2021 Connecticut Annual Pavement Report

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Date of the Report
May 26, 2023

Name of the performing organization
Connecticut Advanced Pavement Laboratory
Connecticut Transportation Institute
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University of Connecticut

Submitted to:
Connecticut Department of Transportation
Bureau of Engineering and Construction
Pavement Management Unit

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TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No.	2. Government Accession No.	3. Recipients Catalog No.
4. Title and Subtitle Connecticut Annual Pavement Report		5. Report Date May 26, 2023 6. Performing Organization Code
7. Author(s) Alexander Bernier PE, Iliya Yut, James Mahoney		8. Performing Organization Report No. CAPLAB 301-2023
9. Performing Organization Name and Address University of Connecticut Connecticut Transportation Institute 270 Middle Turnpike, U-5202 Storrs, Connecticut 06269-5202		10. Work Unit No. (TRIS) N/A 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Connecticut Department of Transportation 2800 Berlin Turnpike Newington, CT 06131-7546		13. Type of Report and Period Covered Final- CY 2020 14. Sponsoring Agency Code
15. Supplementary Notes A report generated in cooperation with the U.S. Department of Transportation and Federal Highway Administration		
16. Abstract Presented herein is the third annual administrative report on pavements for the Connecticut Department of Transportation (CTDOT). This report provides a summary of the current condition (2020 data) of pavements for two roadway systems; 1) the entire CTDOT-maintained roadway network (including state NHS) and 2) the National Highway System (NHS) designated roads in Connecticut (state- and town-maintained NHS). Also described within are CTDOT's paving programs, condition projections, and targets, anticipated available funding, and projections of future activity in Connecticut resulting from the use of the CTDOT Pavement Management program. This annual report will be used to produce future Transportation Asset Management Plan (TAMP) updates as they occur.		
17. Key Words Network Asset Management, Pavement Management, Pavement Preservation, Pavement Performance, State of Good Repair	18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA. 22161	

19. Security Classif. (Of this report)	20. Security Classif.(Of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	71	N/A

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ACKNOWLEDGEMENTS

This report was prepared by the University of Connecticut, in cooperation with the Connecticut Department of Transportation and the United States Department of Transportation, Federal Highway Administration. The opinions, findings, and conclusions expressed in the publication are those of the author(s) and not necessarily those of the Connecticut Department of Transportation or the Federal Highway Administration. This publication is based upon publicly supported research and is copyrighted. It may be reproduced in part or in full, but it is requested that there be customary crediting of the source.

FOREWORD

Except where noted otherwise, the information presented in this document for mileage, pavement type distributions, pavement condition ratings, future condition performance projections, treatment costs, and vehicle miles of travel is determined using calendar year 2020 data. Generally, the TAMP information was derived using calendar-year 2020 data. Construction data reflects information through the 2021 construction season.

METRIC CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

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1. INTRODUCTION AND BACKGROUND

Purpose of Annual Report

This is the third annual administrative report on pavements for the Connecticut Department of Transportation, representing the calendar year 2021. This report provides executive-level management and outside parties with information about Connecticut's pavement conditions (both current and the past few years). It provides a summary of the current condition of pavements for two roadway systems; 1) the entire CTDOT-maintained roadway network (including state NHS) and 2) the National Highway System (NHS) designated roads in Connecticut (state- and town-maintained NHS). Also summarized within this report are CTDOT's paving programs, funding, and projections of future activity resulting from the use of the Connecticut Department of Transportation (CTDOT) Pavement Management System (PMS). Except where otherwise noted, the current information presented in this document, such as pavement condition, inventory of lane-miles of roadway, etc. is derived from calendar year 2020 data.

Asset Management Objectives for Maintaining "State of Good Repair"

'Pavement' is the structure that comprises the traveled road, it is typically multiple layers of stone and sand mixed with liquid asphalt, or Portland Cement Concrete. Pavements are designed to support anticipated traffic loads over the life of a structure and are designed and constructed to provide a safe and relatively smooth driving surface. Maintaining pavements in a smooth and good condition lengthens their life, enhances safety, reduces road user operating costs, reduces vehicle delays, reduces fuel consumption, reduces air pollution, and minimizes pavement maintenance costs.

To understand the current condition of the network and project the conditions in the future, CTDOT uses a Pavement Management System (PMS). State pavement engineers analyze pavement-rating data collected annually and then perform analyses and generate reports from this data. The PMS is also used to evaluate the effectiveness of funding priorities, pavement treatments, and to provide guidance in the decision-making process.

Monitoring and measuring pavement conditions (as well as other transportation asset conditions) enables CTDOT to assess the performance of the transportation system, analyze deficiencies and predict future needs, allocate funding, and schedule projects to address what is known as the 'State of Good Repair' (SOGR). CTDOT has prepared and adopted a Transportation Asset Management Plan (TAMP) the objectives of which are in line with the vision and mission of the agency. The CTDOT TAMP objectives are:

- 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

Performance measures, projections, targets, and goals were developed to help achieve CTDOT TAMP objectives. These are being linked so that CTDOT can operate more effectively, and simultaneously make progress towards federal requirements and state goals. This also allows for the establishment of funding priorities and targets that are achievable.

Connecticut Roadway Treatment Costs

Table 1-1 contains the relative costs of treatments used on roadways across Connecticut. Preservation treatments, such as "mill and fill," ultra-thin bonded overlays, and asphalt-rubber chip seals cost between 50 and 90 percent less than more complex activities associated with rehabilitation and reconstruction. Figure 1-1 illustrates graphically the relationships between effectiveness, costs, and approximate timing of various treatments, with the understanding that more frequent preservation of a pavement maintains its condition at a higher level across its lifetime.

Table 1-1 General Illustration of Treatments and 2021 Approximate Unit Costs for Showing Relative Life Cycles (see also Figure 1-1)*

FHWA Work Type	CTDOT Treatment	Expected Surface Life (years)	Approx. Cost per 2-lane mile, ($)	Approx. Cost Per Year of Life[1]
Initial Construction	New Construction	20	$1,535,000	$77,000
Reconstruction	Reconstruction Flexible	15-20	$1,882,500	$94,000
Reconstruction	Reconstruction Composite	15-20	$2,070,500	$103,530
Rehabilitation	Structural Rehabilitation	15	$740,500	$49,500
Preservation	Mill and Fill	10-12	$350,000	$29,500
Preservation	Ultra-thin bonded overlay	7-10	$150,000	$15,000
Preservation	Asphalt Rubber Chip Seal	7-10	$124,500	$12,500
Preservation	Crack and Joint Fill & Seal	2-6	$16,500	$3,000
Maintenance[2]	Pothole repair,	1-5	N/A	N/A
Maintenance[3]	Emergency overlays	1-3	N/A	$100,000

[1]Approximate cost is determined per 2-lane mile per year of maximum expected service life
[2] contains approximate costs only for illustrative purposes, as costs can vary significantly by project, location and timing.
[3]These items are not necessarily eligible for federal funds

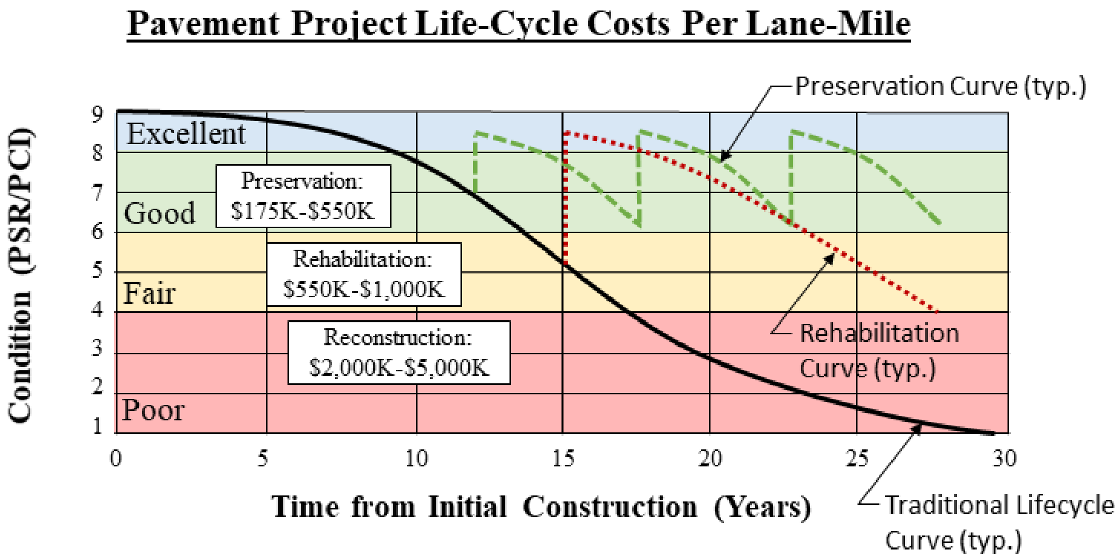


Figure 1-1 Illustration of General Costs and Appropriate Timing for Pavement Remediation (Lane-miles)

Note: The majority of existing state-maintained roads were designed with a 20-year structural design life. Through rehabilitation and resurfacing programs, CTDOT has in most instances managed to extend original expectations.

CTDOT Pavement Management System

CTDOT's PMS was first developed and implemented in the early 1980s. It has continually evolved since via incorporation of various paving programs such as the maintenance vendor-in-place (VIP) resurfacing program, pavement preservation program (PPP), resurfacing-by-contract pavement rehabilitation and reconstruction program, use of prioritization and optimization routines for identifying candidate roadway sections for activity, performance prediction modeling, and cost estimating for budgeting.

Data Collection

Since the 1970s, CTDOT has been one of the pioneers and leaders in highway-speed road survey technology. This technology has evolved to become one of the most critically important and prominent tools in use by CTDOT and in many other state DOTs for asset management (which is now also federally mandated). The equipment enables the collection of highly technical, detailed, and complex pavement condition and infrastructure data, which is critical not only to planners and designers in the state but also required for reporting to FHWA for performance metrics. Pavement images and sensor data collected by two (2) specially equipped Fugro Roadware Automatic Road Analyzer 9000 (ARAN) vans (Figure 1-2) are processed to identify the presence of different types of pavement distress, including wheel path rutting, cracking, patching, raveling, faulting, as well as surface cross slope. (Faulting applies to concrete pavements only, which make up approximately 0.5% by centerline miles of CTDOT's pavement network.). The ARANs also provide 3D imaging using a Laser Crack Measurement System (LCMS), which includes two scanning lasers. This provides great detail in the measurement of cracking, Table 1-2 lists the equipment components contained within the two current CTDOT ARAN vehicles (vans 9 and 10).

Data flows into the CTDOT PMS from several sources (Figure 1-3). Roadway inventory data (e.g., lane widths, route mileage, intersection locations) are merged with pavement condition data (e.g., level of distress present from annual ARAN survey), and activity data (e.g., maintenance, paving, or construction). The pavement condition data are collected by the Photolog Unit in the Bureau of Policy and Planning, Roadway Information Systems Section. The entire CTDOT-maintained road network, as well as municipally owned segments of the NHS, are surveyed each year.

Figure 1-2 CTDOT Photolog Vehicle (One of Two Vehicles Currently Utilized)

Table 1-2 CTDOT ARAN 9000 Series Vans and Latest Equipment Installed on Each

CTDOT ARAN System Component	Component Description
Geographic Coordinates	Real-Time Differential GPS +POS LV Inertial Positioning System (1-meter accuracy) using OmniStar
Distance	Wheel-mounted Distance Measurement Instrument Measures linear distance within ± 0.005%
Roughness (IRI)/Longitudinal Profile	South Dakota Profiler with Gocator Senors Class 1 Profiler under ASTM E950, AASHTO R56-10 Certification & ASTM E1926
Crack Detection, Classification & Rating, Texture, Rutting & Transverse Profile	Pave3D Pavemetrics New Laser Crack Measurement System II (LCMS- 2)
Right of Way (Front View) Imagery	SONY HD Camera w/90 Degree Field of View Lens

**Two current generation CTDOT vehicles are named ‘Van 9’, and ‘Van 10. Van 9: 2015 Mercedes Benz Sprinter. Van 10: 2020 Mercedes Benz Sprinter.*

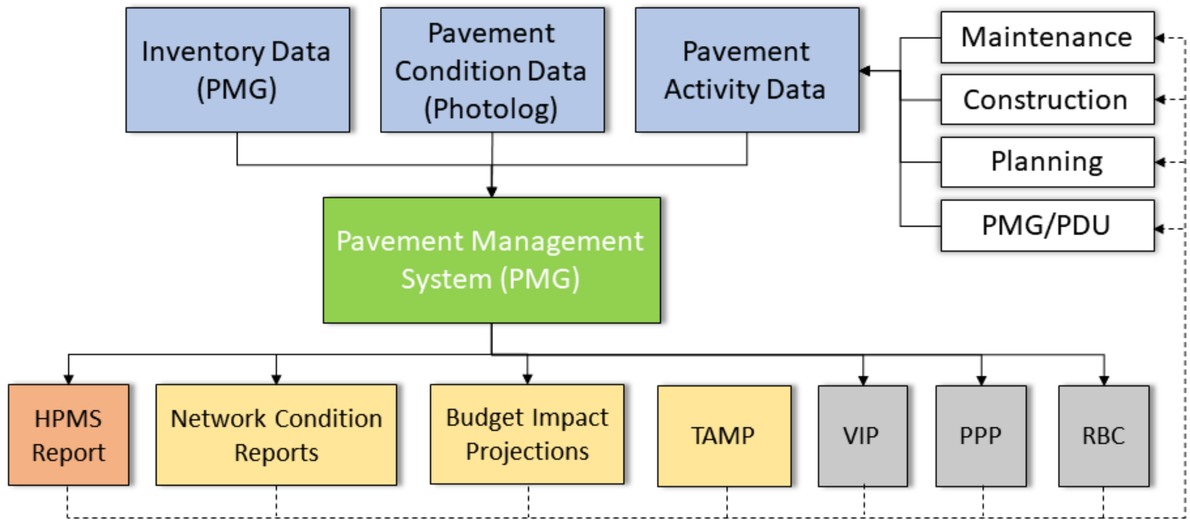


Figure 1-3 CTDOT Pavement Data Information Flow Chart

Pavement condition data are collected according to the CTDOT Data Quality Management Plan (DQMP) that was approved by FHWA on August 22, 2018 with revisions approve on June 21st, 2022 per CFR 490.319(c). 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.

Data Analysis

After collecting pavement condition data, the Photolog Unit then reports it out to the Pavement Management Group into flat files at a five-meter granularity along the roadway surface using ARAN proprietary software. The Pavement Management Group then imports these flat files into a Microsoft SQL Server database where data are aggregated by tenth-mile sections, and then again by defined pavement-analysis sections. Next, these data are combined with existing meta-data specific to each roadway segment to calculate International Roughness Index (IRI) (roughness), rutting, cracking (structural and environmental), faulting, and cross slope and grade indices used for determining drainage adequacy. These indices are then used to calculate the Pavement Condition Index (PCI) described later in this report, as well as for data used to report the condition of the NHS. Condition data are summarized by lane-miles for federal Highway Performance Monitoring System (HPMS) reporting, and FHWA subsequently uses the reported data to determine the Federal performance measures. Condition data are summarized by centerline miles (aka road or route miles) for State performance measures. In many cases, for comparison purposes, data are shown both ways in this annual report.

CTDOT uses a customized version of Deighton Total Infrastructure Management System (dTIMS®) software to analyze, present the current, and predict the future condition of both CTDOT-maintained pavements and the designated NHS in Connecticut. The system was initially implemented in 1998 and has been upgraded since. It provides capabilities for storing, reporting, and viewing pavement inventory and condition information. Primary data sources for dTIMS and the PMS include basic road inventory data from the CTDOT Road Inventory System, pavement condition data collected each year with the photolog vans described earlier, 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. dTIMS is also used for analyzing alternative investment scenarios and for assisting with planning a single- or multi-year pavement treatment program.

Transportation Asset Management Plan (TAMP)

Rather than continuing to rely solely on a traditional decentralized approach in which individual units such as Pavement Management, Office of Construction, Bridge Safety & Evaluation, and Traffic Engineering collect, store and report on data to meet their individual operational needs, CTDOT is moving toward an enterprise approach to make the best use of agency data for informed decision-making. The initial Transportation Asset Management Plan (TAMP) was published in July 2018 for roads, bridges, and other assets such as sign supports, traffic signals, and pavement markings and was updated in August 2019. The most recently published TAMP was developed for publication in 2022 and includes additional assets (illumination, retaining walls, drainage culverts, and ITS). The FHWA and federal legislation direct that states maintain an asset management plan that is supported by a pavement management system. States are required to use pavement management systems, such as described earlier for CTDOT, which, in addition to other capabilities, collect, process, store, and update inventory and condition data. The TAMP is the federally required plan intended to document transportation asset management practices and processes at CTDOT. Rules outlined in "Moving Ahead for Progress in the 21st Century Act" (MAP-21) and "Fixing America's Surface Transportation Act" (FAST) require reporting by all states for bridges and pavements contained on the NHS.

In addition to NHS-required information for pavement and bridge assets, CTDOT has opted to include traffic signals, signs, sign supports, pavement markings, and highway building assets in its TAMP. Additional assets including guiderail, illumination, and others will also be included in future versions of CTDOT's TAMP.

Specific to pavement assets, the CTDOT TAMP includes:

- Inventory and condition
- Data management
- Asset valuation
- Performance measures
- Performance targets
- Performance gap analysis
- Life cycle planning
- Risk management

- Financial planning, and
- Investment strategies

The Connecticut TAMP addresses assets on the two previously noted overlapping highway systems: CTDOT-maintained roads and the NHS designated routes. Even though the NHS in Connecticut is primarily composed of CTDOT-maintained roads, 159 lane miles of NHS town roads are maintained by local municipalities.

2. CONNECTICUT ROADWAY NETWORK CONDITIONS

Overview of Network Mileage

According to (FHWA 2019), in 2014, the Nation's public road network included 4,177,074 miles of roadways: 226,767 miles of this network (5.4 percent) are designated as the National Highway System (NHS); with a subset of 47,944 miles comprising the Interstate System (Interstates). The Interstates (1.1 percent of the nation's centerline miles) carry 24.7 percent of the total Vehicle Miles Traveled (VMT) in the United States.

Statistics on the extent and length of Connecticut's roadway network, in both centerline (road) miles and lane-miles, are provided in Table 2-1, below. Although Connecticut is the third smallest state in terms of area, it is ranked 44th for length of network centerline road mileage (USDOT 2020a).

Table 2-1 Connecticut Centerline (Roadway) Miles and Lane-Miles* (2020)

Classification	Centerline (Road) Miles	Lane-Miles**
CTDOT Maintained NHS	**1,406**	**5,018**
Interstate	**346**	**1,883**
Non-interstate NHS (state only)	**1,060**	**3,136**
CTDOT Maintained Non-NHS	**2,309**	**4809*** **
Total CTDOT maintained routes and roads (excluding ramps)	**3,715**	**9,827**
Municipal NHS	**56**	**159**
Total Municipal Roads	**17,454**	**~35,300**
Total Municipal and CTDOT Roads	**21,169**	**~45,159**

* All figures have been rounded to the nearest whole mile. These mileages are from CTDOT Bureau of Policy and Planning Public Road Mileage as officially reported to the FHWA on Dec 31, 2020. The exact mileage on the ground, used for inventory, measured with automated equipment, and analyzed with software varies slightly from these reported figures. These totals exclude 110 centerline miles of Federal roads and 295 centerline miles of state park, state forest, and state institution roads.
**Lane-miles are defined as centerline (road) miles multiplied by the number of lanes. These miles do not count shoulders as lanes.
***State Routes and Roads Lane Miles includes 249 lane miles of bridges and 464 lane miles of ramps.

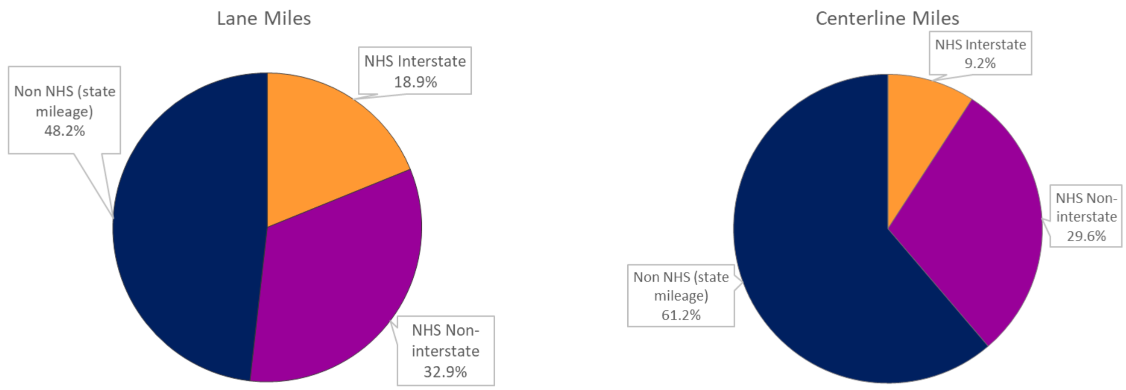
Table 2-2 provides the number of centerline miles and lane-miles in Connecticut within each of the four CTDOT-designated highway maintenance districts. For reference, maps showing CTDOT districts, as well as regional planning agencies within Connecticut can be found in Appendix 4.

Table 2-2 Approximate Centerline (Road) Miles and Lane-Miles by CTDOT District *

	Centerline (Road) Miles	Lane-Miles
District 1	800	2,500
District 2	1,100	2,700
District 3	700	2,200
District 4	1,100	2,500

Notes:* These mileages are from CTDOT Bureau of Policy and Planning Public Road Mileage
** The mileage amounts have been rounded to the nearest 100 miles.

Figure 2-1 below shows the relative distribution of NHS and non-NHS roadways in Connecticut as of December 31, 2020, the latest available year-end dataset. This excludes Federal roads, and CTDOT maintained bridges and ramps.



Connecticut	*Centerline (Road) Miles*	*Lane-Miles*
NHS Interstate	346	1,883
NHS Non-interstate	1115	3,289
Total NHS (state + town)	1462	5,177
Non NHS (state mileage)	2309	4,809
Total NHS (town + state) + Non NHS (state mileage)	3,771	9,986

Figure 2-1 Distribution of all NHS and CTDOT Maintained non-NHS Roadways in Connecticut (2020)

The average surface age from 2008 through 2020 of the CTDOT-Maintained network can be seen in Figure 2-2 CTDOT-Maintained Network Average Surface Age Over Time. It is noteworthy that the scale of the y-axis is only 8.6 to 10, in that the fluctuation in age is relatively tight. In fact, a regression model of age versus time suggests a trend line slope of -0.042, indicating that CTDOT's network pavement surface is getting younger at a nominal rate, very nearly a stable age.

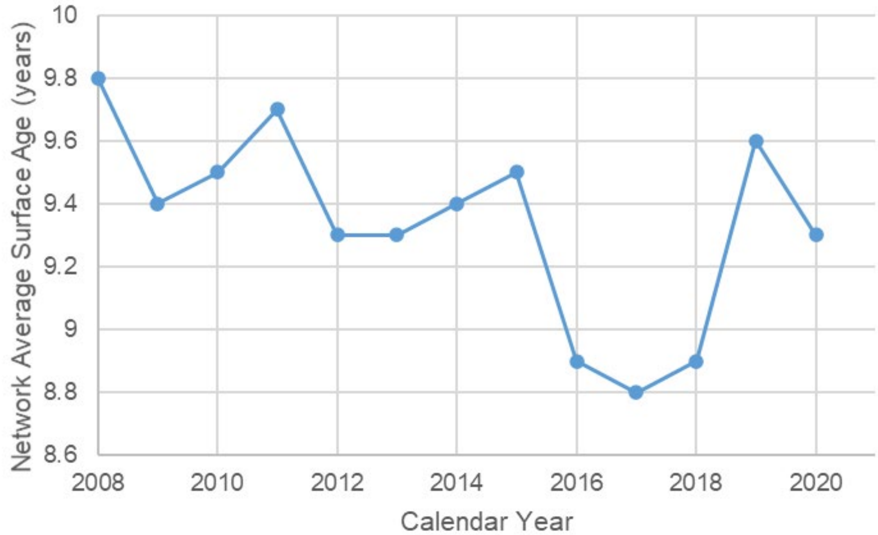


Figure 2-2 CTDOT-Maintained Network Average Surface Age Over Time (2008-2020)

Functional Classification System for Roadways

The FHWA defines the highway functional classification system in the 2016 HPMS Field Manual (USDOT 2016 & FHWA 2013). *Access control is a major factor in defining the functional classification system.* However, the use of the word "access" in this context refers to the ability to access the roadway (not the abutting land use). The functional classification system groups roadways into a so-called "logical series of decisions" based upon the character of travel service the roads provide. Detailed definitions for the seven rural and urban functional classification categories can be found in Appendix 7.

The centerline miles of state-maintained roadways in Connecticut as categorized by the federal functional classification system are given in Table 2-3 below.

Table 2-3 Approximate CTDOT Centerline (Road) Miles* by Functional Classification (Rural and Urban)(2020)**

	Functional Classification & Code							
CODE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
CLASS	*Interstate*	*Other Freeways & Expressways*	*Other Principal Arterial*	*Minor Arterial*	*Major Collector*	*Minor Collector*	*Local*	***Total***
RURAL	30	40	120	220	740	20	5	1,175
URBAN	320	240	660	940	370	10	15	2,555

** Mileages from CTDOT Bureau of Policy and Planning Public Road Mileage. Amounts rounded to the nearest 10.

Vehicle Miles of Travel

Vehicle Miles Traveled (VMT) can be used to normalize network travel with the population. Due to high population density, Connecticut ranks as 37th overall in the U.S. for vehicle miles of travel on the network (USDOT 2017c). Eighty-two percent of total mileage in Connecticut is composed of locally maintained roads (17,454 road miles, see Table 2-1). These local roads, however, carry only 24 percent of the total VMT. Seventy-six percent of motor vehicle travel occurs on the CTDOT-maintained network of roads, which represents less than 18 percent (3,716 road miles) of total mileage in Connecticut.

Total annual and daily VMT on CTDOT roadways for selected years between 2010 and 2020 are given in Table 2-4 below.

Table 2-4 Total Annual & Daily VMT on Connecticut Roadways (2010 to 2020)*

Year	***CTDOT Annual VMT*** ***(in millions of miles traveled)***		***CTDOT Average Daily VMT*** ***(in millions of miles traveled)***	
	NHS only	***Entire Network***	***NHS only***	***Entire Network***
2020	**17,994**	**22,625**	**49.30**	**61.99**
2019	18,928	23,954	*51.86*	*65.63*
2018	18,889	23,924	51.75	65.55
2017	18,762	23,779	51.40	65.15
2016	18,766	23,844	51.42	65.33
2015	18,788	23,849	51.47	65.34
2010	16,382	23,584	44.99	64.62

*All data from Policy and PlanningAnnual Vehicle Miles traveled equals average daily traffic multiplied by miles of roadway multiplied by the number of days per year (365) for each roadway category (e.g., interstate) then summed for all categories, excluding local roads.

Distribution of Pavement Surface Type

The distribution of roadway mileage by pavement type in Connecticut for both lane-miles and centerline miles is shown in Figure 2-3 below. This demonstrates that the predominant pavement surface type is flexible (asphalt concrete), representing approximately 59% and 70% of road miles and lane-miles, respectively. Most of the remainder of the pavement network is composite pavement, defined as Portland Cement Concrete (PCC) overlaid with bituminous (asphalt concrete) pavement. The amount of PCC (rigid pavement) remaining uncovered in Connecticut is less than 1% of the network by lane miles.

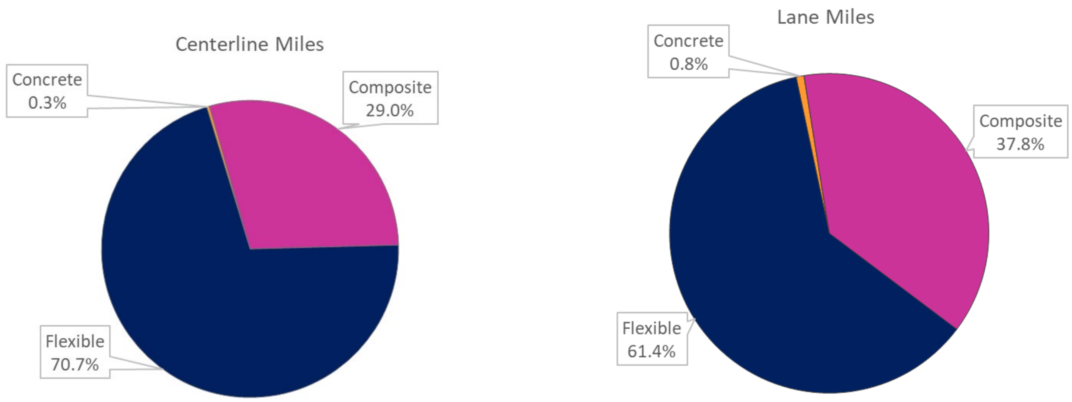


Figure 2-3 Distribution of CTDOT Pavement Network Surface Type by Centerline and Lane-Miles

Condition of Statewide CTDOT-maintained Roadway Network

CTDOT's internal performance measure for the overall category of CTDOT-maintained roads is the percentage of centerline miles in a state of good repair (SOGR)**.** SOGR was adopted by CTDOT in 2019 as the measure for all state assets reported in the TAMP.

The SOGR (also defined as SGR) is a term that was initially used by the Federal Transit Administration. According to "Transit Asset Management Practices" (FTA, 2010), SGR is defined as "a state in which a transit agency preserves its physical assets in compliance with a policy that minimizes asset life-cycle costs while preventing adverse consequential impacts to its service." In 2013, the American Public Transportation Association (APTA) developed a much simpler definition for SGR: "SGR is a condition in which assets are fit for the purpose for which they were intended" (APTA, 2013). SOGR has also been adopted by FHWA following the FAST Act, and as defined in Code of Federal Regulations 23 CFR 490.313, National Performance Management Measures, (April 2017) and is now required to be included in the TAMP.

CTDOT currently uses a composite rating system, referred to as the Pavement Condition Index (PCI) to express the condition of CTDOT-maintained pavements. A PCI is calculated for each 0.1-mile segment based on five pavement characteristic sub-indices; the overall PCI is a weighted average. The weights for the constituent indices which comprise the overall PCI are shown in Table 2-5 and described below.

Table 2-5 Relative Weights of Pavement Characteristics (Metrics) used in PCI

Index_Roughness [IRI] (10%)
Index_Rutting (15%)
Index_Cracking (25%)
Index_Disintegration (30%)
Index_Drainage (20%)

Index_Roughness (based on International Roughness Index), Index_Rutting, and Index_Cracking are similar to the FHWA metrics described later for the NHS. Index_Disintegration is the wearing away of the pavement surface caused by age, traffic, and weather exposure (similar to the ASTM D6433-designated distress Weathering/Raveling). In the CTDOT PMS, Index_disintegration is currently calculated using pavement age as a proxy for measured distresses that are more elusive to measure using automated data collection techniques. Drainage refers to the ability of the surface of the roadway to properly transport rainwater from the pavement structure. CTDOT uses information collected on pavement transverse cross slope and longitudinal grade to compute the Index_Drainage metric.

The PCI and each constituent index are scales from 1.0 to 9.0, where a pavement without defects would be scored as 9.0. A pavement section for which the PCI is calculated at 6.0 or higher is classified as being in a SOGR (see Figure 2-4). The numerical relationship of the PCI score for defining Good, Fair, or Poor roadways is also indicated in Figure 2-4.

Figure 2-4 PCI Ratings used to define SOGR and Pavement Condition

Figure 2-5 illustrates the difference in Connecticut road surfaces rated as being good, fair and poor. These are for illustration purposes only, since some elements of the PCI, namely roughness (IRI), and drainage are typically not a ‘visible’ condition yet can affect the overall PCI rating.

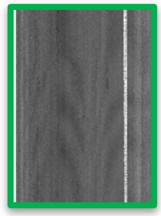
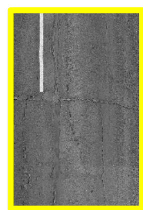
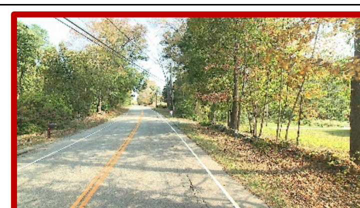
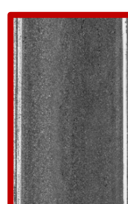
Good (PCI ≥ 6) Sample Section: CT Route 22 Mile point:2.5 Sample PCI: 8.2	Pavements in Good condition exhibit minimal quantities of the measured distresses and low to moderate distress severities. A Good pavement requires a pavement preservation project to maintain or improve the pavement condition and delay costlier treatments.	 
Fair (4≤ PCI <6) Sample Section: CT Route 130 Mile Point: 1.1 Sample PCI: 5.3	Pavements in Fair condition exhibit moderate to large quantities of the measured distresses and a range of distress severities. A Fair pavement tends to be beyond the scope of a preservation project and requires a pavement rehabilitation project when the PCI values are at the lower-end of the PCI range in order to improve the pavement condition.	 
Poor (PCI < 4) Sample Section: CT Route 169 Mile Point: 9.8 Sample PCI: 3.5	Pavements in Poor condition exhibit large quantities of the measured distresses and high distress severities; in particular, structural failures. A Poor pavement is beyond the scope of a preservation project and requires either a major rehabilitation project or reconstruction to improve the pavement condition.	 

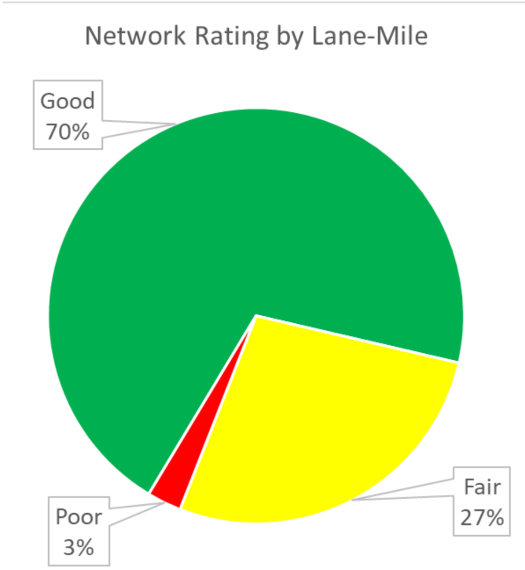
Figure 2-5 Illustrative Comparison of Good, Fair and Poor CTDOT-maintained Roads

The centerline miles of CTDOT-maintained roads in good, fair and poor condition are tabulated for all sections at 0.1-mile increments to determine the overall percentage of pavement in good, fair and poor condition. The results for 2020 conditions are shown in Table 2-6 below. The percentage of sections on the CTDOT maintained roads in 2020 that are in a SOGR (i.e., PCI ≥ 6 and rating of 'good') is 63.3%. It is worth noting again that these figures are for CTDOT-maintained roads only, therefore the condition of the 17,446 miles of municipal roads are not included in these percentages, nor are conditions for federal roads or state roads (parks, forests and institutions) that are not maintained by CTDOT. For a side-by-side comparison of the condition of the CTDOT-maintained roads by centerline mile versus lane-mile, see Figure 2-6.

Table 2-6 Connecticut Inventory and Conditions (2020 of CTDOT-Maintained Roadways Using the PCI by Centerline Miles (Excludes Towns + Overlapping Routes)

Route Category	*Centerline Miles Good*	*% Good**	*Centerline Miles Fair*	*% Fair**	*Centerline Miles Poor*	*% Poor**	*Total Centerline Miles*
INTERSTATE	322	93.1%	24	6.9%	1	0.1%	346
NON INTERSTATE NHS	805	76.2%	235	22.3%	16	1.5%	1,056
NHS	1128	80.4%	259	18.5%	16.1	1.1%	1,403
NON_NHS	1,439	61.9%	794	34.2%	90.1	3.9%	2,323
ENTIRE_NETWORK	2,132	70.1% SOGR	834	27.4%	73.7	2.4%	3,039.7

Notes: *These Good, Fair, and Poor percentages were calculated using CTDOT's Pavement Condition Index.



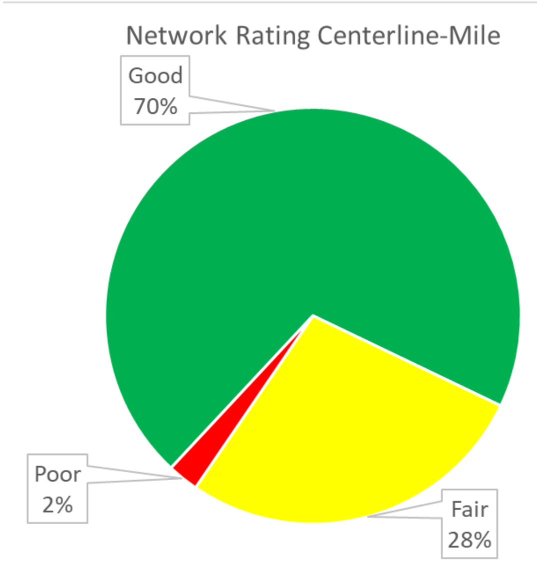


Figure 2-6 Conditions of CTDOT-Maintained Roadways (2020) Using the PCI, by Lane Mile and Centerline Miles (Excludes Town Roads + Overlapping Routes)

Historical Pavement Data

Highway Performance Monitoring System data for the state of Connecticut was plotted as good/fair/poor from the year 2000 to present (**Figure 2-7**). It is important to note large technological leaps and adaptations to reporting requirements occurred across these two decades of pavement data. In general, the categorical conditions are trending in the right direction (increase in good, decrease in fair and poor).

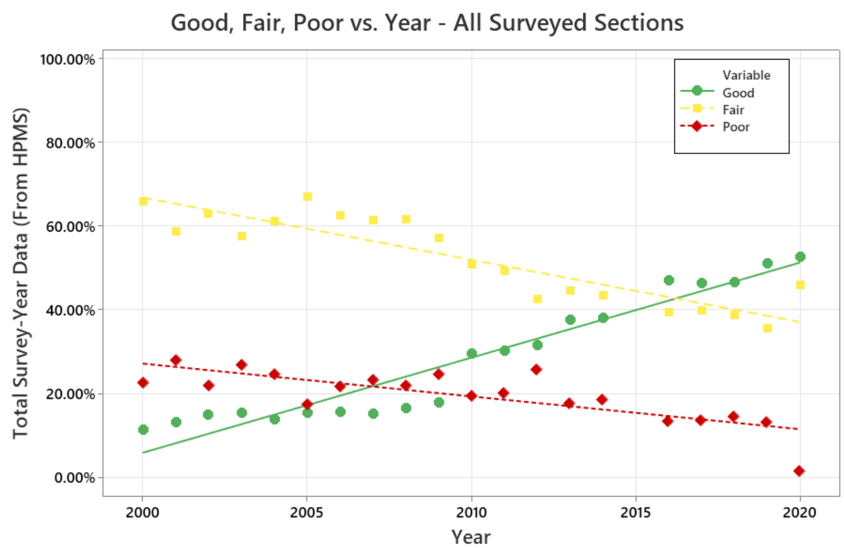


Figure 2-7 FHWA records for 2000-2009 and CTDOT records 2010-2020

Figure 2-8 breaks International Roughness Index (IRI) data into functional class groupings across the decade of available internal data for CT DOT. By separating the IRI into these functional classes, it can be seen that interstates (functional class 1) has been maintained at a relatively stable level with the largest increase in 'good' pavement occurring in functional classes 2 and 3.

Figure 2-8 Historical IRI Data by Functional Class Grouping 2008-2020

Development of a new Pavement Condition Rating System

CT DOT and the University of Connecticut are currently modernizing the CTDOT internal pavement condition rating system to increase the reliability and sensitivity to the metrics currently mandated from the FHWA and overall changes in network condition. From a high level – each pavement rating system currently in use (by CT DOT and elsewhere globally) has advantages and shortcomings. The HPMS guidelines, for example, work very well for high-speed roadways such as limited access freeways but penalize lower-speed functional classes due to attributes inherent to their level of service such as increase curb cuts for driveways to businesses and residents and drainage and utility structures. The existing PCI system was developed with visual distresses such as rutting and cracking at the forefront of the system with less emphasis on smoothness. As superpave has been implemented in Connecticut, the level of service of our roadways has improved to the point where attributes like smoothness can be given more importance (or an equal share of the rating). This alters the weights of prioritization for certain conditions, ultimately adjusting the overall approach to preservation.

The Pavement Surface Performance Index (PSPI) was conceived in 2019 and is currently in a *testing* stage. This system utilizes a relative scale of distresses split by pavement type or functional class and ultimately divided across pavement age, to establish an 'expected' performance target for any given pavement section in the state. A particular section can be performing above target or below target, and these target values will be re-calculated every 3 to 5 years to ensure the overall network is trending in the right direction.

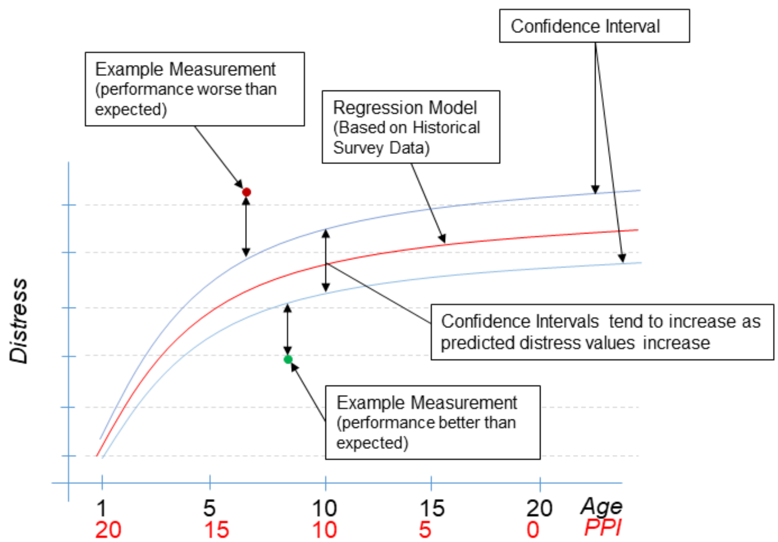


Figure 2-9 Concept-Level Graphic for PSPI Model Prediction

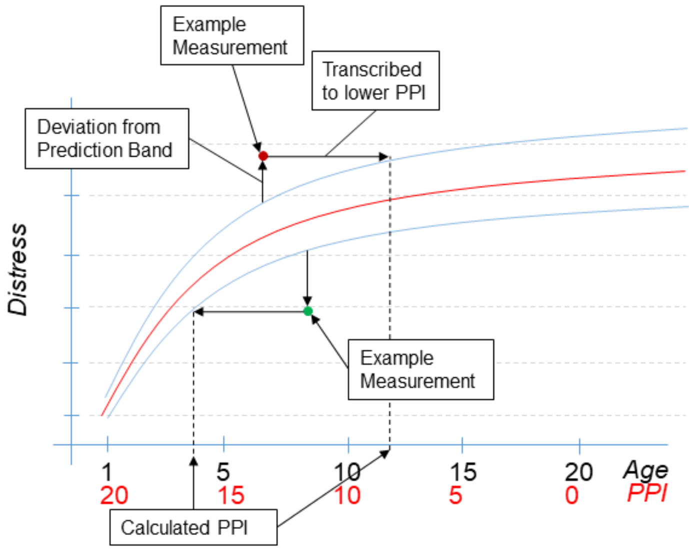


Figure 2-10 Concept Level Graphic for PSPI Model Determination

When ranking each 0.1-mile segment by its lowest-value sub-index (roughness, wheel path or non-wheel path cracking, or rutting), the Figure 2-11 indicates the trend of pavement sections performing at or above target versus those acting below target. It is important to keep in mind, this high-level metric is the combination of five different sub-index distress models based on Functional Class or Pavement Type. Not only do we expect this graphic to be relatively stable across time, but it is also a reflection of the uniformity of data collection with multiple devices and operators within Photolog across time (the technological changes explain the largest variability in the graphic).

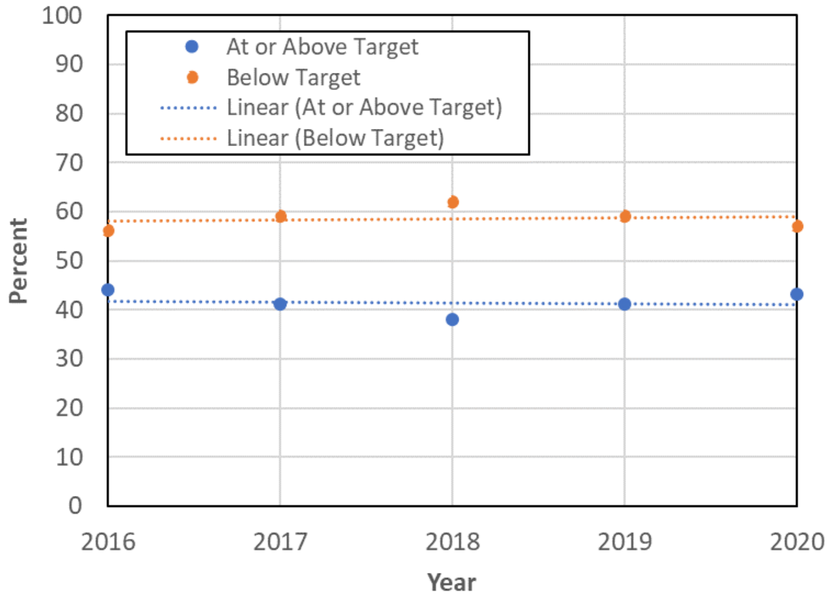


Figure 2-11 Network PSPI Performance, 2016 – 2020

Conceptually, pavements performing below target can still be good pavements, and those performing at target can be in need of repair. The PSPI streamlines the ability to monitor changes in the network health and generate preservation candidates easily by simply setting lower-valued PSPI thresholds for various treatments. In Figure 2-12 and Figure 2-13 the percent of a given functional class and age above or below the target PSPI is shown. One important consideration for "Age 0" pavements is that this subset of data is often ignored because sometimes the annual survey for a given road does not capture the post-construction condition.

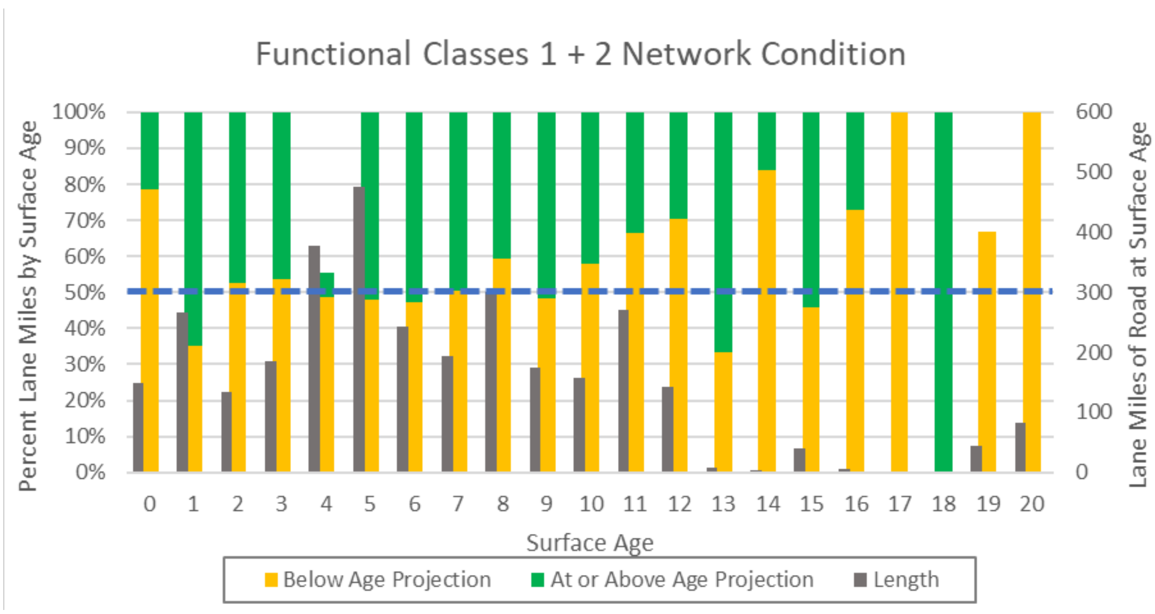


Figure 2-12 PSPI Ranking at or above projected condition level vs. age for Functional Classes 1 and 2

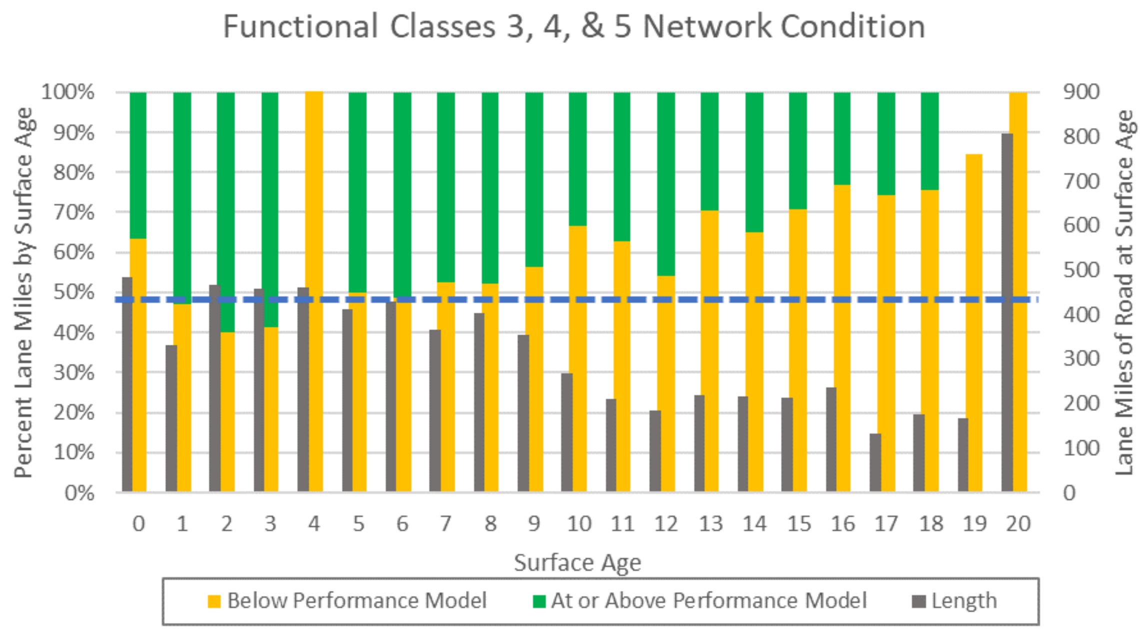


Figure 2-13 PSPI Ranking at or above projected condition level vs. age for Functional Classes 3, 4, and 5

Condition of National Highway System (NHS) in Connecticut

The FHWA defines the National Highway System (NHS) as consisting of the Interstate Highway System and other roads important to the nation's economy, defense, and mobility. The NHS was developed by the U.S. Department of Transportation in cooperation with states, local officials, and metropolitan planning organizations (MPOs). For Connecticut, the NHS includes interstates, other principal arterials, strategic highway network (STRAHNET), major strategic highway network connectors, and intermodal connectors. Examples of these designations as well as a map of Connecticut NHS routes can be found in Appendix 4.

For flexible (asphalt concrete), composite (PCC overlaid with asphalt concrete), and rigid (PCC surface) pavements, the performance metrics shown in Table 2-7 are used to calculate the pavement condition performance measures used for the NHS.

Table 2-7 NHS Performance Measure Metrics for Flexible, Composite and Rigid* Pavements

Performance Metric	**Pavement Type**		
	Flexible	*Composite*	*Rigid**
Ride Quality (International Roughness index-IRI)	Pavement roughness experienced by road users traveling over the pavements computed from a single longitudinal profile.	Same as Flexible	Same as Flexible
Rutting	The depth of ruts (longitudinal surface depression) within and along the wheelpath**).	Same as Flexible	Not Applicable
Cracking	The percentage of cracked pavement surface. The percentage of the total area exhibiting all severities of visible fatigue type cracking, in the wheelpath.**	Same as Flexible	The percentage of slabs in the section that exhibits transverse cracking
Faulting	Not Applicable	Not Applicable	Average vertical misalignment of adjacent slabs

* In Connecticut less than 0.5% of center-line mileage is composed of rigid surface (see Figure 2-6)
** There is a left and a right wheelpath, with each wheelpath being 1 meter wide, and the center of each wheelpath being separated by 70 inches.

For each of the above performance metrics, FHWA has established thresholds for good, fair, and poor condition (see Table 2-8). The performance metrics are used to calculate the FHWA performance measures for pavement condition. Conditions are assessed using these criteria for each 1/10-mile-long pavement section. Unlike the CTDOT maintained network, which is summarized by centerline miles, the NHS condition is summarized and reported by lane-miles, per the requirement of FHWA.

The FHWA performance measures can be transcribed into a good-fair-poor rating as well (Figure 2-13). An individual section is rated as being in good overall condition if all of the metrics for that section are rated as good. An individual section is rated in poor condition when two or more metrics are rated as poor. For all other combinations, the individual sections are rated as fair.

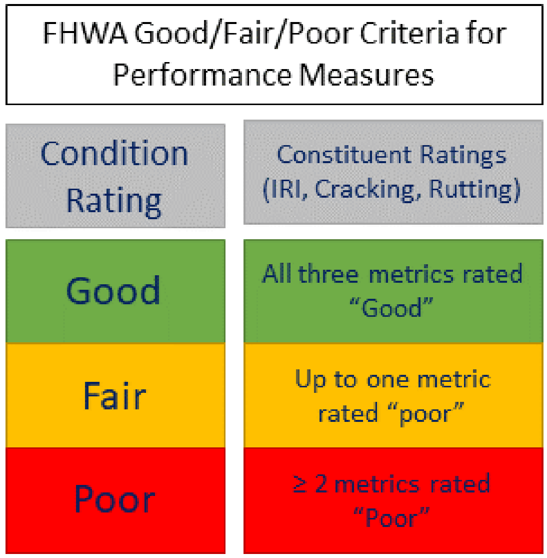


Figure 2-14 FHWA Performance Measure Criteria for Good/Fair/Poor Ratings

Table 2-8 Pavement Condition Thresholds for MAP21 Reporting used on the NHS in Connecticut

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

The lane miles in good, fair, and poor condition are tabulated for all NHS sections to determine the overall percentage of pavement on the NHS in good, fair, and poor condition. Again, all of the methodology for the NHS described above is that prescribed by the FHWA in MAP21.

The resultant overall conditions for the NHS in 2020 are shown in Table 2-9.

Additional detail about the condition of the NHS, broken down into interstate and non-interstate NHS in Connecticut, using the categories delineated by FHWA is given in Figure 2-14. Specifically, CTDOT has adopted the FHWA's pavement condition performance measures for the NHS pavements.

Table 2-9 Overall Connecticut NHS Inventory and Conditions (2020) (Includes State and Town NHS)(FHWA 2020)

	Lane miles	Good	Fair	Poor
NHS Pavement*	5,172	49.55%	43.21%	1.35%

*Note: "Missing, invalid or unsolved lane-miles are excluded from calculations to determine G, F, P percentages. Lane miles on the full extent basis coded as bridges in HPMS are also excluded from the calculations but are included in the total lane-miles.

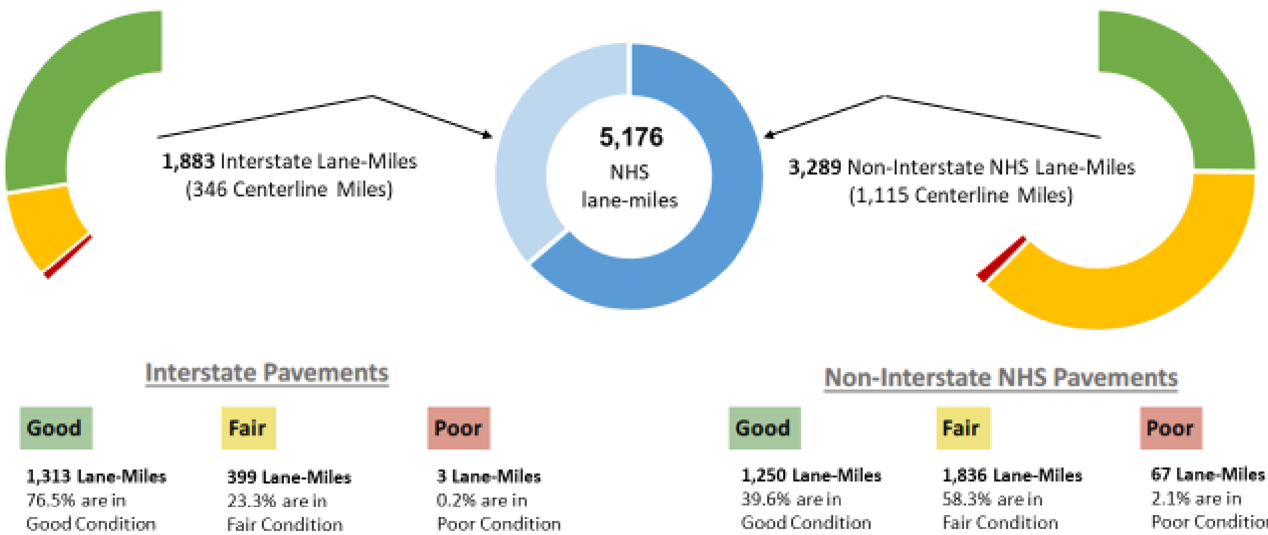


Figure 2-15 Connecticut NHS Pavement Inventory and Conditions as Required for FHWA Reporting (Based on 2020 HPMS pavement condition data submitted to FHWA June 14, 2021)

Historical Presentation of Pavement Performance Measures

Prior to the advent of the TAMP, and even before MAP21 was enacted, CTDOT reported the following two pavement performance measures as representative of the condition of the road network:

- Percent of State Maintained Roads with Acceptable or Better Ride Quality ≤170 in/mi (NHS)
- Percent of State Maintained Roads with Acceptable or Better Ride Quality ≤170 in/mi (Entire Network)

The definition of acceptable or better (≤170 in/mi) is utilized by FHWA for reporting the HPMS ride quality in their Highway Statistics Series reports (USDOT 2017). Since 2009, these along with many other transportation system measures have also been reported at CTDOT's performance measures website at *https://portal.ct.gov/DOT/Performance-Measures/Performance-Measures*.

The above-cited pavement measures are based on ride quality only. Ride quality refers to the pavement's smoothness over a measured section of roadway. If a roadway isn't smooth often it is alternatively referred to as rough; thus, smoothness and roughness are used interchangeably when referring to measured ride quality.

The roadway characteristic known as the International Roughness Index (IRI), which is obtained from longitudinal profile measurements along the two-wheel paths of a travel lane, is used as a measurement for ride quality and is a well-established indicator of current roadway pavement condition as experienced by road users. In Connecticut, this is obtained with the CTDOT ARAN vehicles. The left wheel path and right wheel path IRI values are averaged to determine the IRI metric for the individual roadway segment being considered. The ride quality using IRI is reported as the change of height (inches) per mile of roadway, where a lower measured value indicates a smoother road.

To compute the CTDOT performance measures, the percentage of roadway centerline-miles having an IRI of less than or equal to 170 in/mile is calculated. That percentage represents the Percent of State Maintained Roads with Acceptable or Better Ride Quality.

Figure 2-15 below shows the condition of the CTDOT maintained network and the NHS elements of the network over the past ten years. Based on IRI alone the condition of both networks has improved every year since 2012. Note the PCI is not included in these particular graphs. In addition, the Ride Quality (IRI) values reported in this graphic use a 3-year moving average.

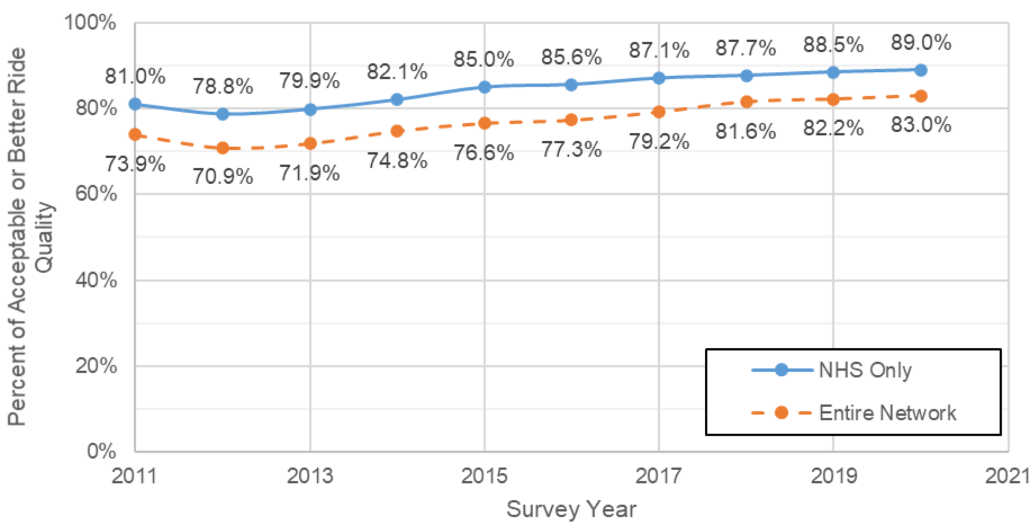


Figure 2-16 Ride Quality (IRI) Using 3-year Moving Average for the NHS Systems, and the Entire CTDOT-maintained Network, for Calendar Years 2011 through 2020.

Performance Projections for the Future

As defined in federal regulation 23 CFR 490.313, the FHWA requires states to include targets (as well as the measures discussed previously) for the condition of NHS pavements reported in the TAMP. Connecticut performance targets have been set to be aligned with both the federal requirements and state goals and objectives **and are based on anticipated funding levels**

projected to be available for transportation. The targets help guide Connecticut in allocating resources to projects and programs, to make progress toward the goals.

Using the measures of condition defined by FHWA, consistent with state asset management objectives, all State DOTs must also specify their desired "state of good repair" for the 10-year analysis period of the TAMP. The desired SOGR must also support progress toward achieving goals.

As part of the federal rule (23 CFR Part 490), states must set two and four-year asset condition performance targets. These targets must be included in the TAMP, as well as be reported separately to FHWA. States are also required to maintain NHS pavements to meet federally-established minimum condition levels. **The federal minimum condition level for pavements is to ensure that no more than five percent of pavement lane miles on the Interstate system are in poor condition**. Finally, for the TAMP the FHWA also requires that states establish a performance gap analysis process.

Federal Minimum Condition Level for Interstate System Highway Pavements
Maximum of 5% of pavement lane-miles in poor condition

Figure 2-17 Federal Minimum Condition Level for Interstate Pavements

Two and Four-Year Performance Targets

Anticipated two- and four-year performance targets for CTDOT-maintained roads are shown in Table 2-10. This table shows the percentage of road mileage projected to be in a SOGR in the target year. Two- and four-year performance targets for Connecticut's designated NHS pavements are shown in Table 2-11. **Note that these target values are not necessarily desirable target values but instead are predictions of what is likely to occur based on projected funding (assuming no changes in funding over the projection period).**

Table 2-10 Performance Projections for CTDOT-Maintained Roads (Percent of Centerline Miles Projected to be in SOGR)

CTDOT Maintained Roads	**State of Good Repair**	
	2-Year Projection (2022 Data)	**4-Year Projection (2024 Data)**
Pavement (Centerline Miles)	72.0%	67.3%

Table 2-11 Performance Targets for Connecticut NHS (Percent of Lane-miles Projected to be in Good and Poor Condition)

	2-Year Targets (EoY 2023)		4-Year Targets (EoY 2025)	
	Good	Poor	Good	Poor
Interstate Pavements	72.0%	1.0%	70%	1.3%
Non-Interstate NHS Pavements	37.0%	2.7%	35%	3.5%

NOTE: Performance targets were also submitted to FHWA by CTDOT via a report called "Transportation Performance Management - State Biennial Performance Report for Performance Period 2018-2021- 2020-MID PERFORMANCE PERIOD (MPP) PROGRESS REPORT." (CTDOT 2020b)

Ten Year Performance Goals

The ten-year Performance Goal for SOGR on CTDOT-maintained roads is presented in Table 2-12. The 10-year performance goals, based on national measures for NHS, are presented in Table 2-13. Table 2-13 shows the desired percentage of NHS in good and poor condition. The values shown in the table were determined based on a review of a set of performance projections performed at varying funding levels. The values reflect federal requirements and state goals and, if achieved, will satisfy the minimum NHS condition levels defined by FHWA. CTDOT recognizes adjustments to these long-term goals (for both NHS and the CTDOT network) will be needed over time as the asset management process matures and funding strategies change with future needs.

Table 2-12 10-Year Performance Goal, SOGR, CTDOT-maintained Roads

	SOGR
Pavement (Centerline Miles)	*80.0%*

Table 2-13 10-Year Federal PM Goals, Good and Poor, NHS Pavements

	Good	*Poor*
Interstate Pavement (lane miles)	*75.0%*	*<5.0%*
Non-Interstate NHS Pavement (lane miles)	*50.0%*	*<8.0%*

3. RECAP OF ANNUAL EFFORTS (2021)

Valuation of Total Pavement Assets

FHWA requires state DOTs to include an estimate of asset value for NHS pavements. The financial plan 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 State DOTs to select their methodology. CTDOT chose to take a replacement value approach to calculate asset valuation. The asset valuation uses the asset inventory unit multiplied by the unit replacement cost and the non-asset related project cost factor that results in the replacement value. The replacement value is equal to the asset valuation for the asset. Unfortunately, this method of asset valuation does not reflect changes in asset condition. CTDOT is using this asset valuation data strictly as a means to fulfill federal requirements and communicate the importance of investment relative to the magnitude of the value of the assets. It is anticipated that non-asset related cost factors will be refined for future TAMP updates to account for costs related to design, rights of way, project administration, utilities, maintenance, protection of traffic, etc.

As shown in Table 3-1, the total replacement value for Connecticut's NHS roads (interstate and non-interstate) and for the CTDOT maintained roads that are not NHS, i.e., estimated value for the 3,719 centerline miles of CTDOT-maintained pavement, is $10,838,143,000. (CTDOT 2020a)

Table 3-1 Pavement Asset Valuation Estimates* (CTDOT 2020a)

Pavement Asset	Inventory Unit (Square Yards)	Asset Valuation Replacement Cost
CTDOT Maintained Pavement (includes NHS)	~99,100,000	$10,838,143,000

** NOTES: The unit replacement cost used in the calculation is $109/sy, and the non-asset related cost factor used is 1.0.*

<u>Pavement Treatments Specified by CTDOT</u>

Generally speaking, the pavement program categories used in Connecticut are:

- Maintenance – Efforts such as crack sealing and pothole patching, tasks which are undertaken by the district maintainers and not considered project-based.
- **Preservation** -- Keeping good roads good -- "apply the right treatment on the right road at the right time". To be effective, preservation treatments should be applied to roads in good condition without serious structural deficiencies.
- **Rehabilitation** - restores pavements, in poor or fair condition, that have significant structural deficiencies through actions such as structural overlays, reclamation, and deep mill and inlay operations.
- **Reconstruction** - removes the entire existing pavement structure to subgrade and replaces it with new materials.
- **New Construction** – New alignment or new full design of non-existing road
- **Other** Specialized Treatments or activities -- for less common situations encountered, or for unique projects special treatments or combinations of treatments are developed, such as rubblization, full-depth reclamation, diamond grinding, and others

As there are multiple sources of funds for any given pavement treatment type, neither the pavement program listed above nor the sources of funding can be used to directly define pavement treatments deployed in the state. Sources of funds are discussed later in this report.

Table 3-2 contains a list of pavement treatments by program category that have been prescribed by CTDOT for DOT projects. There is, however, overlap between some treatments for certain categories and the color scale is intended to indicate the level of effort, cost, and magnitude of repair for the given treatments. For example, specialized treatments can be used for preservation, rehabilitation, or reconstruction, and overlays could be employed for preservation or reconstruction depending upon the complexity of a specific project. There are several other treatments, such as slurry seals, fog seals, crack and seat, whitetopping, cold in-place recycling that are not specified routinely in CTDOT, and, therefore, are not included in Table 3-2. These other treatments, however, are considered and evaluated individually for possible implementation in Connecticut, typically via research studies.

Table 3-2 Connecticut Typical Pavement Treatments by Program Category

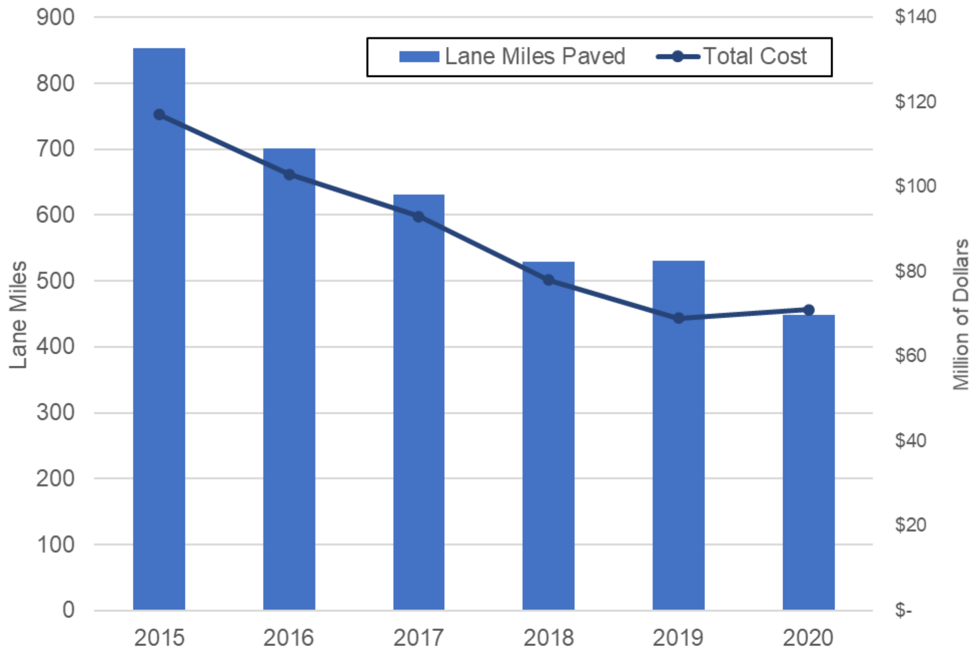
Program	***Treatment***
Maintenance	Pothole Patching
	Emergency Overlays and Repairs
	Crack Seal
Preservation	Crack Seal or Crack Fill
	Asphalt Rubber Chip Seal
	Ultra-Thin Bonded Overlay
	Mill and Fill
	Microsurfacing
Rehabilitation	Structural Overlay
	Functional Overlay
	Structural + Joint Repairs
Reconstruction	Light, Medium, Heavy (Flexible)
	Light, Medium, Heavy (Composite)
	Widening
New Construction	New Construction
Other Special	Rubblization
	Diamond Grinding
	Full Depth Reclamation
	In-Place Recycling

Maintenance Resurfacing Paving Program

A substantial number of CTDOT miles of paving is accomplished each year under a paving program called the Maintenance Resurfacing Program which was initiated approximately 40 years ago. These projects are primarily state-funded using state bond financing. Although this has traditionally been an annual paving program developed approximately 18 months before the actual paving, PMU is currently developing multi-year programs, which involve pavement preservation projects as well (see also next section),and allow for better and more efficient planning and programming by utilizing models that include Cost-Benefit Analysis.

The original premise behind the Maintenance Resurfacing program, when it was established around 1981, was to overlay 10 percent (approximately 350 centerline miles) of the state-maintained road network each year. The actual miles paved has varied over the years based on fluctuations in available funding and CTDOT resources for planning and oversite of the program.

The paving generally occurs between April 1st and November 30th, each year. This paving program was traditionally developed and overseen entirely in the CTDOT Office of Maintenance. Figure 3-1 below shows the total historical lane miles paved under this program.



Annual Construction costs are based on agency-established average costs per 2-lane mile of Maintenance and Resurfacing Program work. These values exclude associated work outside the scope of milling and paving.

Figure 3-1 Historical Maintenance & Resurfacing Paving Annual Total Lane Miles

For calendar year 2021, paving was planned for approximately 495 lane miles on 79 state roads. During the previous calendar year (2020) approximately 492 lane miles were resurfaced. Generally, the pavement overlay is placed at 1.5 to 3 inches thick, including in some cases a leveling course followed by the surface layer. The amount budgeted for these 492 lane miles in 2020 was approx. $69 million. A summary of the 2021 Resurfacing program is contained below in Table 3-3. The complete list of route segments planned to be paved during 2021 can be found in Appendix 2.

Table 3-3 Summary of Planned Maintenance Resurfacing Paving Program[1] (2021)

Treatment Type	Location	Number of state roads	Lane Miles	Approx. Material Quantities (tons)**	Approx. Cost ($million)***
Overlay	District 1	21	113.34	204,200	17.3
Overlay	District 2	19	130.00	234,400	19.8
Overlay	District 3	16	109.58	197,400	16.7
Overlay	District 4	23	142.36	256,700	21.7
Grand Total		**79**	**495.28**	**892,700**	**75.5**

Notes: [1] This Table is based on the CTDOT Final Resurfacing Program mileages, quantities and cost are estimated
* Mileage excludes ramps
** An estimated average cost of $80/ton is used to calculate approx. quantities. However, before calculating the quantities the approximate cost was reduced by 30% to exclude safety improvement costs that are not directly related to paving.
***These are estimated using the department-established $305,000 per 2-lane mile cost.

CTDOT Pavement Preservation Program

As noted earlier, pavement preservation is the preferred surface treatment program, in that every mile of road that is preserved defers the higher cost of rehabilitation. Additionally, using network preservation techniques, it is easier to keep the condition of the roads in an SOGR and lower the highway user costs with smoother pavements. CTDOT has begun to prioritize and implement preservation projects utilizing a 3-year condition/funding projection. Three types of preservation treatments have been employed to date; asphalt-rubber chip seals, ultra-thin bonded overlays, and mill and fill (overlay). The 2021 Pavement Preservation Program (PPP) included two ultra-thin bonded overlay projects valued at approximately $31.58 million: 85 lane-miles on I-84 in Willington, Ashford, and Union, and 75 lane-miles Routes 2, 95, and 395 in Lebanon, Bozrah, Norwich, Groton, and Montville. In addition to being low-cost preservation treatments that will extend the overall life of the pavement, the ultra-thin overlay will also increase skid resistance and decrease stormwater spray at the tire-pavement interface compared to traditional overlays. The 2020 PPP also included three Asphalt Rubberized Chip Seal (ARCS) projects valued at approximately $5.7 million: 16.8 lane-miles in Griswold, Voluntown, and Woodstock in CTDOT District 2, 6.3 lane-miles in Fairfield and Easton in CTDOT District 3, and 27.2 lane-miles in Roxbury, Washington, Torrington and Goshen in CTDOT District 4. These cost-effective surface treatments are expected to last approximately ten years before these roadways need to be treated or resurfaced, which improves the overall life-cycle performance of the pavements. Like the ultra-thin treatments, the ARCS treatments will also improve the skid resistance of pavements. Historic preservation construction quantities are show in Figure 3-2 below.

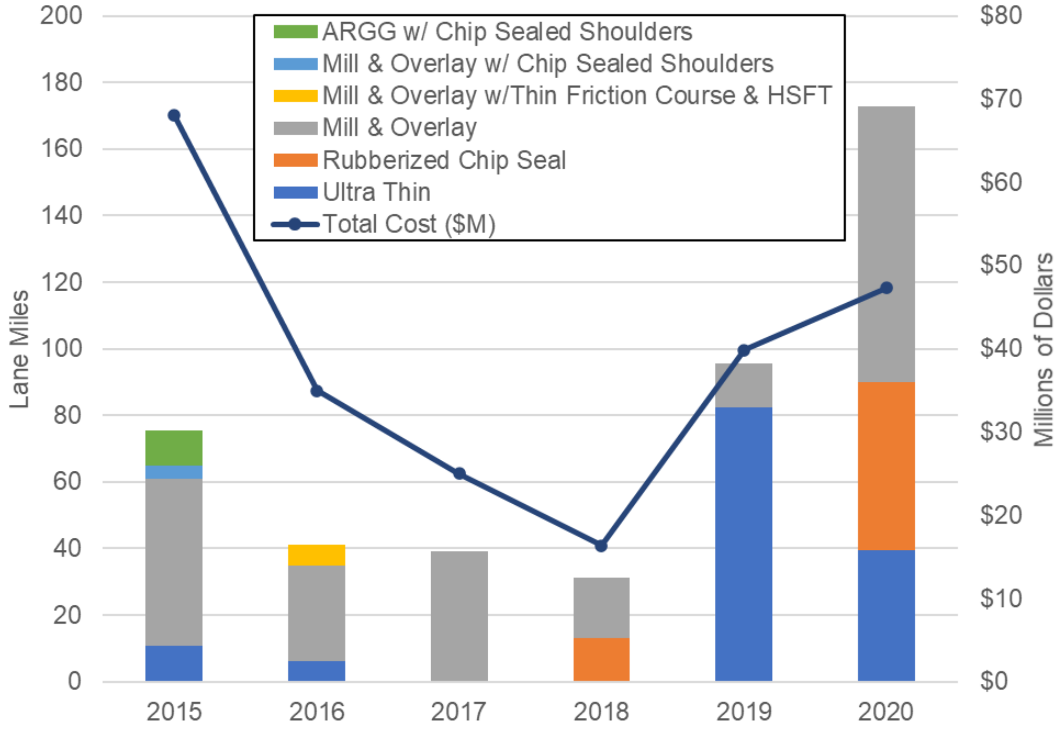


Figure 3-2 Historic Preservation Annual Paving Annual Total Lane Miles

Table 3-4 below contains a list of the locations where pavement preservation was planned to be utilized during 2021. A complete list of preservation projects for the year 2021 can be found in Appendix 3.

Table 3-4 Summary of Planned Pavement Preservation Program (2021)

Treatment Type*	Location	Number of state roads	Centerline Miles	Lane-Miles**	Material Quantities	Approx. Cost ($million)
UTBO	District 1 RTE 84 Project 0160-0153	1	23.80	85.23	707,300 SY of UTBO[1]	7.86[1]
	District 2 RTES 2, 95, 395 Project 0172-0500	3	28.72	74.73	683,870 SY of UTBO[2]	12.475[2]
ARCS	District 2 RTES 165,198 Project 0172-0499	2	8.42	16.84	153,370 SY of ARCS[3]	1.599[3]
	District 3 RTE 58 Project 0174-0441	1	3.15	6.30	226,233 SY Of ARCS[4]	2.65[4]
GRAND TOTAL		7	64.1	183.1	1,770,773	24.58

*Notes:*UTBO=Utra-thin bonded Polymer Modified Asphalt (PMA)overlay*
ARCS=Asphalt-rubber chip seal

1. *From low bid https://portal.ct.gov/-/media/DOT/documents/dcontracts/0000-2021-Bid-Tabs/0160-0153.pdf*
2. *From low bid https://portal.ct.gov/-/media/DOT/documents/dcontracts/0000-2021-Bid-Tabs/0172-0500.pdf*
3. *From low bid https://portal.ct.gov/-/media/DOT/documents/dcontracts/0000-2021-Bid-Tabs/0172-0499.pdf*
4. *From low bid https://portal.ct.gov/-/media/DOT/documents/dcontracts/0000-2021-Bid-Tabs/0174-0441.pdf*
5. *From preliminary quantities and estimates by Pavement Design*

Budget and Funding Sources (2017-2020)

Transportation funding in Connecticut comes primarily from federal and state gas tax revenues. The federal gas tax is the main revenue stream for federal highway programs through the Highway Trust Fund. In recent years the Highway Trust Fund has been supported with transfers from the General Fund. Connecticut's state gas tax revenue, gross receipts tax on petroleum products, a portion of the new car sales tax revenue, and other fees are directed to a transportation-related state account, the Special Transportation Fund (STF), which is used to fund a wide variety of transportation programs. This includes asset management activities through the Fix-it-First legislative authorization, among others. Connecticut sells bonds to finance transportation projects and pays the debt service using revenue from the STF.

Funding for roadway maintenance and improvements in Connecticut comes from three programs: The STF (described above), a second program that specifically gives priority to roadways in poor condition, and a third program that funds projects by addressing maintenance and preservation needs, as well as system expansion.

Historically, approximately 58% of the Maintenance Resurfacing pavement projects took place on the NHS. (CTDOT 2018a) The basis for this assumption is that of the Maintenance Resurfacing pavement projects that took place from 2011 to 2015. It is projected that 85% of pavement preservation projects will take place on the NHS in near-term projections. The basis for this assumption is as follows: From 2009 to 2015 about 96% of pavement preservation projects took place on the NHS. However short-term preservation program projects are expected to include additional treatments on non-NHS segments.

Applying 58% to CTDOT's expected $69M in Maintenance Resurfacing funding and 85% to $40M in preservation funding yields a result of $61M future annual spending on NHS pavements. An additional $33M is projected to be available for non-NHS state roads each year. These figures are shown in Table 3-5, with all values reported based on 2019 dollars. Due to a continued focus on the pavement preservation program, the mix of preservation and maintenance resurfacing is projected to vary over the next 10 years as shown in more detail in Table 3-5, "Funding Uses", adapted from the CTDOT Pavement Fact Sheet dated May, 2020. Even with the variations indicated, the totals (maintenance and preservation) range between $119M and $152M each year, an increase from previous spending forecasts.

Table 3-5 Funding Uses

	2019	***2020***	***2021***	***2022***	***2023***	***2024***	***2025***	***2026***	***2027***	***2028***
Treatment	*Actual*		*Planned*				*Estimated*			
Initial Construction	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Maintenance Resurfacing	$ 69.0	$ 71.4	$ 56	$ 99	$ 96	$ 96	$ 97	$ 97	$ 97	$ 97
Preservation	$ 39.8	$ 50.0	$ 38	$ 50	$ 50	$ 50	$ 55	$ 55	$ 55	$ 55
Rehabilitation*	$ 25	$ 25	$ 25	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Reconstruction (Replacement)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	$ 134	$ 146	$ 119	$ 149	$ 146	$ 146	$ 152	$ 152	$ 152	$ 152
Project work recommended outside of the pavements analysis	*$ 83*	*$ 37*	*$ 110*	*$ 24*	*$ 31*	*$ 42*	*$ 48*	*$ 60*	*n/a*	*n/a*

**Estimates based on projects with multi-disciplinary work items, cost multipliers, and incidental [temporary] pavement quantities make the actual investment to the network difficult to quantify.*

Life-Cycle Planning

Life cycle planning (LCP) strategies for pavement are developed using predictive models for how pavements will deteriorate if no treatments are performed, as well as how they deteriorate under different treatment strategies. A treatment strategy is a sequence of maintenance, preservation, and rehabilitation events selected over the analysis period (which is adjustable but can be as long as 30 years) based on inputs like funding constraints and priorities, as well as indicated distresses and pavement section work history. CTDOT creates models for pavement condition and deterioration using the Deighton dTIMS PMS. As noted earlier in this report, dTIMS is CTDOT's primary tool for storing, managing, analyzing, and reporting pavement condition information. The dTIMS model predicts future pavement conditions 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.

CTDOT uses dTIMS as a primary component of its LCP strategy for pavements and to perform network condition projections. After planned pavement rehabilitation projects are committed, analyses/budget scenarios are run so dTIMS can select preservation treatments with a projected budget for preservation over 10 years. This allows for the comparison of the outcomes achieved with actual programming practice versus the outcomes possible with a strategy that optimizes life-cycle cost.

Performance Projections Based on Various Funding Levels

In what is called a scenario analysis, dTIMS is used to examine what treatments each pavement segment is eligible to receive for each year in the future and develops possible strategies for each road segment over the scenario time horizon. These strategies are driven by the performance curves and the amount of improvement assigned to each treatment. Each strategy calculates an incremental benefit/cost value that represents the maximum benefit-to-cost ratio. dTIMS then compares across strategies to select an optimal set of treatments based on benefit/cost. Benefits are normalized using annual average daily traffic volumes (AADT), recognizing that, in this way, benefits will accrue to a larger number of users. As indicated earlier in Table 2-12 and Table 2-11, network condition projections using a stagnant total annual funding level of $119 million for pavement projects in CTDOT are anticipated to lead to declining conditions in the future. In fact, if the present level of funding is maintained and not increased, it can be expected to lead to a decline of both the SOGR rating for the CTDOT-maintained network and the percent of good roads for the NHS according to the dTIMS/ CTDOT PCI Rating System. This will also result in an increase of roads in poor condition, which will cause the overall network condition to approach the NHS threshold shown in Figure 2-16. This is indicated in the four-year target projections (see Table 2-10 and Table 2-11).

For the May 2020 CTDOT Pavement Asset Facts Sheet, a 10-year projection using three levels of funding was calculated to illustrate the long term sensitivity of the network condition to varying funding levels between zero and an elevated 'preferred' level. This is reproduced below as Figure 3-1, for the entire CTDOT maintained network. The three scenarios presented are

- zero funding,

- current funding ($119 million/year) and
- preferred funding ($375 million/year) as determined with the PCI system (see section 2 of this report).

Note that in Figure 3-1 the preferred funding ($375M) includes reconstruction, whereas the current funding ($130M based on the 2019 consistency review) only includes maintenance, preservation and rehabilitation.

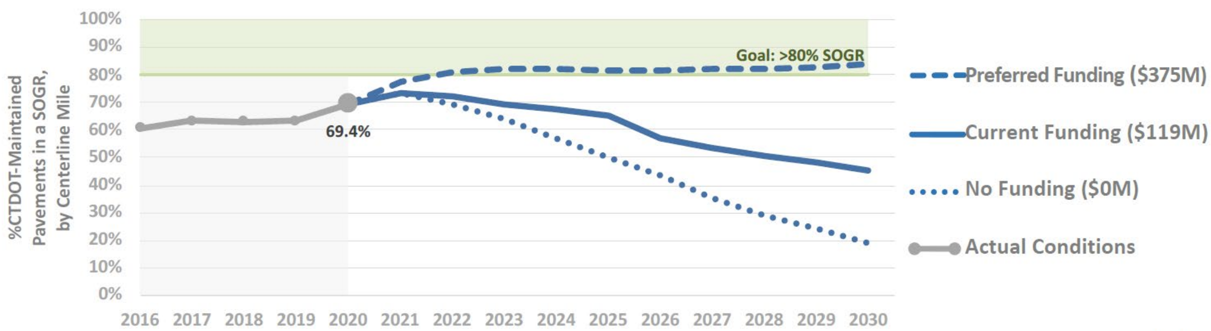


Figure 3-3 Connecticut Pavement Performance Projections for the CTDOT Maintained Network (from May, 2020 CTDOT Asset Fact Sheet)

Table 3-6 CTDOT Maintained Network Performance Projections at Current Funding Level ($119M Budget)

Year	**2021**	**2022**	**2023**	**2024**	**2025**	**Goal**
SOGR	**73.5%**	**72.0%**	**69.5%**	**67.3%**	**65.0**	**80.0%**

Table 3-7 NHS Performance Projections at Current Funding Level ($119M Budget)

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%**

In the zero funding, it can be seen that the network condition will decline rapidly but at a steady rate. Even under the 'current' funding level, the network is predicted to decline significantly over the next ten years reaching a SOGR of 30% by 2029, well below the SOGR goal of 80%. Again using 2019 data, the level of funding required to reach the ten-year target for SOGR at 80% has been estimated at $375 million/year (total of reconstruction, maintenance, and preservation).

4. OTHER DOT PAVEMENT-RELATED ACTIVITIES

Strategies to improve MAP-21 pavement performance metrics (crack percent, smoothness, and rutting) continue to be employed. These strategies include the use of polymer modified asphalt (PMA); deployment of pre-treatment repairs such as surface patching and crack filling of existing pavement before paving; the application of thin preservation treatments (ultra-thin overlays and rubberized chip seals) and for selected pavement sections, and incorporation of specifications for improved pavement smoothness and uniformity. The continued specified use of material transfer vehicles (MTVs) during paving operations and a requirement for contractors to obtain pavement cores for the determination of asphalt concrete pavement density have resulted in more pavements that are smooth, dense, and uniform. Undoubtedly, the above specification improvements, which were developed over years of collaboration with industry, are bearing positive outcomes.

New Technology

As noted previously, Connecticut has a demonstrated history of being a leader in adoption and use of automated technology for road inventory and analysis, i.e., products that eventually led the CTDOT to purchase and use ARANs for network data collection. CTDOT has been collecting network-level roadway images and data since the early 1970s. Through current research initiatives with the Pavement Design Unit and the CAP Lab, CT DOT has been piloting the use of traffic-speed Ground Penetrating RADAR to conduct pre-project forensic investigations.

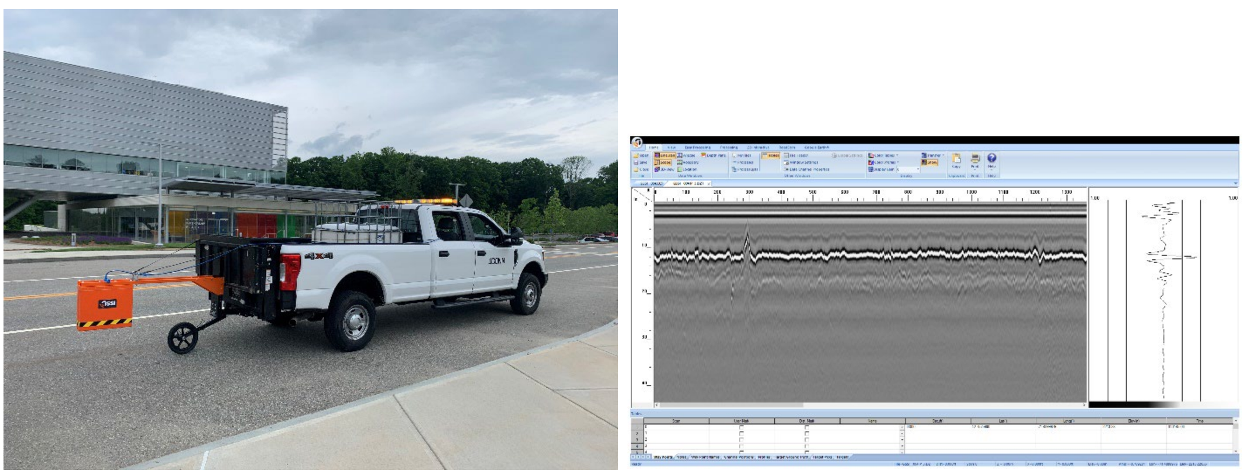


Figure 4-1 CAP Lab vehicle with the 2.0 GHz Air-Launched RADAR (left), Software output showing radio signal of GPR data (right)Research Initiatives in Pavement Management, Maintenance, and Preservation

Implementation of a new Pavement Management Framework

The Pavement Management Group with support from the CAP Lab is undertaking the implementation of a new framework within the state's pavement management system. The use of a new rating system and distress-based triggers within the dTIMS™ software package will enable more responsive condition forecasting and treatment selection as well as simplification of the computer models to ensure flexibility far into the future.

<u>*Preparatory Analysis in Advance of Balanced Mix Design Implementation*</u>

The pavement materials community has long searched for viable mixture performance tests that are simple to run and have meaningful correlation with field performance. To this end, a national effort has been underway to implement modern performance tests into state specifications as a means of modernizing Quality Assurance specifications to what is being referred to as "Balanced Mix Design," or BMD. In its purest form, BMD would have less material characteristics in a contract specification and instead, would require pavement designs to meet a certain threshold for a set of mixture performance tests.

A long-term CTDOT study at the CAP Lab has been sampling and testing asphalt pavement mixes placed across the state since 2016 with these modern mixture performance tests. Now that several years of in-service loading has occurred on the oldest pavements in the study, researchers are beginning to link field performance and laboratory performance in order to identify desirable traits to target in a new iteration of pavement specifications to be implemented in our state in the next 3 to 5 years.

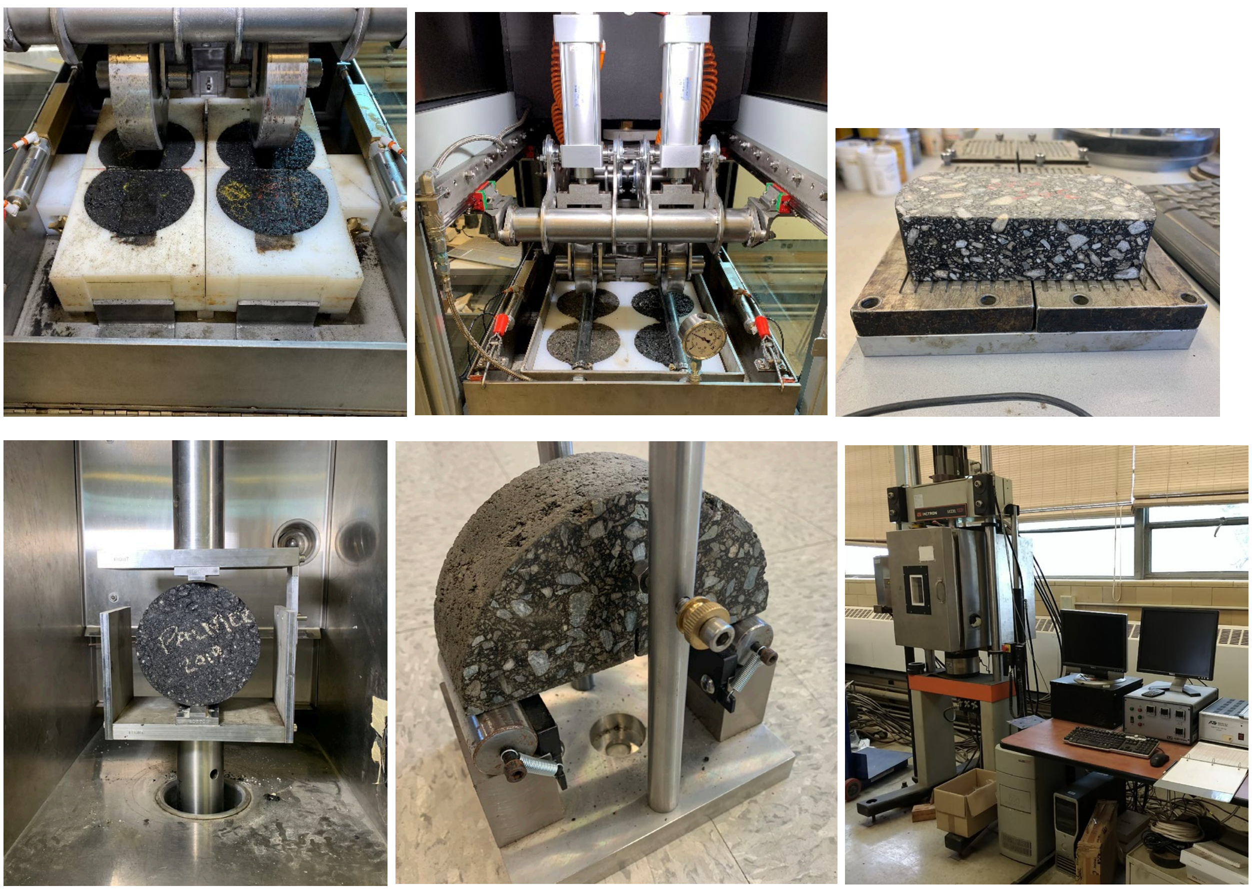


Figure 4-2 Mixture Performance Testing conducted at the CAP Lab in preparation for Balanced Mix Design Implementation. Clock-wise from the top-left corner: Hamburg Wheel Tracker (AASHTO T324), Asphalt Pavement Analzyer (AASTO T340), Texas Overlay Test, 100 Kn Instron 1331 Load Frame with FastTrack 8800 Data Acquistion System, SCB-FIT Test (AASHTO TP-124), IDEAL CT Cracking Test (ASTM D8225)

<u>*Implementation of a GIS Database for Forensic Coring in the Transportation Enterprise Database (TED)*</u>

This year, CT DOT worked with the CAP Lab to develop a GIS layer for pavement core data across the state. As forensic cores are taken prior to project design for preservation (PPP) or reconstruction (RBC), a team of researchers from the CAP Lab collects full-depth cores across the length of the proposed project. Each core is now catalogued in the CT DOT Enterprise GIS system with photos and other pertinent meta data while being tied directly to the Linear Referencing System (LRS). The goal of this new implementation is to minimize coring in the future and for the core data to serve a wider audience within the DOT.

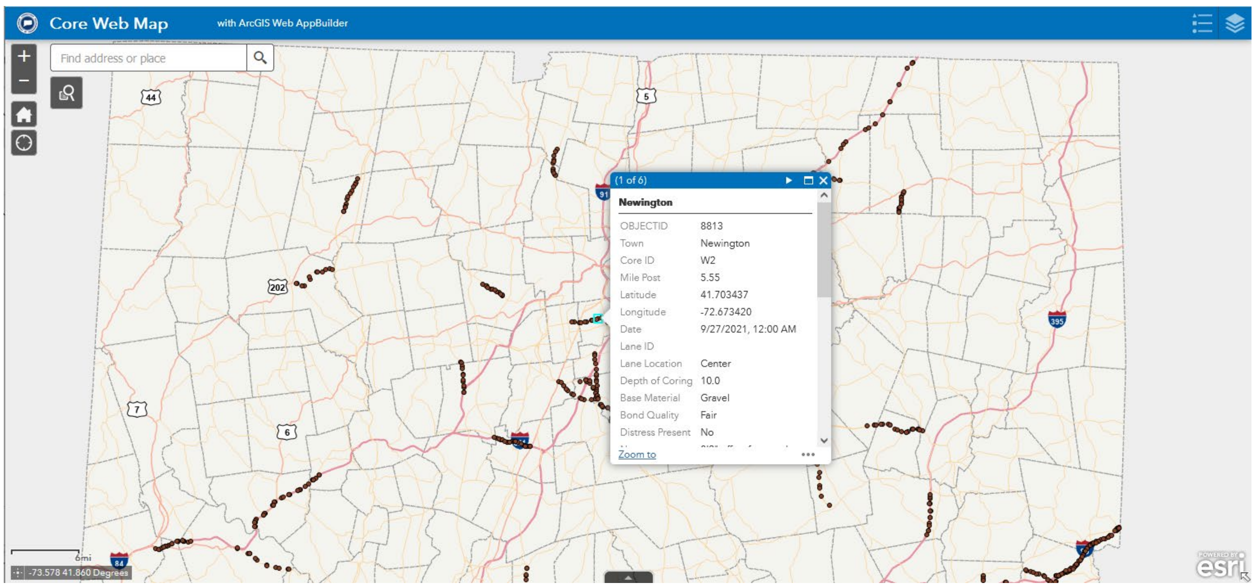


Figure 4-3 Core Database for State-wide Forensic Pavement Coring in the TED/GIS Interface

<u>*Sustainability*</u>

The first-annual report identified Warm Mix Asphalt Modification, Recycling, Reclaimed Asphalt Pavement, Reclaimed Asphalt Shingles and Polymer Modification as materials and methodologies which improve the sustainability of pavements across Connecticut either with longer-lasting materials or diversions of materials that would otherwise be a waste product. In fact, any action taken to improve the *in-situ* performance of pavement can be attributed to improve its sustainability. To that end, the CTDOT/CAP Lab effort to update and enhance the modeling methods for pavement management to optimize project selection and improve the overall performance of the network while extending the service life of pavements where appropriate continues to contribute to the sustainability of the State’s roadway network.

5. SUMMARY AND CONCLUSIONS

Keeping pavements smooth, and in good condition, lengthens their life, enhances safety, helps reduce road users' operating costs, and reduces vehicle emissions. Through its various rehabilitation and resurfacing programs, CTDOT strives to extend the useful life of pavements. In particular, the increased use of pavement preservation treatments, state-of-the-art condition surveys, and forecasting employing deterioration modeling supports the concept of maintaining a State of Good Repair (SOGR).

CTDOT has over forty-five years of experience using photolog survey technology. Many other state DOTs have traditionally looked to Connecticut as a leader in this field. Implementation of photolog technology and adoption of state-of-the-art upgrades makes this technology a critically important and prominent tool for CTDOT. These data inform CTDOT's condition indices that are currently under development at the Connecticut Transportation Institute within UConn's School of Engineering. In addition, CTDOT as a whole is moving towards an enterprise data approach for asset management (including pavements) in order to make the best use of agency data for informed decision-making.

Although Connecticut is geographically a small state, the high traffic levels, as well as a relatively severe climate, hasten the wear and tear on Connecticut's roadways. Therefore, keeping roads in SOGR requires a significant level of resources.

During 2021, CTDOT programmed the paving of 705.6 lane miles of roadway through its Pavement Maintenance Resurfacing and Pavement Preservation programs (Table 3-3 and Table 3-4). The two programs addressed 495.3 and 210.3 lane miles of pavement, respectively, to keep them in a SOGR. The costs for pavement placement and peripheral related activities were approximately $146 million, which also includes safety improvements in some cases for the maintenance resurfacing program.

According to the American Society of Civil Engineers (ASCE) in their 2021 Infrastructure Report Card publication, the United States has underfunded its highway system for many years, resulting in a $435 billion backlog for repairing existing highways. (ASCE 2021). ASCE further estimates states that the funding gap required to rehabilitate pavement and make other operational condition improvements in the U.S. will average $53 billion annually over the next 20 years and spending on highways must increase 29 percent over current spending levels to address the current backlog and anticipated future backlogs." (ASCE 2021)

For Connecticut to be able to reach and maintain pavement conditions that meet the ten-year goals noted above, CTDOT would need to expend, according to current computer modeling, an estimated $3.75 billion on pavements between 2020 and 2030. At the current projected level of spending for pavements, which is anticipated to be in the area of $1.2 billion over the next ten years, models suggest that the condition of Connecticut's pavements will actually decline over this period. Although this problem is not unique to Connecticut, as most states have less than the required resources to maintain a SOGR, it is a critical shortcoming that is predicted to become more apparent in future years.

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APPENDIX 1. ACRONYMS/DEFINITIONS/GLOSSARY

AADT – (Annual Average Daily Traffic) - The total yearly traffic volume on a given highway segment divided by the number of days in a year. AADT is expressed in vehicles per day, and in limited cases is measured directly, but for many roads is estimated from a traffic samples collected over a 24 to 48 hour time period.

ARAN – (Automatic Road Analyzer) – Vendor-built data collection vehicle used in Connecticut and several other states to collect roadway condition data at highway speeds.

Centerline (Road or Route) Mile – A mile of highway, without considering the number of lanes in the facility.

Cracking – A fissure or discontinuity of the pavement surface not necessarily extending through the entire thickness of the pavement. CTDOTs method of identifying and extracting flexible pavement cracking data is from AASHTO **PP67-16 "**Standard Practice for Quantifying Cracks in Asphalt Pavement Surfaces from Collected Pavement Images Utilizing Automated Methods," and AASHTO **R55-10** "Standard Practice for Quantifying Cracks in Asphalt Pavement Surfaces," 2013 2017. On flexible pavements, fatigue-type cracking is identified and used for performance measurement on the NHS. However, cracking on rigid pavements is reported as the percentage of slabs within the section that exhibit transverse cracking.

dTIMS CT® – Proprietary customizable asset management software used by many States. dTIMS-CT was purchased by CDOT for the purpose of calculating benefit/cost analyses used to recommend projects. dTIMS provides assistance in making funding decisions by finding the optimal set of strategies to apply to a network under a given set of constraints such as costs. dTIMS also provides a mechanism for analyzing a variety of maintenance, rehabilitation, and reconstruction treatments over a period of time and assists in the selection of the most cost-effective treatments for a range of budget scenarios.

Faulting – A difference in elevation across a joint or crack in slabs of PCC pavement. Usually the approach slab is higher than the leave slab causing a drop off of the departure end of one slab onto the leading edge of the next slab. Faulting adversely affects the ride quality (smoothness) of the surface of pavements.

FAST Act– (Fixing Americas Surface Transportation). a federal funding and authorization bill from 2015 to govern United States federal surface transportation spending.

Flexible Pavement – Pavement constructed with asphalt concrete, also known as 'bituminous,' 'flexible' HMA, or 'black' pavement.

Functional Classification – the process by which streets and highways are grouped into systems according to the character of traffic service that they are intended to provide. Each roadway is classified in two ways. First by whether it is 'urban' or 'rural.' Then into one of three groups according to its function within the network. The three groups as defined by the FHWA are: arterial, collector, and local.

FY State – (State Fiscal Year) – Administrative year used in Connecticut government covering period of July 1 through June 30.

FY Federal– (Federal Fiscal Year) - Administrative year used in federal government covering period of October 1 through September 30.

HMA – (Hot Mix Asphalt) - A combination of stone, sand, or gravel bound together by asphalt cement, also called 'bituminous,' 'flexible' or 'black' pavement.

HPMS – (Highway Performance Monitoring System) - According to FHWA, the HPMS is a national level highway information system that includes data on the extent, condition, performance, use and operating characteristics of the nation's highways.

IRI – (International Roughness Index) - A standardized method of measuring the roughness of the pavement surface developed by the World Bank and expressed in inches per mile or centimeters per kilometer. It can also be termed a measure of highway smoothness. The lower the number, the smoother the road surface.

Lane Mile – A pavement measuring one mile long and one lane wide is an example of a lane mile. Other examples: a one mile stretch of a two-lane road equals two lane miles; a ten mile section composed of four lanes is measured as forty lane miles.

MAP21 – (Moving Ahead for Progress in the 21st Century Act) a federal funding and authorization bill from 2012 to govern United States federal surface transportation spending.

NHS (National Highway System) – includes the Interstate Highway System as well as other roads important to the nation's economy, defense, and mobility. The NHS routes in Connecticut were designated by the US Department of Transportation in cooperation with CTDOT, local officials, and metropolitan planning organizations.

Pavement Preservation – the FHWA defines pavement preservation as work that is planned and performed to improve or sustain the condition of the transportation facility in a state of good repair. Preservation activities generally do not add capacity or structural value, but do restore the transportation facility's overall condition.

Pavement Rehabilitation – Measures to improve, strengthen or salvage existing deficient pavements which allow service to continue with only routine maintenance. Deficient pavements exhibit distress in excess of what can be handled through routine maintenance or preservation. Rehabilitation extends the life by 10 or more years.

PCC (Portland Cement Concrete) – Pavement constructed with PCC, also known as 'concrete' or 'rigid' pavement.

PCI – (Pavement Condition Index) An index developed specifically within and for CTDOT. The CTDOT PCI is composed of five weighted metrics: IRI (10%), Rutting (15%), Cracking (25%), Disintegration (30%), Drainage (20%). Note: this index is <u>not</u> equivalent to the PCI developed by the US Army Corps of Engineers, which is now ASTM D6433-11: “Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys.”

Performance Curves – A performance curve is a deterioration model based on data collected over a period of time. Performance curves can be used to estimate future conditions and the time period to reach certain threshold values.

PMS – (Pavement Management System) -- AASHTO defines pavement management as “the effective and efficient directing of the various activities involved in providing and sustaining pavements in a condition acceptable to the traveling public at the least life cycle cost” [18] The FHWA defines pavement management systems as providing an ability to: Identify and prioritize maintenance and rehabilitation needs; evaluate the cost effectiveness of various strategies; and recommend projects and treatments under various budget scenarios.

Preventative Maintenance – According to the definition of the AASHTO Standing Committee on Highways in 1997, it is “a planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system (without significantly increasing the structural capacity).”

Rigid pavement – Pavement constructed with Portland Cement Concrete (PCC), also known as ‘concrete’ or ‘PCC’ pavement.

Rutting – A longitudinal depression in the wheel path caused by the consolidation or lateral movement of either roadbed or surface material under heavy loads. The two types of rutting are mix rutting and subgrade rutting. Mix rutting occurs when the pavement surface exhibits wheelpath depressions as a result of compaction/mix design problems. Subgrade rutting occurs when the roadbed exhibits wheelpath depressions due to loading.

SOGR (SGR) (State of Good Repair) –A condition in which pavements both individually and as a system are functioning as designed and can be sustained through regular maintenance, preservation and replacement programs. Currently, in CTDOT roads designated as SOGR have a condition score (PCI) of 6 or higher on a scale of 1 to 9.

STF – (Special Transportation Fund) – a dedicated fund used to finance Connecticut's transportation infrastructure program and operate CTDOT

TAM (Transportation Asset Management) -- Transportation Asset Management is a strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively throughout their life cycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well defined objectives. [19]

TED – (Transportation Enterprise Database) CTDOT SQL Server data warehouse that contains geospatial information

TSDD (Traffic Speed Deflectometer Device) A roadway survey device which collects structural deflection data as it traverses a pavement's surface at normal speeds. Continuous measurements are made of the deflection basin from a partially-loaded tractor trailer at one of the rear wheel paths.

UC (Uniform Compaction)/IC (Intelligent Compaction): Intelligent Compaction (IC) uses real-time GPS to track paving equipment during the placement and compaction of the pavement. A monitor is mounted on the rolling equipment that provides instantaneous information to the operator, including where the roller has been, how many roller passes have taken place in that location, roller speed and the temperature of the pavement. IC also utilizes accelerometers mounted to the rollers to measure the pavement's stiffness. Uniform Compaction (UC) is Intelligent Compaction excepting the use of the accelerometers. UC is used to ensure that the pavement receives approximately the same amount of compactive effort in all locations, at the appropriate temperatures and speeds.

VIP (Vendor-in-Place) Connecticut's maintenance resurfacing program was formerly called the vendor in place paving program.

VMT (Vehicle Miles Traveled) – the amount of travel by vehicles on a specified network of roads, (such as within a geographic region), over a given period of time, typically a one-year period. VMT can be calculated as the sum of the length of sections of a highway network multiplied by the Annual Average Daily Traffic per section.

Worst First – Giving roadway pavement rated the poorest (or lowest score) the highest priority for repairs.

APPENDIX 2. LIST OF MAINTENANCE RESURFACING PAVING PROJECTS (2021)

Districts 1 and 2

DIST	RTE	DIR	TOWNS	TERMINI	BEGIN	END	2Lane Mile	DEPTH	EST. COST
1	19	N+S	STAFFORD	RT 190 (EAST MAIN ST) TO HYDEVILLE RD	0.00	3.02	3.02	2.00	$ 921,100.00
1	30	N+S	ELLINGTON	TOLLAND TL TO RT 140 (CRYSTAL LAKE RD)	17.05	17.81	0.76	2.00	$ 231,800.00
1	44	E+W	MANSFIELD	COVENTRY TL TO RT 195 (STORRS RD)	73.35	76.58	3.38	2.00	$ 1,030,900.00
1	75	N+S	WINDSOR, WINDSOR LOCKS	.17 MI S/O BGN OP RT 20 TO RT 140 (ELM ST)	4.81	6.02	2.72	2.00	$ 829,600.00
1	140	E+W	EAST WINDSOR, ELLINGTON	SB RT 191 (MAIN ST) TO CON FR RT 286 (ONE WAY)	7.38	12.78	5.51	2.00	$ 1,680,550.00
1	140	E+W	WINDSOR LOCKS	RT 75 (ELLA GRASSO TPKE) TO RT 159 (SOUTH MAIN ST)	0.00	2.28	2.35	2.00	$ 716,750.00
1	187	N+S	BLOOMFIELD	HARTFORD TL TO RT 218 (COTTAGE GROVE RD)	1.70	2.35	1.23	2.00	$ 375,150.00
1	502	E+W	EAST HARTFORD	FORBES ST TO MANCHESTER TL	2.85	4.05	1.52	2.00	$ 463,600.00
1	510	N+S	EAST WINDSOR, ENFIELD	US 5 (SOUTH MAIN ST) TO US 5 (KING ST)	0.00	2.55	2.61	2.00	$ 796,050.00
1	44	E+W	EAST HARTFORD	SR 907 TO BGN OVLP US 5	54.27	55.05	1.68		$ 512,400.00
1	84	W/B	EAST HARTFORD	WB ACC FR SR 518 (ROBERTS ST) TO X56 NB SR 500 INC RAMP	62.88	64.39	2.24	3.00	$ 683,200.00
1	3	N+S	MIDDLETOWN, CROMWELL	RT 66 (WASHINGTON ST) TO RT 372 (WEST ST)	0.00	3.37	3.98	2.00	$ 1,213,900.00
1	10	N+S	SOUTHINGTON, PLAINVILLE	.01 MI SO QUINN RV TO .04 MI NO RT 372 (EAST MAIN ST)	27.74	30.04	2.55	2.00	$ 777,750.00
1	15	N+S	BERLIN,	MERIDEN TL TO .13 MI SO MIDDLETOWN RD	67.96	70.75	6.19	2.00	$ 1,887,950.00
1	42	E+W	CHESHIRE,	SOUTH BROOKSVALE RD TO RT 10	11.82	13.66	1.84	2.00	$ 561,200.00
1	69	N+S	WOLCOTT,	OP MAD RIVER TO .02 MI SO NORTH ST	21.33	23.89	3.03	2.00	$ 924,150.00
1	70	E+W	MERIDEN,	MAIN ST TO NEW HANOVER ST	9.68	10.16	0.52	2.00	$ 158,600.00
1	71	N+S	NEW BRITAIN,	SR571 (WB) TO BUELL ST	2.42	2.92	0.52	2.00	$ 158,600.00
1	84	E/B	NEW BRITAIN,	.01 MI EO WB RMP TR 815 TO .03 MI WO ACC FR NB RT 72	50.40	50.76	1.25	3.00	$ 381,250.00
1	84	W/B	PLAINVILLE, NEW BRITAIN	BGN OP RT 72-RR & RT TO .14 MI WO UP I-84 RMPS 181,184	50.21	50.80	1.19	3.00	$ 362,950.00
1	173	N+S	NEWINGTON,	RT 175 (CEDAR ST) TO .03 NO END OP AMTRAK (01477)	2.64	3.97	1.78	2.00	$ 542,900.00
1	217	N+S	MIDDLEFIELD, MIDDLETOWN, CROMWELL	RT 66 (MERIDEN RD) TO RT 372 (BERLIN RD)	0.00	3.84	4.08	2.00	$ 1,244,400.00
1	322	E+W	WOLCOTT	WOODTICK RD TO .01 MI WO SR 844 (MERIDEN RD)	1.58	4.30	2.72	2.00	$ 829,600.00
									$ 17,284,350.00
2	32	N+S	WINDHAM	SR 661 THREAD CITY CROSSING TO OVLP RT66	28.55	29.27	0.72	2.00	$ 219,600.00
2	14	E+W	PLAINFIELD	W JCT RT 14A TO RT 12	13.46	16.99	3.53	2.00	$ 1,076,650.00
2	169	N+S	POMFRET, WOODSTOCK	RT 101 TO RT 171	25.50	30.96	5.46	2.00	$ 1,665,300.00
2	195	N+S	MANSFIELD	RT 275 TO US 44	7.11	9.39	2.28		$ 695,400.00
2	607	N+S	KILLINGLY	RT 12 TO SOUTH FRONTAGE RD	0.00	2.54	2.54	2.00	$ 774,700.00
2	196	E+W	HADDAM, EAST HAMPTON	RT 151 TO RT 66	0.00	5.38	5.38	2.00	$ 1,640,900.00
2	12	E+W	THOMPSON	EX FR NB I-395 TO .03 MI SO RT 131	48.88	51.95	3.07	2.00	$ 936,350.00
2	275	N+S	MANSFIELD	RT 32 TO RT 195	2.01	4.15	2.14	2.00	$ 652,700.00
2	354	E+W	COLCHESTER, SALEM	STANAVAGE RD TO RT 82	3.03	7.37	4.34	2.00	$ 1,323,700.00
2	163	N+S	BOZRAH	.04 MI NO CAROLINE RD TO BOZRAH ST EXT	10.86	12.56	1.70	2.00	$ 518,500.00
2	612	E+W	BOZRAH	RT 163 TO SR 608	0.00	0.14	0.14	2.00	$ 42,700.00
2	2	E+W	MONTVILLE, PRESTON	BGN OP I-395 TO RT 12 (INC RMPS)	4.37	7.05	6.02	2.00	$ 1,836,100.00
2	145	N+S	CLINTON, WESTBROOK, DEEP RIVER	US 1 TO S JCT RT 80	0.00	6.64	6.64	2.00	$ 2,025,200.00
2	625	N+S	WESTBROOK	US 1 TO RT 145	0.00	0.99	0.99	2.00	$ 301,950.00
2	201	N+S	GRISWOLD	NO STONINGTON TL TO RT 165	9.30	12.08	2.78	2.00	$ 847,900.00
2	81	N+S	HADDAM	KILLINGWORTH TL TO RT 154 (SAYBROOK RD)	10.05	15.75	5.70	2.00	$ 1,738,500.00
2	138	E+W	GRISWOLD	RT 12 (MAIN ST) TO ACC TO NB I-395	6.17	7.28	1.11	2.00	$ 338,550.00
2	1	N+S	STONINGTON	US 1 TO TRUMBULL AVE	0.00	0.65	0.65	2.00	$ 198,250.00
2	95	N/B	STONINGTON, NORTH STONINGTON	OP TAUGWONK RD TO RHODE ISLAND SL (INC RMPS)	104.25	111.57	9.21	3.00	$ 2,809,050.00
2	95	S/B	NORTH STONINGTON	.03 MI N/O BOOM BRIDGE RD TO .03 MI S/O BOOM BRIDGE RD	110.20	110.80	0.60	3.00	$ 183,000.00
									$ 19,825,000.00

Districts 3 and 4

DIST	RTE	DIR	TOWNS	TERMINI	BEGIN	END	2Lane Mile	DEPTH	EST. COST
3	15	N/B	HAMDEN, NORTH HAVEN	.17 MI NO END OP CONNOLLY PKWY TO WLFD TL	50.63	56.54	5.91	2.00	$ 1,802,550.00
3	10	N+S	CHESHIRE	.10 MI NO KINGS RD TO RT 42 (EB) (NO BROOKSVALE RD)	15.36	15.95	0.77	2.00	$ 234,850.00
3	454	E+W	SHELTON	RT 110 (HOWE AVE) TO BIRCHBANK RD #1	0.00	1.89	1.89	2.00	$ 576,450.00
3	34	E+W	ORANGE, WEST HAVEN	RT 121 (GRASSY HILL RD) (SB) TO .13 MI WO RT 122	16.58	20.89	9.69	2.00	$ 2,955,450.00
3	720	E+W	NORTH HAVEN	HARTFORD TPKE #1 TO US 5 (STATE ST)	0.00	0.26	0.52	2.00	$ 158,600.00
3	1	N+S	MADISON	GUILFORD TL TO RT 79 (DURHAM RD)	65.01	67.85	2.88	2.00	$ 878,400.00
3	77	N+S	GUILFORD	RT 80 (KILLINGWORTH RD) TO .20 MI NO ELM ST CON	5.46	6.16	0.70	2.00	$ 213,500.00
3	63	N+S	WOODBRIDGE	NEW HAVEN TL TO .87 MI NO RT 114	1.62	3.73	3.11	2.00	$ 948,550.00
3	749	N+S	WOODBRIDGE	RT 63 (AMITY RD) TO RT 69 (LITCHFIELD TPKE)	0.00	0.21	0.23	2.00	$ 70,150.00
3	705	N+S	WEST HAVEN	RT 162 (JONES HILL RD) TO RT 162 (PLATT AVE)	0.00	2.63	2.63		$ 802,150.00
3	25	N+S	TRUMBULL	.37 MI SO RT 111 TO RT 111	9.50	9.87	0.84	2.00	$ 256,200.00
3	1	N/B	FAIRFIELD	.02 MI SO UP I-95 TO .03 MI NO BR# 00093	27.18	27.23	0.05	2.00	$ 15,250.00
3	1	S/B	FAIRFIELD	.06 MI SO UP I-95 TO SB-SR 732	27.07	27.16	0.09	2.00	$ 27,450.00
3	137	N+S	STAMFORD	US 1 (SB)(TRESSR BLVD) TO HIGH RIDGE RD #1	0.00	1.83	4.23	2.00	$ 1,290,150.00
3	130	E+W	FAIRFIELD, BRIDGEPORT	EB-US 1 NB TO UP I-95 (GOV JOHN D LODGE TPKE)	0.00	1.93	3.91	2.00	$ 1,192,550.00
3	137	N+S	STAMFORD	HIGH RIDGE RD #1 TO ACC TO SB RT 15	1.83	4.61	6.51	2.00	$ 1,985,550.00
3	111	N+S	TRUMBULL, MONROE	.01 MI NO RT 25 (MAIN ST) TO .12 MI NO PURDY HILL RD	4.09	5.40	2.81	2.00	$ 857,050.00
3	59	N+S	FAIRFIELD	CORNELL RD TO .05 MI SO BGN RT 15	1.29	3.64	2.41	2.00	$ 735,050.00
3	713	N+S	FAIRFIELD	CONGRESS ST #2 TO RT 59 (EASTON TPKE)	0.00	0.27	0.27	2.00	$ 82,350.00
3	130	E+W	STRATFORD	RT 113 (MAIN ST) TO EB-NB JCT US-1 (FERRY BLVD)	7.06	8.21	1.52	2.00	$ 463,600.00
3	137	N+S	STAMFORD	INTERLAKEN RD TO NEW YORK SL	5.51	9.33	3.82	2.00	$ 1,165,100.00
									$ 16,710,950.00
4	4	E+W	SHARON	E JCT OLD SHARON RD #1 TO W JCT US 7	3.78	7.64	3.86	1.00	$ 1,177,300.00
4	272	E+W	NORFOLK	BRUEY RD TO US 44	10.00	13.31	3.31	2.00	$ 1,009,550.00
4	43	N+S	CORNWALL	RT 4 TO RT 63	0.00	5.06	5.16	2.00	$ 1,573,800.00
4	20	E+W	WINCHESTER, BARKHAMSTED	RT 8 TO HARTLAND TL	0.00	2.64	2.64	2.00	$ 805,200.00
4	202	E+W	TORRINGTON	.06 MI WO WALNUT ST TO FERN DR	43.11	45.00	2.56	2.00	$ 780,800.00
4	254	E+W	LITCHFIELD	THOMASTON TL TO RT 118	3.15	8.41	5.26	2.00	$ 1,604,300.00
4	45	N+S	WASHINGTON, WARREN	US 202 TO .26 MI NO N JCT RT 341	0.00	5.67	5.67	2.00	$ 1,729,350.00
4	540	E+W	EAST GRANBY	RT 189 TO RT 187	0.00	1.43	1.44	2.00	$ 439,200.00
4	318	E+W	BARKHAMSTED	US 44 TO RT 181	0.00	1.47	1.47	2.00	$ 448,350.00
4	219	N+S	NEW HARTFORD	US 44 TO OP E BRANCH FARMINGTON RV	4.63	5.77	1.14	2.00	$ 347,700.00
4	847	N+S	NAUGATUCK	ACC TO SB RT 8 TO WATERBURY TL	0.00	0.27	0.54	2.00	$ 164,700.00
4	69	N+S	WATERBURY	WASHINGTON ST TO FROST RD	16.10	17.86	2.37	2.00	$ 722,850.00
4	69	N+S	WATERBURY	PROSPECT TL TO OP I-84 EB ON RMP	14.01	15.81	2.84	2.00	$ 866,200.00
4	172	E+W	SOUTHBURY	EX FR I-84 EB TO SPRUCE BROOK RD	0.40	4.45	4.05	2.00	$ 1,235,250.00
4	133	N+S	BROOKFIELD	RT 25 TO BGN OP HOUSATONIC RV	1.26	3.57	2.31	2.00	$ 704,550.00
4	7	N+S	NEW MILFORD	.70 MI NO OP BULLYMUCK BK TO .49 MI SO OP POND OUTLET	34.92	36.39	3.55	2.00	$ 1,082,750.00
4	69	N+S	PROSPECT	BETHANY TL TO RT 68 (UNION CITY RD)	9.43	12.04	2.68	2.00	$ 817,400.00
4	67	N+S	SEYMOUR	OXFORD TL (MOUNTAIN RD) TO SR 721	25.83	27.38	2.75	2.00	$ 838,750.00
4	313	N+S	WOODBRIDGE	SEYMOUR TL TO RT 114 (RACEBROOK RD)	3.42	4.76	1.35	2.00	$ 411,750.00
4	102	E+W	RIDGEFIELD	RT 35 (MAIN ST) TO BLOOMER RD	0.00	1.87	1.87	2.00	$ 570,350.00
4	6	E+W	BRISTOL	SHERMAN ST TO COLLINS RD	46.50	48.99	3.70	2.00	$ 1,128,500.00
4	58	E+W	REDDING	SOUTH LA TO RT 107 (PUTNAM PARK RD)	13.13	15.77	2.64	2.00	$ 805,200.00
4	6	E+W	PLYMOUTH	RTE. 72 (SOUTH RIVERSIDE AVE) TO BRISTOL TL	44.15	44.64	0.49	2.00	$ 149,450.00
4	84	E+W	DANBURY, BETHEL, BROOKFIELD, NEWTOWN	.01 MI W/O ACC FR WB US 6 TO .01 MI E/O EB EX TO RT 25	8.09	11.33	7.53	2.00	$ 2,296,650.00
									$ 21,709,900.00

APPENDIX 3. PAVEMENT PRESERVATION PROJECTS (2021)

Mill and Overlay

District 1

Ultra Thin Bonded PMA

District 1

<table>
<tr><th>ROUTE</th><th>DIRECTION</th><th>TOWN</th><th>LOG TERMINI</th><th>START MILE POINT</th><th>END MILE POINT</th><th>CENTER LINE MILES</th><th>LANE MILES</th></tr>
<tr><td rowspan="2">84</td><td>E</td><td rowspan="2">WILLINGTON, ASHFORD, UNION</td><td>.01 MI W/O EB BGN OP RTE 32 (RIVER RD) TO END I-84 (MASSACHUSETTS SL)</td><td>85.56</td><td>97.90</td><td rowspan="2">23.80</td><td rowspan="2">85.23</td></tr>
<tr><td>W</td><td>.38 MI W/O BGN OP ROARING BK TO END I-84 (MASSACHUSETTS SL)</td><td>86.44</td><td>97.90</td></tr>
</table>

District 2

ROUTE	DIRECTION	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
2	E	LEBANON, BOZRAH, NORWICH	.12 MI W/O UP SCOTT HILL RD TO BGN OP SR 642	30.79	35.20	5.88	13.33
	W		.32 MI E/O WB BGN OP CAMP MOOWEEN RD TO WB END OP SR 642	30.01	31.48		
	E	BOZRAH, NORWICH	BOZRAH - NORWICH TL (EB) TO BGN OP 642	35.20	35.85	5.02	11.47
	W		0.73 MI W/O UP BASHON HILL RD TO WB END OP SR 642	31.48	35.85		
95	N	GROTON	END OP THAMES RV (LOC RD/P&WRR) TO .05 MI N/O NB EXIT TO SR 614 (ALLEN ST)	94.71	99.91	10.40	33.28
	S		.01 MI S/O SB ACC FR BRIDGE ST #1 (313) TO .14 MI S/O SB ACC FR SR 614 (MYSTIC ST)	94.71	99.91		
395	N	MONTVILLE	.01 MI N/O NB-JCT SR 693 (MONTVILLE CON) TO .02 MI S/O UP GALLIVAN LA	5.53	9.26	7.42	16.65
	S		.10 MI N/O SB-JCT SR 693 (MONTVILLE CON) TO .02 MI S/O UP GALLIVAN LA	5.56	9.26		

Asphalt Rubber Chip Seals

District 2

ROUTE	DIRECTION	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTER LINE MILES	LANE MILES
165	E/W	GRISWOLD, VOLUNTOWN	RTE 201 (GLASGO RD) TO RTE 138 (JEWETT CITY RD)	10.17	12.20	2.03	4.06
198	N/S	WOODSTOCK	RTE 171 (SOMERS TPKE) TO END RTE 198 (MASSACHUSETTS SL)	12.83	19.22	6.39	12.78

District 3

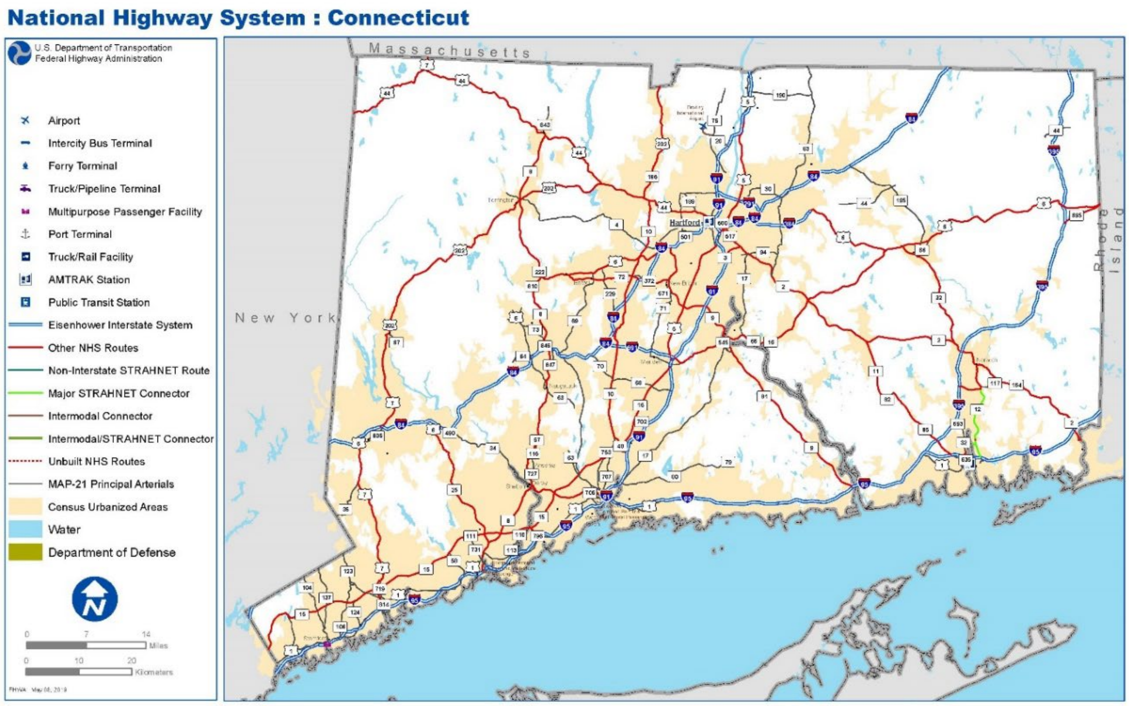
ROUTE	DIRECTION	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
58	N/S	FAIRFIELD, EASTON	.30 MI N/O EXIT FR SB RTE 15 (087) TO RTE 136 (WESTPORT RD)	3.75	6.90	3.15	6.30

District 4

ROUTE	DIRECTION	TOWN	LOG TERMINI	START MILE POINT	END MILE POINT	CENTERLINE MILES	LANE MILES
199	N/S	ROXBURY, WASHINGTON	RTE 67 (BAKER RD) TO RTE 47 (GREEN HILL RD)	0.00	4.62	4.62	8.87
272	N/S	TORRINGTON, GOSHEN	RTE 4 (MIGEON AVE) TO RTE 263 (WINCHESTER RD)	0.00	6.02	6.02	12.04

APPENDIX 4. REFERENCE MAPS

Appendix 4A. Map of Connecticut: National Highway System (as of May 2019)

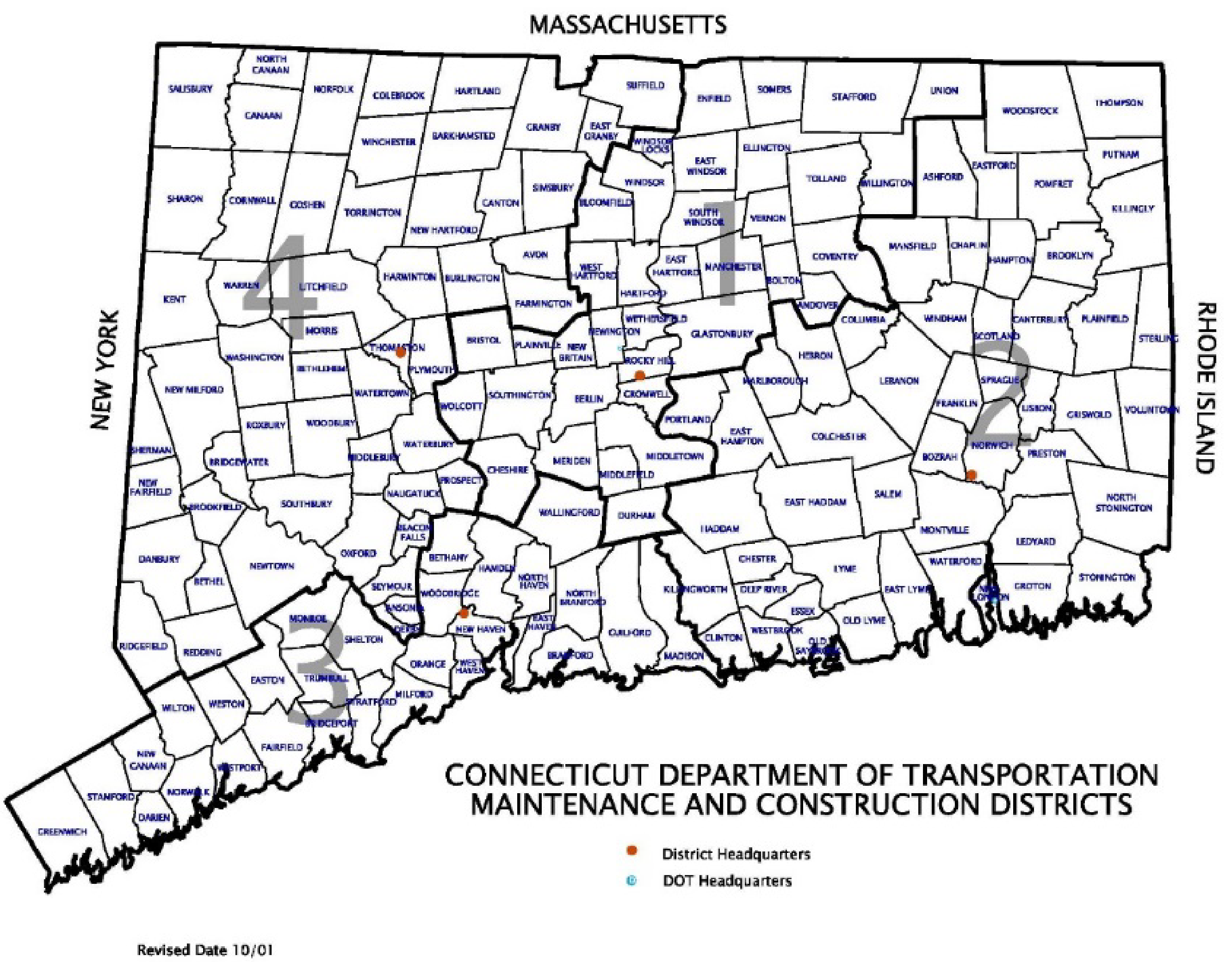


Examples of NHS categories

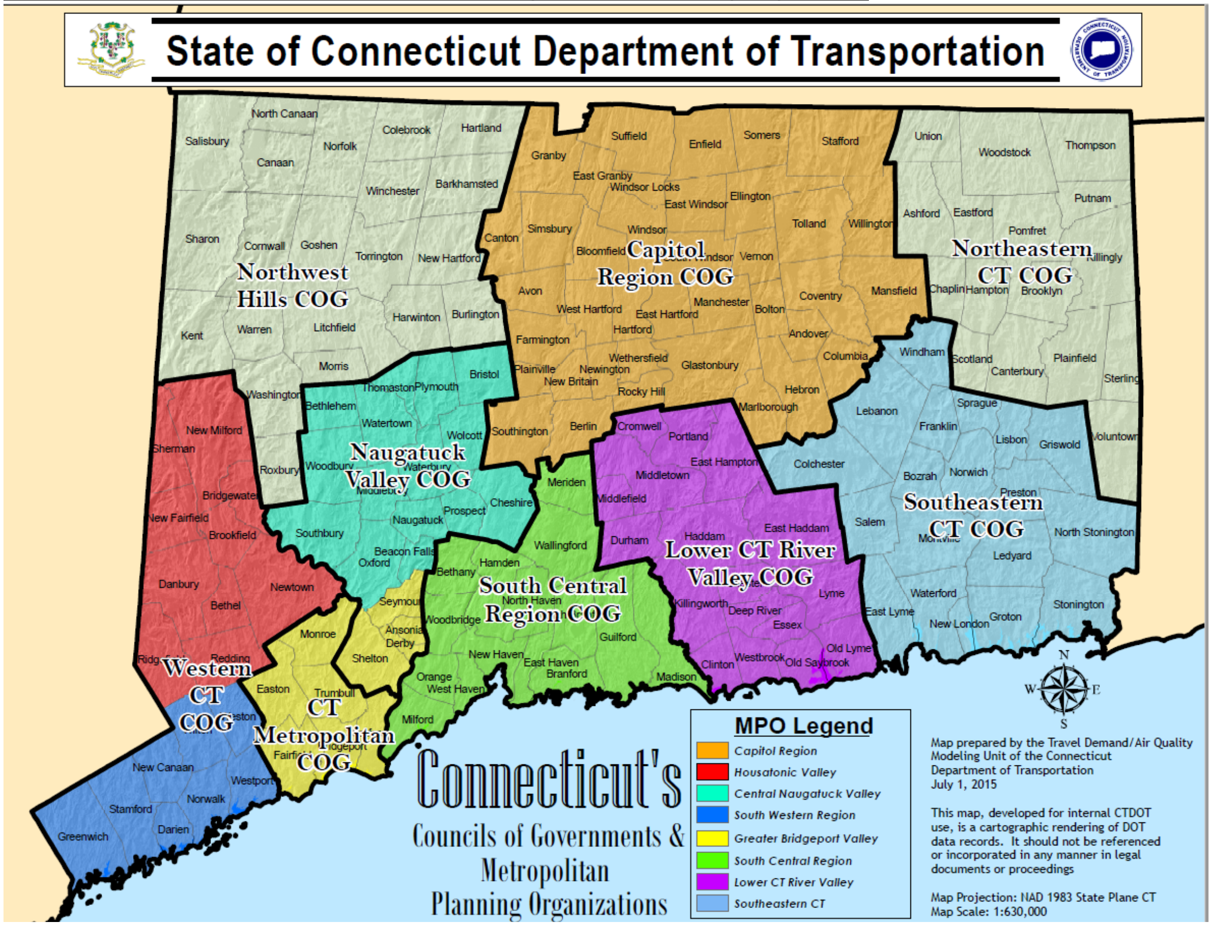
- ***Interstate:*** *The Dwight D. Eisenhower National System of Interstate and Defense Highways. e.g., I-91, I-84, I-95, I-395, I-291, I-691*
- ***Other Principal Arterials:*** *These are highways in rural and urban areas which provide access between an arterial and a major port, airport, public transportation facility, or other intermodal transportation facility. e.g., Rt 20, U.S. 6, U.S. 44, Rt 9*
- ***Non-interstate Strategic Highway Network (STRAHNET):*** *This is a network of highways which are important to the United States' strategic defense policy and which provide defense access, continuity and emergency capabilities for defense purposes. e.g., I-395,*
- ***Major STRAHNET Connectors:*** *These are highways which provide access between major military installations and highways which are part of the Strategic Highway Network. e.g. Rt 12*

- ***Intermodal Connectors:*** *These highways provide access between major intermodal facilities and the other four subsystems making up the National Highway System.*

Appendix 4B. Map of Connecticut: Maintenance/ Construction Districts



Appendix 4C. Map of Connecticut Regional Planning Agencies



APPENDIX 5. GOOD-FAIR-POOR (G-F-P) PAVEMENT RATINGS IN CONNECTICUT FOR 2018, 2019 AND 2020

NOTES:

1.Unlike data published by FHWA for HPMS, the data in the following tables includes bridges and some ramps serving as mainline routes.

2. For each year, there is a difference in total reported centerline miles and lane miles compared other years data due to the varied length of survey for various routes.

OVERALL G-F-P Ratings by Lane-Miles

Pavement G-F-P (Lane Miles) for 2020)							
Route Category	Lane Miles Good	Lane Miles % Good	Lane Miles Fair	Lane Miles % Fair	Lane Miles Poor	Lane Miles % Poor	Lane Miles Total
INTERSTATE	1120	54.2%	935	45.3%	10	0.5%	2065
NON_INSTERSTATE NHS	1154	33.6%	2248	65.5%	30	0.9%	3432
NHS	2274	41.4%	3183	57.9%	40	0.7%	5497
NON_NHS	1120	22.5%	3741	75.3%	107	2%	4968
ENTIRE NETWORK	3394	32.4%	6924	66.2%	147	1%	10465

Pavement GFP (Lane Miles) for 2019							
Route Category	LaneMilesGood Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles %Fair	LaneMiles Poor Miles	LaneMiles %Poor	LaneMiles Total Miles
INTERSTATE	1426.5	69.60%	620.6	30.30%	3.8	0.20%	2051
NON_INTERSTATE NHS	1329.6	39.50%	1928.3	57.30%	105.6	3.10%	3363
NHS	2756.1	50.90%	2548.9	47.10%	109.4	2.00%	5414
NON_NHS	1058.3	21.60%	3583.3	73.30%	249.5	5.10%	4891
ENTIRE_NETWORK	3814.3	37.00%	6132.2	59.50%	358.9	3.50%	10305

Pavement GFP (Lane Miles) for 2018							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1459.7	71.2%	583.2	28.4%	8.2	0.4%	2051
NON_INTERSTATE NHS	1416.9	41.1%	1970.1	57.2%	58.3	1.7%	3455
NHS	2876.6	52.3%	2553.3	46.5%	66.5	1.2%	5506
NON_NHS	1005.0	20.3%	3768.0	76.3%	167.0	3.4%	4962
ENTIRE_NETWORK	3868.5	37.1%	6332.1	60.7%	234.3	2.2%	10469

Ride Quality (IRI) G-F-P Ratings by Lane-Miles

Pavement Ride Quality G-F-P (Lane Miles) for 2020)							
Route Category	Lane Miles Good	Lane Miles % Good	Lane Miles Fair	Lane Miles % Fair	Lane Miles Poor	Lane Miles % Poor	Lane Miles Total
INTERSTATE	1361	65.9%	533	25.8%	170	8.2%	2064
NON_INSTERSTATE NHS	1614	47.0%	1392	40.5%	427	12.4%	3433
NHS	2975	54.1%	1925	35.0%	597	10.9%	5497
NON_NHS	1868	38.4%	2168	44.6%	826	17%	4862
ENTIRE NETWORK	4843	46.8%	4093	39.5%	1423	14%	10359

Pavement GFP (Lane Miles) for 2019							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles %Fair	LaneMiles Poor Miles	LaneMiles %Poor	LaneMiles Total Miles
INTERSTATE	1686.9	82.3%	332.6	16.2%	31.5	1.5%	2051
NON_INTERSTATE NHS	1574.4	46.8%	1304.5	38.8%	484.6	14.4%	3363
NHS	3261.3	60.2%	1637.0	30.2%	516.0	9.5%	5414
NON_NHS	1174.9	24.0%	2657.7	54.3%	1059.2	21.7%	4892
ENTIRE_NETWORK	4436.2	43.0%	4294.7	41.7%	1575.2	15.3%	10306

Pavement GFP (Lane Miles) for 2018							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1651.0	80.5%	356.8	17.4%	43.3	2.1%	2051
NON_INTERSTATE NHS	1580.3	45.9%	1342.6	39.0%	522.3	15.2%	3455
NHS	3231.3	58.8%	1699.4	30.9%	565.7	10.3%	5506
NON_NHS	1091.7	22.1%	2689.2	54.4%	1160.5	23.5%	4962
ENTIRE_NETWORK	4323.0	41.4%	4388.6	42.0%	1726.2	16.5%	10469

Rutting G-F-P Ratings by Lane-Miles

Rutting G-F-P (Lane Miles) for 2020)							
Route Category	Lane Miles Good	Lane Miles % Good	Lane Miles Fair	Lane Miles % Fair	Lane Miles Poor	Lane Miles % Poor	Lane Miles Total
INTERSTATE	1910	92.6%	148	7.2%	5.5	0.3%	2063.5
NON_INSTERSTATE NHS	3137	91.4%	291	8.5%	6.0	0.2%	3434
NHS	5047	91.8%	439	8.0%	11.5	0.2%	5497.5
NON_NHS	4427	91.1%	421	8.7%	13	0%	4861
ENTIRE NETWORK	9474	91.5%	860	8.3%	24.5	0%	10358.5

Pavement GFP (Lane Miles) for 2019							
Route Category	LaneMiles Good Miles	LaneMiles % Good	LaneMilesFair Miles	LaneMiles %Fair	LaneMiles Poor Miles	LaneMiles %Poor	LaneMiles Total Miles
INTERSTATE	1823.0	90.3%	192.9	9.6%	2.6	0.1%	2018
NON_INTERSTATE NHS	2871.3	84.9%	493.9	14.6%	17.7	0.5%	3383
NHS	4694.3	86.9%	686.8	12.7%	20.3	0.4%	5401
NON_NHS	4011.0	80.9%	916.4	18.5%	32.7	0.7%	4960
ENTIRE_NETWORK	8705.3	84.0%	1603.2	15.5%	52.9	0.5%	10361

Pavement GFP (Lane Miles) for 2018							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1772.9	88.3%	223.8	11.1%	12.3	0.6%	2051
NON_INTERSTATE NHS	2935.1	86.0%	459.7	13.5%	17.4	0.5%	3455
NHS	4708.0	86.8%	683.4	12.6%	29.7	0.5%	5506
NON_NHS	4139.0	83.5%	781.3	15.8%	39.5	0.8%	4962
ENTIRE_NETWORK	8847.0	85.2%	1464.8	14.1%	69.2	0.7%	10469

Cracking G-F-P Ratings by Lane-Miles

Cracking G-F-P (Lane Miles) for 2020)							
Route Category	Lane Miles Good	Lane Miles % Good	Lane Miles Fair	Lane Miles % Fair	Lane Miles Poor	Lane Miles % Poor	Lane Miles Total
INTERSTATE	1761	85.3%	248	12.0%	55	2.7%	2064
NON_INSTERSTATE NHS	2417	70.4%	837	24.4%	179.0	5.2%	3433
NHS	4178	76.0%	1085	19.7%	234	4.3%	5497
NON_NHS	2975	59.9%	1438	28.9%	555	11%	4968
ENTIRE NETWORK	7153	68.4%	2523	24.1%	789	8%	10465

Pavement GFP (Lane Miles) for 2019							
Route Category	LaneMiles Good Miles	LaneMiles % Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1723.9	84.0%	284.0	13.8%	44.3	2.2%	2052
NON_INTERSTATE NHS	2283.9	66.6%	910.0	26.5%	233.8	6.8%	3428
NHS	4007.8	73.1%	1194.0	21.8%	278.1	5.1%	5480
NON_NHS	2896.5	58.4%	1600.4	32.3%	464.5	9.4%	4961
ENTIRE_NETWORK	6904.3	66.1%	2794.3	26.8%	742.7	7.1%	10441

Pavement GFP (Lane Miles) for 2018							
Route Category	LaneMiles Good Miles	LaneMiles% Good	LaneMiles Fair Miles	LaneMiles % Fair	LaneMiles Poor Miles	LaneMiles % Poor	LaneMiles Total Miles
INTERSTATE	1814.5	88.5%	219.5	10.7%	17.1	0.8%	2051
NON_INTERSTATE NHS	2562.3	74.2%	792.8	22.9%	100.2	2.9%	3455
NHS	4376.8	79.5%	1012.3	18.4%	117.3	2.1%	5506
NON_NHS	3040.2	61.3%	1659.7	33.5%	260.4	5.2%	4962
ENTIRE_NETWORK	7417.1	70.9%	2672.0	25.5%	377.6	3.6%	10469

OVERALL G-F-P Ratings by Centerline Miles

Pavement G-F-P (Centerline Miles) for 2020)							
Route Category	Centerline Miles Good	Centerline Miles %	Centerline Miles Fair	Centerline Miles % Fair	Centerline Miles Poor	Centerline Miles %	Centerline Miles Total
INTERSTATE	181	52.2%	164	47.3%	1.7	0.5%	346.7
NON_INSTERSTATE NHS	326	30.7%	728	68.5%	9.5	0.9%	1063.5
NHS	507	36.0%	892	63.3%	11.2	0.8%	1410.2
NON_NHS	568	22.8%	1877	75.2%	51.2	2%	2496.2
ENTIRE NETWORK	1075	27.5%	2769	70.9%	62.4	2%	3906.4

Pavement GFP (Centerline Miles) for 2019							
Route Category	CTLine Miles Good Miles	CTLineMiles% Good	CTLine Miles Fair Miles	CTLine Miles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	251.3	72.5%	94.7	27.3%	0.6	0.2%	347
NON_INTERSTATE NHS	378.3	36.4%	625.1	60.1%	36.6	3.5%	1040
NHS	629.6	45.4%	719.8	51.9%	37.2	2.7%	1387
NON_NHS	502.0	21.9%	1677.6	73.0%	117.4	5.1%	2297
ENTIRE_NETWORK	1131.5	30.7%	2397.4	65.1%	154.6	4.2%	3684

Pavement GFP (Centerline Miles) for 2018							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	254.0	73.3%	90.7	26.2%	1.8	0.5%	347
NON_INTERSTATE NHS	401.1	38.0%	633.9	60.0%	20.8	2.0%	1059
NHS	655.1	46.7%	724.6	51.7%	22.6	1.6%	1406
NON_NHS	477.6	20.6%	1761.9	76.0%	78.0	3.4%	2326
ENTIRE_NETWORK	1132.7	30.5%	2486.5	66.8%	100.6	2.7%	3732

Ride Quality (IRI) G-F-P Ratings by Centerline Miles

Pavement Ride Quality G-F-P (Centerline Miles) for 2020)							
Route Category	Centerline Miles Good	Centerline Miles %	Centerline Miles Fair	Centerline Miles % Fair	Centerline Miles Poor	Centerline Miles %	Centerline Miles Total
INTERSTATE	277	79.8%	55	15.9%	15	4.3%	347
NON_INSTERSTATE NHS	467	44.0%	454	42.8%	140	13.2%	1061
NHS	744	52.8%	509	36.2%	155	11.0%	1408
NON_NHS	957	38.3%	1121	44.9%	418	17%	2496
ENTIRE NETWORK	1701	43.6%	1630	41.8%	573	15%	3904

Pavement GFP (Centerline Miles) for 2019							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	289.6	83.6%	52.2	15.1%	4.8	1.4%	347
NON_INTERSTATE NHS	448.8	43.2%	436.9	42.0%	154.3	14.8%	1040
NHS	738.4	53.3%	489.0	35.3%	159.1	11.5%	1387
NON_NHS	556.4	24.2%	1250.2	54.4%	490.5	21.4%	2297
ENTIRE_NETWORK	1294.8	35.1%	1739.2	47.2%	649.7	17.6%	3684

Pavement GFP (Centerline Miles) for 2018							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	280.0	80.8%	59.3	17.1%	7.2	2.1%	347
NON_INTERSTATE NHS	446.2	42.3%	445.9	42.2%	163.7	15.5%	1059
NHS	726.2	51.8%	505.2	36.0%	170.9	12.2%	1406
NON_NHS	518.1	22.3%	1268.0	54.7%	532.1	23.0%	2326
ENTIRE_NETWORK	1244.3	33.4%	1773.2	47.7%	703.0	18.9%	3732

Rutting G-F-P Ratings by Centerline Miles

Rutting G-F-P (Centerline Miles) for 2020)							
Route Category	Centerline Miles Good	Centerline Miles %	Centerline Miles Fair	Centerline Miles % Fair	Centerline Miles Poor	Centerline Miles %	Centerline Miles Total
INTERSTATE	322	92.9%	24	6.9%	0.6	0.2%	346.6
NON_INSTERSTATE NHS	978	92.0%	83	7.8%	1.6	0.2%	1062.6
NHS	1300	92.3%	107	7.6%	2.2	0.2%	1409.2
NON_NHS	2281	91.4%	208	8.3%	6.8	0%	2495.8
ENTIRE NETWORK	3581	91.7%	315	8.1%	9	0%	3905

Pavement GFP (Centerline Miles) for 2019							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles % Fair	CTLineMiles Poor Miles	CTLineMiles % Poor	Total CTLineMiles Miles
INTERSTATE	311.66	91.0%	30.3	8.8%	0.51	0.1%	342
NON_INTERSTATE NHS	895.4	85.1%	152.3	14.5%	5.1	0.5%	1053
NHS	1207.0	86.5%	182.6	13.1%	5.6	0.4%	1395
NON_NHS	1886.9	81.2%	422.1	18.2%	15.7	0.7%	2325
ENTIRE_NETWORK	3093.9	83.2%	604.6	16.3%	21.3	0.6%	3720

Pavement GFP (Centerline Miles) for 2018							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles % Poor	Total CTLineMiles Miles
INTERSTATE	299.2	88.0%	38.5	11.3%	2.3	0.7%	347
NON_INTERSTATE NHS	913.2	86.7%	135.2	12.8%	4.4	0.4%	1059
NHS	1212.3	87.0%	173.7	12.5%	6.7	0.5%	1406
NON_NHS	1947.5	83.8%	358.7	15.4%	18.3	0.8%	2326
ENTIRE_NETWORK	3159.9	85.0%	532.4	14.3%	25.0	0.7%	3732

Cracking G-F-P Ratings by Centerline Miles

Cracking G-F-P (Centerline Miles) for 2020)							
Route Category	Centerline Miles Good	Centerline Miles %	Centerline Miles Fair	Centerline Miles % Fair	Centerline Miles Poor	Centerline Miles %	Centerline Miles Total
INTERSTATE	301	86.7%	41	11.8%	5.3	1.5%	347.3
NON_INSTERSTATE NHS	725	68.3%	273	25.7%	63.2	6.0%	1061.2
NHS	1026	72.8%	314	22.3%	68.5	4.9%	1408.5
NON_NHS	1513	60.6%	712	28.5%	270	11%	2495
ENTIRE NETWORK	2539	65.0%	1026	26.3%	338.5	9%	3903.5

Pavement GFP (Centerline Miles) for 2019							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	296.27	85.5%	46.19	13.3%	4.21	1.2%	347
NON_INTERSTATE NHS	679.9	64.2%	296.3	28.0%	83.4	7.9%	1060
NHS	976.2	69.4%	342.5	24.4%	87.6	6.2%	1406
NON_NHS	1353.4	58.2%	753.7	32.4%	218.3	9.4%	2325
ENTIRE_NETWORK	2329.6	62.4%	1096.1	29.4%	305.9	8.2%	3732

Pavement GFP (Centerline Miles) for 2018							
Route Category	CTLineMiles Good Miles	CTLineMiles% Good	CTLineMiles Fair Miles	CTLineMiles% Fair	CTLineMiles Poor Miles	CTLineMiles% Poor	Total CTLineMiles Miles
INTERSTATE	310.8	89.7%	33.4	9.6%	2.3	0.7%	347
NON_INTERSTATE NHS	761.5	71.9%	260.0	24.5%	37.9	3.6%	1059
NHS	1072.3	76.3%	293.4	20.9%	40.2	2.9%	1406
NON_NHS	1426.0	61.3%	777.5	33.4%	121.4	5.2%	2326
ENTIRE_NETWORK	2498.4	67.0%	1070.8	28.7%	161.6	4.3%	3732

APPENDIX 6. TYPICAL AVERAGE CTDOT PAVEMENT TREATMENT COSTS BASED ON RECENTLY BID PROJECTS

Table 5-6. Pavement Treatment Costs using Estimator

Treatment	Unit	Unit Cost
Ultra Thin Treatment	SY	$7.57
Mill and Fill /Maintenance Resurfacing (2 in.)	SY	$22.13
Mill and Fill (2 inches)	SY	$22.13
Mill and Fill (3 inches)	SY	$33.33
Rubblization	SY	$134.74
Structural Rehabilitation + Joint Repair	SY	$57.24
Structural Rehabilitation	SY	$56.05
Reclamation	SY	$45.73
Reconstruction (light, flexible)	SY	$82.87
Reconstruction (medium, flexible)	SY	$98.70
Reconstruction (heavy, flexible)	SY	$118.79
Reconstruction (light, composite)	SY	$91.41
Reconstruction (medium, composite)	SY	$107.67
Reconstruction (heavy, composite)	SY	$128.62
Diamond Grinding	SY	$45.32
Diamond Grinding + Joint Repair	SY	$51.30
Concrete Pavement Repairs and Structural Overlay	SY	$48.47
Rubberized Chip Seal	SY	$7.69
Thin Overlay	SY	$16.35
Microsurfacing	SY	$7.28

APPENDIX 7. HIGHWAY FUNCTIONAL CLASSIFICATION DEFINITIONS AND CHARACTERISTICS [21]

Functional Class	**Definition**	**Context**
ARTERIALS		
Class 1 -- Interstates	All routes that comprise the Dwight D. Eisenhower National System of Interstate and Defense Highways	Interstates are the highest classification of Arterials and were designed and constructed with mobility and long-distance travel in mind. Roadways in this functional classification category are officially designated as Interstates by the U.S. Secretary of Transportation
Class 2 -- Other Freeways and Expressways	Contain directional travel lanes that are usually separated by some type of physical barrier, and their access and egress points are limited to on- and off-ramp locations or a very limited number of at-grade intersections.	Like Interstates, these roadways are designed and constructed to maximize their mobility function, and abutting land uses are not directly served by them.
Class 3 --Other Principal Arterials	Serve major centers of metropolitan areas, provide a high degree of mobility and can also provide mobility through rural areas.	Unlike Interstates and Other Freeways, abutting land uses can be served directly. Forms of access for Other Principal Arterial roadways include driveways to specific parcels and at-grade intersections with other roadways.
Class 4 -- Minor Arterials	Provide service for trips of moderate length, serve geographic areas that are smaller than their higher Arterial counterparts and offer connectivity to the higher Arterial system.	In an urban context, they interconnect and augment the higher Arterial system, provide intra-community continuity and may carry local bus routes. In rural settings, Minor Arterials should be identified and spaced at intervals consistent with population density, so that all developed areas are within a reasonable distance of a higher level Arterial. Additionally, Minor Arterials in rural areas are typically designed to provide relatively high overall travel speeds, with minimum interference to through movement.
NON ARTERIALS		
Class 5 -- Major Collectors	Gather traffic from Local Roads and funnel them to the Arterial network. Urban major collectors Serve both land access and traffic circulation in *higher* density residential, and commercial/industrial areas. Rural major collectors provide service to any county seat not on an Arterial route, to the larger	Generally, Major Collector routes are longer in length; have lower connecting driveway densities; have higher speed limits; are spaced at greater intervals; have higher annual average traffic volumes; and may have more travel lanes than their Minor Collector counterparts.

Functional Class	Definition	Context
	towns not directly served by the higher systems and to other traffic generators of equivalent intra-county importance such as consolidated schools, shipping points, county parks and important mining and agricultural areas	
Class 6 -- Minor Collectors	Gather traffic from Local Roads and funnel them to the Arterial network.	Urban Minor Collectors serve both land access and traffic circulation in *lower* density residential and commercial/industrial areas. Rural minor collectors are spaced at intervals, consistent with population density, to collect traffic from Local Roads and bring all developed areas within reasonable distance of a Collector.
Class 7 -- Local Roads	Provide direct access to abutting land, and are often designed to discourage through traffic.	Locally classified roads account for the largest percentage of all roadways in terms of mileage. They are not intended for use in long distance travel. Local Roads are often classified by default; once all Arterial and Collector roadways have been identified, all remaining roadways are classified as Local Roads