2020

Maintenance Operations and Performance Analysis Report (MOPAR)

Required by G.S. 136-44.3

NORTH CAROLINA
Department of Transportation
Division of Highways

Contents

1 Asset Management Program

The N.C. Department of Transportation (the Department) is responsible for the second largest state-maintained road network in the country, and its transportation system continues to grow. Lane miles and bridges are added each year through widening and new location capital projects, as well as secondary road additions. With each new addition, maintenance and operations responsibilities increase.

Transportation assets include pavements and pavement markings, bridges, and roadside features such as drainage structures, roadway shoulders, drainage ditches, signs and guardrail. The Department's asset management program continues to evolve as vision is translated into goals that drive system improvement plans. These plans are supported by performance measures which allow for tracking overall achievement of the goals. The program is decentralized, allowing Highway Division staff to use appropriate maintenance strategies to address needs specific to their areas. These strategies are then measured against production and expenditure targets that tie back to the Department's wider asset management vision.

In addition to routine maintenance activities, crews prepare for and respond to weather events that can cause significant damage to the Department's infrastructure. Major events such as hurricanes and other tropical storms, localized heavy rain events, as well as significant winter storms, can have lasting impacts. These impacts can cause accelerated deterioration of assets, necessitating early replacement of drainage systems, emergency bridge repairs and replacement, and significant repairs to pavements. Responding to each of these scenarios can also significantly strain maintenance budgets and limit the Department's ability to perform planned maintenance activities.

Transportation assets are interdependent and their effective maintenance requires a holistic approach. For example, unaddressed drainage issues can lead to cascading impacts to the entire roadway. Inadequate drainage can erode roadway shoulders and ditches or cause standing water which saturates subgrades leading to pavement deterioration and potholes. Wet surfaces also increase the risk for traffic crashes.

Even with a focus on planned maintenance, the Department must be able to adapt to constant, yet unpredictable events. With appropriate investments in maintenance programs, the Department can focus efforts on identified planned maintenance strategies, while motorists will see improved safety and a decline in costly reactive maintenance needs.

1.1 Recent Program Advances

The Department continues to work with the General Assembly and industry partners to implement policies and projects to advance the Asset Management program. These and other initiatives impact the way the Department sets goals, determines workplans and effectively allocates funding. Recent initiatives include:

- **Spend Plan -** Allocations for maintenance and operations programs have historically been on an annual basis, but, starting FY 2020, the 14 highway divisions received 6-month allocations for these programs. This provides the Chief Engineer's Office with the ability to adjust anticipated programmatic investments each quarter, as needed, to ensure FY expenditures do

not exceed available revenues and expenditure forecasts. Beginning in December of 2019, the Highway Divisions also began submitting quarterly expenditure forecasts to align with spending targets. These expenditure estimates are uploaded into the Department's Spend Plan Dashboard and used to compare project-level expenditures with spending targets. This data gives the Chief Engineer's Office additional information needed to make corrections throughout the year and improve oversight of the highway divisions' delivery of the maintenance programs. Finally, the Chief Engineer's Office continues to review anticipated expenditure amounts within each program and adjust allocations as necessary to prevent potential overspending across all programs.

- **Combined HMIP –** In previous years, the Department implemented the asset management vision through three independent maintenance programs. These programs included the Highway Maintenance Improvement Program (HMIP) which was specific to pavement assets, the Bridge Maintenance Improvement Program (BMIP) which was specific to bridge assets and the Routine Maintenance Improvement Program (RMIP), which was specific to other roadway assets such as drainage pipes, roadway shoulders and ditch lines, pavement markings, and signs. Pursuant to Session Law 2017-57, and to support the need for a more holistic approach to maintenance, these three distinct programs were merged and are now managed under a single "Highway Maintenance Improvement Program". The new unified HMIP is not to be confused with the prior HMIP which only included pavement assets.

- **Asset-Specific Data –** The Department continues to collect condition data on an annual basis for both pavements and bridges. This data is not only critical to maintenance planning efforts but is also required for other federal reporting needs. To further support maintenance planning needs, the Department has also been collecting new, asset specific inventory and condition data for assets such as maintenance size pipes (under 48" in diameter), non-National Bridge Inspection Standard (NBIS) pipes (48" in diameter or greater), noise walls, and retaining walls. While collection of this data has recently slowed due to budgetary constraints, as budgets improve we will be prioritizing collection of remaining data needs across the state, as well as continued updates to the data each year to ensure accuracy and consistency. Historically, non-pavement and bridge maintenance condition assessments have been performed at the system level through statistical sampling within the Maintenance Condition Assessment Program (MCAP). This practice will continue for assets with highly varying deterioration such as ditches, shoulders, and pavement markings and markers. Where possible, however, the Department is transitioning to a collection of asset-specific condition data as previously described. In addition, the Department is also reviewing its MCAP to ensure data collection points are accurate and do not overlap with other inventory efforts. This will ensure the data more accurately reflects performance and desired level of service.

- **Transportation Emergency Reserve** - Session Law 2019-251 established a Transportation Emergency Reserve for use on events declared as emergencies under the Stafford Act (42 U.S.C. §§ 5121 – 5207). The fund will maintain a balance of $125 million each fiscal year through transfers from the Highway Fund, notwithstanding an initial $64 million provided from the General Fund.

- **Unanticipated Expenditures** – Session Law 2019-251 also established authority for the Department to transfer funds from every departmental division, grant-in-aid, and category of

expenditures, excluding salaries and personal services, to pay for any unanticipated expenditures from snow and ice removal, and emergencies. In previous years, all snow and ice or other non-declared emergency expenditures directly impacted the General Maintenance Reserve (GMR) fund, which is the primary resource for performing planned and other routine highway maintenance activities. In years with significant unanticipated expenditures due to winter storms or emergencies, the Department's ability to perform routine maintenance and deliver the planned maintenance programs was negatively impacted. This legislative authority has provided the Department additional financial resources to absorb potentially significant expenditures incurred from major weather events or other non-declared emergencies by allowing budgetary transfers from other programs into GMR to offset these unexpected costs.

- **Resiliency** – In part due to response efforts following Hurricanes Matthew, Florence, and Michael, and in part due to Governor Cooper's Executive Order 80 (EO80) on Climate Change, NCDOT is beginning a statewide vulnerability assessment, starting with the Strategic Transportation Corridor (STC) system and assets.

  Directive #9 of Governor Cooper's Executive Order 80 ordered all cabinet agencies to include climate adaptation and resiliency into their policies and called for the preparation of the North Carolina Climate Risk Assessment and Resilience Plan. Within Chapter 7 of the Risk Assessment and Resilience Plan, NCDOT identified the main climate and non-climate stressors that may make elements of the state's transportation infrastructure vulnerable in the future: hurricane storm surges and sea level rise; intense rain events and flooding; landslides; additional non-climate factors such as age of pipes and bridges; land use change/development; and potential dam breaches upstream of transportation assets.

  Session Law 2019-251 provided funding for a flood risk and vulnerability assessment of the STC system. NCDOT is currently refining a scope of work that will utilize the Federal Highway Administration's (FHWA) Vulnerability Assessment and Scoring Tool (VAST) to identify vulnerable areas or elements of the STC system and the associated risks. The aim, moving forward, is for NCDOT to develop a comprehensive resilience policy to guide decision making in long-range transportation planning, individual project planning and design, and operations and maintenance. By addressing these three main areas the department will be able to deliver a robust transportation system that can adapt to, withstand and quickly recover from climate-related hazards.

2 Investment Recommendations and Actions

As the Department works towards achieving the goals set forth in the Highway Maintenance Improvement Program, the success of this plan and the overall asset management program depends on long-term, consistent and sufficient funding. **Table 1** summarizes the investment recommendation as it relates to each of the major maintenance groups.

Fund	FY 2020 Appropriation ($ Million)	Activity	Need Per Year ($ Million)	Recommended Investment Per Year ($ Million)
Pavement Preservation	85.36	Preservation	*182.0	120.0
Contract Resurfacing	558.67	Resurfacing	*640.0	600.0
Bridge Program	273.94	Bridge Replacement	286.6	287.0
Bridge Preservation	69.69	Bridge Preservation	80.0	90.0
General Maintenance Reserve (GMR)	517.38	GMR Total	783.1	669.0
		Bridge Maintenance (Planned + Unplanned)	45.6	50.0
		Routine Maintenance Activities (Planned + Unplanned)	572.5	450.0
		Snow and Ice/Non-Declared Emergencies	90.0	94.0
		Statewide Programs	75.0	75.0
Roadside Environmental	101.33	Roadside Activities (Planned + Unplanned)	134.4	135.0

***Table 1**: Appropriations, Needs and Investment Recommendation*
** Resurfacing and Pavement Preservation need is based on the total funding amount needed to meet pavement condition targets, spread over a 5-year period*

2.1.1 Pavements

Recommendations to provide consistent and sufficient investment for Contract Resurfacing and Pavement Preservation are as follows:

- Support long-term consistent investment for resurfacing and pavement preservation activities to meet and sustain industry recommended cycle times and goals
- Increase Contract Resurfacing investment to $600 million, an increase of $42 million
- Increase Pavement Preservation investment to $120 million, an increase of $35 Million

2.1.2 Bridges

Recommendations to moderately increase the current investment for the Bridge Program:

- Fully fund Bridge Program needs of $287 million annually, an increase of $14 million over FY 2021 appropriations. This funding is used for replacement and major rehabilitation activities to meet or exceed Structurally Deficient targets by 2030.
- Increase funding to the Bridge Preservation Program to $90 million annually, an increase of $10 million, to provide additional investments focused on high value bridge preservation and lower maintenance costs of these assets.

2.1.3 Highway Assets

Recommendations to provide consistent and sufficient investment for Highway Assets include:

- Increase Roadside Environment investment to $135 million, an increase of $34 million, renewing efforts to better maintain vegetation growth, remove litter and debris, improve rest area conditions, and increase roadside aesthetics.
- Increase GMR investment to $669 million, an increase of $152 million. This investment level is determined by the routine maintenance needs (planned and unplanned) to reach production and expenditure goals. It includes statewide programs.

3 Delivering Asset Management Program

3.1 Highway Maintenance Improvement Program

The Highway Maintenance Improvement Program, or HMIP, is the Department's primary tool for planning asset level investments across the North Carolina highway system. With focus areas including pavements, bridges and other roadway assets, the current 5-year HMIP covers fiscal years 2021-2025. Each highway division has a schedule by county for each plan year within the 5-year plan. The first year is expected to be "firm," reflecting what will be delivered that year.

The HMIP is submitted annually with modifications to adjust years two through five (which will become years one through four) based on changing conditions such as needs and appropriation levels. For example, an unusually cold and wet winter may cause roads in western North Carolina to deteriorate faster than usual, requiring substantial investment in pavement repairs. Flooding in eastern North Carolina due to a hurricane can also cause deterioration to all assets, requiring unanticipated replacement and stabilization of drainage pipes. In some cases, the highway division may become aware of local economic development planned along one or more roadways that makes widening and strengthening those roadways a priority. A new year five will be developed as others roll forward.

The process is managed through the Asset Management System (AMS) which is composed of three subsystems: Pavement Management System (PMS); Bridge Management System (BMS); and the Maintenance Management System (MMS). AMS is used to identify potential areas which meet the treatment and funding requirements for inclusion in HMIP. Highway divisions use this data to develop and refine their work plans. Engineers use data from routine condition surveys on all assets to assist in developing their plans.

3.1.1 Pavements

Every year, the Department conducts pavement condition surveys of all its pavement assets on the interstate, primary and secondary systems. These surveys provide a point in time snapshot of the systems' pavement conditions. To develop the maintenance improvement plans, the Pavement Management System's (PMS) group uses the PMS's optimization capabilities to develop a five-year roadway section plan using the previous year's needs-based allocation. Divisions utilize the pavement condition information, and the recommendations from PMS, to develop contract resurfacing and pavement preservation investment plans to stay within budget over the 5-year period. The approved plans are released to the Divisions in AMS so they can track their work accomplished versus the plan. Additionally, interstate pavement maintenance project recommendations are also identified from the PMS and provided to the Divisions for development of resurfacing and preservation projects along interstate routes. These interstate maintenance projects are programmed within the 10-year STIP document and are updated as needed to be responsive to maintenance needs.

3.1.2 Bridges

The Department develops the 5-year bridge investment plan to make progress towards reaching the state goals for Structurally Deficient (SD) bridges. The Structures Management Unit (SMU) and the

Divisions work cooperatively to identify and schedule bridge replacements within the 5-year improvement plan to ensure positive movement toward established goals. 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, provided to each Division and reported to NCDOT senior management. Bridge performance is estimated based on current condition and budgetary amounts. Anticipated results are compared to NCDOT's long-term state asset targets. 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 use this list as they develop the 5-year replacement schedule. Like pavements, interstate bridge maintenance project recommendations are also identified from the BMS and provided to the Divisions for development of bridge rehab and preservation projects for bridge structures along interstate routes. These projects may be stand alone or included within previously described interstate pavement maintenance project limits and are also programmed within the 10-year STIP document and are updated as needed to be responsive to maintenance needs.

3.1.3 Highway Assets

Highway Divisions also create 5-year routine maintenance investment plans at a detailed level for non-pavement and bridge assets for the first two fiscal years (2021-2022) based on the previous fiscal year's maintenance allocations. As further described in **Section 4.3: Highway Assets - General Maintenance Reserve,** this effort includes establishing monetary investment amounts for unplanned activities, as well as anticipated investments and resulting production levels for planned activities. The final three years of the five-year plan (2023-2025) are planned at a Division-wide level, based on historical expenditures and long-range maintenance needs.

3.2 Citizen Action Request System

The Citizen Action Request System (CARS) was created to provide a place for both citizens and state personnel to report and track reactive maintenance needs. The Department strives to address each submission in a timely manner, however meeting CARS Responsiveness goals provides limited benefit to highway infrastructure longevity and is completely reactive, pulling staff away from any planned maintenance activities that impact infrastructure health. In FY 2020, the Department responded to 54,043 action requests.

Pursuant to the DOT Report Program (G.S. 136-18.05), the Department tracks its responsiveness for a selection of CARS maintenance categories including drainage, guardrail damage, pothole, shoulder repair, signal malfunction, and signing. Excluding potholes which must be repaired within two days of notification, safety-related items must be properly addressed within 10 days of notification, and non-safety items must be addressed within 15 days of notification. Department performance in these categories for FY 2020 is shown in the **Table 2**.

Legislative Category	Deadline to Address	Legislative Action Requests	
		Total Reported	Total Addressed On-Time
Pothole	2 days	14,293	10,108
Non-Pothole Safety	10 days	10,522	8,663
Non-Pothole Maintenance	15 days	8,999	7,268
Total		**33,814**	**26,039**

Table 2: *FY 2020 Completed Citizen Action Requests, Legislative Categories Only*

3.3 Staffing

To examine staffing efficiency, staffing distribution across the 14 Highway Divisions are shown along with the number of lane-miles, **Table 3**. The table includes the 2018 vacancy rate to demonstrate the increasing vacancy rate across most divisions. Overall staffing trends are consistent with urban/rural and geographical differences such as the Coastal, Sandhills, Piedmont or Mountain regions. For example, Division 1 manages fewer lane miles per employee (27 lane miles per employee) but has a higher area served per employee (13 square miles served per employee).

Division	2018 Vacancy Rate	2020 Filled Positions	2020 Vacancy Rate	Lane Mile / Employee	Population Served / Employee	Area Served / Employee
1	20%	401	22%	27.2	650	13.15
2	26%	346	28%	31.3	1439	12.05
3	24%	352	27%	34.3	2017	12.59
4	20%	410	23%	33.5	1444	8.49
5	33%	399	34%	37.5	3889	8.07
6	27%	362	26%	36.8	1871	11.07
7	17%	380	22%	31.9	2452	6.47
8	14%	434	15%	33.6	1219	9.43
9	10%	372	15%	29.5	2045	5.87
10	18%	408	20%	28.0	3775	5.99
11	21%	411	25%	30.4	897	8.06
12	20%	337	27%	38.9	2236	6.98
13	14%	436	16%	24.9	1164	7.23
14	9%	477	16%	22.0	760	8.47
Average	**19%**	**395**	**23%**	**31.4**	**1,847**	**9**
Total	**-**	**5,525**	**-**	**-**	**-**	**-**

Table 3: *Division Staffing, 2020*

3.4 Adverse Weather Impacts on Maintenance

Hurricanes, winter storms, heavy rainfall, rockslides, earthquakes and other weather-related events all affect the highway system and the Department's ability to perform planned maintenance activities. These events may receive emergency declarations and become eligible for federal reimbursement, but those reimbursements typically take three to five years to receive in full. Even then, full reimbursement is typically only 70% of the total cost of a declared event. The impact of these events is twofold: the cost of immediate response reduces funds available for routine planned maintenance, and weather-related events accelerate system degradation, creating additional maintenance needs for years to come.

While it can be expected that North Carolina will experience some degree of emergency impacts each year, the severity and scope is unpredictable. For example, as seen in Figure 1 below, the Department incurred an average of $181 million per annum in emergency expenses over the past five fiscal years (2016-2020). In that same time, expenses ranged from as low as $86 million to as high as $297 million. In general, only half of the total amount of emergency expenditures are eligible for federal reimbursement.

The Emergency Reserve, established in Session Law 2019-251, will aid the Department in managing annual fluctuations in declared disaster spending needs. However, since the reserve fund is legislatively mandated to be maintained at $125 million through annual transfers from the Highway Fund, the primary funding source for all highway maintenance activities, significant weather and other disaster events will still directly impact spending on core highway maintenance programs. **Figure 1** illustrates that both declared and non-declared disaster spending are trending upward. The chart also illustrates the lag time in federal reimbursements for declared events.

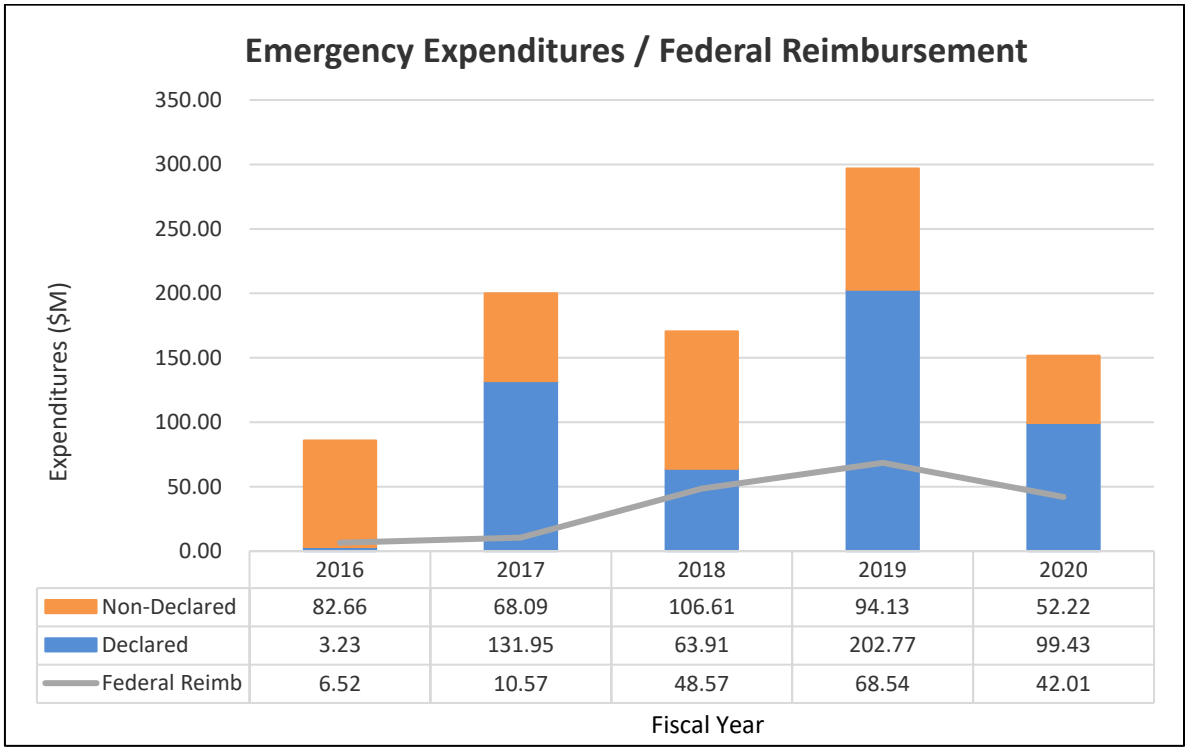


Figure 1: *Emergency Expenditures and Federal Reimbursement*

4 Current Conditions and Trends

Pursuant to NCGS 136-44.3, Section 2, goals for each of the major assets including pavements, bridges and highway asset are described below. The Highway Maintenance Improvement Plan (HMIP) governs these major assets and determines the production levels and investment required to meet stated goals. As stated previously, this new unified HMIP is not to be confused with the prior HMIP which only included pavement assets.

4.1 Pavements

The pavement section of the Highway Maintenance Improvement Plan (HMIP) focuses on maintaining pavements of the state's primary and secondary roadway system. To develop and implement a successful work plan, the specific roadway characteristics, treatment type and timing of treatment must be carefully considered. The Department has a large roadway system, requiring a substantial financial investment to maintain. And while the Department continues to provide significant financial investment into pavements, the improvements to pavement conditions will be gradual. And while overall system conditions may change slowly from year to year, individual roadway conditions can vary greatly from season to season dependent upon rainfall, freeze thaw cycles, and traffic loads. As such, the ability to easily respond to rapid condition changes by shifting resources and modifying previously identified treatments is critical.

With the funding level for resurfacing and pavement preservation programs over the past two years, the Department has been able to make some improvements in the number of miles treated and cycle time for which the Department treats pavements. Cycle time (the interval between each treatment activity) helps to identify the number of miles needed to reach the LOS goal. The industry recommends contract resurfacing to be completed every 12-15 years, while pavement preservation every 4-7 years. The following section provides a summary of plans and accomplishments for each treatment type – contract resurfacing and pavement preservation.

While not included within the Department's HMIP planning process, it should be noted that maintenance of the pavement and bridge assets along the interstate system also require a significant annual monetary investment to ensure condition targets are maintained. Although the amount of road miles and bridges contained within the interstate system is far less than that of the primary and secondary systems, the highest volumes of traffic across the state use these routes every day. Interstate routes are critical to the movement of freight and other goods in and through the state and must be maintained at a higher level of service. Interstate maintenance (IM) projects are funded with federal aid funds, and as such are programmed within the 10-year State Transportation Improvement Program (STIP) and not within the 5-year HMIP. In the current 2021-2029 STIP, interstate maintenance investment levels average just over $106 million for the 10-year period. IM projects are prioritized similarly to other paving projects within the HMIP. Divisions utilize the pavement condition information, and the recommendations from PMS, to develop interstate maintenance investment plans to stay within budget over the 10-year STIP period.

4.1.1 Cycle Times

4.1.1.1 *Contract Resurfacing*

As shown in **Table 4**, cycle time for contract resurfacing on the primary system is 16 years and is nearly consistent with industry recommendations described in the prior section. Cycle time for contract resurfacing on the secondary system is 29 years, roughly double industry recommendations. Reaching the recommended cycle times is essential to meeting an expected level of service for pavement conditions.

Contract Resurfacing	Planned	Completed + Under Contract
Primary (lane miles)	2,327	2,254
Percent Statewide System	7%	6%
Cycle Time (years)	15	16
Secondary (lane miles)	3,769	4,276
Percent Statewide System	3%	3%
Cycle Time (years)	33	29

Table 4: *Contract Resurfacing Planned and Accomplished Work, HMIP Plan Year 2019*

4.1.1.2 *Pavement Preservation*

The current accomplished cycle time for pavement preservation is 25 years, almost three times industry recommendations, **Table 5**.

Pavement Preservation	Planned	Completed + Under Contract
Secondary (lane miles)	5,299	4,978
Percent Statewide System	4%	4%
Cycle Time (years)	23	25

Table 5: *Pavement Preservation Planned and Accomplished Work, HMIP Plan Year 2019*

4.1.2 Current Conditions and Trends

As stated previously, each year the Department conducts pavement condition surveys of all its pavement assets on the 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 Index (PCI). The PCI considers observed defects in the pavement such as cracking, patching, rutting, traveling, 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 a rating of “fair” or “poor.” A Good rating is defined as a PCI greater than 80 percent; a Fair rating is a PCI between 80 to

60 percent; a Poor rating is a PCI less than 60 percent. Pavement condition is influenced by activities funded through interstate maintenance (STIP), contract resurfacing, pavement preservation and routine highway maintenance programs.

Figure 2, **Figure 3** and **Figure 4** show pavement condition for interstate, primary and secondary routes since 2006. Primary road percentage of good pavements have increased in the past 1-2 years, while the secondary road good pavements are stable.

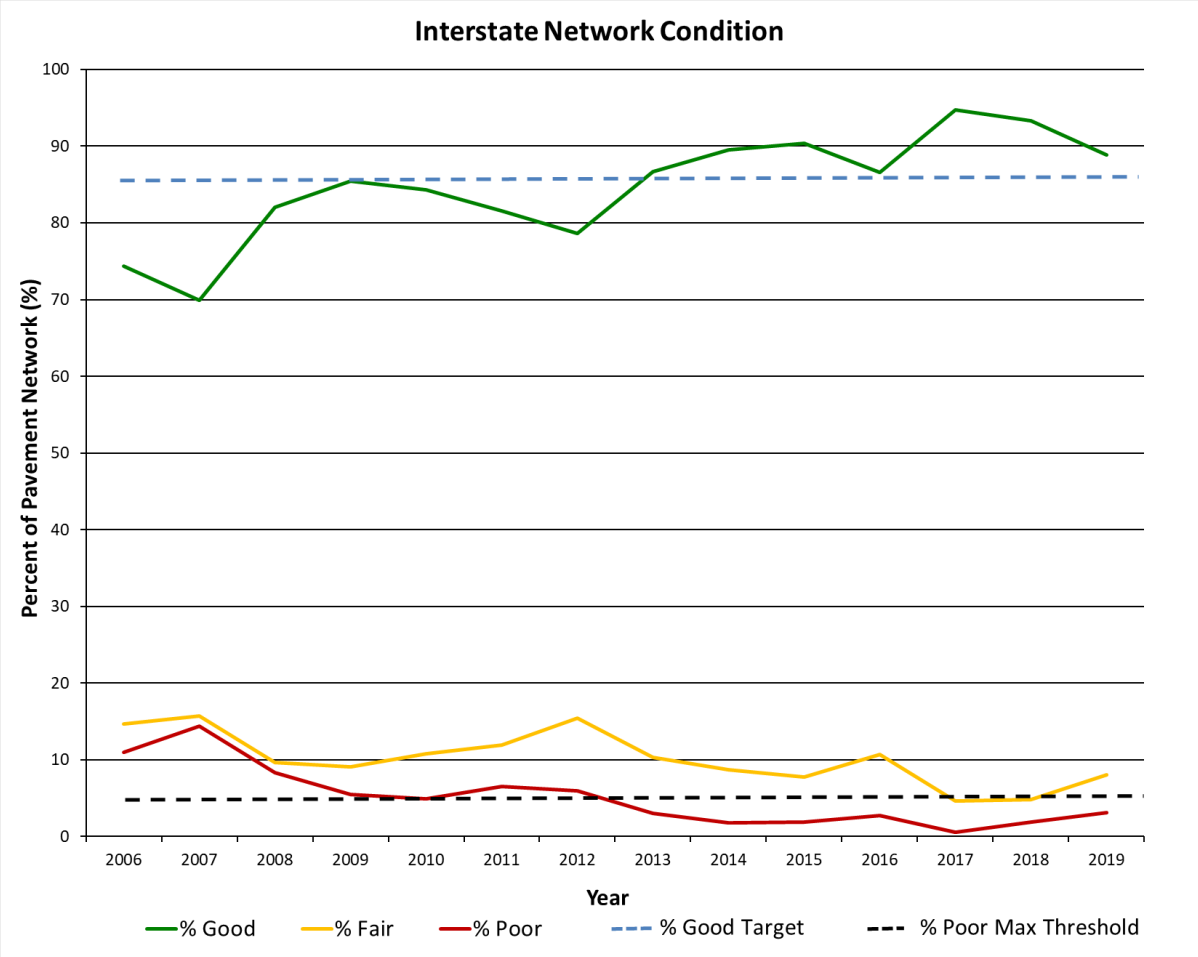


***Figure 2**: Interstate Pavement Condition, 2006-2019*

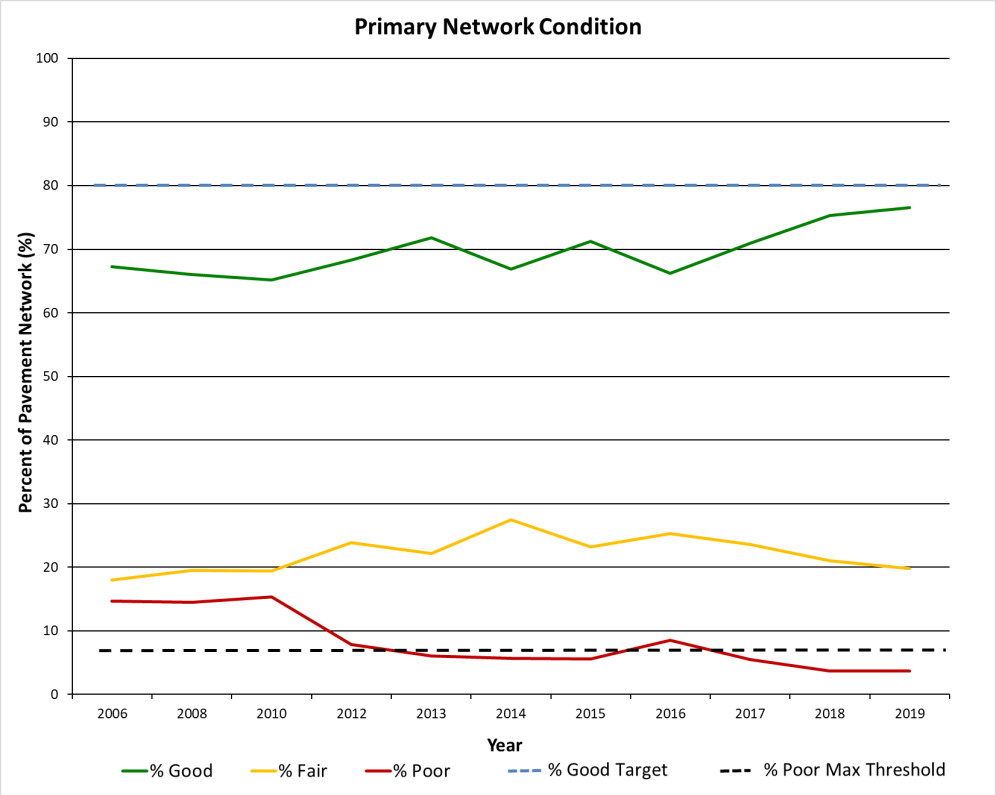


***Figure 3**: Primary Network Pavement Condition, 2006-2019*

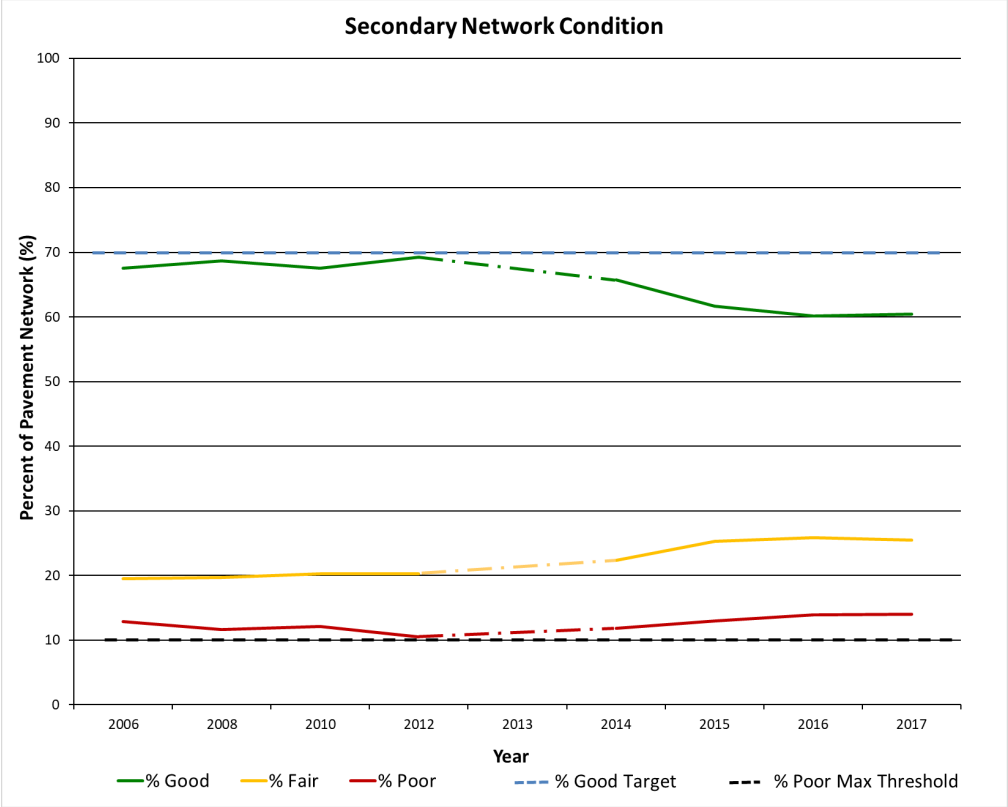


***Figure 4**: Secondary Network Pavement Condition, 2006-2017*

To understand the impact of funding, specifically for maintenance and operations programs, **Figure 5** and **Figure 6** compare funding levels and pavement condition. For the primary system, the steady funding for Contract Resurfacing (CR) has reduced the percentage of fair and poor pavements over the past 2 years. This continued focus is needed to further increase the percentage of good pavements. In contrast, secondary pavement condition has fluctuated more over the past decade. However, with a renewed focus on funding Pavement Preservation (PP), the percentage of good pavements have begun to increase. With consistent investment, Divisions can implement the HMIP as expected and systematically improve or maintain current conditions.

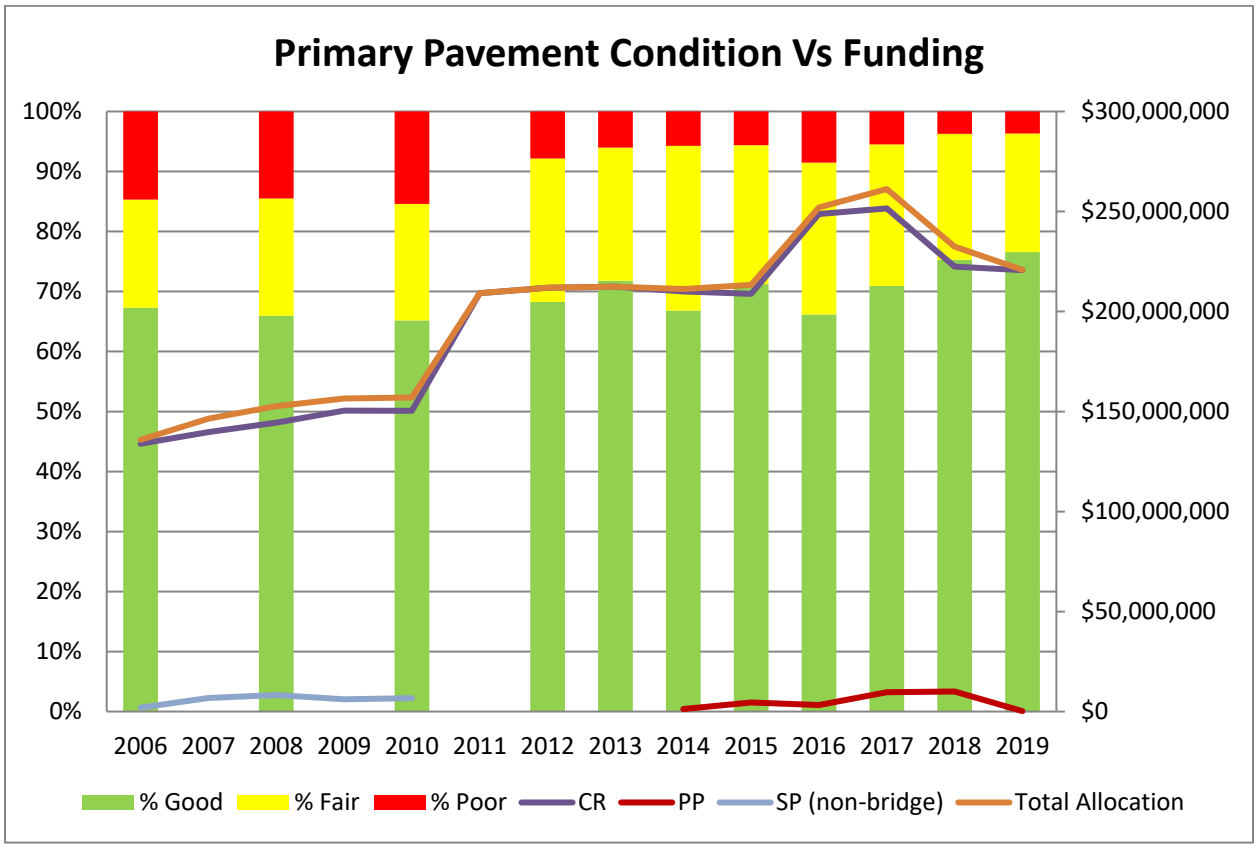


Figure 5: *Allocations and Primary System Condition*

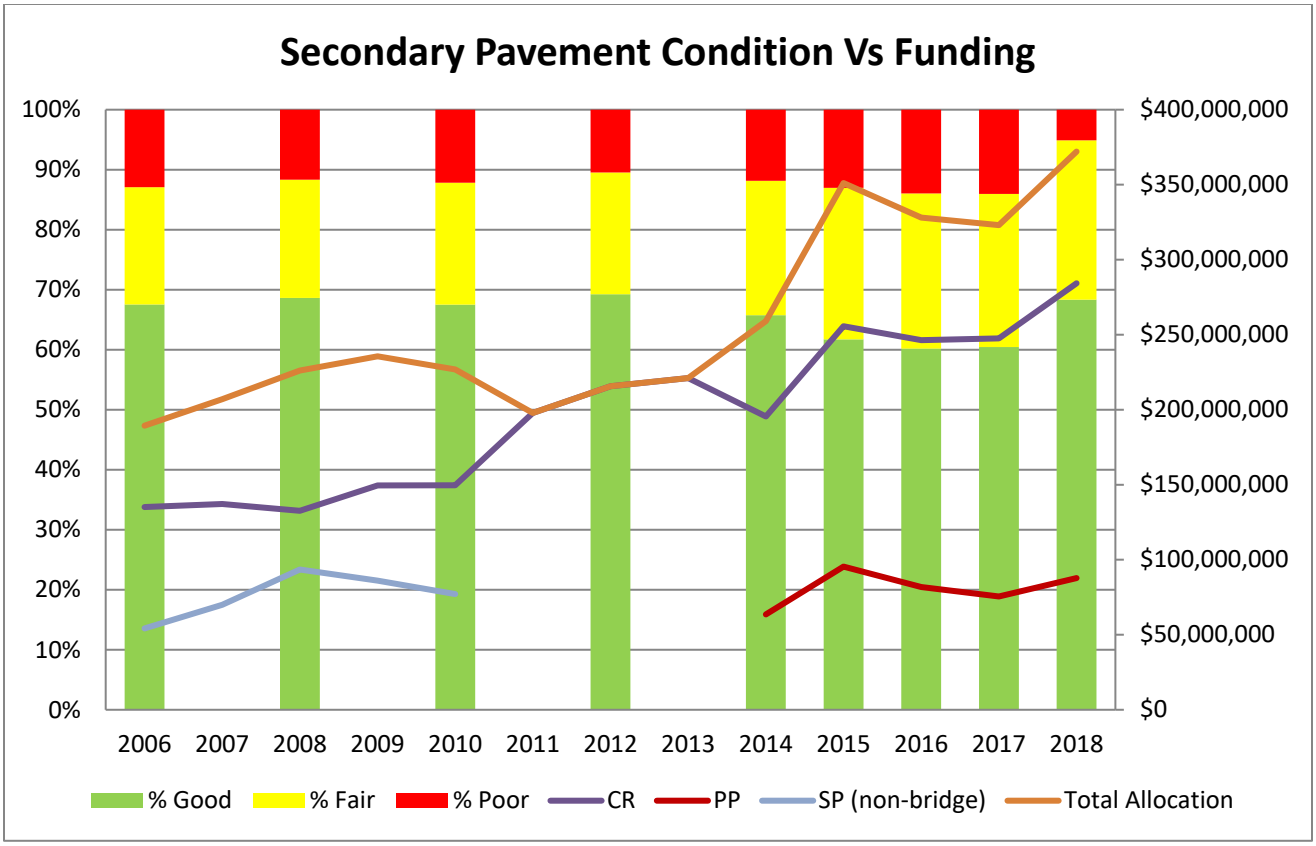


Figure 6: *Allocations and Secondary System Condition*

4.1.3 National Highway System Pavements – Federal Performance Measures

There are 21,148 miles of pavements on the National Highway system. Conditions and progress towards targets are reported to the Federal Highway Administration (FHWA) in the Transportation Asset Management Plan (TAMP). 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. 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 uses these metrics to quantify the condition of pavements in terms of roughness (International Roughness Index - IRI), % cracking, rutting (asphalt) and faulting (concrete). As shown in **Figure 7** and **Figure 8**, the percentage of Poor NHS pavements has decreased and the percentage of good NHS pavements has stabilized.

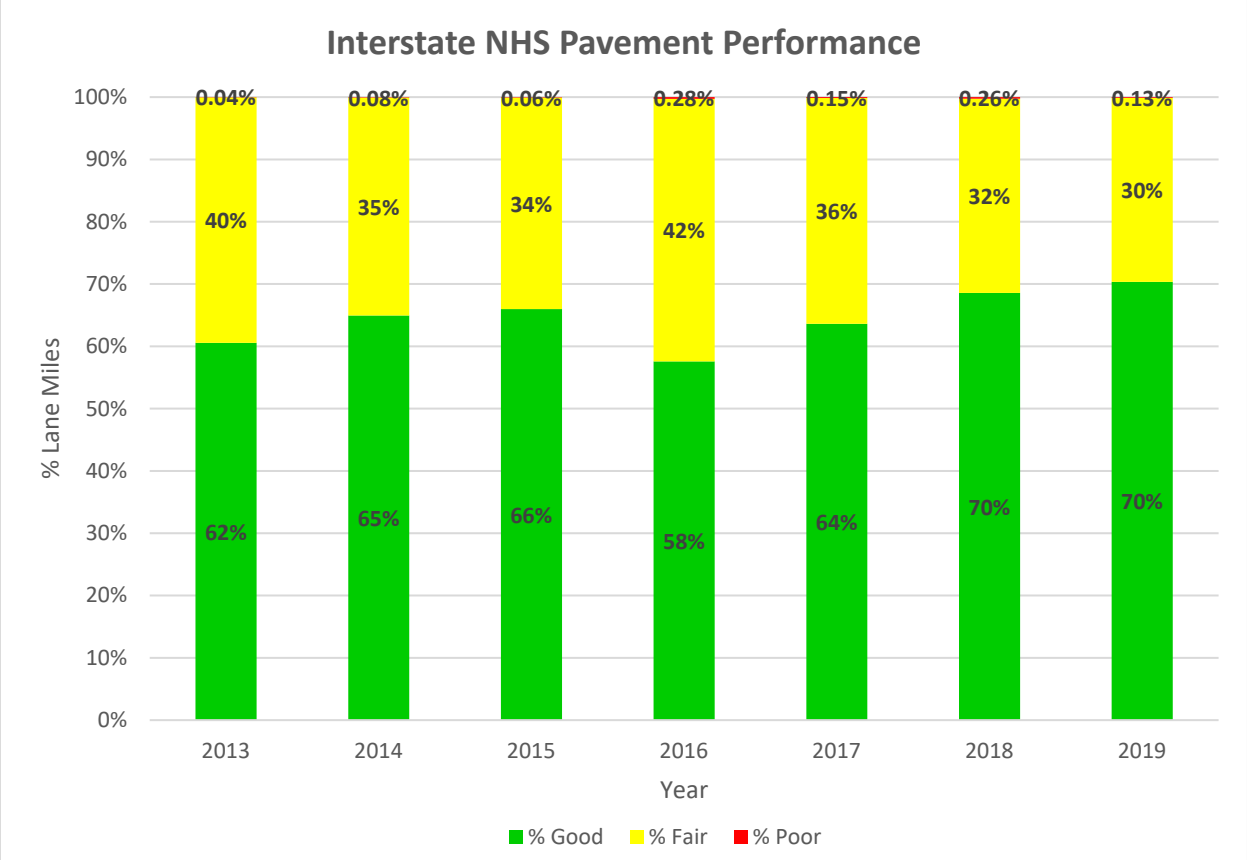


Figure 7:*NHS Interstate System Pavement Conditions*

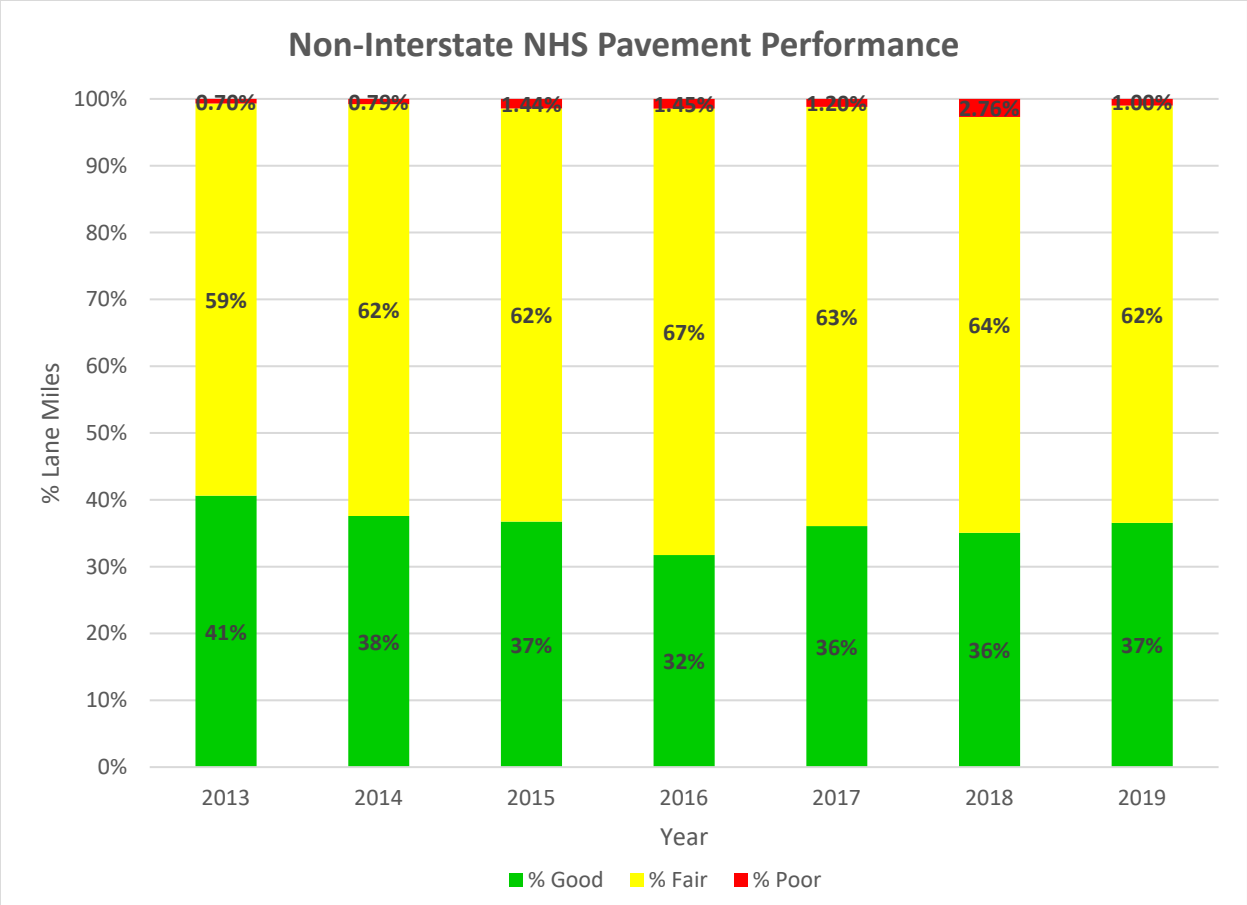
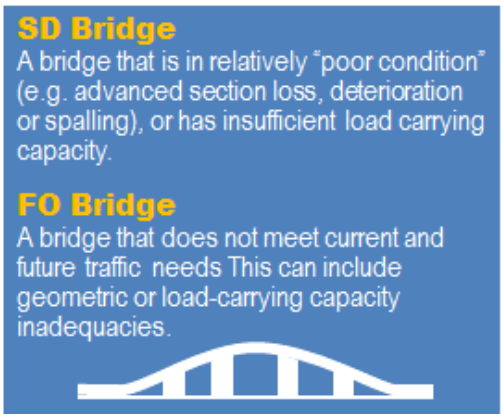


***Figure 8**: NHS Non-Interstate System Pavement Conditions*

4.2 Bridges

All bridges go through a natural deterioration or aging process, although each bridge is unique in the way it ages. Regular inspections help the Department identify and schedule bridges for maintenance, repair and replacement. The Department follows National Bridge Inspection Standards (NBIS) and ensures that each bridge is inspected at least every two years. The bridge conditions are recorded into WIGINS, an electronic data capture system for bridge inspection data. Structurally Deficient bridges are safe; however, they have components in poor condition due to deterioration including advanced section loss, deterioration or spalling. They require significant maintenance to remain in service and might require limits on vehicle weights. To fully address the issues on a structurally deficient bridge, extensive rehabilitation or replacement is usually required.

Prior to fiscal year 2015, funding for bridge replacements came from federal programs. As these funds were transitioned for capacity improvement projects, state funds became the primary and necessary funding source for bridge replacements. As shown in **Table 6**, state funds for the improvement of Structurally Deficient (SD) and Functionally Obsolete (FO) bridges have increased substantially since fiscal year 2015. The State Bridge Program has increased from $150 million in SFY 2015 to $273 million in SFY 2021. Beginning in fiscal year 2017, additional bridge preservation dollars were provided to fund cost effective solutions to maximize bridge life and lower lifetime costs.



Program	2015	2016	2017	2018	2019	2020	2021
Bridge Program	$150M	$242M	$242M	$280M	$272M	$201M	$273M
Bridge Preservation	-	-	-	$80M	$82M	$76M	$60M

Table 6: *Bridge Program and Preservation Allocations*

4.2.1 Inventory, Goals and Targets

North Carolina's bridge portfolio consists of approximately 13,500 bridges statewide, of which 8.6 percent are considered SD. As shown below in **Table 7**, the percent of SD bridges has decreased since 2015. This decrease has continued as funds focused on reducing the number of SD bridges has increased.

System / Year	SFY 2015	Current	Impact / Change	2030 Goal
Interstate	4%	2.4%	-1.6%	2%
Primary	9%	5.8%	-3.2%	6%
Secondary	21%	10.9%	-10.1%	15%
Statewide (weighted average)	**16%**	**8.6%**	**-7.4%**	**10%**

Table 7: *Percent SD Bridges, 2015 vs. Current*

While bridges being built today are designed for a 75-year life or longer, most of the bridges on the state system were designed for a useful life between 50-60 years. However, not all bridges that exceed this age are inherently SD, or even necessarily FO. There are several bridges older than this age that are safely handling traffic and are not SD or FO. By contrast, there are several bridges that have become SD well in advance of the 50 - 60-year average age expectation. This can be due to a variety of factors including harsh environments, higher than anticipated traffic volumes and local/regional development. Approximately 5,000 of the Department's bridges are more than 50 years old, and many are likely nearing the end of their useful lives. As these bridges continue to deteriorate with age and continued exposure to traffic and environment, they will become poor in condition and considered SD. **Figure 9** provides the count of bridges by age and SD percentage by age. In addition, **Figure 10** shows the number of bridges that have become SD in each of the last 8 years since 2013.

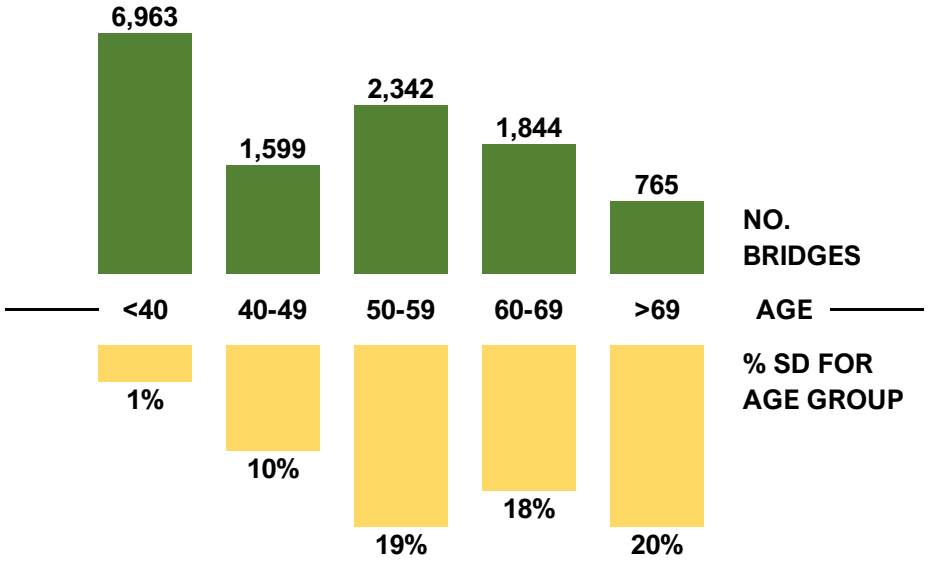


Figure 9*: Bridge Age versus Percent SD*

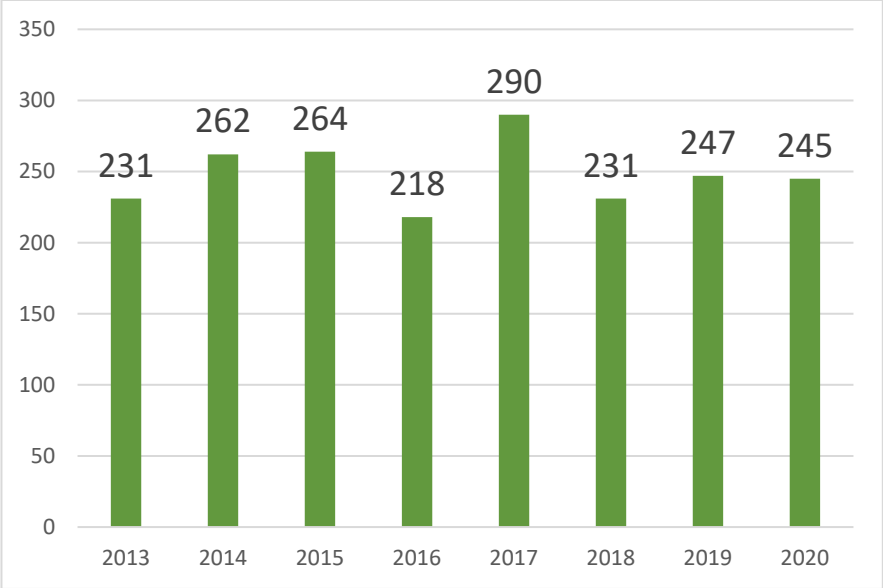


***Figure 10**: Number of New SD bridges 2013 to 2020*

At current funding levels, the Department is confident the Bridge Program will be able to overcome deterioration to continue recent condition improvements and achieve statewide goals by, or before, year 2030. **Figure 11** provides both recent and predicted performance for the Department's bridge inventory.

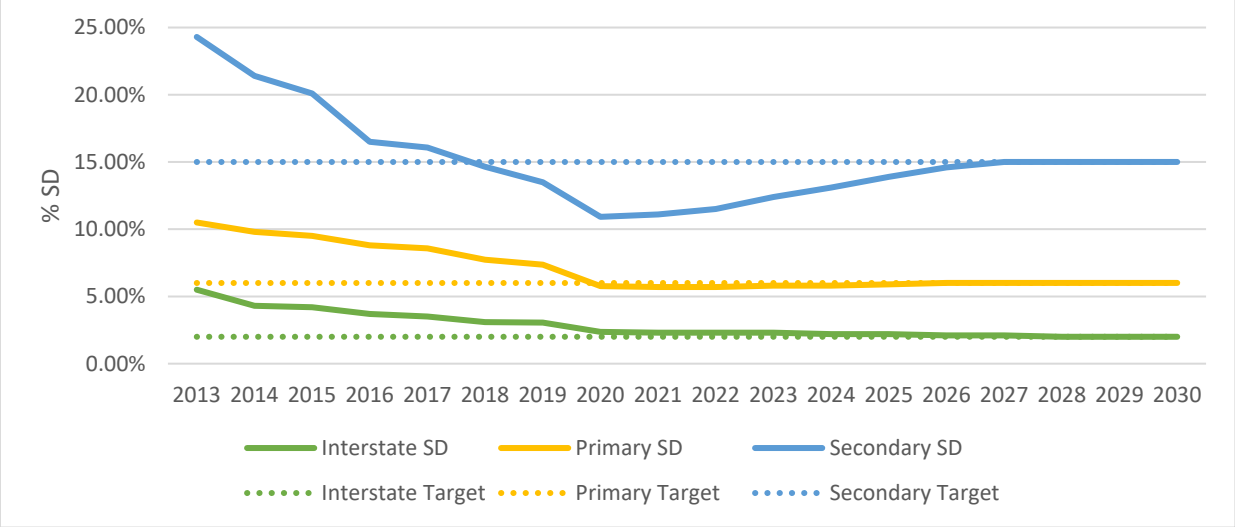


***Figure 11:** Historical and Forecasted SD Bridges by Network*

Several risks to achieving these goals have been identified. If the Department's "high value bridges," those which would cost more than $20 million to replace, are allowed to deteriorate, then progress toward goals may slow as a large portion of available funds would be required to replace a small number of costly structures. Additionally, while the annual average number of bridges becoming SD has stayed relatively constant, there is risk of this number increasing given the large portion of the bridge system that is nearing the average end of life age.

The Department is currently able to manage these risks, and is confident in projected performance, with the newly implemented Bridge Preservation Program. These funds are used to employ cost effective solutions to maximize bridge life and lower lifetime costs. The program is targeting high value bridges with innovative preservation projects that will prevent continued deterioration and circumvent replacement. Once the risk associated with the high value bridge inventory is mitigated, bridge preservation funds will be employed on a larger number of bridges which is expected to reduce the number of bridges becoming SD each year, thereby lowering funds required for maintenance.

4.2.2 Bridge Program—Replacements

As shown in **Figure 11**, 21 percent of bridges on the secondary system were rated SD in 2015. That number has been reduced to 10.9 percent in less than six years due to the recent increase in Bridge Program funds provided. These funds were used in a concerted effort to improve the secondary system and the Department is now focused on ensuring these gains are maintained or further improved upon.

Having achieved the goal for the secondary system, the Department has increased focus on the primary and interstate system to achieve all goals by 2030. Since primary and interstate system bridges are much more costly to replace, often between five and 10 times that of a secondary bridge, the rate of progress is expected to be slower than experienced with the secondary system.

As shown in **Table 8**, the Department will use approximately $520 million provided in the 2021 and 2022 Bridge Program to fund the replacement of 218 bridges, or 1.6 percent of the total bridge inventory. It is important to note that the impact on SD does not account for additional bridges that will become structurally deficient during this period, so the net reduction of SD percentages will be less than a 1.6% reduction.

Road System	Total Bridges	SD Bridges	Current % SD	Replacements SFY21 & SFY22	Impact on % SD
Interstate	1,053	25	2.4%	1	0.1%
Primary	4,330	250	5.8%	53	1.2%
Secondary	8,130	887	10.9%	164	2.0%
Statewide	**13,513**	**1,162**	**8.6%**	**218**	**1.6%**

***Table 8**: Impact of Bridge Program Replacements on SD Percentages through SFY 2022*

4.2.3 Bridge Program—Preservation

While the Department is confident that funding for bridges is sufficient to reach performance goals, risks have been identified that delay goal achievement. One such risk is associated with bridges that have disproportionately high replacement costs. There are 185 “high value bridges” that would each cost between $20 million and $300 million to replace. While these only account for 1.4 percent of the inventory by bridge count, their combined replacement cost of $9 billion dollars accounts for 15 percent of the total bridge system value. If long term goals are to be met, it is imperative that these bridges are maintained in the best possible condition through systematic preservation.

In FY2018, the Bridge Preservation Program was established and initially funded at $80 million and is funded at $60 million in FY 2021. This program was sub-allocated into two programs. The first is a program that focuses on preserving the Department’s high replacement cost bridges. As shown in

Table 9, the upcoming two years of the preservation program focuses on preserving high value bridges and includes 68 bridges that would cost the Department $2.9 billion to replace. The total funds required to deliver these preservation projects is $99 million. The remaining funds provided by the Bridge Preservation Program are allocated to Divisions to assist state bridge maintenance crews in prolonging the life of bridges by funding preservation projects, timely bridges repairs and maintaining bridge components critical to reducing long term maintenance costs.

Fiscal Year	# Bridges	Cost to Preserve	Cost to Replace
2021	29	$59 million	$1,542 million
2022	39	$40 million	$1,361 million

Sample of projects included in the 2021-2022 Bridge Preservation Program:

Bridge No.	County	Route Carried	Intersected Feature	Cost to Preserve ($M)	Cost to Replace ($M)
090013	Brunswick	NC904	ICW	$2.9	$40.7
410063	Halifax	US158	Roanoke River	$2.4	$23.6
640048	New Hanover	I40EBL	NE Cape Fear	$1.9	$31.4
640049	New Hanover	I40WBL	NE Cape Fear	$1.7	$31.5
060353	Beaufort	US17	Tar River	$1.8	$730.2
640021	New Hanover	US76	Banks Channel	$1.7	$33.6
100705	Buncombe	SR3548	French Broad River	$4.3	$32.5
930015	Washington	NC32	Albemarle Sound	$6.0	$419.8

Table 9: *High Value Bride Preservation Projects*

4.2.4 National Highway System Bridges – Federal Performance Measures

Bridges on the National Highway system comprise 2,902 or 21% of the total number of bridges on state-maintained routes. Conditions and progress towards targets are reported to the FHWA in the Transportation Asset Management Plan (TAMP). Per FHWA guidance, condition of NHS bridges is reported in percent of Deck Area in Good and Poor condition. As shown in **Table 10** and **Table 11**, 8.2 percent of NHS bridge deck area was rated SD in 2015. That number has been reduced to 4.2 percent in less than six years due to the recent increase in Bridge Program funds provided and discussed in the previous section.

System	Total Bridges	Total Deck Area (SF)	Poor Deck Area (SF)	% Poor Deck Area	Good Deck Area (SF)	% Good Deck Area
Interstate	1,053	17,572,244	322,925	1.8%	7,708,042	43.9%
Primary	1,748	29,704,718	1,723,361	5.8%	11,325,295	38.1%
Secondary	101	2,005,823	42,128	2.1%	1,353,122	67.5%
Total	**2,902**	**49,282,785**	**2,088,413**	**4.2%**	**20,386,459**	**41.4%**

***Table 10**: Current Inventory and Condition of NHS Bridges*

	SFY 2015	Current	Impact/ Change	2 Year Target	4 Year Target
% Poor Deck Area	8.2%	4.2%	-4.0%	< 8%	< 9%
% Good Deck Area	45.0%	41.4%	-3.6%	> 33%	> 30%

***Table 11:** Condition Trends of NHS Bridges*

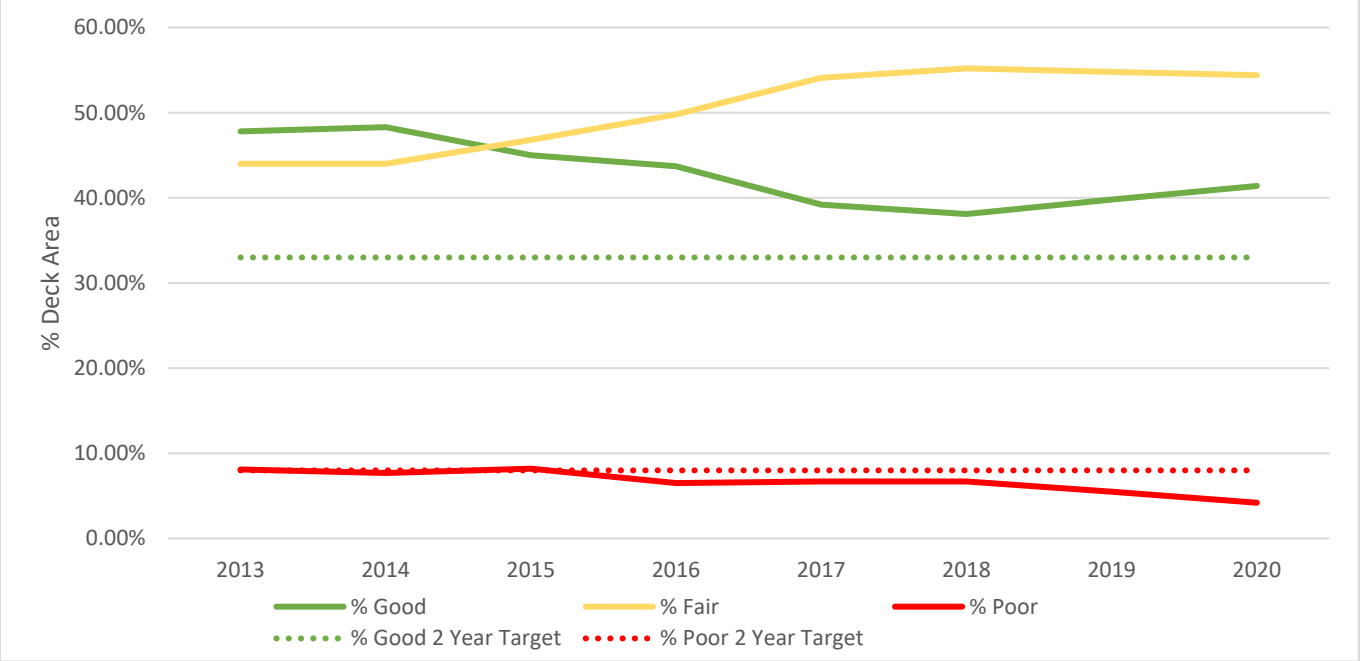


***Figure 12:** Historical and Forecasted NHS Bridge Condition*

4.3 Highway Assets - General Maintenance Reserve

The General Maintenance Reserve appropriations support a wide range of core maintenance activities essential to the upkeep of the highway system. In addition to the planned work functions in HMIP, Divisions also conduct unplanned routine maintenance work on a significant amount of additional work functions. **Table 12** shows historic expenditures across all activity categories, both planned and unplanned, funded by General Maintenance Reserve.

Activity Description	SFY 2018	SFY 2019	SFY 2020	3-Year Average
Snow and Ice	$87,949,521	$67,003,359	$34,553,841	$63,168,907
Shoulder/ Ditch Maintenance	$72,448,502	$69,219,150	$30,390,679	$57,352,777
Pavement Maintenance	$40,810,687	$62,914,702	$42,160,542	$41,024,460
Bridge Maintenance*	$12,376,246	$11,387,496	$5,821,313	$9,861,685
Removal of Hazards	$27,296,555	$30,568,006	$35,406,700	$31,090,421
Traffic Devices/ Services	$63,227,737	$60,255,003	$41,786,057	$55,089,599
Barriers (Guardrail/Cablerail)	$17,007,163	$20,573,962	$17,326,697	$18,302,607
Pipe Installation/ Replacement/ Repairs	$90,033,610	$89,030,938	$22,645,684	$67,236,744
Vegetation Management*	$8,190,735	$8,376,046	$9,710,046	$8,758,942
Office Engineering/ Inspection/ Assessments	$76,018,537	$94,516,609	$70,497,659	$80,344,269
Incident Management Assistant Program	$7,576,027	$7,314,266	$5,293,345	$6,727,879
Unpaved Roadway Maintenance	$17,273,439	$13,341,707	$4,864,628	$11,826,591
Electricity for Signals and Roadway Lighting	$6,686,731	$6,730,797	$6,722,737	$6,713,422
Construction/ Maintenance of Facilities	$19,622,678	$9,112,719	$1,967,352	$10,234,249
Specialty Services & Operations*	$24,032,068	$60,293,801	$56,498,648	$46,941,505
Training & Development	$5,608,027	$6,477,724	$3,030,050	$5,038,600
Core Maintenance Activities (Subtotal)	$600,938,187	$598,272,072	$365,650,489	$521,620,250
Other GMR Activities*	$6,713,594	$1,407,618	$9,195,617	$5,772,276
TOTAL EXPENDITURES:	**$607,651,781**	**$599,679,691**	**$374,846,106**	**$527,392,526**

***Table 12**: Historical expenditures in General Maintenance Reserve by Activity Type*

** Some work functions were moved from GMR to other funding categories during the reporting periods*

Planned maintenance work activities/work functions are those that are performed on a recurring basis and can be planned to the route, system or asset level in advance of the work taking place. However, as is typical with all work activities, there are unexpected events that will require forces to be reactive in

their maintenance efforts. Therefore, not every expenditure associated with a planned maintenance work activity/work function can be anticipated in advance, resulting in both planned and reactive costs. The planned and reactive costs associated with these planned maintenance activities are in **Table 13**.

Planned Routine Maintenance activities are based on condition and LOS targets. Examples include shoulders and ditch maintenance, crossline pipe replacements, pavement striping, bridge joint repairs, mowing, and painting steel girders, among others.

In addition to the planned work activities/work functions, Divisions conduct significant amounts of reactionary maintenance work on several additional work functions. These are activities that cannot be planned in advance and typically require an immediate response. Examples of these activities include pothole repair, removal of hazards and guardrail repair.

	In-Plan Costs	Reactive Costs	Total Costs	% Total Planned
Bridge Joints	$4,221,513	$7,366,900	$11,588,413	36%
Bridge Pipe	$7,778,573	$58,356,660	$66,135,233	12%
Brush and Tree	$14,061,049	$16,182,289	$30,243,338	46%
Ground Signs	$4,459,095	$8,928,336	$13,387,431	33%
IMAP	$6,725,095	$4,012,513	$10,737,609	63%
Litter	$13,864,518	$6,097,480	$19,961,998	69%
Maintenance Pipe	$20,545,432	$25,858,954	$46,404,386	44%
Mowing	$40,293,660	$1,543,239	$41,836,899	96%
Pavement Markings - Long Life	$2,334,542	$7,682,787	$10,017,329	23%
Pavement Markings - Paint	$3,104,065	$4,518,868	$7,622,934	41%
Rest Area Maintenance	$10,580,121	$5,300,761	$15,880,882	67%
Shoulder and Ditch	$19,016,779	$29,946,343	$48,963,122	39%
Traffic Signal Maintenance	$3,781,677	$9,203,513	$12,985,190	29%
Grand Total	$150,766,119	$184,998,644	$335,764,763	**45%**

Table 13: *Planned and Reactive Costs Associated with Planned Maintenance Activities/Work Functions- SFY 2019*

4.4 Highway Assets - Roadside Environmental

The Roadside Environmental Apportionment supports a wide variety of vegetation management, litter removal, rest area maintenance, and aesthetic and beautification efforts along roadsides. Conditions of roadside assets frequently vary depending on seasonality, rainfall, and other factors, so establishing condition levels of service is not feasible. As such, performance criteria associated with delivery of programs at specific time intervals and cycles are established and measured/monitored by visual inspection. Monitoring of Roadside Environmental performance was paused in Summer 2019 due to limited financial resources. During this period, Roadside Environmental operations no longer targeted specific dates; instead, operations were limited to those necessary to ensure the safety of the public. The Department will return to monitoring Roadside Environmental performance once financial conditions allow for the planned management of roadsides.

5 Safety and Mobility

5.1 Update and Trends

An efficient transportation network means faster and more reliable travel times for both people and goods. For example, with predictable travel times manufacturers can reduce distribution costs and, in turn, pass savings onto consumers. This section uses three measures to evaluate mobility. Each one provides insights into different aspects of congestion and should be viewed together to provide a more complete picture.

- Travel Time Index – the variability of travel time during rush hour
- Average Number of Congested Hours – the number of hours that speeds are slow
- Travel Time Reliability – the variability of travel time on a "bad day"

5.1.1 Travel Time Index

The first way the Department evaluates congestion is by comparing the variability of travel times. Specifically, travel at the speed limit is compared to travel during rush hour. This comparison is known as Travel Time Index (TTI). For example, if a trip takes 20 minutes when made at the speed limit and that same trip takes 30 minutes during rush hour, the TTI is 30/20 =1.50 and the Congestion Level is "Poor." The values and levels are provided in **Table 14**. The higher the TTI, the more travel time varies between rush hour and non-rush hour trips. This means that commuters and businesses must allow extra time to make a trip during those hours.

Congestion Level	Additional Travel Time/Travel Speed	Travel Time Index	
Great	■ Congestion increases trip time by less than 15% ■ Travel speed within 15% of Posted Speed Limit (PSL)	<1.15	
Good	■ Congestion increases trip time by 15%-30% ■ Travel speeds 15%-30% below PSL	1.15 to 1.30	
Poor	■ Congestion increases trip time by more than 30% ■ Travel speeds 30% below PSL	>1.30	

***Table 14**: Congestion Level and Travel Time Index*

During the most congested hour of the day, 73 percent of heavily travelled interstates were rated as Great, 10 percent were rated as Good and 17 percent were rated as Poor. Interstate congestion is concentrated in urban and suburban areas such as Raleigh, Charlotte, Asheville, Greensboro, and Winston-Salem, shown in **Figure 13**.

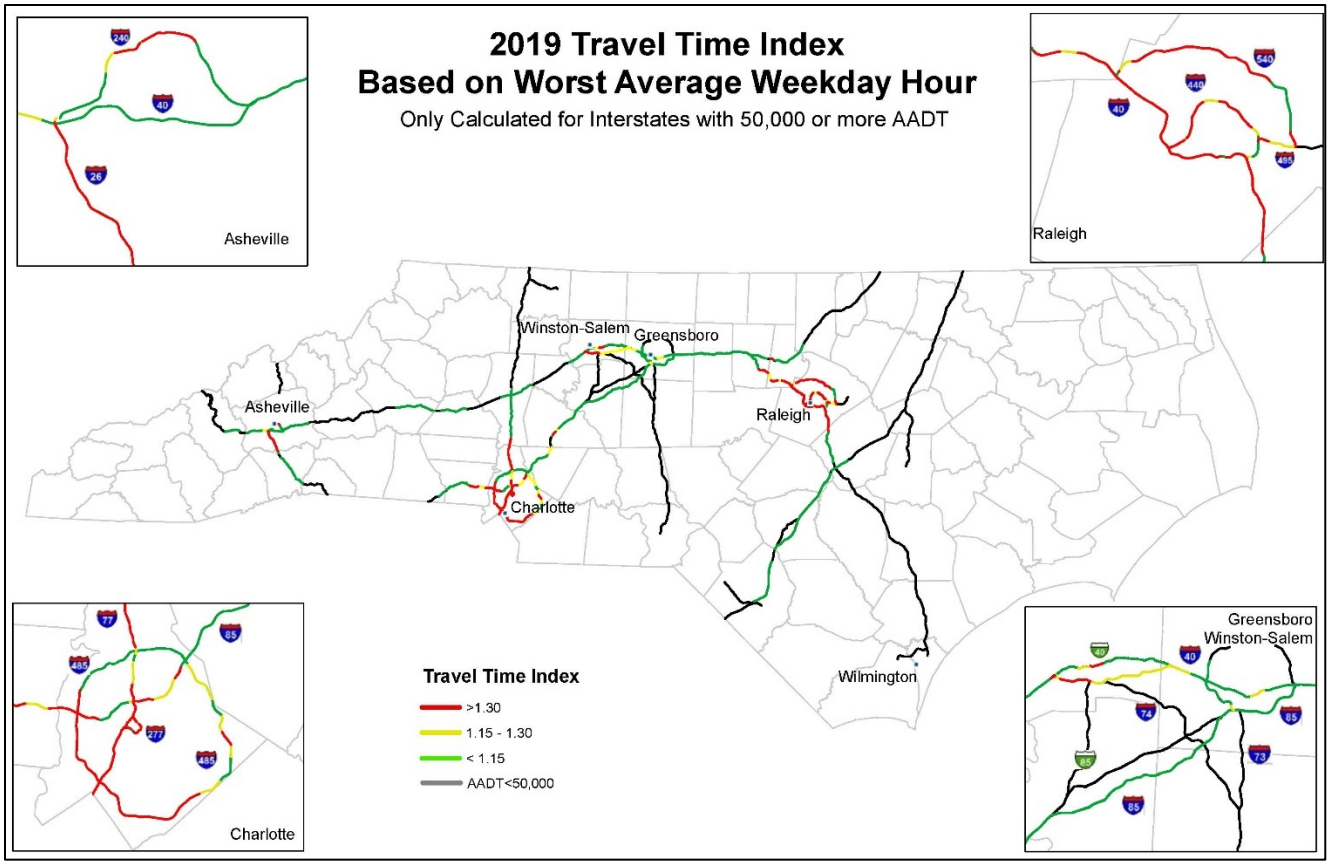


***Figure 13**: Levels of Traffic Congestion on Heavily Travelled Interstates, 2019*

5.1.2 Average Number of Congested Hours

A second dimension of congestion is "How long does it last?" On freeways the Department considers congestion to begin when speeds drop below 45 miles per hour. **Table 15** shows the average number of hours that speeds drop below 45 miles per hour at the top 10 most congested locations. I-77 in the Charlotte area experiences Poor congestion levels during rush hour (TTI greater than 1.3) and the most frequent congestion in the state, with several locations experiencing between an average of 5-7 hours of congestion per day.

Rank	County	Route	Cross Street	Exit Numbers	Direction	Avg Congested Hours/Day
1	Mecklenburg	I-77	Remount Road	Exit 8	South	7
2	Mecklenburg	I-77	NC-73	Exit 25	South	7
3	Mecklenburg	I-77	Arrowood Rd - Nations Ford Rd	Exit 3-4	North	7
4	Mecklenburg	I-77	Tyvola Rd	Exit 5	North	7
5	Mecklenburg	I-77	Gilead Rd	Exit 23	South	7
6	Mecklenburg	I-77	Gilead Rd	Exit 23	North	6
7	Mecklenburg	I-277	I-77	Exit 5	Outer	6
8	Mecklenburg	I-277	US-29/NC-49	Exit 4	Inner	6
9	Mecklenburg	I-77	I-277/US-74	Exit 9	South	5
10	Mecklenburg	I-77	I-485	Exit 2	North	5

Table 15: *Highest average number of congested hours on heavily travelled interstates, 2019*

5.1.3 Travel Time Reliability

In addition to assessing the variability in travel times during different periods of the day, the Department also evaluates day to day travel time reliability. The Level of Travel Time Reliability (LOTTR) index represents how poorly a road performs on a "bad day" – i.e. that day with a crash, weather event or active work zone, compared to an average day. For example, if it takes a motorist 40 minutes to make a given trip on a bad day compared with 20 minutes to make the same trip on an average day, then the LOTTR would be 40/20 = 2.0. The Federal Highway Administration defines an LOTTR higher than 1.5 to mean that the road was considered "unreliable." This means there is a wide variability in travel times from day to day. In addition to the trip taking longer than normal, this variability makes trip planning challenging for motorists.

Table 16: Peak Period Congestion

Figure 14 below shows the percent reliability on North Carolina Interstates over the last three years. The values show what percentage of the 1,270 miles of Interstate are operating with a LOTTR of better than 1.5 and therefore operating reliably. The peaks and valleys can be explained by seasonality.

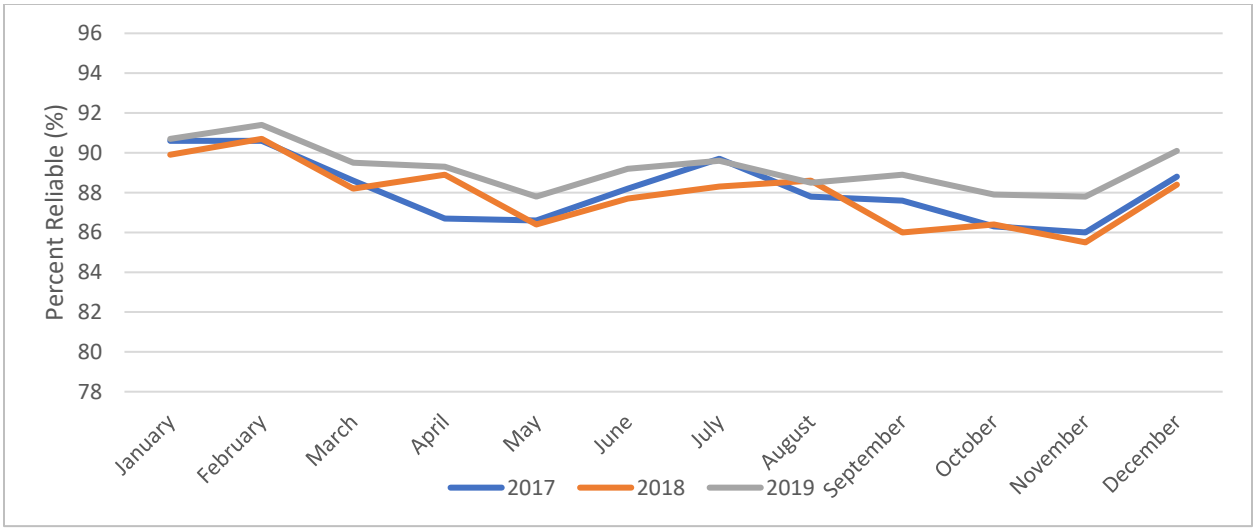


Figure 14: *Monthly Interstate Reliability*

5.1.4 Responding to Roadway Incidents

Crashes and disabled vehicles significantly contribute to congestion. Clearing crashes quickly minimizes delay and improves travel time reliability and safety. The Department works with local first responders to promote the quick clearance of incidents that disrupt the flow of traffic. NCDOT recently completed the construction of a Traffic Incident Management (TIM) Training Facility. The training facility will allow NCDOT and first responder partners from all disciplines and regions of the state to train side-by-side in a real-world environment. Currently 75% of reported crashes are cleared within 90 minutes; however, the Department is optimistic this enhanced training opportunity will move the state towards the "best practices standard" of 90% of crashes cleared within 90 minutes. The combined efforts and partnerships of law enforcement, emergency medical services, fire, towing, utilities and NCDOT will help achieve this goal.

One of NCDOT's most visible and effective congestion management resources is the Incident Management Assistance Patrol (IMAP). Their primary function is to help manage and expedite the safe clearance of crashes and other incidents along major corridors in the state. One notable example is the 10-minute reduction in clearance times realized when the newest IMAP Unit is on patrol on Interstate 95 (I-95). Amongst several other benefits, quickly clearing the scene of an incident reduces congestion and improves safety by minimizing the likelihood of secondary crashes. IMAP also assists disabled motorists by changing flat tires, jump starting vehicles, providing small quantities of fuel, and many other tasks which keep motorist safe and moving. In 2019, IMAP responded to more than 70,000 calls for service and assisted nearly 50,000 motorists. Sixty-five IMAP drivers patrol over 750 miles of roadway across the state. While the Department is maximizing the current allocation of IMAP resources, more drivers would be necessary to effectively provide the ideal level of service. The lack of IMAP resources is most evident during peak travel times, hurricane evacuations and winter weather events.

5.2 Recommendations for Congestion Reduction

Reducing congestion requires a multi-faceted approach which includes both capital and operational improvements.

NCDOT completed the Monroe Expressway in 2018 and HOT Lanes on I-77 in 2019. These capital projects are currently under development:

- Express lanes on I-485
- Integrated Corridor Management, I-85 west of Charlotte
- Managed lanes on I-77 from uptown Charlotte to South Carolina
- Added capacity to US-74 between uptown and I-485
- Widening NC-73 in northern Mecklenburg County
- Making NC-16 four lanes from Charlotte to I-40
- Early planning for the Silver Line light rail system from Belmont to Matthews

Operationally, NCDOT has had a Transportation Management Center in Charlotte since 2000 and IMAP since 1991. Dynamic message signs and traffic cameras are valuable tools NCDOT uses to manage congestion from crashes, work zones and weather. NCDOT retimes traffic signal systems to maximize throughput on busy corridors.

More robust deployment of these operational strategies would improve mobility in Charlotte and across North Carolina:

- Additional traffic cameras and dynamic message signs at needed locations
- Fully staffing IMAP and NCDOT Transportation Management Centers
- Upgrading traffic camera images on DriveNC.gov website to full motion video
- Dedicated resources for maintaining traffic cameras and dynamic message signs
- Implementing Advanced Traffic Management Software to optimize traffic management processes