GOVERNMENT OF PUERTO RICO

Puerto Rico Highway and Transportation Authority

2028 Puerto Rico Transportation Asset Management Plan

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Acronyms

Acronym	Stands for
CIP	Capital Investment Plan
DOT	Department of Transportation
FAST	Fixing America's Surface Transportation ACT
FHWA	Federal Highway Administration
HPMS	Highway Performance Monitoring System
MAP-21	Moving Ahead for Progress in the 21st Century Act
NBIS	National Bridge Inventory System
NHS	National Highway System
PRHTA	Puerto Rico Highway and Transportation Authority
PRTAMP	Puerto Rico Transportation Asset Management Plan
STIP	State Transportation Improvement Program
TAM	Transportation Asset Management
TAMP	Transportation Asset Management Plan
TIP	Transportation Improvement Program

Preface

This is the Puerto Rico Highways and Transportation Authority (PRHTA) Transportation Asset Management Plan (TAMP) for the National Highway System (NHS) for pavements and bridges for the years 2019 to 2028.

As reflected in this TAMP, PRTA establishes a strategic approach to planning, programming, engineering, financing, managing, maintaining, and operating physical assets with the objective of providing the required level of service in the most cost-effective manner.

Asset management refers to a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the life cycle of the assets at optimum cost (23 CFR Part 515 § 515.5).

The PRTAMP is developed in accordance with Federal laws and regulations, such as the Moving Ahead for Progress in the 21st Century Act (MAP-21) and Fixing America's Surface Transportation ACT (FAST Act). The PRTAMP is subject to acceptance and certification by the Federal Highway Administration (FHWA).

The components of the PR-TAMP are disclosed in Preface Figure 1.

PREFACE FIGURE 1: PR-TAMP COMPONENTS

This asset management plan accomplishes four critical purposes:

1. It helps Puerto Rico by identifying processes that will lead to better infrastructure conditions for a lower cost over the long term.
2. It supports national requirements that transportation agencies adopt asset management practices.
3. It also helps PRHTA avoid substantial Federal penalties that otherwise would cost the island's government tens of millions of dollars in lost Federal highway assistance each year.
4. In doing the above, it also incidentally is helping rebuild the Puerto Rico transportation industry and revitalizing the economy by adding important transportation sector jobs addressing critical infrastructure needs.

Federal law requires PRHTA to adopt an asset management plan and failure to do so brings a substantial penalty. If PRHTA does not produce a plan, the penalty increases the local match for using Federal highway funds to 35 percent. Presently, the local match varies between 10 percent and 20 percent but often PRHTA can fund projects with 100 percent Federal funds using toll credits [1]. If Puerto Rico's central and local governments must provide a 35 percent local match for every Federal highway dollar used, many Federal funds may go unused.

Asset Management Plans

Sec. 515.7 of Federal Highway Administration (FHWA) regulations say: A State shall develop a risk-based asset management plan that describes how the NHS (National Highway System) will be managed to achieve system performance effectiveness and State DOT targets for asset condition, while managing the risks, in a financially responsible manner, at a minimum practicable cost over the life cycle of its assets.

FHWA regulation define asset management as,

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

Required Asset Management Processes

The Federal rule requires agencies to adopt in their plan ongoing processes for how they will implement asset management. The implication of this requirement is that PRHTA must adopt permanent, ongoing processes for how it will achieve and sustain a state of good repair.

[1] Section 120(i) of Title 23 of the United States Code permits states to substitute certain previous toll-financed investments for state matching funds on current Federal-aid projects. Toll credits are earned when the state funds a capital transportation investment serving interstate travel with toll revenues earned on existing toll facilities (excluding revenues needed for debt service, returns to investors, or the operation and maintenance of toll facilities).

Federal rules require PRHTA to have processes for managing, at least, the NHS pavements and bridges using:

1. A gap analysis process that compares the agency's objectives, measures, and targets to actual conditions;
2. A life-cycle strategy that continually implements strategies to preserve assets in good condition and does not only repair them once they have deteriorated;
3. Risk management to analyze and address risks not only to the safety of people but also to the condition of roads and bridges;
4. A 10-year financial planning and investment strategy process;
5. A process for coordinating improvement and preservation activities with local governments if they own parts of the NHS, and;
6. Acceptable pavement and bridge management systems which use the best available data about asset conditions, costs, and their rates of deterioration.

Good Roads Cost Less

Many studies over the years documented that treating assets when they are in good or fair condition saves money by extending the assets' life and avoiding for many years the need to replace them. This concept has been summarized as, "good roads cost less."

Although PRHTA is motivated to fulfill Federal regulations, it also recognizes that good asset management practices will lead to much better highway conditions in the future. Asset management treats roads and bridges with proper treatments at every stage of their lifecycle. Treating roads and bridges in good or fair condition with minor preservation and maintenance treatments prevents more rapid deterioration. This process contrasts with the practice of waiting until a pavement or bridge is in poor condition then rehabilitating or replacing it. Many studies over the years documented that treating assets when they are in good or fair condition saves money by slowing deterioration and extending the assets' life and avoiding for many years the need to replace them. This concept has been summarized as, "good roads cost less".

Puerto Rico, for many decades, has relied on a "worst-first" strategy, or the strategy of first prioritizing bridges and pavements in poor condition, disregarding those that need minor maintenance and preservation. Those needing minor preservation and maintenance continue to deteriorate and the result is that the backlog of poor-condition assets overwhelms the government's ability to repair them.

The adoption of these new Federal requirements should, over many years, lead to improved preservation practices that will provide better pavements and bridges for lower costs. However, the plan requirements also mean that PRHTA must transition its current project priorities and processes to a new era in which it operates with asset management practices that keep its pavements and bridges in good if not fair condition.

Mandatory Condition Targets

PRHTA must also comply with another Federal requirement to achieve minimum conditions on its major pavements and bridges. Federal regulation sets a target for the Interstate Highway System that no more than 5 percent of the system can have pavement conditions in poor condition.

The asset management plan must span a 10-year period which means that PRHTA must describe in this plan how it will achieve the condition target of 5 percent and sustain that higher condition into the future. Otherwise, it faces a Federal penalty that it must devote a portion of its Federal funds to improving its Interstate pavements.

For bridges, Federal regulation sets a standard that no more than 10 percent of the bridges on the NHS can be in poor condition. The NHS includes the Interstates plus other major highways. The Federal bridge standard of no more than 10 percent poor is measured by bridge area, or deck size, and not just the number of bridges. In other words, the size of each bridge as measured by its surface or deck area is calculated and the total area of all Puerto Rico NHS bridges that can be in poor condition cannot exceed 10 percent.

Because of the bridge-condition target, PRHTA must adopt investment levels and bridge maintenance practices that will ensure that the 10 percent target is achieved, and that ongoing investment and maintenance practices will keep NHS bridge deficiencies below 10 percent.

Review of Processes, Investments, and Conditions

The Federal asset management requirements go beyond only requiring PRHTA to adopt a one-time plan. The regulations establish an ongoing review process in which PRHTA's investments in bridges and pavements, its achievement of condition targets, and its use of good asset management practices are regularly reviewed. Failure to invest adequately in pavements and bridges, failure to achieve targets, or failure to continue using asset management processes could result in Federal penalty or restrictions in how Federal funds can be used.

FHWA "certifies" that the plan was produced by processes consistent with the asset management statute and rule. The asset management rule in Sec. 515.13 says in part, "The FHWA will treat the State DOT's submission of an initial State-approved asset management plan under § 515.11(b) as the State DOT's request for the first certification of the State's DOT's plan development processes."

FHWA will conduct an annual "consistency" determination by Aug. 31, 2019. This determination is based on whether the plan is being implemented as proposed. The FHWA bases its consistency determination upon, in large part, whether the agency is allocating funds consistent with the investment strategies in the asset management plan. In other words, FHWA will review PRHTA's projects and the island's highway and bridge

expenditures and determine if they are, or are not, consistent with the investments described in this plan.

Another FHWA rule (23 CFR 490.107) also requires reporting every two years on whether the bridge and pavement targets are met. If they are not being met, PRHTA must direct more of its Federal highway funds to bridge and pavement projects until the target is achieved.

Achievement of condition targets alone is not enough to warrant a consistency approval by FHWA. The consistency review examines adherence to asset management processes, objectives, and investment strategies, and not only the achievement of targets.

The Start of a New Era

The result of the Federal regulations and the adoption of this plan is the start of a new era in Puerto Rico. Starting gradually at first but increasing over time, PRHTA is:

1. Focusing on achieving bridge and pavement condition targets;
2. Investing more in preserving assets in good condition and avoiding higher future costs;
3. Continuing to replace deteriorated pavements and bridges that are too damaged to benefit from preservation;
4. Relying on documented processes to select projects and treatment strategies that reduce life-cycle costs;
5. Developing better data on the conditions of pavements and bridges, particularly to identify those assets that can benefit from preservation;
6. Using modern bridge and pavement computer models to estimate needed investment levels and select projects, and;
7. Systematically improving bridge and pavement conditions and then focusing on sustaining them in a state of good repair.

Because good roads cost less, the result over the long-term will be better highways, bridges and other transportation assets for less cost in Puerto Rico. Good pavements lower crash likelihood by improving stopping distances and reducing crashes caused by vehicles sliding off curves. Bridges will be safer and less likely to fail during floods. The island's highways will look better, ride smoother, and be more attractive to investors and tourists. Over time, Puerto Rico will save money and enjoy the benefits of smoother, safer, better conditions, and more attractive highways.

Organization of This Plan

This plan is organized to ensure it directly addresses each of the Federally required plan elements. Aligning the plan's organization to the Federal requirements clarifies for PRHTA what information it must include, and in what sequence, to expedite FHWA's consistency review.

The U.S. Code of Federal Regulations for Title 23 Part 515 requires eight sections in an asset management plan. Three of those sections, asset management objectives, measures, and targets are combined in the first chapter.

Chapter 1 Asset Management Objectives. Measures and Targets

This chapter summarizes the PRHTA mission, asset management objectives, performance measures, and targets. As required by regulation, the objectives align with the agency's mission and are consistent with the purpose of asset management which is to achieve and sustain the desired state of good repair over the lifecycle of the asset at a minimum practicable cost. The objectives adopted in Chapter 1 relate directly to PRHTA's mission and is aligned to satisfying the Federal asset management process requirements, and to improving PRHTA's asset management processes.

This chapter also describes PRHTA's asset management performance measures and targets. As required, the measures and targets are consistent with the objectives and help assess the condition and performance of PRHTA's highways. At least two Federally required targets must be included, no more than 10 percent of NHS bridges by area in poor condition, and no more than 5 percent of the Interstate Highway System pavements in poor condition. Additionally, PRHTA must set a pavement-condition target for the non-Interstate NHS pavements.

PRHTA, as detailed in this chapter, adopts the targets of no more than 5 percent of Interstate pavements in poor condition and no more than 10 percent of NHS bridge deck areas in Poor condition. This is also the Federal minimum condition levels for Interstate Highway System pavements and NHS bridges. It also set a target for NHS pavement conditions.

Chapter 2 Summary of Assets and Conditions

Federal regulations intend for this chapter to describe the number, size, and condition of PRHTA's assets. For purposes of FHWA review, these include bridges and pavements on the NHS only. The chapter also briefly describes all other roads in addition to those on the NHS. These other roads are not included in PRHTA's asset management plan for Federal review. However, PRHTA must maintain these lower-volume roads as they are critical to the island's communities and rural areas. They are described in this chapter and in the Financial Plan and Investment Strategy chapters because they are critically important and require an investment that limits the amounts PRHTA can spend on improving NHS bridges and pavements.

Chapter 3 Performance Gaps

This chapter describes PRHTA processes for identifying asset management gaps which FHWA defines as the gap between the current asset condition and State DOT targets for asset condition.

Additionally, a gap could be any gaps in system performance effectiveness that are best addressed by improving the physical assets. A gap in system performance effectiveness could include any failure to achieve congestion, safety, or freight objectives caused by poor asset conditions. For example, if poor bridges are weight limited and restrict freight movement, they could be considered a gap between the island's freight objectives and its performance.

Chapter 4 Lifecycle Planning

This chapter describes PRHTA's lifecycle planning process which FHWA defines as a process to manage an asset class over its whole life while minimizing costs and preserving or improving its condition. This chapter describes the logic PRHTA will apply to identify the most cost-effective treatments for each stage of an asset's life.

Chapter 5 Risk Management Analysis.

This section identifies PRHTA's risk management process. It also includes risks considered in the plan and PRHTA's responses to those risks. FHWA defines risk as the positive or negative effects of uncertainty or variability upon agency objectives. It defines risk management as the processes and framework for managing potential risks, including identifying, analyzing, evaluating, and addressing the risks to assets and system performance. Obvious risks include PRHTA's financial constraint, as well as the island's severe hurricane damage. The risk chapter documents the substantial uncertainty that faces PRHTA because of the island's insolvency, Hurricane María damage, its economic downtown, and uncertain Congressional and bankruptcy court actions.

Chapter 6 The Financial Plan

This chapter describes the required 10-year financial planning process to support the asset management strategies. FHWA defines a financial plan as a long-term plan spanning 10 years or longer, presenting a State DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets. It should highlight how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies. This financial plan is strongly influenced by PRHTA's Fiscal Plan developed by the central government to fund the agency after the island's bankruptcy.

Chapter 7 Investment Strategies

This chapter describes the investment strategies that were selected to achieve the plan's objectives, measures, and targets based upon analysis of various alternatives. Investment strategies are defined as 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. Given the extensive hurricane damage and severe financial constraints, the investment strategies are significantly constrained and emphasize PRHTA's highest priorities.

The plan includes not only conclusions and recommendations but a description of the asset management processes PRHTA adopts. To address FHWA's process-documentation requirements, each chapter describes the processes that led to conclusions. These processes will be improved over time as the agency's data and finances improve. These processes, however, include the basic elements of asset management which satisfy the Federal requirements and will lead to a state of good repair.

Chapter 1 Objectives, Measures, and Targets

1.1 Introduction

This section describes the mission, objectives, measures, and targets that guide the PRHTA transportation asset management plan. In keeping with Federal regulations, the asset management plan adopts performance objectives that support the agency's mission and are consistent with the purpose of asset management. The agency's mission is:

> "Our mission is to stimulate the economic development of Puerto Rico through safe, efficient and well-maintained transportation systems that innovate and facilitate the movement of people and goods in harmony with the environment."

The mission recognizes the acute need for PRHTA to help Puerto Rico improve its economy while trying to invest in maintaining, preserving and sustaining the transportation infrastructure essential to the movement of people and goods that are also integral to revitalizing the island's economy.

While PRHTA will need years to repair all the damage from Hurricane María, it also needs to address a substantial backlog of unmet highway repair needs that existed before the hurricane. The prolonged recession in Puerto Rico, combined with a lack of a sustained maintenance program, contributed to pavement and bridge conditions that are well below national averages.

1.2 Adopted Objectives

Building from its mission, PRHTA adopted the objectives shown in Figure 1-1 to guide its asset management effort.

"PRHTA will improve and implement a comprehensive **pavement management process** that allows us to achieve our condition targets while managing pavements with effective life-cycle strategies."

"PRHTA will improve and implement a comprehensive **bridge management process** to achieve and sustain a state of good repair, reduce life-cycle costs, and capitalize on effective preservation strategies."

"PRHTA will **partner with the metropolitan planning organization** to integrate effective asset management projects into the Transportation Improvement Program."

"PRHTA will implement long-term pavement and bridge programs and strategies to **address safety and achieve and sustain a state of good repair**."

FIGURE 1-1: ADOPTED OBJECTIVES

These objectives lead PRHTA to develop the processes that support the achievement of sound assets and sustain them into the future. These objectives also contribute significantly to other key Puerto Rican objectives such as improving safety and enhancing economic development. Well-maintained pavements have better surface friction and fewer ruts, both of which improve vehicle stopping distance and make roads safer. Also, well-maintained roads reduce vehicle operating costs which increase when pavements are rough or filled with potholes that increase vehicle damage and the need for repairs. Good roads also support economic development by making the island more attractive to tourists, and to an industry that depends upon shipping goods into, across, or out of the island.

PRHTA's asset management objectives also will save money over the long term because good roads cost less. It is much cheaper over the lifecycle of pavements and bridges to treat them with low-cost maintenance and preservation treatments when the assets are in good and fair condition as opposed to rebuilding them after they have deteriorated. A well-maintained bridge can last decades longer than one that receives no maintenance. Maintenance and preservation address small problems caused by rust and minor cracking that will worsen and lead to a failed bridge other time. Similarly, with pavements, when small cracks and potholes are repaired quickly, the water stays out of the pavement base, the cracks don't expand, and the pavement lasts much longer. Almost universally, highway agencies have calculated that timely preservation and maintenance will cost a little each year but save the agency from large backlogs of deteriorated bridges and pavements that require expensive replacement.

This mission and objectives also support the seven national transportation goals which are to: Improve safety, maintain highway infrastructure in a state of good repair, reduce congestion, improve system reliability, improve the freight network to support economic vitality, protect the environment, and reduce project delays.

1.3 Bridge and Pavement Management Processes

Federal asset management rules require every state transportation department to document its asset management processes, and to document that its asset management plan strategies were generated by those processes. Also, FHWA will review annually whether the investments made by PRHTA are consistent with the investments shown in the asset management plan.

PRHTA has used in recent years asset management processes to select its bridge and pavement projects. PRHTA uses automated techniques to objectively measure its pavements. A sophisticated pavement-data-collection vehicle is used to measure pavement conditions. PRHTA attempts to measure the NHS Interstate annually, the NHS Non-Interstate bi-annually, and one-third of the routes annually that must be reported for the Federal Highway Performance Monitoring System (HPMS). Other routes are driven as petitioned to assess pavements if a section is considered for a project. PRHTA uses

Minimum Measures and Targets

FHWA has set only two minimum condition levels, the 5 percent Interstate pavement level and the 10 percent NHS bridge level. The rule requires PRHTA to set a target for non-Interstate NHS pavements. All other targets are optional.

PRHTA choses to adopt for its targets the minimum Federal condition levels.

Federal regulations encourage agencies to go beyond the minimum requirements of the asset management rule which address only bridges and pavements on the NHS. FHWA encourages states to include in their asset management plan other highway systems, such as all state routes. It also encourages agencies to include other types of assets such as signs, signals, guardrail, culverts, retaining walls, or drainage structures.

PRHTA is including in its plan the minimum Federal requirements of addressing NHS bridges and pavements. The agency is too constrained by the island's finances and the damage caused by Hurricane María to pursue more than the Federal minimum requirements.

The asset management plan will include references to the need to invest in more than the NHS including the other state routes that serve much of the population. These other routes are referenced in the plan but are not officially included as part of the plan.

high-speed video equipment, lasers, and devices to measure pavement roughness. The vehicle's computers generate detailed condition data for each one-tenth-mile section for all PRHTA roads. The vehicle's computers produced detailed information on the condition of the pavement including cracking, rutting, roughness, or faulting which is the amount of vertical misalignment between concrete pavement sections.

With the data, PRHTA staff recommend projects based upon the condition data. Pavements that are most in need of treatment, and with the highest traffic volumes are prioritized for funding in the State Transportation Improvement Program or STIP. The STIP is a four-year list of projects that will use Federal highway and transit funds.

For bridges, PRHTA continually inspects its bridges so that each is inspected at least every two years and the data updated to National Bridge Inventory (NBI.) The bridges are inspected according to Federal processes by trained engineers and inspectors. Based upon the bridges with the worst conditions, a Critical Bridge List is developed. Bridges are pulled from that list and selected for funding in the STIP.

The adopted objectives will lead to the enhancement of these current processes. The processes will not only identify bridges and pavements that need to be replaced or rehabilitated but they will seek pavements and bridges that will benefit from preservation and maintenance before they deteriorate. The earlier treatment will reduce deterioration of bridges and pavements and lower their life-cycle cost, as called for in the Federal regulation. The processes will become more comprehensive because they will forecast not only the bridges and pavements that need to be addressed today but the processes also will forecast which pavements and bridges need to be treated for each of the next 10 years. This forecasting will allow the agency to better prepare contractors or prepare

maintenance crews so that the maintenance and preservation that is needed each year can be scheduled.

Penalties and Requirements

Penalties for Plans and Targets

There are serious penalties for not developing an asset management plan. If a state has not developed and implemented an asset management plan, the maximum Federal share of National Highway Performance Program funds falls to 65 percent from 90 percent.

If the state does not identify the required NHS performance targets, no further National Highway Performance Program (NHPP) funds will be approved. NHPP is the largest Federal Highway funding program.

If the Authority does not meet the Federal interstate highway system pavement level of no more than 5 percent poor for two consecutive years, it will be subject to penalty provisions including some restrictions on how it can obligate NHPP and Surface Transportation Program funds. If PRHTA does not meet the bridge condition target for 3 consecutive years, the Authority must set aside and obligate NHPP funds for eligible projects on bridges on the NHS. The effect of not meeting the targets is that PRHTA will be restricted in how much of its Federal-aid it can spend on non-bridge, and non-pavement projects until the Commonwealth achieves the condition targets.

Use of Management Systems and Best Available Data

FHWA rules say states DOTs shall use the best available data to develop their asset management plans. Pursuant to 23 U.S.C. 150(c)(3)(A)(i), each State DOT shall use bridge and pavement management systems meeting the requirements of § 515.17 to analyze the condition of NHS pavements and bridges for developing and implementing the asset management plan required under this part.

Deadlines

The asset management rule provides for phased implementation. The State DOTs submitted an initial plan by April 30, 2018. PRHTA's 2018 plan was certified by FHWA in August of 2018. This plan is due June 30, 2019. The plan must be updated at least every four years, and more frequently if major assumptions change.

1.4 Performance Measures

Federal regulation also required each state transportation agency to adopt performance measures. These are used to assess the bridges and pavements and to monitor their performance over time.

PRHTA adopts as its performance measures the Federally required measures. These are shown in Table 1-1.

TABLE 1-1: PERFORMANCE MEASURES AND INDICATORS

Asset Type	Measures	System	Indicator
Pavements	Lane Miles	Interstate	Percent in Good Condition
			Percent in Poor Condition
		Non-Interstate NHS	Percent in Good Condition
			Percent in Poor Condition
Bridges	Deck Area	NHS	Percent in Good Condition
			Percent in Poor Condition

These will be the measures that PRHTA will assess each year as it documents to FHWA that it is implementing its asset management plan. These also will be the measures PRHTA will report to satisfy a related Federal performance management rule. PRHTA will assess its pavements and bridges each year, and then report the conditions by these measures.

1.5 Performance Targets

The performance target is the level of condition the authority wants to achieve. PRHTA has set the targets shown in Table 1-2. This table also shows the current condition. More details regarding condition calculations are provided in Chapter 2.

TABLE 1-2: PERFORMANCE TARGETS

Indicator	Boundary Type	2-Year Target	4-Year Target	10-Year Target	25-Year Target	Current
Interstate Pavement						
% Lane Miles in Good Condition	no less than	5.0%	5.0%	2.0%	2.0%	10.8%
% Lane Miles in Poor Condition	no more than	14.0%	14.0%	10.0%	5.0%	16.7%
Non-Interstate NHS Pavement						
% Lane Miles in Good Condition	no less than	1.0%	2.0%	2.0%	2.0%	2.2%
% Lane Miles in Poor Condition	no more than	20.0%	20.0%	20.0%	20.0%	30.3%
NHS Bridges						
% Area in Good Condition	no less than	10.0%	10.0%	10.0%	10.0%	18.5%
% Area in Poor Condition	no more than	10.0%	10.0%	10.0%	10.0%	8.6%

1.6 Non-Federal Priorities

These objectives, measures, and targets satisfy the Federal asset management planning requirements without burdening PRHTA with additional data to report or targets to achieve. PRHTA is striving to achieve good conditions on all its highways, including the non-NHS state route pavements and bridges. By not setting measures or targets for the non-NHS, PRHTA is not ignoring those assets. However, by omitting them from the plan, PRHTA reduces Federal oversight and reporting on them. Over time, PRHTA may add additional measures and targets, and asset classes, to its asset management plan. For the time being, it adopts the minimum Federal measures and targets given the challenging conditions in the post-bankruptcy and post-Hurricane Irma and María era.

Chapter 2 Asset Inventory and Conditions

2.1 Introduction

Puerto Rico has a main highway network composed of 4,813 center line miles which are monitored within the Federal Highway Administration (FHWA) Highway Performance Monitoring System (HPMS) and 2,314 bridges monitored under the FHWA National Bridge Inventory (NBI). These infrastructure facilities provide a mean for transportation services to Puerto Rico population, composed of 3.2 million inhabitants (2018 US Census Bureau estimate), as they travel to work, home, school, medical care, and recreation, among other trip types. This chapter introduces the pavement and bridges inventory and condition. Some additional assets such as traffic signals are mentioned to illustrate that PRHTA has additional assets it must maintain. This description sets the scene for the remainder of the plan which describes how PRHTA will manage these important assets.

2.1.1 FHWA Requirements

FHWA rules and guidance say the asset management plan must include a summary listing of NHS pavement and bridge assets, regardless of ownership. This section addresses that requirement and describes the number, size, and type of assets on the PRHTA highway network. It also describes the condition of the assets as required in the regulation.

The NHS assets represent only a portion of the PRHTA highway network. Although the assets outside of the NHS are critically important, they are not addressed in detail in this

plan. They are, however, referenced and the plan notes that PRHTA will invest in those non-NHS highways to maintain an acceptable condition level.

If PRHTA were to include those non-NHS highways in the plan, those assets would require the same detailed analysis as required for the National Highway System. Therefore, PRHTA chooses to only include National Highway System roads and bridges in this asset management plan. PRHTA may decide to include additional assets or highway networks into future asset management plans.

Asset Description Requirements

Sec. 515.9 (3) says the plan shall include:

A summary description of the condition of NHS pavements and bridges, regardless of ownership. The summary must include a description of the condition of those assets based on the performance measures established under 23 U.S.C. 150(c)(3)(A)(ii) for condition, once promulgated. (Those are the bridge and pavement condition measures. These provisions require that the pavements be reported per Sec. 409.307 as the:

- Percent of Interstate pavements in Good condition
- Percent of Interstate pavements in Poor condition
- Percent of pavements on the non-Interstate NHS in Good condition
- Percent of pavements on non-Interstate NHS in Poor condition.

Sec. 490.407 requires that NHS bridges be reported by the following measures:

- Percent of NHS bridges in Good condition
- Percent of NHS bridges in Poor condition

2.1.2 Use of the Best Available Data

Data used for the verification process include:

1. Roadway Network and Traffic: HPMS data provided by the PRHTA's Roadway Systems Office, corresponding to the most recent year for which data is available (2017)
2. Pavement: PathRunner data provided by the Pavement Office, corresponding to the most recent year for which data is available (2017)
3. Bridges: NBIS data provided by the PRHTA Bridges Office corresponding to the most recent year for which data is available (2017)
4. Safety: Data from SAFETY system developed for Puerto Rico by The University of Alabama's Center for Advanced Public Safety, corresponding to the most recent years with available data including all types of severity (2014 to 2017).
5. Population: U.S. Census Bureau data, corresponding to the most recent 5-year estimates for which data is available (2013 to 2017)
6. Signals: Traffic Operations Office After Hurricane María Signal's Condition Inventory
7. Budget: Transportation Improvement Program (TIP) 2019-2022, *Programa Estatal de Modernización de Carreteras (PEMOC), Abriendo Caminos* Program, Bridge Replacement Program (some included in TIP), Deck Replacement Program (some included in TIP), and Bridge Projects derived from Initial TAMP

8. Costs: Average unit costs derived from representative PRHTA projects
9. Facilities impacted by emergency events: Information provided by the FHWA Puerto Rico & Virgin Islands Division Office

2.1.3 Asset Managers for Puerto Rico's Highways, Bridges and Transportation Facilities

The main asset manager is the Puerto Rico Highway and Transportation Authority (PRHTA). The PRHTA is a public corporation responsible for developing, operating and maintaining Puerto Rico's toll road network, major highways, and mass transportation facilities. The PRHTA originated as Puerto Rico Highway Authority, created under Law Number 74 of June 23, 1965. It developed into PRHTA when it expanded its inherence from only highways to also include transit modes, as per Law Number 1 of March 6, 1991.

Another asset manager is *Autopistas* de Puerto Rico (APR), which is part of the Abertis Group. APR operates the longest bridge over a body of water in Puerto Rico, the Teodoro Moscoso Bridge. This bridge connects San Juan with Isla Verde over the San José lagoon since 1994.

Autopistas Metropolitanas de Puerto Rico, LLC ("Metropistas") is the consortium that manages the first Public-Private Highway Alliance project on Puerto Rico under Law Number 29 of June 8, 2009, known as the Public-Private Partnerships of Puerto Rico Law. Metropistas, composed of Abertis Infrastructures and its investment partners, is responsible for operating, rehabilitating and preserving infrastructure conditions and offering world-class services on PR-22 and PR-5 highways, under a 50-year Concession Agreement between Metropistas and the PRHTA, signed on June 27, 2011, after a competitive bidding process.

2.2 Background Information

Puerto Rico is a chain of islands located in the Caribbean Sea (see Figure 2-1). It is composed of 78 municipalities; two of them are smaller surrounding islands.

FIGURE 2-1: LOCATION OF PUERTO RICO

The following subsections describe population, travel, and traffic safety characteristics.

For population and travel characteristics, the most recent five-year estimates published by the U.S. Census Bureau, corresponding to years 2013 to 2017, were reviewed and compared with the previous non-overlapping five-year period covering 2008 to 2012.

For traffic safety characteristics, data from the SAFETY system (version ADVANCE 0.0.1.7) developed for Puerto Rico by The University of Alabama's Center for Advanced Public Safety was used. The most recent years with available data including all types of severity were analyzed; these included 2014 to 2017.

2.2.1 Population

Figure 2-2 shows the overall population average and other population groups for which statistics are determined. The average population decreased by 6.67% in the 2013-2017 period as compared to the 2008-2012 period.

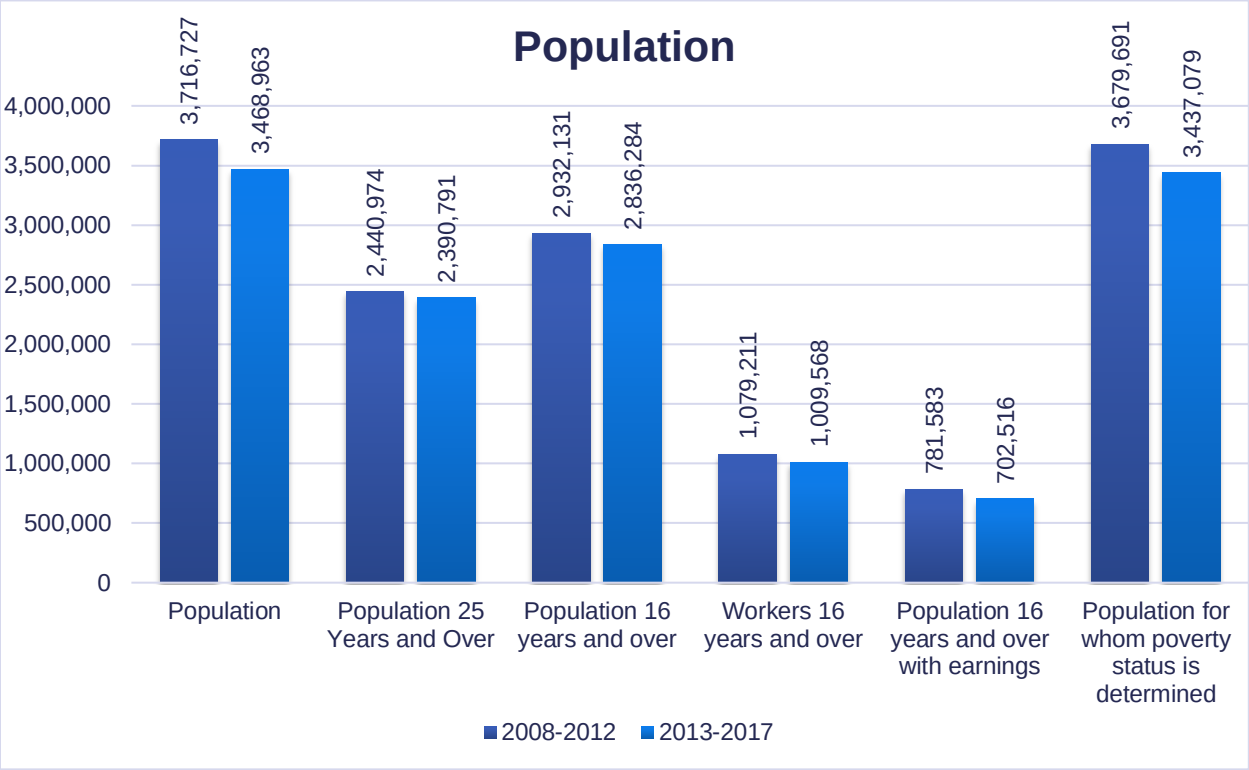


FIGURE 2-2: POPULATION

As shown in Figure 2-3, the proportion with less than high school degree decreased from 30 percent to 25%, while the proportion with bachelor's degree increased from 16 percent to 18 percent and the proportion with graduate degrees increased from 6 percent to 7 percent.

As shown in Figure 2-4, most population earnings range from $15k to $25k.

A 45 percent of the population falls below 100 percent of the poverty level (see Figure 2-5).

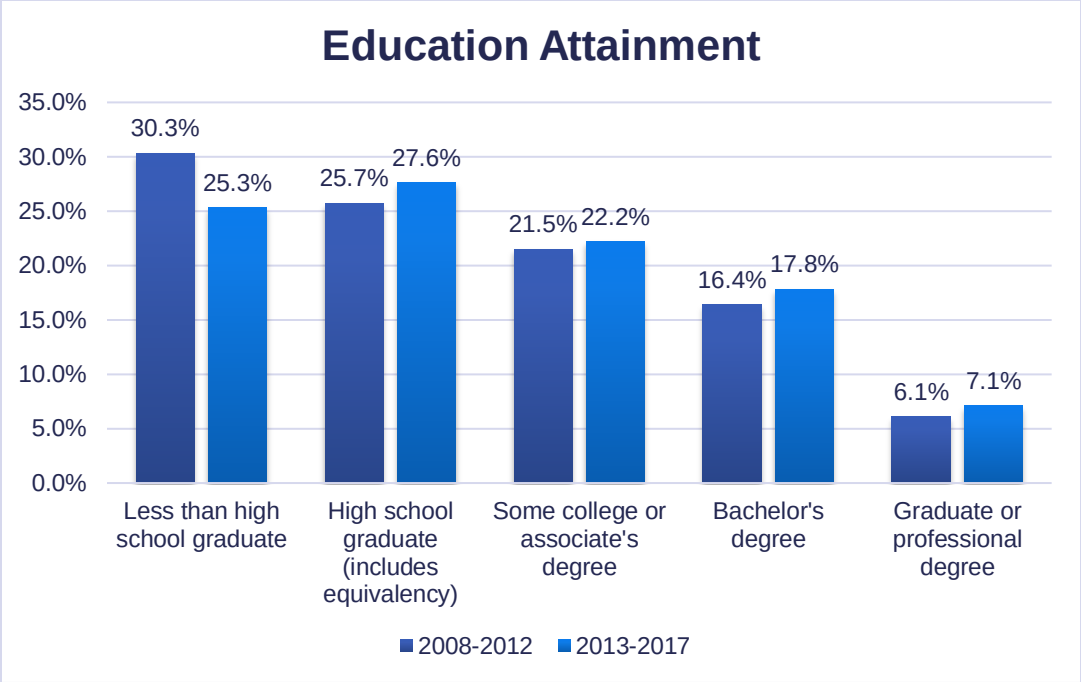


FIGURE 2-3: EDUCATION ATTAINMENT

FIGURE 2-4: EARNINGS

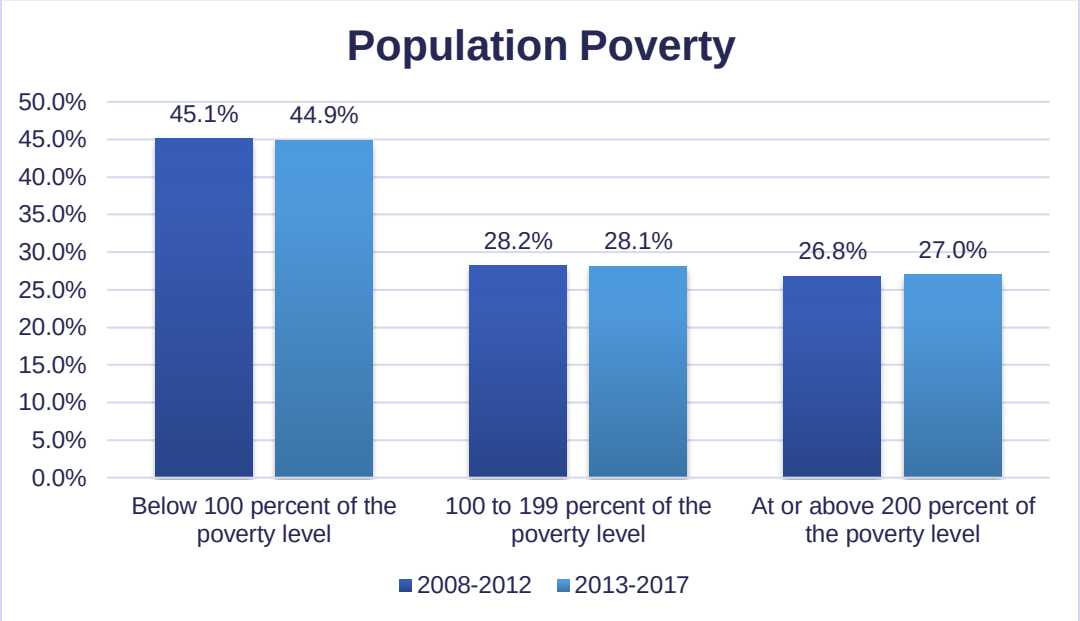


FIGURE 2-5: POVERTY IN PUERTO RICO

Figure 2-6 shows a map with the distribution of median income. Highest incomes ($35k-$50k), demarked in pink, are at San Juan and Guaynabo. Medium incomes ($20k-35k), demarked in light orange, are in the cities surrounding these two, Humacao and Mayagüez. The rest of Puerto Rico has the lowest income range ($5k-$20k).

Figure 2-7 shows a map with the distribution of population below 100% poverty level. The highest proportions (67 percent -100 percent), demarked in pink, are located at the south and central western sites of Puerto Rico. The lowest proportions (26 - 35 percent), demarked in yellow, are at the San Juan metropolitan area, and some zones near the coast.

Figure 2-8 shows a map with the population 25 years old and older with less than high school education. Most (46 percent - 65 percent), demarked in pink, is in the central western area. The smallest proportion (<22 percent), demarked in yellow, is observed around the San Juan metropolitan area.

Therefore, it appears that most of the population with the best socio-economic situation is in the San Juan metropolitan area.

FIGURE 2-6: MEDIAN INCOME

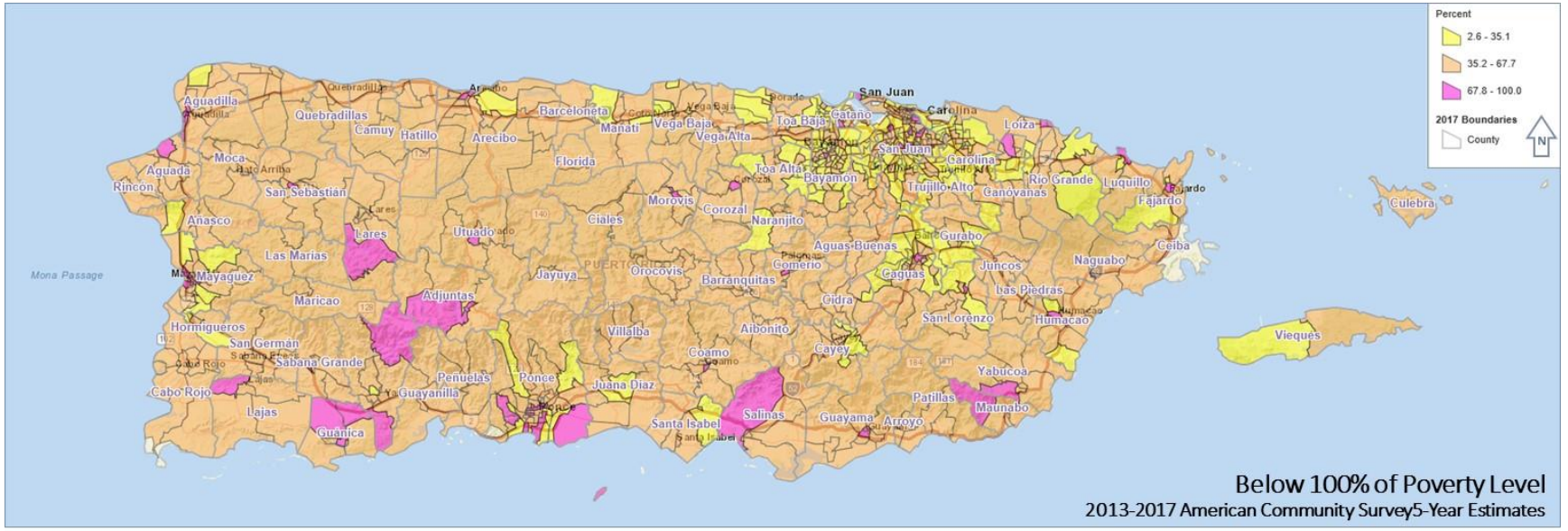


FIGURE 2-7: BELOW 100 PERCENT POVERTY LEVEL DISTRIBUTION

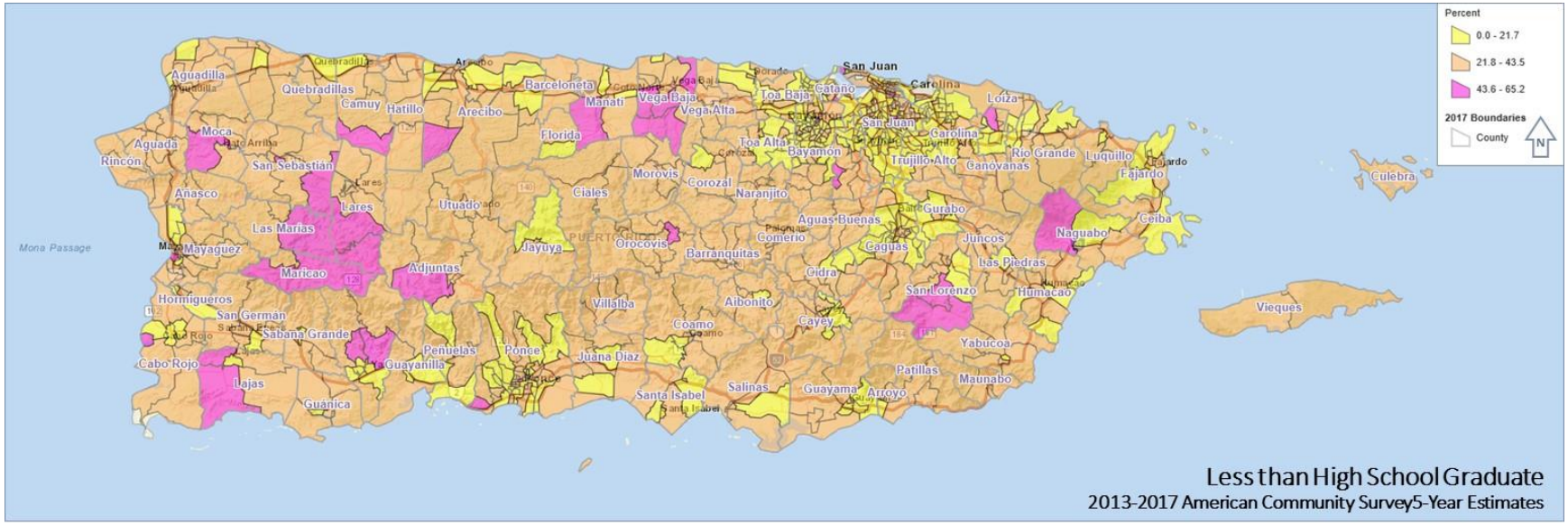


FIGURE 2-8: LESS THAN HIGH SCHOOL DISTRIBUTION

2.2.2 Travel

The most recent five-year estimates published by the U.S. Census Bureau, corresponding to years 2013 to 2017, were reviewed and compared with the previous non-overlapping five-year period covering 2008 to 2012.

Figure 2-9 shows the modes used to work by workers 16 years old and older.

The proportion of driving alone increased from 78.8 percent in 2008-2012 to 82.1 in 2013-2017.

The proportion of carpooling decreased from 10.2% in 2008-2012 to 8.4 percent in 2013-2017.

The proportion of working at home remain at 2.2 percent for both periods.

The proportion of cycling remain at 0.2 percent for both periods.

Other modes slightly decreased from 2008-2012 to 2013-2017:

1. Public transportation from 2.8 percent to 2.1 percent
2. Walking from 3.7 percent to 3.2 percent
3. Taxi, motorcycle, and others from 2.0 percent to 1.7 percent

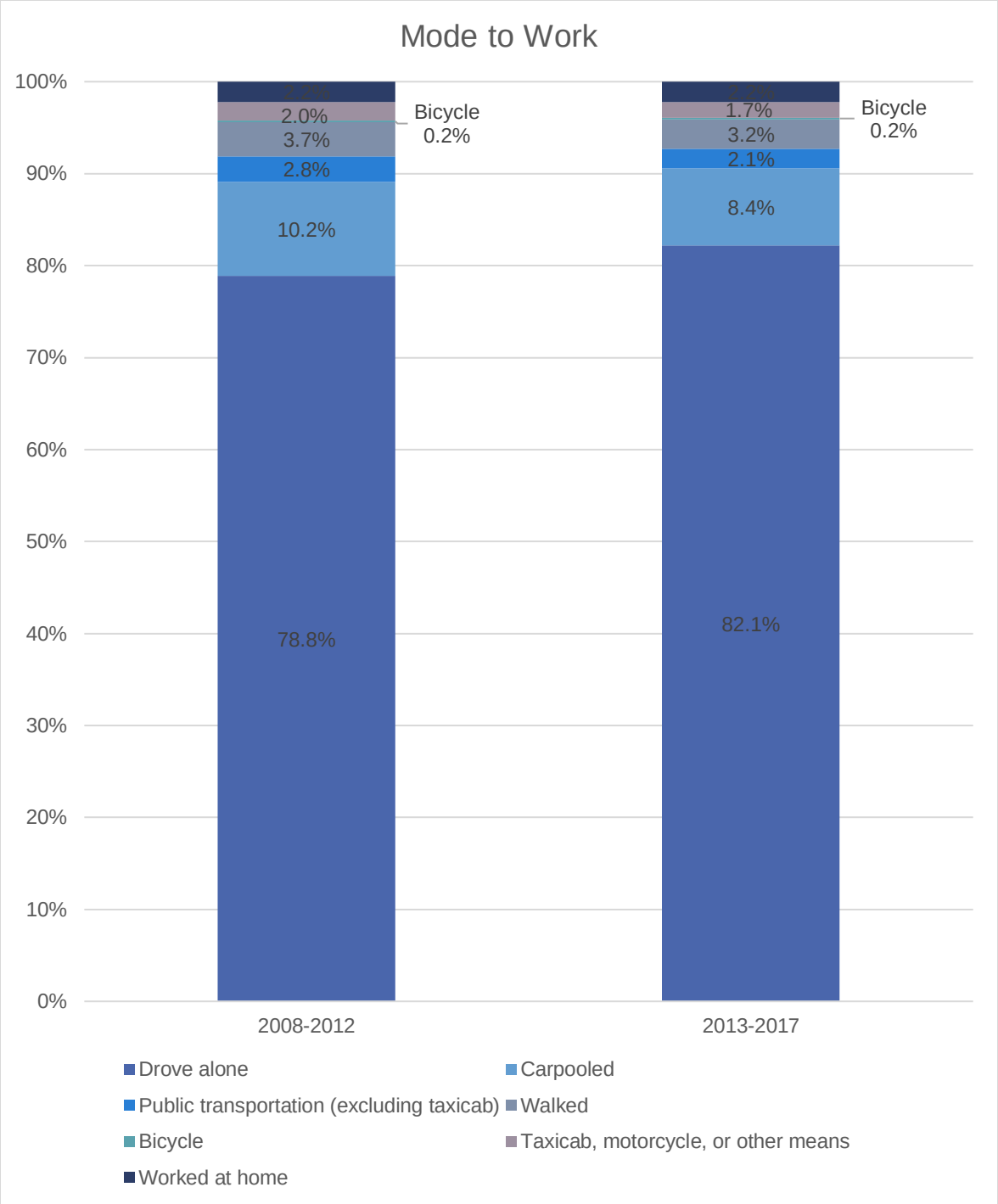


FIGURE 2-9: MEANS OF TRANSPORTATION TO WORK

Mean travel time to work slightly decreased from 29.3 minutes in 2008-2012 to 29.2 in 2013-2017. The most common travel time is 30 to 34 minutes (17 percent in 2008-2012, 16.6 percent in 2013-2017).

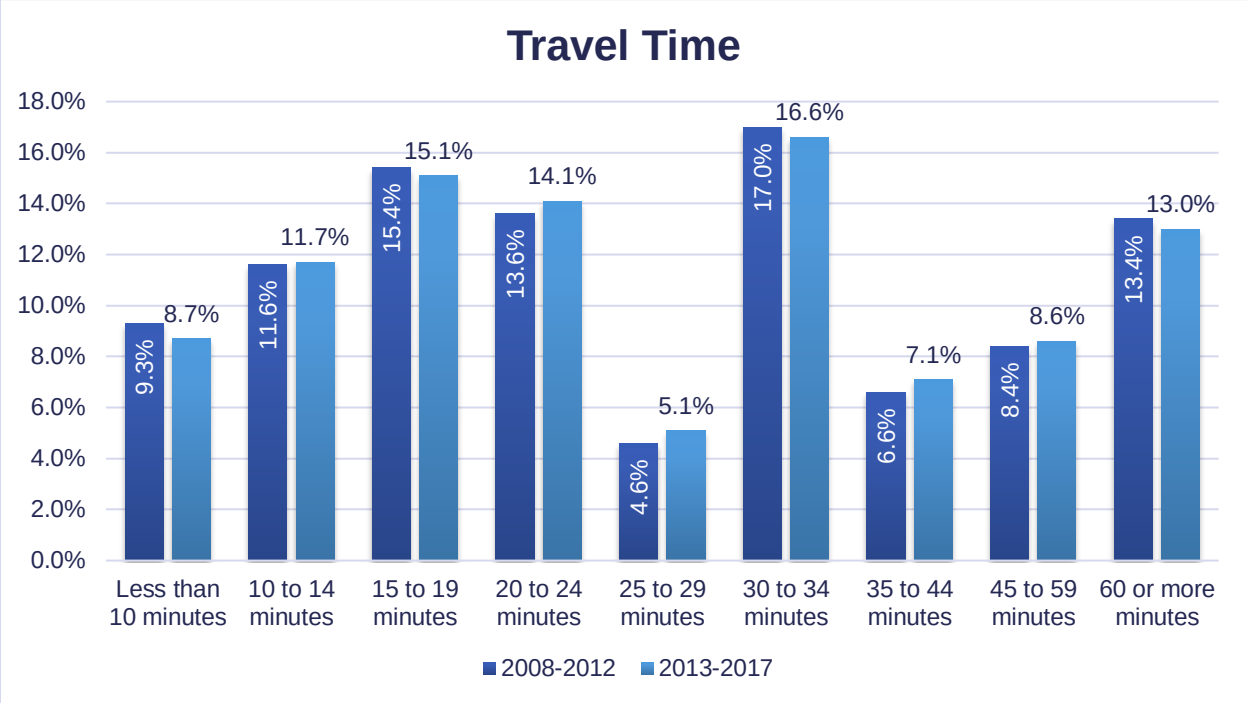


FIGURE 2-10: TRAVEL TIME

As shown in Figure 2-11, most workers (more than 60 percent) have access to two or more vehicles in their households. Also, more than half of workers work outside their municipality of residence (see Figure 2-12); as shown in Figure 2-13, most are in the surroundings of San Juan, and the north and south of Puerto Rico.

Mean travel time to work distribution is shown on the map in Figure 2-14. Longest travel times to work are in the surroundings of the San Juan metropolitan area and the central western part of Puerto Rico.

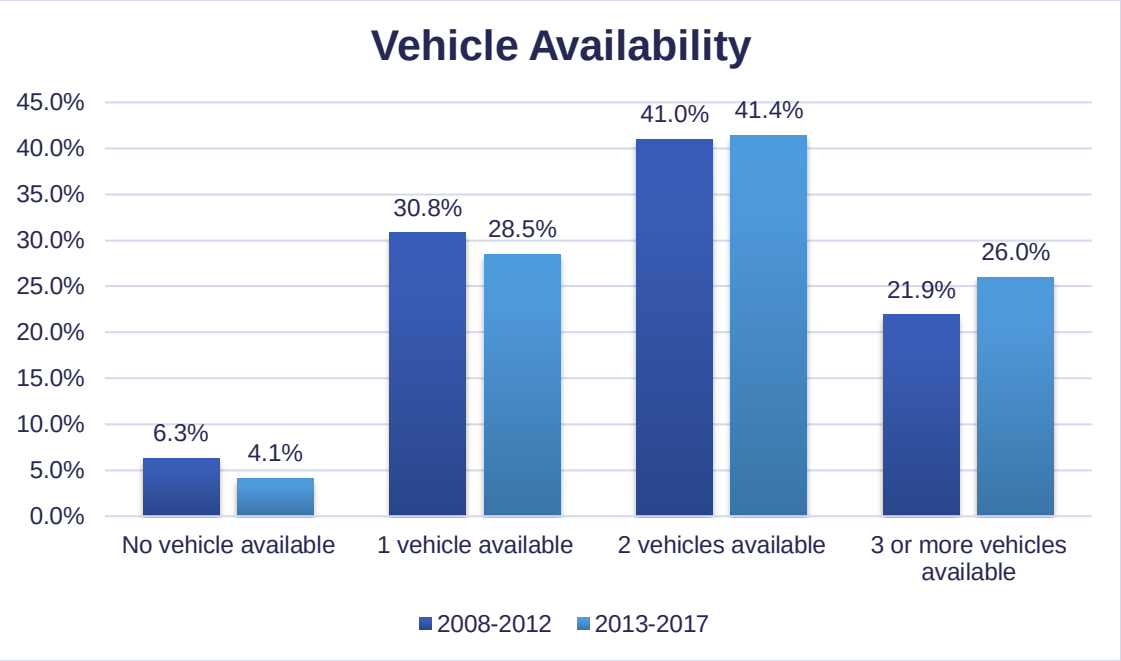


FIGURE 2-11: VEHICLE AVAILABILITY

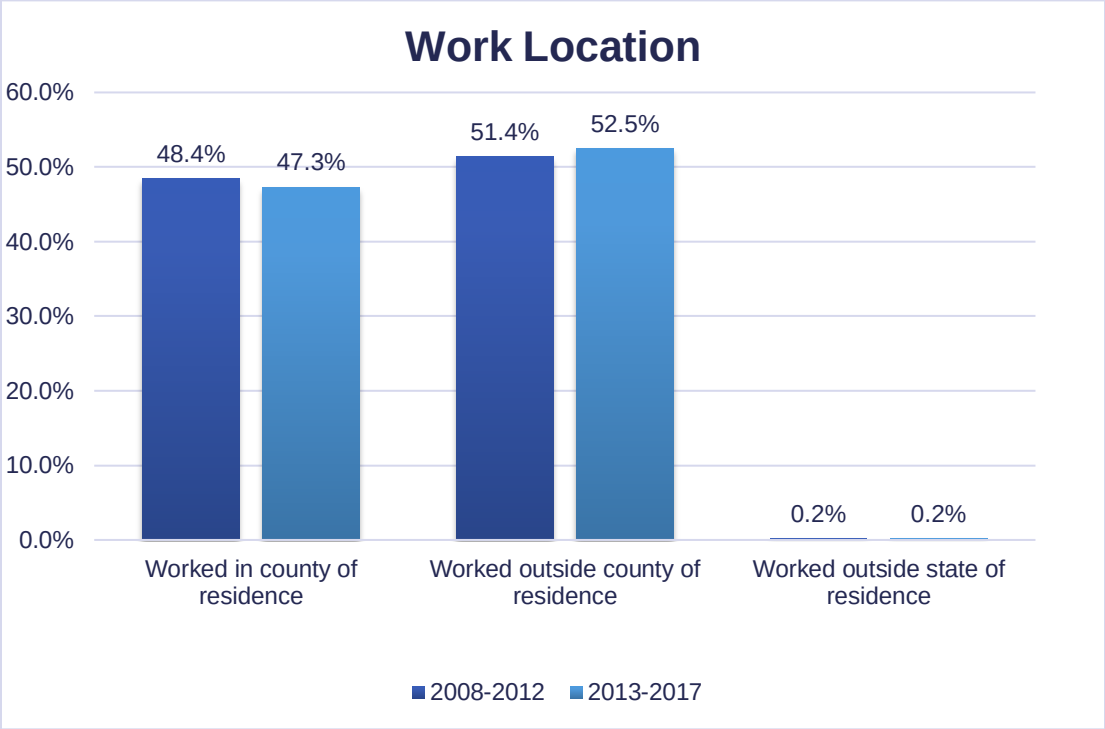


FIGURE 2-12: WORK LOCATION

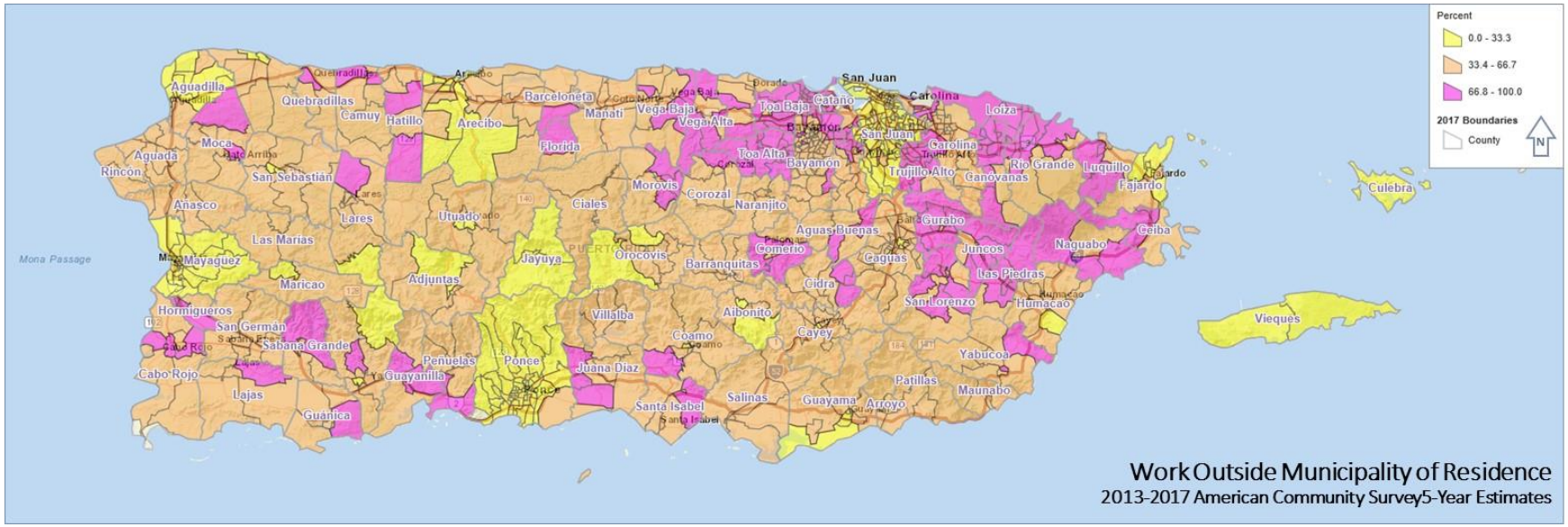


FIGURE 2-13: WORK OUTSIDE MUNICIPALITY OF RESIDENCE DISTRIBUTION

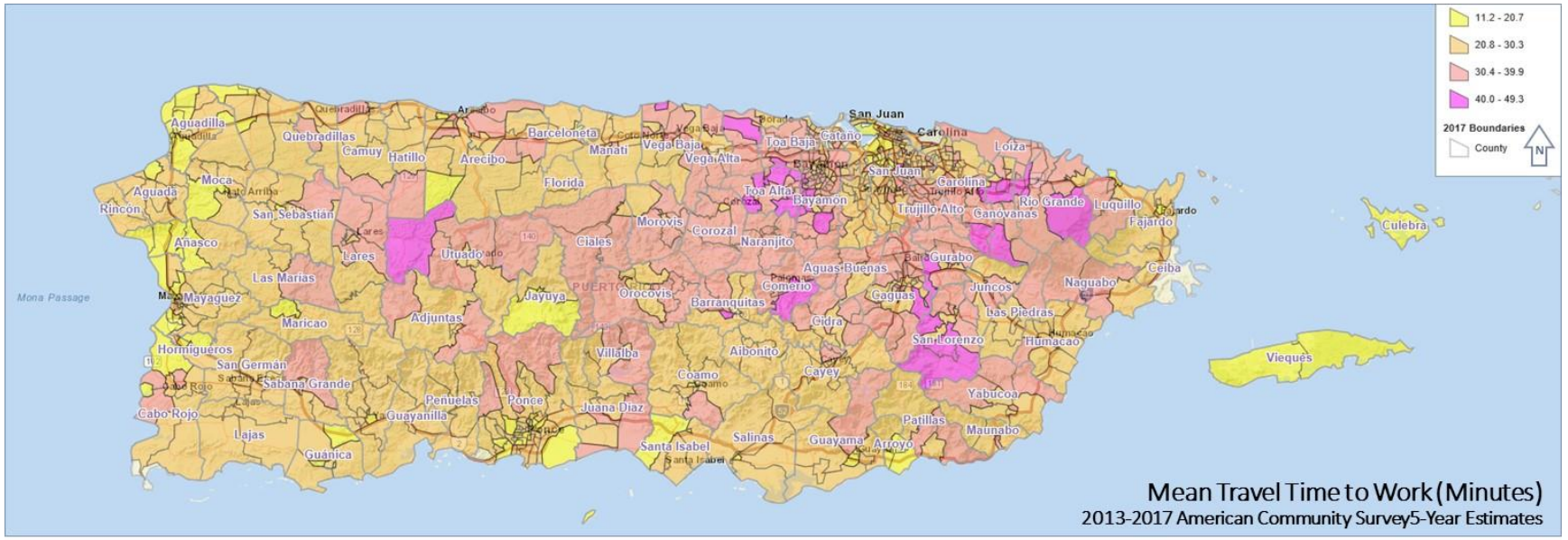


FIGURE 2-14: MEAN TRAVEL TIME TO WORK

2.2.3 Traffic

The Table 2-1 shows the estimated Average Annual Daily Traffic (AADT) for 2017, as per Highway Performance Monitoring System (HPMS) table, included in Appendix A. Highest AADT are at Interstate, Freeway, and Expressway roads. Lowest AADT are at local and collectors.

TABLE 2-1: AVERAGE DAILY TRAFFIC

Average AADT	System	
Functional Class	***NHS***	***Non-NHS***
COLLECTOR	N/A	5,698
FREEWAY & EXPRESSWAY	45,748	N/A
INTERSTATE	56,892	N/A
LOCAL	N/A	1,097
MAJOR COLLECTOR	N/A	2,048
MINOR ARTERIAL	20,800	9,629
MINOR COLLECTOR	N/A	1,808
PRINCIPAL ARTERIAL	22,871	N/A
SMALL URBAN COLLECTOR	N/A	3,647
SMALL URBAN INTERSTATE	36,400	N/A
SMALL URBAN LOCAL	N/A	979
SMALL URBAN MINOR ARTERIAL	N/A	8,561
SMALL URBAN PRINCIPAL ARTERIAL	7,962	N/A

From HPMS Table, Average AADT 2017

2.2.4 Traffic Safety

As per the SAFETY system developed for Puerto Rico by The University of Alabama's Center for Advanced Public Safety, there is an average of 146,008 crashes per year (see Figure 2-15), 86 percent of them are property damage only, 14 percent resulted in injuries, and 0.2 percent were fatal.

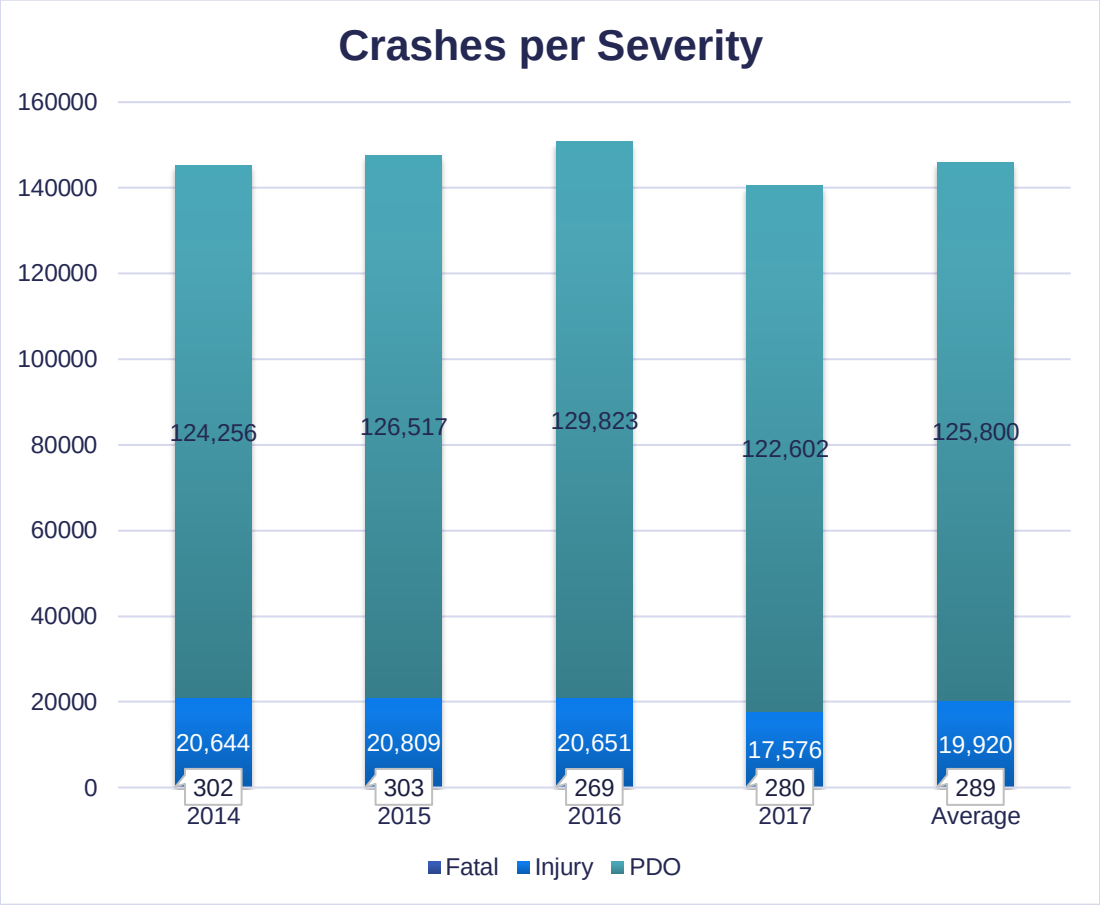


FIGURE 2-15: CRASH SEVERITY

A 29 percent of crashes occurred at primary roads, 22 percent at secondary roads, 17 percent at municipal roads, 16 percent at tertiary roads, 2 percent at branch streets, 1 percent at exits, and 13 percent had location unknown (see Figure 2-16).

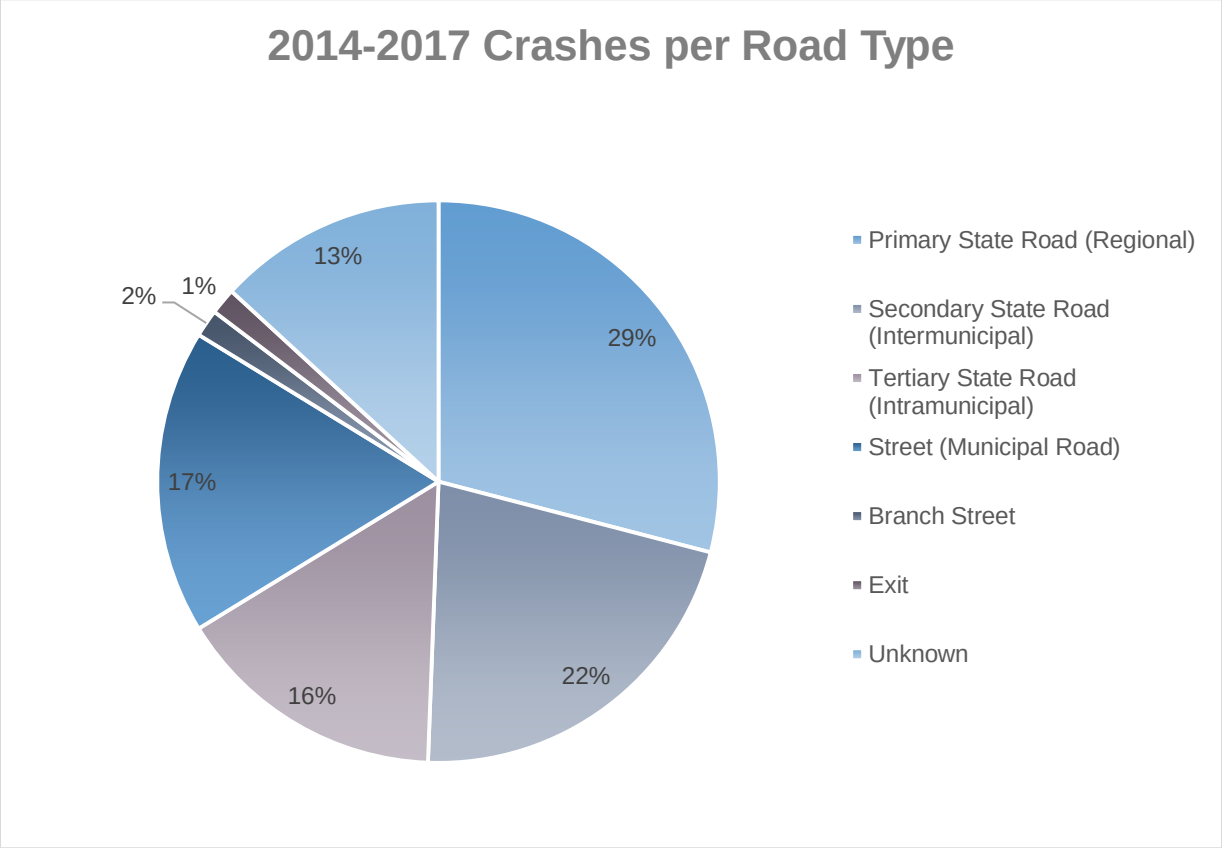


FIGURE 2-16: CRASHES PER ROAD TYPE

From the data with information about the functional class, most crashes occurred at Interstates (see Figure 2-17).

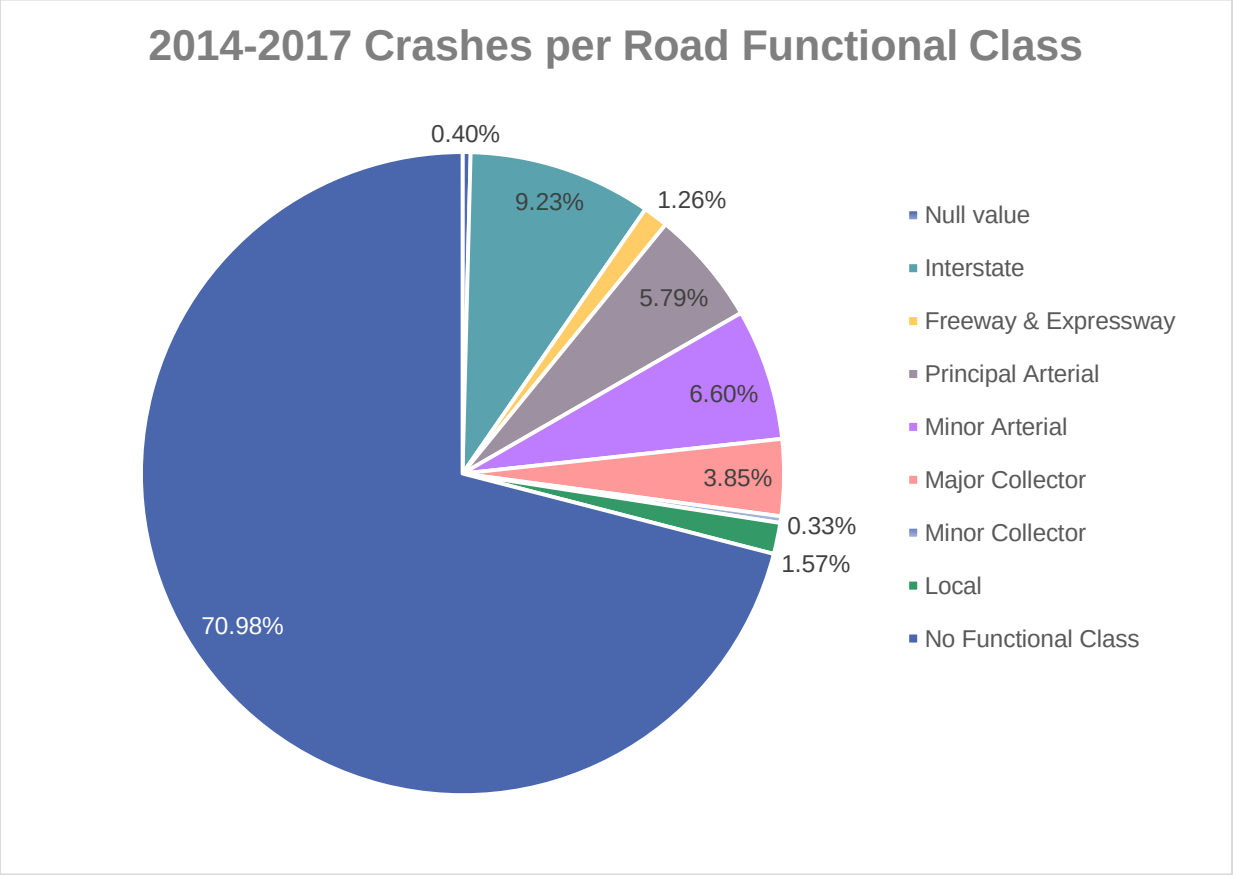


FIGURE 2-17: CRASHES PER ROAD FUNCTIONAL CLASS

The most harmful event identified were crashes between two vehicles (61.1%), with parked vehicle (15%), hit and run (7.2%), and among three or more vehicles (2.9%). Several included fixed objects: 2.4% with barriers and safety drums, 1.4% with utility poles and traffic signs, 1.1% with trees, 0.8% with fences, 3.5% with other fixed objects.

TABLE 2-2: MOST HARMFUL EVENTS

Most Harmful Event	Proportion
Pothole & irregular lane surface	1.7%
Backslope & fell off cliff	0.7%
Storm drain, bridge, collapsed road/bridge	0.2%
Barrier & safety drums	2.4%
Utility poles & traffic signs	1.4%
Tree	1.1%
Fence	0.8%
Other fixed object	3.5%
Two vehicles	61.1%
Parked vehicle	15.0%
Hit and run	7.2%
Three or more vehicles	2.9%
Motorcycle	0.8%
Pedestrian & cycle	1.3%
Animal	1.1%
Other events	0.8%
Other event without collision	0.5%

Figure 2-18 shows the 2014-2018 fatal crash locations. Most are in the San Juan metropolitan area and interstate roads PR-2, PR-3, PR-22, and PR-52. Note that interstate roads are the ones with the highest speed limit.

Figure 2-19 shows 2014-2017 injury crash locations. They cover practically all the main roads.

Figure 2-20 shows the location of 2017 crashes of all types. They cover practically all roads.

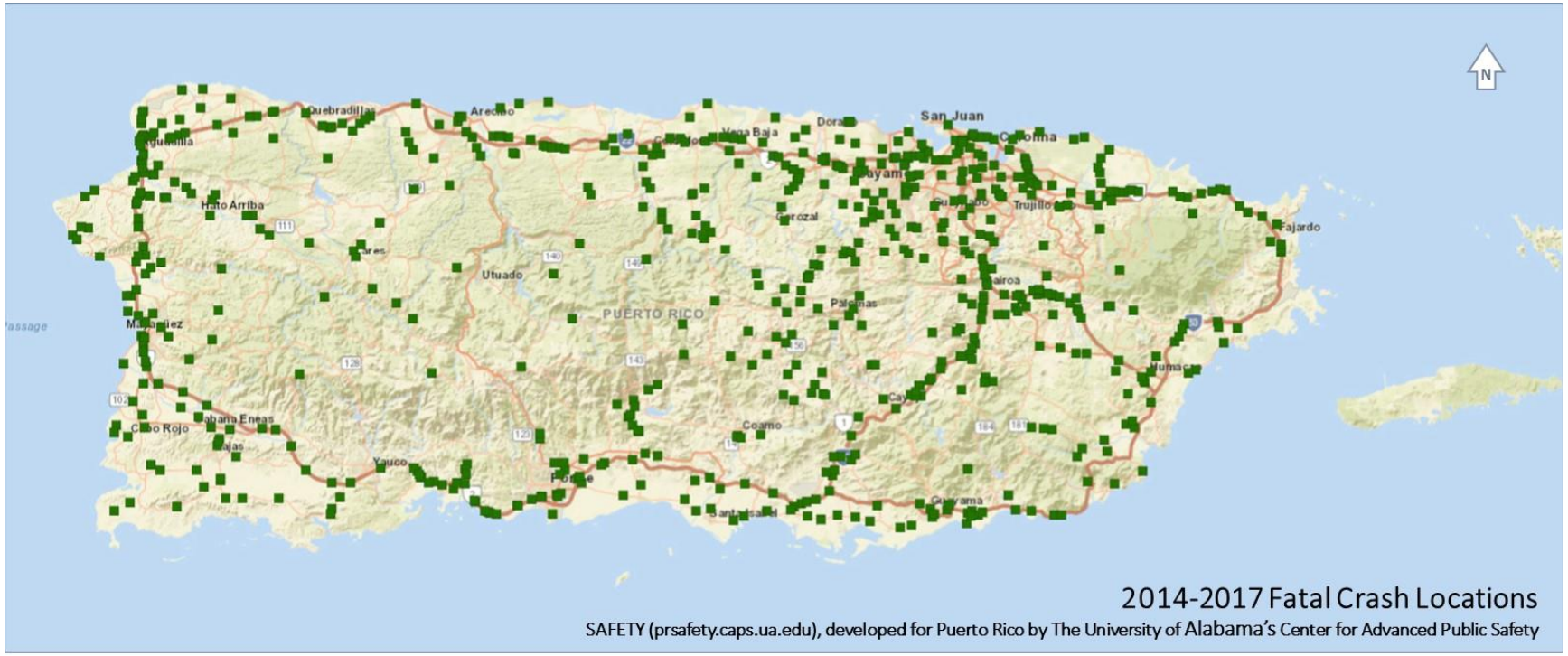


FIGURE 2-18: 2014-2017 FATAL CRASH LOCATIONS

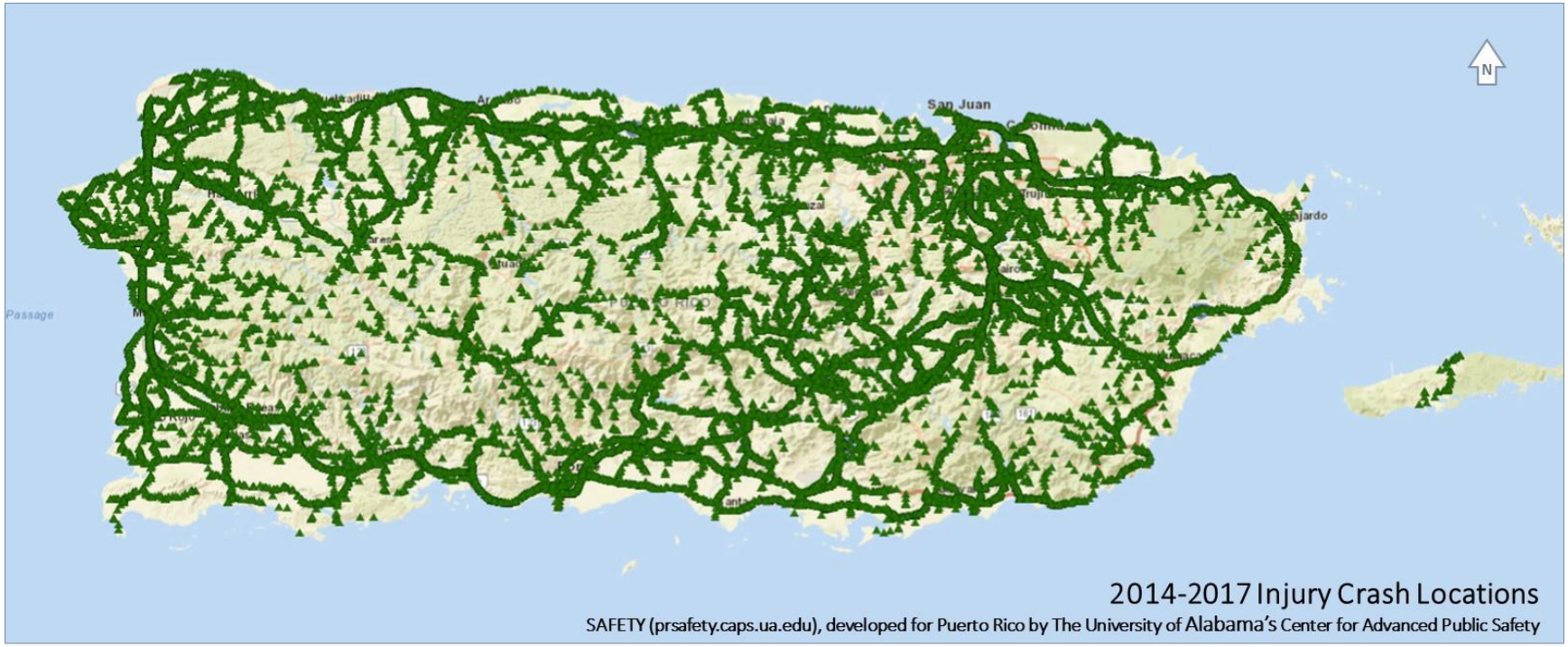


FIGURE 2-19: 2014-2017 INJURY CRASH LOCATIONS

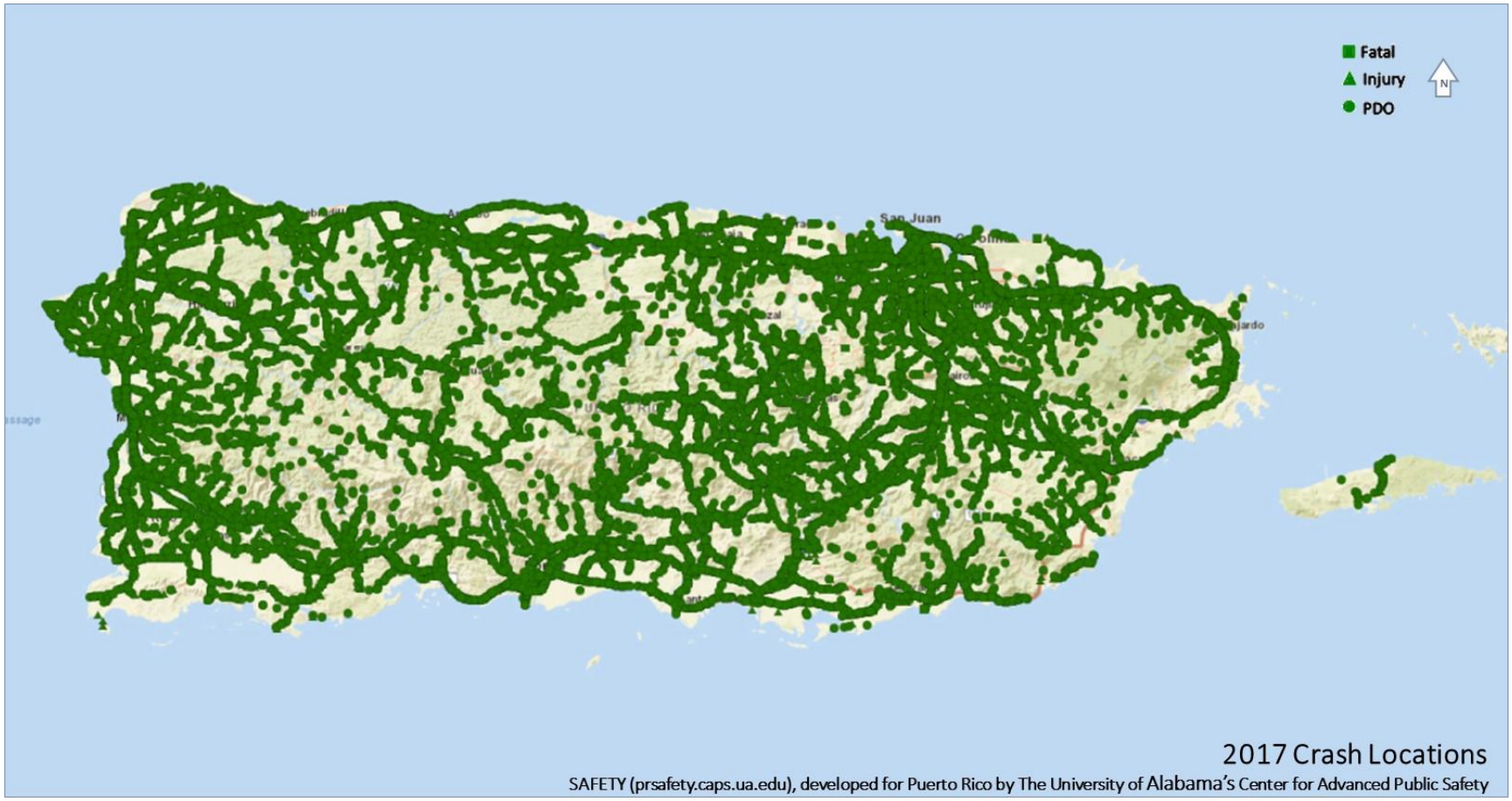


FIGURE 2-20: 2017 CRASH LOCATIONS

2.3 Scope

For this TAMP asset means all physical highway infrastructures located within the right-of-way corridor of a highway. The scope of this first PR-TAMP encompasses the assets described in Figure 2-21.

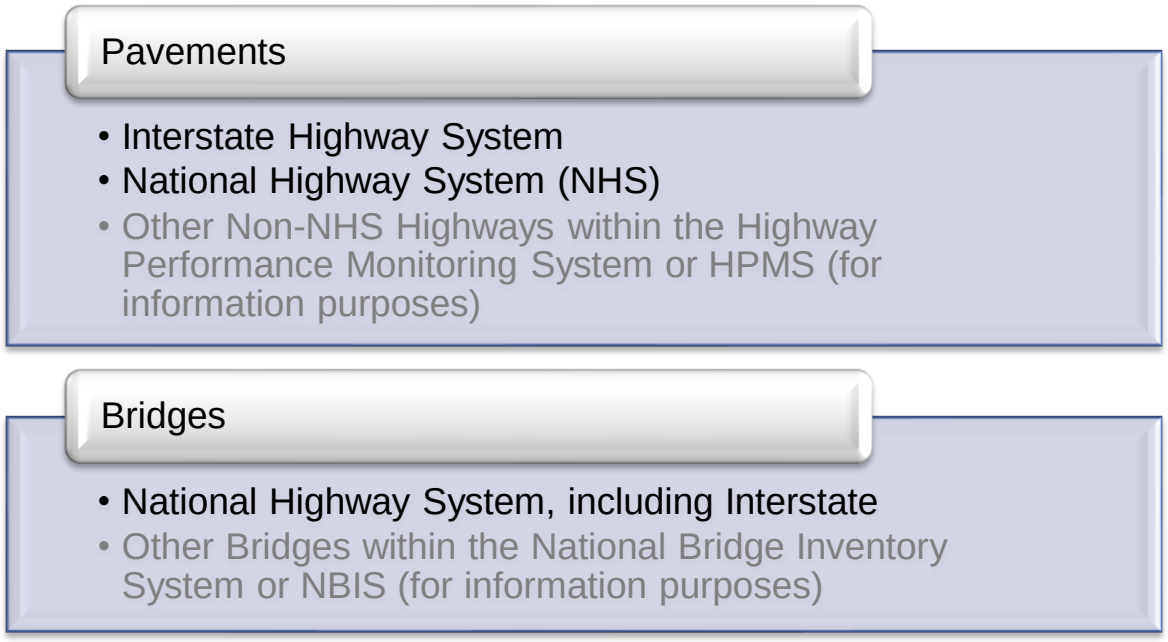


FIGURE 2-21: PR-TAMP ASSET SCOPE

The next subsections of the PR-TAMP will provide a summary listing of the pavements and bridges on the NHS and include a description of the condition of those assets as per requirements of Section 515 of Title 23 of the Code of Federal Regulations (23 CFR 515). General information will be provided regarding pavements and bridges outside the NHS, as they are part of the assessments that need to be maintained.

This document includes information about other assets such as Non-NHS pavements and bridges, and traffic signals. Although they are not included in the TAM approach, they are presented here as an information basis for general planning.

2.4 Network Inventory

2.4.1 Roads

Puerto Rico road network database, as per HPMS, is included in Appendix A. This inventory includes the following information:

1. Route Number
2. County/Municipality Code
3. Municipality Name
4. Km From
5. Km from Description
6. Km To
7. Km to Description
8. Section Length
9. AADT
10. AADT Year
11. Through Lanes
12. AADT 2026
13. DVKT 2005
14. Functional Class
15. Length (Km)

A summary is presented in Table 2-3. Eleven percent of network lane miles are part of the Interstate Highway System, which is also part of the National Highway System (NHS), 16 percent is not Interstate that is part of the NHS, and 73 percent are non-NHS. Figure 2-22 shows the network.

TABLE 2-3: HPMS NETWORK

System	Length (Mi)		Lane Miles	
INTERSTATE	232.99	284.60	1,034.01	1,288.31
INTERSTATE Concessioned	51.60		254.30	
NHS NON-INTERSTATE	495.91	497.74	1,736.88	1,740.54
NHS NON-INTERSTATE Concessioned	1.83		3.67	
OTHERS	4,030.83	4,030.83	8,223.91	8,223.91
TOTAL	**4,813.17**		**11,252.76**	

Concession segments are managed by *Autopistas Metropolitanas de Puerto Rico*, LLC (Metropistas). The segments include:

1. PR-22 between kilometers 0.65 and 83.7 - Interstate segment
2. PR-5 between kilometers 7.65 (Intersection with PR-2) and 10.6 (Intersection with PR-199) - Non-Interstate NHS segment

Puerto Rico also has three (3) interstate routes (PRI).

1. **PRI-1** is composed of the highways PR-18 and PR-52. It has a total length of 70.5 miles. The route has between four (4) and ten (10) lanes, including both directions.
2. **PRI-2** is composed of the highway PR-22 and a portion of PR-2. It has a total length of 139.3 miles. The route has between four (4) and ten (10) lanes, including both directions.
3. **PRI-3** is composed of portions of PR-3 and PR-26, PR-53, and PR-66. It has a total length of 69.3 miles. The route has between four (4) and eight (8) lanes, including both directions.

The HPMS is composed of portions of 1,563 different roads. The National Highway System has a total length of 782.34 centerline miles, including 284.6 centerline miles of Interstate. The network routes have an average of 3.87 lanes. Other Non-NHS roads include a length of about 4,030 miles. The network routes have an average of two (2.0) lanes.

Total network is shown in Figure 2-22. Interstate are demarked in red, non-interstate NHS are demarked in blue, and the rest of the network is demarked in yellow.

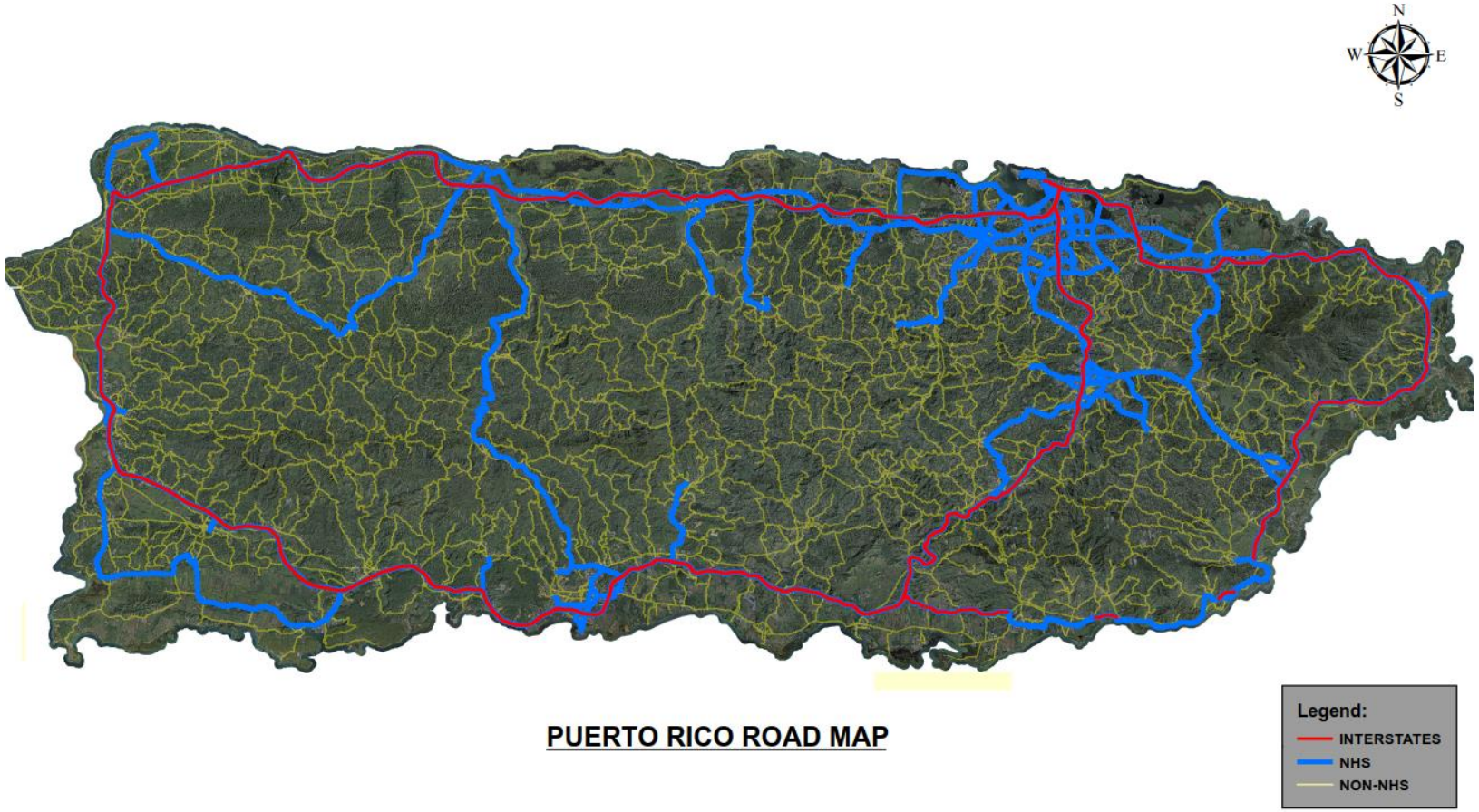
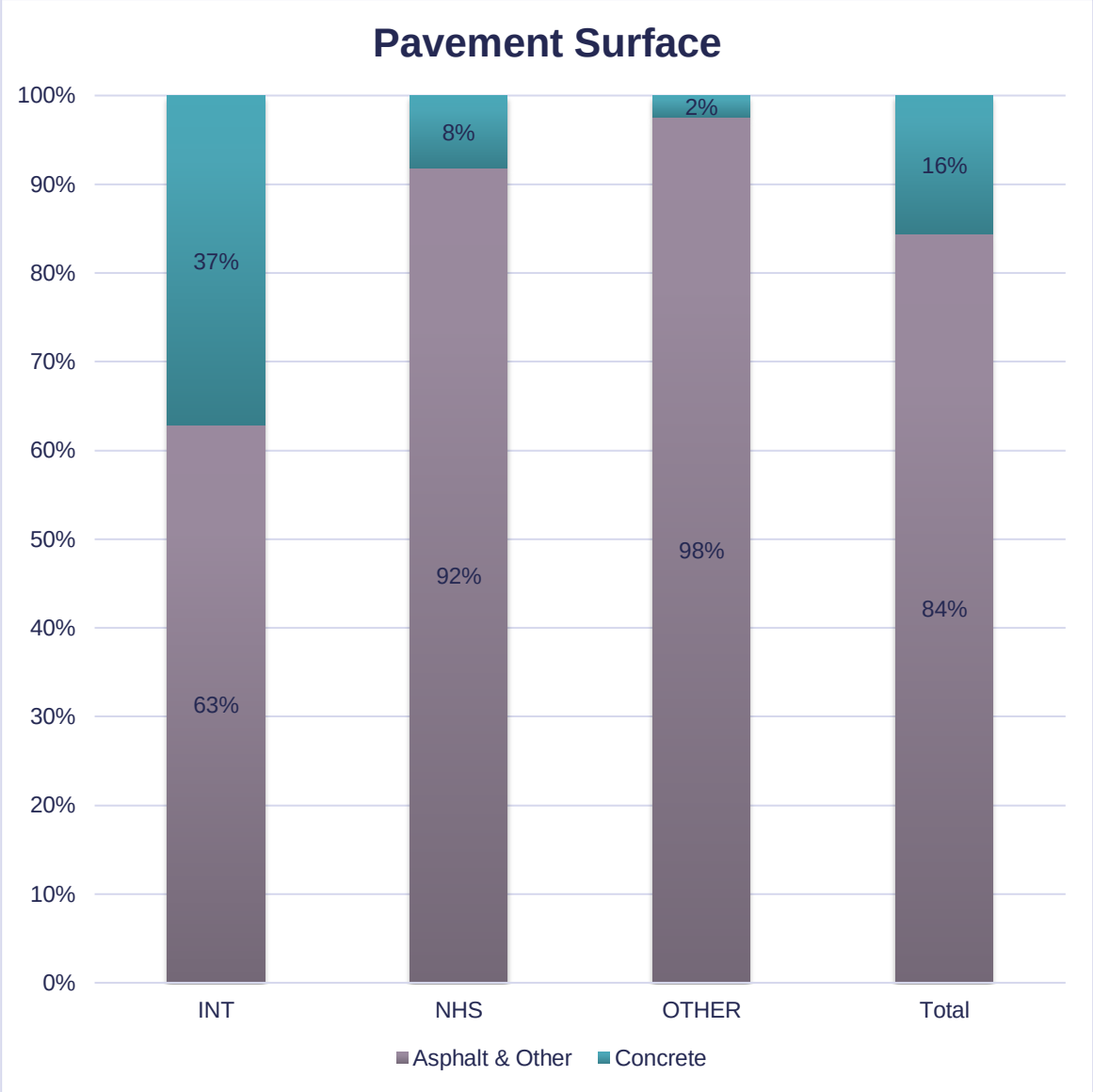


FIGURE 2-22: PUERTO RICO NETWORK

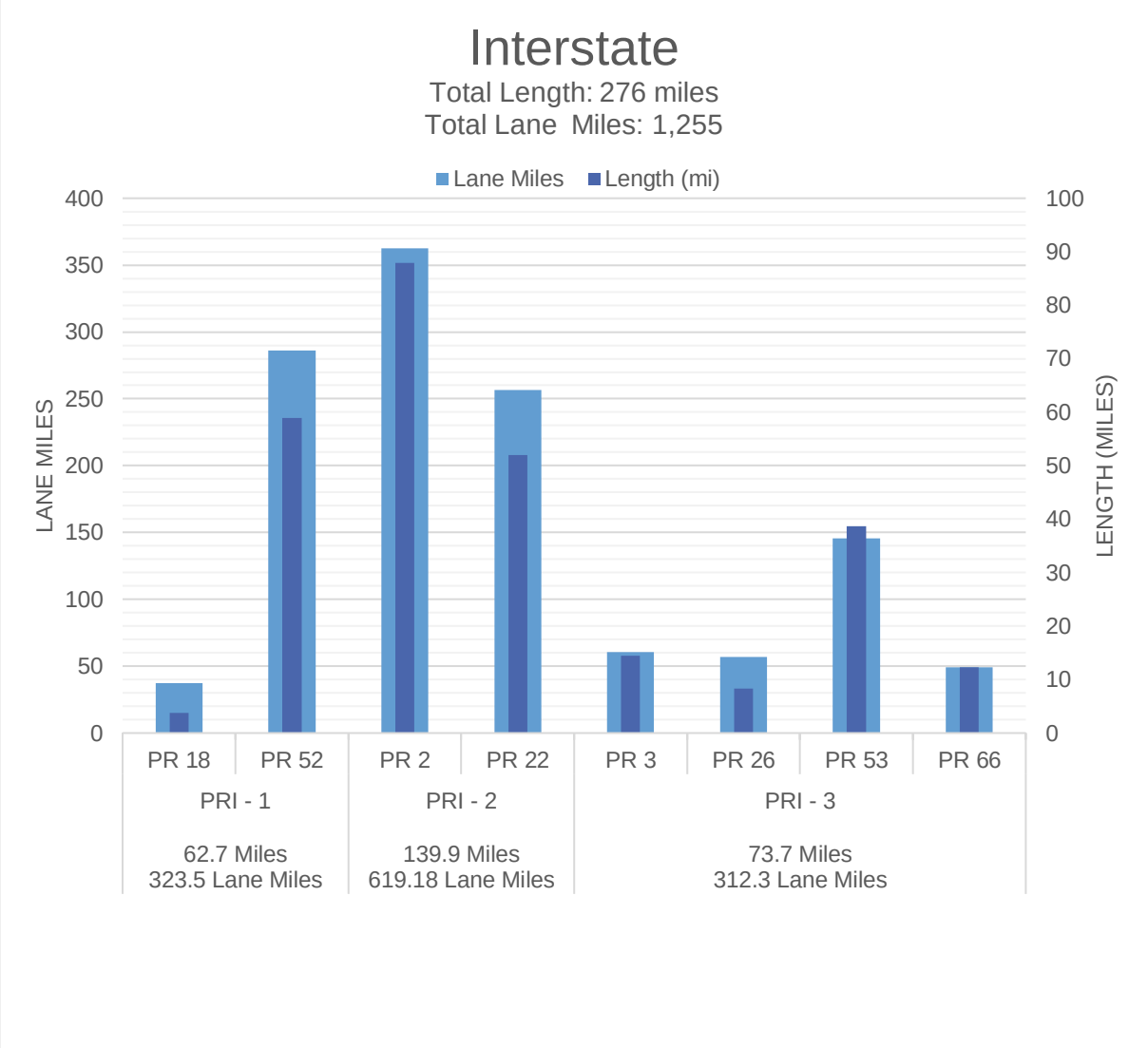
Figure 2-23 shows the pavement type. Most of the pavement is asphalt.



Proportions are based on available validated data (98.5% Interstate, 78.7% Non-Interstate NHS, 11.27% Others), with universe based on the HPMS 2017 inventory.

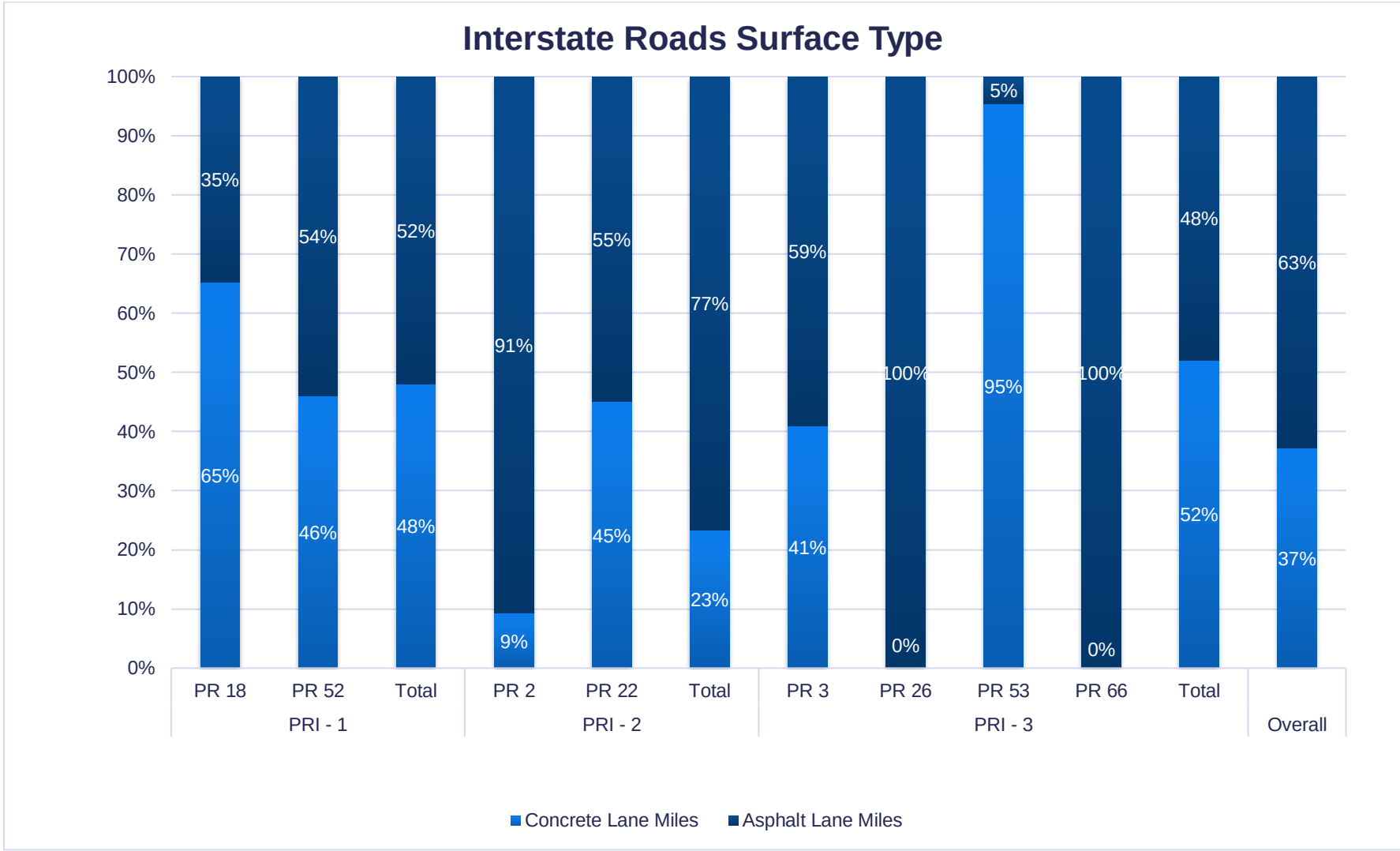
FIGURE 2-23: PAVEMENT SURFACE

Interstate system is further described in Figure 2-24 and Figure 2-25. Figure 2-24 shows the length and lane miles per road and route. Figure 2-25 shows the proportion per surface type of each road. There are 276 miles of interstate roads with 1,255 lane miles. A 62.8 percent of interstate lane miles are asphalt and 37.2 percent are concrete.



Values are based on HPMS 2017 data.

FIGURE 2-24: INTERSTATE ROADS



Percentages are based on the 96.5 percent *measured.*

FIGURE 2-25: INTERSTATE SURFACE TYPE

2.4.2 Bridges

As shown in Figure 2-26, the network includes 2,325 bridges with a total deck area of 2,180,690 square meters.

A total of 123 of the bridges with 340,687 square meters are managed by concessionaire Metropistas. Of them, 110 are part of the NHS.

One toll bridge (Teodoro Moscoso) with an area of 54,114 square meters is managed by concessionaire *Autopistas* de Puerto Rico. It is not part of the NHS.

All other bridges are managed by PRHTA: 738 with an area of 1,204,413 square meters are part of the NHS and 1,463 with an area of 581,476 square meters are not part of the NHS.

Bridge inventory is included in Appendix C.

System	Manager	Amount	Deck Area (Sq. Mts.)
NHS	PRHTA	738	1,204,413
	Metropistas	110	325,800
	Autopistas de PR	1	54,114
	Subtotal	**849**	**1,584,328**
NON-NHS	PRHTA	1,463	581,476
	Metropistas	13	14,887
	Autopistas de PR	0	0
	Subtotal	**1,476**	**596,363**
TOTAL	PRHTA	2,201	1,785,889
	Metropistas	123	340,687
	Autopistas de PR	1	54,114
	Total	**2,325**	**2,180,690**

Data obtained from the PRHTA 2018 Bridge Inventory published by FHWA.

FIGURE 2-26: BRIDGE INVENTORY SUMMARY

Figure 2-27 shows the percentage of bridges and bridge area by built decade. The greatest amount was built between 1963 and 1973. The greatest area is from bridges built between 1985 and 2006.

Build Year	Amount	Area (Sq. Mts.)
1842 to 1852	1	60
1853 to 1863	3	1,158
1864 to 1874	1	87
1875 to 1885	5	477
1886 to 1896	13	1,491
1897 to 1907	17	2,305
1908 to 1918	28	4,164
1919 to 1929	102	14,873
1930 to 1940	117	15,671
1941 to 1951	169	37,800
1952 to 1962	209	93,945
1963 to 1973	450	334,546
1974 to 1984	354	367,659
1985 to 1995	316	510,619
1996 to 2006	346	513,978
2007 to 2017	194	281,858
Total	**2,325**	**2,180,690**

Data obtained from the PRHTA 2018 Bridge Inventory published by FHWA.

FIGURE 2-27: BRIDGE YEAR BUILT

2.4.3 Signal Systems

Traffic signals are not part of the TAMP. However, the existing inventory is presented here as these are important assets that the PRHTA needs to maintain and set aside a necessary budget to address them. The network includes 1,258 signalized intersections; they are shown in Figure 2-28 and detailed in Appendix D.

The Hurricane María passed over Puerto Rico on September 20, 2017. It had a significant impact on traffic signals. An inspection program was implemented by PRHTA to assess traffic signals systems. The report that we have available included assessment for 41 percent of the traffic signals. Of these, 71 percent had power (29 percent of total inventory). From the inspected signal systems that had power, 83 percent were set operational, while 17 percent were not. Those that were not operational had significant parts missing such as signal faces, backplates, post, among others. From interviews with PRHTA employees, it was found that even operational signals needed intervention to set the system to optimal conditions.

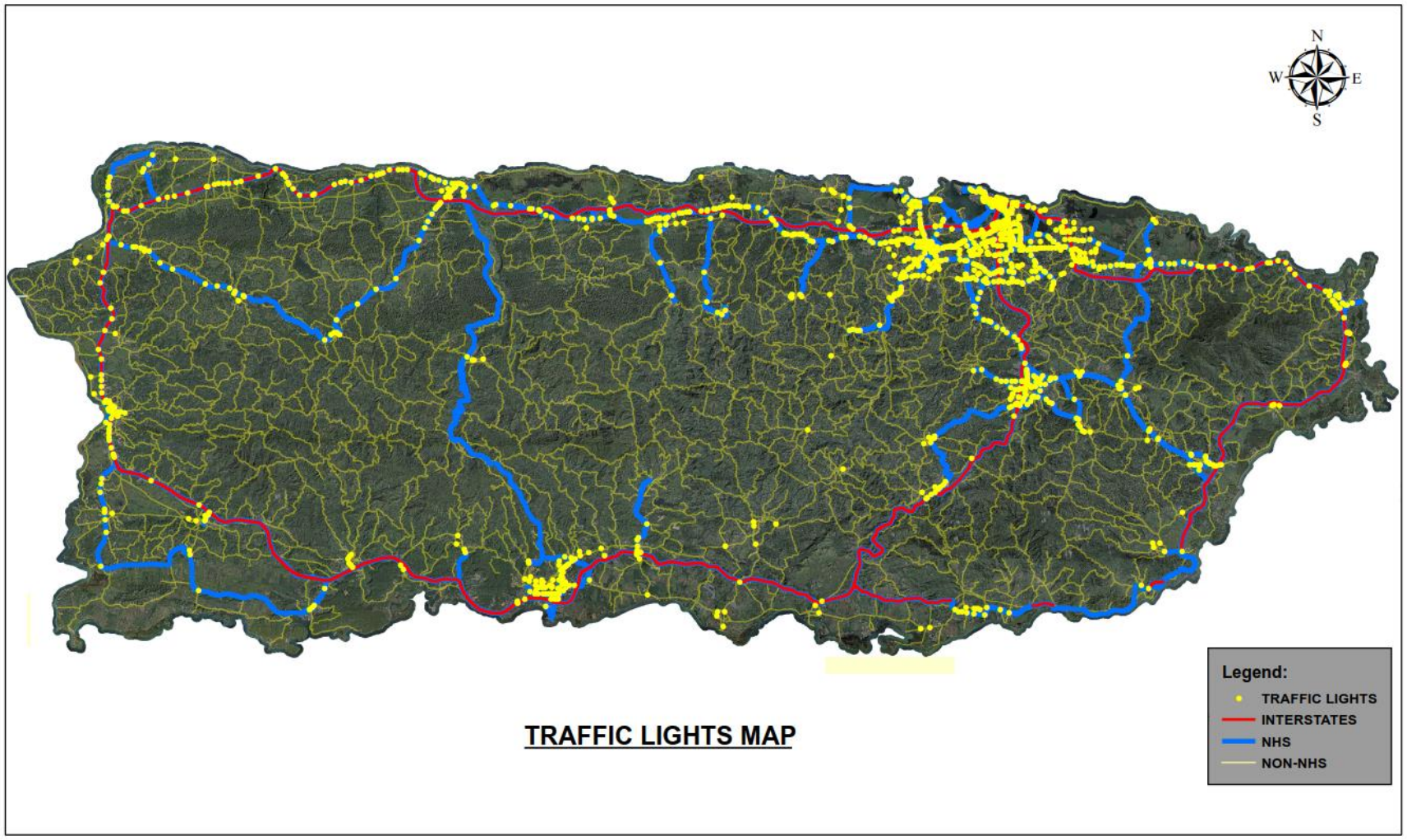


FIGURE 2-28: TRAFFIC SIGNALS INVENTORY

2.5 Pavement Condition Assessment

2.5.1 Data Collection

Pavement condition data was collected by the PRHTA using the PathRunner vehicle, presented in Figure 2-29.

FIGURE 2-29: DATA COLLECTION VEHICLE

A data point is reported every 0.1 miles. The data is collected only at the rightmost lane in the post increasing direction. Condition results for this lane are then extrapolated to all lanes.

2.5.2 Measures and Criteria

The pavement condition criteria are based on three distress types:

1. International Roughness Index or IRI (in/mile)
2. Percentage of Cracks
3. Faulting in concrete or Rutting in asphalt (in)

The criteria used are presented in Table 2-4.

For the 0.1-mile segment to be considered in:

1. Good condition - The results for all three distress types must be good.
2. Poor condition - The results for two or more distress types must be poor.
3. Fair condition – The results must include any other combination not included in the good or poor conditions.
    a. The Fair condition was sub-divided to help discern those that were closer to Good (F1) and closer to Poor (F3). Knowing this helped in the determination of required treatment and in the 10-year budget and treatment planning.

TABLE 2-4: PAVEMENT CONDITION CRITERIA

Condition	Code	Criteria Limit for Individual Distresses	Distress Criteria						Overall Criteria Considering the Three Distresses
			IRI 		Rutting or Faulting 		Cracking 		
			Asphalt & Concrete		Asphalt	Concrete	Asphalt	Concrete	
			NHS	Non-NHS					
Good	G	<	95	135	0.2	0.05	5	5	3G
Fair - Good	F1	<	110	185	0.3	0.1	10	10	2G & F1 or F2 1G & 2 F1 or F2 or Combination 3 F1 or F2 or Combination
Fair - Fair	F2	<	130	235	-----	-----	15	-----	Other Combinations
Fair - Poor	F3	<=	170	285	0.4	0.15	20	15	> 1F3 and no P 1F3 and 1P
Poor	P	>	170	285	0.4	0.15	20	15	>1P

Note: For the purpose of these evaluations, composite pavements are classified according to their surface pavement type, except for concrete slabs patched with asphalt concrete pavement. Thus, a road segment previously cracked, seated, and resurfaced (CRR, PRHTA Spec. 509), will be evaluated as flexible (asphalt).

2.5.3 Condition

The pavement condition described here is based on the best and most recent data available. Such data was collected by the Pavement Management Office during the year 2017[2]. Note that data was collected throughout the entire year, including before and after the passing of Hurricane Maria on September 20, 2017.

The pavement condition database includes the following information:

1. Route number
2. Start and end kilometer
3. Latitude and longitude of start and end kilometer
4. Amount of lanes
5. Network (interstate, NHS, other)
6. Pavement type
7. IRI (in/mi)
8. Faulting or rutting (In)
9. Percent cracks

Most recent available data are from 2017. Data is available for:

1. 96.5 percent of Interstate
2. 78.7 percent of NHS Non-Interstate
3. 11.3 percent of Non-NHS.

The pavement condition summary for available data is shown in Figure 2-30.

Figure 2-31.shows a map with the overall pavement condition for all networks as per available data.

Most of the measured network appears to be in Fair-Fair and Fair Good condition. It is noticeable that the southeast corridor of PR-3 and PR-53 is in Poor condition.

[2] The PRHTA submitted the 2018 HPMS data on June 15, 2019.

System / Condition		Interstate		NHS Non-Interstate		Non-NHS		Total	
		Lane Miles	%	Lane Miles	Percent of Total	Lane Miles	Percent of Total	Lane Miles	Percent of Total
Good		138.85	10.8%	38.14	2.2%	20.12	0.2%	197.10	1.8%
Fair	Fair to Good (F1)	319.29	24.8%	131.38	7.5%	257.36	3.1%	708.02	6.3%
	Fair-Fair (F2)	369.73	28.7%	735.77	42.3%	446.99	5.4%	1,552.48	13.8%
	Fair to Poor (F3)	244.97	19.0%	308.28	17.7%	129.74	1.6%	682.99	6.1%
Poor		170.17	13.2%	156.45	9.0%	72.83	0.9%	399.45	3.5%
Incomplete		0.00	0.0%	286.39	16.5%	193.40	2.4%	479.79	4.3%
Not Measured		45.30	3.5%	84.15	4.8%	7,103.47	86.4%	7,232.92	64.3%
Roads Total		**1,288.31**	**100.0%**	**1,740.54**	**100.0%**	**8,223.91**	**100.0%**	**11,252.76**	**100.0%**

Information is from PRHTA 2017 Data.

Notes:

- *Not Measured = Number of lane miles in the HPMS in excess to the measured ones.*
- *Incomplete = Lane miles measured but at least one of the three (3) indicators (IRI, Rutting/Faulting, Cracking) resulted in an error; hence, the overall condition couldn't be obtained.*
- *For the purpose of presenting the condition and comparing it to targets, all NHS segments with incomplete or non-measured data were considered as "Poor".*

FIGURE 2-30: PAVEMENT CONDITION SUMMARY

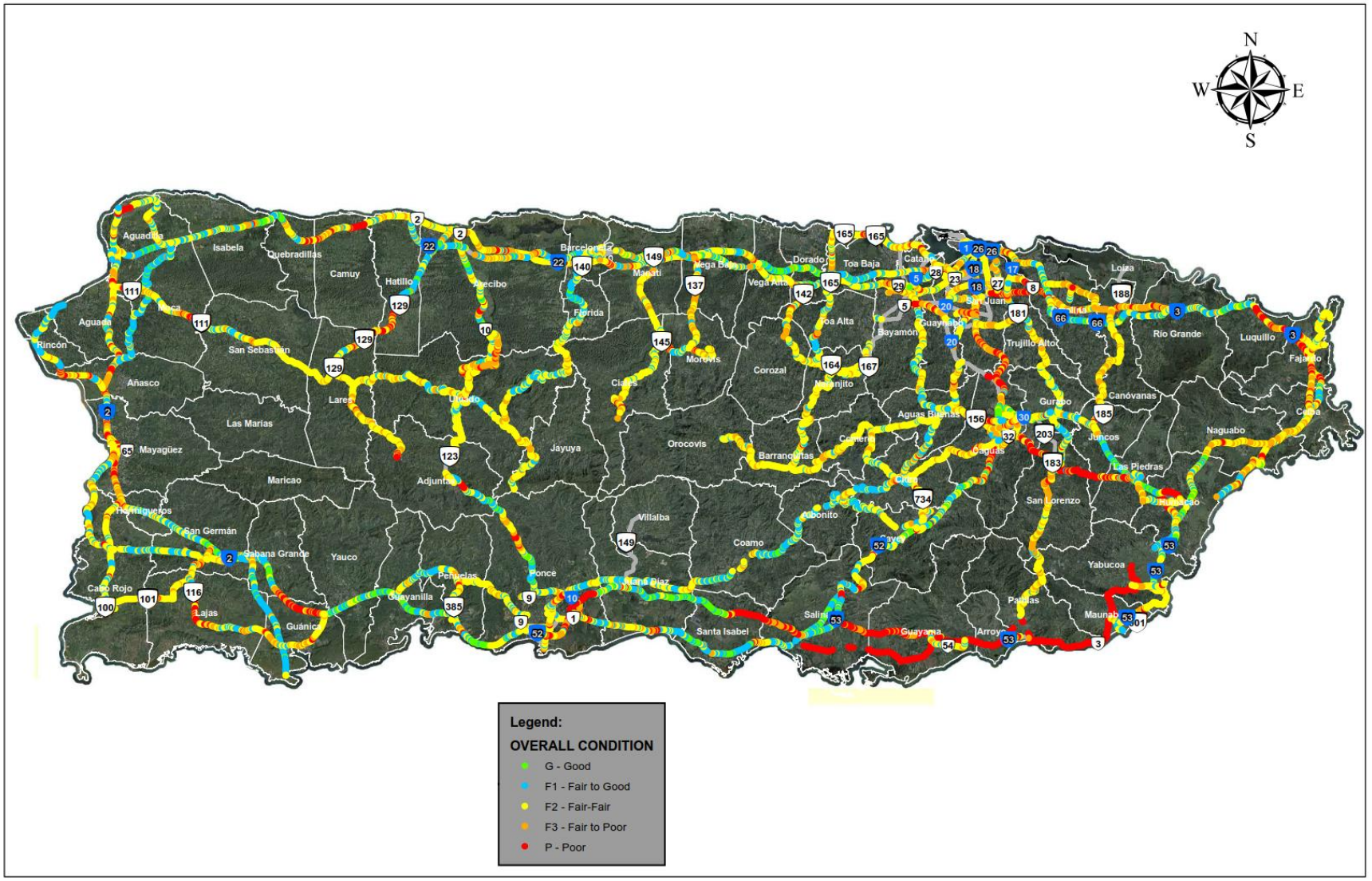


FIGURE 2-31: OVERALL PAVEMENT CONDITION

Details of the condition measured per pavement surface are shown in Figure 2-32.

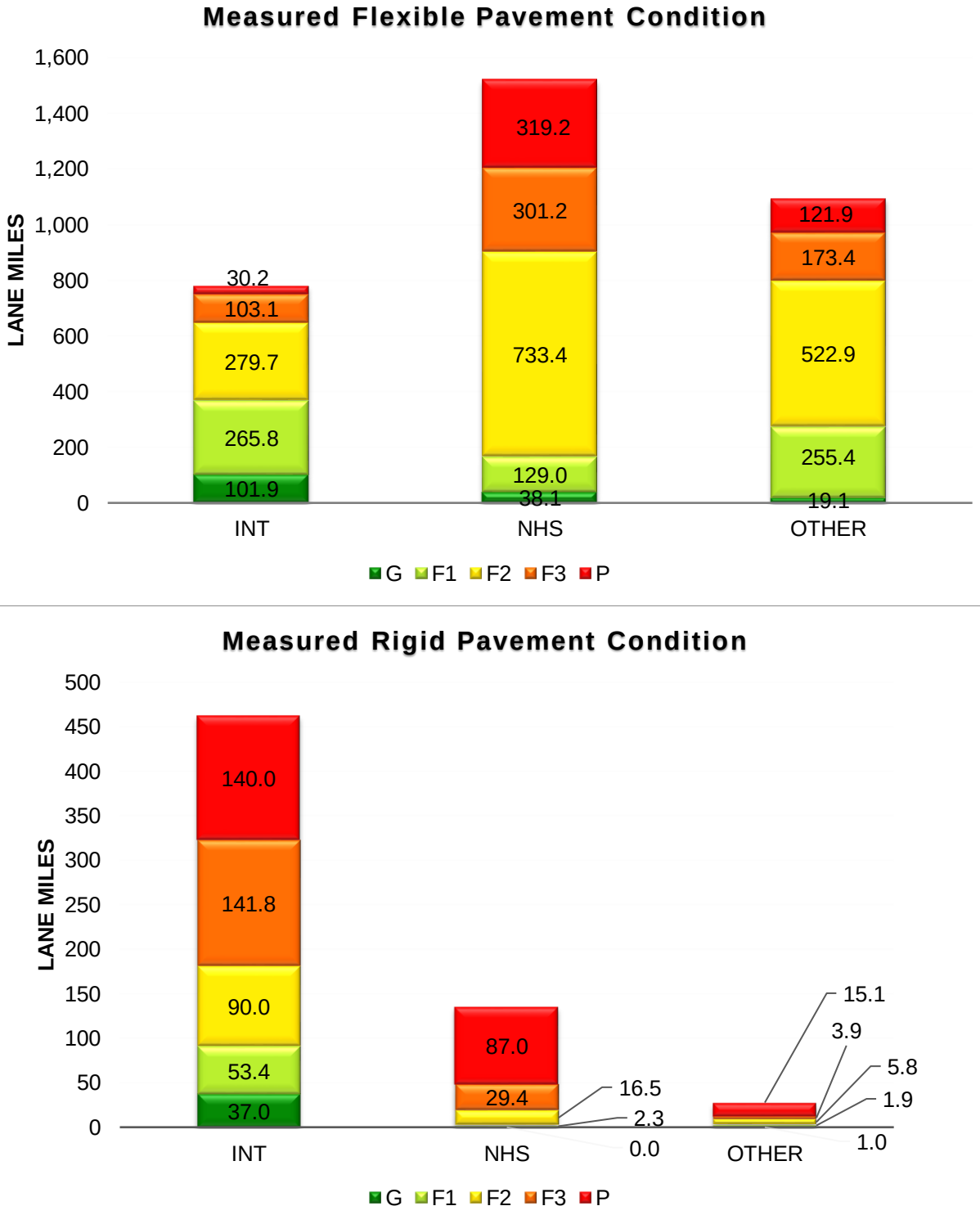
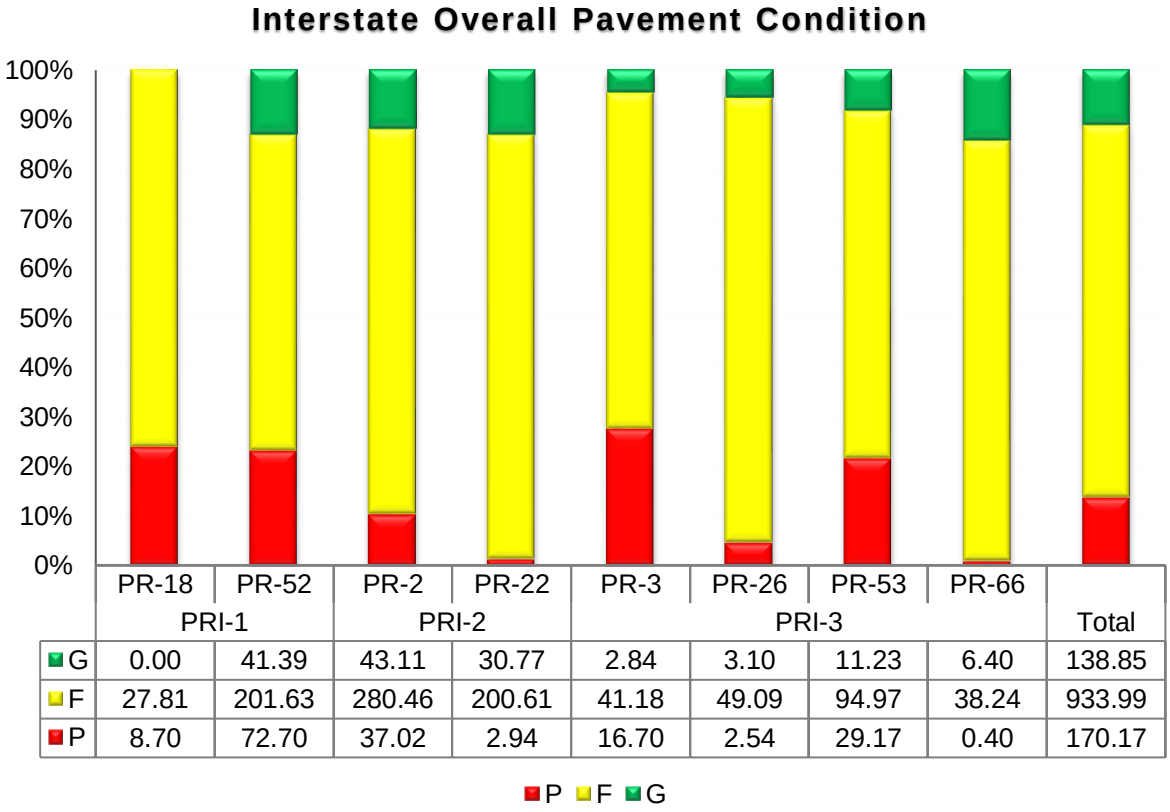


FIGURE 2-32: PAVEMENT CONDITION PER SURFACE TYPE

The pavement condition of interstate routes is further described in Figure 2-34. The table shows the following information per each highway or highway segment that constitutes an interstate route:

1. Lane miles per condition and per pavement material
2. Percentage per condition and per pavement material

As shown in
Figure 2-33, most of the pavement is in fair condition (75.14 percent). An 11.17 percent of the pavement is in good condition, and 13.69 percent of pavement is in poor condition.

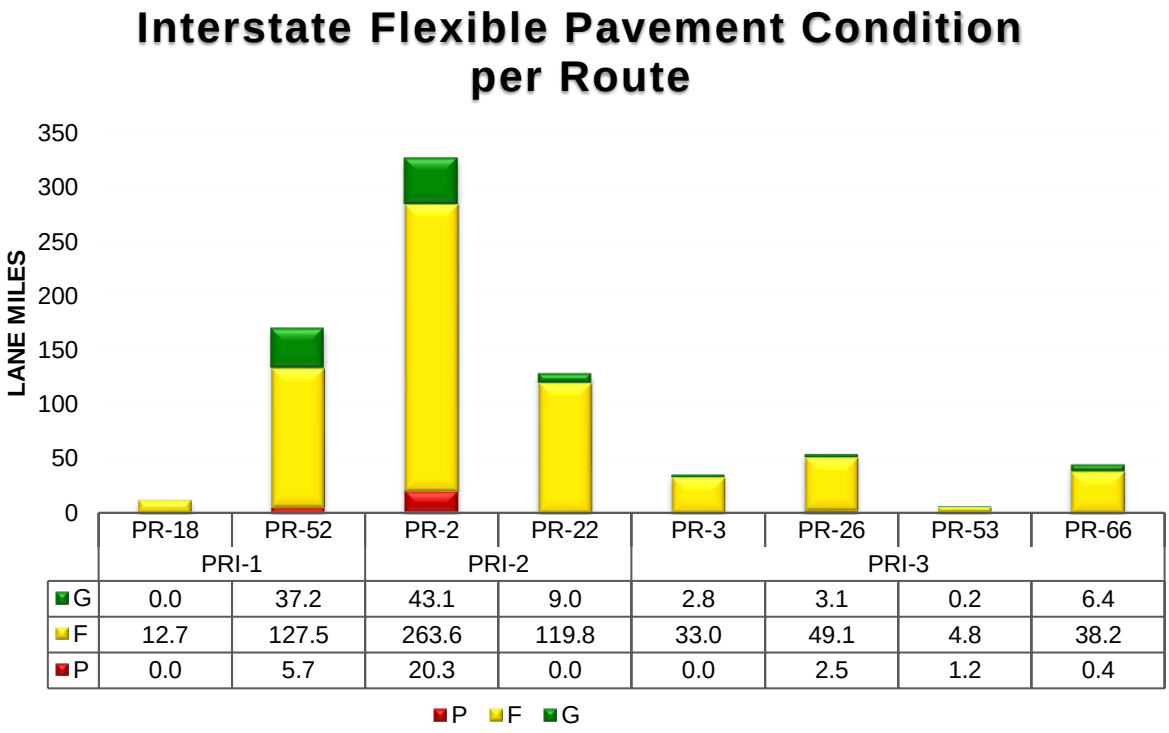


	PR-18	PR-52	PR-2	PR-22	PR-3	PR-26	PR-53	PR-66	
	PRI-1		PRI-2		PRI-3				Total
G	0.00	41.39	43.11	30.77	2.84	3.10	11.23	6.40	138.85
F	27.81	201.63	280.46	200.61	41.18	49.09	94.97	38.24	933.99
P	8.70	72.70	37.02	2.94	16.70	2.54	29.17	0.40	170.17

FIGURE 2-33: INTERSTATE OVERALL PAVEMENT CONDITION

From Figure 2-34 can be observed the following:

1. Most Poor lane miles are in concrete pavements.
2. Most Poor lane miles are at PR-52.
3. Most asphalt lane miles are in Fair condition.
4. Most Good lane miles are asphalt at PR-2 and PR-52, followed by concrete at PR-22.



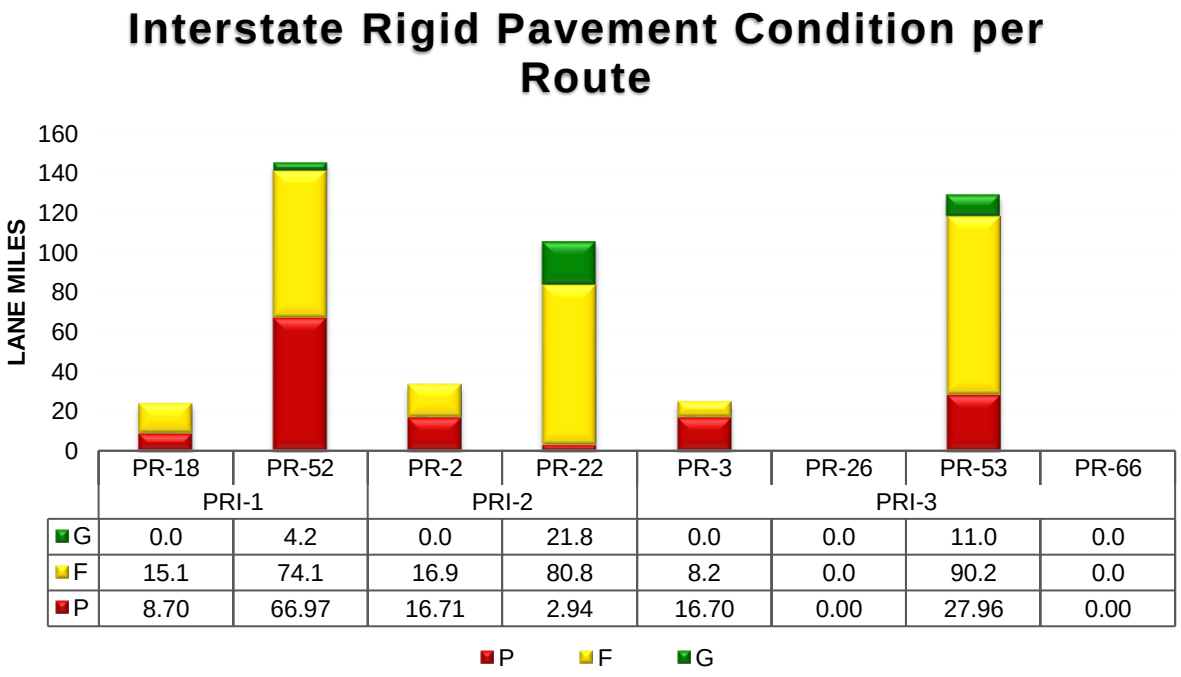
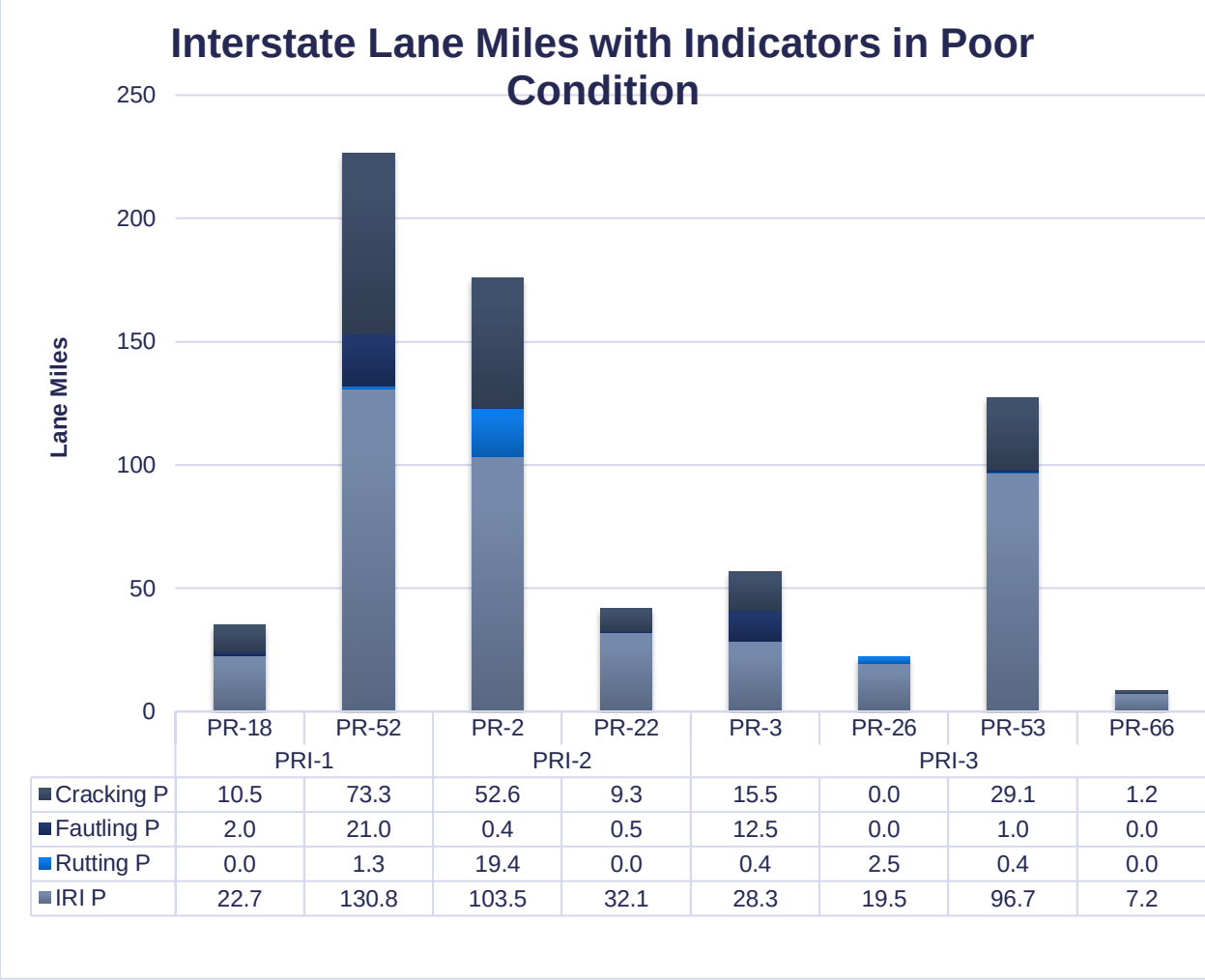


FIGURE 2-34: INTERSTATE PAVEMENT CONDITION PER HIGHWAY AND MATERIAL

Figure 2-35 shows those defects classified as poor per each highway of the interstate routes. From Figure 2-35 can be observed the following:

1. Most common poor defect is not meeting roughness measures (IRI).
2. Poor IRI can be observed on all highways.
3. Poor IRI is 63.5% of the total lane miles with poor defects (including overlapping defects).
4. The greatest number of lane-miles with poor IRI is present at PR-52, PR-2, and PR-53.
5. Another important defect in poor condition is cracking.
6. Cracking in poor condition is present at almost all highways (except PR-26).
7. The greatest number of lane-miles with poor cracking is present at PR-52.



	PR-18	PR-52	PR-2	PR-22	PR-3	PR-26	PR-53	PR-66
	PRI-1		PRI-2		PRI-3			
Cracking P	10.5	73.3	52.6	9.3	15.5	0.0	29.1	1.2
Fautling P	2.0	21.0	0.4	0.5	12.5	0.0	1.0	0.0
Rutting P	0.0	1.3	19.4	0.0	0.4	2.5	0.4	0.0
IRI P	22.7	130.8	103.5	32.1	28.3	19.5	96.7	7.2

FIGURE 2-35: INTERSTATE POOR DEFECTS

Based on the inventory and pavement conditions, a detailed analysis was conducted and PRHTA made the following recommendations for the interstate system:

1. Evaluate the quality of concrete pavements for future projects, as most Poor lane miles are in concrete pavements.
2. As most Fair pavements are flexible, it is recommended to monitor and as appropriate implement treatments on the asphalt pavements, so they don't degrade to Poor, especially at PR-2 which currently has most of its lane miles in Fair condition.
3. PR-52 is the road exhibiting more lane miles in Poor condition; the strategy recommended and being considered is to evaluate projects to improve these pavements, especially to correct roughness and cracking.
4. The most common Poor defect is not meeting roughness. This issue is present in all interstate highways. Therefore, PRHTA analysis has recommended evaluating projects to improve roughness at all roads, especially at PR-2, PR-52, and PR-53, which had more amount of poor IRI lane miles.

2.5.4 Deterioration

PRHTA also has historical data on pavement conditions. However, this data was collected with a different instrument (ARAN), at different intervals, and with different criteria compared to the most recent available data. This data is also saved in different files by road.

There is data collected through the current instrument (PathRunner) for 2014 to 2017. This data was used to estimate pavement surface deterioration based on changes in overall condition.

The following procedure was used:

1. An Excel file was prepared, including a different tab for each year's data. The data includes the following fields: road, direction, start kilometer, end kilometer, start mile, end mile, pavement type, average IRI (in/mi), average rutting or faulting (in), average crack percent, and road system. A field was added with the start mile rounded to one decimal. Data was sorted by direction and then by road and starting kilometer in ascending order. Resulting sample size is shown in Table 2-5. The sample totals 98.6 miles, which is 2% of the HPMS network. The summary database is included in Appendix F.

TABLE 2-5: SAMPLE SIZE

Sample 0.1 mi Segments	Asphalt	Concrete	Overall
INT	193	332	**525**
NHS	270	178	**448**
OTHER	13	0	**13**
Overall	**476**	**510**	**986**

2. Each year's data was compared to identify the roads for which data was successfully collected for all four years in the same direction. Those roads are PR-1, PR-2, PR-3, PR-17, PR-18, PR-20, PR-22, PR-30, PR-52, PR-53, and PR-60. Some segments of some of these roads belong to each of the three system categories, and some have different pavement surfaces. For example, feasible data of PR-1 has some segments that are NHS and others that are Non-NHS, and some segments with an asphalt surface and others with concrete surface.
3. The range for which data may be available for all roads was determined. This was done by identifying the smallest and the biggest start mile of the data sets for each road. This became the sample for the analysis (see Table 2-6).

TABLE 2-6: ANALYSIS SEGMENTS

Roads in All Sets I Direction	Start KM From	Start KM To	Start Mi	End Mi
1	13.2	126.2	8.2	78.4
2	89.7	194.5	55.7	120.8
3	0.0	47.9	0.0	29.7
17	5.0	6.8	3.1	4.2
18	0.8	6.0	0.5	3.7
20	2.0	9.5	1.2	5.9
22	0.0	0.5	0.0	0.3
30	0.0	29.8	0.0	18.5
52	0.0	101.1	0.0	62.8
53	0.0	94.0	0.0	58.4
60	0.5	3.1	0.3	1.9

4. A master data set was prepared including each road divide by 0.1-mile segments starting from the smallest and ending on the biggest round start mile for each one. The system and surface type for each line item was determined by comparing the round start mile of the master data set with the round start mile of the 2017 data set. See example in Table 2-7.

TABLE 2-7: PAVEMENT DETERIORATION MASTER DATABASE EXAMPLE

PR	Round Start Mi	System	Surface Type
1	8.20	NHS	Concrete
1	8.30	NHS	Concrete
1	8.40	NHS	Concrete
1	76.00	OTHER	Asphalt
1	76.10	NHS	Asphalt
1	76.20	NHS	Asphalt
1	76.30	NHS	Asphalt

5. To the master data set were added columns for each year and each of the three distresses. It was presumed that each indicator's measure applied to the entire 0.1-mile length segment. See example in Table 2-8.

TABLE 2-8: DISTRESS VALUES PER YEAR

PR	Start Mi From	System 2017	Type 2017	IRI 2014	IRI 2015	IRI 2016	IRI 2017	Ru/Fa 2014	Ru/Fa 2015	Ru/Fa 2016	Ru/Fa 2017	Cra 2014	Cra 2015	Cra 2016	Cra 2017
1	8.20	NHS	Concrete	115	116	216	161	0.2	0.1	0.1	0.1	80	55	10	15
1	8.30	NHS	Concrete	140	100	191	237	0.1	0	0.1	0.1	75	70	10	5
1	8.40	NHS	Concrete	392	224	178	185	0.3	0.3	0.1	0.1	75	55	10	10
1	8.70	NHS	Concrete	224	216	266	330	0.1	0.1	0.1	0.1	80	70	25	20

6. Another worksheet was created to evaluate the condition of each distress and the overall condition per year. See example in Table 2-9. The table includes the condition per indicator, the count of conditions for the segment, and the resulting overall condition.

TABLE 2-9: CONDITION

PR	Start Mi From	IRI	RU/Fa	Cra	G	F1	F2	F3	P	Cond 2014	…	IRI	RU/Fa	Cra	G	F1	F2	F3	P	Cond 2017
1	8.20	F2	P	P	0	0	1	0	2	P	**…**	F3	F3	F3	0	0	0	3	0	F3
1	8.30	F3	F3	P	0	0	0	2	1	F3	**…**	P	F3	F1	0	1	0	1	1	F3
1	8.40	P	P	P	0	0	0	0	3	P	**…**	P	F3	F3	0	0	0	2	1	F3
1	8.50	P	F3	P	0	0	0	1	2	P	**…**	P	F3	P	0	0	0	1	2	P
1	8.60	P	P	P	0	0	0	0	3	P	**…**	P	F3	G	1	0	0	1	1	F3
1	8.70	P	F3	P	0	0	0	1	2	P	**…**	P	F3	P	0	0	0	1	2	P
1	8.80	P	F3	P	0	0	0	1	2	P	**…**	F3	F3	F1	0	1	0	2	0	F3

7. A score was assigned for the overall conditions, as shown in Table 2-10.

TABLE 2-10: CONDITION SCORE

Condition	Code	Score
Good	G	5
Fair to Good	F1	4
Fair - Fair	F2	3
Fair to Poor	F3	2
Poor	P	1

8. The overall score per year was added to the table. See example in Table 2-11.

TABLE 2-11: OVERALL SCORE PER YEAR

PR	Start Mi From	System 2017	Type 2017	Cond 2014	Cond 2015	Cond 2016	Cond 2017
1	8.20	NHS	Concrete	1	2	2	2
1	8.30	NHS	Concrete	2	3	2	2
1	8.40	NHS	Concrete	1	1	2	2
1	8.50	NHS	Concrete	1	1	1	1
1	8.60	NHS	Concrete	1	1	2	2
1	8.70	NHS	Concrete	1	1	1	1

9. The change in score was determined by adding columns and calculations corresponding to the score subtraction for the following combinations:
    a. 2015 - 2014 if none of them are blank and 2015>2014
    b. 2016 - 2015 if none of them are blank and 2016>2015
    c. 2017 - 2016 if none of them are blank and 2017>2016
    d. 2016 - 2014 if none of them are blank, 2016>2014 and 2015 is blank
    e. 2017 - 2014 if none of them are blank, 2017>2014, 2015 and 2016 are blank
    f. 2017 - 2015 if none of them are blank, 2017>2015 and 2016 is blank

    See example in Table 2-12.

TABLE 2-12: SCORE CHANGE TABLE EXAMPLE

PR	Start Mi From	2015-2014 If None is Blank and 2015>2014	2016-2015 If None is Blank and 2016>2015	2017-2016 If None is Blank and 2017>2016	2016-2014 If None is Blank, 2016>2014 and 2015 = Blank	2017-2014 If None is Blank, 2017>2014, 2015 and 2016= Blank	2017-2015 If None is Blank, 2017>2015 and 2016=Blank
1	8.20		0	0			
1	8.30		-1	0			
1	8.40	0		0			
1	8.50	0	0	0			
1	8.60	0		0			
1	8.70	0	0	0			

10. The average deterioration rate (change in score points per year) for each segment and combination was determined by dividing the difference in score by the number of years in the combination. See example in Table 2-13.

TABLE 2-13: AVERAGE IRI PER YEAR TABLE EXAMPLE

PR	Start Mi From	2015-2014 If None is Blank and 2015>2014 1 Year	2016-2015 If None is Blank and 2016>2015 1 Year	2017-2016 If None is Blank and 2017>2016 1 Year	2016-2014 If None is Blank, 2016>2014 and 2015 = Blank 2 Years	2017-2014 If None is Blank, 2017>2014, 2015 and 2016= Blank 3 Years	2017-2015 If None is Blank, 2017>2015 and 2016=Blank 2 Years
1	8.20		0	0			
1	8.30		-1	0			
1	8.40	0		0			
1	10.30			0	-0.5		
1	10.40				-1		
1	10.50			0			
1	10.60			0			

11. The average deterioration per line item was calculated by obtaining the average of the deterioration per year of the different applicable combinations in the table presented in the above step. See example in Table 2-14.

TABLE 2-14: AVERAGE RATE TABLE EXAMPLE

PR	Start Mi From	Average Deterioration Rate (score points per year)
1	8.20	0
1	8.30	-0.5
1	8.40	0
1	10.30	-0.25
1	10.40	-1
1	10.50	0
1	10.60	0

12. The average deterioration overall, per system, per pavement type, and per combination of system and pavement type was obtained by averaging the deterioration presented in the above step that meets each specific set of criteria. See results in Table 2-15.

TABLE 2-15: AVERAGE DETERIORATION RATES

Deterioration Rate Score Point Change per Year	Asphalt	Concrete	Overall
Interstate	-0.5475	-0.5369	-0.54079
NHS Non-Interstate	-0.34506	-0.57116	-0.4349
Non-NHS	-0.28846	No Data	-0.28846
Overall	-0.4256	-0.54886	-0.48935

13. The resulting deterioration graphs are shown in Figure 2-36.

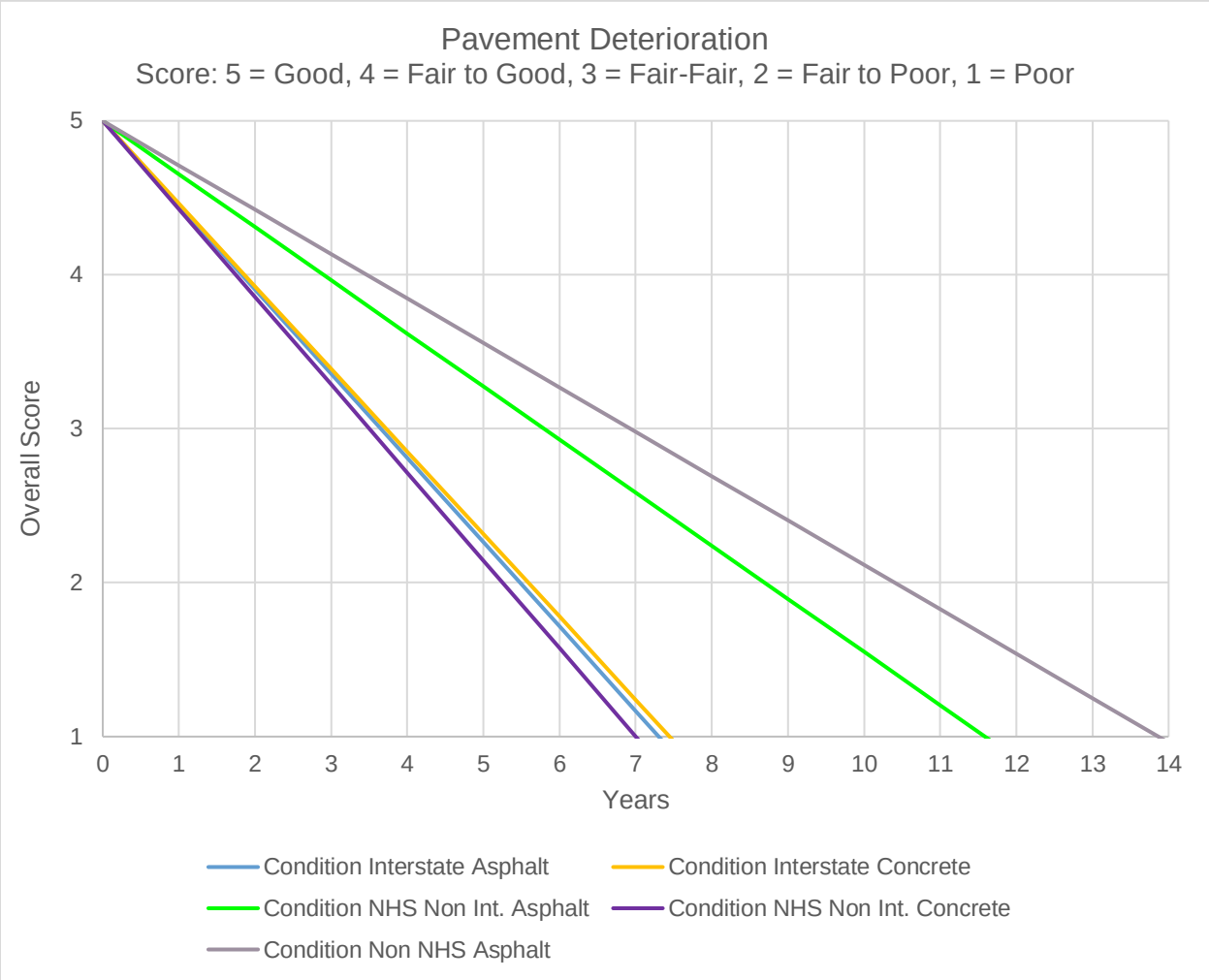


FIGURE 2-36: PAVEMENT DETERIORATION

14. A similar exercise was performed for each of the defects. Resulting charts are presented in for IRI, in for Rutting & Faulting, and in for Cracking.

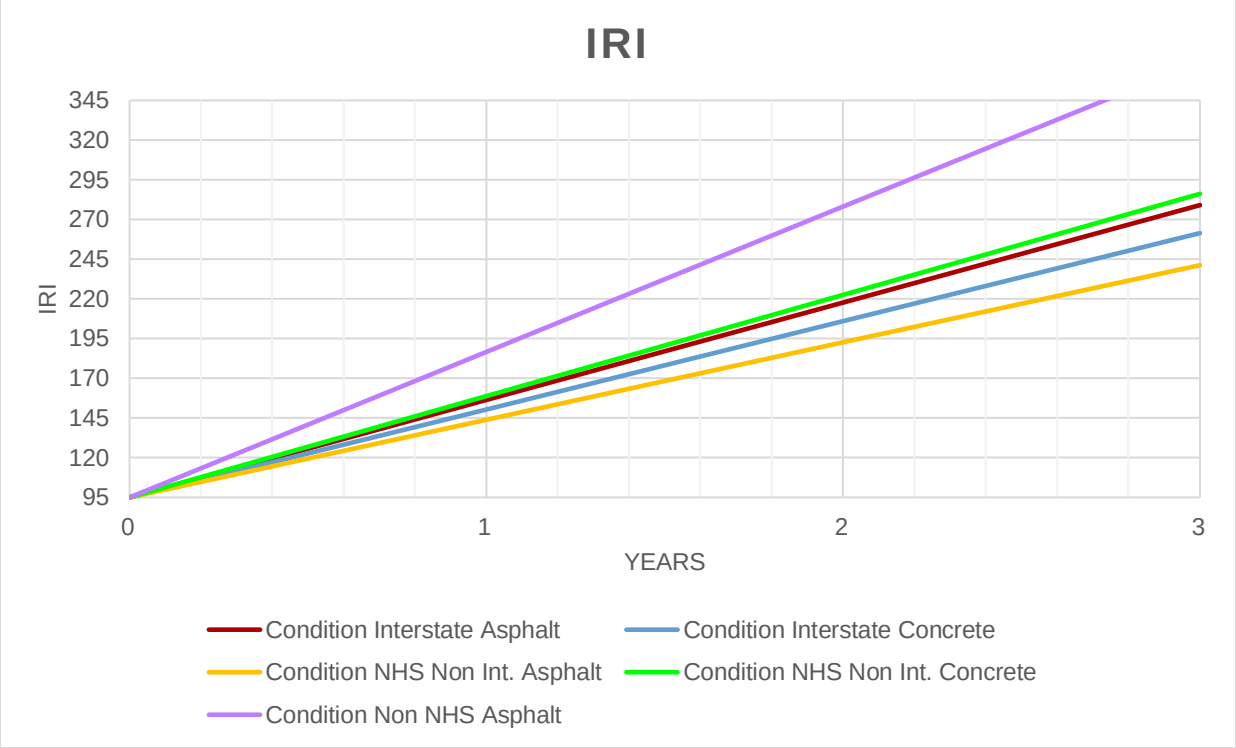


FIGURE 2-37: ROUGHNESS PROPAGATION

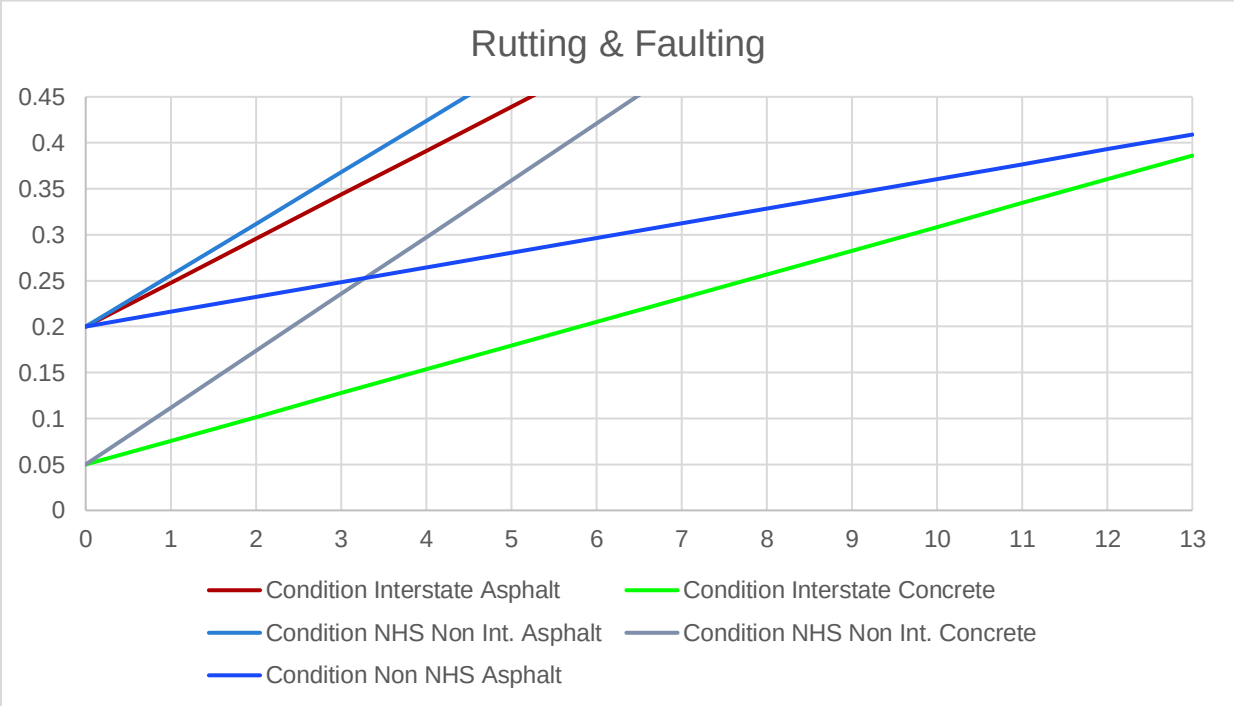


FIGURE 2-38: RUTTING AND FAULTING PROPAGATION

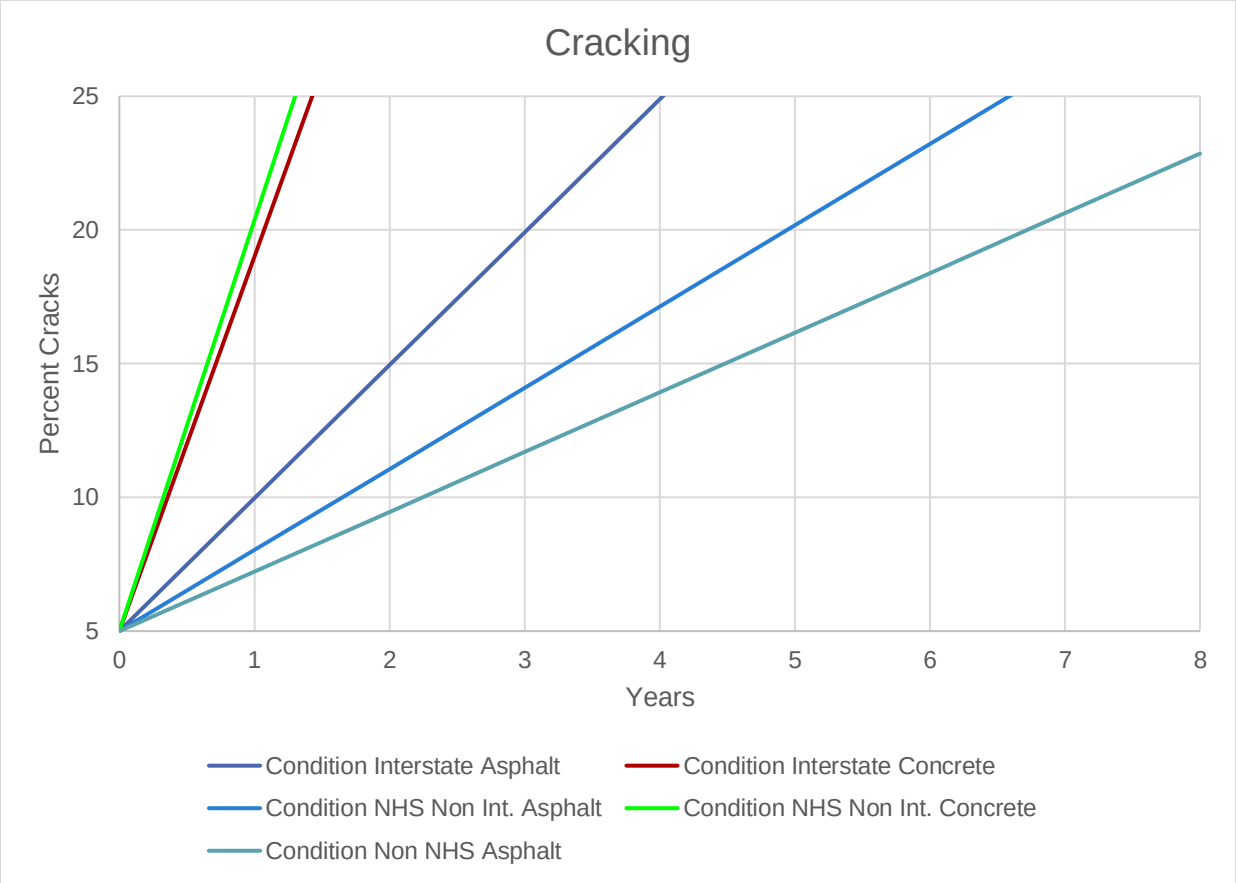


FIGURE 2-39: CRACKING PROPAGATION

15. The analysis showed that the resulting deterioration rates very high, especially at concrete pavements. As the total lane miles is very high, the recent treatments are likely to represent a small percentage of total lane miles. It is probable that the sample contains a lot of lane miles on its final life years; hence, deteriorating more rapidly than younger pavements. Since available data is limited, additional tools for the consideration of pavement deterioration will be considered, until more data is available. The approach currently being considered is to use the performance period values listed on PRHTA's Pavement Preservation Management Program as part of the tools for the consideration of pavement deterioration. These are listed in Table 2-16.

TABLE 2-16: PERFORMANCE PERIOD OF TREATMENTS

Treatment	Performance Period			
Thin (1-1.5 in.) HMA Overlay	4	-	8	years
Cold Milling Overlay	6	-	10	years
CJ Reseal	4	-	8	years
CC Seal	4	-	8	years
Diamond Grinding	8	-	15	years
Partial Depth Repair	5	-	15	years
Full Depth Concrete Pavement Repair	10	-	15	years
Dowel Bar Retrofit	5	-	15	years

Information is from PRHTA's Pavement Preservation Management Program (Appendix E)

2.5.5 Potential Treatments

The identified potential treatments being considered for planning purposes[3] are shown in Table 2-17. They are shown for both asphalt and concrete pavements. Color code for the treatment application criteria matrix (see Figure 2-40) is also shown.

TABLE 2-17: POTENTIAL TREATMENTS

Matrix Color Code	Asphalt	Concrete
No Immediate Action	No Immediate Action	No Immediate Action
Preservation	2-in Cold Milling & Overlay	Joint Sealing & Slab Repair
Minor Rehabilitation	5-in Cold Milling & Overlay	Joint & Crack Sealing, Partial Depth Patching, New Dowels, Grinding
Major Rehabilitation	8-in Full Depth + 10% Base Replacement	Rubblization & Overlay
Reconstruction	Full Depth + Base + 10% Sub-base Replacement	6-in Base Replacement, Slab Replacement

[3] Note that the maintenance is responsibility of the Public Works Directory, which is locally funded. The treatments included in the TAMP were defined based on the ones that the PRHTA typically performs. As this is for planning purposes, treatments were defined to be on the safe side for cost estimation purposes.

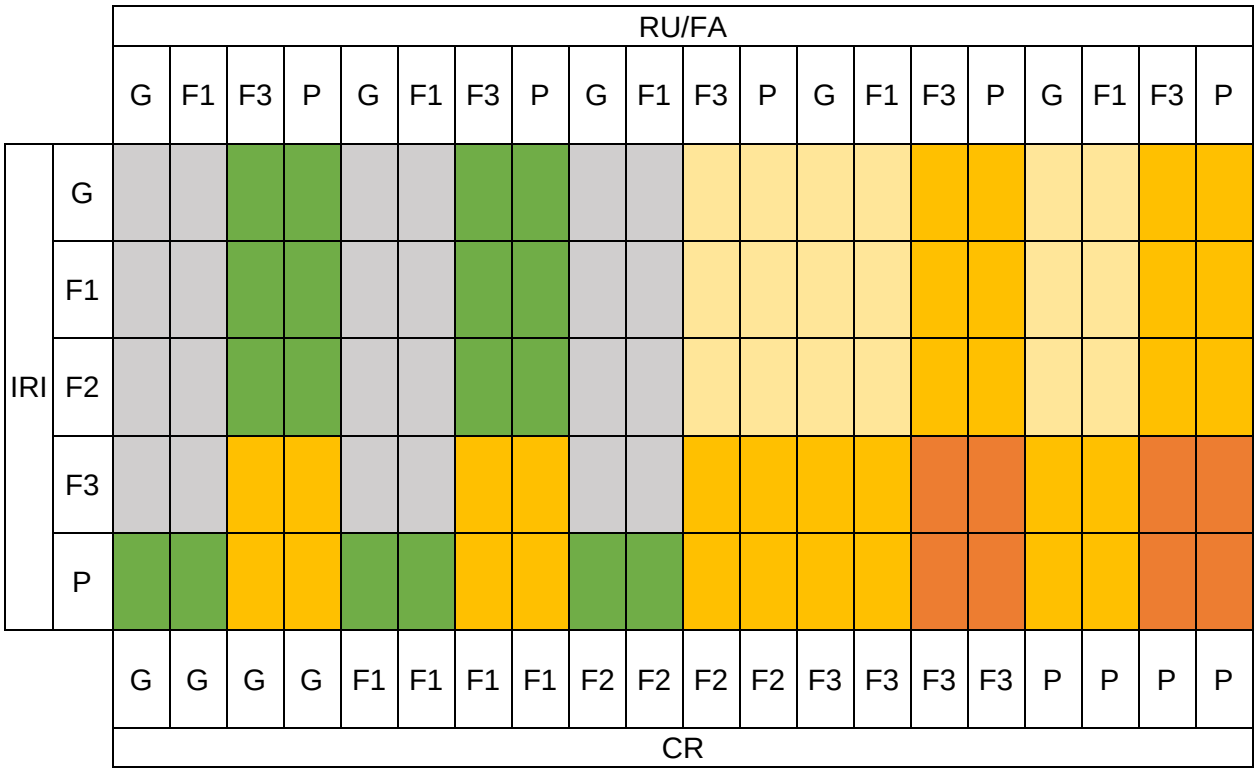


FIGURE 2-40: PAVEMENT TREATMENT MATRIX

Based on the pavement treatment criteria matrix shown in Figure 2-40, the number of lane miles per treatment was estimated and extrapolated. The summary is presented in Figure 2-41. For the entire network shown in the HPMS, the lane miles per treatment, surface type, and system are shown in Table 2-18.

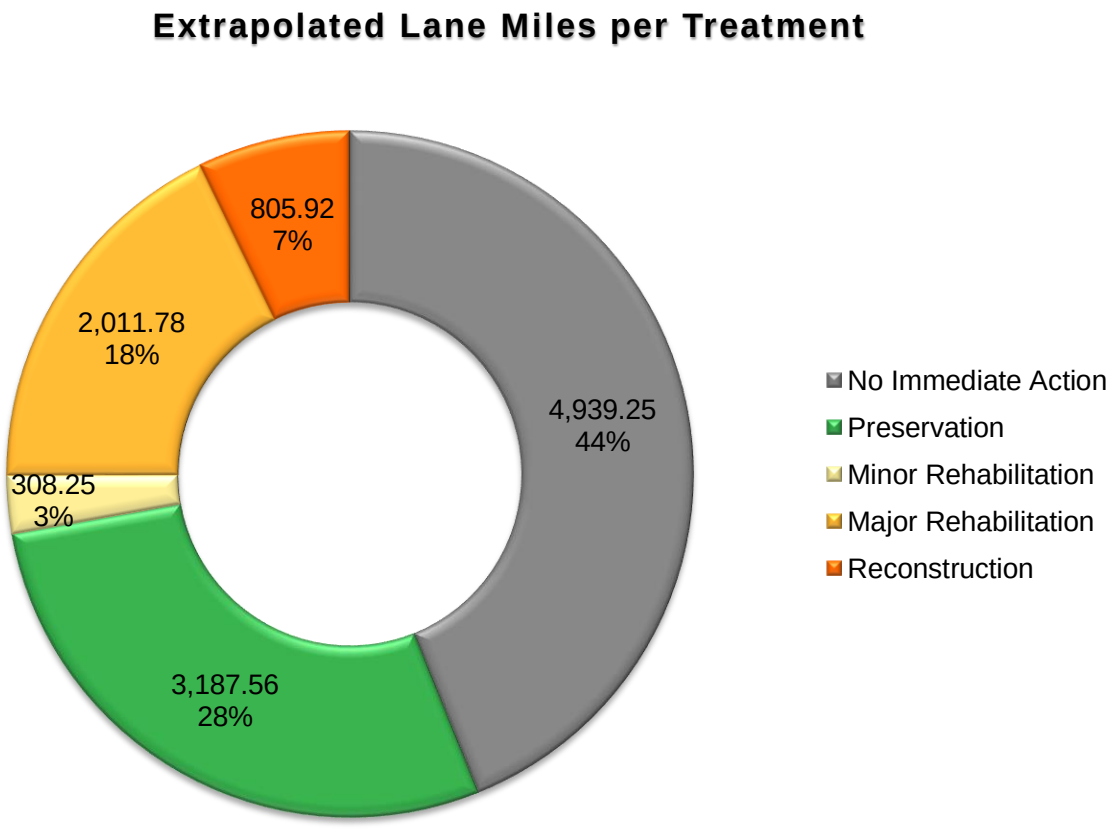


FIGURE 2-41: LANE MILES PER TREATMENT

TABLE 2-18: LANE MILES PER TREATMENT, SYSTEM, AND PAVEMENT TYPE

		INT		NHS		Other	
Treatment	Total Lane Miles	Asphalt	Concrete	Asphalt	Concrete	Asphalt	Concrete
No Immediate Action	4,939.25	512.75	117.19	480.75	6.70	3,785.28	36.60
Preservation	3,187.56	143.69	48.61	636.27	14.97	2,325.86	18.15
Minor Rehabilitation	308.25	14.58	21.21	9.52	1.91	247.47	13.55
Major Rehabilitation	2,011.78	123.09	107.71	396.22	37.77	1,317.70	29.29
Reconstruction	805.92	15.10	184.37	94.39	62.04	361.78	88.24
Total	**11,252.76**	**809.22**	**479.09**	**1,617.15**	**123.39**	**8,038.08**	**185.82**
	11,252.76	**1,288.31**		**1,740.54**		**8,223.91**	

2.5.6 Available Processes

The PRHTA has a documented Pavement Preservation Plan (PPP). The objective of this Plan is to "establish a solid preventive maintenance program that will, over time, improve pavement conditions ultimately providing substantial long-term cost savings and improved pavement conditions, leading to greater user satisfaction".

The PPP describes the following:

1. Pavement surface types
2. Distress types
3. Treatments
4. Treatment selection criteria
5. New treatments and technologies
6. Reporting (evaluation and documentation)
7. Training
8. Implementation

The PPP is included in Appendix E.

2.6 Bridge Condition Assessment

2.6.1 Data Collection

PRHTA performs bridge inspections regularly. The bridge inspection is scheduled, so all bridges are inspected every 12 or 24 months, depending on the bridge. An example of a bridge inspection report is presented in Appendix G.

2.6.2 Measures and Criteria

The National Bridge Inventory system rates bridges in 9 categories. A bridge rated 0 has completed failed while a new, perfect bridge is rated as a 9. Three primary components comprise the rating of most bridges, such as the stringers, tee beams, box beams, slabs and others that are common in Puerto Rico. These three are the deck, superstructure, and the substructure, which are all rated on a 0-9 scale (defined in Table 2-19).

TABLE 2-19: STRUCTURES RATING

Score	Condition Definition	Criteria
9	Excellent	Excellent condition
8	Very good	No problems noted.
7	Good	Some minor problems noted.
6	Satisfactory	Structural elements show some minor deterioration.
5	Fair	All primary structural elements are sound but may have minor section loss, cracking, spalling or scour.
4	Poor	Advanced section loss noted. Deterioration. Spelling or scour.
3	Serious	Loss of section, deterioration, spalling or scour has seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	Critical	Advanced deterioration or primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge
1	Imminent Failure	Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge Is closed to traffic but corrective action may put back in light service.
0	Failed	Out of service - beyond corrective action

The overall bridge condition is determined by the lowest rating of deck, superstructure, substructure, or culvert, as shown in Table 2-20. Note that, for detailed analysis, PRHTA further segregated the Fair bridges into Fair to Poor and Fair to Good.

TABLE 2-20: OVERALL CLASSIFICATION CRITERIA

Classification	Score Criteria	
Poor	Less or equal to	4
Fair to Poor	Equal to	5
Fair to Good	Equal to	6
Good	Greater or equal to	7

2.6.3 Condition

The bridge inventory and conditions are shown in Appendix C. A summary of bridges' condition is shown in Figure 2-42. It shows 8.98 percent by deck area is in Poor condition, while 21.09 percent is in Good condition. From the NHS, 8.61 percent is in Poor condition, while 18.47 percent is in Good condition. From the Non-NHS, 9.96 percent is in Poor condition, while 28.04 percent is in Good condition. Bridge conditions are mapped in Figure 2-43.

Percent per structural elements' condition is shown in Figure 2-44. The smallest proportion good is on decks, the largest proportion good is on superstructures.

System	Condition	Amount	Area (Sq. Mts.)	% Area	Target
NHS	Good	179	292,631.57	18.47%	10%
	Fair to Good	284	539,981.47	34.08%	40%
	Fair to Poor	316	615,351.00	38.84%	40%
	Poor	70	136,363.51	8.61%	10%
	Total	**849**	**1,584,327.55**	**100.00%**	**100%**
Non-NHS	Good	265	167,234.81	28.04%	10%
	Fair to Good	476	187,781.06	31.49%	40%
	Fair to Poor	532	181,921.40	30.51%	40%
	Poor	203	59,425.57	9.96%	10%
	Total	**1,476**	**596,362.84**	**100.00%**	**100%**
Total	Good	444	459,866.38	21.09%	10%
	Fair to Good	760	727,762.53	33.37%	40%
	Fair to Poor	848	797,272.40	36.56%	40%
	Poor	273	195,789.08	8.98%	10%
	Total	**2,325**	**2,180,690.39**	**100.00%**	**100%**

Note: Based on 2018 NBI data.

FIGURE 2-42: OVERALL BRIDGE CONDITION SUMMARY

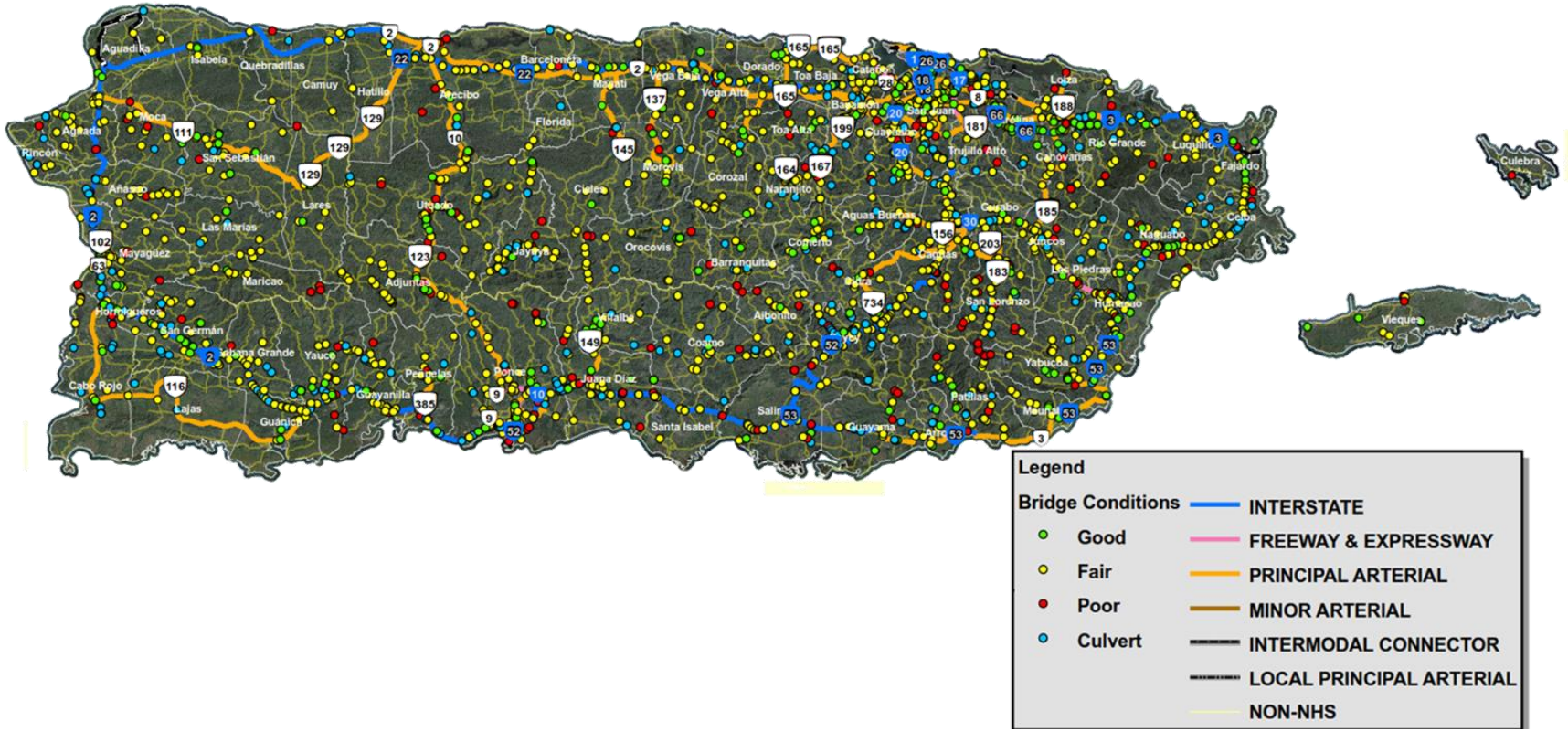


FIGURE 2-43: BRIDGE CONDITION MAP

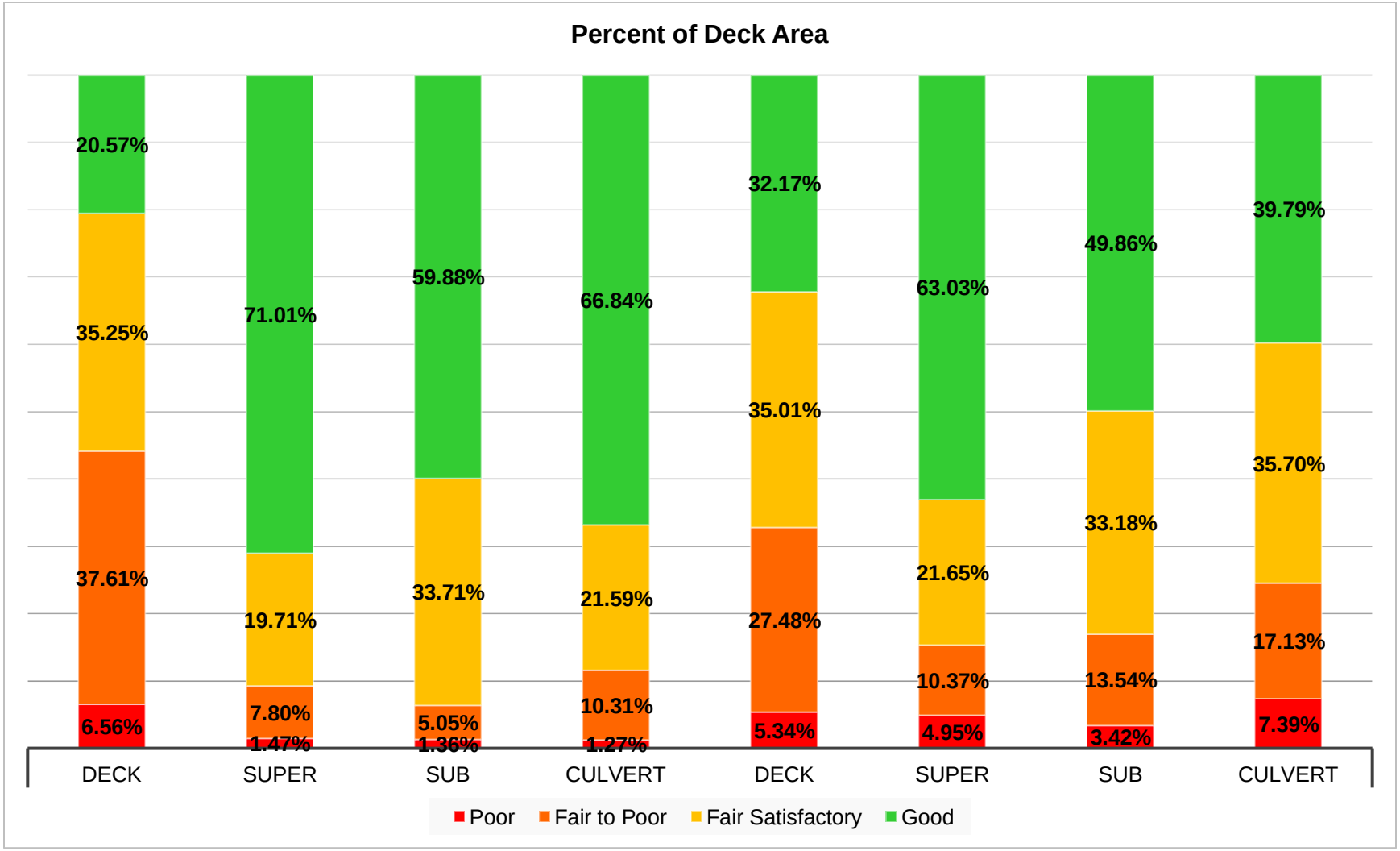


FIGURE 2-44: CONDITION PER STRUCTURAL ELEMENT

2.6.4 Deterioration

An analysis was made to estimate bridge deck deterioration. The following procedure was used:

1. The analysis scope included every 5th year from 1992 to 2017, inclusive. Data used was the one published by FHWA.
2. An Excel file was prepared, including a different worksheet) for each year's data. The data included the following fields: bridge number of ID, NHS marker, deck rate, superstructure rate, substructure rate, culvert rate, structure length, deck width, approach width. The data in each worksheet was ordered by bridge number.
3. An additional field with the area calculation was included. The area was calculated using the length and width data (deck width or approach width if deck width had zero value). Another field was added to include an overall rate for each bridge, calculated as the minimum of all element's ratings. A year's example is shown in Table 2-21.

TABLE 2-21: 1992 DATA EXAMPLE

STRUCTURE NUMBER	AREA (SQ MTS)	DECK RATE	SUPER STRUCTURE RATE	SUB STRUCTURE RATE	CULVERT RATE	OVERALL RATE	STRUCTURE LENGTH (MTS)	DECK WIDTH (MTS)	APPROACH WIDTH (MTS)
11	2169.35	4	3	3		3	100.9	21.5	15.8
31	132.06	5	5	5		5	21.3	6.2	7.9
41	977.67	4	4	4		4	120.7	8.1	7
51	118.77	5	5	5		5	10.7	11.1	3.4
61	140.91				5	5	18.3	7.7	6.7
81	336.54				5	5	15.8	21.3	19.8
121	206.08				6	6	12.8	16.1	11.3

4. Additional worksheets were prepared including all bridges' ID, NHS marker, deck area, and ratings for each of the years. One worksheet was prepared for each structural element (deck, superstructure, substructure, culvert) and for an overall rating. See example Table 2-22.

TABLE 2-22: BRIDGE DETERIORATION MASTER WORKSHEET EXAMPLE

STRUCTURE NUMBER	HIGHWAY SYSTEM	DECK AREA	OVERALL RATE					
			1992	1997	2002	2007	2012	2017
11	0	2169.35	3	4	4			
31	0	132.06	5	5	5	6	6	
41	0	977.67	4	4	4	4	4	4
51	0	118.77	5	6	5	5	5	5
61	0	140.91	5	6	5	7	6	6
81	1	336.54	5	6	6	6	6	6
121	0	206.08	6	6	5	5	5	5

5. The change in rate per pair of years was calculated, for those consecutive years that had the later year with a rate equal or less than the previous year. Then, an average of the calculated rates of change per 5 years was obtained per bridge. An additional field was included to weight the average by the deck area. See example in Table 2-23.

TABLE 2-23: CHANGE IN RATE TABLE EXAMPLE

STRUCTURE NUMBER	HIGHWAY SYSTEM	1997-1992	2002-1997	2007-2002	2012-2007	2017-2012	Average Change in 5 Years	Average x Area
11	1		0				0.00	0.00
31	0	0	0		0		0.00	0.00
41	0	0	0	0	0	0	0.00	0.00
51	0		-1	0	0	0	-0.25	-29.69
61	0		-1		-1	0	-0.67	-93.94
81	0		0	0	0	0	0.00	0.00
121	0	0	-1	0	0	0	-0.20	-41.22

6. Average rates of change per year were calculated for NHS and for Non-NHS by averaging the corresponding 5-year averages and dividing them by 5. Results are shown in Table 2-24.

TABLE 2-24: AVERAGE RATES OF CHANGE

Average Rate Change per Year (Weighted by Deck Area)	Deck	Superstructure	Substructure	Culvert	Overall
NHS	-0.0574	-0.0276	-0.0358	-0.0303	-0.0525
Non-NHS	-0.0789	-0.0633	-0.0648	-0.0596	-0.0742
Note: Results are based on NBI data from 1992, 1997, 2002, 2007, 2012, and 2017.					

7. The proportion of deteriorating area was also calculated. Results are shown in Table 2-25.

TABLE 2-25: PROPORTION DETERIORATING

System	Data Area	Deteriorating Area	% Deteriorating
NHS	1,230,657.92	506,157.78	41.13%
Non-NHS	482,059.34	286,447.07	59.42%
Overall	**1,712,717.26**	**792,604.85**	**46.28%**

8. Resulting estimated deterioration graphs are shown in Figure 2-45.

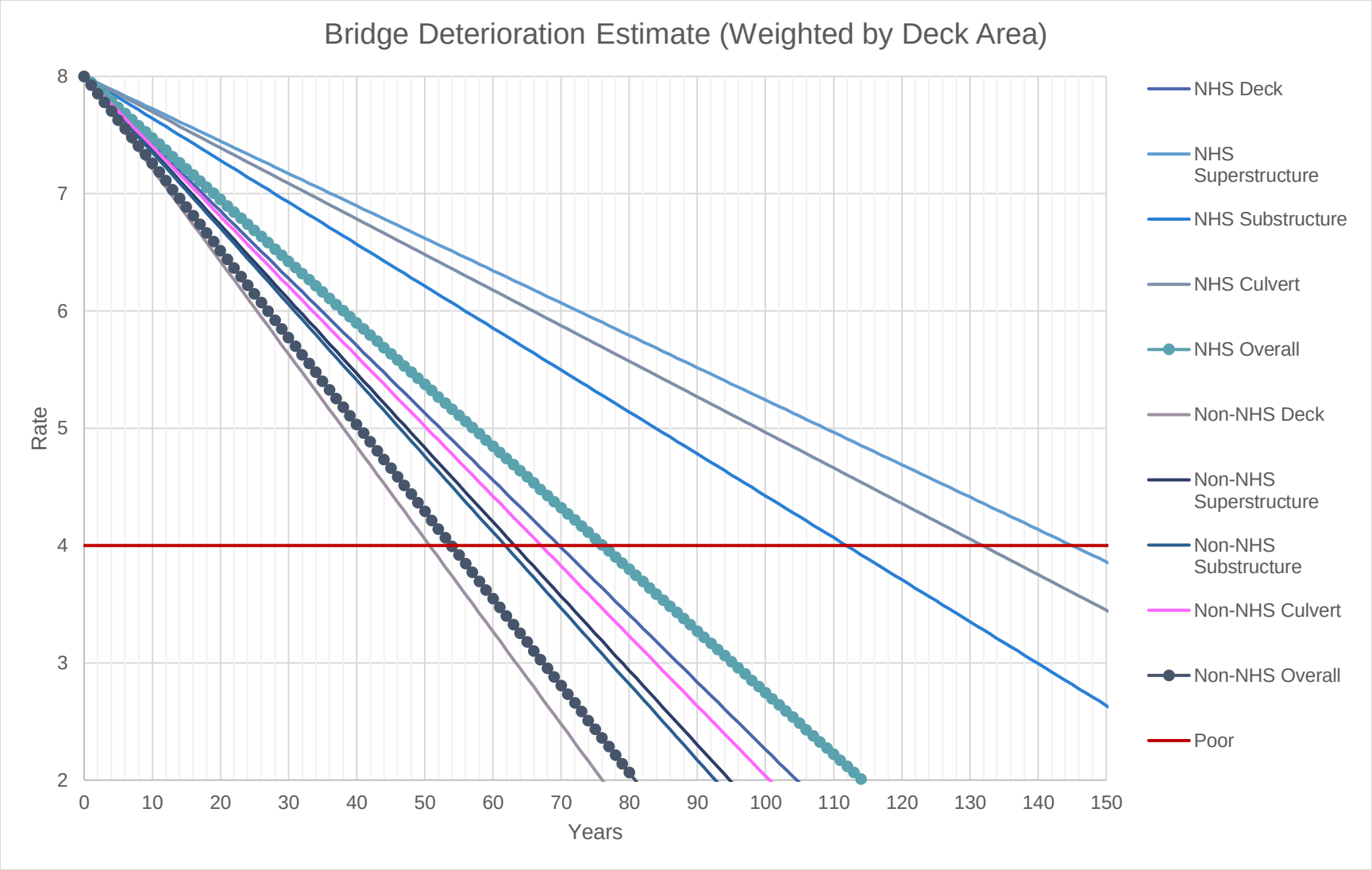


FIGURE 2-45: ESTIMATED DETERIORATION CHART

2.6.5 Potential Treatments

The identified potential treatment criteria to be considered for planning purposes are disclosed in Table 2-26.

TABLE 2-26: BRIDGE TREATMENT CRITERIA

Treatment	Rate			
	Deck	Superstructure	Substructure	Culvert
Replace	<=4 or Sup<=4 or Sub<=4	<=4 or Sub<=4	<=4	<=4
Major Rehabilitation	5	5	5	5
Minor Rehabilitation	6	6	6	6
Preservation	7	7	7	7
No Immediate Action	>7	>7	>7	>7

For presentation purposes, the treatment combinations among structure elements were summarized as indicated in Table 2-27.

TABLE 2-27: TREATMENT COMBINATION SUMMARY DEFINITION FOR BRIDGES AND CULVERTS

Treatment Group	Culverts	Bridges
No Immediate Action	No Immediate Action is Required. Periodical Inspections to Address Need for Preventive Maintenance is Recommended.	
Preservation	An Action is Required. Culvert Requires Preservation.	An Action is Required. Substructure and Superstructure Require Preservation or No Action, and Deck Requires Minor Rehabilitation, Preservation, or No Action.
Minor Rehabilitation	Culvert Requires Minor Rehabilitation.	Substructure or Superstructure Requires Minor Rehabilitation and the Other Requires Minor Rehabilitation, Preservation, or No Action. Deck may require Replacement, Rehabilitation, or No Action.
Major Rehabilitation	Culvert Requires Major Rehabilitation.	Substructure Requires Major Rehabilitation, or Superstructure Requires Replacement or Major Rehabilitation. Deck may require Replacement, Rehabilitation, or No Action.
Replacement	Culvert Requires Replacement.	Substructure or All Elements Require Replacement.

Based on the bridge treatment criteria shown in Table 2-26 and the treatment group defined in Table 2-27; Figure 2-46 shows the proportion by deck area per treatment group.

Treatment Group	Deck Area (Sq. Mts.)		Amount	
	NHS	Non-NHS	NHS	Non-NHS
No Immediate Action	41,839.3	13,970.3	20	41
Preservation	533,256.8	218,387.9	272	303
Minor Rehabilitation	773,621.8	218,952.1	403	536
Major Rehabilitation	214,114.8	123,316.3	139	482
Replacement	21,494.8	21,736.3	15	114
Subtotal	**1,584,327.6**	**596,362.8**	849	1,476
Total	**2,180,690.4**		**2,325**	

FIGURE 2-46: TREATMENT GROUP PROPORTION

2.6.6 Available Processes

The PRHTA has a Bridge Systematic Preventive Maintenance (SPM) Program. Its protocol is included in Appendix I.

The PRHTA also has a Standard Operation Procedure for Bridge Project Prioritization. It is included in Appendix J.

2.7 Assessment for Recurring Damages

The 23 CFR Part 515 *Asset Management Plans*, subpart 515.7, indicates that a process for developing a risk management plan shall be established and shall include the "identification of risks that can affect condition of National Highway System (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 repeated damaged by emergency events carried out under part 667 of this title".

Declared emergencies in Puerto Rico are shown in Table 2-28.

TABLE 2-28: DECLARED EMERGENCIES

ID	Disaster	FEMA Code	From	To	Declaration
1	Tidal Waves	N/A	04-Mar-18	07-Mar-18	
2	Hurricane María	DR-4339	17-Sep-17	15-Nov-17	20-Sep-18
		EM-3391	17-Sep-17	15-Nov-17	18-Sep-18
3	Hurricane Irma	DR-4336	05-Sep-17	07-Sep-17	10-Sep-17
		EM-3384	05-Sep-17	07-Sep-17	05-Sep-17
4	Heavy Rains	N/A	Nov-16		
5	Heavy Rains	N/A	05-Nov-14	08-Nov-14	
6	Heavy Rains	N/A	22-Aug-14	24-Aug-14	
7	Heavy Rains	N/A	10-May-14		
8	Heavy Rains	N/A	08-May-13	13-May-13	
9	Heavy Rains	N/A	26-Mar-12	28-Mar-12	
10	Tropical Storm María	DR-4040	08-Sep-11	14-Sep-11	18-Oct-11
11	Hurricane Irene	DR-4017	21-Aug-11	24-Aug-11	27-Aug-11
		EM-3326	21-Aug-11	24-Aug-11	22-Aug-18
12	Severe Storms, Flooding, Mudslides, and Landslides	DR-4004	20-May-11	08-Jun-11	14-Jul-11
13	Severe Storms, Flooding, Mudslides, and Landslides Associated with Tropical Storm Otto	DR-1946	04-Oct-10	08-Oct-10	26-Oct-10
14	Severe Storms and Flooding	DR-1919	26-May-10	31-May-10	24-Jun-10
15	Rain and Flooding	N/A	16-Jul-10	26-Jul-10	
16	Explosions and Fire	EM-3306	23-Oct-09	26-Oct-09	24-Oct-09
17	Severe Storms and Flooding	DR-1798	21-Sep-08	03-Oct-08	01-Oct-08
18	Severe Storms, Flooding, Landslides, and Mudslides	DR-1613	09-Oct-05	15-Oct-05	10-Nov-05
19	Tropical Storm Jeanne and Resulting Landslides and Mudslides	DR-1552	14-Sep-04	19-Sep-04	17-Sep-04
20	Severe Storms, Flooding, Mudslides, and Landslides	DR-1501	10-Nov-03	23-Nov-03	21-Nov-03
21	Severe Storms and Flooding	DR-1396	07-Nov-01	09-Nov-01	28-Nov-01
22	Flooding	DR-1372	06-May-01	11-May-01	16-May-01
23	Hurricane Lenny	EM-3151	17-Nov-99	20-Nov-99	17-Nov-99
24	Hurricane Georges	DR-1247	20-Sep-98	27-Oct-98	24-Sep-98
		EM-3130	20-Sep-98	20-Sep-98	21-Sep-98

The best available data was obtained from FHWA PR & USVI Division Office and from PRHTA's Project Control Office.

The events for which FHWA had some data are also indicated in Table 2-28. However, the following event files didn't have site-specific information:

1. Heavy Rain- May 8-13, 2013
2. Heavy Rain- Nov. 5-18, 2014
3. Heavy Rain- July 19-23, 2010
4. Marejadas- March 4-7, 2018

Also, the following Hurricane María files didn't have enough information for an analysis:

1. PR-759 KM 4.2, Maunabo
2. PR-901 KM 11.8, Yabucoa
3. PR-916 KM 2.0, San Lorenzo
4. PR-922 KM 2.3, Humacao
5. PR-9957 KM 2.1, Río Grande
6. PR-15, KM 6.0, Guayama
7. PR-52, KM 94.4, Ponce
8. PR-128 KM 9.0, Yauco
9. PR-128 KM 10.8, Yauco
10. PR-128 KM 15.2, Yauco
11. PR-128 KM 17.3, Yauco
12. PR-135 KM 5.8, Adjuntas
13. PR-501 KM 4.65, KM 5.6, KM 5.75, Ponce
14. PR-131 KM 0.6, Adjuntas
15. PR-106, KM 6.3, Mayagüez
16. PR-106, KM 12.9, Mayagüez
17. PR-119, KM 21.7 y KM 22.0, San Sebastián
18. PR-124 KM 1.5, Las Marías
19. PR-124 KM 10.1, Las Marías
20. PR-476 KM 0.55, Isabela
21. PR-2 KM 50.9, Manatí
22. PR-836 KM 0.1, Guaynabo

At the time of developing this TAMP, the PRHTA office only has readily available information related to hurricanes Irma and María.

Available information was tabulated and is included in Appendix K.

As per available information:

1. A total of 1,758 damages were reported. Most of them occurred in year 2017 (see Table 2-29).

TABLE 2-29: REPORTED DAMAGES PER YEAR

Year	Count	Percent
2008	90	5.1%
2010	98	5.6%
2011	103	5.9%
2012	4	0.2%
2013	24	1.4%
2014	62	3.5%
2017	1377	78.3%

2. Most damages were due to hurricanes (see Table 2-30).

TABLE 2-30: DAMAGES PER EVENT TYPE

Main Event Type	Count	Percent
Hurricane	1478	84.1%
Storm	118	6.7%
Heavy Rains	162	9.2%

3. A total of 260 roads had more than one damage recorded (see Table 2-31). PR-111 was the one with most damages (63), followed by PR-3 (40), PR-143 (31), PR-10 (28), and PR-181 (28).

TABLE 2-31: DAMAGES PER ROAD

Road Name or Number	Count
1	16
2	18
3	40
10	28
14	11
15	25
26	2
30	4
31	6
52	11
53	4
64	2

Road Name or Number	Count
103	2
105	21
108	2
109	17
110	4
111	63
112	2
114	2
115	3
119	25
120	7
121	4

Road Name or Number	Count
123	24
124	6
125	2
127	2
128	14
131	10
132	6
135	8
139	9
140	20
141	18
143	31

Road Name or Number	Count
144	20
149	13
150	3
151	12
152	2
155	19
156	6
157	17
162	3
167	3
172	9
173	12

Road Name or Number	Count
174	6
175	5
177	2
179	12
181	28
182	22
183	8
184	18
185	13
186	12
191	23
198	3
250	2
332	4
344	2
345	3
346	3
348	2
352	8
353	3
354	3
356	3
364	4
366	3
368	2
372	14
374	9
377	2
378	4
379	2
386	3
387	2
391	2
398	3
404	6
405	9
406	4
408	2
411	14

Road Name or Number	Count
415	4
417	4
419	3
420	9
425	4
426	4
427	2
430	3
431	4
432	5
433	2
436	3
438	5
444	2
445	2
458	2
470	2
476	2
488	3
495	2
501	5
504	4
505	3
511	7
512	10
513	2
516	5
518	5
521	6
524	11
525	6
526	2
527	8
528	7
529	3
531	6
539	3
547	3
548	6

Road Name or Number	Count
551	2
553	3
555	3
556	4
564	12
566	6
567	7
568	3
576	2
577	2
590	10
593	2
595	3
603	2
605	13
606	4
607	6
608	6
611	2
612	3
613	4
614	2
615	4
621	3
623	2
646	2
656	3
704	3
708	12
712	6
713	4
714	2
715	2
716	3
722	4
723	13
725	3
730	2
739	4

Road Name or Number	Count
742	6
748	3
749	7
752	3
757	5
759	12
763	8
765	6
770	7
771	5
772	5
779	4
781	2
782	3
784	7
791	3
793	2
794	2
796	4
798	4
800	3
802	2
803	8
809	2
811	3
812	3
815	3
816	7
825	2
829	3
830	6
831	2
833	2
834	7
835	2
836	4
837	2
851	2
853	7

Road Name or Number	Count
856	4
857	2
879	5
882	4
900	9
901	3
902	5
905	3
906	4
907	6
908	16
909	2
916	9
917	3
918	2

Road Name or Number	Count
919	3
920	4
927	2
928	2
931	2
936	3
939	2
941	2
947	2
948	5
950	3
951	5
953	4
957	2
969	2

Road Name or Number	Count
971	2
975	4
976	6
984	2
991	2
3365	6
3378	2
4109	5
4131	2
4417	2
4419	2
4435	3
4466	2
5141	5
5521	4

Road Name or Number	Count
5525	2
5556	2
7729	3
7740	2
7765	3
7773	2
7787	2
9918	2
9920	3
9933	3
9957	2

4. Most damages (91.7 percent) occurred on Non-NHS roads (see Table 2-32).

TABLE 2-32: ROAD SYSTEM

Road System	Count	Percent
Interstate	26	1.5%
NHS Non-Interstate	116	6.6%
Non-NHS	1612	91.7%
Unclear	4	0.2%

5. 91.1 percent of the events were on road segments (see Table 2-33),

TABLE 2-33: ASSET TYPE

Asset Type	Count	Percent
Road Segment	1508	91.1%
Bridge	117	7.1%
Culvert	9	0.5%
Retaining Wall	1	0.1%
Drainage Structure	21	1.3%

6. Most of the damages (58.4 percent) were landslides (see Table 2-34).

TABLE 2-34: DAMAGE TYPE

Damage Type	Count	Percent
Landslide over Asset	46	3.3%
Collapse of Asset	226	16.0%
Scour	172	12.2%
Flood	14	1.0%
Debris	31	2.2%
Landslide	824	58.4%
Other	98	6.9%

7. Most of the performed repairs (93.5 percent) were permanent (see Table 2-35).

TABLE 2-35: REPAIR NATURE

Repair Nature	Count	Percent
Emergency	32	6.5%
Permanent	464	93.5%

8. Most of the repairs (95.7 percent) were reconstructions (see Table 2-36).

TABLE 2-36: REPAIR TYPE

Repair Type	Count	Percent
Cleaning & Debris Removal	2	1.7%
Repair	3	2.6%
Reconstruct	110	95.7%

9. There were 18 sites that suffered damages in more than one event: three at NHS Non-Interstate ant the rest at Non-NHS. The sites, damage year and specific damage are shown in Table 2-37.

TABLE 2-37: REPEATED IMPACT SITES DETAILS

ID	Event Year	Road Name or Number	Road System	KM	Damage Type	Other Damage Description	Repair Nature	Repair Type
1	2008	3	Non-NHS	99.2		Construction of retaining walls, pavement repair and other misc. work		
	2017	3	Non-NHS	99.2	Scour	Road scour	Permanent	
2	2014	111	NHS Non-Interstate	13.1				
	2017	111	NHS Non-Interstate	13.1	Scour	Scouring at temporary Acrow bridge		
3	2014	123	Non-NHS	42	Landslide over Asset	Lanes partially closed due to landslide		
	2017	123	Non-NHS	42	Other	Restore drainage structures		
4	2014	132	Non-NHS	19.4	Landslide over Asset	The road is collapsing		
	2017	132	Non-NHS	19.4		Slip rap		
5	2014	140	Non-NHS	6	Landslide over Asset	Small Landslide		
	2017	140	Non-NHS	6	Landslide	Right lane slide-Landslide		
6	2011	144	Non-NHS	6.8	Collapse of Asset	Reconstruction of PR-144, km 6.8	Permanent	Reconstruct
	2017	144	Non-NHS	6.8	Collapse of Asset	One lane collapsed		
7	2010	157	Non-NHS	6.8		Landslide		
	2011	157	Non-NHS	6.8	Collapse of Asset	Reconstruction of PR-157, Km 6.8	Permanent	Reconstruct
8	2010	157	Non-NHS	14.8		Landslide		
	2011	157	Non-NHS	14.8	Collapse of Asset	Reconstruction of PR-157, Km 14.8	Permanent	Reconstruct
9	2008	172	Non-NHS	2.5		Roadway Emergency Opening		
	2010	172	Non-NHS	2.5	Landslide	Landslide stabilization and construction of concrete barrier with expanded metal fence	Permanent	
10	2008	181	Non-NHS	22.6		Construction of retaining walls, pavement repair and other misc. work		
	2011	181	Non-NHS	22.6	Collapse of Asset	Reconstruction of PR-181 KM 22.6	Permanent	Reconstruct
11	2008	182	Road System	7.9		Construction of retaining walls, pavement repair and other misc. work		
	2017	182	Non-NHS	7.9	Landslide	Landslide	Permanent	
12	2008	182	Road System	10.9		Roadway Repair and Drainage Repair		
	2017	182	Non-NHS	10.9	Scour	Road scour	Permanent	

ID	Event Year	Road Name or Number	Road System	KM	Damage Type	Other Damage Description	Repair Nature	Repair Type
13	2011	185	NHS Non-Interstate	17.6	Collapse of Asset	Reconstruction of PR-185 KM 17.6	Permanent	Reconstruct
	2017	185	NHS Non-Interstate	17.6	Landslide	Landslide	Permanent	
14	2010	185	NHS Non-Interstate	18.3		Roadway Section reconstruction and construction of gravity wall	Permanent	
	2011	185	NHS Non-Interstate	18.3	Collapse of Asset	Reconstruction of PR-185 KM 18.3	Permanent	Reconstruct
15	2010	759	Non-NHS	4.2	Landslide	Landslide correction and roadway section reconstruction	Permanent	
	2017	759	Non-NHS	4.2		No hay información en archivo	Permanent	
16	2011	853	Non-NHS	7.7	Collapse of Asset	Reconstruction of PR-853 Km 7.7	Permanent	Reconstruct
	2017	853	Non-NHS	7.7	Landslide	landslide	Permanent	
17	2011	908	Non-NHS	10.9	Collapse of Asset	Reconstruction of PR-908 Km 10.9	Permanent	Reconstruct
	2017	908	Non-NHS	10.9	Scour	Road scour	Permanent	Repair Type
18	2010	928	Non-NHS	3.6	Landslide	Landslide Stabilization	Emergency	
	2011	928	Non-NHS	3.6	Collapse of Asset	Reconstruction PR-928 Km 3.6, Florida Ward	Permanent	Reconstruct

Chapter 3 Gap Identification and Analysis

Federal regulations require PRHTA to analyze asset condition and performance gaps using a formal gap analysis process. PRHTA adopted a process in the 2018 asset management plan and used the process for this 2019 plan.

The PRHTA gap analysis process fulfills the FHWA requirements described in the box at right. The process identifies three types of gaps. First, are the gaps between the current bridge and pavement conditions and the 2-year and 4-year targets PRHTA adopted. Second, are gaps to the long-term state of good repair. FHWA allows each agency to define a state of good repair. PRHTA adopted the following statement to define its state of good repair.

Gap Requirements

The asset management rule in Sec. 515.7 (a) says, "A State DOT shall establish a process for conducting performance gap analysis to identify deficiencies hindering progress toward improving or preserving the NHS and achieving and sustaining the desired state of good repair. The asset management rule describes a performance gap as:

Performance gap means the gaps between the current asset condition and State DOT targets for asset condition, and the gaps in system performance effectiveness that are best addressed by improving the physical assets.

FHWA's guidance to its divisions that will be certifying TAMPs tells them to look for the following required elements.

The TAMP must describe a methodology about 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).
- Identifying deficiencies hindering progress toward achieving and sustaining the desired state of good repair (as defined by the State DOT).
- Developing alternative strategies that will close or address the identified gaps.

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 deficiencies in the effectiveness of the NHS in providing safe and efficient movement of people and goods. (23 CFR 515.7(a)(2))
- Identify strategies to close or address the identified gaps. (23 CFR 515.7(a)(3))

The PRHTA state of good repair for pavements is to have within 25 years no more than 5 percent of the Interstate pavements in Poor condition and no more than 20 percent of the non-Interstate NHS pavements in Poor condition.

The third type of gap are gaps in bridge and pavement conditions that contribute to congestion, safety, or freight-movement problems. For example, if rutted pavements contribute to crashes, or weight-limited bridges restrict freight movement, those are performance gaps.

The gap analysis process influenced and will continue to influence PRHTA's decisions about allocating funds to highway programs and selecting projects for the STIP. PRHTA balances the need for short-term projects to address current bridge and pavement deficiencies while also investing to keep good pavements and bridges in good condition with timely preservation.

3.1 Gap Analysis Process

PRHTA adopted in the 2018 TAMP a simple but effective annual process for conducting the performance gap analysis. This process was used for the 2019 TAMP and includes the following steps.

1. Prior to the update of the 2019-2023 STIP and the development of the 2019 TAMP, PRHTA pavement and bridge staff reviewed the pavement and bridge conditions based upon the most recent and best available condition data.
2. The current condition of NHS bridges and pavements was compared against the targets and the current gaps, if any, were noted.
3. Because the sophisticated pavement and bridge models were not available, to estimate future gaps the staff forecasted future conditions using their best available data and analysis tools. They based the future analysis upon known investment levels and deterioration curves.
4. The future NHS bridge and pavement condition gaps were noted and analyzed to determine what types and amounts of treatments were needed to close current and future gaps.
5. The PRHTA bridge and pavement staff recommended to PRHTA leadership the addition of projects for the "out years" of the STIP that will address continued progress toward achieving the bridge and pavement targets. General project scopes were also recommended to address the gaps as appropriate.
6. In the future, if additional funding is available, PRHTA's planning and programming staff will recommend an update to future STIPs to include the additional projects that will help PRHTA to continue progressing toward, or sustaining, the targeted condition levels.
7. Once the STIP was approved, PRHTA staff updated their bridge and pavement programs to reflect the projects scheduled for the life of the STIP.

   The cycle will continue annually to allow the continual review of the bridge and pavement condition and performance gaps and to influence the selection of projects included in the STIP.

3.2 Current Pavement Gaps

The analysis show that a gap exists between the current Interstate Highway System pavement conditions and the condition target that no more than 5 percent of the Interstate

pavement be in Poor condition. (Table 3-1) Presently, about 13.2 percent of the *measured* Interstate pavements are Poor when calculated by lane miles. Another 3.5 percent of the Interstate lane miles, or 45.3 lane miles, were not measured because of equipment malfunction, or the sections were under construction, or for other reasons. Officially, pavement sections with missing condition data are considered by FHWA to be Poor. If the Interstate lane miles with missing Interstate data are considered Poor, the total amount of Poor Interstate lane miles is 16.7 percent, which is the Poor percentage used later in the Investment Strategies section.

Like all States, PRHTA was required to also set a target for Good Interstate pavement. PRHTA set a target of having no less than 2 percent of the Interstate pavements in Good condition. Based on the 2017 data, 10 percent of the Puerto Rico Interstates are in Good condition, meaning there is no gap in that measure.

PRHTA's targets for non-Interstate NHS pavement are that no more than 20 percent will be Poor and no less than 2 percent will be Good. Based on the 2017 data, 9.0 percent of the *measured* non-Interstate NHS miles are Poor, and 2.2 percent are in Good condition. Based on the *measured* lane miles there are no current non-Interstate NHS pavement condition gaps. However, 21.3 percent of the pavement condition data for the non-Interstate NHS are missing. Therefore, the official percentage of the NHS in Poor condition is 30.3 percent resulting in an official gap of 10.3 percent, which is the Poor percentage used later in the Investment Strategies section.

For bridges, PRHTA adopted a target that no more than 10 percent of the NHS bridges by deck area will be in Poor condition. Based on the 2017 data, 8.61 percent of the NHS bridges by area are Poor, meaning there is no gap. The target for Good NHS bridges is no less than 10 percent. Based on the 2017 data, 20.5 percent of the bridges are in Good condition, meaning there is no gap for the NHS bridges by the Good condition measure.

TABLE 3-1: CONDITION TARGETS AND GAPS.

Measure	Target		2017 condition	Gap
Interstate pavements in Good condition	No less than	2%	10.8%	None
Measured Interstate pavements in Poor condition	No more than	5%	13.3%	8.3%
Interstate sections with missing data			3.5%	
% Interstate Poor if missing data included as Poor			16.8%	11.8%
Non-Interstate NHS pavements in Good condition	No less than	2%	2.2%	None
Measured Non-Interstate NHS pavements in Poor Condition	No more than	20%	9.0%	None
Missing non-Interstate NHS data			21.3%	
% Non-Interstate NHS Poor if missing data included as Poor			30.3%	10.30%
NHS target for % of Good bridges	No less than	10%	20.5%	None
NHS target for % of Poor bridges	No more than	10%	8.60%	None

3.2.1 Detailed Analysis of Interstate Pavement Gaps

PRHTA conducted a detailed gap analysis of the pavement conditions by pavement section and by pavement distresses. By understanding the nature and location of pavement distresses that generate the Poor lane miles, PRHTA's limited funds were applied most effectively.

PRHTA manages 1,034 lane miles of Interstate Highway System pavement. Metropistas manages another 254 lane miles for a total of 1,288 lane miles of Interstates in Puerto Rico. The target of no more than 5 percent Poor equates to 64 lane miles out of the total Puerto Rico Interstate Highway network that can be Poor and still achieve the target. Presently, about 170 of the measured Interstate lane miles are Poor, all on the PRHTA managed Interstates. If the 3.5 percent of the Interstate pavement lane miles with missing data are considered to be poor, 215.47 lane miles of Interstates are Poor.

To understand and address the size of the gaps and the investment needed to close them, a detailed analysis of the 2016 pavement condition data was conducted in 2018 and a detailed analysis of the 2017 data was conducted in 2019. (Table 3-2) Both year's pavement data were reviewed in detail to analyze how many miles were Good, Fair, and Poor by Federal standards. Also, the analysis estimated how much of the Fair could become Poor in the 10 years of the asset management plan. Also, lane miles were analyzed to estimate how many could benefit from lower cost preservation treatments. The analysis was intended to answer the question of, "What options does PRHTA have to close the pavement gap?"

As noted in Chapter 2, FHWA rules require pavements to be evaluated by three criteria. For both asphalt and concrete pavements, they are measured by roughness, or IRI, and

the percentage of cracking. Asphalt pavements are also measured for rutting, while concrete pavements are measured for faulting.

To be considered in Poor condition, a pavement must be Poor in two categories. Depending on the type of distress, this could allow some treatments to be applied to a pavement to reduce one of the two distresses that caused the pavement to be rated Poor. By eliminating one of the two distresses, the pavement would no longer be rated Poor. The analysis looked in detail at every Interstate Highway lane mile for which data were collected. The intent was to identify feasible lower-cost options PRHTA could consider achieving the Interstate pavement-condition target.

Table 3-2 shows that PR-2 and PR-52 have by far the greatest amount of Poor pavement. Sixty-five percent of all the Interstate lane miles rated Poor are on those two routes. IRI is the most significant distress with 53 percent of all the Poor Interstate IRI occurring on those two routes. Fifty-four percent of all cracking serious enough to be rated Poor is on those two routes, as well.

TABLE 3-2: PAVEMENT DISTRESSES BY INTERSTATE HIGHWAY.

Interstate				Lane Miles													
Inter-state	Rd.	Length (mi)	Lane Miles	IRI			Rutting			Faulting			Cracking			Overall	
				P	F	G	P	F	G	P	F	G	P	F	G	P	F	G
PRI-1	PR-18	3.65	36.51	22.7	12.8	1.0	0.0	7.1	5.6	2.0	14.0	7.8	10.5	17.0	9.00	8.70	27.81	0.00
	PR-52	66.38	315.73	130.8	127.2	57.8	1.3	69.9	99.2	21.0	95.8	28.4	73.3	92.1	150.27	72.70	201.63	41.39
PRI-2	PR-2	87.48	360.59	103.5	184.5	72.6	19.4	126.7	180.9	0.4	22.6	10.6	52.6	132.4	175.65	37.02	280.46	43.11
	PR-22	47.30	234.32	32.1	110.7	91.5	0.0	94.5	34.3	0.5	25.8	79.2	9.3	66.6	158.45	2.94	200.61	30.77
PRI-3	PR-3	14.42	60.72	28.3	28.8	3.6	0.4	17.4	18.1	12.5	12.0	0.4	15.5	16.1	29.17	16.70	41.18	2.84
	PR-26	7.98	54.73	19.5	31.3	3.9	2.5	33.8	18.4	0.0	0.0	0.0	0.0	11.1	43.66	2.54	49.09	3.10
	PR-53	35.11	135.37	96.7	25.4	13.3	0.4	4.6	1.2	1.0	51.8	76.3	29.1	41.0	65.32	29.17	94.97	11.23
	PR-66	11.26	45.04	7.2	25.8	12.0	0.0	18.2	26.8	0.0	0.0	0.0	1.2	14.4	29.40	0.40	38.24	6.40
Total		**274**	**1,243**	**440.83**	**546.51**	**255.66**	**24.10**	**372.13**	**384.53**	**37.51**	**221.97**	**202.76**	**191.49**	**390.61**	**660.91**	**170.17**	**933.99**	**138.85**
				1,243			**1,243**						**1,243**			**1,243**		

Figure 3-1 shows the amount of Interstate lane miles by distress which clearly shows that IRI is the most common distress. Of the 1,243 measured lane miles, 35 percent are poor for IRI. (Note: 1,243 NHS lane miles were measured out of 1,288 lane miles.) When one other distress becomes severe enough to be rated Poor, the entire section becomes Poor. Thirteen percent are Poor because of cracking.

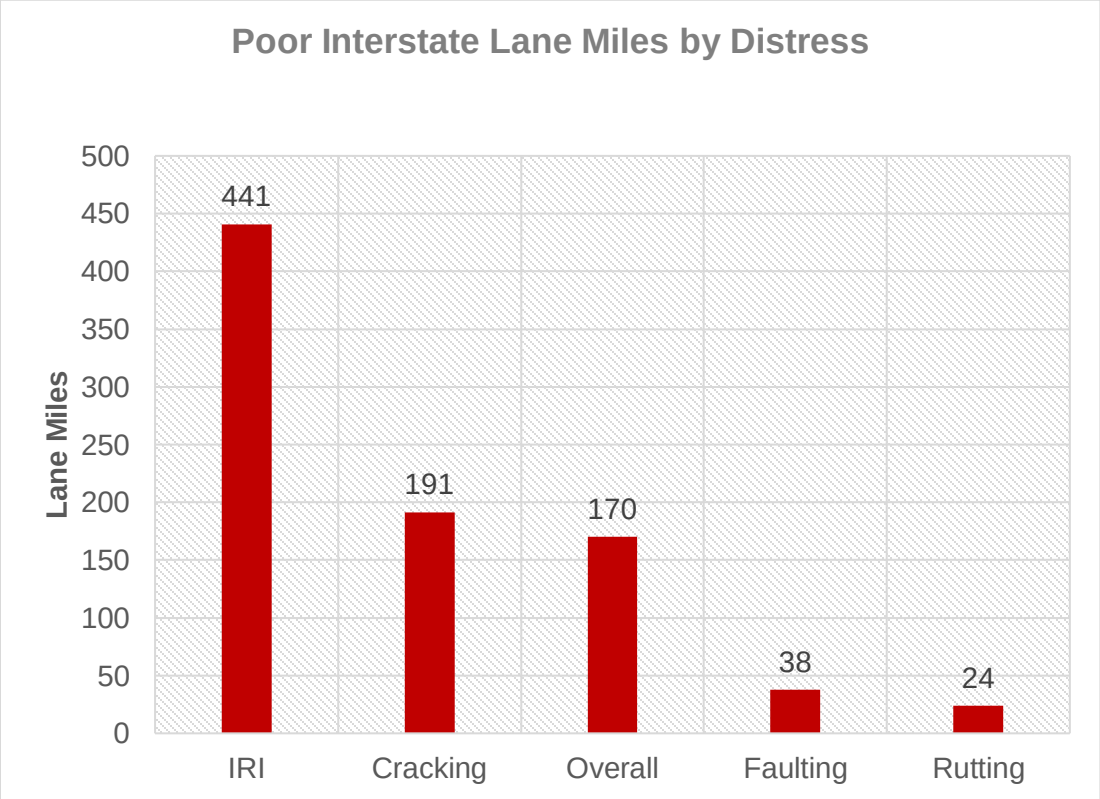


FIGURE 3-1: LANE MILES OF POOR INTERSTATE PAVEMENTS BY DISTRESS TYPE

Figure 3-2 shows the number of lane miles in Fair condition for each distress. Any worsening in cracking, rutting, or faulting among the Fair pavements could cause the amount of lane miles with two Poor distresses to increase, and the section will be considered Poor under the Federal definition.

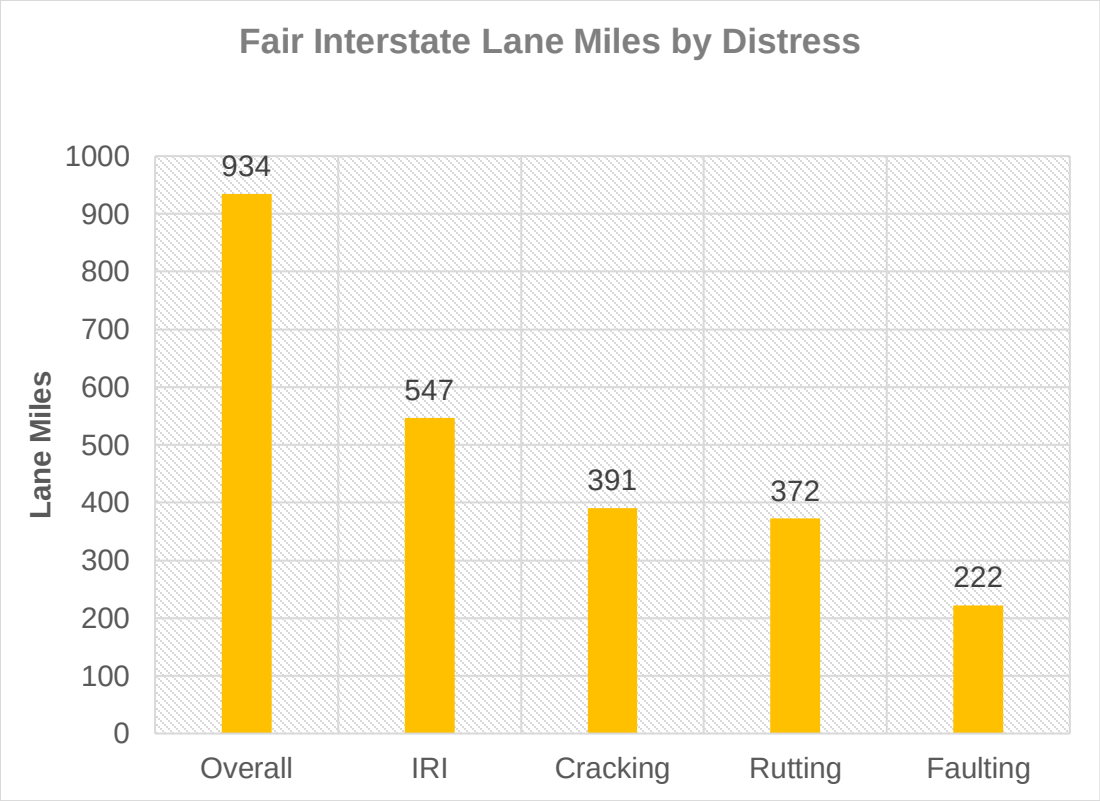


FIGURE 3-2: LANE MILES OF FAIR INTERSTATE PAVEMENTS BY DISTRESS TYPE.

3.2.2 Lane Miles Critical to Achieving the Interstate Target

Deteriorated sections of concrete are particularly important to treat if PRHTA wants to achieve the target of no more than 5 percent of Interstate pavements to be in Poor condition.

Here is the logic:

1. There are 1,288 lane miles of Interstate in Puerto Rico.
2. If the target is no more than 5 percent Poor, then only 64 lane miles can be Poor.
3. Presently about 170 lane miles of Interstate are in Poor condition.
4. To reach 5 percent, then 106 lane miles of Poor pavement must be improved.
5. Of the 170 lane miles that are Poor, 30 lane miles are asphalt and 140 are concrete. Therefore, 82 percent of the Poor Interstate pavement is concrete.
6. Those 140 concrete lane miles equal 10.9 percent of all the Interstate lane miles that PRHTA manages.
7. If all the Poor asphalt were improved, the Puerto Rico Interstates would still be at 10.9 percent Poor because of the Poor concrete sections.
8. Severely cracked and faulted concrete does not perform well after being resurfaced therefore a more extensive treatment is needed. These include “crack and seat,” in which the concrete is pulverized, compressed and resurfaced, or the

pavement segment is replaced. Those treatments are expensive at an estimated cost of $600,000 to $1 million per lane mile compared to $195,000 per lane mile for thin asphalt treatments.

9. Until PRHTA addresses those deteriorated concrete sections, it cannot achieve the target of no more than 5 percent Poor.

In 5.3 and Chapter 7 the cost to address the Interstate pavements are discussed and scenarios presented.

3.2.3 Response to the Pavement Gap Analysis

The pavement gaps identified in the 2018 initial asset management plan had a near-immediate effect upon PRHTA's programming process. PRHTA quickly developed using State funds a program called *Abriendo Caminos*, or Open Roads, to address the most seriously deteriorated routes. PRHTA focused first upon NHS routes with its Phase 1 of the program. It delivered $48.5 million in 2018 and 2019 projects to immediately repair 429 lane miles (691 lane kilometers) of NHS pavements with serious pavement deficiencies. For example, Table 3-2 shows that the Interstate highway PR-52 had the most deterioration of any Interstate route with 73 lane miles in Poor condition. *Abriendo Caminos* targeted PR-52 and treated 44 lane miles (70-kilometer lanes) for $8.9 million. Treatments focused upon the most damaged sections. One half-mile section had an average IRI of 277, an average of 10 percent faulted concrete sections, and an average of 41 percent cracking. Sections of deteriorated asphalt pavement were milled off and replaced while damaged concrete slabs were replaced. Although not all lanes were treated in a section, the treatments eliminated the most immediate distresses and better prepared the pavement for more extensive treatments in future years. STIP projects also plan for 2.5 miles of pavement reconstruction on PR-52 and 6.8 miles of minor rehabilitation. *Abriendo Caminos* also treated 101 lane miles (161 lane kilometers) of Interstate PR-2 for $8 million. In all, 66 different NHS sections, ramps, or access roads were repaired under *Abriendo Caminos*.

For 2020, the program shifts to the Non-NHS routes. An estimated $69 million is expected to be allocated in State funds for the *Abriendo Caminos* program on the Non-NHS routes.

3.2.4 Further Detailed Analysis of Each Pavement Section

The pavements were further analyzed to identify the most economical means to bring them to a state of good repair. Further analysis was required because many pavements are rated Fair by the FHWA rating criteria. One pavement could be "almost Good" and another "almost Poor" and both would be rated Fair by the FHWA method. A pavement that is "almost Good" can be treated economically with a thin overlay or other light treatment. While a pavement that is "almost Poor" requires heavier, more expensive treatment. As explained in Table 2-4, the Fair pavements were broken down into three subcategories of Fair 1, Fair 2, and Fair 3. Fair 1 is "Fair-Good." Fair 2 is "Fair-Fair." And Fair 3 is "Fair-Poor" Fair 1 pavements could be properly treated with thin overlays or light

treatments while Fair 3s require heavier treatments and are on the verge of becoming Poor.

All concrete and asphalt Interstate Highway sections were analyzed using a three-dimensional matrix as seen in Figure 3-3. Each matrix has three axis each representing one of the three pavement distresses. In Figure 3-3 IRI is on the vertical left axis, cracking is on the bottom axis and faulting or rutting are on the top horizontal axis. Within each cell are colors indicating the treatment based upon the condition. Five cells were numbered to aid in explaining the treatment logic. Pavements that have the conditions shown in Cell 1 would be recommended for no treatment at this time. By following the three axes, it is shown that Cell 1 is Good for Rutting, Good for IRI, and Good for cracking, hence "No Action" is recommended. Cell 2 is recommended for Preservation because it is F3, or Fair/Poor for Rutting, but is Good for IRI and Cracking. Pavements with the distresses shown in Cell 3 are recommended for Major Rehabilitation. They are F3 or Fair/Poor and Fair/Fair for Cracking and Good for IRI. Pavements with distress such as in Cell 4 are recommended for Reconstruction. They are F3 or Fair/Poor for Rutting, IRI, and Cracking. Pavements with the distress shown in Cell 5 also would be recommended for Reconstruction. They are Poor for Rutting, IRI, and Cracking. Figure 3-4 shows treatment types.

		Rutting or Faulting																			
		G	F1	F3	P	G	F1	F3	P	G	F1	F3	P	G	F1	F3	P	G	F1	F3	P
IRI	G	1		2								3									
	F1																				
	F2																				
	F3															4					
	P																				5
		G	G	G	G	F1	F1	F1	F1	F2	F2	F2	F2	F3	F3	F3	F3	P	P	P	P
		Cracking																			

FIGURE 3-3: THE 3-DIMENSIONAL PAVEMENT ANALYSIS TREATMENT LOGIC

No Treatment
Preservation
Minor Rehabilitation
Major Rehabilitation
Reconstruction

FIGURE 3-4: PAVEMENT TREATMENT COLOR CODES

Table 3-3 illustrates how the three-dimensional analysis was applied to four sections of PR-2. Beginning and end points are shown as are the number of lanes resulting in the lane miles. The IRI values are shown which range for these four sections from 146 to 354 inches per mile. Those values range from F3 which is Fair-Poor to Poor. Rutting varies between one-tenth of an inch to two-tenths of an inch which are either Fair/Good or Good. Cracking percentages vary from 5 percent to 25 percent. Those create values of Fair/Good, Fair/Poor, and Poor. These conditions on these four asphalt pavements

generate recommended treatments. Three are recommended for Major Rehabilitation and one for Preservation. Projects are seldom scoped for only four sections but if one were scoped it probably would be to treat all four sections uniformly with Major Rehabilitation. It is unlikely to be economical to vary the scope to apply a tenth-of-a-mile of preservation between sections receiving heavier treatments.

TABLE 3-3: EXAMPLE OF HOW EACH SECTION WAS ANALYZED

ROAD	System	Start Mile	End Mile	Avg. IRI (in/mi)	IRI Condition	Avg. RUT (in)	RUT Condition	Cracking Percent	Crack Condition Asphalt	Lanes	Lane Miles	Pavement Type	Treatment
2	NHS	0.00	0.10	420	P	0.2	F1	0	G	4	0.40	Asphalt	Preservation
2	NHS	0.10	0.19	0	G	0.3	F3	5	F1	4	0.36	Asphalt	Preservation
2	NHS	0.19	0.29	483	P	0.3	F3	5	F1	4	0.40	Asphalt	Major Rehabilitation
2	NHS	0.29	0.37	0	G	0.3	F3	0	G	4	0.32	Asphalt	Preservation
2	NHS	0.37	0.47	325	P	0.1	G	5	F1	4	0.40	Asphalt	Preservation

Table 3-3 illustrates the type of detailed analysis applied to all sections of the NHS. The analysis enabled the detailed type of gap analysis shown in Table 3-2 which, in turn, will support the Investment Strategy recommendations shown in Chapter 7.

The analysis was broken down to such detail to allow assessment of several things. First, which sections are “on the bubble” and likely to move in a few years from Fair to Poor. Also, which sections may benefit from preservation because they are in relatively Good condition and their deterioration could be slowed with light treatments. Also, which sections have moderate distresses and warrant a heavier treatment. Also, which sections are severely distressed and probably need a heavy rehabilitation or replacement.

3.2.5 Other Pavements Off the NHS

Pavements off the NHS are included in the TAMP only for informational purposes. PRHTA does not include them as assets to be reviewed under 23 CFR 515.19 (l). They are shown here to illustrate the significant investment required to maintain them in a state of good repair. PRHTA must balance the need to maintain the NHS with the need to maintain its important Non-NHS routes. There are 8,112 lane miles of Non-NHS routes. Pavement data were collected on 927 lane miles or 11.4 percent. Table 3-4 shows the conditions of the 927 lane miles that were measured. It also extrapolates the percentages of Good, Fair, and Poor pavement assuming the conditions of the measured pavements are proportional to the entire Non-NHS network.

TABLE 3-4: CONDITIONS ON THE NON-NHS ROUTES

Non-NHS Measured Conditions		Measured Lane Miles by Condition	Lane Miles if Extrapolated to Entire System
Good	2.2%	20.12	178
Fair-Good	27.8%	257.36	2,283
Fair-Fair	48.2%	446.99	3,965
Fair-Poor	14.0%	129.74	1,151
Poor	7.9%	72.83	646

As can be seen on Table 3-4, only 2.2 percent of the pavements are good, almost 8 percent are poor leaving nearly 90 percent in the Fair condition. Further analysis of the Non-NHS route data indicated that the Average IRI is 281, the average cracking is 10.5 percent, and the average rutting is .16 inches. (Any sections that appeared to have invalid data, such as values of 999, were omitted from the calculations.) The IRI values are more than 100 higher than the Poor value of 171 inches per mile. The average cracking and rutting values put the average Non-NHS route in the Fair/Poor category for those distresses.

A target of no more than 20 percent Poor is adopted for the Non-NHS routes, resulting in no current gaps. However, in the next section, future gaps are shown. The condition of the Non-NHS is reported to illustrate the relatively poor condition of these routes, which require substantial PRHTA investment.

3.3 Future Pavement Gaps

An analysis was conducted to forecast future pavement gaps on the Interstates, non-Interstate NHS, and Non-NHS routes. Numerous scenarios were analyzed each with different assumptions about funding levels and deterioration rates. The preferred[4] investment scenario is shown in Chapter 7, the Investment Strategy. To summarize how the preferred investment scenario affects future gaps Table 3-5 is included. It shows the annual gaps between the targets and the forecasted conditions. As can be seen, the percent Poor Interstate target is to face a gap through 2027 with the target being reached in 2028. For the percent Good Interstate pavement, there is no gap throughout the period. For NHS Non-Interstate pavements, there are gaps in the percent Poor in 2019, and from 2022-2024. In other years, the target is met or bettered.

The largest gaps occur on the Non-NHS. The percentage Poor on those routes is expected to grow to 39 percent by 2029. That gap reflects the lack of investment for the Non-NHS that hopefully can be addressed in subsequent asset management plans, as additional funding becomes available.

TABLE 3-5: FORECASTED PAVEMENT CONDITIONS AND GAPS

	Interstate Pavement Forecasted Conditions and Gaps										
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
% Good Forecast	29.8%	30.2%	27.3%	25.3%	23.3%	23.2%	23.1%	22.6%	22.1%	21.8%	21.9%
Target for Good	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Gap	None	None	None	None	None	None	None	None	None	None	None
% Poor Forecast	12.8%	12.8%	13.7%	14.1%	13.9%	10.8%	7.9%	6.4%	5.3%	5.0%	5.0%
Target for Poor	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Gap	7.8%	7.8%	8.7%	9.1%	8.9%	5.8%	2.9%	1.4%	0.3%	0.0%	0.0%
	NHS Non-Interstate Pavemenent Forecasted Conditions and Gaps										
% Good Forecast	21.1%	23.9%	24.1%	22.8%	21.7%	21.6%	21.5%	22.3%	21.7%	21.2%	20.7%
Target for Good	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Gap	None	None	None	None	None	None	None	None	None	None	None
% Poor Forecast	22%	19%	19%	21%	22%	21%	20%	20%	20%	20%	20%
Target for Poor	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Gap	2%	None	None	1%	2%	1%	0%	0%	0%	0%	0%
Non-NHS Pavement Forecasted Conditions and Gaps											
% Poor Forecast	12.0%	14.0%	17.0%	20.3%	23.6%	26.5%	29.4%	32.1%	34.4%	36.7%	39.0%
Target for Poor	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Gap	None	None	None	0.3%	3.6%	6.5%	9.4%	12.1%	14.4%	16.7%	19.0%

[4] Baseline funding levels are explained in Chapters 6 and 7. Table 6-2 shows the amounts as per PRHTA Fiscal Plan and projections. Table 6-3 shows the total allocation per asset type and year. Refer to Section 6.1 for details regarding the relation of the Fiscal Plan and the Financial Oversight and Management Board.

3.4 Important Caveats to the Gap Analysis Scenarios

All future gap forecasts depend upon several key conditions (e.g. inflation rates, industry capacity, etc.). If future conditions change, then the size of the future gaps will change.

The treatment definition and corresponding unit costs used for the analyses are shown in Table 3-6. These unit costs are a result of the analysis of costs of recent projects developed by PRHTA for similar categories. They are as per current USD. More information about these unit costs is provided in Appendix L.

TABLE 3-6: ADOPTED UNIT COSTS AND TREATMENTS

Asphalt & Other	Description	Base Unit Cost		
		Interstate	NHS (Non-Interstate)	Non-NHS
Preservation	2-in Cold Milling & Overlay	$195,709.30	$161,124.20	$133,082.03
Minor Rehabilitation	5-in Cold Milling & Overlay	$409,018.20	$379,067.60	$312,161.18
Major Rehabilitation	Full Depth (8-in) Cold Milling & Overlay	$632,680.55	$444,195.55	$365,690.23
Reconstruction	Full Depth (8-in) + 6-in Base Replacement	$646,689.85	$464,712.01	$382,539.57
Concrete	**Description**	**Base Unit Cost**		
		Interstate	**NHS (Non-Interstate)**	**Non-NHS**
Preservation	Joint Sealing & Slab Repair	$428,274.95	$398,294.45	$333,992.20
Rehabilitation	Joint & Crack Sealing, Partial Depth Patching, New Dowels, Grinding	$578,872.05	$548,891.55	$454,921.60
Rubblization & Overlay	Rubblization & Overlay	$620,429.60	$585,833.00	$482,079.43
Reconstruction	6-in Base Replacement, Slab Replacement	$1,033,576.30	$1,003,595.80	$825,341.20

The life of the treatments is estimated based on history and a PRHTA pavement preservation treatment manual. If the lives of the treatments differ, so will the gaps. Furthermore, the analysis of future gaps is based on a steady future investment[5] of $130 million annually[6] for pavements from 2024 and beyond. If funding changes, so will the size of the gaps.

3.5 Gaps to System Performance Effectiveness

PRHTA has determined that poor pavement conditions can contribute to highway crashes and thereby limit the performance effectiveness of the National Highway System. The PRHTA links its asset management program and its safety program to improve the system performance effectiveness. PRHTA includes thin preservation treatments on

[5] Currently programmed pavement investments for 2019 to 2023 are shown in Table 1-1.
[6] This value comes from the most recent Fiscal Plan approved by the Oversight Board at the time of the analysis.

roadway sections that have been identified for improvement by the Highway Safety Improvement Program (HSIP). These thin treatments allow for visible highway pavement markings to be restored on the sections as part of a larger project to also improve signage, guardrail, and other safety barriers. The combination of safety treatments and pavement preservation also is economical as it reduces the costs for project development, mobilization, and inspection.

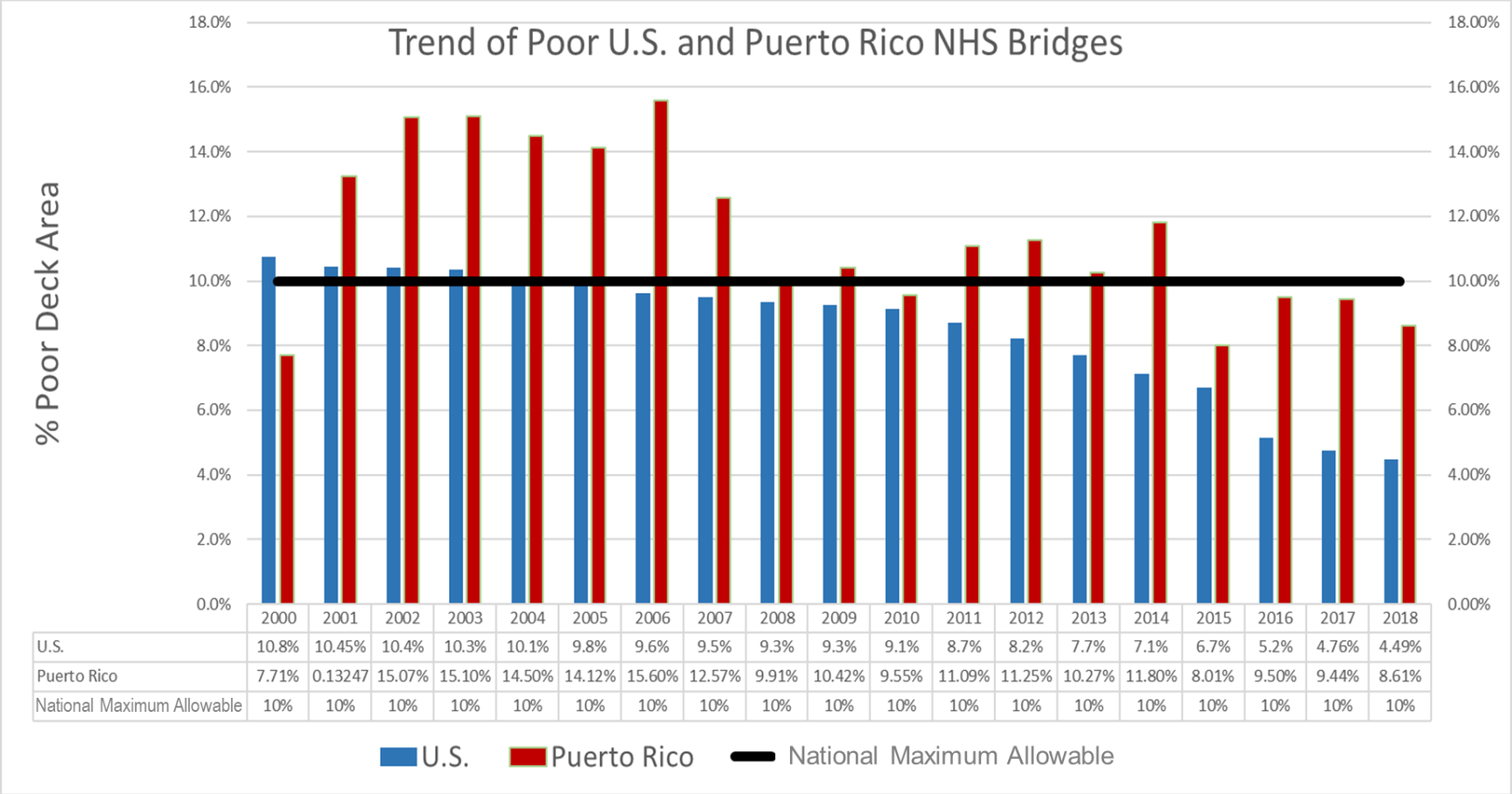
3.6 Current Bridge Gaps

PRHTA bridges remain better than the targeted levels but the long-term trend of deteriorating conditions remains a concern for the agency.

As seen in Figure 3-5, the percentage of Poor NHS bridges steadily declined since the early 2000s. For 2018, the percentage of Poor NHS bridges was 8.61 percent which is better than the PRHTA target of no more than 10 percent Poor. The allowable national threshold of Poor bridge area for a State also is no more than 10 percent. PRHTA's target for NHS bridges in Good condition is no less than 10 percent while the percentage Good is 20.5 percent.

Currently, PRHTA achieves its NHS bridge-condition target. However, the overall condition of the bridge inventory is declining by some important measures. A review of bridge condition trends from 2008 to 2018 indicates that a substantial number of Puerto Rico bridges have declined into condition state 5 which is in the lower end of the Fair category. The implication of this shift is that if it continues, Puerto Rico will experience in the next decade a substantial increase in the number of Poor bridges that could be well in excess of the minimum Federal condition level allowed for the National Highway System.

The analysis began with a categorization of PRHTA bridges by their age, condition, and type as seen in Table 3-7. The most typical bridge is the "stringer or girder" which in Puerto Rico comprises just about 80 percent of the bridge deck area and 1190 of the approximately 2314 bridges listed in the NBI for Puerto Rico. What is noticeable about the Stringers and Girders is both their dominance of the size of the inventory as well as their age. The average age is 39 years, meaning they are nearly into their fourth decade. At that age, they are well past half of their expected useful life and are likely in need of repair or rehabilitation unless they have been well maintained. Maintenance funds have been lacking in Puerto Rico and many bridges have not undergone routine maintenance.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
U.S.	10.8%	10.45%	10.4%	10.3%	10.1%	9.8%	9.6%	9.5%	9.3%	9.3%	9.1%	8.7%	8.2%	7.7%	7.1%	6.7%	5.2%	4.76%	4.49%
Puerto Rico	7.71%	0.13247	15.07%	15.10%	14.50%	14.12%	15.60%	12.57%	9.91%	10.42%	9.55%	11.09%	11.25%	10.27%	11.80%	8.01%	9.50%	9.44%	8.61%
National Maximum Allowable	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%

FIGURE 3-5: PERCENT OF POOR BRIDGES NATIONALLY AND IN PUERTO RICO

TABLE 3-7: BRIDGE BY TYPE, COUNT, AREA, AND CONDITION

Type	Avg. Deck	Avg. Super	Avg. Sub	Year Built Avg.	Count	Area Sum	% of Area
Stringer Girder	5.8	6.6	6.4	1980	1190	1,730,301	79.92%
Tee Beam	5.4	5.7	5.7	1963	202	113,040	5.22%
Slab	5.5	5.6	5.5	1957	403	90,269	4.17%
Box Beam	6.6	6.9	6.8	1990	81	71,060	3.28%
Culvert				1976	330	53,597	2.48%
Girder Floorbeam	5.2	5.5	5.9	1953	42	43,802	2.02%
Segmental Box Girder	7.5	7.5	7.5	2002	2	19,182	0.89%
Stayed Girder	5.0	6.0	7.0	2010	1	14,343	0.66%
Frame	5.6	5.9	6.3	1967	27	13,340	0.62%
Arch Deck	5.1	5.1	5.5	1920	18	9,540	0.44%
Thru Truss	6.5	6.2	7.2	1987	9	3,266	0.15%
Arch Thru	7.0	7.5	7.5	2005	2	1,901	0.09%
Deck Truss	4.3	4.3	5.8	1962	4	902	0.04%
Orthotropic	0.0	0.0	7.0	2003	1	284	0.01%
Other	8.0	8.0	8.0	2014	1	149	0.01%
Lift	7.0	4.0	7.0	1979	1	146	0.01%
Grand Total	**5.7**	**6.3**	**6.1**	**1973**	**2314**	**2,165,121**	**100.0%**

Eleven years of NBI data from the FHWA website were downloaded and analyzed for the change in conditions. Although PRHTA has done a commendable job in addressing its Poor bridges, it has lacked the funds for preservation or rehabilitation. PRHTA is not a maintenance organization and the Department of Transportation and Public Works (DTPW) has not been able to conduct maintenance. Other than on the tolled roads, little maintenance is conducted. Maintenance does occur on the tolled roads, but those roads and bridges comprise a small part of the overall Puerto Rico highway network.

What the analysis of data from 2008 to 2018 revealed was a substantial increase in bridges in the "Fair/Poor" categories and a substantial decrease in the bridge area in the Good and "Fair/Good" categories. Bridges are rated 0-9 with 9 being a new bridge in excellent condition. Bridges 0-4 are Poor, 5s and 6s Fair, and bridges 7 and above are Good.

Figure 3-6 illustrates the change in conditions since 2008. Overall, the inventory expanded as did the amount of bridge area in the Fair/Poor category or condition state 5 shown in the light-yellow color. The percentage of Poor area has not changed significantly but the increase in Fair/Poor structures represents a growing liability. Based upon the rate of deterioration seen in the past decade, a high percentage of those bridges are expected to become Poor without substantial investment.

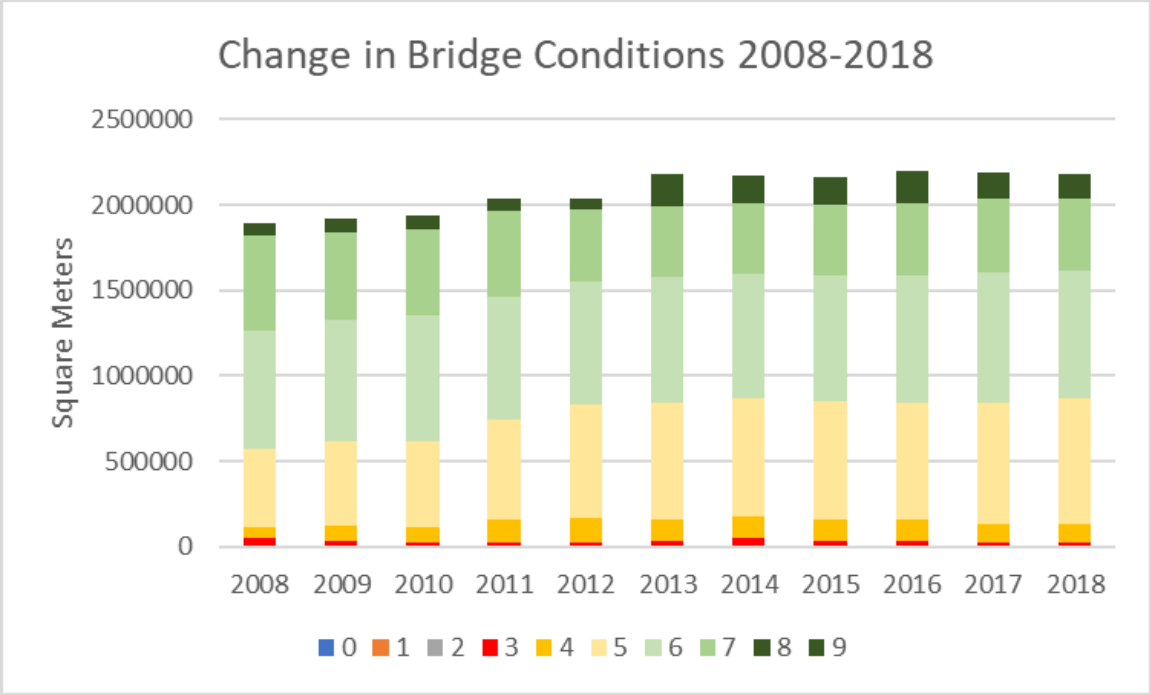
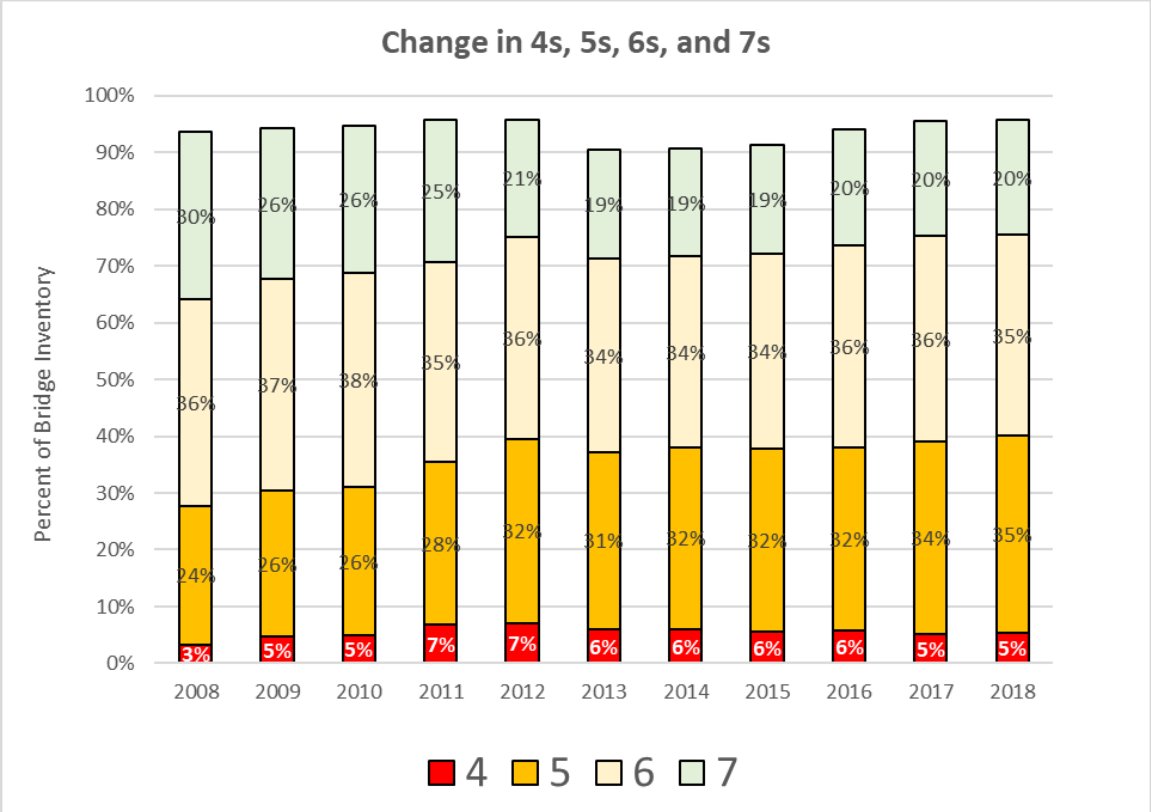


FIGURE 3-6: CHANGE IN BRIDGE CONDITIONS SINCE 2008



Percentages indicate the percent of the overall inventory in each condition state.

FIGURE 3-7: CHANGE IN POOR, FAIR, AND GOOD BRIDGES

Figure 3-7 indicates the percentage of the overall bridge inventory in condition state 5 increased from 24 percent of the inventory to 35 percent. In terms of bridge area, that is an increase from 461,403 square meters in condition state 5 in 2008 to 737,072 square meters in 2018. That is a 60 percent increase. Bridges in condition 7 declined 24 percent over those 11 years.

To be classified as Poor under the Federal definition, a bridge must be below 4 in any of the three component categories. Decks are by far the component most likely to be Poor. As seen in Table 3-8, the subtotal of Poor deck area is more than twice as large as the Poor area in the superstructure and substructure categories.

TABLE 3-8: NUMBER, AREA OF POOR BY BRIDGE COMPONENT

	Decks	Superstructures	Substructures
Number of Poor by Category	509	388	352
Area Poor by Category	131,730	50,638	40,314

Further analysis shows that 76 of the structures are Poor in only one component while the other two components are in category 6 or above. These are bridges that if the one Poor component were addressed, the bridge would increase to a 6, or Fair/Fair or better condition. Table 3-9 shows that 39 bridges have Poor decks, but the superstructure and substructure are rated 6 or above. Fourteen bridges have Poor superstructures, but their decks and substructures are in category 6 or better. There are 23 bridges with Poor substructures, but the decks and superstructures are rated 6 or above. Those 76 bridges have a total of 108,230 square meters of area that could be changed from Poor to Fair/Fair by only improving one of the three components.

TABLE 3-9: BRIDGES POOR IN ONLY ONE COMPONENT WITH THE OTHER TWO COMPONENTS IN CATEGORY 6 OR BETTER

	Decks	Superstructures	Substructures
Decks 4, Other 6 or Above	39	14	23
Area of Decks 4, Other 6 or Above	91,519	11,330	5,380

The Investment Strategy chapter focuses upon treatment strategies to address the Poor components while preserving the Fair components. Such a strategy will cost significantly less than bridge replacement and will result in better long-term conditions.

3.6.1 Response to the Bridge Gap Analysis

The 2018 initial TAMP warned of the future decline in bridge conditions. PRHTA launched a near-immediate response by initiating projects to preserve, rehabilitate, and replace bridges based on the structures' conditions. PRHTA also substantially increased the bridge program. In recent years, the bridge program was constrained by an informal agreement with the MPO that $17 million would be allocated annually for replacement of critical structures. The 2018 Capital Improvement Program increased the annual bridge allocation to $86 million.

PRHTA also substantially increased the programming of projects as seen in Table 3-10. Now, over $199 million in bridge projects are programmed for years 2019-2022. These projects include those on the STIP, Metropistas, and others that are not in the STIP. They would address almost 186,000 square meters of bridges. PRHTA also adopted a balanced "mix of fixes." More than $38.8 million is now programmed for bridge preservation, $31.6 million for minor rehabilitation, $91.6 million for major rehabilitation, and $37.1 million for bridge replacement. Many of the bridge preservation projects are "bundled." That means they are grouped geographically so that a contractor can work on several nearby bridges in one project. Bundling saves money on project development, maintenance of traffic, and mobilization.

TABLE 3-10: BRIDGE PROJECTS PROGRAMMED

Treatment	Area	Cost
Preservation	80,581.25	$38,839,109
Minor Rehabilitation	28,744.27	$31,636,565
Major Rehabilitation	72,286.33	$91,677,540
Replacement	4,815.32	$37,132,407
TOTAL	**186,427.17**	**$199,285,621**

3.7 Future Bridge Gaps

Chapter 7 includes the bridge investment strategy that balances available revenue, life cycle strategies, and asset conditions to achieve a state of good repair. To summarize the future conditions, Table 3-11 shows the forecasted conditions, based on projected future funding that indicate there will be no condition gaps except for Non-NHS bridge conditions between 2019-2026. After that, all gaps are forecast to be closed. The lack of gaps despite the increase in Fair bridges seen in the past decade reflects the increased funding and investment strategy that targets bridge preservation and rehabilitation described in later chapters.

TABLE 3-11: FORECASTED BRIDGE CONDITIONS AND GAPS

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
NHS Bridges										
% Good Forecast	**19.2%**	**18.8%**	**19.2%**	**19.9%**	**20.3%**	**20.8%**	**21.4%**	**21.9%**	**22.4%**	**23.1%**
Target for Good	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Gap	None	None	None	None	None	None	None	None	None	None
% Poor Forecast	**9.0%**	**9.7%**	**9.0%**	**8.5%**	**8.3%**	**8.5%**	**8.9%**	**9.3%**	**9.7%**	**9.4%**
Target for Poor	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Gap	None	None	None	None	None	None	None	None	None	None
Non-NHS Bridges										
% Good Forecast	**27.5%**	**26.5%**	**25.9%**	**25.1%**	**25.3%**	**26.0%**	**26.6%**	**27.2%**	**28.0%**	**28.3%**
Target for Good	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Gap	None	None	None	None	None	None	None	None	None	None
% Poor Forecast	**10.5%**	**11.2%**	**12.4%**	**13.2%**	**12.6%**	**11.9%**	**11.1%**	**10.4%**	**10.0%**	**9.9%**
Target for Poor	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Gap	0.5%	1.2%	2.4%	3.2%	2.6%	1.9%	1.1%	0.4%	None	None

3.7.1 Deterioration Models for Life Cycle Planning

Factored into the life cycle analysis and recommended investment strategy in Chapter 7 are the deterioration rates for PRHTA's bridges. Based upon an analysis of bridge conditions from 1992 to 2017, the average NHS bridge deck deteriorates from a condition state 8 to 4 in 52 years. However, substructures deteriorate more slowly, moving from condition state 8 to 4 in 83 years.

Of most importance to the PRHTA analysis is the accelerating rating of change for bridges in condition state 5, of which there is a disproportionate number. According to the rate of change from 1992 to 2017, an NHS bridge in Puerto Rico declines from condition state 5 to condition state 4 in 19 years. Based on that rate, within 19 years all the bridges rated 5 will be Poor if left untreated. Even more rapid is the rate of change of NHS bridge decks. The analysis indicates they move from a condition 5 to a condition 4 in 13 years. With a large number of bridges, and particularly bridge decks, in condition state 5, the life cycle analysis indicates a need for an expanded program to preserve and rehabilitate bridges in condition state 5 and 6, while also replacing those in condition state 4. Figure 3-8 shows the calculated deterioration rates.

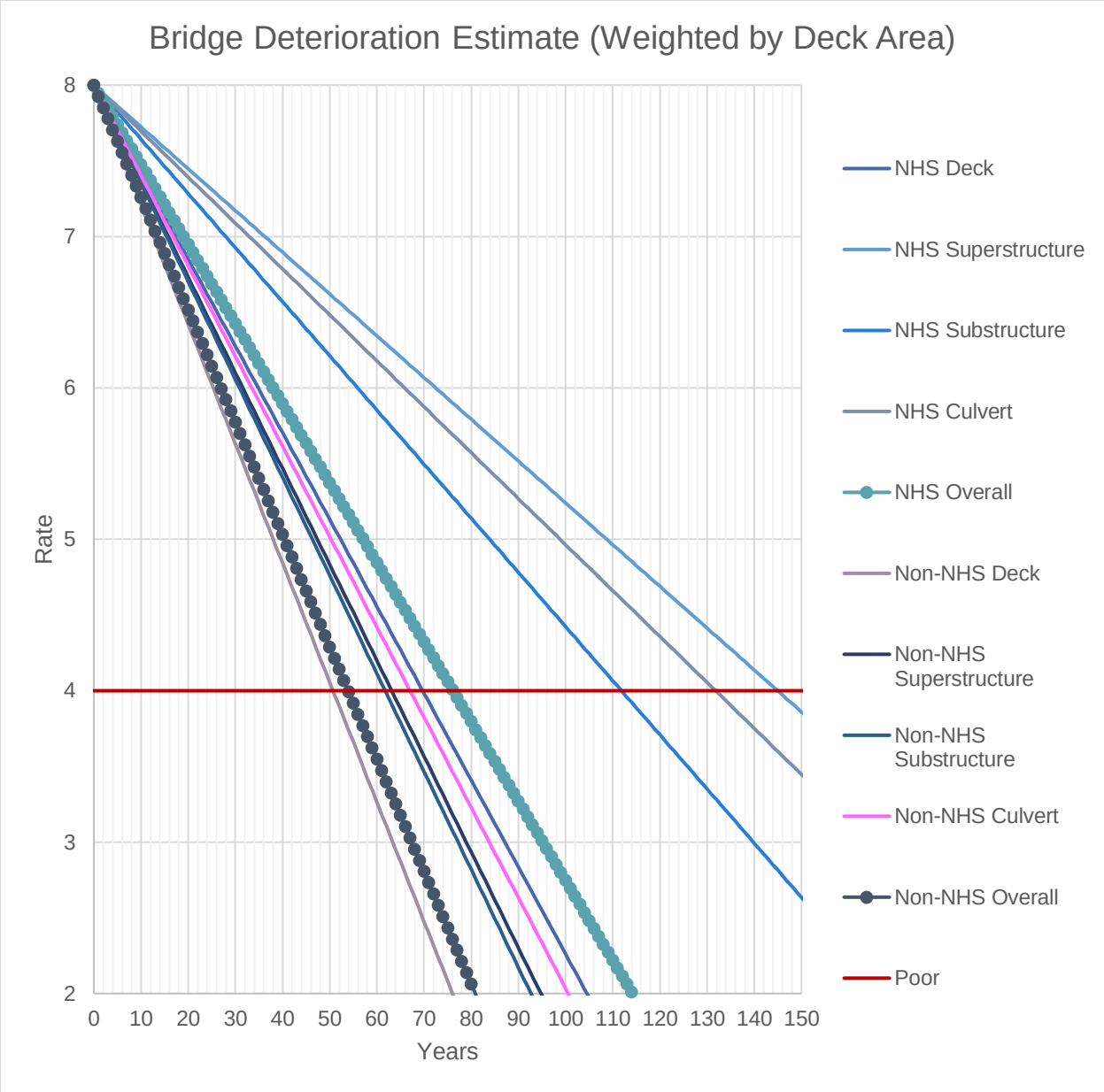


FIGURE 3-8: DETERIORATION RATES FOR DECKS, SUPERSTRUCTURES, AND SUBSTRUCTURES ON AND OFF THE NHS

As is common in most forecasts of future bridge conditions, the analysis does not consider that all bridges deteriorate at the same time. The analysis considers that a percentage of all bridges in each condition state move to the next lower state each year. Table 3-12 shows the considered percentage deteriorating per year, based on the analysis of historical NBI data.

TABLE 3-12: PERCENTAGE DETERIORATING PER YEAR

System	Data Area	Deteriorating Area	Percentage Deteriorating
NHS	1,230,657.92	506,157.78	41.13%
Non-NHS	482,059.34	286,447.07	59.42%
Overall	**1,712,717.26**	**792,604.85**	**46.28%**

3.8 Important Caveats to the Bridge Analysis

As with the pavement gap analysis, there are several important assumptions, that if they change, will affect the outcome of the gap analysis. Table 3-13 shows the estimated treatment costs. If they change because of inflation, or material prices, or other factors, the resulting costs in this analysis will change.

TABLE 3-13: ESTIMATED TREATMENT COSTS

Treatment	Average Cost per Square Meter			
	Deck	Superstructure	Substructure	Culvert
Replacement	$1,200.00	$1,050.00	$900.00	$800.00
Major Rehabilitation	$1,200.00	$600.00	$600.00	$600.00
Minor Rehabilitation	$600.00	$400.00	$400.00	$400.00
Preservation	$150.00	$125.00	$125.00	$125.00

Also, this analysis is not based upon increased storm effects that could further mage the bridge inventory. It considers that the construction industry has the capacity to deliver this larger program in the years anticipated. Furthermore, the analysis contemplate that PRHTA will be able to bring to bid this program and that the available revenue will approximate $86 million annually through 2028.

If there are any changes in those assumptions, the gaps will change accordingly.

3.9 Process Gaps

In addition to condition gaps, several critical process gaps were identified as part of the gap analysis.

3.9.1 Implementing the New PRHTA Management Structure

PRHTA is fundamentally changing how it manages its projects and its processes. It has substantially downsized and is relying on consultants for many processes formerly managed by staff. The PRHTA will need to continue incorporating the new management approach into its asset management processes.

3.9.2 Management Systems

3.9.2.1 Pavement Management System

PRHTA intends to steadily improve its pavement management system to allow further analysis of investment needs. PRHTA has a pavement management system but the agency's constrained finances have not allowed the Authority to adequately invest in data collection, data analysis, and training to fully use the pavement management system. PRHTA is studying available pavement management systems to determine which best meets its needs.

3.9.2.2 Bridge Management System Analysis

PRHTA owns the new AASHTO BrM bridge management software and uses its for tracking the department's inventory. However, the agency lacks the staff to fully develop the model's ability to forecast and analyze investment scenarios. Developing more analytical capabilities is a priority for the department.

3.9.2.3 Implementation Plan

The PRHTA is currently fulfilling a contract for the assessment and recommendation for implementation of pavement and bridge management systems. The ROA for these works has already been approved by FHWA on June 14, 2019. A preliminary implementation schedule is presented in Table 3-14. The main tasks are as follow:

1. Assessment
    a. Gather and document PRHTA and FHWA system requirements
    b. Identify and document minimum software requirements
    c. Survey PMS and BMS software
    d. Create PMS and BMS Short Lists
    e. Create DOTs Short List
    f. Prepare questions for each state and send it ahead to them
    g. DOTs review
    h. Summarize and prioritize DOTs reviews
    i. Present recommendations

j. Vendors' presentation's
k. Final recommendation

2. Procurement
    a. Development of programs' specifications and terms
    b. Identification of resources to operate program
        i. Development of RFP for program operation
        ii. Proposal submission and evaluation period
        iii. Contracting process
    c. Program acquisition process
    d. Testing period
    e. Validation and certification
3. Implementation
    a. Data types and formats needs training to PRHTA
    b. Organization adoption of data collection and storage as per needs
    c. Program training to operators
    d. Pilot period and start of full implementation
    e. Schedule re-assessment and continuing training

TABLE 3-14: PAVEMENT AND BRIDGE MANAGEMENT SYSTEMS PRELIMINARY IMPLEMENTATION SCHEDULE

	TASK	Estimated Week Start	10/1/19	10/8/19	10/15/19	10/22/19	10/29/19	11/5/19	11/12/19	11/19/19	11/26/19	12/3/19	12/10/19	12/17/19	12/24/19	12/31/19	1/7/20	1/14/20	1/21/20	1/28/20	2/4/20	2/11/20	2/18/20	2/25/20	3/3/20	3/10/20	3/17/20	3/24/20	3/31/20	4/7/20	4/14/20	4/21/20
PRHTA Pavement and Bridges Management Program Implementation																															
1	**Assessment**																														
1.1	Gather and document PRHTA and FHWA system requirements																														
1.2	Identify and document minimum software requirements																														
1.3	Survey PMS and BMS software																														
1.4	Create PMS and BMS Short Lists																														
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1.6	Prepare questions for each state and send it ahead to them																														
1.7	DOTs review																														
1.8	Summarize and prioritize DOTs reviews																														
1.9	Present recommendations																														
1.10	Vendors' presentation's																														
1.11	Final recommendation																														
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2.2	Identification of resources to operate program																														
2.2.2	Development of RFP for program operation																														
2.2.3	Proposal submission and evaluation period																														
2.2.4	Contracting process																														
2.3	Software acquisition process																														
2.4	Testing period																														
2.5	Validation and certification																														
3	**Implementation**																														
3.1	Data types and formats needs training to PRHTA																														
3.2	Organization adoption of data collection and storage as per needs																														
3.3	Program training to operators																														
3.4	Pilot period and start of full implementation																														
3.5	Schedule re-assessment and continuing training																														

Assessment Task

Procurement Task

Implementation Task

Summary

This Stage Needs to Finish
For This Stage to Start

	TASK	Estimated Week Start	4/28/20	5/5/20	5/12/20	5/19/20	5/26/20	6/2/20	6/9/20	6/16/20	6/23/20	6/30/20	7/7/20	7/14/20	7/21/20	7/28/20	8/4/20	8/11/20	8/18/20	8/25/20	9/1/20	9/8/20	9/15/20	9/22/20	9/29/20	10/6/20	10/13/20	10/20/20	10/27/20	11/3/20	11/10/20	11/17/20	11/24/20	12/1/20	12/8/20	12/15/20	12/22/20	12/29/20
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3.5	Schedule re-assessment and continuing training																																			

Assessment Task

Procurement Task

Implementation Task

Summary

This Stage Needs to Finish
For This Stage to Start

	TASK	Estimated Week Start	1/5/21	1/12/21	1/19/21	1/26/21	2/2/21	2/9/21	2/16/21	2/23/21	3/2/21	3/9/21	3/16/21	3/23/21	3/30/21	4/6/21	4/13/21	4/20/21	4/27/21	5/4/21	5/11/21	5/18/21	5/25/21	6/1/21	6/8/21	6/15/21	6/22/21	6/29/21	7/6/21	7/13/21	7/20/21	7/27/21	8/3/21	8/10/21	8/17/21	8/24/21	8/31/21	9/7/21	9/14/21
PRHTA Pavement and Bridges Management Program Implementation																																					
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3.4	Pilot period and start of full implementation																																				
3.5	Schedule re-assessment and continuing training																																				

Assessment Task

Procurement Task

Implementation Task

Summary

This Stage Needs to Finish
For This Stage to Start

3.9.3 Project Delivery Capacity

Closing the bridge and pavement gaps will require increased project delivery efforts. Adopting a bridge preservation program will involve letting to bid more small preservation projects. Instead of replacing a few structures each year, PRHTA needs to let to bid many smaller preservation projects. Each project requires design, biding, construction engineering and testing. The increased number of projects will challenge both the industry and PRHTA.

3.9.4 MPO Engagement

On April 2018, the TAMP requirements, timeline, objectives, targets, and processes were presented to the MPO for their comments and approval. All MPO's welcomed and approved the information presented.

After the final plan is certified, PRHTA will go through a process of coordinating with the MPO's. Note that the DTOP/PRHTA is the sole owner of the NHS in PR.

The MPO members need to continue supporting the shift to larger investments in bridge and pavement projects that may come at the expense of locally supported capacity projects.

Chapter 4 Lifecycle Planning Considerations

FHWA requires each transportation agency to develop and implement a life-cycle planning process. FHWA defines life-cycle cost and life- cycle planning as:

Lifecycle Planning Requirements

The asset management rule says in Sec. 515.7 (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 of 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 subgroup, 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).

Life-cycle cost means the cost of managing an asset class or asset sub-group for its whole life, from initial construction to its replacement.

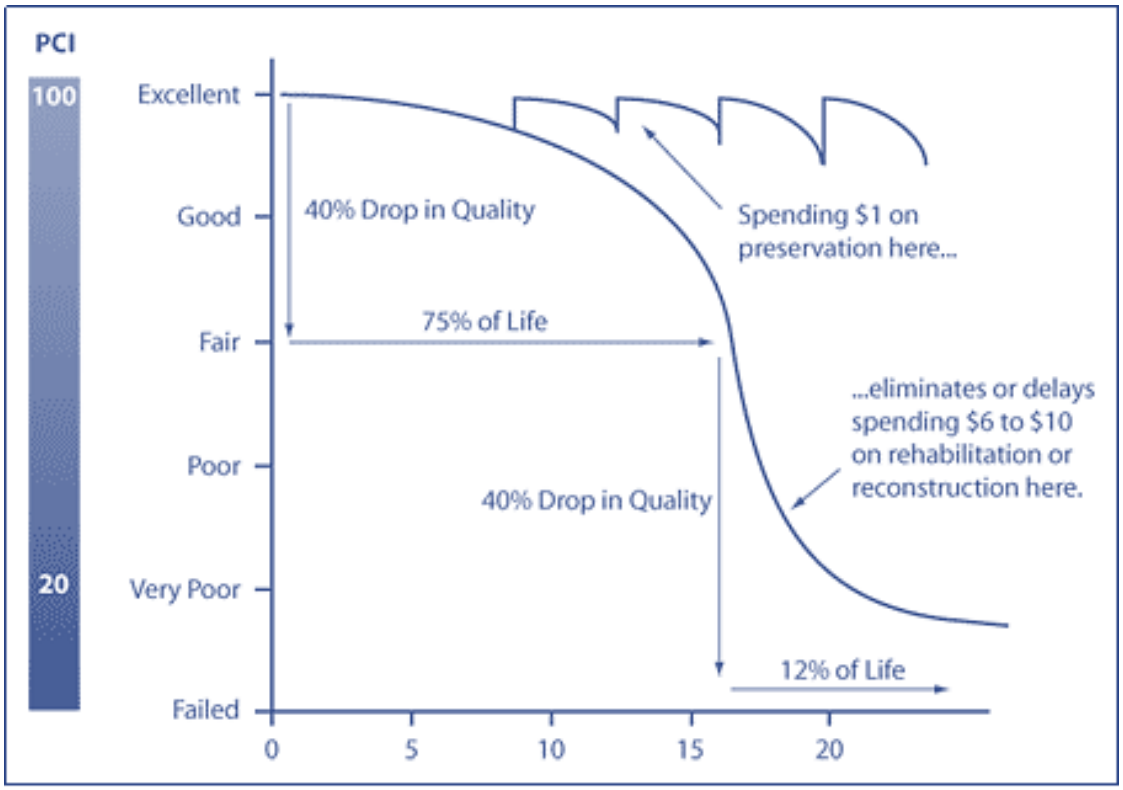
Life-cycle planning means a process to estimate the cost of managing an asset class, or asset sub-group over its whole life with consideration for minimizing cost while pre-serving or improving the condition.

Life-cycle planning is based on the knowledge that assets tend to degrade slowly in the early years but then rapidly deteriorate if they are not adequately maintained. Proper maintenance and treatments at key points in the life of bridges and pavements can extend their life by many years. The timely treatments usually are less expensive than allowing the assets to fail and then replacing them.

Figure 4-1 illustrates this concept for pavements, although similar curves exist for bridges. This figure shows that for the first 10 years of a pavement's life it slowly degrades but left untreated after about year 13 it begins to rapidly deteriorate. The small series of curves at the top indicates a series of inexpensive surface treatments that extend the life of the pavement and prevent the rapid descent into poor condition. Although cost savings will vary state-by-state and asset-by-asset, engineers agree that in most cases timely preservation and maintenance will extend the life of assets and save money over

the long term. For example, the practice of sealing cracks on pavements prevents water from infiltrating the pavement base and keeps the cracks from enlarging into a serious pavement failure. Thin overlays on pavements perform a similar function of sealing the pavement and protecting its structure from rapid deterioration. On bridges, strategies such as painting steel beams and protecting piers from erosion can extend a bridge's life by decades.

FIGURE 4-1: THE PAVEMENT DETERIORATION CURVE.



For the procedures described next, we are using the following nomenclature:

1. "Programmed" - Those projects that are already defined and with budgets allocated.
2. "Planned" – Those potential interventions that were found needed (lane miles and deck area per treatment type) but haven't been defined as projects yet (specific location). These are included in the investment strategy from 2024 and beyond, as PRHTA convert them into projects. Hence, funding is allocated for these on the investment strategy, as explained in Chapter 7.

The basic analysis followed the following general steps:

1. Identify needs.
2. Identify available funding.
3. Identify programmed projects.
4. Plan interventions based on remaining needs, deterioration, and budget.

These stages are shown separately and summarized in different tables. The final strategy combines them all (refer to Chapter 7).

4.1 Pavement Life-Cycle Planning

4.1.1 Pavement Life-Cycle Analysis

The life cycle analysis process adopted in the 2018 initial asset management plan was used for the 2019 plan. The intent of the life cycle process for pavements is to achieve the state of good repair which is defined as to have within 25 years no more than 5 percent of the Interstate pavements in Poor condition and no more than 20 percent of the non-Interstate NHS pavements in Poor condition. The life cycle analysis process also intends to make progress toward the 2-year and 4-year targets which are to have no less than 5 percent of Interstate pavements in Good condition and no more than 14 percent in Poor condition. For the Non-Interstate NHS pavements, the targets are to have no more than 20 percent Poor and no less than 1 percent Good (2-year) or no less than 2 percent Good (4-year).

PRHTA's life cycle process seeks to achieve the state of good repair at the lowest reasonable life-cycle cost. The PRHTA life cycle analysis for pavements begins with an analysis of current pavement conditions. Those pavements which are Good or Good to Fair can benefit from low-cost preservation. Those that are Fair tend to require Minor Rehabilitation and those Fair to Poor typically require Major Rehabilitation. Those that are already Poor require Major Rehabilitation or Reconstruction.

The life cycle analysis for pavements is focused upon achieving the targets based on FHWA's performance measures. Unlike for bridges, for a pavement to be Poor, it must be Poor in two conditions. To restate, to be Poor an asphalt pavement must be in Poor condition for two of the following: IRI (roughness), rutting, or cracking. For concrete pavement, the measures are IRI, cracking, and faulting.

The analysis began with an assessment of current conditions which are shown in Table 4-1. For the Interstates, 13.2 percent are Poor, not counting the missing 3.5 percent of the data. Also, for Interstates, 10.8 percent is Good, and the rest are Fair.

TABLE 4-1: CONDITIONS OF INTERSTATE, NHS, AND NON-NHS PAVEMENTS

Condition	System						Total	
	Interstate		NHS Non-Interstate		Non-NHS			
	Lane Miles	%	Lane Miles	%	Lane Miles	%	Lane Miles	%
Good	138.8	10.80%	38.1	2.20%	20.1	0.20%	197.1	1.80%
Fair-Good	319.3	24.80%	131.4	7.50%	257.4	3.10%	708	6.30%
Fair-Fair	369.7	28.70%	735.8	42.30%	447	5.40%	1,552.50	13.80%
Fair-Poor	245	19.00%	308.3	17.70%	129.7	1.60%	683	6.10%
Total Fair	934	72.50%	1175.5	67.50%	834.1	10.10%	2943.5	26.20%
Measured Poor	170.2	13.20%	156.4	9.00%	72.8	0.90%	399.5	3.50%
Incomplete Data	0	0.00%	286.4	16.50%	193.4	2.40%	479.8	4.30%
Not Measured	45.3	3.50%	84.1	4.80%	7,103.50	86.40%	7,232.90	64.30%
Regulation Poor	215.5	16.70%	526.9	30.30%	N/A	N/A	N/A	N/A
Total	**1,288.30**	**100.00 %**	**1,740.50**	**100.00 %**	**8,223.90**	**100.00 %**	**11,252.80**	**100.00 %**

As has been discussed earlier, the FHWA category of Fair is so broad that it required additional analysis to understand a pavement's true condition. Therefore, the amounts are also shown in Fair-Good, Fair-Fair, and Fair-Poor.

4.1.2 Detailed Analysis for Life Cycle Planning

Table 4-1 shows that most of the lane miles are in one of the three Fair categories. This indicates that a substantial amount of minor and major rehabilitation is required.

Another key factor in the pavement life cycle analysis is the amount of Poor concrete on the Interstate system. Poor concrete does not respond well to minor rehabilitation treatments. When thin layers of asphalt are applied to severely cracked concrete pavements, the distresses in the concrete usually reflect through the asphalt making the pavement Poor again in a few years. This tendency usually requires more expensive major rehabilitation or reconstruction treatments for Poor concrete sections, with some exceptions. As noted in Chapter 3, most of the Poor Interstate pavements are of concrete and require heavy treatments for them to perform well over their life cycle. Of the 170 lane miles of Poor Interstate, 140 of them are of concrete. Therefore, providing long-term repairs to the concrete pavement is essential to sustaining the Interstates in a state of good repair. Table 4-2 shows the average condition for all Interstate concrete pavement. To be Good, the IRI should be less than 95 and the cracking should be less than 5 percent. As Table 4-2 shows, the cracking is more than three times the Good level, and the IRI is more than 100 inches of roughness per mile greater than the Good threshold.

TABLE 4-2: INTERSTATE CONCRETE PAVEMENT AVERAGE CONDITION

Average Interstate Concrete Condition		
Average Cracking (%)	15.8%	Poor
Average IRI (in/mi)	204	Poor
Average Faulting (in)	0.06	Fair-Good

The recommended investment strategy in Chapter 7 builds from the gap analysis in Chapter 3 and the life cycle process shown here. Because of the heavily distressed concrete Interstate pavements, and because of the large amount of Fair NHS Non-Interstate pavements, the best life cycle strategies for Interstate and Non-Interstate NHS are to combine substantial amounts of rehabilitation on the Fair pavements and a substantial amount of Reconstruction of Poor Interstate pavements, particularly the concrete ones. The analysis is constrained by the $130 million annual pavement budget. If more funds were available, the preferred life cycle strategy would increase the amount of concrete reconstruction. However, because of their cost, the investments in the most expensive, but longest lasting, treatments were constrained.

The average unit costs and treatment strategies are shown in Table 4-3. Asphalt preservation treatments are averaged by a unit cost of including milling and 2-inch asphalt overlay. Minor rehabilitation involves a 5-inch overlay, a major rehabilitation involves an 8-inch overlay, and reconstruction involves base replacement and 8-inch overlay.

Concrete preservation involves joint sealing and selective slab repairs. Minor concrete rehabilitation also involves partial depth patching, surface grinding, and dowel bar retrofits. Major rehabilitation involves rubblization and overlay or “crack and seat.” Reconstruction involves removing the existing pavement and replacing it and its base.

TABLE 4-3: TREATMENTS AND THEIR UNIT COSTS

Treatment	Description	Base Unit Cost		
		Interstate	NHS (Non-Interstate)	Non-NHS
Asphalt & Other				
Preservation	2-in Cold Milling & Overlay	$195,709.30	$161,124.20	$133,082.03
Minor Rehabilitation	5-in Cold Milling & Overlay	$409,018.20	$379,067.60	$312,161.18
Major Rehabilitation	Full Depth (8-in) Cold Milling & Overlay	$632,680.55	$444,195.55	$365,690.23
Reconstruction	Full Depth (8-in) + 6-in Base Replacement	$646,689.85	$464,712.01	$382,539.57
Concrete				
Preservation	Joint Sealing & Slab Repair	$428,274.95	$398,294.45	$333,992.20
Rahabilitation	Joint & Crack Sealing, Partial Depth Patching, New Dowels, Grinding	$578,872.05	$548,891.55	$454,921.60
Rubblization & Overlay	Rubblization & Overlay	$620,429.60	$585,833.00	$482,079.43
Reconstruction	6-in Base Replacement, Slab Replacement	$1,033,576.30	$1,003,595.80	$825,341.20

The treatment logic was stated in Chapter 3. Basically, preservation is applied to Good and Fair-to-Good pavements, while minor rehabilitation is applied to Fair pavements, major rehabilitation to Fair-to-Poor pavements, and reconstruction to Poor pavements.

4.1.3 Deterioration Models for Life Cycle Pavement Planning

An analysis was conducted to analyze the optimum life cycle strategies given the pavement conditions, available investment levels, and the expected life of different treatments. Deterioration rates were applied to forecast future conditions based upon different investment scenarios.

Chapter 2 showed the deterioration rates based on the historic PRHTA data. These were based on the past four years of pavement condition data. Because only four years of pavement data were available. PRHTA using research and engineering judgment concluded that to compute the actual deterioration rates for the new pavements and new treatments it would require 10 to 20 years of data.

Also, considering that PRHTA is adopting more systematic preservation as well as applying new treatments, it is projecting that current and future pavements will not deteriorate at the same rate as pavements that were treated in the past. PRHTA concluded it was unrealistic to assume that new pavement treatments would deteriorate at the same rate as existing pavements have deteriorated in the past four years.

PRHTA believes the deterioration of the past four years was unusually high for several reasons. First, the agency's severe financial constraints limited pavement budgets for the past decade. Second, pavement treatments were delayed, and pavements damaged because of Hurricanes María and Irma. Third, pavement preservation programs that are now beginning were not in place.

To compensate for the lack of deterioration curves for new treatments, the analysis took the expected life of treatments from the Pavement Preservation Management Program with some modifications. For example, the analysis considers that a Major Rehabilitation or Reconstruction on the Interstate will provide about 19 years of service before declining from Good to Poor condition. This value is based upon the Pavement Preservation Management Program and the engineering judgment of the PRHTA staff. Values used are shown in Table 4-4.

TABLE 4-4: DETERIORATION ASSUMPTIONS

System	Condition	Deterioration Rate per Year	Percent Deteriorating
Interstate	Good	-0.2	66.0%
	Fair to Good	-0.2	66.0%
	Fair - Fair	-0.25	66.0%
	Fair to Poor	-0.25	66.0%
	Poor	1	0.0%
NHS Non-Interstate	Good	-0.2	43.0%
	Fair to Good	-0.2	43.0%
	Fair - Fair	-0.25	43.0%
	Fair to Poor	-0.25	43.0%
	Poor	1	0.0%
Non-NHS	Good	-0.2	54.0%
	Fair to Good	-0.2	54.0%
	Fair - Fair	-0.25	54.0%
	Fair to Poor	-0.25	54.0%
	Poor	1	0.0%

4.1.4 PRHTA Life Cycle Based Pavement Investments

As was the case with bridges, PRHTA responded quickly after the 2018 initial TAMP and began programming additional projects to carry out the life cycle strategy.

Table 4-5 indicates in the color coding the condition of pavements being treated by currently programmed projects. Interstate pavements receive 842 lane miles of treatments with 192 of those lane miles occurring on already Poor sections. Another 650 lane miles of Interstates will receive lesser treatments which represent the start of PRHTA's program to balance treatments with preservation, rehabilitation, and reconstruction while moving away from only worst-first strategies. Those treatments on non-Poor sections will delay the sections from reaching the Poor condition as quickly necessitating more expensive treatments.

The non-Interstate NHS will receive 1,232 miles of treatment with 331 of those lane miles already Poor. An estimated 901 lane miles of non-Interstate NHS pavements that are between Good and Fair-to-Poor will receive various treatments appropriate to their condition.

TABLE 4-5: LANE MILES TO BE TREATED BASED ON CURRENTLY PROGRAMMED PROJECTS

Lane Miles Programmed to be Treated per Year							
Programmed	**Condition**	**2019**	**2020**	**2021**	**2022**	**2023**	**Total**
Interstate	Good	37.72	11.08	0.00	1.59	0.00	50.39
	Fair to Good	122.13	31.79	0.00	2.57	0.00	156.48
	Fair - Fair	185.91	28.44	2.89	3.20	0.00	220.44
	Fair to Poor	96.13	24.90	5.09	10.30	0.00	136.43
	Poor	77.77	27.22	13.25	20.73	0.00	138.96
	Total	**519.66**	**123.43**	**21.23**	**38.39**	**0.00**	**702.70**
NHS Non-Interstate	Good	34.93	0.87	0.00	0.00	0.00	35.81
	Fair to Good	111.33	11.30	4.51	1.06	3.30	131.50
	Fair - Fair	350.94	86.33	38.93	15.36	21.77	513.34
	Fair to Poor	129.35	30.69	30.08	6.90	2.00	199.02
	Poor	205.17	90.00	23.78	5.64	1.02	325.60
	Total	**831.74**	**219.20**	**97.29**	**28.96**	**28.09**	**1,205.27**
Non-NHS	Good	9.09	19.05	1.74	2.65	0.58	33.12
	Fair to Good	85.63	261.89	22.42	33.95	7.45	411.35
	Fair - Fair	165.93	460.40	44.86	58.96	12.94	743.10
	Fair to Poor	47.19	136.70	13.40	17.11	3.76	218.16
	Poor	22.23	81.56	6.69	9.61	2.11	122.20
	Total	**330.08**	**959.61**	**89.12**	**122.29**	**26.84**	**1,527.94**
Total		**1,681.47**	**1,302.24**	**207.64**	**189.63**	**54.93**	**3,435.91**

Notes: For NHS, non-measured segments were presumed to be Poor; hence, treatments to be performed at non-measured segments are presumed to be performed on Poor segments. For Non-NHS, the treatments performed on non-measured segments were presumed to be performed on segments with a condition distribution as per the measured segments; that is: 2.17% was assigned to Good pavements, 27.76% to Fair-Good, 48.22% to Fair-Fair, 13.99% to Fair- Poor, and 7.86% to Poor.

The Non-NHS has 8,224 lane miles and receives proportionally the least amount of treatment, representing the priority given to the Interstates and NHS. They will receive 1,467 lane miles of treatment most of them on deteriorated sections.

Table 4-6 shows the amounts by work type programmed for pavements from 2019 through 2023. It does not include any planned projects. A total of $549 million is programmed. Of that, $261 million is programmed for preservation, $113 million for rehabilitation, and $174 million for reconstruction.

The mix of treatments represents PRHTA's embrace of life-cycle strategies to manage its pavement inventory.

TABLE 4-6: AMOUNTS CURRENTLY PROGRAMMED FOR PAVEMENT TREATMENTS

System	Treatment	Programmed					
		2019	2020	2021	2022	2023	Total
Interstate	Preservation	$17,847,301	$3,334,500	$0	$0	$0	$21,181,801
	Minor Rehabilitation	$18,935,524	$0	$0	$0	$0	$18,935,524
	Major Rehabilitation	$23,987,474	$8,606,743	$13,705,593	$0	$0	$46,299,810
	Reconstruction	$0	$13,176,518	$5,113,600	$32,908,859	$0	$51,198,977
	Total	$60,770,299	$25,117,761	$18,819,193	$32,908,859	$0	$137,616,112
NHS Non-Interstate	Preservation	$20,233,426	$30,009,739	$30,808,666	$17,295,000	$10,000,000	$108,346,831
	Minor Rehabilitation	$0	$0	$0	$0	$0	$0
	Major Rehabilitation	$2,876,026	$1,615,761	$713,348	$0	$0	$5,205,135
	Reconstruction	$13,225,679	$15,400,000	$16,644,946	$0	$46,800,000	$92,070,625
	Total	$36,335,131	$47,025,500	$48,166,960	$17,295,000	$56,800,000	$205,622,592
Non-NHS	Preservation	$27,265,307	$59,891,800	$0	$19,505,000	$25,000,000	$131,662,107
	Minor Rehabilitation	$0	$0	$0	$3,001,623	$0	$3,001,623
	Major Rehabilitation	$1,954,566	$23,971,223	$13,905,811	$6,028	$0	$39,837,628
	Reconstruction	$12,649,149	$0	$0	$18,610,885	$0	$31,260,034
	Total	$41,869,022	$83,863,023	$13,905,811	$41,123,536	$25,000,000	$205,761,392
Total		**$138,974,452**	**$156,006,285**	**$80,891,964**	**$91,327,395**	**$81,800,000**	**$549,000,096**

4.2 Bridges Life-Cycle Planning

4.2.1 PRHTA's Life-Cycle Process for Bridges

PRHTA applied the life cycle planning process adopted in the initial 2018 asset management plan as it developed its 2019 TAMP and as it updated its 2019-2023 STIP. The PRHTA life cycle process for bridges analyzes the bridge inventory to determine how to best invest the agency's limited resources to achieve its short-term condition targets and its long-term state of good repair. As mentioned earlier, the 2-year and 4-year targets are to have no more than 10 percent of the NHS bridges in Poor condition and to have at least 10 percent in Good condition, as measured by area. The PRHTA state of good repair for bridges is to increase the percent of Good and Fair over the next 10 years and over the next 20 years reduce the percent poor below 10 percent based on an assumption of receiving $86 million annually for bridges. The life cycle analysis considered how to achieve the targets and state of good repair with the lowest life-cycle costs using the agency's $86 million bridge budget.

The same type of three-dimensional analysis described in Chapter 3 for pavements was also applied for the bridge life cycle planning analysis seen in Table 4-7. The 2018 PRHTA bridge inventory was analyzed by the overall condition of each structure, as well by the condition of each deck, superstructure, and substructure. The NHS and non-NHS

bridges were analyzed with the same logic but separately so that the costs to address NHS and Non-NHS bridges were identified. This granularity in analysis allowed for the identification of funding needs to support a life-cycle approach. Bridges that are in Good condition can be identified for preservation, those that are Fair can be identified for rehabilitation, and those that are Poor can be identified for replacement. While Fair pavements were divided into three subcategories, Fair bridges were divided into two, Fair-to-Satisfactory and Fair-to Poor.

As seen in Table 4-7 out of 767 NHS bridges, 50 have Poor decks, 283 Fair to Poor decks, 281 Fair to Satisfactory decks, and 153 Good decks. The area as measured in square meters is also shown. Table 4-7 shows the same information for superstructures and substructures on the NHS and Non-NHS. Overall 195,789 square meters are Poor out of a total of 2,180,690 square meters.

TABLE 4-7: CONDITION OF PRHTA BRIDGES BY COMPONENT AND NHS, NON-NHS

System	Structure	Measure	Poor	Fair to Poor	Fair Satisfactory	Good	Total
NHS	Deck	Amount	50	283	281	153	767
		Area (Sq. Mts.)	101,638.77	582,372.70	545,884.98	318,593.21	1,548,489.66
	Super	Amount	20	77	169	501	767
		Area (Sq. Mts.)	22,768.81	120,854.71	305,271.95	1,099,594.19	1,548,489.66
	Sub	Amount	13	54	322	378	767
		Area (Sq. Mts.)	21,040.12	78,238.81	521,933.84	927,276.89	1,548,489.66
	Culvert	Amount	2	9	25	46	82
		Area (Sq. Mts.)	454.67	3,694.69	7,735.95	23,952.58	35,837.89
	Overall	Amount	70	316	284	179	849
		Area (Sq. Mts.)	136,363.51	615,351.00	539,981.47	292,631.57	1,584,327.55
Non-NHS	Deck	Amount	92	424	469	238	1,223
		Area (Sq. Mts.)	30,091.22	154,699.63	197,100.79	181,142.49	563,034.13
	Super	Amount	93	286	392	452	1,223
		Area (Sq. Mts.)	27,869.18	58,372.79	121,920.10	354,872.06	563,034.13
	Sub	Amount	91	265	509	358	1,223
		Area (Sq. Mts.)	19,273.95	76,245.88	186,809.60	280,704.70	563,034.13
	Culvert	Amount	23	56	100	74	253
		Area (Sq. Mts.)	2,462.35	5,708.97	11,897.15	13,260.24	33,328.71
	Overall	Amount	203	532	476	265	1,476
		Area (Sq. Mts.)	59,425.57	181,921.40	187,781.06	167,234.81	596,362.84
Total	Deck	Amount	142	707	750	391	1,990
		Area (Sq. Mts.)	131,729.99	737,072.33	742,985.77	499,735.70	2,111,523.79
	Super	Amount	113	363	561	953	1,990
		Area (Sq. Mts.)	50,637.99	179,227.50	427,192.05	1,454,466.25	2,111,523.79
	Sub	Amount	104	319	831	736	1,990
		Area (Sq. Mts.)	40,314.07	154,484.69	708,743.44	1,207,981.59	2,111,523.79
	Culvert	Amount	25	65	125	120	335
		Area (Sq. Mts.)	2,917.02	9,403.66	19,633.10	37,212.82	69,166.60
	Overall	Amount	273	848	760	444	2,325
		Area (Sq. Mts.)	195,789.08	797,272.40	727,762.53	459,866.38	2,180,690.39

Figure 4-2 shows the same data as in Table 4-7 only it illustrates the data graphically. Of importance for the PRHTA bridge life cycle strategy is the amount of bridge area that includes culverts shown in orange, or the large amount of Fair to Poor bridge area. As will

be shown with the deterioration models, the area of Fair to Poor will degrade to Poor within 20 years or less if left untreated. So much area is Fair, that as it becomes Poor it can overwhelm PRHTA's ability to repair it and overall bridge conditions can decline. A total of 797,272 square meters are Fair to Poor compared to 195,789 already Poor.

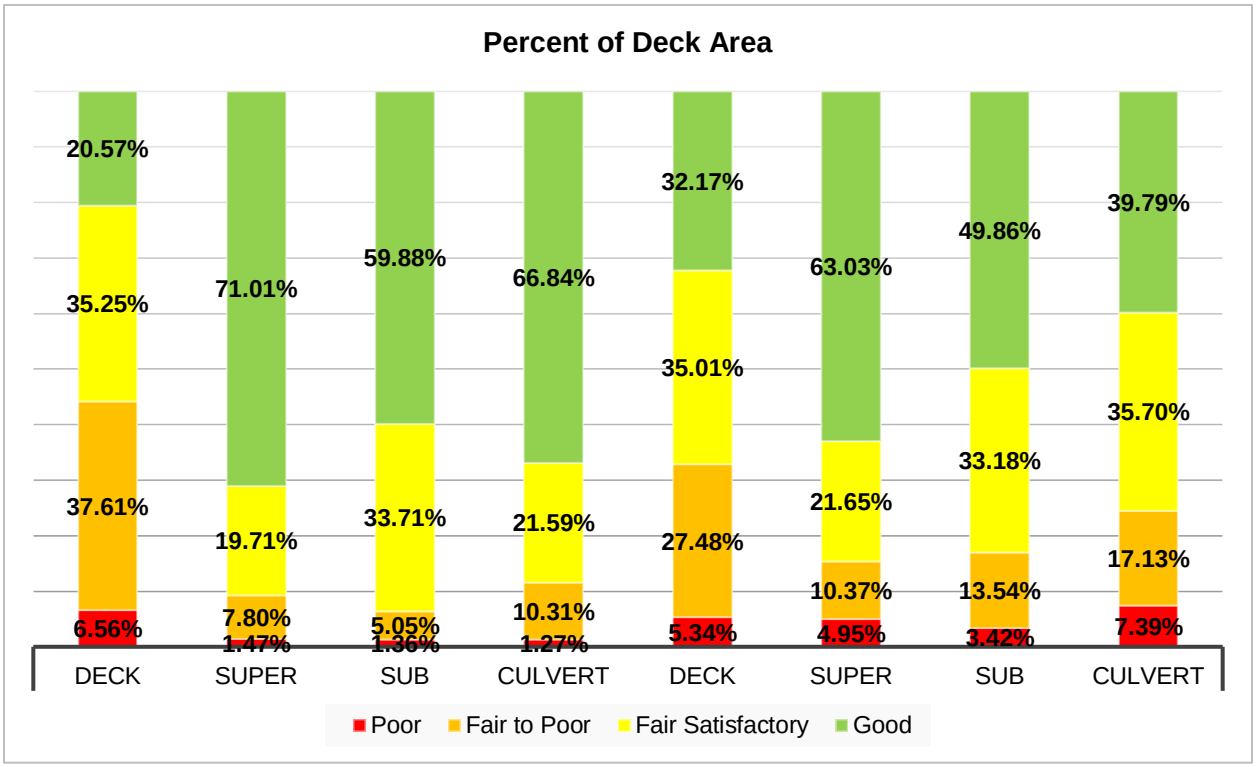


FIGURE 4-2: BRIDGE CONDITIONS DEPICTED GRAPHICALLY

This detailed analysis allows PRHTA to apply life cycle treatments and not only replace already Poor structures. Table 4-8 shows important inputs to the bridge life cycle analysis. In the top half of Table 4-8, the logic of treatments is shown. For example, if the deck, superstructure, and substructure all are poor, a bridge replacement is adopted in the life cycle planning analysis. If both the superstructure and substructure are Poor, replacement also is adopted. Finally, if the substructure is Poor, replacement is used except in the cases where the substructure is Poor only because of a reparable scour problem. About 21 structures fall into that category. By repairing the scour potential, they would move out of the Poor category. Also shown in Table 4-8 is the general logic applied to structures in other condition states. Generally, if bridge components are rated 5, the components receive rehabilitation, which could include a new deck or new superstructure, and major repairs to the substructure. Bridge components in condition state 6 receive minor rehabilitation. Components in condition 7 receive preservation treatments such as sealing decks, painting beams or repairing joints and bearings.

These strategies lower the life cycle cost of managing the bridge inventory. For example, PRHTA has 39 bridges with 91,519 square meters of area that are rated Poor because the deck is Poor, but the substructure and superstructure are rated 6 or above. Based on average unit costs, it would cost $2,000 per square foot to replace the deck and provide minor rehabilitation to the substructure and superstructure. The alternative of replacing the bridge costs $3,150 per square meter or 58 percent more. The life-cycle planning strategy took into consideration such detailed analysis to recommend cost-effective and appropriate treatments for the bridges. The bridge work types and unit prices are shown in Table 4-8 illustrate the substantial cost differences of the treatments. By investing in minor rehabilitation and preservation, the cost of bridge replacement can often be delayed by decades. The lowest life-cycle cost for managing the bridge inventory over the long-term is to frequently apply preservation and minor rehabilitation to keep Fair bridges from deteriorating to the Poor state.

TABLE 4-8: BRIDGE TREATMENT LOGIC, WORK TYPES, AND UNIT COSTS.

Treatment Criteria				
Treatment	**Rate**			
	Deck	**Superstructure**	**Substructure**	**Culvert**
Replacement	<=4 or Sup<=4 or Sub<=4	<=4 or Sub<=4	<=4	<=4
Major Rehabilitation	5	5	5	5
Minor Rehabilitation	6	6	6	6
Preservation	7	7	7	7
No Immediate Action	>7	>7	>7	>7
Treatment	**Average Cost per Square Meter**			
	Deck	**Superstructure**	**Substructure**	**Culvert**
Replacement	$1,200.00	$1,050.00	$900.00	$800.00
Major Rehabilitation	$1,200.00	$600.00	$600.00	$600.00
Minor Rehabilitation	$600.00	$400.00	$400.00	$400.00
Preservation	$150.00	$125.00	$125.00	$125.00
No Immediate Action	$0.00	$0.00	$0.00	$0.00
Total Bridge Replacement	$3,150			

Table 4-9 displays the rating criteria. These ratings apply not only to the entire structure but also to each deck, substructure, and superstructure. The logic applied in this analysis incorporated FHWA's relatively recent redefinition of Good, Fair, and Poor.

TABLE 4-9: BRIDGE RATING CRITERIA

Rating	Condition Definition	Criteria
9	Excellent	Excellent condition
8	Very good	No problems noted.
7	Good	Some minor problems noted.
6	Satisfactory	Structural elements show some minor deterioration.
5	Fair	All primary structural elements are sound but may have minor section loss, cracking, spalling or scour.
4	Poor	Advanced section loss noted. Deterioration. Spalling or scour.
3	Serious	Loss of section, deterioration, spalling or scour has seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	Critical	Advanced deterioration or primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge
1	Imminent Failure	Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge Is closed to traffic but corrective action may put back in light service.
0	Failed	Out of service - beyond corrective action

4.2.2 Caveats to the Analysis

It should be emphasized that this logic does not lead to automatic decisions about which bridges are selected or how they are treated. Engineers will assess each structure and ensure that the rating data are correct, or that there are not additional needs for the bridges and the recommended treatments are appropriate to address the bridge condition considering a life-cycle planning approach for the bridges as whole.

By understanding which structures need which types of treatments, PRHTA was able to:

1. Identify which structures are critical and how much they are likely to cost over the next decade.
2. Manage to keep less than 10 percent of NHS structures in poor condition.
3. Estimate how much rehabilitation effort is needed to slow the acceleration of bridges from category 6 to category 5 and down to category 4, the Poor condition state.
4. Select opportunistically bridges for preservation and add their treatments to adjacent projects that address pavements, capacity, or safety. If PRHTA develops “stand-alone” preservation projects, it could pay higher costs for design, maintenance of traffic, and contractor mobilization. By knowing which bridges would benefit from preservation, the preservation treatments can be added to projects that are near those structures.
5. Take a corridor approach. If a bridge needs replaced, the bridges near it can also be treated with the rehabilitation and preservation they need. This grouping by adjacent bridges in a corridor also can reduce costs for design, mobilization, and maintenance of traffic.

4.2.3 PRHTA Life Cycle Based Bridge Investments

The life cycle planning process is having an immediate effect upon PRHTA’s investments. PRHTA is using the increased funding provided under the Revised Fiscal Plan to embrace the life cycle strategy. More projects that apply preservation, rehabilitation, and appropriately timed reconstruction are now in the STIP compared to earlier years. For many years, PRHTA had bridge preservation protocols but it lacked enough money to fund them. PRHTA has a Standard Operation Procedure for Bridge Project Prioritization, a Systematic Preventive Maintenance protocol for bridges, and it has a Bridge Preventive Maintenance Selection Toolkit and Checklist. The increased funding from the Fiscal Plan is allowing those preservation protocols to be applied.

Until recent years, the STIP was largely driven by the island’s communities which often prioritized local projects over those investing in major state route pavements and bridges. PRHTA bridges were allocated about $17 million annually in recent years in the STIP. That was enough to replace several structures annually from a Critical Bridge List but has not been enough for an adequate bridge preservation and rehabilitation program. Table

4-10 summarizes how little of the PRHTA bridge inventory could be treated with $17 million annually. There are 2,089,888 square meters of bridges managed by PRHTA. One-hundred and twenty-three other bridges are managed by Metropistas. When the annual bridge budget of $17,000,000 is divided by the $3,150 cost to replace one square meter of bridge it results in 5,397 meters of bridge deck area. That area equals .27 of one percent of the total PRHTA bridge deck area treated annually. That amount was so little that PRHTA devoted it to replacing structures already critical, and not addressing bridges that needed preservation or rehabilitation.

TABLE 4-10: LEVEL OF EFFORT POSSIBLE WITH PREVIOUS BRIDGE BUDGET

Annual Bridge Program	
Total Bridge Area (Square Meters)	2,089,888
Previous Bridge Budget	$17,000,000
Cost to replace one square meter	$3,150
Square meters replaced annually	5,397
% of bridge area addressed annually	0.27%

PRHTA' s analysis has highlighted the funding needed to address its bridges. PRHTA has received a substantial bridge budget increase and is pursuing an aggressive bridge program based upon life cycle strategies.

Table 4-11 shows the break down in square meters of bridge projects programmed for development and Table 4-12 shows the dollar amounts programmed. They include those in the STIP, Bridge Replacement program, Deck Replacement program, Initial TAMP bridge initiative, and Metropistas program. The distribution per program is shown in Table 4-13 (area) and Table 4-14 (investment).

TABLE 4-11: BRIDGE PROGRAMMED TREATMENT AREA

Programmed Sq. Mts.		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
NHS	Preservation	10,599.17	51,907.15	15,728.58	2,308.53	46,897.50	0.00	0.00	0.00	0.00	0.00	127,440.93
	Minor Rehabilitation	6,126.40	0.00	0.00	18,062.67	11,661.27	0.00	0.00	0.00	0.00	11,457.00	47,307.34
	Major Rehabilitation	24,175.15	0.00	7,741.23	18,740.79	0.00	0.00	0.00	0.00	0.00	0.00	50,657.17
	Replacement	0.00	0.00	0.00	1,012.74	0.00	0.00	0.00	0.00	0.00	0.00	1,012.74
	TOTAL	**40,900.72**	**51,907.15**	**23,469.81**	**40,124.73**	**58,558.77**	**0.00**	**0.00**	**0.00**	**0.00**	**11,457.00**	**226,418.18**
Non-NHS	Preservation	0.00	0.00	0.00	37.82	22,669.45	0.00	0.00	0.00	0.00	0.00	22,707.27
	Minor Rehabilitation	2,462.10	0.00	0.00	2,093.10	3,998.76	0.00	0.00	0.00	0.00	0.00	8,553.96
	Major Rehabilitation	3,540.48	10,656.78	7,365.82	66.08	127.02	0.00	0.00	0.00	0.00	0.00	21,756.18
	Replacement	1,753.12	0.00	0.00	2,049.46	1,113.99	0.00	0.00	0.00	0.00	0.00	4,916.57
	TOTAL	**7,755.70**	**10,656.78**	**7,365.82**	**4,246.46**	**27,909.22**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**57,933.98**
TOTAL		**48,656.42**	**62,563.93**	**30,835.63**	**44,371.19**	**86,467.99**	**0.00**	**0.00**	**0.00**	**0.00**	**11,457.00**	**284,352.16**

TABLE 4-12: BRIDGE PROGRAMMED INVESTMENT PER TREATMENT

Programmed Investment		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
NHS	Preservation	$21,280,057	$6,700,000	$9,122,240	$1,724,462	$8,089,819	$0	$0	$0	$0	$0	$46,916,578
	Minor Rehabilitation	$11,902,326	$0	$0	$13,542,597	$22,425,705	$0	$0	$0	$0	$20,817,369	$68,687,997
	Major Rehabilitation	$13,032,942	$0	$12,539,324	$29,300,000	$0	$0	$0	$0	$0	$0	$54,872,266
	Replacement	$0	$0	$0	$769,825	$0	$0	$0	$0	$0	$0	$769,825
	TOTAL	**$46,215,324**	**$6,700,000**	**$21,661,564**	**$45,336,885**	**$30,515,524**	**$0**	**$0**	**$0**	**$0**	**$20,817,369**	**$171,246,666**
Non-NHS	Preservation	$0	$0	$0	$12,350	$4,088,633	$0	$0	$0	$0	$0	$4,100,983
	Minor Rehabilitation	$4,943,182	$0	$0	$1,248,460	$5,242,375	$0	$0	$0	$0	$0	$11,434,016
	Major Rehabilitation	$5,421,816	$16,851,011	$12,963,276	$1,569,171	$364,890	$0	$0	$0	$0	$0	$37,170,164
	Replacement	$11,861,968	$0	$0	$24,500,614	$3,836,860	$0	$0	$0	$0	$0	$40,199,441
	TOTAL	**$22,226,966**	**$16,851,011**	**$12,963,276**	**$27,330,594**	**$13,532,758**	**$0**	**$0**	**$0**	**$0**	**$0**	**$92,904,605**
TOTAL		**$68,442,290**	**$23,551,011**	**$34,624,840**	**$72,667,479**	**$44,048,282**	**$0**	**$0**	**$0**	**$0**	**$20,817,369**	**$264,151,272**

TABLE 4-13: BRIDGE PROGRAMMED AREA PER PROGRAM (SQ. MTS.)

System	List	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
NHS	Bridge Replacement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Deck Replacement	4,979.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,979.94
	Initial TAMP	0.00	0.00	0.00	0.00	58,558.77	0.00	0.00	0.00	0.00	11,457.00	70,015.77
	Metropistas	16,230.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16,230.75
	STIP	19,690.03	51,907.15	23,469.81	40,124.73	0.00	0.00	0.00	0.00	0.00	0.00	135,191.72
	Total	**40,900.72**	**51,907.15**	**23,469.81**	**40,124.73**	**58,558.77**	**0.00**	**0.00**	**0.00**	**0.00**	**11,457.00**	**226,418.18**
Non-NHS	Bridge Replacement	1,753.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,753.12
	Deck Replacement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Initial TAMP	0.00	0.00	0.00	0.00	27,909.22	0.00	0.00	0.00	0.00	0.00	27,909.22
	Metropistas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	STIP	6,002.58	10,656.78	7,365.82	4,246.46	0.00	0.00	0.00	0.00	0.00	0.00	28,271.64
	Total	**7,755.70**	**10,656.78**	**7,365.82**	**4,246.46**	**27,909.22**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**57,933.98**
Total		*48,656.42*	*62,563.93*	*30,835.63*	*44,371.19*	*86,467.99*	*0.00*	*0.00*	*0.00*	*0.00*	*11,457.00*	**284,352.16**

Note: 2019-2022 STIP amounts indicating "future investment" were assigned to the year 2023.

TABLE 4-14: BRIDGE PROGRAMMED INVESTMENT PER PROGRAM

System	List	2019	2020	2021	2022	2023	2024	2028	Total
NHS	Bridge Replacement	$0	$0	$0	$0	$0	$0	$0	$0
	Deck Replacement	$11,753,174	$0	$0	$0	$0	$0	$0	$11,753,174
	Initial TAMP	$0	$0	$0	$0	$30,515,524	$0	$20,817,369	$51,332,893
	Metropistas	$2,111,586	$0	$0	$0	$0	$0	$0	$2,111,586
	STIP	$32,350,565	$6,700,000	$21,661,564	$45,336,885	$0	$0	$0	$106,049,014
	Total	**$46,215,324**	**$6,700,000**	**$21,661,564**	**$45,336,885**	**$30,515,524**	**$0**	**$20,817,369**	**$171,246,667**
Non-NHS	Bridge Replacement	$0	$0	$0	$0	$0	$0	$0	$0
	Deck Replacement	$11,753,174	$0	$0	$0	$0	$0	$0	$11,753,174
	Initial TAMP	$0	$0	$0	$0	$30,515,524	$0	$20,817,369	$51,332,893
	Metropistas	$2,111,586	$0	$0	$0	$0	$0	$0	$2,111,586
	STIP	$32,350,565	$6,700,000	$21,661,564	$45,336,885	$0	$0	$0	$106,049,014
	Total	**$46,215,324**	**$6,700,000**	**$21,661,564**	**$45,336,885**	**$30,515,524**	**$0**	**$20,817,369**	**$171,246,667**
Total		*$92,430,648*	*$13,400,000*	*$43,323,129*	*$90,673,770*	*$61,031,047*	*$0*	*$41,634,739*	*$342,493,333*

Note: 2019-2022 STIP amounts indicating "future investment" were assigned to the year 2023.

4.2.4 Achieving a State of Good Repair

In the Chapter 7 Investment Strategies, it will be shown that the current level of investment and the recently embraced life-cycle bridge planning process will allow PRHTA to sustain both its bridge conditions and achieve its state of good repair with the $86 million long-term average bridge budget.

4.2.5 Addressing Future Environmental Conditions and Risk

Included in the life cycle planning process for bridges is recognition of the threat caused by a changing climate and future environmental conditions. The 20 bridges being addressed for their scour issues will be more resilient to withstand future hydraulic events. PRHTA also is in process of analyzing all the sites damaged since 1997 as part of the Section 667 requirements. Sites of repeated damage will be reviewed for needed resilience mitigation before they are improved again. The overall increase in bridge spending and the focus upon strengthening the inventory are driven, in part, by the memory of Hurricanes Mariá and Irma and the need to harden structures to withstand future environmental conditions.

4.3 Pavement and Bridge Additional Scenarios

Several tools were developed to perform lifecycle analyses. These are explained with detail in Appendix M.

Diverse scenarios were tested using the developed tools, including applying different budget priorities per system and condition, and different budgets. The ones presented in this chapter optimize the projected available funding and feasible amount / capacity of work per year to meet the NHS targets within the 10-year TAMP period. For illustration purposes, additional “step scenarios” (interim iterations) are included in Appendix N as follows:

1. Pavement Tool – Preferred Scenario
2. Pavement Tool - Test With $200M instead of $134M-1$37M, Same Proportions
3. Pavement Tool - Test with Available Budget ($134M-1$37M), 4% Int, 3% NHS Non-Interstate, 3% Non-NHS, Same Proportions per Condition
4. Pavement Tool - Test with $200M, 4% Int, 3% NHS Non-Interstate, 3% Non-NHS, Same Proportions per Condition
5. Pavement Tool - Possible Scenario to Reach Interstate Pavement Goal by 2024 and Maintain It - $280M investment in 2024, $130M Investment the Following Years
6. Bridge Tool – Preferred Scenario
7. Bridge Tool - Test with $125M instead of $90M, Same Proportions
8. Bridge Tool - Test with $90M Budget, 60% NHS, 40% Non-NHS
9. Bridge Tool - Test with $125M, 60% NHS, 40% Non-NHS, Same Proportions per Condition

Chapter 5 Risk Identification and Management

This chapter presents PRHTA's risk management plan based on the risk management process adopted in the 2018 asset management plan.

PRHTA has adopted the FHWA definition of risk as, "the positive or negative effect of uncertainty or variability upon agency objectives." PRHTA also has adopted a risk management process based upon the FHWA document entitled Guidance on Incorporating Risk Management into Transportation Asset Management Plans and the AASHTO Guide for Enterprise Risk Management.

The risk process covers the major steps that systematically allows PRHTA to establish objectives, identify risks to these objectives, analyze, evaluate and prioritize these risks, and then based on the risk's priority, develop and implement risk mitigation strategies. The results of this risk management process are incorporated into a risk register.

To develop the risk register, PRHTA conducted a webinar session that was followed by a workshop with subject matter experts from Pavements, Bridges, Transit, Finance, Metropistas, and DTPW. The workshops also included several FHWA personnel. The webinar created a common understanding of risk and the risk management process. It also highlighted some of the factors that influence the impact, likelihood, consequence, and priority of risks.

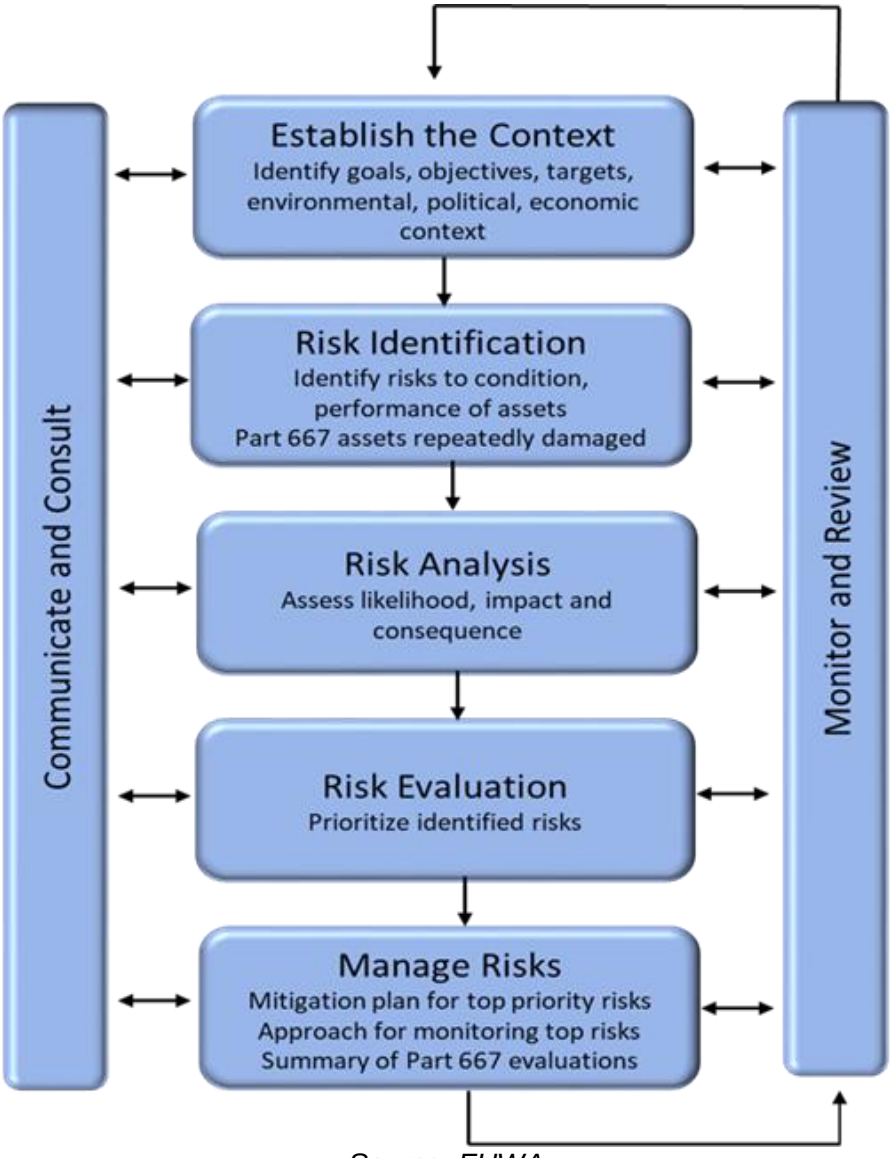
For the 2019 TAMP, PRHTA subject matter experts updated the risk register. They reviewed the 2018 risks to various objectives, the risks' ratings, and the mitigation strategies. This annual update reflected changes to the agency's risks that have occurred in the past year.

Risk Analysis Requirements

Sec. 515.7 (c) of the final rule, FHWA says "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 repeated 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

The following steps summarize PRHTA's risk management process that it adopted per the asset management rule (see Figure 5-1). This process was followed for the 2018 initial TAMP and will be used for each TAMP update. Annually, the risk register will be updated by the agency's leadership and bridge and pavement subject matter experts.



Source: FHWA

FIGURE 5-1: RISK MANAGEMENT FRAMEWORK

5.1.1 TAM Objectives Identification

The context for the risk management workshop was provided through discussions with the asset managers from pavements, bridges and the PRHTA leadership. The objectives for the workshop included those addressing pavements, bridges, data management systems, stakeholder involvement, construction, extreme weather, and those related to agency personnel. During this step, the workshop participants reviewed a list of asset management objectives that were developed in the early stages of the plan development process.

5.1.2 Risk Identification

The workshop participants then split into four groups. Members of each group then reviewed the assigned objectives and brainstormed on risks to achieving the objectives. They considered internal and external threats and opportunities including those related to finance, industry, extreme weather events, other agency partners, data, quality control, accelerated deterioration of damaged assets, and staff expertise.

Risks that were agreed upon by the group members were documented as “if/then” statements such as, “If PRHTA does not achieve the less than 5 percent poor interstate system target then it can be subject to funding restrictions and lose much needed Federal funding”. Collectively the four groups recorded 75 risk statements that were developed for sixteen objectives. The sixteen objectives are discussed in the following section and 75 risk statements are included in Table 5-2.

5.1.3 Risk Analysis and Evaluation

For this step, workshop participants used the risk matrix shown in Figure 5-2 as a guide. The subject-matter experts then applied their expertise and knowledge and deliberated on the likelihood of occurrence of each risk and the resulting impact of such occurrence. Based on the combination of the likelihood and the impact, they then rated the consequence of each risk. The consequence could be Low, Medium, High, Very High or Unacceptable.

Risk Matrix with Impact and Likelihood Definitions			Likelihood				
			Rare	Unlikely	Likely	Very Likely	Almost Certain
			Less than once in 10 years	Less than once in 5 years	Once in 3 years	Once per year	More than once per year
Impact	Very Significant	Potential for multiple deaths & injuries, substantial public & and private cost.	Medium	Medium	High	Very High	Unacceptable
	Major	Potential for multiple injuries, substantial public or private costs, and/or foils agency objectives.	Low	Medium	High	Very High	Very High
	Moderate	Potential for injury, property damage, increased agency costs and/or impedes agency objectives.	Low	Medium	Medium	High	High
	Minor	Potentential for moderate agency cost and impact to agency objectives.	Low	Low	Low	Medium	Medium
	Insignificant	Potential impact low and manageable with normal agency practices.	Low	Low	Low	Low	Medium

FIGURE 5-2: RISK MATRIX

5.1.4 Risk Response Strategies

The workshop participants prioritized the risks based on the consequence of each. The areas in red are given higher priority. Participants then selected and developed mitigation strategies for risks that had the “High”, “Very High” or “Unacceptable” consequences. The Response strategies shown in Table 5-1 guided the development of these strategies. The participants chose the “Treat” option in developing mitigation strategies. Table 5-1 will continue to guide the Response strategies for PRHTA as it monitors and updates the risks in the future.

TABLE 5-1: POTENTIAL RISK RESPONSES

Response Strategies			
1	**Treat**	-	Take steps to reduce risks.
2	**Tolerate**	-	Decide the risk is not worth treating or can't be treated.
3	**Transfer**	-	Shift risk to a third party.
4	**Terminate**	-	End the situation that creates the risk
5	**Take Advantage of**	-	Capitalize on the risk.

5.1.5 Risk Monitoring and Update

During the June 2019 TAMP update process, the PRHTA leadership along with the TAMP project manager managed the risk register update. The process for on-going monitoring and managing of the risk register will be the responsibility of the appropriate subject matter experts in the different business units. The TAMP project manager will serve as the coordinator and at least once annually schedule a meeting of the subject matter experts to review and update the risk register. If significant events occur or risk triggers are seen that necessitate more frequent meetings, at the request of the subject matter experts or the agency leadership the project manager will coordinate and facilitate additional meetings to review and make necessary updates to the Risk Register. Risk triggers are events that may require PRHTA to stop ongoing initiatives, redirect or invest resources in new initiatives, or increase funding to already planned initiatives. A risk trigger will also require PRHTA to review and update its current high-priority risks. It may require expediting action for some initiatives and canceling or delaying action for others to address high priority risks.

5.1.6 Risk Communication and Consultation

The communication and consultation of risks will be a shared responsibility of the subject matter experts and the project manager. The subject matter experts monitoring the assigned risks will communicate changes to the risk priorities, major impacts, and mitigation strategies as well as any change in resources needed for risk mitigation. These subject matter experts will also be responsible for communicating and consulting with others in their business units to develop strategies for changed risks or new risks.

The project manager working with the subject matter experts will communicate to the agency leadership risks that may impact any PRHTA objectives including those that impact the asset management objectives. Feedback and guidance received from the communication and consultation with the leadership will be used by the subject matter experts to update the risk register.

The communication and consultation step is also intended to integrate the asset management risk mitigation with all other PRHTA risk management activities.

5.2 PRHTA TAM Objectives

The following section summarizes the workshop results from the risk management framework shown in Figure 5-1. The workshop participants reviewed numerous objectives and selected the following 16 objectives to be addressed in the risk register.

The risk register is an assessment of what are the potential, not actual, items that could keep PRHTA from achieving the adopted condition targets and its consequences. The objective of this register is to have already identified the risks and feasible

countermeasures, so if any of the risks actually happens, PRHTA will be guided by the general mitigation strategy already identified. The updated risk register is shown in Table 5-2. The register addresses the following objectives:

Objective 1: Achieve less than 5 percent of the Interstate Highway System pavements in poor condition and less than 20 percent of the National Highway System pavements in poor condition.

Objective 2: Systematically implement a pavement preservation program.

Objective 3: Develop, implement, and use customized management systems to support data-driven asset management decisions.

Objective 4: Use data to drive project decisions.

Objective 5: Continuously educate stakeholders to support long-term funding of asset management activities, including preservation.

Objective 6: Educate and communicate to internal and external stakeholders the benefits of asset management.

Objective 7: Manage quality, timely delivery, and schedule of construction activities and develop the construction industry to support the projects and programs necessary for asset management.

Objective 8: Ensure subject matter expert continuity through succession planning to sustain the long-term cost-effective management of assets, and the data and management systems that support them.

Objective 9: Integrate and formalize the impact of weather in the planning, delivery, and long-term management of assets.

Objective 10: Implement the long-term cost-effective management of bridges to achieve a state of good repair.

Objective 11: Achieve and sustain the target of no more than 10 percent of the National Highway System bridges in poor condition.

Objective 12: Systematically select bridge projects to manage them effectively over their entire lifecycle.

Objective 13: Maintain pro-active inspection procedures for inspection of critical bridges.

Objective 14: Reduce the backlog of deteriorated pavements and develop a program to systematically reduce the backlog of deteriorated bridges.

Objective 15: Secure adequate funding to achieve and sustain a state of good repair.

Objective 16: Adapt asset management practices to PRHTA's new management structures and procedures.

TABLE 5-2: RISK REGISTER

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 1: Achieve less than 5% of the Interstate Highway System pavements in poor condition and less than 20% of the National Highway System pavements in poor condition.					
1.1	If PRHTA does not achieve the less than 5% poor interstate system targets, then it can be subject to funding restrictions and lose much needed federal funding.	Likely	Major	**High**	PRHTA will monitor closely and systematically to strategically identify and treat Interstate pavements to try to achieve the less than 5% poor target. It will communicate the impact of penalties to stakeholders to try and obtain additional funding to apply preservation to keep the "fair" pavements from falling into the "poor" category.
1.2	If PRHTA has more than 5% poor Interstate system conditions, then it will be forced to change the projects it programs for future years.	Likely	Major	**High**	PRHTA will use preservation to minimize degradation of Fair pavements and to slow further degradation of Poor pavements and focus on changing the program of projects to address them. It will also communicate this need to its stakeholders to gain their support for life-cycle strategies.
1.3	If data collection is compromised by lack of equipment, then PRHTA will have data missing to make important project selection decisions. This will influence its long-term cost-effective management of assets.	Likely	Moderate	Medium	PRHTA will proactively address data collection issues and establish QA/QC procedures to ensure that data collection meets its needs and the data quality meets data standards. This will be a step towards ensuring that PRHTA can use the data with confidence to support decision making.
1.4	If data collection contracts are not completed on time, then PRHTA will not have the data it needs to make necessary decisions.	Likely	Moderate	Medium	PRHTA will proactively work to ensure that timely contract renewal for the data collection contract occurs. It will also proactively work to ensure that roadblocks are removed to ensure timely contract renewal.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 2: Systematically implement a pavement preservation program.					
2.1	If PRHTA does not get adequate funding it will not have a preservation program.	Likely	Major	**High**	PRHTA will continue to communicate with its stakeholders the need for additional funding for a preservation program, while prioritizing preservation with the funds available.
2.2	If PRHTA lacks industry experience, then the quality of construction will suffer.	Likely	Major	**High**	PRHTA will focus on providing additional training on construction quality. If feasible, PRHTA will also work to obtain additional monies from FHWA to support on-site practical hands-on training of agency personnel.
2.3	If PRHTA lacks stakeholder support, then the projects will not get implemented	Likely	Major	**High**	PRHTA will work closely with stakeholders and engage and educate them, so that stakeholders have a better understanding of asset management and the importance of asset management projects as well as the implications and costs of delaying or not doing these projects.
2.4	If PRHTA does not implement a systematic pavement preservation program, the high percentage of its pavements that are in the "Fair-Good" condition will fall into the "Poor" category necessitating higher levels of investments.	Likely	Major	**High**	PRHTA will focus on managing the three tiers of Fair pavements. These are the "Fair-Good", "Fair" and "Fair-Poor". PRHTA has severe funding constraints and therefore will have to make many tradeoffs when allocating funding. It will systematically prioritize the pavements in Fair condition while considering the projected deterioration. This will allow PRHTA to use its limited preservation budget most effectively to reduce the lane miles in Fair degrading to Poor.
2.5	If PRHTA does not have proper guidelines for preservation projects, it will result in improper decisions and selection of incorrect projects.	Unlikely	Moderate	Medium	PRHTA will review its guidance on preservation projects and request FHWA to provide support for Peer Exchanges with states whose preservation strategies can be easily transferred to PRHTA. PRHTA will then update its guidelines and systematically move to adopt these updated guidelines. Once updated, these guidelines will be shared with the industry as necessary to create alignment and adoption internally and with the industry.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
2.6	If PRHTA does not implement new preservation technologies, it may be using more costly treatments.	Likely	Moderate	Medium	PRHTA will work to update its pavement preservation decision tree to take advantage of more effective preservation treatments.
2.7	If PRHTA lacks industry experience, then the project costs will increase.	Likely	Moderate	Medium	PRHTA will focus on providing additional training on construction quality and mitigate any lack of expertise necessary to manage project costs. Where these risks are due to lack of staff, if additional funding is available, based on the priority of needs, PRHTA will consider adding and training staff to address these issues
2.8	Implementation of new preservation technologies will enable PRHTA to maximize the use of funds.	Likely	Moderate	Medium	PRHTA will work with FHWA to evaluate through peer exchanges with other states that use new preservation treatment that can be implemented in PR. PRHTA will then partner with the PR construction industry on these practices and systematically move to adopt these applicable technologies.
2.9	IF PRHTA does not implement some of the new preservation technologies it will have outdated decision trees that may not be the best and optimal solution.	Likely	Moderate	Medium	PRHTA will work to update its pavement preservation decision tree to improve its decision making.
2.10	If data collection is compromised by lack of equipment, then PRHTA will have data missing to make important project selection decisions. This will influence its long-term cost-effective management of assets.	Likely	Moderate	Medium	PRHTA will proactively address data collection issues and establish QA/QC procedures to ensure that data collection meets its needs and the data quality meets data standards. This will be a step towards ensuring that PRHTA can use the data with confidence to support decision making.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 3: Develop, implement, and use customized management systems to support data-driven asset management decisions.					
3.1	If PRHTA develops performance models, then it will have more confidence in the results of the management systems.	Likely	Major	**High**	PRHTA will develop performance models and incorporate them into the appropriate management systems.
3.2	Without consistent data and the tools to support the analysis and the personnel to operate the systems, then PRHTA will not be able to accurately forecast its investment needs	Likely	Major	**High**	PRHTA will analyze commercial management systems and determine if one meets its needs and can be operated with agency resources.
3.3	If PRHTA does not establish metrics and measurement systems, then it will not be able to make decisions based on validated data.	Likely	Minor	Medium	PRHTA will refine its metrics and measures and will train all the necessary personnel on them and have agency personnel update the data as well as use data to make decisions. PRHTA will also formally communicate how these metrics and measures will be used at the executive level for decision making, so agency personnel understand the importance of the metrics, measures and updating the data.
3.4	If PRHTA implements a QA/QC program, then it will reduce errors and uncertainties in its decision making.	Very Likely	Minor	Medium	PRHTA will implement a formal QA/QC program and train appropriate agency personnel on these programs subject to the funds being available.
3.5	If PRHTA develops validation rules, then it will be able to standardize its data validation procedures.	Very Likely	Minor	Medium	PRHTA will develop and formalize data validation procedures and educate the appropriate agency personnel on their use.
3.6	If PRHTA does not have Standard Operating Procedures, then there will be no consistency in practices and there can be errors and waste of resources	Likely	Moderate	Medium	PRHTA will develop and train staff on Standard Operating Procedures to eliminate duplication and ensure consistency and efficiency in its routine activities.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 4: Use data to drive project decisions.					
4.1	If PRHTA does not use data for decision making it could unintentionally make poor decisions.	Likely	Major	**High**	PRHTA will formalize the use of data to support decisions and will train agency personnel on its use.
4.2	If PRHTA does not have reliable data, then it can result in incorrect decisions.	Likely	Major	**High**	PRHTA will work to improve the reliability of data. It will have a tiered approach to this process by first focusing on data that drives critical decisions and then systematically addressing the reliability of other data important to decision making.
4.3	If PRHTA does not have the necessary equipment, it will be unable to collect data on time and this will negatively affect the project and other decisions.	Likely	Major	**High**	PRHTA will analyze the purchase cost and maintenance of the necessary data-collection equipment. It will compare these costs to other options such as contracting out the work and based on a cost/benefit analysis, and factoring the agency's financial situation, decide on the best approach to collect and make data of good quality available to PRHTA.
4.4	If PRHTA lacks historical data, then it will not have a good predictive model.	Very Likely	Moderate	**High**	PRHTA will implement necessary data governance. As part of this effort, PRHTA will review its existing database of historical data and create the necessary backup as well as compile where feasible the available historical data into databases. Moving forward PRHTA will identify the data that needs to be saved for historical trends and other analyses and create the appropriate databases and technology solutions to save and backup such data and have the technology solutions for quick and easy retrieval of such data.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
4.5	If PRHTA does not have stakeholder support, then it will not be able to make the necessary decisions.	Likely	Major	**High**	PRHTA will continue to work with its stakeholders and educate and engage them in important agency decisions, where appropriate, to gain their support and confidence.
4.6	If the quality of the data being used to make decisions is poor, then the decisions made to treat assets may be less than optimal or poor.	Likely	Major	**High**	PRHTA will continue to use data to support decision making. It will also develop and implement a continuous improvement process to improve the quality of data, focusing first on the data that supports executive decision making and then move to the next levels of data used in PRHTA. It will also monitor the quality of data and use feedback to continuously improve the quality of data.
4.7	If PRHTA does not have the necessary technical knowledge, it will be unable to collect data on time	Unlikely	Moderate	Medium	PRHTA will have agency personnel trained to gain the necessary knowledge to either collect the data or to QA/QC the data collected by contractors depending on whether the PRHTA will collect the data or contract out the data collection.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 5: Continuously educate stakeholders to support long-term funding of asset management activities, including preservation.					
5.1	If PRHTA does not continuously educate its stakeholders to support long-term preservation and other asset management activities it may not get the support necessary to achieve its asset management objectives.	Likely	Major	**High**	PRHTA will continue to work with its stakeholders and educate them on the importance and benefits of asset management and engage them on an on-going basis in important asset management decisions, where appropriate to gain their support and confidence.
5.2	If PRHTA educates its stakeholder on infrastructure condition (preservation + maintenance), MPOs and other stakeholders will support the allocation of adequate funding for managing infrastructure assets.	Likely	Major	**High**	PRHTA will continue to work with its stakeholders and educate them on the importance and benefits of preservation and maintenance, so they are well informed and inclined to support adequate funding for maintenance, preservation and improvement of existing infrastructure assets.
5.3	If decision-makers and other stakeholders are not educated on asset management, the project-selection process may not prioritize or give the necessary importance to asset management projects.	Unlikely	Major	Medium	PRHTA will continue to work with its stakeholders and educate them on the importance and benefits of asset management and engage them so they understand and support asset management projects in the selection process.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 6: Educate and communicate internal and external stakeholders on the benefits of asset management.					
6.1	If PRHTA does not educate and communicate the benefits of asset management to external stakeholders, then they will not understand the need or support the strategies necessary to achieve compliance with the Federal regulations.	Very Likely	Major	**Very High**	PRHTA will continue to work with its stakeholders and educate them on the importance and benefits of asset management and create a high-level understanding of the Federal regulation and implications of not achieving them. It will do so in a manner to create an understanding and support for compliance of the regulations and the benefits of improving and sustaining the condition and performance of the infrastructure assets.
6.2	If PRHTA does not have the participation of its stakeholders, then it can lose support for its programs.	Likely	Major	**High**	PRHTA will be transparent in its decision making to improve its credibility and gain support for its decisions. When funding permits, it will update its website to augment this transparent communication.
6.3	If PRHTA lacks effective communication tools, then it will not be able to communicate and engage the stakeholders on the benefits of asset management.	Unlikely	Moderate	Medium	PRHTA will continue to educate and train its staff and provide them necessary communication tools that they can use to effectively communicate the benefits of asset management to stakeholders.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 7: Manage quality, timely delivery, and schedule of construction activities and develop the construction industry to support the projects and programs necessary for asset management.					
7.1	If PRHTA does not have a robust construction industry, then the quality of construction projects will suffer.	Very Likely	Major	**Very High**	1-PRHTA will share with the industry its long-term investment plan so that industry has enough information and time to plan to deliver the program of construction projects. 2-PRHTA will also develop and implement performance measures and QA/QC to monitor, evaluate, address and improve the quality of construction.
7.2	If PRHTA does not have integration between planning and construction processes, then the time required to develop and construct projects will increase.	Very Likely	Major	**Very High**	PRHTA will develop and implement a process to ensure close coordination between planning and construction. It will also develop performance measures to track the coordination and collaboration necessary to expedite projects.
7.3	If there is an insufficient number of contractors, then there will be price increases and the overall program will suffer and a relatively fewer number of projects will be delivered.	Very Likely	Major	**Very High**	PRHTA will develop and publish a long-term plan for projects. This will encourage and develop the contractor industry. This should create an environment for competition and better quality and faster delivery of projects.
7.4	If there is a lack of ability of the construction industry to adopt new technology, then there will be a delay in implementing these new technologies that could improve project quality, reduce time and be less expensive.	Likely	Major	**High**	PRHTA will proactively work with the construction industry to ensure adoption of new technologies. It will also publish the long-term list of projects to encourage the growth of the construction community. Where feasible, it will support showcasing new technologies so that the construction industry can get exposed to these options.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
7.5	If there is improper planning of construction projects then, the quantities used will be more than planned and there will be delays resulting in increased costs.	Likely	Major	**High**	PRHTA will provide the necessary training internally so that the agency personnel can compute quantities correctly. This will also improve the engineer's estimate and can be used to monitor and manage the quantities planned and used by contractors.
7.6	If PR experiences natural events, (disasters) then projects will get delayed affecting the overall program delivery.	Likely	Major	**High**	PRHTA cannot control natural events, however, it can have good contracting procedures in place, streamline project delivery and develop good inventories of its assets so that after a natural disaster contracts can be awarded promptly
7.7	If PRHTA does not get adequate resources, then projects will get delayed and delays can result in cost increases.	Unlikely	Major	Medium	PRHTA will improve the planning process and communicate the need for adequate resources.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 8: Ensure subject matter expert continuity through succession planning to sustain the long-term cost-effective management of assets, and the data and management systems that support them.					
8.1	If there is no succession planning and career growth path for agency personnel, then there is no opportunity to grow inside the agency resulting in no motivation to excel in the job. This directly influences the quality of work as well as the incentive to be creative or develop new "out of the box" solutions.	Very Likely	Major	**Very High**	PRHTA will develop a succession plan and an HR plan to train and provide opportunities for growth within the agency. Growth opportunities are hindered by funding issues and to address this PRHTA will continue to educate, communicate and gain the support necessary for increasing PRHTA funding.
8.2	If PRHTA does not have succession planning and mentoring programs in place, there will be no knowledge transfer resulting in learning on the job and reinventing solutions to problems that may have already been developed and refined, and potential for missteps and errors that can add to the overall costs.	Very Likely	Major	**Very High**	PRHTA will develop a succession plan and an HR plan to train and provide opportunities for growth within the agency. Where possible, it will also create mentoring programs, formalize the documentation of agency processes and best practices. It will also look for supporting mentoring of agency personnel through other forums such as AASHTO.
8.3	If there is a lack of a comprehensive training program in PRHTA then agency personnel will be outdated on many new strategies and solutions that are tried and tested nationally and result in lack of necessary skills to do the job.	Very Likely	Major	**Very High**	PRHTA will implement a comprehensive training program and take advantage of Peer Exchanges with other state DOTs through FHWA to keep agency personnel updated on successful and tested practices and new technologies.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 9: Integrate and formalize the impact of weather in the planning, delivery, and long-term management of assets.					
9.1	If PRHTA lacks the necessary funding to fix the assets that were affected by the weather events, these assets will continue to deteriorate at a rapid pace and cost more to fix.	Very Likely	Major	**Very High**	PRHTA will continue to emphasize the extreme importance of fixing these assets and additional cost of delaying action. It will also continue to emphasize the importance of funding to fix these. It will also try to get support for alternative funding sources.
9.2	If there is a lack of documentation of previous weather events, then PRHTA will not be able to take advantage of past experiences and this will delay the response time to recover from events.	Very Likely	Major	**Very High**	PRHTA will try to collect and consolidate information and successful action of past events. It will refine, formalize and train agency personnel and other partners on how to collaboratively address future weather events.
9.3	If PRHTA does not have guidelines on how to respond to weather events, staff will improvise on mitigation strategies.	Very Likely	Major	**Very High**	PRHTA will try to collect and consolidate information and successful action of past events and create a catalog or database. It will refine, formalize and train agency personnel and other partners on how to collaboratively address future weather events. This will ensure that personnel is not improvising to address issues. Additionally, PRHTA can add to this catalog successful solutions that are applicable to Puerto Rico from other states that experienced similar events.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
9.4	If addressing weather events is not a priority for the leadership, it can result in poor implementation of the program	Unlikely	Moderate	Medium	PRHTA's current leadership is fully engaged and supports developing solutions to address future weather events. Formalizing the process, conducting mock testing as is being done by other States can help. In addition, having collaboration with other States that face similar problems (example Florida) can strengthen the importance to support robust implementation of such action.
9.5	If PRHTA does not implement the results of the vulnerability analysis in design and project development, it will increase the risks and deterioration.	Rare	Very Significant	Medium	PRHTA will implement the results of the vulnerability analysis in design and project development to mitigate risks and minimize accelerated deterioration.
9.6	If PRHTA does not update and implement its mitigation plan, it could result in losing lives and negatively impacting socioeconomic conditions.	Unlikely	Major	Medium	PRHTA plans to update and implement its mitigation plan, with a special focus on saving lives and improving the socioeconomic conditions.
9.7	If the State experiences heavy rains and earthquakes, then the critical facilities will collapse.	Rare	Very Significant	Medium	PRHTA will continue to prioritize critical facilities and implement solutions to make them withstand heavy rains and earthquakes to avoid collapses. It will pay close attention and prioritize "lifeline routes" and other critical and sole-access structures based on the funding available to it.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
9.8	The hurricane's impact on pavements and bridges will lead to accelerated deterioration.	Rare	Very Significant	Medium	PRHTA will continue to monitor the condition of the damaged bridges and pavements and prioritize and fix them based on criticality and funds available. It will also continue to emphasize the importance of fixing those that cannot be addressed due to funding and seek stakeholder support for additional necessary funds. Where feasible, it will try to implement some treatments to halt accelerated deterioration.
9.9	The hurricane's impact on pavements and bridges will result in the need for more ER funding	Rare	Very Significant	Medium	PRHTA will continue to monitor the condition of the damaged bridges and pavements and prioritize and fix them based on criticality and funds available. It will also continue to emphasize the importance of fixing those that cannot be addressed due to funding limitations and seek additional ER monies.
9.10	The hurricane's impact on pavements and bridges will result in delays to delivering STIP projects.	Rare	Very Significant	Medium	PRHTA will work to streamline processes to manage delays in the STIP projects and where necessary based on criticality slide projects by a year or two to accommodate the delivery of projects necessary to fix pavements and bridges affected by the hurricane.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 10: Implement the long-term cost-effective management of bridges to achieve a state of good repair.					
10.1	If the necessary human resources and equipment are not made available/ allocated to implement the bridge projects, then the quality of the projects may be poor or less than acceptable.	Likely	Major	**High**	PRHTA will continue to advocate for adequate human resources and equipment to ensure that the quality of bridge projects is acceptable.
10.2	If insufficient funds are allocated to bridges, then PRHTA will be unable to implement the right asset management program for bridges to implement cost-effective projects, and treatments to achieve a state of good repair.	Unlikely	Moderate	Medium	The PRHTA has developed a strategic approach to managing its bridges and the funding needed to maintain, improve and sustain these assets in a state of good repair. The amount of funds needed is significantly higher than the amount projected to be available. PRHTA has developed multiple scenarios based on different levels of funding and will implement the strategy based on the funds that it is allocated. It will continue to communicate the importance and benefits of adequate funding.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 11: Achieve and sustain the target of no more than 10% of National Highway System bridges in poor condition.					
11.1	If project delivery is slow, then PRHTA will be unable to address all the bridges on the critical findings list.	Likely	Major	**High**	PRHTA is working to streamline many aspects of project delivery including contracting and other requirements to remove unnecessary steps and expedite project delivery.
11.2	If no systematic maintenance is done, then bridges will deteriorate at an accelerated rate.	Very Likely	Moderate	**High**	PRHTA has conducted detailed analysis of its current and future bridge needs accounting for current condition and projected deterioration. It will continue to do some preservation and will continue to advocate for routine systematic maintenance to DPTW. It will also communicate the need for additional funding for bridge maintenance.
11.3	If weather and other climate risks occur, then PRHTA will be unable to deliver the necessary projects per schedule. This could result in bridge conditions worsening and necessitate additional funds to fix the assets.	Likely	Major	**High**	PRHTA will continue to monitor the condition of the damaged bridges and prioritize and fix them based on criticality and those that could degrade at an accelerated rate. PRHTA will share the analysis of such bridges and request FHWA to fast track these bridges.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 12: Systematically select bridge projects to manage them effectively over their entire lifecycle.					
12.1	If the selection of bridge projects is not done systematically, then PRHTA may not be able to meet its bridge targets	Likely	Major	**High**	The PRHTA has developed the funding needs to address its assets. PRHTA has also developed strategies for investment to systematically address the bridges based on prioritizing Interstates, NHS-non interstate and other routes. If PRHTA receives $86M per year as is currently projected, it will slow the rate of deterioration of its bridges.
Objective 13: Maintain pro-active inspection procedures for inspection of critical bridges.					
13.1	If PRHTA delays contracting consultants to perform the timely inspections, then the bridge inspection data will be outdated, resulting in less than optimal decisions	Unlikely	Major	Medium	PRHTA will work internally to expedite its contracting process to contract more bridge inspectors.
13.2	If there is a lack of equipment to inspect the critical bridges then the bridge inspectors will be unable to perform inspection on time, this could also result in delaying necessary treatments of these bridges.	Unlikely	Moderate	Medium	PRHTA will review its equipment needs and request additional equipment for inspecting the critical bridges. If some of the additional equipment needed is to address the large numbers of bridges affected by the hurricane and is a "one time need" PRHTA will look at alternate strategies such as to lease equipment, where feasible.
13.3	If PRHTA lacks the personnel necessary to perform inspections on time, then the bridge condition data will be outdated and not reflect the treatments needed	Unlikely	Major	Medium	PRHTA will communicate the importance and the need to hire additional personnel for bridge inspection.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 14: Reduce the backlog of deteriorated pavements and develop a program to systematically reduce the backlog of deteriorated bridges.					
14.1	If PRHTA lacks State funding to fix its backlog of deteriorated pavements and bridges, the number of these deteriorated assets will increase creating additional needs.	Very Likely	Major	**Very High**	PRHTA will continue to communicate with its stakeholders the impact of the existing gap in funding and the need for additional funding. It will also work to educate and engage stakeholders, so they understand the benefits of asset management and support PRHTA's need for additional funding.
14.2	If PRHTA loses federal funds it will not be able to fix its deteriorated bridges and pavements nor will it be able to treat the pavements in Fair condition that are close to being in Poor condition resulting in additional deteriorated assets and backlogs.	Likely	Very Significant	**High**	PRHTA will continue to work most responsibly with the funds allocated. PRHTA needs additional monies to fix its existing infrastructure and will continue to work with FHWA to receive additional Federal funding while also working with other stakeholders to get additional state funding.
14.3	If PRHTA lacks a systematic maintenance program, then pavements and bridges that could be fixed will deteriorate and need more expensive treatments, increasing the overall funding needed to fix these assets.	Very Likely	Major	**Very High**	PRHTA will continue to encourage adequate resources to DTPW so it can conduct necessary maintenance activities.
14.4	If PRHTA does not have control over DTPW's maintenance program, then it will be unable to do systematic and timely maintenance of bridges and pavements and PRHTA will be at risk of not achieving its asset management targets.	Very Likely	Moderate	**High**	PRHTA will continue to communicate to the central government the need to increase funding for DTPW to address routine maintenance.
14.5	If PRHTA does not do systematic preservation, then the pavements will continue to have increased potholes, cracking, and other distresses and road users will incur increased costs.	Very Likely	Major	**Very High**	Routine maintenance is necessary for all assets. PRHTA will prioritize and systematically do preservation activities to minimize to the extent possible the need for maintenance. PRHTA will continue to encourage adequate resources to DTPW so it can conduct necessary maintenance activities.

Risk		Likelihood	Impact	Consequence	Mitigation Strategies
Objective 15: Secure adequate funding to achieve and sustain a state of good repair.					
15.1	If the Oversight Board's need to fund other agencies affects its ability to provide the necessary funding to PRHTA, then PRHTA will not be able to implement its investment strategies to address its bridge and pavement needs.	Likely	Major	**High**	Publicize the asset management plan and encourage officials to fund its investment strategies to achieve a state of good repair.
Objective 16: Adapt asset management practices to PRHTA's new management structure and procedures.					
16.1	If essential consulting contracts are not renewed it will delay project development activities for pavements and bridges and will result in poor coordination between consultants.	Likely	Moderate	**Medium**	Ensure that contracts are promptly renewed or re-bid to ensure continuity in planning and project development activities.
16.2	If there is not good communication and coordination of the new PRHTA management processes, it can lead to delays in planning and programming.	Likely	Moderate	**Medium**	Develop effective communication channels to keep staff informed of new processes to plan, program, develop, and deliver projects.
16.3	If new types of contracts such as on-call indefinite delivery/indefinite quantity contracts are not provided, there could be delays in planning, programming, and project development.	Likely	Major	**High**	Issue requests for proposals to have consultant support available to provide needed services to support asset management programs.

5.3 Risks Associated with Environmental Conditions

Emergency Events in Risk Management

In Sec. 515.9 (c) of the final rule FHWA says "Risk management analysis should include the results for NHS pavements and bridges of the periodic evaluations under part 667 of this title of facilities repeatedly damaged by emergency events."

Section 667.1 of the statewide evaluation says

Each State, acting through its department of transportation (State DOT), shall conduct statewide evaluations to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events. The evaluations shall be conducted in accordance with the requirements in this part.

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

§ 667.7 Timing of evaluations
Not later than November 23, 2018, the State DOT must complete the statewide evaluation for all NHS roads, highways and bridges

§ 667.9 Consideration of evaluations
The State DOT shall consider the results of an evaluation prepared under this part when developing projects. State DOTs and metropolitan planning organizations are encouraged to include consideration of the evaluations during the development of transportation plans and programs, including TIPs and STIPs, and during the environmental review process under part 771 of this title. Nothing in this section prohibits State DOTs from proceeding with emergency repairs to restore functionality of the system, or from receiving emergency repair funding under part 668 of this title.

As required in 23 CFR 515.7(c), an assessment was performed to identify potential risks that can affect the condition and performance of assets, associated with current and future environmental conditions, such as extreme weather events, climate change, seismic activity, and a summary of the evaluations of facilities repeatedly damaged by emergency events, as defined in 23 CFR Part 667.

In accordance with Part 667, an evaluation was made of the best available data concerning declared emergencies. This was discussed in Chapter 2, section 2.7. It was found that there were 18 sites damaged more than once from different extreme weather declared emergencies. The list is shown in Table 5-3.

Three of the 18 sites were on the NHS and are discussed below. The remainder are discussed in an appendix. Sites on the Non-NHS are required to be analyzed by Nov. 23, 2020.

PRHTA will consider the results of the evaluation of each site when developing projects at these locations. PRHTA will consider the past damage at these locations and will consider reasonable alternatives during project planning, the environmental review process, and preliminary and final design.

TABLE 5-3: SITES WITH REPEATED DAMAGE DUE TO WEATHER

Count	Road Name Class	Road Number	Road System	Kilometer
1.	PR-	3	Non-NHS	99.20
2.	PR-	111	NHS Non-Interstate	13.10
3.	PR-	123	Non-NHS	42.00
4.	PR-	132	Non-NHS	19.40
5.	PR-	140	Non-NHS	6.00
6.	PR-	144	Non-NHS	6.80
7.	PR-	157	Non-NHS	6.80
8.	PR-	157	Non-NHS	14.80
9.	PR-	172	Non-NHS	2.50
10.	PR-	181	Non-NHS	22.60
11.	PR-	182	Non-NHS	7.90
12.	PR-	182	Non-NHS	10.90
13.	PR-	185	NHS Non-Interstate	17.60
14.	PR-	185	NHS Non-Interstate	18.30
15.	PR-	759	Non-NHS	4.20
16.	PR-	853	Non-NHS	7.70
17.	PR-	908	Non-NHS	10.90
18.	PR-	928	Non-NHS	3.60

Sites visits were conducted to assess the sites and provide specific recommendations. Pictures, observations, and recommendations per site are provided next.

5.3.1 PR-111 KM 13.2 - 13.2 near the community of Moca

A bridge at this location was destroyed by Hurricane Mariá and a temporary steel truss Acrow bridge has been installed. The temporary structure allows traffic in both directions and has the regulatory safety barriers, signing, and pavement marking on both directions. Both bridge abutments were treated with a stone and concrete coating.

PRHTA will plan for the permanent replacement of this structure as part of its normal bridge-program development process. When a permanent structure is developed, PRHTA will consider the hydrologic and soil conditions that could reduce the risk of future damage to this site.

PR-111 km 13.3 - Aerial imagery from Google Maps 2019 (https://www.google.com.pr/maps/@18.3589071,-67.0421909,159m/data=!3m1!1e3?hl=en&authuser=0)

PR-111 km 13.3 Westbound Direction

PR-111 km 13.2 Eastbound Direction

PR-111 km 13.2 Temporary ACROW Bridge

5.3.2 PR 185 Km 17.6 near the community of Juncos

This site experienced damage twice during storm events. A repair project included landslide reconstruction, pavement repairs, new drainage, concrete gutters, guardrail barriers / end-terminal, and other miscellaneous improvements. The existing roadway does have an acceptable pavement surface, marking and signage posting. After hurricane María, the site was subject to an evaluation and a permanent intervention was approved by FHWA.

PR-185 Km. 17.6 Juncos - Aerial photo from NOAA Maria Imagery (https://storms.ngs.noaa.gov/storms/maria/index.html#20/18.25790/-65.91359)

PR-185 Km. 17.6 Southbound to Juncos

5.3.3 PR 185 Km 18.3 near the community of Juncos

This site also experienced two landslides during emergency events. A repair project included landslide reconstruction, pavement repairs, new drainage system including concrete gutters and catch basins, guardrails barriers / end-terminal, concrete barriers with extended chain-link fences and other miscellaneous improvements. The existing roadway does have an acceptable pavement surface, marking and signage posting.

PR-185 Km. 18.3 Juncos - Aerial photo from Google Earth

PR-185 Km. 18.3 Northbound to Carolina

PR-185 Km. 18.3 Landslide Reconstruction

Chapter 6 Financial Plan

FHWA requires states to develop 10-year financial plans that indicate how they will pay for the bridge and pavement investments included in their transportation asset management plan. These financial plans have a long horizon of 10 years because it can take many years of consistent funding to repair the deteriorated bridge and pavement assets. Also, because bridges and pavements deteriorate slowly, it can take several years before the consequences of inadequate investments are evident in bridge and pavement conditions.

Financial Plan Requirements

FHWA is quite specific about the Transportation Asset Management Financial Plans. It defines them as a long-term plan spanning 10 years or longer, presenting a State DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets for asset condition during the plan period, and highlighting how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies.

The financial plan leads to investment strategies. Those are defined as a set of strategies that result from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effective-ness at a minimum practicable cost while man-aging risks.

FHWA in Sec. 515.7 (6) (d) says the state shall establish a financial plan development process that identifies annual costs over a minimum of 10 years. The plan shall produce:

(1) The estimated cost of expected future work to implement investment strategies contained in the asset management plan, by State fiscal year and work type;

(2) 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;

(3) Identification of anticipated funding sources; and

(4) 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.

This chapter describes the process used and conclusions reached in developing the 10-year asset management financial plan.

6.1 Summary of Puerto Rico's Finances

PRHTA's financial structure differs from that of many States which complicates its development of a typical financial plan as described in the Federal regulations. First, Puerto Rico is not a State but a territory. States' Federal-aid funds come from formulas which can be used to predict how much they will receive if Federal highway and transit appropriations change. Puerto Rico's Federal-aid funds come in a separate appropriation that is not driven by the typical formula. This complicates PHRTA's ability to predict its future Federal-aid apportionments.

Secondly, unlike many states, transportation-related taxes and fees in Puerto Rico are not constitutionally dedicated to transportation purposes. The island's government can in times of fiscal crisis re-direct those revenues to non-transportation purposes. In Puerto Rico, this has been informally called the "claw-back" of those revenues to the central government.

Puerto Rico has suffered from many consecutive years of a shrinking economy, population loss, and increasing debt payments. The draft Revised Fiscal Plan for Puerto Rico of March 10, 2019, states that between 2006 and 2018 Puerto Rico's real Gross National Product (GNP) shrank by more than 22 percent. More than 45 percent of the island's population lives in poverty, a rate that is two times the national average. In the past decade, more than 300,000 have moved from the island to the mainland U.S. The continued migration is estimated to further reduce the island's population from 3.168 million in 2018 to 2.929 million by 2024.

The severe economic crisis compounded by the island's debt load led Congress to enact PROMESA, or the Puerto Rico Oversight, Management, and Economic Stability Act of 2016. PROMESA places significant budgeting decisions in the hands of the Financial Oversight and Management Board. The island's government and Board are now engaged in a multi-year effort to renegotiate the debt load and oversee the development of long-term financial plans for the island's agencies.

Because of PROMESA, PRHTA does not by itself develop a financial plan. PRHTA and the island's central government developed a five-year Fiscal Plan for PRHTA that was approved by the PROMESA oversight board. The steps involved included:

1. PRHTA and the island's government established as guiding policy the intent to achieve a steady state of good repair for the island's infrastructure;
2. For the NHS, PRHTA used the FHWA bridge and pavement performance measures and minimum condition levels as targets to define a state of good repair;
3. PRHTA and its consultants estimated the investment levels necessary to achieve the performance targets and therefore the state of good repair;
4. PRHTA
    a. Reviewed scenarios for how to allocate funds to achieve the highest conditions with limited resources;

   b. Considered alternative strategies to economize or achieve the targets through different treatments;
   c. Reviewed risks that could accompany the investment levels;
5. The PRHTA submitted its state of good repair funding request to the central government that submitted it to the PROMESA board;
6. The board approved the 2018-2023 PRHTA Fiscal Plan in June 2018 that included $130 million for pavements and $86 million for bridges to achieve the state of good repair.

An updated PRHTA fiscal plan for 2019-2024 is expected to go into effect on June 30, 2019.

6.2 Identifying Funding Sources and Expected Funding Levels

Table 6-1 shows the local revenue sources and the expected receipts from each local source without Federal funds. PRHTA staff worked with central government experts and consultants to forecast the expected revenues from all the sources as seen in Table 6-1.

In Puerto Rico, this forecast does not determine how much revenue will be available for investment in assets because of the central government's need to "claw back" or retain revenues for other purposes such as debt repayment or general government services. The draft 2019-2024 PRHTA fiscal plan anticipates $4.572 billion of the revenue from Table 6-1 to be retained by the Central Government. That is shown as Central Government Retention.

The need for the central government to retain transportation revenues, and then for the Oversight and Management Board to approve the government's budgets, significantly affects PRHTA's ability to forecast revenues. The allocation of transportation-related tax receipts will be determined by the central government and the oversight board. Although forecasting revenue such as fuel tax receipts can be done mathematically based upon demographic factors, forecasted transportation-related receipts do not automatically come to PRHTA. How much revenue comes to PRHTA is determined by the central government and oversight board annually.

Table 6-2 builds from Table 6-1 and shows the transportation financial plan including State and Federal sources. It begins with State Operating Revenue After Retention carried over from Table 6-1. To those amounts are added Federal Highway Funds, Federal emergency funds, insurance proceeds from Mariá, and CAPEX which are the State funds provided to PRHTA for capital purposes.

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TABLE 6-1: PRHTA TRANSPORTATION STATE REVENUE SOURCES

Local Sources							
	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	total
Toll Fares	133,701	146,247	160,168	162,909	165,198	165,079	1,053,768
Gas Tax	173,867	182,096	182,837	188,047	190,775	190,357	1,239,048
Diesel Tax	21,196	21,196	21,196	21,196	21,196	21,196	139,675
Petroleum Product Tax	305,079	305,079	305,079	305,079	305,079	305,079	2,121,221
Cigarette Taxes	19,992	19,992	19,992	19,992	19,992	19,992	139,944
License Fees	22,046	23,089	23,183	23,844	24,190	24,137	168,785
Act 30 Transfer	111,708	116,995	117,471	120,818	122,571	122,302	763,862
Transit Revenues	25,571	25,835	25,859	26,026	26,113	26,100	163,555
Electronic Toll Fines	12,020	10,326	27,063	29,673	30,259	30,459	166,977
Other Income	10,685	11,932	12,752	13,827	13,982	13,958	81,754
Operating Revenue Before Retention	**835,865**	**862,786**	**895,599**	**911,409**	**919,354**	**918,659**	**6,038,590**
Central Goverment Retentation	(653,887)	(668,447)	(669,757)	(678,976)	(683,802)	(683,063)	(4,572,535)
Transfer from Central Government	97,300	-	222,400	238,000	223,900	224,900	1,144,600
Total Operating Revenue	**279,278**	**194,339**	**448,241**	**470,434**	**459,451**	**460,496**	**2,610,656**

TABLE 6-2: TRANSPORTATION FINANCIAL PLAN FOR 2019-2028

	PRHTA Fiscal Plan Amounts						Projected			Totals
	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025	2025-2026	2027-2028	
State Operating Revenue After Retention	$279,278	$194,339	$448,241	$470,434	$459,451	$460,496	$460,496	$460,496	$460,496	$3,693,727
FHWA Funds After Penalty	$117,406	$131,624	$131,624	$131,624	$131,624	$136,500	$136,500	$136,500	$136,500	$1,189,904
Carry Forward Unobligated Federal Balances		$119,855	$139,443	$102,987						$362,285
Federal Emergency Funds	$12,800	$80,594	$41,692	$29,301	$18,347					$182,734
Total Federal Available Each Year	$130,206	$332,073	$312,760	$263,913	$149,971	$136,500	$136,500	$136,500	$136,500	$1,734,923
CAPEX Annual Allocation	$85,181	$67,334	$59,067	$53,020	$53,761	$53,761	$286,944	$0		$659,068
Carry Forward CAPEX Balances		$164,235	$72,121							$236,356
Total CAPEX Available Per Year	$85,181	$231,569	$131,188	$53,020	$53,761	$53,761	$53,761	$53,761	$53,761	$769,764
Insurance, Hurricane Loss	$54,004	$21,111								$75,115
Total Federal and State Available per Year	$548,668	$779,093	$892,189	$787,367	$663,184	$650,757	$650,757	$650,757	$650,757	$6,273,529

Table 6-2 shows both the annual amounts of FHWA funds expected to be received each year and the amount of State or CAPEX, funds. Also, it shows carry forward balances for both FHWA funds and CAPEX funds from earlier years. Those balances accumulated before Hurricane Mariá because of undelivered but programmed projects. When Maria hit, PRHTA's program was severely delayed as emergency projects were pursued. Between 2019 and 2022, those past State and Federal balances will be spent upon already programmed projects.

Table 6-2 indicates that for 2019-2020 to 2021-2022, PRHTA will invest $362 million in carry forward Federal balances and $236 million in CAPEX balances. Those past balances are largely responsible for the much larger bridge and pavement program in years 2019 to 2022. The State Operating Revenue will be used for salaries, operations, pension payments, debt repayment, and other "off the top" expenditures. The draft fiscal plan includes the construction of only three large capacity projects that have been under development for many years. After that, it anticipates no new projects to add capacity or alleviate congestion. All capital funds are anticipated to be directed only to safety, traffic engineering, bridges, and pavements. The only exceptions are transportation alternatives and other projects funded through the funds sub-allocated to the MPO.

The 2018-2023 PRHTA Fiscal Plan anticipates providing for the years 2019-2023 $13 million annually for traffic signals, $33 million for safety, $86 million for bridges, and $130 million for pavements. The TAMP fiscal plan projects that those amounts will be continued through 2028. As was mentioned, that represents a nearly five-fold increase in bridge expenditures compared to recent STIPs and a more than doubling of pavement expenditures. The fiscal plan emphasizes as a priority the need to improve system conditions and to fund PRHTA asset programs to sustain a steady state of good repair. Table 6-3 shows the planned and programmed amounts for bridges and pavements from 2019 to 2028.

TABLE 6-3: PAVEMENT AND BRIDGE ALLOCATIONS 2019-2028

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Pavement											
Interstate	$60,770,299	$28,505,966	$23,356,979	$36,054,450	$32,574,410	$67,585,424	$68,666,584	$57,162,956	$56,322,246	$49,617,217	$480,616,531
NHS Non-Interstate	$36,335,131	$47,401,968	$48,671,158	$17,644,510	$67,842,173	$40,551,255	$39,826,619	$33,461,243	$32,184,141	$28,161,123	$392,079,320
Non-NHS	$41,869,022	$83,863,023	$13,905,811	$41,123,536	$36,594,281	$27,034,170	$28,839,965	$48,797,646	$45,594,199	$56,322,246	$423,943,900
Total	**$138,974,452**	**$159,770,956**	**$85,933,949**	**$94,822,496**	**$137,010,864**	**$135,170,849**	**$137,333,168**	**$139,421,845**	**$134,100,586**	**$134,100,586**	**$1,296,639,751**
Bridge											
NHS	$46,215,324	$6,700,000	$21,661,564	$45,336,885	$55,686,555	$51,600,000	$51,600,000	$51,600,000	$51,600,000	$59,926,948	$441,927,276
Non-NHS	$22,226,966	$16,851,011	$12,963,276	$27,330,594	$30,313,445	$34,400,000	$34,400,000	$34,400,000	$34,400,000	$26,073,052	$273,358,345
Total	**$68,442,290**	**$23,551,011**	**$34,624,840**	**$72,667,479**	**$86,000,000**	**$86,000,000**	**$86,000,000**	**$86,000,000**	**$86,000,000**	**$86,000,000**	**$715,285,621**
Grand Total	**$207,416,742**	**$183,321,967**	**$120,558,789**	**$167,489,975**	**$223,010,864**	**$221,170,849**	**$223,333,168**	**$225,421,845**	**$220,100,586**	**$220,100,586**	**$2,011,925,371**

Chapter 7 Investment Strategies

7.1 Chapter Summary

To summarize the chapter, the investment strategies indicate that PRHTA should achieve its condition targets and its state of good repair, if current assumptions hold. Based upon the aggressive delivery of backlogged projects underway in 2019-2022 and based upon annual allocations between 2023-2028 of $130 million for pavements and $86 million for bridges, the investment analysis indicates that PRHTA can achieve its condition targets near the end of the 10-year asset management plan period. The analyses indicate that a properly timed mix of preservation, rehabilitation, and reconstruction projects based upon the 2018 Fiscal Plan investment levels should be adequate to improve conditions and achieve the defined state of good repair.

However, in the risk section of this chapter, the serious risks that could impede the state of good repair are highlighted. That section emphasizes that the 2019 Transportation Asset Management Plan analysis represents a “point in time” forecast based upon 2019 assumptions about investment levels, inflation, asset deterioration rates, and future investment strategies. If any of those change, the resulting asset conditions also will change.

Investment Strategies Requirements

23 CFR 515.7 (e) says, 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.
(5) 23 CFR 515.9 (f) says, an asset management plan shall discuss how the plan’s investment strategies collectively would make or support progress toward:
(6) Achieving and sustaining a desired state of good repair over the life cycle of the assets,
(7) Improving or preserving the condition of the assets and the performance of the NHS relating to physical assets,
(8) Achieving the State DOT targets for asset condition and performance of the NHS in accordance with 23 U.S.C. 150(d), and
(9) Achieving the national goals identified in 23 U.S.C. 150(b).

FHWA defines investment strategies 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.*

Chapter 3 and Chapter 4 describe processes by which all PRHTA pavements and bridges, were examined for their condition and the condition's relationship to the PRHTA targets and to the minimum Federal condition levels. Deterioration rates were estimated to forecast how the assets will deteriorate over 10 years. Unit costs for different treatment types were identified ranging from light preservation to keep good assets in good condition to complete reconstruction of severely deteriorated pavements and bridges. Then, estimates were made of how many lane miles and how many square meters of bridges need to be treated with preservation, rehabilitation, and reconstruction to achieve the condition targets.

The sections below describe how based upon the revenue forecast, gap analysis, risk analysis, and investment strategies, funds will be allocated across work types to make progress toward a state of good repair.

7.2 The Investment Strategy Process

The investment strategy steps were based upon the process adopted in the 2018 initial TAMP that included the following.

1. PRHTA subject matter experts updated the three-dimensional matrix analyses with the most current condition data and unit cost information.
2. They updated the gap analysis by comparing the results of the best available data with the condition targets and determined how gaps may have changed since the analysis in the 2018 initial TAMP.
3. They reviewed the categories of needs, such as how much of the total investment need is to preserve, rehabilitate, or reconstruct assets based upon the needs identified through the three-dimensional matrices.
4. They developed the scenarios contained in this chapter to balance the mix of preservation, rehabilitation, and reconstruction to achieve the best conditions with the available revenue.
5. They conducted iterations of funding levels and compared tradeoffs between investments in NHS bridges and pavements to determine an acceptable investment level that achieved the condition targets between the two asset classes.
6. They also considered investments needed for the Non-NHS assets to maintain the more than 8,000 lane miles of Non-NHS routes.
7. Project-development schedules were considered. Although projects such as complex concrete-pavement replacements are priorities, they may take several

years to develop. How investments are spread across the 10-years of the TAMP was based on project-development realities.

8. The subject matter experts considered the risks facing the department such as the need to address scour-critical structures, the need to consider the assets identified in the Sec. 667 analysis, hurricane-recovery or resilience needs, and other risks that were identified.
9. The Highway Safety Improvement Plan, the congestion, and freight plans were reviewed to consider overlapping needs between the asset investments and the objectives in those plans.

Scenarios were generated reflecting the available revenues identified in the financial plan and the considerations in steps 1-9.

As indicated in at the beginning of Chapter 4, for the analyses, we are naming "Programmed" those projects that are already defined and with budgets allocated and "Planned" those additional lane miles and deck area identified to be treated but that haven't been defined as projects yet. These are included in the investment strategy from 2024 and beyond, as PRHTA will be converting them into projects.

Also as indicated at the beginning of Chapter 4, the basic analysis followed the following general steps:

1. Identify needs.
2. Identify available funding.
3. Identify programmed projects.
4. Plan interventions based on remaining needs, deterioration, and budget.

7.3 Investment Strategies

The three investment strategies below represent the preferred investment strategies and they span two distinct eras from 2019 to 2028. The current era of 2019-2022 reflects the current STIP and State-funded programs of PEMOC and *Abriendo Caminos*. Projects in those three categories respond to the Puerto Rico priorities of repairing Mariá damage, clearing the backlog of previously programmed projects, and immediately responding to poor pavements with the PEMOC and *Abriendo Caminos* efforts. The current program of projects is almost twice as large as normal which reflects the spending of past balances and the inclusion of Federal emergency repair funds.

The 2018 initial asset management plan also is influencing the 2019-2022 period. The number of bridge preservation projects has increased substantially in response to the 2018 TAMP documenting the growth in Fair-to-Poor structures. Also, the *Abriendo Caminos* and PEMOC programs are responding to the Poor pavement conditions documented in the 2018 TAMP. The 2019 asset management plan investment strategies reflect the 2019-2022 STIP, PEMOC, and *Abriendo Caminos* programs. Those form most of the investments seen in the strategies for 2019 to 2022.

Beginning in 2023, the number and cost of projects recommended in the TAMP increase. The investment strategies are based upon expecting that by 2023 the past State and Federal balances have been cleared, the Mariá repairs complete, and the full $130 million for pavements and $86 million for bridges are available. The 2023-2028 investment strategies build upon the bridge and pavement improvements achieved by the 2019-2022 projects. Based upon the conditions explained above for 2023, the investment strategies through 2028 include a balanced mix of preservation, rehabilitation, and replacement to best use the agency's bridge and pavement funds. The investment strategies are the following.

Strategy 1 Addressing Existing Programmed Projects: The 2019 to 2028 asset management plan incorporates the already underway investments from the 2019-2022 STIP, *Abriendo Caminos*, PEMOC, and Metropistas. The large program funded by those efforts substantially improves Puerto Rico's pavements and bridges and phases in the lifecycle-based strategies for 2023-2028 while incorporating existing PRHTA project priorities.

Strategy 2 Additional Projects Proposed in Years that Have Some Projects Programed but Have Additional Funds Available[7]: Years 2020- 2023 and 2028 have some projects already defined and programmed for the period. However, additional projects have been proposed to take advantage of the remaining available funds. Those additional projects will align with the TAMP recommendations of a mix of preservation, rehabilitation, and reconstruction.

Strategy 3 Projects Planned for Years that Have Not Yet Been Programmed: The $130 million for pavements and $86 million for bridges are allocated as shown in Table 7-6 and Table 7-12 to achieve the condition levels as shown below in Table 7-13 and Table 7-14. Based on the needs and assuming these funds will be available for investments in pavements and bridges, using life-cycle planning strategies projects have been proposed. This strategy of entirely proposed projects applies to years 2024 to 2027.

The next subsections and sections describe in detail the above strategies, which considered programmed projects, available budget, proposed projects, deterioration, and resulting condition changes. For calculation process details, refer to Appendix M.

7.3.1 Pavement Financial Plan Until and After 2023

This first investment plan period is highlighted by an intense focus on recovering from Mariá and delivering the backlog of State and Federal-aid projects. An important aspect of the current era is two State-funded programs that are making an immediate impact on

[7] This strategy includes a mixed of already programmed projects and newly proposed ones. Note that some of the projects assigned for year 2023 are actually identified as "future investment" on the STIP and were assigned to this year for analysis purposes. Also, there are some bridge projects already defined but with no specific date assigned, that were allocated to year 2028.

Puerto Rico's highway conditions. Those two are *Abriendo Caminos*, or Opening Roads, and PEMOC which is *Programa Estatal de Modernización de Carreteras*, or State Highway Modernization Program. Both are one-time programs that develop quick projects to address the most seriously deteriorated pavements. The *Abriendo Caminos* program focuses on minor repairs and preservation and PEMOC focus on rehabilitation and reconstruction. Table 7-1 shows the amount from 2019 through 2023 for all four programs. Beyond 2021, only the STIP program and Metropista investments are anticipated.

TABLE 7-1: PROGRAMMED INVESTMENTS

Program \ Year	2019	2020	2021	2022	2023	Total
Abriendo Caminos	$42,492,041	$69,041,250				$111,533,291
Metropistas	$4,292,067					$4,292,067
PEMOC		$26,403,052	$14,619,159			$41,022,211
STIP	$92,190,344	$60,561,983	$66,272,805	$91,327,395	$81,800,000	$392,152,526
Total	**$138,974,452**	**$156,006,285**	**$80,891,964**	**$91,327,395**	**$81,800,000**	**$549,000,096**

Pavement projects in the STIP, PEMOC, and *Abriendo Caminos* combined are expected to treat nearly one-third of all PRHTA pavements between 2019 and 2023. Table 7-2 shows the lane miles to be treated by Interstate, non-Interstate NHS, and non-NHS. A total of 702.7 lane miles of Interstate, 1,205.3 lane miles of non-Interstate NHS, and 1,527.9 lane miles of Non-NHS are to be treated for a total of 3,435.91 lane miles. PRHTA manages 11,253 lane miles in total.

TABLE 7-2: PROGRAMMED LANE MILES

Lane Miles Programmed to be Treated (2019-2028)				
Program	**System**			
	INT	**NHS**	**Other**	**Total**
Abriendo Caminos	538.47	895.67	1,095.11	**2,529.25**
Metropistas	1.20	0.00	0.00	**1.20**
PEMOC	4.23	13.16	238.85	**256.24**
STIP	158.80	296.43	193.98	**649.22**
Total	**702.70**	**1,205.27**	**1,527.94**	**3,435.91**

The pavement needs identified for the base condition, as explained in section 2.5.5, are summarized in Table 7-3.

TABLE 7-3: BASE CONDITION PAVEMENT NEEDS

Base Condition Needs as per Treatment Matrix and Unit Costs				
System	**Surface**	**Treatment**	**Lane Miles (Extrapolation)**	**Estimated Cost**
INT	Asphalt	**Preservation**	143.69	$28,122,447.75
		Minor Rehabilitation	14.58	$5,964,761.65
		Major Rehabilitation	123.09	$77,878,481.40
		Reconstruction	15.10	$9,767,271.15
	Concrete	**Preservation**	48.61	$20,819,720.43
		Minor Rehabilitation	21.21	$12,278,280.85
		Major Rehabilitation	107.71	$66,826,814.06
		Reconstruction	184.37	$190,559,614.38
	Total		**658.38**	**$412,217,391.67**
NHS	Asphalt	**Preservation**	636.27	$102,518,264.46
		Minor Rehabilitation	9.52	$3,610,413.67
		Major Rehabilitation	396.22	$176,000,495.49
		Reconstruction	94.39	$43,864,363.78
	Concrete	**Preservation**	14.97	$5,964,015.57
		Minor Rehabilitation	1.91	$1,050,345.39
		Major Rehabilitation	37.77	$22,125,192.30
		Reconstruction	62.04	$62,262,713.62
	Total		**1,253.10**	**$417,395,804.27**
Other	Asphalt	**Preservation**	2,325.86	$309,530,363.50
		Minor Rehabilitation	247.47	$77,250,182.63
		Major Rehabilitation	1,317.70	$481,868,984.97
		Reconstruction	361.78	$138,394,141.44
	Concrete	**Preservation**	18.15	$6,060,779.30
		Minor Rehabilitation	13.55	$6,163,831.46
		Major Rehabilitation	29.29	$14,118,570.79
		Reconstruction	88.24	$72,828,760.67
	Total		**4,402.03**	**$1,106,215,614.77**
Grand Total			**6,313.51**	**$1,935,828,810.71**

Based on the needs identified for the base condition, a strategy was developed to address those needs based on available programs and budget. This strategy was applied in the second phase which is from 2023 to 2028.

By 2023, the backlog of unobligated balances and unspent State funds are invested and most of the Mariá recovery projects are complete. Then, the annual pavement program of $130 million as allocated in the Puerto Rico fiscal plan goes into effect. The $130 million represents the total of State and Federal-aid funds expected to be allocated to pavements. The investment strategies anticipate that about 37 percent of the $130 million will be allocated to Interstate projects, 21 percent to non-Interstate NHS, and about 42 percent to the Non-NHS. These percentages are preliminary and could change. However, as a “snapshot in time,” they represent the current analysis driving the investment

strategies. The resulting proportions per year, including programmed and proposed projects, are shown in Table 7-4.

TABLE 7-4: BUDGET PROPORTION PER SYSTEM PER YEAR

Budget Proportion	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
INT	44%	18%	27%	38%	24%	50%	50%	41%	42%	37%
NHS	26%	30%	57%	19%	50%	30%	29%	24%	24%	21%
Other	30%	52%	16%	43%	27%	20%	21%	35%	34%	42%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 7-5 builds from the 2019-2023 STIP projects and forecasts the amount of lane miles of treatment through 2028. The values in each cell represent expected lane miles. Table 7-5 is color-coded to show the Mariá era period of 2018 to 2022 in blue. Lane miles of treatments in those years are already programmed and under development in the STIP, or in *Abriendo Caminos* or PEMOC. Because they are State funded, not all *Abriendo Caminos* or PEMOC projects are included in the STIP. The year 2023 is shown in pink as a transition year. Some of the lane miles in 2023 are already programmed and additional ones are recommended in the preferred Investment Strategy shown below. Years 2024 to 2028 are shown in teal and represent the estimated lane miles by pavement condition included in the preferred investment strategy.

The lane miles to be treated in Table 7-5 are forecast to achieve the Interstate and non-Interstate NHS pavement condition targets by 2028 although by the slimmest of margins. In terms of proportion per treatment, 65 percent of the lane miles to be treated are for preservation treatments, and 19 percent for rehabilitation, and 16 percent for replacement. (see Figure 7-1). The Interstate pavement condition is forecast to be 5.0 percent Poor by 2028 and the non-Interstate NHS to be 20 percent poor. The targets are 5 percent and 20 percent respectively.

Between the publication of this TAMP and 2023, the projects for 2023-2028 will need to be planned, scoped, and readied for delivery. Many assumptions could change in the interim but based on the 2019 assumptions the pavement financial plan from 2019 to 2028 would generally be as shown in Table 7-6. The table represents the planning-level allocations expected as annual averages. It is unlikely that the annual expenditures will match these allocations. Pavement funds will be co-mingled with safety and bridge funds to plan projects that minimize maintenance of traffic impacts and mobilization costs. In some years, expenditures will be above $130 million and others below that amount. These amounts in Table 7-6 represent the average, annual pavement allocations expected between 2023 and 2028 based upon the assumptions in place as of June of 2019.

TABLE 7-5 LANE MILES OF TREATMENT PROGRAMMED AND PLANNED

Programmed & Proposed Lane Miles		2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Interstate	Good	11.08	0.00	1.59	0.00	0.00	0.00	0.00	0.00	0.00	50.39
	Fair to Good	31.79	0.00	2.57	0.00	0.00	0.00	0.00	0.00	0.00	156.48
	Fair - Fair	30.75	5.97	5.34	2.21	4.59	4.66	9.70	13.39	32.01	294.52
	Fair to Poor	25.84	6.35	11.17	0.90	1.87	1.90	3.95	3.89	3.43	155.43
	Poor	29.44	16.22	22.79	34.18	70.91	72.04	56.23	54.17	41.21	474.95
	Total	**128.89**	**28.54**	**43.45**	**37.29**	**77.37**	**78.60**	**69.88**	**71.45**	**76.65**	**1,131.78**
NHS Non-Interstate	Good	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	35.81
	Fair to Good	11.30	4.51	1.06	3.30	0.00	0.00	0.00	0.00	0.00	131.50
	Fair - Fair	86.78	39.52	15.77	44.41	23.75	23.33	49.00	37.70	32.99	704.18
	Fair to Poor	30.85	30.29	7.05	7.90	8.66	8.51	12.87	10.31	6.02	251.82
	Poor	90.37	24.28	5.98	8.28	53.32	52.37	31.35	34.39	32.40	537.91
	Total	**220.17**	**98.60**	**29.86**	**63.88**	**85.74**	**84.21**	**93.21**	**82.40**	**71.41**	**1,661.21**
Non-NHS	Good	19.05	1.74	2.65	0.58	0.00	0.00	0.00	0.00	0.00	33.12
	Fair to Good	261.89	22.42	33.95	7.45	0.00	0.00	0.00	0.00	0.00	411.35
	Fair - Fair	460.40	44.86	58.96	28.08	26.48	18.83	47.79	29.77	55.16	936.26
	Fair to Poor	136.70	13.40	17.11	9.96	3.62	3.86	6.53	6.10	7.54	252.01
	Poor	81.56	6.69	9.61	18.33	50.43	57.16	91.03	90.37	105.06	532.47
	Total	**959.61**	**89.12**	**122.29**	**64.41**	**80.52**	**79.85**	**145.34**	**126.23**	**167.76**	**2,165.20**
Total	**Total**	**1,308.67**	**216.25**	**195.60**	**165.58**	**243.63**	**242.66**	**308.44**	**280.08**	**315.81**	**4,958.19**

First Period – Includes STIP and locally funded projects to improve SOGR after Hurricane María.
Second Period – Includes STIP programmed projects and some additional lane miles planned but without particularly assigned projects.
Third Period – Includes planned lane miles without particularly assigned projects.

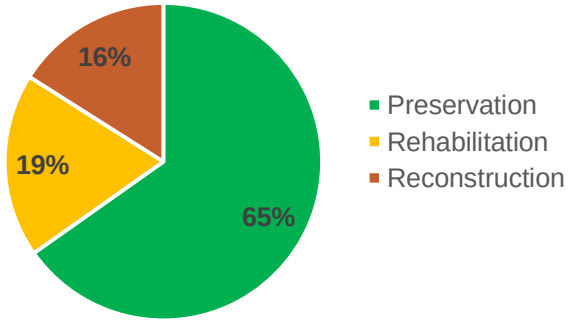


FIGURE 7-1: PAVEMENT TREATMENTS PLANNED AND PROGRAMMED (% LANE MILES)

TABLE 7-6: AMOUNT PROGRAMMED AND PLANNED FOR PAVEMENTS 2019-2028

System	Treatment	Total Expected Investment										
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Interstate	Preservation	$17,847,301	$3,828,139	$661,125	$458,291	$474,587	$984,674	$1,000,426	$2,082,065	$2,872,020	$6,867,450	$37,076,079
	Minor Rehabilitation	$18,935,524	$184,002	$246,432	$170,827	$176,901	$367,034	$372,906	$776,083	$1,070,537	$2,559,821	$24,860,067
	Major Rehabilitation	$23,987,474	$9,374,303	$14,733,577	$712,598	$5,502,543	$11,416,682	$11,599,314	$10,205,016	$9,871,858	$7,728,980	$105,132,344
	Reconstruction	$0	$15,119,522	$7,715,845	$34,712,734	$26,420,379	$54,817,034	$55,693,939	$44,099,792	$42,507,831	$32,460,966	$313,548,042
	Total	**$60,770,299**	**$28,505,966**	**$23,356,979**	**$36,054,450**	**$32,574,410**	**$67,585,424**	**$68,666,584**	**$57,162,956**	**$56,322,246**	**$49,617,217**	**$480,616,531**
NHS Non	Preservation	$20,233,426	$30,081,931	$30,905,352	$17,362,023	$13,705,557	$3,888,081	$3,818,602	$8,020,714	$6,171,673	$5,400,213	$139,587,572
	Minor Rehabilitation	$0	$3,102	$4,154	$2,880	$159,203	$167,045	$164,060	$344,597	$265,156	$232,011	$1,342,206
	Major Rehabilitation	$2,876,026	$1,751,868	$895,634	$126,361	$3,789,724	$13,628,348	$13,384,814	$11,199,527	$10,726,200	$8,589,574	$66,968,077
	Reconstruction	$13,225,679	$15,565,067	$16,866,019	$153,247	$50,187,688	$22,867,782	$22,459,143	$13,896,405	$15,021,112	$13,939,324	$184,181,465
	Total	**$36,335,131**	**$47,401,968**	**$48,671,158**	**$17,644,510**	**$67,842,173**	**$40,551,255**	**$39,826,619**	**$33,461,243**	**$32,184,141**	**$28,161,123**	**$392,079,320**
Non NHS	Preservation	$27,265,307	$59,891,800	$0	$19,505,000	$26,834,088	$3,207,381	$2,281,083	$5,789,438	$3,606,250	$6,682,170	$155,062,518
	Minor Rehabilitation	$0	$0	$0	$3,001,623	$484,768	$847,744	$602,914	$1,530,209	$953,169	$1,766,167	$9,186,594
	Major Rehabilitation	$1,954,566	$23,971,223	$13,905,811	$6,028	$5,369,270	$11,800,043	$13,299,735	$21,299,501	$21,026,058	$24,583,886	$137,216,121
	Reconstruction	$12,649,149	$0	$0	$18,610,885	$3,906,155	$11,179,001	$12,656,234	$20,178,497	$20,008,722	$23,290,023	$122,478,666
	Total	**$41,869,022**	**$83,863,023**	**$13,905,811**	**$41,123,536**	**$36,594,281**	**$27,034,170**	**$28,839,965**	**$48,797,646**	**$45,594,199**	**$56,322,246**	**$423,943,900**
Total		**$138,974,452**	**$159,770,956**	**$85,933,949**	**$94,822,496**	**$137,010,864**	**$135,170,849**	**$137,333,168**	**$139,421,845**	**$134,100,586**	**$134,100,586**	**$1,296,639,751**

Notes: The PRHTA pavement investment strategy amounts for 2019-2022 are already programmed. The amounts for 2023 and beyond are forecasts.

7.3.2 Pavement Investment by Work Types

FHWA regulation also requires that asset management plans include estimates of how funds will be allocated by five work types which are initial construction, maintenance, preservation, rehabilitation, and reconstruction. PRHTA categorizes its work types somewhat differently so a "cross-walk" is provided between the PRHTA work types and the FHWA work types. Table 7-7 shows the "cross walk" from the PRHTA work types to the FHWA work types for both pavements and bridges.

TABLE 7-7:THE CROSS WALK BETWEEN PRHTA AND FHWA WORK TYPES FOR BOTH BRIDGES AND PAVEMENTS

PRHTA Description	Crosswalk to FHWA Category
No Immediate Action **Routine Inspection** **Maintenance**	**Maintenance**
Preservation (Including *Abriendo Caminos*)	**Preservation**
Minor Rehabilitation	**Rehabilitation**
Major Rehabilitation (Including PEMOC)	
Replacement **Reconstruction**	**Reconstruction**

Table 7-6 shows the expected expenditures by work type by year. The financial plan amounts shown for 2019 to 2022 are based upon actual STIP projects, and projects from *Abriendo Caminos*, PEMOC, and Metropista. In other words, 2019 through 2022 are "actuals" based upon already programmed projects. The year 2023 is a hybrid with some already programmed projects and additional lane miles recommended by the preferred investment strategy. Years 2024 through 2028 are recommended based upon the best mix of treatments and available revenue to achieve a state of good repair.

7.3.3 Pavement Financial Gap

As noted earlier in this section, the investments seen in Table 7-6 are forecast to achieve 5 percent Poor Interstate pavements and 20 percent Poor NHS non-Interstate pavement conditions by 2028 which achieves both targets. However, the Non-NHS pavements are forecast to deteriorate substantially. The amount of Poor Non-NHS is expected to increase from 7.9 percent in 2019 to 36.5 percent by 2028.

The plan assigns most of the budget to NHS segments at the earlier years of the 10-year period, aiming to reach NHS federal targets as soon as possible. After SOGR for NHS is reached, the proportion of budget assigned to NHS starts decreasing (as less funds are expected to be needed to keep the achieved SOGR than to reach it) and increasing for Non-NHS. Hence, the aim is to achieve a SOGR for the NHS and then, stabilize the % Poor of Non-NHS in the decade after 2028.

7.3.4 Bridge Financial Plan and Investment by Work Type

As with pavements, the bridge financial plan falls into two eras, 2019-2022 and 2023-2028. The current period of 2019-2022 is marked by the focus on Mariá repairs, the delivery of delayed projects, spending of accumulated balances, and the introduction of additional projects in response to the analysis from the 2018 initial TAMP. Immediately following the 2018 analysis that showed the need for more rehabilitation and preservation projects, PRHTA began programming additional projects. Using its unspent balances and the $86 million allocated by the 2018-2023 Fiscal Plan, PRHTA programmed a series of additional preservation projects, and deck-replacement projects. The apportioned investment per program per year is presented in Table 7-8. The area to treat per program and system is shown in Table 7-9.

TABLE 7-8: PROGRAMMED BRIDGE INVESTMENT

Program	2018	2019	2020	2021	2022	2023	2024 - 2027	2028	Total
Bridge Replacement	$0	$11,861,968	$0	$0	$0	$0	$0	$0	$11,861,968
Deck Replacement	$0	$11,753,174	$0	$0	$0	$0	$0	$0	$11,753,174
Initial TAMP	$0	$0	$0	$0	$0	$44,048,282	$0	$20,817,369	$64,865,651
Metropistas	$10,672,610	$2,111,586	$0	$0	$0	$0	$0	$0	$12,784,195
STIP	$8,095,000	$42,715,563	$23,551,011	$34,624,840	$72,667,479	$0	$0	$0	$181,653,894
Total	**$18,767,610**	**$68,442,290**	**$23,551,011**	**$34,624,840**	**$72,667,479**	**$44,048,282**	**$0**	**$20,817,369**	**$282,918,882**

TABLE 7-9: PROGRAMMED BRIDGE AREA TO TREAT

Program	NHS Sq. Mts.	Non-NHS Sq. Mts.
Bridge Replacement	0.00	1,753.12
Deck Replacement	4,979.94	0.00
Initial TAMP	70,015.77	27,909.22
Metropistas	18,036.45	0.00
STIP	142,122.54	28,352.92
Total	**235,154.70**	**58,015.26**

The pavement needs identified for the base condition, as explained in section 2.6.5, are summarized in Table 7-10

TABLE 7-10: BASE CONDITION BRIDGE NEEDS

Treatment Group	Investment Cost		Deck Area (Sq. Mts.)		Amount of Bridges	
	NHS	Non-NHS	NHS	Non-NHS	NHS	Non-NHS
No Immediate Action	$0	$0	41,839.3	13,970.3	20	41
Preservation	$298,410,814	$94,305,754	533,256.8	218,387.9	272	303
Minor Rehabilitation	$1,125,704,348	$296,215,778	773,621.8	218,952.1	403	536
Major Rehabilitation	$423,618,379	$241,428,100	214,114.8	123,316.3	139	482
Replacement	$66,640,114	$62,682,823	21,494.8	21,736.3	15	114
Treatment Subtotal	**$1,914,373,655**	**$694,632,455**	**1,542,488.3**	**582,392.6**	**829**	**1,435**
Treatment Total	**$2,609,006,110**		**2,124,880.8**		**2,264**	
Subtotal			**1,584,327.6**	**596,362.8**	**849**	**1,476**
Total			**2,180,690.4**		**2,325**	

Based on the needs identified for the bridge inventory, a strategy was developed to address those needs, based on available programs and budget. This strategy was applied for the second phase of the investment period from 2023-2028 as PRHTA programs the full $86 million annually and fully implements its bridge investment strategies. Table 7-11 shows the amount of bridge area, both programmed and planned. As with Table 7-5 for pavements, it is color-coded to denote the three eras. Pink is used for 2023 to show it contains both already programmed projects and the amount of additional improvement included in the investment strategy. In terms of proportion per treatment, 36 percent of the area to be treated is for preservation treatments, and 58 percent for rehabilitation, and 6 percent for replacement (see Figure 7-2).

Table 7-12 shows the dollar amounts already programmed, and those planned, by work type and by year for 2019 through 2028. In the years 2023 to 2028 there is a systematic

level of investment in preservation, rehabilitation, and replacement. Those planned amounts represent the implementation of a systematic bridge investment strategy.

As was stated earlier for the pavement financial plan, the bridge investment strategy represents a “snapshot in time” based upon the assumptions of 2019. As assumptions change between the publication of this plan and 2023, the bridge investment strategies will change. The plan represents allocations on an average annual basis. In some years, expenditures may be more or less than shown as bridge projects are combined with projects to address pavements or safety.

TABLE 7-11: SQUARE METER OF BRIDGE IMPROVEMENT PROGRAMMED AND PLANNED

Sq. Mts.		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
NHS	Preservation	10,599.17	51,907.15	15,728.58	2,308.53	50,608.84	7,340.84	9,798.37	9,809.21	9,800.16	7,533.34	175,434.18
	Minor Rehabilitation	6,126.40	0.00	0.00	18,062.67	20,448.08	17,379.88	18,361.57	18,381.89	18,364.93	25,574.05	142,699.46
	Major Rehabilitation	24,175.15	0.00	7,741.23	18,740.79	2,287.06	4,523.69	3,973.36	3,977.76	3,974.09	3,054.86	72,447.99
	Replacement	0.00	0.00	0.00	1,012.74	690.08	1,364.95	1,024.82	1,025.95	1,025.01	787.92	6,931.46
	TOTAL	**40,900.72**	**51,907.15**	**23,469.81**	**40,124.73**	**74,034.06**	**30,609.35**	**33,158.11**	**33,194.81**	**33,164.18**	**36,950.17**	**397,513.10**
Non-NHS	Preservation	0.00	0.00	0.00	37.82	23,467.25	1,578.01	1,579.71	1,581.46	3,160.00	2,429.08	33,833.34
	Minor Rehabilitation	2,462.10	0.00	0.00	2,093.10	7,938.11	7,791.84	7,800.26	7,808.89	10,432.61	8,019.51	54,346.42
	Major Rehabilitation	3,540.48	10,656.78	7,365.82	66.08	4,271.12	8,196.81	8,205.67	8,214.76	7,430.02	5,711.42	63,658.96
	Replacement	1,753.12	0.00	0.00	2,049.46	3,401.38	4,524.34	4,529.23	4,534.24	3,882.91	2,984.78	27,659.46
	TOTAL	**7,755.70**	**10,656.78**	**7,365.82**	**4,246.46**	**39,077.85**	**22,091.00**	**22,114.88**	**22,139.35**	**24,905.54**	**19,144.79**	**179,498.18**
TOTAL		**48,656.42**	**62,563.93**	**30,835.63**	**44,371.19**	**113,111.92**	**52,700.35**	**55,272.99**	**55,334.17**	**58,069.72**	**56,094.96**	**577,011.28**

First Period – Includes STIP and locally funded projects to improve SOGR after Hurricane María.
Second Period – Includes STIP programmed projects and some additional lane miles planned but without particularly assigned projects.
Third Period – Includes planned lane miles without particularly assigned projects.

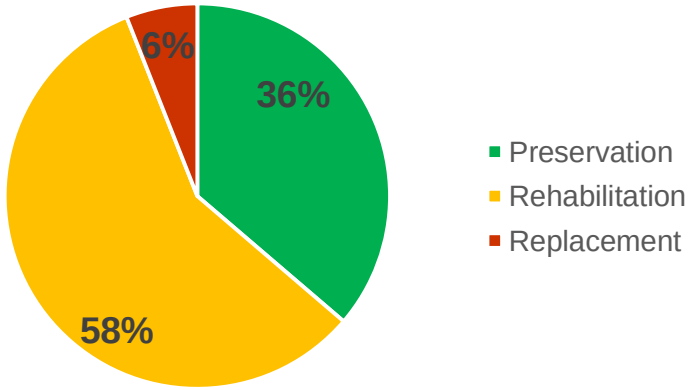


FIGURE 7-2 PLANNED AND PROGRAMMED TREATMENTS BY TYPE.

TABLE 7-12 AMOUNT PROGRAMMED AND PLANNED FOR BRIDGES 2019-2028

Investment		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
NHS	Preservation	$21,280,057	$6,700,000	$9,122,240	$1,724,462	$11,163,595	$6,079,776	$8,115,130	$8,124,112	$8,116,615	$6,239,208	$86,665,195
	Minor Rehabilitation	$11,902,326	$0	$0	$13,542,597	$34,970,483	$24,812,942	$25,241,210	$25,269,146	$25,245,828	$40,223,734	$201,208,265
	Major Rehabilitation	$13,032,942	$0	$12,539,324	$29,300,000	$4,964,096	$9,818,733	$8,458,194	$8,467,555	$8,459,742	$6,502,969	$101,543,556
	Replacement	$0	$0	$0	$769,825	$2,139,457	$4,231,739	$3,177,235	$3,180,751	$3,177,816	$2,442,774	$19,119,597
	TOTAL	**$46,215,324**	**$6,700,000**	**$21,661,564**	**$45,336,885**	**$53,237,631**	**$44,943,190**	**$44,991,770**	**$45,041,564**	**$45,000,000**	**$55,408,685**	**$408,536,613**
Non-NHS	Preservation	$0	$0	$0	$12,350	$4,731,634	$1,271,822	$1,273,197	$1,274,606	$2,546,860	$1,957,761	$13,068,231
	Minor Rehabilitation	$4,943,182	$0	$0	$1,248,460	$11,045,289	$11,477,874	$11,490,280	$11,502,997	$14,120,040	$10,854,017	$76,682,139
	Major Rehabilitation	$5,421,816	$16,851,011	$12,963,276	$1,569,171	$10,044,744	$19,146,265	$19,166,961	$19,188,174	$17,135,625	$13,172,085	$134,659,128
	Replacement	$11,861,968	$0	$0	$24,500,614	$10,433,199	$13,047,228	$13,061,331	$13,075,787	$11,197,475	$8,607,453	$105,785,055
	TOTAL	**$22,226,966**	**$16,851,011**	**$12,963,276**	**$27,330,594**	**$36,254,866**	**$44,943,190**	**$44,991,770**	**$45,041,564**	**$45,000,000**	**$34,591,315**	**$330,194,552**
TOTAL		**$68,442,290**	**$23,551,011**	**$34,624,840**	**$72,667,479**	**$89,492,497**	**$89,886,380**	**$89,983,540**	**$90,083,128**	**$90,000,000**	**$90,000,000**	**$738,731,165**

7.4 Achieving and Sustaining a State of Good Repair

The investment strategies are required to support or make progress toward the state of good repair, preserving and improving the NHS, and achieving the condition targets. The bridge and pavement investment strategies do all three. As noted earlier, PRHTA defined the state of good repair as achieving the condition targets.

7.4.1 Scenarios

As indicated in Section 4.3, several tools were developed to perform lifecycle analyses. These are explained with detail in Appendix M. Diverse scenarios were tested using the developed tools, including applying different budget priorities per system and condition, and different budgets. The ones presented in this chapter optimize the projected available funding and feasible amount / capacity of work per year to meet the NHS targets within the 10-year TAMP period. For illustration purposes, additional "step scenarios" (interim iterations) are included in Appendix N.

7.4.2 Preferred Strategy

Table 7-13 shows the improving Interstate pavement conditions resulting from the investment strategies. The percentage of Poor Interstate pavement rises through 2022 before declining steadily as the full effects of the increased investment are experienced. Before 2023, the rate of deterioration continues to outpace improvement. That trend reverses starting in 2023. Then, the full effect of the reconstruction of Poor pavements, rehabilitation of Fair pavements, and preservation of Good pavements stabilizes the Interstate pavements. They begin to approach a sustainable, steady state of conditions that meet the State target and Federal minimum condition level. A substantial increase is shown in the Interstate Good pavements and a substantial decrease in the Fair to Poor pavements. Overall the inventory is more robust. Interstate target for maximum Poor is expected to be reached by year 2027[8].

The NHS Non-Interstate pavements remain at about 20 percent Poor through 2028. The Non-NHS pavements meet their target, but the target is to allow up to 40 percent to be Poor. As seen, the percentage of Poor Non-NHS pavement increases from 12 percent in 2019 to 36.5 percent by 2028. This trend reflects the higher priority placed on the Interstates. The Interstates have the highest traffic volumes, are the most expensive to maintain per mile, and are the pavements that can bring a Federal penalty to PRHTA if the minimum condition of 5 percent Poor is not achieved.

Table 7-14 shows that the bridge investment strategy also should result in PRHTA achieving and maintaining a state of good repair for its bridges. Although the Non-NHS

[8] If the target were to be met by the first year after current STIP (2024), an investment of $280 millions would be required that year and $100 million the next years of the period (see Appendix N).

bridges are shown only for informational purposes and are not intended for review under 23 CFR 515. (9) (I), the analysis for them is included as well. It shows that the conditions will be worse than the agency's 10 percent Poor target for years 2020-2025 before declining to 10 percent in 2026.

TABLE 7-13: ACTUAL AND FORECASTED PAVEMENT CONDITIONS RESULTING FROM THE INVESTMENT STRATEGY.

Expected Condition Proportion per Year		Target	Base	Estimate	Forecast									
			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good	2.0%	10.8%	14.4%	29.8%	30.2%	27.3%	25.3%	23.4%	23.2%	23.2%	22.8%	22.4%	22.2%
	Fair to Good	31.0%	24.8%	24.4%	25.4%	26.3%	27.3%	27.9%	28.1%	28.7%	29.3%	29.6%	29.9%	30.4%
	Fair - Fair	31.0%	28.7%	26.7%	18.1%	17.7%	18.3%	19.1%	20.0%	21.3%	22.5%	23.0%	23.3%	22.4%
	Fair to Poor	31.0%	19.0%	18.7%	13.9%	13.0%	13.5%	13.7%	14.8%	16.1%	17.4%	18.4%	19.3%	20.0%
	Poor	5.0%	16.7%	15.7%	12.8%	12.8%	13.7%	14.1%	13.7%	10.7%	7.7%	6.2%	5.0%	5.0%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
NHS Non-Interstate	Good	2.0%	2.2%	2.6%	20.9%	23.9%	24.2%	22.8%	22.3%	22.1%	21.9%	22.0%	21.9%	21.5%
	Fair to Good	26.0%	7.5%	7.3%	13.6%	16.8%	18.6%	19.5%	20.6%	21.9%	23.0%	24.3%	25.2%	25.9%
	Fair - Fair	26.0%	42.3%	38.0%	25.5%	22.3%	20.5%	19.5%	17.5%	17.5%	17.5%	16.3%	15.9%	15.6%
	Fair to Poor	26.0%	17.7%	20.2%	17.8%	18.0%	17.2%	17.3%	17.2%	17.4%	17.6%	17.2%	17.0%	16.9%
	Poor	20.0%	30.3%	31.9%	22.2%	19.0%	19.5%	21.0%	22.4%	21.2%	20.0%	20.1%	20.0%	20.0%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Non-NHS	Good	0.5%	2.2%	1.9%	3.0%	6.5%	6.1%	5.9%	5.5%	5.2%	4.9%	4.8%	4.6%	4.6%
	Fair to Good	19.8%	27.8%	25.0%	22.7%	21.0%	19.5%	18.1%	16.9%	15.9%	15.0%	14.3%	13.6%	13.1%
	Fair - Fair	19.8%	48.2%	44.7%	40.5%	35.3%	32.6%	30.0%	27.9%	26.0%	24.3%	22.8%	21.5%	20.1%
	Fair to Poor	19.8%	14.0%	18.6%	21.8%	23.2%	24.8%	25.7%	26.2%	26.5%	26.6%	26.4%	26.1%	25.7%
	Poor	40.0%	7.9%	9.7%	12.0%	13.9%	17.0%	20.2%	23.5%	26.4%	29.3%	31.8%	34.2%	36.5%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 7-14 ACTUAL AND FORECASTED BRIDGE CONDITIONS BASED ON THE INVESTMENT STRATEGY

Expected Condition Proportion per Year		Target	Base	Forecast									
			2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
NHS	Good	10%	18%	19%	19%	19%	20%	20%	21%	21%	22%	22%	23%
	Fair Satisfactory	40%	34%	34%	34%	34%	34%	34%	34%	33%	33%	32%	32%
	Fair to Poor	40%	39%	38%	37%	38%	37%	37%	37%	37%	36%	36%	36%
	Poor	10%	9%	9%	10%	9%	8%	8%	9%	9%	9%	10%	9%
	TOTAL	**100%**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Non-NHS	Good	10%	28%	27%	27%	26%	25%	25%	26%	27%	27%	28%	28%
	Fair Satisfactory	40%	31%	31%	31%	31%	31%	31%	32%	32%	32%	32%	31%
	Fair to Poor	40%	31%	31%	31%	30%	30%	31%	31%	31%	30%	30%	30%
	Poor	10%	10%	10%	11%	12%	13%	13%	12%	11%	10%	10%	10%
	TOTAL	**100%**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

7.5 Responding to the Gap and Life Cycle Planning Analyses

The investment strategies indicate the amount recommended to be invested by bridge and pavement work type between 2019 and 2028. Those amounts respond directly to the Gap Analysis documented in Chapter 3.

The highlights of the bridge gap and life cycle analysis included:

1. PRHTA bridges currently meet the agency's condition targets and are better than the minimum Federal threshold of no more than 10 percent of the NHS bridges as measured by area in Poor condition. However, the past 11 years have seen a substantial increase in the number of bridges in category 5, or the Fair-to-Poor condition. In that time, the percent of the inventory in condition state 5 grew from 24 percent of the inventory to 35 percent. Those bridges are at high risk of declining to condition state 4, which is Poor.
2. Also, the primary deficiency seen in the Fair-to-Poor bridges is declining bridge decks. The amount of Poor bridge area that is Poor for decks is larger than the area Poor combined for superstructure and substructures.
3. Thirty-nine bridges rated as Poor are only Poor because of Poor decks while their superstructure and substructures are rated 6 or higher.
4. PRHTA historically lacked a bridge preservation or rehabilitation program because its limited funding forced the agency to only address already Poor structures.

The highlights of the pavement gap and life cycle analysis included:

1. PRHTA Interstate pavements do not meet the agency's condition target of no more than 5 percent in Poor condition, which also is the minimum allowable Federal threshold.
2. The Poor Interstate conditions are driven primarily by Poor concrete pavement that requires major rehabilitation or reconstruction.
3. The Non-NHS pavements include more than 8,000 lane miles and receive proportionally the lowest funding. The Poor pavements on the Non-NHS are forecast to increase to 36 percent unless funding is increased above that included in this investment strategy.

The investment strategies respond directly to these gaps as well as to the life cycle planning analysis.

The pavement investment strategy directly responds to and addresses the pavement gaps and life cycle analysis. As seen in Table 7-15, the largest amount of investment is for the Interstates and over the 10 years reduces the percentage of deficient lane miles to 5 percent from the current 16.3 percent. Also, as seen in the percentages, the investment strategies recommend a mix of treatments to reconstruct already Poor Interstates while also preserving good pavements and rehabilitating Fair ones. The largest amount of reconstruction funds goes by far to the Interstates to address the

backlog of deteriorated pavements, particularly the concrete ones. The pavement investment strategy achieves the targets for Interstate and NHS Non-Interstate pavements but comes at the expense of growing numbers of Poor lane miles on the Non-NHS. The TAMP recommends additional spending on the Non-NHS if funding increases.

TABLE 7-15: AMOUNTS AND PERCENTAGES IN THE PAVEMENT INVESTMENT STRATEGY

Treatment	Total Expected Investment				Percent per Treatment
	Interstate	NHS Non-Interstate	Non-NHS	Total	
Preservation	$37,076,079	$139,587,572	$155,062,518	$331,726,168	**25.58%**
Minor Rehabilitation	$24,860,067	$1,342,206	$9,186,594	$35,388,868	**2.73%**
Major Rehabilitation	$105,132,344	$66,968,077	$137,216,121	$309,316,542	**23.86%**
Reconstruction	$313,548,042	$184,181,465	$122,478,666	$620,208,173	**47.83%**
Total	**$480,616,531**	**$392,079,320**	**$423,943,900**	**$1,296,639,751**	**100.00%**
Percent per System	**37.07%**	**30.24%**	**32.70%**	**100.00%**	

The amount of bridge funding increases overall from the $17 million allocated before 2019 to $86 million. Additionally, the investment funding levels shown in Table 7-16 show a balanced “mix of fixes” attuned to the gaps in the inventory conditions and which lower the life cycle costs. Of the $738 million proposed to be invested in bridges from 2019 to 2028, 13.50 percent is for preservation, 37.62 percent for minor rehabilitation, 31.97 percent for major rehabilitation, and 16.91 percent for replacement. Bridge decks are classified as minor rehabilitation and the emphasis upon them is evident by the 37.62 percent of the allocation dedicated to minor rehabilitation.

TABLE 7-16: AMOUNTS AND PERCENTAGES IN THE BRIDGE INVESTMENT STRATEGY

Investment	NHS	Non-NHS	Total	Percent per Treatment
Preservation	$86,665,195	$13,068,231	$99,733,426	**13.50%**
Minor Rehabilitation	$201,208,265	$76,682,139	$277,890,403	**37.62%**
Major Rehabilitation	$101,543,556	$134,659,128	$236,202,683	**31.97%**
Replacement	$19,119,597	$105,785,055	$124,904,653	**16.91%**
Total	**$408,536,613**	**$330,194,552**	**$738,731,165**	**100.00%**
Percent per System	**55.30%**	**44.70%**	**100.00%**	

7.6 Responding to the Risk Analysis

The investment strategies respond directly to High and Very High risks that can be addressed through capital investments and programming. Other risks relate to staffing or stakeholder support that must be addressed through means other than programming.
For example, High or Very High risks that are directly addressed by the investment strategies include:

1. If PRHTA does not achieve the less than 5 percent poor interstate system targets, then it can be subject to funding restrictions and lose much needed federal funding.
2. If PRHTA has more than 5 percent poor Interstate system conditions, then it will be forced to change the projects it programs for future years.
3. If PRHTA does not get adequate funding it will not have a preservation program.
4. If PRHTA does not implement a systematic pavement preservation program, the high percentage of its pavements that are in the "Fair-Good" condition will fall into the "Poor" category necessitating higher levels of investments.
5. If PRHTA lacks the necessary funding to fix the assets that were affected by the weather events these assets will continue to deteriorate at a rapid pace and cost more to fix.
6. If the selection of bridge projects is not done systematically, then PRHTA may not be able to meet its bridge targets.
7. If PRHTA lacks State funding to fix its backlog of deteriorated pavements and bridges, the number of these deteriorated assets will increase, necessitating even additional increases in funds to fix them.

The investment strategies focused upon how to achieve the bridge and pavement condition targets which define the state of good repair. By achieving the targets, the investment strategies lead to PRHTA avoiding the Federal penalties that occur when Interstate pavement and NHS bridge conditions are worse than the Federal minimum thresholds. Inherent in the strategies, is the achievement of the state of good repair.

Also, the investment strategies directly address threats to the resilience of the NHS. Included in the 2019-2023 bridge program are about 20 projects that will address scour-critical structures. Those structures had substructure ratings of 4 or 3 which indicate substantial deterioration. Bridges in those conditions were identified through the bridge inventory and are on a fast track for repair.

The larger strategy of increasing bridge investment and developing a “mix of fixes” will make the overall inventory more robust and more likely to withstand future climate events.

The substantial sums invested in preservation address the identified risk of not having a preservation program that would result in accelerated bridge and pavement deterioration.

Also, the substantial focus upon bridge decks and Interstate concrete pavements directly address the most pressing asset risks that threaten the future state of good repair.

In summary, the investment strategies were crafted to address the highest risks that could be addressed through programming decisions.

7.7 Risks Facing the Investment Strategies

PRHTA also acknowledges the risks surrounding these investment strategies. They are based upon several assumptions, and if they change, it will affect the expected outcomes. The investment strategies are based upon the expectation that the accelerated inflation experienced after Mariá will normalize and not continue throughout the 10 years. The plan also considers that the bridge and pavement investment levels from the 2018-2023 Fiscal Plan will continue through 2028. Another assumption is that future Puerto Rico administrations will retain the long-term commitment to a mix of preservation, rehabilitation, and reconstruction projects. Those assumptions represent risks that could influence future outcomes.

7.8 Achieving the National Goals

When enacting the Moving Ahead for Progress in the 21st Century Act (MAP-21), Congress adopted the following goals found in U.S.C 23 Sec. 150.

Safety - To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.

Infrastructure condition - To maintain the highway infrastructure asset system in a state of good repair.

Congestion reduction - To achieve a significant reduction in congestion on the National Highway System.

System reliability - To improve the efficiency of the surface transportation system.

Freight movement and economic vitality - To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.

Environmental sustainability - To enhance the performance of the transportation system while protecting and enhancing the natural environment.

Reduced project delivery delays - To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project

development and delivery process, including reducing regulatory burdens and improving agencies' work practices.

The asset management rule requires that the investment strategies each agency adopts make progress toward achieving the national goals. The investment strategies and other practices PRHTA has adopted directly support the national goals.

PRHTA adopted objectives are shown in Figure 1-1. These objectives are aligned with the Federal Aid Program National Goals (23USC §150(b)) mentioned above.

PRHTA addresses safety by linking its pavement program with its Highway Safety Improvement Program. Pavement resurfacings are included with safety projects so that pavement markings can be refreshed upon a smooth, clear surface. Also, when pavements are in good condition, surface friction is improved and stopping distances shortened. PRHTA's focus upon improving pavements complements its safety goals and supports the national safety goals.

Infrastructure condition obviously is improved by the investment strategies. The analysis shown in the Investment Strategy chapter demonstrates that pavement conditions will substantially improve. The overall PRHTA bridge inventory will improve as the agency reverses the trend of Fair-to-Poor bridges increasing.

The investment strategies indirectly support the goals of congestion reduction, system reliability, and freight movement by reducing the possibility that potholes or bridge closures impede traffic and freight movement. If bridge conditions deteriorate enough, bridges must be closed which creates detours. Increased preservation activities also prevent the need for lengthy bridge closures as bridges are replaced. Improved pavement surfaces allow motorists to travel at posted speeds and not to decelerate because of poor conditions.

The goal of environmental sustainability is not directly affected by the asset management plan.

Reduced project delivery delays are supported by recent PRHTA efforts to eliminate its backlog of projects, unspent State funds, and unobligated Federal balances. PRHTA has streamlined its project delivery process and has substantially increased the reliability of its project schedules.

7.9 Investment Strategy Summary

The bridge and pavement investment strategies will substantially improve the NHS pavements and bridges in Puerto Rico. The strategies represent not only a substantial increase in investment, but they also represent an increased emphasis on life cycle strategies. The investment strategies move away from a worst-first approach and move the agency to manage assets for a lower cost over their entire life cycle. As forecasted in

this plan, the investment strategies will lead to a state of good repair unless impeded by the risks acknowledged in this plan.

7.10 Developing a Summary of Asset Values

Asset valuation is the assignment of monetary value to physical assets based upon their condition, construction cost, age, obsolescence, and other factors. The rationale for reporting asset valuation is to ensure that investments are adequate to ensure that the public's investment in its highway network is maintained. Highway networks generally represent a state's largest capital investment. Investing adequately in them can ensure that future generations inherit a well-maintain asset, and not a major liability that is in a state of disrepair and requires substantial investment to maintain.

PRHTA estimated the value of its assets for this asset management plan using the concept of Depreciated Replacement Cost. This is an accounting concept adopted in Australia and Great Britain. It seeks to estimate the value of highway assets "as is." That is, what would it cost to replace them "in kind" to their current conditions.

This depreciation method differs from the historical cost method often used to estimate asset values. The historic cost usually applies a fixed amount of deterioration to an asset-based entirely on its age. For example, if a bridge is built for $1 million and is expected to provide a useful life of 50 years, its value is depreciated by 2% annually. At the end of 50 years, the bridge will have a "book value" of $0. Even if the bridge has been rehabilitated and is in good condition, it still will be carried on the books at a value of $0. By this logic, the Golden Gate Bridge and Brooklyn Bridge have no monetary value simply because of their age.

The historic cost method provides little value for asset management. If an asset is valued at $0 there is little incentive to invest further in its maintenance. However, as a practical matter, an aged bridge or pavement could have significant utility and warrant substantial maintenance and investment to prolong its useful life.

7.10.1 Pavement Asset Valuation

To calculate the depreciated replacement cost of PRHTA's pavements, the analysis first estimates what it would cost to replace the authority's pavements. This provides a "like new" or "replacement cost" estimate of the pavement assets. Then, depreciated cost is calculated based on the existing condition.

The logic of the analysis follows:

1. PRHTA data indicate that PRHTA manages 11,253 lane miles of pavement.
2. Based on PRHTA's previous projects, the average cost per lane mile to replace pavements at each system and surface type were calculated. They are shown in Table 7-17.

3. The corresponding average unit costs were multiplied by the lane miles under each category to obtain the replacement cost if all pavement were “as new”.
4. A depreciated replacement proportion was obtained based on the current condition of the assets. Note that for this calculation, the conditions of measured assets were extrapolated to all inventory.
    a. First, a numerical rate was assigned to the previously defined conditions of Good, Fair to Good, Fair-Fair, Fair to Poor, and Poor. A value of 5 was assigned to Good, and a point less to each subsequent condition up to a value of 1 for Poor. Good condition and its assigned value of 5 was also used to represent the “like new” condition.
    b. A weighted rate was calculated for each system and surface type combination, based on the assigned rates and their corresponding lane miles. This resulted on an average rate of 2.97.
    c. Dividing the resulting average rate of 2.97 by the rate of 5 representing the “as new” condition equals 59 percent. In other words, PRHTA’s pavements are in 59 percent of “as new” condition.
5. Multiplying the Replacement Cost by the 59 percent generates a Depreciated Replacement Value of $2,984,419,437. Hence, 41 percent of the value of the pavements has been "consumed".

Based upon the financial plan, the PRHTA pavement investments should be more than adequate to sustain the value of Interstate and NHS non-Interstate pavements. In fact, their value should increase as their conditions increase. However, the future value of the Non-NHS pavements is likely to decline given the forecast of their declining conditions by 2029.

TABLE 7-17: PAVEMENT ASSET VALUES FOR REPLACEMENT COST AND DEPRECIATED REPLACEMENT COST

System	Surface	Lane Miles		Replacement Cost per Lane Mile	Pavement Replacement Cost		Rate*	Rate* for "As New"	Ave. Rate Difference from New	Discounted by Condition	Remaining	Depreciated Replacement Cost	
INT	**Asphalt**	809	1,288	$646,690	$523,314,496	$1,018,489,258	3.39	5	1.61	32%	68%	$355,011,153	$589,050,283
	Concrete	479		$1,033,576	$495,174,763		2.36	5	2.64	53%	47%	$234,039,131	
NHS	**Asphalt**	1,617	1,741	$464,712	$751,509,969	$875,345,331	2.77	5	2.23	45%	55%	$416,981,243	$459,094,060
	Concrete	123		$1,003,596	$123,835,362		1.70	5	3.30	66%	34%	$42,112,817	
Other	**Asphalt**	8,038	8,224	$382,540	$3,074,883,718	$3,228,252,681	3.05	5	1.95	39%	61%	$1,873,608,147	$1,936,275,094
	Concrete	186		$825,341	$153,368,962		2.04	5	2.96	59%	41%	$62,666,947	
Total		**11,253**			**$5,122,087,270**		2.97	5	2.03	41%	59%	$2,984,419,437	

* Assigned rate goes from 5 for Good to 1 for Poor.

7.10.2 Bridge Asset Valuation

To calculate the depreciated replacement cost of PRHTA's bridges, the analysis first estimates what it would cost to replace the authority's bridges. This provides a "like new" or "replacement cost" estimate of the bridge assets. Then, depreciated cost is calculated based on the existing condition.

The logic of the analysis follows:

6. PRHTA bridge data indicate that PRHTA manages 1,180,690 square meters of bridges.
7. Based on PRHTA's previous projects, the cost to replace NHS and Non-NHS bridges are almost the same. Therefore, a replacement cost $3,150 and $800 per square meter is being used for bridges and culvert bridges, respectively. This averages $3,075 per square meter of deck area of current inventory.
8. Multiplying the square meter area by the cost to replace generates a total Replacement Cost of $6,706,633,219.
9. Bridges are rated from 0-9 with 9 representing an "as new" structure.
10. The average condition of all PRHTA bridges is 5.66 out of the 0-9 scale.
11. Dividing 5.66 by 9 equals 63%. In other words, PRHTA's bridges are in 63% of "as new" condition.
12. Depreciating the Replacement Cost by the 63 percent generates a Depreciated Replacement Value of $4,219,648,646.

These costs only reflect the actual structures and don't include rights-of-way which represent a very substantial value. However, rights-of-way don't depreciate but instead grow in value. Their value may be of interest from an accounting standpoint, but they do not add much to the asset-investment-need calculations. If the depreciated replacement cost is divided by the replacement, a value of 63% results. In other word, the value of PRHTA's bridges is 63% of the "as new" cost. Or stated another way 37% of the value of the bridges has been "consumed" (see Table 7-18).

TABLE 7-18: BRIDGE ASSET VALUATION SHOWN BY REPLACEMENT COST AND DEPRECIATED REPLACEMENT COST

Calculation for Depreciated Replacement Cost of PRHTA Bridges	NHS Bridges	NHS Culvert Bridge	Non-NHS Bridges	Non-NHS Culvert Bridge	Total
Total Sq. Mts.	1,548,490	35,838	563,034	33,329	2,180,690
Ave. Cost/Sq. Mts.	$3,150	$800	$3,150	$800	$3,075
Replacement Cost	$4,877,742,429	$28,670,312	$1,773,557,510	$26,662,968	$6,706,633,219
Average Condition Rage	5.61	6.65	5.73	6.07	5.66
As New Condition Rate	9	9	9	9	9
Ave. Rate Difference from New	3.39	2.35	3.27	2.93	3.34
Discounted by Condition	38%	26%	36%	33%	37%
Remaining	62%	74%	64%	67%	63%
Depreciated Replacement Cost	$3,038,789,796	$21,184,540	$1,128,957,305	$17,969,406	$4,219,648,646

7.11 Use of Compliant Management System

PRHTA is committed on the acquisition and implementation of the best suited management system alternative.

On June 14, 2019, FHWA signed a Record of Authorization for the tasks related to the assessment of pavement and bridge management softwares. The PRHTA is currently fulfilling the contract for this assessment. The general tasks for the assessment and implementation are outlined in Section 3.9.2.3 entitled Implementation Plan (page 3-24 of this document). The preliminary schedule for the assessment and implementation is presented in Table 3-14 (page 3-26 of this document).

For this TAMP, PRHTA used a management system process as described in its letter to FHWA Division Administrator Michael Avery of April 11, 2019. See Appendix O.

Appendices

APPENDIX A: PR HPMS NETWORK DATABASE

An example of the fields used is below. The complete database is included in the attached CD. This database was used to determine the universe of the study network.

ROUTE NUMBER	FROM KM	TO KM	NUMBER OF LANES	FEDERAL AID	FUNCTIONAL CLASSIFICATION
PR 1	0.00	0.32	4	NHS	PRINCIPAL ARTERIAL
PR 1	1.00	2.28	4	NHS	PRINCIPAL ARTERIAL
PR 2	0.00	0.30	4	NHS	PRINCIPAL ARTERIAL
PR 2	22.00	22.90	4	NHS	PRINCIPAL ARTERIAL
PR 66	0.00	3.10	4	NHS	INTERSTATE
PR 7752	0.00	1.05	2	FEMA	LOCAL
PR 9988	0.00	1.60	2	FEMA	LOCAL

APPENDIX B: PAVEMENT CONDITION DATABASE

An example of the fields used is below. The complete database is included in the attached CD. This database was used to estimate the pavement condition and a base for the required treatments.

Data Year	Managed By	ROAD	Start Mile	End Mile	Avg IRI (in/mi)	Avg RUT (in)	Avg FAU (in)	Cracking Percent	System	Lanes	Start Km	End Km	Pavement Type
2017	PRHTA	1	0.00	0.10	999	999	0	10	NHS	4	0	0.161	Other
2017	PRHTA	3	0.00	0.10	230	0.1	0	0	NHS	6	0	0.161	Asphalt
2017	PRHTA	3	0.30	0.40	274	0	0.1	45	NHS	6	0.483	0.644	Concrete
2017	PRHTA	3	0.50	0.60	186	0	0.1	35	NHS	6	0.805	0.966	Concrete
2017	PRHTA	53	0.00	0.10	359	0.4	0	20	INT	4	0	0.161	Asphalt
2017	PRHTA	53	0.30	0.40	224	0.2	0	5	INT	4	0.483	0.644	Asphalt
2017	PRHTA	53	0.50	0.60	235	0	0	25	INT	4	0.805	0.966	Concrete
2017	PRHTA	9914	0.00	0.10	133	0.1	0	0	NHS	4	0	0.161	Asphalt
2017	PRHTA	9914	0.30	0.37	104	0.1	0	0	NHS	4	0.483	0.6	Asphalt
2017	PRHTA	BORI	0.00	0.10	237	0.2	0	5	NHS	2	0	0.161	Asphalt
2017	PRHTA	BORI	0.30	0.40	207	0.1	0	10	NHS	2	0.483	0.644	Asphalt
2017	PRHTA	BORI	0.50	0.60	176	0.1	0	35	NHS	2	0.805	0.966	Asphalt

APPENDIX C: BRIDGE INVENTORY & CONDITION DATABASE

An example of the fields used is below. The complete database is included in the attached CD. This database was used to estimate the bridge condition and a base for the required treatments.

NBI Data Year	Manager	STRUCTURE NUMBER 008	APPR WIDTH MT 032	DECK WIDTH MT 052	STRUCTURE LEN MT 049	DECK COND 058	SUPERSTRUCTURE COND 059	SUBSTRUCTURE COND 060	CULVERT COND 062	HIGHWAY SYSTEM 104	Area
2018	PRHTA	41	7	8.1	120.7	4	4	4	N	0	977.67
2018	PRHTA	51	9.9	11.1	9	5	5	5	N	0	99.9
2018	PRHTA	61	7.6	6.7	18.4	N	N	N	6	0	123.28
2018	PRHTA	81	19.8	21.3	15.8	N	N	N	6	1	336.54
2018	PRHTA	121	11.3	16.1	12.7	N	N	N	5	0	204.47
2018	PRHTA	131	7.3	10.3	76.9	6	6	6	N	1	792.07
2018	PRHTA	141	8.5	11.3	22.5	N	N	N	6	1	254.25
2018	PRHTA	151	12	10.9	9.4	4	5	6	N	0	102.46
2018	PRHTA	161	10.6	11.7	13.2	4	4	6	N	0	154.44
2018	PRHTA	171	10.1	11.4	9.4	5	5	5	N	0	107.16

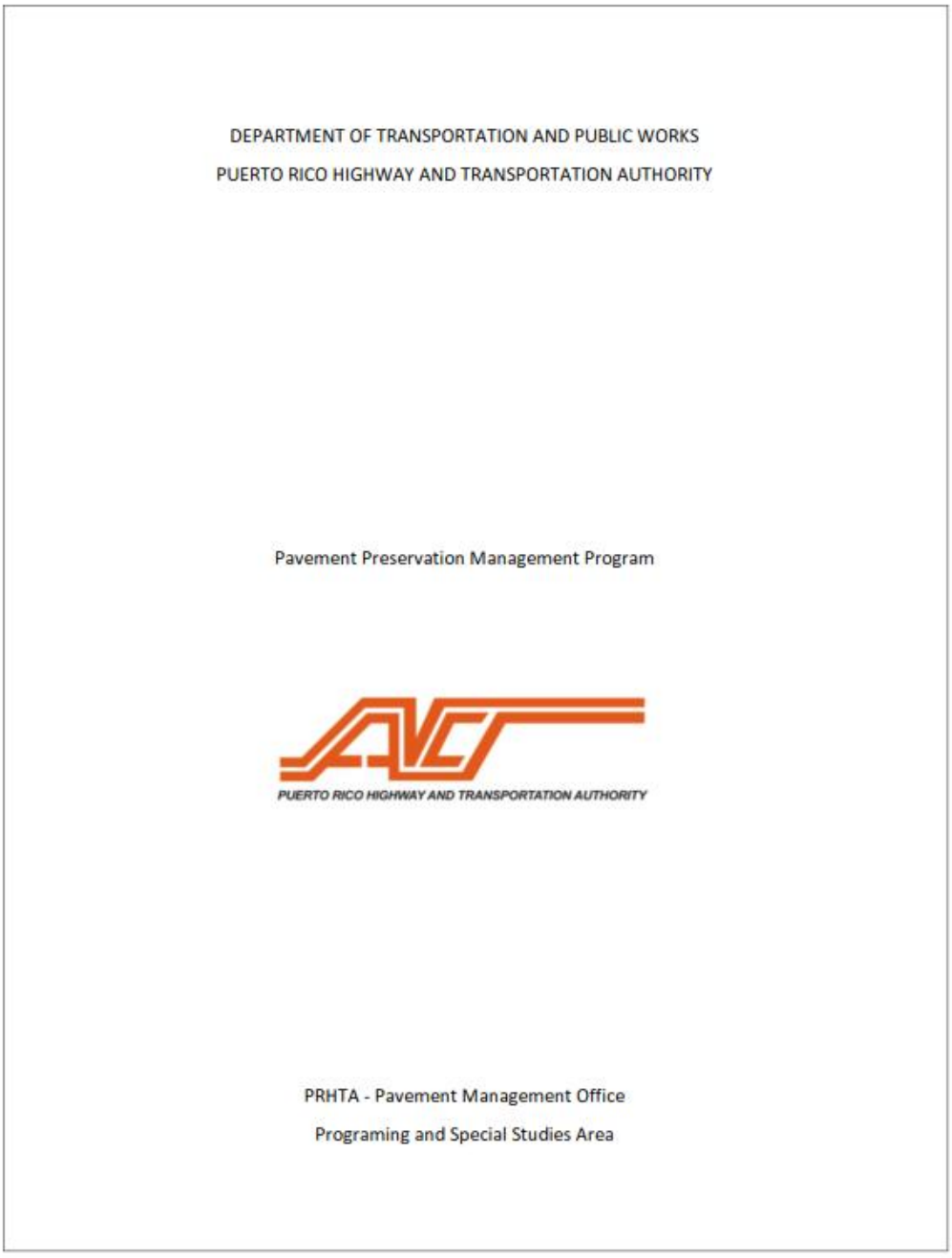
APPENDIX D: SIGNALIZED INTERSECTIONS INVENTORY

An example of the fields used is below. The complete database is included in the attached CD. This database was used to understand the magnitude of the signal network and potential needs.

Roadway	Intersection	Municipality	Classification	Classification
PR-2	PR-864	Bayamón	State	Traffic Lights
PR-2	PR-863	Toa Baja	State	Traffic Lights
PR-2	PR-8865	Toa Baja	State	Traffic Lights
PR-2	*Estación Bombero*	Barceloneta	State	Flasher
PR-2	Ave. Domingo Ruiz	Arecibo	State	Traffic Lights
PR-2	PR-129	Arecibo	State	Traffic Lights
PR-2	PR-443	Aguadilla	State	Traffic Lights

APPENDIX E: PAVEMENT PRESERVATION MANAGEMENT PROGRAM

The cover of the document and its index are presented next. The complete document is included in the attached CD.



DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS

PUERTO RICO HIGHWAY AND TRANSPORTATION AUTHORITY

Pavement Preservation Management Program

PUERTO RICO HIGHWAY AND TRANSPORTATION AUTHORITY

PRHTA - Pavement Management Office

Programing and Special Studies Area

Table of Contents

APPENDIX F: PAVEMENT DETERIORATION MASTER DATA TABLE

An example of the database is next. The complete database is included in the attached CD. This database was used as one of the tools to estimate the pavement deterioration rate.

PR	Start Mi From	System 2017	Type 2017	IRI 2014	IRI 2015	IRI 2016	IRI 2017	Ru/Fa 2014	Ru/Fa 2015	Ru/Fa 2016	Ru/Fa 2017	Cra 2014	Cra 2015	Cra 2016	Cra 2017	Cond 2014	Cond 2015	Cond 2016	Cond 2017	2015 - 2014	2016 - 2015	2017 - 2016	2016 - 2014	2017 - 2014	2017 - 2015	Average per Year
1	8.20	NHS	Concrete	147	143	216	161	0.1	0.1	0.1	0.1	60	80	10	15	2	2	2	2	0	0	0				0
1	8.30	NHS	Concrete	198	246	191	237	0.1	0.1	0.1	0.1	35	60	10	5	1	1	2	2	0		0				0
1	8.40	NHS	Concrete	181	201	178	185	0.1	0.1	0.1	0.1	35	50	10	10	1	1	2	2	0		0				0
1	8.50	NHS	Concrete	187	169	189		0.1	0.1	0.1	0.1	45	75	20	20	1	2	1			-1					-1
1	8.60	NHS	Concrete	181	179	0		0.1	0.1	0.1	0.1	50	65	10	0	1	1	2		0						0
1	8.70	NHS	Concrete	280	241	266	330	0.1	0.1	0.1	0.1	70	85	25	20	1	1	1	1	0	0	0				0
1	8.80	NHS	Concrete	136	138	142	164	0.1	0	0.1	0.1	35	90	0	5	2	2	2	2	0	0	0				0
1	8.90	NHS	Concrete	209	201	246	240	0.1	0.1	0.1	0.1	55	50	15	15	1	1	2	2	0		0				0
1	9.00	NHS	Concrete	261	251	279	264	0.1	0.1	0.2	0.1	60	90	0	5	1	1	1	2	0	0					0

APPENDIX G: BRIDGE INSPECTION REPORT EXAMPLE

Some pages of an inspection report are provided below as an example. The full amount of pages of the report are included in the attached CD.

INSPECTION REPORT SUMMARY & QC SHEET

BRIDGE: 2571

TEAM LEADER: Heriberto González Medina/Inspector: Angel Lopez

INSP. DATE: 12-Mayo-2016

1. Inspection Type and Dates:

NBI	Type	Performed? (Yes / No / NA)	Freq (MONTHS)	Previous Insp. DATE (MONTH/YEAR)	Next Insp. DATE (MONTH/YEAR)
ITEM 90	Routine Inspection	YES	24	Mayo 2014	Mayo 2018
ITEM 93 A	FC Inspection	—			
ITEM 93 B	Underwater Insp.	—			
ITEM 93 C	Other:	—			

2. NBI Condition Rating Summary:

	Item 58	Item 59	Item 60	Item 61	Item 62	Item 113
Previous Inspection	6	7	7	7	N	8
Current Inspection	6	7	7	7	N	8

Other Checks: (Y, N, NA)

Review Comments:

- ✓ Scour Critical (items 113 & 60)
- ✓ AASHTO Core's & NBI CD consistent
- ✓ Smart Flags (scour, steel plate, fire damage, etc)
- ✓ Channel Profile/Clearance Table
- ✓ FC & Underwater Members Tables
- ✓ Asphalt Overlay Thickness
- ✓ Drawings
- ✓ Photos
- ✓ Critical Finding
- ✓ Inspector & Team Leader Signature

Reviewer: _____

Safety Eng.: _____

Your Agency Name

Your Office Name
Your Department Name

Structure Inventory and Appraisal Sheet

Bridge Key: 025711 Agency ID: 025711 SR: 97.9 SD/FO: ND

IDENTIFICATION

State 1:	72 Puerto Rico	Struc Num 6:	025711
Facility Carried 7:	PR 173	Location 9:	5 KM. NE OF AGUNITO
Rte (On/Under) 5A:	Route On Structure	Rte. Signing Prefix 5D:	3 State Hwy
Level of Service 5C:	1 Mainline	Route Number 5D:	00173
Directional Suffix 5E:	0 N/A (NBI)	% Responsibility:	Unknown
SHD District 2:	Guayama	County Code 3:	Aibonito
Place Code 4:		Kilometer Post 11:	2.480 km
Feature Intersected 6:	LA PLATA RIVER		
Latitude 16:	18° 09' 29"	Longitude 17:	066° 13' 43"
Border Bridge Code 98:	Unknown (P)		
Border Bridge Number 99:	Unknown		

STRUCTURE TYPE AND MATERIALS

Number of Approach Spans 46:	0	Number of Spans Main Unit 45:	3
Main Span Material Design 43 A/5:			
5 Prestressed Concrete			
Deck Type 107:	1 Concrete-Cast-in-Place		
Wearing Surface 108A:	1 Monolithic Concrete		
Membrane 108B:	0 None		
Deck protection 108C:	None		

AGE AND SERVICE

Year Built 27:	1968	Year Reconstructed 106:	0		
Type of Service on 42A:	1 Highway				
Type of Service under 42B:	5 Waterway				
Lanes on 28A:	2	Lanes under 28B:	0	Detour Length 19:	8.0 km
ADT 29:	4,000	Truck ADT 109:	4%	Year of ADT 30:	2009

GEOMETRIC DATA

Length Max Span 48:	35.20 m	Structure Length 49:	97.80 m
Curb/Sidwlk Width L 50A:	0.00 m	Curb/Sidewalk Width R 50B:	0.00 m
Width Curb to Curb 51:	11.60 m	Width Out to Out 52:	12.70 m
Approach Roadway width 32: (w/ shoulders)	12.30 m	Median 33:	0 No median
Deck Area:	1,243.33m²		
Skew 34:	42.00°	Structure Flared 35:	0 No flare
Vertical Clearance 10:	99.99 m	Horizontal Clearance 47:	11.80 m
Minimum Vertical Clearance Over Bridge 53:		99.99 m	
Minimum Vertical Underclearance Reference 54A:		N Feature not hwy or RR	
Minimum Vertical Underclearance 54B:		0.00 m	
Minimum Lateral Underclearance Reference R 55A:		N Feature not hwy or RR	
Minimum Lateral Underclearance R 55:		0.00 m	
Minimum Lateral Underclearance L 55:		0.00 m	

State Highway Agency

INSPECTION

Frequency 91:	24 months	Inspection Date 90:	5/12/2015	Next Inspection:	05/12/2015
FC Frequency 92A:		FC Inspection Date 93A:	N/A	Next FC Inspection:	N/A
UW Frequency 92B:		UW Inspection Date 93B:	N/A	Next UW Inspection:	N/A
SI Frequency 92C:		SI Date 93C:	N/A	Next SI:	N/A
Element Frequency:	24 months	Element Insp. Date:	1/1/1901	Next Elem. Insp.:	01/01/1901

CLASSIFICATION

Defense Highway 100:	0 Not a STRAHNET hwy	Parallel Structure 101:	N 3 bridge exists		
Direction of Traffic 102:	2 2-way traffic	Temporary Structure 103:	Unknown (NBI)		
Highway System 104:	0 Not on NHS	NBIS Length 112:	Long Enough		
Toll Facility 20:	3 On free road	Functional Class 26:	17 Urban Collector		
Defense Hwy 110:	0 Not a STRAHNET hwy	Historical Significance 37:	5 Not eligible for NR+P		
Owner 22:	01 State Highway Agency				
Custodian 21:	01 State Highway Agency				

CONDITION

Deck 58:	8 Satisfactory	Super 59:	7 Good	Sub 60:	7 Good
Culvert 62:	N N/A (NBI)	Channel/Channel Protection 61:		7 Minor Damage	

LOAD RATING AND POSTING

Inventory Rating Method 65:	1 LF Load Factor	Operating Rating Method 63:	1 LF Load Factor
Inventory Rating 66:	MS21.3	Operating Rating 64:	MS35.3
Design Load 31:	5 MS 18 (HS 20)	Posting 70:	5 At/Above Legal Loads
Posting Status 41:	A Open, no restriction		

APPRAISAL

Bridge Rail 36A:	1 Meets Standards	Approach Rail 36C:	1 Meets Standards
Transition 36B:	1 Meets Standards	Approach Rail Ends 36D:	1 Meets Standards
Bh Evaluation 67:	7 Above Min Criteria	Deck Geometry 68:	5 Above Tolerable
Underclearance, Vertical and Horizontal 69:		N Not applicable (NBI)	
Waterway Adequacy 71:	8 Above Desirable	Approach Alignment 72:	8 Equal Min Criteria
Scour Critical 113:	8 Stable Above Footing		

PROPOSED IMPROVEMENTS

Bridge Cost 94:	$0	Type of Work 75:	Unknown (P)
Roadway Cost 95:	$0	Length of Improvement 76:	0.0 m
Total Cost 96:	$0	Future ADT 114:	6,300
Year of Cost Estimate 97:	2010	Year of Future ADT 115:	2020

NAVIGATION DATA

Navigation Control 38:	Permit Not Required		
Vertical Clearance 39:	0.0 m	Horizontal Clearance 40:	0.0 m
Pier Protection 111:	1 Not Required	Lift Bridge Vertical Clearance 116:	

INSP011_Inspection_Metric Agency ID: 025711 Wed 07/27/2016 9:44:22
Page 1 of 4

Your Agency Name

Your Office Name
Your Department Name

Structure Inventory and Appraisal Sheet

ELEMENT CONDITION STATE DATA

Str Unit	Elm/Env	Description	Units	Total Qty	% in 1	Qty. St. 1	% in 2	Qty. St. 2	% in 3	Qty. St. 3	% in 4	Qty. St. 4
1	12/1	Re Concrete Deck	sq.m	1,154	75%	866	25%	288	0%	0	0%	0
Notes												
1	1,120/1	Efflorescence/Rust Staining	sq.m	115	0%	0	100%	115	0%	0	0%	0
Notes												
1	1,130/1	Cracking (RC and Other)	sq.m	173	0%	0	100%	173	0%	0	0%	0
Notes												
1	109/1	Pre Opn Conc Girder/Beam	m	587	100%	587	0%	0	0%	0	0%	0
Notes												
1	205/1	Re Conc Column	each	6	100%	6	0%	0	0%	0	0%	0
Notes												
1	215/1	Re Conc Abutment	m	46	96%	44	4%	2	0%	0	0%	0
Notes												
1	1,130/1	Cracking (RC and Other)	m	2	0%	0	100%	2	0%	0	0%	0
Notes												
1	234/1	Re Conc Pier Cap	m	24	100%	24	0%	0	0%	0	0%	0
Notes												
1	302/1	Compressn Joint Seal	m	51	29%	15	71%	36	0%	0	0%	0
Notes												
1	2,310/1	Leakage	m	8	0%	0	100%	8	0%	0	0%	0
Notes												
1	2,350/1	Debris Inspection	m	25	0%	0	100%	25	0%	0	0%	0
Notes												
1	310/1	Elastomeric Bearing	each	39	100%	39	0%	0	0%	0	0%	0
Notes												
1	321/1	Re Conc Approach Slab	sq.m	166	85%	141	15%	25	0%	0	0%	0
Notes												
1	1,130/1	Cracking (RC and Other)	sq.m	25	0%	0	100%	25	0%	0	0%	0
Notes												
1	331/1	Re Conc Bridge Railing	m	196	96%	188	4%	8	0%	0	0%	0
Notes												
1	1,130/1	Cracking (RC and Other)	m	8	0%	0	100%	8	0%	0	0%	0
Notes												

BRIDGE NOTES

-

Your Agency Name

Your Office Name
Your Department Name

Structure Inventory and Appraisal Sheet

PAST INSPECTION

Inspection Date: 05/12/2016
Type: 1 Regular NBI
Inspector: -1
Pontis User Key: Pontis Pontis User
Scope:

NBI: ☑ Other: ☐ Element: ☐
Underwater: ☐ Fracture Critical: ☐

INSPECTION NOTES

DECK SURFACE FINE LONGITUDINAL AND TRANSVESAL CRACKS,SCALING AND SMALL SPALLINGS.BOTTOM SLAB SOME FINE TRANSVERSAL CRACKS.

INSPECTOR WORK CANDIDATES

Work Candidate ID	Action	Agency Status	Agency Priority	Assigned to a Project	Rec. Date	Comp. Date

INSP011_Inspection_Metric Agency ID: 025711 Wed 07/27/2016 9:44:22
Page 3 of 4

BRIDGE INVENTORY MANAGEMENT OFFICE
INFRASTRUCTURE DIRECTORY
PRHTA

Team Leader: Angel T. López
Bridge Inspector: Angel T. López
Bridge Evaluator: Heriberto González
Assistants: Luis D. Collazo Carlos Díaz _ _ _
Driver: José Ortiz
Inspection date: May, 12, 2016
Weather Conditions: Sunny
Amount of Time on Inspection: 1.5 Hours
Equipment: X Bus or Van _ Underwater _ Ladders _ Snooper X Camera _ Boat
_ Other:
Bridge Number: 2571
Road on Structure: State Highway Number or Name: PR-173 Km. 2.4
Road Under Structure: N/A Number or Name: Km.
Ident. Plaque: Yes Num. 2571
36. Traffic Safety Features:
Bridge railings: meets acceptable standards
Transitions: meets acceptable standards
Approach Guardrail: meets acceptable standards
Approach Guardrail Ends: meets acceptable standards
41. Posting: Condition: A - Open Sign Type: _ Posting Load: _
COMMENTS AND/OR RECOMMENDATIONS:

Inspection by: Angel T. López
Bridge Inspector

Revised and Approved by: Heriberto González
Bridge Evaluator
27-JUL-16

BR-2571

1

BRIDGE INVENTORY MANAGEMENT OFFICE
INFRASTRUCTURE DIRECTORY
PRHTA

71. WATER ADEQUACY: Remote-greater 100 years Insig.- minor inconvenience.
72. APPROACH ROADWAY
72.1 Alignment: 8
72.2 Slab or Pavement Condition: 7 Material: Concrete
Cracking: Fine (0.0 to 0.5 mm) Spalling: None Scaling: Light Uneven: No
Rough: No Settlement: No Movement: Approach slab-backwall: No Breaking up: No
Excessive deformation: No
Safety: Hazardous: No
Drainage: Inadequate: No
Movement: Pavement-approach slab: No
Embankment: Condition: 7 Functioning: Yes Erosion: No
Construction: Flimsy: No Integrity impaired: No
72.3 Undesirable Impact: No
72.4 Joints: No Type: None Inadequate: N/A Satisfactory Alignment: N/A
72.5 Guardrail Type: Std. Material: Galvanized Functioning: Yes
Condition: 7 Alignment Horizontal: Good Vertical: Good
Joints Functioning: Yes Safety Securely Attached: Yes Pedestrian Hazards: No
Comments:
72.2-Grietas longitudinales en los approach".
90. INSPECTION DATE: May, 12, 2016
93. CRITICAL FEATURE INSPECTION DATE
Fracture Critical:
Underwater:
Other Special Inspection:
102. DIRECTION OF TRAFFIC: 2-way traffic
106. YEAR RECONSTRUCTED:
107. DECK STRUCTURE TYPE: Concrete Cast-in-Place
108. WEARING SURFACE/PROTECTIVE SYSTEM
Type wearing surface: Concrete
Type Membrane: None
Deck protection: None
111. PIER OR ABUTMENT PROTECTION (FOR NAVIGATION): Navigation protection not required
113. SCOUR CRITICAL BRIDGES: 8
116. MINUMUM NAVIGATION VERTICAL CLEARANCE:
AUXILIARY ITEMS
Signs: Type: None Material: N/A Condition: N

BR-2571 5

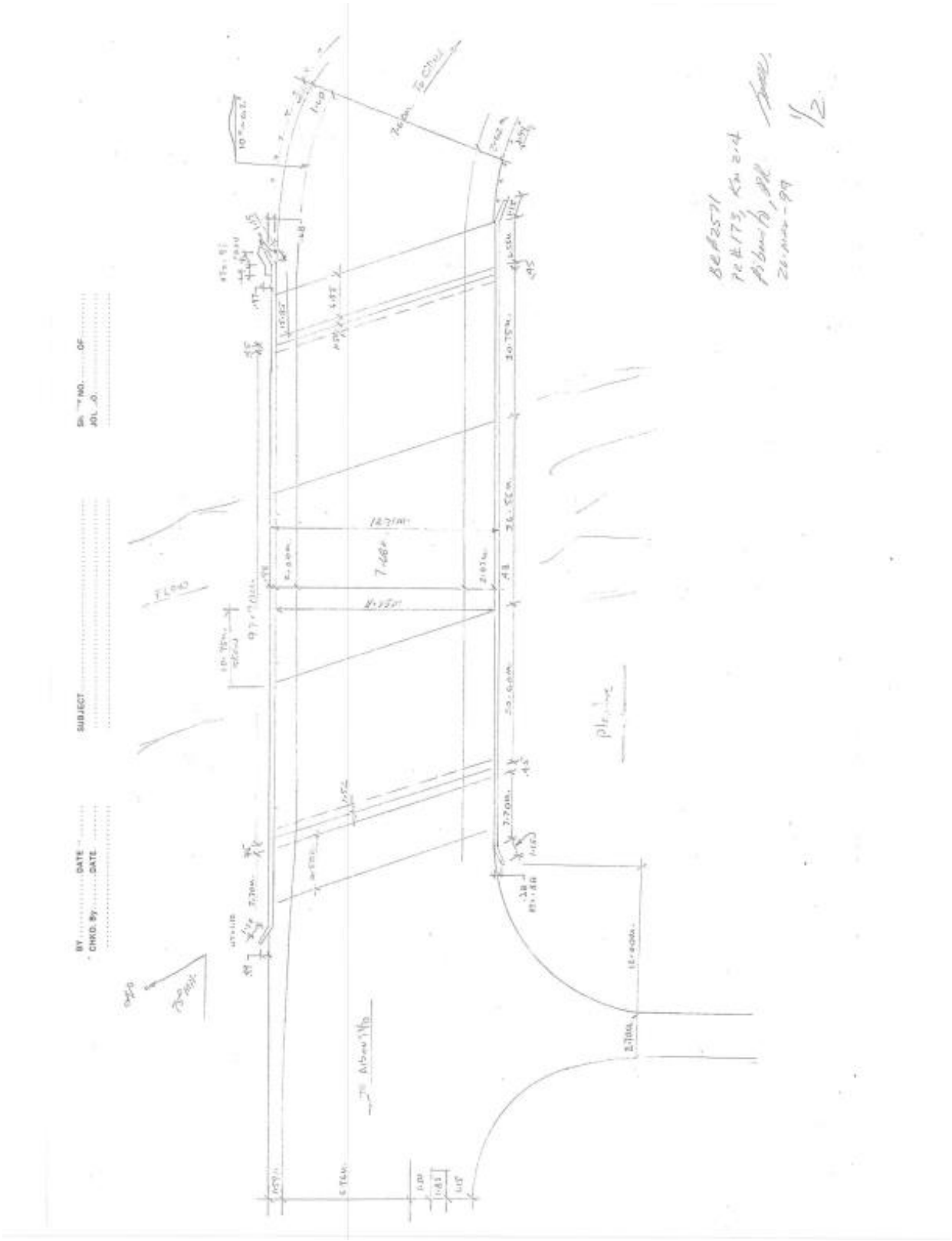
BRIDGE INVENTORY MANAGEMENT OFFICE
INFRASTRUCTURE DIRECTORY
PRHTA

Core Elements

Elem. No.	Elements Description	Env.	State Quantity	Units	Quantity Condition State 1	Quantity Condition State 2	Quantity Condition State 3	Quantity Condition State 4	Total State Quantity
12	Conc Deck (Bare)	3	1,154	SqM.	866	288			1154
1130	Cracking			SqM.		173			173
1120	Efflorescence			SqM.		115			115
109	P/C Open Girder (I Beam)	3	587	LnM.	587				587
205	R/C Columns	3	6	Ea.	6				6
215	R/C Abutment	3	46	LnM.	44	2			46
1130	Cracking			LnM.		2			2
234	R/C Pier Cap	3	24	LnM.	24				24
302	Comp. Joint	3	51	LnM.	15	36			51
2310	Leakage			LnM.		8			8
2350	Debris			LnM.		25			25
310	Elastomeric Bearings	3	36	Ea.	36				36
321	Approachs	3	166	Sq.M	141	25			166
1130	Cracking			Sq.M		25			25
331	Conc. Bridge Railing	3	196	LnM.	188	8			196
1130	Cracking			LnM.		8			8
									0
									0
									0
									0
									0
									0
									0

BR-2571

6



Bridge number: 2571

	Abutment Aibonito	*PIER1*	*PIER2*	*Abutment Cidra*
upstream	4.00	14.60	14.90	5.10
downstream	4.40	12.90	14.70	5.90
highway				

Medidas Tomadas hasta tope Parapeto
Assistant: Carlos Diaz
Bridge inspector:A.Lopez
Date: 05-16


2571-may-12-2016-001.jpg


2571-may-12-2016-003.jpg


2571-may-12-2016-015.jpg


2571-may-12-2016-018.jpg


2571-may-12-2016-021.jpg


2571-may-12-2016-023.jpg


2571-may-12-2016-024.jpg


2571-may-12-2016-032.jpg


2571-may-12-2016-033.jpg

APPENDIX H: BRIDGE DETERIORATION MASTER DATA TABLE

An example of the database is next. The complete database is included in the attached CD. This database was used to estimate the bridge deterioration rate.

STRUCTURE NUMBER	System 104	DECK AREA	RATE:	1992	1997	2002	2007	2012	2017	1997-1992	2002-1997	2007-2002	2012-2007	2017-2012	Average Change in 5 Years	Ave X Area
11	0	2169.35		3	4	4					0				0.00	0.00
31	0	132.06		5	5	5	6	6		0	0		0		0.00	0.00
41	0	977.67		4	4	4	4	4	4	0	0	0	0	0	0.00	0.00
51	0	118.77		5	6	5	5	5	5		-1	0	0	0	-0.25	-29.69
61	0	140.91		5	6	5	7	6	6		-1		-1	0	-0.67	-93.94
81	1	336.54		5	6	6	6	6	6		0	0	0	0	0.00	0.00
121	0	206.08		6	6	5	5	5	5	0	-1	0	0	0	-0.20	-41.22
131	1	791.04		5	6	6	6	6	6		0	0	0	0	0.00	0.00
141	1	255.38		6	6	6	6	6	6	0	0	0	0	0	0.00	0.00
151	0	102.46		3	4	4	3	4	4		0	-1		0	-0.33	-34.15
161	0	153.27		3	4	4	4	4	4		0	0	0	0	0.00	0.00

APPENDIX I: BRIDGE SYSTEMATIC PREVENTIVE MAINTENANCE PROGRAM PROTOCOL

The letter of agreement and the first two pages of the document are presented next. The complete document is included in the attached CD.

COMMONWEALTH OF
PUERTO RICO
Puerto Rico Highway and
Transportation Authority

June 11, 2013

Mr. David C. Hawk
Division Administrator
Federal Highway Administration
350 Chardon Ave., Suite 210
San Juan, PR 00918-2148

LETTER OF AGREEMENT FOR ELIGIBILITY OF SYSTEMATIC PREVENTIVE MAINTENANCE (SPM) ON FEDERAL-AID PROJECTS BETWEEN PRHTA AND FHWA

Dear Mr. Hawk:

One part of the Puerto Rico Highway and Transportation Authority's (PRHTA) actions to meet MAP-21 requirements, is the implementation of a Systematic Preventive Maintenance (SPM) Program. This program fulfills the national performance goals (NPG), performance measures and performance targets set by MAP-21 regarding bridge condition.

One of the NPG established by MAP-21 is a minimum infrastructure condition to maintain the highway infrastructure asset system in a state of good condition. To achieve this, if more than 10% of the total deck area of NHS bridges in a State is on structurally deficient (SD) bridges, the State must devote a portion of the National Highway Performance Program (NHPP) funds to improve this condition. These are the only performance goals and performance measures defined by MAP-21 at the moment. Based on this, PRHTA will be implementing preservation activities on bridge decks to keep the percentage of SD deck area in NHS bridges below 10%. PRHTA will include a recurrent item on the STIP every year for bridge preservation to meet MAP-21 asset management requirements. The amount of this item will be $5,000,000.

The attached SPM Program is based on research done by our structural engineer related to preservation techniques and best practices. PRHTA has also been an active member of the Southeast Bridge Preservation Partnership (SEBPP) since its creation in 2010. We have participated in annual meetings and have been able to develop a SPM Program based in the numerous meetings, peer exchanges and in existing documentation from other states such as Virginia, Florida and Louisiana.

Roberto Sánchez Vilella, Government Center
PO Box 42007, San Juan, PR 00940-2007
Tel. (787) 729.1531
Tel. (787) 721.8787 x-1008
Fax. (787) 727.5456
www.dtop.gov.pr

June 11, 2013
Letter of Agreement for Eligibility of SPM
Page 2

Enclosed, for your review and concurrence, you will find the SPM Program Protocol that PRHTA is going to implement to meet MAP-21 requirements. This program includes a wide variety of preservation activities as of: deck overlays, joint repair, joint elimination (link slabs) beam strengthening, scour countermeasures, beam painting (spot, zone and overcoat), among others. PRHTA will be focusing in deck preservation because the only performance target and measure defined currently by MAP-21 relate to that specific element.

When USDOT Secretary publishes rulemaking that establishes additional performance measures and standards, PRHTA will coordinate with FHWA the additional performance targets to be set for implementation.

If you have any questions, please contact Mr. Héctor R. Laureano, Bridge Program Manager, at 787-725-2566.

Sincerely,

Miguel A. Torres Díaz
Secretary

6004/HLP
Enclosure

CONCURRENCE: 7/3/2013
Date

Division Administrator
Federal Highway Administration

PRHTA BRIDGE SYSTEMATIC PREVENTIVE MAINTENANCE (SPM) PROGRAM PROTOCOL

INTRODUCTION

Bridge preservation has taken major importance after the approval of Moving Ahead for Progress in the 21st Century (MAP-21) law. MAP-21 sets as a national goal to maintain bridges in a state of good condition.

It is important to define and understand the *preservation*, *preventive maintenance* (PM) and *rehabilitation* terms.

> Bridge preservation: actions or strategies that prevent, delay or reduce deterioration of bridges or bridge elements, restore the function of existing bridges, keep bridges in good condition and extend their life. Preservation actions may be preventive or condition-driven.
>
> Preventive Maintenance: a planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system.
>
> Rehabilitation: major work required to restore the structural integrity of a bridge as well as work necessary to correct major safety defects.

As shown in Figure 1, Bridge Preservation includes both preventive maintenance and rehabilitation. Rehabilitation projects typically require significant engineering resources from design, a lengthy completion schedule and considerable costs.

The Puerto Rico Highway and Transportation Authority (PRHTA) will assign a portion of its Statewide Transportation Improvement Program (STIP) allocation toward funding a Systematic Preventive Maintenance (SPM) Program. The program activities will serve to extend the service life of bridges in a cost effective manner while maintaining/improving the current level of safety.

Our focus will be on bridges in fair to good structural condition. The most important activities considered are:

1. slab preservation were condition rating = 5, 6 or 7 which would include concrete overlays, partial and full depth patching, polymer overlays with broadcast aggregate and waterproofing with penetrating sealants among others

2. joint replacement/repairs including bearing replacement/repairs were deemed necessary
3. joint elimination using link slabs on those suitable bridges
4. installation of scour countermeasures
5. steel bridge paint/coating including trusses and steel beam bridges
6. fiber reinforced polymer (FRP) installation to cracked elements or bridges with load rating (LR) < 1.0
7. bridge washing/cleaning and drainage cleaning/repair/modification
8. approach slab lifting/leveling to eliminate LL impact increase

These activities are not all inclusive and the PRHTA intends to review new technologies and performance continuously to determine, in coordination with FHWA, new activities.

PAST BEHAVIOR OF PRHTA BRIDGE DECKS

It has been identified that, in general, one of the bridge elements that shows considerable deterioration is the slab.

The number of slabs with CR=3 (serious), 4 (poor) and 5 (fair) has steadily increased since 2010 (See Figure 2). This reflects an increase in the number of deficient slabs, but most important, in the number of slabs that will become deficient in a relative short period of time going from a CR=5 or 6 to CR=4.

In a similar way, the number of slabs with CR=6 (satisfactory), 7 (good), 8 (very good) has decreased since 2010 (See Figure 3 and 4). As a result we are having an inventory were the amount of slabs in a satisfactory to very good condition is decreasing while the amount of slabs in poor and fair condition is increasing.

If this trend is not addressed our inventory will become very costly to maintain at a satisfactory level with the available funds that the PRHTA has. And most important, PRHTA will not be able to meet National Highway Performance Program (NHPP) minimum requirements.

APPENDIX J: STANDARD OPERATION PROCEDURE FOR BRIDGE PROJECT PRIORITIZATION

The document's cover, index, and executive summary are presented next. The complete document is included in the attached CD.

COMMONWEALTH OF PUERTO RICO
DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS
PUERTO RICO HIGHWAY AND TRANSPORTATION AUTHORITY

Standard Operation Procedure

Bridge Project Prioritization

PUERTO RICO HIGHWAY AND TRANSPORTATION AUTHORITY

Bridge and Structures Design Office

ESTADO LIBRE ASOCIADO DE
PUERTO RICO
Autoridad de Carreteras y Transportación

September 2015

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I. EXECUTIVE SUMMARY

In most US states, including Puerto Rico, human and economic resources tend to be limited and insufficient to promptly address the impending issues affecting bridge infrastructure. For this reason, establishing a detailed, well-documented, and systematic project prioritization protocol is a crucial step to ensure the most-efficient use of PRHTA's resources, as well as to help make better-informed decisions that follow guidelines set forth to minimize the risk to the public and the Agency. In this document, PRHTA establishes the factors that must be considered for the prioritization of bridge-related projects and also defines the weight of each factor in determining the project's priority level.

The following factors have been selected as the ones that must be considered for the prioritization of bridge-related projects: NBIS Rating (Bridge Condition), Only Access Route, NHS, Fracture Critical, AADT, Weight Limit Posting, and Project Queue.

Given that some of the aforementioned factors are inherently more important than others, each factor was assigned a specific weight or percentage value of the overall priority level score, as follows: NBIS Rating (Bridge Condition): 45%, Only Access Route: 15%, NHS: 10%, Fracture Critical: 10%, AADT: 10%, Weight Limit Posting: 5% and Project Queue: 5%, for a total of 100%.

Even though this protocol provides an objective and systematic method to prioritize bridge projects, it is worth mentioning that engineering judgment must always be considered as an integral part of the decision-making process to ensure the decisions made are in accordance with the Agency's public policies, as well as to account for current events. Although every effort was made to include all significant and relevant project prioritization factors, it is not possible to include every single item that ultimately influences the final project prioritization process. The main purpose of developing a systematic project prioritization protocol is to objectively provide a starting point for PRHTA to define the final priority list.

APPENDIX K: EXTREME WEATHER DATA TABULATION

An example of the database is next. The complete database is included in the attached CD. This database was used to determine which locations have had damages due declared emergencies in more than one occasion.

Site	Event Year	Event Start Date	Event Duration	Main Event Type	Municipality	Road Name	Road Name or	Road System	From KM	To KM	Asset Type	Damage Type	Other Damage Description	Repair Nature	Repair Type
1	2008	09/21/2008	2	Heavy Rains	San Juan	PR-	3	Non-NHS	99.20	99.20	Road Segment		Construction of retaining walls, pavement repair and other misc. work	Repair Nature	Repair Type
1	2017	09/19/2017	1	Hurricane	Yabucoa	PR-	3	Non-NHS	99.20	99.20	Road Segment	Scour	Road scour	Permanent	Repair Type
2	2014	11/05/2014	13	Heavy Rains	Moca	PR-	111	NHS Non-Interstate	13.10	13.10	Asset Type			Repair Nature	Repair Type
2	2017	09/19/2017	1	Hurricane	Moca	PR-	111	NHS Non-Interstate	13.10	13.10	Road Segment	Scour	Scouring at temporary Acrow bridge		
3	2014	08/22/2014	2	Storm	Utua-do	PR-	123	Non-NHS	42.00	47.00	Road Segment	Landslide over Asset	Lanes partially closed due to landslide	Repair Nature	Repair Type
3	2017	09/19/2017	1	Hurricane	Adjuntas	PR-	123	Non-NHS	42.00	42.00	Road Segment	Other	Restore drainage structures		
4	2014	08/22/2014	2	Storm	Ponce	PR-	132	Non-NHS	19.40	19.40	Road Segment	Landslide over Asset	The road is collapsing	Repair Nature	Repair Type
4	2017	09/19/2017	1	Hurricane	Ponce	PR-	132	Non-NHS	19.40	19.40	Road Segment		Slip rap		

APPENDIX L: UNIT COSTS

An example of the historical project cost database is next. The complete database is included in the attached CD.

Recent

Num	Longitud (Kms)	Num. AC	Num. Subasta	Municipios	Descripción	Ayuda Federal	Estimado	F. Anuncio	F. Subasta	Contratista	Monto	F. Adjudicación	Ejecutado	F. Comienzo	F. Terminación	Dias
1	17.20	014979	P-16-07	Villalba Juana Díaz	Rehabilitación del Pavimento Carretera PR-149, Villalba - Juana Díaz, Desde Kilómetro: 57.20 Hasta Kilómetro: 74.40	MP-149(18)	$5,500,000.00	12-Oct-15	3-Nov-15	Super Asphalt Pavement Corporation	$5,013,512.00	18-Apr-16	13-Jul-16	26-Jul-16	20-Jul-17	360
2	7.00	800505	P-16-08	Villalba	Rehabilitación del Pavimento Carretera PR-151 Desde Kilómetro: 0.00 Hasta Kilómetro: 7.00	MP-9999(229)	$1,300,000.00	12-Oct-15	4-Nov-15	Super Asphalt Pavement Corporation	$1,271,937.00	3-Feb-16	29-Feb-16	10-Mar-16	6-Aug-16	150
3	5.70	071507	P-16-09	Cayey	Rehabilitacion Pavimento PR-715 Kms 0.00 a 5.70	MP-715(1)	$1,140,000.00	12-Oct-15	5-Nov-15	Super Asphalt Pavement Corporation	$1,096,742.00	3-Feb-16	29-Feb-16	10-Mar-16	6-Aug-16	150
4	5.10	200285	P-16-13	Toa Baja Dorado	Rehabilitación del Pavimento Carretera PR-2 Desde Kilómetro: 22.00 Hasta Kilómetro: 27.10	MP-2(71)	$2,800,000.00	19-Oct-15	13-Nov-15	C.J.O. Construction Corp.	$2,443,000.00	10-Mar-16	13-Apr-16	25-Apr-16	21-Oct-16	180
5	6.20	001869	P-16-15	San Juan	Rehabilitación del Pavimento Carretera PR-18 Desde Kilómetro: 0.00 Hasta Kilómetro: 6.20	MP-18(13)	$5,140,000.00	26-Oct-15	22-Dec-15	Desarrolladora JA, Inc.	$4,283,928.00	28-Apr-16	24-May-16	3-Jun-16	28-May-17	360
6	7.60	070406	P-16-16	Coamo Peñuelas	Rehabilitación Pavimento PR-704, Desde Kilómetro: 3.50 Hasta Kilómetro: 6.40, Coamo y PR-132 Desde Kilómetro: 5.40 Hasta Kilómetro: 10.10, Peñuelas	MP-9999(233)	$2,480,000.00	26-Oct-15	18-Nov-15	Constructora I. Melendez LLC	$2,252,000.00	3-Feb-16	29-Feb-16	11-Mar-16	3-Feb-17	330

History

SPECIFICATION CODE	ITM NAME	PROYECT NUM	PROYECT NAME	START DATE	MUNICIPALITY	CONTRACTOR	QUANTITY	UNIT	UNIT PRICE
636-589	½ inch Air Vent And Vaccum Release Valve	075206	Rehab Y Mitig Socavacion P/S Qda Jacana Num 672	30-Dec-2016	Arroyo	Obratec Contratista General Inc	2.000	Ea	$665.00
612-309	1 1/2 Inch Galvanized Steel Conduit	520123	Preservacion Del P/S PR-172 Num 909 Autopista Luis A. Ferre	29-Sep-2016	Caguas	Del Valle Group SP	140.000	LnM	$56.35
612-050	1 in. Galvanized Steel Conduit	800470	Reemplazo P/S PR-189 Num 982	29-Sep-2016	Gurabo	Constructora Santiago II Corp	500.000	LnM	$10.00
636-581	1 inch diameter Ball Valve	012324	Correcion De Deslizamiento	19-Sep-2016	Adjuntas	Obratec Contratista General, Inc	4.000	Ea	$106.00
636-072	1" Air Vent	010161	Extension A La Avenida Caridad Del Cobre	01-Sep-2016	Bayamon	Constructora Santiago II Corp	3.000	Ea	$400.00
636-311	1" PVC Pipe SCH 40	012324	Correcion De Deslizamiento	19-Sep-2016	Adjuntas	Obratec Contratista General, Inc	185.000	LnM	$6.00
636-124	1/2 inch Air Vent	802271	Reemplazo Puente Num 178 Quebrada Toita	17-Jun-2016	Cayey	Tamrio, Inc.	2.000	Ea	$350.00
636-270	10 inch Ductile Iron Pipe Class 350	061511	Reemplazo P/S Rio Toro Negro Num 599 PR-615 Km 4.05 Bo. Poza	09-Nov-2016	Ciales	Constructora Hartmann SE	239.000	LnM	$210.00
636-050	10" Gate Valve	061511	Reemplazo P/S Rio Toro Negro Num 599 PR-615 Km 4.05 Bo. Poza	09-Nov-2016	Ciales	Constructora Hartmann SE	3.000	Ea	$2,100.00
605-096	12 inch Corrugated PE Pipe Underdrain Non Perforated	010161	Extension A La Avenida Caridad Del Cobre	01-Sep-2016	Bayamon	Constructora Santiago II Corp	23.000	LnM	$90.00
605-095	12 inch Corrugated PE Pipe Underdrain Perforated	010161	Extension A La Avenida Caridad Del Cobre	01-Sep-2016	Bayamon	Constructora Santiago II Corp	63.000	LnM	$150.00
636-279	12 inch Ductile Iron Pipe Class 350	010161	Extension A La Avenida Caridad Del Cobre	01-Sep-2016	Bayamon	Constructora Santiago II Corp	223.000	LnM	$180.00

Representative unit cost details are presented next.

Interstate Asphalt

A	**Preservation - Cold Milling & Overlay**					
	151	1	LS	Mobilization (10%)	15,470.00	15,470.00
	403	294	CuM	Cold Milling Bituminous Concrete Pavement *(0.05 Mt.Th.)*	57.00	16,758.00
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	33,300.00
	964	781	Ton	Warm Mix Asphalt Pavement Superpave Mix (SPS) *(0.05 Mt.Th.)*	134.00	104,654.00
				Sub-Total		170,182.00
				15% Engineering and Contingencies		25,527.30
				TOTAL *(Cost per Lane-Miles)*		**$ 195,709.30**
B	**Minor Rehabilitation**					
	151	1	LS	Mobilization (10%)	32,330.00	32,330.00
	403	746	CuM	Cold Milling Bituminous Concrete Pavement *(0.127 Mt.Th.)*	57.00	42,522.00
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	33,300.00
	964	781	Ton	Warm Mix Asphalt Pavement Superpave Mix (SPS) *(0.05 Mt.Th.)*	134.00	104,654.00
	964	1171	Ton	Warm Mix Asphalt Pavement Superpave Mix (SPB) *(0.075 Mt.Th.)*	122.00	142,862.00
				Sub-Total		355,668.00
				15% Engineering and Contingencies		53,350.20
				TOTAL *(Cost per Lane-Miles)*		**$ 409,018.20**
C	**Major Rehabilitation**					
	151	1	LS	Mobilization (10%)	50,010.00	50,010.00
	403	1175	CuM	Cold Milling Bituminous Concrete Pavement *(0.20 Mt.Th.)*	57.00	66,975.00
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	33,300.00
	964	781	Ton	Warm Mix Asphalt Pavement Superpave Mix (SPS) *(0.05 Mt.Th.)*	134.00	104,654.00
	964	2343	Ton	Warm Mix Asphalt Pavement Superpave Mix (SPB) *(0.15 Mt.Th.)*	126.00	295,218.00
				Sub-Total		550,157.00
				15% Engineering and Contingencies		82,523.55
				TOTAL *(Cost per Lane-Miles)*		**$ 632,680.55**
D				**Replacement**		
	151	1	LS	Mobilization (10%)	51,120.00	51,120.00
	402	1175	CuM	Full Depth Removal of Bituminous Conc. Pavement	39.40	46,295.00
	402	882	CuM	Replacement Aggregate Base Course *(0.15 Mt.Th.)*	36.00	31,752.00
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	33,300.00
	964	781	Ton	Warm Mix Asphalt Pavement Superpave Mix (SPS) *(0.05 Mt.Th.)*	134.00	104,654.00
	964	2343	Ton	Warm Mix Asphalt Pavement Superpave Mix (SPB) *(0.15 Mt.Th.)*	126.00	295,218.00
				Sub-Total		562,339.00
				15% Engineering and Contingencies		84,350.85
				TOTAL *(Cost per Lane-Miles)*		**$ 646,689.85**

NHS Asphalt Pavement

A	Cold Milling & Overlay					
	151	1	LS	Mobilization (10%)	15,120.00	$15,120.00
	401-011	781	Ton	Hot Plant-Mix Bituminous Pavement Mix S(75)(12) (0.05 Mt.Th.)	129.50	$101,139.50
	403-001	294	CuM	Cold Milling Bituminous Concrete Pavement (0.05 Mt.Th.)	57.00	$16,758.00
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	$33,300.00
				Sub-Total		$166,317.50
				15% Engineering and Contingencies		$24,947.63
				TOTAL (Cost per Lane-Miles)		$191,265.13
B	Rehabilitation					
	151	1	LS	Mobilization (10%)	26,640.00	$26,640.00
	401-011	781	Ton	Hot Plant-Mix Bituminous Pavement Mix S(75)(12) (0.05 Mt.Th.)	129.50	$101,139.50
	401-012	781	Ton	Hot Plant-Mix Bituminous Pavement Mix B(75)(1) (0.05 Mt.Th.)	126.00	$98,406.00
	403-001	588	CuM	Cold Milling Bituminous Concrete Pavement (0.10 Mt.Th.)	57.00	$33,516.00
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	$33,300.00
				Sub-Total		$293,001.50
				15% Engineering and Contingencies		$43,950.23
				TOTAL (Cost per Lane-Miles)		$336,951.73
C	Replacement					
	151	1	LS	Mobilization (10%)	50,770.00	$50,770.00
	401-011	781	Ton	Hot Plant-Mix Bituminous Pavement Mix S(75)(12)) (0.05 Mt.Th.)	129.50	$101,139.50
	401-012	2,343	Ton	Hot Plant-Mix Bituminous Pavement Mix B(75)(1) (0.15 Mt.Th.)	126.00	$295,218.00
	402	1,175	CuM	Full Depth Removal of Bituminous Conc. Pavement	39.40	$46,295.00
	402	882	CuM	Replacement Aggregate Base Course (0.15 Mt.Th.)	36.00	$31,752.00
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	$33,300.00
				Sub-Total		$558,474.50
				15% Engineering and Contingencies		$83,771.18
				TOTAL (Cost per Lane-Miles)		$642,245.68
B2	Approximation					
						2.00
				Rehabilitation		1.58
	151	1	LS	Mobilization (10%)	38,420.00	$38,420.00
	401-011	781	Ton	Hot Plant-Mix Bituminous Pavement Mix S(75)(12) (0.05 Mt.Th.)	129.50	$101,139.50
	401-012	1,563	Ton	Hot Plant-Mix Bituminous Pavement Mix B(75)(1) (0.15 Mt.Th.)	126.00	$196,938.00
	403-001	926	CuM	Cold Milling Bituminous Concrete Pavement (0.10 Mt.Th.)	57.00	$52,782.00
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	$33,300.00
				Sub-Total		$422,579.50
				15% Engineering and Contingencies		$63,386.93
				TOTAL (Cost per Lane-Miles)		$485,966.43

Concrete

A	**Preservation**					
	151	1	LS	Mobilization (10%)	33,860.00	$33,860.00
9				Seal Joints		$0.00
	507-001	1784	LnM	Sealing of PCC Pavement Joint	7.00	$12,488.00
	507-002	1610	LnM	Sealing of Pavement/Shoulder Joint	8.00	$12,880.00
14				Slab Repair		$0.00
	504-001	705	SqM	Partial Depth Patching-Portland Cement Conc. Pavt. *(Assumed 12% of Total Area)*	391.00	$275,655.00
	506-001	846	SqM	Grind Concrete Pavement	5.00	$4,230.00
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	$33,300.00
				Sub-Total		$372,413.00
				15% Engineering and Contingencies		$55,861.95
				TOTAL *(Cost per Lane-Miles)*		**$428,274.95**
B	**Rehabilitation**					
15&16	Alternate A - Rubblization & Overlay					
	151	1	LS	Mobilization (10%)	48,690.00	$48,690.00
	509-002	5875	SqM	Cracking, Reseating and Cleaning Conc. Pavt.	60.00	$352,500.00
	401-011	781	Ton	Hot Plant-Mix Bituminous Pavement Mix S(75)(12) *(0.05 Mt.Th.)*	129.50	$101,139.50
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	$33,300.00
				Sub-Total		$535,629.50
				15% Engineering and Contingencies		$80,344.43
				TOTAL *(Cost per Lane-Miles)*		**$615,973.93**
17	Alternate B - Rehabilitation - Concrete					
	151	1	LS	Mobilization (10%)	45,760.00	$45,760.00
	507-001	2171	LnM	Sealing of PCC Pavement Joint and Cracks	7.00	$15,197.00
	507-002	1610	LnM	Sealing of Pavement/Shoulder Joint	8.00	$12,880.00
	504-001	705	SqM	Partial Depth Patching-Portland Cement Conc. Pavt. *(Assumed 12% of Total Area)*	391.00	$275,655.00
	505-001	1200	Each	New Dowels	76.00	$91,200.00
	506-001	5875	SqM	Grind Concrete Pavement	5.00	$29,375.00
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	$33,300.00
				Sub-Total		$503,367.00
				15% Engineering and Contingencies		$75,505.05
				TOTAL *(Cost per Lane-Miles)*		**$578,872.05**
C	**Replacement**					
18						
	151	1	LS	Mobilization (10%)	81,710.00	$81,710.00
				Replacement - Concrete		$0.00
	503-001	5875	SqM	Removal of Portland Cement Concrete Pavement	26.00	$152,750.00
	503-003	882	CuM	Replacement Aggregate Base Course *(0.15 Mt.Th.)*	36.00	$31,752.00
	503-010	5875	SqM	PCC Slab Replacement (Acc. Strength) (0.25 Mt.Th.)	102.00	$599,250.00
	638	1	LS/Miles	Maintenance and Protection of Traffic	33,300.00	$33,300.00
				Sub-Total		$898,762.00
				15% Engineering and Contingencies		$134,814.30
				TOTAL *(Cost per Lane-Miles)*		**$1,033,576.30**

Non NHS

A	Cold Milling & Overlay					
	151	1.00	LS	Mobilization (10%)	10,520.00	$10,520.00
	401-011	641.00	Ton	Hot Plant-Mix Bituminous Pavement Mix S(75)(12) (0.05 Mt.Th.)	129.50	$83,009.50
	403-001	242.00	CuM	Cold Milling Bituminous Concrete Pavement (0.05 Mt.Th.)	57.00	$13,794.00
	638	1.00	LS/Miles	Maintenance and Protection of Traffic	8,400.00	$8,400.00
				Sub-Total		$115,723.50
				15% Engineering and Contingencies		$17,358.53
				TOTAL (Cost per Lane-Miles)		$133,082.03

Approximate

B	Rehabilitation					
	151	1.00	LS	Mobilization (10%)	19,980.00	$19,980.00
	401-011	641.00	Ton	Hot Plant-Mix Bituminous Pavement Mix S(75)(12) (0.05 Mt.Th.)	129.50	$83,009.50
	401-012	641.00	Ton	Hot Plant-Mix Bituminous Pavement Mix B(75)(1) (0.05 Mt.Th.)	126.00	$80,766.00
	403-001	484.00	CuM	Cold Milling Bituminous Concrete Pavement (0.10 Mt.Th.)	57.00	$27,588.00
	638	1.00	LS/Miles	Maintenance and Protection of Traffic	8,400.00	$8,400.00
				Sub-Total		$219,743.50
				15% Engineering and Contingencies		$32,961.53
				TOTAL (Cost per Lane-Miles)		$252,705.03
B2	Rehabilitation (major)					
	151	1.00	LS	Mobilization (10%)	29,630.00	$29,630.00
	401-011	641.00	Ton	Hot Plant-Mix Bituminous Pavement Mix S(75)(12) (0.05 Mt.Th.)	129.50	$83,009.50
	401-012	1,282.00	Ton	Hot Plant-Mix Bituminous Pavement Mix B(75)(1) (0.05 Mt.Th.)	126.00	$161,532.00
	403-001	759.88	CuM	Cold Milling Bituminous Concrete Pavement (0.10 Mt.Th.)	57.00	$43,313.16
	638	1.00	LS/Miles	Maintenance and Protection of Traffic	8,400.00	$8,400.00
				Sub-Total		$325,884.66
				15% Engineering and Contingencies		$48,882.70
				TOTAL (Cost per Lane-Miles)		$374,767.36
C	Replacement					
	151	1.00	LS	Mobilization (10%)	39,780.00	$39,780.00
	401-011	641.00	Ton	Hot Plant-Mix Bituminous Pavement Mix S(75)(12)) (0.05 Mt.Th.)	129.50	$83,009.50
	401-012	1,923.00	Ton	Hot Plant-Mix Bituminous Pavement Mix B(75)(1) (0.15 Mt.Th.)	126.00	$242,298.00
	402	964.37	CuM	Full Depth Removal of Bituminous Conc. Pavement	39.40	$37,996.28
	402	723.90	CuM	Replacement Aggregate Base Course (0.15 Mt.Th.)	36.00	$26,060.22
	638	1.00	LS/Miles	Maintenance and Protection of Traffic	8,400.00	$8,400.00
				Sub-Total		$437,544.00
				15% Engineering and Contingencies		$65,631.60
				TOTAL (Cost per Lane-Miles)		$503,175.60

Bridges

Construction Unit Price for Programing Proposes			
1	Total Replacement	$	3,500.00
2	Slab Replacement	$	1,750.00
3	Superstructure Replacement	$	2,625.00
4	Scour Repair	$	880.00
5	Mayor Scour Repair	$	1,170.00
6	Mayor Bridge Repair	$	1,320.00
7	Preservation (Type-1)	$	400.00
8	Preservation (Type-2)	$	1,300.00
9	Preservation (Type-3)	$	2,100.00
100	OK	$	-

Type	Area M^2	Factor
"Small deck"	120	1.3
"Average deck"	940	1
"Large deck"	3098	0.85
"Q-50"	338	

	Bridge Cost ONLY
	Average Cost per Squre Meter (11 Bridges Sample)
Replace all superstructure, concrete slab 0.20 Th. & Steel Beams	$621.86
Replace all superstructure, concrete slab 0.20 Th. & AASHTO Beams	$727.34
Replace all superstructure, concrete slab 0.15 Th. & Concrete Box Beams	$1,098.73
Replace bridge deck, concrete slab 0.20 Th. over existing Beams	$332.80
Bridge Deck Partial Patch and Repair	$108.59
Mobilization 10%	
MOT $33,300 / mi	
Safety Devices $90,000 / lane mi	

Structure Type	Rating		Strategy	Code*	Cost per Sq. meter
All	<=	4	Replace	a	$3,150
Deck & Superstructure	<=	6	Replace	c	$2,250
Deck	<=	5	Replace	b	$1,200
Deck	=	5	Rehabilitation 1	d	$1,200
Deck	=	6	Rehabilitation 2	g	$600
Deck	>=	7	Preservation	j	$150
Super	=	5	Rehabilitation 1	e	$600
Super	=	6	Rehabilitation 2	h	$400
Super	>=	7	Preservation	k	$125
Substructure	=	6	Rehabilitation 2	i	$400
Substructure	=	5	Rehabilitation 1	f	$600
Substructure	>=	7	Preservation	l	$125

Treatment	Average Cost per Square Meter			
	Deck	Superstructure	Substructure	Culvert
Replacement	$1,200.00	$1,050.00	$900.00	$800.00
Major Rehabilitation	$1,200.00	$600.00	$600.00	$600.00
Minor Rehabilitation	$600.00	$400.00	$400.00	$400.00
Preservation	$150.00	$125.00	$125.00	$125.00
No Immediate Action	$0.00	$0.00	$0.00	$0.00

APPENDIX M: INVESTMENT STRATEGIES CALCULATION PROCESS

1. Investment Calculation Process

1.1. Identify Programmed Projects

Information regarding the available programs and corresponding projects were compiled. The first step was to identify the segments and bridges that are going to be treated. The subsections next describe the programs, the format of the information, and the difficulties found to gather necessary data from them together with the corresponding assumptions.

1.1.1. STIP

This is the State Transportation Improvement Program, main project program of PRHTA. It contains mostly projects related to regular federal funds, earmarked, Accelerated Highway Reconstruction Program (AHRP), among others. This information is compiled in Excel files; however, they are prepared for presentation purposes and can't be used as a form of database. The projects had to be identified by observation and re-written in a database form. It contains information about the general type of project to be performed; however, it is not clear for all the projects. For example, there is a category for pavements named "Rehabilitation and Reconstruction", so the projects under that category may include either types of treatments or both. For purposes of the analysis, major rehabilitation was presumed for most, unless most of the segment was in fair or good condition, where minor rehabilitation was presumed. The STIP tables indicate the segment or bridge to be treated but doesn't indicate the number of lane miles, the bridge area, or the system where the segments or bridges belongs to. Therefore, it had to be cross-referenced with the HPMS and NBI databases to identify the number of lanes, the bridge width and length, and the system. Then, this information was added to the databases that were developed for this purpose.

1.1.2. PEMOC

The initials stands for Programa Estatal de Modernización de Carreteras or State Program for Highway Modernization. This is a single time funded pavement reconstruction and rehabilitation program that is in effect from 2019 to 2021. The information about this program is compiled in Excel files; however, they are prepared for presentation purposes and can't be used as a form of database. The way the information is provided presented several challenges. Each project includes several segments of different roads from different systems and a lump sum investment is presented for the project. Therefore, it is not clear the proportion of the investment corresponding to each segment or system. In this case, it was presumed an investment per segment proportional to the lane miles, regardless of the system. In addition, each project may have investment assigned in up to three years. For the purpose of the analysis, it was presumed that the project would be completed by the last year and all investment was assigned also to that year. The PEMOC information had to be re-written in a usable

database form and also to be crossed-checked with the HPMS database to determine the lanes and calculate lane miles, and to determine how much of that belongs to each road system.

1.1.3. PEMAC

Although the Abriendo Caminos initiative encompass three programs (seeAppendix Figure M 1), this name is commonly used for the PEMAC program. For the purpose of this document, we are calling Abriendo Caminos the specific component of PEMAC, which are the initials for Programa Estatal para el Mantenimiento de Alta Calidad en Pavimentos or State Program for the Maintenance of High-Quality Pavement. This is a single time funded pavement preservation and maintenance program that is in effect from 2019 to 2020. The information about this program is compiled in Excel files; however, they are prepared for presentation purposes and can't be used as a form of database. For some segments, the information includes different line items with different treatments and costs for the same segments. The repeated segments may imply one or several of the following, but is not specified which one: separated per direction, different alternatives, separation of pavement marking from other treatments. For the purpose of this analysis, the cheapest option was presumed. Also, all the projects were presumed to be preservation ones. The Abriendo Caminos information had to be re-written in a usable database form and also to be crossed-checked with the HPMS database to determine the lanes and calculate lane miles, and to determine how much of that belongs to each road system. Abriendo Caminos had projects in roads that are not part of the HPMS (this TAMP scope), so they were taken out for purposes of analysis. The PEMOC component of Abriendo Caminos is considered separately, as shown in section 1.1.2. The AHRP component projects are federally funded and already included in the STIP, shown in section 1.1.1.

http://act.dtop.pr.gov/index.php/abriendo-caminos/

APPENDIX FIGURE M 1: ABRIENDO CAMINOS

1.1.4. Metropistas

These are the projects that are executed by the PRHTA's PR-22 and PR-5 concessionaire Autopistas Metropolitanas de Puerto Rico, LLC or Metropistas (commercial name). The information provided includes the specific segments and bridges, treatments, completion year, and expected condition after treatment. This doesn't include the investment amounts. The investment amounts are disclosed through their Capital Investment Plan (CIP); however, the updated one wasn't available at the moment of this analysis. For purposes of the analysis, an older version of their CIP (2016), which covers years 2017 to 2026. Note that this CIP was prepared before hurricane María, so the priorities probably changed.

1.1.5. Bridge Replacement

A bridge replacement initiative also was developed, and they generated a list of eleven projects. Out of those projects, five were already on the STIP under the category of Replacement, Rehabilitation, Critical Bridges. Only the six projects that were not in the STIP were added for the analysis. Those in the STIP were considered as indicated on the STIP. These projects were considered to be completed by the end of 2019.

1.1.6. Deck Replacement

A bridge deck replacement initiative also was developed, and they generated a list of eighteen projects. Out of those projects, twelve were already on the STIP under the category of Replacement, Rehabilitation, Critical Bridges. Only the six projects that were not in the STIP were added for the analysis. Those in the STIP were considered as indicated on the STIP. These projects were considered to be completed by the end of 2019.

1.1.7. Initial TAMP Bridges

An initiative was developed to address treatments and areas following the recommendations of the Initial TAMP. This list includes 86 bridges, of which 45 were already on the STIP. Only the 41 that were not in the STIP were added for the analysis. Those in the STIP were considered as indicated on the STIP. They included a mix of treatments such as slab preservation, deck replacement, bridge replacement, superstructure replacement, among others. The list had assigned these projects to years 2020 to 2023 and 2028.

1.1.8. Recommendations

As indicated in the previous subsections, the way the information is currently gathered doesn't allow for exact determination of lane miles and area to be impacted, the specific type of treatment, and the corresponding amounts per highway system. The information is collected for presentation purposes and is not usable as a database. It is recommended that all concerning parties adopt a process for data maintenance that can be used for

calculations. This is especially important if pavement and bridge management software are going to be implemented, as they will need that data to function. Also, this will allow quick re-calculations on real time whenever a program change is warranted.

2. Process for Developing the Preferred Pavement Investment Strategy

2.1. Determination of Needs

2.1.1. **Base condition** - Based on the best available data, base condition was estimated. It is shown in Appendix Table M 1. Information used was from 2017 PathRunner. Please refer to Chaper 2 for more information. As data was collected for a portion of the universe, the following was presumed:

a. For NHS, the non-measured or those with incomplete data were presumed to be in Poor condition.
b. For Non-NHS, the non-measured or those with incomplete data were presumed to be distributed in the same manner as the measured.

APPENDIX TABLE M 1: BASE CONDITION

Expected Condition Proportion per Year		BASE 2017
Interstate	Good	10.8%
	Fair to Good	24.8%
	Fair - Fair	28.7%
	Fair to Poor	19.0%
	Poor	16.7%
	Total	100.0%
NHS Non-Interstate	Good	2.2%
	Fair to Good	7.5%
	Fair - Fair	42.3%
	Fair to Poor	17.7%
	Poor	30.3%
	Total	100.0%
Non-NHS	Good	2.2%
	Fair to Good	27.8%
	Fair - Fair	48.2%
	Fair to Poor	14.0%
	Poor	7.9%
	Total	100.0%

2.1.2. **Required treatments** – Based on the matrix shown in Appendix Table M 2 and the treatment definitions and unit costs shown in Appendix Table M 3, treatment needs were calculated for each 0.1 mile of pavement data. Please refer to Chapter 2 for more details. Needs results are shown in Appendix Table M 4.

APPENDIX TABLE M 2: TREATMENT MATRIX

		RU/FA																			
		G	F1	F3	P	G	F1	F3	P	G	F1	F3	P	G	F1	F3	P	G	F1	F3	P
IRI	G																				
	F1																				
	F2																				
	F3																				
	P																				
		G	G	G	G	F1	F1	F1	F1	F2	F2	F2	F2	F3	F3	F3	F3	P	P	P	P
		CR																			

APPENDIX TABLE M 3: TREATMENTS AND UNIT COSTS

Adopted Treatment Unit Costs				
Asphalt & Other	**Description**	**Base Unit Cost**		
		Interstate	**NHS (Non-Interstate)**	**Non-NHS**
Preservation	2-in Cold Milling & Overlay	$195,709.30	$161,124.20	$133,082.03
Minor Rehabilitation	5-in Cold Milling & Overlay	$409,018.20	$379,067.60	$312,161.18
Major Rehabilitation	Full Depth (8-in) Cold Milling & Overlay	$632,680.55	$444,195.55	$365,690.23
Reconstruction	Full Depth (8-in) + 6-in Base Replacement	$646,689.85	$464,712.01	$382,539.57
Concrete	**Description**	**Base Unit Cost**		
		Interstate	**NHS (Non-Interstate)**	**Non-NHS**
Preservation	Joint Sealing & Slab Repair	$428,274.95	$398,294.45	$333,992.20
Rehabilitation	Joint & Crack Sealing, Partial Depth Patching, New Dowels, Grinding	$578,872.05	$548,891.55	$454,921.60
Rubblization & Overlay	Rubblization & Overlay	$620,429.60	$585,833.00	$482,079.43
Reconstruction	6-in Base Replacement, Slab Replacement	$1,033,576.30	$1,003,595.80	$825,341.20

APPENDIX TABLE M 4: RESULTING NEEDS

Base Condition Needs as per Adopted Treatment Matrix and Unit Costs				
System	**Surface**	**Treatment**	**Lane Miles (Extrapolation)**	**Estimated Cost**
INT	Asphalt	**Preservation**	143.69	$28,122,447.75
	Asphalt	**Minor Rehabilitation**	14.58	$5,964,761.65
	Asphalt	**Major Rehabilitation**	123.09	$77,878,481.40
	Asphalt	**Reconstruction**	15.10	$9,767,271.15
	Concrete	**Preservation**	48.61	$20,819,720.43
	Concrete	**Minor Rehabilitation**	21.21	$12,278,280.85
	Concrete	**Major Rehabilitation**	107.71	$66,826,814.06
	Concrete	**Reconstruction**	184.37	$190,559,614.38
	Total		**658.38**	**$412,217,391.67**
NHS	Asphalt	**Preservation**	636.27	$102,518,264.46
	Asphalt	**Minor Rehabilitation**	9.52	$3,610,413.67
	Asphalt	**Major Rehabilitation**	396.22	$176,000,495.49
	Asphalt	**Reconstruction**	94.39	$43,864,363.78
	Concrete	**Preservation**	14.97	$5,964,015.57
	Concrete	**Minor Rehabilitation**	1.91	$1,050,345.39
	Concrete	**Major Rehabilitation**	37.77	$22,125,192.30
	Concrete	**Reconstruction**	62.04	$62,262,713.62
	Total		**1,253.10**	**$417,395,804.27**
Other	Asphalt	**Preservation**	2,325.86	$309,530,363.50
	Asphalt	**Minor Rehabilitation**	247.47	$77,250,182.63
	Asphalt	**Major Rehabilitation**	1,317.70	$481,868,984.97
	Asphalt	**Reconstruction**	361.78	$138,394,141.44
	Concrete	**Preservation**	18.15	$6,060,779.30
	Concrete	**Minor Rehabilitation**	13.55	$6,163,831.46
	Concrete	**Major Rehabilitation**	29.29	$14,118,570.79
	Concrete	**Reconstruction**	88.24	$72,828,760.67
	Total		**4,402.03**	**$1,106,215,614.77**
Grand Total			**6,313.51**	**$1,935,828,810.71**

2.1.2. **Cost of treatments per condition** – Based on the costs per treatment, an average lane mile cost per condition was determined. They are shown in Appendix Table M 5. The average unit costs per condition were used to determine the amount of lane miles to treat per condition based on available budget per year.

APPENDIX TABLE M 5: NEEDS PER CONDITION

Needs per Base Condition	Condition	Total Lane Miles	Total Cost	Ave. Unit Cost
Interstate	Good	0.00	$0.00	$0.00
	Fair to Good	0.00	$0.00	$0.00
	Fair - Fair	228.10	$67,185,210.67	$294,540.47
	Fair to Poor	253.90	$183,647,640.27	$723,305.63
	Poor	176.38	$161,384,540.73	$915,004.70
NHS Non-Interstate	Good	0.00	$0.00	$0.00
	Fair to Good	0.00	$0.00	$0.00
	Fair - Fair	662.68	$113,143,039.10	$170,735.43
	Fair to Poor	391.66	$183,328,218.61	$468,082.72
	Poor	198.76	$120,924,546.57	$608,387.48
Non-NHS	Good	0.00	$0.00	$0.00
	Fair to Good	0.00	$0.00	$0.00
	Fair - Fair	2,605.03	$399,005,156.90	$153,167.44
	Fair to Poor	1,150.92	$430,128,836.20	$373,726.99
	Poor	646.08	$277,081,621.67	$428,862.57
TOTAL		**6,313.51**	**$1,935,828,810.71**	**$306,617.05**

2.2. Assess Programmed Projects

2.2.1. Determine **the surface type and existing condition the segments to be treated** – To determine the condition, the segments had to be crossed-referenced with the Pavement Condition database. This was performed through observation and manual calculation because of the following:

a. The segment delimitation between the databases didn't match.
b. The single road segments on projects contained several sub-segments within the Pavement Condition database. Each may have sub-segments in different conditions.
c. Some project segments may start or end at the middle of a Pavement Condition database line item.
d. Some project segments of sub-segments may have not been recorded on the Pavement Condition database.
e. If the HPMS database had more length than the Pavement Condition one, the difference was presumed to be non-measured. For NHS, the non-measured were presumed to be in Poor condition. For Non-NHS, the non-measured were presumed to be distributed in the same manner as the measured.

2.2.2. **Determine the lane miles and investment per condition, treatment, and year** – Based on the information from the different investment programs, lane miles and investment per condition, treatment, and year were calculated. See lane miles per condition per year, system, and program in Appendix Table M 6 and investment per treatment, system, year, and program in Appendix Table M 7.

APPENDIX TABLE M 6: LANE MILES PROGRAMMED

Program	System	Condition	2019	2020	2021	2022	2023	Total
Abriendo Caminos	Interstate	Good	34.12	10.28	0.00	0.00	0.00	44.40
		Fair to Good	112.13	28.09	0.00	0.00	0.00	140.21
		Fair - Fair	156.69	23.92	0.00	0.00	0.00	180.61
		Fair to Poor	88.76	13.08	0.00	0.00	0.00	101.84
		Poor	59.53	11.88	0.00	0.00	0.00	71.41
		Not Measured	0.00	0.00	0.00	0.00	0.00	0.00
		Total	**451.23**	**87.24**	**0.00**	**0.00**	**0.00**	**538.47**
	NHS Non-Interstate	Good	34.93	0.87	0.00	0.00	0.00	35.81
		Fair to Good	91.51	8.75	0.00	0.00	0.00	100.26
		Fair - Fair	337.18	63.78	0.00	0.00	0.00	400.96
		Fair to Poor	118.46	24.44	0.00	0.00	0.00	142.89
		Poor	188.44	27.32	0.00	0.00	0.00	215.76
		Not Measured	0.00	0.00	0.00	0.00	0.00	0.00
		Total	**770.52**	**125.16**	**0.00**	**0.00**	**0.00**	**895.67**
	Non-NHS	Good	4.20	0.00	0.00	0.00	0.00	4.20
		Fair to Good	23.01	15.80	0.00	0.00	0.00	38.81
		Fair - Fair	56.97	30.74	0.00	0.00	0.00	87.71
		Fair to Poor	15.62	10.60	0.00	0.00	0.00	26.23
		Poor	4.51	9.70	0.00	0.00	0.00	14.21
		Not Measured	180.91	743.05	0.00	0.00	0.00	923.96
		Total	**285.22**	**809.88**	**0.00**	**0.00**	**0.00**	**1,095.11**
	Total		**1,506.97**	**1,022.28**	**0.00**	**0.00**	**0.00**	**2,529.25**
Metropistas	Interstate	Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair to Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair - Fair	1.20	0.00	0.00	0.00	0.00	1.20
		Fair to Poor	0.00	0.00	0.00	0.00	0.00	0.00
		Poor	0.00	0.00	0.00	0.00	0.00	0.00
		Not Measured	0.00	0.00	0.00	0.00	0.00	0.00
		Total	**1.20**	**0.00**	**0.00**	**0.00**	**0.00**	**1.20**
	NHS Non-Interstate	Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair to Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair - Fair	0.00	0.00	0.00	0.00	0.00	0.00
		Fair to Poor	0.00	0.00	0.00	0.00	0.00	0.00
		Poor	0.00	0.00	0.00	0.00	0.00	0.00
		Not Measured	0.00	0.00	0.00	0.00	0.00	0.00
		Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Non-NHS	Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair to Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair - Fair	0.00	0.00	0.00	0.00	0.00	0.00
		Fair to Poor	0.00	0.00	0.00	0.00	0.00	0.00
		Poor	0.00	0.00	0.00	0.00	0.00	0.00
		Not Measured	0.00	0.00	0.00	0.00	0.00	0.00
		Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Total		**1.20**	**0.00**	**0.00**	**0.00**	**0.00**	**1.20**

Program	System	Condition	2019	2020	2021	2022	2023	Total
PEMOC	Interstate	Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair to Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair - Fair	0.00	0.40	0.00	0.00	0.00	0.40
		Fair to Poor	0.00	2.23	0.00	0.00	0.00	2.23
		Poor	0.00	1.60	0.00	0.00	0.00	1.60
		Not Measured	0.00	0.00	0.00	0.00	0.00	0.00
		Total	**0.00**	**4.23**	**0.00**	**0.00**	**0.00**	**4.23**
	NHS Non-Interstate	Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair to Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair - Fair	0.00	4.89	0.00	0.00	0.00	4.89
		Fair to Poor	0.00	2.40	0.00	0.00	0.00	2.40
		Poor	0.00	0.00	0.00	0.00	0.00	0.00
		Not Measured	0.00	0.91	4.97	0.00	0.00	5.88
		Total	**0.00**	**8.19**	**4.97**	**0.00**	**0.00**	**13.16**
	Non-NHS	Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair to Good	0.00	2.40	0.20	0.00	0.00	2.60
		Fair - Fair	0.00	6.40	6.26	0.00	0.00	12.66
		Fair to Poor	0.00	3.24	2.20	0.00	0.00	5.44
		Poor	0.00	2.90	0.40	0.00	0.00	3.30
		Not Measured	0.00	134.78	80.06	0.00	0.00	214.84
		Total	**0.00**	**149.73**	**89.12**	**0.00**	**0.00**	**238.85**
	Total		**0.00**	**162.15**	**94.09**	**0.00**	**0.00**	**256.24**
STIP	Interstate	Good	3.60	0.80	0.00	1.59	0.00	5.99
		Fair to Good	10.00	3.70	0.00	2.57	0.00	16.27
		Fair - Fair	28.02	4.13	2.89	3.20	0.00	38.23
		Fair to Poor	7.37	9.60	5.09	10.30	0.00	32.36
		Poor	18.24	13.74	13.20	20.60	0.00	65.77
		Not Measured	0.00	0.00	0.05	0.13	0.00	0.17
		Total	**67.23**	**31.96**	**21.23**	**38.39**	**0.00**	**158.80**
	NHS Non-Interstate	Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair to Good	19.82	2.56	4.51	1.06	3.30	31.24
		Fair - Fair	13.77	17.67	38.93	15.36	21.77	107.49
		Fair to Poor	10.90	3.85	30.08	6.90	2.00	53.73
		Poor	8.10	20.13	13.12	1.54	0.40	43.28
		Not Measured	8.63	41.64	5.69	4.10	0.62	60.68
		Total	**61.22**	**85.85**	**92.32**	**28.96**	**28.09**	**296.43**
	Non-NHS	Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair to Good	0.00	0.00	0.00	0.00	0.00	0.00
		Fair - Fair	0.20	0.00	0.00	0.00	0.00	0.20
		Fair to Poor	0.00	0.00	0.00	0.00	0.00	0.00
		Poor	0.00	0.00	0.00	0.00	0.00	0.00
		Not Measured	44.66	0.00	0.00	122.29	26.84	193.78
		Total	**44.86**	**0.00**	**0.00**	**122.29**	**26.84**	**193.98**
	Total		**173.30**	**117.81**	**113.55**	**189.63**	**54.93**	**649.22**
TOTAL			**1,681.47**	**1,302.24**	**207.64**	**189.63**	**54.93**	**3,435.91**

APPENDIX TABLE M 7: PROGRAMMED INVESTMENT PER TREATMENT, YEAR, SYSTEM, AND PROGRAM

Programmed Investment per Treatment								
Program	**System**	**Treatment**	**2,019**	**2,020**	**2,021**	**2,022**	**2,023**	**Total**
Abriendo Caminos	Interstate	**Preservation**	9,064,446	3,334,500				12,398,946
		Minor Rehabilitation						0
		Major Rehabilitation						0
		Reconstruction						0
		Total	**9,064,446**	**3,334,500**	**0**	**0**	**0**	**12,398,946**
	NHS	**Preservation**	15,997,474	5,814,950				21,812,424
		Minor Rehabilitation						0
		Major Rehabilitation						0
		Reconstruction						0
		Total	**15,997,474**	**5,814,950**	**0**	**0**	**0**	**21,812,424**
	Non-NHS	**Preservation**	17,430,121	59,891,800				77,321,921
		Minor Rehabilitation						0
		Major Rehabilitation						0
		Reconstruction						0
		Total	**17,430,121**	**59,891,800**	**0**	**0**	**0**	**77,321,921**
	Total		**42,492,041**	**69,041,250**	**0**	**0**	**0**	**111,533,291**
Metropistas	Interstate	**Preservation**	4,292,067					4,292,067
		Minor Rehabilitation						0
		Major Rehabilitation						0
		Reconstruction						0
		Total	**4,292,067**	**0**	**0**	**0**	**0**	**4,292,067**
	NHS	**Preservation**						0
		Minor Rehabilitation						0
		Major Rehabilitation						0
		Reconstruction						0
		Total	**0**	**0**	**0**	**0**	**0**	**0**
	Non-NHS	**Preservation**						0
		Minor Rehabilitation						0
		Major Rehabilitation						0
		Reconstruction						0
		Total	**0**	**0**	**0**	**0**	**0**	**0**
	Total		**4,292,067**	**0**	**0**	**0**	**0**	**4,292,067**
PEMOC	Interstate	**Preservation**						0
		Minor Rehabilitation						0
		Major Rehabilitation		816,067				816,067
		Reconstruction						0
		Total	**0**	**816,067**	**0**	**0**	**0**	**816,067**

Programmed Investment per Treatment								
Program	**System**	**Treatment**	**2,019**	**2,020**	**2,021**	**2,022**	**2,023**	**Total**
	NHS	**Preservation**						0
		Minor Rehabilitation						0
		Major Rehabilitation		1,615,761	713,348			2,329,110
		Reconstruction						0
		Total	**0**	**1,615,761**	**713,348**	**0**	**0**	**2,329,110**
	Non-NHS	**Preservation**						0
		Minor Rehabilitation						0
		Major Rehabilitation		23,971,223	13,905,811			37,877,034
		Reconstruction						0
		Total	**0**	**23,971,223**	**13,905,811**	**0**	**0**	**37,877,034**
	Total		**0**	**26,403,052**	**14,619,159**			**41,022,211**
STIP	Interstate	**Preservation**	4,490,787					4,490,787
		Minor Rehabilitation	18,935,524					18,935,524
		Major Rehabilitation	23,987,474	7,790,676	13,705,593			45,483,743
		Reconstruction		13,176,518	5,113,600	32,908,859		51,198,977
		Total	**47,413,785**	**20,967,194**	**18,819,193**	**32,908,859**	**0**	**120,109,031**
	NHS	**Preservation**	4,235,952	24,194,789	30,808,666	17,295,000	10,000,000	86,534,407
		Minor Rehabilitation						0
		Major Rehabilitation	2,876,026					2,876,026
		Reconstruction	13,225,679	15,400,000	16,644,946		46,800,000	92,070,625
		Total	**20,337,657**	**39,594,789**	**47,453,612**	**17,295,000**	**56,800,000**	**181,481,058**
	Non-NHS	**Preservation**	9,835,187			19,505,000	25,000,000	54,340,187
		Minor Rehabilitation				3,001,623		3,001,623
		Major Rehabilitation	1,954,566			6,028		1,960,594
		Reconstruction	12,649,149			18,610,885		31,260,034
		Total	**24,438,902**	**0**	**0**	**41,123,536**	**25,000,000**	**90,562,438**
	Total		**92,190,344**	**60,561,983**	**66,272,805**	**91,327,395**	**81,800,000**	**392,152,526**
Total			**138,974,452**	**156,006,285**	**80,891,964**	**91,327,395**	**81,800,000**	**549,000,096**

2.3. Proposed Interventions

2.3.1. **Budget** - Information about available budget for the 10-year TAMP period was collected. A summary is provided in Appendix Table M 8. The total available per year was then distributed per system and condition based on determined priorities. The budget allocation proportion per system, condition, and year, for the preferred alternative for the 2028 TAMP 10-year period is shown in Appendix Table M 9. This allocation is oriented to reach the NHS targets within the 10-year 2028 TAMP period. It is slowly moving from addressing the poor to preserving the fair. Once the target is approaching, more proportion is allocated to the fair.

APPENDIX TABLE M 8: ADDITIONAL BUDGET

Additional Budget	2020	2021	2022	2023	2024	2025	2026	2027	2028
Metropistas*	$3,764,672	$5,041,985	$3,495,101	$7,010,864	$5,170,849	$7,333,168	$9,421,845	$4,100,586	$4,100,586
STIP & Local~				$48,200,000	$130,000,000	$130,000,000	$130,000,000	$130,000,000	$130,000,000
Total	**$3,764,672**	**$5,041,985**	**$3,495,101**	**$55,210,864**	**$135,170,849**	**$137,333,168**	**$139,421,845**	**$134,100,586**	**$134,100,586**

* Budget from Metropistas 2016 Capital Improvement Plan.

~ As per PRHTA Fiscal Plan certified on June 29, 2018.

Presumed value based on years 2020-2022.

APPENDIX TABLE M 9: BUDGET ALLOCATION PROPORTION PER SYSTEM, CONDITION, AND YEAR

Expected Budget Allocation* per Year		2020	2021	2022	2023	2024	2025	2026	2027	2028
System										
INT		90%	90%	90%	59%	50%	50%	41%	42%	37%
NHS		10%	10%	10%	20%	30%	29%	24%	24%	21%
Other		0%	0%	0%	21%	20%	21%	35%	34%	42%
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Condition per System										
Interstate	Good (G)	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Fair to Good (F1)	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Fair - Fair(F2)	20%	20%	20%	2%	2%	2%	5%	7%	19%
	Fair to Poor (F3)	20%	20%	20%	2%	2%	2%	5%	5%	5%
	Poor (P)	60%	60%	60%	96%	96%	96%	90%	88%	76%
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
NHS Non-Interstate	Good (G)	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Fair to Good (F1)	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Fair - Fair(F2)	20%	20%	20%	35%	10%	10%	25%	20%	20%
	Fair to Poor (F3)	20%	20%	20%	25%	10%	10%	18%	15%	10%
	Poor (P)	60%	60%	60%	40%	80%	80%	57%	65%	70%
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Non-NHS	Good (G)	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Fair to Good (F1)	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Fair - Fair(F2)	0%	0%	0%	20%	15%	10%	15%	10%	15%
	Fair to Poor (F3)	0%	0%	0%	20%	5%	5%	5%	5%	5%
	Poor (P)	0%	0%	0%	60%	80%	85%	80%	85%	80%
	Total	**0%**	**0%**	**0%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

* Additional budget for 2020-2022 is from Metropistas (NHS only, mostly Interstate). Allocation applies to recommended additional investment. The proportion was applied to total annual remaining budget (available budget minus already programmed) per system and condition. Lane miles to treat were obtained by dividing the resulting budget allocation by the estimated average unit costs per base condition identified needs.

2.3.2. **Treatment** – First, the available budget per year was allocated based on the proportions presented in Appendix Table M 9. Second, the resulting budget per condition was divided by the average unit costs per condition shown in Appendix Table M 5 to determine the number of lane miles to treat per condition and year. The results are shown in Appendix Table M 10.

APPENDIX TABLE M 10: PROPOSED INVESTMENT AND LANE MILES TO TREAT PER CONDITION AND YEAR

Proposed	Condition	2020		2021		2022		2023		2024		2025		2026		2027		2028	
		Additional Investment	Additional Lane Miles	Additional Investment	Additional Lane Miles	Additional Investment	Additional Lane Miles	Additional Investment	Additional Lane Miles	Investment	Lane Miles	Investment	Lane Miles	Investment	Lane Miles	Investment	Lane Miles	Investment	Lane Miles
Interstate	Good	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00
	Fair to Good	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00
	Fair - Fair	$677,641	2.30	$907,557	3.08	$629,118	2.14	$651,488	2.21	$1,351,708	4.59	$1,373,332	4.66	$2,858,148	9.70	$3,942,557	13.39	$9,427,271	32.01
	Fair to Poor	$677,641	0.94	$907,557	1.25	$629,118	0.87	$651,488	0.90	$1,351,708	1.87	$1,373,332	1.90	$2,858,148	3.95	$2,816,112	3.89	$2,480,861	3.43
	Poor	$2,032,923	2.22	$2,722,672	2.98	$1,887,354	2.06	$31,271,433	34.18	$64,882,007	70.91	$65,919,921	72.04	$51,446,661	56.23	$49,563,577	54.17	$37,709,085	41.21
NHS Non-Interstate	Good	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00
	Fair to Good	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00
	Fair - Fair	$75,293	0.44	$100,840	0.59	$69,902	0.41	$3,864,760	22.64	$4,055,125	23.75	$3,982,662	23.33	$8,365,311	49.00	$6,436,828	37.70	$5,632,225	32.99
	Fair to Poor	$75,293	0.16	$100,840	0.22	$69,902	0.15	$2,760,543	5.90	$4,055,125	8.66	$3,982,662	8.51	$6,023,024	12.87	$4,827,621	10.31	$2,816,112	6.02
	Poor	$225,880	0.37	$302,519	0.50	$209,706	0.34	$4,416,869	7.26	$32,441,004	53.32	$31,861,295	52.37	$19,072,908	31.35	$20,919,691	34.39	$19,712,786	32.40
Non-NHS	Good	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00
	Fair to Good	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00	$0	0.00
	Fair - Fair	$0	0.00	$0	0.00	$0	0.00	$2,318,856	15.14	$4,055,125	26.48	$2,883,997	18.83	$7,319,647	47.79	$4,559,420	29.77	$8,448,337	55.16
	Fair to Poor	$0	0.00	$0	0.00	$0	0.00	$2,318,856	6.20	$1,351,708	3.62	$1,441,998	3.86	$2,439,882	6.53	$2,279,710	6.10	$2,816,112	7.54
	Poor	$0	0.00	$0	0.00	$0	0.00	$6,956,569	16.22	$21,627,336	50.43	$24,513,970	57.16	$39,038,117	91.03	$38,755,069	90.37	$45,057,797	105.06
TOTAL		**$3,764,672**	**6.43**	**$5,041,985**	**8.61**	**$3,495,101**	**5.97**	**$55,210,864**	**110.65**	**$135,170,849**	**243.63**	**$137,333,168**	**242.66**	**$139,421,845**	**308.44**	**$134,100,586**	**280.08**	**$134,100,586**	**315.81**

2.4. After Treatment Assumptions

Assumptions were made regarding the condition after treatments are applied, based on base condition. The matrix on Appendix Table M 11 shows the proportion of the current condition treated that will remain on same condition or will change to a different one.

APPENDIX TABLE M 11: AFTER TREATMENT CONDITION MATRIX ASSUMPTION

Used Treated % Change due Treatment	From \ To	Good (G)	Fair to Good (F1)	Fair - Fair(F2)	Fair to Poor (F3)	Poor (P)	Total
Interstate	Good (G)	100%					100%
	Fair to Good (F1)	50%	50%				100%
	Fair - Fair(F2)	40%	30%	30%			100%
	Fair to Poor (F3)	50%	20%	20%	10%		100%
	Poor (P)	50%	20%	20%	10%		100%
NHS Non-Interstate	Good (G)	100%					100%
	Fair to Good (F1)	50%	50%				100%
	Fair - Fair(F2)	40%	30%	30%			100%
	Fair to Poor (F3)	50%	20%	20%	10%		100%
	Poor (P)	30%	20%	30%	20%		100%
Non-NHS	Good (G)	100%					100%
	Fair to Good (F1)	50%	50%				100%
	Fair - Fair(F2)	20%	30%	50%			100%
	Fair to Poor (F3)	50%	10%	15%	25%		100%
	Poor (P)	25%	20%	35%	20%		100%

2.5. Deterioration

2.5.1. **Data driven** - PathRunner data from 2014 to 2017 was used to estimate deterioration rates. Resulting values are shown in Appendix Table M 12. Please refer to Chapter 2 for the detailed procedure used to determine deterioration.

APPENDIX TABLE M 12: PAVEMENT DETERIORATION PER DATA

Deterioration Rate of Change per Year from One Condition to the Next Lower One	Overall	% Deteriorating
INT	-0.5408	66.1%
NHS	-0.4349	43.1%
OTHER	-0.2885	53.8%
Overall	-0.4894	55.5%

2.5.2. **Limitations on data** - Data was limited on years and on segments with repeated information. Also, most of this information was about pavements that were already fair, fair to poor and poor; therefore, the available information is biased on already deteriorated pavement (see Appendix Table M 13).

APPENDIX TABLE M 13: DETERIORATION SAMPLE SUMMARY

Number of 0.1-mile Segments per Year and Condition on Sample	Good	Fair to Good	Fair	Fair to Poor	Poor	Total
2014	38	120	335	203	260	956
2015	46	128	265	204	233	876
2016	76	150	310	237	209	982
2017	99	145	247	226	147	864
Total	**264**	**547**	**1,160**	**872**	**850**	**3,693**
Percent	**7.15%**	**14.81%**	**31.41%**	**23.61%**	**23.02%**	**100.00%**

2.5.3. **Additional tools** - The performance period values listed on PRHTA's Pavement Preservation Management Program were also used as part of the tools for the consideration of pavement deterioration. Related information and calculations are shown in Appendix Table M 14

APPENDIX TABLE M 14: DETERIORATION ESTIMATED BASED ON PERFORMANCE PERIOD

Treatment	Max Performance Period in Years	Presumed Condition After Treatment	Condition Changes to Poor	Average Rate of Change from One Condition to the Next per Year
Thin HMA Overlay	8	Fair - Fair	2	0.25
Cold Milling Overlay	10	Fair - Fair	2	0.20
CJ Reseal	8	Fair - Fair	2	0.25
CC Seal	8	Fair - Fair	2	0.25
Diamond Grinding	15	Fair to Good	3	0.20
Partial Depth Repair	15	Fair to Good	3	0.20
Full Depth Concrete Pavement Repair	15	Fair to Good	3	0.20
Dowel Bar Retrofit	15	Fair to Good	3	0.20

Performance data from PRHTA's Pavement Preservation Management Program

2.5.4. **Deterioration for analysis** - The deterioration rates and % deteriorating used for the analysis are shown in Appendix Table M 15.

APPENDIX TABLE M 15: USED: PAVEMENT DETERIORATION RATES

Deterioration	Condition	Deterioration Rate per Year	% Deteriorating
Interstate	Good	-0.2	66.0%
	Fair to Good	-0.2	66.0%
	Fair - Fair	-0.25	66.0%
	Fair to Poor	-0.25	66.0%
	Poor	1	0.0%
NHS Non-Interstate	Good	-0.2	43.0%
	Fair to Good	-0.2	43.0%
	Fair - Fair	-0.25	43.0%
	Fair to Poor	-0.25	43.0%
	Poor	1	0.0%
Non-NHS	Good	-0.2	54.0%
	Fair to Good	-0.2	54.0%
	Fair - Fair	-0.25	54.0%
	Fair to Poor	-0.25	54.0%
	Poor	1	0.0%

2.6. Strategy Calculations

Since the base data is from 2017, the strategy analysis was started in year 2018. Last year's STIP was used to estimate investment and lane miles treated for 2018. The lane miles per condition per year were calculated as follows:

a. The previous year lane miles per condition were used as base.
b. The net lane miles changes per condition, due treatments expected to end by that year, were added or subtracted, as appropriate.
c. The net lane miles changes per condition due deterioration were added or subtracted, as appropriate. Final lane mile results and those per step are shown in Appendix Table M 16.

APPENDIX TABLE M 16: PAVEMENT STRATEGY PROCESS RESULTS

Estimated Net Lane Miles		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good	138.8	186.1	383.9	389.0	351.4	325.4	300.9	299.4	298.7	293.2	288.9	285.9
	Fair to Good	319.3	314.5	327.1	339.0	351.9	358.9	362.2	370.0	376.9	381.5	385.5	391.3
	Fair - Fair	369.7	344.0	233.4	227.6	235.1	245.8	258.1	274.7	289.7	296.9	300.5	288.3
	Fair to Poor	245.0	241.3	179.5	168.1	173.8	176.2	190.3	206.9	223.5	236.5	248.4	258.0
	Poor	215.5	202.4	164.4	164.6	176.1	182.0	176.9	137.4	99.5	80.1	65.0	64.8
NHS Non-Interstate	Good	38.1	45.9	364.2	415.8	420.5	396.5	388.3	384.7	380.9	383.6	381.2	374.3
	Fair to Good	131.4	127.4	236.9	292.5	323.6	338.8	358.7	380.7	400.2	422.1	439.1	451.7
	Fair - Fair	735.8	661.5	443.1	388.4	357.5	339.1	304.7	303.9	305.1	284.4	276.1	272.0
	Fair to Poor	308.3	351.0	309.0	313.7	299.3	300.4	299.1	302.6	305.6	300.2	296.1	295.0
	Poor	527.0	554.7	387.2	330.1	339.5	365.7	389.8	368.6	348.8	350.3	348.1	347.6
Non-NHS	Good	178.5	159.2	247.2	532.3	503.3	488.7	454.8	425.4	399.5	391.9	381.2	381.1
	Fair to Good	2,283.1	2,055.8	1,867.1	1,729.3	1,604.9	1,490.3	1,391.5	1,308.7	1,230.8	1,174.2	1,117.3	1,076.1
	Fair - Fair	3,965.3	3,676.6	3,334.2	2,904.5	2,681.1	2,468.9	2,290.5	2,136.5	2,000.6	1,872.4	1,764.1	1,656.9
	Fair to Poor	1,150.9	1,530.9	1,789.6	1,911.9	2,037.2	2,113.2	2,157.4	2,182.8	2,185.0	2,173.5	2,146.3	2,110.1
	Poor	646.1	801.5	985.9	1,145.9	1,397.3	1,662.8	1,929.7	2,170.5	2,408.0	2,612.0	2,815.0	2,999.7
Total		**11,252.8**	**11,252.8**	**11,252.8**	**11,252.8**	**11,252.8**	**11,252.8**	**11,252.8**	**11,252.8**	**11,252.8**	**11,252.8**	**11,252.8**	**11,252.8**

Programmed Treatments		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good		1.6	37.7	11.1	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0
	Fair to Good		17.1	122.1	31.8	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0
	Fair - Fair		34.5	185.9	28.4	2.9	3.2	0.0	0.0	0.0	0.0	0.0	0.0
	Fair to Poor		32.9	96.1	24.9	5.1	10.3	0.0	0.0	0.0	0.0	0.0	0.0
	Poor		53.5	77.8	27.2	13.2	20.7	0.0	842.3	0.0	0.0	0.0	0.0
NHS Non-Interstate	Good		0.0	34.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fair to Good		3.7	111.3	11.3	4.5	1.1	3.3	0.0	0.0	0.0	0.0	0.0
	Fair - Fair		12.9	350.9	86.3	38.9	15.4	21.8	0.0	0.0	0.0	0.0	0.0
	Fair to Poor		4.8	129.4	30.7	30.1	6.9	2.0	0.0	0.0	0.0	0.0	0.0
	Poor		5.4	205.2	90.0	23.8	5.6	1.0	0.0	0.0	0.0	0.0	0.0
Non-NHS	Good		0.0	9.1	19.1	1.7	2.7	0.6	1,232.1	0.0	0.0	0.0	0.0
	Fair to Good		0.0	85.6	261.9	22.4	33.9	7.5	0.0	0.0	0.0	0.0	0.0
	Fair - Fair		0.0	165.9	460.4	44.9	59.0	12.9	0.0	0.0	0.0	0.0	0.0
	Fair to Poor		0.0	47.2	136.7	13.4	17.1	3.8	0.0	0.0	0.0	0.0	0.0
	Poor		0.0	22.2	81.6	6.7	9.6	2.1	0.0	0.0	0.0	0.0	0.0

Proposed Treatment Lane Miles		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fair to Good					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fair - Fair					3.1	2.1	2.2	4.6	4.7	9.7	13.4	32.0
	Fair to Poor					1.3	0.9	0.9	1.9	1.9	4.0	3.9	3.4
	Poor					3.0	2.1	34.2	70.9	72.0	56.2	54.2	41.2
NHS Non-Interstate	Good					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fair to Good					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fair - Fair					0.6	0.4	22.6	23.8	23.3	49.0	37.7	33.0
	Fair to Poor					0.2	0.1	5.9	8.7	8.5	12.9	10.3	6.0
	Poor					0.5	0.3	7.3	53.3	52.4	31.3	34.4	32.4
Non-NHS	Good					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fair to Good					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Fair - Fair					0.0	0.0	15.1	26.5	18.8	47.8	29.8	55.2
	Fair to Poor					0.0	0.0	6.2	3.6	3.9	6.5	6.1	7.5
	Poor					0.0	0.0	16.2	50.4	57.2	91.0	90.4	105.1

Condition Change due Treatment		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good		65.6	222.4	55.8	13.7	20.4	18.4	38.2	38.8	34.0	34.4	35.1
	Fair to Good		19.1	29.5	4.4	6.3	7.1	7.7	15.9	16.2	14.9	15.6	18.5
	Fair - Fair		-6.9	-95.4	-10.5	0.3	3.1	5.5	11.3	11.5	5.2	2.2	-13.5
	Fair to Poor		-24.2	-78.7	-20.3	-4.1	-7.8	2.6	5.4	5.5	2.1	1.9	1.0
	Poor		-53.5	-77.8	-29.4	-16.2	-22.8	-34.2	-70.9	-72.0	-56.2	-54.2	-41.2
NHS Non-Interstate	Good		11.0	322.3	82.9	40.5	12.2	25.8	29.8	29.3	35.4	30.6	25.9
	Fair to Good		4.1	116.5	44.6	20.5	6.8	14.9	19.5	19.2	23.5	20.2	17.6
	Fair - Fair		-6.4	-158.2	-27.5	-14.3	-7.8	-27.0	1.1	1.1	-22.3	-14.0	-12.2
	Fair to Poor		-3.2	-75.4	-9.7	-22.4	-5.1	-5.5	2.9	2.8	-5.3	-2.4	1.1
	Poor		-5.4	-205.2	-90.4	-24.3	-6.0	-8.3	-53.3	-52.4	-31.3	-34.4	-32.4
Non-NHS	Good		0.0	105.2	311.8	28.6	39.7	18.9	19.7	20.0	35.6	31.6	41.1
	Fair to Good		0.0	16.1	37.2	4.9	4.3	9.4	18.4	17.5	33.2	27.6	38.3
	Fair - Fair		0.0	-68.1	-181.1	-18.1	-23.6	-6.1	5.0	11.2	8.9	17.7	10.3
	Fair to Poor		0.0	-30.9	-86.2	-8.7	-10.9	-3.8	7.4	8.5	13.3	13.5	15.4
	Poor		0.0	-22.2	-81.6	-6.7	-9.6	-18.3	-50.4	-57.2	-91.0	-90.4	-105.1

Condition Net Change due to Deterioration		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good		-18.3	-24.6	-50.7	-51.4	-46.4	-43.0	-39.7	-39.5	-39.4	-38.7	-38.1
	Fair to Good		-23.8	-17.0	7.5	6.6	-0.1	-4.4	-8.1	-9.3	-10.3	-11.7	-12.7
	Fair - Fair		-18.9	-15.2	4.7	7.2	7.7	6.8	5.2	3.5	1.9	1.4	1.3
	Fair to Poor		20.6	16.9	8.9	9.8	10.1	11.5	11.2	11.2	10.9	10.0	8.6
	Poor		40.4	39.8	29.6	27.7	28.7	29.1	31.4	34.1	36.9	39.0	41.0
NHS Non-Interstate	Good		-3.3	-3.9	-31.3	-35.8	-36.2	-34.1	-33.4	-33.1	-32.8	-33.0	-32.8
	Fair to Good		-8.0	-7.0	10.9	10.6	8.3	5.0	2.5	0.3	-1.7	-3.3	-5.0
	Fair - Fair		-67.8	-60.2	-27.3	-16.6	-10.6	-7.3	-1.9	0.1	1.6	5.7	8.1
	Fair to Poor		46.0	33.4	14.4	8.0	6.3	4.2	0.6	0.1	-0.1	-1.7	-2.1
	Poor		33.1	37.7	33.2	33.7	32.2	32.3	32.2	32.5	32.8	32.3	31.8
Non-NHS	Good		-19.3	-17.2	-26.7	-57.5	-54.4	-52.8	-49.1	-45.9	-43.1	-42.3	-41.2
	Fair to Good		-227.3	-204.8	-175.0	-129.3	-119.0	-108.2	-101.2	-95.4	-89.8	-84.5	-79.5
	Fair - Fair		-288.7	-274.3	-248.5	-205.3	-188.6	-172.4	-158.9	-147.1	-137.2	-126.0	-117.5
	Fair to Poor		379.9	289.7	208.5	134.0	86.9	48.0	18.0	-6.2	-24.9	-40.6	-51.6
	Poor		155.4	206.7	241.6	258.1	275.0	285.3	291.3	294.7	295.0	293.4	289.8

2.7. Strategy Expected Results

2.7.1. **Condition** – Expected condition per system and year as a result of the strategy application is shown in Appendix Table M 17.

APPENDIX TABLE M 17: EXPECTED CONDITION PER SYSTEM AND YEAR

Expected Condition Proportion per Year		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good	10.8%	14.4%	29.8%	30.2%	27.3%	25.3%	23.4%	23.2%	23.2%	22.8%	22.4%	22.2%
	Fair to Good	24.8%	24.4%	25.4%	26.3%	27.3%	27.9%	28.1%	28.7%	29.3%	29.6%	29.9%	30.4%
	Fair - Fair	28.7%	26.7%	18.1%	17.7%	18.3%	19.1%	20.0%	21.3%	22.5%	23.0%	23.3%	22.4%
	Fair to Poor	19.0%	18.7%	13.9%	13.0%	13.5%	13.7%	14.8%	16.1%	17.4%	18.4%	19.3%	20.0%
	Poor	16.7%	15.7%	12.8%	12.8%	13.7%	14.1%	13.7%	10.7%	7.7%	6.2%	5.0%	5.0%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
NHS Non-Interstate	Good	2.2%	2.6%	20.9%	23.9%	24.2%	22.8%	22.3%	22.1%	21.9%	22.0%	21.9%	21.5%
	Fair to Good	7.5%	7.3%	13.6%	16.8%	18.6%	19.5%	20.6%	21.9%	23.0%	24.3%	25.2%	25.9%
	Fair - Fair	42.3%	38.0%	25.5%	22.3%	20.5%	19.5%	17.5%	17.5%	17.5%	16.3%	15.9%	15.6%
	Fair to Poor	17.7%	20.2%	17.8%	18.0%	17.2%	17.3%	17.2%	17.4%	17.6%	17.2%	17.0%	16.9%
	Poor	30.3%	31.9%	22.2%	19.0%	19.5%	21.0%	22.4%	21.2%	20.0%	20.1%	20.0%	20.0%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Non-NHS	Good	2.2%	1.9%	3.0%	6.5%	6.1%	5.9%	5.5%	5.2%	4.9%	4.8%	4.6%	4.6%
	Fair to Good	27.8%	25.0%	22.7%	21.0%	19.5%	18.1%	16.9%	15.9%	15.0%	14.3%	13.6%	13.1%
	Fair - Fair	48.2%	44.7%	40.5%	35.3%	32.6%	30.0%	27.9%	26.0%	24.3%	22.8%	21.5%	20.1%
	Fair to Poor	14.0%	18.6%	21.8%	23.2%	24.8%	25.7%	26.2%	26.5%	26.6%	26.4%	26.1%	25.7%
	Poor	7.9%	9.7%	12.0%	13.9%	17.0%	20.2%	23.5%	26.4%	29.3%	31.8%	34.2%	36.5%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

2.7.2. **Treatments** – To determine the budget per treatment as a result of the strategy, a conversion from condition to treatment was developed based on the need calculations. The base information and proportion results are shown in Appendix Table M 18. Resulting investment per treatment type per year is shown in Appendix Table M 19.

APPENDIX TABLE M 18: INVESTMENT DISTRIBUTION CALCULATION PER CONDITION AND TREATMENT

System	Treatment	Total Cost (Base Condition Needs)					Budget Distribution				
		G	F1	F2	F3	P	G	F1	F2	F3	P
Interstate	Preservation	$0	$0	$48,942,168	$0	$0	0.00%	0.00%	72.85%	0.00%	0.00%
	Minor Rehabilitation	$0	$0	$18,243,042	$0	$0	0.00%	0.00%	27.15%	0.00%	0.00%
	Major Rehabilitation	$0	$0	$0	$118,477,012	$26,228,283	0.00%	0.00%	0.00%	64.51%	16.25%
	Reconstruction	$0	$0	$0	$65,170,628	$135,156,257	0.00%	0.00%	0.00%	35.49%	83.75%
NHS Non Interstate	Preservation	$0	$0	$108,482,280	$0	$0	0.00%	0.00%	95.88%	0.00%	0.00%
	Minor Rehabilitation	$0	$0	$4,660,759	$0	$0	0.00%	0.00%	4.12%	0.00%	0.00%
	Major Rehabilitation	$0	$0	$0	$160,564,398	$37,561,290	0.00%	0.00%	0.00%	87.58%	31.06%
	Reconstruction	$0	$0	$0	$22,763,821	$83,363,256	0.00%	0.00%	0.00%	12.42%	68.94%
Non NHS	Preservation	$0	$0	$315,591,143	$0	$0	0.00%	0.00%	79.09%	0.00%	0.00%
	Minor Rehabilitation	$0	$0	$83,414,014	$0	$0	0.00%	0.00%	20.91%	0.00%	0.00%
	Major Rehabilitation	$0	$0	$0	$359,274,565	$136,712,991	0.00%	0.00%	0.00%	83.53%	49.34%
	Reconstruction	$0	$0	$0	$70,854,272	$140,368,631	0.00%	0.00%	0.00%	16.47%	50.66%

APPENDIX TABLE M 19: PREFERRED INVESTMENT SCENARIO

System	Treatment	Total Expected Investment										
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Interstate	Preservation	$17,847,301	$3,828,139	$661,125	$458,291	$474,587	$984,674	$1,000,426	$2,082,065	$2,872,020	$6,867,450	$37,076,079
	Minor Rehabilitation	$18,935,524	$184,002	$246,432	$170,827	$176,901	$367,034	$372,906	$776,083	$1,070,537	$2,559,821	$24,860,067
	Major Rehabilitation	$23,987,474	$9,374,303	$14,733,577	$712,598	$5,502,543	$11,416,682	$11,599,314	$10,205,016	$9,871,858	$7,728,980	$105,132,344
	Reconstruction	$0	$15,119,522	$7,715,845	$34,712,734	$26,420,379	$54,817,034	$55,693,939	$44,099,792	$42,507,831	$32,460,966	$313,548,042
	Total	**$60,770,299**	**$28,505,966**	**$23,356,979**	**$36,054,450**	**$32,574,410**	**$67,585,424**	**$68,666,584**	**$57,162,956**	**$56,322,246**	**$49,617,217**	**$480,616,531**
NHS Non Interstate	Preservation	$20,233,426	$30,081,931	$30,905,352	$17,362,023	$13,705,557	$3,888,081	$3,818,602	$8,020,714	$6,171,673	$5,400,213	$139,587,572
	Minor Rehabilitation	$0	$3,102	$4,154	$2,880	$159,203	$167,045	$164,060	$344,597	$265,156	$232,011	$1,342,206
	Major Rehabilitation	$2,876,026	$1,751,868	$895,634	$126,361	$3,789,724	$13,628,348	$13,384,814	$11,199,527	$10,726,200	$8,589,574	$66,968,077
	Reconstruction	$13,225,679	$15,565,067	$16,866,019	$153,247	$50,187,688	$22,867,782	$22,459,143	$13,896,405	$15,021,112	$13,939,324	$184,181,465
	Total	**$36,335,131**	**$47,401,968**	**$48,671,158**	**$17,644,510**	**$67,842,173**	**$40,551,255**	**$39,826,619**	**$33,461,243**	**$32,184,141**	**$28,161,123**	**$392,079,320**
Non NHS	Preservation	$27,265,307	$59,891,800	$0	$19,505,000	$26,834,088	$3,207,381	$2,281,083	$5,789,438	$3,606,250	$6,682,170	$155,062,518
	Minor Rehabilitation	$0	$0	$0	$3,001,623	$484,768	$847,744	$602,914	$1,530,209	$953,169	$1,766,167	$9,186,594
	Major Rehabilitation	$1,954,566	$23,971,223	$13,905,811	$6,028	$5,369,270	$11,800,043	$13,299,735	$21,299,501	$21,026,058	$24,583,886	$137,216,121
	Reconstruction	$12,649,149	$0	$0	$18,610,885	$3,906,155	$11,179,001	$12,656,234	$20,178,497	$20,008,722	$23,290,023	$122,478,666
	Total	**$41,869,022**	**$83,863,023**	**$13,905,811**	**$41,123,536**	**$36,594,281**	**$27,034,170**	**$28,839,965**	**$48,797,646**	**$45,594,199**	**$56,322,246**	**$423,943,900**
Total		**$138,974,452**	**$159,770,956**	**$85,933,949**	**$94,822,496**	**$137,010,864**	**$135,170,849**	**$137,333,168**	**$139,421,845**	**$134,100,586**	**$134,100,586**	**$1,296,639,751**

3. Process for Developing the Preferred Bridge Investment Strategy

3.1. Determination of Needs

3.1.1. Base **condition** - Based on the Bridge Condition database, base condition was estimated as % of total area. The following formulas were used to determine bridge deck area:

a. Bridges: Length X Width
b. Culverts: Length X Approach Width

Base condition is shown in Appendix Table M 20. Please refer to Chapter 2 for more information about condition evaluation.

APPENDIX TABLE M 20: BASE CONDITION

System	Condition	% Area
NHS	Good	18.47%
	Fair to Good	34.08%
	Fair to Poor	38.84%
	Poor	8.61%
	Total	**100.00%**
Non-NHS	Good	28.04%
	Fair to Good	31.49%
	Fair to Poor	30.51%
	Poor	9.96%
	Total	**100.00%**
Total	Good	21.09%
	Fair to Good	33.37%
	Fair to Poor	36.56%
	Poor	8.98%
	Total	**100.00%**

3.1.2. **Required treatments** – Based on the criteria shown in Appendix Table M 21, treatment needs were identified. Please refer to Chapter 2 for more details. Needs results are shown in Appendix Table M 22.

APPENDIX TABLE M 21: TREATMENT CRITERIA

Treatment	Rate			
	Deck	Superstructure	Substructure	Culvert
Replacement	<=4 or Sup<=4 or Sub<=4	<=4 or Sub<=4	<=4	<=4
Major Rehabilitation	5	5	5	5
Minor Rehabilitation	6	6	6	6
Preservation	7	7	7	7
No Immediate Action	>7	>7	>7	>7
Treatment	**Average Cost per Square Meter**			
	Deck	**Superstructure**	**Substructure**	**Culvert**
Replacement	$1,200.00	$1,050.00	$900.00	$800.00
Major Rehabilitation	$1,200.00	$600.00	$600.00	$600.00
Minor Rehabilitation	$600.00	$400.00	$400.00	$400.00
Preservation	$150.00	$125.00	$125.00	$125.00

APPENDIX TABLE M 22: BRIDGE TREATMENT NEEDS

Treatment Group	Investment Cost		Deck Area (Sq. Mts.)		Amount	
	NHS	Non-NHS	NHS	Non-NHS	NHS	Non-NHS
No Immediate Action	$0	$0	41,839.3	13,970.3	20	41
Preservation	$298,410,814	$94,305,754	533,256.8	218,387.9	272	303
Minor Rehabilitation	$1,125,704,348	$296,215,778	773,621.8	218,952.1	403	536
Major Rehabilitation	$423,618,379	$241,428,100	214,114.8	123,316.3	139	482
Replacement	$66,640,114	$62,682,823	21,494.8	21,736.3	15	114
Subtotal	**$1,914,373,655**	**$694,632,455**	**1,584,327.6**	**596,362.8**	849	1,476
Total	**$2,609,006,110**		**2,180,690.4**		**2,325**	

3.1.3. **Cost of treatments per condition** – Based on the costs per treatment, average area per condition was determined. They are shown in Appendix Table M 23. The average unit costs per condition were used to determine the amount of lane miles to treat per condition based on available budget per year.

APPENDIX TABLE M 23: AVERAGE AREA AND COST PER CONDITION

System	Condition	Area (Sq. Mts.)	Estimated Cost	Ave. Unit Cost
NHS	Good	250,792.27	$64,470,126.25	$257.07
	Fair Satisfactory	539,981.47	$518,804,026.25	$960.78
	Fair to Poor	615,351.00	$1,047,998,925.75	$1,703.09
	Poor	136,363.51	$283,100,576.50	$2,076.07
	TOTAL	**1,542,488.25**	**$1,914,373,654.75**	**$1,241.09**
Non-NHS	Good	153,264.53	$41,818,478.50	$272.85
	Fair Satisfactory	187,781.06	$185,477,585.50	$987.73
	Fair to Poor	181,921.40	$316,191,938.00	$1,738.07
	Poor	59,425.57	$151,144,452.75	$2,543.42
	TOTAL	**582,392.56**	**$694,632,454.75**	**$1,192.72**
TOTAL		**2,124,880.81**	**$2,609,006,109.50**	**$1,227.84**

3.2. Assess Programmed Projects

3.2.1. **Determine the area and existing condition of the bridges to be treated** - To determine the project area and condition, the bridge numbers were cross-referenced with the Bridge Condition Database. However, the Bridge Condition database downloaded from the FHWA website had the bridge numbers with an extra digit at the end, either a 1 or a 2. Hence, the first step was to match the bridge numbers.

3.2.2. **Determine the investment per condition, treatment, and year** – Based on the information from the different investment programs, investment per condition, treatment, and year were calculated. See area per system, year, and initiative in Appendix Table M 24, per condition in Appendix Table M 25, and per treatment in Appendix Table M 26.

APPENDIX TABLE M 24: TREATMENT AREA PROGRAMMED PER YEAR AND INITIATIVE

System	List	2019	2020	2021	2022	2023	2024-20270	2028	Total
NHS	Bridge Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Deck Replacement	4,979.9	0.0	0.0	0.0	0.0	0.0	0.0	4,979.9
	Initial TAMP	0.0	0.0	0.0	0.0	58,558.8	0.0	11,457.0	70,015.8
	Metropistas	16,230.8	0.0	0.0	0.0	0.0	0.0	0.0	16,230.8
	STIP	19,690.0	51,907.1	23,469.8	40,124.7	0.0	0.0	0.0	135,191.7
	Total	**40,900.7**	**51,907.1**	**23,469.8**	**40,124.7**	**58,558.8**	**0.0**	**11,457.0**	**226,418.2**
Non-NHS	Bridge Replacement	1,753.1	0.0	0.0	0.0	0.0	0.0	0.0	1,753.1
	Deck Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Initial TAMP	0.0	0.0	0.0	0.0	27,909.2	0.0	0.0	27,909.2
	Metropistas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	STIP	6,002.6	10,656.8	7,365.8	4,246.5	0.0	0.0	0.0	28,271.6
	Total	**7,755.7**	**10,656.8**	**7,365.8**	**4,246.5**	**27,909.2**	**0.0**	**0.0**	**57,934.0**
Total		*48,656.4*	*62,563.9*	*30,835.6*	*44,371.2*	*86,468.0*	*0.0*	*11,457.0*	**284,352.2**

APPENDIX TABLE M 25: TREATMENT AREA PROGRAMMED PER YEAR AND CONDITION

Programmed Sq. Mts.		2019	2020	2021	2022	2023	2024-2027	2028	Total
NHS	Good	0.00	51,907.15	0.00	0.00	46,897.50	0.00	0.00	98,804.65
	Fair Satisfactory	3,540.47	0.00	0.00	0.00	0.00	0.00	0.00	3,540.47
	Fair to Poor	29,604.62	0.00	0.00	19,169.41	0.00	0.00	0.00	48,774.03
	Poor	7,755.63	0.00	23,469.81	20,955.32	11,661.27	0.00	11,457.00	75,299.03
	TOTAL	**40,900.72**	**51,907.15**	**23,469.81**	**40,124.73**	**58,558.77**	**0.00**	**11,457.00**	**226,418.18**
Non-NHS	Good	0.00	7,171.85	0.00	0.00	22,317.40	0.00	0.00	29,489.25
	Fair Satisfactory	2,462.10	0.00	0.00	1,031.60	0.00	0.00	0.00	3,493.70
	Fair to Poor	177.05	0.00	6,313.58	243.10	0.00	0.00	0.00	6,733.73
	Poor	5,116.55	3,484.93	1,052.24	2,971.76	5,591.82	0.00	0.00	18,217.30
	TOTAL	**7,755.70**	**10,656.78**	**7,365.82**	**4,246.46**	**27,909.22**	**0.00**	**0.00**	**57,933.98**
TOTAL		**48,656.42**	**62,563.93**	**30,835.63**	**44,371.19**	**86,467.99**	**0.00**	**11,457.00**	**284,352.16**

APPENDIX TABLE M 26: TREATMENT AREA PROGRAMMED PER YEAR AND TYPE

Programmed Sq. Mts.		2019	2020	2021	2022	2023	2024-2027	2028	Total
NHS	**Preservation**	10,599.17	51,907.15	15,728.58	2,308.53	46,897.50	0.00	0.00	127,440.93
	Minor Rehabilitation	6,126.40	0.00	0.00	18,062.67	11,661.27	0.00	11,457.00	47,307.34
	Major Rehabilitation	24,175.15	0.00	7,741.23	18,740.79	0.00	0.00	0.00	50,657.17
	Replacement	0.00	0.00	0.00	1,012.74	0.00	0.00	0.00	1,012.74
	TOTAL	**40,900.72**	**51,907.15**	**23,469.81**	**40,124.73**	**58,558.77**	**0.00**	**11,457.00**	**226,418.18**
Non-NHS	**Preservation**	0.00	0.00	0.00	37.82	22,669.45	0.00	0.00	22,707.27
	Minor Rehabilitation	2,462.10	0.00	0.00	2,093.10	3,998.76	0.00	0.00	8,553.96
	Major Rehabilitation	3,540.48	10,656.78	7,365.82	66.08	127.02	0.00	0.00	21,756.18
	Replacement	1,753.12	0.00	0.00	2,049.46	1,113.99	0.00	0.00	4,916.57
	TOTAL	**7,755.70**	**10,656.78**	**7,365.82**	**4,246.46**	**27,909.22**	**0.00**	**0.00**	**57,933.98**
TOTAL		**48,656.42**	**62,563.93**	**30,835.63**	**44,371.19**	**86,467.99**	**0.00**	**11,457.00**	**284,352.16**

3.3. Proposed Interventions

3.3.1. **Budget** - Information about available budget for the 10-year TAMP period was collected. A summary is provided in Appendix Table M 27. The total available per year was then distributed per system and condition based on determined priorities. The budget allocation proportion per system, condition, and year, for the preferred alternative for the 2028 TAMP 10-year period is shown in Appendix Table M 28. This allocation is oriented to maintain targets within the 10-year 2028 TAMP period. It is moving from addressing the poor to preserving the fair. The budget is equally distributed between NHS and Non-NHS.

APPENDIX TABLE M 27: ADDITIONAL BUDGET

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Metropistas	$2,486,308	$1,370,640	$1,790,620	$3,492,497	$3,886,380	$3,983,540	$4,083,128	$4,000,000	$4,000,000	$29,093,113
PRHTA	---	---	---	$41,951,718	$86,000,000	$86,000,000	$86,000,000	$86,000,000	$65,182,631	$451,134,349
Total	$2,486,308	$1,370,640	$1,790,620	$45,444,215	$89,886,380	$89,983,540	$90,083,128	$90,000,000	$69,182,631	$480,227,462

APPENDIX TABLE M 28: BUDGET ALLOCATION PROPORTION PER SYSTEM, CONDITION, AND YEAR

Priority (% Budget)		2020	2021	2022	2023	2024	2025	2026	2027	2028
System										
NHS		100%	100%	100%	50%	50%	50%	50%	50%	50%
Non-NHS		0%	0%	0%	50%	50%	50%	50%	50%	50%
TOTAL		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Condition										
NHS	Good				0%	0%	0%	0%	0%	0%
	Fair Satisfactory	10%	10%	30%	30%	30%	40%	40%	40%	40%
	Fair to Poor	25%	30%	30%	30%	30%	30%	30%	30%	30%
	Poor	65%	60%	40%	40%	40%	30%	30%	30%	30%
	TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Non-NHS	Good				0%	0%	0%	0%	0%	0%
	Fair Satisfactory				10%	10%	10%	10%	20%	20%
	Fair to Poor				20%	20%	20%	20%	20%	20%
	Poor				70%	70%	70%	70%	60%	60%
	TOTAL	**0%**	**0%**	**0%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

3.3.2. **Treatment** – First, the available budget per year was allocated based on the proportions presented in Appendix Table M 28. Second, the resulting budget per condition was divided by the average unit costs per condition shown in Appendix Table M 23 to determine the number of lane miles to treat per condition and year. The results are shown in Appendix Table M 29.

APPENDIX TABLE M 29: PROPOSED INVESTMENT AND AREA TO TREAT PER CONDITION AND YEAR

Estimated Additional Investment		2020	2021	2022	2023	2024	2025	2026	2027	2028
NHS	Good	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Fair Satisfactory	$248,631	$137,064	$537,186	$6,816,632	$13,482,957	$17,996,708	$18,016,626	$18,000,000	$13,836,526
	Fair to Poor	$621,577	$411,192	$537,186	$6,816,632	$13,482,957	$13,497,531	$13,512,469	$13,500,000	$10,377,395
	Poor	$1,616,100	$822,384	$716,248	$9,088,843	$17,977,276	$13,497,531	$13,512,469	$13,500,000	$10,377,395
	TOTAL	**$2,486,308**	**$1,370,640**	**$1,790,620**	**$22,722,107**	**$44,943,190**	**$44,991,770**	**$45,041,564**	**$45,000,000**	**$34,591,315**
Non-NHS	Good				$0	$0	$0	$0	$0	$0
	Fair Satisfactory				$2,272,211	$4,494,319	$4,499,177	$4,504,156	$9,000,000	$6,918,263
	Fair to Poor				$4,544,421	$8,988,638	$8,998,354	$9,008,313	$9,000,000	$6,918,263
	Poor				$15,905,475	$31,460,233	$31,494,239	$31,529,095	$27,000,000	$20,754,789
	TOTAL				**$22,722,107**	**$44,943,190**	**$44,991,770**	**$45,041,564**	**$45,000,000**	**$34,591,315**
Total					**$45,444,215**	**$89,886,380**	**$89,983,540**	**$90,083,128**	**$90,000,000**	**$69,182,631**

Estimated Additional Sq. Mts.		2020	2021	2022	2023	2024	2025	2026	2027	2028
NHS	Good	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fair Satisfactory	258.78	142.66	559.11	7,094.89	14,033.33	18,731.33	18,752.06	18,734.76	14,401.33
	Fair to Poor	364.97	241.44	315.42	4,002.51	7,916.76	7,925.31	7,934.08	7,926.76	6,093.27
	Poor	778.44	396.12	345.00	4,377.90	8,659.27	6,501.47	6,508.67	6,502.66	4,998.57
	TOTAL	**1,402.19**	**780.22**	**1,219.53**	**15,475.29**	**30,609.35**	**33,158.11**	**33,194.81**	**33,164.18**	**25,493.17**
Non-NHS	Good				0.00	0.00	0.00	0.00	0.00	0.00
	Fair Satisfactory				2,300.43	4,550.13	4,555.05	4,560.09	9,111.77	7,004.18
	Fair to Poor				2,614.64	5,171.62	5,177.21	5,182.94	5,178.16	3,980.43
	Poor				6,253.57	12,369.24	12,382.61	12,396.32	10,615.61	8,160.17
	TOTAL				**11,168.63**	**22,091.00**	**22,114.88**	**22,139.35**	**24,905.54**	**19,144.79**
Total					**26,643.93**	**52,700.35**	**55,272.99**	**55,334.17**	**58,069.72**	**44,637.96**

3.4. After Treatment Assumptions

Assumptions were made regarding the condition after treatments are applied, based on base condition. The matrix on Appendix Table M 30 shows the proportion of the current condition treated that will remain on same condition or will change to a different one.

APPENDIX TABLE M 30: AFTER TREATMENT CONDITION MATRIX ASSUMPTION

% Change due Treatment	From \ To	Good	Fair Satisfactory	Fair to Poor	Poor	Total
NHS	Good	100%				100%
	Fair Satisfactory	50%	50%			100%
	Fair to Poor	40%	30%	30%		100%
	Poor	50%	25%	25%	0%	100%
Non-NHS	Good	100%				100%
	Fair Satisfactory	50%	50%			100%
	Fair to Poor	40%	30%	30%		100%
	Poor	50%	25%	25%	0%	100%

3.5. Deterioration

Condition rate data from 1992 to 2017 was used to estimate deterioration rates. Results are shown in Appendix Table M 31. Please refer to Chapter 2 for the detailed procedure used to determine deterioration.

APPENDIX TABLE M 31: BRIDGE DETERIORATION PER DATA

System	Average Rate per Year Weighted by Area	% Deteriorating
NHS	-0.0525	41.13%
Non-NHS	-0.0742	59.42%
Overall	**-0.0586**	**46.28%**

3.6. Strategy Calculations

Since the base data is from 2018, the strategy analysis was started in year 2019. The area per condition per year were calculated as follows:

a. The previous year area per condition were used as base.
b. The net area changes per condition, due treatments expected to end by that year, were added or subtracted, as appropriate.
c. The net area changes per condition due deterioration were added or subtracted, as appropriate. Final lane mile results and those per step are shown in Appendix Table M 32.

APPENDIX TABLE M 32: BRIDGE STRATEGY PROCESS RESULTS

Expected Sq. Mts. Per Year		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
SHN	Good	292,632	303,798	297,898	303,561	315,725	322,070	329,624	338,287	346,781	355,077	365,269	372,464
	Fair to Good	539,981	543,686	538,677	539,442	545,235	541,939	534,711	524,916	515,515	506,505	501,974	493,894
	Fair to Poor	615,351	594,938	593,770	598,377	588,789	589,056	584,661	579,659	574,549	569,350	567,841	562,669
	Poor	136,364	141,905	153,983	142,948	134,578	131,263	135,333	141,465	147,483	153,396	149,244	155,301
	TOTAL	**1,584,328**	**1,584,328**	**1,584,328**	**1,584,328**	**1,584,328**	**1,584,328**	**1,584,328**	**1,584,328**	**1,584,328**	**1,584,328**	**1,584,328**	**1,584,328**
Non-SHN	Good	167,235	163,720	158,243	154,317	149,611	151,132	154,996	158,701	162,254	167,034	168,843	172,802
	Fair to Good	187,781	186,976	186,822	187,719	186,546	187,513	188,277	189,181	190,211	188,630	187,409	186,258
	Fair to Poor	181,921	183,335	184,367	180,319	181,218	182,584	182,273	182,010	181,797	181,197	180,779	180,143
	Poor	59,426	62,331	66,931	74,008	78,988	75,134	70,816	66,471	62,101	59,502	59,332	57,160
	TOTAL	**596,363**	**596,363**	**596,363**	**596,363**	**596,363**	**596,363**	**596,363**	**596,363**	**596,363**	**596,363**	**596,363**	**596,363**

Program		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
SHN	Good		0	51,907	0	0	46,898	0	0	0	0	0	0
	Fair to Good		3,540	0	0	0	0	0	0	0	0	0	0
	Fair to Poor		29,605	0	0	19,169	0	0	0	0	0	0	0
	Poor		7,756	0	23,470	20,955	11,661	0	0	0	0	11,457	0
	TOTAL		**40,901**	**51,907**	**23,470**	**40,125**	**58,559**	**0**	**0**	**0**	**0**	**11,457**	**0**
Non-SHN	Good		0	7,172	0	0	22,317	0	0	0	0	0	0
	Fair to Good		2,462	0	0	1,032	0	0	0	0	0	0	0
	Fair to Poor		177	0	6,314	243	0	0	0	0	0	0	0
	Poor		5,117	3,485	1,052	2,972	5,592	0	0	0	0	0	0
	TOTAL		**7,756**	**10,657**	**7,366**	**4,246**	**27,909**	**0**	**0**	**0**	**0**	**0**	**0**

Proposed		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
SHN	Good			0	0	0	0	0	0	0	0	0	0
	Fair to Good			259	143	559	7,095	14,033	18,731	18,752	18,735	14,401	17,902
	Fair to Poor			365	241	315	4,003	7,917	7,925	7,934	7,927	6,093	7,574
	Poor			778	396	345	4,378	8,659	6,501	6,509	6,503	4,999	6,214
	TOTAL		**0**	**1,402**	**780**	**1,220**	**15,475**	**30,609**	**33,158**	**33,195**	**33,164**	**25,493**	**31,690**
Non-SHN	Good			0	0	0	0	0	0	0	0	0	0
	Fair to Good			0	0	0	2,300	4,550	4,555	4,560	9,112	7,004	8,707
	Fair to Poor			0	0	0	2,615	5,172	5,177	5,183	5,178	3,980	4,948
	Poor			0	0	0	6,254	12,369	12,383	12,396	10,616	8,160	10,144
	TOTAL		**0**	**0**	**0**	**0**	**11,169**	**22,091**	**22,115**	**22,139**	**24,906**	**19,145**	**23,799**

Net Change (Treatment)		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
NHS	Good		17,490	665	12,101	18,724	13,168	14,513	15,787	15,804	15,789	17,866	15,088
	Fair to Good		9,050	175	5,968	10,891	1,663	-2,477	-5,363	-5,369	-5,364	-1,259	-5,125
	Fair to Poor		-18,784	-61	5,797	-8,314	1,208	-3,377	-3,922	-3,927	-3,923	-151	-3,749
	Poor		-7,756	-778	-23,866	-21,300	-16,039	-8,659	-6,501	-6,509	-6,503	-16,456	-6,214
	TOTAL		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Non-NHS	Good		3,860	1,742	3,052	2,099	8,119	10,528	10,540	10,551	11,935	9,174	11,405
	Fair to Good		101	871	2,157	300	2,596	2,369	2,371	2,374	-349	-268	-333
	Fair to Poor		1,155	871	-4,156	573	1,131	-528	-528	-529	-971	-746	-928
	Poor		-5,117	-3,485	-1,052	-2,972	-11,845	-12,369	-12,383	-12,396	-10,616	-8,160	-10,144
	TOTAL		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Net Change (Deterioration)		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
NHS	Good		-6,324	-6,565	-6,437	-6,560	-6,823	-6,960	-7,123	-7,310	-7,494	-7,673	-7,893
	Fair to Good		-5,345	-5,184	-5,203	-5,097	-4,960	-4,751	-4,432	-4,033	-3,646	-3,272	-2,954
	Fair to Poor		-1,629	-1,108	-1,191	-1,274	-941	-1,018	-1,079	-1,183	-1,276	-1,358	-1,423
	Poor		13,297	12,856	12,831	12,931	12,723	12,729	12,634	12,526	12,416	12,303	12,271
	TOTAL		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Non-NHS	Good		-7,375	-7,220	-6,978	-6,805	-6,597	-6,664	-6,835	-6,998	-7,155	-7,366	-7,445
	Fair to Good		-906	-1,026	-1,260	-1,473	-1,629	-1,604	-1,468	-1,344	-1,233	-952	-819
	Fair to Poor		258	161	108	326	235	217	265	316	371	328	292
	Poor		8,022	8,084	8,130	7,951	7,991	8,051	8,038	8,026	8,017	7,990	7,972
	TOTAL		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

3.7. Strategy Expected Results

3.7.1. **Condition** – Expected condition per system and year as a result of the strategy application is shown in Appendix Table M 33.

APPENDIX TABLE M 33: EXPECTED CONDITION PER SYSTEM AND YEAR

Expected Condition Proportion per Year		Base	Forecast									
		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
NHS	Good	18%	19%	19%	19%	20%	20%	21%	21%	22%	22%	23%
	Fair Satisfactory	34%	34%	34%	34%	34%	34%	34%	33%	33%	32%	32%
	Fair to Poor	39%	38%	37%	38%	37%	37%	37%	37%	36%	36%	36%
	Poor	9%	9%	10%	9%	8%	8%	9%	9%	9%	10%	9%
	TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Non-NHS	Good	28%	27%	27%	26%	25%	25%	26%	27%	27%	28%	28%
	Fair Satisfactory	31%	31%	31%	31%	31%	31%	32%	32%	32%	32%	31%
	Fair to Poor	31%	31%	31%	30%	30%	31%	31%	31%	30%	30%	30%
	Poor	10%	10%	11%	12%	13%	13%	12%	11%	10%	10%	10%
	TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

3.7.2. **Treatments** – To determine the budget per treatment as a result of the strategy, a conversion from condition to treatment was developed based on the need calculations. The base information and proportion results are shown in Appendix Table M 34. Resulting investment per treatment type per year is shown in Appendix Table M 35.

APPENDIX TABLE M 34: INVESTMENT DISTRIBUTION CALCULATION PER CONDITION AND TREATMENT

System	Treatment	Total Cost (Base Condition)				Budget Distribution			
		Good	Fair Satisfactory	Fair to Poor	Poor	Good	Fair Satisfactory	Fair to Poor	Poor
NHS	Preservation	$64,470,126	$233,940,688	$0	$0	100.0%	45.1%	0.0%	0.0%
	Minor Rehabilitation	$0	$284,863,339	$710,657,219	$130,183,791	0.0%	54.9%	67.8%	46.0%
	Major Rehabilitation	$0	$0	$337,341,707	$86,276,671	0.0%	0.0%	32.2%	30.5%
	Replacement	$0	$0	$0	$66,640,114	0.0%	0.0%	0.0%	23.5%
Non	Preservation	$41,818,479	$52,487,276	$0	$0	100.0%	28.3%	0.0%	0.0%
	Minor Rehabilitation	$0	$132,990,310	$143,109,411	$20,116,058	0.0%	71.7%	45.3%	13.3%
	Major Rehabilitation	$0	$0	$173,082,528	$68,345,572	0.0%	0.0%	54.7%	45.2%
	Replacement	$0	$0	$0	$62,682,823	0.0%	0.0%	0.0%	41.5%

APPENDIX TABLE M 35: PREFERRED INVESTMENT SCENARIO

Investment		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
NHS	**Preservation**	$21,280,057	$6,700,000	$9,122,240	$1,724,462	$11,163,595	$6,079,776	$8,115,130	$8,124,112	$8,116,615	$6,239,208	$86,665,195
	Minor Rehabilitation	$11,902,326	$0	$0	$13,542,597	$34,970,483	$24,812,942	$25,241,210	$25,269,146	$25,245,828	$40,223,734	$201,208,265
	Major Rehabilitation	$13,032,942	$0	$12,539,324	$29,300,000	$4,964,096	$9,818,733	$8,458,194	$8,467,555	$8,459,742	$6,502,969	$101,543,556
	Replacement	$0	$0	$0	$769,825	$2,139,457	$4,231,739	$3,177,235	$3,180,751	$3,177,816	$2,442,774	$19,119,597
	TOTAL	**$46,215,324**	**$6,700,000**	**$21,661,564**	**$45,336,885**	**$53,237,631**	**$44,943,190**	**$44,991,770**	**$45,041,564**	**$45,000,000**	**$55,408,685**	**$408,536,613**
Non-NHS	**Preservation**	$0	$0	$0	$12,350	$4,731,634	$1,271,822	$1,273,197	$1,274,606	$2,546,860	$1,957,761	$13,068,231
	Minor Rehabilitation	$4,943,182	$0	$0	$1,248,460	$11,045,289	$11,477,874	$11,490,280	$11,502,997	$14,120,040	$10,854,017	$76,682,139
	Major Rehabilitation	$5,421,816	$16,851,011	$12,963,276	$1,569,171	$10,044,744	$19,146,265	$19,166,961	$19,188,174	$17,135,625	$13,172,085	$134,659,128
	Replacement	$11,861,968	$0	$0	$24,500,614	$10,433,199	$13,047,228	$13,061,331	$13,075,787	$11,197,475	$8,607,453	$105,785,055
	TOTAL	**$22,226,966**	**$16,851,011**	**$12,963,276**	**$27,330,594**	**$36,254,866**	**$44,943,190**	**$44,991,770**	**$45,041,564**	**$45,000,000**	**$34,591,315**	**$330,194,552**
TOTAL		**$68,442,290**	**$23,551,011**	**$34,624,840**	**$72,667,479**	**$89,492,497**	**$89,886,380**	**$89,983,540**	**$90,083,128**	**$90,000,000**	**$90,000,000**	**$738,731,165**

APPENDIX N: INTERIM INVESTMENT SCENARIOS

For illustration purposes, the following interim (iteration) example scenarios are included next:

1. Pavement Tool – Preferred Scenario
2. Pavement Tool - Test With $200M instead of $134M-1$37M, Same Proportions
3. Pavement Tool - Test with Available Budget ($134M-1$37M), 4% Int, 3% NHS Non-Interstate, 3% Non-NHS, Same Proportions per Condition
4. Pavement Tool - Test with $200M, 4% Int, 3% NHS Non-Interstate, 3% Non-NHS, Same Proportions per Condition
5. Pavement Tool - Possible Scenario to Reach Interstate Pavement Goal by 2024 and Maintain It - $280M investment in 2024, $130M Investment the Following Years
6. Bridge Tool – Preferred Scenario
7. Bridge Tool - Test with $125M instead of $90M, Same Proportions
8. Bridge Tool - Test with $90M Budget, 60% NHS, 40% Non-NHS
9. Bridge Tool - Test with $125M, 60% NHS, 40% Non-NHS, Same Proportions per Condition

Pavement Tool – Preferred Scenario

	Priority (% Budget)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	System										
	INT		0.9	0.9	0.9	0.59	0.5	0.5	0.41	0.42	0.37
	NHS		0.1	0.1	0.1	0.2	0.3	0.29	0.24	0.24	0.21
	Other					0.21	0.2	0.21	0.35	0.34	0.42
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Condition										
Interstate	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair		0.2	0.2	0.2	0.02	0.02	0.02	0.05	0.07	0.19
	Fair to Poor		0.2	0.2	0.2	0.02	0.02	0.02	0.05	0.05	0.05
	Poor		0.6	0.6	0.6	0.96	0.96	0.96	0.9	0.88	0.76
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
NHS Non-Interstate	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair		0.2	0.2	0.2	0.35	0.1	0.1	0.25	0.2	0.2
	Fair to Poor		0.2	0.2	0.2	0.25	0.1	0.1	0.18	0.15	0.1
	Poor		0.6	0.6	0.6	0.4	0.8	0.8	0.57	0.65	0.7
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Non-NHS	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair					0.2	0.15	0.1	0.15	0.1	0.15
	Fair to Poor					0.2	0.05	0.05	0.05	0.05	0.05
	Poor					0.6	0.8	0.85	0.8	0.85	0.8
	Total					**1**	**1**	**1**	**1**	**1**	**1**

Additional Budget		$0.00	$3,764,671.95	$5,041,984.52	$3,495,100.90	$55,210,864.11	$135,170,848.85	$137,333,167.94	$139,421,844.78	$134,100,585.79	$134,100,585.79

Expected Condition Proportion per Year		Target	Base	Estimate	Forecast									
			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good	2.0%	10.8%	14.4%	29.8%	30.2%	27.3%	25.3%	23.4%	23.2%	23.2%	22.8%	22.4%	22.2%
	Fair to Good	31.0%	24.8%	24.4%	25.4%	26.3%	27.3%	27.9%	28.1%	28.7%	29.3%	29.6%	29.9%	30.4%
	Fair - Fair	31.0%	28.7%	26.7%	18.1%	17.7%	18.3%	19.1%	20.0%	21.3%	22.5%	23.0%	23.3%	22.4%
	Fair to Poor	31.0%	19.0%	18.7%	13.9%	13.0%	13.5%	13.7%	14.8%	16.1%	17.4%	18.4%	19.3%	20.0%
	Poor	5.0%	16.7%	15.7%	12.8%	12.8%	13.7%	14.1%	13.7%	10.7%	7.7%	6.2%	5.0%	5.0%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
NHS Non-Interstate	Good	2.0%	2.2%	2.6%	20.9%	23.9%	24.2%	22.8%	22.3%	22.1%	21.9%	22.0%	21.9%	21.5%
	Fair to Good	26.0%	7.5%	7.3%	13.6%	16.8%	18.6%	19.5%	20.6%	21.9%	23.0%	24.3%	25.2%	25.9%
	Fair - Fair	26.0%	42.3%	38.0%	25.5%	22.3%	20.5%	19.5%	17.5%	17.5%	17.5%	16.3%	15.9%	15.6%
	Fair to Poor	26.0%	17.7%	20.2%	17.8%	18.0%	17.2%	17.3%	17.2%	17.4%	17.6%	17.2%	17.0%	16.9%
	Poor	20.0%	30.3%	31.9%	22.2%	19.0%	19.5%	21.0%	22.4%	21.2%	20.0%	20.1%	20.0%	20.0%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Non-NHS	Good	0.5%	2.2%	1.9%	3.0%	6.5%	6.1%	5.9%	5.5%	5.2%	4.9%	4.8%	4.6%	4.6%
	Fair to Good	19.8%	27.8%	25.0%	22.7%	21.0%	19.5%	18.1%	16.9%	15.9%	15.0%	14.3%	13.6%	13.1%
	Fair - Fair	19.8%	48.2%	44.7%	40.5%	35.3%	32.6%	30.0%	27.9%	26.0%	24.3%	22.8%	21.5%	20.1%
	Fair to Poor	19.8%	14.0%	18.6%	21.8%	23.2%	24.8%	25.7%	26.2%	26.5%	26.6%	26.4%	26.1%	25.7%
	Poor	40.0%	7.9%	9.7%	12.0%	13.9%	17.0%	20.2%	23.5%	26.4%	29.3%	31.8%	34.2%	36.5%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Pavement Tool - Test With $200M instead of $134M-1$37M, Same Proportions

	Priority (% Budget)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	System										
	INT		0.9	0.9	0.9	0.59	0.5	0.5	0.41	0.42	0.37
	NHS		0.1	0.1	0.1	0.2	0.3	0.29	0.24	0.24	0.21
	Other					0.21	0.2	0.21	0.35	0.34	0.42
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Condition										
Interstate	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair		0.2	0.2	0.2	0.02	0.02	0.02	0.05	0.07	0.19
	Fair to Poor		0.2	0.2	0.2	0.02	0.02	0.02	0.05	0.05	0.05
	Poor		0.6	0.6	0.6	0.96	0.96	0.96	0.9	0.88	0.76
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
NHS Non-Interstate	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair		0.2	0.2	0.2	0.35	0.1	0.1	0.25	0.2	0.2
	Fair to Poor		0.2	0.2	0.2	0.25	0.1	0.1	0.18	0.15	0.1
	Poor		0.6	0.6	0.6	0.4	0.8	0.8	0.57	0.65	0.7
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Non-NHS	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair					0.2	0.15	0.1	0.15	0.1	0.15
	Fair to Poor					0.2	0.05	0.05	0.05	0.05	0.05
	Poor					0.6	0.8	0.85	0.8	0.85	0.8
	Total					**1**	**1**	**1**	**1**	**1**	**1**

Additional Budget		$0.00	$3,764,671.95	$5,041,984.52	$3,495,100.90	$55,210,864.11	$200,000,000.00	$200,000,000.00	$200,000,000.00	$200,000,000.00	$200,000,000.00

Expected Condition Proportion per Year		Target	Base	Estimate	Forecast									
			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good	2.0%	10.8%	14.4%	29.8%	30.2%	27.3%	25.3%	23.4%	24.7%	25.8%	26.2%	26.7%	27.2%
	Fair to Good	31.0%	24.8%	24.4%	25.4%	26.3%	27.3%	27.9%	28.1%	29.3%	30.5%	31.6%	32.7%	34.0%
	Fair - Fair	31.0%	28.7%	26.7%	18.1%	17.7%	18.3%	19.1%	20.0%	21.7%	23.3%	24.1%	24.5%	23.2%
	Fair to Poor	31.0%	19.0%	18.7%	13.9%	13.0%	13.5%	13.7%	14.8%	16.3%	17.8%	18.9%	20.0%	20.9%
	Poor	5.0%	16.7%	15.7%	12.8%	12.8%	13.7%	14.1%	13.7%	8.0%	2.6%	-0.8%	-3.9%	-5.4%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
NHS Non-Interstate	Good	2.0%	2.2%	2.6%	20.9%	23.9%	24.2%	22.8%	22.3%	22.9%	23.4%	24.3%	24.8%	24.9%
	Fair to Good	26.0%	7.5%	7.3%	13.6%	16.8%	18.6%	19.5%	20.6%	22.4%	24.1%	25.9%	27.5%	28.8%
	Fair - Fair	26.0%	42.3%	38.0%	25.5%	22.3%	20.5%	19.5%	17.5%	17.5%	17.6%	16.0%	15.3%	15.0%
	Fair to Poor	26.0%	17.7%	20.2%	17.8%	18.0%	17.2%	17.3%	17.2%	17.5%	17.7%	17.3%	16.9%	16.8%
	Poor	20.0%	30.3%	31.9%	22.2%	19.0%	19.5%	21.0%	22.4%	19.7%	17.2%	16.5%	15.4%	14.5%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Non-NHS	Good	0.5%	2.2%	1.9%	3.0%	6.5%	6.1%	5.9%	5.5%	5.3%	5.1%	5.1%	5.2%	5.3%
	Fair to Good	19.8%	27.8%	25.0%	22.7%	21.0%	19.5%	18.1%	16.9%	16.0%	15.2%	14.7%	14.1%	13.9%
	Fair - Fair	19.8%	48.2%	44.7%	40.5%	35.3%	32.6%	30.0%	27.9%	26.0%	24.4%	22.9%	21.7%	20.5%
	Fair to Poor	19.8%	14.0%	18.6%	21.8%	23.2%	24.8%	25.7%	26.2%	26.6%	26.7%	26.6%	26.3%	26.0%
	Poor	40.0%	7.9%	9.7%	12.0%	13.9%	17.0%	20.2%	23.5%	26.1%	28.7%	30.7%	32.6%	34.3%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Pavement Tool - Test with Available Budget ($134M-1$37M), 4% Int, 3% NHS Non Inter, 3% Non NHS, Same Proportions per Condition

	Priority (% Budget)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	System										
	INT		0.9	0.9	0.9	0.59	0.4	0.4	0.4	0.4	0.4
	NHS		0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.3
	Other					0.21	0.3	0.3	0.3	0.3	0.3
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Condition										
Interstate	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair		0.2	0.2	0.2	0.02	0.02	0.02	0.05	0.07	0.19
	Fair to Poor		0.2	0.2	0.2	0.02	0.02	0.02	0.05	0.05	0.05
	Poor		0.6	0.6	0.6	0.96	0.96	0.96	0.9	0.88	0.76
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
NHS Non-Interstate	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair		0.2	0.2	0.2	0.35	0.1	0.1	0.25	0.2	0.2
	Fair to Poor		0.2	0.2	0.2	0.25	0.1	0.1	0.18	0.15	0.1
	Poor		0.6	0.6	0.6	0.4	0.8	0.8	0.57	0.65	0.7
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Non-NHS	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair					0.2	0.15	0.1	0.15	0.1	0.15
	Fair to Poor					0.2	0.05	0.05	0.05	0.05	0.05
	Poor					0.6	0.8	0.85	0.8	0.85	0.8
	Total					**1**	**1**	**1**	**1**	**1**	**1**
Additional Budget		$0.00	$3,764,671.95	$5,041,984.52	$3,495,100.90	$55,210,864.11	$135,170,848.85	$137,333,167.94	$139,421,844.78	$134,100,585.79	$134,100,585.79

Expected Condition Proportion per Year		Target	Base	Estimate	Forecast									
			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good	2.0%	10.8%	14.4%	29.8%	30.2%	27.3%	25.3%	23.4%	22.6%	22.1%	21.7%	21.4%	21.5%
	Fair to Good	31.0%	24.8%	24.4%	25.4%	26.3%	27.3%	27.9%	28.1%	28.5%	28.7%	29.0%	29.2%	29.7%
	Fair - Fair	31.0%	28.7%	26.7%	18.1%	17.7%	18.3%	19.1%	20.0%	21.1%	22.1%	22.7%	22.9%	21.9%
	Fair to Poor	31.0%	19.0%	18.7%	13.9%	13.0%	13.5%	13.7%	14.8%	16.0%	17.2%	18.1%	19.0%	19.8%
	Poor	5.0%	16.7%	15.7%	12.8%	12.8%	13.7%	14.1%	13.7%	11.8%	9.9%	8.5%	7.5%	7.2%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
NHS Non-Interstate	Good	2.0%	2.2%	2.6%	20.9%	23.9%	24.2%	22.8%	22.3%	22.1%	21.9%	22.6%	22.9%	23.0%
	Fair to Good	26.0%	7.5%	7.3%	13.6%	16.8%	18.6%	19.5%	20.6%	21.9%	23.0%	24.6%	25.9%	27.1%
	Fair - Fair	26.0%	42.3%	38.0%	25.5%	22.3%	20.5%	19.5%	17.5%	17.5%	17.5%	16.0%	15.4%	15.0%
	Fair to Poor	26.0%	17.7%	20.2%	17.8%	18.0%	17.2%	17.3%	17.2%	17.4%	17.6%	17.2%	16.9%	16.8%
	Poor	20.0%	30.3%	31.9%	22.2%	19.0%	19.5%	21.0%	22.4%	21.2%	19.9%	19.6%	18.9%	18.1%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Non-NHS	Good	0.5%	2.2%	1.9%	3.0%	6.5%	6.1%	5.9%	5.5%	5.3%	5.1%	4.9%	4.7%	4.6%
	Fair to Good	19.8%	27.8%	25.0%	22.7%	21.0%	19.5%	18.1%	16.9%	16.0%	15.2%	14.4%	13.7%	13.1%
	Fair - Fair	19.8%	48.2%	44.7%	40.5%	35.3%	32.6%	30.0%	27.9%	26.0%	24.4%	22.9%	21.5%	20.2%
	Fair to Poor	19.8%	14.0%	18.6%	21.8%	23.2%	24.8%	25.7%	26.2%	26.6%	26.7%	26.5%	26.1%	25.7%
	Poor	40.0%	7.9%	9.7%	12.0%	13.9%	17.0%	20.2%	23.5%	26.1%	28.7%	31.3%	33.9%	36.6%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Pavement Tool - Test with $200M, 4% Int, 3% NHS Non Inter, 3% Non NHS, Same Proportions per Condition

	Priority (% Budget)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	System										
	INT		0.9	0.9	0.9	0.59	0.4	0.4	0.4	0.4	0.4
	NHS		0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.3
	Other					0.21	0.3	0.3	0.3	0.3	0.3
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Condition										
Interstate	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair		0.2	0.2	0.2	0.02	0.02	0.02	0.05	0.07	0.19
	Fair to Poor		0.2	0.2	0.2	0.02	0.02	0.02	0.05	0.05	0.05
	Poor		0.6	0.6	0.6	0.96	0.96	0.96	0.9	0.88	0.76
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
NHS Non-Interstate	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair		0.2	0.2	0.2	0.35	0.1	0.1	0.25	0.2	0.2
	Fair to Poor		0.2	0.2	0.2	0.25	0.1	0.1	0.18	0.15	0.1
	Poor		0.6	0.6	0.6	0.4	0.8	0.8	0.57	0.65	0.7
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Non-NHS	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair					0.2	0.15	0.1	0.15	0.1	0.15
	Fair to Poor					0.2	0.05	0.05	0.05	0.05	0.05
	Poor					0.6	0.8	0.85	0.8	0.85	0.8
	Total					**1**	**1**	**1**	**1**	**1**	**1**

Additional Budget		$0.00	$3,764,671.95	$5,041,984.52	$3,495,100.90	$55,210,864.11	$200,000,000.00	$200,000,000.00	$200,000,000.00	$200,000,000.00	$200,000,000.00

Expected Condition Proportion per Year		Target	Base	Estimate	Forecast									
			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good	2.0%	10.8%	14.4%	29.8%	30.2%	27.3%	25.3%	23.4%	23.8%	24.2%	24.7%	25.2%	26.3%
	Fair to Good	31.0%	24.8%	24.4%	25.4%	26.3%	27.3%	27.9%	28.1%	28.9%	29.7%	30.6%	31.6%	33.0%
	Fair - Fair	31.0%	28.7%	26.7%	18.1%	17.7%	18.3%	19.1%	20.0%	21.5%	22.8%	23.5%	23.9%	22.5%
	Fair to Poor	31.0%	19.0%	18.7%	13.9%	13.0%	13.5%	13.7%	14.8%	16.1%	17.5%	18.6%	19.6%	20.5%
	Poor	5.0%	16.7%	15.7%	12.8%	12.8%	13.7%	14.1%	13.7%	9.7%	5.8%	2.6%	-0.3%	-2.2%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
NHS Non-Interstate	Good	2.0%	2.2%	2.6%	20.9%	23.9%	24.2%	22.8%	22.3%	22.9%	23.5%	25.1%	26.2%	27.1%
	Fair to Good	26.0%	7.5%	7.3%	13.6%	16.8%	18.6%	19.5%	20.6%	22.4%	24.1%	26.5%	28.5%	30.5%
	Fair - Fair	26.0%	42.3%	38.0%	25.5%	22.3%	20.5%	19.5%	17.5%	17.5%	17.6%	15.5%	14.6%	14.0%
	Fair to Poor	26.0%	17.7%	20.2%	17.8%	18.0%	17.2%	17.3%	17.2%	17.5%	17.7%	17.2%	16.7%	16.6%
	Poor	20.0%	30.3%	31.9%	22.2%	19.0%	19.5%	21.0%	22.4%	19.7%	17.1%	15.7%	13.9%	11.7%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Non-NHS	Good	0.5%	2.2%	1.9%	3.0%	6.5%	6.1%	5.9%	5.5%	5.5%	5.4%	5.3%	5.3%	5.2%
	Fair to Good	19.8%	27.8%	25.0%	22.7%	21.0%	19.5%	18.1%	16.9%	16.2%	15.5%	14.9%	14.3%	13.8%
	Fair - Fair	19.8%	48.2%	44.7%	40.5%	35.3%	32.6%	30.0%	27.9%	26.1%	24.6%	23.1%	21.8%	20.6%
	Fair to Poor	19.8%	14.0%	18.6%	21.8%	23.2%	24.8%	25.7%	26.2%	26.7%	26.8%	26.7%	26.4%	26.0%
	Poor	40.0%	7.9%	9.7%	12.0%	13.9%	17.0%	20.2%	23.5%	25.6%	27.8%	30.1%	32.2%	34.4%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Pavement Tool - Possible Scenario to Reach Interstate Pavement Goal by 2024 and Maintain It - $280M investment in 2024, $130M Investment the Following Years

	Priority (% Budget)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	System										
	INT		0.9	0.9	0.9	0.59	0.5	0.5	0.41	0.42	0.37
	NHS		0.1	0.1	0.1	0.2	0.3	0.29	0.24	0.24	0.21
	Other					0.21	0.2	0.21	0.35	0.34	0.42
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Condition										
Interstate	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair		0.2	0.2	0.2	0.02	0.02	0.02	0.05	0.07	0.19
	Fair to Poor		0.2	0.2	0.2	0.02	0.02	0.02	0.05	0.05	0.05
	Poor		0.6	0.6	0.6	0.96	0.96	0.96	0.9	0.88	0.76
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
NHS Non-Interstate	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair		0.2	0.2	0.2	0.35	0.1	0.1	0.25	0.2	0.2
	Fair to Poor		0.2	0.2	0.2	0.25	0.1	0.1	0.18	0.15	0.1
	Poor		0.6	0.6	0.6	0.4	0.8	0.8	0.57	0.65	0.7
	Total		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Non-NHS	Good					0	0	0	0	0	0
	Fair to Good					0	0	0	0	0	0
	Fair - Fair					0.2	0.15	0.1	0.15	0.1	0.15
	Fair to Poor					0.2	0.05	0.05	0.05	0.05	0.05
	Poor					0.6	0.8	0.85	0.8	0.85	0.8
	Total					**1**	**1**	**1**	**1**	**1**	**1**
Additional Budget		$0.00	$3,764,671.95	$5,041,984.52	$3,495,100.90	$55,210,864.11	$280,000,000.00	$100,000,000.00	$100,000,000.00	$100,000,000.00	$100,000,000.00

Expected Condition Proportion per Year		Target	Base	Estimate	Forecast									
			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Interstate	Good	2.0%	10.8%	14.4%	29.8%	30.2%	27.3%	25.3%	23.4%	26.4%	25.1%	23.7%	22.6%	21.6%
	Fair to Good	31.0%	24.8%	24.4%	25.4%	26.3%	27.3%	27.9%	28.1%	30.0%	30.5%	30.6%	30.6%	30.6%
	Fair - Fair	31.0%	28.7%	26.7%	18.1%	17.7%	18.3%	19.1%	20.0%	22.3%	23.2%	23.7%	24.0%	23.3%
	Fair to Poor	31.0%	19.0%	18.7%	13.9%	13.0%	13.5%	13.7%	14.8%	16.5%	17.8%	18.8%	19.7%	20.5%
	Poor	5.0%	16.7%	15.7%	12.8%	12.8%	13.7%	14.1%	13.7%	4.8%	3.4%	3.2%	3.2%	4.0%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
NHS Non-Interstate	Good	2.0%	2.2%	2.6%	20.9%	23.9%	24.2%	22.8%	22.3%	23.9%	23.1%	22.6%	21.9%	21.2%
	Fair to Good	26.0%	7.5%	7.3%	13.6%	16.8%	18.6%	19.5%	20.6%	23.1%	24.0%	24.8%	25.5%	26.0%
	Fair - Fair	26.0%	42.3%	38.0%	25.5%	22.3%	20.5%	19.5%	17.5%	17.5%	17.7%	16.9%	16.6%	16.5%
	Fair to Poor	26.0%	17.7%	20.2%	17.8%	18.0%	17.2%	17.3%	17.2%	17.6%	17.7%	17.5%	17.3%	17.3%
	Poor	20.0%	30.3%	31.9%	22.2%	19.0%	19.5%	21.0%	22.4%	17.9%	17.6%	18.2%	18.6%	19.1%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Non-NHS	Good	0.5%	2.2%	1.9%	3.0%	6.5%	6.1%	5.9%	5.5%	5.4%	5.0%	4.8%	4.6%	4.4%
	Fair to Good	19.8%	27.8%	25.0%	22.7%	21.0%	19.5%	18.1%	16.9%	16.2%	15.1%	14.3%	13.6%	12.9%
	Fair - Fair	19.8%	48.2%	44.7%	40.5%	35.3%	32.6%	30.0%	27.9%	26.0%	24.4%	22.8%	21.4%	20.1%
	Fair to Poor	19.8%	14.0%	18.6%	21.8%	23.2%	24.8%	25.7%	26.2%	26.6%	26.6%	26.4%	26.1%	25.6%
	Poor	40.0%	7.9%	9.7%	12.0%	13.9%	17.0%	20.2%	23.5%	25.7%	28.8%	31.6%	34.4%	36.9%
	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Bridge Tool – Preferred Scenario

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028
Programmed	$23,551,011.00	$34,624,840.48	$72,667,479.24	$44,048,281.80	$0.00	$0.00	$0.00	$0.00	$20,817,369.46
Budget	$26,037,319.04	$35,995,480.85	$74,458,099.24	$89,492,496.64	$89,886,380.14	$89,983,539.65	$90,083,128.14	$90,000,000.00	$90,000,000.00
Remaining	$2,486,308.04	$1,370,640.37	$1,790,620.00	$45,444,214.84	$89,886,380.14	$89,983,539.65	$90,083,128.14	$90,000,000.00	$69,182,630.54

Priority (% Budget)		**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
System										
NHS		100%	100%	100%	50%	50%	50%	50%	50%	50%
Non-NHS		0%	0%	0%	50%	50%	50%	50%	50%	50%
TOTAL		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Condition										
NHS	Good				0%	0%	0%	0%	0%	0%
	Fair Satisfactory	10%	10%	30%	30%	30%	40%	40%	40%	40%
	Fair to Poor	25%	30%	30%	30%	30%	30%	30%	30%	30%
	Poor	65%	60%	40%	40%	40%	30%	30%	30%	30%
	TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Non-NHS	Good				0%	0%	0%	0%	0%	0%
	Fair Satisfactory				10%	10%	10%	10%	20%	20%
	Fair to Poor				20%	20%	20%	20%	20%	20%
	Poor				70%	70%	70%	70%	60%	60%
	TOTAL	**0%**	**0%**	**0%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Expected Condition Proportion per Year		**Target**	**Base**	**Forecast**								
			2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
NHS	Good	10%	18%	19%	19%	19%	20%	20%	21%	21%	22%	22%	23%
	Fair Satisfactory	40%	34%	34%	34%	34%	34%	34%	34%	33%	33%	32%	32%
	Fair to Poor	40%	39%	38%	37%	38%	37%	37%	37%	37%	36%	36%	36%
	Poor	10%	9%	9%	10%	9%	8%	8%	9%	9%	9%	10%	9%
	TOTAL	**100%**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Non-NHS	Good	10%	28%	27%	27%	26%	25%	25%	26%	27%	27%	28%	28%
	Fair Satisfactory	40%	31%	31%	31%	31%	31%	31%	32%	32%	32%	32%	31%
	Fair to Poor	40%	31%	31%	31%	30%	30%	31%	31%	31%	30%	30%	30%
	Poor	10%	10%	10%	11%	12%	13%	13%	12%	11%	10%	10%	10%
	TOTAL	**100%**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Bridge Tool - Test with $125M instead of $90M, Same Proportions

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028
Programmed	$23,551,011.00	$34,624,840.48	$72,667,479.24	$44,048,281.80	$0.00	$0.00	$0.00	$0.00	$20,817,369.46
Budget	$26,037,319.04	$35,995,480.85	$74,458,099.24	$89,492,496.64	$125,000,000.00	$125,000,000.00	$125,000,000.00	$125,000,000.00	$125,000,000.00
Remaining	$2,486,308.04	$1,370,640.37	$1,790,620.00	$45,444,214.84	$125,000,000.00	$125,000,000.00	$125,000,000.00	$125,000,000.00	$104,182,630.54

Priority (% Budget)		**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
System										
NHS		100%	100%	100%	50%	50%	50%	50%	50%	50%
Non-NHS		0%	0%	0%	50%	50%	50%	50%	50%	50%
TOTAL		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Condition										
NHS	Good				0%	0%	0%	0%	0%	0%
	Fair Satisfactory	10%	10%	30%	30%	30%	40%	40%	40%	40%
	Fair to Poor	25%	30%	30%	30%	30%	30%	30%	30%	30%
	Poor	65%	60%	40%	40%	40%	30%	30%	30%	30%
	TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Non-NHS	Good				0%	0%	0%	0%	0%	0%
	Fair Satisfactory				10%	10%	10%	10%	20%	20%
	Fair to Poor				20%	20%	20%	20%	20%	20%
	Poor				70%	70%	70%	70%	60%	60%
	TOTAL	**0%**	**0%**	**0%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Expected Condition Proportion per Year		**Target**	**Base**	**Forecast**									
			2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
NHS	Good	10%	18%	19%	19%	19%	20%	20%	21%	22%	23%	24%	25%
	Fair Satisfactory	40%	34%	34%	34%	34%	34%	34%	34%	33%	32%	32%	31%
	Fair to Poor	40%	39%	38%	37%	38%	37%	37%	37%	36%	36%	36%	35%
	Poor	10%	9%	9%	10%	9%	8%	8%	8%	9%	9%	9%	9%
	TOTAL	**100%**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Non-NHS	Good	10%	28%	27%	27%	26%	25%	25%	27%	28%	29%	31%	32%
	Fair Satisfactory	40%	31%	31%	31%	31%	31%	31%	32%	32%	32%	32%	32%
	Fair to Poor	40%	31%	31%	31%	30%	30%	31%	31%	30%	30%	30%	30%
	Poor	10%	10%	10%	11%	12%	13%	13%	11%	10%	8%	7%	6%
	TOTAL	**100%**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Bridge Tool - Test with $90M Budget, 60% NHS, 40% Non-NHS

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028
Programmed	$23,551,011.00	$34,624,840.48	$72,667,479.24	$44,048,281.80	$0.00	$0.00	$0.00	$0.00	$20,817,369.46
Budget	$26,037,319.04	$35,995,480.85	$74,458,099.24	$89,492,496.64	$89,886,380.14	$89,983,539.65	$90,083,128.14	$90,000,000.00	$90,000,000.00
Remaining	$2,486,308.04	$1,370,640.37	$1,790,620.00	$45,444,214.84	$89,886,380.14	$89,983,539.65	$90,083,128.14	$90,000,000.00	$69,182,630.54

Priority (% Budget)	2020	2021	2022	2023	2024	2025	2026	2027	2028
System									
NHS	100%	100%	100%	50%	60%	60%	60%	60%	60%
Non-NHS	0%	0%	0%	50%	40%	40%	40%	40%	40%
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Expected Condition Proportion per Year		Target	Base	Forecast								
			2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
NHS	Good	10%	18%	19%	19%	19%	20%	20%	21%	22%	22%	23%	24%
	Fair Satisfactory	40%	34%	34%	34%	34%	34%	34%	34%	33%	32%	32%	31%
	Fair to Poor	40%	39%	38%	37%	38%	37%	37%	37%	36%	36%	36%	36%
	Poor	10%	9%	9%	10%	9%	8%	8%	8%	9%	9%	9%	9%
	TOTAL	**100%**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Non-NHS	Good	10%	28%	27%	27%	26%	25%	25%	26%	26%	26%	27%	27%
	Fair Satisfactory	40%	31%	31%	31%	31%	31%	31%	31%	32%	32%	31%	31%
	Fair to Poor	40%	31%	31%	31%	30%	30%	31%	31%	31%	31%	30%	30%
	Poor	10%	10%	10%	11%	12%	13%	13%	12%	12%	12%	12%	12%
	TOTAL	**100%**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Bridge Tool - Test with $125M, 60% NHS, 40% Non-NHS, Same Proportions per Condition

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028
Programmed	$23,551,011.00	$34,624,840.48	$72,667,479.24	$44,048,281.80	$0.00	$0.00	$0.00	$0.00	$20,817,369.46
Budget	$26,037,319.04	$35,995,480.85	$74,458,099.24	$89,492,496.64	$125,000,000.00	$125,000,000.00	$125,000,000.00	$125,000,000.00	$125,000,000.00
Remaining	$2,486,308.04	$1,370,640.37	$1,790,620.00	$45,444,214.84	$125,000,000.00	$125,000,000.00	$125,000,000.00	$125,000,000.00	$104,182,630.54

Priority (% Budget)		**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
System										
NHS		100%	100%	100%	50%	60%	60%	60%	60%	60%
Non-NHS		0%	0%	0%	50%	40%	40%	40%	40%	40%
TOTAL		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Condition										
NHS	Good				0%	0%	0%	0%	0%	0%
	Fair Satisfactory	10%	10%	30%	30%	30%	40%	40%	40%	40%
	Fair to Poor	25%	30%	30%	30%	30%	30%	30%	30%	30%
	Poor	65%	60%	40%	40%	40%	30%	30%	30%	30%
	TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Non-NHS	Good				0%	0%	0%	0%	0%	0%
	Fair Satisfactory				10%	10%	10%	10%	20%	20%
	Fair to Poor				20%	20%	20%	20%	20%	20%
	Poor				70%	70%	70%	70%	60%	60%
	TOTAL	**0%**	**0%**	**0%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Expected Condition Proportion per Year		**Target**	**Base**	**Forecast**									
			2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
NHS	Good	10%	18%	19%	19%	19%	20%	20%	21%	23%	24%	25%	26%
	Fair Satisfactory	40%	34%	34%	34%	34%	34%	34%	34%	33%	32%	31%	31%
	Fair to Poor	40%	39%	38%	37%	38%	37%	37%	37%	36%	36%	35%	35%
	Poor	10%	9%	9%	10%	9%	8%	8%	8%	8%	8%	8%	8%
	TOTAL	**100%**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Non-NHS	Good	10%	28%	27%	27%	26%	25%	25%	26%	27%	28%	29%	29%
	Fair Satisfactory	40%	31%	31%	31%	31%	31%	31%	32%	32%	32%	32%	32%
	Fair to Poor	40%	31%	31%	31%	30%	30%	31%	31%	31%	30%	30%	30%
	Poor	10%	10%	10%	11%	12%	13%	13%	12%	11%	10%	9%	9%
	TOTAL	**100%**	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX O: LETTER TO MICHAEL AVERY, FHWA

The first page of the letter is e presented next. The complete letter is included in the attached CD.

GOVERNMENT OF PUERTO RICO
Puerto Rico Highway and Transportation Authority

April 11, 2019

Mr. Michael Avery
Associate Division Administrator
Federal Highway Administration
Puerto Rico and US Virgin Islands Division Office
350 Carlos Chardon Ave, Suite 210
San Juan PR 00918-2161

Re: Proposed Approach to Satisfy 23 CFR 515.17 Regarding Bridge and Pavement Management Systems

Dear Mr. Avery:

Thank you and the Division staff for their assistance with the Puerto Rico Transportation Asset Management Plan (TAMP). As we reported in a recent update meeting, PRHTA is making substantial progress on the Plan and we are confident of a June 30, 2019 submission.

An outstanding issue regards the use of compliant management systems. We propose the following approach to addressing the requirements of 23 CRF 515.17 regarding the use of pavement and bridge management systems to develop the plan.

For the June 2019 TAMP we propose to conduct the analysis using our in-house developed bridge and pavement analysis tools that were used to develop the April 2018 initial TAMP. We believe those tools satisfy the requirements of 515.17. We will explain in more detail later in this letter.

We also propose that by June 30, 2020, PRHTA will complete an analysis of commercially available systems to determine if any of them are practical for the Authority's use. A consultant team will evaluate available systems such as those provided by Deighton, Agile Assets, Stantech, AASHTO, and others. Because those systems are so expensive and so cumbersome and may not be practical for PRHTA, the consultant also will review systems such as the National Bridge Analysis Information System (NBIAS), Pavement Surface Evaluation Rating System (PASER), Roadsoft and other less complex and expensive systems.

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