. This consists of approximately $1.984 billion in core construction funds and $830 million dedicated for priority projects. NYSDOT's capital funding also supports approximately $1.3 billion in engineering, planning, ROW, inspections, administration, and other program delivery support; $804 million in additional funding for traffic operations, safety, and routine maintenance; $430 million in additional funding for transit, modal projects, and transportation alternatives; and $1.2 billion in funding for direct assistance to local governments and off-system bridges. Figure 3.4 shows NYSDOT's current finance plan as it is distributed to these different missions. The segments of figure 3.4 are governed by distinct, legislated appropriations that direct how the funding can be used.

[1] Current Five-Year Capital Program covers State fiscal years 2020-2021 through 2024-2025.

*Figure 3.4 NYSDOT capital plan ($ millions).*




*Priority projects are part of core construction, but are selected outside of asset management processes to address needs of Statewide concern

- Engineering, planning, ROW, inspections, and administration include the following types of expenditures:
  - Engineering and administrative funds are used to support NYSDOT's engineering and administration expenses.
  - ROW and non-construction phase funds are used for the ROW acquisition of property to support the construction of projects throughout the State transportation system, not just on the NHS.
  - Structures inspection funds are used to inspect bridges, large culverts, and other structures to ensure the safety of the traveling public.
- Traffic operations, safety, and routine maintenance include the following types of expenditures:
  - Operational maintenance funds are used to support NYSDOT's non-winter maintenance operations, as well as the Department's maintenance facilities.
  - Construction safety funds are used to support NYSDOT's efforts to provide a safe work area for workers within the roadway while facilitating the safe and orderly flow of all road users.
  - Safety project funds are dedicated funds used to pay for projects delivered under the HSIP.
- Transit, modal projects, and transportation alternatives include the following types of expenditures:

- Transfers to Metropolitan Transportation Authority (MTA) are funds that NYSDOT transfers to the MTA to help maintain the transit infrastructure around New York City.
- Traffic Management Centers (TMCs), Highway Emergency Local Patrol (HELP) trucks, 511, etc. are funds used to support the State's TMCs and other operational endeavors, such as the State's roadside HELP trucks, the 511-traveler information system, and operation of high-occupancy vehicle lanes in New York City.
- Modal funds are used to support NYDOT's modal programs: transit, rail, and aviation. These do not include the State's transit operating aid (approximately $5 billion annually), Federal Transit Administration (FTA) funds provided directly to the State's transit systems, or State capital funds provided to the MTA.
- TAP are dedicated funds used to deliver projects that promote non-vehicle transportation such as bicycle and pedestrian facilities.
- CMAQ funds are used to support projects that reduce emissions and improve air quality. These are primarily mobility projects.

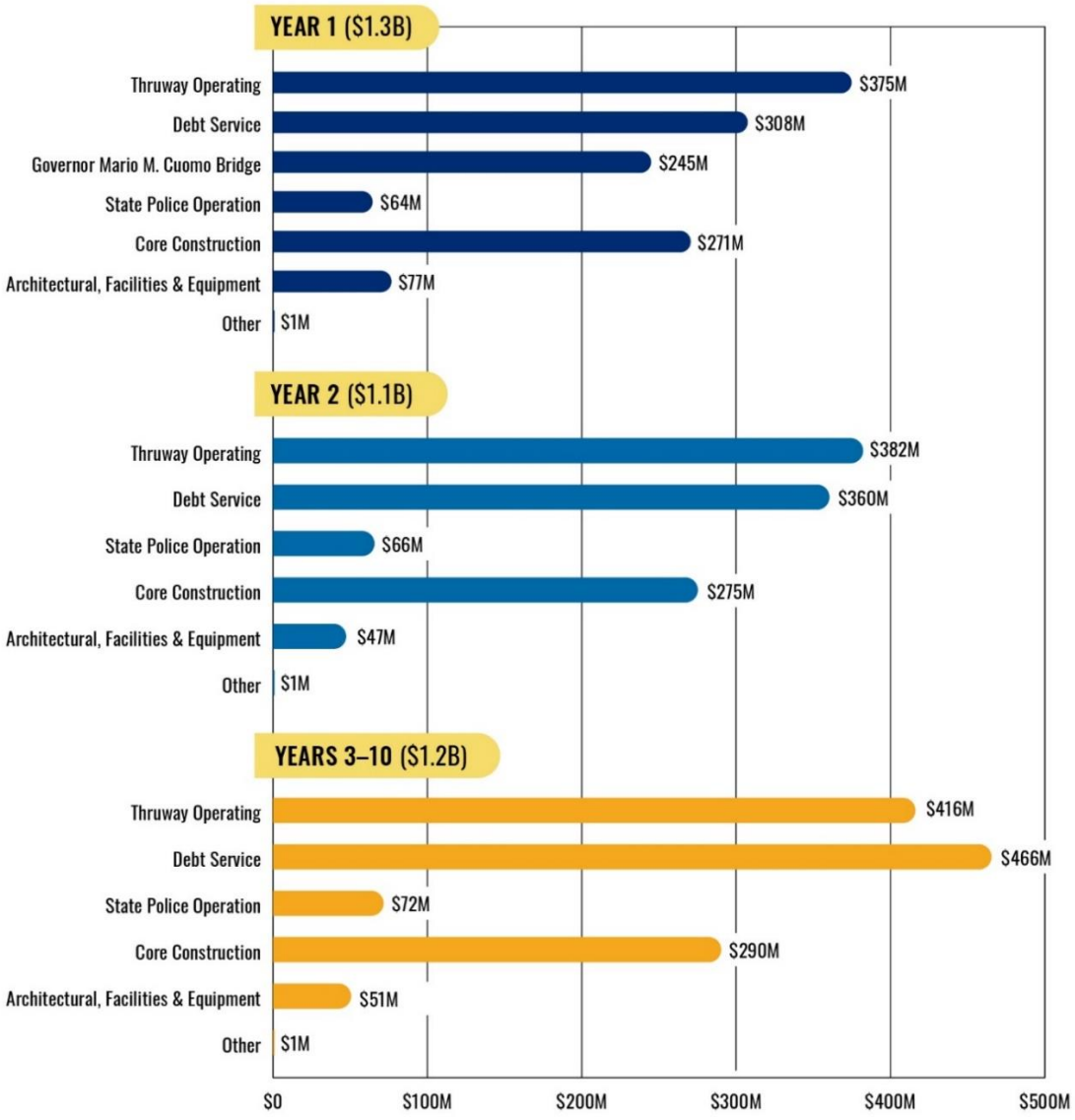
- Direct assistance to local governments and off-system bridges include the following:
  - Direct assistance to local governments is paid for with CHIPS, Extreme Winter Recovery, and Marchiselli funds. These funds, by law, cannot be used for anything except local infrastructure.
  - The Off-system Bridge Program dedicates funding to State and local bridges that are not eligible for other Federal Aid programs.
- Core construction funds are used for construction projects to meet the needs of the entire State-maintained portion of the transportation system, not just on the NHS. The methods of allocating these funds to meet those needs are detailed in chapter 7. Included within core construction are priority projects that address transportation needs of Statewide concern. Examples of priority projects include:
  - **I-81 Viaduct Project** which will address the structural deficiencies and non-standard highway features in the I-81 corridor while creating an improved corridor through the City of Syracuse that meets transportation needs and provides the transportation infrastructure to support long-range planning efforts (such as SMTC LRTP, Syracuse Comprehensive Plan, and others). The existing elevated structure will be replaced by a new Business Loop 81 with an integrated Community Grid that will disperse traffic along local north-south and east-west streets. Portions of Interstates 481 and 690 will also be reconstructed to accommodate high speed traffic going around and through the city. The current construction estimate is $2.13 billion to be delivered through a series of construction projects.
  - **Hunts Point Interstate Access Improvements** (Contract) which will provide access improvements for the Hunts Point Market and Hunts Point Peninsula in Bronx Co. NYC to address limited direct routes via nearby highways and reduce travel through local streets. This project is the third of three contracts (or phases) for this improvement effort and has an estimated cost of $543 million.
  - **Van Wyck Expressway Capacity Improvements** (Phase 3) which will widen the Van Wyck Expressway mainline to complete the construction of one Managed Use Lane in each direction between Hoover Ave and Federal

Circle in order to improve capacity and access to JFK airport, in Queens County, NYC. In addition to the mainline widening, this contract includes the reconfiguration of exit and entrance ramps within the project limits, replacement of six bridges, widening of two bridges, and construction of a new bridge. The estimated construction cost is $804 million.

## Expected Annual NYSTA Expenditures

Figure 3.5 shows the 10-year financial plan for the NYSTA. NYSTA expenses include operating and maintenance expenses, debt service, snow and ice, policing, core construction funds, architectural and engineering services, equipment purchases and upgrades, and other major initiatives such as the Mario M. Cuomo Bridge capital project. Pursuant to the requirements of the NYSTA's bond resolution, operating expenses and debt service requirements are funded prior to the capital program and reimbursement of the State police.

*Figure 3.5 NYSTA financial plan: 2022 through 2031 ($ thousands).*



## Financial Plan Overview

When all the various budget sources from NYSDOT and the NYSTA are combined, a total picture of the core construction funding available on the State system can be seen, as shown in table 3.1. For purposes of this analysis, NYSTA's year 2 funding was used to model future outcomes. These combined funding amounts were used in the performance modeling and forecasting of the State system and the NHS and in setting the 2- and 4-year condition targets shown in chapter 7.

*Table 3.1 Total average funds available for NHS work 2022-2031 ($ millions).*

| | |
|---|---|
| **NYSDOT Total Annual Funding (From Figure ES.2)** | **$6,560** |
| **Minus:** | |
| Engineering, planning, ROW, inspections, and administration | ($1,312) |
| Traffic operations, safety, and routine maintenance | ($804) |
| Transit, modal projects, and transportation alternatives | ($430) |
| Direct assistance to local governments and off-system bridges | ($1,200) |
| **Sub-total for NYSDOT core construction** | **$2,814** |
| **NYSTA Total Annual Funding (From Figure ES.3)** | **$1,132** |
| **Minus (From Fig. 3.6):** | |
| Thruway operating | ($382) |
| Debt service | ($360) |
| State police operating | ($67) |
| Arch, facilities, and equipment | ($47) |
| Other | ($1) |
| **Sub-total for NYSTA core construction funds** | **$275** |
| **Total Annual Average Core Construction Funds** | **$3,089** |

# 4. Asset Management Practices

This chapter describes NYSDOT's asset management business structure, policies, and practices, as well as the asset management practices of the NYSTA. It provides an overview of how NYSDOT's organizational structures support its asset management business processes, including the role of the TAMP in asset management practices. These practices include TAMP management and asset management improvements as well as partnering efforts with other owners of NHS assets.

## 4.1 NYSDOT'S ORGANIZATIONAL STRUCTURE

NYSDOT is led by the Commissioner of Transportation. NYSDOT has four main office divisions responsible for Statewide policy and oversight of the program in the areas of engineering, legal affairs, operations and asset management, and policy and planning. The heads of each of these divisions report directly to the Commissioner. NYSDOT's eleven Regional offices are responsible for program delivery and operating NYSDOT's highway network. The overall organizational structure of NYSDOT is shown in Appendix B.

## 4.2 NYSDOT'S ASSET MANAGEMENT BUSINESS STRUCTURE

NYSDOT established its asset management business structure to enable consistent decision-making at all levels of the organization and to set consistent fiscal limits for performance across geographic boundaries. It helps to manage expectations and allows NYSDOT, as steward of the transportation system, to facilitate the best investment for the system and the State, regardless of ownership. To support this effort, measures of accountability have been established to maximize return on investment and long-term public benefits.

NYSDOT's internal asset management business structure is illustrated in figure 4.1. The structure is functional, rather than organizational. These teams are not organizational units but are groups of staff from across program areas in the main office and Regions. The focus areas represented by the Statewide and Regional teams consist of the highest priority program areas for asset consideration.

*Figure 4.1 NYSDOT's internal asset management business structure.*


This structure has been established to:

- Generate consistent decision-making.
- Set consistent performance measures and establish appropriate targets.
- Ensure accountability.
- Guide local and Regional decisions for preservation of the system.
- Make centralized decisions for the most important system renewal and strategic improvement projects.
- Manage expectations.
- Ensure the best investment practices regardless of ownership.

The following is a synopsis of each team's role in asset management governance and practice. Additional details for each of the groups included in NYSDOT's asset management business structure are provided in Appendix C.

## Capital Program Delivery Committee (CPDC)

The CPDC, headed by the Commissioner of Transportation and consisting of executive-level and other key staff, provides strategic vision and executive leadership for asset management.

## Comprehensive Program Team (CPT)

The CPT provides Statewide leadership on asset management policies, practices, tools, and investments. Since its inception, CPT has been co-chaired by the Asset Management Champion and the Program and Project Management Champion. This linkage has been established to foster a connection between program development and program delivery.

## Statewide Asset Management Teams (SAMT)

SAMTs have been established for specific asset classes and functions such as pavement, safety and operations, structures, and sustainability. Each team has an established charter that clearly articulates assets managed, mission, purpose, composition, meeting frequency, and roles and responsibilities.

**The asset management business structure calls for NYSDOT to:**

- Improve the quality of investment decisions—deliver projects that impact conditions; do not just report on them.
- Leverage existing data and tools—minimize initial investment and time needed to implement new practices by utilizing current data and technology.
- Establish collaborative relationships across the bureaucracy—break through organizational cultures and data stovepipes.
- Employ TAM guidance developed by AASHTO—start with what is available now and work to improve.
- Adopt a systems approach—deliver the best possible results to the most users.

## Regional Asset Management Teams (RAMTs)

RAMTs are responsible for programming decisions related to their specific areas of responsibility such as pavement, safety and operations, structures, and sustainability. The teams work under the direction of the Regional Program Committee (RPC). RAMTs are shown in figure 4.1 as subordinate to Statewide teams in that they receive some goals and functional guidance from Statewide teams.

# 4.3 THE ROLE OF THE TAMP IN ASSET MANAGEMENT PRACTICES

According to AASHTO guidelines, "the TAMP plays a key role in connecting the Agency's corporate strategic direction with implementation tools, ensuring that the Agency can achieve its mission in the most cost-effective manner while achieving the required levels of service."[5] This plan provides a link between NYSDOT's strategic investment decisions and program development practices. NYSDOT's Comprehensive Program is its primary mechanism for delivering on its mission to provide safe and reliable transportation to its customers. The TAMP provides transparency to NYSDOT's objectives and the path to achieving them. Finally, it helps maximize

[5] AASHTO, 2010; *AASHTO Transportation Asset Management Guide: A Focus on Implementation*, p. 4-23.

return on investment by ensuring asset investments are delivered at the optimal time to minimize whole life costs.

## 4.4 ASSET MANAGEMENT POLICY DEVELOPMENT PROCESS

This section describes the process for the development, review, and acceptance of all NYSDOT asset management policies and standards. Asset management policy includes documents such as the TAMP, Comprehensive Program and STIP update guidance, and similar strategic and tactical directives related to investments in highway infrastructure.

Policy may be drafted by a Statewide asset team, an organizational unit, or a temporary task force. In the case of a temporary task force, a member of CPT will be identified to champion the effort and will be responsible for informing the CPT on the status of the assignment.

Once the policy is drafted, it is reviewed internally by the CPT and any internal stakeholders identified by the CPT. For policy impacting the STIP or CPU this will, at a minimum, include the Statewide teams. The internal review process utilizes the resources of NYSDOT's asset management framework described in section 4.2. This framework provides thorough reviews at multiple layers of management within the organization and makes it easier to obtain full support for the policy document and its implementation. Although NYSDOT's asset management structure contains representatives from several of the Regions in order to ensure their full buy-in, it is recommended that Regional Directors and Regional Planning and Program Managers be briefed on the content and purpose of policy changes impacting their programs through normal organizational channels of communication.

For policy impacting external stakeholders, a minimum of 30 days is typically provided for external review and comment. The CPT will oversee the collection of comments and develop any necessary revisions. Following revisions from external review, the draft is resubmitted to CPT and then to CPDC for approval. Statewide policy will be approved by the Commissioner of Transportation.

## 4.5 TAMP MANAGEMENT

NYSDOT's TAMP is designed to be a living document, in that the processes, strategies, and funding levels described are all subject to continuous improvement. The TAMP is also very closely related to NYSDOT's CPU and STIP processes, and hence changes to the TAMP is reflective of revisions made to those processes since the previous TAMP was certified.

The TAMP will be subject to a series of continuous improvements, including the need to address additional assets and the clarification or creation of new performance measures or definitions. Accordingly, the TAMP update process will include the creation of a list of improvements to asset management business practices that should be addressed over time.

The TAMP quadrennial update process will be initiated by the Office of Operations and Asset Management by identifying a TAMP project manager and working group. The TAMP Working Group will develop a draft scope of changes such as practices, tools, policies, fiscal projections, condition projections, risks, and mandates that impact asset management outcomes. The draft scope may expand the TAMP to include additional assets as well. Following review, the TAMP working group will draft a revised TAMP for approval through the asset management policy development process as described above.

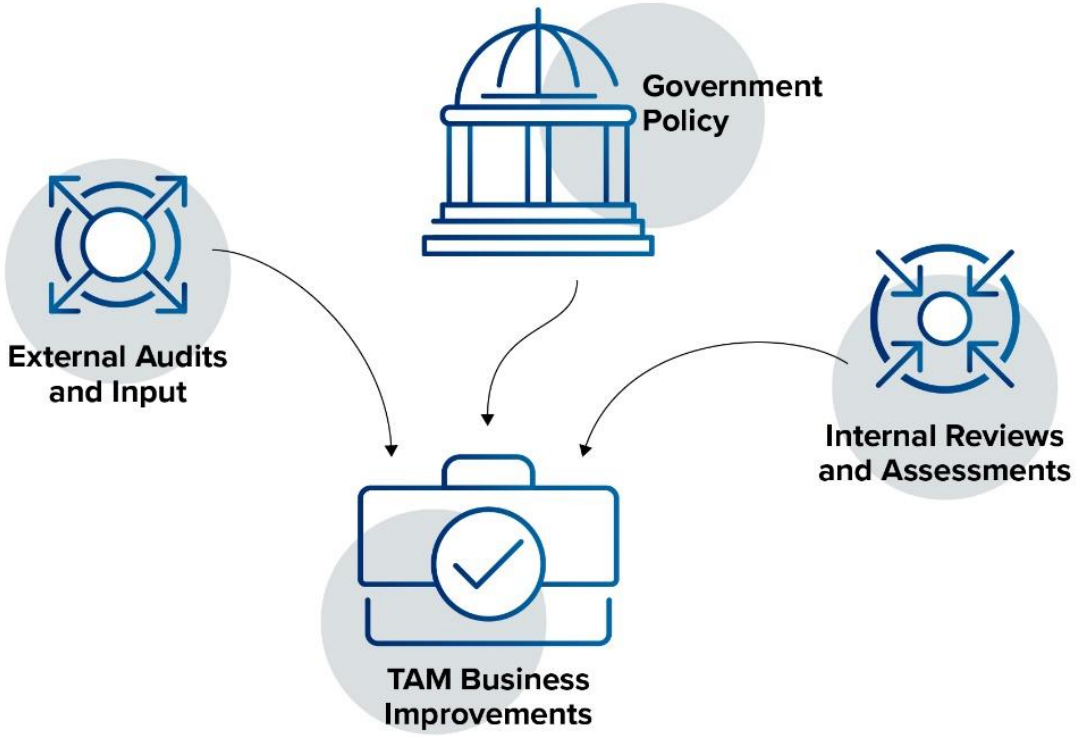
## 4.6 ASSET MANAGEMENT IMPROVEMENT PROCESS

NYSDOT is continually improving the efficiency and efficacy of its asset management business practices and tools. Until all highway assets are incorporated into the asset management business structure, and the business structure is fully integrated with other strategic plans, NYSDOT will continue to expand the scope of its asset management practices.

Targeted business improvements are generated from many sources, as shown in figure 4.2. The four primary sources are:

- External policies including legislative actions, Federal agency rules, and judicial findings.
- External reviews and audits by regulatory agencies such as FHWA and the New York State Office of the State Comptroller.
- Input and best practices from external partners.
- Internal assessments, reviews, and audits that are performed by program areas as part of the normal business practice of continual improvement, as well as on a larger scale in preparation for major efforts such as a program update or reorganization.

*Figure 4.2 Asset management improvement sources.*




The result of this process is NYSDOT's Asset Management Improvement Plan, which is the focus of chapter 8. Development and updating of the Improvement Plan is managed according to the Asset Management Policy Development Process as described in Section 4.4.

## 4.7 NYSTA PRACTICES

The NYSTA operates as an independent authority and manages a significant portion of the State's NHS assets. Their program areas are highways, bridges, architecture, and intelligent transportation systems, with the majority of the funding going to highways and bridges.

Specific treatments for bridges and highway segments are selected based on current condition, actual and projected rate of deterioration, expected service life of the last treatment, traffic/truck volumes, vulnerabilities, coordination requirements, and available funding. Currently, life-cycle costs are considered during scoping.

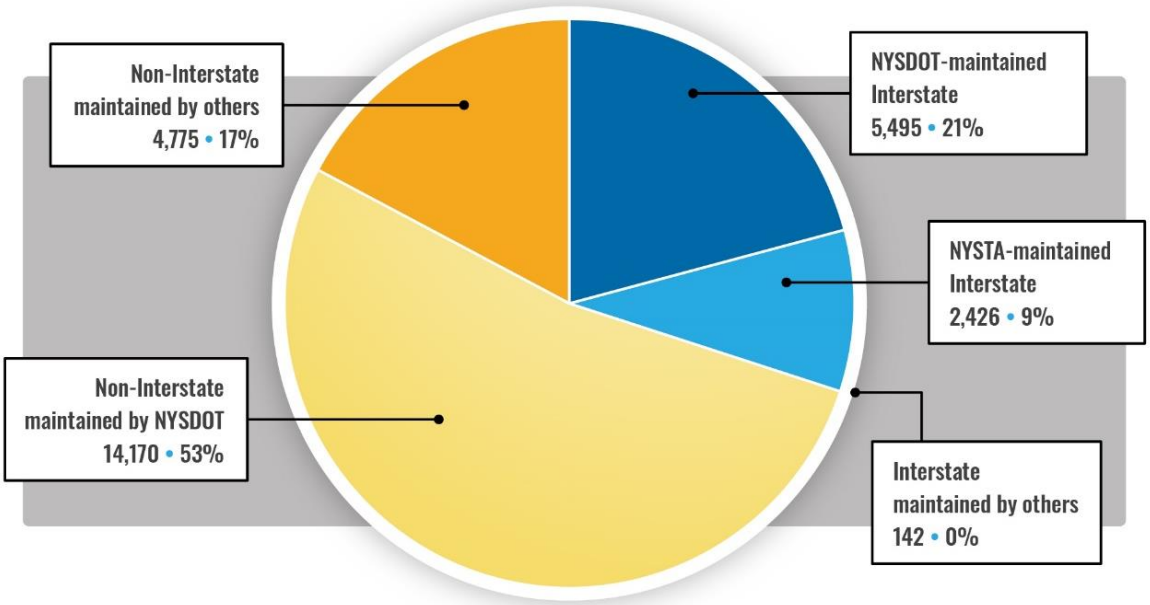
The NYSTA Board-approved capital program is updated annually by adding a new year to the program and reviewing the projects in the existing program. Other changes are made to the program over the course of the year due to a variety of factors, including changing financial conditions or the need to modify the scope of work, cost, and schedule of existing projects. The update process involves evaluating various bridges and all 70-plus highway planning segments on the Thruway, using the most current condition data and other information. The purpose is to review performance predictions and to compare predicted versus actual performance in order to improve modeling efforts.

The bridge evaluation and long-range plan for bridges included in the existing program is reviewed to confirm the appropriateness of the project scope, budget, and timing. New bridge projects are added based on the same analysis, taking into account the recommendations of maintenance and the NYSTA's four Divisions. The result is a prioritized list of candidate projects subject to both network-level goals, objectives, and constraints as well as project-level conditions and needs for inclusion in the capital program. A letting and cash flow analysis is performed by the Office of Capital and Contracts Management and the Department of Finance to verify consistency with available funds.

## 4.8 PARTNERING WITH OTHER OWNERS OF NHS ASSETS

Federal law requires that the TAMP cover all of the NHS. However, NYSDOT does not have jurisdiction over the entire NHS in the State. Portions of the NHS are owned and maintained by local governments and independent public authorities such as the NYSTA, the New York State Bridge Authority, and the Triborough Bridge and Tunnel Authority. Specifically, 74 percent of the NHS is owned by NYSDOT, which has the responsibility of developing the TAMP; 17 percent is owned by other governmental entities (county, town, village or city); and 9 percent is owned by the NYSTA. Figure 4.3 shows a breakdown of this system by jurisdiction.

*Figure 4.3 NHS pavement lane-miles by jurisdiction.*




NYSDOT coordinates with these other asset owners as necessary to facilitate the effective operation, preservation, and improvement of the NHS throughout the State. Coordination is conducted through Statewide and metropolitan planning processes. In metropolitan areas, NYSDOT coordinates through MPOs and consults directly with local governments in areas outside of any MPO jurisdiction.

MPO review facilitates local input to the TAMP. NYSDOT has shared TAM principles with its partners and is working cooperatively with MPO staff and membership and local governments outside of MPO areas to adopt asset management practices. To assist other NHS owners in adopting asset management, NYSDOT is working to provide data, analysis tools, and support through the MPO and rural consultative processes.

NYSDOT provides guidance and financial resource estimates for the Federal Aid program through the STIP update process. The STIP is developed by including the State's fourteen MPOs' Transportation Improvement Programs (TIPs) in their entirety. The STIP also includes the nonmetropolitan projects, developed in consultation with affected nonmetropolitan transportation officials, and in cooperation with local governments. The STIP is a compilation of regional TIPs that are adopted by MPOs and, combined with transportation projects in nonmetropolitan areas, becomes a comprehensive list of all highway and transit projects that propose to use Federal funds.

NYSDOT provides two sets of guidance to MPOs and Regions for developing the STIP. The first is STIP Policy Guidance that reflects NYSDOT's capital program direction for asset management practices. These asset management practices focus investments in current infrastructure on preventive, corrective, and high-demand maintenance to preserve the functionality of the existing transportation system. Planning targets, or estimates of future Federal funding, are established for each NYSDOT Region and used for planning in conjunction with the MPOs and nonmetropolitan transportation officials. Planning targets reflect estimates of anticipated Federal funding and may not reflect actual Federal funds received. Planning targets for FHWA funds are distributed in conjunction with the STIP Policy Guidance.


AP1000F
CAT

# 5. Life-Cycle Planning

This chapter introduces the principles of life-cycle planning and the resulting processes adopted by NYSDOT and the NYSTA. Life-cycle planning considers the most economical approach to manage assets throughout their service lives. It evaluates strategies for applying various treatments, such as those shown in table 5.1, to determine the most cost-effective approach to using available funding and achieving asset management goals. Life-cycle planning applies the principles of life-cycle cost analysis to system-wide program management practices. Just as traditional life-cycle cost analysis leads to the selection of the most cost-effective alternative for a project, life-cycle planning leads to the selection of the most cost-effective strategies for managing multiyear, multi-asset investment programs.

*Table 5.1 NYSDOT treatment types by Federal work type.*

| FHWA Work Type | Pavement Treatment Category | Bridge Treatment Category |
|---|---|---|
| Preventive maintenance | Maintenance activities, including:<br>■ Crack seal<br>■ Crack fill<br>■ Filling potholes<br>■ Pavement patching | Preventive maintenance, including:<br>■ Painting<br>■ Cleaning<br>■ Joint resealing<br>■ Deck sealing and overlays |
| Preservation | Preventive maintenance, including:<br>■ Chip seal<br>■ Quick set slurry<br>■ Microsurfacing<br>■ Paver-placed surface treatment<br>■ 6.3mm hot mix asphalt (HMA) overlay<br>■ Single course HMA overlay<br>■ PCC repair | Preservation encompasses all preventive and corrective maintenance activities. Therefore, bridge preservation will not be shown as a separate category in any of the following tables and charts. |
| Rehabilitation | Corrective maintenance, including:<br>■ HMA mill and fill<br>■ Hot-in-place recycling<br>■ Cold-in-place recycling<br>■ HMA mill and fill on composite Pavement with underlying joint repair | Corrective maintenance, including:<br>■ 5 to 7 repairs, which are element-level repair work performed on structures that are in generally good condition<br>■ Deck replacement<br>■ General rehab<br>■ General repairs |
| Highway Reconstruction/ Bridge Replacement | Renewal, including:<br>■ Multi-course HMA<br>■ Multi-course mill and fill<br>■ Multi-course cold-in-place recycling<br>■ Crack and seat or Rubblization of PCC<br>■ Reconstruction; remove and replace | Renewal, including:<br>■ Structure replacement<br>■ Superstructure replacement |

The State's transportation system is extensively built out and fully constructed. Because of the age and extent of the existing State highway system, construction of brand-new facilities is extremely rare and is not included in NYSDOT's asset management modeling. The overall inventory of pavements and bridges does increase slightly on a year-to-year basis, but this is primarily due to replacements of bridges with larger bridges, or realignments of relatively short sections of roadway. The overall system growth is not anticipated to impact the life-cycle planning strategies for the State's NHS within the TAMP period.

## 5.1 WINDOWS OF OPPORTUNITY

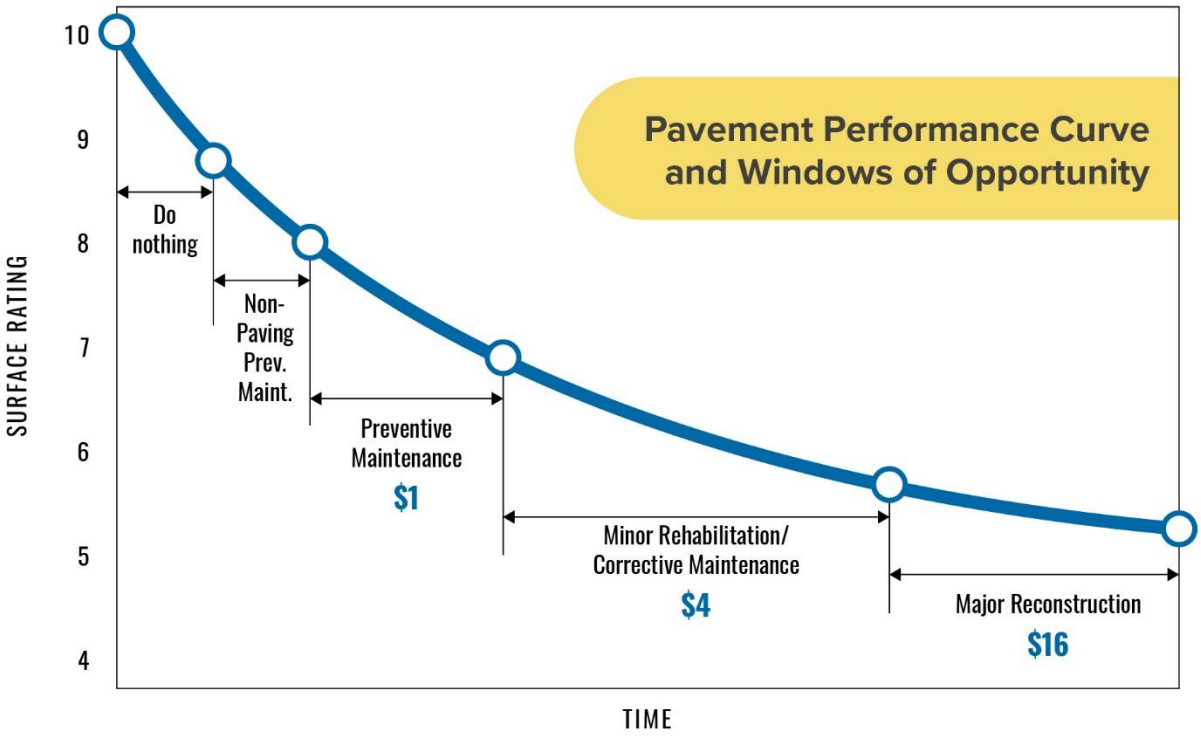
Over time, assets deteriorate through different stages of condition. As the asset condition gets worse, it will require more extensive treatments to bring it back to a state of good repair. The period where a particular work type is the proper treatment for the distress in the asset is called the "window of opportunity."

Figure 5.1 illustrates the window of opportunity concept for pavements. As a pavement deteriorates there is a period, a window of opportunity, to perform a lower cost treatment before the distress becomes too severe and a more expensive treatment is required to properly repair the pavement. This concept is true for each treatment window the pavement passes through, as untreated distress continues to advance.

Windows of opportunity are treatment specific. For example, the window of opportunity for a preventive maintenance overlay on an asphalt pavement is approximately 3 years, while the window of opportunity for a more extensive treatment like mill and inlay is between 5 and 10 years. This does not mean the preventive maintenance overlay will only last for 3 years. It is simply the time in which a preventive maintenance overlay is the appropriate treatment for the pavement. If applied within the window of opportunity the preventive maintenance overlay should last 8 years or more. These precepts are reflected in modeling rules used in both the PMS and bridge management system (BMS) analyses.

The dollar amounts shown in figure 5.1 represent the ratio of typical costs between treatments that are appropriate in each window of opportunity. In general, the cost of treatment increases exponentially between categories. For example, the typical cost of a thin overlay on a good pavement is approximately $75,000 per lane mile. The cost to mill and place two layers of asphalt on the same pavement when it reaches fair condition is typically $175,000 to $250,000 per lane mile. The typical cost to rehabilitate that pavement if it reaches poor condition is $1 to $5 million per lane mile. Because major work is necessary to recover the condition of poor assets, the cumulative cost of multiple preservation treatments applied multiple times over the life of the asset is several times less expensive than postponing that work and replacing the asset prematurely.

*Figure 5.1 Pavement performance windows of opportunity.*[6]




This same concept applies to bridges but is more complex as each component of the bridge deteriorates along its own curve and each has independent windows of opportunity. NYSDOT's whole life approach to managing bridges recognizes the relationship between robust cyclical and preventive maintenance programs and prolonging the structure's service life, along with slowing the rate of deterioration. Conceptually, the costs of a systematic maintenance program by condition are presented in table 5.2.

*Table 5.2 Bridge treatment costs by condition.*

| Condition | Cost per Structure for Applicable Treatment |
|---|---|
| Good | Cyclical treatment—$10K per year |
| Fair | Corrective treatment—range $100K–$2.0M |
| Poor | Renewal treatment—median cost $8M |

NYSDOT's engineering staff continually engage in State and national research projects to identify and evaluate the effectiveness of new treatments. As treatments are deemed effective, they are adopted through the development of new specifications and included in the pavement and bridge life-cycle planning analyses.

[6] The shape of this curve is a function of the unique rating scale used by the NYSDOT's pavement surface rating system. It may appear to be inverted to those in the pavement management industry.

# 5.2 PAVEMENT AND BRIDGE MODELING SYSTEMS / TRACKING ASSET NEEDS AND DETERMINING BACKLOG

At NYSDOT, asset needs are defined on both a micro level (the needs of each individual asset based on its current or projected conditions) and the macro level (the annual program funding required to achieve a target set of conditions for the entire population of a given asset). As outlined in chapter 2, NYSDOT collects comprehensive and varied sets of data on all its pavements and bridges to meet the State's programming and reporting needs and to meet all Federal mandates. These data sets are updated annually, and they reside in the Agile Assets EAMS, which includes the Pavement Analyst and Bridge Analyst Management Systems (PMS and BMS, respectively).

These pavement and bridge management systems meet all the requirements of 23 CFR 515.17, including the ability to:

- Collect, process, store, and update inventory and condition data for all NHS pavement and bridge assets (as described in chapter 2 and further outlined in the department's Data Quality Management Plan).
- Forecast deterioration for all NHS pavement and bridge assets.
- Determine the benefit-cost over the life cycle of assets to evaluate alternative actions (including no action decisions) and to manage the condition of NHS pavement and bridge assets.
- Identify short- and long-term budget needs to manage the condition of all NHS pavement and bridge assets.
- Determine the strategies to identify potential NHS pavement and bridge projects that maximize overall program benefits within the financial constraints.
- Recommend programs and implementation schedules to manage the condition of NHS pavement and bridge assets within policy and budget constraints.

## Asset Performance Models

The EAMS uses sophisticated computer models to forecast asset conditions and determine the appropriate treatment for each individual asset based on its condition. NYSDOT uses the Pavement and Bridge modules of the EAMS, which employ asset inventory and condition data along with NYSDOT custom-developed deterioration curves and treatment decision trees to determine the appropriate treatment for each asset in a given year. NYSDOT regularly reviews performance curves and other model inputs and updates them as necessary.

### Pavement Deterioration Curves

Pavement deterioration curves, 45 in all, account for the significant factors that impact asset deterioration in the State, including:

- Asset type and material (e.g., flexible, rigid, or composite pavements).
- The last work type performed on the asset (more extensive work types last longer).
- The condition the asset was in the last time work was performed (work types performed on assets in good condition last longer).
- The location within the State to address climatic differences between geographic regions (for example, pavements in the Adirondacks deteriorate rapidly due to severe freeze-thaw cycles, but they stay in fair condition much longer than other parts of the State because of the strong soils).

### Bridge Deterioration Curves

For bridge structures, following publication of the 2019 TAMP, a detailed study of deterioration rates of various bridge elements was carried out using the historical bridge inspection data. In order to investigate the effects of numerous factors—including annual daily traffic, climate, regions, ownership, and design types—on deterioration rates, a versatile cascading approach was developed to classify bridge elements on the basis of selected factors. The cascading approach generates classes of bridges based on the classification factors selected. These classes can be analyzed to calculate deterioration rates.

A detailed case study was carried out to compare Markov chain and Weibull-based approaches for deterioration rates. Since the Weibull-based method utilizes actual scatter in duration data for a particular rating and considers this duration as a random variable, it has been found to be more reliable for calculating deterioration rates for bridge elements. Hence, deterioration curves and equations using the Weibull-based method were used.

Deterioration plots for various bridge elements inspected by the State (and rated on a 1-7 scale) were developed using these historical data. Components included abutment backwall, various abutment bearings, various joints, abutment pedestal, abutment stem, abutment wingwall, deck curb, pier bearing, pier cap, pier column, pier footing, pier joints, pier pedestal, pier stem, primary members, secondary members, sidewalk fascia, structural deck, and wearing surface. Equations of condition ratings of bridge elements were developed as functions of the element age in years—considering the effects of key factors, such as the bridge material type—on the deterioration rates. These deterioration rate equations were then incorporated into the bridge model on a regional basis to account for climatic differences between geographic regions.

## Model Work Recommendations

Pavement and bridge models make work recommendations for each stretch of road or individual bridge on the NHS. The recommended treatments are always appropriate for the amount of distress present in the asset. For example, the pavement model will only recommend a lighter maintenance treatment on a stretch of road that is relatively smooth with little cracking. It will not recommend a lighter treatment for a road in very bad shape, because the treatment will not give the required service life and is not adequate to address the damage on the road. In this way, the recommended treatments maximize the overall project and program benefits within the fiscally constrained environment.

The models also determine the optimal time to treat each asset to minimize the life-cycle cost. The software uses the windows-of-opportunity approach described above to optimize the timing of each treatment on each asset. In general, the models aim to maximize investment in maintenance treatments to keep assets in good condition as long as possible and delay the need for substantially more expensive treatments. This is analogous to performing routine maintenance on a car to maximize the life of its engine. Some assets may be within a window of opportunity for a specific treatment for many years. The pavement model optimizes treatment timing by predicting which year the asset is likely to deteriorate beyond its current window and recommends appropriate treatments to take place a year or two before that time. This allows NYSDOT to plan its treatments in advance to maximize return on investment and provide sufficient lead time for project delivery. BMS can perform multiple runs to determine optimal treatment timing.

These work recommendations are then prioritized using cost/benefit optimization, with preventive and corrective maintenance usually getting precedence over more expensive reconstruction projects. The model then recommends a program of pavement or bridge projects that provides the highest overall benefits to the system for the cost incurred, within the policy and budget constraints. In addition, PMS and BMS can handle projects previously programmed on the STIP, taking these projects "off the top" for overall budget purposes, as well as to show the benefits to the system of accomplishing these projects.

This approach is further refined for pavements and bridges using NYSDOT's PMS and BMS to compare actual investment decisions to optimized investment scenarios. Differences between actual and ideal represent opportunities to improve future decisions or improve the data used for modeling. By varying inputs to the PMS and BMS, such as overall funding levels, dedicated projects, or funding restrictions for certain types of work, NYSDOT staff can evaluate different strategies in both the short- and long-term to determine the most cost-effective approach to managing asset conditions. These alternative strategies can be used to determine the best means of managing the full inventory of assets and establish the most efficient life-cycle strategies given available funding and other real-world constraints.

## Lifecycle Planning Considerations for Vulnerabilities, Extreme Weather, and Resiliency

NYSDOT's life-cycle planning practices consider the need to support and enhance the resiliency of highway infrastructure to risks such as extreme weather, seismic events, and climate change. Resiliency in life-cycle planning begins with the implementation of inspection and design standards that appropriately consider the likelihood, impact, and expected response to extreme weather events during planning, project development, and operations—including operations during emergency events. NYSDOT's integrated approach to managing vulnerabilities is reflected in its life-cycle planning processes through performance data, new or enhanced treatments, revised treatment strategies, and updated unit costs. These changes allow NYSDOT to continually improve its ability to reflect the impact of resiliency in life-cycle strategies. The resulting life-cycle strategies then impact how the agency manages assets at each stage of the life cycle, as summarized below.

### Addressing Resiliency Through Maintenance

NYSDOT has identified debris prone structures across its system. These structures are culverts and bridges that are likely to be clogged during storm events. These locations receive proactive maintenance to remove debris prior to major storms. The data also allows maintenance managers to better monitor conditions during storms and deploy resources quickly in response to emergency conditions.

In recent years, NYSDOT has overhauled its bridge maintenance program to prioritize repairs based on criticality. Through this effort, the agency has revamped its equipment fleet and training efforts to improve repair quality and improve the resiliency of the infrastructure.

### Addressing Resiliency Through Project Development

NYSDOT has a long history of addressing vulnerabilities in inspection and design standards and guidance. Examples include NYSDOT's Project Development, Highway Design, Bridge Design, and Bridge Inspection manuals. In addition, NYSDOT's fiscally constrained prioritization and project selection process for bridges considers structural conditions as well as measures of

importance (e.g., annual average daily traffic and detour length, carried restrictions (e.g., postings), and structural vulnerabilities (e.g., lack of redundancy or scour criticality).

NYSDOT conducted a Statewide flooding vulnerability assessment in 2014 with a 2018 update. These assessments included any asset (e.g., roads, bridges, culverts, or slopes) that is known to be vulnerable due to its history, or assets that are believed to become vulnerable in the future due to increased heavy precipitation. Assets were identified by frontline staff (mostly Regional Maintenance, but also Design and Structures staff). Information is shared on a geographic information system (GIS) Viewer available to all NYSDOT staff. NYSDOT ranks and selects resiliency projects for locations or corridors particularly vulnerable to extreme weather events. For bridges and pavements, these projects often relate to feature-crossed functional restrictions, such as hydraulic restriction causing upstream flooding or scour. For pavements and highways, these projects often relate to inadequacies of drainage systems, which will leave the highway vulnerable to flooding and associated damage, and closure.

In life-cycle planning, as in all NYSDOT's asset management exercises, the Forward Four guiding principles are followed as described in section 1.1. The Make it Sustainable section in particular is pertinent to addressing extreme weather and resiliency.

### Addressing Resiliency Through Engineering

NYSDOT continually reviews and improves bridge standards to address areas of vulnerability. These areas are generally identified through the bridge inspection program or through bridge maintenance. Examples include the elimination of spread footings in streams and the development of low-permeability concrete mixes to improve resiliency to chloride-induced corrosion. Pavement managers conduct similar efforts to improve resiliency. Past enhancements include the installation of edge drains to improve resiliency to high water tables, and the use of performance-graded asphalt binders to improve performance within expected future temperature ranges. NYSDOT has incorporated future conditions due to climate change into its Highway Design Manual and the Bridge Manual.

## Determining Budget Needs for Managing Assets

One key metric that NYSDOT uses is the infrastructure debt, or backlog, of the system. The backlog is the total cost to do all the work recommendations for all assets in a given year, minus the spending in that year. The difference, or the gap, represents the remaining backlog of the system. If the backlog increases over time, it means that the system conditions have necessitated more expensive repairs and that additional funding will be required in the future to bring the system back to a state of good repair. For example, average pavement conditions in the State have stayed relatively stable, but the backlog has grown by $800 million in the past 5 years. This is due to the increase in the lane-miles of poor pavements as well as the increased cost to do construction work in the State due to inflation. Backlog is one of the main metrics used, along with average condition rating and percent poor, to determine if a given pavement or bridge program is acceptable.

At the macro level, NYSDOT uses their pavement and bridge models to predict system-wide conditions for various funding levels and preservation and renewal splits. This helps inform funding decisions for how to allocate funds between assets and work levels. The PMS and BMS can develop an efficient work plan given a set budget and spending strategy and conversely, it can also show the overall cost required to meet certain system-wide metrics. For example, NYSDOT uses the PMS and BMS to determine the overall funding required to achieve a state of good repair on the NHS, or to meet Federal targets on parts of the system, such as the

Interstates. The PMS and BMS identify short- and long-term budget needs for managing the condition of all NHS pavement and bridge assets. The analysis that NYSDOT conducts with these tools is a vital component of the target-setting and resource allocation processes described in subsequent chapters. The EAMS is used by NYSDOT to set Federal targets for pavements and bridges on the entirety of the NHS, including portions owned and operated by local government agencies and the NYSTA.

## NYSTA Pavement and Bridge Models

As stated earlier, NYSDOT collects pavement and bridge condition information for all the assets on the NHS and stores the data in their EAMS. The EAMS is then used to set Federal targets and to forecast conditions. This condition information is shared with the NYSTA. The NYSTA has its own pavement and bridge models used to perform pavement and bridge management activities and to help manage its portions of the NHS. These models are described below.

NYSTA has developed a PMS with the capability to define the needs and forecast conditions for its network of roadways (network-level analysis) and define a list of individual projects for inclusion in the capital program (project-level analysis). The PMS was developed by those experienced in the field and has been tailored to the unique aspects of the NYSTA pavement network. NYSTA's PMS has been peer reviewed by Applied Research Associates, Inc., an internationally recognized consulting firm in the field of asset management. The data and its collection procedures are relatively objective, inexpensive, repeatable, and are critical to management of the pavement network. Extensive pavement construction and rehabilitation history has been well documented and is readily retrievable.

As mentioned in chapter 2, the basis of PMS is the annual Pavement Distress Survey, data from which is used to generate a Lane Distress Index (LDI) for each segment of the NYSTA pavement network. At the network level, PMS helps to evaluate capital investment scenarios using performance-based management approaches, goals, and constraints. The results of the network-level analysis facilitate a more thorough understanding of current and future infrastructure needs and serve to better communicate NYSTA's long-term and major project needs, prepare the NYSTA for economic changes, address unfunded mandates, and help strategize viable business solutions.

The project-level analysis develops feasible pavement treatment alternatives, estimates costs, and combines these needs with other infrastructure needs into capital projects. The project-level analysis helps to prioritize projects using a repeatable, clearly-defined structure. The result is a set of well-defined project needs in terms of scope of work, timing, cost estimate, and coordination requirements subject to network-level goals and constraints.

NYSTA enhanced its BMS, incorporating lessons learned during the development of PMS. Each of the 816 NYSTA bridges are evaluated on a two-year cycle in order to develop a unique long-range plan. The bridge evaluation process is integrated and multi-tiered. Each bridge is evaluated as a whole, taking into account current and past conditions, load rating, vulnerabilities, work history, and maintenance and operational concerns. In addition, the bridge's location (e.g., a congested corridor or a paving section prioritized for reconstruction) is considered in the development of its long-range plan. A field review may be conducted, and division input sought as well.

It should be reiterated that the NYSTA uses its asset management systems to help program planning on the Thruway, while the State uses its EAMS to forecast conditions on the entire NHS, predict future needs, and set performance targets.

# 6. Managing Risk and Building Resiliency

Risk management is a key component of asset management, as it allows NYSDOT to prepare for the occurrence of events that could impact the Agency's ability to 1) deliver its planned infrastructure investments, or 2) manage its network effectively. Risks can be beneficial to a program, such as increased funding, or detrimental, such as damage from a major weather event. In either case, it is important for NYSDOT to be prepared for major risks that could impact the delivery of the Comprehensive Program, ultimately affecting asset conditions and the performance of its transportation system.

NYSDOT's approach to risk management is consistent with its overall approach to asset management, with the objective of managing risks at the system level to maximize opportunities and minimize threats to the comprehensive program. This approach requires balancing risk across geographic areas and programs with a focus on minimizing overall risk to the comprehensive program. The focus is not on making the most conservative decision on any specific project or policy. Instead, the intent is to make informed decisions based on reasonable consideration of future events and estimates of their impacts.

## 6.1 DEFINITIONS

The following definitions are provided within the context of asset management at NYSDOT:

- **Risk:** the positive or negative effect of uncertainty or variability upon agency objectives (23 CFR 515.5). The chance of something happening that will impact highway infrastructure or the NYSDOT's ability to manage the highway infrastructure, measured as a combination of the likelihood an event will occur and its impact.
- **Risk management:** the identification, assessment, and prioritization of risks followed by coordinated and efficient application of resources to monitor risks, mitigate threats, and maximize the realization of opportunities.
- **Gap:** an existing condition that limits NYSDOT's ability to manage its highway infrastructure. Gaps can be in policy, tools, available information, resources, or performance.
- **Risk context:** the risk categories to which the Comprehensive Program is sensitive. The context allows risk management to be tailored to the Agency's needs and circumstances. Context is represented by categories established in NYSDOT's risk management policy. The risk categories used by NYSDOT are shown later in this chapter.
- **Risk assessment:** the combination of likelihood and impact that defines the significance of a risk to the highway infrastructure or NYSDOT's ability to manage that infrastructure. Risk assessment is established in the risk analysis process, which culminates in the development of a risk register.

- **Risk level:** risks can have impacts on an agency at various levels. Some risks may impact the entire Department, whereas others may impact a single asset type or a single region as shown in figure 6.1. To illustrate, inflation would be an example of agency risk, while asphalt price volatility would be a program risk, and the ability to get hot-mix asphalt to a job site would be a project risk. For the TAMP, only agency and program risks were considered.

*Figure 6.1 Levels of risks.*

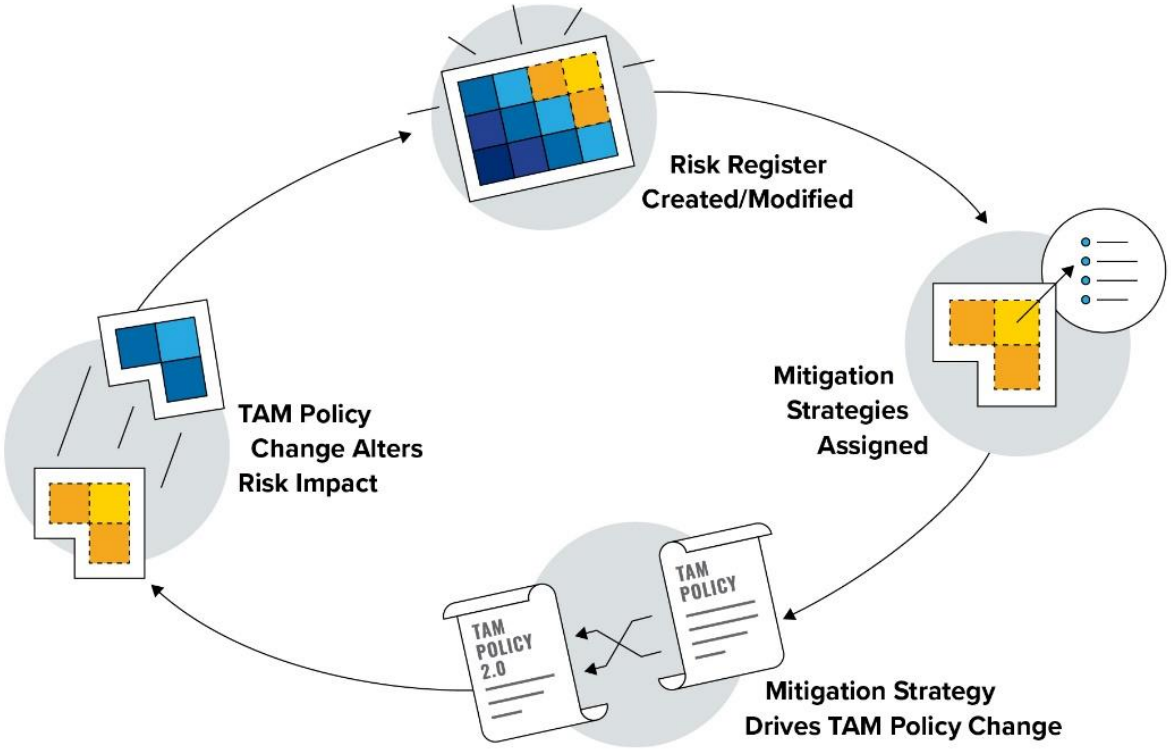

*Source: Risk-Based Asset Management: Examining Risk-based Approaches to Transportation Asset Management; Report 2: Managing Asset Risks at Multiple Levels in a Transportation Agency, FHWA, 2013.*

- **Asset management business unit:** the groups, teams, and committees identified in the TAMP as being active in the development and execution of asset management policy. Examples include the CPDC, CPT, Statewide asset management teams, and regional asset management teams.

## 6.2 ROLE OF RISK MANAGEMENT IN THE ASSET MANAGEMENT PROCESS

The CPT and Statewide teams refer to the risk register when developing or revising asset management policies or guidance. Figure 6.2 demonstrates the feedback loop between the risk register and policy development process. As risks are identified and mitigated, the risk register will need to be updated. Updating the risk register will alter mitigation strategies and drive new policy improvements.

*Figure 6.2 Risk management and asset management.*




To facilitate this process, NYSDOT assigns each mitigation strategy to a specific resource that can be a business unit or an asset management team. The assigned resource will be responsible for delivery of the mitigation strategy and keeping the CPT informed on their status.

## 6.3 NYSDOT'S RISK MANAGEMENT PROCESS

NYSDOT's risk management process consists of the following five primary steps:

- **Step 1—Establish Context.** NYSDOT develops an understanding of the social, cultural, legal, regulatory, economic, and natural environment to which the Agency is sensitive and documents the findings.
- **Step 2—Identify Risks.** NYSDOT formally identifies the risks that could affect its programs.
- **Step 3—Analyze Risks.** NYSDOT evaluates the probability of the risk with its impact.
- **Step 4—Evaluate Risks.** NYSDOT supports decision making by comparing the magnitude of the risks identified in the preceding two steps with its risk tolerance.
- **Step 5—Treat Risks**. NYSDOT applies the "five Ts." These are to treat, tolerate, terminate, transfer, or take advantage of the risk.

This process, which NYSDOT has adopted from the International Organization for Standardization (ISO), is illustrated in figure 6.3.

*Figure 6.3 ISO risk management framework.*


*Source: International Standards for Risk Management Principles and Guidelines (modified from ISO 31000:2009).*

More details on these steps are provided below.

## Step 1. Establish Context and Step 2. Identify Risks

NYSDOT combines steps 1 and 2 into a group exercise that includes brainstorming of risks by individuals representing a cross section of the agency's offices. The exercise includes combining of risks by the group, developing risk descriptions, and reaching a working consensus on which risks will be included in further analysis and prioritization. This process is done by Statewide asset teams through facilitated discussion. Before analysis and prioritization can begin, the risks must be clearly defined so each member of the asset team has the same understanding of the risk, and the risk can be communicated to other stakeholders.

## Step 3. Analyze Risks

The analysis and prioritization of risks is an iterative process, in which risks are initially prioritized by each asset team, then a combined risk register is reprioritized by the CPT, and finally the CPDC may recommend adjustments to this prioritized order.

Initial prioritization by the asset team is done objectively. Each risk is assigned an overall risk score equal to the product of its impact and likelihood scores, as shown below. The asset team records the risk score in their risk register and sorts the list in order of descending score.

Risk score = impact score × likelihood score

The likelihood and impact scales that NYSDOT used for its analysis are listed in table 6.1.

**Risk categories considered in the NYSDOT TAMP:**

- Economic
- Effectiveness of TAMP and TAM policies
- Environmental
- External stakeholders
- Fiscal
- Leadership change
- Legal/liability
- Organizational capacity
- Political
- Regulatory
- Reputation, public perception
- Safety
- Security
- Technology

*Table 6.1 NYSDOT's risk likelihood and impact scales.*

| Rating | Scale | Definition | Score |
|---|---|---|---|
| Likelihood | Certain | Already occurring or is certain to occur within the life cycle of the asset | 4 |
| | Probable | Very likely to occur, has happened before in the recent past | 3 |
| | Possible | May occur, has happened before | 2 |
| | Unlikely | Not likely to occur | 1 |
| Impact | Major | Program operations in the immediate term are significantly reduced or impacted; long-term operations are potentially impaired | 4 |
| | Moderate | Program operations avoid suspension or long-term impairment, but modifications to operations must be implemented | 3 |
| | Minor | Program impairments are limited to short-term consequences with few or no long-term effect. Minimal changes to current operations needed | 2 |
| | Insignificant | Program remains mostly unchanged in the immediate or long term, but risk awareness and monitoring remain worthwhile | 1 |

### Step 4. Evaluate Risks and Step 5. Treat Risks

During risk evaluation, each asset management team compares each risk to the NYSDOT's risk tolerance and develops a recommended treatment. In this context, treatments are referred to as risk mitigation strategies. The strategy is recorded in the risk register.

## 6.4 COMPILING THE RISK REGISTER

Compiling the risk register and the subsequent review process are the final key elements to the risk management process. When the CPT receives the risk registers from the other asset teams, the risks are added to the CPT's register. CPT then reviews the combined risk register looking for opportunities to combine risks, find synergies between mitigation strategies, and adjust priorities.

- **Combining Risks.** It is likely that a given risk can impact several of NYSDOT's programs and possibly impact the Department at both the program and agency level. In such cases, the same risk may be identified by multiple business groups. The CPT identifies such redundant risks and determines how best to include the risk in the comprehensive risk register. The CPT has the ability to eliminate duplicate risks, edit the description of risks, and revise the prioritization of the remaining risks. The CPT may also delegate this role to representatives of the other asset teams.
- **Synergies in Mitigation Strategies.** In some cases, a single strategy such as a policy change may act to mitigate multiple risks. When reviewing the asset team's risk registers, the CPT looks for opportunities to mitigate multiple risks with a single strategy. This is done by looking for similar mitigation strategies proposed by multiple program areas or by deciding to handle some program-level risks with agency-level mitigation strategies.
- **Adjusting Overall Priorities.** Initially, the combined register is sorted according to the scores assigned by the original asset teams. CPT then reviews the list, comparing each risk to the risks immediately above and below, and determining if adjustments need to be made in the overall priority. If the CPT determines an adjustment is needed, they may change the score of any specific risk as necessary

to achieve the appropriate overall priority. This process is done only to adjust the relative priority of risks identified by different asset teams.

## 6.5 RISK REGISTER

Table 6.2 presents NYSDOT's 2022 risk register. It defines priority risks, summarizes their impacts, defines mitigation strategies, identifies who is responsible for tracking and mitigating the risks, and provides a status of the mitigation strategy. It should be noted that the risk register only includes agency- and program-level risks. This register will continually evolve as described in the following section. NYSDOT will continue updating this register on a biennial basis in accordance with updating the TAMP.

## 6.6 UPDATING THE RISK REGISTER

Keeping the risk register up to date is the responsibility of the CPT. The risk register is managed following the asset management policy development process as described in section 4.4. Under the CPT's direction, Statewide teams discuss risks and the status of mitigation strategies as part of normal meetings. As changes to risks or mitigation strategies that impact the risk register emerge, the Statewide team will notify the CPT.

The CPT is responsible for making necessary changes to the risk register and recommending new or modified mitigation strategies to CPDC. At least annually, the CPT will review the risk register and make necessary changes. The CPT may also assign a working group or sub-team to track the register. Any changes requiring CPDC approval will be presented at CPDC meetings.

### Enterprise Risk Management at NYSDOT

NYSDOT manages many risks to ensure the performance of the State's transportation system. This TAMP and risk chapter does not portray all risk management activities conducted by NYSDOT. Many risk reduction activities are part of day-to-day operations, manuals, guidance, and inspection protocols. Risk management principles are also applied to promote the successful delivery of projects.

*Table 6.2 Risk register.*

| Risk Description and Primary Impacts | Mitigation Strategies | Details |
|---|---|---|
| If NYSDOT does not address existing limited staff resources e.g., insufficient planning, engineering, and maintenance field staff,<br><br>and<br><br>if NYSDOT is unable to recruit staff with needed skill sets, e.g., structural, hydraulics, pavement & bridge management, equipment operations and technical skills, planning and data management,<br><br>■ NYSDOT will lack the staff, ability, skills, and expertise to appropriately plan, design, build, operate, maintain, and manage the State's transportation infrastructure amidst a rapidly changing environment and emerging transportation technologies.<br>■ NYSDOT will experience increased project delays, possible safety issues for the public, issues with meeting Federal mandates, increased exposure to tort liability, and an erosion of public trust.<br>■ NYSDOT will be unable to efficiently respond to severe weather and other safety issues.<br>■ NYSDOT will continue to increase reliance on consultants, which could result in higher program costs and exacerbate the erosion of institutional knowledge and expertise from NYSDOT staff.<br>■ NYSDOT will lose the ability to be expert owners. | ■ Continue reassessing use of resources for program development versus program delivery activities.<br>■ Train additional staff to take on mission-critical asset management tasks, reduce the reliance on specific individuals, create redundancy, and support succession planning.<br>■ Continue using automation to reduce the amount of staff time needed for capital program development and review.<br>■ Ensure IT solutions are supported at the enterprise level and reduce use of "one-off" solutions.<br>■ Commit to strengthening the internal planning capacity and partnering with others.<br>■ Assess what can be done well by consultants and what must be done in-house and reorganize NYSDOT staff to handle the must-dos.<br>■ Develop a plan to partner with academia and other external institutions to develop new technologies and practices and bring them into practice to improve program effectiveness.<br>■ Establish access to areas of expertise not traditionally found in department of transportations or in the transportation industry (e.g., economists).<br>■ Investigate the need for new skills and develop a plan for modifying civil service titles, recruitment practices, or job descriptions accordingly. | **Rating**: High<br><br>**Responsible:**<br><br>■ Assistant Commissioners<br>■ Executive Deputy Commissioner<br>■ Operations and Asset Management (AM) Division<br>■ Engineering Division<br>■ Policy and Planning Division<br>■ Administrative Services Division<br><br>**Status:** Ongoing |
| If overall long-term funding for transportation continues to be insufficient to efficiently operate, maintain and improve system asset conditions, or funding does not address price spikes or inflation,<br><br>■ Asset conditions will deteriorate to a level requiring progressively more expensive treatments, ultimately deteriorating to a level that is financially unrecoverable.<br>■ There will be an increasing need to post and close structures to maintain public safety.<br>■ Demand maintenance costs will increase.<br>■ The list of safety deficiencies will continue to increase along with the likelihood of serious crashes and the Department's exposure to tort liability.<br>■ Asset conditions, especially on the non-NHS system, will continue to deteriorate adding to system risk. | ■ Continue to engage our political representatives on the importance and urgency of providing stable, adequate funding to sustain and modernize the existing transportation system.<br>■ Continue capital planning that most cost effectively gets the State's infrastructure to a sustainable condition at the lowest cost, including levels of service achievable for various funding levels.<br>■ Ensure that sufficient funds are set aside to account for the increasing cost of Demand Repairs or sudden price spikes of products and services.<br>■ Consider divestment of portions of the transportation system based on usage and risk. | **Risk Rating:** High<br><br>**Responsible:**<br><br>■ Executive Deputy Commissioner<br>■ Office of Finance<br>■ CPT<br>■ CPDC<br>■ Policy and Planning Division<br><br>**Status:** Ongoing |

| Risk Description and Primary Impacts | Mitigation Strategies | Details |
|---|---|---|
| If assets deteriorate to condition levels requiring progressively more expensive treatments,<br>■ Fewer assets can be treated within available funding, ultimately deteriorating to a level that is financially unrecoverable.<br>■ NYSDOT will provide a reduced level of service that has an impact on the State economy.<br>■ Demand maintenance costs will increase.<br>■ The list of safety deficiencies will continue to increase, increasing the likelihood of serious crashes, and increasing the Department's exposure to tort liability. | ■ Continue to engage our political representatives on the importance and urgency of providing stable, adequate funding to sustain and modernize the existing transportation system.<br>■ Continue to use asset management principles to drive the capital program and develop a capital plan that gets the State's infrastructure to a sustainable condition at the lowest cost.<br>■ Have regional and Statewide asset teams review projects annually to ensure that projects are appropriate for the distresses present.<br>■ Continue to fund preventive maintenance and preservation contracts.<br>■ Regularly monitor performance and adjust asset management models and engineering practices as needed.<br>■ Assess performance for new mandates such as those requiring lower embodied carbon materials or greater resiliency to climate change. | **Risk Rating:** Medium<br>**Responsible:**<br>■ Executive Deputy Commissioner<br>■ Office of Finance<br>■ CPT<br>■ Regional Directors<br>■ Pavement and Bridge Management<br>■ Technical Services<br>■ Chief Engineer<br>**Status:** Ongoing |
| If there is an increased need to post and close structures to maintain public safety,<br>■ Mobility of passenger and freight traffic will be reduced.<br>■ Congestion will increase.<br>■ Safety could be negatively impacted if postings and closings don't happen in time.<br>■ Greenhouse gas (GHG) emissions will increase due to the need to divert from closed bridges. | ■ Partner with other transportation agencies, industry, and other States to share best practices and work collectively to consider options for increased transportation funding.<br>■ Continue to implement Maintenance First strategies that focus on delivering the greatest benefit to the greatest number of transportation users at the least cost. | **Risk Rating:** Medium<br>**Responsible:**<br>■ Executive Deputy Commissioner<br>■ CPT<br>■ CPDC<br>■ Office of Finance<br>**Status:** Long term / Ongoing |
| If more emergency/ demand response maintenance is needed to address poor asset conditions and maintain public safety,<br>■ Funding will be drawn from lower life-cycle costs solutions.<br>■ Maintenance resources (labor, materials, equipment, and budget) will be pulled from other maintenance needs.<br>■ The likelihood of safety impacts will increase. | ■ Continue dedicated emergency/demand response funding as a top priority of the capital program.<br>■ Enable shifting emergency repair work from JOC/Where & When contracts to maintenance crews to minimize the cost of demand work, emergencies, and flag response. | **Risk Rating:** Medium<br>**Responsible:**<br>■ Office of Finance<br>■ CPT<br>■ Operations & AM Division<br>**Status:** Ongoing |
| If NYSDOT is unable to address known safety deficiencies of secondary assets (e.g., signs, guiderail, and markings),<br>■ The likelihood or severity of crashes will increase.<br>■ The DOT's exposure to tort liability could increase. | ■ Ensure current inventory of secondary assets and develop prioritized locations for investments. | **Risk Rating:** Medium<br>**Responsible:**<br>■ Engineering Division<br>■ Operations & AM Division<br>**Status:** Ongoing |

| Risk Description and Primary Impacts | Mitigation Strategies | Details |
|---|---|---|
| If there are unfunded mandates (new responsibilities being placed on NYSDOT that may come without needed funding or staff targets, political changes),<br>■ Funding and staff resources will be drawn from other areas of need to address the mandate(s). | ■ Engage the FHWA, State regulatory agencies, and political representatives to raise the awareness of the impacts of various mandates to balance needs and overall infrastructure conditions.<br>■ Review existing strategies, practices, and design manuals to ensure comprehensive solutions that look beyond traditional vehicle-based performance measures (such as levels of service) to achieve optimal performance and ensure consistency with the State's low carbon future.<br>■ Continue collaboration with other agencies and States to meet existing and new mandates. | **Risk Rating:** Medium<br>**Responsible:**<br>■ Policy and Planning Division<br>■ Engineering Division<br>■ Operations & AM Division<br>**Status:** Ongoing |
| If the frequency and intensity of storm events increase,<br>■ There will be more road closures to protect public safety and for response and recovery activities.<br>■ More debris will clog culverts and block bridges, causing overtopping and failures.<br>■ More tree debris will require removal from roadways.<br>■ Operations resources (staff and contract) will be drained and result in reduction of planned safety improvements.<br>■ Repairs and replacements of damaged assets will be required before the end of their life cycle.<br>■ More icing events will increase road salt use and result in greater costs and environmental impacts. | ■ Dedicate sufficient resources to demand response contracts to respond to events.<br>■ Develop an infrastructure hardening plan with prioritized locations.<br>■ Continue or increase funding for dedicated culvert and bridge programs.<br>■ Continue debris-prone bridges and culverts program.<br>■ Utilize capital funds to ensure the maintenance equipment fleet is adequate for response.<br>■ Enhance tree pruning/removal capacity through maintenance crews, equipment, and contracts.<br>■ Improve and maintain emergency response plans. Coordinate those plans with OEM and Local Emergency Operations Centers.<br>■ Ensure contractual mechanisms to provide emergency response and recovery to locals, particularly when the event is not a declared event. | **Risk Rating:** High<br>**Responsible:**<br>■ CPT<br>■ Operations & AM Division<br>■ Engineering Division<br>■ Policy and Planning Division<br>**Status:** Ongoing |
| If energy sources, availability, or reliability change, NYSDOT may not be able to respond to emergencies if energy sources are impacted by the emergency.<br>If fossil fuels are phased out, the agency will be unable to generate emergency power with current stationary or portable generators. | ■ Ensure all critical facilities have back-up generator power.<br>■ Mobilize portable fuel tanks in advance of potential storms to ensure adequate resources are available if fuel cannot be delivered.<br>■ Continue to identify and implement energy efficiency improvements at maintenance facilities.<br>■ Evaluate options for clean energy generation and battery storage at State facilities.<br>■ Support more robust energy infrastructure by working with utilities to encourage underground utilities for crossing Interstates and major roadways. | **Risk Rating:** Medium<br>**Responsible:**<br>■ Operations & AM Division<br>■ Policy and Planning Division<br>■ Administrative Services Division<br>■ Division of Legal Affairs<br>**Status:** Ongoing |

| Risk Description and Primary Impacts | Mitigation Strategies | Details |
|---|---|---|
| As sea-level rises,<br>■ Tidally exposed infrastructure may require repeated repair or replacement.<br>■ Land use and customer expectations in coastal areas may change.<br>■ Standards for assets in coastal areas may change, increasing costs. | ■ Develop an infrastructure hardening plan with prioritized locations.<br>■ Continue developing apps and models to analyze infrastructure at risk and support prioritization efforts.<br>■ Review critical evacuation and detour routes and design interventions to prevent flooding and closure of these routes.<br>■ Explore addressing climate change through new or updated policies.<br>■ Review policies for potential improvements in how climate change and sea level rise are addressed.<br>■ Regularly review engineering practices to identify robustness to future climate (projections).<br>■ Continue providing information on climate forecasts to engineering to support durable designs. | **Risk Rating:** Medium<br>**Responsible:**<br>■ Office of Policy and Planning<br>■ Office of Operations<br>■ Engineering Division<br>**Status:** Ongoing |
| If the frequency and severity of flooding increases,<br>■ Asset damage will increase.<br>■ Roadways and bridges will be overtopped more frequently.<br>■ Staff will be diverted from other priorities for response and recovery. | ■ Complete a comprehensive small culvert inventory, funded centrally out of the capital program.<br>■ Develop tools and models to support prioritization of culvert work that includes hydraulic assessments and aging steel pipes under deep fills.<br>■ Prioritize addressing remaining scour-critical Interstate bridges.<br>■ Continue working with regulatory agencies to develop programmatic agreements for adaptive stream work.<br>■ Review critical evacuation and detour routes and design interventions to prevent flooding and closure of these routes. | **Risk Rating:** Medium<br>**Responsible:**<br>■ Engineering Division<br>■ CPT<br>■ Office of Policy, Planning and Performance<br>■ Operations and AM Management<br>**Status:** Ongoing |
| If there are changes in highway user expectations due to new technology (e.g., connected and automated vehicles [CAV], Internet of Things), | ■ Evaluate establishing a Transportation Innovations group to monitor and respond to changes in transportation automation that includes assessing automation for internal | **Risk Rating:** Medium<br>**Responsible:**<br>■ Office of Traffic Safety and Mobility |

| Risk Description and Primary Impacts | Mitigation Strategies | Details |
|---|---|---|
| ■ ITS infrastructure may become obsolete and require replacement.<br>■ There will be a need to expand communications throughout the network to engage with CAV (investment and operating costs).<br>■ Platooning trucks over bridges will increase loading and decrease service life.<br>■ Additional funding will be needed to meet new standards.<br>■ The need for new skills such as data specialists to manage "big data"; electrical engineering and technology specialists will increase, likely increasing the need to engage outside expertise. | operations such as automation of traffic counts.<br>■ Keep abreast of national and regional developments in new transportation technology by attending national forums, research conferences, and working with other States.<br>■ Produce transition plan to prepare for wide adoption of emerging technologies, evaluate data collection practices; review policies and procedures for consistency; consider comprehensive solutions including GHG impacts.<br>■ Evaluate the impact of automation on design standards, e.g., rating bridges for platoon truck loading and quantify fiscal impact. | ■ Engineering Division<br>■ Status: Planned |
| If NYSDOT is the target of a broad cyber-security attack,<br>■ Traffic signals and/or ITS functionality could be disrupted for a Region or major metropolitan area.<br>■ The agency network, servers, email, or major software applications could be shutdown.<br>■ NYSDOT may be unable to conduct essential or routine business activities. | ■ Establish a cybersecurity review team to develop a risk management plan and evaluate vulnerabilities to office and highway operations functions and develop strategies to address risks.<br>■ Survey technologies for cybersecurity risks (cameras, traffic signals, data systems, etc.) and develop plans to mitigate risks.<br>■ Continue to educate employees of potential threats. Work with ITS to employ off-network backup procedures to preserve information. | **Risk Rating:** Medium<br>**Responsible:**<br>■ Office of Traffic Safety and Mobility<br>■ Administrative Services Division<br>■ Engineering Division<br>**Status:** Planned |

## 6.7 MANAGING NEW YORK'S TRANSPORTATION ASSET MANAGEMENT RISKS

Risks identified include organizational capacity, economic risks such as those related to uncertainty in funding and price fluctuations, unfunded mandates, effectiveness of TAMP and TAM policies, public perception in light of emerging technologies, security from cyberattacks, and environmental risks—in particular climate change and extreme weather. Below is an overview of identified risks and potential impacts. The following narrative describes strategies to mitigate these risks.

1. **Organizational capacity: staffing and training**—staff resources are limited, e.g., insufficient planning, engineering, maintenance field staff, and NYSDOT cannot recruit qualified staff with required skills, e.g., structural, hydraulics, pavement and bridge management, equipment operation skills, planning, and data management staff.
2. **Insufficient long-term funding, price spikes, and inflation**—overall long-term funding for transportation continues to be insufficient to sustainably operate and maintain the system and asset conditions or funding does not address price spikes or inflation.
3. **Unfunded regulatory requirements**—unfunded mandates could place new responsibilities on NYSDOT that may come without needed funding or staff targets.
4. **Asset performance: effectiveness of TAMP and TAM policies/unforeseen consequences**

- Asset conditions could deteriorate to levels requiring progressively more expensive treatments.
- Structure postings and closures could increase.
- Emergency and demand response maintenance needs could increase to address poor asset conditions and maintain public safety.
- NYSDOT may be unable to address known safety deficiencies of secondary assets (e.g., signs, guiderail, and markings).

5. **Public perception: emerging transportation technologies**—potential changes in highway user expectations may come about due to new technologies (e.g., CAV, Internet of Things).
6. **Security: cyber threats**—potential impacts from a broad cyber-security attack.
7. **Climate change and extreme weather**

- The frequency and intensity of storm events increases.
- The frequency and severity of flooding increases.
- Sea-level rise is causing more coastal flooding.
- Energy sources, availability, or reliability change or experience disruption.

## Mitigation Strategies

### Organizational Capacity: Staffing and Training, Improved IT Systems

NYSDOT's organization is experiencing staff turnover due to retirements while simultaneously working to recruit and train new staff. One-third of the workforce has already retired or is eligible for retirement within the next few years. The COVID-19 pandemic may have accelerated retirements since 2020. NYSDOT looks to recruit new talent, with a focus on essential operations staff to address seasonal and urgent maintenance needs along with restaffing engineering positions. NYSDOT's Design/Build program is alleviating pressures on in-house engineering services. NYSDOT has also updated its engineering civil service titles to attract new talent for program areas relying on professional engineers.

Despite these efforts, and in light of potential continuing staff retirements, NYSDOT considers limited staff resources (e.g., insufficient planning, engineering and maintenance, and operations field staff) a high risk. In addition, the potential inability to recruit qualified staff with required skills (e.g., structural, hydraulics, pavement and bridge management, equipment operation, and planning and data management) could also impede operations and asset management.

Some strategies to address staffing, such as addressing civil service constraints, are beyond the purview of this TAMP. However, NYSDOT has identified strategies to mitigate potential impacts to the CPU process including:

- Continue reassessing the use of resources for program development versus program delivery activities and ensure adequate staffing and resources for the CPU process.
- Train additional staff to take on CPU mission-critical tasks such as asset management and capital planning to reduce the reliance on specific individuals, create redundancy, and support succession planning. The CPU process requires specialized expertise, technical skills, and knowledge on a wide variety of program and planning topics and training is accomplished over months and years.
- Continue using automation to reduce the amount of staff time needed for capital program development and review. NYSDOT has invested in updated critical data

systems such as its EAMS for pavement and bridges and its capital program management system (Oracle Primavera Portfolio Management [OPPM]) as well as other modeling tools to support automation and efficient decision-making.
- Engage the FHWA, State regulatory agencies, and political representatives to raise their awareness on the impacts of various mandates to balance needs and overall infrastructure conditions.
- Ensure information technology (IT) solutions are supported at the enterprise level and reduce the use of "one-off" solutions.
- Strengthen the internal planning capacity and continue to partner with others, including universities, to provide additional expertise such as data and economic analysis.

NYSDOT will continue monitoring and engaging with its regions and program areas to ensure adequate organizational resources to support asset management including planning, engineering and operations, and maintenance activities.

## Insufficient Long-term Funding, Price Spikes, and Inflation

Uncertainty regarding transportation funding has existed for multiple budget cycles and has made it difficult to program all asset needs. The passage of the Bipartisan Infrastructure Law has provided States with a much-needed boost in resources and stability in the availability of Federal funding for the next few years. While additional funding is welcome, it is not sufficient to address all needs. Furthermore, the Highway Trust Fund sufficiency has not been addressed and the underlying need for stable and growing transportation funding remains. Without adequate long-term funding, asset conditions will likely deteriorate to a level requiring progressively more expensive treatments and may ultimately deteriorate to a level that is financially unrecoverable. Ultimately, there could be a greater need to post and close structures to maintain public safety and, as a result, increase demand maintenance costs. The list of safety deficiencies could also continue to increase, along with the likelihood of serious crashes and NYSDOT's exposure to tort liability. Impacts due to insufficient funding are beginning to become apparent on portions of the non-NHS system and, if kept unchecked, asset conditions on all portions of the system could be at risk. Years of austerity have resulted in progressing the most critical infrastructure projects, causing less critical assets to deteriorate further. Such assets now require reconstruction and rehabilitation at greater costs.

Strategies to reduce the risk include continuing the capital planning approach that gets the State's infrastructure to a sustainable condition in the most cost-effective way and at the lowest cost, including levels of service achievable for various funding levels. NYSDOT will set aside sufficient funds to account for the increasing demand maintenance repair costs, including those caused by weather emergencies, and to account for price spikes of products and services. It will be essential to continue engaging political representatives to address the consequences of shortages in funding and to underscore the continued urgency of providing adequate funding to sustain the transportation system. Engagement with the FHWA and political representatives should continue to stress the impacts of various mandates and the need to balance these requirements with overall infrastructure conditions. As a last resort, NYSDOT will need to consider divestment of portions of the transportation system based on risk and need.

## Unfunded Regulatory Requirements

NYSDOT identified unfunded regulatory mandates as a risk that could require additional funding and staff. Changes in Federal or State leadership can result in diverse sets of mandates that

may affect asset management through added or reduced investments from Federal and State sources, or new regulatory requirements. If not adequately funded, these requirements can take resources away from asset management.

NYSDOT recognizes the importance of, and need to address, emphasis areas and mandates. For example, the recent 2021 Bipartisan Infrastructure Law increased transportation funding and included additional emphasis areas that require attention such as addressing environmental justice, resiliency to climate change, reductions in greenhouse gas emissions, and readying infrastructure for electric vehicle fueling. Although the Bipartisan Infrastructure Law comes with increased funding, needs continue to be great and balancing all needs is a risk that will impact asset management. NYSDOT will need to review its policies and practices to ensure a balanced approach to asset management and meets the needs of all users, along with recognizing the environment and social challenges within the resources that are available.

NYSDOT is deeply committed to providing safe transportation that fully addresses the needs of all users including meeting the requirements of the Americans with Disabilities Act (ADA), addressing project impacts on surrounding communities, and considering climate change and greenhouse gas emissions stemming from the transportation sector including how the State builds, operates, and maintains its infrastructure. NYSDOT will engage with the FHWA, State regulatory agencies, and political representatives to balance the impacts of various mandates, improve overall infrastructure conditions, and meet the needs of all stakeholders.

## Asset Performance: Effectiveness of TAMP and TAM Policies/Unforeseen Consequences

NYSDOT identified several risks that pertained directly to asset conditions.

### *Worsening Asset Deterioration*

Asset condition deterioration is addressed in many ways through NYSDOT's asset management Maintenance First strategies that focus on delivering the most benefit to the most transportation users at the least cost, as described in chapters 2 and 5.

However, it is important to recognize that this risk can be caused by circumstances beyond NYSDOT control. Potential impacts include fewer assets being treated with available funding and ultimately deteriorating to a level that is financially unrecoverable. In addition, NYSDOT would potentially need to provide reduced levels of service, which could impact the State's economy. Furthermore, deteriorated asset conditions would likely cause safety deficiencies, requiring greater demand response to avert the potential increase of serious crashes. As a result, NYSDOT could have greater exposure to tort liability.

NYSDOT's approach, described in chapter 5, makes a strong case for cost-effective asset management approaches that prevent asset conditions from deteriorating further and achieve sustainable asset conditions at the lowest cost. Nevertheless, factors beyond NYSDOT's control could impact available funding for asset management. NYSDOT intends to engage political representatives and continue raising their awareness on the need for adequate funding to maintain and modernize the existing transportation system, as well as ensuring that preventive maintenance and preservation contracts are funded appropriately.

Regional and Statewide asset teams will review projects annually to ensure that projects are appropriate for the distresses present. NYSDOT will regularly monitor performance and adjust asset management models and engineering practices as needed. NYSDOT will also assess performance relative to new mandates such as using lower embodied carbon materials and ensuring greater resiliency to climate change. NYSDOT will continue to review its policies,

practices, and standards and will update these as appropriate. This ensures quality materials and construction practices are employed, such as considering low greenhouse gas materials where practical. In turn this improves resiliency, supports the economy, lowers NYSDOT's carbon footprint, and meets the needs of all users.

### *Structural Postings and Closures*

NYSDOT identified increased structure postings and closures as a risk. Postings can limit freight deliveries and closures impact safety, which causes increased travel due to detours and can slow down emergency services.

To mitigate this risk, NYSDOT will continue implementing Maintenance First strategies that focus on delivering the greatest benefit to the most transportation users at the least cost. NYSDOT could also consider divestment of portions of the transportation system, where practical, to provide resources to more heavily traveled portions of the system. Increased funding for transportation agencies remains a high priority. NYSDOT will continue partnering with other transportation agencies, industry, and other States to increase awareness of the urgency for transportation funding including exploring alternatives for funding transportation.

### *Increased Demand Response*

Emergency/demand response maintenance needs are increasing with the increase in extreme weather events and the growing demands to maintain aging assets for safety. Greater use of demand response could result in funding drawn from lower life-cycle cost solutions and maintenance resources (e.g., labor, materials, equipment, and budget) and from other maintenance needs that ultimately increase the likelihood of safety impacts.

To mitigate this risk, NYSDOT will continue its dedicated emergency/demand response funding as a top priority of the capital program. In addition, NYSDOT will continue the shift of emergency repair work from demand response contracts such as Job Order Contacts or Emergency Where and When to work being performed by maintenance crews. This will minimize the cost of demand work, emergencies, and flag response. To succeed, this strategy needs to be supported with appropriate staffing, equipment, and staff training.

### *Secondary Assets*

The inability to address known safety deficiencies of secondary assets (e.g., signs, guiderail, and markings) could result in an increased likelihood in the severity of crashes and increase NYSDOT's exposure to tort liability.

For mitigation purposes, an inventory of secondary assets needs to be expanded and continually updated so that assets can be appropriately prioritized for upgrades and replacement. NYSDOT is undertaking secondary asset inventories such as small culverts, overhead signs, guiderail, and retaining walls, however these are not complete. For additional information please see chapter 8.

## Public Perception: Emerging Transportation Technologies

NYSDOT identified changing highway user expectations as a risk that impacts public perception. User expectations are likely to increase as new technologies such as CAV and the Internet of Things mature. Portions of the public may find that the introduction rate of enabling technologies such as installation of sensors and other roadside features needed to enable CAV is too slow, while others may have privacy concerns and oppose such technologies altogether. In both cases, NYSDOT's perception as a trusted public agency may be at risk.

NYSDOT will need to weigh potential strain on funding as well as staffing and training needs across a wide range of issues. Risks include:

- Expanding communications capacity throughout the network to engage with CAV will increase NYSDOT's capital/investment and operating costs.
- Increasing numbers of ITS infrastructure may become obsolete and require replacement.
- Inadequate funding to meet new standards.
- Increasing demand for skills including big data management and analysis, electrical engineering, and technology, likely resulting in the need to engage outside expertise.
- Decreasing bridge service life due to increased deterioration from truck platoons.

To mitigate risks, NYSDOT will continue to monitor and respond to changes in transportation automation. Examples of changes include how infrastructure needs are assessed as well as how NYSDOT collects and analyzes data (e.g., automating traffic counts versus manual counting versus using "big data" to monitor system performance and shape policies). NYSDOT anticipates that it will produce a transition plan to prepare for a wider adoption of emerging technologies. This transition plan would evaluate infrastructure needs and data collection practices, review policies and procedures for consistency, and consider comprehensive solutions to take advantage of technology advances. In the interim, NYSDOT is preparing by maintaining signs and pavement markings and modernizing its cabinets to accept new technology.

For any emerging trend that may impact NYSDOT's operations and in turn its asset needs, it is essential that NYSDOT keep abreast of national and regional developments in new transportation technology. NYSDOT program areas involved at the forefront of new technologies will stay informed by attending national forums and research conferences and will work with other States and technology providers.

### Security: Cyber Threats

Cyber threats are a security risk, both to the transportation system and to the Agency itself. As other public and private entities have already experienced, NYSDOT could become a target of a broad cyberattack. Impacts would depend on the extent and on the prime target. Traffic signals or ITS functionality could be disrupted for a region or a major metropolitan area, or the Agency network, servers, email, or major software applications could be shut down and NYSDOT would be unable to conduct essential or routine business activities.

NYSDOT's strategy includes establishing a Cybersecurity Review Team to evaluate vulnerabilities to office and highway operations functions. NYSDOT will develop a risk management plan by surveying vulnerabilities and developing strategies to address these. As many of the State's IT services are managed at the Statewide level, it will be critical to engage the State's IT team to partner in this endeavor. NYSDOT will work with IT to continue educating employees of potential threats and to support off-network backup procedures to preserve NYSDOT information.

# 6.8 SPECIFIC CLIMATE CHANGE AND EXTREME WEATHER RISKS IDENTIFIED PER RISK REGISTER

23 USC 119(e)(4)(D) requires that the TAMP risk management analysis include information on current and future environmental conditions including extreme weather events, climate change, and other factors that could impact the whole life cost of assets. NYSDOT meets this requirement as it continually assesses risk and has identified climate change and extreme weather as significant factors to be addressed in asset management planning.

NYSDOT utilizes FHWA's definition of resiliency, which is "the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions" (FHWA Order 5520). Generally, resiliency to climate hazards is improved any time infrastructure is maintained, rehabilitated, or reconstructed by making assets more robust or "resilient" to withstand climate stressors. Therefore, a well-supported asset management system also improves resiliency.

NYSDOT has considered potential impacts of climate change and extreme weather to its assets since 2007 when it launched a Statewide work group to evaluate the risk. In addition, NYSDOT has stayed informed on climate change through State and national research, symposiums, developing expertise, and engaging with State and Federal agencies as well as national organizations. Taking future climate conditions into consideration has become part of NYSDOT's culture and has been widely integrated into planning, design, construction, maintenance, and operations decision-making. NYSDOT's capital program approach requires that all projects consider strategies to address potential disruptions including extreme weather, flooding, and storm events. Importantly, project selections and engineering considerations consider past repairs and future conditions throughout the expected life cycles of assets.

Life-cycle planning relies on known trends and averages. However, catastrophic events can disrupt expected life spans, especially for assets with known vulnerabilities such as the presence of scour or debris, or assets nearing the end of their useful life. To prevent catastrophic losses of bridges and highways due to extreme events, NYSDOT has instituted protocols that are carried out throughout the year, including before and after flooding events:

- Flood Watch Bridge Program requires inspection protocols for all scour-critical bridges in the State.
- NYSDOT instituted a Debris Prone Bridges and Culverts Instruction in 2017 that requires inspection protocols for known debris-prone bridges and culverts.
- NYSDOT identifies maintenance needs of roadway and roadside drainage (culverts, ditches, closed drainage systems, etc.) on a continual basis through a variety of sources including windshield inspections, patrols, observations from field staff, conditions reported by the public, in-depth drainage investigations, and regular inspections.

Needs are prioritized and highest priorities are given to the greatest public safety risks. Urgent maintenance needs including culvert or bridge red flags are addressed in a timely manner by NYSDOT crews or emergency stand-by contractors. Determining priorities requires that risk management considerations and engineering judgement be employed on a case-by-case basis.

Additional information regarding life-cycle planning, extreme events and resiliency to climate change can be found in chapter 5.

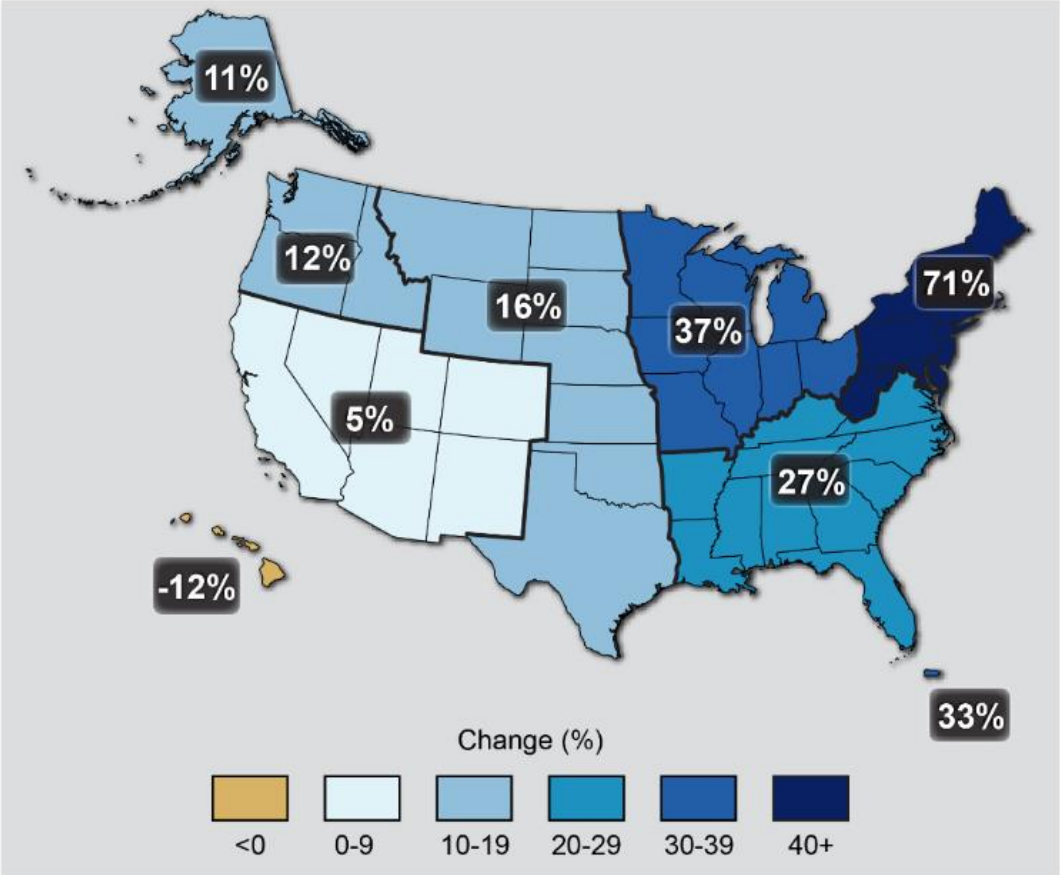
NYSDOT considers cost-effective solutions to reduce extreme weather and future climate change risk through project and program level decision-making. Some examples are:

- **BMS:** NYSDOT has built resiliency-related criteria into its BMS, which is used to help prioritize bridge investments. A portion of a structure's prioritization score is determined by hydraulic vulnerability. Another factor accounts for the required detour length should a facility need to be closed.
- **Bridge NY:** To mitigate the impacts of flooding and scour, the Bridge NY program provides $200 million annually in enhanced assistance to local governments for the rehabilitation and replacement of bridges and culverts.
- **NYSDOT Statewide Flooding Vulnerability Assessment:** In 2014 (and in a 2018 update), NYSDOT completed an evaluation of NYSDOT assets that are vulnerable to flooding, which resulted in a GIS-based tool that that identifies low-, medium-, and high-impact vulnerabilities based on criticality factors as assessed by regional staff. The information is available for informing program and project decisions. NYSDOT has shared its approach with MPOs and localities, some of whom have undertaken similar analyses.
- **Bridge and Culvert Design:** After NYS's Community Risk and Resiliency Act (CRRA) was signed into law in 2014, NYSDOT worked with the lead agencies to identify ways to implement the provisions of the Act and supported the development of the NYS Flood Risk Management Guidance. After careful analysis of climate data and projections, along with following coordination with other State and Federal agencies, NYSDOT revised its Bridge and Highway Design Manuals to accommodate future design flows for bridges and culverts. These standards now factor into every project. In addition, NYSDOT added a consideration for sea level rise for bridges and culverts (via the Bridge Manual and the Highway Design Manual Drainage Chapter) in current and future tidal areas. Sea-level rise elevations are based on NYS's officially adopted projections.
- **Smart Growth Public Infrastructure Act Guidance and Screening Tool**: NYSDOT is planning to release an updated version of this tool in 2022. The new Guidance will include a resiliency section applicable to new bridge and culvert construction or replacements, projects near water bodies or having potential exposure to the forces of the tides (including future sea level rise), evacuation routes, projects traversing heat islands, or projects that have repeatedly damaged facilities within project limits. The Screening Tool and signed Attestation Form become part of a project's records and are carried through the project development process.

## More Extreme Storms

NYSDOT recognizes that the projected increase of the frequency and intensity of storm events remains high. Extreme events are a growing risk for New York State's transportation system as illustrated by storms that occurred in 2021, including named storms Ida, Henri, and Fred. Extreme hourly rainfalls broke all-time weather records at many locations and caused widespread flooding impacts to urban and rural highways including washouts to highway assets. High wind events resulted in tree debris, both on-road and off. Extreme winter precipitation also presents enormous challenges to maintaining reasonable levels of safety on the highways for travelers and the movement of goods, especially if hourly precipitation rates are extreme or if precipitation changes to ice in a short amount of time. Although weather forecasts are becoming more sophisticated, the storm intensity is difficult to forecast with high accuracy for specific locations. Observed increases in the amount of precipitation falling in very heavy events for each region of the United States are shown in Figure 6.4. The amount of precipitation falling in very heavy events has increased for each region of the United States, except Hawaii.

*Figure 6.4 Observed increases in precipitation from heavy rain events, 1958 to 2012*[7].




[7] Observed Change in Very Heavy Precipitation | U.S. Climate Resiliency Toolkit

The major impacts of concern associated with more extreme storm events include:

- More road closures, impacting both public safety and response and recovery activities.
- More debris clogging culverts and block bridges, causing overtopping and failures.
- More tree debris, requiring removal from roadways.
- The diversion of Operations resources (staff and contract), resulting in a reduction of planned safety improvements.
- More repairs and replacements of damaged assets, before the end of their life cycles.
- More icing events, increasing road salt use and result in greater costs and environmental impacts.

Strategies to mitigate the risk include increasing the portion of the program dedicated to demand response contracts and to improve the capacity to respond to these events. Strategies also include continuing or increasing funding for the dedicated culvert and bridge programs. In addition, capital funds should ensure that the critical maintenance equipment fleet is adequate for response. Deployment of in-house maintenance forces has been proven to shorten response time and lower costs over demand response contracts.

An important component of the State's response occurs at the local level, which NYSDOT fully supports. This includes ensuring that contractual mechanisms to provide emergency response and recovery locally are in place, particularly when events are not State- or Federal-declared disasters. Additionally, emergency response plans need to be in place, improved and maintained, and coordinated with the State's Office of Emergency Management and Local Emergency Operations Centers.

## Flooding

Of particular concern is the transportation infrastructure's vulnerability to flooding, especially if the frequency and severity of flooding increases. The State's landscape is drained by an extensive system of streams that crisscross or are adjacent to transportation infrastructure. With climate change causing more heavy precipitation events—both in intensity and frequency—streams and rivers are more likely to jump their banks or overwhelm or scour culverts and roads. Urban drainage systems are often overwhelmed and cannot absorb intense heavy precipitation.

Flood risks include increased damage to assets, more frequent overtopping of roadways, and having to divert staff from other priorities for response and recovery.

Mitigation strategies include addressing known vulnerabilities and prioritizing and addressing the remaining scour-critical Interstate bridges. Ongoing flood risk mitigation considerations include addressing vulnerabilities identified under the Flood Watch Bridge program, conducting flooding vulnerability assessments, utilizing the Debris-prone Bridges and Culverts Instruction, and assessing repetitive damage sites and other known flood impact locations. NYSDOT is also working to complete a comprehensive small culvert inventory. It will be essential to continue to develop tools and models to help prioritize culvert work. This should include hydraulic assessments and factor in aging steel pipes under deep fills, often found on Interstates. To facilitate response and resiliency work, NYSDOT will continue working with regulatory agencies to develop programmatic agreements for adaptive stream work. Critical evacuation and detour routes will also be reviewed to evaluate design interventions to prevent flooding and closure of these critical routes.

## Sea Level Rise

Coastal flooding is of great concern, especially if sea level rises at an accelerated rate in the coming decades. New York State's tidal coast is indicated by a heavy outline shown in figure 6.5, with many miles of tidal coast making it vulnerable to sea level rise. Most roads considered highly vulnerable to current tidal flooding are on the local system, often in densely developed areas. As the century progresses and seas continue to rise, more State highways will be impacted. In 2012, Superstorm Sandy's storm surge also impacted State highways and bridges in the coastal areas, heralding what a future world with higher seas may portend. State highways carry critical coastal evacuation routes that are themselves vulnerable to overtopping due to ocean proximity. State highways also serve as important collector routes in case of evacuations and the resiliency of these routes (as well as associated detour routes) is of prime importance.

*Figure 6.5 Location of NYS's Tidal Coast (indicated by heavy outline).*


NYSDOT recognizes that this risk will result in increased repetitive repairs and more replacement needs of tidally exposed infrastructure, change in land use, and customer expectations in coastal areas and the potential of increased costs due to changing standards for assets in coastal areas.

NYSDOT's strategies to mitigate this emerging risk include:

- Develop an infrastructure hardening plan with prioritized locations.
- Continue developing apps and models to analyze at-risk infrastructure and support prioritization efforts.
- Review critical evacuation and detour routes and design interventions to prevent flooding and closure of these routes.
- Review policies for potential improvements in how climate change and sea level rise are addressed.
- Regularly review engineering practices to identify robustness to future climate (projections).
- Continue providing information on climate forecasts to support durable designs.

## Energy Availability and Reliability

### Impacts on NYSDOT Operations and Demand Response

NYSDOT's operations and demand response activities currently rely on motor fuel for the heavy-duty fleet (diesel). Light-duty vehicles (LDV), both pick-up trucks and passenger, are also essential for response activities and are also reliant on motor fuel, apart from a steadily growing number of electric vehicles. Refueling is generally accomplished at NYSDOT's residency yards, which have petroleum bulk storage facilities or electric chargers. In addition, each facility has the capability to run generators off the yards' supplies of petroleum fuels should there be an electric power outage.

Over the last decade, the State has increasingly committed to transitioning its LDV fleet to electric power. More than 135 hybrid-electric LDVs have been introduced into its fleet along with the necessary charging stations. With the State's passing of the Climate Leadership and Community Protection Act in 2019 and the State's commitment to a carbon-neutral economy by 2050, public and regulatory expectations on how NYSDOT powers its fleet and facilities are likely to change. As a State agency, NYSDOT will support the State's greenhouse gas reduction goals. In addition, the State might transition its power needs to be supplied through green sources only, phasing out fossil fuel altogether and potentially making portions of NYSDOT's current fueling and power supply structure obsolete.

NYSDOT therefore identified potential changes, availability, and reliability of energy sources as risks to asset management. NYSDOT may not be able to respond to emergencies if it must rely on outside energy sources that may be impacted by such an event. If fossil fuels are phased out, NYSDOT will be unable to generate emergency power with current stationary or portable generators.

Mitigation strategies include ensuring that all critical facilities have backup generator power. Portable fuel tanks should be mobilized in advance of potential storms to ensure adequate resources are available if fuel cannot be delivered. Energy efficiency improvements at maintenance facilities should continue to be identified and implemented. NYSDOT should also evaluate options for clean energy generation and battery storage at State facilities.

### Protecting the Electric Power Grid

As NYS is transitioning its power grid to renewable sources, it is also expanding its transmission network to bring energy to where it is needed the most, such as metropolitan areas. Electric utilities traverse and utilize the roadside ROW for energy transmission. NYSDOT can support reducing disruptions to electricity transmission by supporting more robust energy infrastructure and working with utilities to encourage underground utilities where possible.

## 6.9 SUMMARY OF PERIODIC EVALUATION OF FACILITIES REPEATEDLY REQUIRING REPAIR AND RECONSTRUCTION DUE TO EMERGENCY EVENTS

Federal Regulation 23 CFR 667 requires that State DOTs evaluate Federal Aid eligible assets that have been repeatedly damaged due to events that are declared disasters by Presidential or Gubernatorial offices. The rule[8] requires DOTs to conduct Statewide evaluations to determine the root cause and to consider reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events.

### NYSDOT's Process

For these purposes, NYSDOT evaluated historical records submitted to FHWA under the Federal Emergency Relief (ER) program. These records consist of reimbursement requests for repair and reconstruction of damaged Federal Aid eligible highways and bridges in the State, regardless of ownership (i.e., State and locally owned and maintained assets).

NYSDOT's analysis includes ER events from late 1996 to December 31, 2020. Damaged and repaired assets are digitally mapped in GIS and linked to available ER information. After mapping, identification of repeatedly damaged assets is accomplished using GIS and spreadsheet tools.

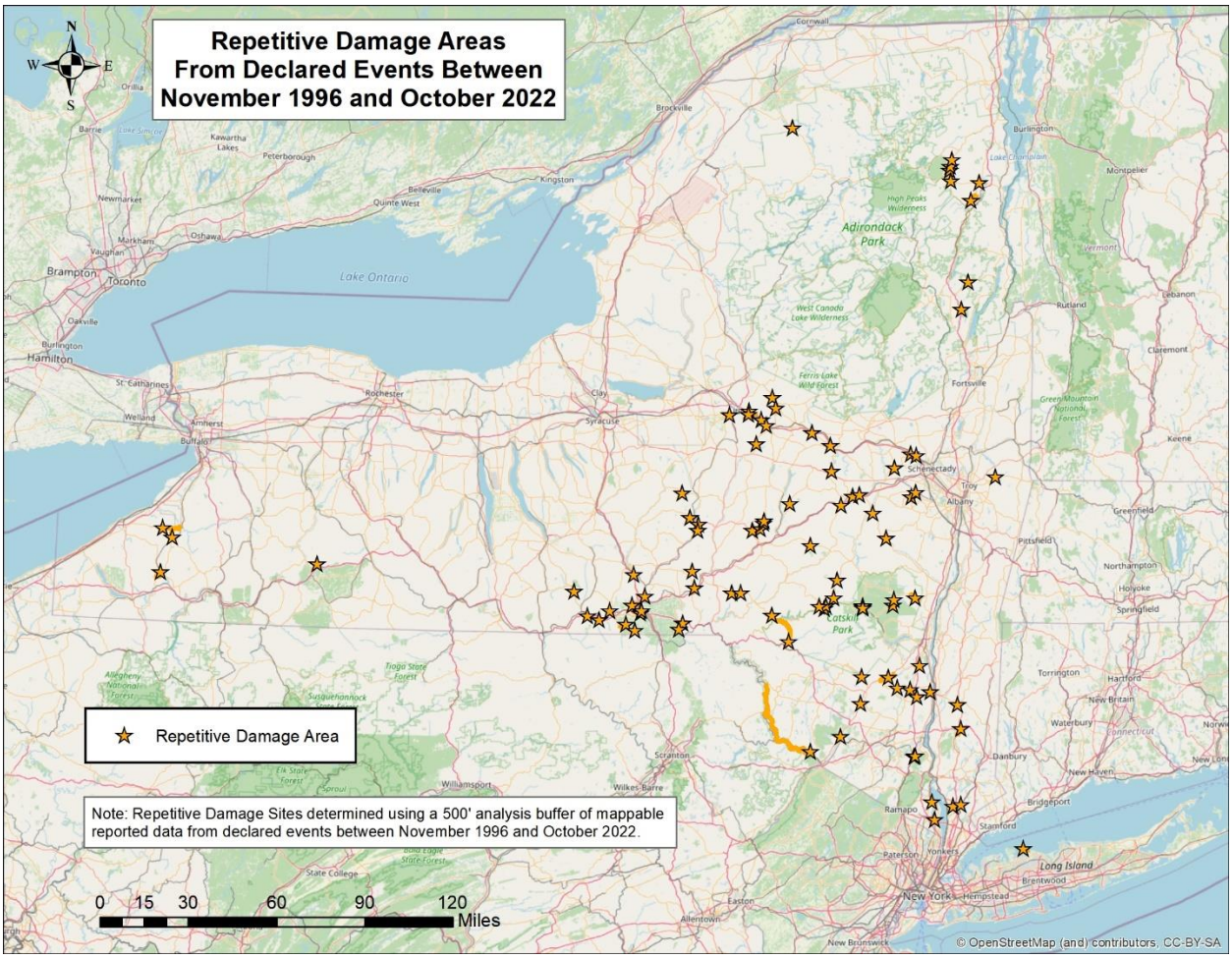
Mapping is based on the descriptions associated with the submissions to FHWA for ER reimbursements. Mapping historical repair sites can be difficult. While linking repeated damage events to easily identifiable assets such as bridges or culverts is fairly straightforward, some past damage assessments are described vaguely. For example, a summary may simply state: *"road damage for five miles due to multiple shoulder washouts, ditch damage and culvert damage."* In these situations, information on specific assets is extracted where identified; otherwise, such damages may be displayed as linear sections of roadways. These linearly displayed damage sites could trigger more frequent evaluations as the probability of repeated events are more likely along longer stretches of roadway.

[8] Federal Register https://www.govinfo.gov/content/pkg/CFR-2018-title23-vol1/xml/CFR-2018-title23-vol1-part667.xml

## Results

As of November 7, 2022, GIS mapping has been accomplished for 2,092 ER repair sites for events from late 1996 to 2020, and the general locations are shown in figure 6.6. Mapped assets include roads, bridges, culverts, ditches, shoulders, slopes, and walls, as well as several others. For these events, ninety-one repeatedly damaged areas have been identified. The effort to map repair sites and keep data current is conducted on a continual basis. GIS mapping dating back to November 1996 was accomplished as highlighted in the 2019 TAMP.

*Figure 6.6 Statewide map of repeatedly damaged areas identified in analysis (11/07/2021).*




## Evaluations

Once an asset has been repeatedly damaged, 23 CFR 667 requires that an evaluation be completed to find the root causes and to consider what reasonable alternatives could partially or fully reduce the need for repeated repairs, better protect public health and safety, better protect the human and natural environment, and meet transportation needs described in transportation plans including the STIP and TIP.

NYSDOT has an established ongoing process to evaluate these sites as they are identified. Repairs to the ninety-four sites identified to date have been completed, except for some recently added repair sites. As a first step, NYSDOT is implementing evaluations when repetitive

repair sites are identified by the ER program. NYSDOT is utilizing FHWA's ER portal when entering ER data. NYSDOT is using previously mapped repairs to identify any new repetitive repair locations in the portal database. Any repetitive repair site will undergo an evaluation that includes cost-benefit analyses of design alternatives for permanent repairs, also known as "betterments." Key to such evaluations is the identification of damaged assets by location during emergency events.

### Informing Planning and Program Management

The information developed under this process is also used to inform the STIP and future project development in repeatedly damaged areas. For this purpose, repetitive repair locations have been made available on NYSDOT's Comprehensive Asset Management Capital Investment Viewer, an internal GIS based tool. Regions are asked to use this tool and identify projects whose limits include locations of repetitive repairs. Although project needs were already addressed at the time of repairs during the ER process, NYSDOT is adding this additional screening layer to facilitate any additional evaluations as needed. The identification of repetitive repair sites due to declared disasters is also being added to NYSDOT's Smart Growth Screening Tool. This will ensure that the consideration for repetitive repairs is carried along in the project development process, which also includes locally sponsored projects.

## Impacts of Extreme Weather and Climate Change in New York State

### Declared Events

The State has experienced a multitude and variety of officially declared emergency events. Since November 1996, 42 declared events resulted in submissions under FHWA's ER reimbursement program, as shown in table 6.3. Approximately 75 percent of these ER events were related to flooding, with the remainder associated with wind damage, snow and ice storms, a power outage, and the 9/11 World Trade Center terrorist event.

*Table 6.3 NYS declared events that required FHWA ER submissions since 1997.*

| Count | Date and Event | FHWA ER Number | Event Type |
|---|---|---|---|
| 1 | November 1996 \| Flooding | 97-01 | Flooding |
| 2 | January 1998 \| Ice Storm and Flooding | 98-01 | Ice and Flooding |
| 3 | June to July 1990 \| Flooding | 98-02 | Flooding |
| 4 | September 1998 \| Windstorms | 98-03 | Wind |
| 5 | July 1999 \| Flooding and Windstorms | 99-01 | Flooding & Wind |
| 6 | September 1999 \| Hurricane Floyd | 99-02 | Flooding |
| 7 | Summer 2000 \| Floods and Windstorms | 00-01 | Flooding & Wind |
| 8 | December 2000 \| Storms | 01-01 | Snow |
| 9 | September 11, 2001 \| World Trade Center Incident | 01-02 | Terror |
| 10 | April 2002 \| Earthquake | 02-01 | Seismic |
| 11 | April 2003 \| Ice Storm | 03-01 | Ice |
| 12 | July 20 to August 18, 2003 \| Storms | 03-02 | Flooding & Wind |

| Count | Date and Event | FHWA ER Number | Event Type |
|---|---|---|---|
| 13 | August 14, 2003 \| Power Outage | 03-03 | Power Outage |
| 14 | Spring 2004 \| Flooding and Windstorms | 04-01 | Flooding & Wind |
| 15 | August 29 to September 24, 2004 \| Flooding | 04-02 | Flooding |
| 16 | April 2 to 4, 2005 \| Flooding | 05-01 | Flooding |
| 17 | June 12, 2005 \| Henry Hudson Parkway Wall Collapse | 05-02 | Collapse of Privately Owned Retaining Wall |
| 18 | June 13, 2005 \| Flooding | 05-03 | Flooding |
| 19 | July 2, 2005 \| Hadlock Pond Dam Failure | 05-04 | Dam Failure |
| 20 | September 17, 2005 \| Route 56 Washouts/Damages | 05-05 | Beaver Dam Failure |
| 21 | June 2006 \| Flooding | 06-01 | Flooding |
| 22 | October 12 to 13, 2006 \| Snowstorm | 06-02 | Snow |
| 23 | November 16, 2006 \| Flooding | 06-03 | Flooding |
| 24 | April 2007 \| Nor'easter | 07-01 | Flooding & Wind |
| 25 | June 19, 2007 \| Flash Flood | 07-02 | Flooding |
| 26 | July 23 to 27, 2008 \| Severe Storms | 08-01 | Flooding |
| 27 | December 11, 2008 \| Ice Storm | 09-01 | Ice |
| 28 | August 2009 \| Severe Rainstorms and Flooding | 09-02 | Flooding |
| 29 | January 24 to 25, 2010 \| Floods | 10-01 | Flooding |
| 30 | February 24 to 26, 2010 \| Heavy Snow (Tree Debris Event) | 10-02 | Snow |
| 31 | March 13 to 15, 2010 \| Nor'easter | 10-03 | Flooding |
| 32 | September 29 to October 1, 2010 \| Severe Storms | 10-04 | Flooding |
| 33 | April to May 2011 \| Flooding | 11-01 | Flooding |
| 34 | August 2011 \| Hurricane Irene | 11-02 | Flooding |
| 35 | September 2011 \| Tropical Storm Lee | 11-03 | Flooding |
| 36 | October 2012 \| Super Storm Sandy | 13-01 | Flooding & Wind |
| 37 | June to July 2013 \| Severe Storms and Flooding | 13-02 | Flooding |
| 38 | May 2014 \| Severe Storms and Flooding | 14-01 | Flooding |
| 39 | August 13 to 15, 2018 \| Flooding | 18-02 | Flooding |
| 40 | October 31, 2019 \| Severe Storms, Straight-Line Winds and Flooding | 20-01 | Flooding |
| 41 | August 18-19, 2021 Remnants of Tropical Storm Fred | 21-01 | Flooding |
| 42 | Sept 1- 3, 2021 Remnants of Hurricane Ida | 21-02 | Flooding |

## New York State's Approach to Extreme Weather and Climate Change

The State has launched multi-pronged efforts to protect its citizens from the impacts of extreme weather events, such as those brought by Hurricanes Sandy (2012) and Irene (2011) and by Tropical Storms Fred, Henri, and Ida (2021). The State's focus includes proactively addressing transportation infrastructure risks to increase public safety and reduce future transportation disruptions and the high costs of emergency reconstruction. The State has also passed legislation to reduce greenhouse gas emissions and make the economy carbon neutral by 2050.

Two recent legislations are especially relevant:

- **Community Risk and Resiliency Act (CRRA)**[9] was signed into law in 2014 and requires that certain State permit and funding programs consider future climate risk including sea level rise, storm surge, and inland future conditions in project design and planning. The Climate Leadership and Community Protection Act updated CRRA in 2019 to address additional hazards including storms, wind, and extreme temperatures. NYSDOT and other agencies are working with the Department of Environmental Conservation and the Department of State to identify ways to implement the provisions of the CRRA and provide State guidance.
- **Climate Leadership and Community Protection Act**[10] was signed into law in 2019 and requires that the State reduce economy-wide greenhouse gas emissions 40 percent by 2030 and no less than 85 percent by 2050 from 1990 levels. The law created a Climate Action Council, charged with developing a scoping plan that will place the State on a path toward carbon neutrality. The recently released multi-sectoral Draft Scoping Plan (December 2021) has recommendations that specifically address climate change and resiliency across all State agencies. NYSDOT will be involved in developing these strategies further, especially those impacting transportation, resiliency, and greenhouse gas mitigation.

The State also invests in climate science and guidance to help decision-making. Climate projections, resources, and guidance can be found below:

- State-adopted sea level rise projections: Part 490, Projected Sea-level Rise—Express Terms—NYS Dept. of Environmental Conservation.
- Observed and Projected Climate Change in New York (August 2021): Observed and Projected Climate Change in New York State 2021 (ny.gov).
- Responding to Climate Change in NYS (ClimAID): Responding Climate Change in New York State (ClimAID)—NYSERDA.
- Community Risk and Protection Act Implementation Guidance including the Flood Risk Management Guidance; Using Natural Resiliency Measures to Reduce Risk; Guidance for Smart Growth Public Infrastructure Assessment: Community Risk and Resiliency Act (CRRA)—NYS Dept. of Environmental Conservation.

[9] NYS Community Risk and Resiliency Act website: https://www.dec.ny.gov/energy/102559.html

[10] New York's Climate Leadership and Community Protection Act (CLCPA) (ny.gov)

# 7. Investment Plan

This chapter describes the investment strategies that guide NYSDOT, the NYSTA, and the local agencies with maintenance jurisdiction over parts of the NHS in maintaining NHS bridge and pavement assets. Unless otherwise stated, the rest of this chapter will refer to the combined efforts of the NYSDOT, the NYSTA, and the myriad of local agencies that maintain the NHS, as "the State" or "New York State."

## 7.1 NYSDOT'S ASSET MANAGEMENT INVESTMENT STRATEGIES

NYSDOT and the NYSTA are operating in an environment in which the needs of the transportation system outweigh the funding available to address them. NYSDOT is responsible for the conditions of the whole Statewide transportation system, not only the NHS. In this context, NYSDOT currently has thirty-five percent of the funding required to address the NHS pavement and bridge state of good repair needs (See appendix D). To keep the NHS and New York State's wider transportation system functioning in a safe and reliable manner, while at the same time recognizing the current fiscal constraints, it is essential to follow a deliberate and strategic approach to setting planning targets. By necessity, this includes setting priorities that will allow the State to meet both long-term goals and short-term objectives.

**NYSDOT's Commitment to Building a Resilient System**

The STIP reflects a balance of many needs including resiliency. Resilience is a significant factor in selecting projects, but there are many considerations in developing the comprehensive program and statewide transportation improvement program (STIP). Every project in NYSDOT's comprehensive program considers extreme weather and climate change risk to incorporate NYSDOT's built-to resiliency standards. Prior to each comprehensive program and STIP update, NYSDOT issues guidance to its Regions and to the MPOs that includes consideration of resilience needs.

Given the significant needs of the transportation system, the State has established a strategy to invest in a way that produces the greatest possible return on investment. As stated in chapter 5, a large part of this approach emphasizes proper management of assets with appropriate treatments that are placed at appropriate times and at appropriate locations. At NYSDOT, this means making strategic and deliberate decisions that support the transportation system today, while optimizing transportation for future generations. This starts with taking care of the existing system first. By preserving the existing system, NYSDOT will help build the foundation for future economic growth of the State. How NYSDOT makes funding decisions is consistent with this strategy.

Where allowed under the program area guidelines and where appropriate for the underlying infrastructure, NYSDOT uses the Highway and Bridge Core Construction Program funding to address two broad purposes: system preservation (Maintenance First) and system renewal.

## Maintenance First

As stated in chapter 5, the State has embraced a Maintenance First approach in its program planning activities. Preservation activities are undertaken to extend or maximize the service life of an existing asset or highway facility. This work includes preventive maintenance and preservation activities on pavements. For bridges, this includes preventive maintenance, preservation, and rehabilitation treatments.

The Maintenance First strategy prioritizes activities that maximize the service life of existing infrastructure assets over expansion or enhancement of the highway network. The strategy prioritizes managing conditions across the entire system, not just the NHS, by keeping preservable assets in the lower-cost preservation treatment cycle.

For any funding and project prioritization scenario, system conditions will stabilize given enough time. In most instances of underfunding, subsections of the system may never rise to the importance of being programmed for work on a regular cycle. For example, if a State has only a fraction of the funding required to keep the entire system in good condition, they may opt to prioritize higher volume facilities, letting the lower volume, secondary system deteriorate to poor. In this manner, the size of the unrepaired portion of the system will increase as available funding decreases. System conditions could stabilize with a majority of the system in poor condition if funding was chronically inadequate to meet annual construction needs.

Once network conditions are stabilized, the amount of preservation funding required from year to year will stabilize as well. If the State funds the Core Construction Program at a higher amount than the required preservation funding, then the additional funds are applied to System Renewal or reconstruction and replacement projects on pavements and bridges. These projects are performed on more deteriorated assets to bring them into a state of good repair. It is important to recognize that a Maintenance First strategy is a long-term commitment and will take years before the State fully achieves the desired results. This must be recognized by NYSDOT and NYSTA staff, external stakeholders, and decision-makers.

The following Maintenance First precepts are considered as part of NYSDOT's Program Update efforts:

- The overall program strategy is preservation focused and safety sensitive.
- Preservation projects will address all applicable safety and accessibility requirements and will go through a Safety Appurtenance Program screening to make sure any deficiencies are addressed during construction.
- Preservation performance targets for structures and pavements are set and agreed upon. Each asset team determines the needs required to achieve a state of good repair in a 10-year period for each of their assets. The relative preservation and renewal needs, by asset type and by region, are reviewed and agreed to by the CPT. The planning targets are set based on the relative needs of each region and heavily weighted toward preservation needs. Regions are expected to spend most of their planning targets on preservation activities.
- The details of what treatments and combinations of treatments are considered preservation are set by the asset management teams and are defined in program update instruction documents. The detailed breakdown can be found in chapter 5.
- The expectation is that a Maintenance First strategy is a long-term commitment and requires adequate funding. It may take years before the desired results are fully achieved and the system reaches a state of good repair.
- In general, preservation project selection decisions are prioritized on a regional basis. Resources are managed and prioritized by regional offices and MPOs for purposes of infrastructure preservation.

As detailed in chapter 5, these needs are determined by the State's pavement and bridge management systems and include not just the recommended lowest cost-effective treatment, but also whether that treatment is due within the window of opportunity for that treatment. These systems analyze each highway segment and bridge and recommend treatments based on a combination of historical cost information, models that estimate how an asset will deteriorate over time, and a set of work treatment selection algorithms that reflect conditions, life-cycle costs, and Statewide policies. The regional planning target development process enables NYSDOT to balance system preservation across the network.

## System Renewal

System Renewal projects address assets that have deteriorated beyond a state in which they can be preserved or meet Statewide goals of economic development, resiliency, or sustainability. These projects include highway reconstruction and bridge replacement projects. System Renewal projects are divided into two categories.

- **Renewal** investments are existing system restorations and are defined as all bridge replacements and major rehabilitations; road reconstructions in villages, hamlets, and cities; and major rehabilitation and reconstruction pavement projects. Projects are designed and constructed to address complete street enhancement needs such as new sidewalks, bicycle access, or any other elements necessary to meet accessibility needs.
- **Enhancement** is a term for investments that provide capacity or operational improvements like new roadways, capacity projects, and any fundamental change in function or functional class. In addition to asset management resources, system improvement projects can be funded with discretionary sources such as Better Utilizing Investment to Leverage Development, Infrastructure for Rebuilding

America, and TAP. These resources are outside of the scope of the TAMP and can be used, when awarded, for system improvement type projects by NYSDOT and local recipients as appropriate.

Major system renewal and enhancement projects are usually not affordable within a region's planning targets, as regions provide information on these projects as part of the capital program update process. The objective of the Statewide planning process is to identify projects at the locations of greatest need from an overall Statewide perspective. The process considers asset condition, facility importance, and potential risk to infrastructure condition. This is necessary because of the very limited amount of funding available and the need to channel that funding where it is most desperately needed. Projects that are selected through this process are then proposed for addition to the STIP.

## 7.2 NEW YORK STATE CAPITAL PROGRAM DEVELOPMENT

NYSDOT implements its asset management investment strategies through its capital program. Approximately every 2 years NYSDOT goes through a CPU process. Regions receive CPU Instructions from the CPT that provide guidance on NYSDOT's strategies and emphasis areas for the upcoming update. All Statewide asset teams participate in the writing of the Program Update instructions. The comprehensive program is comprised of four primary components:

1. Preservation and renewal projects selected by the Regions.
2. Major capital projects selected based on Statewide needs.
3. Projects selected through Statewide competitive solicitations.
4. Projects selected through the New York State Freight Transportation Plan process.

### Preservation and Renewal Projects

In advance of the CPU, the Department performs a needs analysis that determines the funding required to achieve a state of good repair for each asset class in each region of the State within a 10-year period. This process involves an analysis of the State's entire highway system, not just the NHS. This involves analyzing bridge and pavement conditions and includes secondary assets like guiderail, signs, drainage, signals, and others. The needs study also includes safety and system optimizations, which include TMC operations, HELP trucks, signal timing, ADA, and ITS. Most needs are broken down into a preservation component (i.e., what funds are necessary to preserve an asset) and a renewal component (i.e., what funds are necessary to enhance, reconstruct, or replace an asset).

Regions are provided with planning targets for preservation and renewal work. Those planning targets are based on the proportional needs of the transportation system. Over the last several updates the Regions have been instructed to use their planning targets almost exclusively on projects that will preserve the existing transportation system.

### Major Capital Projects

In addition to preservation projects, Regions typically have a large list of renewal projects to support system conditions and performance but are beyond their available planning targets to fund. The regional asset teams review these projects and submit them to the Statewide asset management teams for review and evaluation. The asset teams and CPT review all the submitted projects and determine which of these projects are the most important to the State.

These projects typically consist of system renewal projects on critical facilities across the State, as well as strategic investments that will benefit the State's economic well-being.

### Statewide Competitive Solicitations

NYSDOT also conducts competitive solicitations for TAP on a Statewide basis and for CMAQ projects in nineteen upstate counties eligible to use CMAQ. This is in addition to Local Bridge NY projects that have been scored by Regional Review Teams and are selected and approved for funding by the Commissioner of NYSDOT. Projects funded through the Strategic Highway Safety Improvement Program are selected through a similar competitive solicitation also conducted in coordination with asset management but outside of the CPU process.

### Freight Projects

Freight Projects identified in the New York State Freight Transportation Plan that use NHFP funds are added to the program. These projects use funds dedicated for specific freight purposes and are separate from the analysis of the main portions of the capital program.

### Ongoing Program Management

The Program Management Bureau manages the Capital Program. Regions are monitored to ensure they stay within their planning targets and Statewide selected projects are monitored for cost, scope, and schedule. Delivery of the capital program is coordinated with other NYSDOT programs including Safety, TSMO, Design, and Construction. This coordination is performed through the financial management of the Program Management Bureau that oversees all Federal Aid authorizations and project lettings.

## 7.3 EXPECTED INVESTMENT LEVELS AND CONDITIONS

Following the processes described above, NYSDOT has established expected investment levels for NHS pavements and bridges. Using the pavement and bridge management systems, NYSDOT can reasonably predict future asset conditions based on these expected investments.

### Funds Available for Pavement and Bridge Assets on the NHS

As stated in chapter 3, NYSDOT and the NYSTA have a combined $3.089 billion in core construction funds available to meet the needs of the entire State transportation system (and not just pavement and bridge assets on the NHS). Not all core construction funds are used for pavement and bridge construction; a portion are used for other needs, such as maintenance of ancillary assets and other improvements such as drainage repairs, pedestrian upgrades, or for large mobility projects or new construction. The Other category includes:

- Mobility improvements.
- Drainage improvements.
- Secondary assets such as guiderail and signs.
- Overhead sign structures.
- ITS.
- Signal improvements.
- Noise and retaining walls.
- Truck and freight facilities.
- Rest Area projects.

- Bicycle and pedestrian projects including ADA mandates on paving projects.
- Park and ride work.
- Tree trimming.

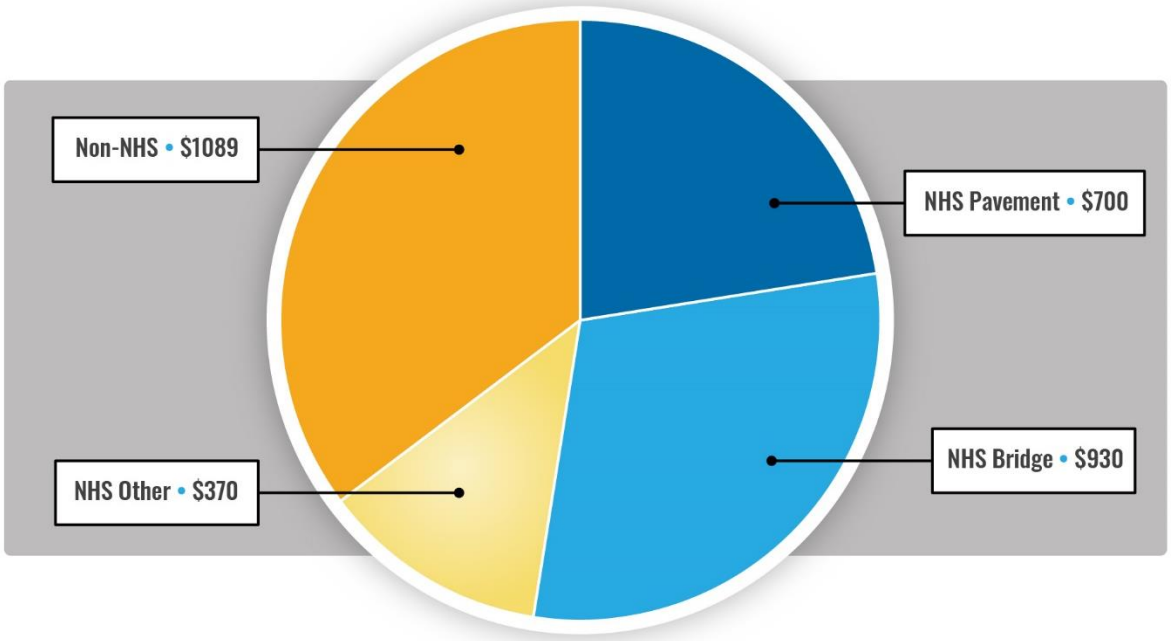
These funds are subtracted from the total available funds as they do not contribute directly to the asset management of pavement and bridge assets on the NHS. As stated earlier, NYSDOT assesses the needs of these assets as part of the needs study performed during the CPU process. These needs are then weighed against the pavement and bridge needs and a portion of the overall funding is supplied to the regions to meet these needs. In the context of the capital program, these Other projects are handled in two ways:

- First, NYSDOT and the NYSTA design and bid projects specifically to meet these system needs.
- Second, a given pavement or bridge project may have an Other component based on the scope of elements included in the project. For example, if a bridge replacement project includes the addition of a dedicated bicycle/pedestrian lane, then some of the cost for that project would be attributed to the Bridge category and some would be attributed to the Other category. On average, about fifteen percent of the total pavement spending and thirty percent of the total bridge spending goes toward the other category. These portions have been removed from the pavement and bridge budgets presented in the sections below and are represented in the Other category in the associated figures and tables.

As presented in chapter 2, the NHS comprises only a portion—roughly forty percent—of the total lane-miles of Federal Aid eligible highway system in the State. However, the NHS carries almost seventy percent of the State's traffic as expressed in VMT. Virtually all the New York State Thruway is on the NHS, so it can be assumed that all the $275 million in NYSTA core construction funding is used on the NHS. However, unlike the NYSTA, NYSDOT is responsible for the conditions of the entire Federal Aid system. Therefore, when developing the system needs, and when running pavement and bridge management systems, the entire State system is considered, not just the NHS. However, pavement and bridge projects are prioritized using traffic volume, functional class, and other factors that keep the NHS in better condition than the non-NHS portions of the system. For example, in the latest Capital Program, it is anticipated that the non-NHS portions of the system will be in considerably worse condition than the NHS over a 10-year period.

When trade-off analysis is done to balance the future conditions of pavement and bridge assets in the State, funding is included for the entire system, not just the NHS. Once the Statewide outcomes are calculated, the project estimates are separated between what is planned on the NHS from the non-NHS portions of the State system. All the funding amounts presented in the later sections of this document are for the NHS only, unless stated otherwise. This breakdown of core construction funds is demonstrated in figure 7.1. The figure shows the average amount of NYSDOT and NYSTA funding available for pavement and bridge work on the NHS over the next 10-year period.

*Figure 7.1 NYSDOT and NYSTA average annual funds available for NHS work ($ millions).*




These funding amounts were derived from the Department's CPU exercise and are reflected in the current 4-year STIP document, which outlines the current NYSDOT infrastructure commitments. The level of investment planned for the non-NHS part of the system is only thirty-five percent of the available total core construction funding, even though it comprises more than sixty percent of the total lane-miles. Further details of planned investments in NHS pavement and bridge assets are presented in the sections below.

Of the $2.814 billion for NYSDOT core construction, an $830 million subset has been established for priority system enhancement projects. While system enhancement projects will improve pavement and bridge conditions, a higher percentage of the costs of these projects go to other work and appurtenances such as realignment and improvements to bicycle, pedestrian, safety, and ITS assets and functionality. All of these investments advance NYSDOT's mission. However, the full costs of these projects cannot be considered available for asset management. As a result, the average annual revenue available to sustain and improve NHS conditions is approximately $450 million for NHS pavements and $700 million for NHS bridges. The differences between these amounts and the core construction funds for pavements and bridges, shown in figure 7.1 is considered "Initial Construction" and is excluded from the analysis to determine expected asset management investments and outcomes.

Figure 3-6 shows the average annual funding available for NHS pavements and bridges 2022-2031.

## Expected NHS Pavement Investments and Resulting Conditions

NYSDOT and the NYSTA plan to invest a combined $450 million per year over the next 10 years to preserve and improve the conditions of NHS pavements. Figure 7.2 shows how this investment will be divided between work categories. Neither NYSDOT nor NYSTA plan any significant investments in system expansion during this period. While some projects may include the construction of additional lane-miles, this is typically occurring through actions such as minor realignments, the creation of turning lanes, or the extension of exit or entrance merge lanes, not through the construction of new centerline miles.

*Figure 7.2 Annual NHS pavement construction spending by FHWA treatment type at $450 average annual spending.*

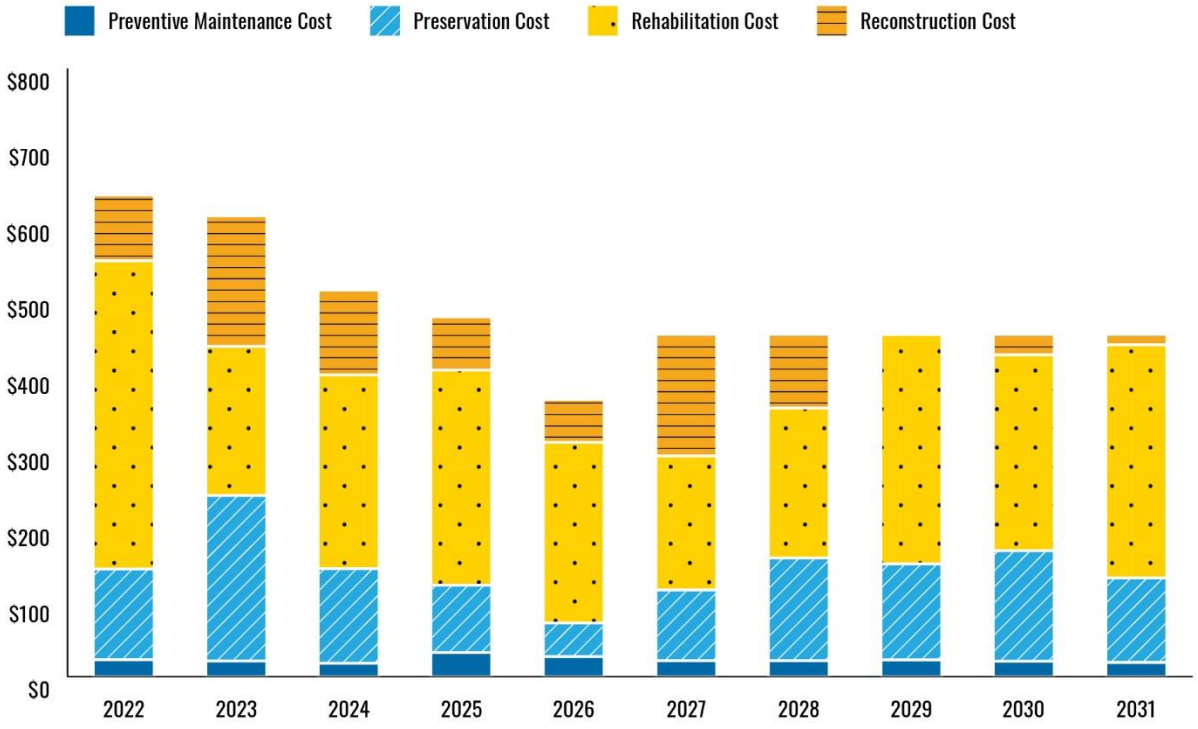
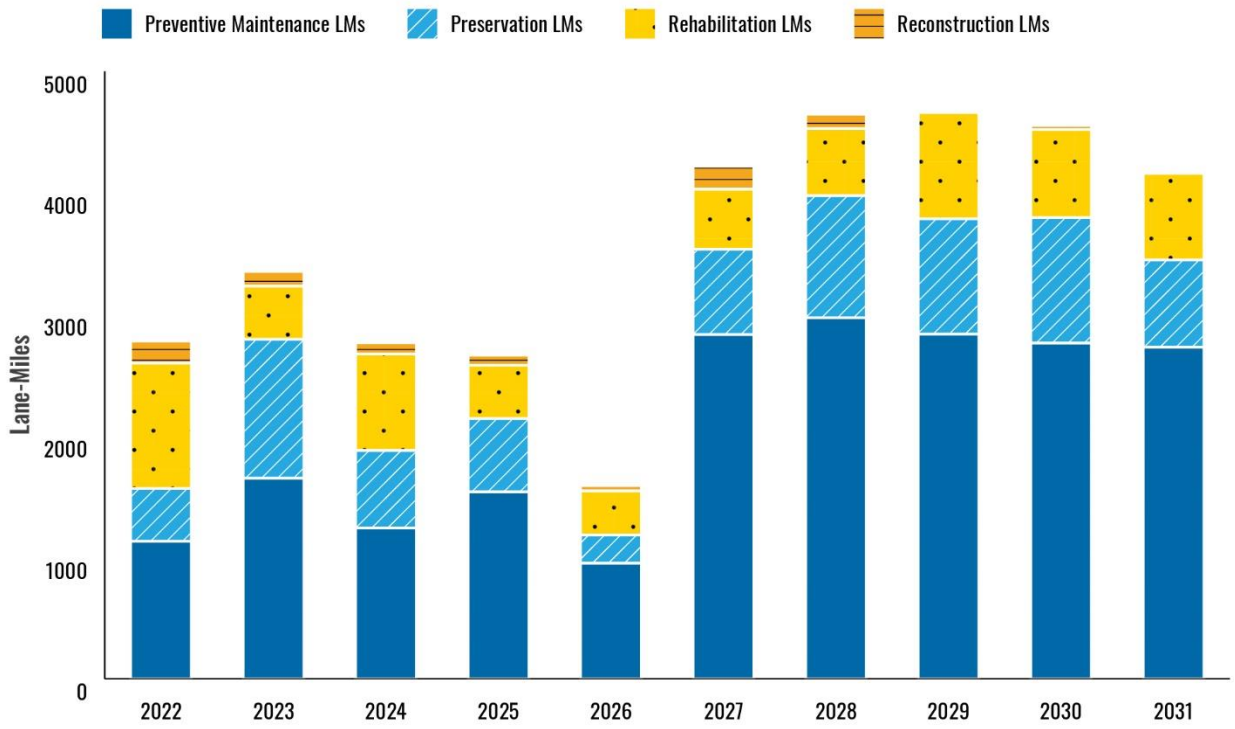



Figure 7.3 shows a breakdown of these investments in terms of the number of lane-miles of pavement expected to be treated with each work type. As can be seen from this chart, the relatively small investment in preventive maintenance addresses the needs of nearly as many lane-miles as the other work types combined. This demonstrates the importance and effectiveness of preventive maintenance in sustaining overall pavement conditions.

*Figure 7.3 Annual NHS pavement investment levels by FHWA treatment type at $450M average annual spending.*




Figures 7.4 and 7.5 compare the current and expected future conditions of Interstate and non-Interstate NHS pavements, respectively. These charts are based on forecasts of conditions determined with NYSDOT's PMS. Additional details on this analysis are provided in Appendix E. As can be seen from these graphs, NYSDOT and NYSTA's focus on preventive maintenance and preservation is expected to increase the percentage of lane-miles in Good condition. However, additional funding is needed to address the pavements expected to fall from Fair to Poor condition. This is discussed later in this chapter.

*Figure 7.4 Interstate pavement conditions by lane mile—$**450M** average annual spending.*

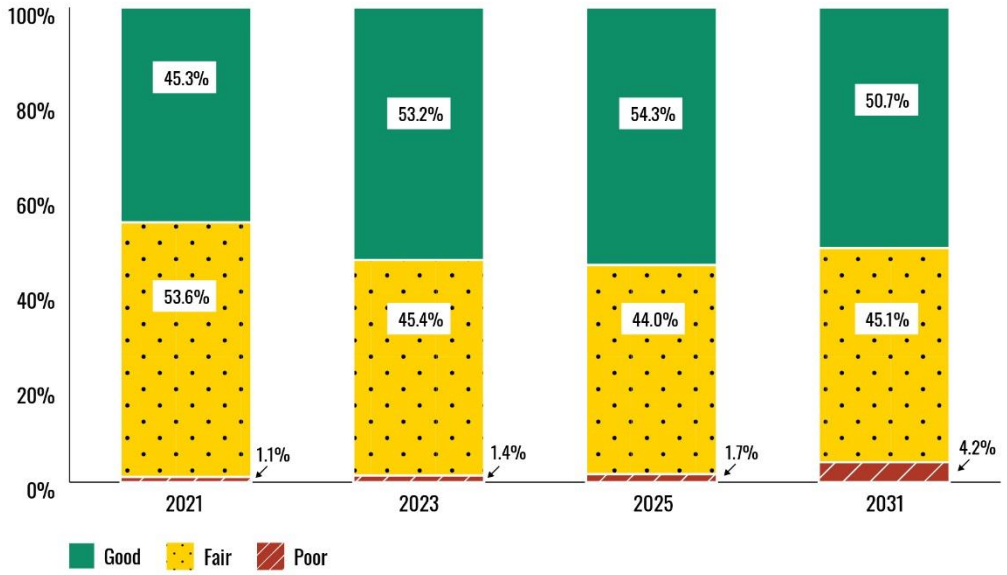
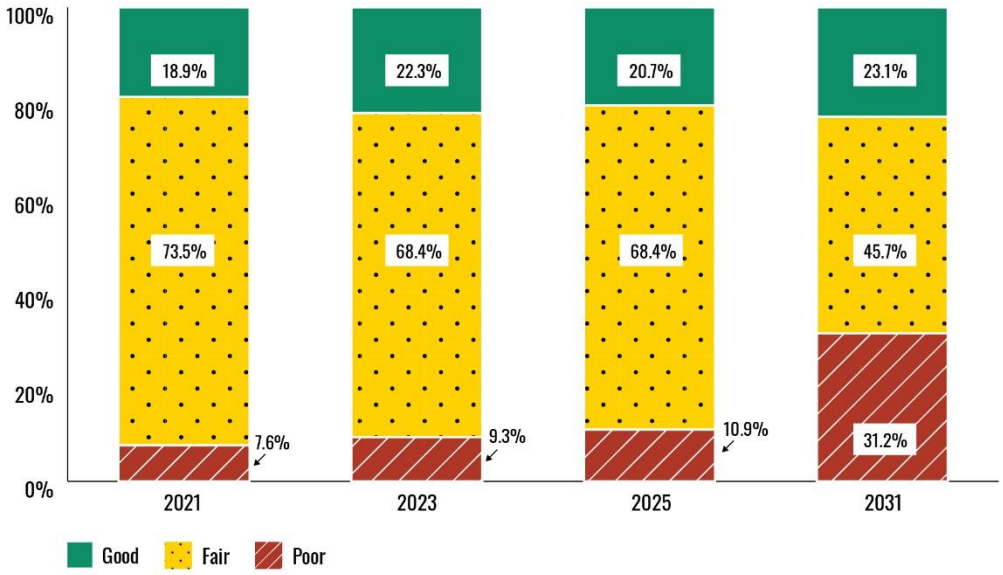



*Figure 7.5 Non-Interstate NHS pavement conditions by lane mile—$**450M** average annual spending.*




## Expected NHS Bridge Investments and Resulting Conditions

NYSDOT and the NYSTA expect to invest a combined $700 million per year, on average, in bridge work over the next 10 years. Figures 7.6 and 7.7 provide details of the construction spending and the number of projects, respectively. The planned investments shown in these graphs are heavily influenced by the existing STIP. This level of funding is bolstered by a significant investment in priority projects, in particular the replacement of I-81 through

Syracuse. Years 7 through 10 of this analysis indicate a steadier long-term forecast of investment levels.

As seen in these graphs, the investment levels across work types vary by year based on the prioritized needs of specific bridges. As described in chapter 5, NYSDOT and the NYSTA use their bridge management systems to identify the appropriate type and timing of work to manage bridge conditions throughout the life cycle. Currently, NYSDOT does not classify any specific bridge treatments within the preservation work type, but instead sees preservation as a category that incorporates maintenance and rehabilitation.

Neither NYSDOT nor the NYSTA currently expect any significant expansion of the bridge population through initial construction of new bridges. Even major projects like I-81 through Syracuse are reconstruction projects. While new bridges often are constructed on a different alignment and of a larger size than the bridges they are replacing, NYSDOT and the NYSTA consider such work to be bridge replacement, not initial construction. While this is expected to lead to a steady increase in the bridge population by deck area, it is not expected that the population of bridges by count will change significantly over the next 10 years.

*Figure 7.6 Bridge construction spending by FHWA treatment type at $**700M** average annual funding.*

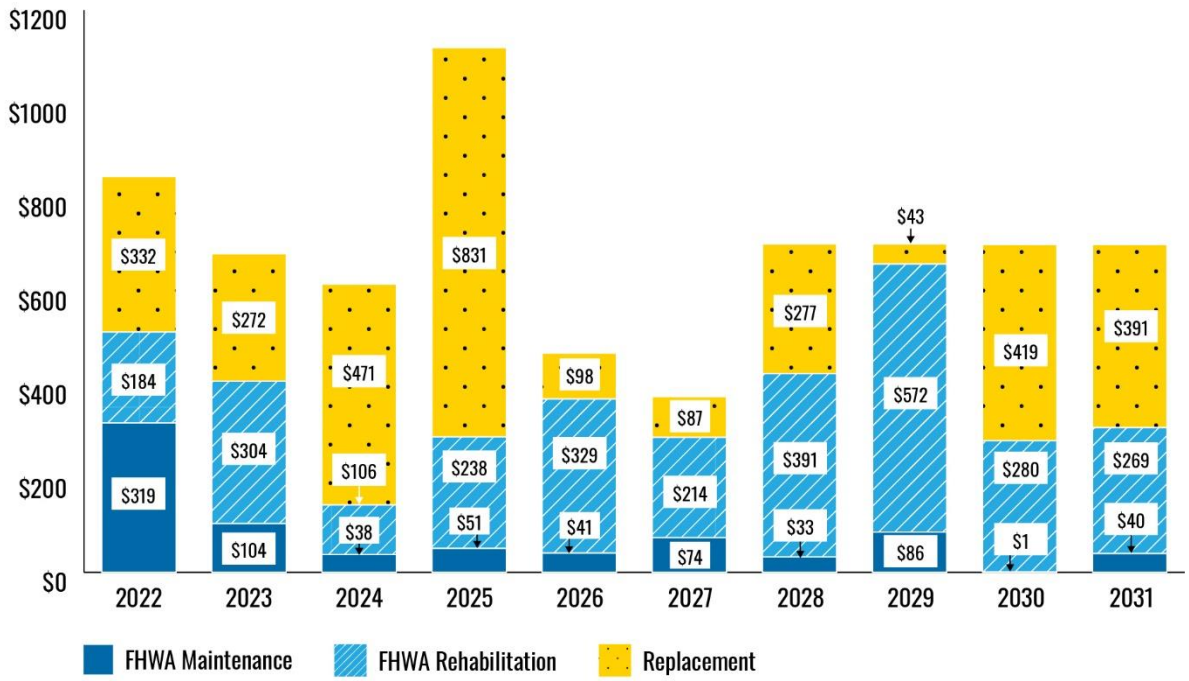


*Figure 7.7 Bridge projects by year by FHWA treatment type at $**700M** average annual funding.*

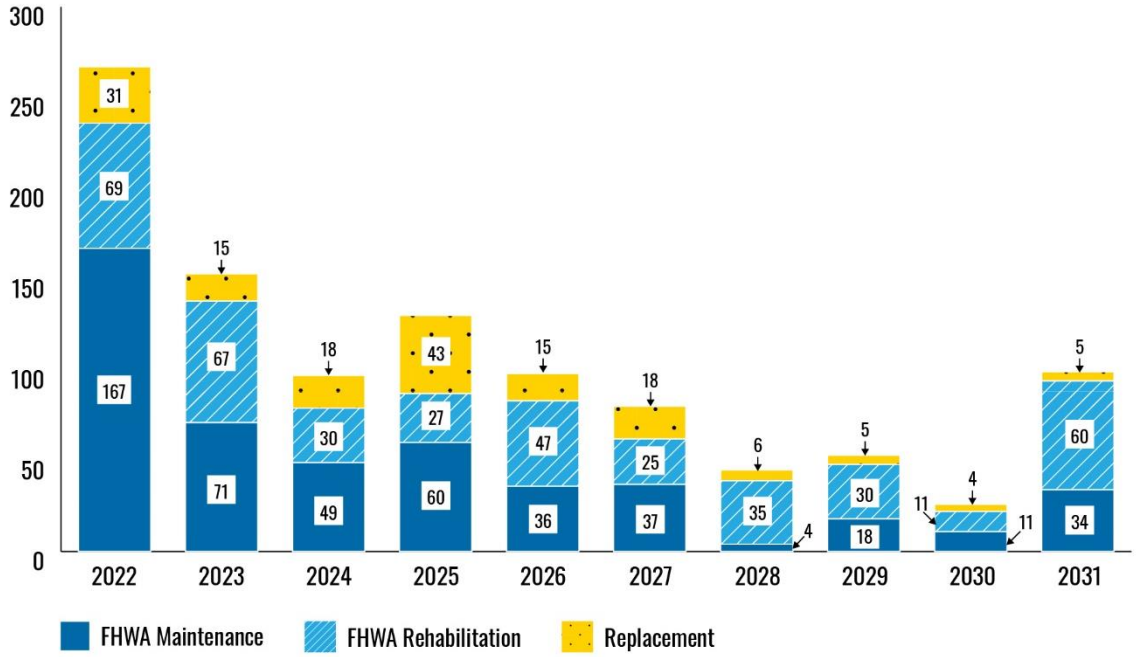
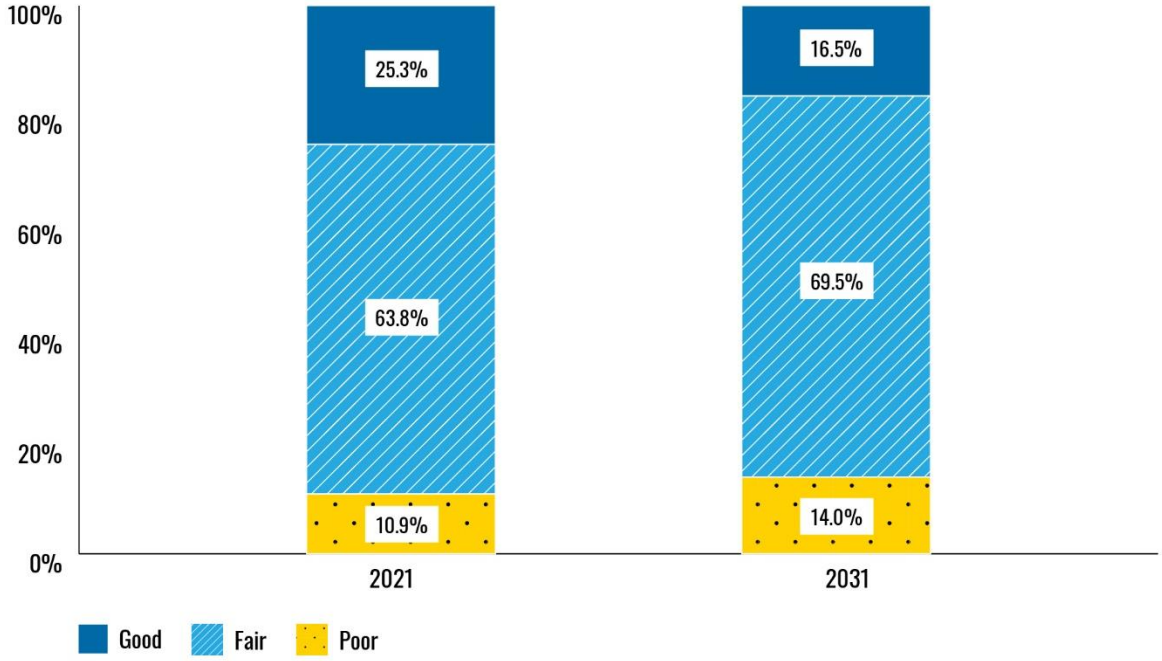



Figure 7.8 shows the current and 10-year forecasted bridge conditions based on expected average annual investment in NHS bridges. As seen in the graph, NHS bridge conditions are expected to decline over the next 10 years. This is discussed further in the next section of this chapter.

*Figure 7.8 Bridge condition by deck area—$**700M** average annual spending.*



# 7.4 PERFORMANCE GAP ANALYSIS

23 CFR 515.9(f) requires the TAMP to discuss how the plan's investment strategies collectively would make or support progress towards:

1. Achieving and sustaining a desired state of good repair over the life cycle of the assets.
2. Improving or preserving asset conditions and the performance of the NHS relating to the condition of physical assets.
3. Achieving the State DOT targets for asset condition and performance of the NHS in accordance with 23 USC 150(d).
4. Achieving the national goals identified in 23 USC 150(b).

The State targets for asset condition and performance are established and reported using the national performance measures, as described in chapter 2. Further, pursuant to § 490.315 and § 490.407, this rule establishes minimum condition levels for pavement and bridges as follows:

- No more than five percent of the pavement lane-miles on the Interstate system can be in Poor condition.
- No more than ten percent of the total bridge deck area on the entire NHS in the State can be classified as Structurally Deficient.

Failing to meet the minimum conditions can result in penalties that limit NYSDOT's flexibility in funding projects. The penalties apply to Federal funding on a Statewide basis. Penalties are not applied regionally to local apportionments or to sub-allocations (23 USC 119(f)).

The State currently meets the Federal pavement requirement but fails the Federal bridge requirement. However, the State is already allocating more money to address bridge conditions than are required by the penalty. The Federal metrics are key components of the asset management strategy for the NHS. The State's method for establishing asset management investment strategies, and for setting condition targets, is detailed in the following sections.

## Target Setting for Pavement and Bridge Conditions

To be compliant with 23 CFR Part 490 subparts A, C, and D, NYSDOT established condition targets for pavements and bridges on the NHS, in 2018. These are not aspirational goals but reflect an effort to minimize deterioration of the existing highway and bridge infrastructure in an environment where available resources are about one-third of what is needed to maintain a state of good repair. The targets represent conditions that are attainable, based on the investment strategies described in NYSDOT's 2019 TAMP.

Based on the requirements of 23 CFR Part 490 subparts A, C, and D, NYSDOT will establish updated targets by October 1, 2022, and every 4 years thereafter. However, at the time that this TAMP was being developed, official data were not yet available from FHWA to support the target setting process. The targets shown in this TAMP for pavement and bridge conditions on the NHS were established in 2018.

When establishing performance targets, NYSDOT uses the PMS and BMS described in chapter 5 to forecast future conditions based on delivery of the projects included in the current STIP. After accounting for the approved STIP projects, any remaining funds will be programmed in an efficient manner using asset management principles and taking the new Federal metrics into account.

## Performance Target MPO Coordination

NYSDOT has coordinated target setting with MPOs. The New York State Association of Metropolitan Planning Organizations (NYSAMPO) established a Working Group, which held periodic discussions to coordinate comments on performance management rulemaking and discuss target setting processes and timelines.

Any issues related to performance management are discussed at the NYSAMPO bi-weekly Director's meetings (which includes all fourteen MPOs, NYSDOT, FHWA, and FTA) and questions are addressed in coordination with Federal partners. This includes not only target setting, but the development of templates for State/MPO performance management agreements and templates for TIP Anticipated Effects Narratives, along with Long-Range Plan System Performance Reports.

NYSDOT developed fact sheets describing how all Statewide targets were established. These were discussed and shared in person with the MPOs for their use in coordinating with their members and considering next steps, such as supporting Statewide targets or developing separate targets. NYSDOT also provided data and technical assistance to the MPOs as they considered whether to develop their own targets. Each of the State's fourteen MPOs have adopted resolutions supporting the Statewide targets for all measures, as applicable.

# Current and Expected Performance Gaps

The scenario analysis described above shows the amounts needed to stabilize each of the measures used by the State to manage its pavements and bridges. However, the fiscally constrained targets defined in table 7.1 indicate that stabilization is not feasible within the current funding environment. Therefore, the performance of NHS pavements and bridges is expected to worsen over the next 10 years, based on the current resources available. This difference between state of good repair levels and future target levels is considered a performance gap. Table 7.1 illustrates this performance gap.

*Table 7.1 NYS NHS asset management performance gap.*

| System / Asset | Performance Measure | Baseline 2020 | Target 2023 | Target 2025 | Desired SOGR | 10-year Forecast | Projected Performance Gap* |
|---|---|---|---|---|---|---|---|
| Interstate Pavement | % Good | 45.3% | 53.2% | 54.3% | 83.0% | 50.7% | 32.3% |
| | % Fair | 53.6% | 45.6% | 44.0% | 16.7% | 45.1% | NA |
| | % Poor | 1.1% | 1.4% | 1.7% | 0.3% | 4.2% | 3.9% |
| Non-Interstate NHS Pavement | % Good | 18.9% | 22.3% | 20.7% | 95.1% | 23.1% | 72.0% |
| | % Fair | 73.5% | 68.4% | 68.4% | 2.0% | 39.4% | NA |
| | % Poor | 7.6% | 9.3% | 10.9% | 2.9% | 31.2% | 28.3% |
| NHS Bridges | % Good | 25.33% | 25.33% | 24.0% | 34.3% | 16.5% | 17.8% |
| | % Fair | 63.81% | 63.81% | 64.3% | 55.7% | 69.5% | NA |
| | % Poor | 10.86% | 10.86% | 11.7% | 10.0% | 14.0% | 4.0% |

*Calculated as the difference between baseline conditions and the desired SOGR.

At the current funding levels, conditions on the NHS are projected to deteriorate. However, NYSDOT is tasked with sustaining the conditions of the entire highway network in the State. Additionally, asset condition is only one area of performance managed by NYSDOT. In developing the capital program and specific projects, NYSDOT prioritizes opportunities to

address multiple performance objectives. This is supported through NYSDOT's CPT and asset team structure described in Appendix B that works to prioritize needs programmatically and Statewide.

## 7.5 SCENARIOS TO ADDRESS PERFORMANCE GAPS

An important aspect of the State's CPU process is understanding the relationship between funding levels and future asset management performance. This section describes how NYSDOT forecasts future performance levels on the NHS and conducts scenario analysis as part of the CPU. This is done for two primary reasons:

- To provide a basis for cross-asset trade-off analysis to see what critical performance levels can be achieved by moving funds from one asset class to another.
- To demonstrate critical thresholds that could be achieved by additional funding. For example, at what funding level could bridge conditions be stabilized or pavement conditions achieve a perpetual state of good repair, or what combination of pavement and bridge funds would be needed to keep the backlog of funding needs from further increasing.

As outlined in chapter 5, the various funding levels for each asset and subset of the entire highway network are developed in relation to the overall needs for those assets. Through the comprehensive needs study that is completed as part of the CPU, the relative needs for pavements, bridges, other structures, secondary assets, safety, mobility, and more can be determined. Funding scenarios are then run for each asset, on a Statewide level, to compare condition outcomes. The last step in the exercise involves analyzing the Statewide conditions of the overall highway system using different combinations of asset funding scenarios that total the overall core construction budget.

Because the TAMP is primarily concerned with NHS conditions, a representative selection of various funding levels for pavement and bridge assets on the NHS are presented below. Please note that these are just a few of the dozens of funding scenarios that are considered between the various assets during the capital program development process.

The PMS and BMS were used to develop the forecasts that follow. The forecasts reflect the core construction funding levels described in chapter 3 and the investment strategies described earlier. All model runs were performed to include all State-maintained and NHS pavement and bridges over a 10-year time frame.

## Pavement Scenarios

When developing potential pavement scenarios, NYSDOT evaluated many annual funding levels for all pavements on the State highway network. For the TAMP, the following was chosen to highlight four representative funding levels for the NHS pavements in the State. Each option represents a different constant annual funding level for the next 10 years.

- **$450 million**—Current funding level.
- **$550 million**—Amount required to stabilize the percent of VMT on Good and Excellent pavement on the NHS at the existing value of 68 percent. This is a customer-focused metric that the State uses to reflect driver satisfaction and to prioritize pavement work on the higher volume roadways.
- **$1 billion**—Amount needed to:
  - Achieve the Federal target of no more than five percent Poor pavement on the Interstates.
  - Hold the Poor pavements on the entire NHS at ten percent.
  - Provide that ninety percent of the VMT on the NHS is on Good roads.
- **$1.125 billion**—Amount needed to achieve a state of good repair on the entire NHS, including:
  - Achieve a maximum of no more than five percent Poor pavement on the entire NHS, according to the FHWA definition of Poor from the Notice of Proposed Rulemaking (NPRM).
  - Provide that over ninety percent of the VMT on the NHS is on roads with a NYSDOT condition rating of 7 or better.
  - Hold the backlog of infrastructure needs steady over the 10-year period.
  - Achieve a state of good repair for pavements, which means that they will reach a condition state in year 10 and will take the least funding after that to maintain pavement conditions.

These funding levels were selected to illustrate the gap between current funding and the funding needed to stabilize critical State and Federal pavement performance measures. The large jumps in cost between scenarios are due to the need to address the Poor Interstate and NHS pavements in order to stay compliant with new Federal performance measures and priorities. The existing NHS pavement system is in relatively good condition, especially when compared to the rest of the State highway network. But in order to hold these conditions constant, the percentage of renewal work required is much higher than a standard Maintenance First approach.

The results of the pavement analysis are shown in figures 7.9 and 7.10. Each figure shows projected performance for the four funding scenarios described above for the year 2031. The projections were developed using the PMS and by applying the preservation-first logic and priorities described above.

*Figure 7.9 Expected 2031 Interstate pavement conditions by average annual funding.*

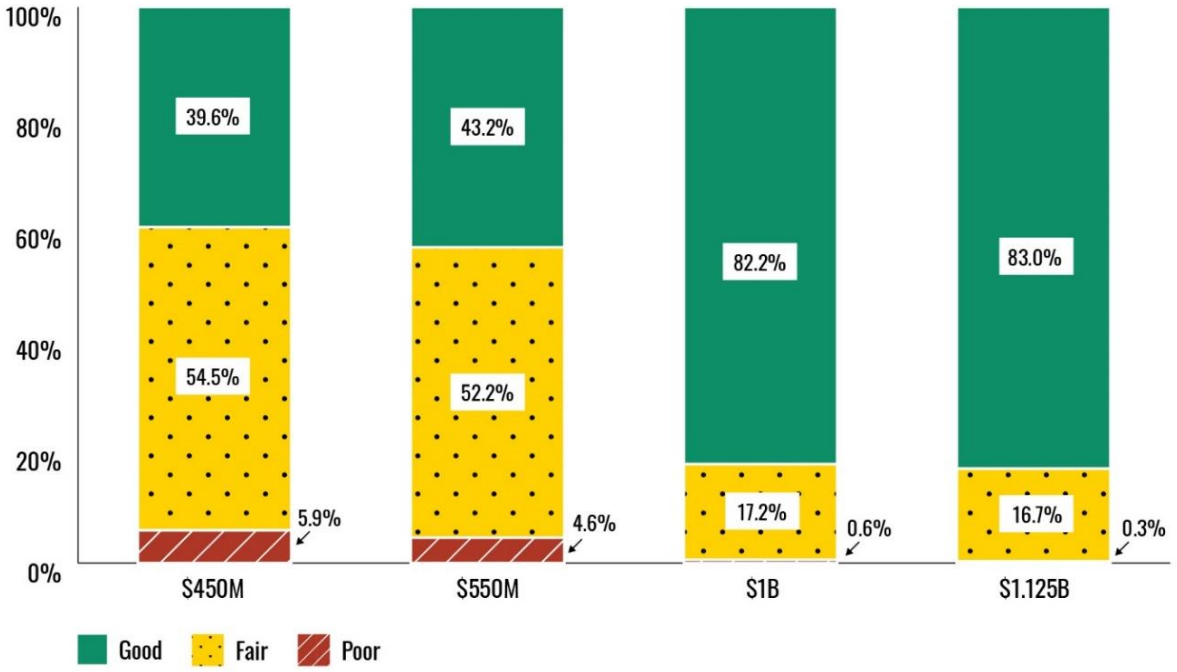
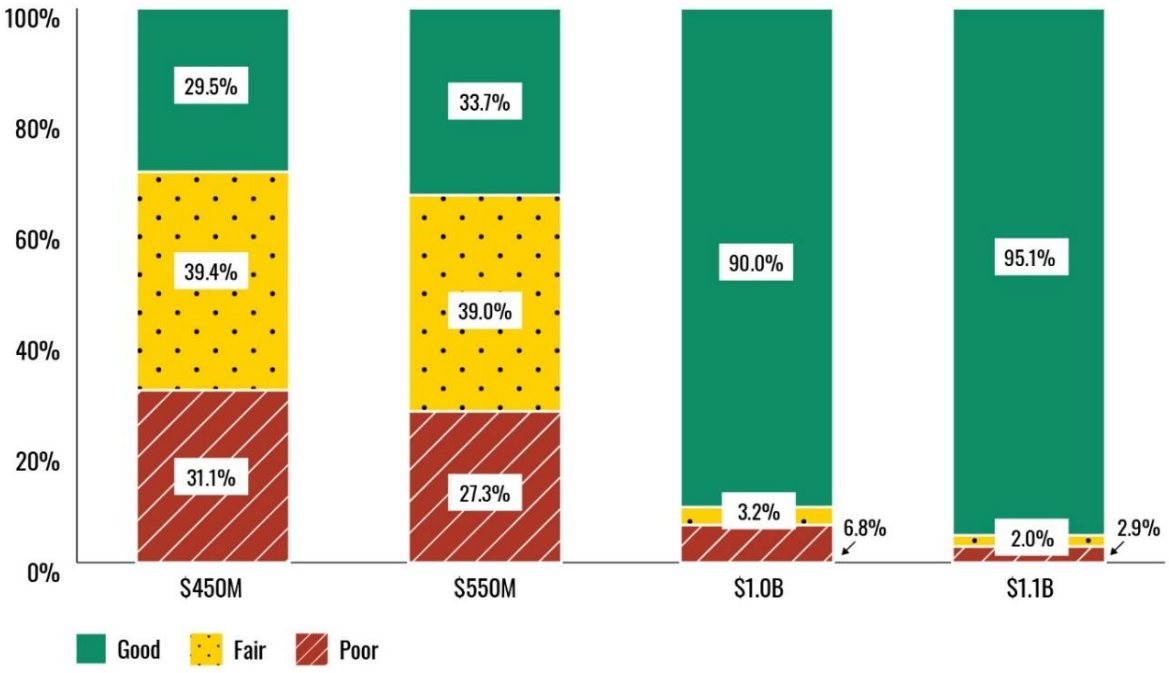



*Figure 7.10 Expected 2031 Non-Interstate NHS pavement conditions by average annual funding.*



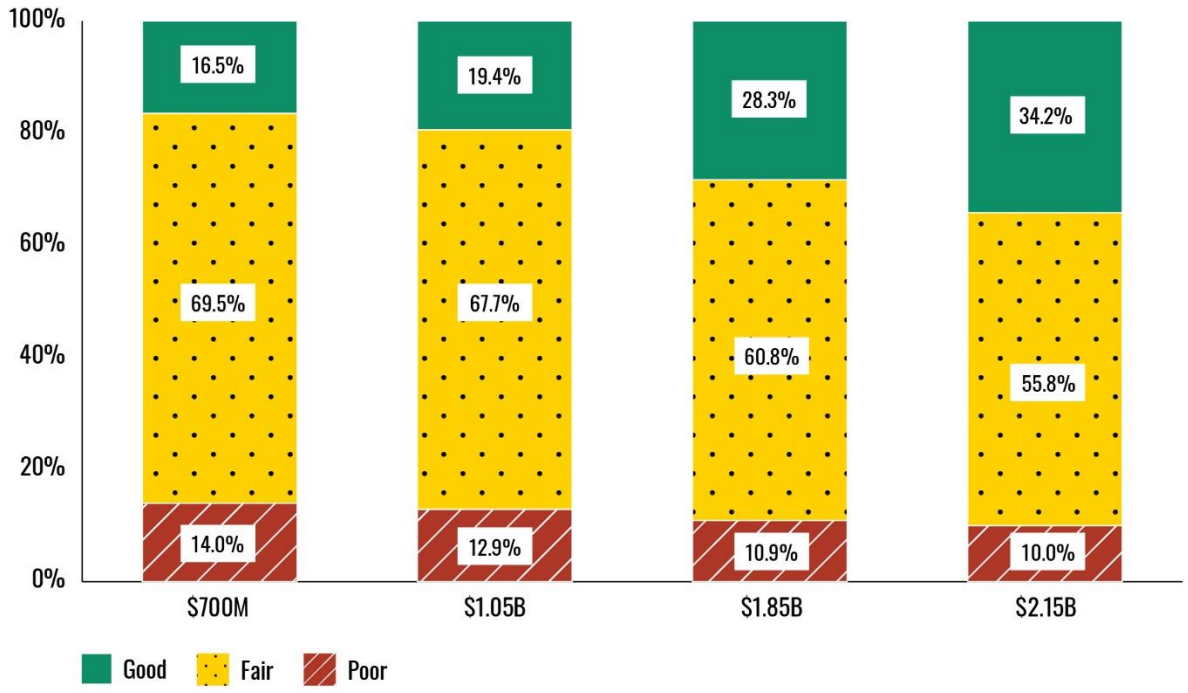
## Bridge Scenarios

Similar to pavements, NYSDOT reviews many funding scenarios for bridge assets on the State highway network. For the TAMP, the following four funding scenarios have been highlighted for structures on the NHS.

- **$700 million**—Current funding level.
- **$1.05 billion**—Funding range needed to stabilize the combination of fair-corrective and lower (using the State condition metrics) at the existing value of 40.7 percent.
- **$1.85 billion**—Amount needed to stabilize the percent Poor at the current value of 10.9 percent.
- **$2.15 billion**—Amount needed to achieve a state of good repair over the 10-year period, where the population of Poor bridges is reduced to and stabilized at 10 percent by deck area. This will also allow the State to be compliant with the new Federal minimum condition for NHS bridges, per 23 CFR 490.411.

The results of the bridge analysis are shown in figure 7.11, which shows a summary of bridge conditions for NHS bridges in the year 2031 that would result from each funding level. The projections were developed using the BMS and by applying the preservation-first logic where possible and the priorities described above.

*Figure 7.11 2031 NHS bridge conditions by average annual funding.*



# 8. Asset Management Improvements and Next Steps

The practice of asset management requires the comparison of alternatives to determine the best option. This is applied to every aspect of asset management practice including data collection, data management, tools, documentation, analysis, and decision-making. NYSDOT continually works through its asset management business units to improve the cost effectiveness of its practices and investments. This chapter identifies NYSDOT's priorities for future improvements to its asset management program and the TAMP.

## 8.1 RECENT IMPROVEMENTS

The State will continue to improve its investment strategies through improvements in data collection, modeling software, organizational efficiency, management of risks, and overall asset management capabilities to ensure that the State is making the best use of its available resources. To that end, NYSDOT has implemented an EAMS suite of applications including Structures Manager, Structures Analyst, Pavement Analyst, Roadway Inventory System, Portfolio Analyst, and a Maintenance Management System. The EAMS is built on one common linear referencing system and is linked to the Department's geospatial data warehouse. The warehouse is the system of record for the inventory of the most critical secondary assets including point and linear drainage, guiderail, and signs. By having a fully mapped inventory of pavements, bridges, and secondary assets, all maintenance activities can be recorded against these individual assets, enabling the generation of work histories for these assets. The warehouse also provides key source data for the agency's Maps and Apps portal, which is an agency-wide library of geospatially based applications that make these data widely available through this system of engagement. Other advancements made to support managing the State's bridge and pavement assets over the past 5 years include:

- Implementation of the capital program portfolio management system, or OPPM tool.
- Enhancement of the EAMS Software to include:
  - Enhancement of bridge management.
  - Enhancement of pavement management.
  - Maintenance management.
  - Portfolio analysis (cross-asset trade-off).
- Implementation of a new roadway inventory module, including:
  - Smart entry engine to reduce data entry effort.

    - Straight line diagramming tool.
    - New data warehouse to include secondary assets.
    - Allowance for dual carriageways.
  - Inventory collection of ancillary assets visible from the roadway.

## 8.2 ASSET MANAGEMENT CHALLENGES

There are profound and practical challenges ahead for New York State (and for much of the country) due to the aging of the transportation infrastructure, changing climate, and inadequate funding relative to the growing needs of the State's infrastructure assets. NYSDOT will continue to expand the capabilities of its asset management systems, practices, and staff to better enable the agency to meet the challenge of tomorrow. Improvements expected to be implemented by August 2026 include:

- Expanding the asset management program to understand decision-making processes and develop life-cycle strategies for assets beyond pavements and bridges.
- Developing a new bridge performance measure to more precisely rate the conditions and support the preservation needs of bridges in New York State.
- Advancing new technologies to make asset management systems easier to improve and adapt to changing priorities.
- Continue to expand the system of engagement to provide custom data input, offer solutions that reduce staff time and improve data quality, and make information more widely available for improved asset management decision-making.
- Improve coordination of capital construction programs and State maintenance forces to ensure work is being delivered in the most efficient manner.
  - Understand the type, extent, and location of others' assets in the DOT ROW.
  - Integrate maintenance, planning, programming, and engineering data.
  - Use electronic as-built plans and MMS work reporting to update asset inventory and condition data.
- Establish full data sharing (collect once for the enterprise).
- Improve the way construction contracts are developed and managed.
- Improve the efficiency of program delivery.

## 8.3 NEXT STEPS

Most of the initiatives described above are already underway. This section defines next steps that NYSDOT will take in order to improve its asset management program.

### Refine the Balance of Investments

Continue to refine the distribution of available resources between preventive and corrective maintenance versus system renewal and improvements. This will always be a fluid process. In the next 4 years NYSDOT will work to strengthen the linkage between risks and investments by better understanding:

- What risks might impact the funding available to the Department.
- What risks might impact how funding is distributed between assets and work types.
- What risks might lead to changing capital programming priorities.

## Continue to Develop a True Enterprise Asset Management System

Since 2019, NYSDOT has implemented pavement, bridge, and maintenance management systems and collected inventory of ancillary assets visible within the ROW. The EAMS now has the capability to optimize investment alternatives within and across multiple asset classes. In the next few years, NYSDOT will develop performance measures and life-cycle planning practices for assets other than pavements and bridges. With this advancement, investment optimization can be expanded to include additional assets and programs.

As the types and number of assets included in the EAMS inventory continue to expand, NYSDOT will need to implement more efficient means of entering and accessing data. Currently, very detailed asset information is created in the form of computer aided design and drafting (CADD) files and electronic construction acceptance forms used to design and construct highway projects. Unfortunately, these data are not collected or stored in a way that can easily populate or update asset inventory and condition datasets. As a result, after an asset such as a new pavement or bridge is inspected for construction acceptance it is again inspected to collect asset management data. NYSDOT is working in cooperation with the FHWA and other States to develop and implement standards for connecting design, construction, and maintenance and maintenance data to asset management data. These standards will allow data to be collected once for the enterprise instead of requiring redundant data collection processes. This is expected to both reduce the level of effort for collecting data and improve the quality of the collected data.

NYSDOT also recognizes that they are not the only organization with assets located in the highway ROW. Many public and private organizations have utility, communication, and other assets that intersect or parallel New York's highways within the ROW. NYSDOT is working to identify and track these assets. This will begin with the identification of an asset owner for these assets.

## Improve Condition Modeling and Forecasting

With the recent implementation of the Federal NPRM Performance Measures, the EAMS for pavements and bridges will need to develop new deterioration models, decision trees, and benefit calculations to accommodate the new metrics and targets. NYSDOT is also working toward being able to consider multiple decision trees that vary based on fiscal environment, treatment strategies, and program objectives. NYSDOT will be able to use these decision trees to create different scenarios that can be used to support resource allocation and programming processes.

The Department has begun to investigate how the use of National Bridge Element-based inspections will change how bridge needs modeling will have to be done in the future. *Research has been recently completed to support integrating the National Bridge Element data into the bridge management process. Moving forward, the Department will work to further evaluate this and also develop a condition-based performance measure.*

## Assess Non-Condition Related Trade-Off Impacts

Additional factors beyond condition outcomes need to be systematically considered in establishing an ideal program balance. Factors that should be considered in making trade-off decisions include bridge closures and postings; maintenance costs; roads deteriorating to a point where they can no longer be plowed or traveled at the posted speed (Very Poor roads); impacts to associated assets such as safety appurtenances, bicycle routes or sidewalks;

economic impacts to businesses and freight efficiencies; mobility and congestion; resiliency; flood vulnerability; and any other quantifiable impacts. NYSDOT will evaluate these options to determine which can become systematically measured and used in decision making.

## Improve Program Balance for Optimal Sustainability

The primary goal of the current pavement and bridge program is to preserve the condition of as much of the system as possible. NYSDOT will continue to investigate options for assessing additional impacts of programming decisions such as social, economic, and environmental consequences to create a highway system that is sustainable not just in terms of asset conditions levels but also in regard to supporting sustainable communities. NYSDOT will seek to address and respond to climate change through infrastructure resiliency and preparedness to minimize the impacts of anticipated increased flooding and heat extremes. The use of LiDAR models will be evaluated for predicting flood risk or vulnerability. These models can help in understanding the interconnection between watersheds and highway corridors. This work will be done in coordination with the New York State Climate Action Plan.

## Determine Best Mechanism to Complete Work

Determining the best delivery mechanism for maintenance work starts with understanding the type of maintenance work that is needed. For newer assets, maintenance consists of actions such as sealing pavement cracks or bridge decks that delay the onset of deterioration to extend service life. However, assets in poor condition require maintenance activities to keep the highway operating safely and efficiently, such as pothole patching or bridge deck repairs. NYSDOT will continue to evaluate system conditions and overall work needs to determine the most appropriate maintenance work.

There is currently very little connection from a cost effectiveness perspective of what types of work activities should be done by in-house State maintenance forces, by simple service contracts, or by full Department-led heavy construction contracts. NYSDOT is aware that certain bridge maintenance activities like element-level corrective bridge repairs, repairs to short runs of damaged guiderail, and painted pavement markings are done at much lower cost by State forces than by contractors, while production type work like highway paving, major bridge rehabilitation or replacements, and production guiderail installation are done more effectively and efficiently by contractors. By having State forces do work that is not cost effectively done by contract leaves more contract dollars available to do the types of work contractors do best, thereby making more optimal use of available funding.

## Implement Countermeasures to Identified Risks

Chapter 6 of this document summarizes the key risks to the State's highway and bridge assets and NYSDOT's ability to manage those assets effectively. The key identified risks include climate change, the need for data-driven decision-making, organizational issues, program balance, funding, inflation, demographic changes, and understanding the key corridors for critical transportation purposes like commerce; tourism; commuting; emergency response and evacuation; pedestrian and bicycle use; and mass transit. NYSDOT will dedicate resources to either evaluate or act on the countermeasures identified in the Risk Register.

## Improve Reliability of Program Delivery

With the implementation of OPPM since 2020, the Department is now able to calculate and report on the benefits from specific projects or phases of projects that contribute toward

specific program and programmatic goals. In addition, project data can now be linked to the latest condition, safety, and maintenance data. Moving forward, NYSDOT will leverage OPPM's capabilities to link project data to the Department's suite of mapping tools to better communicate program goals, objectives, and accomplishments with internal and external stakeholders and partners.

## Develop and Implement Tools to Keep Asset Management Data Up to Date

Asset inventory and condition data have been obtained by a Statewide assessment linked to pavement inventory and condition updates. As maintenance and construction activities change the inventory or conditions of those assets, the Department is developing tools to keep these current, including:

- Creating a specification that all construction contracts should use field mapping tools provided by NYSDOT to update assets impacted by construction activities.
- Providing field map applications to maintenance managers to update inventory and conditions impacted by maintenance activities.
- Developing CADD standards to update asset inventories directly from as-built plans.
- Developing a mobile application to allow field staff to update the inventory of system vulnerabilities.

# Appendices

# Appendix A – List of Acronyms

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| ADA | Americans with Disabilities Act |
| Ag | General Alligator Cracking |
| AM | Asset Management |
| ASI | Asset Sustainability Index |
| BIL | Bipartisan Infrastructure Law |
| BMS | Bridge Management System |
| CADD | Computer Aided Design and Drafting |
| CAV | Connected and Automated Vehicles |
| CHIPS | Consolidated Local Street and Highway Improvement Program |
| CMAQ | Congestion Management Air Quality |
| CPDC | Capital Program Delivery Committee |
| CPT | Comprehensive Program Team |
| CPU | Comprehensive Program Update |
| CR | Condition Rating |
| CRRA | Community Risk and Resiliency Act |
| DHBTF | Dedicated Highway and Bridge Trust Fund |
| EAMS | Enterprise Asset Management System |
| ER | Emergency Relief |
| FHWA | Federal Highway Administration |
| FTA | Federal Transit Administration |
| GHG | Greenhouse Gas(es) |
| GIS | Geographic Information System |
| HELP | Highway Emergency Local Patrol |
| HMA | Hot Mix Asphalt |
| HSIP | Highway Safety Improvement Plan |

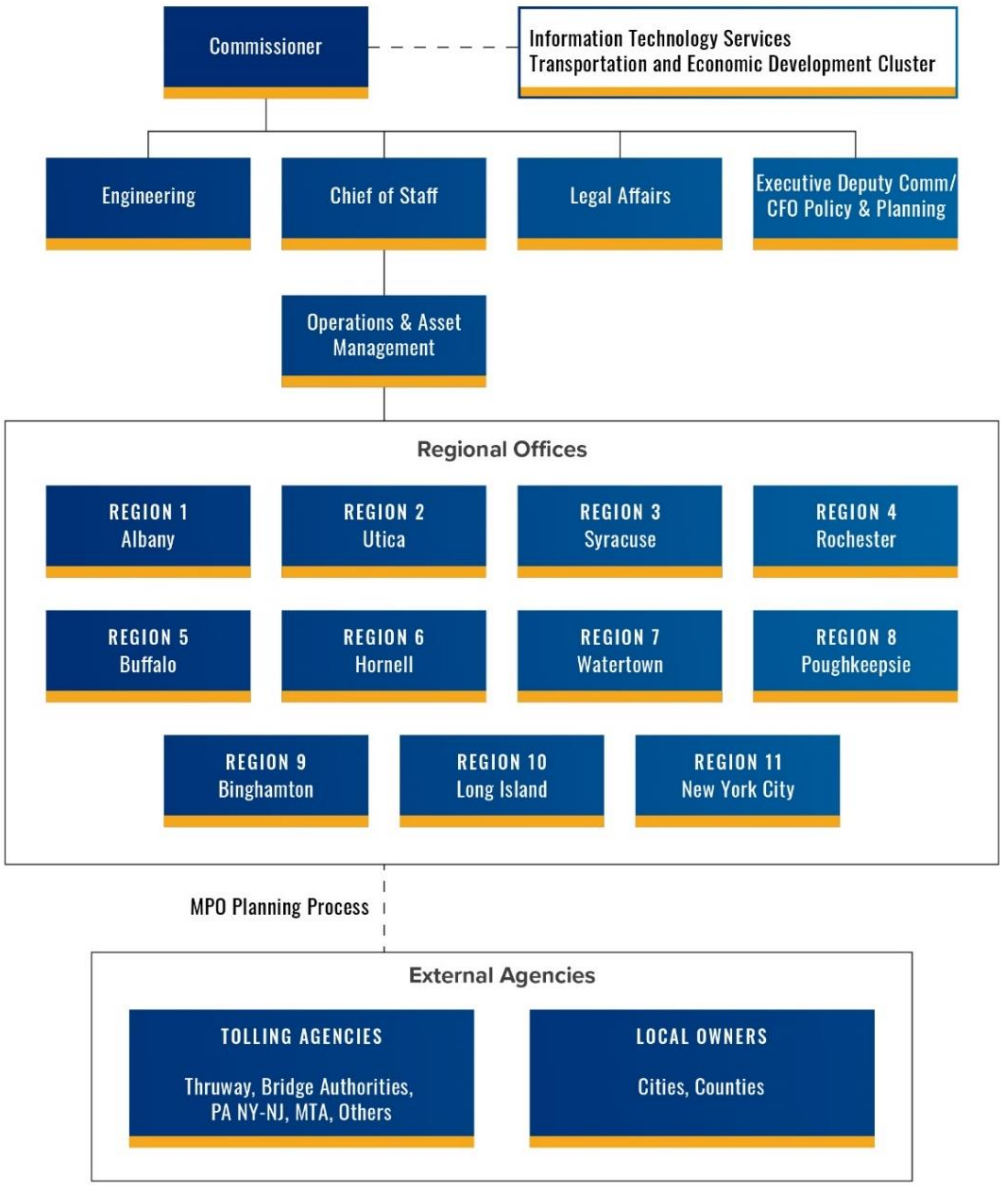
| | |
|---|---|
| IRI | International Roughness Index |
| ISO | International Organization for Standardization |
| IT | Information Technology |
| ITS | Intelligent Transportation System |
| LDV | Light Duty Vehicles |
| LM | Lane-Miles |
| MAP-21 | Moving Ahead for Progress in the 21st Century Act |
| MMS | Maintenance Management System |
| MPO | Metropolitan Planning Organization |
| MTA | Metropolitan Transit Authority |
| NBI | National Bridge Inventory |
| NHFP | National Highway Freight Program |
| NHS | National Highway System |
| NPRM | Notice of Proposed Rulemaking |
| NYSAMPO | New York State Association of Metropolitan Planning Organizations |
| NYSDOT | New York State Department of Transportation |
| NYSTA | New York State Thruway Authority |
| OPPM | Oracle Primavera Portfolio Management |
| PCC | Portland Cement Concrete |
| PDI | Pavement Distress Index |
| PMS | Pavement Management System |
| PSR | Pavement Serviceability Rating |
| RAMT | Regional Asset Management Team |
| ROW | Right of Way |
| RPC | Regional Program Committee |
| SAMT | Statewide Asset Management Team |
| Sg | General Spalling |
| SOGR | State of Good Repair |
| STIP | Statewide Transportation Improvement Program |
| TAM | Transportation Asset Management |
| TAMP | Transportation Asset Management Plan |
| TAP | Transportation Alternatives Program |
| TIP | Transportation Improvement Program |

| | |
|---|---|
| TMC | Traffic Management Center |
| TSMO | Traffic Systems Management and Operations |
| VMT | Vehicle Miles Traveled |
| Wh | High-Severity Widening Dropoff |

# Appendix B – NYSDOT's Organizational Structure

NYSDOT's organizational structure is shown in figure B.1.

*Figure B.1 NYSDOT organizational chart.*



# Appendix C – NYSDOT Asset Management Business Units

As described in chapter 4, NYSDOT's asset management business structure is an assembly of cross-functional teams. This appendix documents the description, mission, responsibilities, and membership listing of each of the groups and components of NYSDOT's asset management business structure. An overview of the business structure is provided in chapter 2.

## CPDC

The CPDC, headed by the Commissioner of Transportation and consisting of executive-level and other key staff, provides strategic vision and executive leadership for asset management.

### Mission

- Develop and communicate a vision for a sustainable transportation system to support a vibrant New York State economy.
- Ensure asset management strategy and policy is in harmony with long-term strategic plans and Statewide economic development policy.
- Create an environment in which the most effective program of projects is selected and delivered on time and on budget.

### Responsibilities

- Approve of all asset management policies and standards that impact external stakeholders.
- Manage communications with external stakeholders.
- Set expectations for CPU and STIP updates.
- Approve final program.

### Membership

- Commissioner.
- Executive Deputy Commissioner.
- Chief Financial Officer.
- Assistant Commissioner for Operations and Asset Management.
- Chief Engineer.
- Director of Regional Planning and Program Management.

# CPT

The CPT provides Statewide leadership on CPU policies, practices, tools, and investments. Since its inception, CPT has been chaired by the Program and Project Management Champion. CPT has been established to foster a connection between program development and program delivery.

## Mission

- Bring leaders from across the Agency together to direct asset management policies and effort.
- Establish policy to achieve CPDC's vision.
- Recommend deliverables for CPDC approval.
- Develop and articulate an investment strategy, framework, and process to preserve and manage the multimodal transportation assets of the State in a manner that is economically, environmentally, and socially sustainable. Elements include:
  - Asset management business structure and process: definitions, descriptions, roles, and responsibilities.
  - Investment strategy definition.
  - Accountability definition.
  - Immediate focus: augmenting program update instructions.
  - Create a standard asset management business structure and process using existing titles to staff permanent asset/goal teams.
- Serve as an advocate and provide guidance for the SAMT.
- Issue Asset Management Manuals as appropriate.
- Define objectives and strategies for preservation—both preventive and corrective maintenance.
- Recommend performance measures and review performance of RAMTs.
- Align NYSDOT's asset specific management efforts across engineering, operations, and policy and planning.
- Develop and share best practices across SAMTs.
- Recommend policy and procedure modifications to improve project development and delivery.
- Provide an advocacy role with FHWA on policy and procedural matters relating to asset management.

## Responsibilities

- Prepare draft Program Update Instructions.
- Prepare draft STIP Update Instructions.
- Develop and oversee the continual improvement of the TAMP.
- Prepare and manage asset management Risk Register.
- Recommend actions to be taken on submitted programs and projects as detailed in the Comprehensive Program and/or STIP Update Instructions.

## Membership

In general, members should be main office bureau directors, regional group directors, or higher in rank. The following is a list of organizational units that should be represented on the CPT:

- Assistant Commissioner for Operations and Asset Management.
- Assistant Commissioner for Policy and Planning.
- Chief Engineer.
- Director of Regional Planning and Program Management.
- Chief Financial Officer.
- SAMT Co-Chairs.
- At least 1 Regional Director.

# STATEWIDE ASSET MANAGEMENT TEAMS

Statewide SAMTs have been established for specific asset classes and functions: pavement, safety and operations, structures, and sustainability. Each team will establish a charter that clearly articulates the assets managed, mission, purpose, composition, meeting frequency, and roles and responsibilities.

## Mission

Each Statewide team shall be responsible for the management of their specific asset class from a Statewide perspective. The focus includes maintenance and operations, preservation, and capital program actions necessary to efficiently manage the State's assets. The teams are established in support of the overall strategy and asset management priorities provided by the CPT. The specific mission of the group is to:

- Bring technical experts from across the Agency together to direct asset management policies and efforts.
- Establish practices and tools to achieve CPDC's vision.
- Provide CPT with input to program update guidelines.
- Prepare a uniform approach to estimating accomplishments associated with block funded projects.
- Propose operational impairment (i.e., bridge posting) tradeoffs for less important assets if necessary to fund higher priority investments.
- Analyze deliverables for CPT recommendations.
- Serve as an advocate and provide guidance for the RAMTs.
- Coordinate cross-organizational actions as necessary to advance asset management practices.
- Recommend objectives and strategies for preservation—both preventive and corrective maintenance.
- Review performance of RAMTs.
- Develop measures and indices to advance objective systems-based decision-making.
- Provide a forum for sharing best practices and addressing issues and concerns related to each team's area of focus.
- Identify and promote best practices to improve project development and delivery.
- Support CPT in their advocacy role with FHWA.

## Responsibilities

- Draft technical guidance for CPU and STIP updates.
- Propose quantifiable prioritization criteria to be used by regional asset management teams in capital program development. Where possible, criteria should incorporate

both asset condition and operational performance characteristics. Priorities should be ranked from most important to least important (short- and long-term tasks).
- Develop necessary measures, forms, and submission tools for CPU and STIP updates.
- Provide leadership and guidance to Regions in complying with asset management policies and directives.
- Analyze CPU and STIP deliverables to advance consistency with overall goals, objectives, and strategies as established by the CPT.
- Recommend the approval of individual Regional comprehensive programs and capital investment projects to the CPT.
- Gather Regional feedback on asset management policies, directives, requirements and tools, and recommend improvement actions to CPT.
- Establish a charter that clearly articulates the assets managed, mission, purpose, composition, meeting frequency, and roles and responsibilities.
- Set requirements for RAMT charters.

### Membership

SAMTs are assembled of managers and technical experts in the areas of pavement, safety and operations, structures, and sustainability. Teams are diverse in areas of expertise and geography (i.e., main office and regional employees). The chair or at least one co-chair of each team will be a member of the CPT. SAMTs will typically have approximately twelve members.

In general, SAMTs are comprised of:

- Main Office: Policy and Planning.
- Main Office: Operations.
- Main Office: Engineering.
- Regions: Two or more Regional asset team representatives.
- Information Technology Services and Transportation and Economic Development Cluster: database and GIS support as needed.

## REGIONAL ASSET MANAGEMENT TEAMS

RAMTs are responsible for programming decisions related to their specific areas of responsibility: pavement, safety and operations, structures, and sustainability. The teams work under the direction of the RPC. RAMTs are shown in figure C.1 as subordinate to Statewide teams in that they receive some goals and functional guidance from Statewide teams.

### Mission

The mission of RAMTs is to take ownership of the region's achievement of targets within their respective program area, lead project selection processes, and manage delivery of projects to ensure the achievement of program targets and support the SAMT mission to develop and disseminate best practices.

### Responsibilities

- Prioritize capital investment and preservation project candidates for recommendation to RPC.
- Lead regional efforts to develop CPU and STIP updates.

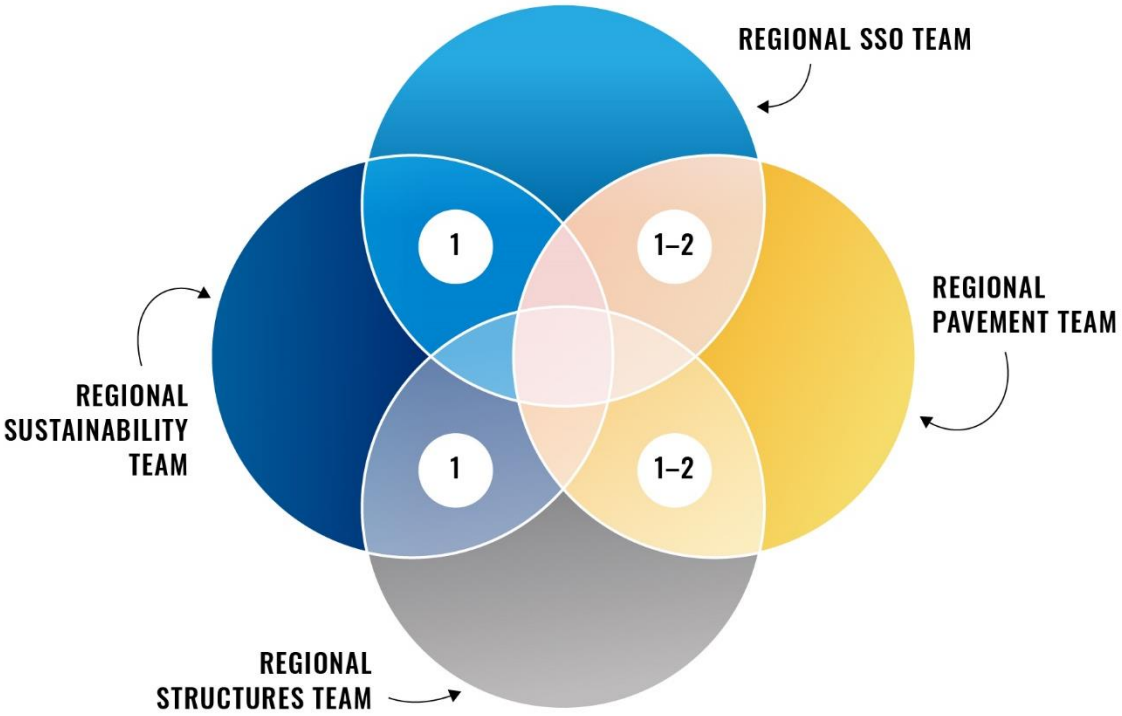
- Select projects for capital investment and develop any necessary submittal documentation.
- Oversee delivery of Region's program to optimize return on investment for the program, not individual projects.
- Establish a team charter according to SAMT directions.
- Perform additional program-specific responsibilities as identified in team charters.

*Figure C.1 Regional program committee components.*


## Membership

Membership varies by program area and Region. Figure C.2 presents guidelines for membership on each team showing program areas that should be represented. Typically, RAMTs will have four to nine members. Typical membership composition is described in the following bullets.

*Figure C.2 Regional asset management team cross-participation.*



- Regional Structures Team:
  - Regional Structures Engineer.
  - Regional Structures Management Engineer.
  - Regional Bridge Maintenance Engineer.
  - Planning and Program Management.
  - Representative from Sustainability Team.
  - Representative from Safety and Operations Team.
- Regional Pavement Team:
  - Maintenance.
  - Pavement Manager/Modeler.
  - Materials.
  - Highway Design.
  - Representative from Sustainability Team.
  - Representative from Safety and Operations Team.
- Regional Safety and Systems Operations Team:
  - Traffic Safety.
  - Traffic Operations.
  - Maintenance.
  - Highway Design.
  - Representative from Sustainability Team.
  - Representative from Pavement Team.
  - Representative from Structures Team.
- Regional Sustainability Team:
  - Sustainability Team Leader.
  - Cross-discipline representation.
  - At least one member shared with each of the other regional teams.

# Appendix D – Asset Sustainability Index

The word "sustainability" is used in many different contexts and NYSDOT has a formal definition for the concept that includes considerations such as generational equity, environmental impacts, and balanced transportation options. The discussion below is more narrowly focused on the ASI, defined as an index comparing a given level of resource investment with the underlying asset need.

A basic economic notion behind asset management is the idea that assets deteriorate from use and exposure to environmental factors such as the forces of water, various weather conditions, and age. That loss can be quantified as a "need," or amount of asset value lost through deterioration. That loss is counter balanced through investment in restoring asset conditions and functionality. The ASI evaluates the balance between the needed and actual level of funding to indicate the overall health of an agency's asset management program. The index, as follows, is simply the amount of money budgeted that directly impacts asset conditions divided by the amount needed to restore the asset. An ASI value of 1.0 indicates that the asset is economically sustainable. Values lower than 1.0 indicate under investment which will lead to declining asset conditions.

ASI = Amount Budgeted ($/year)/Amount Needed ($/year)

Currently the ASI for State highways and bridges combined is 0.35. That indicates that no matter how sophisticated the treatment strategy that an agency uses, the funding alone is inadequate to sustain the current portfolio of assets that the State owns.

Before the accounting exercise associated with tabulating investment levels or asset needs, any computation of an ASI must first set the boundaries being considered with a clear definition of:

- **System Extent:** Whether the whole system is being considered, or just a subset of it, such as bridges. System extent may also be used to reflect variations in system ownership, such as between a State and array of local municipalities or geographic variations.
- **Performance Metric:** Used to characterize the system being evaluated. For the example of bridges, this might be the fraction of the system that is characterized by a certain condition metric, such as percent Structurally Deficient under the Federal definition.
- **Level of Service:** Performance goal or target associated with the system under consideration. The two basic infrastructure cases that might be considered include:
  - **Status Quo or Steady State:** Maintaining current level of service.
  - **State of Good Repair (SOGR):** Improving level of service to ideal.
- **Time Horizon:** Period of analysis over which the performance target must be reached or maintained.

NYSDOT has traditionally characterized the performance of major assets like pavement and bridges in terms of an operational component and a condition component.

The most recent detailed assessment of major asset needs was conducted as part of the 2022 CPU. This effort relied on the detailed bridge and pavement modeling tools, all project costs, and all work types for each asset. This effort showed needs assessments in construction costs yielding an approximate ASI value of 0.35, as shown in Table D.1 below.

*Table D.1 Asset sustainability index—NYSDOT bridges and pavements.*

| Asset | State of Good Repair ($ millions) | Anticipated Investment Level ($ millions) | Asset Sustainability Index |
|---|---|---|---|
| Bridge | $2,150 | $700 | 0.33 |
| Pavement | $1,125 | $450 | 0.40 |
| Combined | $3,275 | $1,150 | 0.35 |

# Appendix E– Processes for Forecasting Pavement and Bridge Conditions in Terms of the National Performance Measures

## Process for Forecasting Pavement Conditions in Terms of the National Performance Measures

Pursuant to new Federal requirements, NYSDOT forecasts Interstate NHS and non-Interstate NHS pavement conditions to establish 2- and 4-year pavement targets. At the time the current targets were set, not all data needed to calculate the Federal metrics had matured, so calculated data were used to supplement actual historical data.

As mentioned in chapter 2, FHWA has recently instituted new data collection requirements, using automated crack detection methods. NYSDOT currently does not have enough automated distress data to develop new deterioration curves or provide treatment recommendations in models using these new measures. The existing pavement management system, like most systems in use, relies on legacy condition indices to do modeling. The State currently uses the New York State Condition Rating to assess the amount of cracking in the pavement. This means that existing models cannot be used to forecast conditions using the new Federal metrics, which are required to set adequate condition targets on the NHS to meet 23 CFR 490 Subpart C.

After consultation with FHWA, NYSDOT decided to use its percent Poor and percent Very Good and Excellent as surrogates for the Federal percent Poor and percent Good measures, respectively. Pavement management sections rated Poor by NYSDOT's standard will typically have fatigue-type cracking in the wheel path throughout most of the section, as well as poor ride quality or rutting. In contrast, pavement management sections rated Very Good and Excellent by NYSDOT's standard will typically have minimal to no cracking in the wheel path while exhibiting good ride quality and minimal rutting.

In addition, this new pavement condition data are currently collected and stored on 0.1-mile-long sections. Because NYSDOT's PMS, like most in the country, uses pavement management

sections longer than 0.1 miles, there is no direct correlation to the Federal condition metrics that are reported on 0.1-mile increments and the forecast conditions from a given PMS analysis. For example, if a given mile of roadway has two 0.1-mile-long segments that are rated Poor but the remaining eight segments are rated Fair, then when the average condition of the combined one-mile project-level segment is calculated, the entire mile would be rated Fair. The two-tenths of Poor pavement would disappear from the data, reducing the overall amount of Poor pavement in the system.

To account for differences between the Federal measures on 0.1-mile segments and the averaging that occurs for pavement management sections, NYSDOT calculated the differences in percent Poor and percent Good between the 2020 Federal report card and NYSDOT's data, as shown in table E.1. The differences were calculated independently for Interstate NHS and non-Interstate NHS separately to account for the differences in how those pavements deteriorate. The differences are assumed to remain relatively constant over the span of a given modeling scenario.

*Table E.1 Pavement performance measures.*

| NHS Type | National Performance Measures for Pavement Condition (2020) | | NYSDOT Pavement Sufficiency Score (2020) | | Delta (Fed Rep—NYSDOT) | |
|---|---|---|---|---|---|---|
| | % Good | % Poor | % VG/E | % Poor | % Good | % Poor |
| Interstate | 45.3 | 1.1 | 34.2 | 1.8 | 11.1 | -0.7 |
| Non-Interstate | 18.9 | 7.6 | 25.3 | 7.5 | -6.4 | 0.1 |

For example, once the 0.1-mile sections on the Interstates are rolled up to project length sections, there is a drop of 0.5 percent in percent Poor. To account for this drop, an additional 0.5 percent Poor is subtracted to forecasted Poor conditions from any model run in regard to the NPRM target setting.

All NHS pavement segments, regardless of ownership, were loaded into the PMS along with the projects in the current STIP to be considered in the target setting analysis. A PMS scenario was run using the committed projects and projected funding. Constraints related to IRI, rutting, faulting, and cracking (i.e., surface score) were included for Interstates to set the constraint to a maximum of five percent Poor lane-miles. The results of this analysis are shown in tables E.2 and E.3.

*Table E.2 Interstate NHS—final performance measure.*

| Federal Rating | Current (%) | 2023 Interim Target (%) | 2025 Target (%) | 10 Year Projection (%) |
|---|---|---|---|---|
| Good | 45.3 | 53.2 | 54.3 | 50.7 |
| Fair | 53.6 | 45.4 | 44.0 | 45.1 |
| Poor | 1.1 | 1.4 | 1.7 | 4.2 |

*Table E.3 Non-Interstate NHS—final performance measure.*

| Federal Rating | Current (%) | 2023 Interim Target (%) | 2025 Target (%) | 10 Year Projection (%) |
|---|---|---|---|---|
| Good | 18.9 | 22.3 | 20.7 | 23.1 |
| Fair | 73.5 | 68.4 | 68.4 | 39.4 |
| Poor | 7.6 | 9.3 | 10.9 | 31.2 |

When running NYSDOT models to set targets and predict future conditions, a single amount of funding is used for the entire NHS, and NYSDOT's endorsed preservation strategy is used to direct investments toward lower-cost, maintenance-type treatments on Good pavements, thereby optimizing system conditions with the available funds. However, to ensure compliance with the Federal Interstate pavement condition threshold, NYSDOT was forced to use a tiered approach, treating Interstate NHS and non-Interstate NHS pavements differently. For Interstate NHS pavements, the analysis was constrained by IRI, rutting, faulting, and cracking (i.e., surface score) in a manner that directed investments toward Poor pavements—essentially a worst-first approach.

Because of this tiered investment approach and the Federal worst-first strategy toward Interstates, overall NHS conditions deteriorate more quickly than if NYSDOT used a Maintenance First strategy for all pavements. In years 5-10 of the analysis, the model directs more and more of the available funding to the Interstate system, regardless of the actual VMT on the roadway, in order to meet the Federal percent Poor threshold. This is at the expense of doing preservation work on the non-Interstate NHS, which sees a drastic increase in percent Poor pavement between years 5-10 of the analysis. At current funding levels, conditions on Interstate NHS pavements decline marginally, but conditions on non-Interstate NHS pavements decline precipitously with percent Poor pavement jumping from 6.1 percent to 31.1 in 10 years. Further, this worst-first approach on the Interstates directs, on average, almost fifty percent of the available funding toward only thirty percent of the NHS pavement system.

## Process for Forecasting Bridge Conditions in Terms of the National Performance Measures

The Statewide bridge team used the latest condition data for each structure to perform the analysis. All NHS structures in the State were part of the analysis. The model calculates work strategies for all analyzed structures that depend on Component Condition Indices based on current AASHTO element data converted into legacy logic. Work strategy types include preventive maintenance (e.g., bridge painting, cleaning, joint resealing, deck sealing, and overlays), rehabilitation (e.g., element level repair work, deck replacement, general rehabilitation, and repairs), and renewal (e.g., structure and superstructure replacement). The program prioritizes work based on Bridge Priority Index (which is a weighted index that takes the structure condition), the operational function, and the vulnerability aspects of the structure into account. The analysis also includes deterioration of the bridge components. Like pavements, projects from the STIP were used in the Federal target setting analysis.

Once modeling was complete, structures were sorted into NYSDOT condition categories (Good, Fair Protective, Fair Corrective, and Poor). TAMP/NPRM requires reporting in NBI rating (a 0-9 scale) based condition categories (Good, Fair, and Poor). In continuation of practice reviewed and approved by FHWA, a translation was performed using base year data for correlating State categories to NBI categories. To verify the consistency of this approach, NYSDOT previously performed an analysis of variability over the NPRM recording requirement timeframe (4 years) and the overall TAMP timeframe (10 years). Conveniently, the correlation was excellent at the 4-year timeframe, however consistency decreased at the 10-year mark. This long-term inconsistency is expected due in part to the differing deterioration modeling strategies. NYSDOT is currently in the process of creating both an AASHTO element and NBI component for deterioration curves which will help alleviate this concern in the future.

As mentioned in Chapter 2, NYSDOT uses several metrics to report on bridge conditions, most notable a traditional NYSDOT metric converted to use an AASHTO element of data. Converting from AASHTO element data to NYSDOT component data for modeling, then again converting NYSDOT condition categories to NBI categories will cause variability in results and therefore must be noted. In addition, there are several modeling issues that particularly affect short-term modeling consistency. Most notably, use of a by-area metric. While this is certainly appropriate for overall performance, it generally results in chaotic and unpredictable changes to performance due to the non-discrete nature of bridges, as individual bridges are quite large (some more than one percent of the NHS deck area, individually), and individual structures change performance unpredictably. Further, the modeling system does not consider the delay in completion of a construction project from its programmed date and assumes the project is completed instantaneously. This is particularly vexing due to several very large projects on the STIP. The overall effect of this issue will cause modeled conditions to appear better than actual conditions in the short term. These limitations, at the system level, are addressed in the risk matrix and in setting the targets at the end of the 4 years.