



Massachusetts Bay
Transportation Authority

Capital Needs Assessment and Inventory

MBTA Board of Directors
2023

Orange Line heavy rail cars stored at Wellington Yard.

Overview

- The **Capital Needs Assessment and Inventory (CNAI)** is a routine analysis, undertaken by the MBTA, that helps us better understand the overall condition of the transit system.
- A key output of the CNAI is the **State of Good Repair (SGR) Index**, which documents the magnitude of the agency's capital asset needs and helps the agency determine how best to invest in improvements that will ensure our physical assets are able to operate reliably and efficiently.
- This updated SGR Index reflects a more mature inventory of the T's assets that will be used to inform investment priorities. It represents a single moment in time and is an important step toward fixing the system and building a modernized transportation network of the future.
- The goals of the 2023 CNAI effort are to:
 - Establish agency-wide standards for measuring asset condition, criticality, and risk
 - Apply these standards to the asset inventory, to understand the state of the system and our SGR needs
 - Use the findings of the SGR Index to set the stage for a pipeline of SGR capital projects



Understanding State of Good Repair (SGR)

- Each asset has a useful life, which is an estimate of the number of years it will remain in service. An asset operating within this window of time, and at an expected level of performance is in a **State of Good Repair (SGR)**.
- Assets beyond this window are considered “out of SGR.” They have higher operating and maintenance costs and higher risk of failure.
 - “Out of SGR” does not indicate the safety of the asset, but rather inefficiency of operations. An asset can perform well beyond its expected useful life, but the MBTA may need to invest more time and resources around inspection, maintenance and repair.
- SGR is an approximate measure of an asset’s condition and expected life and is used by the agency to support planning for investments that will repair, rehabilitate, or replace that asset.

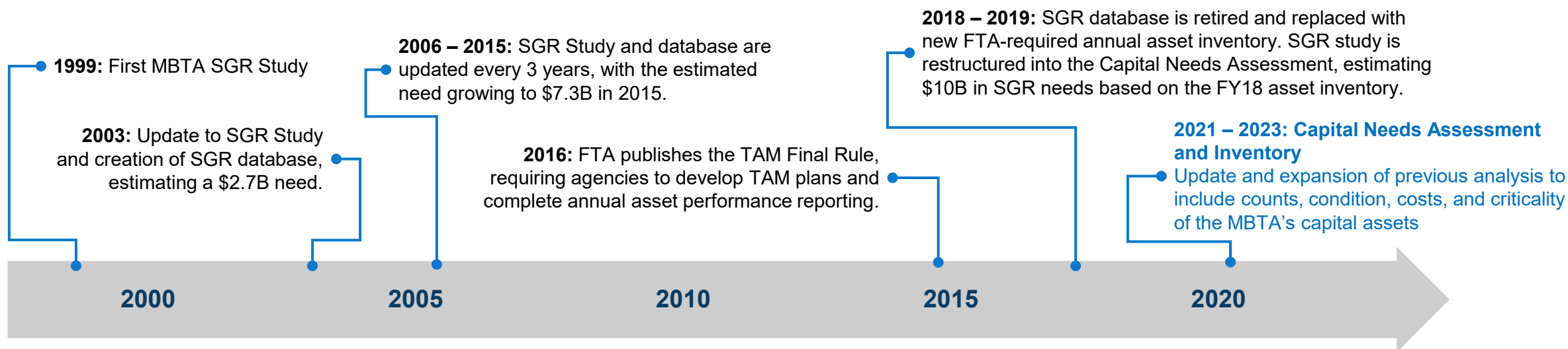
Example – Car Maintenance

A well-maintained car may last longer than originally expected but will require more frequent and intensive maintenance over time and will eventually need to be replaced.



Background

- Roughly every 3-4 years the MBTA completes an updated assessment of the agency's capital needs.
- The Capital Needs Assessment is not a Federal requirement, but rather an MBTA-led exercise to better understand the magnitude of the agency's capital asset needs. It is aligned with the 2022 Transit Asset Management Plan (TAMP) as well as the MBTA's annual submissions to the FTA's National Transit Database (NTD).
- The first State of Good Repair (SGR) study was completed in 1999. In May 2019, the last Capital Needs Assessment was presented to the FMCB and estimated approximately \$10B in SGR needs.



Purpose

- The SGR Index is a point-in-time snapshot of the condition of the MBTA's capital assets.
- As an asset-based resource, it does not address modernization opportunities or the cost of those of opportunities.
- It is a tool that will help the agency develop investment strategies to address our most critical needs first.
- The implementation of these investment strategies represent an opportunity for the agency to modernize and upgrade our assets as they are rehabilitated and/or replaced.
- As a routine exercise, the data and methodology used for the Capital Needs Assessment and Inventory continue to mature. This analysis does not yet include information technology, communications assets, security assets, or business and operational support programs, although these may be included in future analyses.



Scope of the State of Good Repair Index

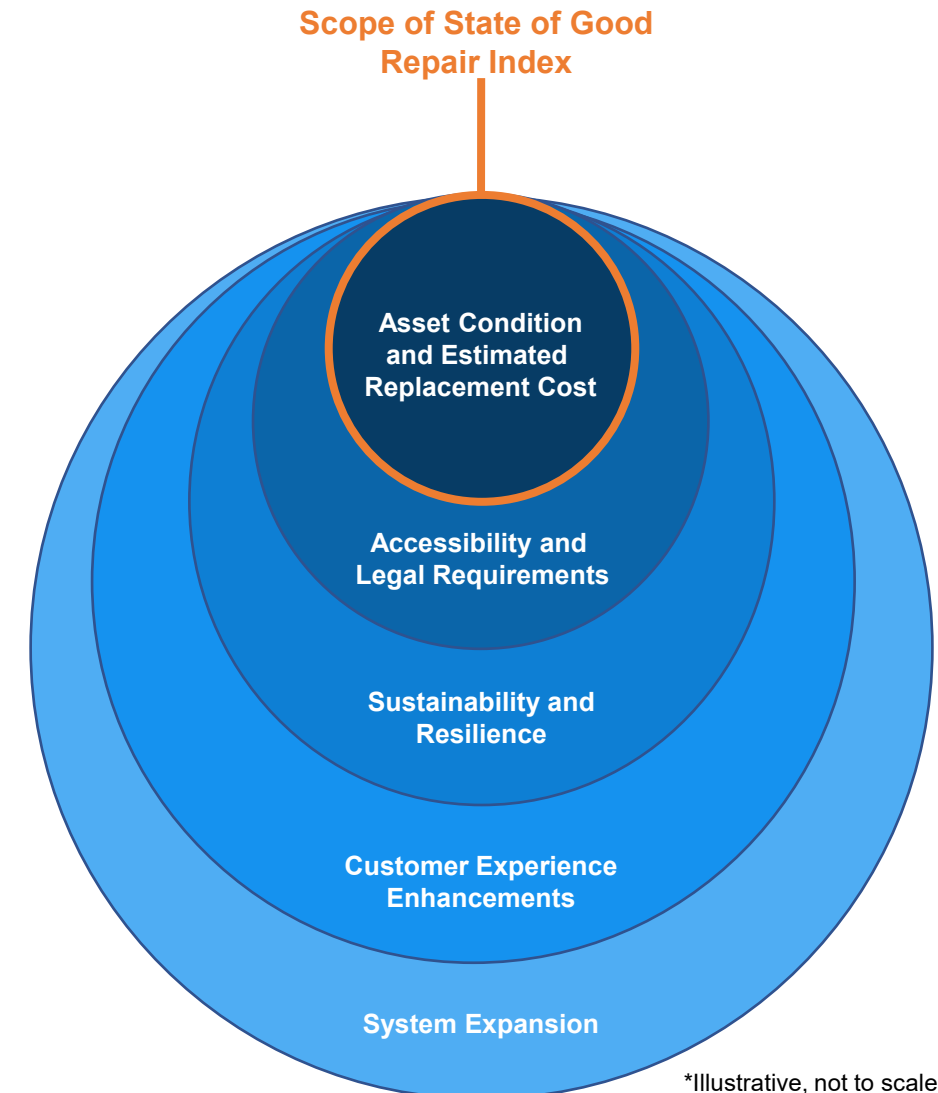
The State of Good Repair Index is meant to capture the baseline condition and replacement cost of the MBTA's assets. It does not reflect total project costs, nor does it capture the full universe of capital investment that may be needed to meet additional requirements or agency goals.

For example, a station asset is recorded in the Facilities inventory and includes the following information to support the SGR Index calculation:

- **Asset Condition** – Record of the facility asset and a baseline measure of its condition with regard to State of Good Repair
- **Estimated Replacement Cost** – Estimated equivalent replacement cost for the station asset

There are additional elements outside the scope of the SGR Index that would be incorporated into a real-world capital project to rehabilitate or replace a station. These elements include, but are not limited to:

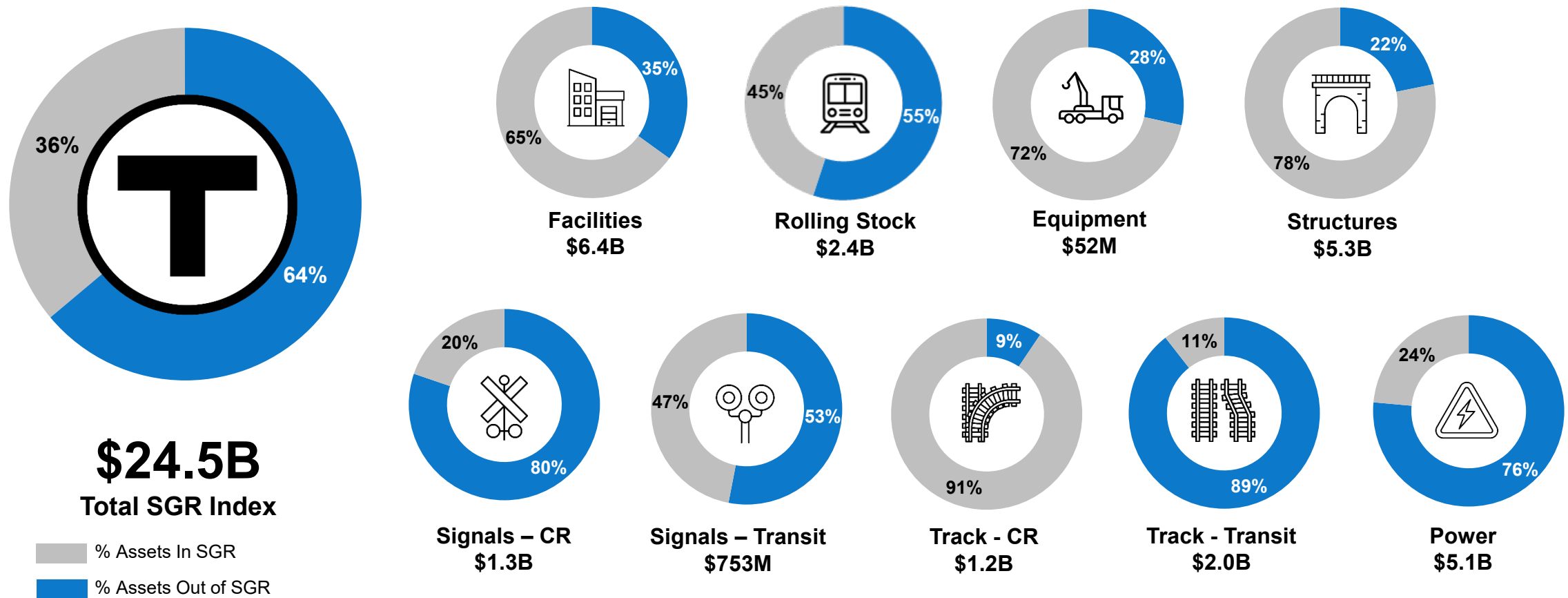
- **Accessibility and Legal Requirements** – Renovation of the station to add accessibility features and bring it into compliance with current ADA standards, including “trigger” upgrades that would require a full station renovation
- **Sustainability and Resilience** – Waterproofing and flood mitigation, energy management systems, drainage improvements, fleet electrification, and other sustainability and severe weather resilience measures
- **Customer Experience Enhancements** – Technology enhancements, installation of electric chargers in the parking area, new customer amenities, increased frequency of service
- **System Expansion** – Extension of a line or addition of a transfer to other modes and/or lines on the transit system



*Illustrative, not to scale

Summary of Results | SGR Index by Asset Class

- Using updated asset inventory data, condition ratings, and cost estimates (in 2022 dollars), the MBTA has developed a baseline capital needs estimate of \$24.5B. Approximately 64% of the assets included in this analysis have been identified as being out of SGR.*



*Assets are counted differently depending on the functional asset class, e.g., some track elements are counted by mileage while others use a per-unit or per-site count.

Asset Replacement and Modernization

- Understanding the condition of our assets is a critical first step to not only fixing the current system, but building the **transportation system of the future**
- Bringing the system into a State of Good Repair also represents an opportunity to upgrade and modernize the transit network at the same time.
 - Assets are rarely replaced exactly one-for-one; assets that have reached the end of their useful life are frequently replaced with more innovative, modernized equipment
 - The CNAI is helping us better identify and prioritize assets that are ready for replacement and upgrade
- **Modernization Example:** Commuter Rail PTC/ATC Implementation (Commuter Rail Safety and Resiliency Program) is replacing older, outdated signal assets with modernized equipment.
 - The new signal equipment represents an upgrade and uses innovative technologies to monitor a train's location, direction, and speed in real time. The PTC and ATC systems will alert the engineer to potentially unsafe conditions and, if necessary, automatically stop the train.





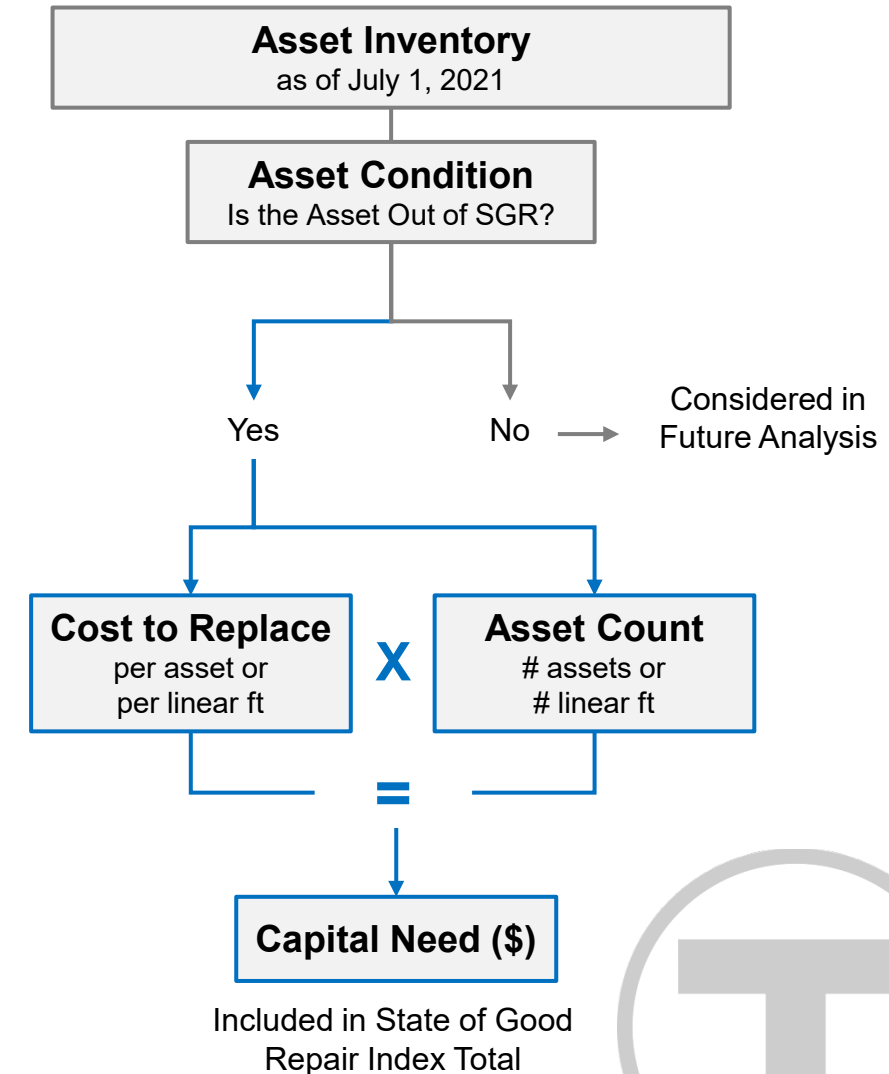
A Commuter Rail train crossing Plymouth Street in Abington.



Process and Approach

Calculating the State of Good Repair (SGR) Index

- The **State of Good Repair Index** value is calculated by assembling an inventory of all the MBTA's capital assets, identifying which assets are out of a State of Good Repair, and then estimating the total cost (in 2022 dollars) of bringing those assets into a State of Good Repair.
- In alignment with FTA guidance, assets considered **Out of a State of Good Repair** include:
 - **Facilities, Structures, Signals – Commuter Rail, Signals – Transit, Track, and Power** assets with a condition score of 2.90 or lower on the 5-point TERM scale
 - **Rolling Stock and Equipment** assets with a condition score of 2.50 or lower on the 5-point TERM scale
- A standard, per-unit **Replacement Cost** (in 2022 dollars) was identified for each asset type within the asset classes, using cost information for recent capital projects.
 - **Facilities** – Cost per square foot
 - **Rolling Stock and Equipment** – Cost per vehicle
 - **Structures** – Cost per linear foot
 - **Signals – Commuter Rail and Signals – Transit**
 - Cost per linear foot for wayside equipment and cable
 - Per-unit cost for instrument houses and switch machines
 - **Track – Commuter Rail and Track – Transit**
 - Cost per linear foot for tangent, curve, and non-revenue service track
 - Per-unit cost for turnouts, crossovers, and grade crossings
 - **Power**
 - Per-unit cost for TPSS, USS, generators, high voltage yards, and the South Boston Power Plant
 - Cost per linear foot for overhead catenary



Asset Management | Alignment & System Maturity

- The Capital Needs Assessment and Inventory effort is aligned with the agency's asset management practices, which have continued to mature and expand since 2018.
- The MBTA's asset management program uses a data-driven approach to implement a strategic process for acquiring, operating, maintaining, upgrading and replacing transit assets. This program and process support the agency's vision, mission, and values set forth in the strategic plan.
- In 2016, the FTA published the TAM Final Rule requiring agencies receiving federal funding to develop TAM plans and submit annual asset performance targets to the National Transit Database.
 - The MBTA annually submits asset performance targets to FTA and has published TAM Plans in both 2018 and 2022 detailing the agency's approach to managing assets that support the transit network.
- The Asset Management team has been rapidly expanding since 2018 and the MBTA continues to work towards developing Enterprise Asset Management Systems that are the source of truth for all asset data.

2007	2016	2018	2020	2021	2023	2023 and Beyond
<ul style="list-style-type: none">• Current Rolling Stock Enterprise Asset Management System (EAMS) is Implemented	<ul style="list-style-type: none">• FTA Transit Asset Management Final Rule is finalized, having been heavily influenced by MBTA efforts	<ul style="list-style-type: none">• MBTA establishes an independent Asset Management Department• Asset Management Maturity Assessment and Improvement Plan developed• Transit Infrastructure EAMS is procured, and staff begin to load safety critical assets into the system	<ul style="list-style-type: none">• Deployed mobile work management solution for timely accurate recording of transit infrastructure maintenance	<ul style="list-style-type: none">• All safety critical assets are loaded into the Transit Infrastructure EAMS and Preventative Maintenance Inspections (PMIs) are digitized using EAMS	<ul style="list-style-type: none">• Currently underway, all system critical assets are being loaded into the Transit EAMS, including PMIs.• Currently underway, condition assessment renewals of facilities	<ul style="list-style-type: none">• Further implement asset prioritization framework• Refresh Systemwide Condition Assessments• In 2026, the next TAMP update is due to FTA



Analysis

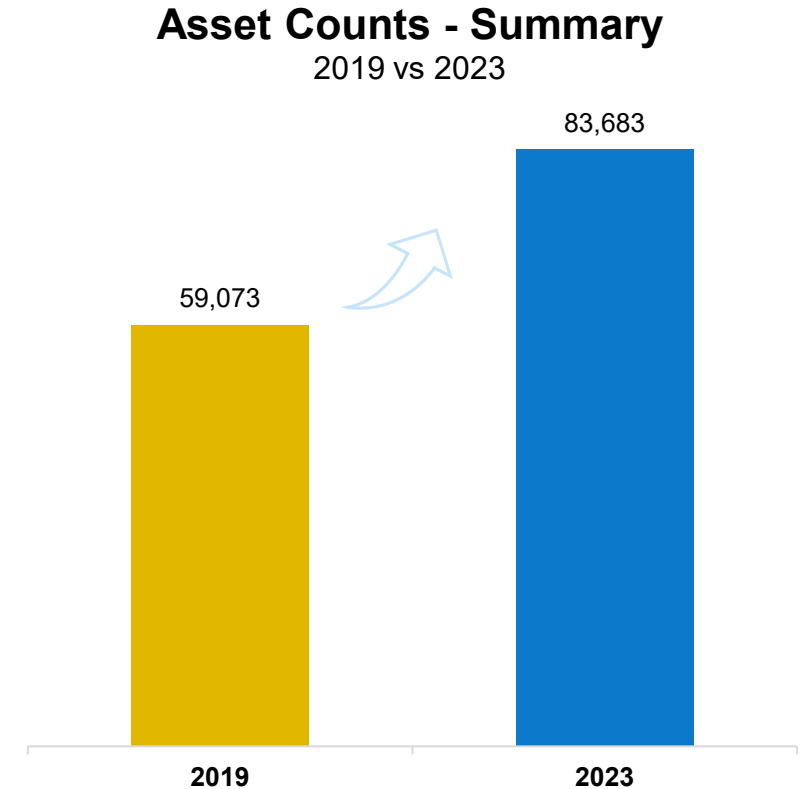
Red Line maintenance underway at Cabot Maintenance Facility.

What changed, and what have we learned?

As before, between the 2019 and 2023 assessments the agency's calculated State of Good Repair Index continued to increase.

This was driven by several factors, including:

- **Count:** Overall improvements in the MBTA's asset management systems have resulted in a more sophisticated asset inventory.
- **Cost:** Inflation is driving industry-wide increases in infrastructure and construction costs, making it more costly to replace or rehabilitate assets
- **Condition:** The MBTA's assets continue to age faster than they are being replaced, resulting in an increase in the total number of assets that are out of a State of Good Repair.
- **Time:** Capital projects are multi-year efforts, as a project advances through planning, design and construction. Underway projects to replace assets are not reflected as complete in this update of the analysis.



Understanding Changes in Asset Count

The MBTA continues to invest significant resources into asset management and has continued to document our asset inventory at a more granular level, resulting in some notable changes to the number of assets included in this update of the analysis.

Power



Left: Control room at the South Boston Power Turbine. Right: Exterior of the South Boston Power Turbine.

- Asset count increased significantly from 4,959 in the 2019 assessment to 14,514 in the 2023 CNAI
- The 2019 inventory did not include DC cable, AC cable, overhead catenary, South Boston power station, emergency generators, or high voltage yard
- Performed baseline visual condition assessments and validation of the Power and Signal Transit asset inventory in FY21, supporting a more sophisticated inventory of these assets in the 2023 CNAI

Signals - Transit



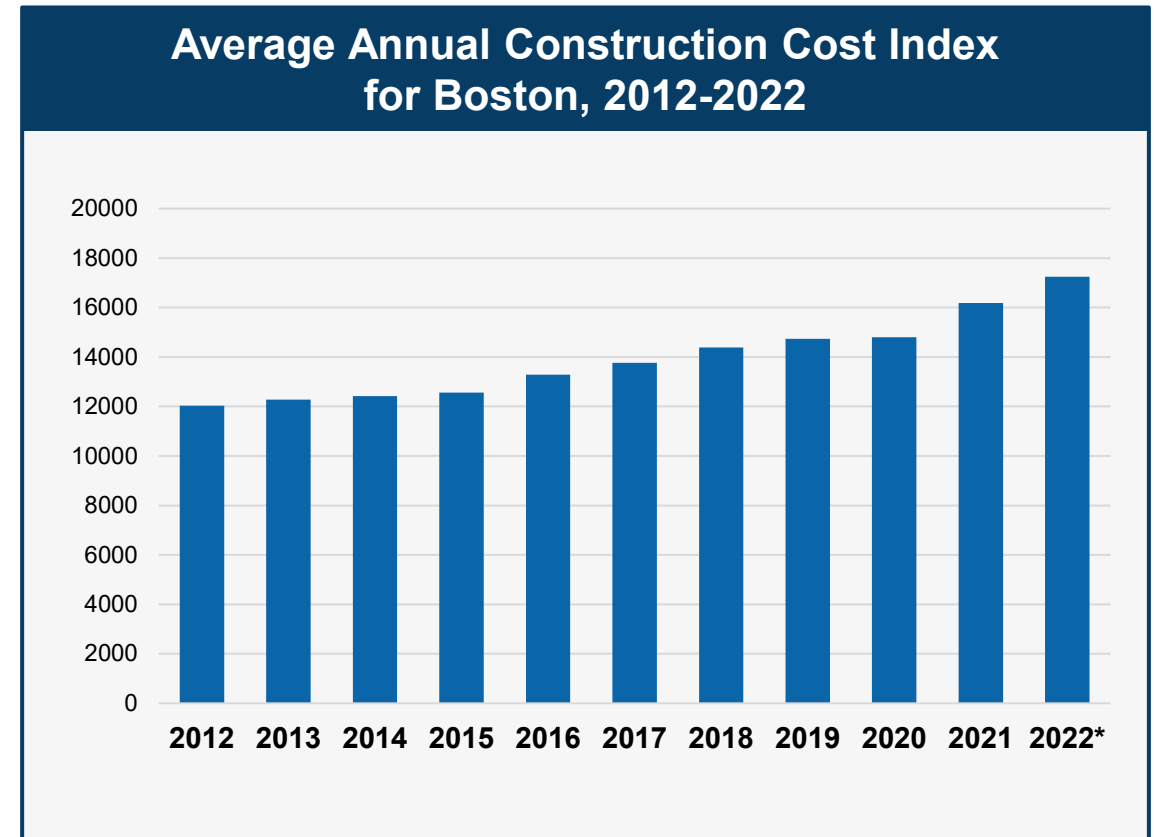
Left: Park Street Signal Room on the Red Line. Right: New signal equipment serving the Blue Line.

- Asset count decreased slightly from 37,697 in the 2019 assessment to 34,013 in the 2023 CNAI
- Decrease in count caused by introduction of Programmable Logic Controller (PLCs) on the Blue Line. The modernization of this asset with the introduction of PLC's significantly reduces the number of relays and cables in the system.

Cost | Increases Driven by Inflation

The MBTA continues to use existing capital project cost information to inform the cost to replace an asset. Between 2019 and 2022, this reflects rather significant cost increases driven by post pandemic inflation rates and supply chain challenges.

- The 2022 Capital Needs Assessment uses cost information in 2022 dollars, reflecting these cost increases when compared to 2019.
- Based on a recent Construction Economist Report completed for the MBTA, the potential construction cost escalation rates over the coming five-year period show a more predictable, and less volatile outlook with rates expected around 5-6% in FY2024 and lowering to 3-4% by FY2026-2028.

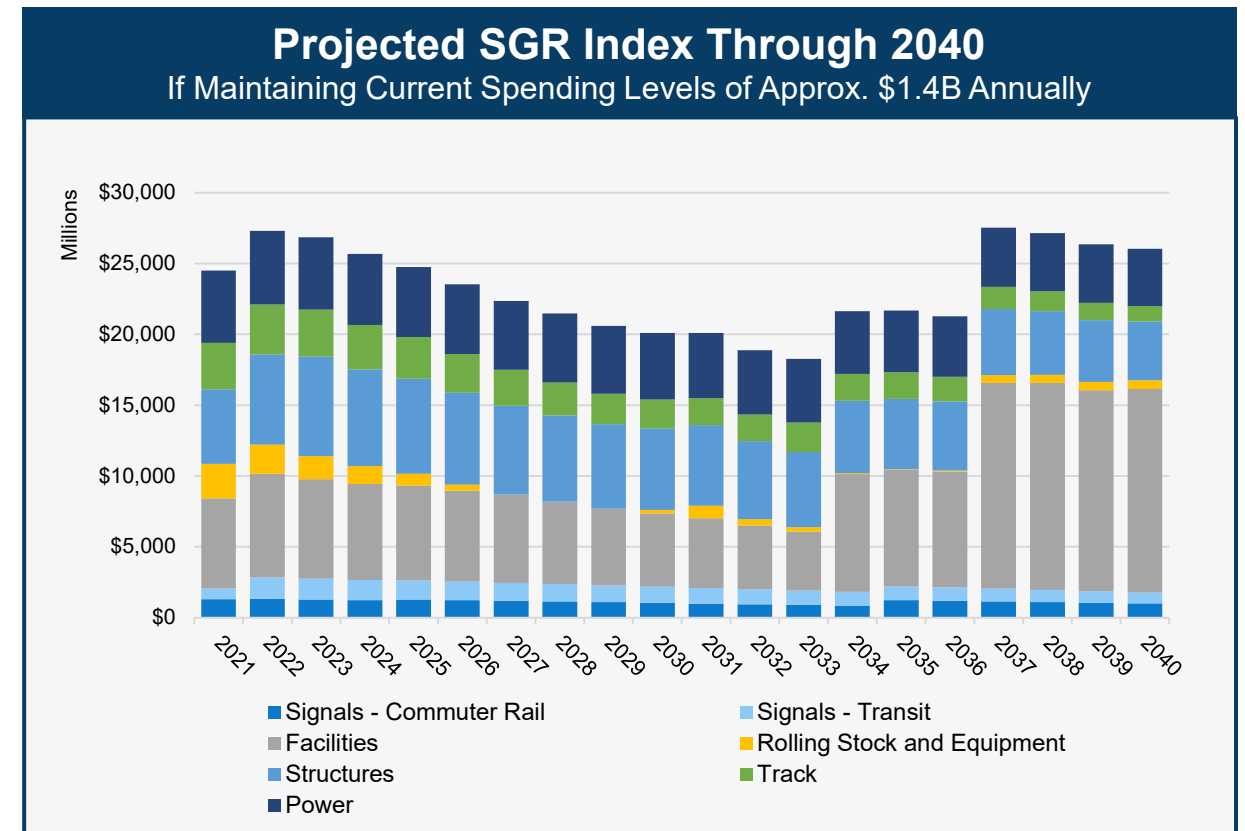


*2022 average is based on January, February, and March 2022 index values

Condition | Continued Aging of the MBTA's Assets

The MBTA's assets continue to age faster than they are being replaced, resulting in an increase in the total number of assets that are out of a State of Good Repair.

- The MBTA asset inventory is vast and diverse, with a wide range of expected useful lives (EUL) and installation years depending on asset type.
- Sustained investment in the MBTA's capital assets is critical to addressing not only the current State of Good Repair (SGR) need, but also the ongoing and future needs associate with these asset replacement and rehabilitation cycles.
- Even with sustained levels of investment, the agency is expected to continue to see a significant need for the foreseeable future. Some years are projected to see more significant spikes in the SGR Index as large numbers of assets reach the end of their useful life.



Time | Long Lead Time for Capital Investments

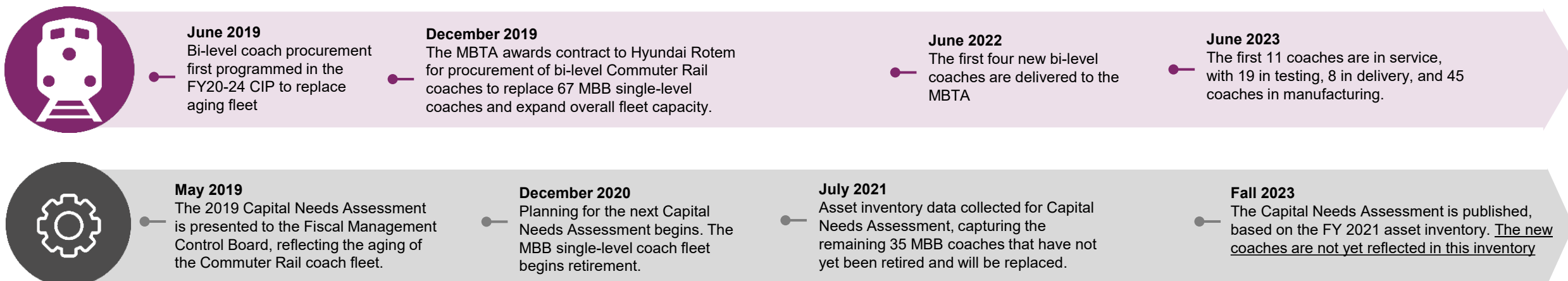
The MBTA continues to advance a robust capital program that is working to replace a wide range of assets across the system. As a point in time calculation, with asset inventory data as of July 1, 2021, the SGR index does not account for the impact of underway capital projects, or any project that may have reached substantial completion since then.

- Capital projects advance through a long, multi-year process of planning, design and construction. Some assets reflected as “out of SGR” in this analysis are being actively addressed by the agency with funding programmed in the five-year Capital Investment Plan (CIP).
- Asset inspection and rating occurs on a cyclical basis; improvements to asset condition can take several years to show up in the inventory.



A new bi-level Commuter Rail coach at South Station.

Example: Commuter Rail Coach Procurement Project Timeline





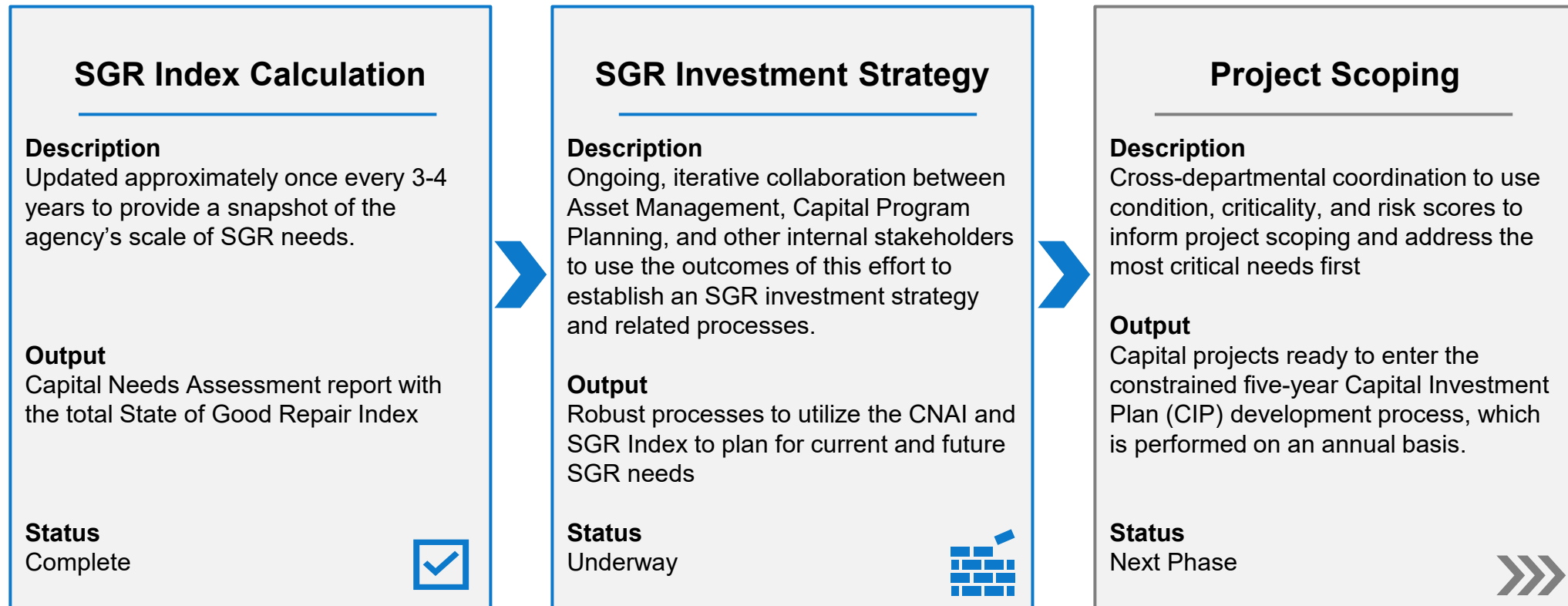
SL3 Silver Line bus at the Box District stop in Chelsea.



Moving Forward

Looking Ahead | Stronger Capital Asset Planning

- The overall outcome of the CNAI is a more robust, repeatable, data-informed approach to identifying and prioritizing the replacement of the MBTA's most critical asset needs over the long term.
- The MBTA continues to further develop the asset inventory and build out additional data complexity, while standing up new processes to support smarter capital investment decision-making.



Opportunities for Innovation

- Although the CNAI does not address modernization, assets out of SGR requiring rehabilitation or replacement represent an opportunity to modernize and upgrade.
- This modernization work is already underway as the MBTA is replacing assets out of SGR while building a system that is more accessible, sustainable, and reliable – the **transportation system of the future**.

Bus Facility Modernization Program



Left: Exterior rendering of North Cambridge Bus Facility retrofitted for battery-electric charging.
Right: Interior rendering of the new Quincy Bus Facility.

- Renovation and replacement of existing bus facilities to support a modernized battery-electric bus (BEB) fleet
- Implementation of more sustainable, resilient, and environmentally friendly infrastructure
- Expansion of facility capacity to support larger fleets, modernized equipment, better work environments for our employees, and more service during peak demand times.

Green Line Type 10 Vehicle Procurement



Left: Rendering of the future Type 10 Green Line light rail vehicle.

- Replacement of the aging Type 7 and Type 8 Green Line fleets with modernized vehicles
- The new fleet will feature increased capacity, upgraded communication systems, improved accessibility, and the latest generation of crash-safety technology, which will create a safer environment for both operators and riders.

Where Do We Go From Here?

- The MBTA is among the oldest and most complex transit agencies in the United States, with some assets dating back more than 50 years. Our State of Good Repair needs are significant, but **we can fix this**.
 - We are not alone in facing a significant backlog of assets in need of repair and replacement. New York MTA, MDOT MTA, and WMATA have all launched similar exercises to address their SGR needs.
- The agency has sustained a significant level of investment in the repair and replacement of our assets. Using current investment levels, models show that the MBTA is headed in the right direction.
 - To maintain these significant levels of investment, on-going and sustainable future capital funding sources are required to support safe and reliable service.
- Moving forward, we envision a transportation system of the future that is safe, reliable, electrified, resilient and accessible. Understanding our SGR needs, and the level of investment required to address them is a step toward fixing the transit system, reestablishing public trust, and advancing our modernization goals.





Appendix: Asset Class Summaries

Fare gates and entrance to Suffolk Downs station on the Blue Line.

Facilities: Passenger

Facilities assets are buildings or structures that support maintenance, operations, and/or administrative functions.

Passenger facilities are stations, stops, or terminals.

Unit of Count

Each individual station, stop, or terminal is a separate asset.

Cost Methodology

- Cost per square foot for each passenger facility type, based on current and planned capital projects.
- Square footage of existing facilities is used, rather than potential future expansion or consolidation of a facility's footprint.

Condition Methodology

- Every facility asset undergoes a condition assessment at least once every four years.
- The facility's substructure, shell, interiors, plumbing, HVAC, fire protection, electrical, site, fare equipment, and conveyance are all assessed separately, and then aggregated into an overall condition assessment for the asset.

Exclusive Platform Station



Simple At-Grade Platform Station



Elevated
Fixed Guideway Station



At-Grade
Fixed Guideway Station



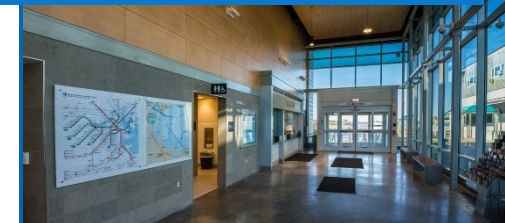
Underground
Fixed Guideway Station



Bus Transfer Center



Ferryboat Terminal



Facilities: Parking

Facilities assets are buildings or structures that support maintenance, operations, and/or administrative functions.

Parking facilities include parking structures (garages) and surface parking lots that enable customers to access the system.

Unit of Count

Each individual station, stop, or terminal is a separate asset.

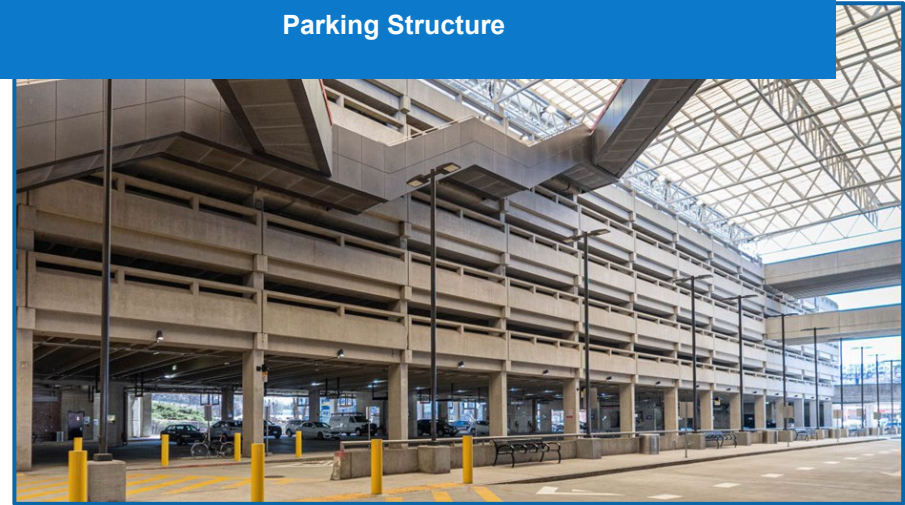
Cost Methodology

- Cost per square foot for each passenger facility type, based on current and planned capital projects.
- Square footage of existing facilities is used, rather than potential future expansion or consolidation of a facility's footprint.

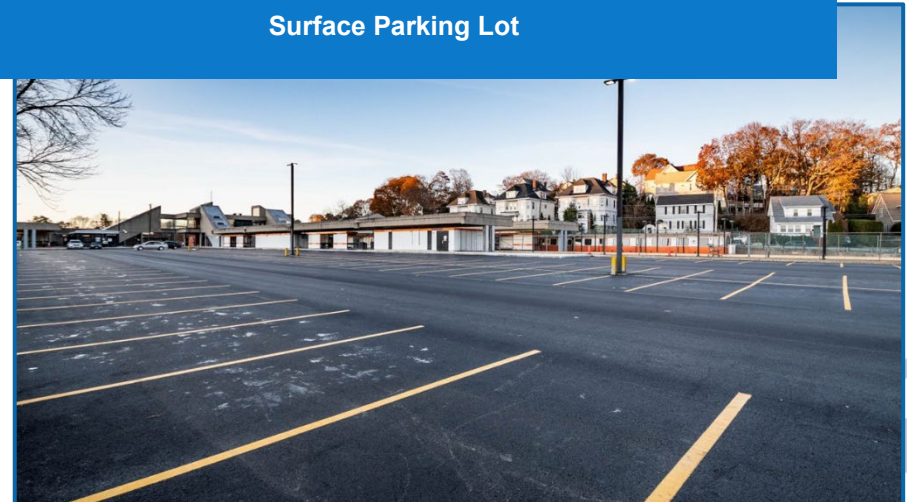
Condition Methodology

- Every facility asset undergoes a condition assessment at least once every four years.
- The facility's substructure, shell, interiors, plumbing, HVAC, fire protection, electrical, site, fare equipment, and conveyance are all assessed separately, and then aggregated into an overall condition assessment for the asset.

Parking Structure

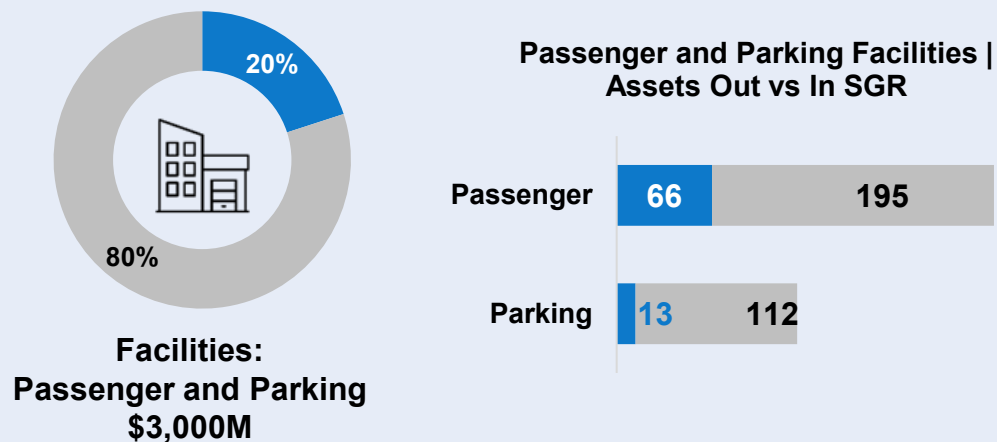


Surface Parking Lot



Facilities: Passenger and Parking

This analysis found that approximately **20%** of the MBTA's passenger and parking facility assets were out of a State of Good Repair as of July 1, 2021, totaling to a **\$3.0B** SGR Index.



Inventory Notes

- The SGR Index value does not reflect the cost of modernization, regulatory compliance (accessibility, electrification) or climate resiliency improvements. Replacement costs for facilities assets were calculated using existing square footage and do not reflect facility expansion.

Key Underway Investments

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

- Symphony Station Improvements (P0168)
- Natick Center Station Accessibility (P0174)
- Braintree and Quincy Adams Garage Rehabilitation (P0087)

Passenger and Parking Facilities | SGR Index by Asset Type and Primary Mode

Facility Type	Primary Mode	# Assets In/Out of SGR	SGR Index
Parking	Bus		\$0M
	Commuter Rail		\$1,334M
	Ferry		\$0M
	Heavy Rail		\$567M
	Light Rail		\$812M
Passenger	Bus		\$0M
	Commuter Rail		\$37M
	Ferry		\$0M
	Heavy Rail		\$247M
	Light Rail		\$4M
		0 50 100 # Facility Assets	

■ Out of SGR ■ In SGR

Facilities: Support

Facilities assets are buildings or structures that support maintenance, operations, and/or administrative functions.

Passenger facilities are stations, stops, or terminals.

Unit of Count

Each individual building or structure is considered a separate asset.

Cost Methodology

- Cost per square foot for each passenger facility type, based on current and planned capital projects.
- Square footage of existing facilities is used, rather than potential future expansion or consolidation of a facility's footprint.

Condition Methodology

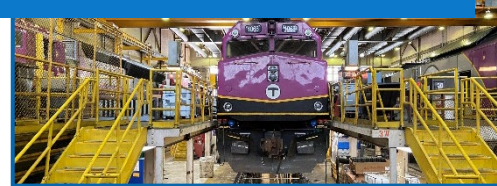
- Every facility asset undergoes a condition assessment at least once every four years.
- The facility's substructure, shell, interiors, plumbing, HVAC, fire protection, electrical, site, fare equipment, and conveyance are all assessed separately, and then aggregated into an overall condition assessment for the asset.

General Purpose
Maintenance Facility



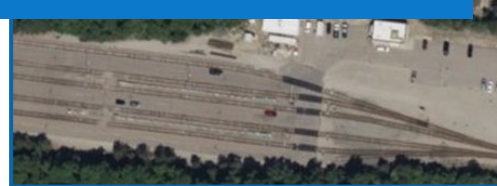
Garage or building where mechanics perform routine maintenance and repairs. Vehicles are stored and dispatched for revenue service.

Heavy Maintenance Facility



Facility used for major maintenance and/or overhaul activities.

Layover Facility



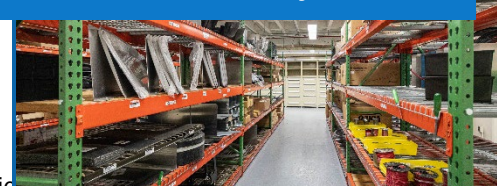
Provides storage and routine servicing of commuter rail rolling stock. May include crew buildings and ancillary track.

Administrative Facility



Includes offices and other buildings serving an administrative purpose.

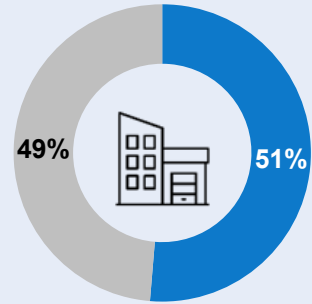
Other Facility



Buildings used for vehicle fueling, revenue collection, or other purposes not described above.

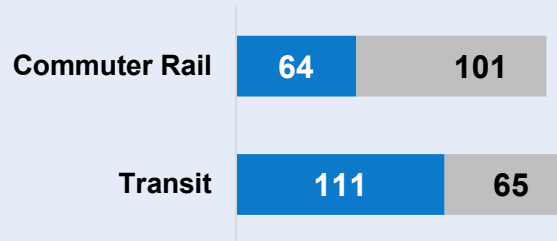
Facilities: Support

This analysis found that approximately **51%** of the MBTA's support facility assets were out of a State of Good Repair as of July 1, 2021, totaling to a **\$3.6B** SGR Index.



Facilities: Support
\$3,357M

**Support Facilities |
Assets Out vs In SGR by Mode**



Inventory Notes

- The SGR Index value does not reflect the cost of modernization, regulatory compliance (accessibility, electrification) or climate resiliency improvements. Replacement costs for facilities assets were calculated using existing square footage and do not reflect facility expansion

Key Underway Investments

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

- Quincy Bus Facility Modernization (P0671a)
- Charlestown Campus State of Good Repair (P1136)

Support Facilities | SGR Index by Asset Type and Primary Mode

Facility Type	Primary Mode	# Assets In/Out of SGR	SGR Index
Support	Bus		\$567M
	Commuter Rail		\$1,759M
	Heavy Rail		\$886M
	Light Rail		\$145M
		0 50 100 150 # Facility Assets	

■ Out of SGR ■ In SGR

Rolling Stock

Rolling Stock includes heavy and light rail vehicles, buses, Commuter Rail locomotive and coach cars, ferry vessels, and paratransit automobiles and vans that provide revenue service to customers.

Unit of Count

- Each vehicle in a fleet is considered a separate asset

Cost Methodology

- Per-vehicle cost for each vehicle type, based on current and planned capital project.

Condition Methodology

- Condition scores are based on fleet age compared to the useful life benchmark, or expected lifecycle, for each vehicle type.

Standard Bus



Articulated Bus



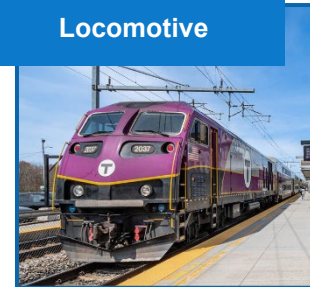
Heavy Rail



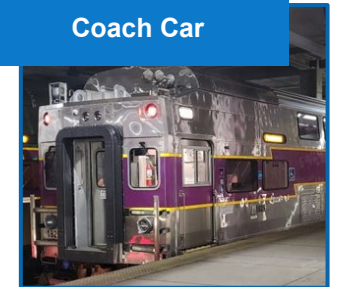
Light Rail



Locomotive



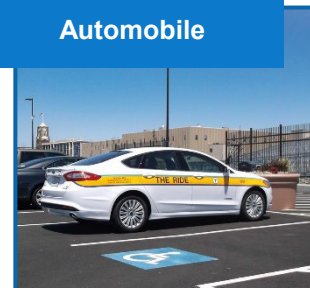
Coach Car



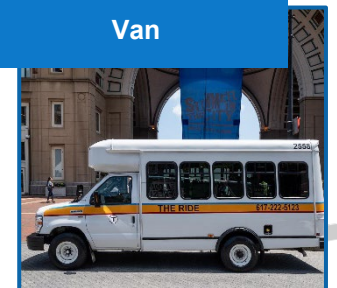
Ferry Vessel



Automobile

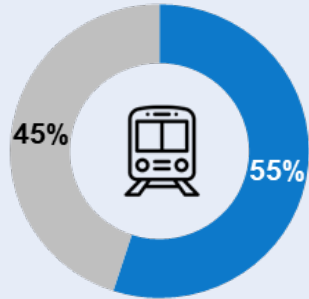


Van



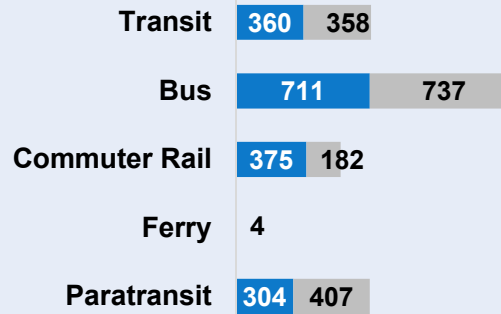
Rolling Stock

This analysis found that approximately **55%** of the MBTA's rolling stock assets were out of a State of Good Repair as of July 1, 2021, totaling to a **\$2.4B** SGR Index.



Rolling Stock
\$2,382M

**Rolling Stock |
Assets Out vs In SGR by Mode**



Inventory Notes

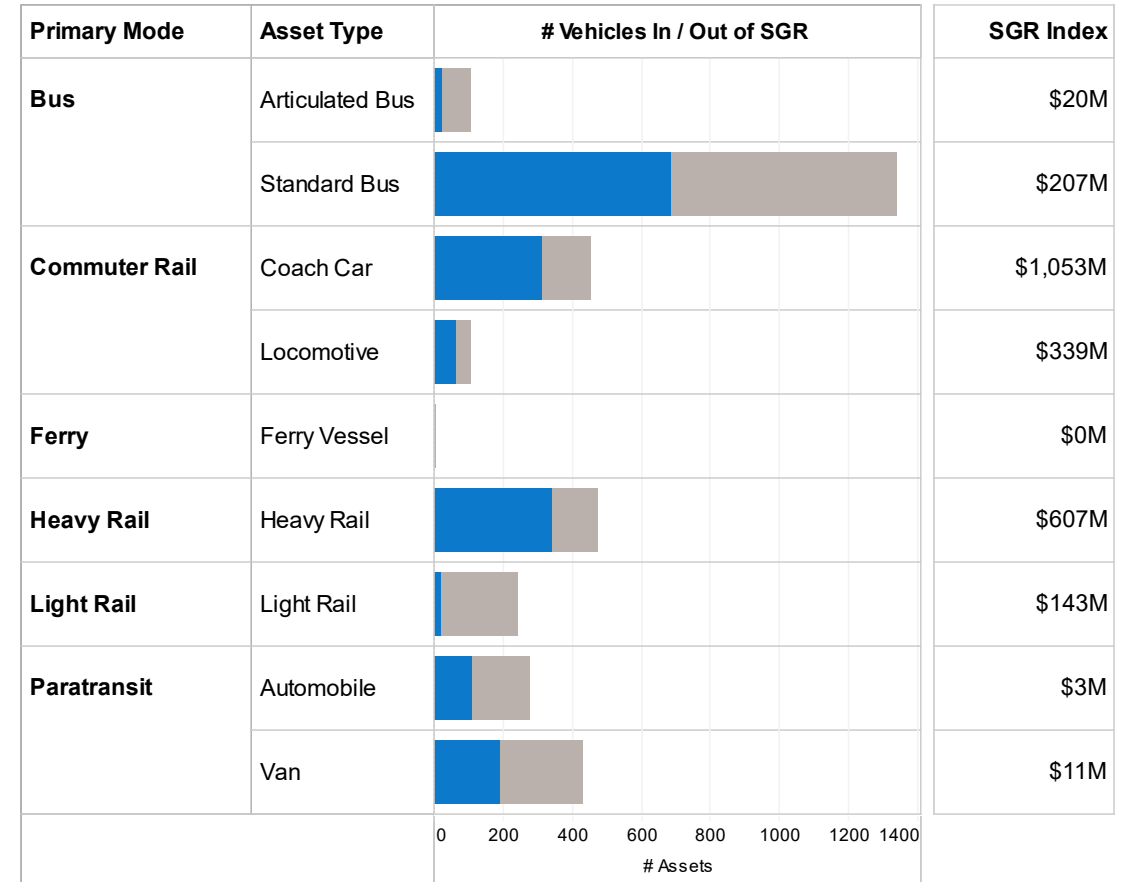
- The SGR Index value reflects replacement costs for current fleet size; it does not account for potential future fleet expansion
- Mid-life overhauls are intended to ensure the safe and reliable operation of vehicle fleets, but do not extend the useful life benchmark of the fleet

Key Underway Investments

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

- Red / Orange Line Vehicle Procurement (P0362)
- Procurement of Battery Electric 40ft Buses and Related Infrastructure (P0653)
- Procurement of Bi-Level Commuter Rail Coaches (P0893)

Rolling Stock | SGR Index by Asset Type and Primary Mode



■ Out of SGR ■ In SGR

Equipment

Equipment includes non-revenue steel wheel and rubber tire vehicles supporting system operations and maintenance.

Unit of Count

- Each vehicle in a fleet is considered a separate asset.

Cost Methodology

- Per-vehicle cost for each vehicle type, based on current and planned capital project.

Condition Methodology

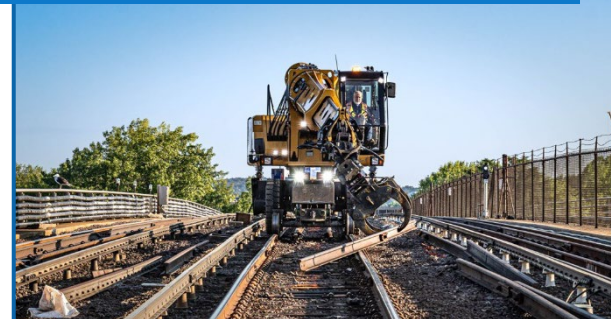
- Condition scores are based on fleet age compared to the useful life benchmark, or expected lifecycle, for each vehicle type.

Rubber Tire Vehicles



Automobiles, vans, trucks, and construction equipment such as mobile pumps, generators, swing loaders, tractors, cranes, backhoes, and snowplows using rubber tires.

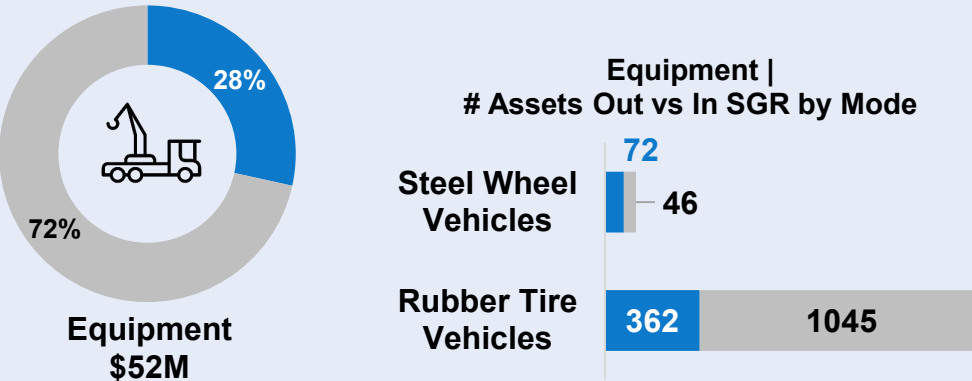
Steel Wheel Vehicles



Rail-based construction equipment such as ballast tampers, tie saws and handlers, rail spike and clip applicators, and cranes.

Equipment

This analysis found that approximately **28%** of the MBTA’s equipment assets were out of a State of Good Repair as of July 1, 2021, totaling to a **\$52M** SGR Index.



Inventory Notes

- Some equipment is stored indoors and used sporadically, and therefore can perform adequately despite vehicle age

Key Underway Investments

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

- Systemwide Non-Revenue Vehicles Program (P0662)
- Work Car Procurement (P0547)
- Equipment Lease – Power Department Support (P0673L)

Equipment | SGR Index by Asset Type and Primary Mode

Asset Type	Primary Mode	# Vehicles In/Out of SGR	SGR Index
Rubber Tire Vehicles	Bus	<div><div></div></div>	\$2.56M
	Commuter Rail	<div><div></div></div>	\$12.99M
	Heavy Rail	<div><div></div></div>	\$15.25M
	Light Rail	<div><div></div></div>	\$0.27M
Steel Wheel Vehicles	Commuter Rail	<div><div></div></div>	\$11.33M
	Heavy Rail	<div><div></div></div>	\$10.08M
		0200400600 Total Vehicles	

Out of SGR In SGR

Structures

Structures include bridges (steel, non-steel, and viaducts) and tunnels (both structural and non-structural elements).

Unit of Count

Each individual bridge is considered a separate asset.

Tunnel assets are counted by tunnel section, or distinct length of tunnel that mirrors a corresponding power section

Cost Methodology

Cost assumptions were created using current and planned capital projects, and based on asset type.

Capital costs reflect estimated replacement costs for bridges and rehabilitation costs for tunnels.

Condition Methodology

Condition scores are assigned by engineers who perform a visual assessment of the structure.

Rail Bridge



Allows rail service to cross over other modes of transport or natural barriers without interference to the operation of either.

Drawbridge



Allows passage over obstructions, with a movable platform that allows other modes of transportation to pass underneath.

Highway Bridge



Allows automobiles, bicycles, and pedestrians to cross over rail service without interference to the operation of either.

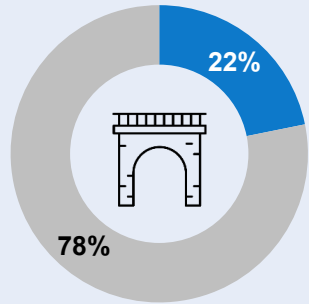
Tunnel



Provides underground means of passage though densely populated areas or past obstructions.

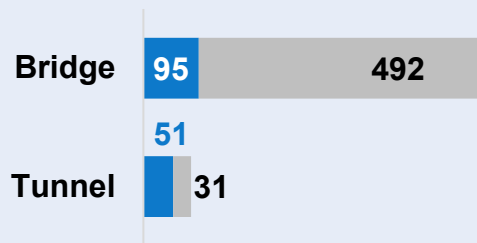
Structures

This analysis found that approximately **22%** of the MBTA's structure assets were out of a State of Good Repair as of July 1, 2021, totaling to a **\$5.3B** SGR Index.



Structures
\$5,265M

Structures |
Assets Out vs In SGR by Mode



Inventory Notes

- Culverts, retaining walls, pedestrian bridges, and dams are not yet included in the inventory.
- Capital costs for this asset class reflect estimates replacement costs for bridges and rehabilitation costs for tunnels.
- Some transit tunnels designated as Heavy Rail also support Light Rail underground right-of-way.

Key Capital Investments Currently Underway

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

- North Station Draw 1 Bridge Replacement (P0018)
- Tunnel Repairs On-Call (P0466)
- Systemwide Bridge Inspection and Rating (P0627)

Structures | SGR Index by Asset Type and Primary Mode

Asset Type	Primary Mode	# Assets In / Out of SGR	SGR Index
Bridge	Commuter Rail		\$902M
	Heavy Rail		\$71M
	Light Rail		\$17M
Tunnel	Bus		\$0M
	Heavy Rail		\$2,815M
	Light Rail		\$1,459M
		0 100 200 300 400 # Assets	

Out of SGR In SGR

Signals – Commuter Rail

Commuter rail signal assets include wayside equipment and cables, relays, cabinets, instrument houses, and signals that allow vehicles to move about the rail network safely and efficiently.

Unit of Count

- **Wayside Equipment and Cables** are located along the right-of-way and are counted by linear foot
- **Instrument Houses and Rooms** and **Grade Crossings** are each considered separate assets representing signal locations.

Cost Methodology

Cost per linear foot (for wayside equipment and cables) or cost per asset (for instrument houses/rooms and grade crossings) for each asset type, based on current and planned capital projects.

Condition Methodology

Condition scores are assigned by engineers who perform a visual assessment of signal assets.

Instrument Houses and Rooms



Enclosures containing a variety of signal equipment

Wayside Equipment and Cables



Signals, track circuits, power switches, circuit controllers, and bridge controls alongside the right-of-way

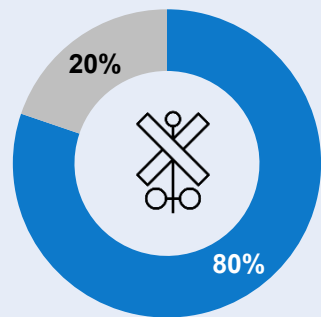
Grade Crossings



Signaled intersections where track and a road cross at grade level

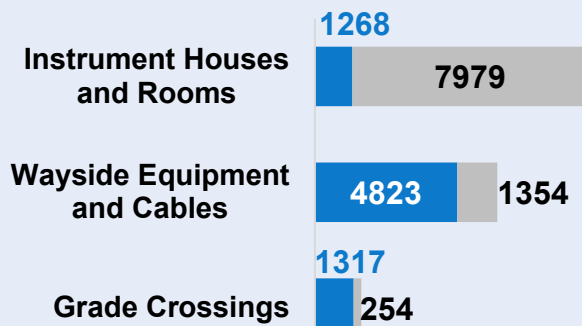
Signals – Commuter Rail

This analysis found that approximately **80%** of the MBTA's commuter rail signal assets were out of a State of Good Repair as of July 1, 2021, totaling to a **\$1.3B** SGR Index.



Signals – CR
\$1,310M

Signals – Commuter Rail |
Assets Out vs In SGR by Mode



Inventory Notes

- Signal systems are designed to fail-safe. A signal system out of SGR represents more frequent failures and difficult maintainability due to obsolete parts and is representative of inefficient service rather than unsafe operations.

Key Underway Investments

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

- Commuter Rail Positive Train Control (PTC) (P0148)
- ATC Implementation – North Side Commuter Rail Lines (P0606)

Signals – Commuter Rail | SGR Index by Asset Type and Primary Mode

Line	Wayside Equipment and Cables	Instrument Houses and Rooms	Grade Crossings	SGR Index
Fairmount Line				\$40M
Fitchburg Line				\$27M
Framingham/Worcester Line				\$79M
Franklin/Foxboro Line				\$137M
Greenbush Line				\$125M
Haverhill Line				\$83M
Kingston Line				\$90M
Lowell Line				\$67M
Middleboro/Lakeville Line				\$163M
Needham Line				\$82M
Newburyport/Rockport Line				\$233M
Providence/Stoughton Line				\$32M
Wildcat Branch				\$8M
Systemwide				\$144M
	0 500 1000 # Assets	0 500 1000 # Assets	0 500 1000 # Assets	

■ Out of SGR ■ In SGR

Signals – Transit

Transit signal assets include wayside equipment and cables, relays, cabinets, instrument houses, and signals that allow vehicles to move about the rail network safely and efficiently.

Unit of Count

- **Wayside Equipment and Cables** are located along the right-of-way and are counted by linear foot
- **Instrument Houses and Rooms** are each considered separate assets representing signal locations.

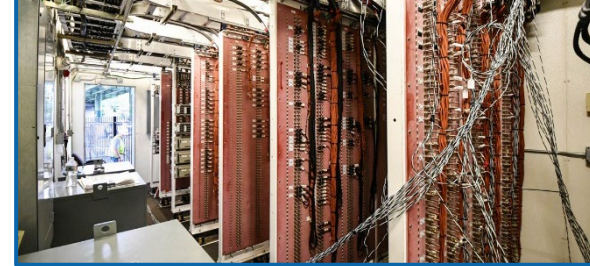
Cost Methodology

Cost per linear foot (for wayside equipment and cables) or cost per asset (for instrument houses and rooms) for each asset type, based on current and planned capital projects.

Condition Methodology

Condition scores are assigned by engineers perform a visual assessment of signal assets.

Instrument Houses and Rooms



Enclosures containing a variety of signal equipment

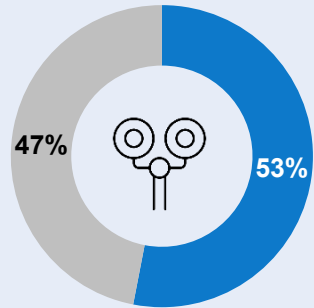
Wayside Equipment and Cables



Signals, track circuits, power switches, circuit controllers, and bridge controls alongside the right-of-way

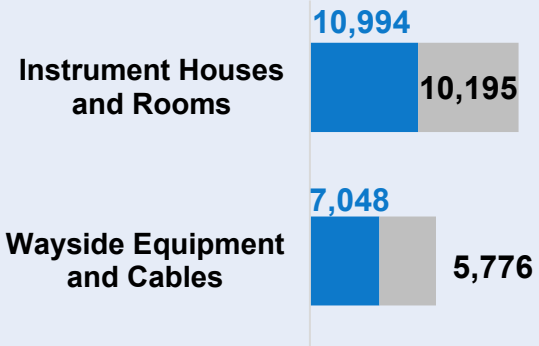
Signals – Transit

This analysis found that approximately **53%** of the MBTA's transit signal assets were out of a State of Good Repair as of July 1, 2021, totaling to a **\$0.8B** SGR Index.



Signals – Transit
\$753M

Signals – Transit |
Assets Out vs In SGR by Mode



Inventory Notes

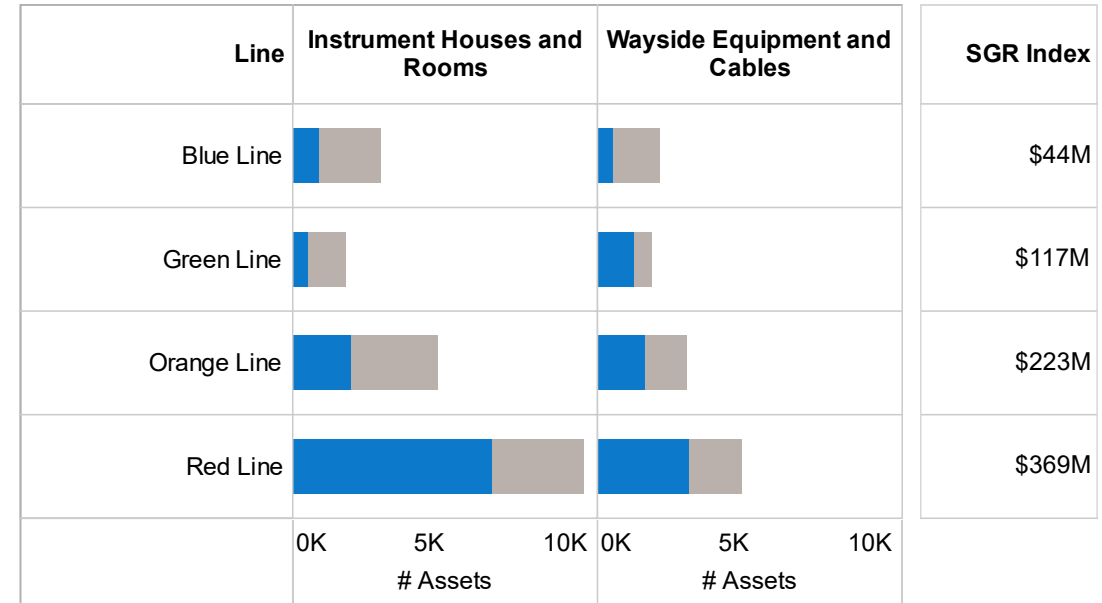
- Signal systems are designed to fail-safe. A signal system out of SGR represents more frequent failures and difficult maintainability due to obsolete parts and is representative of inefficient service rather than unsafe operations.

Key Underway Investments

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

- Green Line Central Tunnel Signal – 25 Cycle (P0283)
- Blue Line Signal Improvements (P0938)
- Signal Program – Red/Orange Line (P0285)

Signals – Transit |
SGR Index by Asset Type and Primary Mode



■ Out of SGR ■ In SGR

Track – Commuter Rail

Commuter rail track assets include curve and tangent (straight) revenue track, non-revenue track, turnouts, crossovers, and grade crossings.

Unit of Count

- **Linear assets** (curve, tangent, and non-revenue track) are counted by linear track mile.
- **Special trackwork assets** (turnouts and grade crossings) are counted individually as separate assets.

Cost Methodology

Cost per mile (for linear track) or cost per asset (for special trackwork) for each asset type, based on current and planned capital projects.

Condition Methodology

Condition scores are assigned by engineers who walk the track and perform a visual assessment.

Revenue Track: Curve and Tangent



Regular revenue track mileage is divided into tangent (straight) and curved track

Non-Revenue Track



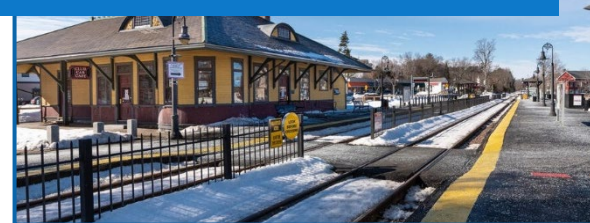
Includes all track that is not used for passenger revenue service

Turnouts



Used to divert (turnout) a rail vehicle from the line it is currently on

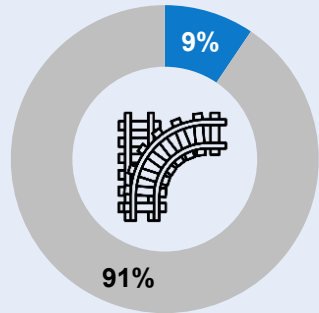
Grade Crossings



A location where railway and roadway or footpaths meet at grade

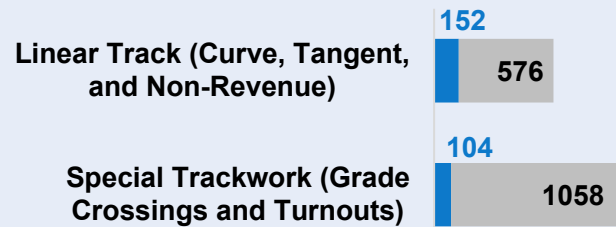
Track – Commuter Rail

This analysis found that approximately **9%** of the MBTA's commuter rail track assets were out of a State of Good Repair as of July 1, 2021, totaling to a **\$1.2B** SGR Index.



Track - CR
\$1,235M

Track – Commuter Rail | # Assets / Track Miles Out vs In SGR by Mode



Inventory Notes

- The dataset includes the track inventory as of July 1, 2021 and does not account for recent investments, including Haverhill Line track replacement.

Key Underway Investments

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

- Tower 1 Interlocking Early Action Project (P0889)
- Haverhill Interlocking Improvements (P0880)

Track – Commuter Rail | SGR Index by Asset Type and Primary Mode

Primary Mode	Analysis Level	Track Miles In / Out of SGR	SGR Index
Commuter Rail	Curve		\$1,179M
	Tangent		\$0M
	Non-Revenue Service		\$0M
		0 100 200 300 400 Sum of Length (miles)	

Primary Mode	Analysis Level	# Assets In / Out of SGR	SGR Index
Commuter Rail	Grade Crossings		\$1M
	Turnout		\$56M
		0 100 200 300 400 500 600 700 # Assets	

■ Out of SGR ■ In SGR

Track – Transit

Transit track assets include curve and tangent (straight) revenue track, non-revenue track, turnouts, crossovers, and grade crossings.

Unit of Count

- **Linear assets** (curve, tangent, and non-revenue track) are counted by linear track mile.
- **Special trackwork assets** (turnouts, crossovers, and grade crossings) are counted individually as separate assets.

Cost Methodology

Cost per mile (for linear track) or cost per asset (for special trackwork) for each asset type, based on current and planned capital projects.

Condition Methodology

Condition scores are assigned by engineers who walk the track and perform a visual assessment.

Revenue Track: Curve and Tangent



Regular revenue track mileage is divided into tangent (straight) and curved track

Non-Revenue Track



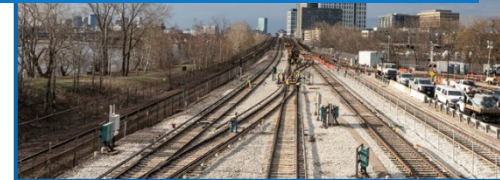
Includes all track that is not used for passenger revenue service

Turnouts



Used to divert (turnout) a rail vehicle from the line it is currently on

Crossovers: Single and Double



A pair of turnouts connected back-to-back, permitting movement between parallel tracks

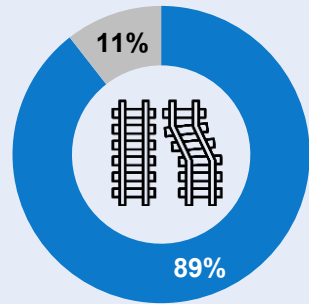
Grade Crossings



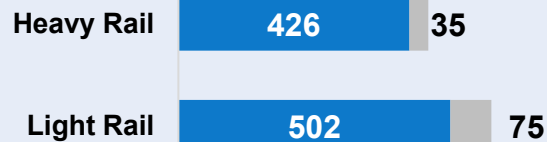
A location where railway and roadway or footpaths meet at grade

Track – Transit

This analysis found that approximately **89%** of the MBTA's transit track assets were out of a State of Good Repair as of July 1, 2021, totaling to a **\$2.0B** SGR Index.



**Track – Transit |
Assets / Track Miles
Out vs In SGR by Mode**



Inventory Notes

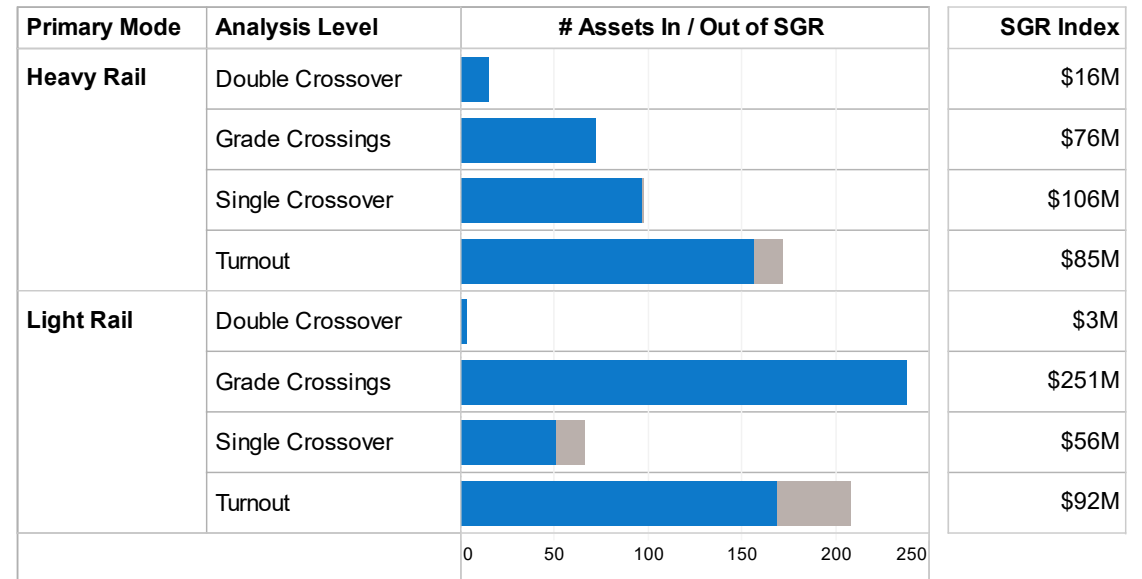
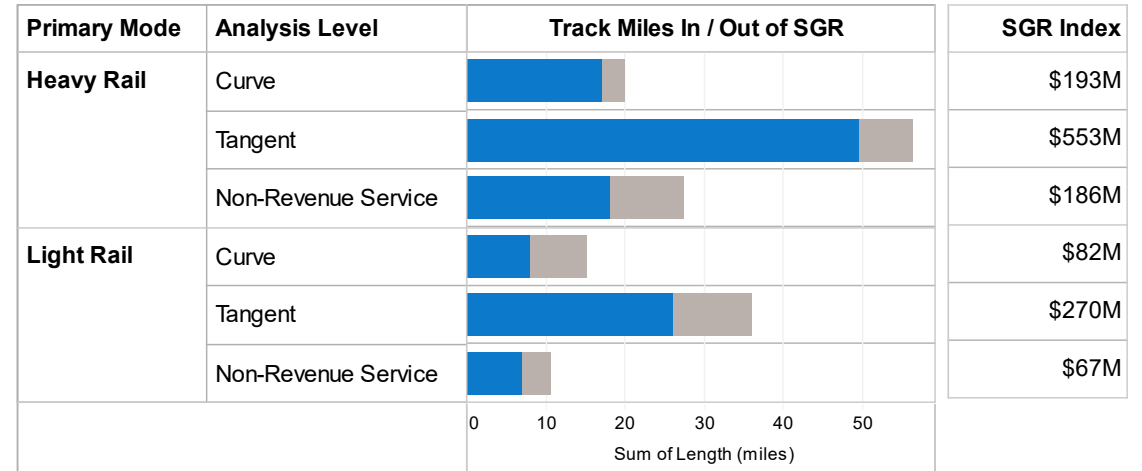
- Overall asset count has increased to include 200+ light rail grade crossings that were not previously captured
- Curve, tangent, and non-revenue service track represent the highest proportion of the SGR Index at \$1.4B

Key Capital Investments Currently Underway

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

- Copley to Arlington Track Replacement (P0917)
- Wellington (P0514) and Cabot Yard (P0512) Complete Upgrade
- Red Line Braintree Branch (P1133) and Ashmont Branch (P1132) Track Replacement

Track – Transit | SGR Index by Primary Mode and Track Type



■ Out of SGR ■ In SGR

Power

Power assets include the infrastructure to generate power, move transit rail cars, support key network systems, and provide facilities with energy.

Unit of Count

- Overhead catenary assets are broken into linear foot sections, with each section representing one asset.
- Individual components within the South Boston Power Gas Turbine, High Voltage Yard, wayside equipment, and substations are each counted as separate assets
- Generators are each considered a separate asset

Cost Methodology

- Overhead catenary assets use cost-per-linear-foot
- Traction power and unit substation equipment assets use cost per substation
- Costs for the South Boston Power Gas Turbine and High Voltage Yard reflect estimates for the facilities as a whole
- Wayside equipment and cable use cost per linear foot of cable
- Cost-per-generator was used to estimate replacement cost for emergency generators

Condition Methodology

Condition scores are assigned by engineers who perform a visual assessment of power assets.

Traction Power Substation (TPSS) Equipment



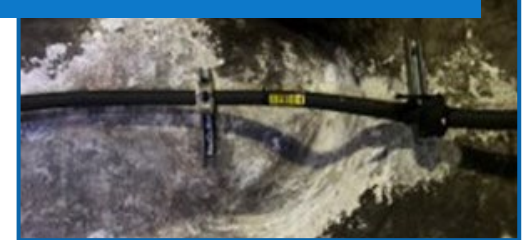
Unit Substation (USS) Equipment



Overhead Catenary



Wayside Equipment and Cable



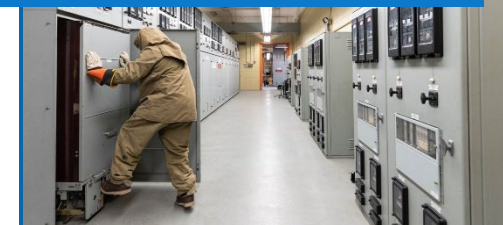
Generators



High Voltage Yard

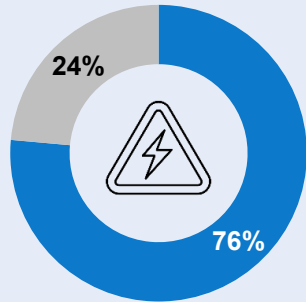


South Boston Power Gas Turbine Generator System



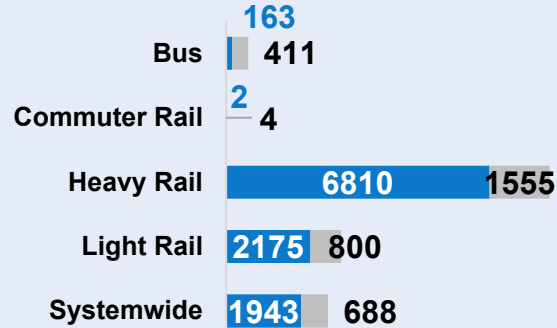
Power

This analysis found that approximately **76%** of the MBTA's power assets were out of a State of Good Repair as of July 1, 2021, totaling to a **\$5.1B** SGR Index.



Power
\$5,108M

**Power |
Assets Out vs In SGR by Mode**



Inventory Notes

- This inventory does not include Commuter Rail power-related assets, except for a small number of emergency generators located within the transit service area.
- Heavy Rail overhead catenary assets support Blue Line service
- This analysis builds from the 2019 Systemwide Power Assessment to estimate power-related capital needs at the asset type and mode level.

Key Underway Investments

The following in-flight projects will rehabilitate or replace assets that are currently out of SGR:

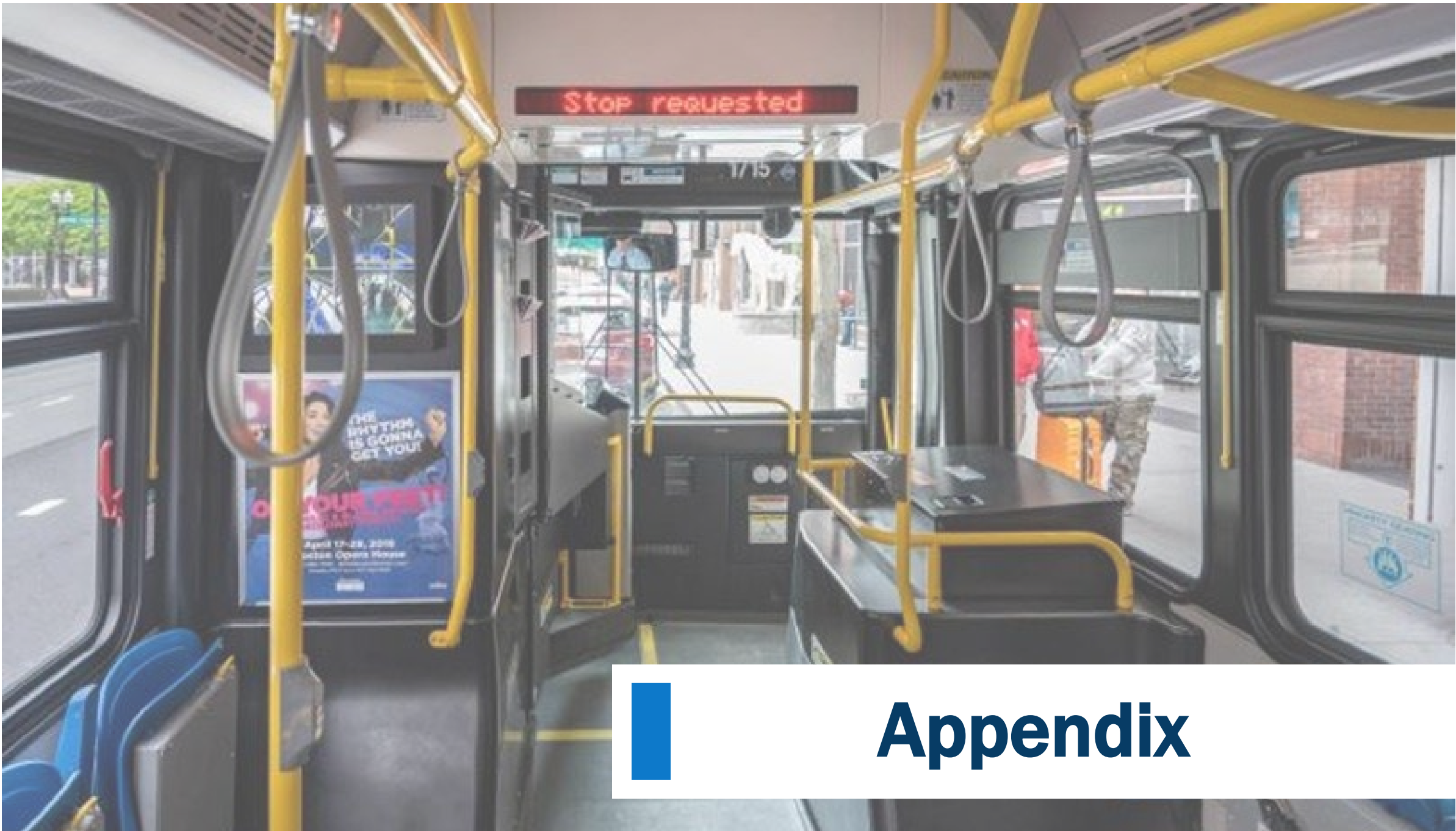
- Red Line Substation Traction Power Upgrades (P0144)
- South Boston to Forest Hills Duct Bank Replacement (P1114)
- Green Line Overhead Catenary System State of Good Repair (P0919)

Power | SGR Index by Asset Type and Primary Mode

Asset Type	Primary Mode	# Assets In/Out of SGR	SGR Index
Traction Power Substation Equipment	Bus	<div><div></div></div>	\$44M
	Heavy Rail	<div><div></div></div>	\$2,790M
	Light Rail	<div><div></div></div>	\$1,146M
	Systemwide	<div><div></div></div>	\$571M
Unit Substation Equipment	Systemwide	<div><div></div></div>	\$397M
Emergency Generators	Bus	<div><div></div></div>	\$2M
	Commuter Rail	<div><div></div></div>	\$0M
	Heavy Rail	<div><div></div></div>	\$19M
	Light Rail	<div><div></div></div>	\$2M
High Voltage Yard	Systemwide	<div><div></div></div>	\$24M
South Boston Power Gas Turbine Generator Systems	Systemwide	<div><div></div></div>	\$20M

Asset Type	Primary Mode	Sum of Length (ft)	SGR Index
Overhead Catenary (Line, Power Section Grouping)	Heavy Rail	<div><div></div></div>	\$18M
	Light Rail	<div><div></div></div>	\$74M

■ Out of SGR ■ In SGR



Interior of an MBTA bus.



Appendix

Asset Inventory

- The CNAI effort kicked off in December 2020 and is based on an asset inventory collected as of July 1, 2021.
 - Due to the cyclical nature of condition assessments and inventory activities, the inventory data was collected between 2018 – 2021.
 - This analysis does not account for recent capital investments since July 1, 2021, such as PTC/ATC signals or track replacement associated with the 2022 Orange Line surge work.
 - A refresh of the asset inventory and condition assessments is currently underway in preparation for the 2026 Transit Asset Management Plan (TAMP) update
- For the Capital Needs Assessment, assets have been grouped into the following 9 functional asset classes, each of which include several different asset types:



Facilities

Stations and stops, parking structures, trailers, bus garages, pump rooms, and other buildings.



Structures

Bridges and tunnels, some of which may include multiple lines or complex spans.



Track - CR

Linear feet of rail and special trackwork elements such as grade crossings, turnouts, and crossovers on the Commuter Rail network.



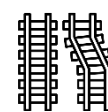
Rolling Stock

Trains, buses, ferryboats, and other vehicles used for revenue service.



Signals - CR

Switches, signals, train detection circuits, and related components supporting the Commuter Rail system.



Track - Transit

Linear feet of rail and special trackwork elements such as grade crossings, turnouts, and crossovers on the transit network.



Equipment

Non-revenue steel wheel or rubber tire vehicles, including swing loaders, cranes, snowplows, ballast tampers, and other support vehicles.



Signals - Transit

Switches, signals, train detection circuits, and related components supporting the transit system.

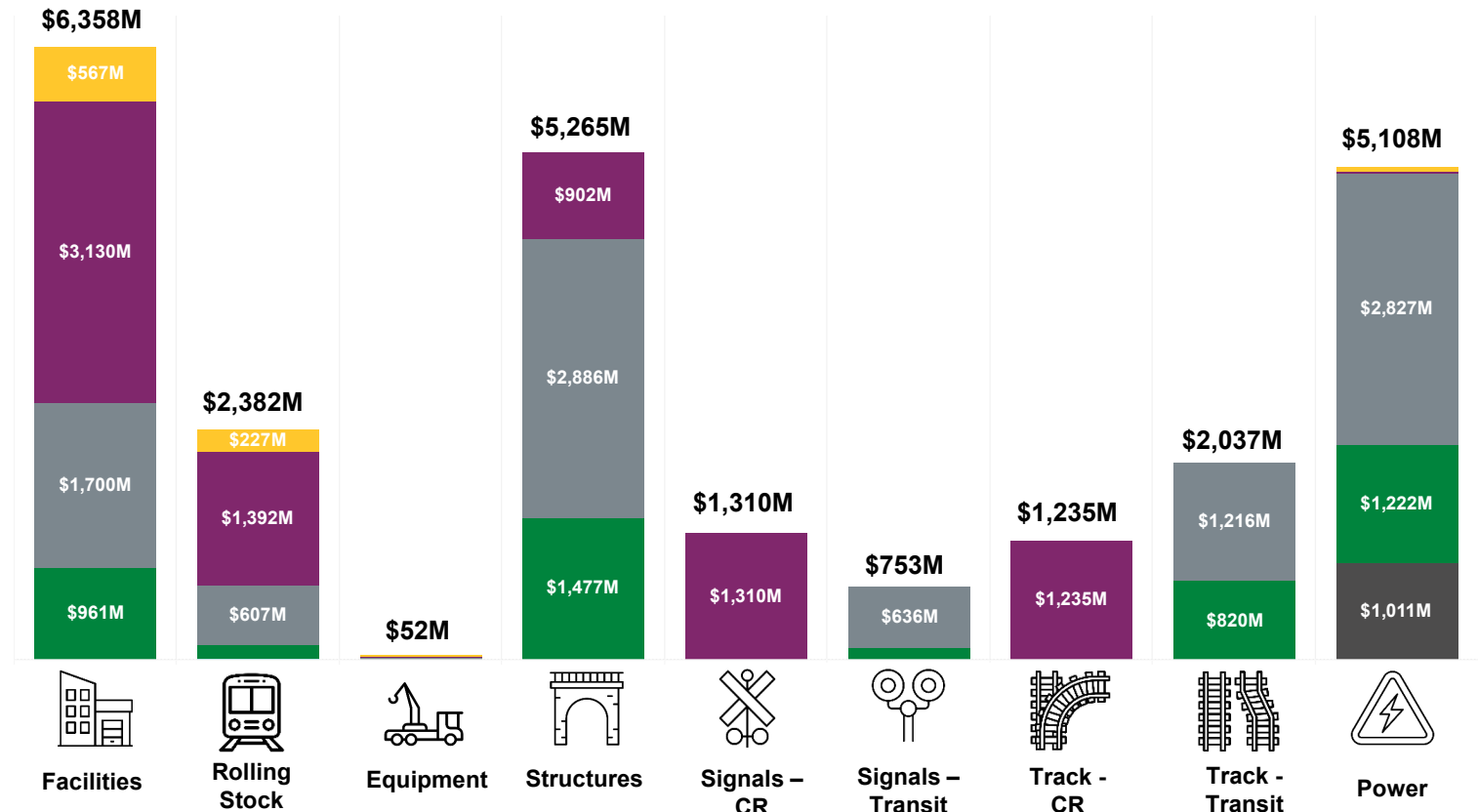
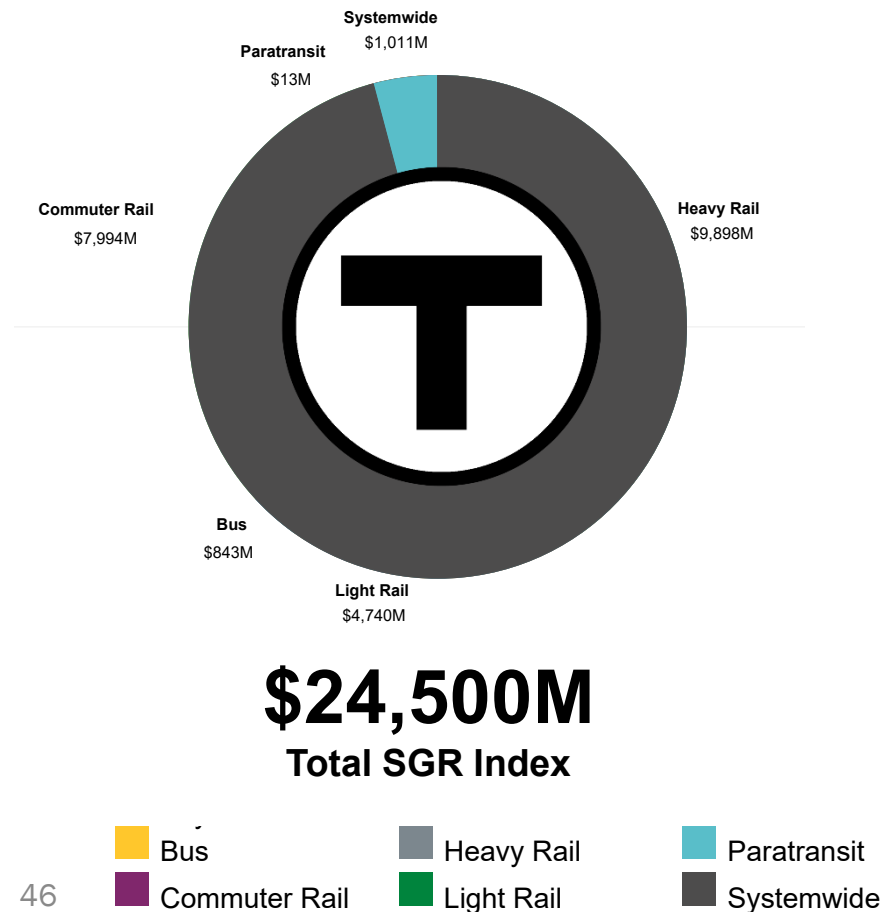


Power

Emergency generators, traction power substations, unit substations, high voltage yards, overhead catenary, and the South Boston power turbine.

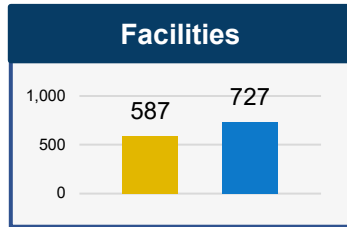
Summary | SGR Index by Mode

- Using an updated approach and a more developed inventory of assets, the MBTA has developed a capital needs estimate of \$24.5B, demonstrating a significant need for on-going and increased investment across the network
- “Out of a State of Good Repair” indicates the risk of more frequent failure and greater maintenance efforts. It is not a representation of unsafe operations, but of inefficient service.

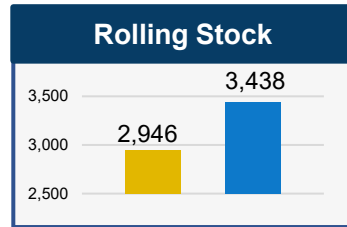


Changes to Asset Counts

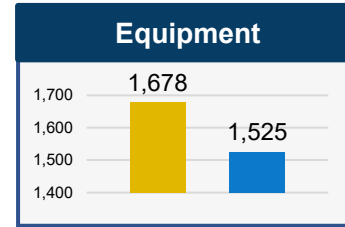
Changes in the asset inventory since 2019 include:



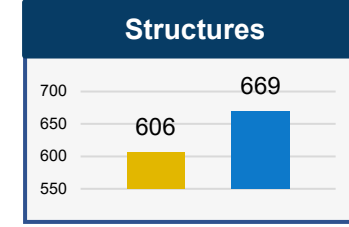
Increased asset count to include trailers, sheds, and other minor facilities



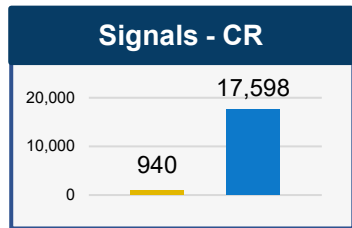
Increased count due to expansion of bus and transit vehicle fleets



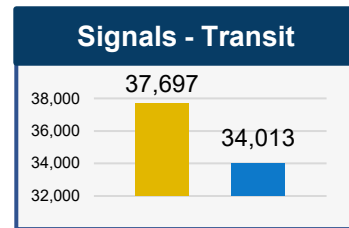
Decreased asset count due to auction of retired, antiquated vehicles



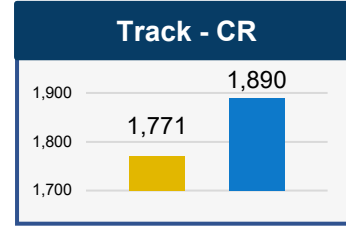
Increased asset count to include non-revenue bridges and culverts



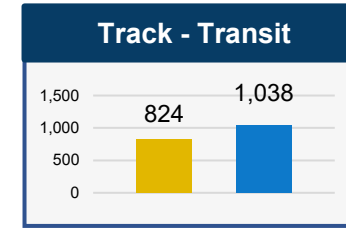
Increased asset count to capture individual switch machines and signal houses, rather than groupings of assets



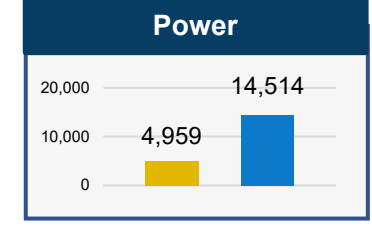
Decreased asset count, capturing introduction of a more efficient relay system on the Blue Line



Increased asset count to include additional special track assets not previously captured



Increased asset count to include ~200 light rail grade crossings that were not previously captured

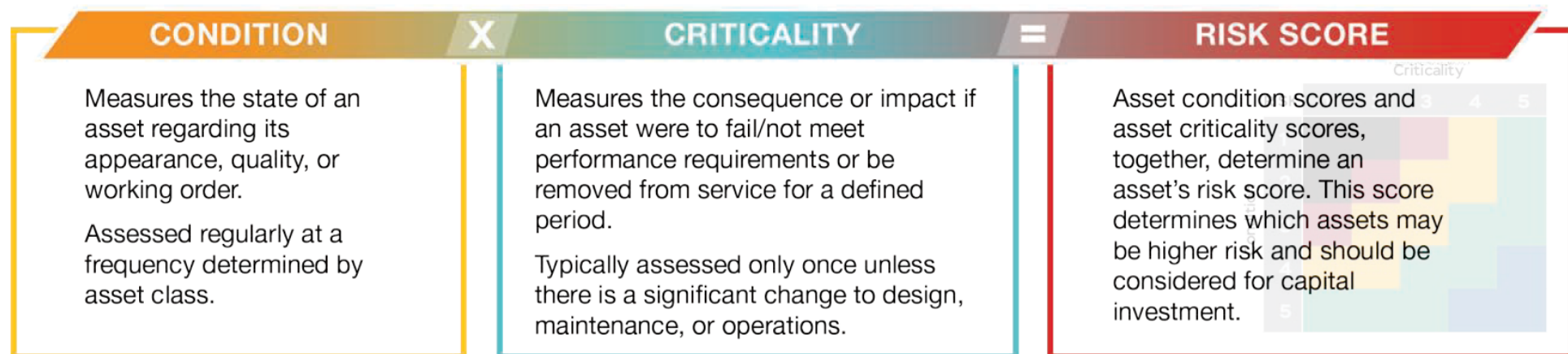


Increased asset count to capture cable, overhead catenary, emergency generators, high voltage yard, and power station equipment at a greater level of detail

2019 2023

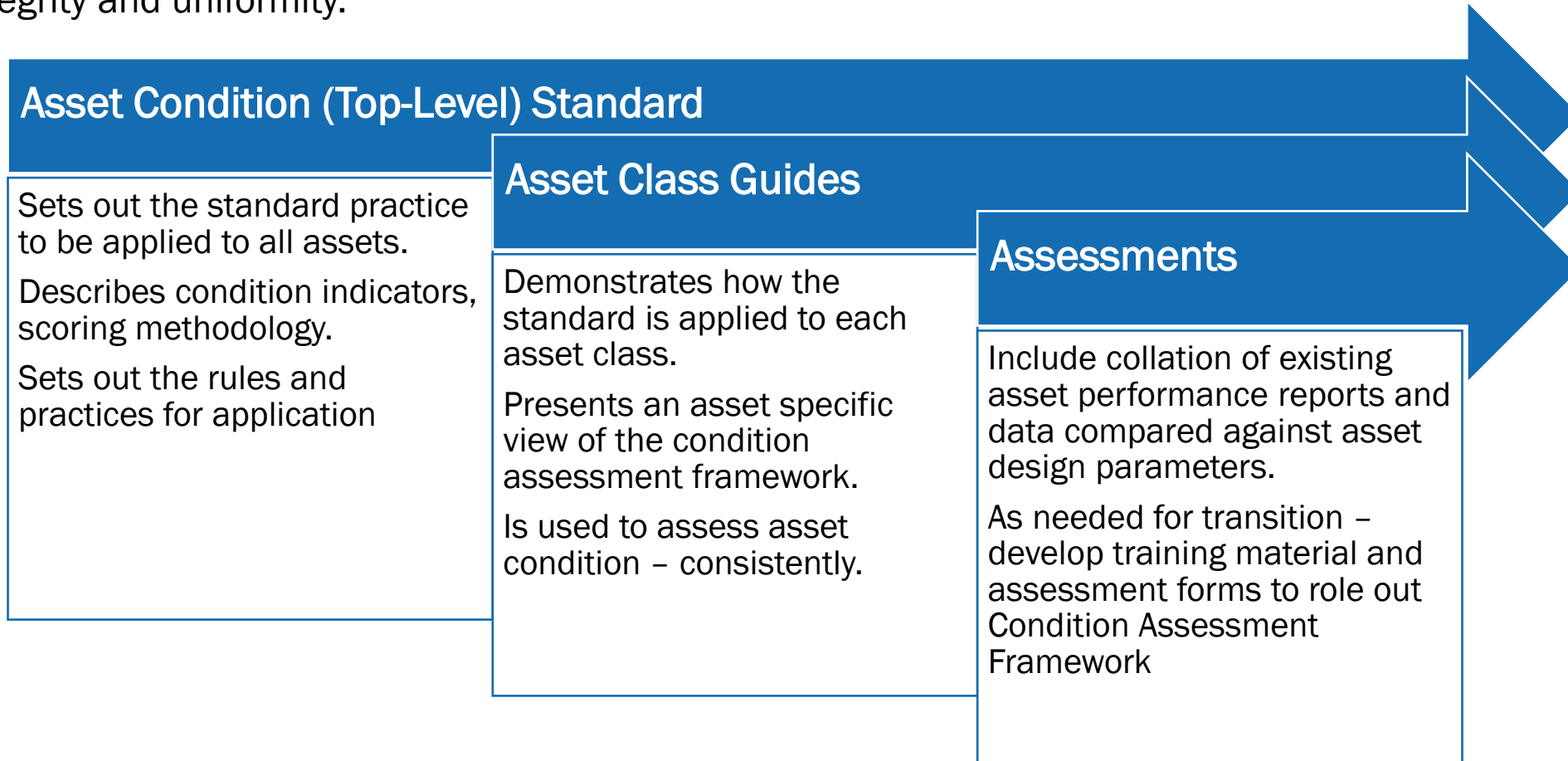
Condition, Criticality, and Risk Score

- The CNAI developed an Asset Prioritization Framework, using each asset's condition and criticality, to support the agency's understanding of which assets are higher risk and should be considered and prioritized for capital investment
 - The **Condition Score** refers to the state of an asset regarding its appearance, quality, or working order and the probability of asset failure or underperformance. Condition is rated on a scale of 1-5, with a lower Condition Score indicating worse condition.
 - The **Criticality Score** refers to the relative impact of an asset's failure or underperformance regarding safety, service, equity, and sustainability. Criticality is rated on a scale of 1-5, with a lower Criticality Score indicating the asset is more critical.
- **Risk Score** is the product of an asset's Condition and Criticality Scores. Risk indicates both the likelihood of failure and the consequence of failure and informs the relative priority for capital investment. The Risk Score is calculated on a scale of 0-25, with a lower score indicating higher risk and thus higher priority for investment.



Condition Assessment Framework | Outline

- Over the last 2 years, the Asset Management team has developed Condition Assessment Standards and Guidelines to drive towards a more holistic view of our asset's state of good repair, beyond just age, and ensure data integrity and uniformity.



FTA Guidance and Condition Rating Scale

- The FTA has set a five-point scale for transit agencies to use when measuring asset condition.
 - An asset is deemed to be in good repair if it has a rating of 3, 4, or 5 on this scale.
 - An asset with a rating of 1 or 2 is considered not in good repair and in need of replacement.
- Additional information:
 - [TAM Facility Performance Measure Reporting Guidebook](#)
 - [TAM Infrastructure Performance Measure Reporting Guidebook](#)

FTA TERM Condition Assessment Scale

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



Condition Score | Five Condition Indicators

- The **Condition Score** refers to the state of an asset regarding its appearance, quality, or working order and the probability of asset failure or underperformance. Condition is rated for each indicator where applicable to an asset class on a scale of 1-5, with a lower Condition Score indicating worse condition.
 - Condition Scores in the 2022 CNAI were primarily driven by the **age** and **visual** indicators. Visual condition is determined by field assessments performed by professional engineering firms.
 - As the Agency refreshes its condition data using this standard, more indicators will contribute to the overall condition scores

Condition Indicator	Description
Age	Estimate based on the share of an asset's expected useful life elapsed (proxy for condition)
Visual Condition	Assessment based on visually identifiable signs of asset wear or deterioration (physical condition)
Reliability	Assessment based on an asset's continued ability to function at its required standard, which should include consideration of the historic failure rates of the asset (functional condition)
Measured Condition	Assessment based on repeatable, automated equipment-based or manual measurement of one or more specific asset characteristics which are indicative of the asset's overall condition (physical or functional condition)
Maintenance Condition	Assessment based on the ability to maintain condition (or performance of the asset) using planned maintenance activities, and the number of outstanding maintenance activities that exist.

Criticality Score | Framework

- The **Criticality Score** refers to the relative impact of an asset's failure or underperformance regarding safety, service, equity, and sustainability. Criticality is applied to all assets and is rated on a scale of 1-5, with a lower Criticality Score indicating the asset is more critical.

MBTA Strategic Priorities	Criticality Factor	Factor Weight	Description
Safety	Safety	30%	Consider whether an asset is classified as safety-critical or not
Sustainability	Climate Vulnerability	20%	Consider climate vulnerability including extreme heat, sea level rise and storm surge, inland flooding, high winds, and winter weather
Service	Operations & Maintenance	20%	Consider impacts on operations and maintenance including an asset's operational importance, redundancy, time to repair, and regulatory compliance.
	Ridership (Overall)	10%	Consider the volume of riders impacted should an asset fail or go out of service for a period of time.
Equity	Ridership Equity Impact	15%	Consider the proportion of riders impacted that are low income, minority, low vehicle households, seniors, or persons with disabilities.
	Accessibility	5%	Consider whether an asset is an accessibility feature or not that would impact people with disabilities or seniors