HAWAII

Statewide Transportation Asset Management Plan

JULY 30, 2022

Hawaii Statewide Transportation Asset Management Plan

July 30, 2022

The State of Hawaii Department of Transportation (HDOT) is pleased to present its July 2022 update to the Transportation Asset Management Plan. The HDOT remains committed to its mission and to preserving the investment it has made in its infrastructure. This Plan provides a solid foundation for making informed pavement and bridge infrastructure planning and programming decisions for the next 10 years. The benefits of this present-day transportation asset management plan are critical in developing a process for the State to achieve and sustain a state of good repair over the life cycle of its pavement and bridge assets.

Pavement and bridge infrastructure provide the central transportation network that allows for the efficient movement of people, goods, and services on each of our islands. If the transportation system cannot keep up with demand, we feel the effects in our schedules, our pocketbooks, and throughout our daily lives. This infrastructure needs regular maintenance and preservation activities to help it last longer and enable us to receive the most value from our transportation dollars.

The HDOT uses a data-driven, risk-based approach to asset management. Our Pavement Management System and Bridge Management System help to ensure that the right treatment is applied at the right time. The management systems optimize the asset condition and lowest practical life cycle to prioritize the right projects and best manage the transportation system. With this update, the Management Systems and the Plan incorporate resilience measures to increase the resiliency of the transportation system to existing and future risks.

This Transportation Asset Management Plan, as required by the FAST Act, describes those processes and formally defines HDOT's framework for asset management. Further, it projects needed levels of future investment to meet asset condition targets, contrasted with expected funding levels. This Plan evokes an important conversation regarding funding for a sustainable transportation system and allows a strong future for the State to provide it. We will also continue our collaborative efforts statewide to be resilient and meet our future needs.

In addition, this Transportation Asset Management Plan is available online at the HDOT's Highway Division webpage (http://hidot.hawaii.gov/highways/).

Sincerely,

JADE T. BUTAY
Director of Transportation

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CHAPTER 1

Introduction

Overview

The Hawaii Department of Transportation (HDOT) is responsible for planning, designing, constructing, operating, and maintaining transportation assets in the state of Hawaii that are under the HDOT's jurisdiction. Maintaining the National Highway System (NHS) is a top priority for the HDOT because of its vital contribution towards the economy, national security, and mobility and because the pavements and bridges of the NHS represent the HDOT's two largest land transportation assets.

> The HDOT's mission is to provide a safe, efficient, accessible, and sustainable inter-modal transportation system that ensures the mobility of people and goods and enhances or preserves economic prosperity and the quality of life.
> To this end, the TAMP establishes and documents policies and processes to guide the efficient use of Hawaii's resources for infrastructure investments in a data-driven, performance-based, and risk-based approach that is transparent and defensible.

Transportation asset management is a process to systematically manage transportation infrastructure through the asset's life cycle, in a cost-effective way. The Moving Ahead for Progress in the 21st Century Act (MAP-21), signed into law in July 2012 and codified in Title 23 United States Code (U.S.C.) 119, requires all states to develop and implement a risk-based Transportation Asset Management Plan (TAMP) that provides strategies to achieve national goals and state-established condition and performance thresholds for the NHS. The Fixing America's Surface Transportation Act (FAST Act), which was signed into law in December 2015, continued the TAMP requirements. The recent Bipartisan Infrastructure Law (BIL), signed on November 15, 2021, changes Title 23 U.S.C. 119 (e)(4) to require the consideration of extreme weather and resilience as part of the life cycle planning and risk management analyses within the state TAMP.

What is the TAMP?

A TAMP is a document that outlines a 10-year investment strategy for preserving existing assets. This plan facilitates the documentation of current system conditions, condition targets, risk evaluation, and guidance for transportation investment decision-making.

This TAMP focuses on pavement and bridges on the NHS to meet the requirements specified in 23 *Code of Federal Regulations* (CFR) Part 515. The HDOT will consider additional assets for future inclusion into the TAMP as additional data are collected, processes are enhanced or developed, TAMP operational funding is secured, and an adequate organizational structure is further established. Statewide, the HDOT Highways Division is responsible for multiple assets, which include pavement, bridges, drainage (structures and culverts), tunnels, highway lighting, overhead signs, traffic signals, transportation management systems (including interconnect fiber), sidewalks, guard rails, pavement markings, office buildings, maintenance yards, and other transportation-related facilities.

The TAMP is organized as follows:

Chapter 2 outlines the proposed TAMP approach and process.

Chapter 3 documents current asset conditions.

Chapter 4 establishes asset performance measures and targets.

Chapter 5 evaluates risks that could impact the system condition and shows how resiliency is incorporated.

Chapter 6 identifies available funding.

Chapter 7 documents life cycle planning strategies.

Chapter 8 recommends investment strategies.

Chapter 9 identifies areas of potential improvement in asset management.

Transportation asset management is defined by FHWA as 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."

Hawaii's Transportation System

The state of Hawaii includes eight major islands, six of which are permanently inhabited and have functionally classified roadways. The statewide transportation system is approximately 9,803 lane-miles. The federal-aid system, which consists of interstates, arterials, and collectors, is 40 percent of the entire system. Statewide, there are 1,124 bridges in total, with a total deck area of approximately 14,516,076 square feet.

Island State

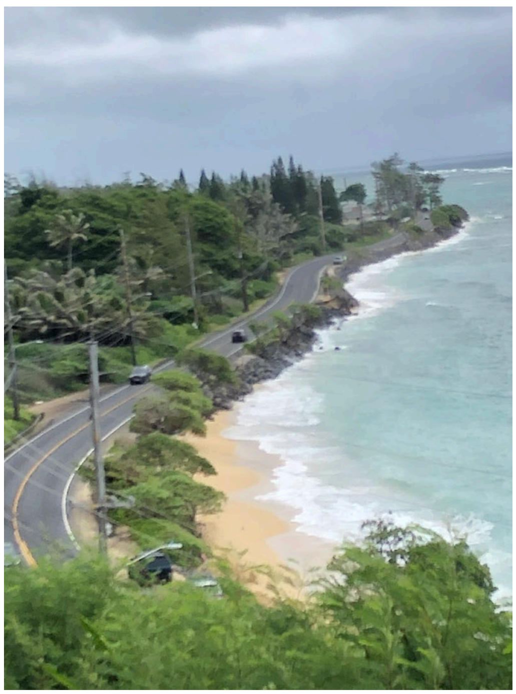
Hawaii is the 50th and most recent state to join the United States, having joined on August 21, 1959, and is the only state composed entirely of islands. The state's eight major islands are Niihau, Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, and the island of Hawaii. The last, the largest island in the group, is often called the Big Island or Hawaii Island to avoid confusion with the state as a whole.


Ninole Bridge on Hawaii Island

The Hawaiian Islands are home to more than 1.46 million people and draw over 9 million visitors each year. Hawaii's population is expected to grow to 1.65 million by 2045; this rise in population will bring greater pressure on natural resources and increasing demand on the transportation system.[1] The state's coastline is about 1,052 miles long, the 18th-longest in the U.S.[2]

Uniqueness of Hawaii's Roadway System

All of Hawaii's islands are of volcanic origin, and as such, many of the islands feature one or more mountains or mountain ranges in the interior sections of the island, with flatter eroded topography along the coastline. Most of the major roadways that provide vehicular connectivity and mobility are constructed on these flatter coastline sections. On the islands of Hawaii and Maui, roadway systems completely encircle the island, forming a belt road or beltway. For other islands, roadways systems may encircle only a portion of the island, or roadways may continue along the coastline and end at some point, providing only one-way major access to communities.



Typical belt, shoreline road on the windward side of Oahu

Unlike other parts of the U.S., the useable land area in Hawaii is very limited. Many of the roadways are confined by developments abutting the facilities or by natural topographic features. Expansion of existing facilities or constructing alternative routes are cost-prohibitive and come with significant environmental impacts. In addition, the high cost of construction is exacerbated by the limited resources (including materials and labor) on the islands. Each island has its own unique roadway system, vital to that island.

Hawaii's existing functional classification system is like that of the rest of the U.S.; however, because of island geography and topography, Hawaii significantly relies on belt roads around the islands more so than the mainland. The functional classification of these belt roadways is either principal arterials on the NHS or minor arterials.

Because of the limited roadway options, the NHS serves many functions in many areas. The reliance on the NHS and the constrained geography increases traffic and congestion on roadways designated as arterials. Many of these belt roadways carry a large volume of traffic and serve as the primary means to transport freight and goods and are essential to the well-being of the communities they serve. Furthermore, there can be significant adverse effects to those communities in the event of an emergency road closure or utility construction closure, or other unplanned incidents on the roadway system.

As the primary road, the arterials also serve as both collectors and local roads, with small roads and driveways connecting directly to the principal arterial. Conversely, there are roadways on the smaller islands or in other areas that are isolated from the remaining parts

[1] DBEDT. 2018. Population and Economic Projections for the State of Hawaii to 2045.

[2] WorldAtlas.com. 2020. US States With The Longest Coastlines. Geography. September 8. https://www.worldatlas.com/articles/us-states-by-length-of-coastline.html.

of the state. These roads may not meet the specific criteria for a given classification, but still operate as an arterial or collector because they provide primary access.

Unique Challenges in Hawaii

Because of its location in a tropical zone, predominant coastal environment, and geologic and topographic factors, there are many challenges to Hawaii and its land transportation system. Hawaii's dependence on imported supplies, along with its geographic isolation, presents additional challenges when considering construction resources and emergency recovery and response factors. In addition to these local factors, global warming and sea level rise (SLR) also present significant challenges to Hawaii.

> Resilience is the ability to adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions. *(HDOT Highways Division definition, December 20, 2019)*

These challenges are important considerations in the HDOT's life cycle planning and risk register. As the emphasis on transportation asset management continues to grow and the HDOT works on formalizing processes and policies, tough decisions will need to be made about preserving assets that are subject to climate change and natural disasters.

The Existing System

The NHS is a subset of the entire roadway system. It provides an interconnected system of freeway and principal arterial routes that serve population centers, ports, airports, military bases, public transportation facilities, and other intermodal transportation facilities and major travel destinations; meet strategic national defense requirements; and serve interregional travel. With Hawaii being an island state, although there are no interstate or international border crossings, the NHS remains vital infrastructure providing service to the state. The non-NHS assets are considered to be the remainder of the statewide roadway system.

Six of the eight major islands contain functionally classified roadways, and four of those islands include NHS routes: Hawaii, Maui, Oahu, and Kauai. These NHS roadways are under both state and county jurisdictions, as shown on Figure 1.1. The islands of Molokai and Lanai have both State and county roads (none of which are on the NHS). The islands of Niihau and Kahoolawe do not have any roads under the jurisdiction of the HDOT or individual county public works departments. The breakdown of NHS pavement and bridges compared to the statewide system is shown in Table 1.1 and on Figure 1.2.

National Highway System : Hawaii

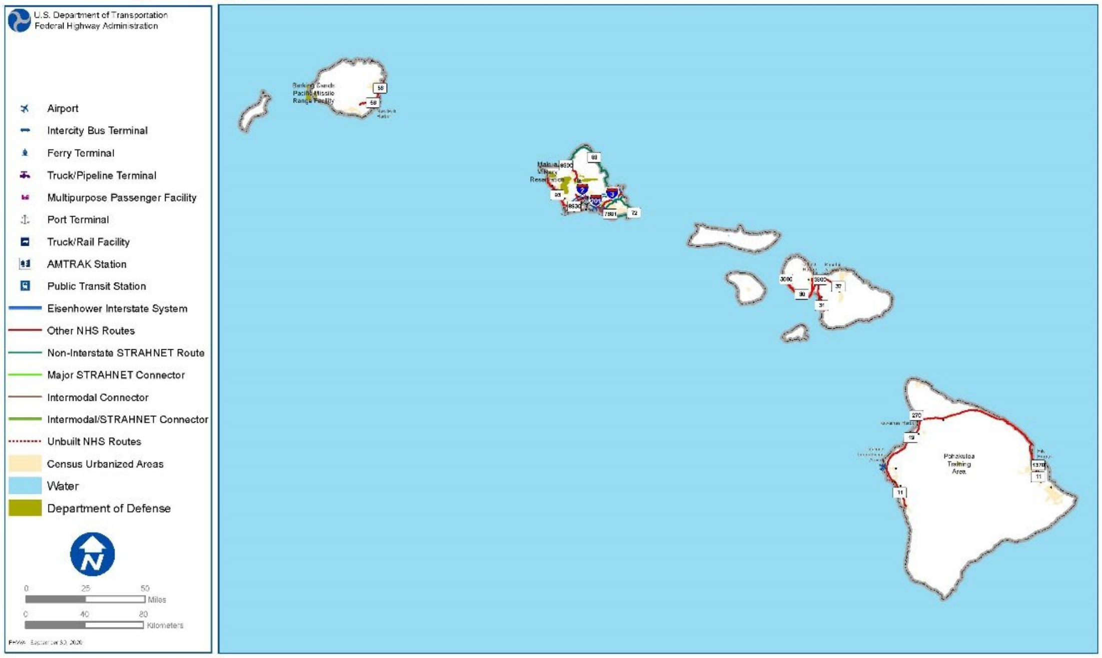


Figure 1.1. National Highway System

Source: http://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/hawaii/hi_hawaii.pdf

Table 1.1. Statewide NHS vs. Non-NHS Pavement and Bridges

NHS Pavement	1,496 lane-miles
Non-NHS Pavement	8,307 lane-miles
NHS Bridges	511 bridges (12,078,704) square feet of deck area)
Non-NHS Bridges	613 bridges (2,437,373 square feet of deck area)

Source: HDOT pers. comm. 2022

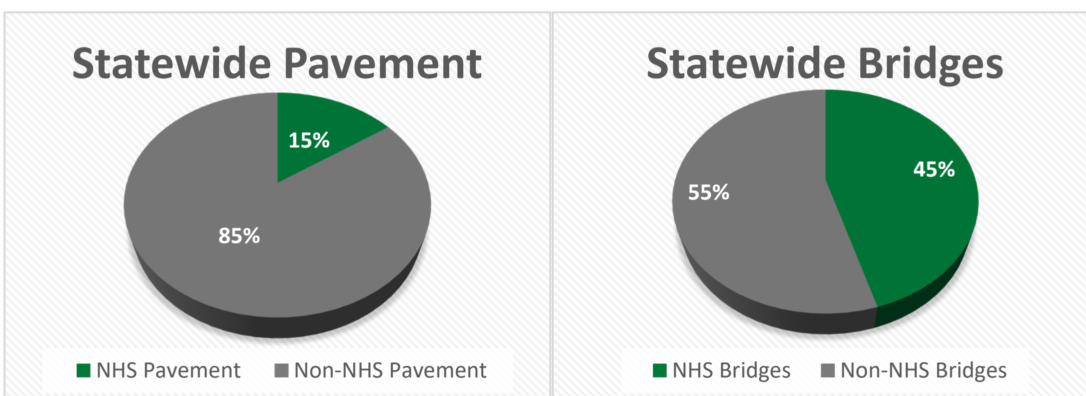


Figure 1.2. Percentage of NHS Pavement and Bridges on the State Land Transportation System

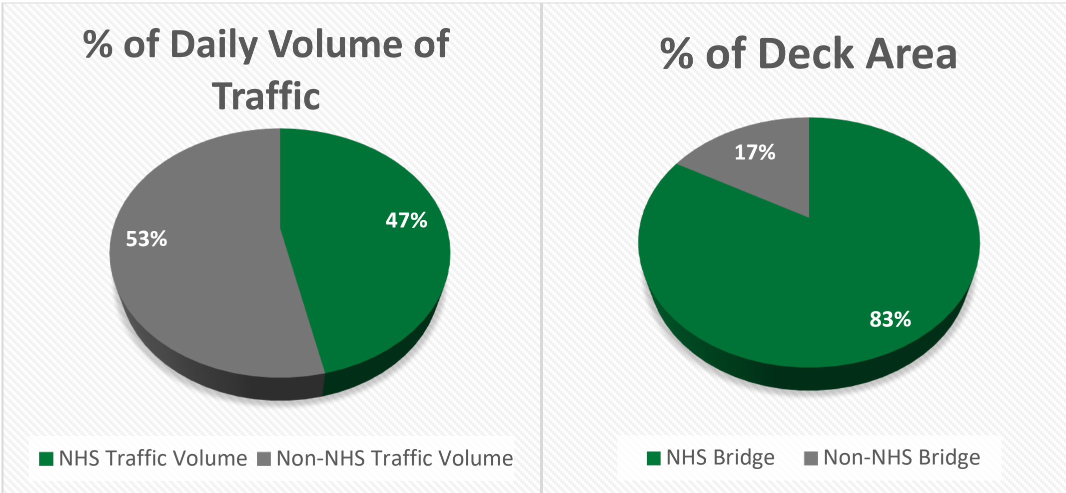


Figure 1.3. Daily Volume of NHS vs. non-NHS Traffic and Deck Area

Although only 15 percent of the state's entire land transportation system is part of the NHS, those roads carry close to 47 percent of the daily volume of traffic, as shown on Figure 1.3. Similarly, the number of bridges that are on the NHS is 45 percent of the total number of bridges; however, the deck area of the NHS bridges is 83 percent of the total, as shown on Figure 1.3.

Local Jurisdictions

There are five counties and two metropolitan planning organizations (MPOs) in the state of Hawaii, and four HDOT districts. Counties in Hawaii are the only legally constituted government bodies below state level. Honolulu is governed as the City and County of Honolulu, a county that covers the entire island of Oahu. Table 1.2 and Figure 1.4 show a breakdown of the jurisdictions in the state.

Table 1.2. Jurisdiction Breakdown

State	City/County	Island
HDOT Kauai District	County of Kauai	Kauai, Niihau [a]
HDOT Oahu District	City and County of Honolulu	Oahu
HDOT Maui District	County of Maui	Maui, Lanai, Molokai, [b] Kahoolawe [a]
	County of Kalawao [a]	Molokai
HDOT Hawaii District	County of Hawaii	Hawaii

[a] There are no state roads within this island or county.
[b] With the exception of the Kalaupapa peninsula on Molokai, which is the County of Kalawao
Note: There are also two MPOs within the state: OahuMPO comprises the entire island of Oahu and the Maui MPO comprises the entire island of Maui.

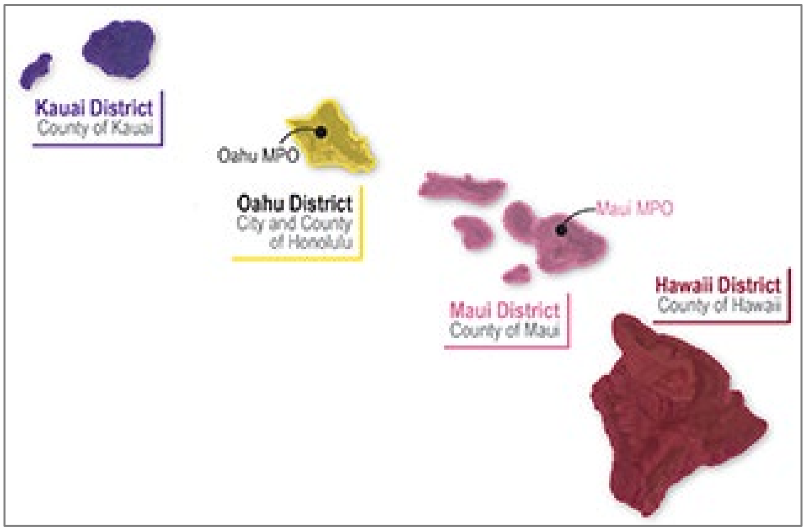


Figure 1.4. Jurisdiction Map in the State of Hawaii

Figure 1.5 shows the breakdown of all pavement and bridges (state and county jurisdictions) within each county.

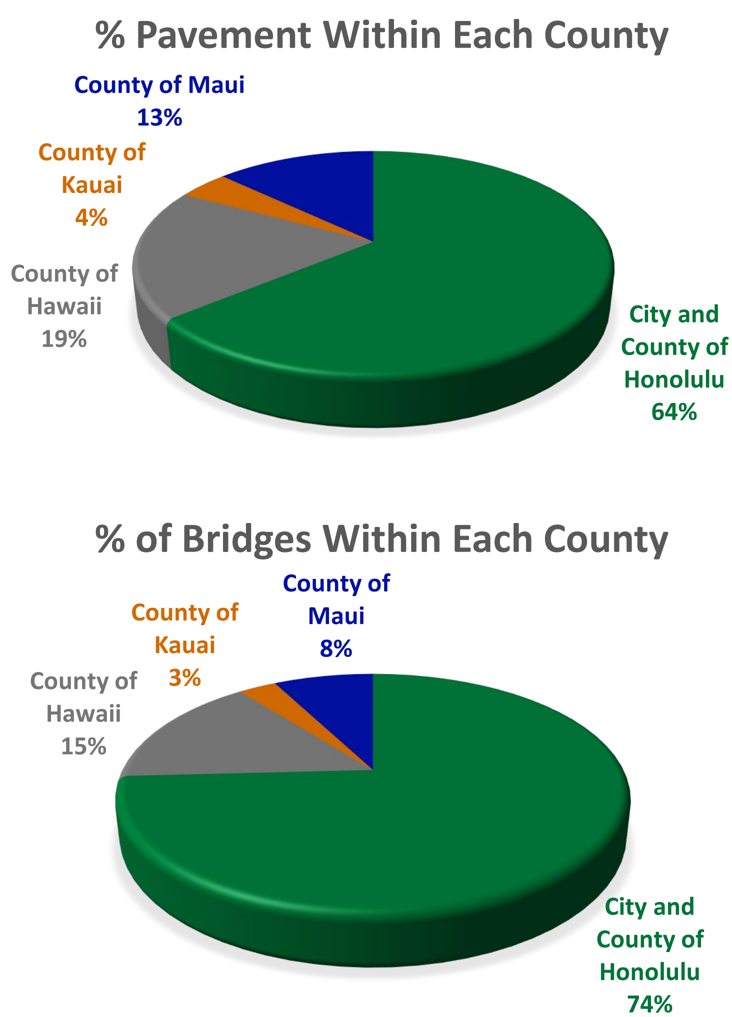


Figure 1.5. Percentage of Pavement and Bridges in each County

CHAPTER 2

Asset Management Approach and Process

Asset management is an integrated set of processes to minimize the life cycle costs of owning and cost-effectively operating and maintaining assets. Asset management provides data-driven answers to the question of how to operate and maintain assets while accepting some level of risk and meeting the level of service the traveling public expects. The HDOT's executive leadership is committed to implementing asset management initiatives for the state's roadways so that valuable resources can be effectively used to provide maximum benefits to the people of Hawaii.

Asset Management uses data analyses to compare processes and results against desired results and performance goals and targets.

Federal Requirements

MAP-21 contains requirements for the development of TAMPs that include strategies leading to a program of projects that would make progress toward achieving the state targets for asset condition and performance of the NHS. MAP-21 requires a TAMP to include, at a minimum, the following seven components:

- A summary listing of the pavement and bridge assets on the NHS and a description of their condition
- Asset management objectives and measures
- Performance gap identification and analysis
- Risk management analysis
- Life cycle planning analysis
- A financial plan
- Investment strategies

The FAST Act was signed into law in December 2015 and includes provisions to (1) make the federal surface transportation system more streamlined, performance-based, and multimodal and (2) address challenges facing the U.S. transportation system. This includes improving safety, maintaining infrastructure condition, reducing traffic congestion, improving the efficiency of the system and freight movement, protecting the environment, and reducing delays in project delivery. The FAST Act builds on the changes and requirements of MAP-21 as they relate to asset management.

The BIL, signed on November 15, 2021, focuses on a significant investment in our nation's roads and bridges, promoting safety for all road users, helping to combat climate change, and advancing equitable access to transportation. The BIL encourages projects that build a better America and changes Title 23 U.S.C. 119 (e)(4) to require the consideration of extreme weather and resilience as part of the life cycle planning and risk management analyses within the state TAMP.

Governance

Asset management is viewed as a way of doing business, and organizational culture may be one of the most significant obstacles to advancing asset management in an agency. Implementation of the TAMP requires coordinated business processes between the HDOT's districts and branches to successfully achieve the performance goals and objectives.

Development of this TAMP has provided the opportunity to improve coordination between the HDOT's maintenance, preservation, and capital programs, as well as the Planning and Design offices, Materials and Testing Laboratory (Lab), and individual district offices. To emphasize the HDOT's commitment to asset management, an Asset Management Leadership Team to guide the implementation of asset management throughout the HDOT and to monitor the progress at every step was created.

The enhanced organization structure brings greater clarity to the process, better identifies the roles and responsibilities at each level, and brings new parties to the process. The Asset Management Leadership Team works to achieve the TAMP goal and objectives as follows.

HDOT TAMP Goal

Provide a process to achieve and sustain a state of good repair over the life cycle of the assets and to improve and preserve the condition of the state's transportation assets.

The **HDOT's objectives** are as follows:

- Implement plans and projects to support the transportation asset management process
- Establish data governance and data collection standards
- Facilitate coordination, collaboration, and knowledge transfer within the team
- Communicate the transportation asset management activities to the executive levels of the HDOT
- Pursue the solicitation and promotion of asset management best practices
- Promote transportation asset management benefits and uses throughout the HDOT, counties, and other external stakeholders

The Asset Management Leadership Team is supported by the activities of various subgroups, as highlighted on Figure 2.1.

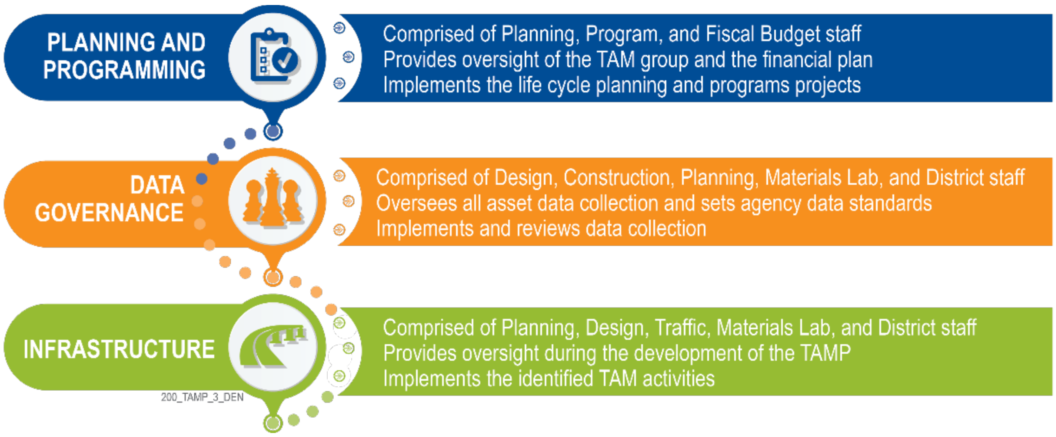


Figure 2.1. Asset Management Leadership Team Subgroup Organization

The Approach

Consistent with best management practices, this TAMP uses a data-driven, performance-based, and risk-based approach that does the following:

- Guides decisions that are consistent with overarching national and state policies and goals
- Uses a technical and data-driven process based on quality information
- Evaluates assets using performance-based targets
- Considers the life cycle of assets to develop preservation and investment strategies
- Considers resiliency in the life cycle of assets and as part of the HDOT's risk register
- Tracks progress in a long-term, ongoing, and collaborative process
- Is transparent and defensible

The Leadership Team is led by the Highways Administrator, who serves as TAMP leader, and includes representatives of the HDOT's major branches. Comprehensive asset management requires a full team effort and important input and participation from all of the technical branches. Figure 2.2 further breaks down the roles and responsibilities of asset management at the HDOT, as well as the inclusion of the City and County of Honolulu and the MPOs (OahuMPO and the Maui MPO). As reflected in Chapter 3, the City and County of Honolulu is the only jurisdiction that owns and maintains a portion of the NHS, other than the HDOT.

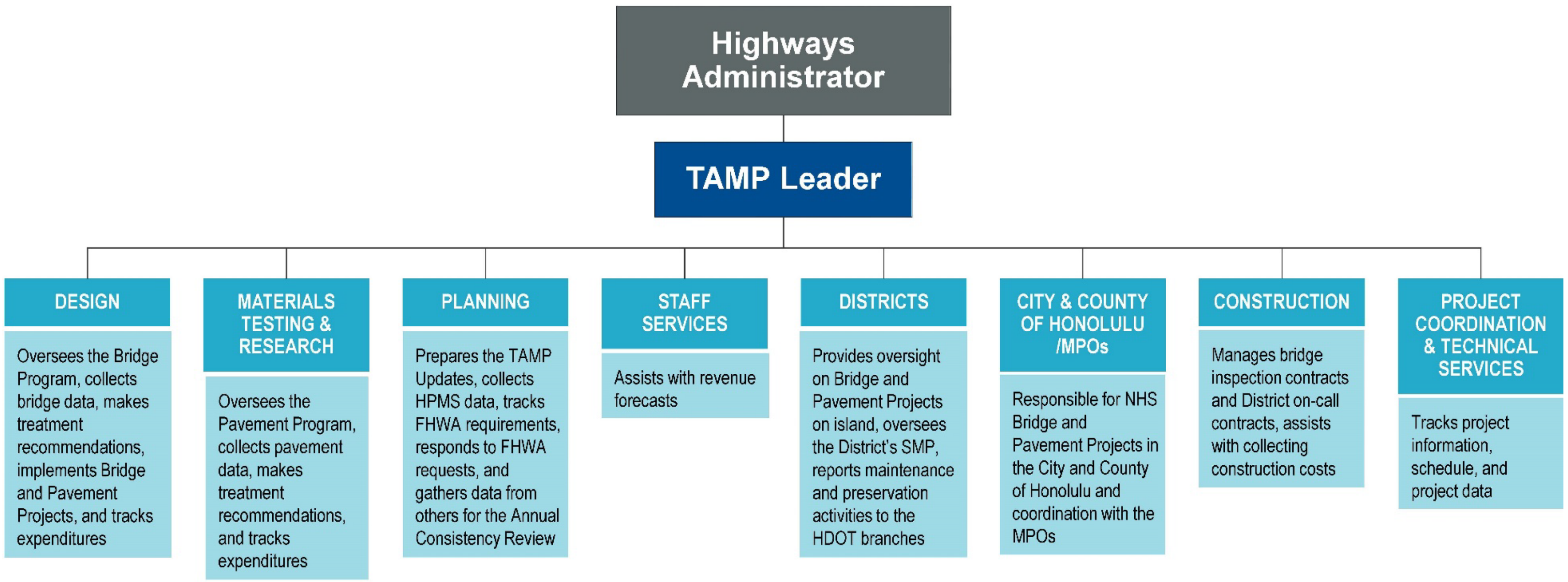


Figure 2.2. Asset Management Roles and Responsibilities by Branch/Agency

The Process

The TAMP will use a data-driven and technical process that will objectively guide investment decisions to operate, maintain, and improve transportation assets, and will justify the HDOT's funding needs. The data collection and technical evaluation will be conducted in an ongoing and iterative process of activities, as shown on Figure 2.3 and described in this section.

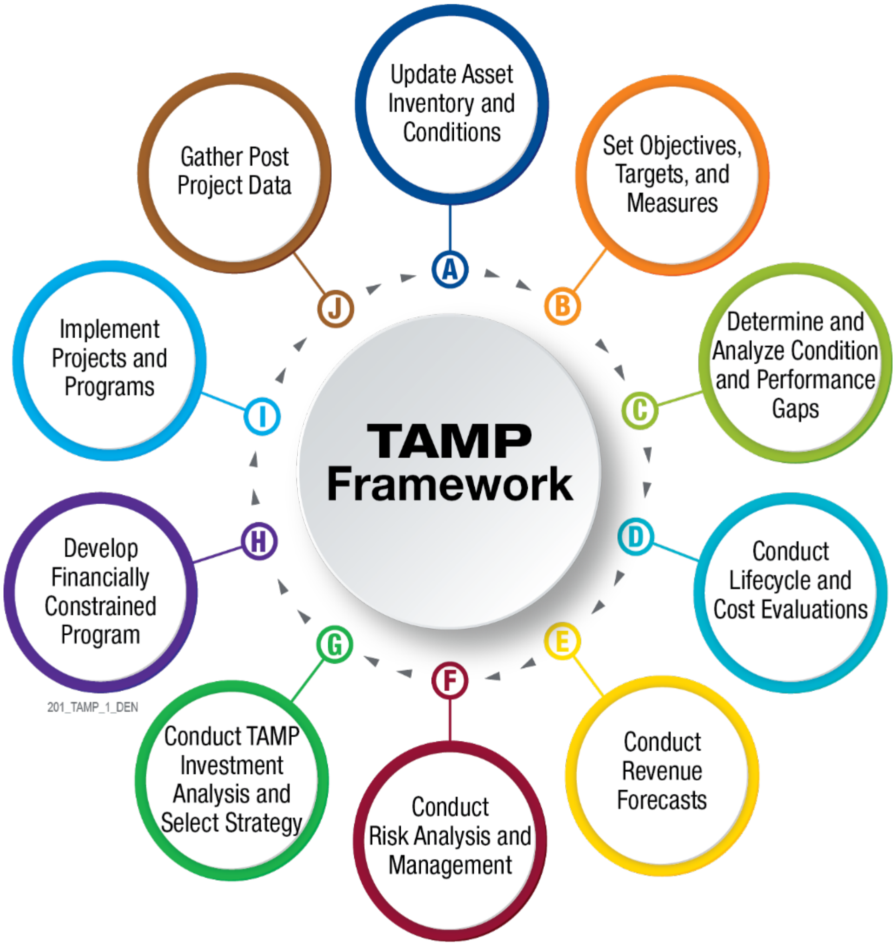


Figure 2.3. HDOT TAMP Framework and Activities

A. **Update Asset Inventory and Conditions**

- What assets do we have?
- What are the current conditions of the assets?
- How well are they performing?

B. **Set Objectives, Targets, and Measures**

- What are the objectives of the TAMP?
- What is the desired state of repair?
- How will it be measured?

C. **Determine and Analyze Condition and Performance Gaps**

- What and where are the differences between actual and desired conditions?
- What are the differences between asset types?

D. **Conduct Life Cycle and Cost Evaluations**

- What is the expected life of the assets?
- How will the assets depreciate and decline in value and state of good repair?
- Are the assets located within the HDOT's hazard zone?
- When will repairs or treatment be necessary to prevent assets from slipping from one level of maintenance to the next?
- What is the cost of the appropriate level of maintenance?

E. **Conduct Revenue Forecasts**

- What is the current revenue and sources?
- What factors might affect revenues in the future?
- How much money can we reasonably expect?
- What are the present inflation rate assumptions and future purchasing power?

F. **Conduct Risk Analysis and Management**

- What are the threats and risks that may prevent achieving desired goals?
- What are the strategies to avoid, minimize, mitigate, and manage risks?

G. **Conduct Investment Analysis and Select Strategy**

- What are the best investment strategies?
- What is the minimum life cycle cost of the assets?
- What life cycle treatment types can be considered?
- What is the cost of treatment type?
- What risks should be considered?
- Identify investment scenarios and select an investment strategy
- Perform gap analysis

H. **Develop Financially Constrained Program**

- Which projects from the pavement and bridge management systems should be carried forward to the Mid-Range Transportation Plan (MRTP)?
- Make cross-asset comparisons and decisions between the range of HDOT's programs

I. **Implement Programs and Projects**

- Programming in the MRTP and Statewide Transportation Improvement Program (STIP)
- Monitoring costs and schedules
- Performing improvements

J. **Gather Post-Project Data**

- How are we doing?
- Gather data related to estimated vs. actual costs
- Update management systems and long-range plans with data

Figure 2.4. Plan-Do-Check-Act Process

Much like every Plan-Do-Check-Act process, as shown on Figure 2.4, the TAMP process starts all over again to ensure the best investments are being made. As operational budgets are planned for and secured, reorganizations are implemented, additional data are collected and made available, and data systems are enhanced or established, the HDOT will incorporate other relevant asset data into the TAMP as the program matures. Time is needed to further research and evaluate the availability of existing data and challenges in the extraction and conversion of such data into a new or enhanced data system, and then to determine additional data needs and develop budgetary and implementation timeline estimates. These will be presented in future updates to the TAMP.

Integration of the TAMP into HDOT Highways Division Planning and Programming Components

System preservation has been a priority for the HDOT for many decades, and starts at the top. Figure 2.5 depicts the HDOT's family of plans and the relationship with the Hawaii Statewide Transportation Plan (HSTP), which provides overarching policy to implementation of transportation plans and programming components. The HSTP focuses on broad policy, goals, and objectives for the three primary modes of transportation—air, water, and land systems—as well as nonmotorized modes and intermodal connections. The HSTP has an infrastructure goal emphasizing maintenance of its assets.

The highway statewide system plan provides overarching goals and ensures equity and consistency among the regional or county plans. Each of these plans identifies needs and potential solutions to address those needs. The Statewide Land Transportation Plan also has an infrastructure goal emphasizing the maintenance of highway assets, further prioritizing the need for system preservation.

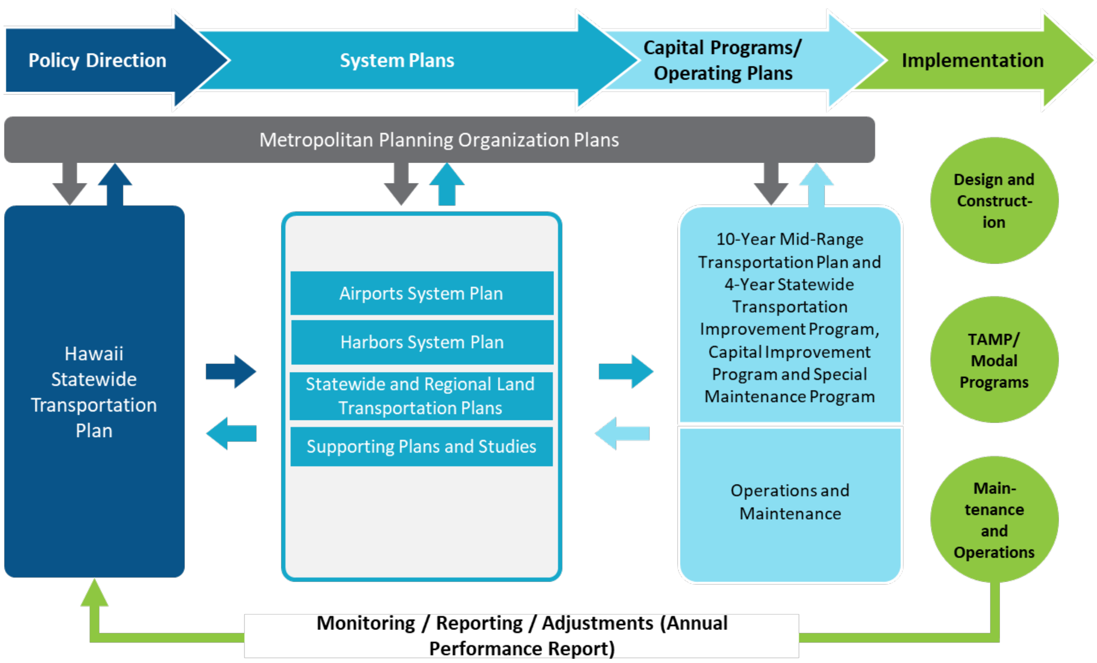
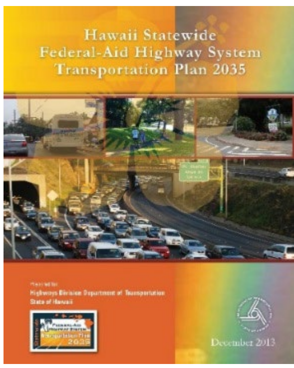


Figure 2.5. HDOT's Family of Plans

In the Statewide Federal-Aid Highway System Transportation Plan 2035, the HDOT committed 65 percent of its program needs to safety and preservation. The Statewide and Regional plans and the HDOT primary programs (that is, pavement, bridge, rockfall, shoreline, traffic safety, and congestion) identify priorities and program that feed into the HDOT's MRTP. The MRTP provides the bridge between the 20-year long-range transportation plans (LRTP) and the HDOT's 4-year STIP and 2-year Capital Improvement Program (CIP). The MRTP has a 10-year planning horizon and evaluates the projects against the State's goals and objectives, priorities, and project readiness. A cross-asset/program evaluation and prioritization is conducted.

Infrastructure

HSTP Infrastructure Goal:
Provide a high-quality, well-maintained multimodal system



Hawaii Statewide Federal-Aid Highway System Transportation Plan 2035 Goal 3.1:
Manage transportation assets and optimize investments.

To show the importance of asset management and how it is further integrated into the HDOT's planning and programming process, the MRTP evaluates whether a project is improving pavement and bridge conditions. The project receives additional evaluation points if the project is on the NHS and the roadway is used by many (that is, if it has a higher amount of annual average daily traffic). The prioritized projects on the MRTP are programmed in the STIP, Transportation Improvement Plans (TIP), CIP, and Special Maintenance Program (SMP), and are then implemented. This process ensures that all of the investments made in programming are consistent with the HDOT's long-term vision and goals. Figure 2.6 shows the evaluation of the long-range transportation goal to project delivery and how asset management is fully integrated.

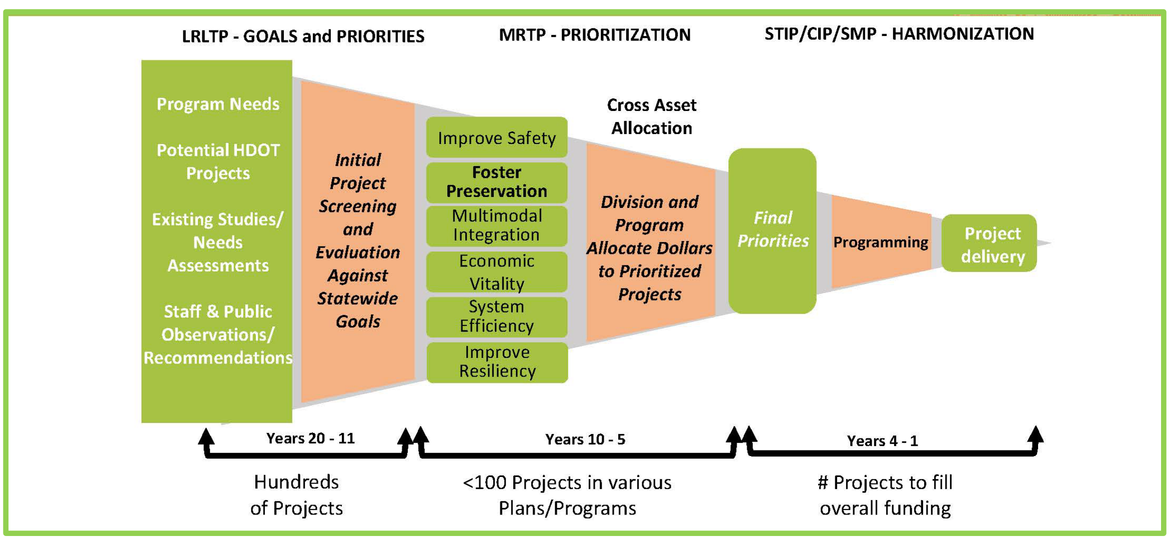


Figure 2.6. HDOT Programming Process

Figure 2.7 reflects an overview of this process – the HDOT Highway Division's Planning and Programming Process. It starts with the LRTP, where a 20-year forecast is conducted and needs are assessed. With the LRTP, programs and projects are prioritized, funding is forecasted, and the funding gap is identified. The next step is to further develop those programs (for example, the bridge and pavement programs), update modal plans (such as the bicycle, pedestrian, and freight plans) and the TAMP. Out of these plans and programs, the HDOT program managers submit their 10-year plan and prioritized projects to the MRTP. As mentioned previously, projects placed on the MRTP feed into the STIP, TIP, CIP, and SMP, and are then implemented. Monitoring and feedback from implementation, maintenance, and operations go back to the plans, creating a continuous feedback loop of data and process improvements.

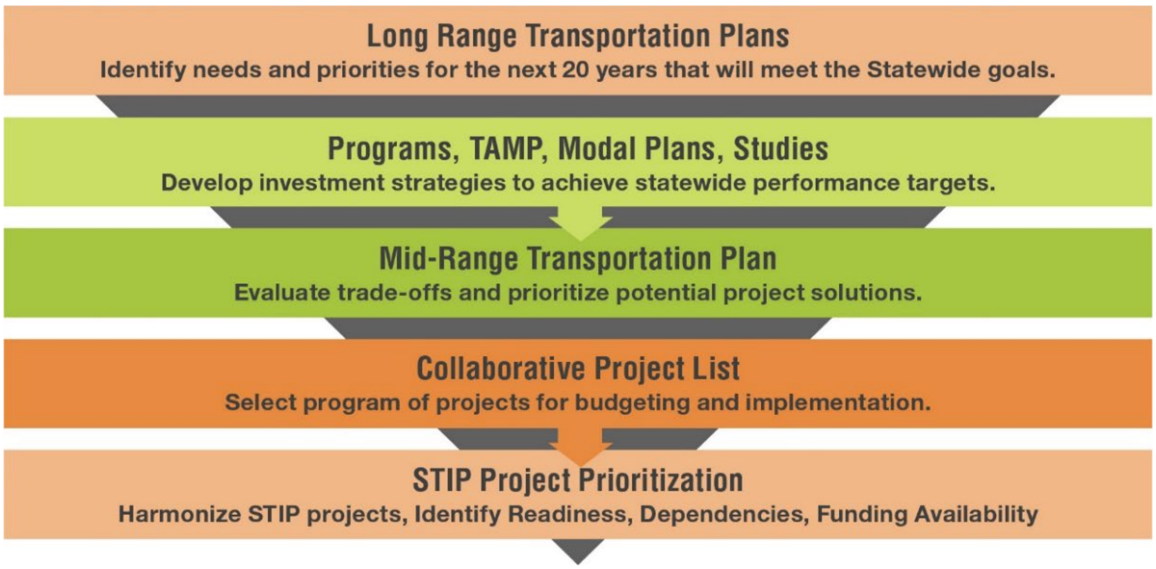


Figure 2.7. Implementation from Long-Range Plan to Mid-Range Plan to STIP

CHAPTER 3

Inventory and Condition

Overview

Information is necessary to develop a robust TAMP. To have a data-driven, performance-based, and risk-based TAMP, asset inventory and condition data are needed. These data provide the foundation for supporting asset management process, such as life cycle planning, prioritizing projects, and determining future needs.

As mentioned earlier, the HDOT has a lot of assets to maintain and manage. This TAMP is focused on NHS pavement and bridges, critical transportation infrastructure that is vital for Hawaii's economy and survival. Pavement and bridge conditions for the entire state system are considered in the development of this TAMP but are not included. Future TAMPs may include all of the State's pavement and bridges and other important infrastructure.

Hawaii's NHS System

As mentioned in Chapter 1, the NHS provides an interconnected system of freeway and principal arterial routes that connects communities, ports, airports, military bases, and major travel destinations. The majority of the NHS in Hawaii is under State jurisdiction, with a small percentage under county jurisdiction. The jurisdictional breakdown in Hawaii of pavement and bridges on the NHS is summarized in Table 3.1 and shown on Figures 3.1 and 3.2.

Table 3.1. NHS Pavement and Bridges (2020)

Jurisdiction	NHS Pavement (lane-miles)	NHS Bridges (each)
State	1,367	492
Oahu District	874	361
Hawaii District	249	77
Maui District	189	39
Kauai District	55	15
City and County of Honolulu	79	18
County of Maui	0	0
County of Hawaii	24 [a]	1 [a]
County of Kauai	0	0
Total	**1,433**	**511**

[a] This remaining portion of the NHS under County of Hawaii jurisdiction was transferred to the State in 2021.

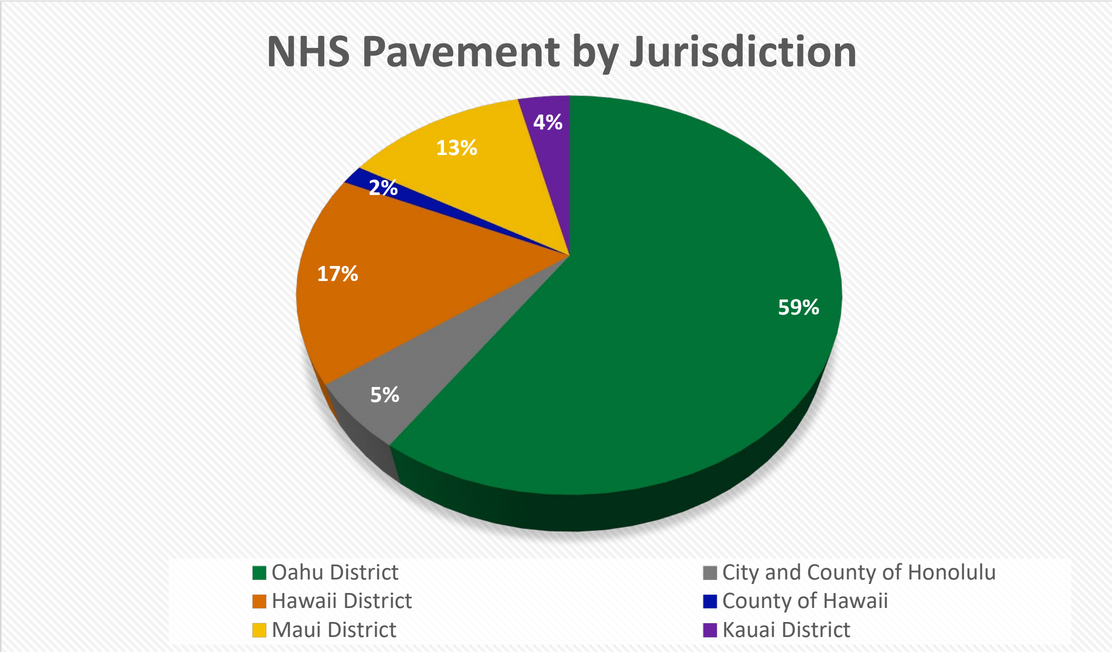


Figure 3.1. NHS Asset Jurisdiction – Pavement

Note: Numbers have been rounded to the nearest whole percent.

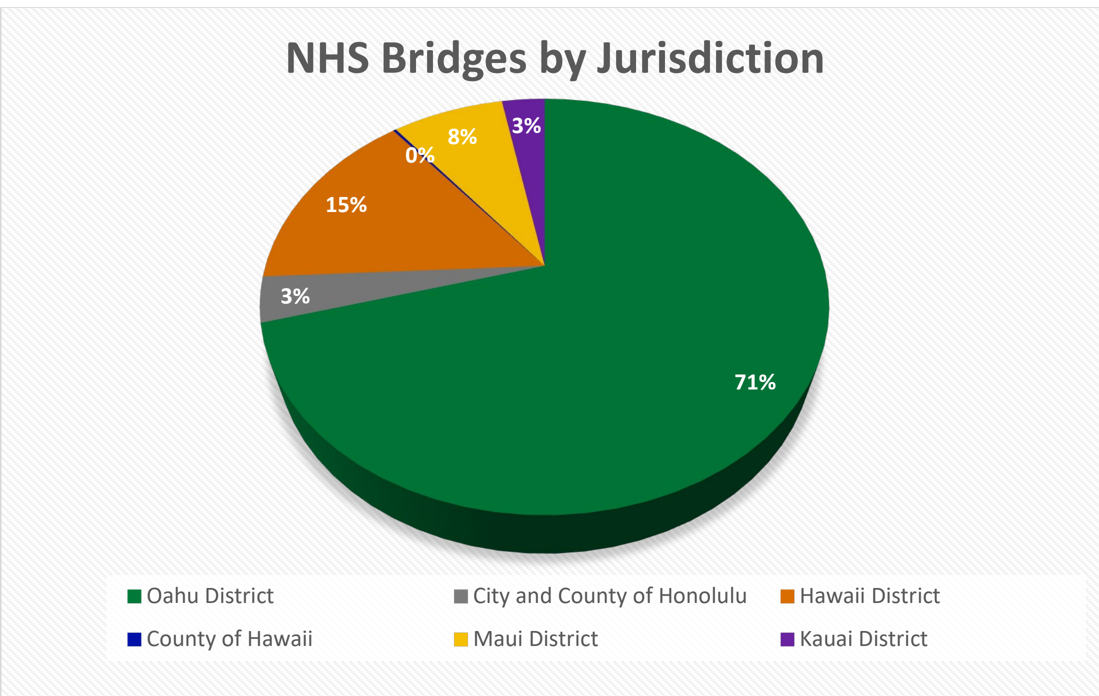


Figure 3.2. NHS Asset Jurisdiction – Bridges

Note: Numbers have been rounded to the nearest whole percent.

Coordination with Counties and MPOs

The State Transportation Planning (STP) office implements the HDOT's transportation planning process. STP convenes quarterly (or as needed) meetings that bring together governmental agencies imperative to transportation planning in Hawaii, to coordinate and collaborate on the State's transportation planning process. Involved agencies include the HDOT Highways, Airports, and Harbors Divisions, City and County of Honolulu, County of Hawaii, County of Maui, County of Kauai, Federal Highway Administration (FHWA), Federal Transit Administration (FTA), Federal Aviation Administration (FAA), OahuMPO, Maui MPO, and other applicable governmental agencies. During the development of this and the previous TAMP, the process and methodology was shared with these important stakeholders.

The City and County of Honolulu is the only jurisdiction that has roads on the NHS that are not owned by the HDOT. Previously, the County of Hawaii had jurisdiction of a portion of Route 11 (NHS). There was a transfer of ownership and jurisdiction in 2021 to establish continuity of the ownership.

The HDOT met separately with the City and County of Honolulu to discuss their pavement management and bridge management programs. Data collection, data sharing, risks, maintenance strategies, and how the pavement and bridge projects are prioritized were all discussed. The HDOT collects all of the NHS pavement data for the state. The City and County of Honolulu also collect their own pavement condition data.

The HDOT continued collaboration and coordination with the OahuMPO and Maui MPO to discuss the TAMP objectives, TAMP program needs, and program priorities, and share draft pavement and bridge performance targets. Important discussions about performance measures, impacts to other program needs, vision, and goals for their LRTPs, as well as effects to the STIP and TIP, are covered. The HDOT has data-sharing agreements with both MPOs.

Data Management

Through the Highway Performance Monitoring System (HPMS) program, the HDOT collects a variety of data on the federal-aid highway system, regardless of jurisdiction. These data are shared with the City and counties. Each jurisdiction manages their own pavement management system (PMS) but collaborates on lessons learned and successful preservation strategies. Bridge condition data are collected through bridge inspections done by the individual jurisdictions, then reported to the HDOT and ultimately to the FHWA, to support the National Bridge Inventory (NBI). The jurisdictions also share strategies and resources; for example, bridge inspectors from one jurisdiction may assist with bridge inspections in another (because of the limited number of bridge inspectors a jurisdiction may have). Communication and coordination of the inspections is helping to ensure consistency and quality of the inspection reports.

The HDOT has numerous data management systems for storing and managing inventory and condition data.

The HDOT also understands the significance of the management and quality control of its data resources. Data provide the foundation of the PMS and Bridge Management System (BMS). As part of the TAMP process and HDOT's commitment, the HDOT has established a data governance group to oversee the collection of all asset data collection and to establish data standards and guidelines.

Data management is at the foundation of a TAMP, as follows:

- Data access (How easy is it to retrieve the data?)
- Data quality (How accurate and useful are the data?)
- Data integration (Can different data sets be combined and from different sources?)
- Data governance (Who oversees the data and what are the policies for managing the data?)

HDOT Pavement Program

Hawaii Pavement Inventory

Pavements are a critical part of the HDOT transportation network, providing mobility and access to a wide variety of users and being used to move goods for the economic vitality of the state. Overall, the State and individual counties maintain over 9,803 lane-miles of pavement. The federal-aid highway system consists of approximately 3,916 lane-miles (Table 3.2). As the population and economy continues to grow, the state's pavement inventory is also expected to grow. As required by the FHWA, this TAMP only includes the pavement conditions for the 1,496 lane-miles of Interstate and non-Interstate NHS. The remainder of the state's pavement system is considered in the life cycle planning and investment strategies for the NHS system but is not included in this TAMP document. The HDOT may include the entire state system in future iterations of the TAMP.

Table 3.2. Federal-Aid Highway System Pavement Breakdown (excluding bridges)

Federal-Aid Highway System	Lane-Miles
Interstate	317
Non-Interstate NHS	1,179
State Highways/Roads	1,071
County Highways/Roads	1,349

Pavement Conditions

The HDOT has adopted FHWA's definitions of pavement condition performance measures, as follows:

- Good condition: Suggests no major investment is needed.
- Fair condition: Suggests that minor investment and preventative maintenance is needed.
- Poor condition: Suggests major reconstruction investment is needed.

The pavement conditions are calculated based on data that the HDOT collects through the HPMS. The pavement conditions are determined by using quantitative data on the following metrics (and shown on Figure 3.3):

- **International Roughness Index (IRI)** is often referred to as pavement roughness. It is an indicator of irregularities in the pavement surface that adversely affect the ride quality of a vehicle (and therefore the road user).
- **Cracking** is measured by the percentage of cracks in the pavement surface. Cracks are often caused (or accelerated) by excessive loading, poor drainage, poor subbase, and construction flaws.
- **Rutting** is a typically caused by heavy traffic and heavy vehicles. It is measured in asphalt by the depth of the rut along the wheel path.
- **Faulting** is a difference in elevation across a concrete joint or crack (usually along concrete slab edges). It can be caused by misaligned concrete slabs, settlement, warping, or a combination thereof. There are two types of concrete pavement: jointed

concrete pavement (JCP) and continuously reinforced concrete pavement (CRCP). Currently, only the JCP type is used in the state.

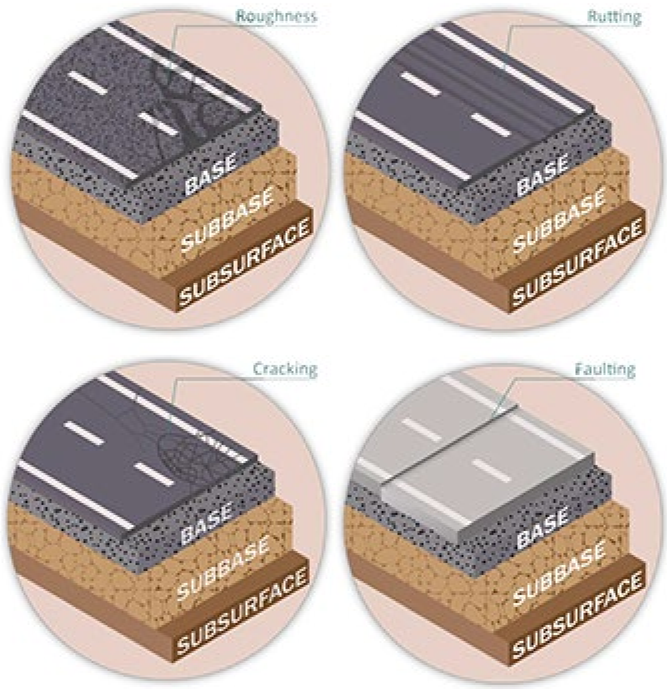


Figure 3.3. Four Pavement Condition Metrics

Source: Caltrans Draft Transportation Asset Management Plan, October 2017

Pavement Raveling

Rippling or Shoving

Wheel Track Rutting

Alligator Cracking

Potholes/Raveling

Examples of Bad Pavements

Examples of Good Pavements

It should also be noted the FHWA does allow the Present Serviceability Rating (PSR) to be used for roads where the speed limit is less than 40 miles per hour.

The FHWA provides guidance for pavement condition thresholds for each section of roadway, as shown in Table 3.3.

Table 3.3. Pavement Condition Thresholds

	Good	Fair	Poor
IRI (inches/mile)	<95	95 to 170	>170
Rutting (inches)	<0.20	0.20 to 0.40	>0.40
Faulting (inches)	<0.10	0.10 to 0.15	>0.15
Cracking (%)	<5	5-20 (asphalt) 5-15 (JCP) 5-10 (CRCP)	>20 (asphalt) >15 (JCP) >10 (CRCP)

Notes:

> = greater than

< = less than

Each pavement section is then determined to be in good, fair, or poor condition by the FHWA guidance for the calculation of pavement measures shown in Table 3.4.

Table 3.4. Calculation of Pavement Measures

	Pavement Type		
	Asphalt and Jointed Concrete	Continuously Reinforced Concrete	
Overall Section Condition Rating	**3 metric ratings (IRI, cracking, rutting/faulting)**	**2 metric ratings (IRI and cracking)**	**Measures**
Good	All three metrics rated "Good"	Both metrics rated "Good"	**Percentage of lane-miles in "Good" condition**
Poor	Two out of three metrics rated "Poor"	Both metrics rated "Poor"	**Percentage of lane-miles in "Poor" condition**
Fair	All other combinations	All other combinations	

HDOT Pavement Management System (PMS)

The HDOT is responsible for managing and maintaining all State-managed roadways classified as Interstate, non-Interstate NHS, and non-NHS Routes. HDOT pavements consist of two types: flexible and rigid. Flexible pavements are typically asphalt pavement, while rigid pavement is jointed concrete (that is, JCP). Figure 3.4 shows the percentage of NHS pavement type in the state.

HDOT collects automatic pavement condition data annually for both NHS and non-NHS routes since 2017. The collected data are then entered into the HDOT's PMS for data analytics and scheduling of maintenance activities.

The HDOT is currently transitioning from the modified AASHTOWare Bridge Management (BrM) system to Deighton Total Infrastructure Management System (dTIMS) as its PMS and is currently in the dTIMS implementation stage. Until dTIMS is fully implemented and validated, the HDOT will continue to use modified BrM as the PMS.

Modified BrM

The AASHTOWare BrM software was customized for pavements as its PMS. BrM uses a data-driven foundation that assigns a score for every pavement section. This is called the utility value, shown on Figure 3.5.

Deterioration models are developed for every element of asphalt and concrete. The BrM modeling system uses multi-objective decision-making to evaluate a utility value based on the weighted averages of conditions of the pavement elements, life cycle (preservation actions), risk, and mobility strategies. Deterioration of the elements is considered and all possible work actions evaluated, and the BrM program selects the work action that provides the highest increase in utility value (also known as benefit) divided by the cost of the work action. Ultimately, each project (work action) can be scored and ranked. The project score is based on the benefit/cost ratio times the structure weight of each section, which is based on the total surface area, traffic volume, and functional classification. The result is a draft prioritized list of pavement recommendations.

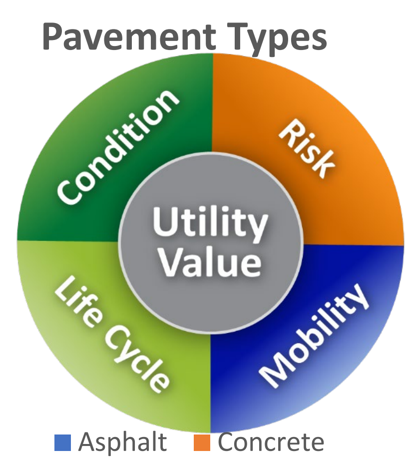


Figure 3.5. PMS Utility Value

NHS Pavement Type

PMS Process

A further breakdown of the PMS process is reflected in Figure 3.6, Pavement Wheel, which represents a continuous cycle of collecting data, analyzing data, implementing recommendations, and verifying the performance of the recommendations.

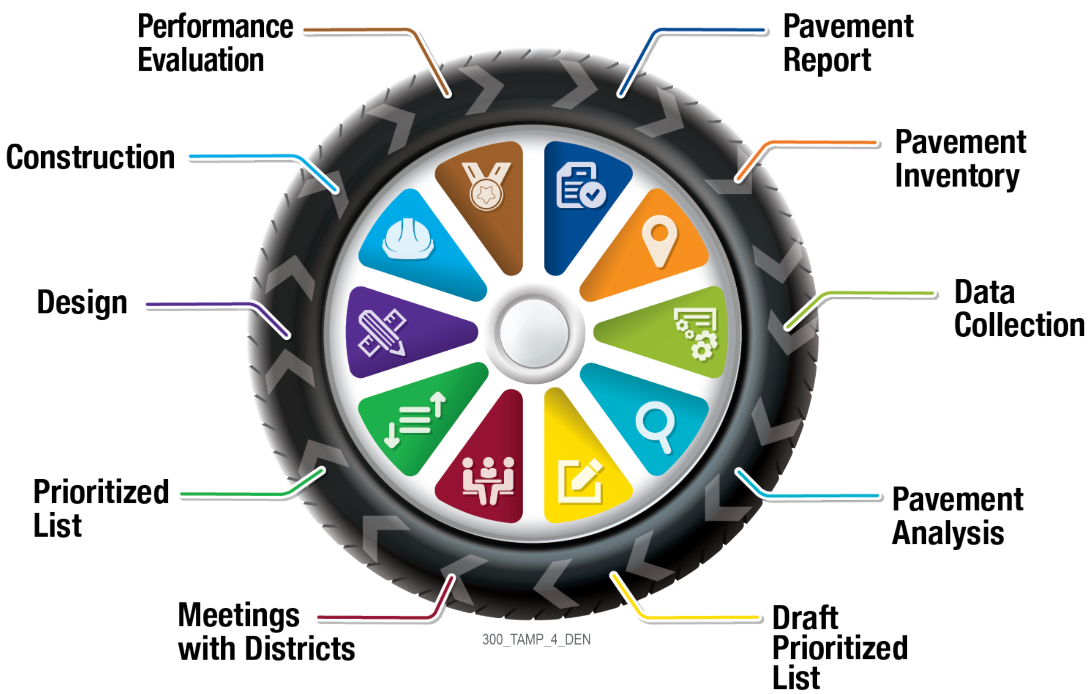


Figure 3.6. Pavement Wheel

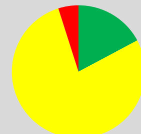
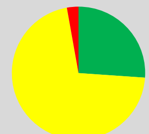
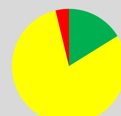
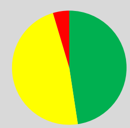
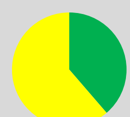
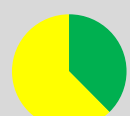
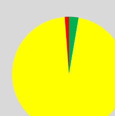
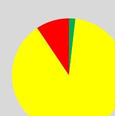
The continuous cycle includes the following activities:

- Reviewing pavement inventory statewide.
- Collecting pavement data annually and sharing with other NHS owners.
- Conducting the BrM pavement analysis, where the result is a multi-year pavement program with prioritized projects and yearly predicted pavement condition under various budget scenarios.
- Sharing the draft pavement program list, which includes both preservation and reconstruction projects, with pavement engineers and district engineers. At this stage, additional pavement segments that are exhibiting structural or performance-based issues that were not apparent in the initial data collection phase (that is, not included in the pavement program) are investigated and scheduled for treatment as a means of providing users with a safe and operable highway transportation system. In collaboration with the districts, other resiliency and risk factors are considered, such as proximity to exposure hazards, SLR, and coordination with Shoreline and Rockfall programs.
- Establishing the prioritized list. Once the pavement program is vetted, finalized, and approved by the HDOT administration, HDOT staff will coordinate with other branches to address other needs such as safety, maintenance needs (such as filling of potholes), and other upcoming projects in the corridor. The prioritized list is then incorporated into the HDOT's MRTP and programmed for funding. The MRTP also has evaluation criteria that further prioritizes system preservation and resiliency.
- Designing and constructing the projects.
- After design and construction, further evaluating performance the roadway segment and updating the pavement report and incorporating into the PMS.
- Continuing the cycle as needed.

Summary of NHS Pavement Conditions

Table 3.5 summarizes NHS pavement inventory and conditions by NHS and by jurisdiction.

Table 3.5. 2020 NHS Pavement Inventory and Condition (HPMS)

	Lane- Miles	Good	Fair	Poor	
All NHS					
Interstate	317	17.2%	77.9%	4.9%	
Non-Interstate NHS	1,179	26.1%	71.1%	2.8%	
By Jurisdiction					
Oahu District	874	16.2%	80.1%	3.8%	
Hawaii District	249	47.6%	47.8%	4.6%	
Maui District	189	38.7%	61.3%	0%	
Kauai District	55	37.6%	62.4%	0%	
City and County of Honolulu	79	2.7%	96.1%	1.2%	
County of Hawaii	24	1.8%	88.8%	9.4%	

Pavement Process Improvements

In addition, the HDOT continues to explore new and innovative ways to improve the pavement network and expedite project delivery. The pavement program is exploring the incorporation of a new PMS software, dTIMS, which will provide more functionality than the current modified BrM software.

The dTIMS software performs three core functions to produce an actionable multi-year treatment program: condition forecasting, treatment selection, and optimization. The following briefly describes these core functions:

1) <u>Condition Forecasting:</u> Predicting future pavement conditions is essential to scheduling multi-year maintenance activities and establishing budget requirements. Historic and current condition data are imported into dTIMS and are used to create deterioration models that predict future condition states over the life of the pavement. Understanding past, present, and future condition states, dTIMS determines (a) when typical maintenance treatments should be considered, (b) what life expectancy can be achieved, and (c) what impact particular treatments will have over the subsequent performance of the pavement.
2) <u>Treatment Selection:</u> dTIMS uses a treatment decision tree that determines when a pavement segment should be considered for a particular treatment. A list of potential life cycle maintenance strategies and alternative strategies is created for every pavement segment that is included in its inventory. Each strategy consists of maintenance activities such as preventative maintenance, rehabilitation, and reconstruction treatments. Table 7.1, in Chapter 7, lists the activity types that the HDOT uses as pavement treatment activities.
3) <u>Optimization:</u> A life cycle cost analysis is completed for each project section (that is, at a project level). Optimization is about optimizing the benefit of the network, which is commonly used to compare different strategies for maintaining and/or improving the pavement network (that is, at a network level). dTIMS considers all the HDOT pavement segments, each with various treatment strategies and benefits with varying annual budget constraints, to select the 'best' investment strategy for the HDOT pavement network.
4) <u>Risk and Resiliency:</u> With the dTIMS software, the HDOT will be able to assign up to 25 percent benefit/cost to risk. The 25 percent risk provides the opportunity to influence the project, which would allow the project to move higher up in the prioritized list, if the proposed treatment will address the risk. Examples of this risk or importance include whether the pavement is on a high volume or low volume road, is in front of a hospital, or is prone to flooding due to extreme weather. The proposed pavement treatment does not always address the risk or importance (that is, pavement in front of the hospital is not dependent on the pavement treatment). However, considerations such as saturated soil conditions can be addressed through programming and design where extreme weather and resiliency factors can be further implemented.

The HDOT Highways Division Material Testing and Research Branch (HWY-L) is also preparing a pavement manual and establishing new standards, with the use of new pavement types to help increase the life cycle benefit and costs. As time progresses, HWY-L will be able to better customize their deterioration rates and optimize their PMS.

HDOT Bridge Program

Hawaii Bridge Inventory

There are 1,124 total bridges on State and county roadways in Hawaii, of which 511 structures are on the NHS. A structure is considered to be a bridge (23 CFR 650 Subpart C –National Bridge Inspection Standards) if the following conditions are met:

- Is a structure including supports erected over a depression or an obstruction?
- Has a track or passageway for carrying traffic or other moving loads.
- Has an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring lines of arches or extreme ends of openings for multiple boxes.

The majority of bridges in Hawaii are predominately concrete girder structures, although a small number of the bridges were originally constructed for the sugar plantation railroads and are of steel trestle construction, which were later retrofitted to carry vehicular traffic. The HDOT also has a small number of wood bridges that are in the process of being replaced by concrete structures. The majority of bridges in Hawaii are over 50 years old. In comparison, the average bridge-structure age of bridges nationwide is 40 years.[3] With the large number of older bridges in Hawaii, the HDOT implements repairs and rehabilitation to extend the service life of bridges as much as possible. Bridge replacement projects are expensive and usually challenging, with environmental issues and limited redundancy or alternative routes.

In accordance with 23 CFR 650, Subpart D, the HDOT maintains a BMS that contains data for all state- and county-owned bridges in the state. The HDOT BMS is AASHTOWare BrM, which includes a programming module that meets FHWA requirements.

Data are collected from bridge inspection reports biannually using in-house forces or vendors. As recorded in the NBI, the HDOT determines and tracks structural condition and sufficiency ratings.

Bridge Conditions

The HDOT has adopted FHWA's bridge condition performance measures, as follows:

- Good condition (weighted by deck area)
- Fair condition (weighted by deck area)
- Poor condition (weighted by deck area)

The FHWA NBI standards for inspections are based on a minimum value rating for a bridge's three components: deck, superstructure, and substructure, as shown on Figure 3.7. The scale goes from 0 (worst) to 9 (best).

NBI Component Condition Rating Values:

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

[3] Transportation Research Board. 2009. Demographic Changes Drive Change. TR News 264.-September-October 2009. https://onlinepubs.trb.org/onlinepubs/trnews/trnews264.pdf.

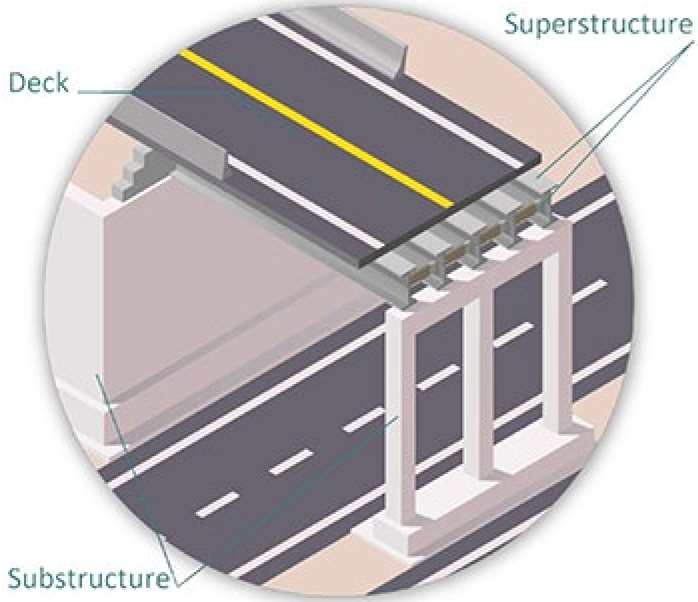


Figure 3.7. Bridge Components
Source: Caltrans Draft Transportation Asset Management Plan, October 2017

The FHWA has provided the following guidance for determining bridge condition:

- The lowest of the three ratings for deck, superstructure, and substructure determines the overall rating of the bridge as shown on Figure 3.8.
- A bridge is determined to be in poor condition when the minimum value of NBI deck, superstructure, and substructure is calculated and is considered to be in poor condition.

	Condition Rating Thresholds for Classification Type			
	NBI Rating Scale *(from 0 -9)*	9 8 7 Good	6 5 Fair	4 3 2 1 0 Poor
BRIDGE	Deck *(Item 58)*	≥ 7	5 or 6	≤ 4
BRIDGE	Superstructure *(Item 59)*	≥ 7	5 or 6	≤ 4
BRIDGE	Substructure *(Item 60)*	≥ 7	5 or 6	≤ 4

Figure 3.8. Bridge Condition Rating Thresholds
Source: FHWA 2017[4]

[4] Federal Highway Administration (FHWA). National Performance Management Measures; Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program. Final Rule. *Federal Register.* 82(11):5886-5970. https://www.govinfo.gov/content/pkg/FR-2017-01-18/pdf/2017-00550.pdf.

HDOT Bridge Management System (BMS)

To achieve and sustain a bridge inventory that is in alignment with the HDOT mission, the HDOT continues to employ and enhance its BMS. The HDOT's BMS is a strategic and systematic data-driven process that uses life cycle planning to move and keep its bridge assets in a state of good repair and other HDOT policy requirements. This process allows the HDOT to improve system preservation, safety, and resiliency, at minimum practicable cost.

Foundational to the HDOT's BMS being a data-driven process are its Bridge Inspection Program (BIP) and the AASHTOWare BrM BMS. Through the BIP, inspectors collect bridge inventory appraisal and condition data on a 24-month (or less) cycle. Subsequently, these data, along with inspection reports and other related bridge information, are processed and stored in BrM.

Using the condition and appraisal data available, each bridge in the HDOT's inventory is analyzed and assigned to a State of Good Repair subprogram and an action, if applicable, to restore or keep the bridge in a state of good repair. The subprograms and actions (that is, potential projects) assigned are the result of a benefit/cost analysis, which considers a bridge's life cycle phase and forecasted deterioration, as well as risk and resiliency, such as bridge element condition severity. Figure 3.9 illustrates the breakdown of the bridge subprograms.

As applicable, each bridge may also be assigned to the bridge Safety Restoration subprogram, which addresses safety-driven deficiencies, or to one or more of the Resiliency subprograms of Strengthening, Scour, and Seismic Retrofit. Bridges within these subprograms will also be assigned an action to address a safety or resiliency need.

Acknowledging similarities between the scope of potential projects and simplifying project prioritization, potential projects are grouped into Primary Actions. Primary Actions are prioritized considering bridge state of good repair, safety, and resiliency objectives. Within each Primary Action, potential projects are further prioritized considering community impacts such as average daily traffic and detour length and risks such as seismic vulnerability. The list of Primary Actions is shown in Figure 3.10.

Using the two levels of prioritization in the HDOT's BMS, projects are selected through an iterative process of running funding scenarios until all bridge state of good repair objectives and other HDOT policy requirements are met in the short- and long term. More information on the HDOT's BMS can be found in the *HDOT Bridge Asset Management Manual (BAMM)*.

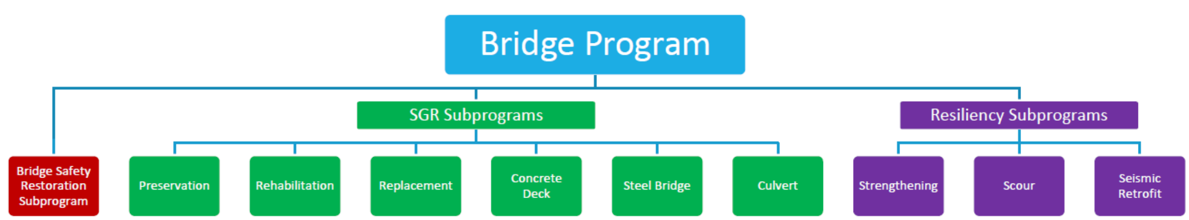


Figure 3.9. Bridge Subprograms

Primary Actions

1. Bridge Safety
2. Replacement
3. Rehabilitation – Structural Rehabilitation – Bridge
4. Rehabilitation – Structural Rehabilitation - Culvert
5. Preservation – Scour Repairs
6. Preservation – Steel Bridge – Rehabilitation & Painting
7. Preservation – Rehabilitation - Bridge
8. Preservation – Rehabilitation - Culvert
9. Preservation – Steel Bridge – Repairs & Painting
10. Preservation – Repairs – Bridge
11. Preservation – Repairs – Culvert
12. PM – Steel Bridge – Painting Restoration
13. PM – Concrete Deck – Overlay Restoration
14. Preservation – Scour Countermeasures
15. Preservation – Strengthening (Capacity-Driven)
16. Preservation – Seismic Retrofit (Capacity-Driven)

Figure 3.10. Primary Actions

Summary of NHS Bridge Conditions

Table 3.6 summarizes 2020 NHS bridge inventory and condition data by jurisdiction.

Table 3.6. 2020 NHS Bridge Inventory and Conditions

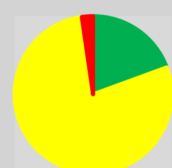
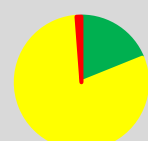
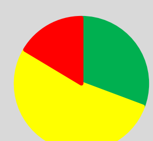
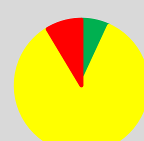
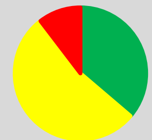
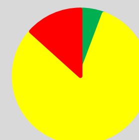
	Amount	Good	Fair	Poor	
All NHS					
NHS Bridges	511	19.4%	78.3%	2.3%	
By Jurisdiction					
Oahu District	361	18.9%	79.9%	1.2%	
Hawaii District	77	30.7%	52.9%	16.4%	
Maui District	39	6.9%	84.5%	8.6%	

Table 3.6. 2020 NHS Bridge Inventory and Conditions

	Amount	Good	Fair	Poor	
Kauai District	15	36.2%	53.4%	10.4%	
City and County of Honolulu	18	5.7%	81.0%	13.3%	
County of Hawaii	1	0%	100%	0%	

Bridges in poor condition require additional monitoring, maintenance, or repair to ensure safe and continued service. If a bridge is in poor condition, it does not mean that it is unsafe or will immediately collapse. With updated federal legislation, the FHWA requires that state DOTs maintain NHS bridges at less than 10 percent of the bridge deck area in poor condition. Table 3.7 provides a summary of the percentage of bridge deck area in poor condition for the last 5 years. Table 3.8 shows the number of bridges in poor condition for the last 5 years.

Table 3.7. Bridge Deck Area in Poor Condition

Network System	Year								
	2013	2014	2015	2016	2017	2018	2019	2020	2021
NHS - ALL	1.2%	1.2%	1.2%	1.2%	1.8%	2.0%	2.3%	2.3%	1.2%
Interstate	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Non-Interstate NHS	4.8%	4.9%	5.1%	5.2%	7.8%	8.4%	9.4%	9.2%	4.8%
Non-NHS	3.2%	3.7%	3.3%	3.4%	4.2%	4.5%	4.1%	3.7%	3.2%

Note: The values provided are based on the condition history of the HDOT’s inventory from the 2021 NBI data submittal.

Table 3.8. Number of Bridges in Poor Condition

Network System	Year								
	2013	2014	2015	2016	2017	2018	2019	2020	2021
NHS - ALL	22	21	22	23	30	31	31	35	22
Interstate	1	1	0	0	0	0	0	0	1
Non-Interstate NHS	21	20	22	23	30	31	31	35	21
Non-NHS	35	36	38	40	46	47	49	48	35

Note: The values provided are based on the condition history of the HDOT's inventory from the 2021 NBI data submittal.

The data show that bridge conditions on the NHS in Hawaii are well below the FHWA threshold of 10 percent of total deck area of bridges on the NHS classified as poor condition.

CHAPTER 4

Asset Management Performance Measures and Targets

A key component of asset management is using performance-based measures and targets to identify needed transportation improvements and monitor their effectiveness over time. To evaluate how well a project is performing, the transportation system is monitored and the results measured against the predetermined performance targets. Meeting these targets could mean that the implemented project was the appropriate one, and that there is value being gained from the dollars invested. If targets are not met, changes to the projects or priorities could be made to more effectively achieve the goal. Using these measures to assess roadway system performance after projects are implemented is an important part of the overall long-range planning process.

The performance management process, as illustrated on Figure 4.1, begins with shared goals and objectives, performance measures and targets for gauging progress, strategies for achieving the goals, and reporting to periodically assess and revise goals and objectives as needed.

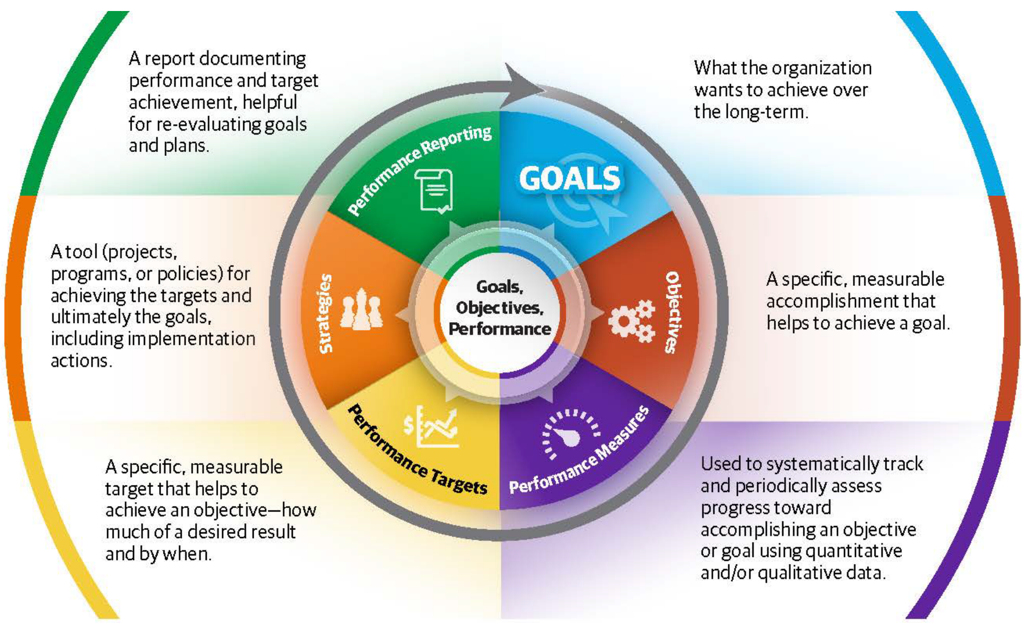


Figure 4.1. Performance Management Process

Long-range Planning Goals

Collectively, the long-range state, regional, and local plans guide the planning of Hawaii's transportation system and ultimately provide the basis for investment decisions in the system. As described in Chapter 2, these plans are developed within a consistent planning framework to ensure that the long-range planning process at the state and regional levels reflect the State's overall vision guiding future transportation investment decisions consistent with the HDOT mission and implementation of TAMP priorities.

HDOT Goal and Objectives

The overarching goal of the HDOT TAMP is to provide a process to achieve and sustain a state of good repair over the life cycle of the assets and to improve and preserve the condition of the state's transportation assets. As noted in Chapter 2, the HDOT's objectives are as follows:

- Implement plans and projects to support the transportation asset management process.
- Establish data governance and data collection standards.
- Facilitate coordination, collaboration, and knowledge transfer within the team.
- Communicate the transportation asset management activities to the executive levels of the HDOT.
- Pursue the solicitation and promotion of best practices.
- Promote transportation asset management benefits and uses throughout the HDOT, counties, and other external stakeholders.

Performance Measures and Targets

The FHWA requires TAMPs to include performance measures and targets for asset condition for pavements and bridges on the NHS. The performance measures are intended to fulfill HDOT's goal and objectives, carry out the National Highway Performance Program, and assess the condition, performance, effectiveness, and progress of the Federal-Aid Highway Program at a regional, state, and national level. Using the performance measures, states must define their desired state of good repair for the 10-year analysis period of the TAMP.

Table 4.1 presents the HDOT's performance measures and 10-year performance goals (desired state of good repair) for bridges and pavements on the NHS. The HDOT considered multiple risks and factors in its goal-setting, including the following:

- Existing inventory and conditions for all of the state's pavement and bridges
- Large number of older non-NHS bridges in the state's highway system that provide the only access to communities
- Other assets, such as drainage facilities, tunnels, highway lighting, signage, and traffic management facilities
- The needs of other programs (for example, capacity, congestion, bike and pedestrians, environment, and similar)
- Limited resources and funding
- Shifting administrative and legislative priorities
- Diverting funds for emergency events

As part of the performance management rule, MAP-21 and the FAST Act set minimum condition levels for NHS pavements and bridges. States are required to have no more than 5 percent of their interstate pavements in poor condition and no more than 10 percent of NHS bridges, by total deck area, in poor condition. The HDOT meets both of these minimum condition requirements.

Table 4.1. HDOT's Performance Measures and Performance Goals for NHS Pavements and Bridges

Asset	Performance Measure	Current Condition 2020	2-year Target 2024	4-year Target 2026	Performance Goal (Desired Condition) 10-year Goal
NHS Pavements	Percentage of pavements on the interstate in good condition	17.2%	15%	15%	20%
	Percentage of pavements on the interstate in poor condition	4.9%	4%	4%	4%
	Percentage of non-Interstate NHS pavements in good condition	26.1%	20%	20%	20%
	Percentage of non-Interstate NHS pavements in poor condition	2.8%	4%	4%	4%
NHS Bridges	Percentage of NHS bridges classified in good condition	19.4%	20%	20%	20%
	Percentage of NHS bridges classified in poor condition	2.3%	2%	2%	2%

State DOTs are also required to establish 2- and 4-year targets that serve as interim indicators of changes in condition levels. The targets can help states determine how well they are progressing towards its long-term state of good repair goals. Table 4.1 also reflects the 2- and 4-year targets. Chapters 7 and 8 further discuss how the HDOT selected these targets for this TAMP.

CHAPTER 5

Risk and Resiliency

Overview and Requirements

Overview

With the increased emphasis on performance-based planning and programming, it is even more important to manage risk. By managing risk and pursuing resiliency, agencies can achieve their goals, objectives, and targets. The purpose of risk management is to identify threats, followed by an assessment of likelihood and consequences, then develop response strategies to preemptively manage the risks and increase the possibility of the agency in being successful in meeting its goals and objectives.

The FHWA considers risk the positive or negative effects of uncertainty or variability upon agency objectives. Risk management generally consists of the cultures, processes, and structures that are directed towards the effective management of potential opportunities and threats. However, the FHWA recognizes that different agencies can use different definitions. The FHWA requires transportation agencies to consider risk as part of the strategic and systematic process of operating, maintaining, and improving physical assets and managing their highway network with a focus on the program and agency level. A risk-based plan can make tradeoffs based on risk. In addition, risk should be considered at a programmatic level and the project level to control cost, scope, and schedule.

Risk management enables agencies to thrive amidst uncertainty by being more understanding of and better poised to respond to the full range of possible outcomes—both threats and opportunities—that may impact the success of their organization.

State DOTs are required to establish a management plan that identifies risks to assets and the highway system, including those associated with current and future conditions, such as extreme weather events and climate change. The risk analysis also needs to account for roads and bridges that require repeated repair or reconstruction as a result of emergencies.

With the recently passed BIL, the TAMP is required to do the following:

- Clearly explain the processes used to consider the extreme weather and resilience within the risk management and life cycle planning sections of the TAMP
- Discuss how the investment strategies are influenced by the results of the risk management and life cycle planning analyses

The HDOT has recognized the importance of resiliency early on. As previously discussed in the HDOT 2019 TAMP, there are many challenges to Hawaii and its land transportation system because of its location in a tropical zone, predominant coastal environment, geologic and topographic factors, and geographic isolation.

Resiliency

The HDOT adopted a Resiliency Policy on June 18, 2021, that was developed to ensure that resilience measures are implemented into all HDOT Highway Division programs and projects to increase the resiliency of the highway system to existing and future risks. The focus of the policy is to adjust internal practices within the Highways Division to ensure that all decisions made include future-oriented designs and cost-effective investments that lead to a more resilient highway system. The directive applies to all operations and branches of the Highways Division, such as maintenance, construction, right-of-way, design, and planning, which will include actions that help achieve highway network resilience.

> *Resilience is a cross functional discipline that should be engrained in the project delivery process as a part of everyone's job, like safety, as it enhances asset management, sustainability, and the public's quality of life.*
> -Highways Division Resilience Policy

Statewide Coastal Highway Program Report

In 2017, the HDOT, in partnership with the University of Hawaii, worked to develop a scientifically rigorous method to assess and rank the susceptibility of the HDOT's coastal roads to erosion and structural degradation. The project team developed an evaluation methodology that considers all ocean hazards, such as waves, currents, tides, storm surges, and SLR. The purpose of the report was to identify and rank stretches of roadway, in a quantifiable way, that are in need of short- to mid-term remediation measures to prevent traffic interruptions and road closures during storm and hurricane events.

Through site visits, previous studies, and input from field staff, the final report offered a new, single index that considered the principal factors that cause coastal erosion and road degradation. The Coastal Road Erosion Susceptibility Index (CRESI) approach involves the characterization of coastal road locations using an index that reflects how likely the roadway will erode and structurally collapse. A similar index was developed by the HDOT to evaluate and rank roads susceptible to rock falls and soil slides. The CRESI is based on the concept that the width of the land between the road and the ocean acts as a buffer to erosion and controls how vulnerable a particular location is to structural road damage and collapse. A road further inland has a more significant buffer from damage than a road that is low and adjacent to the ocean. The following variables are used in the calculation of CRESI and are reflected on Figure 5.1:

- Beach geomorphology
- Coast geomorphology
- Erodible volume
- Slope
- Coastal ground cover and existing structures above ground
- Road base and subgrade conditions
- Armoring
- Rate of sea level change
- Shoreline accretion or erosion rate
- Mean tidal change
- Significant wave height

The 20 most critical road locations are reflected in the final report, and available the HDOT's website, [Statewide Coastal Highway Program Report (hawaii.gov)](). The report was prepared to address the FHWA requirement to provide a process in the TAMP to include extreme weather events and resiliency. As the Pavement and Bridge Program develops their prioritized list, they collaborate and coordinate improvements with the Shoreline Program to ensure that resiliency efforts are considered.

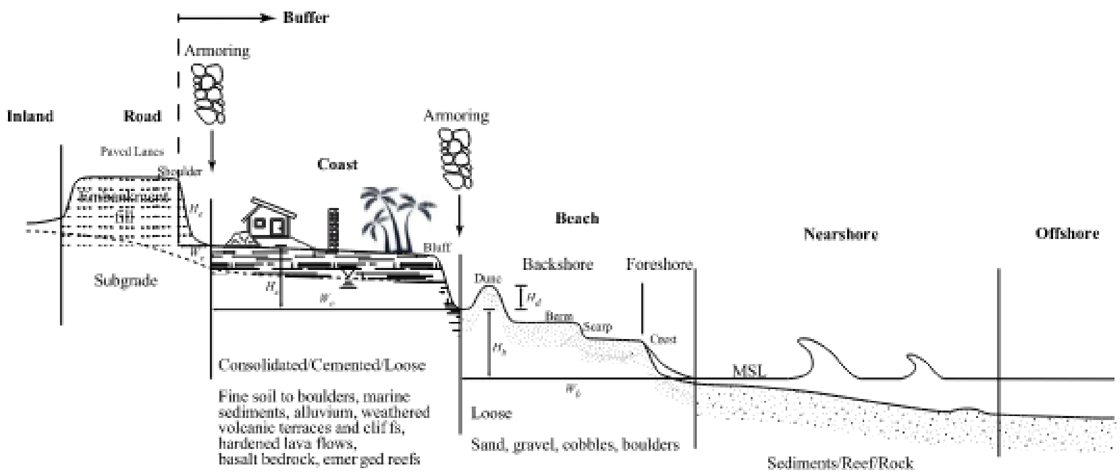
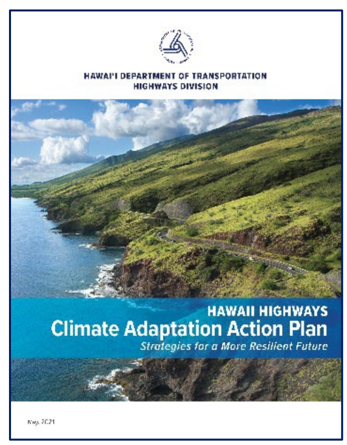


Figure 5.1. Generic Road to Ocean Cross Section
Source: State of Hawaii 2019[5]

Hawaii Highways Climate Adaptation Action Plan



Going further, the HDOT developed a Climate Adaptation Action Plan (CAP)[6] in 2021 to explore and ensure that they have the information required to minimize impacts and increase asset and system resiliency. The purpose of the CAP is to provide a roadmap for the HDOT to make the highway system more resilient to climate-related effects. The CAP identifies locations through an exposure assessment of climate hazards to the State's highways based on both historical and future climate condition research and data. The CAP then outlines strategies to be implemented and actions to be taken to incorporate resilience into its programs and policies. The multi-year implementation plan encompasses all aspects of HDOT's core functions – funding, planning, designing, constructing, operating, and maintaining.

Figure 5.2 shows the basic framework from the CAP that the HDOT is taking to achieve system resilience to continue to serve communities and businesses in the Hawaiian Islands. The process starts by looking forward at potential future risks to developing cost-effective investments and solutions.

[5] State of Hawaii. 2019. *Statewide Coastal Highway Program Report*. Prepared by Oceana Francis, Ph.D, P.E., Horst Brandes, Ph.D, P.E, Guohui Zhang, Ph.D, David Ma, Ph.D. August 21. https://hidot.hawaii.gov/highways/files/2019/09/State-of-Hawaii-Statewide-Coastal-Highway-Program-Report_Final_2019.pdf

[6] State of Hawaii Department of Transportation Highways Division. 2021. *Hawaii Highways Climate Adaptation Action Plan*. May. HDOT-Climate-Resilience-Action-Plan-and-Appendices-May-2021.pdf

Figure 5.2. Basic Framework for Achieving System Resilience
Source: HDOT 2021

Figure 5.3. Makaha Bridge No. 3

An example of how this framework is implemented within the TAMP and the HDOT's pavement and bridge programs is the Makaha Bridge Replacement Project No. 3 and No. 3A. Along Farrington Highway (Route 93) on the west side of the Island of Oahu, the Makaha bridges (Figure 5.3) were in need of replacement. Considering the location of the bridge within the identified exposure hazard, a standard bridge replacement in the same location would not be a wise investment. However, Farrington Highway provides the sole method of access to the communities on the west side, which must be maintained. Doing nothing is also not acceptable. The HDOT decided on the mid-term cost-effective solution of a replacement bridge with a 25- to 30-year design life versus the 75-year design standard. In the meantime, the HDOT can complete the necessary environmental studies and community outreach to pursue a permanent solution.

HDOT's Risk Management Process

Management of Risk

The HDOT uses a continuous cycle of risk management. Figure 5.4 shows the steps of the risk management cycle. The following pages describe each step in more detail.

A. Risk Identification – The identification and documentation of the material threats to the organization's achievement of its objectives and goals is accessed in Step 1. A risk matrix is developed for each identified risk, as shown in Table 5.1.

B. Analyzing, Quantifying & Assessing Risks – Identifying the probability and consequences of each risk occurs at Step 2.

C. Developing & Implementing Response Strategies – The formulation of methods and implementation measures to avoid, minimize, transfer (share), or mitigate risks at the organizational, programming, and project levels is completed at Step 3. This may include project prioritization or project-specific implementation considerations.

D. Risk Monitoring – Step 4 includes the continual measurement and monitoring of the risk strategies using a risk register.

Risk Identification and Levels of Risks

The HDOT knows that the identification of risk is the important first step. Management and consideration of the risks occurs at the following, multiple levels to be effective:

- A higher, organizational level
- The programming level
- The project implementation level

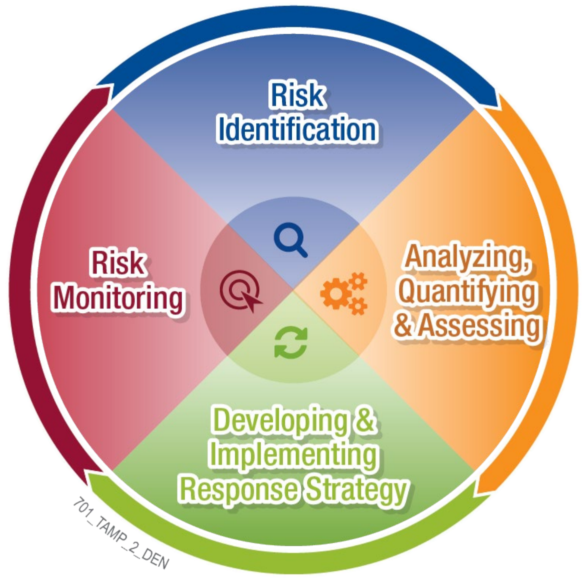


Figure 5.4. Risk Management Cycle

For example, for anticipated severe weather caused by climate change, at the global level, the HDOT implements updated design policies for certain facilities by using a larger design storm event (such as a 500-year event instead of 100-year). At the project selection and prioritization process (programming) stage, if it is recognized that a bridge structure is located in an area with repeated flooding history, that particular bridge may be given additional priority considerations within the BMS. Finally, when the project is designed, the HDOT may determine that using a larger design storm event or selecting a certain type of foundation (for example, using drilled shafts because of scour history) is appropriate given the identified risks for the structure. In addition, dependent on the bridge location, different design adaptation may also be implemented. Figure 5.5 illustrates this principle.

Figure 5.5. Levels of Risks, Management, and Response

This approach allows the HDOT to develop and address response measures to risks and foster resiliency at the appropriate levels. Risks related to asset management often faced by the HDOT include those noted in Table 5.1.

Table 5.1. HDOT Risks related to Asset Management

Risk Category	Risk Description	Organization	Program	Project
Hazard	Severe weather events (tropical storms, hurricanes, and tsunamis)	X	X	X
	Climate change and SLR	X	X	X
	Shoreline erosion	X	X	X
	Rockfall/slope stability	X	X	X
	Lava flows	X	X	X
	Earthquakes	X	X	X
Financial	Dependence on fuel tax revenues	X	X	
	Understanding of financial data to make appropriate TAMP planning decisions	X	X	
	Continuous short-term federal transportation bills or extensions	X	X	
	Renewable energy policies	X	X	
Organizational	Changes in administration or division priorities	X	X	
	HDOT and its partnering agencies staff shortage	X	X	
	Loss of organizational or departmental information as a result of HDOT and its partnering agencies' staff turnover and retirements	X	X	X
	Program prioritization	X	X	
Strategic	Maintenance policies	X	X	X
	Complexity and amount of environmental regulations	X	X	X
	Length of procurement	X	X	X
	Data management	X	X	X
	Lack of a variety of effective preventative practices and maintenance measures	X	X	
	Resistance to culture change and TAMP sustainment	X	X	X

After a risk has been identified (step 1), the probability or likelihood of the risk occurring is considered and the impact of each risk accessed (step 2). This information is inputted into a risk matrix, as shown in Table 5.2. Table 5.2 also includes the probability inputs and impact inputs. A risk matrix is developed for each identified risk. Following this approach, the highest priority risk would be almost certain to occur and have extreme consequences. The lowest priority risk would be rare and would have negligible consequences. This practice builds resiliency into HDOT programs and incorporates the appropriate response strategies.

Table 5.2. Risk Matrix

Probability						
	VH					
	H					
	M					
	L				X	
	VL					
		VL	L	M	H	VH
		Impact				

Risk Matrix - Probability Input		
VL	-	Some certainty it will occur within the next 20 years
L	-	Somewhat certain it may occur within the next 8 years
M	-	Likely to occur within the next 4 years
H	-	Currently occurring to some extent
VH	-	Occurring daily or almost certain to occur

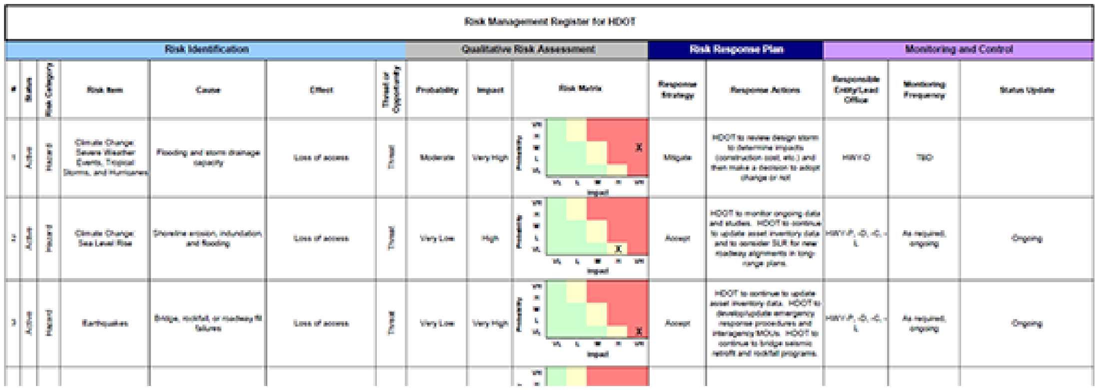
Risk Matrix - Impact Input		
VL	-	Little noticeable impact to the system; system minimally affected; little or no public awareness and pressure; most HDOT operational processes unaffected
L	-	Some noticeable impact to the system performance; some localized but noticeable difference in performance; general public complaints, but mostly accepts; HDOT operational processes slightly affected
M	-	Noticeable impact to the system performance; portions of system poorly performing; localized public complaints; some public awareness; some effect to operational processes
H	-	Large Impacts to the overall system performance; large portions of system poorly performing; public aware and concerned; widespread effect on operational processes
VH	-	Catastrophic to overall system performance; public safety and health severely compromised; widespread impact, loss of public trust and confidence; large segments of society and operational processes not functioning

Risk Response Strategies and Risk Monitoring

Strategies and mitigation for each risk are developed and placed in a risk register, similar to the sample shown on Figure 5.6. The risk register is used to do the following:

- Identify the risk (risk item, cause, and effect).
- Conduct a qualitative risk assessment (probability, impact, and risk matrix).
- Develop the risk response plan (response strategy and actions).
- Monitor and control (responsible office/lead, monitoring frequency, and status updates).

The risks are continually measured and monitored. The HDOT reviews the risk register annually or more frequently, as needed. The risk register inputs are shown in Table 5.3. The HDOT risk register for the TAMP is included in Appendix A.



Risk Management Register for HDOT															
Risk Identification							Qualitative Risk Assessment			Risk Response Plan		Monitoring and Control			
#	Status	Risk Category	Risk Item	Cause	Effect	Threat or Opportunity	Probability	Impact	Risk Matrix	Response Strategy	Response Actions	Responsible Entity/Lead Office	Monitoring Frequency	Status Update
1	Active	Hazard	Climate Change: Severe Weather Events, Tropical Storms, and Hurricanes	Flooding and storm drainage capacity	Loss of access	Threat	Moderate	Very High	X	Mitigate	HDOT to review design storm to determine impacts (construction cost, etc.) and then make a decision to adopt change or not	HWY-D	TBD	
2	Active	Hazard	Climate Change: Sea Level Rise	Shoreline erosion, inundation, and flooding	Loss of access	Threat	Very Low	High	X	Accept	HDOT to monitor ongoing data and studies. HDOT to continue to update asset inventory data and to consider SLR for new roadway alignments in long-range plans.	HWY-P, -D, -C, -L	As required, ongoing	Ongoing
3	Active	Hazard	Earthquakes	Bridge, rockfall, or roadway fill failures	Loss of access	Threat	Very Low	Very High	X	Accept	HDOT to continue to update asset inventory data. HDOT to develop/update emergency response procedures and interagency MOUs. HDOT to continue to bridge seismic retrofit and rockfall programs.	HWY-P, -D, -C, -L	As required, ongoing	Ongoing

Figure 5.6. Sample Risk Register

Table 5.3. Risk Register Inputs

Status	Active – risk strategy implemented or to be implemented Closed – risk item avoided or eliminated due to implementing strategy
Risk Category	Hazards – item related to climate, weather, and/or emergencies Financial – item related to budgeting and/or revenues involving federal, state, or other funds Organizational – item related to HDOT policy, processes, personnel, or culture Strategic – item related to data, program processes, operations, or similar
Matrix Reference	Reference number assigned to Risk Matrix developed for a particular risk Item
Response Strategy	Avoid – strategies to reduce or eliminate a risk Minimize – strategies to reduce or minimize the effects Transfer – strategies to transfer (or share) risk to other parties Mitigate – strategies to take acceptable actions to address risk, but may require additional resources Accept – accept that the risk will occur and develop strategies and/or opportunities to address the effects; typically associated with initiatives (such as Everyday Counts), where this may result in possible opportunities, but may affect schedules or cost
Lead Office	Office in HDOT that would be responsible to assess, develop response strategies lead, or participate in the implementation, and monitor effectiveness of implemented strategy

How Resiliency and Risk are Considered in Programming and Projects

Both the PMS and BMS actively consider a variety of risks and resiliency in their programming and prioritization of projects. Pavement projects have a shorter design life than bridges, so the approach to resiliency is different from the approach to bridges, where the design life is typically 75 to 100 years. As mentioned in Chapter 3, the PMS considers the proximity of the pavement to the exposure hazards during programming and design.

Resiliency solutions are addressed in collaboration with the Shoreline and Rockfall programs.

For the Bridge Program, the following resiliency policy was adopted:

HWY-DB Resiliency Policy:

1. **Key assumptions:**
    a. The *HDOT Climate Adaptation Action Plan*, dated May 2021, identifies "the 3.2 feet sea level rise (SLR) exposure area projected to occur in the State by the end of the century as one of the primary planning criteria for existing and future development". This policy regards "3.2 feet SLR by the end of the century" as implicit.
    b. Based on the 3.2 ft. SLR by the end of the century, the *Hawaii Sea Level Rise Vulnerability and Adaptation Report* determined that a 1.1 ft. sea level rise is expected by 2050.
    c. This policy considers the sea level rise effects on State of Hawaii bridges in the next 30 years and will assume 1.1 ft. SLR as its projection in the next 30 years.
    d. This policy does not apply to culverts.
2. **Determining which State of Hawaii bridges are subject to 1.1 ft. SLR.**
    a. The *HDOT Climate Adaptation Action Plan*, dated May 2021, Appendix B identifies the online Pacific Islands Ocean Observing System, 2020, Hawaii Sea Level Rise Viewer at: https://www.pacioos.hawaii.edu/shoreline/slr-hawaii/
    b. When using the 1.1 ft. SLR on the PACIOOS website, please note that the 1.1 ft. SLR overlay on State of Hawaii bridges also includes:
        i. Passive flooding which is for all islands.
        ii. Annual High Wave Flooding which is for only Oahu, Kauai and Maui
        iii. Coastal Erosion which is only for Oahu, Kauai and Maui
    c. Using PACIOOS, 1.1 ft. SLR shape files are overlaid over the State of Hawaii bridges in Google Earth. If the 1.1 ft. SLR covers the bridge area (highway approaches), the user should assume the 1.1 ft. SLR will inundate that bridge area *and you will have identified if a State of Hawaii bridge is subject to the 1.1 ft. SLR*. If the sea level rise appears to be limited to the stream area under the bridge, the user should assume the 1.1 ft. SLR will not inundate that bridge.
    d. Also, as mentioned below, the bridge's highway should be checked for "choke points" along the highway *which will also identify if a State of Hawaii bridge is subject to the 1.1 ft. SLR.*

Source: HWY-DB Bridge Program

The Bridge Program has an identified list of routes, locations, and bridges where portions of the highway are susceptible to the 1.1-foot SLR anticipated in 2050. The first alternative considered for any bridge that needs rehabilitation or replacement that is subject to 1.1-foot SLR is one that does not require the use of a temporary detour road or temporary detour bridge. Other considerations include replacing the existing bridge with a prefabricated steel bridge system that can be easily removed and replaced in the future until a longer-term solution for the highway route is determined (such as harden and remain in place or relocate).

After a project is selected for implementation, additional risks may be considered and either eliminated, minimized, or mitigated at the project level in design. Examples of such other risk-related concerns include maintenance history related to overtopping, scouring, over-height and over-weight vehicle movements, economic importance (for example, Sand Island Bridge, which is a significant freight route), and limited right-of-way.

Therefore, in addition to project identification and prioritization using asset condition and other technical factors within each management system, specific risks are recognized, and additional prioritization considerations are given in addition to the normal prioritization factors within the management system processes.

In addressing these organizational and program-level risks, and further considering project-specific risks, the HDOT is fulfilling the FHWA requirement to consider resiliency and risk in asset management.

Continued Risk Monitoring and Data Collection

After projects are constructed, the HDOT collects post-project data to confirm if unit cost estimates, and other assumptions were accurate. The data are also used to determine the effectiveness of resiliency and risk response measures incorporated in the projects. These data and inspection data provide the foundation for the Bridge and Pavement Management Systems to update asset inventories, forecasting models, and input into the applicable risk registers.

Dependent on the type of data, collection frequencies can be matched with normal cycles prescribed by federal requirements or existing or newly developed HDOT procedures, or as applicable upon completion of projects.

In special circumstances, the HDOT considers incorporating research studies as part of projects that may provide opportunities for alternative construction materials or methods that may be used for risk management responses. Collection of such data would be determined by procedures established in the research project.

Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction due to Emergency Events

As part of the federal requirements, state DOTs are required to identify roads and bridges that require repeated repair or reconstruction as a result of emergencies. The rule is designed to ensure that state transportation asset management plans are truly risk-based, as required by MAP-21, by ensuring that states have the information required to minimize impacts and increase asset and system resiliency.

As defined by 23 CFR 667.3, *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.

In 2019, the HDOT conducted a statewide evaluation of all emergency events dating back to January 1997. Using an iterative process, the HDOT cross-referenced the 33 Federal Emergency Management Agency (FEMA) events between January 1997 and May 2019 and 60 State Proclamations between January 1997 and May 2019 with emergency projects that identified work on a road, highway, or bridge with reconstruction elements (permanent repair). Not every emergency event caused permanent damage to the transportation assets. Emergency repairs that minimized the extent of the damage, protected the remaining facilities, or helped to restore essential traffic were not included (23 CFR 668.103). In the 2019 TAMP, 19 locations were identified; there was no transportation asset that had been replaced or reconstructed on two or more occasions as a result of an emergency event.

As required by 23 CFR 667, as of November 23, 2020, the HDOT has included all roads, highways, and bridges in the evaluation, and additional locations were added to the updated summary of emergency events and transportation assets affected. The statewide evaluation must be updated every 4 years and its results must be considered in the TAMP updates and preparation of the STIP. The updated summary of the emergency events and transportation assets affected is provided in Appendix B.

For this TAMP update, the following two locations have received emergency funding on at least two occasions for similar events:

- Route 56, Kuhio Highway, Wailua Bridge, Milepost 5.8: Scour repairs near the piers and footings
- Route 560, Kuhio Highway, Milepost 4.43: Landslide repairs.

A summary of each event is provided in Appendix B.

The Construction Branch maintains a log of all emergency repairs and events. All project managers are required to check the log before their project is submitted to the MRTP and the STIP.

CHAPTER 6

Financial Plan

The purpose of the TAMP financial plan is to create a link between performance targets and project prioritization and funding. The financial plan summarizes current revenue sources, trends, and projections, estimates funding needs, and identifies potential funding needs, and potential funding gaps.

Financial Plan Process

The HDOT uses the following steps to develop its financial plan:

A. **Identify Available Revenue.** The first step in TAMP financial planning is to identify what sources of revenue are available for asset management. In addition, the amount of annual funding available for asset management for the duration of the TAMP needs to be estimated.

B. **Estimate Funding Needs.** In the TAMP financial plan, funding needs are generally described as the amount of money needed in each year of the TAMP period to implement the asset strategies recommended by the life cycle planning, to manage risks, and to address other performance gaps detailed in the TAMP. Estimating the funding needs is not as straightforward as projecting revenue because the funding needs is also dependent on condition targets that the HDOT has selected.

C. **Quantify Funding Gaps.** In Step 3, the results of the revenue projections of Step 1 and the funding needs analysis of Step 2 will be compared. The results of this analysis will indicate if the project annual funding levels are sufficient to achieve the condition targets and mitigate risks and identify whether there is a funding gap or funding surplus.

D. **Selecting an Investment Strategy.** Selecting an investment strategy is an iterative process. If a funding gap is identified, the HDOT will need to conduct a cross-asset (trade-off) analysis. This gap can be addressed in several ways, such as increasing the level of funding, redistributing funding from other programs to asset management, lowering the condition targets, changing life cycle planning strategies, or modifying the HDOT's resiliency and risk mitigation approach and level of tolerance.

Financial Analysis

The following sections are a summary of the recent financial forecast of the Highways Division that was conducted by the HDOT Statewide Transportation Planning Office for the 2045 HSTP.

State Revenue Sources

The HDOT collects revenues from multiple sources in the form of taxes, fees, and surcharges to fund the operating and capital costs. These sources include charges for services, taxes, grants, and proceeds from highway revenue bonds issued by the Highways Division. For the 5-year period from fiscal year (FY) 2016 to FY 2020, the average operating revenues (including operating grants) was $367 million, and the average amount for capital grants was $115 million. Revenues are deposited into the State Highway Fund and are used for the design, construction, repair, and maintenance of the public highways. Figure 6.1 summarizes the Highway Division's revenue and funding sources.

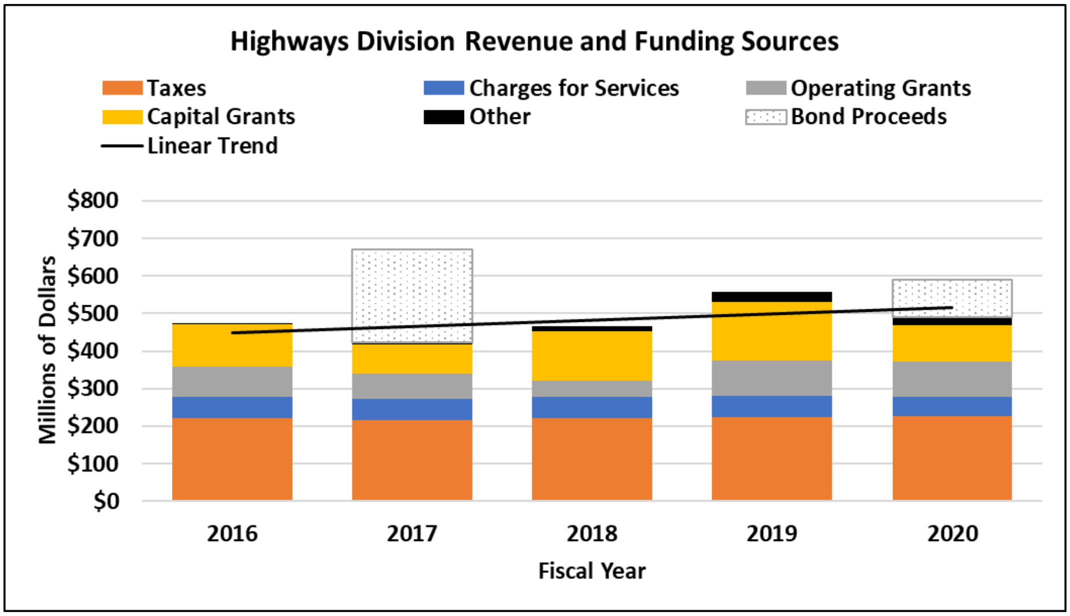


Figure 6.1. State Revenue Resources (millions of dollars)

Charges for Services

Table 6.1 summarizes the revenue items for charges for services. The largest portion includes registration fees and includes revenues generated from annual vehicle registrations. As of June 30, 2020, the vehicle registration fee was $45 per vehicle and the motor carrier safety inspection was $1.50 per vehicle.

Table 6.1. Highways Division: Charges for Services, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020
Vehicle registration fees	$45.0	$45.0	$46.7	$45.9	$42.8
Other fees and permits	$3.2	$3.1	$3.4	$3.2	$3.3
Penalties and fines	$5.6	$5.2	$5.7	$4.7	$3.6
Rentals	$1.4	$1.3	$1.2	$1.1	$1.0
Charges for services	**$55.2**	**$54.6**	**$57.0**	**$54.9**	**$50.7**
Annual percent change	N/A	-1%	4%	-4%	-8%

Source: Financial statements for HDOT Highways FY 2016 to FY 2020

Note: N/A = not applicable

Taxes

Table 6.2 summarizes the revenue items for taxes related to highways, including the state liquid fuel tax, vehicle weight tax, and surcharge tax for rental motor and tour vehicles. Annually, these taxes generate approximately $227 million. As of June 30, 2020, the state liquid fuel tax includes the following items:

- Gasoline: $0.16 per gallon
- Diesel Fuel: Non-highway use, $0.01 per gallon
- Diesel Fuel: Highway use, $0.16 per gallon
- Liquified petroleum gas: $0.52 per gallon

The vehicle weight tax ranged from $0.0175 to $0.0225 per pound of the net vehicle weight and is capped at $300 per vehicle. During FY 2018, the rental motor surcharge tax was $3 per day. In FY 2020, the rental motor surcharge tax increased to $5 per day for the rental. Effective January 1, 2022, the rate increased to $5.50 per day for rentals. During FY 2018, the tour vehicles surcharge was $65 per month for vehicles categorized as 25 or more passengers and $15 per month for vehicles categorized 8 to 25 passengers. In FY 2019, the tour vehicles surcharge was increased to $66 per month for vehicles categorized as 25 or more passengers and $16 per month for vehicles categorized 8 to 25 passengers. There is also a car-sharing vehicle surcharge tax of $0.25 per half-hour for rentals by car-sharing organizations.

Table 6.2. Highways Division: Taxes, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020
State liquid fuel tax	$87.8	$83.0	$83.2	$83.5	$77.3
Vehicle weights taxes and penalties	$79.5	$80.6	$83.9	$83.1	$77.4
Rental motor and tour vehicle surcharge tax	$54.9	$53.2	$54.8	$58.0	$72.5
Taxes	$222.2	$216.8	$222.0	$224.6	$227.2
Annual percent change	N/A	-2%	2%	1%	1%

Source: Financial statements for HDOT Highways FY 2016 to FY 2020

Operating and Capital Grants

The FHWA provides operating and capital grants for the maintenance and construction of public highways. These grants require a matching share and funds are provided on a reimbursement basis. The annual grant funding changes year over year due to maintenance and construction activity. Capital grant funds, mostly related to FHWA programs, are deposited into the Capital Project Fund. Operating grant funds are deposited into the State Highway Fund. Table 6.3 summarizes the disbursement of grants funds based on the single audit documents for the Highways Division.

Table 6.3. Highways Operating and Capital Grants, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020
Operating Grants	$82.2	$68.5	$42.5	$95.6	$93.3
Capital Grants	$112.9	$79.1	$130.9	$155.8	$96.7
Grants	$195.1	$147.6	$173.4	$251.4	$190.0
Annual Percent Change	N/A	-24%	18%	45%	-24%

Source: Financial statements for HDOT Highways FY 2016 to FY 2020

The operating and capital grants for highways are derived from FHWA programs. Table 6.4 summarizes the FHWA grant funding provided to Hawaii from 2016 to 2021. During this period, the average apportionment was $180.2 million per year. In 2021, FHWA updated apportionments to states resulting from the Infrastructure Investment and Jobs Act (IIJA). Table 6.5 summarizes the estimated apportionments for FY 2022 to FY 2026.

The apportionments presented in Table 6.4 and Table 6.5 reflect what is available to the state of Hawaii. It is possible that actual spending on projects and reimbursements from FHWA do not track the annual amounts shown. For purposes of the 2045 HSTP financial analysis, it is assumed 25 percent is allocated to cities and counties and 75 percent is allocated to the State. It is also assumed that the State allocation is split between operations (40 percent) and capital (60 percent) based on historical data provided in highway fund annual reports.

Table 6.4. State of Hawaii Allocation of FHWA Apportionments, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020	2021
National Highway Performance Program	$96.0	$98.2	$100.0	$102.1	$104.2	$103.0
Surface Transportation Block Grant Program	48.0	49.1	50.2	51.1	52.2	51.6
Highway Safety Improvement Program	9.4	9.6	9.8	10.0	10.2	10.0
Railway - Highway Crossings Program	1.1	1.2	1.2	1.2	1.2	1.2
Congestion Mitigation and Air Quality Improvement (CMAQ) Program	10.3	10.5	10.7	10.9	11.2	11.0
Metropolitan Planning	1.7	1.8	1.8	1.9	1.9	1.9
National Freight Program	4.9	4.7	5.1	5.8	6.4	6.3
Apportioned Total	$171.6	$175.1	$178.9	$182.9	$187.3	$185.2

Source: HDOT Highways Division and FHWA

Table 6.5. State of Hawaii Allocation of FHWA Apportionments, FY 2022 to FY 2026 (millions of dollars)

Fiscal Year	2022	2023	2024	2025	2026
National Highway Performance Program	$ 120.9	$ 123.3	$ 125.8	$ 128.3	$ 130.9
Surface Transportation Block Grant Program	58.8	60.0	61.2	62.4	63.7
Highway Safety Improvement Program	12.5	12.8	13.0	13.3	13.6
Railway - Highway Crossings Program	1.2	1.2	1.2	1.2	1.2
CMAQ Program	11.3	11.5	11.7	12.0	12.2
Metropolitan Planning	2.3	2.4	2.4	2.4	2.5
National Freight Program	5.9	6.0	6.1	6.2	6.3
Carbon Reduction Program	5.2	5.3	5.5	5.6	5.7
PROTECT formula Program	6.0	6.1	6.2	6.3	6.5
Total	$ 224.1	$ 228.6	$ 233.1	$ 237.8	$ 242.5

Source: HDOT Highways Division

Highway Revenue Bonds

On occasion, the HDOT Highways Division will issue highway revenue bonds to fund construction projects, with the bond proceeds deposited into the Capital Projects Fund (Table 6.6). During FY 2016, the Highways Division issued Series 2016A for $103,395,000 at a premium of $17,107,039 amortized over the life of the bonds. The Highways Division also refunded outstanding amounts for Series 2008 and Series 2011A by issuing Series 2016B for $101,090,000. During FY 2019, the Highways Division issued Series 2019A for $81,835,000. In 2021, the Highways Division issued Series 2021 for $137,205,000 at a premium of $43,908,935 amortized over the life of the bonds. The proceeds from the Series 2016A, Series 2019A, and Series 2021A bonds were used for construction of capital projects. The net proceeds for Series 2016B were used to purchase U.S. Treasury Securities to fund the debt service on the unrefunded portions of Series 2008 and Series 2011A bonds. The annual debt service on outstanding highway revenue bonds is discussed further under Operating Expenses.

Table 6.6. Highway Revenue Bonds, FY 2016 to FY 2021 (millions of dollars)

Fiscal Year	2017	2020	2021
New Money	N/A	N/A	N/A
Series 2016A	$103.4	N/A	N/A
Series 2019	N/A	$81.8	N/A
Series 2021	N/A	N/A	$137.2
Refunding	N/A	N/A	N/A
Series 2016B	$101.1	N/A	N/A
Highway Revenue Bonds	$231.5	$81.8	$137.2

Sources:
FY 2020 Financial Statement for HDOT Highways
Official Statement for State of Hawaii Highway Revenue Bonds, Series 2021

Operating Expenses

Over the past 5 years (FY 2016 to FY 2020), on average the annual operating expenses have been approximately $307 million. Figure 6.2 and Table 6.7 summarize the annual operating expenses. While the annual amount has fluctuated during this period, there has been a slight increase, a compound annual growth rate of 2.5 percent. The Highways Division's audit report attributes the decrease in FY 2018 compared to FY 2017 to a lower payroll as a result of staff vacancies. The operating costs for the Highways Division are categorized in the annual audit reports as follows:

- Operations and maintenance
- Motor Vehicle Safety Office
- Surcharges on gross receipts
- Administration of Highways Division

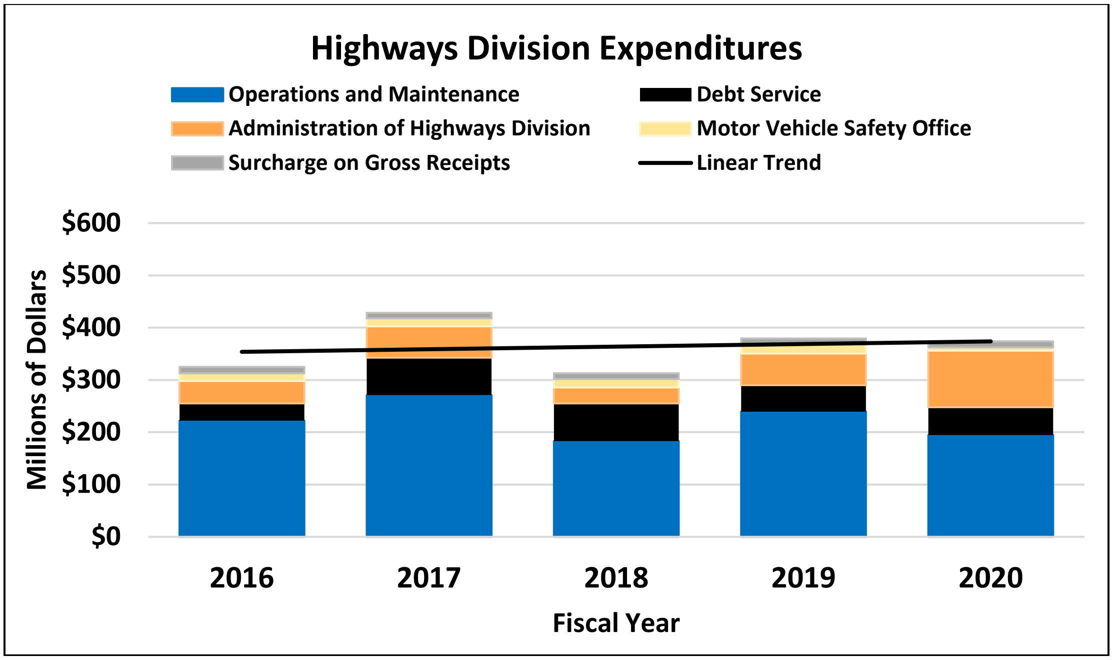


Figure 6.2. Highways Division Operating Expenditures

Operations and Maintenance

Highways Division operations and maintenance expense is the largest component of operating expenses. Table 6.7 summarizes the annual operations and maintenance for the past 5 years, organized by island. Operations and maintenance accounts for approximately 72 percent of annual operating expenses.

Motor Vehicle Safety Office

The Motor Vehicle Safety Office oversees highway vehicle safety and was established as part of the Hawaii Highway Safety Act in 1967 and reorganized in 1977 to include heavy motor vehicles. The Motor Vehicle Safety Office accounts for approximately 5 percent of the annual operating expenses.

Surcharge on Gross Receipts

To recover expenses for shared central services among government agencies, the State of Hawaii assesses a 5 percent surcharge on all receipts of the State Highway Fund. The surcharge on gross receipts accounts for approximately 4 percent of the annual operating expenses.

Administration of Highways Division

Similar to the surcharge on gross receipts, the HDOT Highways Division is assessed a percentage of the costs for general administration. Assessments account for approximately 19 percent of the annual operating expenses.

Table 6.7. Highway Operating Expenses, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020
Oahu highways and services	$99.5	$154.2	$109.8	$93.2	$92.1
Kauai highways and services	18.1	22.5	16.0	53.6	20.0
Maui highways and services	25.9	23.5	22.2	45.5	17.8
Hawaii highways and services	22.9	28.0	16.0	12.8	28.1
Molokai highways and services	7.1	5.6	2.1	5.6	2.4
Lanai highways and services	0.5	3.3	0.6	0.3	0.6
Pass through for County highways and services	48.0	33.7	16.3	28.4	33.9
Operations and maintenance	222.0	270.9	183.0	239.3	194.8
Administration of Highways Division	42.7	59.7	30.7	60.4	108.4
Motor Vehicle Safety Office	14.5	15.6	15.4	16.9	6.2
Surcharge on gross receipts	12.1	10.0	11.1	11.7	11.6
Total operating	291.3	356.2	240.2	328.4	321.0
Annual percent change	N/A	22%	-33%	37%	-2%

Source: Financial statements for HDOT Highways FY 2016 to FY 2020

Debt Service

As of June 30, 2020, there was approximately $431 million in highway revenue bonds outstanding, net of unamortized premium and principal payment for FY 2020. Table 6.8 summarizes the amount of highway revenue bonds outstanding. Figure 6.3 summarizes the annual debt service for the past 5 years for the outstanding obligations identified in Table 6.8. Assuming no other highway revenue bonds are issued during the 25-year period from FY 2021 to FY 2045, the outstanding bonds will mature in 2041. The projected debt service for the outstanding obligations identified in Table 6.8 is summarized in Figure 6.4.

Table 6.8. Highway Revenue Bonds Outstanding, FY 2016 to FY 2020 (millions of dollars)

Highway Revenue Bond Series	Maturity (July 1)	Outstanding Amount
2005B	2021	$12.6
2011	2032	$42.7
2014	2034	$103.5
2016	2036	$190.9
2019A	2040	$81.8
2021A	2027 to 2041	$137.2
	Total	$568.7

Sources:
FY 2020 Financial Statement for HDOT Highways
Official Statement for State of Hawaii Highway Revenue Bonds, Series 2021

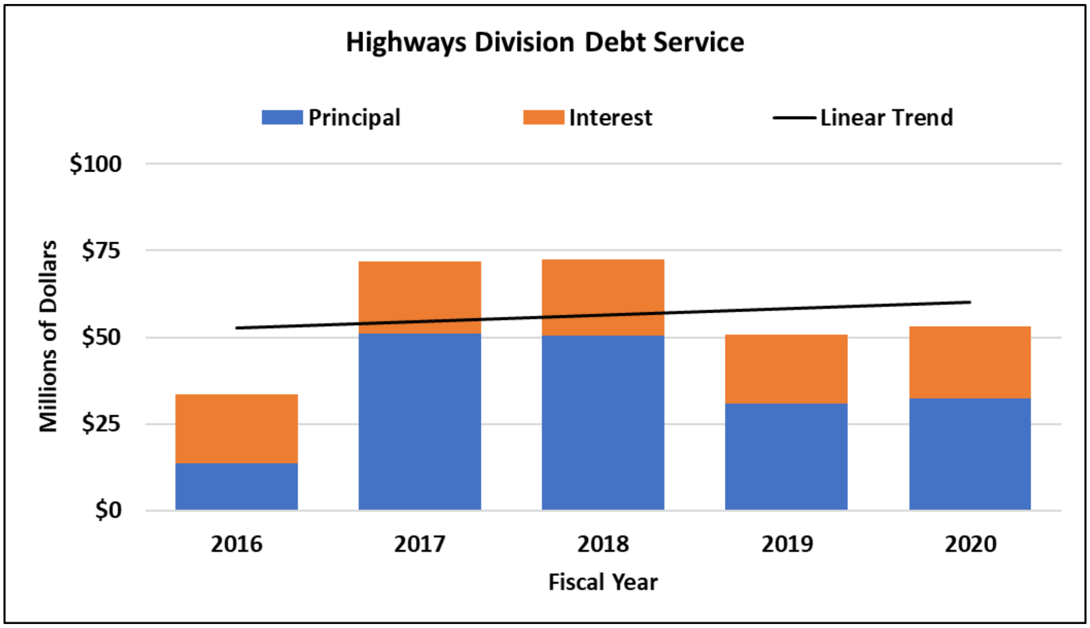


Figure 6.3. Highways Division Debt Service

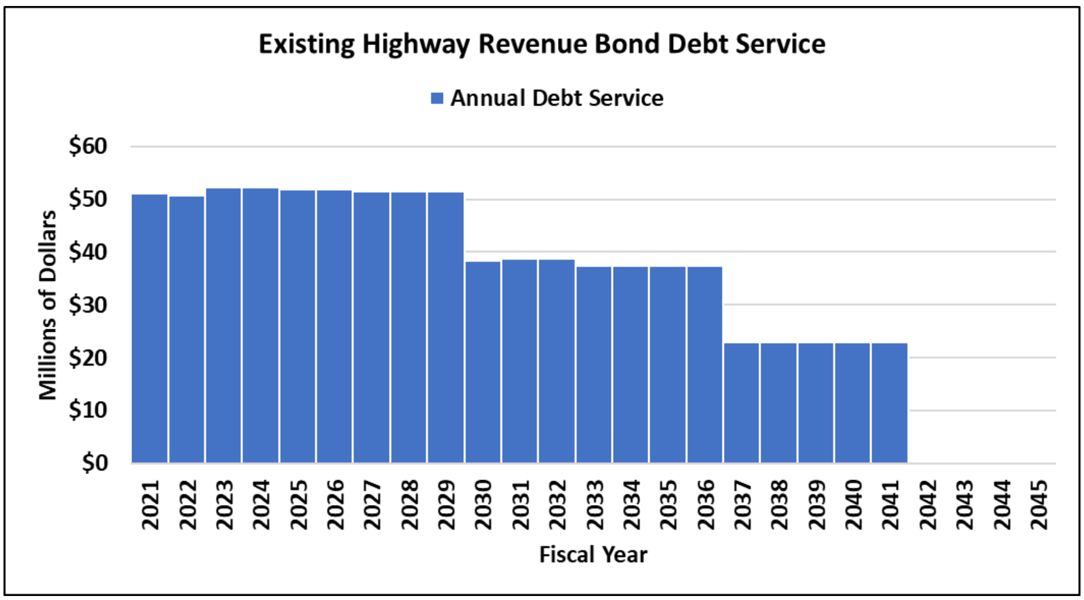


Figure 6.4. Existing Highway Revenue Bond Debt Service for Currently Outstanding Bonds

Capital Project Costs

Based on HDOT budgets for the Highways Division, Figure 6.5 summarizes the historical annual capital budgets amounts by category. The actual capital expenditure may differ from the budgeted amounts, but this summary provides approximate annual capital needs. The budget documents identify funding sources to include capital grants, highway revenue bonds, and the State Highway Fund. Table 6.9 summarize the CIP budget for FY 2016 to FY 2020. It is important to note that this is for planning purposes and may not reflect actual activity, including use of bonds. This table is provided for reference and helps identify a starting point for projections.

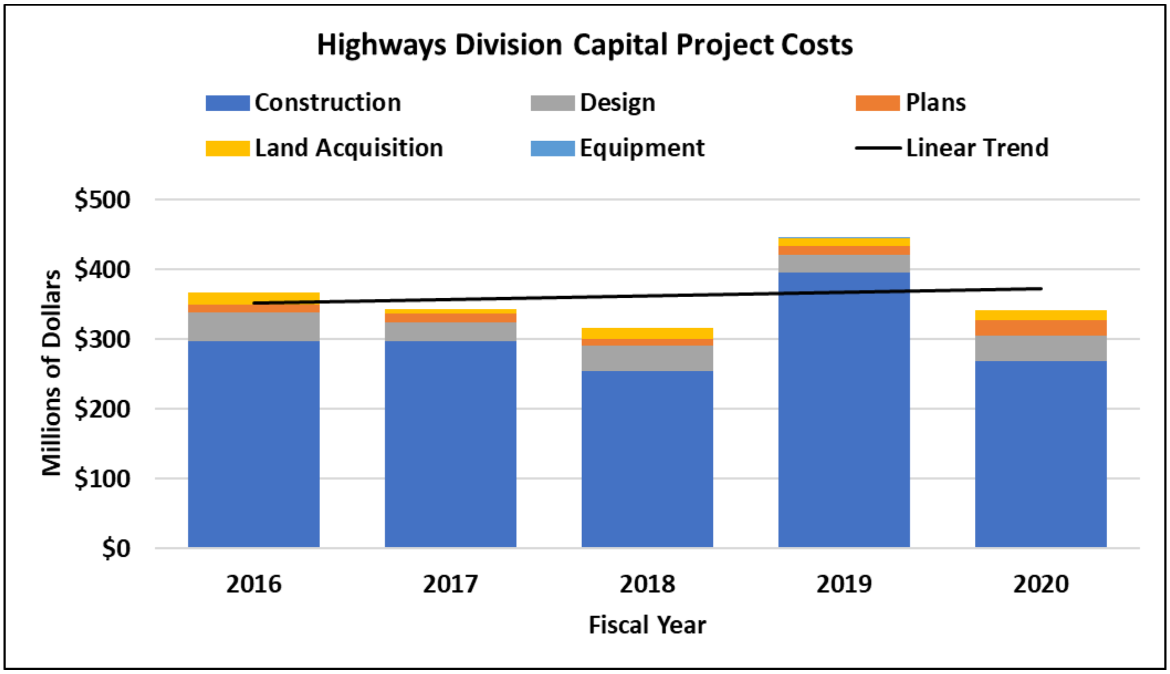


Figure 6.5. Highways Division Capital Budget, FY 2016 to FY 2020

Table 6.9. Highways Division CIP Budgets, FY 2016 to FY 2020 (millions of dollars)

Fiscal Year	2016	2017	2018	2019	2020
Use of Funds [a]					
Plans	$12.1	$12.9	$9.7	$12.7	$23.3
Land Acquisition	$17.3	$5.9	$15.4	$10.6	$13.2
Design	$41.3	$26.9	$35.8	$25.3	$35.8
Construction	$296.5	$297.5	$255.0	$395.9	$268.9
Equipment	N/A	N/A	N/A	$1.0	N/A
Total Uses	$367.2	$343.2	$316.0	$445.5	$341.3
Sources of Funds					
Capital Grants [b]	$112.9	$79.1	$130.9	$155.8	$96.7
Special Fund, Bonds and Other [c]	$254.4	$264.1	$185.1	$289.7	$244.6
Total Sources	$367.2	$343.2	$316.0	$445.5	$341.3

[a] Based on HDOT Budgets FB17-19, FB19-21, FB21-23

[b] Based on HDOT Highways Division Financial Statements FY 2016 to FY 2020

[c] Difference Between Total Uses And Capital Grants

Financial Forecast

25-Year Forecast

A financial forecast of the HDOT Highway Division was prepared as part of the 2045 HSTP, which includes projections for the 25-year study period FY 2021 to FY 2045. As a starting point, the audited financial reports for FY 2016 to FY 2020 were used to analyze historical revenues and expenditures from the Highways Division. For FY 2021 to FY 2023, the biennial budget (FB21-23) was used. Figure 6.6 summaries the revenues and expenditures for the study period (2021 to 2045). The revenues include charges for services, taxes, grants, other income, and is net of transfers. The expenditures include operations and maintenance, administration, Motor Vehicle Safety Office, and surcharge on gross receipts. Debt service includes existing schedules for outstanding obligation, as well as projected debt service for assumed future bond issuances. Based on feedback provided by the Highways Division, bonds are issued every other year. Projected CIP costs (gross) were calculated based on the 3-year trailing average. As shown on Figure 6.6 and tabulated in Table 6.10, the area between the black line and top of the bars is the assumed funding gap; the cumulative funding gap over the forecast period is estimated to be $5.9 billion, with an annual average funding gap of $237 million.

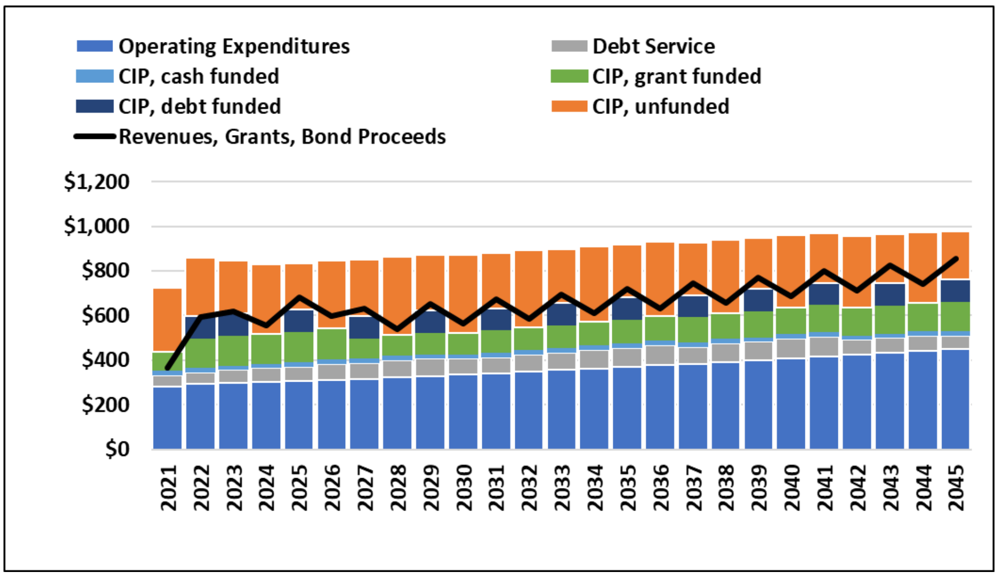


Figure 6.6. 25-Year Financial Forecast

Table 6.10. 25-Year Financial Forecast (Millions of Dollars)

Fiscal Year	Revenues, Grants, Bond Proceeds ($)	O&M, Debt Service & CIP ($)	Funding gap ($)	Cumulative Funding Gap ($)
2021	366.4	723.3	356.9	356.9
2022	591.4	858.5	267.2	624.1
2023	620.1	847.9	227.8	852.0
2024	556.7	829.5	272.7	1,124.7
2025	683.7	835.2	151.5	1,276.2
2026	598.2	847.8	249.6	1,525.8
2027	629.7	851.2	221.6	1,747.4
2028	540.2	864.3	324.1	2,071.5
2029	650.9	870.7	219.8	2,291.2
2030	561.9	871.0	309.1	2,600.3
2031	673.1	878.0	204.9	2,805.2
2032	584.5	891.5	307.0	3,112.3
2033	696.1	897.2	201.0	3,313.3
2034	608.0	911.0	303.0	3,616.3
2035	720.1	918.2	198.1	3,814.4
2036	632.4	932.3	299.9	4,114.3
2037	745.0	925.3	180.3	4,294.6
2038	657.9	939.8	281.9	4,576.4
2039	771.0	947.6	176.6	4,753.0
2040	684.4	962.3	277.9	5,031.0
2041	798.0	970.4	172.4	5,203.4
2042	711.9	955.1	243.2	5,446.6
2043	826.1	963.6	137.5	5,584.0
2044	740.6	973.6	233.1	5,817.1
2045	855.3	975.7	120.4	5,937.5

Funding Needs and Gaps

Although a funding gap remains in the forecast year of 2032, the Highways Division is committed to prioritizing system preservation needs. There is an anticipated $584.5 million in revenue and $891.5 in operations and maintenance, debt service, and capital improvement project expenses. The projected $307 million gap will likely delay implementation of some of the capital improvement projects, but the Highways Division administration has made a commitment to fund the System Preservation Program and meet the NHS pavement and bridge targets. Figure 6.7 represents current breakdown of funding per program in the current STIP. As reflected, there is a significant commitment to system preservation and the necessary funding to meet the NHS pavement and bridge targets so there is no performance gap.

In the meantime, the HDOT continues to explore sustainable funding solutions that allow Hawaii's economy and communities to achieve their goals. Through the HDOT's implementation of its mid-range transportation plan and prioritization of projects, project managers are better able to plan and deliver projects. In addition, the HDOT has been exploring ways to more efficiently contract and deliver their projects in a timely manner. In combination with the update of their 20-year Statewide Long-Range Land Transportation Plan, which will include a comprehensive review of the State's transportation needs and capital improvement program, the HDOT will be able to better make more data-driven decisions and more efficiently prioritize and deliver their projects to help reduce and eliminate the overall transportation system the funding gap.

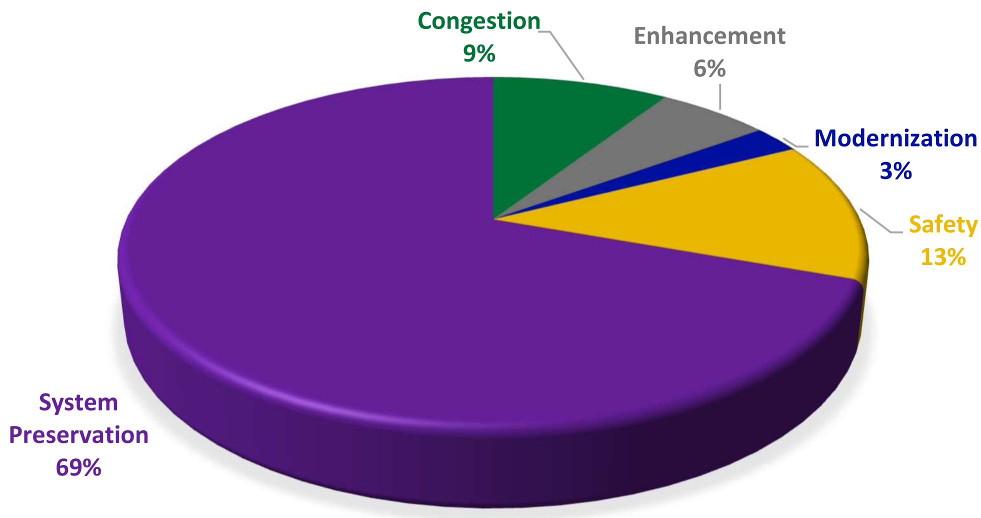


Figure 6.7. HDOT Expenditures by Program in FY 2019-22 STIP

Summary Valuation of NHS Assets

FHWA requires an estimate of the asset value for bridges and pavements on the NHS be included in the TAMP. This asset valuation is summarized in Table 6.11.

Table 6.11. Summary of Inventory and Asset Value of NHS Pavement and Bridge Assets

National Highway System Asset	Count	2021 Asset Value
Bridges	12.1 million square feet (deck area)	$2.6 billion
Interstate Pavements	317 lane-miles	$2.4 billion
Non-Interstate Pavements	1,179 lane-miles	$4.9 billion
Total	**-**	**$9.9 billion**

Source: HDOT Highways Division Fiscal Office

Asset value is recorded at estimated historical cost and does not take into account maintenance or rehabilitation. Therefore, replacement value is often more meaningful when analyzing future costs. The replacement values of NHS pavement and bridge assets are summarized in Table 6.12.

Table 6.12. Replacement Value of NHS Pavement and Bridge Assets

National Highway System Asset	Count	Unit Replacement Cost	Current Replacement Value
Interstate Bridges	9.1 million square feet (deck area)	$8,000/ square foot	$72.8 billion
Non-Interstate Bridges	3.0 million square feet (deck area)	$6,000/ square foot	$18.0 billion
Pavements	739 centerline miles	$5 million/centerline mile	$3.7 billion
Total			**$94.5 billion**

CHAPTER 7

Life Cycle Planning

Life cycle planning is an integral part of the TAMP approach and can be applied to any highway asset that relies on maintenance and perseveration activities to cost-effectively extend its service life. Life cycle planning is performed at the network level, where the needs of all assets in a system are considered over a specified period. The general stages of an asset life cycle are shown on Figure 7.1.

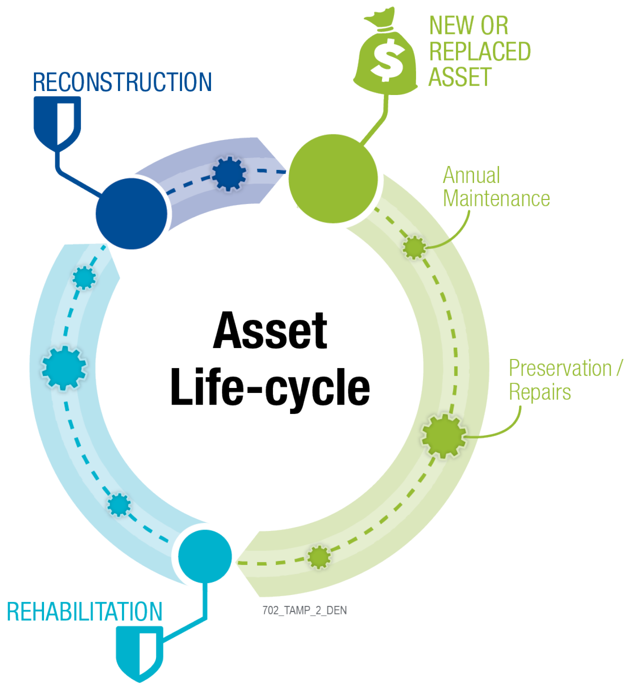


Figure 7.1. Stages of an Asset Life Cycle

Life cycle planning saves money. It helps to achieve the lowest practical cost for improving and preserving the HDOT's transportation assets.

Life cycle planning considers the cost and benefits of an asset from the time its need is identified until the need no longer exists and the asset is replaced or retired. It requires consideration of future outcomes and not just current performance. By considering the current condition of system assets relative to their life cycle, actions can be developed that reduce long-term costs, which in turn allows a wider range of investment choices. To this end, the HDOT's TAMP is based on a maintenance and preservation philosophy to prolong the service life of HDOT assets and get the best return on the HDOT's investment.

Federal Requirements

FHWA requires that state DOTs establish a process for conducting life cycle planning at the network level for NHS pavements and bridges. FHWA defines life cycle planning as "a process to estimate the cost of managing an asset class, or asset subgroup over its whole life with consideration for minimizing cost while preserving or improving the condition." Life cycle planning should include potential work types, including treatment options and unit costs, identification of deterioration models, and a strategy for minimizing life cycle costs and achieving asset performance targets.

Life Cycle Planning Process

The HDOT is using the AASHTOWare BrM system for bridges and pavements to support life cycle and investment planning. BrM meets the requirements outlined in 23 CFR 515.17 and is part of a multi-step process used for conducting the following steps to conduct its life cycle planning analysis:

A. **Select and identify the asset classes and networks that will be analyzed.** The HDOT will decide how best to develop a life cycle planning scenario for its transportation network. For example, a different life cycle planning scenario may be developed for the NHS system vs. the rest of the state's transportation system.

B. **Define life cycle planning strategies.** Each life cycle planning strategy includes a variety of treatment costs and options that considers the condition and asset performance needs (deterioration rates) over the life of the asset. The following section shares some of the preservation treatments that the HDOT uses and the importance of implementing preventative maintenance. Various treatment options are used to address the pavement and bridge network, including routine maintenance, preservation, rehabilitation, and reconstruction.

C. **Set life cycle planning scenario inputs.** Establish the analysis period to be used, desired state of good repair, identify risks, anticipated funding levels (which comes from financial planning), and any constraints or requirements, such as minimum pavement and/or bridge conditions, that must be taken into consideration in evaluating life cycle planning scenarios. The variety of life cycle planning scenarios include a preservation scenario, a worst-first scenario, and a hybrid of the two.

D. **Run various life cycle planning scenarios.** Using the asset strategies developed in Step B and the inputs from Step C, various life cycle planning scenarios are run. Because of the iterative nature of the analysis, the development of these scenarios may lead back to Step B and the development of new asset strategies.

E. **Select an investment strategy.** Using the information from Step D, professional judgement, and an agreed-upon funding scenario, the best strategy to carry forward is selected and implemented.

Minimizing the Whole Life Cost

While the HDOT strives to make facilities, equipment, and other assets function for a long, useful life at the lowest reasonable cost, they are challenged by the dual problems of deferred maintenance and balancing current needs with future needs. The HDOT's life cycle planning process is guided by our BMS and PMS that uses deterioration models for elements, specific work actions, and costs to generate system-wide recommendations. The HDOT is committed in investing in life cycle planning strategies, which prioritizes preventative maintenance.

Figure 7.2 shows the importance of how timely investments in an asset can result in improved condition and lower long-term cost. Figure 7.2 reflects the HDOT's previous practice of rehabilitating asphalt pavement (mill and fill) every 12 years until a full reconstruction is needed after 60 years. With the consideration of a 2 percent inflation rate per year, the full pavement life cycle cost is $29.0 million. Figure 7.2 also reflects the implementation of preventative maintenance activities over the full pavement life cycle.

With the consideration of a 2 percent inflation rate per year, the full pavement life cycle cost is $21.4 million.

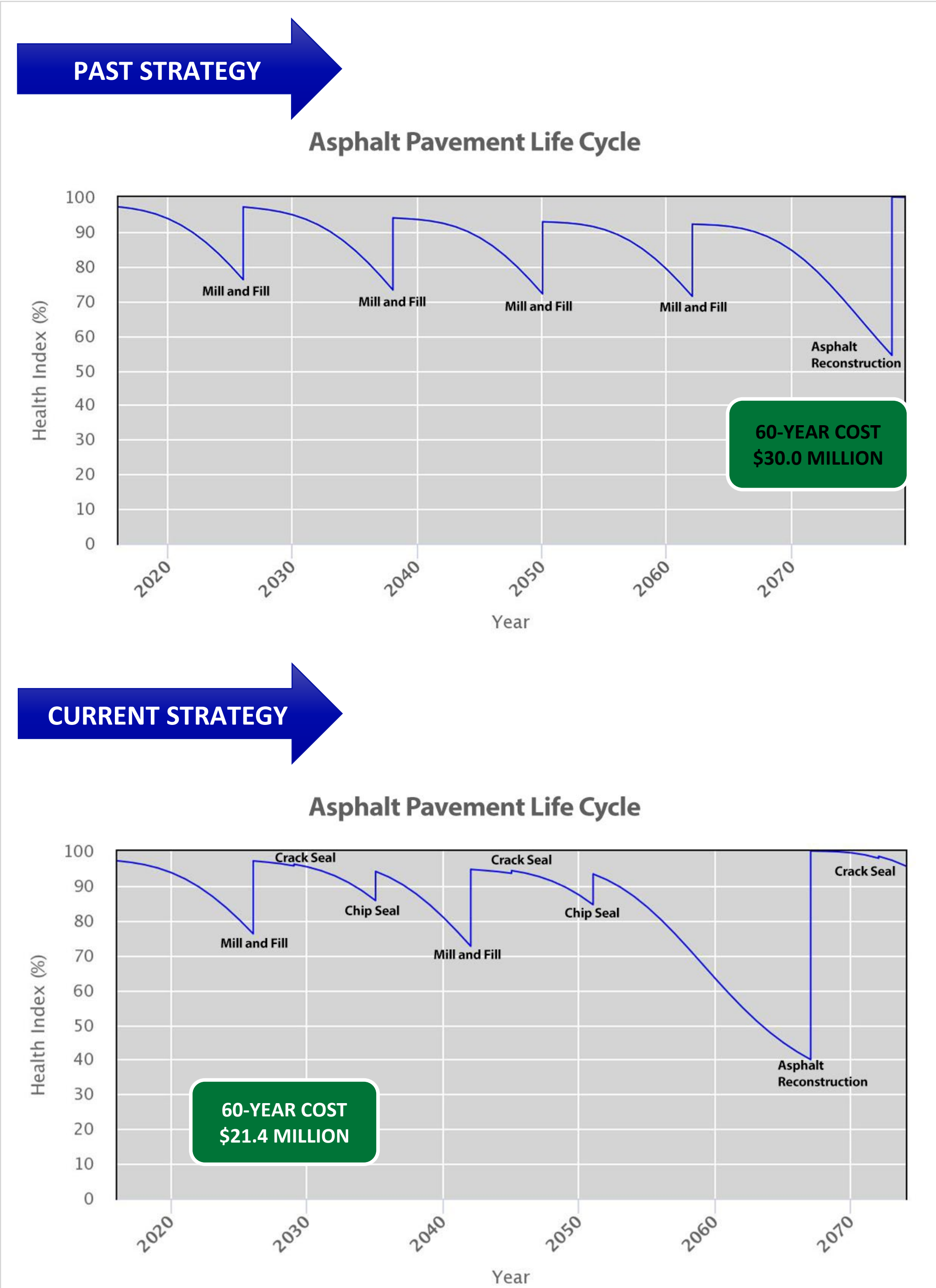


Figure 7.2. Pavement Preservation Strategies

Life Cycle Planning Strategies

A preservation strategy is designed to include low-cost treatments for assets already in good condition and to keep these assets in good condition longer. It optimizes the timing of rehabilitation and replacement options, as effective preventative maintenance activities involve a small, near-term expenditure calculated to avoid or delay a later, much larger expenditure. Agencies have found that asset strategies employing low-cost treatments that extend service life, preserve desired asset conditions longer, and postpone the need for rehabilitation can be effective at reducing performance gaps. This approach also enables agencies to reallocate more funding towards other preservation needs by deferring the need for more costly rehabilitation activities.

The HDOT is committed to achieving the lowest practical cost for improving and preserving HDOT's transportation assets over the service life of its assets. As the next section shares, the HDOT is committed to activities or strategies that prevent, delay, or reduce deterioration of its elements, keeps it assets in good or fair condition, and extends their service life. These maintenance and preventative activities may be cyclic or condition driven.

Preservation Treatments

Pavement

The HDOT maintains State-managed roadways by programming and executing maintenance strategies that address the needs of the roadway. Each maintenance strategy uses a combination of treatment activities that optimize the pavement life cycle and reducing overall life cycle costs. Treatment activities can be separated into the following four categories:

1) Routine Maintenance: Routine maintenance generally consists of day-to-day activities that are scheduled for maintenance personnel to preserve a desired level of service to the users. Typical work may include clearing of roadside shoulders, cleaning of drainage structures, or filling of potholes.

2) Preventative Maintenance: Preventative maintenance activities are cost-effective, proactive, surface treatments that prevent the deterioration of pavements that are in good structural and operational condition.

3) Rehabilitation: Rehabilitation activities address pavements in overall poor condition due to surficial deterioration with limited or no indications of structural failure.

4) Reconstruction: Reconstruction activities are the most expensive and invasive treatment activity that can be employed. Reconstruction is typically used where the surficial pavement structure is in a poor condition and there are indications that the underlying layers are structurally deficient or need to be rebuilt to accommodate current or future traffic conditions.

Table 7.1 shows the pavement preservation and rehabilitation treatments that the HDOT is pursuing. These work activities are incorporated into the asset management process and the HDOT PMS's life cycle planning. The PMS recommends a program of work activities based on various funding scenarios and the goal of more cost-effectively extending the life of pavements in good condition statewide at the lowest practical cost.

Table 7.1. Pavement Management System Work Activities

Work Activity	Activity Type	Unit Cost
Preservation/ Preventative	Asphalt Crack Fill/Seal	$30,000 to $500,000 per lane-mile
	Asphalt Slurry Seal	
	Asphalt Microsurfacing	
	Asphalt Thin Overlay	
	Concrete Joint Resealing	
	Concrete Spall Repair	
	Concrete Diamond Grinding	
Rehabilitation	Asphalt Localized Repair	$400,000 to $900,00 per lane-mile
	Asphalt Mill and Fill	
	Concrete Dowel Bar Retrofit	
	Concrete Slab Replacement	
Reconstruction	Asphalt Reconstruction	$1,100,000 to $2,300,000 per lane-mile
	Concrete Reconstruction	

Figure 7.3 shows the projected state of good repair for interstate pavements with an emphasis on life cycle planning strategies to keep the good pavement good and fair pavement fair, and address the poor pavement. Several scenarios were run with various fundings levels and targets to achieve the desired state of good repair. With the need to reduce the percentage of poor interstate pavements, a hybrid scenario approach to effective preservation and worst-first best achieved the desired targets.

Figure 7.3 shows the results of the hybrid approach at various funding levels and what happens to the state of good repair when no investment (funding) is made to the PMS. Based on the HDOT's financial plan, historic spending, and a variety of performance scenarios run in the modified BrM, the HDOT estimates that the average annual amount for the interstate should be $20 million per year over the next 10 years to meet the desired target of 20 percent good and 4 percent poor in 10 years.

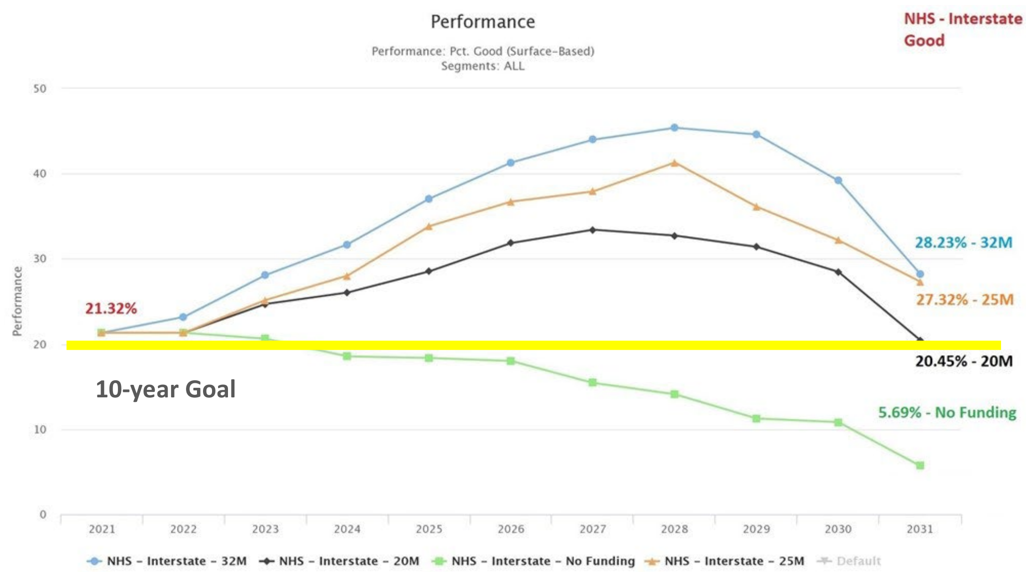


Figure 7.3. Projected State of Good Repair for Interstate Pavements

Figure 7.4 shows the projected state of poor repair. In this case, the emphasis on life cycle planning strategies is less effective than an emphasis on pavement condition. This is likely due to the current age and condition of the interstate. Preservation work activities will not be enough to prevent the good and fair pavement from reaching a poor condition (thus the increase in the percentage of poor condition). Figure 7.4 also shows the increase to the state of poor repair when no investment (that is, funding) is made to pavements.

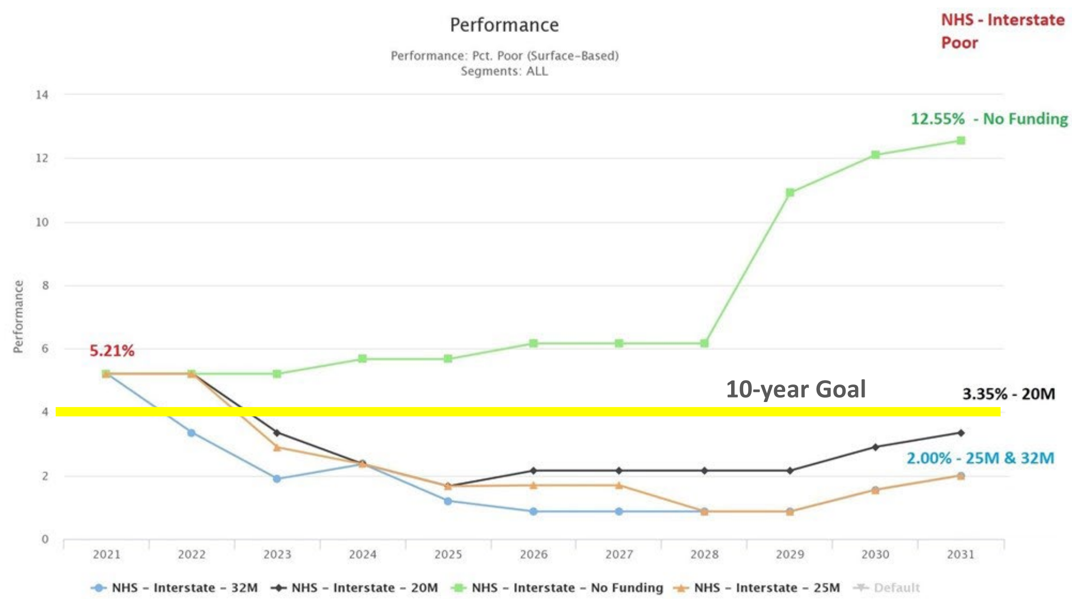


Figure 7.4. Projected State of Poor Repair for Interstate Pavements

Figure 7.5 shows the projected state of good repair for non-Interstate NHS pavements. Based on the wide variety of performance scenarios run in BrM, it was discovered that the most effective strategy is one that has an equal emphasis on life cycle planning strategies and condition-based strategies. This scenario will keep more of the pavement in good condition over time. Figure 7.5 also shows what happens to the state of good repair when no investment (funding) is made to the pavements.

The HDOT looked at the forecast of revenue over the next 10 years, as well as the annual program and expenditures on the non-Interstate NHS pavement. Based on the HDOT's financial plan, historic spending, and a variety of performance scenarios, the HDOT estimates that the average annual amount for non-Interstate NHS pavement should be $35 million per year over the next 10 years to meet the targets and goals.

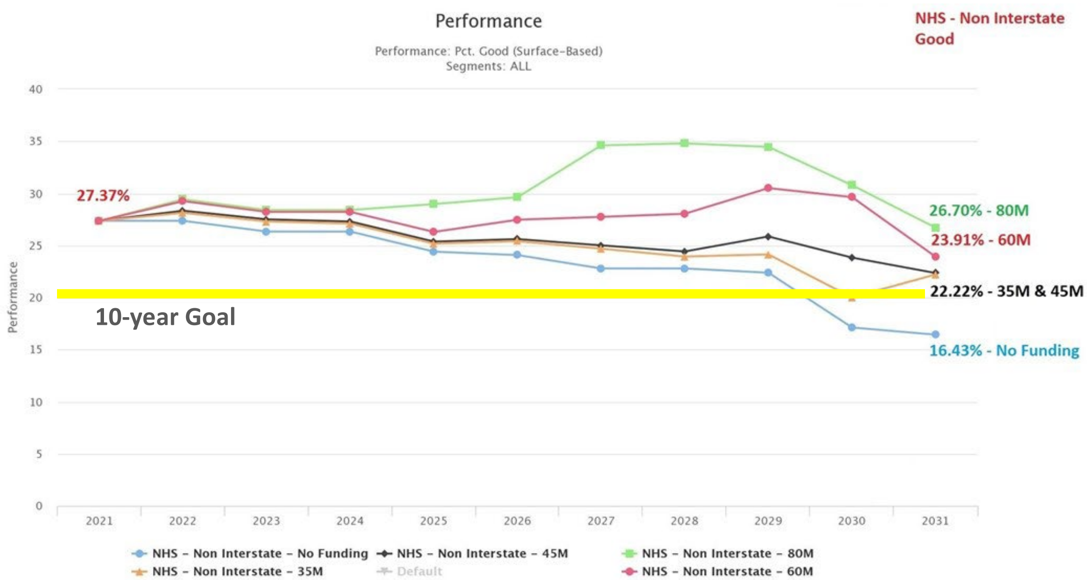


Figure 7.5. Projected State of Good Repair for Non-Interstate NHS

Figure 7.6 shows the projected state of poor repair. In this case, the emphasis on life cycle planning strategies is an effective preservation approach. Preservation work activities will help to prevent the pavement from reaching a poor condition. Figure 7.6 also shows the increase to the state of poor repair when no investment (funding) is made to the pavements.

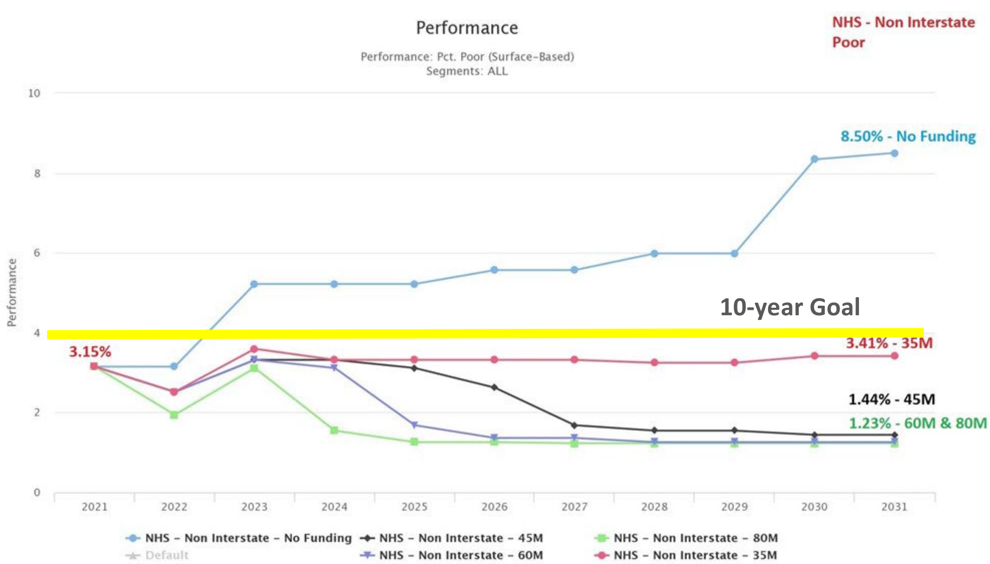


Figure 7.6. Projected State of Poor Repair for Non-Interstate NHS

Bridge

The BrM program also conducts a life cycle cost analysis for bridges for given treatments or work to ensure the lowest practical cost over the life span of a structure. The BrM considers the deterioration of 70 bridge elements and 43 different defects. Similar to the PMS, the BMS produces a recommendation of work activities based on various funding scenarios and the goal of more cost-effectively extending the life of bridges in good condition statewide. The HDOT also implements best practices in its maintenance work activities for bridges. Crack sealing, spall repairs, inlet cleaning, and bridge inspections are done annually, in addition to the preservation, rehabilitation, and reconstruction work activities. Table 7.2 has the bridge work activities and preventative measures that have been incorporated into BrM.

Using the condition and appraisal data available, the HDOT BMS assigns each bridge in its inventory to a subprogram and an action, if applicable, to restore or keep the bridge in a state of good repair. The assigned actions (that is, potential projects) are in accordance with the following work types:

1) Routine and Preventative Maintenance: Routine and preventative maintenance includes work or strategies that arrest or slow the deterioration of a bridge to keep it in good or fair condition. They can also consist of day-to-day activities to preserve a desired level of service to the users. Work or strategies that restore the condition of a bridge are categorized as preservation.
2) Preservation: Preservation involves work that restore the condition of a bridge while it is in good or fair condition. Restoration work includes minor non-structural repairs of elements and major non-structural repairs of components (that is, rehabilitation).
3) Rehabilitation: Rehabilitation involves work required to restore the structural integrity of a bridge as well as work necessary to correct major safety defects. Work includes localized structural repairs of components, major structural repairs of bridges (that is, structural rehabilitation), partial or complete component replacement (that is, reconstruction), major safety improvements, strengthening, and seismic retrofits.
4) Replacement/Initial Construction: Replacement involves the total replacement of an existing bridge with a new facility constructed in the same general traffic corridor. This is new or initial construction.

Table 7.2. Bridge Life Cycle Work Activities

Work Activity	Activity Type	Frequency (years)	Baseline Unit Cost
Preventative Maintenance	Paint Structure	*Additional information can be found in the HDOT Bridge Asset Management Manual (BAMM)*	$315/square foot
	Scour Countermeasures		$140/square foot
Preservation	Repair of Steel Bridge		$325/square foot
	Repair of Concrete Bridge		$500,000/bridge
	Repair of Culvert		$300,000/bridge
	Rehabilitation of Steel Bridge		$885/square foot
	Rehabilitation of Concrete Superstructure or Substructure		$375/square foot
	Rehabilitation of Deck		$75/square foot
	Rehabilitation of Culvert		$125/square foot

Table 7.2. Bridge Life Cycle Work Activities

Work Activity	Activity Type	Frequency (years)	Baseline Unit Cost
Rehabilitation	Replacement of Deck	*Additional information can be found in the HDOT Bridge Asset Management Manual (BAMM)*	$1,100/square foot
	Structural Rehabilitation of Concrete Bridge		$800/square foot
	Structural Rehabilitation of Steel Bridge		$2,600/square foot
	Structural Rehabilitation of Culvert		$175/square foot
	Seismic Retrofit		$140/square foot
Replacement	Replacement of Concrete Bridge		$6,030/square foot
	Replacement with Modular Steel Bridge		$3,250/square foot

Figures 7.7 and 7.8 show the projected state of good and poor repair for the next 10 years. For the Bridge Program, ambitious targets of 2 percent poor and 20 percent good were selected. To meet those targets, an aggressive preservation, rehabilitation, and replacement strategy scenario was run, and an annual amount of $78 million is needed as a comfortable baseline. As reflected in the scenarios below, if preventative actions aren't implemented, a large number of NHS bridges will slip from a fair to poor condition.

Both Figures 7.7 and 7.8 reflect a range of spending scenarios, with the following outcomes:

- $90 million average scenario
  - Advances preservation rehabilitation projects on fair bridges
  - Advances preservation repairs and preventative maintenance projects on good bridges
- $82 million average scenario
  - Advances preservation rehabilitation projects on fair bridges
- $78 million average scenario
  - Baseline selected based on the life cycle planning and preventing fair bridges from slipping to poor to achieve a 2% poor target
- $66 million average scenario
  - Assumes more risk with fair bridges and allows fair bridges to potentially deteriorate in later years
  - Fewer preservation repairs and preventative maintenance projects done, allowing good bridges to deteriorate

The strategies in place for the Bridge Program attempt to prevent the fair bridges from becoming poor, keep the good bridges good, and address the poor bridges.

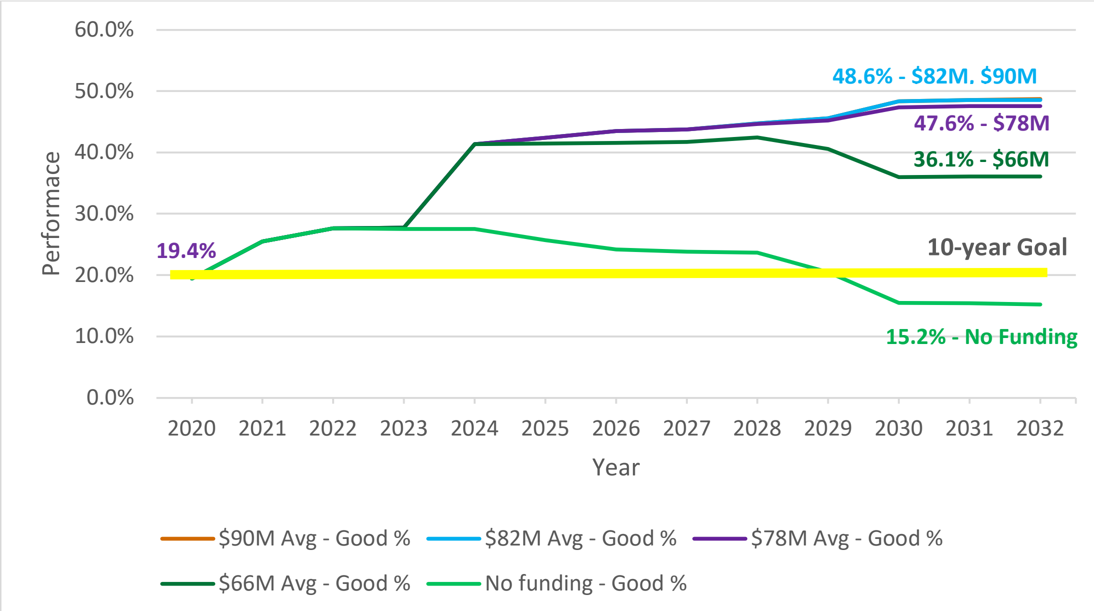


Figure 7.7. Projected State of Good Repair for NHS Bridges

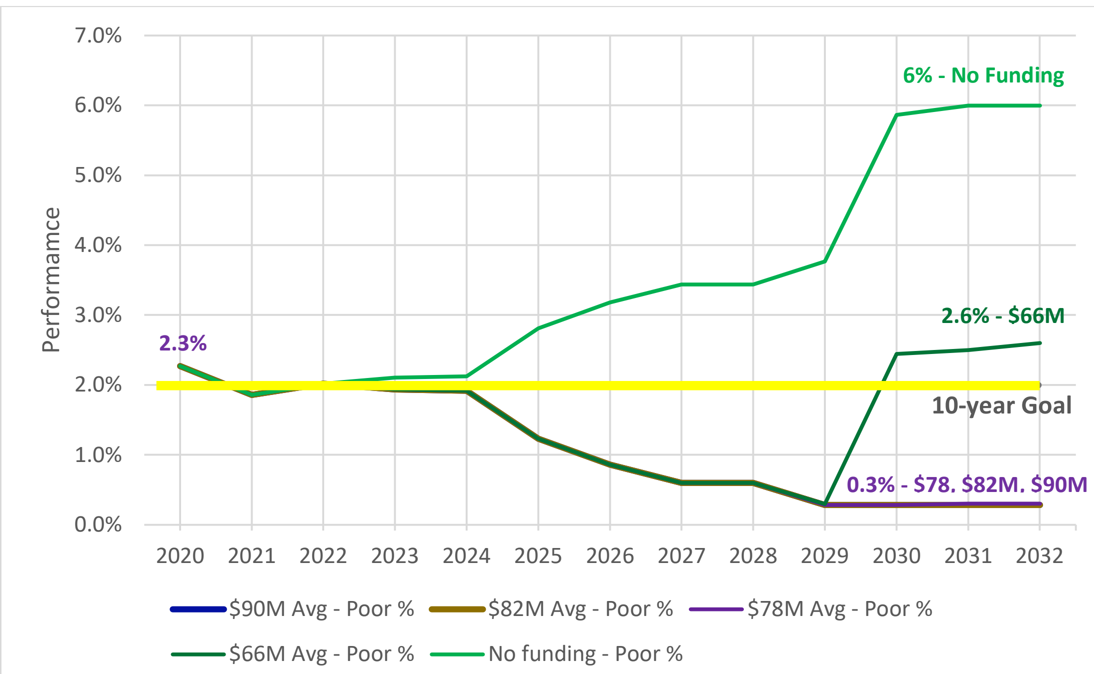


Figure 7.8. Projected State of Poor Repair for NHS Bridges

Implementation

Using the steps mentioned in the above life cycle planning section, the HDOT implements the pavement and bridge work activities through its PMS and BMS and programming. The preservation strategies are implemented at the network level so that the HDOT can devise an optimal long-term strategy.

As the various strategies and work activities are implemented, the HDOT continues to collect data on the cost and effectiveness. The HDOT will use the data to reinforce or revise the predictive models of how the assets will deteriorate following different types of treatments. The modeling of future asset conditions based on funding assumptions and application of life cycle strategies will continued to be improved and inputted to BrM.

CHAPTER 8

Performance Gap and Investment Strategies

As noted in Chapter 4, this TAMP provides an opportunity for the HDOT to develop performance measures and targets that unify federal, state, and regional goals and link observed performance to subsequent planning and programming decisions. These performance targets can be used to compare the current condition against the desired performance condition. Any gap between the current condition and desired condition will inform the HDOT about the improvements and cost that may be necessary to meet asset management objectives.

Performance Gap Analysis Process

The HDOT is using the following steps to conduct its performance gap analysis:

A. Performance measures were proposed and established in Chapter 4 of this TAMP.

B. The current condition of the assets is presented in Chapter 3 of this TAMP.

C. BrM is used to conduct multiple performance-based scenarios based on condition and life cycle policies and consideration of the full life cycle. In addition, funding assumptions and risks are considered.

D. Based on the results of the different life cycle planning scenarios, the HDOT is able to identify a performance strategy and the gap between the desired condition or target and the current condition.

E. If a gap occurs between the desired condition/target and current condition, investment strategies will be identified to close or reduce the gaps.

> 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.

What are the Gaps between Existing and Desired Performance?

The current asset conditions for NHS pavement and bridges were shared in Chapter 3. With the application of life cycle planning strategies shared in Chapter 7, the HDOT is planning on investing in more preventative maintenance strategies to cost-effectively minimize the life cycle cost and extend the overall pavement and bridge life.

The HDOT conducted a forecast of revenue over the next 10 years; this forecast is reflected in Chapter 6, where there is an anticipated $584.5 million in revenue over the next 10 years. The HDOT administration has committed to provide the funding necessary to achieve the program's desired targets.

Table 8.1 presents the performance gap analysis for the NHS Interstate pavements, showing the HDOT-planned investments and life cycle strategies appear to be effective in the HDOT meeting its 2- and 4-year targets and 10-year goal for the Interstate. There is no performance gap for the Interstate.

Table 8.1. NHS Interstate Asset Performance and Gap

NHS INTERSTATE	Annual Funding	Good	Poor
Current Performance (2020) and 2022 Consistency Review expenditures	$21.4 million	17.2%	4.9%
2-year Target (2024)	N/A	15%	4%
2-year Projection	$20 million	26.5%	2.8%
4-year Target (2026)	N/A	15%	4%
4-year Projection	$20 million	30.1%	2.1%
10-year Desired State of Repair (2032)	N/A	20%	4%
10-year Projection	$20 million	20.45%	3.35%
10-year Projected Gap	N/A	No gap	No gap

Table 8.2 presents the performance gap analysis for the non-Interstate NHS pavement, showing the HDOT-planned investments and life cycle planning strategies are effective in the HDOT meeting and exceeding its 2- and 4-year targets and its 10-year goal for the non-Interstate NHS pavement. There is no performance gap for the non-Interstate NHS pavement.

Table 8.2. Non-Interstate NHS Pavement Asset Performance and Gap

Non-Interstate NHS Pavement	Annual Funding	Good	Poor
Current Performance (2020) and 2022 Consistency Review expenditures	$55 million	26.1%	2.8%
2-year Target (2024)	N/A	20%	4%
2-year Projection	$35 million	27.3%	3.2%
4-year Target (2026)	N/A	20%	4%
4-year Projection	$35 million	27.4%	3.3%
10-year Desired State of Repair (2032)	N/A	20%	4%
10-year Projection	$35 million	22.2%	3.4%
10-year Projected Gap	N/A	No gap	No gap

Table 8.3 presents the performance gap analysis for the NHS bridges, showing the HDOT-planned investments and life cycle strategies appear to be effective in the HDOT meeting its 2- and 4-year targets and 10-year goal for the NHS bridges. There is no performance gap for the bridges.

Table 8.3. NHS Bridge Asset Performance and Gap

NHS BRIDGES	Annual Funding	Good	Poor
Current Performance (2020) and 2022 Consistency Review expenditures	$34 million	19.4%	2.3%
2-year Target (2024)	N/A	20%	2%
2-year Projection	$62 million	41.4%	1.9%
4-year Target (2026)	N/A	20%	2%
4-year Projection	$75 million	43.5%	0.9%
10-year Desired State of Repair (2032)	N/A	20%	2%
10-year Projection	$78 million	54%	0.3%
10-year Projected Gap	N/A	No gap	No gap

Investment Strategies

Investment strategies are the culmination of the risk management, life cycle planning, and performance gap analyses and results, and take into consideration the anticipated available funding and estimated cost of future work. It is through this TAMP process that the HDOT will determine how best to invest in and prioritize projects that will achieve the performance targets and national and statewide goals.

In accordance with FHWA requirements, the TAMP must identify investment strategies that make progress towards:

- Achieving a desired state of good repair over the life of the assets
- Improving or preserving the asset condition and performance
- Achieving the targets for asset condition and performance of the NHS
- Achieving national performance goals

Performance-based Investment

Table 8.4 shows the HDOT's commitment in its financial plan and investment in life cycle planning strategies to keep the existing transportation system in a state of good repair over the next 10 years and reach the HDOT's performance goal for NHS bridges and pavements.

Table 8.4. Condition, Targets, and 10-year Investment Levels

Asset	Current Condition 2020	10-year Target	10-year Projection	Investments Required to Achieve Targets in 2032
NHS bridges	Good 19.4%	20%	54%	$36 to 78 million annually
	Poor 2.3%	2%	.03%	
Interstate pavements	Good 17.2%	20%	20.4%	$20 million annually
	Poor 4.9%	4%	3.3%	
Non-Interstate NHS pavements	Good 26.1%	20%	22.2%	$35 million annually
	Poor 2.8%	4%	3.4%	

Strategies

The TAMP recognizes the need to make hard investment decisions and provides a data- and technical-driven prioritization process that will objectively guide investment decisions. Overall, the funding allocation emphasizes statewide needs by program and asset, rather than by district. The HDOT's commitment to its PMS and BMS also reflects the network prioritization approach vs. a district approach.

The HDOT's investment strategies are consistent with national and statewide goals of improving or enhancing current assets and preserving and maintaining the existing system through low-cost treatments. The combined results from life cycle planning (Chapter 7), performance gap analysis (Chapter 8), risk analysis (Chapter 5), the financial plan (Chapter 6), and pavement and bridge management systems (Chapter 3) form the foundation for establishing these investment strategies. The HDOT runs a variety of performance scenarios with different combinations of funding and different combinations of work activities (that is, maintenance, preservation, rehabilitation, and reconstruction) to determine the preferred investment strategy moving forward. The end result is the Pavement and Bridge's 10-year Program, which is submitted to the MRTP and ultimately implemented through the STIP, the HDOT's CIP, or its SMP.

TAMP NHS Funding

The HDOT's performance goal is to maintain and improve the overall condition of its NHS assets over the next 10 years. The HDOT will prioritize its NHS assets and strive to maintain its current funding of the System Preservation Program, understanding that there will be consequences to its other programs and non-NHS assets. The HDOT is committed to the funding in Table 8.4. Tables 8.5, 8.6, and 8.7 reflect the anticipated annual expenditures for the next 10 years by work activity. The HDOT is working to improve their procurement, design, and construction processes to close the gap between programming and expenditures.

Table 8.5. Anticipated Annual Expenditures for NHS Interstate Pavement Assets (millions of dollars)

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Maintenance	1	1	1	1	1	1	1	1	1	1
Preservation	2	2	2	2	2	2	2	2	2	2
Rehabilitation	11	11	8	8	11	11	11	11	11	11
Reconstruction	6	6	4	4	6	6	6	6	6	6
Initial Construction	0	0	5	5	0	0	0	0	0	0
Annual Total	**$20**	**$20**	**$20**	**$20**	**$20**	**$20**	**$20**	**$20**	**$20**	**$20**

Table 8.6. Anticipated Annual Expenditures for NHS Non-Interstate Pavement Assets (millions of dollars)

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Maintenance	4	4	4	4	4	4	4	5	5	5
Preservation	8	8	8	8	8	8	8	8	8	8
Rehabilitation	25	28	28	25	25	25	25	17	17	17
Reconstruction	8	10	10	8	8	8	8	5	5	5
Initial Construction	0	0	0	0	0	0	0	0	0	0
Annual Total	**$45**	**$50**	**$50**	**$45**	**$45**	**$45**	**$45**	**$35**	**$35**	**$35**

Table 8.7. Anticipated Annual Expenditures for NHS Bridge Assets (millions of dollars)

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Maintenance	4	4	4	5	6	7	7	8	10	10
Preservation	10	15	20	35	38	40	40	50	50	60
Rehabilitation	15	25	25	20	20	25	20	15	15	15
Reconstruction	0	0	0	0	0	0	0	0	0	0
Initial Construction	7	18	25	15	10	5	4	1	0	0
Annual Total	**$36**	**$62**	**$74**	**$75**	**$74**	**$77**	**$71**	**$74**	**$75**	**$78**

The PMS and BMS reinforce the investment strategies and process improvements that will be implemented to achieve the HDOT's long-term performance goals. However, the HDOT understands that funding needs may change over time due to the amount of funding available, the backlog of work types, accelerated deterioration or slower deterioration on different parts of the system, and agency capacity to get work done. The HDOT expects to review and amend the 10-year goals and funding commitments when the TAMP is reviewed in 4 years.

CHAPTER 9

Process Improvements

TAMP Governance and Sustainment

Failure to establish an accepted TAMP and failure to obtain a positive annual Consistency Determination by FHWA will result in a lowered federal participation rate of 65 percent for projects on the NHS.

The goal of the federal performance measures is to establish transparent, formalized policies and processes that aid the various DOTs to make consistent and defensible decisions in asset investments, regardless of whether they are on or off the NHS. The TAMP performance measures will satisfy this need and can also be used to justify HDOT investment decisions and legislative funding requests. The HDOT's top officials are committed to providing resources, including funding, training, and personnel for the long-term sustainment of the asset management program.

Continuous Review (Living Document)

It is recognized that the TAMP program is not static and it is good business practice to continuously re-evaluate practices and procedures. The HDOT administration is working on its organizational structure to build a stronger connection between its mission and the transportation asset management goals and objectives. This requires a strategy and successful implementation that needs to address culture change, identification of new requirements and functions, HDOT reorganization, process review and changes, operational budgeting, and contracting actions.

The Asset Management Leadership Team is focusing on the following key process improvements:

- **Planning and Programming**
  - Strengthen the programming process – providing detailed information on the data, tools, and measures that are used to support transportation asset management decisions and actions
  - Merge capital and maintenance activities into a district's work plan
- **Data Governance**
  - Strengthen information systems and data – investing, as necessary, in the data and information systems needed to be confident in transportation asset management decisions and actions

- Establish data collection standards and implement a data governance plan
- Integrate the maintenance management processes of the districts into the asset management program
- Continue to work with the City and County of Honolulu on sharing data on the NHS

- **Infrastructure**
  - Continue with the process improvements on the AASHTOWare BrM software for the bridge management systems
  - Transition the PMS from the modified BrM software to the dTIMS software, as mentioned in Chapter 3
  - Identify and implement opportunities to incorporate new means, methods, treatments, specifications, and technology into the construction of preservation treatments for both pavement and bridges

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Appendix A

Risk Register

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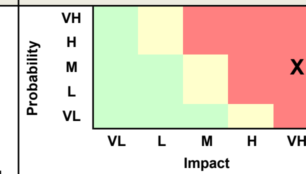
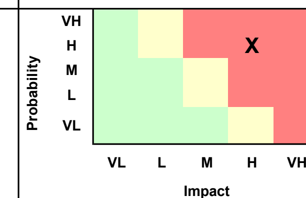
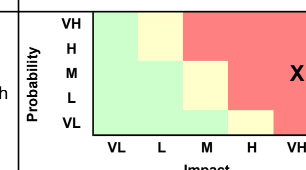
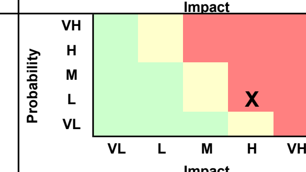
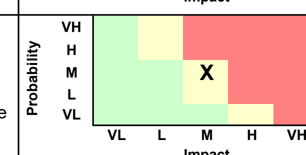
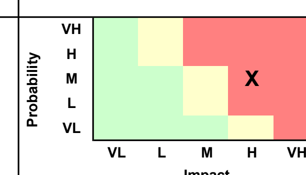
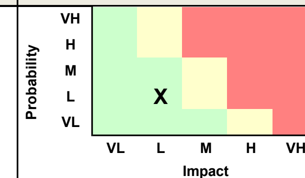
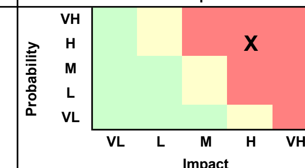
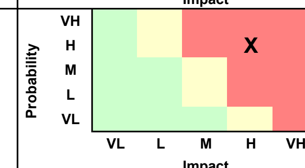
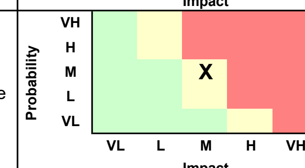
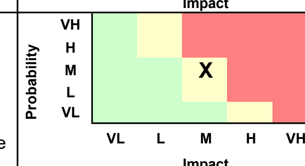
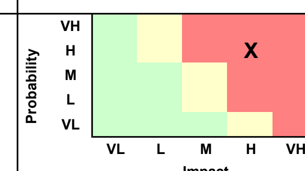
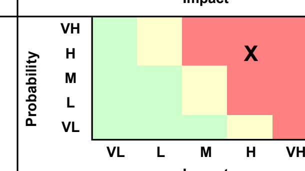
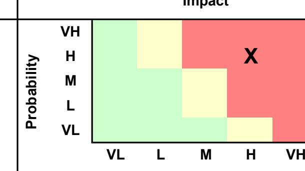
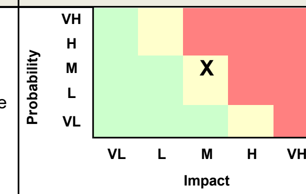
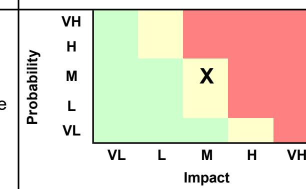
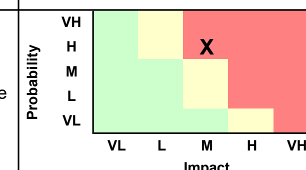
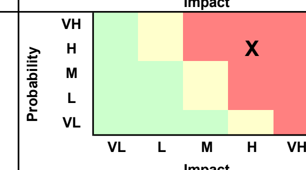
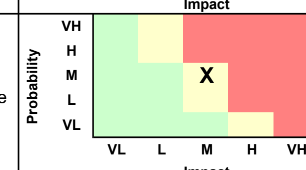
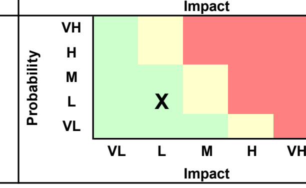
TAMP Risk Management Register for HDOT

Risk Identification							Qualitative Risk Assessment			Risk Response Plan		Monitoring and Control		
#	Status	Risk Category	Risk Item	Cause	Effect	Threat or Opportunity	Probability	Impact	Risk Matrix	Response Strategy	Response Actions	Responsible Entity/Lead Office	Monitoring Frequency	Status Update
1	Active	Hazard	Severe Weather Events, Tropical Storms, Hurricanes, and Tsunamis	Flooding, landslides, bridge failures, and storm drainage capacity	Loss of access	Threat	Moderate	Very High		Mitigate	The HDOT created a Statewide Coastal Highway Program Report in 2019, which identified 20 most critical road locations. In addition, the HDOT developed a Climate Adaptation Action Plan (CAP) in 2021, which provides a roadmap for the HDOT to make the highways system more resilient to climate-related effects. The CAP identifies locations through an exposure assessment of climate hazards based on historical and future climate condition research and data.	Districts, HWY-D, HWY-P, HWY-C	1-2 years depending on the program	The HDOT adopted a Resiliency Policy on June 18, 2021 to further emphasis the importance of this risk. Storm drains and culverts are inspected every 2-5 years, depending on the criticality, size, and location; storm drainage inlets, manholes, open channels, and outfalls are inspected annually or semi-annually as part of the Districts MS4 programs; bridges are inspected every 1-2 years. The HDOT is working the development of their Resiliency Improvement Program and the establishment of formal design adaptation guidelines.
2	Active	Hazard	Climate Change: Sea Level Rise	Shoreline erosion, inundation, and flooding	Loss of access	Threat	High	High		Accept	The HDOT created a Statewide Coastal Highway Program Report in 2019, which identified 20 most critical road locations. In addition, the HDOT developed a Climate Adaptation Action Plan (CAP) in 2021, which provides a roadmap for the HDOT to make the highways system more resilient to climate-related effects. The CAP identifies locations through an exposure assessment of climate hazards based on historical and future climate condition research and data.	HWY-P, -D, -C, -L and other State and City/County agencies	More frequent monitoring is occurring on the 20 most critical locations.	The HDOT adopted a Resiliency Policy on June 18, 2021 to further emphasis the importance of this risk. The HDOT is working the development of their Resiliency Improvement Program and the establishment of formal design adaptation guidelines.
3	Active	Hazard	Earthquakes	Bridge failures, landslides, rockfall, or roadway fill failures	Loss of access	Threat	Moderate	Very High		Accept	HDOT continues to update asset inventory data. HDOT to develop/update emergency response procedures and interagency MOUs. HDOT to continue to bridge seismic retrofit and rockfall programs.	HWY-P, -D, -C, -L	As required, ongoing	Ongoing. These hazards were included as part of the exposure assessment for the 2021 CAP.
4	Active	Hazard	Lava Flows	Volcanic Activity; lava crossing roadways	Loss of access	Threat	Low	High		Accept	HDOT continues to improve and work on interagency MOUs and emergency response procedures. Look for alternate routes in active lava zones.	HWY-P, -D, -C, -L	As required, ongoing	Ongoing. These hazards were included as part of the exposure assessment for the 2021 CAP.
5	Active	Hazard	Repeated (Emergency) Damage of Facilities	Natural disaster events	Loss or interruption of access	Threat	Moderate	Moderate		Mitigate	HDOT has been actively tracking projects related to emergency events and tracks restoration activities. Program and project managers pro-actively verify if any of their upcoming projects fall within the geographical location on the list prior to programming and address appropriately, as needed.	HWY-C, District Offices, HWY-D	As required, ongoing	Program/Project managers verify if any of their future projects are within the geographical location of the repeated damage of facilities list and address appropriately, as needed.
6	Active	Financial	Federal Revenues	High dependence on fuel tax collection	Reduction in Federal Revenues	Threat	Moderate	High		Mitigate	HDOT continues to participate in national initiatives in alternative tax or fee collection methods.	HWY-S	As required, ongoing	With the passing of the BIL, the risk of a reduction in federal funds is less of a current risk and the probability has been adjusted. The HDOT has also been much more pro-active in pursuing grant funds on various projects.

TAMP Risk Management Register for HDOT

Risk Identification							Qualitative Risk Assessment			Risk Response Plan		Monitoring and Control		
#	Status	Risk Category	Risk Item	Cause	Effect	Threat or Opportunity	Probability	Impact	Risk Matrix	Response Strategy	Response Actions	Responsible Entity/Lead Office	Monitoring Frequency	Status Update
7	Active	Financial	Continuous short-term federal transportation bills or extensions	High dependence on Congress and the President to continue to support and fund transportation bills	Delay in Federal Oversight and Funding	Threat	Low	Low		Accept	HDOT continues to monitor to see if it impacts the funding of any TAMP activities.	HWY-S	As required, ongoing	With the passing of the BIL, this is less of a current risk and the probability has been adjusted. The HDOT has also been much more pro-active in pursuing grant funds on various projects.
8	Active	Financial	State Revenues	High dependence on fuel tax collection and dependence on state obligations from the Legislature	Reduction in State Highway Revenues available for programs and projects	Threat	High	High		Accept	HDOT continues working with State Legislature to diversify revenue collection methods or updating fee schedules.	HWY-S	As required, ongoing	The HDOT continues to work on the Road User Charge demonstration project, which could help to establish some stability in the State's revenue generation.
9	Active	Financial	Renewable Energy policies	Increase use of hybrid, electric, and fuel efficient vehicles	Reduction in State Highway Revenues	Threat	High	High		Mitigate	HDOT continues working with State Legislature to diversify revenue collection methods or updating fee schedules.	HWY-S	As required, ongoing	The HDOT continues to work on the Road User Charge demonstration project, which could help to establish some stability in the State's revenue generation.
10	Active	Financial	Understanding of financial data to make appropriate TAMP planning decisions	Current method of collecting and using the data appropriately	Funding directly influences investment strategies and TAMP life cycle policy decisions	Threat	Moderate	Moderate		Mitigate	HDOT continues to develop new policies and processes to efficiently collect and understand the necessary financial data.	HWY-S, HWY-P, HWY-A	As required, ongoing	Ongoing
11	Active	Organizational	Program Prioritization	Establishing stronger program processes and management for pavement and bridges, including resistance to culture change	Impacts to an ineffective performance-based planning and programming process	Opportunity	Moderate	Moderate		Mitigate	The HDOT has created a mid-range transportation plan (MRTP) to bridge the gap between HDOT's 20-year long-range transportation plans and the 4-year Statewide Transportation Improvement Program (eSTIP) as well as the Capital Improvement Program (CIP) and Special Maintenance Program (SMP). The MRTP will be a 10-year transportation program and a vehicle for the HDOT to communicate its investment strategy for the next ten years.	HWY-D, -L	As required, ongoing	Through implementation of the MRTP, Program Managers are better planning their needs and projects for their programs (i.e. bridge, pavement, ped/bike) based on data-driven, performance-based processes.
12	Active	Organizational	Staff Shortage	Length of the State's hiring process and lack of interest in working for the public sector	Limited staff resources available to complete the standard processes and analyses	Threat	High	High		Mitigate	Develop a hiring campaign and work with HR to expedite the hiring process. Implement the Wikiwiki process for all open positions.	HDOT Administration	As required, ongoing	To help expedite the hiring process, hiring for all positions should be transitioned to the Wikiwiki process; establish more staff augmentation or open end contracts to assist with staff shortages as needed
13	Active	Organizational	Staff Turnover and Retirement	Loss of important information and processes due to high levels of retirement and staff turnover	Impacts to time and budgets for staff education	Threat	High	High		Minimize	Develop a mentoring program and strategies to engage and keep staff. Develop a training program for staff and to update the Highways Procedure Manual.	HDOT Administration	As required, ongoing	Ongoing. The HDOT has started to record training sessions and post it on their internal website (Socrata).
14	Active	Organizational	Changes in administration, or division priorities	Change in political/administrative priorities	Programs are implemented ineffectively and become less performance-based (subject to changing priorities)	Threat	High	High		Mitigate	Rely and focus on a data- and performance-driven process to establish priorities	HDOT Administration HWY-P	As required, ongoing	The MRTP process is designed to be data and performance-driven and to be more transparent on decision-making, incoprporating data, life cycle analyses, and asset performance.

TAMP Risk Management Register for HDOT

Risk Identification							Qualitative Risk Assessment			Risk Response Plan		Monitoring and Control		
#	Status	Risk Category	Risk Item	Cause	Effect	Threat or Opportunity	Probability	Impact	Risk Matrix	Response Strategy	Response Actions	Responsible Entity/Lead Office	Monitoring Frequency	Status Update
15	Active	Strategic	Maintenance Policies	Lack of clear maintenance policies (including other policies on jurisdictions and utility agreements regarding maintenance responsibilities)	Impacts to pavement and bridge conditions and project delivery	Opportunity	Moderate	Moderate		Mitigate	Develop consistent project delivery and maintenance policies District-wide for pavement and bridge.	HWY-P, -D, -L, Districts	As required, ongoing	Communication between the Districts and Bridge and Pavement Programs have increased and are becoming more formalized within the Programs. HWY-P is developing a formal process for a 10-year Mid-Range Plan to better help the Programs prioritize project delivery.
16	Active	Strategic	Data Management	Lack of resources to collect and process the appropriate data needed for Bridge Management Program and Pavement Management Program.	Impacts to an ineffective performance-based planning and programming process	Opportunity	Moderate	Moderate		Mitigate	Provide resources within HWY-DB and HWY-L for BMS and PMS.	HWY-P, -L, -DB, Districts	As required, ongoing	New processes and implementation of eConstruction is helping to improve the data flow from the field back to the Programs. The Programs are also being more pro-active about collecting the data they need for their Programs.
17	Active	Strategic	Length of procurement	State process for procurement is lengthy	Delay in project implementation (delivery)	Threat	High	Moderate		Transfer	Work closely with other the State Procurement Office, Attorney General, and FHWA	HDOT Administration	As required, ongoing	The Programs are using more IDIQ contracts in order to efficiently issue task orders as needed.
18	Active	Strategic	Complexity of environmental regulations	Multiple environmental challenges in Hawaii with numerous endangered species and historic/cultural resources	Delay in project implementation (delivery)	Threat	High	High		Minimize	Develop environmental guidelines and standards for the project managers	HWY-D	As required, ongoing	The HDOT worked with FHWA to develop a pre-approval process (for Section 106) for various pavement preservation strategies and surface treatments.
19	Active	Strategic	Lack of effective preventative practices in Hawaii	The technology or equipment for a wide variety of preventative strategies are not available in Hawaii	Limited strategies for preventative maintenance	Opportunity	Moderate	Moderate		Mitigate	Discuss the priority of preventative work with the asphalt industry and encourage new resources	HWY-P, -D, -C, -L, Districts	As required, ongoing	HWY-L has been conducting several pilot programs to test new asphalt mixtures.
20	Active	Strategic	Resistance to culture change and TAMP sustainment	Staff are used to the old way of doing business	Slower implementation of strategies	Opportunity	Low	Low		Mitigate	Provide education on the TAMP and how the revised processes will save time and money	HWY-P, -D, -C, -L, Districts	As required, ongoing	The HDOT staff have been utilizing FHWA technical support to assist with more education and workshops to better inform staff.

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Appendix B

Summary of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events

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Summary of Evaluation for Route 56, Kuhio Highway Milepost 5.77 to 5.87, Wailua River Bridge and Wailua Plantation Bridge

- DDIR ER-19(009) – In April 2018, parts of Kauai and Oahu received unprecedented amounts of rainfall. The heavy rains led to flash flooding and the Hawaii Emergency Management Agency reported that 532 homes were impacted by the flooding on Kauai and Oahu.[1] On the north side of Kauai, the torrential rains and flooding caused massive landslides cutting off access to the west side of Hanalei, Wainiha, and Haena for more than two weeks. In Hanalei, over a 24-hour period, a rain gauge measured over 28 inches of rain before the gauge stopped working. After 48 hours, Wainiha received more than 32" of rain.[2]

  The heavy rains and flooding in the rivers exposed the footings at the Wailua River Bridge and Wailua Plantation Bridge. Debris was removed and scour repairs to the exposed footings and timber foundations were completed. The majority of the work occurred below the water surface.

- DDIR ER-23(001) - In March 2020 a cold core Kona low brought extreme rainfall to the island of Kauai. Many locations recorded more than 6" of rainfall within a 24-hour period on the northern side of the island. Hanalei observed 8.33" of rainfall causing massive flooding, landslides, and road closures.[3] Scouring occurred at the bridge piers. The debris was cleared out and the timber piers were protected at Wailua River bridge. The grouted riprap placement (GRP) damage at the abutments was repaired. At the Wailua Plantation bridge the GRP at the abutments was repaired and additional grout bags were placed to protect the piers.

In order to address further damage to the timber foundations for the Wailua River Bridge, the HDOT has developed and is implementing a project to replace the substructure of the bridge, which was built in 1945 and has surpassed its 50-year intended design life. This permanent solution has been designed, advertised, and awarded. Construction is expected to start summer 2022 to replace the substructure.

[1] Record Kauai and Oahu Rainfall and Flooding - April2018 (weather.gov)
[2] Donated goods en route to Kauai as rescue crews, communities aid in recovery (hawaiinewsnow.com)
[3] March 2020 National Climate Report | National Centers for Environmental Information (NCEI) (noaa.gov)

Summary of Evaluation for Route 560, Kuhio Highway, Milepost 4.43

- DDIR ER-19 (003) - In April 2018, parts of Kauai and Oahu received unprecedented amounts of rainfall. The heavy rains led to flash flooding and the Hawaii Emergency Management Agency reported that 532 homes were impacted by the flooding on Kauai and Oahu.[4] On the north side of Kauai, the torrential rains and flooding caused massive landslides cutting off access to the west side of Hanalei, Wainiha, and Haena for more than two weeks. In Hanalei, over a 24-hour period, a rain gauge measured over 28 inches of rain before the gauge stopped working. After 48 hours, Wainiha received more than 32" of rain.[5]

  

  The April flooding created gullies and chutes of water into the hillsides on the mauka (mountain-side) slopes of the roadway at various locations. The channelized runoff damaged the mauka slopes and the roadway, creating a safety hazard for all roadway users.

  The debris was removed and slopes were stabilized. Where appropriate, a soil nail wall was constructed to stabilize the slope with erosion control matting.

- DDIR ER-24(003) – In March 2021, a low pressure system tapped into an area of enhance low level moisture embedded within the trade wind flow and created a significant amount of rainfall. Overall, March was the wettest month across the state since 2006.[6] Due to the saturated soils, a large landslide occurred and covered a portion of Kuhio Highway leading into Hanalei and cut off the communities west of the Hanalei Bridge from the rest of the island. At Milepost 4.43, the debris was removed from the roadway and the mauka slope. Soil nails and erosion mats were installed for stability.

In order to protect future roadway users, an anchored wire mesh system was constructed on the mauka slope.

[4] Record Kauai and Oahu Rainfall and Flooding - April2018 (weather.gov)
[5] Donated goods en route to Kauai as rescue crews, communities aid in recovery (hawaiinewsnow.com)
[6] https://kauainownews.com/2021/04/11/march-2021-rainfall-summary/

Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Hawaii	11	Kuakini Hwy	108.42	---	Oct 2006 6.5 Earthquake	10/15/2006	---	DR-1664	6.5 earthquake	ER-15(20)	Emergency Earthquake Rockfall Repairs, Various Location on Hawaii, Unit 2	MP108.8 Pour concrete footing, shotcrete slope wall, pave shoulder, install guardrail
Hawaii	11	Kuakini Hwy	108.43	---	Oct 2006 6.5 Earthquake	10/15/2006	---	DR-1664	6.5 earthquake	ER-15(20)	Emergency Earthquake Rockfall Repairs, Various Location on Hawaii, Unit 2	MP108.9 Fill void, pour concrete footing, shotcrete slope wall
Hawaii	11	Mamalahoa Hwy	114.17	114.02	Oct 2006 6.5 Earthquake	10/15/2006	---	DR-1664	6.5 earthquake	ER-15(20)	Emergency Earthquake Rockfall Repairs, Various Location on Hawaii, Unit 2	MP114.1 Regrade slope, place geotextile fabric, install GRP
Hawaii	11	Mamalahoa Hwy	117.13	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(20)	Emergency Earthquake Rockfall Repairs, Various Location on Hawaii, Unit 2	MP117.7 Repair damaged CRM waill with GRP, pave void adjacent to wall
Hawaii	11	Mamalahoa Hwy	10.15	10.02	Hurricane Lane	8/22/2018	HI18-3 8/23/2018 Hurricane Lane on Maui and Hawaii	HS021A	Heavy runoff	HS021A		GRP-line eroded ditch, construct CRM wall, install drainlines under driveways
Hawaii	11	Mamalahoa Hwy	15.49	---	Hurricane Lane	8/22/2018	HI18-3 8/23/2018 Hurricane Lane on Maui and Hawaii	HS020a	Heavy runoff	HS020a		Backfill eroded embankment, restore GRP, reconstruct pavement around culvert
Hawaii	11	Mamalahoa Hwy	28.40	31.81	Volcanic eruption and earhquakes	5/3/2018	HI18-2 5/3/2018 Kilauea Earthquake and Lava Flow	ERH-002(3)	Earthquake and magma movement			Emergency repairs to roadway and embankment. Grind vertical displacement. Fill sinkholes.
Hawaii	11	Mamalahoa Hwy	29.10	---	Volcanic eruption and earhquakes	5/3/2018	HI18-2 5/3/2018 Kilauea Earthquake and Lava Flow	ERH-003?	Earthquake and magma movement	ER-21(002)	Mamalahoa Hwy, Emergency Road Repairs, Vicinity of Mile Posts 28 to 32 (2018 Kilauea Lava Flow Event)	Repave roadway
Hawaii	19	Hawaii Belt Rd	12.74	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(21)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 3 (Route 19, Hawaii Belt Road, MP 12.9 to 45.0)	MP12.9 Construct/install retaining wall, backfill, pavement, curb and gutter, guardrails

Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Hawaii	19	Hawaii Belt Rd	25.86	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(21)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 3 (Route 19, Hawaii Belt Road, MP 12.9 to 45.0)	MP26.1 Construct/install manhole and riprap apron, shotcrete retaining system, pavement with soil anchors, guardrail, slope dressing
Hawaii	19	Hawaii Belt Rd	26.03	25.81	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(21)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 3 (Route 19, Hawaii Belt Road, MP 12.9 to 45.0)	MP26.3 Rock scaling, install rockfall impact barrier, draped wire mesh systems
Hawaii	19	Hawaii Belt Rd	26.41	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(21)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 3 (Route 19, Hawaii Belt Road, MP 12.9 to 45.0)	MP26.55 Rock scaling, remove boulders, install anchored wire mesh system
Hawaii	19	Hawaii Belt Rd	26.56	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(21)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 3 (Route 19, Hawaii Belt Road, MP 12.9 to 45.0)	MP26.65 Rock scaling, install draped wire mesh system
Hawaii	19	Hawaii Belt Rd	26.57	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(21)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 3 (Route 19, Hawaii Belt Road, MP 12.9 to 45.0)	MP26.75 Rock scaling, install draped wire mesh system
Hawaii	19	Hawaii Belt Rd	28.46	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(21)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 3 (Route 19, Hawaii Belt Road, MP 12.9 to 45.0)	MP28.6 Install rockfall impact barrier system
Hawaii	19	Hawaii Belt Rd	44.55	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(21)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 3 (Route 19, Hawaii Belt Road, MP 12.9 to 45.0)	MP44.9 Reconstruct pavement section
Hawaii	19	Hawaii Belt Rd	44.66	44.75	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(21)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 3 (Route 19, Hawaii Belt Road, MP 12.9 to 45.0)	MP45.0 Reconstruct pavement section, construct geocell/geogrid system, replace guardrails
Hawaii	19	Hawaii Belt Rd	44.99	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(21)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 3 (Route 19, Hawaii Belt Road, MP 12.9 to 45.0)	MP45.3 Reconstruct pavement section, construct geocell/geogrid system, replace guardrails

Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Hawaii	19	Kawaihae Rd	64.56	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(20)	Emergency Earthquake Rockfall Repairs, Various Location on Hawaii, Unit 2	MP64.8 Cold plane and repave roadway
Hawaii	19	Queen Kaahumanu Hwy	71.39	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(20)	Emergency Earthquake Rockfall Repairs, Various Location on Hawaii, Unit 2	MP71.6 Cold plane and repave roadway
Hawaii	19	Queen Kaahumanu Hwy	71.98	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(20)	Emergency Earthquake Rockfall Repairs, Various Location on Hawaii, Unit 2	MP73.3 Crack-sealing of culvert crossing headwalls with epoxy
Hawaii	19	Hawaii Belt Rd	3.24	---	Hurricane Lane	8/22/2018	HI18-3 8/23/2018 Hurricane Lane on Maui and Hawaii	HS008a	Heavy runoff down slope	HS008a		Construct MSE with GRP face
Hawaii	19	Hawaii Belt Rd	3.64	---	Hurricane Lane	8/22/2018	HI18-3 8/23/2018 Hurricane Lane on Maui and Hawaii	HS010a	Heavy runoff down slope	HS010a		Construct MSE with GRP face
Hawaii	19	Hawaii Belt Rd	6.34	---	Hurricane Lane	8/22/2018	HI18-3 8/23/2018 Hurricane Lane on Maui and Hawaii	HS022N	Heavy stream flow	HS022N		Scour repairs at pier footings
Hawaii	19	Hawaii Belt Rd	6.58	---	Hurricane Lane	8/22/2018	HI18-3 8/23/2018 Hurricane Lane on Maui and Hawaii	HS014a	Heavy runoff down slope	HS014a		Construct MSE wall with GRP face
Hawaii	19	Hawaii Belt Rd	6.72	---	Hurricane Lane	8/22/2018	HI18-3 8/23/2018 Hurricane Lane on Maui and Hawaii	HS015a	Heavy runoff down slope	HS015a		Construct Keystone MSE wall with GRP face
Hawaii	19	Hawaii Belt Rd	19.25	---	Hurricane Lane	8/22/2018	HI18-3 8/23/2018 Hurricane Lane on Maui and Hawaii	HS002a	Heavy runoff	HS002a		Place GRP on slope, restore water lateral
Hawaii	190	Mamalahoa Hwy	12.04	12.16	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP12.1-Site 1 Restore slope, construct containment curb, pave shoulder, install guardrail
Hawaii	190	Mamalahoa Hwy	13.48	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP13.4-Site 2 Restore slope, place GRP, construct CRM wall, pave shoulder, install guardrail

Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Hawaii	190	Mamalahoa Hwy	13.84	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP13.80-13.81-Site 3 Restore slope, place GRP, construct CRM wall, pave shoulder, install guardrail
Hawaii	190	Mamalahoa Hwy	15.11	15.28	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP15.3-Site 4 Restore slope, place GRP, construct CRM wall, pave shoulder, install guardrail
Hawaii	190	Mamalahoa Hwy	27.73	28.37	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP27.2-28.7=Site 6 Restore slope, place GRP, construct CRM wall, pave shoulder, repave roadway
Hawaii	190	Mamalahoa Hwy	27.75	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP27.7-Site 5 Scale slope, drape wire mesh
Hawaii	190	Mamalahoa Hwy	27.86	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP27.7-Site 5 Scale slope, drape wire mesh
Hawaii	190	Mamalahoa Hwy	29.02	29.11	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP29.2-Site 7 Restore slope, pave shoulder
Hawaii	190	Mamalahoa Hwy	29.19	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP29.2-Site 7 Restore slope, pave shoulder
Hawaii	190	Mamalahoa Hwy	29.44	29.62	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP29.5-29.6=Site 8 Restore slope, place GRP, construct CRM wall, pave shoulder, reset guardrail
Hawaii	190	Mamalahoa Hwy	29.66	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP29.7-Site 9 Scale slope, drape wire mesh

Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Hawaii	190	Mamalahoa Hwy	30.66	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP30.8-Site 10 Scale slope, drape wire mesh, apply shotcrete to slope, replace cattle fence
Hawaii	190	Mamalahoa Hwy	31.06	30.95	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(22)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 4	MP31.1-31.5=Site 11 Scale slope, drape ring net, place rip-rap, repave gutter
Hawaii	200	DKI Hwy	0.87	1.37	Hurricane Lane	8/22/2018	HI18-3 8/23/2018 Hurricane Lane on Maui and Hawaii	HS002E	Heavy runoff	ER-20(005), Unit 1	DKI Highway, Emergency Roadway Repairs, Vicinity of Mile Post 8.9 to Mile Post 11.1 (Route 200)	Restore rip rap drainage ditch, instll pipe culvery, headwall
Hawaii	200	DKI Hwy	2.37	3.07	Hurricane Lane	8/22/2018	HI18-3 8/23/2018 Hurricane Lane on Maui and Hawaii	HS001E	Heavy runoff	ER-20(005), Unit 1	DKI Highway, Emergency Roadway Repairs, Vicinity of Mile Post 8.9 to Mile Post 11.1 (Route 200)	Restore rip rap drainage ditch, concrete access crossings
Hawaii	250	Kohala Mountain Rd	0.26	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(19)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 1	MP2.7-Site 1 Reconstruct slope with geogrid/shotcrete, roadway and shoulder. Install guardrail.
Hawaii	250	Kohala Mountain Rd	5.29	5.49	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(19)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 1	MP7.9-Site 2 Reconstruct pavement section
Hawaii	270	Akoni Pule Hwy	12.67	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(19)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 1	MP14.5-Site 3 Replace headwalls; install riprap; reconstruct shoulders, swale; install guardrail
Hawaii	270	Akoni Pule Hwy	25.33	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	ER-15(19)	Emergency Earthquake Rockfall Repairs, Various Locations on Hawaii, Unit 1	MP27.2-Site 5 Reconstruct roadway, repair spalls and cracks in bridge

Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Kauai	50	Kaumualii Hwy	11.24	---	Hurricane Flossie	8/13/2007			Excessive rainfall	ER-14(8)	Kaumualii Hwy, Emergency Repairs and Drainage Improvements at Various Locations	Removed trees, rocks, and material; restore pavement and roadway; place shotcrete over existing dumped riprap; install thru gutter.
Kauai	50	Kaumualii Hwy	11.50	---	Hurricane Flossie	8/13/2007			Excessive rainfall	ER-14(8)	Kaumualii Hwy, Emergency Repairs and Drainage Improvements at Various Locations	Repair/replace thru/concrete gutter
Kauai	50	Kaumualii Hwy	16.97	---	Hurricane Flossie	8/13/2007			Excessive rainfall	ER-14(8)	Kaumualii Hwy, Emergency Repairs and Drainage Improvements at Various Locations	Clean silt basin. New paved swale, grassed swale, GRP swale and apron, Geocell system with hydroseed, guardrail, chain-link fabric
Kauai	50	Kaumualii Hwy	27.56		March 2020 Heavy Rains and Flooding	3/27/2020	HI20-1 3/27/2020 Storms and Flooding	ER-23(002)	Heavy rains, runoff	23(002), Unit 1	Kekaha Drainage Canal 3 Repairs	Repair canal w/CLSM, GRP (incl traffic control)
Kauai	56	Kuhio Hwy	5.80	---	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-009	Heavy rains and flooding	ER-19(009)	Kuhio Hwy, Wailua Bridge Scour Remediation	Concrete grout bag scour measures around piers
Kauai	56	Kuhio Hwy	5.80	---	March 2020 Heavy Rains and Flooding	3/27/2020	HI20-1 3/27/2020 Storms and Flooding	ER-23(001)	Heavy rains, runoff	23(001)	Wailua Bridge Permanent Repairs	Concrete piers with drilled shafts
Kauai	56	Kuhio Hwy	5.82		March 2020 Heavy Rains and Flooding	3/27/2020	HI20-1 3/27/2020 Storms and Flooding	ER-23(003)	Heavy rains, runoff	23(003), Unit 1	Wailua Plantation Bridge Scour Repairs, GRP	Scour repairs, GRP

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Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Kauai	56	Kuhio Hwy	5.90	6.20	Rains and Flooding	3/8/2021		KS-004	Heavy rains and flooding	ER-24(004)		Emergency work: Debris removal, place Super Sack sandbags at toe of slope below bike path. Provide traffic control and BMPs. Permanent work: Rip-rap revetment over Kyowa rock-filled bags or Tensar mattress, and Sandsaver modular wall over Kyowa rock-filled bags.
Kauai	56	Kuhio Hwy	9.92	---	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-010	Heavy rains and flooding	ER-19(010)	Kuhio Hwy, Emergency Scour Repair at Kapaa Stream Bridge	Concrete grout bag scour measures around middle pier.
Kauai	56	Kuhio Hwy	21.69	---	40 Days of Rain	2/20/2006			40 days of rain, Kaloko dam breach	ER-14(1)	Kuhio Hwy, Emergency Repairs, Vicinity of M.P. 21.70 (Wailapa Stream)	Resize inlet and outlet structures, harden stream invert and banks, repave, install new guardrails
Kauai	56	Kuhio Hwy	24.87	---	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-005	Heavy rains and flooding	ER-19(005)	Kuhio Hwy, Emergency Debris Removal and Repairs at Kalihiwai	Replace CRM wall
Kauai	56	Kuhio Hwy	24.98	24.81	Rains and Flooding	2/26/2012	HI12-1 2/26/2012 Heavy Rains and Severe Flooding		Slope instability	ER-16(003)	Kuhio Hwy Emergency Slope Stabilization in the Vicinity of Kalhiwai Bridge, Unit 1	Remove trees, perform slope scaling, hydromulch, install anchor wire mesh, draped wire mesh, chain-link fence, cold plane and repave roadway
Kauai	560	Kuhio Hwy	0.88	1.07	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	---	Rockfall	HWY-K-01-19M	Kuhio Hwy (Rte 560) Emergency Slope and Rockfall Mitigation, Post-April2018 Events, Kauai	Mauka - Grouted anchors with wire mesh, erosion control matting. 1000 KJ rockfall impact barriers Makai - Grouted anchors with wire mesh, erosion control matting
Kauai	560	Kuhio Hwy	0.94	---	Rains and Flooding	2/26/2012	HI12-1 2/26/2012 Heavy Rains and Severe Flooding		Heavy rains and flooding	ER-16(004)	Kuhio Hwy (Route 560) Emergency Slope Stabilization in Hanalei @ MP1	Install vertical and battered soil nails, reconstruct roadway, re-install guardrail/post

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Due to Emergency Events

Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Kauai	560	Kuhio Hwy	0.98	0.91	Rains and Flooding	3/8/2021		KS-002	Heavy rains and flooding	ER-24(003)		Emergency work: Debris removal and roadway cleanup. Permanent: Soil nails, drainage inlets, guardrail, anchored wire mesh
Kauai	560	Kuhio Hwy	4.43	4.70	Rains and Flooding	3/8/2021		KS-003	Heavy rains and flooding	ER-24(003) & ER-24(003) Unit 1	Kuhio Hwy Emergency Flood Repairs in the Vicinity of MP 4.4 to 6.3.	Emergency work: Debris removal and roadway cleanup. Traffic control and BMPs. Permanent: Soil nails and anchored wire mesh system.
Kauai	560	Kuhio Hwy	4.43		April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-003	Heavy rains and landslides	ER-19(003)	Kuhio Hwy Emergency Flood Repairs in the Vicinity of MP 4.4 to 6.3.	Soil nail wall and rock revetment
Kauai	560	Kuhio Hwy	4.50	---	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-003	Heavy rains and landslides	ER-19(003)	Kuhio Hwy Emergency Flood Repairs in the Vicinity of MP 4.4 to 6.3.	Roadway repair and guardrail
Kauai	560	Kuhio Hwy	5.10	5.30	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-008	Heavy rains and landslides	ER-19(008), Unit 1	Kuhio Hwy, Emergency Road Repairs at Lumahai	Restoration of constructed work and completion of items originally contracted under ER-16(002)
Kauai	560	Kuhio Hwy	5.31	---	Rains and Flooding	2/26/2012	HI12-1 2/26/2012 Heavy Rains and Severe Flooding		Heavy rains and landslides	560A-02-12	Kuhio Hwy, Emergency Slope Repairs, Vicinity of Lumahai	Cold plane/reconstruct/repave roadway, mat and hydromulch slopes, construct GRP swale, install anchored wire mesh, shotcrete wall, install guardrail
Kauai	560	Kuhio Hwy	5.43	5.45	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-002	Heavy rains and landslides	ER-19(002)	Kuhio Hwy (Route 560) Emergency Slope Stabilization in Lumahai in the Vicinity of MP 6.0 to 6.1	Site 5. Clear and grub slope. Install soil nails and shotcrete. Restore roadway, guardrails

Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Kauai	560	Kuhio Hwy	6.17	6.18	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-002	Heavy rains and landslides	ER-19(002)	Kuhio Hwy (Route 560) Emergency Slope Stabilization in Lumahai in the Vicinity of MP 6.0 to 6.2	Site 4 Clear and grub, and excavate slope. Install soil nails, shotcrete slope. Restore roadway and guardrails.
Kauai	560	Kuhio Hwy	6.20	6.21	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-002	Heavy rains and landslides	ER-19(002)	Kuhio Hwy (Route 560) Emergency Slope Stabilization in Lumahai in the Vicinity of MP 6.0 to 6.3	Site 3 Clear and grub, and excavate slope. Install soil nails, shotcrete slope. Restore roadway and guardrails.
Kauai	560	Kuhio Hwy	6.22	6.12	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-002	Heavy rains and landslides	ER-19(002)	Kuhio Hwy (Route 560) Emergency Slope Stabilization in Lumahai in the Vicinity of MP 6.0 to 6.4	Zone (Slide) B Trim, excavate slope. Install soil nails and anchored wire mesh. Place GRP. Restore roadway, guardrail, landscaping.
Kauai	560	Kuhio Hwy	6.29	6.31	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-002	Heavy rains and landslides	ER-19(002)	Kuhio Hwy (Route 560) Emergency Slope Stabilization in Lumahai in the Vicinity of MP 6.0 to 6.5	Site 2 Clear and grub, and excavate slope. Install soil nails, shotcrete slope. Construct revetment. Restore roadway and guardrails.
Kauai	560	Kuhio Hwy	6.34	6.23	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-002	Heavy rains and landslides	ER-19(002)	Kuhio Hwy (Route 560) Emergency Slope Stabilization in Lumahai in the Vicinity of MP 6.0 to 6.4	Zone (Slide) A Trim, excavate slope. Install soil nails and anchored wire mesh. Place GRP. Restore roadway, guardrail, landscaping.
Kauai	560	Kuhio Hwy	6.73	?	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai		Heavy Rains and Landslides	560A-01-18	Kuhio Hwy, Emergency Slpe Stabilization in the Vicinity of Haena and Wainiha	Install rock slope stabilization measures including mesh, soil nails, micropiles; concrete walls and footings; AC pavement; guardrails?
Kauai	560	Kuhio Hwy	8.75	---	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-001	Heavy rains and flooding	ER-19(001)	Kuhio Hwy Emergency Road Repairs in Haena	Replace ford crossing with precast concrete planks

Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Kauai	560	Kuhio Hwy	9.55	---	April 2018 Kauai Storms	4/14/2018	HI18-1 4/14/2018 Flooding and Landslides on Kauai	ERK-001	Heavy rains and flooding	ER-19(001)	Kuhio Hwy Emergency Road Repairs in Haena	Replace stream crossing with precast concrete planks
Maui	30	Honoapiilani Hwy	10.33	10.39	40 Days of Rain	2/20/2006	?	?	?	30C-01-07M	Honoapiilani Hwy, Emergency Rockfall Mitigation at the Tunnel	?
Maui	30	Honoapiilani Hwy	13.00	16.00	Rains and Flooding	2/26/2012	HI12-1 2/26/2012 Heavy Rains and Severe Flooding		Wind, rain, surf, storm surge, flooding	ER-17(002)	Honoapiilani Hwy, Emergency Shoreline Repairs, MP 13 to MP 16	Shoreline repairs
Maui	30	Honoapiilani Hwy	18.63	18.30	Waves and Heavy Rain	6/7/2012	?	?	Erosion from waves and heavy rain	30C-01-12	Honoapiilani Hwy, Shoreline Improvements in the Vicinity of Launiupoko	Shoreline improvements?
Maui	360	Hana Hwy	8.00	7.95	Rains and Flooding	9/11/2016	?	?	Heavy rains and flooding	360AB-01-16	Hana Hwy Improvements, Phase 2B, Huelo to Hana	Construct/install soil nailed retaining wall, pavement structure, guardrail, drainline, pavement markings, signs
Maui	360	Hana Hwy	10.61	---	Rains and Flooding	2/26/2012	HI12-1 2/26/2012 Heavy Rains and Severe Flooding		Slope instability	ER-16(008)	Hana Hwy Route 360 Emergency Repairs	Clear slope surface, install anchored erosion mat, anchored wire mesh, new guardrai and chain-link fence, cold planed/repaved roadway, and new pavement
Maui	360	Hana Hwy	11.27	---	Rains and Flooding	9/11/2016	?	?	Heavy rains and flooding	360AB-01-16	Hana Hwy Improvements, Phase 2B, Huelo to Hana	Install signage, guardrail

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Maui	360	Hana Hwy	13.81	---	Rains and Flooding	2/26/2012	HI12-1 2/26/2012 Heavy Rains and Severe Flooding		Slope instability	ER-16(009)	Hana Hwy Route 360 Emergency Repairs	Clear slope surface, install anchored erosion mat, guardrail, retaining wall, micropiles, AC berm, and reconstructed pavement
Maui	360	Hana Hwy	15.95	---	Rains and Flooding	2/26/2012	HI12-1 2/26/2012 Heavy Rains and Severe Flooding		Slope instability	ER-16(010)	Hana Hwy Route 360 Emergency Repairs	Clear slope surface, install anchored erosion mat and anchored wire mesh
Maui	360	Hana Hwy	17.61	---	Rains and Flooding	9/11/2016	?	?	Heavy rains and flooding	360AB-01-16	Hana Hwy Improvements, Phase 2B, Huelo to Hana	Regrade slope, construct new pavement, install guardrail
Maui	360	Hana Hwy	18.85	---	Rains and Flooding	9/11/2016	?	?	Heavy rains and flooding	360AB-01-16	Hana Hwy Improvements, Phase 2B, Huelo to Hana	Construct/install soil nailed retaining wall, pavement structure, guardrail, pavement markings
Maui	360	Hana Hwy	19.04	19.31	Rains and Flooding	12/4/2007	?	?	Heavy rains and flooding	360AB-02-98, Ph 2	Route 360 Hana Highway, Rockfall Mitigation, Phase 2	New 10'-high, minimum, rockfall impact barrier
Maui	360	Hana Hwy	19.35	---	Storm	10/28/2000	?	?	Heavy rains and flooding?	ER-12(5)	Hana Highway, Emergency Federal-aid Project, Roadway Repairs at Various Locations	Construct concrete slab, concrete gutter; install guardrail
Maui	360	Hana Hwy	21.80	---	Rains and Flooding	9/11/2016	?	?	Heavy rains and flooding	360AB-01-16	Hana Hwy Improvements, Phase 2B, Huelo to Hana	Construct CRM wall, install signage, new pavement markings

Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Maui	360	Hana Hwy	28.28	---	Storm	10/28/2000	?	?	Heavy rains and flooding?	ER-12(5)	Hana Highway, Emergency Federal-aid Project, Roadway Repairs at Various Locations	Repave shoulder, construct gabion wall and GRP on slopes, restore undermined CRM wall and pavement, install guardrail
Maui	360	Keawa Place (end of Hana	34.40	---	Storm	10/28/2000	?	?	Heavy rains and flooding?	ER-12(5)	Hana Highway, Emergency Federal-aid Project, Roadway Repairs at Various	Constructed concrete-lined ditch, chain-link fence, pre-cast cover over ditch; repaired CRM wall and
Maui	360	Keawa Place (end of Hana Hwy)	34.58	---	Storm	10/28/2000	?	?	Heavy rains and flooding?	ER-12(5)	Hana Highway, Emergency Federal-aid Project, Roadway Repairs at Various Locations	Reconstruct CRM wall, fill void with concrete
Oahu	61	Pali Hwy	5.42	---	40 Days of Rain	2/20/2006	---	---	40 days of rain	61A-01-07M	Pali Hwy Slope Stabilization Vicinity of 1st Pali Tunnel	Grade and hydromulch slope, install anchored erosion control mat, fill eroded shoulder area
Oahu	61	Pali Hwy	5.66	---	40 Days of Rain	2/20/2006	---	---	40 days of rain	61A-01-07M	Pali Hwy Slope Stabilization Vicinity of 1st Pali Tunnel	Remove trees, grade and hydromulch slope, install Anchormat system
Oahu	61	Pali Hwy	5.88	---	Prolonged heavy rains	2/9/2019	HI19-1 2/9/2019 Pali Highway Landslide	ER-22(001), ER-22(002)	Prolonged rainfall	ER-22(02)	Pali Hwy, Landslide Mitigation Project	Scaling, rockfall mitigation, tunnel extension
Oahu	61	Kailua Rd, along Kalaheo HS	10.29	10.53	40 Days of Rain	2/20/2006	---	---	40 days of rain	61D-02-06	Kailua Road, Permanent Rockfall and Landslide Mitigation	Rockfall mitigation (removal, rock bolts, strapping, pedestals), interceptor trech/baffle, cable net system, catchment ditch, anchored wire mesh, rock protection fence, median landscaping
Oahu	83	Kamehameha Hwy	20.81	---	Rains and Flooding	3/8/2021		OS-005	Heavy rains and flooding	?	?	Remove damaged pedestrian walkway and debris, replace walkway, repair rock wall and channel lining, backfill voids with CLSM. Provide traffic control and BMPs.

Island	Route Number	Route Name	Milepost Start	Milepost End	Event Name	Event Start Date	FHWA Disaster Name	FHWA DDIR	Cause of Damage	Project Number	Project Name	Project Scope
Oahu	99001	Kamehameha Hwy Ext to H-1 & H-2 (short segment btwn Kuala St and Waihona St)	0.23	---	Rains and Flooding	3/8/2021		OS-007	Heavy rains and flooding			Clear 80' x 60' area, scale loose rocks, remove damaged mesh. Install new mesh and hydroseed area. Provide traffic control and BMPs, remove and dispose of debris.
Hawaii County	19	Hawaii Belt Rd	104.40	---	Oct 2006 6.5 Earthquake	10/15/2006	---	---	6.5 earthquake	?	?	Slope stabilization
Hawaii County	2850	Akolea Road	0.48	---	November 2000 Flood		2000 Flood	---	Flooding	C.000130	Flood Damage Repairs to Akolea Road Bridge	Repair to Road Bridge
Maui County	3700	Hana Highway	25.38	25.28	10/15/06 Earthquake	10/15/2006	N/A	N/A	6.3 earthquake	A: 06-66	A: Emergency Work for Kalepa-Alalele Rockfall Protection	A: Slope stabilization & installation of rockfall netting B: 8/16/17 - Repair tears in the rockfall netting C: 8/30/17 - Repair rockfall netting due to damage from a landslide
Maui County	3700	Hana Highway	25.29	25.39	Tropical Storm Iselle	8/7/2014	N/A	N/A	Tropical Storm Iselle	In-house	---	A: 4/3/17 - Repair sinkhole in the road B: 8/16/17 - Repair the road and revetment
Maui County	3700	Hana Highway	25.29	25.39	Tropical Storm Iselle	8/7/2014	N/A	N/A	Tropical Storm Iselle	A: 16-37 B: 14-54 C: 19-31	A: Kalepa Repairs Project B: Kalepa Emergency Repairs C: Kalepa Revetment & Seawall Repair	A: Basis of design report to determine scope of work B: Road & revetment repair C: Road & revetment repair
Maui County	3700	Hana Highway	29.10	---	Hawaii Severe Storms, Flooding, Landslides, and Mudslides	9/11/2016	N/A	N/A	Excessive rain	17-34	Hana Highway Landslide Repair at MP42.3 (Rte 31)	Slope stabilization and erosion control

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