Connecticut Department of Transportation

2022 Highway Transportation Asset Management Plan

September 30, 2022
FHWA Certified

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Message from the Commissioner

As Commissioner of the Connecticut Department of Transportation, I am pleased to present the 2022 Highway Transportation Asset Management Plan. This plan goes beyond the federal requirements by including nine additional assets, four of which are new assets since the 2019 Highway Transportation Asset Management Plan. This plan also expands the road and bridge networks under consideration from the National Highway System to the entire state highway system. This initiative demonstrates a continued strong commitment toward achieving a State of Good Repair for all aspects of our transportation system. This Transportation Asset Management Plan is compliant with the Bipartisan Infrastructure Law Section 11105 to consider extreme weather and resilience within the TAMP lifecycle cost and risk management analysis.

Connecticut’s multimodal transportation system supports state, local and regional economies by enabling the efficient movement of people, goods, and services. Connecticut’s transportation system provides an important link between northern New England and New York, New Jersey and the Mid-Atlantic states. The transportation system also links our communities by connecting our neighborhoods, towns, and cities. In order for Connecticut’s economy to function properly and continue to grow, the transportation system needs continued and consistent investment. The Connecticut Department of Transportation remains committed to keeping the state moving. Despite the many challenges posed by the COVID-19 pandemic in recent years, construction was never shut down, State of Good Repair projects continued to move forward, and technology allowed the workforce to adapt and innovate.

This Transportation Asset Management Plan explains Connecticut Department of Transportation’s approach to managing eleven of Connecticut’s transportation assets and includes detailed information about the processes for each one.

The Department continues to make significant progress in advancing the condition of our transportation system, especially with the increase in funding provided by the Bipartisan Infrastructure Law . Implementation of this plan aligns well with the Department’s priority to maintain and preserve the transportation system.

Joseph J. Giulietti

Commissioner

July 2022

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Appendices

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List of Acronyms

AADT	Annual Average Daily Traffic
ARAN	Automatic Road Analyzer
ATLAS	Asset Tracking & Location System
ATMS	Advanced Traffic Management System
AWARI	AssetWise Asset Reliability Inspections software
BIL	Bipartisan Infrastructure Law
CMP	Corrugated Metal Pipe
CCTV	Closed Circuit Television Camera
CMAQ	Congestion Mitigation and Air Quality
CMMS	Computerized Maintenance Management System
CPD	Composite Project Database
CTDOT	Connecticut Department of Transportation
CTSS	Computerized Traffic Signal System
COG	Council of Government
COTS	Commercial Off The Shelf
DQMP	Data Quality Management Plan
FAST	Fixing America’s Surface Transportation
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GIS	Geographic Information System
GPS	Global Positioning System
HI	Health Index

HMA	Hot Mix Asphalt
HPMS	Highway Performance Monitoring System
HTF	Highway Trust Fund
IBC	Incremental Benefit Cost
IRI	International Roughness Index
ITS	Intelligent Transportation Systems
IIJA	Infrastructure Investment and Jobs Act
KML	Keyhole Markup Language
LCCA	Life Cycle Cost Analysis
LCP	Life Cycle Planning
LED	Light-Emitting Diode
LRS	Linear Referencing System
MAP-21	Moving Ahead for Progress in the 21st Century
MIRE	Model Inventory of Roadway Elements
MMS	Maintenance Management System
MPO	Metropolitan Planning Organization
MUTCD	Manual on Uniform Traffic Control Devices
NBE	National Bridge Element
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NHPP	National Highway Performance Program
NHS	National Highway System
OBL	CTDOT’s Capital Program Obligation Plan
PCI	Pavement Condition Index
PMS	Pavement Management System

PROTECT	Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation
RCP	Reinforced Concrete Pipe
RIS	Roadway Inventory System
ROW	Right-of-Way
RSR	Rehabilitation Study Report
RWIS	Roadway Weather Information System
SMS	Structure Management System
SOGR	State of Good Repair
STBG	Surface Transportation Block Grant
STF	Special Transportation Fund
STIP	Statewide Transportation Improvement Program
STRAHNET	Strategic Highway Network
SQL	Structured Query Language
TAM	Transportation Asset Management
TAMP	Transportation Asset Management Plan
TSMP	Traffic Signal Management Plan
TED	Transportation Enterprise Database
TIR	Traffic Investigation Report
VIP	Vendor-in-Place
VMS	Variable Message Sign
VMT	Vehicles Miles Traveled

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Connecticut Department of Transportation

2022 Highway Transportation Asset Management Plan Executive Summary

About the TAMP

The Connecticut Department of Transportation (CTDOT) has created this Transportation Asset Management Plan (TAMP) to document the agency's asset management processes, project future performance of our assets given expected funding, and construct a blueprint for transportation asset management improvements moving forward. The plan is also designed to meet federal requirements that are tied to transportation system funding. The TAMP builds on past practices and accomplishments in maintaining Connecticut's transportation infrastructure while also emphasizing the importance of implementing a plan to maintain our infrastructure today and in the future.

Connecticut's TAMP outlines a 10-year strategy for managing the state's pavements and bridges, as required by federal law. It also includes the asset management strategies for nine other assets CTDOT oversees. The strategy includes setting goals and objectives, reporting the current conditions of assets, and projecting conditions 10 years into the future. The TAMP also details life cycle planning, presents a financial plan, and discusses how to manage risk. Taken together, these elements give Connecticut a path towards transparent and efficient use of taxpayer dollars, and helps ensure the future good performance of the transportation system.

In Connecticut, asset management practices are needed to keep highway assets, many of which are beyond their design life, in good repair extending their useful life. This aging infrastructure combined with increased demands on the transportation network and limited funding strongly substantiates the need to implement asset management practices.

What's In the TAMP

Each chapter of this Highway TAMP addresses a separate asset management process requirement and its federal legislative and regulatory context. FHWA's role is to certify the process and annually conduct a consistency review to ensure the processes are being implemented. CTDOT worked closely with staff from the FHWA Connecticut Division Office in development of these processes and this TAMP.

For quick reference, an overview of CTDOT's Asset Management Program and Asset Fact Sheets were developed as a communication tool and are available in Appendix A of the TAMP. The Asset Fact Sheets, for each of the eleven assets, include pertinent details in the following asset management areas: inventory and condition summaries, State of Good Repair definition, performance projections, targets and asset valuation. An indication of the data confidence level is also included.

TAMP Scope

Federal requirements to establish TAMPs for NHS pavements and bridges were established in the legislation Moving Ahead for Progress in the 21st Century (MAP-21) and Fixing America's Surface Transportation (FAST) Act. The recent Bipartisan Infrastructure Legislation (BIL) added requirements to consider extreme weather and resilience as part of TAMP-related processes. In addition to meeting the requirements to report on NHS pavement and bridges, this TAMP also includes the following assets maintained by CTDOT: traffic signals, signs, sign supports, pavement markings, highway buildings, roadway illumination, retaining walls, drainage culverts, and intelligent transportation systems (ITS) devices.

Connecticut's TAMP Assets

The NHS is primarily composed of CTDOT-maintained roads. However, 56 centerline miles (154 lane miles) of the NHS are locally maintained. The NHS in Connecticut consists of:

- **1,406** centerline miles of pavement
- **1,822** NBI bridges (26,690,852 square feet of deck area)

The other CTDOT-maintained assets include:

- **3,715** centerline miles of non-NHS pavement
- **4,058** non-NHS bridges
- **2,786** traffic signals
- **246,657** signs (2,354,178 square feet)
- **1,653** sign supports
- Pavement markings
  - **97,000,000** linear feet of pavement lines
  - **3,400,000** square feet of pavement symbols
- **508** highway buildings
- **23,472** light fixtures and 207 light systems
- **1,500** retaining walls estimated (891 known to date)
- **20,235** drainage culverts estimated (2,687 known to date)
- **545** ITS devices

Transportation Asset Management

Transportation asset management (TAM) is a strategic and systematic process of taking care of our assets, with a focus on both engineering and economics and is based upon quality information that we collect.

The TAM process identifies a structured sequence of work to better maintain assets in a state of good repair (SOGR) over their lifecycle at a minimum cost.

National Highway System

The National Highway System (NHS) is a system of roadways which includes the Interstate Highway System and other roads important to the nation's economy, strategic defense and overall mobility.

The NHS was developed by the US Department of Transportation in cooperation with the states, local officials and metropolitan planning organizations (MPOs). The NHS consists of roadways important to the nation's economy, defense, and mobility.

Measuring Asset Condition

For depicting NHS conditions, this TAMP uses definitions of good, fair, and poor condition developed by the FHWA for bridges and pavements and required for use in the TAMP. This TAMP uses bridge data reported by CTDOT to the NBI and NHS pavement data reported by CTDOT to the Highway Performance Management System (HPMS) for the NHS inventory and condition values. There are no federal requirements for the additional assets; therefore, only CTDOT performance measures and data are included.

Projecting Performance

Monitoring and measuring transportation asset condition enables CTDOT to assess the performance of the transportation system, predict future needs, allocate funding, and schedule projects in order to address the state of good repair. Asset condition is also an important public-facing measure. Users of the transportation network notice and experience asset condition every day and recognize changes in asset condition. Connecticut has selected performance measures for this plan based on a combination of federal requirements and a desire to set performance goals for state-maintained assets.

To close performance gaps, CTDOT is focused on investing in assets to achieve and maintain a State of Good Repair (SOGR). CTDOT is adopting asset strategies that involve a series of treatments at optimal times to maintain assets in a SOGR and help improve asset condition over the life cycle of the asset while minimizing cost. CTDOT is also moving further towards a proactive, preservation-first approach. Using available funding, CTDOT will prioritize projects that can help close performance gaps using asset management principles and practices.

Life Cycle Planning at CTDOT

As part of its asset management practice, CTDOT makes investment decisions that consider not only the current condition, but also the full life cycle and associated costs of assets. Life cycle planning is used to determine which actions to perform to preserve an asset over its life cycle considering costs and benefits. Timely investment can improve asset condition over a longer time period and lower long-term cost. Life cycle planning links the TAMP condition data and targets to the financial plan and investment strategies by using deterioration rates and treatment options to help identify optimal asset strategies. Application of preventive maintenance early in an asset's life when it is still in relatively good condition can delay the need for more costly rehabilitation, replacement, or reconstruction and result in an overall lower life cycle cost. Life cycle planning is also an opportunity to evaluate how assets perform in extreme weather and resilience.

Life Cycle Planning

The basic principle underlying life cycle planning is:
Timely investments in an asset result in improved condition over a longer time period and lower long-term cost.

TAMP Financial Plan

CTDOT estimates a total highway capital program of $14.6 billion over the ten-year period of the TAMP, including state and FHWA funds. An estimated $8.3 billion of that total will be dedicated to SOGR activities. Funding sources data come from the January 2022 Obligation Plan, which does not include additional future federal funding from the Bipartisan Infrastructure Law (BIL). Projected funding, exclusive of BIL, is known for 2022-2026, and estimated for years after that, based on 2026 funding.

Risks to the System

CTDOT must balance and mitigate a wide variety of risks on an ongoing basis, from daily operational concerns to potentially catastrophic asset failures. Of particular focus are risks associated with resources to achieve the agency’s goals. Currently, CTDOT is monitoring risks to its budget and seeking increased revenue through the Legislature to replenish the Special Transportation Fund so that investments can be made to sustain performance of the transportation system.

Staffing is also becoming a significant risk. The number of experienced staff at CTDOT is being reduced through retirements and job turnovers. Approximately nineteen percent of employees are currently eligible to retire. In addition to the state employee shortage, CTDOT's consultants and contractors are also facing staffing shortages which limits their ability to deliver the work. Inflation and supply chain disruptions present additional, significant risks to CTDOT.

Infrastructure resiliency is another risk facing CTDOT. The Department created a Sustainability and Resiliency Unit in the Bureau of Policy and Planning to coordinate a department-wide vulnerability assessment, develop a culvert management program, and report on critical assets. CTDOT also partnered with the CT Department of Energy and Environmental Protection in 2021 to update the model showing potential flooding of coastal roads due storms and sea level rise, which allows CTDOT to better incorporate climate risk as a factor in prioritizing projects.

TAMP Implementation

In addition to specific process improvements for each type of asset CTDOT is responsible for, the agency also tracks four process improvements that cut across all assets in the TAMP.

- Coordinate implementation of data quality standards
- Continue to refine models and proposed treatment options
- Verify field performance of treatment life expectancies to incorporate into models and improve forecasting of asset deterioration
- Track planned and completed work by FHWA work types and CTDOT work codes along with associated costs to support the TAMP financial plan and investment strategies

Developing the TAMP

Building this TAMP involves continuing to educate and engage staff throughout the department in a coordinated effort. Asset stewards were particularly instrumental in providing information and participation in the development of this TAMP.

CTDOT Values

- **Measurable results**
- **Customer service**
- **Quality of life**
- **Accountability & Integrity**
- **Excellence**

CTDOT Vision and Mission

CTDOT's vision is to lead, inspire, and motivate a progressive, responsive team, striving to exceed customer expectations.

CTDOT's mission is to provide a safe and efficient intermodal transportation network that improves the quality of life and promotes economic vitality for the State and the region.

This TAMP uses the best available data to compile asset inventory and condition data to perform life cycle analyses. This TAMP assumes the current funding scenarios based on the funding available as of December 31, 2021, not including BIL.

What's New in 2022

The following highlights notable changes made since the 2019 TAMP.

BIL Compliance

- Extreme weather and resilience considered throughout the entire TAMP

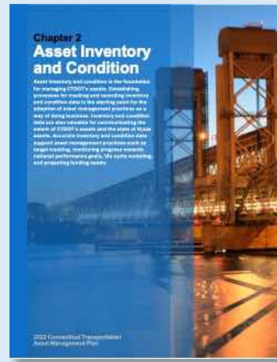
Asset Inventory and Condition

Added four new assets:

- Roadway illumination
- Retaining walls
- Drainage culverts
- Intelligent transportation systems

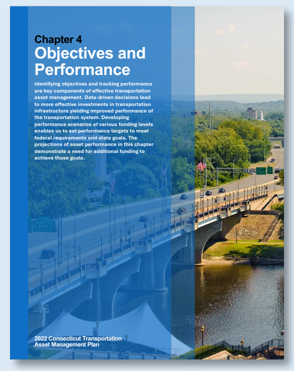
Enhanced inventory and condition approach:

- Revised Signs inventory and condition from Limited Access / Non-Limited Access to Extruded / Sheet Aluminum
- Recalculated Pavement Markings inventory using different methodology



Objectives and Performance

- Added historical conditions to performance projections
- Established new 2-year and 4-year targets

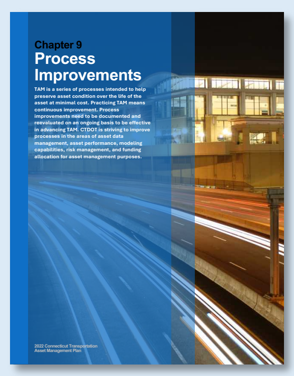


Risk Management

- Added enterprise risks
- Added resiliency discussion

Process Improvements

- Added "Status" to process improvements



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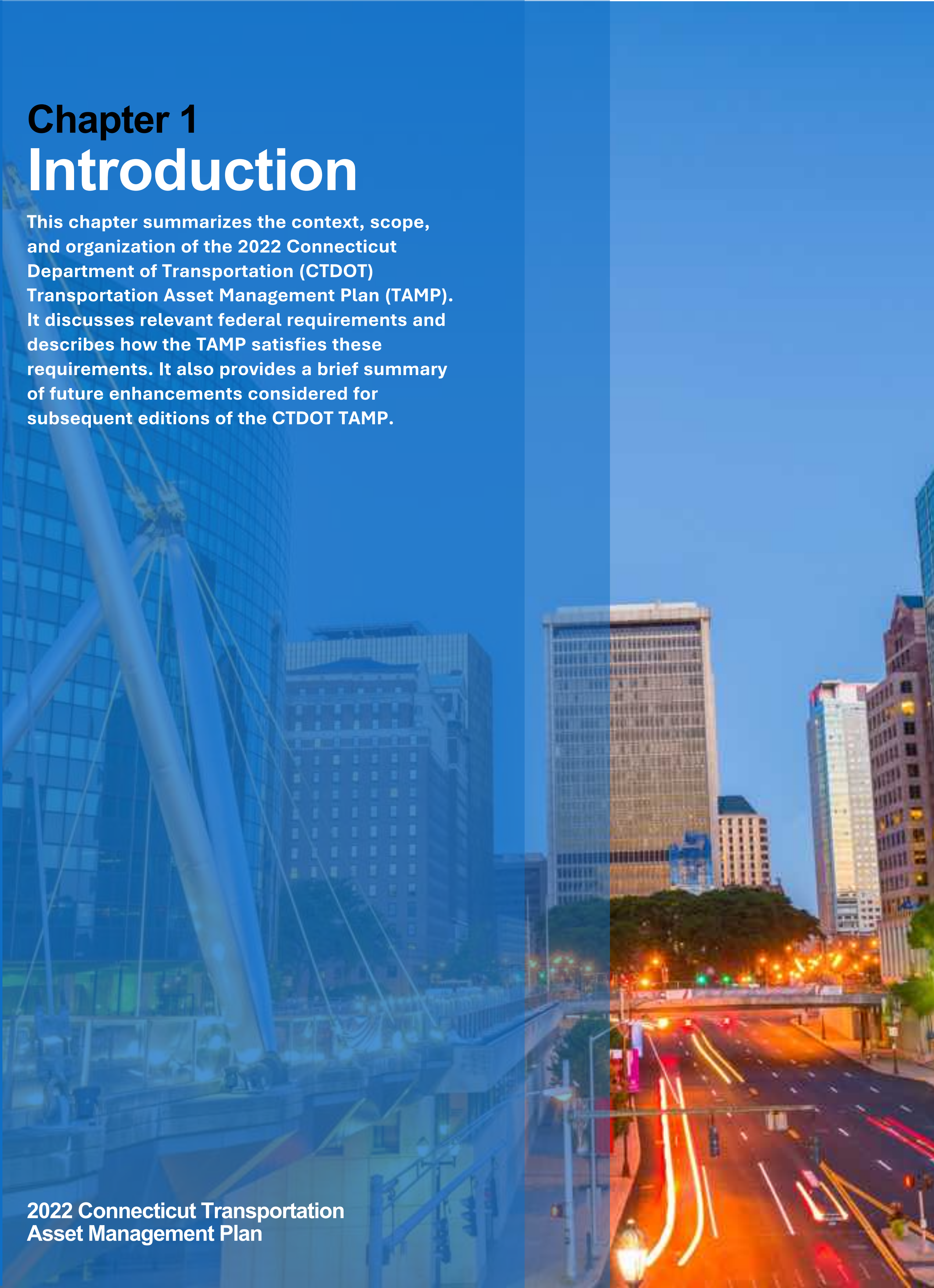
Chapter 1
Introduction

This chapter summarizes the context, scope, and organization of the 2022 Connecticut Department of Transportation (CTDOT) Transportation Asset Management Plan (TAMP). It discusses relevant federal requirements and describes how the TAMP satisfies these requirements. It also provides a brief summary of future enhancements considered for subsequent editions of the CTDOT TAMP.



Welcome

Federal regulations require each state department of transportation to develop and implement a risk-based asset management plan in accordance with 23 U.S.C. 119. The intent is to encourage states to achieve and sustain a state of good repair over the life cycle of transportation assets—regardless of ownership—and to preserve or improve the condition of the National Highway System (NHS).

This document satisfies the requirements of the Federal Highway Administration (FHWA) rulemaking 2125-AF57, which provides detailed guidance on developing and implementing state Transportation Asset Management Plans (TAMPs).

The Connecticut Department of Transportation's (CTDOT's) TAMP demonstrates that its asset management practices are consistent with federal requirements. This document:

- Summarizes Connecticut's inventory of NHS pavement and bridge assets by structure type, class, owner, and condition;
- Forecasts NHS asset condition by year for at least a 10-year planning horizon at current funding levels;
- Establishes targets for NHS pavement and bridge condition; and
- Outlines Connecticut's asset management processes, which are integrated into long-range planning, project programming, financial planning, and risk assessment processes.

In addition, the CTDOT TAMP provides similar information for 11 other asset classes that it oversees, including state-owned non-NHS pavements and bridges, traffic signals, signs, sign supports, pavement markings, highway buildings, roadway illumination, retaining walls, drainage culverts, and Intelligent Transportation System (ITS) devices. This information is not federally-required, but is an important aspect of CTDOT's holistic asset management approach to infrastructure.

Accurate fiscally-constrained asset condition analyses and projections must consider all the financial responsibilities of a DOT. As CTDOT systematically expands the scope of its asset management tools and processes to analyze an increasing percentage of Connecticut's transportation assets, asset management practices will become more fully integrated into its operations statewide. This will result in continually refined project selection processes, with more in-depth and accurate cost and condition projections providing a clear picture of the current and needed level of investment to maintain Connecticut's complete transportation system in a state of good repair.

Agency Overview

CTDOT owns, operates and maintains a multi-modal transportation network comprised of highway assets and transit assets. CTDOT owns and maintains the entire Interstate System in Connecticut and approximately 95% of the non-Interstate NHS. CTDOT also owns and maintains all bridges and pavements on the State Highway System. Finally, CTDOT owns or subsidizes nearly all of the Connecticut's public transportation services, including commuter rail, bus, bus rapid transit, paratransit, and ferry service.

According to the CTDOT Transportation Fast Facts 2020 (pre-pandemic), there were 31.6 billion Vehicle Miles Traveled (VMT) on our roadways, of which nearly 42 million miles (0.13% of the VMT) were traveled by buses and paratransit. 86% of Connecticut's labor force commuted to work as motorists while 5% used public transportation. The breakdown of commuters by mode of travel is shown in Figure 1-1.

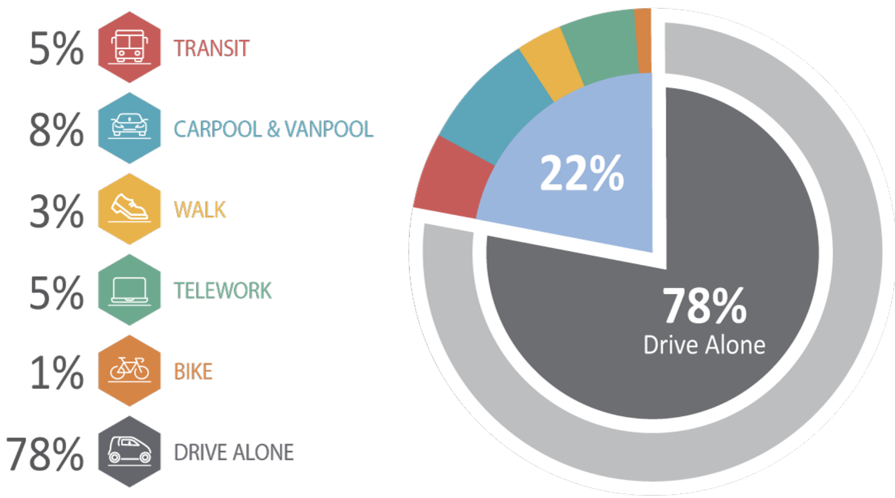


Figure 1-1. Connecticut Commuters by Mode

Agency Structure Regarding TAM

Organizational alignment and support for transportation asset management (TAM) is a key element for program success. The TAMP-building and updating process itself brings together the agency's stakeholders, disciplines, and business processes to work towards a common understanding of the TAM mission and objectives.

TAM Mission

CTDOT uses a risk-based, data-driven process to maximize transportation performance and user experience, to prioritize resources, and to optimize treatments and costs over the life cycle of an asset for the state's multimodal transportation system.

CTDOT is organized into five bureaus: Engineering & Construction; Finance & Administration; Highway Operations; Policy & Planning; and Public Transportation. The Bureau of Engineering & Construction leadership initiated an effort in 2013 to implement TAM and develop a TAMP to improve decision-making processes throughout the agency. The current organization chart is included as Figure 1-2.

TAM Objectives

- Attain the best asset conditions achievable given available resources, while striving towards a State of Good Repair
- Deliver an efficient and effective program to optimize the life of our infrastructure
- Improve communication and transparency regarding decisions and outcomes
- Achieve and maintain compliance with Federal requirements regarding asset management

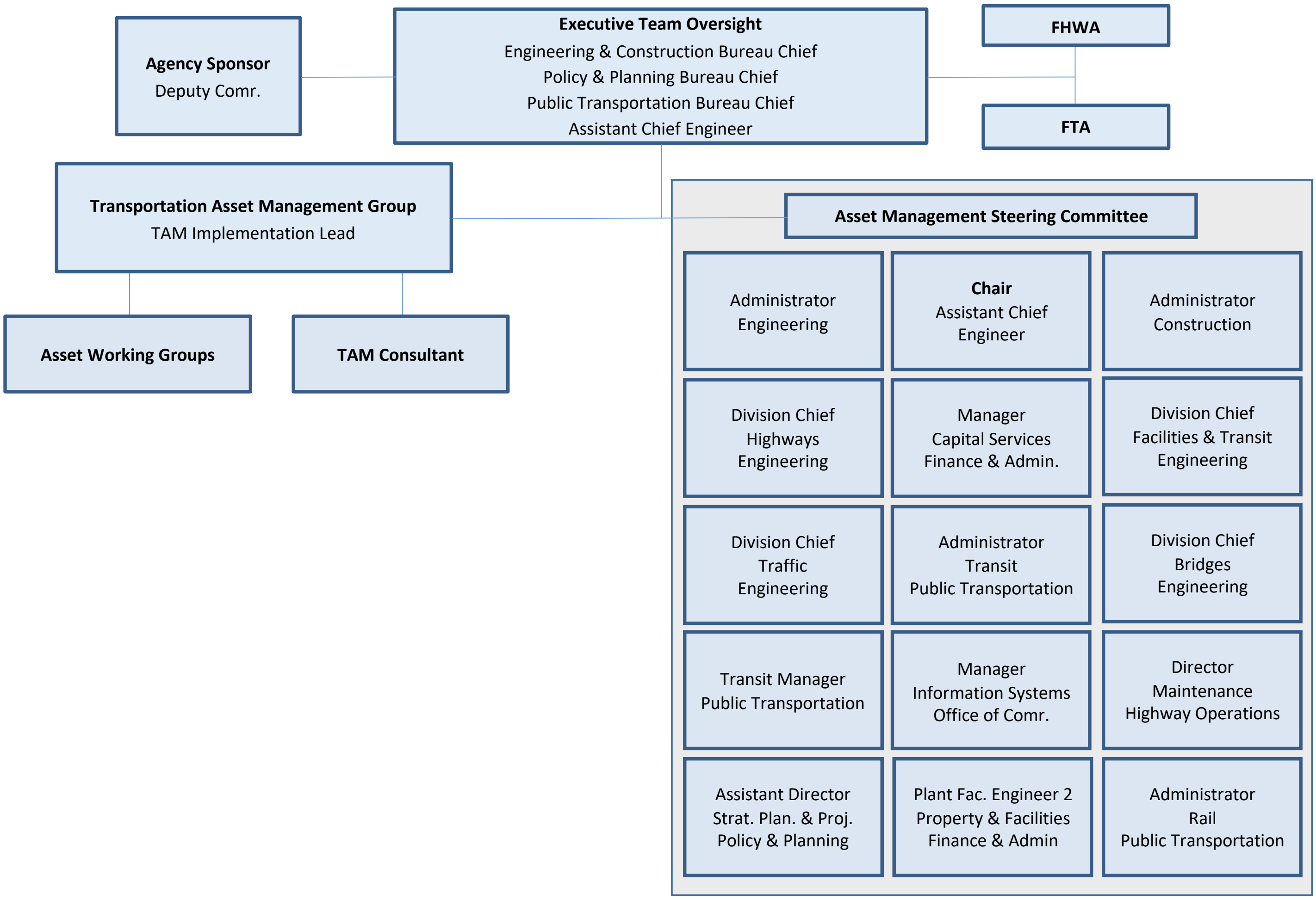


Figure 1-2 CTDOT TAM Organizational Structure

As part of the initial effort, CTDOT designated key TAM roles, formed a TAM Steering Committee, staffed a Transportation Asset Management Group, and identified asset stewards and asset working groups.

The Agency Sponsor for TAM is the Deputy Commissioner of Transportation and Chief Operating Officer. The Agency Chairperson for TAM is the Assistant Chief Engineer.

The TAM Steering Committee includes representatives from the Commissioner's Office and all five bureaus. The role of each member of this committee is to support TAM and recognize the value of TAM for CTDOT and the state. The TAM Steering Committee acts as a liaison to bureaus and divisions to ensure that each area's interests are properly represented and that each area is informed of and supports the TAMP and TAM initiatives. The TAM Steering Committee meets annually or as needed.

The Transportation Asset Management Group operates under the Assistant Chief Engineer position in the Bureau of Engineering and Construction and under the new Project Administration Unit established in 2019. The Transportation Asset Management Group was created as a result of the CTDOT's commitment toward implementing asset management. The group includes a TAM Implementation Lead and four additional support staff to assist in developing an asset management strategy for each asset. The strategy is focused on obtaining and maintaining each asset in a SOGR. This group is responsible for:

- Developing and implementing the CTDOT's TAMP to ensure CTDOT's compliance with all Federal requirements
- Coordinating asset management activities with asset stewards
- Facilitating progress towards improving asset conditions, inventories and data sharing capabilities
- Acting as asset liaisons and facilitators for each Asset Working Group, in assisting the group in meeting its asset goals and objectives

An individual asset steward has been identified for each asset. The steward:

- Is a "Champion" for the Asset (defend, support and promote the asset)
- Leads the Asset Working Group
- Facilitates the exchange of information
- Supports development and implementation of the TAMP for their asset
- Serves as the asset's primary contact
- Is responsible for compiling and submitting inventory and condition data, performance measure data, and performance targets for the asset
- Oversees internal and external asset data needs

Asset Working Groups for each asset were convened as part of the interview and workshop processes during the TAMP building process. Working Group members were designated based on their function, expertise and experience with regard to a particular asset. Within each working group, membership is targeted to include strategic, operational and data-oriented perspectives. These members play a vital role in providing technical guidance throughout the asset's life cycle. The working group members support the asset stewards in achieving and maintaining a SOGR and meet to discuss and address:

- State of the asset
- Best practices to meet Connecticut needs
- Advancements in knowledge in life cycle or technology
- Assess Risks and update mitigation strategies for the asset
- Review and update asset process improvements

Coordinating with Partners

Other entities, including Councils of Government (COG) and Metropolitan Planning Organizations (MPO), are responsible for portions of the NHS in Connecticut. CTDOT hosts monthly meetings with its COG and MPO partners on a variety of topics. Through this process, CTDOT coordinates with its COG and MPO partners in order to establish infrastructure performance targets for the entire NHS. Prior to submitting infrastructure performance targets in FHWA's web-based Performance Management Form, CTDOT Asset Management, Bridge Management and Pavement Management present infrastructure performance targets at an appropriate monthly meeting. COGs and MPOs then review CTDOT's targets and determine whether to accept CTDOT's targets or set their own.

Throughout this process, CTDOT emphasizes that performance optimization is conducted for the entire CTDOT-maintained network and this analysis is not optimized per COG or MPO. Due to the complexities of the analysis, software costs, and limited staff expertise and time, the COGs and MPOs have in the past chosen to accept CTDOT's performance targets.

TAMP Scope

While the FHWA TAMP rules outlined in MAP-21/FAST Act/ Bipartisan Infrastructure Law (BIL) require reporting on NHS bridges and pavements, Connecticut's transportation system includes other assets. For this Highway TAMP, CTDOT is including traffic signals, signs, sign supports, pavement markings, highway buildings, roadway illumination, retaining walls, drainage culverts, and ITS in addition to all of its state-maintained network of pavement and bridges. The inclusion of additional assets into CTDOT's TAMP will drive the collection and use of data for better business practices and investment decisions.

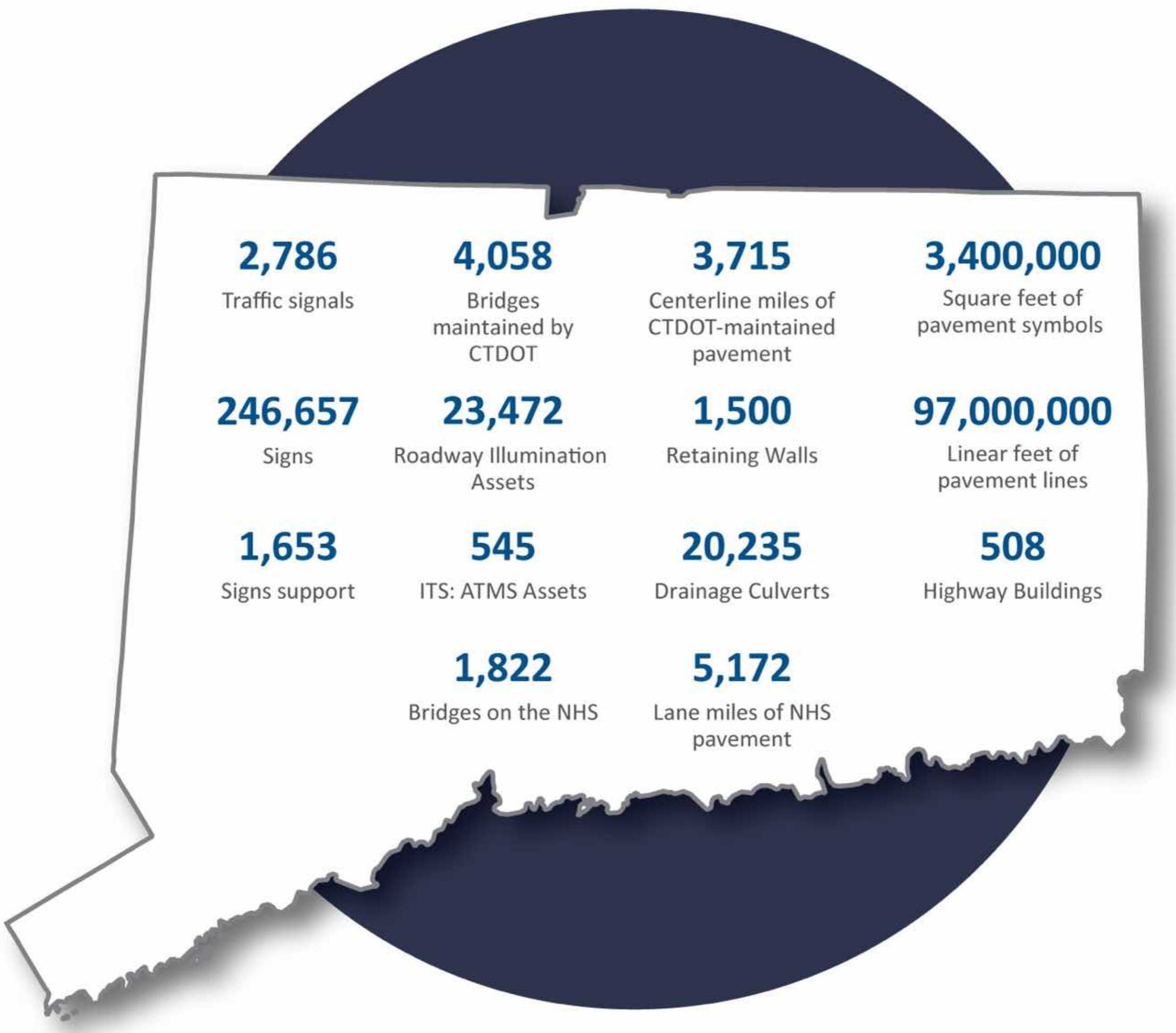


Figure 1-3. CTDOT TAMP Assets

Related CTDOT Plans

Awareness of other CTDOT plans, such as those listed below, is important for context and alignment with the TAMP.

List of CTDOT Plans

Transportation Infrastructure Capital Plan Report, 2022-2026

Statewide Transportation Improvement Program

Statewide Long-Range Transportation Plan

Strategic Highway Safety Plan

State Freight Plan

State Rail Plan

Connecticut Active Transportation Plan

Public Transportation Transit Asset Management Plan

CTDOT Americans with Disabilities Act (ADA) Transition Plan

State Plan of Conservation and Development

TAMP Building Process

A wide range of CTDOT organizational units and FHWA were involved in the development of the TAMP. For this 2022 TAMP, the processes developed in the 2019 TAMP were deployed and followed. Inventory and condition information has been updated with the latest available data. Life cycle analyses were rerun with the latest available condition data, cost data and refinements to treatment decisions. The risk management process was conducted again. Impact, likelihood, risk ratings and mitigation strategies were updated. The financial plan process also includes a breakdown by work types defined by FHWA. CTDOT's TAMP Building process is depicted in Figure 1-4. This graphic was developed to guide stakeholders through the many steps involved in TAMP development and implementation.

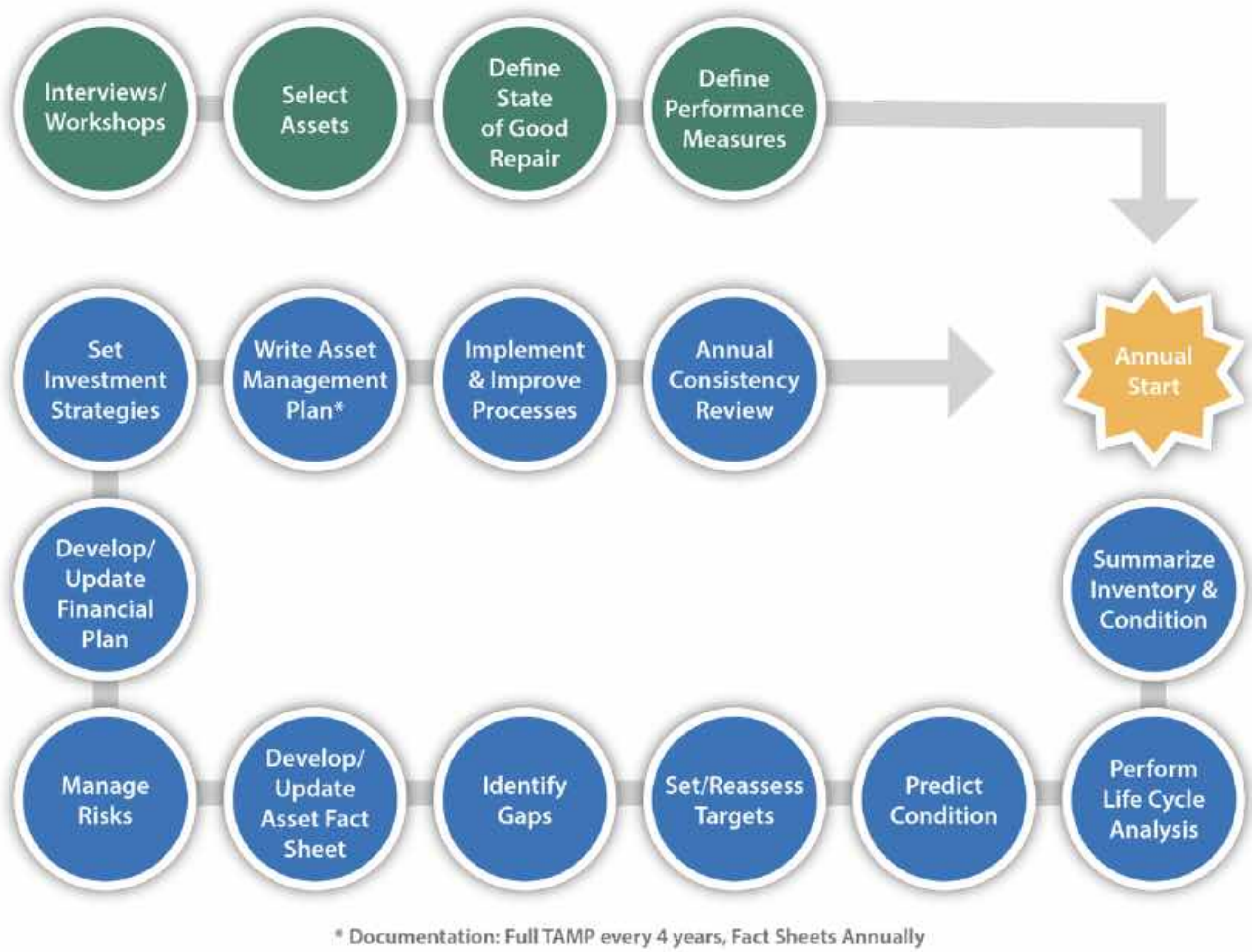


Figure1-4. CTDOT Highway TAMP Building Process

TAM is an ongoing process. Inventory and condition data, performance projections, asset valuation, risk management analysis, and process improvements are updated annually along with the asset fact sheets to assist in compiling Implementation Documentation for the FHWA annual consistency determination. The TAMP is a living document that is reviewed, updated and submitted to FHWA for certification every four years.

Chapter 2

Asset Inventory and Condition

Asset inventory and condition is the foundation for managing CTDOT's assets. Establishing processes for tracking and recording inventory and condition data is the starting point for the adoption of asset management practices as a way of doing business. Inventory and condition data are also valuable for communicating the extent of CTDOT's assets and the state of those assets. Accurate inventory and condition data support asset management practices such as target tracking, monitoring progress towards national performance goals, life cycle modeling, and projecting funding needs.

Overview

This chapter presents summary information on asset inventory and condition. Connecticut's TAMP addresses assets on state-maintained roads, as well as bridges and pavements on the NHS maintained by CTDOT and other entities. To comply with federal requirements, bridges and pavements will be reported separately for those on the NHS.

Federal Legislative Context

FHWA requires that a state's TAMP include a summary listing of NHS pavements and bridges, including a description of asset condition. FHWA identifies NHS assets as Interstate System pavements; NHS pavements (excluding the Interstate System); and bridges on the National Bridge Inventory (NBI) carrying the NHS. Interstate pavements are part of the Interstate Highway System, a highway network which is part of the NHS. The BIL requires TAMPs to consider extreme weather and resilience as part of the lifecycle cost and risk management analyses.

States may include other assets or systems in their TAMP. If a state chooses to include additional assets, those assets must be included in all of the TAMP processes: inventory and condition, performance measures, targets, performance gap analysis, life cycle planning (LCP), risk management, financial planning, and investment strategies.

In addition to providing inventory and condition data, states must also have documented procedures for collecting, processing, storing, and updating inventory and condition data for NHS pavement and bridge assets. States are required to use bridge and pavement management systems that, in addition to other capabilities, collect, process, store, and update inventory and condition data.

Connecticut TAMP Assets

Connecticut's transportation system consists of a wide variety of physical assets. Besides bridges and pavement, which are the most significant in terms of their cost and extent,

National Highway System (NHS)

The NHS is a system of roadways which includes the Interstate Highway System and other roads important to the nation's economy, strategic defense and overall mobility.

The NHS was developed by the US Department of Transportation in cooperation with the states, local officials and MPOs.

New Assets in 2022 TAMP

In 2022, four new assets were added to CTDOT TAMP: roadway illumination, retaining walls, drainage culverts, and intelligent transportation systems.

Connecticut's highway TAMP includes the following CTDOT-maintained assets: traffic signals, signs, sign supports, pavement markings, highway buildings, roadway illumination, retaining walls, drainage culverts, and ITS devices.

Note that many other assets are needed to improve safety and support mobility besides these. In many cases, replacement or rehabilitation of roads and bridges includes replacement or upgrades to other assets depicted in Figure 2-1. For instance, the cost of reconstructing or replacing a bridge includes the cost of guiderail, and pavement projects often include upgrades to associated traffic and safety assets.

Communication

The TAMP is a valuable tool to communicate needs and to advocate for resources.

Figure 2-1. Highway Assets in the CTDOT TAMP

This plan addresses assets on two overlapping highway systems: CTDOT-maintained assets and the NHS. CTDOT-maintained assets include all assets within the state highway network. The NHS is primarily composed of CTDOT-maintained roads. However, 56 centerline miles (154 lane miles) of the NHS are locally maintained. Table 2-1 summarizes the federal and state reporting included in the TAMP.

Table 2-1. Federal and State TAMP Reporting

Asset	NHS Assets Included to Meet Federal Requirements	Additional CTDOT-Maintained Assets
Bridges	✓	✓
Pavements	✓	✓
Traffic Signals		✓
Signs		✓
Sign Supports		✓
Highway Buildings		✓
Roadway Illumination		✓
Retaining Walls		✓
Drainage Culverts		✓
Intelligent Transportation System (ITS) Devices		✓

Throughout the remainder of the TAMP document, asset information is summarized in two ways: for the entire CTDOT-maintained system (portions of which are on the NHS), and for the entire NHS (which includes a portion of the state system and a portion of the local system). For bridges and pavement, this means that both federal and state performance measures and data are included. There are no federal requirements for the additional assets; therefore, only CTDOT performance measures and data are included. This approach is used to provide a complete picture of CTDOT-maintained assets, as well as to meet federal requirements for including all NHS bridges and pavement in the TAMP.

Connecticut's Transportation System Summary

The NHS in Connecticut consists of:

- 1,406 centerline miles of pavement
- 1,822 bridges totaling 26,690,852 square feet of bridge deck area

For the purposes of the TAMP, the CTDOT-maintained system consists of:

- 3,715* centerline miles of pavement
- 4,058 bridges
- 2,786 traffic signals
- 246,657 signs (2,354,178 square feet)
- 1,653 sign supports
- Pavement markings
  - 97,000,000 linear feet of pavement lines
  - 3,400,000 square feet of pavement symbols
- 508 highway buildings
- 23,472 light fixtures and 207 light systems
- 891 retaining walls
- 20,235** drainage culverts
- 545 ITS devices

Note: The other assets are not broken out by their NHS designation.

*Note: The CT Public Road mileage is 21,260 centerline miles which includes 17,454 centerline miles of public roads that are not under CTDOT's purview for pavement condition (of which 56 centerline miles are on the NHS).

**Note: CTDOT has inspected 2,687 drainage culverts, with approximately 6,400 mapped but not inspected, and an estimated 11,000 not yet mapped.

Monitoring and measuring transportation asset conditions enables CTDOT to assess the performance of the transportation system, analyze deficiencies and predict future needs, allocate funding, and schedule projects in order to address the State of Good Repair (SOGR). Asset condition is also an important public-facing measure. Users of the transportation network notice and experience asset condition every day and recognize changes in asset condition. Further, public trust and confidence is bolstered when objective, measurable results can be demonstrated from increased public investment.

The NHS in Connecticut is shown in Figure 2-2.

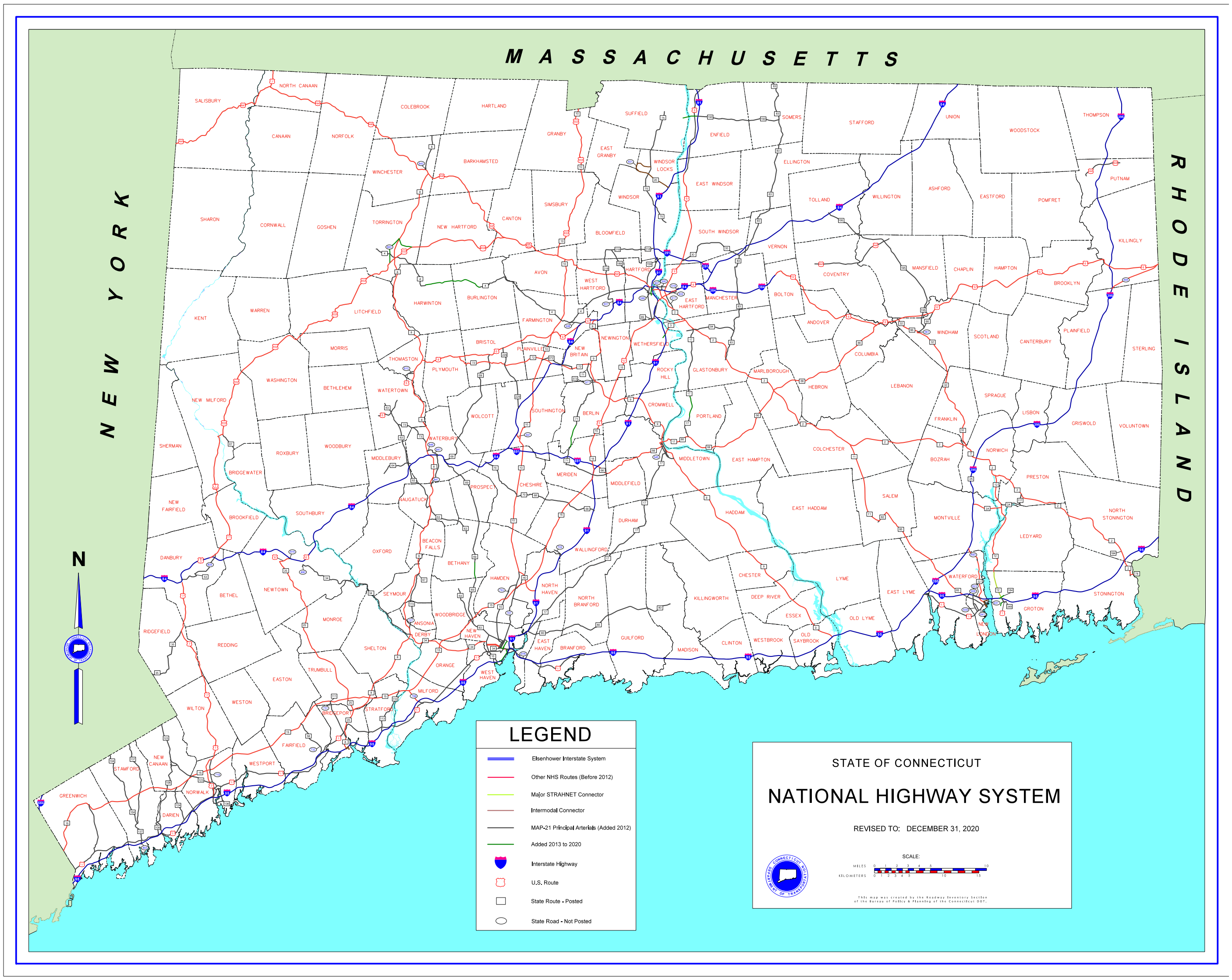


Figure 2-2. NHS in Connecticut

The State highway network is shown in Figure 2-3.

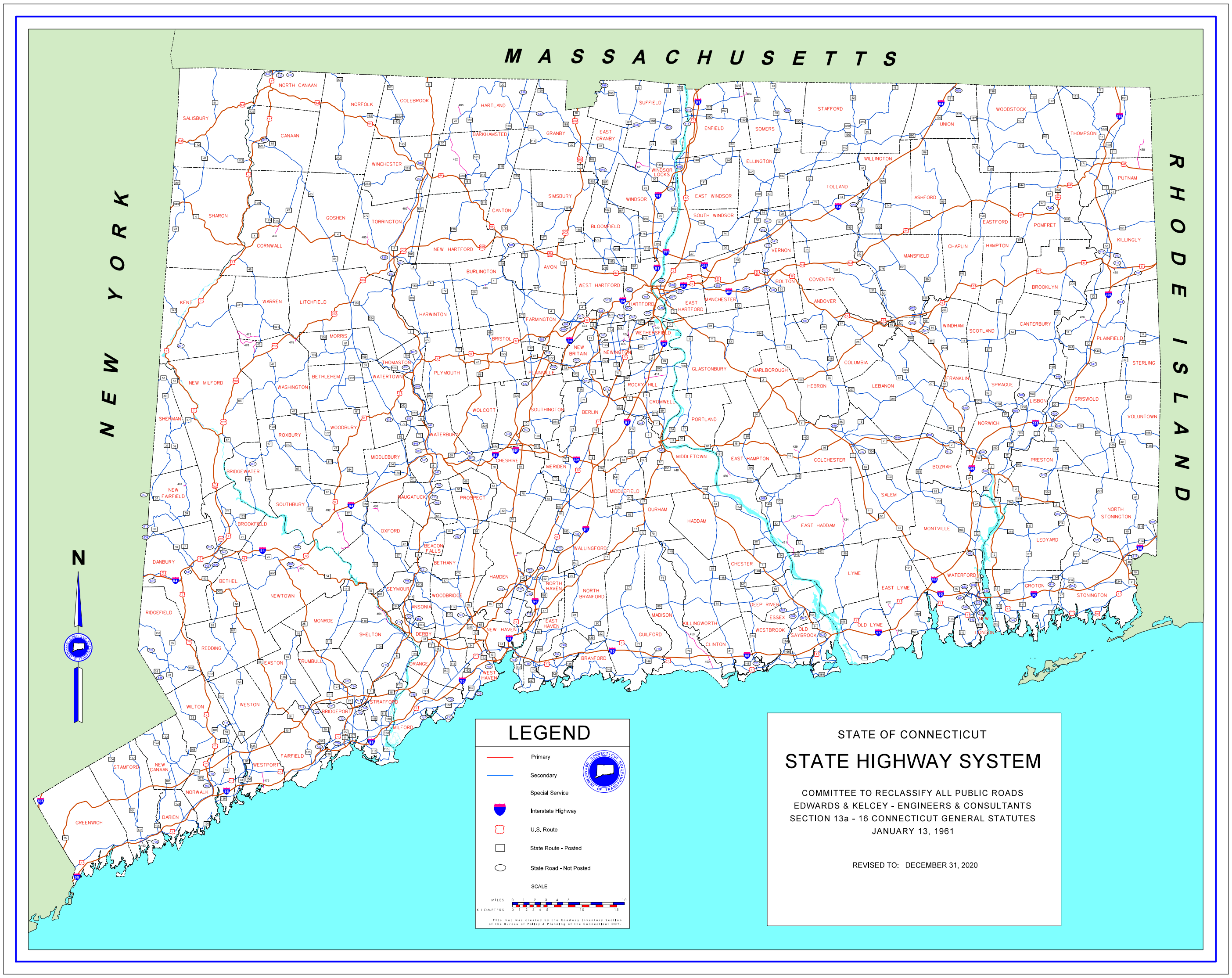


Figure 2-3. Connecticut's State Highway Network

For depicting NHS conditions, this TAMP uses definitions of good, fair, and poor condition developed by the FHWA and required by MAP-21/FAST Act for use in the TAMP. CTDOT also tracks state performance measures on the CTDOT-maintained system for bridges, pavement, traffic signals, signs, sign supports, pavement markings, highway buildings, roadway illumination, retaining walls, drainage culverts, and ITS devices.

Table 2-2 summarizes the asset inventory and conditions for NHS bridges and pavements with condition ratings based on the federal performance criteria for good, fair, and poor.

Table 2-2. Inventory and Conditions for NHS Assets in the TAMP (Federal criteria)

NHS	Inventory	Good	Fair	Poor
Bridges	26,690,852 Square feet of deck area	14.2%	77.7%	8.1%
Pavement*	5,172 Lane miles	52.6%	46.0%	1.4%

Table 2-3 summarizes CTDOT-maintained asset inventory and conditions for the eleven asset classes of this TAMP using CTDOT performance criteria for good, fair, and poor. Bridges follow the federal criteria for CTDOT-maintained bridges as well; pavement uses a CTDOT Pavement Condition Index defined on Page 2-14, and the remaining assets do not have federal criteria defined at this time. This TAMP uses bridge data reported by CTDOT to the NBI and NHS pavement data reported by CTDOT to the Highway Performance Management System (HPMS) for the NHS inventory and condition values.

Table 2-3. Inventory and Conditions for CTDOT-Maintained Assets in the TAMP (CTDOT criteria)

CTDOT-Maintained	Inventory	Good	Fair	Poor
Bridges	4,058 Bridges	25.3%	70.9%	3.8%
Pavement**	3,715 Centerline miles	69.4%	27.8%	2.8%
Traffic Signals	2,786 Assets	30.2%	31.6%	38.2%
Signs	246,657 Assets	29.4%	11.7%	58.9%
Sign Supports	1,653 Assets	44.5%	53.9%	1.6%
Roadway Illumination	23,472 Assets	55.1%	29.8%	15.1%
Retaining Walls	891 Assets	71.0%	27.0%	2.0%
Drainage Culverts	2,687 Assets	61.9%	24.4%	13.7%
ITS: ATMS	545 Assets	38.0%	10.6%	51.4%
		State of Good Repair		Poor
Pavement Markings*** (estimated by assumptions)	97,000,000 Linear feet of pavement lines	83.8%		16.2%
	3,400,000 Square feet of pavement symbols	48.2%		51.8%
Highway Buildings	508 Assets	79.5%		20.5%

*Note: The percentages were based only on available pavement condition data and do not include NHS concrete pavements and less than 0.5% (~22 lane miles) of the NHS pavement condition data not available due to construction, etc.

**Note: Centerline miles where data were missing or invalid are excluded from the calculations.

***Note: Pavement marking inventory and condition is simply reported in State of Good Repair and Poor based on age. Assumptions did not consider a detailed good and fair condition breakdown for this TAMP.

What Does Poor Condition Mean?

Although an asset may be in poor condition as defined by asset management, this doesn't mean that the asset is unsafe, not functioning, etc.

This categorization is simply a process to identify assets that need to be addressed and evaluated as funding becomes available.

Asset Data Collection and Key Milestone Timelines

Data collection for each asset varies due to the processes involved in managing the asset information. Figure 2-4 shows when the data that is in the TAMP was made available for inclusion in the TAMP. It highlights that the latest data for an asset type can vary by over a year.

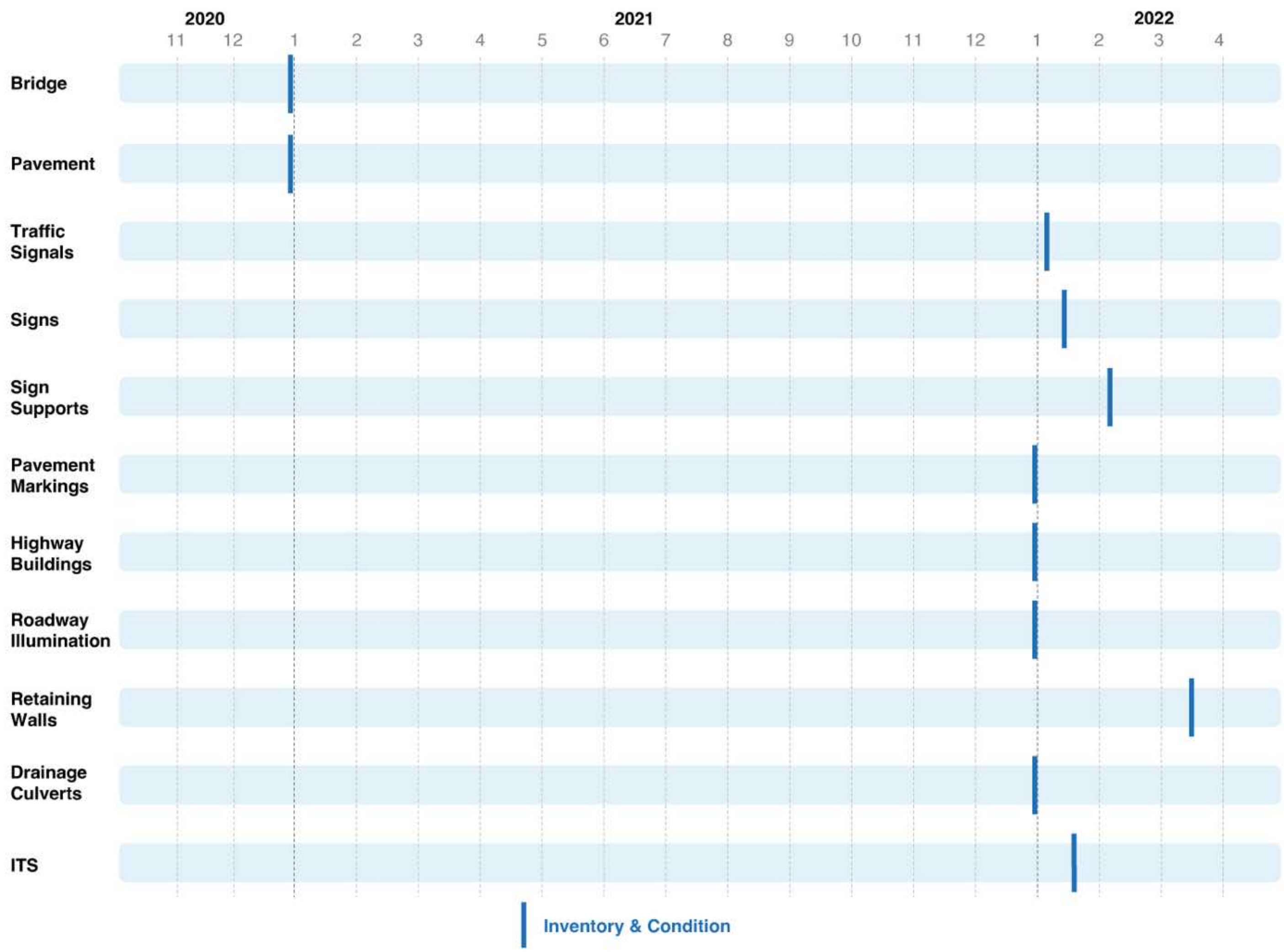


Figure 2-4. CTDOT Data Capture Milestones

Bridge

The FHWA defines an NBI Bridge as a structure carrying a public roadway with a span greater than 20 feet. In addition to the FHWA designation, CTDOT has also expanded the bridge classification to include all structures with a span of 6 feet or greater, including culverts. For purposes of this TAMP, all NHS bridge references and measurements use the FHWA NBI bridge designation; whereas all CTDOT bridge references and measurements use the expanded bridge classification.

Bridges provide road network connectivity, spanning water bodies and other natural features, rail lines, and other roadways. New bridges are designed to last at least 75 years, and in practice, many bridges remain in service for much longer. However, bridges require periodic maintenance to replace individual components (such as decks) that have a shorter life than the bridge as a whole. If preservation work on a bridge is deferred, then deterioration may accelerate to the point where more costly repairs are needed. In some cases, deteriorated conditions may require restricting the loads the bridge can carry or closing the bridge until needed repairs are complete–which can mean extensive detours for road users. Thus, maintaining bridges in good condition pays off, resulting in the lowest long-term costs both to transportation agencies and road users. Bridges in a state of good repair allow access to essential services and have a positive impact on the economy.

Bridge Performance Measures

FHWA has established two measures of bridge condition:

- Percentage of NHS bridges classified in good condition (weighted by deck area)
- Percentage of NHS bridges classified in poor condition (weighted by deck area)

FHWA requires that states use the above measures in their TAMPs to describe condition, set targets, and analyze performance gaps of NHS bridges. Note that if a bridge is not in good or poor condition, it is deemed to be in fair condition. CTDOT follows FHWA NBI standards for inspecting all

National Bridge Inventory (NBI)

The NBI is a database that includes all bridges longer than 20 feet and on a public road.

Bridge Condition – Federal Measure

NBI Ratings and Good/Fair/Poor Classification

9	Excellent	Good
8	Very Good	Good
7	Good	Good
6	Satisfactory	Fair
5	Fair	Fair
4	Poor	Poor
3	Serious	Poor
2	Critical	Poor
1	Imminent Failure	Poor
0	Failed	Poor

Connecticut bridges. Inspectors record overall ratings for a bridge's deck, superstructure and substructure on a scale from 0 (failed) to 9 (excellent). Structures classified as culverts are included in the NBI inventory if they span more than 20 feet. For these structures, a single culvert rating is recorded using the same 0-9 scale.

Bridge condition ratings are used to classify the bridge as being in good, fair or poor condition. The lowest of the three ratings for deck, superstructure and substructure (or a culvert rating for a culvert) determines the overall rating of the bridge. If this value is 7 or greater, the bridge is classified as being in good condition. If it is 5 or 6, the bridge is classified as being in fair condition, and if it is 4 or less, the bridge is classified as being in poor condition. Thus, if any major component is classified as being in poor condition, the bridge will be considered Poor. Note that the fact that a bridge is classified as Poor does not imply that the bridge is unsafe, just that deficiencies have been identified that require maintenance, rehabilitation, or replacement. A graphical depiction of the three bridge components is shown in Figure 2-5.

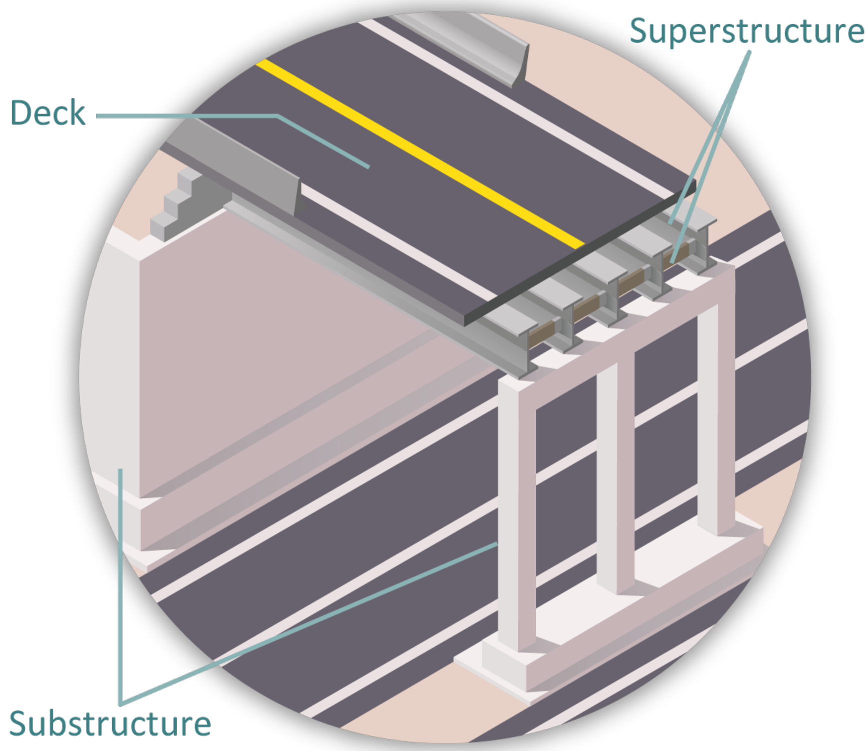


Figure 2-5. Bridge Components

In addition to the federal performance measures above, CTDOT has adopted a Good, Fair, and Poor condition rating

Bridge Condition – State Measure

NBI Ratings and Good/Fair/Poor Classification

9	Excellent	Good	SOGR
8	Very Good		
7	Good		
6	Satisfactory	Fair	
5	Fair		
4	Poor	Poor	
3	Serious		
2	Critical		
1	Imminent Failure		
0	Failed		

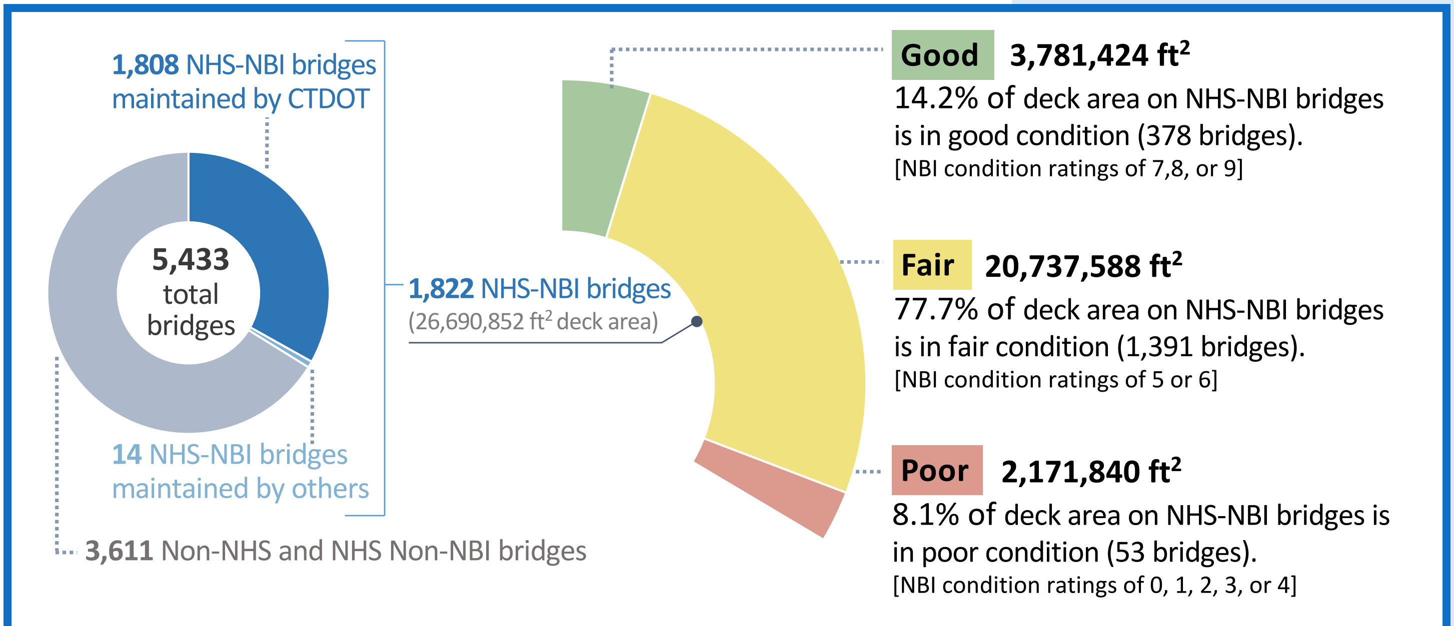
system per structure rather than by deck area for state-maintained bridges using the same deck, superstructure, substructure, and culvert ratings described previously. CTDOT defines a bridge as a crossing of at least six feet in length, including culverts.

CTDOT's performance measure for CTDOT-maintained bridges is the percent of CTDOT-maintained bridges in a SOGR. A bridge for which the NBI rating is 5 or greater is classified by CTDOT as being in a SOGR. CTDOT's measure for 4,058 CTDOT-maintained bridges is based on the number of bridges, unlike FHWA's required measure which is based on total bridge deck area for 1,822 NHS bridges. CTDOT bases its measure by number of bridges rather than by deck area since the number of bridges is a more appropriate representation of the network condition. In Connecticut, a measure by deck area can disproportionately represent the network based on a few large sized bridges.

Inventory and condition data for bridges are gathered through the bridge inspection process. The data are stored in the Structure Management System (SMS) using customized AssetWise Asset Reliability Inspection (AWARI) software and updated based on inspections, which happen most commonly on a biennial cycle. CTDOT reports on the condition of the NBI to FHWA on an annual basis. Asset data management is discussed in greater detail in Chapter 3.

Bridge Inventory and Conditions

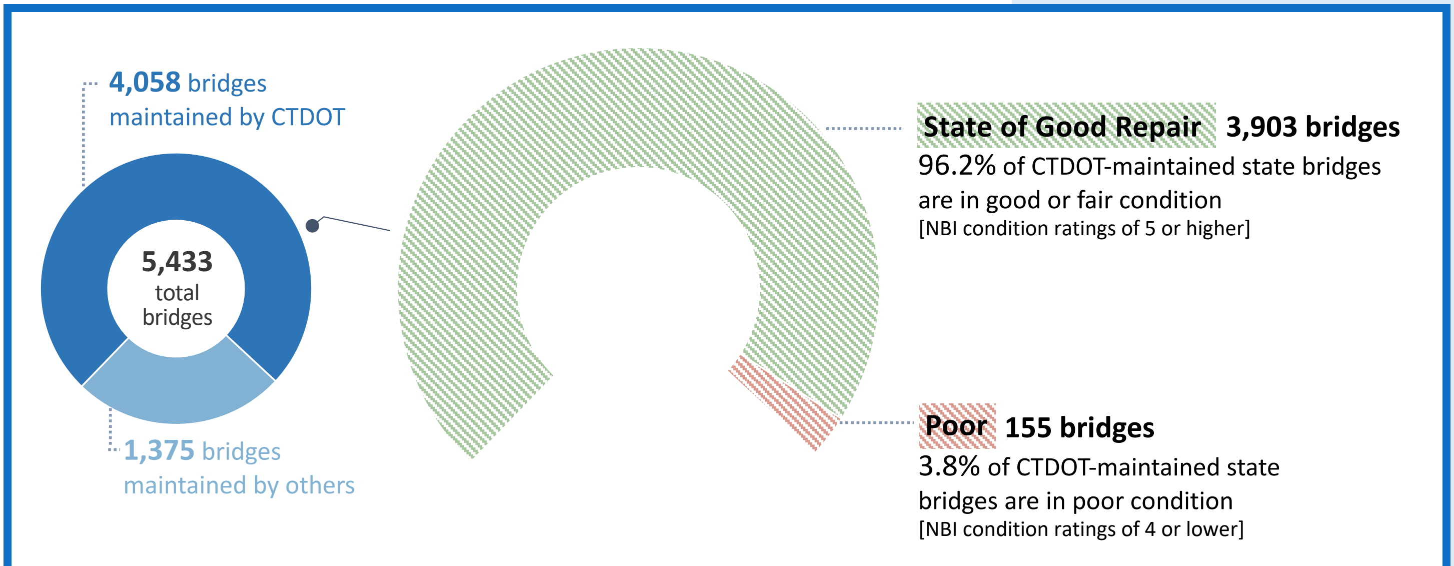
CTDOT inspects a total of 5,433 roadway bridges, including all of Connecticut's NBI bridges (20 feet or longer) and all of CTDOT's bridges (6 feet or longer). Of this total, 1,822 are NBI bridges on the NHS, and 4,058 are maintained by CTDOT. Figure 2-6 summarizes the NHS-NBI bridge inventory and its condition in Connecticut.



Based on CTDOT 3/15/21 NBI Submittal

Figure 2-6. NHS-NBI Bridge Inventory and Conditions

Figure 2-7 shows the inventory and condition of CTDOT-maintained bridges.



Based on CTDOT 3/15/21 Snapshot

Figure 2-7. CTDOT-Maintained Bridge Inventory and Conditions

Bridge Asset Valuation

For the purposes of this TAMP, the estimated value of the 5,306 CTDOT-maintained bridges is $17.1 billion. Asset valuation is discussed in further detail in Chapter 7.

Pavement

Pavement is the layered structure that forms the road. Pavements are designed to support anticipated traffic loads and provide a safe and relatively smooth driving surface. Maintaining pavements in good condition lengthens their life, enhances safety, helps reduce road users' operating costs, and reduces vehicle emissions. On the other hand, rough roads cause more wear and tear on vehicles, increasing user costs.

A typical pavement structure is shown below in Figure 2-8.

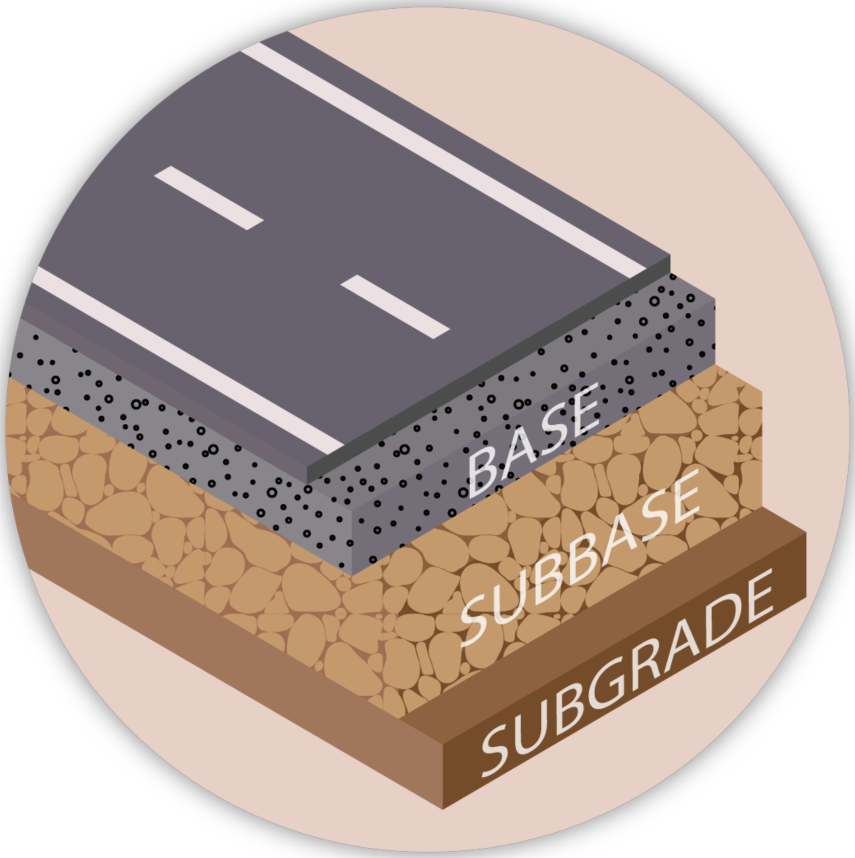


Figure 2-8. Pavement Structure

Pavement Performance Measures

CTDOT has adopted FHWA's four pavement condition performance measures for NHS pavements:

- Percentage of pavements on the Interstate System in Good condition
- Percentage of pavements on the Interstate System in Poor condition

Centerline miles and Lane Miles

A centerline mile is a measure of the total length (in miles) of highway facility in-place or proposed, as measured along the highway centerline.

A lane-mile is a measure of the total length of traveled pavement surface. Lane-miles equate to the center-line length (in miles) multiplied by the number of lanes.

- Percentage of pavements on the NHS (excluding the Interstate System) in Good condition
- Percentage of pavements on the NHS (excluding the Interstate System) in Poor condition

Each of the performance measures are calculated based on data reported to the HPMS.

For asphalt pavements, the International Roughness Index (IRI), rutting, and cracking are used to calculate the pavement condition performance measures. For concrete pavements, in addition to IRI described for asphalt pavements, faulting and cracking are used to calculate the pavement condition performance measures. Only 0.3% of pavements in Connecticut have concrete surfaces.

For each of the above metrics, FHWA has established thresholds for good, fair and poor condition. These thresholds are summarized in Table 2-4. The pavement condition metrics are used to calculate the FHWA performance measures for pavement condition. Conditions are assessed using these criteria for 0.1- mile- long pavement sections, although shorter sections are permitted at the beginning of a route, end of a route, at bridges, or other locations where a section length of 0.1 mile is not achievable, as described in the December 2016 HPMS Field Manual. An individual section is rated as being in good overall condition if all of the metrics are rated as good, and poor when two or more are rated as poor. All other combinations are rated as fair. The lane miles in good, fair, and poor condition are tabulated for all sections to determine the overall percentage of pavement in good, fair, and poor condition.

Table 2-4. FHWA Pavement Condition Thresholds

Metric	Good	Fair	Poor
IRI (inches/mile)	<95	95-170	>170
Rutting (inches)	<0.20	0.20-0.40	>0.40
Cracking (%) - Asphalt	<5	5-20	>20
- Jointed Concrete	<5	5-15	>15
- Continuously Reinforced Concrete	<5	5-10	>10
Faulting (inches)	<0.10	0.10-0.15	>0.15

Calculating Pavement Condition

For asphalt pavements, the following metrics are used to calculate the pavement condition performance measures.

- **International Roughness Index (IRI)** is an indicator of pavement roughness experienced by road users traveling over the pavements, and is computed from the average of two wheelpath single longitudinal profiles.
- **Rutting** is quantified for asphalt pavements by measuring the depth of ruts along the wheelpaths. Rutting is commonly caused by a combination of high traffic volumes, heavy vehicles and the instability of the pavement mix.
- **Cracking** is measured in terms of the percentage of cracking in the wheelpaths within a pavement section. Cracks can be caused or accelerated by aging, loading, poor drainage, frost heaves or temperature changes, or construction flaws.

For concrete pavements, IRI, faulting and cracking are used to calculate the pavement condition performance measures.

- **Faulting** is computed as the average vertical misalignment of adjacent slabs.
- **Cracking** in concrete pavements is measured as the percentage of slabs in the section that are cracked according to the HPMS Field Manual.

In addition to using the above federally-required measures for NHS pavements, CTDOT uses a Pavement Condition Index (PCI) to measure the condition of all CTDOT-maintained pavements. PCI is calculated for 0.1-mile sections, although smaller sections are used where that length is not achievable, such as at the end of a roadway.

For asphalt pavements, the PCI is based on five indices. A new method for weighting the PCI is under development. However, the current overall PCI is a weighted average of these indices, with each metric weight shown in parentheses:

- IRI (10%)
- Rutting (15%)
- Cracking (25%)
- Disintegration (30%)
- Drainage (20%)

IRI, rutting and cracking are also used for the FHWA metrics described earlier in this section; however, the IRI, cracking, and rutting indices used for calculating the PCI are handled differently than they are for determining the FHWA metrics. Disintegration is the wearing away of the pavement surface caused by the dislodging of aggregate particles and loss of asphalt binder. The disintegration index is estimated using the pavement age. Drainage refers to the ability of the surface of the roadway to drain and uses the collected cross slope and grade of the roadway to compute the drainage index. For concrete pavements, the PCI is based solely on the IRI index.

The PCI is scaled from 1.0 to 9.0, with 9.0 describing a pavement without defects. Within this scale, roadways with a PCI less than 4.0 are classified in “Poor” condition, those between 4.0 and less than 6.0 are in “Fair” condition, and 6.0 to 9.0 PCI indicates “Good” condition. A pavement section for which the PCI is 6 or greater is classified as being in a SOGR. CTDOT’s performance measure for CTDOT-maintained pavement is the percentage of centerline miles in a SOGR.

Changes in the December 2016 publication of the HPMS Field Manual resulted in differences in the way in which the

Pavement Condition

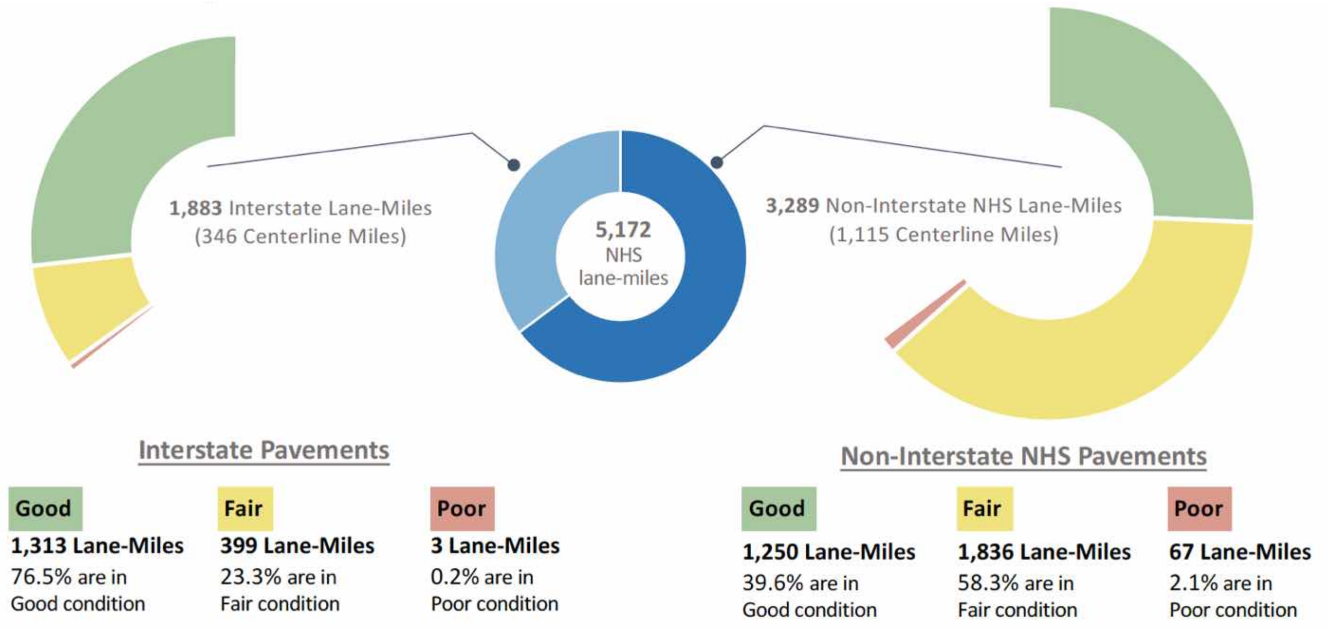
PCI Ratings and State of Good Repair

9.0	Good	SOGR
8.0		
7.0		
6.0		
5.0	Fair	
4.0		
3.0	Poor	
2.0		
1.0		

percent cracking metric was calculated for the Federal performance measures for asphalt pavements. In addition to these changes, cracking calculations were further automated for 2017 pavement condition data using features in Fugro's Vision software that provided the capability to output cracking directly in units of area, as opposed to units of length. Previously, in order to find areas of cracking, cracks measured in length had to be multiplied by an imputed cracking distress width to determine an area. This process was especially difficult for alligator type cracking, where series of random interconnected cracks complicated the estimation of cracking distress widths to determine cracking areas. The process of outputting cracking directly in units of areas using Fugro's Vision software for 2017 pavement condition data significantly improved the accuracy of measured cracking areas compared to 2016, which resulted in improved quality of the cracking metric for CTDOT. This process continues today.

Pavement Inventory and Conditions

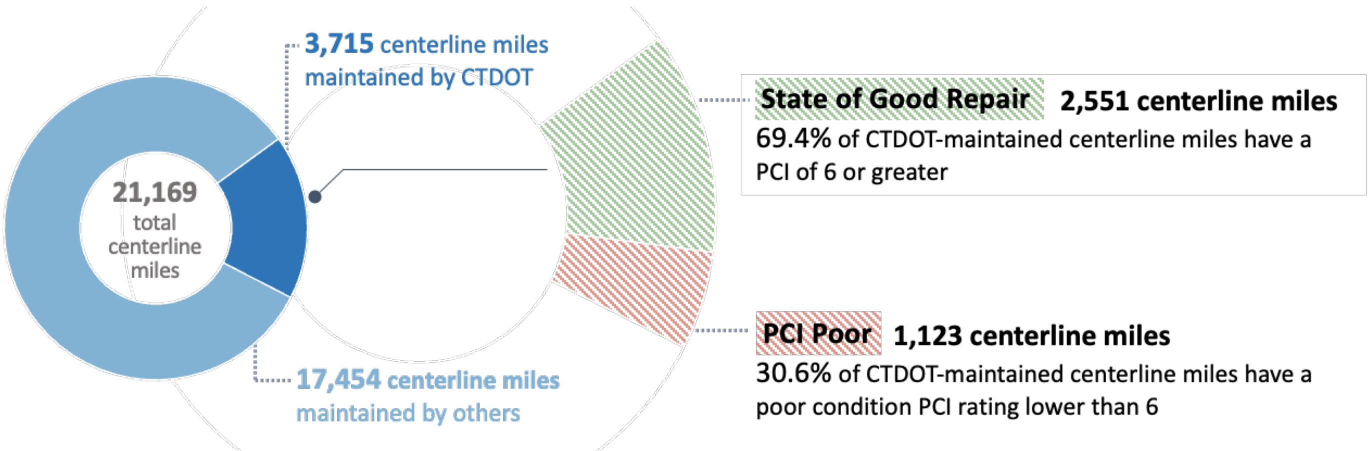
The pavement inventory is organized by system, divided into NHS and state highway network pavements. The NHS is further broken down into Interstate and Non-Interstate NHS pavements. Federal performance measures based on data reported to the HPMS exclude bridges and ramps. For consistency, bridges and ramps are also excluded from pavement condition presented in this TAMP. Figure 2-9 shows current inventory and conditions on CTDOT-maintained NHS pavements. Note that 131 Interstate lane miles are coded as bridge and 37 Interstate lane miles are missing/invalid; these 168 lane miles have no reported condition data. There are 81 Non-Interstate NHS lane miles coded as bridge and 55 Non-Interstate NHS lane miles missing/invalid; these 136 lane miles have no reported condition data. The non-interstate NHS includes 127 lane-miles which are locally maintained.



Based on 2020 HMPS pavement condition data submitted to FHWA June 14, 2021

Figure 2-9. NHS Pavement Inventory and Conditions

Figure 2-10 shows current inventory and conditions of CTDOT-maintained pavements.



Based on CTDOT 1/11/22 Snapshot

Figure 2-10. CTDOT-Maintained Pavement Inventory and Conditions

Pavement Asset Valuation

For the purposes of this TAMP, the estimated value of the 3,715 centerline miles of CTDOT-maintained pavement is $10.8 billion. Asset valuation is discussed in further detail in Chapter 7.

Traffic Signals

CTDOT defines a traffic signal unit as all traffic control equipment at a given intersection or location.

Traffic Signal Performance Measures

Traffic signal condition is currently approximated based on age. The life-cycle for a traffic signal is estimated to be 25 years based on expectations of traffic controller and signal head life with interim component replacements at varying intervals. For the purpose of the TAMP, traffic signals between 0 and 15 years old are considered to be in good condition, traffic signals between 16 and 25 years old are considered to be in fair condition, and traffic signals older than 25 years are considered to be in poor condition. A traffic signal installed within the past 25 years is classified as being in a SOGR. CTDOT is working on developing a revised approach to managing the inventory and condition of this asset to a component based rating system.

Traffic Signals Inventory and Condition

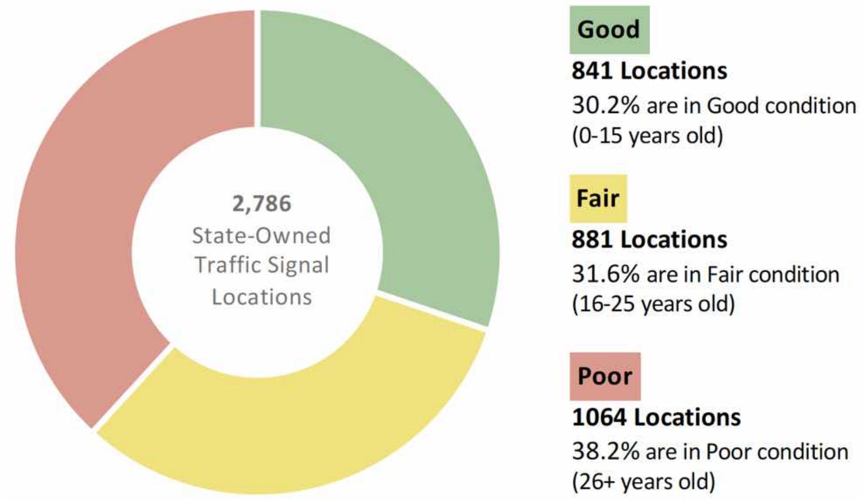
CTDOT is currently responsible for maintaining 2,786 state-maintained traffic signals:

- 2,560 traditional traffic signals
  - 966 of the traffic signals are part of 111 computerized traffic signal systems
- 226 overhead flashing beacons
- An additional 279 signs with flashers are tracked in the traffic signal inventory. The associated signs are included under the sign asset

Figure 2-11 shows the current inventory and conditions of CTDOT-maintained traffic signals.

Traffic Signal Condition

Good	0–15 Years	SOGR
Fair	16–25 Years	SOGR
Poor	26+ Years	



Based on CTDOT 1/3/22 Snapshot

Figure 2-11. Traffic Signal Inventory and Conditions

Traffic Signal Asset Valuation

For the purposes of this TAMP, the estimated value of the 2,786 CTDOT-maintained traffic signals, including flashing beacons, is approximately $830 million. Asset valuation is discussed in further detail in Chapter 7.

Signs

CTDOT defines a sign as a panel attached to a post(s) or sign structure and a sign assembly as the combination of sign panel(s) and their post(s), support, or sign structure at a single location. For the purpose of the TAMP, the sign asset category includes all state-maintained sign panels (side-mounted and overhead) and the posts, supports and foundations for side-mounted sign panels located adjacent to a roadway. Overhead sign supports with their associated foundations are managed as a separate asset.

Signs Performance Measures

Sign condition is approximated based on age. A sign installed within the past 17 years is classified as being in a SOGR based on expectations of retroreflectivity life. Retroreflectivity is a measure of the amount of light reflected by a surface back to the source of the light.

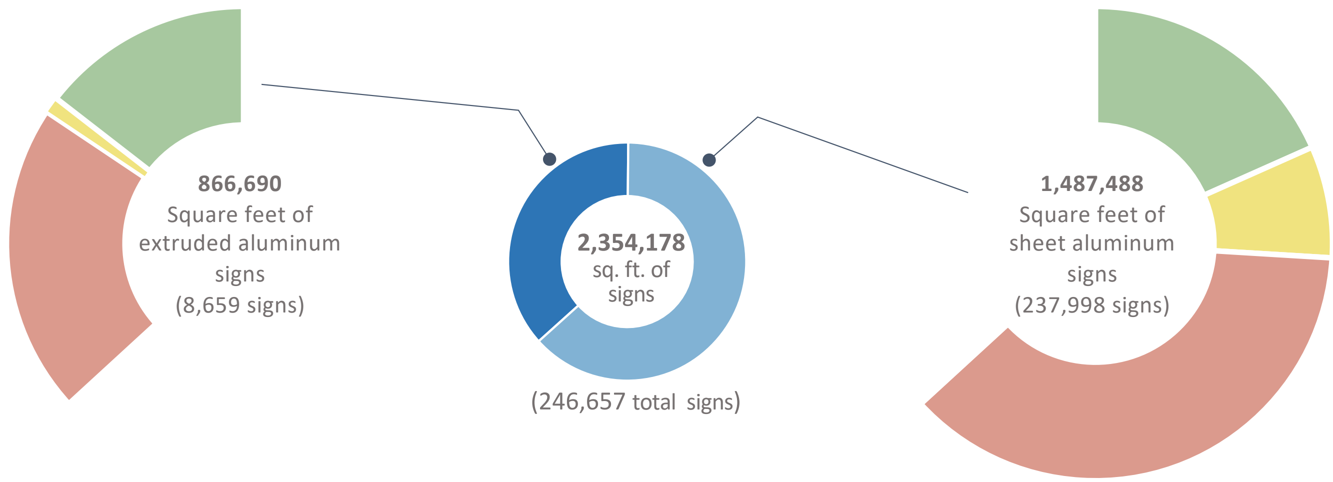
Signs between 0 and 12 years old are considered to be in good condition, signs between 13 and 17 years old are considered to be in fair condition, and signs older than 17 years are considered to be in poor condition.

Signs Inventory and Conditions

CTDOT is responsible for maintaining 246,657 regulatory, warning, and guide signs that are located on state-maintained roadways. Sign inventory is also represented as 2,354,178 square feet of sign area. The sign asset is organized by type of material: extruded aluminum signs and sheet aluminum signs. Figure 2-12 shows the inventory and conditions of CTDOT-maintained signs.

Sign Condition

Condition	Age	
Good	0–12 Years	SOGR
Fair	13–17 Years	SOGR
Poor	18+ Years	



Extruded Aluminum Signs

Good	Fair	Poor
3,412 Signs 39.4% are in Good condition (0-12 years old)	**260 Signs** 3.0% are in Fair condition (13-17 years old)	**4,987 Signs** 57.6% are in Poor condition (18+ years old)

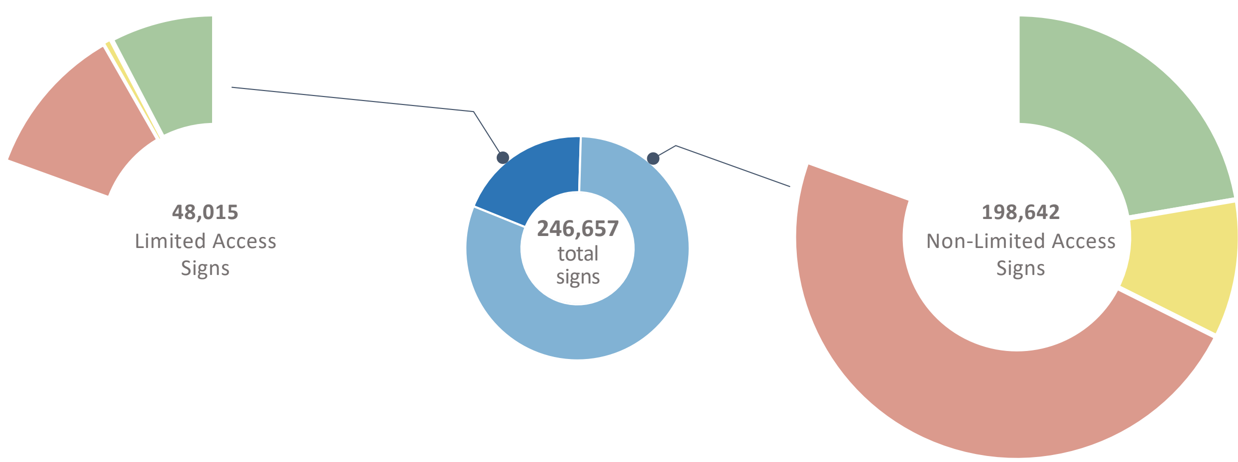
Sheet Aluminum Signs

Good	Fair	Poor
69,077 Signs 29.0% are in Good condition (0-12 years old)	**28,718 Signs** 12.1% are in Fair condition (13-17 years old)	**140,203 Signs** 58.9% are in Poor condition (18+ years old)

Based CTDOT 1/12/22 Snapshot

Figure 2-12. Sign Inventory and Conditions

Previous to 2022, sign inventory and condition was organized by limited access roadways and non-limited access roadways, as shown in Figure 2-13 for comparison.



Limited Access Signs

Good	Fair	Poor
18,915 Signs 39.4% are in Good condition (0-12 years old)	**1,455 Signs** 3.0% are in Fair condition (13-17 years old)	**27,645 Signs** 57.6% are in Poor condition (18+ years old)

Non-Limited Access Signs

Good	Fair	Poor
55,024 Signs 27.7% are in Good condition (0-12 years old)	**24,830 Signs** 12.5% are in Fair condition (13-17 years old)	**118,788 Signs** 59.8% are in Poor condition (18+ years old)

Based CTDOT 1/12/22 Snapshot

Figure 2-13. Sign Inventory and Conditions – By Access

Sign Asset Valuation

For the purposes of this TAMP, the estimated value of the 246,657 CTDOT-maintained signs is approximately $182 million. Asset valuation is discussed in further detail in Chapter 7.

Sign Supports

CTDOT defines a sign support as the structure (horizontal member(s), post(s), vertical attachments and foundation) carrying sign panels or variable message boards at a single location. Overhead sign panels attached to the sign support are managed as part of the sign asset.

Sign Support Performance Measures

Sign support condition ratings are used to classify a sign support as being in good, fair, or poor condition. The lowest of the ratings for the structure or the foundation determines the overall rating of the sign support. Sign support condition is measured using a 0-9 rating scale. If the overall rating is 7 or greater, the sign support is classified as being in good condition. If it is 5 or 6, the sign support is classified as being in fair condition, and if it is 4 or less, the sign support is classified as being in poor condition. Sign supports with an overall rating of 5 or better are classified as being in a SOGR. Sign support condition ratings are re-evaluated every 6 years for full span overhead sign supports; 4 years for cantilever or bridge mounted sign supports; and 2 years for any aluminum sign supports (regardless of type).

Sign Support Inventory and Conditions

CTDOT is responsible for maintaining 1,653 overhead sign supports on state-maintained roadways. The sign support inventory is made up of three categories:

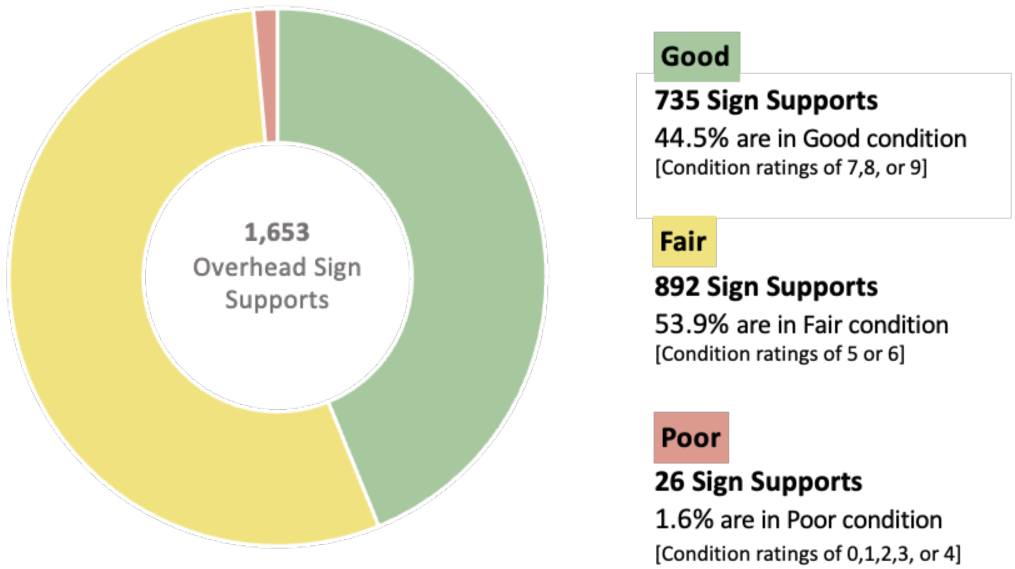
- 679 Cantilevers
- 618 Full-Span
- 356 Bridge Mounted

Figure 2-14 shows the current inventory and conditions of sign supports.

Sign Support Condition

State of Good Repair

9	Excellent	Good	SOGR
8	Very Good	Good	SOGR
7	Good	Good	SOGR
6	Satisfactory	Fair	SOGR
5	Fair	Fair	SOGR
4	Poor	Poor	
3	Serious	Poor	
2	Critical	Poor	
1	Imminent Failure	Poor	
0	Failed	Poor	



Based on CTDOT 2/4/22 Snapshot

Figure 2-14. Sign Support Inventory and Conditions

Sign Support Asset Valuation

For the purposes of this TAMP, the estimated value of the 1,653 CTDOT-maintained sign supports is approximately $294 million. Asset valuation is discussed in further detail in Chapter 7.

Pavement Markings

Pavement markings are organized into two categories: line striping, measured in linear feet; and symbols and legends (arrows, crosswalks, etc.), measured in square feet. Both categories of pavement markings can be applied as either water-based or epoxy. For line striping, a newer method of application used is in-laid epoxy markings.

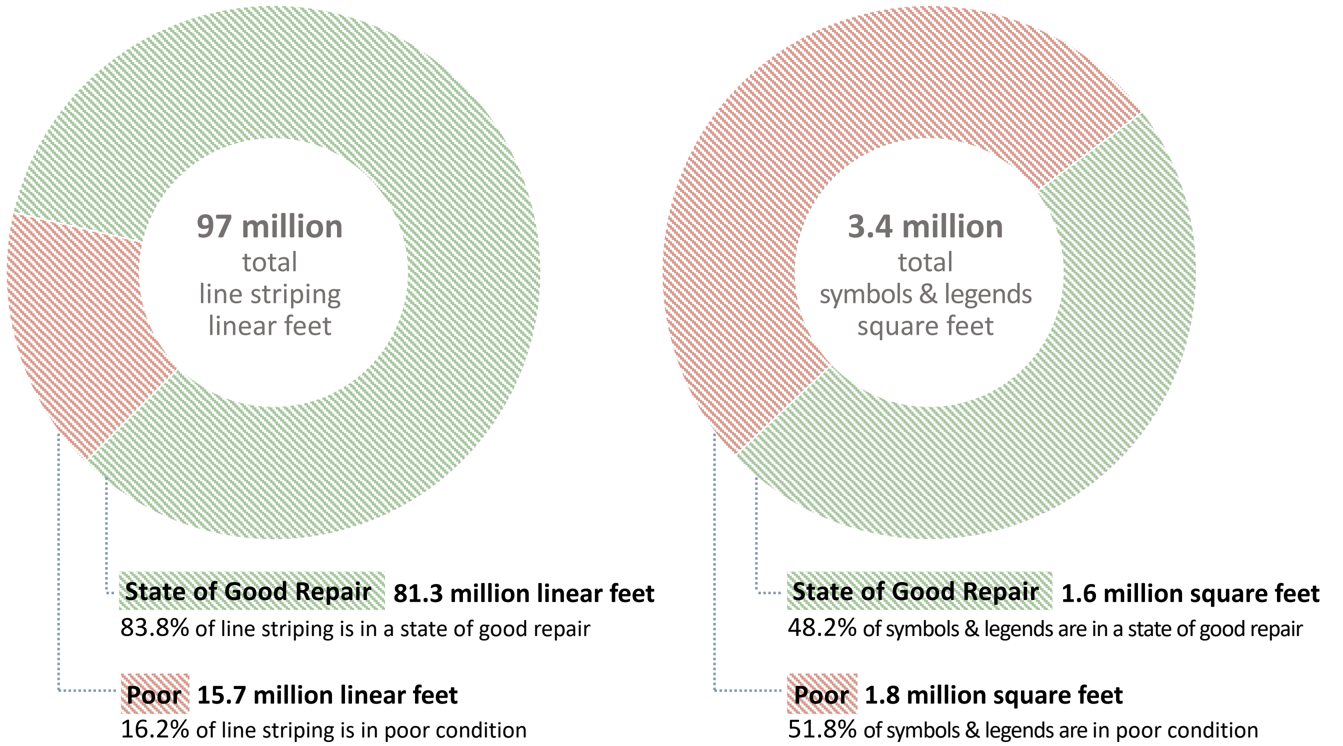
Pavement Markings Performance Measures

In-laid epoxy pavement markings installed within 6 years, epoxy pavement markings installed within the past 3 years and water-based pavement markings installed within 1 year are classified as being in a SOGR. This is based on expectations of retroreflectivity life and wear. Pavement markings older than the years identified above are classified in a Poor condition. Due to the short life cycle of this asset, CTDOT has chosen not to include a Fair condition rating at this time.

Pavement Markings Inventory and Conditions

CTDOT is responsible for maintaining pavement markings on approximately 3,715 centerline miles of state-maintained roadways. More than 16% of all line striping and nearly 52% of all symbol and legend pavement markings have exceeded their expected service life. Figure 2-15 shows the current inventory and conditions of both types of pavement markings. This inventory combines epoxy and water-based markings.

Note that CTDOT implemented a revised inventory calculation methodology since the 2019 TAMP, which has resulted in changes to the SOGR. Pavement line SOGR increased by roughly 20%, while pavement symbol SOGR decreased by roughly 20%.



Based on CTDOT 12/31/21 Snapshot

Figure 2-15. Pavement Markings Inventory and Conditions

Pavement Markings Asset Valuation

For the purposes of this TAMP, the estimated value of CTDOT-maintained pavement markings is approximately $63 million. Asset valuation is discussed in further detail in Chapter 7.

Highway Buildings

CTDOT defines a building as a relatively permanent structure to house persons or property. Highway buildings are needed to support the overall maintenance and operation of the highway system. They vary dramatically in size, function and cost so they are grouped into tiers and sub-tiers to be managed effectively.

Highway Buildings Performance Measures

The condition of the highway buildings is based on a combination of age-based and condition-based component ratings. Components with known or industry standard life cycles, like roofs and boilers, were assigned calculated ratings based on an installation date; components without known life cycles, like interior building finishes, were assigned a rating based on a visual inspection.

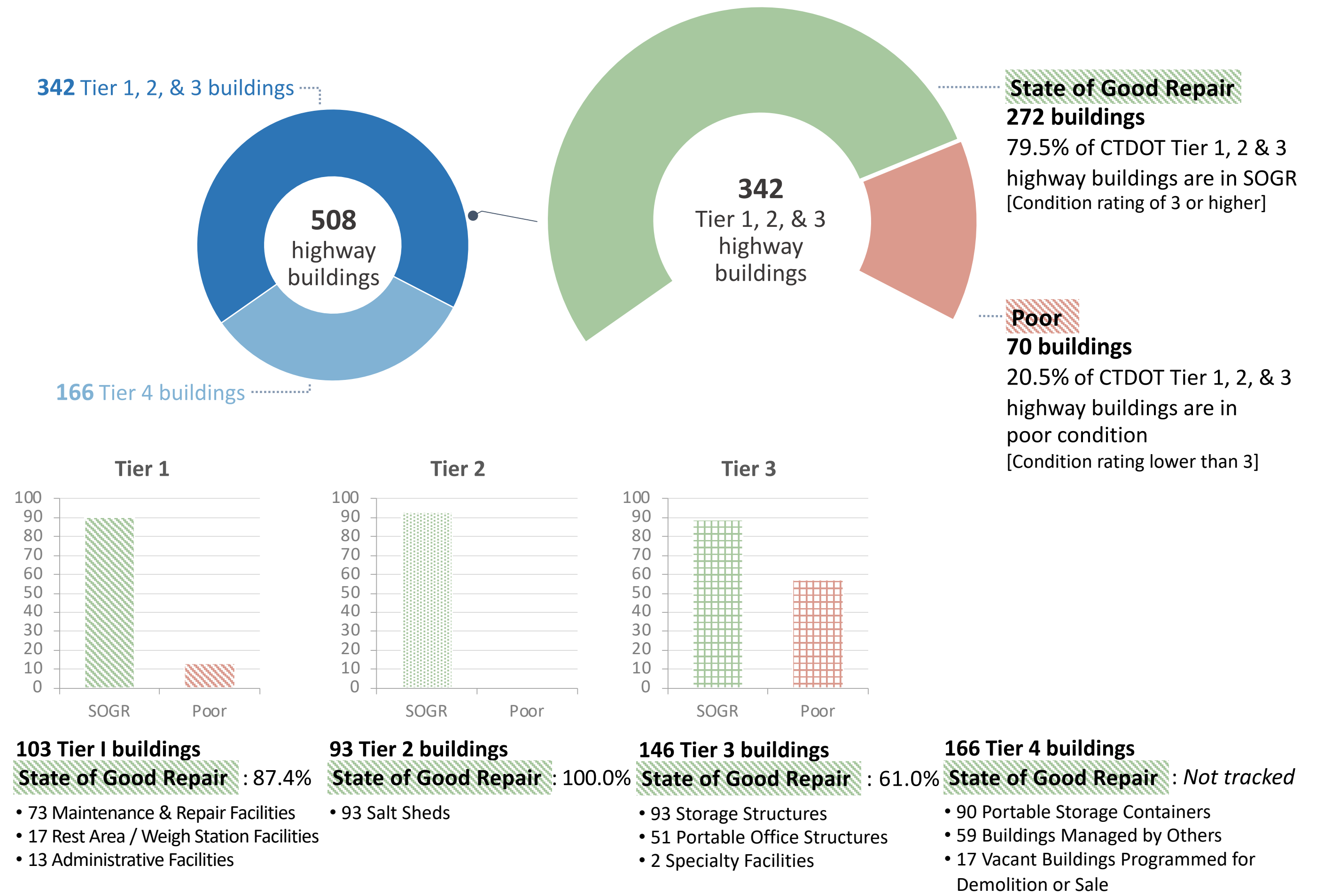
Individual component ratings were weighted and averaged to provide an overall building score.

An overall building score of 3 or higher on a scale of 1-5 is considered to be in a SOGR, while a building with an overall building score lower than 3 is not in a SOGR. CTDOT's performance measure for highway buildings is the percent of buildings maintained in a SOGR.

Highway Buildings Inventory and Conditions

CTDOT currently has 508 buildings on 154 sites in the highway buildings inventory that have been grouped into tiers and sub-tiers. Tier 1 buildings are significant structures from a size, function or cost perspective that are normally occupied by employees or the public and are therefore the most critical buildings in the program. Tier 2 buildings are salt sheds that are critical for winter snow and ice operations. Tier 3 buildings are typically much smaller in scale and cost than the Tier 1 and Tier 2 buildings but are vital in supporting maintenance operations from a storage and portable office function. Tier 4 buildings are tracked in the inventory as assets, but they are not included in the asset management plan. These buildings are either being managed by entities other than CTDOT Property & Facilities Services, are storage containers that are not tracked, or are vacant buildings programmed for demolition or sale. Appendix C includes a detailed list of all building types broken down by tier and sub-tier.

Figure 2-16 shows the current inventory and condition for each building type.



Based on CTDOT 12/31/21 Snapshot

Figure 2-16. Highway Buildings Inventory and Conditions

Table 2-5 shows the owner/occupant relationship for each building type.

Table 2-5. Highway Building Owners and Occupants

Building Type	Owner	Occupant
Tier 1 - Maintenance & Repair Type Facilities	P&FS	M, P&FS
Tier 1 - Rest Area Facilities	M	M
Tier 1 - Weigh Station Facilities	P&FS	CT State Police/CT DMV Truck Squad
Tier 1 - Administration Facilities	P&FS	All DOT Bureaus
Tier 2 - Salt Sheds	P&FS	M
Tier 3 - Specialty Facilities	M	M
Tier 3 - Storage Structures	P&FS	M/P&FS
Tier 3 - Portable Office Structures	P&FS	M
Tier 4 - Portable Storage Containers, Buildings Managed by Others, and Vacant Buildings Scheduled for Demolition or Sale	Various	Various

Highway Buildings Asset Valuation

For the purposes of this TAMP, the estimated value of CTDOT-maintained highway buildings is approximately $890 million. The breakdown by tier is as follows:

- Tier 1: $710 million
- Tier 2: $167 million
- Tier 3: $13 million
- Tier 4: value not assessed

Asset valuation is discussed in further detail in Chapter 7.

Roadway Illumination

The majority of lighting systems are located along the roadway network. A typical lighting system includes a control cabinet, conduit, conductors, cabinet and light pole foundations, handholes, transformer bases, light poles, light fixture brackets and light fixtures. Specialized lighting systems exist for underpasses, tunnels, commuter lots and decorative lighting.

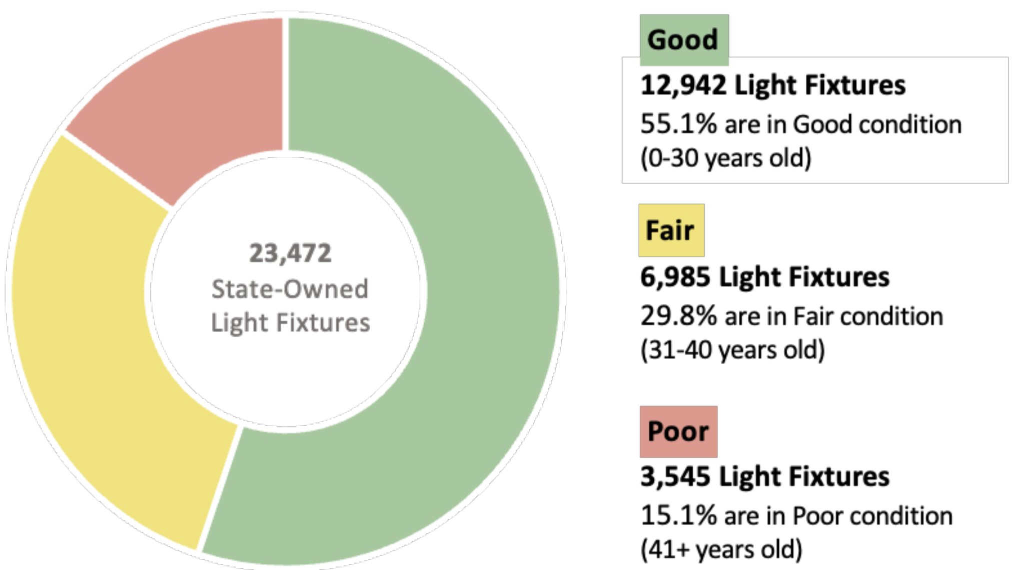
Roadway Illumination Performance Measures

Lighting systems and components have an average projected useful life of 40 years. Lighting systems installed within the last 40 years are classified as being in a SOGR.

Lights between 0 and 30 years old are considered to be in good condition, lights between 31 and 40 years old are considered to be in fair condition, and lights older than 40 years are considered to be in poor condition.

Roadway Illumination Inventory and Conditions

CTDOT is responsible for maintaining a total of 207 lighting systems that include 23,472 light fixtures. Figure 2-17 shows the current inventory and conditions.



Based on CTDOT 12/31/21 Snapshot

Figure 2-17. Roadway Illumination Inventory and Conditions

Roadway Illumination Asset Valuation

For the purposes of this TAMP, the estimated value of CTDOT-maintained lighting systems is approximately $447 million. Asset valuation is discussed in further detail in Chapter 7.

Retaining Walls

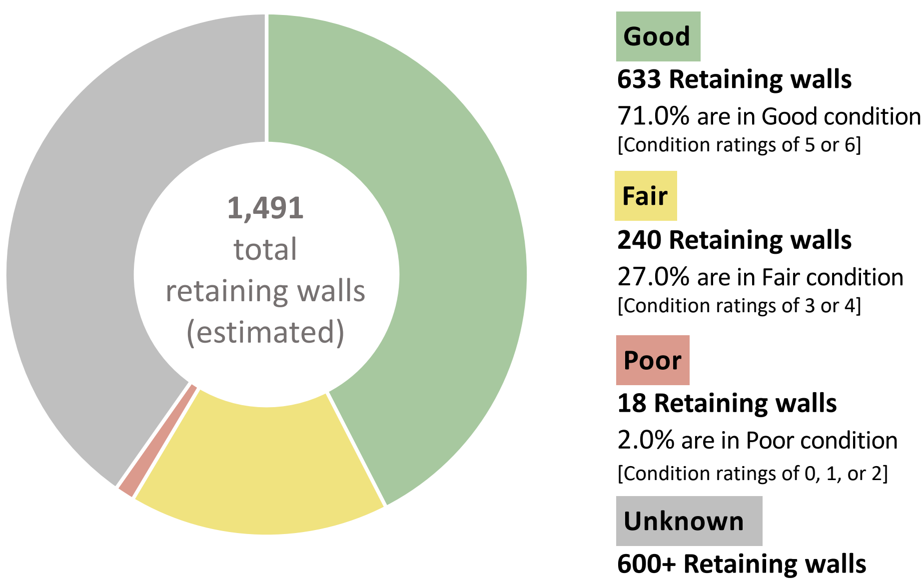
CTDOT defines a retaining wall as a structure that provides a grade separation by retaining earth and/or rock. Bridge abutments, wingwalls, culvert headwalls and barrier curbs with minor grade differential are considered separate assets.

Retaining Walls Performance Measures

While there is limited data available on life expectancy of retaining walls, empirical evidence indicates life expectancy ranging from 50 years (for Metal Bin walls or Concrete Crib walls) to well over 100 years (for Masonry walls). Retaining Walls with an overall rating of at least a 3 on a 0-6 condition scale are classified as being in a SOGR.

Retaining Walls Inventory and Conditions

CTDOT has currently identified and incorporated 891 retaining walls into its asset database. CTDOT estimates more than 600 retaining walls have not yet been identified. Plans to capture and rate the remaining walls are ongoing. Figure 2-18 shows the current inventory and conditions.



Based on CTDOT 2010 inventory with 2021 updates

Figure 2-18. Retaining Walls Inventory and Conditions

Retaining Walls Asset Valuation

For the purposes of this TAMP, the estimated value of CTDOT-maintained retaining walls is approximately $250 million. Asset valuation is discussed in further detail in Chapter 7.

Drainage Culverts

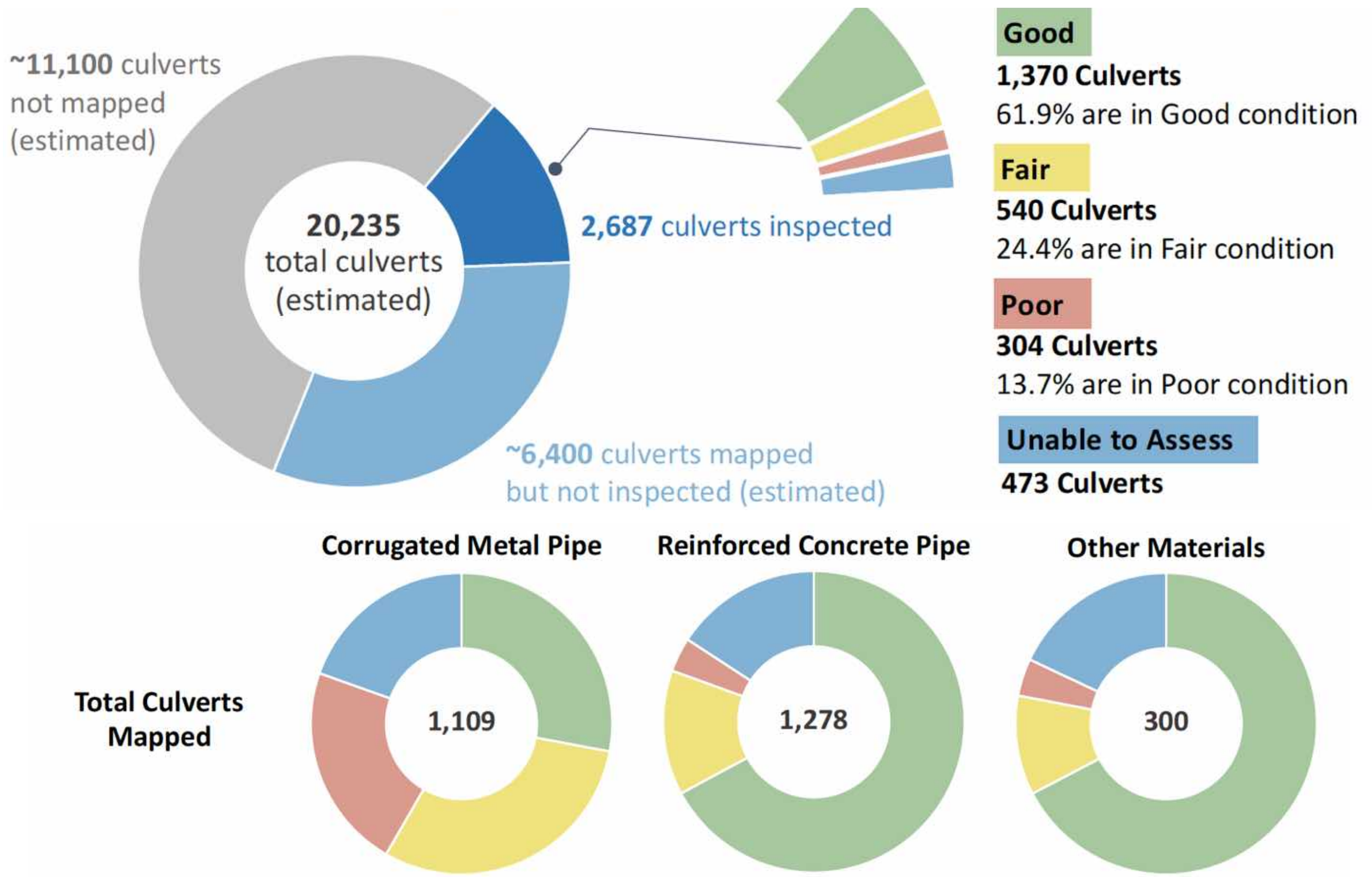
CTDOT is responsible for a complex drainage system including storm drains, manholes, closed conveyance pipes, culverts, headwalls, and endwalls. Culverts convey watercourses or stormwater runoff underneath state roads. In Connecticut, the majority of culverts are reinforced concrete pipes (RCPs) or corrugated metal pipes (CMPs). CMPs can have asphalt coating. Culverts over 6’ in diameter are considered bridge structures and are inspected and tracked as bridges. Culverts that span less than 6' along the centerline of the roadway are considered drainage culverts.

Drainage Culvert Performance Measures

A culvert which has been rated Fair, Good, or Excellent is classified as being in a SOGR. This rating is based on the Culvert Condition Rating Assessment developed by the CTDOT Office of Environmental Planning.

Drainage Culvert Inventory and Conditions

CTDOT is responsible for maintaining an estimated 20,200 culverts, of which 2,687 culverts have been mapped and inspected. Figure 2-19 shows the current inventory and conditions.



	Corrugated Metal Pipe	Reinforced Concrete Pipe	Other Materials
Good	**310** (34.8%)	**858** (79.7%)	**202** (82.1%)
Fair	**337** (37.7%)	**171** (15.9%)	**32** (13.0%)
Poor	**245** (27.5%)	**47** (4.4%)	**12** (4.9%)
Unable to Assess	217	202	54

Based on CTDOT 12/31/21 Snapshot

Figure 2-19. Drainage Culvert Inventory and Conditions

Drainage Culvert Asset Valuation

For the purposes of this TAMP, the estimated value of CTDOT-maintained drainage culverts is approximately $2.7 billion. Asset valuation is discussed in further detail in Chapter 7.

ITS

Advanced Traffic Management System (ATMS) field devices comprise 362 Closed Circuit Television Cameras (CCTV), 143 Variable Message Signs (VMS), and 40 Roadway Weather Information Systems (RWIS). ATMS field devices rely on Operation Centers, Fiber Hubs, and Video Data Transport that are tracked as part of CTDOT's Highways Buildings Asset. ATMS field devices also relies on servers, software, central equipment, and 198 miles of fiber optic cable trunkline to communicate with ATMS field devices. These assets are being evaluated and will be considered for future updates.

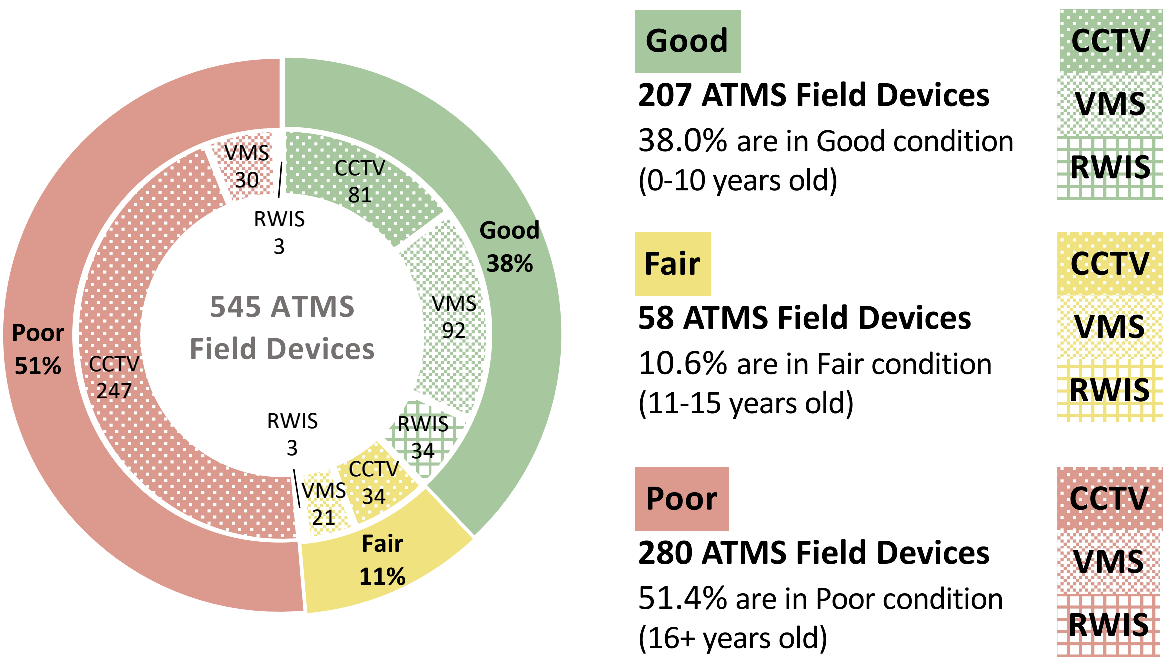
ITS Performance Measures

ATMS field devices have an average projected useful life of 15 years. ATMS field devices installed within the last 10 years are classified as being in a SOGR.

ATMS field devices between 0 and 10 years old are considered to be in good condition, ATMS field devices between 11 and 15 years old are considered to be in fair condition, and devices older than 15 years are considered to be in poor condition.

ITS Inventory and Conditions

CTDOT currently owns and maintains a total of 545 ATMS devices. Figure 2-20 shows the current inventory and conditions.



Based on CTDOT 1/8/22 Snapshot

Figure 2-20. ITS Inventory and Conditions

ITS Asset Valuation

For the purposes of this TAMP, the estimated value of CTDOT-maintained ATMS devices is approximately $168 million. Asset valuation is discussed in further detail in Chapter 7.

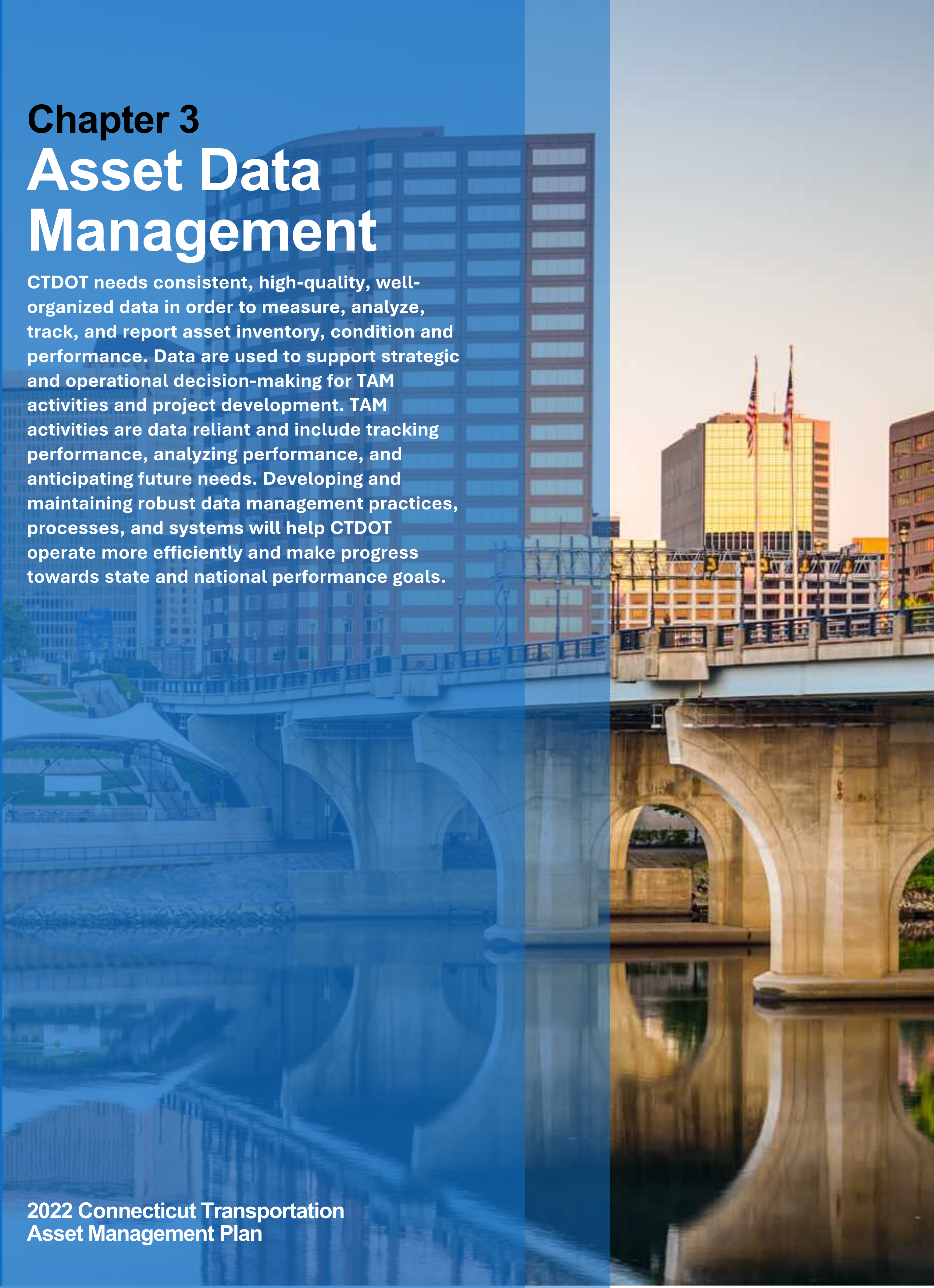
Summary

CTDOT is implementing TAM not only because it is federally required, but also because CTDOT recognizes that asset management is a better way to do business. Developing systems and processes to gather, record, process, and analyze asset inventory and condition data is a key initial step towards TAM. The inventory and condition data captured in this chapter helps outline the extent and condition of the statewide system and NHS. Subsequent chapters describe performance targets, performance gaps, life cycle plans, risks, and financial details of the system.

Chapter 3

Asset Data Management

CTDOT needs consistent, high-quality, well-organized data in order to measure, analyze, track, and report asset inventory, condition and performance. Data are used to support strategic and operational decision-making for TAM activities and project development. TAM activities are data reliant and include tracking performance, analyzing performance, and anticipating future needs. Developing and maintaining robust data management practices, processes, and systems will help CTDOT operate more efficiently and make progress towards state and national performance goals.



Overview

The TAMP reflects CTDOT's need for good asset data management to provide a strong foundation for transportation asset and performance management. Data management is a set of practices for specification, collection, quality assurance, standardization, integration, reporting, and data accessibility to meet information needs and promote efficiency and consistency. Rather than relying on a decentralized approach in which individual units collect, store and report on data to meet their individual operational needs, CTDOT has been moving towards an enterprise approach to make best use of agency data for informed decision-making, as shown in Figure 3-1.

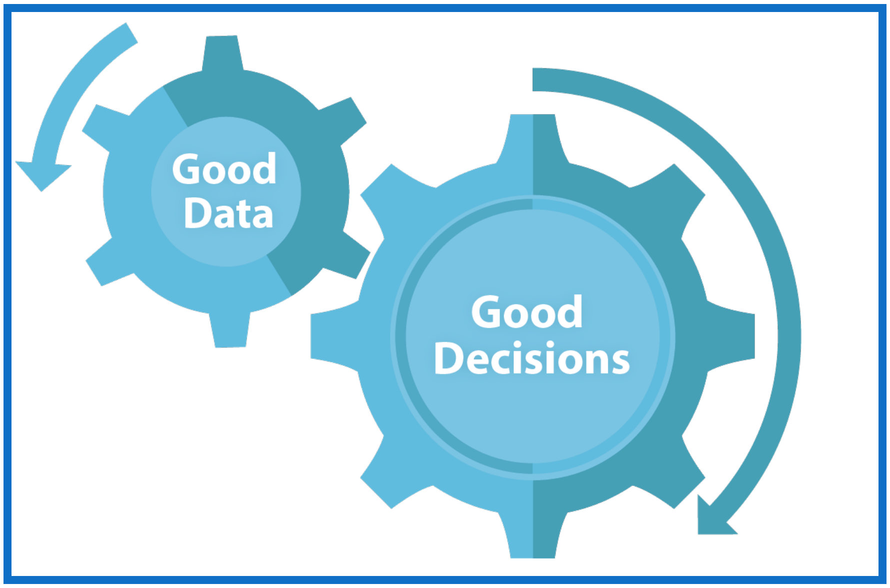


Figure 3-1. Data-Driven Decision Making

This chapter presents a summary of data management practices and processes for the assets in the TAMP and an overview of TAM data systems used at CTDOT.

Federal Legislative Context

FHWA requires that State DOTs use the best available data to develop their asset management plans. In addition, states must use bridge and pavement management systems to support development of the asset management plan. Management systems used by State DOTs to support the asset management plan must include documented procedures for:

- Collecting, processing, storing, and updating inventory and condition data for NHS bridges and pavement
- Forecasting deterioration for NHS bridges and pavement
- Conducting life cycle analysis of alternative strategies for NHS bridges and pavement
- Identifying short- and long-term budget needs for managing condition for NHS bridges and pavement
- Determining the optimal strategies for identifying potential projects for NHS bridges and pavement
- Recommending programs and implementation schedules to manage condition for NHS bridges and pavement

Practices and Processes

Data should be used within a well-defined set of practices and processes to maximize its value. This section summarizes asset data management practices at CTDOT such as data collection and updates.

An asset data readiness assessment was completed for each asset for the following categories and a blank sample assessment form is attached in Appendix B

- Administrative Information
- Asset Definition and Identification
- Asset Data Requirements
- Data Ownership and Stewardship
- Asset Data Collection, Storage and Updating
- Derivative Data Set Creation and Management
- Asset Work History Tracking
- Data Access Points
- Additional Notes

Bridge Data

CTDOT Bridge Safety and Evaluation Unit perform bridge inspections in accordance with the National Bridge Inspection Standards (NBIS) as well as more detailed element-level inspections. Structures are inspected on a regular interval, typically every 24 months. Select structures in poor condition are strategically scheduled for more frequent inspections. As part of a bridge inspection, bridge inspectors rate a bridge's structural condition through careful inspection and evaluation of the three main components for a span bridge: (1) deck and wearing surface; (2) superstructure (structural supports beneath the deck); and (3) substructure (piers and abutments); or for a culvert: the structural condition. Element-level inspections supplement component inspections, providing detailed data on the condition of each structural element of a bridge. CTDOT reports on the condition of bridges that are part of the NBI to FHWA on an annual basis. CTDOT also reports element-level data for NHS bridges as part of its FHWA NBI

National Bridge Inspection Standards

FHWA has specified data to be collected as part of a bridge inspection through the National Bridge Inspection Standards (NBIS) in accordance with 23 U.S.C. 151. The standards apply to all publicly owned highway bridges longer than twenty feet located on public roads.

annual submittal. Bridge inspection quality control and quality assurance procedures are documented in Chapter 4 of the CTDOT Bridge Inspection Manual Version 2.1. Each bridge is geospatially represented by a single GPS location point within AWARI and is represented by a polygon within ATLAS (Asset Tracking & Location System). AWARI and ATLAS are described later in this chapter. There are substantial updates and modifications in the 2022 NBIS to allow for better clarity, provide for data based decisions, and establish more consistent oversight. Implementation of new standards will occur over a 5 year timeframe.

Pavement Data

Data flows into the Pavement Management System (PMS) from several sources (see Figure 3-2). Pavement condition data are collected by the Bureau of Policy and Planning's Photolog Unit using specially equipped Fugro Roadware Automatic Road Analyzer (ARAN) vans. The entire CTDOT-maintained mainline, locally owned segments of the NHS, and locally owned HPMS sections are measured each year.

Starting with the 2015 data collection, the ARANs were updated to provide 3D Pavement imaging using Pavemetrics™ Laser Crack Measurement System, which includes two scanning lasers. This provides greater detail in the measurement of cracking, which will support future refinements to CTDOT's condition indices and PCI. The pavement images captured by the ARANs are processed to determine various pavement metrics, including wheel path rutting, cracking, cross slope, and faulting. Faulting is applicable to concrete pavements only, which make up less than 0.5% of CTDOT's network, while rutting is applicable to flexible (asphalt) pavements only.

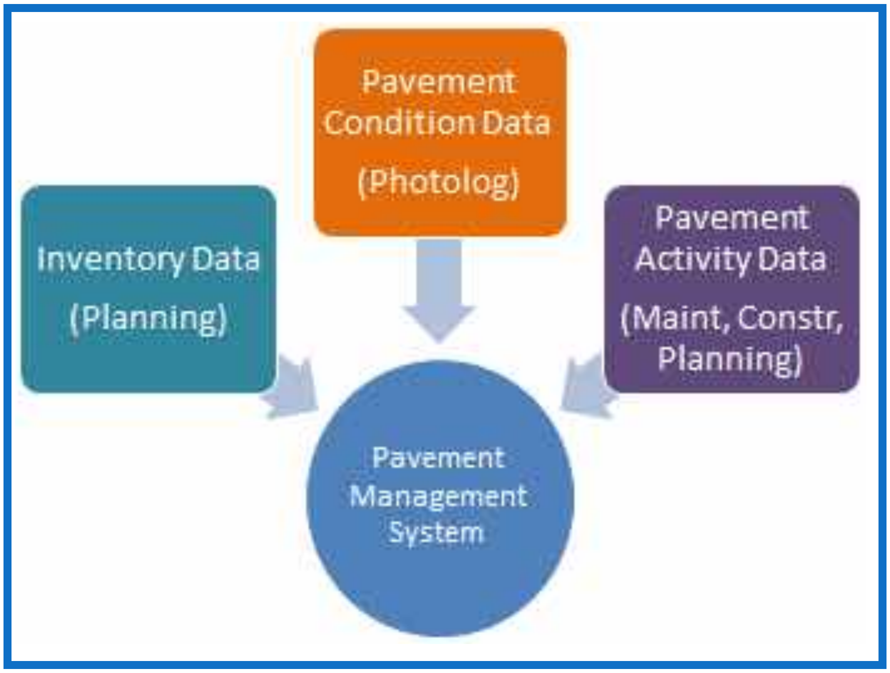
Also starting with the 2015 data collection, the ARANs were updated to include two Selcom RoLine sensors that feature laser line sensing (versus point laser sensing) located along each wheel path to collect longitudinal profiles to compute the roughness metric.

The condition data are then processed by the Pavement Management Group to calculate IRI (roughness), rutting (distortion), cracking (structural and environmental), disintegration (age), and drainage (cross slope and grade) indices, which are in turn used to calculate the PCI. Condition data are also processed to calculate the Federal performance metrics, including Percent Cracking (for asphalt pavements), Percent Cracked Slabs (for concrete pavements), and Faulting (for concrete pavements).

Condition ratings are collected every five meters, aggregated by tenth-mile sections and then by pavement analysis sections and stored in a Structured Query Language (SQL) database. Condition data are summarized by lane-miles for Federal HPMS reporting, and FHWA subsequently uses the reported data to determine the Federal performance measures. Finally, condition data are summarized by centerline miles for the State performance measures.

Pavement condition data are collected according to the CTDOT Data Quality Management Plan (DQMP) that was approved by FHWA on August 22, 2018. The DQMP addresses the following critical areas:

- Data collection equipment calibration and certification;
- Certification process for persons performing manual data collection;
- Data quality control measures to be conducted before data collection begins and periodically during the data collection program;
- Data sampling, review and checking processes; and
- Error resolution procedures and data acceptance criteria.



Source: Provided by CTDOT, July 2015

Figure 3-2. Pavement Management System Data Flow Diagram

Traffic Signals Data

The traffic signal inventory contains location, location history, ownership, maintenance, estimated energy use, pedestrian features, and other limited attributes. This database was developed years ago and was designed to meet operational rather than asset management needs. The data are stored in a SQL database with a Microsoft Access front end for data entry and viewing. The system was developed and is maintained by CTDOT's Office of Information Systems. Support structure data are stored in AWARI.

Signs Data

CTDOT currently has a sign inventory that was developed through a consultant contract in 2013 that involved capture of sign locations based on the CT Photolog images. The inventory is currently maintained in Excel spreadsheets which are published to ArcGIS as a snapshot.

CTDOT has recently implemented a process within Traffic Engineering, the Sign Shop, Office of the State Traffic Administration and District Maintenance to capture changes to the sign inventory as they occur, using a module of the Maintenance Management System (MMS).

Sign Supports Data

Sign support condition data are collected during inspections by the Bridge Safety and Evaluation Unit, typically every 6 years for full span overhead sign supports; 4 years for cantilever or bridge mounted sign supports; and 2 years for any aluminum sign supports (regardless of type). Sign supports in poor condition are scheduled for more frequent inspections. As part of a sign support inspection, inspectors rate a sign support's condition through careful inspection and evaluation of the main components: (1) signs & illumination; (2) structure; (3) foundation; and (4) traffic safety features. Each sign support is geospatially represented by a single GPS location point within AWARI, described later in this chapter.

Pavement Markings Data

Pavement markings data are based on assumptions for inventory and age. Methods to capture and track data for this asset are being explored. Baseline inventory data could be compiled using the Photolog; information on work affecting pavement markings is currently captured in the TR-8 (paper) forms by district Signs and Markings Units. Epoxy pavement markings are tracking in an Excel sheet based on District contracts and work history, while water-based markings are tracked by material use at the District level.

Highway Buildings Data

Highway buildings condition data was collected utilizing AWARI through a 2017/2018 inspection program developed by CTDOT and performed by consultant inspectors. All buildings, except Tier 4, were inspected unless there was a project to renovate, replace, or decommission the building.

Each highway building is represented by a single GPS location point within AWARI. Each site has been designated by a polygon that may eventually be integrated and maintained in ATLAS 2.0. The inventory is also maintained in Core-CT for financial reporting.

The duration between building inspection cycles has not been determined yet. Buildings are not being deteriorated in the system automatically and condition data needs to be updated manually as building maintenance and repairs occur requiring a more frequent inspection interval. CTDOT is currently investigating the possibility of implementing a Facilities Management System that can issue electronic work orders and update asset condition data, which would allow CTDOT the flexibility to increase the duration between inspections to as much as 10 years.

Roadway Illumination

The roadway illumination inventory consists of a database of roadway illumination “systems”, where a system is defined by a single lighting control cabinet and the light poles, roadway luminaires, under bridge luminaires, foundations, splice enclosures, conduit, and circuit conductors served by that lighting control cabinet. Other information available for the Roadway Illumination asset include asset age, location, work history, equipment descriptions, electrical characteristics, and utility company information (utility account numbers and meter numbers). Asset data is stored in an Excel spreadsheet maintained by Facilities Design, Electrical Engineering. Data is collected based on work completed, field trips, calls to utility companies, and review of utility bills.

In 2019, CTDOT created an illumination GIS layer that maps the poles, service cabinets, and approximate conduit/circuit locations. GIS data is updated as work is performed.

Retaining Walls

CTDOT maintains a partial inventory of retaining walls that was developed through CTDOT maintenance personnel in early 2010s. The existing inventory contains the retaining wall type(s), wall geometry and location, and retaining wall condition ratings. CTDOT is in the process of acquiring the service of consultant(s) to complete its retaining wall inventory and to implement a routine inspection program.

The retaining wall inventory is stored in a SQL database with a Microsoft Access front end for data inventory and viewing. The existing retaining wall inventory and the initial inspection reports will be migrated and stored in COMPASS. CTDOT intends to create a GIS based map of retaining walls that can be integrated in the CTDOT TED (Transportation Enterprise Database) and CTDOT ATLAS and other CTDOT-maintained GIS based systems.

Drainage Culverts

CTDOT began creating a drainage culvert inventory database in 2017. Culverts over 6’ in diameter are considered bridge structures and are inspected and tracked as bridges. Culverts spanning less than 6’ are considered drainage culverts. Currently, an estimated 45% of the drainage culvert network has been mapped in ArcGIS. Once mapped, maintenance inspectors are able to perform a field assessment of the culvert condition using the ESRI collector app. The culvert assessment data is stored in the same ArcGIS map layer as drainage “hot spots” designated by District Drainage Engineers, so potential drainage improvements can be easily identified and included in nearby project scopes, if feasible. In addition to asset management purposes, the drainage culvert network data is being collected in alignment with MS4 requirements.

Intelligent Transportation Systems- ATMS

CTDOT- Highway Operations maintains an inventory of ATMS field devices and has age-based conditions ratings. The inventory of the ATMS field devices consist of the CCTV Cameras, VMS, RWIS. Each field device is a system that includes the device, the structure, the cabinet, the communications equipment, the service cabinet, the conduits, and all wires needed to run the device. The age-based conditions are developed by assessing current equipment’s lifespan and failures to the equipment during the lifespan. The inventory of ATMS field devices is stored in a consultant designed web-based application. The application connects the users of the field device to Highway Operations maintenance contractors so when a field device fails, it is logged and fixed rapidly.

CTDOT-Highway Operations maintains a GIS layer that maps the field devices, device cabinets, service cabinets, and approximate conduit locations. GIS data is updated as work is performed.

TAM Information Management Systems

This section summarizes the key asset and project-related information systems used and the data held within them. This summary includes a description of how each type of data are collected, analyzed, managed, housed, and used within the CTDOT. Figure 3-3 shows the assets in the Connecticut TAMP and the systems used to manage those assets. The data within these systems are also used to generate annual Federal submittals for NBI and HPMS. Additional applications, such as ESRI Collector, are being used for other assets that may be included in future TAMPs.

Inventory and condition data are maintained in AWARI, dTIMS, Exor, ESRI, or asset specific databases, while DigitalHIWAY contains the authoritative set of right-of-way images of the state highway system. Predicted asset conditions are modeled using dTIMS for bridge and pavement, and estimated for other assets using spreadsheets. The Composite Project Database (CPD) and COMPASS include project details and the MMS tracks maintenance activities. Asset location data are stored in Exor, ATLAS, or ESRI, and TED is an enterprise database that draws data from many of the other systems listed in this chapter and offers views, queries, and analysis of the data.

	Bridges	Pavement	Traffic Signals	Signs	Sign Supports	Pavement Markings	Highway Buildings	Illumination	Retaining Walls	Drainage	ITS
AWARI (InspectTech)	•		•		•		•		-		
dTims	•	•			-						
Exor	-	•	-		-	-					
Traffic Signals Database			•								
Transportation Enterprise Database (TED) (internal)	•	-	•	•	-	-	-				
Transportation Enterprise Database (TED) (public)	•	-	•	•	-	-	-				
CT ATLAS	•		•			-	-		-		
COMPASS			-		•			•			
Composite Project Database (CPD)	•	-	•	-	•	-	-				
DigitalHIWAY	•	•	•	•	•	•					
Maintenance Management System (MMS)	-	-	-	•	-	-					
ESRI			-	•				•			
SharePoint											

\- Considered for future deployment.

Figure 3-3. TAM Information Management Systems

AWARI (formerly InspectTech)

TAMP Assets: Bridges, Traffic Signals, Sign Supports, Highway Buildings

Description:

CTDOT uses a customized version of AWARI for its Structure Management System to store and report information on CTDOTs highway bridges, sign supports, and highway buildings. The system was implemented in 2015 and consolidates a variety of structure information that was previously stored in multiple repositories.

Contents:

AWARI includes inventory data and inspection results, with a separate directory for highway bridges, sign supports, and highway buildings and in addition to the assets in the TAMP also includes town bridges (less than 20 feet), railroad bridges, and traffic signal span poles and mast arms. For highway bridges over 20 feet in length, the system stores the federally required NBI and bridge element items.

AWARI also includes a maintenance module that is being implemented to store inspector work recommendations and structure maintenance history.

AWARI is integrated with project tracking data to identify federal work types and CTDOT work codes for bridges within a project; integration of project tracking data for other asset types is pending

Bridge

Bridge inventory and condition data is collected and stored in AWARI using the following custom inspection forms:

- Structure Inventory and Appraisal (BRI-19)
    - Identification
    - Age and Service
    - Load Rating and Posting
    - Structure Type and Materials
    - Geometric Data
    - Waterway
    - Proposed Improvements
    - Conditions and Appraisals
    - Other Features

  - Classification
  - Posted Signs and Utilities
- Inventory Route Under Bridge (BRI-25)
- Fracture Critical Data Field Inspection
  - Deck
  - Approach Condition
  - Superstructure
  - Substructure
  - Channel and Channel Protection
  - Culverts and Retaining Walls
  - Load Posting
  - Notes/Comments
- National Bridge Element (NBE)
  - Elements
- Underwater (BRI-58)
  - Underwater Report (BRI 58/59)
- Special Bridge Inspection (BRI-20)
- Fracture Critical Data Fracture Critical Data (BRI-12)
  - Fracture Critical Data Sheet
- Parapet Joint Inspection (BRI-17)
  - Joint Measurements
- Construction Punch List (BRI-9)
  - Bridge Construction Punch List
- Plan of Action (POA)
  - Scour Critical Plan of Action

Sign Supports

Sign supports inventory and condition data is collected and stored in AWARI using the following custom inspection forms:

- Signs and Illumination
- Structure
- Foundation
- Traffic Safety Features
- Overall Condition
- Notes

Span Poles and Mast Arms

Span Poles and Mast Arms, a sub-component of the traffic signal asset, has inventory condition data collected and stored in AWARI using the following custom inspection forms:

- Identification
- Age and Service
- Structure
- Signal
- Foundation
- Overall Condition
- Notes

Highway Buildings

Highway buildings inventory and condition data was collected for the first time during a 2017/2018 inspection program. This was the first time all CTDOT highway buildings were able to be rated and ranked in a transparent manner. Inventory and condition data was collected and stored in AWARI using 8 custom building inspection forms:

- General Information
- Employee Health & Wellness
- Site
- Architectural & Structural
- Mechanical
- Plumbing
- Specialty Systems
- Electrical

Individual component ratings are weighted and averages per form, values from each form are averaged together for an overall building score.

Functions/Uses:

AWARI is the authoritative database for bridges, sign supports and highway buildings inventory and inspection data. It is used to:

- Produce individual asset inspection reports detailing inventory and condition data, inspection schedule assignments and due dates, and other information
- Produce bridge NBI and element level reports for FHWA
- Monitor asset performance
    - For bridges, AWARI includes a dashboard view depicting bridge condition performance data (e.g. Percent Poor Bridges on the NHS), bridge status, and bridges posted for load restrictions.

- Assign and track work recommendations

Data Sources:

The Primary data source for AWARI is inspections along with updates based on maintenance work performed for bridges.

Issues/Improvement Needs:

- The maintenance module of AWARI has not yet been fully implemented for assets beyond bridges
- AWARI is not currently intended to be used as CTDOT's network analysis system, therefore improved data transfer with bridge analysis systems is needed.
- Reliability of the AWARI system

dTIMS

TAMP Assets: Bridges and Pavements

Description:

CTDOT uses a customized version of dTIMS to predict conditions and treatments based on deterioration curves and life cycle costs of CTDOTs bridges and pavements. For bridges, the system was implemented in phases beginning in 2013 and is used solely for analysis. For pavements, the system has been used since 1998 and provides capabilities for storing, reporting, and viewing pavement inventory and condition information. For both bridges and pavements, dTIMS is capable of analyzing alternative investment scenarios and planning a program of projects.

Contents:

Bridge

The bridge portion of the application includes:

- Current NBI and element level condition data imported from AWARI
- Treatment rules (a.k.a. decision trees) that specify what types of treatments are recommended for bridges based on their condition indices, and the condition improvements expected for each treatment type.
- Unit costs that are used to calculate costs for each of the bridge treatment types.

- Deterioration/performance curves for various bridge types are used to predict changes in bridge condition over time.
- Information on planned projects extracted from the Capital Plan.
- Budget scenarios which are used to constrain treatment selections.

Pavements

The pavement portion of the application includes:

- Pavement Inventory Data: width, number of lanes
- Road Inventory Data: Functional class, NHS designation, Overlaps (parent routes carried), Divided/Undivided Status, Administrative District, Annual Average Daily Traffic (AADT), and percent heavy trucks assigned based on functional class
- Pavement Construction History and Composition: year of original construction, pavement type and thickness, year of last resurfacing (initial data from Roadway Inventory System (RIS), updated based on completed paving work)
- Soil assessment by town
- Detailed (0.1 mile) pavement condition data: cracking (length and orientation by road zone; cross-slope, grade, roughness (IRI), rutting. Faulting is collected for the five concrete sections on the network
- Summarized pavement condition data by analysis unit – including
    - PCI: 1-9 scale, based on IRI, rutting, cracking, disintegration, and drainage
        - 8.0-9.0 Excellent
        - 6.0-<8.0 Good
        - 4.0-<6.0 Fair
        - <4.0 Poor
    - Structural Index, Environmental Index, IRI
- Pavement Activity Data-
    - Maintenance Vendor-in-Place (VIP) Projects (Initial, monthly, and final reports– includes milling and filling depth), VIP Projects are verified using DigitalHIWAY

    - Construction Projects with greater than 300 tons of Hot Mix Asphalt (HMA) – based on SiteManager queries for HMA pay items using locations based on stationing from project plans
- Rules (a.k.a. decision trees) that specify what types of treatments are recommended for pavement sections based on their condition indices
- Unit costs ($/square yard) that are used to calculate costs for each of the pavement treatment types for unconstrained needs or scenario analysis including direct pavement costs and markup for engineering and contract administration. Deterioration/performance models used to predict changes in pavement condition over time for each pavement family. Over 100 pavement families are defined in dTIMS according to climatic zone, pavement type, pavement thickness, traffic volume and soil condition.
- Planned or programmed pavement projects – used within scenario analysis to ensure scheduling of pipeline projects; also used to support development of resource-constrained work programs

Functions/Uses:

Bridge
For bridges, dTIMS is used to:

- Conduct strategic analysis that estimates future network bridge condition under various investment scenarios. This analysis includes a life cycle cost optimization function that selects a set of bridge treatments to maximize benefits for a given budget – where benefits are based on condition improvement relative to doing nothing
- Produce recommended bridge treatments

Pavement
For pavements, dTIMS is used to:

- Store, summarize and report pavement condition data
- Conduct strategic analysis that estimates future network pavement condition (average PCI and percent of mileage in poor condition) under various investment

scenarios. This analysis includes an optimization function that selects a set of pavement treatments to maximize benefits for a given budget – where benefits are based on condition improvement relative to doing nothing (based on the area under the deterioration curve), weighted by traffic volume estimates

- Produce recommended pavement treatments and inform pavement project scoping and development
- Produce projected pavement condition by tenth of a mile for federal reporting with recent software enhancements. This was performed manually for the 2018 TAMP.

Data Sources:

Bridge

InspectTech is the authoritative database for bridge condition data for dTIMS. Planned project data is extracted from the CPD. A live connection between AWARI and the CPD is planned.

Pavement

Primary data sources for the PMS include basic road inventory data from the Road Inventory System (including traffic volumes), pavement condition data collected each year from the photolog vans, and pavement treatment history information. In addition, dTIMS includes soil classification information by town (poor or good) provided by the CTDOT Soils and Foundation Unit in 2007.

Issues/Improvement Needs:

Bridge

Deterioration Models: Continued efforts are needed in validating and updating the bridge deterioration models to include repairs and maintenance items.

Component Ages: The age of most bridge components is not tracked in AWARI. Deterioration modeling needs the age of a component to forecast future condition, but without tracking actual ages, the age of most components must be estimated from the year constructed, year reconstructed, or the year that an improvement was noted in that component's condition rating. These estimates may not be accurate and may cause condition forecasts to vary by a wide margin.

Tracking Work: Most maintenance-initiated work performed on a structure, except for major reconstruction, is not tracked in a central database, making it impossible to determine the effectiveness or existence of maintenance and minor rehabilitation work.

Committed Projects: An automated method to import lists of committed bridge projects is needed. The current method of using a spreadsheet involves extensive manual data entry and reformatting.

Budgeting: Most bridge projects involve expenditures over several years. However, dTIMS is not able to handle projects which involve costs distributed over several years, with all the benefits realized in the final project year. Multi-year projects involve extensive manual adjustments of available budgets, and each schedule modification in the capital plan requires considerable manual effort.

Scenario Runs: CTDOT has capped analysis runs at 30 years as a reasonable timeframe for deterioration predictions and funding capabilities. Longer durations would require better deterioration data and more predictable value of money.

Preservation: Currently, there is no method for a treatment to preserve an asset component in the same condition, such as using a penetrating sealer to lock-in the condition of a substructure for 10 years.

Pavement

Pavement Sections: Work is required to eliminate short sections that have resulted from splitting existing sections based on maintenance or construction project limits. Pavement sections were updated in 2021, but this will be an ongoing cycle.

Inventory Data: Divided/undivided status in the PMS is tailored for analysis units but does not exactly match the linear referencing system (LRS) Exor. An automated process to keep the pavement network in sync with the agency LRS has not yet been developed.

Condition Data: CTDOT collects information in both directions for all roads, but on undivided roads CTDOT can only process the data in one direction in dTIMS. With the transition to 3D imaging in 2015, there is a need to ensure consistency and continuity with prior years' condition given that the new images may reveal more deficiencies than were previously discernable.

Pavement Structure and History Data: Improvements/validation needed for information on pavement type, thickness and year of last resurfacing.

Pavement Activity: There are challenges establishing locations on the LRS for construction projects from stationing information in plans. Information on pavement work associated with smaller construction projects, and with developer (encroachment permits) and other (e.g. emergency) projects is not readily available.

Traffic Data: Current system has AADT based on functional class. Improved traffic data (potentially to include truck traffic) to be added in the future once the new Traffic Monitoring System is complete and an interface can be developed. Also, volumes, truck classifications, and loadings should be included.

Exor

TAMP Assets: Pavement and Bridge

Description:

CTDOT uses Bentley's Exor, a software package for road network management that uses Oracle, for its LRS. Exor is used to maintain both spatial and attribute data for the road network, which has been expanded to cover both State and local roads. Exor includes reporting capabilities that enable aggregation of information about features stored using different sets of linear segments.

The RIS, which was originally developed as an in-house mainframe application, and was converted into an in-house

Oracle-based system in 2004 is in the process of being phased out and eventually these data sets will be managed in Exor. RIS includes the official state highway mileage log, and stores data on road inventory features required for the HPMS submittal and a variety of other internal purposes.

Contents:

Exor stores information for multiple roadway features including:

- Descriptive information about route legal limits and intersections
- Basic road characteristics: facility type, number of lanes, surface width, median type
- Basic administrative characteristics: ownership, maintenance responsibility HPMS sections, functional classification, NHS status
- Other HPMS data items – for roadway full extent and sample sections
- AADT by sections (to be added soon)
- Bridge locations

Functions/Uses:

Exor enables storage and management of geospatial representations of the road network, the routes, measures and reference points that make up the LRS, and characteristics of roadways required for a wide variety of purposes including HPMS reporting, safety planning and project scoping.

Data Sources:

Updates to spatial and LRS information are made based on completed construction projects. Annual field data collection of data using the photolog vehicles provide a source of information for updates to roadway characteristics.

Issues/Improvement Needs:

- The transition of RIS data needs to be completed
- The MAVRIC field collection tool needs to be fully implemented

- Pavement characteristic fields not being carried over to Exor need to be integrated and maintained in another database
- Better coordination between roadway inventory information and bridge NBIS items is planned.

Traffic Signals Database

TAMP Assets: Traffic Signals

Description:

The traffic signal database is a custom CTDOT application originally created to track power consumption of signals for Power Letters, letters sent to utility companies to serve as the basis for billing for power. This application is required because power for the majority of state-maintained signals is unmetered. Over time the database has been expanded to store additional information.

Contents:

The database contains inventory and power consumption information for over 2700 state-maintained traffic signals. Each signal is identified by a six-digit number in which the first three digits represent the town number (e.g., "017-201"). The database includes a record for the initial signal installation as well as a record for each change that has impacted power consumption. The database includes, but is not limited to, the following types of information:

- Location
- Traffic Signal type/description (traffic control signal, flashing beacon, etc.)
- Status (pending, active, removed)
- Maintenance responsibility
- State Maintenance Level (priority for response to service issue)
- Ownership
- Energy "paid by" (i.e. who pays the bill)
- Traffic Investigation Report (TIR)/Office of the State Traffic Administration report that ties the signal back to the original warrant approval

- Project number/Service Memo number generating the revision
- Traffic Signal Coordination type (time based, closed loop, etc.)
- Pedestrian control information
- Pre-emption (system type, method)
- Mast arm/span pole – quantity, install years
- Vehicle detection information
- Lamp type, wattages, and other information needed to calculate estimated power consumption

Functions/Uses:

The primary function of the database is to generate power letters for the utility companies. The database is available for use by signal maintenance technicians in the Office of Maintenance and Highway Operations to provide reference information needed for effective response to service calls. It is also used to scope traffic signal improvement projects and plan replacement schedules, primarily based on age of span poles and mast arms.

The database includes a reports menu that allows users to make limited queries of traffic signal information within a given town and/or route.

Data Sources:

Data are maintained by staff within the Electrical Section of the Division of Traffic Engineering. When new signals are designed, information is manually entered from the signal plans to create a new “pending” record. A semi-final inspection by Traffic Engineering of the constructed signal provides additional information to complete the record. As changes to the signal are made that impact its power consumption, the original record is set to “Removed” status and a new record is created using information from the revision.

Issues/Improvement Needs:

The database is adequately serving its initial purpose of tracking power consumption to generate Power Letters, however now that the database serves a greater function for asset management, additional details will need to be collected and added. This may necessitate the need to eventually convert to a different database that will allow for easier updating and provide better functionality for the management of the assets. CTDOT is currently developing an ESRI database for traffic signals to help manage the asset. Additional detail is needed for certain traffic signal components so that tracking and managing life cycle replacement of signal components can occur, resulting in the timely replacement of major signal components.

The database also includes some information on ITS assets that consume power such as cameras and variable message signs. However, it is not currently the definitive system of record for these assets. Separate databases and different asset identifications are maintained by the Office of Maintenance and Highway Operations for these assets.

Transportation Enterprise Database Internal (available to CTDOT staff only)

TAMP Assets: Bridges, Traffic Signals, Signs

Description:

TED has been transformed in 2021 from a SQL Server data warehouse to an ESRI ArcSDE database and associated Esri ArcGIS Enterprise Portal infrastructure along with appropriate governance and change management processes. This is part of TED's ongoing development. The vision for TED is to: "manage and to continue to evolve an accessible transportation safety and asset data enterprise system where authoritative data sets are managed by data stewards and formatted for consumption and analysis in a manner that allows stakeholders to use tools that are both effective and meet their business needs including rich metadata for each data layer."

A TED Development Group meets once a week to provide oversight and governance for improvements to TED and related data gathering efforts. An initial priority focus of this group has been to support safety data and analysis capabilities. However, asset management needs are being developed as well. Specific responsibilities include:

- Coordinate data management activities
- Oversee the development of a data business plan
- Monitor implementation tasks within the data business plan
- Serve as a forum to review data issues
- Advise on data-related software procurement
- Develop an FHWA-compliant data capture plan for the Model Inventory of Roadway Elements (MIRE)
- Report and make recommendations to the CTDOT Data Governance Council
- Data governance and change management process developments

Within the TED Development Group, work groups were established to provide a focus on different aspects of data and analysis improvements.

Contents:

TED contains the following data:

- State & Local Road Network and linear attribution
- Road inventory attributes including NHS, Functional class, lanes, etc.
- Projects, bridges, and signal control areas
- Crash
- Rights of Way, Monuments, and Geodetic Surveys
- Static reference data (districts, MPOs, towns, urbanized areas, etc.)
- Metadata for each data asset set.

Functions/Uses:

TED information within the ESRI Portal is a high level linked roadway, asset, and safety data base with dashboard, reporting, and mapping capabilities that can serve the viewing, query and analytical needs of data stewards and external customers in a user-friendly manner. TED will offer the most current views and queries of resident data sets while also enabling in depth analysis of selected data attribute relationships for any defined period of time.

The geospatial information in TED can be consumed by most mapping or reporting tools. Dashboards and ESRI Story Maps can be built to suit the needs of the asset stewards and subject matter experts (SMEs).

A new tool in the toolbox is a software called Feature Manipulation Engine (FME) by Safe.inc™. This application is the industry standard tool for geospatial data integration and ETL (extract transform and load) from one data format to another.

Data Sources:

TED data sources include:

- Exor
- ATLAS
- CPD
- AWARI
- CAS2 – new Collision Analysis System deployed in 2015
- ESRI
- Town boundaries, legislative districts etc.
- Metadata

The authoritative data is updated nightly from the various data sources.

Issues/Improvement Needs:

- Continued alignment between TED and asset management business requirements
- Continued migration and integration of authoritative business and geospatial data into the ESRI portal will develop opportunities to use Commercial Off The Shelf (COTS) applications and data analytics and visualization tools
- Continued migration of authoritative data into the ESRI portal will develop opportunities to use COTS applications and data analytics and visualization tools

Transportation Enterprise Database External (available to the public)

TAMP Assets:

Bridges, Traffic Signals, Signs

Description:

The TED external facing access point, otherwise known as the Open Data Portal, is built upon Esri's Hub technology to organize and make available the DOT's content for public consumption.

CTDOT personnel, practicing data governance, follow a prescribed procedure to obtain approval to make available stewarded asset data and associated applications so that they can be used by any public stakeholder. Utilizing CTDOT's TED architecture, personnel are able to confidently make their data available to the public because what resides in the open data portal is a direct copy from the source database that is updated every morning, but with the benefit of offering the steward the opportunity to change what particular fields are exposed to the public, and in what manner, different than what is available to internal personnel.

This all happens as a part of CTDOT's geodatabase replication, service publication, collaboration, and sharing to the Open Data Portal.

The TED External Open Data Portal is hosted in the Department's ArcGIS Online environment, creating a nice redundancy that if servers in one environment fail, we can direct staff with appropriate access to the other environment while troubleshooting issues.

Contents:

TED external contains the following data:

- Road Network and linear attribution
- Road inventory attributes including NHS, Functional class, and traffic volumes, among others
- Project Work Areas
- Bridges & Bridge Project Information
- Crash Data and Crash Data Emphasis Areas

Functions/Uses:

TED External is the primary way that the Department is going to provide access to its geospatial data. By publishing web services and having available the REST end point, consumers of CTDOT data can quickly find datasets they are seeking and then "hook in" to the data feed so that their own tools, analysis software, or applications continue to receive updated information directly from the CTDOT.

Additionally, there are some basic capabilities of the Open Data Portal that allow users to perform basic filtering/cross filtering and sorting for any and all hosted datasets. This function allows for users to efficiently ask simpler questions and get answers very quickly without any custom application development – e.g. How many structure are on I-91 North.

The Open Data Portal also allows the DOT to create and publish web based applications for use by our public stakeholders. These can be applications that have a variety of intents and uses; from quick view dashboards intended to give high level insight into capital program status to more in depth applications that let users identify certain assets conditions and then zoom into street level or aerial imagery to further inspect those assets themselves, the platform offers a lot of opportunity to be more transparent with the Department's data and assessments.

One last critical function of the Open Data Portal is that it allows the Department to use its data, maps, web apps, graphics, etc. to create analysis and narratives around projects, initiatives, or public outreach. By using Esri Sites and StoryMaps, CTDOT can make available single cohesive pieces of content that guide the general public through an analysis, a process, a project planning exercise, whatever the business need it; all while utilizing authoritative data and content directly from what is being fed to the Open Data Portal from the internal TED database. Sites can be designed for a wide variety of uses, and as more data becomes available in the TED External, Open Data Portal, the opportunities will continue to grow to meet these needs.

Data Sources:

TED data sources include:

- Exor
- ATLAS
- CPD
- AWARI
- CAS2 – new Collision Analysis System deployed in 2015
- ESRI
- Town boundaries, legislative districts etc.
- Metadata

The authoritative source data feeding TED External is the same as what feeds TED Internal, just with an opportunity for stewards to make adjustments to attribute availability and symbology.

Issues/Improvement Needs:

CTDOT needs to work to make more data publicly available on this platform and to encourage transparency

More public outreach and communication to bring more awareness and utilization of the Open Data Portal's capabilities

Continue to add applications that more easily allow for access to complex datasets and simple dashboards to answer frequently asked questions by the general public

ATLAS

TAMP Assets: Bridges, Traffic Signals

Description:

ATLAS is a custom GIS application intended to serve as the agency's GIS data integration and display platform. It is being developed incrementally using the open source MapServer/GeoMoose framework.

Contents:

ATLAS incorporates the agency's authoritative spatial data foundation including base maps, LRS, and other authoritative GIS data layers – including layers for capital projects, proposed and completed VIP paving projects, bridges, signals, traffic monitoring locations. It provides standard web feature services and web mapping services for exchanging data to use in other applications.

Functions/Uses:

ATLAS is being used at CTDOT to integrate spatial data for assets and projects. For example, a user can click on a section of roadway and view available AADT, project and asset data for that location. Users can also link to available documents pertaining to the selected projects and assets.

ATLAS is also being used to manage spatial data records for capital projects, proposed capital projects and major assets such as bridges, traffic signals and in the near future buildings and sign supports. For example, users can locate and associate polygons for bridge deck and traffic signal control areas with their respective data from their authoritative systems. Users can also draw a polygon representing a new proposed or recommended project area and complete a form with information needed to create a Proposed Project Information (PPI) record for this new project. Underlying authoritative route, milepoints, geometry, classifications and characteristics along with any underlying major asset data are automatically identified within the limits of the polygon. Additional functionality to track programmed work against the assets for each project is under development.

ATLAS is available only within the CTDOT firewall. In order to provide access to CTDOT's asset and project information to partners, ATLAS publishes data to ALIM, a web-based GIS publishing tool.

The current ATLAS framework provides the following functions:

- Access to maps from: ArcGIS, MapServer, Google, VirtualEarth
- Publishing of spatial data layers
- Configuration of multiple views of data sources
- Obtaining and filtering of data from data catalogs
- Multiple data navigation and exploration tools
- Integration with non-spatial systems

Data Sources:

Base map information and spatial data layers published to ATLAS are maintained using the open source GeoMoose tool.

Issues/Improvement Needs:

ATLAS is a useful tool for geospatial location and LRS ties for capital projects, proposed capital projects and bridges, traffic signal control areas.

Discussions of an update of the ATLAS system have materialized into the development of the ATLAS 2.0 product. This application is being developed within the ESRI Portal environment and its top priority is expandability of additional assets by means of configurations. This would eliminate the need for Developers when adding new asset or information layers.

Progress has been made utilizing ATLAS as part of a standard workflow process for adding new assets to the inventory:

- The designer uses computer-aided design (CAD) to locate a new asset with a spatially correct polygon and exports to keyhole markup language (KML)
- The designer submits KML to the asset steward in exchange for a new asset ID
- The asset steward obtains a new asset ID in the asset's authoritative inventory and imports the KML with a new ID into ATLAS
- ATLAS business attributes are updated nightly from the authoritative sources

Composite Project Database

TAMP Assets: Bridges, Traffic Signals, Sign Supports

Description:

The CPD is a custom SQL database application that was created in 2015 to integrate data on capital projects from several different sources.

Contents:

Currently the CPD contains data for over 3,300 CTDOT projects, sourced from CTDOT's Capital Program Obligation Plan (OBL, Microsoft Access database), the State's financial management system (Core-CT), CTDOT's construction project management system (SiteManager), and the Project Asset Form (in the CPD). CPD data are then joined with geo-located project work areas within ATLAS. Data in the CPD includes:

- Project description, schedule and budget information
- Payment and expenditure information
- Asset identification and limited work information
- Design and construction team information
- Current Project Phase (Final Design, Construction, etc…)

Functions/Uses:

CPD's purpose is to aggregate project information from several different sources into one convenient location for viewing. The CPD is located on a SQL server for internal agency use only.

Data Sources:

As previously listed, the CPD pulls in data from the OBL, Core-CT, and SiteManager. Some information, such as asset and design team, are entered directly into a CPD form.

Issues/Improvement Needs:

Further development and build-out of the CPD to include additional asset classes and associated work to provide more thorough asset life cycle information for asset management purposes.

DigitalHIWAY

TAMP Assets: Bridges, Pavement, Traffic Signals, Signs, Sign Supports, Pavement Markings

Description:

The CTDOT DigitalHIWAY is a custom photolog application that is uploaded with images and data of the State highway system on an annual basis. CTDOT's photolog program was initiated in 1973, and DigitalHIWAY images are currently available for each year back to 1985.

Contents:

DigitalHIWAY includes:

- Forward-view Right-of-Way (ROW) images
- The corresponding set of pavement conditions, GPS, and geometric data

Engineering data include:

- Downward-facing high resolution pavement images
- Rut-depth measurements
- IRI
- GPS coordinates
- Horizontal and vertical geometry
- Pavement cross slope
- Pavement grade

Functions/Uses:

Images are used for pavement analysis, safety analysis, project scoping, derivation of HPMS sample section data values, asset inventory data updates, fulfillment of special requests, and for a variety of reference purposes. Imagery is made available to FHWA, the University of Connecticut, the Connecticut State Library, and the State Police.

Data Sources:

CTDOT uses state-of-the-art ARANs to collect high resolution images and roadway condition, geometric and position data every 16.4 feet (5-meters) for the entire state-maintained roadway network and local-maintained NHS. Roadway images are taken at equal intervals to provide the appearance of continuous video. The ramp system is also captured periodically.

Issues/Improvement Needs:

The DigitalHIWAY is being continually enhanced based on user feedback. Future improvements under consideration include integration of point cloud data from LiDAR to enable increased use of information for engineering applications.

Maintenance Management System

TAMP Assets: Signs

Description:

The MMS is a custom CTDOT application used to track and manage maintenance activities and tasks performed by state forces.

Contents:

MMS includes several modules for tracking work accomplishments (quantities of work completed by activity code), tracking and reporting maintenance costs (labor, equipment and materials), tracking delivery and use of winter maintenance materials (sodium and magnesium chlorides), tracking temperature, road conditions, and snow accumulation during winter snow and ice events, ordering signs from the CTDOT Sign Shop, traffic service memos and encroachment permits. Specific data includes:

- Maintenance accomplishments by activity. Work locations are recorded on trip tickets and supervisor rundown sheets but are not entered into the MMS
- Labor hours by maintenance activity by crew – regular and overtime; crew size
- Sodium and magnesium chloride amounts delivered and used by each maintenance facility
- Costs by activity, type (labor, equipment, materials) and Interstate/non-Interstate. Maintenance activity codes indicate Interstate/Non-Interstate as well as type of crew
- For storm events, temperature and precipitation type, road conditions and total amounts are collected at specific garages at given intervals throughout the event

Note: CTDOT fleet assets are managed in a separate system.

Functions/Uses:

The MMS is used to track and report on maintenance accomplishments and associated costs at each of the state's 48 maintenance garages (there are 2 maintenance sections in each of the 4 CTDOT maintenance districts, and 6 garages per section), 4 electrical and 4 signs & markings district specialty garages, 6 bridge maintenance garages and 1 sign shop. This information is used for budgeting. Work is not currently planned within the MMS – crews get their daily assignments on paper trip tickets.

Material usage for snow and ice control is tracked through internal reporting. This information is used for materials inventory purposes as well as application rate validation.

The MMS also includes a module used by Traffic Engineering and District Maintenance to order signs from the Sign Shop. The sign order information is used to update the sign inventory.

Data Sources:

Maintenance accomplishments and time are logged on paper forms by crew members, provided to maintenance garage supervisors, and then entered into the MMS by clerks at the garages. During the winter, clerks track sodium and magnesium chloride inventory as well as patching materials and other associated tasks.

Issues/Improvement Needs:

Currently the MMS does not identify work done to a specific asset with the exception of the recently added Sign asset. In order to facilitate the use of the MMS for other asset management purposes, asset identification needs must be included in the tracking of work accomplished and the associated costs determined.

Initial requirements for a new Computerized Maintenance Management System (CMMS) were scoped to advertise a Request for Information in 2018. Vendors presented their CMMS solutions. The next step planned is to pursue funding and a Request for Proposal. The new system will address asset tracking and condition as well as work tracking with associated costs using electronic field data collection capabilities.

ESRI

TAMP Assets: Signs, Illumination, Drainage Culverts

Description:

ESRI provides mapping services including ArcGIS. For Drainage assets, this provides a visual layer with specific location data for culverts which have been mapped.

Contents:

In terms of drainage culvert assets, all current available data for mapped culverts is in a continual process of being updated to the best of known available information. Current data includes, year of installation, type of culvert, project under which the culvert was installed, height, length and diameter of pipes, inspector, inspection date and condition rating.

ESRI also includes, but is not limited to, the following types of sign attributes:

- Mounting Type
- Number of Posts
- Status
- Position
- Latitude
- Longitude
- Route ID
- Asset Code
- Catalog Number
- MUTCD Number
- Height
- Width
- Area
- Background Color
- Legend Color
- Panel Thickness
- Material
- Sheeting Type
- Sign Legend
- Panel Direction
- Fabricator
- Fabrication Date
- Manufacturer

- Installation Date
- Panel Maintenance

Functions/Uses:

Drainage assets are currently in the process of being mapped, inspected and information updated, which will allow for a systemic view of known culverts and eventually provide a look ahead projection of the state of good repair.

ESRI also has the ability to manage assets on individual layers. This allows assets, such as Signs, to continuously reference the latest road network from the authoritative source.

An authoritative Sign layer is used to manage the sign inventory. This layer is made up of two sub-layers. The first sub-layer is for Sign Assembly, the parent sub-layer of the sign asset. The Sign Assembly sub-layer contains information related to the geospatial location of all signs as well as the type of support system the signs are installed on. The second sub-layer is for Sign Panel, the child sub-layer of the asset. Each Sign Panel is associated to a Sign Assembly location, which creates a parent/child relationship between the two sub-layers. Each Sign Assembly contains one or more Sign Panels. The Sign Panel sub-layer contains specific information relating to the signs such as the sign legend, colors, and size.

Data Sources:

District drainage engineers and staff physically map and inspect various culverts, which are updated to the ESRI database allowing for a concise view of culvert information, current condition, and physical location.

Sign information is updated by project work or service memos either manually or by a formatted spreadsheet uploader. These data are maintained by the Division of Traffic Engineering.

Issues/Improvement Needs:

Regarding drainage culvert assets, accessibility needs to be expanded to more users, improved mapping capability, both in terms of mapping and how data can be extracted. Consistency between culverts which have been inspected and those pending inspection needs to be cleaned up and comments need to be made clearer and uniform.

ProjectWise

ProjectWise is a cloud-based engineering project collaboration and content management platform. CTDOT has replaced this application as of December 31, 2021. It has been replaced with COMPASS, a COTS customized MS O365 SharePoint solution that's been under development since 2018.

SharePoint

Description:

SharePoint is a cloud-based document management and collaboration platform. CTDOT is using SharePoint for document storage for non-project documents related to our assets. Each asset has a document library that is located on the Asset Steward's discipline SharePoint page.

Contents:

- Bridge Documents – Located on the Division of Bridges SharePoint page and has a folder for each bridge. These folders are also integrated with AWARI , which transfers any files from AWARI over to SharePoint on a nightly basis.
- Sign Support Documents – Located on the Division of Bridges SharePoint page and has a folder for each sign support. These folders are also integrated with AWARI, which transfers any files from AWARI over to SharePoint on a nightly basis.
- Building Documents - Located on the Facilities Design SharePoint page and has a folder for each site with subfolders for each building. These folders are also integrated with AWARI, which transfers any files from AWARI over to SharePoint on a nightly basis.
- Traffic Signal Documents - Located on the Division of Traffic SharePoint page and has a folder for each traffic signal.

Functions/Uses:

The folders can be accessed by all CTDOT users and can be shared with external users. It provides access to non-project related content and includes indexing, search, and versioning capabilities.

Data Sources:

SharePoint is populated by a variety of internal and external CTDOT users as well as nightly by AWARI. The system is currently managed by the CTDOT Architecture, Engineering and Construction Applications Unit within the Bureau of Engineering and Construction.

Issues/Improvement Needs:

Access to these document libraries for external users has been a challenge. Currently AEC Applications is working with IT on how we can use an Office 365 tool called Access Packages to handle permissions on these document libraries.

COMPASS

TAMP Assets: Sign Supports, Illumination

Description:

COMPASS is a scalable customized Microsoft O365 cloud-based Transportation Project Management Solution used to manage the delivery of the Department's Capital Program. COMPASS provides one location, accessible to all Department staff and invited stakeholders, for each project's information and documentation.

COMPASS is built on O365, SharePoint Online, and Azure. O365 was chosen so that COMPASS could be agile and cost effective.

Contents:

COMPASS provides a custom Project SharePoint Site for each project. Sites are currently automatically created when a project is added to the Bureau of Finance and Administration's Obligation Plan. Each Project site provides the following functionality:

- Landing Page

    - Provides fundamental project information
- Details Page
    - Provides more granular and specific project information
        - Project description
        - Important project dates
        - Document Libraries for document storage
        - Dashboard for Pre-Construction schedule milestones
        - Dashboard for tracking environmental permitting applications
        - Dashboard for tracking completion of property maps and property acquisitions
        - Project budget by phase and overall graphs
- Integration with Microsoft Project Pre-Construction Schedules
    - Integrating MS Project Schedules into COMPASS allows PMs to access important project information along with their schedules in one location. Additionally, Project milestone tasks can be automatically displayed in a COMPASS project dashboard. Additionally, Project schedule information can be consumed via PowerBI for program-wide reporting.
- Project Staff Tracking Application
    - Allows units to manage staff assigned to specific projects in COMPASS. This staff information will be available to all COMPASS users, providing direct contact to engineering, construction and consultant staff improving collaboration in the S&T and response times to project questions
- Dashboard Page
    - Schedule Metrics for FDP
- Submittal and Transmittal Application (S&T)
    - Document Control solution that provides Ball-In-Court tracking of documents with specified time constraints.

- Dashboard with flexible filtering and searching capabilities

Functions/Uses:

COMPASS was designed to be used by project team members, which include all Department staff and any external partners, municipalities, contractors, and consultants to support real time collaboration for project delivery. It is used as a one stop shop to track project delivery tasks, dates, documents, and important information, and allows Department staff to monitor specific project activities.

COMPASS is also the authoritative data source for some project data.

COMPASS project data is also used to generate custom PowerBI program wide reports that aid in the managing the Capital Program.

Data Sources:

COMPASS uses authoritative data sources including CORE, ViewPort, SiteManager, Atlas GIS, Obligation Plan, ROW IRMS, ESTP, AWARI, CPD, and TED.

Issues/Improvement Needs:

COMPASS is a solution that is in production but was built to be agile and dynamic. Therefore, COMPASS will constantly be evolving to add new applications and enhancements to existing applications that support evolving business processes.

COMPASS needs a steady source of funding. Currently the Department is working with the FHWA to complete an NCAP so that federal project dollars can be used to support the development of COMPASS.

COMPASS has several new applications in the cue for development, including ROW's IRMS replacement, The Project Generator/ Integration with the Departments Atlas GIS solution (to establish all project types into COMPASS during inception), the Digital Project Invoicing, the Utility Coordination Application, and the Environmental Permitting Tracking Application.

COMPASS needs to continue to integrate with other Bureaus in the Department such as the Bureau of Finance and Administration to continuously eliminate one off data source and supersede redundant data collection.

Data Confidence

Data confidence for each asset is based on the accuracy and reliability of data. Each of the assets have varying degrees of data completeness, inspections, work history, and condition modeling. Below are the general guidelines used to determine the confidence level of each asset.

Very High

- Complete asset data
- Condition data based on inspection on established routine interval
- Future condition is modeled

High

- Complete asset data
- Condition based on inspection or work history
- Future condition is estimated

Medium

- Complete Asset Data
- Condition and future condition are estimated

Low

- Partial Asset Data
- Condition and future condition are estimated

Very Low

- All asset data based on estimates

Table 3-1. Data Confidence for TAMP Assets

	Inventory Method	Inventory Currency/ Accuracy	Condition Method	Projection Method	Other Notes	Confidence Level
Pavement	Regular Collection	Data age ≤ 2 years	Inspection	Modeled	Formalized QA/QC - DQMP	Very High
Bridge	Regular Collection	Data age ≤ 2 years	Inspection	Modeled		Very High
Signals	Update on installation / rehabilitation	Data age ≤ 2 years	Estimated based on installation / rehabilitation dates	Estimated		High
Sign Supports	Inspection on installation	Data age ≤ 2 years	4-6 year inspection cycle	Estimated		High
ITS	On installation	Data age ≤ 2 years	Age based	Estimated		High
Signs	2013 inventory	Data age > 2 years	Video log	Estimated		Medium
Highway Buildings	On acquisition	Data age ≤ 2 years	Age-based & condition-based	Estimated		Medium
Illumination	On installation	Data age ≤ 2 years	Age based	Estimated		Medium
Retaining Walls	2010 inventory with 2021 updates	Data age > 2 years	Inspection	Estimated		Low
Pavement Markings	Estimated based on mileage / intersections	N/A	Estimated	Estimated		Very Low
Drainage Culverts	Creating Database	<20% assessed, ~45% mapped	Inspection	Estimated	Inspections will take years to complete	Very Low

Data Governance

CTDOT formed a tiered data governance structure including a Change Management Team, TED Development Group, and Data Governance Council in July 2017 to build a framework of rules, policies, and procedures regarding data availability, usability, data quality, and security. As the top level to the tiered structure, the data Governance Council includes representation from all 5 CTDOT Bureaus. The Data Governance Council is responsible to:

- Prioritize safety and asset data governance solutions to provide the foundational tools necessary to expand enterprise data participation across all disciplines within the agency
- Identify data being collected and maintained agency wide.
- Document data standards and coordinate development of new standards.
- Develop guidance for data dictionaries, user manuals, and training programs.
- Establish quality assurance /quality control (QA/QC) processes.
- Facilitate the integration and interoperability of information between authoritative roadway inventory databases and CTDOT's enterprise-wide data system.
- Identify and inform and gather feedback/guidance from the Executive Committee of emerging data priorities
- Report to the Executive Committee as needed to make recommendations regarding data governance challenges or technology opportunities.

The Data Governance Council, in conjunction with the TED Development Group, have prioritized data to be developed and integrated into the TED environment and drafted data management guidance regarding: 1) definition of data assets, 2) the assignment of asset data owners and asset data stewards as well as their roles and responsibilities, 3) metadata requirements, and 4) a process for establishing TED asset data readiness.

The Change Management Team handles most day-to-day "working level" data governance, with weekly meetings to discuss standards, methodology, workflow development, quality control/quality assurance processes, and overall database and architecture maintenance and sustainability. An organization as complex as CTDOT requires constant communication between the business users and the technology team to ensure that the needs of all users are being addressed in a sustainable and consistent manner. The Change Management Team operates as a vehicle.

Chapter 4

Objectives and Performance

Identifying objectives and tracking performance are key components of effective transportation asset management. Data-driven decisions lead to more effective investments in transportation infrastructure yielding improved performance of the transportation system. Developing performance scenarios at various funding levels enables us to set performance targets to meet federal requirements and state goals. The projections of asset performance in this chapter demonstrate a need for additional funding to achieve those goals.

Overview

Establishing targets, articulating strategies, linking agency processes to asset management, and other performance strategies are all integral parts of the TAMP. The performance measures and targets included in this chapter are used to track progress towards goals.

CTDOT is quantifying inventory, measuring condition and setting performance targets for its transportation assets. The targets that have been set are aligned with federal requirements and state goals and objectives, and are based on the projected funds available for transportation. The targets will help guide CTDOT in allocating resources to projects and programs in order to ensure progress is made towards meeting set goals.

This chapter presents CTDOT's goals and objectives, TAM performance targets, performance projections over a 10-year period, and a gap assessment comparing current performance, targets, and projected future performance.

Federal Legislative Context

The FHWA requires states to include measures and targets for asset condition for NHS bridges and pavements in their TAMP as defined in 23 CFR 490.313. States may choose to include additional assets with their accompanying measures and targets.

Using the measures of condition defined by FHWA, State DOTs must specify their desired "state of good repair" for the 10-year analysis period of the TAMP consistent with state asset management objectives. The desired SOGR must also support progress in the national goal areas of safety, infrastructure condition, congestion reduction, system reliability, freight movement and economic vitality, environmental sustainability, and reduced project delivery delays.

As part of the FHWA rule on performance management, 23 CFR Part 490, states must set two and four-year asset condition performance targets. The next target setting period is in

Federal Minimum Condition Levels

Bridges:
Poor NHS < 10%

States must maintain bridges on the NHS (greater than 20-ft in length) so that the percentage of deck area of bridges classified as poor does not exceed 10 percent of the overall deck area in a state. If FHWA determines a state DOT to be out of compliance, the state must obligate and set aside funding for eligible projects on bridges on the NHS. This funding requirement will remain in effect each year until the state is in compliance.

Pavements:
Poor Interstate < 5%

States must ensure that no more than 5 percent of pavement lane miles on the Interstate system are in poor condition.

If FHWA determines a state DOT to be out of compliance, the state must obligate funding to the National Highway Performance Program (NHPP) and transfer funds from the Surface Transportation Block Grant Program to the NHPP.

October 2022, after this TAMP's submittal date. These targets will continue to be reported to FHWA every two years. As part of the performance management rule, states are also required to maintain NHS bridges and interstate pavements to meet federally-established minimum condition levels. For assets not meeting federal minimum condition levels, penalties will be applied that require the obligation of funding to those NHS assets.

The FHWA also requires that states establish a performance gap analysis process for TAMPs. Specific requirements for the process are listed below.

Performance Gap Analysis Process Requirements

- Establish desired SOGR based on Federal requirements and State goals
- Establish state targets for asset condition
- Determine performance gaps
- Develop strategies to close or address the gaps

Poor vs. Structurally Deficient

As of 2018, FHWA defines structurally deficient and poor condition to be the same – a bridge that is in poor condition is also considered structurally deficient

Goals and Objectives

Vision and Mission

Connecticut strives to achieve a nationally competitive transportation system that is multi-modal, resilient, and long-lasting; addresses capacity issues; and helps the economy.

CTDOT Vision & Mission

CTDOT's **vision** is to lead, inspire, and motivate a progressive, responsive team, striving to exceed customer expectations.

CTDOT's **mission** is to provide a safe and efficient intermodal transportation network that improves the quality of life and promotes economic vitality for the State and the region.

Summary of TAM Objectives

CTDOT has adopted a set of TAM objectives that are aligned with the vision and mission of the agency. These objectives are helping to steer CTDOT as it develops, refines, and implements TAM policies, processes, and practices.

TAM Objectives

- Attain the best asset conditions achievable, given available resources
- Deliver an efficient and effective program that preserves our existing infrastructure
- Improve communication and transparency regarding decisions and outcomes
- Achieve and maintain compliance with FHWA asset management rules

Performance measures, projections, and targets are being developed to help achieve CTDOT TAM objectives. These are being linked so that CTDOT can operate more effectively and make progress towards federal requirements and state goals.

CTDOT Values

- Measurable Results
- Customer Service
- Quality of Life
- Accountability & Integrity
- Excellence

Asset Performance Measures

CTDOT has selected performance measures for this plan based on a combination of federal requirements and a desire to set performance goals for state-maintained traffic signals, signs, sign supports, pavement markings, and highway buildings. These measures are helping CTDOT actively manage the performance of each asset by understanding the impact of investments on the asset's SOGR. This allows for the establishment of funding priorities and targets that are achievable. A summary of the federal performance measures for bridges and pavements on the NHS is provided in Table 4-1.

Table 4-1. Summary of Federal Performance Measures for NHS Bridges and Pavements

Asset	Performance Measure	Measure Definition
Bridges	• Percentage of NHS bridges classified as in Good condition (weighted by deck area) • Percentage of NHS bridges classified as in Poor condition (weighted by deck area)	• Good and Poor are defined by FHWA's rule on Performance Management
Pavements	• Percentage of pavements on the Interstate System in Good condition • Percentage of pavements on the Interstate System in Poor condition • Percentage of pavements on the NHS (excluding the Interstate System) in Good condition • Percentage of pavements on the NHS (excluding the Interstate System) in Poor condition	• Good and Poor are defined by FHWA's rule on Performance Management

A summary of the State performance measures for the eleven state-maintained assets in the TAMP is provided in Table 4-2. The table also shows the criteria for achieving a SOGR.

Table 4-2. Summary of State Performance Measures for CTDOT-Maintained Assets

Asset	Performance Measure	Measure Definition
Bridges	• Percentage of bridges classified as in a SOGR (by number of bridges)	• SOGR is defined by CTDOT as an NBI condition rating of 5 or higher
Pavements	• Percentage of centerline miles in a SOGR	• SOGR is defined by CTDOT as a PCI rating of 6 or higher
Traffic Signals	• Percentage of traffic signals in a SOGR	• SOGR is defined by CTDOT as an age of 25 years or less • Traffic signal condition rating is age-based with the following thresholds: 0-15 years is Good, 16 – 25 years is Fair, and over 25 years is Poor
Signs – Extruded Aluminum	• Percentage of signs in a SOGR	• SOGR is defined by CTDOT as an age of 17 years or less • Sign condition rating is age-based with the following thresholds: 0-12 years is Good, 13 – 17 years is Fair, and over 17 years is Poor
Signs – Sheet Aluminum	• Percentage of signs in a SOGR	• SOGR is defined by CTDOT as an age of 17 years or less • Sign condition rating is age-based with the following thresholds: 0-12 years is Good, 13 – 17 years is Fair, and over 17 years is Poor
Sign Supports	• Percentage of sign supports in a SOGR	• SOGR is defined by CTDOT as a condition rating of 5 or higher
Pavement Markings – Line Striping	• Percent of pavement markings in a SOGR	• For in-laid epoxy pavement markings, SOGR is defined by CTDOT as markings installed within six years • For epoxy pavement markings, SOGR is defined by CTDOT as markings installed within three years • For water-based pavement markings, SOGR is defined by CTDOT as markings installed within one year

Asset	Performance Measure	Measure Definition
Pavement Markings – Symbols & Legends	• **Percent of pavement markings in a SOGR**	• For epoxy pavement markings, SOGR is defined by CTDOT as markings installed within three years • For water-based pavement markings, SOGR is defined by CTDOT as markings installed within one year
Highway Buildings	• **Percent of highway buildings in a SOGR**	• SOGR is defined by CTDOT as a condition rating of 3 or higher on a scale of 1-5
Illumination	• **Percent of lighting systems in a SOGR**	• SOGR is defined by CTDOT as an age of 40 years or less
Retaining Walls	• **Percent of retaining walls in a SOGR**	• SOGR is defined by CTDOT as a condition rating of 3 or higher on a scale of 0-6
Drainage Culverts	• **Percent of drainage culverts in a SOGR**	• SOGR is defined by CTDOT as a condition rating of Fair or Good • Culvert condition rating is based on the Culvert Condition Rating Assessment developed by CTDOT Office of Environmental Planning
ITS	• **Percent of ATMS field devices in a SOGR**	• SOGR is defined by CTDOT as an age of 10 years or less

Asset Performance Targets

Asset performance and desired projections specify the conditions CTDOT seeks to achieve and sustain over a 10-year period to meet federal requirements, support state goals, and make progress in national goal areas. Projections presented in this section reflect both desired performance and expected performance at varying funding levels. CTDOT has set targets based on the current funding level. This assumes no increase and when coupled with the age of the infrastructure, the ability to improve the condition of the assets is limited.

NHS Performance Targets

Federal regulation 23 CFR Part 490.107 requires that 2 and 4-year targets be set for bridges and pavements on the NHS. These targets are the expected performance of the assets based on the federally required measures given the funding availability and investment choices made by CTDOT.

As the next targets will not be submitted to FHWA until October 2022, this TAMP includes implied targets based on the performance projections developed for the TAMP. The 2-year and 4-year performance targets for Connecticut bridges and pavements on the NHS are shown in Table 4-3, representing performance at the end of year 2023 and 2025.

Table 4-3. Implied NHS Asset Performance Targets

	2-Year Targets (End of Year 2023)		4-Year Targets (End of Year 2025)	
Asset (unit of measure)	Good	Poor	Good	Poor
NHS Bridge (deck area)	14.2%	6.2%	14.5%	6.0%
Interstate Pavement (lane miles)	72.0%	1.0%	70.0%	1.3%
Non-Interstate NHS Pavement (lane miles)	37.0%	2.7%	35.0%	3.5%

FHWA Minimum Condition Level for Bridges

States must maintain bridges on the NHS so that the percentage of deck area of bridges classified as Poor does not exceed 10 percent of the overall NHS deck area in a state.

CTDOT Performance Targets

The anticipated 2- and 4-year performance targets for CTDOT-maintained assets are shown in Table 4-4. The targets for CTDOT-maintained assets reflect the performance projections in this TAMP. The table shows the percentage of the asset quantity expected to be in a SOGR in the target year. The 2- and 4-year time periods are determined by the bridge and pavement assets; other assets then use the same years for targets (end of year 2023 and 2025).

Table 4-4. CTDOT-Maintained Asset Performance Targets

Asset (unit of measure)	2-Year Targets (End of Year 2023)	4-Year Targets (End of Year 2025)
	SOGR	SOGR
Bridges (number of bridges)	96.9%	96.6%
Pavement (centerline miles)	69.5%	65.0%
Traffic Signals (number of signalized intersections)	62.2%	60.4%
Signs – Extruded Aluminum (number of signs)	57.6%	69.7%
Signs – Sheet Aluminum (number of signs)	44.6%	48.1%
Sign Supports (number of sign supports)	95.7%	97.4%
Pavement Markings – Lines (linear feet)	68.7%	74.8%
Pavement Markings – Symbols (square feet)	31.4%	37.3%
Highway Buildings – Tier 1 (number of buildings)	84.5%	87.4%
Highway Buildings – Tier 2 (number of buildings)	98.9%	98.9%
Highway Buildings – Tier 3 (number of buildings)	59.1%	65.3%
Illumination (number of lighting systems)	88.3%	88.7%
Retaining Walls (number of retaining walls)	97.6%	96.4%
Drainage Culverts (number of drainage culverts)	82.8%	82.2%
ITS (number of ATMS field devices)	43.0%	53.0%

10-Year Performance Goals

CTDOT has set long-term performance goals for both NHS assets and CTDOT-Maintained assets. In working towards these goals, CTDOT recognizes that the effort to achieve them may surpass 10 years and adjustments to these long-term goals will be needed over time as the asset management process matures and funding strategies change with future needs.

CTDOT's 10-year performance goals, based on national measures, for NHS assets are presented in Table 4-5. The table shows the desired percentage of assets in good and poor condition. The values shown in the table were determined based on review of a set of performance projections performed at varying funding levels. The resulting performance goals were established considering CTDOT's life cycle plans described in Chapter 5, and conditions achievable given a range of various funding levels. The values reflect federal requirements and state goals and, if achieved, will satisfy the minimum NHS condition levels defined by FHWA.

Table 4-5. CTDOT 10-Year Performance Goals, Based on National Measures: NHS Assets

Asset (unit of measure)	Good	Poor
NHS Bridge (deck area)	>20%	<10%
Interstate Pavement (lane miles)	75%	<5%
Non-Interstate NHS Pavement (lane miles)	50%	<8%

CTDOT also utilizes performance projections for the other state-maintained assets in the TAMP. CTDOT's 2030 performance goals for SOGR of state-maintained assets are presented in Table 4-6. Due to bridge and pavement 10-year projections going to 2030, all other assets have set their targets for the same year, and performance graphs show projections through 2030.

FHWA Minimum Condition Level for Pavement

States must ensure no more than 5 percent of pavement lane miles on the Interstate System are in Poor condition.

Table 4-6. CTDOT 10-Year Performance Goals, Based on SOGR: State-Maintained Assets

Asset (unit of measure)	**SOGR**
Bridges (number of bridges)	95%
Pavement (centerline miles)	80%
Traffic Signals (number of signalized intersections)	80%
Signs – Extruded Aluminum (number of sign panels)	80%
Signs – Sheet Aluminum (number of sign panels)	70%
Sign Supports (number of sign supports)	90%
Pavement Markings – Lines (linear feet)	75%
Pavement Markings – Symbols (square feet)	75%
Highway Buildings – Tier 1 (number of buildings)	80%
Highway Buildings – Tier 2 (number of buildings)	80%
Highway Buildings – Tier 3 (number of buildings)	50%
Illumination (number of lighting systems)	90%
Retaining Walls (number of retaining walls)	90%
Drainage Culverts (number of culverts)	80%
ITS (number of ATMS field devices)	75%

In addition to these measures of condition, CTDOT tracks and publishes a number of other performance measures on the CTDOT Performance Measures website, through an online dashboard. The dashboard includes 21 performance measures organized into four CTDOT goal areas:

- Safe & Secure Travel
- Preserve & Maintain Network
- Mobility, Connectivity, Accessibility
- Efficiency & Reliability

Performance measure data is updated at regular intervals. The data are presented both as an interactive dashboard and as a printable report.

Measures are regularly reviewed by CTDOT's Performance Measures Standing Committee to ensure that they remain relevant to CTDOT's strategic decisions for managing infrastructure assets.

The performance measures outlined in this TAMP are not yet included on the CTDOT Performance Measures website but are proposed to be included in the future.

Asset Performance Projections

CTDOT manages its assets throughout their life cycle. Understanding each asset's life cycle and developing projections of future asset performance based on this understanding is key component of managing assets. Chapter 5, Life Cycle Planning, provides more information on CTDOT's LCP and management practices.

Projected conditions for the eleven assets in the TAMP are included at multiple funding levels for each asset. The following three funding levels were selected to be projected: No Funding, Current Funding, and Preferred Funding. In the projection Figures 4.1-4.17, red lines are used to indicate the percent of assets in Poor condition while green lines are used to indicate the percent of assets in Good condition according to federal performance measures; blue lines are used to indicate the percent of assets in a SOGR as defined by CTDOT performance measures; grey lines indicate the historical performance, where available. A 3.8% inflation rate was applied to generate projections for all assets, except for pavement which used a rate of 3.5% due to pavement projections being run early in the TAMP process, prior to setting a higher inflation rate estimate. The complete performance projections are included in Appendix C.

Funding uncertainty is a concern for every state DOT. The funding levels used for these projections reflect the best available information as of December 2021. CTDOT considers the TAMP to be a living document that will continue to be updated going forward at regular intervals.

SOGR Funding

Only dedicated SOGR funding is captured in the graphs, which is only a portion of total funding dedicated to those assets. Assets are routinely updated during a capital project such as a major bridge rehabilitation or a highway or major interchange reconfiguration. Many highway bridges are replaced or modified in highway projects to add capacity or to revise geometry. While the bridge may not have been slated for replacement using an asset management approach, the lifecycle was extended and the asset was improved.

Bridges

Projections of bridge performance were developed in dTIMS using a snapshot of condition data from 2021. The bridge projection analysis is run to optimize a bridge health index. The bridge health index is comprised of condition ratings weighted as follows: 15% deck, 15% superstructure, 15% substructure, 10% structural evaluation, 5% deck geometry, 5% underclearances, 5% waterway adequacy, 4% approach alignment, 2% structure open/posted/closed, 5% paint/coating, 5% bearings, 5% girders, 5% joints and 4% wearing surface. From the results, 10-year performance projections were developed for NHS bridges and state-maintained bridges.

Performance projections for NHS bridges are shown in Figure 4-1. These forecasts show the direct correlation between investment and performance over a 10-year period. CTDOT predicts that the percent of NHS bridges in Poor condition will be under the FHWA minimum condition threshold of 10% at the end of the 10-year period of the TAMP.

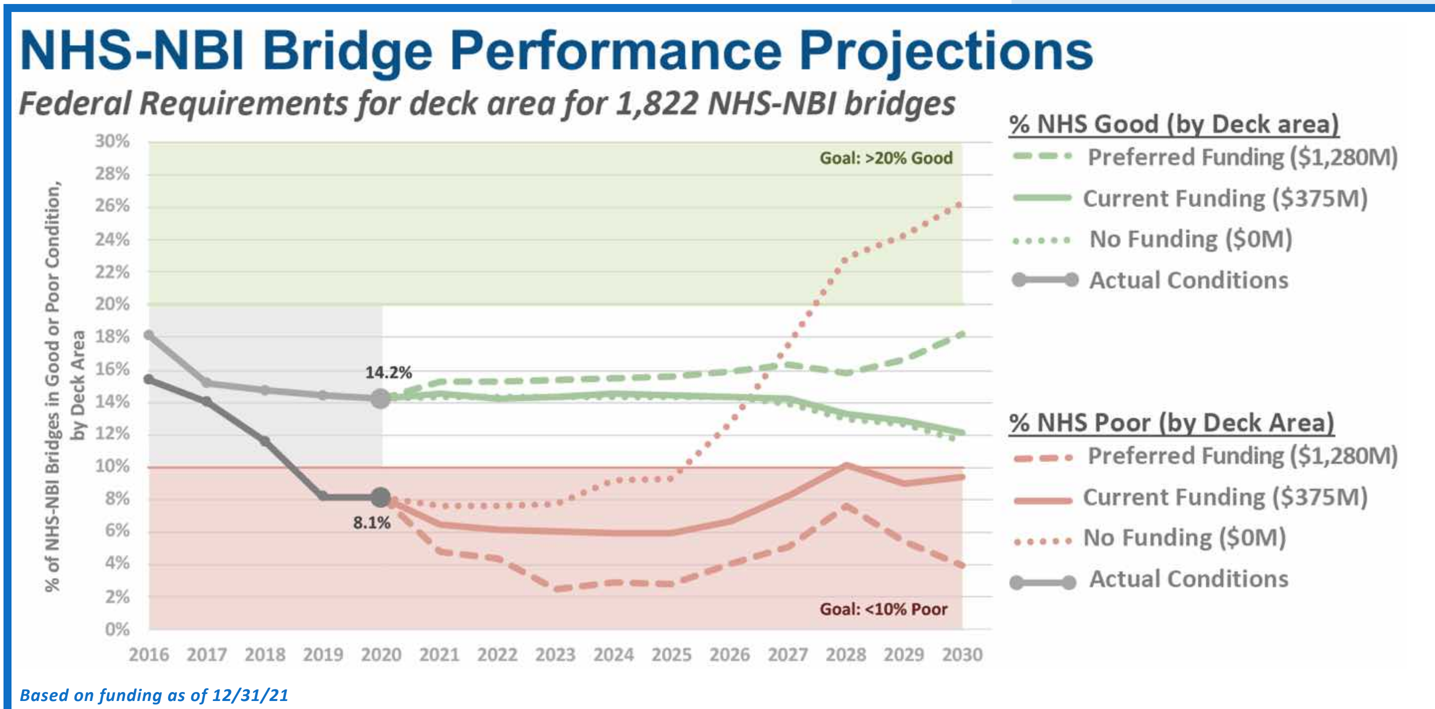


Figure 4-1. NHS-NBI Bridge Performance Projections

The performance projections for state-maintained bridges are shown in Figure 4-2. The condition of CTDOT-maintained bridges currently exceeds the SOGR goal, but is expected to decline below the goal by the end of the 10 year period of the TAMP. However, current projections may be conservative due to the recent use of more durable materials and removal of bridge joints where possible.

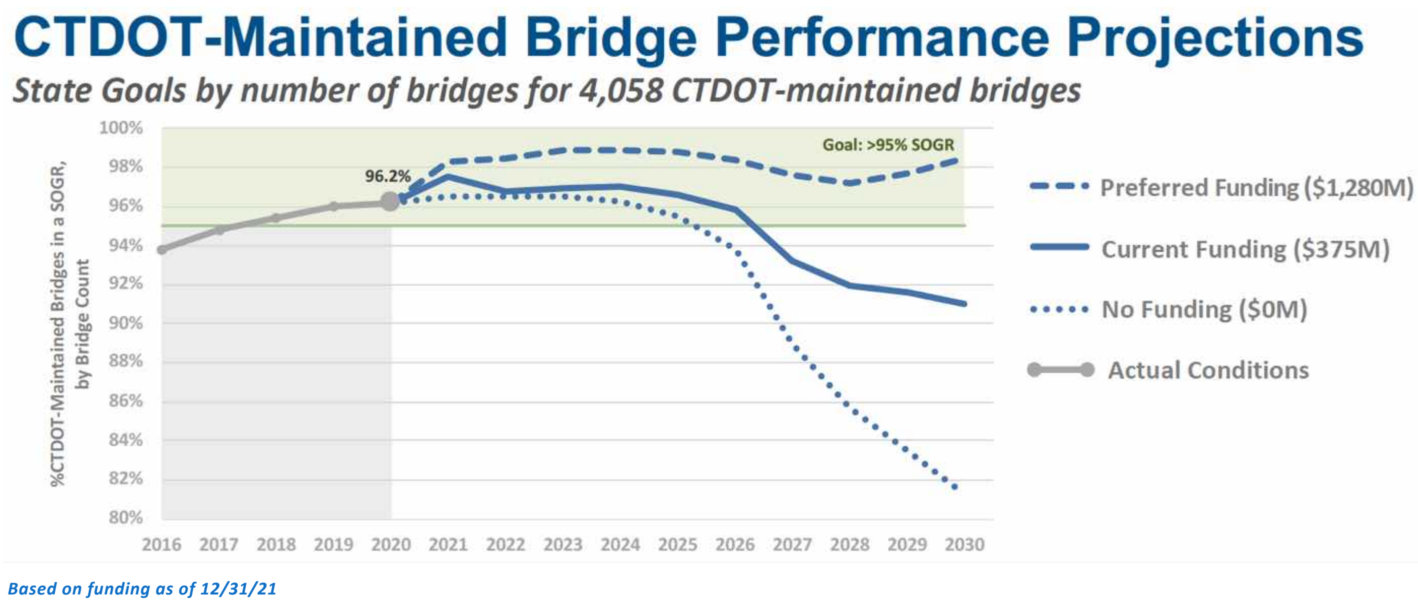


Figure 4-2. CTDOT-Maintained Bridge Performance Projections

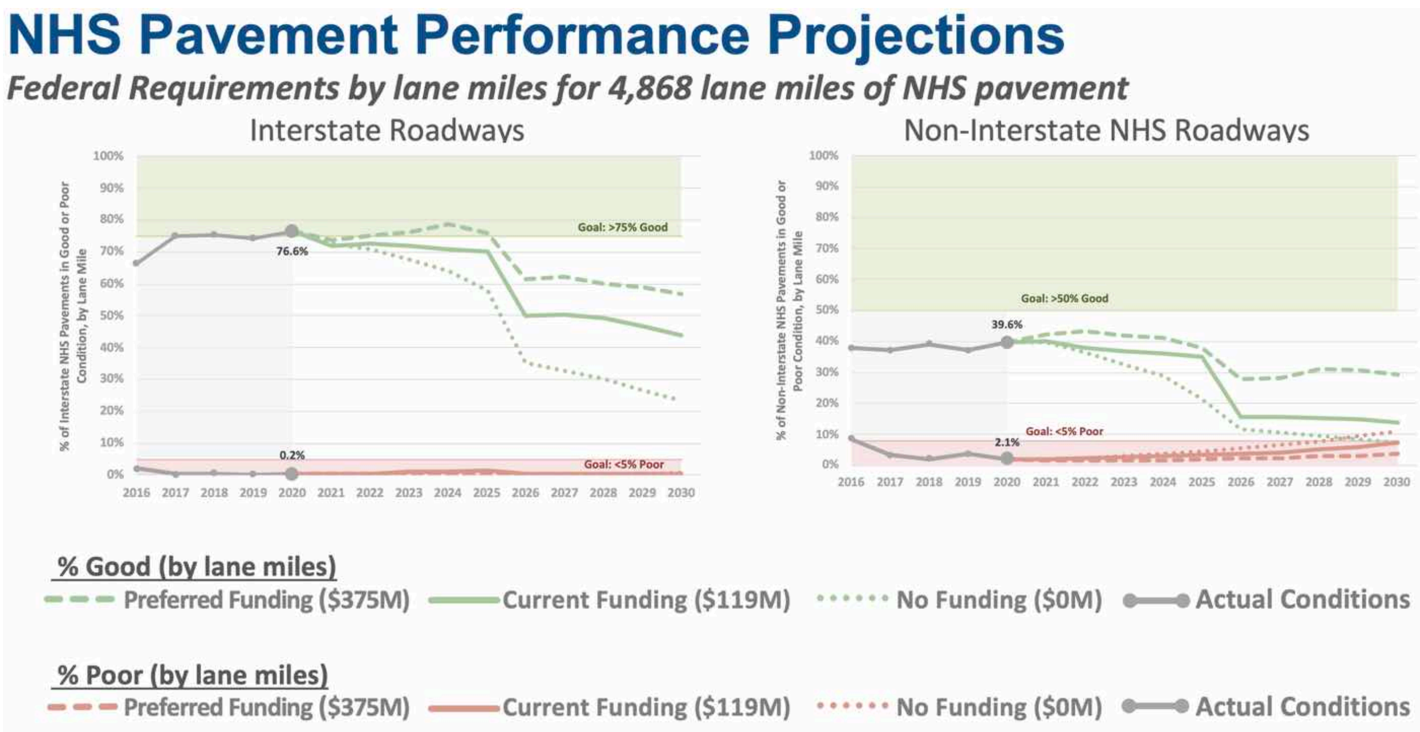
In addition to the 10-year performance projections, 30-year analyses were performed. These longer-term analyses are reviewed internally and indicate the value of a preferred funding investment to better maintain and sustain the minimum federal condition level.

Pavement

Projections of pavement performance were developed in dTIMS using 2020 condition data submitted on June 14, 2021. The analyses were run to optimize various budget scenarios to determine how to use funding to get the best return on investments. dTIMS was used to generate strategies based on Incremental Benefit Costs (IBC). Treatment costs were updated from historical CTDOT bid item records, and dTIMS measured benefits of strategies by comparing their PCI to the PCI for a “do-nothing” strategy. From the results, 10-year performance projections were developed for Interstate pavements, Non-Interstate NHS pavements and state-maintained pavements. Note that an inflation rate of 3.5% when predicting future pavement conditions, which differs slightly from the 3.8% rate used for all other assets.

The performance projections for both Interstate pavements and Non-Interstate NHS pavements are shown in Figure 4-3. The current funding refers to pavement preservation and maintenance resurfacing treatments only. The preferred funding refers to all work types including reconstruction treatments. Overall pavement condition is anticipated to decline throughout the entire 10-year period. To address the decline, more pavement funding is being allocated to improve timeliness and volume of preservation treatments, and a strategic rehabilitation program is in development.

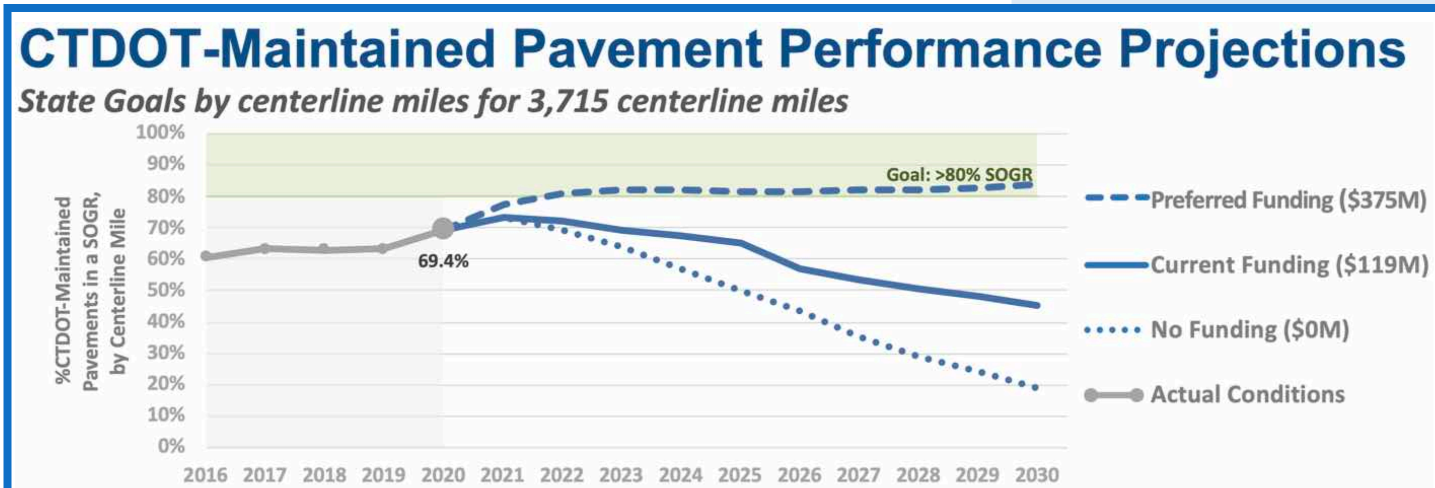
The sharp drop in Good condition projected between 2025 and 2026 stems from two conditions: the first is that unusually large segments of pavement that date from the same paving years will move into lower condition states in this time period, the second major source of this drop is a function of the way that condition states are defined for the national performance measures. There are only three condition states and the middle Fair range is very broad compared to the Good range, which is relatively stringent. It is difficult to maintain a pavement in Good condition.



Based on funding as of 12/31/21

Figure 4-3. NHS Pavement Performance Projections

The performance projections for state-maintained pavements are shown in Figure 4-4. Although the preferred funding allows us to maintain the existing condition, it is beyond the present capacity to deliver. The current funding leads to an overall decline of state-maintained pavement condition over the 10-year period.



Based on funding as of 12/31/21

Figure 4-4. CTDOT-Maintained Pavement Performance Projections

Traffic Signals

Performance projections for traffic signals were developed based on the current process for managing this asset. Each year roughly 120 traffic signals that have exceeded their service life would need to be replaced for this asset class to achieve its performance target in future years. Currently, CTDOT replaces approximately 45-55 signals each year under the annual traffic signal program that have exceeded their service life. An additional 5-10 traffic signals are upgraded each year under other highway projects and encroachment permits by developers. The performance projections for traffic signals are shown in Figure 4-5.

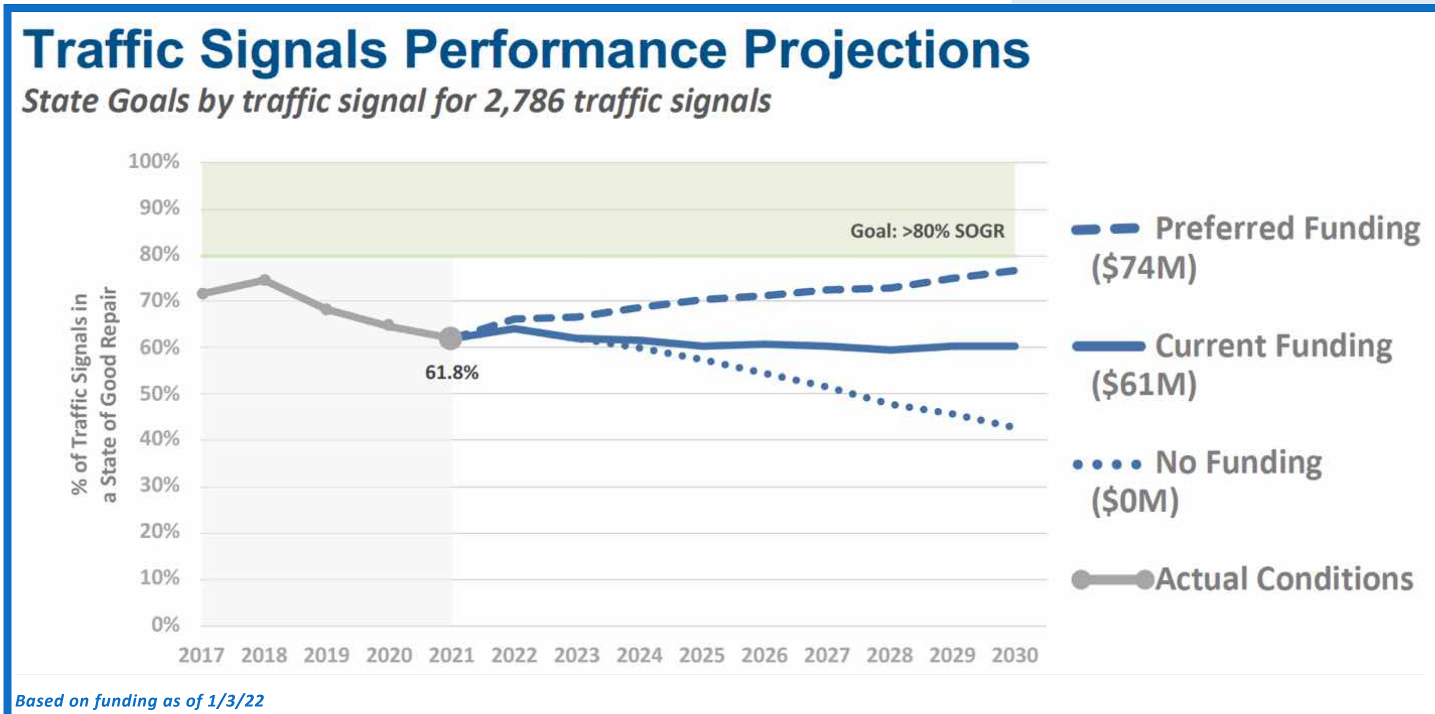


Figure 4-5. Traffic Signals Performance Projections

Current funding level includes $29 million for TAM Traffic Signals Preservation projects, $20 million for Computerized Traffic Signal System (CTSS) replacement projects, and $12 million for Traffic Signal Safety & Technology projects. The CTSS projects will affect SOGR rating; Traffic Engineering is taking on the prime designer role starting FY2024. The Traffic Signal Safety & Technology projects are funded through FY2026 and will not affect SOGR rating.

Signs

Performance projections for signs were developed based on the current process for managing this asset. Each year 14,500 signs require replacing to achieve CTDOT's State of Good Repair performance target. Currently, CTDOT replaces 5,000 signs each year that have exceeded their service life. Additional signs are replaced each year under other highway projects, but these have not necessarily reached their service life. Funding value includes the cost of overhead sign supports and foundations that may not be in Poor condition but require replacement due to sign revisions.

Previously, CTDOT categorized signs by limited access and non-limited access. Now, signs are categorized by material, as this provides more information for asset management needs. Performance projections were estimated using a method that is not affected by sign type categorization, therefore only the material type charts are shown.

Performance projections for Extruded Aluminum signs are shown in Figure 4-6. Under the current funding levels, CTDOT should meet and sustain conditions above the state goal in 2028, within the 10-year period of the TAMP.

Figure 4-6. Extruded Aluminum Signs Performance Projections

Performance projections for Sheet Aluminum signs are shown in Figure 4-7. Under the current funding levels, CTDOT would not meet the state goal within the 10-year period of the TAMP.

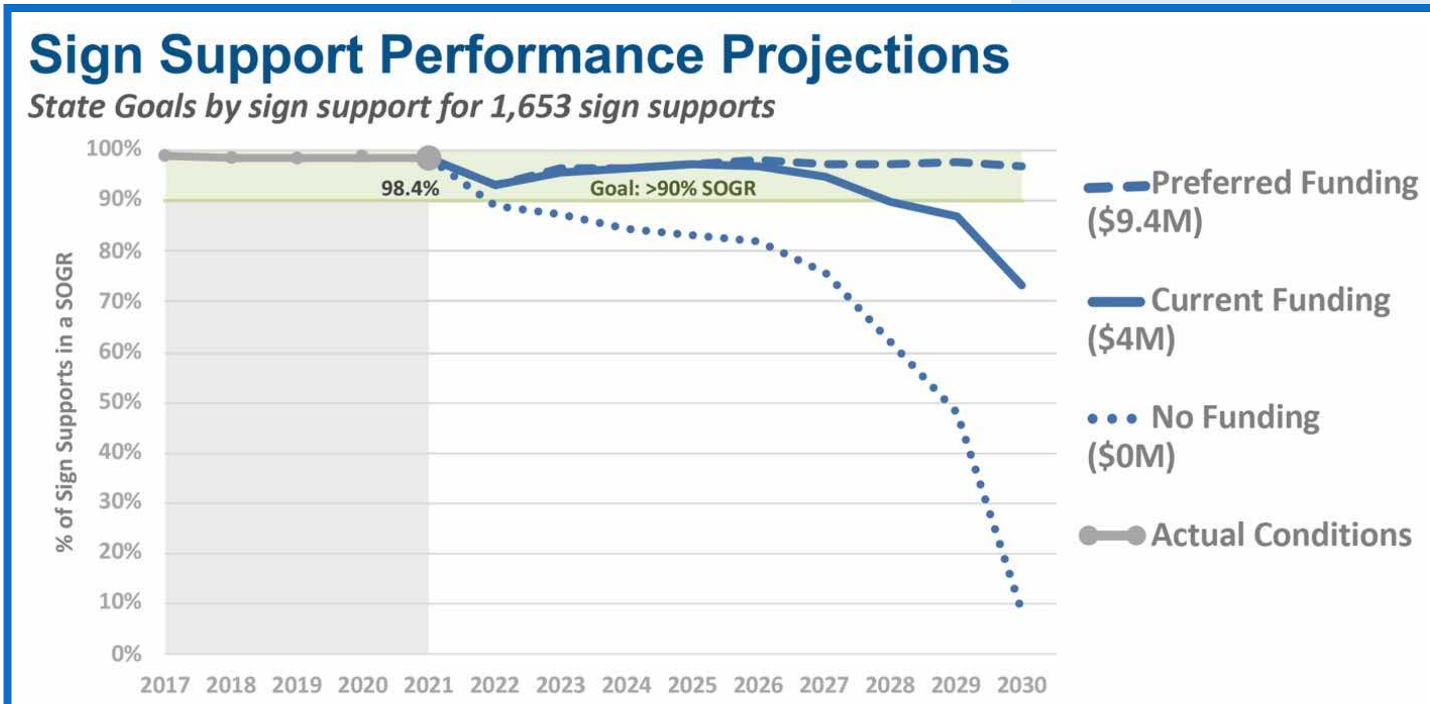
Based on funding as of 12/31/21

Figure 4-7. Sheet Aluminum Signs Performance Projections

Sign Supports

Performance projections for sign supports were developed based on the current process for managing this asset. CTDOT used deterioration curves based on a 34-year service life of a sign support. The scenario assumes current funding of $4 million per year and that replacement of 40% of sign supports in Poor condition will be included in other types of projects.

Performance projections for sign supports are shown in Figure 4-8. Sign supports meet SOGR goals at the preferred funding level over the 10-year period of the TAMP, but would fall short given the current funding. The noticeable decline in performance starting in 2026 is due to the number of sign supports reaching their life expectancy at the same time.



Based on funding as of 12/31/21

Figure 4-8. Sign Support Performance Projections

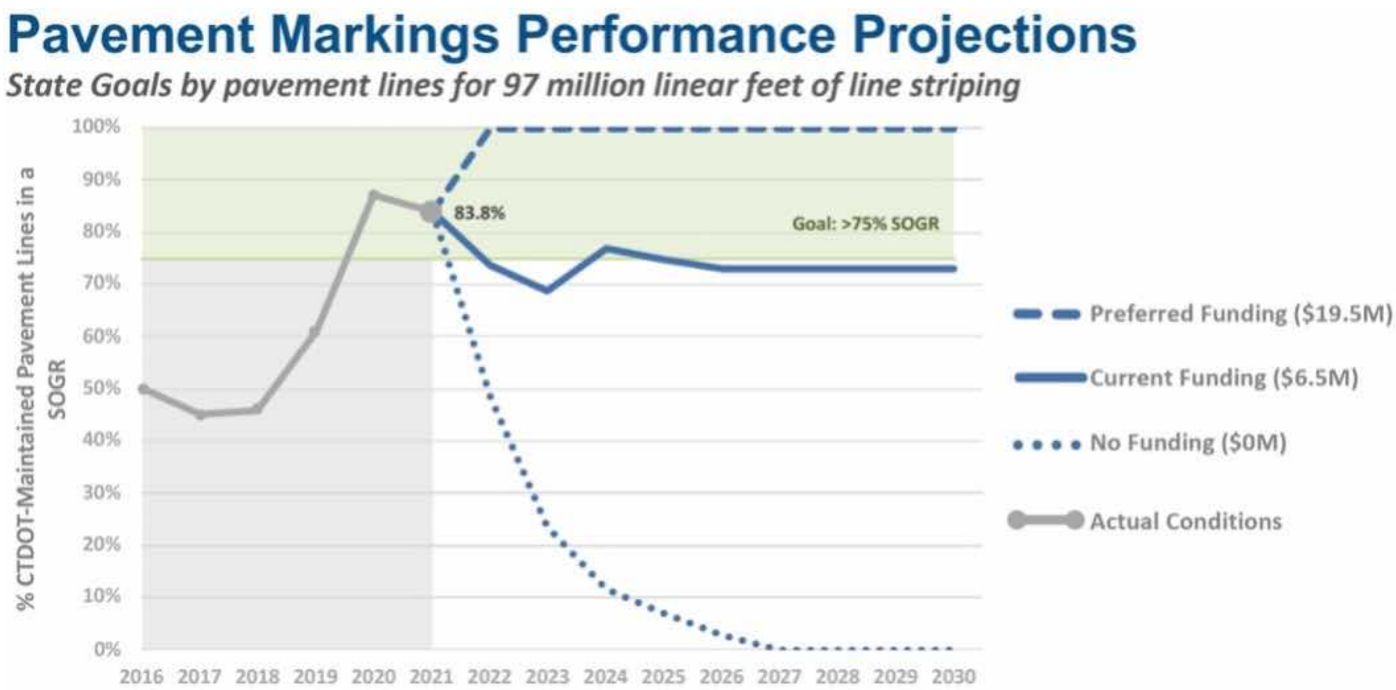
Pavement Markings

Performance projections for pavement markings were developed based on the current process for managing this asset. Pavement markings are organized into two categories determined by unit of measure: Line Striping (linear feet) and Symbols & Legends (square feet). In order to determine performance projections, the two categories are then further defined by three types: in-laid epoxy, epoxy and water-based. The distinction of the three types is important to the projection modeling since in-laid epoxy pavement markings have a six-year service life, epoxy pavement markings have a three-year service life and water-based pavement markings have a one-year service life.

Each year, about 32 million linear feet of line striping and 1.1 million square feet of symbols and legends epoxy markings need to be remarked for this asset class to achieve and maintain its performance target in future years. Currently, CTDOT replaces approximately 30 million linear feet of line striping and 640,000 square feet of symbols and legends each year that have exceeded their service life. Additional epoxy pavement markings are replaced each year under other highway projects but these have not necessarily reached their service life.

Performance projections for pavement lines are shown in Figure 4-9. CTDOT would meet SOGR goals under the preferred funding scenario, but would fall slightly short given current funding.

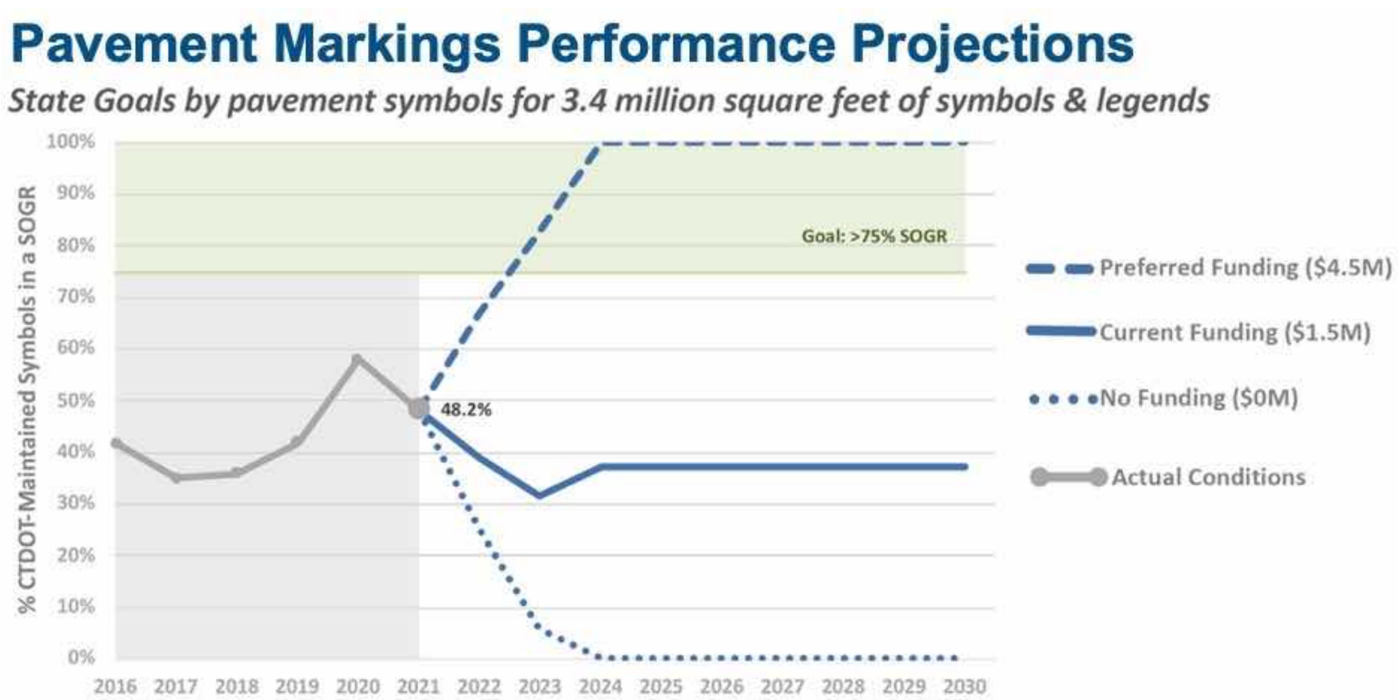
Note that CTDOT implemented a revised condition calculation methodology since the 2019 TAMP, which has resulted in changes to the historical conditions. Pavement line historical conditions increased by roughly 20% SOGR, while pavement symbol historical conditions decreased by roughly 20% SOGR.



Based on funding as of 12/31/21

Figure 4-9. Pavement Lines Performance Projections

Performance projections for symbols and legends are shown in Figure 4-10. CTDOT would meet SOGR goals under the preferred funding scenario, but would fall short given current funding.



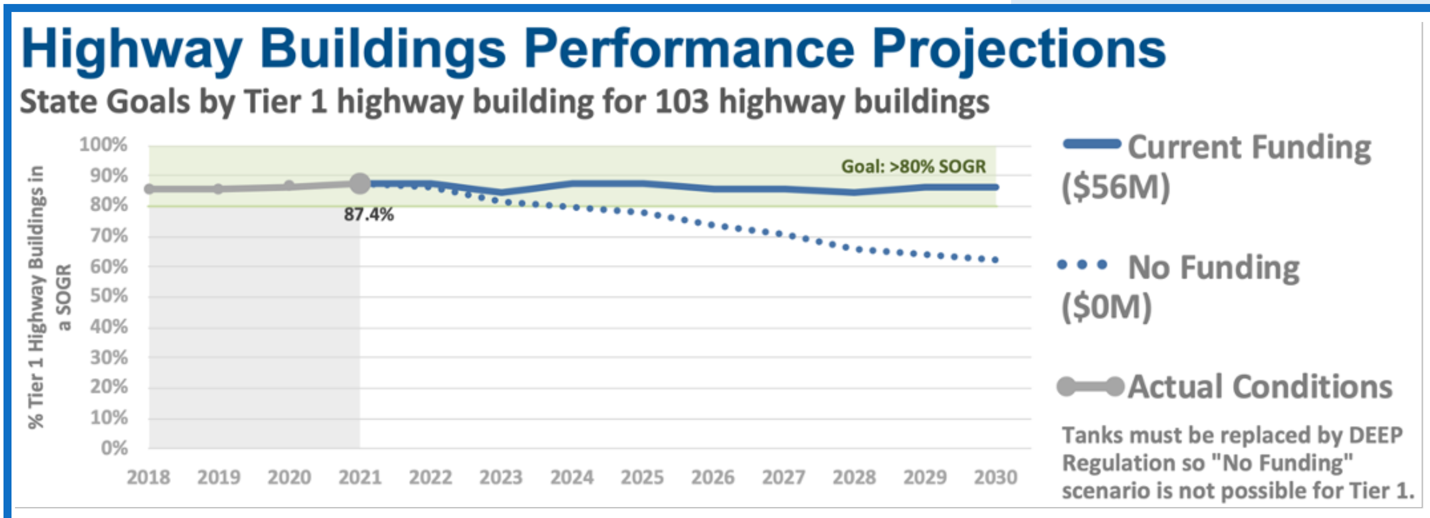
Based on funding as of 12/31/21

Figure 4-10. Pavement Symbols Performance Projections

Highway Buildings

Performance projections for highway buildings were developed for each tier by manually applying capital improvements and an assumed rate of deterioration across the building inventory for a 10-year period. CTDOT began modeling highway building conditions in 2019 and the manual process is constantly being refined. CTDOT is attempting to procure and implement a Facilities Management System that would automate this process.

Tier 1 highway building projections are shown in Figure 4-11. At current funding levels, Tier 1 highway building condition will meet the SOGR goal over the 10-year period of the TAMP.



Based on funding as of 12/31/21

Figure 4-11. Tier 1 Highway Buildings Performance Projection

Tier 2 highway building projections are shown in Figure 4-12. At current funding levels, Tier 2 highway building condition will meet the SOGR goal over the 10-year period of the TAMP.

Based on funding as of 12/31/21

Figure 4-12. Tier 2 Highway Buildings Performance Projection

Tier 3 highway building projections are shown in Figure 4-13. At current funding levels, Tier 3 highway building condition will meet the SOGR goal over the 10-year period of the TAMP.

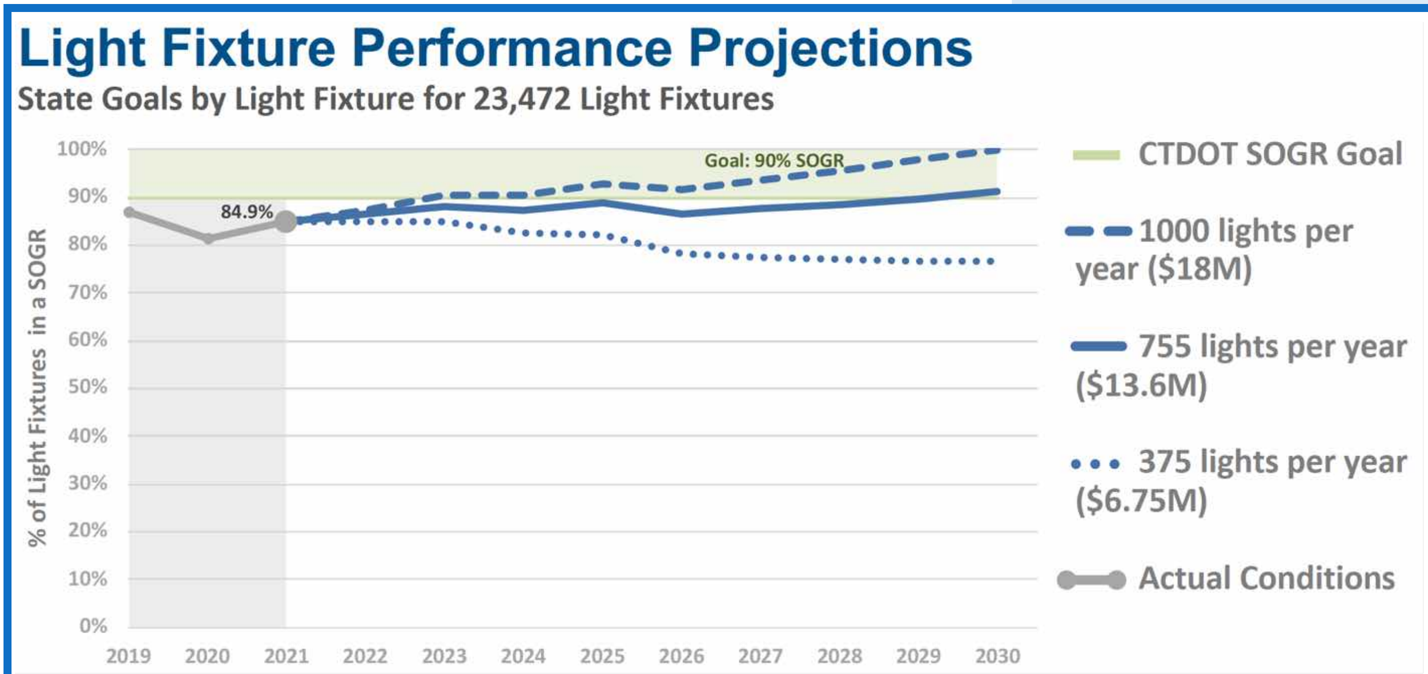
Based on funding as of 12/31/21

Figure 4-13. Tier 3 Highway Buildings Performance Projection

Roadway Illumination

Performance projections for illumination were developed based on the current process for managing this asset. An average of 1000 light fixtures needs to be replaced each year to reach SOGR in the 10-year TAMP period. Replacement of light fixtures includes the luminaire, light standard, foundation, and underground circuitry. An average of 400 light fixtures should be replaced per year to maintain SOGR. Currently, the Highway Safety Improvement Projects replace about 250 light fixtures per year. Additional light fixtures will need to be installed by roadway lighting replacement projects.

Performance projections for light fixtures are shown in Figure 4-14. Roadway illumination almost meets the SOGR goal in the 10-year TAMP period when 755 light fixtures are replaced each year. The preferred replacement level of 1,000 light fixtures replaced per year would bring CTDOT to nearly 100% SOGR in the 10-year TAMP period. The preferred scenario includes approximately 755 signals replaced through illumination specific projects and 250 signals replaced through safety improvement projects.



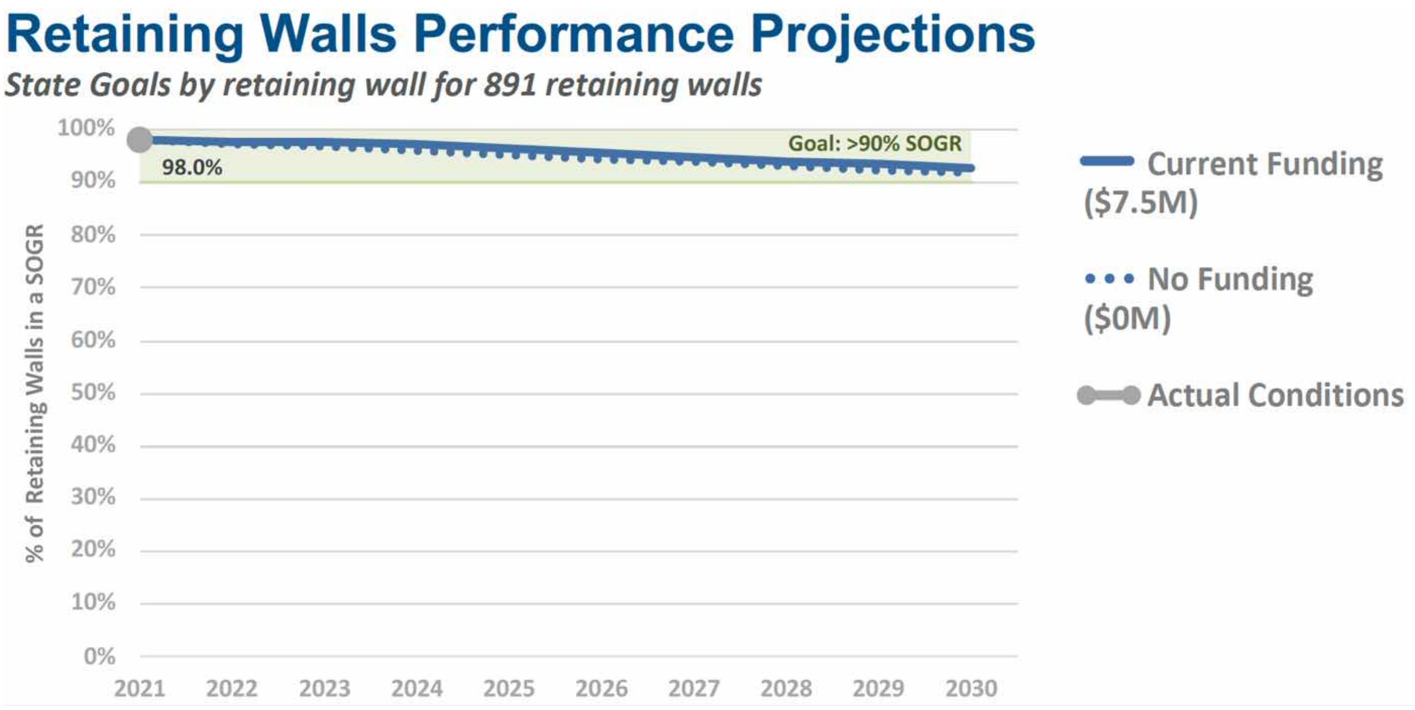
Based on funding as of 12/31/21

Figure 4-14. Roadway Illumination Performance Projection

Retaining Walls

Performance projections for retaining walls were developed based on the current process for managing this asset which assumes that CTDOT invests in retaining walls over 60 years old in the next 10-year TAMP period. Current funding averages $7.5 million per year.

Performance projections for retaining walls are shown in Figure 4-15. Under current funding levels, retaining walls meet the SOGR goal in the 10-year TAMP period.

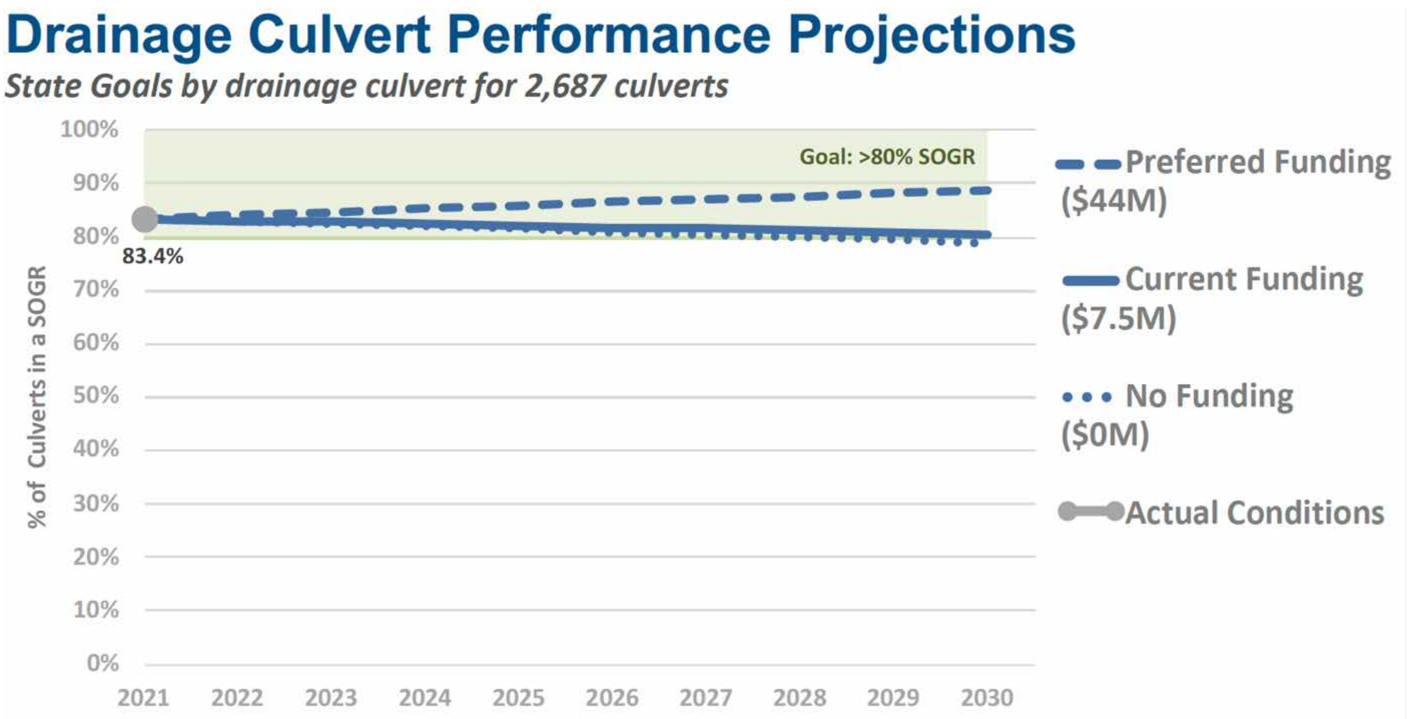


Based on CTDOT 2010 inventory with 2021 updates and funding levels from 12/31/21

Figure 4-15. Retaining Walls Performance Projection

Drainage Culverts

Performance projections for drainage culverts were created using data from the limited number of culverts with both age and condition data. The projections follow the current process for managing this asset, and they are shown in Figure 4-16. Under the current funding scenario, which averages $7.5 million per year, the drainage culvert assets will remain in a SOGR.



Based on funding as of 12/31/21

Figure 4-16. Drainage Culvert Performance Projection

ITS

Performance projections for ATMS field devices were developed based on the current process for managing this asset. To achieve the SOGR goal of 75% within the 10-year TAMP period, Highway Operations has been approved for 9 projects to replace an average of 25 ATMS field devices and install 12 new devices per project. Current Highway Operations projects replace about 20 ATMS field devices per year, the remainder are installed through other projects.

Figure 4-17 displays the performance projections for ITS. Current funding levels will result in CTDOT meeting the SOGR goal.

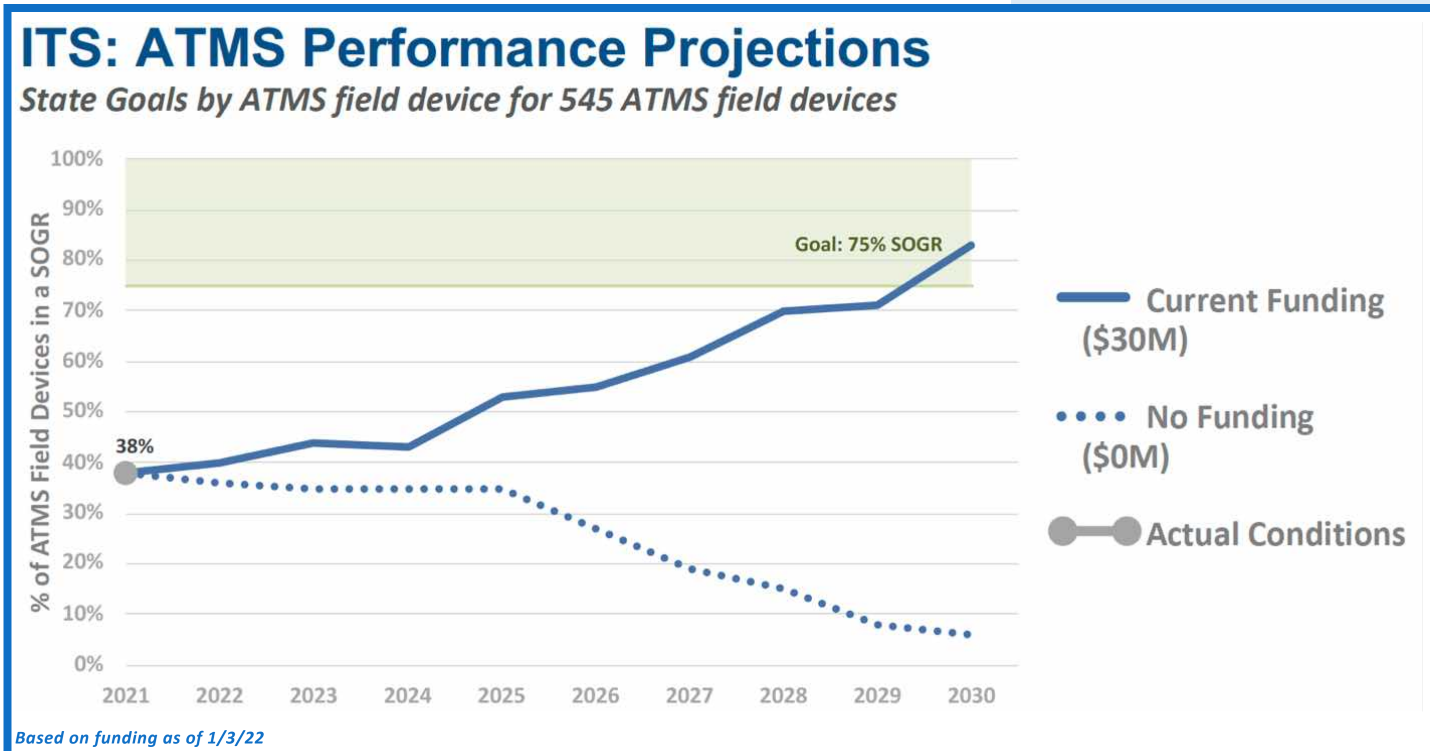


Figure 4-17. ITS: ATMS Performance Projection

Asset Performance Gap Analysis

CTDOT has established a process for conducting a gap analysis by evaluating gaps between current and desired condition and developing strategies to close those gaps. FHWA defines a performance gap as “the gaps between the current asset condition and State DOT targets for asset condition, and the gaps in system performance effectiveness that are best addressed by improving the physical assets.”

Connecticut’s gap analysis includes two gap calculations: current gap and projected gap.

- **Current gap** is the gap between current performance and the 10-year desired SOGR.
- **Projected gap** is the gap between the current funding 10-year performance projection and the 10-year desired SOGR.

For this TAMP, 10-year projection refers to the projected performance in 2030.

Both current and projected gaps are shown in terms of the change in performance required to meet the desired SOGR. For measures of Good conditions, a gap indicates the need to increase the percent of assets in Good conditions by the specified amount. For measures of Poor conditions, a gap indicates the need to reduce Poor conditions by the specified amount.

NHS Assets

The gap analysis for NHS bridges and pavements is shown in Table 4-7. Connecticut's NHS Bridges and Pavements mostly meet goals related to assets in Poor condition. However, there are current and projected gaps for NHS bridges and pavements in Good condition.

Table 4-7. Performance Gaps using Federal Performance Measures for NHS Assets using Current Budget Scenarios

Asset	Good	Gap	Poor	Gap
NHS Bridge Performance Goal	20.0%		10.0%	
Current Performance	14.2%	5.8%	8.1%	Meets Goal
10-Year Projected Performance	12.1%	8.9%	9.4%	Meets Goal
Interstate Pavement Performance Goal	75.0%		5.0%	
Current Performance	76.6%	Meets Goal	0.2%	Meets Goal
10-Year Projected Performance	43.8%	31.2%	0.3%	Meets Goal
Non-Interstate NHS Pavement Performance Goal	50.0%		8.0%	
Current Performance	39.6%	10.4%	2.1%	Meets Goal
10-Year Projected Performance	13.8%	36.2%	7.4%	Meets Goal

CTDOT-Maintained Assets

The gap analysis for CTDOT-maintained assets is shown in Table 4-8. Highway buildings, retaining walls, and drainage all currently exceed performance goals and are forecasted to sustain those conditions. All other state-maintained assets in the TAMP have current and/or projected performance gaps.

Table 4-8. Performance Gaps using CTDOT Performance Measures for CTDOT-Maintained Assets Using Current Budget Scenario

Asset	SOGR	Gap
Bridge Performance Goal	**95.0%**	
Current Performance	**96.2%**	Meets Goal
2030 Projected Performance	**91.0%**	4.0%
Pavement Performance Goal	**80.0%**	
Current Performance	**69.1%**	10.9%
2030 Projected Performance	**45.4%**	34.6%
Traffic Signals Performance Goal	**80.0%**	
Current Performance	**61.8%**	18.2%
2030 Projected Performance	**60.4%**	19.6%
Signs – Extruded Aluminum Performance Goal	**80.0%**	
Current Performance	**42.4%**	37.6%
2030 Projected Performance	**87.9%**	Meets Goal
Signs – Aluminum Sheeting Performance Goal	**70.0%**	
Current Performance	**41.1%**	28.9%
2030 Projected Performance	**56.9%**	23.1%
Sign Supports Performance Goal	**90.0%**	
Current Performance	**98.4%**	Meets Goal
2030 Projected Performance	**73.3%**	16.7%
Pavement Markings – Line Striping Performance Goal	**75.0%**	
Current Performance	**83.8%**	Meets Goals
2030 Projected Performance	**72.9%**	2.1%

Asset	SOGR	Gap
Pavement Markings – Symbols & Legends Performance Goal	**75.0%**	
Current Performance	**48.2%**	26.8%
2030 Projected Performance	**37.3%**	37.7%
Highway Buildings – Tier 1 Performance Goal	**80.0%**	
Current Performance	**87.4%**	Meets Goal
2030 Projected Performance	**86.0%**	Meets Goal
Highway Buildings – Tier 2 Performance Goal	**80.0%**	
Current Performance	**100.0%**	Meets Goal
2030 Projected Performance	**90.2%**	Meets Goal
Highway Buildings – Tier 3 Performance Goal	**50.0%**	
Current Performance	**61.0%**	Meets Goal
2030 Projected Performance	**50.9%**	Meets Goal
Illumination Performance Goal	**90.0%**	
Current Performance	**84.9%**	5.1%
2030 Projected Performance	**91.2%**	Meets Goal
Retaining Walls Performance Goal	**90.0%**	
Current Performance	**98.0%**	Meets Goal
2030 Projected Performance	**92.8%**	Meets Goal
Drainage Culverts Performance Goal	**80.0%**	
Current Performance	**83.4%**	Meets Goal
2030 Projected Performance	**80.6%**	Meets Goal
ITS Performance Goal	**75.0%**	
Current Performance	**38.0%**	37.0%
2030 Projected Performance	**83.0%**	Meets Goal

To close these performance gaps, CTDOT is focused on investing in assets to achieve and maintain a SOGR. CTDOT is also moving further towards a proactive, preservation-first approach. Using available funding, CTDOT will prioritize projects that can help close performance gaps using asset management principles and practices. In addition, performance projections may be conservative because the impact of asset investments beyond SOGR projects are not fully captured. For bridge projects there is an emphasis to maintain schedules of all projects addressing Poor bridges on the NHS in order to meet performance targets as projected. For pavements, most preservation treatments have been on the NHS. For performance that indicates declining conditions, additional funds, or a reallocation of funds from other assets will be needed to make progress in closing the performance gaps. The approaches for closing these gaps, achieving state targets, and making progress towards national goals are further detailed in subsequent chapters of the TAMP, including Chapter 5 Life Cycle Planning, Chapter 7 Financial Plan, and Chapter 8 Investment Strategies.

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Chapter 5

Life Cycle Planning

Asset management involves operating, maintaining, and improving assets using analysis to identify a sequence of actions that seek to achieve a state of good repair over the life cycle of the assets. Thus, asset management concepts apply over the full life of an asset, spanning from installation or construction of an asset to its replacement or retirement. As part of asset management practice, CTDOT makes investment decisions that consider not only the current condition, but also the full life cycle and associated costs of assets. Life cycle planning is used to determine actions to perform on an asset over its life cycle considering costs and benefits.

Overview

This chapter describes CTDOT's LCP for its bridges, pavements, traffic signals, signs, sign supports, pavement markings, highway buildings, roadway illumination, retaining walls, drainage culverts, and ITS devices. FHWA defines LCP as "a process to estimate the cost of managing an asset class, or asset sub-group over its whole life with consideration for minimizing cost while preserving or improving the condition." LCP differs from life cycle cost analysis (LCCA) in that LCP is a network-level analysis to identify treatment strategies, while LCCA is a project-level analysis that compares design alternatives. LCP optimizes cost efficiency over the life of an asset and is a key element of asset management which helps extend asset life and improve performance.

The basic principle underlying both LCP and LCCA is fundamental to asset management: **Timely investments in an asset result in improved condition over a longer time period and lower long-term cost**. Application of preventive maintenance early in an asset's life when it is still in relatively good condition can delay the need for more costly rehabilitation, replacement, or reconstruction and result in an overall lower life cycle cost. This principle is illustrated by Figure 5-1. The figure shows asset condition and costs over time for two scenarios: an asset management approach of preventive maintenance and a reactive approach. The example shows potential savings of $160 million over 40 years with assets maintained in better overall condition.

LCP links the TAMP condition data and targets to the financial plan and investment strategies by using deterioration rates and treatment options to help identify optimal asset strategies. These LCP asset strategies are defined in FHWA's guidance on using LCP to support asset management as "a collection of treatments that represent the entire life of an asset class or sub-group."

LCP involves development of deterioration models based on condition history data, assumption of a life expectancy for each maintenance and rehabilitation treatment, and

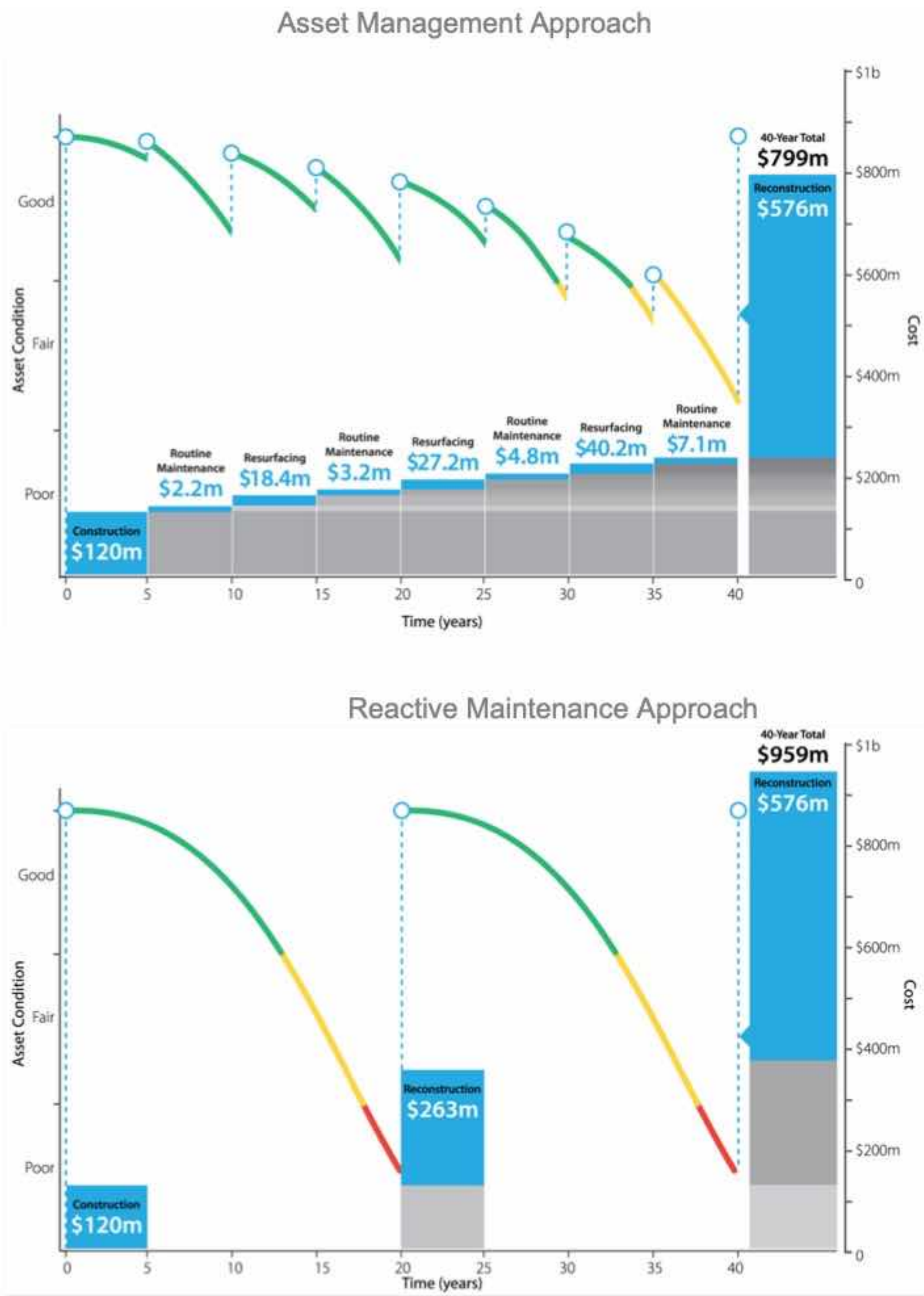
Life Cycle Cost

The cost of managing an asset class or asset sub-group for its whole life, from initial construction to the end of its service life.

calculating full life cycle costs associated with alternative treatment strategies.

Future conditions such as extreme weather events and climate change are also considered. These environmental conditions can increase the rate of deterioration of an asset, or end the life of an asset if an extreme weather event causes sufficient damage. Initial construction and rehabilitations are designed with resiliency in mind to mitigate the negative impact of climate change and extreme weather.

CTDOT conducts LCP for the eleven asset classes in the TAMP, using management systems or spreadsheets to model performance outcomes by evaluating treatments and funding levels. LCP is a tool that can help CTDOT make progress toward asset performance targets because it allows the best use of available funds to bring the greatest number of assets to a SOGR. CTDOT's data collection, performance targets, modeling approach, asset treatments, and treatment strategies are key components of LCP. Current CTDOT LCP practices are summarized in this chapter.



Asset management saves money: Performing preventive maintenance keeps assets in better condition – at a lower cost over the long term.

Deferring maintenance costs more: Higher-cost reconstruction or replacement is needed when assets are not maintained in a state of good repair.

Figure 5-1. Sample Representation of Proactive Maintenance vs. Reactive Maintenance

Source: Rhode Island DOT, Investing in Rhode Island's Future: A 10-Year Plan to Strengthen Our State's Transportation Systems. 2014. Based on an analysis published by TXDOT. Texas DOT, Typical Life Cycle Costs of a Highway, 2014. http://ftp.dot.state.tx.us/pub/txdot-info/tpp/2040/Life Cycle-costs-of-a- highway.pdf

Federal Legislative Context

FHWA requires that State DOTs establish a process for conducting LCP at the network level for NHS pavements and bridges.

Life Cycle Planning Process Requirements

The following elements must be included in a LCP process:

- Identification of deterioration models
- Potential work types, including treatment options and unit costs
- A strategy for minimizing life cycle costs and achieving performance targets
- Asset performance targets

BIL also requires TAMPs to consider extreme weather and resilience as part of the life cycle planning and risk management analyses.

CTDOT's Life Cycle Planning Approach

CTDOT's approach to life cycle planning includes consideration of scenarios at various funding levels including no funding, current funding and preferred funding. A 3.8% inflation rate was applied to generate performance projections for all assets except for pavement, which used a rate of 3.5% due to pavement projections being run early in the TAMP process. The inflation rate was developed by CTDOT's Cost Estimating Unit and published in the CTDOT 2017 Estimating Guidelines. A discount rate of 0% was used by all assets based on Bridge Management's recommendation. These rates are variable and will be updated as applicable.

Life Cycle Planning Considerations

LCP should include future changes in traffic demand and information on current and future environmental conditions including extreme weather events, climate change and seismic activity.

Life Cycle Planning for Bridges

Data Collection

Bridge data, including culverts, are collected through inspections performed to meet NBIS requirements, as well as more detailed element-level inspections. Data collection is discussed in detail in Chapter 3 Asset Data Management.

Modeling Approach

CTDOT uses dTIMS to detail its LCP strategy for bridges and to perform network-wide bridge analysis based on this strategy. CTDOT is also experimenting with AASHTOWare BrM software for deterioration modeling, but at this time, integrating inventory and condition data into the BrM system is still in development. CTDOT staff run deterioration models in dTIMS for the entire network, deduct the 60 designated major bridges from the dTIMS analysis, and then adds a separately prepared major bridge analysis to obtain a more accurate network-wide forecast. Engineers manually review bridge conditions and make recommendations for future projects on major bridges. Some major bridge projects can easily exceed the available budget in any given year, which will either cause the dTIMS analysis to stop or will result in no work ever being recommended on a particular major bridge because sufficient funds will never be available in any one year. Therefore, for the foreseeable future, treatments and associated costs for work on major bridges will be entered into dTIMS manually, and the budgets available for other structures will be adjusted accordingly.

The dTIMS model predicts bridge conditions using inspection data with both component and element level rating systems. Condition is measured on a scale from 0 (worst/failed) to 9 (best) for components and a scale from 1 (best) to 4 (worst) for elements. As detailed in Chapter 2, overall bridge condition is established by determining the minimum value of the deck, superstructure, or substructure for span bridges and the culvert rating for culverts. If the rating is 4 or lower, the bridge is defined to be in poor condition. If the rating is 5 or 6, the bridge is defined to be in fair condition. If the rating is 7 or higher, the bridge is defined to be in good condition. The dTIMS system also calculates a Health Index (HI) on a scale from 0.00 to 100 based on a weighted average of component and element condition ratings. The maximum item ratings used for the HI calculation are shown in Table 5-1 with the data source of the rating identified: NBI field, Element-Level field, CTDOT Bridge Inspection Form (CTDOT BRI-18) field.

Table 5-1. Bridge Health Index Components

Item	Maximum Points
Deck (NBI 58)	15
Superstructure (NBI 59)	15
Substructure (NBI 60)	15
Structural Evaluation (NBI 67)	10
Deck Geometry (NBI 68)	5
Underclearances (NBI 69)	5
Waterway Adequacy (NBI 71)	5
Approach Alignment (NBI 72)	4
Structure Open/Posted/Closed (NBI 41)	2
Paint (CTDOT BRI-18)	5
Bearings (Element-Level)	5
Girders (Element-Level)	5
Joints (Element-Level)	5
Wearing Surface (CTDOT BRI-18)	4
Total	100

Table 5-2 indicates the index value for the specified condition rating for the above components listed in Table 5-1.

Table 5-2. Bridge Health Index Weight Point Scale (May 2019)

Item	Item Rating	Weight Points
Deck (NBI 58), Superstructure (NBI 59), Substructure (NBI 60), Wearing Surface (BRI-18), Paint (BRI-18)	9	10
	8	10
	7	9
	6	7
	5	6
	4	4
	3	2
	2	0.5
	1	0
	0	0
Joints (Element-Level) Girders (Element-Level) Bearings (Element-Level)	1	5
	2	3
	3	1
	4	0
Structure Open/ Posted/Closed (NBI 41)	A (open) or G (new but not open)	2
	Other than A, G, or K	1
	K (closed)	0
Structural Evaluation (NBI 67), Deck Geometry (NBI 68), Underclearances (NBI 69), Waterway Adequacy (NBI 71), Approach Alignment (NBI 72)	9	10
	8	10
	7	9
	6	7
	5	6
	4	4
	3	2
	2	0.5
	1	0
	0	0

For items with weighted points, the score is determined by taking the fraction of the total possible points that the item rating represents. For example, for a deck with a rating of 5, the HI deck component score would be (6 weighted points / 10 maximum points) [from Table 5-2] X 15 maximum points [from Table 5-1] = 9.

dTIMS models deterioration using deterioration curves for each material, design type, and type of component, with sets of high, medium, and low curves for each modeled component or element, with a curve corresponding to each starting condition rating. The middle curve represents the performance of the typical example of a particular component; upper and lower curves are for components performing better or worse, respectively, than expected for their age. The curves were generated based on historical condition inspection data collected from 1992 through 2015, and then manually adjusted using engineering judgement to eliminate minor discrepancies related to year rebuilt data and issues identified in software coding. The curves were then run against historical data and further refined so that predictions based on historical data would replicate currently observed conditions. There are currently 2,122 deterioration curves for components, and 104 transition probability curves for elements.

A dTIMS run determines all feasible treatments for every bridge, including preservation, maintenance and replacement treatments; and calculates the costs and benefits for each possible treatment for each bridge. Multiple preservation and maintenance treatments may be recommended simultaneously. The treatment strategies are then optimized using an Information-Based Complexity strategy. Information-Based Complexity is an optimization approach using a search strategies method within the network to maximize benefits while meeting a budget cost constraint. It is calculated using a compilation analysis variable holding the present value cost of all treatments and a compilation analysis variable holding the present value benefit (improvement in HI).

If replacement and rehabilitation actions are both feasible, the model chooses the treatment with the greater life cycle cost effectiveness over the analysis period (currently a 30 year analysis for bridges), with a minimum of 10 years between major treatments. The ultimate objective is to select an annual project mix which generates the greatest increase in the aggregate HI by the end of the analysis period given the available funding. As a result, it is possible that, given limited funds, dTIMS will select a less than optimum strategy for a particular structure in order to free up funds for a more beneficial project on another bridge.

Treatments

The treatments and costs used in the model are listed in Table 5-3. Note that economies of scale allow larger structures to have a lower unit replacement cost than small structures.

Table 5-3. Bridge Model Treatments and Unit Costs (January 2019) provided by the CTDOT Bridge Management Group

Treatment	Unit	Unit Cost
Total Bridge Replacement Large	Deck Area (SF)	$499
Total Bridge Replacement - Medium	Deck Area (SF)	$567
Total Bridge Replacement -Small	Deck Area (SF)	$709
Culvert Repair	Culvert Area Repaired (SF)	$294
Culvert Replacement	Culvert Area (SF)	$452
Deck Rehabilitation	Deck Area Repaired (SF)	$181
Deck Replacement	Deck Area (SF)	$187
Superstructure Repair	Deck Area (SF)	$170
Superstructure Replacement	Deck Area (SF)	
Small (< 1,600 SF)		$454
Medium (1,600 – 11,000 SF)		$414
Large (> 11,000 SF)		$300
Substructure Repair	Deck Area (SF)	$260
Beam End Repair	Girder Quantity (LB/LF)	$5,785
Bearing Replacement	Bearing Quantity (LB/LF)	$3,360
Joint Replacement	Joint Length (LF)	$260
Paint Rehabilitation	Area Repainted (SF)	$92
Paint Replacement	Area Painted (SF)	$47
Wearing Surface Replacement	Deck Area (SF)	$18

Strategy

The specific set of treatments performed for each bridge modeled in dTIMS are determined based on the available budget and the life cycle cost-effectiveness of each treatment. Only bridges in good or fair condition are considered for preservation treatments. When a bridge has deteriorated to poor condition, the basic strategy is to either repair or replace the component driving the poor condition or replace the entire structure if that is more cost-effective. Functional adequacy is also weighed when considering repair versus replacement.

In addition to using dTIMS to forecast condition, CTDOT maintains a list of bridges that are already structurally deficient and in need of repair. A Rehabilitation Study Report (RSR) is prepared for each bridge in need of rehabilitation. In 2019, CTDOT began comparing repair or replace options when selecting a treatment. In 2021, CTDOT standardized the method of comparing treatment options. Starting in mid-2022, CTDOT will require all designers to perform a life cycle cost analysis for all alternates proposed. This will serve as a tool for CTDOT to select a low cost, low maintenance solution.

A challenge in developing an effective life cycle strategy for Connecticut's bridges is determining how best to maintain bridges reaching and exceeding the end of their design life. More than half of the bridges in Connecticut are over 50 years old. When these bridges were built, they were designed to last 50 years. New bridges are now typically designed to last 75 years. Preventive maintenance (replacing joints, repairing beam ends, painting, or replacing bearings) and timely rehabilitation actions can extend the life of a structure. Without routine maintenance, costly bridge replacement becomes necessary for addressing needs of a deficient bridge.

A new strategy CTDOT is undertaking is the use of larger-scale bridge preservation projects. CTDOT has identified key points of failure that lead to deterioration in other components of the bridge. The first example is the corridor length replacement of bridge joints to prevent bridge joint failure, preventing the associated bearing and beam related deterioration. Similar programs include deteriorated beam ends, painting bridges, more durable membranes for bridge decks, low permeability concrete for superstructures, and sealing concrete exposed to salt spray. These are to be applied to bridges already rated good or fair, with the intent to keep them in that condition for longer.

Rehabilitation Study Report

An RSR considers various rehabilitation options for the individual bridge, and an analysis is performed comparing the costs and benefits of major rehabilitation (e.g. deck replacement, select girder replacement, etc.), full superstructure replacement, and complete bridge replacement. The analysis starts with an assumption of a 75-year life cycle. The RSR presents various maintenance scenarios with the associated present value costs and future treatment schedule.

Steps are being taken by CTDOT to address extreme weather and resilience. Due to Executive Order 21-3 issued by the Governor in December 2021, resiliency is considered in the design of all structures. Bridges are designed without joints when possible, which reduces the impact of high temperatures or increased freeze-thaw cycles. Some of the preservation techniques noted previously will increase the resilience of bridges in the face of climate change and extreme weather. The hydraulic design of bridges considers increased precipitation severity during storm events, as well as sea level rise, where applicable.

Life Cycle Planning for Pavement

Data Collection

Pavement data are collected annually using specially equipped ARAN vans as discussed in detail in Chapter 3 Asset Data Management.

Modeling Approach

LCP strategies for pavement are developed using predictive models for how pavements will deteriorate if no treatments are performed, as well as following different treatment strategies. A treatment strategy is a sequence of treatments over the analysis period. CTDOT models pavement condition and deterioration using the dTIMS PMS. dTIMS is CTDOT's primary tool for storing, managing, analyzing and reporting pavement condition information.

CTDOT uses Deighton's dTIMS to detail its LCP strategy for pavements and to perform network-wide pavement analysis based on this strategy. As part of these analyses, CTDOT staff model the worst-first Maintenance Resurfacing Program in dTIMS to obtain a network-wide forecast that is more aligned with actual programming practices.

This is accomplished by committing mill and fill resurfacing on a worst-first basis for the projected maintenance budget over 10 years. Planned pavement rehab projects are committed. After these treatments are committed, analyses/budget scenarios are run so dTIMS can select preservation treatments with a projected budget for preservation over 10 years. This allows the comparison of outcomes achieved with actual programming practices versus the outcomes possible with a strategy that optimizes life-cycle cost.

The dTIMS model predicts future pavement condition from current conditions using individual condition indices (transformations of distress measurements) which are understood by pavement managers to reflect pavement performance and consequently enable the application of treatments and prediction of performance.

Types of distresses included in each index are shown in Table 5-4. The lower of either the Structural Index or the Environmental Index is later used as the Cracking component in the PCI.

Table 5-4. Distresses Included in dTIMS Indices

Index	Included Distresses
Structural Index	Longitudinal and transverse cracking within wheel paths, plus all alligator cracking
Environmental Index	Longitudinal and transverse cracking outside of wheel paths
IRI	Longitudinal roughness based longitudinal profile
Rutting Index	Pavement distortion within wheel paths

Although the calculation of the individual condition indices is technically possible within dTIMS, CTDOT calculates the indices outside of dTIMS during the data-reduction processing of raw, 5-meter condition data into 0.10-mile segments used at the network level. Once loaded into dTIMS, they are used as the basis for the scenario analysis, which is represented at a high-level in Figure 5-2 and described in more detail below.

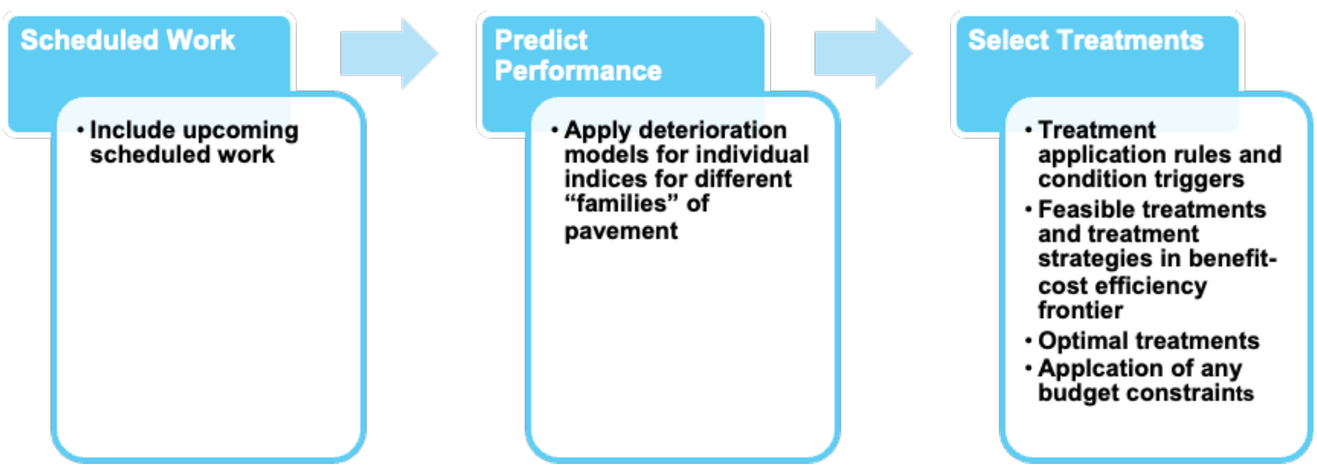


Figure 5-2. Overview of dTIMS Scenario Analysis

A composite condition index, called the PCI, is comprised of these indices plus other legacy components such as drainage and disintegration. The PCI correlates to the individual "triggering" indices and is used in the optimization (the benefit-cost analysis). The PCI is on a 1.0 to 9.0 scale, from worst to best, reflects legacy agency practice, and is well recognized within CTDOT. PCI calculation values are shown in Table 5-5.

Table 5-5. Pavement Condition Index

Component	Pavement Condition Index Weight (%)	Rating	Classification
Cracking	25	≥6	Good
		≥4 and <6	Fair
		<4	Poor
Rutting	15	≥6	Good
		≥4 and <6	Fair
		<4	Poor
Disintegration	30	≥6	Good
		≥4 and <6	Fair
		<4	Poor
Drainage	20	≥6	Good
		≥4 and <6	Fair
		<4	Poor
IRI	10	≥6	Good
		≥4 and <6	Fair
		<4	Poor
Total	100	≥6	Good
		≥4 and <6	Fair
		<4	Poor

To begin the scenario analysis, initial treatments are entered to include scheduled work for the initial year as well as projects that are in the project-development pipeline and expected to be accomplished. The dTIMS analysis then applies models for different pavement families to predict performance of those pavements and to select subsequent treatments. Feasible treatments are selected based on treatment triggers (conditions under which a treatment is feasible) that have been refined over time.

In the scenario analysis, dTIMS examines what treatments each pavement segment is eligible to receive for each year (including future years), and develops multiple strategies for each road segment representing a series of treatments over the scenario time horizon. These strategies are driven by the performance curves and the values that conditions are reset to following treatments. Each strategy calculates an incremental benefit/cost value that represents maximum benefit-to-cost ratio. The scenario analysis then compares across strategies to select an optimal set of treatments based on benefit/cost. Costs are pavement-related costs and benefits are the difference in condition between the strategy and a baseline do-nothing strategy, weighted by a function, the square root of the AADT, recognizing that benefits accrue to a larger number of users.

Treatments

CTDOT's pavement treatments and unit costs are listed in Table 5-6. Each treatment has conditions under which it is feasible to be applied, a treatment trigger, and an impact on pavement condition which resets values for each of the individual condition indices.

Table 5-6. Pavement Treatment Costs using Estimator

Treatment	Unit	Unit Cost
UltraThin Treatment	SY	$10.70
Mill and Fill /Maintenance Resurfacing (2 in.)	SY	$24.34
Mill and Fill (2 inches)	SY	$24.34
Mill and Fill (3 inches)	SY	$32.48
Rubblization	SY	$112.42
Structural Rehabilitation + Joint Repair	SY	$51.52
Structural Rehabilitation	SY	$52.59
Reclamation	SY	$51.91
Reconstruction (light, flexible)	SY	$90.57
Reconstruction (medium, flexible)	SY	$109.36
Reconstruction (heavy, flexible)	SY	$133.01
Reconstruction (light, composite)	SY	$103.29
Reconstruction (medium, composite)	SY	$122.52
Reconstruction (heavy, composite)	SY	$147.06
Diamond Grinding	SY	$46.15

Treatment	Unit	Unit Cost
Diamond Grinding + Joint Repair	SY	$52.13
Concrete Pavement Repairs and Structural Overlay	SY	$47.71
Rubberized Chip Seal	SY	$8.83
Thin Overlay	SY	$14.74
Microsurfacing	SY	$7.53

Strategy

The LCP strategy modeled in dTIMS is analyzed by first running an “unconstrained program” in terms of treatment scopes. The benefit-cost optimization leads to the observation that pavement preservation strategies are prioritized at all funding levels; rehabilitation and reconstruction are also selected but even more often at higher funding levels, in particular to decrease the “backlog” of pavement segments that are beyond the condition levels at which preservation is feasible.

Approximately 26% of CTDOTs pavement lane miles were constructed prior to 1950 and another 47% were constructed between 1950 and 1980. A majority of these pavements were built with a 20-year design life. Through rehabilitation and resurfacing programs, CTDOT has been working to extend the useful life of these pavements, particularly through increased use of preservation treatments. In 2010, CTDOT began a transition to a more balanced program of pavement maintenance, preservation, overlays, and rehabilitation. The intent is to move away from a “worst first” strategy which emphasizes treating pavements in poor condition. A preservation program strives to extend the life of pavements in good condition.

Recommended treatments are evaluated by CTDOT staff when determining what work to perform on a pavement section. There are many reasons why some variation from the recommendations is inevitable – actual project costs vary based on funding source and delivery mechanism, actual pavement deterioration varies based on site-specific characteristics, and selection of paving locations includes multiple considerations beyond pure benefit/cost.

Additionally, project limits may be altered to coordinate with another infrastructure need, to capture economies of scale in project delivery (adjacent segments in similar conditions) and other factors.

CTDOT is increasingly developing data-driven construction programs and has made a lot of progress with the preservation program. CTDOT has made some progress with the Maintenance Resurfacing program in that CTDOT has increased the level of concurrence by adjusting triggers to fall more in line with the program.

CTDOT mandates use of Superpave mix design on all pavement construction projects, with polymer-modified asphalts on all resurfacing for Interstates, Expressways (Functional Class 1 or 2), and roadways where Superpave Traffic Level 3 mixes are used. CTDOT uses a Performance Grade (PG) PG 64S-22 standard asphalt binder in its Superpave mixes, and a PG 64E-22 binder in its polymer modified mixes, where 64 represents a maximum 7-day pavement temperature of 64°C and 22 represents a minimum pavement temperature of 22°C. CTDOT leverages the work of the Pavement Advisory Team and the Pavement Program Coordination Committee to provide lessons learned into effective pavement materials, design, construction and preservation techniques. In the event of climate change and associated extreme weather, including higher temperatures, CTDOT will consider higher-temperature PG binders to achieve greater resiliency. CTDOT continues to refine its pavement management program to be increasingly resilient.

Life Cycle Planning for Traffic Signals

Data Collection

Traffic signals data are managed by the Division of Traffic Engineering in a SQL database with a Microsoft Access front end for data entry and viewing. Data collection is discussed in detail in Chapter 3 Asset Data Management.

Modeling Approach

CTDOT models traffic signals using an age-based approach. The model assumes that traffic signals should be replaced after 25 years, the age at which they are no longer considered in a SOGR.

Treatments

Typical treatments and costs are shown in Table 5-7. Replacement of all the signal equipment at an intersection and light emitting diode (LED) replacements at fixed intervals are the only treatments used for lifecycle planning for traffic signals.

Table 5-7. Traffic Signal Model Treatments and Unit Costs using Estimator®

Treatment	Unit	Unit Cost
Replace Traffic Signal	Each	$320,000
Replace Overhead Flashing Beacon	Each	$50,000

Strategy

CTDOT's life cycle strategies for traffic signals are summarized in Table 5-8. The current life cycle strategy for traffic signals in Connecticut is to replace traffic signals after 25 years. Traffic signals are also upgraded during intersection improvement projects, through encroachment permits by developers, and in response to customer complaints. During traffic signal replacement, increased wind loads are considered due to climate change and extreme weather events. CTDOT currently replaces approximately 60 signalized intersections per year under the annual traffic signal program.

Table 5-8. CTDOT's Life Cycle Strategies for Traffic Signals

Asset Management Method	Description
Age-Based Replacement	Traffic signals replacement based on expected life
Service Replacement	Traffic signal replacement based on response to customer complaints, sensor detection malfunction, etc.
Other Projects	Traffic signal upgrade, replacement, installation, or removal due to modifications to the roadway, regardless of age
Light-emitting Diode (LED) Replacements	Traffic signal LED replacements on a regular basis, based on current expected life of 15 years

CTDOT's intent in the future is to expand component level replacements to manage the lifecycle of traffic signal assets rather than as an entire signalized intersection. CTDOT has only begun implementing this approach for the LED component. Future life cycle strategies will include regular component level replacements of controllers, detection, span poles, and mast arms. Future strategies will also include condition of the components by integrating data collected through electronic maintenance records on the operational status of controllers and detectors at the traffic signals, and inspection of span poles and mast arms at regular intervals. These inspections will also identify damages due to climate change and extreme weather events.

Life Cycle Planning for Signs

Data Collection

CTDOT has a sign inventory that was captured using images from the 2013 Photolog. Data collection is discussed in detail in Chapter 3 Asset Data Management.

Modeling Approach

CTDOT models signs using an age-based approach. The model assumes that signs are replaced after 17 years, the age at which they are no longer considered in a SOGR.

Treatments

Typical treatments and costs for signs are shown in Table 5-9. Replacement is currently the only treatment for signs.

Table 5-9. Sign Model Treatment and Unit Costs using Estimator®

Treatment	Unit	Unit Cost
Replace Sheet Aluminum Sign	SF	$48
Replace Extruded Aluminum Sign		
• Sign Sheeting	SF	$30
• Sign Support Steel	CWT	$444
• Foundation (typically 2 per sign) for signs mounted on the side of the road.	EA	$5,700

Note: CWT = Hundredweight (US weight equivalent to 100 pounds)

Strategy

CTDOT's life cycle strategies for signs are summarized in Table 5-10. The current life cycle strategy for signs in Connecticut is to replace assets after 17 years. Signs may also be scheduled for replacement following visual inspections, corridor replacement of all signs by type or location, corridor replacement of signs in a project area such as Maintenance Resurfacing projects, or for statewide safety initiatives such as school zone warning signs and ramp wrong way signs. During sign replacement, increased wind loads are considered due to climate change and extreme weather events.

Table 5-10. CTDOT's Life Cycle Strategies for Signs

Management Method	Description
Age-Based Replacement	Signs are replaced based on manufacturer expected life
Nighttime Visual Inspections	Signs are replaced based on visual observation of each sign
Corridor Replacement	Signs are replaced by type or location regardless of age or condition
Safety Initiatives	Signs are removed, replaced, or installed by type regardless of age or condition based on safety needs
Other Projects	Sign upgrade, replacement, installation, or removal due to modifications to the roadway, regardless of age

Life Cycle Planning for Sign Supports

Data Collection

Sign support data are collected during inspections, typically every 6 years for full span overhead sign supports; 4 years for cantilever or bridge mounted sign supports; and 2 years for any aluminum sign supports (regardless of type). Data collection is discussed in detail in Chapter 3 Asset Data Management.

Modeling Approach

CTDOT models sign supports using an age-based approach. The model assumes that sign supports should be replaced after 34 years. The 34 year life-cycle is based on the assumption that after two-cycles of sign panel replacements (17 year life-cycle) a new sign support would be needed. Although CTDOT uses a condition-based approach for inventory, SOGR and life cycle strategy, the current projection model uses an age-based approach until condition-based deterioration models can be fully developed and validated.

Treatments

Typical treatments and costs are shown in Table 5-11. Replacement is currently the only treatment for sign supports.

Table 5-11. Sign Support Model Treatments and Unit Costs provided by CTDOT Traffic Engineering

Treatment	Unit	Avg. Unit Cost
Replace Cantilever	Each	$150,000
Replace Full Span	Each	$285,000
Replace Bridge Mount	Each	$45,000

Strategy

CTDOT’s life cycle strategies for sign supports are summarized in Table 5-12. The current life cycle strategy for sign supports in Connecticut is to replace assets when they fall into poor condition (overall rating less than 5). CTDOT staff review the inspection list and program assets for replacement based on condition. Also, many sign supports are replaced during projects initiated for other assets (signs) or highway improvements. During sign support replacements, increased wind loads are considered to mitigate the impact of extreme weather events.

For signing projects, the recent code changes and sign size increases have caused older sign supports to become functionally obsolete. This has required many non-condition based replacements over the past several years. Other strategies are now being implemented to reduce these types of replacements. Whenever possible, sign supports are being removed and replaced with signs mounted along the side of the road, which improves the resilience of the sign support network through a reduction in the number of sign supports. Also, more recently, Traffic Engineering has begun reducing the sign legend spacing to maintain current sign sizes to retain existing sign supports in good condition.

Table 5-12. CTDOT’s Life Cycle Strategies for Sign Supports

Management Method	Description
Condition-Based Replacement	Sign support replacement or repair based on poor or overstressed condition
Signing Replacement Projects	Sign support replacements driven by installation of larger sign panels on the support to meet MUTCD requirements.
Corridor Replacement	Sign supports are replaced by location regardless of condition
Other Projects	Sign upgrade, replacement, installation, or removal due to modifications to the roadway, regardless of condition

Life Cycle Planning for Pavement Markings

Data Collection

Pavement markings data are based on assumptions of current inventory and age. Data collection is discussed in Chapter 3 Asset Data Management.

Modeling Approach

CTDOT models pavement markings using an age-based approach. The model assumes that water-based pavement markings are replaced after 1 year, epoxy pavement markings are replaced after 3 years, and in-laid epoxy pavement markings are replaced after 6 years.

Treatments

Typical treatments and costs for pavement markings are shown in Table 5-13. Replacement is currently the only treatment for pavement markings. Currently CTDOT is not able to easily calculate a unit cost for water-based treatments. Although a partial breakdown of costs has been obtained, the labor, equipment, and maintenance and protection of traffic costs are complex to calculate across the network.

Table 5-13. Epoxy Pavement Marking Model Treatments and Unit Costs using Estimator®

Treatment	Unit	Unit Cost
Line Striping Replacement (epoxy only)	Linear Feet	$0.50
Symbols and Legends Replacement (epoxy only)	Square Feet	$2.50
In-laid Line Striping Replacement (grooved and epoxy)	Linear Feet	$1.15
In-laid Line Striping Replacement (wet reflective grooved and epoxy)	Linear Feet	$1.62

Strategy

CTDOT's life cycle strategies for pavement markings are summarized in Table 5-14. The current life cycle strategy for pavement markings in Connecticut is to replace pavement markings at the end of their expected life cycle, replace water-based pavement markings with epoxy pavement markings whenever possible and replace epoxy pavement markings on a 3-year cycle. Location and priority are often based on visual inspection, public requests, and needs designated by construction projects. Since maintenance personnel are unable to apply epoxy markings due to application constraints, maintenance's only available in-house treatment is water-based markings.

Table 5-14. CTDOT's Life Cycle Strategies for Pavement Markings

Management Method	Description
Condition-Based Replacement	Reduced retroreflectivity or level of service triggers location-specific treatments.
Age-Based Replacement	Replace pavement marking based on asset age with epoxy preferred.

CTDOT envisions moving towards a pavement marking program that would systematically replace all pavement markings based on life cycle. On select new resurfacing projects in-laid pavement markings are being installed. CTDOT is continuously researching products to find marking materials and methods that can provide a longer service life for the conditions in Connecticut.

CTDOT Maintenance has been looking into alternative paint markings due to the COVID supply chain issues in acquiring epoxy raw materials the past 2 years. The alternative paint marking materials include polyurea and high build water borne.

CTDOT is also researching different possibilities for the use of a wet reflective bead which increases the reflectivity of the installed paint markings on the roadway during periods when rain impacts the visibility on the roadways, such as during extreme weather events.

Life Cycle Planning for Highway Buildings

Data Collection

Highway buildings condition data was collected through a 2017/2018 inspection program. Data collection is discussed in more detail in Chapter 3 Asset Data Management.

Modeling Approach

CTDOT currently models highway buildings using an age-based approach. Table 5-15 shows the life cycle assumptions for highway buildings, organized by tier and type.

Table 5-15. Highway Building Life Cycles

Tier	Description	Life Cycle (years)	Mid-Life SOGR Upgrade (years)
1	Maintenance & Repair Type Facilities	60	30
1	Rest Area & Weigh Stations	60	30
1	Administration Facilities	60	30
2	Salt Shed Post 1995	40	0
2	Salt Shed 1980-1994	30	15
2	Salt Shed Fabric Reserve	20	10
3	Specialty Facilities	30	15
3	Storage Buildings & Sheds	30	15
3	Jet Hangars	20	0
3	Rest Area Storage	20	0
3	Personnel Shelters	20	0
3	Office Containers	20	0
3	Office Trailers	10	0

Treatments

Typical treatments and costs for Highway Buildings are shown below in Table 5-16. An exact unit cost for the treatments listed is difficult due to the unique nature of each individual building and site. An attempt has been made to provide an average or approximate cost where possible. These costs can be tracked and updated as additional data becomes available.

Table 5-16. Highway Building Treatments and Approximate Unit Costs

Type	Treatment	Unit	Approximate Unit Cost
Rehabilitation or Reconstruction	Tier 1 - Maintenance & Repair	SF	$410
Rehabilitation or Reconstruction	Tier 1 - Rest Area	SF	$750
Rehabilitation or Reconstruction	Tier 1 - Weigh Station	SF	$1,050
Rehabilitation or Reconstruction	Tier 1 - Administration	SF	$320
Rehabilitation or Reconstruction	Tier 2 –Salt Shed	SF	$450
Rehabilitation or Reconstruction	Tier 3 – Specialty Facility	SF	$1,250
Reconstruction (Replacement)	Tier 3 – Storage Buildings	SF	$200
Reconstruction (Replacement)	Tier 3 – Portable Office Structures	SF	$100
Preservation	Tier 1 - Roof SOGR Upgrades (doesn't include HVAC or other upgrades)	SF	$30
Preservation	Tier 2 - Roof SOGR Upgrades (doesn't include HVAC or other upgrades)	SF	$35
Preservation	Tier 1 – Fuel/Storage Tank SOGR Upgrades	LS	**TBD** - Site layouts and tank arrangements vary too much to determine an approximate unit cost
Preservation	Tier 1 - Various Building SOGR Upgrades	LS	**TBD** - Range of treatments varies too much to determine an approximate unit cost
Demolition	All Buildings	LS	**TBD** - Historical data for building demolitions varies too much to determine an approximate unit cost

Strategy

CTDOT's life cycle strategies for highway buildings are shown below in Table 5-17. The current strategy is to perform mid-life SOGR upgrades to Tier 1 and Tier 2 buildings before a major renovation or replacement at the end of their life cycle. During the COVID-19 pandemic, highway buildings were retrofitted to address resiliency of viral contagions. CTDOT has not yet determined a systematic way to quantify the impacts of preservation projects to building condition ratings but intends to address with the implementation of a Facilities Management System (FMS). The FMS will also help to identify repairs needed after an extreme weather event. Tier 3 buildings are more basic in nature and therefore receive no mid-life SOGR upgrades and are replaced or demolished at the end of their lifecycle. CTDOT is exploring ways to better consider extreme weather and resiliency in the management of highway building assets.

Table 5-17. CTDOT's Life Cycle Strategies for Highway Building

Management Method	Description
Rehabilitation or Reconstruction	Rehabilitate or reconstruct Tier 1 buildings at end of 60-year life cycle and Tier 2 buildings at end of 20/30/40-year life cycles
Reconstruction (Replacement)	Replace Tier 3 buildings at end of 10/20/30-year life cycles
Preservation - Roofs	Mid-life SOGR roof replacement for Tier 1 & 2 buildings
Preservation - Tanks	End-of-life SOGR fuel/storage tank replacement
Preservation - Various	Mid-life SOGR upgrades to Tier 1 building components
Demolition	Demolish assets that are no longer needed and cannot be sold

Life Cycle Planning for Roadway Illumination

Data Collection

Roadway illumination system data is managed by the Office of Facilities Electrical Engineering in an Excel database format. Tabulated data for each illumination system is updated on a continuous basis to reflect replacements and revisions carried out during State construction projects and LED conversions performed by District Maintenance. A "system" is defined as a single lighting control cabinet including all the light standards, luminaires, foundations, handholes, conduit, conductors, and circuitry controlled from that cabinet.

Modeling Approach

CTDOT models roadway illumination using an age-based approach. The model assumes that an illumination system should be replaced after 40 years of service life, the age at which the system is no longer considered in a SOGR.

Treatments

Typical treatments and costs are calculated on a per light standard basis including all supporting conduit and cable infrastructure and all power and controls. Replacement of a complete roadway illumination system is based on a per light standard cost of $18,000.

Table 5-18. Illumination Treatments and Approximate Unit Costs

Treatment	Unit	Unit Cost
Replace Roadway Illumination	Each	$18,000

Strategy

The current life cycle strategy for roadway illumination in Connecticut is to replace a roadway illumination system after 40 years of service life. Roadway illumination systems are replaced under the following programs:

- Safety improvement projects.
- Roadway/Bridge construction and rehabilitation projects.
- Dedicated District wide “lighting only” rehabilitation projects.
- CTDOT District Maintenance activities which includes a limited number of LED luminaire conversions in addition to normal maintenance activities (replacement of pole knockdowns, lamp replacements, circuit repairs, etc.)
- DEEP and Eversource Energy efficiency LED conversion programs.

CTDOT’s intent in the future is to replace an average of 1000 light standards and associated infrastructure each year to achieve a system wide SOGR within ten years. It should be noted that a substantial number of CTDOT highway lighting systems were installed in the 1980’s, and therefore, are quickly approaching their 40-year projected “end of life”.

CTDOT is also in the process of evaluating existing and proposed light poles for capacity to withstand extreme weather events of heightened wind loading due to climate change. Based on the results of the ongoing structural analysis, CTDOT may initiate a program to address the impact of increased wind events to make lighting structures more resilient.

Table 5-19. CTDOT’s Life Cycle Strategies for Roadway Illumination

Management Method	Description
Reconstruction (Replacement)	Replace roadway illumination at end of life cycle

Life Cycle Planning for Retaining Walls

Data Collection

Retaining wall data are collected during inspections, typically every ten years for the retaining walls that are rated as good or fair and shorter cycles for the retaining walls that are rated poor if no actions were taken to improve their condition. Data collection is discussed in detail in Chapter 3 Asset Data Management.

Modeling Approach

CTDOT models retaining walls Life Cycle Planning using a combination of age-based and condition-based approach. Retaining walls are generally resilient structure which would require minimal repairs during their life cycle. The retaining walls, regardless of the wall type, have an average life cycle of 75 years and would require some form of repair or rehabilitation after 75 years to maintain their integrity and extend their service life. The 75-year life cycle is based on the assumption that environmental and site conditions as well as weather condition and roadway treatments would have deteriorated or disintegrated the retaining walls elements which would require some form of repair or rehabilitation to maintain the state of good repair. The condition-based approach is considering deterioration rate of the walls based on wall type. The current data indicate that various aspects including, but not limited, wall type and wall age as well as wall location (in relation to roadway) should be taken into consideration to develop a model that fully captures the Life Cycle of the retaining walls.

Treatments

Typical treatment and costs for retaining walls are shown in Table 5-20. Treatment and costs are not fully developed for all wall types and replacement is considered the only treatment for most of the wall types.

Table 5-20. Retaining Wall Treatment and Unit Costs

Treatment	Unit	Unit Cost
To Replace [1]	SF	$110
To repair [2] – Metal Bin Wall	SF	$25

[1] The unit cost to replace is based on the unit cost of proprietary retaining walls and is applicable to all wall types.

[2] The unit cost to repair the metal bin walls is based on data provided by CTDOT Bridge Maintenance for repairs on metal bin wall in Waterbury (12/2021)

Strategy

CTDOT's life cycle strategies for the retaining walls are summarized in Table 5-21. The current life cycle strategy for retaining walls is to repair the walls that are in poor condition, improve the site conditions (for example by adding elements to improve stability) until the walls can be replaced, and replace the retaining wall that are in poor condition. CTDOT is initiating a proactive approach by developing retaining wall program which includes completing the existing inventory of retaining wall assets, initiating a routine inspection program, and identifying the retaining walls which would require treatment based on the inspection program.

Table 5-21. CTDOT's Life Cycle Strategies for Retaining Walls

Management Method	Description
Condition Based Repairs	Retaining wall repair or site improvement for the walls that are in poor condition. These repairs or improvements are generally performed by CTDOT maintenance personnel.
Function Based Elimination	Retaining walls that can be eliminated and sloped.
Corridor Projects	Retaining walls that are added due to new projects.
Other Projects	Retaining walls that can be repaired or replaced by identifying the projects in the vicinity of the retaining wall.
Retaining Wall Projects	Retaining wall replacement for the walls that are in poor condition and cannot be repaired or improved by CTDOT maintenance personnel.

CTDOT intends to utilize the readily available information, investigate and invest in new technologies to model and measure the retaining wall condition, investigate the existing models and prospective research that would enhance deterioration rate and life cycle of different retaining wall types and impacts of weather condition, extreme weather, and climate change on the retaining wall life cycle.

CTDOT is exploring different alternatives to improve the wall condition, including repairs and replacement performed by CTDOT maintenance; rehabilitation and replacement by project initiation; and identifying prospective candidates for alternative treatments. Improving wall condition through CTDOT maintenance would require a better understanding of staff qualifications, resources, cost analysis and staff hours for different types of treatments. Improving wall condition through rehabilitation and replacement projects would require feasibility studies by Department's design groups. The Soils and Foundations Group is compiling and review information on past retaining wall repairs and replacements performed by CTDOT maintenance to improve the cost models.

Life Cycle Planning for Drainage Culverts

Data Collection

Drainage culvert data is collected during an ongoing inspection process that maps the State's culverts and assesses them on a Good, Fair, Poor, and Unable to Assess rating. Currently there is no typical inspection period for culverts, as the initial database has not been completed yet, but data collection is discussed in detail in Chapters 2 and 3. In addition to this inspection and mapping, data is provided by District Drainage Engineers regarding hot spot locations, where there may be recurring issues or locations with deteriorating conditions.

Modeling Approach

CTDOT's modeling approach for drainage culverts considers age and condition. Using the sample of the limited number of culverts that have both a known age and condition rating, a linear trend was used to determine future network performance. The average culvert lifespan is expected to be 50-75 years, and since the average age of the network is about 60 years, this method will need to be refined once more condition data has been collected.

Treatments

Drainage culvert treatments occur through various means, either being maintained or replaced as part of a larger project. Culverts are also individually addressed if the scope of work is greater than feasible for the Department's forces and are treated as stand-alone projects.

For purposes of achieving a baseline cost for replacement, a review of recent applicable projects estimated that the average replacement cost for a culvert is approximately $140,000 each, or $485 per square foot of pipe. Typical treatments and unit costs for drainage culverts are shown in Table 5-22.

Table 5-22. Drainage Culvert Treatment and Unit Costs

Treatment	Unit	Unit Cost
Replacement	SF	$485

Strategy

Currently the strategy for addressing drainage culverts is an as-needed basis consisting of hotspot locations where there are ongoing issues or locations that are exhibiting quickly deteriorating conditions which can no longer be addressed by maintenance forces. Culvert rehabilitation projects are one of the most common Emergency Declaration projects. CTDOT's life cycle strategies for drainage culverts are summarized in Table 5-23.

Table 5-23. CTDOT's Life Cycle Strategies for Drainage Culverts

Management Method	Description
Routine maintenance	Drainage culvert maintenance and preservation, generally performed by CTDOT maintenance personnel.
Other Projects	Drainage culverts are often addressed as part of larger highway projects.
Drainage Culvert Projects	Rehabilitation or reconstruction for culverts that need significant repair and require stand alone projects.

Looking forward, utilizing the present and future mapping and inspection data in conjunction with a linear deterioration estimate, along with an 80% SOGR goal, it is expected that the Department will implement a condition based approach for culverts reducing the number of recurring issue hotspots and emergency declarations. Further data collection and consideration of culverts as an asset allows the Department to move away from a “Worst First” treatment strategy for drainage culverts.

Extreme weather and climate change directly impacts the performance of drainage. Most of the network was designed and built 60 years ago. Since that time, Connecticut has seen higher precipitation volumes for design storm events. The rainfall intensity used to design a culvert in the 1960s is less than the rainfall intensity used to design a culvert today, and some existing culverts may be considered undersized by modern standards.

As a large number of drainage culverts approach the end of their life cycle, CTDOT understands the importance of replacing these parts of the network with more resilient structures, and will design them to withstand extreme weather, including higher precipitation frequencies and sea level rise where applicable.

Life Cycle Planning for Intelligent Transportation Systems

Data Collection

ITS-ATMS field devices (CCTV, VMS, RWIS) data are managed by Highway Operations in a web-based application that connects the users of the field device to Highway Operations maintenance contractors so when a field device fails, it is logged and fixed rapidly.

CTDOT Highway Operations maintains a GIS layer that maps the field devices, device cabinets, service cabinets, and approximate conduit locations. GIS data is updated as work is performed.

Modeling Approach

CTDOT models ITS-ATMS field devices using an age-based approach. The model assumes that ITS-ATMS field devices should be replaced after 15 years, the age at which they are no longer considered in a State of Good Repair.

Treatments

Typical treatments and costs are calculated on a per ITS-ATMS field devices basis including all supporting conduit and cable infrastructure and all power and communication. Table 5-24 includes average costs of ITS-ATMS field devices.

Table 5-24. ITS-ATMS Treatments and Unit Costs

	CCTV	VMS	RWIS
Initial Construction	$250,000	$500,000	$150,000
Preventive Maintenance	$1,000	$1,700	$1,000
Average Device Repair	$2,500	$2,500	$2,000
Device Replacement*	$50,000	$100,000	$20,000

*Device Replacement is changing out the ITS-ATMS field device on an existing structure (Camera pole, VMS structure, or RWIS tower).

Strategy

The current life cycle strategy for the ITS-ATMS field devices is to replace the devices after 15 years of service life. During replacement, high wind loads due to extreme weather events are considered for structural components such as poles and sign supports. ITS-ATMS field devices are replaced under the following programs:

- Dedicated Highway Operations replacement projects
- Safety improvement projects
- Roadway/Bridge construction and rehabilitation projects
- Traffic-Signage projects
- Illumination projects

CTDOT's life cycle strategies for ITS-ATMS are summarized in Table 5-25.

Table 5-25. CTDOT's Life Cycle Strategies for ITS-ATMS

Management Method	Description
Replacement	Replace devices after 15 years of service life. Devices are replaced through a number of different programs.

Summary

The LCP process helps CTDOT consider the costs of maintaining an asset throughout its life and the optimal strategies for preserving asset condition while minimizing costs. CTDOT's LCP approach for bridge and pavement assets is relatively advanced, analyzing component condition ratings using management systems and developing management strategies based on modeled treatments. LCP for traffic signals, signs, sign supports, pavement markings, highway buildings, roadway illumination, retaining walls, drainage culverts, and intelligent transportation systems are less mature processes. CTDOT uses a combination of age-based and condition-based approach for sign supports, retaining walls, and drainage culverts. For all other assets, an age based replacement approach is used. CTDOT is starting to invest in and improve modeling capabilities. The results of the LCP processes are used to define the TAMP financial plan and investment strategies.

Chapter 6

Risk Management

Managing transportation assets entails managing risk. Risk is the positive or negative effects of uncertainty or variability upon Connecticut's transportation objectives. The application of risk management to asset management supports the ability to plan for negative impacts and supports effective decision-making. CTDOT must balance a wide variety of risks on an ongoing basis and take prudent mitigation actions given funding constraints. Risks range from daily operational concerns to potentially catastrophic risk of asset failures.

Overview

This chapter discusses CTDOT's risk management approach, identifies risks to the CT transportation systems, and discusses CTDOT's TAM risk assessment, evaluation, prioritization, and mitigation strategies. The objective for the TAM risks is to achieve the SOGR defined for each asset.

Considering risk is important in developing a TAMP for the simple reason that reacting to risks is more expensive than proactive management. Employing risk management strengthens asset management programs by explicitly recognizing that any objective faces uncertainty and implementing mitigation strategies to reduce that uncertainty and its effects. Being proactive rather than reactive in managing risk will help CTDOT to better utilize capital funding toward maximizing the condition of all transportation assets.

Federal Legislative Context

The Federal Rules and Regulations Part 515 Section 515.7 (c) mandates that, "a State DOT shall establish a process for developing a risk management plan."

Risk Management Process Requirements

- Identification of risks that can affect the condition of NHS pavements and bridges and the performance of the NHS, including risks associated with current and future environmental conditions, such as extreme weather events, climate change, seismic activity, and facilities repeatedly damaged by emergency events
- Assessment of the identified risks in terms of the likelihood of their occurrence and their impact and consequence if they do occur
- Evaluation and prioritization of the identified risks
- Mitigation plan for addressing the top priority risks
- Approach for monitoring the top priority risks
- Summary, for NHS bridges and pavement, of the evaluations of facilities repeatedly damaged by emergency events

Defining Risk

FHWA defines risk as "the positive or negative effects of uncertainty or variability upon agency objectives."

Ref FHWA-HIF-12-035.

In addition, 23 USC §119(e)(4)(d) states that each TAMP must include lifecycle cost and risk management analyses, both of which shall take into consideration extreme weather and resilience.

Transportation Risk

Every transportation system faces a range of general types of risks as well as risks specific to the individual system and state. Some of the broad transportation risks faced by State DOTs that are also encountered by CTDOT are listed below.

Common Transportation Agency Risks faced by State DOTs

- Construction inflation costs
- Extreme weather or climate events
- Insufficient State and Federal funding
- Insufficient and/or inexperienced staffing
- Ability to meet 2-year and 4-year targets and adhere to the TAMP financial plan due to project delay and budget constraints
- Support for asset management implementation throughout the Agency
- Changing agency priorities due to political pressures
- Availability and quality of data, information, and reliable models to allow the accurate projection of future conditions

Of particular focus at CTDOT are risks associated with resources to achieve the goals of both Asset Management and the Agency overall goals. Currently, CTDOT is monitoring risks to its budget and seeking increased revenue through the legislature to replenish the Special Transportation Fund (STF) so that investment can be made in our infrastructure.

Staffing is becoming a significant risk to CTDOT to perform all of its functions including designing and delivering work. Experienced staff is a crucial resource that is being reduced through retirements and job turnovers. Approximately twenty-five percent of the employees are currently eligible to retire. In addition to the state employee shortage, CTDOT's vendors are also facing staffing shortages which limits their ability to deliver the work.

Sufficient asset inventory and condition data are fundamental to the effective practices of asset management. As such, there are inherent and numerous program risks regarding adequate collection, accuracy, and completeness of asset data.

Resiliency

CTDOT has adopted the Federal Highway Administration's definition of resilience as "The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions." To promote the incorporation of resilience across department services, and to implement the requirements of the Governor's 2019 Executive Order #3 and 2021 Executive Order #21-3, included in Appendix F, the Department created a Sustainability and Resiliency Unit in the Bureau of Policy & Planning. To meet the intent of the executive orders, the unit will be coordinating a department-wide vulnerability assessment, developing a culvert management program, and reporting on critical assets.

CTDOT previously participated in FHWA's Climate Resilience Pilot Program in 2013-2014, resulting in a Climate Change and Extreme Weather Vulnerability Report. CTDOT was also part of the tri-state Hurricane Sandy *Follow-up and Vulnerability Assessment and Adaption Analysis with New York and New Jersey*, which focused on coastal assets and adaptation efforts.

To complete the vulnerability assessment, the Department will begin with using prior work including pilots for analyzing the effects of climate change and increased frequency extreme weather events on culverts, and coastal road flooding. The Department partnered with the CT Department of Energy and Environmental Protection in 2021 to update the Sea Level Affecting Marshes Model. This model, and associated map viewer shows the potential flooding of

Resilience Projects

A resilience project is defined in 23 USC § 101(a)(24) as a project with the ability to anticipate, prepare for, or adapt to conditions or withstand, respond to, or recover rapidly from disruptions, including the ability:

- **to resist hazards or withstand impacts from weather events and natural disasters.**
- **to reduce the magnitude or duration of impacts of a disruptive weather event or natural disaster on a project.**
- **to have the absorptive capacity, adaptive capacity, and recoverability to decrease project vulnerability to weather events or other natural disasters.**

coastal roads in Connecticut due to the effects of both present day extreme weather as well as future storms with incorporated sea level rise. The result is a mapped network of roads that may be susceptible to future flooding in different extreme weather scenarios. The mapping tool shows depth of flooding for each vulnerable road asset and will be used as a planning tool. One potential use for this tool is to assist in incorporating climate risk as a factor in prioritizing projects.

In addition to the actions required by the executive orders, the Sustainability and Resiliency Unit will oversee some of the programs included in the BIL. One program, the Promoting Resilient Operations for Transformative, Efficient and Cost-Saving Transportation (PROTECT), will enable the Department to increase the resilience of Connecticut's transportation assets. Investments for formula and competitive funds will be driven by the Department's Resilience Improvement Plan, a recommendation under the PROTECT program. This planning effort, which will incorporate parts of the vulnerability assessment completed to satisfy Executive Orders 3 and 21-3, will be focused on the best ways to ensure the resilience of the State's assets.

CTDOT has established a Resilience Working Group to contribute to working knowledge of resilience within the Department. The focus will be best practice sharing, providing input, and developing guidance for incorporating resilience into Department programs and procedures. The group includes members from Asset Management, Sustainability and Resilience, Public Transportation, Maintenance, Highway Operations, Engineering, Environmental Planning, Engineering Project Coordination, Hydraulics and Drainage, and Project Development. One initial activity for the working group will be to advise on the creation of a culvert management program and ensure that appropriate resilience measures are incorporated into each project that is generated through the program.

Additional resilience efforts being led by other Connecticut entities are aligned with CTDOT's work to manage extreme weather risks and build resiliency. One example is the

CT Executive Orders on Climate Change and Resiliency

Executive Order #3 in 2019 expanded the scope of the Governor's Council on Climate Change, empowering it to monitor and report on, among other things, the development and implementation of adaptation strategies to assess and prepare for the impacts of climate change on infrastructure. The Council was also charged with preparing a revised statewide Adaptation and Resilience Plan for CT.

Executive Order 21-3 in 2021 required 23 actions on climate change, including charging CTDOT a vulnerability assessment of agency assets. The order also directs CTDOT to establish criteria to identify state-owned culverts in need or repair or replacement, and with setting a VMT reduction target for 2030.

Connecticut Institute for Resilience and Climate Change, which helps communities identify critical infrastructure at risk and identifies mitigation strategies. Individual towns, such as Mansfield, have led resilience building exercises.

CTDOT's Risk Management Approach

Traditionally, transportation risks have been addressed during the execution of projects or as part of asset inspections and programs. For example, addressing risks to bridges has been a vital focus for CTDOT. The tragic Mianus River bridge collapse in 1983 on I-95 in Greenwich, Connecticut, drew national attention to the need to carefully inspect and maintain highway bridges. CTDOT's Bridge Safety and Evaluation Unit in the Division of Bridges is charged with ensuring the safety of the traveling public by identifying bridge deficiencies through the inspection process and ensuring that these deficiencies are quickly addressed.

CTDOT is actively engaged in improving its approach to risk management. Specific initiatives have been undertaken at the project, program, and enterprise levels. The goal is to identify and plan ahead for potential project risks instead of reacting to issues that could have been avoided. Training was held for targeted groups and functions within CTDOT to expand the understanding of key components of implementing risk management.

Project Level

At the project level, the goal is to improve project execution by better managing project risks through identifying and planning for potential risks to the public, the project schedule or to the project budget. A proactive approach is accomplished by identifying project risks and creating a risk register, which is then used to evaluate projects for potential risks to the project design, scope, schedule, or budget. To reduce the risk of design project delays, CTDOT has implemented a standard project management program to plan and follow the many tasks needed to complete a project . The schedule is available to support units and when various tasks are delayed, mitigation strategies to the schedule can be implemented. NHI Training was conducted in Connecticut in 2016 with a specific focus on training Project Engineers on the Risk Management process. Risk registries are included in all FHWA Projects of Division Interest, which are typically projects that are larger in size or apply innovative methods. A Construction Directive for Project Modifications and Contingency Management was issued in 2017 and amended in 2020 to address the financial risks of a project.

Program Level

TAM, addressed at the program level, has been the most significant risk management initiative to-date. CTDOT initiated development of a risk management plan for asset management as an improved business process and to address the federal rules and regulations. This federal mandate requires specific information, including the identification of risks, assessment, evaluation prioritization, and mitigation.

In 2021, FHWA conducted a review of CTDOT's methodology for generating TAMP Consistency Determination numbers. The review concluded that while CTDOT goes beyond federal requirements in some areas, there was not a consistent methodology in place for calculating the numbers. As a result, CTDOT has developed a documented a methodology to be used in the 2022 Consistency Determination. This joint effort will not only help CTDOT invest efficiently, but will also mitigate succession planning and knowledge transfer risks if different personnel are responsible for future TAMP and Consistency Determinations.

Enterprise Level

At the enterprise level, there has been considerable action at the executive level to identify risks and implement a risk management strategy across CTDOT. Following the productive launch at the asset management program level, an executive seminar was conducted on October 26, 2016 to provide introductory exposure to risk management to executives and managers. The program included presentations by FHWA Connecticut Division to share their working knowledge with risk management at the agency, program, and project levels. This was a valuable experience to gain a better understanding of how priorities are set.

CTDOT continues to train on risk management topics. Asset management staff regularly attend American Association of State Highway and Transportation Officialas (AASHTO) webinars and meetings regarding risk management throughout each year. In April of 2022, a risk management training course was conducted at CTDOT, primarily for the benefit of staff who were new to involvement with the TAMP. This included the asset stewards for the four new assets being included in the TAMP, as well as new staff who joined teams working on existing TAMP assets. The training covered the yearly meetings held by each asset to review and re-evaluate the risks surrounding their asset. Additionally, it covered the initiative to advance risk management at the executive level, through development of an agency level risk registry.

In 2022, 15 enterprise level risks have been identified for the risk registry. These enterprise level risks have been evaluated by each asset working group with a focus on how each risk would affect their specific asset. Some assets had already included some of these risks in previous registries. For overall consistency, it was important to assess these same risks for all assets at an enterprise level.

The following is the list of enterprise risks.

1. If asset data are not complete and current, then we cannot optimize investments and set priorities.
2. If we don't select the right projects, then lifecycle costs will increase to achieve or maintain SOGR.
3. If funding is not adequate, then conditions will deteriorate and future funding needs to achieve or maintain SOGR will increase.
4. If there's a lack of maintenance staff, then assets will deteriorate faster and public safety could be affected.
5. If design staffing levels are inadequate or if staff are not properly trained, then program delivery will struggle to meet goals.
6. If staff knowledge is not transferred and retained, then capabilities and capacity are reduced and SOGR may be negatively impacted.

7. If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted, then future funding may be insufficient.
8. If FHWA minimum conditions for NHS pavement and bridge aren't met, then funding flexibility will be removed and funds may be reallocated from other assets.
9. If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced.
10. If asset deterioration is not addressed in a timely manner, then it will create greater needs and cost in the future.
11. If focused on worst first rather than preservation, then assets reach end of life faster.
12. If politics influence the prioritization of projects, then less optimal projects may be selected, compromising SOGR.
13. If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed.
14. If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted.
15. If there is a cyber-attack on CTDOT data systems, then CTDOT asset management functions may be impeded.

The following table communicates how each asset supports the enterprise risk and its risk rating.

Table 6-1 Enterprise Risks by Asset

Enterprise No.	Risk Topic	Statement	Bridge	Pavement	Traffic Signals	Signs	Sign Supports	Pavement Markings	Highway Buildings	Illumination	Retaining Walls	Drainage Culverts	ITS
1	Data	If asset data are not complete and current, then we cannot optimize investments and set priorities.	Low	Low	Medium	Very High	Medium	Medium	High	Low	Low	Medium	Low
2	Prioritization	If we don't select the right projects, then lifecycle costs will increase to achieve or maintain SOGR.	Low	Medium	Medium	Medium	Low	Medium	Low	Medium	Medium	Medium	Low
3	Funding	If funding is not adequate, then conditions will deteriorate and future funding needs to achieve or maintain SOGR will increase.	Medium	Medium	Medium	Medium	Medium	High	Medium	High	Medium	Medium	Medium
4	Staffing	If there's a lack of maintenance staff, then assets will deteriorate faster and public safety could be affected.	Medium	Medium	High	High	Medium	High	High	High	Medium	Medium	Low
5	Staffing	If design staffing levels are inadequate or if staff are not properly trained, then program delivery will struggle to meet goals.	Medium	Medium	Medium	Medium	Low	Very High	Medium	Medium	Low	Low	Medium
6	Staffing	If staff knowledge is not transferred and retained, then capabilities and capacity are reduced and SOGR may be negatively impacted.	Medium	Low	Medium	Medium	Low	Medium	Low	Medium	Low	Medium	Medium
7	Funding	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted, then future funding may be insufficient.	Low	Medium	Medium	High	Medium	Medium	Low	Medium	Medium	High	Medium
8	Compliance	If FHWA minimum conditions for NHS pavement and bridge aren't met, then funding flexibility will be removed and funds may be reallocated from other assets.	Medium	Medium	Medium	Low	Medium	Low	Low	Low	Low	Medium	Low
9	Resilience	If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced.	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Medium	Low
10	Preservation	If asset deterioration is not addressed in a timely manner, then it will create greater needs and cost in the future.	Medium	Medium	High	Medium	Medium	Medium	Low	Medium	Medium	High	Medium
11	Prioritization	If focused on worst first rather than preservation, then assets reach end of life faster.	Low	Medium	Medium	Low	Low	Low	Low	Low	Low	Medium	Low
12	Other	If politics influence the prioritization of projects, then less optimal projects may be selected, compromising SOGR.	Low	Medium	Low	Medium	Medium	Low	Low	Medium	Medium	Medium	Medium
13	Technical	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed.	Low	Medium	Low	Medium	Low	High	Low	Low	Low	Medium	Medium
14	Resilience	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted.	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Medium	Very High	Medium
15	Resilience	If there is a cyber attack on CTDOT data systems, then CTDOT asset management functions may be impeded.	Medium	Medium	Medium	Low	Medium	Low	Low	Low	Low	Low	Medium

CTDOT TAM Risk

CTDOT introduced risk management to asset stewards and working groups through training, workshops, and meetings in 2016. These meetings focused on development of registers for specific asset classes. At that time, asset stewards for future TAMP assets, specifically geotechnical and hydraulic assets, were included in the training and workshop development processes so that they could better integrate risk management into their own asset management activities. An introductory, two-hour webinar was conducted for the group to introduce participants to the concepts and terminology prior to the risk workshop. At the beginning of the TAMP development process, a full-day risk workshop guided participants through the initial identification and ranking of key asset risks, and to learn the risk management development process. Follow-up meetings were held annually to continue the risk management process for the assets in the TAM program.

In 2019, the asset steward for each of the original six assets as a part of the TAM working group were tasked with conducting the TAM Risk Process by reviewing and revising the 2018 TAMP Risk Registers. The TAM Risk process was applied to the new assets that were added to the TAM program and an updated risk registry was developed. Mitigation strategies and status were identified for each CTDOT TAM risk. In addition, responsibility was assigned for each mitigation strategy task by unit and person for tracking purposes. These assignments were submitted to FHWA-CT under a separate transmittal.

Additional meetings were held to introduce and initiate the process for new assets that were added to the program. In April of 2022 a refresher course was conducted for the four assets new to the TAMP and for new staff that were part of the existing TAMP assets.

The steps to develop the information required by FHWA as part of the Risk Management Plan for the TAMP are shown schematically in Figure 6-1. The process also includes the tracking and mitigation of risks. The arrows in the schematic demonstrate the cyclical and continuous cycle that is followed as part of effectively managing the risks.

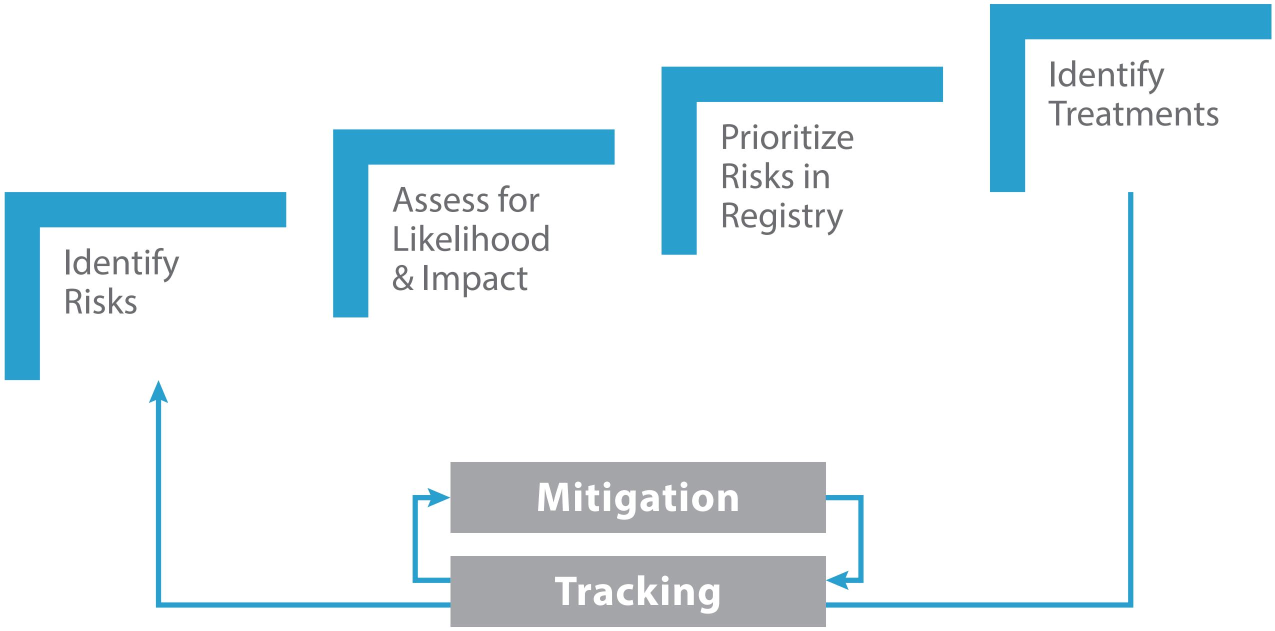


Figure 6-1. Steps to Achieving CTDOT's TAM Risk Process

Identification and Assessment

As part of its asset management initiative, CTDOT identified and assessed asset risks to achieving the objective, which in the case of the assets, is the risk to obtaining a SOGR target. SOGR targets are defined for each asset in Chapter 4 Objectives and Performance. The risk register is a simple table format or matrix that is used as a risk management tool to summarize an organization's risks, analyze the likelihood and impact, and record possible risk-response strategies.

Each risk is defined by a risk statement that consists of two elements: a description of the risk event and a summary of its potential impact. For example:

Risk Event (*if*)

- CTDOT does not have a certified TAMP in accordance with MAP-21/FAST Act

Potential Impact (*then)*

- Federal funding on projects will be reduced to 65% federal participation

In performing the assessment, CTDOT staff used the risk matrix shown in Figure 6-2 to classify the likelihood and impact of each identified risk. The matrix includes five categories for likelihood and five categories for impact. The rating of a risk is classified as “Low, Medium, High, or Very High” based on the combination of likelihood and impact.

The CTDOT risk registry includes risk registers identified for the TAM program and the eleven asset classes included in the TAMP.

In developing the risk management process, the initial focus was on threats. Throughout the process, asset stewards were asked to consider and assess opportunities using the same approach. Opportunities identified through this process are included in the TAM Risk Registry in Appendix D.

Risk Matrix with Impact and Likelihood Definitions			Likelihood				
			Rare	Unlikely	Likely	Very Likely	Almost Certain
			Less than once every 10 years	Once in more than 3 but less than 10 years	Once between 1-3 years	Once a year	Several times a year
Impact	Catastrophic	Potential for multiple deaths & injuries, substantial public & private cost.	Medium	Medium	High	Very High	Very High
	Major	Potential for multiple injuries, substantial public or private cost and/or foils agency objectives.	Low	Medium	Medium	High	Very High
	Moderate	Potential for injury, property damage, increased agency cost and/or impedes agency objectives.	Low	Medium	Medium	Medium	High
	Minor	Potential for moderate agency cost and impact to agency objectives.	Low	Low	Low	Medium	Medium
	Insignificant	Potential impact low and manageable with normal agency practices.	Low	Low	Low	Low	Medium

Figure 6-2. Risk Matrix with Impact and Likelihood Definitions

Risk Prioritization and Mitigation Plan

The TAM Risk Registry serves as the framework for CTDOT’s risk mitigation plan. A total of 269 risks have been identified at the TAM Program Level for this TAMP and are listed in the TAM Risk Registry in Appendix D. The risks are assessed and updated annually by the working groups. The mitigation strategies and responsible individuals to implement the plans are also reviewed at the same time. These risks are organized according to asset class. Risks are simply grouped by risk rating (very high, high, medium, and low) and are not further prioritized. CTDOT asset working groups helped identify risk mitigation strategies and the current mitigation status (under consideration, in discussion, initiated, in progress/deployed, implemented/ongoing or implemented/completed). High and Very High priority risks with mitigation strategies and status are listed in the risk register in Table 6-2.

Table 6-2. High and Very High Priority Risks and Mitigation Strategies

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Pavement	If we don't deliver the recommended projects, then pavement conditions will deteriorate and we will lose public credibility	**High**	• Still working toward multi-year program (rec for 22 and 23 this year), possible new DOT contract mechanism (for preservation currently, other treatments possible in future)	Initiated
Traffic Signals	If traffic signal assets deteriorate to a poor condition, then the safety to the public, the efficiency of travel, and the quality of life will be affected	**High**	• Ensure adequate resources are dedicated to these assets and their related activities • Develop and implement an Asset Management Plan	In Progress/ Deployed
Traffic Signals	If there is not adequate maintenance staff who are technically skilled in signal repair, then the performance of traffic control devices will degrade and public safety will be affected	**High**	• Ensure appropriate and sufficient staff and provide technical training to staff • Investigate leveraging outside resources for some work if needed/possible	Initiated
Traffic Signals	If vehicle and pedestrian detector systems are not functioning properly, then the signal will not run efficiently, and safety, congestion, and quality of life will be impacted	**High**	• Include in the M-88, add connectivity to all signals, contract re-installation of video detection, and add electronic self reporting at CTSS locations.	Initiated
Signs	If sign inventory is not complete and current then we cannot optimize investments and set priorities.	**Very High**	• Develop comprehensive plan to address the needs of Maintenance and Design. • Implement new ways of designing projects to capture design data and construction data.	Implemented/Ongoing

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Signs	If staff is not trained to an adequate level then we will not operate as efficiently as we should. There will be potential duplication of efforts, wasted resources, impacts to public safety and negative public perception.	**High**	• Come up with a training plan for implementation	In Progress/ Deployed
Signs	If there is a lack of adequate maintenance staff to fabricate, install & repair signs then the performance of sign devices will degrade and public safety will be affected.	**High**	• Add staffing • Upgrade fabrication equipment • Look into fabrication techniques to allow for faster fabrication such as digital printing	Implemented/Ongoing
Signs	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted then future funding may be insufficient	**High**	• Increase funding to assets based on inflation	Under Consideration
Pavement Markings	If there is insufficient staffing due to sign priorities, VIP paving, complaints, and available staff skill sets, then less work will get done and safety will be impacted, then less work will get done and safety will be impacted	**Very High**	• Address staffing issues; address critical need for specially trained operators	In Progress/ Deployed
Pavement Markings	If funding decreases or is uncertain, then less work will get done and safety will be impacted	**High**	• Take steps to ensure necessary funding. Funding is locked in through 2023.	In Discussion
Pavement Markings	If there is insufficient MPT (Maintenance and Protection of Traffic) staff and equipment, then work cannot be achieved and safety will be impacted	**High**	• New cone trucks are in the process of procurement. Additional crash units are under consideration. Crew schedules need improved coordination given current resources.	Implemented / Ongoing
Pavement Markings	If there are improved technologies, then lifecycle of the markings will be extended and more work can be accomplished	**High**	• Continue to pursue new technologies: Wet reflective pilot projects are ongoing.	In Progress/ Deployed
Pavement Markings	If pavement marking products are unavailable, then the ability to complete work will be compromised	**High**	• Consider alternative products such as different epoxy or paints.	In Discussion

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Pavement Markings	If there's a lack of maintenance staff, then assets will deteriorate faster and public safety could be affected	**High**	• Potentially offset with contracted vendors.	Implemented/Ongoing
Highway Buildings	If we have a lack of building maintenance staff to make minor building repairs and perform minimal preventative maintenance on our buildings, then buildings will deteriorate at a faster rate than predicted	**High**	• Timely replacement of maintenance staff as they leave state service so building repairs can continue • Hire additional building maintenance staff to initiate a standard and reoccurring preventative maintenance program for all Tier 1 and Tier 2 buildings	In Discussion
Highway Buildings	If we do not keep our building condition data current, then we will not be able to have a data driven and transparent program	**High**	• Research and implement a Facilities Management System (FMS) that can issue work orders that automatically update asset condition data as work orders are completed • Develop and implement a method to get notified of minor capital repairs that impact overall building condition so condition data in InspectTech/AWARI can be updated manually until an FMS can be implemented	In Discussion
Illumination	If there's a lack of maintenance staff, then assets will deteriorate faster and public safety could be affected	**High**	• Get approval to hire more staff. • Reduce requirements for CDL. The CDL and electrical requirement is highly sought after and private contractors are paying more, therefore CTDOT is unable to fill the positions.	Under Consideration
Illumination	If funding is not adequate, then conditions will deteriorate and future funding needs to achieve or maintain SOGR will increase	**High**	• Preserve the annual budget. The past few years the budget has been cut. • Apply for additional funding through different programs.	Under Consideration

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Illumination	If funding budget is not maintained, then illumination assets will deteriorate and increase future costs	**High**	• Increase funding to get approval to hire more staff. • Reduce requirements for CDL. The CDL and electrical requirement is highly sought after and private contractors are paying more, therefore CTDOT is unable to fill the positions.	Under Consideration
Illumination	If there are a limited number of contractors bidding on projects, then fewer projects will be completed and costs will increase	**High**	• Make projects smaller to enable more contractors to bid.	Under Consideration
Drainage Culverts	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted.	**Very High**	• Coordinate with the Office of Maintenance to develop and employ a prescribed plan to assess & repair damaged assets in the event of a natural disaster.	In Progress/ Deployed
Drainage Culverts	If drainage culverts are not replaced by the end of their life span, then they could fail	**High**	• Begin asset management approach for drainage culverts	In Discussion
Drainage Culverts	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted, then future funding may be insufficient.	**High**	• DAS accounts for inflation. Increase available funding to account for inflation.	Implemented/Ongoing
Drainage Culverts	If asset deterioration is not addressed in a timely manner, then it will create greater needs and cost in the future.	**High**	• Use inspection reports to identify which assets to address.	In Progress/ Deployed

A categorized summary of the total number and assessment of the risks identified as part of the initial TAMP is provided in Figure 6-3.

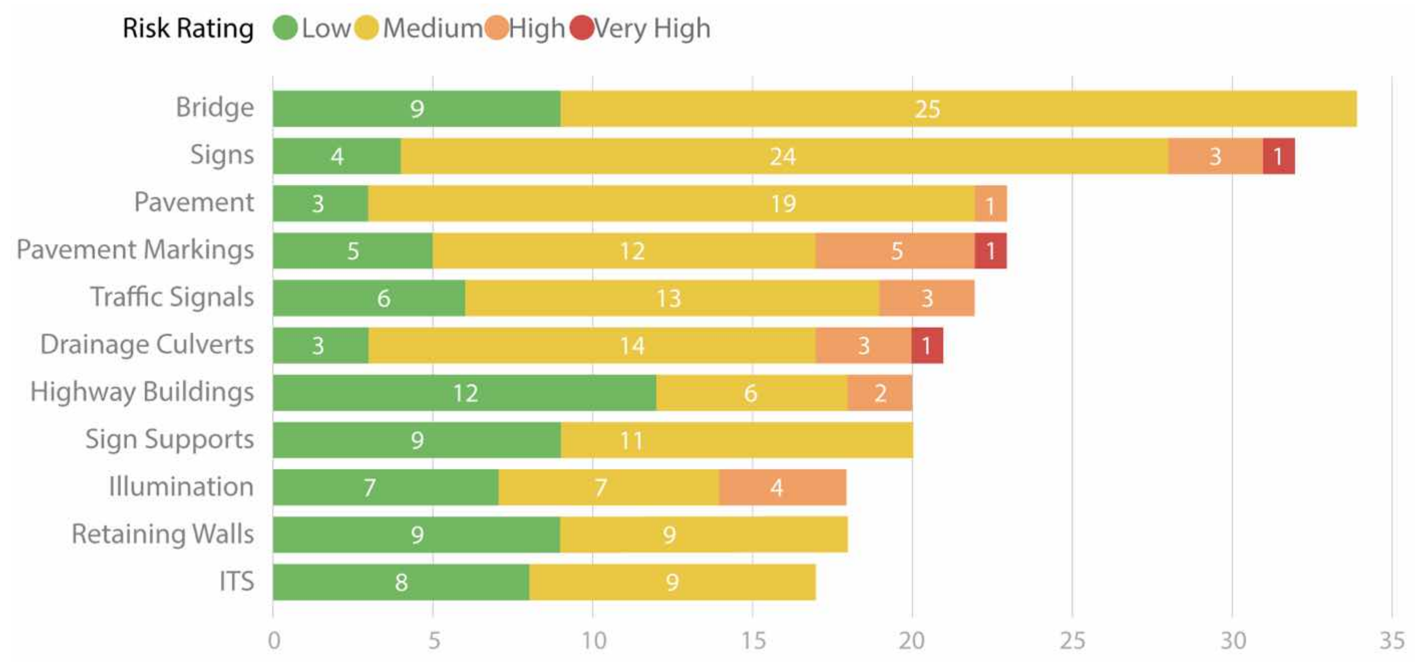


Figure 6-3. Summary of Risks by Category

From the initial summary of risks, four common topics were identified: funding, staffing, coordination, and data. These common topics were also apparent at the enterprise risk level. A distribution of risk topics is presented in Figure 6-4.

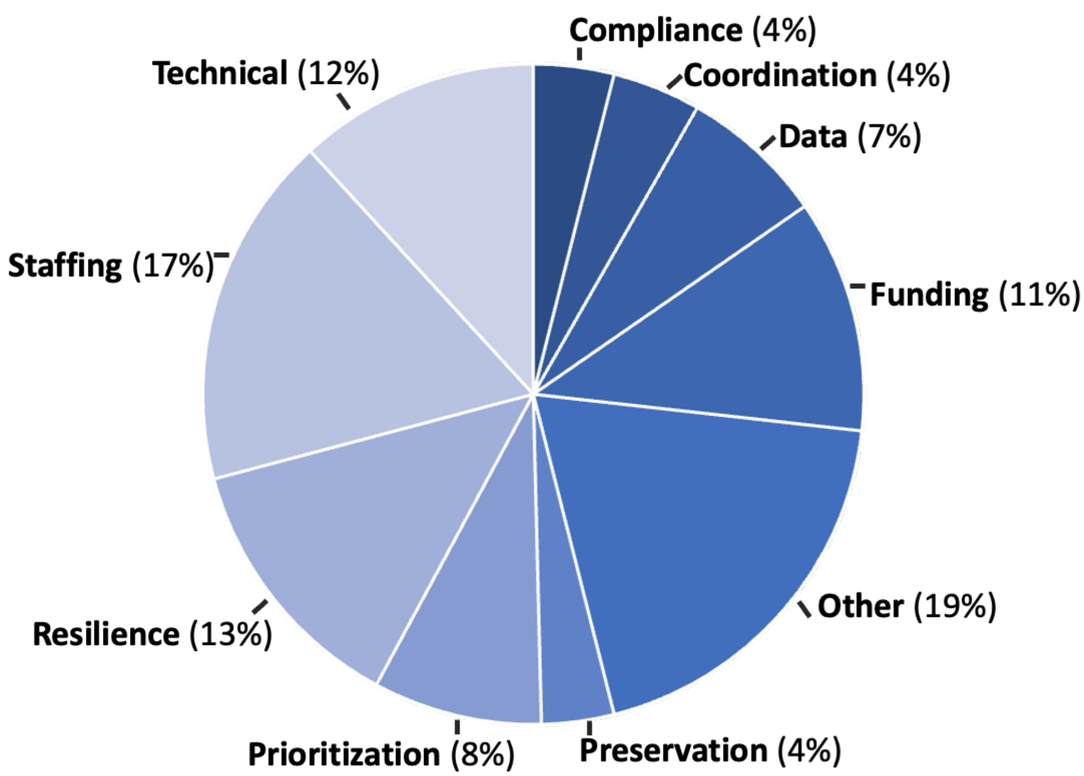


Figure 6-4. Distribution of Risk Topics

The TAM risk management reassessment cycle is anticipated to review and assess risks annually and report with the TAMP update cycle every four years. As experience is gained, it is envisioned that more advanced analyses can be employed to include quantitative analyses of the risks and information gained.

The following figure illustrates how data can be used in the future to gain greater insights through visualization. Figure 6-5 shows how a heat map can be used to map where a majority of risks lie within the risk assessment framework.

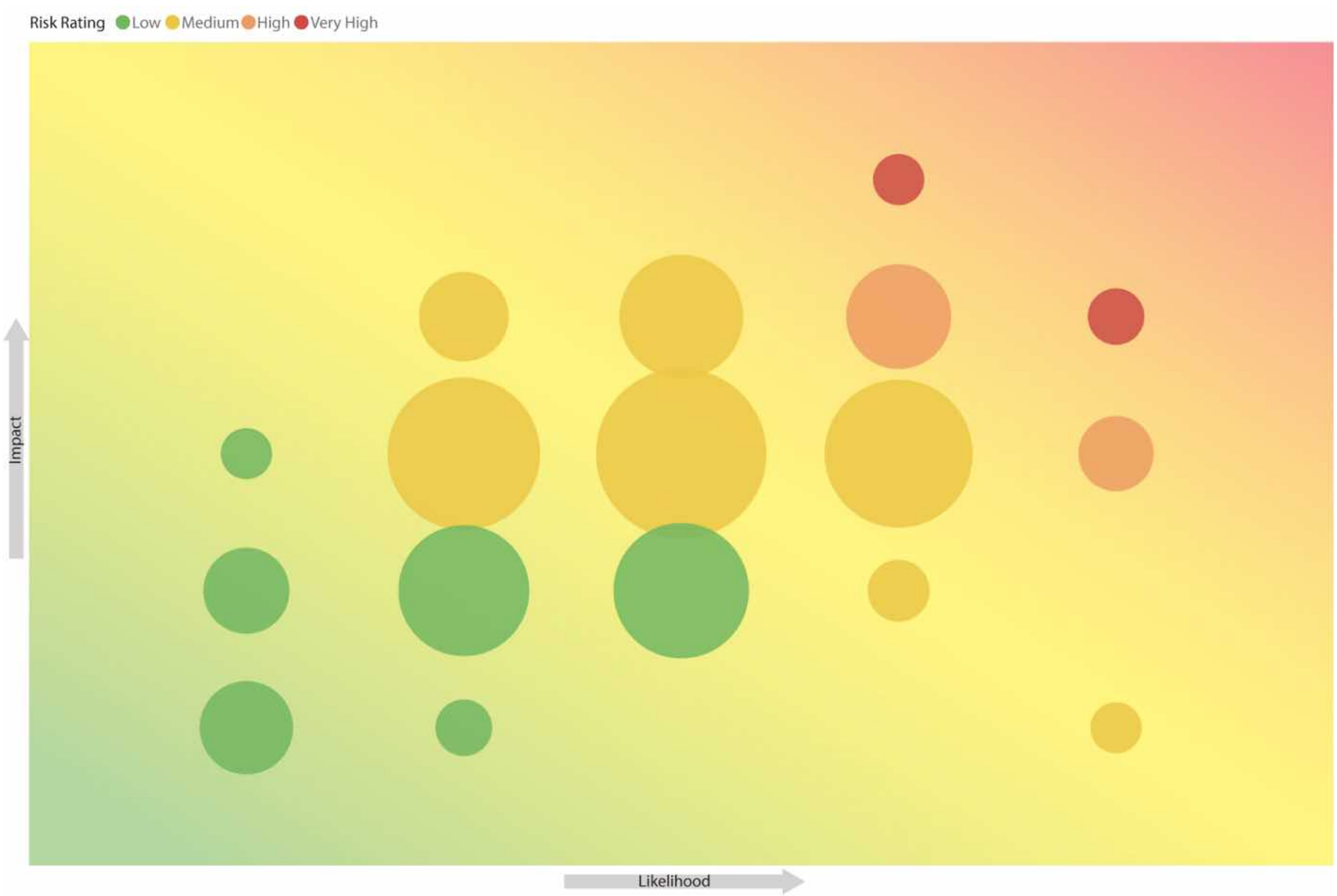


Figure 6-5. Risk Summary Heatmap

Summary of Transportation Assets Repeatedly Damaged by Emergency Events

As part of the Federal Legislation, FHWA requires State DOT's to perform periodic evaluation of facilities repeatedly requiring repair and reconstruction due to emergency events, typically caused by extreme weather. This requirement, commonly referred to as 'Part 667,' is the second part to the requirement for each State to develop a Risk-Based TAMP to improve and preserve the condition of assets on the NHS.

CTDOT completed a Statewide evaluation for all NHS roads, highways, and bridges in the Fall of 2020. Results of this evaluation (January 1, 1997 – December 31, 2019) concluded that there were no roads, highways or bridges on the NHS that have required repair and reconstruction activities on two or more occasions due to emergency events in Connecticut.

A report was submitted to FHWA-CT in November 2020 outlining these findings in addition to information on CTDOT's initial methodology and proposed process improvements to fulfill federal requirements. A copy of this report is included in Appendix E.

Federal Legislative Context

As stated in Title 23 Code of Federal Regulations, Part 667 (dated October 24, 2016): 'Each State, acting through its Department of Transportation (State DOT), shall conduct statewide evaluations to determine if there are reasonable alternatives to roads, highway, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events. The evaluations shall be conducted in accordance with the requirements in this part.'

Part 667 Regulations

Timing of Evaluations

- The State DOT shall update the evaluation after every emergency event to the extent needed.
- The State DOT shall review and update the entire evaluation at least every 4 years.
- In establishing its evaluation cycle, the State DOT should consider how this evaluation can best inform the State DOT's in preparation of its asset management plan and Statewide Transportation Improvement Program (STIP).
- Beginning on November 23, 2020, for all roads, highways, and bridges not included in the evaluation prepared (11/23/18), the State DOT must prepare an evaluation that conforms with this part of the affected portion of the road, highway, or bridge prior to including any project relating to such facility in its STIP.
- The beginning date for every evaluation under this part shall be January 1, 1997. The end date must be no earlier than December 31 of the year preceding the date on which the evaluation is due for completion.

Consideration of Evaluations

- The State DOT and metropolitan planning organizations are encouraged to include considerations of the evaluations during the development of transportation plans and programs, including TIPS and STIPs, and during the environmental review process
- The FHWA will periodically review the State DOT's compliance.
- The State DOT must make evaluations under this part available to FHWA upon request.

Definition of Emergency Event

- 'Emergency event means a natural disaster or catastrophic failure resulting in an emergency declared by the Governor of the State or an emergency or disaster declared by the President of the United States.'.

Overall Strategy

The initial evaluation process involved identification of emergency events, retrieval of data and information, and interviews and meetings with key personnel throughout the Department. This process was useful in identifying current practices and facilitated the exchange of information regarding both risk and resiliency to CTDOT's assets.

Moving forward, mapping of impacted locations is anticipated to occur after each emergency event. While no locations have been impacted on multiple occasions so far, this process will allow for any such location to be identified as soon as a second impact occurs. This also means the information needed to periodically fulfill federal reporting requirements will be readily available.

Chapter 7
Financial Plan

The financial plan connects the transportation asset management objectives and targets to investment strategies, revenues, and project delivery programs. The financial plan summarizes current and anticipated future funding sources, outlining the financial constraints under which CTDOT operates. These constraints drive the decision-making process. The financial plan also estimates the cost of future work to implement the investment strategies and achieve progress towards targets set for federal requirements and state goals.

2022 Connecticut Transportation
Asset Management Plan

Overview

This chapter describes CTDOT's TAM funding sources, which include funds available for asset management activities. It also summarizes expected TAM expenditures by asset class and by work type, for CTDOT-maintained assets as well as CTDOT's NHS bridges and pavements. The chapter also provides a valuation of assets included in the TAMP. It should be noted that the estimated allotments shown throughout this chapter do not capture all work planned in projects that contain multiple assets.

Federal Context

FHWA requires each state DOT to include a financial plan in their TAMP. FHWA defines financial plan as "a long-term plan spanning 10 years or longer, presenting a State DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets for asset condition during the plan period, and highlighting how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies." The plan should provide a summary of financial resources and needs for pursuing asset management objectives and achieving performance targets.

FHWA also requires that states establish a process for developing a financial plan as part of the TAMP. The process must produce the items listed below.

Financial Plan Process Requirements

- Estimated cost of expected future work to implement the investment strategies of the TAMP, by fiscal year and work type
- Estimated funding levels to address the costs of future work types, by fiscal year
- Identification of anticipated funding sources
- Asset valuation estimate for NHS bridge and pavement assets and the needed annual investment to maintain asset value

CTDOT's Financial Plan Approach

Financial Process Mapping

CTDOT has made progress in mapping the financial plan processes since the 2019 TAMP. The flow of processes identifies how the various financial plans, including the Capital Plan and the Statewide Transportation Improvement Program (STIP), interact with each other, as shown in Figure 7-1.

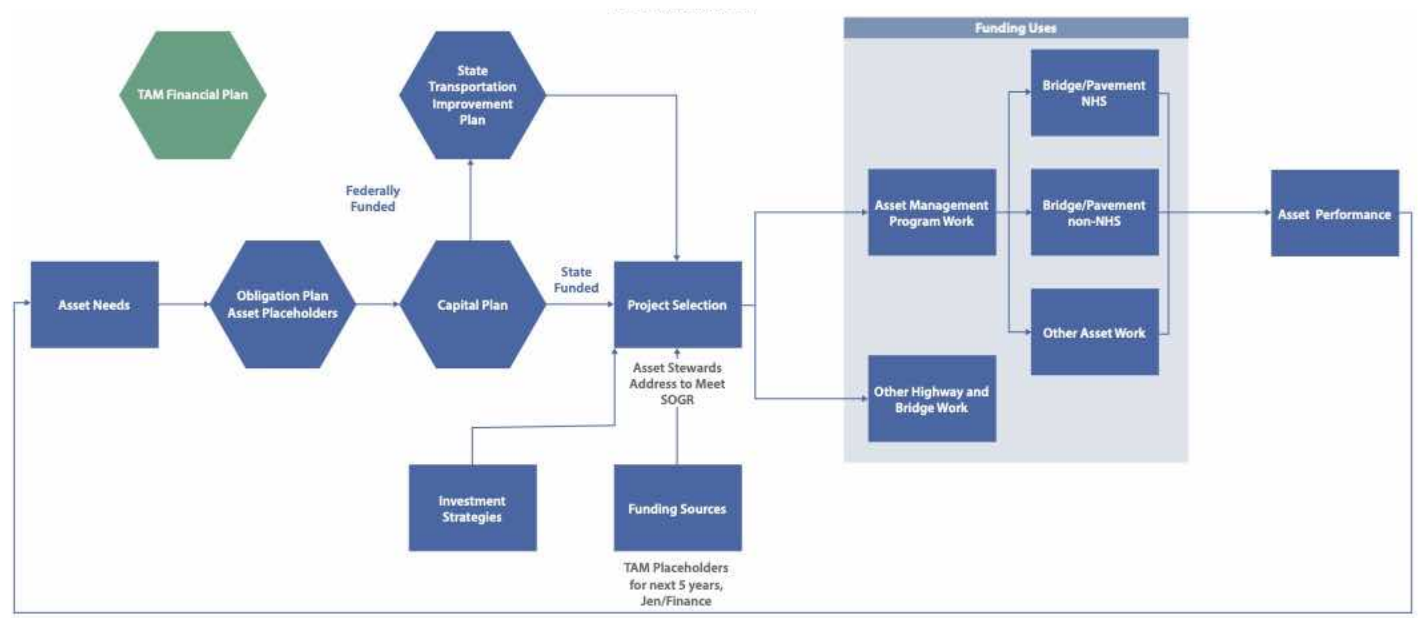


Figure 7-1. CTDOT Financial Plan Process Map

The financial process is cyclical and begins with the needs of CTDOT assets. These needs, which can be SOGR related or otherwise, drive the development of the Department's Schedule of Federal-aid Obligations (Obligation Plan).

The Obligation Plan is a key document that summarizes CTDOT's planned obligations of FHWA funds for future years. The Obligation Plan contains entries for planned projects, and some potential projects that do not necessarily have a final funding plan developed. Placeholders are used to reserve funding for categories of work that do not have specific projects identified yet. The Obligation Plan identifies the funding sources for every project, as well as the federal/state/local share, and the year(s) the project will be financed. CTDOT tags planned SOGR (i.e. TAM) funding for TAMP assets with an FHWA work type in the Obligation Plan database.

Project candidates for SOGR needs are proposed by each asset steward for their own particular assets, using asset placeholder information available from the Obligation Plan and their overall investment strategies.

Once projects have been proposed, the Capital Plan is built using information from the Obligation Plan and the PPI process. The Bureau of Finance and Administration supports this process, particularly the Offices of Finance and Capital Services.

Executive level approval is required for projects to be included in the STIP. Federally funded projects then go through the STIP approval process and are included in that document, before proceeding to the Project Initiation Phase. Projects with only state funding go straight to the Project Initiation Phase.

Funding is used for both SOGR and non-SOGR projects. SOGR projects include bridge and pavement NHS work, bridge and pavement non-NHS work, and other asset work (e.g. signs, highway buildings, roadway illumination). After the SOGR projects are funded, asset performance is evaluated and considered when determining needs for future projects, which marks the start of another financial cycle.

Obligation Plan

In the previous TAMP, CTDOT used the Capital Plan to determine asset funding by FHWA work type. While the information in the Capital Plan and Obligation Plan are similar, the Obligation Plan can contain information which is not included in the fiscally-constrained Capital Plan but is useful for TAM purposes.

The Obligation Plan is updated and issued monthly and summarizes all identified projects. This document is the primary source of planned transactions to obligate Federal funds. Information from this plan is used to create the 5 year Capital Plan, manage the STIP, and develop the TAMP.

Asset Placeholders

Since 2020, the Obligation Plan has included TAM Placeholders to program available funds specifically for SOGR projects for each asset (including some future assets). TAM Placeholders are new entries in the obligation plan, showing designated, asset-specific funding reservations, even when specific projects are not yet identified. The placeholder remaining totals are sent to asset stewards monthly as part of the Obligation Plan distribution. This allows for visibility of TAM projects as well as communicating to asset stewards what future funds remain unprogrammed, to maximize asset management interpretation and planning of available funds.

TAM Tagging

In addition to TAM placeholders for yet-to-be-identified projects, a column was added to the Obligation Plan database to specify the asset and FHWA work type for identified projects. This allows the information in the Obligation Plan (funding source, total cost, project number, etc.) to be linked to the assets and work type, and allows for more versatile ways to visualize the estimated TAM funding in this report. Tags include both the asset name and the FHWA work type, for example “Bridge Maintenance” or “Pavement Preservation.”

TAM asset and work type tags were initially assigned based on project descriptions in the Obligation Plan, and were refined based on specific project qualities. Only projects with “A” priority (programmed) were included in the summary tables. Projects with “B” (over programmed) or “F” (future need) priority are included in the Obligation Plan for when additional funding becomes available. As funds for those projects are not currently available, they are not included in this summary. Only the Construction (“CN”) phases of projects are counted towards TAM funding (other phases not included are planning, engineering, other, etc.).

Once tagged, summary tables can be generated and used for the TAMP (e.g. spending by asset and by FHWA work type). Further analysis regarding funding sources for each asset and work type can be performed with the help of links to existing information from available projects.

TAM Placeholders are tagged to the appropriate asset and work type (eg. “TAM Pavement Markings Placeholder” is tagged to “Pavement Markings Reconstruction”). As the funding is moved from the placeholders into new projects, the total in the summary table should remain the same.

FHWA Work Types

- Initial Construction
- Maintenance
- Preservation
- Rehabilitation
- Reconstruction

2022 TAMP Financial Plan Data Sources

The January 2022 Obligation Plan was used to create the estimated TAM sources and uses tables shown in this chapter. The Obligation Plan generally covers a five-year period (2022-2026), but the first three years of the Obligation Plan (2022-2024) are the most detailed and are included as planned spending in the TAMP. For years 2025-2031, an average of the three years of planned sources and uses is assumed to carry forward each year. The later seven years of the ten-year period is deemed estimated sources and uses. The January 2022 Obligation Plan does not include the expected funding increases from the BIL. As BIL funds are distributed, projects are being selected and developed to fill those programs, so they will be more visible in future documents. For certain assets with clearly defined future spending (i.e. Highway Buildings and ITS-ATMS), years 2025-2031 are predictions for each year rather than averages.

Note that funding sources and uses in this plan are presented in constant 2022 dollars. The funding has been adjusted for inflation using an assumed rate of 3.8%.

Local entities are responsible for only 154 lane miles (3%) of NHS pavement and no NHS bridges. The remaining NHS assets are the capital responsibility of CTDOT. As the local ownership portion is so small, it is a challenge for CTDOT to gather meaningful data on funding sources and expected expenditures for the locally-maintained NHS. This financial plan covers all CTDOT-maintained assets, including CTDOT-maintained NHS.

Since the January 2022 Obligation plan does not include new federal funding under BIL, this plan likely underestimates CTDOT's TAM investments over the 10-year period of the TAMP. Once the increase in funding under BIL is reflected in the Obligation Plan and tagged, CTDOT expects to see additional TAM planned projects, particularly on NHS bridges and pavements.

CTDOT Funding Sources

This section shows CTDOT's projected TAM funding over the 10-year period of the TAMP, organized by source. Data for this section of the TAMP comes from the January 2022 Obligation Plan.

Table 7-1 provides a high level summary of TAM funding sources. Years 2022-2024 are based on planned funding, while years 2025-2031 are estimated values based on an average of the first three years of the period. CTDOT estimates a total TAM program of $8.3 billion over the ten-year period of the TAMP. While the capital program is expected to remain steady, CTDOT's SOGR needs will outpace available funding, leading to a growing financial gap to achieve asset condition goals.

Table 7-1. Summary of TAM Funding Sources

	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Description	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Federal	$168	$315	$296	$259	$259	$259	$259	$259	$259	$259
State	$595	$350	$671	$632	$540	$559	$563	$534	$528	$546
Non Federal / Non State	$40	$15	$2	$19	$19	$19	$19	$19	$19	$19
Total	$803	$680	$968	$911	$819	$838	$842	$813	$807	$825

Federal Funds

Federal funding for transportation is provided through the Highway Trust Fund (HTF), which is funded by the federal gas tax supplemented with additional revenues from other funds. For a detailed explanation of federal funding support, refer to *Funding Federal-Aid Highways*[1], a 2017 publication by FHWA.

Typically, Congress authorizes federal transportation funding in advance of the states' capital planning process. Once authorized, funds are apportioned or allocated to states through federal programs. Apportioned funds must then be obligated or committed to specific projects and expended before the HTF reimburses money to the state.

The expected federal funding for asset management at CTDOT by source is summarized in Table 7-2. The two primary programs for highway federal funds are the National Highway Performance Program (NHPP) and the Surface Transportation Block Grant (STBG). The NHPP represents the single largest category of federal revenues for Connecticut and the majority of funding for the state's highway and bridge assets. The NHPP was created to provide support for the NHS and to ensure that federal-aid highway investments help support progress towards NHS performance targets.

The Surface Transportation Program was renamed the Surface Transportation Block Grant Program by the FAST Act. This program provides flexible funding for state and local transportation improvements and preservation. Portions of the STBG fall within the statewide discretion of CTDOT and therefore are considered eligible for asset management spending. In addition to the NHPP and the STBG, CTDOT uses other federal sources such as Congestion Mitigation and Air Quality (CMAQ) that are directed to asset management activities and are represented in Table 7-2 as Other Federal Programs. In addition to the federal funding sources shown in Table 7-2, CTDOT also typically receives redistribution of additional

National Highway Performance Program (NHPP)

The NHPP provides funding to support the condition and performance of the NHS and to support progress towards federal requirements and state goals.

1 FHWA, "Funding Federal-Aid Highways", January 2017, https://www.fhwa.dot.gov/policy/olsp/fundingfederalaid/FFAH_2017.pdf

obligational authority after fully obligating its federal program.

In the fall of 2021, Congress passed the Infrastructure Investment and Jobs Act (IIJA), also known as the BIL. The BIL funds the transportation program for five years (FFY22-26) subject to annual appropriations. The BIL provides Connecticut with approximately $5.38 billion in federal transportation funding over the five years, which is an increase of $1.6 billion over the levels authorized in the previous federal legislation, the FAST Act. The BIL maintains the FAST Act highway program while providing a focus on safety, bridges, climate change, resiliency, and project delivery. The BIL also creates more than a dozen new highway programs, including: reducing carbon emissions, increasing resiliency, reconnecting communities, and rehabilitating bridges in critical need of repair. However, the TAMP does not include the BIL funding as the January 2022 CTDOT Obligation Plan was not updated with the additional funding.

Table 7-2. Summary of Federal Funding Sources for TAM

Value by Fiscal Year ($M) in 2022 dollars										
	Planned			Estimated						
Description	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
NHPP	$20	$148	$129	$99	$99	$99	$99	$99	$99	$99
STBG	$108	$93	$73	$91	$91	$91	$91	$91	$91	$91
Other Federal Programs	$40	$74	$94	$69	$69	$69	$69	$69	$69	$69
Total	$168	$315	$296	$259	$259	$259	$259	$259	$259	$259

State Funds

State funding for transportation is provided through the STF, which is primarily funded with state gas taxes, new car sales tax, sales and use tax, driver license fees, and motor vehicle registration fees. Connecticut sells bonds to finance transportation projects and pays the debt service using revenue from the STF.

The expected state funding for TAM by funding source is summarized in Table 7-3. Prior to 2008, state funds were traditionally used to match federal funds and pay for CTDOT's maintenance program and other non-federally eligible programs. CTDOT moved to a constrained state funding program in 2008 and readjusted the allocation of state funding to now include SOGR work specific to asset classes. CTDOT has been successful in demonstrating the need for state match to the federal program that supports preservation, and in recent years new programs have provided additional funding for SOGR work.

Fix-it-First is a 100% state program comprising two sub-programs: one for bridges and one for roads. Fix-it-First, established in July 2007, has increased TAM funding available for preserving Connecticut's transportation infrastructure.

Table 7-3. Summary of State Funding Sources for TAM

Value by Fiscal Year ($M) in 2022 dollars										
	Planned			Estimated						
Description	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
State Funds	$248	$186	$275	$330	$238	$257	$261	$232	$226	$244
Fix It First	$347	$164	$396	$302	$302	$302	$302	$302	$302	$302
Total	$595	$350	$671	$632	$540	$559	$563	$534	$528	$546

Asset Management Funding Uses

This section shows CTDOT's projected asset management allotments over the 10-year period of the TAMP, organized by asset. These amounts are further broken down by the five FHWA work types: initial construction, maintenance, preservation, rehabilitation and reconstruction (replacement). These values draw on the various federal and state funding sources described later in the chapter.

These funding uses were developed using the Obligation Plan tagging process described previously. The first three years are planned spending from the Obligation Plan, the following seven years are estimated spending based on the average of the first three years of the Obligation Plan.

Asset management funding (or SOGR funding) is only a portion of the overall capital program. Operational improvement and capacity improvement designated projects may preserve or replace an asset; however, these projects are not considered asset management projects and thus are not included in the TAMP financial plan. There are also other programs in the Capital Program for assets not yet included in the TAMP (e.g. guiderail, noise walls, curb ramps, etc.); these assets are not included in this financial plan.

CTDOT publishes an annual Capital Program Report that accompanies the Capital Plan. The Capital Program Report details expected available funding over the next five years and general investment strategies, while the Capital Plan contains specific projects and programs. An update to the Capital Program was published in February 2022 in response to the new BIL transportation law. The final 2022 Capital Program Report is expected to be published in summer 2022.

Figure 7-2 shows the portion of the 2022 $1.37 billion dollar capital program for highways and bridges that is programmed through the asset management process. The asset management program accounts for approximately

$803 million (59%) of the $1.37 billion dollar highway and bridge capital plan.

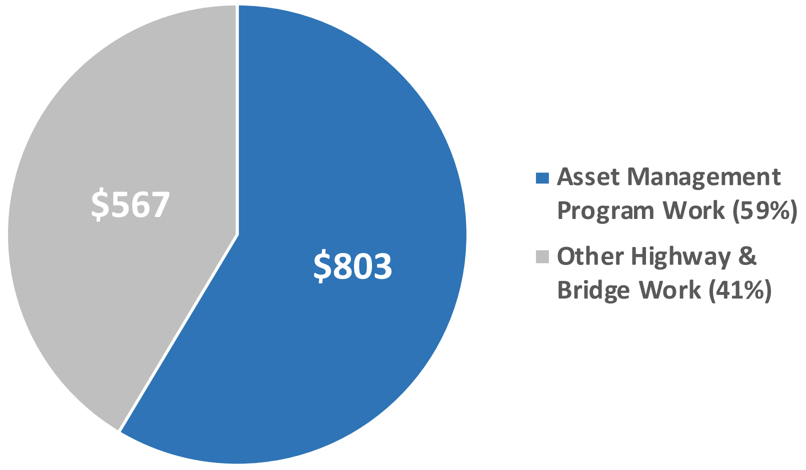


Figure 7-2. CTDOT Capital Program for Highway and Bridge

Note that in the 2019 TAMP, the TAM program was estimated to make up 61% of the overall highway and bridge capital program. However, CTDOT considers the lower percentage estimated in this TAMP to be the result of improved tagging and detailed sorting of TAM projects, yielding a more accurate picture of TAM expenditures, rather than reflecting a decline in TAM spending. In other words, the figure reported in the 2019 TAMP may have been an over estimation due to the limited TAM tagging capabilities at that time.

As the asset management process matures, the financial plan process will change with asset management needs having more impact in driving the capital program.

CTDOT-Maintained TAMP Assets

A summary of estimated asset management funding uses for the CTDOT-maintained assets in the TAMP is shown in Table 7-4. These estimates were developed based on the January 2022 Obligation plan. Tables 7-5 through 7-15 show each asset's estimated funding breakdown by FHWA work types. CTDOT's expected TAM expenditures on assets in the TAMP total nearly $8.3 billion over the ten-year period of the plan.

TAM expenditures are expected to remain steady over the next ten years, with bridge spending averaging $483 million per year and pavement spending averaging $152 million per year. Spending on the other assets is anticipated to average $196 million per year.

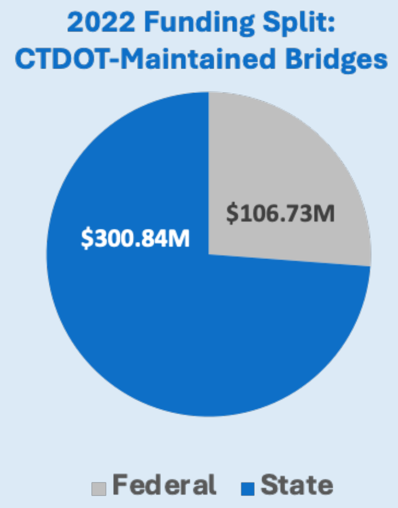
Table 7-4. Summary of Estimated TAM Funding Uses for the TAMP's Assets

Value by Fiscal Year ($M) in 2022 dollars										
	Planned			Estimated						
Description	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Bridge	$447	$354	$648	$483	$483	$483	$483	$483	$483	$483
Pavement	$163	$146	$146	$152	$152	$152	$152	$152	$152	$152
Traffic Signals	$34	$25	$27	$29	$29	$29	$29	$29	$29	$29
Signs	$29	$49	$36	$38	$38	$38	$38	$38	$38	$38
Sign Supports	$1	$5	$4	$3	$3	$3	$3	$3	$3	$3
Pavement Markings	$9	$8	$8	$8	$8	$8	$8	$8	$8	$8
Highway Buildings	$78	$68	$44	$147	$39	$58	$65	$35	$28	$46
Roadway Illumination	$17	$0	$16	$11	$11	$11	$11	$11	$11	$11
Retaining Walls	$1	$6	$18	$8	$8	$8	$8	$8	$8	$8
Drainage Culverts	$8	$8	$8	$8	$8	$8	$8	$8	$8	$8
ITS: ATMS	$16	$11	$15	$24	$40	$40	$37	$38	$39	$39
Total	**$803**	**$680**	**$968**	**$911**	**$819**	**$838**	**$842**	**$813**	**$807**	**$825**

Table 7-5 shows estimated TAM funding uses for CTDOT-maintained bridges by FHWA work type. Figure 7-3 shows actual TAM funding obligations reported annually in the implementation documentation for the FHWA consistency review.

Table 7-5. Estimated TAM Funding Uses for CTDOT-Maintained Bridges

Bridge	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance	$20	$20	$20	$20	$20	$20	$20	$20	$20	$20
Preservation	$28	$14	$49	$31	$31	$31	$31	$31	$31	$31
Rehabilitation	$182	$180	$481	$281	$281	$281	$281	$281	$281	$281
Reconstruction	$217	$139	$97	$151	$151	$151	$151	$151	$151	$151
Total	**$447**	**$354**	**$648**	**$483**	**$483**	**$483**	**$483**	**$483**	**$483**	**$483**



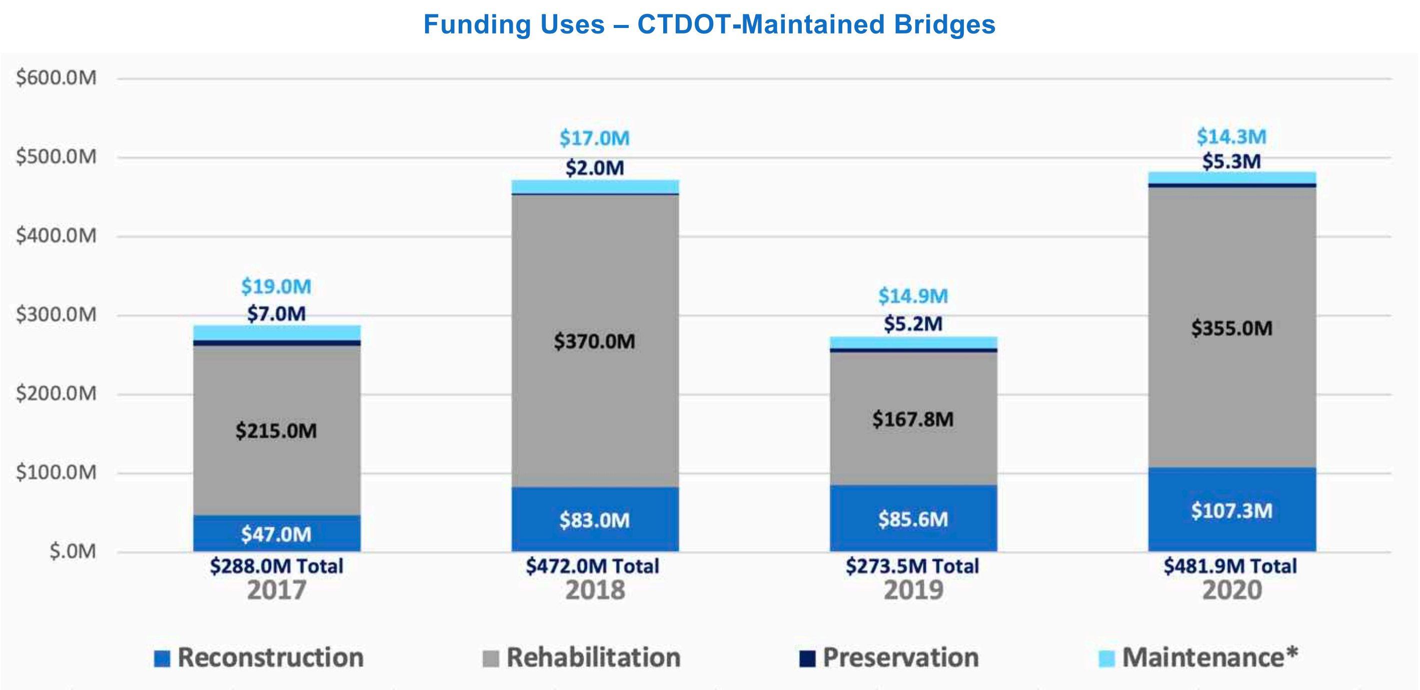
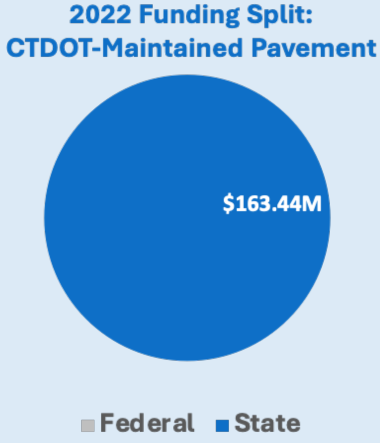


Figure 7-3. TAM Funding Obligated for CTDOT-Maintained Bridges by Federal Work Type
*For Maintenance, this is expended dollars

Table 7-6 shows estimated TAM funding uses for CTDOT-maintained pavement by FHWA work type. Figure 7-4 shows actual TAM funding obligations reported annually in the implementation documentation for the FHWA consistency review.

Table 7-6. Estimated TAM Funding Uses for CTDOT-Maintained Pavement

Pavement	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance	$99	$96	$96	$97	$97	$97	$97	$97	$97	$97
Preservation	$64	$50	$50	$55	$55	$55	$55	$55	$55	$55
Rehabilitation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reconstruction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	$163	$146	$146	$152	$152	$152	$152	$152	$152	$152



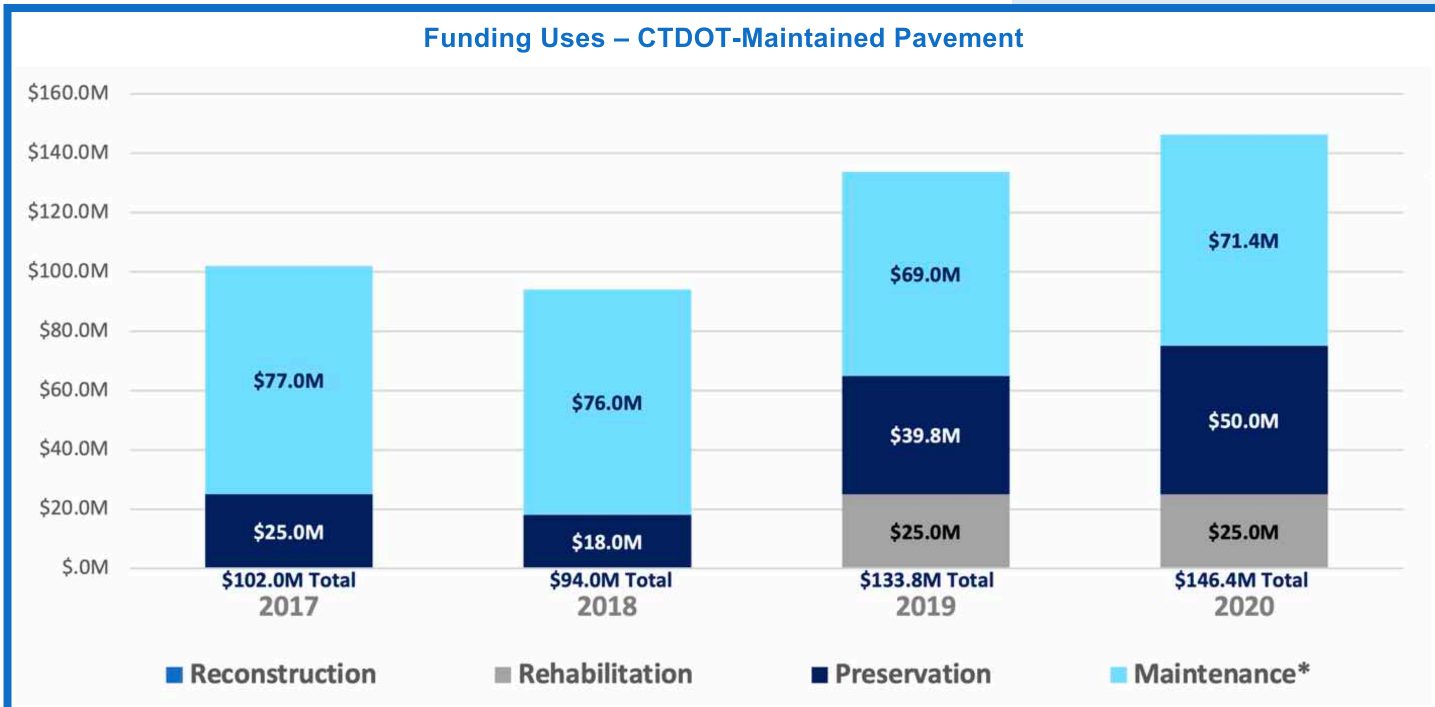


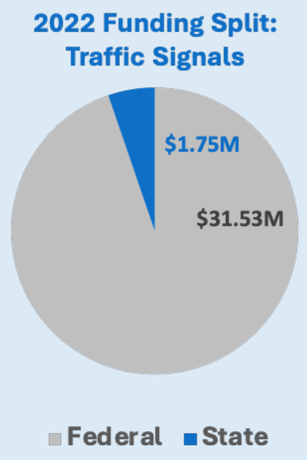
Figure 7-4. TAM Funding Obligated for CTDOT-Maintained Pavement by Federal Work Type

*For Maintenance, this is expended dollars

Table 7-7 shows estimated TAM funding uses for CTDOT-maintained traffic signals by FHWA work type. Figure 7-5 shows actual TAM funding obligations reported annually in the implementation documentation for the FHWA consistency review.

Table 7-7. Estimated TAM Funding Uses for CTDOT-Maintained Traffic Signals

Traffic Signals	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$7	$0	$2	$2	$2	$2	$2	$2	$2
Maintenance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Preservation	$5	$0	$0	$2	$2	$2	$2	$2	$2	$2
Rehabilitation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reconstruction	$29	$19	$27	$25	$25	$25	$25	$25	$25	$25
Total	**$34**	**$25**	**$27**	**$29**	**$29**	**$29**	**$29**	**$29**	**$29**	**$29**



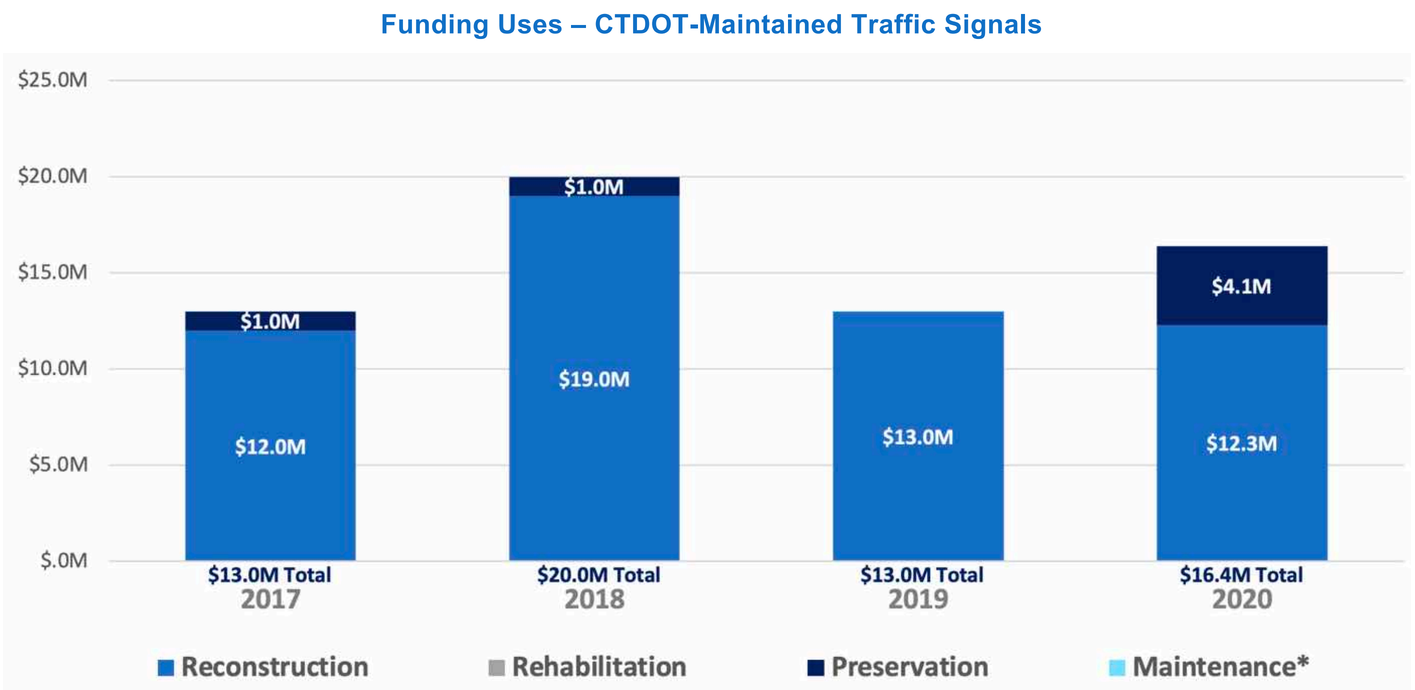


Figure 7-5. TAM Funding Obligated for CTDOT-Maintained Traffic Signals by Federal Work Type
*For Maintenance, this is expended dollars

Table 7-8 shows estimated TAM funding uses for CTDOT-maintained signs by FHWA work type. This includes $1 million in annual maintenance funding which is not caputured in the Obligation Plan. Figure 7-6 shows actual TAM funding obligations reported annually in the implementation documentation for the FHWA consistency review.

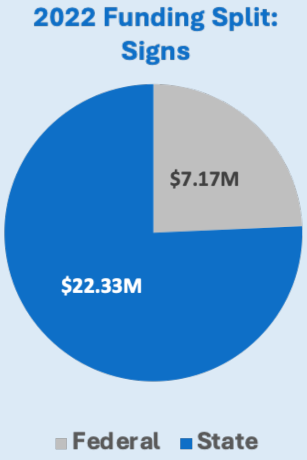


Table 7-8. Estimated TAM Funding Uses for CTDOT-Maintained Signs

Signs	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance	$1	$1	$1	$1	$1	$1	$1	$1	$1	$1
Preservation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Rehabilitation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reconstruction	$28	$48	$35	$37	$37	$37	$37	$37	$37	$37
Total	**$29**	**$49**	**$36**	**$38**	**$38**	**$38**	**$38**	**$38**	**$38**	**$38**

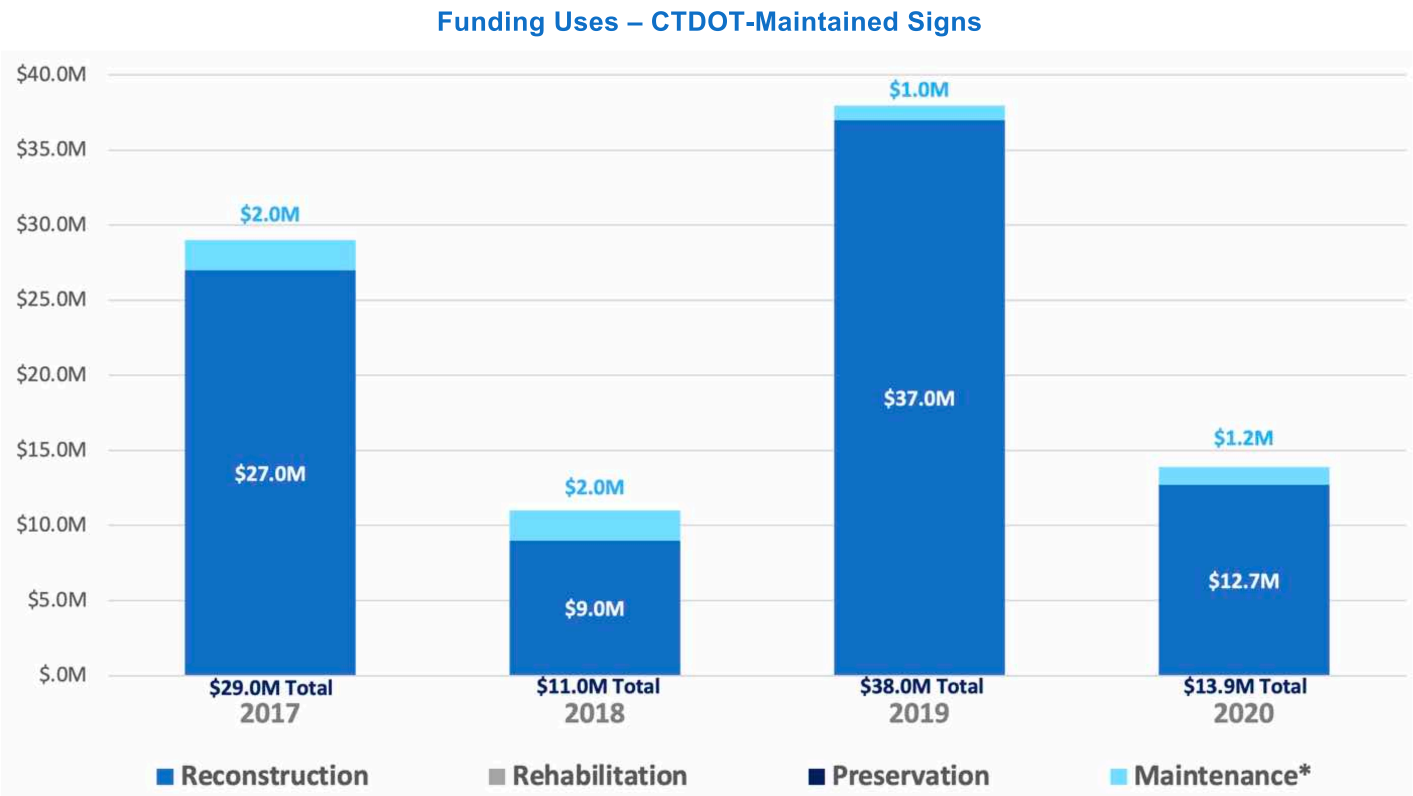


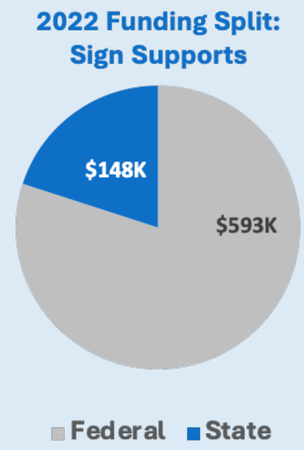
Figure 7-6. TAM Funding Obligated for CTDOT-Maintained Signs by Federal Work Type

*For Maintenance, this is expended dollars

Table 7-9 shows estimated TAM funding uses for CTDOT-maintained sign supports by FHWA work type. Figure 7-7 shows actual TAM funding obligations reported annually in the implementation documentation for the FHWA consistency review.

Table 7-9. Estimated TAM Funding Uses for CTDOT-Maintained Sign Supports

Sign Supports	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Preservation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Rehabilitation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reconstruction	$1	$5	$4	$3	$3	$3	$3	$3	$3	$3
Total	**$1**	**$5**	**$4**	**$3**	**$3**	**$3**	**$3**	**$3**	**$3**	**$3**



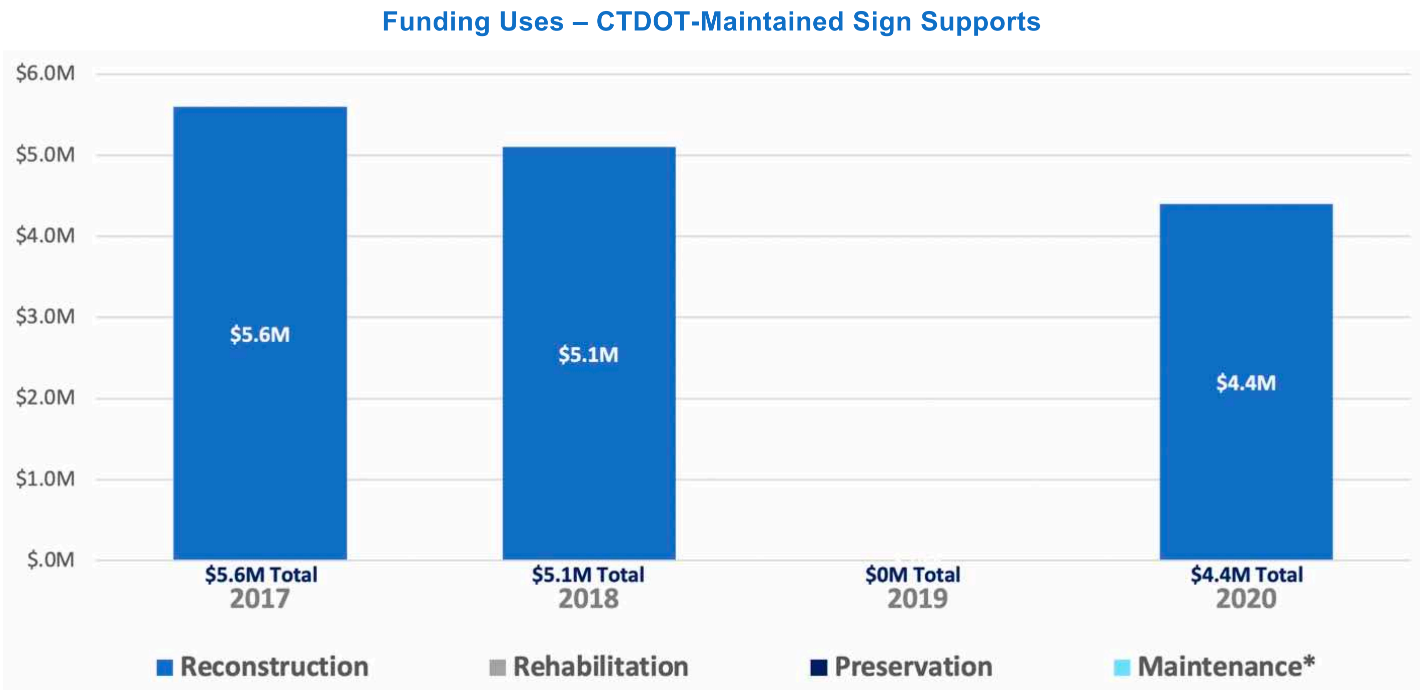


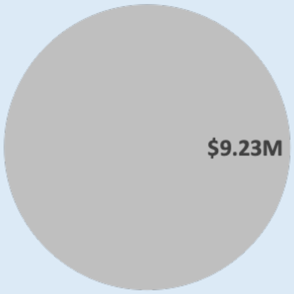
Figure 7-7. TAM Funding Obligated for CTDOT-Maintained Sign Supports by Federal Work Type
*For Maintenance, this is expended dollars

Table 7-10 shows estimated TAM funding uses for CTDOT-maintained pavement markings by FHWA work type. Figure 7-8 shows actual TAM funding obligations reported annually in the implementation documentation for the FHWA consistency review.

Table 7-10. Estimated TAM Funding Uses for CTDOT-Maintained Pavement Markings

Pavement Markings	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Preservation	$9	$8	$0	$6	$6	$6	$6	$6	$6	$6
Rehabilitation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reconstruction	$0	$0	$8	$3	$3	$3	$3	$3	$3	$3
Total	$9	$8	$8	$8	$8	$8	$8	$8	$8	$8

2022 Funding Split: Pavement Markings



Funding Uses – CTDOT-Maintained Pavement Markings

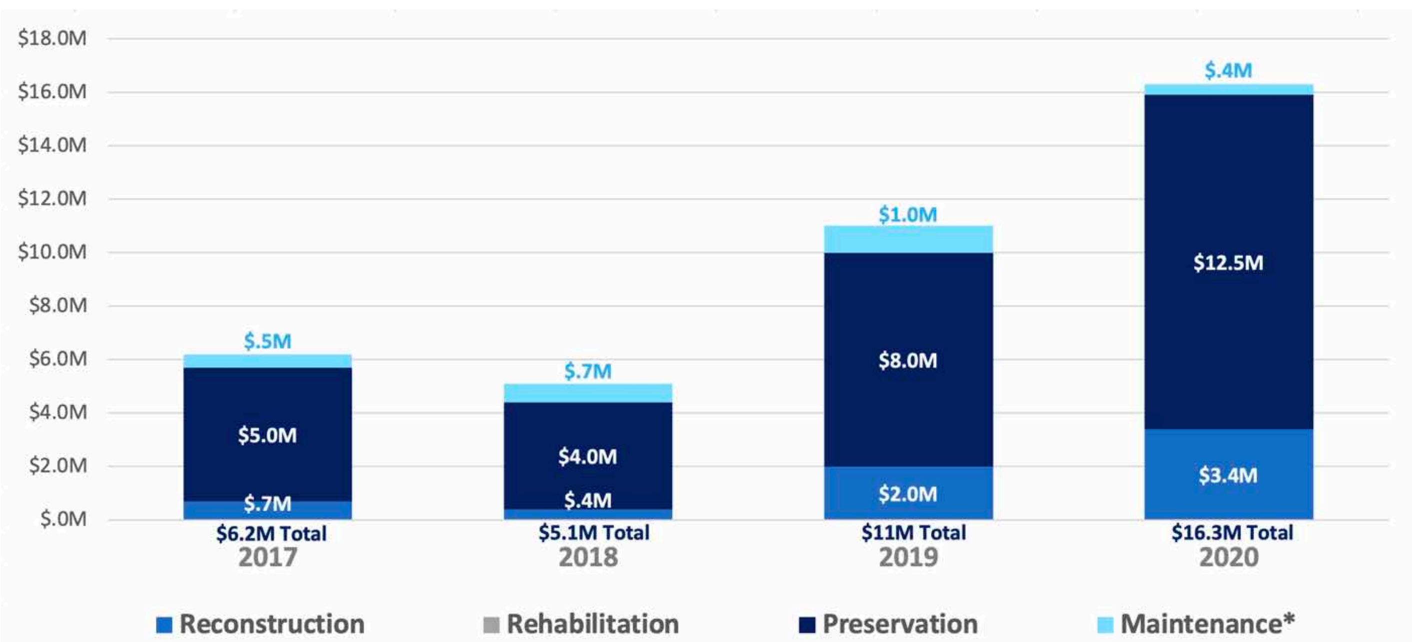


Figure 7-8. TAM Funding Obligated for CTDOT-Maintained Pavement Markings by Federal Work Type

*For Maintenance, this is expended dollars

Table 7-11 shows estimated TAM funding uses for CTDOT-maintained highway buildings by FHWA work type. Figure 7-9 shows actual TAM funding obligations reported annually in the implementation documentation for the FHWA consistency review.

Table 7-11. Estimated TAM Funding Uses for CTDOT-Maintained Highway Buildings

Highway Buildings	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Preservation	$8	$14	$5	$10	$12	$6	$7	$1	$1	$1
Rehabilitation	$1	$4	$9	$11	$20	$15	$11	$9	$1	$1
Reconstruction	$69	$50	$30	$126	$7	$37	$47	$25	$26	$44
Total	**$78**	**$68**	**$44**	**$147**	**$39**	**$58**	**$65**	**$35**	**$28**	**$46**

Funding Uses – CTDOT-Maintained Highway Buildings

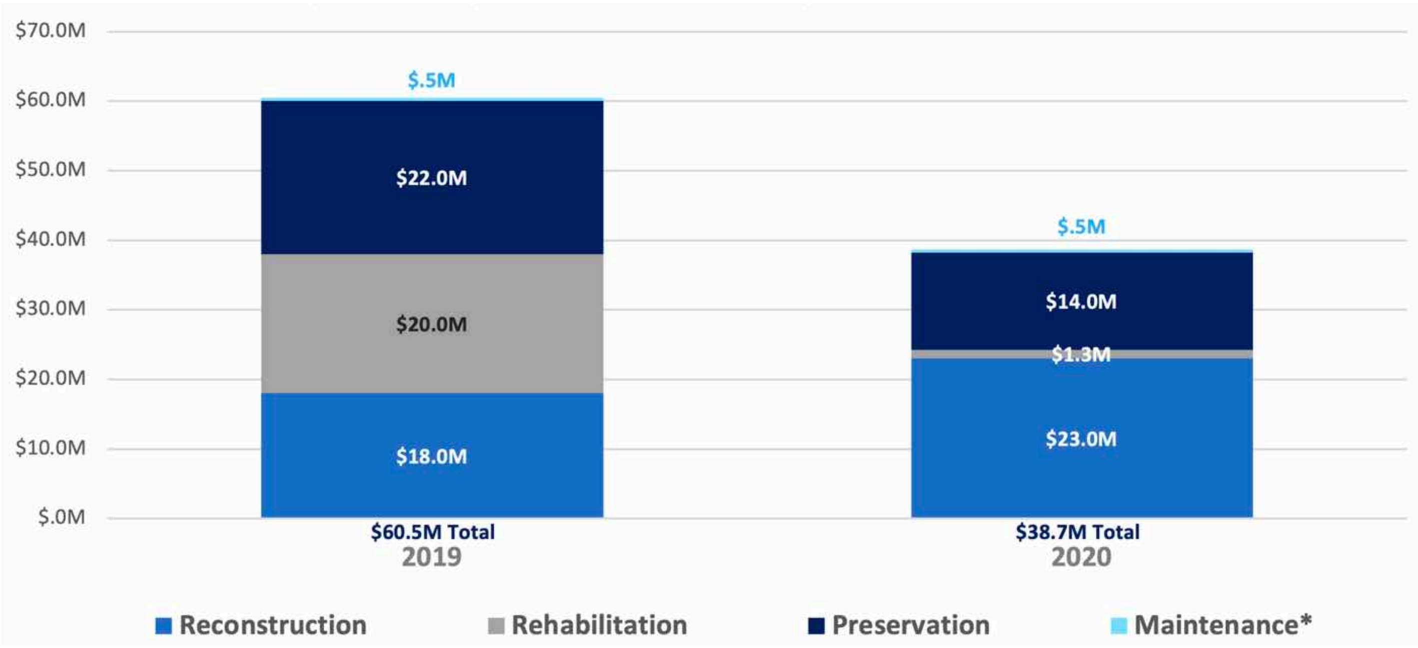


Figure 7-9. TAM Funding Obligated for CTDOT-Maintained Highway Buildings by Federal Work Type

*For Maintenance, this is expended dollars

Table 7-12 shows estimated TAM funding uses for CTDOT-maintained roadway illumination by FHWA work type.

Table 7-12. Estimated TAM Funding Uses for CTDOT-Maintained Roadway Illumination

Roadway Illumination	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$0	$6	$2	$2	$2	$2	$2	$2	$2
Maintenance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Preservation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Rehabilitation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reconstruction	$17	$0	$10	$9	$9	$9	$9	$9	$9	$9
Total	**$17**	**$0**	**$16**	**$11**	**$11**	**$11**	**$11**	**$11**	**$11**	**$11**

Table 7-13 shows estimated TAM funding uses for CTDOT-maintained retaining walls by FHWA work type.

Table 7-13. Estimated TAM Funding Uses for CTDOT-Maintained Retaining Walls

Retaining Walls	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Preservation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Rehabilitation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reconstruction	$0	$6	$18	$8	$8	$8	$8	$8	$8	$8
Total	**$1**	**$6**	**$18**	**$8**	**$8**	**$8**	**$8**	**$8**	**$8**	**$8**

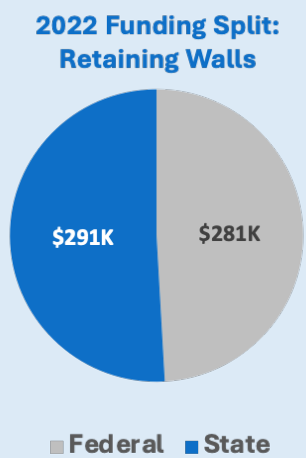


Table 7-14 shows estimated TAM funding uses for CTDOT-maintained drainage culverts by FHWA work type.

Table 7-14. Estimated TAM Funding Uses for CTDOT-Maintained Drainage Culverts

Drainage Culverts	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance	$1	$1	$1	$1	$1	$1	$1	$1	$1	$1
Preservation	$2	$2	$2	$2	$2	$2	$2	$2	$2	$2
Rehabilitation	$2	$2	$2	$2	$2	$2	$2	$2	$2	$2
Reconstruction	$2	$2	$2	$2	$2	$2	$2	$2	$2	$2
Total	**$8**	**$8**	**$8**	**$8**	**$8**	**$8**	**$8**	**$8**	**$8**	**$8**

Note that values are rounded and may not appear to sum.

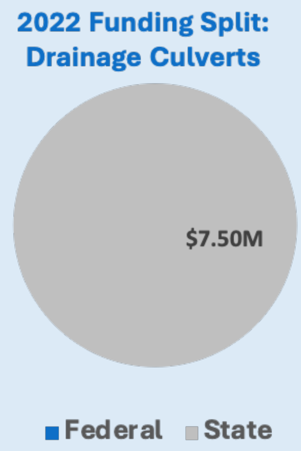
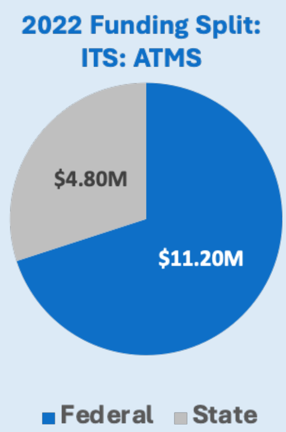


Table 7-15 shows estimated TAM funding uses for CTDOT-maintained intelligent transportation systems: ATMS by FHWA work type.

Table 7-15. Estimated TAM Funding Uses for CTDOT-Maintained Intelligent Transportation Systems: ATMS

ITS: ATMS	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$13	$8	$6	$11	$19	$14	$9	$9	$20	$28
Maintenance	$2	$2	$2	$2	$2	$2	$2	$2	$2	$2
Preservation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Rehabilitation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reconstruction	$1	$1	$7	$11	$19	$24	$26	$27	$17	$9
Total	**$16**	**$11**	**$15**	**$24**	**$40**	**$40**	**$37**	**$38**	**$39**	**$39**



NHS Assets

The TAMP also identifies expected expenditures on NHS bridges and pavements by FHWA work type. NHS bridge spending was identified by referencing the project number of NHS projects in the Obligation Plan. CTDOT expects to spend $3.1 billion on NHS bridges over the ten-year period of the TAMP, mostly on rehabilitation.

NHS pavement was not possible to break out from non-NHS pavement in the Obligation Plan. For NHS pavement, CTDOT used historical spending averages by program to estimate future NHS pavement expenditures. CTDOT assumed 80% of the $50 million PPP program, 33% of the $69 million Maintenance VIP program, and 70% of the $40 million Construction program to be performed on the NHS. CTDOT expects to spend $908 million on NHS pavements over the ten-year period of the TAMP, with the biggest portion of the money spent on preservation.

A summary of estimated NHS asset management funding uses is shown in Table 7-16.

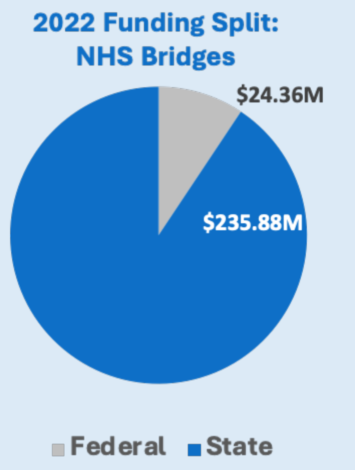
Table 7-16. Summary of Estimated NHS Asset Management Funding Uses

NHS	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Asset	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
NHS Bridge	$285	$170	$476	$310	$310	$310	$310	$310	$310	$310
NHS Pavement	$91	$91	$91	$91	$91	$91	$91	$91	$91	$91
Total	$376	$261	$567	$401	$401	$401	$401	$401	$401	$401

Table 7-17 shows estimated TAM funding uses for NHS bridge by FHWA work type. Figure 7-10 shows actual TAM funding obligations reported annually in the implementation documentation for the FHWA consistency review.

Table 7-17. Estimated TAM Funding Uses for NHS Bridge

NHS Bridge	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Preservation	$9	$8	$24	$14	$14	$14	$14	$14	$14	$14
Rehabilitation	$125	$128	$424	$226	$226	$226	$226	$226	$226	$226
Reconstruction	$151	$34	$27	$71	$71	$71	$71	$71	$71	$71
Total	$285	$170	$476	$310	$310	$310	$310	$310	$310	$310



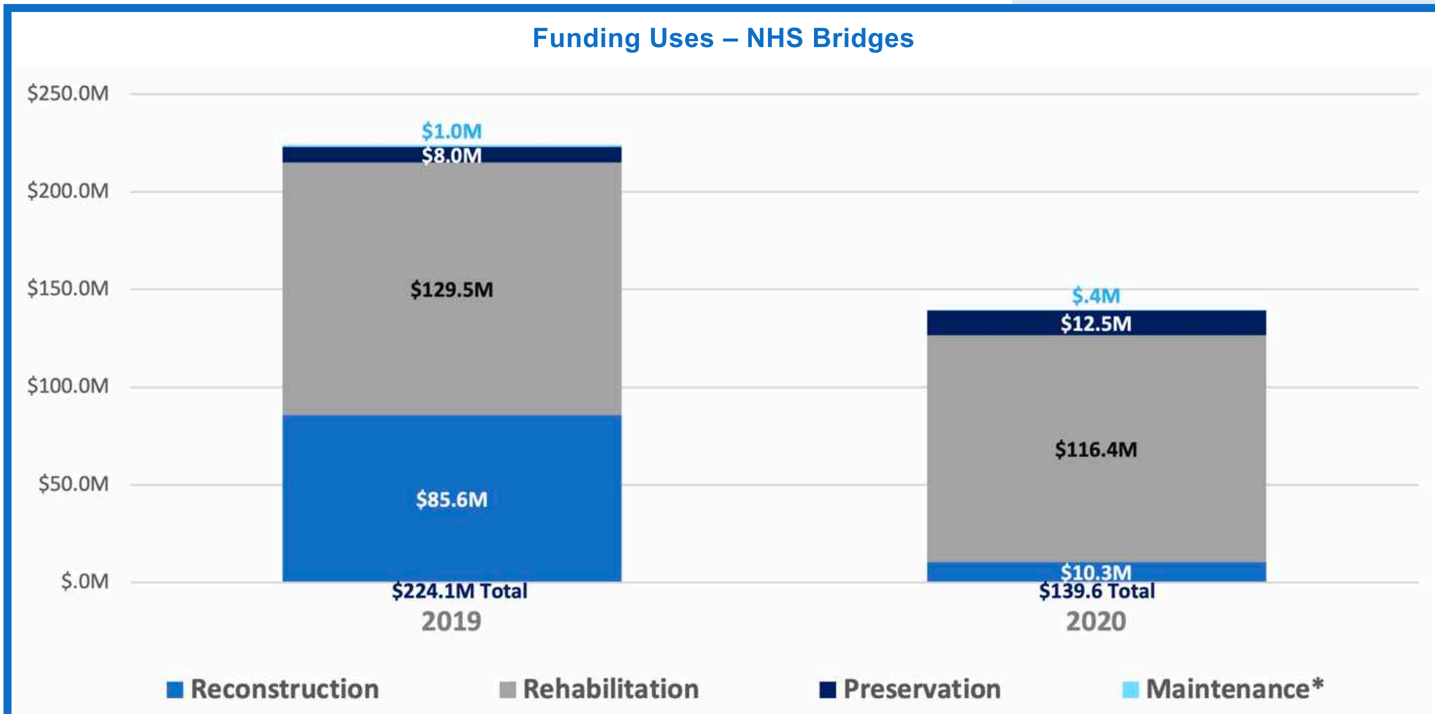


Figure 7-10. TAM Funding Obligated for NHS Bridges by Federal Work Type
*For Maintenance, this is expended dollars

Table 7-18 shows estimated TAM funding uses for NHS pavement by FHWA work type. Figure 7-11 shows actual TAM funding obligations reported annually in the implementation documentation for the FHWA consistency review.

Table 7-18. Estimated TAM Funding Uses for NHS Pavement

NHS Pavement	Value by Fiscal Year ($M) in 2022 dollars									
	Planned			Estimated						
Work Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Initial Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance	$23	$23	$23	$23	$23	$23	$23	$23	$23	$23
Preservation	$40	$40	$40	$40	$40	$40	$40	$40	$40	$40
Rehabilitation	$28	$28	$28	$28	$28	$28	$28	$28	$28	$28
Reconstruction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	**$91**	**$91**	**$91**	**$91**	**$91**	**$91**	**$91**	**$91**	**$91**	**$91**

2022 Funding Split: NHS Pavement

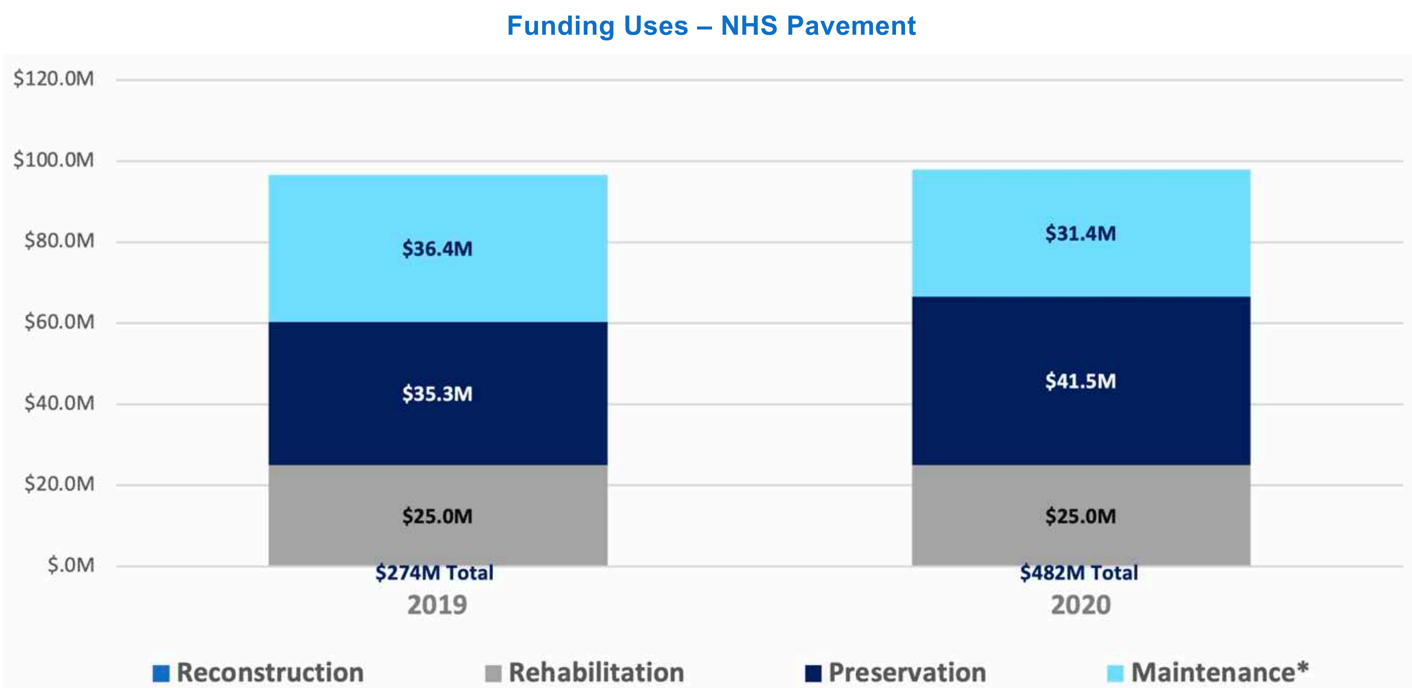


Figure 7-11. TAM Funding Obligated for NHS Pavement by Federal Work Type

*For Maintenance, this is expended dollars

Asset Management Funding Needs

The financial plan in this TAMP only includes the estimated available annual funding. In order to reach and maintain the SOGR goals set for each asset, the annual funding needed is over $1.8 billion, a gap of over $1.2 billion. Table 7-19 shows the breakdown of funding needs by each of the TAMP assets. These values were generated by modeling future conditions in different funding scenarios, and determining the funding needed to achieve SOGR goals. Performance projections are shown in detail in Chapter 4.

Nearly every asset in the TAMP has an annual funding gap to achieve SOGR, with bridge ($905 million gap) and pavement ($281 million gap) being the two largest. As CTDOT continues to be more effective at managing assets and investing in more preservation techniques, the gaps may decrease. For example, in the previous TAMP, Signs and Highway Buildings had projected gaps that were significantly reduced due to efficiency and effectiveness at implementing TAM best practices.

Note that funding levels needed to achieve SOGR are calculated based on CTDOT performance measures, not FHWA measures.

Table 7-19. State of Good Repair Funding Needs (Highway Only)

	Value by Fiscal Year ($M) in 2022 dollars		
Asset	Current Average Annual Funding	Estimated Annual Funding Needed to Achieve SOGR Goal	Estimated Gap
Bridge	$375	$1,280	$905
Pavement	$119	$375	$256
Traffic Signals	$61	$74	$13
Signs*	$30	$30	$0

Value by Fiscal Year ($M) in 2022 dollars			
Asset	**Current Average Annual Funding**	**Estimated Annual Funding Needed to Achieve SOGR Goal**	**Estimated Gap**
Sign Supports	$4	$9.4	$5.4
Pavement Markings	$8	$24	$16
Highway Buildings**	$56.8	$56.8	$0
Roadway Illumination	$13.6	$13.6	$0
Retaining Walls	$7.5	$7.5	$0
Drainage Culverts	$5.5	$44	$38.5
Intelligent Transportation Systems: ATMS	$14	$37.5	$23.5
Total	**$669**	**$1,952**	**$1,282**

*Current funding is predicted to achieve SOGR goals over a twenty year period
**Current funding is predicted to achieve SOGR goals over a ten year period

Asset Valuation

FHWA requires state DOTs to include an estimate of asset value for NHS pavements and bridges. The financial plan process must also calculate the investment needed to maintain asset value. FHWA has acknowledged that there are many ways to estimate asset value and are leaving it to DOT's to select their methodology.

For the purposes of this TAMP, CTDOT applies the replacement value approach to calculate asset valuation. The asset replacement value is the product of the asset inventory unit, the unit replacement cost, and the non-asset related project cost factor. At this time, non-asset related construction costs assume a 1.0 project cost factor; however, it is expected that this factor will be refined for each asset in future TAMPs to account for costs related to design, right of way, project administration, utilities, maintenance and protection of traffic. The asset values for all NHS bridges and pavements are summarized in Table 7-20. As asset inventories and unit costs are updated for the annual fact sheet revision, asset valuation estimates will also be updated.

Unfortunately, this method of asset valuation does not reflect changes in asset condition. CTDOT is using this asset valuation data as a means to fulfill federal requirements and communicate the importance of investment relative to the magnitude of the value of the assets.

Table 7-20. NHS Asset Valuation Estimate

Asset	Inventory (unit)	Unit Replacement Cost	Non-Asset Related Project Cost Factor (Under Review)	Asset Valuation (Replacement Value)
NHS Bridge	26,690,852 Square Feet	$490	1.0	$13,078,517,000
NHS Pavement	54489358 Square Yards	$109	1.0	$5,939,340,022

The asset values for all CTDOT-maintained assets included in the TAMP is summarized in Table 7-21.

Table 7-21. CTDOT-Maintained Asset Valuation Estimate

Asset	Inventory (unit)	Unit Replacement Cost	Non-Asset Related Project Cost Factor (Under Review)	Asset Valuation (Replacement Value)
Bridge (includes NHS)	**34,827,984 Square Feet**	**$490**	**1.0**	**$17,065,712,000**
Pavement (Includes NHS)	**99,100,000 Square Yards**	**$109**	**1.0**	**$10,801,900,000**
Traffic Signals				**$830,500,000**
Traffic Signals	2,560 Each	$320,000	1.0	$819,300,000
Overhead Flashing Beacons	226 Each	$50,000	1.0	$11,300,000
Signs				**$182,373,000**
Sheet Aluminum	1,487,488 SF	$48	1.0	$71,399,000
Extruded Aluminum	8,659 SF	$12,816	1.0	$110,974,000
Sign Supports				**$294,000,000**
Cantilever	679 Each	$150,000	1.0	$101,850,000
Full Span	618 Each	$285,000	1.0	$176,130,000
Bridge Mount	356 Each	$45,000	1.0	$16,020,000
Pavement Markings				**$62,916,000**
Lines	97,000,000 Linear Feet	$0.50 (epoxy)	1.0	$48,500,000
Symbols	3,400,000 Square Feet	$4.24 (epoxy)	1.0	$14,416,000
Highway Buildings				**$890,000,000**
Tier 1	103 Each	$6,890,000 (average cost)	1.0	$710,000,000
Tier 2	93 Each	$1,795,000 (average cost)	1.0	$167,000,000
Tier 3	146 Each	$89,000 (average cost)	1.0	$13,000,000
Roadway Illumination	**207 Each**	**2,160,000**	**1.0**	**$447,120,000**

Asset	Inventory (unit)	Unit Replacement Cost	Non-Asset Related Project Cost Factor (Under Review)	Asset Valuation (Replacement Value)
Retaining Walls	**2,271,076 Square Feet**	**$110**	**1.0**	**$249,818,00**
Drainage Culverts	**20,235 Each**	**$133,860 (average cost)**	**1.0**	**$2,708,657,000**
Intelligent Transportation Systems: ATMS				**$168,000,000**
CCTV	362 Each	$250,000	1.0	$90,500,000
VMS	143 Each	$500,000	1.0	$71,500,000
RWIS	40 Each	$150,000	1.0	$6,000,000
Total				**$33,451,178,000**

The TAMP financial plan paints a picture of available funding for asset management, expected allotments on asset management, and the value of the assets included in the TAMP. CTDOT currently invests 2/3 state sources for every 1/3 federal funded activities. CTDOT has planned funding for the assets in the TAMP and has a plan to fund asset management activities over the 10-year period of the TAMP. It is envisioned that these funds will be allotted according to the maturing asset management practices and investment strategies at CTDOT.

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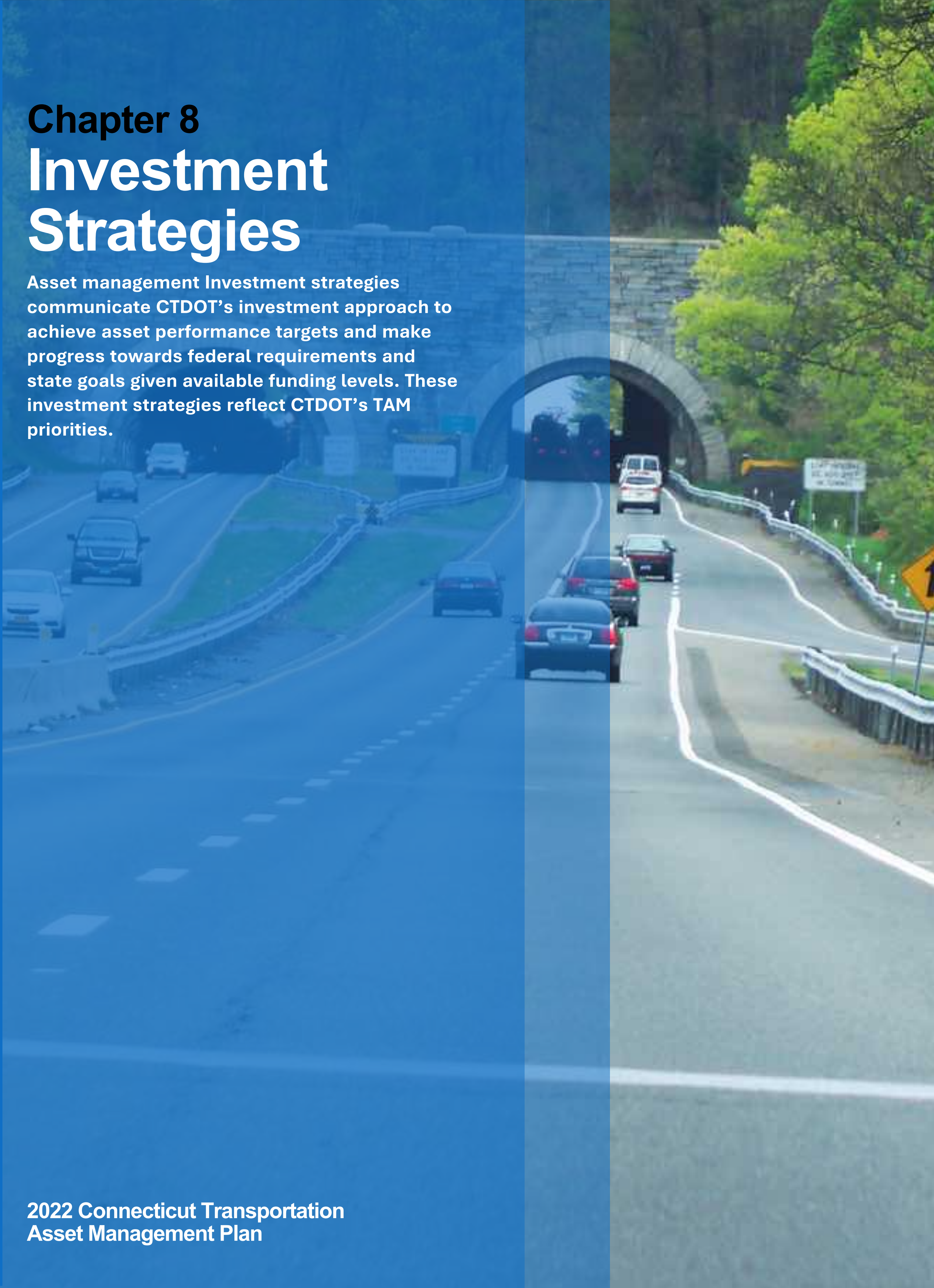
Chapter 8

Investment Strategies

Asset management Investment strategies communicate CTDOT's investment approach to achieve asset performance targets and make progress towards federal requirements and state goals given available funding levels. These investment strategies reflect CTDOT's TAM priorities.



Overview

CTDOT's mission for transportation is to provide a safe and efficient intermodal transportation network that improves the quality of life and promotes economic vitality for the State and the region. Asset management is a process that CTDOT is embracing to help fulfill this mission. The TAMP is documenting asset management practices and serves as a tool to aid investment decision-making.

The investment strategies represent an approach to applying the resources described in the Chapter 7 Financial Plan, using the treatment strategies described in Chapter 5 Life Cycle Planning, managing the risks presented in Chapter 6 Risk Management, and closing the performance gaps detailed in Chapter 4 Objectives and Performance. The strategies in this TAMP represent CTDOT's asset management investment philosophy, showing investment priorities.

Federal Legislative Context

FHWA requires that states include investment strategies as part of their TAMP. FHWA defines investment strategies as "a set of strategies that results from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks." The TAMP must discuss how the investment strategies make progress towards achieving a desired SOGR over the life cycle of the assets in the plan, improving or preserving asset condition, achieving 2- and 4-year state DOT targets for NHS asset condition and performance, and achieving national performance goals. "Desired SOGR" means the desired asset condition over the 10-year period of the TAMP, also referred to as 10-year desired SOGR in this plan.

FHWA also requires that states establish a process for developing investment strategies as part of the TAMP. Specific requirements for the process are listed below.

Investment Strategies Process Requirements

The process must describe how investment strategies are influenced, at a minimum by:

- Performance gap analysis (Chapter 4)
- Life cycle planning (Chapter 5)
- Risk Management analysis (Chapter 6)
- Anticipated available funding and estimated cost of furture work (Chapter 7)

Overall Strategy

The asset management processes support and contribute to the investment strategies that guide resource allocation. Investment strategies are what make the technical details meaningful at a transportation network level and help communicate Connecticut's message of maintaining a SOGR and making progress towards federal requirements and state goals. CTDOT follows a series of investment strategies that guide resource allocation, including an investment philosophy of maintaining a SOGR, a focus on safety, and developing Complete Streets.

SOGR investment strategies are driven by performance targets and projections, life cycle planning, risk management analysis, and anticipated funding and cost of future work described in other chapters of the TAMP. The performance gap analysis, enabled by life cycle planning, helps define the investment needs of the system. Life cycle plans use the estimated cost of future work to establish network level strategies for managing assets. Available funding is a constraint for performance modeling, allowing Connecticut to predict future scenarios more accurately. Risk management adds to the analysis, adjusting potential outcomes based on positive and negative risks. These asset management processes are required in the TAMP and contribute to the investment strategies.

CTDOT’s primary investment strategy for TAM is to invest in assets to maintain a SOGR. This strategy focuses on using a statewide approach to preserve and maintain CTDOT’s transportation assets in such a manner that sustains the asset condition in a SOGR and extends the asset life until replacement is warranted. CTDOT is moving towards a proactive, preservation-first strategy. As CTDOT continues to transition towards this strategy, the financial demand to address reactive, worst-first needs is expected to decrease; however, it is recognized that there will still be situations when a worst-first response is appropriate.

CTDOT anticipates two challenges to a SOGR asset management investment strategy. The first is that in order to most effectively maintain SOGR for assets in the TAMP, CTDOT must implement cross-asset optimization. As CTDOT strives to meet minimum federal requirements and make progress towards state goals, cross-asset optimization will be vital to ensure that all asset categories receive due attention. This involves balancing and prioritizing spending across all assets, including bus and rail Public Transportation assets. The second challenge is that CTDOT must ensure that there is adequate, skilled staff to maintain all of CTDOT’s assets.

Resilience and extreme weather events are a risk which is noted across CTDOT's assets. In new construction, these concerns are considered during the design process. At the appropriate points in an asset's life cycle (when a significant rehabilitation or replacement occurs) there is consideration made to determine if the intended work can address other concerns, including the impacts of future extreme weather events.

Asset-Specific Strategies

CTDOT strives to run a balanced transportation network with investments occurring where needed for preservation and for safe operation of its transportation network. The investment strategies for the assets included in the TAMP are developed at a statewide level.

Bridge

CTDOT has been contending with the combination of aging infrastructure and resource constraints. Recent improvements in network-level bridge condition can be attributed to the following bridge-specific investment strategies.

Bridge-Specific Investement Strategies

- Focus on maintenance activities that directly improve asset performance
- Focus on planning and programming future work on major bridges
- Focus on programming NHS bridges in poor condition
- Constructing low maintenance bridges (i.e. jointless bridges, resilient and durable materials)

In 2010, CTDOT began to focus on maintenance activities and SOGR operations to reduce a growing backlog of bridge maintenance needs identified during the biennial inspection program. In 2014, CTDOT took a forward-looking approach to the 60 major bridges and setup individual rehabilitation or replacement schedules for each of the major bridges for the next 10 years with the intent to update these schedules by the end of the year. Additionally, for all state-maintained bridges, CTDOT's Bridge Management Group programs work through quarterly coordination meetings with engineering and maintenance staff to determine if a capital project is needed or if deficiencies can be addressed through Bridge Maintenance in the Office of Maintenance Operations. In 2015, following the proposed federal bridge performance measures, CTDOT began to focus on designating and prioritizing bridge projects addressing NHS bridges in poor condition in the Capital Program to safeguard their schedules from delays. CTDOT is pursuing technological advancements that promise to extend the life of the bridge and reduce maintenance. CTDOT seeks to design low maintenance bridges by reducing the number of joints or by designing a bridge with no joints, and by utilizing corrosion resistant materials and durable concrete. In the fall of 2018, CTDOT introduced a penetrating sealer protective spray compound to reduce deterioration and extend the life of parapets; the first corridor length penetrating sealer project was initiated in 2022. For new bridges or other new concrete bridge components, the Department is moving towards low permeability concrete to preserve the concrete bridge element against salt infiltration and carbonation. The Department is using other materials for durability such as galvanized bars and metalizing.

CTDOT is currently developing a Bridge Preservation Program which targets NBI bridges and covers a variety of activities. Roughly half of the funding from the program is focused on various bridge preservation methods, including replacing bridge joints, cleaning and painting of bridges, replacing waterproofing membranes and overlay, and concrete sealer application. While these preservation methods existed in some capacity in the past, the extent of bridges being addressed will be greater due to increased funding from the Bipartisan Infrastructure Law. The preservation funding is intended to keep good bridges in good condition and maximize the life of those structures. In some cases, such as replacing bridge joints and concrete sealing, these treatments are targeting a corridor, in order to benefit from the efficiencies of doing so. In these cases, some fair or poor structures will be addressed; however, the corridor was selected to target as many good bridges as possible.

Pavement

CTDOT has several pavement-specific investment strategies listed below.

Pavement-Specific Investement Strategies

- Continue efforts towards a single pavement management system for modeling and programming treatments
- Increase systematic preservation of good condition pavements
- Incorporate additional preservation treament options
- Increase systematic rehabilitation/reconstruction of pavements in backlog (beyond conditon for preservation).

Management of and investment in pavement assets is increasingly being guided by the CTDOT PMS in addition to existing methods and engineering judgment. Progress has been made over the past couple years in developing a single-pavement program. A draft Resurfacing Pavement Process Map continues to be refined as the process continues to evolve. The process is iterative in that the Pavement Management Group recommends a select set of preservation and maintenance resurfacing sections to Pavement Design and Maintenance respectively, those units review, select or defer sections, then the Pavement Management Group offers alternative candidate sections for those that were not selected. Maintenance uses the condition data provided by Pavement Management to aid in selection of resurfacing projects. CTDOT has been able to model the maintenance resurfacing treatment in dTIMS, allowing future analyses to better select treatments that will most likely increase systematic preservation. The pavement preservation program has expanded in funding and quantity of work over recent years to keep good roads in good condition. The preservation program can expand further as additional preservation treatment options are incorporated. An increase of rehabilitation and reconstruction of pavement sections will gradually eliminate the backlog of this type of work, leading to the subsequent preservation of these pavements in the future.

Traffic Signals

CTDOT's traffic signal-specific investment strategies are listed below.

Traffic Signal-Specific Investment Strategies

- Continue efforts to develop and implement a Traffic Signal Management Plan (TSMP)
- Continue planning traffic signal replacement projects based on projected age and/or identified deficiencies
- Continue efforts to develop traffic signal component based life cycle planning
- Seek to improve traffic operations through enhanced signal control systems
- Initiate computerized traffic signal system upgrade projects based on operational considerations

Development of a TSMP will help guide investment in traffic signal asset needs in the areas of design, maintenance and operations to improve safety, mobility, SOGR, and efficiency. In the meantime, CTDOT will primarily continue to replace traffic signals based on age until a component-based life cycle approach is developed and implemented.

Signs

CTDOT's sign-specific investment strategies are listed below.

Sign-Specific Investment Strategies

- Continue planning sign replacement projects based on projected age
- Continue efforts towards replacing signs deemed poor based on nighttime visual inspections

CTDOT strives to maintain investment in the sign asset. Under budget constraints in the past, there was often a tendency to defer sign replacement projects. Currently, sign replacement projects are based on either projected age or nighttime visual inspections.

Sign Supports

CTDOT's sign support-specific investment strategies are listed below.

Sign Support-Specific Investment Strategies

- Continue programming sign support projects based on poor or overstressed conditions
- Include specifications to upgrade sign supports in other capital projects
- Continue efforts to reduce the number of sign supports whenever possible by removing and replacing with signs mounted along the side of the road
- Increase efforts to maintain sign panel sizes, by reducing the legend spacing, on signs in good condition. In order to minimize the number of unnecessary replacements
- Overdesign sign supports with a larger factor of safety to accommodate larger sign panel requirements anticipated in future Manual or Uniform Traffic Control Devices (MUTCD) in order to minimize the number of unnecessary replacements.

CTDOT continues to invest in sign support replacement projects determined using asset condition. In 2010, CTDOT began making a conscious effort to remove bridge-mounted sign supports where possible and replace them with side mounted or other overhead mounted structures during sign replacement projects to reduce loading on bridges and to allow for easier inspection of the supports and bridges. This provided reduced inspection costs and additional safety benefits. In 2017, in an effort to reduce the number of sign supports in good condition that were being replaced due to increased panel needs, CTDOT received approval to reduce the legend spacing on sign panels to be able to continue to utilize existing sign supports in good condition. In 2018, in an additional effort to reduce the number of sign supports in good condition needing replacement due to increased sign panels, CTDOT began overdesigning sign supports with a slightly larger factor of safety to accommodate for larger sign panel requirements anticipated in future MUTCD.

Pavement Markings

CTDOT's pavement marking-specific investment strategies are listed below.

Pavement Marking-Specific Investment Strategies

- Continue efforts towards developing a pavement markings replacement program to obtain a State of Good Repair across the network
- Continue increasing investments in grooved epoxy markings where applicable
- Continue to invest in epoxy pavement markings
- Consider increasing investments in wet reflective grooved epoxy markings
- Investigate alternative paint markings such as polyurea and high build water borne
- Include specifications to replace pavement markings in other capital projects

CTDOT strives to maintain investment in pavement markings through the development of a pavement markings program that maintains this asset in a SOGR. Pavement markings have a very short life cycle with 1 year for water-based markings, 3 years for traditional epoxy markings, and up to 6 years for grooved epoxy markings; therefore, this short life requires a timely and continuous replacement program. Investment in epoxy and grooved epoxy pavement marking programs is important to maintain a SOGR. Although the anticipated lifespan of wet reflective grooved epoxy markings is currently 6-years, the increased benefits of an improved safety factor are invaluable.

Highway Buildings

CTDOT's highway buildings-specific investment strategies are listed below.

Highway Buildings-Specific Investment Strategies

- Demolish obsolete highway buildings to eliminate safety hazards
- Meet regulatory requirements associated with pretroleum and chloride storage tanks
- Focus on maintenance activities that directly imporve asset performance
- Focus on SOGR preservation projects to extend asset life cycle
- Continue to refine the Highway Building program in order to achieve and maintain a SOGR across all building tiers
- Acquire a Facilities Management System software

CTDOT invests in its Highway Buildings through several programs:

- The Facilities Design Unit within the Bureau of Engineering and Construction manages the Department's major capital program and is responsible for constructing, preserving, rehabilitating, and reconstructing highway buildings.
- The Environmental Compliance Unit within the Bureau of Engineering and Construction jointly manages the underground storage tank and Salt Shed Program with Facilities Design.
- The Office of Property and Facilities Services within the Bureau of Finance and Administration manages the minor capital program which addresses routine maintenance and emergency repairs.

Coordination meetings are held annually with Department stakeholders and Engineering Management to discuss building priorities based on the above investment strategies. Historically, CTDOT has focused investments on maintenance facilities and salt sheds. With the implementation of an asset management strategy for buildings, CTDOT has come to realize that all building tiers require a level of investment to achieve and maintain a SOGR. As such, rest areas/weigh stations, specialty buildings, and storage and portable office structures have become an added focus of the major building capital program.

Roadway Illumination

CTDOT's roadway illumination-specific investment strategies are listed below.

Roadway Illumination-Specific Investment Strategies

- Continue to plan, fund, and replace roadway illumination systems through dedicated roadway illumination projects.These "lighting only" projects will seek to prioritize the replacement of roadway illumination systems based on their state of age and repair
- Continue to replace deficient roadway illumination systems through highway safety improvement and roadway reconstruction projects
- Seek to partner with State Utility Companies to enlist utility company contractors to carry out LED luminaire conversions of highway lights through the utility administered energy efficiency programs
- Continue to coordinate with CTDOT District Electrical Maintenance forces to carry out limited illumination repairs and LED luminarie conversions
- Seek to partner with the Department of Energy and Environmental Protection to provide funding (Lead by Example Grant program) to carry out LED luminaire conversions of highway lights

Through the above strategies, CTDOT will strive to improve the efficiency and overall condition of our roadway illumination systems, and in so doing, improve motorist and pedestrian safety.

Retaining Walls

CTDOT's retaining wall specific strategies are listed below.

Retaining Wall Investment Strategies

- Continue maintenance efforts to improve retaining wall asset performance
- Repair or replace the retaining walls that are in poor condition
- Establish a routine inspection program to assess the condition of retaining walls periodically
- Develop a retaining wall program to maintain the SOGR based on projected retaining wall condition and age

Through implementation of a retaining wall program and the above stated investment strategies, CTDOT strives to improve the overall condition of retaining walls and maintain the SOGR.

Drainage Culverts

CTDOT's drainage culvert specific strategies are listed below.

Drainage Culvert Investment Strategies

- Continue maintenance efforts to map and assess drainage culvert conditions
- Repair or replace the drainage culverts that are in poor or failed condition
- Integrate drainage hot-spot mapping with project initiation process
- Create a strategy to begin to move from an emergency response approach to an asset management-based approach to rehabilitate or replace aging culverts, especially corrugated metal pipes

Through the above stated investment strategies, CTDOT is attempting to manage the aging drainage infrastructure more proactively by using asset management strategies. CTDOT hopes to avoid more costly emergency projects caused by failure of corrugated metal pipes underneath state roads.

Intelligent Transportation Systems – ATMS

CTDOT's ITS-ATMS field devices investment strategies are listed below.

Intelligent Transportation Systems – ATMS Investment Strategies

- Implement a Statewide Advanced Traffic Management System (ATMS) for Limited Access Highways- Strategic Plan
- Continue planning ATMS projects based on crash frequency, traffic volume, traffic delay, gaps in coverage and projected age of equipment
- Continue efforts for preventative maintenance on existing equipment to help prolong the equipment's life

Implementation of the Statewide ATMS Strategic Plan will guide investment in ATMS field devices asset needs in the areas of design, maintenance and operations to improve safety, mobility, SOGR, and efficiency.

Summary

CTDOT's overarching investment strategy for TAM is to invest in assets to maintain a SOGR. More narrowly, CTDOT follows a number of asset-specific investment strategies that guide resource allocation. These strategies are driven by the asset management processes detailed in this TAMP, including life cycle planning, performance management, risk management, and financial planning.

Chapter 9

Process Improvements

TAM is a series of processes intended to help preserve asset condition over the life of the asset at minimal cost. Practicing TAM means continuous improvement. Process improvements need to be documented and reevaluated on an ongoing basis to be effective in advancing TAM. CTDOT is striving to improve processes in the areas of asset data management, asset performance, modeling capabilities, risk management, and funding allocation for asset management purposes.

Overview

This chapter supplements the discussion of current asset management practices in Connecticut with identifying key process improvements that will serve as a guide to advance CTDOT TAM practices. The TAMP is a living document that will evolve to reflect changing TAM practices and processes at CTDOT.

Federal Legislative Context

FHWA recommends that state DOTs conduct periodic self-assessments of asset management capabilities. As written in the TAMP Final Rule, "based on the results of the self-assessment, the State DOT should conduct a gap analysis to determine which areas of its asset management process require improvement."

TAM Process Improvements

Throughout the TAMP development, process improvements were identified and monitored by CTDOT's TAM team and asset stewards. The improvements suggested in this chapter include key ideas generated by participants throughout the Department. These represent CTDOT's next steps in its implementation of TAM.

Each process improvement is given one of six statuses:

- Under Consideration
- In Discussion
- Initiated
- In Progress – Deployed
- Implemented – Ongoing
- Implemented - Completed

This chapter also records progress made towards each process improvement and progress remaining.

Process improvements are organized by CTDOT group (e.g. asset management, finance, engineering) and by asset (e.g. bridge, pavement, signs) in Tables 9-1 through 9-18.

Table 9-1. Asset Management Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Apply the asset management development process for additional assets to incorporate into future TAMPs.	**In Progress - Deployed**	Incorporated ITS, Illumination, Drainage, and Retaining Walls into TAMP.	Incorporate Fleet, Noise Walls, ADA, and Guiderail into a future TAMP.
Establish a Standard Operating Procedure for all asset modeling with specified scenario funding levels, time periods based on asset life cycle and consistent inputs for inflation and discount rates with defined scheduling.	**Under Consideration**		Have asset stewards create a guide on how asset management calculations are performed.
Establish a Standard Operating Procedure for the calculation of asset valuation. Also improve the process by developing and incorporating a depreciation methodology based on condition and age into the asset valuation for each asset.	**Under Consideration**	Received FHWA guidance regarding establishing a standard for calculating asset valuation.	Evaluate FHWA guidance for feasibility with CTDOT process.
Complete development of the Project Asset Form initiative to identify and confirm assets, work types, work codes and costs by asset throughout the project milestones.	**In Discussion**	Develop preliminary spreadsheets with work codes and work types for bridges, pavement, traffic signals, sign supports, and highway buildings. Other assets to be done just by work type. Drafted E&C Directive. (9/2020) Developed project asset form requirements to be integrated as part of the COMPASS development for Pavement, pavement markings, bridges, traffic signals, sign supports, and highway buildings. (11/2/2021)	AEC needs to integrate the project asset form into COMPASS. The E&C directive needs to be finalized.

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Correlate project selection process with network performance by asset.	**In Discussion**	Bridge indicates on the PPI the percent change on all bridge performance measures due to work performed. Pavement began process of vetting dTIMS treatment recommendations and where feasible included in the 2022 pavement projects for pavement preservation. For the resurfacing program, treatment candidates were provided to maintenance staff for consideration of inclusion. Percent of recommended treatment programs was recorded.	Work with bridge to track progress made on programming dTIMS recommendations similar to bridge.
Explore and implement methodologies using cross asset allocation to improve project selection and prioritization.	**Under Consideration**		As the asset management process matures and funding may be reduced, cross asset allocation will become more important.
Continue to formalize and improve the risk management process.	**Implemented - Ongoing**	Review and assess TAM Program risks annually. Further develop methods to track mitigation strategies.	Identify key data needed to better assess risk. Use qualitative data to determine cost to mitigate.
Continue development of processes for compliance with 'Part 667,' Summary of Transportation Assets Repeatedly Damaged by Emergency Events.'	**In Progress - Deployed**	Submitted NHS evaluation in 2018 and submitted all federally eligible roads in 2020.	Develop geospatial tracking of assets damaged by emergency events to assist in reporting of requirements for Part 667.
Identify opportunities for alignment of TAMP with other CTDOT plans as applicable.	**Under Consideration**		Find a better way to connect TAMP with STIP. Review all other plans.
Consider other national goal areas, in particular freight, in regards to the TAMP investment strategies.	**Under Consideration**		Learn how they tie together. Mapping the intersection of national goal areas and the TAMP performance measures.
Develop and issue CTDOT Policy Statement on Asset Management.	**Initiated**	Drafted CTDOT policy statement.	Approve and distribute CTDOT policy statement.
Formalize TAM Steering Committee into a CTDOT Standing Committee.	**Under Consideration**		Determine standing committee members and draft charter.

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Continue to improve data collection, and upgrade systems and revise procedures to monitor and track asset condition.	**In Progress - Deployed**	ESRI app tools under development through UCONN for guiderail, ADA curb ramps, and traffic signal M-88.	
Consider aligning the TAMP with the Americans with Disabilities Act (ADA) Transition Plan for the following assets/asset components: pedestrian buttons (Traffic Signals asset), sidewalks and curb ramps (Highway Buildings, Sidewalk, and Curb Ramp assets)	**In Discussion**	Current focus is on curb ramps and crosswalks locations as part of the app. Pedestrian push buttons are being recorded as a component of the traffic signal assets. Drafted curb ramp fact sheet.	Continue collecting curb ramp inventory, slopes, and measurements to determine a state of good repair. Transition from using the previous 2014 inventory visual deficiencies to using measured compliance.
Develop a standardized template to collect annual asset management data updates from asset stewards.	**Implemented - Completed**	Version 2 of the fact sheet/data collection template completed.	
Develop an action plan to assign, track and monitor process improvements identified in this chapter.	**Initiated**		A consultant will draft this action plan.
Develop criteria for assigning data confidence ratings for the fact sheets.	**Initiated**	Criteria has been drafted.	Criteria needs to be reviewed and implemented.

Table 9-2. Engineering Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Integrate asset management in capital planning and programming.	**Initiated**	The capital program now includes TAM placeholders for each asset. Also a placeholder has been included in a future needs category for the difference between preferred funding and current funding. A spreadsheet has been developed that is updated/revised based on the monthly obligation plan and includes asset work types linked to projects with the intent to verify projects and remaining placeholders.	As asset projects come in to the capital program, to decrease the placeholders and be sure to make updates to the placeholders as project costs change.
Implement asset data updates associated with capital projects through the CAD to GIS initiative and the Project Asset Form initiative to CTDOT TAMP.	**In Discussion**	Developed project asset form requirements for work types and work items to be integrated as part of the COMPASS development for Pavement, pavement markings, bridges, traffic signals, sign supports, and highway buildings. (11/2/2021) For sign asset a pilot is underway to update asset inventory directly from design stage into database.	Move the CAD to GIS initiative from pilot phase to implementation for more projects.
Implement new technology methods, which extend asset life cycles.	**Implemented - Ongoing**	Wet reflective pavement markings are in pilot projects, which is anticipated to increase life and retroreflectivity at night and wet conditions. New sign sheeting type XI is implemented, increasing nighttime visibility and extending life. Signals has switched from loop detectors to video detection, which reduces malfunctions and simplifies replacement. Illumination is switching to LEDs from metal halides, extending life and reducing power consumption.	Continue research of new technologies.

Table 9-3. Construction Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Relate work items to asset identification in AASHTOware Project (AWP) where appropriate to update inventory and condition and capture needed costs for asset life cycle management.	**Under Consideration**	There is a pilot underway using Project Estimation to integrate estimation items directly to assets.	Continue pilot and implement.

Table 9-4. Maintenance Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Relate work items to asset identification in a MMS where appropriate to update inventory and condition and capture needed costs for asset life cycle management.	**In Discussion**	The RFI was done in 2018 and companies presented in January 2019. CTDOT submitted application for the state's capital improvement grant. Application is currently on hold, awaiting internal discussions.	Develop and implement MMS.
Implement Asset Management positions responsible for maintaining the asset inventories at each district for all work accomplished through Maintenance and also under encroachment permit projects	**Under Consideration**		

Table 9-5. Finance Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Coordinate financial management of capital planning with asset management priorities.	**In Discussion**	Asset Management meets monthly with Capital Services to discuss upcoming needs and existing project adjustments.	Include adjustments to TAM placeholder project monitoring as part of the meeting.
Distinguishing Emergency Relief funds by asset for Part 667.	**Initiated**	Part 667 spreadsheet created to track locations of emergency relief projects.	Add column in Part 667 tracking for asset type.

Table 9-6. Planning Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Support locating assets on the LRS.	**Initiated**	Bridges, signs, traffic signals, and the maintenance paving program (VIP).	Correlate the assets from ESRI to the LRS.
Coordination of performance measures with MPOs.	**Implemented - Ongoing**	Occasional updates at MPO quarterly meetings, as needed.	Discuss NHS Bridge and Pavement targets with MPOs in spring 2022.

Table 9-7. Technology Services Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Provide necessary resources (hardware, software, communications, technical) to support a data-driven asset management approach to our transportation system.	**In Progress - Deployed**	Engineering has provided maintenance with 34 iPads for inventory collection of traffic signals work orders (M-88) and curb ramps.	
Provide server capabilities to run deterioration modeling and life cycle analyses.	**Implemented - Completed**	dTIMs for bridge and pavement were moved to cloud based analysis for better server capabilities (for the 2020 TAM analyses).	
Continue to support and implement the TED to meet the needs of asset management.	**In Progress - Deployed**	Working with the Traffic Signal database structure (data model). Bridge, sign supports, traffic signals are all being incorporated into the new version of TED.	Future improvements in TED development are expected to meet the needs of asset management.

Table 9-8. Bridge Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Review and program feasible treatments recommended by the bridge analysis model to prioritize work and improve network performance.	**In Discussion**	dTIMS and BRM are currently used as a check for projects being chosen.	Begin programming directly with dTIMS and BRM in the future.
Bridge Preservation: Bridge washing in spring	**In Progress - Deployed**	Currently occurs on a limited number of bridges, but still ongoing.	Continue on current bridges, and attempt to expand if possible.

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Bridge Preservation: Concrete sealant application	**Implemented - Ongoing**	There is a project underway with an FDP of July 2022. The sealant application should begin in 2023 along the I-95 corridor.	Concrete sealant is planned to be completed on a yearly basis going forward.
Bridge Preservation: Bridge painting, initiation of clean and coat program	**Initiated**	A project on I-395 and Route 8 is planned to begin in 2023.	
Bridge Preservation: Bridge joint program	**Initiated**	A project is planned with an FDP of July 2022; it will replace bridge joints along Route 9.	
Develop and implement a process to address deteriorated elements in addition to the Capital Project process. (IDIQ)	**Initiated**	Variable quantities were used on a project at bridge 00032. Deck patching and partial depth patching quantities were overestimated and it cost the department. A meeting on lessons learned is planned for September 2022.	Plan to follow up next year to investigate the lessons learned.
Continue to refine analysis modeling abilities.	**Implemented - Ongoing**		The University of Hartford began their study of this in February 2022. This is expected to be a 2-year study.
Use more durable materials and protect older elements to slow deterioration.	**In Progress - Deployed**	All new bridge decks and parapets should be low permeability concrete	
BSP review of new materials and techniques	**Implemented - Ongoing**	Currently looking at using glass fiber reinforcing bars. These have been used for one bridge in Manchester so far.	
Maximize use of jointless bridges where applicable to minimize maintenance cost	**In Progress - Deployed**		Attempt to use UHPC link slab to eliminate joints.
Discussing having joints addressed in PPP's	**Under Consideration**	Looking at addressing joints separately from pavement projects. Looking to do low permeability pavements as well as waterproofing membranes. Still in flux but heading in this direction.	
Suggest standardizing model for life cycle cost analysis	**Under Consideration**	As of May 1st 2022 everyone has to comply with a standard model. https://portal.ct.gov/-/media/DOT/documents/AEC/EB-2022-2_LCCA-Guidance_Signed-by-THN.pdf	

Table 9-9. Pavement Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Develop a comprehensive and consolidated 3-year program identifying Preservation and Maintenance Resurfacing projects by year, to be updated annually.	**Implemented - Ongoing**	2021 Preservation and Maintenance Resurfacing projects were identified, and an Annual Resurfacing Program Process Map was developed for 2022/2023. Candidate lists for 2022/2023 were generated by Pavement Management and are under review by Maintenance and Pavement Design. This is also true for ‘23/’24. The process map has been refined, and progress has been made towards a final version of a live document.	Possible engineering bulletin, design streamlining, and implementation of IDIQ contracting to minimize design effort for preservation.
Develop a 10-year Reconstruction and Rehabilitation program identifying projects by year, to be updated annually.	**Under Consideration**	Still under discussion in a subcommittee.	Make progress with subcommittee.
Implement Pavement Action Plan recommendations pertinent to asset management including: -Refine pavement analysis methodology -Improve tracking of paving work -Sync pavement sections with LRS	**Initiated**	A CTDOT - UConn agreement was executed with a task to implement redefined PCI within dTIMS software, where UConn will partner with Deighton to help accomplish this objective. UConn continued updating pavement sections, and Pavement Management worked with Planning and Bentley to sync sections in EXOR. UConn updated pavement sections, sections are in sync with EXOR, moving away from old system.	Partner with Deighton to get this fully implemented.
Continue to refine analysis modeling abilities.	**Implemented - Ongoing**	This is an ongoing process with Deighton, and requires significant troubleshooting by CTDOT. Some revisions have been made to triggers.	Implementation of new PCI developed by UConn should improve the modeling, as the new index will better represent actual conditions.

Table 9-10. Traffic Signals Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Complete development and implement a component and condition based approach to managing traffic signals.	**Initiated**	Traffic Engineering has developed a formula to calculate SOGR. UCONN is working on logic to calculate using fields in ESRI.	Traffic Engineering will collect controller, detector, and various other signal component information. Bridge Safety & Evaluation will provide inspection ratings on span poles 26+ years old. UCONN will finalize calculations in ESRI.
Improve capability of Traffic Signals Database to include an additional level of detail for signal component installation years as required for tracking and managing life cycle replacement of signal components for asset management purposes.	**Initiated**	100% of the intersections have been digitized in ESRI by UCONN. Traffic Signal support structure inspection ratings managed in InspectTech/AWARI have been linked to signal locations in ESRI. Electronic M-88 modified to collect information and update ESRI for controller, cabinet, & conflict monitor.	UConn will sync with current Traffic Signal Database prior to moving the platform to production.
Complete development and implement CTDOT's TSMP.	**Initiated**	A streamlined draft TSMP was assembled by CTDOT, and a final draft has been reviewed.	Finalize and publish the TSMP.

Table 9-11. Signs Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Consistently capture date and sign attributes at Construction and Maintenance installations.	**Implemented - Ongoing**	Three construction projects are actively being worked on, including a little over 5,000 signs that are commissioned with dates and pictures. The switch to ESRI has been completed.	Creating a portal with visualizations.
Update initial 2013 sign data to reflect current inventory.	**Implemented - Ongoing**	Route overlap duplication have been identified (discrepancies have not all been removed).	Update data model.
Implement CAD to GIS solution upon successful completion of pilots.	**In Progress - Deployed**	Switched from CAD to GIS to a straight GIS solution.	90% completion of first construction project.

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Laminating according to manufacturer specs	Initiated	Manufacturer came in to provide training.	This is currently only being used at the sign shop. The printer needs to provide additional training. Options for new ink types are under consideration.
Digital printing instead of screening in sign shop only	Implemented - Completed	The sign shop has removed all screen printing.	
GIS team member added (CCT/Planner)	Implemented - Completed	Two GIS positions have been filled.	
Potential of District 5 administering all signing projects in construction	Under Consideration		Currently not planned to do all signing projects.
Retroreflective sheeting type increased service life	Implemented - Completed	New standard has been implemented for sheeting type XI.	

Table 9-12. Sign Supports Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Maintain inspection cycle.	Implemented - Ongoing	An inspection cycle is ongoing, using 5 consultants.	Monitor and check in with Bridge Safety.
Complete development of condition-based deterioration modeling.	Initiated	CCSU Started working on this in December 2021. No updates beyond this.	CCSU will be setting up a sign support deterioration model. Project Asset Form still being developed.
Complete process in the CPD to allow for tagging of sign supports as an asset in projects.	In Discussion	AEC is working on overhauling this, deadline unknown.	AEC needs to complete this.

Table 9-13. Pavement Markings Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Develop a consistent network investment program cycle.	In Discussion	Funding is more consistently programmed.	Need to coordinate with Signs and Markings. Federal program is age based, replaced every 3 years.

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Improve methods to track and maintain pavement marking data utilizing mobile devices for better lifecycle management.	**In Progress - Deployed**	Retro-reflectometer purchased by UConn. To be turned over to DOT after several year program.	Acquire from UConn. Also need to integrate the process into photolog and manage the data process.
Seek alternative contracting methods including performance based.	**In Discussion**	Environmental review request form updated to eliminate need for specific termini.	Include new spec testing.
Investigate impacts of carbide snow plow blades on the life expectancy of pavement markings.	**In Discussion**	Annual discussions. Recessed markings are reducing negative impacts of the blade.	Attempt to use more grooved pavement marking to eliminate the issue.

Table 9-14. Highway Buildings Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Refine the overall building scores that were derived from the 2017/2018 Building Inspection Program to more accurately reflect building condition SOGR ratings by: -Reevaluating the impact the Site forms have on Tier 3 building scores since Tier 3 projects don't receive site improvements like Tier 1 and Tier 2 projects -Reevaluating the impact the weight factor has on Tier 2 and Tier 3 building ratings since Tier 2 & Tier 3 buildings only have a small portion of the components that Tier 1 buildings have -Reevaluating overall building scores as they appear slightly higher than anticipated, but still provide an accurate SOGR ranking of the inventory	**Under Consideration**	Reevaluating due to low benefit to effort. Note: Reevaluation makes sense to do after FMS.	On hold until FMS is implemented.

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Refine the building inspection report formats for specific building types to include only the pertinent data fields for greater efficiency	**Under Consideration**	Reevaluating due to low benefit to effort. Note: Reevaluation makes sense to do during FMS.	On hold until FMS is implemented.
Implement a Facilities Management System that can track and update asset inventory and condition; issue and track electronic work orders, and forecast performance and treatments using deterioration modeling		A statewide Team consisting of DOT/DAS/CSCU has been established and a group CIPA application has been submitted to OPM in 2021. Several meetings have occurred with OPM in 2021 & 2022 who continue to question the initiative and are currently pushing the Team to explore a PeopleSoft (Core-CT) solution.	Get statewide CIPA application approved and begin FMS implementation.

Table 9-15. Roadway Illumination Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Increase maintenance staff.	**Under Consideration**	N/A	Schedule a meeting.
Start a formalized training program or manual for transfer of knowledge.	**Under Consideration**	N/A	Start discussions.

Table 9-16. Retaining Walls Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Establish/Maintain inspection cycle.	**Initiated**	Consultants should begin inspections in the fall.	Considering inspections on a 10 year cycle for good/fair walls. Poor condition walls would be inspected on a shorter cycle.
More consistent inspection program using a training program for consultants	**In Discussion**		Training expected to be completed for staff within the next year.
Working with AEC to include retaining walls as a linear asset within Atlas for more precise location	**Initiated**		Working with Bridge Safety and AEC to incorporate the scope of work for consultants, and determine required equipment.

Table 9-17. Drainage Culverts Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Identify responsibility for various aspects of "drainage"	**Initiated**	Working on presentation to senior leadership regarding MS4, SOGR, and Resiliency.	Continue identifying responsibility.
Mapping/Inventory	**Implemented - Ongoing**	~45% of the system has been mapped.	Continue mapping asset (on-going).
Inspection	**Implemented - Ongoing**	OEP is managing the culvert assessment program. 45% of the network has been mapped and 15% has been inspected. The inspection process is ongoing.	Continue ongoing inspections. Identify new source of funding and potential new source of inspectors.
Managing inspection data	**In Discussion**	A meeting was held on 4/26 for inspection data-steward to be identified.	Identify the inspection data-steward.
Create a process for culvert replacement priority	**In Discussion**	Preliminary prioritization/analysis of 12/31/2021 snapshot	Continue manually updating list as needed.

Table 9-18. ITS Process Improvements

Process Improvement	Status (2022)	Progress Made	Progress Remaining
Institute a formal training process or develop a training manual.	**In Discussion**	Meetings have occurred to identify processes and work flows for engineers.	Schedule follow up meetings and document.
Asset management of fiber network allocation.	**In Discussion**	Meetings have occurred to discuss.	Identify funding and implement fiber optic network software.
Hiring new engineers. Current salaries are not competitive with the private sector. (Global issue across all assets)	**Under Consideration**	Job postings submitted and currently conducting interviews.	Start discussions of potential barriers (e.g. increasing wages).
Update strategic plan	**Implemented - Completed**	Created Strategic Plan.	Update Strategic Plan as needed.

CTDOT also tracks four process improvements that cut across all assets in the TAMP. Below is a summary of progress in those areas.

Coordinate implementation of data quality standards

The assets in the TAMP have varying levels of asset management maturity and of data quality standards. More mature assets like pavement are working to improve control site validation testing, improving reference measurements, and sharing resources with other states. For assets such as highway buildings and retaining walls, data quality is part of the inspection and data collection process. Other assets in the TAMP are less mature in this area and are just starting to develop data quality standards.

Continue to refine models and proposed treatment options

As with data quality, certain assets, such as bridge and pavement, have established modeling systems and processes. For pavement, CTDOT is working to implement the new PCI developed by UConn, which will improve modeling by better representing actual conditions. Traffic signals has also partnered with UConn to develop a model that includes ESRI mapping elements. In another partnership with an academic institution, CCSU is helping CTDOT develop a sign support model. Highway buildings are currently modeled manually, but CTDOT expects to update the process when a facility management system is implemented.

Verify field performance of treatment life expectancies to incorporate into models in order to improve forecasting of asset deterioration.

This process improvement is in early stages for most assets, with nine of eleven assets reporting it as “under consideration” or “in disucssion”. The two assets that have initiated the process are bridge and signs. Bridge will use GIS to record when joint and sealant is installed to better track deterioration over time, while signs are also using GIS to track asset dates and manufacturer. Traffic signals plans to use an electronic tracking form, while pavement markings plans to acquire a retroreflectometer to better measure asset condition in the field.

Track planned and completed work by FHWA work types and CTDOT work codes along with associated costs to support the TAMP financial plan and investment strategies.

This key process improvement helps CTDOT develop the TAMP financial plan. As described in Chapter 7, TAM placeholders and asset tagging in the obligation plan are the first step in tracking investments by FHWA work type. For certain assets, CTDOT is also planning to track work codes at a more detailed level.

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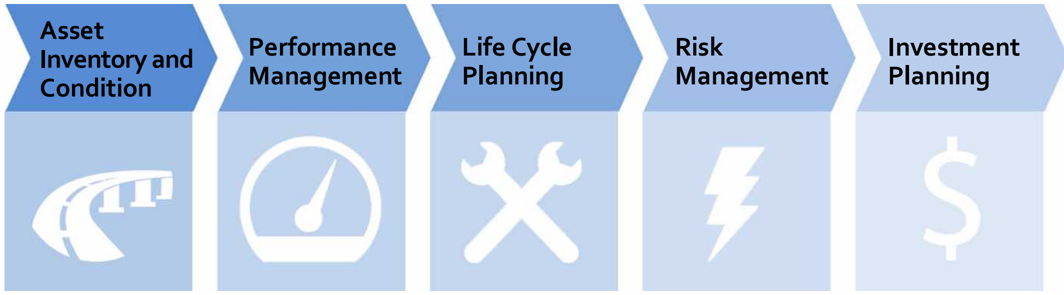
Appendix A. Asset Fact Sheets

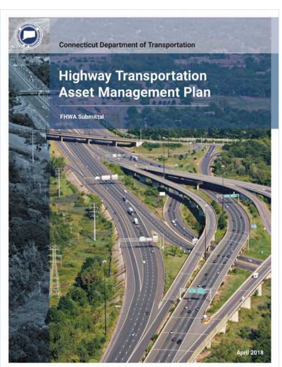
CTDOT's Asset Management Program



Asset management at CTDOT is a risk-based, data-driven process to maximize transportation performance and user experience, to prioritize resources, and to optimize treatments and costs over the life cycle of an asset for the state's multimodal transportation system. In Connecticut, the implementation of transportation asset management (TAM) is needed to address the condition of infrastructure as many assets have aged beyond their intended life expectancy while demands on the transportation network have increased.

The Connecticut Transportation Asset Management Plans

CTDOT has created its Transportation Asset Management Plans (TAMPs) in accordance with federal mandates to establish and document the agency's strategic and systematic process of managing its transportation assets.



Asset Inventory and Condition. CTDOT owns, operates and maintains a multimodal transportation network comprised of highway and transit assets. In terms of their cost and extent, the most significant assets on the system are bridges and pavement. CTDOT owns and maintains the entire Interstate Highway System in Connecticut and approximately 95% of the non-Interstate National Highway System (NHS). CTDOT also owns and maintains all bridges, pavements, traffic signals, signs, sign supports, pavement markings, highway buildings, roadway illumination, retaining walls, drainage culverts, and intelligent transportation systems on the State Highway System. CTDOT also owns or subsidizes nearly all of Connecticut's public transportation services, including commuter rail, bus, bus rapid transit, paratransit, and ferry service.

Performance Management. Monitoring and measuring transportation asset condition enables CTDOT to assess the performance of the transportation system, predict future needs, allocate funding, and schedule projects in an effort to achieve a state of good repair. Asset condition is also an important public-facing measure. Users of the transportation network experience asset condition every day.

Life Cycle Planning. Life cycle planning (LCP) is used to determine what actions to perform on an asset over its life cycle considering these costs. The basic principle underlying LCP is fundamental to asset management: Timely investments by CTDOT in an asset results in improved condition over a longer time period and lower long-term costs. Application of preventive maintenance early in an asset's life when it is still in relatively good condition can delay the need for more costly rehabilitation, replacement, or reconstruction and result in an overall lower life cycle cost.

Risk Management. Managing transportation assets also entails managing risk. CTDOT must balance a wide variety of risks on an ongoing basis and take prudent mitigation actions given funding constraints. Risks range from daily operational concerns to potentially catastrophic risk of asset failures. Being proactive in managing risk helps CTDOT to better utilize capital funding towards maximizing the condition of transportation assets.

Investment Planning. Asset management investment strategies reflect CTDOT's TAM priorities and communicate CTDOT's investment approach to achieve asset performance targets given available funding levels. A TAM financial plan connects the TAM objectives and targets to investment strategies, revenues, and project delivery programs.

Asset management is the process of balancing performance, cost, and risk. Achieving this balance involves a strategic and systematic process of operating, maintaining, upgrading and expanding physical assets effectively through their lifecycle with better decision-making based on quality information and well-defined objectives. It requires business processes, data, information systems, financial commitment and an agency culture capable of implementing asset management.

Asset Management Process Improvements

TAM is a series of processes intended to help preserve asset condition over the life of the asset at minimal cost. Practicing TAM means continuous improvement.

These TAM principles shape the vision that CTDOT has for delivering added value to Connecticut travelers. In recent years, CTDOT created an asset management office and has advanced TAM practices. These advancements include improved understanding of assets and their condition; the relationship between financial investment and longer term performance; implications of risk; and integrating all of these factors into CTDOT's funding allocation process.

The improvements in business practices of better data, better processes, and better tools are leading to CTDOT's ability to answer the following questions:

- What are CTDOT's physical assets; where are these assets; what condition are they in; how well are they performing?
- What work has been performed on the assets and when, how much did it cost, and what was the outcome?
- How much will it cost to reach and maintain performance targets?
- What work should be performed with the money available; what work is already funded and scheduled?
- Where are the biggest risks?

CTDOT continues to make progress in implementing an overall asset management program that results in getting the most performance for the resources available. This includes striving for efficient collection of data, timely updates of business-critical information, improved life cycle planning, and analysis of asset performance in projects and programs to enable CTDOT to deliver programs and projects that improves the assets.

CTDOT's asset management program will :

- **Reduce life cycle costs of asset maintenance** by better tracking asset costs and performance, and making decisions that minimize costs over time to deliver the best value for every public tax dollar;
- **Focus staff resources on tasks that will add the greatest value** through business processes and tools that deliver efficiency and effectiveness;
- **Enhance CTDOT's credibility and accountability** to the Governor, legislature, and customers with investment decisions based on understanding CTDOT's asset needs, priorities, and available funds.

To complement the Connecticut TAMP, CTDOT developed a series of quick reference Fact Sheets providing at-a-glance summaries of asset inventory and condition, State of Good Repair, performance projections and targets. The Fact Sheets use simplified graphs and other information displays with supporting contextual detail to document CTDOT's TAM approach.

Connecticut Transportation Asset Management Plan

Bridge

Data Confidence
High

Description

- CTDOT inspects 5,433 roadway bridges, 1,822 of which are National Bridge Inventory (NBI) structures on the National Highway System (NHS).
- 4,058 of these bridges are state maintained; the remaining 1,375 are maintained locally or under another jurisdiction
- CTDOT defines a bridge as a crossing of at least six feet in length, including culverts. The Federal Highway Administration (FHWA) defines an NBI bridge as a structure measuring more than 20 feet in length.
- CTDOT has a distinct Major Bridge Program for large or expensive-to-replace bridges. 60 structures are currently categorized as Major Bridges.

State of Good Repair (SOGR)

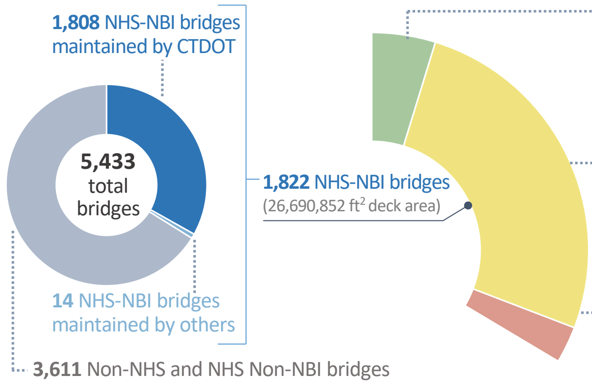
A bridge for which the condition rating for each of the three major components for a span bridge (Substructure, Deck, and Superstructure) or the structural condition of a culvert is rated at least a 5 on a 0-9 condition scale is classified as being in a SOGR.

Bridge Age

The average NHS-NBI bridge in Connecticut is 55 years old, which is 7 years older than the national average of 48 years. The state has a higher percentage of Poor bridges (by deck area) compared to the national average.

NHS-NBI Inventory and Condition

Federal Requirements



Good **3,781,424 ft²**
14.2% of deck area on NHS-NBI bridges is in good condition (378 bridges).
[NBI condition ratings of 7,8, or 9]

Fair **20,737,588 ft²**
77.7% of deck area on NHS-NBI bridges is in fair condition (1,391 bridges).
[NBI condition ratings of 5 or 6]

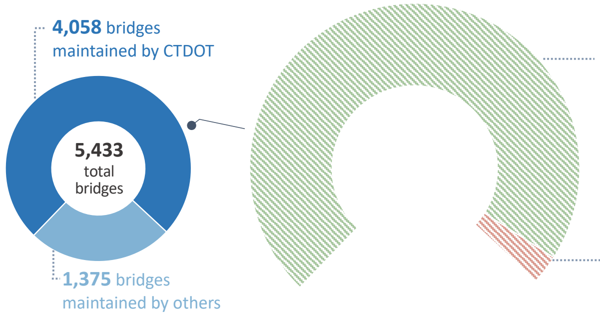
Poor **2,171,840 ft²**
8.1% of deck area on NHS-NBI bridges is in poor condition (53 bridges).
[NBI condition ratings of 0, 1, 2, 3, or 4]

Good-Fair-Poor defined by MAP-21/FAST Act

Based on CTDOT 3/15/21 NBI Submittal

CTDOT-Maintained Inventory and Condition

State Goals



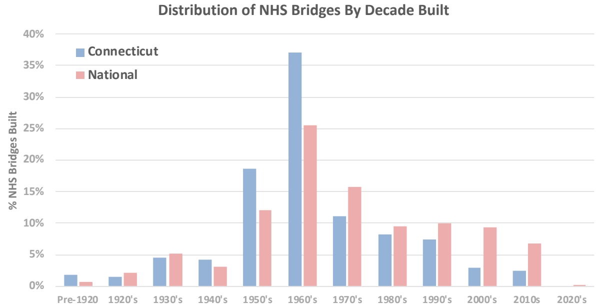
State of Good Repair **3,903 bridges**
96.2% of CTDOT-maintained state bridges are in good or fair condition
[NBI condition ratings of 5 or higher]

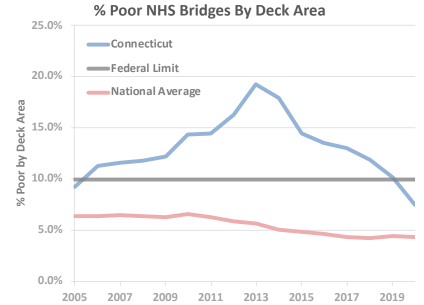
Poor **155 bridges**
3.8% of CTDOT-maintained state bridges are in poor condition
[NBI condition ratings of 4 or lower]

SOGR defined by CTDOT

Based on CTDOT 3/15/21 Snapshot

History





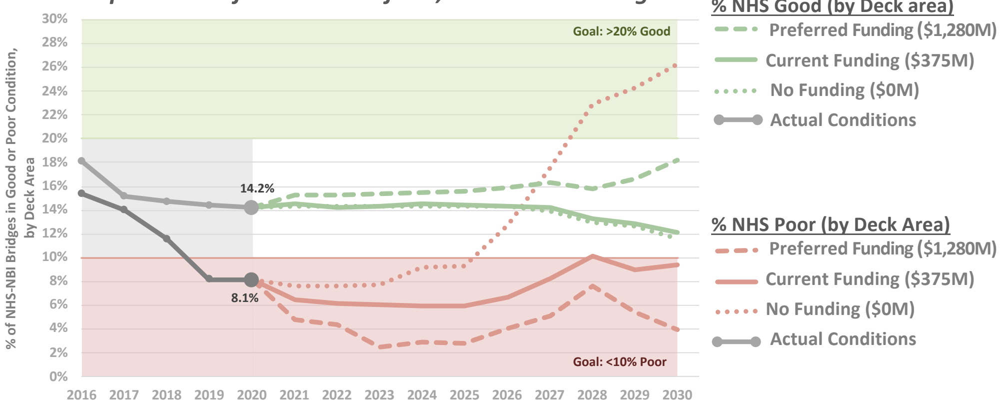
Based on National Data available from FHWA LTBP InfoBridge

Connecticut Transportation Asset Management Plan

Bridge

NHS-NBI Bridge Performance Projections

Federal Requirements for deck area for 1,822 NHS-NBI bridges



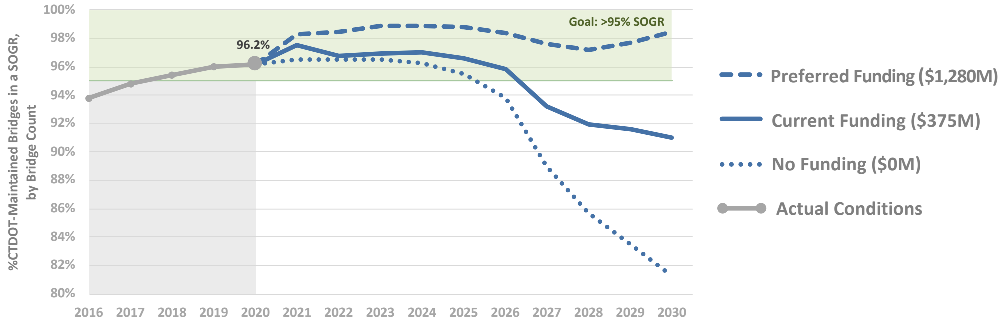
'No Funding' scenario assumes routine bridge maintenance continues, but all capital work is canceled

Performance Projections at Current Funding Level ($375M Budget)

End of Year	2021	2022	2023	2024	2025	Goal
NHS Good (by deck area)	14.5%	14.2%	14.4%	14.5%	14.4%	>20.0%
NHS Poor (by deck area)	6.5%	6.2%	6.1%	6.0%	6.0%	<10.0%

CTDOT-Maintained Bridge Performance Projections

State Goals by number of bridges for 4,058 CTDOT-maintained bridges



'No Funding' scenario assumes routine bridge maintenance continues, but all capital work is canceled

Performance Projections at Current Funding Level ($375M Budget)

End of Year	2021	2022	2023	2024	2025	Goal
SOGR	97.5%	96.8%	96.9%	97.0%	96.6%	95.0%

NOTE: "Current Funding" shown in the graphs is limited to funding programed to address State of Good Repair. Projected performance is expected to be greater due to asset improvements funded through CTDOT's Capital Program which are not captured. The Department will soon be able to capture this funding through a project asset data system in development.

Performance Projections

The chart on the left depicts bridge condition for various funding scenarios. These were developed through an analysis program using CTDOT bridge condition data, as of February 2021.

Asset Valuation

$17,065,712,000

Asset value is estimated using the replacement value. For bridges, replacement value is the product of deck area and unit construction cost. For 4,058 bridges: 34,827,984 sqft * $490/sqft = $17.1 billion.

Measures and Goals

CTDOT has set the following bridge condition goals:

Federal Requirements:

- 10% or less Poor by deck area on NHS-NBI bridges (Federal minimum is less than 10% Poor)
- 20% or more Good by deck area on NHS-NBI bridges. (Percent Good is established by each state; no Federal minimum for this goal)

State Goal:

- 95% or more of State-Maintained bridges in a SOGR (State target)

Connecticut Transportation Asset Management Plan

Pavement

Data Confidence
High

Description

- There are 3,715 centerline miles of state-maintained routes and roads in Connecticut, 1,406 of which are on the National Highway System (NHS), including 346 Interstate miles.
- There are another 17,454 centerline miles of town maintained roads, 56 of which are on the NHS.
- 70.7% of CTDOT maintained centerline miles are flexible (asphalt) pavements, 29.0% are composite pavements (asphalt over concrete), and 0.3% are rigid (concrete) pavements.

State of Good Repair (SOGR)

A pavement section for which the Pavement Condition Index (PCI) is 6 or greater is classified as being in a State of Good Repair (SOGR). The PCI is based on cracking, rutting, drainage disintegration, and ride. FHWA uses different condition measures for NHS pavements.

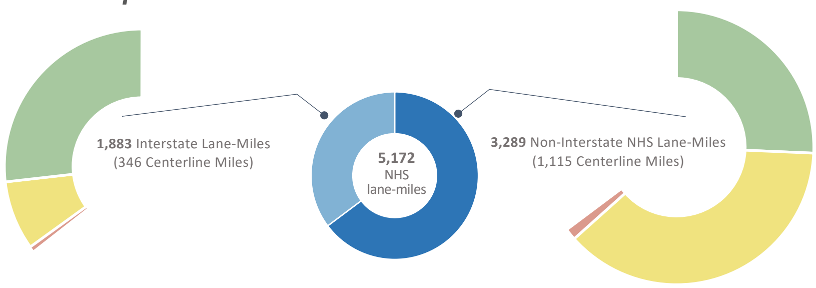
Pavement Age

The average Connecticut NHS pavement structure was constructed 47.6 years ago, and the average surface age is 7.3 years old, based on lane miles.

NHS Roadways Inventory and Condition

Federal Requirements

Good-Fair-Poor defined by MAP-21/FAST Act



Interstate Pavements

Good	Fair	Poor
1,313 Lane-Miles 76.5% are in Good condition	**399 Lane-Miles** 23.3% are in Fair condition	**3 Lane-Miles** 0.2% are in Poor condition

Non-Interstate NHS Pavements

Good	Fair	Poor
1,250 Lane-Miles 39.6% are in Good condition	**1,836 Lane-Miles** 58.3% are in Fair condition	**67 Lane-Miles** 2.1% are in Poor condition

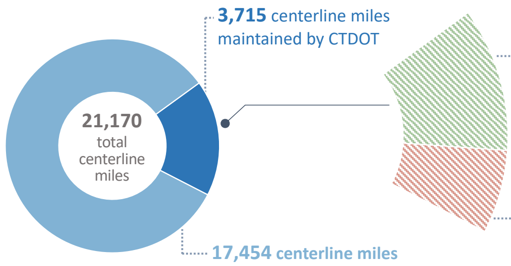
Note on Interstate: Total condition lane miles of 1,715 excludes 131 lane miles coded as bridge and 37 lane miles missing/invalid.
Note on Non-Interstate NHS: Total condition lane miles of 3,153 excludes 81 lane miles coded as bridge and 55 lane mile missing/invalid. Totals include 127 NHS lane miles which are locally maintained, 3.5% in good condition, 91.7% in fair condition and 4.8% in poor condition.

Based on 2020 HPMS pavement condition data submitted to FHWA June 14, 2021

CTDOT-Maintained Roadways Inventory and Condition

State Goals

SOGR defined by CTDOT



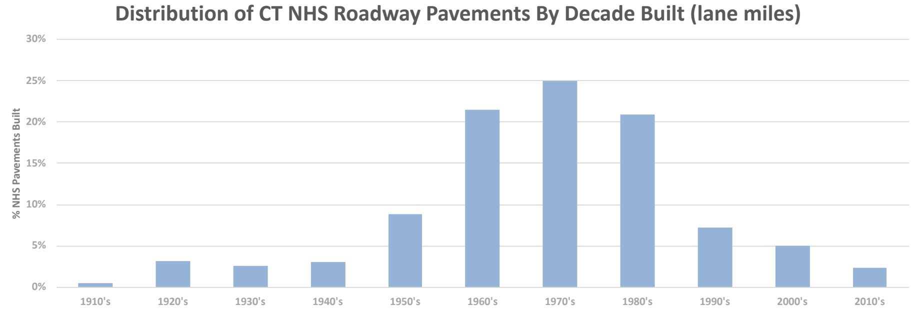
State of Good Repair **2,551 centerline miles**
69.4% of CTDOT-maintained centerline miles have a PCI of 6 or greater

PCI Poor **1,123 centerline miles**
30.6% of CTDOT-maintained centerline miles have a poor condition PCI rating lower than 6

Based on CTDOT 1/11/22 Snapshot

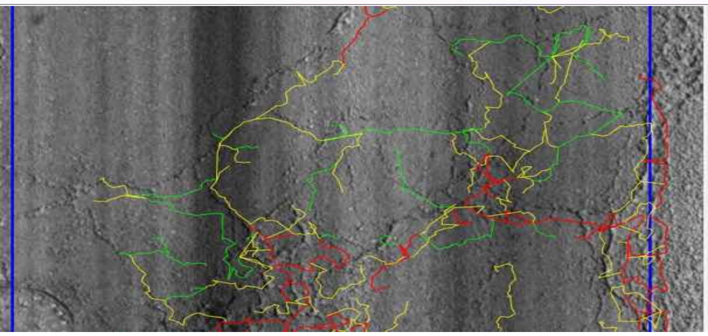
History

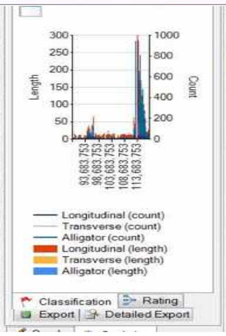
Distribution of CT NHS Roadway Pavements By Decade Built (lane miles)



Connecticut Transportation Asset Management Plan

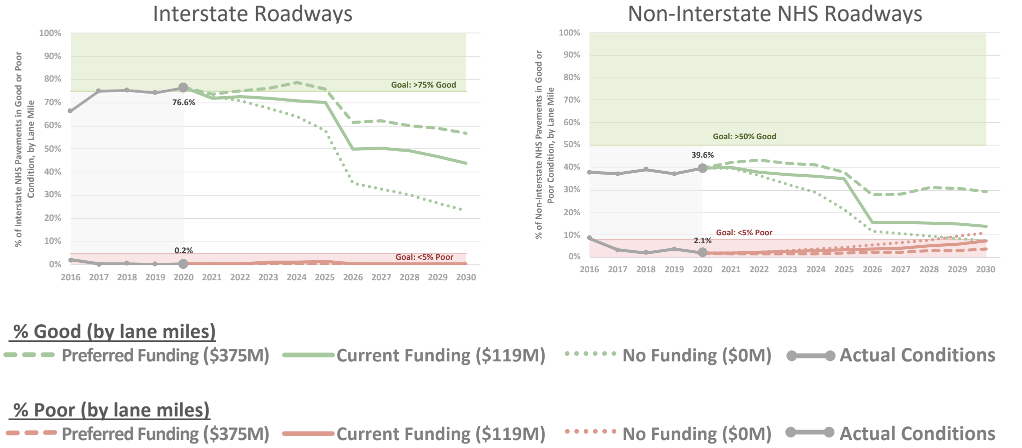
Pavement





NHS Pavement Performance Projections

Federal Requirements by lane miles for 4,868 lane miles of NHS pavement



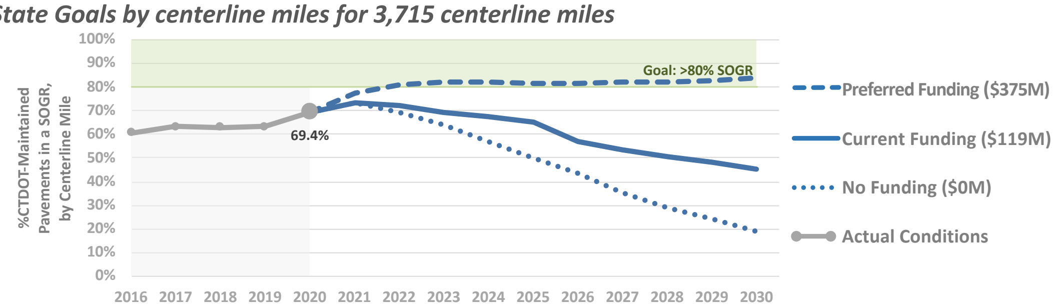
Based on funding as of 12/31/21

Performance Projections at Current Funding Level ($119M Budget)

End of Year	2021	2022	2023	2024	2025	Goal
Interstate Good	71.8%	72.5%	72.0%	71.0%	70.0%	75.0%
Interstate Poor	0.2%	0.2%	1.0%	1.1%	1.3%	<5.0%
Non-Int NHS Good	40.2%	38.1%	37.0%	36.0%	35.0%	50.0%
Non-Int NHS Poor	2.0%	2.2%	2.7%	3.1%	3.5%	<8.0%

CTDOT-Maintained Pavement Performance Projections

State Goals by centerline miles for 3,715 centerline miles



Based on funding as of 12/31/21

Performance Projections at Current Funding Level ($119M Budget)

End of Year	2021	2022	2023	2024	2025	Goal
SOGR	73.5%	72.0%	69.5%	67.3%	65.0%	80.0%

NOTE: "Current Funding" shown in the graphs is limited to funding programed to address State of Good Repair. Projected performance is expected to be greater due to asset improvements funded through CTDOT's Capital Program which are not captured. The Department will soon be able to capture this funding through a project asset data system in development.

Performance Projections

The charts on the left depicts pavement condition for various funding scenarios developed through an analysis program using CTDOT pavement deterioration curves projected from 2020 pavement condition data.

Asset Valuation

$10,838,143,000

Asset value is estimated using the replacement value. For pavements, replacement value is the product of pavement area (SY) and unit construction cost. For 3,715 centerline miles of pavement: 99.1 million SY
* $109/SY = $10.84 Billion

Measures and Goals

CTDOT has set the following pavement condition goals:

Federal Requirements:

- Interstate: 75% good condition and less than 5% poor condition (Federal minimum is less than 5% poor)
- Non-Interstate: 50% good condition and less than 8% poor condition

State Goal:

- 80% or more of State-maintained pavements in a SOGR (State)

Connecticut Transportation Asset Management Plan

Traffic Signals

Data Confidence
Medium

Description

- CTDOT is currently responsible for maintaining 2,786 State owned traffic signals:
  - 2,560 Traditional Traffic signals
  - 226 Overhead flashing beacons
- Of the 2,560 traditional traffic signals, 966 are part of 111 computerized traffic signal systems
- CTDOT defines a traffic signal unit as all traffic control equipment at a given intersection or location
- There are an additional 279 independent signs with flashers that are managed as part of the sign asset

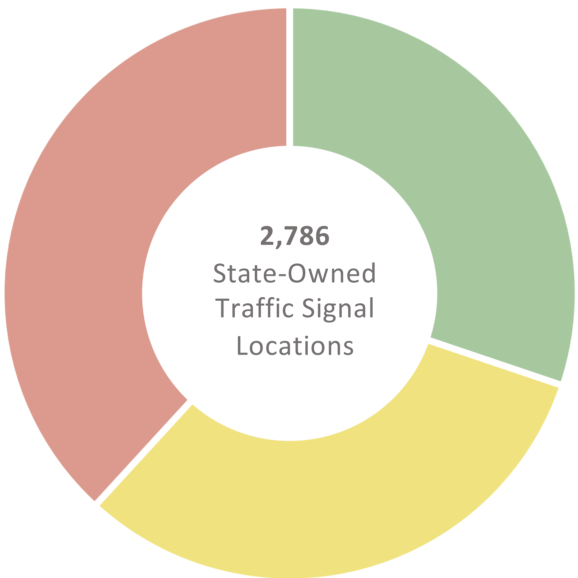
State of Good Repair (SOGR)

The State of Good Repair for traffic signals is determined to be 25 years of life based on expectations of controller and signal head life. Major component upgrades improve operation and safety of traffic signals but are not reflected in SOGR calculations.

Traffic Signal Age

- 38.2% of traffic signals are older than 25 years
- 1.7% of traffic signals are older than 50 years

Traffic Signal Inventory and Condition



Good

841 Locations

30.2% are in Good condition (0-15 years old)

Fair

881 Locations

31.6% are in Fair condition (16-25 years old)

Poor

1064 Locations

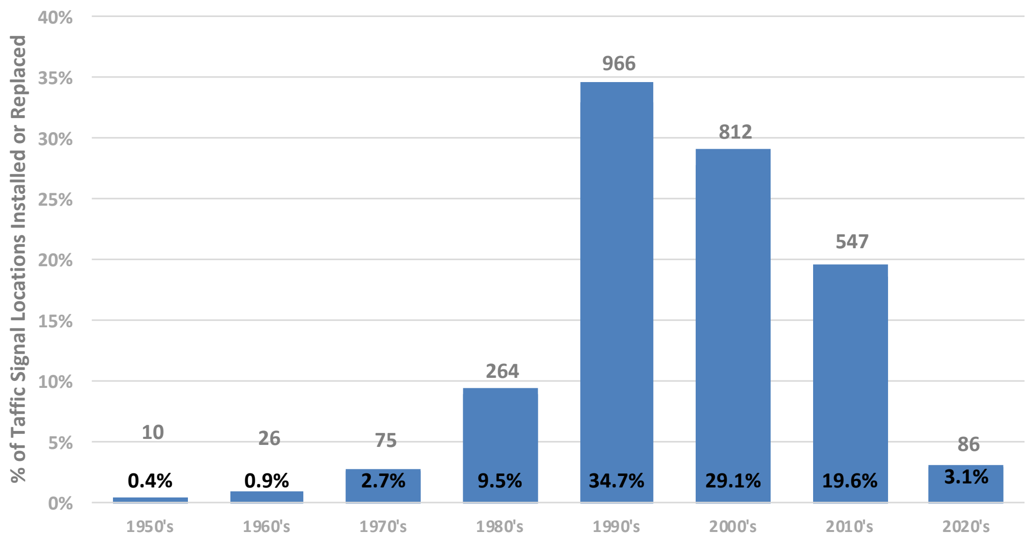
38.2% are in Poor condition (26+ years old)

Good-Fair-Poor and SOGR defined by CTDOT

Based on CTDOT 1/3/22 Snapshot

History

Distribution of Traffic Signal Locations by Year Installed or Replaced

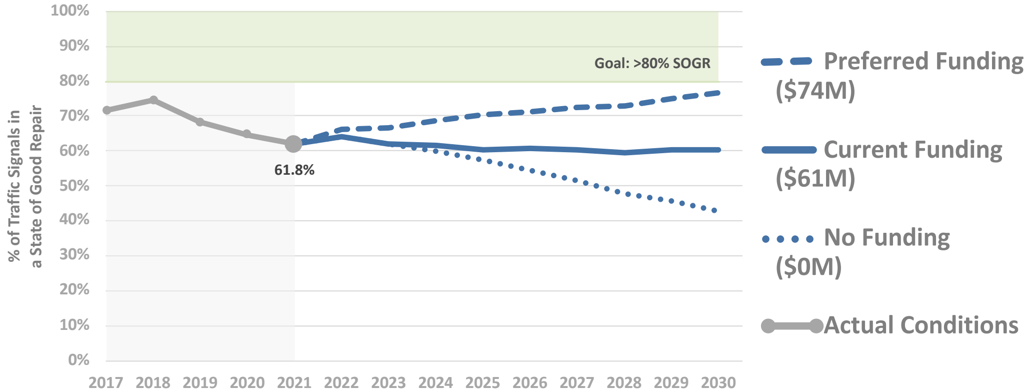


Based on CTDOT 1/3/22 Snapshot

Traffic Signals

Traffic Signals Performance Projections

State Goals by traffic signal for 2,786 traffic signals



Based on funding as of 1/3/22

Projected Performance at Current Funding Level ($61M Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	64.1%	62.2%	61.8%	60.4%	60.8%	80.0%

Note: Current funding level includes $29 million for TAM Traffic Signals Preservation projects, $20 million for Computerized Traffic Signal System (CTSS) replacement projects, and $12 million for Traffic Signal Safety & Technology projects. The CTSS projects will affect SOGR rating; Traffic Engineering is taking on the prime designer role starting FY2024. The Traffic Signal Safety & Technology projects are funded through FY2026 and will not affect SOGR rating.

Note: "Current Funding" shown in the graphs is limited to funding programed to address State of Good Repair. Projected performance is expected to be greater due to asset improvements funded through CTDOT's Capital Program which are not captured. The Department will soon be able to capture this funding through a project asset data system in development.

Performance Projections

In order to maintain a State of Good Repair, roughly 120 traffic signals need replacement each year. Currently, approximately 50-60 traffic signals are replaced each year. Of those, 45-55 signals are programmed under the signal replacement program and 5-10 signals are replaced under other state projects annually.

Asset Valuation

$830,500,000

Asset value is estimated using the replacement value. For traffic signals, replacement value is the product of traffic signal and unit construction cost.
For 2,560 traffic signals :
2,560 * $320,000 = $819,300,000
For 226 Overhead flashing beacons: 226 * $50,000 = $11,300,000

Measures and Goals

There are no Federal requirements at this time. CTDOT has set the following traffic signal condition goal:

State Goal:

- 80% or more of state owned traffic signals in a SOGR

Signs

Data Confidence
Low

Description

- CTDOT is responsible for maintaining approximately 247,000 signs (regulatory, warning, and guide) that are located on State owned and maintained roadways. Sign inventory is also represented as 2,354,178 square feet of sign area.
- CTDOT defines a sign as a panel attached to a post(s) or sign structure and a sign assembly as the combination of sign panel(s) and their post(s), support, or sign structure at a single location.
- Overhead sign supports and foundations are managed as a separate asset

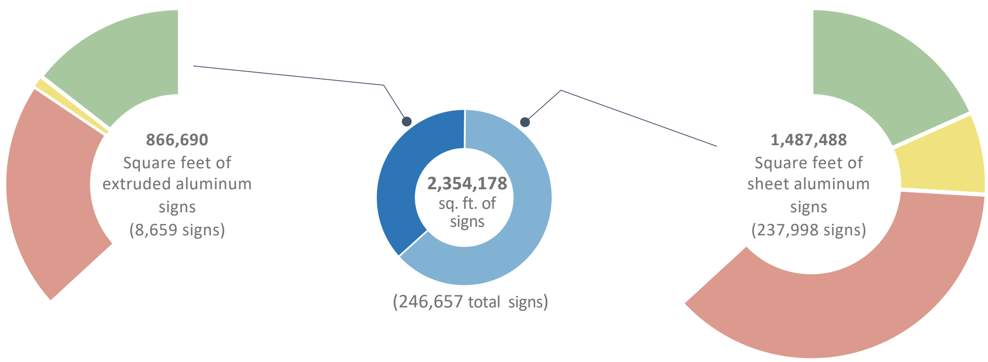
State of Good Repair (SOGR)

A sign installed within 17 years is classified as being in a State of Good Repair. This is based on expectations of retroreflectivity life. Retroreflectivity is a measure of the amount of light reflected by a surface back to the source of the light.

Sign Age

- More than 38% of all signs have are within their expected sign life or effective service life
- Nearly 58% of extruded aluminum signs are less than 25 years old.

Sign Inventory and Condition



Good-Fair-Poor and SOGR defined by CTDOT

Extruded Aluminum Signs

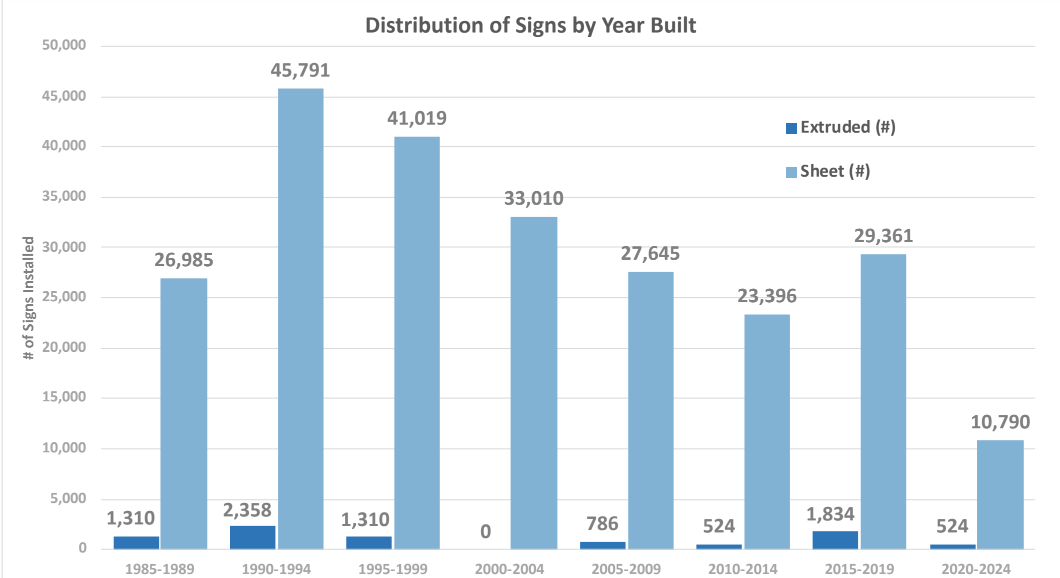
Good	Fair	Poor
3,412 Signs 39.4% are in Good condition (0-12 years old)	**260 Signs** 3.0% are in Fair condition (13-17 years old)	**4,987 Signs** 57.6% are in Poor condition (18+ years old)

Sheet Aluminum Signs

Good	Fair	Poor
69,077 Signs 29.0% are in Good condition (0-12 years old)	**28,718 Signs** 12.1% are in Fair condition (13-17 years old)	**140,203 Signs** 58.9% are in Poor condition (18+ years old)

Based on CTDOT 1/12/22 snapshot

History

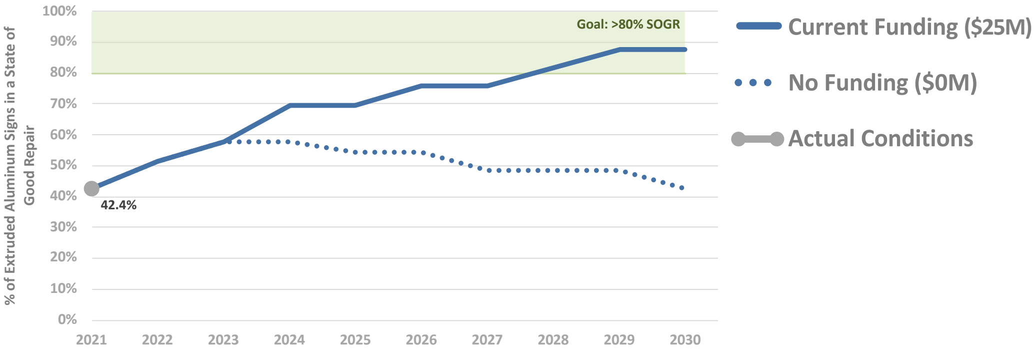


Based on CTDOT 1/12/22 snapshot

Signs

Extruded Aluminum Signs Performance Projections

State Goals by extruded aluminum sign for 8,659 signs



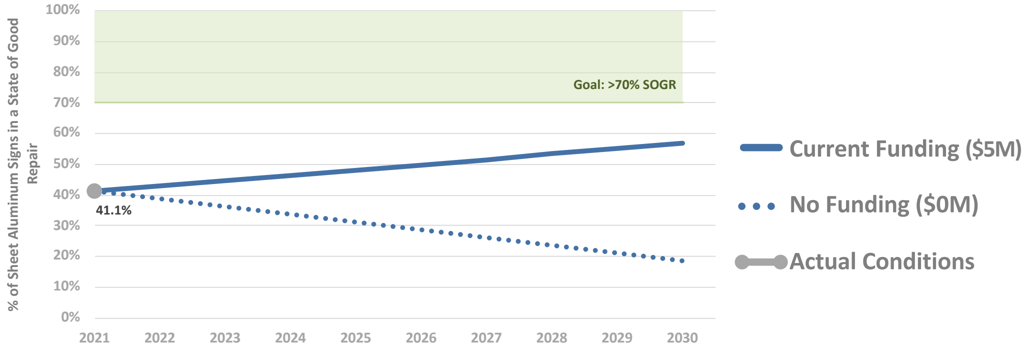
Based on funding as of 12/31/21

Projected Performance at Current Funding Level ($25M Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	51.5%	57.6%	69.7%	69.7%	75.8%	80.0%

Sheet Aluminum Signs Performance Projections

State Goals by sheet aluminum sign for 237,998 signs



Based on funding as of 12/31/21

Projected Performance at Current Funding Level ($5M Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	42.9%	44.6%	46.4%	48.1%	49.9%	70.0%

NOTE: "Current Funding" shown in the graphs is limited to funding programed to address State of Good Repair. Projected performance is expected to be greater due to asset improvements funded through CTDOT's Capital Program which are not captured. The Department will soon be able to capture this funding through a project asset data system in development.

Performance Projections

In order to maintain a State of Good Repair, nearly 500 extruded and 14,000 sheet signs need replacement each year. Currently, approximately 5,000 signs are replaced each year.

Asset Valuation

$182,373,168

Asset value is estimated using the replacement value. For signs, replacement value is the product of square footage and unit construction cost.

Note: This value does not include the cost of overhead sign supports and foundations.

Measures and Goals

There are no Federal requirements at this time. CTDOT has set the following sign condition goals:

State Goals:
- 80% or more of extruded aluminum signs in a SOGR
- 70% or more of sheet aluminum signs in a SOGR

Connecticut Transportation Asset Management Plan

Sign Supports

Data Confidence
Medium

Description

- CTDOT is responsible for maintaining approximately 1,653 overhead sign supports on state maintained roadways
- Sign supports are made up of three categories:
  - 679 Cantilevers
  - 618 Full-Span
  - 356 Bridge Mounted
- CTDOT defines a sign support as the structure (horizontal member(s), post(s) and foundation) carrying sign panels or variable message boards at a single location
- Sign panels attached to the sign support are managed as a separate asset

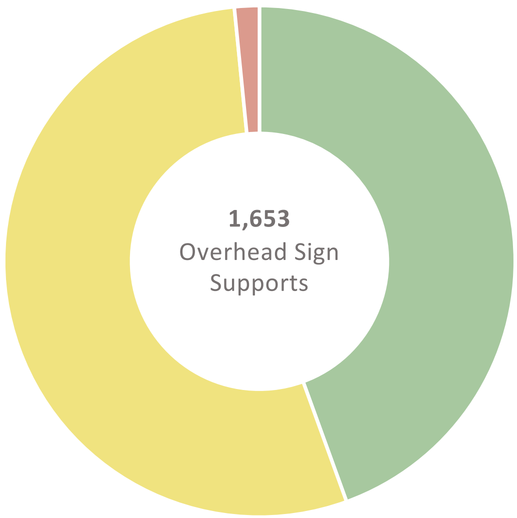
State of Good Repair (SOGR)

Condition ratings are determined via inspection of sign supports on a predetermined cycle. Sign supports with an overall rating of at least a 5 on a 0-9 condition scale are classified as being in a State of Good Repair.

Support Age

- Overhead sign supports are assigned a 34-year service life based on a 17-year sign replacement cycle
- 26.0% (431) of sign supports are 34 years or older.
- 229 sign supports with unknown age were assigned to 1980's based on available imagery from DigitalHIWAY or Google Earth.

Sign Support Inventory and Condition



Good

735 Sign Supports

44.5% are in Good condition

[Condition ratings of 7,8, or 9]

Fair

892 Sign Supports

53.9% are in Fair condition

[Condition ratings of 5 or 6]

Poor

26 Sign Supports

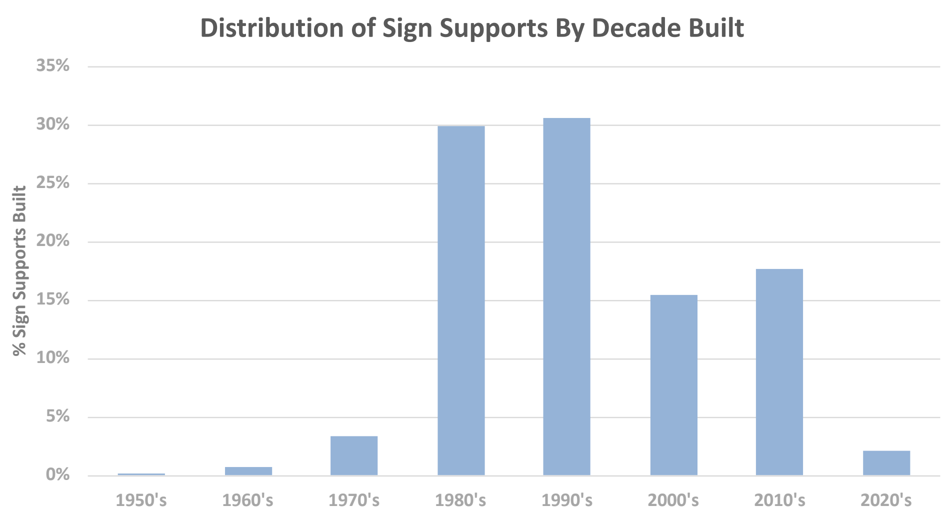
1.6% are in Poor condition

[Condition ratings of 0,1,2,3, or 4]

Good-Fair-Poor and SOGR defined by CTDOT

Based on CTDOT 2/4/22 Snapshot

History



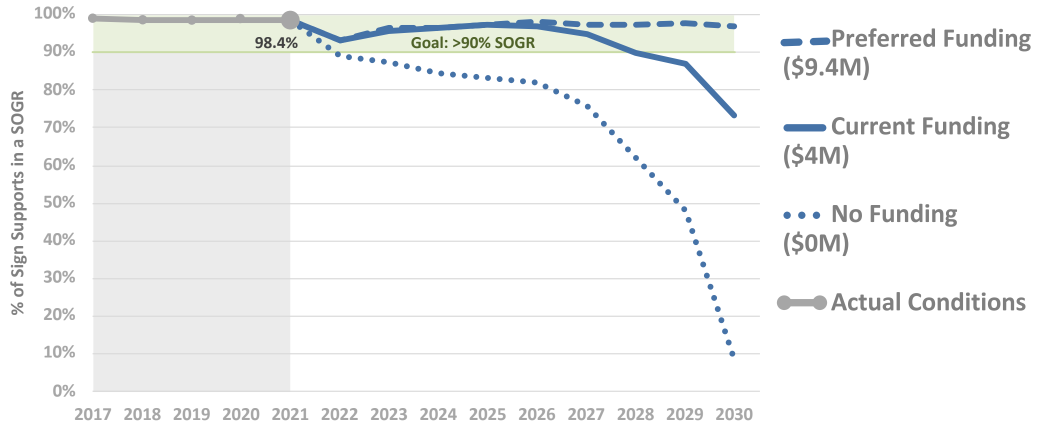
Based on CTDOT 2/4/22 Snapshot

Connecticut Transportation Asset Management Plan

Sign Supports

Sign Support Performance Projections

State Goals by sign support for 1,653 sign supports



Projected Performance at Current Funding Level ($4M Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	93.1%	95.7%	96.4%	97.4%	97.1%	90.0%

NOTE: "Current Funding" shown in the graphs is limited to funding programed to address State of Good Repair. Projected performance is expected to be greater due to asset improvements funded through CTDOT's Capital Program which are not captured. The Department will soon be able to capture this funding through a project asset data system in development.

Performance Projections

Sign support projections use deterioration curves for the overall structure condition rating. These curves are based on the assigned 34-year service life of sign supports.

Asset Valuation

$294,000,000

Asset value is estimated using the replacement value. For sign supports, replacement value is based on the average unit construction cost by type:
Cantilever $150,000 * 679 = $101,850,000
Full Span $285,000 * 618 = $176,130,000
Bridge Mount $45,000 * 356 = $16,020,000

Note: This value does not include the cost of the sign panels.

Measures and Goals

There are no Federal requirements at this time. CTDOT has set the following sign support condition goal:

State Goal:

- 90% or more of sign supports in a SOGR

Pavement Markings

Data Confidence
Very Low

Description

- CTDOT is responsible for maintaining pavement markings on approximately 3,715 centerline miles of on State maintained roadways
- Pavement Markings include:
  - Line Striping
  - Symbols & Legends (arrows, crosswalks, etc.)
- CTDOT pavement marking applications are either water-based by State forces and Epoxy by Contractor

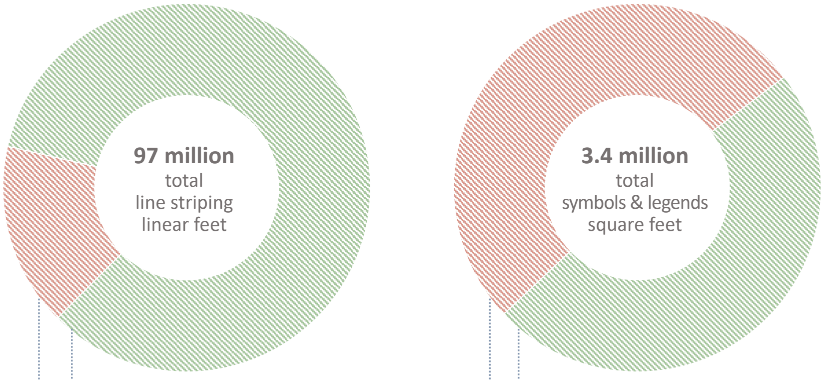
State of Good Repair (SOGR)

In-laid epoxy pavement markings installed within 6 years, epoxy pavement markings installed within the past 3 years and water-based pavement markings installed within 1 year are classified as being in a SOGR. This is based on expectations of retroreflectivity life and wear. Retroreflectivity is a measure of the amount of light reflected by a surface back to the source of the light.

Marking Age

- More than 16% of all line striping and nearly 52% of all symbol and legend pavement markings have exceeded their expected service life.

Pavement Markings Inventory and Condition: Line Striping and Symbols & Legends



State of Good Repair **81.3 million linear feet**
83.8% of line striping is in a state of good repair

Poor **15.7 million linear feet**
16.2% of line striping is in poor condition

State of Good Repair **1.6 million square feet**
48.2% of symbols & legends are in a state of good repair

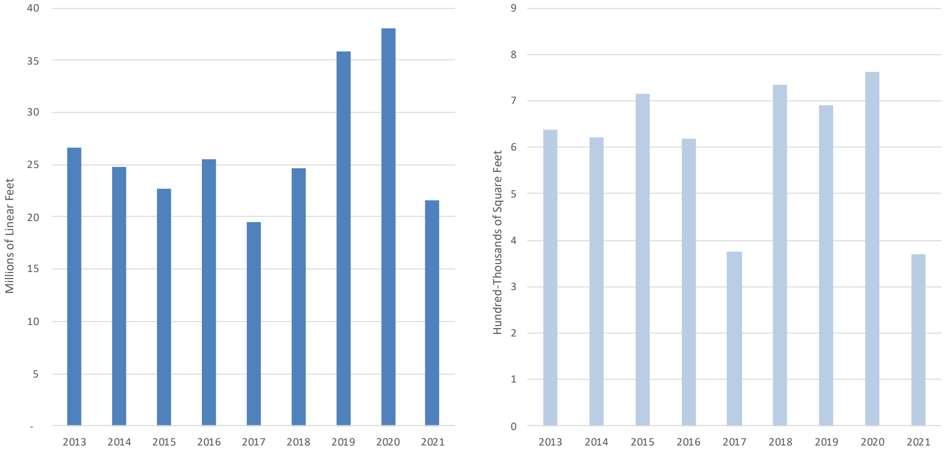
Poor **1.8 million square feet**
51.8% of symbols & legends are in poor condition

SOGR defined by CTDOT

Based on CTDOT 12/31/21 Snapshot

History

Line Striping and Symbols & Legends Painted Annually
2013 – 2021



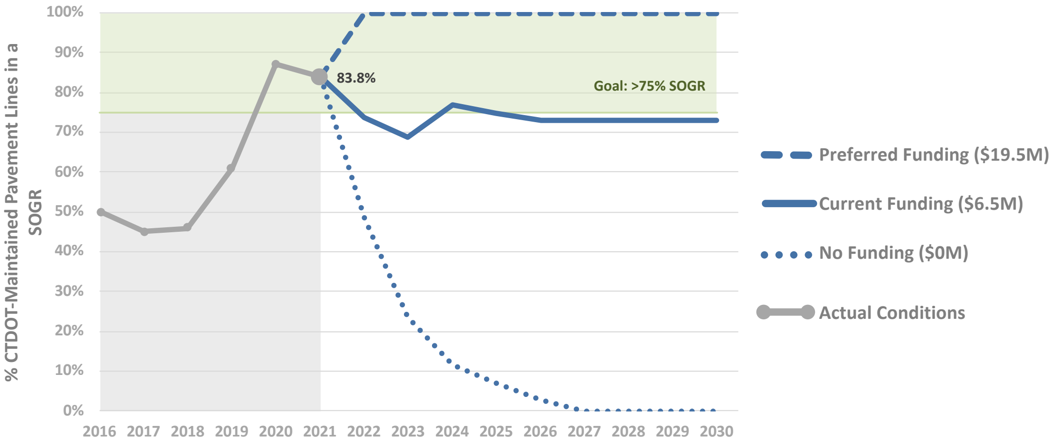
Based on CTDOT 12/31/21 Snapshot

Pavement Markings



Pavement Markings Performance Projections

State Goals by pavement lines for 97 million linear feet of line striping

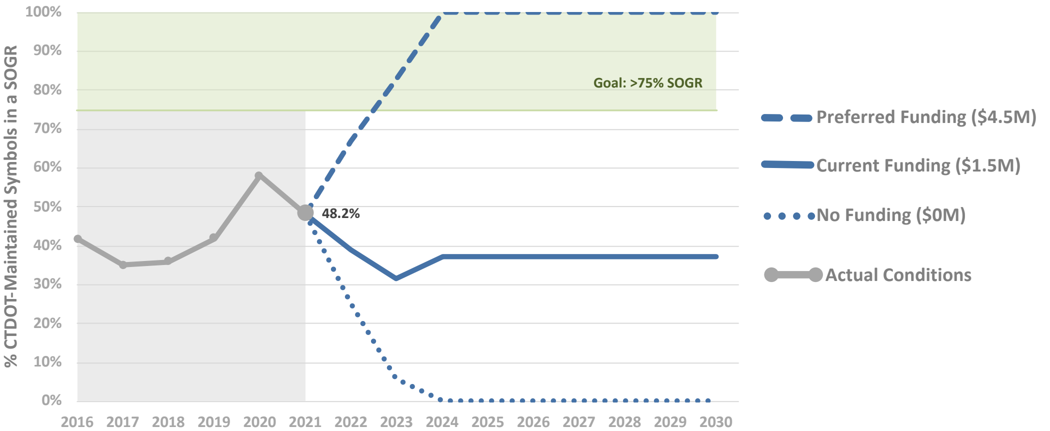


Based on funding as of 12/31/21

Performance Projections at Current Funding Level ($6.5M Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	73.7%	68.7%	76.7%	74.8%	73.0%	75.0%

State Goals by pavement symbols for 3.4 million square feet of symbols & legends



Based on funding as of 12/31/21

Performance Projections at Current Funding Level ($1.5M Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	39.0%	31.4%	37.3%	37.3%	37.3%	75.0%

NOTE: "Current Funding" shown in the graphs is limited to funding programed to address State of Good Repair. Projected performance is expected to be greater due to asset improvements funded through CTDOT's Capital Program which are not captured. The Department will soon be able to capture this funding through a project asset data system in development.

Performance Projections

In order to maintain a State of Good Repair, about 32 million linear feet of line striping and 1.1 million square feet of symbols & legends epoxy pavement markings need to be remarked each year. Currently, approximately 30 million linear feet and 640,000 square feet are remarked each year.

Asset Valuation

$62,916,000

Asset value is estimated using the replacement value method. For pavement markings, replacement value is the product of square footage and unit construction cost considering epoxy only.
Line striping: 97 million LF * $0.50/LF = $48,500,000
Symbols: 3.4 million SF * $4.24/SF = $14,416,000

Measures and Goals

There are no Federal requirements at this time. CTDOT has set the following pavement marking condition goals:

State Goals:

- 75% or more of line striping pavement markings in a SOGR
- 75% or more of symbols & legends pavement markings in a SOGR

Connecticut Transportation Asset Management Plan

Highway Buildings

Data Confidence **Medium**

Description

- CTDOT defines a highway building as a relatively permanent structure to house persons or property
- CTDOT owns 508 highway buildings classified into four Tiers:
  - Tier 1: significant structures normally occupied by employees or the public
  - Tier 2: salt sheds
  - Tier 3: specialty, storage, and portable office type structures
  - Tier 4: no asset management plan; portable storage containers, buildings managed by other entities or programmed for demolition or sale

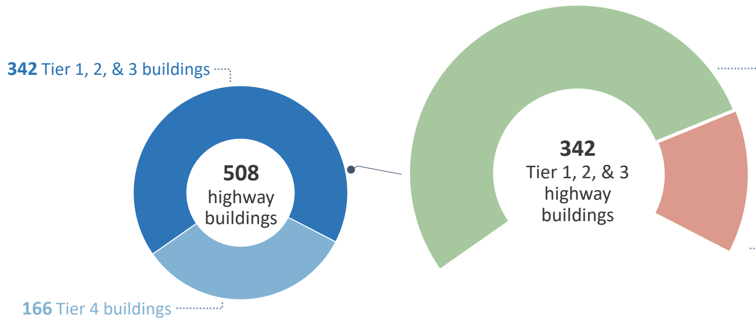
State of Good Repair (SOGR)

- Buildings with an overall rating of 3 or better on a scale of 1-5 are classified as being in a SOGR
- Building ratings are a combination of age-based and condition-based component ratings

Building Age

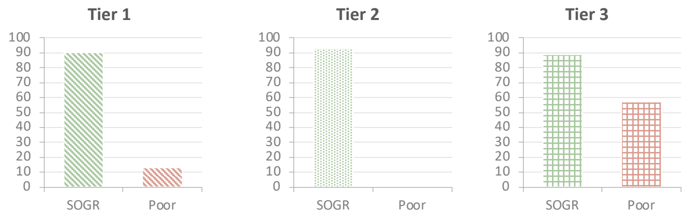
- Building age is based on the date CTDOT acquired the asset or the date of the last (like new) renovation
- Tier 1 buildings have a 60-year life cycle with a 30-year mid-life SOGR upgrade
- Life cycles and the need for mid-life SOGR upgrades vary for Tier 2 & 3 buildings

CTDOT-Maintained Inventory and Condition



State of Good Repair
272 buildings
79.5% of CTDOT Tier 1, 2 & 3 highway buildings are in SOGR
[Condition rating of 3 or higher]

Poor
70 buildings
20.5% of CTDOT Tier 1, 2, & 3 highway buildings are in poor condition
[Condition rating lower than 3]



103 Tier I buildings
State of Good Repair : 87.4%
- 73 Maintenance & Repair Facilities
- 17 Rest Area / Weigh Station Facilities
- 13 Administrative Facilities

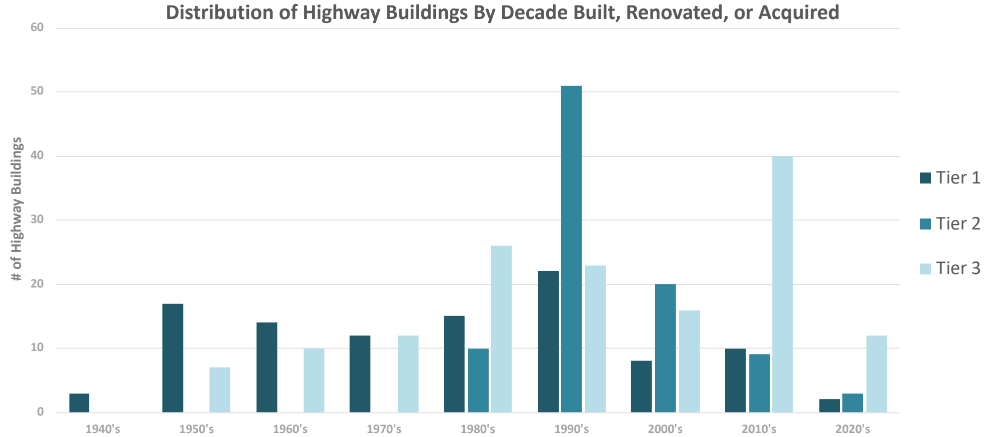
93 Tier 2 buildings
State of Good Repair : 100.0%
- 93 Salt Sheds

146 Tier 3 buildings
State of Good Repair : 61.0%
- 93 Storage Structures
- 51 Portable Office Structures
- 2 Specialty Facilities

166 Tier 4 buildings
State of Good Repair : *Not tracked*
- 90 Portable Storage Containers
- 59 Buildings Managed by Others
- 17 Vacant Buildings Programmed for Demolition or Sale

Based on CTDOT 12/31/21 Snapshot

History



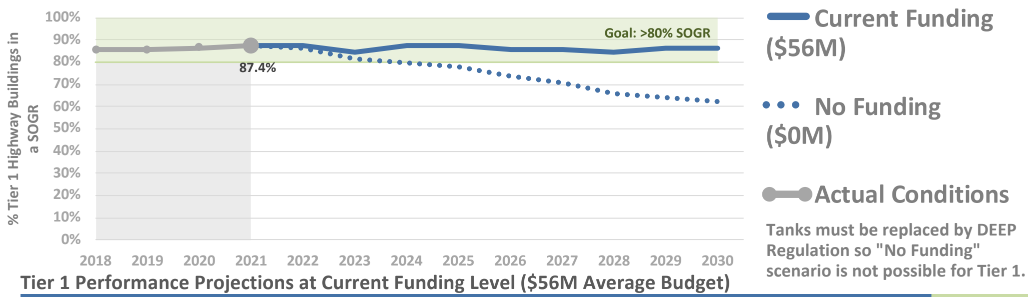
Based on CTDOT 12/31/21 Snapshot

Connecticut Transportation Asset Management Plan

Highway Buildings

Highway Buildings Performance Projections

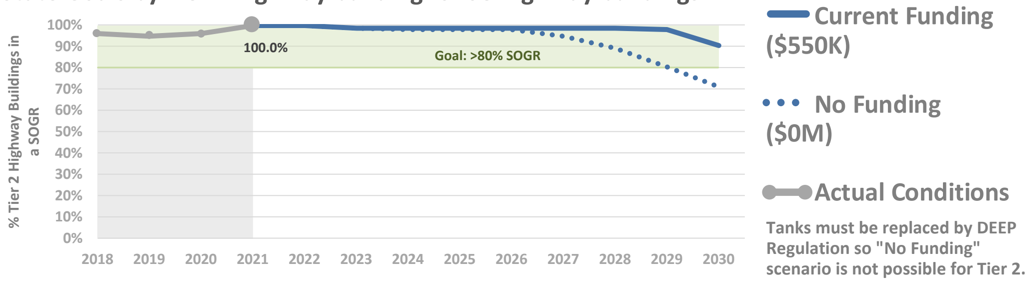
State Goals by Tier 1 highway building for 103 highway buildings



Tier 1 Performance Projections at Current Funding Level ($56M Average Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	87.4%	84.5%	87.4%	87.4%	85.4%	80.0%

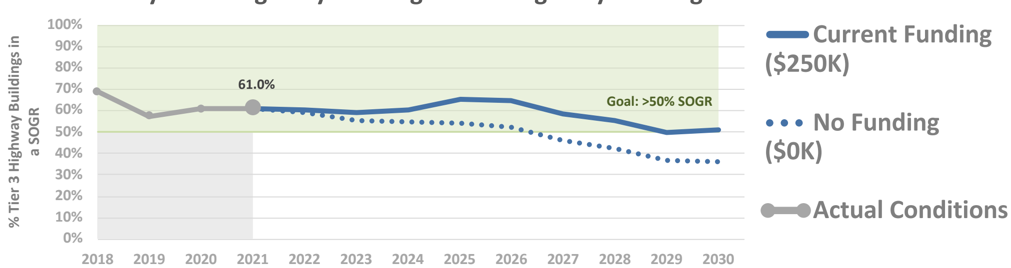
State Goals by Tier 2 highway building for 93 highway buildings



Tier 2 Performance Projections at Current Funding Level ($550K Average Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	100.0%	98.9%	98.9%	98.9%	98.9%	80.0%

State Goals by Tier 3 highway building for 146 highway buildings



Tier 3 Performance Projections at Current Funding Level ($250K Average Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	60.6%	59.1%	60.2%	65.3%	65.0%	50.0%

Tier 1, 2, and 3 projections based on funding as of 12/31/21

NOTE: "Current Funding" shown in the graphs is limited to funding programed to address State of Good Repair. Projected performance is expected to be greater due to asset improvements funded through CTDOT's Capital Program which are not captured. The Department will soon be able to capture this funding through a project asset data system in development.

Performance Projections

Performance projection funding levels are based on the replacement value and include a 1.6 factor to account for non-building related project administration costs for engineering, rights-of-way, and construction incidentals and contingencies.

Asset Valuation

$890,000,000

- Tier 1 buildings: $710M
- Tier 2 buildings: $167M
- Tier 3 buildings: $13M

Asset valuation is the replacement cost of the asset in current year dollars. For buildings, the replacement costs includes any site work necessary for the building to function such as water and sewer systems, generators, and fuel stations as applicable.

Measures and Goals

Federal targets for buildings have not yet been established. The following State Goals have been set:

- Tier 1 buildings: maintain 80% in a SOGR
- Tier 2 buildings: maintain 80% in a SOGR
- Tier 3 buildings: maintain 50% in a SOGR

Connecticut Transportation Asset Management Plan

Illumination

Data Confidence
Medium

Description

- CTDOT owns and maintains a total of 207 lighting systems that include 23,472 light fixtures.
- The majority of lighting systems are located along the roadway network.
- A typical lighting system includes a control cabinet, conduit, conductors, cabinet and light pole foundations, handholes, transformer bases, light poles, light fixture brackets and light fixtures.
- Specialized lighting systems exist for underpasses, tunnels, commuter lots and decorative lighting.

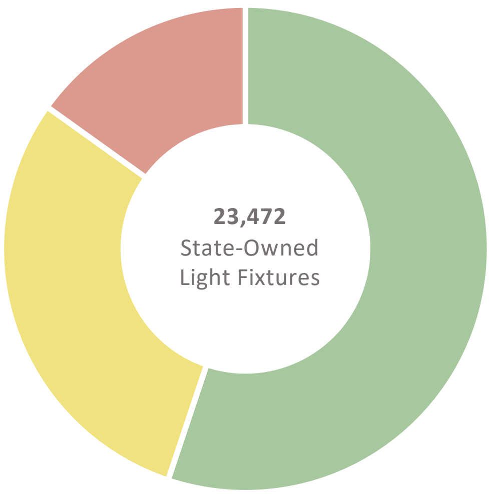
State of Good Repair (SOGR)

- Lighting systems installed within the last 40 years are classified as being in a SOGR.

Asset Age

- Lighting systems and components have an average projected useful life (PUL) of 40 years.
- 15% of light fixtures are beyond the end of their PUL.

CTDOT-Maintained Inventory and Condition



Good

12,942 Light Fixtures
55.1% are in Good condition
(0-30 years old)

Fair

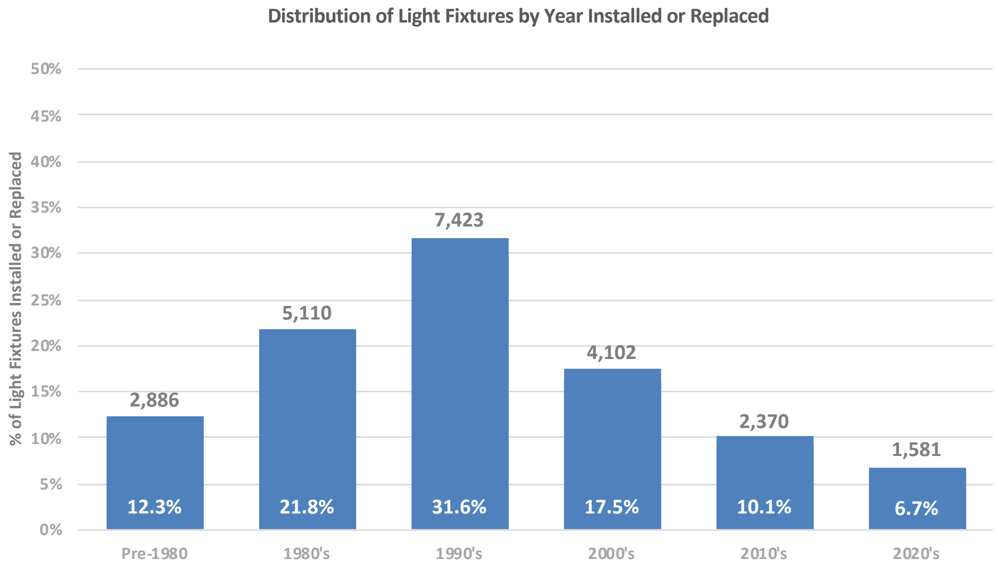
6,985 Light Fixtures
29.8% are in Fair condition
(31-40 years old)

Poor

3,545 Light Fixtures
15.1% are in Poor condition
(41+ years old)

Based on CTDOT 12/31/21 Snapshot

History

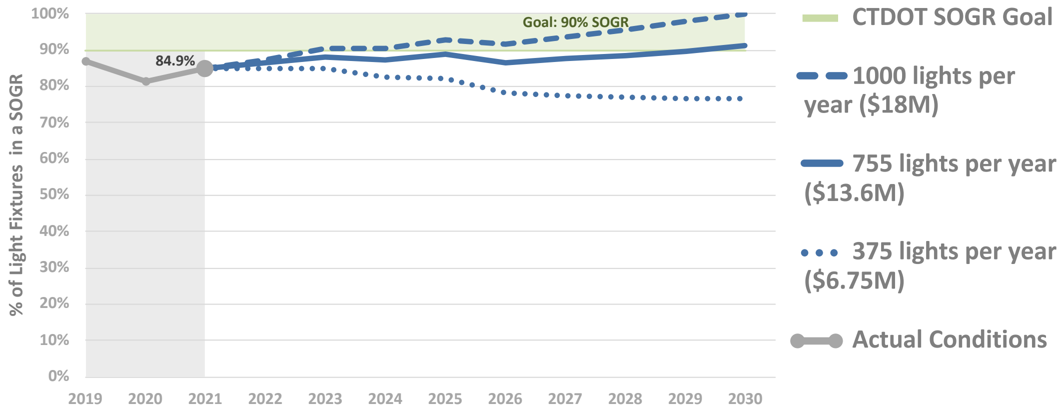


Based on CTDOT 12/31/21 Snapshot

Illumination

Light Fixture Performance Projections

State Goals by Light Fixture for 23,472 Light Fixtures



Performance Projections at Current Funding Level ($13.6M Average Budget)

Year	2022	2023	2024	2025	2026	Goal
SOGR	86.5%	88.3%	87.4%	88.7%	86.4%	90.0%

Projections based on funding as of 12/31/21

NOTE: "Current Funding" shown in the graphs is limited to funding programed to address State of Good Repair. Projected performance is expected to be greater due to asset improvements funded through CTDOT's Capital Program which are not captured. The Department will soon be able to capture this funding through a project asset data system in development.

Performance Projections

In order to achieve a SOGR an average of 755 light fixtures need to be replaced each year for approximately 10 years; replacements then drop to an average of 400 lighting fixtures per year to maintain a SOGR. Highway Safety Improvement Projects currently replace an average of 250 light fixtures per year, leaving the remainder to be installed by roadway lighting replacement projects.
The preferred scenario includes approximately 755 signals replaced through illumination specific projects and 250 signals replaced through safety improvement projects.

Asset Valuation

$447,120,000

Asset value is estimated using an average replacement value per lighting system.

207 lighting systems * $2.16M each = $447.1million

Measures and Goals

There are no Federal requirements for illumination at this time. CTDOT has set the following State goal:

- 90% of lighting systems in a SOGR

Connecticut Transportation Asset Management Plan

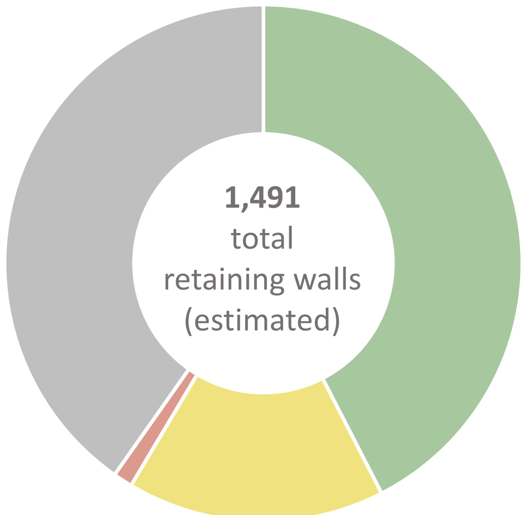
Retaining Walls

Data Confidence
Low

Description

- CTDOT defines a retaining wall as a structure that provides a grade separation by retaining earth and/or rock.
- CTDOT has currently identified and incorporated 891 retaining walls into its asset database. Plans to capture and rate the remaining wall population are ongoing.
- There are 12 different retaining wall categories.
- Bridge abutments, wingwalls, culvert headwalls and barrier curbs with minor grade differential are considered separate assets.

CTDOT-Maintained Inventory and Condition



Good

633 Retaining walls

71.0% are in Good condition

[Condition ratings of 5 or 6]

Fair

240 Retaining walls

27.0% are in Fair condition

[Condition ratings of 3 or 4]

Poor

18 Retaining walls

2.0% are in Poor condition

[Condition ratings of 0, 1, or 2]

Unknown

600+ Retaining walls

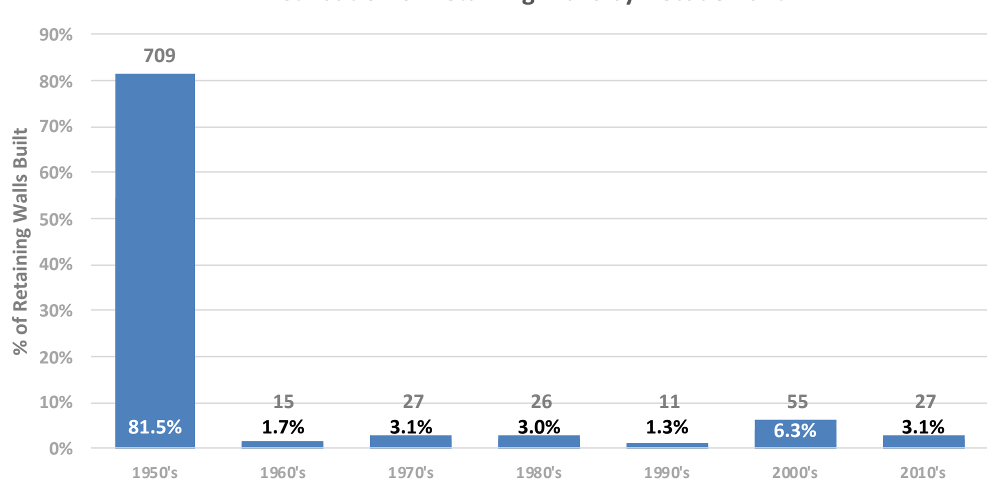
Good-Fair-Poor and SOGR defined by CTDOT

Based on CTDOT 2010 inventory, with 2021 updates

State of Good Repair (SOGR)

Retaining walls with an overall rating of at least a 3 on a 0-6 condition scale are classified as being in a State of Good Repair.

History



Based on CTDOT 2010 inventory

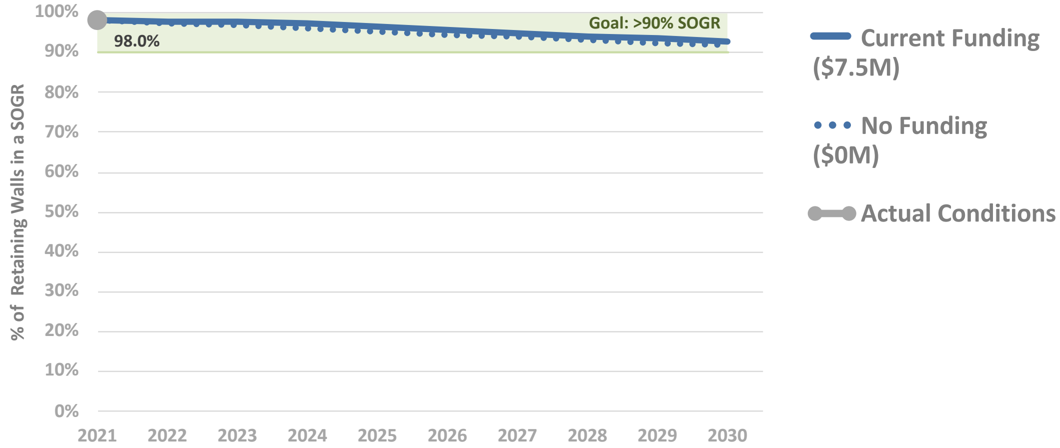
Retaining Wall Age

While there is limited data available on life expectancy of retaining walls, empirical evidence indicate life expectancy ranging from 50 years (for Metal Bin walls or Concrete Crib walls) to well over 100 years (for Masonry walls).

Retaining Walls

Retaining Walls Performance Projections

State Goals by retaining wall for 891 retaining walls



Based on CTDOT 2010 inventory, with 2021 updates

Projected Performance at Current Funding Level ($7.5M Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	97.8%	97.6%	97.3%	96.4%	95.6%	90.0%

NOTE: "Current Funding" shown in the graphs is limited to funding programed to address State of Good Repair. Projected performance is expected to be greater due to asset improvements funded through CTDOT's Capital Program which are not captured. The Department will soon be able to capture this funding through a project asset data system in development.

Performance Projections

The projections assume the CTDOT retaining wall fund invests in improvements to walls 60+ yrs old. Current data shows that concrete (cantilever, gravity) and masonry walls (50% of inventory) are in better condition compared to concrete crib and metal bin walls (3% of inventory). This inventory ratio is expected to change once the full retaining wall inventory is completed.

Asset Valuation

$249,819,000

Asset value is estimated using an average replacement cost per retaining wall unit area. For retaining walls, the average unit cost to replace a wall is estimated to be $110/sf. For 891 retaining walls with 2,271,076 sq ft (total average area) x $110/sq ft = $249,818,580

Measures and Goals

There are no Federal requirements at this time. CTDOT has set the following retaining wall condition goal:

State Goal:

- 90% or more of retaining walls in a SOGR

Connecticut Transportation Asset Management Plan

Drainage Culverts

Data Confidence
Low

Description

- CTDOT is responsible for a complex drainage system including storm drains, manholes, closed conveyance pipes, culverts, headwalls, and endwalls.
- Culverts convey watercourses or stormwater runoff underneath state roads. In Connecticut, the majority of culverts are reinforced concrete pipes (RCPs) or corrugated metal pipes (CMPs). CMPs can have asphalt coating.
- Culverts over 6' in diameter are considered bridge structures and are inspected and tracked as bridges. Culverts smaller than 6' in diameter (<72" horizontal dimension for box culverts) are considered drainage culverts.

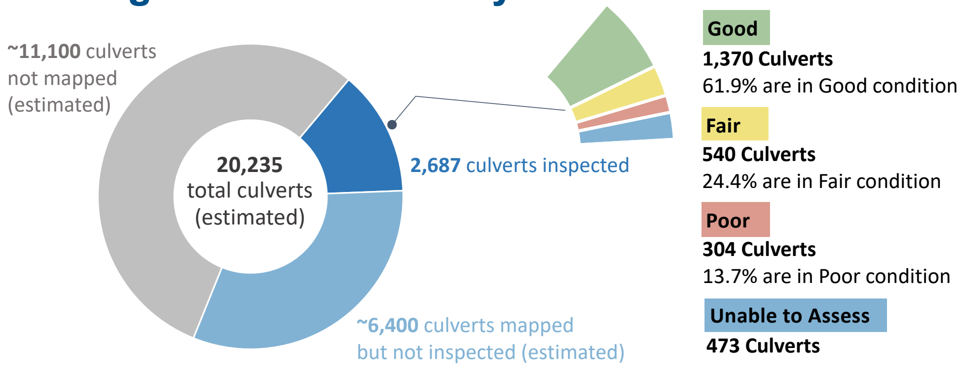
State of Good Repair (SOGR)

A culvert which has been rated Fair or Good is classified as being in a State of Good Repair (SOGR). This rating is based on the Culvert Condition Rating Assessment developed by the CTDOT Office of Environmental Planning.

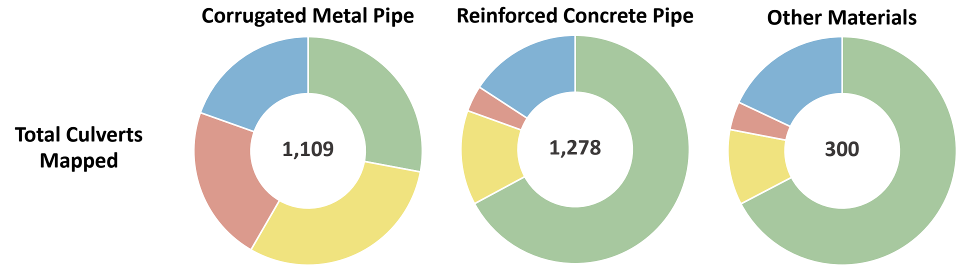
Drainage Culvert Age

The average drainage culvert in the CTDOT network is 62 years old. The average drainage CMP in the CTDOT network is 59 years old.

Drainage Culvert Inventory and Condition



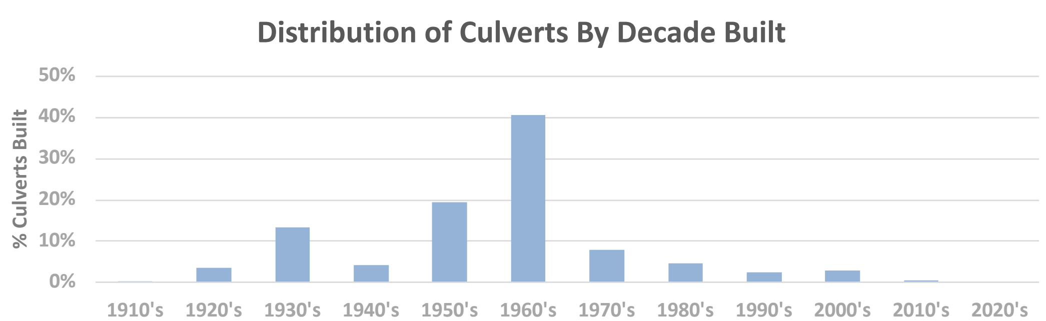
Inspected Culvert Inventory and Condition by Material



	Corrugated Metal Pipe	Reinforced Concrete Pipe	Other Materials
Good	**310** (34.8%)	**858** (79.7%)	**202** (82.1%)
Fair	**337** (37.7%)	**171** (15.9%)	**32** (13.0%)
Poor	**245** (27.5%)	**47** (4.4%)	**12** (4.9%)
Unable to Assess	217	202	54

Based on CTDOT 12/31/21 Snapshot

History

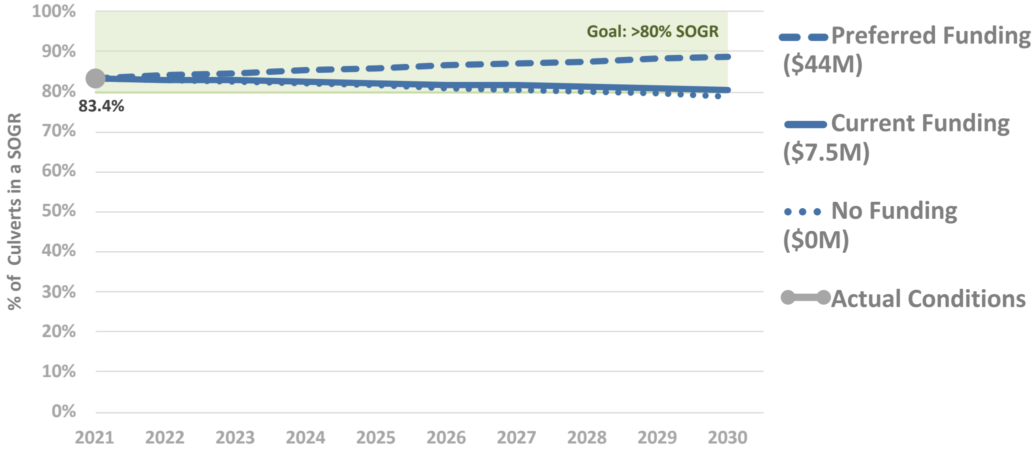


Based on CTDOT 12/31/21 Snapshot

Drainage Culverts

Drainage Culvert Performance Projections

State Goals by drainage culvert for 2,687 culverts



Based on funding as of 12/31/21

Projected Performance at Current Funding Level ($7.5M Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	83.1%	82.8%	82.5%	82.2%	81.8%	80.0%

NOTE: "Current Funding" shown in the graphs is limited to funding programed to address State of Good Repair. Projected performance is expected to be greater due to asset improvements funded through CTDOT's Capital Program which are not captured. The Department will soon be able to capture this funding through a project asset data system in development.

Performance Projections

Culvert performance projections were created using very limited data from culverts that had both age and condition data associated with them.

Asset Valuation

$2,708,657,000

Asset value is estimated using the replacement value. For 20,235 estimated culverts, replacement value is 20,235 * 276 sq ft of pipe * $485 per sq ft of pipe = $2,708,657,100

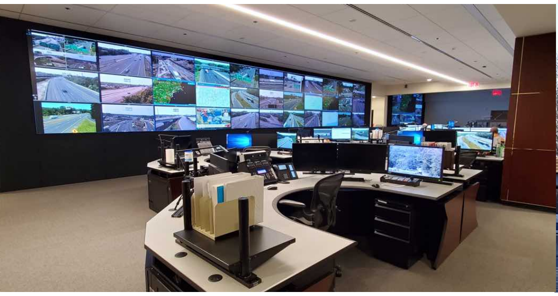
Measures and Goals

CTDOT has not determined measures and targets for culverts at this point.

Connecticut Transportation Asset Management Plan

Intelligent Transportation Systems: ATMS

Data Confidence
High





Description

- CTDOT currently owns and maintains a total of 545 Advanced Traffic Management System (ATMS) field devices.
- ATMS field devices are comprised of 362 Closed Circuit Television Cameras (CCTV), 143 Variable Message Signs (VMS), and 40 Roadway Weather Information Systems (RWIS)
- ATMS field devices relies on Operation Centers, Fiber Hubs, and Video Data Transport that are tracked as part of the Highways Buildings Asset.
- ATMS field devices also relies on servers, software, central equipment, and 244 miles of fiber optic cable trunkline to communicate to ATMS field devices. These assets are being evaluated and will be considered for future updates.

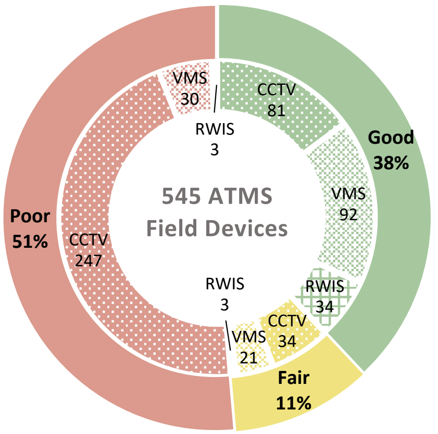
State of Good Repair (SOGR)

- ATMS field devices installed within the last 10 years are classified as being in a SOGR.

Asset Age

- ATMS field devices have an average projected useful life (PUL) of 15 years.
- 51% of ATMS field devices have aged beyond their PUL.

CTDOT-Maintained Inventory and Condition



Good

207 ATMS Field Devices
38.0% are in Good condition (0-10 years old)

CCTV
VMS
RWIS

Fair

58 ATMS Field Devices
10.6% are in Fair condition (11-15 years old)

CCTV
VMS
RWIS

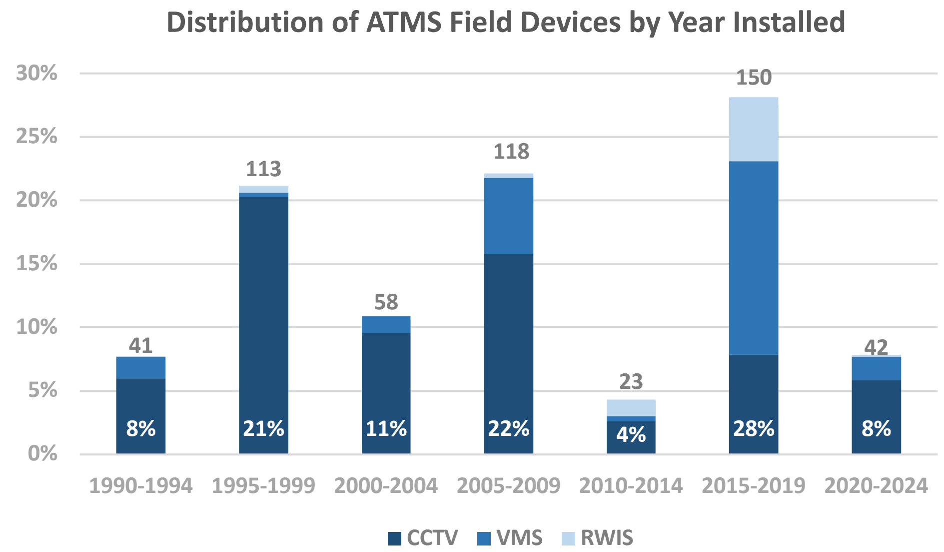
Poor

280 ATMS Field Devices
51.4% are in Poor condition (16+ years old)

CCTV
VMS
RWIS

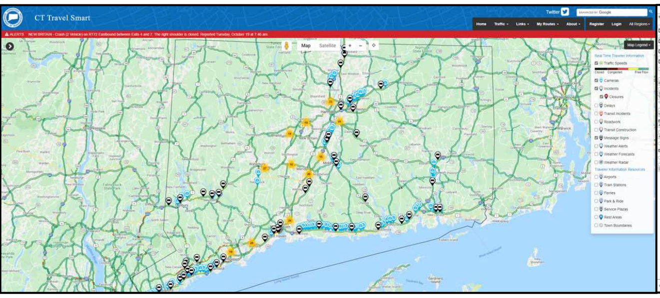
Based on CTDOT 1/8/22 Snapshot

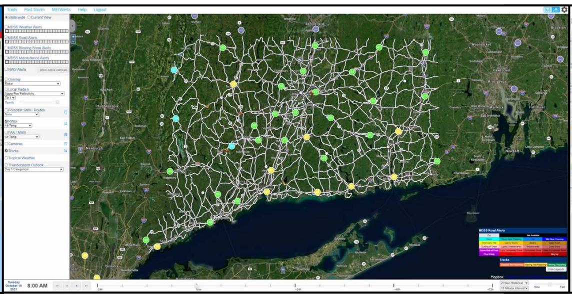
History

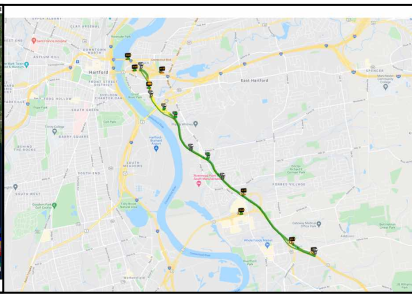


Based on CTDOT 1/8/22 Snapshot

Intelligent Transportation Systems: ATMS

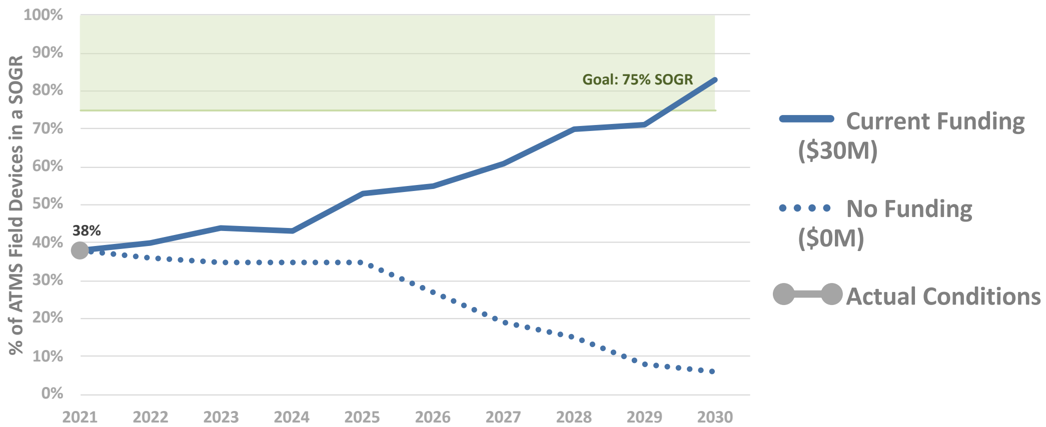






ITS: ATMS Performance Projections

State Goals by ATMS field device for 545 ATMS field devices



Based on funding as of 1/3/22

Projected Performance at Current Funding Level ($30M Budget)

End of Year	2022	2023	2024	2025	2026	Goal
SOGR	40.0%	44.0%	43.0%	53.0%	55.0%	75%

NOTE: "Current Funding" shown in the graphs is limited to funding programed to address State of Good Repair. Projected performance is expected to be greater due to asset improvements funded through CTDOT's Capital Program which are not captured. The Department will soon be able to capture this funding through a project asset data system in development.

Performance Projections

In order to achieve a SOGR of above 75% within 10 years, Highway Operations has been approved for 9 projects that will replace an average of 25 ATMS field devices per project and install new 12 ATMS field devices per project.

Highway Operations projects currently replace an average of 20 ATMS field devices per year, leaving the remainder to be installed by other various projects.

Asset Valuation

$168,000,000

Asset value is estimated using an average replacement value per ATMS field device. Asset value does not include the cost for communication network, hardware, software, or portable ATMS field devices.

362 CCTV* $0.25M each
143 VMS* $0.5M each
40 RWIS* $0.15M each
Total = $168 M

Measures and Goals

There are no Federal requirements for ATMS field devices at this time. CTDOT has set the following state goal:

- 75% of ATMS in a SOGR

Appendix B. Data Readiness Form Blank

Readiness Form Sections

Using the Data Readiness Assessment Form

This form was developed to assist CTDOT Asset Stewards plan, document and share information about how asset data is be collected, updated, stored, and accessed. It is intended to be used both for assets that have established data programs as well as for assets that are in the beginning stages of the data planning process:

- For assets that do not yet have an established inventory or condition assessment process, the form provides a checklist of items that should be considered before moving forward with data collection. For example, is there a plan in place for how the data will be updated? Have potential data users been identified and involved in planning what attributes should be gathered?
- For established assets, the form helps the asset steward to document the current data program document changes and process improvements as well as consider future improvements

The process for completing and updating this form is as follows:

1. The asset steward meets with Asset Management liaisons to walk through the form. This initial meeting provides a good opportunity to share information about current practices and potential future improvements. This will typically require a 1-2 hour session, and will result in an initial draft of the form plus a list of follow up questions that require further investigation or discussion.
2. The asset steward or their designee follows up as needed to complete the draft form.
3. The asset steward completes the data readiness assessment form or reviews the most recent version, provides a common understanding of current practice and future needs, and discusses any concerns or ideas for improvement.
4. The asset steward updates the form every four years and as needed and transmits a copy to Asset Management. The asset steward obtains input from the working group, as applicable.
5. The competed forms are posted internally on the Asset Management Sharepoint site for access by asset stewards.

Note that this form is intended to supplement rather than replace metadata creation for CTDOT GIS data layers and other data sets.

Administrative Information	
Asset Name	Click or tap here to enter text.
Asset Steward Name and Position	Click or tap here to enter text.
Person Completing this Form (if different)	Click or tap here to enter text.
Date of Update	Click or tap here to enter text.
Has this form been completed previously?	Choose an item. Date Initial form(s): Click or tap here to enter text.

Asset Definition and Identification	
Asset Definition	Click or tap here to enter text.
Unit of Measure (list all – e.g. “each” and “linear feet”)	Click or tap here to enter text.
Has Components? • If “Yes”, list components	Choose an item. Click or tap here to enter text.
Unique Asset ID *(Name of Data Element)*	Click or tap here to enter text.

Asset Data Information	
Data Users and Uses	
Primary CTDOT users of the data (current or anticipated) – list business unit names	Click or tap here to enter text.
Is some or all of the asset data being shared externally? What data are not shared (i.e., sensitive /confidential)?	Choose an item. Click or tap here to enter text.
If yes, who are the anticipated external data recipients or users?	Click or tap here to enter text.
Is the data necessary to meet a Federal or State Requirement? *(describe as necessary)*	Choose an item. Click or tap here to enter text.
What business decisions will be made based on the data?	Click or tap here to enter text.
Data Needs	
Type(s) of data that **currently** exist for this asset *(check all that apply)*	☐ **Inventory (quantity/extent, type, etc.)** ☐ **Individual Asset Location** ☐**Asset Condition** ☐ **Asset Condition History** ☐ **Work History** ☐ **Other** **Additional Notes:** Click or tap here to enter text.

Asset Data Information	
Type(s) of data that are being considered for **future** collection for this asset *(check all that apply)*	☐ **Individual Asset Location** ☐ **Inventory (quantity/extent, type, etc.)** ☐ **Asset Condition** ☐ **Asset Condition History** ☐ **Work History** ☐ **Other** **Additional Notes:** Click or tap here to enter text.
If/when additional asset data are collected, what will CTDOT be able to do that it cannot do now?	Click or tap here to enter text.
Geographic Scope of Asset Data • If "Other", describe	Choose an item. **Additional Notes:** Click or tap here to enter text.
Data Dictionary	
Has a Data Dictionary Been Defined? • If Yes, include link(s) or document reference(S) • Note: Include inventory ***and*** condition data elements	Choose an item. Click or tap here to enter text.
•	Choose an item. Click or tap here to enter text.
Was the Data Dictionary Reviewed? *(check types of review criteria used)*	☐ **Check for Coverage of Important Attributes of Interest to Multiple Stakeholders?** ☐ **Check for Future Maintainability/Sustainability of Information?** ☐ **Check for Consistency with Location Referencing Standards?** ☐ **Check for Duplication with other Data Sets?** ☐ **Check for Integration Needs with Existing Data Sets?**

Asset Data Information	
• Have potentially sensitive data elements been identified? *(describe as necessary)*	Choose an item. Click or tap here to enter text.

Data Ownership and Stewardship	
Individual authorized to approve changes to data structure *(e.g. new attributes, changes to attribute coding)*	☐ **Asset Steward** ☐ **Others:** Click or tap here to enter text.
Individual authorized to grant access to data	☐ **Asset Steward** ☐ **Others:** Click or tap here to enter text.
Technical contact for questions about data meaning, derivation or quality	☐ **Asset Steward** ☐ **Others:** Click or tap here to enter text.

Asset Data Collection, Storage and Updating	
Data Collection	
Units responsible for asset inventory/condition data collection, oversight, QA, and data acceptance (list all units involved, roles and responsibilities)	Click or tap here to enter text.
Data Collection Method(s) (current or proposed)	Click or tap here to enter text.
Is a data QA/QC Plan in place? • If "Yes", provide reference to plan	Choose an item. Click or tap here to enter text.
Has the data collection process been mapped?	Choose an item. Provide link or attach: Click or tap here to enter text.

Asset Data Collection, Storage and Updating	
Asset Location Identification and Management	
GIS Feature Type(s) for this Asset *(describe as necessary)*	☐ **Point:** Click or tap here to enter text. ☐ **Linear (Continuous):** Click or tap here to enter text. ☐ **Polygon (Area):** Click or tap here to enter text. **Additional Notes:** Click or tap here to enter text.
Type of Location Referencing and Workflow for Assignment *(describe as necessary)* ***Note:*** ***X/Y*** *- location definition independent of LRS* ***Linear Referencing*** *– relies on LRS definition (e.g. Route + Milepoint) for location*	To Be Determined **How is the asset location determined, when, and by whom?** Click or tap here to enter text.
Business Unit(s) with responsibility for asset location data updating & frequency	☐ **Asset Steward:** Click or tap here to enter text. ☐ **Others:** Click or tap here to enter text.
Method for synchronizing asset location with the official LRS to reflect periodic road changes.	Click or tap here to enter text.
Data Storage	
Authoritative system for current asset attribute data	Click or tap here to enter text.
Business Unit(s) responsible for loading data into the authoritative system	Click or tap here to enter text.

Asset Data Collection, Storage and Updating	
Data Updating	
Is data for this asset updated via periodic inventory/inspections that refresh data for the entire inventory?	☐ **Yes – periodic refresh is currently used** ☐ **Yes – this is the intended future method for data updating** ☐ **NA/Not in place or planned** **If in place or planned, what is the refresh cycle (# years)?** Click or tap here to enter text.
Is there a plan or interest in updating asset data based on capital project plans?	☐ **Yes – currently in place** ☐ **Yes – currently under investigation** ☐ **Would like to explore for future implementation** ☐ **NA/Not in place or planned** **What attributes can be updated based on capital project information?**
Is there a plan or interest in updating asset data based on maintenance work orders?	☐ **Yes – currently in place** ☐ **Yes – currently under investigation** ☐ **Would like to explore for future implementation** ☐ **NA/Not in place or planned** **What attributes can be updated based on maintenance service memos?** Click or tap here to enter text.
Is there a plan or interest in updating asset data based on encroachment permits?	☐ **Yes – currently in place** ☐ **Yes – currently under investigation** ☐ **Would like to explore for future implementation** ☐ **NA/Not in place or planned** **What attributes can be updated based on encroachment permits?** Click or tap here to enter text.

Asset Data Collection, Storage and Updating	
What asset data elements can be derived from project plans or other project data sources but are difficult to observe in the field for this asset? (e.g. quantities, material types, buried features, administrative classifications)?	**Describe:** Click or tap here to enter text.
Contract Requirements for Data Provision	
Are there any applicable contract requirements for data provision for this asset? *(please describe)*	Yes - Contract Language is in place
• If Yes or Under Development, are data elements and format standards in place? *(please describe)*	To Be Decided
Technology Solutions	
Is a mobile application for field data collection currently available or being developed for this asset? *(please describe)*	Click or tap here to enter text.
• If Yes, please describe platform and provide reference to further information on attributes collected.	**Current Mobile Application Description:** Click or tap here to enter text.
• If No, would a mobile application for field data collection be of potential value? *(please describe how it might be used)*	**Potential Uses:** Click or tap here to enter text.
Please describe any other technology solutions or improvements which would benefit data collection and maintenance for this asset	Click or tap here to enter text.

Derivative Data Set Creation and Management
Provide information for spatial data layers, enterprise data (TED), and other specialized derivative data sets created from the authoritative source of asset inventory and condition data. These derivative data sets may contain subsets of data elements from the source, or transformations of data elements to facilitate particular uses.

Derivative Data Set Creation and Management	
Derivative Data Set #1	
Type of Derivative Data Set *(Provide data set name and description)*	Other NA
Data Update Methodology	Choose an item. **Describe:** Click or tap here to enter text.
Data Refresh Cycle (e.g. continuous – as data changes; nightly; annual; no set cycle)	**Cycle:** Click or tap here to enter text.
Business Unit responsible for performing or managing the data update	Click or tap here to enter text.
Is a Data Dictionary available for this data set? • If Yes, include link or document reference	Choose an item. Click or tap here to enter text.
Derivative Data Set #2	
Type of Derivative Data Set *(Provide data set name and description)*	Other Click or tap here to enter text.
Data Update Methodology	Choose an item. **Describe:** Click or tap here to enter text.
Data Refresh Cycle (e.g. continuous – as data changes; nightly; annual; no set cycle)	**Cycle:** Click or tap here to enter text.
Business Unit responsible for performing or managing the data update	Click or tap here to enter text.
Is a Data Dictionary available for this data set? • If Yes, include link or document reference	Choose an item. Click or tap here to enter text.
Derivative Data Set #3	
Type of Derivative Data Set *(Provide data set name and description)*	Other Click or tap here to enter text.

Derivative Data Set Creation and Management	
Data Update Methodology	Choose an item. **Describe:** Click or tap here to enter text.
Data Refresh Cycle (e.g. continuous – as data changes; nightly; annual; no set cycle)	**Cycle:** Click or tap here to enter text.
Business Unit(s) responsible for performing or managing the data update	Click or tap here to enter text.
Is a Data Dictionary available for this data set? • If Yes, include link or document reference	Choose an item. Click or tap here to enter text.
Derivative Data Set #4	
Type of Derivative Data Set *(Provide data set name and description)*	Other Click or tap here to enter text.
Data Update Methodology	Choose an item. **Describe:** Click or tap here to enter text.
Data Refresh Cycle (e.g. continuous – as data changes; nightly; annual; no set cycle)	**Cycle:** Click or tap here to enter text.
Business Unit responsible for performing or managing the data update	Click or tap here to enter text.
Is a Data Dictionary available for this data set? • If Yes, include link or document reference	Choose an item. Click or tap here to enter text.

Derivative Data Set #5 -Resiliency/ Climate Risks	
Type of Derivative Data Set *(Provide data set name and description)*	Other Click or tap here to enter text.
Data Update Methodology	Choose an item. **Describe:** Click or tap here to enter text.

Data Refresh Cycle (e.g. continuous – as data changes; nightly; annual; no set cycle)	**Cycle:** Click or tap here to enter text.
Business Unit responsible for performing or managing the data update	Click or tap here to enter text.
Is a Data Dictionary available for this data set? • If Yes, include link or document reference	Choose an item. Click or tap here to enter text.
Asset Work History Tracking	
Are you currently able to track work that impacts the inventory or condition of this asset?	Click or tap here to enter text.
If yes, what sources are you able to use? *(describe as appropriate)*	☐ **Capital Project Plans:** Click or tap here to enter text. ☐ **Maintenance Service Memos:** Click or tap here to enter text. ☐ **Encroachment Permits:** Click or tap here to enter text. ☐ **Other (Describe):** Click or tap here to enter text.
What data can you currently track? *(describe as appropriate)*	☐ **Asset ID or Route Location(s) treated:** Click or tap here to enter text. ☐ **Type of work activity:** Click or tap here to enter text. ☐ **Specific components of assets treated:** Click or tap here to enter text. ☐ **Quantity of assets treated:** Click or tap here to enter text. ☐ **Cost of work on specific assets:** Click or tap here to enter text. ☐ **Other:** Click or tap here to enter text.

What data would you like to track? *(describe as appropriate)*	☐ **Asset ID or Location(s) treated:** Click or tap here to enter text. ☐ **Type of work activity:** Click or tap here to enter text. ☐ **Specific components of assets treated:** Click or tap here to enter text. ☐ **Quantity of assets treated:** Click or tap here to enter text. ☐ **Cost of work on specific assets:** Click or tap here to enter text. ☐ **Other:** Click or tap here to enter text.
Authoritative system available for tracking **asset specific** work history? *(describe as necessary)*	**System:** Click or tap here to enter text. Click or tap here to enter text.

Data Access Points	
How will the asset inventory and condition data be made accessible to potential users within CTDOT?	**Asset Stewards/Managers:** Click or tap here to enter text. **General Data Users:** Click or tap here to enter text.
How will the asset inventory and condition data be made accessible to potential users external to CTDOT?	Click or tap here to enter text.

Additional Notes
Please provide any additional information which may be useful to the management of the asset:
Click or tap here to enter text.

Glossary

Asset Condition History. Changes in condition over time for the asset - for development of deterioration curves or service life estimates.

Authoritative System. The single source system of record for a particular type of data. This is the data repository where the data is maintained.

Contract Requirements. Contract language that requires provision of asset inventory and/or work accomplishment data elements in a specified format following completion of a project.

Data Access Points. Where users go to obtain data – this may be a desktop application, a web portal, or a data service/API.

Data Dictionary. Data element names, descriptions, types, sizes. May include domain information such as sample values or lists of values.

Derivative Data Set. A data set that is derived from one or more authoritative data sources - e.g. a GIS layer showing basic bridge characteristics - with data pulled from the bridge management system.

Electronic Data Dictionary. Electronic means in a digital, tabular format (e.g. spreadsheet or database table.)

Process Mapping. Process mapping is a technique of using flowcharts to illustrate the process functional steps from start to finish. Commonly used to depict the collection, storage, quality assurance and distribution in the data production process.

Sensitive Data. Private data such as personally identifying information or other data that should have restricted access for security reasons.

Synchronizing Asset Location. For example, a highway realignment to straighten a curve would shorten a route. A sign that had been located at milepoint 3.0 might now be located at milepoint 2.9. Synchronization would correct milepoint locations in historical data.

Tip*: use Alt+← to return to the original hyperlink location.*

Appendix C. Performance Projections

Bridge

Table C-1. % NHS Good, by Deck Area

Funding	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($1,280M)	14.2%	15.2%	15.3%	15.3%	15.5%	15.6%	15.9%	16.3%	15.8%	16.6%	18.2%
Current ($375M)	14.2%	14.5%	14.2%	14.4%	14.5%	14.4%	14.3%	14.2%	13.3%	12.9%	12.1%
No Funding ($0M)	14.2%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	13.9%	13.0%	12.6%	11.7%

Table C-2. % NHS Poor, by Deck Area

Funding	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($1,280M)	8.1%	4.8%	4.4%	2.5%	2.9%	2.8%	4.1%	5.1%	7.6%	5.4%	3.9%
Current ($375M)	8.1%	6.5%	6.2%	6.1%	6.0%	6.0%	6.7%	8.3%	10.2%	8.9%	9.4%
No Funding ($0M)	8.1%	7.7%	7.7%	7.7%	9.2%	9.3%	12.8%	17.5%	22.9%	24.3%	26.2%

Table C-3. % CTDOT-Maintained SOGR, by Number of Bridges

Funding	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($1,280M)	96.2%	98.3%	98.5%	98.9%	98.9%	98.8%	98.4%	97.6%	97.2%	97.7%	98.5%
Current ($375M)	96.2%	97.5%	96.8%	96.9%	97.0%	96.6%	95.8%	93.2%	91.9%	91.6%	91.0%
No Funding ($0M)	96.2%	96.5%	96.5%	96.5%	96.3%	95.5%	93.8%	89.0%	85.7%	83.4%	81.3%

Pavement

Table C-4. % Interstate Good, by lane miles

Funding	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($375M)	76.6%	73.7%	75.1%	76.1%	78.6%	75.9%	61.5%	62.2%	60.1%	58.8%	56.7%
Current ($119M)	76.6%	71.8%	72.5%	72.0%	71.0%	70.0%	50.0%	50.4%	49.2%	46.7%	43.8%
No Funding ($0M)	76.6%	72.8%	70.9%	67.7%	63.9%	57.8%	35.2%	32.7%	30.2%	26.7%	23.5%

Table C-5. % Interstate Poor, by lane miles

Funding	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($375M)	0.2%	0.2%	0.2%	0.2%	0.1%	0.2%	0.2%	0.1%	0.1%	0.2%	0.1%
Current ($119M)	0.2%	0.2%	0.2%	1.0%	1.1%	1.3%	0.3%	0.2%	0.3%	0.3%	0.3%
No Funding ($0M)	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%	0.5%	0.5%	0.6%

Table C-6. % Non-Interstate NHS Good, by lane miles

Funding	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($375M)	39.6%	42.4%	43.4%	42.1%	41.3%	37.8%	27.9%	28.4%	31.0%	30.7%	29.5%
Current ($119M)	39.6%	40.2%	38.1%	37.0%	36.0%	35.0%	15.7%	15.5%	15.2%	15.1%	13.8%
No Funding ($0M)	39.6%	39.9%	36.5%	32.6%	28.9%	21.3%	11.7%	10.6%	9.6%	8.4%	7.2%

Table C-7. % Non-Interstate NHS Poor, by lane miles

Funding	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($375M)	2.1%	1.7%	1.7%	1.6%	1.6%	1.9%	2.2%	2.5%	2.9%	3.1%	3.7%
Current ($119M)	2.1%	2.0%	2.2%	2.7%	3.1%	3.5%	3.6%	4.2%	5.1%	6.1%	7.4%
No Funding ($0M)	2.1%	1.9%	2.4%	3.0%	3.6%	4.6%	5.6%	6.6%	7.9%	9.4%	11.1%

Table C-8. % CTDOT-maintained SOGR, by centerline miles

Funding	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($375M)	69.4%	77.7%	80.9%	82.3%	82.4%	81.5%	81.3%	82.3%	82.2%	83.0%	83.8%
Current ($119M)	69.4%	73.5%	72.0%	69.5%	67.3%	65.0%	57.0%	53.6%	50.7%	48.2%	45.4%
No Funding ($0M)	69.4%	73.5%	69.1%	63.9%	56.8%	50.1%	43.5%	35.6%	29.2%	24.0%	18.8%

Traffic Signal

Table C-9. % SOGR, by traffic signal

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($74M)	61.8%	66.4%	66.7%	68.9%	70.4%	71.3%	72.4%	73.1%	75.0%	76.6%
Current ($61M)	61.8%	64.1%	62.2%	61.8%	60.4%	60.8%	60.5%	59.7%	60.2%	60.4%
No Funding ($0M)	61.8%	64.1%	62.1%	59.9%	57.2%	54.6%	51.5%	47.9%	45.5%	42.8%

Sign

Table C-10. % Extruded Signs SOGR

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($50M)	42.4%	51.5%	57.6%	69.7%	72.7%	84.8%	90.9%	100%	100%	100%
Current ($25M)	42.4%	51.5%	57.6%	69.7%	69.7%	75.8%	75.8%	81.8%	87.9%	87.9%
No Funding ($0M)	42.4%	51.5%	57.6%	57.6%	54.5%	54.5%	48.5%	48.5%	48.5%	42.4%

Table C-11. % Sheet Signs SOGR

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($10M)	41.1%	47.1%	53.1%	59.1%	65.1%	71.1%	77.1%	83.1%	89.1%	95.1%
Current ($5M)	41.1%	42.9%	44.6%	46.4%	48.1%	49.9%	51.6%	53.4%	55.1%	56.9%
No Funding ($0M)	41.1%	38.6%	36.1%	33.6%	31.1%	28.6%	26.1%	23.6%	21.1%	18.6%

Sign Support

Table C-12. % Sign Support SOGR, by sign support

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($9.4M)	98.4%	93.1%	96.3%	96.7%	97.4%	98.0%	97.4%	97.4%	97.8%	97.0%
Current ($4M)	98.4%	93.1%	95.7%	96.4%	97.4%	97.1%	94.7%	89.9%	86.8%	73.3%
No Funding ($0M)	98.4%	88.9%	87.4%	84.3%	83.1%	81.9%	75.6%	62.0%	47.8%	8.7%

Pavement Marking

Table C-13. % Line Striping SOGR, by linear foot

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($19.5M)	83.8%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Current ($6.5M)	83.8%	73.7%	68.7%	76.7%	74.8%	73.0%	72.9%	72.9%	72.9%	72.9%
No Funding ($0M)	83.8%	48.5%	23.5%	11.4%	7.0%	2.6%	0.0%	0.0%	0.0%	0.0%

Table C-14. % Symbols SOGR, by square foot

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($4.5M)	48.2%	66.8%	82.7%	100%	100%	100%	100%	100%	100%	100%
Current ($1.5M)	48.2%	39.0%	31.4%	37.3%	37.3%	37.3%	37.3%	37.3%	37.3%	37.3%
No Funding ($0M)	48.2%	25.1%	5.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Highway Building

Table C-15. % Tier 1 Highway Buildings SOGR, by building

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Current ($46M)	87.4%	87.4%	84.5%	87.4%	87.4%	85.4%	85.4%	84.5%	86.0%	86.0%
No Funding ($0M)	87.4%	86.4%	81.6%	79.6%	77.7%	73.8%	70.9%	66.0%	64.1%	62.1%

Table C-16. % Tier 2 Highway Buildings SOGR, by building

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Current ($4M)	100%	100%	98.9%	98.9%	98.9%	98.9%	98.9%	98.9%	97.8%	90.2%
No Funding ($0M)	100%	100%	98.9%	97.8%	97.8%	97.8%	94.6%	89.2%	80.6%	71.0%

Table C-17. % Tier 3 Highway Buildings SOGR, by building

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Current ($0.25M)	61.0%	60.6%	59.1%	60.2%	65.3%	65.0%	58.5%	55.2%	50.0%	50.9%
No Funding ($0M)	61.0%	58.9%	55.5%	54.8%	54.1%	52.1%	45.9%	42.5%	37.0%	36.3%

Roadway Illumination

Table C-18. % Light Fixture SOGR

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1,000 lights / year ($18M)	84.9%	87.5%	90.3%	90.6%	92.9%	91.6%	93.8%	95.8%	98.0%	84.9%
775 lights / year ($13.6M)	84.9%	86.5%	88.3%	87.4%	88.7%	86.4%	87.6%	88.5%	89.6%	84.9%
375 lights / year ($6.8M)	84.9%	84.8%	85.0%	82.6%	82.2%	78.3%	77.5%	77.1%	76.7%	84.9%

Retaining Walls

Table C-19. % Retaining Wall SOGR

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Current ($7.5M)	98.0%	97.8%	97.6%	97.3%	96.4%	95.6%	94.8%	94.2%	93.4%	92.8%
No Funding ($0M)	98.0%	97.4%	96.8%	96.3%	95.4%	94.6%	93.8%	93.2%	92.4%	91.7%

Drainage Culverts

Table C-20. % Drainage Culvert SOGR

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($44M)	83.4%	84.1%	84.7%	85.3%	85.9%	86.4%	87.0%	87.6%	88.2%	88.8%
Current ($7.5M)	83.4%	83.1%	82.8%	82.5%	82.2%	81.8%	81.5%	81.2%	80.9%	80.6%
No Funding ($0M)	83.4%	83.0%	82.5%	82.0%	81.5%	81.0%	80.5%	80.0%	79.5%	79.0%

Intelligent Transportation Systems

Table C-21. % ITS SOGR

Funding	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Preferred ($30M)	38.0%	40.0%	44.0%	43.0%	53.0%	55.0%	61.0%	70.0%	71.0%	83.0%
No Funding ($0M)	38.0%	36.0%	35.0%	35.0%	35.0%	27.0%	19.0%	15.0%	8.0%	6.0%

Appendix D. Risk Registry

Table D-1. List of Risks

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Bridge	If we don't maintain Poor (by deck area) below 10% in the future, then FHWA will levy a bridge penalty and there may not be enough eligible NHS-NBI bridge projects available to use the bridge penalty funding, therefore we will lose federal money	Medium	• Use modeling to initiate projects on fair bridges projected to become poor	Implemented / Completed
Bridge	If we have scour critical bridges in the bridge inventory, then we risk having a design storm event or a more frequent storm event damage or destroy a bridge	Medium	• ·Continued monitoring through bridge inspection/rating, storm monitoring/alerts and updates • Provide maintenance repairs where viable or Initiate rehab or replacement project within constraint of capitol programing	Implemented / Completed
Bridge	If we have a lack of engineering consultant management staff, then we can't oversee consultants adequately	Medium	• Use in-house design staff to oversee consultants.	Implemented / Completed
Bridge	If we cannot expediently execute bridge analysis software, then we cannot run scenarios for TAMP performance projections or deliver treatment program recommendations	Medium	• Upgrade software versions outside of TAMP submittal window. • Provide sufficient processing to allow for multiple asset users and longer analysis periods.	Implemented / Completed
Bridge	If asset deterioration is not addressed in a timely manner, then it will create greater needs and cost in the future	Medium	• Continue to track inventory and condition, address routine maintenance, and use lifecycle planning to preserve and rehabilitate assets at appropriate intervals.	Implemented / Ongoing
Bridge	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted	Medium	• Damaged assets should be addressed as needed. The department will continue to consider extreme weather and design assets to an appropriate resiliency standard.	Implemented / Ongoing
Bridge	If we have a lack of trained staff or equipment for bridge safety inspection (State and Consultants), then we do not discover bridge deficiencies in a timely manner and will not meet	Medium	• Retain staff and maintain equipment. • Hire and train to address the needs.	Implemented / Ongoing

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	the FHWA NBIS Oversight Program			
Bridge	If we do not coordinate with future highway design planning, then we may not pick the most cost-effective solution to rehabilitate or replace our bridges in highway lead projects.	Medium	• Continue to facilitate communication between the Division of Bridge's Bridge Management Group and the Division of Highway Design's Highway Management Unit.	Implemented / Ongoing
Bridge	If we do not have load ratings with models that can run on current software, on all bridges, then we may not be able to quickly evaluate safe loads for deteriorated bridges discovered during inspections	Medium	• Leverage qualified outside resources to perform load ratings	Implemented / Ongoing
Bridge	If the rate of bridge deterioration increases faster than predicted as bridges age, then the percent of Poor bridges (by deck area) will increase	Medium	• Make necessary adjustments to the deterioration modeling and recommended treatments in the dTIMS software	Implemented / Ongoing
Bridge	If we do not predict and prepare accurate schedules at design approval, then it can lead to schedule delays and impacts to the financial program	Medium	• Take advantage of using and maintaining project scheduling programs (Microsoft Project) to generate, mitigate, and track project schedules.	Implemented / Ongoing
Bridge	If we do not change how we address/prevent corrosion due to the use of deicing salts on our bridges, then the cost of rehabilitation will take away from maintaining bridge assets in a SOGR	Medium	• Now doing programmatic concrete sealing program for high risk areas • Continue to Rinse Bridges	Implemented / Ongoing
Bridge	If we don't provide correct scope and cost estimates at the initiation of the PPI (Proposed Project Information), then it will impact initial schedules and change costs which may impact the capital plan	Medium	• Refine how preliminary cost estimates are performed	Implemented / Ongoing
Bridge	If there is inadequate funding, then limited work will be conducted and bridge conditions will deteriorate which may lead to limiting permit loads, having to post bridges for lighter loads or closing bridges.	Medium	• Prioritize our bridge projects using performance-based decisions. • Develop lower cost project delivery to repair/replace more bridges with the same funding such as design build and Variable Quantity contracting.	In Progress/ Deployed
Bridge	If we have a lack of design engineering staff, then we won't gain knowledge in the new methods to design more durable bridges and possibly not maximize our federal funds	Medium	• Convince the legislature to increase staff. • Leverage qualified outside resources to help with the bridge design program.	In Progress/ Deployed

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Bridge	If we don't document institutional knowledge and existing processes, then we will spend more on design time, be less efficient at preparing quality plans, and it will result in longer project schedules.	Medium	• Work to develop division of bridge Wiki to document how our design process works	In Progress/ Deployed
Bridge	If we don't have the ability to permit at preliminary design ("conditional permits") for design-build bridge projects, then we cannot do: a) design/build projects that require permits efficiently ; b) we may eliminate possible design-build project candidates which would save Connecticut money and time	Medium	• ·Develop performance based permitting to focus upon best practices and limits. • Develop new, improved processes	In Progress/ Deployed
Bridge	If the load on the bridge exceeds the load rating of the bridge, then the bridge may not achieve its expected life	Medium	• Identify locations that this is frequently occurring. • Coordinate with freight enforcement and regulations to develop a plan to understand and address impacts of loadings to the bridges. • Obtain better information of loadings via the use of technology.	In Progress/ Deployed
Bridge	If maintenance forces are reduced and repairs of damage or other deterioration are needed that could be repaired in-house, then repairs would need to be accomplished under the Capital Program or done under an Emergency Declaration, costing Connecticut more money to repair	Medium	• Maintain or increase bridge maintenance staff.	Initiated
Bridge	If we lack bridge maintenance staff and don't continue to maintain our bridges, then bridges will continue to deteriorate leading to more serious bridge conditions requiring a more costly capital project to repair or replace bridges earlier than necessary	Medium	• Share resources by having the Office of Construction (construction inspectors) and the Office of Maintenance Operations / Transportation Maintenance (maintenance district staff) coordinate on bridge maintenance needs thru Bridge Repair Unit (BRU) contracts, administered by the Office of Construction	In Discussion
Bridge	Climate change may, increase the number of hydraulically inadequate bridges, increase the frequency of upstream flooding /property damage and increase	Medium	• Incorporate guidance from FHWA and/or AASHTO for evaluating the potential effects of climate change in the hydrologic and hydraulic design of inland and coastal bridges into the	In Discussion

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	the number of scour critical bridges		Department's design manuals. Implement on a project basis. Support ongoing and future research in the design of climate resilient bridges.	
Bridge	If we don't address the continual deterioration of a bridge that occurs during the design/bid/award process, then the repairs tend to exceed the estimated deterioration, leading to increased construction costs and project delays	Medium	• Use Variable Quantity Contracting to handle field changes. • Use forensic inspections near design completion.	In Discussion
Bridge	If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced	Medium	• N/A	Under Consideration
Bridge	If there is a cyber attack on CTDOT data systems, then CTDOT asset management functions may be impeded	Medium	• Rely on IT do address this. Backup inventory and asset data.	Under Consideration
Bridge	We can't accurately assess deterioration until removal of all corrosion at the start of construction, therefore repairs required tend to exceed the estimate, leading to increased construction costs and project delays	Medium	• Track the impact when this situation occurs on projects, to help inform estimates and expectations for future projects	Under Consideration
Bridge	If asset data are not complete and current, then we cannot optimize investments and set priorities	Low	• There is an existing inspection cycle with contractors in place; these inspections should continue.	Implemented / Ongoing
Bridge	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted, then future funding may be insufficient	Low	• DAS accounts for inflation. Increase available funding to account for inflation.	Implemented / Ongoing
Bridge	If focused on worst first rather than preservation, then assets reach end of life faster	Low	• Continue to track inventory and condition, address routine maintenance, and use lifecycle planning to preserve and rehabilitate assets at appropriate intervals.	Implemented / Ongoing
Bridge	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed	Low	• Continue exploring new technologies as part of process improvements.	Implemented / Ongoing
Bridge	If we don't have reliable deterioration modeling, then we won't program appropriate treatments efficiently or cost effectively	Low	• Take advantage of dTIMS' ability to modify and adjust the deterioration modeling with updated historical information.	Implemented / Ongoing

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Bridge	If we don't select the right projects, then lifecycle costs will increase to achieve or maintain SOGR	Low	• Use the Asset Management Approach to select projects.	In Progress/ Deployed
Bridge	If we don't embrace new materials and technologies to reduce future maintenance costs, then we cannot increase investment in capital improvements	Low	• · Continue effort to coat concrete surfaces with a sealer to keep out salt-laden moisture. Investigate products advertised to remove salts that have already migrated into the surface and then protects from further salt contamination. • Use other state's knowledge and experiences and CTDOT research for low maintenance materials.	In Progress/ Deployed
Bridge	If we have inadequate or late public involvement and controversy arises, then it can lead to schedule delays, and we may have to re-scope projects, and experience increased costs	Low	• Early public outreach. • Reinvent new ways to reach stakeholders.	In Discussion
Bridge	If politics influence the prioritization of projects, then less optimal projects may be selected, compromising SOGR	Low	• No mitigation strategy currently (Tolerate).	Under Consideration
Pavement	If we don't deliver the recommended projects, then pavement conditions will deteriorate and we will lose public credibility	High	• Still working toward multi-year program (rec for 22 and 23 this year), possible new DOT contract mechanism (for preservation currently, other treatments possible in future)	Initiated
Pavement	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted	Medium	• Coordinate with the Office of Maintenance to develop and employ a prescribed plan to assess & repair damaged assets in the event of a natural disaster.	Implemented / Ongoing
Pavement	If we do not embrace pavement preservation, then costs will increase and conditions will decrease (worsen.)	Medium	• Educate and promote pavement preservation practices inside and outside of the Agency • Conduct public outreach to understand preservation project selection • Collaborate with (CT) LTAP for local agency education	Implemented / Ongoing
Pavement	If we don't consider the age of the network, then we could have unexpected performance and changed field conditions in projects	Medium	• Understanding the impacts of the aging network • Use of nondestructive and forensic techniques to minimize uncertainty	Implemented / Ongoing
Pavement	If we don't select the right projects, then lifecycle costs will	Medium	• Rehab program to address "worst" roads that might get left	In Progress/ Deployed

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	increase to achieve or maintain SOGR		behind without worst-first, need to address backlog before more roadways deteriorate, work to develop strategy to balance, working with UConn	
Pavement	If staffing levels are inadequate or if staff are not properly trained, the program delivery will suffer	Medium	• Leverage qualified outside resources • Develop a multi-year work program identifying resources needed to achieve objectives • Develop and implement a succession plan	In Progress/ Deployed
Pavement	If don't routinely address longitudinal paving joints, cracks and potholes, then we will shorten the life of the asphalt paving surfaces, particularly at high value roadways and creates a safety issue	Medium	• Institute Crack Fill/Seal Program • Investigate preventative maintenance techniques • Allocate appropriate resources	In Progress/ Deployed
Pavement	If we do not consider the complexity of implementing changes in technology, contracting etc. , then opportunities that will enable us to achieve SOGR will be missed.	Medium	• Incorporate change/new technology into the business process • Develop and deploy effective implementation plans • Match resources to objectives	In Progress/ Deployed
Pavement	If the construction is of poor quality, then performance will be shortened, costs will increase, and public perception will be impacted negatively	Medium	• Continue implementation of statistically based specifications that support more consistent and higher quality of construction	In Progress/ Deployed
Pavement	If the materials are of poor quality, then performance will be shortened and costs will increase	Medium	• Continue to review specifications and controls to address changes in materials	In Progress/ Deployed
Pavement	If the pavement analysis model is inaccurate, then funding could be inadequate, needed projects won't be identified and constructed, and we can't identify correct treatments and cost	Medium	• Review and continuously update analysis inputs: specifically, deterioration models, treatment triggers and costs • Allocate appropriate resources to achieve	In Progress/ Deployed
Pavement	If we don't get adequate funding, then pavement conditions will deteriorate and; future funding needs to achieve or maintain SOGR will increase	Medium	• Requesting more funding, creating a pavement map (0.1 mi sections) to identify poor/backlog pavements	Initiated
Pavement	If construction costs increase, then we cannot deliver the recommended program	Medium	• Express paving program needs in terms of lane-miles or lane-mile-years instead of current costs • Provide flexible funding options	In Discussion

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Pavement	If construction industry can't handle the capacity, then pavement conditions will deteriorate, maintenance and construction will decline in quality, costs will increase, and some treatments won't be available	Medium	• Establish a multi-year plan so that the industry can plan for the program requirements.	In Discussion
Pavement	If there's a lack of maintenance staff, then assets will deteriorate faster and public safety could be affected	Medium	• Add staffing	Under Consideration
Pavement	If FHWA minimum conditions for NHS pavement and bridge aren't met, then funding flexibility will be removed and funds may be reallocated from other assets	Medium	• Educate and promote pavement preservation practices inside and outside of the Agency • Conduct public outreach to understand preservation project selection • Collaborate with (CT) LTAP for local agency education	Under Consideration
Pavement	If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced	Medium	• Ensure design restrictions are met through signing and public outreach. Design for future predicted weights and volumes	Under Consideration
Pavement	If focused on worst first rather than preservation, then assets reach end of life faster	Medium	• Educate and promote pavement preservation practices inside and outside of the Agency • Conduct public outreach to understand preservation project selection • Collaborate with (CT) LTAP for local agency education	Under Consideration
Pavement	If politics influence the prioritization of projects, then less optimal projects may be selected, compromising SOGR	Medium	• Conduct public outreach to understand preservation project selection	Under Consideration
Pavement	If there is a cyber attack on CTDOT data systems, then CTDOT asset management functions may be impeded	Medium	• Coordinate with IT to develop and employ a prescribed plan in the event of a cyber attack	Under Consideration
Pavement	If staff knowledge is not transferred and retained, then capabilities and capacity are reduced and SOGR may be negatively impacted	Low	• Continue to develop training programs	Implemented / Ongoing
Pavement	If pavement data are incomplete or of poor quality for the program level, then we can't identify correct treatments and costs	Low	• Implement the QMP (Quality Management Plan) • Develop a QMP for all other data inputs	In Progress/ Deployed

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Pavement	If there are computer hardware, software, or network issues that result in excessively slow pavement condition processing speeds, then pavement condition data will not be delivered in a timely manner in order to produce quality data to submit to FHWA as part of the annual HPMS program, and to run analyses to deliver a data-driven construction program.	Low	• Implement a pavement data action plan developed during a November 2018 LEAN Event to streamline pavement data processing and work flow.	In Progress/ Deployed
Traffic Signals	If traffic signal assets deteriorate to a poor condition, then the safety to the public, the efficiency of travel, and the quality of life will be affected	High	• Ensure adequate resources are dedicated to these assets and their related activities • Develop and implement an Asset Management Plan	In Progress/ Deployed
Traffic Signals	If there is not adequate maintenance staff who are technically skilled in signal repair, then the performance of traffic control devices will degrade and public safety will be affected	High	• Ensure appropriate and sufficient staff and provide technical training to staff • Investigate leveraging outside resources for some work if needed/possible	Initiated
Traffic Signals	If vehicle and pedestrian detector systems are not functioning properly, then the signal will not run efficiently, and safety, congestion, and quality of life will be impacted	High	• Include in the M-88, add connectivity to all signals, contract re-installation of video detection, and add electronic self reporting at CTSS locations.	Initiated
Traffic Signals	If we lack asset inventories with adequate information on condition, then we can't optimize investments and set priorities	Medium	• Develop an inventory of traffic signal assets - ESRI is near completion • Use new technology to inventory assets and document their age/condition; • Coordinate with the Offices of Maintenance and Construction to update/maintain the inventory • Improve tracking of part service records to retire components that repeatedly break down and/or do not achieve the expected service life	Implemented / Ongoing
Traffic Signals	If there is insufficient succession planning, then there could be a gap in knowledge and experience.	Medium	• SharePoint page created that includes standardized guidelines, forms, training, etc.	Implemented / Ongoing
Traffic Signals	If design staffing is inadequate, then we will not be able to maintain state of good repair and upgrade to current design	Medium	• Ensure adequate staff for SOGR projects • Established a new position to oversee the on call consultants	In Progress/ Deployed

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	and safety standards of traffic signal assets		for assigning additional SOGR projects • Develop and implement asset management system to increase efficiency of SOGR projects.	
Traffic Signals	If we do not coordinate between work units (Bridge Safety, Bridge Design, Office of Maintenance (including District Offices, Highway Operations, and the Signal Lab.) Office of Information Systems (GIS) and Engineering Applications), , then we will not operate as efficiently as we could	Medium	• Develop a coordination strategy based on the alignment of work schedules and strategic communication • Ensure appropriate offices are included in the Traffic Signal Asset Management working group • Ensure appropriate offices are involved with design reviews • Develop clearly defined roles and responsibilities for each unit	In Progress/ Deployed
Traffic Signals	If we don't select the right projects, then lifecycle costs will increase to achieve or maintain SOGR	Medium	• Ensure adequate staff for SOGR projects • Develop an inventory of traffic signal assets and use to inventory assets and document their age/condition • Develop and implement asset management system to increase efficiency of SOGR projects.	Initiated
Traffic Signals	If FHWA minimum conditions for NHS pavement and bridge aren't met, then funding flexibility will be removed and funds may be reallocated from other assets	Medium	• Designate annual allocated traffic signal funds to best use to obtain SOGR for maximum number of locations.	Initiated
Traffic Signals	If focused on worst first rather than preservation, then assets reach end of life faster	Medium	• Ensure adequate staff for SOGR projects • Develop an inventory of traffic signal assets and use to inventory assets and document their age/condition. • Develop and implement asset management system to increase efficiency of SOGR projects.	Initiated
Traffic Signals	If we do not maintain IT systems, then signals have potential to fail	Medium	• Discussion of having IT staff to monitor	In Discussion
Traffic Signals	If we experience reductions in funding, then the performance of our traffic signal assets will suffer	Medium	• Seek needed funding using data and support information to clearly define the need and consequences of no action	Under Consideration

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
			• Employ a traffic signal asset system to optimize the use of resources over the life cycle of the assets • Establish dedicated funding for signal maintenance activities	
Traffic Signals	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted, then future funding may be insufficient	Medium	• Seek needed funding using data and support information to clearly define the need and consequences of no action • Employ a traffic signal asset system to optimize the use of resources over the life cycle of the assets • Develop and implement asset management plan to increase efficiency of SOGR projects	Under Consideration
Traffic Signals	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted	Medium	• Coordinate with the Office of Maintenance to develop and employ a prescribed plan to assess & repair damaged assets in the event of a natural disaster.	Under Consideration
Traffic Signals	If there is a cyber attack on CTDOT data systems, then CTDOT asset management functions may be impeded	Medium	• Coordinate with the IT to develop and employ a prescribed plan in the event of a cyber attack.	Under Consideration
Traffic Signals	If we do not assess signal timing on regular intervals, then the safety to the public, the efficiency of travel, and the quality of life will be affected	Medium	• Have yet to establish regular retiming program	Under Consideration
Traffic Signals	If we do not coordinate between work units within the Division of Traffic Engineering (Operations, Safety, Project Design), then we will not operate as efficiently as we could	Low	• Develop and employ a prescribed plan to communicate and coordinate work being conducted between units in the Division of Traffic Engineering • Ensure each office has a representative in the Asset Management Working Group • Create dedicated signal asset management section	In Progress/ Deployed
Traffic Signals	If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced	Low	• Create policy to eliminate in-pavement traffic signal detection to minimize disruption to traffic signal operation.	Initiated
Traffic Signals	If politics drives our traffic decisions, then we may install unwarranted traffic signals which could cause issues, or a location could be programmed for an	Low	• Provide education of the disadvantage of unwarranted traffic signals	In Discussion

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	equipment upgrade when there may be a location with a greater need		• Implement a data driven selection process for locations for equipment upgrades • Evaluate more appropriate traffic control for the intersection (including removal, roundabout, etc.) • Discussion of an ICE group	
Traffic Signals	If there is not adequate technology, design tools and training, then we cannot meet project deadlines, there will be duplication of work, we will not be able to maintain a state of good repair and upgrade to current design and safety standards and the quality of life will be impacted.	Low	• Support efforts to update technology, design tools and training • Re-establish technology review committee	In Discussion
Traffic Signals	If we continue to use the Department's current signal controller requirements, then future upgrades to meet new MUTCD requirements will be more difficult and costly to implement	Low	• Develop program for continually upgrading requirements for traffic signal equipment to ensure compatibility with current national best practices for optimal flexibility to accommodate future changes	In Discussion
Traffic Signals	If future regulations (MUTCD, AASHTO, NESC,PURA,etc.) and requirements are revised or developed, then we could face higher costs and efforts to be compliant	Low	• Staff engagement and involvement in development of future regulations, so that we have the longest time possible to anticipate future needs and so that the requirements align with CT's needs.	Under Consideration
Signs	If sign inventory is not complete and current then we cannot optimize investments and set priorities.	Very High	• Develop comprehensive plan to address the needs of Maintenance and Design. • Implement new ways of designing projects to capture design data and construction data.	Implemented/Ongoing
Signs	If there is a lack of adequate maintenance staff to fabricate, install & repair signs then the performance of sign devices will degrade and public safety will be affected.	High	• Add staffing • Upgrade fabrication equipment • Look into fabrication techniques to allow for faster fabrication such as digital printing	Implemented/Ongoing
Signs	If staff is not trained to an adequate level then we will not operate as efficiently as we should. There will be potential duplication of efforts, wasted resources, impacts to public	High	• Come up with a training plan for implementation	In Progress/ Deployed

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	safety and negative public perception.			
Signs	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted then future funding may be insufficient	High	• Increase funding to assets based on inflation	Under Consideration
Signs	If the Department's sign catalog, associated database, and sign details are not current and accurate then Department staff and Consultants can't request proper signage; the Sign Shop will receive orders for obsolete signs; and signage being installed will not meet current MUTCD requirements.	Medium	• Update all sign details • Update the sign catalog • Update the associated database	Implemented / Completed
Signs	If there is a lack of support staff (clerical, planning, OEP, Environmental Compliance) for project delivery then we cannot meet project deadlines and we will not be able to maintain a state of good repair and overall efficiency.	Medium	• Add staffing • Streamline required procedures	Implemented / Ongoing
Signs	If sign posts are not installed properly then sign visibility and sign post breakaway safety features may be minimized.	Medium	• As signs are replaced, replace the post with a proper breakaway post. • Maintain quality control on the specifications.	Implemented / Ongoing
Signs	If there is not adequate coordination with the Division of Bridges then we cannot meet project deadlines and we will not be able to maintain a state of good repair and the efficiency of travel will be impacted.	Medium	• See if Bridge Design can create a plan to utilize On-Call staff more efficiently. • Standardize structure types to reduce in-house design time.	Implemented / Ongoing
Signs	If new technologies are not implemented at the sign shop or for sheeting materials then retroreflective properties of the signing will degrade requiring more frequent replacement.	Medium	• Continue coordination with sheeting manufacturers • Make purchases as necessary • Receive training on new equipment	Implemented/Ongoing
Signs	If new technologies are not implemented for designers then quality and quantity of signing projects will not be able to be improved.	Medium	• Continue to implementing and utilizing new technology as it becomes available	Implemented/Ongoing
Signs	If warning signs deteriorate to poor condition then the safety to the public, the efficiency of travel, and the quality of life will suffer.	Medium	• Implement the use of longer lasting sheeting (Type XI) • Look into overlaminate products to be added onto high risk signs (ex. Stop signs) in order to reduce graffiti	Implemented/Ongoing

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
			• Sign replacement projects targeting high risk signs to maintain state of good repair	
Signs	If guide signs deteriorate to poor condition then the safety to the public, the efficiency of travel, and the quality of life will suffer.	Medium	• Implement the use of longer lasting sheeting (Type XI) • Look into overlaminate products to be added onto high risk signs (ex. Stop signs) in order to reduce graffiti • Sign replacement projects targeting high risk signs to maintain state of good repair	Implemented/Ongoing
Signs	If we don't select the right projects then lifecycle costs will increase to achieve or maintain SOGR	Medium	• Utilize improved asset data to select the appropriate projects.	In Progress/ Deployed
Signs	If funding is inadequate then the performance of the signs will suffer.	Medium	• Accept the risk	In Progress/ Deployed
Signs	If design staff levels are inadequate then we will not be able to maintain a state of good repair for signs.	Medium	• Outsource to Consultants • Reprioritize staffing • Add staffing	In Progress/ Deployed
Signs	If staff knowledge is not transferred and retained then capabilities and capacity are reduced and SOGR may be negatively impacted	Medium	• Come up with a training plan for implementation	In Progress/ Deployed
Signs	If there is not adequate technology, design tools and training then we cannot meet project deadlines, there will be duplication of work, we will not be able to maintain a state of good repair and the efficiency of travel and quality of life will be impacted.	Medium	• Make purchases • Develop plan to stay current and effective. • Implement GIS based solutions for all projects	In Progress/ Deployed
Signs	If there is not adequate coordination with the Office of Maintenance then we will not operate as efficiently as we should. There will be potential duplication of efforts, wasted resources, impacts to public safety and negative public perception.	Medium	• Continue coordination as necessary • Create opportunities to improve technology for the signing crews • Implement a Maintenance Work Order System that works with the Sign Inventory	In Progress/ Deployed
Signs	If regulatory signs deteriorate to poor condition, then the safety to the public, the efficiency of travel, and the quality of life will suffer.	Medium	• Implement the use of longer lasting sheeting (Type XI) • Look into overlaminate products to be added onto high risk signs (ex. Stop signs) in order to reduce graffiti	In Progress/ Deployed

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
			• Sign replacement projects targeting high risk signs to maintain state of good repair	
Signs	If there is not adequate coordination within the Division of Traffic then we will not operate as efficiently as we should. There will be wasted resources, duplication of efforts, and negative public perception.	Medium	• Improve coordination • Potential for Lean or reorganization to eliminate gaps	In Progress/ Deployed
Signs	If there are not adequate sign shop supplies and equipment then Maintenance staff will not be able to replace and repair signs.	Medium	• Make purchases • Try to maintain current technologies	In Progress/ Deployed
Signs	If signing decisions are determined by public acts set forth by the legislature then we will install signs that cause confusion, clutter, violate federal standards, and detract resources.	Medium	• Provide information to politicians supporting Federal and Department standards and guidance • Be willing to say no to acts that violate Federal standards and guidance	In Progress/ Deployed
Signs	If asset deterioration is not addressed in a timely manner then it will create greater needs and cost in the future	Medium	• Improve asset data collection to reduce duplication of effort • Increase productivity to maintain a SOGR	In Progress/Deployed
Signs	If future regulations and requirements are instituted then we could face higher costs, greater efforts to remain compliant, greater demands on limited resources, and negative initial public perception.	Medium	• Involvement with MUTCD process.	In Progress/Deployed
Signs	If politics influence the prioritization of projects then less optimal projects may be selected, compromising SOGR	Medium	• Provide information to politicians supporting the Department's project prioritization	Initiated
Signs	If posted signs do not match approved OSTA signage requirements and MUTCD requirements then FHWA funding may be in jeopardy, potential for litigation based on incorrect signage, and potential for crashes.	Medium	• Complete TIR's in a timely manner • Compare authoritative databases for discrepancies	Initiated
Signs	If there is a natural disaster, extreme weather, or state of emergency then assets may be damaged and travel may be interrupted	Medium	• Accept the risk	In Discussion
Signs	If posted signs do not match roadway conditions then drivers may not be prepared for the roadway conditions.	Medium	• Program projects to address identified deficiencies	Under Consideration

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Signs	If FHWA minimum conditions for NHS pavement and bridge aren't met then funding flexibility will be removed and funds may be reallocated from other assets	Low	• Accept the risk	In Progress/ Deployed
Signs	If truck weights and volumes exceed the design values then the asset lifecycle may be reduced	Low	• Minimal impact to the sign asset	Under Consideration
Signs	If focused on worst first rather than preservation then assets reach end of life faster	Low	• Minimal impact to the sign asset as there is no preservation techniques for sign sheeting	Under Consideration
Signs	If there is a cyber attack on CTDOT data systems then CTDOT asset management functions may be impeded	Low	• Coordinate with IT to develop and employ a prescribed plan in the event of a cyber attack	Under Consideration
Sign Supports	If we don't have an accurate or complete inventory, then we cannot properly manage this asset	Medium	• Continue keeping the inventory current and improve data as new data is acquired	Implemented / Ongoing
Sign Supports	If there's a lack of maintenance staff, then assets will deteriorate faster and public safety could be affected	Medium	• Hire, train, and retain staff.	Implemented / Ongoing
Sign Supports	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted, then future funding may be insufficient	Medium	• DAS accounts for inflation. Increase available funding to account for inflation.	Implemented / Ongoing
Sign Supports	If asset deterioration is not addressed in a timely manner, then it will create greater needs and cost in the future	Medium	• Continue to track inventory and condition, address routine maintenance, and use lifecycle planning to preserve and rehabilitate assets at appropriate intervals.	Implemented / Ongoing
Sign Supports	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted	Medium	• Damaged assets should be addressed as needed. The department will continue to consider extreme weather and design assets to an appropriate resiliency standard.	Implemented / Ongoing
Sign Supports	If sign supports are not inspected regularly, then there is the potential for failure	Medium	• Sign supports are being inspected on a regular cycle. This cycle is an interval of 2/4/6 years depending on the material and sign type. New sign structures are inspected on a 6 years cycle	Implemented / Ongoing
Sign Supports	If there is insufficient funding for sign support replacements, then there is the potential for failure and will create a backlog of asset needs	Medium	• Seek funding as needed. • Give these projects a higher priority in the obligation plan, during the project prioritizations.	In Progress/ Deployed
Sign Supports	If FHWA minimum conditions for NHS pavement and bridge aren't	Medium	• N/A	Under Consideration

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	met, then funding flexibility will be removed and funds may be reallocated from other assets			
Sign Supports	If politics influence the prioritization of projects, then less optimal projects may be selected, compromising SOGR	Medium	• No mitigation strategy currently (Tolerate).	Under Consideration
Sign Supports	If there is a cyber attack on CTDOT data systems, then CTDOT asset management functions may be impeded	Medium	• Rely on IT do address this. Backup inventory and asset data.	Under Consideration
Sign Supports	If we have a lack of Bridge Safety & Evaluation staff for inspection due to insufficient funding, then it impedes the management of the sign support asset due to lack of current condition information	Medium	• Increase the funding to cover the inspection cost. (currently the funding is sufficient, and is not expected to be an issue in the future)	Under Consideration
Sign Supports	If design staffing levels are inadequate or if staff are not properly trained, then program delivery will struggle to meet goals	Low	• Hire, train, and retain staff.	Implemented / Ongoing
Sign Supports	If focused on worst first rather than preservation, then assets reach end of life faster	Low	• Continue to track inventory and condition, address routine maintenance, and use lifecycle planning to preserve and rehabilitate assets at appropriate intervals.	Implemented / Ongoing
Sign Supports	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed	Low	• Continue exploring new technologies as part of process improvements.	Implemented / Ongoing
Sign Supports	If new and altered sign supports are not properly accounted for, then we will not have a complete inventory which can lead to possible duplication of inspections or overlooked inspection cycle	Low	• Utilize new sign support IDs when sign supports are removed or replaced and archive data associated with the removed/replaced supports. • Schedule coordination meetings as necessary between Bridge Safety, Bridge Maintenance, and Traffic Engineering.	Implemented / Ongoing
Sign Supports	If standards change (for signs or sign supports), then existing good sign supports may need to be replaced	Low	• Use safety factors for the design of new signs. • Explore the real need to upgrade existing signs. • Consider designing supports for larger signs now, taking into account that larger may be required in the future (coordination between Bridge and Traffic).	In Progress/ Deployed

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Sign Supports	If we don't select the right projects, then lifecycle costs will increase to achieve or maintain SOGR	Low	• Use the Asset Management Approach to select projects.	Initiated
Sign Supports	If staff knowledge is not transferred and retained, then capabilities and capacity are reduced and SOGR may be negatively impacted	Low	• Training programs, product knowledge, and employee cross training. Establish standard procedures in writing so they are not lost.	In Discussion
Sign Supports	If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced	Low	• N/A	Under Consideration
Sign Supports	If there is not adequate coordination between the Division of Highway Design and the Division of Traffic Engineering for guiderail design to protect the sign support, then project schedules need to be adjusted and appropriate design features may not be included which would lead to change orders in construction.	Low	• Improve coordination. • See if Highway Design can create a plan to utilize On-Call staff more efficiently. • See if there is a way to incorporate a design/build spec into projects for guiderail • Look into using Traffic on calls in CLE or Design	Under Consideration
Pavement Markings	If there is insufficient staffing due to sign priorities, VIP paving, complaints, and available staff skill sets, then less work will get done and safety will be impacted, then less work will get done and safety will be impacted	Very High	• · Address staffing issues; address critical need for specially trained operators	In Progress/ Deployed
Pavement Markings	If there is insufficient MPT (Maintenance and Protection of Traffic) staff and equipment, then work cannot be achieved and safety will be impacted	High	• New cone trucks are in the process of procurement. Additional crash units are under consideration. Crew schedules need improved coordination given current resources.	Implemented / Ongoing
Pavement Markings	If there's a lack of maintenance staff, then assets will deteriorate faster and public safety could be affected	High	• Potentially offset with contracted vendors.	Implemented/Ongoing
Pavement Markings	If there are improved technologies, then lifecycle of the markings will be extended and more work can be accomplished	High	• Continue to pursue new technologies: Wet reflective pilot projects are ongoing.	In Progress/ Deployed
Pavement Markings	If funding decreases or is uncertain, then less work will get done and safety will be impacted	High	• Take steps to ensure necessary funding. Funding is locked in through 2023.	In Discussion
Pavement Markings	If pavement marking products are unavailable, then the ability to complete work will be compromised	High	• Consider alternative products such as different epoxy or paints.	In Discussion

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Pavement Markings	If the carbide plow blades are damaging the lane striping, then the lane striping will not perform as intended	Medium	• Continue the installation of grooved centerline pavement markings	Implemented / Ongoing
Pavement Markings	If weather conditions are not favorable for paint application (cold/rain), then less work will get done and safety will be impacted	Medium	• Adopt strategies to account for variability in weather . Giving the contractor an additional day to work, allowing flexibility to work around weather.	Implemented / Ongoing
Pavement Markings	If equipment is not functioning properly and up-to-date for application needs (example painting of rumble strips, etc.), then work cannot be achieved and safety will be impacted	Medium	• · Develop plan to address critical equipment redundancy needs.	Implemented / Ongoing
Pavement Markings	If the public drives over wet paint, then claims will increase	Medium	• Seek operational improvements that allow for additional painting without the concern of impacting the travelling public. Extra effort already being done by using additional cones and no longer painting both white and yellow lines.	Implemented / Ongoing
Pavement Markings	If staff knowledge is not transferred and retained, then capabilities and capacity are reduced and SOGR may be negatively impacted	Medium	• Training programs, product knowledge, and employee cross training.	Implemented/Ongoing
Pavement Markings	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted, then future funding may be insufficient	Medium	• DAS accounts for inflation. Increase available funding to account for inflation.	Implemented/Ongoing
Pavement Markings	If asset deterioration is not addressed in a timely manner, then it will create greater needs and cost in the future	Medium	• The determination of project work is done through inspection and addressing deteriorated assets first.	Implemented/Ongoing
Pavement Markings	If we don't select the right projects, then lifecycle costs will increase to achieve or maintain SOGR	Medium	• Looking into different marking materials. Currently use average daily traffic and current pavement conditions to select projects. New retroreflectometer will also help to select projects in future.	In Progress/Deployed
Pavement Markings	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted	Medium	• Repair localized damage.	In Progress/Deployed
Pavement Markings	If asset data are not complete and current, then we cannot optimize investments and set priorities	Medium	• Better tracking of asset data, again the new retroreclectometer should help track asset condition.	Initiated

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Pavement Markings	If MUTCD standards change, then more work is required	Medium	• Anticipate changes to MUTCD and develop strategy to effectively transition to new standards	In Discussion
Pavement Markings	If the quality of paint is poor but meets specifications, then 1) the longevity of the markings are reduced and 2) in some cases impacts ability to apply, clogs equipment, decreases productivity	Medium	• Review the specifications and what materials meet the specifications under the contract. Consider reducing length of contract to reduce the impact of poor quality paints that meet the specifications but do not perform well. • Review the testing specifications to update the process to newer methodologies.	In Discussion
Pavement Markings	If FHWA minimum conditions for NHS pavement and bridge aren't met, then funding flexibility will be removed and funds may be reallocated from other assets	Low	• Support pavement and bridge through VIP and pavement preservation programs.	Implemented/Ongoing
Pavement Markings	If focused on worst first rather than preservation, then assets reach end of life faster	Low	• The determination of project work is done through inspection and addressing deteriorated assets first.	Implemented/Ongoing
Pavement Markings	If there is a cyber attack on CTDOT data systems, then CTDOT asset management functions may be impeded	Low	• Rely on IT do address this. Backup inventory and asset data.	Implemented/Ongoing
Pavement Markings	If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced	Low	• Using new materials and methods to extend life expectancy.	In Progress/Deployed
Pavement Markings	If politics influence the prioritization of projects, then less optimal projects may be selected, compromising SOGR	Low	• No mitigation strategy set as of now.	Under Consideration
Highway Buildings	If we do not keep our building condition data current, then we will not be able to have a data driven and transparent program	High	• Research and implement a Facilities Management System (FMS) that can issue work orders that automatically update asset condition data as work orders are completed • Develop and implement a method to get notified of minor capital repairs that impact overall building condition so condition data in InspectTech can be updated manually until an FMS can be implemented	In Discussion
Highway Buildings	If we have a lack of building maintenance staff to make minor building repairs and perform minimal preventative maintenance on our buildings,	High	• Timely replacement of maintenance staff as they leave state service so building repairs can continue	In Discussion

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	then buildings will deteriorate at a faster rate than predicted		• Hire additional building maintenance staff to initiate a standard and reoccurring preventative maintenance program for all Tier 1 and Tier 2 buildings	
Highway Buildings	If we do not get the necessary funding, then the capital program will be reduced and building conditions will drop below a SOGR	Medium	• Use asset management data to support current financial strategies and justify increased financial needs in the future • Monitor and track project funding to confirm the necessary funding is in place at the required time	Implemented / Ongoing
Highway Buildings	If staffing levels are inadequate or if staff are not properly trained, then program delivery will suffer	Medium	• Continue to leverage qualified outside Consultant resources • Resource load the program to determine the minimum and optimal staffing levels required to deliver the program • Develop a succession plan	Implemented / Ongoing
Highway Buildings	If we don't deliver the recommended projects, then building conditions will deteriorate below desired thresholds	Medium	• Use Microsoft Project to monitor and track design schedules	Implemented / Ongoing
Highway Buildings	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted	Medium	• Emergency generators at all critical facilities. Goal to include generators at all Tier 1 facilities. • Consideration of moving critical activities out of flood zones.	Implemented/Ongoing
Highway Buildings	If the rate of building deterioration increases faster than anticipated as buildings age, then the percent of buildings in a SOGR will decrease	Medium	• Refine deterioration modeling and building life-cycles • Increase the number of SOGR upgrades buildings receive between major renovations or replacements • Refine the proposed 10-year cycle between building condition inspections • Seek and justify additional funding if necessary	In Discussion
Highway Buildings	If the Department does not procure and implement a Facilities Management System, then the asset cannot be effectively managed to meet industry standards and TAMP objectives	Medium	• Continue to do manually, work through overall joint agency process, investigate investing in a DOT only system.	In Discussion

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Highway Buildings	If we don't select the right projects, then life cycle costs to achieve or maintain a SOGR will increase	Low	• Continually improve the project selection process • Begin to transition from a manual project selection process to a data driven transparent process	Implemented / Ongoing
Highway Buildings	If we do not research and implement new technologies, then the functionality and energy efficiency of our buildings will decrease and life cycle costs for parts and repairs will increase as the industry phases out old technologies	Low	• Have Design Engineers research new products coming into the industry • Attend Vendor/Building Code seminars • Meet with Sales Representatives of the major building components to stay informed of future industry and technological advancements	Implemented / Ongoing
Highway Buildings	If we do not follow documented design standards and processes, then we will spend more time on design efforts and have buildings that are not standardized which will increase life cycle costs	Low	• Continue to document institutional knowledge, provide training, etc. to address attrition within CTDOT • Update the Facilities Design Manual as design standards and processes change	Implemented / Ongoing
Highway Buildings	If we do not increase the size and operational capacity of our maintenance and repair facilities as the fleet increases in size, then we will be unable to maintain and store the fleet inside making the buildings functionally obsolete	Low	• Coordinate with Maintenance to determine future fleet changes • Continually update list of functionally obsolete buildings from Maintenance to ensure those buildings are included in the process to determine the future capital program	Implemented / Ongoing
Highway Buildings	If staff knowledge is not transferred and retained, then capabilities and capacity are reduced and SOGR may be negatively impacted	Low	• TE3 are expected to transfer discipline knowledge to subordinates. • Lack of TE3s with PEs affect succession planning.	Implemented/Ongoing
Highway Buildings	If we don't address deteriorated buildings, then the buildings become unusable	Low	• Continue to identify and prioritize Tier 3 buildings to be demolished • Initiated a new mini-program to demolish any identified structure that can be removed from inventory as funding becomes available • Locked all priority buildings to prevent future access • Include any priority buildings whose function must remain in	Implemented/Ongoing

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
			future capital projects that renovate a major structure on the same site within the next 3 years	
Highway Buildings	If focused on worst first rather than preservation, then assets reach end of life faster	Low	• Buildings takes a mixed approach. End of life replacements take the worst first approach, which optimizes building life cycle. Buildings also receives midlife upgrades to extend building life cycle.	Implemented/Ongoing
Highway Buildings	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted, then future funding may be insufficient	Low	• If sufficient program funding is not available, projects are moved to the bin for future consideration.	Under Consideration
Highway Buildings	If FHWA minimum conditions for NHS pavement and bridge aren't met, then funding flexibility will be removed and funds may be reallocated from other assets	Low	• Relying on pavement and bridge to meet goal.	Under Consideration
Highway Buildings	If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced	Low	• Not applicable	Under Consideration
Highway Buildings	If politics influence the prioritization of projects, then less optimal projects may be selected, compromising SOGR	Low	• No strategy.	Under Consideration
Highway Buildings	If there is a cyber attack on CTDOT data systems, then CTDOT asset management functions may be impeded	Low	• Currently relying on BITS	Under Consideration
Roadway Illumination	If funding is not adequate, then conditions will deteriorate and future funding needs to achieve or maintain SOGR will increase	High	• Preserve the annual budget. The past few years the budget has been cut. • Apply to additional funding through different programs.	Under Consideration
Roadway Illumination	If there's a lack of maintenance staff, then assets will deteriorate faster and public safety could be affected	High	• Get approval to hire more staff. • Reduce requirements for CDL. The CDL and electrical requirement is highly sought after and private contractors are paying more, therefore CTDOT is unable to fill the positions.	Under Consideration
Roadway Illumination	If funding budget is not maintained, then illumination assets will deteriorate and increase future costs	High	• Increase funding to get approval to hire more staff. • Reduce requirements for CDL. The CDL and electrical requirement is highly sought after and private contractors are paying more, therefore CTDOT is unable to fill the positions.	Under Consideration

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Roadway Illumination	If there are a limited number of contractors bidding on projects, then fewer projects will be completed and costs will increase	High	• Make projects smaller to enable more contractors to bid.	Under Consideration
Roadway Illumination	If we don't select the right projects, then lifecycle costs will increase to achieve or maintain SOGR	Medium	• In 2018, design met with maintenance to determine which order to replace lighting systems.	Implemented / Completed
Roadway Illumination	If staff knowledge is not transferred and retained, then capabilities and capacity are reduced and SOGR may be negatively impacted	Medium	• Institutional knowledge is passed on from senior staff to junior staff.	Implemented / Ongoing
Roadway Illumination	If there is a supply shortage, then lead times are affected	Medium	• Stockpile supplies in advance. Consider a central warehouse to stock electrical supplies.	Initiated
Roadway Illumination	If design staffing levels are inadequate or if staff are not properly trained, then program delivery will struggle to meet goals	Medium	• In the process of hiring new staff to refill vacancies. • Consider creating new positions to help with design projects.	In Discussion
Roadway Illumination	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted, then future funding may be insufficient	Medium	• Projected budgets are currently based on 2% inflation rate. Will need to revisit to consider increasing inflation rates. • Increasing estimates to account for increased cost.	Under Consideration
Roadway Illumination	If asset deterioration is not addressed in a timely manner, then it will create greater needs and cost in the future	Medium	• Increase maintenance staff to address issues immediately.	Under Consideration
Roadway Illumination	If politics influence the prioritization of projects, then less optimal projects may be selected, compromising SOGR	Medium	• Don't let political influence affect priority list. Provide engineering justification.	Under Consideration
Roadway Illumination	If asset data are not complete and current, then we cannot optimize investments and set priorities	Low	• In 2022 a new spreadsheet created to track lighting systems more efficiently.	Implemented / Ongoing
Roadway Illumination	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed	Low	• Currently lag behind the most current technologies to assess which technologies are most effective.	Implemented / Ongoing
Roadway Illumination	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted	Low	• Some new studies done by UCONN and CTDOT have come out to increase the wind load and potentially remove breakaways on median light pole.	Implemented / Ongoing
Roadway Illumination	If there is a cyber attack on CTDOT data systems, then CTDOT asset management functions may be impeded	Low	• Backup data systems are in place. • Also lighting systems are not connected to the internet.	In Progress/ Deployed

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Roadway Illumination	If FHWA minimum conditions for NHS pavement and bridge aren't met, then funding flexibility will be removed and funds may be reallocated from other assets	Low	• Preserve the annual budget. The past few years the budget has been cut. • Apply to additional funding through different programs.	Under Consideration
Roadway Illumination	If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced	Low	• Cannot increase foundation offset any further.	Under Consideration
Roadway Illumination	If focused on worst first rather than preservation, then assets reach end of life faster	Low	• In 2018, design met with maintenance to determine which order to replace lighting systems. Hire more in house maintenance staff and reduce requirements for the positions. • Maintenance Management System could help prioritize projects and streamline the work process in conjunction with the use of in field tablets.	Under Consideration
Retaining Walls	If funding is not adequate, then conditions will deteriorate and future funding needs to achieve or maintain SOGR will increase.	Medium	• Properly fund assets.	Implemented / Ongoing
Retaining Walls	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted, then future funding may be insufficient.	Medium	• DAS accounts for inflation. Increase available funding to account for inflation.	Implemented / Ongoing
Retaining Walls	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted.	Medium	• Damaged assets should be addressed as needed. The department will continue to consider extreme weather and design assets to an appropriate resiliency standard.	Implemented / Ongoing
Retaining Walls	If asset deterioration is not addressed in a timely manner, then it will create greater needs and cost in the future.	Medium	• Continue to track inventory and condition, address routine maintenance, and use lifecycle planning to preserve and rehabilitate assets at appropriate intervals.	In Progress/ Deployed
Retaining Walls	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed.	Medium	• Establish a permanent procedure for communication between maintenance and the retaining wall group. Establish the retaining wall inspection program.	Initiated
Retaining Walls	If we don't select the right projects, then lifecycle costs will increase to achieve or maintain SOGR.	Medium	• Use the Asset Management Approach to select projects.	In Discussion
Retaining Walls	If there's a lack of maintenance staff, then assets will deteriorate	Medium	• Hire, train, and retain staff.	Under Consideration

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	faster and public safety could be affected.			
Retaining Walls	If politics influence the prioritization of projects, then less optimal projects may be selected, compromising SOGR.	Medium	• No mitigation strategy currently (Tolerate).	Under Consideration
Retaining Walls	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed.	Medium	• Make sure maintenance staff is sufficiently trained. Maintenance can bring in VIP contractor to do certain repairs. There can potentially be a formalized process to do certain types of repairs with a contractor. Repairs handled by maintenance rather than in a project will likely have cost savings	Under Consideration
Retaining Walls	If design staffing levels are inadequate or if staff are not properly trained, then program delivery will struggle to meet goals.	Low	• Hire, train, and retain staff.	Implemented / Ongoing
Retaining Walls	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed.	Low	• Continue exploring new technologies as part of process improvements.	Implemented / Ongoing
Retaining Walls	If focused on worst first rather than preservation, then assets reach end of life faster.	Low	• Continue to track inventory and condition, address routine maintenance, and use lifecycle planning to preserve and rehabilitate assets at appropriate intervals.	In Progress/ Deployed
Retaining Walls	If asset data are not complete and current, then we cannot optimize investments and set priorities.	Low	• There is a planned inspection cycle for the future; work should continue towards establishing these inspections.	Initiated
Retaining Walls	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed.	Low	• Consultants will be starting inspections in the fall. A first inspection of all walls may occur within a year or two. More information should be available to update the status of this risk next year.	Initiated
Retaining Walls	If staff knowledge is not transferred and retained, then capabilities and capacity are reduced and SOGR may be negatively impacted.	Low	• Training programs, product knowledge, and employee cross training. Establish standard procedures in writing so they are not lost.	In Discussion
Retaining Walls	If FHWA minimum conditions for NHS pavement and bridge aren't met, then funding flexibility will be removed and funds may be reallocated from other assets.	Low	• N/A	Under Consideration

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Retaining Walls	If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced.	Low	• N/A	Under Consideration
Retaining Walls	If there is a cyber attack on CTDOT data systems, then CTDOT asset management functions may be impeded.	Low	• Rely on IT do address this. Backup inventory and asset data.	Under Consideration
Drainage Culverts	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted.	Very High	• Coordinate with the Office of Maintenance to develop and employ a prescribed plan to assess & repair damaged assets in the event of a natural disaster.	In Progress/ Deployed
Drainage Culverts	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than predicted, then future funding may be insufficient.	High	• DAS accounts for inflation. Increase available funding to account for inflation.	Implemented/Ongoing
Drainage Culverts	If asset deterioration is not addressed in a timely manner, then it will create greater needs and cost in the future.	High	• Use inspection reports to identify which assets to address.	In Progress/ Deployed
Drainage Culverts	If drainage culverts are not replaced by the end of their life span, then they could fail	High	• Begin asset management approach for drainage culverts	In Discussion
Drainage Culverts	If politics influence the prioritization of projects, then less optimal projects may be selected, compromising SOGR.	Medium	• Use a defined process to guide project selection.	Implemented / Ongoing
Drainage Culverts	If staff knowledge is not transferred and retained, then capabilities and capacity are reduced and SOGR may be negatively impacted.	Medium	• Continue development of training programs.	Implemented/Ongoing
Drainage Culverts	If focused on worst first rather than preservation, then assets reach end of life faster.	Medium	• Use inspection reports to identify which assets to address.	In Progress/ Deployed
Drainage Culverts	If asset data are not complete and current, then we cannot optimize investments and set priorities.	Medium	• Currently in the process of inspecting and inventorying drainage culverts.	In Progress/Deployed
Drainage Culverts	If we don't select the right projects, then lifecycle costs will increase to achieve or maintain SOGR.	Medium	• Develop an inventory of drainage culverts and use to document age and condition. This inventory can be used to better select projects.	In Progress/Deployed
Drainage Culverts	If funding is not adequate, then conditions will deteriorate and future funding needs to achieve or maintain SOGR will increase.	Medium	• Drainage presentation to leadership to determine who is responsible for this, ask for funding/staffing	In Discussion
Drainage Culverts	If there's a lack of maintenance staff, then assets will deteriorate faster and public safety could be affected.	Medium	• Drainage presentation to leadership to determine who is responsible for this, ask for funding/staffing	In Discussion

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
Drainage Culverts	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed.	Medium	• Incorporate new technologies into the business process.	In Discussion
Drainage Culverts	If FHWA minimum conditions for NHS pavement and bridge aren't met, then funding flexibility will be removed and funds may be reallocated from other assets.	Medium	• Rely on Bridge and Pavement to meet FHWA minimums.	Under Consideration
Drainage Culverts	If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced.	Medium	• Design drainage deep enough to minimize effect of track traffic. Coordinate with bridge and pavement designs.	Under Consideration
Drainage Culverts	If we do not have the resources to perform culvert condition assessments, then we will not be able to complete an inventory of conditions	Medium	• Drainage presentation to leadership to determine who is responsible for this, ask for funding/staffing	Under Consideration
Drainage Culverts	If we do not identify a source of funding for the culvert assessment program, then we cannot continue assessing culvert condition	Medium	• Drainage presentation to leadership to determine who is responsible for this, ask for funding/staffing	Under Consideration
Drainage Culverts	If we don't have the resources to continue mapping, then we will not be able to complete an inventory	Medium	• Hiring more staff or consultants	Under Consideration
Drainage Culverts	If climate change/sea level rise raises water levels, then some drainage culvert networks could be submerged and roadways could overtop, making them impassible	Medium	• Raise roads where possible	Under Consideration
Drainage Culverts	If design staffing levels are inadequate or if staff are not properly trained, then program delivery will struggle to meet goals.	Low	• Drainage presentation to leadership to determine who is responsible for this, ask for funding/staffing	In Discussion
Drainage Culverts	If there is a cyber attack on CTDOT data systems, then CTDOT asset management functions may be impeded.	Low	• Coordinate with IT to develop and employ a prescribed plan in the event of a cyber attack	Under Consideration
Drainage Culverts	If rainfall intensity continues increasing, then our drainage culverts could be undersized	Low	• Design for future predicted rainfalls.	Under Consideration
ITS	If there is a cyber attack on CTDOT data systems, then CTDOT asset management functions may be impeded.	Medium	• Our traffic management systems are on a closed non-Conn DOT network	Implemented / Completed
ITS	If staff knowledge is not transferred and retained, then capabilities and capacity are reduced and SOGR may be negatively impacted.	Medium	• Staff knowledge is always shared in Highway Operations team. We all work together to help maintain our ATMS infrastructure.	Implemented / Ongoing
ITS	If costs (inflation, discount rate, materials, cost escalation) increases at a greater rate than	Medium	• Highway Operations uses the latest guidelines from the Estimating group to perform our	Implemented / Ongoing

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	predicted, then future funding may be insufficient.		estimates prior to project initiation.	
ITS	If asset deterioration is not addressed in a timely manner, then it will create greater needs and cost in the future.	Medium	• Highway Operations ensures that our Maintenance Contractor has adequate spare parts available to fix asset deterioration.	Implemented / Ongoing
ITS	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed.	Medium	• Highway Operations has dedicated staff that researches new technologies.	Implemented / Ongoing
ITS	If there is a natural disaster, extreme weather, or state of emergency, then assets may be damaged and travel may be interrupted.	Medium	• ITS- ATMS infrastructure is rarely damaged by natural disasters/ extreme weather/ or state of emergency. Communication and/or power to our ITS-ATMS infrastructure can become damaged. When this occurs, we deal with the Telephone or Power company to restore our service.	Implemented / Ongoing
ITS	If funding is not adequate, then conditions will deteriorate and future funding needs to achieve or maintain SOGR will increase.	Medium	• Highway Operations have just been approved for 6 projects on our ATMS Strategic Plan. We also have funding to support operations and maintenance.	In Progress/ Deployed
ITS	If design staffing levels are inadequate or if staff are not properly trained, then program delivery will struggle to meet goals.	Medium	• The staffing levels in the ATMS group have recently been cut in half due to the retirements. We have been looking to achieve the same workload while trying to hire new employees.	Initiated
ITS	If politics influence the prioritization of projects, then less optimal projects may be selected, compromising SOGR.	Medium	• ITS- ATMS projects are low cost compared to politically sensitive projects.	Under Consideration
ITS	If we don't select the right projects, then lifecycle costs will increase to achieve or maintain SOGR.	Low	• The projects selected in our ATMS Strategic Plan were selected in a specific order to address SOGR first before expansion.	Implemented / Completed
ITS	If focused on worst first rather than preservation, then assets reach end of life faster.	Low	• The projects selected in our ATMS Strategic Plan were selected in a specific order to address SOGR first before expansion.	Implemented / Completed
ITS	If asset data are not complete and current, then we cannot optimize investments and set priorities.	Low	• Highway Operations designs, operates, and maintains our own infrastructure. Therefore, a complete and current list of asset data is needed at all times.	Implemented / Ongoing
ITS	If there's a lack of maintenance staff, then assets will deteriorate	Low	• Highway Operations has a Maintenance Contract so that we	Implemented / Ongoing

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	faster and public safety could be affected.		do not have to perform in house maintenance on our ITS-ATMS devices.	
ITS	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed.	Low	• 23CFR940 and stewardship requirements are already a part of the design process.	Implemented / Ongoing
ITS	If we do not research and implement new technologies, then opportunities that will enable us to achieve SOGR will be missed.	Low	• Consultant selection processes are already in place if new consultants are needed.	Implemented / Ongoing
ITS	If FHWA minimum conditions for NHS pavement and bridge aren't met, then funding flexibility will be removed and funds may be reallocated from other assets.	Low	• Not Applicable because ITS uses federal funding.	Under Consideration
ITS	If truck weights and volumes exceed the design values, then the asset lifecycle may be reduced.	Low	• Not Applicable	Under Consideration
TAM	If there is insufficient staffing to support the design, construction and maintenance of assets, then the targets set in our TAMP cannot be achieved	Very High	• Quantify impacts to asset performance due to staffing shortages • Prioritize work and allocate staff based on most critical needs • Seek alternative means to achieve work • Ensure backfill of retirement positions.	In Progress/ Deployed
TAM	If multiple processes to handle each asset are not streamlined into a unified asset management approach, then the effectiveness of programming according to TAM methods will be reduced.	Very High	• Understand and accept the benefits of the asset management approach • Have mechanisms in place to facilitate unified management across functional areas (e.g. Asset Working Groups) • Accept that a percentage of work will not be done according to TAM methods	In Progress/ Deployed
TAM	If a significant percentage of the of the assets are beyond the expected life (age), then the practical ability to achieve SOGR will be impeded	High	• Monitor relationship(s) between age and expected lifecycle/performance • Evaluate tradeoff to lifecycle for replacement vs rehabilitation on SOGR	Initiated
TAM	If there is insufficient ability to collect, store, retrieve, analyze, interpret and report data, then	High	• Develop and implement an effective strategy to provide information technology support	Initiated

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	key asset management functions, such as current and projected performance prediction, cannot be properly achieved		for asset management functions Assist assets in data management development. • Increase use of automated data management (i.e. PowerBI)	
TAM	If there is not public stakeholder understanding of preservation practices over 'worst first' practices,, then there will be confusion regarding project selection, diminished credibility and lack of public support	High	• Develop a communication plan that includes information for public stakeholders Implement DOT media to communicate TAM practices to the public.	In Discussion
TAM	If work is not programmed based on TAM methodologies, then there will be inefficient use of funding, reduction in the ability to achieve SOGR, reduced credibility to the program and potential FHWA financial penalties in bridge and pavement programs	High	• Utilize information from TAM methods to program work • Track and quantify work programmed based on TAM methodologies to analyze the effectiveness to achieving SOGR	In Discussion
TAM	If there is not sufficient alignment with the STIP CTDOT Statewide Transportation Improvement Program (STIP), then CTDOT will not pass the consistency determination assessment and penalties will be imposed.	High	• Refine a strategy to track asset management specific work • Track information for the consistency determination assessment • Identify projects in the STIP by performance categories.	Initiated
TAM	If an electronic maintenance management system to track work conducted by asset ID or location is not deployed, implemented, and supported, then TAM information on inventory and condition cannot be updated or reflected in lifecycle planning.	High	• Procure MMS • Train Staff on use of MMS • Deploy in the field • Ensure asset management needs are integrated	In Discussion
TAM	If there is insufficient funding to support the design, construction and maintenance of assets, then the targets set in our TAMP cannot be achieved	Medium	• Identify and implement mechanisms to optimize and prioritize the use of funding towards maximum benefit in achieving SOGR • Monitor SOGR placeholders in the obligation plan to ensure all funds are used.	Initiated
TAM	If there are not processes in-place to systematically manage and maintain additional assets, specifically those not yet included in the TAMP, then these additional assets will deteriorate and the SOGR will be impacted	Medium	• Identify and prioritize additional assets • Develop plans to address SOGR of these additional assets • Include in future TAMPs	In Progress/ Deployed

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
TAM	If there is not adequate understanding, acceptance and support at the executive and management levels, then the objectives of the TAMP will not be achieved	Medium	• Efforts should be conducted to sustain engagement, including: 1) reaching out to new executives and managers; 2) continue communication to steering committee	Implemented
TAM	If there is not adequate understanding, acceptance and support at the working level, then the objectives of the TAMP will not be achieved	Medium	• Support of asset working groups • Disseminate information and set clear expectations • Provide training	In Progress/ Deployed
TAM	If key knowledgeable staff involved in the TAM lifecycle are not retained, then progress towards implementation of TAM will be stagnated	Medium	• Train multiple staff to be less dependent upon the expert knowledge of one/few people • Provide career opportunities and favorable working conditions to retain experienced staff • Document procedures to address turn-over	Initiated
TAM	If there are not adequate (electronic, user-friendly, accurate, and timely) asset management collection and storage systems, then we do not have the foundational data needed for effective TAM practices	Medium	• Improved mechanisms to adopt and contract technological advancements • Provide training to users • Own data in non-proprietary formats to allow for integration with newer data management systems • Acquire Facilities Management System to allow for work order system to collect timely data • Implement a condition based pavement marking inventory system through use of a retroreflectometer	In Progress/ Deployed
TAM	If there are not processes in-place to systematically manage and maintain additional assets included in the TAMP other than bridge and pavement, then these additional assets will deteriorate and the SOGR will be impacted	Medium	• Continue to manage the original and additional assets in the TAMP • Develop plans to address SOGR of the remaining additional assets	Implemented / Ongoing
TAM	If we do not have a FHWA certified TAMP in accordance with the deadlines set forth by legislation, then the Department is penalized with a reduction in Federal participation from 80/90% to 65%, resulting in an additional $135 Million in State	Medium	• Continue efforts to support and meet applicable TAM requirements including those for the FHWA Annual Consistency Determination.	Implemented / Ongoing

Asset	Risk Statement	Risk Rating	Mitigation Strategies	Mitigation Status
	funds needed to maximize Federal dollars.			
TAM	If there is not coordination with other plans (such as CT Strategic Highway Safety Plan, CTDOT Freight Plan, CTDOT Long Range Plan, etc.), then: 1) the benefits of the TAM will not be fully realized; 2) there is potential for wasting resources as well as overlap/redundancy; 3) the credibility of the Department and program will be impacted.	Medium	• Strategically improve coordination as the plans are developed and evolve along with the ability to quantify and project performance.	In Discussion
TAM	If there is not the ability to easily adapt organizationally or technologically, then CTDOT will not be able to integrate new processes and improvements that will enable the cost effective and timely management of assets.	Medium	• Explore agile contracting and delivery that allows the organization to adapt technology in a timely manner • Seek improved methods of implementing improved processes. • Establish a cross-unit group to identify, prioritize and adopt new technologies	Initiated
TAM	If we do not make the minimum condition requirements for pavement and bridge, then we lose flexibility to move funding between asset needs and restricts our financial planning.	Medium	• Concentrated effort to address minimum condition requirements.	Implemented / Ongoing
TAM	If asset stewards do not have the time to compile, evaluate, and review TAM related work due to competing priorities, then TAM analyses and documentation may not be completed on time to meet FHWA deadlines	Medium	• Facilitate processing of information • Develop and set up a calendar and interval status meetings • Establish asset management processes/updates as an integral part of asset steward's normal workload	Implemented / Ongoing
TAM	If best practices for security and back-up of asset data are not employed, then the data needed to employ TAM will not be readily available, extensive work and cost will be required to rebuild asset data, if at all possible.	Low	• Design and employ data management best practices including security and back-ups	Implemented / Ongoing

Appendix E. Part 667

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

2800 BERLIN TURNPIKE, P.O. BOX 317546
NEWINGTON, CONNECTICUT 06131-7546
Phone: (860) 594-2931

November 23, 2020

Ms. Amy Jackson-Grove
Division Administrator
Federal Highway Administration
628-2 Hebron Avenue, Suite 303
Glastonbury, Connecticut 06033

Dear Ms. Jackson-Grove:

Subject: Connecticut DOT's 2020 Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction due to Emergency Events

Attached is Connecticut DOT's process with which we evaluated Facilities Repeatedly Requiring Repair and Reconstruction due to Emergency Events for your review. This evaluation has been prepared in accordance with U.S. Code Title 23, Part 667. The evaluation concluded that there were no roads, highways or bridges meeting the criteria and intent of Part 667 that have required repair and reconstruction activities on two or more occasions due to emergency events in Connecticut. Therefore, there are no affected locations to be considered prior to including projects in the STIP.

Please contact Karen Riemer at karen.riemer@ct.gov if you have any questions.

Very truly yours,

Scott Hill, P.E.
2020.11.23
19:37:16-05'00'

Scott A. Hill, P.E.
Chief Engineer
Bureau of Engineering and Construction

Attachment

CTDOT FHWA Part 667 Evaluation Report Update – November 2020

The Connecticut Department of Transportation (CTDOT) has conducted evaluations to identify if there are roads, highway and bridges that have required repairs and reconstruction due to emergency events in accordance with Federal Rules and Regulations (MAP-21/FAST-Act.) This requirement, commonly referred to as 'Part 667,' is the second part to the requirement for each State to develop a Risk-Based Transportation Asset Management Plan (TAMP) to improve and preserve the condition of assets on the National Highway System (NHS.) CTDOT's latest FHWA Certified TAMP (2019) is available on link: https://portal.ct.gov/-/media/DOT/documents/dplansprojectsstudies/plans/Highway-Transportation-Asset-Management-Plan-FHWA-Certified-082819.pdf

This report provides information on federal legislative context, Connecticut's initial and recent evaluation methodology, results from the initial and recent evaluation, and proposed process improvements to address the process of tracking for future evaluations.

Federal Legislative Context

As stated in Title 23 Code of Federal Regulations, Part 667 (dated October 24, 2016): 'Each State, acting through its Department of Transportation (State DOT), shall conduct statewide evaluations to determine if there are reasonable alternatives to roads, highway, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events. The evaluations shall be conducted in accordance with the requirements in this part.'

Regulations include:

Timing of Evaluations

- (a) Not later than November 23, 2018, the State DOT must complete the statewide evaluation for all NHS roads, highways and bridges. The State DOT shall update the evaluation after every emergency event to the extent needed to add any roads, highways, or bridges subject to this paragraph that were affected by the event. The State DOT shall review and update the entire evaluation at least every 4 years. In establishing its evaluation cycle, the State DOT should consider how the evaluation can best inform the State DOT's preparation of its asset management plan and STIP.
- (b) Beginning on November 23, 2020, for all roads, highways, and bridges not included in the evaluation prepared under paragraph (a) of this section, the State DOT must prepare an evaluation that conforms with this part for the affected portion of the road, highway, or bridge prior to including any project relating to such facility in its STIP.

Definition of Emergency Event

> '*Emergency event* means a natural disaster or catastrophic failure resulting in an emergency declared by the Governor of the State or an emergency or disaster declared by the President of the United States.'

Note: The beginning date for every evaluation under this part shall be January 1, 1997. The end date must be no earlier than December 31 of the year preceding the date on which the evaluation is due for completion.

Evaluation Methodology

Reasonable efforts were conducted for the evaluation process including identification of the emergency events, internal interviews, retrieval of data and information, and meetings with key personnel including FHWA-CT and the listing of locations from pervious Emergency Relief (ER) events.

Emergency events, according to the Part 667 definition, were identified for the time period January 1, 1997 – December 31, 2019 in Connecticut using information from the FEMA website. The summary of events is listed in Table 1.

Table 1: Emergency Events in Connecticut (January 1, 1997 – December 31, 2019)*

	Connecticut	Emergency Declaration Date	Incident Period		
			Start	End	Damage Applicable to Tracking for Part 667
1	Snowstorm	3/11/2003	2/17/2003	2/18/2003	
2	Snow	1/15/2004	12/5/2003	12/7/2003	
3	Hurricane Katrina Evacuation	9/13/2005	8/29/2005	10/1/2005	
4	Snow	5/2/2006	2/11/2006	2/12/2006	
5	Hurricane Irene	8/27/2011	8/26/2011	9/1/2011	X
6	Severe Storm	10/31/2011	10/29/2011	10/30/2011	X
7	Hurricane Sandy	10/28/2012	10/27/2012	11/8/2012	X
8	Severe Winter Storm	2/10/2013	2/8/2013	2/11/2013	
9	Severe Winter Storm	4/8/2015	1/26/2015	1/28/2015	
10	Severe Storms, Tornadoes, and Straight-line Winds	8/20/2018	7/11/2018	7/15/2018	
11	Severe Storms and Flooding	12/5/2018	9/25/2018	9/26/2018	X

*Source: https://www.fema.gov/disasters/

Initial meetings and interviews were conducted beginning in 2016 with key personnel in the Offices of Highway Operations and Maintenance, Policy and Planning, Hydraulics and Drainage, and Bridge. Experience was cited with various assets and additional information was sought on the specific nature of repairs and funding. Discussions included identification of efforts that have been taken to assess and address resiliency of assets. An inquiry was made to the FHWA-CT staff to determine if their records could provide information to address this evaluation. In addition, inquiries were made with asset owners during the TAMP Building processes, and in particular during the risk registry development to identify assets requiring repairs from emergency related events.

In 2018, meetings were held with staff from Financial Services to review their available data for tracking FHWA Emergency Relief (ER) funding. Additional meetings were held to identify other sources of federal funding for emergency events such as FEMA's Disaster Relief Fund (DRF) and HUD Capitol Fund Emergency/Natural Disaster Fund.

ER and HUD documentation included information that was retained electronically and included specific asset locations. FEMA documentation was retained in paper file format and did not include asset specific information.

To conclude the initial evaluation process, a meeting was held in October 2018 with key staff whose roles involve asset resiliency. Representation included the Offices of Asset Management, Environmental Planning, Hydraulics and Drainage, Highway Operations and Maintenance, Financial Services and FHWA-CT. During this meeting the 667 Evaluation process was presented. Participants were asked to conduct additional reviews.

In communication with the FHWA-CT Division Office and available data, a review of Emergency Event locations was conducted. The 2020 methodology included review of past information, FHWA-CT ER Event Spreadsheet records from DDIRs (Detailed Damage Inspection Report) and asset inspection and project plans and files. Criteria was clarified by the FHWA-CT Office that the Part 667 Evaluation applies to FHWA Emergency Relief (ER) Events and to not include snow or debris removal (ER) activities.

Results of Initial 2018 Evaluation (January 1, 1997 – December 31, 2017)

The meetings and reviews regarding Part 667 concluded: There were no roads, highways or bridges on the NHS that have required repair and reconstruction activities on two or more occasions due to emergency events in Connecticut.

Results of 2020 Evaluation (January 1, 1997 – December 31, 2019)

There were no roads, highways or bridges meeting the criteria and intent of Part 667 that have required repair and reconstruction activities on two or more occasions due to emergency events in Connecticut. Therefore, there are no affected locations to be considered prior to including projects in the STIP.

Future Evaluation Requirements

The State DOT shall update the evaluation after every emergency event to the extent needed to add any roads, highway or bridges affected by the event. The State DOT shall review and update the entire evaluation at least every 4 years. In establishing its evaluation cycle, the State DOT should consider how this evaluation can best inform the State DOT's in preparation of its asset management plan and STIP.

Process Improvements

In 2019, the CTDOT Asset Management Group also became the contact for the FHWA Emergency Relief (ER) program at CTDOT. In doing so, the TAM Group is integral to recording the location and damage of events and works in close coordination with both the CTDOT Office of Maintenance and Highway Operations, CTDOT Office of Finance and Administration and FHWA-CT. In addition, additional meetings and activities have been initiated with the purpose of facilitating the exchange of information regarding resiliency and the Part 667 Evaluation.

The process of tracking FHWA Emergency Relief (ER) locations, funding and damage will continue to be improved, with a focus on recording asset specific information.

CTDOT will review and update the evaluation at least every four years and seek to consider the evaluation plan in preparation of the asset management plan and STIP processes when applicable.

Appendix F. Governor's Executive Orders on Climate Change

STATE OF CONNECTICUT

BY HIS EXCELLENCY

NED LAMONT

EXECUTIVE ORDER NO. 3

WHEREAS, there is overwhelming evidence and scientific consensus that man-made greenhouse gas (GHG) emissions are causing an overall rise in global temperatures, affecting global climate now, and profoundly affecting global climate in the future; and

WHEREAS, the increased intensity of weather events, rising sea levels, and ecological disturbances caused by climate change, including Tropical Storm Irene and Superstorm Sandy, continue to put Connecticut residents, businesses, infrastructure, and cultural and natural resources at risk; and

WHEREAS, pursuant to the 2008 Global Warming Solutions Act and the 2018 Act Concerning Climate Change Planning and Resiliency, Connecticut seeks to substantially decarbo nize electricity generation, the transportati on system, and thermal energy for buildings, in an effort to cut GHG emissions to 10 percent below 1990 levels by 2020, to 45 below 2001 levels by 2030 and to 80 percent below 2001 levels by 2050; and

WHEREAS, the Governor's Steering Committee on Climate Change produced the April 2010 report, *The Impacts of Climate Change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health*, which predicted that climate change would have a significant negative impact on agriculture, infrastructure, natural resources, and public health, and produced the 2011 report, *Connecticut Climate Change Preparedness Plan*, which recommended climate adaptation strategies for the State; and

WHEREAS, the Governor's Council on Climate Change, established on April 22, 2015 by Executive Order No. 46, released a report in December 2018, *Building a Low Carbon Future for Connecticut: Achieving a 45% GHG reduction by 2030,* which set forth meaningful strategies to ensure the state meets its mandatory GHG reduction targets; and

WHEREAS, Executive Order No. 50, issued on October 26, 2015, established a new State Agencies Fostering Resilience Council, which was tasked with, among other things, collaborating on the creation of a Statewide Resilience Roadmap based on the best climate impact research and data, and assisting in the creation of state policy on Disaster Resilience by using science-based, forward looking risk analysis; and

WHEREAS, the Connecticut Wildlife Action Plan, approved by the U.S. Fish and Wildlife Service on January 21, 2016, established that rising temperatures and precipitation, reduced snow pack, rising sea levels, and increased prevalence of vector-borne diseases and invasive species are altering animal and plant distributions, disrupting plant and animal life cycles, and altering community compositions and structures; and

WHEREAS, the 2018 Act Concerning Climate Change Planning and Resiliency requires that municipalities and the state use recent forecasts by the National Oceanic and Atmospheric Administration and Connecticut Institute for Resilience and Climate Adaptation (CIRCA) that sea level in Long Island Sound will rise up to 20 inches (50 cm) higher than the national tidal datum by 2050 to prepare municipal evacuation or hazard mitigation plans, the state's civil preparedness plan and program, municipal plans of conservation and development, and revisions to the state's plan of conservation and development;

NOW, THEREFORE, I, NED LAMONT, Governor of the State of Connecticut, by virtue of the power and authority vested in me by the Connecticut Constitution and by the statutes of the State of Connecticut, do hereby **ORDER AND DIRECT**:

1. Executive Order No. 46 of April 22, 2015, is amended as described herein.

2. **Governor's Council on Climate Change.** The Governor's Council on Climate Change (Council) shall have an expanded scope of responsibility, to wit, the Council shall monitor and report on the state's progress on the implementation of carbon mitigation strategies, as well as on the development and implementation of adaptation strategies to assess and prepare for the impacts of climate change in areas such as infrastructure, agriculture, natural resources and public health.

3. **Council Subcommittees and Working Groups.** To address the purposes of the Council in paragraph 1 above, the Council may establish subcommittees and working groups, including, but not limited to, a Climate Change Mitigation Subcommittee and a Climate Change Adaptation and Resiliency Subcommittee, comprised of Council members and other participants as designated by the Chair, as defined in paragraph 5 below, to deliberate and produce the reports required under this Executive Order. In addition, the State Agencies Fostering Resilience Council, established pursuant to Executive Order No. 50, shall become a subcommittee of the Council established herein.

4. **Oversight of Climate Mitigation Progress.** The Council shall report to the Governor no later than January 15, 2021 and annually thereafter, on the state's progress on the implementation of the strategies identified in *Building a Low Carbon Future for Connecticut: Achieving a 45% GHG reduction by 2030*, including, but not limited to:
    a. Prioritizing, integrating, and advancing equitable distribution of the costs and benefits of climate change mitigation planning and policies, specifically addressing disproportionate impacts of such strategies on environmental justice communities;
    b. A description of how such strategies are being integrated into existing and new agency policy planning efforts;
    c. Evaluation of the efficacy of existing and proposed policies and regulations aimed at reducing GHG emissions; and

d. Identification of new and emerging mitigation strategies that maximize climate change adaptation and resiliency opportunities while ensuring the state is on a sustainable path to meet its reduction targets.

5. **Oversight of Climate Change Adaptation / Resiliency.** The Council shall undertake the following activities with respect to the development, implementation and institutionalization of the climate change adaptation strategies:
   a. Establish a framework, in consultation with the state's Chief Data Officer, for which state agencies shall compile and maintain an inventory of vulnerable assets and operations in coordination with CIRCA's ongoing vulnerability assessment;
   b. By January 15, 2021, prepare and report to the Governor on a revised statewide Adaptation and Resilience Plan for Connecticut that encompasses the most current and locally-scaled scientific information and analysis available with respect to the effects of climate change, including sea level rise, changes in precipitation and temperature patterns, and storm preparedness in the context of the State's changing land use and demographics. The plan shall provide updated recommendations for adapting to and improving the state's resilience to such changes, including, but not limited to:
      i. A review of recommendations from the 2011 Climate Change Adaptation/Preparedness Plan and 2013 revision thereto, to assess current implementation status and continued relevance of recommendations from those plans;
      ii. Recommendations and proposals for funding sources and financing mechanisms to advance investment in recommended strategies;
      iii. Recommended strategies to prioritize climate change adaptation efforts to protect vulnerable communities that may be disproportionately impacted by the effects of climate change; and
      iv. Recommendations for aligning with municipal and regional adaptation efforts;
   c. By December 31, 2021, each state agency member of the Climate Change Adaptation and Resiliency subcommittee shall report to the Council on the alignment of climate change adaptation strategies incorporated into their relevant planning processes and documents including, but not limited to:
      i. the Integrated Resources Plan (DEEP);
      ii. Forest Action Plan (DEEP);
      iii. Wildlife Action Plan (DEEP);
      iv. Green Plan (DEEP);
      v. State Water Plan (Water Planning Council – PURA, OPM, DPH, DEEP);
      vi. Coordinating Water Systems (DPH);
      vii. Statewide Natural Hazard Mitigation Plan (DESPP);
      viii. State Building Code (DAS);
      ix. State Plan of Conservation and Development (OPM);
      x. Housing and Community Development Plan (DOH); and
      xi. Five-Year Capital Program for All Modes of Transportation (DOT); and

d. The Council shall report at least once, by the close of each calendar year, on its progress to the chairpersons and ranking members of relevant joint standing committees of the Connecticut General Assembly, including, but not limited to, the joint standing committees having cognizance of matters relating to energy and technology, the environment, planning and development, and insurance.

6. **Council Membership and Administration.** The Council shall be administered through the Department of Energy and Environmental Protection, which shall provide staff support. The Council shall meet at least biannually, at dates, times, and locations established by the Chairperson. The Council shall be comprised of the following individuals as appointed by the Governor:
   a. The Commissioner of Energy & Environmental Protection, or the Commissioner's designee, shall serve as Chairperson;
   b. The Secretary of the Office of Policy & Management, or the Secretary's designee;
   c. The Commissioner of Public Health, or the Commissioner's designee;
   d. The Commissioner of Transportation, or the Commissioner's designee;
   e. The Commissioner of Administrative Services, or the Commissioner's designee;
   f. The Commissioner of Economic & Community Development, or the Commissioner's designee;
   g. The Insurance Commissioner, or the Commissioner's designee;
   h. The Commissioner of Housing, or the Commissioner's designee;
   i. The Chairperson of the Public Utilities Regulatory Authority, or the Chairperson's designee;
   j. The Chief Executive Officer of the Connecticut Green Bank;
   k. The Executive Director of the Connecticut Institute for Resilience & Climate Adaptation;
   l. The Commissioner of Agriculture, or the Commissioner's designee;
   m. The Commissioner of Emergency Services and Public Protection, or the Commissioner's designee;
   n. A representative of the insurance industry familiar with climate change impact planning;
   o. Two individuals who represent business and industry;
   p. Five individuals who represent non-governmental or academic organizations, of which two shall represent health, equity, affordability, or environmental justice; and
   q. Two municipal or local government leaders or representatives thereof.

7. Membership on this Council for agency heads shall run concurrently with their service as agency heads. Other members shall serve at the pleasure of the Governor.

8. **Integrated Resource Plan – Achieving the Zero Carbon Target.** In order to accelerate achievement of the goals in the 2008 Global Warming Solutions Act and the 2018 Act Concerning Climate Change Planning and Resiliency, spur innovation in carbon-reduction strategies and economic development throughout the state and region, and ensure that strategic electrification strategies for decarbonizing the transportation and buildings sectors

will result in real emission reductions, DEEP shall, in consultation with the Public Utilities Regulatory Authority as appropriate, in the Integrated Resources Plan (IRP) pursuant to sections 16a-3a and 16a-3b of the Connecticut General Statutes, analyze pathways and recommend strategies for achieving a 100% zero carbon target for the electric sector by 2040.

This Order shall take effect immediately.

Dated at Hartford, Connecticut this 3rd day of September, 2019.

Ned Lamont

Ned Lamont
Governor

By His Excellency's Order

Denise W Merrill

Denise W. Merrill
Secretary of the State

STATE OF CONNECTICUT

BY HIS EXCELLENCY

NED LAMONT

EXECUTIVE ORDER NO. 21-3

WHEREAS, there is overwhelming and incontrovertible evidence that man-made greenhouse gas emissions are causing climate change, and that according to the Long Island Sound Study and the University of Connecticut, the state is already experiencing climate change impacts including 8 to 9 inches of global sea level rise since 1880, accelerating coastal erosion, a warming Long Island Sound, hotter warmest and coldest days of the year, more annual rain and snowfall, and more intense rainfall; and

WHEREAS, in 2021 alone, Connecticut communities have been harmed by multiple unprecedented and extreme weather events, including record-breaking rainfall from Tropical Storms Elsa, Fred, Henri, and the remnants of Hurricane Ida, poor air quality and closed schools and businesses due to heat waves, multiple federal disaster declarations, and the first National Weather Service "Flash Flood Emergency" in Connecticut's history, which resulted in more than 1,000 rescues of residents trapped by floodwaters; and

WHEREAS, the Governor's Council on Climate Change ("GC3"), established pursuant to Executive Order No. 3 ("EO3"), issued September 3, 2019, has concluded that because of delays in reducing (or mitigating) dangerous greenhouse gases, such extreme events as we saw in Connecticut in 2021 will worsen, such that the state will experience the following changes by 2050: stronger storms with more wind and rain, longer, more frequent droughts, up to 20 inches of sea level rise along the coast, increased frequency of coastal flooding with levels like those seen in Superstorm Sandy every 5-10 years, increased risk of extreme rainfall, and an average of 20 additional 90°F+ days per year; and

WHEREAS, the GC3 also found that without rapid climate mitigation action now, warming in Connecticut will accelerate and sea level rise could be as much as 80 inches by 2100; and

WHEREAS, the Intergovernmental Panel on Climate Change ("IPCC")'s report issued in August 2021 underscored that sharply cutting global greenhouse gas ("GHG") emissions now and stopping emissions by the year 2050 can limit global warming to a total of 1.5°C, preventing worsening impacts of climate change, but that inaction puts the world on a path to more and more warming and more dangerous and life-threatening heat, sea level rise, and storms; and

WHEREAS, the Global Warming Solutions Act ("GWSA"), Section 22a-200a of the Connecticut General Statutes, established a requirement to reduce GHG emissions economy-wide by 45% below 2001 levels by 2030 and 80% below 2001 levels, and these targets contribute to the United States' national emissions reduction target of 50 to 52% below 2005 levels by 2030 and net zero by 2050; and

WHEREAS, the Department of Energy and Environmental Protection ("DEEP") is required to report annually on Connecticut's progress toward meeting the GWSA targets, and DEEP's most recent progress report, the *2018 Connecticut Greenhouse Gas Emissions Inventory*, indicates that Connecticut continues to reduce emissions from its electric supply, with a 35% drop in power sector emissions since 2001, but that emissions continue to increase from the building and transportation sectors, at a time when emissions from both need to be reduced by one-third in order for the state to meet its 2030 GWSA target. The use of fossil fuels for heating and cooling makes buildings the second largest source of GHG emissions in the state, while emissions from internal combustion engine vehicles make transportation the largest source of emissions in Connecticut, accounting for 38% of total emissions in the state; and

WHEREAS, the significant GHG emissions reductions necessary to achieve the GWSA 2030 target and become resilient to the impacts of climate change cannot be achieved unless the

General Assembly authorizes expanded investment and decarbonization programs, but my administration is committed to using existing executive authority where appropriate and to the extent possible to address climate mitigation and resilience; and

WHEREAS, through EO3, I reconvened the GC3 and expanded the scope of its responsibilities to include monitoring and reporting on the state's implementation of carbon mitigation strategies, and the development and implementation of adaptation strategies to prepare for the impacts of climate change in areas including infrastructure, agriculture, natural resources, and public health; and

WHEREAS, amidst a global pandemic, the GC3 established a broad, participatory process to seek input and solutions from stakeholders across the state, established seven working groups with 231 members representing over 100 organizations, and over the course of nearly 200 meetings delivered the *Phase 1 Report: Taking Action on Climate Change and Building a More Resilient Connecticut for All*, with 61 recommendations for near-term climate action, and those 61 recommendations inform the executive actions directed in this order; and

WHEREAS, reducing GHG emissions now is not only necessary to provide a more livable future for current and future generations, but will also advance health equity and environmental justice for communities overburdened by the effects of climate change and pollution, protect Connecticut's natural resources and working lands, provide for more affordable and reliable energy options, and make Connecticut's infrastructure more resilient while expanding economic opportunity and providing for a safer, healthier environment for Connecticut's citizens;

WHEREAS, adopting sustainability measures in state facilities and operations not only reduces emissions, but also saves taxpayers money on operating costs, and through Executive Order No. 1 ("EO1"), issued April 24, 2019, I directed that by 2030, all Executive Branch operations shall Lead By Example by reducing greenhouse gas emissions 45% below 2001 levels, waste disposal by 25% from 2020 baseline, water use by 10% from 2020 baselines, and by achieving any subordinate targets established by the Steering Committee in GHG emissions from onsite heating and cooling, vehicle fleet, purchased electricity, and product procurement, as well as materials management, water use, and land use and grounds management; and

WHEREAS, GreenerGov CT, a Lead By Example initiative, has, since 2014, implemented measures at the facilities of state agencies that have led, or will lead to, significant energy savings, cost savings, and greenhouse gas reductions, including 165 Energize CT projects at a savings of $2.1 million in annual utility costs, energy retrofit improvements at several District 1 Department of Correction facilities, installing GPS telematics hardware on 85% of executive branch light duty vehicles to identify operational fuel savings and candidates for transition to electric vehicles, and securing zero emission renewable energy credit contracts for pilot projects at nine state facilities that will, once built, host over 10,000 kWDC of new solar capacity; and

WHEREAS, the Appliance Standards Awareness Project has estimated that adoption of modernized appliance efficiency standards has the potential to lower energy demand in Connecticut by 81 GWh per year by 2025 and 243 GWh per year by 2035, thereby avoiding 19,000 metric tons of annual carbon emissions by 2025 and 68,000 metric tons by 2035, and saving consumers, including low-income customers, approximately $20 million dollars per year in energy costs in 2025 and $70 million in 2035; and

WHEREAS, Governor Malloy's Executive Order No. 53 ("EO53") of April 22, 2016 recognized the need for updates to statewide building codes to address carbon mitigation and climate adaptation, but further research and study, as described herein, demonstrates a clear and present need for more comprehensive and equitable action, substantial evidence demonstrates that adopting more energy-efficient building codes will reduce the climate change impacts from the building sector, and adopting up-to-date building codes is an effective climate mitigation and resiliency strategy; and

WHEREAS, in light of recent price spikes for heating oil, propane, and natural gas and their negative impact on Connecticut consumers, as well as the findings of the *2018 Connecticut Greenhouse Gas Emissions Inventory* that GHG emissions from buildings have increased instead of being on track to achieve the roughly one-third reduction in such emissions needed to achieve the GWSA 2030 target, a new Comprehensive Energy Strategy is needed that identifies the best clean, affordable and resilient heating and cooling options for buildings, and reconsiders the natural gas expansion program recommended in the 2013 Comprehensive Energy Strategy; and

WHEREAS, with the enactment of the federal *Infrastructure Investment and Jobs Act*, Connecticut's state agencies and local governments, tribes, non-profits, and universities are eligible for billions of dollars of federal funding opportunities for climate mitigation and resilience projects that require planning and project design, non-federal matching funds, the use of nature-based solutions, including green infrastructure and climate-smart agriculture and forestry, and prioritization of vulnerable communities; and

WHEREAS, *An Act Concerning Climate Change Adaptation*, signed into law as Public Act 21-115, provides all Connecticut municipalities with the option to adopt a stormwater authority to address flooding and water quality in their communities and to establish flood prevention, climate resilience and erosion control boards to implement climate resilience projects; and

WHEREAS, recent storms and extreme weather events have demonstrated that state government assets and operations can be vulnerable to the impacts of climate change; and ensuring safe and efficient operation of these assets and operations in the face of climate change is critical for public safety, economic competitiveness, and safeguarding taxpayer investment; and

WHEREAS, guidance on the design and protection of infrastructure and critical facilities must be updated regularly to reflect the best available climate science and understanding of risk; and

WHEREAS, the transportation sector is the largest contributor to GHG emissions (38%), ozone forming emissions (67%), and particulate matter emissions, contributing to poor air quality and asthma rates that are worse than the nation's average – 11% of children and 10.5% of adults – with these burdens falling disproportionately on our cities, and investments in zero-emission transit vehicles will significantly reduce GHG emissions and air pollution from state operations; and

WHEREAS, the GC3 Public Health and Safety Working Group found that impacts of climate change have a direct impact on public health, including heat stress, poor air quality, restricted access to safe and adequate drinking water, food insecurity, negative impacts on mental health and wellbeing, increased prevalence of vector-borne disease, and the need to directly address health equity and the impact to the most vulnerable populations in Connecticut; and

WHEREAS, the Connecticut Department of Public Health ("DPH") and Connecticut Health Improvement Coalition's 2019 State Health Assessment found that Connecticut's residents are susceptible to heat-related illness, with an average of 410 Emergency Department visits per year, and that those rates are strongly associated with the number of days each year for which the heat index was over 95°F, a threshold used by the National Weather Service for issuing a heat advisory, in Connecticut Non-Hispanic Black populations are at higher risks for heat-related illness compared to both non-Hispanic White and Hispanic populations, and populations most vulnerable to heat-related illness generally include people with chronic health problems (cardiovascular disease, diabetes, and obesity), infants and young children, outside workers, and older people; and

WHEREAS, EO3 called for equitable distribution of the costs and benefits of climate mitigation, including addressing disproportionate impacts of these strategies on environmental justice communities, and the protection of vulnerable communities disproportionately impacted by the effects of climate change; and

WHEREAS, the GC3 Equity and Environmental Justice Working Group recommended ongoing community engagement for climate planning with a commitment to recognizing existing disparities, including health and living conditions, providing communities with meaningful opportunities to participate in policy processes that address climate justice, health equity and mitigate environmental racism, and consideration of community perspectives and viewpoints; and

WHEREAS, a United States Environmental Protection Agency ("EPA") 2021 report assessing climate change and social vulnerability found that Black and African American individuals are projected to face disproportionately higher impacts of climate change compared to all other demographic groups, including being more likely to live in areas with increased rates of childhood asthma and deaths from extreme temperatures, and that Hispanics and Latinos have high participation in weather-exposed industries, such as construction and agriculture, which are especially vulnerable to the effects of extreme temperatures; and

WHEREAS, clean energy and climate-resilient economic development investments directly enhance the quality of life for all residents while promoting shared prosperity, providing equitable access to good jobs at good wages in growing industries, supporting our regional strategic partnerships, strengthening long-term economic resilience, and creating innovative infrastructure to attract new businesses and train talented employees who want to thrive and contribute to their communities; and

WHEREAS, the U.S. Climate Alliance's 2020 *Clean Energy Employment Report* found that Connecticut added 44,094 clean energy jobs between 2016 and 2019, a 7.3% increase, and the state continues its growth as a national leader in the clean energy economy; and

WHEREAS, economic and community development programs provide an opportunity to improve community resilience to the impacts of climate change by integrating climate resilience into project planning and design; and

WHEREAS, the GC3 Natural and Working Lands Working Group found that nature-based solutions associated with forests, agriculture, wetlands, and rivers offer the potential dual benefit of carbon sequestration and storage while also making Connecticut more resilient to the impacts of climate change;

NOW, THEREFORE, I, NED LAMONT, Governor of the State of Connecticut, by virtue of the authority vested in me by the Constitution and the laws of the State of Connecticut, do hereby **ORDER AND DIRECT:**

CLIMATE, BUILDINGS, and INFRASTRUCTURE

1. **Comprehensive Energy Strategy – Achieving GHG reductions consistent with the Global Warming Solutions Act.** DEEP shall include in its next Comprehensive Energy Strategy developed pursuant to Section 16a-3d of the Connecticut General Statutes, an identification of strategies to provide for more affordable heating and cooling for Connecticut residents and businesses, achieve reductions in greenhouse gas emissions from residential and commercial buildings and industrial processes as needed to enable the state to meet the economy-wide greenhouse gas reduction target for 2030 and 2050 required by the Global Warming Solutions Act, and to identify strategies to improve the resilience of the state's energy sector to extreme weather events, fuel commodity price spikes, and other disruptions.

2. **Energy efficient and climate resilient building codes.**
   A. Governor Malloy's EO53, issued April 22, 2016, is repealed and superseded in its entirety by this order.
   B. The State Building Inspector shall prepare and present to the Codes and Standards Committee for adoption pursuant to Section 29-252 of the Connecticut General Statutes by October 1, 2022 the most recent International Building Code, International Existing Building Code, International Plumbing Code, International Mechanical Code, International Energy Conservation Code and International Residential Code of the International Code Council, Inc. and the NFPA 70 National Electrical Code of the National Fire Protection Association Inc., or their successor codes.
   C. The State Building Inspector shall develop a plan to incorporate the reduction of greenhouse gas emissions as a core consideration when adopting the State Building Code given the health implications of continued greenhouse gas emissions.
   D. During the State Building Code amendment process, the State Building Inspector and the Codes and Standards Committee shall:
      i. consider changes needed to increase the resilience of structures to flood and wind hazards and impacts of climate change reasonably expected during the lifespan of the structure, including as applicable a sea level change scenario of up to 0.5 m (1 foot 8 inches) of sea level rise over the national tidal datum of Long Island Sound by 2050 adopted under subsection (b) of Section 25-

68o of the Connecticut General Statutes and projected climate impacts by 2050 included in the January 2021 report of the GC3;

ii. solicit testimony from members of the GC3 and other experts regarding resilience to assist the Committee in its development of the State Building Code;

iii. consider resiliency standards based on best available science such as the Insurance Institute of Business & Home Safety's FORTIFIED standards, including those endorsed, promulgated, or otherwise supported by the United States Department of Energy, Federal Emergency Management Agency ("FEMA") and other federal agencies.

E. DAS shall, pursuant to Section 29-251c of the Connecticut General Statutes, incorporate into existing training and educational programs for code officials and candidates, information and standards relating to construction techniques that maximize energy efficiency and minimize greenhouse gas emissions and provide improved resilience to flood and wind hazards, including the impacts of climate change.

F. In appointing members to the Codes and Standards Committee pursuant to Section 29-251 of the Connecticut General Statutes, DAS shall continue to recruit and appoint individuals who have training or certification in energy efficiency or construction techniques that minimize greenhouse gas emissions or increase resilience to natural hazards and the impacts of climate change.

G. DEEP, in consultation with DAS, shall recommend the adoption of the most current edition of the International Green Construction Code as its High Performance Building Standards as the nationally recognized model for sustainable construction codes to be adopted by reference pursuant to section 16a-38k of the Connecticut General Statutes.

3. **Strengthening interim targets for GreenerGov CT Lead By Example**. The state shall commit to implementing the following interim targets in order to meet the state government 45% GHG emissions reduction by 2030 goal under EO1:

   A. By 2024, all executive branch agency facilities, to the extent practicable, shall implement an organics and food waste diversion program.
   B. By 2030, all electricity purchased and generated by the Executive Branch will be 100% zero carbon.
   C. By 2030, all newly leased light duty state vehicles shall be zero emission vehicles.
   D. By 2023, DEEP and DAS shall develop a plan to retrofit existing fossil fuel-based heating and cooling systems at state buildings to systems capable of being operated without carbon emitting fuels.
   E. By 2023, DEEP and DAS shall develop a plan and a budget to achieve zero-GHG emissions for all new construction and major renovations funded by the state or in facilities owned/operated by the Executive Branch, targeting construction beginning in fiscal year 2024 and after.
   F. By 2024, the state shall divest 1% of all Executive Branch building square footage, and an additional 2% by 2028.
   G. The state shall deploy an average of 10,000 kWDC of new solar capacity annually for the next 10 years, primarily sited new projects sited on state buildings or property.
   H. The state shall commit to reducing executive branch building GHG emissions by at least 1% annually.

4. **Appliance standards.** DEEP shall promulgate regulations for increased and additional appliance and product efficiency standards, pursuant to Section 16a-48 of the Connecticut General Statutes, to promote energy conservation and efficiency, provided that the subject appliances remain cost-effective for consumers who purchase and use them. New product categories or updates to existing product standards shall be selected based on the following criteria for each product category:

   A. there is an existing EPA ENERGY STAR standard or other state standard;
   B. there is an existing test procedure;
   C. there are multiple manufacturers producing at that standard;
   D. sufficient data for measurement and verification exists; and
   E. products manufactured to the standard are cost-effective for consumers.

5. **Resilient state buildings.** All buildings designed and constructed with state funding for the use by a state agency shall, to the extent feasible and in consideration of the Insurance Institute of Business & Home Safety's FORTIFIED standards and in accordance with advice from DAS pursuant to Section 4b-54 of the Connecticut General Statutes, be capable of withstanding wind and flood risks reasonably expected during the lifespan of the structure.

6. **Solar arrays on DAS and Department of Transportation ("DOT") state properties.** DAS and DOT shall, to the extent feasible and pursuant to, as applicable, Sections 4b-30, 4b-35, 4b-38, 13a-80, or 13a-80a of the Connecticut General Statutes, use their property, facilities, and rights-of-way to construct or provide for the hosting of solar power arrays. By the end of 2023, each state agency shall, in consultation with DEEP, analyze appropriate locations for solar arrays consistent with the factors set forth in section 16a-4e of the Connecticut General Statutes.

CLEAN TRANSPORTATION

7. **Statewide battery electric bus fleet by 2035.** The DOT shall cease purchasing or providing state funding to third parties for the purchase of diesel buses by the end of 2023. DOT shall create an implementation plan which identifies any barriers to full bus fleet electrification.

8. **2030 vehicle miles traveled reduction target.** DOT shall set a 2030 vehicle miles traveled reduction target and develop a plan of investments to contribute to and encourage the achievement of such targeted reductions.

COMMUNITY CLIMATE RESILIENCE

9. **Connecticut Community Climate Resilience Program.** DEEP shall establish a Connecticut Community Climate Resilience program, to provide funds in accordance with Section 16-243y of the Connecticut General Statutes for climate adaptation and resilience planning and project development. Funding for this program should be allocated to ensure that at least 40% of resources for municipalities are targeted to municipalities where vulnerable populations, as defined in Section 16-243y, reside and where plans are developed specifically to address the needs of identified vulnerable populations.
    A. The program may be funded by grant or loan funds provided pursuant to Section 16-243y and associated authorized bond funds pursuant to Public Act 21-111 or as may otherwise be authorized by the General Assembly.
    B. Funding under this program shall be prioritized for project planning and design purposes, but may also be made available for construction.
    C. Funding shall be made available for design of nature-based solutions (which for purposes of this order shall include but not be limited to green infrastructure as defined by the Clean Water Act (33 U.S.C. §1362(27)), natural infrastructure and nature-based infrastructure as defined by the National Oceanic and Atmospheric Administration ("NOAA") in NAO 216-117, nature-based solutions as promulgated by FEMA in their Building Resilient Infrastructure in Communities program, and climate-smart agriculture and forestry strategies as promulgated by the U.S. Department of Agriculture ("USDA") and for flood prevention, climate resilience and erosion control systems as defined by Public Act 21-115, gray infrastructure, and non-structural, project solutions.
    D. Projects shall, where feasible, be integrated into relevant state and local plans that ensure they are eligible for implementation through existing and new funding programs, in consultation with other mitigation and resilience partners and/or programs.

10. **Community resilience engagement and technical assistance.** DEEP shall work in cooperation with its partners, including the University of Connecticut, to advance community engagement and provide technical assistance to municipalities and Councils of Governments on implementing climate resilience actions across the state, including:
    A. providing assistance to municipalities with the creation, utilization, and operation of stormwater authorities and municipal flood prevention, climate resilience and erosion control boards pursuant to Public Act 21-115;

B. prioritizing assistance to vulnerable populations;
C. addressing both short-term and long-term impacts of climate change;
D. integrating all relevant planning documents; and
E. facilitating dialogue among vulnerable populations, state, regional and local stakeholders.

11. **State Vulnerability Assessment of state government assets and operations and climate resilience project pipeline.** The Secretary of OPM, the Commissioner of DAS, and the Commissioner of DEEP, through the interagency Steering Committee on State Sustainability established by EO1 and in cooperation with the Commissioner of the Department of Emergency Services and Public Protection ("DESPP"), shall conduct a State Vulnerability Assessment to assess the vulnerability of State government assets and operations to the impacts of climate change as described in the January 2021 GC3 report.
    A. Such Assessment may be funded by grant or loan funds provided pursuant to Section 16-243y of the Connecticut General Statutes and associated authorized bond funds pursuant to Public Act 21-111 or as may otherwise be authorized by the General Assembly.
    B. Such Assessment shall include an update of the statewide inventory of real property, including critical facilities and buildings and where vulnerable populations reside.
    C. Such Assessment shall include an evaluation of vulnerability to the loss in operations of public and private utility facilities critical to maintaining and restoring normal services to the state government.
    D. Such Assessment shall include, in consultation with each state agency, a list of priority assets and infrastructure for climate resilience projects for each state agency.
    E. Upon completion of the assessment, each state agency shall (1) as appropriate, incorporate the findings thereof into such state agency's planning processes and (2) transmit the findings to DESPP, which shall include these findings, as appropriate, in the next update to the State Natural Hazard Mitigation plan.

12. **Resilient stormwater and drainage Systems.**
    A. DEEP shall update the design criteria for stormwater management systems in accordance with NOAA Atlas 14.
    B. DOT shall establish a culvert program with criteria to identify state-owned culverts in need of repair or replacement and develop a prioritized list to guide applications for competitive grant funding.

13. **Resilient critical facilities.** DESPP, in consultation with DEEP, DAS, OPM, and other appropriate partners shall maintain lists of state and local critical facilities, including but not limited to: all facilities deemed critical by the local, state, or federal governments; wastewater treatment plants; power generation facilities; data storage facilities; emergency shelters; and police and fire facilities. All state agencies and all state quasi-public agencies shall consider such lists in their capital and climate resilience planning and shall give special consideration in such planning to all such facilities located in a floodplain or a flood-prone area.

CLIMATE, HEALTH, EQUITY & ENVIRONMENTAL JUSTICE

14. **Community air quality monitoring.** DEEP, in consultation with DPH, shall develop a community-based air quality monitoring program, within available resources, to collect localized air quality data; increase access and transparency to air quality data; and inform citizens of the action steps they can take to reduce personal exposure and improve public health. Such data may also inform the development of local and state regulatory and mitigation activities that can reduce GHG emissions and improve localized air quality.

15. **Assess the need to adopt California Medium and Heavy-Duty ("MHD") vehicle emissions standards.** DEEP shall assess the need to adopt the California Air Resources Board ("CARB") standards for MHD vehicles as part of the state's efforts to meet air quality and climate change goals. DEEP shall develop and publish the assessment no later than January 31, 2022. At the conclusion of the assessment process, DEEP shall determine

if adoption of the CARB standards is necessary to attain health-based air quality standards and necessary to meet statutorily required emission reduction targets under the GWSA.

16. **DPH Office of Climate and Public Health.** DPH shall establish an Office of Climate and Public Health ("OCPH") to address the intersection of climate change and health equity. The OCPH may:
    A. use the social vulnerability index ("SVI") in climate change planning for vulnerable populations, including for use in targeting resources;
    B. establish guidance and policies, including recommending revisions to statutes and regulations, to reduce illness and death among Connecticut's residents from climate-related disease and exposures with health equity as a consistent focus;
    C. implement actions identified in the Public Health & Safety section of the GC3 January 2021 report, including addressing extreme heat, urban heat islands, extreme weather, air quality, vector-borne diseases, resilient public and private drinking water systems and sources, water-related illnesses, food security, and needs of mental health populations in disaster response and recovery;
    D. develop plans to assist residents in high SVI locations for climate control in dwellings that are not equipped to mitigate sudden temperature change and other sudden extreme weather events, including planning for adequate shelters for warming and cooling while permanent mitigation plans are developed and implemented;
    E. apply lessons learned from the ongoing COVID19 pandemic response and recovery to address the impacts of climate change and recognize the underlying health disparities that contribute to vulnerability to climate change and COVID19;
    F. provide training and education for DPH staff and public health stakeholders on climate and incorporate climate change preparedness strategies into public health education;
    G. convene and form partnerships with climate and health stakeholders, including universities and non-profits focused on health and equity and the private sector; and
    H. The OCPH shall coordinate efforts to implement the above charge drawing upon the expertise within DPH and across state agencies.

17. **Connecticut Equity and Environmental Justice Advisory Council.** There is established within DEEP the Connecticut Equity and Environmental Justice Advisory Council ("CEEJAC").
    A. The purpose and mission of the CEEJAC shall be to advise the Commissioner of DEEP on current and historic environmental injustice, pollution reduction, energy equity, climate change mitigation and resiliency, health disparities, and racial inequity, including but not limited to the following:
        i. integrating environmental justice considerations into the programs, policies, and activities of DEEP to improve the health and environment of Environmental Justice Communities, in key areas including, but not limited to, (1) rulemaking, (2) permitting standards and processes, (3) compliance and enforcement, (4) science and data, and (5) equitable program delivery;
        ii. providing mechanisms for Environmental Justice Communities to have a meaningful opportunity to participate in any decision to allow in such communities certain types of facilities which, by the nature of their activity, have the potential to increase environmental and public health stressors and where appropriate, to limit the further placement and expansion of such facilities in these communities;
        iii. developing a model plan for community engagement and stakeholder outreach centered around meaningful participation; and
        iv. strengthening DEEP's partnerships with other governmental agencies, other states, tribal, local governments, and community leaders and organizations regarding environmental justice issues.
    B. The CEEJAC shall consist of the Commissioner of DEEP and the following members appointed by the Commissioner of DEEP:
        i. three (3) representatives of Environmental Justice Communities, which for purposes of this order shall be defined as members of communities of color, members or representatives of low-income communities, representatives of community-based organizations, or academics with knowledge about or

experience in environmental justice, climate change, racial inequity, or any other area determined by the Commissioner to be of value to the CEEJAC;
ii. three (3) representatives of Connecticut-based environmental advocacy organizations;
iii. two (2) representatives of large and small business and industry;
iv. two (2) representatives from municipalities or regional Councils of Government established pursuant to Chapter 127 of the Connecticut General Statutes;
v. a representative from DPH;
vi. a representative from the Department of Economic and Community Development ("DECD");
vii. a representative from the Department of Housing ("DOH"); and
viii. a representative from DOT.

C. The Commissioner of DEEP shall appoint additional members to the CEEJAC as needed in furtherance of the purpose of the CEEJAC.
D. The Commissioner of DEEP, and a representative of an Environmental Justice Community who is not a state agency employee, shall co-chair the CEEJAC. Membership on the CEEJAC for each representative who is an agency head shall run concurrent with their service as agency head. Each member of the CEEJAC who is not a public official shall serve a term of two years or until his or her successor is appointed. A member appointed to fill a vacancy shall serve the remainder of the term of the member they succeeded. The co-chairs shall convene the first meeting of the CEEJAC not later than three (3) months after the effective date of this section, with subsequent meetings occurring at least once per month thereafter.
E. The Commissioner of DEEP may establish subcommittees or working groups of the CEEJAC to address specific topics, and such subcommittees and working groups may include participants who are not members of the CEEJAC.
F. Staffing for the CEEJAC shall be performed, insofar as practicable, by DEEP personnel. The CEEJAC may request and shall receive from any state agency such assistance and data as will enable it to properly carry out its activities hereunder and effectuate the purposes set forth herein, within available resources.

CLIMATE, JOBS and ECONOMIC DEVELOPMENT

18. Connecticut Clean Economy Council

A. There is established a Connecticut Clean Economy Council ("CCEC") that shall advise on strategies and policies to strengthen our climate mitigation, clean energy, resilience, and sustainability programs, thereby lowering emissions and advancing the state of economic and environmental justice for our residents.
B. The CCEC shall:
    i. meet at least quarterly, at dates, times, and locations to be established by the co-chairpersons;
    ii. identify opportunities to leverage state and federal funding to scale economic opportunities associated with clean energy, climate, and sustainability investments; and maximize local economic development benefits from investments needed to meet climate and sustainability goals;
    iii. ensure Connecticut's workforce is trained to deliver climate and sustainability solutions;
    iv. support equitable and diverse participation in climate and sustainability economic development opportunities from both diverse employers and diverse job seekers; and
    v. form working groups to address workforce development in specific sectors within the fields of clean energy and sustainability.
C. The CCEC shall be comprised of the following people:
    i. the Commissioner of DECD, or the Commissioner's designee, who shall also serve as co-chairperson;
    ii. the Commissioner of DEEP, or the Commissioner's designee, who shall also serve as co-chairperson;
    iii. the Secretary of OPM, or the Secretary's designee;
    iv. the Commissioner of DOT, or the Commissioner's designee;

v. the Commissioner of the Office of Workforce Strategy, or the Commissioner's designee;
vi. a representative from the Office of the Governor;
vii. the Chief Executive Officer of the Connecticut Green Bank, or the Chief Executive Officer's designee;
viii. the Chief Executive Officer of Connecticut Innovations, or the Chief Executive Officer's designee; and
ix. any other member so designated by the co-chairpersons.

D. Membership on this Council for the heads of state agencies or quasi-public agencies shall run concurrently with their service as agency heads. Other members of the CCEC shall serve at the pleasure of the co-chairpersons.
E. A majority of the members of the CCEC shall constitute a quorum.
F. The CCEC shall report its findings and recommendations to the Governor, OPM, and the joint standing committees of the General Assembly having cognizance of matters relating to energy and commerce in accordance with Connecticut General Statutes by November 1, 2022, and annually thereafter.

19. **Climate resilient economic development.** DECD shall evaluate whether a project enhances community climate resilience or assists a community with adapting to the impacts of climate change as part of its considerations when determining which projects will receive funding under the Municipal Brownfield Grant Program and the Connecticut Communities Challenge grants in the current and subsequent rounds.
    A. DECD shall give additional consideration to projects submitted for funding through the above programs that were planned and/or designed under the Connecticut Community Climate Resilience Program created pursuant to Section 9 of this order.

CLIMATE and NATURAL & WORKING LANDS

20. **Forest climate resilience and mitigation potential**. DEEP shall engage with stakeholders to evaluate the feasibility, needed resources, and associated programs to ensure the resilience of Connecticut's forests to a changing climate and to maximize our forested lands' mitigation potential through carbon storage and sequestration.
    A. Consideration shall be given to the following actions as part of the stakeholder process: avoid forest conversion; conserve healthy, intact, and resilient forests; offset all planned or permitted forest losses; provide incentives for stewardship, forest retention, and forest resiliency; protect urban forests; build more parks; and plant more trees.
    B. DEEP shall evaluate the feasibility and reliability of monitoring and reporting on negative carbon emissions from Connecticut's forests as part of the greenhouse gas inventory report required by the GWSA.

21. **Agriculture climate resilience and mitigation potential.** The Department of Agriculture shall engage with stakeholders to evaluate the feasibility, needed resources, and associated programs to ensure the resilience of Connecticut's working lands and soils to a changing climate and to maximize mitigation potential through carbon storage and sequestration. This stakeholder engagement shall include, but is not limited to the following actions:
    A. Accelerate and streamline the process to protect working lands with a goal of closing on properties within two years and doubling the number of easements closed in four years. Evaluate program challenges needed to achieve these goals, while including equity, adaptation, mitigation, and resiliency elements.
    B. Enhance renewable energy and energy efficiency programs available to farms by identifying barriers, risk, and unexpected costs for farms seeking to implement on-farm energy projects.
    C. In partnership with state and federal agencies, improve soil health practices on working lands through technical assistance and training, education, and outreach, and leveraging of state and federal funding and programs.

22. **Climate resilience using nature-based solutions on state properties.** In order to improve the resilience of state properties to the impacts of climate change:
    A. DEEP and DAS shall develop guidance for state agencies on how to:

i. implement nature-based and/or nonstructural solutions to control flooding and erosion, improve water quality and manage stormwater on State properties;
ii. integrate consideration of coastal marsh migration in design and implementation of state projects, state-funded projects, and land acquisition in coastal areas to ensure continued ecosystem services from wetlands; and
iii. employ techniques and materials for low impact development and design and green infrastructure for new state construction, redevelopment and state-funded construction or redevelopment to mitigate flooding and water quality degradation.

B. All state agencies shall follow the above guidance in all capital project planning, to the extent feasible and consistent with other requirements, and report annually on the implementation of such efforts to the Steering Committee on State Sustainability established pursuant to EO1.

C. All capital projects administered by state agencies shall, to the extent feasible and consistent with other requirements, be designed in conformity with the above guidance. Each administering agency shall annually report on compliance with such guidance to the Steering Committee on State Sustainability established pursuant to EO1.

GOVERNOR'S COUNCIL ON CLIMATE CHANGE

23. Continue Governor's Council on Climate Change. Sections 4 and 5 of EO3, issued September 3. 2019, are amended to provide that the reports required therein shall be submitted by December 31, 2022 and on December 31 of each year thereafter.

This order shall take effect immediately.

Dated at Hartford, Connecticut, this 16th day of December 2021.

Gov Ned Lamont

Ned Lamont
Governor

By His Excellency's Command

Denise W Merrill

Denise W. Merrill
Secretary of the State