GEORGIA DEPARTMENT OF TRANSPORTATION

Transportation Asset Management Plan

FY 2019 – 2028

GDOT
Georgia Department of Transportation

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Executive Summary

Georgia's Transportation Asset Management Plan (TAMP) defines the condition of the state's pavements and bridge structures, including culverts over 20' in length, on the National Highway System (NHS). This TAMP outlines the priorities and strategies used to cost effectively manage and preserve these assets over the next 10 years.

What are our assets?

GEORGIA State Route System		GEORGIA NHS *Covered in TAMP*	
17,940 Centerline miles	6,750 Bridge Structures	7,100 Centerline miles	4,050 Bridge Structures

What condition are our assets in?

NHS Bridge Condition As of Feb. 2019

52% Good | **47%** Fair | **1%** Poor

2-year Target: **≥50%** ✓ — 2-year Target: **≤10%** ✓
4-year Target: **≥60%** ✗ — 4-year Target: **≤10%** ✓

Interstate Pavement Condition 2018

63% Good | **37%** Fair | **0%** Poor

2-year Target: **≥50%** ✓ — 2-year Target: **≤5%** ✓
4-year Target: **≥50%** ✓ — 4-year Target: **≤5%** ✓

Non-Interstate NHS Pavement Condition 2018

42% Good | **57%** Fair | **1%** Poor

2-year Target: **≥40%** ✓ — 2-year Target: **≤12%** ✓
4-year Target: **≥40%** ✓ — 4-year Target: **≤12%** ✓

What are the requirements of this TAMP?

This TAMP meets the requirements of Title 23 Code of Federal Regulations (23 CFR) §515 (which defines compliance with 23 USC 119(e)). This regulation defines the processes and minimum requirements that a State Department of Transportation (DOT) must use to develop a TAMP.

How do we make decisions about when and how to invest?

The Georgia Department of Transportation (GDOT) monitors assets over their lifespan and applies preservation and rehabilitation activities to extend their lives at a lower cost over the long term. For both pavement and bridge assets, GDOT utilizes life-cycle planning that includes analyzing asset deterioration rates and employing a wide range of treatment types that ensure the most appropriate maintenance activities are applied at the right time.

Pavement Management: Across Georgia's entire 17,940 centerline miles of the State Route System (SRS), GDOT uses computer models to predict future pavement conditions and to identify the most cost-effective means of treating pavements with available funding. The Department's Pavement Management System (PMS) establishes long-term life-cycle strategies for pavements and uses those strategies to inform project selection. GDOT is currently implementing a new PMS, Deighton Total Infrastructure Management System (dTIMS) which will be used to establish long-term strategies, support life-cycle planning and inform selection of treatments for delivery within a short-term program.

In 2018, GDOT set two- and four-year condition targets for the NHS as required by the National Highway Performance Program (NHPP). These targets were set based on a review of the Highway Performance Monitoring System (HPMS) data and comparing it to current and historical funding levels.

For the full SRS (including the NHS), GDOT uses and reports a comprehensive pavement rating measure, called the Overall Condition Index (OCI) as a basis for decision making. The use of OCI began in 2019, replacing the previous Computerized Pavements Condition Evaluation System (CoPACES) rating. GDOT is currently in the process of updating the summary definitions for pavements in good/fair/poor conditions based on the OCI measure. Once these are developed, they will be utilized to set performance targets for all SRS pavements.

Bridge Management: With the average age of NHS bridges at 46 years, which is close to the designed service life of 50 years for most GDOT bridges, GDOT employs life-cycle management practices and effective preservation techniques to extend their service life.

GDOT uses a Bridge Management System (BMS) to track its bridge condition data and to support the planning of bridge preservation work across the 6,750 bridge structures on the SRS. The Department is currently implementing AASHTOWare Bridge Management (BrM), which analyzes condition at two levels of detail—National Bridge Inventory (NBI) components and American Association of State Highway Officials (AASHTO) elements. It uses a probabilistic model to estimate the fraction of a population of elements in each condition state at any future point in time. Because GDOT has 25 years of NBI component-level data, only this first level of data was utilized in the initial model development. The AASHTO element-level data is more precise; however, this level of data is limited to four years. As more data is collected, GDOT will be able to further refine the BMS.

Nationally, Georgia's NHS bridge condition is better than average; 52% of bridges are in good condition. Only 1% of bridges are in poor condition which surpasses federal minimum condition levels and is considerably better than most. With recent analysis indicating that the percentage of bridges in good condition declined from 2012-2018 while the percent of those in poor condition improved, GDOT has established an enhanced bridge program to achieve its goal to reverse the decline of bridges in good condition. This goal is reflected in the current NHPP two- and four-year targets for bridges.

Alignment with Other GDOT Planning Initiatives: GDOT is currently updating the GDOT 2050 Statewide Transportation Plan (SWTP) / 2020 Statewide Strategic Transportation Plan (SSTP). The investment strategies and decision-making processes presented in this TAMP will be reflected in both plans.

What are our top risks?

Risk management within this TAMP focuses on risks that could potentially limit the Department's ability to deliver the investment strategies in this document, and ultimately to deliver service to SRS and NHS users. GDOT established its risk management process and developed an enterprise-wide risk register covering three risk groups: enterprise / agency risks, program risks and project / activity risks. Each risk was assigned a consequence level, resulting in three High-consequence risks – the first two at the enterprise / agency level and the third at the program level:

1 **Funding Restrictions:** If there are legislative changes to fuel tax and areas in which it can be spent (opportunity and risk) it can increase/ decrease available funding.

2 **Delay in Federal Funding:** If there is federal budget uncertainty (timing) caused by a delay in Congress passing a full year funding bill, this can result in a delay in delivering projects and reduce the capacity to deliver within the financial year.

3 **Extreme Weather Events:** If extreme weather events (flooding, storm, fire) occur, then funding may need to be diverted from planned activities.

Prevention and recovery actions, owners and timeframes have been identified for top-priority risks, including the three above.

What are the projected 10-Year funding levels we require for the NHS?

$1.2B **Pavement management**

$2B **Bridge management**

What will we achieve?

GDOT is currently satisfying the federal minimum condition levels for both pavements and bridges by having less than 5% of interstate pavements in poor condition, and less than 10% of total NHS bridge

deck area in poor condition. GDOT is also meeting the target set for pavements in good condition and this performance can be maintained. GDOT can meet its goal to bring 60% of the bridge inventory to good condition based on the investment strategy established in this TAMP.

Where will we enhance the process?

GDOT is committed to continuous enhancement of its TAM processes and has identified several future actions. One of the most significant enhancements is to complete implementation of the BMS and PMS. With additional refinement of the BMS and PMS, GDOT will be better positioned to:

- Determine the benefit-cost, over the life-cycle of assets, for alternative approaches to managing the condition of NHS pavement and bridge assets
- Identify short- and long-term budget needs (for a range of investment scenarios) for managing the condition of all NHS pavement and bridge assets
- Further define and quantify a state of good repair, resulting in performance targets for measurement and reporting
- Expand this analysis to the broader SRS, enabling future investment decisions to be made across the entire GDOT network

GDOT's Commitment to Georgia

Georgia's SRS provides an integral foundation for the state's 10 million[1] citizens and for its $554.3 billion[2] economy to thrive and grow. For more than a decade, GDOT has been deploying transportation asset management (TAM) and risk principles to make better data-based investment decisions in its existing infrastructure. At a time when funding for transportation is constrained and programs are forced to compete with one another, GDOT considers TAM an effective tool to determine how best to spend every transportation dollar in the most efficient way possible.

GDOT submits this TAMP in accordance with Title 23 Code of Federal Regulations (23 CFR) § 515[3], focusing on pavement and bridge assets on the NHS. As with the 2018 TAMP, this 2019 TAMP update complies with federal requirements. As demonstrated through the collaborative development of this TAMP, and through the planned enhancements identified within, GDOT's Executive Leadership is committed to implementing the principles and practices defined in this TAMP for the benefit of Georgia's transportation system and its citizens.

Russell McMurry, P.E.
Georgia Department of Transportation Commissioner

1. http://www.dot.ga.gov/PartnerSmart/Public/Documents/publications/StrategicPlan/StrategicPlan-FY2019.pdf
2. http://www.dot.ga.gov/PartnerSmart/Public/Documents/publications/StrategicPlan/StrategicPlan-FY2019.pdf
3. https://www.federalregister.gov/documents/2015/02/20/2015-03167/asset-management-plan

Section 1
Introduction

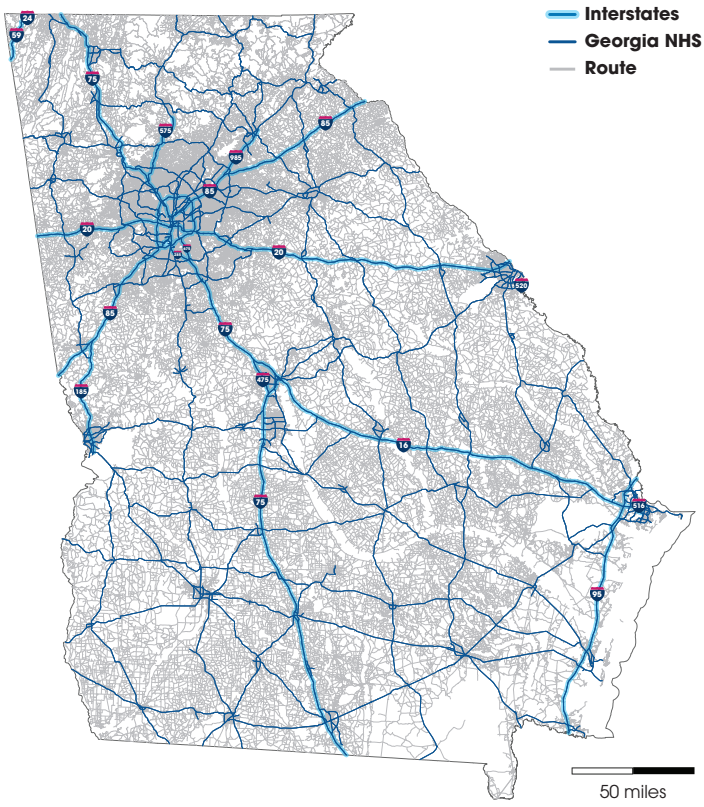
The purpose of the Georgia Department of Transportation (GDOT) Transportation Asset Management Plan (TAMP) is to outline the risk-based priorities and strategies used to cost effectively manage and preserve Georgia's pavement and bridge assets on the National Highway System (NHS). It supports GDOT's approach to manage the transportation system through responsible stewardship, providing maximum efficiency and effectiveness.

1.1 Overview

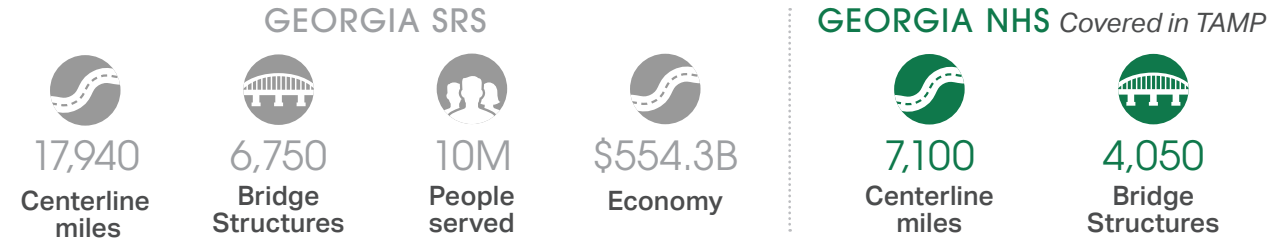
Serving a statewide population of over 10 million[4] residents, retirees and workers, the health of Georgia's state route system (SRS)—approximately 17,940 centerline miles of pavement—is critical to the state's $554.3 billion[5] economy. The SRS, which also includes over 6,750 bridge structures, including culverts over 20' in length, provides an integral foundation upon which industries that are crucial to the state economy can grow.

The NHS in Georgia is comprised of over 7,100 centerline miles of pavement and approximately 4,050 bridge structures. **Figure 1** illustrates the NHS in Georgia. In accordance with Title 23 Code of Federal Regulations (23 CFR) § 515[6] this TAMP focuses on these NHS assets, documents GDOT's existing Transportation Asset Management (TAM) practices and describes improvement actions to increase the Department's TAM maturity level.

Figure 1 — *NHS in Georgia*



4. http://www.dot.ga.gov/PartnerSmart/Public/Documents/publications/StrategicPlan/StrategicPlan-FY2019.pdf
5. http://www.dot.ga.gov/PartnerSmart/Public/Documents/publications/StrategicPlan/StrategicPlan-FY2019.pdf
6. https://www.federalregister.gov/documents/2015/02/20/2015-03167/asset-management-plan



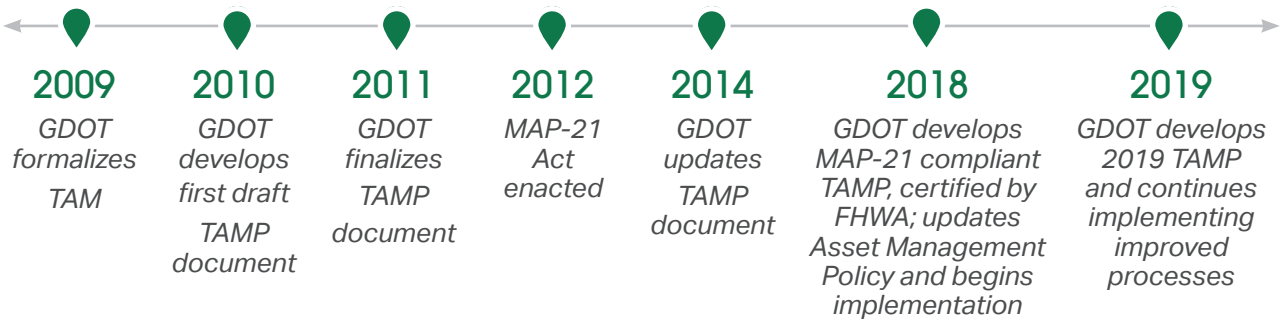
1.2 GDOT Transportation Asset Management Program

TAM provides GDOT with an integrated, comprehensive and strategic approach to meet Georgia's transportation needs. TAM's key strengths are that it is data-driven, and decisions can be supported by the data it uses and generates, as well as by sound engineering judgment. At a time when funding for transportation is constrained and programs are forced to compete with one another, TAM is an effective tool to help determine how to efficiently spend every transportation dollar.

GDOT formally embraced TAM in the fall of 2009. Previously, the Department's investments were made independently within each asset category leading to a reactive "worst first" approach in managing programs and allocating resources to address deteriorated assets. The use of this approach resulted in limited resources for investing in lower cost preservation activities that slow the rate of deterioration. In 2010, GDOT developed its first TAMP draft – a document that outlined the Department's strategy for incorporating TAM philosophy into its business processes to support cost-effective decision making. The draft TAMP was finalized in 2011 and updated in 2014.

In 2012, the Moving Ahead for Progress in the 21st Century (MAP-21) Act was enacted. MAP-21 established minimum requirements which continued with the Fixing America's Surface Transportation Act (FAST Act) for states to develop risk and performance based asset management plans for preserving and improving the condition of pavements and bridges on the NHS.

In 2018, GDOT developed an initial TAMP that met the requirements of MAP-21 and was certified by the Federal Highway Administration (FHWA). In the same year, GDOT updated its TAM policy to confirm TAM as the official, institutional approach in managing infrastructure assets and making capital investment decisions at GDOT. From this point, the Department has been implementing new pavement and bridge management systems to enhance TAM decision making. The implementation continues and this 2019 TAMP provides an update on continuing the development of GDOT's TAM processes.



1.3 Federal TAMP Requirements

Title 23 Code of Federal Regulations (23 CFR) § 515[7] defines the following asset management requirements:

- Establish the processes that a State transportation department (State DOT) must use to develop its asset management plan, as required under 23 U.S.C. 119(e)(8)
- Establish the minimum requirements that apply to the development of an asset management plan
- Describe the penalties for a State DOT's failure to develop and implement an asset management plan in accordance with 23 U.S.C. 119 and this part
- Set forth the minimum standards for a State DOT to use in developing and operating highway bridge and pavement management systems under 23 U.S.C. 150(c)(3)(A)(i)

23 CFR § 515.9 defines TAMP requirements, including:

- A State DOT shall develop and implement an asset management plan to improve or preserve the condition of the assets and improve the performance of the NHS in accordance with the requirements of this part. Asset management plans must describe how the State DOT will carry out asset management as defined in § 515.5;
- An asset management plan shall include, at a minimum, the items identified in **Table 1**.

ASSET MANAGEMENT PLANS (§ 515.5)

Asset management plan means a document that describes how a State DOT will carry out asset management as defined in this section. This includes how the State DOT will make risk-based decisions from a long-term assessment of the NHS, and other public roads included in the plan at the option of the State DOT, as it relates to managing its physical assets and laying out a set of investment strategies to address the condition and system performance gaps. This document describes how the highway network system will be managed to achieve State DOT targets for asset condition and system performance effectiveness while managing the risks, in a financially responsible manner, at a minimum practicable cost over the life cycle of its assets. The term asset management plan under this part is the risk-based asset management plan that is required under 23 U.S.C. 119(e) and is intended to carry out asset management as defined in 23 U.S.C. 101(a)(2). the life cycle of the assets at minimum practicable cost."

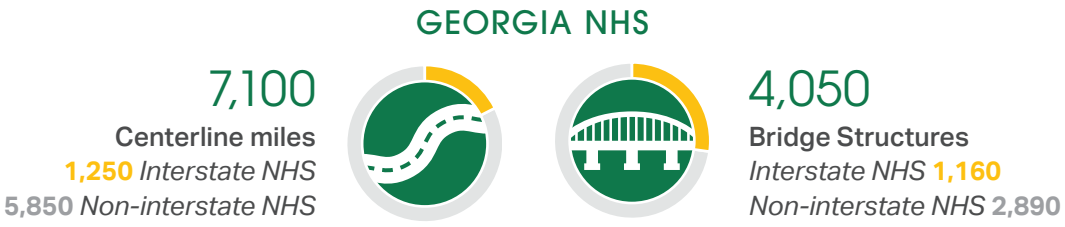
7. https://www.federalregister.gov/documents/2015/02/20/2015-03167/asset-management-plan

Table 1 — *Federal Elements of a TAMP*

Requirement 23 CFR § 515.9	Description
Asset Management Objectives and Measures	• Alignment between asset management and the agency's mission.
Inventory and Condition	• A summary listing of all NHS pavement and bridge assets. • Measures and associated targets the State DOT can use in assessing the condition of the assets and the performance of the highway system as it relates to those assets. • State DOTs are encouraged but not required to include all other NHS infrastructure assets within the right-of-way corridor and assets on other public roads.
Life-cycle Planning	• A process for conducting a life-cycle planning analysis. • Considering strategies to manage assets by minimizing life-cycle cost while achieving State DOT targets.
Risk Management Analysis	• Implementing a process to identify, assess, prioritize, mitigate and monitor risks that can affect the condition of assets.
Financial Plan and Investment Strategies	• Determining funding sources and expected funding levels (10-year) for NHS pavements and bridges. • An investment strategy (dollars to be spent in defined work type categories).
Performance Gap Analysis	• A comparison between current condition, short and long term targets and the desired State of Good Repair.

1.4 TAMP Scope and Organization

The scope of this TAMP includes pavements and bridges on the NHS. Despite the focus of this TAMP, GDOT's decision making considers the broader transportation system for which it is responsible. Additional assets will be considered during GDOT's TAM planning updates.



GDOT's TAMP is comprised of seven sections.

- **Section 1 —** Summarizes GDOT's progress on advancing its TAM program, provides the purpose of developing a TAMP and presents its scope and organization.
- **Section 2 —** Describes GDOT's approach to TAM, how it aligns with organizational goals, its relationship with other planning processes and planned future enhancements.
- **Section 3 —** Presents GDOT's condition assessment and inspection processes, inventories and current conditions for pavement and bridge assets.
- **Section 4 —** Outlines GDOT's life-cycle planning practices for pavement and bridge assets.
- **Section 5 —** Defines GDOT's risk management methodology.
- **Section 6 —** Discusses GDOT's revenue sources and estimated funding levels, and proposes its investment strategies for effectively managing its pavement and bridge assets over the next 10 years.
- **Section 7 —** Compares current performance to state and national targets.

Section 2

Asset Management at GDOT

GDOT adopts the FHWA's definition of asset management and continues advancing its holistic approach to preserving and improving transportation systems rather than focusing solely on areas of worst conditions.

2.1 Goals and Objectives

GDOT's recently updated TAM policy mandates the adoption of TAM principles for managing infrastructure and making investment decisions at GDOT. This policy defines the intent of the TAM program and TAM Committee structures. Aligned with the strategies, objectives, goals and mission outlined in the FY2018-FY2021 Strategic Plan, the TAM policy establishes GDOT's TAM program to consist of:

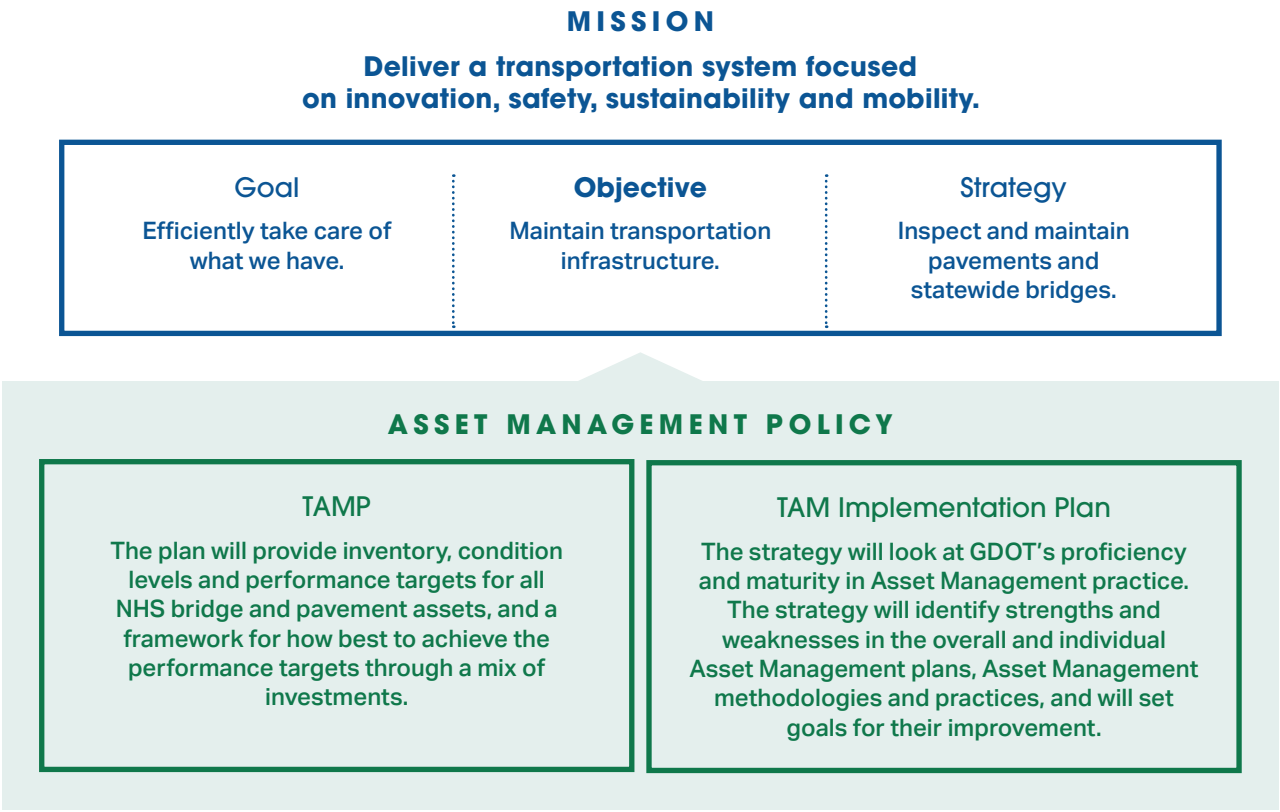
- **TAMP —** The plan will provide inventory, condition levels and performance targets for all bridge and pavement assets on the NHS, and a framework for how best to achieve the performance targets through a mix of investments.
- **TAM Implementation Plan —** The plan will look at GDOT's proficiency and maturity in TAM practice. The plan will identify strengths and weaknesses in the overall and individual TAM plans, TAM methodologies and practices, and will set goals for their improvement.

DEFINING ASSET MANAGEMENT

"Asset management is a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the life cycle of the assets at minimum practicable cost."

The TAM policy and this TAMP complement and support GDOT's strategic direction. Established in the Department's FY2018-FY2021 Strategic Plan, GDOT's mission is to deliver a transportation system focused on innovation, safety, sustainability and mobility. Among GDOT's five (5) goals to support this mission, one—*efficiently taking care of what GDOT has*—directly relates to TAM. **Figure 2** illustrates the alignment of GDOT's TAM policy and the Department's strategic direction.

Figure 2 — *Alignment of TAM Policy and Agency Mission, Goals, Objectives and Strategies*



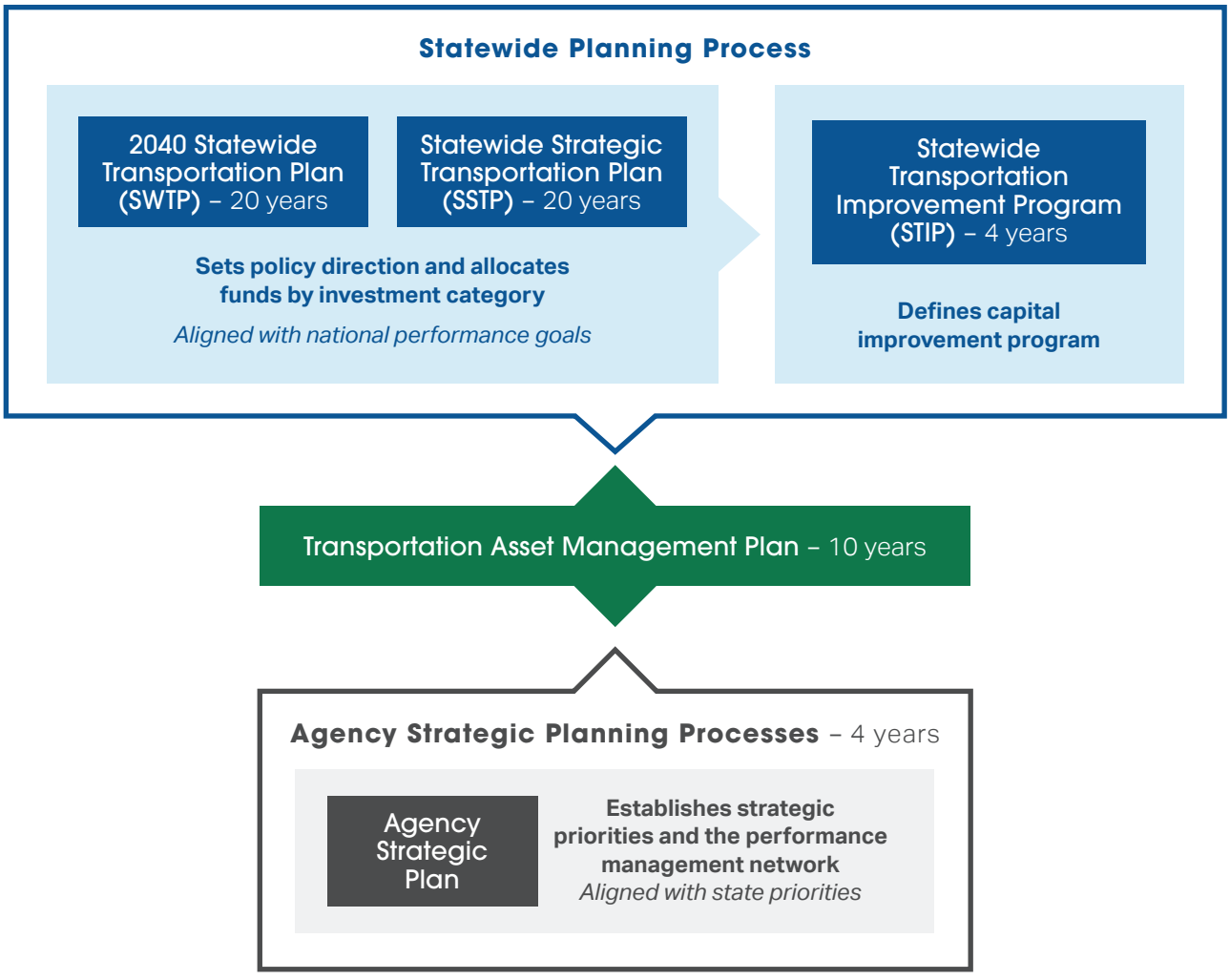
2.2 TAMP Relationship to Other GDOT Planning Processes

Many of GDOT's existing planning processes and documents incorporate effective infrastructure management principles and indicate a commitment to preservation of major transportation assets. In particular, performance-based management and TAM are seen as two interrelated activities, whereas performance management is utilized by TAM to set objectives, define measures, establish targets and monitor results.

Performance-based management is a two-step process. In the first step, performance measures are developed to assess if the Department is achieving the targets set in the strategic objectives. This determines if GDOT is meeting the level of service for assets included in the Strategic Plan/TAMP. In the second step, the results of the performance measures are used to make decisions and take corrective actions where necessary, or to implement strategies and initiatives as laid out in the TAMP to re-stabilize the process. Currently, GDOT facilitates performance-based discussions focused on the delivery of its internal goals, objectives and performance measures. In the future, the Department will expand this practice by regularly documenting, monitoring an updating progress towards achievement of its targets outlined in its TAMP.

Achieving the targets for asset condition and performance of the NHS will ultimately translate into progress toward national performance goals[8]. TAMP implementation will be aligned with proposed investments in the Statewide Transportation Plan (SWTP), Statewide Strategic Transportation Plan (SSTP) and the Statewide Transportation Improvement Program (STIP). **Figure 3** illustrates the relationship of statewide planning processes, this TAMP and GDOT's Strategic Plan.

Figure 3 — *TAMP Relationship to GDOT's Other Planning Processes*



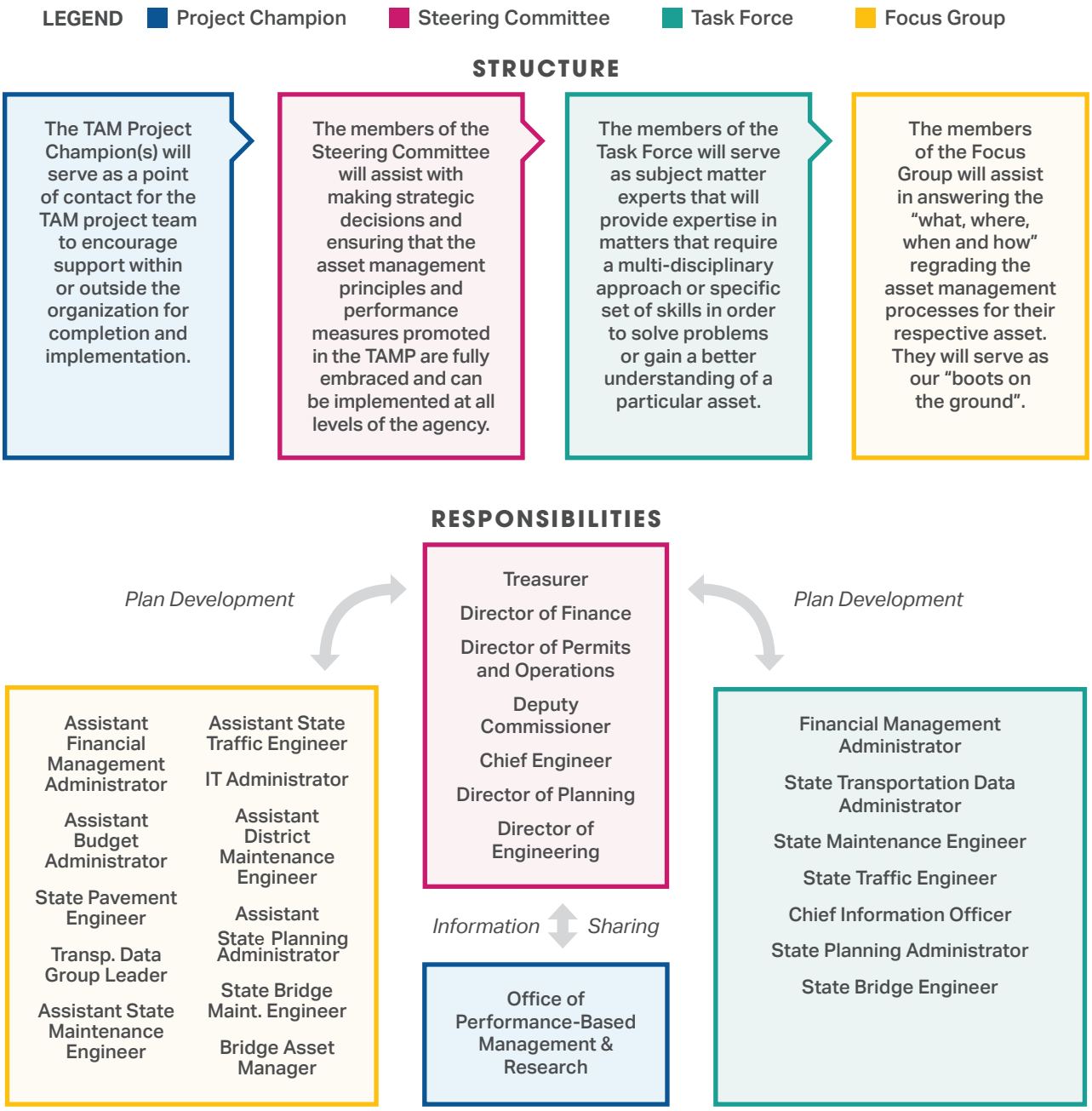
2.3 TAM Organizational Structure

TAM entails working across multiple offices within an organization and requires a variety of skill sets and knowledge. Having representatives from various functional areas that play a role in TAM is crucial for both plan development and implementation process. TAM committees were formed to enhance communication between the subject matter experts (SMEs), asset managers and executive leadership.

8. CFR Title 23 Part 515.11: https://www.ecfr.gov/cgi-bin/text-idx?SID=b2ae954ebca2fdd091546658a23dd871&mc=true&node=pt23.1.515&rgn=div5

The committees are also directly responsible for the Department-wide TAM implementation. Improved communication and clear roles and responsibilities will lead to better synergies and coordination of TAM practices and implementation. The responsibilities and structure of the TAM committees are shown in **Figure 4**.

Figure 4 — *TAM Committee Structure and Responsibilities*



Section 3

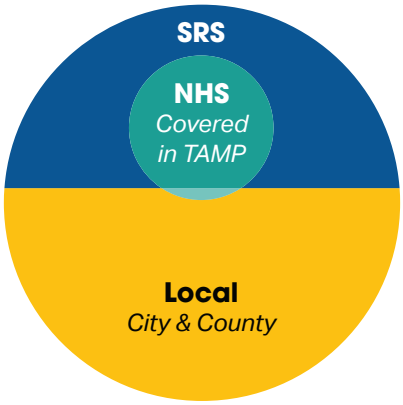
Asset Inventory and Conditions

GDOT's knowledge of its assets provides the foundation for data-driven decision making which includes condition, asset value, asset performance and performance targets for the future.

3.1 Introduction

Georgia's integrated roadway system of city streets, county roads, state highways and national highways are among the best maintained in the country[9]. The ownership responsibility for the roadway system is illustrated in **Figure 5**. The part of the network owned and maintained by GDOT, the SRS, includes 17,940 centerline miles of pavement and over 6,750 bridge structures. The focus of this TAMP is the NHS. Some (5%) of the NHS is owned and maintained by local cities and counties in conjunction with their responsibility for the broader local road system.

Figure 5 — *Composition of Georgia's Integrated Roadway System*



DEFINITION OF ROADWAY SYSTEM'S

SRS – Georgia's State Highway System, owned and maintained by GDOT.

NHS – A network of selected principal arterial routes identified as essential for international, interstate and regional commerce and travel, national defense and the transfer of people and goods to and from major intermodal facilities.

Interstate System – Officially known as the Dwight D. Eisenhower National System of interstate and defense highways, and consists of routes of highest importance which are constructed to the standards of 23 U.S.C. 109(h), and connects principal metropolitan areas, cities and industrial centers.

9. CNBC.COM (2018, July)

Knowing what assets are owned by GDOT provides the foundation for data-driven decision making which includes condition, asset value, asset performance and performance targets for the future. This TAMP presents the inventory, evaluation methodology and condition of pavements and bridges on the NHS in accordance with Federal requirements. Requirements for collection, processing, storage and updating inventory and condition data for pavement and bridge management systems are stated in 23 CFR 515.17.

3.1.1. State Route Prioritization

In 2014, GDOT implemented the initial State Route Prioritization Network, which is periodically updated. As part of the 2018 update, GDOT undertook an assessment of the State's 17,940 centerline miles, using Geographic Information System (GIS) technology to graphically display and assist with the evaluation of proposed prioritization criteria. Through a series of internal workshops and input from GDOT management, prioritization criteria were established, resulting in four categories of State Routes – Critical, High, Medium and Low.

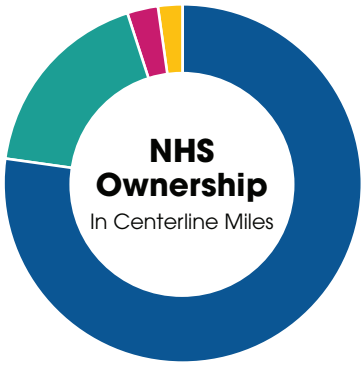
GDOT focuses its resources on components of the transportation system that are most important to Georgia's economy – those significant to freight movement, intrastate travel, tourism and business travel.

- **Critical:** Interstates, Strategic Highway Network (STRAHNET) / STRAHNET Connectors, State Freight Corridors
- **High:** NHS / Intermodal Connectors, Governor's Road Improvement Program (GRIP) Corridors, Georgia Emergency Management Agency (GEMA) Routes (including the Hurricane Evaluation Route), Annual Average Daily Traffic – High (Variable Thresholds Based on Geographic Area)
- **Medium:** U.S. Highways, routes with four-or-more lanes, Annual Average Daily Traffic – Medium (Variable Thresholds Based on Geographic Area)
- **Low:** All other unclassified routes, routes with less than four lanes, low regional significance, Annual Average Daily Traffic – Low (Variable Thresholds Based on Geographic Area)

GDOT implemented the results of the prioritization effort to effectively allocate maintenance funding, and ensure a high level of service and quality on Critical and High Priority routes. GDOT will continue focusing its resources on the components of the transportation system that are most important to Georgia's economy – specifically, those that serve a significant role in freight movement, intrastate travel, tourism and business travel.

3.2 Pavements

GDOT is responsible for the majority (95%) of pavement centerline miles on the NHS, with the remainder being the responsibility of other state agencies, local cities and counties. However, the responsibility for maintaining pavements and bridges on the toll roads belongs to GDOT, therefore these routes are included in the following discussion as part of this TAMP. Most (85%) NHS pavements were constructed with asphalt with the remainder being concrete.



5,500 *Non-interstate NHS (state route)*

1,250 *Interstate*

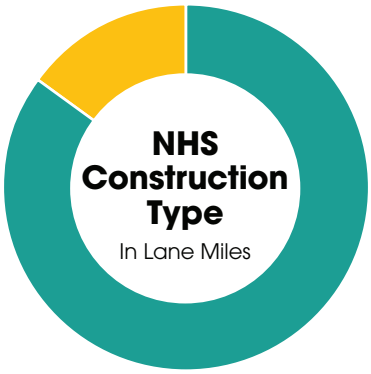
200 *County NHS (Non state route)*

150 *City NHS (Non state route)*

3.2.1. Pavements Evaluation

Interstate and roadway maintenance needs are identified through scheduled inspections, performance reports and public reporting. Scheduled maintenance inspection programs are managed by GDOT's Office of Maintenance and GDOT District Offices.

GDOT's Office of Transportation Data (OTD) collects and records asphalt and concrete pavement data annually. The pavement data is collected using an automated data collection vehicle, equipped with an array of sensors to collect data on ride quality, cracking and rutting, as well as video log in both directions. Data collection on multilane highways is performed in the outside lane only.



22,470 *Asphalt*

3,890 *Concrete*

Georgia is collecting the condition data on the entire NHS, regardless of ownership, in accordance with the 2010 Highway Performance Monitoring System (HPMS) field guide and subsequent updates (including PM2). The preparation, collection, quality control, assimilation and reporting remain unchanged regardless of ownership.

For NHS pavements, GDOT reports data on rutting, cracking, international roughness index (IRI) and faulting for every 0.10-mile segment. This is in accordance with federal regulations, 23 CFR 490. IRI is a measure of the ride quality or smoothness experienced by vehicles traveling on the pavement. Cracking, for federal reporting, is a measure of cracking present in the wheel paths of the measured lane. Rutting measures the average depth of depression in the wheel path of the measured lane. In addition to being required for federal reporting, IRI is used by the GDOT Maintenance office for their assessment of the pavement condition on the SRS. **Table 2** provides a summary of how the metrics of IRI, rutting and cracking are combined to calculate the federal performance measures.

Table 2 — *National Highway Performance Measures for Pavement Condition (23 CFR 490)*

		Measure		
Metric	**Units**	**Good**	**Fair**	**Poor**
International Roughness Index	Inches/mile	<95	95-170	>170
Cracking	Percent	<5	Jointed Concrete: 5-15 Asphalt: 5-20	>15 >20
and either				
Rutting (Asphalt)	Inches	<0.20	0.20-0.40	>0.40
or				
Faulting (Concrete)	Inches	<0.10	0.10-0.15	>0.15

For the full SRS (including the NHS), GDOT reports and uses a more comprehensive pavement management measure, called the Overall Condition Index (OCI) as a basis to inform decision making. The OCI for asphalt surfaces is calculated by averaging six distress indices with an additional adjustment index score. The six distress indices utilized are: Load Cracking, Edge Cracking, Block Cracking, Reflective Cracking, Rutting and Raveling (**Figure 6**).

Figure 6 — *Examples of Pavement Distress – Rutting, Load Cracking and Raveling (left to right)*

The additional adjustment index equals the value of the distress index that triggers a recommended treatment in the decision tree. The additional adjustment index score is generally the lowest of the six other indexes, with parameters in place to mitigate the impact of Rutting on the overall score.

OCI = AVERAGE (Load, Edge, Block, Reflective, Rutting, Raveling, Adjustment Index Score)

The use of OCI began in 2019 and replaces the previous, Computerized Pavements Condition Evaluation System (COPACES). GDOT is currently in the process of developing summary definitions (good/fair/poor) for pavement conditions. When these are developed, they will be utilized to set performance targets for all SRS assets (including NHS), and it is likely these targets will be aligned with the State Route Prioritization categories.

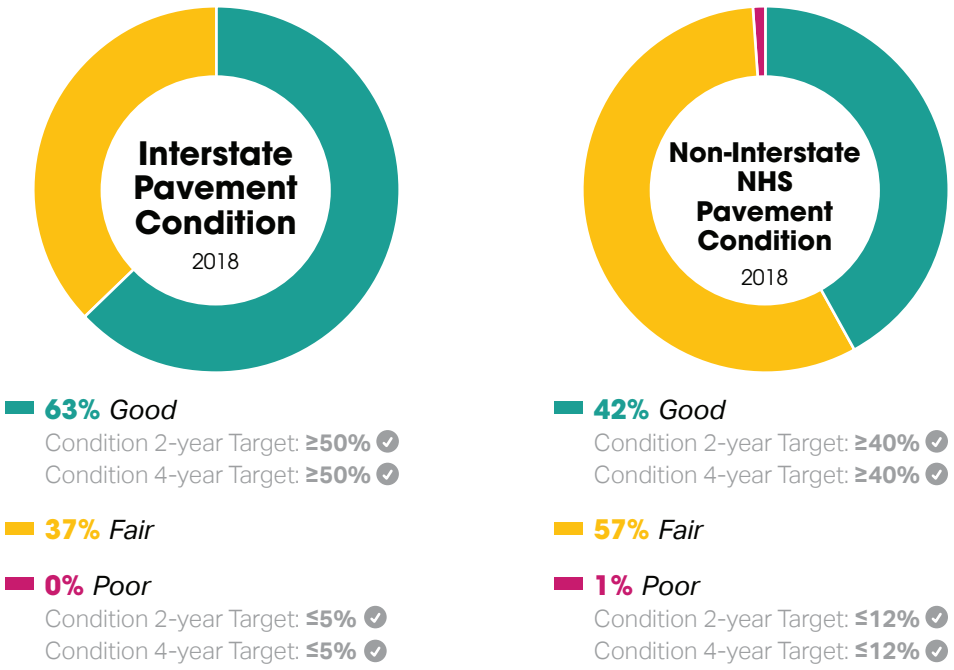
Despite these definitions still being under development, this TAMP uses preliminary OCI definitions for reporting on percentage of good and poor pavements. This will provide some consistency with future TAMP documents recognizing that there may be some changes in how good/fair/poor is defined moving forward.

3.2.2. Pavement Condition and Targets

In 2018, GDOT set two and four-year condition targets for the NHS as required by the National Highway Performance Program (NHPP). These targets were based on a review of the HPMS data with a comparison to current and historical funding levels. In 2018, GDOT also moved to a fully automated process with 3D detection and evaluation. This process will not only provide a comprehensive analysis of the Department's network, but will also accomplish this work much more safely, as the visual inspection required by the legacy CoPACES system will no longer be necessary. Conservative targets were selected to account for the potential variability in pavement scores (through the transition in collection and reporting methods), for predicted trends in the network with current funding, and for the uncertainty in the current TAMP process and how it might be managed by FHWA.

Results from the 2018 pavement condition assessment revealed that current pavement conditions on the NHS meet the NHPP, two- and four-year targets set by GDOT. Current pavement condition data for both Interstate and Non-Interstate NHS in Georgia, compared to GDOT NHPP condition targets for pavement, is presented in **Figure 7**.

Figure 7 — *NHS Pavement Condition (by Lane Miles)*

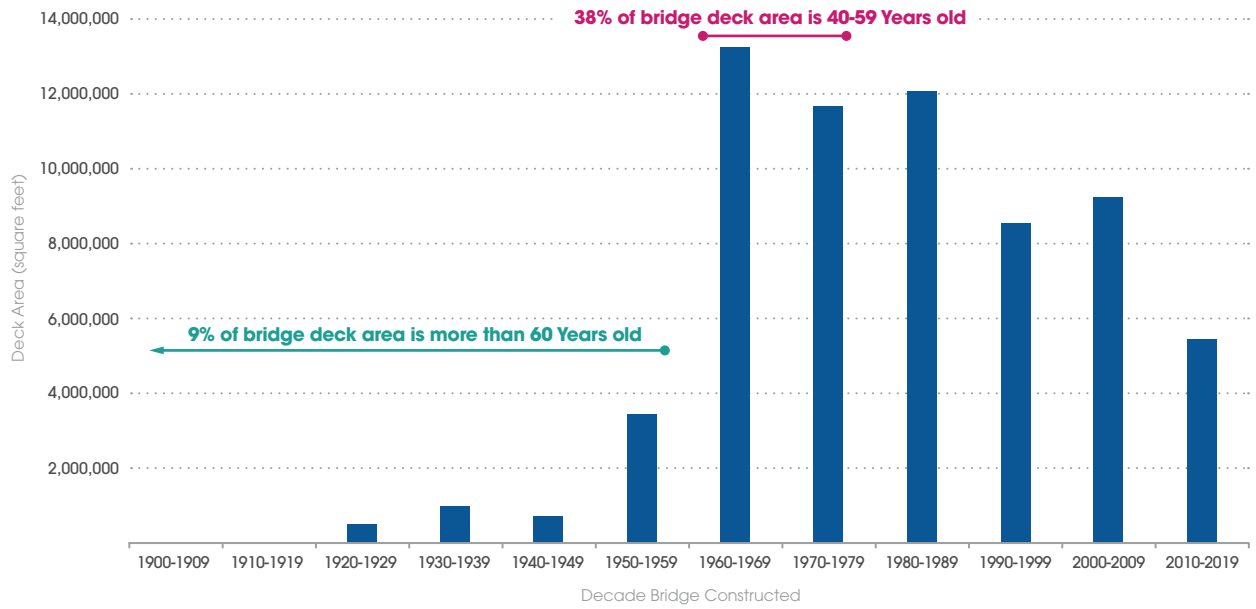


3.3 Bridge Structures

As of February 2019, the NHS in Georgia contains approximately 4,050 bridge structures, with a total deck area of 65,732,990 square feet.

Illustrated in **Figure 8**, the average age of NHS bridges in Georgia is 46 years which is close to the designed service life for most GDOT bridges (50 years). Nearly 50% of GDOT bridges are more than 40 years old. Effective preservation can extend this service life. This is demonstrated by the fact that only 1.5% of the bridges (by count) constructed before 1960 (being more than 60 years old) are currently in poor condition. In recent years, bridges are designed with a 75-year service life expectancy.

Figure 8 — *Average Age of NHS Bridges*



GDOT owns, operates and manages 96% (by deck area) of the bridges on the NHS. Only 1% of those bridges are in poor condition, surpassing federal minimum condition levels.

3.3.1. Bridge Evaluation

GDOT's Bridge Maintenance Unit (BMU) in the Bridge Design Office is responsible for inspecting bridge structures in compliance with federal regulations, including the National Bridge Inspection Standards (NBIS). The NBIS defines a "bridge structure" and sets minimum requirements for inspection. Most of Georgia's bridge structures are inspected every two years. Some are inspected more frequently, depending on condition or structure type (such as fracture critical bridges).

For federal reporting purposes, structure condition is assessed by bridge inspectors on the National Bridge Inventory (NBI) scale from 0 to 9. Each bridge is given three ratings corresponding to its deck, superstructure and substructure. Culverts that are large enough (i.e. 20 feet or longer) to qualify for the

NBI are given one 0-9 condition rating. These condition ratings are summarized for TAMPs by selecting the worst condition rating on each bridge, then characterizing it as good, fair or poor as in **Table 3.**

Table 3 — *National Bridge Inventory Condition Metrics*

Condition rating scale									
Good			Fair		Poor				
9	8	7	6	5	4	3	2	1	0

Bridge condition is summarized as the percent of the inventory in good or poor condition. For example, percent good is calculated from the total size of all bridges in good condition, divided by the total size of all bridges in the inventory. Size is expressed as deck area, which is approximately the length of the structure times its width, in square feet. In this TAMP, bridge conditions are always expressed in this manner.

For maintenance planning purposes, GDOT uses the American Association of State Highway and Transportation Officials (AASHTO) elements and condition states in addition to the bridge condition. Each bridge is divided into spans delineated by their supporting piers or abutments. Each span is divided into distinct structural elements such as railings, deck wearing surface, deck slab, expansion joints, girders, coating system, bearings, columns, etc. When the inspector examines each element, its condition is assessed by the percent of the element in each of four condition states ranging from good condition to severe condition. These elements and condition states relate directly to feasible agency actions for maintenance, preservation or rehabilitation.

An important function of GDOT's bridge management system (BMS) is to keep track of all this detailed information and use it to support decision making. Data on spans, elements and condition states are used to propose treatment actions, to estimate their cost, to forecast their effect on future condition and to calculate life-cycle cost, which is used in setting priorities for the most effective use of limited funding.

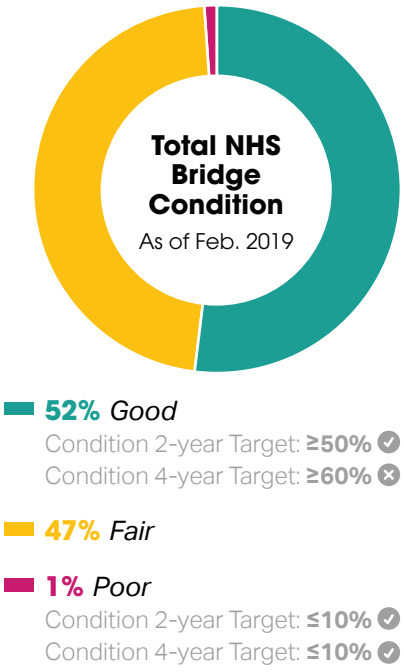
Bridge and bridge culvert data are collected by 12 topside inspection teams, two specialized inspection teams and two underwater inspection teams. The inspection process undergoes quality assurance by regional bridge inspection specialists, who conduct field checks to confirm inspection data. The Department also utilizes consultant inspectors to conduct a quality assurance program and some specialized inspections. Further review of the data occurs periodically throughout the year using FHWA's error-check program. This check is also performed before the annual submission to FHWA and then again by FHWA.

3.3.2. Bridge Inventory and Condition

Nationally, the condition of Georgia's NHS bridges are better than average with 52% of bridges in good condition, and only 1% in poor condition. With federal law imposing penalties only when bridges in poor condition exceeds 10%, there is minimal possibility that Georgia's bridges will deteriorate that severely in 10 years under anticipated funding levels.

From 2012-2018, the percentage of bridges in good condition declined while the percent in poor condition improved, as shown in **Figure 10**. One of GDOT's current goals is to reverse the decline of bridges in good condition with an enhanced program of bridge work. This goal is reflected in the current NHPP two- and four-year targets, as shown in **Figure 9**. These targets were set in 2018 based on a review of the NBI condition data with a comparison to current and historical funding levels.

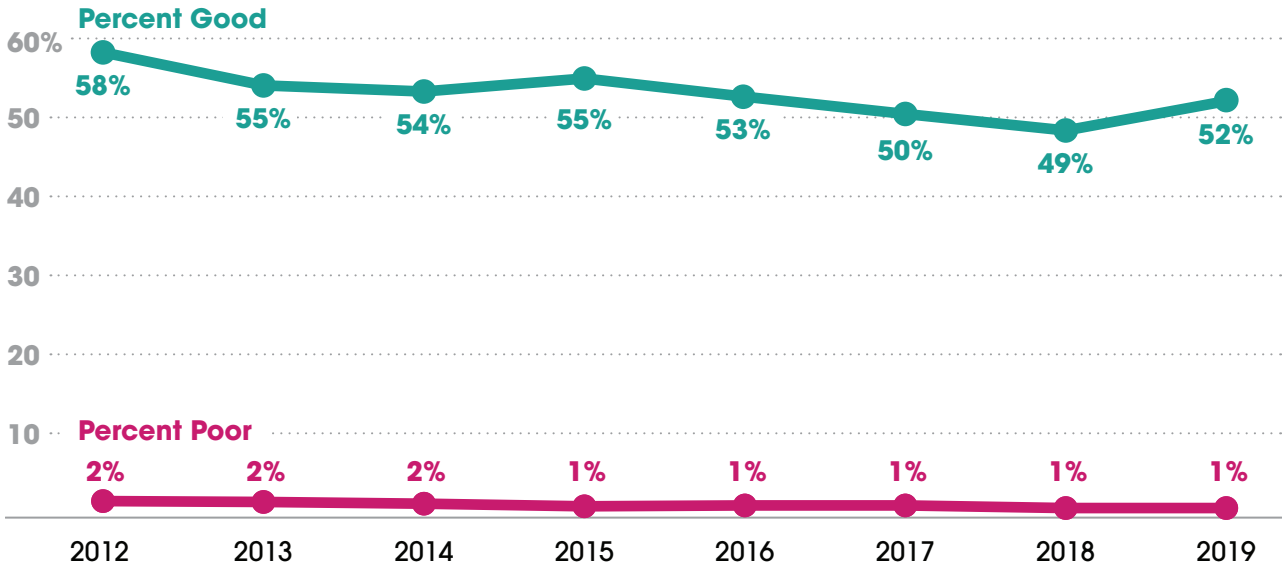
Figure 9 — *NHS Bridge Performance as of February 2019*



The two-year good target was set using the current list of projects that will be let and completed by the end of the 2019 deadline. The four-year good target was set following an assessment of projects that are currently in the planning stage.

A conservative poor target was selected to account for the following: predicted trends in the network with current funding, the uncertainty in moving to an updated data management system and the uncertainty in the current TAMP process and how it might be managed by FHWA. The positive impact of recent investment can be seen in the 2019 data (**Figure 10**).

Figure 10 — *Condition Trends, NHS bridges in Georgia 2012-2019*



Section 4

Life-Cycle Planning

GDOT's asset life-cycle planning involves looking at assets over their lifespans and applying cost effective preservation treatments to prolong the remaining useful life while supporting progress toward transportation system performance goals.

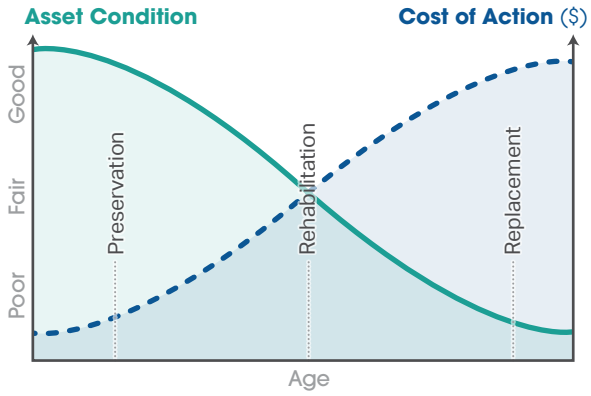
4.1 Introduction

Life-cycle planning is the cost-effective management of transportation assets over their whole lives, from the initial construction until the time the assets are replaced, retired or disposed. Life-cycle planning emphasizes long term performance through cost-effective preservation, seeking sustainable asset conditions while providing needed system performance or public safety.

Different asset preservation methods prolong an asset's useful life while sustaining performance at the most optimal level affordable. Investing in preservation is significantly less costly over the long term than allowing assets to deteriorate and investing in premature replacements.

Figure 11 illustrates the connection between asset condition, age, treatments and cost. Early in the life of an asset, there is limited deterioration, so preventive maintenance treatments can be used to delay the onset or stop the progression of distress. As deterioration progresses, rehabilitation is needed to fix the deteriorated areas. Eventually, the asset needs to be completely replaced. As the cost-of-action curve shows, the cost of each level of repair increases exponentially as the amount of distress increases and the overall asset condition decreases.

Figure 11 — *Illustration of the Relationship between Asset Conditions and Cost*



As part of TAM implementation, GDOT applies life-cycle planning strategies to its pavement and bridge assets – identifying preservation and rehabilitation activities that will extend the life of the assets at a lower cost over the long term.

Although Georgia's population and travel demand continue to grow, GDOT places highest priority on the preservation of existing infrastructure. Specific allocations are identified for maintenance, preservation and rehabilitation, to ensure that these needs are adequately funded. Projects in these categories, particularly maintenance and preservation, are applied to facilities that are in relatively good condition, because the strategic timing of this work is often the least expensive way to maintain service in the long term.

In past practice, the allocation of funds to these categories has been according to historical levels and managerial judgment. However, in recent years the Department has improved its condition monitoring, and has become aware of the need to increase funding, particularly for preservation, to offset the effects of aging and deterioration.

At the same time, GDOT has progressed in developing technology and business processes that more rigorously forecast future preservation and rehabilitation needs, as a means of optimizing its investments. While GDOT continues to satisfy the immediate needs of its customers, the Department is also improving its ability to choose the scope and timing of preservation work to keep costs as low as possible over the long term. The methods for doing this are known as life-cycle planning.

4.2 Factors that Influence Life-cycle Planning at GDOT

All pavement and bridge assets decline in condition due to exposure to traffic and weather. There are several factors that can influence the rate of deterioration of these assets. In addition to understanding these factors it is important to understand the role pavement and bridge assets have in addressing the goals of the transport network.

Bridge and pavement assets help GDOT achieve the federal transportation system goals listed in 23 USC 150(b), which are also aligned to the goals GDOT established in its FY18-FY21 Strategic Plan (FY19 Update). GDOT considers several key factors that influence its life-cycle planning.

- **Safety —** Condition of pavements and bridges influence the probability of crashes. In addition, standards for bridge roadway width and railings influence the frequency and severity of crashes. The ability of pavement and bridges to avoid and/or resist certain natural or man-made hazards, such as flooding, may have an impact on safety.
- **Condition —** Changes in condition due to normal deterioration influence the feasibility and cost of maintenance and preservation. Bridges and pavements that are allowed to deteriorate too far may require much more expensive rehabilitation or replacement. Therefore, condition is a primary driver of life-cycle costs.

- **Mobility, including congestion and reliability —** The number of lanes and geometrics of bridges affect their ability to carry sufficient traffic at free-flowing legal speeds.
- **Freight movement —** The demands of commerce increasingly rely on an increasing volume and weight of trucks. System performance is affected by increased rates of deterioration and by GDOT efforts to accommodate heavy truck traffic.
- **Environmental sustainability —** Certain maintenance and preservation actions can have positive or negative impacts on the environment, depending on the methods used – for example, bridge painting. Bridge inspection, especially of trusses and bearings, often requires cleaning (and accompanying environmental protection) to gain safe access and visibility. Traffic congestion contributes to air pollution.
- **Project delivery —** Work zone traffic control is increasingly important in deciding the timing of preservation work. GDOT strives to coordinate this work with other needs on a corridor, and with the work of other agencies, all with the goal of delivering work quickly and with minimal disruption to the public.

Georgia's leading industry is agribusiness, producing 1.3 billion chickens annually, and leading the nation in timber production. In addition, the ports in Georgia, including two ports in Savannah and one port in Brunswick, open commerce to nearly 44% of the United States. This includes a large volume of containerized freight with trucks weighing 100,000 pounds and moving by annual permit across roads and bridges. In any given week, a combined 5.9 million tons of freight is moved across Georgia (Georgia Department of Economic Development).

NATIONAL PERFORMANCE GOALS

(1) **Safety.** To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.

(2) **Infrastructure condition.** To maintain the highway infrastructure asset system in a state of good repair.

(3) **Congestion reduction.** To achieve a significant reduction in congestion on the National Highway System.

(4) **System reliability.** To improve the efficiency of the surface transportation system.

(5) **Freight movement and economic vitality.** To improve the National Highway Freight Network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.

(6) **Environmental sustainability.** To enhance the performance of the transportation system while protecting and enhancing the natural environment.

(7) **Reduced project delivery delays.** To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.

GDOT and the Georgia Department of Public Safety (DPS) have been appointed by the Governor to coordinate and oversee the issuance of permits for oversized and overweight vehicles in the state of Georgia (Official Code of Georgia, volume 23, Title 32-6-28). Oversized and overweight vehicles are used mostly for the movement of goods and the movement of heavy equipment for the construction industry. These vehicles may weigh anywhere from 150,000 pounds to 1,000,000 pounds. GDOT and DPS evaluate and issue permits for these vehicles while prioritizing the safety of the traveling public and the safeguard of the state's roadway pavement and bridge assets.

The costs borne by road users are a significant GDOT concern, particularly in the context of freight movement. Over the last 50 years, as Georgia has increased in population, so has its traffic. Georgia's population continues to grow at 1.1% annually which is among the top 10% of the country. At the same time, the state's Gross Domestic Product grows 4.4% per year. Traffic growth is a causative factor for adverse changes in asset performance.

The increased use of deicing chemicals to help maintain safe winter travel speeds in the colder regions of the state can also increase the rate of deterioration of GDOT's bridges and pavements.

Performance is also affected by changes in functional requirements, changes in design standards (such as the required thickness of concrete over reinforced steel) and by localized problems, such as the effect of marine organisms on the integrity of concrete materials.

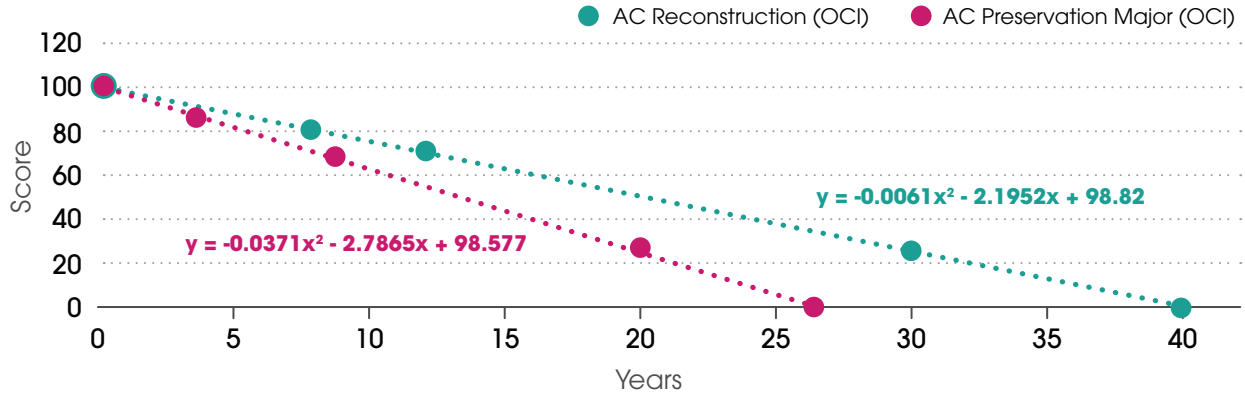
These factors are closely associated with life-cycle cost and risk. Preservation work is selected in a manner that tries to offset deterioration and reduce long-term costs, while also minimizing near-term inconvenience to the public. The risks associated with natural and man-made hazards are regularly assessed, to consider the economic effect on road users when service is disrupted by road/bridge closures or restrictions. Effective planning of agency actions to protect and improve performance depends on several tools and concepts discussed in the following sections.

4.3 Pavement Management

Pavement management involves the use of computer models to predict pavement conditions in the future and identify the most cost-effective means of treating pavements with available funding. GDOT utilizes its pavement management system (PMS) to establish long-term life-cycle strategies for pavements, and uses those strategies to inform capital and maintenance project selection.

While all factors mentioned in the previous section, and more (including quality of drainage, type of underlying material, material properties and maintenance frequency), play a role in pavement performance, it is impractical to incorporate each of these factors in performance models. GDOT has used information on pavement type, design, environment and traffic loading to establish performance models that are used to forecast pavement conditions. These deterioration models are used within the PMS in conjunction with treatment selection rules and cost data to determine the appropriate treatment at the current or any future time, for each pavement. **Figure 12** provides examples of two pavement performance curves, illustrating how anticipated performance varies after different treatments.

Figure 12 — *Examples of Pavement Performance Curves*



There are various factors that impact pavement condition. For example, recent years have seen greater use of deicing chemicals. Traffic volumes continue to increase. Heavy trucks are expected to increase as a percentage of total vehicles, particularly on interstate pavements. These changes in the factors that affect pavement condition require GDOT to monitor pavement conditions and update models on a regular basis.

GDOT is currently implementing a commercial PMS, Deighton Total Infrastructure Management System (dTIMS), to support both life-cycle planning for pavements and to determine which projects should be delivered with available funding. Pavement management can be used to establish long-term strategies, or select treatments for delivery within a short-term program. GDOT uses their PMS to support both objectives.

4.3.1. Treatments to Maintain and Improve Performance

GDOT employs a wide variety of treatments to manage its pavements, all of which are considered in the life-cycle planning process. **Table 4** provides a summary of the pavement treatments and their typical costs used for analysis in the PMS.

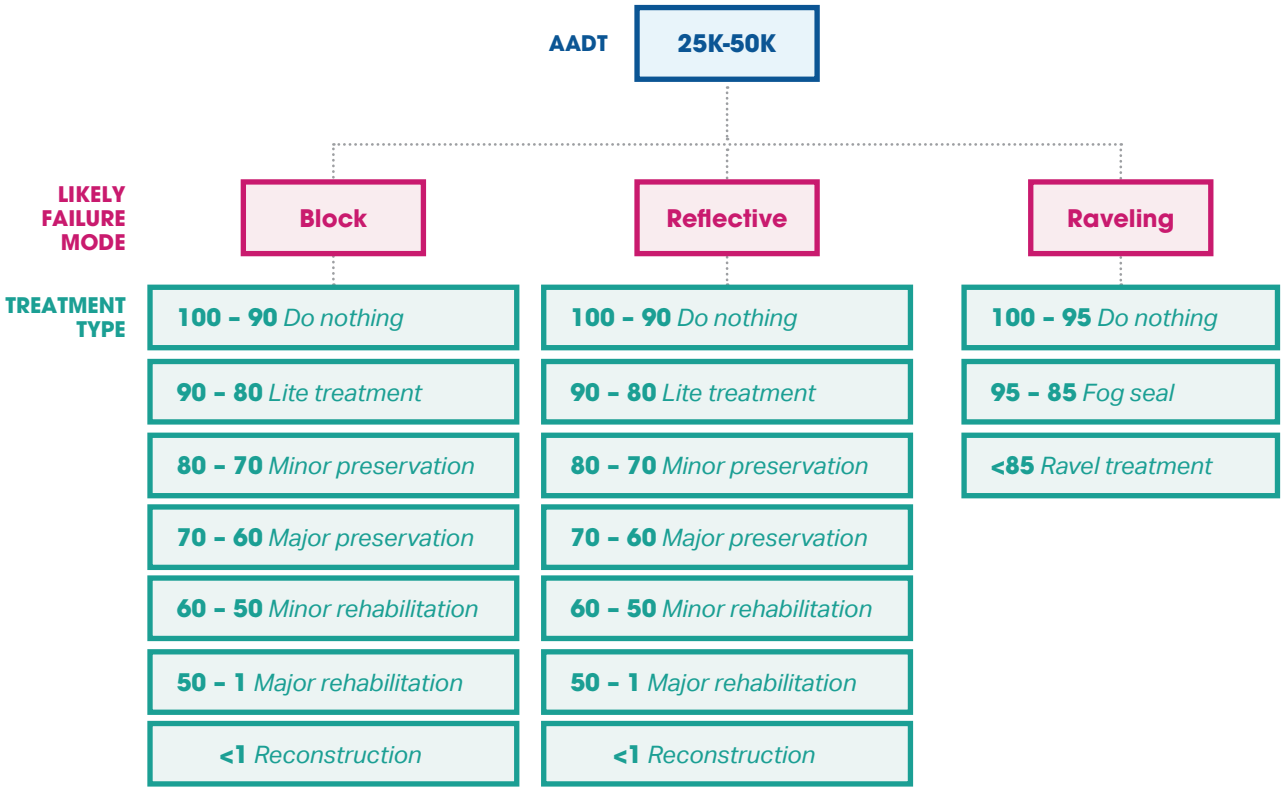
Table 4 — *Summary of GDOT Pavement Treatments by Work Type*

Work Type	Treatment Category	Typical Treatments	Weighted Unit-Cost / Lane-Mile
Maintenance	Light Treatment	• Crack Seal; Strip Seal; Fog Seal	$7,300
	Rutting Treatment	• Micro Seal, Mill-Spot Overlay, Thin Lift Asphaltic, Concrete Overlay, Level-Resurface (< 2" Depth)	$53,000
	Ravel Treatment - Fog	• Fog Seal	$8,000
	Ravel Treatment	• Mill-Resurface (< 2"), Micro Mill Resurfacing	$86,000
Preservation	Preservation (Minor)	• Mill, Chip Seal, Slurry Seal, Micro Seal, Mill-Micro Seal • Mill-Spot Overlay, Scrub Seal. Double Chip Seal • Chip Seal with Light Weight Aggregate, Double Chip Seal with Sand, Double Strip Seal, Double Strip Seal with Sand • Thin Lift Asphaltic Concrete Overlay, Cape Seal	$36,000
	Preservation (Major)	• Patch, Mill-Resurface (< 2"), Level-Resurface (< 2") • Mill-Level-Resurface (< 2"), Shoulder Paving/Widening (< 2") • Overlay (< 2"), Chip Seal-Resurface (< 2") • Single Chip Seal-Level-Resurface, Double Chip Seal-Resurface • Chip Seal-Resurface/Shoulder Build (< 2") • Level Chip Seal-Resurface/Shoulder Build (< 2") • Overlay/Shoulder Build (< 2"), Mill-Resurface/Shoulder Build (< 2"), Level-Resurface/Shoulder Build (< 2") • Mill-Level-Resurface/Shoulder Build (< 2"), Micro Mill Resurfacing • Ultra-Thin Bonded Wearing Course (Asphalt) • Hot in Place Recycle (≤ 2") • Open-graded Crack Relief Interlayer with Resurface	$76,000

Work Type	Treatment Category	Typical Treatments	Weighted Unit-Cost / Lane-Mile
Rehabilitation	**Rehabilitation (Minor)**	• Mill-Resurface (2"- 4"), Level-Resurface (2"- 4") • Mill-Level-Resurface (2"- 4"), Shoulder Paving/Widening (2"- 4") • Overlay (2"- 4"), Chip Seal-Resurface (2"- 4" Depth) • Level Chip Seal-Resurface (2"- 4" Depth) • Level Chip Seal-Resurface/Shoulder Build (2"- 4" Depth) Overlay/ Shoulder Build (2"- 4"), Mill-Resurface/Shoulder Build (2"- 4"), Level-Resurface/Shoulder Build (2"- 4") • Mill-Level-Resurface/Shoulder Build (2"- 4") • Chip Seal-Resurface/Shoulder Build (2"- 4") • Ultra-Thin White Topping, Cold in Place Recycle (2"- 4") • Shoulder Paving and Resurface (2"- 4")	**$204,000**
	Rehabilitation (Major)	• Mill-Resurface (> 4"), Level-Resurface (> 4") • Mill-Level-Resurface (> 4"), Shoulder Paving/Widening (> 4") • Overlay (> 4"), Overlay/Shoulder Build (> 4") • Mill-Resurface/Shoulder Build (> 4") • Level-Resurface/Shoulder Build (> 4"), White Topping/Concrete Overlay • Shoulder Paving and Resurface (> 4")	**$437,000**
Reconstruction	**Reconstruction**	• Full Depth Reconstruction, Reconstruction as AC • Reconstruction as PCC, Reconstruction as CRC	**$590,700**

Each treatment is appropriate for use under certain conditions, and not appropriate for use under others. Maintenance and preservation treatments are generally used on pavements in good and fair condition to prevent further deterioration or restore surface conditions. Rehabilitation and reconstruction are used for pavements that have deteriorated to the point of losing structural capacity and need more substantial work. The PMS uses treatment rules, organized in decision trees, to select the appropriate treatment for each pavement in each year of an analysis. **Figure 13** provides an example of a decision tree from the PMS. In this figure, the Treatment Type boxes indicate the likely treatment type for different OCI scores (0-100); meaning, with an OCI score of 90-100 no treatment (do nothing) will be recommended.

Figure 13 — *Example of PMS Decision Tree*



4.3.2. Life-Cycle Strategies for Minimizing Long-Term Cost

GDOT uses its PMS to perform analysis of various treatment strategies on each roadway segment across the full network. The life-cycle analysis is based on the benefit-cost ratio developed from the cumulative costs and benefits for the analysis period. For developing life-cycle strategies GDOT performs analyses of at least 10 years.

The PMS models the deterioration of each individual pavement segment and identifies potential treatment options for that segment. The cost for each potential treatment (or combination of treatments) over time, is calculated, along with the benefit.

The benefit is calculated as the cumulative increase in the OCI pavement condition score over the analysis period, as compared to a do-nothing scenario. The benefit calculation also incorporates a traffic-weighting factor, which increases the benefit proportional to the amount of Average Annual Daily Traffic (AADT) on the highway segment. This ensures that treatments on highway segments with high traffic volumes may take precedence over segments with low volumes. The benefit of a treatment or strategy on a given highway segment is divided by the cost to determine the benefit-cost ratio. The higher the benefit-cost ratio for a treatment or strategy, the more cost-effective the strategy is. This analysis allows for both the determination of both the best long-term strategy for each pavement section, and the best set of treatments to maximize benefit to the entire network.

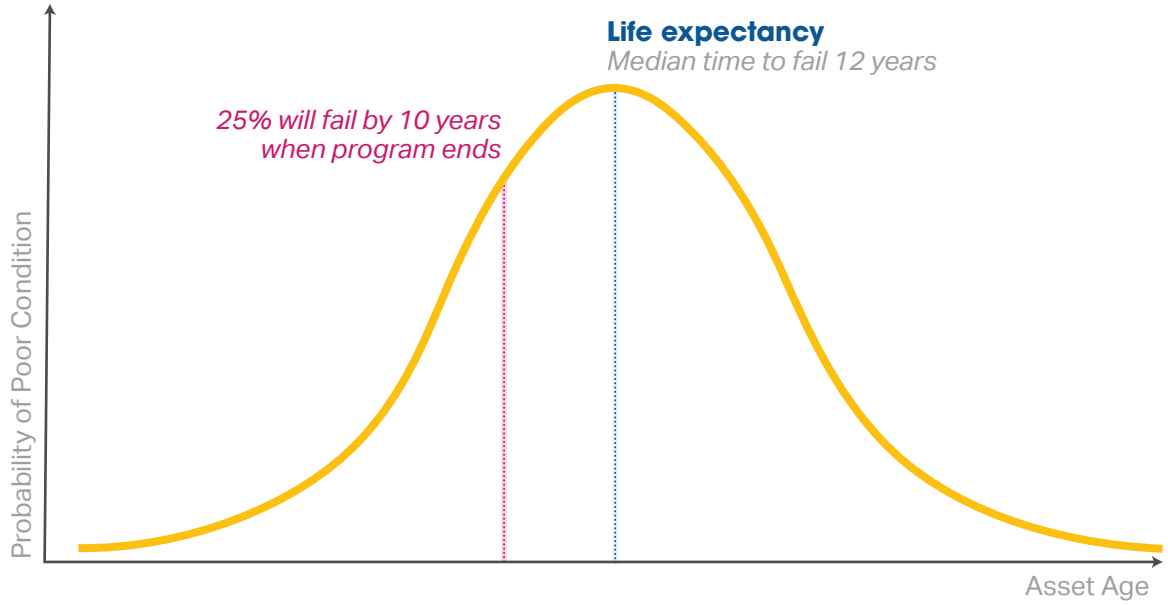
Based on life-cycle analysis, GDOT has developed a strategy that prioritizes the most cost-effective preservation treatments to extend the service life of its network. By employing an array of preservation treatments applied at the proper times, GDOT extends the time before more costly rehabilitation or replacement activities are needed. When it is no longer cost effective to apply a preservation treatment, a more substantial project may be programmed, which could include rehabilitation or reconstruction. In addition, a well-maintained roadway can benefit end users by reducing overall vehicle operating costs. The biggest benefit to GDOT is the strategic allocation of funding based on data-driven decisions that result in performing the right activities at the right time.

4.4 Bridge Management

Most existing bridges in Georgia were designed for a 50-year lifespan, with some of the newest bridges designed for 75 years. However, bridges can be made to last much longer if appropriate steps are taken to preserve them. The planning of preservation work is partly a scientific activity that depends on research about deterioration, risks and costs. GDOT has taken steps to gather data and analyze it, to enable the accurate forecasting of these factors. Forecasting always entails uncertainty about the future, so the models used for bridge life-cycle planning are careful to estimate uncertainty and use it in planning.

Figure 14 shows an example of the effects of uncertainty. The graph shows the uncertainty in lifespan of a group of bridge decks. Some of these decks may reach poor condition within just two years, while others might last two decades longer. The median remaining life might be 12 years, yet a significant fraction will deteriorate to poor condition within 10 years. In a 10-year estimate of needs, it would be important to make allowance for this "premature deterioration," even though none have yet reached poor condition.

Figure 14 — *Premature Deterioration is a Result of Uncertainty*



Different parts of a bridge deteriorate at different rates. For example, expansion joints wear out quickly, and decks deteriorate at a moderate rate, while piers often last a very long time. This influences the timing of the work that must be done to overcome deterioration and keep bridges performing well. GDOT bridge inspectors monitor the conditions of all these bridge elements so they can detect the best opportunities for maintenance and preservation.

GDOT uses a BMS to track its bridge inventory and condition data, and to support its planning activities. Like most states, Similar to other states, in the past, GDOT used a software system known as Pontis, developed by AASHTO. GDOT is now implementing the successor to Pontis, known as AASHTOWare Bridge Management (BrM). Some of the BrM capabilities GDOT will need for life-cycle planning have become available just in the past few months and still require more work to support full implementation. Nonetheless, GDOT is taking steps to allocate and train staff to take advantage of this tool as fully as possible (discussed near the end of this chapter).

GDOT has licensed release 6 of BrM and, in early 2019, established its bridge database in this system by migrating inventory and condition data from its Georgia Asset Management System (GAMS). BrM can analyze condition at two levels of detail:

- **NBI components:** These are the traditional deck, superstructure, substructure and culvert 0-9 rating system that GDOT has used since 1992.
- **AASHTO elements:** This is a more detailed system which describes each span of each bridge as a collection of elements selected from a catalog of more than 100 types of bridge members of varying functions and materials. Each element is rated on a scale of 1-4. GDOT has been gathering condition data in this format since 2014.

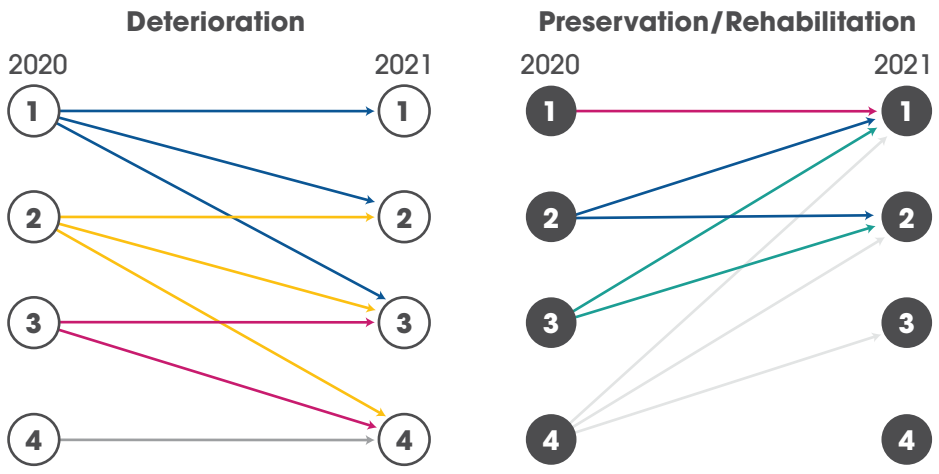
The University of Georgia was contracted by GDOT to analyze Georgia's existing bridge data and develop deterioration models. These models vary by structure type and geographic region. For instance, the northern part of the state typically has several winter storms annually, prompting the use of deicing materials on roads and bridges. This can accelerate corrosion. Therefore, the deterioration models can differ from the northern to southern zones. The initial effort by University of Georgia developed models based on NBI component condition ratings; they are now working to develop models based on element level data.

GDOT has 25 years of NBI component-level data that was utilized in the initial model development. While the element-level data is more precise, this level of data is limited to four years. As more data is collected, GDOT will be able to enhance the calibration of the models.

As discussed earlier, uncertainty is an essential part of any forecast of bridge conditions. As a result, BrM uses a probabilistic model to estimate the fraction of a population of elements in each condition state at any future point in time. The model has two parts, as depicted in **Figure 15**.

- Deterioration paths (blue, yellow and red) estimate the downward movements (indicating condition degradation) among condition states from year to year, if no agency action is taken.
- Preservation paths (blue and red), rehabilitation (green and grey) estimate the upward movements (indicating condition improvements) among condition states when an agency conducts a preservation or rehabilitation action.

Figure 15 — *Changes in Condition Estimated by a Forecasting Model (1 is best condition state and 4 is worst)*



For convenience, deterioration models are typically expressed in terms of the median number of years to transition from each condition state to the next-worse state. The relative size of upward and downward movements determines the overall change in condition. If the deterioration and preservation movements are balanced, then network condition remains unchanged.

Since the models quantify year-to-year changes in condition, they can be developed using a relatively small amount of data – two inspection cycles (four years) at a minimum. However, the models are more reliable if developed using a longer time series. Having begun the new element level inspection process only recently, GDOT needed time to refine its inspector training and does not yet feel confident in its element level deterioration models. Substantial improvement is expected over the coming years.

The federal performance measures of percent of bridges in good and poor condition are expressed in terms of NBI component ratings, but for most management purposes the element level is far superior. This is especially the case for planning of preservation activities, since they depend heavily on the condition of wearing surfaces, coatings, expansion joints and other aspects of a bridge that are not quantified in the NBI component system, but are explicitly measured using elements.

For this reason, GDOT has not found the NBI component level analysis suitable for life-cycle planning. The element level of analysis is suitable, but is not fully developed as of June 2019. GDOT is cooperating with the software developer to help them further refine the necessary functionality.

While awaiting additional BrM development, GDOT has prepared a spreadsheet model to compile all of the input data it will eventually need for BrM. This model currently operates at the NBI component level, so it is considered only a first approximation. The outcome forecasts developed in this TAMP are based on the spreadsheet model and initial component level analysis from BrM.

4.4.1. Treatments to Maintain and Improve Performance

Table 5 provides a summary of the bridge treatments and their typical costs used for analysis in BrM.

Table 5 — *Summary of GDOT Bridge Treatments by Work Type*

Work Type	Treatment Description	Typical Treatments	Approximate Unit-Cost
Maintenance	**Condition-based or interval-based activities that do not require engineering or multi-year programming, usually determined by local crews.**	• Drift removal • Deck sweeping and/or bridge washing • Minor deck spall repairs or deck crack sealing • Cleaning of scuppers and expansion joints • Cleaning and lubrication of bearings • Spot painting of girder ends or bearings	**$4 to $25 per square foot**
Preservation	**Actions or strategies that prevent, delay or reduce deterioration of bridges or bridge elements.**	• Seal bridge decks (polymer overlay) • Paint steel super and substructure components • Joint replacements or resealing of joints • Minor spall repairs to the super and substructure components • Edge beam reconstruction • Major deck spall repairs • Slope paving repair • Installation of sway bracing • Epoxy injection of cracks • Header repair	**$7 to $42 per square foot**
Rehabilitation	**Major work required to restore or increase the structural integrity of a bridge, as well as improvements to function, capacity, resilience or safety.**	• Deck Rehab • Latex overlay • Polyester Polymer Concrete Overlay • Hydro-blasting of the bridge deck overlay • Replacement of the deck • Pile encasements/jacketing • Bridge jacking to reset bearings or increase vertical clearance • Steel or concrete beam repair or replacement • Major spall repairs to the super and substructures components • Scour counter measures • Carbon-reinforced polymer repairs and strengthening • Wingwall repair on culverts • Heat straightening of damage steel beams • Widening of the bridge	**$43 to $82 per square foot**
Reconstruction	**Bridge Replacement – Removal of an existing bridge and construction of a replacement bridge to serve the same alignment as the removed bridge.**		**$250 per square foot**

In GDOT bridge management, the distinction between rehabilitation and preservation is mainly determined by the severity of defects. Both categories are programmed on a multi-year basis within BrM, both are managed within the same office, and both types of activities can occur within the same project on the same bridge. All actions are selected and prioritized based on treatment feasibility, traffic impacts, environmental concerns and life-cycle cost. As GDOT continues to implement BrM, it is transitioning to greater reliance on quantified life-cycle cost where possible. This will be phased in over multiple years as the Department gains confidence with the forecasting applicable to each type of treatment.

Actions in the Maintenance category (see **Table 5** above) slow the rate of deterioration. Because these activities are frequent, low-cost and minimally disruptive, they are not programmed as individual projects in BrM. GDOT plans these as operational activities that crews perform on a scheduled basis or in response to work orders. Real-time monitoring is also beginning to play a role. GDOT's BridgeWatch system, for example, monitors the clearance between a body of water and the underside of a bridge to warn of potential flood damage due to rainfall or storm surge.

The allocation of funding is determined in the budgeting process. A GDOT goal for its BrM implementation is to incorporate life-cycle cost within the budgeting process, which may have the effect of further increasing the allocation of funds to preservation work.

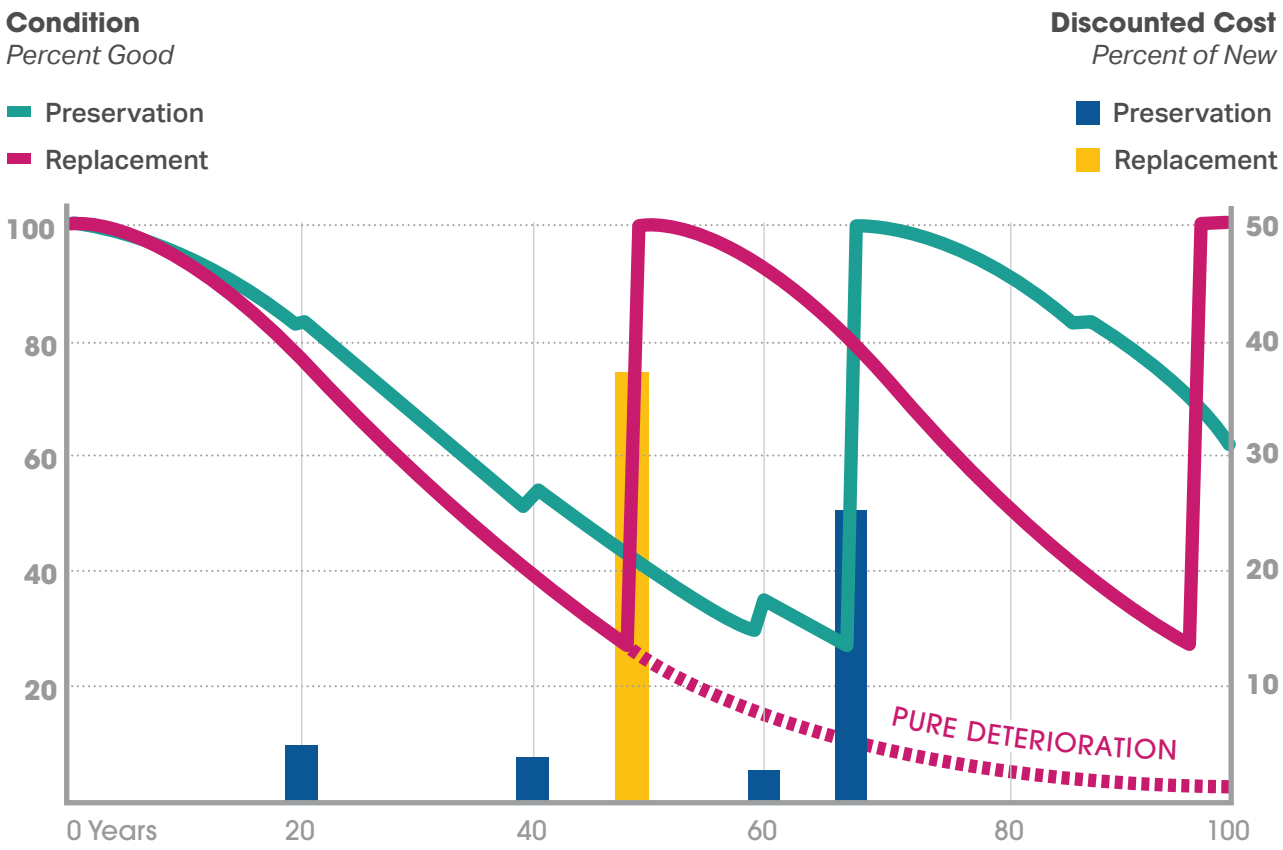
4.4.2. Strategy for Minimizing Life-cycle Cost

In recent years, bridge materials and construction methods have vastly improved, enough so that the standard design life for new bridges has increased from 50 years to 75 years. However, most of the existing bridges in Georgia were built before that period of innovation, and some are already past their design life. The reason these bridges continue to serve the public safely is GDOT's preservation program.

Figure 16 shows the effects of preservation schematically. The lines in the chart show typical condition (in terms of percent good) over a 100-year period:

- The dotted line is uninterrupted deterioration. If left unrepaired, the bridge would eventually have to be closed.
- The solid yellow line shows the situation where the bridge is replaced after conditions become intolerable. A replacement cost is incurred, represented by the yellow bar.
- The solid green line shows the effects of a preservation program. In this case, preservation or rehabilitation work is performed on an interval of about 20 years, and routine maintenance is also performed. The costs of these activities are shown using green bars. The bridge still must be replaced eventually, but this large cost is significantly postponed.

Figure 16 — *Effects of a Preservation Program on Bridge Condition and Cost*



Postponing high costs is always beneficial as it extends the benefit of the significant investment the people of Georgia make in their bridges, and it reduces overall costs in the long run. GDOT, like all transportation agencies, evaluates this benefit using a discount rate, which has been set by the Department at 2% per year. In effect, the importance of a large expenditure declines by this amount for each year that the cost can be delayed, since the money saved can then be used for higher-priority investments. The cost bars in **Figure 16** become smaller over time because of this discounting. If the total length of the blue bars is less than the orange bar, then the preservation program is cost-effective.

Given the long lifespan of bridges, uncertainty in the rate of deterioration and the conservative discount rate, GDOT evaluates life-cycle costs over a time horizon of 200 years. This may incorporate multiple cycles of preservation and reconstruction.

4.4.3. Other Factors Influencing Bridge Life-Cycle Planning Decision Making

Georgia has been replacing all state-owned bridges that require truck weight restriction, also called "posted bridges." There are only 10 structures on the NHS requiring load limit posting, all of which are either under construction or are in the program for replacement. The Department has also scheduled replacement of bridges that require temporary shoring to keep the structures open and carrying trucks meeting state legal limits.

Bridges on the interstate were built to the HS20 design standard. However, off the interstate there are nearly 2,000 bridges designed at a standard below the HS20 standard. Georgia has prioritized these structures to ensure mobility for permitted heavy loads.

Currently there are 1,313 structures owned by local jurisdictions or counties across Georgia that are weight restricted or even closed. With limited funding available, GDOT has been focused on reducing the number of these posted/closed bridges. The Department has been replacing bridges using a streamlined approach for low impact bridges that can be temporarily closed during construction, can be constructed within existing right-of-way and have minimal environmental and utility impacts. GDOT has also partnered with many local agencies to replace posted/closed bridges that require a conventional approach.

Because of the emphasis on heavy freight movement, many large bridges on Georgia's NHS have already been replaced. Given more modern design standards and the state's benign climate, these structures remain in excellent condition. The Department's focus in the coming years for life-cycle planning is to determine how much deterioration should be allowed, and use the preservation strategy to regulate deterioration to keep the state's bridges in optimal condition to minimize costs in the long term. GDOT's analysis thus far indicates that the percent of NHS deck area in good condition may be economically increased to at least 60% with a strategic preservation and rehabilitation program. Analytical work over the next two years will help to refine and implement this strategy.

4.5 Process Enhancements

GDOT is in the process of implementing the BMS and PMS software to further inform its preservation program. Preliminary outputs from these models have informed this TAMP; however, complete implementation requires fully operational software, sufficient staffing to use the software, incorporation of the outputs into routine decision making for the Operating Budget and the STIP, evaluation of the effectiveness of delivery of the preservation program, and continuous improvement of planning metrics and preservation and rehabilitation methods. GDOT is already well progressed in:

- Collecting, processing, storing and updating inventory and condition data for all NHS pavement and bridge assets
- Forecasting deterioration for all NHS pavement and bridge assets

In the future, the PMS and BMS will be utilized to further assist GDOT in:

- Determining the benefit-cost over the life cycle of assets to evaluate alternative actions (including no action decisions), for managing the condition of NHS pavement and bridge assets
- Identifying short- and long-term budget needs for managing the condition of all NHS pavement and bridge assets

- Determining the strategies for identifying potential NHS pavement and bridge projects that maximize overall program benefits within the financial constraints
- Recommending programs and implementation schedules to manage the condition of NHS pavement and bridge assets within policy and budget constraints

GDOOT specific process enhancements include:

Item	Action	Discussion	Timeframe for Implementation
1	**Further benefit-cost analysis to evaluate alternative actions/ strategies for managing pavement and bridge asset condition to achieve GDOT targets.**	As an example, there is currently a strong focus on bridge replacement to achieve the 4-year target of 60% of bridges in good condition. Future analysis will consider alternative splits between work types (Maintenance, Preservation, Rehabilitation, Reconstruction) to maintain this (or future) targets.	Late 2020 (Calendar Year)
2	**Complete PMS implementation.**	GDOT is well advanced in implementation of the PMS, but needs to continue refining the model to be confident in the analysis required to deliver some of the other actions identified as process enhancements (e.g. evaluating strategies and setting targets).	Late 2020 (Calendar Year)
3	**Complete BMS implementation, including adding the ability to undertake element-level analysis.**	GDOT has identified activities for full BMS implementation that includes: • Complete training, develop model inputs and calibrate BrM • Update life-cycle analysis and adjust GDOT processes/ targets etc. where/if necessary • Incorporate outputs into STIP development process and share new targets • Continue to evaluate and improve the system	Calendar Years: 2020 2021 2023 and beyond

Section 5

Risk Management

GDOT's risk management process focuses on risks that limit the Department's ability to deliver the investment strategies presented in this TAMP, and ultimately to deliver service to NHS users.

5.1 Introduction

Risk management is critical when making asset-related decisions at GDOT. It entails considering and managing uncertainties that might adversely affect business objectives and the safety of stakeholders. When considering the risk inherent to an asset, five key questions are considered:

- How likely will a catastrophic event or hazard occur that could impact the asset?
- What are the consequences to the asset if a catastrophic event or hazard occurs?
- What are the impacts to the agency or public if the asset can no longer perform its function?
- What various risk categories should we consider?
- What agency and programmatic risk does the Department face?

Overall, the goal is to enhance GDOT's decision-making capabilities regarding the preservation of its assets.

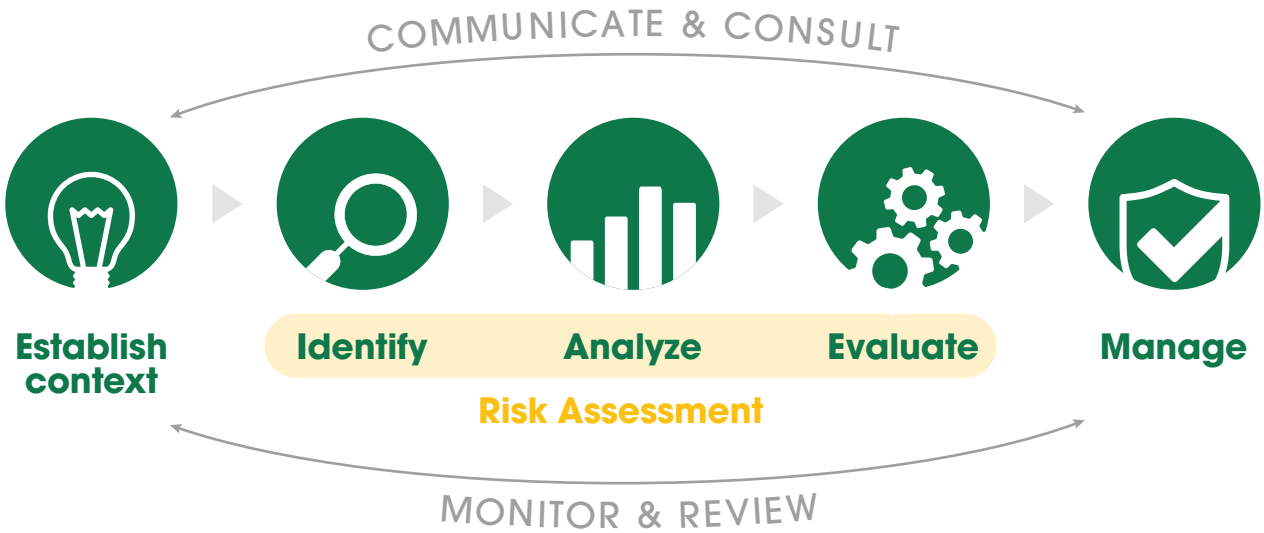
5.2 Risk Management Process

GDOT has adopted a risk management process to support TAM activities. It addresses internal risks at the enterprise, program and project levels, and external risks affecting different categories of consequences.

Risks include current and future environmental conditions relevant to GDOT such as extreme weather events, and the risks of recurring damage and costs from repeated emergency events specified in 23 CFR 667 which relate to pavements and bridges. Financial risks, operational risks and other strategic risks are also addressed by the risk management plan. The risk management process

undertaken by GDOT, illustrated in **Figure 17** meets federal TAMP requirements for managing risk, follows the FHWA risk management guidance, and is aligned with the International Organization for Standardization (ISO) 31000 Risk Management System framework.

Figure 17 — *GDOT Risk Management Process*[10]



As depicted above, the risk management process includes the following elements:

- **Establishing the context** involves developing an understanding of the internal and external drivers of the risk management process. This includes establishing an approach and a team to develop, implement and maintain the risk management framework, and document and administer action items for managing risk.
- **Risk identification** is the process of compiling effects generated from uncertainties impacting organizational objectives. Risks can come from various sources, span different time frames with varying scopes or resolution, whether enterprise wide or project specific.
- **Risk analysis** involves understanding the cause of risks, the likelihood of their occurrence, the possible outcomes and their potential impacts. Likelihood has been defined with a qualitative description of the chance of an event occurring defined by combining information about probability and the agency's historical records and experience, while consequence has been defined with a qualitative description of the impact or outcome of a risk event. In this analysis step, both factors are assigned a grade to aid in risk evaluation.
- **Risk evaluation** compares the likelihood of a risk event occurring against the consequence of the event, and uses the level determined to prioritize the risks.
- **Risk management** refers to the selection of a(n) action(s) to respond to the risks identified. There are several response options to manage risk and the determined risk rating can inform the selected response option.

10. Incorporating Risk Management into Transportation Asset Management Plans. FHWA (November 2017)

- **Communicate, consult, monitor and review** are overarching, continual improvements demonstrating the iterative nature of risk management. Communicating and consulting allows for the exchange of information and dialogue with stakeholders to ensure varied views are considered, that all participants are aware of their roles and responsibilities, and to ensure transparency and understanding around specific actions in response to risks raised. Continuous reviews will include evaluations to update, refine the risk management framework, policy and process for the changing organization's context and if (and how) they are followed.

5.2.1. Establish the Context

As part of the initial TAMP submitted in April 2018, GDOT developed an enterprise-wide risk register covering three risk groups and six consequence categories. This process was further developed in 2019.

The development of the risk management process was led by the Office of Performance-Based Management & Research and utilized the TAM Committees with significant involvement by the Steering Committee and Task Force.

RISK MANAGEMENT PROCESS

GDOT's risk management process focuses on risks that limit the Department's ability to deliver the investment strategies presented in this TAMP, and ultimately to deliver service to SRS and NHS users.

5.2.2. Assess Risk – Identification, Analysis and Evaluation

The risk identification process (involving the TAM Steering Committee, Task Force and members of the Focus Group) identified 19 risks (see **Table 8** for full list) that were organized into three groups:

- **Enterprise/Agency —** Risks that affect more than one major program or objective of the organization.
- **Program —** A collection of related projects or on-going efforts to ensure achievement of specific organizational objectives.
- **Project/Activity —** In this context these risks refer to a single or group of assets.

The risk analysis step identified six consequence categories (**Table 6**) and five consequence levels upon risk occurrence.

Table 6 — *Consequence Scale*

	Consequence Category	System Performance	Reputation	Safety	Legal & Compliance	Workforce	Financial
Consequence Levels	**Catastrophic**	Loss of asset functionality causing significant travel disruption on multiple highway systems.	Public Investigation, international media, potential management change.	Several deaths, severe injuries.	Significant legal consequences with major interruption to operations.	Disrupts operations and hinders agency objectives.	Lack of financial resources to maintain acceptable level of service. Potential risk of penalties, loss of federal funds. Critical cost impact.
	Major	Extended travel disruption on highway systems.	Loss of confidence, sustained national publicity, public protest for action.	Low number of deaths or injuries.	Legal consequences with interruption to operations.	Significant organizational changes required for operations, meet agency objectives.	Inadequate financial resources to maintain acceptable level of service with considerable difficulty justifying requests for funds. High impact on costs.
	Moderate	Some travel disruption.	Public community discussion, broad negative regional media coverage.	Minor injuries, possible serious injury.	Requiring investigation, non-compliance with major fine, legal action.	Some organizational change for operations and agency objectives.	Potential gap between resources and acceptable level of service. May be able to meet compliance with funding. Moderate impact on costs.
	Minor	Short delays, operational slowdowns.	Minor community interest, and local media coverage.	Possible minor injury.	Non-compliance with minor fine, managed internally.	Agency can meet objectives with slight difficulty, operational interruption.	Adequate financial resources with little to no difficulty justifying funds. Minor impact on costs.
	Insignificant	Un-noticed operational delays.	Individual interest.	No injury.	No consequences, manageable actions.	Manageable work-arounds for agency objectives.	Largely adequate financial resources with no difficulties justifying funds. Little to no cost impact.

A risk rating is then assigned from the Risk Matrix (**Table 7**), based upon the consequence level and likelihood of occurrence. The descriptions and indicators (timeframes for likelihood) are indicative only and have been developed by GDOT to help prioritize the risks identified.

Table 7 — *Risk Matrix*

Consequence	Likelihood:	Rare <1x/20year	Unlikely <1x/10year	Possible 1x/5year	Likely 1x/year	Very likely >1x/year
Catastrophic	Potential for multiple deaths, injuries, substantial public, private costs				Extreme	
Major	Potential for multiple injuries, substantial public, private costs, and/or foils agency objectives				High	
Moderate	Potential for injury, property damage, increased agency cost, and/or impedes agency objectives				Medium	
Minor	Potential for minor agency cost and impact to agency objectives				Low	
Insignificant	Potential impact low and manageable with normal agency practices				Very Low	

The risk rating (based upon the consequence and likelihood) is used to prioritize each item in the risk register to identify the top risks. **Table 8** presents the risk register with risks identified and assessed.

Table 8 — *GDOT Risk Register*

Risk ID	Risk Description	Consequence Category	Rating (Consequence x Likelihood)
Enterprise / Agency Risks			
1	**Staffing /Knowledge Retention:** If the agency does not implement workforce planning for required skillsets, then there may not be enough qualified employees for project delivery.	Workforce	Low
2	**Economic Downturn:** If there is an economic downturn and impact on fuel tax revenue then it can increase/decrease available funding.	Financial	Medium
3	**Funding Restrictions:** If there are legislative changes to fuel tax and areas in which it can be spent (opportunity and risk) it can increase/decrease available funding.	Financial	High
4	**Delay in Federal Funding:** If there is federal budget uncertainty (timing) caused by a delay in Congress passing a full year funding bill, this can result in a delay in projects and reduce the capacity to deliver within the financial year.	Financial	High
5	**Lack of Organizational Alignment:** If the agency is not aligned on priorities and the delivery of investment strategies, the agency may not deliver planned activities.	Workforce	Low
Program Risks			
6	**Project Delivery:** If projects are not delivered on time it can affect the ability to delivery in the following year, and future ability to secure support from public, political and regulatory stakeholders.	Reputation	Low
7	**Data Reliability:** If data for decision making is inaccurate, then the ability to meet performance targets may be reduced.	System Performance	Low
8	**Shift in Modal Choice:** If there is a shift to alternative transport modes resulting in a reduction in fuel usage, then available funding can decrease.	Financial	Low
9	**Construction Pricing Variations:** If there is an increase in construction prices then the ability to deliver planned activities can be compromised.	Financial	Low
10	**Extreme Weather Events:** If extreme weather events (flooding, storm, fire) occur, then funding may need to be diverted from planned activities.	Financial	High

Risk ID	Risk Description	Consequence Category	Rating (Consequence x Likelihood)
11	**Access to Assets Due to Natural Emergencies:** If flooding, storm, fires occur with assets becoming difficult to service, it can pose a safety concern for the public and staff.	Safety, System Performance, Legal & Compliance	Medium
12	**Major Capacity Projects:** If there is a higher than anticipated delivery of new assets, then existing funding levels may be inadequate to deliver asset outcomes (likely longer term).	Financial, System Performance	Low
13	**Emerging Technology:** If the cost of implementing new technology (e.g. CAV, BrM) is significant, then available funding may need to be diverted from planned activities.	Financial, System Performance	Low
Project / Activity Risk			
14	**Increased Asset Deterioration:** If environmental impacts (marine environment, sea level rises, snow (increasing deicing use) occur at levels greater than currently expected, then asset deterioration rates could increase.	System Performance	Low
15	**Quality of New Assets:** If workmanship on new projects (e.g. poor construction quality) does not meet expectations, then earlier/increased interventions may be required.	System Performance	Low
16	**Vehicle Loading:** If there are increases in legal/illegal vehicle loads, then asset deterioration rates will increase.	System Performance	Medium
17	**Emergency Situation:** If there is a localized emergency event (e.g. bridge hit, flooding, fire), then service can be disrupted.	System Performance	Low
18	**Effective Intervention:** If preservation activities are not effective (don't achieve expected life extension outcome), then performance targets may not be met.	System Performance, Legal & Compliance	Low
19	**Timely Intervention:** If preservation activities are not performed at the right time, then the treatment required may increase in cost.	System Performance, Financial	Medium

5.2.3. Manage Risk – Prevention and Mitigation

For each item on the risk register, two actions were identified:

- **Risk Prevention —** An action to be taken before the event to reduce the likelihood, or prepare for the event occurrence.
- **Risk Recovery —** A recovery action taken after the event occurs to minimize the consequence.

The event occurrence is referred to as the Event Trigger. These two types of actions are presented in **Figure 18**. Subsequently, a management plan for top priority risks including the trigger, actions, owners and timeframes is presented in **Table 9**.

Figure 18 — *Risk Prevention/Recovery Actions*

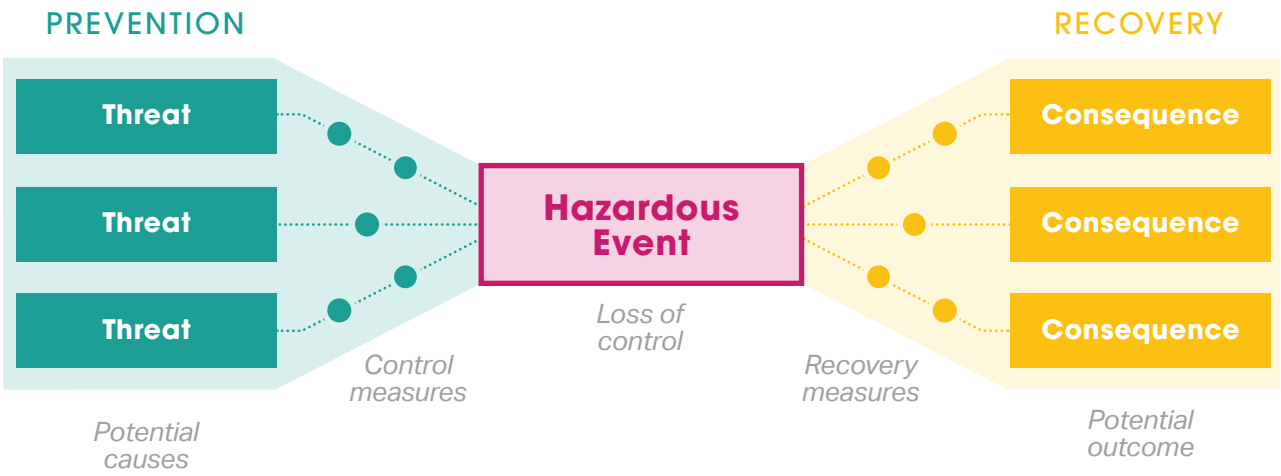


Table 9 — *Top Priority Risk Management Plan*

Risk ID	Rating	Trigger	Prevention and Recovery with Owners	Mitigation Start Date, End Date
3	High	**Legislative changes to fuel tax such as spending criteria, tax amounts**	**Prevention Action:** Develop or find other revenue mechanisms. Build-in excess funding to lessen impact of legislative changes, develop strategies for operating with less funding. Owner: Executive Leadership/ Planning / Finance and Budget **Recovery Action:** Apply asset management prioritization processes to determine highest priority work with reduced funding, raise funding from other sources or operate with less funding. Owner: Executive Leadership/ Planning/ Finance and Budget	**Start:** (January each year) Regular discussions during the legislative session (January through mid-April) with the Office of Planning and Budget (OPB), House and Senate Budget offices to ensure a full understanding of the Department's budget. **End:** (April each year) Before Conference Committee changes are agreed to.
10	High	**Extreme weather events and natural disasters (Risk – Extreme weather events)**	**Prevention Action:** Define extreme weather events and build in excess funding in the planning process. Owner: Executive Leadership/ Planning/ Asset SMEs **Recovery Action:** Use contingency fund, or divert spare resources from other programs in the event of extreme weather events. Seek Federal Emergency Management Agency (FEMA)/ FHWA support where appropriate. Owner: Executive Leadership/ Planning/Asset SMEs	**Start:** (Already in place) Areas of extreme weather risk have been identified. Dedicated GDOT funding reserve exists for extreme events.
4	High	**Federal budget delay and/or reduction**	**Prevention Action:** Develop or find other revenue mechanisms. Build-in excess funding to lessen impact of federal funding delay, develop strategies for completing projects with less funding. Owner: Georgia Congressional Delegation/ General Assembly/ Governor/ GDOT Commissioner **Recovery Action:** Utilize funding from other sources beyond federal funding to support projects, find ways to complete projects with less funding, and use asset prioritization to optimize funding allocation. Communicate with stakeholders to modify project timelines. Owner: Executive Leadership/ Planning/ Finance and Budget/ Program Delivery	**Start:** (Ongoing) At monthly meetings discussing project mix for upcoming lettings, available funding and budget capacity. **End:** (Continual) Project funding, financial priorities and budget capacity re-evaluated as notice of federal funding is received.

Risk ID	Rating	Trigger	Prevention and Recovery with Owners	Mitigation Start Date, End Date
2	Medium	**Economic downturn with fewer people driving on fuel decreasing tax revenue**	**Prevention Action:** Develop or find other revenue mechanisms. Build-in excess funding to lessen the impact of economic downturn, develop strategies for operating with less funding. Owner: Executive Leadership/ Planning/ Finance and Budget **Recovery Action:** Apply asset management prioritization processes to determine highest priority work during downturns, raise funding from other sources or operate with less funding. Owner: Executive Leadership/ Planning/ Finance and Budget	**Start:** (Ongoing) Monitor news and media outlets daily. **End:** Two to three months after projections indicate a high probability of declining revenues for a sustained period of time.
11	Medium	**Extreme weather events and natural disasters (Risk – Access to assets due to natural emergencies)**	**Prevention Action:** Highlight areas of vulnerability for flooding, storm, fires, and natural hazards to implement monitoring systems, warning programs. Exercise emergency scenarios for safety preparation among staff, including potential evacuation. Owner: District/ State Maintenance Office/ Maintenance SMEs **Recovery Action:** Enact appropriate emergency action protocols, including escalation, evacuation. Owner: District/ State Maintenance Office/ Maintenance SMEs	**Start:** Areas of risk/ vulnerability have been identified.
16	Medium	**Increased traffic, economic activity for higher vehicle loads**	**Prevention Action:** Highways susceptible to increased loading will be highlighted for more monitoring, additional maintenance, treatment, divert traffic and load to prevent, slow down deterioration. Owner: Asset SMEs/ Department of Public Safety **Recovery Action:** Implement repairs, treatment to slow deterioration. Owner: Asset SMEs/ Department of Public Safety	**Start:** Key freight corridors and those used by heavier loads have been identified. Need to consider additional monitoring requirements. and effectiveness of this approach.
19	Medium	**Preservation activities not conducted at right time**	**Prevention Action:** Have preservation timing based on performance, condition, and risk. Keep track of preservation timing activities and enforce with the right resources to support it. Owner: Asset SMEs **Recovery Action:** Review performance targets for the next period to see if targets can be improved. Inform stakeholders of implications of targets not being met. Owner: Asset SMEs	**Start:** GDOT to review current practices for tracking and reporting completion of preservation (and other work type) activities. **End:** Expected 2020
6	Medium	**Untimely project delivery**	**Prevention Action:** Determine factors affecting project delivery timing and prevent them. Keep clear communication on all project phases with stakeholders to inform status and potential scenarios. Owner: Planning/ Program Delivery **Recovery Action:** Explain to stakeholders the reasons for untimely deliveries to manage expectations affecting future funding. Owner: Planning/ Program Delivery	**Start:** Assess year to year project delivery to identify appropriate investment levels that can be effectively managed. **End:** Expected 2020

5.2.4. Communicate, Consult, Monitor and Review – The Risk Register

Risk management is an iterative process to reduce risk, re-prioritize and continually improve and refine with new risks that may emerge. As indicated in the risk register, those risks determined to have the largest potential impact have risk prevention and recovery actions to actively work to reduce risk.

5.3 Assessment of Assets Repeatedly Damaged by Emergency Events

23 CFR Part 667, Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events, requires GDOT to conduct an evaluation of facilities (on the NHS at a minimum) that have required repairs to emergency events on two or more occasions.

GDOT undertook this analysis for all State Routes and there were no roads with two or more repairs or reconstruction due to emergency events since 1997.

The process to undertake this assessment included a review of the following data sources:

- **Bi-Annual Pipe Inspection —** Identifies damaged or non-functioning drainage assets.
- **Maintenance Management System —** Manages day-to-day activities and tracking of work orders for damaged assets.
- **PMS —** Identifies the condition and prioritization of GDOT's largest asset. It is used to plan pavement preservation to prolong the life of these assets.
- **GEARS —** Identifies damages that are recovered by insurance claims to roadside assets.
- **Collector app / GIS based mapping —** Inventories roadside assets and MS4 structures to gather current data and build a historical database.

The systems enable GDOT to look at historical damage and work orders to identify any instance of the same work occurring in the same location.

The State Maintenance Office is responsible for this process. After each future emergency event the event is logged and the system is checked to see if this is a repeat event. This will inform decision making on repairs and whether an alternative approach is required.

Section 6

Financial Plan and 10-Year Investment Strategies

GDOT's TAMP Financial Plan provides projected available annual revenues and anticipated expenditures over a 10-year period. These projections are used to support asset management objectives to achieve Department targets.

6.1 Introduction

GDOT's 10-year Financial Plan uses the STIP, a four-year program of anticipated revenues, as a base for funding projections, and incorporates funding sources from anticipated federal funds, state funds and General Obligation Bonds. Inputs to the Financial Plan set the baseline funding for bridge maintenance bridge replacements and pavement maintenance and resurfacing. Investment strategies then define the mix of work types that will be used to deliver the outcomes discussed in this TAMP.

6.2 Projected Funding Levels

Federal funding levels are derived from GDOT's Highway Funding Matrix and the Balancing sheet produced by the Office of Financial Management. This includes the matched federal funding level for the four-year STIP period. After the STIP period (currently FY18-21), funding levels are grown at 1% annually for long range planning, such as the SWTP and TAMP development; however, numbers are revisited with each STIP update. The SWTP is currently being updated and outputs from this TAMP are being utilized in the SWTP development process.

State funding levels currently use expected motor fuel and fee revenues budgeted for the amended FY19 and FY20 budgets and are then grown at 1% annually. Bond issuances and other financing revenues are recognized in their anticipated year based on investment assumptions.

A state or federal "lump sum" is programmatic funding to address the highest priority needs (including bridge maintenance, operations, Intelligent Transportation System (ITS), and resurfacing) on an annualized basis without having to program individual projects in the STIP/TIP. Funding amounts are provided for the STIP years and then grown at 1% annually. These amounts are provided by the Chief Engineer based on the needs to address asset management versus the capital program. The lump sum program comprises set aside funds for 11 groups of projects that do not alter the capacity of the

roadway. The lump sum program is intended to give the Department flexibility on a programmatic basis while fulfilling the requirements of the STIP.

All funding within this section is presented in 2019 dollars.

6.2.1. Funds Available for Pavement Investment Strategies

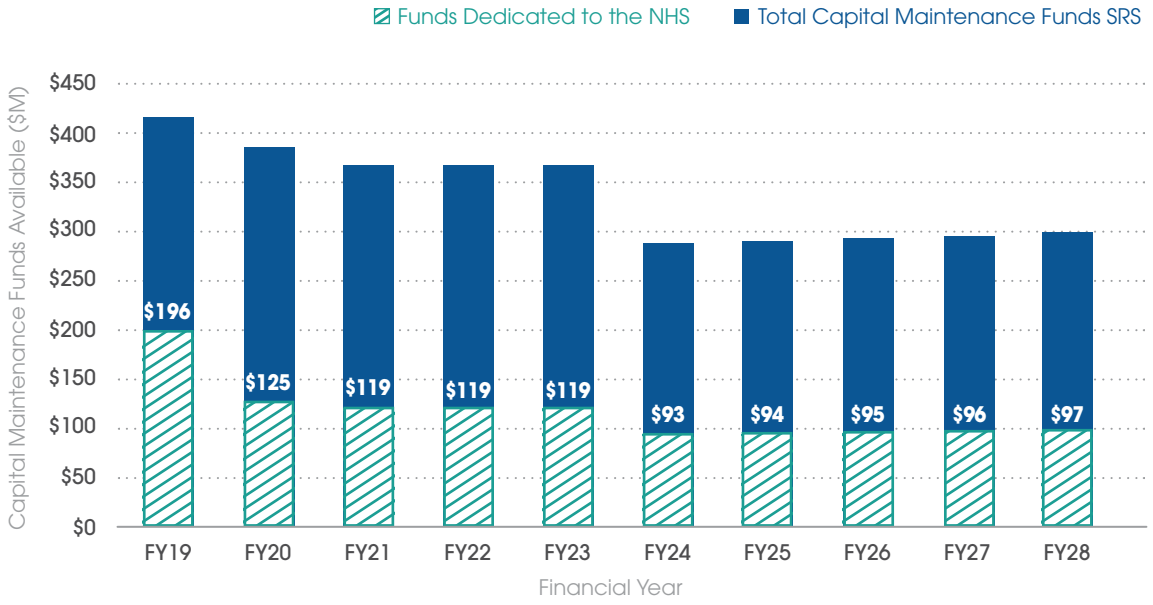
The capital maintenance budget funds resurfacing and striping for the full SRS. A portion of the total capital maintenance budget is available specifically to meet pavement targets on the NHS. As a result of increased funding through the Transportation Funding Act (2015), GDOT has been able to increase its focus on deferred maintenance activities. This has enabled GDOT to work towards a 15-year pavement resurfacing cycle compared to a previous 50-year cycle.

TRANSPORTATION FUNDING ACT

In 2015, GDOT initiated the Transportation Funding Act, to provide much-needed funding to repair, improve and expand the state's transportation network through routine and capital improvement projects.

The 10-year funding available for the NHS represents a total of about $1.2B (see **Figure 19**). The remainder of the capital maintenance budget is utilized for the broader SRS for which GDOT is responsible. GDOT maintains some flexibility to utilize the non-NHS capital maintenance funds to ensure that NHS performance targets will be achieved.

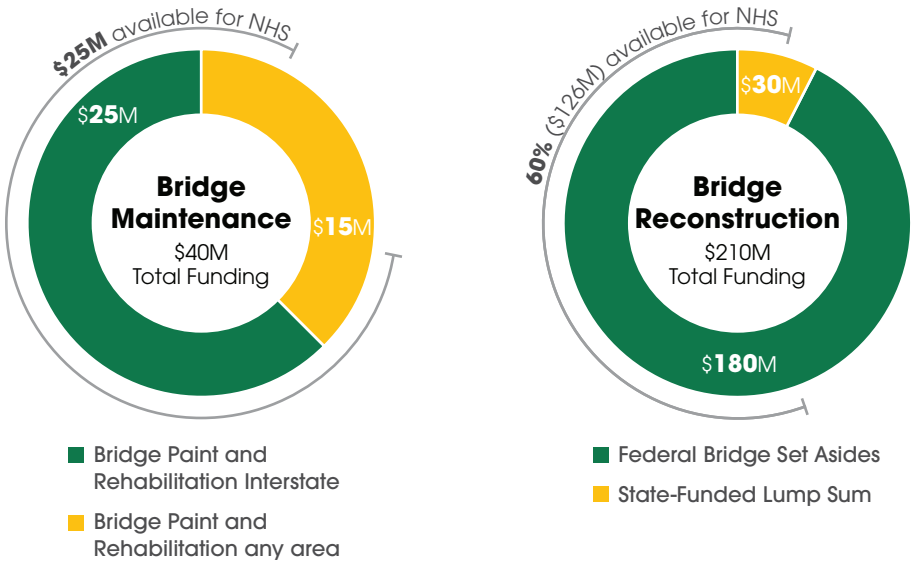
Figure 19 — *Capital Maintenance Funds Available for the SRS and Specifically for NHS Pavements, FY2019 - FY2028*



GDOT has identified a desire to quantify the funds available to the NHS from local NHS owners (for both pavements or bridges). This dollar value is very small compared to GDOT funding, as would be expected based on the relative proportion of the network under local ownership. This has been identified as a future TAMP process enhancement.

6.2.2. Funds Available for Bridge Investment Strategies

Figure 20 — *Funds Available for SRS and NHS Bridge Maintenance and Bridge Reconstruction / Replacement (For FY 2020, in FY 2019 dollars)*

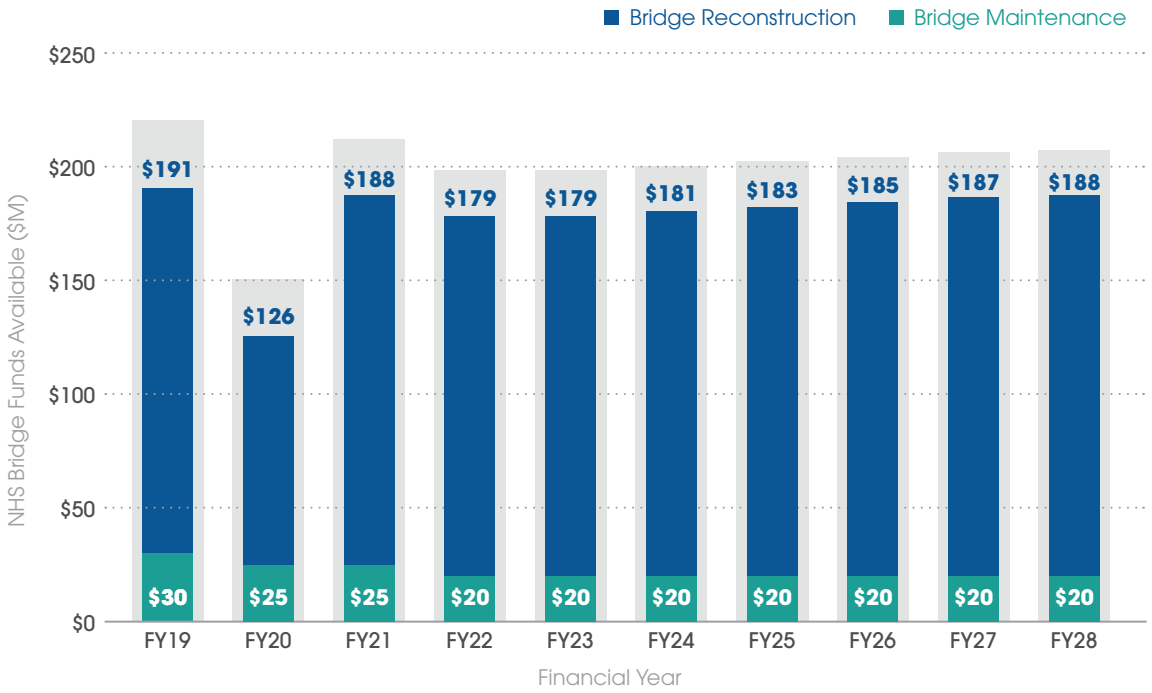


The bridge program receives funding from several sources. Bridge maintenance, including preservation and rehabilitation, primarily receives funding from two federal lump-sum pools: 1) Bridge Paint and Rehabilitation Interstate; 2) Bridge Paint and Rehabilitation Any Area. As illustrated in **Figure 20**, of the $40M of funding anticipated in FY 2020 for bridge maintenance, $25M is available for bridge maintenance on the NHS.

Bridge reconstruction also obtains funding primarily from two sources: 1) federal bridge set asides; 2) state-funded lump sum. **Figure 20** illustrates that 60% or $126M of the total $210M of funding anticipated for 2020 bridge reconstruction, is available to meet bridge performance targets on the NHS.

In total, GDOT anticipates approximately $2B in bridge funding over the 10-year period 2019-2028 (see **Figure 21**).

Figure 21 — *Funds Available for NHS Bridges FY2019 – FY2028.*



6.2.3. Managing Risk to Funding Levels

The TAMP risk assessment identified two High risks and one Medium risk related to uncertainty in future funding. These risks were:

- **Funding Restrictions:** If there are legislative changes to fuel tax and areas in which it can be spent (opportunity and risk) it can increase/decrease available funding. (High rating)
- **Delay in Federal Funding:** If there is federal budget uncertainty (timing) caused by a delay in Congress passing a full year funding bill, this can result in a delay in projects and reduce the capacity to deliver within the financial year. (High rating)
- **Economic Downturn:** If there is an economic downturn and impact on fuel tax revenue then it can increase/decrease available funding. (Medium rating)

These areas of risk are a significant priority to GDOT and mitigation actions have been identified that can be applied to the NHS. These actions include the following, already in place:

- The ability to supplement the funding for the NHS (from the wider SRS) through flexibility in the capital maintenance and bridge reconstruction budgets.
- Prioritization processes where limited funds are available as defined by the State Route Prioritization.

6.3 Asset Valuation

Asset valuation informs public officials and citizens of the value of transportation assets owned and the maintenance they require. It also enhances the importance of, and provides an indicator in, the level of investment needed to preserve and maintain assets. An asset valuation assigns a monetary amount to the asset based on criteria such as size, age, condition, performance and replacement cost. There is a range of different approaches to asset valuation with advantages and disadvantages of each. Many state DOTs use more than one approach for different purposes.

GDOT has used two sources of existing information as a basis for asset valuation. Both methods have limitations, as described below. Recognizing these limitations, GDOT has determined NHS asset valuations as an upper and lower bound, presented in **Table 10** on page 58.

6.3.1. Depreciated GASB 34 Approach — Lower Bound

For federal reporting purposes, GDOT produces an asset valuation that is consistent with the Governmental Accounting Standards Board (GASB 34) accounting rules and regulations. This approach starts with the original cost at the year of construction, the annual depreciation and accumulated depreciation are determined and subtracted from the original cost to yield the asset value at any year. This approach is expected to form a lower bound as it is based on the original rather than current day cost of the asset. This approach is not linked to asset condition so any improvements made to the asset are not recognized.

6.3.2. Replacement Value Approach — Upper Bound

This approach estimates the cost of replacing the asset now with an asset of the same function and performance. This approach is expected to form an upper bound as it does not take in to account that assets in almost all instances are not in a new condition; meaning, there has been some depreciation in their value. However, this 'new' value may represent value to the traveling public better as it reflects current costs and technology.

Based on these two approaches the estimated valuation for NHS pavements is a range of $4.9–$33.4 billion. For NHS bridges the range is $360 million–$16.4 billion.

6.3.3. Asset Valuation — Comparison to Funding Levels

When comparing these valuation numbers to the funding levels identified in the Financial Plan, yearly funding for pavements on the NHS is in the range of 0.5%–2% and for bridges the funding is likely greater than 1% of the asset valuation (based on the upper bound valuation). An ongoing comparison of the funding levels to asset value can be used as an indicator of whether the level of investment, relative to the value of the asset, is increasing or decreasing.

6.4 Process Enhancements — Financial Plan

GDOT has identified areas where the Financial Plan process can be enhanced. These improvements will enable GDOT to better quantify the full extent of expenditure on the NHS and ensure this full value is considered through life-cycle planning processes as defined in this TAMP.

GDOT is currently progressing the following process enhancement:

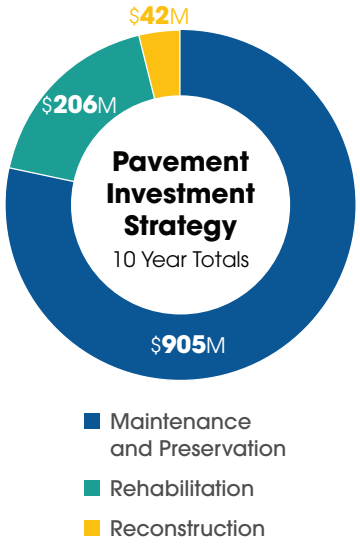
Item	Action	Discussion	Timeframe for Implementation
4	**Further identification of additional funding available for the NHS.**	There are several areas where GDOT will focus this effort: • Understanding the contribution made to preservation and maintenance activities from available district (routine maintenance) budgets. • Establishing a method to quantify the contribution new capacity projects (initial construction) make towards improving the condition of existing pavements and bridges. GDOT is also aware of the asset management responsibility that will come from new capacity projects and is focused on ensuring that the maintenance and operational responsibility and cost is considered as these projects are developed. • Working with locals (cities and counties) to quantify their expenditure on NHS pavements and bridges.	Calendar Year 2021

6.5 Investment Strategies

For the purposes of this TAMP, GDOT has analyzed investment strategy options that will enable the Department to preserve and improve the condition of the NHS. This process leverages GDOT life-cycle planning tools (including deterioration modelling and treatment selection), and has considered funding and delivery risk to provide investment strategies that can be achieved.

The outcomes of the recommended strategy are discussed in more detail in **Section 7**, Performance Gap Analysis.

GDOT is currently developing the GDOT 2050 SWTP / 2020 SSTP. The investment strategies and the broader decision-making processes presented in this TAMP will be reflected in these two documents.



6.5.1. Investment Strategy – NHS Pavements

The proposed investment strategy for NHS pavements was developed based on outputs from the PMS. Different investment scenarios were modelled to understand the impacts of funding levels on work-type recommendations. The outputs from this analysis were discussed with District teams responsible for delivery, and considered against historical work achievements. GDOT is confident that the investment strategy recommended by the new PMS can be delivered.

As expected for pavements that currently exceed NHPP targets, the investment strategy includes a focus on maintenance and preservation activities to continue on-target performance (see **Table 10**). This proactive approach to pavement management will enable GDOT to continue to achieve high standards in pavement condition.

Table 10 — *Planned Investment for NHS Pavements by Work Type FY2019 – FY2028 ($M)*

	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	10 Year Totals
Maintenance and Preservation	$116	$94	$95	$95	$97	$77	$82	$83	$84	$82	$905M
Rehabilitation	$80	$19	$14	$14	$12	$16	$12	$12	$12	$15	$206M
Reconstruction	$0	$12	$10	$10	$10	$0	$0	$0	$0	$0	$42M
Total:	**$196**	**$125**	**$119**	**$119**	**$119**	**$93**	**$94**	**$95**	**$96**	**$97**	**$1.2B**

6.5.2. Investment Strategy – NHS Bridges

The investment strategy for NHS bridges is influenced by existing funding processes and by a range of analysis. Although the BMS is still at an early stage of development the results of NBI component-level analysis align with results from a spreadsheet analysis developed by GDOT. With the investment levels available, both anticipate achieving similar outcomes given the proposed split between Maintenance / Preservation and Rehabilitation.

With some aggressive NHPP targets set for increasing the number of good bridges over the next three fiscal years, the amount of reconstruction proposed—89% of total planned investment for bridges on the NHS—will be necessary (see **Table 11**). Once these goals are met, and the BMS is better refined to suit Georgia, the split between Reconstruction and other work types will be further considered.

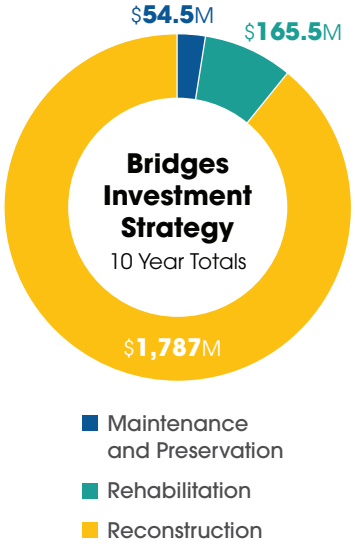


Table 11 — *Planned Investment for NHS Bridges by work type FY2019 – FY2028 ($M)*

	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	10 Year Totals
Maintenance and Preservation	$7.5	$6	$6	$5	$5	$5	$5	$5	$5	$5	$54.5M
Rehabilitation	$22.5	$19	$19	$15	$15	$15	$15	$15	$15	$15	$165.5M
Reconstruction (Replacement)	$191	$126	$188	$179	$179	$181	$183	$185	$187	$188	$1.8B
Total:	**$221**	**$151**	**$213**	**$199**	**$199**	**$201**	**$203**	**$205**	**$207**	**$208**	**$2.0B**

6.6 Process Enhancements — Investment Strategies

Current investment approaches have enabled GDOT to achieve high standards in bridge and pavement condition. With further implementation and refinement of the PMS and BMS, GDOT will be well positioned to quantify the outcomes of alternative investment strategies.

Further refinements will also include an expansion of this analysis to the broader SRS, enabling future investment decisions to be made across the entire GDOT network.

The following specific process enhancement has been identified:

Item	Action	Discussion	Timeframe for Implementation
5	**Further analysis of alternative investment strategies for the NHS that support progress toward GDOT and national transport system goals.**	Once the PMS and BMS are fully implemented and refined, GDOT will be able to quantify and assess the investment requirements to: • Achieve and sustaining a desired state of good repair over the life-cycle of an asset • Improve or preserve the condition of the NHS • Achieve state DOT targets for NHS pavements and bridges • Achieve national goals identified in 23 USC 150(b): (safety, infrastructure condition, congestion reduction, system reliability, freight movement and economic vitality, environmental sustainability, reduced project delivery delays)	Calendar Year 2021

Section 7

Performance Gap Analysis

With limited condition performance gaps for NHS pavements and bridges, GDOT is well positioned to continue TAM process enhancements.

7.1 Introduction

GDOT has identified condition targets to meet or exceed minimum federal requirements. GDOT is also, in most cases, already achieving the two- and four-year NHPP minimum condition levels for the NHS that were set in 2018.

As introduced in **Section 2.2**, meeting the targets for asset condition on the NHS will assist GDOT in achieving national performance goals.

7.2 State of Good Repair (SOGR)

GDOT has developed a definition for SOGR: *A capital asset is in a state of good repair when that asset is able to perform its designed function and does not pose a known safety risk.*

GDOT SOGR

A capital asset is in a state of good repair when that asset is able to perform its designed function & does not pose a known safety risk.

GDOT's bridge and pavement assets are currently performing as designed and the goal is to maintain or exceed current levels of service. This goal will continue beyond the two- and four-year NHPP condition targets.

Through the TAMP development process GDOT identified a desire to further quantify the definition of SOGR. This will progress once the PMS and BMS are fully refined, and is identified as a process enhancement in this TAMP.

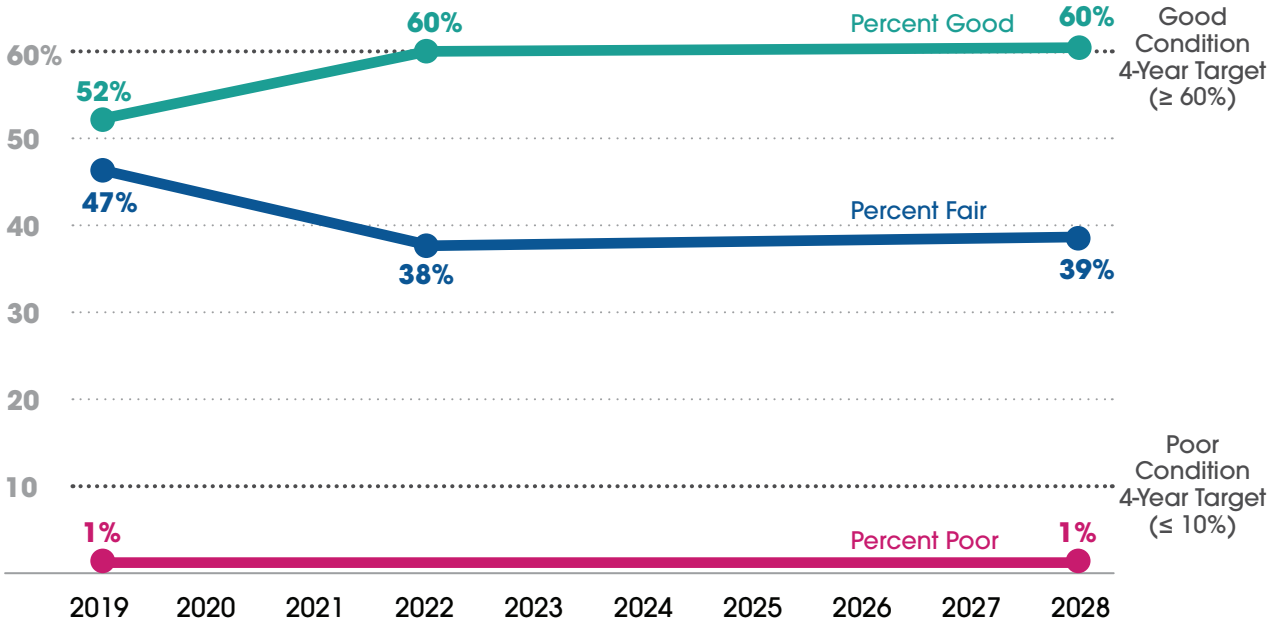
GDOT works to ensure the state's transportation infrastructure is well-maintained, allowing residents and travelers across Georgia to enjoy a safe and sustainable transportation system that improves mobility and connectivity, and supports the state's growing population and economy. GDOT is confident in its robust life-cycle planning and effective financial decision making. This is reflected in the current SOGR of the NHS system.

7.3 Performance Gap Analysis

Comparing the current condition of GDOT's NHS assets to performance targets identifies limited gaps. Based on analyses, expected asset deterioration over the next 10 years will be offset by the investment strategy proposed within this TAMP.

The one gap that exists between current and future performance is for NHS bridges in good condition. GDOT has set a target of increasing the percentage of good bridges from 53% to 60% as defined by the NHPP four-year target. GDOT analyzed a range of investment scenarios within BrM, and other analysis tools, and has determined that the 60% good target is achievable over the four-year timeframe and can be maintained. **Figure 22** illustrates the predicted bridge condition over the 10-year period given the estimated funding levels and investment strategy presented in this TAMP (see **Table 12**).

Figure 22 — *Predicted NHS Bridge Condition (2019-2028)*



GDOT recognizes the role that the condition of pavement and bridge assets have in the overall performance of the NHS. There are currently 10 structures on the NHS requiring load limit posting; all of which are either currently under construction or in preliminary engineering.

7.4 Process Enhancements — Gap Analysis

With additional refinement of the PMS and BMS, GDOT will be better positioned to further define and quantify SOGR, resulting in additional performance targets that will be measured and reported. Assets beyond the NHS on the full SRS will also be considered.

The following process enhancement has been identified:

Item	Action	Discussion	Timeframe for Implementation
6	**Define the long-term vision (performance goals and targets) of a state of good repair.**	Utilizing the PMS and BMS GDOT will set performance targets that are based on a developed understanding of the cost to achieve a range of targets and consideration of the full GDOT transport network (NHS and SRS).	Late 2020 (Calendar Year)

7.5 Performance Summary

GDOT is currently satisfying the federal requirement of having less than 5% of interstate pavements in poor condition, and having less than 10% of total NHS bridge deck area in poor condition. GDOT is also meeting the target for good condition pavements and this performance can be maintained. The goal to bring 60% of the bridge inventory to good condition can be met based on the investment strategy established in this TAMP.

If funding remains as defined within this TAMP then GDOT will continue to meet federal condition performance requirements and SOGR goals.

GDOT has identified several process improvments that will form part of a broader initiative to enhance TAM processes within the Department. These improvements will inform future decision making, across the entire SRS, and improve efficiency and effectiveness.