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# MBTA **Transit Asset Management Plan**



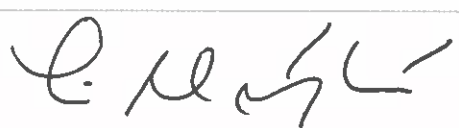
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Transportation Authority

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Massachusetts Department of Transportation

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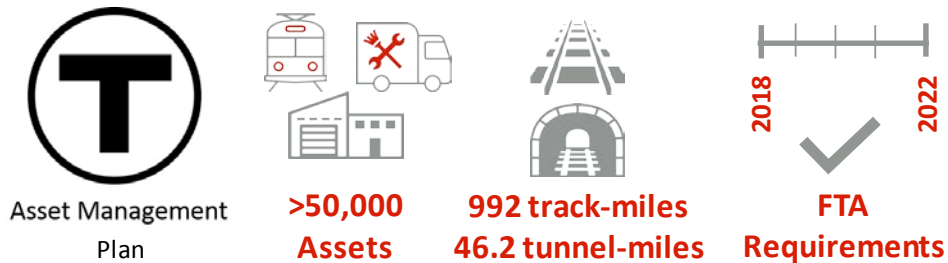
  

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# Executive Summary

MBTA’s 2018 Transit Asset Management (TAM) Plan documents its asset portfolio, current condition, and asset management practices while setting the direction, strategies, and actions to improve the management of its physical assets.

Figure ES 1. Summary of MBTA TAM Plan



The Massachusetts Bay Transportation Authority (MBTA) is one of the oldest and largest transit agencies in the United States, providing over 1.3 million daily passenger trips across the Greater Boston area. In total, the MBTA relies on over 50,000 individual assets to provide this service.

The multimodal agency operates:

- **Transit Rail:** 293 miles of track, consisting of five lines connecting riders across downtown Boston. Three are heavy rail rapid transit lines (Red, Orange, and Blue lines) and two are light rail lines (Green Line and the Mattapan High Speed Trolley Line).
- **Bus:** 173 bus routes, with five bus rapid transit lines (Silver Line).
- **Ferry:** Service through the Boston Harbor and connections between Charlestown Navy Yard, Logan Airport Boat Ferry Dock, Hull, and Hingham.
- **The RIDE:** The MBTA on-demand pick-up and drop-off transit service.
- **Commuter Rail:** over 699 miles of track consisting of 15 lines across the Greater Boston area and parts of Rhode Island.

## TAM PLAN OBJECTIVES

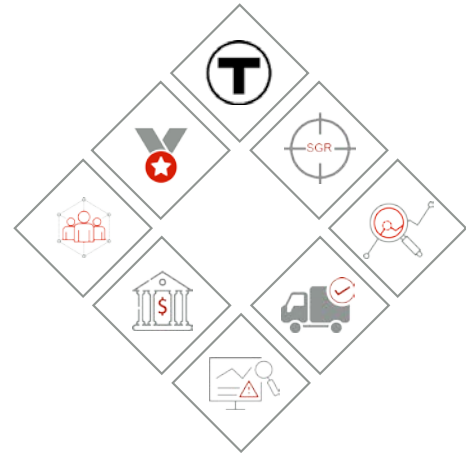
This TAM Plan establishes MBTA’s approach to managing assets that deliver regional public transportation services in the City of Boston and surrounding suburbs. Its purpose is to:

- Document the asset portfolio – including nature, extent, age and condition of MBTA’s physical assets.
- Identify existing and/or proposed levels of service to be achieved with these assets.
- Identify lifecycle management needs by asset class – including maintenance, overhaul, renewal and replacement.
- Assess the resources required to support safe and reliable service delivery, and to bring the assets to a state of good repair (SGR).
- Document the key processes, organization and tools that enable effective asset management.
- Establish action plans for improving MBTA’s approach to asset management activities.

## ASSET MANAGEMENT POLICY

The MBTA is committed to implementing a strategic process for acquiring, operating, maintaining, upgrading and replacing its transit assets to support the agency’s vision, mission, and values set forth in its strategic plan. The MBTA Asset Management Policy consists of seven principles by which MBTA will manage its assets to effectively deliver public transportation services in the greater Boston region. The seven principles address state of good repair, transparency, delivering services efficiently and effectively, risk, safety, fiscal responsibility, and social responsibility.

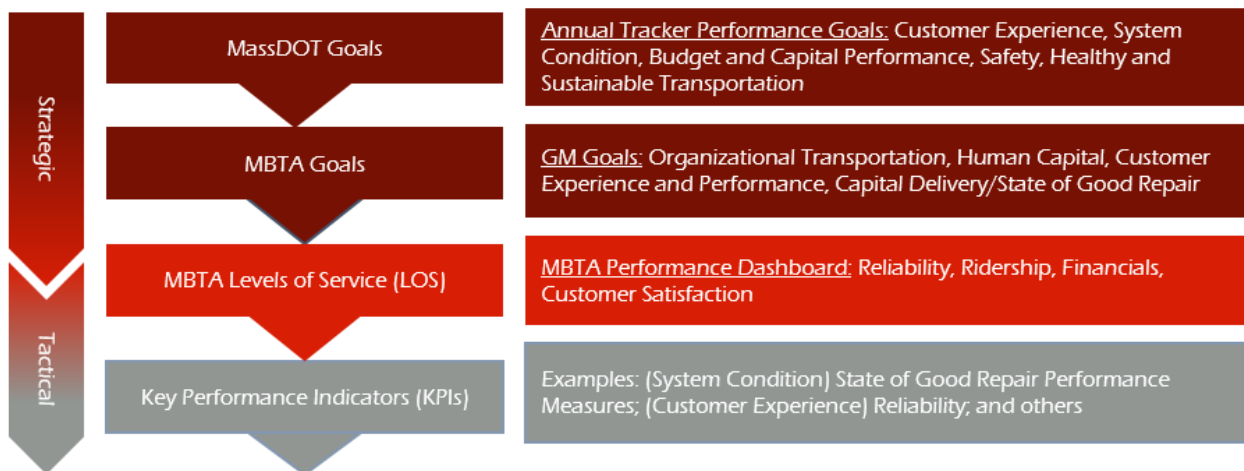
Figure ES 2. MBTA Policy Principles



## ASSET AND ASSET MANAGEMENT PERFORMANCE

An asset management framework shapes how performance is measured and managed organization-wide to meet the needs of customers and stakeholders. It establishes the relationship between the strategic goals of the MBTA, levels of service, and the required technical performance of the physical assets involved.

Figure ES 3. MBTA Performance Framework

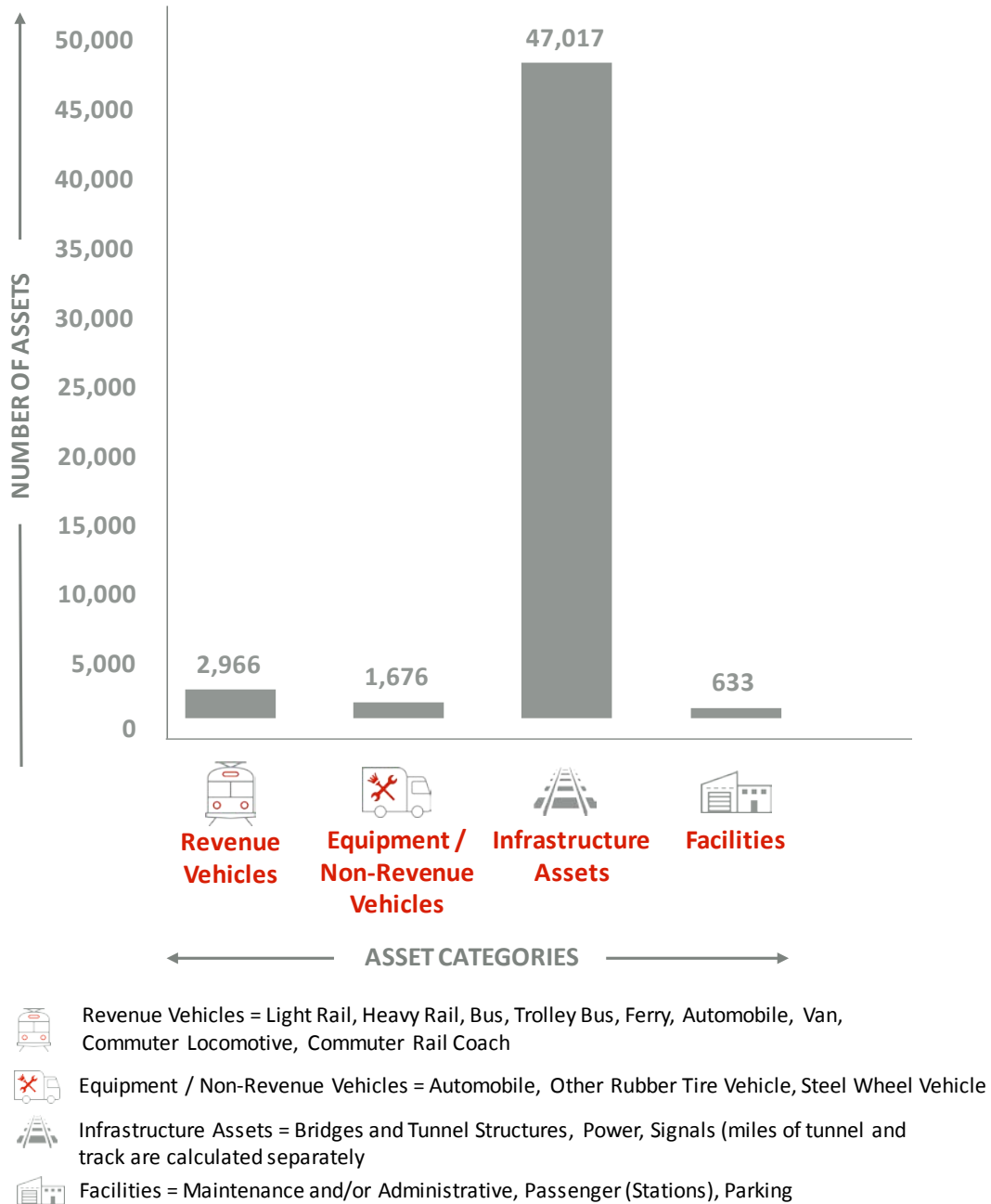


**Current Performance:** Annual performance is reported through the MassDOT *Tracker Performance Management Report* and National Transit Database. MBTA’s current performance in the areas of customer service, system condition, budget and capital performance, health and sustainable transportation are provided below. MassDOT Office of Performance Management and Innovation (OPMI) is also working with MBTA leaders and the FMCB to establish long-term performance targets.

## ASSET PORTFOLIO

MBTA manages a vast portfolio of assets, consisting of over 50,000 individual assets, including 992 miles of track and 46.2 miles of tunnel. Figure ES 4 provides a snapshot of MBTA’s current asset inventory. The inventory presented represents approximately 60% of MBTA’s baselined asset inventory (in accordance with FTA requirements) and will be updated following completion of MBTA’s inventory validation and condition assessments currently underway.

Figure ES 4. MBTA Asset Inventory (Approximately 60% of Total Asset Inventory)

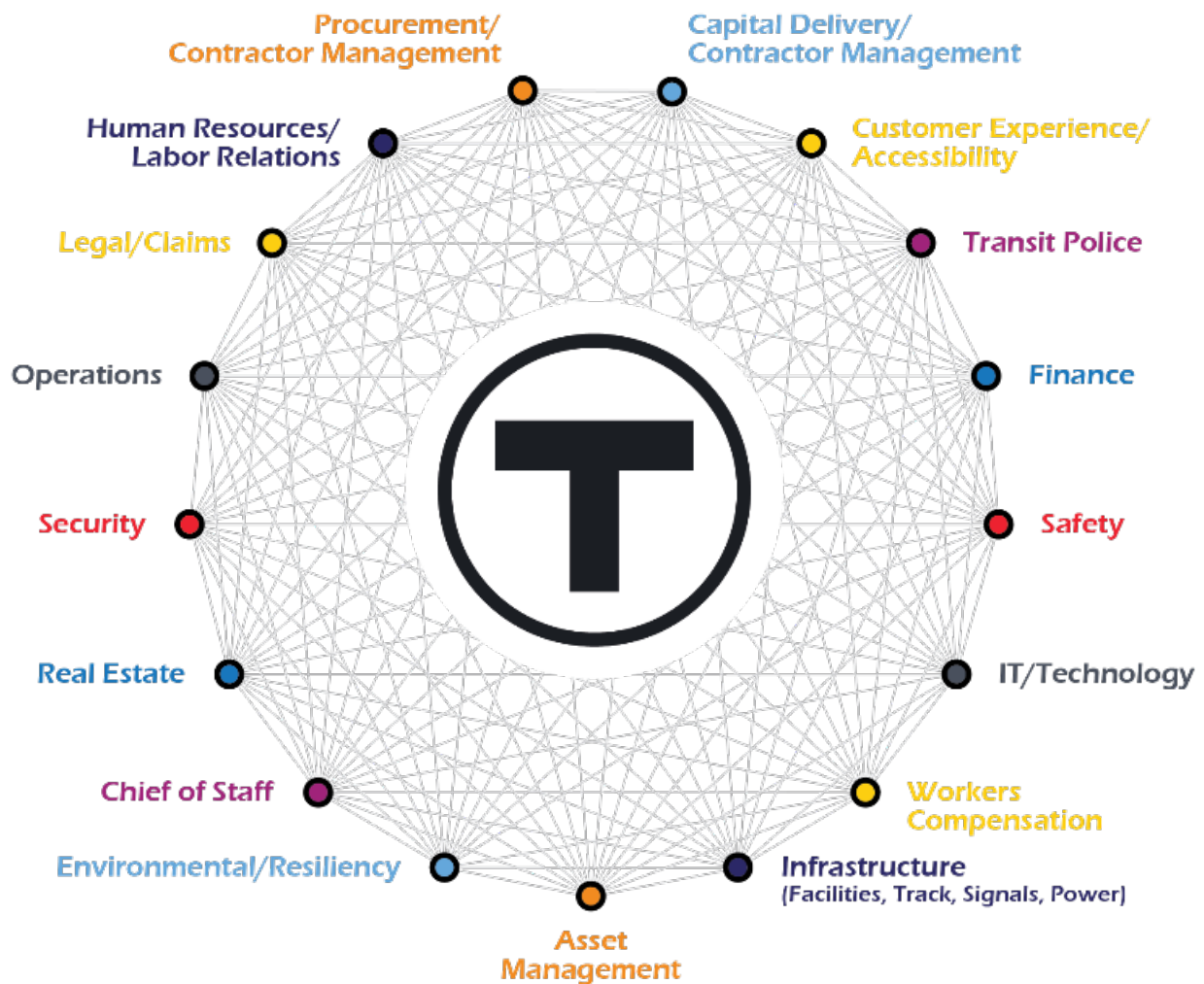


## RISK MANAGEMENT

The Transit Asset Management Final Rule (49 CFR § 625.33 (d)) requires that a “provider must give due consideration to those state of good repair projects to improve that pose an identified unacceptable safety risk when developing its investment prioritization.” Moreover, incorporating risk processes into MBTA’s asset management and asset lifecycle management strategies supports MBTA’s goal to maintain its assets in a state of good repair and is good industry practice.

MBTA’s established processes and procedures for managing risk have historically focused on insurance, weather and other incident management, in addition to safety risk management linked to the agency’s safety management policy and safety assurance, as mandated by the MAP-21, FAST Act, and 49 CFR 673 requirements for development of a Transit Agency Safety Plan. MBTA’s recent efforts to develop an enterprise risk management approach builds upon these established processes while supporting asset management decision making, planning, and prioritization.

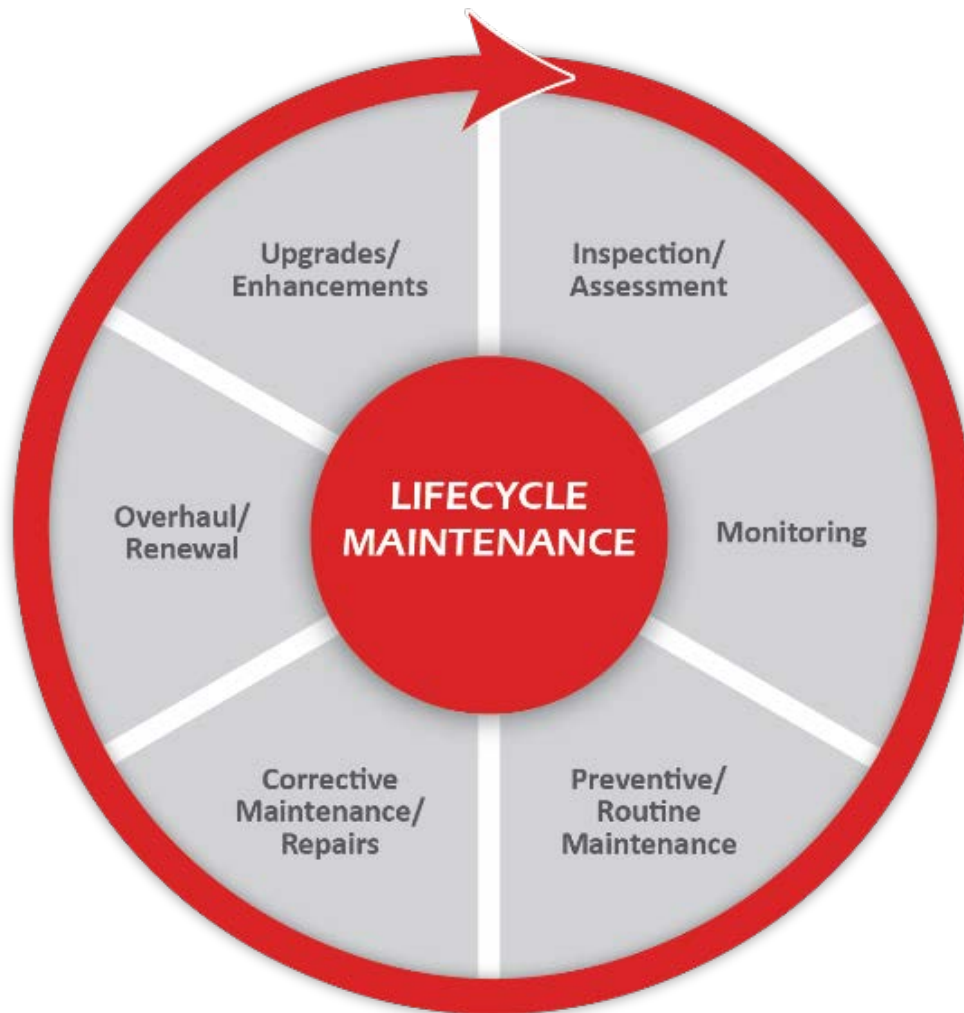
Figure ES 5. Proposed MBTA Enterprise Risk Management Council Management Council



## LIFECYCLE MANAGEMENT STRATEGIES

Lifecycle management strategies outline, through proposed actions, how an asset is managed over its life. MBTA is reviewing and further developing these asset class strategies as part of the organization's 2018-2019 asset management program of work to capture the steady state capital maintenance activities and resources required to achieve and maintain a state of good repair.

Figure ES 6. MBTA Lifecycle Management Strategies



This TAM Plan outlines lifecycle strategies MBTA's management strategies for assets are primarily driven by inspections and preventive maintenance strategies. MBTA's maintenance practices comply with industry standards (e.g., Original Equipment Manufacturer [OEM], American Railway Engineering and Maintenance [AREMA], Federal Railroad Administration [FRA], and National Fire Protection Association [NFPA]) and state requirements (e.g., MassDOT, DPU), and MBTA specific requirements.



## Vehicles

Preventive maintenance for MBTA's bus fleet complies with and exceeds OEM requirements and MBTA specific requirements. Bus fleet preventive maintenance activities are usage based, scheduled by 6,000-mile intervals, with differing scopes at various intervals (e.g., 6,000-mile, 12,000-mile, and 18,000-mile intervals).

For Rail Fleet, maintenance strategies involve continuous and frequent preventive maintenance inspections. Parts replacement is also on a programmed schedule to prevent component failure. Additionally, maintenance campaigns on certain lines have also been instituted (e.g., annual lubrication programs, component overhauls, and equipment upgrades) to improve reliability and performance of assets.

For Commuter Rail, in addition to regular inspection and preventive maintenance strategies, main engine overhauls as well as mid-life overhauls are performed for locomotives.

## Infrastructure

The Transit Maintenance of Way (MOW) Department is responsible for the maintenance and repair of all track. The Maintenance of Way Department regularly performs all types of lifecycle management activities including inspection, preventive maintenance, corrective maintenance, repairs/renewals/replacement, capital improvements, construction support, special projects, asphalt paving, to maintain assets under its control. Additionally, MOW performs ROW trash cleanup and removals, pot hole repair, snow removal, and landscaping.

Track inspections are performed per 220 CMR 151, MBTA System Safety Program Plan guidelines, and the MBTA Light Rail Transit Track Maintenance and Safety Standards, and MBTA Heavy Rail Transit Track Maintenance and Safety Standards.

The Power System Maintenance Department for Transit is responsible for the maintenance and operation of: gas generation plant, bulk power yard, South Boston Switching Station, AC cabling and duct bank system, traction power substations, DC distribution system, overhead catenary system, power SCADA system, generator control system, and ISO dispatch system.

The Signal and Communications Maintenance Department for Transit is responsible for the maintenance and operation of signal assets including: track circuits, wiring, bonds, switches, third rail heaters, and central instrument houses/wayside cases. Communications assets include: telephone hardware, police call boxes, public address system hardware, customer communication alarms, and message boards.

The Transit Facilities Maintenance Department is responsible for a large range of assets and asset types that span the transit system. They include buildings, subway facilities, passenger stations, bus stops, parking garages, patching and inspecting bridges, tunnels, culverts and retaining walls. Maintenance strategies comply with state building codes, requirements of MBTA's insurance carrier, and national standards such as the National Bridge Inspection Standards (NBIS), National Fire Protection Association, and federal and state guidance.

If issues are identified at any point during inspection, they are reported and if corrective repairs are required, these are subsequently scheduled through Planning and Scheduling. Repairs, renewals, and replacements of infrastructure assets are performed as needed. All contracted services are managed in a similar manner.

## WORK PLANS AND BUDGET FORECASTS

The MBTA’s FY2019-2023 Capital Investment Plan (CIP) update was approved in June 2018. This reflects a plan to invest over \$8 billion over the next five-year period to support projects that maintain and improve the condition of MBTA’s assets; modernize the system to improve accessibility, reduce risk, and accommodate growth; and make targeted investments in network expansion.

The MassDOT/MBTA CIP is divided across three priority categories: reliability, modernization, and expansion. Reliability and modernization investments together form MBTA’s state of good repair investments.

Figures ES 7 and ES 8 illustrate the share of program investments across reliability, modernization, and expansion projects over the next five years. Approximately 47% of total FY2019-2023 investments are funding reliability projects. About 37% of total FY2019-2023 investments are funding modernization projects, followed by 16% for expansion projects. Total investments in this five-year period primarily address MBTA Transit needs (68% of funding), followed by Commuter Rail (18% of funding), and System-wide improvements (14% of funding). The forecasted state of good repair investments in the FY2019-FY2023 capital program totals \$6.7 billion, representing 84% of the total \$8 billion MBTA CIP.

Figure ES 7. MBTA FY19-FY23 Program Investments by Priority Category

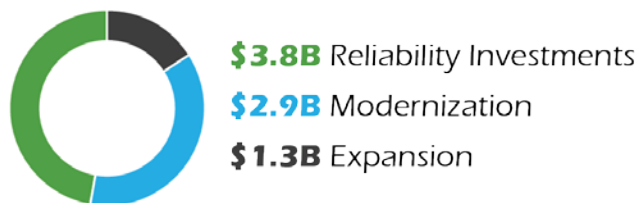
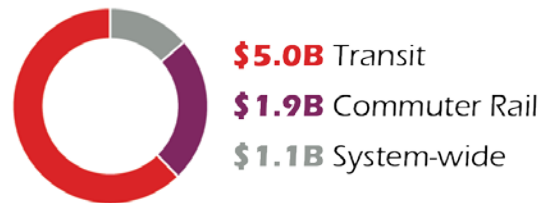


Figure ES 8. MBTA FY19-FY23 Program Investments – Transit, Commuter Rail, System-wide



The MBTA prioritizes potential capital investments by evaluating the costs and benefits of proposed projects using a consistent, objective, and data-informed approach, as required by MBTA’s enabling legislation and recommended by the MassDOT Project Selection Advisory Council (PSAC). Over 400 project-based investments have been prioritized and programmed over the FY2019-FY2023 period.

## ASSET MANAGEMENT PRACTICES

Asset Management provides for better decision making through asset knowledge and validated information supported by technology and documented business processes to ensure consistent practices.

The MBTA General Manager has charged the Chief Engineering Officer, Senior Director of Capital Planning, Senior Director of Reliability Engineering, and Director of Asset Management with the



development and implementation of this 2018 TAM Plan, with support from the Asset Management Governance Board made up of Business Unit leaders from across the MBTA and MassDOT.

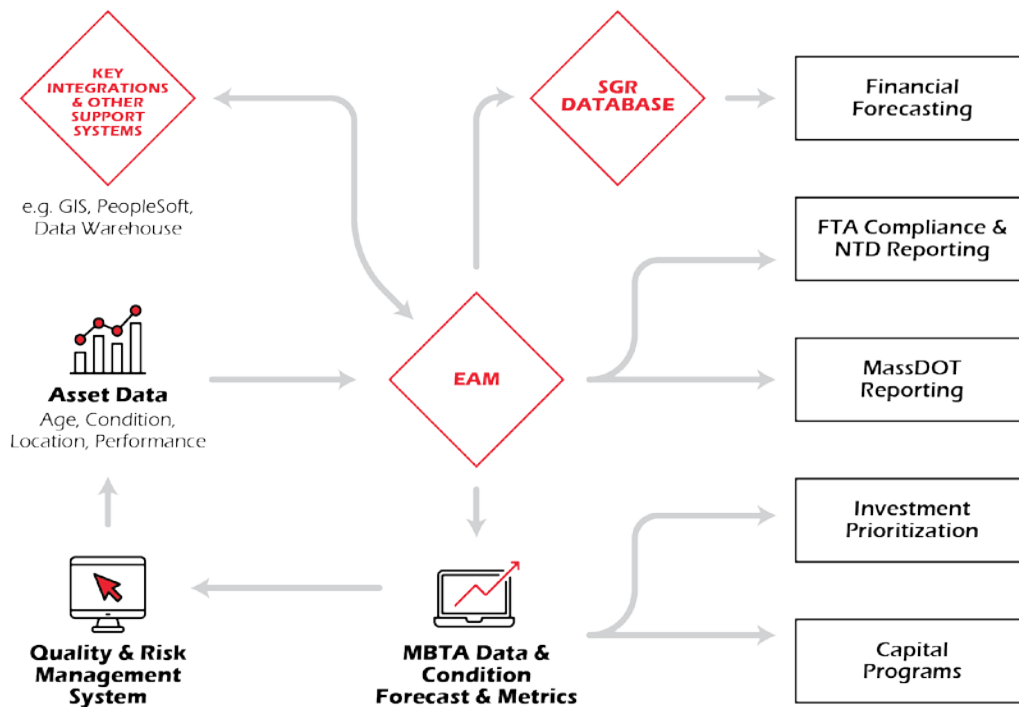
Asset management business processes define how the asset management strategies are implemented. In early 2018, MBTA conducted a series of workshops to capture and review its current asset management business processes, including the capture of as-is enterprise level processes (capital planning, delivery, performance, risk, asset handover, and others) in addition to as-is lifecycle management processes for the following asset types:

- Bus Fleet
- Non-Revenue Fleet
- Paratransit Fleet (The RIDE)
- Rail Fleet
- Commuter Rail Fleet
- Ferry Fleet
- Right-of-Way Infrastructure (Track, Power, Signals)
- Bridges and Tunnels
- Stations and Facilities (including Parking)

At the asset level, processes for how maintenance is scheduled, managed, and delivered were captured, including inspections, maintenance, component replacement, and overhaul.

The MBTA is moving all transit infrastructure based Asset Management functions to an Enterprise Asset Management (EAM) System over FY19 and FY20. MBTA’s vision for its future information management system for existing assets is illustrated in Figure ES 9.

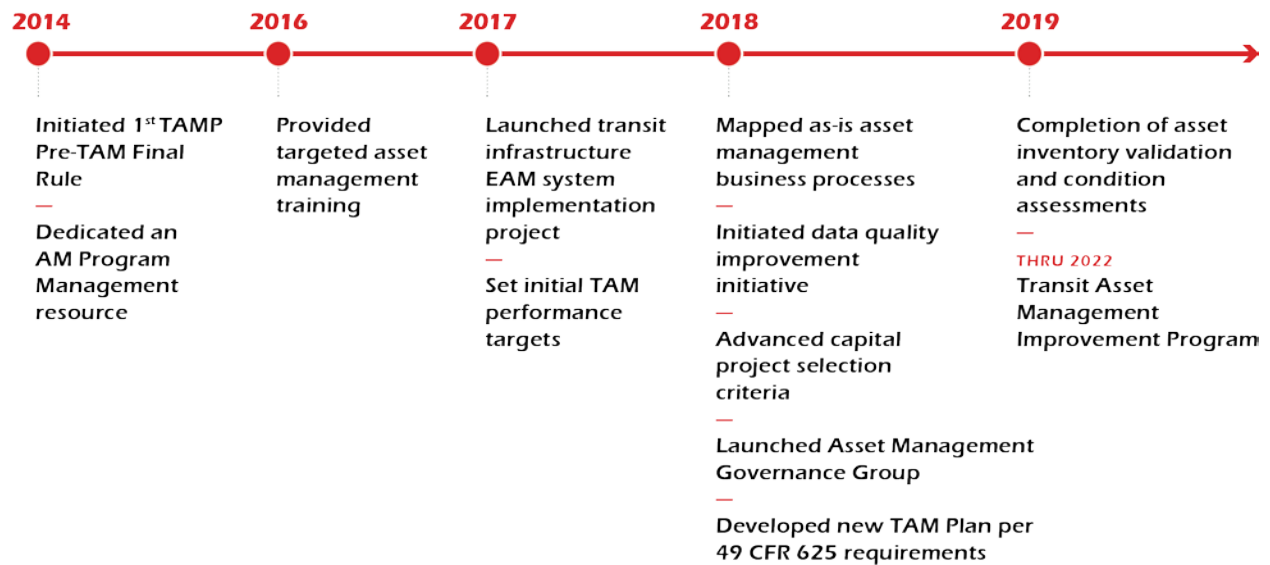
Figure ES 9. Proposed Management System for Existing Assets and Data Process Flow



## IMPROVEMENT ACTIONS

The following forms the current program of projects and actions to continue to advance MBTA’s asset management capability: existing improvement actions as defined in MBTA’s 2014 TAM Plan, new improvement opportunities and new regulatory requirements as identified in MBTA’s 2018 TAM Plan development, best practice asset management (e.g., International Standards ISO 55001:2014, ISO 31000:2018, PAS 1192, etc.) and MBTA’s 2018 asset management capability assessment.

Figure ES 10. MBTA TAM Improvement Timeline



**Asset Management Areas for Improvement:** Improvement projects have been identified through the development of MBTA’s transit asset management improvement program and are included in this TAM Plan. The projects and actions cover the key asset management areas of excellence below which include review against the 39 subject areas of asset management as defined by the Global Forum for Maintenance and Asset Management. Key improvement actions identified as part of the TAM Plan development process focus on:

- Continuously improving asset inventory and condition data
- Advancing enterprise risk management and associated data and processes related to asset management
- Further developing asset class strategies
- Continuously improving existing asset management business processes
- Continuously refining internal processes to align CIP investment program sizes with MBTA’s asset management objectives and performance targets

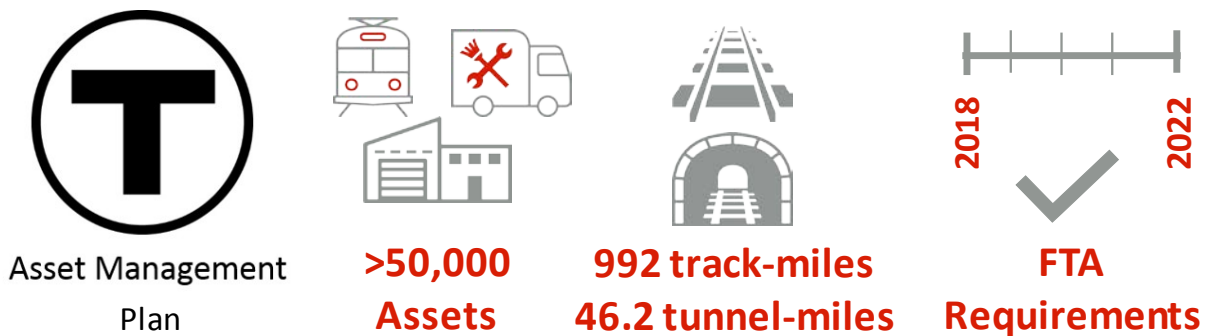
Figure ES 11. MBTA Asset Management Areas for Improvement

<p><b>★ Transformation Enablers</b></p> <ul style="list-style-type: none"> <li>• Organizational Design</li> <li>• Roadmap and Improvement Program Setup, Governance, Management &amp; Assurance</li> <li>• Change Management</li> <li>• Communication Strategies &amp; Plans</li> <li>• Training &amp; Mentoring Plans</li> </ul>	<p><b>1 Strategy &amp; Planning</b></p> <ul style="list-style-type: none"> <li>• Asset Management System &amp; Documentation</li> <li>• Goals &amp; Objectives</li> <li>• Criticality &amp; Decision-Making</li> <li>• Strategic Asset Management Plan</li> <li>• Demand &amp; Capacity</li> <li>• Strategic Planning</li> <li>• FTA Transit Asset Management Plans</li> </ul>	<p><b>3 Lifecycle Delivery</b></p> <ul style="list-style-type: none"> <li>• Portfolio &amp; Project Management</li> <li>• Design Engineering &amp; Configuration Management</li> <li>• Outage Management</li> <li>• Reliability Engineering</li> <li>• Maintenance &amp; Operations</li> <li>• Resource Management</li> </ul>	<p><b>5 Organization &amp; People</b></p> <ul style="list-style-type: none"> <li>• Supply Chain</li> <li>• Contract Management</li> <li>• Asset Management Governance</li> <li>• Culture Development</li> <li>• Competence &amp; Training</li> </ul>
	<p><b>2 Asset Management Decision Making</b></p> <ul style="list-style-type: none"> <li>• Investment Planning</li> <li>• Maintenance Strategies</li> <li>• Asset Class Strategies &amp; WLC Models</li> <li>• Outage Strategies</li> <li>• Strategic Resourcing</li> </ul>	<p><b>4 Asset Information</b></p> <ul style="list-style-type: none"> <li>• Asset Information Strategy</li> <li>• Information Systems Strategy</li> <li>• Information Standards</li> <li>• Data &amp; Information Management &amp; Quality</li> </ul>	<p><b>6 Risk &amp; Review</b></p> <ul style="list-style-type: none"> <li>• Risk &amp; Change Management</li> <li>• Performance &amp; Assurance</li> <li>• Contingency &amp; Business Continuity</li> <li>• Asset Accounting</li> <li>• Sustainability Strategy</li> <li>• Stakeholder Management</li> </ul>

# 1 Introduction

MBTA’s 2018 Transit Asset Management Plan sets the direction, strategies, and plans to improve the management practices of its physical assets. This section introduces the organization, scope of physical assets covered in this Transit Asset Management (TAM) Plan, the federal requirements and how they are met within the structure of this document.

Figure 1-1. Summary of MBTA 2018 TAM Plan



## 1.1 MBTA BACKGROUND

The Massachusetts Bay Transportation Authority (MBTA) is one of the oldest and largest transit agency in the United States, offering transportation across 175 cities and towns in the Greater Boston area via light rail, heavy rail, regional rail, electric trolley buses, motor buses and ferries. In total, the MBTA has over 50,000 individual assets and provides more than 1.3 million daily passenger trips system-wide.

MBTA is governed by the Massachusetts Department of Transportation (MassDOT) Board and by the Fiscal and Management Control Board (FMCB). The MassDOT Board consists of 11 members who are appointed by the Governor. The Secretary of Transportation is the Chair of the Board. The MassDOT Board is responsible for all transportation in Massachusetts including highways, mass transit, vehicle licensing and

### WHAT IS AN ASSET MANAGEMENT PLAN?

An asset management plan provides an organization-wide view of the work necessary to deliver MBTA’s goals and objectives. This Transit Asset Management (TAM) Plan establishes MBTA’s approach to managing the assets that deliver regional public transportation services in the City of Boston and surrounding suburbs.

aeronautics, among others. The FMCB was established on July 17, 2015 as a provisional board to closely monitor MBTA's finances, management and operations for three to five years. It comprises of five members appointed by the Governor, three of whom are MassDOT Board members. The FMCB reports to the Secretary of Transportation.

MBTA's subway line, the "T," is also known as America's First Subway, with the 1897 opening of the Tremont Street Subway. Many of MBTA's assets pre-date the founding of the organization, and have since been integrated into a cohesive system. The age of many assets from these legacy systems requires extra care to maintain in a state of good repair.

MBTA primarily generates operating revenues through its portion of the commonwealth sales tax, passenger fares and formula assessments of cities and towns MBTA serves. Supplemental funding for the operating budget is generated through parking lots, real estate operations, and advertising.

Capital funding comprises multiple sources including federal funds programmed through the Boston Metropolitan Planning Organization (MPO), federal grants, allocations from the Commonwealth's general budget (i.e., for legal commitments and expansion projects), MBTA bonds and Commonwealth bonds.

## 1.2 SCOPE OF TRANSIT ASSET MANAGEMENT PLAN

The TAM Plan covers the physical assets owned, contracted, and/or managed by MBTA and used to provide public transportation services – including rolling stock (commuter rail cars/locomotives, transit rail and bus fleet), Commuter Rail, guideway infrastructure (e.g., structures, track, power, signals and communications), stations and facilities, ferry assets as well as MBTA's door-to-door, shared-ride paratransit service, known as "The RIDE." Table 1-1 summarizes the assets owned and/or managed by MBTA. Further detail is provided in the Asset Portfolio section.

## HOW WILL THIS PLAN BE USED?

In striving to achieve a state of good repair, this plan provides MBTA with:

- Consolidated set of current practices and policies
- Comprehensive strategies to move toward steady state capital maintenance
- MBTA physical assets information
- Current evaluation of the risks associated with managing assets
- Clearly established link between corporate goals and asset management outcomes

Table 1-1. Summary Scope of MBTA Assets

Asset Categories	MBTA Asset Types
Revenue Vehicles	<ul style="list-style-type: none"> <li>• Heavy Rail Passenger Cars</li> <li>• Light Rail Vehicles</li> <li>• Buses</li> <li>• Trolley Buses</li> <li>• Ferryboats</li> <li>• Paratransit Vehicles</li> <li>• Commuter Rail Locomotives and Passenger Coaches</li> </ul>
Equipment (Non-Revenue Vehicles)	<ul style="list-style-type: none"> <li>• Support Vehicles (Automobiles, Sport Utility Vehicles, Vans, Minibuses)</li> <li>• Steel Wheel Vehicles</li> <li>• Other Rubber Tire Vehicles</li> </ul>
Infrastructure	<ul style="list-style-type: none"> <li>• Track</li> <li>• Bridges and Tunnels</li> <li>• Culverts</li> <li>• Power and Substations</li> <li>• Signals</li> <li>• Communications</li> <li>• Retaining Walls</li> <li>• Dams</li> </ul>
Facilities	<ul style="list-style-type: none"> <li>• Transit and Commuter Rail Passenger Facilities</li> <li>• Transit and Commuter Rail Parking Facilities</li> <li>• Transit Support Facilities (Maintenance and/or Administrative)</li> <li>• Commuter Rail Support Facilities (Maintenance and/or Administrative)</li> </ul>

### 1.3 OBJECTIVES

The MBTA’s TAM Plan describes the asset maintenance, overhaul, replacement and enhancement strategies to provide public transportation services in the City of Boston and surrounding suburbs.

The purpose of this plan is to:

- Document the asset portfolio – including nature, extent, age and condition of MBTA’s physical assets.
- Identify existing and proposed levels of service to be achieved with these assets.
- Identify lifecycle management needs by asset class – including maintenance, overhaul, renewal and replacement.
- Assess the resources (including human and financial resources) required to support safe and reliable service delivery, and to bring the assets to a state of good repair (SGR).

- Document the key processes, organization and tools that enable effective asset management.
- Establish action plans for improving MBTA's approach to asset management activities.

The MBTA TAM Plan provides a baseline from which the MBTA will continue to build and improve its asset management capability. The TAM Plan is intended to be a living plan. Improvement actions identified throughout the TAM Plan, and summarized as projects in Chapter 9, provide steps for improvement.

## 1.4 ACCOUNTABLE EXECUTIVE AND STRATEGIC ALIGNMENT

Pursuant to 49 CFR § 625, the Accountable Executive with responsibility for carrying out TAM practices at MBTA is the General Manager & CEO, supported by its Governance Board Members:

- Deputy General Manager
- Chief of Staff
- Chief Engineer
- Chief Mechanical Officer
- Chief Safety Officer
- Chief Transportation Officer
- Chief Information Officer
- Chief Financial Officer
- Chief Procurement Officer
- Assistant General Manager Commuter Rail and Ferry Operations
- Assistant General Manager Capital Delivery
- Assistant General Manager Capital Programs
- Assistant General Manager for Human Resources

The MBTA TAM Plan documents the agency's asset management framework and establishes the maintenance, overhaul and renewal strategies for all MBTA owned or managed infrastructure assets. The plan is aligned to and consistent with multiple MBTA documents:

- MBTA Transit Asset Management Plan (2014).
- MBTA Strategic Plan (2017). This plan establishes MBTA's vision, mission and value statements, and sets definitive objectives for MBTA under safety, customers, infrastructure, fiscal sustainability, accessibility, workforce, management, environment, governance and capacity – consistent with the MBTA TAM Plan.
- Charting Progress to 2040. This long-range transportation plan sets the vision, goals and objectives that guide transportation investments in the Boston region, to which we have aligned the MBTA TAM Plan.
- Focus40. The 25-year investment plan to position MBTA to meet the needs of the Greater Boston region in 2040.
- Other Planning Documents. Additional planning documents have been used for context only.



# 1.5 PLAN STRUCTURE

The plan structure illustrated in Figure 1-2 outlines the sections contained in this TAM Plan.

Figure 1-2. MBTA TAM Plan – Summary Outline





## 1.6 TAM PLAN PERIOD

The TAM Plan covers a five-year horizon period, consistent with other federal planning cycles (i.e., for Transportation Improvement Programs [TIPs] developed by the Boston MPO) that feed into the statewide TIP and the MBTA’s Capital Investment Program (CIP).

## 1.7 TRANSIT ASSET MANAGEMENT PLANNING REQUIREMENTS

With *Moving Ahead for Progress in the 21st Century* (MAP-21) and the subsequent *Fixing America’s Surface Transportation* (FAST) Act, the MBTA has developed this plan consistent with asset management performance measures and targets as included in United States (US) Code of Federal Regulations (CFR) Title 49 Parts 625 and 630, which relate to TAM and NTD respectively.

Under the definitions of US 49 CFR Part 625, MBTA is considered a Tier I Provider<sup>1</sup>. Table 1-2 lists the TAM Plan requirements for Tier I Providers and describes how the contents of this document meets these requirements.

**Table 1-2: Summary of US 49 CFR 625 TAM Plan Requirements and Strategy for Compliance**

Ref. No.	US 49 CFR 625 Ref.	Requirement	TAM Plan Strategy for Compliance / Section No.
<b>A TAM plan must include the following elements:</b>			
<b>TFR 1</b>	49 CFR § 625.25 (b)(1)	Inventory of the number and type of all capital assets a provider owns, except equipment with an acquisition value under \$50,000 that is not a service vehicle.	<b>Section 4.2</b> presents a summary inventory of all capital assets used in the provision of public transportation and is organized by major asset category: revenue vehicles, equipment (non-revenue vehicles), infrastructure, and facilities.
<b>TFR 2</b>	49 CFR § 625.25 (b)(1)	An inventory must also include third-party owned or jointly procured exclusive-use maintenance facilities, passenger station facilities, administrative facilities, rolling stock, and guideway infrastructure used by a provider in the provision of public transportation	
<b>TFR 3</b>	49 CFR § 625.25 (b)(2)	Condition assessment of those inventoried assets for which a provider has direct capital responsibility and to level of detail to monitor, predict performance of assets, and inform investment prioritization.	<b>Section 4.3</b> presents the condition for all capital assets used in the provision of public transportation and is organized by major asset category: revenue vehicles, equipment (non-revenue vehicles), infrastructure, and facilities. MBTA assumes capital responsibility for all capital assets presented in its TAM Plan.

<sup>1</sup> A Tier I Provider “owns, operates, or manages either (1) one hundred and one (101) or more vehicles in revenue service during peak regular service or in any one non-fixed route mode, or (2) rail transit.” (US 49 CFR § 625.5)

Ref. No.	US 49 CFR 625 Ref.	Requirement	TAM Plan Strategy for Compliance / Section No.
TFR 4	49 CFR § 625.25 (b)(3)	Description of analytical processes or decision-support tools to estimate capital investment needs over time and develop its investment prioritization.	<b>Section 7.2.1</b> describes MBTA’s capital planning and investment prioritization approach. <b>Section 8.3</b> summarizes MBTA’s core asset management business processes that support analysis and decision-making.
TFR 5	49 CFR § 625.25 (b)(4)	Project-based prioritization of investments.	<b>Section 7.3</b> summarizes MBTA’s FY2019-FY2023 investment priorities. <b>Appendix F</b> provides a detailed listing of MBTA’s project-based investment priorities.
TFR 6	49 CFR § 625.25 (b)(5)	Provider’s TAM and SGR policy.	<b>Section 2</b> presents MBTA’s TAM/SGR Policy.
TFR 7	49 CFR § 625.25 (b)(6)	Provider’s TAM Plan implementation strategy.	<b>Section 9.3</b> presents MBTA’s TAM Plan implementation strategy, improvement roadmap and action items.
TFR 8	49 CFR § 625.25 (b)(7)	A description of key TAM activities that a provider intends to engage in over the TAM Plan horizon period.	
TFR 9	49 CFR § 625.25 (b)(8)	A summary or list of the resources, including personnel, that a provider needs to develop and carry out the TAM Plan.	<b>Section 7.4</b> summarizes the MBTA’s methodology to identify and address current estimated state of good repair backlog and assess capital needs. <b>Section 9.3</b> summarizes the human resources required to implement the TAM Plan and key improvement actions.
TFR 10	49 CFR § 625.25 (b)(9)	An outline of how a provider will monitor, update, and evaluate, as needed, its TAM Plan and related business practices, to ensure the continuous improvement of its TAM practices.	<b>Section 9.3</b> includes MBTA’s TAM improvement roadmap and key action items to ensure continuous improvement of its TAM practices.
<b>When developing its investment prioritization, provider must:</b>			
TFR 11	49 CFR § 625.33 (a)	Identify a program of projects to improve or manage the SGR of capital assets for which the provider has direct capital responsibility over the TAM Plan horizon period.	<b>Section 7.3</b> summarizes MBTA’s SGR program investments over the FY2019-FY2023 period to improve or manage the state of good repair for MBTA’s capital assets.
TFR 12	49 CFR § 625.33 (b)	Rank projects to improve or manage the SGR of capital assets in order of priority and anticipated project year.	<b>Appendix F</b> provides a detailed listing of MBTA’s project-based investment priorities, including reliability/SGR investments.
TFR 13	49 CFR § 625.33 (c)	Ensure project rankings are consistent with its TAM policy and strategies.	
TFR 14	49 CFR § 625.33 (d)	Give due consideration to state of good repair projects to improve those that pose an identified unacceptable safety risk.	<b>Section 7.2.1</b> describes MBTA’s capital planning and investment prioritization approach, including the project selection criteria that ensures

Ref. No.	US 49 CFR 625 Ref.	Requirement	TAM Plan Strategy for Compliance / Section No.
			that safety as well as other criteria is given due consideration.
TFR 15	49 CFR § 625.33 (e)	Take into consideration its estimation of funding levels from all available sources that it reasonably expects will be available in each fiscal year during the TAM Plan horizon period.	<b>Section 7.2.2</b> provides a summary of MBTA funding sources. Additional detail can be found in Appendix E. <b>Section 7.3</b> provides a summary of funding levels committed in MBTA’s FY2019-FY2023 Capital Investment Plan. <b>Appendix F</b> summarizes the MBTA’s project-based listing of investments and programmed funding for fiscal years 2019-2023.
TFR 16	49 CFR § 625.33 (f)	Take into consideration requirements under 49 CFR 37.161 and 37.163 concerning maintenance of accessible features and the requirements under 49 CFR 37.43 concerning alteration of transportation facilities.	<b>Section 7.2.1</b> describes MBTA’s capital planning and investment prioritization approach, including the project selection criteria that ensures that mobility, social equity and fairness, as well as other criteria are given due consideration.

The federal deadline to develop an initial TAM Plan is October 1, 2018, as stated in US 49 CFR 625.29 (a) with an update of the plan in its entirety at least once every four years. Agencies are required to have their Accountable Executives certify their TAM Plans, as well as share them with the MPO. MBTA may update the TAM Plan in interim years to incorporate significant changes to the asset inventory, condition assessment, and investments, and/or critical TAM policies and processes.

In addition to a current TAM Plan, the TAM Final Rule also requires MBTA to submit two annual reports to the National Transit Database (NTD), as summarized in Table 1-3. The capital asset inventory and condition data in the TAM Plan will be consistent with MBTA’s inventory data which will be organized for submittal to NTD.

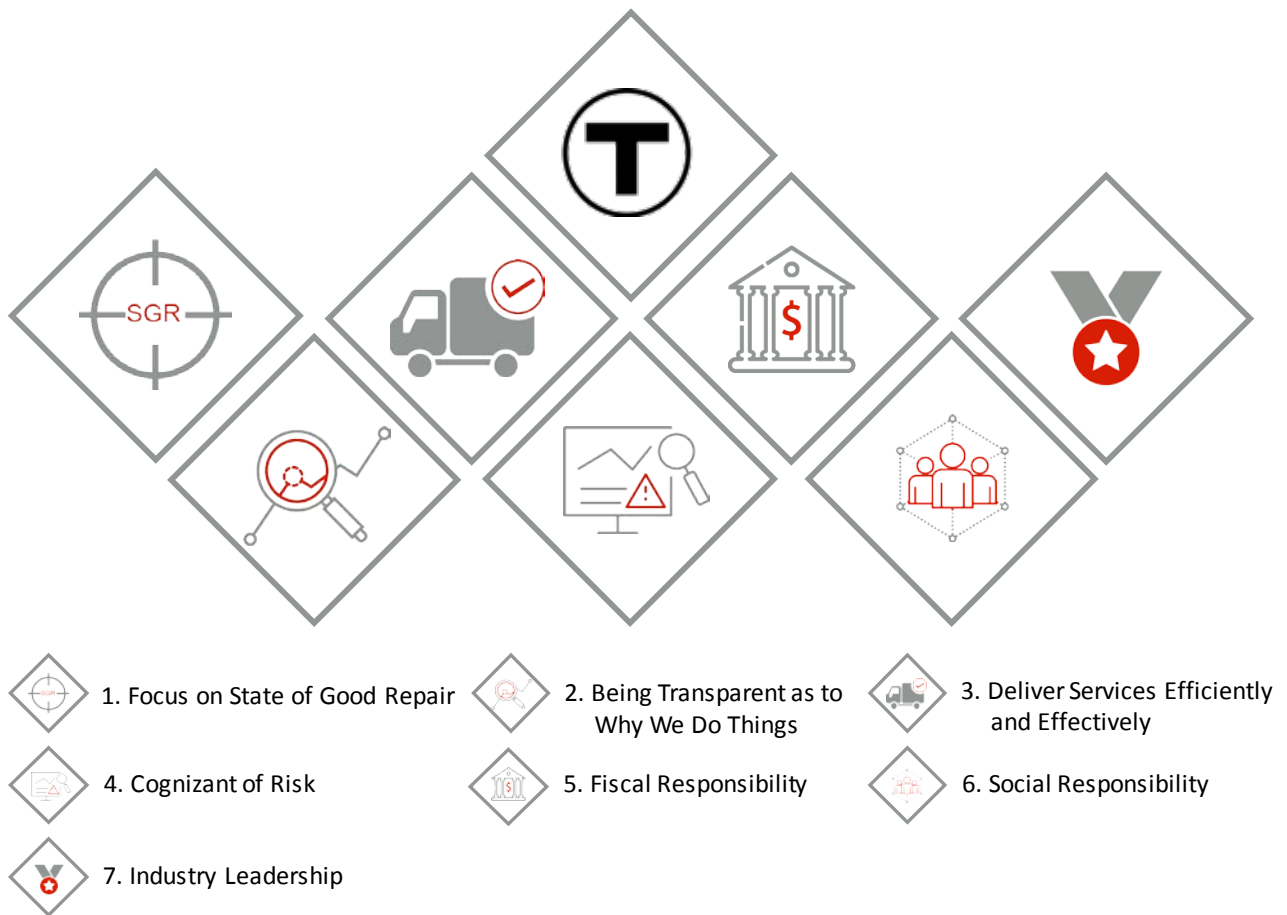
Table 1-3. NTD Submission Requirements

Required Submission	Elements	Deadline
Data Submission	Asset inventory data Condition assessments and performance results Performance targets for the next fiscal year	No later than four months after the end of MBTA’s FY2018 and every year thereafter
Narrative Report	Changes in the transportation system Progress towards achieving the performance targets from the previous year	No later than four months after the end of MBTA’s FY2019 and every year thereafter

## 2 Asset Management Policy

The asset management policy defines the guiding principles by which MBTA will manage its assets to effectively deliver public transportation services in the greater Boston area.

Figure 2-1. MBTA Policy Principles



### 2.1 PURPOSE

The MBTA is committed to implementing a strategic process for acquiring, operating, maintaining, upgrading, and replacing its transit assets to support the agency’s vision, mission, and values set forth in its strategic plan.

## 2.2 PRINCIPLES

Guiding MBTA’s asset management program, plans, and strategies are seven core principles aligned to each of the organization’s strategic objectives and priorities which support the delivery of safe, reliable, accessible, cost-effective and sustainable transit service. In no particular order, the seven core principles include:



1. **Focus on State of Good Repair.** We will work to bring all of the MBTA’s assets, including fleets and facilities, to a state of good repair.



2. **Being Transparent as to Why We Do Things.** We will ensure that all decisions are data driven, and are both transparent and consistent, enabling us to clearly demonstrate the prioritized investments across asset classes.



3. **Deliver Services Efficiently and Effectively.** We will work to meet or exceed service delivery goals by ensuring necessary work to maintain service is undertaken for all MBTA assets and opportunities for improving service delivery are considered.



4. **Cognizant of Risk.** We will effectively identify, prioritize, and manage asset and asset-related risks, including safety, reliability, financial, performance and climate-related risk.



5. **Fiscal Responsibility.** We will continue and sustain the MBTA’s fiscal discipline by optimizing available resources through lifecycle management, reliability-centered maintenance, business process improvements, and the adoption of other best practices.



6. **Social Responsibility.** We will work to build the confidence and trust of all internal and external stakeholders demonstrating good practice in all that we do.

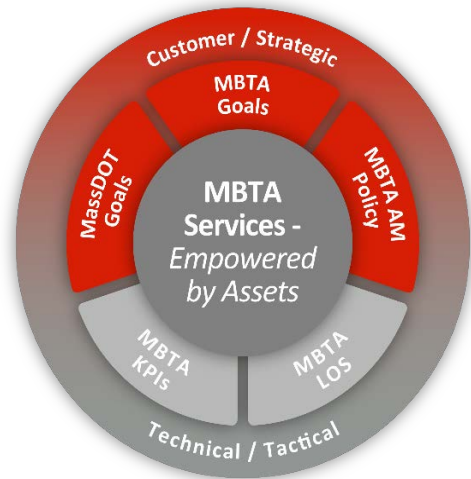


7. **Industry Leadership.** As one of the largest agencies in the US, we will work to both achieve compliance with Federal and State requirements and serve as a leader among peer agencies.

### 3 Asset and Asset Management Performance

This section provides a summary of the public transportation services provided by MBTA and establishes the relationship between the strategic goals of an organization, customer level of service, and the required technical performance of the physical assets involved.

Figure 3-1. MBTA Performance Framework



#### 3.1 OVERVIEW

An asset management framework shapes how performance is measured and managed organization-wide to meet the needs of customers and stakeholders.

A robust performance management framework specifically links to asset management by:

- Allowing MBTA to define asset management programs in terms of specific and measurable outcomes;
- Providing staff with tangible objectives to manage day-to-day and long-term decisions;
- Establishing a framework to optimize investments based on lifecycle cost, performance, risk, and level of service impact;
- Providing a mechanism to measure the outcome of business process improvement initiatives and IT investments;
- Enhancing data-based decision making, providing robust information for management decisions, and improving stakeholder transparency.

There are three primary categories of asset management performance metrics: Levels of Service (LOS); Key Performance Indicators (KPIs); and day-to-day Operational Metrics. These measurement levels are illustrated in Figure 3-2 as a hierarchy, aligned with MBTA’s overall asset management and strategic plan goals and transition from strategic to tactical measures.

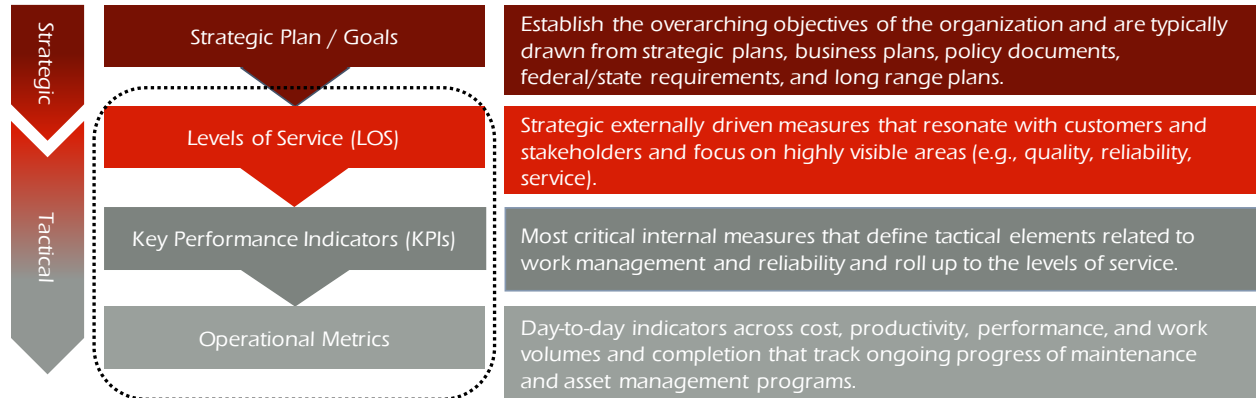
#### LINK BETWEEN ASSET AND CUSTOMER LEVELS OF SERVICE

The alignment between customer levels of service and required technical levels of service allows the relationship to be determined between the level of service and cost of service delivery. In turn, this relationship can be evaluated to:

- Determine the affordability of steady state maintenance needed to meet the customer levels of service;
- Develop asset management strategies and plans to meet the required performance targets;
- Where necessary, justify additional funding or service cut-back requirements; and/or
- Monitor asset performance to ensure MBTA continues to meet the established levels of service.



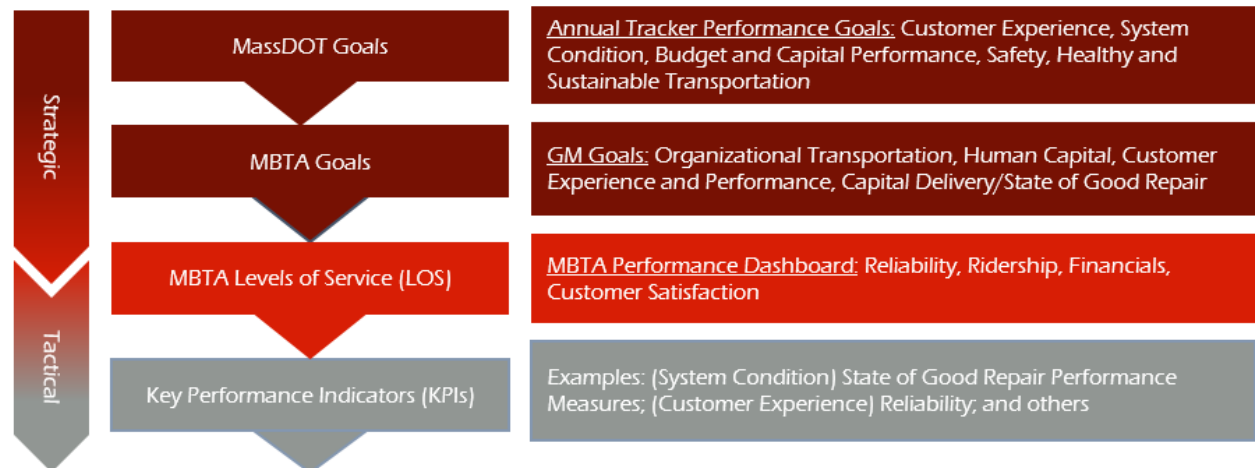
Figure 3-2. Illustrative Performance Management Structure



## 3.2 MBTA PERFORMANCE MANAGEMENT APPROACH

The MBTA tracks its performance through the Annual Report of the Performance and Asset Management Advisory Council, annual Tracker Performance Management Report, and the MBTA Performance Dashboard. The MBTA is committed to continuous improvement and performance measurement and reporting. Figure 3-3 describes how these performance reports and initiatives align to achieve the goals set at the MBTA and state level.

Figure 3-3. MBTA Performance Management Approach



### 3.2.1 MBTA GM Goals

MBTA General Manager (GM) goals were established and introduced June 4, 2018, corresponding with a set of structural changes key to the transformation of the MBTA. Four major categories of KPIs were identified by the GM and have been cascaded down throughout the organization to deliver on MBTA’s commitment to continuous improvement, both in its people and as an organization. These goals and initiatives are presented in Table 3-1 and are used in the TAM Plan to drive a series of asset performance measures that in turn support a measure of accomplishment of the customer level of service.

Table 3-1: MBTA GM Goals and KPI Categories

GM Goals	Initiatives
Organizational Transformation	<ul style="list-style-type: none"> <li>• Achieve Strategic Plan targets through re-organization to ensure the right people are in the right roles. Ensure organizational focus, ability to execute on safety, performance, customer experience, capital delivery, and fiscal stability objectives of the Strategic Plan.</li> <li>• Achieve the FY18 budget objectives both for limiting the structural budget to \$30 million and achieving non-fare, own source revenue targets (advertising, parking, and real estate).</li> <li>• Complete critical procurement processes, including Automated Fare Collection and bus maintenance.</li> <li>• Build and secure FMCB approval of FY19 operating and capital budget that continues to balance objectives of fiscal stability with the need to invest in operations and assets consistent with achieving the Strategic Plan.</li> </ul>
Human Capital	<ul style="list-style-type: none"> <li>• Fill key management and operational vacancies (as identified for each functional area) that exist in the organization.</li> <li>• Redesign key internal processes in Human Resources with a focus on hiring and performance management.</li> <li>• Establish key goals and measurements for employees and ensure proper compensation programs are in place.</li> <li>• Oversee the labor relations and collective bargaining strategy to achieve desired objectives in renegotiation of all collective bargaining agreements set to expire in June 2018.</li> </ul>
Customer Experience and Performance	<ul style="list-style-type: none"> <li>• Measure and achieve quarter over quarter improvement in on-time performance of the Commuter Rail system, the four subway lines and bus systems.</li> <li>• Hire senior leadership in Customer Experience. Execute on the near-term Customer Experience Improvement Plan.</li> <li>• Develop and execute on a plan for investing “lockbox” capital resources intended to produce near term improvements in performance and customer experience.</li> <li>• Develop and execute a customer communication plan for both real-time customer information across modes and communicate MBTA objectives, challenges, and accomplishments.</li> <li>• Develop one or more statistically valid KPI(s) for customer satisfaction. Develop a system to collect baseline data to align new indicators for FY19.</li> </ul>
Capital Delivery / State of Good Repair	<ul style="list-style-type: none"> <li>• Achieve all FY18 capital delivery objectives. Increase State of Good Repair/Modernization spending from \$709 million in FY17 and \$795 million in FY18.</li> <li>• Redesign key capital delivery processes to ensure that the MBTA is capable of delivering \$1 billion annually in the State of Good Repair/Modernization investments beginning in FY19.</li> <li>• Complete 20-year Fleet and Facilities Plan for revenue vehicles across all modes and for maintenance facilities.</li> </ul>



GM Goals	Initiatives
	<ul style="list-style-type: none"> <li>Develop a near term (FY18 and FY19) for accelerating investment in signals, power, and track in order to meet spending targets for that infrastructure in the five-year capital plan.</li> </ul>

### 3.2.2 Levels of Service

MBTA reports on specific measures that aim to meet goals established at the organization, state, and federal levels. These measures are summarized in Table 3-2 on the following page.

Table 3-2: Summary of Performance Goals and Measures

MassDOT Performance Areas	Goal 1 Customer Experience	Goal 2 System Condition	Goal 3 Budget and Capital Performance	Goal 4 Safety	Goal 5 Health and Sustainable Transportation
MBTA Measures	<ul style="list-style-type: none"> <li>→ Reliability</li> <li>→ Travel time</li> <li>→ Accessibility</li> <li>→ Passenger comfort</li> <li>→ Customer satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>→ Revenue vehicle condition*</li> <li>→ Non-revenue vehicle condition*</li> <li>→ Facility condition*</li> <li>→ Track condition*</li> </ul>	<ul style="list-style-type: none"> <li>→ Fare recovery ratio</li> <li>→ Number of projects completed, ongoing, or planned for next year</li> <li>→ Project delivery performance measures</li> </ul>	<ul style="list-style-type: none"> <li>→ Fatalities as a result of transit accidents</li> </ul>	<ul style="list-style-type: none"> <li>→ Ridership</li> </ul>
Supports GM Goals	<ul style="list-style-type: none"> <li>→ Customer experience and performance</li> <li>→ Capital delivery / State of Good Repair</li> <li>→ Organizational transformation</li> </ul>	<ul style="list-style-type: none"> <li>→ Capital delivery / State of Good Repair</li> <li>→ Human Capital</li> <li>→ Organizational transformation</li> </ul>	<ul style="list-style-type: none"> <li>→ Capital delivery / State of Good Repair</li> <li>→ Organizational transformation</li> <li>→ Human Capital</li> </ul>	<ul style="list-style-type: none"> <li>→ Capital delivery / State of Good Repair</li> <li>→ Organizational transformation</li> </ul>	<ul style="list-style-type: none"> <li>→ Customer experience and performance</li> <li>→ Capital delivery / State of Good Repair</li> <li>→ Organizational transformation</li> </ul>
Aligned to Asset Management Policy Principles					

\*Note: MBTA measures notated with an asterisk represent those that meet the FTA requirements for SGR performance measures. See Appendix C State of Good Repair Performance Measures and Targets for more information.

- 1. Focus on State of Good Repair
- 2. Being Transparent as to Why We Do Things
- 3. Deliver Services Efficiently and Effectively
- 4. Cognizant of Risk
- 5. Fiscal Responsibility
- 6. Social Responsibility
- 7. Industry Leadership

In addition to the annual Tracker Performance Management Report, MBTA developed an online and interactive performance dashboard to provide performance information in an easy and accessible format for the public. MBTA’s performance dashboard focuses initially on the four key performance areas:

- Reliability – How dependable is MBTA’s service?
- Ridership – How many trips are taken on MBTA services on an average weekday?
- Financials – How is MBTA tracking against its operating budget?
- Customer Satisfaction – How do riders rate the MBTA?

### 3.3 CURRENT PERFORMANCE

Annual performance on measures is reported through the Tracker Performance Management Report and National Transit Database. Table 3-3 summarizes MBTA’s FY18 performance against FY18 targets. Improvement goals for FY19 have also been established and are summarized in Table 3-3. MassDOT Office of Performance Management and Innovation (OPMI) is also working with MBTA Leaders and the FMCB to establish 2020, 2022 and long-term performance targets. Please refer to Chapter 4 “Asset Portfolio” of the TAM Plan for additional details on current performance of state of good repair measures.

Table 3-3. Summary of MBTA FY18 Performance and FY19 Targets

1) Rolling Stock - Percent of Revenue Vehicles that have met or exceeded their useful life benchmark				
Mode	Asset type	ULB	2018 measure	2019 target
Bus	Bus	14	25%	25%
Light Rail	Light Rail Vehicle	31	46%	41%
Heavy Rail	Heavy Rail Vehicle	31	58%	56%
Commuter Rail	Commuter Rail Locomotive	39	27%	24%
	Commuter Rail Passenger Coach	39	0%	0%
Ferry	Ferryboat	42	0%	0%
Paratransit	Automobile	6	46%	3%
	Minivan	7	0%	0%
	Van	7	29%	13%
Total			30%	23%

2) Equipment - Percent of service vehicles that have met or exceeded their useful life benchmark				
<i>Mode</i>	<i>Asset type</i>	<i>ULB</i>	<i>2018 measure</i>	<i>2019 target</i>
Transit	Automobile	varies	22%	22%
	Other Rubber Tire Vehicle	varies	25%	29%
	Steel Wheel Vehicle	varies	38%	38%
Commuter Rail	Automobile	varies	12%	17%
	Other Rubber Tire Vehicle	varies	12%	13%
	Steel Wheel Vehicle	varies	33%	33%
MBTA-wide	Automobile	varies	20%	21%
	Other Rubber Tire Vehicle	varies	19%	21%
	Steel Wheel Vehicle	varies	34%	34%
Total			20%	22%

3) Facility - Percent of facilities rated below 3 on the condition scale			
<i>Asset Type</i>	<i>Baseline Condition Assessment?</i>	<i>2018 measure</i>	<i>2019 target</i>
Passenger / Parking Facilities	Assessed	13%	11%
	Not Assessed	In progress	TBD
	Total	In progress	TBD
Administrative / Maintenance Facilities	Assessed	68%	63%
	Not Assessed	In progress	TBD
	Total	In progress	TBD
Total		In progress	TBD

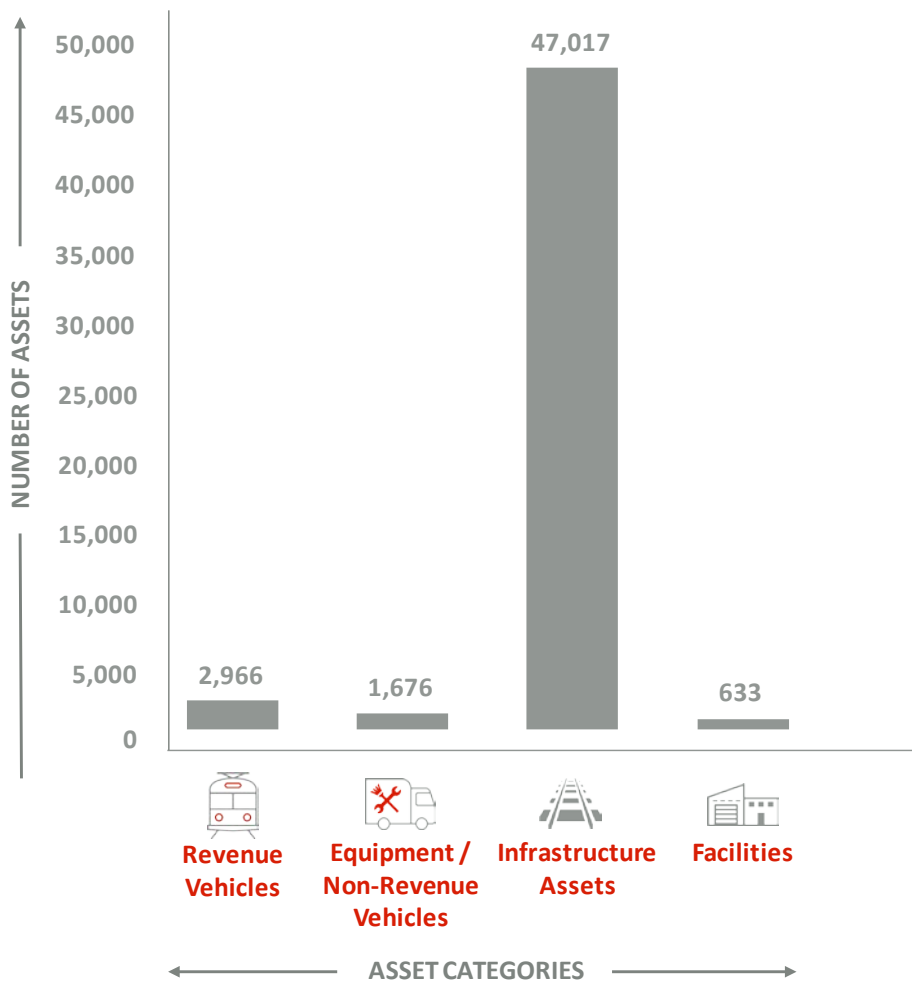
4) Infrastructure - percent of track segments with performance restrictions			
<i>Mode</i>	<i>Asset type</i>	<i>2018 measure</i>	<i>2019 target</i>
Transit	Heavy Rail Fixed Guideway	12%	11%
	Light Rail Fixed Guideway	9%	8%
Commuter Rail	Commuter Rail Fixed Guideway	1%	1%
Total		2%	2%

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## 4 Asset Portfolio

As the oldest transit system in the United States, MBTA owns and manages a vast asset portfolio. This section defines the current portfolio of inventoried assets and respective conditions; these assets represent approximately 60% of the total asset inventory.

Figure 4-1. Snapshot of Current Portfolio of MBTA Inventoried Assets



Revenue Vehicles = Light Rail, Heavy Rail, Bus, Trolley Bus, Ferry, Automobile, Van, Commuter Locomotive, Commuter Rail Coach



Equipment / Non-Revenue Vehicles = Automobile, Other Rubber Tire Vehicle, Steel Wheel Vehicle



Infrastructure Assets = Bridges and Tunnel Structures, Power, Signals (miles of tunnel and track are calculated separately)



Facilities = Maintenance and/or Administrative, Passenger (Stations), Parking

## 4.1 OVERVIEW

MBTA, or “the T” is the primary provider of public transportation service throughout the greater Boston region. The multimodal agency operates transit and Commuter Rail, bus, ferry, and paratransit service. Table 4-1 provides a summary of MBTA’s transit network by mode.

Table 4-1: MBTA Current Mode Summary

Mode Category	Mode Name	Mode Type	Number of Lines/Routes	Track Miles	Revenue Vehicles
Transit	Transit Rail	Heavy and Light Rail	5	293	637
	Bus	Bus	173	N/A	1,022*
	Ferry	Ferry	5	N/A	4
	The RIDE	Demand Response	N/A	N/A	763
Commuter	Commuter Rail	Commuter Rail	14	699	520**

\*Includes 28 trolley buses

\*\*Commuter Rail revenue vehicles includes 426 rail coaches and 94 locomotives.

### 4.1.1 Transit

MBTA Transit covers transit rail – both heavy and light rail lines, bus service, ferry service, as well as door-to-door, shared-ride paratransit service called, “The RIDE.”

#### Rail

MBTA’s transit rail system covers 293 miles of track, consisting of five major lines connecting riders across downtown Boston. Three are heavy rail rapid transit lines (Red, Orange, and Blue lines) and two are light rail lines (Green Line and the Mattapan High Speed Trolley Line). The Red, Orange and Blue lines run on electric third rail, while the Green, Mattapan and part of the Blue Line utilize overhead catenary systems. The Red Line includes two branches to the south (Ashmont and Braintree) while the Green Line includes four branches to the west (Boston College, Cleveland Circle, Riverside, and Heath).

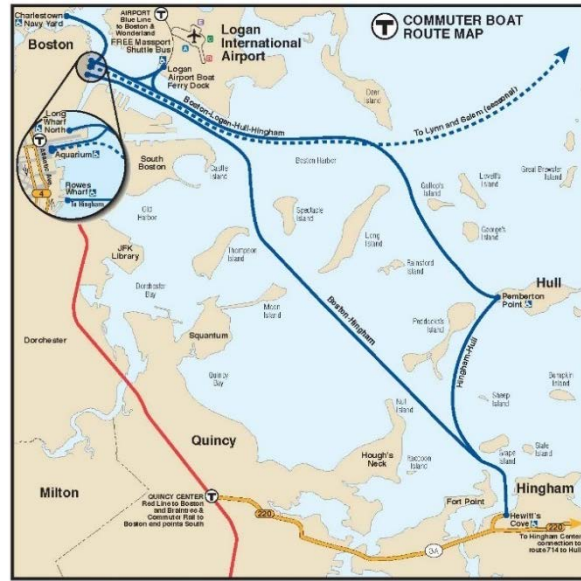


## Bus

The MBTA bus system covers 173 bus routes, with five bus rapid transit lines (Silver Line), including one BRT line providing connection between the Boston Logan International Airport and downtown. Additionally, MBTA operates three crosstown bus lines with limited stops; all buses running on crosstown lines are equipped with bicycle racks.

## Ferry

The MBTA ferry system is operated by an external contractor, providing service through the Boston Harbor and connections between Charlestown Navy Yard, Logan Airport Boat Ferry Dock, Hull, and Hingham.



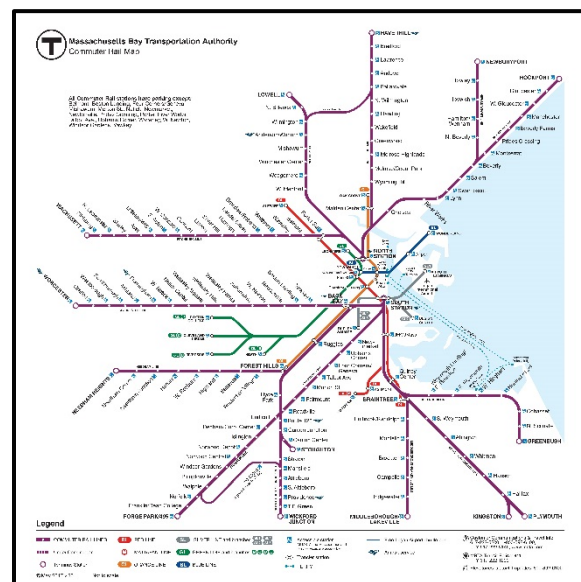
## The RIDE

The MBTA on-demand pick-up and drop-off transit service, The RIDE, is also operated by an external contractor and available in 58 cities and towns in the greater Boston area. In addition to The RIDE, MBTA is running an on-demand paratransit pilot with Uber, Lyft, and Curb where RIDE customers can book subsidized rides instantly using smartphone applications.

## 4.1.2 Commuter Rail

The MBTA Commuter Rail system is a regional rail network covering over 699 miles of track, reaching from Boston into eastern and central Massachusetts, and parts of Rhode Island. The system consists of 15 total lines including the following main lines:

- Fairmount
- Fitchburg
- Framingham/Worcester
- Franklin
- Greenbush
- Haverhill
- Kingston/Plymouth
- Lowell
- Middleborough/Lakeville
- Needham
- Newburyport/Rockport
- Providence/Stoughton
- Foxboro (Special Events)





## 4.2 ASSET INVENTORY

MBTA manages an asset portfolio consisting of over 50,000 individual assets in addition to 992 miles of track and 46.2 miles of tunnel. Figure 4-1 provides a snapshot of MBTA’s current asset inventory. These estimates represent about 60% of MBTA’s total asset inventory and will be updated following completion of MBTA’s inventory validation and condition assessments currently underway. Table 4-2 summarizes the status of inventory and condition data currently available as reflected in this TAM Plan.

**Table 4-2. Status Summary of MBTA Inventory and Condition Assessment Data Validation**

Asset Type	Transit		Commuter Rail	
	Inventory	Physical Condition Assessment	Inventory	Physical Condition Assessment
<b>Vehicles</b>				
Revenue Vehicles	✓	✓	✓	✓
Non-Revenue Vehicles	✓	✓	✓	✓
<b>Infrastructure</b>				
Track (Revenue and Non-Revenue)				
Track	✓	✓	✓	✓
Civil Structures				
Bridges (incl. Viaducts)	✓	✓	✓	✓
Tunnels	✓	-	✓	-
Culverts	✓	-	✓	-
Retaining Walls	✓	-	✓	-
Dams	N/A	N/A	✓	✓
Signals				
Track Circuits	✓	-	✓	-
Signals	✓	-	✓	-
Processor Based Systems	✓	-	✓	-
Cables	✓	-	✓	-
Relays	✓	-	✓	-
Shelters	✓	-	✓	-
Bonds	✓	-	✓	-
Switch M/C	✓	-	✓	-
Loops	✓	-	✓	-
Trip Stops	✓	-	N/A	N/A
Energy Systems	✓	-	✓	-
Recorders	✓	-	✓	-
Positive Train Control (PTC)	N/A	N/A	In Progress	In Progress
Grade Crossings (Signalized)	N/A*	N/A*	✓	-
Hot Box Detectors	N/A	N/A	-	-
High Car Detectors	N/A	N/A	-	-
Dragging Equipment Detector	N/A	N/A	-	-
Power				
Generation	-	-		

Asset Type	Transit		Commuter Rail	
	Inventory	Physical Condition Assessment	Inventory	Physical Condition Assessment
Combustion Turbines	-	-	N/A	N/A
Portable Power	-	-	✓	-
Stationary Power	-	-	✓	-
Transmission	-	-	-	-
High Voltage (Yard)	-	-	N/A	N/A
Switching Station	-	-	✓	-
Distribution	-	-	-	-
Substations	✓	✓	✓	-
AC Distribution System	-	-	✓	-
DC Distribution System	-	-	N/A	N/A
SCADA	-	-	-	-
<b>Facilities</b>				
Maintenance Facilities	✓	In Progress	✓	In Progress
Administrative Facilities	✓	In Progress	✓	In Progress
Combined Maintenance & Admin.	✓	In Progress	✓	In Progress
Parking Facilities	✓	In Progress	✓	In Progress
Passenger Stations	✓	In Progress	✓	In Progress
<b>Facility Systems and Equip.</b>				
Fare Collection Equip.	-	-	-	-
Communications Equip.	-	-	-	-
Security Equipment	-	-	-	-
IT Equipment	-	-	-	-

\*Grade crossings are not signalized for Transit and are considered part of Track.

The FTA Transit Asset Management Final Rule, 49 CFR Part 625 Subpart Section 625.25(b), requires agencies to report all assets used in the provision of public transportation regardless of whether the agency has direct capital responsibility or not. Only for those assets for which the agency has capital responsibility is a condition assessment required.

The following tables provide a summary of MBTA’s capital asset inventory and are organized around FTA’s four major capital asset categories as defined in 49 CFR §625.43:

- Rolling Stock: Revenue transit rail, bus, ferry, paratransit, and Commuter Rail vehicles
- Equipment: (non-revenue) service vehicles
- Infrastructure: rail fixed guideway, track, signals, and systems
- Facilities: maintenance, administrative, passenger, and parking

**Revenue and Non-Revenue Vehicles**

MBTA’s rolling stock inventory consists of over 2,900 revenue vehicles. MBTA’s bus fleet makes up the largest portion (35%) of revenue vehicles, followed by paratransit vehicles (26%) and transit rail vehicles (22%), Commuter Rail fleet (17%), and ferry boats (four ferry boats). In addition to its revenue vehicle fleet, at least 1,676 support vehicles are accounted for split between transit (968 non-revenue vehicles) and Commuter Rail (708 non-revenue vehicles).

Table 4-3. Revenue Vehicles Inventory Summary

MBTA Mode Category	MBTA Mode	NTD Vehicle Type	Quantity (2018)
Transit	Transit Rail <sup>i</sup>	Heavy Rail Passenger Car (HR)	432
		Light Rail Vehicle (LR)	205
	Bus	Bus (BU)	1,022
	Ferry	Ferryboat (FB)	4
	The RIDE <sup>ii</sup>	Automobile (AO)	274
		Van (VN)	489
Transit Revenue Vehicles Subtotal			2,426
Commuter Rail	Commuter Rail <sup>iii</sup>	Commuter Rail Locomotive (RL)	87
		Commuter Rail Passenger Coach (RP)	415
	Commuter Rail Revenue Vehicles Subtotal		
MBTA Revenue Vehicle Totals			2,946

Table 4-4. Non-Revenue Vehicles Inventory Summary

MBTA Mode Category	NTD Vehicle Type	Quantity (2018)
Transit <sup>iv</sup>	Automobile	347
	Other Rubber Tire Vehicle (ORTV)	600
	Steel Wheel Vehicle (SWV)	21
	Transit Non-Revenue Vehicle Subtotal	
Commuter Rail <sup>v</sup>	Automobile (AO)	95
	Other Rubber Tire Vehicle (ORTV)	546
	Steel Wheel Vehicle (SWV)	67
	Commuter Rail Non-Revenue Subtotal	
MBTA Non-Revenue Vehicle Totals		1,676

**Infrastructure**

MBTA’s infrastructure inventory covers assets within the right-of-way, including track assets, bridges and tunnels, culverts, power assets, and signaling equipment.

MBTA’s rail network consists of over 992 track miles, including 293 track miles for transit rail (heavy and light rail) and 699 track miles for Commuter Rail. In addition, MBTA’s infrastructure asset portfolio includes 459 bridges, with 58% consisting of steel bridges and 42% non-steel bridges. There are also 2 dams and 1,303 culverts, with 92% (1,202 culverts) on MBTA’s Commuter Rail right-of-way.

Table 4-5. Infrastructure – Track Inventory Summary

Mode	Type	Unit	Count
Transit <sup>vi</sup>	Track	Track-miles	293
	Grade Crossings	Each	53
	Crossovers	Each	124
	Turnouts	Each	326
Commuter Rail <sup>vii</sup>	Track	Track-miles	699
	Grade Crossings	Each	304
	Crossovers	Each	105
	Turnouts	Each	648

Table 4-6. Infrastructure – Signals Inventory Summary

Mode	Infrastructure Asset Type	Infrastructure – Signals	Quantity (2018)	Unit
Transit <sup>viii</sup>	Signals	All signal components	37,697	Count
	Transit Subtotal		37,697	Count
Commuter Rail <sup>ix</sup>	Signals	All signal components	1,034	Count
	Commuter Rail Subtotal		1,034	Count
MBTA Totals			38,731	Count

Table 4-7. Infrastructure – Power Inventory Summary

Mode	Infrastructure Asset Type	Infrastructure – Substations	Quantity (2018)	Unit
Transit <sup>x</sup>	Substations	Switches	232	Count
		Transformers	158	Count
		Circuit Breakers	1,061	Count
		Other Power Components	1,988	Count
Transit Subtotal			3,439	Count
Commuter Rail <sup>xi</sup>	Substations	Substation Equipment	1,507	Count
		Train Control & Signaling	10	Count
		Substation Buildings	6	Count
Commuter Rail Subtotal			1,523	Count
MBTA Totals			4,962	Count

**Table 4-8. Infrastructure – Bridges and Tunnel Structures Inventory Summary**

Mode	Infrastructure Asset Type	Infrastructure – Bridge and Tunnel Structures	Quantity (2018)	Unit
Transit	Bridges and Tunnels <sup>xii</sup>	Steel Bridges	95	Count
		Non-Steel Bridges	57	Count
		Culverts	101	Count
		Tunnels	41.7	Track Miles
Commuter Rail	Bridges and Tunnels <sup>xiii</sup>	Steel Bridges	172	Count
		Non-Steel Bridges	135	Count
		Culverts	1,202	Count
		Tunnels	4.5	Track Miles
		Dams	2	Count

**Facilities**

There are 633 facilities supporting MBTA’s public transportation service. A facility is defined by a single building or structure used in providing public transportation. There are three major types of facilities: support facilities (administrative and/or maintenance), passenger facilities, and parking facilities. MBTA’s largest portion of facilities consist of passenger facilities (42%), followed by maintenance or administrative facilities (38%), and parking facilities (20%). A breakdown of facility types by transit and Commuter Rail modes are provided in Table 4-9.

**Table 4-9. Facilities Inventory Summary**

MBTA Mode Category	Facility Group / Type	Quantity (2018)	Unit
Transit	Maintenance and/or Administrative Facilities <sup>xiv</sup>	201	Count
	Passenger Facilities (Stations) <sup>xv</sup>	130	Count
	Parking Facilities <sup>xvi</sup>	33	Count
	Transit Facilities Subtotal	364	Count
Commuter Rail	Maintenance and/or Administrative Facilities <sup>xvii</sup>	38	Count
	Passenger Facilities (Stations) <sup>xviii</sup>	138	Count
	Parking Facilities <sup>xix</sup>	93	Count
	Commuter Rail Facilities Subtotal	269	Count
MBTA Facilities Total		633	Count

## 4.3 ASSET CONDITION

Condition performance measures for MBTA's assets vary depending on the asset type and current availability of data (please refer to Table 4-2 for a current status summary):

- Vehicle condition performance is based on age per 49 CFR § 625.43 (percentage of vehicles within an asset class that have met or exceeded their ULB)
- Facility condition performance is based on physical condition assessment (percentage of facilities within an asset class rated below condition 3 on the TERM scale per 49 CFR § 625.43)
- Bridge condition performance is based on physical condition assessments as rated in accordance with National Bridge Inspection Standards (NBIS) and translated to the FTA's National Transit Database (NTD) Asset Inventory Module (AIM) scale
- For all other assets where physical condition information may not yet be available, age, informed by installation dates, is utilized as a proxy to measure condition performance

### Revenue and Non-Revenue Vehicles

Figure 4-2 provides a current snapshot summary of MBTA's revenue-vehicle inventory and condition performance.

Following, Table 4-10 and Table 4-11 provide a current condition summary of revenue and non-revenue vehicles, respectively. About 31% of MBTA's revenue fleet and 25% of MBTA's non-revenue fleet has met or exceeded ULBs.

Figure 4-2. Summary Snapshot – MBTA Current Revenue-Vehicle Inventory and Condition Performance

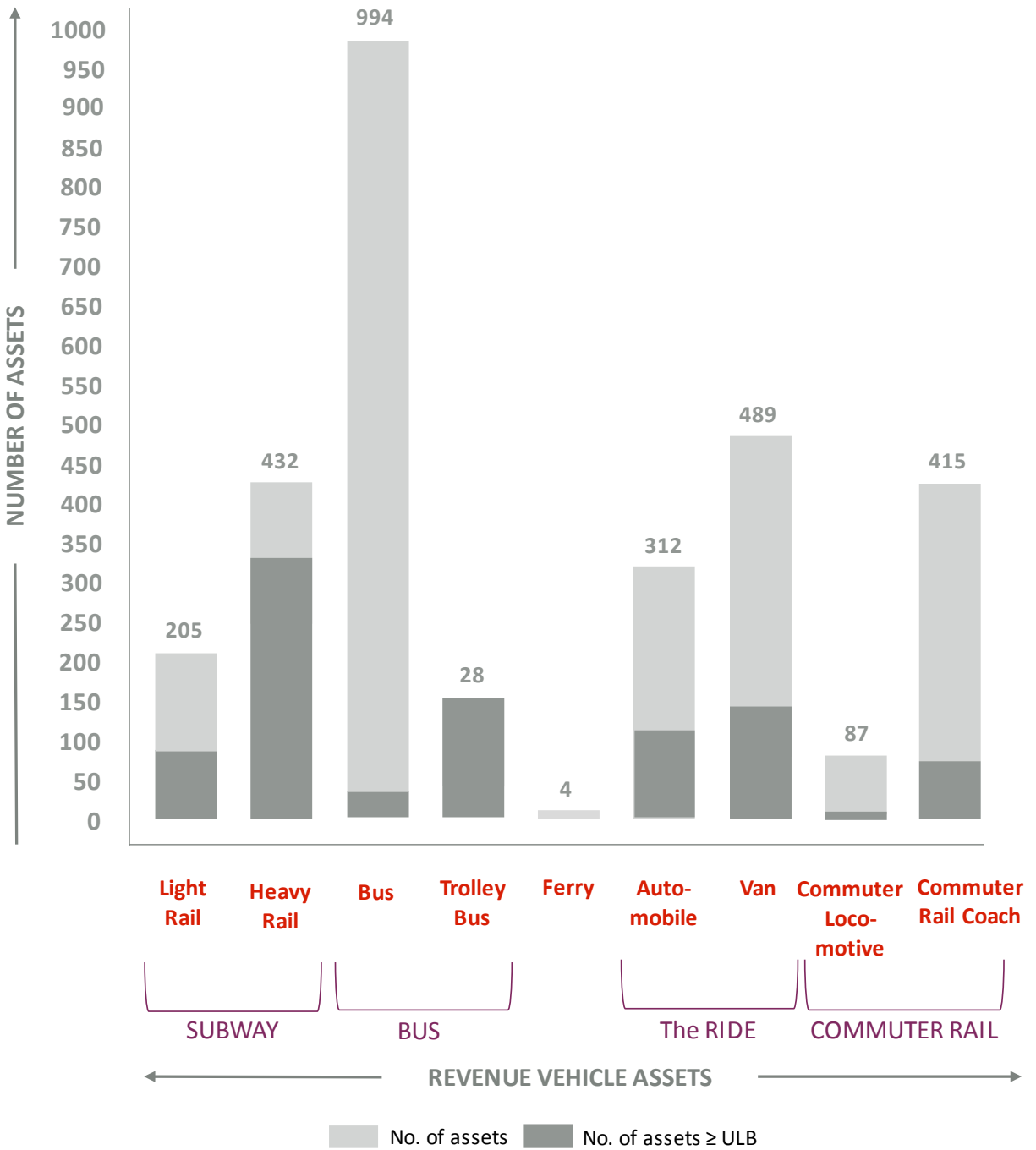




Table 4-10. Revenue Vehicles – Current Condition Performance Summary

Mode Category	Mode	Asset Type	ULB	Quantity (2018)	Quantity ≥ ULB	% ≥ ULB
Transit	Rail	Light Rail	31	205	94	46%
		Heavy Rail	31	432	252	58%
	Bus	Bus	14	994	224	23%
		Trolley Bus	14	28	28	100%
	Transit Subtotal				1,659	598
Commuter Rail	Commuter Rail	Commuter Locomotive	39	94	0	0%
		Commuter Rail Coach	Varies*	426	55	13%
	Commuter Rail Subtotal				520	55
Ferry	Ferry	Ferry	42	4	0	0%
Paratransit	The RIDE	Automobile	6	274	125	46%
		Van	7	489	139	29%
	Paratransit Subtotal				763	264
MBTA Total				2,946	917	31%

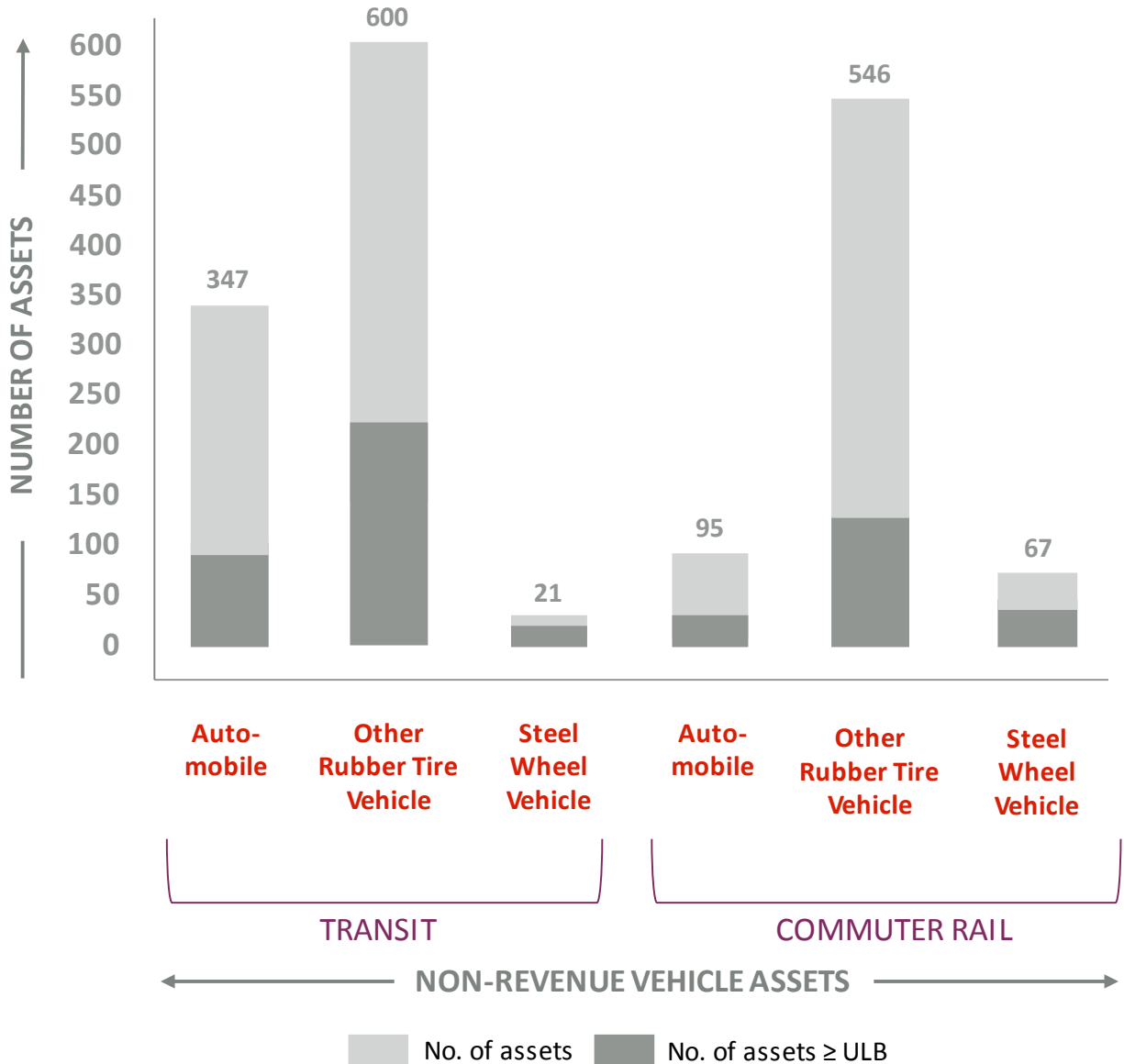
\*ULB for Commuter Rail Coaches vary by manufacturer and rebuild date. Pullman-Standard Coaches, for example, have a ULB of 57 years. All other Commuter Rail Coaches have a ULB of 39 years.

Table 4-11. Non-Revenue Vehicles – Current Condition Performance Summary

Mode Category	Asset Type	ULB	Quantity (2018)	Quantity ≥ ULB	% ≥ ULB
Transit	Automobile	8	347	77	22%
	Other Rubber Tire Vehicle	14	600	147	25%
	Steel Wheel Vehicle	25	21	8	38%
	Transit Subtotal			968	232
Commuter Rail	Automobile	8	95	23	24%
	Other Rubber Tire Vehicle	14	546	128	23%
	Steel Wheel Vehicle	25	67	30	45%
	Commuter Rail Subtotal			708	181
MBTA Total			1,676	413	25%

Figure 4-3 provides a current snapshot summary of MBTA’s non-revenue-vehicle inventory and current performance.

Figure 4-3. Summary Snapshot – MBTA Current Non-Revenue-Vehicle Inventory and Condition Performance



**Infrastructure**

Tables 4-12 through 4-14 summarize the age distribution of track, signals, and power.

Table 4-15 summarizes the condition of MBTA’s bridges, most which are in a state of good repair. Only about 11% of all bridges are considered not in a state of good repair (13% of all steel bridges and 8% of all non-steel bridges).

**Table 4-12. Infrastructure – Track: Current Age Summary**

Track Assets			Distribution by Track Age (By No. of Track Miles)*									
Mode	Total Quantity	Unit	1920-1929	1930-1939	1940-1949	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009	2010-2019
Transit <sup>xx</sup>	293	Track Miles	-	-	-	-	-	27.5	77.8	1.7	11.9	8.7
Commuter Rail	699 <sup>xxi</sup>	Track Miles	4.9	-	28	5.5	4	39.7	274	212.3	101.9	48.3

\* Allocated track miles may not add due to 166 track miles of undetermined track age.

Ref.	Key Improvement Action	Timeline
4-1	Undertake track condition assessment; condition assessment (age based or measured condition) should be evaluated by track segment.	Q3 2019 – Q1 2020
4-2	Estimate the replacement value of track; estimates may be broken down by percent share or segment renewal/replacement costs.	Q3 2019 – Q1 2020

Table 4-13. Infrastructure – Signals: Current Condition Summary

Signals Assets			Distribution by Age (%)									
Mode	Total Quantity	Unit	1920-1929	1930-1939	1940-1949	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009	2010-2019
Transit <sup>xxii</sup>	37,697	Signals	0.0%	0.0%	0.0%	0.0%	0.0%	7.3%	16.0%	58.1%	11.6%	1.0%
Commuter Rail	1,034	Signals	0.0%	0.0%	0.0%	0.0%	1.4%	0.1%	12.6%	6.4%	77.2%	0.8%
<b>MBTA Signal Assets Totals</b>			0%	0%	0%	0%	0%	7%	16%	57%	13%	1%

Table 4-14. Infrastructure – Power: Current Condition Summary

Power Assets			Distribution by Age (%)									
Mode	Total Quan.	Unit	1920-1929	1930-1939	1940-1949	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009	2010-2019
Transit <sup>xxiii</sup>	232	Switches	0.0%	0.0%	0.0%	0.0%	0.0%	13.8%	50.9%	11.2%	19.0%	1.7%
	158	Transformers	0.0%	0.0%	0.0%	0.0%	0.0%	17.7%	39.9%	16.5%	17.1%	5.1%
	1,061	Circuit Breakers	0.0%	0.0%	0.0%	0.0%	0.0%	15.5%	44.4%	14.5%	18.6%	7.1%
	1,988	Other Power Components	0.0%	0.1%	0.0%	0.0%	5.7%	21.5%	40.9%	12.1%	8.8%	9.9%
Commuter Rail	1,507	Substation Equipment	0.9%	2.3%	4.4%	19.2%	29.8%	29.3%	11.9%	0.9%	2.3%	4.4%
	10	Train Control & Signaling	0.0%	0.0%	0.0%	50.0%	10.0%	10.0%	30.0%	0.0%	0.0%	0.0%
	6	Substation Buildings	0.0%	0.0%	0.0%	0.0%	0.0%	83.3%	0.0%	0.0%	0.0%	0.0%

Figure 4-4 provides a current snapshot summary of MBTA’s bridge inventory and current performance.

Figure 4-4. Summary Snapshot – MBTA Current Bridge Inventory and Condition Performance

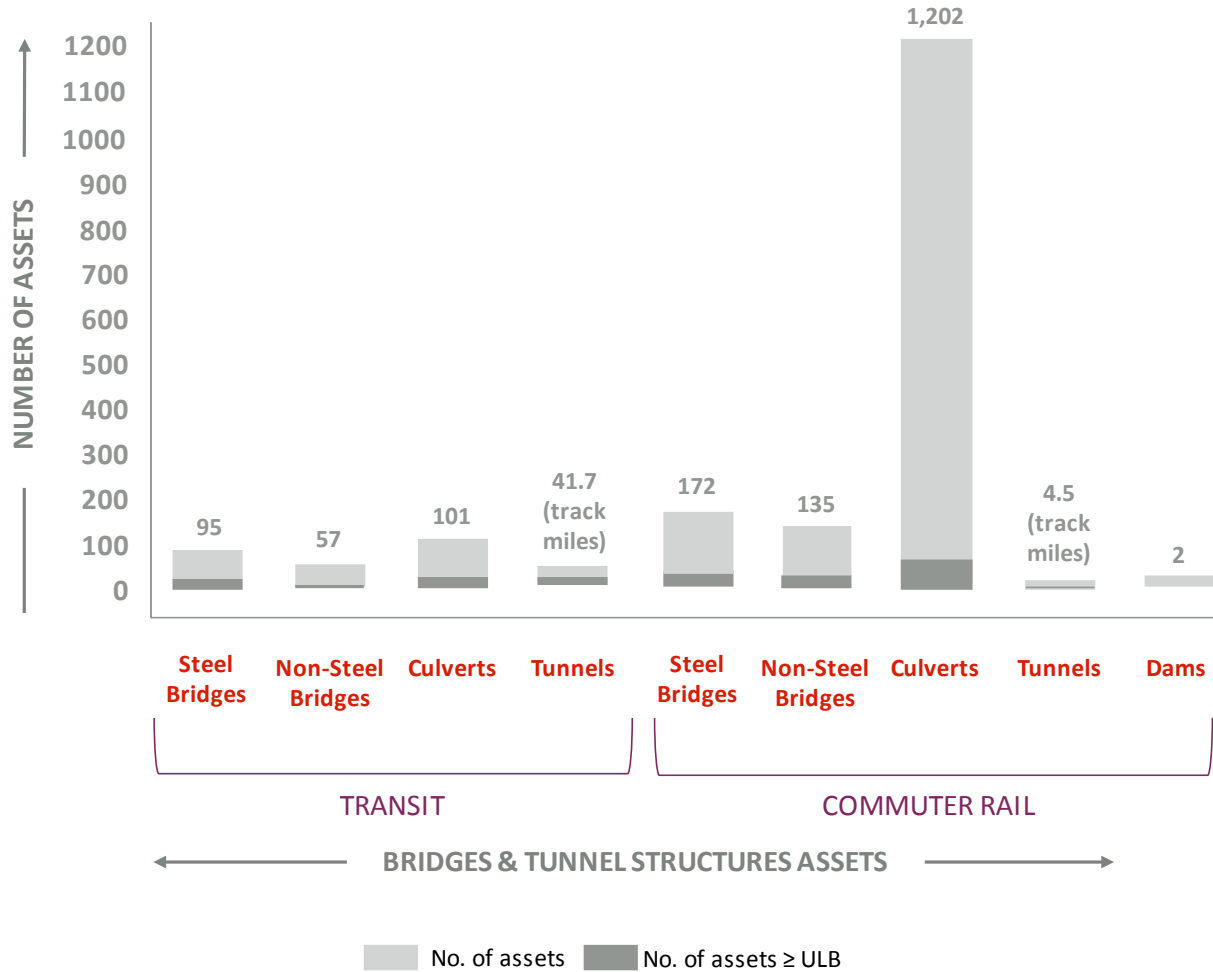


Table 4-15. Infrastructure – Bridges and Tunnel Structures: Current Condition Summary

Mode	Infrastructure Asset Type	Infrastructure – Bridge and Tunnel Structures	Unit	Quantity (2018)	Quantity not in SGR	% not in SGR
Transit	Bridges and Tunnels	Steel Bridges	Count	95	7	7%
		Non-Steel Bridges	Count	57	3	5%
		Culverts	Count	101	8	8%
		Tunnels	Track-Miles	41.7	In progress	In progress
Commuter Rail	Bridges and Tunnels	Steel Bridges	Count	172	27	16%
		Non-Steel Bridges	Count	135	12	9%
		Culverts	Count	1,202	60	5%
		Tunnels	Track-Miles	4.5	In progress	In progress
		Dams	Count	2	N/A	N/A

Ref.	Key Improvement Action	Timeline
4-3	Complete inventory exercise for culverts and tunnels.	Q3 2019 – Q1 2020
4-4	Complete condition assessment of culverts and tunnels.	2019 – 2022

**Facilities**

MBTA is undertaking physical condition assessments of all facilities. Table 4-16 provides a summary of MBTA’s facilities inventory and current performance where physical condition assessments have been completed.

**Table 4-16. Facilities Current Condition Summary**

MBTA Mode Category	Facility Group / Type	Unit	Quantity (2018)	Quantity < TERM Rating 3	% < TERM Rating 3
Transit	Maintenance and/or Administrative Facilities	Each	201	32	21%
	Passenger Facilities (Stations)	Each	130	In Progress	In Progress
	Parking Facilities	Each	33	In Progress	In Progress
	Transit Facilities Subtotal		364	In Progress	In Progress
Commuter Rail	Maintenance and/or Administrative Facilities	Each	38	In Progress	In Progress
	Passenger Facilities (Stations)	Each	138	In Progress	In Progress
	Parking Facilities	Each	93	In Progress	In Progress
	Commuter Rail Facilities Subtotal		269	In Progress	In Progress
MBTA Facilities Total			633	In Progress	In Progress

Ref.	Key Improvement Action	Timeline
4-5	Baseline all facilities assets in line with minimum FTA requirements. Maintenance and administrative facilities should be differentiated where possible. Train control rooms and substations should also be counted under guideway per federal reporting requirements.	Q3 2019 – Q1 2020
4-6	Complete physical condition assessments of at least 25% of all facilities each year over the next four years per federal requirements.	Q3 2019 – Q1 2020

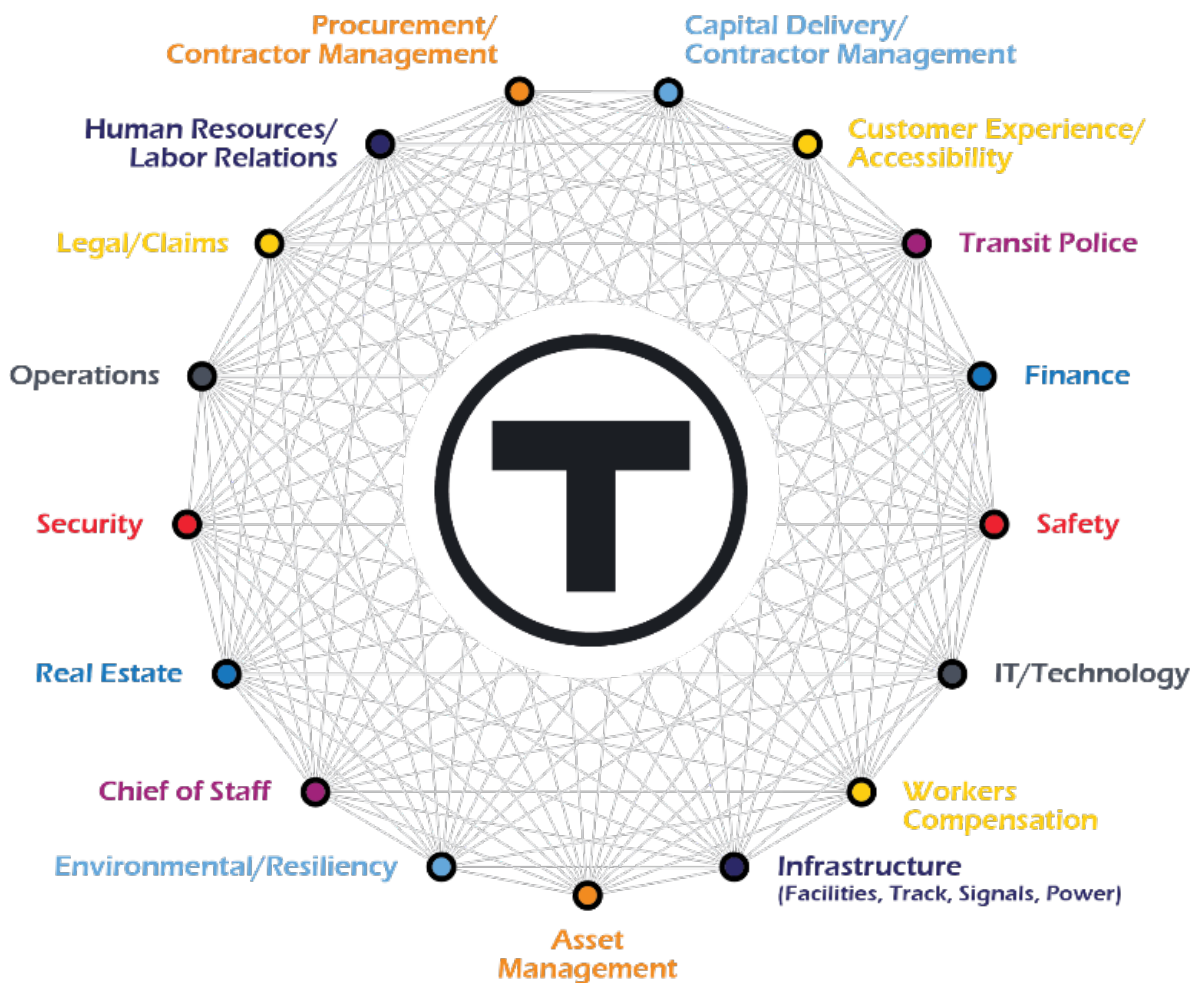


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## 5 Risk Management

MBTA’s established processes and procedures for managing risk have historically focused on insurance, weather and other incident management, while identifying and addressing safety risks related to its physical assets and operations. This TAM Plan highlights MBTA’s recent efforts to develop an enterprise risk management approach that also supports asset management decision making, planning, and prioritization.

Figure 5-1: Proposed MBTA Enterprise Risk Management Council



## 5.1 OVERVIEW

The Fixing America's Surface Transportation (FAST) Act requires that both asset and asset management risks are to be captured to inform investment prioritization and establish implementation strategies. As noted in the Executive Summary of the Federal Transit Administration's Transit Asset Management Final Rule (49 CFR § 625 and 630), "Critical to the safety and performance of a public transportation system is the condition of its capital assets. When transit assets are not in a state of good repair, the consequences include increased safety risks [but also] decreased system reliability, higher maintenance costs, and lower system performance."

Although federal regulations do not require formal risk management processes and procedures as part of a transit agency's asset management practices, the Final Rule (49 CFR § 625.33 (d)) does require that a "provider must give due consideration to those state of good repair projects to improve that pose an identified unacceptable safety risk when developing its investment prioritization" (see section 7 of this TAM Plan). Moreover, incorporating risk processes into MBTA's asset management and asset lifecycle management strategies supports MBTA's goal to maintain its assets in a state of good repair and is good industry practice.

This section outlines MBTA's current approach to risk management while offering a risk management framework to begin integrating risk identification and control activities in its asset management practices.

## 5.2 RISK MANAGEMENT APPROACH

### 5.2.1 Current Risk Management Activities

MBTA has established approaches for addressing safety risks, managing incidents, and ensuring business continuity. MBTA's Fiscal and Management Control Board adopted the agency's current Strategic Plan in 2017 "intended to ensure that there is never again a deterioration of our public transit system..." The plan includes objectives and strategies for 10 categories, one of which is safety, the key components of which include safety risk management linked to the agency's safety management policy and safety assurance, as mandated by the MAP-21, FAST Act, and 49 CFR 673 requirements for development of a Transit Agency Safety Plan. Safety risk management is also referred to in MBTA's 2018 Safety Plan for Transit Rail as "Hazard Risk Management" and consists of the process to:

- Recognize, identify and evaluate hazards.
- Resolve or reduce those hazards to an acceptable risk level.
- Track the effectiveness of hazard controls.

Mitigation of safety risks is a top priority as demonstrated further through training, regular safety briefings, promotion (e.g., safety awards) and capital project selection criteria. Safety management working groups exist throughout the agency to review and address safety risk issues.

MBTA also regularly addresses other forms of operational and hazard risk to ensure reliable operation of its modes, including:

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- **Developing and maintaining storm preparedness plans and emergency management plans:** The enterprise Snow and Ice Plan and the complimentary documents produced by each department, for example, are completed and issued annually. The plan effectively serves as a coordinated listing of roles and responsibilities to be followed in the event of a cold weather emergency/special events emergency. The plan lists the event and discusses such items as the risks, the action plans, staging, the people management plans, and the equipment needs.
- **Preparing for incident response and recovery:** In preparation for events, MBTA holds at least two major drills annually involving evacuation of Commuter Rail cars and subway cars from tunnels in addition to other preparedness activities like workshops and tabletop exercises. When an incident occurs, Operations plays a central role in coordinating the departments that are responsible for resolving the issue. When an event, major storm, or another incident does occur, MBTA Leadership manages business continuity and the event through the Emergency Operations Center (EOC).
- **Addressing climate risks:** The Environmental Department identifies climate risks to the system and develops resiliency plans addressing vulnerabilities to specific parts of the system (e.g., Blue Line Climate Change Resilience Plan).
- **Regularly identifying risks and threats to, and vulnerability of, MBTA assets and stations:** Threat and vulnerability assessments are conducted by a third party about every three years to identify which assets and stations are vulnerable to certain attacks. It is a collaborative effort with Transit Police and Safety and Security Teams.

### 5.2.1.1 Recent Improvements

The MBTA is expanding the focus of existing operational safety and hazards risk management to look at the impact of operational and hazards risks on the business, socio-economic responsibility, and service delivery more holistically at the enterprise level. Efforts are underway to prioritize and address open recommendations for improvement and to reduce risk.

The MBTA is in the process of forming a Risk Council as part of its overall enterprise risk management strategy. MBTA's Risk Council will play a key role in the implementation of its enterprise risk management strategy through its deliverable-based processes, accountability, and data-driven decision making. Regular participation from senior leaders in various parts of the business ensures that risks and issues are identified and managed in a comprehensive and collaborative manner. The functional areas of the business represented on the Risk Council are presented in Figure 5-1.

MBTA's Strategic Plan also addresses asset management risks. "There is a direct correlation between asset condition and service reliability, maintenance costs, day-to-day operational challenges, and customer experience." MBTA's recent effort to update and validate its complete capital asset inventory and perform asset condition assessments per new industry guidelines will further inform the risk management processes.

## 5.2.2 A Risk Management Process Framework for Asset Management

A risk process not only represents good practice but also is essential for developing lifecycle strategies and achieving the benefits of an asset management plan. Accordingly, this Transit Asset Management Plan provides a framework for enabling MBTA to move toward effectively managing the asset lifecycle, confidently provide sustained performance at the lowest lifecycle cost; effectively manage asset related risk and justify funding requirements to deliver required levels of service.

The intention is to align with the ISO 55000 asset management suite of standards over time, as indicated in the Strategic Plan. Among the relevant ISO 55001:2014 clauses are the following:

*6.1 Actions to address risk and opportunities for the asset management system – determine the risks and opportunities that need to be addressed to assure the asset management system can achieve its intended outcomes, prevent or reduce desired effects, achieve continual improvement.*

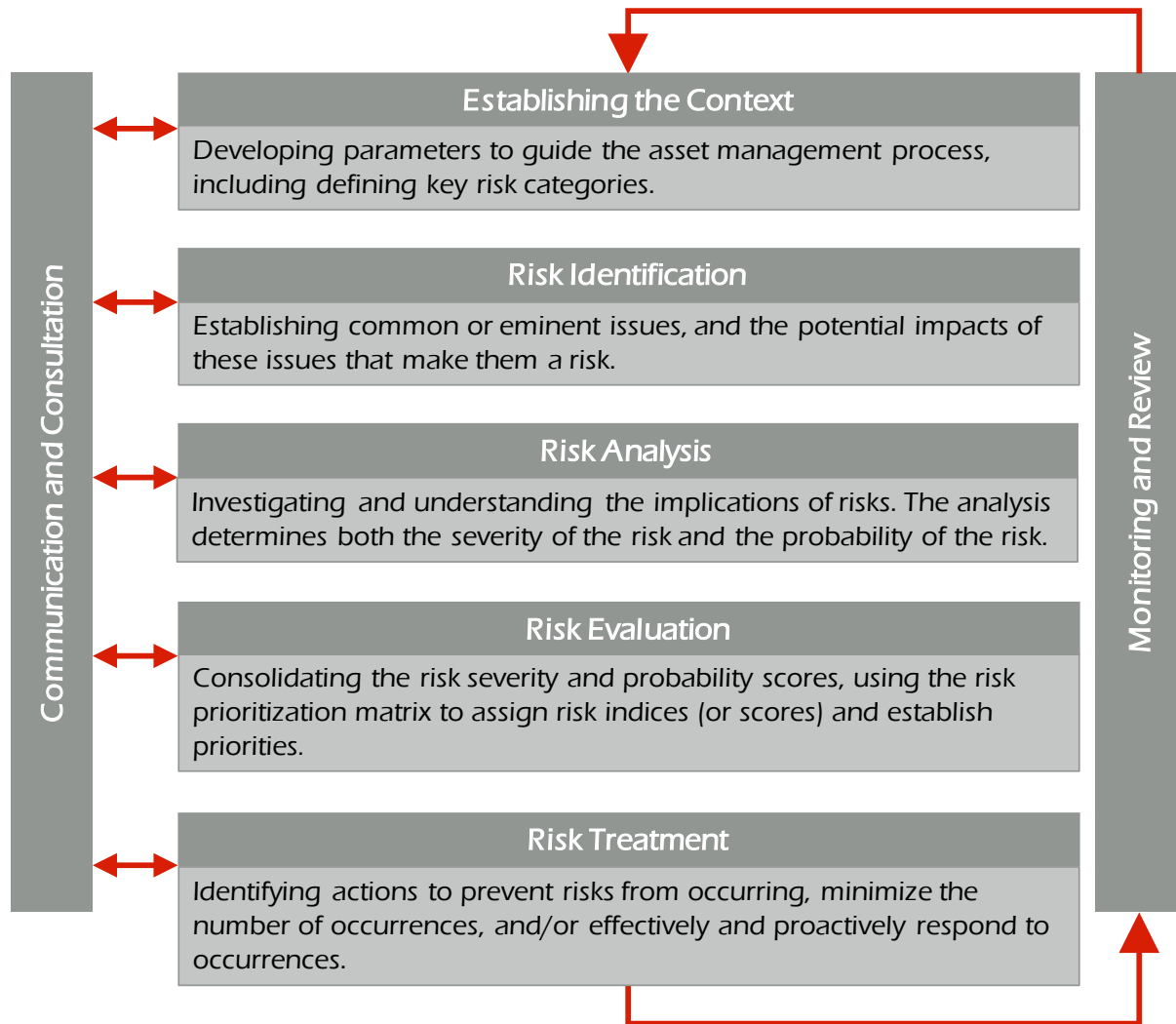
*– Organization shall plan actions to address these risks, taking into account how risks change over time, plan how to integrate and implement the actions into its asset management system processes, and evaluate the effectiveness of these actions.*

*6.22 Planning to achieve asset management objectives – Asset Management Plans (AMPs) shall document the criteria for decision making and prioritizing of activities and resources to achieve management objectives, processes and methods used over the assets lifecycle, actions to address risks, what will be done, resource requirements, responsibilities, when it will be done, how it will be evaluated.*

*– AMPs will consider actions to address risks taking into account how these risks change over time. Establish processes for identification, assessment, significance of the assets, plans for treatment and monitoring.*

The proposed framework for integrating risk management into MBTA’s asset management practices also is aligned to the ISO 31000:2018 risk management standard as illustrated in Figure 5-2 and described in the following sections.

Figure 5-2. ISO 31000 Risk Management Process



**Establishing the Context**

Establishing the context defines the basic parameters for risk evaluation and determines the scope for the rest of the risk management process, focusing on a specific area or areas of the business – whether at an enterprise level or asset level. The following risk categories embody the various functional areas represented on the MBTA enterprise Risk Council:

- Legal/Claims
- Finance
- Safety
- Chief of Staff
- Asset Management
- Operations
- Infrastructure (Facilities, Track, Signals, Power)
- IT/Technology
- Capital Delivery/Contractor Management
- Environmental/Resiliency
- Procurement/Contractor Management
- Security
- Transit Police
- Real Estate
- Human Resources/Labor Relations
- Workers Compensation
- Customer Experience/Accessibility

**Risk Identification**

Risk identification is the process of finding, recognizing, and describing risks. Risk identification is a systematic and continual process to maintaining an up-to-date view of risks. As a starting point, the MBTA is committed to the development of a risk management system software to track and manage claims and provide the basis for data-driven decision-making.

Ref.	Key Improvement Action	Timeline
5-1	Establish risk management system software to track and manage claims and provide for trend analyses and geographic mapping of claims activity	Q1 – Q4 2019

In addition, the systematic management of asset and asset management risks should engage those in the agency with direct asset-facing and other asset management responsibilities in identifying and describing potential risks.

Ref.	Key Improvement Action	Timeline
5-2	Undertake risk identification workshops with department directors to complete the initial risk identification exercise as it relates to assets and asset management.	Q1 – Q4 2019



## Risk Analysis and Risk Evaluation

Risk analysis is the process used to determine the nature and level of risk. Risk evaluation compares the results of the analysis to determine whether the risk is tolerable or acceptable. In this phase, risk consequence, likelihood, and magnitude ratings would be established for risk identified across the risk categories.

Ref.	Key Improvement Action	Timeline
5-3	Conduct risk analysis and evaluation of asset and asset management risks following risk workshops (see previous key improvement action).	Q1 – Q4 2019

## Risk Treatment

Risk treatment involves selecting one or more options for ameliorating the risk.

Best practice risk management considers one or more of four typical strategies:

1. Risk prevention – directed to eliminating sources of risk or substantially reducing its likelihood of occurring. Examples may include engineering and/or design changes, changes to the asset inspection or maintenance frequency, operations and use changes, and quality assurance procedures.
2. Impact mitigation – directed to minimizing the consequences of risk. Some risks such as extreme weather cannot be avoided, therefore risk management should be directed at coping with or managing the impact. Examples may include contingency planning, regular asset inspections, and design changes to harden physical assets from weather damage.
3. Risk transfer – is directed at shifting the responsibility for the risk to another party, who ultimately bears the consequences if the risk arises. Examples include insurance, procurement and contracting, which may require decisions at the time of or prior to asset handover.
4. Risk acceptance – occurs when risks cannot be avoided or transferred, or the cost benefit would not be worthwhile to treat, and therefore the risk is accepted and monitored.

## Addressing Critical Assets

As part of the development of an improved risk management framework, criticality should be defined for assets, and risk tolerances should be determined based on the defined asset criticality. Criticality can be based on a variety of factors, including:

- The asset’s location or functional significance within the network, considering traffic volume, services impacted (multi-modal or shared with other transportation providers), and track class (if applicable)
- The degree to which the failure of the asset impacts safe and efficient operations (especially assets that are necessary for safety, regulatory, or efficiency purposes)
- Other factors such as the potential for the asset to damage or disrupt other physical assets, property, or the environment should the asset fail, and the cost of repairing, replacing, or rebuilding the asset(s).

Ref.	Key Improvement Action	Timeline
5-4	Define criticality for MBTA assets, and identify operations critical, safety critical and climate sensitive.	Q1 – Q4 2019
5-5	Develop risk treatment strategies, especially for risks impacting the identified critical assets.	Q1 – Q4 2019

**Risk Monitoring, Management and Communication**

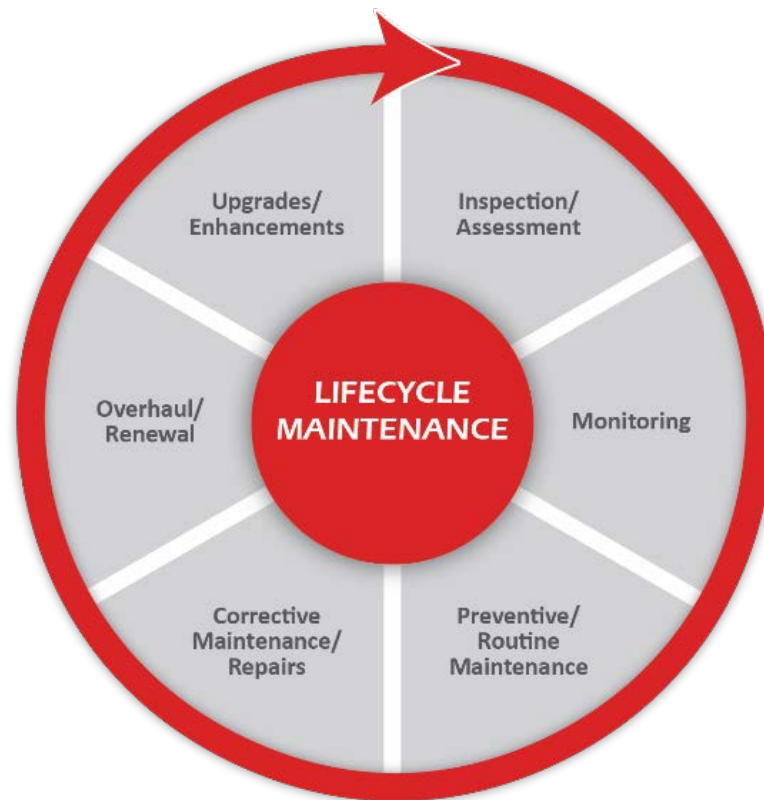
Regular monitoring, reviewing and reporting is an important part of the risk management process, as it ensures that new risks and changes to existing risks are identified and managed.

Ref.	Key Improvement Action	Timeline
5-6	Incorporate risks related to assets and asset management into MBTA’s regular annual risk review cycle.	Q1 – Q4 2019
5-7	Develop an enterprise risk register that recognizes all categories of risk as represented by the functional areas on the Risk Council.	Q1 – Q4 2019
5-8	Regularly update the risk register upon completion of the condition assessment of assets, and incorporate asset and asset management risks, treatments, and responsible parties in the next Transit Asset Management Plan update.	Q1 – Q4 2019
5-9	Use the information generated through the above improvement actions as an input to the decisions of the asset management steering committee.	Q4 2019

## 6 Lifecycle Management Strategies

Lifecycle management strategies are being further developed as part of the 2018-2019 asset management program of work to capture the capital maintenance activities and resources necessary to achieve and maintain MBTA's state of good repair goal. Current strategies or practices to maintain MBTA's assets in safe operating condition are summarized in this section.

Figure 6-1. MBTA Lifecycle Management Strategies



### 6.1 OVERVIEW

Lifecycle management strategies are the proposed actions for maintaining an asset over its life. These strategies are being reviewed and further developed as part of MBTA's 2018-2019 asset management program of work to capture the steady state capital maintenance activities and resources required to achieve and maintain a state of good repair. The steady state is defined by implementation of the regular lifecycle management activities on a year-by-year basis to maintain asset performance. It does not account for deferred maintenance or state of good repair backlog. As this also represents the start of developing a view of the capital investment

needed to meet current and future demands, the steady state and backlog requirements are both addressed in Chapter 7, Work Plans and Budget Forecasts.

## 6.2 CURRENT LIFECYCLE MANAGEMENT STRATEGIES

As stated in its vision, MBTA is committed to providing customers safe, accessible, cost-effective, resilient, sustainable, dynamic, and responsive service. Current lifecycle management strategies implemented at MBTA to achieve this commitment are presented below. For the management of infrastructure assets (track, signal, power, facilities), typical work activities to manage the infrastructure over its life are also described in MBTA's Engineering and Maintenance Directorate Management Plan.

Strategies have been summarized and organized by the following categories:

- **Inspection / Assessment** includes visual inspection and technical testing to ensure safe operating capability. Inspection activities are typically on a time or mileage interval as defined in fleet and/or facilities management plans. Asset assessments or asset health is typically graded on a scale (i.e., zero-to-five or one-to-five scale) and supports long-term planning for the asset.
- **Monitoring** may include real-time sensors or similar electronic equipment that can continuously monitor the status (e.g., temperature, humidity, pressure, etc.) of an asset and provide alerts when thresholds have been exceeded.
- **Preventive / Routine Maintenance** includes regular, sometimes daily activities or tasks (e.g., fueling, fluids check and replenishment, cleaning, etc.) to ensure the assets continue to operate in safe and acceptable conditions. They may also include seasonal preventive programs for extreme temperatures in the summer or winter (e.g., HVAC or air systems, plows or winter pantograph heads installed on certain lines, etc.).
- **Corrective Maintenance / Repairs** includes standard repair tasks that occur due to a condition or fault issue discovered through inspection, monitoring, or during operations. Activities that fall under this category are also known as "running maintenance."

MBTA's maintenance practices comply with industry standards (e.g., Original Equipment Manufacturer [OEM], American Railway Engineering and Maintenance [AREMA], Federal Railroad Administration [FRA]) and state requirements (e.g., MassDOT, DPU), and MBTA specific requirements.

Beyond routine operations and maintenance, larger scale renewals, replacements, enhancements, or expansions may take place to improve service levels and performance. These would include the following categories and activities:

- **Overhaul / Renewal** includes more extensive capital maintenance activities required to bring a set of assets up to an acceptable condition or extend their useful life (e.g., vehicle mid-life overhauls, system or component replacements, etc.). These strategies are typically assigned on time, use, and/or condition based intervals.
- **Upgrades / Enhancements** include asset or system-wide capital improvement activities that go beyond like-for-like replacement and enhance current service levels, performance, reliability, capacity, or technology for existing assets, such as increasing track capacity, track class upgrades, vehicle upgrades, etc.

### 6.2.1 Vehicles

Preventive maintenance for MBTA’s bus fleet, for example, comply with and exceed OEM requirements and MBTA specific requirements, Bus fleet preventive maintenance activities are usage based, scheduled by 6,000-mile intervals, with differing scopes at various intervals (e.g., 6,000-mile, 12,000-mile, and 18,000-mile intervals). For Rail Fleet, maintenance strategies involve continuous and frequent preventive maintenance inspections. Parts replacement is also on a programmed schedule to prevent component failure. Additionally, maintenance campaigns on certain lines have also been instituted (e.g., annual lubrication programs, component overhauls, and equipment upgrades) to improve reliability and performance of assets. For Commuter Rail, in addition to regular inspection and preventive maintenance strategies, main engine overhauls as well as mid-life overhauls are performed for locomotives.

The tables that follow outline the key lifecycle management strategies, primarily the inspection and preventive maintenance strategies to ensure safe operating conditions, for each major vehicle asset group.

**Table 6-1. Revenue Vehicle Lifecycle Management Strategies**

Asset Class	Lifecycle Management Strategy/Activity	Frequency
Bus Fleet <sup>xxiv</sup>	Inspection and Services – Varies by Vehicle	500 miles or 7 days
	Preventive Maintenance	6,000-mile intervals
	Air Conditioning Systems PM Inspection	Annual
	Pre-Summer and Pre-Winter PM Inspection	Annual
Transit Rail Car Fleet <sup>xxv</sup>	Red Line PM Inspections – No. 1 and No. 2 cars	8,500 miles or 90 days
	Red Line PM Inspections – No. 3 cars	15,000 miles
	Red Line HVAC System Inspection	Varies by Vehicle Type
	Orange Line PM Inspections	12,000 miles or 90 days
	Orange Line – HVAC Inspections	4 times / year
	Orange Line – Extensive PM Program	Annually
	Blue Line PM Inspections – No. 5 cars	6,000 and 12,000 miles
	Green Line PM Inspections – Type 7 cars	7,500 miles or 90 days
	Green Line PM Inspections – Type 8 cars	90 days
	Green Line PM Inspections – PCC cars	30 days
	Green Line HVAC System Inspections	Annually
Green Line Air Compressor Inspections	Annually	
Commuter Rail Fleet	Locomotive Inspections	45 days, 92 days, 1 year, 2 years, and 3 years
	Locomotive top deck engine overhaul; mid-life overhaul	6-8 years
	Control Coach Inspections	92 days, 1 year, 2 years, and 3 years
	Blind Coach Inspections	180 days, 1 year, 2 years, and 3 years
Ferry Boats	Vessel Condition Assessment	Annually

## 6.2.2 Infrastructure (Track, Signals, Power, Facilities)

MBTA's Transit Maintenance of Way (MOW) Department is responsible for the maintenance and repair of all track. The Maintenance of Way Department regularly performs all types of lifecycle management activities including inspection, preventive maintenance, corrective maintenance, repairs/renewals/replacement, capital improvements, construction support, special projects, asphalt paving, to maintain assets under its control. Additionally, MOW performs ROW trash cleanup and removals, snow removal, and landscaping.

Track inspections are performed per 220 CMR 151, MBTA SSPP guidelines, and the MBTA Light Rail Transit Track Maintenance and Safety Standards, and MBTA Heavy Rail Transit Track Maintenance and Safety Standards. Inspections fall under two categories: manual visual inspections and mechanized inspections. Visual track inspections are typically performed during the day and night and must be made on foot or by riding over the track in a vehicle at a speed that allows the person making the inspection to visually inspect the track structure for compliance with 220 CMR 151. Mechanized track inspections are used for geometry, ultrasonic (internal rail flaw), and optical (railhead profile) inspections. If speed restrictions are in place, however, track inspections may be conducted at more frequent intervals to ensure safe operations at all times.

Table 6-2 outlines the track inspections as mandated in 220 CMR 151 and the MBTA Safety Management System (SMS), as well as inspection activities for signals and power. If issues are identified at any point during inspection, issues are reported and if corrective repairs are required, these are subsequently scheduled through Planning and Scheduling. Repairs, renewals, and replacements of infrastructure assets are performed as needed.

The Signal and Communications Department is responsible for the maintenance and operation of signal assets including: track circuits, wiring, bonds, switches, third rail heaters, and central instrument houses/wayside cases. Communications assets include: telephone hardware, police call boxes, public address system hardware, and message boards.

The Power Department is responsible for the maintenance and operation of: gas generation plant, bulk power yard, South Boston Switching Station, AC cabling and duct bank system, traction power substations, DC distribution system, overhead catenary system, power SCADA system, generator control system, and ISO dispatch system.

Transit Facilities Maintenance (TFM) is responsible for a large range of assets and asset types that span the transit system. They include buildings, subway facilities, passenger stations, bus stops, parking garages, bridges, tunnels, culvers and retaining walls. Maintenance strategies comply with state building codes, requirements of MBTA's insurance carrier, and national standards such as the National Bridge Inspection Standards (NBIS), National Fire Protection Association (NFPA), and federal guidance.

Table 6-2. Infrastructure (Track, Signals, Power) Lifecycle Management Strategies

Asset Class	Inspection / Assessment Activity	Frequency
Track <sup>xxvi</sup>	Light Rail Passenger-Service Track Inspection	3 times per week (with at least one calendar day interval between inspections)
	Light Rail Yard and Storage Track Inspection Heavy Rail Yard and Storage Track Inspection	Weekly (with at least 3 calendar days interval between inspections, or before use, if track is used less than once a week)
	Heavy Rail Passenger-Service Track	2 times per week (with at least one calendar day interval between inspections)
	Internal Rail Defects Inspection	At least once per year
Signals <sup>xxvii</sup>	Relay Testing	2 years and 4 years
	Track Circuit Testing	2 years
	Switch Obstruction Testing	Monthly
	Automatic Train Stop Testing	Monthly
	Ground Testing	Monthly
	Track Mapping	Monthly
Power	DC Circuit Breaker Routine Maintenance	2 times per year or as required
	Security Check	Every 2 Weeks
	Transformer Maintenance	Once per year or as required
	AC Switchgear Assembly Maintenance	Once every 3 years or as required
	Rectifier Substation Maintenance	2 times per year, or as required
	Filter Maintenance	2 times per year
	AC Feeder Tests	Once per month
	DC Feeder Tests	Once per week
	Overhead Wire Preventive Maintenance	Every 8 to 26 weeks (depending on type and location)
Overhead Wire Head System Video Car Inspection	Quarterly	
Stations / Facilities	Detailed System Inspections	Monthly
Bridges	Routine Bridge Inspections	Bi-Annually
	In-Depth Bridge Inspection	Every 5 years
	Bridge Load Rating (Structural Analysis)	Every 10 years



### 6.3 LIFECYCLE STRATEGY IMPROVEMENTS

The following improvements address gaps in asset class plans.

Ref.	Key Improvement Action	Timeline
6-1	Plan and undertake a maintenance strategy review of all asset classes (prioritized by criticality, vulnerability, utilization) to ensure the most appropriate strategies are applied to respective assets	Q2 2019 – Q1 2020
6-2	Review and further develop lifecycle management strategies for each asset class and assumptions in Chapter 7 Work Plans and Budget Forecasts to better inform work and budget forecasts and analyses	Q2 2019 – Q1 2020
6-3	Upon further review of asset information and development of above lifecycle management strategies, develop tactical asset class strategies for each major asset class (e.g., bridges and tunnels, rail vehicles and facilities, bus fleet and facilities, ferry fleet and facilities, track, power, signals and communications) that specify the activities, timelines, and resources required to achieve/maintain a state of good repair and transition to steady state capital maintenance.	2019 – 2020

## 7 Work Plans and Budget Forecasts

The forecasted reliability and modernization investments in the FY2019-FY2023 capital program totals \$6.7 billion, representing 84% of the total \$8 billion MBTA Capital Investment Plan (CIP).

### 7.1 OVERVIEW

Strategic and thoughtful allocation of financial resources is critical to maintaining safe, reliable, and accessible transit service and the assets that deliver that service. This section provides an overview of the analytic processes employed by the MBTA to develop a Capital Investment Plan that reflects the agency's strategic priorities and asset needs. Section 7.2 describes the approaches used to allocate funds across the portfolio of capital programs and to prioritize and select specific projects within each program. Section 7.3 outlines the reliability, modernization, and expansion programs in the current MBTA CIP and highlights priorities for investment to improve the state of good repair of capital assets.

In accordance with 49 CFR § 625.33, the work plans and investment prioritization presented in this section are based on estimated funding available to MBTA for each fiscal year over the five-year TAM Plan horizon period. MBTA's prioritized projects over the FY2019-2023 period are detailed in **Appendix F** and available in the public FY19-23 MassDOT/MBTA Capital Improvement Plan.

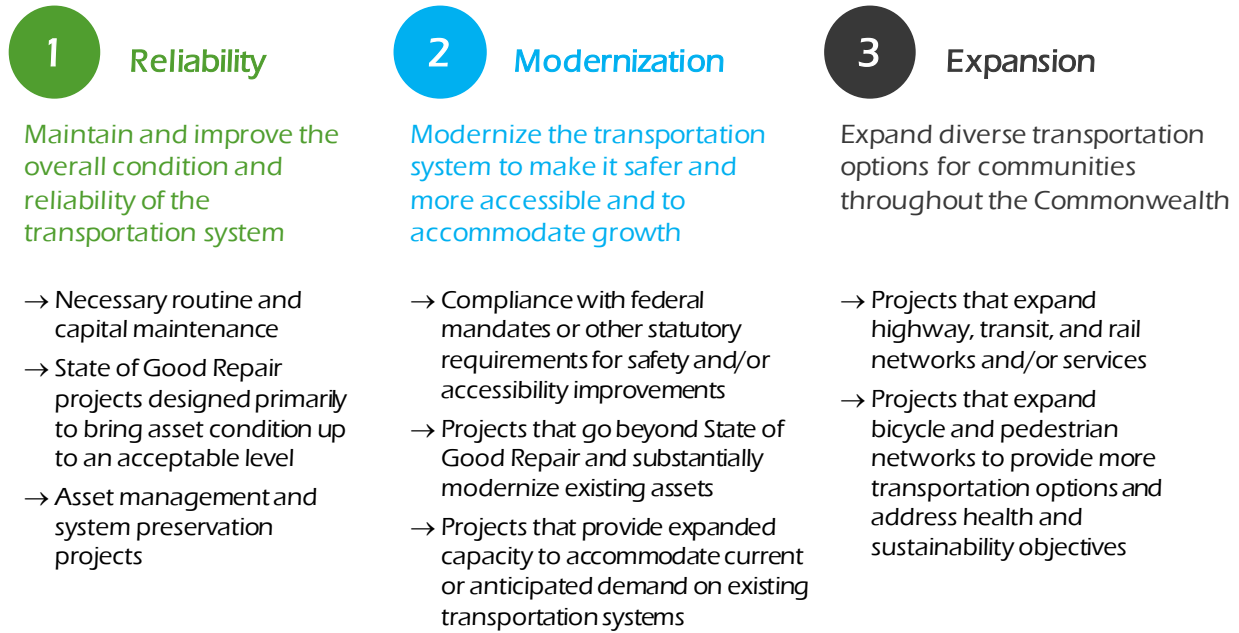
### 7.2 DECISION SUPPORT

#### 7.2.1 Capital Planning and Investment Prioritization

##### Capital Investment Plan Overview

The MBTA Capital Investment Plan is a five-year, resource-constrained portfolio of programs and projects that is updated annually as part of the multi-modal MassDOT CIP process. The MassDOT/MBTA CIP process was dramatically overhauled in 2015 to reflect a more strategic approach to capital planning organized around priorities and programs. The MassDOT/MBTA CIP is divided in three priorities: reliability, modernization, and expansion, detailed in Figure 7-1.

Figure 7-1. MassDOT/MBTA CIP Priorities



Within each priority, funds are divided into investment programs organized around a specific asset type or functional purpose. A list of MBTA programs for the FY19-23 CIP are in Table 7-1.

Table 7-1. MBTA CIP Investment Programs (FY2019-FY2023)

FY19-23 MBTA CIP Investment Programs		
Reliability	Modernization	Expansion
Bridge & Tunnel	Accessibility	Expansion Projects
Facilities	AFC 2.0	Green Line Extension
Revenue Vehicles	Commuter Rail Safety and Resiliency	
Stations	Customer Experience and Technology Improvements	
System Upgrades/Other	Process Improvements & Innovation	
Track, Signal and Power	Red / Orange Line Improvements	
	Risk Management & Mitigation	

State of Good Repair investments fall under both the Reliability and Modernization priorities – for example, a station reconstruction in the Accessibility program falls within the Modernization priority but will also improve the condition of the station. Similarly, the Red and Orange Line Improvements program, also within the Modernization priority, will improve the reliability of the vehicles, maintenance, and signals serving these rapid transit lines, but will also add capacity for enhanced service.

## Investment Prioritization and Decision Support

The MBTA prioritizes potential capital investments by evaluating the costs and benefits of proposed projects using a consistent, objective, and data-informed approach, as required by MBTA's enabling legislation and recommended by the MassDOT Project Selection Advisory Council (PSAC).

As described below, the first step in the annual capital planning process is to estimate available funding sources for the upcoming five-year window. Once sources are identified, the MassDOT/MBTA leadership team, in coordination with the FMCB, allocates these funds to investment programs listed in Table 7-1. These program sizes reflect the relative priorities among asset categories or functional areas, and are tied to specific performance measures or outcomes. MassDOT has developed a decision support tool called "Planning for Performance" to estimate the impact of projected investment levels on asset performance. The MBTA plans to adopt this tool for some asset classes for the FY2020-2024 CIP and continuously refine our internal processes to fully align CIP investment program sizes with our asset management objectives and performance targets.

Concurrent with the program sizing process, the Capital Planning team manages a process to solicit, review, evaluate, and score new projects proposed for the upcoming CIP. MassDOT and the MBTA use a project selection framework with eight criteria: system preservation, mobility, cost effectiveness, economic impact, safety, social equity and fairness, environmental and health effects, and policy support.

- System preservation – Projects should contribute to a state of good repair on the transportation system.
- Mobility – Projects should provide modal options efficiently and effectively.
- Cost effectiveness – Projects should result in benefits commensurate with costs and should be aimed at maximizing the return on the public's investment.

## INVESTMENT PRIORITIZATION REQUIREMENTS

Per 49 CFR 625.33, a provider must:

- Include an investment prioritization in its TAM Plan that identifies a provider's programs and projects to improve or manage over the TAM plan horizon period the state of good repair of capital assets for which the provider has direct capital responsibility.
- Rank projects to improve or manage the state of good repair of capital assets in order of priority and anticipated project year.
- Have project rankings consistent with its TAM Policy and strategies.
- Give due consideration to those state of good repair projects to improve that pose an identified unacceptable safety risk when developing its investment prioritization.
- Consider its estimation of funding levels from all available sources that it reasonably expects will be available in each fiscal year during the TAM Plan horizon period.
- Consider requirements under 49 CFR 37.161 and 37.163 concerning maintenance of accessible features and requirements under 49 CFR 37.43.

- Economic impact – Projects should support strategic economic growth in the Commonwealth.
- Safety – Projects should contribute to the safety and security of people and goods in transit.
- Social equity and fairness – Projects should equitably distribute both benefits and burdens of investments among all communities.
- Environmental and health effects – Projects should maximize the potential positive health and environmental aspects of the transportation system.
- Policy support – Projects should get credit if they support local or regional policies or plans, or state policies not addressed through the other criteria.

Cross-functional evaluation teams review, evaluate, and score each project proposal using the information on costs and benefits in the project request, as well as supplementary data on asset condition, estimated ridership, climate risk, and attributes of the surrounding community. For the most recent CIP, the Safety criterion was scored by the Safety Department using their expertise and resources.

Within the evaluation framework, system preservation is the criterion most closely aligned with asset management. This reflects the extent to which a project contributes to a state of good repair on the transportation system and aligns with asset management goals and strategies. One factor used to develop this score is asset condition, which reflects the current condition of the primary asset and the extent to which the proposed project will improve the asset’s condition or mitigate further deterioration. Where available, data gathered for the FY18 TAM Performance Targets were provided to evaluation teams to assist in their review of each project. While all projects are scored using the criteria, SGR-specific projects are only subject to six of the eight criteria (not including economic impact and social equity) and with different weighting than modernization or expansion projects.

Once all scores are submitted, weighted, and tabulated, projects are ranked by score within each investment program and presented to the senior leadership team for final prioritization within the available program budgets. In addition to the scores, the leadership team also considers project readiness, modal and geographic equity, resource availability, and other impacts. The draft CIP is presented to the FMCB and MassDOT Board of Directors for review and comment, shared with the public for review and comment, and then approved by the Joint Board. The final approved CIP is provided to the State Legislature.

Ref.	Key Improvement Action	Timeline
7-1	Adopt MassDOT decision support tool “Planning for Performance” to estimate the impact of projected investment levels on asset performance.	2019
7-2	Continuously refine internal processes to fully align CIP investment program sizes with MBTA’s asset management objectives and performance targets.	2019

### 7.2.2 Funding Sources

The primary funding sources available for capital investment are Federal grants, State funds, MBTA Revenue Bonds, Pay-As-You-Go capital transferred from the operating budget, and third-party reimbursements. As the first step in the CIP development process, the Capital Planning

and Capital Budget teams estimate available funding sources over the next five years based on existing funding agreements (e.g. the Green Line Extension New Starts Full Funding Grant Agreement) and reasonable assumptions regarding anticipated Federal formula funds, State and MBTA bonding capacity, third-party reimbursements, and carryover from previous years. These projections are then used as the funding constraint for the capital plan, with programmed uses of funds at or below anticipated sources of funds.

Table 7-2 summarizes the MBTA FY19-23 CIP by primary funding sources. A more detailed description of sources can be found in **Appendix E**.

**Table 7-2. MBTA CIP Funding Sources**

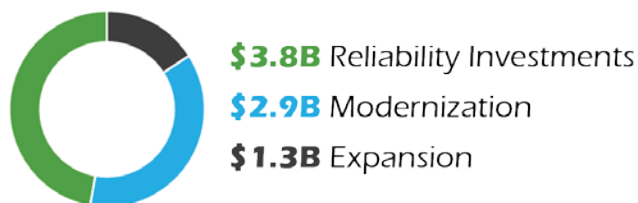
FY19-23 MBTA CIP by Funding Source	
Federal	\$3,692,985,036
State	\$1,099,678,741
MBTA Revenue Bonds	\$2,194,474,269
Pay-As-You-Go	\$855,968,883
Reimbursable/Third Party	\$159,040,548
<b>Total</b>	<b>\$8,002,147,477</b>

### 7.3 FY19-23 CAPITAL INVESTMENT PLAN

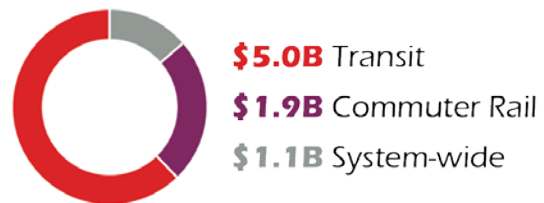
MBTA’s FY2019-2023 Capital Investment Plan Update was approved in June 2018. This reflects a plan to invest over \$8 billion over the next five-year period to support MBTA projects that maintain and improve the condition of our assets; modernize the system to improve accessibility, reduce risk, and accommodate growth; and make targeted investments in network expansion.

Figure 7-2 illustrates the share of program investments across reliability, modernization, and expansion projects over the next five years. Approximately 47% of total FY2019-2023 investments are funding reliability projects. About 37% of total FY2019-2023 investments are funding modernization projects, followed by 16% for expansion projects. Figure 7-3 illustrates the share of program investments across Transit (68%), Commuter Rail (18%), and System-wide improvements (14%).

**Figure 7-2. MBTA Program Investments by Priority Category (FY2019-2023)**



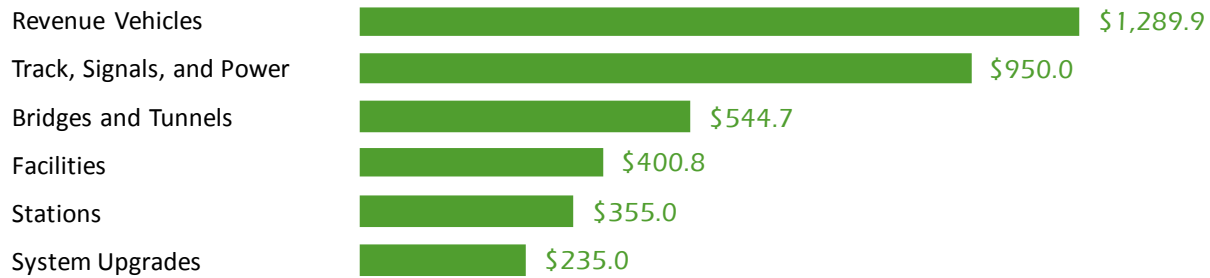
**Figure 7-3. MBTA FY2019-2023 Program Investments (Transit, Commuter Rail, System-wide)**





MBTA's highest reliability investment priorities over the FY2019-FY2023 period are investing in its revenue vehicles (34%), followed by track, signals, and power infrastructure (25%). Figure 7-4 illustrates reliability investment levels by the following major asset groups: Bridges and Tunnels; Revenue Vehicles; Facilities; Stations; System Upgrades; and Track, Signals, and Power.

**Figure 7-4. FY2019-FY2023 MBTA Reliability Investments by Major Programs (in \$ million)**



## 7.4 MBTA CAPITAL NEEDS ASSESSMENT

This section provides an overview of the efforts underway to conduct a comprehensive reevaluation and assessment of the MBTA's capital needs, including a re-estimate of the State of Good Repair Backlog. This analysis will use updated inputs and assumptions to generate a revised forecast of the capital investment necessary to achieve the MBTA's asset management goals as well as other strategic priorities. The asset inventory, condition, and performance data collected for this report and the 2018 NTD Asset Inventory Module submission will provide valuable inputs for this analysis. However, as noted elsewhere in this Plan, the data collection and condition assessments represent approximately 60 percent of the Authority's assets and will be completed over the coming years. As a result of this incremental approach to data collection, the capital needs assessment will also be a dynamic exercise with updated analysis and results as new information is incorporated.

Using the inputs collected to-date from NTD reporting requirements and other asset condition data as a starting point, the Authority is pursuing a phased approach to the capital needs assessment:

- *Phase 1: Revised State of Good Repair Backlog Estimate*
- *Phase 2: Comprehensive Needs Assessment*

During Phase 1, MBTA staff will develop a revised estimate of the total required investment to replace assets that are not in a state of good repair. The following methodology is used to arrive at this estimate:

1. For each asset class, a full inventory is documented using the latest data, including the assets' count, age, useful life benchmark, and condition (if relevant).
2. For an asset whose age is greater than its useful life benchmark or whose physical condition assessment falls below a 3 on the TERM scale for facilities per 49 CFR § 625 and 2.5 for all other asset types, it is considered not in a state of good repair and therefore a part of the backlog.
3. Using recent MBTA project costs or other industry benchmarks, assign estimated replacement values to each asset.
4. The count of each asset identified as part of the backlog is then multiplied by its replacement cost; the sum of these calculations represents the Backlog Estimate.

Phase 2 of the Capital Needs Assessment will build on the former analysis by including costs of modernizing and upgrading assets to meet other MBTA strategic goals. The Agency recognizes that identical, yet new, assets should not always replace assets in our inventory that are not in a state of good repair. Instead, based on the Authority’s strategic objectives, this analysis aims to identify asset replacement costs that go beyond the former analysis to include priorities such as accessibility, sustainability, climate resilience, and capacity. Both of these analyses will inform future capital planning activities and allow for a more comprehensive view of our capital needs. We plan to continuously update these estimates when new information becomes available.



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## 8 Asset Management Practices

Asset Management provides for better decision making through asset knowledge and validated information supported by technology and documented business processes to ensure consistent practices.

### 8.1 OVERVIEW

This section provides an overview of the organization, roles, responsibilities, and key business processes in place to assist and guide MBTA in implementing asset management practices and the information systems that support work planning, scheduling, and management.

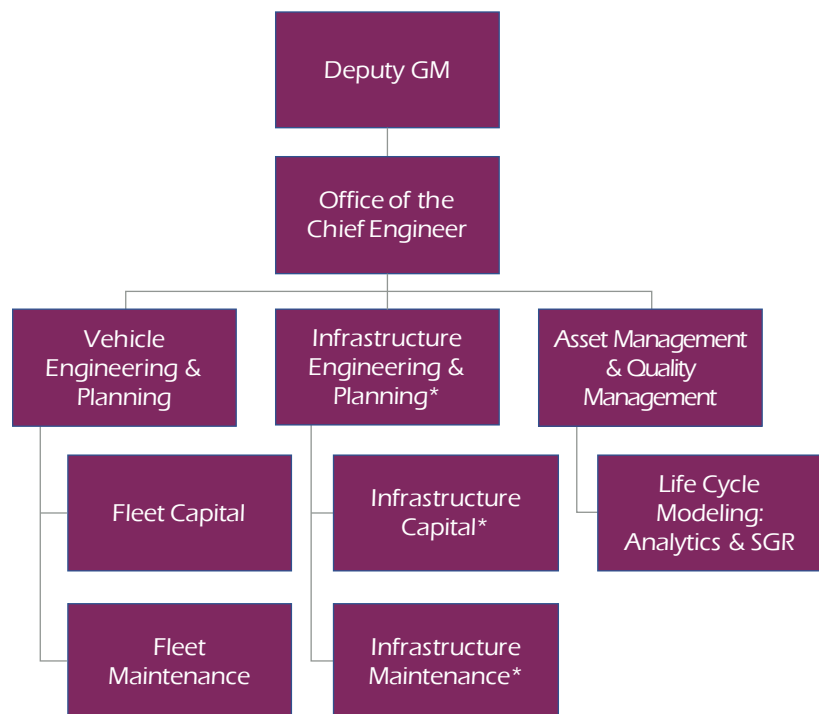
### 8.2 ORGANIZATION

The GM has charged the Chief Engineering Officer, Senior Director of Capital Planning, Senior Director of Reliability Engineering, and Director of Asset Management with the development and implementation of this 2018 TAM Plan, with support from the Asset Management Governance Board made up of Business Unit Leaders from across the MBTA and MassDOT.

The Office of the Chief Engineer is primarily responsible for:

- Medium- and long-term planning and standard setting
- Augmenting critical day-to-day maintenance functions that keep the transit system running and respond to immediate operational needs
- Partnering with capital program development and project planning functions, as well as capital delivery, to ensure the pipeline of state-of-good repair projects is being addressed
- Building out the asset management and life cycle modeling function.

Figure 8-1. Asset Management Organization



\*Includes track, power, signals, and facilities

## 8.3 CORE BUSINESS PROCESSES

### 8.3.1 Enterprise-Level Processes

Table 8-1 summarizes the major enterprise-level processes that support asset management practices, including near- and long-term service planning, capital planning and project delivery, and performance management, among others. Opportunities to improve existing processes as identified through MBTA's As-Is Business Process workshops are also summarized.

Table 8-1. Key Enterprise-Level Asset Management Processes, Improvements, and Benefits

Key Process	Description	Improvement Opportunity
<b>Capital Planning</b>	<p>Capital Program Oversight develops the Capital Investment Plan and allocates funding based on a prioritization methodology to projects. As described in Chapter 7, Work Plans and Budget Forecast, the FY 2019-2023 MBTA capital plan prioritized capital investments by evaluating the costs and benefits of proposed projects using a consistent, objective, and data-informed approach. The project evaluation process includes eight (8) criteria: system preservation, mobility, cost effectiveness, economic impact, safety, social equity &amp; fairness, environmental &amp; health effects, and policy support. Within the evaluation framework, system preservation is the criterion most closely aligned with asset management. This reflects the extent to which a project contributes to a state of good repair of the transportation system and aligns with asset management goals and strategies. One factor used to develop this score is asset condition, which reflects the current condition of the primary asset and the extent to which the proposed project will improve the asset’s condition or mitigate further deterioration.</p>	<p>Align capital programs (funding buckets) with performance targets.</p> <p>Build on work undertaken for Integrated Fleet and Facilities Plan to build lifecycle cost into evaluation criteria.</p> <p>For assets that do not go through the Capital Delivery process because they are bought through a Purchase Order, develop an initial project justification/ business case template and require sign-off regarding maintainability and “system”/context compatibility; develop a gate process that includes evaluation/sign-off at each gate; assure that assets bought by facilities are recorded by the Treasurer and in the EAM system.</p>
<b>Capital (Project) Delivery, including Design Management</b>	<p>Capital Delivery manages the planning, procurement, design, construction, and project close-out for all infrastructure projects. (Management of Special Projects such as the Green Line Extension is contracted out.) In addition to its own project managers, Capital Delivery may also contract out project management staffing, such as project and construction managers, project control specialists, schedulers and project administrators.</p> <p>Throughout the planning and design project phases, Capital Delivery engages the respective operating department staff through Project Development Group (PDG) coordination meetings, which allow operational staff to comment on the completed and anticipated design work, plan for operational necessities, and discuss construction staging, phasing, anticipated closures, and customer concerns. The Capital Delivery group oversees construction through use of MBTA resident engineers, inspectors, and project managers to ensure that the construction is of high quality and is commencing as per the contract documents, work is performed to code and internal MBTA standards, safety and security standards are followed, and</p>	<p>Develop central repository for changes to design and configuration management from initial design through delivery and operation/ maintenance.</p> <p>Develop a standardized phased process for delivery of a capital asset that is consistent across asset types. The process should begin at functional design/ scoping with a project plan (against which configuration management can occur) involving the end user and consideration of compatibility between existing systems and</p>

Key Process	Description	Improvement Opportunity
	<p>the budget and schedule are maintained. For large programs, Capital Delivery may hire an external construction management contractor for additional staffing support. The Real Estate department provides support when a right-of-way or temporary easement is needed. Capital Delivery also engages operating departments during the construction phase through weekly Right-of-Way (ROW) access committee meetings to plan for right-of way access and the use of force account labor.</p> <p>Vehicle Engineering is responsible for managing and delivering vehicle projects (see Asset-Level Business Processes).</p>	<p>include evaluation and validation at each step/gate in the process, including approval from everyone in the agency who will touch that asset. The process should include a maintainability requirement and sign-off, and also a system compatibility review (e.g., facility height must accommodate lifts being procured including concrete base, and concrete base construction should be included as part of lift acquisition)</p> <p>Assure that E&amp;M and Asset Management needs/concerns get incorporated in contract specifications, including training and other handover requirements; define in the original specification when the warranty starts: at beneficial occupancy or at acceptance.</p> <p>Improve handover (see next process) and consider moving the checklists from Form 9 to Form 7 so that the checklists have to be completed before MBTA takes beneficial occupancy.</p> <p>Modify Capital Delivery 9-Step/Form process to include a consistent step for all operating groups for getting the contractor to correct errors if the asset is not what is specified and/or does not fit form and function (even when the asset is accepted for beneficial use) – perhaps, by providing for a change order when</p>

Key Process	Description	Improvement Opportunity
		<p>the department would prefer a different asset, e.g., as a result of changed needs or improved technology since the asset was originally spec'd.</p> <p>Determine how to link Capital Delivery contract to asset information in Trapeze. [Capital Delivery's system (OpenText) is just for drawings, specs, and based on contract number, not asset. (Short-term fix could be to put the project name/location in the contract title.)</p>
<p><b>Asset Handover</b></p>	<p>Asset handover for vehicles is handled by the Vehicle Engineering group. The process includes a testing procedure at the manufacturing site, and a multi-step post-delivery audit and acceptance testing upon delivery to MBTA. Each vehicle is tested individually; upon "conditional acceptance" the vehicle is deemed acceptable for passenger use, and the vehicle warranty initiates. Contract close-out is a stepped process that includes deliverables for bench unit tests, spare parts, and training. The asset information transmitted by the vendor is entered into the asset management system, Trapeze (or WheelHouse for ferry vehicles), where maintenance records can be tracked.</p> <p>For non-vehicle assets procured through Capital Delivery, the asset handover process is managed by the Capital Delivery group and follows a nine-step process for monitoring the delivery and acceptance. The process includes inspection upon construction completion, either for a portion of the construction work or for the entire project. When a portion of the work is acceptable for use, it is approved for "Beneficial Occupancy." Close-out is commenced upon full acceptance of the work, and the asset warranty is initiated. The contractor is contractually obligated to transmit final construction documents such as "as-builts," user manuals, assets specifications, and training – if requested in the contract.</p> <p>Some assets, such as replacement pumps, boilers, etc., are procured through purchase order processes that do not involve Vehicle Engineering or Capital Delivery. These assets are inspected upon receipt, accepted, and recorded for tracking based on inventory (material management) procedures.</p>	<p>As part of the standardized phased project delivery improvement above, define phases of acceptance and ensure that they are consistent across asset type, and develop a standard process for validation and related asset handover process.</p> <p>Clarify roles and responsibilities of Capital Delivery and E&amp;M departments in accepting/ commissioning assets and assuring appropriate disposition of all related requirements for training, manuals and other documentation, warranty information, as-builts/drawings, spare parts, etc.</p> <ul style="list-style-type: none"> <li>- Are the manuals digitized and is the electronic manual accessible from any location that may need to reference it?</li> <li>- Can people in field pull up the drawings?</li> </ul>

Key Process	Description	Improvement Opportunity
	Assets paid for with capital funds are documented with the Treasurer in order to initiate asset tracking in the MBTA's Asset Register.	
<b>Decommissioning and Disposal</b>	Assets that were documented in the Treasurer's asset register upon commissioning must be decommissioned when they are no longer needed by an operating department and removed from the asset register when disposed. Assets are disposed of through either existing or new contracts. Generally, when assets are replaced, their disposal is included as part of the replacement contract. Another mechanism for the disposal of assets is through the Materials, or Procurement and Logistics, group which may issue a specific contract for the disposal or scrapping of the asset(s). Some assets, though, may be disposed of as waste through an existing service disposal contract. For certain assets, such as batteries, paint, or cleaning detergents, asset disposal is managed by the Environmental Department.	<p>Consider developing a specific process for replacement to include a process for decommissioning of the replaced asset; consider including disposal of more assets/ consumables (e.g., oil, batteries, etc.) during the procurement stage, especially for hazardous materials, many of which are sub-components.</p> <p>Create a process that formally decommissions assets regardless of funding source and asset type.</p>
<b>Service Planning</b>	<p>The Planning &amp; Scheduling (P&amp;S) group manages the service planning effort and when appropriate provides recommendations to change levels of service. Service planning involving three distinct efforts: System-wide Service Plan, Quarterly Updates to the Service Plan, and Weekly Schedule Building, all of which consider the constraints posed by budget, fleet size, facility capacities, and operators.</p> <p><b>System-wide Service Planning</b></p> <p>MassDOT's Office of Performance Management and Innovation (OPMI)'s Service Delivery Policy (SDP) defines the standards and metrics – including coverage, frequency, and extent of crowding. P&amp;S develops recommendations to meet the goals reflected in the service tiers set by the MBTA Board:</p> <ul style="list-style-type: none"> <li>• Tier 1: With existing resources, improve reliability to meet SDP standards. Prioritize reliability/on-time performance (OTP) above all.</li> <li>• Tier 2: Provide resources required to run existing level of service (LOS) reliability. That is, increase the service hours and the number of operators (which means an increase in the budget) to run the trip reliably (but still subject to vehicle limitations).</li> <li>• Tier 3: Meet more/all of the SDP including the frequency standards and comfort/crowding standards.</li> </ul>	<p>Align Service Delivery Policy metrics with actual dollars available; develop the capability to determine the measurable effect on SDP metrics from budget changes.</p> <p>Consider doing less frequent than quarterly service changes so can adequately assess impacts of change.</p> <p>Share vehicle reliability data and preventive maintenance schedule with P&amp;S to provide additional data points for informing service planning and scheduling.</p> <p>Log and have service planners review relevant operator complaints.</p>

Key Process	Description	Improvement Opportunity
	<p><b>Quarterly Service Plan Updates</b></p> <p>P&amp;S adjusts the service plan quarterly based on factors such as customer complaints and demand for MBTA services, as determined by passenger counts. The counts may result in a change in bus route or frequency. Customer Experience, the customer complaint service function, is contracted out to an external vendor that compiles the complaints submitted through the website or via phone call and directs the complaint to the appropriate MBTA department.</p> <p><b>Weekly Schedule Building</b></p> <p>The updated service plan is used to develop the weekly schedule, through which P&amp;S tries to make the vehicle count the same on a day-to-day basis to simplify the assignment of buses. (Vehicle reliability data and PM routines/schedules are not used to inform the plan or schedule because that information is not shared with P&amp;S.) P&amp;S uses Hastus software to create the weekly schedule; in the future, the software will also be used to develop a daily schedule.</p>	
<p><b>Track Access Planning</b></p>	<p>Track access planning for maintenance work is handled by a separate P&amp;S group, which manages the track access sheet. The E&amp;M departments for guideway assets, Maintenance of Way (MOW), Signals, and Power, have the same generic windows of track time scheduled every night distributed by the Operations Control Center (OCC), though this schedule may change as needs arise. When planning their maintenance work, the E&amp;M departments base their schedules on the expected window. When exclusive access is required, a maintenance foreman assigns work to the maintenance crews, and the maintenance supervisor, foreman or other individual leading the work submits an access request form generally two days in advance. (In the event of an emergency, less notice is acceptable.) Maintenance crews call the OCC to confirm that they can access the track for their work that day/night.</p> <p>For large projects, “Special Orders” are used to request exclusive track access further in advance based on the planned project phasing or staging. Standard Operating Procedures are in place for planning and scheduling work on the right-of-way during revenue and non-revenue hours.</p>	
<p><b>Risk Management</b></p>	<p>As described in Chapter 5, the MBTA is expanding the focus of existing operational safety and hazards risk management to look at the impact of operational and hazards risks on the business, socio-economic responsibility, and service delivery more holistically at the enterprise level. Efforts are underway to prioritize and address open recommendations for improvement and to reduce risk. MBTA is in the process of forming a Risk Council as part of its overall enterprise risk management strategy.</p>	<p>Integrate job profiles with the Learning Management System (LMS) and HR tracking to inform whether an employee has the appropriate training/certification to perform his/her job.</p>



Key Process	Description	Improvement Opportunity
	<p>The Risk Council will play a key role in the implementation of its enterprise risk management strategy through its deliverable-based processes, accountability, and data-driven decision making. Tactical asset risks currently are addressed by focusing on maintaining reliability.</p>	
<p><b>Incident Management/ Business Continuity</b></p>	<p>When an incident occurs, Operations plays a central role in coordinating the departments that are responsible for resolving the issue.</p> <p>The “Snow and Ice Plan” and the complementary documents produced by each department are completed and issued annually. The plan serves as a coordinated listing of roles and responsibilities to be followed in the event of a cold weather emergency/special events emergency, and includes such items as the risks, the action plans, pre-determined notification lists, staging, people management plans, and equipment needs. Depending on the nature of the incident, protocols may include removing power and evacuating passengers.</p> <p>Each year, at least two major drills are run to prepare for possible evacuation of subway cars and Commuter Rail cars. When an event, major storm, or another incident does occur, MBTA Leadership manages the event and business continuity through the Emergency Operations Center (EOC), which serves as the command center for the event. For storm events, the EOC is often activated before the storm, continues throughout the event, and concludes after normal operations have resumed.</p>	<p>Develop formal continuity planning (beyond Snow and Ice Plan).</p>
<p><b>Security</b></p>	<p>The Department of Security and Emergency Management is responsible for the development and maintenance of preparedness plans, emergency management and continuity of operations plans, coordination with external resources, threat and vulnerability assessments, activation and logistics associated with the EOC, and development of “after action” incident reports. Table top exercises are held to review incident plans for weather events and terrorist or chemical attacks. About every three years a third-party consultant conducts and reviews threat and vulnerability assessments with the security, safety and transit police departments (e.g., station vulnerability).</p>	
<p><b>Safety</b></p>	<p>As mandated by MBTA’s Strategic Plan and demonstrated further through training, regular safety briefings, promotion (e.g., safety awards) and capital project selection criteria, management of safety risks is a top priority. The Safety Department provides leadership by developing safety standards for regulatory compliance and based on MBTA priorities. Safety Plans are updated annually to identify, analyze, and address safety risks, including safety mitigation measures and corrective actions, for each transportation mode. Other guidance documents are created to manage safety</p>	<p>Link the risk assessment and reliability/criticality of assets to safety of the system overall.</p>

Key Process	Description	Improvement Opportunity
	<p>aspects of the agency’s processes. Safety management working groups exist throughout the agency to review and address safety risk issues.</p> <p>Departments are responsible for ensuring that their employees have appropriate safety training. For example, M&amp;E Supervisors/Foremen provide a daily labor safety discussion regarding the day’s assigned tasks to discuss any safety related work hazards, any precautions and required PPE (Personal Protective Equipment).</p>	
<b>Environmental</b>	<p>The Environmental Department is spear-heading a new focus on climate change and resiliency based on climate risks or known flood risks to MBTA systems as identified by other agencies. A pilot effort is the Blue Line Climate Change Resiliency Plan, which is looking at the climate change vulnerabilities and potential mitigation/resiliency solutions for the line.</p> <p>MBTA was recently awarded funding from the FTA for two resiliency projects addressing vulnerability impacts and needed environmental clean-up: the Green Line water incursion from the Muddy River, and the Charlestown retaining wall.</p>	<p>Assure that there are SOPs for regularly-recurring flooding at Aquarium Station.</p> <p>Assess flood risk mitigation solutions to protect assets.</p> <p>Document asset resiliency (or lack of) to storm surges.</p>
<b>Performance Management</b>	<p>MBTA has several avenues through which it measures, monitors and provides performance information. The current approach to performance management is detailed in Chapter 3, Asset and Asset Management Performance.</p>	<p>Integrate asset criticality and risk (with service reliability).</p> <p>Create KPIs that are indicators/proactive.</p> <p>Re-evaluate service delivery metrics and how they are calculated to more accurately capture the weaknesses of the system and the customer experience, for example:</p> <ul style="list-style-type: none"> <li>- Add metric for wait time extended because of crowding (“left behind” metric)</li> <li>- Add metric for dropped trip % by route</li> <li>- Consistently include dropped trips in OTP measure (OTP always counted by headways, not by schedule)</li> </ul>

Key Process	Description	Improvement Opportunity
		- Expand OTP threshold beyond within 90 seconds to include within 180 seconds and beyond 180 seconds

### 8.3.2 Asset-Level Business Processes

Asset lifecycle management *processes*, define how the lifecycle management *strategy* is implemented. In early 2018, MBTA conducted a series of workshops to capture and review its current asset management business processes, including the capture of its as-is lifecycle management processes for the following asset types:

- Bus Fleet
- Rail Fleet
- Paratransit Fleet (The RIDE)
- Non-Revenue Fleet
- Commuter Rail Fleet
- Ferry Fleet
- Right-of-Way Infrastructure (Track, Power, Signals)
- Bridges and Tunnels
- Stations and Facilities (including parking facilities)

At the asset level, processes for how maintenance is scheduled, managed, and delivered were captured, including inspections, maintenance, component replacement, and overhaul. These processes are summarized in Table 8-2.

Table 8-2. Asset-Level Business Processes, Improvements, and Benefits

Key Process	Description	Improvement Opportunity
<p><b>Bus Fleet: Design Management, Inspections and PM, Corrective Maintenance, Fault Analysis and Performance Management</b></p>	<p>Vehicle Engineering monitors and manages any fleet defects and remains engaged with the manufacturers for component engineering changes and subsequent bus deliveries. Vehicle Engineering works with the bus manufacturer to develop ITS (Instruction to Service) documentation and ensures all buses comply with appropriate ITS requirements.</p> <p>Buses are assigned by P&amp;S to operate out of eight maintenance garages and one trolley barn to meet route demands. Bus maintenance may also determine which location is assigned because of garage constraints, such as fuel infrastructure and door height, as well as age-balancing the fleet. The maintenance garages operate 24 hours a day. Maintenance is responsible for making service pull-out, as well as holding buses for maintenance.</p> <p>The revenue bus fleet relies on its mileage tracking processes to drive both PM schedules and MDBF performance metrics. Hubodometer mileage is manually recorded each night as the bus pulls through the fuel lane and stored on the asset record. Mileage is also recorded on each maintenance work order to enable failure analysis.</p> <p>PMs comply with OEM requirements and MBTA-specific requirements. They are reviewed and revised as needed when new buses and technology arrive. PMs are usage-based and generally scheduled at 6000-mile intervals, with differing scopes of work at different intervals. Maintenance work orders are used to track the activity and labor and material costs for the PM.</p> <p>Major rebuilds/overhauls and heavy maintenance are performed at the Central Maintenance Facility at Everett. (Bus mid-life overhauls, performed at six years, are not performed in-house.) Work orders record overhaul activity; material usage or costs are charged to account codes, not assets. Everett also provides the component rebuild shops where about 200 items are rebuilt. A cost analysis is performed to determine which components will be rebuilt in the shops. Currently, only vehicles are tracked as assets. Component movement history (i.e., serial numbers and locations) is kept in logs. Recently, work orders have been opened to track component rebuilds; however, labor and material costs are recorded at the work order level and not at the individual asset level (e.g., an engine rebuild work order might record several engine rebuilds).</p> <p><u>Failure Analysis and Performance Metrics</u> An Engineering Bus Maintenance team has recently been created to perform failure analysis. Repeat failure counts are reported based on work order information that includes the component failing, the mileage and failure/repair coding. Trend analysis is performed and incorporated in ongoing component inspections. In-service failures are tracked via</p>	<p>Improve the interface between FMIS and the maintenance system to facilitate charging issued materials to specific assets. (May also need to alter the business process to ensure that work orders are written against specific assets and materials get charged to specific work orders/assets.)</p> <p>Utilize remote monitoring capability built into new buses to facilitate predictive failure.</p> <p>Develop vehicle data governance framework consistent with work E&amp;M has done.</p>

Key Process	Description	Improvement Opportunity
	<p>“Road Call” work orders and examined against maintenance intervals. These are rolled up by fleet type for fleet defect analysis.</p> <p>The results of these analyses may lead to revising a PM or having Vehicle Engineering engage with the manufacturer to design an equipment modification. In the event of a revised PM, the maintenance staff is trained on the new protocol. Equipment modifications are managed as campaigns, and these work orders are scheduled to coincide with selected PMs.</p> <p>Performance reporting is conducted by extracting data from the maintenance management system. Daily reports provide PM compliance information which over the past 5 years has driven PM compliance to over 95%. One of the PM performance reports identifies failures occurring within 24 hours or 500 miles of a PM completion. Monthly reports provide information on failures and service reliability by fleet and/or maintenance facility. Failures are reported by component, sub-component and in-service failures (road calls).</p>	
<p><b>The RIDE: Procurement and Maintenance</b></p>	<p>Three defined service areas for The RIDE door-to-door paratransit services are operated by three contractors. All contractors use the same types of vehicles, comprised of E350 converted vans (high roof, chair ramps and lifts, etc.), Ford Fusion Hybrid and Crown Victoria vehicles. The MBTA owns two-thirds of the vehicle fleet. The contractors are responsible for insurance, warranty tracking, maintenance and operation of both the MBTA-owned vehicles and their own.</p> <p>The RIDE analyzes the fleet service requirements, dictates the type of vehicles to be purchased, and periodically reviews ridership needs (e.g., chairs, scooters, companions). Each vehicle performs about 3,100 passenger trips per year.</p> <p>New or replacement vehicles for The RIDE are typically procured in bulk and quantities are based on available capital funding. Since they are purchased as a group, they age as a group and must be replaced at the same time.</p> <p>Responsibility for full maintenance costs is required in the contracts with the operators. The RIDE dictates that each vehicle be maintained to a “severe” duty PM cycle. The operators must maintain parts inventories and provide qualified and certified ASE mechanics. The RIDE performs audits of contractors’ maintenance records and performs periodic on-site visual quality checks of work performed. The RIDE has full access to all maintenance records through the Dossier Fleet Maintenance Information System; however, it doesn’t receive automated reports. Contractors cost out their maintenance activities with labor and material charges so the RIDE staff can calculate how much money is spent on each vehicle and determine lifecycle cost.</p>	<p>Consider using available information regarding RIDE paratransit vehicle lifecycle costs to make vehicle replacement decisions. Establish criteria that can be used to trigger vehicle replacement need.</p> <p>Develop process for and include in next contract requirements the automated receipt by MBTA of the contractors’ maintenance reports.</p> <p>Develop decision criteria to evaluate purchase, lease, contract vehicles for providing paratransit service to determine if MBTA should be owning RIDE vehicles at all.</p>

Key Process	Description	Improvement Opportunity
	<p>Corrective maintenance may first be reported by a customer notifying either the MBTA customer service center or The RIDE directly. The RIDE records the issue in ADEPT, the complaint, scheduling and dispatch software. The service provider (contracted operator) receives the complaint, addresses the issue, and notifies The RIDE when the complaint has been addressed.</p>	
<p><b>Non-Revenue Fleet: Procurement, Management and PM</b></p>	<p>Non-Revenue Fleet Services provides necessary support vehicles and equipment to all the revenue operations (bus, subway, ferry) except Commuter Rail. The non-revenue fleet comprises public safety vehicles (police cars), motorcycles, towers, mobile signage, cranes, forklifts, material handling equipment, administration (cars and vans) and all non-revenue maintenance support equipment (trucks, etc.). Vehicles are managed by those to whom they are assigned, which includes vehicles assigned to individuals, pool vehicles, and department-assigned vehicles/equipment.</p> <p>All non-revenue fleet vehicles and equipment are owned and maintained by the MBTA. Telematics are in use on about 250 vehicles in the non-revenue fleet for analysis of the utilization of administration vehicles, and the data are used to support decision making. Police vehicles are managed both as individually-assigned vehicles and shared/pool vehicles; replacement policy is based on age, miles, and condition, whichever comes first.</p> <p>A periodic notification is sent to departments asking if their equipment is meeting their needs. If it is not, it is suggested that the departments include a request in the 5-year CIP process. Non-Revenue Fleet Services looks at the specifications for the requested equipment and needed function, and attempts to standardize the vehicle types, with a focus on winter resiliency.</p> <p>There are two maintenance facilities for the non-revenue fleet. Both facilities perform regulated inspections and corrective maintenance activity. The regulated inspections and OEM-suggested PMs are managed by asset class and type requirements. When it is time for maintenance work on a non-revenue vehicle, the Deputy Director of Non-Revenue vehicles notifies the user department and coordinates with them to bring the vehicles in. Maintenance activity is recorded; however, full lifecycle costs are not tracked.</p>	<p>Develop replacement policy and criteria for non-revenue vehicles (other than police).</p> <p>Record and track maintenance and other lifecycle costs/vehicle.</p>
<p><b>Rail Fleet: Design Management, Inspections, Preventive and Corrective Maintenance, Fault Analysis</b></p>	<p>Vehicle Engineering contributes to development of specifications, working with the Vehicle Fleet Maintenance and Strategy group and the Chief Mechanical Officer to do so. Currently, there are on-going procurements for new subway vehicles to meet fleet needs for each of the lines.</p> <p>The Vehicle Fleet Maintenance and Strategy group is responsible for the lifecycle management of the rail and bus fleet. Periodic maintenance activities are typically annual, performed on systems within the vehicles, and not form-documented. Preventive</p>	<p>Establish a process for bringing all asset classes together when deciding to procure new vehicles; require that approval/ input be sought from all departments that will provide support (either infrastructure or</p>

Key Process	Description	Improvement Opportunity
<p><b>and Performance Management</b></p>	<p>maintenance is considered to be inspections, and preventive maintenance work is assigned to one shift. Any corrective work that is identified during an inspection but cannot be completed during the inspection itself is deferred to be completed by the other two shifts. A corrective work order is created to capture the needed work, and it is assigned a category from A to D to help prioritize all deferred work. Category A, the highest priority, denotes that the necessary corrective work is for safety reasons. Generally, all corrective work identified during inspections is completed within the two shifts following the inspection.</p> <p>Reliability Centered Maintenance (RCM) has been used on the Blue Line heavy rail vehicles for approximately five years and has been useful in making informed decisions regarding changes. The additional data collected through the RCM approach have led to changing inspection intervals on vehicles and the frequency of changing vehicle filters and brakes. MBTA has also noticed decreased maintenance costs associated with RCM. There are 152 new Orange Line cars that will soon be in service, and MBTA intends to apply RCM to those new vehicles as well. There are another 252 new Red Line cars that are being purchased, for which RCM will also be applied when they arrive, about 15 months after the Orange Line cars.</p> <p>Overhauls on light rail vehicles (Green Line) are completed by outside contractors. Only heavy rail overhauls are completed in-house by a dedicated crew.</p> <p><u>Maintenance Performance Measures</u> The goal for rail vehicle maintenance is 75% planned work and 25% corrective work. Planned work includes inspections and any corrective work found and completed during an inspection. The CMO's office runs reports and conducts analyses on standard repair times to consider what percentage of those jobs met that standard and whether additional training may be needed to achieve the standard.</p> <p><u>Warranties</u> Warranty information is captured only for the Blue Line. When the new Red and Orange Line vehicles are procured, they will each have a dedicated warranty manager. It is intended that they will have the warranty function setup in MCRS2/Trapeze available to them at that time.</p> <p><u>Materials</u> Parts are kept in stock to avoid deferring corrective maintenance. There are min/max limits for parts and components, which help to ensure the appropriate number of parts is ordered before running out so that materials are available to maintainers when needed.</p>	<p>maintenance) before vehicle procurement.</p> <p>Proceed to implement planned RCM program for new Orange Line cars once the warranty begins.</p> <p>Proceed to implement planned Warranty Manager program for new Orange and Red Line vehicles.</p> <p>Develop standardized fault categories (code faults) for Subway.</p> <p>Share best practices of RCM internally to infrastructure departments.</p>



Key Process	Description	Improvement Opportunity
<p><b>Maintenance-of-Way: Standards, PM and Inspections, Corrective Maintenance and Fault Management</b></p>	<p>For some lines, MBTA ends up getting a large number of spare parts at once and stores them in local storerooms. An external contractor manages warehousing.</p> <p>MOW (track) is subject to the requirements of the Massachusetts Department of Public Utilities (DPU). Compliance is demonstrated through maintenance records. The MOW maintenance standards address all regulatory requirements and provide additional specifications relevant to MBTA assets. Updates to standards are driven by changes to vehicles, faults/issues and changes to operations.</p> <p>Preventive maintenance and inspections are carried out as dictated in the standards. The software, Blue Zone, soon to be superseded by the Infrastructure EAM, is used to store some of the maintenance records of work performed. Asset records also contain track condition information, assessed based on a red, amber and green scale.</p> <ul style="list-style-type: none"> <li>• Green: asset in good condition.</li> <li>• Amber: needs to be addressed in next 1-2 days; requires low speed.</li> <li>• Red: needs to be addressed in next 1-2 days; requires lower speed.</li> </ul> <p>Track maintenance is carried out primarily during “second shift” which runs from 3 pm- 11pm. Second shift addresses issues such fallen trees, among other items. During the other two shifts, emergency crews are available to address any MOW issues.</p> <p>If faults of a certain level or severity occur, an “all page” email goes out to inform relevant personnel, as well as DPU. When resolved, the Safety Department is responsible for informing DPU. If the fault issue is handled immediately, then no work order is created in Blue Zone.</p>	<p>Complete guideway asset criticality classifications, and documentation of effects on entire system/service of asset failure.</p> <p>Assign specific assets to work orders so that asset failures can be recorded, queried, and analyzed. Include with part of Trapeze new business processes.</p> <p>Standardize fault categories and definitions.</p>
<p><b>Signals: Standards, Inspection and Testing, PM and Fault Management</b></p>	<p>Signals maintainers rely on two maintenance manuals:</p> <ul style="list-style-type: none"> <li>• SM.1 – Signal Maintenance – Light &amp; Heavy Rail Transit – Instructions for Testing Signal Apparatus and Signal Systems</li> <li>• SM.2 – Signal Maintenance – Special Rules, Standards and Instructions (RS&amp;I) Governing Construction and Maintenance of Signals and Interlockings</li> </ul> <p>These manuals have been developed and periodically updated by taking inputs from SMEs, FRA best practices, recommendations from AREMA and the manufacturers. Standards are updated as needed, for example, when there is an equipment or vehicle change, when a repetitive fault has been identified, when the operational needs change and for a variety of other reasons.</p> <p>Periodic testing is conducted on all assets, though the frequency can vary from monthly to every 10 years. The frequency of preventive maintenance and inspection routines is</p>	<p>Complete guideway asset criticality classifications, and documentation of effects on entire system/service of asset failure.</p> <p>Assign specific assets to work orders so that asset failures can be recorded, queried, and analyzed. Include with part of Trapeze new business processes.</p>



Key Process	Description	Improvement Opportunity
	<p>assigned based on the standards. DPU audits MBTA’s maintenance activities for compliance with the standards.</p> <p>Signals bases the schedule for maintenance activities on the window of track time that it has scheduled every night, though this schedule can change as other needs arise. Line Supervisors determine the work needing completion during each shift and assign crews on a daily basis, without use of a scheduling software system.</p> <p>When faults occur, the Line Inspector is notified and sends a crew to resolve the issue. The crew must call- OCC to confirm track access. The Signals maintenance crew defines levels of track access as follows:</p> <ul style="list-style-type: none"> <li>• Level 1: cannot enter while trains are moving</li> <li>• Level 2-3: ongoing work site</li> <li>• Level 4: two people with hand tools up to an hour</li> <li>• Level 5: one person with no hand tools</li> </ul>	<p>Standardize fault categories and definitions.</p> <p>Manage and track all assets in the Infrastructure EAM.</p>
<p><b>Power: Standards, PM, Fault Management and Corrective Maintenance</b></p>	<p>The IEEE guidance (70B) is used as a foundation for maintenance, and has been revised over time to be tailored to MBTA assets. There are annual PMs on DC breakers, and the results of the PMs are stored on spreadsheets. The PM work done by the Power Department is audited by DPU for compliance with MBTA’s standard.</p> <p>When faults occur on Power assets that may affect service, the OCC and Maintenance Control Center coordinate with the Power Dispatcher to resolve the issue. The Power Dispatcher keeps a log book of corrective maintenance activities.</p>	<p>Complete guideway asset criticality classifications, and documentation of effects on entire system/service of asset failure.</p> <p>Assign specific assets to work orders so that asset failures can be recorded, queried, and analyzed. Include with part of Trapeze new business processes.</p> <p>Standardize fault categories and definitions.</p> <p>Manage and track all assets in the Infrastructure EAM.</p>

<p><b>Stations and Facilities: Inspections and PM, Corrective Maintenance, Fault Management and Performance Management</b></p>	<p>Stations and Facilities includes a wide variety of asset types for which MBTA has both maintenance and inspection requirements. Inspections of the assets are managed by the TFM Department who ensures that the inspections proceed as scheduled and are performed to scope.</p> <p>Some assets located at the stations and facilities are managed by various groups. Lighting, elevators and escalators, and ticket vending machines, for example, are managed by the Electrical, Power, and Ticket Fare Vending groups, respectively. MBTA also employs consultant assistance through On-Call General Engineering Contracts (GECs) as well as Service Contracts.</p> <p>Organizationally, stations and facilities are managed by two groups: Commuter Rail and Transit.</p> <p><b>Commuter Rail</b>                  Commuter Rail contracts all maintenance work and inspections to a third party. The present contract term is for eight years (ending in 2022). The Commuter Rail contractor utilizes a maintenance management information system (Trapeze) to manage its work. Corrective maintenance for Commuter Rail stations is typically initiated by notification to the MBTA which directs the contractor to perform the remedial action. The contractor records the completed corrective action via work orders in the maintenance management information system. Commuter Rail relies on data recorded by the contractor to manage faults. Fault analysis is performed based on the type of work performed although there are no formal asset fault codes.</p> <p><b>Transit</b>                  Elevators and escalators are managed by the Power Department. Inspections and maintenance as required by state regulations are provided through third party contracts.</p> <p>For subway stations and facilities, inspections and preventive maintenance are based on asset class. For example, machinists perform work on pumps and compressor systems and record their work in a maintenance management system called FaciliWorks. Other subway assets are tracked in spreadsheets, such as boilers, the inspection of which is required by insurance providers, and sprinklers, the inspection of which is required by fire departments. The spreadsheets provide information on inspection and test results. All other subway stations and facilities work is managed utilizing the Blue Zone system.</p> <p>Corrective maintenance at subway stations may be initiated by customers through customer calls to the Operations Control Center (the call center), via social media such as Twitter, or via the agency website. These complaints are handled and monitored by the Public Information Officer who initiates action through the Maintenance Control Center. Corrective work also may be initiated when MBTA staff notice an issue. Work orders are created in the Blue Zone maintenance management system and directed to the</p>	<p>Develop regular condition assessment and PM schedules for facilities; provide system support.</p> <p>Develop standards, PM procedures and schedules for subway stations and related asset classes/ components other than elevators/escalators.</p> <p>Manage and track all assets via the Infrastructure EAM.</p>
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Key Process	Description	Improvement Opportunity
	<p>appropriate trades for response. The trade supervisor/foreman prioritizes and assigns the work. Upon completion and inspection, the work performed and hours expended are documented in Blue Zone by the supervisor/foreman for close-out or additional follow-up, if necessary.</p>	
<p><b>Commuter Rail Vehicles: Design Management, PM/Inspection Maintenance, Corrective Maintenance, Analysis and Reporting</b></p>	<p>Vehicle Engineering is responsible for acquiring new vehicles for Commuter Rail after Commuter Rail has determined its fleet needs. Vehicle Engineering contracts with the vendor regarding design specifications, training, and more.</p> <p>MBTA’s commuter rail has been operated and maintained by the current external contractor under an 8-year contract since 2014. MBTA owns the vehicles. The Integrated Fleet and Facilities Plan (IFFP) is a comprehensive document that includes strategies for maintaining Commuter Rail vehicles. The contractor is responsible for everything except major overhauls (7-year intervals for locomotive top deck overhaul, 15-year mid-life overhaul for coaches).</p> <p>The contract also specifies service levels and NTD data reporting needs, among other items. Additionally, the contractor is responsible for maintaining the infrastructure (power, signals, track, bridges) for the Commuter Rail. MBTA’s Railroad Operations group (RROPS) manages and enforces the contract.</p> <p>For new fleet vehicles, PM plans are developed in coordination with Commuter Rail for the vehicle and for 16 of its systems; starting with the OEM requirements, and regularly updated following reviews and failure analyses.</p> <p>Commuter Rail has an instance of Trapeze that the contractor uses to record its vehicle maintenance work. Trapeze is also used to store lifecycle cost data derived from OEM Life Cycle Management (LCM) documentation.</p>	<p>Develop standards and additional reliability performance metrics for Commuter Rail equipment types and require Keolis to comply with those standards.</p> <p>Develop and make use of standardized fault categories (code faults) in Trapeze for corrective maintenance work.</p> <p>Provide basic training in Trapeze to MBTA Commuter Rail employees who oversee the Keolis contract so that they have the skills to access data for analysis and to ensure Keolis is carrying out the contract as required.</p>
<p><b>Ferry: Inspection and PM, Corrective Maintenance and Fault Management</b></p>	<p>The MBTA currently owns four ferries. Operation and maintenance of the commuter ferry service is contracted out to a third party. The operator is reimbursed a set cost for operating the service with all revenues going to the MBTA. As part of the contract, the contractor must use its own vessels to supplement the MBTA fleet to provide the required level of service. The Charlestown line requires three ferries and the Hingham/Hull line requires nine.</p> <p>The operator is also required to maintain MBTA-owned vessels in a state of good repair; the ferries currently have the highest average SGR rating of all MBTA fleets at 3.79 (CIP 2016-2020). The MBTA Railroad Operations and Water Transportation Departments oversee and administer the contract.</p>	<p>Have Emergency Maintenance contracts in place to speed up emergency issue resolution.</p> <p>Develop PMs and schedule for water-side infrastructure.</p> <p>In the next contract, update the language to specify that maintenance records show how long the work took to complete, how many people</p>

Key Process	Description	Improvement Opportunity
	<p>The only MBTA-owned land-side ferry facility is the newly rebuilt Hingham Terminal and its park-and-ride lot. The MBTA also is responsible for the maintenance of water-side infrastructure such as piers, gangways and floating docks.</p> <p>A Marine Safety contractor performs vehicle inspections. Vessels are drydocked every 2 years for a full inspection of the hulls and propulsion units. All PM work on ferries is performed by the contractor and adheres to manufacturer-specified maintenance intervention programs. Water-side infrastructure under the responsibility of the MBTA doesn't follow a defined PM schedule.</p> <p>Dock hands or ferry crew will notify the contractor and MBTA for corrective action when an issue is discovered, such as a binding or tilting floating dock or one not aligning with the vessel gangway. Severe weather events, tides and freezing affect the floating docks and gangways. If the repair requires capabilities outside the scope of the MBTA or the contractor, a marine contractor is hired to perform the corrective action. A safety requirement specifies use of a marine contractor when performing repairs in a confined space – an example is entering a float chamber to weld a leaking crack. No emergency contractor is "on-call" for rapid response to an emergency issue.</p> <p>The Coast Guard performs annual and occasionally a periodic safety inspection on the vessels, which may initiate a corrective action. Certain incidents, such as a "hard" landing, may result in a Coast Guard notification which may trigger a safety inspection.</p> <p><u>Failure Analysis and Performance Metrics</u>                      All asset condition ratings and data and maintenance and repair work order information is recorded in a maintenance management system (WheelHouse) utilized by the contractor and accessible by the MBTA. WheelHouse provides reports by component systems (e.g., engine, cooling, jets) for use in failure and performance analysis.</p> <p>Vessels are also equipped with WiTronix systems to monitor real-time GPS location, operating hours, temperatures, etc., which send alerts to the captain, the contractor and Ferry Operations when operating data falls out of range. These data are available for trend analysis, and with the new condition monitoring data an RCM program is anticipated.</p> <p>Failure analysis on water-side infrastructure is not conducted.</p> <p>No lifecycle cost information is stored in WheelHouse; however, the maintenance records are complete with detail on the activity performed which is used to calculate maintenance costs (for contract analysis).</p>	<p>worked on the task, the materials, etc. to support the calculation of lifecycle cost/asset.</p>

Key Process	Description	Improvement Opportunity
<p><b>Bridges and Tunnels: Standards, Inspection and Preventive Maintenance, Corrective Maintenance, and Emergency Work</b></p>	<p>MBTA has implemented bridge and tunnel standards from MassDOT in compliance with FRA, FHWA and FTA guidelines. The program includes annual inspections, 5-year in-depth inspections with condition ratings, and 10-year load rating inspections. A third-party contractor, managed by railroad operations, performs the annual inspections and maintenance; Capital Delivery performs the 5-year and 10-year inspections.</p> <p>The contractor is the first line responder for bridge maintenance. All bridges are inspected and rated according to FRA guidelines and MassDOT requirements. The NBIS bridge condition rating scale is 0-9 based on FHWA requirements and the MassDOT standard. This differs from the FTA rating scale of 1-5, and the MBTA has a mapping scale for aligning the two scales. Any rating of 4 or below on the NBIS scale is considered "structurally deficient" and must be addressed. Decision criteria on whether a bridge should be replaced or repaired is based on the rating and the work involved. Data is recorded in the bridge asset inventory system, 4D.</p> <p>Results of inspections may identify a maintenance problem. If it is a simple repair, Capital Delivery informs Railroad Operations MOW to direct the contractor to complete the repair. Or, as is the case in Transit, internal personnel perform the repair. If it is beyond the contractor's capability, Capital Delivery will hire a contractor with the qualifications to address the issue. Capital Delivery has a standing "emergency bridge repair" contract to address emergency repairs as a Capital project.</p> <p>Bridge PM and inspections are more regulated than tunnels due to current federal requirements. Items discovered during an inspection are handled as "correctives." Corrective issues are sent by email to a pre-determined list of responders based on who has that bridge/tunnel responsibility (Capital Delivery Bridges and Tunnels or E&amp;M). This notification indicates if "Immediate Action" is required for emergency response. Capital Delivery will call Railroad Operations to investigate appropriate bridge or tunnel issues.</p> <p>Capital Delivery has call-in contracts/GECs in place to enable rapid response to emergency work. Emergency funds and sole-source contracts are pre-established to expedite response to dire emergencies. The contractor has a work order for emergency maintenance to record actions. Structural inspections are required before restoring service.</p>	<p>For tunnel construction projects, include a requirement for the contractor to provide asset data as part of the boiler plate language in a construction contract.</p> <p>Develop protocols and/or contract language for receiving operations and maintenance records from the bridges and tunnels contractor.</p>

## 8.4 ASSET INFORMATION AND SUPPORTING TECHNOLOGIES

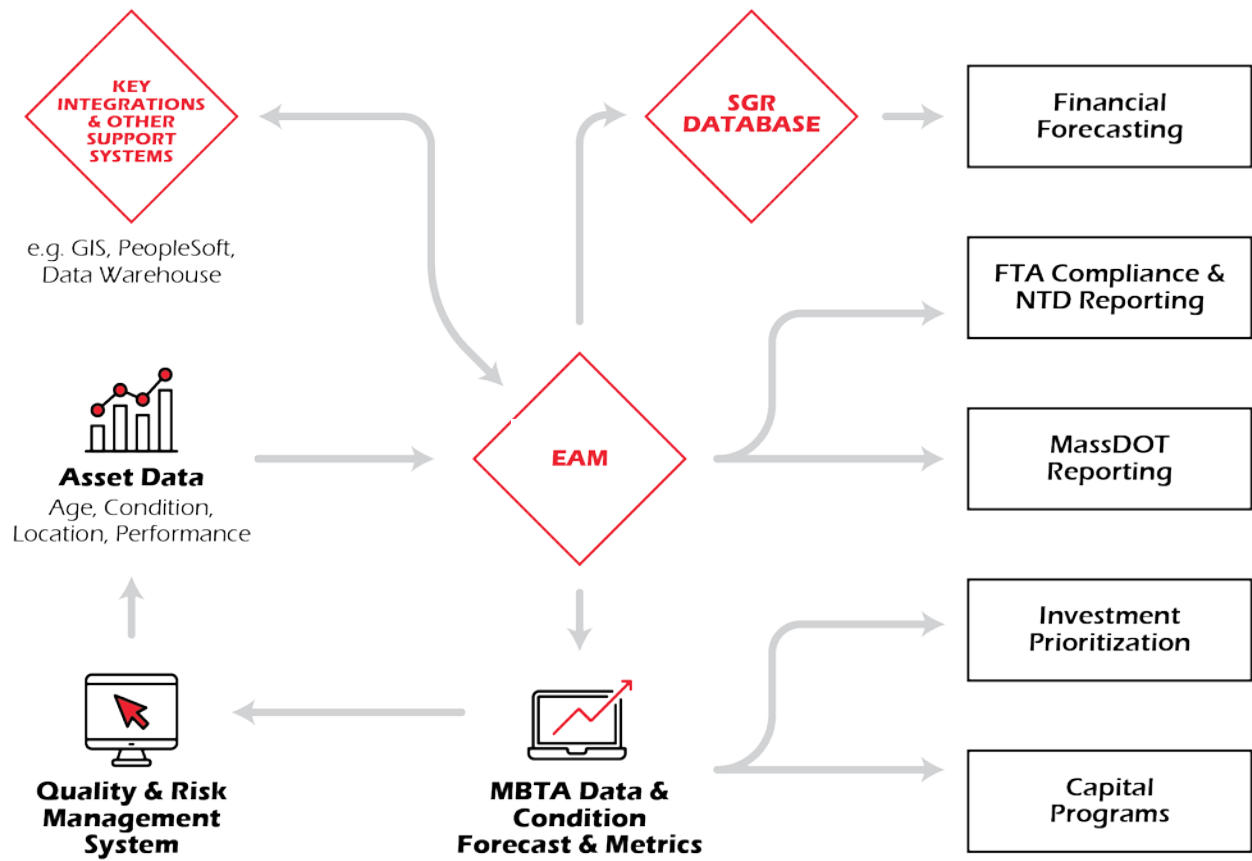
Various systems, both software and non-software based, are used to store and manage asset information. The system and level of detail in information varies based on the asset class and type of asset information managed (e.g., inventory, maintenance management, etc.). Currently, the following supporting technologies for asset information are in use:

- **Bus Fleet (Existing):** The Transit Bus has its own instance of a maintenance management software called internally, "Maintenance Control and Reporting System 2 (MCRS2)." Its materials management system is PeopleSoft Financials and Supply Chain Management, known internally as FMIS. There is a daily batch electronic data exchange posting information from FMIS to Trapeze, such as a daily copy of the inventory to enable validation of part numbers and viewing part availability for work.
- **Bus Fleet (New):** New buses are delivered with remote monitoring capability which send a stream of data, however this feature is currently turned off until appropriate infrastructure systems are established to utilize the data. This will be activated for vehicle maintenance.
- **Rail Fleet:** The maintenance management system used to track the revenue transit rail fleet is referred to as MCRS2.
- **Non-Revenue Fleet (Transit):** The maintenance management system used to track the non-revenue fleet is referred to as MCRS2.
- **The RIDE:** Dossier Fleet Maintenance Information System is used by the contracted operators to record all maintenance activity on the fleet vehicles. The RIDE has full access to all maintenance records. ADEPT is used to schedule and dispatch rides and track complaints.
- **Fixed Guideway Infrastructure (Signals, Power, and Track):** The software, Blue Zone, is used to store maintenance records of work performed.
- **Commuter Rail:** Commuter rail also uses an instance of an EAM to manage assets such as, revenue and non-revenue vehicles, facilities, track, signals, and power.
- **Facilities:** Multiple maintenance management information systems and spreadsheets are utilized for maintenance management or to document maintenance activities in Stations and Facilities, such as FaciliWorks, Blue Zone, and Excel.
- **Ferry:** The asset and maintenance management system utilized by the contractor is WheelHouse Fleet Maintenance. WheelHouse is a cloud based, Software as a Service information system designed for fleet management, which provides the MBTA commuter ferry group with full access to vessel and maintenance records. They do not utilize the maintenance system to track issues reported (no trouble ticket), however all PM and corrective work is recorded.

Ref.	Key Improvement Action	Timeline
8-1	Develop an asset information strategy, providing a comprehensive organization-wide approach to defining asset information requirements and improving information management.	Q2 – Q4 2019
8-2	Consider further development and implementation of business process improvements as identified from As-Is Workshops.	Q4 2018

The MBTA is moving all Transit Infrastructure maintenance Enterprise Asset Management (EAM) functions to its new EAM system over FY19 and FY20. MBTA's vision for its future information management system for existing assets is illustrated in Figure 8-2. The above existing systems will be drawn from in addition to data for power, signals, and parking.

Figure 8-2. Proposed Management System for Existing Assets and Data Process Flow

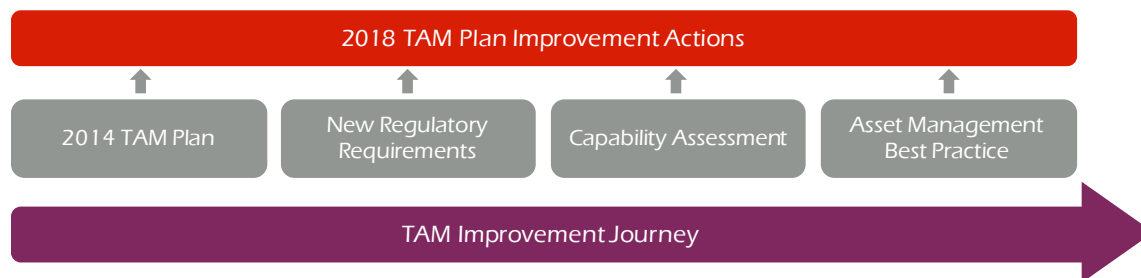




## 9 Improvement Actions

This section summarizes MBTA’s current asset management capability and provides a roadmap for asset management improvement. It brings together existing improvement actions as defined in MBTA’s 2014 TAM Plan, new improvement opportunities and new regulatory requirements as identified in MBTA’s 2018 TAM Plan development, best practice asset management (e.g., International Standards ISO 55001:2014, ISO 31000:2018, PAS 1192, etc.) and MBTA’s 2018 asset management capability assessment.

Figure 9-1. MBTA Asset Management Improvement Journey



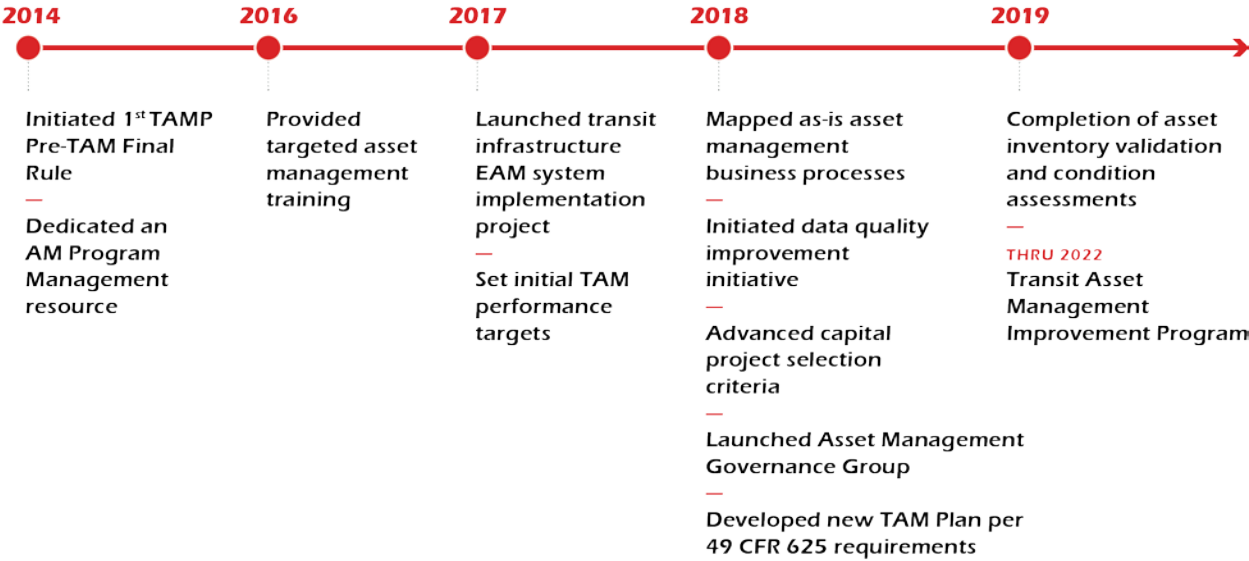
### 9.1 OVERVIEW

The commencement of MBTA’s asset management journey pre-dates the publication of FTA’s Transit Asset Management Final Rule (49 CFR 625 and 630). Since the identification of implementation actions from MBTA’s first transit asset management planning effort in 2014, the agency has progressed significantly as listed below and illustrated in Figure 9-2:

- Dedicated resource to implement the Asset Management Program
- Established an Asset Management Governance Group and Steering Committee
- Provided Targeted Asset Management Training
- Advanced its Capital Project Selection Criteria
- Implementing Enterprise Asset Management System for transit infrastructure, including the development and formalization of asset management standards (underway)
- Mapped the As-Is Asset Management Business Processes to support the establishment of MBTA’s asset management baseline and inform the transition strategy to operate in its future target state (To-Be Business Processes)
- Initiated a Data Quality Improvement Initiative through the validation of its asset inventory and condition information (underway)
- Benchmarked the MBTA against a recognized global Asset Management Maturity model
- Identified further opportunities for improvement for asset management capabilities at the MBTA



Figure 9-2. Timeline of Improvement Actions



In continuing this journey, MBTA has recently undertaken an independent asset management capability assessment. The approach, findings, and resulting improvement program and actions are described in the following sections.

## 9.2 MBTA CURRENT ASSET MANAGEMENT CAPABILITY

The Global Forum for Maintenance and Asset Management (GFMAM) established a structure for the asset management body of knowledge to support assessments and certifications through 39 subject areas. These 39 subject areas have been grouped into 6 key areas of asset management excellence: 1) Strategy and Planning; 2) Asset Management Decision-making; 3) Lifecycle Delivery; 4) Asset Information; 5) Organization and People; and 6) Risk and Review. On the following page, Figure 9-3 presents additional detail on the 6 key areas.

Figure 9-3. Timeline of Improvement Actions



### Strategy & Planning

- 01 Asset Management Policy
- 02 Asset Management Strategy & Objectives
- 03 Demand Analysis
- 04 Strategic Planning
- 05 Asset Management Planning



### Asset Information

- 22 Asset Information Strategy
- 23 Asset Information Standards
- 24 Asset Information Systems
- 25 Data & Information Management



### Asset Management Decision-Making

- 06 Capital Investment Decision-Making
- 07 Operations & Maintenance Decision-Making
- 08 Lifecycle Value Realization
- 09 Resourcing Strategy
- 10 Shutdown & Outage Strategy



### Organization & People

- 26 Procurement & Supply Chain Management
- 27 Asset Management Leadership
- 28 Organizational Structure
- 29 Organizational Culture
- 30 Competence Management



### Lifecycle Delivery

- 11 Technical Standards & Legislation
- 12 Asset Creation & Acquisition
- 13 Systems Engineering
- 14 Configuration Management
- 15 Maintenance Delivery
- 16 Reliability Engineering
- 17 Asset Operations
- 18 Resource Management
- 19 Shutdown & Outage Management
- 20 Fault & Incident Response
- 21 Asset Decommissioning & Disposal



### Risk & Review

- 31 Risk Assessment & Management
- 32 Contingency Planning & Resilience Analysis
- 33 Sustainable Development
- 34 Management of Change
- 35 Asset Performance & Health Monitoring
- 36 Asset Management System Monitoring
- 37 Management Review, Audit & Assurance
- 38 Asset Costing & Valuation
- 39 Stakeholder Engagement

In 2018, MBTA undertook an independent asset management capability assessment that provided a baseline from which the organization could develop its future improvement program. Using a range of assessment criteria and questions, MBTA was scored against each of the 39 subject areas. These subject areas fall into seven categories that comprise the full scope of asset management, as illustrated in Figure 9-4.

Figure 9-4: IAM Scope of Asset Management



### 9.3 FUTURE IMPROVEMENT

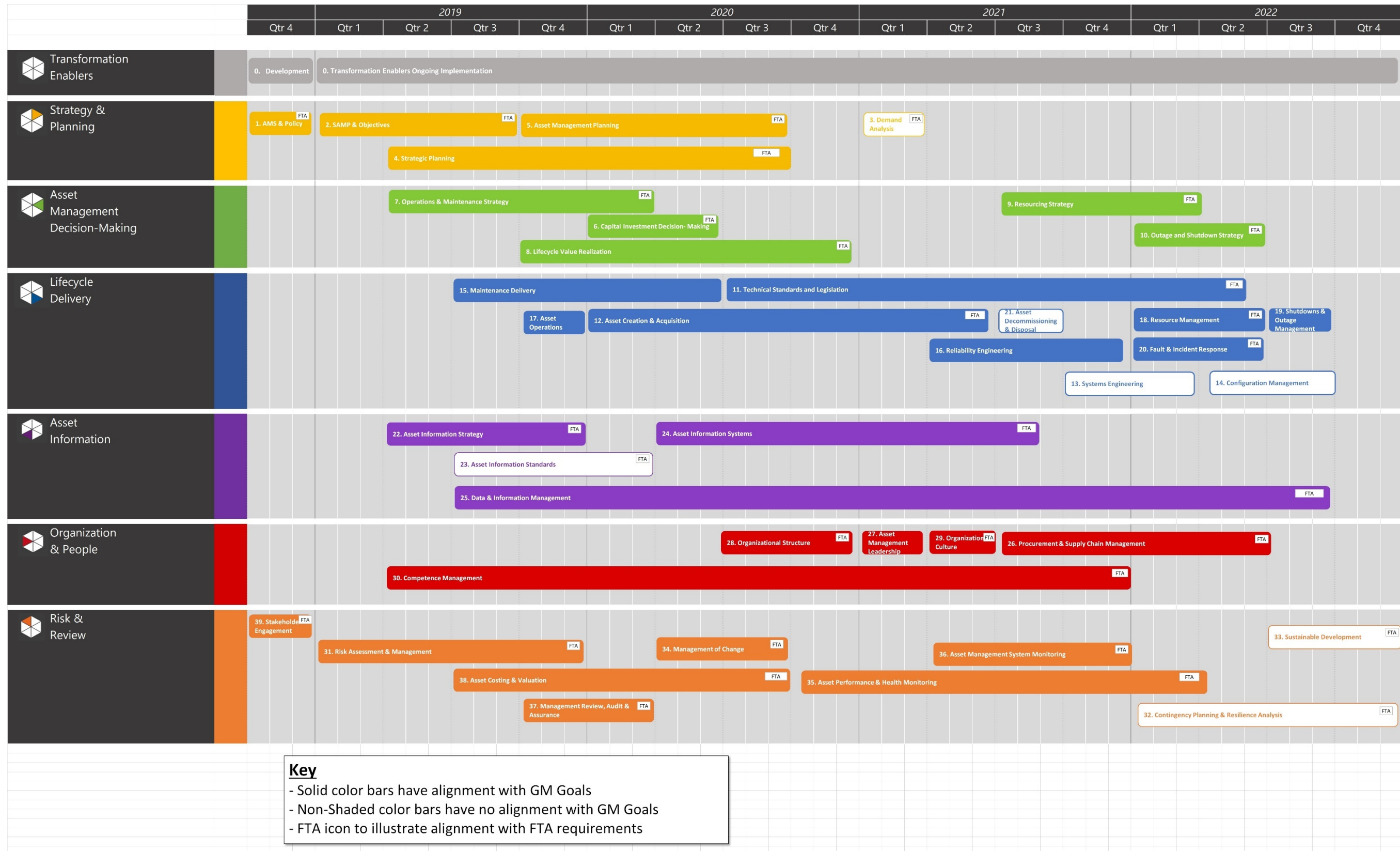
The set of improvement activities that follow are the culmination of findings identified from existing improvement actions as defined in MBTA’s 2014 Transit Asset Management Plan, new improvement opportunities, and new FTA requirements as part of developing its 2018 TAM Plan, as well as the 2018 asset management capability assessment.

The areas identified for improvement are summarized in Figure 9-5 and mapped in the improvement roadmap provided as Figure 9-6. **Appendix G** provides further detail on the specific projects included in MBTA’s Transit Asset Management Improvement Program (TAMIP), and organized chronologically by estimated commencement timeline.

Figure 9-5. MBTA Asset Management Areas for Improvement

<p><b>★ Transformation Enablers</b></p> <ul style="list-style-type: none"> <li>Organizational Design</li> <li>Roadmap and Improvement Program Setup, Governance, Management &amp; Assurance</li> <li>Change Management</li> <li>Communication Strategies &amp; Plans</li> <li>Training &amp; Mentoring Plans</li> </ul>	<p><b>1 Strategy &amp; Planning</b></p> <ul style="list-style-type: none"> <li>Asset Management System &amp; Documentation</li> <li>Goals &amp; Objectives</li> <li>Criticality &amp; Decision-Making</li> <li>Strategic Asset Management Plan</li> <li>Demand &amp; Capacity</li> <li>Strategic Planning</li> <li>FTA Transit Asset Management Plans</li> </ul>	<p><b>3 Lifecycle Delivery</b></p> <ul style="list-style-type: none"> <li>Portfolio &amp; Project Management</li> <li>Design Engineering &amp; Configuration Management</li> <li>Outage Management</li> <li>Reliability Engineering</li> <li>Maintenance &amp; Operations</li> <li>Resource Management</li> </ul>	<p><b>5 Organization &amp; People</b></p> <ul style="list-style-type: none"> <li>Supply Chain</li> <li>Contract Management</li> <li>Asset Management Governance</li> <li>Culture Development</li> <li>Competence &amp; Training</li> </ul>
	<p><b>2 Asset Management Decision Making</b></p> <ul style="list-style-type: none"> <li>Investment Planning</li> <li>Maintenance Strategies</li> <li>Asset Class Strategies &amp; WLC Models</li> <li>Outage Strategies</li> <li>Strategic Resourcing</li> </ul>	<p><b>4 Asset Information</b></p> <ul style="list-style-type: none"> <li>Asset Information Strategy</li> <li>Information Systems Strategy</li> <li>Information Standards</li> <li>Data &amp; Information Management &amp; Quality</li> </ul>	<p><b>6 Risk &amp; Review</b></p> <ul style="list-style-type: none"> <li>Risk &amp; Change Management</li> <li>Performance &amp; Assurance</li> <li>Contingency &amp; Business Continuity</li> <li>Asset Accounting</li> <li>Sustainability Strategy</li> <li>Stakeholder Management</li> </ul>

Figure 9-6. MBTA Transit Asset Management Improvement Plan



Additional tactical improvement actions as identified through the development of MBTA’s TAM Plan are provided in Table 9-1. Key action items are organized by TAM Plan section and aligned to relevant projects in the TAMIP as outlined in Figure 9-6 and **Appendix G**.

To ensure continuous improvement, it is MBTA’s intention that the program of improvement actions will be reviewed and monitored for progress regularly through the Asset Management Coordinating Committee.

**Table 9-1. Summary of Key TAM Plan Improvement Actions**

TAM Plan Ref.	Key Improvement Action	Corresponding TAMIP Project(s)	Timeline
4-1	Undertake track condition assessment; condition assessment (age based or measured condition) should be evaluated by track segment and establish standards. (Commuter Rail and Transit)	23, 25	Q3 2019 – Q1 2020
4-2	Estimate the replacement value of track; estimates may be broken down by percent share or segment renewal/replacement costs. (Commuter Rail and Transit)	8, 23, 25	Q3 2019 – Q1 2020
4-3	Complete inventory exercise for all civil structures.	23, 25	Q3 2019 – Q1 2020
4-4	Complete condition assessment of civil structures.	25	2019-2022
4-5	Baseline all facilities assets in line with minimum FTA requirements. Maintenance and administrative facilities should be differentiated where possible. Train control rooms and substations should also be counted under guideway per federal reporting requirements.	23, 25	Q3 2019 – Q1 2020
4-6	Complete physical condition assessments of at least 25% of all facilities each year over the next four years per federal requirements.	25	Q3 2019 – Q1 2020
5-1	Establish risk management system software to track and manage claims and provide for trend analyses and geographic mapping of claims activity	31, 37	Q1 – Q4 2019
5-2	Undertake risk identification workshops with department directors to complete the initial risk identification exercise as it relates to assets and asset management.	31, 39	Q1 – Q4 2019
5-3	Conduct risk analysis and evaluation of asset and asset management risks following risk workshops (see previous key improvement action).	31	Q1 – Q4 2019
5-4	Define criticality for MBTA assets, and identify operations critical, safety critical and climate sensitive.	31, 37, 39	Q1 – Q4 2019
5-5	Develop risk treatment strategies, especially for risks impacting the identified critical assets.	31, 37, 39	Q1 – Q4 2019
5-6	Incorporate risks related to assets and asset management into MBTA’s regular annual risk review cycle.	31, 37, 39	Q1 – Q4 2019
5-7	Develop an enterprise risk register that recognizes all categories of risk as represented by the functional areas on the Risk Council.	31, 37, 39	Q1 – Q4 2019
5-8	Regularly update the risk register upon completion of the condition assessment of assets, and incorporate asset and	31, 37, 39	Q1 – Q4 2019

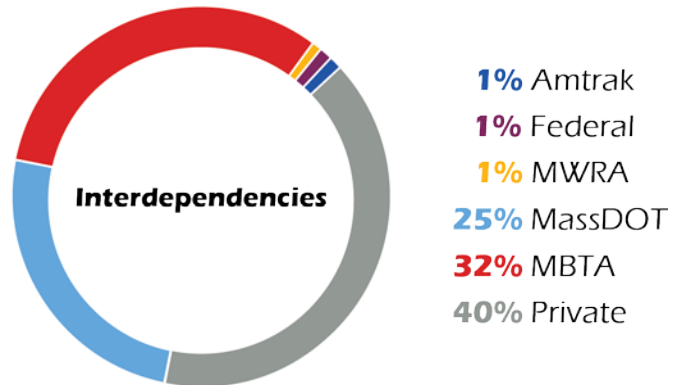


	asset management risks, treatments, and responsible parties in the next Transit Asset Management Plan update.		
5-9	Use the information generated through the above risk-related improvement actions as an input to the decisions of the asset management steering committee.	37	Q4 2019
6-1	Plan and undertake a maintenance strategy review of all asset classes (prioritized by criticality, vulnerability, utilization) to ensure the most appropriate strategies are applied to respective assets.	7; 15	Q2 2019 – Q1 2020; Q3 2019 – Q2 2020
6-2	Review and further develop lifecycle management strategies for each asset class and assumptions in Chapter 7 Work Plans and Budget Forecasts to better inform work and budget forecasts and analyses.	7, 8	Q2 2019 – Q1 2020
6-3	Upon further review of asset information and development of above lifecycle management strategies, develop tactical asset class strategies for each major asset class (e.g., bridges and tunnels, rail vehicles and facilities, bus fleet and facilities, ferry fleet and facilities, track, power, signals and communications) that specify the activities, timelines, and resources required to achieve/maintain a state of good repair and transition to steady state capital maintenance.	7; 15	Q2 2019 – Q1 2020; Q3 2019 – Q2 2020
7-1	Adopt MassDOT decision support tool “Planning for Performance” to estimate the impact of projected investment levels on asset performance.	8	2019
7-2	Continuously refine internal processes to fully align CIP investment program sizes with MBTA’s asset management objectives and performance targets.	8	2019
8-1	Develop an asset information strategy, providing a comprehensive organization-wide approach to defining asset information requirements, managing and securing asset information, and improving information management.	22	Q2 – Q4 2019
8-2	Consider further development and implementation of business process improvements as identified from As-Is Workshops.	1; 4	Q4 2018; Q2 2019 – Q3 2020
9-1	Establish formal internal audit function to assure this TAM Plan is being updated and implemented in accordance with federal rules and requirements.	40; 37; 25	October / November 2018; Q4 2019-2022
9-2	Hire additional full-time asset management personnel to manage the program.	40; 30	October / November 2018; 2019-2021

## 10 Interdependencies

Figure 10-1. MBTA Interdependencies

This section summarizes and introduces the interdependent nature in the management of infrastructure that MBTA operates on or has capital responsibility over.



Nearly 60% of the active railroad system in Massachusetts is now publicly owned (25% MassDOT, 32% MBTA, 1% Amtrak/MWRA/Federal). MBTA and Amtrak operate on MassDOT rail lines to provide daily passenger service; about 47% of MassDOT-owned rail lines have shared use between passenger and freight.

- MassDOT Worcester Line and Grand Junction Branch are used and maintained as part of the MBTA Commuter Rail System.
- The CapeFLYER and Patriots trains operated by MBTA use MassDOT rail lines to the Cape and the Framingham Secondary to Gillette Stadium, respectively.

In June 2010, MassDOT acquired the South Coast Lines. Upon completion of the South Coast Rail project, Commuter Rail service will be restored between Boston and southeastern Massachusetts. The service will be operated by MBTA.

Additionally, the Passenger Rail Investment and Improvement Act (PRIIA) 212 required changes to the Attleboro Agreement by which Amtrak and MBTA share responsibilities on the MBTA-owned section of the Northeast Corridor (NEC) in Massachusetts. The new Attleboro Agreement negotiated for 2017-2021 governs the following:

- Amtrak access to MBTA line
- Amtrak right to dispatch line
- Amtrak maintenance of line
- MBTA and Amtrak payment of allocated share of costs
- MBTA control of jointly funded capital program

As capital responsibility for infrastructure within the Massachusetts border of the NEC now resides with MBTA, about \$173 million has been allocated over FY2019-2023 for NEC capital commitments per the Attleboro Agreement. This includes reliability projects for track, signaling, positive train control, bridges, and tunnels.



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## APPENDICES

Appendix A. List of Acronyms

Appendix B. Key Definitions

Appendix C. State of Good Repair Performance Measures and Targets

Appendix D. Useful Life Benchmarks

Appendix E. MBTA Funding Sources

Appendix F. Project-Based Listing of Investment Priorities

Appendix G. MBTA Transit Asset Management Improvement Program Projects

## APPENDIX A. LIST OF ACRONYMS

<b>ADA</b>	Americans with Disabilities Act
<b>AM</b>	Asset Management
<b>AREMA</b>	American Railway Engineering and Maintenance Association
<b>CFR</b>	Code of Federal Regulations
<b>DPU</b>	Department of Public Utilities
<b>E&amp;M</b>	Engineering and Maintenance
<b>FMCB</b>	Fiscal Management and Control Board
<b>FMIS</b>	PeopleSoft Financials and Supply Chain Management
<b>FRA</b>	Federal Railroad Administration
<b>FTA</b>	Federal Transit Administration
<b>HVAC</b>	Heating, Ventilation, and Air Conditioning
<b>ISO31000</b>	The International Organization for Standardization (ISO) risk management standard
<b>ISO5000</b>	The ISO series of international asset management standards
<b>KPI</b>	Key Performance Indicator
<b>MassDOT</b>	Massachusetts Department of Transportation
<b>MBTA</b>	Massachusetts Bay Transportation Authority
<b>MCRS</b>	Legacy Maintenance Control Reporting System
<b>MCRS2</b>	Maintenance Control and Reporting System 2
<b>MPO</b>	Metropolitan Planning Organization
<b>NTD</b>	National Transit Database
<b>O&amp;M</b>	Operations and Maintenance
<b>OEM</b>	Original Equipment Manufacturer
<b>OPMI</b>	Office of Performance Management and Innovation
<b>PAS 1192</b>	Specification for information management for the operational phase of construction projects using building information modelling
<b>PM</b>	Preventive Maintenance (or Periodic Maintenance in reference to Rail Fleet)
<b>SGR</b>	State of Good Repair
<b>SUV</b>	Sports Utility Vehicle
<b>TAM</b>	Transit Asset Management
<b>TERM</b>	Transit Economic Requirements Model
<b>ULB</b>	Useful Life Benchmark

## APPENDIX B. KEY DEFINITIONS

### Accountable Executive

Defined by 49 CFR 625.5 as a “single, identifiable person who has ultimate responsibility for carrying out the safety management systems of a public transportation agency; responsibility for carrying out transit asset management practices; and control or direction over the human and capital resources needed to develop and maintain both the agency’s public transportation agency safety plan, in accordance with 49 U.S.C. 5329(d), and the agency’s transit asset management plan in accordance with 49 U.S.C. 5326.”

### Asset

An item, entity or thing that has actual or potential value to the organization.

A tangible item of value that is owned, contracted, and/or managed by MBTA for the purposes of providing transit services. This includes fleet, equipment, facilities and infrastructure assets that are repairable, replaceable and subject to a preventive maintenance schedule or inspection or calibration or need to be tracked from a capital depreciation point of view.

### Capital Asset

Defined by 49 CFR 625.5 as a “unit of rolling stock, a facility, a unit of equipment, or an element of infrastructure used for providing public transportation.”

### Directional Route Miles

The mileage in each direction over which public transportation vehicles travel while in revenue service. It excludes non-revenue track such as yards, turn-arounds, and storage tracks.

### Lifecycle

The time interval that begins with the acquisition of a Transit Asset or Land Asset, and ends with the disposal of the asset. Lifecycle phases may include planning, design, procurement, construction, operations, maintenance, rehabilitation, and asset replacement/disposal.

### State of Good Repair (SGR)

Defined by 49 CFR 625.5 as the “condition in which a capital asset is able to [safely] operate at a full level of performance.” The State of Good Repair is further defined by an asset’s Useful Life Benchmark (for rolling stock and equipment) or physical condition (for facilities). Assets are considered in a State of Good Repair when they do not meet or exceed their ULB or physical condition threshold. Vehicle and equipment assets, for example, are considered in a State of Good Repair, when rated as a 2.5 or above on FTA’s TERM Lite scale, where 2.5 is equivalent to the ULB set for an asset class. Additionally, facilities, are considered in a State of Good Repair when rated as a 3 or above on FTA’s TERM scale. *See also definition for Useful Life Benchmark.*

### State of Good Repair (SGR) Backlog

The cumulative dollar value of deferred capital maintenance and replacement needs.

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## TERM Scale

The five-category rating system used in the FTA's Transit Economic Requirement Model (TERM) to describe the condition of an asset, where 5 is excellent condition and 1 is poor condition.

## Tier I Transit Provider

An entity that receives federal financial assistance under 49 U.S.C. Chapter 53, either directly from FTA or as a subrecipient, that owns, operates, or manages either (1) one hundred and one (101) or more vehicles in revenue service during peak regular service across all fixed route modes or in any one non-fixed route mode, or (2) rail transit.

## Transit Asset Management (TAM)

Defined by 49 CFR 625.5 as "the strategic and systematic practice of procuring, operating, inspecting, maintaining, rehabilitating, and replacing transit capital assets to manage their performance, risks, and costs over their lifecycles, for the purpose of providing safe, cost-effective, and reliable public transportation."

## Transit Asset Management Plan

This document, which describes: the capital asset inventory; condition of inventoried assets; TAM performance measures, targets, and prioritization of investments aligned with the agency's TAM and SGR policy, strategic goals and objectives; as well as the strategies, activities, and resources required for delivering this plan (including decision support tools and processes); and other agency-wide approaches to continually improve TAM practices. While this TAM Plan exists as a standalone document, Asset Class Plans may be considered an extension of the TAM Plan by reference.

## Track Miles

The sum of the one-way linear miles of all trackage in a system, including all main track and trackage in yards, car barns, switches, and turnouts.

## Useful Life

Defined by 49 CFR 625.5 as "either the expected lifecycle of a capital asset or the acceptable period of use in service determined by FTA." It generally defines the minimum eligibility for retirement, replacement, or disposal of an asset. *See also definition for Estimated Useful Life (EUL).*

## Useful Life Benchmark (ULB)

Defined by 49 U.S.C. Chapter 53 as "the expected lifecycle or the acceptable period of use in service for a capital asset, as determined by a transit provider, or the default benchmark provided by FTA." The ULB is the realistic expectation for when an asset would be disposed or replaced based on operating environment and procurement timelines. It is not the same as "Useful Life" in FTA grant programs, is reported by age (in years), and usually only pertains to rolling stock or equipment. It is a single number shared for or within specified asset classes, although may vary across different asset classes and providers. *See also definition for Estimated Useful Life (EUL).*

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# APPENDIX C. STATE OF GOOD REPAIR PERFORMANCE MEASURES AND TARGETS

Federal regulation (49 CFR 625.43) requires transit agencies to report on specific state of good repair performance measures. These asset performance measures support MassDOT performance measurement of system condition, but also feed into a common baseline of metrics across transit agencies in the United States to support the analysis of the nation’s state of good repair backlog. In addition to measuring state of good repair performance, agencies are also required to set performance targets for each asset class annually. The required state of good repair performance measures and targets are defined further in Table C-1.

**Table C-1. FTA State of Good Repair Performance Measures and Targets**

Capital Asset Category	State of Good Repair Performance Measure	Performance Target
Rolling Stock (Revenue Vehicles)	Age	% of revenue vehicles that have met or exceeded their Useful Life Benchmark (ULB) by asset class
Equipment (Non-Revenue Vehicles)	Age	% of non-revenue vehicles that have met or exceeded their Useful Life Benchmark (ULB)
Infrastructure (Rail Fixed Guideway, Track, Signals, and Systems)	Performance Restrictions (Slow Zones)	% of track segments with performance restrictions
Facilities (Passenger, Parking, Maintenance, Administrative)	Condition	% of facilities with a condition rating below 3.0 on the FTA Transit Economic Requirements Model (TERM) scale

**Revenue and non-revenue vehicles:** For revenue and non-revenue vehicles, the state of good repair performance measure is set by age; the performance target is the percent of those vehicles that have met or exceeded their Useful Life Benchmark (ULB). The ULB is defined as the expected lifecycle (in years) of an asset or the acceptable period of use in service for a capital asset, as determined by a transit provider, or the default benchmark provided by FTA. ULB is not to be confused with “useful life,” where the useful life is the expected life cycle of a capital asset or the acceptable period of use in service determined by FTA prior to replacement eligibility. For example, a bus may have a useful life of 12 years and at this point is eligible for replacement by FTA standards, but the actual point of replacement and ULB may be 14 years. For further information on MBTA ULBs, please see **Appendix C**.

**Infrastructure:** Rail fixed guideway, track, signals, and systems are measured using the percent of track segments with performance restrictions. While this is the required performance measure for reporting to the National Transit Database, this performance measure does not always accurately reflect the health of the track system. Therefore, MBTA is looking to other performance measures, such as age or Track Quality Index and geometric profile, specifically for track, power, and signals.

Figure C-1. Summary of TERM Scale and Facility SGR Ratings

Rating	Condition	Description
5	Excellent	No visible defects, new or near new condition, may be under warranty if applicable
4	Good	Good condition, but no longer new, may have some slightly defective or deteriorated component(s), but overall is functional
3	Adequate	Moderately deteriorated or defective components; but has not exceeded useful life
2	Marginal	Defective or deteriorated component(s) in need of replacement; exceeded useful life
1	Poor	Critically damaged component(s) or in need of immediate repair; well past useful life

**Facilities:** Facility condition is measured using FTA’s Transit Economic Requirements Model (TERM) one to five condition scale (where 5 is considered excellent condition). Historically, MBTA has assessed facility condition through in-house engineering expertise on the assets, and has begun comprehensive physical

condition assessments of its passenger support facilities. The MBTA seeks to have complete inventory and condition assessments for all facility assets by October 2019.

# APPENDIX D. USEFUL LIFE BENCHMARKS

FTA Asset Category	NTD Asset Type	MBTA ULB
Rolling Stock	Bus	14*
	Heavy Rail Vehicle	31*
	Light Rail Vehicle	31*
	Automobile (Paratransit)	6
	Van (Paratransit)	7
	Ferryboat	42*
	Commuter Rail Locomotive	39*
	Commuter Rail Coach – Non-Pullman Standard	39*
	Commuter Rail Coach – Pullman Standard	57
	Equipment	Service Vehicle - Automobile
Service Vehicle - SUV		10
Service Vehicle - Van		12
Truck and Other Rubber Tire Vehicle		14*
Steel Wheel Vehicle		25*

\*Represents FTA default ULB



# APPENDIX E. MBTA FUNDING SOURCES

Source	Description
Federal Highway Administration (FHWA) Reimbursements	FHWA funds such as Congestion Mitigation Air Quality (CMAQ) or earmarks “flexed” to FTA for use on the Green Line Extension (GLX) project and other eligible MBTA projects.
FTA Reimbursements and grant draws	Reflects Sec. 5307 Urbanized Area Formula funds, Sec. 5337 State of Good Repair/Fixed Guideway funds, and Sec. 5339 Bus and Bus Facilities Funds. Assumes FAST Act levels continue. Federal share only – does not include 20% match from MBTA revenue bonds.
FTA Full Funding Grant Agreement (GLX FFGA)	Amount obligated and projected for the GLX project through the FFGA between FTA and MBTA.
Other Federal Funds	Non-U.S. DOT federal funds, including the Transit Security Grant Program administered by the Department of Homeland Security.
State Bond Cap	Commonwealth general obligation bond proceeds allocated to specific reliability and modernization projects.
Accelerated Bridge Bonds	Commonwealth special obligation bond proceeds allocated to specific bridge projects; primarily for reimbursement of MBTA-related project costs.
Rail Enhancement Bonds	The Commonwealth Rail Enhancement Program is a dedicated \$2.1 billion program for reliability, modernization and expansion initiatives at the MBTA, including the State’s share of the GLX project and elements of the Red and Orange Line Improvements Program.
MBTA Revenue Bonds	Revenue bonds issued by the MBTA, including Sustainability Bonds.
Municipal and Local Funds (GLX)	Cambridge and Somerville contributions toward the GLX project.
Reimbursable and Third Parties	Third-party funding for specific initiatives, includes reimbursable agreements with Amtrak and RIDOT.
Positive Train Control (PTC) financing	Reflects proceeds from revenue bonds issued or to be issued for the PTC project(s). Transportation Infrastructure Finance and Innovation Act (TIFIA) and Railroad Rehabilitation and Improvement Financing (RRIF) financing will be available upon completion of the project.

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Source	Description
Pay-Go Lockbox (MBTA)	Funds that are available due to operating budget savings and state assistance; amounts are allocated to specific reliability and modernization projects.
Capital Maintenance Fund	Funds available at the discretion of the CFO for unanticipated and urgent capital maintenance needs.

## APPENDIX F. PROJECT-BASED LISTING OF INVESTMENT PRIORITIES

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Gloucester Drawbridge Replacement	Bridge & Tunnel	Reliability	Commuter Rail	\$60,000,000	\$53,670,167	FY19-FY22
Gloucester Drawbridge Replacement	Bridge & Tunnel	Reliability	Commuter Rail	\$28,287,060	\$28,287,060	FY22-FY23
Emergency Bridge Design / Inspection & Rating	Bridge & Tunnel	Reliability	Systemwide	\$23,723,554	\$2,000,000	FY19-FY20
Bridges - Design	Bridge & Tunnel	Reliability	Systemwide	\$8,016,107	\$3,900,000	FY19-FY22
Bridges - Design	Bridge & Tunnel	Reliability	Systemwide	\$9,344,578	\$1,235,554	FY19-FY20
Merrimack River Bridge	Bridge & Tunnel	Reliability	Commuter Rail	\$40,538,375	\$16,100,000	FY19-FY21
Shawsheen Wilmington Bridge Rehabilitation	Bridge & Tunnel	Reliability	Commuter Rail	\$3,136,651	\$2,217,020	FY19-FY21
Shoreline and Saugus Bridges	Bridge & Tunnel	Reliability	Commuter Rail	\$11,356,216	\$7,692,790	FY19-FY23
Beverly Drawbridge Rehab	Bridge & Tunnel	Reliability	Commuter Rail	\$26,794,418	\$1,000,000	FY19
Emergency Bridge Repair	Bridge & Tunnel	Reliability	Systemwide	\$10,902,503	\$9,000,000	FY19-FY21
Emergency Bridge Repair	Bridge & Tunnel	Reliability	Systemwide	\$8,753,589	\$256,834	FY19
Bus Route Safety and Service Improvements	Accessibility	Modernization	Bus	\$8,236,777	\$6,521,000	FY19-FY20
Key Bus Route Improvements	Customer Experience and Technology Improvements	Modernization	Bus	\$1,037,503	\$885,000	FY19
Elevator Program	Accessibility	Modernization	Red Line	\$137,441,263	\$67,219,604	FY19-FY22
Elevator Program Multiple Location Design	Accessibility	Modernization	Systemwide	\$10,025,892	\$8,650,000	FY19

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Oak Grove Station Vertical Transportation Improvements	Accessibility	Modernization	Orange Line	\$16,500,000	\$16,016,981	FY19-FY22
Oak Grove Station Vertical Transportation Improvements	Accessibility	Modernization	Orange Line	\$10,542,735	\$10,542,735	FY22-FY23
Ferry System Improvements	Stations	Reliability	Ferry	\$235,678	\$235,678	FY19-FY20
Hingham Ferry Dock Modification	Stations	Reliability	Ferry	\$3,480,315	\$2,200,000	FY19-FY22
Hingham Ferry Dock Modification	Stations	Reliability	Ferry	\$6,050,000	\$6,050,000	FY20-FY22
Hingham Ferry Dock Modification	Stations	Reliability	Ferry	\$6,050,000	\$6,050,000	FY20-FY22
Hingham Ferry Terminal	Stations	Reliability	Ferry	\$4,383,742	\$1,000,000	FY19-FY20
Wachusett Extension	Expansion Projects	Expansion	Commuter Rail	\$24,508,723	\$6,190,000	FY19-FY20
Alewife Garage Improvements	Stations	Reliability	Red Line	\$7,986,220	\$608,688	FY19
Braintree and Quincy Adams Garage Rehab	Stations	Reliability	Red Line	\$54,336,138	\$54,336,138	FY21-FY23
Braintree and Quincy Adams Garage Rehab	Stations	Reliability	Red Line	\$40,835,110	\$25,663,862	FY19-FY21
Lynn Parking Garage Phase 1	Stations	Reliability	Commuter Rail	\$501,575	\$265,876	FY19
45 High Street - Data Center Upgrades	System Upgrades/Other	Reliability	Systemwide	\$11,734,622	\$5,131,834	FY19-FY20
Charlestown Bus - Seawall Rehab	Facilities	Reliability	Bus	\$24,732,660	\$15,852,126	FY19-FY20
Charlestown Bus - Seawall Rehab	Facilities	Reliability	Bus	\$10,252,608	\$10,252,608	FY20-FY21
Everett Bus - Fire Protection	Facilities	Reliability	Bus	\$3,255,168	\$112,617	FY19
Everett Bus - Flowfill Repairs	Facilities	Reliability	Bus	\$13,895,687	\$8,412,327	FY19-FY20

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Everett Bus - Flowfill Repairs	Facilities	Reliability	Bus	\$3,463,148	\$3,463,148	FY19-FY20
Back Bay Station Ventilation (not incl. leasehold improvements)	Stations	Reliability	Commuter Rail	\$4,459,959	\$4,110,339	FY19
Back Bay Station Ventilation (not incl. leasehold improvements)	Stations	Reliability	Commuter Rail	\$10,504,918	\$9,253,200	FY19-FY21
Back Bay Station Ventilation (not incl. leasehold improvements)	Stations	Reliability	Commuter Rail	\$12,000,000	\$12,000,000	FY21-FY22
MassDOT Chelsea-Silver Line/BRT Washington Ave Busway	Expansion Projects	Expansion	Silver Line	\$679,030	\$353,532	FY19
MassDOT Commonwealth Ave I-90 Bridge Replacement	Bridge & Tunnel	Reliability	Green Line	\$2,511,336	\$1,319,853	FY19-FY22
MassDOT Longfellow Bridge Rehab	Bridge & Tunnel	Reliability	Red Line	\$10,241,288	\$350,000	FY19
Facility On-Call	Facilities	Reliability	Systemwide	\$35,166,195	\$16,000,000	FY19-FY22
Fenway Portal Flood Protection	Facilities	Reliability	Green Line	\$17,566,646	\$15,275,000	FY19-FY20
Plan for Accessible Transit Infrastructure (PATI)	Accessibility	Modernization	Systemwide	\$2,980,152	\$390,000	FY19
Underground Storage Tanks	Facilities	Reliability	Systemwide	\$5,952,080	\$2,000,000	FY19
Underground Storage Tanks	Facilities	Reliability	Systemwide	\$1,161,507	\$1,161,507	FY19
Independent Reviews	System Upgrades/Other	Reliability	Systemwide	\$8,033,441	\$1,929,960	FY19-FY22
Misc. Audit Services	System Upgrades/Other	Reliability	Systemwide	\$6,302,251	\$3,239,734	FY19-FY23
Newton Highlands Green Line Station Accessibility Project	Accessibility	Modernization	Green Line	\$292,988	\$55,943	FY19

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
<b>Newton Highlands Green Line Station Accessibility Project</b>	Accessibility	Modernization	Green Line	\$7,199,193	\$6,748,017	FY19-FY22
<b>Newton Highlands Green Line Station Accessibility Project</b>	Accessibility	Modernization	Green Line	\$6,096,250	\$6,096,250	FY21-FY22
<b>Old South Meeting House Leak Repairs</b>	Stations	Reliability	Multimodal	\$1,385,000	\$1,335,549	FY19-FY20
<b>Orange Line Traction Power Upgrade</b>	Track, Signal and Power	Reliability	Orange Line	\$16,818,600	\$15,029,675	FY19-FY21
<b>Orange Line Traction Power Upgrade</b>	Track, Signal and Power	Reliability	Orange Line	\$26,447,226	\$12,201,727	FY19-FY21
<b>Orange Line Traction Power Upgrade</b>	Track, Signal and Power	Reliability	Orange Line	\$3,768,542	\$159,912	FY19-FY22
<b>Power Program A - Traction Power Substation, Ph. 3 &amp; 4</b>	Track, Signal and Power	Reliability	Systemwide	\$11,875,169	\$9,487,708	FY19-FY22
<b>Power Program B - Traction Power Substation, Ph. 3 &amp; 4</b>	Track, Signal and Power	Reliability	Systemwide	\$18,586,192	\$14,983,668	FY19-FY23
<b>SCADA Upgrades</b>	Track, Signal and Power	Reliability	Systemwide	\$1,437,503	\$536,019	FY19-FY20
<b>SCADA Upgrades</b>	Track, Signal and Power	Reliability	Systemwide	\$1,463,400	\$398,747	FY19
<b>Systemwide Transformer Replacement, Phase 2</b>	Track, Signal and Power	Reliability	Systemwide	\$6,105,004	\$4,896,111	FY19-FY20
<b>Systemwide Transformer Replacement, Phase 2</b>	Track, Signal and Power	Reliability	Systemwide	\$6,539,802	\$4,687,931	FY19-FY20
<b>Commuter Rail Positive Train Control</b>	Commuter Rail Safety and Resiliency	Modernization	Commuter Rail	\$450,267,668	\$330,758,934	FY19-FY22
<b>Commuter Rail Positive Train Control</b>	Commuter Rail Safety and Resiliency	Modernization	Commuter Rail	\$3,111,628	\$353,488	FY19-FY22
<b>Commuter Rail Positive Train Control</b>	Commuter Rail Safety and Resiliency	Modernization	Commuter Rail	\$5,932,538	\$5,932,538	FY20

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Red Line / Orange Line Infrastructure Improvements	Red / Orange Line Improvements	Modernization	RL/OL	\$ 144,423,787	\$ 110,366,803	FY19-FY22
Red Line / Orange Line Infrastructure Improvements	Red / Orange Line Improvements	Modernization	RL/OL	\$ 189,641,229	\$ 179,992,648	FY19-FY22
Red Line / Orange Line Infrastructure Improvements	Red / Orange Line Improvements	Modernization	RL/OL	\$ 103,501,331	\$ 72,159,449	FY19-FY22
Red Line / Orange Line Infrastructure Improvements	Red / Orange Line Improvements	Modernization	RL/OL	\$ 5,000,000	\$ 3,316,348	FY19-FY22
Red Line / Orange Line Infrastructure Improvements	Red / Orange Line Improvements	Modernization	RL/OL	\$ 23,792,180	\$ 23,769,420	FY20-FY22
South Coast Rail Expansion	Expansion Projects	Expansion	South Coast Rail	\$ 32,000,000	\$ 5,000,000	FY19-FY23
South Coast Rail Expansion	Expansion Projects	Expansion	South Coast Rail	\$ 10,000,000	\$ 4,800,000	FY20-FY23
Forest Hills Improvement Project	Accessibility	Modernization	Orange Line	\$ 5,000,000	\$ 4,205,916	FY19-FY21
Forest Hills Improvement Project	Accessibility	Modernization	Orange Line	\$ 17,612,204	\$ 17,612,204	FY20-FY22
Government Center Station	Stations	Reliability	Multimodal	\$ 98,826,245	\$ 420,150	FY19
Harvard Square Busway Repairs	Stations	Reliability	Bus	\$ 20,903,273	\$ 19,791,360	FY19-FY21
Symphony Station Improvements	Accessibility	Modernization	Green Line	\$ 5,229,801	\$ 4,240,000	FY19-FY23
Symphony Station Improvements	Accessibility	Modernization	Green Line	\$ 33,040,000	\$ 27,520,000	FY21-FY23
Newton Commuter Rail Stations Study	Accessibility	Modernization	Commuter Rail	\$ 20,639,934	\$ 19,525,740	FY19-FY22
Fairmount Line Improvements (Blue Hill Ave. Station)	Expansion Projects	Expansion	Commuter Rail	\$ 26,550,000	\$ 15,314,380	FY19-FY20
Mansfield Station Accessibility	Accessibility	Modernization	Commuter Rail	\$ 11,240,898	\$ 8,520,000	FY19



Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
<b>Natick Center Station Accessibility Project</b>	Accessibility	Modernization	Commuter Rail	\$2,200,632	\$1,804,683	FY19-FY20
<b>Ruggles Station Upgrade</b>	Stations	Reliability	Multimodal	\$30,000,000	\$22,302,326	FY19-FY21
<b>Ruggles Station Upgrade</b>	Stations	Reliability	Multimodal	\$9,396,773	\$9,316,773	FY19-FY22
<b>South Attleboro Station Improvements</b>	Stations	Reliability	Commuter Rail	\$1,150,000	\$1,000,000	FY19
<b>Winchester Center Station</b>	Stations	Reliability	Commuter Rail	\$1,073,530	\$74,008	FY19-FY22
<b>Winchester Center Station</b>	Stations	Reliability	Commuter Rail	\$33,548,251	\$32,920,647	FY19-FY23
<b>Back Bay Groundwater Remediation</b>	System Upgrades/Other	Reliability	Multimodal	\$3,728,545	\$1,325,000	FY19-FY22
<b>Tunnel Rehab</b>	Bridge & Tunnel	Reliability	Systemwide	\$15,652,922	\$4,418,169	FY19-FY21
<b>Miscellaneous Power Projects - Mobile Substation / Generators</b>	Track, Signal and Power	Reliability	Systemwide	\$3,371,851	\$193,136	FY19-FY22
<b>Orange Line Third Rail Heater</b>	Track, Signal and Power	Reliability	Orange Line	\$10,969,189	\$293,567	FY19-FY22
<b>Locomotive / Coach Improvements</b>	Revenue Vehicles	Reliability	Commuter Rail	\$6,128,331	\$2,069,067	FY19
<b>Locomotive / Coach Improvements</b>	Revenue Vehicles	Reliability	Commuter Rail	\$3,932,943	\$1,199,527	FY19
<b>Commuter Rail - Walpole Lewis' Wye Signal Impr</b>	Track, Signal and Power	Reliability	Commuter Rail	\$2,490,223	\$1,426,233	FY19
<b>Mini-Rehab to Restore Locos and Coaches</b>	Revenue Vehicles	Reliability	Commuter Rail	\$10,250,318	\$4,180,775	FY19-FY20
<b>Franklin Double Track &amp; Signal</b>	Track, Signal and Power	Reliability	Commuter Rail	\$19,731,164	\$19,202,328	FY19-FY21
<b>Commuter Rail - Replace CP3 Crossover</b>	Track, Signal and Power	Reliability	Commuter Rail	\$2,999,154	\$1,498,308	FY19
<b>Retrofit Building for HVAC Shop at BET</b>	Facilities	Reliability	Commuter Rail	\$4,400,000	\$3,549,890	FY19



Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Commuter Rail Facility Improvements	Facilities	Reliability	Commuter Rail	\$1,540,030	\$585,666	FY19-FY22
Commuter Rail - Systemwide Tree Removal	Commuter Rail Safety and Resiliency	Modernization	Commuter Rail	\$13,500,000	\$7,769,959	FY19-FY20
Locomotive Overhaul	Revenue Vehicles	Reliability	Commuter Rail	\$30,000,000	\$19,112,484	FY19-FY21
Locomotive Restoration to Increase Fleet Size	Revenue Vehicles	Reliability	Commuter Rail	\$6,926,844	\$1,118,642	FY19-FY22
MPI HSP46 Remote Diagnostic Monitoring System	Revenue Vehicles	Reliability	Commuter Rail	\$558,300	\$86,909	FY19
Worcester Line Track Improvements Incl. 3rd Track Feasibility Study	Track, Signal and Power	Reliability	Commuter Rail	\$3,143,509	\$386,273	FY19-FY22
Worcester Line Track Improvements Incl. 3rd Track Feasibility Study	Track, Signal and Power	Reliability	Commuter Rail	\$7,098,914	\$772,545	FY19-FY22
Commuter Rail Misc. Equipment (Winter Resiliency)	System Upgrades/Other	Reliability	Commuter Rail	\$21,792,977	\$57,760	FY19
AFC 1.0	System Upgrades/Other	Reliability	Systemwide	\$4,857,391	\$2,370,141	FY19-FY21
AFC 1.0	System Upgrades/Other	Reliability	Systemwide	\$2,330,822	\$336,993	FY19-FY20
AFC 2.0	AFC 2.0	Modernization	Systemwide	\$8,378,276	\$1,222,345	FY19
AFC 2.0	AFC 2.0	Modernization	Systemwide	\$10,312,963	\$8,940,811	FY19-FY20
Green Line - Real Time Tracking	Customer Experience and Technology Improvements	Modernization	Green Line	\$13,426,924	\$4,517,317	FY19
Beacon Junction Special Track Work Replacement	Track, Signal and Power	Reliability	Green Line	\$7,628,316	\$3,500,000	FY19-FY20
Red Line Floating Slabs (Alewife-Harvard)	Track, Signal and Power	Reliability	Systemwide	\$16,865,327	\$12,000,000	FY19-FY21

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Orange Line DC Cable	Track, Signal and Power	Reliability	Orange Line	\$10,367,971	\$6,501,632	FY19-FY22
Orange Line DC Cable	Track, Signal and Power	Reliability	Orange Line	\$13,970,802	\$3,981,764	FY19-FY22
Red Line DC Cable	Track, Signal and Power	Reliability	Red Line	\$13,955,055	\$8,328,200	FY19-FY22
Red Line DC Cable	Track, Signal and Power	Reliability	Red Line	\$15,885,137	\$7,654,509	FY19-FY22
Power Projects	Track, Signal and Power	Reliability	Systemwide	\$36,360,865	\$34,015,481	FY19-FY23
Power Projects	Track, Signal and Power	Reliability	Systemwide	\$6,968,585	\$6,449,513	FY19-FY22
Green Line Central Tunnel Track and Signal Replacement	Track, Signal and Power	Reliability	Green Line	\$18,327,753	\$18,327,753	FY19-FY21
Green Line Central Tunnel Track and Signal Replacement	Track, Signal and Power	Reliability	Green Line	\$61,672,247	\$61,672,247	FY21-FY23
Signal Program - Green Line	Track, Signal and Power	Reliability	Green Line	\$6,024,632	\$3,500,000	FY19-FY20
Signal Program - Red/Orange Line	Red / Orange Line Improvements	Modernization	RL/OL	\$8,358,878	\$2,724,324	FY19-FY20
Signal Program - Red/Orange Line	Red / Orange Line Improvements	Modernization	RL/OL	\$214,529,690	\$205,207,494	FY19-FY23
Signal Program - Red/Orange Line	Red / Orange Line Improvements	Modernization	RL/OL	\$28,394,154	\$25,727,650	FY19-FY23
Signal Program - Red/Orange Line	Red / Orange Line Improvements	Modernization	RL/OL	\$16,359,397	\$16,359,397	FY20-FY21
Red Line Cable Replacement	Track, Signal and Power	Reliability	Red Line	\$27,718,656	\$7,800,000	FY19-FY23
Energy Efficiency	Track, Signal and Power	Reliability	Commuter Rail	\$24,896,702	\$10,696,750	FY19-FY21

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Environmental Remediation	System Upgrades/Other	Reliability	Systemwide	\$26,270,799	\$280,925	FY19-FY22
Various Remediation Projects	System Upgrades/Other	Reliability	Systemwide	\$2,175,900	\$1,651,383	FY19-FY22
Database Governance and Re-Architecture	System Upgrades/Other	Reliability	Systemwide	\$245,745	\$245,745	FY19
Bus Operations Support Equipment	System Upgrades/Other	Reliability	Bus	\$1,515,943	\$138,234	FY19-FY22
Hastus Upgrades–Daily, Bid, MinBus	System Upgrades/Other	Reliability	Systemwide	\$9,100,000	\$4,305,495	FY19-FY20
PCC SGR	Revenue Vehicles	Reliability	Systemwide	\$8,738,889	\$7,738,889	FY19-FY20
Bond Costs / SOMWBA	System Upgrades/Other	Reliability	Systemwide	\$33,035,052	\$2,067,684	FY19-FY20
Power Projects	Track, Signal and Power	Reliability	Systemwide	\$1,434,690	\$91,370	FY19-FY22
Parking Revenue Equipment - Lynn/Wellington	Stations	Reliability	Multimodal	\$784,850	\$584,923	FY19
Canine Explosive Detect Program	Risk Management & Mitigation	Modernization	Systemwide	\$606,000	\$416,644	FY19-FY23
Green Line #8 Car Reliability Improvements	Revenue Vehicles	Reliability	Green Line	\$11,726,255	\$6,220,092	FY19-FY22
Green Line #8 Car Reliability Improvements	Revenue Vehicles	Reliability	Green Line	\$24,750,092	\$23,044,769	FY19-FY23
Green Line #8 Car Reliability Improvements	Revenue Vehicles	Reliability	Green Line	\$21,828,387	\$19,983,050	FY19-FY23
Orange Line Wiring	Revenue Vehicles	Reliability	Orange Line	\$1,585,373	\$39,625	FY19-FY22
Red Line (#1) and Orange Line (#12) Preventive Maintenance	Revenue Vehicles	Reliability	RL/OL	\$25,279,873	\$1,100,000	FY19
Orange Line Journal Bearing Replacement	Revenue Vehicles	Reliability	Orange Line	\$3,266,701	\$300,000	FY19

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Ferry Engine Overhaul & Upgrades	Revenue Vehicles	Reliability	Ferry	\$2,097,195	\$253,525	FY19-FY22
Ferry Engine Overhaul & Upgrades	Revenue Vehicles	Reliability	Ferry	\$1,333,747	\$391,718	FY19-FY22
Red/ Orange Line Vehicles	Red / Orange Line Improvements	Modernization	RL/OL	\$728,968,456	\$445,940,902	FY19-FY23
Coach Procurement for Hyundai Rotem	Revenue Vehicles	Reliability	Commuter Rail	\$5,484,374	\$409,532	FY19-FY22
Coach Procurement for Hyundai Rotem	Revenue Vehicles	Reliability	Commuter Rail	\$31,300,000	\$202,554	FY20
Coach Procurement for Hyundai Rotem	Revenue Vehicles	Reliability	Commuter Rail	\$144,948,570	\$20,692,417	FY20, FY23
Green Line #7 Car Midlife Overhaul	Revenue Vehicles	Reliability	Green Line	\$98,469,777	\$10,358,870	FY19-FY20
Green Line #7 Car Midlife Overhaul	Revenue Vehicles	Reliability	Green Line	\$28,673,275	\$18,278,284	FY19-FY20
Green Line Train Protection	Risk Management & Mitigation	Modernization	Green Line	\$976,604	\$105,731	FY19
Green Line Train Protection	Risk Management & Mitigation	Modernization	Green Line	\$24,919,500	\$23,047,508	FY19-FY20
Green Line Train Protection	Risk Management & Mitigation	Modernization	Green Line	\$144,418,065	\$94,108,527	FY19-FY23
Kawasaki Coaches - Overhaul Option	Revenue Vehicles	Reliability	Commuter Rail	\$37,636,629	\$37,515,496	FY19-FY21
Kawasaki Coaches Overhaul	Revenue Vehicles	Reliability	Commuter Rail	\$129,653,500	\$26,908,012	FY19
LoNo Bus Procurement Project	Revenue Vehicles	Reliability	Bus	\$4,869,633	\$4,667,506	FY19-FY21
LoNo Bus Procurement Project	Revenue Vehicles	Reliability	Bus	\$5,292,268	\$5,291,966	FY19-FY21
New Flyer 325 Bus Procurement	Revenue Vehicles	Reliability	Bus	\$131,439,121	\$11,000,000	FY19

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
New Flyer 325 Bus Procurement	Revenue Vehicles	Reliability	Bus	\$ 100,852,155	\$685,190	FY19
New Flyer 60' Bus Procurement	Revenue Vehicles	Reliability	Bus	\$ 15,484,911	\$3,517,881	FY19
New Flyer 60' Bus Procurement	Revenue Vehicles	Reliability	Bus	\$35,287,598	\$2,377,927	FY19
New Flyer 60' Bus Procurement	Revenue Vehicles	Reliability	Bus	\$8,954,709	\$3,240,983	FY19, FY23
Overhaul of Neoplan 60' DMA Buses	Revenue Vehicles	Reliability	Bus	\$27,445,320	\$5,746,093	FY19
PCC Mattapan High Speed Line (Due Diligence and Initial Study)	Revenue Vehicles	Reliability	Red Line	\$ 1,173,252	\$396,207	FY19
Procure Commuter Rail Locomotives (Base)	Revenue Vehicles	Reliability	Commuter Rail	\$2,921,004	\$43,554	FY20
Procure Commuter Rail Locomotives (Base)	Revenue Vehicles	Reliability	Commuter Rail	\$49,797,561	\$17,211,366	FY19-FY20
Procure Commuter Rail Locomotives (Base)	Revenue Vehicles	Reliability	Commuter Rail	\$13,410,342	\$515,622	FY20
Procure Commuter Rail Locomotives (Base)	Revenue Vehicles	Reliability	Commuter Rail	\$69,862,338	\$3,417,553	FY20
Procure Commuter Rail Locomotives (Base)	Revenue Vehicles	Reliability	Commuter Rail	\$93,750,001	\$4,017,361	FY20
Procure Commuter Rail Locomotives (Base)	Revenue Vehicles	Reliability	Commuter Rail	\$8,412,109	\$1,615,464	FY19-FY20
Quincy High Speed Catamaran	Revenue Vehicles	Reliability	Ferry	\$11,460,193	\$2,311,054	FY19
Quincy High Speed Catamaran	Revenue Vehicles	Reliability	Ferry	\$2,117,805	\$1,162,131	FY19
AFC 1.0	System Upgrades/Other	Reliability	Systemwide	\$1,281,184	\$31,212	FY19

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
<b>Braintree and Codman Yard Security Upgrades</b>	Facilities	Reliability	Red Line	\$1,175,000	\$141,228	FY19
<b>Locomotive and Coach Inspections and Maintenance - Mass Coastal</b>	Revenue Vehicles	Reliability	Commuter Rail	\$405,151	\$97,171	FY19
<b>Worcester Union Station Conceptual Design Study</b>	Stations	Reliability	Commuter Rail	\$3,014,693	\$2,994,932	FY19-FY20
<b>Sullivan Square Station Rehabilitation</b>	Stations	Reliability	Orange Line	\$1,050,000	\$624,189	FY19
<b>Sullivan Square Station Rehabilitation</b>	Stations	Reliability	Orange Line	\$5,200,000	\$5,200,000	FY19-FY20
<b>Court House Station Leaks</b>	Stations	Reliability	Silver Line	\$1,000,000	\$146,837	FY19
<b>Court House Station Leaks</b>	Stations	Reliability	Silver Line	\$3,824,000	\$3,824,000	FY19-FY20
<b>Hingham Commuter Float Replacement</b>	Stations	Reliability	Ferry	\$1,006,235	\$52,573	FY19
<b>System-Wide Radio (SWR) UPS &amp; Microwave Units</b>	System Upgrades/Other	Reliability	Systemwide	\$314,587	\$186,464	FY19
<b>Green Line Hazardous Tree Removal</b>	Track, Signal and Power	Reliability	Green Line	\$2,363,313	\$250,000	FY19
<b>Maintenance Management System</b>	System Upgrades/Other	Reliability	Systemwide	\$1,000,000	\$500,000	FY19
<b>Energy Management System</b>	System Upgrades/Other	Reliability	Systemwide	\$3,500,000	\$3,170,369	FY19-FY22
<b>Environmental Compliance Management</b>	System Upgrades/Other	Reliability	Systemwide	\$1,214,081	\$118,733	FY19-FY22
<b>Computer Tech. Upgrades</b>	System Upgrades/Other	Reliability	Systemwide	\$740,000	\$474,287	FY19-FY22
<b>Various Subway Vehicle Projects</b>	Revenue Vehicles	Reliability	Systemwide	\$839,194	\$58,243	FY19-FY22
<b>FY16 Homeland Security Funds</b>	Risk Management & Mitigation	Modernization	Systemwide	\$974,039	\$374,039	FY19

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
<b>FY16 Homeland Security Funds</b>	Risk Management & Mitigation	Modernization	Systemwide	\$230,882	\$34,123	FY19
<b>FY16 Homeland Security Funds</b>	Risk Management & Mitigation	Modernization	Systemwide	\$190,000	\$24,716	FY19
<b>FY16 Homeland Security Funds</b>	Risk Management & Mitigation	Modernization	Systemwide	\$788,022	\$423,328	FY19–FY20
<b>FY16 Homeland Security Funds</b>	Risk Management & Mitigation	Modernization	Systemwide	\$712,500	\$119,073	FY19
<b>Green Line #7 Selective Systems Overhaul Option</b>	Revenue Vehicles	Reliability	Green Line	\$34,921,593	\$31,025,318	FY19-FY20
<b>Red Line Vehicle Procurement (Replace No.3 Cars)</b>	Red / Orange Line Improvements	Modernization	Red Line	\$225,253,365	\$169,148,612	FY22-FY23
<b>PMIS Implementation</b>	Process Improvements & Innovation	Modernization	Systemwide	\$3,000,000	\$1,084,961	FY19
<b>PMIS Implementation</b>	Process Improvements & Innovation	Modernization	Systemwide	\$6,992,116	\$6,992,116	FY19-FY20
<b>Bus Stop Shelters &amp; Benches</b>	Stations	Reliability	Bus	\$498,748	\$312,000	FY19
<b>Parking Lot Paving - On-Call</b>	Stations	Reliability	Systemwide	\$11,121,895	\$4,602,259	FY19
<b>E&amp;M CAD Plans Digitization</b>	System Upgrades/Other	Reliability	Systemwide	\$1,500,000	\$971,096	FY19
<b>Asset Condition &amp; Performance Assessments</b>	System Upgrades/Other	Reliability	Systemwide	\$4,000,000	\$2,500,000	FY19
<b>Asset Management Systems - Phase 2</b>	System Upgrades/Other	Reliability	Systemwide	\$3,927,778	\$3,325,846	FY19
<b>Transit Asset Management - Pilot</b>	System Upgrades/Other	Reliability	Systemwide	\$233,514	\$23,610	FY19
<b>Bus Training Trailer</b>	Facilities	Reliability	Bus	\$586,000	\$230,222	FY19
<b>Accessibility Improvements</b>	Accessibility	Modernization	Commuter Rail	\$7,000,000	\$4,968,701	FY19-FY21



Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Rail and Bus Lift Upgrade Program	Facilities	Reliability	Bus	\$ 10,000,000	\$ 7,633,710	FY19-FY21
Bridge Bundling Contract	Bridge & Tunnel	Reliability	Systemwide	\$ 130,400,000	\$ 130,400,000	FY19-FY23
Bridge Bundling Contract	Bridge & Tunnel	Reliability	Systemwide	\$ 1,750,000	\$ 1,350,000	FY19-FY23
Purchase and Install 10 Ton Crane at CRMF	Facilities	Reliability	Commuter Rail	\$ 195,530	\$ 44,698	FY19
South Boston Power Complex Generator Replacement	Track, Signal and Power	Reliability	Systemwide	\$ 6,500,000	\$ 6,500,000	FY19-FY20
New Flyer Light Overhaul	Revenue Vehicles	Reliability	Bus	\$ 16,079,462	\$ 2,446,522	FY19
Commonwealth Ave Stations Access	Stations	Reliability	Green Line	\$ 13,000,000	\$ 13,000,000	FY21-FY22
Commonwealth Ave Stations Access	Stations	Reliability	Green Line	\$ 3,300,000	\$ 3,300,000	FY20-FY21
Feasibility Study of Remaining Inaccessible Stations - GL	Accessibility	Modernization	Green Line	\$ 9,030,219	\$ 8,600,000	FY19-FY21
North Station Draw 1 Bridge Replacement	Bridge & Tunnel	Reliability	Commuter Rail	\$ 156,038,739	\$ 149,036,369	FY19-FY23
Infrastructure Asset Management Program Phase 1	System Upgrades/Other	Reliability	Systemwide	\$ 21,411,496	\$ 21,411,496	FY19-FY23
Systemwide Stair Repairs	Stations	Reliability	Systemwide	\$ 3,000,000	\$ 3,000,000	FY19-FY21
Stations Needs Assessments	Stations	Reliability	Systemwide	\$ 3,000,000	\$ 2,800,000	FY19-FY20
East Street Bridge Replacement	Bridge & Tunnel	Reliability	Commuter Rail	\$ 17,610,218	\$ 15,661,355	FY19-FY21
Saugus Draw Bridge Repair	Bridge & Tunnel	Reliability	Commuter Rail	\$ 7,591,685	\$ 4,400,000	FY19-FY21
Park Street Station Wayfinding Improvements Construction	Customer Experience and Technology Improvements	Modernization	Multimodal	\$ 5,225,107	\$ 5,225,107	FY19-FY20



Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Park Street Station Wayfinding Improvements Construction	Customer Experience and Technology Improvements	Modernization	Multimodal	\$6,041,437	\$6,041,437	FY19-FY21
Lynn Station & Parking Garage Improvements Phase II	Stations	Reliability	Commuter Rail	\$33,096,415	\$33,076,415	FY19-FY22
Downtown Crossing Vertical Transportation Improvements Phase 2	Accessibility	Modernization	Multimodal	\$7,407,988	\$7,182,988	FY19-FY20
Tunnel Inspection Systemwide	Bridge & Tunnel	Reliability	Systemwide	\$11,100,000	\$11,100,000	FY19-FY22
Green Line Extension	Green Line Extension	Expansion	GLX	\$996,121,000	\$827,744,599	FY19-FY23
Green Line Extension	Green Line Extension	Expansion	GLX	\$1,060,391,800	\$214,614,970	FY19-FY23
Green Line Extension	Green Line Extension	Expansion	GLX	\$75,000,000	\$75,000,000	FY20-FY22
Green Line Extension	Green Line Extension	Expansion	GLX	\$157,087,201	\$109,889,376	FY19-FY22
Alewife Crossing Improvements	Red / Orange Line Improvements	Modernization	Red Line	\$12,591,911	\$12,591,911	FY19-FY22
Facility Roof Replacement On-Call	Facilities	Reliability	Systemwide	\$500,000	\$250,000	FY19
Facility Roof Replacement On-Call	Facilities	Reliability	Systemwide	\$51,950,000	\$51,950,000	FY19-FY22
Workforce Modernization Program - HASTUS	System Upgrades/Other	Reliability	Systemwide	\$17,050,000	\$13,660,360	FY19-FY22
E&M Capital Maintenance Improvements	Track, Signal and Power	Reliability	Systemwide	\$4,314,800	\$4,314,800	FY19
Wollaston Station / Quincy Center Garage Demolition	Stations	Reliability	Red Line	\$67,208,021	\$56,278,708	FY19-FY21
Wollaston Station / Quincy Center Garage Demolition	Stations	Reliability	Red Line	\$25,707,423	\$21,242,714	FY19-FY21
Red Line Rehab	Bridge & Tunnel	Reliability	Red Line	\$9,899,969	\$4,556,831	FY19-FY21
Red Line Rehab	Bridge & Tunnel	Reliability	Red Line	\$2,690,279	\$1,685,625	FY20-FY21

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
<b>Commuter Rail Track Ties and Switches (On-Call)</b>	Track, Signal and Power	Reliability	Commuter Rail	\$27,289,000	\$26,267,000	FY19-FY21
<b>North Station Terminal Signal</b>	Track, Signal and Power	Reliability	Commuter Rail	\$31,000,000	\$30,386,273	FY19-FY22
<b>Attleboro Agreement - NEC Capital Commitments</b>	Track, Signal and Power	Reliability	Commuter Rail	\$24,000,000	\$24,000,000	FY19-FY22
<b>PRIIA-NEC Baseline Capital Charges, FFY19-23 (Amtrak Share)</b>	Track, Signal and Power	Reliability	Commuter Rail	\$48,882,668	\$45,225,753	FY19-FY23
<b>PRIIA-NEC Baseline Capital Charges, FFY19-23 (MBTA Share)</b>	Track, Signal and Power	Reliability	Commuter Rail	\$70,890,021	\$70,890,021	FY19-FY23
<b>Orange Line Tunnel Repairs</b>	Bridge & Tunnel	Reliability	Orange Line	\$32,500,000	\$32,500,000	FY19-FY23
<b>Commuter Rail Mini-High Platform Repairs</b>	Accessibility	Modernization	Commuter Rail	\$2,500,000	\$2,067,000	FY19-FY20
<b>System-Wide Radio</b>	System Upgrades/Other	Reliability	Systemwide	\$69,300,000	\$67,300,000	FY19-FY23
<b>Non-Revenue Vehicles</b>	System Upgrades/Other	Reliability	Systemwide	\$7,822,904	\$214,000	FY19
<b>Blue Line Cars</b>	Revenue Vehicles	Reliability	Blue Line	\$48,309,800	\$107,516	FY19
<b>ConnDot (60) Bus Procurement</b>	Revenue Vehicles	Reliability	Bus	\$761,751	\$600,000	FY19
<b>ConnDot (60) Bus Procurement</b>	Revenue Vehicles	Reliability	Bus	\$1,381,589	\$413,492	FY19
<b>Green Line Type 10 Light Rail Fleet Replacement</b>	Revenue Vehicles	Reliability	Green Line	\$1,324,607,473	\$5,000,000	FY19
<b>Overhaul of 155 Option New Flyer Buses</b>	Revenue Vehicles	Reliability	Bus	\$43,677,262	\$37,420,106	FY19-FY20
<b>Overhaul of 192 ECD Buses (Outsourced-NeoPlan)</b>	Revenue Vehicles	Reliability	Bus	\$39,422,374	\$2,000,000	FY19
<b>Wheel Truing Machine Replacement Project</b>	Facilities	Reliability	Commuter Rail	\$4,010,800	\$1,972,608	FY19

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Red Line No. 3 Car - Targeted Reliability Improv.	Revenue Vehicles	Reliability	Red Line	\$44,033,424	\$44,033,424	FY19-FY23
AFC 2.0	AFC 2.0	Modernization	Systemwide	\$436,747,037	\$159,165,203	FY19-FY23
Commuter Rail Culverts, Bridges & ROW Impr. (On-Call)	Track, Signal and Power	Reliability	Commuter Rail	\$18,801,811	\$18,701,811	FY19-FY23
Tunnel Repairs (On-Call)	Bridge & Tunnel	Reliability	Systemwide	\$21,100,000	\$20,570,000	FY19-FY23
Systemwide Vegetation Control (On-Call)	Track, Signal and Power	Reliability	Systemwide	\$1,600,000	\$1,500,000	FY19-FY20
Green Line (Non-GLX) Grade Crossings (On-Call)	Track, Signal and Power	Reliability	Green Line	\$19,402,328	\$19,202,328	FY19-FY21
Iron Horse Operations Control Center	Facilities	Reliability	Commuter Rail	\$22,401,865	\$22,401,865	FY19-FY21
Iron Horse Operations Control Center	Facilities	Reliability	Commuter Rail	\$4,232,810	\$1,601,143	FY19
Iron Horse Operations Control Center	Facilities	Reliability	Commuter Rail	\$10,410,113	\$10,410,113	FY20-FY21
Silver Line Gateway - Phase 2	Expansion Projects	Expansion	Silver Line	\$28,046,000	\$28,046,000	FY19-FY21
FY18 MBTA Finance Modernization	System Upgrades/Other	Reliability	Systemwide	\$2,200,000	\$1,085,440	FY19
FY18 HRCMS Integration	System Upgrades/Other	Reliability	Systemwide	\$2,040,000	\$523,000	FY19
Cabot Yard Complete Upgrade	Red / Orange Line Improvements	Modernization	Red Line	\$124,476,900	\$124,476,900	FY19-FY23
Wellington Yard Complete Upgrade	Red / Orange Line Improvements	Modernization	Orange Line	\$99,690,000	\$99,531,743	FY19-FY23
Pawtucket Layover Shelter	Facilities	Reliability	Commuter Rail	\$6,595,663	\$6,120,663	FY19-FY20
Pawtucket Layover Shelter	Facilities	Reliability	Commuter Rail	\$7,127,736	\$4,814,795	FY19-FY20
Direct Fixation - Orange Line Southwest Corridor	Track, Signal and Power	Reliability	Orange Line	\$27,900,000	\$27,700,000	FY19-FY21
Parking Lot Paving - On-Call	Stations	Reliability	Systemwide	\$16,745,248	\$16,745,248	FY19-FY22

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Neponset River Lower Mills Bridge	Bridge & Tunnel	Reliability	Commuter Rail	\$4,061,587	\$2,895,863	FY19
Comm. Rail Legacy Fleet Investment	Revenue Vehicles	Reliability	Commuter Rail	\$4,621,227	\$385,000	FY19
Comm. Rail Wheel Defect Detection Services	Revenue Vehicles	Reliability	Commuter Rail	\$2,301,300	\$462,395	FY19-FY23
Employee Quality of Life Initiative	System Upgrades/Other	Reliability	Systemwide	\$2,288,087	\$2,138,000	FY19-FY22
New Flyer Hybrid Midlife Overhaul Tech Spec Dev.	Revenue Vehicles	Reliability	Bus	\$278,835	\$278,835	FY19
Customer Technology Improvements	Customer Experience and Technology Improvements	Modernization	Systemwide	\$2,363,108	\$273,925	FY19
Occupational Health Services System Impr.	System Upgrades/Other	Reliability	Systemwide	\$750,000	\$198,012	FY19
Occupational Health Services System Impr.	System Upgrades/Other	Reliability	Systemwide	\$997,646	\$997,646	FY19-FY20
T Digital Service	Customer Experience and Technology Improvements	Modernization	Systemwide	\$7,563,043	\$6,375,000	FY19-FY21
Systemwide Platform Edge Inspections	Stations	Reliability	Systemwide	\$1,050,000	\$850,000	FY19-FY20
Work Car Procurement	Track, Signal and Power	Reliability	Systemwide	\$34,000,000	\$29,871,117	FY19-FY23
Green Line Type 8 Coupler Overhaul and Procurement of Couplers	Revenue Vehicles	Reliability	Green Line	\$5,583,932	\$5,583,932	FY20-FY23
Green Line Type 7 Battery Replacement	Revenue Vehicles	Reliability	Green Line	\$794,000	\$550,350	FY19
Green Line Type 8 Vehicle Air Compressor Overhaul	Revenue Vehicles	Reliability	Green Line	\$2,117,077	\$2,117,077	FY20-FY23
Longfellow Approach	Bridge & Tunnel	Reliability	Red Line	\$5,300,000	\$5,300,000	FY19-FY20

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Dorchester Avenue Bridge	Bridge & Tunnel	Reliability	Systemwide	\$4,075,000	\$4,025,000	FY19-FY21
FY18 Keolis Capitalization Initiatives and Extra Work	System Upgrades/Other	Reliability	Commuter Rail	\$17,794,000	\$8,492,356	FY19
E&M MOW Systemwide Initiatives	Track, Signal and Power	Reliability	Systemwide	\$3,919,491	\$2,000,000	FY19
MIT Research Agreement	Process Improvements & Innovation	Modernization	Systemwide	\$1,805,000	\$1,341,161	FY19-FY21
Blue Line Mechanical Trip Stops - Baseline Analysis	Track, Signal and Power	Reliability	Blue Line	\$2,000,000	\$1,600,000	FY19-FY20
Locomotive Restoration Phase 2	Revenue Vehicles	Reliability	Commuter Rail	\$5,280,000	\$1,560,000	FY19
Transit Signal Priority Implementation	Customer Experience and Technology Improvements	Modernization	Green Line	\$1,166,862	\$1,166,862	FY19
Sprinkler & Fire Life Safety Systems - Tr. Facilities	Facilities	Reliability	Systemwide	\$7,700,000	\$7,500,000	FY19-FY21
Blue Line ASI Antenna Upgrade	Revenue Vehicles	Reliability	Blue Line	\$342,013	\$342,013	FY19
Vacuum Car Procurement	System Upgrades/Other	Reliability	Systemwide	\$29,564,333	\$27,279,613	FY19-FY23
Commuter Rail Vision	Process Improvements & Innovation	Modernization	Commuter Rail	\$3,008,100	\$2,443,100	FY19-FY20
Bus Service Replacement Plan	Customer Experience and Technology Improvements	Modernization	Bus	\$4,950,000	\$4,950,000	FY19
Occupational Health & Safety Program	Risk Management & Mitigation	Modernization	Systemwide	\$752,025	\$642,025	FY19
FY17 Homeland Security Funds - Management and Administration	Risk Management & Mitigation	Modernization	Systemwide	\$465,000	\$310,000	FY19-FY20

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
<b>FY17 Homeland Security Funds - Public Awareness</b>	Risk Management & Mitigation	Modernization	Systemwide	\$ 142,500	\$37,500	FY19
<b>FY17 Homeland Security Funds - Training and Exercise</b>	Risk Management & Mitigation	Modernization	Systemwide	\$ 142,500	\$ 102,500	FY19-FY20
<b>FY17 Homeland Security Funds - Tunnel Portal Monitoring Upgrades</b>	Risk Management & Mitigation	Modernization	Systemwide	\$ 1,900,000	\$800,000	FY19
<b>FY17 Homeland Security Funds - Light Rail Video</b>	Risk Management & Mitigation	Modernization	Systemwide	\$ 1,425,000	\$825,000	FY19-FY20
<b>FY17 Homeland Security Funds - Chemical Sensor Replacement</b>	Risk Management & Mitigation	Modernization	Systemwide	\$ 1,187,500	\$927,500	FY19
<b>FY17 Homeland Security Funds - Shovel Ready Station Security</b>	Risk Management & Mitigation	Modernization	Systemwide	\$3,230,000	\$ 1,530,000	FY19-FY20
<b>Blue Line Flange Lubrication</b>	Revenue Vehicles	Reliability	Blue Line	\$599,260	\$589,260	FY19-FY20
<b>Blue Line Flood Protection</b>	Stations	Reliability	Blue Line	\$355,960	\$310,960	FY19-FY20
<b>Blue Line Parking Brake</b>	Revenue Vehicles	Reliability	Blue Line	\$ 1,190,000	\$ 1,170,000	FY19-FY20
<b>Commuter Rail Positive Train Control</b>	Commuter Rail Safety and Resiliency	Modernization	Commuter Rail	\$7,815,963	\$7,815,963	FY19-FY22
<b>Digital Fares – Pass Program Revitalization</b>	Customer Experience and Technology Improvements	Modernization	Systemwide	\$575,000	\$250,000	FY19
<b>Document Management and Retrieval D2</b>	System Upgrades/Other	Reliability	Systemwide	\$2,065,294	\$ 1,388,297	FY19-FY20
<b>Green Line - Central Tunnel Interlocking Signal Design</b>	Track, Signal and Power	Reliability	Green Line	\$8,211,251	\$7,864,584	FY19-FY21
<b>Green Line Lean Study</b>	Process Improvements & Innovation	Modernization	Green Line	\$381,630	\$381,630	FY19



Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Green Line D Branch Track and Signal Replacement	Track, Signal and Power	Reliability	Green Line	\$59,300,000	\$59,300,000	FY19-FY21
Green Line D Branch Track and Signal Replacement	Track, Signal and Power	Reliability	Green Line	\$12,685,527	\$12,685,527	FY21
Green Line D Branch Track and Signal Replacement	Track, Signal and Power	Reliability	Green Line	\$19,614,473	\$19,614,473	FY21
Locomotive Main Engine Procurement (RIDOT)	Revenue Vehicles	Reliability	Commuter Rail	\$4,000,000	\$3,500,000	FY19-FY20
MBTA Police - Larimore Computer-Aided Dispatch System Upgrade	System Upgrades/Other	Reliability	Systemwide	\$424,728	\$214,186	FY19
MBTA360 Data Warehouse	System Upgrades/Other	Reliability	Systemwide	\$3,384,120	\$2,159,120	FY19-FY20
Park Street Red Line Signal Room	Track, Signal and Power	Reliability	Red Line	\$4,000,000	\$3,200,000	FY19
Silver Line Gateway - Phase 2	Expansion Projects	Expansion	Silver Line	\$1,900,000	\$1,900,000	FY19
45 High Street Master Plan and Systems Resiliency	Facilities	Reliability	Systemwide	\$6,750,000	\$6,750,000	FY20-FY22
Air Brake Shop Upgrade	Facilities	Reliability	Commuter Rail	\$600,000	\$600,000	FY19
Alewife Garage Rehabilitation	Stations	Reliability	Red Line	\$14,300,000	\$14,300,000	FY19-FY22
ATC Implementation on the MBTA North Side Commuter Rail Lines	Commuter Rail Safety and Resiliency	Modernization	Commuter Rail	\$230,942,823	\$209,420,718	FY19-FY23
ATC Implementation on the MBTA North Side Commuter Rail Lines	Commuter Rail Safety and Resiliency	Modernization	Commuter Rail	\$23,191,957	\$23,191,957	FY23
ATC Implementation on the MBTA North Side Commuter Rail Lines	Commuter Rail Safety and Resiliency	Modernization	Commuter Rail	\$24,865,220	\$24,865,220	FY23
Back-up Operations Control Center Design	System Upgrades/Other	Reliability	Systemwide	\$1,200,000	\$1,200,000	FY19-FY20

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
<b>BET Fire Sprinkler System Upgrade</b>	Facilities	Reliability	Commuter Rail	\$3,000,000	\$3,000,000	FY19-FY20
<b>Billerica MOW Repair Facility</b>	Facilities	Reliability	Commuter Rail	\$25,000,000	\$25,000,000	FY19-FY21
<b>Blue Line Immobile Infrastructure Due Diligence Analysis</b>	Customer Experience and Technology Improvements	Modernization	Blue Line	\$1,404,131	\$1,404,131	FY19-FY20
<b>Bridge Repairs Systemwide (Contracts 4 and 5)</b>	Bridge & Tunnel	Reliability	Systemwide	\$12,250,000	\$12,250,000	FY19-FY20
<b>Bury 100 Miles of Fiber Annually - Strategic Locations</b>	Commuter Rail Safety and Resiliency	Modernization	Commuter Rail	\$25,000,000	\$15,000,000	FY19-FY23
<b>Bus Service Plan Optimization</b>	Customer Experience and Technology Improvements	Modernization	Bus	\$36,042,070	\$26,042,070	FY19-FY22
<b>Charlestown Campus Study and Early Action Items</b>	Facilities	Reliability	Systemwide	\$3,000,000	\$3,000,000	FY20-FY23
<b>Commuter Rail Slippery Rail Mitigation Project</b>	System Upgrades/Other	Reliability	Commuter Rail	\$1,330,000	\$1,330,000	FY19-FY20
<b>Delivery of 460 40ft Buses - FY 2021 to FY 2025</b>	Revenue Vehicles	Reliability	Bus	\$514,705,239	\$148,918,918	FY19-FY23
<b>DMA Replacement</b>	Revenue Vehicles	Reliability	Silver Line	\$103,362,500	\$103,362,500	FY19-FY23
<b>Floating Barge / Gangway Systems Overhauls Reconditioning</b>	Facilities	Reliability	Ferry	\$750,000	\$750,000	FY19, FY21
<b>Fluid Dispensing System Upgrades</b>	Facilities	Reliability	Commuter Rail	\$4,000,000	\$4,000,000	FY19-FY21
<b>Feasibility Study of Remaining Inaccessible Stations - GL</b>	Accessibility	Modernization	Green Line	\$11,400,000	\$11,400,000	FY21
<b>Green Line and Blue Line Wheel Scanners</b>	Process Improvements & Innovation	Modernization	Multimodal	\$2,100,000	\$2,100,000	FY19-FY20



Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
<b>Green Line Track Upgrade</b>	Track, Signal and Power	Reliability	Green Line	\$ 130,385,527	\$ 130,385,527	FY21-FY23
<b>Hynes Station</b>	Stations	Reliability	Green Line	\$ 15,233,591	\$ 5,000,000	FY19-FY20
<b>Hynes Station</b>	Stations	Reliability	Green Line	\$ 30,500,000	\$ 30,500,000	FY21-FY23
<b>Inspection and Rating of MBTA Systemwide Bridges</b>	Bridge & Tunnel	Reliability	Systemwide	\$ 12,870,000	\$ 12,870,000	FY19-FY22
<b>Integrated Track Inspection Pilot Program</b>	Track, Signal and Power	Reliability	Multimodal	\$ 825,000	\$ 825,000	FY19-FY20
<b>Kawasaki Passenger Coach Primary Spring Replacement</b>	Revenue Vehicles	Reliability	Commuter Rail	\$ 1,716,428	\$ 1,716,428	FY19-FY22
<b>Lean Strategy Implementation</b>	Process Improvements & Innovation	Modernization	Systemwide	\$ 600,000	\$ 600,000	FY19-FY20
<b>Aquarium and Maverick Emergency Life Safety Egress and Infrastructure Study</b>	Track, Signal and Power	Reliability	Blue Line	\$ 13,975,000	\$ 13,975,000	FY19-FY21
<b>Aquarium and Maverick Emergency Life Safety Egress and Infrastructure Study</b>	Track, Signal and Power	Reliability	Blue Line	\$ 18,025,000	\$ 18,025,000	FY22-FY23
<b>Lynn Station Direct Fixation Repairs Track 1 &amp; Station Amenities</b>	Track, Signal and Power	Reliability	Commuter Rail	\$ 1,700,000	\$ 1,700,000	FY19-FY20
<b>MBTA Catamaran Overhauls</b>	Revenue Vehicles	Reliability	Ferry	\$ 9,728,352	\$ 9,728,352	FY19-FY23
<b>MBTA Enterprise Fuel Management System</b>	System Upgrades/Other	Reliability	Bus	\$ 7,500,000	\$ 7,500,000	FY19-FY21
<b>MBTA Security Modernization</b>	System Upgrades/Other	Reliability	Systemwide	\$ 15,795,635	\$ 14,795,635	FY19-FY20
<b>MBTA Vertical Transportation Capital 20 Year Plan</b>	Accessibility	Modernization	Systemwide	\$ 1,000,000	\$ 1,000,000	FY19-FY20
<b>MCRS2 v17 and Business Process Update</b>	System Upgrades/Other	Reliability	Systemwide	\$ 5,200,000	\$ 5,200,000	FY19-FY23

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Midlife Overhaul of 25 New Flyer Allison Hybrid 60ft Articulated Buses	Revenue Vehicles	Reliability	Silver Line	\$15,877,568	\$15,877,568	FY19-FY22
Minor to Moderate Ad Hoc Station Accessibility Improvements	Accessibility	Modernization	Systemwide	\$5,000,000	\$5,000,000	FY19-FY22
Modify Southside S&I Train Wash System	Facilities	Reliability	Commuter Rail	\$1,650,000	\$1,650,000	FY19-FY20
MOW Maintenance Equipment Storage Facility	Facilities	Reliability	Multimodal	\$4,425,000	\$4,425,000	FY20-FY22
MOW Systemwide CWR Replacement Project	Track, Signal and Power	Reliability	Multimodal	\$7,993,879	\$7,993,879	FY19-FY21
New Paratransit Software Solution	System Upgrades/Other	Reliability	Paratransit	\$3,585,000	\$3,585,000	FY19-FY23
NRE Genset Switcher Locomotive Overhaul	System Upgrades/Other	Reliability	Commuter Rail	\$1,432,170	\$1,432,170	FY19
OHS Program Development and Implementation	Risk Management & Mitigation	Modernization	Systemwide	\$22,288,838	\$19,288,838	FY19-FY23
OHS Steering Committee – PPE and Infrastructure Improvements	Risk Management & Mitigation	Modernization	Systemwide	\$19,253,125	\$16,253,125	FY19-FY23
Oil Analytics Initiative	System Upgrades/Other	Reliability	Commuter Rail	\$1,949,909	\$1,949,909	FY19-FY22
On-Call Track II	Track, Signal and Power	Reliability	Multimodal	\$27,919,000	\$27,919,000	FY19-FY21
Option Order Procurement of 194 New Flyer Hybrid 40 ft Buses	Revenue Vehicles	Reliability	Bus	\$172,582,031	\$172,582,031	FY19-FY22
Overhaul of 33 Kawasaki 900 Series Bi-Level Coaches	Revenue Vehicles	Reliability	Commuter Rail	\$66,892,069	\$58,043,912	FY20-FY23
Elevator Program Multiple Location Design	Accessibility	Modernization	Systemwide	\$19,400,000	\$19,400,000	FY20

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
Procurement of 181 Bi-Level Commuter Rail Coaches	Revenue Vehicles	Reliability	Commuter Rail	\$658,543,260	\$244,681,156	FY19-FY23
Procurement of 35 Battery Electric 40ft Buses and Related infrastructure	Revenue Vehicles	Reliability	Bus	\$28,341,736	\$28,341,736	FY19-FY22
Procurement of 35 Battery Electric 40ft Buses and Related infrastructure	Revenue Vehicles	Reliability	Bus	\$24,572,310	\$24,572,310	FY20
Red Line Interlock Upgrades	Track, Signal and Power	Reliability	Red Line	\$12,000,000	\$5,000,000	FY21-FY23
Remote Monitoring of Rolling Stock Subsystems	Revenue Vehicles	Reliability	Commuter Rail	\$6,149,560	\$6,149,560	FY19-FY21
Replacement of RIDE Revenue Vehicles	Revenue Vehicles	Reliability	Paratransit	\$23,476,000	\$23,476,000	FY19-FY22
Rochester Improvements	Facilities	Reliability	Commuter Rail	\$6,000,000	\$6,000,000	FY19-FY21
Rolling Stock Damage Emergency Repairs	Revenue Vehicles	Reliability	Commuter Rail	\$1,500,000	\$1,500,000	FY19-FY20
Switch Crib Heaters - pilot program	Track, Signal and Power	Reliability	Multimodal	\$550,000	\$550,000	FY19
Systemwide Facility Needs and Programming Study	Facilities	Reliability	Systemwide	\$1,000,000	\$1,000,000	FY19-FY20
Systemwide Non-Revenue Vehicles Program	System Upgrades/Other	Reliability	Multimodal	\$16,000,000	\$14,750,000	FY19-FY23
System-wide Storage Tank Compliance Program	Facilities	Reliability	Systemwide	\$3,000,000	\$3,000,000	FY19-FY22
Systemwide Tree Removal	Commuter Rail Safety and Resiliency	Modernization	Commuter Rail	\$10,000,000	\$5,000,000	FY21-FY23
Transit Police Fleet Replacement Program	System Upgrades/Other	Reliability	Systemwide	\$2,564,295	\$2,564,295	FY19-FY23
Underground Structure Design/Repair &	Bridge & Tunnel	Reliability	Systemwide	\$4,000,000	\$4,000,000	FY19-FY21

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
<b>Geotechnical Engineering Services</b>						
<b>Upgrade HVAC &amp; Exhaust Systems at Widett Circle</b>	Facilities	Reliability	Commuter Rail	\$ 2,500,000	\$2,500,000	FY19-FY20
<b>Von Hillern Street Wall Repair</b>	Facilities	Reliability	Systemwide	\$3,000,000	\$3,000,000	FY20-FY21
<b>Wastewater Discharge Infrastructure</b>	Facilities	Reliability	Systemwide	\$3,375,000	\$3,375,000	FY19-FY22
<b>Bus Maintenance Facility</b>	Facilities	Reliability	Bus	\$125,000,000	\$83,126,793	FY19-FY23
<b>Revenue Vehicle Capital Maintenance</b>	Revenue Vehicles	Reliability	Systemwide	\$10,300,000	\$10,300,000	FY19-FY20
<b>Track, Signal, Power Capital Maintenance</b>	Track, Signal and Power	Reliability	Systemwide	\$16,000,000	\$16,000,000	FY20-FY22
<b>Orange Line SW Corridor Slab Replacement - Engineering</b>	Track, Signal and Power	Reliability	Orange Line	\$7,500,000	\$7,500,000	FY20-FY22
<b>Systemwide Security Upgrades</b>	Risk Management & Mitigation	Modernization	Systemwide	\$15,965,000	\$15,965,000	FY19-FY21
<b>Systemwide Wayfinding Improvements</b>	Customer Experience and Technology Improvements	Modernization	Systemwide	\$63,000,000	\$28,000,000	FY19-FY22
<b>Allston Commuter Rail Layover Facility</b>	Track, Signal and Power	Reliability	Commuter Rail	\$8,460,000	\$8,460,000	FY20-FY21
<b>Codman Yard Expansion and Improvements</b>	Red / Orange Line Improvements	Modernization	RL/OL	\$63,554,385	\$63,554,385	FY19-FY23
<b>Climate Change Resiliency Vulnerability Assessment</b>	Risk Management & Mitigation	Modernization	Systemwide	\$2,500,000	\$2,500,000	FY19-FY23
<b>Wellington/Cabot Yard Upgrade - Project Admin.</b>	Red / Orange Line Improvements	Modernization	Red Line	\$10,859,066	\$10,840,285	FY19-FY23
<b>Blue Line RCM</b>	Revenue Vehicles	Reliability	Blue Line	\$9,698,036	\$9,698,036	FY19-FY22

Project Name	CIP Program	Priority	Mode	Total Project Budget	FY19-23 Total	Programmed Years (FY19-23)
<b>FMIS Upgrade and Business Process Re-design</b>	Process Improvements & Innovation	Modernization	Systemwide	\$9,750,000	\$9,750,000	FY19-FY21
<b>Pay-Go Projects</b>	Customer Experience and Technology Improvements	Modernization	Systemwide	\$20,736,635	\$20,736,635	FY19-FY22
<b>Green Line Transformation</b>	Track, Signal and Power	Reliability	Green Line	\$10,000,000	\$10,000,000	FY20-FY23
<b>E&amp;M MOW Green Line Track Rehabilitation 2018</b>	Track, Signal and Power	Reliability	Green Line	\$7,631,755	\$4,131,755	FY19
<b>Capital Maintenance Expenses - Power</b>	Track, Signal and Power	Reliability	Multimodal	\$3,950,000	\$2,450,000	FY19
<b>South Boston to Forest Hills Duct Bank Replacement</b>	Track, Signal and Power	Reliability	Orange Line	\$1,500,000	\$1,500,000	FY19-FY20
<b>Customer Technology Program</b>	Customer Experience and Technology Improvements	Modernization	Systemwide	\$10,000,000	\$10,000,000	FY19-FY21
<b>Design Standards and Guidelines</b>	System Upgrades/Other	Reliability	Systemwide	\$8,800,000	\$8,800,000	FY20-FY23

## APPENDIX G. MBTA TRANSIT ASSET MANAGEMENT IMPROVEMENT PROGRAM PROJECTS

Asset Management Areas	Improvement Groups	Improvement Actions	Timing
Transformation Enablers	Roadmap and Implementation Plan & Management	40.1 Establish & Empower Team 40.2 Implementation Strategy & Plan 40.3 Program Management 40.4 Governance & Controls 40.8 Monitoring & Progress Reviews	October / November 2018
Transformation Enablers	Change Management	40.5 Change Management Plan 40.6 Communication Plan 40.7 Training & Mentoring	October / November 2018
Strategy & Planning	Asset Management System and Documentation	1.1 Develop AMF 1.2 Develop and Rationalize AM documents 1.3 Business Process Change Review 1.4 AM Policy	Q4, 2018
Strategy & Planning	Goals and Objectives	2.1 Develop AM Objectives 2.2 Develop Asset Class Objectives 2.3 Develop Asset Class Criticality 2.4 Develop Network Criticality 2.5 Stakeholder Needs and Requirements	Q1 – Q3 2019
Strategy & Planning	Criticality and Decision Making	2.6 Develop decision-making criteria 2.7 Weighting of decision-making criteria 2.8 Stakeholder consultation	Q1 – Q3 2019
Strategy & Planning	Strategic Asset Management Plan	2.9 Develop SAMP 2.10 Align Existing Plans	Q1 – Q3 2019
Risk & Review	Risk and Change Management	31.1 Develop Risk Appetite 31.2 Develop Risk Framework & Process 31.3 Develop Risk Registers 31.4 Identify Risk Control Owners	Q1 – Q4 2019
Strategy & Planning	Strategic Planning	4.1 Develop Strategic Planning Process 4.2 Agree Planning Scenarios	Q2 2019 – Q3 2020
Asset Management Decision Making	Maintenance Strategies	7.1 Develop Maintenance Strategies 7.2 Develop Maintenance Analysis 7.3 Develop Risk Based Maintenance Regimes 7.4 Update Maintenance Specifications	Q2 2019 – Q1 2020
Asset Information	Asset Information Strategy	22.1 Develop Asset Information Strategy 22.2 Develop EAM Capability Model	Q2 – Q4 2019
Lifecycle Delivery	Maintenance Delivery	15.1 Maintenance Management Rules 15.2 Refine Maintenance Standards 15.3 Defect Categorization & Prioritization 15.4 Maintenance Performance Measures 15.5 Continuous Improvement Approach	Q3 2019 – Q2 2020

Asset Management Areas	Improvement Groups	Improvement Actions	Timing
Asset Information	Information Standards	23.1 Develop Asset Information Specification 23.2 Develop Asset Data Standards	Q3 2019 – Q1 2020
Lifecycle Delivery	Asset Operations	17.1 Develop Feedback Process	Q4 2019
Risk & Review	Management Review and Assurance	37.1 Develop Assurance Framework* 37.2 Undertake Audit & Assurance	Q4 2019
Risk & Review	Stakeholder Management	39.1 Develop Stakeholder Engagement Plan & Requirements	Q4 2019
Asset Management Decision Making	Lifecycle Value Realization & Asset Class Strategies	8.1 Develop Whole-life Cost Models 8.2 Develop ACS Template* 8.3 Develop Asset Class Strategies (ACS)	2019
Strategy & Planning	Asset Management Planning	5.1 Develop AMP	Q4 2019 – Q3 2020
Organization & People	Competence & Training	30.1 Define Competence Requirement 30.2 Update Position Descriptions 30.3 Training Needs Analysis Process 30.4 Undertake Training Needs Analysis 30.5 Identify Training 30.6 Develop Training Plans 30.7 Develop AM Introduction Training	2019 - 2021
Asset Information	Data & Information Management	25.1 Develop Data Governance Framework 25.2 Undertake Data Quality Audits 25.3 Capture Condition & Failure Data	2019 - 2022
Asset Information	Information Systems Strategy	24.1 Develop Asset Information Systems Strategy 24.2 Develop Information System Architecture 24.3 Define AMS and Information System Interface 24.4 Deploy Information System Strategy	2020 - 2021



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- <sup>i</sup> MBTA Transit Revenue Vehicle Inventory: "A-30 - Transit - Revenue Vehicle Inventory v3.xlsx" (2018).
- <sup>ii</sup> MBTA Paratransit Vehicle Inventory: "Copy of A-30 10003 DR PT Export\_11-Sep-2018 11-31-42 AM.xls" (2018).
- <sup>iii</sup> MBTA Commuter Rail Vehicle Inventory: "A-30 - Commuter Rail - Revenue Vehicle Inventory 09-21-2018.xlsx" (2018).
- <sup>iv</sup> MBTA Transit Non-Revenue Vehicle Inventory: "A35 - Transit Non Revenue Vehicles - Final as of 8-24-18.xlsx" (2018).
- <sup>v</sup> MBTA Commuter Rail Non-Revenue Vehicle Inventory: "A-35 Comm Rail - Service Vehicle Inventory v5 08102018.xlsx" (2018).
- <sup>vi</sup> MBTA Transit Track Inventory: "A-20 – Transit Way Mileage – 08292018.xlsx" (2018).
- <sup>vii</sup> MBTA Commuter Rail Track Inventory: "A-20 - Transit Way Mileage v8-Commuter Rail Track Systems REV 09072018.xlsx" (2018).
- <sup>viii</sup> MBTA Transit Signal Assets Inventory: "Signals - Green Line.xlsx," "Signals - Orange Line.xlsx," "Signals - Red Line.xlsx," "Signals - Blue Line.xlsx," "A20 - Signals FTA Spreadsheet.xlsx" (2018).
- <sup>ix</sup> MBTA Commuter Rail Signals Assets Inventory: "A-20 Comm Rail - Signal Spreadsheet - Final -7-26-18 - With Additional Information.xlsx" (2018).
- <sup>x</sup> MBTA Transit Substation Inventory: "A20 – Power – Transit Substation.xlsx," "FTA\_USS\_Spreadsheet\_Power.xlsx" (2018).
- <sup>xi</sup> MBTA Commuter Rail Substation Inventory: "A-20 Comm Rail - Power Spreadsheet - Final -7-26-18 - With Additional Information" (2018).
- <sup>xii</sup> MBTA Transit Civil Structures (Bridges, Tunnels, Culverts, Retaining Walls): "180918 A-20 - Transit Way Mileage v4-Bridges, Culverts and Tunnels.xlsx" (2018).
- <sup>xiii</sup> MBTA Commuter Rail Civil Structures (Bridges, Tunnels, Culverts, Retaining Walls, Dams): "180918 A-20 - Transit Way Mileage v4-Bridges, Culverts and Tunnels.xlsx" (2018).
- <sup>xiv</sup> MBTA Transit Support Facilities Inventory: "A15 - Transit Support Facilities.xlsx" (2018).
- <sup>xv</sup> MBTA Transit Passenger Facilities Inventory: "Location Code Master - V5.4.xlsx" (2018).
- <sup>xvi</sup> MBTA Parking Facilities Inventory: "A-15 - Facilities Inventory v5\_draft - 18-8-31.xlsx" (2018).
- <sup>xvii</sup> MBTA Commuter Rail Support Facilities and Passenger Stations Inventory: "A-15 Comm Rail - Fac - Background Information.xlsx" (2018).
- <sup>xviii</sup> MBTA Commuter Rail Support Facilities and Passenger Stations Inventory: "A-15 Comm Rail - Fac - Background Information.xlsx" (2018).
- <sup>xix</sup> MBTA Parking Facilities Inventory: "A-15 - Facilities Inventory v5\_draft - 18-8-31.xlsx" (2018).
- <sup>xx</sup> MBTA Transit Track Inventory: "A-20 – Transit Way Mileage – 08292018.xlsx" (2018).
- <sup>xxi</sup> MBTA Commuter Rail: "Age of Track.docx" (2018).
- <sup>xxii</sup> MBTA Transit Track Inventory: "A-20 – Transit Way Mileage – 08292018.xlsx"
- <sup>xxiii</sup> MBTA Transit Track Inventory: "A-20 – Transit Way Mileage – 08292018.xlsx"
- <sup>xxiv</sup> MBTA Bus Fleet Maintenance Plan, PDF
- <sup>xxv</sup> MBTA Revised Rail Fleet Management Plan, 9, PDF
- <sup>xxvi</sup> MBTA Infrastructure Management Manual excerpt: "Maintenance Strategies.docx" (2018).
- <sup>xxvii</sup> MBTA Infrastructure Management Manual excerpt: "Maintenance Strategies.docx," "SM1, Signals Maintenance Manual 1"