North Carolina Department of Transportation
Transportation Asset Management Plan
2018 Interim Report

Table of Contents

List of Figures

List of Tables

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Chapter 1 Transportation Asset Management Objectives

1.1 Introduction

North Carolina Department of Transportation's (NCDOT) mission is to connect people, products and places safely and efficiently with customer focus, accountability and environmental sensitivity to enhance the economy and vitality of North Carolina. North Carolina has major tourist destinations both in our coastal communities and our mountains, and one of our missions is to bring those tourists to and from their homes with a pleasant and efficient driving experience. Many of our agricultural and manufacturing businesses rely on NCDOT facilities in getting to market, and this transport is vital to our state and national economy. North Carolina also is home to numerous medical, educational and military sites and as host to these sites, transportation is key. Our mission is to serve all of these customers who use our transportation system at the highest level possible with our available funding.

NCDOT has developed goals that support our mission. They are:

- Make our transportation network safer
- Provide GREAT customer service
- Deliver and maintain our infrastructure effectively and efficiently
- Improve the reliability and connectivity of the transportation system
- Promote economic growth through better use of our infrastructure
- Make our organization a great place to work

Among the initiatives that are directed at making transportation safer is our spot safety program, which provides funding for small projects to improve site distance, correct road geometry and other changes that address known areas with elevated crash rates; our intelligent transportation system that provides advanced warning of delays or incidents along major corridors; and our NCDOT Safety Patrol program to provide assistance to motorists along major highways. In addition, data concerning crashes and crash locations are tracked and used to identify areas where safety improvements may be needed. NCDOT has had a pavement friction testing program for more than 20 years. Due to the high quality of our aggregates, surface friction is rarely the issue causing wet weather accidents, but this program assures that this remains the case. Critical findings from bridge inspections are tracked and scheduled to reduce safety impacts. The Division of Motor Vehicles also plays a significant role in making transportation safer by licensing qualified drivers and instructing them on the importance of seat belts, controlling speed, proper driving around schools and school buses, and numerous other safety-related topics.

NCDOT owns and maintains the second largest road network in the country. By state statutes there are no county owned roads, and all roads other than municipal streets and federal roads, are state owned. As a result, virtually every citizen is a customer, and most are direct customers. Most of these customers interact with NCDOT through our county maintenance yards or district offices. Additionally, the department has a toll-free number 1-877-DOT-4YOU for customers to call for questions or to report potholes or other infrastructure defects. Sometimes items are reported to personnel in central office units, and these are transmitted to the appropriate location for response. The goal is to listen to the issue

and provide a response to the citizen, in a manner that is helpful and courteous. Customer service also consists of attending public meetings, interacting with citizens during right-of-way acquisitions, and numerous other situations that require tact and clear heads.

In addition to direct citizen interactions, NCDOT also interacts with Metropolitan Planning Organizations (MPOs) and Rural Planning Organizations (RPOs). Within North Carolina, both MPOs and RPOs participate in the development and prioritization of projects for the Statewide Transportation Improvement Program (STIP). NCDOT has 14 geographic divisions, each led by a division engineer. One of the many responsibilities of the division engineer is to work with MPOs and RPOs in their area, ensuring good communication with these partners. The division engineer also attends city council meetings, county commissioner meetings, and other public forums to address citizen questions and concerns.

Another significant stakeholder of NCDOT is the North Carolina General Assembly, which guides NCDOT's activities through statute and funding. They are among the agency's biggest customers for asset management system analyses, and DOT personnel strive to provide reports that assist the members in their oversight functions.

The goal of delivering and maintaining our infrastructure effectively and efficiently is directly related to asset management and the Transportation Asset Management Plan (TAMP). To assist with the accomplishment of this goal the department relies on complex computer software systems such as maintenance management system, pavement management system, bridge management system and other systems to manage equipment, signs, signal systems and other asset types. It also includes the data required to use these systems: our maintenance condition assessment, our automated pavement distress data collection for the NHS (automated data collection for the entire network began in 2018), and our regular program of bridge inspections. The data supplied by these condition assessments is used to drive funding decisions in our needs-based allocation process. It also is used to identify project lists for interstate maintenance, pavement and bridge preservation, pavement and bridge rehabilitation, bridge repair and bridge replacement. Our management systems provide key input to field engineers for the development of project to be included in these programs. Engineering judgement is required to combine pavement management system sections into usable construction sections. Central units work with the field divisions to finalize project limits and identify appropriate treatments. The goal of maintaining the infrastructure cuts across all aspects of the Division of Highways and includes:

- applied research to improve processes or materials,
- design of roads and bridges to address current and future needs,
- materials and construction controls to assure that our projects are built to last for the design period,
- funding allocation to assure that our levels of service goals are attained,
- central staff who coordinate the data collection and use the management systems to perform the analysis,
- field division personnel who maintain roads and bridges on a daily basis,
- delivery of pavement and bridge projects on time and on schedule, and

- many others.

In summary, the NCDOT goal of delivering and maintaining our infrastructure effectively and efficiently is directly related to the MAP-21 national goal area for infrastructure condition in the performance of bridge condition on the NHS, and pavement condition on interstates and non-interstate NHS.

Another goal is to improve the reliability and connectivity of the transportation system. Many improvements in this area are the result of local identification of problem areas and potential solutions. Urban improvements have included roundabouts and smart streets to eliminate or reduce turning queues. An ongoing program to provide urban loops also serves to address system reliability by offering alternate routes that do not include the signalized intersections common in cities and towns. The Board of Transportation approved the Strategic Transportation Corridors that identify key connections required for this goal as well as goals in economic development.

The goal of improving the reliability and connectivity of the transportation system is, therefore, directly linked to the MAP-21 national performance goal for system reliability in terms of freight movement, and congestion mitigation.

As previously mentioned, promotion of economic growth through better use of our infrastructure is a department goal. Infrastructure condition is one of the key factors used by industry in deciding where to locate future plants or offices. Access to ports and airports, as well as stable delivery systems for materials aid in attracting industry and promote economic growth. Connections with regional hubs, general aviation and international airports, train stations, ports and inland freight facilities are maintained as part of this goal area. In addition, it is important that workers are able to get to and from work safely and efficiently. These components are directly tied to infrastructure condition and system reliability.

NCDOT strives to be a great place to work and provide challenging and satisfying work for our employees. At no time is the spirit of the agency stronger than when dealing with natural disasters. Our employees pull together and move to the affected areas where they stay as long as needed to clear debris, repair pipes, repair roads, and all other aspects of recovery. It is a great place to work because we have great employees, who are dedicated to public service. As part of our great place goal, we include employee safety with specific goals to reduce accidents, reduce fatalities, and reduce Worker's Compensation claims. While somewhat tied to the MAP-21 national performance goals for safety, this goal is more internally focused and not directly linked to the MAP-21 performance targets. The correspondence between NCDOT goals and MAP-21 program performance goals is summarized in Table 1-1.

Table 1-1: Correspondence between NCDOT goals and MAP-21 National performance goals

NCDOT Goal	MAP 21 National Performance Goal
Make transportation safer	Infrastructure Condition (Bridge and pavement condition on interstates and non-interstate NHS), freight movement, and safety
Provide GREAT customer service	NA
Deliver and maintain our infrastructure effectively and efficiently	Infrastructure Condition (Bridge condition on NHS, pavement condition on interstates and non-interstate NHS), public transportation state of good repair.
Improve the reliability and connectivity of the transportation system	System Reliability; i.e. Freight movement, Interstate and NHS performance, congestion mitigation.
Promote economic growth through better use of our infrastructure	System Reliability; i.e. Freight movement, Interstate and NHS performance, congestion mitigation.
Make our organization a great place to work	NA

All of the goals described here are commendable, but they compete against each other for funding. This is the challenge faced by all agencies when resources are limited. Competing needs must be compared and evaluated so that the available funds are used to their best advantage. The TAMP is part of the mechanism for accomplishing this need.

1.2 The Transportation Asset Management Plan and NCDOT's Goals

Development of a TAMP, and annual certification of the plan, is required under the FHWA rulemaking associated MAP-21. The goal of the rulemaking is to assure that states are using data-driven approaches in the expenditure of federal funds and to facilitate the reporting to Congress in this regard. The development of the TAMP is occurring at the same time as reporting on performance measures regarding safety, infrastructure health (bridges and pavements), system reliability, congestion, freight movement and project delivery. Up until now, each state may have developed their own performance measures in several of these areas. Comparing outcomes across states was tenuous, because the measures were different and the methods used to obtain them were not consistent. The performance measures identified in MAP-21, and in the subsequent rulemaking, applies to all states. The standards to be followed in obtaining the measures have also been clarified and will allow FHWA to provide reports to Congress regarding condition and financial needs based on consistent nationwide measures. For pavements the measures are consistent with the federal reporting requirements of the Highway Performance Monitoring System (HPMS) and bridge condition will be reported in conformance with the federal National Bridge Inventory (NBI) program.

The performance measures provide an annual snapshot of the condition of the state's infrastructure. The TAMP takes that snapshot, in conjunction with preceding condition information, to identify a strategic approach to reach state targets regarding infrastructure condition. The TAMP is not a short-term

planning document. It is a long-term plan where each short-term program of projects fits into the overall plan to incrementally maintain or improve conditions.

The TAMP will be evolutionary. This is NCDOT's first TAMP and it represents our current state of practice and understanding. As the plan is used, the department anticipates processes will be identified that will require adjustment. With the transitioning to an increased level of outsourcing, adjustments to the TAMP may be required to reflect this shift in the delivery of some programs. Future levels of Department funding are also unknown and will affect the ability of the Department to deliver a program of projects based on the 10-year financial plan. As a result, our financial estimates are just that and it would be expected that these numbers would change over time.

Some components of the TAMP will be relatively constant. The agency mission and goals have had modest tweaking, but the focus has remained the same: to provide a safe, well-maintained and reliable transportation system. It is anticipated that the process for identifying gaps and conducting system-wide Life Cycle Cost (LCC) analysis may change some in the first few plans as we refine our methodology for doing these. Similarly, we will be developing a process for identifying risk and especially those facilities that have required repeated emergency repairs. Over time, the process for conducting these analyses should become relatively constant. The NHS has increased in size over time. NCDOT has constructed numerous loop roads in the last 15 years. Each of these limited access facilities requires interchanges that, in turn, add bridges to our system.

The intent is that several existing plans or ones being developed by NCDOT will work in concert with the TAMP. It will incorporate components of the Department's Statewide Long-range Transportation Plan (SLRTP) as applicable to the performance and condition of pavements and bridges on the NHS.

This TAMP represents the intermediate timeframe. It includes gap analysis, life cycle cost analysis of the system, and risk analysis as well as an investment strategy and a 10-year financial plan. The SLRTP and the TAMP should speak to the same vision and priorities. It provides a detailed analysis of the data used to describe the condition of pavements and bridges on the NHS and projects future condition based on the Department's investment strategy to maintain these assets in a state of good repair.

Our various programs must be consistent with and support the long-term vision and targets of the SLRTP through a shorter-term list of projects in goal areas including pavements, bridges, ports, aviation facilities and other assets.

These interrelated plans require coordination and conversation both internally and externally, i.e. within the agency along with MPOs and RPOs. Performance targets must support the MAP-21 National performance goals, the SLRTP, and TAMP and tracked in a way that supports agency mission and goals.

To achieve this level of interdepartmental communication, the development of the TAMP has been coordinated by an Executive Committee consisting of the Chief Engineer, Chief Operating Officer, Deputy Secretary, Chief Information Officer, Director of Performance Management, Transportation Planning Division Branch Manager, and other key staff. Two subcommittees represented the two initial asset classes that will be included in the TAMP: pavements and bridges. These two working committees

included representatives from an MPO and an RPO as well as subject matter experts from the Pavement Management Unit and Structures Management Unit, and several other units from NCDOT. Federal Highway Administration was also represented on each of the three committees. An additional workgroup was added to address the 10-year financial plan. The NCDOT Chief Engineer and his staff will be responsible for the developing, implementing, managing, and updating of the TAMP for the Department with assistance from appropriate units and staff.

1.3 Organization of the Transportation Asset Management Plan

Chapter 1 – Transportation Asset Management Objectives. This section describes the purpose of the TAMP and an overview of the department's mission and goals.

Chapter 2 – Asset Inventory and Condition. This section of the plan includes a summary of assets managed by NCDOT and their condition. It includes an asset register for both pavements and bridges.

Chapter 3 – Performance Goals, Targets, and Gaps. This section contains a description of the gap analysis process and the results of gap analyses for both pavements and bridges. The gap analysis gives a system overview of pavements and bridges in terms of percentage rated "poor" as defined in the final rules.

Chapter 4 – Life-cycle Cost Planning. This section describes the system-wide life cycle cost analysis process. The interim TAMP provides a description of the process NCDOT will use to satisfy this requirement and the analysis will be performed as part of the final plan that is due on June 30, 2019.

Chapter 5 – Risk Management Analysis. This section discusses risk analyses, along with a description of the process used to identify a risk register. The interim TAMP will provide a description of the process NCDOT will use to satisfy this requirement and the analysis that will be performed as part of the final plan that is due on June 30, 2019.

Chapter 6 – Financial Plan. This section contains of the 10-year Financial Plan. The interim TAMP will provide a description of the process NCDOT will use to satisfy this requirement and the analysis will be performed as part of the final plan that is due on June 30, 2019.

Chapter 7 – Investment Strategies. This section includes funding options and investment strategies and the use of PMS and BMS systems for determining optimal asset investments.

Chapter 8 – Process Improvements. This section will describes the plan for maintaining and improving the TAMP into the future. This will include a description of responsibilities, necessary lines of communication, and business process enhancements that were identified as part of the initial version of the plan. The Department will address process improvements as a part of the final TAMP submission in June 2019.

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Chapter 2 Asset Inventory & Conditions

2.1 Our Assets

As mentioned in the Introduction, this is the first Transportation Asset Management Plan (TAMP) developed by NCDOT. Any State Transportation Agencies have a wide variety of assets, including pavements, bridges, retaining walls, noise walls, pipes, signs, traffic signals and intelligent transportation devices. In addition, NCDOT has over 100 equipment shops, 97 county maintenance yards, 14 division offices and provides oversight to 72 general aviation airports. The Division of Motor Vehicles, which is part of NCDOT, has more than 300 facilities. Each facility has both parking and buildings to maintain, although some DMV facilities are located in county government offices or shopping centers. NCDOT also owns and operates 22 ferries which have docks and vessels to be maintained. The Rail Division has more than 3,300 miles of railroad tracks, rolling stock, and facilities to be maintained. The NCDOT fleet has more than 18,000 pieces of equipment and 3,430 pickup trucks and work vans. Trying to include this vast array of assets in the initial TAMP would be a huge undertaking. We do not currently have inventory data for some of these diverse assets.

NCDOT will initially focus on the NHS pavements and bridges as required by MAP 21. However, because North Carolina's non-NHS road system is so large and all pavement and bridge assets are included in the pavement and bridge management systems, we will include those in the analysis so a more complete picture of needs, funding issues and priorities is portrayed which will support the Department's process for achieving goals. NCDOT manages and prioritizes program funding based on conditions of the interstate, primary and secondary road networks. Historical condition data trends demonstrate that by meeting state targets on these three systems, the MAP-21 requirements are met for the NHS network.

2.2 Data Collection Methods

2.2.1 Data Collection Methods- Pavements

In 2012 NCDOT began collecting pavement condition information through an automated system for all interstate and primary highways. As of the beginning in 2018, the Pavement Condition Survey (PCS) is now conducted annually for all state maintained routes and non-state maintained NHS routes using an automated data collection process. Both NHS and non-NHS routes will be evaluated by the automated survey using high definition images for automated crack detection. Line scan sensors provide faulting and rutting measurements as well as International Roughness Indices (IRI). The contract to collect these data elements was developed to meet HPMS reporting requirements and will satisfy the requirements of MAP 21.

2.2.2 Data Collection Methods- Bridges

Structures, as defined by the NBIS are bridges, culverts, and pipe systems that span 20 feet or greater. Inspection of these assets is a primary function of the Structures Management Unit (SMU). A combination of Initial, Routine, In-Depth, Damage, Special, and Fracture Critical Inspections are carried out by NCDOT inspection teams, as well as by private engineering firms by contract. Routine inspections are performed by small, hands-on teams to document the existing physical and functional conditions of

each structure in accordance to FHWA's National Bridge Inspection (NBI) program. The inspection report for these bridges includes condition ratings, photographs, maintenance needs, and recommendations for major improvements.

Routine Inspections, Fracture Critical Member Inspections, and Movable Span and Machinery Inspections occur on a 24-month cycle for all bridges. Inspections less than 24 months are determined on a case by case basis when a condition rating of 3 or less exists for one of the following: Deck, Substructure, Superstructure, or Culvert. Consideration is given to the presence of temporary repairs and other relevant factors. Underwater inspections occur on a 48-month cycle for all bridges over water when structural members underwater cannot be evaluated during a routine above-water inspection. Underwater inspections less than 48 months are determined on a case by case basis. Damage inspections due to vehicle or vessel collisions are also performed on an as-needed basis.

2.3 Inventory and Condition

The NHS includes Interstate highways, interstate business, US, NC and selected secondary routes and ramps connecting to an NHS route. Routes may be owned and maintained by the state, municipalities or federal agencies. Tables 2-1 and 2-2 show the distribution of state and federal designated routes and mileage correlation of the NHS and the state's interstate, primary and secondary routes.

Table 2-1: Mileage correlation by category in North Carolina

Route Designation	Route Miles	Lane Miles	NHS Route Miles	NHS Lane Miles	% NHS by Route Miles	% NHS by Lane Miles
Interstate	1,339.7	6,364.2	1,338.0	6,357.3	99.87%	99.89%
Primary	13,785.3	34,974.8	4,083.5	14,126.7	29.62%	40.39%
Secondary	64,830.5	123,250.0	192.9	752.0	0.30%	0.61%
Total State Maintained	79,955.5	164,589.0	5,614.4	21,236.0	7.02%	12.90%

Table 2-2: NHS Mileage by System and Owner

Route Designation	NHS Route Miles	NHS Lane Miles	% NHS by System Route Miles	% NHS by System Lane Miles
Interstate	1,338.0	6,357.3	23.65%	29.68%
Primary	4,083.5	14,126.7	72.16%	65.95%
Secondary	192.9	752.0	3.41%	3.51%
Total State Maintained	5,614.4	21,236.0	99.22%	99.14%
Federal	2.2	4.5	0.04%	0.02%
Local Government	42.2	180.0	0.75%	0.84%
Total NHS	**5,658.6**	**21,420.5**	**100.00%**	**100.00%**

The NHS in North Carolina make up about 13% of the 164,589 lanes miles of state maintained highways; 96% of the NHS is on the interstate and primary systems. Additionally, there is 184.5 lane miles of the NHS maintained by other agencies. NCDOT collects pavement and bridge condition data for the NHS maintained by local governments.

2.3.1 Interstate Pavements

Based on the MAP-21 performance standards for pavements, Figures 2-1 and 2-2 show the estimated good, fair and poor metrics of the Interstate system for years 2013-2017. Using the best available data, these measures were calculated based on the NHS inventory in 2016. The entries in percent good have all three of the MAP-21 performance measures meeting the good threshold. Entries in percent poor have two or more of the MAP-21 performance measures meeting the poor threshold. Missing and invalid data constitutes no more than 1.1% of the total mileage which is below the 5% cap requirements of 23 CFR 490.109(e)(4)(iii). Figure 2-2 shows trends with a slight decrease for percent good and conversely a slight increase for percent poor from 2013 to 2017.

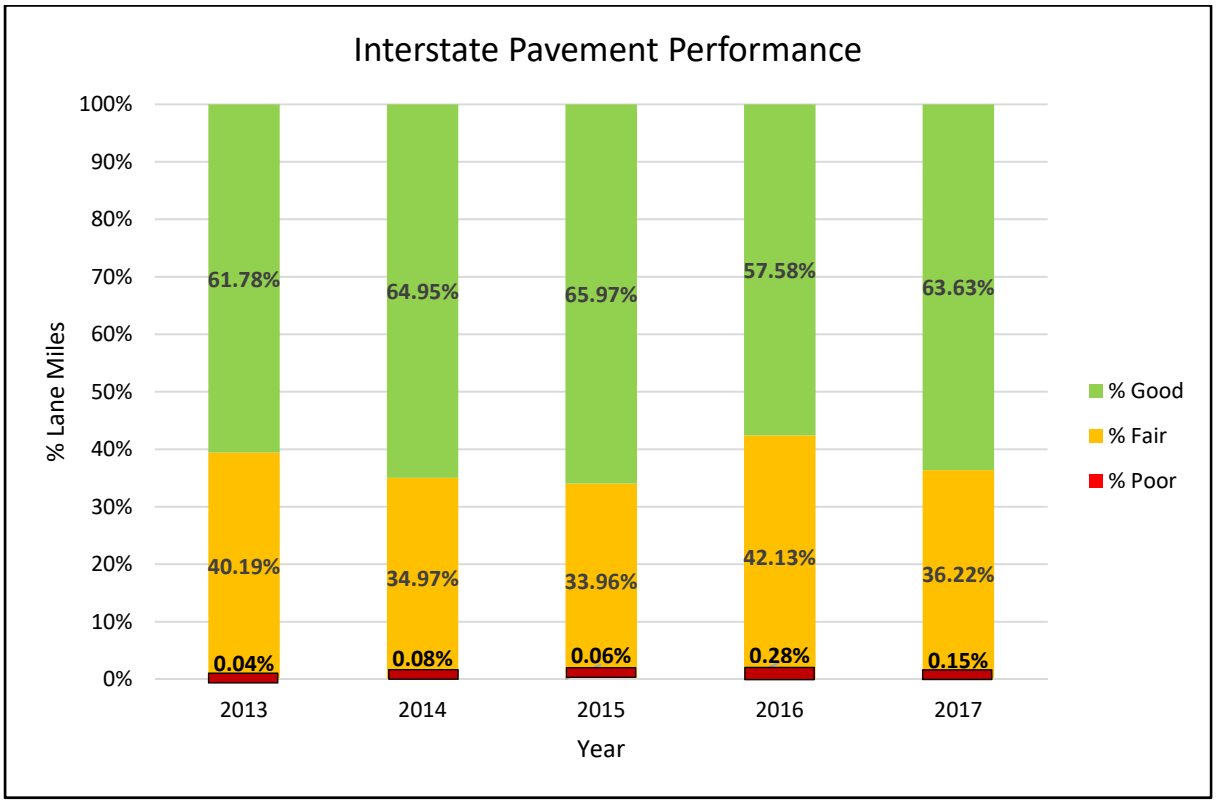

Figure 2-1: Interstate Pavement Performance (MAP-21 Metrics)

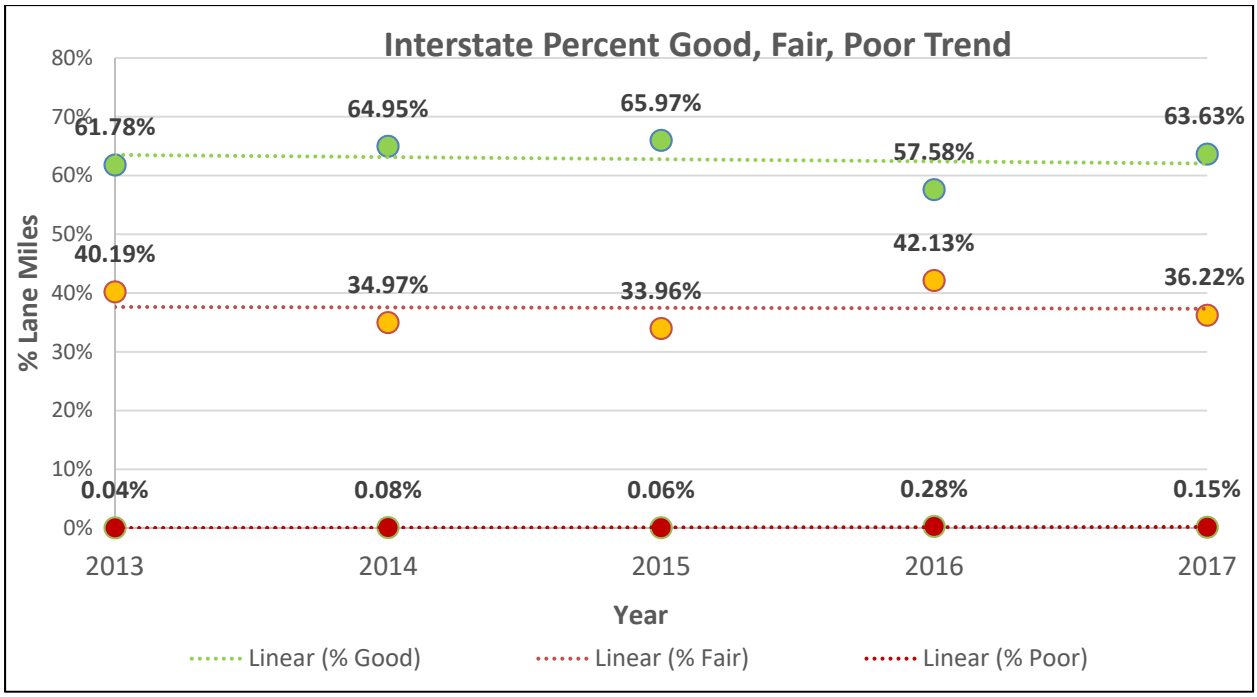

Figure 2-2: Interstate Pavement % Good, Fair, Poor Trends (MAP-21 Metrics)

2.3.2 Non-Interstate NHS Pavements

Figure 2-3 shows the estimated percentage of pavements in good, fair and poor categories for the non-interstate NHS using the MAP-21 performance measures. There are 1,394.7 miles (2.6%) of missing and invalid Non-Interstates NHS for year 2017 of which 735.5 miles are secondary roads that were surveyed with a windshield survey method utilized prior to 2018 and does not conform to the FHWA rules. In addition, there are 180 miles of local government roads (generally municipal streets) and 4.5 miles of Federal Roads. Modification of the contract with the automated distress survey vendor to collect the complete inventory of previously uncollected NHS in accordance with FHWA rules will result in a significant reduction in missing lane miles. Figures 2-4 shows estimated condition trends having 4% decrease for percent good and a 0.5% increase for percent poor from 2013 to 2017.

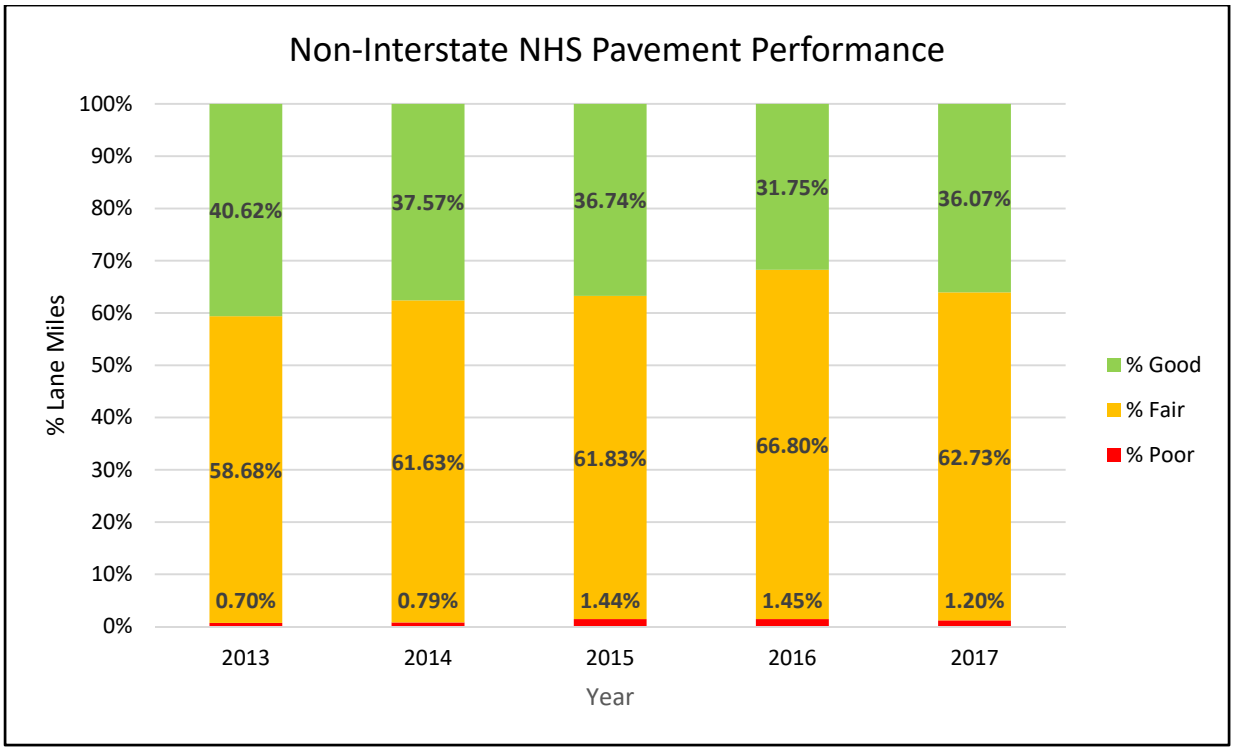

Figure 2-3: NHS non-Interstate Pavement Performance (MAP-21 Metrics)

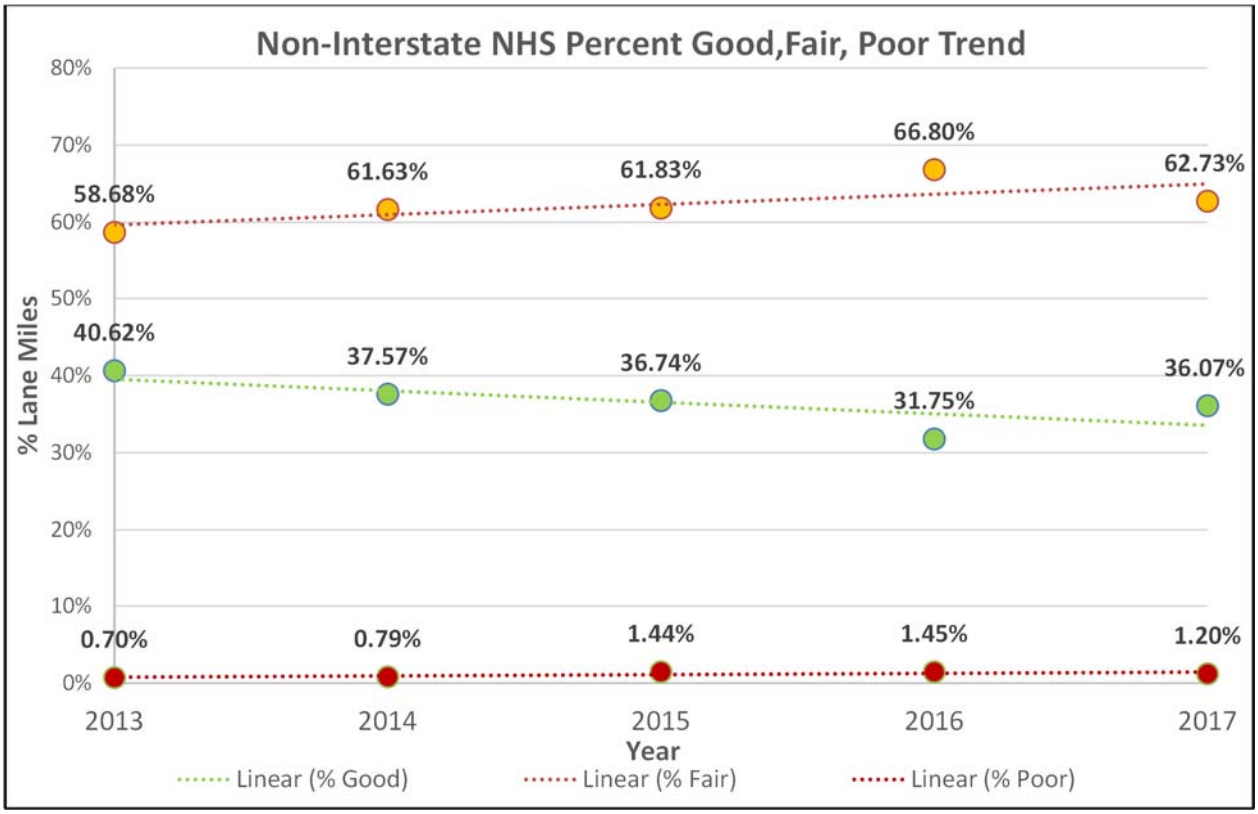

Figure 2-4: NHS non-Interstate % Good, Fair, Poor Trends (MAP-21 Metrics)

2.3.3 NHS Bridge Conditions

There are 3,583 bridges on the NHS in North Carolina including 1,221 that are on the interstate system. All but 20 of them are state owned and state maintained. As will be described in more detail later, 180 of the NHS bridges have condition rating of poor, with a total deck area of 3,405,589 square feet. Two large bridges make up one third of the square feet of these poor bridges.

As shown in Table 2-3 in accordance with MAP-21 performance standards approximately 6.8% of state and locally owned NHS bridges are poor (based on deck area) as compared to the federal standard of no more than 10% poor. By system, 2.5% of the bridges on the Interstate system are poor, 9.6% on the primary system are poor, and 3.2% of the bridges on the secondary system are classified as poor. Locally owned/maintained bridges make up 0.5% of the total NHS bridges with none of them falling into the poor category.

Table 2-3: Current Inventory and Condition of NHS Bridges & Culverts

System	Owner	Number of Bridges & Culverts	Deck Area (SF)	MAP-21 Poor Deck Area (SF)	MAP-21 % Poor	MAP-21 Good Deck Area (SF)	% Good
Interstate	State	1221	17,384,091	426,351	2.50%	7,366,918	42.40%
Primary	State	2176	30,393,177	2,925,499	9.60%	10,331,830	34.00%
Secondary	State	166	1,691,192	53,638	3.20%	1,132,332	67.00%
Local government	Local government	20	259,471	0	0.00%	109,603	42.20%
Total	State	3563	49,727,932	3,405,489	6.80%	18,940,684	38.10%
	Local	20	259,471	0	0.00%	109,603	42.20%
	Total	3583	49,987,403	3,405,489	6.80%	19,050,287	38.10%

Based on the MAP-21 performance standards for bridges, Figure 2-5 shows the good, fair and poor performance of the NHS bridges for years 2013-2018. The entries in percent good have all three of the MAP-21 performance measures meeting the good threshold. Entries in percent poor have one or more of the MAP-21 performance measures meeting the poor threshold. Figures 2-6 shows trends with a slight decrease for percent good and percent poor from 2013 to 2018.

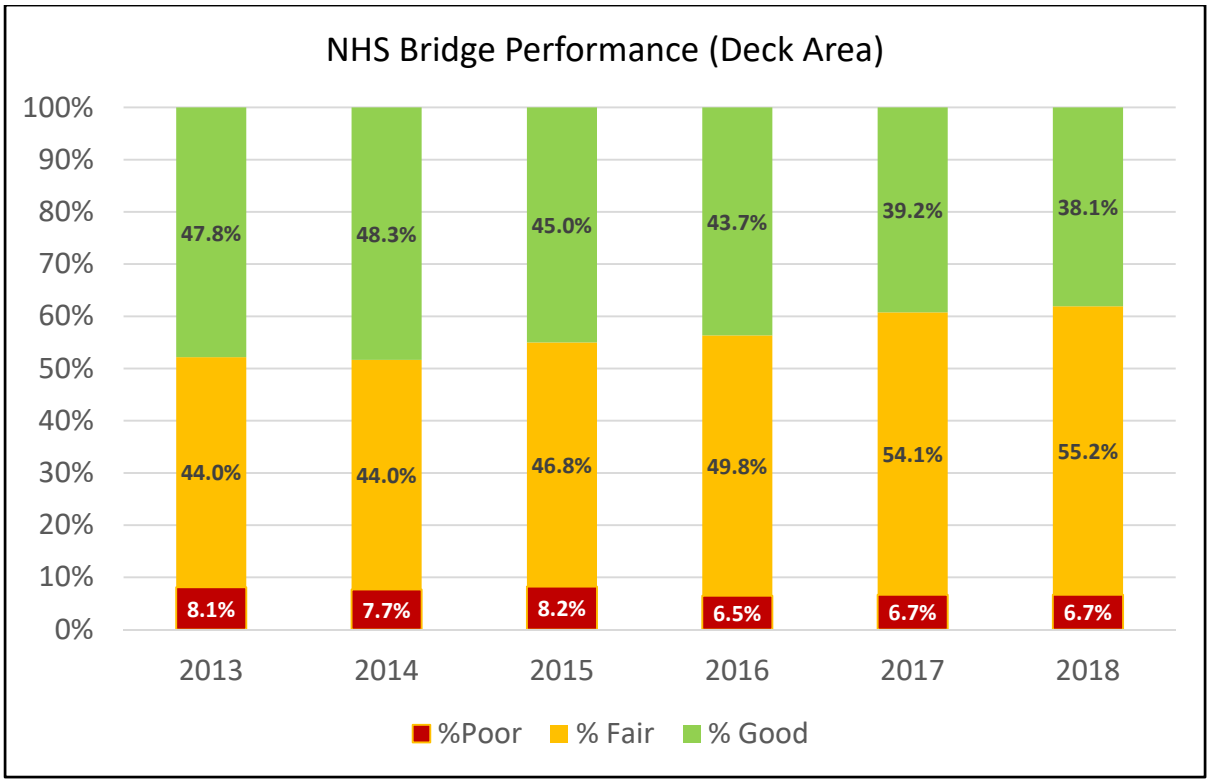

Figure 2-5: NHS Bridge Performance (MAP-21 Metrics)

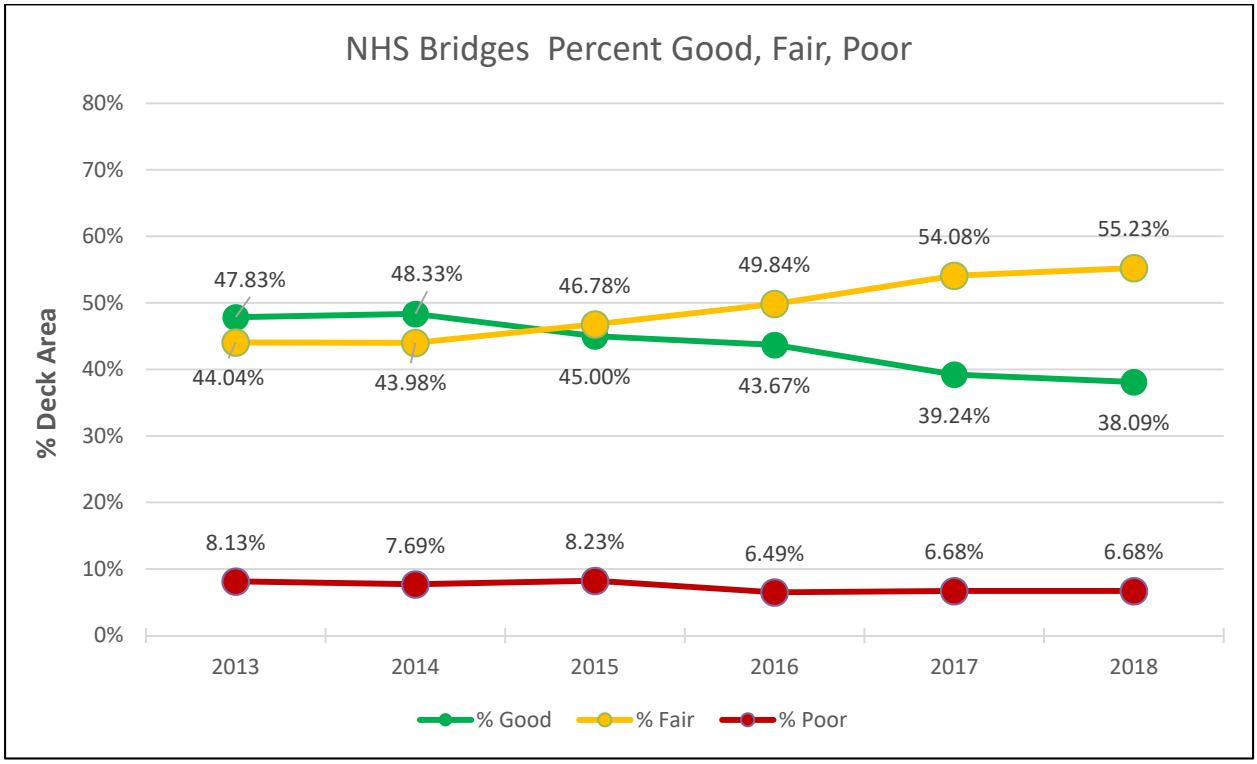

Figure 2-6: NHS Bridge Performance % Good, Fair, Poor Trends (MAP-21 Metrics)

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Chapter 3 Performance Goals, Targets, & Gaps

3.1 Performance goals and targets overview

NCDOT collects information on the condition of pavements and bridges throughout the state in order to evaluate the transportation system's performance. Performance measures and targets were established based on the operations, future conditions, and maintenance of the roadway system in conjunction with customer input. These performance measures have served as a good basis for NCDOT to determine investment strategy, funding amounts, and project identification and provide a good foundation for the Transportation Asset Management Plan.

The national performance management measures and targets required by MAP-21, to address the condition of pavements and bridges, on both the interstate system and the NHS system are discussed in this chapter. NCDOT has defined specific performance targets that constitute the agency's state of good repair (SOGR) for pavement and bridges on the interstate, primary and secondary systems. It should be noted that national performance "targets" will not be finalized in time to include in the interim TAMP but will be addressed in future updates to this document.

Establishing performance measures and targets is fundamental to creating an asset management plan that supports the management and performance of the NHS, as well as, to identify the need for preservation, maintenance, rehabilitation, or construction of new facilities. Tracking measurable conditions for pavements and bridges in relation to targets is a useful tool for NCDOT to determine if the agency's goals for performance are being achieved at a network level as well as at a division or a local level. It is also a transparent tool for NCDOT to identify where funds benefit the various highway systems both on and off interstates.

NCDOT tracks pavement and bridge conditions in a pavement management system and a bridge management system. The historic condition for each of the measurable conditions tracked are shown in Chapter 2. For pavement metrics, NCDOT collects pavement condition data through an automated process which is used to calculate a Pavement Condition Rating (PCR) for each segment of highway. The PCRs of each highway segment are used to calculate a summary score, Pavement Condition Index (PCI) for a highway or highway network which is a gauge of the overall condition of the highway. The schedule for pavement evaluation is annually on all state highways. For the bridges, every two years, inspectors rate the general condition of the culverts, bridge decks, bridge superstructures, bridge substructures. NCDOT stores and tracks this data, along with element level condition data, geometric data, and geographic data for each bridge. The general condition ratings are used to determine to the overall condition of the bridge or culvert. For large culverts (greater than 20' along the centerline of the highway), NCDOT tracks the overall condition.

It is important to note that NCDOT historically meets or exceeds the national performance minimum standards established by MAP-21 for the pavement and bridge conditions, as will be shown in the following sections of this chapter.

3.2 National performance measures and minimum standards

Through MAP-21, national performance goals have been established for pavements and bridges to maintain the condition of these assets in a state of good repair. The National Performance Management Measures for pavements identified in 23 CFR Part 490 have established four measures to assess pavement condition:

1. Percentage of pavements (Lane Miles) on the interstate system in Good condition,
2. Percentage of pavements (Lane Miles) on the interstate system in Poor condition,
3. Percentage of pavements (Lane Miles) on the NHS (excluding the interstate system) in Good condition, and
4. Percentage of pavements (Lane Miles) on the NHS (excluding the interstate system) in Poor condition.

Within the national rule, performance ratings of good, fair, and poor condition for pavements have been established by FHWA based on a combination of several metrics collected by every state DOT in accordance with HPMS (Highway Performance Monitoring System). FHWA will use these metrics to quantify the condition of pavements in terms of roughness (International Roughness Index - IRI), cracking, rutting (asphalt) and faulting (concrete). The following Table 3-1 summarizes the metrics and the performance ratings.

Table 3-1: MAP-21 Pavement Metrics and Performance Ratings

METRIC	PAVEMENT TYPE	GOOD	FAIR	POOR
IRI	ALL	< 95	95 to 170	> 170
Cracking	Asphalt	< 5%	5% to 20%	> 20%
Cracking	Jointed Concrete	< 5%	5% to 15%	> 15%
Cracking	CRCP	< 5%	5% to 10%	> 10%
Rutting	Asphalt	< 0.20"	0.20" to 0.40"	> 0.40"
Faulting	Jointed Concrete	< 0.10"	0.10" to 0.15"	> 0.15"

Using this criterion, an asphalt pavement is considered to be in good condition only if all three metrics, consisting of IRI, percent cracking, and rutting meets the criteria for good. The pavement is considered to be in poor condition if any two of the three metrics (IRI, percent cracking, and rutting) are determined to be in poor condition. Finally, the pavement is classified as fair if it doesn't meet the criteria of the good or poor conditions. Similarly, a jointed concrete pavement is considered to be in good condition only if all three metrics, consisting of IRI, percent cracking, and faulting meets the criteria for good. The pavement is considered to be in poor condition if any two of the three metrics (IRI, percent cracking, and faulting) are determined to be in poor condition. Finally, the pavement is classified as fair if it doesn't meet the criteria of the good or poor classification. Continuously Reinforced Concrete Pavement (CRCP) is evaluated only on two metrics; IRI and cracking. CRCP is considered to be in good condition if both metrics of IRI and cracking is determined to meet the criteria for good. It is considered to be in poor

condition if both IRI and cracking is determined to meet the criteria for poor. It is considered to be in fair condition if it doesn't meet the criteria of the good or poor classification. The following Table 3-2 provides a summarization of this information along with the applicable federal rule, and the minimum standard for interstate pavements.

Table 3-2: MAP-21 good/fair/poor determination for pavements and minimum standard

RULE	23 CFR Part 490.313 (c)				23 CFR Part 490.315(a) – (Interstate only)
PAVEMENT TYPE	**METRICS**	**GOOD**	**POOR**	**FAIR**	**MINIMUM STANDARD (Interstate only)**
Asphalt	IRI, Cracking, Rutting	All 3 = Good	2 of 3 = Poor	All other combinations	< 5% in Poor condition
Jointed Concrete	IRI, Cracking, Faulting	All 3 = Good	2 of 3 = Poor	All other combinations	< 5% in Poor condition
CRCP	IRI, Cracking	All 2 = Good	2 of 2 = Poor	All other combinations	< 5% in Poor condition

In order to give state and local agencies time to modify the way they collect pavement condition data to meet these collection standards, the national rule provides for a transition period. Data collected between Jan 1st, 2018 and December 31st, 2018 will be used for all data items on Interstate routes in the Calendar Year 2019 HPMS submittal. The data collected between January 1st, 2019 and December 31st, 2019 will be used for all items on both the Interstates and NHS in the Calendar 2020 HPMS submittal. State DOTs will only be measured based on IRI rating until after the data collection cycle ending December 31, 2018 for interstate highways and December 31, 2020 for the non-interstate NHS system. After these dates, state DOTs will be evaluated based on the metrics identified in Table 3-2 and will also be required to limit the portion of their inventory data that is missing, invalid, or unresolved to no more than 5 percent.

The process for determining the condition of bridges is similar in concept to that for pavements. The national performance management measures for bridges identified in 23 CFR Part 490 have established three classifications for the purpose of assessing bridge condition (based on square foot of deck area):

1. Percent of NHS bridges classified as in good condition,
2. Percent of NHS bridges classified as in fair condition, and
3. Percent of NHS bridges classified as in poor condition.

Within the national rule, performance ratings of good, fair, and poor condition for bridges have been established by FHWA based on a combination of three metrics that are collected by every state DOT including NCDOT. These metrics, based on a 0 to 9 condition scale will be used to quantify the condition of bridges in terms of bridge deck, superstructure, and substructure. Culverts will be evaluated based on their overall condition. The following Table 3-3 summarizes the metrics and the performance ratings.

Table 3-3: MAP-21 Bridge Components and Performance Ratings

COMPONENT	GOOD	FAIR	POOR
Deck	7 to 9	5 to 6	0 to 4
Superstructure	7 to 9	5 to 6	0 to 4
Substructure	7 to 9	5 to 6	0 to 4
Culverts	7 to 9	5 to 6	0 to 4

Using this criterion, a bridge is considered to be in good condition only if all three metrics for the deck, superstructure, and substructure meet the criteria for good. The bridge is considered to be in poor condition if any of the three metrics are determined to be in poor condition. Finally, the bridge is classified as fair if it doesn't meet the criteria of the good or poor conditions. Similarly, for a NBI culvert, it is considered to be in good condition only if its overall condition is rated as good. It is considered to be in poor condition if its overall condition is determined to be in poor condition. Finally, it is classified as fair if its overall condition is determined to be in fair condition. The following Table 3-4 provides a summarization of this information along with the applicable federal rule, and the minimum standard for all bridges on the NHS.

Table 3-4: MAP-21 good/fair/poor determination for bridges and minimum standard

RULE	23 CFR Part 490.409 (b)				23 CFR Part 490.411(a)
STRUCTURE TYPE	**COMPONENT**	**GOOD**	**FAIR**	**POOR**	**MINIMUM STANDARD**
Bridge	Deck, Superstructure, Substructure	All Components = Good	No Components = Poor, 1 or more = Fair	1 or more Components = Poor	No more than 10% rated as POOR
Culvert	Overall Condition Rating	Rating = Good	Rating = Fair	Rating = Poor	

*Based on square feet of bridge deck

3.3 How NCDOT compares to National performance standards

NCDOT is currently meeting or exceeding the federal minimum performance standards for NHS pavements and bridges as shown in Figures 3-1 thru 3-3 below. In order for NCDOT to maintain this high standard of bridge conditions that have been historically established, the bridge management system (BMS) is used to assist NCDOT in predicting the future needs to preserve the system and maximize the use of their assets at minimum cost. The BMS is used to track the metrics of the bridges and culverts as described in Chapter 2. This same system can be used to evaluate future needs through life cycle analysis.

Similarly, the Pavement Management System (PMS) is the engine that stores the results of the pavement condition survey and provides the analysis to assist NCDOT managers with the information and data to develop pavement management programs to meet NCDOT's goals and objectives using life cycle cost processes discussed in more detail in Chapter 4.

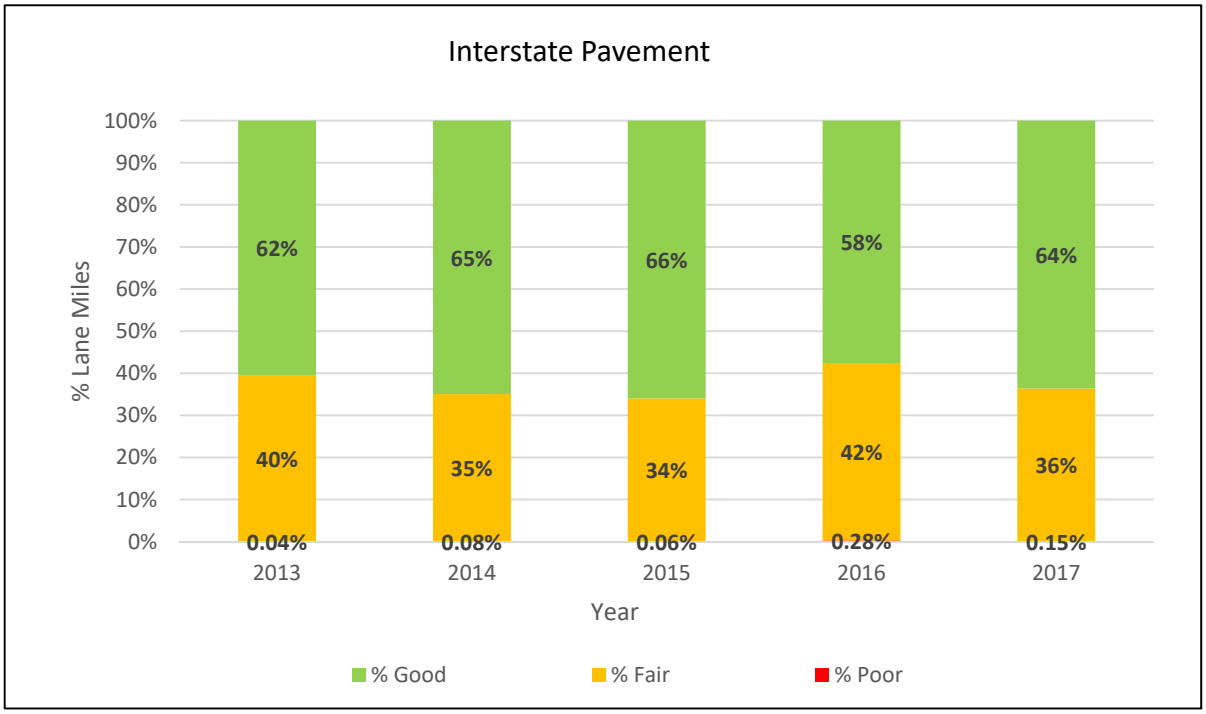

Figure 3-1: NHS Interstate Pavement Performance (MAP-21 Metrics)

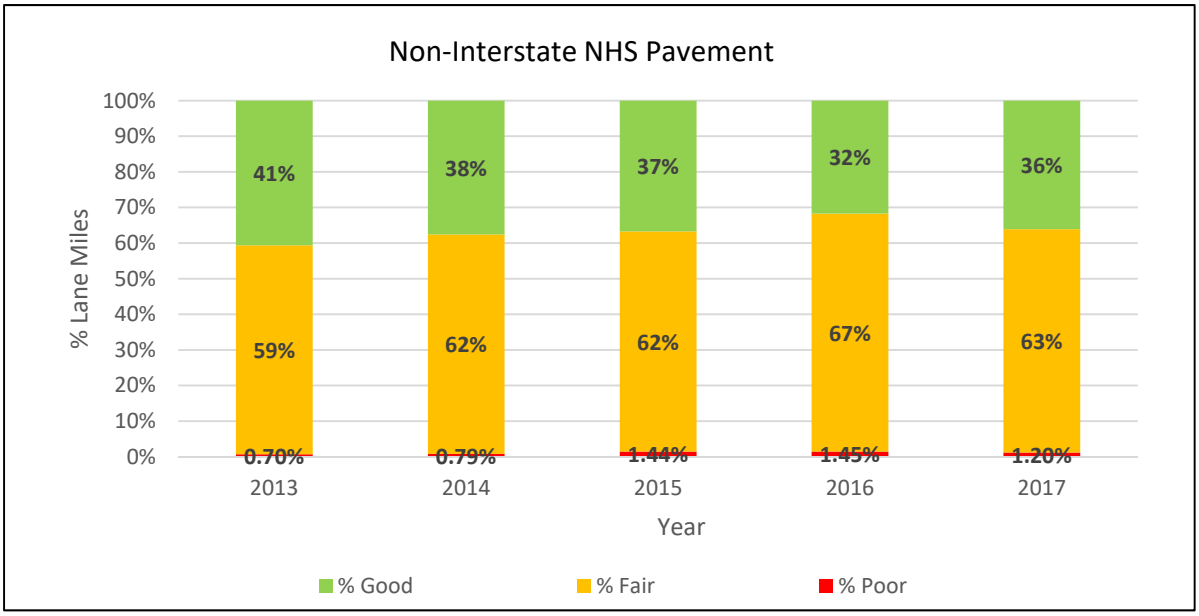

Figure 3-2: NHS Non-Interstate Pavement Performance (MAP-21 Metrics)

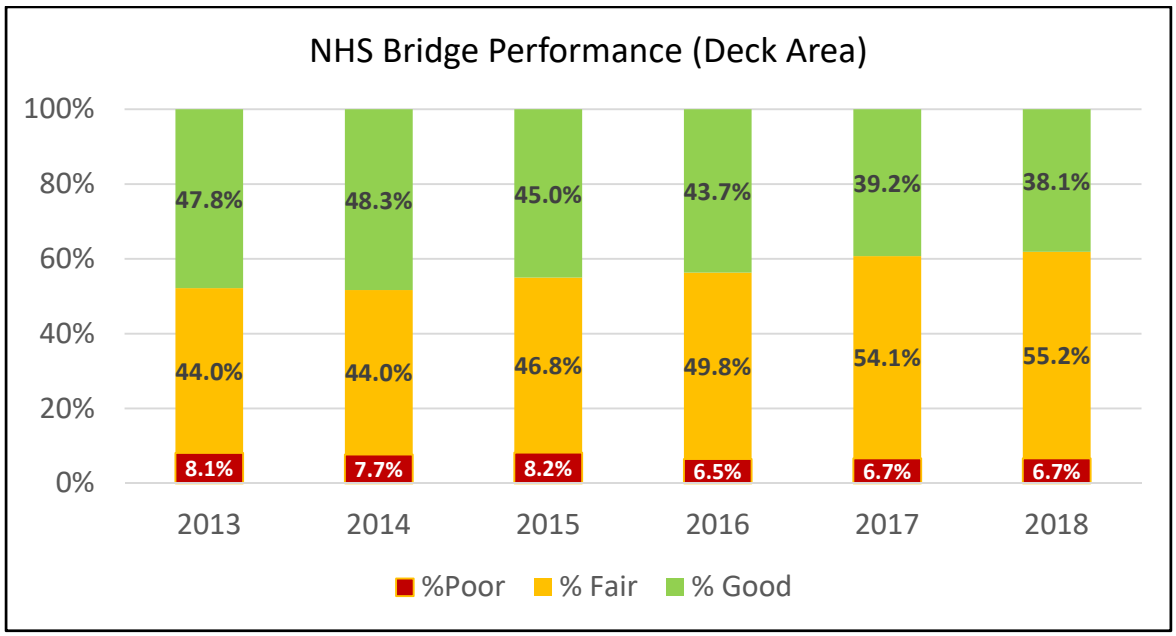

Figure 3-3: NHS Bridge Performance (MAP-21 Metrics)

3.4 NCDOT projections using MAP-21 performance measures

NCDOT has historically managed pavements based on the highway classifications of interstate, primary, and secondary systems. Currently the Department is unable to perform an analysis which would accurately forecast the future condition of pavements on the NHS system using the PMS, therefore, this information is not available at this time and will not be included in the initial TAMP. This has been identified as a gap in the process and will be addressed in the final TAMP.

For bridges on the NHS the Department has the capability to forecast future bridge condition based on the MAP-21 performance measures using trend line analysis and performance history. A more rigorous projection is not possible at this time due to differences between state and federal performance measures regarding both the units of measure and associated bridge systems. However, the differences are small enough for the poor performance measure to enable a trend line analysis to be reasonably accurate and complimentary to projections for the state performance measure. The following Figure 3-4 suggests that the Department will have no trouble meeting the minimum standard of no more than 10% in poor condition.

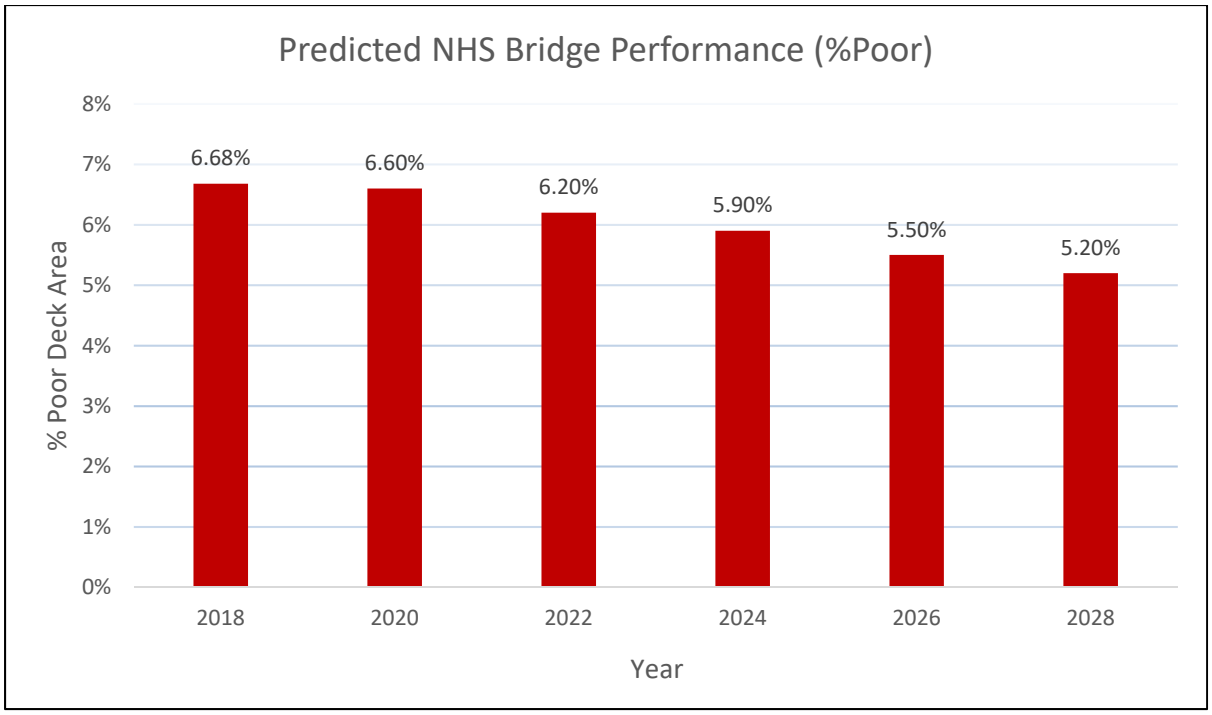

Figure 3-4: Predicted NHS Bridge Performance (MAP-21 Metrics)

3.5 NCDOT state of good repair for pavement and bridges

NCDOT has a long-standing history of maintaining the state's pavement and bridges in good condition and serviceable to the traffic they serve. The agency's long-term goals are to maintain pavement and bridges in a state of good repair (SOGR) throughout the assets life cycle at the lowest possible cost.

NCDOT has established long-term performance targets for pavements and bridges based on their importance and functional need in accordance with the highway system designation of interstate, primary, and secondary. For example, interstate highways are the most important facilities since they provide the backbone for the movement of people, freight, and commerce within and through the state as well as provide access for the majority movement of people and goods into and out of the state. The next most important highways are the primary routes, and lastly the secondary roads. It should be noted that NCDOT's highway system designation of interstate, primary, and secondary does not fully match the state's NHS, however, the interstate and primary system comprises 95.7% of all NHS lane miles. The following Table 3-5 provides the state of good repair performance measures and targets for the agency's pavements and bridges based on highway system.

Bridge performance is determined based on the NBIS rating codes identified in Table 3-3. NCDOT uses these condition ratings for managing the bridge program and considers a bridge to be Structural Deficient (SD) if any one of the three components of bridge deck, superstructure, or substructure is rated a 4 or less. The department's SOGR targets for SD bridges on the interstate, primary, and secondary

systems are; <2%, <6%, and <15% respectively. It should be noted that NCDOT's performance measure for NBIS culverts is slightly different from the MAP-21 rules. The Department uses the NBIS condition code for the overall condition of the culvert, however, the performance standard is based on a minimum condition rating of 6 or better to be consider in good condition, whereas, MAP-21 rules specifies that in order to be considered in good condition, the condition rating has to be 7 or higher. This is reflected in the following tables and charts as indicated.

Table 3-5: State of Good Repair Targets

ASSET	SYSTEM	PERFORMANCE MEASRUE	TARGET
Pavements	Interstate	PCI ≥ 80 (Good)	≥ 85%
	Primary	PCI ≥ 80 (Good)	≥ 80%
	Secondary	PCI ≥80 (Good)	≥ 70%
Pavements	Interstate	PCI ≤ 60 (Poor)	≤ 5%
	Primary	PCI ≤ 60 (Poor)	≤ 7.5%
	Secondary	PCI ≤ 60 (Poor)	≤ 10%
Bridges	Interstate	Structural Deficiency	< 2%
	Primary	Structural Deficiency	< 6%
	Secondary	Structural Deficiency	< 15%
Culverts(NBIS)	Interstate	Condition rating ≥ 6*	≥ 85%
	Primary	Condition rating ≥ 6*	≥ 80%
	Secondary	Condition rating ≥ 6*	≥ 75%

* MAP-21 specifies a condition rating of 7 or higher to be considered good

3.6 Gap between pavement performance and SOGR targets

As described previously, NCDOT tracks the pavement condition index (PCI) for asphalt and concrete highways. The PCI is a composite index number measured on a 0 to 100 scale based on pavement distresses such as ride quality, cracking, rutting, patching, corner breaks, and faulting. A pavement with a PCI of 80 to 100 is in good to very good condition, while a pavement with a PCI of less than 60 is in poor condition. Using these characteristics performance is calculated and reported per number of lane miles. These results are used to assist the department in determining funding amounts, allocations to the 14 divisions, and choosing the appropriate work types to minimize whole-life cost, i.e. combination of maintenance, preservation, rehabilitation, or reconstruction needed for the pavements. The following Figure 3-5 shows the PCI rating for 2016 and 2017 for the interstate, primary and secondary road systems. As shown in 2017, there is 0.60% of pavement rated as poor on the interstate, which is within the SOGR target range of no more than 5%. There is 5.5% poor on the primary state routes, which is within the SOGR target range of no more than 7.5% poor, and 14.1% poor on the secondary state routes, which is above the 10% poor for SOGR on secondary.

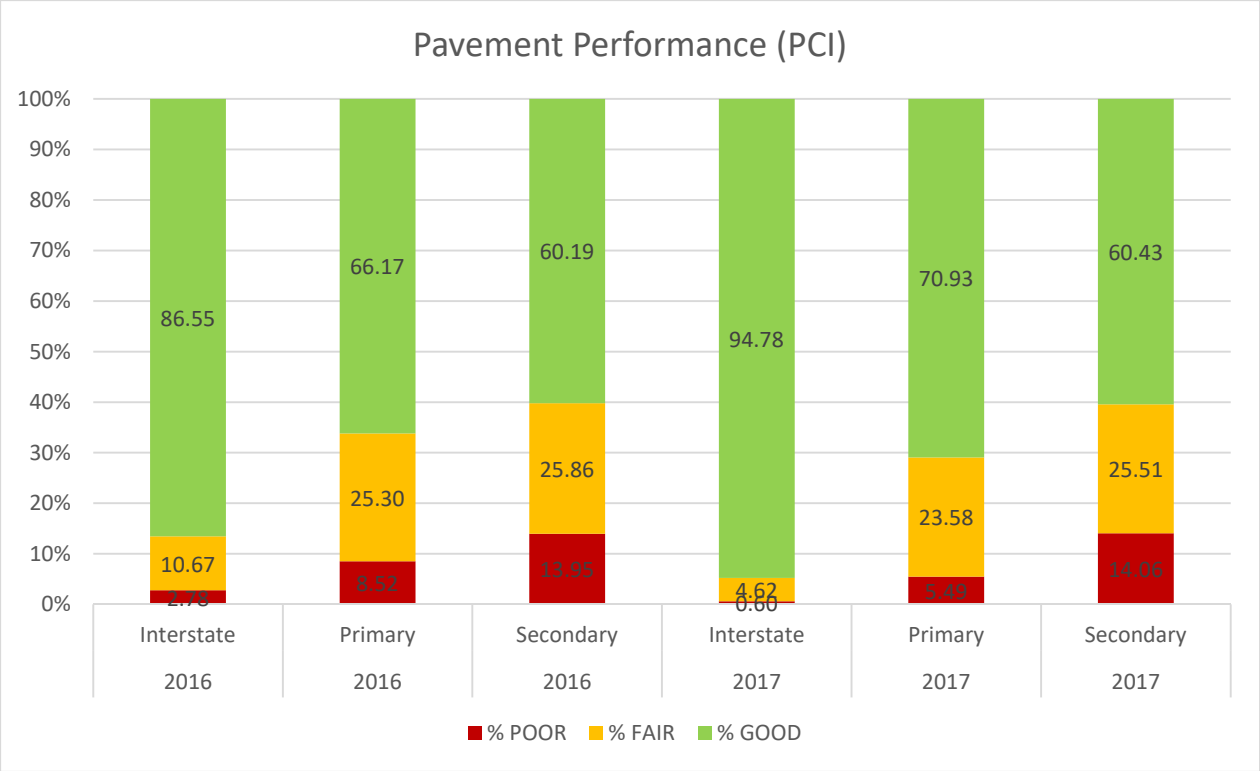

Figure 3-5: Pavement Performance (NCDOT Metrics)

3.7 Gap between bridge performance and SOGR targets

Since NCDOT has established a dependable bridge management process using the NBIS inspection reports to determine program and project needs, the Department will be able to make a smooth transition to the TAMP requirements. The inspection program requires an in-depth evaluation of the deck, substructure, and superstructure for bridges, and key features of culverts based on the NBIS. The results of the inspection are used to determine the type of work activity required for the bridge or culvert, i.e. maintenance, preservation, rehabilitation, or replacement.

Based on NCDOT's SOGR targets listed in Table 3-5, the following Figure 3-6 shows the percent of bridges in poor condition based on bridge data for years 2014-2018. Bridges in poor condition fall into a structurally deficient (SD) category and include those with advanced section loss, deterioration or spalling, or has insufficient load carrying capacity. In 2018 there are 3.5% of the bridges rated as SD on the interstate system, 8.7% SD on the primary system, and 16.1% SD on the secondary system. While the existing conditions are not meeting the SOGR targets, the Department is committed to improve the performance of bridges and that commitment is reflected in the decline of the percent of SD over the past five years as depicted in Figure 3-6.

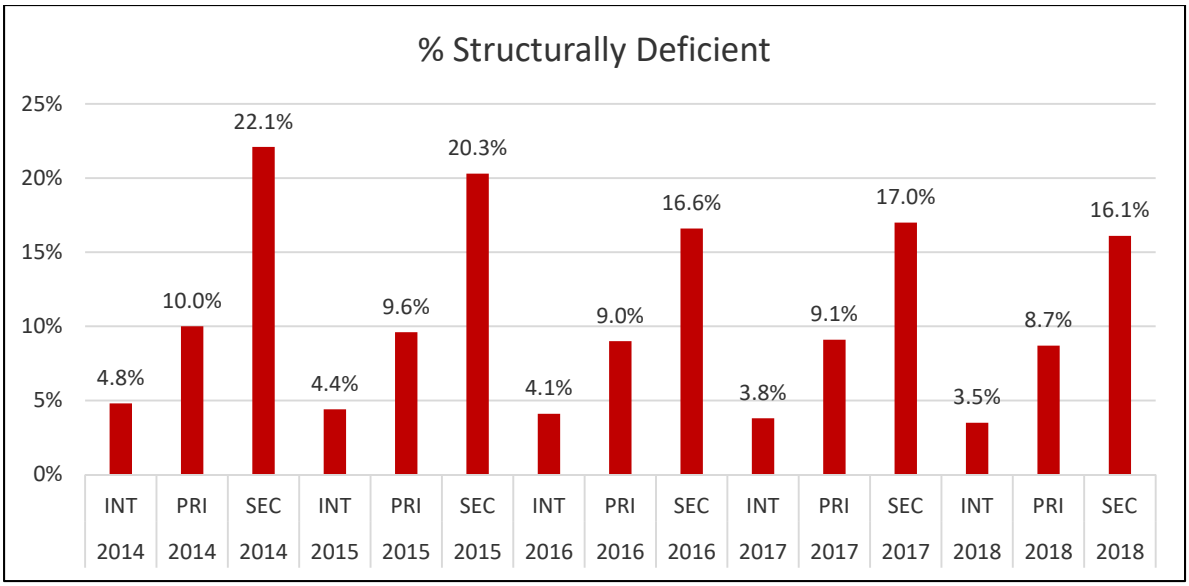

Figure 3-6: Percent of Deficient Bridges by System (NCDOT Metrics)

3.8 NCDOT's predicted pavement condition vs. SOGR targets

The following figures 3-7 thru 3-10 of the PMS analysis show the pavement condition (using PCI) expected between years 2018-2027 for the interstate, primary, and secondary systems. The analysis excludes known capital projects. It should be noted that performing a 10-year analysis is dependent on assumptions that can fluctuate over time and vulnerable to conditions that can change drastically, especially in the latter half of the 10-year period. The longer the period of analysis, the greater the uncertainty becomes in the out years. A review of Figure 3-7 indicates that the PCI for interstate pavements will remain in the SOGR targets until year 2024 and then start to decline. Similarly, the secondary system depicted in Figure 3-9 indicates a gradual improvement over time and achieve the SORG targets in year 2023 and maintain those conditions until 2016. However, the primary system struggles to meet the SOGR targets for the duration of the 10-year analysis period. The department has identified this as a gap in the 2016 MOPAR and identified strategies to overcome this deficiency. The department will continue to monitor the performance of all the paved highway system to identify performance gaps and problems and develop additional strategies to modify programs or amend funding recommendations to the NC General Assembly as budgets are discussed. The results of the analysis are broken down for each facility type in the following graphs:

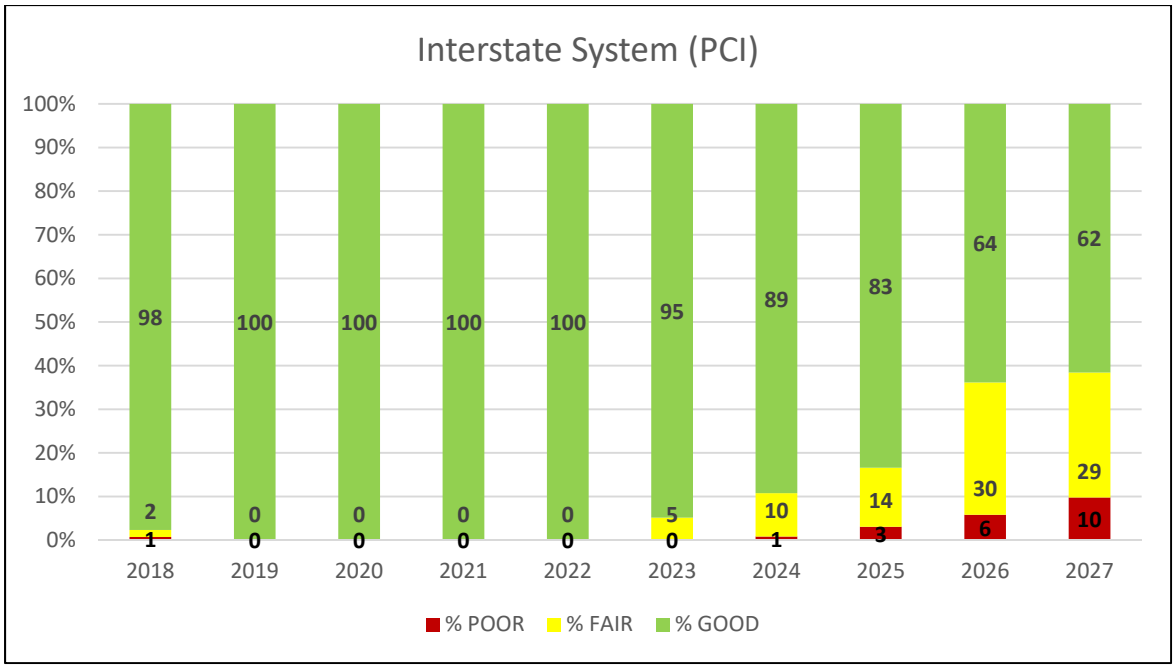

Figure 3-7: Predicted Pavement Performance – Interstate (NCDOT Metrics)

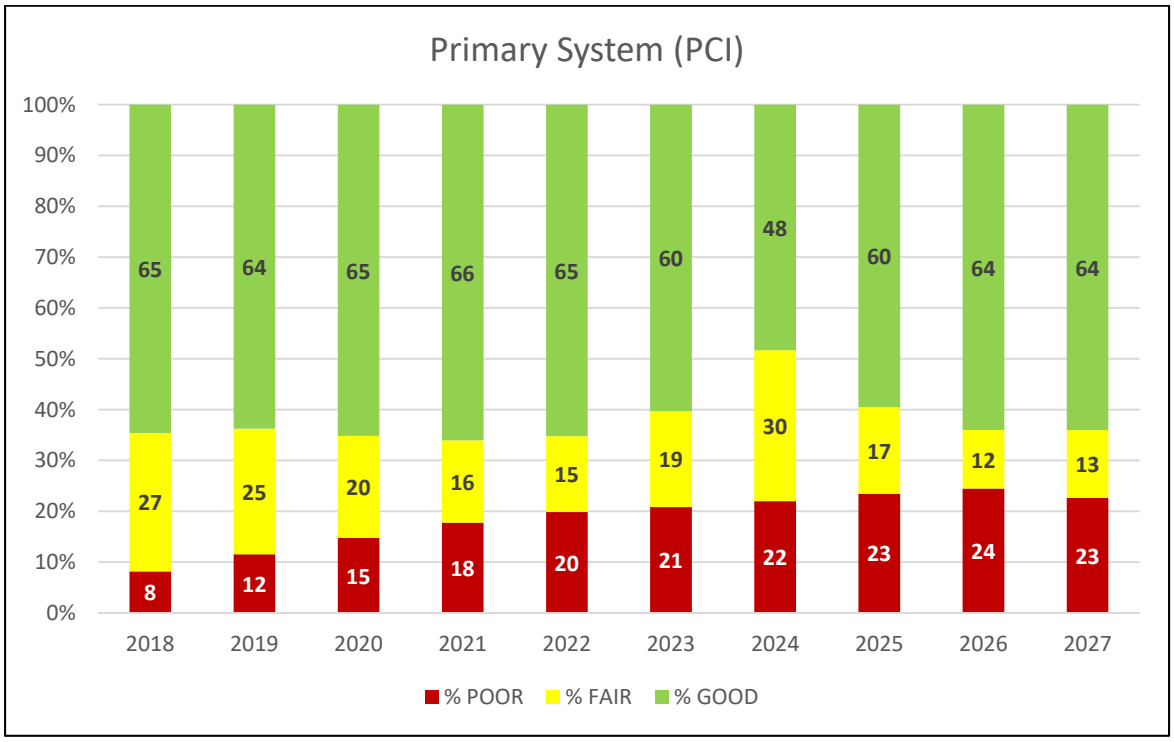

Figure 3-8: Predicted Pavement Performance – Primary (NCDOT Metrics)

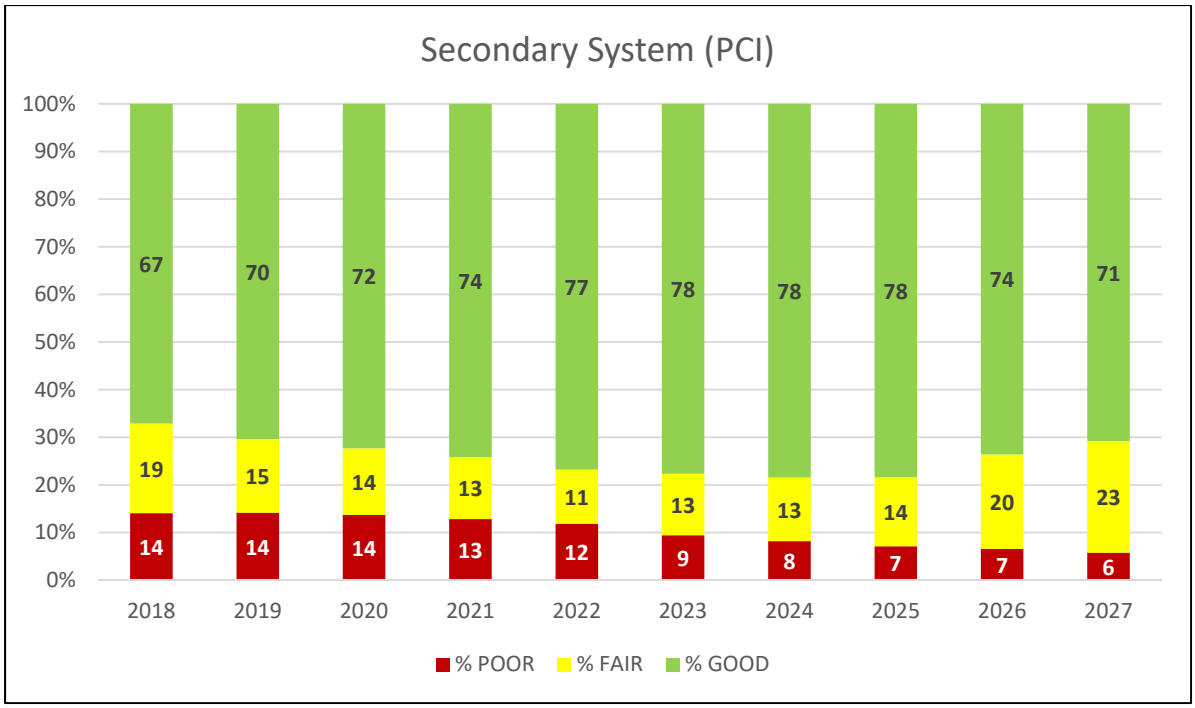

Figure 3-9: Predicted Pavement Performance – Secondary (NCDOT Metrics)

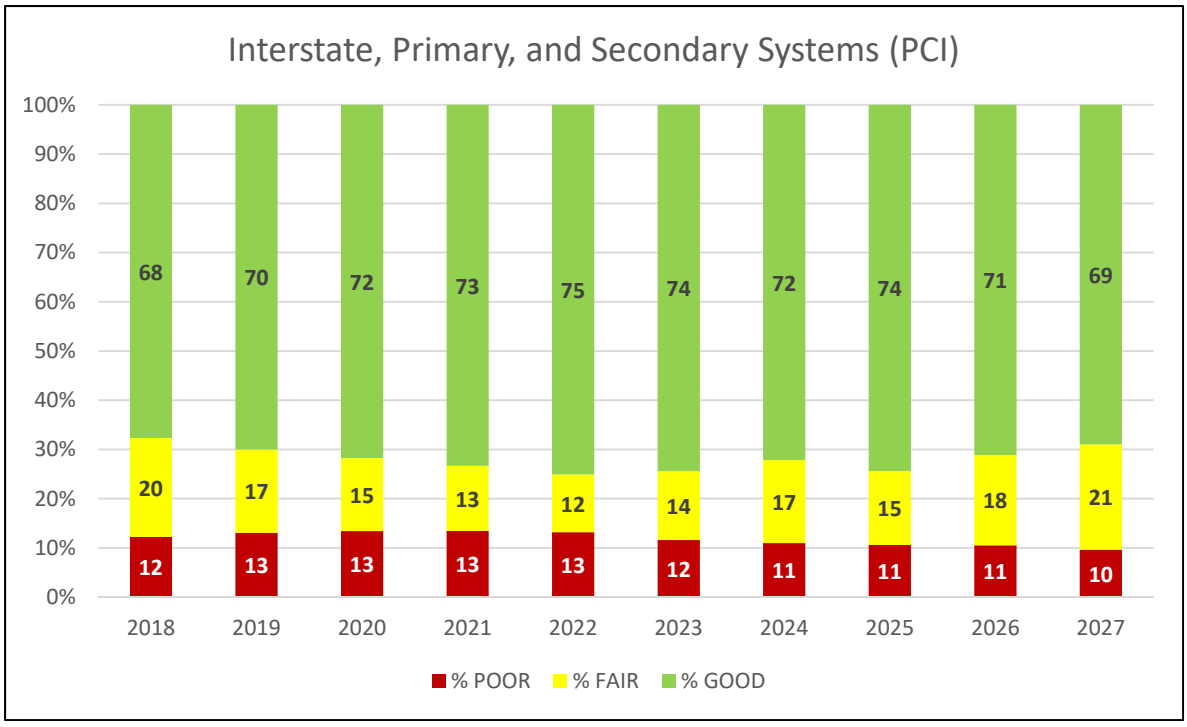

Figure 3-10: Predicted Pavement Performance – All Routes (NCDOT Metrics)

3.9 NCDOT's predicted bridge condition vs. SOGR targets

The following figureshows the bridge condition expected in future years. The results of the analysis are broken down for each system type in the graphs below. Figure 3-11 shows the Department's expected over all trends and the ability to reach SOGR target for percentages of SD bridges (excluding culverts) on the interstate, primary, and secondary road networks in 2030. NBIS Culverts are not tracked through the Department's bridge measures, but through the MCAP program. Currently the Department does not have a process in place to perform a needs analysis to achieve SOGR on culverts and has identified this as a gap.

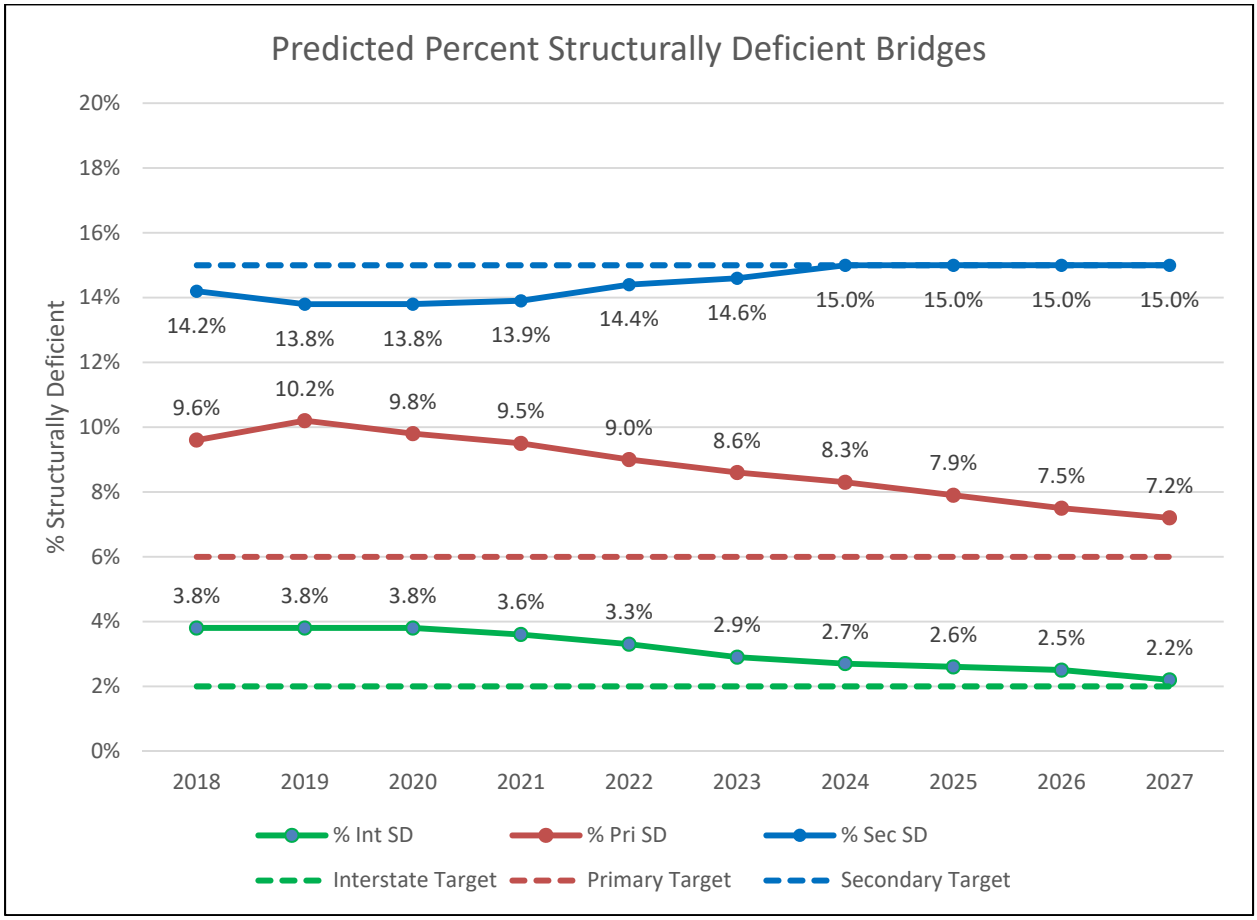

Figure 3-11: Predicted Percent Structurally Deficient Bridges on Interstate, Primary and Secondary Routes (does not include NBIS culverts)

3.10 Factors hindering progress and strategies to address the gap

NCDOT faces a number of challenges in meeting the transportation needs of the state's growing population. The department is responsible for all modes of transportation in the state including highways, ferries, aviation, rail, public transit, bicycle, and pedestrian. With a diverse portfolio of transportation assets, NCDOT has developed a strategic, data-driven decision-making process relying on performance, transparency, and accountability.

Every even-numbered year the department provides a report, "Maintenance Operations and Performance Analysis Report (MOPAR) to the North Carolina General Assembly on the condition of the state highway system and the maintenance funding needs. Within this report the department identifies the funding needed to achieve its performance goals for pavements, bridges, and maintenance. Deficiencies in the various programs are identified and recommendations are listed to meet the performance targets. The 2018 report will be completed by December 2018 and applicable strategies and gaps identified in the report will be considered for inclusion in the final TAMP.

3.11 Monitoring the performance of pavement and bridges

As explained in earlier portions of this section NCDOT has a number of processes in place to monitor the condition of pavements and bridges to determine if the investment strategy and program of projects are in line with the objectives of the agency and the long-term state of good repair targets. Below is a summary of NCDOT processes to identify potential problems, gaps, and development of strategies to head-off issues.

- Pavement Program - Beginning in 2015, the department implemented the Highway Maintenance Improvement Plans (HMIP) which started out as a three-year program but has evolved to a five-year work plan that identifies routes and optimal pavement treatments based on anticipated funding. Each of the 14 highway divisions prepare a plan for their area for adoption by the Board of Transportation. On an annual basis pavement condition results are gleaned from the pavement condition survey and provided to each division and are reported to NCDOT senior management. Additionally, pavement condition performance is estimated based on current condition and budgetary amounts. Results are compared to NCDOT's long-term state of good repair targets and will be compared to the targets NCDOT will establish as a part of 23 USC 150(d) for the NHS. Based on the results of the analysis, each division will prepare a new HMIP for the next 5-year period based on constant dollars; as one year is complete, another year will be added. As described in the chapter on Investment Strategy, the results of the annual pavement performance report will be used to identify issues in NCDOT's pavement management program, determination of funding needs, or other gaps. Adjustments in program strategy and funding will be considered by senior management within the context of the overall vision and funding needs of the department.

- Bridge Program – Similar to the HMIP, the department develops a five-year Bridge Management Improvement Program (BMIP) to make progress towards reaching the state goals for SD bridges. The Structures Management Unit (SMU) and the Divisions work cooperatively to develop the BMIP. Generally, SMU develops initial recommendations for interstate and primary system bridges and the Divisions develops recommendations for secondary road bridges. On an annual basis bridge condition results are gleaned from the BMS and provided to each Division and SMU and reported to NCDOT senior management. Additionally, bridge performance will be estimated based on current condition and budgetary amounts. Results will be compared to NCDOT's long-term state of good repair targets and the targets NCDOT will establish as a part of 23 USC 150(d) for the NHS. Based on the BMS analysis a list of bridges which meet state funding requirements are prioritized using a Priority Replacement Index (PRI). Division and SMU program managers will use this list as they develop their BMIP. As described in the chapter on Investment Strategy, the results of the annual bridge performance report will be used to identify issues in NCDOT's bridge management program, determination of funding needs, or other gaps. Adjustments in program strategy and funding will be considered by senior management within the context of the overall vision and funding needs of the department.

- NCDOT will also evaluate funding needs and effectiveness of the programming of projects, services, and efforts to meet the performance requirements of other sections of MAP-21 on safety, system performance/congestion, freight movement, and congestion mitigation and air quality. All these various performance expectations will be considered by NCDOT's senior management as annual budgets are developed. With well-defined pavement and bridge programs and systems in place to evaluate the condition and future performance based on life-cycle cost planning, NCDOT will be able to make informed decisions based on reliable data and state-of-the practice analysis.

- NCDOT will continue to program pavement and bridge resources to meet the State's measures and targets and continue to monitor the National Performance Measure's targets. Based on historical trends, NCDOT expects the Federal Measures to follow the same trend as NCDOT's measures for their SOGR and meet the MAP-21 requirements.

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Chapter 4 Life Cycle Cost Planning

4.1 Life Cycle Cost Analysis

NCDOT has a long history of providing a well-maintained roadway system for its users. The interstates and other state maintained routes have high quality pavement as a result of the state's commitment to preservation methods that extend the life of the pavement. These pavement preservation methods are embedded within the Pavement Management System (PMS) analysis; and the department has solidified its commitment to extending the asset's useful life through a life cycle cost analysis through policies and approach to pavement management. NCDOT also has a regular bridge inspection program to identify preservation and maintenance needed on its structures that extend the life. This chapter will not address lifecycle cost analysis at this time as a part of the initial TAMP but will be fully explained in the final TAMP that is due in June, 2019. As required by the Final Rule, the following section identifies the process NCDOT will use to satisfy the requirements of MAP-21 for life cycle cost planning.

The LCC analysis considers all the relevant costs incurred throughout the whole life of an asset, not just the initial construction cost. In order to keep an asset functioning adequately, achieve the performance targets established by the agency, and provide users with the level of service that meets their expectation, there are certain actions that must be performed throughout its life. The LCC process begins with the development of different alternatives to fulfill the structural and performance objectives of an asset. A key component of this analysis is the use of deterioration modeling tools that estimate an asset's condition as it ages. This estimation is based on factors such as environment, weather, and in the case of pavements and bridges, heavy vehicle loadings as well as the number of trips. The schedule of initial and future activities to maintain an asset's condition at a predetermined performance level is defined and the costs of these activities are estimated. Direct expenditures (i.e. construction, maintenance, preservation, and rehabilitation activities) are typically included. The predicted schedule of activities and their associated agency form the projected LCC. Considering all of these costs during the service life of an asset, helps the agency to select the lowest cost options to maintain a desired condition at a minimum practicable cost.

4.2 MAP-21 and Final Rule Requirements

Life cycle cost and life cycle planning is defined in 23 CFR Part 515.5 as follows:

- Life Cycle Cost - The cost of managing an asset class or asset sub-group for its whole life, from initial construction to its replacement.
- Life Cycle Planning - A process to estimate the cost of managing an asset class, or asset sub-group over its whole life with consideration for minimizing cost while preserving or improving the condition.

And in 23 CFR Part 515.7, state DOTs are required to develop a risk-based asset management plan to include specific minimum processes including the following section on life cycle planning identified in subsection (b):

- A State DOT shall establish a process for conducting life cycle planning for an asset class or asset subgroup at the network level (network to be defined by the State DOT). As a State DOT develops its life cycle planning process, the State DOT should include future changes in demand; information on current and future environmental conditions including extreme weather events, climate change, and seismic activity; and other factors that could impact whole-life costs of assets. The State DOT may propose excluding one or more asset sub-groups from its lifecycle planning if the State DOT can demonstrate to FHWA the exclusion of the asset sub-group would have no material adverse effect on the development of sound investment strategies due to the limited number of assets in the asset sub-group, the low level of cost associated with managing the assets in that asset sub-group, or other justifiable reasons. A life cycle planning process shall, at a minimum, include the following:
  (1) The State DOT targets for asset condition for each asset class or asset sub-group;
  (2) Identification of deterioration models for each asset class or asset sub-group, provided that identification of deterioration models for assets other than NHS pavements and bridges is optional;
  (3) Potential work types across the whole life of each asset class or asset sub-group with their relative unit cost; and
  (4) A strategy for managing each asset class or asset sub-group by minimizing its life-cycle costs, while achieving the State DOT targets for asset condition for NHS pavements and bridges under 23 U.S.C. 150(d).

4.3 NCDOT's Process for performing Life Cycle Cost Analysis

NCDOT will perform a thorough and systematic LCC analysis on all state-owned pavement and bridge assets, regardless of highway system class, using the agency's PMS and BMS. Prior to conducting the LCC analysis, NCDOT will establish performance goals and targets. The agency is currently in the process of establishing performance targets for the National Performance Management Measures identified in 23 CFR Part 490 and will have these identified by the May 2018 deadline. An Oversight Committee consisting of key NCDOT managers has been established to provide oversight and coordination for implementation of all MAP-21 and FAST Act final rules including development of performance targets. Additionally, NCDOT is considering other performance measures and targets which would be supplemental to the National Measures and Minimum Standards.

A key component of asset management is creating and instituting a performance management culture within all levels of an organization. These performance measures and targets link the overall goals and objectives of the agency to the available funds. Modern computerized management systems allow agencies to perform multiple "what-if" scenarios to analyze the future condition of an asset. These scenarios are based on different funding levels and investment strategies, i.e. strategies based on preservation, maintenance, rehabilitation, reconstruction, or a combination of all work types. Within the core functionality of both a PMS and BMS is the presence of complex computer algorithms, deterioration models, and the ability to predict the future condition of a pavement or bridge based on a number of variables such as weather, climate, environment, age, traffic loading, treatments, funding, etc. Another core function is a LCC analysis component whereby tailored treatments are applied to a pavement or bridge based on their condition. The concept behind this approach is to minimize whole-life cost by

applying low cost treatments to an asset early in its life and extending the service life while minimizing investments.

Performance targets will provide the measuring stick to determine if the asset's condition is meeting the expectations of NCDOT. While no formal targets have been determined at this time, NCDOT may consider adopting tiered approach based on the highway classification and its importance.

Once performance targets have been established for pavements and bridges, NCDOT will perform an evaluation using the results from the PMS and BMS. At the network level, the PMS and BMS will provide several output reports to enable NCDOT managers to gauge success in meeting the agency's goals. Examples of the type of reports that will be evaluated are:

- Historical reports of expenditures, type of treatments (work types), and resulting performance by highway system (interstate, primary and secondary)
- Condition by highway system (interstate, primary and secondary)
- Estimated funding levels to achieve specific condition, by highway system, 10-year projection
- Estimated condition based on various funding scenarios by highway system, 10-year projection
- Treatment work types, (preservation, maintenance, rehabilitation, reconstruction), by highway system, 10-year cost and quantity projections

While NCDOT has typically been satisfied with its network performance, the Department has historically allocated funds without the use of LCC-specific analysis. The TAMP will help to solidify the process to provide greater transparency, consistency, and clarity. The following outline is a generalization of NCDOT's process in using LCC in the development of their annual pavement and bridge management programs.

4.3.1 Pavement Management Program

At the beginning of every year, the Division of Highways (DOH) commences pavement condition surveys of all Department pavement assets – interstate, primary, and secondary systems. These surveys provide a point-in-time snapshot of the condition. The results of these surveys are used to rate the pavement condition using a Pavement Condition Rating (PCI). The PCI has a rating scale of 0 to 100 and considers observed defects in the pavement such as cracking, patching, rutting, raveling, corner breaks, seal breaks, and faulting. A segment of pavement with more of these types of defects will score lower on the PCI and trend towards "fair" or "poor," see Figure 4-1. Pavement condition is influenced primarily by activities funded through state funded programs for contract resurfacing and pavement preservation, and the interstate maintenance program created by NCDOT after the program was merged into the National Highway Performance Program (NHPP).

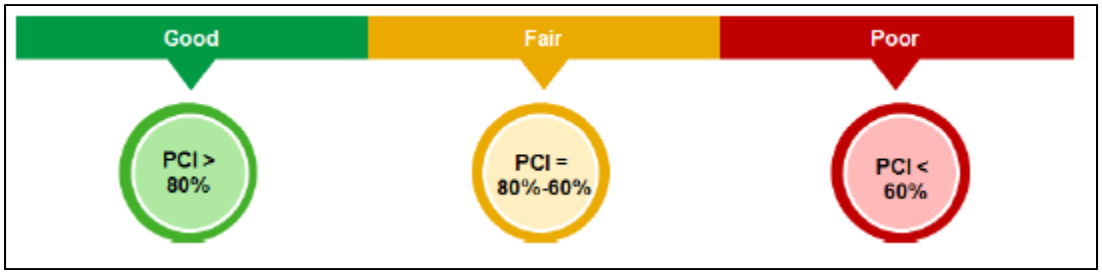

Figure 4-1: Pavement Condition Index

Pursuant to North Carolina General Statutes (N.C.G.S.) 136-44.3A NCDOT will produce a Highway Maintenance Improvement Plan (HMIP) for a five-year work plan based on annual funding appropriations. The first step in developing the plan is to load the most recent pavement condition data into the Pavement Management System (PMS). The PMS is used to identify the sections to treat to achieve the best pavement condition rating. The budget used in the PMS optimization is based on the previous fiscal year's allocation of the pavement treatment programs previously mentioned. The HMIP will use the data collected for PCI to identify routes and optimal treatments to reach LOS goals. A list of routes and recommended treatments will then be created and provided to each of the 14 Divisions for review and recommendations for assembling routes into annual programs for projects suitable for contract lettings. These Division plans, pursuant to legislation, are adopted by the Board and updated annually to reflect actual budget allocations for years two through five. For example the FY2019 to FY2023 plans are based on FY2018 appropriations; this assumes that future year appropriations remain consistent. It is anticipated that annual modifications and additions will be made to the plan to adjust years 2 through 5 (which will become years 1 through 4) to changing conditions and needs. For example, an unusually cold and wet winter may cause roads in western NC to deteriorate faster than usual. Similarly, flooding due to a hurricane can also cause rapid road deterioration. Additionally, the division may become aware of local economic development planned along one or more roadways that makes strengthening those roadways a division priority.

4.3.2 Structures Management Program

Bridge inspections are performed in accordance with the federally National Bridge Inspection Standards (NBIS) and results are uploaded to the BMS upon completion of each bridge inspection. The BMS program will be used to determine feasible maintenance and rehabilitation strategies and performing network optimization based on performance and funding constraints. This run will provide life cycle analysis of costs and performance based on NCDOT's defined strategies. The system has the capability to perform multiple optimization scenarios based on user defined constraints. The Structures Management Unit (SMU) will use the results from the BMS analysis in conjunction with information contained in the bridge inspection reports to develop a 5-year Bridge Management Improvement Program (BMIP).

The bridge program is predominantly made up of four funding sources

- Strategic Transportation Investments (STI) program (Federal Funds)
- Interstate Maintenance Program (IM) (Federal Funded)
- Bridge Program (State Funded)

- Bridge Preservation Program (State Funded)

Within the federally funded STI program, a relatively small amount of funding is typically set aside for bridge replacements. The STI is NCDOT's capital improvement program where bridge replacements generally do not compete well in the prioritization formula. Bridge replacements included in the STI program are selected based on alternate criteria using the Priority Replacement Index (PRI). The PRI is composite index from 0 - 120 determined by elements such as condition rating, service characteristics, weight limit postings, ADT and detours. For bridge projects programmed in the federal funded IM program, priority is given to bridges that are located on routes within contracts for interstate pavement improvements in order to minimize traffic flow impacts.

The funding allocation for bridge improvements in the STI legislation is not sufficient to meet the Department's committed goals of reducing the percentage of structurally deficient bridges. In order to close the funding gap, the state legislature established a state funded Bridge Program to provide dollars from the State Highway Fund. The legislature has required that Bridge Program appropriations only be used to for improvements to structurally deficient or functionally obsolete bridges, and a 10% maximum be used for NBIS and non-NBIS culverts.

The combined STI and State Funded Bridge Program are utilized to create a five-year Bridge Management Improvement Plan (BMIP). The BMIP is made up of two portions: Centrally funded to address needs on the interstate and primary road networks, and a Division funded program to address needs on the secondary system. Funds are apportioned to both the Centrally and Division funded programs in proportion with the needs to achieve SD goals in each county for the interstate, primary and secondary systems.

The division funded program is allocated in two parts:

- An equal share is provided to each division to ensure the most deficient bridges can be replaced.
- Remaining balance is allocated to each division based upon the proportionate need to achieve statewide goals.

The (BMS) will be used create a list of bridges that qualify for the state funded bridge program. The list of qualified bridges will be prioritized within the BMS by the Priority Replacement Index (PRI) and will serve as an initial guidance for bridge program managers. Division and Central bridge program managers review the recommended prioritized list of candidates and will make changes to reflect additional concerns based on local knowledge. The final prioritized bridge improvements will then be entered in the BMIP as funding becomes available.

While NCDOT is committed to reducing its inventory of SD bridges, the department has also been a long standing advocate of bridge preservation. A previous bridge preservation program was sunset upon implementation of the STI legislation in 2013. In the 2017-2018 biennium, the state legislature established a state funded bridge preservation program. Project prioritization for this program is initially based on replacement value of bridges as identified in the BMS. This supports extending good service life of bridges identified by NCDOT as high value bridges for which replacement may not be financially feasible.

4.4 Treatments for Pavements and Bridges

4.4.1 Pavement Treatments

NCDOT uses a systematic approach in developing the annual pavement management program consisting of a multitude of treatments (work types). The suite of treatments are key inputs into the PMS's optimization program using life cycle cost analysis. Typical treatments can be classified into three major categories; routine, reactive, or preventive as follows:

1. Routine - Routine maintenance is the day-to-day pavement maintenance activities that are scheduled or whose timing is within the control of maintenance personnel. Some example of routine maintenance are:
    - Shallow Patching
    - Skin Patching
    - Partial-depth patching
    - Repair concrete corner breaks
    - Concrete joint repair
2. Reactive - Reactive maintenance occurs when the pavement section is allowed to deteriorate to a fair to poor condition in terms of both ride quality and structural condition. At this point, structural damage has occurred, and the objective of rehabilitative treatment is to repair that damage and restore the pavement. Thus, the approach is reactive and can be a costly and time-consuming process. Some examples of reactive maintenance are:
    - Full-depth patching
    - Repair/replacing concrete slabs
    - Mill and fill asphalt overlays
3. Preventive - A proactive or preventive maintenance approach entails the application of a series of low-cost, preventive maintenance treatments that individually last for a few years and extend the life cycle. Some examples of preventive maintenance are:
    - Thin asphalt overlay
    - Microsurfacing
    - Chip seals
    - Cape seals
    - Crack sealing
    - Concrete joint sealing

4.4.2 Bridge Treatments

Similar to pavement management, NCDOT uses a systematic approach in developing the annual structures management program consisting of a multitude of treatments (work types). The suite of treatments are key inputs into the BMS's optimization program using life cycle cost analysis. Typical treatments can be classified into three major categories; preservation, repair/rehabilitation, or replacement as follows:

1. Preservation: Repainting structural steel, vegetation removal, sweeping, deck repairs and waterproofing deck surface (with membrane, thin epoxy overlay, polymer modified concrete, or a reinforced concrete overlay), navigation light maintenance/replacement, guardrail protection at bridge ends, object marker replacement, cleaning and sealing or replacement of expansion joints.

2. Repair/Rehabilitation: Bridge deck and expansion joint repairs, spall repairs and steel repairs on superstructure, scour prevention, bearing replacements, and preventative measures such as waterproofing the deck or repainting structural steel. A repair project may also include the replacement of the deck or full superstructures of bridges.

3. Replacement: Bridge candidates are considered for replacement if they are structurally deficient and are prioritized utilizing PRI. Other bridges may get replaced if they are within the limits of a large roadway improvement project programmed in the STIP.

4.5 Strategies to Manage Assets

NCDOT has a long history of effectively managing state-owned assets to extend service life, especially pavement and bridges. A key feature of the success of using asset management principles is understanding the connection between funding and maintaining asset performance at an established target. In order to successfully manage the agency's assets, formal and informal practices have been implemented that rely on quality data, systematic processes, and analytical evaluation that complement the technical expertise in the State Pavement Management and Structures Management Unit. Below are examples of strategies NCDOT uses to effectively manage the pavement and bridge assets.

4.5.1 Pavement

- NCDOT has a Data Collection unit; Pavement Design & Distress Analysis unit, and Pavement Management Systems unit responsible for designing, testing and monitoring the health of pavements on the 80,000 mile NCDOT network. They establish the vision, objectives, and procedures for managing the agency's pavements. The PMS is used to manage pavement condition data, maintain a history of road construction and maintenance treatments, and conduct pavement analyses which assist the department in optimizing limited funding resources. The Pavement Management unit provides guidance in the selection of candidates for maintenance, preservation, resurfacing, and rehabilitation projects for both rigid (concrete) and flexible (asphalt) pavement with an emphasis on employing preventive maintenance treatments until repair costs exceed the benefit, i.e. using LCC concepts.
- Pavement Condition Index (PCI) - The PCI is a composite index number measured on a 0 to 100 scale based on pavement distresses such as ride quality, cracking, rutting, patching, corner breaks and faulting. NCDOT tracks this number for the Interstate, Primary and Secondary network to monitor the health of the system and to ensure the Department is meeting its performance goals and targets discussed in Chapter 3.

4.5.2 Bridges

- BMS – The Structures Management Unit conducts bridge inspections on all the bridges in the state except the federally owned bridges on a two-year schedule and the condition information is entered into the BMS. The BMS is used to create a prioritized list of bridges that qualify for bridge fund sources and prepare the 5-year BMIP.
- In recent years, NCDOT has placed an emphasis on reducing the number of structurally deficient bridges to no more 2% for the Interstate, 6% on the primary system and 15% on the secondary system by programming enough funds to reach these goals by 2030. Approximately 78% of the budget for Structure Management is allocated to replacement of structural deficient bridges, while the remaining 22% is allocated to preservation.

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Chapter 5 Risk Management Analysis

5.1 NCDOT's Plan for Risk Management Analysis

NCDOT's Risk Management Analysis process has not been fully completed at this time, but the final TAMP that is due in June 2019, will include the full risk assessment with the findings. This chapter will describe requirements of the final rule and identify the process NCDOT will use to satisfy the requirements of MAP-21 for risk management analysis.

5.2 MAP-21 and Final Rule Requirements

Risk Management Analysis requirements are identified in 23 CFR Part 515.7 (c) as follows:

A State DOT shall establish a process for developing a risk management plan. This process shall, at a minimum, produce the following information:

(1) Identification of risks that can affect condition of NHS pavements and bridges and the performance of the NHS, including risks associated with current and future environmental conditions, such as extreme weather events, climate change, seismic activity, and risks related to recurring damage and costs as identified through the evaluation of facilities repeatedly damaged by emergency events carried out under part 667 of this title. Examples of other risk categories include financial risks such as budget uncertainty; operational risks such as asset failure; and strategic risks such as environmental compliance.
(2) An assessment of the identified risks in terms of the likelihood of their occurrence and their impact and consequence if they do occur;
(3) An evaluation and prioritization of the identified risks;
(4) A mitigation plan for addressing the top priority risks;
(5) An approach for monitoring the top priority risks; and
(6) A summary of the evaluations of facilities repeatedly damaged by emergency events carried out under part 667 of this title that discusses, at a minimum, the results relating to the State's NHS pavements and bridges.

5.3 Risk Management Definitions

For the purposes of this section, the following definitions are listed to provide the framework and context for the discussion of Risk and Risk Management, as it applies to the TAMP at NCDOT.

Risk – The impact of uncertainty upon NCDOT's ability to deliver its programs, projects, and services. Risk is an event that is a deviation from the expected outcome. Risk can either be positive or negative and is measured in terms of a combination of the likelihood of an event occurring and the consequence if the event did occur.

Risk Management – A systematic process of identifying, analyzing, and prioritizing risks with the development of strategies to respond to potential threats and opportunities.

Risk Identification – The process of finding, recognizing, and describing risks.

Risk Register – A formal listing of risks identified by the department, which may include such information as priority, type, likelihood, consequence, impact, and mitigating actions.

Risk Context – The social, cultural, legal, regulatory, economic, and natural environment in which an entity operates that is unique to the department.

Risk Analysis – A process to understand the potential impact of various risks, in terms of likelihood and consequence.

Risk Assessment – The process of identifying risks, analyzing risks, and evaluating risk.

Risk Evaluation – The process of reviewing the results from the Risk Analysis and comparing the impact with the department's risk tolerance.

Risk Tolerance – The capacity of the department to accept or tolerate risk.

Risk Treatment – A process to determine how a department will respond to an identified risk.

Likelihood – The probability that a specific event might occur.

Consequence – The outcome of an event impacting the department's objectives.

Mitigation – actions taken to address or reduce risk. Generally, it refers to the entire process of responding to risks.

Risk Levels – The different levels of risk which can be categorized into three major risk areas: Agency/Enterprise, Programmatic, and Project/Asset. They can be distinct or overlapping from one level to the next.

Agency/Enterprise Risk – Risks that are high-level issues and can impact the achievement of the agency's goals and objectives involving a multitude of issues, i.e. budgets, legislative requirements, regulatory reforms, public sentiment, broad managerial and personnel decisions.

Programmatic Risk – Risks that are typically a collection of related projects or program delivery issues that may be attributed to an entire sub-unit or business unit, e.g., bridge program, preservation program, maintenance program, program budgets.

Project/Asset Risk – Risks that are associated with an individual project, location, or individual asset class; can be associated with providing continuity of service of a bridge or highway and system resilience and asset failure.

5.4 Steps NCDOT has taken towards Risk Management

With the passage of MAP-21, NCDOT has taken this opportunity to initialize a more comprehensive approach to assess risk across the agency in accordance with asset management concepts. In October of 2015, NCDOT hosted the National Highway Institute (NHI) risk management workshop. Several NCDOT managers came together for a two-day workshop to kick-off the formal risk management effort and establish processes for identifying, evaluating and analyzing risks.

Risks for NCDOT have been identified by the pavement and bridge work committees. Many of the threats are common to both pavement and bridge. These include the impacts of population growth,

funding level uncertainty, and hurricanes and/or flooding. Additional risks associated with Information Technology (IT) have also been identified. The work of the two work groups will be combined into a single risk register for the final TAMP due in June-2019.

As part of the two-day workshop, the workgroup was guided by the framework identified in the NHI course and FHWA publication, "Risk-Based Transportation Asset Management Report 1: Evaluating Threats, Capitalizing on Opportunities." Based on these two documents, the risk management process framework consists of a five-step methodology, as follows:

- **Step 1: Establishing context** – In this step, the department's social, cultural, legal, regulatory, economic, and natural environment in which it operates will be identified. This can be thought of as the department's DNA and its purpose for existence.
- **Step 2: Identify Risk** – In this step, the department will formally identify and document risks that could prohibit it from meeting the requirements of MAP-21. Included in this step will be a review of the results from the evaluation of facilities that are repeatedly damaged by emergency events as required by 23 CFR Part 667.
- **Step 3: Analyze Risk** – In this step, for each of the risks identified in Step 2, the department will determine the likelihood of the event happening and its consequence based on expert judgment. This provides a method to quantify the importance and initial priority of each risk.
- **Step 4: Evaluate Risk** – The purpose of this step is to (1) evaluate the identified risks based on their importance and (2) make decisions, based on the outcome of the risk analysis. This includes a review of which risk needs treatment and its priority. The top priority risks will be identified during this step.
- **Step 5: Treat Risk** - In this step the department will determine option(s) to address or mitigate the top priority risks as well as who is responsible for each one.

Two additional components are identified as a part of the framework: 1) **Monitoring and Review**, and 2) **Communication and Consultation**. Monitoring and Review is a planned part of the process that is accomplished on an established frequency, as determined by the Risk Management Committee and identification of who is responsible for monitoring each risk. Communication and Consultation provides an avenue to keep internal and external stakeholders abreast of the issues where risk problems and events are known throughout the department. This information is then shared with the public, legislature, media, and oversight bodies. The five-step process, as depicted in ISO literature, is illustrated in Figure 5-1.

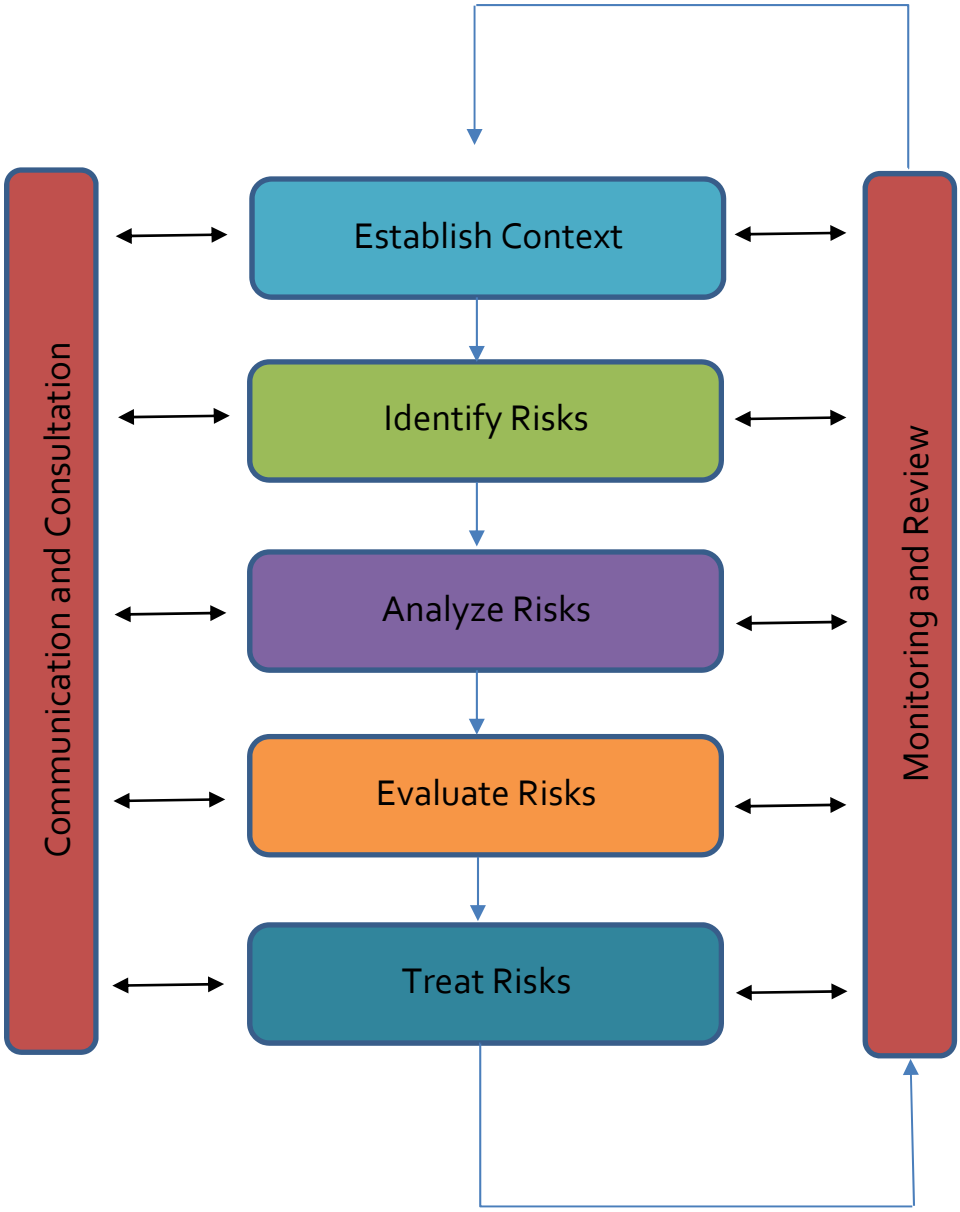

Figure 5-1: Risk Management Framework, ISO 31000:2009

As mentioned previously, NCDOT has selected a broad-based group of managers to serve on the risk management committee who represent each of the major business units within the department that contribute to the vision and guiding principles of the asset management plan for pavement and bridges. Additional members may be added to the committee, based on the needs of the department or to address additional areas of risk. Representatives from each of the following divisions and regions are members of the committee:

Chief Engineer's Office	Structures Management Unit
Financial Management Division	Pavement Management Unit
Division of Information Technology	Roadside Environmental Unit
FHWA – North Carolina Division	Operations Program Management Unit
Planning & Programming Division	State Maintenance Operations Unit

In order to meet the requirements for Part 667 – Annual evaluation of facilities repeatedly requiring repair and reconstruction due to emergency events NCDOT will employ the following process:

- Conduct an evaluation using the best data available to determine if any road, highway or bridge has been damaged to the point which required repair or reconstruction activities on two or more occasions due to emergency events (Presidential or Governor declared event) since January 1, 1997
- Produce a map and spreadsheet identifying areas that have been damaged on two or more occasions due to an emergency event
- Evaluation of the risk of recurring damage at same site and cost of future repairs
- Identification of reasonable alternatives to avoid or eliminate the need for federal emergency relief funds
- Sites identified through this process will be considered for inclusion in both the STIP and state funded pavement and bridge programs that do not fall under the STI prioritization

NCDOT will build off the efforts of the October 2015 workshop to finalize the agency's Risk Management Analysis to satisfy MAP-21 requirements for the Final TAMP which is due in June 2019.

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Chapter 6 Financial Plan

6.1 NCDOT's Financial Plan

The North Carolina Department of Transportation has its own budget separate and apart from the state's General Fund. North Carolina's annual State budget identifies sources of revenue and estimated amounts to contribute to NCDOT's Highway Fund and Highway Trust Fund. Budgetary control is maintained by the Department, working in conjunction with the Office of State Budget and Management.

NCDOT's financial plan for Asset Management will not be addressed at this time as a part of the initial TAMP but will be fully explained in the final TAMP that is due in June, 2019. As required by the final rule, the following section identifies the process NCDOT will use to satisfy the requirements of MAP-21 for the financial plan.

6.2 MAP-21 and Final Rule requirements

Definitions as they apply to this section are found in 23 CFR Part 515.5 and repeated here as follows:

- ***Financial Plan*** means a long-term plan spanning 10 years or longer, presenting a State DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets for asset condition during the plan period, and highlighting how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies.
- ***Investment strategy*** means a set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risk.
- ***Work type*** means initial construction, maintenance, preservation, rehabilitation, and reconstruction.

And in 23 CFR Part 515.7, state DOTs are required to develop a risk-based asset management plan to include specific minimum processes. The following section on financial plan is identified in subsection (d):

- A State DOT shall establish a process for the development of a financial plan that identifies annual costs over a minimum period of 10 years. The financial plan process shall, at a minimum, produce:
  (5) The estimated cost of expected future work to implement investment strategies contained in the asset management plan, by State fiscal year and work type;
  (6) The estimated funding levels that are expected to be reasonably available, by fiscal year, to address the costs of future work types. State DOTs may estimate the amount of available future funding using historical values where the future funding amount is uncertain;
  (7) Identification of anticipated funding sources; and
  (8) An estimate of the value of the agency's NHS pavement and bridge assets and the needed investment on an annual basis to maintain the value of these assets.

6.3 NCDOT's Process for developing a Financial Plan

The State of North Carolina is a fiscally conservative state where annual budgets are prepared based on a cash-flow basis. The Governor is required to present a proposed budget to the General Assembly on a biennial basis. The General Assembly, in consideration of the Governor's recommendations, passes an appropriation act which is the financial plan for all state agencies. The annual fiscal year budget begins on July 1 and ends on June 30th.

As discussed in Chapter 7 on Investment Strategy, NCDOT's revenues are grouped into three major fund categories: Highway Fund, Highway Trust Fund, and Federal Funds. Both the Highway Fund and Highway Trust Fund are from state revenues that make up approximately 80% of the Department's transportation funding. The Federal Fund makes up approximately 20%. Each revenue source and the program it generally supports is as follows:

- Highway Fund – The Highway funds are generated by highway user fees such as the state's registration fees, driver license fees, truck license plate fees other user fees and 71% of the motor fuel tax. These funds are used to support the maintenance and upkeep of the state's 80,000-mile system, administration cost of NCDOT and DMV, the multi-modal programs including public transportation, aviation, ferries, rail, and bicycle and pedestrian program, state-aid to municipalities for road maintenance, state park road maintenance, and other general obligations as defined by law. The pavement and bridge programs that affect condition of pavements and bridges are predominantly supported by the highway funds. These projects are prioritized through processes outside the STIP.
- Highway Trust Fund – The Highway Trust funds are generated by similar highway user fees such as, tax on motor vehicle sales and title transfers, title and registration fees, and 29% of the motor fuel taxes. These funds are used for the design and construction of the State Transportation Improvement Program (STIP) and used to match the funds North Carolina receives from the Federal Highway Trust fund.
- Federal Funds – These are federal funds that come to North Carolina through three federal administrations, Federal Highway Administration, Federal Transit Administration, and Federal Aviation Administration that support the construction and maintenance of projects that meet each federal agency's requirements.

The state budget appropriates funds to the department from the Highway Fund and the Highway Trust Fund to accomplish its mission. The Appropriations Act of 2017 provided revenue projections for the two years of the biennium budget and in 2018 the NCGA will adjust those revenue projections and establish a budget for fiscal year 2018-19. NCDOT employs a cash-flow budgeting practice to maximize use of funds to deliver its various programs therefore it is critical to ensure revenue projections are as accurate as possible. The department in collaboration with the Office of State Budget and Management develops a revenue forecast that is used to:

- Develop a four-year cash flow estimate,
- Develop the Strategic Transportation Improvement Program, and
- Compute debt capacity by the State Treasurer.

Based on these considerations the following 10-year forecast in Table 6.1 provides an estimate of the state revenues expected to be generated by the Highway Fund and Highway Trust Fund for the state fiscal year 2017-18 to state fiscal year 2027-28 time frame. It should be noted that the NCGA has the approval authority for all state revenues and the following Table 6-1 are estimates only and are subject

to change as the NCGA develops the annual Appropriations Act. Federal funds are conservatively estimated to remain about the same due to the uncertainty at the federal level.

Table 6-1: NCDOT 10-Year Revenue Forecast (Millions of Dollars)

Fiscal Year	Highway Fund	Highway Trust Fund	Federal Funds	Total NCDOT Funds
2018-19	$ 2,245.8	$ 1,551.0	$ 1,044.9	$ 4,841.7
2019-20	$ 2,288.5	$ 1,576.4	$ 1,044.9	$ 4,909.8
2020-21	$ 2,376.7	$ 1,604.1	$ 1,044.9	$ 5,025.7
2021-22	$ 2,415.6	$ 1,631.5	$ 1,044.9	$ 5,092.0
2022-23	$ 2,449.6	$ 1,669.4	$ 1,044.9	$ 5,163.9
2023-24	$ 2,480.3	$ 1,711.9	$ 1,044.9	$ 5,237.1
2024-25	$ 2,577.9	$ 1,768.0	$ 1,044.9	$ 5,390.8
2025-26	$ 2,600.2	$ 1,804.8	$ 1,044.9	$ 5,449.9
2026-27	$ 2,625.2	$ 1,842.7	$ 1,044.9	$ 5,512.8
2027-28	$ 2,652.6	$ 1,885.3	$ 1,044.9	$ 5,582.8
Total	$ 24,712.4	$ 17,045.1	$ 10,449.0	$ 52,206.5

Since the Financial Plan will not be finalized until June of 2019, NCDOT will have an opportunity to incorporate more accurate budgetary numbers in the final TAMP. With these new numbers NCDOT's investment strategy for pavements and bridges identified in Table 7.1 of Chapter 7 will be updated as necessary to reflect any changes in subsequent budgets or revenue forecasts.

6.4 NCDOT's Asset Evaluation for Pavements and Bridges

A quick gauge to determine if an agency is maintaining an asset at steady, declining, or improving state is to look at the monetary value of the asset over a defined time frame. If the value of the asset is increasing or staying the same year to year, the agency's investment in the asset is large enough to offset any decline in condition, i.e. depreciation. This type of strategy is typically consistent with maintaining an asset in a state-of-good-repair. Likewise, if the value of the asset is declining, it is depreciating faster than the agency's investment in that asset. NCDOT will leverage the work that has already been done to satisfy the requirements of Governmental Accounting Standards Board, Statement Number 34 (GASB 34) to determine the value of the agency's pavements and bridges. Minor modifications may need to be made to the process by reviewing historical expenditures from highway lettings and incorporating values as needed.

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Chapter 7 Investment Strategies

7.1 Introduction

NCDOT's process for developing an investment strategy will be covered in this chapter. It includes a discussion on how the agency takes a holistic approach by reviewing and analyzing historical performance based on expenditures to determine future funding needs and projected performance of all modes of transportation that fall under NCDOT's purview. Since the analysis for Life cycle planning, Risk management planning, and a Financial plan will not be completed in time for the initial TAMP, the discussion will review how NCDOT uses historical data and information to develop an investment strategy that meets their needs and sustains a state of good repair for pavement and bridge assets. As required by the final rule, the following sections identifies the process NCDOT will use to satisfy the requirements of MAP-21 for investment strategy.

7.2 MAP-21 and final rule requirements

Investment strategy is defined in 23 CFR Part 515.5 as follows:

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

And in 23 CFR Part 515.7(e) and 515.9(f), state DOTs are required to develop a risk-based asset management plan to included specific minimum processes for developing an investment strategy as listed in the following subsections:

- 515.7(e) A State DOT shall establish a process for developing investment strategies meeting the requirements in § 515.9(f). This process must result in a description of how the investment strategies are influenced, at a minimum, by the following:
  (1) Performance gap analysis required under paragraph (a) of this section;
  (2) Life-cycle planning for asset classes or asset sub-groups resulting from the process required under paragraph (b) of this section;
  (3) Risk management analysis resulting from the process required under paragraph (c) of this section; and
  (4) Anticipated available funding and estimated cost of expected future work types associated with various candidate strategies based on the financial plan required by paragraph (d) of this section.

- 515.9(f) An asset management plan shall discuss how the plan's investment strategies collectively would make or support progress toward:
  (1) Achieving and sustaining a desired state of good repair over the life cycle of the assets,
  (2) Improving or preserving the condition of the assets and the performance of the NHS relating to physical assets,
  (3) Achieving the State DOT targets for asset condition and performance of the NHS in accordance with 23 U.S.C. 150(d), and
  (4) Achieving the national goals identified in 23 U.S.C. 150(b).

7.2 NCDOT's Process

Beginning in 1998 the Department began taking an in-depth look at the condition of the state's highway maintenance, pavement, and bridge needs and quantifying the cost to maintain these assets at an acceptable level of service in order to satisfy newly enacted legislation by the North Carolina General Assembly (NCGA). This effort has matured and evolved over the last 20 years into the Maintenance Operations and Performance Analysis Report (MOPAR). NCDOT is required to perform an analysis and submit a formal report to the NCGA on a biennial basis. The report satisfies many of the requirements of MAP-21 Investment Strategy by performing a gap analysis, using life-cycle planning, estimates cost to achieve state of good repair targets, and identifies a 5-year work program and estimated cost of various work types. The MOPAR does not specifically address MAP-21 requirements of risk analysis considerations, improving the condition and performance of the NHS, achieving NCDOT targets for the NHS, and achieving the national goals; these items will be discussed in greater detail in this section.

The 2016 MOPAR documents the gap between existing condition versus performance targets and identifies funding needs for NCDOT's infrastructure assets by interstate, primary, and secondary highway systems. The MOPAR, and companion Highway Maintenance Improvement Plans (HMIP) and Bridge Maintenance Improvement Plans (BMIP), are formalized reports that identified pavement and bridge projects which are intended to help the department sustain and make progress toward meeting their state of good repair targets.

7.3 Influencing Factors

7.3.1 Funding

NCDOT's revenues are grouped into three major funds, Highway Fund, Highway Trust Fund, and Federal Funds. Each funding source has a specific purpose in funding NCDOT's programs, but at the same time contribute to projects and initiatives that will help the department achieve their state of good repair targets for pavement and bridges. Each funding source and the program it generally supports is as follows:

- Highway Fund – The Highway funds are generated by highway user fees such as the state's motor fuel tax, registration fees, driver license fees, truck license plate fees and other user fees. These funds are used to support the maintenance and upkeep of the state's 80,000-mile system, administration cost of NCDOT and DMV, the multi-modal programs including public transportation, aviation, ferries, rail, and bicycle and pedestrian program, state-aid to municipalities for road maintenance, state park road maintenance, and other general obligations as defined by law.
- Highway Trust Fund – The Highway Trust funds are generated by similar highway user fees such as motor fuel taxes, tax on motor vehicle sales and title transfers, title and registration fees. These funds are used for the design and construction of the State Transportation Improvement Program (STIP) and used to match the funds North Carolina receives from the Federal Highway Trust fund.
- Federal Funds – These are federal funds that come from three different federal administrations, the Federal Highway Administration, Federal Transit Administration, and Federal Aviation Administration that support the construction and maintenance of projects that meet each federal agency's requirements.

7.3.2 Revenue Forecast

Revenue forecasting is discussed in section 6.3 of Chapter 6 and the reader's attention is directed to this section for information about the department's process.

Based on the revenue forecast identified in Table 6-1 of Chapter 6 NCDOT estimates that a significant portion of the available revenue will be used to support the maintenance, pavement, and bridge programs. In the case of the pavement and bridge programs, funds will be used for a multitude of treatments including preservation, rehabilitation, reconstruction, and replacement. The following Table 7.1 provides an estimate of the funds to support these programs over the next ten years. It should be noted that this does not include funds for the construction of new highways and bridges which are identified in the State Transportation Improvement Program (STIP).

Table 7-1: Estimated Funds for Highway Maintenance, Pavement Program, and Bridge Program (Millions of Dollars)

Fiscal Year	Highway Maintenance	Pavement Program*	Bridge Program**	Total Funds
2018-19	$ 402.9	$ 725.9	$ 453.5	$ 1,582.3
2019-20	$ 410.6	$ 737.6	$ 460.5	$ 1,608.7
2020-21	$ 426.4	$ 761.8	$ 475.0	$ 1,663.2
2021-22	$ 433.4	$ 772.4	$ 481.4	$ 1,687.2
2022-23	$ 439.5	$ 781.7	$ 486.9	$ 1,708.1
2023-24	$ 445.0	$ 790.2	$ 492.0	$ 1,727.2
2024-25	$ 462.5	$ 816.9	$ 508.0	$ 1,787.4
2025-26	$ 466.5	$ 823.0	$ 511.6	$ 1,801.1
2026-27	$ 471.0	$ 829.9	$ 515.7	$ 1,816.6
2027-28	$ 475.9	$ 837.4	$ 520.2	$ 1,833.5
Total	$ 4,433.7	$ 7,876.8	$ 4,904.8	$ 17,215.3

*Pavement program includes $110 million of Federal funds to be used for pavement preservation on the Interstates

**Bridge program includes Federal funds in the amount of $20 million for bridge preservation projects on the Interstates, and $65 million for bridge replacements on the interstate, primary and secondary systems

7.3.3 Risk Analysis

Risk Analysis – While a comprehensive risk analysis will not be completed until the final TAMP is due in 2019, there are a number of risk the department has faced over the years and will continue to address as the need arises. Some examples are: hurricanes, floods, snow and ice storms, rock slides, federal aid funding, revenue stagnation, economic down-turn, etc. Once the risk analysis is complete the results will be evaluated and considered as this document is updated.

Additionally, the majority of pavement and bridge projects on the State's Primary and Secondary system there are funded through state programs. Because NCDOT does not have an "NHS-specific" funding program, there are two risk statements noted below:

- Risk: There is a possibility that in any given year projects may or may not be on the Non-Interstate NHS. The Non-Interstate NHS makes up approximately 30% of the route miles of NCDOT's "Primary System" and about 40% of the Lane Miles.

- Opportunity: Because the pavement and bridge projects on the primary and secondary systems are state funded and the amount currently exceeds the Federal Aid Apportionment for North Carolina, should a need be identified for the Non-Interstate NHS, NCDOT has the ability to shift focus and funding to more projects on the Non-Interstate NHS rapidly with little to no coordination needed with outside entities.

Interstate highways have a dedicated program (an NCDOT designated "Interstate Maintenance" program) funded with Federal Aid dollars to address needs on the interstate system.

7.3.4 Life-cycle planning

Life-cycle planning – NCDOT has been a national leader in advocating for a holistic approach in managing and sustaining pavements and bridges through an active comprehensive program to not only address assets in poor condition, but to also invest in maintenance and preservation strategies to keep good pavements and bridges in good condition. The department has historically embraced the concepts behind life-cycle planning and optimization of the work program for maintenance, pavement management, and the bridge program and has worked with the NCGA to identify funds for these purposes as indicated in the 2017 Appropriations Act and identified in the 2016 MOPAR. More details on this subject will be covered once the life-cycle planning section is complete when the final TAMP is finish in 2019.

7.3.5 Gap Analysis

Gap analysis – The department has performed an in-depth assessment of the condition of their highway assets for a number of years and has produced reports on the actual condition versus agency targets and estimated the cost to achieve an acceptable level of service. The 2016 MOPAR is the most recent report and has identified the condition and targets for the agency's pavements and bridges by highway system. The following Figure 7.1 provides this information. While the report does not specifically identify pavement and bridge conditions on the NHS, it should be noted that 95.7 % of NHS is included in either the interstate or primary highway systems, therefore, their condition will be similar to those reported in Figure 7.1 for the interstate and primary systems.

Asset	Condition Element	Performance Measure	Highway System	Target	Actual Condition
Pavement	Minimum Pavement % Good	Pavement Condition Rating ≥ 80	Interstate	86	**90**
Pavement	Minimum Pavement % Good	Pavement Condition Rating ≥ 80	Primary	80	**71**
Pavement	Minimum Pavement % Good	Pavement Condition Rating ≥ 80	Secondary	75	**61**
Pavement	Maximum Pavement % Poor	Pavement Condition Rating < 60	Interstate	5	**2**
Pavement	Maximum Pavement % Poor	Pavement Condition Rating < 60	Primary	7.5	**5**
Pavement	Maximum Pavement % Poor	Pavement Condition Rating < 60	Secondary	10	**13**
Bridges	Percent of Structural Deficient Bridges	Percent of SD bridges by system and statewide target of 10% by 2030	Interstate	2	**4**
Bridges	Percent of Structural Deficient Bridges	Percent of SD bridges by system and statewide target of 10% by 2030	Primary	6	**9**
Bridges	Percent of Structural Deficient Bridges	Percent of SD bridges by system and statewide target of 10% by 2030	Secondary	15	**17**
Culverts	NBIS Culverts	Percent Condition Rating ≥ 6	Interstate	85	**67***
Culverts	NBIS Culverts	Percent Condition Rating ≥ 6	Primary	80	**67***
Culverts	NBIS Culverts	Percent Condition Rating ≥ 6	Secondary	75	**73***

Source: 2016 Maintenance Operations and Performance Report (MOPAR), December 2016

Note: The current minimum % Good pavement targets are 86% for Interstate, 70% for Secondary

*The percent condition ratings shown for NBIS Culverts reflect most recent data

Figure 7-1: Statewide Asset Condition from 2016 Maintenance Operations and Performance Analysis Report

7.4 How Investment Strategies Support Condition Performance

7.4.1 Achieving a State of Good Repair

As mentioned earlier the Department began taking an in-depth look at the condition of the state's highway maintenance, pavement, and bridge needs and quantifying the cost to maintain these assets at an acceptable level of service. The 2016 MOPAR documents the gap between existing conditions versus performance targets and identifies funding needs for NCDOT's infrastructure assets by interstate, primary, and secondary highway systems. The MOPAR, and companion Highway Maintenance Improvement Plans (HMIP) and Bridge Maintenance Improvement Plans (BMIP), are formalized reports that identify pavement and bridge projects which are intended to help the department sustain and make progress toward meeting their state of good repair targets. Figure 7.1 provides a summary of the condition of pavements and bridges on the interstate, primary, and secondary highway systems. As

indicated by the green colored boxes, the department is meeting its targets for three of the twelve performance measures and close to meeting it targets in five other areas as represented by the yellow colored boxes. Only two of the four areas that are severely deficient are on the interstate and primary systems, identified as red colored boxes.

7.4.2 Improving and preserving Condition and Performance of NHS

A key component of asset management is the creation and institutionalizing of a performance management culture within all levels of an organization whereby performance measures and performance targets are linked to the overall goals and objectives of the agency. Modern computerized management systems allow agencies to perform multiple "what-if" scenarios to analyze the future condition of an asset based on different funding levels and investment strategies, i.e. strategies based on preservation, maintenance, rehabilitation, reconstruction, or a combination of all work types. Within the core functionality of both a PMS and BMS is the presence of complex computer algorithms, deterioration models, to predict the future condition of a pavement or bridge based on a number of variables such as weather, climate, environment, age, traffic loading, treatments, funding, etc. Another core function is a life cycle cost analysis component whereby tailored treatments are applied to a pavement or bridge based on their condition. The concept behind this approach is to minimize whole-life cost by applying low cost treatments to an asset early in its life. NCDOT will use the power of its management systems along with the technical expertise in the central units and divisions to develop HMIP and BMIP plans to preserve the condition and performance of the NHS.

7.4.3 Achieving NCDOT targets on NHS in accordance with 23 U.S.C 150(d)

Performance targets will provide the measuring stick to determine if the asset's condition is meeting the expectations of NCDOT. While no formal targets have been determined at this time, NCDOT may adopt a tiered approach based on the highway classification and its' importance

Once performance targets have been established for pavements and bridges NCDOT will perform an evaluation using the results from the Pavement and Bridge management systems. At the network level the PMS and BMS will provide output reports to enable NCDOT managers to gage success in meeting the agency's goals.

The agency is currently in the process of establishing performance targets for the National Performance Management Measures identified in 23 CFR Part 490 and will have these identified by the May 2018 deadline. An Oversight Committee consisting of key NCDOT managers has been established to provide oversight and coordination for implementation of all MAP-21 and FAST Act final rules including development of performance targets. More details on this subject will be covered once the targets have been established and the life-cycle planning section is complete in the final TAMP.

7.4.4 Achieving National Goals identified in 23 U.S.C. 150(b)

NCDOT will evaluate funding needs and effectiveness of the programming of projects, services, and efforts to meet the performance requirements of other sections of MAP-21 on safety, congestion reduction, system reliability, freight movement and economic vitality, environmental sustainability, and reducing project delivery delays. All of these various performance expectations will be considered by NCDOT's senior management as annual budgets are developed in conjunction with the STIP, HMIP, and BMIP programs. With well-defined pavement and bridge programs and systems in place to evaluate the condition and future performance based on life-cycle cost planning, NCDOT will be able to make informed decisions based on reliable data and state-of-the practice analysis.

As mentioned earlier, an Oversight Committee has been established to develop performance targets and provide oversight for implementation of all MAP-21 and FAST Act final rules. More details on this subject will be covered once the targets have been established.

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Chapter 8 Process Improvements

The Department will address process improvements as a part of the final TAMP submission in June 2019.

NCDOT TAMP 2018 Certification Guideline Checklist

1. Process to complete a performance gap analysis and to identify strategies to close gaps (23 CFR 515.7(a))		
Required Element	**How Requirement is Addressed in This Document**	**Required Elements Addressed on These Pages**
Physical Condition of Assets - The TAMP must describe a methodology, with regard to the physical condition of the assets, for:		
• Identifying gaps affecting the State DOT targets for the condition of NHS pavements and bridges as established pursuant to 23 U.S.C. 150(d).	Gaps affecting NCDOT's targets for the condition of pavements and bridges are described in Figures 3-1 to 3-3 that display pavement performance rating and bridge performance rating (using current state targets of PCI for pavement, bridge performance rating for bridges) for the state's interstate, primary and secondary systems. The interstate and primary systems comprise 96% of the NHS	Chapter 3, Section 3.3, Figures 3-1 to 3-3
• Identifying deficiencies hindering progress toward achieving and sustaining the desired state of good repair (as defined by the State DOT).	NCDOT faces a number of challenges in meeting the transportation needs of the state's growing population. The department is responsible for all modes of transportation in the state including highways, ferries, aviation, rail, public transit, bicycle, and pedestrian. With a diverse portfolio of transportation assets, NCDOT has developed a strategic, data-driven decision-making process relying on performance, transparency, and accountability.	Chapter 3, Section 3.10
• Developing alternative strategies that will close or address the identified gaps.		

NCDOT TAMP 2018 Certification Guideline Checklist

1. Process to complete a performance gap analysis and to identify strategies to close gaps (23 CFR 515.7(a))		
Required Element	**How Requirement is Addressed in This Document**	**Required Elements Addressed on These Pages**
NHS Effectiveness Performance - The TAMP must describe a methodology for analyzing gaps in the performance of the NHS that affect NHS bridges and pavements regardless of their physical condition, that will:		
• Identify gaps in the effectiveness of the NHS in providing safe and efficient movement of people and goods. (23 CFR 515.7(a)(2)).	NCDOT will also evaluate funding needs and effectiveness of the programming of projects, services, and efforts to meet the performance requirements of other sections of MAP-21 on safety, system performance/congestion, freight movement, and congestion mitigation and air quality. All these various performance expectations will be considered by NCDOT's senior management as annual budgets are developed. With well-defined pavement and bridge programs and systems in place to evaluate the condition and future performance based on life-cycle cost planning, NCDOT will be able to make informed decisions based on reliable data and state-of-the practice analysis.	Chapter 3, Section 3.11
• Identify strategies to close or address the identified gaps affecting the physical assets. (23 CFR 515.7(a)(3)).		

2. Process to complete life cycle planning (23 CFR 515.7(b))		
Required Element	**How Requirement is Addressed in This Document**	**Required Elements Addressed on These Pages**
The TAMP must describe a methodology for:		
• Incorporating the State DOT targets for asset condition for each asset class or asset sub-group into the analysis.	While no formal targets have been determined at this time, NCDOT may consider adopting tiered approach based on the highway classification and its importance.	Chapter 4; Section 4.3

NCDOT TAMP 2018 Certification Guideline Checklist

2. Process to complete life cycle planning (23 CFR 515.7(b))		
Required Element	**How Requirement is Addressed in This Document**	**Required Elements Addressed on These Pages**
• Modeling deterioration for NHS bridges and pavements for each asset class or asset sub-group.	Within the core functionality of both a PMS and BMS is the presence of complex computer algorithms, deterioration models, and the ability to predict the future condition of a pavement or bridge based on a number of variables such as weather, climate, environment, age, traffic loading, treatments, funding, etc.	Chapter 4, Section 4.3
• Analyzing potential work types across the whole life of each asset class or asset sub-group with the general unit costs identified.	NCDOT uses a systematic approach in developing the annual bridges and pavement management programs consisting of a multitude of treatments (work types). The suite of treatments are key inputs into the PMS and BMS optimization programs using life cycle cost analysis.	Chapter 4, Section 4.4
• Identifying management strategies for each asset class or asset sub-group to minimize the life cycle costs while achieving the 23 U.S.C. 150(d)	This document outlines NCDOT's general process in using LCC in the development of their annual pavement and bridge management programs. Both PMS and BMS are critical components of the management strategies.	Chapter 4, Section 4.3
• Identifying any subgroups that have been excluded, with justification for their exclusion.	NCDOT is responsible for nearly 80,000 centerline miles of road network which includes the NHS, and the department is committed to meeting or exceeding all of the MAP-21 requirements related to the NHS. Though the funding and planning methods of this document may not be specific to the NHS, the department is confident the condition requirements for NHS will be met by continuing it's strategic investments on the interstate, primary and secondary systems.	Chapter 3. Section 3.11 (last bullet)

NCDOT TAMP 2018 Certification Guideline Checklist

3. Process to complete a risk analysis and develop a risk management plan (23 CFR 515.7(c))		
Required Element	**How Requirement is Addressed in This Document**	**Required Elements Addressed on These Pages**
The TAMP must describe a methodology for:	NCDOT's Risk Management Analysis process has not been fully completed at this time, but the final TAMP that is due in June 2019 will include the full risk assessment with the findings. Chapter 5 of this document describes requirements of the final rule and identifies the process NCDOT will use to satisfy the requirements of MAP-21 for risk management analysis.	Chapter 5, Section 5.1
• Identifying risks that can affect the condition of NHS pavements and bridges, and the performance of the NHS, including the risks listed in 23 CFR 515.7(c)(1).	The department will formally identify and document risks that could prohibit it from meeting the requirements of MAP-21. Included in this step will be a review of the results from the evaluation of facilities that are repeatedly damaged by emergency events as required by 23 CFR Part 667.	Chapter 5, Section 5.4 (Step 2)
• Assessing the identified risks in terms of the likelihood of their occurrence and their impact and consequence if they do occur.	For each of the risks identified the department will determine the likelihood of the event happening and its consequence based on expert judgment. This provides a method to quantify the importance and initial priority of each risk.	Chapter 5, Section 5.4 (Step 3)
• Evaluating and prioritizing the identified risks.	The department will evaluate the identified risks based on their importance and make decisions, based on the outcome of the risk analysis.	Chapter 5, Section 5.4 (Step 4)
• Developing a mitigation plan for addressing the top priority risks that involve potentially negative consequences.	The department will prioritize identified risks and determine treatment needed. The top priority risks will be identified during this step.	Chapter 5, Section 5.4 (Step 5)
• Developing an approach for monitoring top priority risks.	Monitoring and Reviewing risks is a planned part of the process that will be accomplished on an established cycle, as determined by the Risk Management Committee. Identification responsible person for monitoring each risk will be conducted by the Risk Management Committee.	Chapter 5, Section 5.4
• Including in the analysis, and considering, a summary of the results of the 23 CFR Part 667 evaluations of facilities in the State repeatedly damaged by emergency events, including at a minimum the results relating to NHS pavements and bridges.	Chapter 5 of this document describes the process NCDOT will employ to meet the requirements for Part 667 – Annual evaluation of facilities repeatedly requiring repair and reconstruction due to emergency events.	Chapter 5, Page 5-5

NCDOT TAMP 2018 Certification Guideline Checklist

4. Process to develop a financial plan covering at least a 10-year period (23 CFR 515.7(d))		
Required Element	**How Requirement is Addressed in This Document**	**Required Elements Addressed on These Pages**
The TAMP must describe a methodology for producing a financial plan that:		
• Covers at least a 10-year period.	This document discusses NCDOT's process for development of an annual fiscal year budget and projections to cover a 10-year period and include cost estimates to implement the investment strategy.	Chapter 6, Section 6.3 Chapter 7 Section 7.3.2
• Includes the estimated cost to implement the investment strategies by State fiscal year and work type.		
• Includes the estimated funding levels that are expected to be reasonably available, by fiscal year, to address the costs of implementing the investment strategies, by work type	This document includes table listing NCDOT's 10-year estimated program funding for pavements and bridges	Chapter 7, Section 7.3.2 (Table 7-1)
• Identifies anticipated sources of available funding.	State funding sources are summarized including highway fund, highway trust fund and federal funds in Table 6-1	Chapter 6, Section 6.3
• Includes a summary asset valuation for the State's NHS pavement and bridges, including the investment needed on an annual basis to maintain the asset value.	This document discusses NCDOT's proposal to leverage its Governmental Accounting Standards Board, Statement Number 34 (GASB 34) report to determine and monitor monetary value of pavement and bridge assets.	Chapter 6, Section 6.4

5. Process to develop investment strategies (23 CFR 515.7(e) and 515.9(f))		
Required Element	**How Requirement is Addressed in This Document**	**Required Elements Addressed on These Pages**
The TAMP must describe a methodology for:		
• Producing investment strategies that collectively make or support progress toward:		

NCDOT TAMP 2018 Certification Guideline Checklist

5. Process to develop investment strategies (23 CFR 515.7(e) and 515.9(f))		
Required Element	**How Requirement is Addressed in This Document**	**Required Elements Addressed on These Pages**
o Achieving and sustaining a desired state of good repair over the life cycle of the assets,	By use of its 2016 MOPAR, this chapter documents the gap between existing condition versus performance targets and identifies funding needs for NCDOT's infrastructure assets by interstate, primary, and secondary highway systems. Figure 7.2 summarize a listing of key findings and recommendations.	Chapter 7, Section 7.4.1
o Improving or preserving the condition of the assets and the performance of the NHS relating to physical assets,	NCDOT will use the power of its management systems along with the technical expertise in the central units and divisions to develop HMIP and BMIP plans to preserve the condition and performance of the NHS.	Chapter 7, Section 7.4.2
o Achieving the State DOT targets for asset condition and performance of the NHS in accordance with 23 U.S.C. 150(d), (TPM Targets)	The results of these processes and strategies described in Chapter 7 have produced a highway system that is in a state of good repair as described in Chapter 3 Performance Goals & Targets. While no targets for pavement and bridges will be set before the completion of the initial TAMP, the performance of the system far exceeds the minimum federal standards	Chapter 7, Section 7.4.3
o Achieving the national goals identified in 23 U.S.C. 150(b).	An Oversight Committee has been established to develop performance targets and provide oversight for implementation of all MAP-21 and FAST Act final rules.	Chapter 7, Section 7.4.4
• Identifying and describing how the investment strategies are influenced by:		
o Anticipated available funding to implement strategies and estimated cost of future work types associated with investment strategies being considered, based on the TAMP financial plan.	Section 7.3.2 provides an estimate of the state revenues expected to be generated by the Highway Fund and Highway Trust Fund for the fiscal year 2017-18 to fiscal year 2027-28 time frame. Federal funds are conservatively estimated to remain about the same due to the uncertainty at the federal level.	Chapter 7, Section 7.3.2

NCDOT TAMP 2018 Certification Guideline Checklist

5. Process to develop investment strategies (23 CFR 515.7(e) and 515.9(f))		
Required Element	**How Requirement is Addressed in This Document**	**Required Elements Addressed on These Pages**
o Results of the TAMP risk, management, life cycle planning, and performance gap analyses.	NCDOT has historically had an effective process for determining allocation of funds and resources to meet the agency's vision and guiding principles. This document outlines a summarization of NCDOT's process in the development of their annual pavement and bridge management programs. While the section on risk will not be finalized as a part of the initial TAMP, NCDOT has formal and informal processes in place to address risk and funding of the projects caused by non-recurring factors. As NCDOT moves forward with the development of the section on risk management, additional risks will be identified and a formal risk management process will be developed which includes funding of these projects.	Chapter 7,Section 7.3.3 to Section 7.3.5

6. Process for obtaining necessary data from NHS owners other than the State DOT (23 CFR 515.7(f))		
Required Element	**How Requirement is Addressed in This Document**	**Required Elements Addressed on These Pages**
The TAMP must describe a methodology for obtaining necessary data from other NHS owners in a collaborative and coordinated effort	Other than Federal Lands, NCDOT collects the data for other NHS owners and will share applicable pavement and bridge condition data with other NHS owners on an annual basis.	Chapter 2, Section 2.3

NCDOT TAMP 2018 Certification Guideline Checklist

7. Process for Ensuring Use of Best Available Data and Use of Bridge and Pavement Management Systems (23 CFR 515.7(g))		
Required Element	**How Requirement is Addressed in This Document**	**Required Elements Addressed on These Pages**
The TAMP must describe a methodology for		
• Ensuring that the State DOT uses the best available data for development of the TAMP.	The TAMP will be produced using the most recent data from the PMS and BMS databases.	Chapter 3, Section 3.2 Chapter 4, Section 4.3.1 Chapter 7 Section 7.3.5 Chapter 7 Figure 7-1
• Ensuring that the TAMP is developed using bridge and pavement management systems that meet the requirements of 23 CFR 515.17. If, at the time of the first certification, the State DOT does not have bridge and pavement management systems that fully comply with 23 CFR 515.17 standards, the State DOT process identifies additional means it will use to provide analyses or other information needed to meet all of the requirements in 23 CFR 515.17.	In order for NCDOT to maintain this high standard of bridge conditions that have been historically established, the bridge management system (BMS) assists NCDOT in predicting the future needs to preserve the system and maximize the use of their assets at minimum cost. The BMS is used to track the metrics of the bridges and culverts as described in Chapter 2. This same system can be used to evaluate future needs through life cycle analysis. Similarly, the Pavement Management System (PMS) is the engine that stores the results of the pavement condition survey and provides the analysis to assist NCDOT managers with the information and data to develop pavement management programs to meet NCDOT's goals and objectives using life cycle cost	Chapter 3, Section 3.3
• Ensuring the process for using information from the State DOT's Statewide Transportation Improvement Program (STIP) in the development of the State DOT's TAMP is consistent with TAMP process and data requirements. This means that the STIP may be used to provide background information, but cannot be used as a substitute for carrying out the required analyses, or be used to override the results of the required independent analyses of relevant data when developing investment strategies.	NCDOT's programs having most impact on the NHS are predominantly state funded programs. NCDOT will continue to program pavement and bridge resources to meet the State's measures and targets and continue to monitor the National Performance Measure's targets. Based on historical trends, NCDOT expects the Federal Measures to follow the same trend as NCDOT's measures for their SOGR and meet the MAP-21 requirements.	General theme throughout document