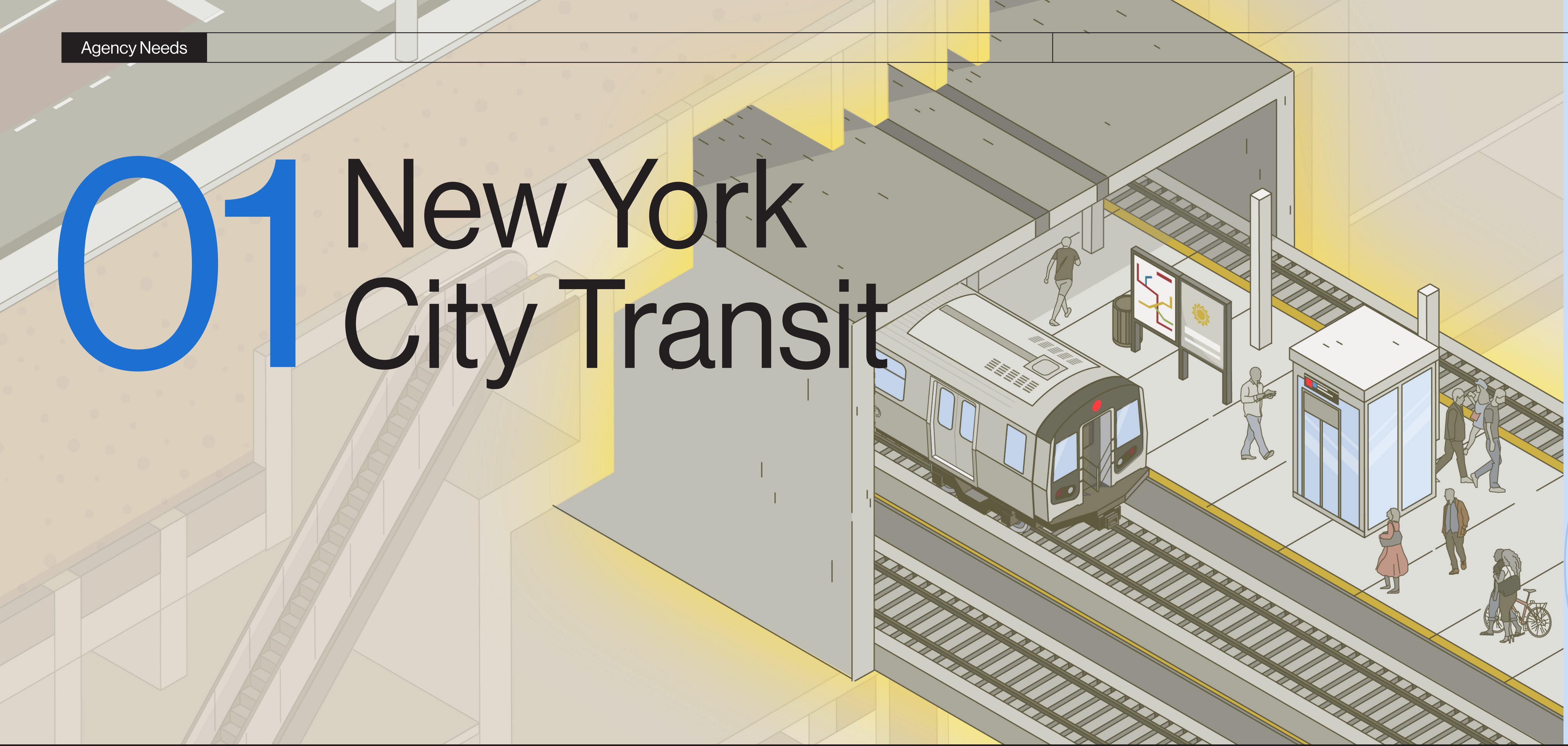
20-Year Needs Assessment

Appendix

APPENDIX

01 New York City Transit



Subway cars, maintenance facilities, and yards

Buses, depots, and bus maintenance facilities

Passenger stations

Subway infrastructure systems: Line structures, track, signals, traction power, line equipment, and communications infrastructure

Overview of agency and assets

New York City Transit (NYCT), together with Staten Island Railway (SIR) and MTA Bus, operates the most extensive and highest ridership subway and bus systems in the United States. We operate 24 hours a day, 365 days a year. Our trains, buses, stations, and all auxiliary equipment and infrastructure—like rail yards, bus depots, signals, power, and communication systems—are the foundation of our network, and require substantial and sustained capital investment to address historical underinvestment and to allow us to deliver the frequent and reliable service our riders have come to expect.

Our vision for New York City's transit system 20 years from now is one with more reliable and frequent service that is more resilient and sustainable, runs with more modern equipment, and is more accessible. The 20-Year Needs Assessment lays out a plan for us to get there.

NYCT, SIR, and MTA Bus by the numbers:

- Weekday ridership: Approximately 6.8 million (4.5 million subway and 2.3 million bus)
- 6,540 subway cars, 56 shops, and 24 rail yards
- 5,840 buses, 38 bus depots and facilities
- 493 passenger stations
- 306 station elevators and 231 escalators
- 266 miles of line structures
- 694 miles of mainline track and 1,825 track switches
- 794 miles of signal equipment and 217 signal interlockings
- 233 substations and 321 circuit breaker houses
- 209 fan plants
- 254 pump rooms and 23 deep wells
- 680 work train cars

J train entering Broadway Junction station

Investment needs highlights

Over the next 20 years, our priority investment needs include:

- **Subway cars, maintenance facilities, and yards**
  - Purchasing over 3,900 subway cars to replace aging cars, expand the fleet, and improve reliability, accessibility, and passenger experience.
  - Reconstructing and upgrading car maintenance facilities at Livonia Yard and 240th Street Yard to address poor facility conditions and enable them to accommodate modern subway cars.
- **Buses, depots, and bus maintenance facilities**
  - Continuing cyclical replacement of buses, replacing about 9,000 buses over the next 20 years.
  - Transitioning to zero-emissions buses as buses are retired, achieving a full transition to a zero-emissions fleet by 2040.
  - Installing infrastructure to support the zero-emissions bus transition at depots and maintenance facilities.
- **Passenger stations**
  - Continuing station component repair programs with quicker implementation of projects as deteriorated components or other needs are identified.
  - Installing modern public address and digital information screens in every station.
  - Building new elevators and ramps to expand the number of accessible stations, in line with MTA's goal of at least 95% of subway stations being accessible by 2055.
  - Addressing water infiltration conditions in at least 40 stations, targeting the root causes of structural deterioration.
  - Reducing extreme heat conditions in stations' critical equipment rooms.
- **Subway infrastructure systems**
  - Ensuring structural soundness of elevated steel structures by repairing all significant defects and routinely applying or renewing protective coating systems.
  - Improving power reliability across the network by renewing or upgrading approximately 190 substations, addressing critically poor power cable and circuit breaker house conditions, and upgrading the Power Control Center and its remote control system (SCADA).
  - Improving subway performance and reliability and unlocking additional capacity by modernizing over 300 miles of signals, ensuring 90% of riders are served by modern signals.

Q train, NYCT

New York City Transit appendix structure

This appendix provides an overview of our assets, their current condition, and expected investment actions to maintain these assets over the next 20 years. This appendix is divided into asset groupings, based on how our categories function together. For example, our passenger vehicles are supported by our shops, yards, and facilities. We provide a summary of each asset grouping, describe how the asset categories support each other, and then provide a 20-year vision for their maintenance and enhancement. Each asset category section then provides a more detailed description of the asset, an inventory showing their ages or the percentage of assets in poor or marginal condition, followed by the agency's investment needs and priorities for the next 20 years.

Our asset rating methodology

We perform regular and comprehensive inspections of all of our assets. Through these inspections, all assets are given a condition rating on a scale of 1 to 5, based on various factors, including age, condition assessment, performance, reliability, safety history, and location. Assets with a rating of 1 (poor) or 2 (marginal) help us identify where we need to focus investment needs the most. This rating scale is consistent with the Federal Transit Administration's Transit Economic Requirements Model scale. A brief description of the rating scale is provided below.

1. Poor (Deteriorated): Critically damaged or in need of immediate repair, well past useful life. Assets are operable with extraordinary maintenance, but have serious functional deficiencies and/or can be expected to experience potentially unacceptable stoppages over the next five years, which could have serious negative impacts on service within the existing maintenance framework. Assets require operating-funded interventions, which may include more frequent inspections and/or repairs that may include removing the asset from service until repairs can be performed. Capital investment in these assets is needed on a priority basis.

2. Marginal (Deficient): Deteriorated, in need of replacement, and may have exceeded useful life. Assets have functional deficiencies and/or can be expected to experience above-normal stoppages over the next five years, but severity of customer impacts or changes to operational practices can be held within acceptable bounds for a time within the existing maintenance framework. If capital investment is/was deferred for these assets, added maintenance and operating expenses would be expected.

3. Adequate (Acceptable): Moderately deteriorated, but has not exceeded its useful life. Assets that are not necessarily meeting all current technical and functional standards, but are considered adequate for service and can be expected to experience normal stoppages that can be fully accommodated within the existing maintenance framework. These assets may require cyclical replacement in the next five years.

4. Good: No longer new, but in good condition and still within its useful life. Assets may be slightly deteriorated, but are overall functional within the normal maintenance practices.

5. Excellent (Modernized): No visible defects, new or near new condition and may still be under warranty (if applicable). Considered to meet most or all important technical and functional standards.

It is important to note that an asset condition rating is not an indicator of safety. Safety and risk assessments are performed separately from asset condition ratings and are addressed on an ongoing basis.

SUBWAY CARS MAINTENANCE FACILITIES AND YARDS

NYCT and SIR operate and maintain about 6,500 passenger railcars, which are linked together to make up nearly 600 trains used for daily service. To keep our railcars in good condition throughout their 40-year lifespan, they receive regular inspections and maintenance at our railcar maintenance shops and occasionally get more extensive heavy maintenance work at our overhaul shops. When they are not in service, they are staged at one of the many yards located throughout the network.

Reliable railcars are critical to quality service and make up a significant portion of the anticipated investment needs over the 20-year timeframe. This level of investment is needed to maintain the high service level that NYCT has achieved through our past railcar purchases and comprehensive railcar maintenance program. Renewing the railcar fleet and keeping our subway car maintenance and storage facilities in good condition is essential for us to be able to provide reliable service and create a better transportation experience for riders.

Over the next 20 years, our investment needs include:

- **Subway cars**
  - **Replace nearly 1,500 cars coming due for replacement in the next five years and continue lifecycle replacement of over 2,400 more cars as they reach 40 years of age.**
- **Subway shops and yards**
  - **Reconstruct and upgrade railcar maintenance facilities at Livonia Yard and 240th Street Yard to address poor facility conditions and enable them to accommodate the new train cars. We will also repair and rehabilitate hundreds of facility components at other shops where there are poor or marginal conditions.**
  - **Upgrade selected shops and yards, such as at 207 Street and Coney Island Overhaul shops, to accommodate increased maintenance needs, as well as expand Jamaica Yard to provide sufficient storage capacity for trains serving the Queens Boulevard and other lines.**
  - **Install low-emissions building systems and renewable power generation where feasible to reduce carbon emissions and advance MTA's sustainability goals.**

Subway cars

Because our subway network is essentially two distinct systems,[1] we have two basic types of railcars which are divided into the A Division and B Division. Our current NYCT subway fleet has 2,890 railcars in the A Division and 3,589 railcars in the B Division, for a total fleet of 6,479 railcars. With the 61 SIR railcars, the complete fleet totals 6,540 railcars.

The B Division currently operates with two different railcar sizes (60-foot and 75-foot), but is now being standardized to the shorter 60-foot railcar length. As older 75-foot railcars are replaced with newer 60-foot ones, more railcars will be needed to make up the same number of train sets. SIR has a much smaller fleet, with a total of 61 railcars currently operating and scheduled to be replaced by the ongoing R211 railcar purchase.

Interior of R211 subway car

Subway train cab

Asset inventory and status

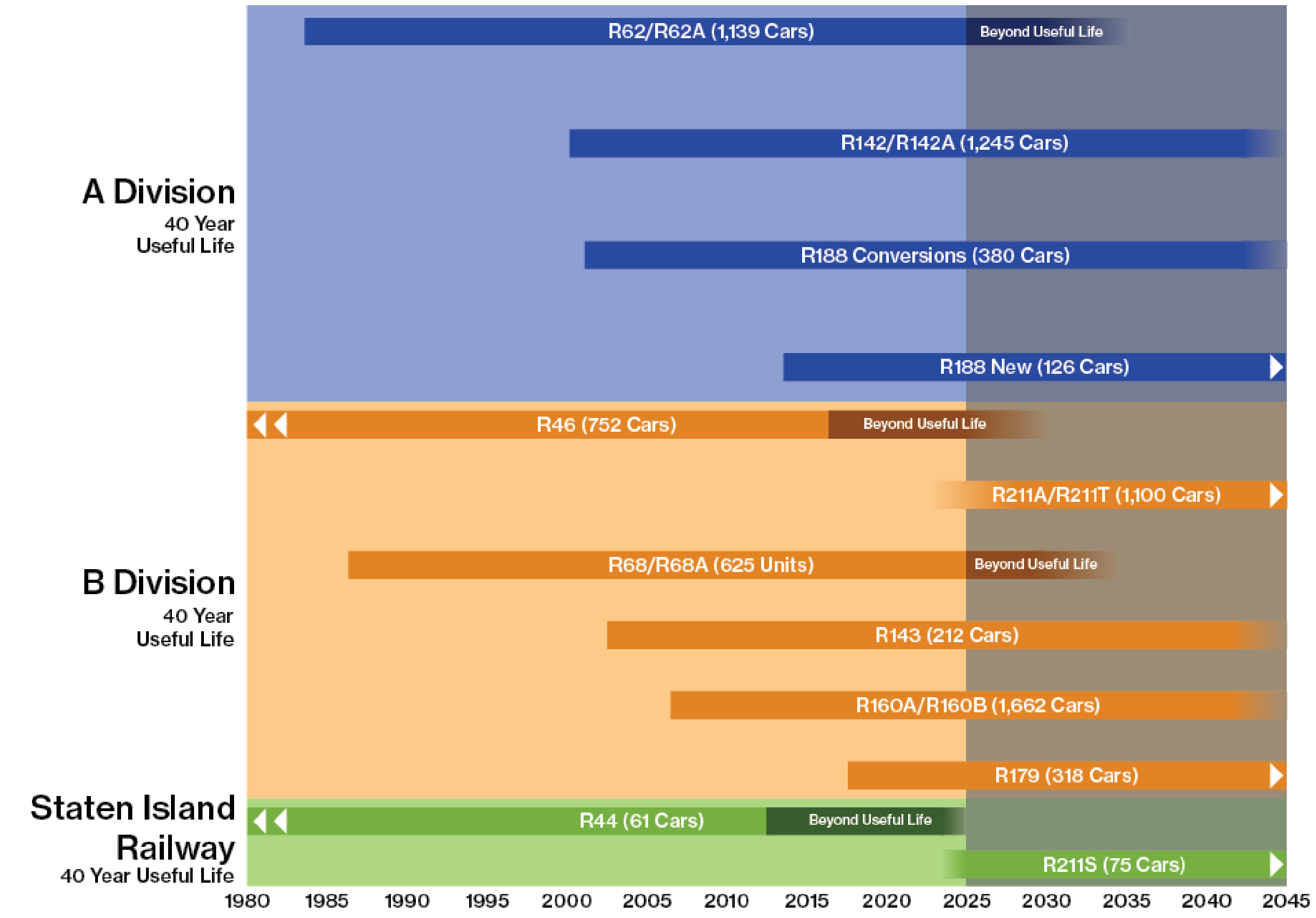
We use two primary indicators to assess the condition and performance of our railcars, which together guide decisions on when further investment or replacement is warranted.

- **Useful life:** Older railcars are more prone to breakdowns, require more frequent and costly maintenance to keep in service, and are less comfortable for our passengers due to worn interiors. They also sometimes lack modern amenities or do not meet the latest accessibility standards we have for new railcars. Any railcar over the age of 40 is considered past its designed useful life. We plan to continue replacing railcars before they reach the end of their useful life.
- **Mean Distance Between Failures (MDBF):** This is a measure of reliability that expresses the subway car's mean (average) operating distance mileage traveled between all relevant train delay failures.
  - Investments since 1982 have increased reliability from an average of 7,000 miles between breakdowns to more than 127,000 miles today. Comparatively, today's newer railcars' MDBF can reach above 250,000 miles while the oldest railcars at the end of their useful lives can fall to about 40,000 miles—a six-fold difference.
  - Older railcar classes were three times more likely to undergo a "hot car" incident (revenue service vehicles with an HVAC component failure) over the past three years. These older railcar types are equipped with underbody-mounted HVAC units, compared to the newer railcar models with modern overhead units.

For the A Division, 39% of cars are reaching their expected useful life and are planned for replacement starting in the current capital program and continuing in the next. For the B Division all railcars except for the R46 model are within their useful life. Replacement of the R46s—the system's oldest railcars—is already funded under the R211 railcar project, which has entered the delivery phase this year. The current fleet of 61 SIR railcars has exceeded its useful life and is on track to be replaced with soon-to-be-delivered R211 railcars as well.

In addition to reliability benefits, new railcars will be equipped to utilize a more modern signaling system, known as Communications Based Train Control (CBTC), which leads to even greater reliability of service. See below the section on Signals for definition and benefits of CBTC.

Rail Fleet - New York City Transit



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[1] The A Division has narrower car widths and includes the numbered routes and the 42nd Street Shuttle, the remaining parts of the former Interborough Rapid Transit Company (IRT). The B Division has wider car widths and is comprised of the lettered routes along with the Rockaway Park and Franklin Avenue Shuttles, the combined remaining parts of the former Brooklyn-Manhattan Transit Corporation (BMT) and the city-owned Independent Subway System (IND).

G train, NYCT

Investment needs

Periodically renewing the railcar fleet is essential to providing reliable service and creates a better experience for riders. Our newest railcars have equipment failures much less frequently than older railcars. They also have improved features like wider doors to expedite boarding and alighting, security cameras, digital information displays, and automated announcements. Over the next 20 years, we plan to continue to purchase railcars as they reach the end of their useful lives. New railcars will be delivered with CBTC equipment installed.

Over the next 20 years, we need to:

- Replace over 3,900 subway cars:
    - Approximately 1,500 railcars to replace R62, R62A, R68, and R68A railcars. (Some of these cars may be funded from the 2020-2024 Capital Program.)
    - Approximiately 1,600 railcars will be needed for the normal replacement of the R142/R142A and R188 converted car fleets starting in the 2040-2045 timeframe.
    - Near the end of the 20-year period, we will begin replacing the approximately 200 R143 railcars and 1,700 R160 railcars.
- Ensure we have the right fleet size for the future by assessing fleet growth needs before new subway car purchases.
- Evaluate retrofitting existing R142/R142A with CBTC equipment, depending on progress of planned signal system upgrades and if needed to expedite the conversion of more lines to the CBTC signaling system.

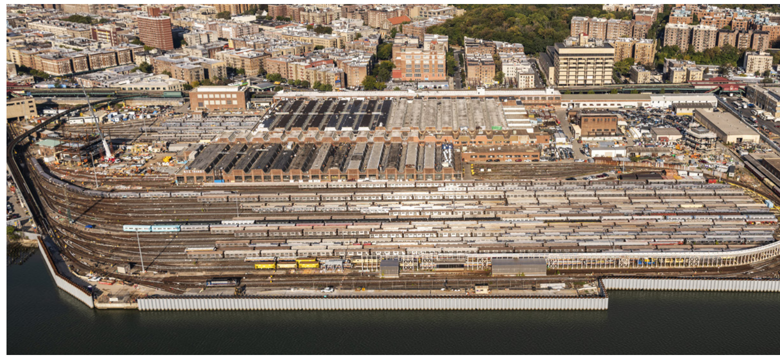
Shops and yards

Our railcar maintenance and overhaul shops are essential to keeping our subway railcars in good working order throughout their 40-year lifespan. Together, these facilities house the inspection, repair, and comprehensive component change-outs and overhauls, as well as other repairs that might be needed. We also have a separate set of facilities used to support Maintenance of Way (MOW) and other divisions and their work in keeping the signals, electronics, track, structures, stations, and other assets in good working order.

Our yards are large properties that we use for the storage of passenger railcars when they are not in service and where we do car cleaning and washing of railcar exteriors. As fleets expand, additional train storage space may be needed.

Asset inventory and status

Many of the maintenance shops and facilities have many critical elements that are not in good condition, and some facilities are over 100 years old. These facilities' components, their functional areas, production capacities, and space configurations are often not in good condition or are not adequate for our staff to be able to optimally perform work on new technology rail fleets that have more electronic components.



207 St Yard, NYCT

Inventory and status

Asset/Component		Total	Percent in Poor/Marginal Condition
Railcar Maintenance Shops (15 Shops)	Roof	15	47%
	HVAC	15	47%
	Exterior	15	33%
	Building Structure	15	73%
	Electrical	15	33%
	Elevators	8	63%
	Employee Facilities	15	80%
	Heavy Shop Equipment	41	10%

Inventory and status

Asset		Total	Percent in Poor/Marginal Condition
Railcar Overhaul Shops (2 Overhaul Complexes, 15 Sub-shops)	Roof	15	13%
	HVAC	15	67%
	Exterior	15	13%
	Building Structure	15	73%
	Electrical	15	13%
	Elevators	12	100%
	Employee Facilities	15	47%
	Heavy Shop Equipment	246	36%
Rail Storage Yards (24 Rail Yards)	CCTV*	2	50%
	Fencing	24	0%
	Hydrants	24	8%
	Lighting	24	50%
	Yard Track (miles)	102	25%
	Yard Signal	23	42%
	Yard Switch	874	19%

Inventory and status

Asset/Component		Total	Percent in Poor/Marginal Condition
Car Washer (8 Car Washers)	Enclosures	8	13%
	Equipment	8	13%
	Lighting	8	13%
	Electrical	8	0%
	Plumbing and Drain	8	13%
Maintenance Support Shops	Roof	29	69%
	HVAC	29	48%
	Exterior	29	48%
	Building Structure	29	38%
	Electrical	29	55%
	Employee Facilities	29	45%
	Heavy Shop Equipment	29	31%
SIR Maintenance Shops	Overall Rating	2	50%

** Only two yards currently have CCTV systems that meet the capitally eligible technical standards.*

Below, Livonia Yard, NYCT

Coney Island Shop, NYCT

Investment needs

Our investment needs include addressing poor and marginal building components and making upgrades to the shops and yards to provide a safer and more efficient workplace. Additionally, an ongoing condition survey of all subway facilities will provide a more comprehensive assessment of the facilities to be used to prioritize specific capital projects in future capital programs.

To meet energy efficiency and emissions reduction goals, we will also explore opportunities to upgrade building HVAC equipment, incorporate renewable energy technologies (e.g., rooftop solar photovoltaics), conserve energy, and reduce GHG emissions through other means. We will actively work towards integration of energy efficiency and renewable energy strategies, wherever feasible.

Over the next 20 years, we need to:

- Increase the pace of investment to address the repair and rehabilitation of hundreds of facility building components and systems that are in poor or marginal conditions. Over 200 facility components are rated poor or marginal at our passenger railcar maintenance and MOW facilities combined.
- Reconstruct and reconfigure selected facilities, such as the 240th Street and Livonia car maintenance shops. These facilities require reconfigurations and upgrades to allow them to service the new car fleets' roof mounted air conditioning (HVAC) units and to provide working aisle widths between shop tracks that meet industry standards and best practices.
- Improve car HVAC and A/C traction motor maintenance capacity at 207th Street and Coney Island facilities to meet expected workloads from thousands more railcar HVAC units and A/C motors coming online with new fleets.
- Add to SIR's car washing capabilities and address needs at its non-revenue vehicle repair shop.
- Install additional security systems including CCTV and Laser Intrusion Detection Systems at yards and maintain adequate fencing and lighting to prevent unauthorized entries and damage to railcars or yard assets.
- Expand shop and yard capacity where needed to support a larger fleet
- Upgrade non-revenue support facilities, such as at 38th St and Westchester Yards, which are vital hubs for our work train fleet.
- Install electric vehicle charging equipment dedicated for NYCT use in appropriate locations to meet MTA goals of transitioning to 100% zero-emissions light-duty non-revenue vehicles by 2035 and medium/heavy-duty non-revenue vehicles by 2040.
- Advance climate resilience measures in NYCT facilities facing climate change hazards, including flooding and extreme temperature risks.

BUSES, DEPOTS AND BUS MAINTENANCE FACILITIES

NYCT and MTA Bus together operate the largest public bus system in the U.S., carrying 1.4 million riders each weekday (16% of the nation's bus passengers) and operating 10% of all the public transit buses in the nation. More than 90% of New York City residents live within a quarter mile of a bus stop, and buses provide affordable and safe mobility throughout the five boroughs. Our buses are fully accessible to riders with mobility disabilities, and each bus, regardless of propulsion or type, combats congestion and greenhouse gas emissions by carrying far more people than a private vehicle.

Depots and bus maintenance facilities are where buses are fueled, inspected, serviced, and parked when not in use. We have dozens of bus depots and other support facilities located throughout the city, and these facilities range in age from brand new to more than 100 years old.

The MTA has initiated a transition to a 100% zero-emissions bus fleet by 2040, a central component of our agencywide goal to reduce greenhouse gas emissions 85% by 2040. The zero-emissions bus transition will reduce operational emissions by 530,000 tons annually compared to a 2015 baseline. The transition will also eliminate carbon monoxide and nitrous oxide emissions and significantly reduce particulate matter compared to the current bus fleet.

Over the next 20 years, our investment needs include:

- **Buses**
    - **Continue regular replacement of buses, replacing about 9,000 buses over the next 20 years. As buses are retired, we will transition to zero-emissions buses, achieving a full transition to a zero-emissions fleet by 2040.**
- **Depots and facilities**
    - **Upgrade all 28 depots, the two central maintenance facilities, and other support locations with the infrastructure to support zero-emissions buses, as well as non-revenue vehicle fleets.**
    - **Continue depot facility component repairs and normal replacement of depot heavy equipment, based on their condition and in coordination with zero-emissions depot modifications.**
    - **Install zero- or low-emissions building systems and renewable energy generation infrastructure at all depots.**
    - **Reduce exposure to flood risks that are exacerbated by climate change.**

Buses

Express bus

Our bus fleet consists of approximately 5,800 buses of various vehicle and propulsion types. Prior purchases coupled with our service program, including preventative maintenance and general overhauls, have resulted in fleet reliability improving from less than an average of 1,000 miles MDBF in 1982 to more than 7,000 miles today

Asset inventory and status

To best serve our customers, our buses must uphold a high standard for comfort and reliability. As buses age, maintenance needs increase, increasing operating costs to keep older buses in service. As such, we have a cyclical replacement program for buses, and we plan to replace every bus as it reaches approximately 12 years in age. As a part of the planning for each five-year capital program, fleet age is reviewed along with expected changes in capacity requirements to accommodate growth, conversions, and other potential service adjustments.

The current bus fleet is composed of clean diesel, hybrid diesel-electric, compressed natural gas (CNG)-fueled buses, as well as zero-emissions buses. We made our first purchase of zero-emissions buses in 2019, with an order of 15 articulated battery-electric buses. We have either procured or are in the process of procuring 560 battery-electric buses to replace those buses reaching their maximum age. In addition to the existing 15 articulated buses, 60 standard buses are expected to start to be delivered in 2023, and the remaining 485 will be delivered starting in 2025. As of 2020, all CNG buses are fueled with renewable natural gas, a biogas derived from organic waste. This offers a reliable and clean fuel solution without sacrificing vehicle performance.

- **Standard bus:** These operate on most local routes; typically, 40 feet long. Currently there are 3,662 standard buses, and 7% are at or beyond expected useful life.
- **Express bus:** Many operate only during weekday rush hours; looks like a coach bus, with routes generally between Manhattan and another borough; typically, 45 feet long. Currently there are 1,020 over-the-road buses, and 5% are at or beyond their expected useful life.
- **Articulated bus:** Vehicles have increased capacity and length compared to standard buses; look like two standard buses connected by a flexible middle; typically, about 60 feet long. Currently there are 1,158 articulated buses, and 14% are at or beyond expected useful life.

Investment needs

The transition to a zero-emissions bus fleet represents a significant commitment of the 20-year capital needs for NYCT. As we transition, the normal replacement cycle for buses will include an increasing number of purchases of zero-emissions vehicles, and beginning in 2029, all new bus purchases will be zero-emissions. For the next few years, since there are limited bus suppliers with increased zero-emissions demand, we anticipate challenges with supply. However, our phased-in approach, as well as our test and evaluation fleets, give us an opportunity to apply lessons learned while we undergo this transformation.

Our current bus purchase plan for 2025-2044 is summarized in the table below. The full fleet is replaced on a staggered basis, and buses bought in the first five years will be replaced again at the end of the period. Approximately 9,000 replacement buses will be needed over the coming 20-year timeframe.

Changes in ridership or policy that determines bus frequency may affect future bus inventory needs. Inventory needs and planned purchases will be assessed periodically.

NYCT and MTA Bus Fleet Replacement / Transition Plan

		2025-2029	2030-2034	2035-2039	2040-2044
Standard Buses	New Bus (any bus type)	758	-	-	-
	New Bus ZEF	700	1,455	1,880	1,022
Articulated Buses	New Bus (any bus type)	425	-	-	-
	New Bus ZEF	200	195	760	395
Express Buses	New Bus (any bus type)	300	-	-	-
	New Bus ZEF	-	335	695	138
Total		2,483	1,985	3,335	1,555

Additionally, we are working on several new bus seating configurations that will better accommodate riders of all abilities, as well as opportunities for visual and audible communications, such as hearing induction loops (a special type of sound system for use by people with hearing aids). Other enhancements like exterior cameras for Automatic Bus Lane Enforcement will continue. To improve passenger security, we more than tripled the number of cameras onboard buses in 2022 and are adding at least 600 more in 2023. While many of our new buses will have these features built in, staying up to date with bus innovations like these requires regular investment.

Articulated electric bus

Standard bus

Depots and bus maintenance facilities

Supporting our extensive bus fleet are dozens of major facilities encompassing over 6 million square feet across our bus depots, central maintenance facilities, and shops throughout the region. Each of these require ongoing maintenance, major modifications to serve our evolving bus fleet, and strategic investments to tackle the challenges posed by climate change. Due to the facilities' various ages and design, there are many different structure types and sizes, equipment and machinery housed, types of buses stored, and kinds of work that each facility can support. For example, some bus depots are equipped to service CNG buses, while other depots have been modified for articulated buses.

Zero-emissions bus charging

Inventory and status

Depot/Facility Component	Total	Percent in Poor/Marginal Condition
Roof	38	29%
Boiler	38	21%
Air Curtain	31	26%
Ventilation	38	42%
Architectural/Structural	38	24%
Electrical	38	37%
Lighting	38	26%
Elevator	19	53%
Employee Facilities	38	39%
Admin Office	38	45%
Emergency Generators	31	42%
Fire Alarm and Suppression	38	21%
Bus Wash	29	7%
All Rated Bus Depot/ Facility Components	452	31%

Asset inventory and status

We monitor the condition of bus depots, shops, and maintenance facilities on a component basis, and we make investment prioritizations based on the physical conditions and/or age of each component, depending on the component. These components include things like structural elements, building systems, lighting, repair and cleaning equipment, and more. Moving forward, we will analyze the needs for new assets that will reach the end of their typical lifespan over the next 20 years.

Investment needs

With the expansion of the zero-emissions bus fleet, depots must be adapted for electric bus charging, use of alternative fuels, and other functions. This transition will require an unprecedented investment in new charging infrastructure and power supplies, like pantographs and chargers. In addition, we will have to make significant investment to substantially increase the electrical loads (two to four times the capacity needed for depots without electric buses), as well as HVAC modifications to maintain optimal functionality of charging equipment, structural modifications to support the weight of charging equipment, data and communication infrastructure, and enhanced fire suppression. Installing these capabilities requires significant modifications to the buildings' structural and electrical systems. As depots are selected for zero-emissions bus fleet deployments, we will ensure that zero-emissions upgrades are done in tandem with other depot component and condition investments.

In parallel to these ongoing maintenance needs, we will evaluate opportunities for energy-efficient equipment, to phase out fossil fuel building systems, and to incorporate on-site renewable energy generation. For facilities vulnerable to coastal and inland flooding, we will consider strategies such as porous pavements and subsurface detention to reduce stormwater runoff, back-flow preventers to prevent flood water flow into buildings, deployable coastal flood panels at garage doors and other openings, and ensuring exterior walls at buildings are watertight.

Over the next 20 years, we need to:

- Increase the pace of repairing, renovating, and replacing poor or marginal depot and facility components and equipment to clear a backlog of assets that are not in adequate condition. Hundreds of facility components (approximately one third of all major components) are currently in poor or marginal condition.
- Repair depot components as they reach their lifespan limits, including roofs, facades, and systems.
- Implement depot upgrades and modifications to achieve zero-emissions fleet transition goals.
- Incorporate materials, equipment, and designs that reduce exposure to climate risks and the facilities' carbon footprint.

Mother Clara Hale Bus Depot, NYCT

PASSENGER STATIONS

Subway cars, maintenance facilities, and yards

Buses, depots, and bus maintenance facilities

→ Passenger stations

Subway infrastructure systems: Line structures, track, signals, traction power, line equipment, and communications infrastructure

With 493 stations, our transit network has more stations than any other subway or metro network in the world. Some of these stations are nearly 120 years old, with many others at or over 100 years in age. The age and sheer size of our stations' overall footprint—more than 16 million square feet and 16,000 components—leads to substantial capital and maintenance needs. Below we discuss our stations' structural component needs, and we also address some of the other major asset types found in our stations, which we summarize in two sub-sections: one on accessibility, elevators, and escalators and another covering station communication systems.

Over the next 20 years, our investment needs include:

- **Station structures and components**
    - **Continue station component repair programs with quicker implementation of projects when deteriorated components or other needs are identified.**
    - **Enhance security by improving lighting, CCTV, and other station elements. New lighting is also part of our strategy to make stations more energy efficient.**
    - **Improve passenger circulation at chronically overcrowded locations by adding stairs or reconfiguring station elements.**
- **Accessibility, elevators, and escalators**
    - **Build new elevators and ramps to expand the number of accessible stations, in line with MTA's commitment of at least 95% of subway stations being accessible by 2055.**
    - **Ensure the reliability of existing elevators and escalators by replacing approximately 350 station elevators and 150 escalators as they reach the end of their useful lives.**
    - **Replace emergency exit doors at fare arrays with wide-aisle gates to improve access to the system.**
- **Station communication systems**
    - **Upgrade customer communication systems in stations so that all stations have public address systems and customer information screens that can convey audio and text messages sent from staff at our centralized train control centers.**

Times Square Shuttle, NYCT

Station structures and components

This asset category refers to all the major structural elements that comprise our stations, such as floors, walls, ceilings, columns, and stairways, as well as the many architectural finishes that make up our stations' platforms and mezzanines.

Asset inventory and status

Beginning in the 2010-2014 Capital Program, we adopted a component-based strategy for station capital investment, which focuses on fixing or replacing the most deteriorated station components at a greater quantity of stations rather than performing more costly comprehensive station renovations at a more limited number of stations.

In implementing this methodology, we begin by inspecting and assessing the condition of our stations' structural components—platforms, stairs, canopies, ventilators, floors, columns, walls, ceilings, and more—every five years. We assess and keep track of over 16,000 unique station components throughout our network. This strategy emphasizes essential structural components and allows us to address prioritized needs at a sustainable pace that also considers the varying lifespans of different components.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Platform Canopies	436	8%
Mezzanine Floors, Columns, Walls, and Ceiling	3,246	10%
Platform Edges	1,198	36%
Platform Floors, Columns, Walls, and Ceilings	3,276	13%
Stairways	5,502	13%
Passive Ventilation Systems	2,425	39%
Windscreens (above-ground station platform fencing)	214	21%
Electrical Distribution Rooms	916	15%

96 St Subway, NYCT

Investment needs

Going forward, we plan to accelerate the capital repair and renewal process and quickly implement the results of rolling comprehensive condition surveys that are currently taking place.

Over the next 20 years, we need to::

- A faster pace of repairing or replacing station components (approximately 1,500 per each capital program): over 5,000 platforms, 4,000 platform components, and 2,400 street vents, as well as ventilators, electrical utility rooms and other elements in poor condition.
- Reduce water infiltration conditions at approximately 40 station locations.
- Evaluate ways to control temperatures in stations' critical equipment rooms that house electrical and telecommunications equipment.
- Reduce energy usage by upgrading lighting to LED or other energy saving types of lighting. Currently, about three-quarters of station lighting is less energy efficient than modern standards.

Accessibility, elevators, and escalators

Elevators and ramps are critical assets that ensure subway access for customers with disabilities and others who cannot use the stairs, such as caregivers with strollers, older adults, or customers with luggage. These assets also are also necessary for us to comply with the Americans with Disabilities Act (ADA). In 2022, we reached a historic settlement with accessibility advocates that affirmed our commitment to accessibility in the subway system and outlined a commitment to make at least 95% of the subway and SIR stations accessible by 2055, if our capital plans are adequately funded.

In addition to elevators and ramps, escalators are also important assets for facilitating access from the street to the platform, particularly at deeper stations. At some deep stations, elevators and escalators are the sole means of access and egress to the platform, and if they fail to operate, trains must bypass the station.

Asset inventory and status

Our primary considerations for elevator and escalator lifecycle replacements center on age and projected lifespan. Older elevators and escalators are likely to break down more frequently. We also consider obsolescence and unavailability of spare parts, reliability, and the number and frequency of maintenance calls. Because elevators and escalators require increased maintenance as they age and some parts become more costly to replace, we generally aim to replace elevators and escalators as they reach the end of their approximate 17-22-year useful life.

Using existing funding, we are progressing rapidly on expanding accessibility and ensuring continued access to stations that are already accessible. We are replacing 78 existing elevators and 66 escalators as part of the normal lifecycle replacement process, as well as installing over 170 new elevators and ramps to expand accessibility.

Right, Escalator at 96 St Station

Far right, Elevator at E 149 St Station

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Elevator - Hydraulic	246	0%
Elevator - Traction	60	0%
Escalator	231	6%

Investment needs

We need to continue our increased pace of investment to make subway stations accessible and to ensure that our existing elevators and escalators remain functional and reliable. In addition to replacing our existing station elevators, as we install more elevators and expand accessibility throughout the network, we will have an increasing number of elevators to maintain in the future.

Over the next 20 years, we need to:

- Continue the increased pace of elevator and ramp installation to make more stations accessible, in line with our commitment for 95% subway and SIR accessibility by 2055.
  - When identifying specific stations that will be made accessible during each capital planning cycle, we consider many factors including coverage, destination significance, ridership and transfers, demographics constructability, and cost.
- Continue to replace elevators and escalators as they reach their useful age.
  - The large expansion of the station accessibility program over the next 20 years will ultimately lead to a doubling of the lifecycle replacement needs by the 2040-2044 timeframe; approximately 350 elevators will be due for replacement over the next 20 years.

Station communication systems

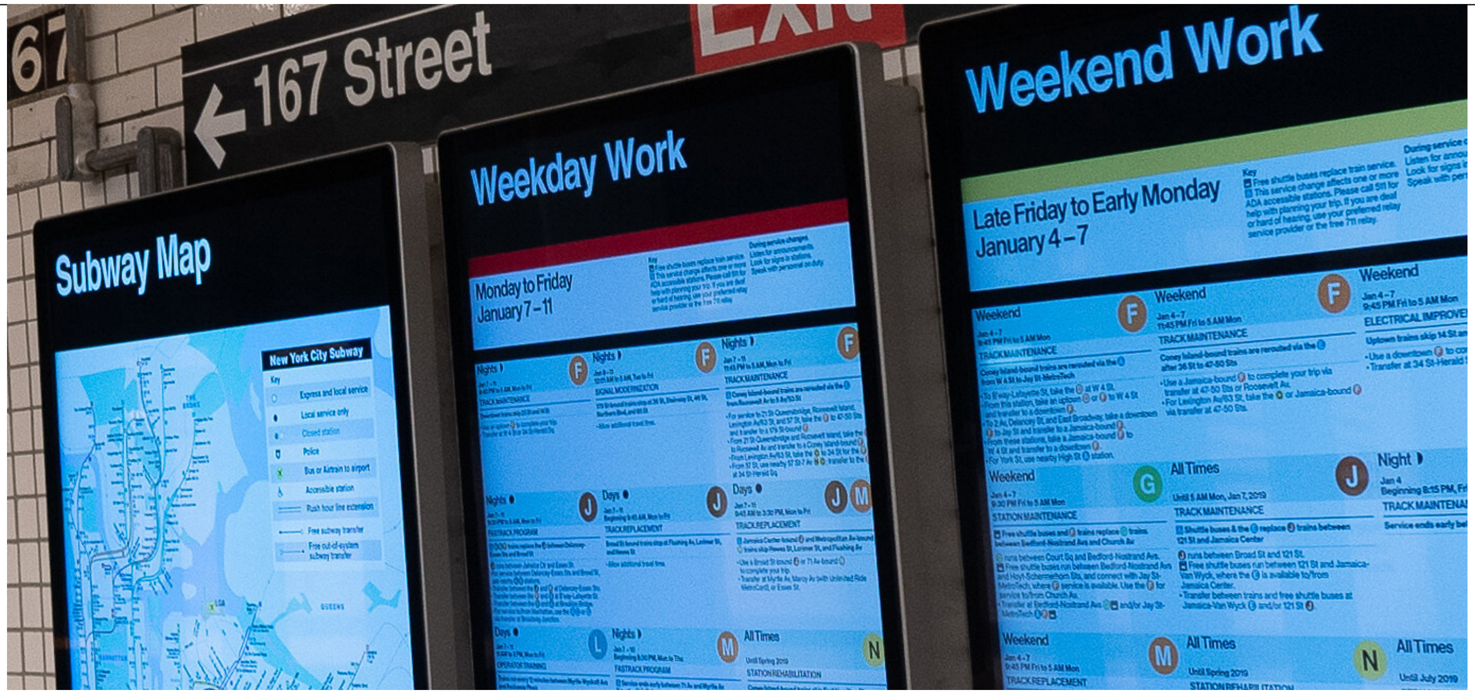
Our communication infrastructure is comprised of several comprehensive and interrelated systems that support several other asset types such as signals. In this section, we will focus specifically on communication assets that are found in subway and SIR stations, while the system's underlying communication infrastructure is addressed in a separate section below.

The communication system elements found in our stations include station public address systems, digital screens in stations, and Help Point intercoms, all of which are key ways for us to provide passengers with train arrival times and other information that may affect their trips. Because our station fare collection system (and its related components), as well as our station security systems are dependent on the communication systems in our stations, these systems are also discussed here.

All of these communication systems and their dependent assets and components are composed of many elements that need frequent upgrade or renewal.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Public Address/Customer Information Screens	472	52%
Help Points	1,886	1%
ADA Farecard Access System	278	0%
Fare Collection Vending Machines (transitioning to configurable vending machines and changing quantity for OMNY cards)	1,720	0%
Fare Collection Electronic Turnstiles	4,461	0%
Emergency Booth Communication System	478	0%
NYCT Station CCTV (cameras, monitors, and recorders for emergency alarm, passenger ID, police security, platform edge, and crowd control)	11,210	55%
SIR Station CCTV	406	100%



167 St Station service information displays, NYCT

Asset inventory and status

The condition of our station communication system assets is assessed based on age, parts obsolescence, and capability. It is essential for these assets to meet current functional requirements, so communications assets that do not are considered to be in poor condition.

One of the capabilities we are planning for in the next twenty years is the ability for riders to receive both audio and visual messages in real time in every station.

Investment needs

Over the next 20 years, we are also prioritizing installing and upgrading audio and visual communication so we can provide timely and accurate travel information, providing better station security, and completing roll out of a simpler fare payment and more secure fare control systems.

Over the next 20 years, we need to:

- Award projects to upgrade public address and customer information screens at 244 stations by 2030.
- Help Points will be renewed or replaced over the next 20 years as these devices reach the end of useful life.
- CCTV is an integral part of the security and safety strategy at stations as well. In the coming 20 years, we will improve our passenger identification and other CCTV systems to the latest security standards, replacing all poor condition passenger identification CCTVs and at access control locations. We will also install camera systems at stations with only passenger identification CCTVs.
- Improve fare collection by completing transition to the OMNY system, making lifecycle replacements of existing electronic turnstiles with upgraded turnstiles, and introduce other fare collection solutions guided by the findings of the MTA's Blue-Ribbon Panel on Fare Evasion.
- Improve access to the system by replacing ADA farecard entry units at current and future accessible stations with wide-aisle gates.
- Implement technological advancements such as track intrusion detection once they have been evaluated and proven effective in our station environment.

SUBWAY INFRASTRUCTURE SYSTEMS LINE STRUCTURES, TRACK SIGNALS, TRACTION POWER LINE EQUIPMENT AND COMMUNICATIONS INFRASTRUCTURE

Our right-of-way infrastructure includes line structures, track, signals, traction power, and line equipment. All are essential to get our riders to and from their destinations safely and on time.

- Line structures are the structures on which the tracks sit, which include bridges, elevated steel, viaduct sections, under river tubes, subway tunnels, embankments, and open cuts.
- Track and switches constitute the fixed guideway on which trains travel and are two of the most critical assets for safe, efficient, and reliable train service.
- Signals are a train control system that ensure trains maintain safe distances from each other and travel at safe speeds.
- The traction power system provides electricity via the third rail that provides propulsion power for trains, as well as lighting and AC on trains.
- Line equipment refers to the array of equipment distributed along the right-of-way, including tunnel lighting, ventilation plants, pump rooms, and deep wells.

Over the next 20 years, our investment needs include:

- Line structures
    - Maintain and ensure structural soundness of elevated steel structures, repair all significant defects, and routinely apply or renew protective coating systems.
    - Continue the line structure component repair program for subway, viaduct, and other line structure types with an increased investment pace than has been conducted in previous years.
- Track
    - Continue to replace 60-70 miles of mainline track and hundreds of switches in each capital program as their condition warrants.
- Signals
    - Improve subway on-time performance and reduce crowding by modernizing 315 more signal miles, from 234 signal miles already complete or underway to 549 total signal miles, improving service for about 90% of all trips. This will:
        - Reduce delays due to signal failure by 44% systemwide.
        - Lower signal maintenance incidents by 22% systemwide.
    - Where modern technology signals have already been installed, ensure continued reliability by replacing the signals as they reach the end of their expected useful life.
- Traction power
    - Ensure service continuity and improve power reliability network-wide by addressing critically poor power cable and circuit breaker house conditions and addressing a backlog of repairs for about 300 major substation components. Beyond that, we will need to invest in hundreds of major substation components over the next 20 years to keep them in adequate condition.
    - Improve management of the power system by completing the modernization of the power system's remote management system.
- Line equipment
    - Continue component replacement and upgrades at pump and fan locations based on condition.
    - Evaluate tunnel ventilation and construct new fan plant facilities as needs and priorities dictate.
    - Continue periodic upgrades of deep wells and tunnel lighting.

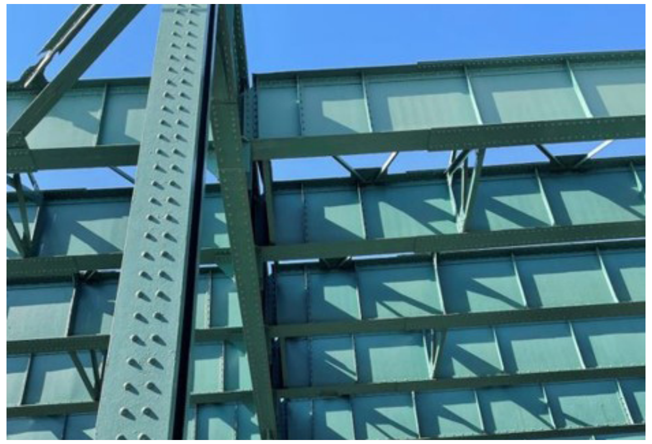
Line structures

Line structures have a long lifespan and slow deterioration rate, so most of our line structures date back to original construction of the subway system. Proactive maintenance mitigates the need for extensive repairs or costly rehabilitations in years to come

Asset inventory and status

Over time, exposure to the elements and heavy usage results in structural defects that are identified through periodic inspections. These defects are classified and prioritized for repair according to a defect's severity or concentration of defects in an area. Unfortunately, the historical pace of defect correction has not been sufficient due to constraints on conducting structural work along the active right-of-way. The inventory and status table shows line structure inventory and the respective high defect concentration mileage, which is an indication of high priority needs.

Exposed elevated structures benefit greatly by being protected with a robust paint system that can prevent defects due to corrosion. Therefore, we track elevated structures and monitor where the paint coating is reaching the end of its useful life so that paint investments can be made that minimize future costly defects. Additionally, we are implementing a new elevated steel structure painting technique that addresses any existing corrosion on the steel structure through the application of an abrasive blast technique and applies a more durable paint that will protect the elevated steel structure from critical defects. The pace of painting needs to increase, in order to ensure that all paint is in good condition.



Elevated structure, NYCT

Inventory and status

Structure Type	Route Miles	Percentage of Miles with High Defect Concentration
Elevated	61.0	8%
Viaduct	9.3	58%
Open Cut	10.6	5%
Subway	155.4	29%
Embankment	15.2	2%
Total	**251.5**	22%

SIR Inventory and status

Structure Type	Route Miles	Percent in Poor/ MarginalCondition
At-Grade	12.0	83%
Bridge	0.4	24%
Elevated	1.1	100%
Open Cut	1.0	0%
Tunnel	0.2	100%
Fencing	27.0	8%

The table below shows the status of NYCT's steel structure paint.

NYCT Elevated steel structure paint status

	Good	Poor/Marginal	Under Construction
Miles	31.2	11.3	20.8
Percent	49%	18%	33%

Investment needs

Over the next 20 years, we need to:

- Increase the pace to clear backlogs of thousands of high priority defects on all line structures with emphasis on high defect concentration areas.
- Repaint steel structures using the most thorough techniques - abrasive blasting that removes paint to bare steel-and applying new high performance and durable coatings; repainting provides these structures with the best protection from corrosion.
- Completing a full painting cycle on elevated structures.
- Waterproof SIR bridges, making drainage improvements and repair existing bridge deck damage.

Rockaway Park Shuttle train crossing Hammels Wye, NYCT

Track

Our subway system contains 665 miles of mainline track and 1,770 mainline switches. The 24 rail yards also contain storage track and switches.

This page, Track panel replacement work on elevated track, NYCT

Right page, Track replacement work in subway, NYCT

Asset inventory and status

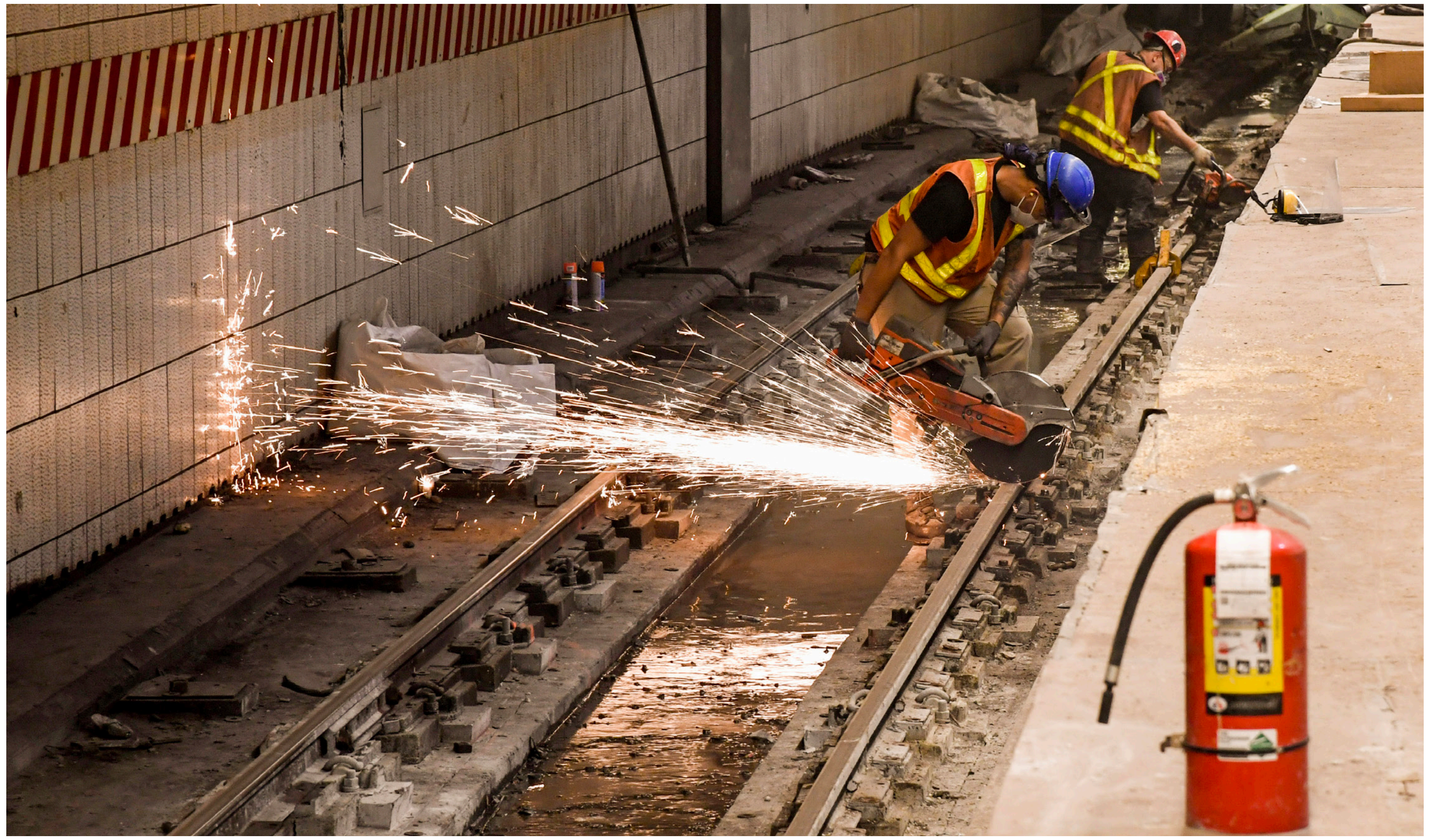
We assess the condition of every segment of track several times each month on a scheduled basis to identify locations needing maintenance repairs. We inspect switches with joint teams of track and signal maintainers so they can perform immediate maintenance. For capital investments, we assess all track segments and switches for their remaining useful life approximately every four years. These remaining life assessments yield information that enables the track and switch replacement program to target priority location supports, which mean we have kept track and switches in 100% good repair since the 1990s.

Investment needs

Based on the condition survey results, track replacement and renewal projects are prioritized for locations where there are switches or track segments rated as having less than six years of useful life remaining. Additionally, the ongoing rollout of CBTC in the 2025-2044 period will require all switches within the limits of CBTC projects to be assessed to determine their utility and confirm if they should be replaced, reconfigured, or removed altogether. A portion of the planned switch investment may be packaged with this CBTC work.

Over the next 20 years, we need to:

- Rebuild or replace approximately 60-70 miles of mainline track and 250 mainline switches per five-year program. Additional switches or track may also be replaced on specific lines to work with the new CBTC systems as well.
- Address SIR track, we will address locations approaching the end of their service life with approximately 32 miles of track and 57 switches forecasted needing replacement over the 20-year timeframe.



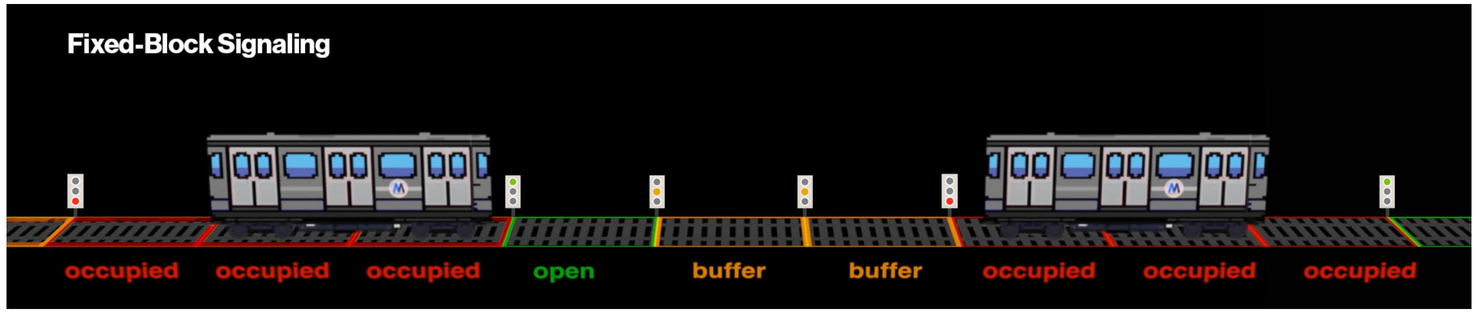
Inventory and status

Asset	Total Miles or Number	Miles/Number (Remaining Life Less Than 6 Years)	Percent with Remaining Life Less Than 6 Years
Mainline Revenue	665 Miles	68	11%
Non-Revenue	39 Miles	5	12%
Yard	102 Miles	14	13%
Mainline Switches	1,770	275	16%
Yard Switches	874	97	11%
SIR - Mainline	29 Miles	2	7%
SIR - Non-Revenue	3 Miles	0.3	11%
SIR - Switches	62	8	13%

Note: Track segments and switches with less than six years of estimated remaining useful life are prioritized for replacement.

Signals and train control

Our signal system governs the movement of trains along the right-of-way, ensuring that trains operate at safe speeds and maintain safe distances from other trains. Signals also provide instructions to train operators so they know when they can proceed safely. The more modern signals within the system share train location information to centralized train service supervision at the rail control center. The signal system also consists of interlockings, which are interconnected arrangements of switches and signals that allow for safe movement of trains.



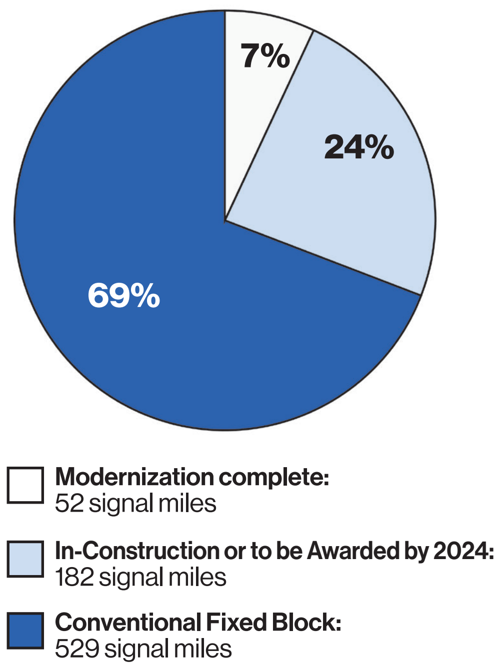
Currently, NYCT's signal system utilizes two types of technology: fixed-block electro-mechanical signaling and modern digital moving-block technology known as Communications-Based Train Control (CBTC). Fixed-block relies on technology that dates to the opening of the subway over 110 years ago. It uses wayside track circuits, signal heads, and train stop arms to enforce speed restrictions and safe distance between trains, as shown in the figure above.

CBTC uses carborne and wayside radio equipment, train operator displays, and computerized dispatch systems to enforce "virtual blocks" that govern speed and train separation. CBTC allows trains to move closer together than fixed block signaling, which increases throughput capacity and allows service to be recovered from disruptions more quickly. Paired with advanced Automated Train Supervision (ATS) systems, CBTC also allows more accurate train movement monitoring at the Rail Control Center (RCC) and more accurate customer information.

So far, signal modernization has been completed on the L and 7 lines, which are our highest performing lines in terms of on-time-performance. Signal modernization is currently underway on the Queens Boulevard, Culver, 8th Avenue, and Crosstown lines. Significantly increased investment in the 2020-2024 program also means we plan to award signal modernization projects on the Fulton, 6th Avenue, and 63rd Street Lines by the end of 2024.

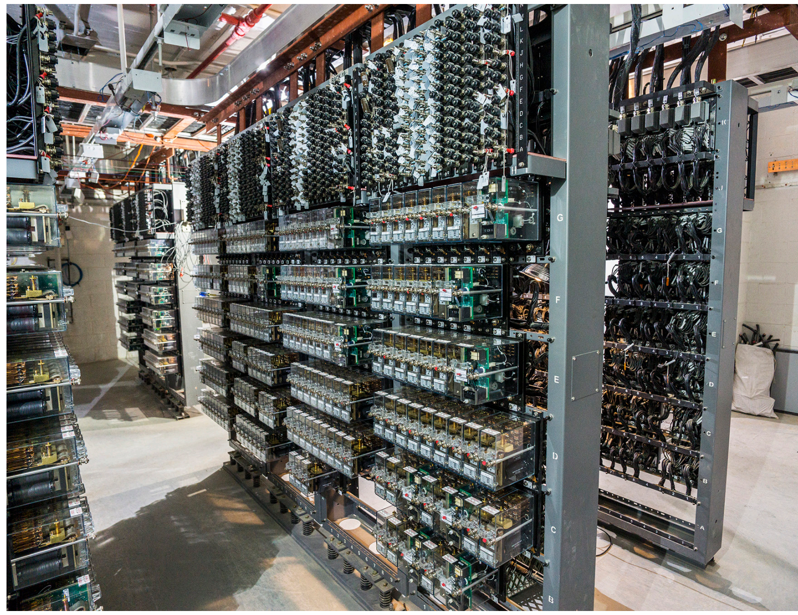
Beyond the projects above, 529 miles of signaling and 118 interlockings use conventional fixed block signaling.

Modernized signaling status



Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Mainline Signals	794 Miles	24%
Mainline Interlockings	183	23%
Yard Signals	24	42%
Yard Interlockings	20	30%
SIR - Signals	31 Miles	3%
SIR - Interlockings	14	7%


Relay room, NYCT

Investment needs

To increase service reliability, minimize disruptions and delays, and provide the ability to increase service, we must continue modernization of our signaling system. To facilitate this modernization effort, substantial investment is also required in CBTC enabled railcars, work trains, RCC information systems, power capacity improvements, as well as fiber and radio infrastructure upgrades.

Modernization will be prioritized in areas where signals are beyond their operational lifespan or will reach it by 2044. In addition, to drive five-year capital program prioritization and sequencing, we will continue assessing ridership patterns, signal asset reliability, on-time performance, and operational constraints.

Over the next 20 years, we need to:

- Improve subway on-time performance and reduce crowding by expanding modernized signaling from approximately 234 signal miles (already complete or underway) to 549 total signal miles, resulting in improved service for about 90% of all trips.
- Renew hardware and software on lines that already have CBTC as part of cyclical replacement to keep the systems up to date.


F train and signal indicators

Traction power

Our traction power system delivers electric power to the trains for propulsion. These assets include substations, circuit breaker houses (CBH), power cabling, and third rail. The traction power system for NYCT consumes nearly 2 billion KW-hours of electricity annually. NYCT substations receive power generated by the New York Power Authority as high voltage alternating current (AC) distributed by Con Edison via high tension transmission feeders. The substation's transformer and rectifier transform this power into 600-volt direct current (DC), which is fed to the third rail where it is accessed by the trains. The traction power system is divided into zones, which are under the Supervisory Control and Data Acquisition (SCADA) remote-control system centered at the Power Control Center (PCC).

Maspeth Substation, NYCT

Investment needs

Investments in our traction power infrastructure are needed to replace aging assets. Substations are prioritized for investment based on the condition of their major power unit components, the criticality of their location, and the level of redundancy in a power zone. In addition to these basic investments, upgrades to the system are needed to accommodate future load growth, and these upgrades will also enable better demand management. We will explore mechanisms to utilize electricity more efficiently, for example, by making more effective use of the developing technology to capture and utilize regenerative braking energy and managing power load demand.

Over the next 20 years, we need to:

- Upgrade the PCC's SCADA remote control systems, as well as the facility itself (PCC conditions and investment needs are detailed within the Operational Facilities section below.)
- Renew substations or substation components and address existing backlog of over 300 major components at approximately one-third of our substations.
- In the latter half of the 20-year period replace hundreds more major components at approximately 100 locations as they reach the end of their service life.
- Replace critically poor power cable and rehabilitate circuit breaker equipment or structural components at approximately 260 CBH locations.
- Replace poor condition or obsolete Emergency Alarms and Emergency Telephones.
- Include additional design and specification changes to make power equipment more able to withstand prolonged heat conditions and less vulnerable to coastal flooding and extreme participation, which can be particularly damaging to electrical equipment.

Asset inventory and status

Traction power is service-critical and has a sizeable backlog of equipment rated poor or marginal. In recognition of this, the 2020-2024 Capital Program doubled the level of investment in traction power assets. This allowed us to rehabilitate double the number of substations and CBHs as well as replace and upgrade the majority of the traction power SCADA system.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Substation Overall	224	36%
Transformers	392	15%
Rectifiers	394	13%
HT Switchgear	393	25%
DC Feeder Breakers	1,461	18%
Structural Elements	224	26%
Circuit Breaker Houses	317	27%
Breakers	1,802	30%
SCADA System Control Zones	93	39%
Emergency Alarm/Emergency Telephone	2,627	26%
SIR - Substations	9	11%
SIR - Substation Components	119	45%
SIR - Circuit Breaker Houses	4	100%
SIR - Circuit Breaker House Breakers	13	100%

Line equipment

Line equipment refers to a diverse set of assets that protect our tunnel infrastructure, primarily including tunnel lighting; fan plants to ventilate and mitigate smoke events; and pump rooms, deep wells, and drain lines that remove water from the subway into the New York City sewer system on a daily basis and are particularly critical for quick recovery following an extreme weather event.

Asset inventory and status

The condition of our line equipment assets is assessed through inspection. Ratings are primarily based upon physical condition and, in some cases, functional sufficiency such as pumping capacity or lighting type. Assets that do not meet current functional requirements set forth by the agency are prioritized for investment in order to achieve appropriate levels of efficiency or effectiveness that ensure agency goals for service reliability and safety are met.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Deep Wells	23	0%
Fan Plants	209	29%
Pump Rooms (ROW)	254	11%
Tunnel Lighting	440 Miles	4%

Deep wells

Fan plants

Pump rooms (ROW)

Tunnel lighting

Pump room, NYCT

Prince Street Fan Plant

Investment needs

Over the next 20 years, we need to:

- Address components at 28 priority pump rooms, as well as improved sump pump capacity, and increased water detention capacity to temporarily hold large volumes of stormwater at hot-spot stations that are vulnerable to flooding from extreme precipitation and/or are in areas where nearby sewer capacity is limited.
- Address components at 39 priority fan plant locations to eliminate backlog of poorly rated components and enter a normal replacement cycle in the latter half of the 20-year timeframe. Fan plants in locations vulnerable to inland risks were mitigated already at the SLOSH Cat2 + 3 via the Sandy program. Flooding will be prioritized for flood risk mitigations, such as elevating equipment. New fan plant facilities will be constructed as needs and priorities dictate.
- Perform periodic backflushing and equipment renewals at deep wells to maintain needed performance and monitor impacts of changing ground water levels.
- Eliminate tunnel lighting backlogs and invest on a normal replacement cycle. Enhance tunnel lighting by replacing older lighting types with more energy efficient lighting, like LED.

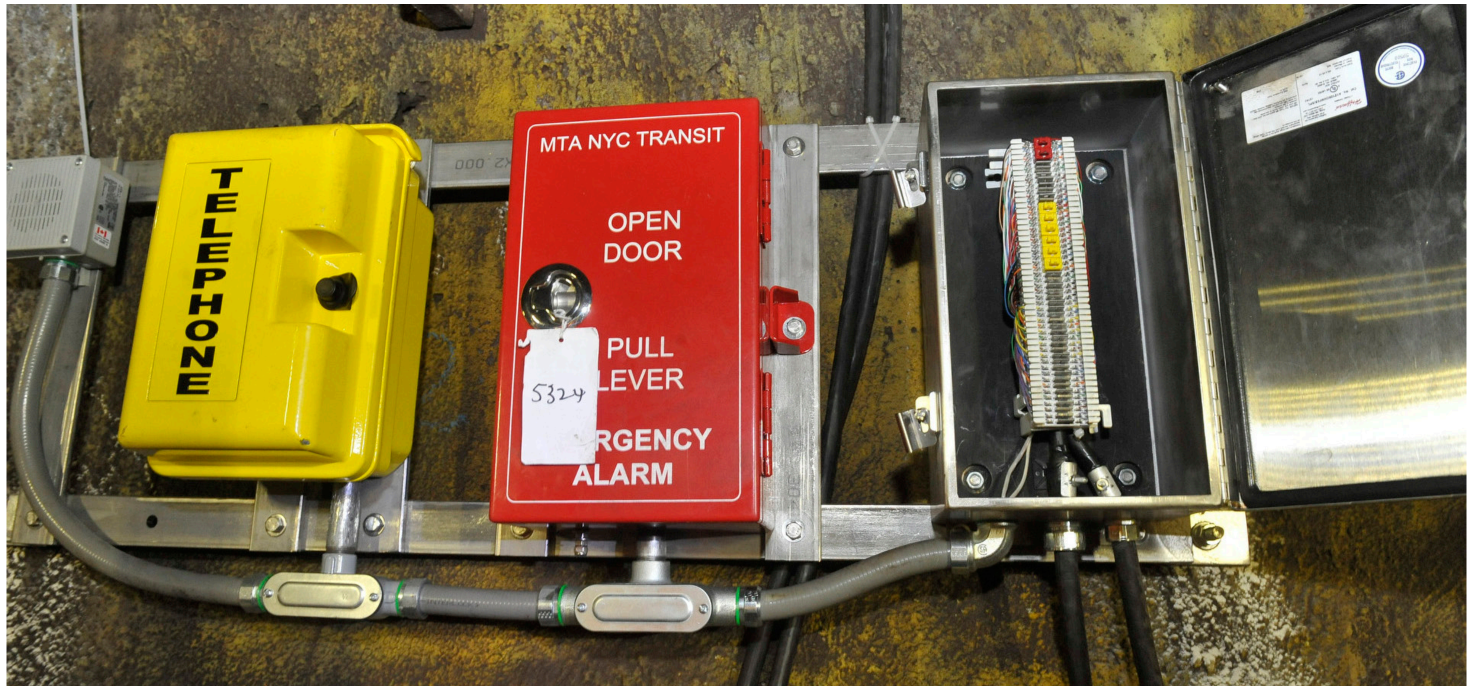
Communication infrastructure and systems

We have an extensive portfolio of communication infrastructure to facilitate many aspects of our daily operation. Though not as visible as other assets, communication networks span our entire system and enable our customer communications, system operations, fare collection, safety, security, and business operations.

Our communication backbone consists of systemwide fiber optic, antenna, and copper cabling, as well as networking equipment, which handle a vast array of voice and data communications between control center head-ends, operators in the field, and equipment like cameras, fare arrays, and radio devices throughout the system.

Our secondary telecommunication networks include passenger station local area networks (PSLAN) connected to fiber optic cable, private branch exchanges (PBX), Connection Oriented Ethernet (COE), and communication rooms, which are located in our subway stations.

A variety of communication applications and systems utilize components of the infrastructure listed above. Station public address and customer information screens, as well as Help Points, depend on PSLAN. SCADA systems are used for remote control and monitoring of power equipment; fan plants and pump rooms use the fiber and copper networks. The newer safety and security systems in stations and tunnels depend on fiber optics, PSLAN, and COE. Additionally, our radio systems for in-service operations and emergency response utilize antenna cable and radio base station infrastructure.



Radio systems

Asset inventory and status

Communication technology becomes obsoletefaster than other assets due to rapid technological advancement. Whereas other assets have a typical lifespan of 25 to 50 years, communication assets tend to have a shorter lifespan of 10-15 years. Each technology also has different challenges, dependencies, and vulnerabilities, as well as compatibility requirements. For example, there have been instances of rapid decline in the fiber cable condition in outdoor, elevated locations, as well as transitional locations where the cable routes from outdoor elevated structures to indoor below ground subways.

We have been making advances in rehabilitating and upgrading communication assets. Our 2020-2024 Capital Program included a 97% increase in funding for communication infrastructure over the previous capital program. When 2020-2024 capital projects are complete, we will have reached several key milestones, including having rolled out connection oriented ethernet (COE) across the system, upgraded 60% of network ring equipment and replaced 20% of our legacy fiber cable. Even with these investments, most of our fiber cable was installed between 1988 and 1990, and fiber optic network and cable infrastructure will need continued investment and accelerated upgrades to support the latest standards for data communication, increased bandwidth needs, and to address obsolescence of old equipment.

Inventory and status: Backbone communication infrastructure

Asset	Total	Percent in Poor/Marginal Condition
Fiber Cable	896 Miles	81%
Fiber Nodes (support transmission equipment)	85	36%
Fiber Rings (supporting critical functions composed of interconnected nodes)	7	43%
Antenna Cable	200 Miles	21%
Copper Cable	561 Miles	65%
UHF/VHF Radio Equipment	464	69%
SIR - Fiber Optic Cable	145 Miles	11%

Inventory and status: Secondary communication infrastructure

Asset	Total	Percent in Poor/Marginal Condition
Communication Rooms	478	27%
Passenger Station Local Area Network (PSLAN)	472	46%
Connection Oriented Ethernet (COE)	1 System	0%
Private Branch Exchanges	8	0%

Further investment in our communication infrastructure assets will greatly improve the reliability and capacity of our communication system. It will also improve reliability and functionality of assets that depend on that infrastructure.

- The antenna cable throughout the subway system is essential to the transmission of radio signal for the VHF system used by service delivery, and the UHF radio system used by the police, FDNY, and EMS. Between deteriorating antenna cable and poor condition radio equipment, there is a critical need for a sustained replacement program over the next 20 years.
  - An additional goal is to increase antenna cable capacity to support various radio frequencies and radio technologies and expand system frequency and modulation capabilities to support VHF, UHF, 700MHz, and 800MHz. We need to increase the ability of the antenna infrastructure to carry not only additional analog systems, but also narrowband digital technologies.
- Copper supports analog phone service, the 6-wire, emergency alarms/emergency telephones (mentioned in the power section), and other communications.
  - Over the 20-year timeframe, we should continue the accelerated replacement of radio antenna cable and copper cable.
- Communication rooms. Each passenger station has a communication room that provides secure enclosure and connection points for communication assets. These rooms house fiber distribution panels, radio infrastructure, telephone terminals, PSLAN access nodes, COE, and other systems.
  - Communication room temperatures should not exceed 108°F, but often do. Equipment inside communication rooms cannot function when exposed to this level of extreme heat for a prolonged time without sustaining damage.
- PSLAN interconnects many devices together within a network at passenger stations, allowing for connectivity between various communications assets.
  - Currently, about half of the stations have full networks with nodes sufficient for 21st Century technology. Partial PSLAN coverage results in suboptimal information delivery to and within stations.
- PBXs are major switching centers for tens of thousands of phone, copper cable, and fiber optic cable lines. PBXs allow the managing of data and voice traffic of the system's phones, communication rooms, and emergency telephones along the right-of-way.
  - PBXs have been updated and currently are in good condition from a recent capital investment, but keeping them in good condition will require regular investment in the next 15-20 years, as well as normal replacement of PBX components.

Investment needs

With investments in communication assets over the next 20 years, we will enhance operations, improve incident response, manage obsolescence, and improve customer communication. Across these categories, investment in both new technology and in measures to protect existing assets will provide increased resilience during extreme weather events, including periods of extreme heat.

Over the next 20 years, we need to:

- Increase the pace of fiber optic cable replacement by replacing at least 20% of fiber optic cable in every five-year program, leading to full replacement by 2044.
- Continue regular investment and normal replacement of rings and equipment.
- Continue the accelerated replacement of radio antenna cable and copper cable.
- Invest in communication rooms' data cabinets, cooling, and ventilation systems.
  - * To address heat and capacity issues in communication rooms, our plans include investments in communication rooms' data cabinet and ventilation systems, including split cooling systems.
- Equip all stations with a PSLAN capable of delivering reliable information to the public address and customer information screen system.
- Boost bandwidth to increase reliability for the security command center, CCTV, and access control.

Snow thrower at Coney Island-Stillwell Av

Work trains and service vehicles

NYCT maintains a fleet of 643 specialized railcars for work trains, along with hundreds of heavy-duty rubber-tire vehicles such as trucks and vans. Additionally, 37 work cars support the operations of SIR. As we look to push the pace on addressing a variety of maintenance and capital projects, it is vital that these support fleets are both large enough and reliable enough to get the job done. From locomotives and flat cars to refuse collection cars and vacuum trains, the diverse work train fleet supports capital construction and routine operational functions. When prioritizing service vehicle replacement, we look at a combination of asset age and condition.

A sample of work train types includes those listed below:

- **Ballast regulator:** Used to shape and distribute the gravel track ballast that supports the ties in the rail track.
- **Crane cars:** 1-ton, 3-ton and 10-ton cranes to lift and move materials like track panels.
- **Flat car:** MOW vehicle typically used for material handling or refuse management. It requires a locomotive for propulsion.
- **Hopper car:** Work vehicle used for material handling of track ballast.
- **Hose and reach:** Work vehicle that includes pumps and metal pipes used to extend the reach of the work train.
- **Locomotive:** Type of railway locomotive in which the prime mover is a diesel engine. An important goal is to transition to lower emission propulsion technologies for work locomotives.
- **Pump car:** A work vehicle that includes one or more pumps used for pumping liquids. Once the liquid is pumped, it will be channeled through "reach" vehicles for discharge.
- **Refuse flat:** A MOW vehicle used for refuse collection. It requires a locomotive for propulsion.
- **Rider car:** A MOW vehicle solely used to transport workers.
- **Snow thrower:** A machine that uses a two-stage impeller and side-mounted rotating brushes to churn up and throw snow up to 200 feet. These vehicles can remove 3,000 tons of snow per hour.
- **Tamper:** A MOW vehicle used to pack the track ballast under railway tracks.
- **Track geometry car (TGC):** An automated track inspection vehicle to test several geometric parameters of the track without obstructing normal railroad operations. The TGC is used to inspect tracks on a regular basis and produce reports of defects found during the inspection.
- **Vacuum train:** a vehicle that removes debris and eliminates steel dust from the right-of-way.

Investment needs


Work train with crane

Highlights of these investments are the purchase of rail bound work vehicles such as flat cars, hopper cars, and locomotives for use in general maintenance and construction functions in the system. Among these, the retrofit and replacement of older model diesel locomotives with new engines meeting the latest EPA emissions standards, as well as hybrid locomotives that will employ battery technology in tunnels, will result in significant improvements to air quality for employees and customers, and reduce overall operational greenhouse gas emissions. We will also procure several specialized function vehicles such as vacuum trains, snow throwers, and track geometry cars, which facilitate specific maintenance functions along the right-of-way.

Over the next 20 years, we need to:

- Purchase 230 work train cars of various types.
  - Approximately 44% of the work train fleet is beyond the useful service life. Some of these units are now in the process of procurement and others will be replaced to restore the full fleet to good repair.
  - Specifically, we will replace the following types of work train—crane cars, hopper cars, locomotives, and refuse trains. This change is part of our initiative to replace the aging diesel work locomotive fleet with low-emission alternatives, aiming to reduce greenhouse gas emissions and enhance air quality.
- Invest in equipment to permit work trains consists of all types to operate under CBTC.
- Steady replacement of rubber-tire service vehicles is planned at a rate of approximately 300 per program. The vehicles to be replaced in each five-year period will be selected based on the age, condition, functional needs, and to meet goals for fleet transition to zero-emissions models.
  - For all non-revenue vehicle fleets, the MTA is working to transition 100% of its light-duty fleet to zero-emissions by 2035, and 100% of its medium- and heavy-duty fleet to zero-emissions by 2040.

Inventory and status: NYCT work trains

Work Train Type	Total	Percent Beyond Useful Life
Ballast Regulator	4	50%
Crane Car-1 Ton	17	29%
Crane Car-10 Ton	9	0%
Crane Car-3 Ton	12	0%
CWR Car	32	50%
De-Icer Car	8	100%
Flat Car	243	31%
Hopper Car	28	100%
Hose and Reach Car	9	100%
Locomotive, Diesel	100	17%
Pump Car	9	100%
Pump Flat Car	2	0%
Rail Adhesion	3	100%
Refuse Coll. Prop.	18	100%
Refuse Flat	27	100%
Rider Car	39	100%
Signal Supply Car	2	100%
Snow Removal Car	5	100%
Snow Thrower	12	33%
Tamper	4	0%
Tank Car	3	100%
Track Geometry	4	50%
Vacuum Train Car	12	0%
Weld Car	2	100%
Work Motor	39	100%
Total	**643**	**44%**


De-icer car

Employee and operational support facilities

Employee, operations support, and training facilities house critical operations and support elements of the NYCT subway system. Train crew and other employee rooms are located throughout the system. We supervise and manage train service and the power system from our central facility buildings. Training facilities are where we train our staff, and as technologies in the field modernize, we need our training facilities to follow suit. Importantly, as technologies in the field modernize, we need training facilities to follow suit.

Asset inventory and status

There are over 3,000 employee facility rooms within the subway system, making up about 800,000 square feet of crew rooms, offices, bathrooms, breakrooms, workshops, and locker rooms, all of which support the daily tasks of the train crews, maintenance workers, station employees, and others working across the system. Currently, there is a comprehensive survey underway to assess and identify the subway facility rooms across the system that are in marginal or poor condition and will require investment in the next 20 years. The results of this assessment will help determine investment priorities in the next capital program.

In addition, we have numerous stand-alone operational facilities. Several of these facilities were constructed for activities different than their current uses and have required continual retrofitting and upgrading to accommodate these changes. Principal operational facilities include:

- **The Operations Control Center consists of the RCC and in an adjacent building the PCC.** Together, these are the nerve-centers for service delivery, power system operations, and other operations divisions, which together operate and manage subway service.
  - **The RCC** is a five-story control center completed in 1997. An around-the-clock team monitors train movement and power distribution throughout the entire system. RCC is responsible for overseeing normal train service, directing responses to subway incidents, managing service diversions, monitoring field conditions, and directing emergency or inclement weather responses. Train service is monitored using radio communication, computer-based train tracking and control systems, and CCTV, with the associated technology equipment housed in the control center's data centers and communication rooms.
  - **The PCC** is an antiquated facility with systems and building components that are almost 50 years old. The three-story PCC structure was completed in 1974 and houses the power system operations, which manages substations, circuit breaker houses, and emergency ventilation plants. The PCC has major space constraints, and its configuration does not meet modern operations control center standards.
- **130 Livingston Street** is a 13-story building constructed in 1991 that houses numerous subway departments, including operating and engineering divisions, training facilities, information technology centers, security, emergency response, and administrative support offices. The building operates on a 24- hour, seven-day weekly schedule.
- **Signal Learning Center** comprises roughly 28,000 square feet within a subway station, with 13 classrooms utilized for a variety of in-house educational purposes. Importantly, as technologies in the field modernize, we need training facilities to follow suit, such as the development of a CBTC training facility.
- **PS 248 TA School** is in a former NYC public school building in Brooklyn, NY. Built in 1932, the four-story building currently serves as a NYCT training facility. Training activities include track, RTO, stations, car equipment, induction, infrastructure, and conductors.

Looking southeast across 86 Street and Avenue U, at New York City Transit Learning Center in Gravesend, Brooklyn

Employee locker Room, NYCT

Wakefield 241 St Employee Break Room, NYCT.

Above, Livonia employee restroom, NYCT
Left, Livonia employee break room, NYCT

Investment needs

Over the next 20 years, the operations control center (RCC and PCC) will exceed its original useful life and will need to have overall space and technology issues in its current location evaluated and addressed. Additionally, upgrades to various existing facility components, such as building envelope, HVAC, space layouts, and electrical generators will be required.

Over the next 20 years, we need to

- Address the PCC's immediate needs, by improving space configuration, replacing the roof, upgrading HVAC systems, completing replacement of obsolete power control systems, and pursuing longer-term improvements to make the PCC more functional and sustainable.
- Upgrade the RCC's systems and building components to keep pace with the increased technical requirements of service delivery that have advanced since the RCC's commissioning in 1997, including roll-out of CBTC and other field-management system. Additionally, the RCC's building systems and components require periodic upgrades, including to the building envelope, HVAC, space configuration, and generators.
- Invest in subway facility rooms, as most are in poor condition. Prioritized locations will need to be upgraded and modernized to fit their purposes, including providing appropriate breakroom and bathroom facilities to support employees as they perform their crucial work on the transit system. Priorities will reflect the results of ongoing surveys and are expected to prioritize facility HVAC, breakrooms, bathrooms, and other crew facilities.

02 Long Island Rail Road

Passenger vehicles and yards

Passenger stations

Right-of-way

Signals, power, and communications

Overview of agency and assets

The largest and busiest commuter railroad in the nation, the Long Island Rail Road (LIRR) comprises 126 passenger stations, more than 700 miles of electrified and non-electrified track, and 11 branches stretching from Montauk on the eastern tip of Long Island to Penn Station and Grand Central Madison in Manhattan, nearly 120 miles away. On weekdays, the LIRR provides up to 250,000 trips per day, which represents almost 75% of its ridership prior to the COVID-19 pandemic.

The LIRR has a rich history dating back to 1834, making it the oldest continuously operating commuter railroad in North America. Some of our infrastructure has even been around since those early days, like the Atlantic Avenue Tunnel, portions of which were built in 1905. Given our age, we have significant work to do to rebuild and rehabilitate aging assets so we can boost reliability and provide our community with world-class service.

The LIRR by the numbers

- Weekday ridership: Approximately 230,000
- Approximately 1,100 electric multiple unit (EMU) passenger railcars, 134 coaches, 45 passenger locomotives, 33 work locomotives
- Six shops and 32 yards
- 126 passenger stations
- 700 miles of track
- 56 overgrade bridges, 504 undergrade bridges, four tunnels, 29 viaducts
- 578 mainline switches
- 129 power substations

Cherry Valley Avenue Bridge

Investment needs highlights

Over the next 20 years, our priority investment needs include:

- **Passenger vehicles and yards**
  - Purchasing new railcars to meet expanding service needs and replace aging cars to improve reliability, accessibility, and passenger experience.
  - Advancing MTA sustainability goals by replacing locomotives with new dual-mode locomotives.
- **Passenger stations**
  - Achieving full ADA accessibility for 100% of our stations.
  - Rehabilitating or replacing deteriorating station components such as platforms, canopies, and station buildings throughout the system.
- **Right-of-way**
  - Fixing the Atlantic Avenue Tunnel through structural rehabilitation, waterproofing and enhanced lighting, fire safety, and security systems.
  - Replacing or rehabilitating 60-100 bridges and 11-23 viaducts to bring our all bridges and viaducts into good condition.
  - Improving service reliability by completing the reconfiguration of track at Jamaica to alleviate bottlenecks, reduce delays, and help trains move faster.
- **Signals, Power and Communications**
  - Renovating or replacing substations to ensure reliable traction power throughout electrified territory.
  - Improving customer communications, ensuring reliability, and increasing safety and security by installing new digital signage and upgrading the control systems that serve stations.
  - Modernizing approximately 50 miles of signal systems and replacing aging and/or obsolete components with latest-generation electronics providing modern and more reliable signal systems.

Mineola Station

Long Island Rail Road appendix structure

The LIRR appendix provides an overview of the agency's assets, their current condition, and expected investment actions t.to maintain and improve them over the next 20 years. The appendix is divided into asset groupings, based on how our asset categories function together. For example, our passenger vehicles are supported by our shops, yards, and facilities, so together they form an asset grouping. We provide a summary of each asset grouping, describe how the asset categories support each other, and then provide a 20-year vision for their maintenance and enhancement. Each asset category section then provides a more detailed description of the asset, an inventory showing asset ages or the percentage of assets in poor or marginal condition, followed by the agency's investment needs and priorities for the next 20 years.

Our asset rating methodology

We perform regular and comprehensive inspections of all of our assets. Through these inspections, all assets are given a condition rating on a scale of 1 to 5, based on various factors, including age, condition assessment, performance, reliability, safety history, and location. Assets with a rating of 1 (poor) or 2 (marginal) help us identify where we need to focus investment needs the most. This rating scale is consistent with the Federal Transit Administration's Transit Economic Requirements Model scale. A brief description of the rating scale is provided below.

1. Poor (Deteriorated): Critically damaged or in need of immediate repair, well past useful life. Assets are operable with extraordinary maintenance, but have serious functional deficiencies and/or can be expected to experience potentially unacceptable stoppages over the next five years, which could have serious negative impacts on service within the existing maintenance framework. Assets require operating-funded interventions, which may include more frequent inspections and/or repairs that may include removing the asset from service until repairs can be performed. Capital investment in these assets is needed on a priority basis.

2. Marginal (Deficient): Deteriorated, in need of replacement, and may have exceeded useful life. Assets have functional deficiencies and/or can be expected to experience above-normal stoppages over the next five years, but severity of customer impacts or changes to operational practices can be held within acceptable bounds for a time within the existing maintenance framework. If capital investment is/was deferred for these assets, added maintenance and operating expenses would be expected.

3. Adequate (Acceptable): Moderately deteriorated, but has not exceeded its useful life. Assets that are not necessarily meeting all current technical and functional standards, but are considered adequate for service and can be expected to experience normal stoppages that can be fully accommodated within the existing maintenance framework. These assets may require cyclical replacement in the next five years.

4. Good: No longer new, but in good condition and still within its useful life. Assets may be slightly deteriorated, but are overall functional within the normal maintenance practices.

5. Excellent (Modernized): No visible defects, new or near new condition and may still be under warranty (if applicable). Considered to meet most or all important technical and functional standards.

It is important to note that an asset condition rating is not an indicator of safety. Safety and risk assessments are performed separately from asset condition ratings and are addressed on an ongoing basis.

PASSENGER VEHICLES AND YARDS

02

The LIRR operates passenger service with a fleet of roughly 1,300 railcars. When these trains are not running in passenger service, they are either staged at one of our 22 passenger fleet rail yards or they are at one of our six shops, where they are cleaned, inspected, or undergoing maintenance.

To ensure passenger safety, federal regulations and LIRR procedures require testing and inspections of railcar and locomotive components and systems such as braking and power systems, lights, wires, cables, doors, air conditioning, radios, and more, each day they are in service. These basic inspections take place at our yards before trains are put into service. Railcars also undergo regular interior and exterior cleaning and more comprehensive inspections and scheduled maintenance at recurring intervals at our shops to ensure reliability. In the rare event of a mechanical failure, unscheduled maintenance for all railcars is also performed at these shops. In addition to our 22 yards and six shops dedicated to passenger railcars, we have five yards and one shop dedicated to the maintenance, storage, and inspection of work trains, including materials and support equipment we use to make repairs to our tracks, bridges, and other railroad infrastructure.

To deliver high quality, safe, comfortable, and reliable train service to our passengers, it is necessary that we have a modern and well-maintained fleet, as well as yards and shops with adequate capacity and that are in a condition that allows us to work safely and efficiently. Toward that end, we must continue to invest in new railcars, and we must invest in our yards and shops so that we can maintain our fleet effectively and meet our service guidelines.

Our investment needs over the next 20 years include:

- Purchasing new electric railcars to meet expanding service needs and replacing aging cars to improve reliability, accessibility, and passenger experience.
  - The expanded fleet is needed to support increases in train service made possible by the opening of Grand Central Madison and Main Line Third Track.
- Upgrading our coach fleet through the replacement of the aging C3 Bilevel as they reach the end of their service life later in the 20 year timeframe.
- Replacing of all locomotives, which are nearing the end of their 30-year “useful life,” with new Tier IV dual-mode units that will use more electric power and less diesel than current locomotives.
- Rehabilitating or replacing existing components in various LIRR maintenance shops and yards, and renovation or expansion of electric fleet maintenance facilities to ensure that facilities are safe and are adequate for future operational needs.
  - Renovating, expanding, and adding shops and yards to care for the technologically evolving and expanding fleet.
  - Ensuring these facilities are climate-resilient—to address risks like increased flooding and heat—and sustainable to advance MTA’s goal to reduce greenhouse gas emissions 85% by 2040.

Passenger vehicles

The majority of the time that our customers spend with us is on board our passenger vehicles, and thus the condition and performance of our passenger vehicles is a major determinant of overall customer experience and satisfaction, as well as a major factor in our ability to deliver safe and reliable service. Our passenger vehicle fleet is comprised of four distinct types of railcars: two that carry passengers and two types of locomotives.

EMU
Short for electric multiple unit, this is our most common type of passenger railcar. Electricity from a third rail powers these self-propelled carriages which are grouped into "married pairs" (permanently linked pairs of cars) that share equipment, currently including M9, M7, and M3 railcars; they do not require a locomotive.

Double Decker Coach
A push-pull railcar that carries passengers on two levels; one or more coaches make up a train propelled by a locomotive.

DE-30 Locomotive
A diesel-powered vehicle that pulls and pushes double decker coaches; the locomotive's motor is powered by a diesel engine that can operate in electrified track territory, but still runs on diesel. These trains cannot run in the East River Tunnels between Queens and Manhattan.

DM-30 Locomotive
A dual-mode (DM) powered vehicle that pulls and pushes double decker coaches; has a motor that can be powered by a diesel engine or third rail electricity, allowing these trains to operate in the East River Tunnels between Queens and Manhattan.

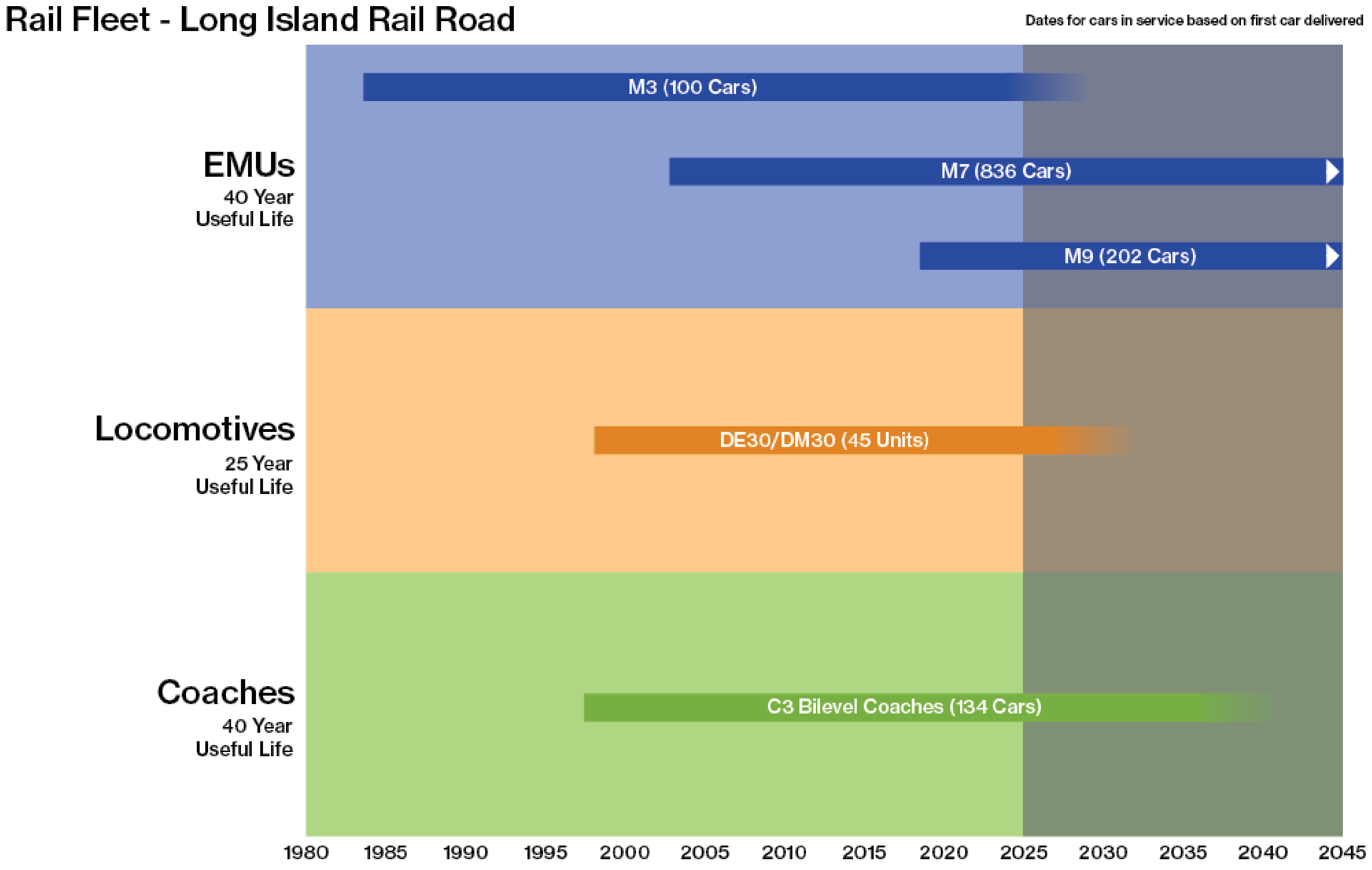
For the railcars that carry passengers, we have a need to replace them as they reach the end of their useful life. For our locomotives, upgraded dual-mode engine technology will maximize the use of electric, third rail power instead of diesel whenever possible. This will reduce our use of fossil fuels and decrease our greenhouse gas emissions.

Right, on board LIRR train

Asset inventory and status

We use two primary indicators to assess the condition and performance of our railcars, which together guide decisions on when further investment or replacement is warranted.

- **Useful life:** Older railcars are more prone to break down, generally require more extensive and costly maintenance to keep in service, and are less comfortable for our passengers due to worn interiors. Any railcar over the age of 40 is considered past its useful life, though for some models this number may be as low as 25 years or as high as 40 years. Railcars built prior to the enactment of the federal Americans with Disabilities Act (ADA) do not meet current standards for accessibility. We plan to replace railcars before they reach the end of their useful life.
- **Mean Distance Between Failures (MDBF):** This is a measure of reliability that expresses the railcar's mean (average) operating distance mileage traveled between all relevant train delay failures. The MDBF measure is used to inform decisions about how and when to perform maintenance. Our maintenance plans and our program for continued replacement of old cars have resulted in great fleet reliability successes. In 2022, the MDBF for the entire fleet was 229,824 miles, a vast improvement over the 50,000-mile MDBF from 2005.


Rail Fleet - Long Island Rail Road

Dates for cars in service based on first car delivered

Investment needs

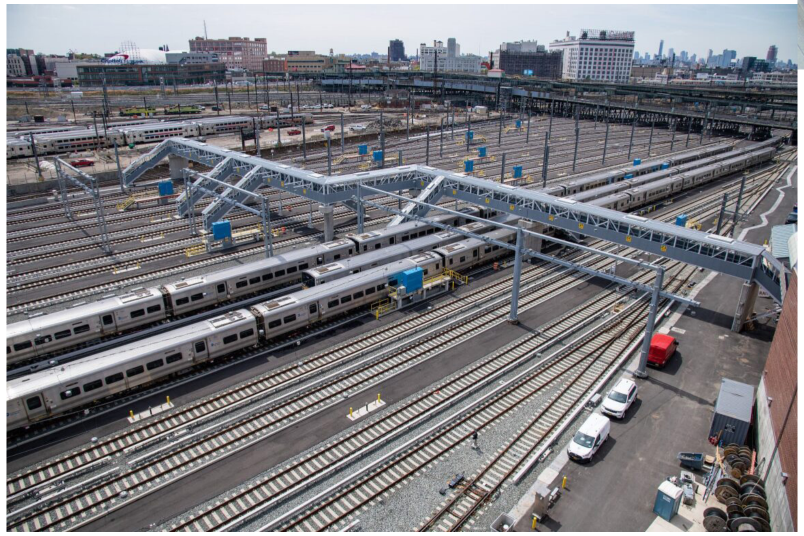
Over the next 20 years, we will focus our upcoming fleet investments to achieve two objectives:

1. **Keep up with the normal replacement of the passenger railcar fleet and expand the fleet to support increases in train service made possible by the opening of Grand Central Madison and Main Line Third Track.**
    - Complete the fleet expansion to support service increases made possible by opening of Grand Central Madison and Main Line Third Track.
        - M3s have been in service since the 1980s and are past their useful life.
        - New cars would be a significant improvement over the M3s in multiple ways: they will be equipped with amenities to improve customer experience and safety including better accessibility, wider seats, electrical outlets, and multimedia screens.
        - The M7 fleet (67% of the total fleet) will reach the end of its useful life at the end of the 20-year period. We must prepare for the replacement of the M7 railcars or risk less reliable service and increased operating cost.
        - The C3 Bilevel reach the end of their service life later in the 20 year timeframe and will need to be replaced.
2. **Transition to a locomotive fleet comprised fully of DM locomotives, and cease operating any diesel-only locomotive.**
    - We plan to replace all locomotives that are or will be beyond their useful life with locomotives that have the newest DM engine technology, which enables traction power motors to be powered from both diesel and third rail. In addition to improved reliability, replacing aging diesel locomotives with DM technology is key to the MTA's climate commitment.
        - New DM locomotives maximize use of third rail electricity and minimize use of diesel, thus reducing both greenhouse gas emissions and local air quality pollutants.
        - The new Tier IV final engines (or latest EPA standard) reduce emissions of local air quality pollutants like particulate matter and nitrous oxides by over 97% and 86%, respectively.

Shops, yards, and facilities

The primary purpose of rail yards is for railcar staging or inspections, while our shops fall into two distinct categories based on function:

- **Maintenance of Equipment (MOE) shops and yards are where our employees perform comprehensive inspections, cleaning, repairs, component changeouts, retrofits, and overhauls of the passenger railcars.**
- **Maintenance of Way (MOW) shops and yards are where we store or maintain equipment and materials needed for maintenance of track and other right-of-way infrastructure.**



For the purposes of this assessment, we are also treating MOW assets such as work trains as a subset of MOW shops. In addition to shops and yards, we have several other employee facilities that support various operational or maintenance functions. We assess the condition of the various building systems and components that make up these facilities.

Above, West Side Yard, Manhattan
Left, Mid-Day Storage Yard, Queens

Asset inventory and status

Condition assessments of the employee facilities and shops (except rolling stock support equipment) within this category are performed every five years. During inspection, a rating is assigned to all components, such as building exteriors, building interiors, electrical systems, plumbing, HVAC, etc. We can then understand condition trends, set priorities, and begin to identify the required capital investments—as well as maintenance activities—by either component type or facility location.

Rolling stock support equipment includes all the machinery within a shop that is used to maintain our railcars and locomotives. Most of our rolling stock support equipment is located within the Hillside Maintenance Facility and has not been replaced since the facility opened in the late 1980s.

In addition to measuring the age and condition of our shops and yards, we also measure these assets by their performance. Asset performance considers the ability of the shops and yards to support the fleet and meet maintenance needs. Facilities that are unable to meet these fleet and maintenance needs will be upgraded and reconfigured, or in some cases replaced, with replacement targeted toward poor performing components that are likely to impact fleet reliability or operations..

Inventory and status

	Asset	Total	Percent in Poor/Marginal Condition
Employee Facilities	Conveyance (elevator and escalators)	5	0%
	Electrical (electrical - load, panels, light)	16	31%
	Shop Equipment (generator/ATS/UPS)	3	67%
	Fire Protection, Security	15	33%
	HVAC (heating, ventilation, and air conditioning)	31	32%
	Interior (interior walls, stairwells, restrooms.)	39	46%
	Plumbing (sanitary waste, drainage, etc.)	16	13%
	Shell (roof, doors, windows, facade)	62	34%
	Site (roadways, parking lot, pedestrian bridge, platform, sidewalk, walkway, sidewalk/ramp, etc.)	48	19%
Shops	Conveyance (elevator and escalators)	3	0%
	Electrical (electrical distribution, lighting, etc.)	10	30%
	Shop Equipment	6	17%
	Fire Protection, Security	8	38%
	HVAC (heating, ventilation, and air conditioning)	19	5%
	Interior (walls, restrooms, stairs)	19	16%
	Plumbing (sanitary waste, drainage, etc.)	10	20%
	Shell (structure, floor, windows, doors, etc.)	39	13%
	Site (sidewalks, ramps, parking lot, security fence)	21	14%
	Rolling Stock Support Equipment	1,105	84%

	Asset	Total	Percent in Poor/Marginal Condition
Yards	Electrical (electrical distribution, lighting, etc.)	6	17%
	Fire Protection, Security	3	0%
	HVAC (heating, ventilation, and air conditioning)	12	25%
	Interior (walls, doors, stairs)	12	25%
	Plumbing (sanitary waste, drainage, etc.)	6	17%
	Shell (structure, floor, windows, etc.)	22	23%
	Site (roadways, misc. structures, etc.)	13	23%
Work Vehicles	Work Locomotives	33	94%

Babylon Train Car Wash
Right page, West Side Yard, Manhattan

Investment needs

In order to provide optimal support for our train fleet, we require shops and yards that are modern, safe, and have adequate capacity and equipment to meet our evolving fleet maintenance needs. Equipment should be in a condition that allows for work to be carried out safely and efficiently, and our facilities must be safe and adequate for staff needs. We must also make investments to mitigate the effects of climate change on our assets.

We will prioritize investments in our assets based on asset condition and asset performance.

Over the next 20 years, we need to:

- Replace poor condition, marginal condition, or over-age components throughout storage yards, heavy equipment within maintenance shops, and components of buildings and building systems for each of these asset categories.
- Upgrade and reconfigure support shops and facilities to meet evolving maintenance needs in conjunction with the procurement of new railcars, such as new work locomotives and new fleet expansion of the M9 and M9-A.
- Ensure that maintenance facilities are properly equipped to store, inspect, maintain, and clean rolling stock by replacing outdated and underperforming equipment in Hillside and other shops. Ensure maintenance facilities meet the needs of our future fleets:
  - Explore the benefits of renovating and expanding maintenance facilities in the next 20 years to better support our fleet. For example, Hillside Maintenance Complex is currently the only location equipped to fully maintain the electric train fleet, creating operational inefficiencies and adding to operating cost.
  - Rebuild the Morris Park locomotive turntable and refurbish train wash facilities.
  - Make operational improvements to Arch Street Shop and Yard Facility to better support network needs following the opening of Grand Central Madison, including establishing an engineering headquarters and employee facility in Long Island City.
- Replace work locomotives that are in poor condition.
- Fortify shops, yards, and facilities likely to be affected by climate change impacts.
  - Arch Street Shop and the West Side Shop are in coastal flood zones and face an increased risk of flooding.
  - Sheridan Car Shop, Morris Park Shop, and the Hillside Maintenance Complex are at risk of stormwater flooding from extreme rainfall. Where relevant and necessary, facilities will be hardened to enhance drainage systems, install backflow valves, implement pumping mechanisms, floodproof or elevate assets, install perimeter protection, add heat monitoring equipment to assets, and ensure access to back-up power.
- Use asset replacement opportunities to conserve energy, reduce fossil fuel use, and generate renewable energy on-site. By integrating these practices into normal investment cycles, we will maximize the long-term operational cost savings that are generated through updated building systems that reduce fossil fuel dependence and reduce demand for grid electricity.
- Install electric vehicle charging equipment dedicated for LIRR use in appropriate locations to meet MTA goals of transitioning to 100% zero-emissions light-duty non-revenue vehicles by 2035 and medium/heavy-duty non-revenue vehicles by 2040.

PASSENGER STATIONS

02

Our 126 passenger stations are a rider's first and last point of contact with the LIRR system. Each station is unique, and there is a wide range in the level of complexity of stations across the network, from simple at-grade platforms to the massive underground complex of Penn Station.

Passenger stations contain numerous interrelated systems and individual elements, all of which must be maintained so that customers can safely access trains. Stations contain several types of stuctures including buildings with waiting rooms, restrooms, and agents, as well as platforms with shelters, stairs, ramps, overpasses, public address systems, and digital display signage. Station assets also include elevators, escalators, walkways from local streets to the platform, parking lots, security cameras, and numerous other amenities to make it more safe, convenient, and comfortable to wait for or access trains. Communication systems inform riders of train arrivals, departures, and delays; make safety announcements; and provide other information to help passengers complete their journey. Beneath it all are the structural elements of the station, which must be kept in safe condition for millions of annual riders.

Our investment needs over the next 20 years include:

- Replacing platforms or platform components that are not in good condition.
  - Replace all platform components with structural deficiencies identified in annual inspections.
- Rebuilding and rehabilitating station buildings.
  - Repairing and replacing station building components including doors, windows, HVAC, restrooms, roofs, fire safety systems, and more at approximately four stations per five-year program.
- Keeping our new facilities at Grand Central Madison in good condition and continuing to improve facilities that LIRR customers rely on in Penn Station.
- Investing in communication systems to improve real-time train information and providing improved audio and visual communications in stations.
- Improving systemwide station accessibility.
  - Making 100% of our stations accessible by completing ADA projects at seven stations.
  - Adding new elevators at 13 stations and replace 17 elevators to keep them within their useful life.

Passenger stations

Inventory and status

Asset		Total	Percent in Poor/Marginal Condition
Platform Components	ADA Ramp	152	7%
	Platform Substructure	206	19%
	Platform Slabs	206	19%
	Platform Joints	206	15%
	Platform Railing	157	5%
	Platform Waiting Room	29	0%
	Canopy	100	24%
	Shelter	182	6%
	Stairs	751	5%
Elevators & Escalators	Elevators	50	32%
	Escalators	19	63%
Station Building Components	Station Building Exterior	88	3%
	Station Building Interior*	88	1%
Paving	Walkways/Sidewalks	260	5%
Parking	Parking (surface lot)	151	20%
	Parking Structure	1	0%
	Parking (garage)	3	0%

** Station Building Interior includes doors, windows, floor, walls, restrooms, security systems, HVAC systems, and fire suppression systems.*

Islip Station

Asset inventory and status

Condition assessments of station assets are performed annually. During inspection, a rating is assigned to all components of the station such as building exteriors, building interiors, escalators, platforms, and lighting. Based on these component ratings, an overall rating is assigned to each station. We can then understand condition trends, set priorities, and begin to identify the required capital investments (as well as maintenance activities) to preserve and maintain the integrity of assets and their components.

Examples of age-based and condition assessments for station components are:

- **Useful life:** Older assets are more prone to break down and generally require more extensive and costly maintenance to keep in service. For example, an elevator over the age of 20 is considered past its useful life.
- **Condition:** The amount of deterioration in each component of the station building and platform is assessed by a qualified inspector and assigned a numerical rating.

The results of a condition-based assessment of station assets and components are shown here in a table. (This table excludes Penn Station and Grand Central Madison, which are each assessed separately.)

Wyandanch Station

Investment needs

For stations other than Penn Station or Grand Central Madison,[3] we will continue to prioritize making all stations accessible and rehabilitating stations that have platforms and station buildings with significant structural deterioration while addressing other poorly rated components.

Over the next 20 years, we need to:

- Replace platforms that are in poor or marginal condition, prioritizing locations that have platform integrity or structural issues.
    - Similar to accessibility projects, where feasible, when performing major platform structure work, we will seek to replace all related assets that are in poor or marginal condition like overpasses, platform lighting, signage, security systems, etc. at the affected stations.
    - Platforms that are being rebuilt or repaired and that are shorter than standard platforms will be evaluated to determine if it is cost effective and operationally beneficial to lengthen to allow for all-car boarding.
    - When platforms are being replaced, we will take advantage of the opportunity to install tactile edging to improve platform safety.
- Rehabilitate station building assets such as building doors, windows, roofing, restrooms, HVAC systems, boilers, sewer systems, lighting, painting, signage, security, fire suppression systems, and CCTV security systems.
    - Improve accessibility by adding ADA-compliant bathrooms and egress.
    - Invest in historic station building restoration.
- When upgrading stations, maximize opportunities to conserve energy and reduce fossil fuel use, and explore the feasibility to deploy solar photovoltaics for on-site renewable energy generation.
- Where possible, incorporate climate resilience strategies alongside necessary repair work, including:
    - Floodproofing or elevating station assets that are already or will soon be vulnerable to flooding due to climate change.
    - Investing in improved drainage such as larger culverts, stormwater retention, pumps, and/or backflow prevention.
- Advance accessibility at East New York in Brooklyn; Kew Gardens, Mets-Willets Point, Douglaston, and Hunterspoint Ave in Queens; Bellerose in Nassau; and Cold Spring Harbor in Suffolk County to achieve 100% of stations being fully accessible.
    - Where feasible, as accessibility enhancement projects are planned and executed, other station projects will be bundled with the accessibility projects to increase construction efficiency and time savings. The additional work can include critical infrastructure replacement work, normal component replacements, and climate resilience improvements.
    - Replace elevators as they approach the end of their 20-year useful life.

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[3] Due to their complexity, size, and importance to the network, Penn Station and Grand Central Madison are each discussed individually below.

Passenger station public communications and security

Audio/visual paging systems (AVPS), public address systems, security cameras, intercoms, radios, real-time information digital signs, and countdown clocks improve our riders' experience by providing important service updates to passengers, enhancing security within our stations, and facilitating fare payments. The backbone of this technology is our extensive fiber optic network, which is discussed separately within the Communication Infrastructure section below. Recent investments in the fiber optic network have made it possible to upgrade to next-generation technology on downstream systems and equipment such as station public address systems and ticket vending machines.

AVPS includes station public address systems and digital displays at branch line stations, as well as audio public address systems at LIRR terminals. AVPS provides schedule-based information in combination with real-time status as it reflects projected arrival and departure times including information about the nature and casues of delay.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
AVPS Color Signs	230	0%
Platform, Large, Indoor, Parking & Safety Signs	506	99%
Public Address	122	0%
Security - Access Control Readers	699	100%
Security - Cameras	2,987	7%
Security - Network Video Recorders	292	68%

Asset inventory and status

Several prioritization factors are considered for communication investments and are evaluated in concert with a paced, continuous replacement cycle. Asset age compares the actual age of the communication equipment to its lifespan; when the equipment is close to exceeding its maximum age, it is prioritized for replacement. Asset obsolescence prioritizes installing new technologies; as communication technology changes, obsolete technology becomes more difficult to maintain, and parts are harder and more expensive to acquire. Asset condition defines the physical state of the communication equipment, based on number and frequency of repairs and tickets. Asset criticality includes factors such as a role in maintaining safety, sustaining LIRR operations, and supporting corporate data needs.

Legacy AVPS screen

Communication and security upgrades are a focus for the LIRR as we strive to incorporate the latest technologies into our integrated public communications and internal train location information systems.

Additionally, one of our biggest obstacles in implementing new communication and security components is the speed at which technologies change. If we wait too long to shift from a functional but older technology system to a new technology system, we risk obsolescent parts, delays in repair schedules, and decreased system compatibility. We will evaluate emerging technologies so we can ensure compatibility with existing systems. We strive to balance immediate needs with long-term scalability and compatibility requirements, which requires careful planning and evaluation.

The results of a condition-based assessment of public communication and security assets and components are shown in the inventory and status table. For electronic assets, such as electronic signs, a rating of poor or marginal does not necessarily indicate that they are not able to perform their intended function. However, they may be functionally obsolete, meaning they are unable to incorporate recent technological improvements, their parts are no longer easily obtained, or maintenance is becoming increasingly challenging or costly. Likewise, for security assets, a rating of poor or marginal does not mean they cannot perform their intended function.

Investment needs

Over the next 20 years, we need to:

- Install new interior and exterior color AVPS signs and implement the station technology upgrade program to replace station signage throughout the LIRR system. Station technology upgrades will enhance the customer experience in numerous locations.
- Repair or replace assets in poor or marginal condition, replace assets that are approaching the end of their useful life, and upgrade obsolete systems to new technologies (in particular older generation AVPS signage, security access control readers, and video recorders).
- Improve customer communication, ensure reliability, and increase safety and security by upgrading the control systems for all station audio/visual communication systems with fully redundant systems that are also integrated with LIRR's centralized train control system.
- Improve security by replacing or upgrading security cameras at station buildings and platforms.
- Seek to incorporate climate resilience strategies when improvements are made, so these assets have reduced risk of being damaged by extreme heat, flooding, or heavy winds.

Penn Station East End Gateway

Penn Station

As the busiest terminal in our network, it is vitally important that the station meets the needs of our operations and of the LIRR passengers who use the station. While Penn Station is owned by Amtrak, the LIRR has capital responsibility for assets and systems within the portion of the station that we operate. A recent major improvement, our spacious new LIRR Concourse at Penn Station opened in 2022, elevating the experience of nearly half of Penn Station's users who walk through this concourse daily. Planning continues for Penn Station Reconstruction, which would modernize the passenger experience throughout the entire station. It is also critical that, separate from the improved concourse, other portions of the station that are leased by the LIRR have numerous assets and integral systems that are in poor or marginal condition and need LIRR investments.

Inventory and status*

Asset		Total	Units	Percent in Poor/Marginal Condition
Structural/ Architectural (Concourse Ceilings, Floors, Walls, etc.)	Structural Platforms (platforms and tactile edging)	**149,800**	Square Feet	**100%**
	Interior Finishes	**496,500**	Square Feet	**10%**
	Architectural Elements (canopy, doors, staircases, etc.)	**111**	Each	**60%**
	Offices/Rooms	**15,235**	Square Feet	**20%**
Communications	Communications (station announcement control board, video recording system)	**11**	Systems	**100%**
	Passenger Information Assets (display boards, signs, clocks, etc)	**317**	Each	**53%**
	Passenger Information Systems	**3**	System	**67%**
Fire and Life Safety	Fire Protection Assets (FS Dampers, Fire Suppression)	**35**	Each	**9%**
	Fire Protection Linear Assets (standpipes)	**2.6**	Miles	**100%**
	Fire Protection System	**1**	System	**0%**
Electrical	PSCI Lighting	**1**	System	**0%**
	Cables/Wiring	**149**	Miles	**97%**
	Equipment (panels, lighting fixtures, switches)	**6,386**	Each	**91%**
Mechanical	Mechanical System	**2**	System	**0%**
	Mechanical Assets (heaters, boilers, pumps, generators, lifts, etc.)	**68**	Each	**8%**
	Mechanical - Elevators	**6**	Each	**0%**
	Mechanical - Escalators	**14**	Each	**0%**
	Mechanical/ HVAC System	**1**	System	**0%**
	Mechanical/HVAC System Assets (fans, air handlers, fan coil units, etc.)	**166**	Each	**17%**

Inventory and status*

Asset		Total	Units	Percent in Poor/Marginal Condition
Plumbing	Pipes	**34**	Miles	**65%**
	Equipment (ejector pumps, fixtures, valves, etc.)	**337**	Each	**84%**

** This inventory does not include new assets added to Penn Station during 2023 concourse construction.*

Investment needs

We plan to do work to replace or repair assets that are in poor or marginal condition. Over the next 20 years we plan to:

- Replace all the HVAC air handlers.
- Rehabilitate the building electrical and plumbing systems.
- Rehabilitate platforms in poor structural condition and their associated components, such as staircases and lighting.

In addition, many assets that are currently in good condition, such as elevators, escalators, station lighting, flooring, and restrooms, will require cyclical replacement during the 2025-2044 period, as they reach the end of their useful lives.

Penn Station

Grand Central Madison

This new station, which integrates connections to the subway and Metro-North Railroad, has opened new travel options for tens of thousands of daily LIRR riders. Passengers now have direct access and shorter commutes to Manhattan's East Side, the most transformative change to LIRR service in over a century. In less than two months of being open with full service, the LIRR surpassed one million customers traveling in or out of Grand Central Madison.

Investment needs

Investments over the next 20 years will focus on maintaining the opening day standard of the new Grand Central Madison station. All components of the station are currently relatively new and are in good condition. However, assets with useful lives of less than 20 years will be due for cyclical replacement during the 2025-2044 period. Keeping up with these normal replacement cycles will ensure Grand Central Madison remains in good condition.

Components slated for normal replacement over the next 20 years include HVAC units, signage, elevators, escalators, and platforms. We will also ensure that operational facilities, tools, and equipment needed to continue maintenance of Grand Central Madison facilities are adequate. Additional improvement priorities include new operational equipment for LIRR trains, and portable HVAC units for use within the tunnel, vent plants, and terminal areas.

Above and below, Grand Central Madison

RIGHT-OF-WAY 02

Right-of-way infrastructure is a grouping of asset categories that make up the physical railroad right-of-way, namely what we call "line structures" and track. Line structure assets include bridges, viaducts, and tunnels. Also included in this asset category are culverts and retaining walls. Culverts are structures that allow water to flow under the right-of-way and must be right-sized to ensure there is adequate drainage capacity. Retaining walls hold soil in place when the railroad is at a different elevation from the adjacent property. Proactive maintenance of line structure assets mitigates the need for extensive repairs or costly rehabilitations in the future. Track includes the rails and ties, as well as switches, grade crossings, and ballasts. These assets, which also support the freight operations that transport goods throughout the region, are subject to heavy use and continuously exposed to harsh and changing weather conditions.

Our investment needs over the next 20 years include:

- Renew the Atlantic Avenue Tunnel through structural rehabilitation, waterproofing, enhanced lighting, fire safety, and security systems.
- Replace or rehabilitate 60-100 bridges and 11-23 viaducts, and apply state-of-the-art protective surface coating and deck waterproofing at up to 100 locations, decreasing future maintenance needs and increasing the lifespan of our structures.
- Improve service reliability by completing the reconfiguration of track at Jamaica to alleviate bottlenecks, reduce delays, and help trains move faster through some of our most congested locations.
- Continue cyclical programs to replace and modernize track components across the network and invest in resilience with new retaining walls and drainage systems.
- Install high security fencing in critical locations to keep the right-of-way secure.

Line structures

Our line structures are crucial for the proper functioning of our system through, over, or under obstacles like roadways, water bodies, or along varying terrain. This includes undergrade bridges, overgrade bridges, viaducts, and tunnels, which are the most critical structures, as well as other structures including culverts, lattice towers, and retaining walls.

Asset inventory and status

The line structures category is primarily focused on undergrade and overgrade bridges, viaducts, and tunnels, as well as less critical structure such as retaining walls, culverts, and structures that support signal utility lines. To maintain their physical integrity, they need considerable and regular investments in maintenance rehabilitation or replacement when they begin to exhibit structural deterioration. To keep our structures in a safe and reliable condition, we conduct annual inspections for critical structures like bridges and viaducts, and perform comprehensive inspections every five years for other structures. During these inspections, a qualified inspector carefully examines and documents elements of each structure. The many components related to each structure—like steel girders, beams, and abutments—are comprehensively assessed to identify steel or concrete corrosion, decay of wooden timbers, or other signs of deterioration. The results of condition-based assessments of line structure assets indicate that several bridges are showing increasing levels of structural deterioration that, if not addressed, could result in unsafe conditions. While it hasn't grown, this percentage has not decreased in recent years. In addition to overall structural condition, undergrade bridge steel painting and deck waterproofing conditions are documented, as these could have significant impact on the structural condition down the road. Most bridges have paint and/or waterproofing that is in poor or marginal condition. Seven viaducts, encompassing 256 individual spans, are in poor or marginal condition. This quantity has grown in recent years due to deferred rehabilitation work. In addition, three of four tunnel segments have never had significant structural rehabilitation investments since they were constructed and are in marginal condition. The results from the 2022 condition assessment are shown in the inventory and status table.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Undergrade Bridge (structure)*	504	13%
Undergrade Bridge (waterproofing)	409	69%
Undergrade Bridge (painting)	390	69%
Overgrade Bridge	56	19%
Tunnel	4	75%
Viaduct	29	24%
Retaining Wall	103	18%
Signal Tower	86	19%
Lattice Tower	277	13%
Culvert	163	20%

** For Undergrade Bridges, total units differ based on category of work. Depending on type and location, not all Undergrade Bridges receive waterproofing or painting.*

Investment needs

Over the next 20 years, we will address the condition of the structures most critical to safe operation of service including bridges, viaducts, and tunnels, while focusing on preservation methods, such as painting and waterproofing, to maintain the integrity of our existing structures and prevent structural deterioration. Priority rehabilitations or replacements are identified based on poor or marginal conditions, as well as structures with defects requiring immediate attention which could impact operations or that are in critical locations. In many cases, the structural components can be rehabilitated to bring the structure to an acceptable condition overall. However, if this type of investment will not effectively improve the condition to an acceptable level or additional investments will be required a short time later, the structure will likely need to be replaced.

Over the next 20 years, we need to:

- Increase the pace in preventative maintenance on structures through increased deck waterproofing and structural steel painting.
- Bring all bridges into good condition through our structures rehabilitation/replacement program by frontloading approximately three to five high-priority bridges and three to six viaducts in each program based on their physical condition and load capacity rating. Rehabilitate tunnel components in the worst condition in the initial part of the next 20 years and then transition to investments that preserve the structures.
- Redesign or retrofit line structures to better withstand future climate hazards in the coming years. Climate resilience strategies include sizing culverts for anticipated future rainstorms and flows, and stabilizing or fortifying retaining walls in areas where steep slope exposure and extreme precipitation is more likely to result in run-off, erosion, and landslides.

Undergrade bridges
Allow an obstacle to pass under the railroad (i.e., the track(s) are on the bridge structure).

Overgrade bridges
Allow the obstacle to pass over the railroad (i.e., the roadway is on the bridge structure).

Tunnels
Underground passages or channels that provide the means for our rail to traverse underneath bodies of water or highly developed neighborhoods.

Viaducts
Provide separation of the railroad from the surrounding community or allow our rail system to traverse a wide valley with a bridge-like structure.

Retaining walls
Built to hold back soil and provide support for our elevated structures or keep steeply sloped surfaces from collapsing onto the adjacent track bed.

Culverts
Are designed to allow water to flow underneath tracks to manage drainage and prevent flooding.

Track

Our track system is made up of several elements:

- **Ties:** These are the cross-members that hold the rails at a fixed width to form the track structure. They're usually made of wood or concrete. In some places, like the Atlantic Avenue Tunnel, we use half-ties. On certain viaducts we use direct fixation or bridge timbers on open deck bridges and viaducts.
- **Rail:** This is what provides a running surface for the train wheels. Together with the ties, they form the track structure.
- **Ballast:** This is the crushed stone that supports the track structure.
- **Switches:** These are arrangements of ties and rails that allow trains to move from one track to another.
- **Crossings:** These are either concrete or rubber pads installed to allow vehicles to travel over tracks at ground level.

Right, Montauk Branch Track Assets, Source: Google Streetview

LIRR Third Track

Asset inventory and status

Our track assets are assessed by age, condition of the asset, and based on operating conditions. When prioritizing track assets for replacement or improvement, we consider different factors by component. Track assets are generally replaced on a cyclical basis based on age or remaining lifespan.

- Rail assets are replaced based on the age of the rail and based on use. Rail that is more frequently traveled requires more frequent replacement.
- Ties are replaced based on age, which ranges from 30 years for wood ties to 50 years for concrete.
- Switches are evaluated for replacement based how much use and wear they receive.
- Crossings are prioritized for replacement based on site and asset conditions. Grade crossing replacements are often coordinated with the local authority responsible for roadway maintenance.
- Yard track and switches require an age-based or conditions-based approach to repair or rehabilitate.
- Track maintenance equipment such as cranes, machines for installing ties and rail, and vehicles used to carry track components are prioritized for replacement based on Federal Railroad Administration requirements.

To ensure all components are meeting our high standards we conduct weekly visual track inspections, quarterly inspections to determine the need for track resurfacing, and ultrasonic testing to detect internal defects in the rail.

Because they must uphold a high standard to support rail service, we schedule replacements for most track assets on a cyclical, age-based replacement based on their lifespan. Each asset has a lifespan that varies from 15 to 50 years. The inventory and status table contains track inventory and quantities that will be coming due for replacement in the upcoming capital programs.

Inventory and status

Asset	Total	Units	Percent Due for Replacement
Ballast	500	Track Miles	35%
Grade Crossing	417	Each	64%
Rail	5,374,021	Linear Feet	16%
Switches	916	Each	26%
Tie	1,519,134	Each	20%
Construction Equipment	372	Each	35%

Investment needs

We evaluate track components individually and together over segments of the railroad to coordinate track work for fewer service disruptions. To facilitate our track asset replacement program and perform work in a more cost-effective manner by addressing longer spans of track at one time, we must occasionally interrupt regular service. As we have limited opportunities to complete replacements without impacting our riders, we must plan track outages carefully and provide advance notice to potentially impacted riders. We have been continuously maintaining our track assets based on our cyclical track program.

Over the next 20 years, we need to:

- Continue cyclical track maintenance program by replacing:
  - Approximately 35,000-40,000 wood ties per year.
  - 18 rail miles of continuous welded rail per year.
  - About 13 mainline switches per year.
- Replace grade crossings at an accelerated pace of about 30 per year for the next few years to address the large number of grade crossings that are due for replacement and then continue a steady pace of about 12 per year after that.
- Continue the pace of investment in track construction equipment that supports track work.
- Plan to upgrade some assets as we replace them, where feasible.
  - Continue the effort to upgrade our busiest branches from wood to longer-lasting concrete ties.
- Construct or reinforce right-of-way retaining walls.
- Install of right-of-way fencing along with targeted track replacement efforts within West Side Yard, Hillside, Penn Station, and other selected areas.
- Improve drainage, where needed, to protect tracks from coastal flooding or heavy rainfall.

Jamaica Capacity Improvements

While planning for normal replacement of assets, we also assess other component or asset improvement opportunities at or around the affected work areas to be as efficient as possible. As an example of this, we are in the process of completing a series of interrelated improvements to track and switch layout at Jamaica that will greatly improve operations and reduce train congestion and delays.

The Jamaica Capacity Improvements will build upon the Hall Interlocking upgrades with additional reconstruction and expansion within Jamaica Station and Jay Interlocking located west of the station. This will greatly improve train routing flexibility and reliability through Jamaica Station and accommodate growing ridership through this busy hub that serves all but one of LIRR's branches. The new signal system will support higher speed switches and streamline the track routes. Jamaica platforms will be extended to accommodate 12-car trains, as well as extending the E Yard of Jamaica. There will also be construction of a new wayside signal system. Throughout the station, there will be ongoing projects to improve passenger accessibility. This includes enhanced signage and implementing various customer amenities to make JFK AirTrain more easily accessible to the LIRR and subway passengers. In addition, new design efforts will take place to improve customer flow and improve passenger accessibility between platforms.

SIGNALS, POWER AND COMMUNICATIONS

02

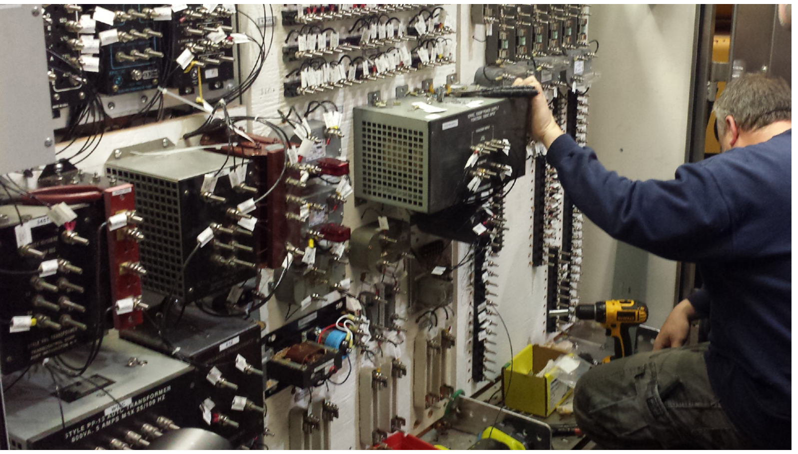
Signal, power, and communication systems work together so trains can run smoothly, safely, and frequently throughout the network. Signals ensure that trains follow the proper route at safe speeds maintaining proper distances from other trains. Our power assets ensure stable and sustainable traction power that provides propulsion for our electric railcars, and the power system provides an energy supply needed to run our signaling and communication infrastructure, as well as station lighting and electrical systems. Our communication systems consist of miles of cables, electronics, network components, displays, and other assets to provide information throughout the system. Upkeep and upgrading of these systems and their components are required for safe and reliable rail service, and investments in technological advancements for these systems will improve customer experience.

Our investment needs over the next 20 years include:

- Modernizing approximately 50 miles of signal systems and replace aging and/or obsolete components with latest-generation electronics providing modern and more reliable signal systems.
- Replacing about 10-14 substations in each capital program and replace or upgrade critical components at other substations. Third rail will also be upgraded to current standards and utility poles, power lines, building lighting, and electrical systems will be replaced.
- Installing up-to-date communication systems and components that will allow us to effectively monitor the system, provide information to LIRR crews and customers, and manage vast amounts of data in a technologically robust system.

Signals

Our signal systems enforce safe speeds and spacing of trains; they consist of interrelated components including cables, track relays, batteries, switch machines, cases and huts, and grade crossing mechanisms. We have multiple types of signal systems, ranging from the recently installed state-of-the-art signal technology on the Montauk Branch between Speonk and Montauk, to obsolete legacy systems installed during the Pennsylvania Railroad era.



Signal case

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Switch Machine	970	24%
Signal	812	51%
Supervisory and Control	174	37%
Equipment Location - Huts and Cases	1,374	59%
Gate Mechanisms	851	28%
Air System	17	82%
Battery	1,088	57%
Cable	7,979	54%
Electronic Equipment	283	6%
Wayside Interface Units (WIUs– PTC signal component)	171	24%
Transponders (PTC signal component)	4,500	26%

Asset inventory and status

Metrics used to identify assets and components slated for replacement or upgrade are a combination of high-level age-based condition assessments supplemented with more granular assessment considering defects, criticality, performance, maintenance, and other metrics. When prioritizing network segments for signal modernization and normal replacement, we will emphasize replacing signal segments that are beyond their expected maximum age, obsolete, or have a high percentage of components rated poor or marginal.

Lines and interlockings (an interconnected system of signals and signal appliances that prevent conflicting train movements) that experience higher train traffic volumes are also assigned a higher priority for maintenance or replacement. For interlocking modernization, we prioritize replacing switch machines and electronic supervisory control systems in concert with track renewal programs. For full signal system replacements, we prioritize branches or a segment of a branch where the system is obsolete, or a majority of the signal assets are in poor or marginal condition. For segments that are not part of a complete signal system replacement project, the normal replacement program addresses the lowest-rated components. We consider age, lifespan, obsolescence, structural conditions of the cases or huts that the components are housed in, operational impacts, failure rates, testing, and vendor support availability when we prioritize signals for normal replacement. Shown here is an inventory and status of major signal assets.

Above, standard LIRR signals system annotated with signals components

Investment needs

In order to ensure high levels of safety and efficiency for trains moving throughout the network, we need to address assets in poor and marginal condition, as well as invest in technology and signaling upgrades so that the system is capable of reliably meeting current operational demands. Some segments of signal infrastructure are more than 60 years old, some have been upgraded recently, and some are at substantial risk of premature failure due to exposure to climate-change-related impacts of increased flooding, heat, and wind events.

We are focused on improving signal condition through asset and component replacements, modernizing corridors to achieve new safety and efficiency standards and preparing corridors for the effects of climate change. Over the next 20 years, we need to:

- Upgrade approximately 50 miles of signal systems in segments where 50%-75% of the signal components are rated poor/marginal on portions of the Port Jefferson, Far Rockaway, Port Washington, Oyster Bay, and Montauk branches.
- Continue normal replacement of relays, cables, batteries, switch machines, huts, and signals while examining all opportunities to combine normal replacement activities with signal modernization.
- Invest further in PTC, which will yield long-term safety benefits for the entire rail network and provide an additional layer of safety protection, particularly in situations where human error or unexpected circumstances may pose risks to train operations.
- Complete implementation of Centralized Train Control (including creating an emergency back-up location), which will give us the ability to monitor all trains from a central location, improving operations, communication, and the ability to respond to service disruptions.
    - The centralized system also replaces our legacy train tower control system, reducing operating costs and future capital costs by eliminating the need to maintain towers and their related communication systems.
- Assets that are exposed to flooding, extreme temperatures, wind, and erosion will be prioritized for climate resilience protections. For signals at risk of flooding, this may include asset elevation and/or waterproofing.

Power

Our power system provides power to our electric railcars via third rail traction power, and it also provides electricity for our signal, lighting, and electrical systems at stations and yard buildings. Power assets, including substations, motor generators, cable, third rail, protection boards, lighting systems, cables, poles, and numerous other elements, are critical to providing reliable train service. Without a stable flow of power from our traction power substations to reliable third rail systems, our electric railcars can't move. Substation condition and capacity are the most critical elements within the power asset category. Substations typically house transformers and other equipment that convert electricity from the electrical grid to the proper current and voltage so it can be used by railcars.

Our power assets also include various third rail system assets, electric light and power assets—including our communication huts and cases, and lighting in station buildings, platforms, tunnels, and yards—as well as high tension assets including high-tension towers, power poles, and power lines. Without reliable electric power and lighting systems at facilities and the assets to carry electricity throughout the system, these facilities would not be functional.

Inventory and status

Asset	Total	Units	Percent in Poor/Marginal Condition
Substation Overall (age based)	129 (incl. ESA)	Each	52%
Substation Components	2,826	Each	22%
Electrical System*	13,217	Each	52%
High Tension Cable, Feeder, and Power Lines	494	Miles	17%
High Tension Equipment	7,805	Each	9%
Third Rail Bracket	42,098	Each	19%
Third Rail Cable	1,247,000	Linear Feet	19%
Third Rail Fiberglass Protection Board	1,662,000	Linear Feet	48%
Third Rail Wood Protection Board	15,000	Linear Feet	0%
Third Rail Reactor	115	Each	66%
Third Rail – Aluminum	79,000	Linear Feet	0%
Third Rail – Composite	1,108,000	Linear Feet	0%
Third Rail – Conventional	55,000	Linear Feet	97%

Includes bridge electrical systems, tunnel and yard lighting, emergency generators, wayside power, communication rooms and huts, station building electrical systems, and station and platform lighting.

Left page, third rail. Above, New Cassel Substation

Asset inventory and status

Evaluation factors used to determine investment priority for power assets include age, location, power demand, equipment obsolescence, and lack of redundancy. This system helps ensure assets that are more crucial to our operations are evaluated for major overhaul or replacement before less critical ones, even if the less critical assets and components have been in service longer.

More than half of our substations were constructed in the early 1970s, and these have all exceeded their 35-year lifespan. While they still function safely, their critical components such as transformers and rectifiers, require additional maintenance and are more prone to failures. Substation replacements are necessary to ensure the proper movement of trains and comply with safety regulations—and they are major undertakings. They must be scheduled so the transfer from an old substation to a new one does not interrupt system power flow, and so the pacing aligns with the production levels of equipment manufacturers.

For substation power demand improvements, we have completed a Traction Power Load Study that evaluated the electrical capacity of our power infrastructure and helps to inform an investment strategy for future capital investments. Traction power simulations of future train operations were performed during the study to identify deficiencies and make recommendations to address these concerns. When performing normal replacements, we have been upgrading third rail from a composite to higher-performing aluminum rail, and we have been upgrading wood third rail protection board to fiberglass.

Investment needs

Our most critical power investment priority is the cyclical replacement of substations. Over the next 20 years, we need to:

- Replace the most critical substations that are beyond their useful life with greater frequency of failures.
- Continue to replace poorly performing critical components within substations to maintain a larger percentage of substations in good condition for a longer period.
    - Prioritize component replacements at substations that don't meet current standards or provide adequate power to meet demand.
- Continue cyclical replacement of third rail systems:
    - This includes cables, disconnect switches, protection board, and the third rail itself, along with replacement of negative reactors, and short tie extension brackets.
    - Third rail negative reactors will perform normal replacement by appromixely 20 per capital program.
- Improve the capacity of our traction power system by implementing recommendations from the Traction Power Load Study:
    - Construct up to two new substations (Penn Station and Malverne on the West Hempstead Branch) to prevent the adjacent substations from being overloaded.
    - Expand Jamaica substation to meet demand.
    - Raise voltage at 22 existing substations.
    - Install additional cables at 60 third rail feeders and 84 negative feeders.
    - Upgrade 49 negative reactors, as well as third rail sections to aluminum in 12 key territories.
- Replace approximately 16,000 linear feet of conventional third rail with higher-performing aluminum rail in every capital program (3,200 linear feet/year) as well as high tension and third rail components.
- Replace tunnel lighting at Atlantic Avenue and upgrade station and building electrical systems.
- Incorporate climate resilience strategies, including asset elevation and/or waterproofing for those that are susceptible to water inundation.

Below, installation of communications ductwork

Communication infrastructure

Communication infrastructure allows effective information flow to keep our rail system running safely and smoothly. Fiber optic and other cable networks support power and signal systems; facilitate clear and timely communication between train operators, control centers, and station personnel; and allow us to make public address announcements and provide train arrival/departure information to our customers.

Some of the main components of the communications network also include communication poles/towers, fiber optic and copper cables, PBX (internal telephone network), radio networks, and communication components that support the customer communication systems. These assets comprise the various networks for continuous transmission of voice and data communications. As communication technology continues to evolve, dependence on reliable and readily available communication services continues to grow.

Radio systems include units onboard trains or carried by railway workers that are used for operations and maintenance. They support police activity, train operations, maintenance efforts, and emergency services.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Wooden Poles	9,998	17%
Fiber Optics (current standard)	225 Miles	0%
Cable - SM Fiber (old standard)	635 Miles	0%
Cable - Copper	720 Miles	100%
Communication Support System	5,796	28%
Outside Plant	622	22%
PTC System	4,178	0%
Radio Base Stations	270	69%
Communication Huts	398	26%
Radio Equipment	3,465	39%
Radio Cable	23 Miles	57%

Asset inventory and status

Our investment strategy focuses on deploying a more consistent generation of technology throughout the LIRR system to improve coverage and replace aging and obsolete components. We prioritize assets for replacement or upgrade when they are outdated or in poor or marginal condition. Assets with safety issues or regulatory compliance problems are given higher priority, as well as those with a higher criticality to operations and management.

Rapid advancements in communication technologies have wide-ranging benefits but can pose challenges when selecting and implementing the most suitable solutions. Emerging technologies will be evaluated so that we can ensure compatibility with existing systems. We will also need to accommodate a phased approach and utilize redundant systems. As communication assets become more interconnected and dependent on digital infrastructure, we will work with experts to ensure our communication assets are protected against cyber threats and safeguarded from unauthorized access to sensitive data. Inventory of major communication assets and their condition status is shown in the inventory and status table.

Wooden poles
These communication poles carry the cable lines providing services to the LIRR communications systems.

PTC system
Positive Train Control System. (transponders, workstations, radio cases, dispatch center.

Above, PTC transponder, Source: Google Streetview

Radio base stations
Exist at numerous locations to provide individual block operators with the capability to communicate with trains entering the block.

Communication huts
Supports increased network capacity needs with CCTV video service at stations at other locations.

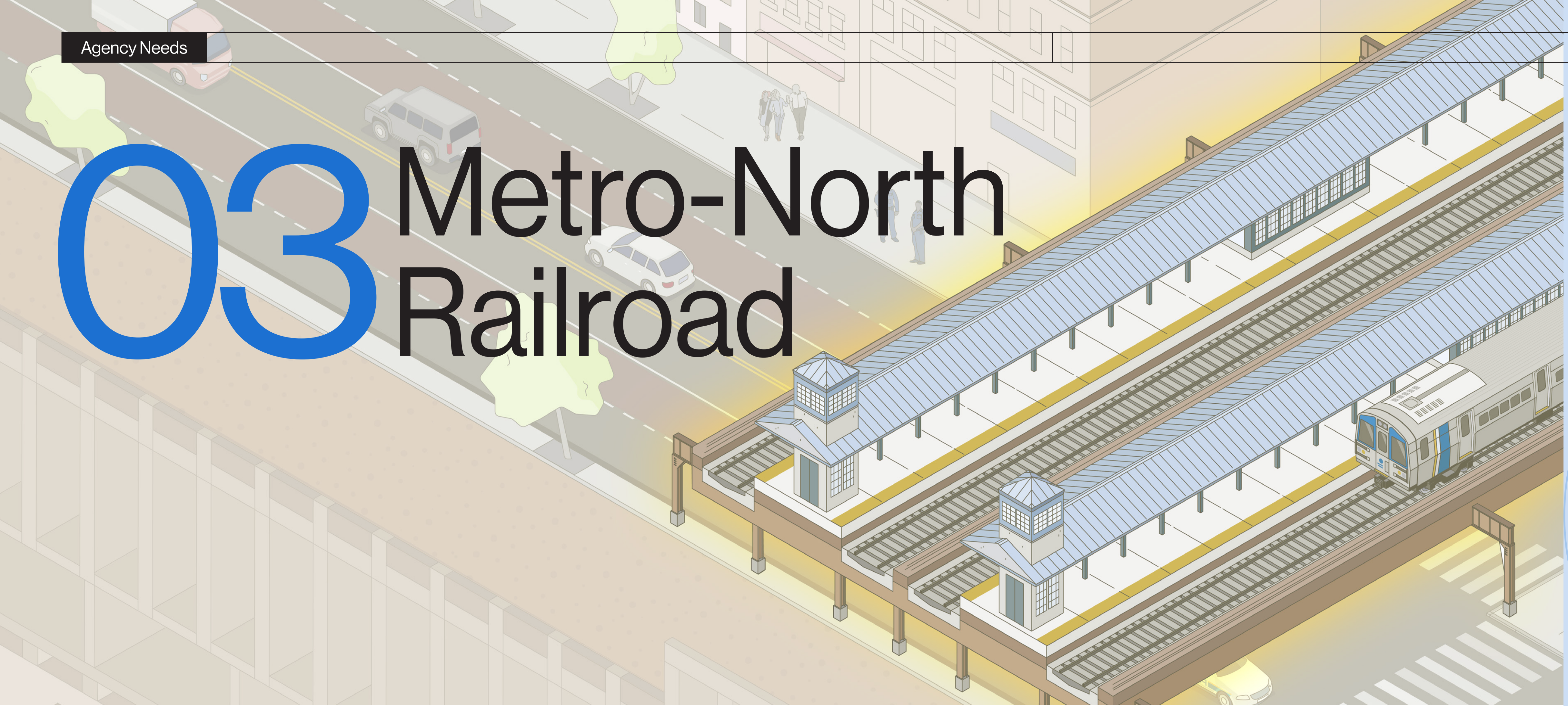
Investment needs

Investments in the fiber optic network and the cyclical replacement of communication pole lines form the core of the communication infrastructure needs. The fiber optic network will be installed with new equipment that will replace obsolete hardware and address assets currently in poor or marginal condition.

Over the next 20 years, we need to:

- Install new fiber optic station nodes to replace legacy equipment at 57 stations.
- Replace the Head End Radio Equipment with Voice over Internet Protocol technology that will remove the last legacy fiber optic network from service.
- Continue the ongoing effort to replace 1,000 communication poles per every five-year program to address deteriorated line poles.
- Invest in our communication component replacement program, alleviating the backup of assets in poor or marginal condition like Volt Direct Power plants, battery backup plants/uninterruptible power supplies, HVAC in communication rooms and huts, radio and antenna assets, and much more.
- Implement new land/wireless communication networks to support expanding business needs such as remote data collection, grade crossing and onboard cameras, and heat-on-rail detection.
- Upgrade 10-15 small communication huts and 4-5 large communication hut per capital program to support network capacity needs.
- Continue to invest in upgrading and modernizing our computer systems to support modern signal and communications systems that rely heavily on computer networking and processing.
- Protect communication infrastructure assets from climate change by elevating or waterproofing equipment at high risk for flooding. We are also considering future risk to communication assets from prolonged extreme heat in specifications and design of capital projects, and in parallel with regular replacements of assets.

Communications room interior



03 Metro-North Railroad

Passenger vehicles and yards

Passenger stations

Grand Central Terminal and Grand Central Artery

Right-of-way

Signals, power, and communications

Overview of agency and assets

Metro-North Railroad (Metro-North) provides service into and out of Grand Central Terminal in New York City on our Hudson, Harlem, and New Haven lines, which extend as far north as Dutchess County in New York and as far east as Fairfield and New Haven counties in Connecticut, forming our East-of-Hudson service territory. West of the Hudson River, riders travel on our Port Jervis and Pascack Valley lines. This West-of-Hudson service—provided under an agreement with New Jersey Transit—serves Rockland and Orange counties in New York.[4]

We need to invest in and properly maintain our aging infrastructure to successfully support current and future operations and ensure the delivery of safe and reliable service that meets the growing and changing demands of Metro-North's riders.

Metro-North by the Numbers:

- **Weekday ridership: Approximately 210,000 trips**
- **912 railcars**
- **39 shops and 11 yards**
- **85 passenger stations**
- **513 miles of track (254 track miles of third rail power)**
- **331 overhead bridges, 201 undergrade bridges, 9 tunnels, 4 viaducts**
- **571 mainline switches**
- **67 power substations**

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[4] This plan reflects Metro-North's New York state assets. The New Haven Line assets operated by Metro-North in Connecticut are the responsibility of Connecticut Department of Transportation and certain assets of the Port Jervis and Pascack Valley Lines are the responsibility of NJ Transit.

EMU trains on the Park Avenue Viaduct

Investment needs highlights

Over the next 20 years, our priority investment needs include:

- **Passenger vehicles and yards**
    - Purchasing over 750 new railcars, including 15 new locomotives for West-of-Hudson service, to replace aging cars and improve reliability, accessibility, and passenger experience.
    - Expanding railcar maintenance facilities and train storage yards, and replacing outdated and temporary shops with modern workshops for our Maintenance of Way teams.
- **Passenger stations**
    - Rehabilitating stations to address high priority structural issues, particularly at Harlem Line stations with deteriorating platforms.
    - Improving the customer experience for all of our riders by replacing station elevators and by installing upgraded public address (PA) systems, real-time train information screens, and security cameras at over 50 stations.
- **Grand Central Terminal and Grand Central Artery**
    - Upgrading and modernizing the structure and support systems of the historic Grand Central Terminal Building and connecting infrastructure.
    - Reconstructing deteriorated structural elements of the 110-year-old Grand Central Train Shed, the massive, bi-level structure underneath Park Avenue.
    - Continuing to reconstruct deteriorated structural elements and make improvements to the Park Avenue Viaduct and the Park Avenue Tunnel.
- **Right-of-way**
    - Doubling the pace of the current track replacement program.
    - Replacing and rehabilitating bridges and drainage systems, focusing on over 100 bridges and existing poor drainage areas.
    - Implementing the climate resilience measures needed to protect Metro-North assets from the effects of climate change, such as stormwater flooding, extreme heat, and sea level rise.
- **Signals, power, and communications**
    - Upgrading our traction power system with new power substations which will improve reliability and allow us to run more trains across the Metro-North network.
    - Replacing over 150 miles of Harlem and Hudson line legacy, relay-based signal systems with new, updated signaling technology and improving our ability to monitor and regulate train service by installing a next generation, modernized Operations Control Center.

Harrison Station on the New Haven Line

Metro-North Railroad appendix structure

The Metro-North appendix provides an overview of the agency's assets, their current condition, and expected investment actions to maintain and improve them over the next 20 years. This appendix is divided into asset groupings, based on how the categories function together. For example, our passenger vehicles are supported by our shops, yards, and facilities, so together they form an asset grouping. We provide a summary of each asset grouping, describe how the asset categories support each other, and then provide a 20-year vision for their maintenance and enhancement. Each asset category section then provides a more detailed description, an inventory showing their ages or the percentage of assets in poor or marginal condition, followed by the agency's investment needs and priorities for the next 20 years.

Our asset rating methodology

We perform regular and comprehensive inspections of all of our assets. Through these inspections, all assets are given a condition rating on a scale of 1 to 5, based on various factors, including age, condition assessment, performance, reliability, safety history, and location. Assets with a rating of 1 (poor) or 2 (marginal) help us identify where we need to focus investment needs the most. This rating scale is consistent with the Federal Transit Administration's Transit Economic Requirements Model scale. A brief description of the rating scale is provided below.

1. Poor (Deteriorated): Critically damaged or in need of immediate repair, well past useful life. Assets are operable with extraordinary maintenance, but have serious functional deficiencies and/or can be expected to experience potentially unacceptable stoppages over the next five years, which could have serious negative impacts on service within the existing maintenance framework. Assets require operating-funded interventions, which may include more frequent inspections and/or repairs that may include removing the asset from service until repairs can be performed. Capital investment in these assets is needed on a priority basis.

2. Marginal (Deficient): Deteriorated, in need of replacement, and may have exceeded useful life. Assets have functional deficiencies and/or can be expected to experience above-normal stoppages over the next five years, but severity of customer impacts or changes to operational practices can be held within acceptable bounds for a time within the existing maintenance framework. If capital investment is/was deferred for these assets, added maintenance and operating expenses would be expected.

3. Adequate (Acceptable): Moderately deteriorated, but has not exceeded its useful life. Assets that are not necessarily meeting all current technical and functional standards, but are considered adequate for service and can be expected to experience normal stoppages that can be fully accommodated within the existing maintenance framework. These assets may require cyclical replacement in the next five years.

4. Good: No longer new, but in good condition and still within its useful life. Assets may be slightly deteriorated, but are overall functional within the normal maintenance practices.

5. Excellent (Modernized): No visible defects, new or near new condition and may still be under warranty (if applicable). Considered to meet most or all important technical and functional standards.

It is important to note that an asset condition rating is not an indicator of safety. Safety and risk assessments are performed separately from asset condition ratings and are addressed on an ongoing basis.

PASSENGER VEHICLES AND YARDS

Our trains provide approximately 200,000 passenger trips every weekday, with most arriving in Manhattan from points north in New York and east in Connecticut. When trains are not in service, our shops, yards, and facilities allow for fleet storage, maintenance, and inspection services, and play an important role in in our continuing ability to provide safe and consistent service.

Metro-North owns a fleet of over 900 passenger vehicles, ranging in age from new to over 50 years old. To ensure passenger safety, federal regulations and Metro-North procedures require testing and inspections of railcars and locomotive components and systems each day they are in service. This includes inspecting braking and power systems, lights, wires, cables, doors, air conditioning, radios, and more. These basic inspections take place at our yards before trains are put into service. Yards are also used to stage repair materials for assets across our network. More extensive work is performed at our shops, where railcars undergo regular interior and exterior cleaning, as well as more comprehensive inspections and scheduled maintenance at recurring intervals to ensure reliability.

As demand for Metro-North service has grown over the years, so too has the size of the fleet, resulting in inadequate shops and yard space in certain locations. Our vision for shops and yards includes new and upgraded facilities configured to better support railroad operations for today and into the future. By providing specialized facilities for different types of railcars, we can better ensure the reliability of our entire fleet. Building new shops for our Maintenance of Way (MOW) crews will provide the space needed to address repairs more rapidly throughout our system.

Our investment needs over the next 20 years include:

- Purchase over 750 new vehicles, including 15 new locomotives for West-of-Hudson service, which will allow us to retire aging railcars in our fleet.
    - The new fleet will be accessible, energy-efficient, utilize environmentally friendly technologies, and will incorporate modern amenities such as charging ports, digital screens, and communication systems to improve the rider experience.
- Replace inadequate, outdated facilities and temporary buildings with modern shops to properly support our MOW teams.
- Expand railcar maintenance facilities and train storage yards at key locations so more trains can be inspected, repaired, and returned to service quickly and efficiently.
- Build resilience against the effects of climate change. We must ensure new facilities account for the impacts of increased flooding and heat by including elements such as enhanced drainage systems, perimeter walls for floodproofing, and elevated assets.
- Continue to support MTA-wide sustainability efforts and reduce greenhouse gas emissions by capitalizing on opportunities to implement technologies that conserve energy, reduce fossil fuel use, and generate renewable energy on-site.

Passenger vehicles

Keeping our passenger vehicles in good condition is vital to ensuring safe and reliable service, making the maintenance and upkeep of these assets critical to providing the riding experience our customers expect. Our passenger vehicle fleet includes:

Coaches
A railcar that carries passengers; one or more coaches make up a train that is pushed or pulled by a locomotive.

Locomotives
A vehicle that pulls and pushes passenger coaches. Locomotives are powered by both diesel and electricity.

Electric Multiple Units (EMU):
These passenger railcars, which include our M3, M7, and M8 models, are self-propelled coaches that draw electric power from a third rail or overhead wires, and do not require a locomotive.

We will continue replacing passenger vehicles as they reach the end of their useful life and we plan to procure locomotives that can use electric power more extensively and efficiently, resulting in reduced greenhouse gas emissions and fossil fuel dependence.

Asset inventory and status

We use two primary indicators to assess the condition and performance of our fleet, which together guide decisions on when further investment or replacement is warranted. For example, for our EMU railcars, the condition and performance indicators are as follows.

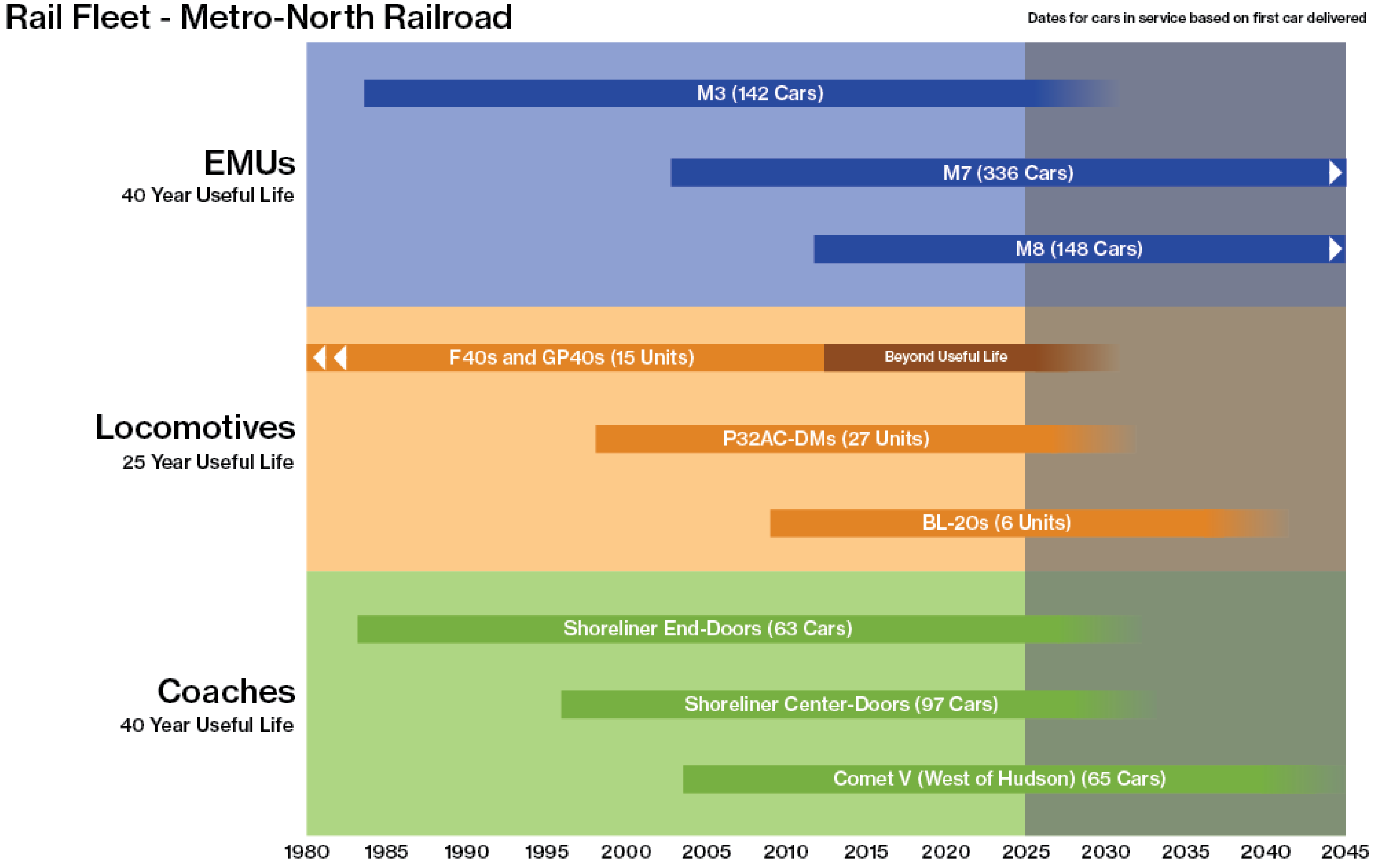
- **Useful life:** Older railcars are more prone to break down, generally require more extensive and costly maintenance to keep in service, and are less comfortable for our passengers due to worn interiors. They also sometimes lack modern amenities or do not meet the accessibility standards we have for new railcars. Any railcar over the age of 40 is considered past its useful life. We plan to continue replacing railcars before they reach the end of their useful life.
- **Mean Distance Between Failures (MDBF):** This is a measure of reliability that expresses the railcar's mean (average) operating distance mileage traveled between all train delay failures. The MDBF measure is used to inform decisions about how and when perform maintenance, as newer cars perform much better than cars slated for replacement. In 2022, the MDBF of the M8 EMUs was approximately 802,000 miles compared to about 93,000 miles for the M3 EMUs

Investment needs

To keep all EMU railcars within their useful life of 40 years, we will need to replace over half the fleet in the next 20 years. We plan to purchase new locomotives for increased reliability and lower emissions; replace our older M3 EMUs with new, modern M9A EMUs; replace the East-of-Hudson coach fleet; and begin the replacement of our M7 EMUs when they reach the end of their useful life.

Over the next 20 years, we need to:

- Upgrade the passenger fleet through the continued replacement of the M3 EMUs that have been in service on the Hudson and Harlem lines since the 1980s and are past their useful life. These will be replaced with new M9As that are a next generation railcar equipped with multiple amenities to improve customer experience, including better accessibility, wider seats, electrical outlets, and multimedia screens.
- Begin the planning process needed to replace the M7 fleet. MNR's M7 fleet (36% of MNR's total fleet), will reach the end of its useful life at the end of the 20-year period. A failure to commence the replacement of the M7 cars by the end of their useful life will potentially cause greater frequency of breakdowns, increased operating costs, and trains not offering the quality and customer experience that our passengers deserve.
- Upgrade our locomotive fleets, including replacing locomotives in service in Metro-North's West-of-Hudson territory and diesel locomotives used in East-of-Hudson service.
    - Upgraded "dual-mode" engine technology will be employed for locomotive procurements. This maximizes the potential to use electricity from the third rail or overhead catenary, greatly reducing the use of diesel, and together with Tier IV engines, will reduce the production of both greenhouse gas emissions and local air quality pollutants, such as particulate matter and nitrous oxide.
- Upgrade our coach fleet through the replacement of the Shoreliner coaches used on our East-of-Hudson services. The oldest cars are nearing the end of their useful life and not up to current accessibility standards. The new fleet will be compliant with the Americans with Disabilities Act (ADA).



Shops, yards, and facilities

Yards are used for the staging, inspecting, servicing, and storage of our passenger vehicle fleets. The yards are also home to many of our shops, which fall into two categories based on function.

- **Maintenance of Equipment (MOE) shops, which are found exclusively in our yards, are where our workers perform inspections, repairs, retrofits, and overhauls of passenger vehicles.**
- **Maintenance of Way (MOW) shops are where we store or maintain equipment and materials needed for maintaining and improving the rail system and right-of-way infrastructure. Most MOW shops are located in our yards, but they also exist throughout the railroad territory.**

Harmon Shop

Asset inventory and status

Shops and yards assets are evaluated based on their condition, age, and performance, as well as if sufficient space is available to meet the needs of the railroad. Asset performance considers the ability of the shops and yards to support the fleet and meet maintenance needs. Facilities that are unable to meet these fleet and maintenance needs will be upgraded and reconfigured or replaced. Replacement will be targeted toward poor performing components that are likely to impact fleet reliability or operations.

Inventory and status

	Asset	Total	Percent in Poor/Marginal Condition
Yards and Yard Assets	Employee Facilities	9	13%
	Utilities	8	38%
	Yard Utilities	36	42%
	Plumbing and Drainage	37	41%
	Fire Protection	2	50%
	Yard Substation	4	0%

Inventory and status

	Asset	Total	Percent in Poor/Marginal Condition
MOE Shops	Employee Facilities	12	18%
	Air Curtain Doors	6	0%
	Building Exterior	19	21%
	Building Utilities	16	6%
	HVAC	19	11%
	Roofs	19	16%
	Walls	27	11%
	Windows	15	7%
	Equipment (e.g., car cranes, equipment lifts, wheel true	235	89%
MOW Shops	Air Curtain Doors	1	0%
	Building Exterior	60	72%
	Building Utilities	65	68%
	Employee Facilities	14	50%
	HVAC	16	44%
	Roofs	59	71%
	Walls	96	75%
	Windows	48	67%

Investment needs

We continuously review the significant interrelated investment needs supporting our shops, yards, and related facilities, including plans supporting new railcars and other yard improvements needed for future needs and fleet growth. To ensure our facilities can meet future operational requirements, we are taking a systemwide planning approach with a focus on reconfiguration, reconstruction, and modernization.

Over the next 20 years, we need to:

- Replace outdated, deteriorated, and temporary shops with new, permanent facilities to support our MOW workforce, providing them with sufficient facilities needed for the ongoing maintenance of the railroad. This includes new facilities at Harmon, North White Plains, Brewster, and in the Bronx.
- Upgrade, reconfigure, and expand MOE shops and yards to better serve the current and future fleet, including the arrival of the M9As, the Shoreliner coach replacements, and new locomotives. We will replace our existing train washing facilities, which have exceeded their useful life.
  - We will reconfigure and expand Brewster Yard to meet our growing fleet needs and improve service operations for the Harlem Line. We will add repair tracks and train servicing locations at our MOE shops and yards.
- Construct a new warehouse to relieve insufficient storage space at existing facilities.
- Make facilities located in coastal flood zones, near streams and rivers, and/or in areas with insufficient local drainage that are prone to flooding, more resilient with investments such as backflow valves and pumping mechanisms.
- Seek to use component replacement opportunities to implement new technologies that can conserve energy, reduce fossil fuel use, and reduce demand for grid electricity. By integrating these practices into normal investment cycles, we will maximize the long-term operational cost savings that are generated through updated building systems.
- Install electric vehicle charging equipment dedicated for MNR use in appropriate locations to meet MTA goals of transitioning to 100% zero-emissions light-duty non-revenue vehicles by 2035 and medium/heavy-duty non-revenue vehicles by 2040.

PASSENGER STATIONS

We have 85 passenger stations across five lines in New York state. Passenger stations contain many interrelated systems and individual components, all of which must be maintained so that customers can safely access trains. Station buildings and canopies provide passengers areas to wait for trains; overpasses and underpasses provide access between platforms and other station areas; and platforms allow for safe boarding of our trains. Elevators and escalators provide critical accessibility for our riders, and public communication systems provide key information and audio/visual messages to inform riders of important service updates.

Our investment needs over the next 20 years include:

- Rehabilitate stations to replace dated structures and aging assets, and provide the communities we serve with modern, comfortable stations.
    - Replace deteriorating platforms and other major components at 19 stations on the Harlem Line.
    - Improve station access by constructing new elevators and overpasses and replacing all 105 existing elevators.
- Improve customer experience by enhancing communication systems at over 50 stations, including new PA systems, real-time train information screens, and security cameras. Once completed, all of our customers would use stations with upgraded communication amenities.
- Replace and enhance our aging communication system and network infrastructure with the latest technology to accommodate current operations, address critical obsolescence issues, and provide compatibility and capacity for future needs. This includes:
    - Cyclical upkeep of short-lived technology assets to maintain existing communication and security services.
    - Upgrading and enhancing network infrastructure and obsolete communication systems to provide for updated PA/real-time train information, security cameras with remote monitoring/video management capability, elevator/escalator control and monitoring capabilities, and station intercoms at passenger stations.

Passenger stations

Asset inventory and status

Comprehensive inspections of station assets are performed on a regular basis. During inspection, a rating is assigned to all components of the station assets such as elevators, platforms, station buildings, stairs, and ramps. Based on these component ratings, a prioritization list is analyzed to understand the trends and the progress toward getting all assets into good or better condition, as well as to schedule the required capital investments to preserve and maintain their integrity.

An example of an age-based assessment for stations is:

- **Condition:** Most station component replacement needs are determined primarily by component condition. The amount of deterioration in each component of the station is assessed during inspection and assigned a numerical rating.
- **Useful Life:** Some station assets or components such as elevators, which are generally replaced on a cyclical basis, are tracked based on their useful life. For example, the useful life of a station elevator is typically 20 years. Older elevators are more prone to break down and generally require more extensive and costly maintenance to keep in service.

The results of a condition-based assessment of station assets and components are shown in the inventory and status table.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Platforms	134	19%
Canopies	113	2%
Shelters	124	2%
Elevators	105	89%
Escalators	2	0%
Stairs	340	7%
ADA Ramps	83	2%
Overpass	50	0%
Underpass	12	33%
Station Building	34	3%
Parking Lot	72	17%
Parking Garage	4	25%

Harlem-125th St Station

North White Plains Station with station components

Investment needs

Our investment strategies focus on station assets in need of rebuilding and replacement, such as platforms, station access, building structures, and parking facilities identified as in poor or marginal condition. Where feasible, we also seek to construct new elevators, crossovers, and ramps to make stations more accessible for our riders.

Over the next 20 years, we need to:

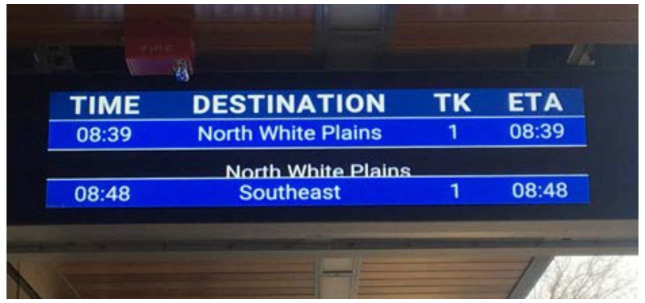
- Address the deteriorated platforms at 19 stations on the Harlem Line that currently require additional structural support and maintenance.
  - We are proposing an accelerated pace to replace platforms at these stations, as well as other critical station components. We aim to minimize disruption to passengers by planning station work in tandem with other rehabilitation work along the right-of-way.
- Accelerate the pace of repairing and replacing station assets. This effort will focus on station access (stairs, ramps, overpasses, and underpasses), station parking facilities (lots and garages), and station buildings.
- Focus first on our oldest elevators and those with the greatest reliability issues. Establish a program to ensure all 105 existing station elevators are replaced over 20 years, as they reach the end of their useful life.
- Continue to add elevators, ramps, and create accessible routes between platforms to make full-service stations in Metro-North-operated territory fully accessible, where feasible.
- Identify opportunities for flood protection and other climate resilience improvements to ensure station components are protected from extreme weather.
- When upgrading stations, maximize opportunities to conserve energy and reduce fossil fuel use, such as exploring the feasibility to deploy solar photovoltaics for on-site renewable energy generation.

Public communications and security

Metro-North's communication information system supports customer service applications including telephone, PA system, visual information display, closed circuit television (CCTV), and fare collection, which includes ticket vending machines, customer communication intercoms, and numerous other functions. Together, these technologies provide key service updates to passengers, increase security within our stations, and facilitate efficient fare payments

Asset inventory and status

Several prioritization factors are considered for communication investments and are evaluated in concert with a paced, continuous replacement cycle. Asset age compares the actual age of the communication equipment to its lifespan; when the equipment is close to exceeding its maximum age, it is prioritized for replacement. Asset obsolescence prioritizes installing new technologies; as communication technology changes, obsolete technology becomes more difficult to maintain and parts are harder and more expensive to acquire. Asset condition defines the physical state of the communication equipment, based on number and frequency of repairs and tickets. Asset criticality includes factors such as a role in maintaining safety, sustaining Metro-North operations, and supporting data needs.



Above, Hanging Digital Sign
Right page, Grand Central Terminal

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Office (head end) Public Address/Visual Information System (PA/VIS)	2	100%
Grand Central Terminal Big Board	1	0%
Grand Central Terminal Arrival/Departure Boards	72	0%
Grand Central Terminal Gate Boards	96	0%
Grand Central Terminal Employee Displays	17	0%
Grand Central Terminal Station PA (speakers, ambient sensing microphones)	600	0%
Grand Central Terminal Customer Communications Network/Cable Plant	1	0%
PA/VIS - Ticket Office	30	100%
Station Digital Displays	827	40%
Station PA (speakers, ambient sensing microphones)	2,293	0%
Station Intercoms	87	10%
Station Communications Network/Cable Plant	10	100%
Station Equipment (controllers, digital signal processors, amplifiers)	87	80%
Security Head End, Workstations, Servers	96	76%
Security Cameras, Recorders and Server	2,743	52%
Security Switches (field data transfer links to head end security system)	382	32%

Investment needs

Our top priority in this category is to improve the customer communication, safety, and security systems for Grand Central Terminal and passenger stations. Over the next 20 years, we need to:

- Advance our Project Customer Service Initiatives (CSI) program, which focuses on improvements to both communication and security assets. Over the next 20 years, we will complete Project CSI at all remaining Metro-North passenger stations in New York. The program includes the following:
  - An integrated PA/video system with voice and video messaging.
  - Real-time train information displays.
  - Elevator and escalator control and monitoring capabilities with the ability to communicate with customers needing elevator service, as well as control of elevators at select stations.
  - Security cameras with remote monitoring/video management capabilities.
  - Station intercoms.
- Upgrade and expand the existing Grand Central Terminal security system including hardware/software platforms, networks and technologies, and camera coverage.
- Replace/upgrade the Grand Central Terminal PA System assets including speakers and amplifiers.
- Replace the Grand Central Terminal LED digital display technology in historic areas, and provide upgrades for interoperability with Grand Central Madison.
- Replace aging and obsolete passenger station communication and security assets on a cyclical basis, as well as upgrade obsolete systems to new technologies, in particular older generation station displays, security cameras, security data transfer switches, and video recorders.
- Upgrade the office control systems for all Grand Central Terminal and station audio/visual communication and security systems with modern systems.

GRAND CENTRAL TERMINAL AND GRAND CENTRAL ARTERY

Grand Central Terminal is one of New York's most iconic buildings and the heart of the Metro-North network. The southern terminus of our Harlem, Hudson, and New Haven lines, many Metro-North journeys begin or end at Grand Central, while others continue from Grand Central—which connects to five subway lines and the Long Island Rail Road—across the city and region.

Many visitors only see the terminal building itself, but for the terminal to fulfill its intended purpose, there is substantial adjacent infrastructure that must also be maintained. All Metro-North trains must first traverse the Grand Central Artery, which is comprised of three other structures: the Park Avenue Viaduct, Park Avenue Tunnel, and the Grand Central Train Shed. Used by four out of every five Metro-North customers each day, the artery is crucial to Metro-North's service.

Our investment needs over the next 20 years include:

- **Investing in the Grand Central Terminal and Grand Central Artery so Metro-North continues to serve the region, bringing nearly 40 million annual riders to New York City on its three East-of-Hudson rail lines.**
    - **Grand Central Terminal: Renovating public areas such as restrooms, elevators and escalators, stairs, and ramps, as well as non-public areas for utilities and employee facilities within the terminal; addressing needed improvements to structural support, passenger platforms, and leak remediation; investing in security and ventilation systems and complete fire and life safety improvements; and performing comprehensive preservation work to the historical landmark building.**
    - **Grand Central Artery - Train Shed: Reconstructing deteriorated structural elements of the 110-year-old Train Shed, the massive, bi-level structure underneath Park Avenue, including the vital Train Shed roof replacement project, as well as other structural repairs, and making improvements to the Train Shed's ventilation and other safety systems.**
    - **Grand Central Artery: Park Avenue Viaduct: Continuing to reconstruct deteriorated structural elements of this critical section of elevated railroad.**
    - **Grand Central Artery - Park Avenue Tunnel: Improving tunnel ventilation and safety systems and emergency egress capabilities, while also completing priority structural repairs needed in the Park Avenue Tunnel.**

Grand Central Terminal

Midtown Manhattan was shaped by Grand Central Terminal. When railroads first arrived on East 42nd Street in the 1830s, much of Midtown was undeveloped. The current terminal building opened in 1913, as Midtown grew into the busy core of New York City. Today, Grand Central receives over 750,000 daily visitors, and it is vital that we invest in this landmark terminal building now in order to keep it running for decades to come.

Biltmore Room at Grand Central Terminal

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
GCT Building and Structures (building and block area structural supports and roof, elevated Park Avenue roadway)	5	60%
Platforms, Platform Edges, Platform Expansion Joints	113	77%
Interior/Exterior Architecture Systems	146	47%
Electrical Systems	13	38%
Fire/Life Safety Systems (fire alarm, standpipe, sprinkler)	10	27%
HVAC Systems	25	48%
Plumbing Systems (domestic hot and cold water, sanitary, sewerage, drainage, steam)	16	75%
Elevators (passenger, freight)	32	19%
Escalators (passenger)	14	7%

Investment needs

Continued planned investments in the terminal building are needed to keep Grand Central Terminal in good condition for years to come. Asset replacement/restoration will help ensure the structural and aesthetic integrity of this major transportation hub and preserve its historical importance to New York City. Over the next 20 years, we need to:

- Make needed structural improvements to the terminal building, including:
    - Improve the terminal's structural support system and roof, and rehabilitate the block area and the roadway viaduct around the terminal.
    - Make repairs to the terminal platforms, platform edges, and expansion joints.
    - Continue to repair leak infiltration from surrounding buildings, streets, and sidewalks into the Grand Central Terminal complex.

Main Concourse, Grand Central Terminal

- Make timely repairs to the architectural features of the historic terminal building, such as walls, floors, ceilings, doors, canopies, and ramps to ensure the landmark Grand Central Terminal remains in first-class condition.
- Prioritize fire protection improvements, guided by a recently completed systemwide utilities study. This includes improvements to sprinkler systems, and the terminal's ventilation, security, and safety systems, as well as carry out plumbing, electrical, and HVAC infrastructure replacements throughout the terminal.
- Improve the customer experience by adding new Biltmore Room restrooms, make repairs to the Roosevelt Passageway, improve elevators and escalators, and install more accessibility and safety signage.

While we work to preserve this landmark structure, we will strive to ensure that operations can continue during updates. Properly planning the investments and funding will be important in minimizing these disruptions given the large number of daily Grand Central Terminal passengers, as well as visitors and tourists.

Grand Central Artery

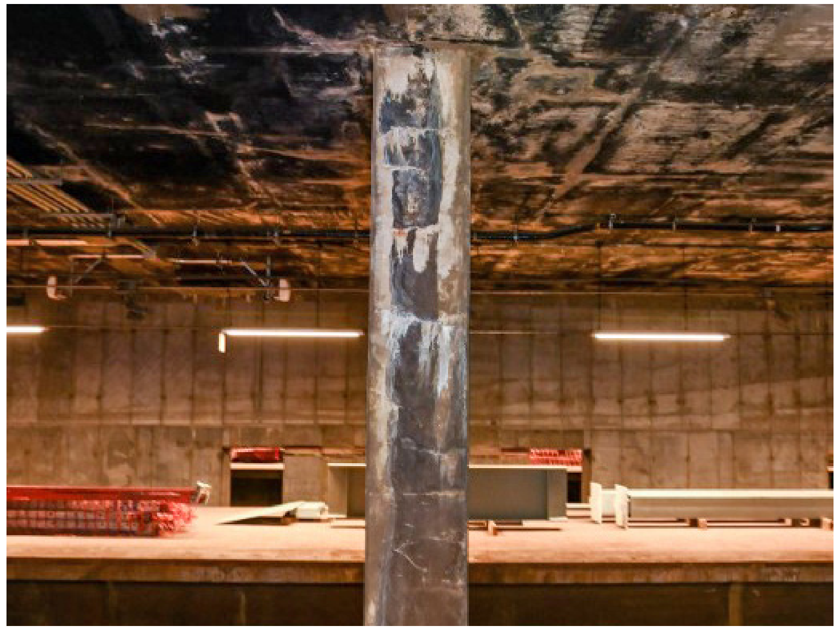
Over the next 20 years, it is critical that we invest in the Grand Central Artery. Each of the artery's three structures is over 100 years old and must be rebuilt, improved, or significantly repaired to keep Metro-North service safe and reliable—all while trains continue to operate. As we work on the artery, we will coordinate closely with the community as work takes place along Park Avenue and surrounding streets.

Grand Central Artery: Train Shed

Grand Central's 44 platforms and 67 operating tracks are housed in the Train Shed, a 110-year-old, two-level structure under Park Avenue that stretches from the terminal building to East 57th Street. Since this is where most Metro-North trips begin or end, the Train Shed is crucial to Metro-North service. In addition to rail infrastructure, the Train Shed hosts a myriad of utility cables, pipes, and structures that support a variety of city services. A century ago, over a dozen city blocks were built directly on top of the Train Shed. Today, the Train Shed holds up several of Midtown's largest skyscrapers, as well as Park Avenue itself. Over time, weather, salt, and water have damaged and deteriorated the roof, making it crucial that we replace the roof as we rehabilitate the Train Shed.

Investment needs

Our priority investment in the Train Shed is roof replacement. This will address water infiltration, corrosion, and structural deficiencies, and make safety improvements. Metro-North recently completed installation of a new fire standpipe system in the Lower Level of Grand Central Terminal and is ready to begin installing a new fire standpipe system for the Upper Level. We are also implementing priority repairs to address the most urgent locations. To save time and money as we reconstruct the Train Shed roof, we are using innovative strategies, for example, our current public-private partnership with JP Morgan Chase for the redevelopment of 270 Park Avenue. The remaining work needed to complete the Train Shed rehabilitation project will continue over the next 15 years, and this work will ensure that the Train Shed is in good condition and able to hold up Park Avenue for decades to come.



Grand Central Train Shed Roof

Inventory and status

Asset	Total	Units	Percent in Poor/Marginal Condition
Train Shed Main Bridge Structural Framing	6	Structure	83%
Train Shed Structural Supports and Roof Slab	4	Structure	100%
Train Shed Expansion Joints	19,045	Feet	12%
Train Shed Drainage System	5	Systems	100%
Train Shed Waterproofing System	5	Systems	80%
Train Shed Misc. Steel (gratings, drip pans, utility service carriers and supports)	5	Systems	80%
Train Shed HVAC System	1	Systems	100%
Train Shed Electrical Systems	3	Systems	33%
Train Shed Fire Standpipe Systems (Upper/Lower Levels)	2	Systems	50%
Train Shed Architectural	15	Structure	60%

Rendering of Train Shed and Park Avenue

Grand Central Artery: Park Avenue Tunnel

Our trains approach or leave the Grand Central Train Shed via the Park Avenue Tunnel. This tunnel carries thousands of Metro-North customers every day under 40 blocks of Park Avenue in Manhattan, between East 57th Street and East 97th Street. Nearly 150 years old, the Park Avenue Tunnel is in need of improvements that will strengthen its structure and safety.

Inventory and status

Asset	Total	Units	Percent in Poor/Marginal Condition
Park Ave Tunnel Electrical Systems (tunnel lighting, tunnel alarm, third rail traction power)	3	Systems	100%
Park Avenue Tunnel Main Structural Framing (brick walls, arches, steel framing)	1	Systems	100%
Park Avenue Tunnel Utility Bays (steel supports, concrete walls, infill)	1	Systems	100%
Park Avenue Tunnel Ventilation Shafts and Gratings	80	Each	100%
Park Ave Tunnel Structures (existing emergency stairs and exits at 59th, 72nd and 86th streets)	3	Sets	83%

Investment needs

The Park Avenue Tunnel investment needs focus on priority structural repairs and safety improvements. Over the next 20 years, we need to:

- Construct two additional emergency exits at 65th Street and 79th Street, supplementing existing exits in the tunnel, as well as completing the following tunnel projects:
  - Replacement of the tunnel lighting.
  - Replacement of the steel conductor third rail with aluminum.
  - Upgrades to the tunnel alarm and tunnel fire standpipe systems.
- Upgrade ventilation and supplement critical infrastructure that provides ventilation for the tunnel.
- Undertake much needed priority structural repairs in the tunnel and, where possible, bundle communication improvements with planned work to take advantage of cost and time savings opportunities.

Right, Park Avenue Tunnel

Park Avenue Viaduct (at East 122nd Street)

Grand Central Artery: Park Avenue Viaduct

The Park Avenue Viaduct is Metro-North's elevated gateway to Manhattan, carrying approximately 750 trains every weekday between the Harlem River and the entrance of the Park Avenue Tunnel at East 97th Street. Much of the aging viaduct's infrastructure dates from the 1890s, and we are focusing on the replacement of the elevated steel structure that carries four tracks between East 110th Street and the Harlem River Lift Bridge

Inventory and status

Asset	Total	Units	Percent in Poor/Marginal Condition
Viaduct Structure	104	Spans	77%
Viaduct Deck	6,346	Linear Feet	77%

Investment needs

After a fire beneath the Park Avenue Viaduct disrupted service for thousands of Metro-North passengers in 2016, the public was reminded of the operational importance and vulnerability of the then 125-year-old structure. With in-depth, hands-on inspections occurring since 2016, there have been numerous structural deficiencies identified. Fatigue-related defects in the steel girders and connections were appearing more frequently, growing each year, and repairs were not keeping up. To address the root causes of these defects, Metro-North has begun a comprehensive rehabilitation of the viaduct. This effort began in the 2020-2024 Capital Program, which planned for the complete replacement of the viaduct between East 115th and East 120th Streets. In 2022 and in 2023, we made arrangements to extend work up to East 123rd Street and began advanced planning work on the next segment planned to be replaced, between East 127th and East 132nd Streets. Future phases, which will focus on replacing other segments and rehabilitating the viaduct deck, are currently planned for inclusion in the 2025-29 Capital Program.

RIGHT-OF-WAY

03

Right-of-way infrastructure is a grouping of asset categories that make up the physical space used by the railroad and include line structures and track. Line structures is a category of assets that includes bridges, viaducts, tunnels, culverts, and retaining walls, as well as various sub-components within each asset that requires continuous maintenance to guarantee their reliability and the safety of our riders. Track assets include rails, ties, switches, grade crossings and ballast. These assets, which also support the freight operations that transport goods throughout the region, are subject to heavy use and continuously exposed to harsh and changing weather conditions.

Our investment needs over the next 20 years include:

- **Increasing our pace of rehabilitating and replacing our track and structures to provide safe and reliable service. We will also increase our use of preservation methods, such as bridge painting, that will extend the lifespan of our existing structures and decrease structural deterioration.**
- **Purchasing equipment such as track laying machines that will allow us to implement construction and track replacement methods that are faster and more cost-effective.**
- **Addressing the threats of climate change by:**
    - **Protecting the Hudson Line from flooding due to rising sea levels.**
    - **Implementing a long-term resilience strategy to protect our right-of-way assets from extreme rainfall and prolonged heat waves.**

Line structures

Our line structures are crucial for the proper functioning of our system through, over, or under obstacles like roadways, water bodies, or along varying terrain. Line structures include undergrade bridges, overhead bridges, tunnels, culverts, and retaining walls. Undergrade bridges allow trains to pass over an obstacle (i.e., the obstacle is under the tracks), and overhead bridges allow trains to pass under an obstacle (i.e., the obstacle is above the tracks). Tunnels are underground passages or channels that provide the means for our rail to traverse underneath highly developed neighborhoods or difficult topography. Culverts are designed to allow water to flow underneath tracks to manage drainage and prevent flooding. Retaining walls are built to hold back soil and provide support for our elevated structures.

Undergrade bridges
Allow an obstacle to pass under the railroad (i.e., the tracks are on the bridge structure).

Culverts
Are designed to allow water to flow underneath tracks to manage drainage and prevent flooding.

Overhead bridges
Allow the obstacle to pass over the railroad (i.e., a roadway on a bridge structure).

Tunnels
Underground passages or channels that provide the means for our rail to traverse underneath difficult topography or highly developed neighborhoods.

Retaining walls
Built to hold back soil and provide support for our elevated structures.

Asset inventory and status

To keep all of our structures in a safe and reliable condition, we conduct regular inspections to determine the overall asset condition and to determine priority locations for rehabilitation and replacement. The many components related to structure, for example steel girders and abutments, are comprehensively assessed through our bridge inspection program. The results from our condition-based assessment of line structure assets and components are shown in the inventory and status table.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Undergrade Bridge	181	46%
Culvert - Undergrade	189	65%
Overhead Bridge	313	23%
Retaining Wall	707	27%
Tunnels	9	11%

Willet Ave undergrade bridge

Investment needs

Our Metro-North Bridge Management Program and inspection manual establishes standards to which bridge assets must be maintained. We monitor assets such as bridges, culverts, tunnels and retaining walls on an individual level and determine the overall rating for each structure to prioritize work throughout the system. Assets are selected for rehabilitation or repair work based on condition rating and other critical factors, including but not limited to inadequate load ratings (the weight of trains that bridges are capable of carrying), fracture critical construction (if a structure has single points of failure), and current operating restrictions (speed or carrying capacity). Once priorities are identified, our MOW team evaluates other structural assets surrounding the prioritized bridge for repairs or rehabilitation to maximize the reach of our work and minimize service disruptions. Over the next 20 years, we aim to bring all line structures into good condition.

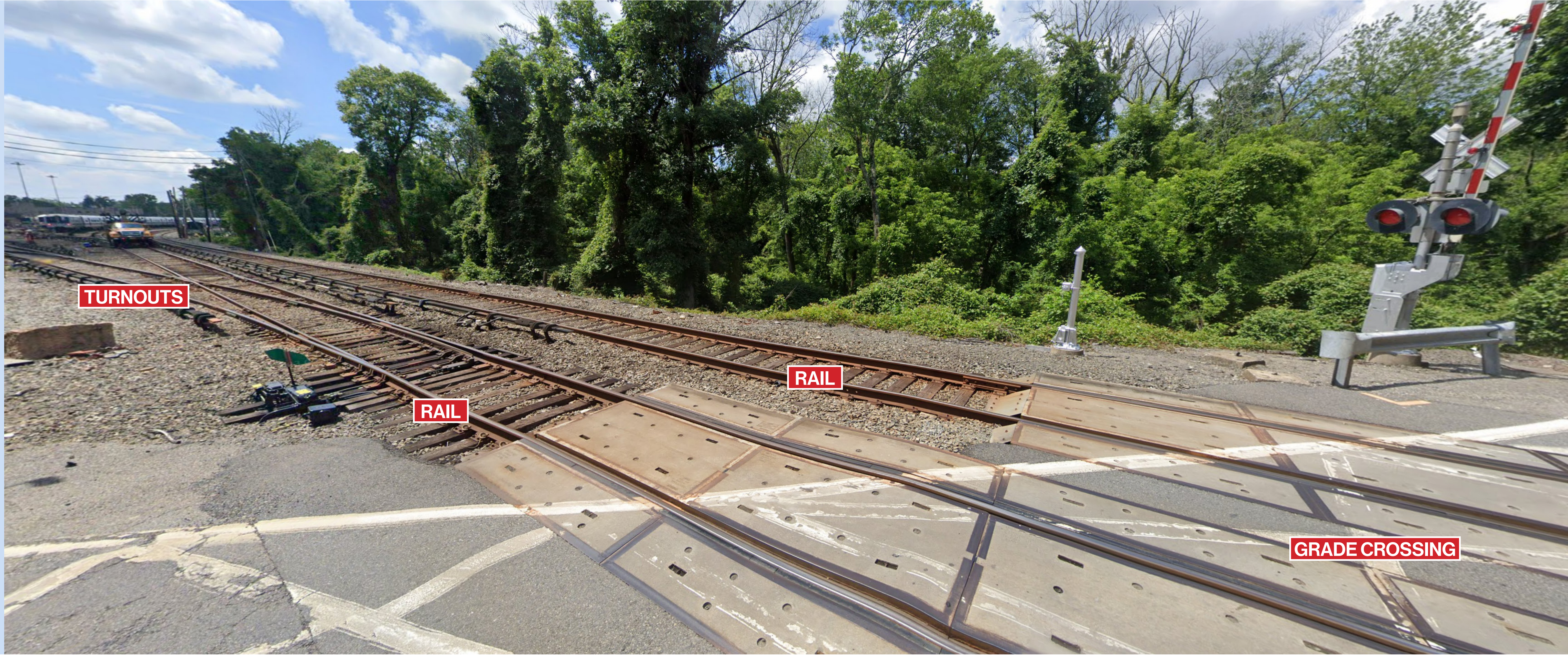
Over the next 20 years, we need to:

- Address the backlog of bridges, culverts and retaining walls in poor and marginal condition by increasing the pace of our work and addressing multiple structures in close proximity at one time. Rehabilitate and replace assets, some over 100 years old with major fatigued components, with new assets to ensure optimal and safe railroad operations.
- Accelerate repair and preventative work, such as removing corroded beams and painting and waterproofing structures to preserve them against further corrosion and extend their lifespan.
- Retrofit line structures for climate resilience. Strategies for achieving this include appropriately sizing culverts for future storm events and stabilizing retaining walls in vulnerable areas. Incorporating these strategies provides better protection to our track, as well as structures.
- Plan structure work in tandem with work on other assets, such as track and stations, to ensure service disruptions to our customers are as minimal as possible.

Track

Our track system is made up of several elements:

- **Ties: Wood or concrete cross-members that hold the rails at a fixed width to form the track structure.**
- **Rail: Provides a running surface for the train wheels. Together with the ties, they form the track structure.**
- **Switches (turnouts): Arrangements of ties and rails that allow trains to move from one track to another.**
- **Crossings: Concrete or rubber pads installed to allow vehicles to travel over streets.**
- **Equipment: On-track machinery and rolling stock supporting track maintenance and construction.**



Harlem Line intersection with Virgina Road (White Plains), Source: Google Streetview

Asset inventory and status

Our track assets are assessed by age, condition of the asset, and based on operating conditions. When prioritizing track assets for replacement or improvement, we consider different factors by component. Track assets are generally replaced on a cyclical basis based on age or remaining lifespan. This includes replacing ties, rail, and turnouts, undercutting of ballast, as well as rail grinding and resurfacing, all of which help to ensure our rail components are meeting our high standards. We conduct regular inspections to determine the need for track resurfacing and ultrasonic testing to detect internal defects in the rail.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Grade Crossing	49	35%
Hi-Rail Work Equipment	607	46%
Non-Revenue Rolling Stock	202	42%
Rail	1,004 miles	39%
Ties - Concrete	468,174	39%
Ties - Wood	1,090,507	16%
Turnouts (switches)	838	45%

Investment needs

Our annual cyclical track program rehabilitates and replaces track and turnouts to provide a safe operating condition throughout our network. We are committed to continuously improving our methods of construction and replacement so that our track program can replace these components more efficiently.

Over the next 20 years, we need to:

- Accelerate the pace of investments to get to a more regular track replacement schedule. We are exploring opportunities to complement our cyclical track program with a third-party contractor utilizing a track-laying machine to efficiently replace tracks, ties, ballast, and third rail, where applicable.
- Address drainage and water inundation issues on tracks. Much of this is due to the topography that we traverse and is of particular focus as climate change puts these locations at further risk of coastal flooding, washouts, saltwater corrosion, and storm exposure.
- Continue investing in our high-rail work equipment, which allows us to replace track components and support right-of-way work and our fleet of service vehicles for maintenance needs that include railcar support equipment, rubber-tire vehicles, and steel wheel vehicles..

SIGNALS, POWER AND COMMUNICATIONS

03

Signals govern the safe movement of trains as they travel along the line to their destinations. Our power system supports 490 track miles of electrified third rail and overhead catenary, which provide traction power to keep our electric trains moving. Our communication systems enable constant communication between customers, on-train staff, and rail controllers. Communication equipment also supports a myriad of other systems—including train control, radios, power, PA systems, and visual displays. Many of our existing legacy systems are aging and technologically obsolete, making them increasingly difficult to maintain. To support future needs, vital upgrades to these systems must be made.

Our investment needs over the next 20 years include:

- **Prioritizing safety and reliability as we improve our signal system, replacing obsolete systems and technology.**
- **Upgrading our traction power system with new power substations, which will improve reliability and allow us to run more trains across the Metro-North network.**
- **Expanding a new, ethernet-based communications system to replace obsolete technology currently in use. This new system will better support the needs of other vital systems, such as signals, security, and radio communications, and improve customer communications through our public address system and informational displays.**

Signals

Our signal system ensures that our trains operate safely, at the correct speeds, and at a safe distance from one another. This system encompasses many kinds of equipment—from the signals themselves that provide instructions to train operators whether to proceed and at what speed, to the switch machines that guide trains onto the correct routes, to the many miles of cables and relays that keep the system running. In addition to the core signal infrastructure, our signal system also includes the flashers and gates at grade crossings and other field infrastructure that alert train crews to potential problems.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Signal Systems - Hudson Line	76 miles	93%
Signal Systems - Harlem Line	81 miles	52%
Signal Systems - New Haven Line (NYS only)	14 miles	0%
Signal Systems - Port Jervis Line	60 miles	0%
Signal CTC[6] Office and SCADA[7] Power Control Centers assets	1,445	78%
PTC[8] (office systems, onboard systems, field systems)	3,825	0%
Grade Crossing Flashers and Gates	37	0%
Signal Field Infrastructure (hot box detectors, dragging equipment detectors, block carries, overlay equipment, etc.)	1,821	49%
Switch Machines	930	46%

Signalized crossing near Manitou Station

Investment needs

Most of our signal systems were installed in the 1980s and early 1990s. These systems have exceeded their typical lifespan of 30 years and are obsolete, with many replacement parts no longer available from manufacturers. On the Hudson Line, 93% of the signal system is in need of replacement, and on the Harlem Line, 52% needs replacement.

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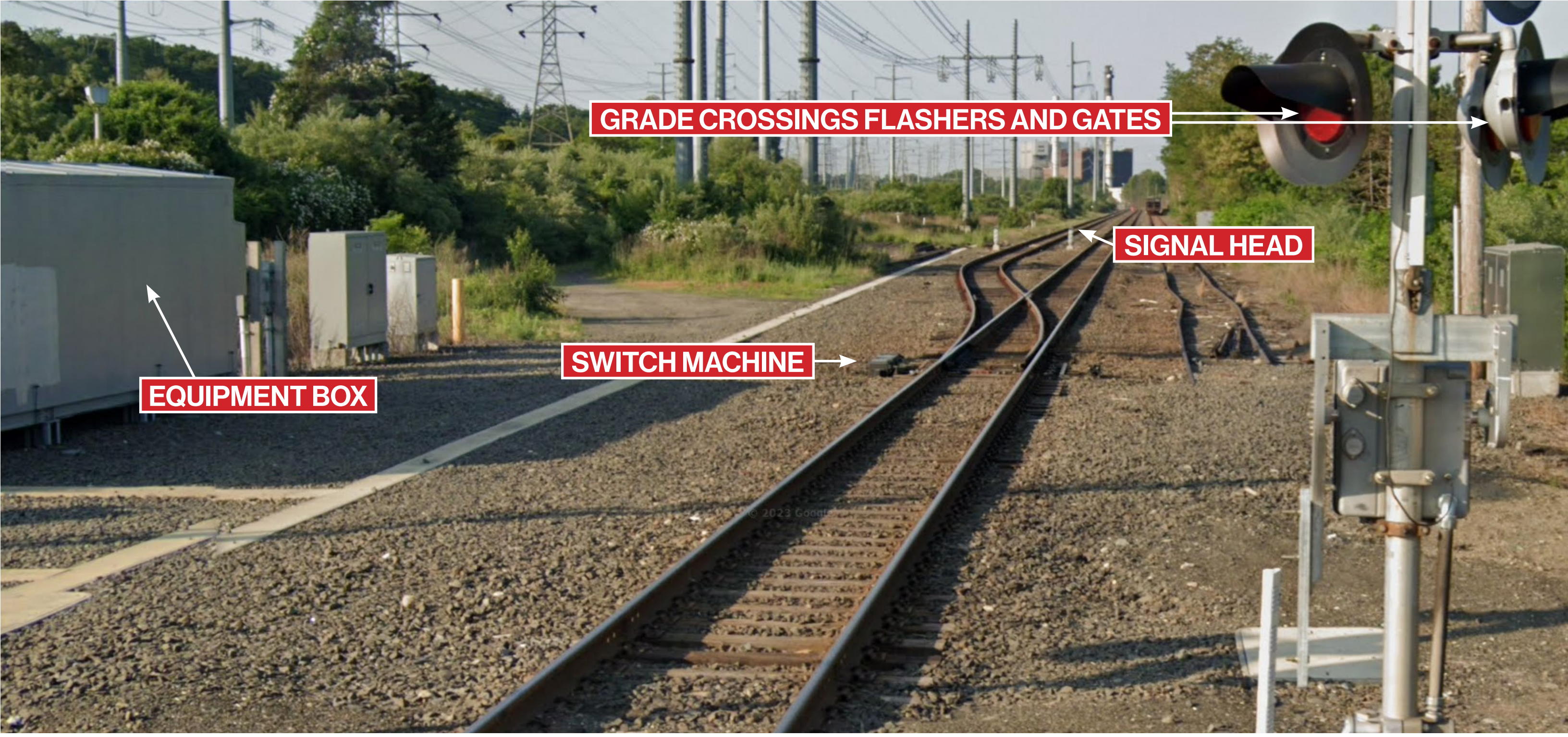
6. Centralized Train Control (CTC) allows us to monitor and control the movement of trains across our network from one central location.
7. The Supervisory Control and Data Acquisition (SCADA) system controls the flow of power from substations to the third rail and overhead lines on the Harlem, Hudson, and New Haven lines.
8. Positive Train Control (PTC) is an integrated command, control, and communication system that adds an additional layer of safety protection for trains and workers on our tracks



New Haven Line Intersection Bic Drive and Danbury Branch, Source: Google Streetview

The nerve center of the Metro-North train control network is the Operations Control Center (OCC) at Grand Central Terminal. Rail traffic controllers at the OCC dispatch Metro-North's trains, guiding them efficiently through Metro-North's complex track network and ensuring they interact safely with dozens of other trains operating along their route. The current OCC is located within an aging facility packed with utilities of various ages and conditions that frequently cause interruptions to operations. To keep Metro-North service secure, safe, reliable, and resilient, we need a new, modernized OCC.

Over the next 20 years, we need to:

- Construct a new OCC at a secure, modern facility, replacing obsolete technology, and preparing us to meet the needs of current and future Metro-North service.
- Replace old signal systems with modern systems that use microprocessors instead of the older signal relay system technology still in use.
    - Microprocessors are designed to be safer, easier to maintain, more reliable, and allow for better train control. We plan to focus signal upgrades on the Hudson and Harlem lines over the next 20 years.
- Replace outdated components of our Centralized Train Control (CTC) and Supervisory Control and Data Acquisition (SCADA) systems, of which over 80% are beyond their typical lifespan.
- Begin upgrades to the oldest components of the Positive Train Control system. This includes office control systems, wayside signal equipment, and wayside radio office/field equipment that will need to be replaced over the 20-year period due to end of life, technological obsolescence, codes and regulatory compliance, and expansions for redundancy and systems integrity.
- Continue to keep grade crossings safe by normal cyclical replacement of obsolete components.
- Replace obsolete components with new technology that will use ethernet and fiber optic connectivity. For example, office and field components of the signals, PA/VIS, SCADA, radio systems, and ticket vending machines will be upgraded to be ethernet/IP capable, which will provide more reliability and capacity, faster data transfers, and vendor support.
- Continue the normal cyclical replacement of end-of-life signal field infrastructure (e.g., hot box detectors, dragging equipment detectors, block carries, and overlay equipment) that are always on and exposed to the elements.
- Replace end-of-life switches through the track replacement program, signal system replacements, and dedicated switch replacement programs.
- Prioritize signals that are in particularly critical locations—such as those exposed to flooding, extreme temperatures, wind, and erosion—for resilience upgrades such as asset elevation and/or hardening.

Metro-North was formed through the consolidation of different railroads that have different systems to power their trains. As a result, we must maintain two power systems, each with their own track infrastructure, substations, transformers and other system specific assets.

Right, New Haven Line power changeover

The New Haven Line north of Pelham is powered by Alternating Current (AC)

South of Pelham, the line is powered by Direct Current (DC) third rail.

Power

Traction power provides the electricity required to propel trains. It is delivered through a complex network consisting of substations—which convert electricity from the power grid into the appropriate voltage and current for our trains—distribution systems, and the DC third rail and overhead AC catenary wire from which the trains draw power. Some of our equipment, such as the signal system and the Harlem River Lift Bridge, require additional power and substations.

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Third Rail Components (brackets, connectors, insulators, snow melters, etc.)	291,065	100%
Third Rail Linear Assets (rail)	308 miles	100%
DC Substations	55	89%
DC Circuit Breaker Houses	3	33%
DC Substation Auxiliary	50 sets	0%
AC Substations	6	83%

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
AC Substation Assets (switches, transformers, supply stations)	20	95%
Signal Power Substations	6	83%
Signal Power Assets (transformers, switches, back-up generators)	301	100%
Signal Power Cable	186 miles	100%
Cable Linear Assets	567 miles	100%
Catenary	36 miles	100%
Cable Plant Catenary Poles	245	100%
Catenary Plant Assets (pulleys, balance assemblies, etc.)	1,935	100%
Transmission Assets	692	95%
Transmission Bare Overhead Feeders (15kV)	18 miles	100%
Transmission Wood Poles	1,400	79%
Harlem River Lift Bridge Plant (control systems, motors, drives)	17	0%
Stand-by Power Assets	66	100%
Passenger Station Lighting Assets	1,500	100%

Investment needs

Our traction power system is critical to Metro-North service, but many assets of our traction power supply system are approaching or have passed their maximum age and require replacement. For example, 88% of our substations have exceeded their expected life. Much of our third rail has not been significantly upgraded since their original installation in the 1980s, and on portions of the New Haven Line, the catenary system is 25-30 years old. New substations are necessary not only to cope with the low-voltage occurrences on the Harlem Line today, but to prepare for greater power needs of newer trains expected in the years to come. Other improvements, such as the electrification of Track 1 on the lower Hudson Line, will focus on operational flexibility to help ensure service recovery is expedited when outages occur.

Over the next 20 years, we need to:

- Improve the Harlem Line traction power supply network with the addition of new substations at eight Upper Harlem locations and at Claremont in the Bronx, one of our most critical locations in need of improvements to properly support all three Metro-North lines.
- Replace temporary substations with permanent ones on the Harlem Line at Mt. Vernon West and Bronxville.
  - New substations will be more reliable and weather-resistant, with up-to-date equipment and technology.
- Improve the power supply capacity and resilience of the AC traction power supply system on the New York state portion of the New Haven Line, with the replacement of two AC traction substations (61 at Shell and 193 at Rye).
- Replace aging power substation feeder distribution systems between certain substations to reliably support current and future operations.
- Commence a replacement program to replace existing steel rail with aluminum third rail, which provides better electrical conductivity and performance. The DC third rail system is over 300 miles long and has not been significantly upgraded since installation in the 1980s.
- Improve service reliability through the replacement of deteriorating Harlem Line Transmission Wood Poles.
- Continue substation major component replacement program to extend life of aged substations until their replacement.
- Make signal power improvements to include replacing transformers, replacing motor alternators in signal substations, and upgrading signal feeders including the installation of a second Upper Harlem signal feeder for redundancy.
- Replace contact wire and catenary components on the New Haven Line and lighting systems at eight passenger stations.
- Upgrade and replace assets to address climate resilience strategies, including hardening assets that are most prone to repeat climate hazard exposure and asset elevation for those that are susceptible to water inundation from storm events.

Right, Harlem Line, White Plains

Overhead catenary power system, New Haven Line

Communication infrastructure

Metro-North's communication systems play a vital role in the safe operation of our network. Our rail traffic controllers, train crews, and station personnel rely on a flow of information to keep the system moving—and to keep our customers informed. Our communication system supports several other systems that are critical to Metro-North's operations, including the power system (e.g., remote control of power systems) and fare collection (e.g., data collection from TVMs). Major elements of the communication systems include radio and telephone systems, fire alarms, and security systems (e.g., CCTV cameras, access systems, and intrusion detection systems), all which are connected by approximately 300 linear miles of fiber optic cables. In addition to communication between controllers, train crews, and customers, these interconnected technologies ensure police, fire, and other emergency personnel can respond rapidly to incidents.

Metro-North's SONET communications systems equipment

Inventory and status

Asset	Total	Percent in Poor/Marginal Condition
Fiber Optic Transmission Equipment (node houses) and Local Fiber Connections to CILs, MLs, Substations, Passenger Stations	970	85%
Voice Radio Equipment	7,268	100%
Voice Radio Cable	100,000 feet	100%
Telephone Equipment	118	100%
Uninterruptible Power Supply System	1	0%
Wire/Fiber*	376 miles	12%
GCT Wire/Fiber	208 segments	45%
Construction Equipment	10	50%
Employee Facilities	15	20%

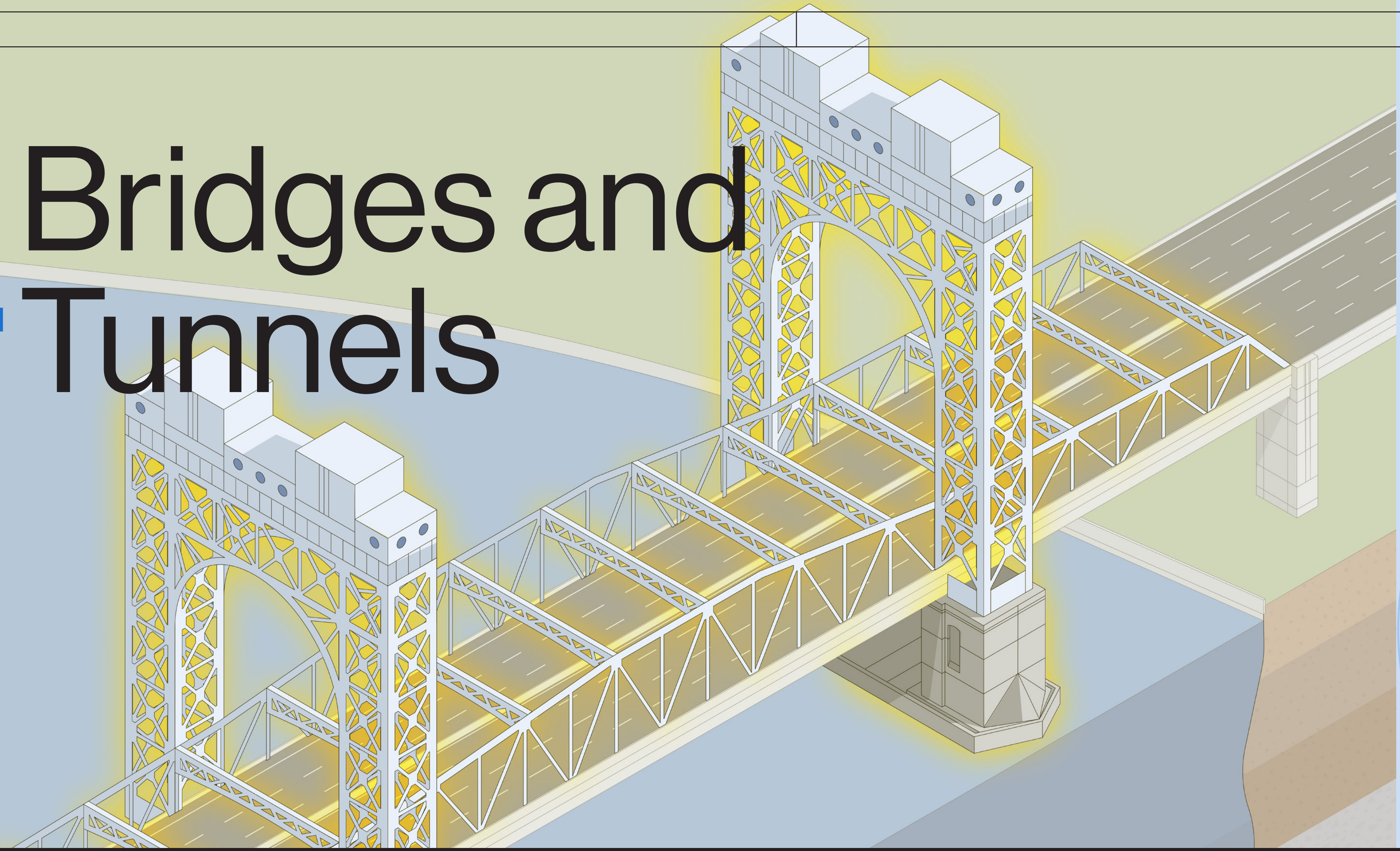
** Along Harlem Line, Hudson Line, New Haven Line (in New York only), and Port Jervis Line.*

Investment needs

Our long-term objective is to replace aging systems with the latest technology to meet current and future operational and agency needs. Over the next 20 years, we need to:

- Continue to move our communication systems from the obsolete Synchronous Optical Network (SONET) to an Ethernet-based Dense Wave Division Multiplexing (DWDM) system. The systemwide ethernet migration includes ethernet/IP capable head-ends, ethernet/IP capable field assets, and new fiber optic links to field assets.
  - This new DWDM system will support a wide range of Metro-North infrastructure—including telephone services, radio systems, CTC/signal, SCADA, PA/VIS, fare collection, and enhanced security services.
  - This will support capacity demands for projects such as security system upgrades and passenger station information upgrades, including Project CSI.
  - This upgraded system will also help us provide improved customer communication, including real-time train information and better PA communication.
- Continue to replace communication elements beyond their typical lifespan on a cyclical basis.
- Replace our current radio and PA systems—whose age makes replacement parts difficult to find—with more reliable communications for our customers and employees, including rail traffic controllers.
  - In accordance with regulatory requirements, our telephone systems and voice recorders will need to be upgraded over the next 20 years.
- Prioritize investments that protect communication infrastructure assets from climate hazards, including flooding, which may include asset elevation and/or hardening, as well as future impacts and risks to communication assets from prolonged extreme heat.

04 Bridges and Tunnels



Key program highlights

Bridges

- Bronx-Whitestone Bridge
- Robert F. Kennedy Bridge
- Throgs Neck Bridge
- Verrazzano-Narrows Bridge
- Henry Hudson Bridge
- Cross Bay Bridge
- Marine Parkway Bridge

Tunnels

- Hugh L. Carey Tunnel
- Queens Midtown Tunnel

Agencywide Projects and Central Business District Tolling Program

Overview of agency and assets

MTA Bridges and Tunnels (B&T) was established in 1933 as the Triborough Bridge Authority. Today, B&T is among the largest of the nation's bridge and tunnel tolling authorities, in terms of both revenue and traffic volume, operating seven bridges and two tunnels in New York City, connecting the boroughs of Manhattan, Brooklyn, Queens, the Bronx, and Staten Island. In 2022, B&T collected more than $2.3 billion in revenue. With over 60% of this toll revenue dedicated to the MTA's mass transit operations, B&T performs a unique and vital function in support of regional mobility.

B&T operates seven bridges:
· Bronx-Whitestone Bridge
· Robert F. Kennedy Bridge
· Throgs Neck Bridge
· Verrazzano-Narrows Bridge
· Henry Hudson Bridge
· Cross Bay Bridge
· Marine Parkway Bridge

B&T also operates two tunnels:
· Hugh L. Carey Tunnel
· Queens Midtown Tunnel

These facilities are essential links for both regional traffic corridors and major truck routes and serve a vital role in the operation of bus/high occupancy vehicle (HOV) traffic operations within NYC.

By the end of this 20-year planning horizon in 2044, all but the Cross Bay Bridge will be over 75 years old, and several facilities will be over 100 years old. As a result of a planned sequence of steady capital investments complemented by a robust operating program of major maintenance work, B&T's facilities are in overall good condition. However, B&T's facilities continue to age, and as B&T continues to address the remaining infrastructure rehabilitation/replacement needs, a sustained high level of capital investment similar to current levels is necessary to maintain the facilities in good condition while also improving them to better serve the region. B&T's investment needs represent a long-term strategy to renew, rebuild, and modernize B&T's bridges and tunnels with the goals of improving safety, resiliency, regional mobility, and accessibility, while also employing sustainable practices that enhance the environment.

B&T appendix structure

The B&T Appendix provides an overview of the agency's assets, their current replacement/upgrade status, and expected investment focus to maintain these assets over the next 20 years. The appendix is divided into four sections, including program highlights, specific details about our bridges, specific details about our tunnels, and an overview about our agencywide projects and the Central Business District Tolling Program.

Verrazzano-Narrows Bridge..

Investment needs highlights

Over the next 20 years, our investment needs include:

- On all bridges and tunnels, continue to replace original structural components to ensure all components remain in good condition, and where new design criteria are applicable for assets being replaced, upgrade them to meet the new criteria.
- On all bridges and tunnel ventilation buildings, upgrade structures where necessary to meet current seismic requirements.
- On all bridges and tunnels, employ sustainable practices during construction such as requiring the use of low carbon concrete and warm mix asphalt, and upgrade our buildings with new energy efficient systems.
- On the Robert F. Kennedy Bridge, replace the elevated Manhattan Plaza structure (former toll plaza area).
- On the Verrazzano-Narrows Bridge, replace the lower-level suspended span deck.
- Implement major safety improvements on the Queens Midtown Tunnel and the Hugh L. Carey Tunnel by installing in-tunnel fixed fire suppression systems (water mist systems).
- On the Bronx-Whitestone Bridge and the Throgs Neck Bridge, dehumidify the main cables.
- Continue to improve bicycle and fully accessible pedestrian paths on our bridges.

KEY PROGRAM HIGHLIGHTS

Key program highlights

Bridges

- Bronx-Whitestone Bridge
- Robert F. Kennedy Bridge
- Throgs Neck Bridge
- Verrazzano-Narrows Bridge
- Henry Hudson Bridge
- Cross Bay Bridge
- Marine Parkway Bridge

Tunnels

- Hugh L. Carey Tunnel
- Queens Midtown Tunnel

Agencywide Projects and Central Business District Tolling Program

Extension of service life for suspension bridges

Main cables are the primary load-carrying elements for our suspension bridges (Throgs Neck Bridge, Bronx-Whitestone Bridge, Verrazzano-Narrows Bridge, and Robert F. Kennedy Bridge suspended spans). The main cables at the Bronx-Whitestone Bridge and Robert F. Kennedy Bridge are well over 80 years old, and the main cables at the Verrazzano-Narrows and Throgs Neck Bridges are already over 60 years old. Main cables are extremely difficult and cost-prohibitive to replace and therefore are critical elements that must be preserved and maintained. As with any cable on an older suspension bridge, main cable strength is reduced from its original new condition by various factors including corrosion. Cable dehumidification is a proven technique used around the world to minimize corrosion and preserve these critical elements.

Above, the Robert F. Kennedy Bridge
Right, aerial view of the Verrazzano-Narrows Bridge

We have already initiated installation of cable dehumidification on the Robert F. Kennedy Bridge and the Verrazzano-Narrows Bridge in the 2020-2024 program and will be prioritizing this investment at the Bronx-Whitestone Bridge and Throgs Neck Bridge in the next program.

Split tolling at the Verrazzano-Narrows Bridge

Implementation of Open Road Tolling and Central Business District Tolling

The implementation of Open Road Tolling (ORT) at all MTA B&T facilities in 2017 was a key component of the New York Crossings Project that aimed at reimagining New York's bridges and tunnels for the 21st century. ORT is providing significant and sustained regional improvements in customer service and customer safety and also has environmental benefits —less traffic congestion for motorists also means cleaner air for everyone, and reducing traffic merging and the need to slow down to pay a toll improves safety for B&T customers. In 2019, legislation was signed into law enabling B&T to implement the Central Business District Tolling Program (CBDTP) to reduce congestion and enhance mobility in Manhattan's Central Business District (south of, and inclusive of, 60th Street). The planning, design, construction, operations, and maintenance of CBDTP is primarily the responsibility of B&T and requires the involvement of New York State Department of Transportation (NYSDOT), New York City Department of Transportation (NYCDOT), and various other regional agencies and stakeholders. Once activated, this program is anticipated to collect annual net revenue sufficient to generate $15 billion for the MTA capital plan.

Over the next 20 years, as toll collection technology improves, we will need to periodically renew the infrastructure required both to support toll collection at the facilities and to support the CBDTP.

Fire safety upgrades

Over recent capital programs, B&T has made significant progress in upgrading our facilities to modern fire safety standards (NFPA 502) adding fire standpipes on bridges that were originally constructed without them, replacing our tunnel standpipes to modern standards and installing supplemental systems to improve fire fighting resiliency on our suspension bridges. At the Hugh L Carey Tunnel we have installed a fixed fire suppression system in a portion of the tunnel to further enhance fire fighting capabilities. Going forward we plan to complete the remaining elements of this program and bring all facilities into compliance with modern fire safety standards as well as completing the installation of fixed fire suppression systems at the remainder of the Hugh L Carey Tunnel as well as the Queens Midtown Tunnel.

Testing of fixed fire supression system in Hugh Carey Tunnel

We will complete the installation of a fixed fire suppression system in both the Hugh L. Carey Tunnel and the Queens Midtown Tunnel as a top priority in the next program.

Resilience initiatives

In previous programs, as well as the current program, B&T has made significant investments in climate resilience by improving the aerodynamic and wind performance of all four suspension bridges, replacing and/or installing fender protection systems at the Cross Bay Bridge, Marine Parkway Bridge, Bronx-Whitestone Bridge, Robert F. Kennedy Bridge, and Throgs Neck Bridge to protect critical assets against marine vessel collision, installing measures to prevent erosion of soil around bridge piers and abutments due to the water flow (known as scour) at the Throgs Neck Bridge, Cross Bay Bridge and Marine Parkway Bridge, and installing flood mitigation measures at various facilities. In addition, as part of major deck or structural rehabilitation and replacement projects, seismic upgrades have been performed to bring many of the structures into compliance with current seismic codes. Over the next 20 years we will continue to improve seismic resiliency of both our bridge structures and our tunnel ventilation buildings which are critical structures that house life safety systems for the tunnels. We have also improved electrical resiliency at the majority of our facilities to ensure adequate backup power is available for critical systems, and will complete replacement of all remaining original substations within the next ten years.

Night view with lights of the Robert F. Kennedy Bridge, formerly the Triborough Bridge

Sustainability initiatives

Over the past several programs, B&T has included sustainability initiatives as part of its projects wherever possible, resulting in approximately 95% of facility lighting being upgraded to more energy-efficient LED lights. We have also made wetland protection/enhancements at the Bronx-Whitestone Bridge and Robert F. Kennedy Bridge and replaced old, inefficient HVAC systems with new, properly sized, and efficient systems at several facilities. In keeping with the Governor's Executive Order 22 on sustainability and decarbonization, B&T is requiring the use of low carbon concrete, as well as the use of other innovative materials such as warm mix asphalt, on current and upcoming projects to minimize the carbon footprint of the projects. B&T is committed to investing in sustainability and is partnering with the New York Power Authority (NYPA) to identify further potential energy savings, evaluate the potential for solar power generation at our facilities, and transition to the use of zero-emission vehicles. In addition, B&T is developing a pilot program to implement EV charging at the Battery Parking Garage with the ability to expand the number of charging stations as demand grows.

Rendering of new bicycle/pedestrian ramp at the Robert F. Kennedy Bridge

Regional mobility and accessibility

Investments over the past two programs have resulted in major improvements to community and regional mobility and access. Recent roadway projects at the Verrazzano-Narrows Bridge, in coordination with off-property improvements on the Gowanus and Staten Island Expressways, resulted in the completion of a transformative, continuous reversible bus/HOV lane connecting Staten Island to Manhattan via the Gowanus bus/HOV lane. Taken in conjunction with the implementation of ORT, this project significantly improved travel times during peak hours. In addition, B&T widened the at-grade Gowanus Expressway to eliminate a pinch point where two lanes merged into one (called a lane drop) and improved traffic flow on the lower level of the Verrazzano-Narrows Bridge. At the Robert F. Kennedy Bridge, B&T constructed a new ramp connecting the Harlem River Lift Span directly to the northbound Harlem River Drive, which has reduced congestion on both the bridge and local city streets in Harlem. At the Bronx-Whitestone Bridge, B&T reconfigured the southbound Queens interchange, creating a shared exit lane to the Cross Island Parkway, which helped minimize last-minute weaving movements and improved customer safety.

Over the next 20 years, B&T will continue to improve bicycle and pedestrian access on its facilities.

In the current program, B&T is improving the Verrazzano-Narrows Bridge and Belt Parkway merge to eliminate a lane drop, and reconfiguring the upper-level Brooklyn Approaches to eliminate non-standard left-hand exits to the Belt Parkway, both of which will greatly improve traffic flow and customer safety on the bridge. At the Robert F. Kennedy Bridge, B&T is improving the southbound Franklin D. Roosevelt (FDR) Drive by eliminating the lane drop where the bridge ramp merges with the southbound FDR, further reducing congestion on the bridge while also improving traffic flow on the FDR. Moving forward, B&T will continue to evaluate its facilities for additional improvements in coordination with its regional partners.

In addition to improving regional vehicular mobility, B&T is committed to improving bicycle and pedestrian access at its facilities wherever possible. Improvements have already been made at the Hugh L. Carey Tunnel by replacing the Morris Street pedestrian bridge over the Manhattan plaza with a new ADA accessible bridge and improving bicycle lanes and pedestrian crossings at Lily Pond Avenue on Staten Island near the Verrazzano-Narrows Bridge. Significant accessibility improvements are also underway on the pedestrian walkways at the Robert F. Kennedy Bridge, the Henry Hudson Bridge and the Cross Bay Bridge. Additional bicycle/pedestrian accessibility improvements are being evaluated for the Robert F. Kennedy Bridge's Harlem River Lift Span and the south side of the Queens Suspension Span, as well as the Marine Parkway Bridge and the Verrazzano-Narrows Bridge.

Overweight vehicle issues and impacts

B&T's bridges are utilized by thousands of trucks everyday, of which up to eight percent are overweight. Overweight trucks inflict severe fatigue damage to B&T's infrastructure, which drastically reduces the service life of decks and supporting steel members, and could lead to replacement of these components much sooner than planned. New York State recently passed legislation that will allow overweight trucks to be issued violations and fines as deterrence on a segment of the Brooklyn-Queens Expressway, using data from weigh-in-motion (WIM) systems as a basis for enforcement. B&T is planning to utilize WIM for enforcement and is adding additional WIM systems, upgrading existing WIM systems to be enforcement capable, and coordinating with regional transportation partners to develop a consistent regional approach to this issue.

Investment categories

Throgs Neck Bridge with beautiful reflection between Queens and the Bronx at sunrise

Structures

Investments in this category generally address components of the superstructure or the substructure that supports the superstructure. Over the next 20 years, B&T will address the remaining backlog of major capital renewal needs, primarily at the Robert F. Kennedy Bridge, Throgs Neck Bridge, and the Verrazzano-Narrows Bridge, as well as potential structural upgrades to enhance bicycle and pedestrian mobility at several facilities.

Roadways and decks

Investments in this category rehabilitate the bridge and tunnel roadways, decks, approaches, and drainage systems. Over the next 20 years, B&T will address the remaining deck replacement needs, the largest of which is the replacement of the Verrazzano-Narrows Bridge lower-level suspended span deck. After the completion of the deck projects included in this 20-year period, all of our bridge structures will have received new decks, with the exception of the Throgs Neck Bridge Approaches.

View of the Verrazzano-Narrows Bridge

Over the next 20 years, B&T will continue to upgrade its systems with the most up-to-date technology to enhance customer safety and experience and to protect the revenue stream.

Transportation Systems Management Operations

This category focuses on investments in operational technologies that can improve the efficiency, safety, and utility of existing infrastructure. Some of these systems, many of which are integrated with those of B&T's regional transportation partners, collect data that impact travel, like weather information or travel time information, or provide transportation-related information to our staff or customers, allowing them to respond better to current conditions. In addition, investments in this category address necessary upgrades to, or expansions of, B&T security systems, as well as renewal of B&T's ORT and CBDTP systems, which maximize throughput and revenue generation. Over the next 20 years, B&T will continue to upgrade its systems with the most up-to-date technology to enhance customer safety and experience and to protect the revenue stream.

Utilities

Investments in this category include the replacement, rehabilitation, or upgrade of mechanical, electrical, and lighting systems; installation of dehumidification systems on suspension bridge main cables; and replacement of tunnel ventilation equipment. B&T's largest investments are in main cable dehumidification at the Bronx-Whitestone Bridge and the Throgs Neck Bridge and in fire suppression systems at our two tunnels, all within the next capital program. B&T will also be completing its power resiliency/redundancy upgrades with the replacement of the primary 13 KV substation and anchorage substations at the Robert F. Kennedy Bridge, as well as the replacement of the substations at the Throgs Neck Bridge. In addition, B&T is committed to implementing sustainability initiatives such as transitioning to a zero-emissions fleet, installation of solar power generation, systems upgrades to improve energy efficiency, and other green initiatives as they are identified in partnership with New York Power Authority.

Buildings and sites

Investments in this category include service buildings, ventilation buildings, and garages which are associated with the various bridges and tunnels. B&T's primary investments in this category are the structural/seismic rehabilitation of the ventilation buildings at the Queens Midtown and Hugh L Carey tunnels. B&T is also focusing on space repurposing and site improvements in response to operational changes that have resulted from the implementation of ORT, as well as upgrades to the Battery Parking Garage to ensure it remains in good condition.

Miscellaneous

This category reflects anticipated needs associated with the support and administration of capital work including program contingency, program administration, protective liability coverage, independent engineering, scope development efforts, miscellaneous studies, etc.

Structural painting

Investments in this category address structural painting, a vital ongoing activity that helps prevent corrosion of bridge steel. Work in this category is typically bundled with structural rehabilitation projects to maximize cost effectiveness and minimize customer impacts. With the completion of projects in the current program, the overwhelming majority of B&T's structures will have had their original lead-based coatings replaced, an important safety and environmental goal. The majority of B&T's investments over the next 20 years involve cyclical maintenance and repair of the bridge coatings.

BRIDGES

Key program highlights

Bridges

- Bronx-Whitestone Bridge
- Robert F. Kennedy Bridge
- Throgs Neck Bridge
- Verrazzano-Narrows Bridge
- Henry Hudson Bridge
- Cross Bay Bridge
- Marine Parkway Bridge

Tunnels

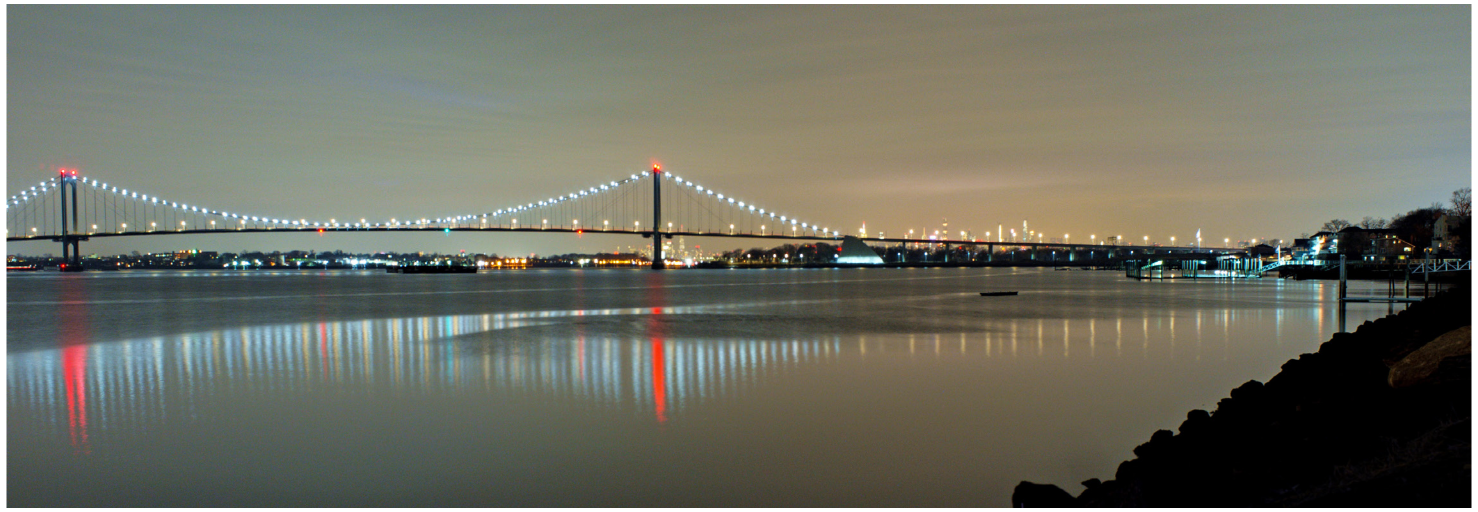
- Hugh L. Carey Tunnel
- Queens Midtown Tunnel

Agencywide Projects and Central Business District Tolling Program

Bronx-Whitestone Bridge

Bridge facility

The Bronx-Whitestone Bridge is one of our oldest bridges and one of two B&T suspension bridges connecting upper Queens with the Bronx. It is a critical link and vital artery in the regional network. Along with the Throgs Neck Bridge, the Bronx-Whitestone Bridge serves as a key link to Long Island. It has a single level that carries six lanes of traffic, supporting almost 50.9 million vehicle trips in 2022.



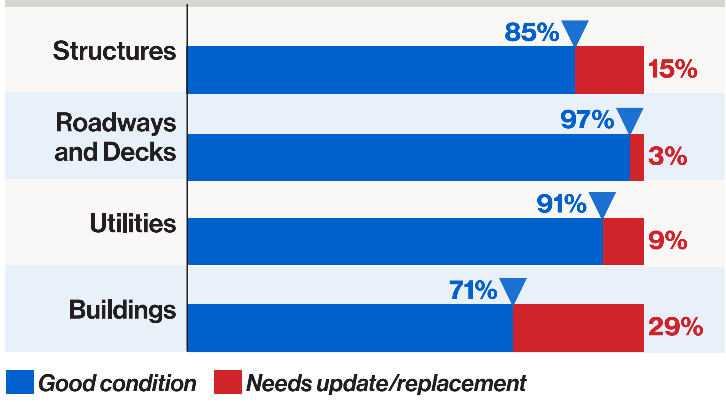
Current status

To date, Bronx-Whitestone Bridge capital investments have focused on replacement and rehabilitation of the bridge's primary structural elements and upgrades to the electrical and communication systems. As a result of investments to date, the Bronx and Queens approach structures have been replaced in their entirety. In addition, we replaced the heavy concrete deck on the suspended span with a lighter steel deck, removed the heavy stiffening truss from the suspended spans and installed a lightweight wind fairing system to improve the wind performance of the suspended spans, all of which significantly reduced the dead load on the main cables. In conjunction with these major structural improvements, the electrical and communication systems on the bridge have been replaced.

In addition, resiliency and security needs have been addressed with a fire standpipe system installed on the structure, expansion and upgrades of the electronic security systems, the installation of protection on main cables and suspender ropes, and construction of fenders to protect the towers from marine impacts. We are currently implementing power and resiliency upgrades, as well as performing structural repairs to the remaining original structural components.

Bronx-Whitestone Bridge
Facility 2022

Major asset categories include roadways and decks, structures, utilities, and buildings. A significant portion of the assets under the utilities and buildings categories, which still require upgrade or replacement, are being addressed under projects currently ongoing in the 2020-2024 program.



Based upon 2022 assessment

Investment needs

Our investment strategy for the Bronx-Whitestone Bridge over the next 20 years focuses on maintaining the structures and associated buildings in good condition while preserving the main cables. Our top priority in the next capital program is the dehumidification of the main cables, along with installation of a safety fence on the suspended spans. Another high priority is the replacement of the under-deck traveler, which provides access to support under-deck inspections and maintenance. The remaining investments over the 20-year planning horizon include replacing the suspender ropes which will be almost 100 years old, as well as cyclical structural repair projects, periodic rehabilitation of the bridge anchorages, bridge deck overlays, and painting projects all aimed at maintaining the Bronx-Whitestone Bridge in good condition.

Robert F. Kennedy Bridge

Bridge facility

B&T's flagship facility, the Robert F. Kennedy Bridge (formerly the Triborough Bridge), is comprised of three bridges—the Queens suspension bridge, the Harlem River Lift Span (HRLS), and the Bronx Truss—plus elevated viaducts and approach roads that connect Manhattan, Queens, and the Bronx. The three main branches meet on Randall's Island, where an elevated interchange supports traffic flowing in 12 directions, including to Randall's Island. Over 65.2 million vehicles crossed the Robert F. Kennedy Bridge in 2022.

Current status

After completion of the projects in the current 2020-2024 program, the majority of the decks will have been replaced and the superstructure supporting the decks will have been rehabilitated and upgraded to meet current load and seismic criteria. In addition, suspender ropes on the Queens suspension bridge have been replaced and, as part of an upcoming 2020-2024 project, the Queens suspension bridge will have improved wind resiliency and the main cables will be dehumidified. On the Harlem River Lift Span, the mechanical and electrical systems have been replaced or upgraded. A new vehicular ramp connecting the Harlem River Lift Span directly to the northbound Harlem River Drive was recently constructed, greatly improving regional mobility along with significant community benefits such as reduced traffic on local roadways and improved air quality. Two new vehicle ramps to Randall's Island are currently under construction. Additional investments in regional mobility will be completed under the 2020-2024 program with the widening a section of the FDR south of the Robert F. Kennedy Bridge, which will improve traffic flow on both the southbound Harlem River Drive and the bridge.

Significant improvements to bicycle and pedestrian access are also underway as part of the current capital program including shared use paths connecting Queens to Randall's Island, the Bronx Truss to Randall's Island, and the Harlem River Lift Span to both the future Manhattan Greenway and Randall's Island. In addition, resiliency and security needs have been addressed with investments in fire standpipe systems on the majority of the structures, expansion and upgrades of the electronic security systems, the installation of protection on the main cables and suspender ropes, replacement of the fenders protecting the Harlem River Lift Span towers against marine vessel impacts, installation of safety fencing on the suspended spans, and the replacement and upgrade of several substations servicing the Randall's Island complex and ORT systems.

Investment needs

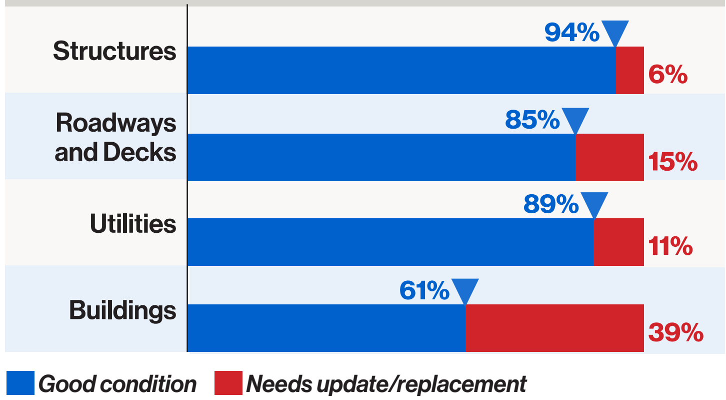
Our investment strategy at the Robert F. Kennedy Bridge over the next 20 years focuses on the continued rehabilitation or replacement of the remaining original roadways in the bridge complex, while also addressing the remaining needs of the supporting assets such as utilities and buildings and continuing to improve accessibility. Our highest priority over the next several programs is the reconstruction of the remaining original roadways, including the Manhattan toll plaza structure and associated ramps, and the FDR ramp. These projects will complete the replacement of all the original 1930s-era roadways at the bridge facility. At the same time, we will focus on a multi-phase substructure retrofit to extend the life of the substructure and improve seismic resiliency of this critical facility.

The bridge also has utility components, as well as buildings, that need to be addressed. The relocation and replacement of its primary 13 KV substation in the next capital program, along with subsequent upgrades to the substations in the anchorages will complete its power resiliency upgrades. In addition, as the center of operations for B&T, the Robert F. Kennedy Bridge facility building and storage space must be upgraded, repurposed, or expanded to accommodate operational changes.

We will continue to construct additional bicycle and pedestrian access where feasible, and continue to work with both NYCDOT and NYSDOT to improve regional mobility where possible. A priority project will be to construct a shared use path on the Harlem River Lift Span, making the Manhattan to Randall's Island connection a fully ADA compliant shared use path from end to end. We are assessing options for improving the Bronx to Robert F. Kennedy Bridge Interchange to address traffic safety, while also improving regional mobiity and bicycle/peestrian acessibility. The remaining investments over the 20-year planning horizon include cyclical structural repair projects, bridge deck overlays, and painting projects all aimed at maintaining the Robert F. Kennedy Bridge in good condition.

Robert F. Kennedy Bridge
Facility 2022

Major asset categories include roadways and decks, structures, utilities, and buildings. A significant portion of the assets under the utilities and buildings categories, which still require upgrade or replacement, are being addressed under projects currently ongoing in the 2020-2024 program.



Based upon 2022 assessment

Throgs Neck Bridge

Bridge facility

The Throgs Neck Bridge crosses the East River, connecting the boroughs of Queens and the Bronx via Interstate 295. This bridge is situated in deep water, with one anchorage and both towers constructed on foundations within the river and exceptionally long approach spans. The bridge carries three lanes in each direction as part of Interstate 295, and it has the highest percentage of truck traffic of all B&T facilities. Currently, due to the fact that the structure supporting the right-hand lane on the original approach viaducts cannot carry the heavy truck loads so common today, trucks are restricted to the middle lane while crossing the bridge. In 2022, the Throgs Neck Bridge carried over 39.6 million vehicles.

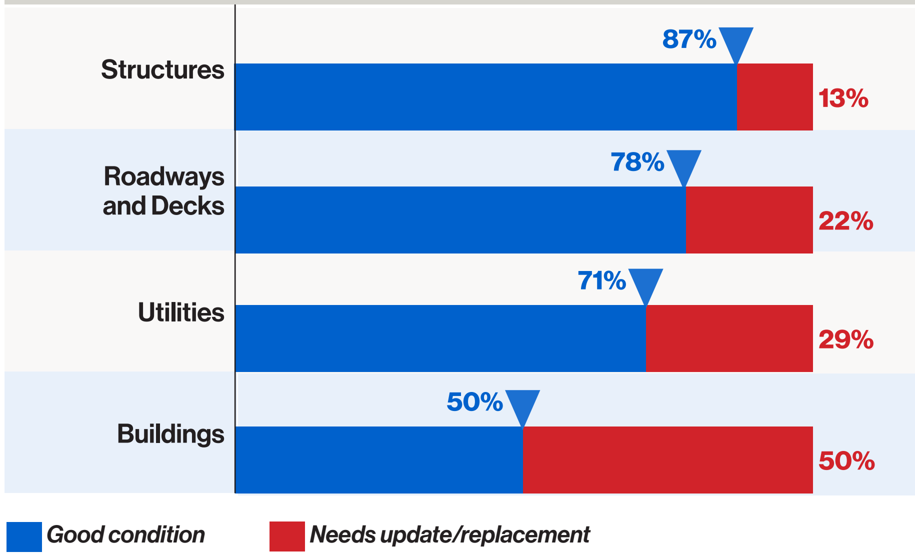
Master planning of Throgs Neck Bridge projects are carried out in careful coordination with planning at the Bronx-Whitestone Bridge, as these two bridges serve a common transportation corridor. Several studies of the Throgs Neck Bridge corridor and Bronx-Whitestone Bridge performed during previous capital programs have evaluated various means of reducing traffic congestion and improving safety, interoperability, and resiliency of both bridges. The recommended strategy that is most feasible is to plan for the possible future reconfiguration of the Throgs Neck Bridge to a seven-lane bridge similar to the reconfiguration of the Verrazzano-Narrows Bridge upper level. The need for the seventh lane could be triggered by traffic growth and/or the need to add additional capacity for an HOV lane. Adding a seventh lane across the bridge requires the replacement of the very long approach structures. Consequently, Throgs Neck Bridge capital investments over the past several programs and those included in the proposed 20-Year Needs Assessment have been aligned so as to allow for the potential implementation of a seventh lane as part of a future replacement of the approach structures.

Current status

Previous investments have focused on rehabilitation of the bridge's superstructure (e.g. roadway decks and supporting steel structures) and primary structural elements. The heavy concrete deck on the suspended spans was replaced with a lighter steel deck which reduced the dead load on the main cables. In addition, the lower half of the Queens Approach has been rehabilitated with a new deck along with substructure strengthening and seismic retrofits. Both the suspended spans and the rehabilitated portion of the Queens Approach are designed to accommodate a future seventh lane on the Throgs Neck Bridge. Extensive steel repairs and drainage improvements, as well as seismic retrofits to the superstructure, have been carried out on the Queens and Bronx Approach structures. In conjunction with these major structural improvements, we have replaced the roadway lighting as well as electrical and communication conduits and wiring on the bridge structure. In addition, resiliency and security needs have been addressed with fire standpipe systems installed on the structures, expansion and upgrades of the electronic security systems, and the installation of protection on the main cables and suspender ropes. As part of a major investment in the current capital program, we will replace the fenders that protect the bridge towers, paint the towers, and rehabilitate the tower elevators.

Throgs Neck Bridge
Facility 2022

Major asset categories include roadways and decks, structures, utilities, and buildings. A portion of the structures and utility assets that still require upgrade or replacement are being addressed under projects currently ongoing in the 2020-2024 program.



Based upon 2022 assessment

Investment needs

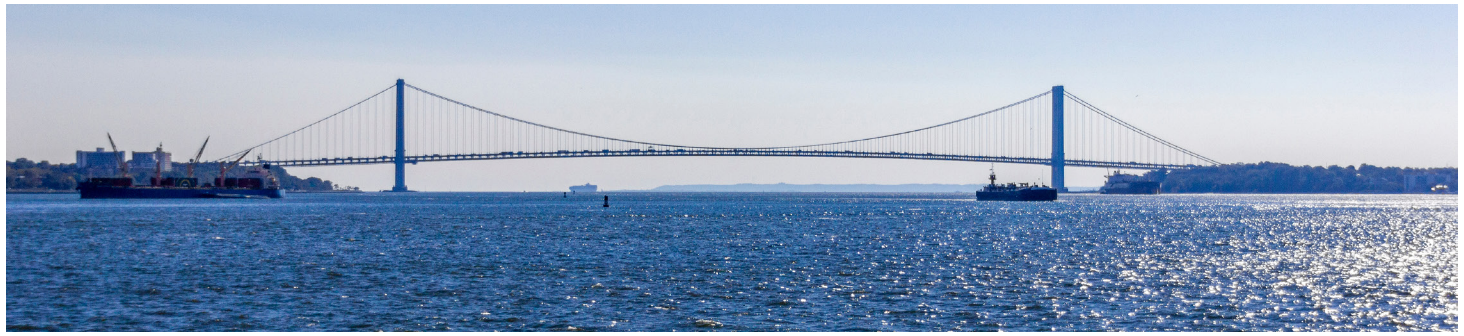
By the end of this 20-year planning horizon, the Throgs Neck Bridge will be over 80 years old. Our investment strategy over the next 20 years focuses on maintaining the structures and associated buildings in good condition, continuing to replace original components as needed, improving resiliency, and preserving the main cables. Our top priorities in the next capital program are the dehumidification of the main cables along with installation of a safety fence on the bridge, power redundancy and resiliency upgrades for all substations servicing the facility, and repairs to the concrete piers supporting the approach structures. Major investments in following programs include reconstruction of the on-bound Cross Island Parkway ramp to improve access to the Throgs Neck Bridge and address flooding issues where the ramp connects with the Cross Island Parkway, as well as replacement of the suspender ropes which will be over 80 years old.

In addition, we will begin design for the full replacement of the approaches to not only allow trucks to return to the right lane but also to allow for the potential creation of a seventh lane end-to-end on the bridge. We are also evaluating the possibiilty of improving interoperability between the Throgs Neck Bridge and the Bronx-Whitestone Bridge by eliminating the constraints that limit traffic flow between the two bridges, which would in turn, allow better use of the two crossings by bus/HOV traffic while also improving regional transportation resiliency. The remaining investments over the 20-year planning horizon include cyclical structural repair projects, periodic rehabilitation of the bridge anchorages, bridge deck overlays, and painting projects all aimed at maintaining the Throgs Neck Bridge in good condition.

Verrazzano-Narrows Bridge

Bridge facility

Opened to traffic in 1964, the Verrazzano-Narrows Bridge, connecting Brooklyn and Staten Island, is the newest of B&T's suspension bridges. It is a double decked suspension bridge and the longest suspended span in North America. It is also the only link connecting Brooklyn with Staten Island across New York Bay. The Verrazzano-Narrows Bridge serves as a critical transit link in the region between Brooklyn, Manhattan, and Staten Island, with 970 express buses and 677 local buses carrying 36,000 passengers across the bridge each weekday. It carried over 78.2 million vehicles in 2022 and is also a major truck route.

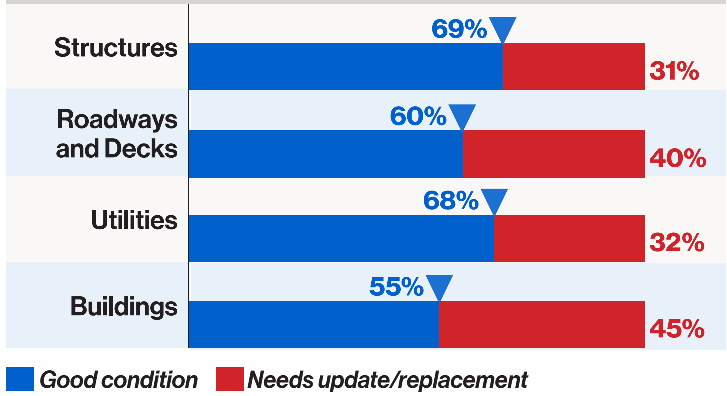


Current status

Given the Verrazzano-Narrows Bridge's status as a critical link in the regional transportation corridor, a significant portion of our investments have been carefully coordinated with NYSDOT's investments on the Staten Island and Gowanus Expressways with the ultimate goal of providing continuous bus/HOV service across the Verrazzano-Narrows Bridge. A series of major investments were implemented over several past programs which included the reconfiguration of the eastbound toll plaza to facilitate bus/HOV access, and the replacement and reconfiguration of the upper-level suspended span deck to meet current loads, improve wind resilience, and provide a reversible bus/HOV peak-travel lane. on the upper level of the suspended spans. These improvements, along with the construction of a new bus/HOV ramp on the Brooklyn Approach and the reconstruction of the Gowanus Expressway connection, resulted in continuous bus/HOV access from Staten Island to Manhattan servicing the express bus network in this transportation corridor. Combined with the conversion of the tolling system to ORT, these projects have transformed regional mobility options and reduced travel time by up to 15-20 minutes between Staten Island and Manhattan for thousands of daily commuters and express bus riders.

Verrazzano-Narrows Bridge
Facility 2022

Major asset categories include roadways and decks, structures, utilities, and buildings. A portion of the structures and utility assets that still require upgrade or replacement are being addressed under projects currently ongoing in the 2020-2024 program.



Based upon 2022 assessment

In addition, we have been improving Verrazzano-Narrows Bridge traffic flow and safety by constructing improvements to the connecting highways on either end of the bridge to facilitate traffic exiting the bridge. Under a major investment in the current capital program, we are reconstructing and reconfiguring the Brooklyn approaches to eliminate substandard left-hand exits to the Belt Parkway.

Not only do these projects improve traffic safety and flow, they also facilitate the eventual replacement of the lower-level suspended span deck in a future program. In conjunction with these major structural improvements, the majority of the Verrazzano-Narrows Bridge electrical and communication systems have been replaced.

We have also addressed safety, resiliency, and security needs with the installation of safety fences on the suspended spans, replacement of substations and improvement of electrical power backup, installation of electronic security systems, and the installation of protection on the main cables and suspender ropes. A high priority project in the current program is the dehumidification of the main cables to preserve these critical assets.

Investment needs

By the end of this 20-year planning horizon, the Verrazzano-Narrows Bridge will be over 80 years old. Our investment strategy over the next 20 years focuses on continued rehabilitation or replacement of the remaining original portions of the bridge complex, while also addressing the supporting assets such as utilities and buildings.

Our highest priority in the next 20 years is the replacement of the lower-level suspended span deck, along with the fire standpipe system and the under-deck travelers that provide access for maintenance and inspection of the suspended spans. In addition, the suspender ropes will be almost 80 years old and will be replaced, and, if deemed feasible, a bicycle/pedestrian path may be added on the bridge. Other priorities include expanding the electronic security system at the Verrazzano-Narrows Bridge facility and addressing building and site space needs to accommodate operational changes. The remaining investments over the 20- year planning horizon include cyclical structural repair projects, cyclical rehabilitation of bridge roadways, cyclical substation upgrades, bridge deck overlays, and painting projects all aimed at maintaining the Verrazzano-Narrows Bridge in good condition.

Henry Hudson Bridge

Bridge facility

The Henry Hudson Bridge is a double-deck steel arch bridge that crosses the Hudson River and connects the northern tip of Manhattan with the Bronx and points north. The lower level carries Manhattan bound traffic, and the upper level carries traffic from Manhattan to the Bronx. There is an existing pedestrian walkway on the lower level of the bridge. Almost 24.9 million vehicles crossed the Henry Hudson Bridge in 2022. In addition to its main structure, two smaller bridges (the Dyckman Street Bridge and the Staff Street Bridge) and the Henry Hudson Parkway south of the bridge are part of the Henry Hudson Bridge facility and are operated and maintained by B&T.

Current status

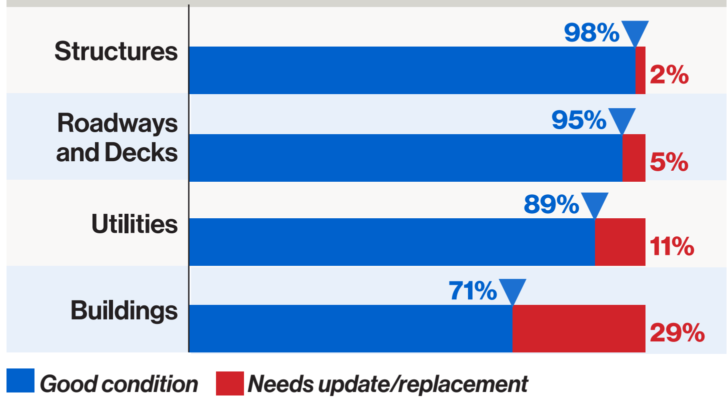
We have replaced all of the original 1930s-era roadway decks on both levels of the Henry Hudson Bridge, painted and rehabilitated the entire steel supporting structure, and upgraded the majority of the substructure to meet current seismic criteria. In conjunction with these major structural improvements, we have replaced the electrical and communication systems on the bridge and eliminated original supporting columns that obstructed driver sight lines on the lower level and impeded traffic flow on the bridge's lower level, greatly improving traffic flow and safety. Significant improvements in the bridge's structural redundancy and longevity have been implemented in a recent major retrofit of the bridge's substructures. Under an ongoing project in the current capital program, we are addressing resiliency needs with replacement of substations and improved electrical power backup. We are also improving bicycle and pedestrian accessibility by enhancing the existing 1930s-era lower-level walkway on the bridge and constructing new connecting ramps on either side of the bridge to provide a shared use path between Manhattan and the Bronx. With the completion of these investments, the Henry Hudson Bridge should continue to serve the traveling public for many years with regular maintenance and consistent levels of capital investments going forward.

Investment needs

Our primary investment strategy at the Henry Hudson Bridge over the next 20-year timeframe is to continue to maintain the facility in good condition. A top priority in the next capital program is to construct a backup operations control center for B&T to create operational redundancy. Other investments include performing traditional structural and concrete repairs and cyclical deck rehabilitation projects to extend the service life of the decks, as well as upgrading the drainage system on the bridge to facilitate maintenance and minimize future impacts of corrosion to the steel supporting structure. Drainage system improvements will also be made on the Henry Hudson Parkway, and the parkway pavement will be rehabilitated toward the end of the 20-year period. In addition, upgrades will be made as necessary on the Dyckman Street and Staff Street structures to ensure they remain in good condition.

Henry Hudson Bridge
Facility 2022

Major asset categories include roadways and decks, structures, utilities, and buildings. A significant portion of utility assets that still require upgrade or replacement are being addressed under projects currently ongoing in the 2020-2024 program.



Based upon 2022 assessment

Cross Bay Bridge

Bridge facility

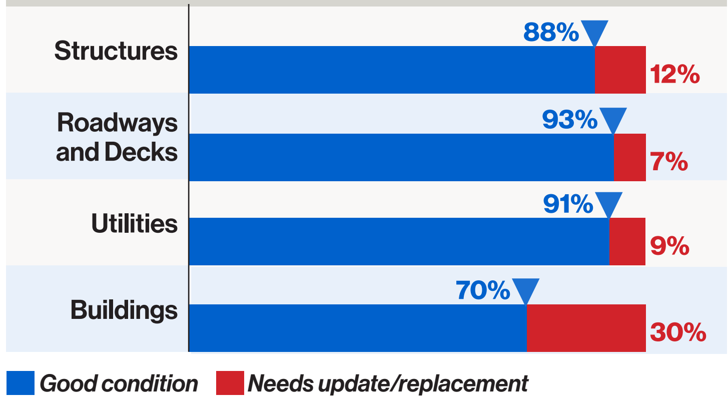
The Cross Bay Bridge (Cross Bay Veterans Memorial Bridge) spans Beach Channel in Jamaica Bay, providing vehicular access from Queens to the Rockaways and area beaches. It was completely reconstructed in 1970 as a high-level fixed bridge with a wide main channel for marine passage. The city of New York's Department of Emergency Management has designated the entire Rockaway Peninsula as Evacuation Zone 1, which contains the first areas to be evacuated in advance of an approaching coastal storm. The Cross Bay Bridge is therefore a crucial lifeline to the Rockaways. Almost 7.9 million vehicles crossed the bridge in 2022.

Current status

We have focused our Cross Bay Bridge investments primarily on structural rehabilitation work including structural rehabilitation of the ramps, rehabilitation of the concrete substructure, and a major rehabilitation of the superstructure/roadway and drainage system. We have also replaced the fender system that protects the navigation span piers from marine vessel impacts and addressed erosion issues at the span piers. After Superstorm Sandy, we replaced all damaged substations and electrical components and studied whether the Cross Bay Bridge and nearby Marine Parkway Bridge should be replaced due to structural conditions and flooding risks. This study recommended replacement of the Cross Bay Bridge due to the condition of critical components on the navigation spans however, we are implementing an innovative rehabilitation of the bridge's navigational span to extend the bridge's life and defer the need for replacement. In addition, we are replacing the existing pedestrian ramp to create an ADA-compliant shared use path across the bridge, which will significantly improve bicycle and pedestrian accessibility.

Cross Bay Bridge
Facility 2022

Major asset categories include roadways and decks, structures, utilities, and buildings. A significant portion of structure assets that still require upgrade or replacement are being addressed under projects currently ongoing in the 2020-2024 program.



Based upon 2022 assessment

Rendering of new bicycle/pedestrian Ramp at the Cross Bay Bridge

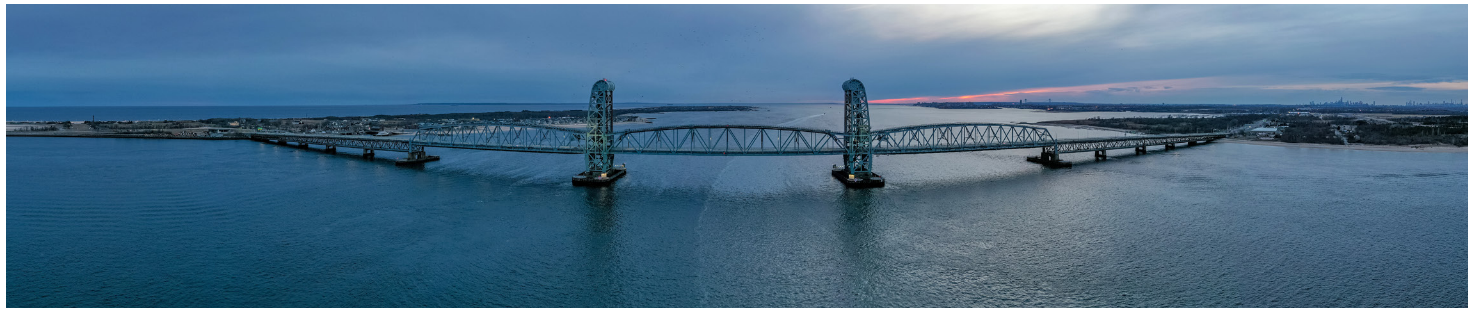
Investment needs

Our primary investment strategy at the Cross Bay Bridge over the next 20-year timeframe is to continue to maintain the facility in good condition, performing traditional concrete repairs deferring the need for bridge replacement. In addition, we will address the need for an electronic security system to facilitate operations and address building and space needs to accommodate operational changes.

Marine Parkway Bridge

Bridge facility

The Marine Parkway Bridge (Gil Hodges Memorial Bridge) is a vertical lift bridge with two secondary structures, the Rockaway Point Boulevard Overpass and the Jacob Riis Park Pedestrian Bridge. The close proximity of Jamaica Bay affects the bridge due to the low clearance of its approach spans over the bay's corrosive salt water, resulting in accelerated deterioration of its coatings and as well as corrosion of the bridge steel. The entire Rockaway Peninsula lies within Evacuation Zone 1, which contains the first areas to be evacuated in advance of an approaching coastal storm. Therefore, like the Cross Bay Bridge, the Marine Parkway Bridge is a crucial lifeline during any storm evacuation. Almost 7.9 million vehicles crossed the bridge in 2022.

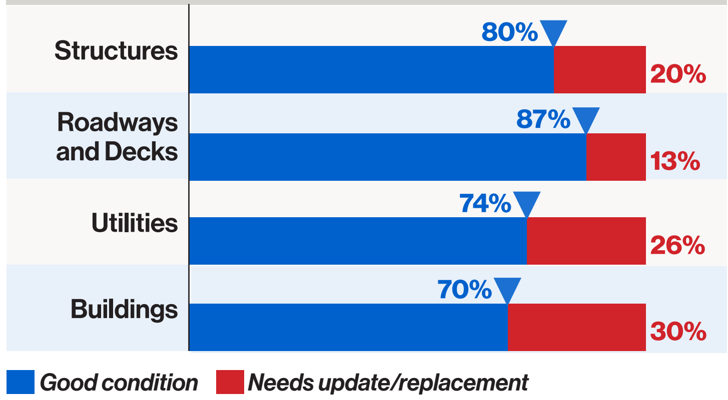


Current status

In earlier capital programs, we addressed the original functional deficiencies of the Marine Parkway Bridge, which included narrow lanes and no center median. The deck was replaced and widened to provide two 12-foot lanes in each direction with a new continuous center median and a cantilevered sidewalk for dedicated pedestrian use on the span's west side. This project also included new lighting and drainage and addressed structural steel repairs. We also have performed extensive steel repairs over several programs, along with an aggressive painting program to protect the steel supporting both the approach spans and the lift bridge. Most recently, we have rehabilitated the lift span electrical and mechanical systems, installed a fire standpipe system on the bridge, replaced the fender system that protects the lift span towers from marine vessel impacts, and addressed erosion issues around bridge abutments and piers. In addition, we rehabilitated the two overpasses in the Rockaways. After Superstorm Sandy, we replaced all damaged substations and electrical components and studied whether the Cross Bay Bridge and Marine Parkway Bridge should be replaced due to structural conditions and flooding risks. This study recommended planning for future replacement of the Marine Parkway Bridge based on its age and load capacity of certain bridge members, however, we recently completed singificant painting and steel repairs, and have been able to defer replacement of the bridge.

Marine Parkway Bridge
Facility 2022

Major asset categories include roadways and decks, structures, utilities, and buildings. A significant portion of utility assets that still require upgrade or replacement are being addressed under an elevator replacement project currently ongoing in the 2020-2024 program.



Based upon 2022 assessment

Investment needs

Our primary investment strategy over the next 20-year timeframe is to continue to maintain the Marine Parkway Bridge in good condition, performing traditional steel repairs and painting and deferring the need for bridge replacement. In addition, during the early part of the 20-year period, we will address the need for an electronic security system to facilitate operations and address building space needs to accommodate operational changes.

We will continue cyclical rehabilitation of the electrical and mechanical components of the lift span as necessary. One of the more significant investments in the 20-year timeframe is the replacement of the existing open-grid steel deck on the lift-span, which if feasible, may also include bicycle and pedestrian accessibility improvements. A prototype installation of the proposed open grid steel deck replacement will be installed as part of an ongoing capital project at the Marine Parkway Bridge and Cross Bay Bridge. The results of this prototype will inform future strategies for deck replacement on the Marine Parkway Bridge.

TUNNELS

Key program highlights

Bridges

- Bronx-Whitestone Bridge
- Robert F. Kennedy Bridge
- Throgs Neck Bridge
- Verrazzano-Narrows Bridge
- Henry Hudson Bridge
- Cross Bay Bridge
- Marine Parkway Bridge

Tunnels

- Hugh L. Carey Tunnel
- Queens Midtown Tunnel

Agencywide Projects and Central Business District Tolling Program

Hugh L. Carey Tunnel

Tunnel facility

The Hugh L. Carey Tunnel (formerly the Brooklyn-Battery Tunnel), the longest underwater vehicular tunnel in North America, is a twin-tube four-lane vehicular tunnel connecting lower Manhattan and Brooklyn. The facility includes two ventilation buildings in lower Manhattan, a third near the Brooklyn portal, and a fourth at Governor's Island, along with the Morris Street pedestrian bridge, and Governor's Island Foot Bridge. The adjacent Battery Parking Garage in Manhattan (the largest self-park garage in Manhattan) is also part of the tunnel facility assets. A critical public transit, private, and commercial vehicle link between Manhattan and Brooklyn, the Hugh L. Carey Tunnel is the terminus of the Gowanus Expressway bus/HOV lane that carries 1,370 express buses with 28,000 riders per weekday from Staten Island and South Brooklyn. During major emergencies, the tunnel also serves as an emergency entry and exit route from lower Manhattan. Almost 21.9 million vehicles traveled through the tunnel in 2022.

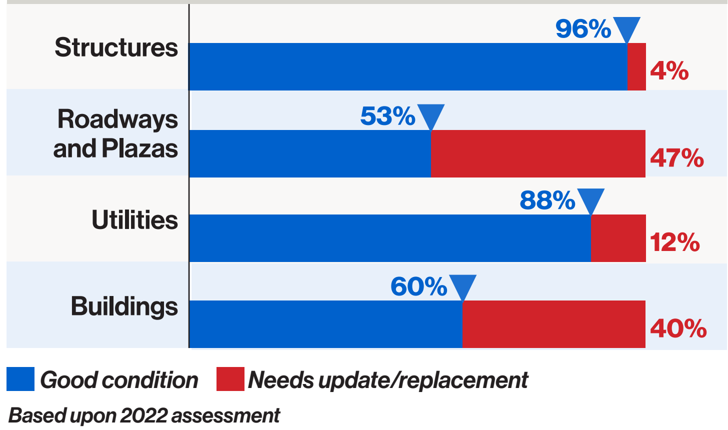
Current status

In 1989, B&T embarked on its first ever comprehensive tunnel inspection, which informed the initial capital tunnel projects under which we replaced the exhaust fans, updated and expanded the power distribution systems, and consolidated the tunnel control systems. We also replaced a portion of the tunnel slab ceiling, ceiling tiles, and traffic signals, as well as rehabilitated the roadway slab. In 2012, Superstorm Sandy caused severe damage to the Hugh L. Carey Tunnel and many of its elements that were replaced in earlier programs, requiring a major reconstruction of the tunnel. Work included complete replacement of wall tiles, tunnel ceiling veneer panels, the fire standpipe system to meet National Fire Protection Agency (NFPA) criteria, as well as all systems in the tunnels such as lighting, wayfinding, and electrical. In addition, the drainage pumps were completely replaced. As a result, the majority of the components within the tunnel itself are essentially new, as are the tunnel systems. The Brooklyn Plaza was also rehabilitated and realigned, and flood doors were installed at each plaza to mitigate the possibility of future flooding.

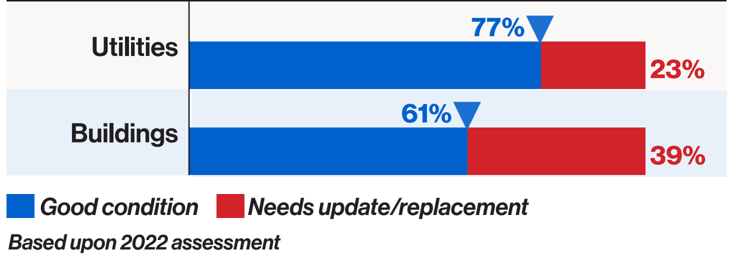
Once the restoration of the tunnel was complete, we focused on upgrades to the life safety systems, including the ventilation system, control center, electrical upgrades at the service building, installation of smoke and fire detection systems at the various tunnel buildings, and installation of a prototype fire-suppression system in a section of the tunnel. Under the current program, the electronic security system is being upgraded and expanded to facilitate tunnel operations.

Hugh L. Carey Tunnel
(formerly the Brooklyn-Battery Tunnel)
Facility 2022

Major asset categories include roadways and decks, structures, utilities, and buildings.



Hugh L. Carey Tunnel
Battery Parking Garage 2022



Investment needs

Our primary investment strategy at the Hugh L. Carey Tunnel over the next 20-year timeframe is to maintain the facility in good condition while continuing to improve life safety systems and upgrade the critical ventilation buildings to meet current seismic criteria. Our top priority in the next capital program is the completion of the fire suppression system installation within the tunnel along with any necessary in-tunnel structural repairs. In addition, we will begin a phased seismic retrofit of the ventilation buildings as well as any necessary structural repairs to the buildings, while also continuing to improve electrical resiliency for critical life safety assets and other upgrades to the ventilation system.

We will also make repairs to the Battery Parking Garage. Pedestrian safety and traffic flow continue to be major issues at the West Street Approaches to the tunnel's Manhattan Plaza. B&T will assess various pedestrian enhancements to improve pedestrian safety and traffic throughput.. The remaining investments over the 20-year planning horizon include cyclical tunnel repairs to address leaks and rehabilitate tunnel walls, ceiling and air ducts, periodic upgrades to tunnel controls, and rehabilitation of the former plaza areas, all aimed at maintaining the tunnel in good condition.

Queens Midtown Tunnel

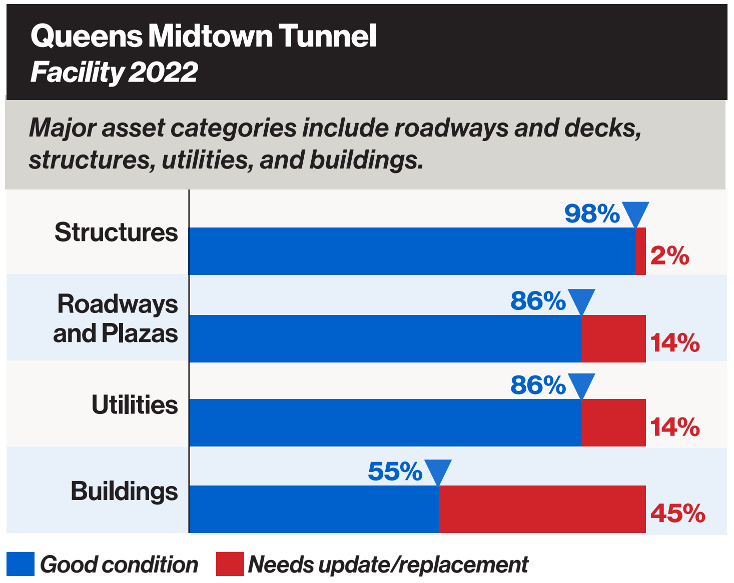
Tunnel facility

Opened to traffic in 1940, the Queens Midtown Tunnel is a twin tube four-lane vehicular tunnel that connects the Long Island Expressway and Midtown Manhattan. Related structures include two ventilation buildings, one in Queens and one in Manhattan. The Queens Midtown Tunnel facility also includes three roadway Manhattan overpasses in Manhattan at 2nd Avenue, 36th Street, and 37th Street entry, along with four approach and exit streets, three entrance and exit plazas, various parking lots, and the Borden Avenue property adjacent to the service building in Queens. The tunnel is a critical transportation link in the region, serving Queens and Long Island. Out of the average of 84,000 daily vehicles, 480 express buses serve approximately 9,600 passengers from Queens each weekday. During major incidents and emergencies, the tunnel serves as an entry and exit route for Midtown Manhattan. It is also an essential link in the interstate highway network, connecting Interstate 495 to the rest of the country via Midtown Manhattan and the Lincoln Tunnel. Over 29.8 million vehicles traveled through the Queens Midtown Tunnel in 2022.

Current status

Major capital investments in the wake of the first comprehensive tunnel inspection in the 1990s included travel roadway slab rehabilitation; replacement of the traffic control wiring; replacement of the ceiling slab, original ceiling tiles, and lighting; and rehabilitation of the ventilation and pump rooms. We modernized the facility power distribution systems, replaced the exhaust fans, and partially rehabilitated the roadway slab. In addition, we completely rehabilitated the roadway drainage system, including the replacement of all pumps and associated power and controls. We also replaced the 37th Street overpass that provides a connection from 37th Street to the south tube, rehabilitated the 36th Street and 2nd Avenue overpasses, and performed work on several buildings to improve functionality for maintenance and operations.

Superstorm Sandy in 2012 caused severe damage, requiring a major reconstruction of the tunnel. Work included complete replacement of wall tiles, ceiling veneer panels, the fire standpipe system to meet NFPA criteria, as well as all systems in the tunnel such as lighting, wayfinding, and electrical. As a result, the majority of the components within the tunnel are essentially new, as are the tunnel systems. The Queens Plaza was also rehabilitated, and flood doors were installed at each plaza to mitigate the possibility of future flooding. Once the restoration of the tunnel was complete, we focused on upgrades to the life safety systems including the ventilation system, controls center, electrical upgrades at the service building, and installation of smoke and fire detection systems in various tunnel buildings. Under the current program the electronic security system is being upgraded and expanded to facilitate tunnel operations. We are also making improvements to the service building, including relocating the fueling station to outside of the building and electrical equipment to above flood levels.



Queens Midtown Tunnel
Facility 2022

Major asset categories include roadways and decks, structures, utilities, and buildings.

Based upon 2022 assessment

Investment needs

Our primary investment strategy at the Queens Midtown Tunnel over the next 20-year timeframe is to maintain the facility in good condition while continuing to improve life safety systems and upgrade the critical ventilation buildings to meet current seismic criteria. Our top priority in the next capital program is the installation of the fire suppression system within the tunnel. In addition, we will begin a phased seismic retrofit of the ventilation buildings as well as any necessary structural repairs to the buildings, while also continuing to improve electrical resiliency for critical life safety assets and other upgrades to the ventilation system. Within the tunnel tubes, we will rehabilitate the roadway slab along with the Manhattan tunnel entrance plaza and Queens Plaza. We will also replace the mainly original exhaust ports. The remaining investments over the 20-year planning horizon include cyclical tunnel repairs to address leaks and rehabilitate tunnel walls, ceiling and air ducts, periodic upgrades to tunnel controls, and rehabilitation of the former plaza areas and roadway overpasses, all aimed at maintaining the tunnel in good condition.

AGENCYWIDE PROJECTS AND CENTRAL BUSINESS DISTRICT TOLLING PROGRAM

Key program highlights

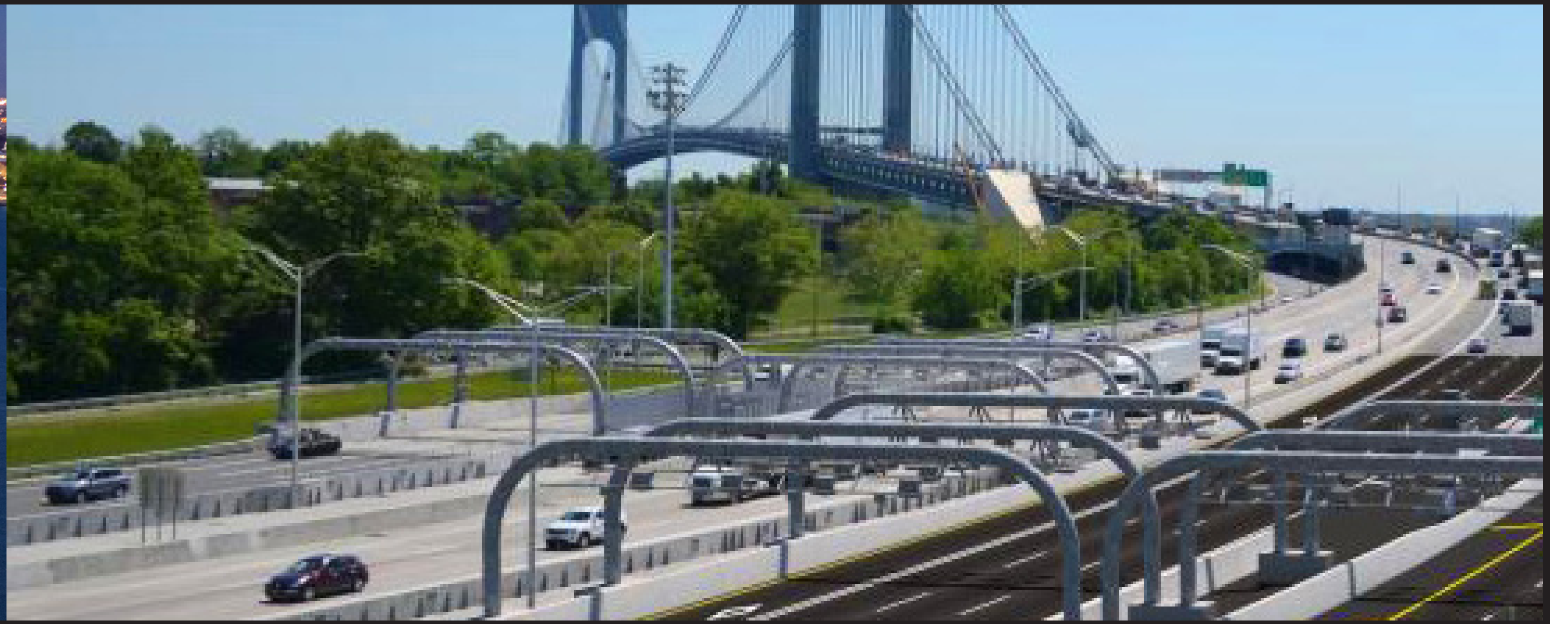
Bridges

- **Bronx-Whitestone Bridge**
- **Robert F. Kennedy Bridge**
- **Throgs Neck Bridge**
- **Verrazzano-Narrows Bridge**
- **Henry Hudson Bridge**
- **Cross Bay Bridge**
- **Marine Parkway Bridge**

Tunnels

- **Hugh L. Carey Tunnel**
- **Queens Midtown Tunnel**

→ **Agencywide Projects and Central Business District Tolling Program**



Agencywide projects

Our needs over the next 20 years include programmatic investments at multiple facilities such as tolling projects, intelligent transportation systems (ITS), security systems, and sustainability as well as efforts for the support and administration of the capital programs.

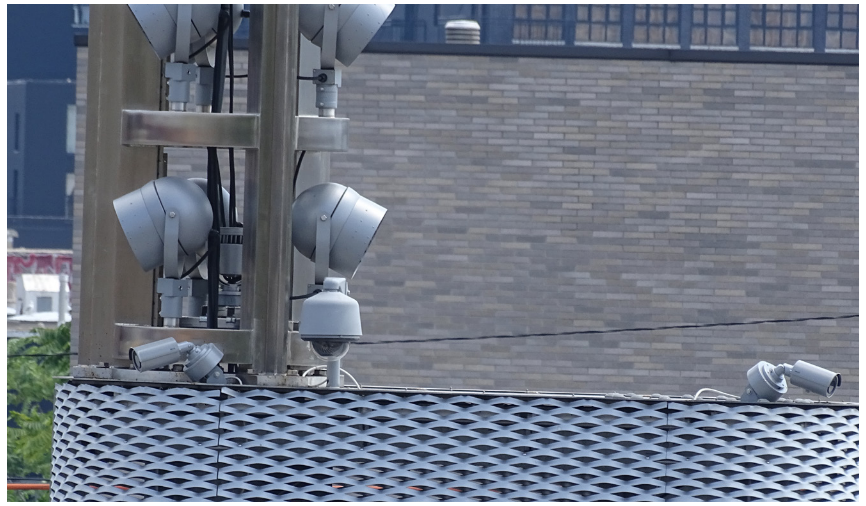
Verrazzano-Narrows Bridge and Belt Parkway

Current status

B&T has been at the forefront of ITS technology implementation since the introduction of E-ZPass in 1997. In 2017, we completely modernized B&T toll collection with the conversion of all conventional tolling facilities to ORT. In addition to advances in tolling, we are keeping pace with the changing technical advances in vehicular travel. In 2018, we opened the B&T Operations Command and Communications Center (OCCC) facility on Randall's Island, a state-of-the-art command center that allows for improved traffic management at all nine B&T facilities and provides critical transportation services to customers, including travel time advisories and safety alerts. The OCCC has dedicated links to other regional transportation agencies that enable the agency's regional partners to effectively coordinate their transportation incident management activities with B&T.

Agencywide ITS systems implemented in the recent past include Closed Circuit Television (CCTV) traffic cameras; variable message signs, which disseminate real-time traffic conditions to motorists; travel time information systems such as TRANSMIT, which allow us to provide live travel time estimates; vehicle traffic detectors, which can measure speed, volume, occupancy, and vehicle classification, allowing for quicker detection and clearance of incidents; over-height vehicle detection systems; and roadway weather systems, which can plan for resource allocation for weather events, particularly in the winter months. Another important investment in this category has been the installation of weigh-in-motion (WIM) systems at each facility. By the end of the current capital program, all bridge facilities carrying truck traffic will have enforcement ready WIM systems in place.

On the security front, we upgraded and expanded the electronic security systems (ESS) at the Throgs Neck Bridge, Bronx-Whitestone Bridge, and Robert F. Kennedy Bridge, and we are currently upgrading and expanding the ESS at the tunnels. We have made strides toward improving the energy footprint of B&T facilities by replacing approximately 95% of the facility lighting with more energy-efficient LEDs and installing energy-efficient HVAC systems at the tunnel service buildings as well as the Bronx-Whitestone Bridge service building. We are partnering with NYPA to perform energy audits on B&Towned buildings to identify further potential energy savings, to evaluate B&T-owned properties for installation of solar power generation, and to develop a plan for transitioning to the use of zero emmission vehicles.



Zoom in of tower cameras.

Cashless tolling and Gateway Towers at the Robert F. Kennedy Bridge

Investment needs

Our primary investment strategy for agencywide projects over the next 20-year timeframe includes the renewal of our ITS systems, periodic renewals of the ITS toll collection technologies at our ORT tolling locations, installing any necessary infrastructure to support the transition to zero-emission vehicles, and implementing sustainability initiatives including solar power generation and replacement of inefficient building systems. We will also expand the security systems at the Verrazzano-Narrows Bridge, as well as plan for security system improvements at the Henry Hudson Bridge, Cross Bay Bridge, and Marine Parkway Bridge. Finally, future programs will need to upgrade WIM systems as necessary to meet the most current performance criteria and allow for coordinated enforcement action against overweight trucks on B&T crossings.

Central Business District Tolling Program

Major investments in the upcoming programs include a series of periodic renewals of its toll collection technologies for the CBDTP system so as to ensure the safe and reliable collection of revenue in the future.

05 MTA Police

Facilities

Vehicles

Communications

Overview of agency and assets

The MTA Police Department (MTAPD) is responsible for ensuring the safety and security of MTA's Metro-North Railroad (Metro-North), Long Island Rail Road (LIRR), and Staten Island Railway (SIR) customers, employees, and facilities. Its service area extends across 14 counties in New York and Connecticut.

On January 1, 1998, the MTA consolidated the LIRR and Metro-North police forces under the jurisdiction of the MTAPD. Subsequently, the Staten Island Rapid Transit Police was added to MTAPD on June 1, 2005. Prior to the merger, capital needs at these operating agencies were addressed as part of the respective agency's capital programs. The MTA Police's 2025-2044 investment strategy will continue to support its mission of providing safety and security throughout the MTA network and build upon the work in the 2020-2024 Capital Program.

MTA Police Department appendix structure

The MTA Police Department Appendix provides an overview of the agency's assets, their current condition, and expected investment focus to maintain these assets over the next 20 years. The appendix is divided into three asset categories, and for each, we provide a description of the asset, an inventory count with percent of assets in poor or marginal condition, followed by the agency's investment needs and priorities. Assets with a rating of 1 (poor) or 2 (marginal) help us identify where we need to focus our investment needs.

1. **Poor (Deteriorated): Critically damaged or in need of immediate repair, well past useful life. Assets are operable with extraordinary maintenance, but have serious functional deficiencies. Capital investment in these assets is needed on a priority basis.**
2. **Marginal (Deficient): Deteriorated, in need of replacement, and may have exceeded useful life. Assets have functional deficiencies. If capital investment is/was deferred for these assets, added maintenance and operating expenses would be expected.**

FACILITIES 05

Facilities

MTAPD plays a vital role in ensuring customer safety and security across the MTA service area. Its responsibilities are diverse, spanning from Patrol and Detective divisions to specialized units such as Canine and Emergency Services. Teams like T.R.A.C.K.S. provide free community outreach programs to educate people about safety on and near railroad grade crossings and tracks, the Right-Of-Way Task Force actively seeks out security- and safety-related issues affecting the right-of-way of our railroads such as trespassing and illegal dumping. Counter Terrorism also contributes to keeping our comprehensive safety measures in place.

To support these functions, MTAPD operates from over 30 facilities spread across 12 New York counties. We have been consistently updating and improving these facilities to better serve our communities. During the 2015-2019 capital phase, we upgraded locations including Nassau District 2, Staten Island District 9, and the Harriman facility. In the ongoing 2020-2024 phase, we have focused on the Mt. Vernon District Office, 1825 Park Avenue Field Office, and the Grand Central Madison facility. Additionally, to support our canine unit, we have established a state-of-the-art canine training center in Dutchess County.

Inventory as of 2023

Asset	Total	Units	Percent in Poor/Marginal Condition
Building Structure	26	Each	4%
Elevator	2	Each	0%
Generator	8	Each	0%
HVAC	17	Each	0%
Office	1	Each	0%
Roof	17	Each	6%
Other	5	Each	0%

Note: Given the diverse range of facilities MTAPD operates from, component level condition ratings are included only for locations where they are relevant to MTA capital costs, excluding some shared facilities.

MTAPD operates from a range of facilities, including leased offices, temporary structures, and spaces shared within existing MTA structures like stations and substations.

MTAPD Canine Training Facility

Investment needs

MTAPD operates from a range of facilities, including leased offices, temporary structures, and spaces shared within existing MTA structures like stations and substations. However, some of these locations are currently inadequate to meet our growing operational needs. To address this, our primary goal is to optimize the use of our existing spaces and to identify additional locations to support MTAPD's expansion. We have begun an Architectural Space Optimization Plan to help guide how we prioritize facility projects and provide estimated timelines.

In the coming years, our investment strategy will also focus on maintaining and upgrading our existing facilities. Depending on specific needs, these efforts could range from component updates to comprehensive facility modernizations. We're also considering a new future headquarters, should the MTA decide to vacate MTAPD space within the Graybar building adjacent to Grand Central Terminal. Additionally, to enhance training capabilities, we're evaluating the feasibility of establishing an independent shooting range facility to help avoid New York Police Department scheduling constraints and associated fees and to comply with new Department of Criminal Justice Services rules impacting the accreditation process.

Facilities

Vehicles

Communications

VEHICLES

05

MTAPD officers at 42 St-Grand Central

Vehicles

We maintain a variety of vehicles to support MTAPD's work. The following category relates only to specialized vehicles, which are capitally eligible. Patrol cars and other standard vehicles are purchased under the operating budget. We utilize three types of specialized rubber-tire vehicles: six emergency service units (ESUs), a field communication unit, and a mobile command vehicle (MCV). These vehicles are crucial for emergency responses and regular ESU patrols. Officers in these units have special training, allowing them to handle significant incidents that go beyond the capabilities of regular patrol officers and other regional police units.

Inventory as of 2023

Asset	Total	Units	Year Built	Useful Life	Remaining Useful Life
Field Communications Unit	**1**	Each	1989	15 years	-19 years
Mobile Command Vehicle	**1**	Each	2006	15 years	-2 years
Emergency Service Units	**4**	Each	2016	8 years	1 year
	2	Each	2017	9 years	2 years

The long-term goal for this category is to maintain our specialized equipment and to replace remaining units at the end of their useful life while providing technological upgrades where appropriate.

MTAPD Canine Training Facility

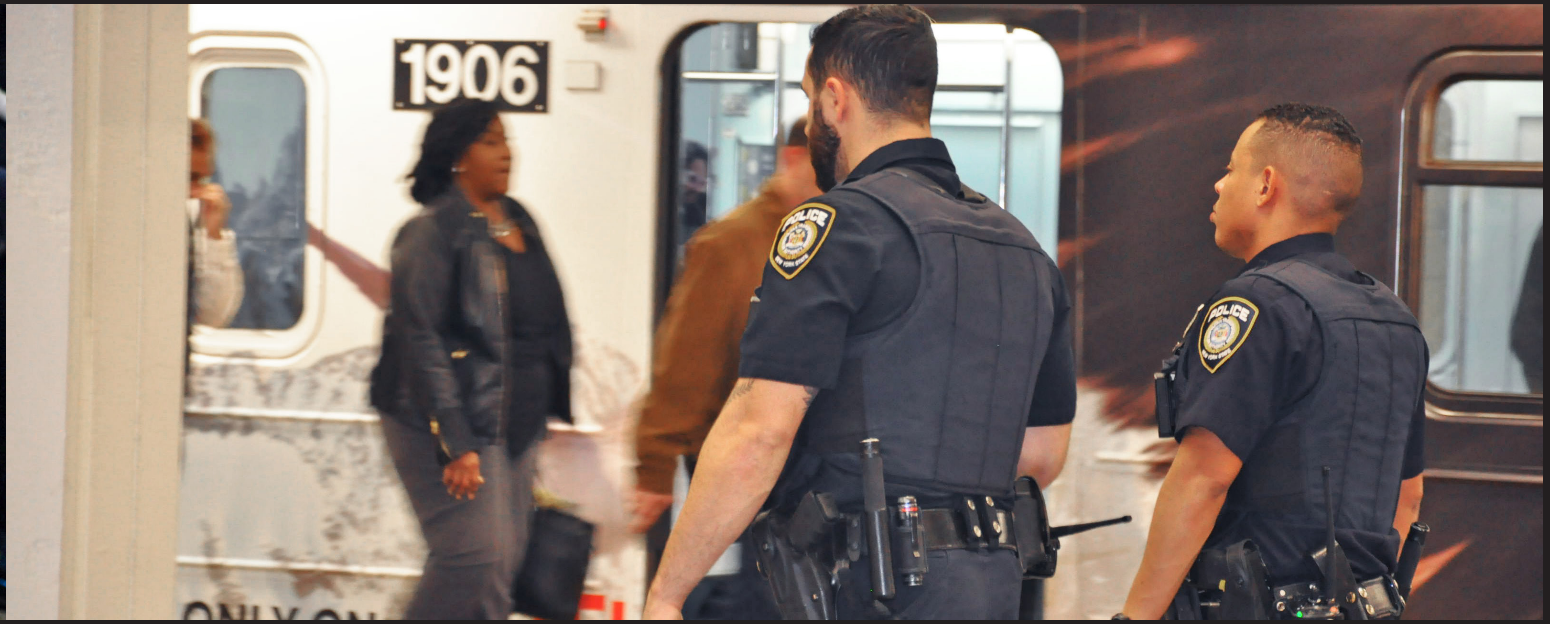
Investment needs

These vehicles are deployed throughout the MTA service region, which includes Metro-North, LIRR, and SIR. In the previous capital program, we retired two ESUs and one MCV. The current program has a project to replace two or three ESUs. The majority of the remaining vehicles will age beyond their useful life horizon before the upcoming capital program.

The long-term goal for this category is to maintain our specialized equipment and to replace remaining units at the end of their useful life while providing technological upgrades where appropriate. This overall investment strategy for police vehicles is consistent with past investment strategies; however, MTAPD will also explore the procurement of one additional MCV and the use of smaller sized field communication vehicles.

COMMUNICATIONS

05



Left page, 17 MTA police officers celebrating graduation day with NYPD officers at Madison Square Garden. Above, left, MTAPD Officers at Metro-North Railroad's Mount Vernon West Station. Right, MTAPD officers and their dogs at the MTAPD Canine Training Facility in Stormville .

Communications

The MTAPD Communications Division plays a crucial role in coordinating our response to both routine and emergency situations affecting transit operations. This division utilizes a range of equipment, including portable radios, base station setups, transmitter sites, and comprehensive Command and Control Communications infrastructure. This setup also includes backup locations and other essential equipment to support seamless communication.

During the 2010-2014 Capital Program, we significantly enhanced our communication capabilities with the introduction of the advanced Command and Control Center (C3). However, the current radio system has limitations, including coverage gaps that can hinder clear communication. To address this, MTAPD has been working on system upgrades, aiming to provide a dependable, interoperable communications system for officers across the region. Funding for this new system has been allocated in three previous capital programs, and we're now in the construction phase, which includes adding two more radio towers. We have also invested in new portable and mobile radios as part of the ongoing 2020-2024 Capital Program.

Inventory as of 2023

Asset	Total	Units	Percent in Poor/Marginal Condition
Emergency Operations Control Systems	108	Each	33%
Radio Equipment	2,500	Each	0%
Metropolitan Regional Radio System	235	Each	0%

Investment needs

The communications investment strategy includes the replacement of communication base station equipment, portable radio systems and equipment, Metropolitan Regional Radio System, enhancement of transmitter sites, and investments in central communications located in Long Island City and the Graybar building. We will make these investments as equipment reaches the end of its useful life as necessary to keep the communications system modernized and up to date with technological advancements.

06

Comparative Evaluation

Overview of Comparative Evaluation

As we look ahead 20 years, our most urgent priority is to secure the survival of our existing system by rebuilding its most imperiled infrastructure, renewing its outdated and broken parts, and implementing improvements that will deliver more inclusive, safe, and reliable service. Unless sufficient resources are made available to address the existing system's most urgent needs, there cannot be investment in expansion projects.

Alongside the foundations of rebuilding and improving our existing infrastructure, targeted investments in the expansion of the MTA network will further support the region's economic growth and prosperity. Our region is forecast to grow by over one million residents and nearly one million jobs in the next 20 years, and travel patterns have, and will continue to, evolve as new business districts and industries emerge. We must prepare our network for new challenges and opportunities in the decades ahead, and we must expand the system in a way that is most beneficial to our riders, and the region.

We must be ready to invest any additional resources into projects that address these challenges most effectively and that will have the greatest regional impact. That is why we have developed the MTA's first-ever Comparative Evaluation, which weighs the costs and benefits of potential expansion projects to help us make smarter, more strategic choices to secure New York's future.

Comparative Evaluation is a framework that can guide smart, strategic investment in expansion over the next 20 years. Many potential expansion projects throughout the MTA region have been proposed over the years. When considered in isolation, virtually every potential expansion project is appealing in some aspect. Our Comparative Evaluation applies a rigorous methodology to fairly assess these projects in comparison to one another and in the context of our limited resources. This helps to ensure that we are ready to direct our limited resources toward the most cost-effective and most transformative projects.

Comparative Evaluation appendix structure

Following industry best practices, all potential expansion projects are evaluated using a consistent set of models and tools, as well as a consistent set of criteria, including ridership, time savings, network resiliency and sustainability, capacity, equity, network leverage, geographic distribution, and cost. This ensures that the analyses of costs and benefits are fair and objective and helps determine which projects are the most promising based on these criteria.

This Appendix describes the overall approach and methodology of Comparative Evaluation, as well as how each proposed expansion project performs against the criteria.

METHODOLOGY

06

Best practices review

We have developed the MTA's first-ever Comparative Evaluation, a rigorous assessment of potential expansion projects that systematically evaluates costs and benefits. To design our methodology, we considered best practices from transit agencies across the country and the world, including:

- National agencies: New Jersey (NJ Transit), Washington DC (WMATA), Boston (MBTA and Boston Metropolitan Planning Organization), Chicago (CTA), and the San Francisco Bay Area (BART and Muni).
- International agencies: Toronto (Metrolinx), Barcelona (ATM and FGC), London (Transport for London) and Sydney (Sydney Trains).

Best practices as outlined by the Transit Cooperative Research Program and Smart Growth America were also considered.

This research provided examples of the methods used by different agencies to prioritize projects, how decisions are made in practice, and the overarching principles used to steer their decisions.

While each agency's approach to prioritizing investments was unique, the four-step process, as listed below, was commonly used by all of them:

1. Definition of agency goals, principles, and desired outcomes.
2. Selection of prioritization criteria, generally 10 or fewer.
3. Selection of metrics nested within the prioritization criteria, qualitative and quantitative, to assess the performance of projects towards the desired outcomes and goals.
4. Definition of scoring of both metrics and prioritization criteria, often by normalizing or using a point system.

Evaluation criteria and metrics

All projects are evaluated against a consistent set of criteria, including ridership, time savings, network resiliency and sustainability, capacity, equity, network leverage, geographic distribution, and cost.

Ridership

How many people will actually use the service is obviously a critical question in evaluating its benefit. We quantify ridership two different ways: Total Riders and New Riders. Total Riders represents any riders that use the project, boarding or alighting at its station or stops. This includes riders who already use MTA services and would switch to use this project instead of their current route. It also includes riders who would be new to the MTA system, switching their trip from one that's currently served by car, walking, or another, non-MTA transit service. The New Riders calculation looks only at that group.

Total Riders is a measure of the overall project usage, while New Riders is a measure of how many new riders would use the project. It can also serve as a proxy for potential new revenue for the MTA, as well as other potential benefits, such as environmental sustainability. Both total and new riders are calculated using the Regional Transit Forecasting Model (RTFM), projecting out to the year 2045 scenario.

Travel time savings

Travel time savings is often the principal benefit of a project, and in this case, is measured by the total door-to-door travel time saved by all the project riders. It accounts for the time to get to and from transit modes, as well as wait, transfer, and in-vehicle travel times. Door-to-door travel time can be reduced by extending an existing line, increasing frequency and/or speed, and creating better connections between services.

This metric is the sum of the total door-to-door travel time saved by the project riders diverted from of MTA's modes, derived from the RTFM, 2045 scenario plus the door-to-door travel time saved by new riders also from the RTFM. Projects that have significant travel time savings benefit a lot of people (high ridership), save a lot of time per trip, or a combination of both. Because it takes into account both the number of riders and the extent to which they benefit, it is a very powerful metric for considering the transportation benefit of a project.

Cost

Cost is an important piece of information needed for project evaluation. However, cost in isolation does not tell the whole story. It must be looked at in terms of how it relates to the project benefits as well. While some projects may be very costly, they may also benefit millions of riders in a significant way and are therefore deserving of consideration. On the other hand, a less costly project that fails to deliver significant benefits may not be a good investment despite its lower cost.

The Comparative Evaluation looks at both the Capital cost of constructing the project and purchasing the appropriate fleet as well as the Operating & Maintenance cost to run the service once it is completed. These are high-level estimates based on the conceptual level of project development—not the type of rigorous cost estimation done based on a precise scope once a project has been further developed. As a project advances, the cost estimates will be revised based on the additional details available. As such, the costs outlined in this document should not be taken as definitive, but rather preliminary estimates for comparison purposes only.

While these are not final, detailed cost estimates, what they do allow is the comparison of project costs to one another on a level playing field, based on similar assumptions and considerations.

Capital

Capital costs, which include construction and fleet costs, were calculated by aggregating the unit costs for projects with previous cost estimating efforts, which were then normalized to ensure a consistent set of unit costs were applied uniformly across each project. For projects in which no level of analysis or cost estimating had previously been performed, the appropriate MTA project teams were consulted to determine project scope and unit quantities that comprise each project. Once these projects were defined, consistent unit costs were then applied to determine the cost of the project. All project costs were then inflated to the common analysis year of 2027 by applying a future escalation rate of 3.5% per year. Final capital costs for all projects have been prepared in the Federal Transit Administration (FTA) Standard Cost Category format for uniformity, and to facilitate comparison across projects.

Operations and maintenance costs

Annual operating and maintenance (O&M) costs were estimated utilizing each project's conceptual infrastructure and service plans as well as mode specific unit costs prepared by MTA based on past project experience. O&M cost estimation approaches varied by mode consistent with the availability of unit cost data. For subway projects, infrastructure O&M costs including station, track, signals, revenue collection, car equipment, substations, and other costs were estimated utilizing per station, per car, and per track mile unit costs. Service Delivery costs including the cost of crews and power were estimated based on car-mile and pay-hour unit costs. For commuter rail projects, fleet operating costs (propulsion, materials), staffing costs (transportation, maintenance of equipment, customer service, security, system safety, etc.) and facilities were estimated using per car-mile and per station unit costs. Light rail transit O&M costs reflect a cost per guideway mile, cost per vehicle required in maximum service, cost per revenue mile, and cost per revenue hour. Bus and Bus Rapid Transit O&M costs were updated from consultant studies and reflect several approaches. All O&M costs were escalated to the common analysis year of 2027 consistent with the capital cost estimates.

Cost Effectiveness

Cost effectiveness is how we consider the relationship between the cost and the benefit of a project. It is measured as ratio between the forecasted costs and travel time savings benefits over a 30-year period.

The costs include the total Capital Costs (construction and fleet costs) for the year 2027, and the annual O&M costs over 30 years. To allow for the aggregation of one-time Capital costs and ongoing O&M costs, annual O&M costs were added up over 30 years, assuming inflation of 3.5% annually, and then discounted to the net present value using a 4.5% discount rate.

Total time savings was chosen as the proxy for the project benefit, as it takes into account both how many riders will use the service, and how much they will benefit compared to the status quo. The total door-to-door time saved by project riders over the same 30-year period isn't just the annual estimate multiplied by 30. However, since newly-opened projects typically take some time to fully realize their ridership, these figures assume that the benefit ramps up in the first three years (from 30% to 50% to 70% of the 2045 figure from the RTFM model) and then gradually approaches the 2045 figure from there. After 2045, this calculation assumes a cumulative 4% percent growth from 2046 to 2057, the end of the 30 year period. This growth rate is based on the NYMTC 2055 Socioeconomic and Demographic projections.

The calculation of this ratio is relatively complex in order to capture the promise of a project over a long time period. The end result, however, is intuitive. Projects with lower ratios (costs per time saved) are indicative of good investments, as they provide significant benefits relative to the costs to operate and construct. Higher ratios indicate that a project provides relatively low benefits compared to the costs to operate and construct.

Projects that do not save travel time overall, such as some infill stations that can delay some existing riders, tend to have the highest ratios, and are the least cost-effective projects. On the other end, projects that save operating costs in relation to a scenario without the project, tend to be the most cost-effective projects.

Cost effectiveness is not the only measure of a project, of course. Other factors, including the other metrics evaluated below, are also critical to consider, especially factors like equity that underpin all the investments we make in the transit system. Cost effectiveness can also change over time, as the region changes and either the cost or benefits shift, whether through intentional action by public policymakers or as a result of broader societal shifts. But knowing whether a project delivers a high ratio of benefits to cost is a critical factor, one that shapes how the MTA considers potential investments.

Equity

Projects that facilitate social and economic opportunities by providing affordable and reliable transportation options based on the needs of the populations being served, particularly populations that are traditionally underserved and vulnerable, are considered to be more equitable. Equity is measured with two metrics: the absolute number or the percentage of project riders that travel to or from an Equity Area. Equity Areas are places where high concentration of low-income, minority, and transit-dependent populations live. Projects with a high percentage, or total number of riders, from these areas will most likely provide the greatest benefits in terms of better access to opportunities for those living or traveling there.

See the description below for more detail on Equity Areas and a map showing their location throughout the New York region.

Sustainability

Sustainability is measured by the reduction of miles traveled by car modes and reflects a project's ability to reduce harmful emissions and pollutants.

The reduction of miles traveled by car is calculated by multiplying the New Riders diverted from car by the distance that they traveled in the scenario without the project. This provides a measure of the reduction of vehicle trips and the distance they would have traveled, which is directly proportional to the potential reduction of Greenhouse Gas (GHG) emissions. The higher the reduction of miles traveled by car, the higher the reduction of GHG emissions.

Resiliency

Resiliency looks at the impact on the project on the resilience of our transit network providing alternate paths of travel in case of a disruption on any one given line. This metric is based on the number of connections to other nearby rail and subway services near the project.

Specifically, this is calculated by aggregating the number of rail or subway stops within ½ from the proposed project's stops in New York City, or within 5 miles in suburban areas. This captures the project's ability to provide or increase connections to other transit options, thereby providing riders with more alternatives, addressing connectivity needs, and increasing access to the region's integrated transit network.

Capacity

Capacity speaks to the ability of our system to meet demand without overcrowding our riders. For purposes of this evaluation, capacity was measured by evaluating how much a potential project would reduce crowding systemwide. This is done by looking at the reduction of passenger-hours in crowded segments systemwide. Crowded segments are those where Volume to Capacity (V/C) ratio is higher than 0.95 during the AM peak period of a weekday. It is calculated by taking the difference between the passenger-hours in crowded conditions in the 2045 Baseline scenario with the project and the 2045 Baseline scenario without the project, derived from the RTFM.

Some projects might decrease crowding in their vicinity but increase crowding in other segments of the transit system. On the other hand, some projects may not increase capacity directly, but they may still help to alleviate capacity issues elsewhere in the system. Projects that run parallel to existing crowded segments, increase service frequency, or distribute riders across the system, tend to alleviate capacity issues. Other projects, such infill stations, might create additional crowding.

Geographic distribution

Geographic distribution is a measure of how well a project connects different areas of the region. It is evaluated using the Regional Accessibility metric, which indicates how a project could change travel time in the MTA service area. It is calculated by aggregating the travel time from any transportation area in the region to all other transportation areas (door-to-door travel time) and compares the times obtained in the 2045 Baseline scenario with and without a project. The point-to-point travel times in the region are obtained using the RTFM.

Projects that connect with more services, or improve the commuter rail system, will tend to save more time to travel across the region than projects located in areas that are already well-served by transit. Improvements in the regional accessibility also translate into better access to remote places and opportunities for development.

Network leverage

The MTA transit system is a vast network with opportunities to enhance and expand service while maximizing use of existing infrastructure and right-of-way. Network Leverage measures how the MTA is using what it already owns. It is calculated as a weighted average of the percentage of a potential project's alignment on MTA-owned right-of-way (ROW), other publicly owned ROW (i.e. City or State), and privately owned ROW. The percentage of alignment owned by the MTA has the highest weight, followed by the percentage of ROW owned by other public agencies. The percentage of privately-owned ROW has the lowest weight. Projects that are entirely within the MTA-owned ROW leverage the network to the greatest extent.

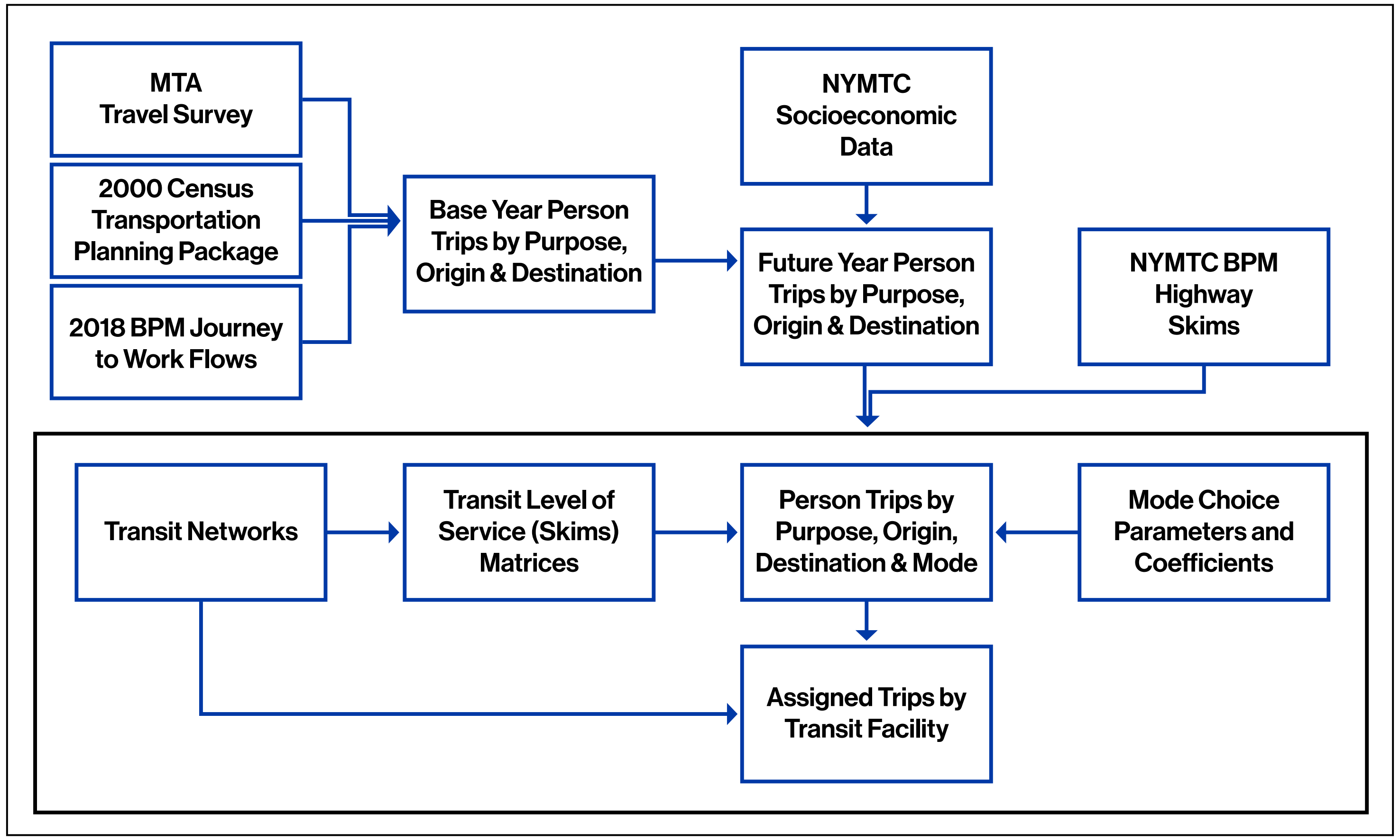
This metric shows how the MTA is getting the most out of what it already owns and can also be a proxy for project control during construction and operation.

To calculate these metrics, we relied on a trusted forecasting model. The MTA's Regional Transit Forecasting Model (RTFM) estimates changes in ridership and travel time on various modes resulting from changes in population and employment, as well as changes in the transportation network and service.

Models

Regional Transit Forecasting Model

The MTA's Regional Transit Forecasting Model (RTFM), which is built on Caliper's TransCAD platform, is a variant of the 4-step ridership forecasting methodology of trip generation, distribution, mode choice and assignment. It is used to forecast changes in ridership on the various modes, resulting from changes in population, employment, and other socioeconomic factors, as well as changes in the transportation network. The figure below details the structure of the model.



Above, structure of the RTFM. BPM: New York Metropolitan Transportation Council (NYMTC) Best Practice Model (Forecasting Model)

The model estimates travel by mode and route during the AM peak period of a weekday within 3,586 Travel Analysis Zones (TAZs) in a 28-county area covering New York City and its suburbs, northern New Jersey and southeastern Connecticut.

The RTFM was calibrated for the year 2019 using data from a variety of sources to replicate how people moved through the region and how transit customers used the transit system for that year. After calibration, a future Baseline scenario (2045) was built reflecting the transit service changes and socioeconomic and demographic growth projected in the region for this horizon year. The estimated changes in transit ridership resulting from these changes are then assigned to individual transit routes and stops based on detailed region-wide transit schedules and the most convenient routing to travel from each trip's origin to destination, considering travel time and out-of-pocket costs.

The 2019 calibration year was chosen as the last full year before the onset of the COVID-19 pandemic, which obviously has had a significant impact in travel patterns over the course of the subsequent years. The regional Metropolitan Planning Organization (NYMTC) adjusted their socioeconomic and demographic projections, which are inputs to the model, to account for the impact of the pandemic on population and employment growth in the region, and this is reflected in the model outputs.

The transportation network in the RTFM 2019 Baseline scenario reflects the 2019 service plans during the AM peak period of a weekday. The transportation network coded in the RTFM 2045 Baseline scenario also includes the major transportation projects planned in the region that are assumed to be in place by this horizon year for the same period of a weekday.

Cost Estimating Tool

In addition to the forecasting model to help define the benefits, Comparative Evaluation also relies on a Cost Estimating Tool to help understand potential costs on a level playing field between projects.

The Cost Estimating Tool was developed to prepare order-of-magnitude capital cost estimates for individual system enhancement and expansion projects (including several with multiple modal/infrastructure options). It utilizes planning-level project data and conceptual infrastructure plans (where available) provided by the MTA and it is consistent with the Federal Transit Administration (FTA) Standard Cost Categories (SCC) for Capital Projects and FTA's SCC Cost Estimation Workbook for MTA's use in preparing capital cost estimates.

The cost estimating process followed these steps: define project scope and limits for each project and alternative, develop and evaluate unit cost data for each project and alternative, assess each project's specific risk factors, apply consistent soft costs, contingency, escalation, and finalize capital cost estimates.

The cost tool is grouped in three elements:

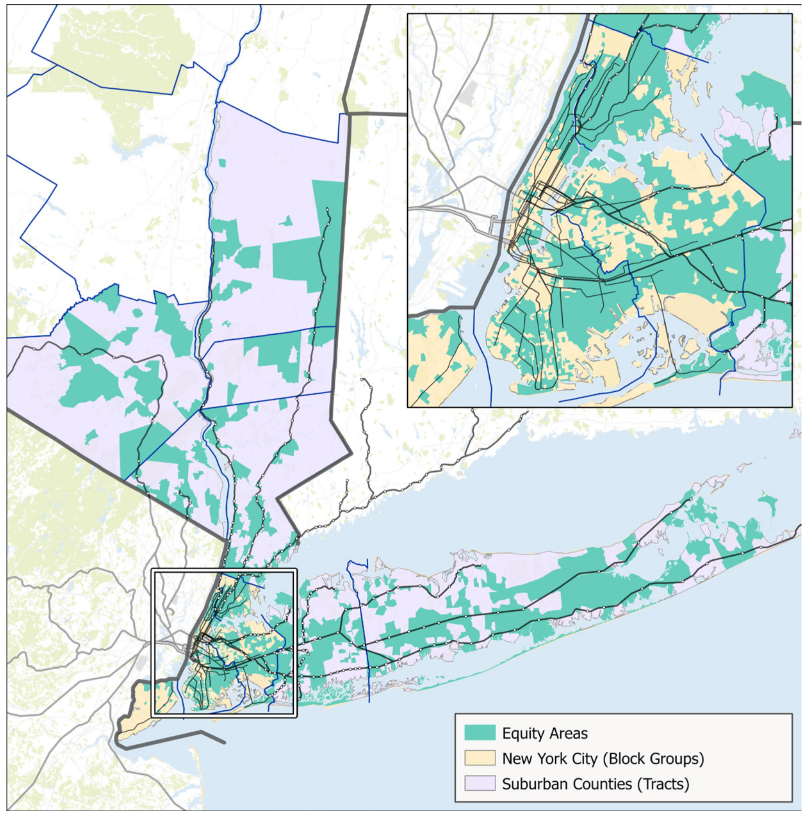
1. Project Information: Infrastructure, and right-of-way, and vehicles
2. Soft Costs: Professional Services, contingencies, consistent by operator
3. Escalation: Historic inflation data through 2022, and growth to mid-year 2027

Equity Areas

Understanding that there are historically disadvantaged populations helps ensure that resources are invested, either through allocation or reallocation, and protected within these communities to reduce obstacles to transit access.

Equity Areas, or places where vulnerable and historically disadvantaged populations live, are defined as the union of Title VI areas (already defined by each MTA operator), and Areas of Concentrated Need in the MTA service area. Title VI Areas are those with a high concentration of low-income or minority populations in each of the MTA's operator service area, and Areas of Concentrated Need consider a variety of socioeconomic indicators such as poverty level, education, language proficiency, vehicle ownership, and commute time, in addition to poverty level and race.

Overall, 61% of the MTA's service region's residents live in these areas: 67% of residents who live in New York City and 48% of residents in New York State-MTA counties outside New York City (Nassau, Suffolk, Westchester, Putnam, Dutchess, Orange, and Rockland counties).



Above, Equity Areas

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[2] 2055 SED Forecasts (nymtc.org)

Methodology

→ **Results**

RESULTS 06

Above, LIRR Third Track Construction Photo

Analysis results

Based on the rigorous modeling described above, each project was evaluated on a level playing field. The results of that evaluation are summarized in the chart below and details of each project are explored in more detail on individual projects pages that follow.

The first metric shown on the summary table and a key metric in understanding a project is cost effectiveness. This figure looks at both the Capital and Operating & Maintenance costs of a project and puts them in the context of their benefits, using Travel Time Savings to account for both the number of riders and the extent to which they benefit from the project compared to the status quo. By putting cost and benefit in relation to one another, it gives us a good sense of how a project fares as an investment of limited public dollars.

While cost effectiveness is important, other measures are also critical to evaluate the potential impact of a project. Equity benefits are greatest when projects serve a greater share of riders from designated Equity Areas. Projects located in areas that are not as well served by transit have the biggest Regional Accessibility improvements, while Sustainability is enhanced by projects that have the biggest reductions in Vehicle Miles Traveled. Resilience is improved by projects that provide connections to other transit options. Systemwide Capacity is most improved by projects that reduce crowding by increasing service frequency and distributing ridership across the system. Network Leverage is greatest for those projects that fall entirely within the MTA's right-of-way. All of these metrics are important, helping to gauge how projects perform relative to each other, as well as the benefits they provide to the region and to riders.

Inclusion in this analysis does not mean that the MTA will be pursuing a project. Decisions about which of these projects, if any, will be included in subsequent MTA Capital Programs, will be made in the context of those future programs, including the amount of funding available to Rebuild and Improve the existing MTA system, which will need to be prioritized before any expansion projects can be considered. Similarly, the cost estimates included in this report are based on known factors today and without extensive site conditions or engineering analysis. While these estimates are based on a consistent set of assumptions for comparison purposes, projects selected for advancement will require additional engineering and planning that will certainly lead to changes in the cost estimate. This analysis is intended to help inform those conversations and decisions, not replace them.

For the purposes of this summary table and to make comparison easier throughout the document, all metrics have been converted to a scale of 0 to 100, where 0 indicates the least favorable value, and 100 indicates the highest favorable value.

The project profiles on the following pages will include both these comparative values as well as the underlying data on which they are based.

Comparative Evaluation summary table

Score	Icon
<20	○
20-39	◔
40-59	◑
60-79	◕
>=80	●

	Cost Effectiveness	Ridership	Equity		Geographic Distribution	Sustain-ability	Resiliency	Capacity	Network Leverage		
Projects	**Cost/Time Saved** (30 yrs) ($/min)	**Total Riders**	**Total Riders from Equity Areas**	**% Riders from Equity Areas**	**Regional Accessibility**	**Change in Vehicular Miles Traveled**	**Subway/Rail Services < 0.5 miles** (NYC) **< 5 miles** (suburbs)	**System Crowding - Passenger Hours in Crowded Conditions**	**% of Project ROW on MTA, Public or Private Land**	**Total Riders** (Daily 2045)	**Construction Cost** ($M 2027)
Danbury-Southeast Connection	$6.35	○	○	○	◕	◕	○	◔	◑	2,600	$820
Elmhurst Station (LIRR)	*No Time Saved**	○	○	●	○	○	○	○	●	3,100	$210
Harlem Line Capacity Improvements	$2.46	◕	◔	◑	◔	○	◕	○	●	83,700	$1000
Hudson Line to Penn Station	$4.54	○	○	◕	◔	◕	●	◕	●	18,900	$750
Inner New Haven Line Yard	$5.07	○	○	◔	○	○	○	○	●	6,000	$390
Interborough Express LRT (IBX)	$1.29	●	●	●	●	●	●	◑	●	118,700	$5,540
Lower Montauk Branch Reactivation	$62.41	○	○	◕	○	◑	◑	○	●	9,200	$4,230
New Lots Ave No 3 Line to Flatlands	$8.64	○	○	●	○	○	○	○	◕	8,600	$1,780
Port Jefferson Branch Capacity Improvements	$6.18	◔	○	◔	●	◑	○	◑	●	27,900	$3,120
Port Jervis Line Capacity Improvements (MP Yard)	$40.46	○	○	◕	○	○	○	○	○	11,000	$360
Ridgewood Busway	$0.0**	○	○	●	○	○	○	○	◔	8,900	$30
Rockaway Beach Branch (NYCT)	$6.72	◔	◔	●	○	◔	◔	○	◑	39,200	$5,940
Second Ave Subway South to Houston	$4.47	●	●	◑	○	○	●	◕	◔	230,400	$13,500
Second Ave Subway West to 125th/Bdwy	$1.43	●	●	●	○	◔	◕	●	◔	239,700	$7,550
Speonk-Montauk Capacity Improvements	$13.66	○	○	○	○	○	○	○	●	1,500	$260
Staten Island North Shore BRT	$1.46	◔	○	◕	◑	○	○	○	◔	32,000	$1,300
Staten Island West Shore BRT via Korean War Vet Pkwy	$1.95	○	○	○	●	◔	○	○	◔	16,900	$1,870
Stewart Airport Commuter Rail	$10.65	○	○	◕	○	●	○	○	○	4,300	$1,400
Sunnyside Station (LIRR)	*No Time Saved**	○	○	◑	●	◔	◔	○	○	7,900	$490
Tenth Ave Station on No 7 Line	$81.29	◑	○	◔	○	○	○	◔	●	55,000	$1,900
Utica - Nostrand Junction Capacity Improvements	$0.28	●	●	●	●	◕	○	●	●	319,900	$410
Utica Alt A - BRT	$0.32	◕	◑	●	◔	◔	◔	○	◑	71,900	$220
Utica Alt B - Subway to Kings Plaza	$4.80	◑	◔	●	◑	◑	○	●	◑	55,600	$15,860
Utica Alt C - Subway to Church Ave + BRT	$1.59	◕	◑	●	◑	◑	◔	●	◑	81,200	$6,780
W Line to Red Hook	$90.46	○	○	○	○	○	○	●	◑	7,600	$11,210

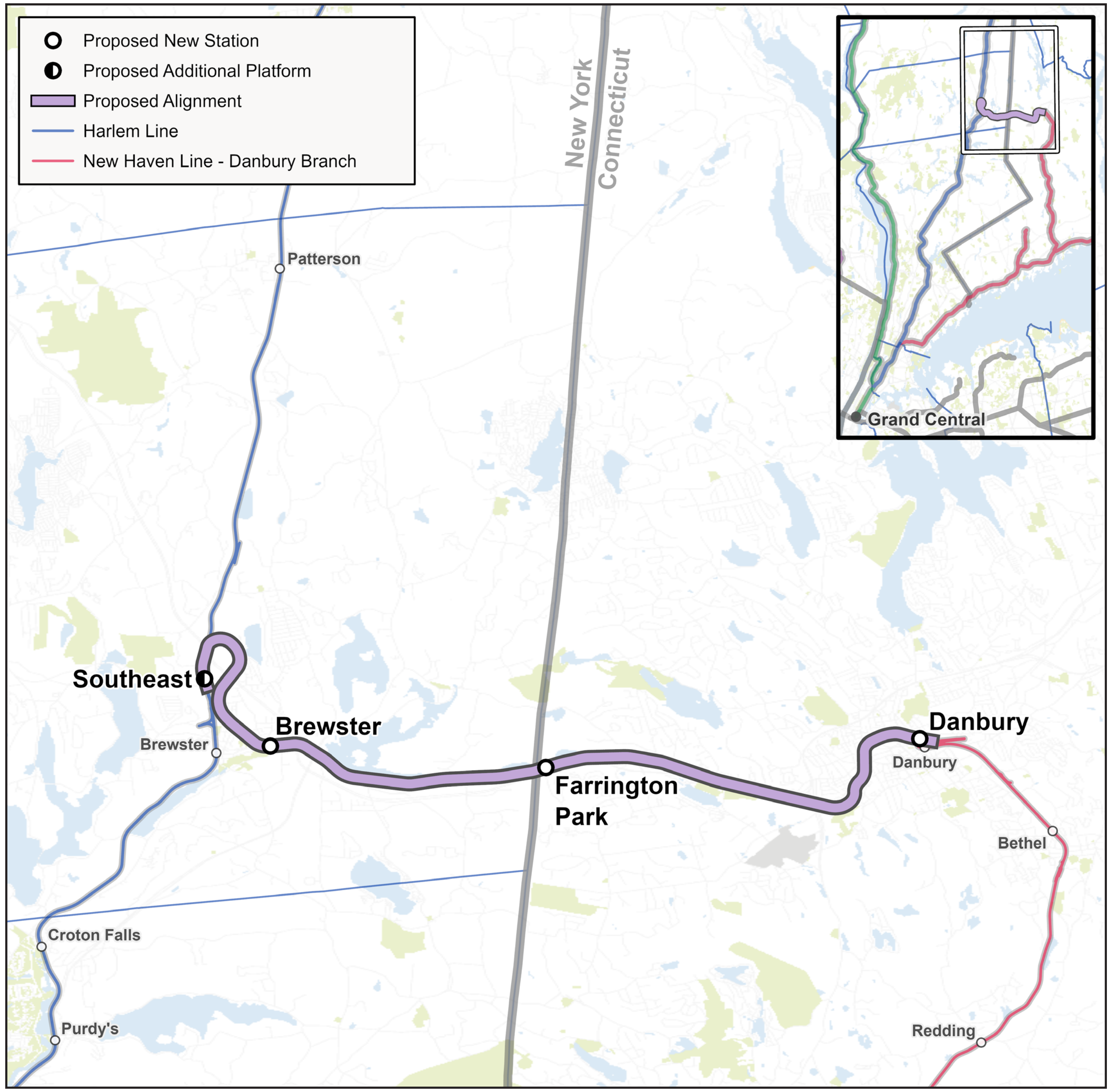
Notes: *Elmhurst and Sunnyside have no overall time savings due to increased travel time for existing customers.

**Ridgewood Busway operational savings over project lifetime exceed capital costs

Danbury-Southeast Connection

Description: Reactivation of a 11-mile portion of the Beacon Line between Southeast New York and Danbury, CT, for passenger service.

Project objectives: Provide a rail connection from Danbury, CT, to the Metro-North Railroad Harlem Line for improved travel time and eased parking demands at Harlem Line stations and I-84/I-684 congestion.



Above, Danbury-Southeast Connection

Evaluation results

Construction Cost (2027): $820 million

Fleet Cost (2027): $52 million

Annual O&M Cost (2027): $29 million

Daily Ridership (2045): 2,600

New Daily Riders (2045): 900

Riders from Equity Areas (2045): 590

Travel Time Saved Per Trip (minutes): 12.2

Special Considerations:
Connecting to Harlem Line at Southeast Station requires construction through wetland areas.

Construction of a new, second station at Danbury is required because of the existing track geometry.

Housatonic Railroad owns corridor in Connecticut.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$6.35/min	59
Equity	Percent of riders from Equity Areas	23%	0
Sustainability	Change in daily vehicle miles traveled	-51,655	71
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	3	19
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-1,423 hours	34
Geographic Distribution	Change in regional accessibility	-16,653 hours	64
Network Leverage	Weighted average of MTA, Public and Private ROW	55%	40

Findings

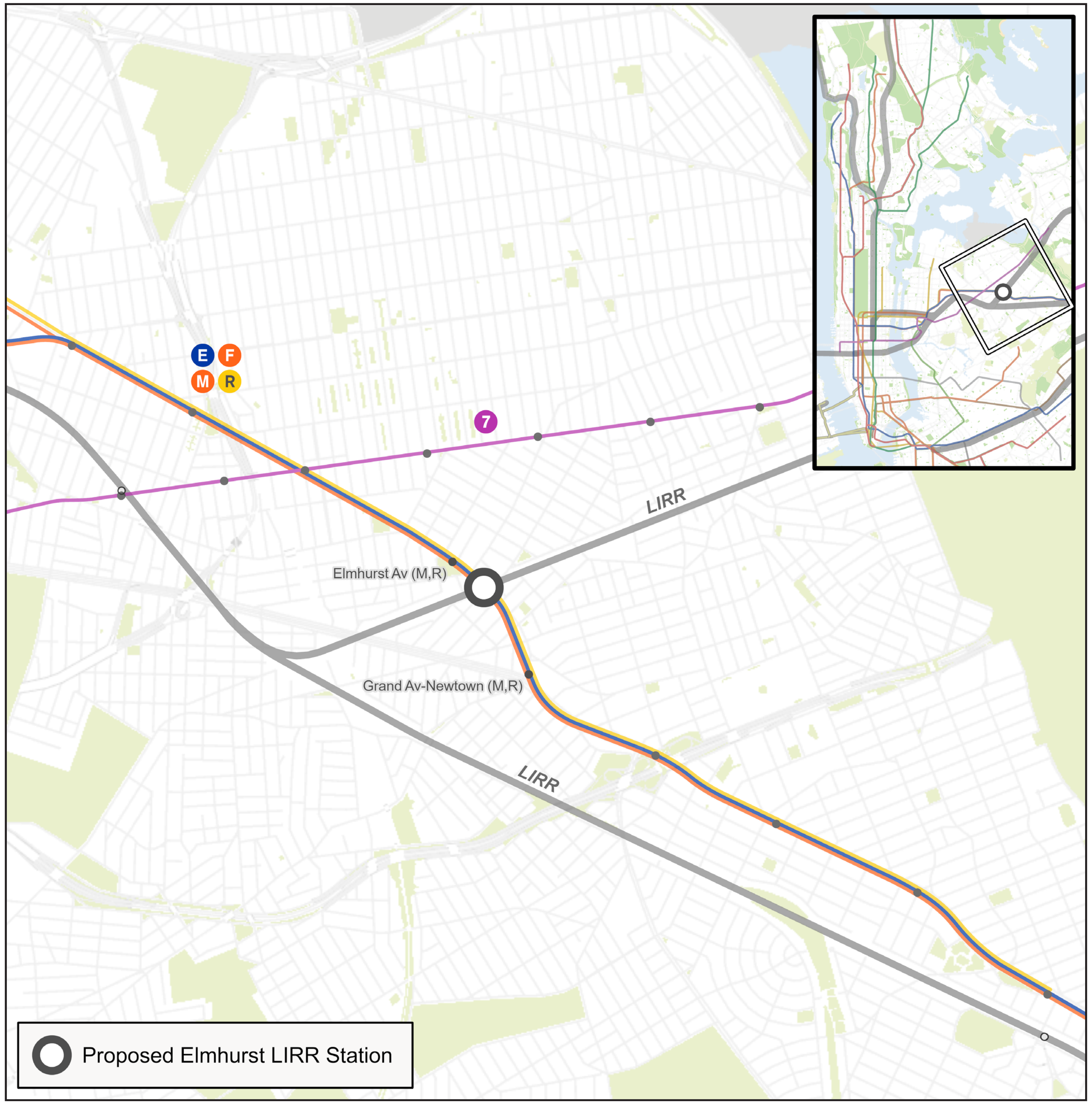
While this project would have a significant time savings for those who ride it, it would serve a very small number of riders in relation to the capital and operating costs.

Reactivating the Beacon Line between Danbury, Connecticut and Southeast, New York would result in significant travel time savings, but for a small number of riders and at a high cost ($800+M), relative to the benefits. Although it would expand regional access by connecting two Metro-North lines and generate sustainability benefits as a result of reduced vehicle travel, it does not benefit equity areas or reduce crowding capacity significantly on the system. Further, the right-of-way is only partially owned by MTA, with the portion in Connecticut owned by Housatonic Railroad, which results in a midrange score for network leverage.

Elmhurst Station (LIRR)

Description: Restoration of Long Island Rail Road service at the former Elmhurst Station on the Port Washington Branch in Queens.

Project objectives: Provide additional access to employment and commercial centers near station.



Above, Elmhurst Station

Evaluation results

Construction Cost (2027): $210 million

Fleet Cost (2027): N/A

Annual O&M Cost (2027): $1 million

Daily Ridership (2045): 3,200

New Daily Riders (2045): 1,200

Riders from Equity Areas (2045): 3,040

Travel Time Saved Per Trip (minutes): 0.6

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	No Time Saved*	0
Equity	Percent of riders from Equity Areas	97%	97
Sustainability	Change in daily vehicle miles traveled	-5,982	8
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	3	19
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	+1,212 hours	0
Geographic Distribution	Change in regional accessibility	+3,944 hours	0
Network Leverage	Weighted average of MTA, Public and Private ROW	99%	99

** No overall time savings due to increased travel time for existing users.*

Findings

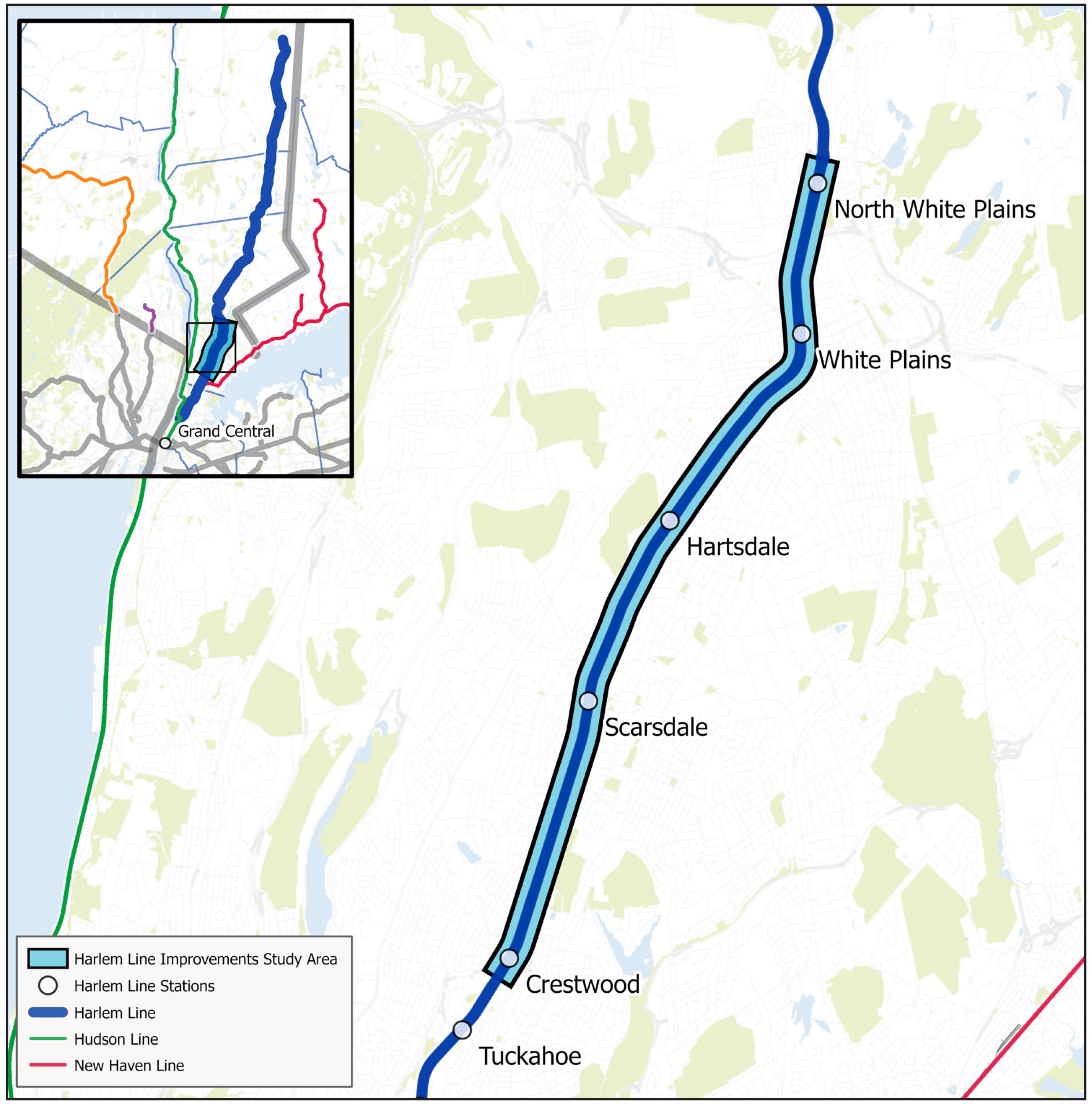
This project provides marginal benefits in an area already well served by transit. It would save travel time for new riders but create additional travel time for existing LIRR customers, resulting in no net time savings.

Despite its low-cost relative to other projects, reopening the Elmhurst station on LIRR scores poorly because of low ridership and no net travel time savings due to added travel time for existing customers going through the station. This project would not increase capacity, nor would it improve regional access, since the area is already well served by transit. The station does well in serving a high percentage of riders from equity areas and in leveraging an MTA asset since the new station would be built in the same location as the old station.

Harlem Line Capacity Improvements

Description: Construction of a third mainline track on the Metro-North Railroad Harlem Line between Crestwood and North White Plains, along with capital investments in power, signals, and communications, and capacity improvements and associated investments at Brewster Yard.

Project objectives: Provide more service during peak periods to accommodate future growth and reduces crowding, improves operational flexibility and service reliability, enhances opportunity for improved reverse peak service, allows for track maintenance without reducing capacity or limiting reverse peak service, and adds additional train service at Scarsdale, Hartsdale, and White Plains.



Above, Harlem Line Capacity Improvements

Evaluation results

Construction Cost (2027): $1 billion

Fleet Cost (2027): $330 million

Annual O&M Cost (2027): $65 million

Daily Ridership (2045): 83,700

New Daily Riders (2045): 500

Riders from Equity Areas (2045): 47,530

Travel Time Saved Per Trip (minutes): 1.8

Special Considerations:
Requires prior investments of:

- A new North Yard at Brewster/Southeast within the original parking facility location, and reconfiguration and upgrade of the existing South Yard.
- New substations, station improvements and communication/signal upgrades.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$2.46 /min	89
Equity	Percent of riders from Equity Areas	57%	45
Sustainability	Change in daily vehicle miles traveled	-13,500	18
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	12	75
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-453 hours	10
Geographic Distribution	Change in regional accessibility	-6,520 hours	25
Network Leverage	Weighted average of MTA, Public and Private ROW	100%	100

Findings

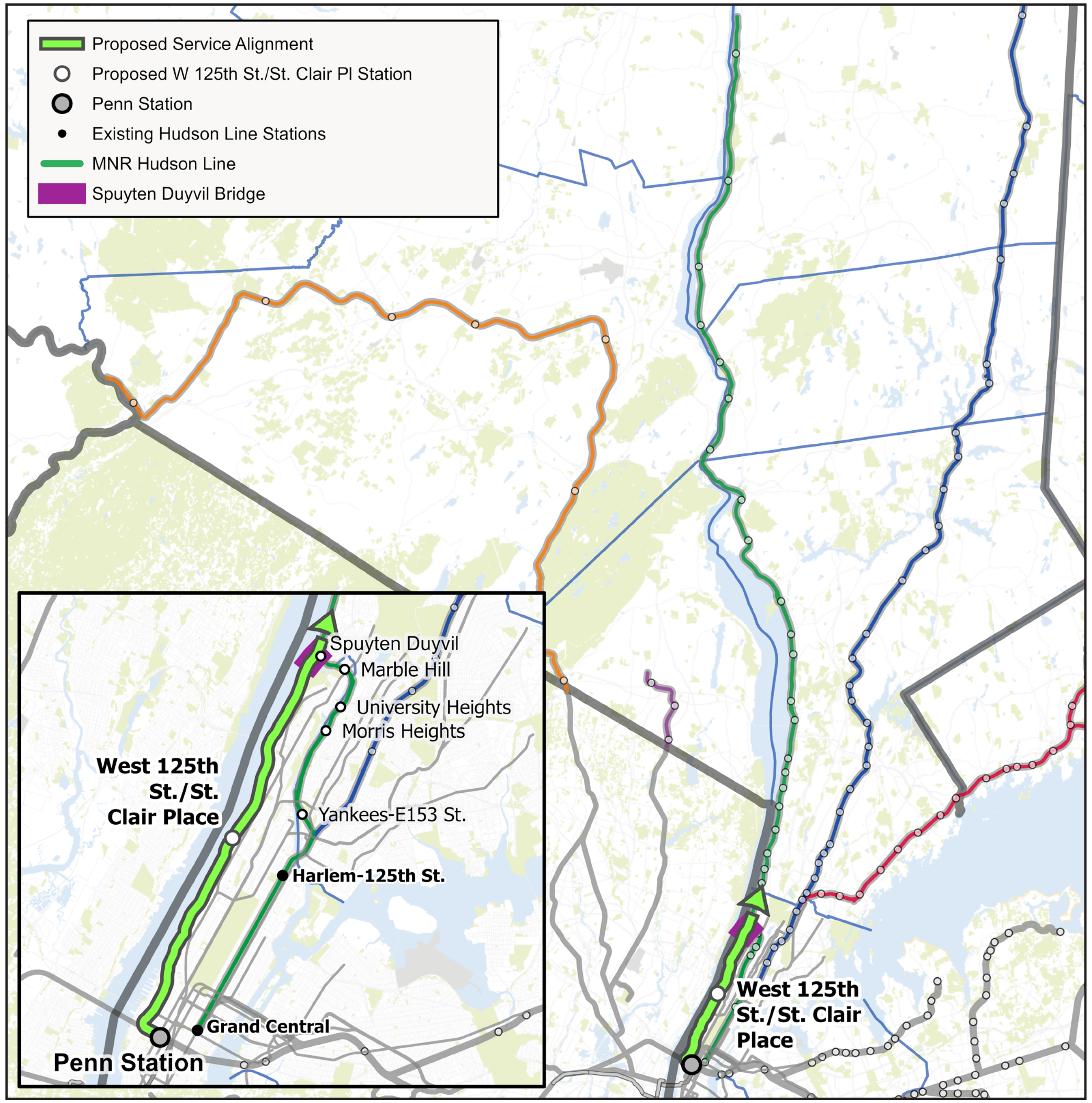
This project would enable additional passenger service and increase operational efficiency and flexibility. It is cost effective due to reduced travel times for many riders.

Providing a third mainline track between Crestwood and North White Plans is cost-effective because it would reduce travel time for a large number of riders for a relative low cost, in relation to other projects. It also scores well in resiliency, with many other rail connections nearby, and in network leverage, as it is on Metro-North's existing right-of-way. It reduces vehicle usage, but that reduction is low in relation to other projects, so it does not score well in sustainability. The additional passenger service as a result of this project reduces crowding slightly and improves regional access, but the improvements are small in relation to other projects and it does not score well in capacity or geographic distribution.

Hudson Line to Penn Station

Description: Provision of Metro-North Railroad Hudson Line commuter rail service between Poughkeepsie and Penn Station via Amtrak's Empire Connection, with one potential new station in Harlem (125th Street and Broadway) and additional fleet storage in Poughkeepsie.

Project objectives: Provide additional transit options and one-seat rides for commuters traveling to/from Manhattan's West Side.



Above, Hudson Line to Penn Station

Evaluation results

Construction Cost (2027): $750 million

Fleet Cost (2027): $766 million

Annual O&M Cost (2027): $141 million

Daily Ridership (2045): 18,900

New Daily Riders (2045): 1,900

Riders from Equity Areas (2045): 14,770

Travel Time Saved Per Trip (minutes): 7.3

Special Considerations:
Will require negotiations with Amtrak regarding Metro-North operations on the Amtrak Empire Line, and the reassignment of trains on Penn Station platforms to accommodate Hudson Line trains.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$4.54/min	73
Equity	Percent of riders from Equity Areas	78%	73
Sustainability	Change in daily vehicle miles traveled	-45,911	63
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	18	100
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-2,526 hours	61
Geographic Distribution	Change in regional accessibility	-9,891 hours	38
Network Leverage	Weighted average of MTA, Public and Private ROW	93%	90

Findings

This project would provide time savings for a modest number of riders and at a high cost. It would increase resiliency by providing an alternative direct service to Penn Station for Hudson Line customers.

Providing service to Penn Station on the Hudson line scores above average in cost effectiveness because of the significant travel time savings it provides, albeit at a high cost and to a relatively low number of riders. It also does well in equity since many of the riders are from equity areas. It does well in sustainability and resiliency by reducing vehicle usage and providing many alternative rail connections. It also scores well in network leverage since it uses Metro-North's existing rail right-of-way for most of the alignment. Even though it does improve capacity and geographic distribution, it does not score as well relative to other projects.

Inner New Haven Line Yard
(Port Chester)

Description: Construction of a new fleet storage yard located between the Rye and Port Chester Stations on the Metro-North Railroad New Haven Line in New York.

Project objectives: Support the storage needs for additional fleet needed to meet ridership demand and increased service levels on the Inner New Haven Line. Improve operational efficiency, flexibility, and service reliability, and provide opportunity for enhanced reverse peak service.

Above, Inner New Haven Line Yard (Port Chester)

Evaluation results

Construction Cost (2027): $390 million

Fleet Cost (2027): N/A

Annual O&M Cost (2027): $5 million

Daily Ridership (2045): 6,000

New Daily Riders (2045): 30

Riders from Equity Areas (2045): 2,860

Travel Time Saved Per Trip (minutes): 2.1

Special Considerations:
Requires coordination with CTDOT and local utility providers for yard power needs.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$5.07/min	69
Equity	Percent of riders from Equity Areas	48%	33
Sustainability	Change in daily vehicle miles traveled	-315	0
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	0	0
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-212 hours	4
Geographic Distribution	Change in regional accessibility	+61 hours	0
Network Leverage	Weighted average of MTA, Public and Private ROW	85%	80

Findings

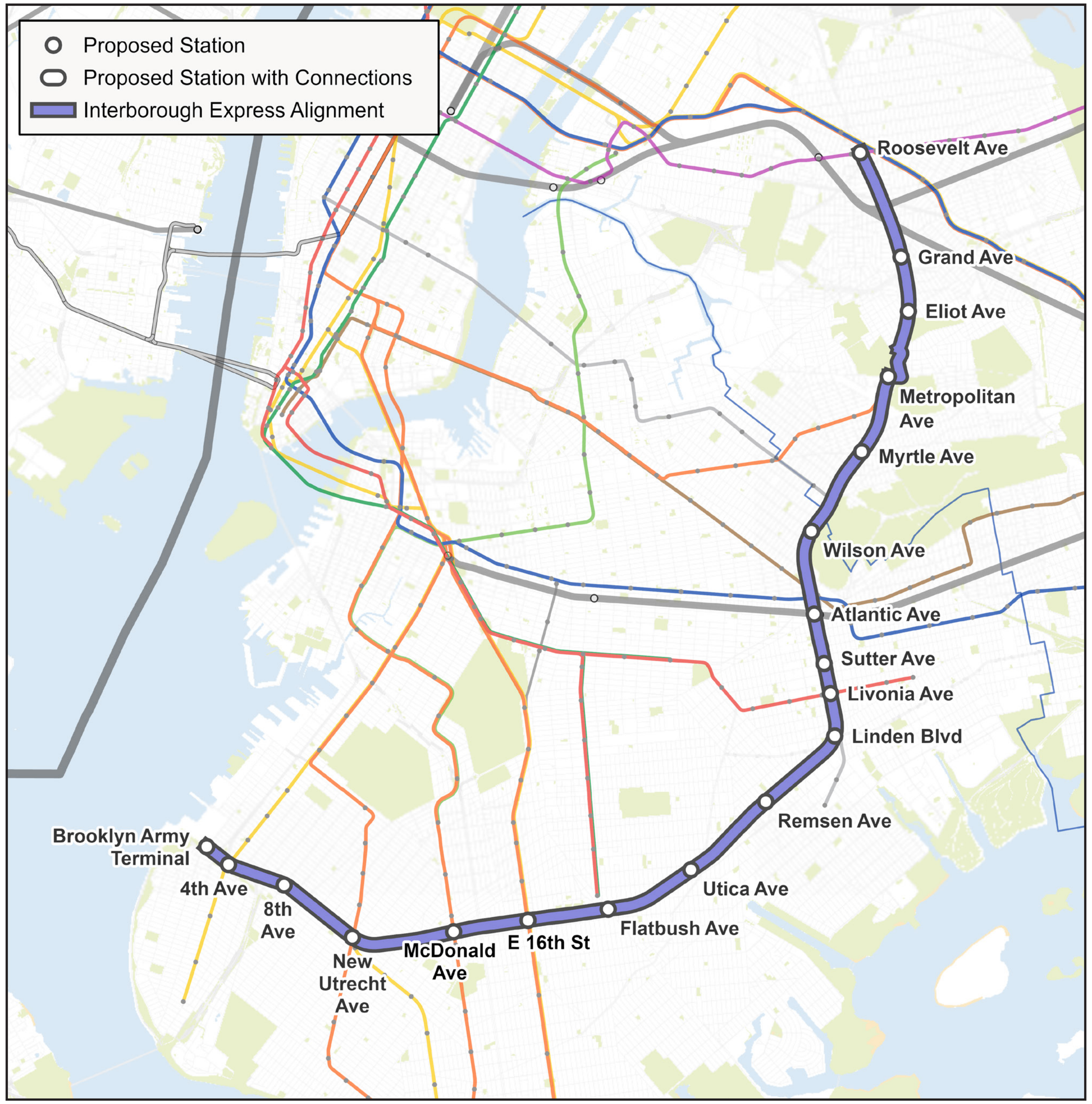
This project would enable some additional service at the Rye station, but its main benefit is operational efficiency and flexibility. Relatively low ridership, as well as cost, result in average cost effectiveness.

A new rail storage yard for the New Haven Line in New York State receives an above average cost effectiveness score since it saves some time for riders at a relatively low cost. It does not have a big impact on ridership because the only difference in the service plan is an additional stop at Rye station for some trains, but no increase in frequency. It does not perform well in equity since it does not have a large share of its riders from equity areas. Similarly, it does not score well in resiliency and sustainability because it does not reduce vehicle usage significantly or provide any new rail connections. The project performs poorly in geographic distribution since a new yard does not improve regional access. The capacity score is low because of how capacity is measured: by reduction in crowding systemwide. However, it would increase capacity in the operational sense of providing more space to store additional trains on the New Haven Line. The project scores well in network leverage since it would be constructed mainly within existing Metro-North right-of-way.

Interborough Express Light Rail Transit

Description: A new transit line between Queens and Brooklyn along an existing freight corridor, connecting to 17 subway lines (2 3 5 7 A B C D E F J L M N R Q Z), and the Long Island Rail Road (LIRR), serving areas of Brooklyn and Queens.

Project objectives: Reduce travel times on transit between Brooklyn and Queens and divert trips from overburdened Manhattan-bound subway lines.



Above, Interborough Express LRT (IBX)

Evaluation results

<20
20-39
40-59
60-79
>=80

Construction Cost (2027): $5.5 billion

Fleet Cost (2027): $432million

Annual O&M Cost (2027): $83 million

Daily Ridership (2045): 118,700

New Daily Riders (2045): 13,200

Riders from Equity Areas (2045): 112,440

Travel Time Saved Per Trip (minutes): 5.9

Special Considerations:
Light Rail Transit (LRT) would be a new and stand-alone mode for MTA.

Street-running required (<1 mile) in Middle Village, Queens.

Requires coordination and concurrence with the following entities:

- CSX, which owns northern three miles of right-of-way
- PANYNJ for the Cross Harbor Freight Program (CHFP)
- EDC and City Hall, for the maintenance & storage facility (MSF) and terminal station at Brooklyn Army Terminal.

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$1.29/min	98
Equity	Percent of riders from Equity Areas	95%	94
Sustainability	Change in daily vehicle miles traveled	-72,687	100
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	18	100
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-2,375 hours	57
Geographic Distribution	Change in regional accessibility	-47,557 hours	100
Network Leverage	Weighted average of MTA, Public and Private ROW	86%	82

Findings

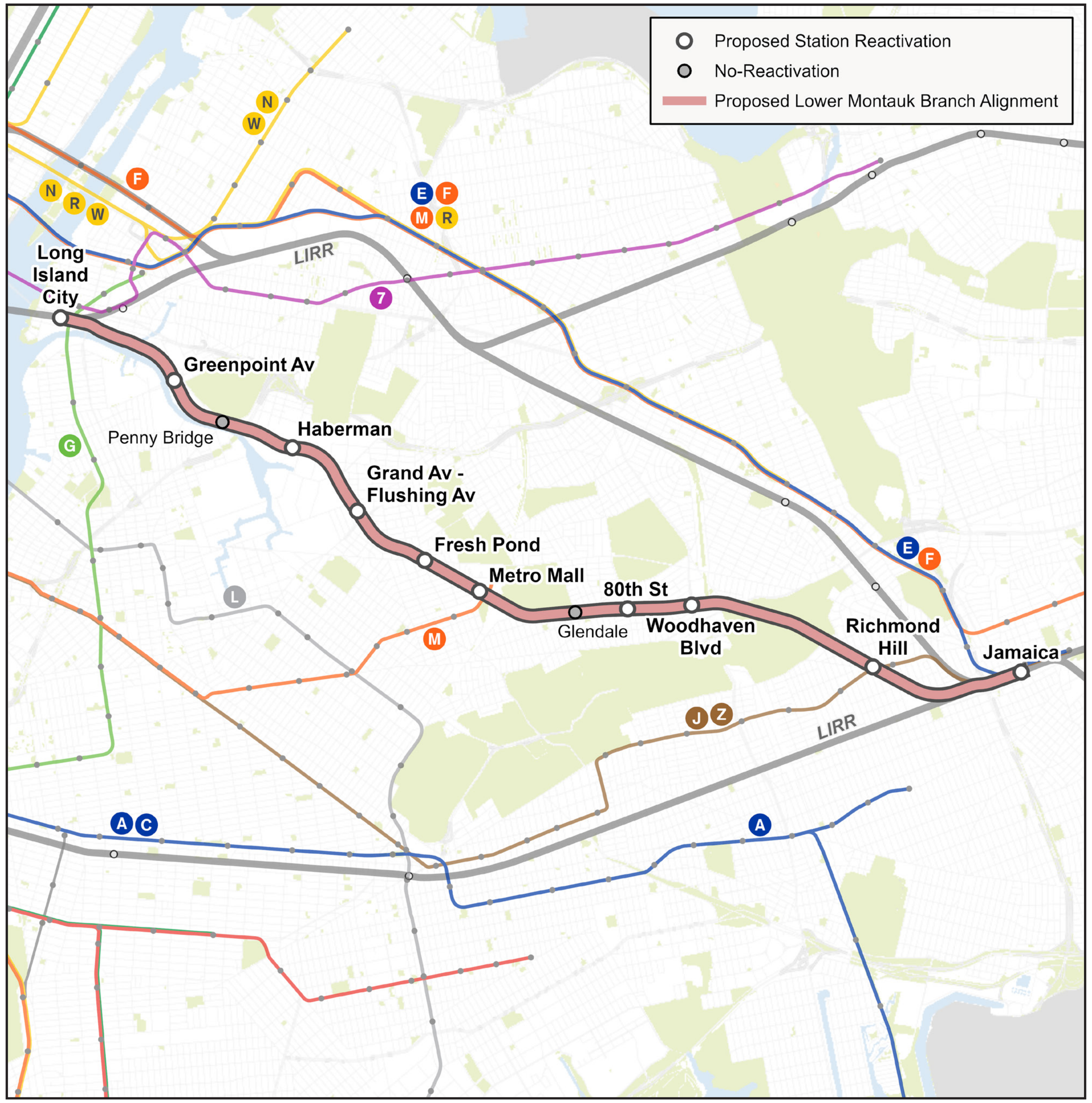
This project scores well in many metrics, including cost effectiveness. It serves a large number of new and total riders, especially from equity areas, and provides connections to many other transit lines, using an existing right-of-way.

The Interborough Express scores well in almost all metrics. High ridership and significant time savings make it cost effective. It does well in equity because it serves a large number of riders from equity areas. Similarly, it scores well in resiliency and sustainability by greatly reducing vehicle usage and providing multiple connections to the subway (up to 17 lines) and LIRR. It scores well in geographic distribution by improving regional access and it gets a high score for network leverage with 11 of its 14 route miles owned by the MTA. It does not score as well in capacity in relation to other projects because it acts as a feeder to existing subway lines, increasing crowding on some that are at, or close to, capacity (i.e. Queens Blvd Line).

Lower Montauk Branch Reactivation

Description: Reactivation of an approximately nine-mile segment of the Long Island Rail Road Lower Montauk Branch between Jamaica and Long Island City, with new stations at Greenpoint Avenue, Haberman, Grand Avenue, Fresh Pond, Metro Mall, 80th St, Woodhaven Blvd, and Richmond Hill.

Project objectives: Increase transit options for underserved communities and improve network connections for intra- and inter-borough travelers; provide opportunities for development and growth near stations; utilize/leverage existing right-of-way.



Above, Lower Montauk Branch Reactivation

Evaluation results

Construction Cost (2027): $4.2 billion

Fleet Cost (2027): $15 million

Annual O&M Cost (2027): $23 million

Daily Ridership (2045): 9,200

New Daily Riders (2045): 6,400

Riders from Equity Areas (2045): 6,950

Travel Time Saved Per Trip (minutes): 1.1

Special Considerations:
Coordination and additional studies needed to evaluate right-of-way constraints, as well as impacts to the LIRR and existing freight operations.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$62.41 /min	0
Equity	Percent of riders from Equity Areas	76%	70
Sustainability	Change in daily vehicle miles traveled	-38,094	52
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	8	50
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	+1,101 hours	0
Geographic Distribution	Change in regional accessibility	-3,947 hours	14
Network Leverage	Weighted average of MTA, Public and Private ROW	100%	100

Findings

This project performs poorly as it provides low time savings in relation to cost. Although the project would provide rail service to equity areas and make use of an existing MTA right-of-way, there are challenges of sharing the use of the corridor with growing freight operations.

Reactivating this section of the LIRR does not score well in cost effectiveness because costs are high, and ridership and time savings are low. It gets above average scores in equity since a large share of its riders are from equity areas, and it does well in resiliency and sustainability, since it takes many trips away from vehicles and provides new connections to rail. It does not improve capacity, making the system more crowded by adding riders to LIRR services. It improves regional access slightly but gets a lower score relative to other projects. Although it scores well in network leverage because MTA owns the right-of-way, it is narrow with adjacent buildings and roadways, making shared use with growing freight operations challenging and costly.

New Lots Avenue ③ Line Extension

Flatlands

Description: Extension of the New Lots Avenue ③ line on an elevated structure southeast past Livonia Yard to a new terminal at Flatlands Avenue and Linwood Street/Elton Street.

Project objectives: Reduce travel times and increase reliability for residents and workers in underserved communities; provide better connectivity to existing subway network.

Above, New Lots Ave ③ line to Flatlands

Evaluation results

Construction Cost (2027): $1.8 billion

Fleet Cost (2027): $101 million

Annual O&M Cost (2027): $17 million

Daily Ridership (2045): 8,600

New Daily Riders (2045): 300

Riders from Equity Areas (2045): 8,510

Travel Time Saved Per Trip (minutes): 3.9

Special Considerations:
Livonia Yard is planned for re-construction and an extension of the ③ line could provide synergies with yard construction, but coordination is needed with the Livonia redesign to not preclude extension.

A potential separation of passenger service tracks from yard lead tracks could have an impact on yard operations.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$8.64/min	41
Equity	Percent of riders from Equity Areas	99%	100
Sustainability	Change in daily vehicle miles traveled	-1,985	2
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	0	0
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-384 hours	8
Geographic Distribution	Change in regional accessibility	+6,200 hours	0
Network Leverage	Weighted average of MTA, Public and Private ROW	76%	68

Findings

This project is not cost effective due to the high cost to extend the line with a small increase in ridership and time savings. Its primary benefit is serving equity areas.

Extending the New Lots Ave ③ line to Flatlands Avenue performs poorly due to its high cost and relatively low ridership and time savings. It scores well in equity since the majority of its riders are from equity areas. Although it reduces auto usage slightly, it is small compared to other projects and it does not score well in sustainability. It scores poorly in resiliency because it does not provide any new connections to rail. It does not provide benefits in capacity and actually increases crowding by adding riders to the existing line. Similarly, it does not score well in geographic distribution because it does not improve regional access significantly. It gets an average score in network leverage since a portion of the right-of-way is owned by MTA.

New Lots Avenue 3 Line Extension

Alternative Considered: Spring Creek

Alternative Considered: Extension of the New Lots Avenue 3 line on an elevated structure southeast past Livonia Yard to a new terminal in the vicinity of Spring Creek and Gateway Center Mall.

Above, New Lots Ave 3 line to Spring Creek

Evaluation results

<20
20-39
40-59
60-79
>=80

Construction Cost (2027): $2.5 billion

Fleet Cost (2027): $101 million

Annual O&M Cost (2027): $26 million

Daily Ridership (2045): 9,800

New Daily Riders (2045): 400

Riders from Equity Areas (2045): 9,510

Travel Time Saved Per Trip (minutes): 3.6

Special Considerations:
Livonia Yard is planned for re-construction and an extension of the 3 line could provide synergies with yard construction, but coordination is needed with the Livonia redesign to not preclude extension.

A potential separation of passenger service tracks from yard lead tracks could have an impact on yard operations.

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$11.74/min	17
Equity	Percent of riders from Equity Areas	97%	97
Sustainability	Change in daily vehicle miles traveled	-3,235	4
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	0	0
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	+648 hours	0
Geographic Distribution	Change in regional accessibility	+2,519 hours	0
Network Leverage	Weighted average of MTA, Public and Private ROW	60%	47

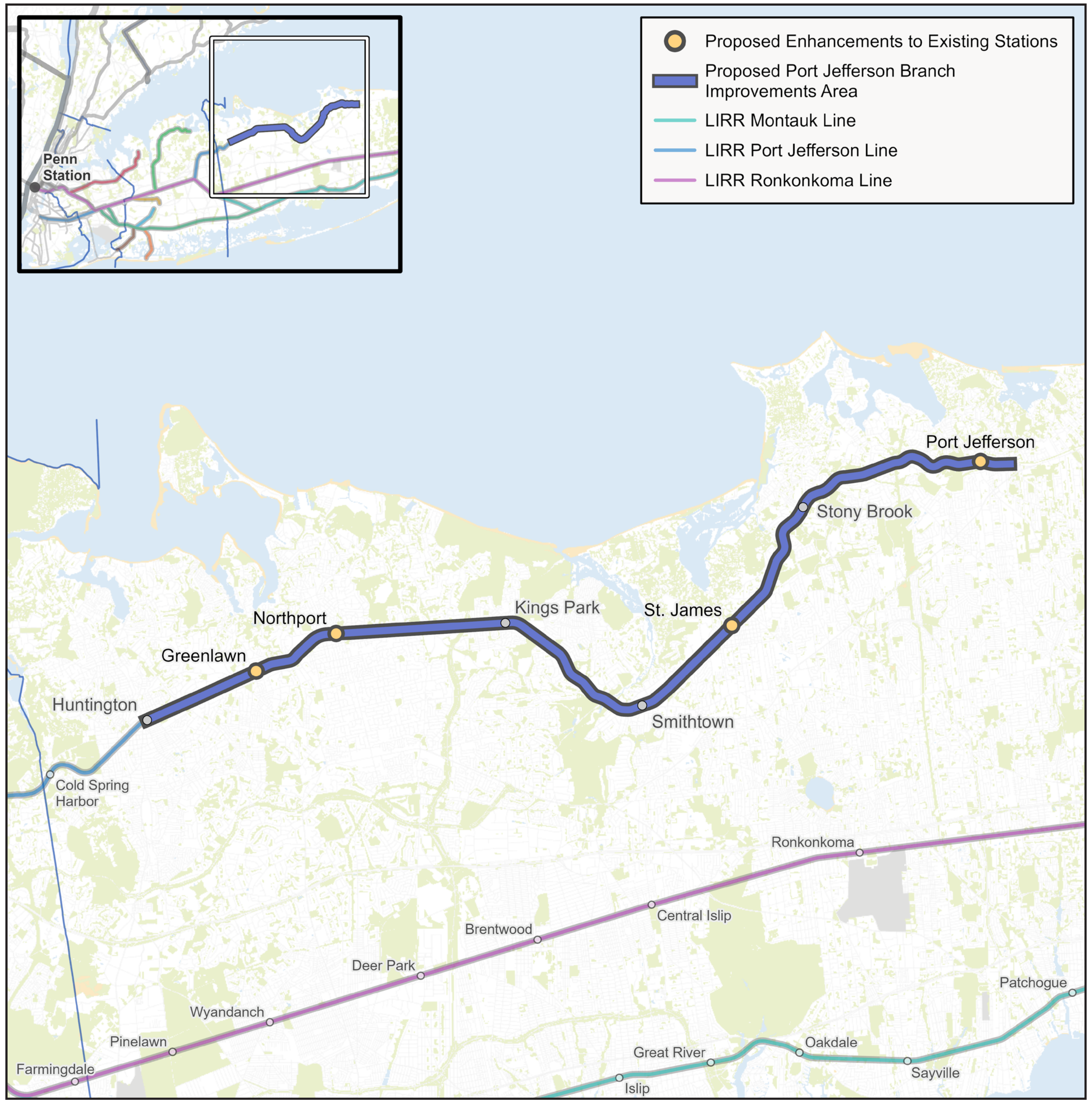
Findings

This alternative is less cost effective than the alternative selected for analysis, with significantly higher construction costs without a corresponding increase in ridership.

Port Jefferson Branch Capacity Improvements

Description: Improvements of the Long Island Rail Road Port Jefferson Branch, including electrification, double tracking, stations, storage yard, and associated infrastructure.

Project objectives: Increase travel speeds and frequency while providing a one-seat ride to Penn Station and Grand Central Madison; reduce demand on the Ronkonkoma Branch.



Above, Port Jefferson Branch Capacity Improvements

Evaluation results

Construction Cost (2027): $3.1 billion

Fleet Cost (2027): N/A

Annual O&M Cost (2027): $74 million

Daily Ridership (2045): 27,900

New Daily Riders (2045): 1,400

Riders from Equity Areas (2045): 10,970

Travel Time Saved Per Trip (minutes): 3.6

Special Considerations:

Electrification of the line requires additional capital improvements to be in place.

Space for a new terminal electric train yard needs to be identified.

Additional studies will need to be conducted to determine right-of-way and fleet needs.

Currently exploring former Lawrence Aviation site in partnership with Suffolk County..

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$6.18 /min	**60**
Equity	Percent of riders from Equity Areas	39%	**22**
Sustainability	Change in daily vehicle miles traveled	-32,796	**45**
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	0	**0**
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-2,018 hours	**48**
Geographic Distribution	Change in regional accessibility	-20,719 hours	**81**
Network Leverage	Weighted average of MTA, Public and Private ROW	96%	**95**

Findings

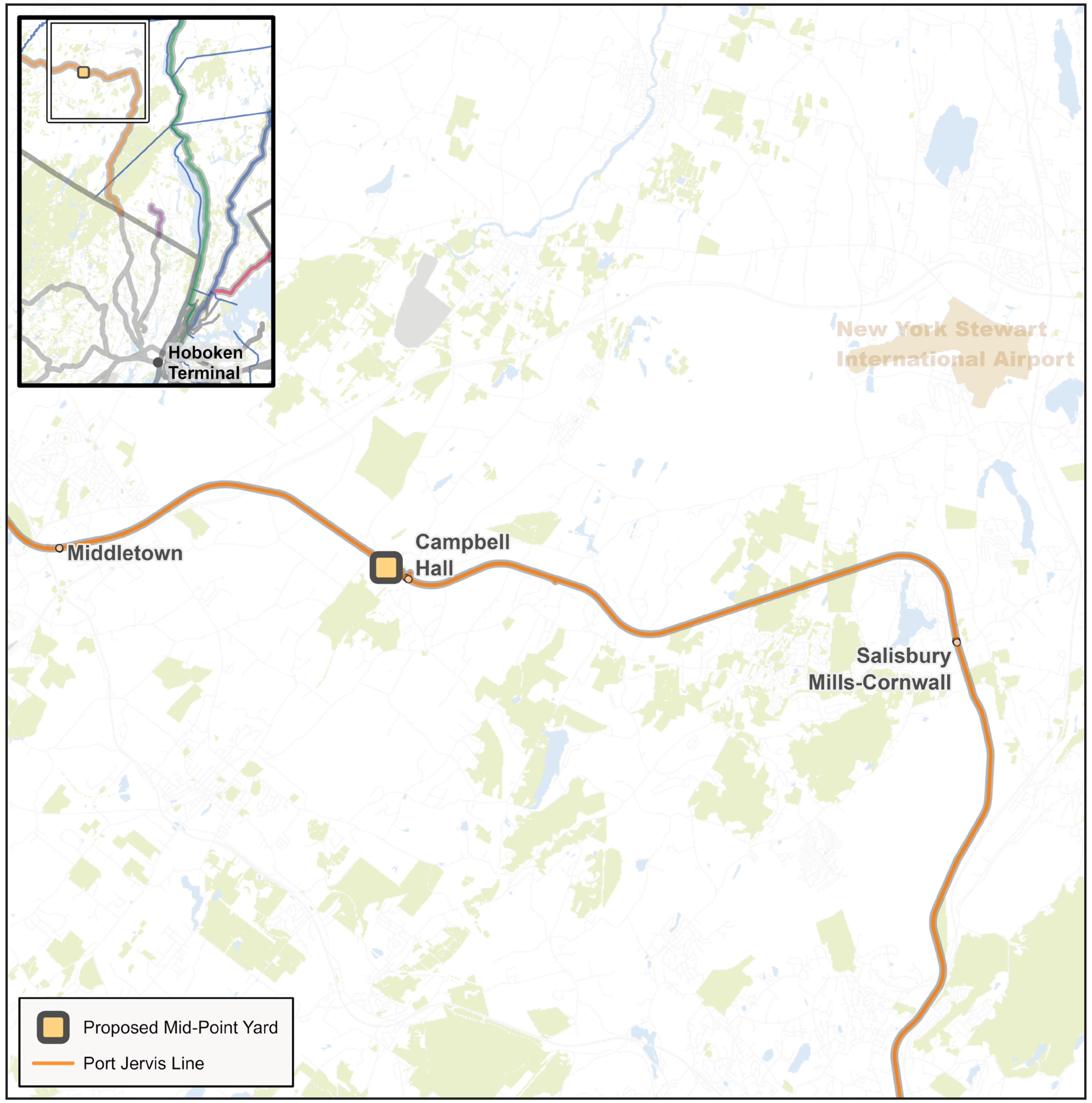
This project has some benefits, but its high cost, coupled with relatively low ridership and time savings, results in an average cost effectiveness.

Improvements on the Port Jefferson Branch get an average cost effectiveness score, mainly due to the high cost and relatively low ridership. Less than half of the riders are from equity areas and so it gets a low score for equity. It does reduce auto usage a fair amount and gets an average score for sustainability, though it does not provide any new rail connections and scores poorly in resiliency. While the project is intended to relieve local crowding in the AM peak, it does not reduce crowding systemwide as much as most other projects. This project gets high scores in geographic distribution, since it improves regional access significantly, as well as network leverage, since it's almost entirely on MTA right-of-way.

Port Jervis Line Capacity Improvements (Midpoint Yard)

Description: Construction of a new rail yard at Metro-North Railroad Campbell Hall station capitalizing on new Port Jervis line track infrastructure.

Project objectives: Improve operational efficiency, flexibility, and service reliability, and introduce reverse peak service.



Above, Port Jervis Line Capacity (Midpoint Yard)

Evaluation results

Construction Cost (2027): $360 million

Fleet Cost (2027): N/A

Annual O&M Cost (2027): $5 million

Daily Ridership (2045): 11,000

New Daily Riders (2045): 40

Riders from Equity Areas (2045): 8,020

Travel Time Saved Per Trip (minutes): 0.1

Special Considerations:
Full benefits only realized with direct Manhattan Service via Secaucus Loop, Gateway Program, Penn Station Expansion, and other NJ improvements.

Requires coordination and agreement with Norfolk Southern and New Jersey Transit.

Additional investments on the Port Jervis Line needed including replacement of bridges, viaducts, construction of passing sidings and more fleet.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$40.46/ min	0
Equity	Percent of riders from Equity Areas	73%	66
Sustainability	Change in daily vehicle miles traveled	-1,726	2
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	0	0
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-152 hours	3
Geographic Distribution	Change in regional accessibility *(efficiency of travel time from anywhere tc anywhere by transit)*	-1,537 hours	5
Network Leverage	Weighted average of MTA, Public and Private ROW	25%	0

Findings

This project would attract relatively few riders at a high cost, and is dependent on additional long-term, high cost regional investments.

Construction of a Mid-Point Yard at Campbell Hall on the Port Jervis Line does not score well in most metrics. Although a new Mid-Point Yard would provide operational flexibility and service improvements, it is not a cost-effective project mainly due to low ridership and negligible increase in travel times savings, capacity and geographic distribution. Network leverage also gets a low score since MTA does not own the property for the construction of the yard. It does scores above average in equity since many of its riders are from equity areas and it reduces vehicle usage significantly, largely because it provides an alternative to bus or driving.

Ridgewood Busway

Description: Conversion of an existing MTA-owned right-of-way into an exclusive busway running approximately half a mile from Palmetto Street near Onderdonk Avenue to Fresh Pond Road. This project has previously been referred to as Myrtle Avenue Busway, as it runs under the Myrtle Avenue M line. Since the actual area of the project is not at Myrtle Avenue, however, the project has been renamed.

Project objectives: Improve operations by eliminating difficult turns and traffic issues. Increase bus speeds and service reliability.

Above, Ridgewood Busway

Evaluation results

Construction Cost (2027): $30 million

Fleet Cost (2027): N/A

Annual O&M Cost (2027): -$2 million

Daily Ridership (2045): 8,900

New Daily Riders (2045): 200

Riders from Equity Areas (2045): 8,350

Travel Time Saved Per Trip (minutes): 1.7

Special Considerations:

Significant operational cost savings. Additional benefits not captured in metrics:

- Service Improvements to riders on multiple bus routes; these improvements would extend beyond project area and include improvements such as increased reliability to entire bus routes.
- Street Safety improvements and decrease number of buses on local street network.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$0/min*	100
Equity	Percent of riders from Equity Areas	94%	93
Sustainability	Change in daily vehicle miles traveled	-287	0
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	2	13
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-239 hours	5
Geographic Distribution	Change in regional accessibility	-347 hours	0
Network Leverage	Weighted average of MTA, Public and Private ROW	50%	33

**Operation and maintenance savings exceed capital costs over project lifetime.*

Findings

This project performs well in cost effectiveness due to operational savings and a relatively low cost to implement. This is a small project, but its positive impacts go beyond the immediate geographic region of the project and benefit riders on multiple bus routes that would become more reliable and operationally efficient.

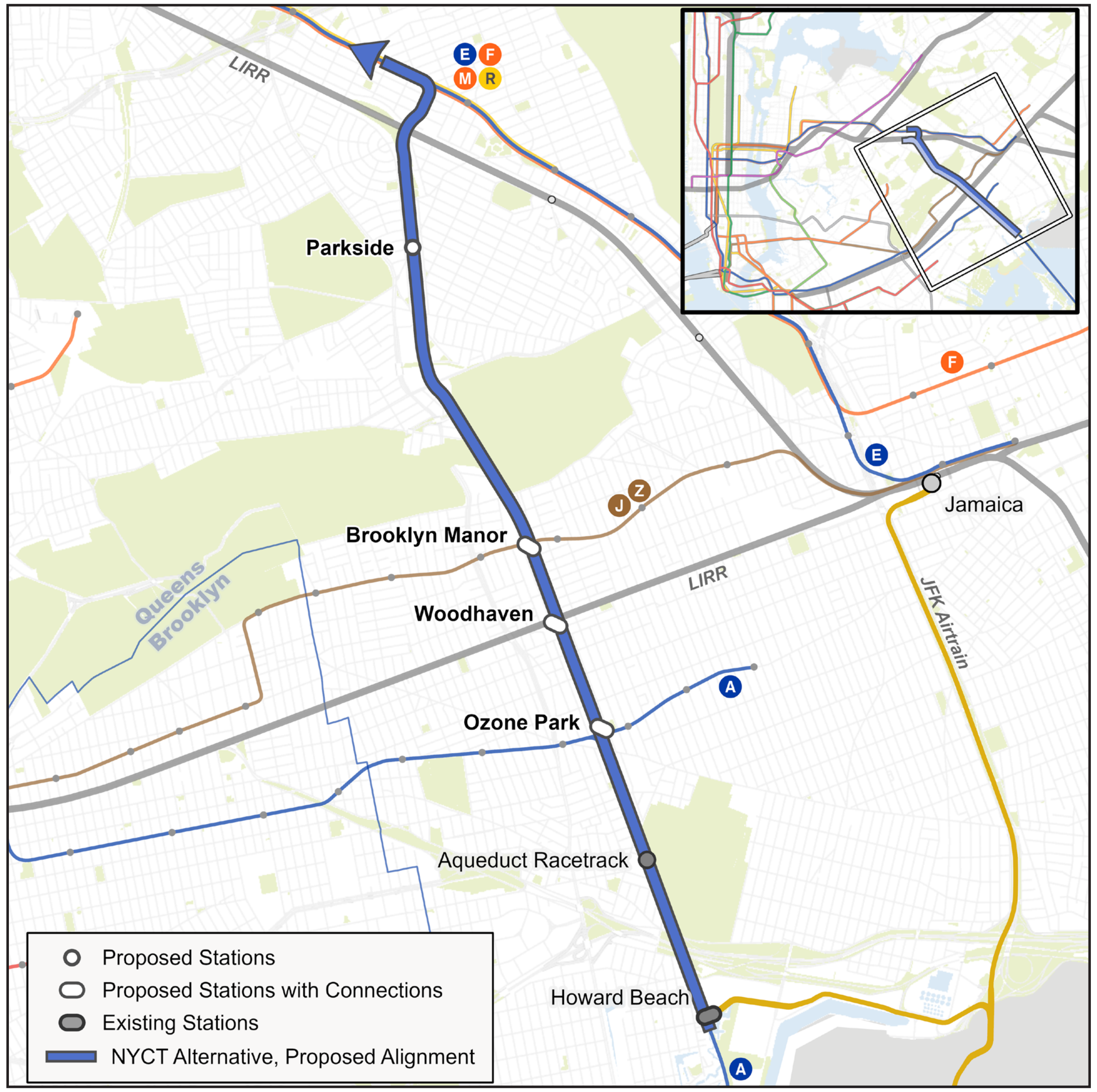
Converting this MTA-owned right-of-way into a busway scores exceptionally well in cost effectiveness since it saves money operationally. It also does well in equity, with most of its riders being from equity areas. However, it does not score well in resiliency and sustainability, nor does it improve systemwide capacity or regional accessibility significantly enough, relative to other projects. Network leverage gets an average score since MTA owns a portion of the proposed busway under the elevated subway line.

Rockaway Beach Branch Reactivation

New York City Transit

Description: Reactivation of 6-mile alignment along former Long Island Rail Road right-of-way serving Central Queens with up to four new stations and connections at Aqueduct and Howard Beach. Alternatives included Long Island Rail Road and New York City Transit subway as the modes.

Project objectives: Provide service to underserved communities; Increase transit options, reduce auto dependence, and improve network connections for intra- and inter-borough travelers; add opportunities for development and growth near stations.



Above, Rockaway Beach Branch Reactivation (NYCT)

Evaluation results

Construction Cost (2027): $5.9 billion

Fleet Cost (2027): $101 million

Annual O&M Cost (2027): $95 million

Daily Ridership (2045): 39,200

New Daily Riders (2045): 2,000

Riders from Equity Areas (2045): 32,940

Travel Time Saved Per Trip (minutes): 4.0

Special Considerations:
New York City-owned right-of-way: plans for a linear park along portions of the corridor, creating a challenge for any future transit alternatives. NYCT option would require tunneling underneath existing buildings north of LIRR right-of-way.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$6.72/min	56
Equity	Percent of riders from Equity Areas	84%	80
Sustainability	Change in daily vehicle miles traveled	-24,297	33
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	6	38
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-842 hours	20
Geographic Distribution	Change in regional accessibility	0 hours	0
Network Leverage	Weighted average of MTA, Public and Private ROW	66%	54

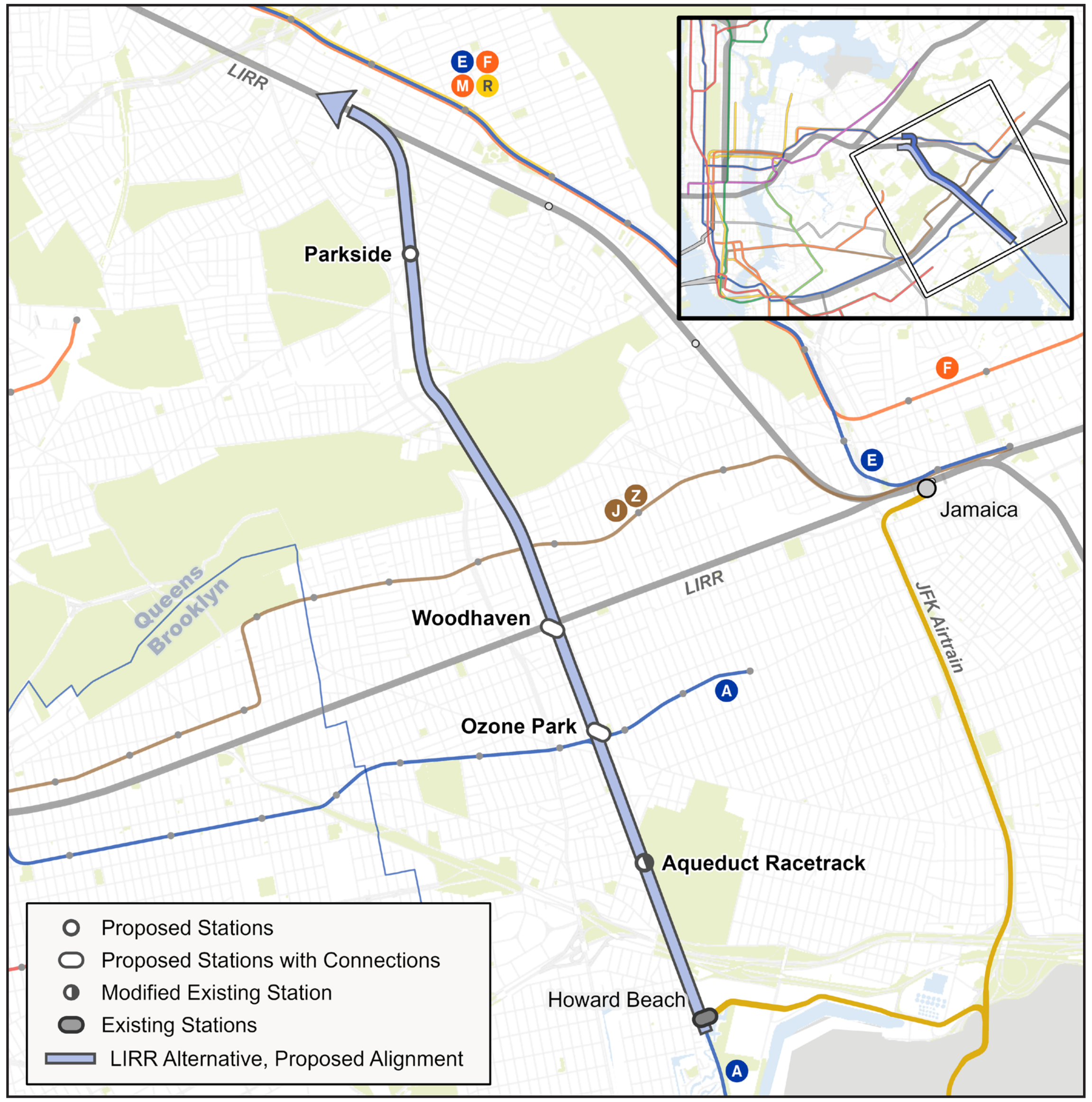
Findings

This project does not score well in most metrics.

Reactivating the Rockaway Beach Branch with NYCT service has a high cost and serves a relatively modest number of riders. This project would reduce auto usage and provide additional rail connections, but compared to other projects, the benefits are average for sustainability and resiliency. There is minimal crowding reduction since some Queens Blvd Line subway service would be moved to serve this new line, and there is no improvement in geographic distribution, resulting in low scores for both. Additionally, a portion of the right-of-way is currently proposed to be a pedestrian and bicycle greenway corridor by New York City, which would compete with a transit alignment along this corridor.

Rockaway Beach Branch Reactivation

Alternative Considered: Long Island Rail Road



Above, Rockaway Beach Branch Reactivation (LIRR)

Evaluation results

Construction Cost (2027): $4.1 billion

Fleet Cost (2027): $169 million

Annual O&M Cost (2027): $22 million

Daily Ridership (2045): 14,500

New Daily Riders (2045): 300

Riders from Equity Areas (2045): 9,430

Travel Time Saved Per Trip (minutes): 0.2

Special Considerations:
New York City-owned right-of-way: plans for a linear park along portions of the corridor, creating a challenge for any future transit alternatives. LIRR option would require reducing service on the main LIRR branch to accommodate services on this new branch.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$262.26/ min	0
Equity	Percent of riders from Equity Areas	65%	56
Sustainability	Change in daily vehicle miles traveled	+19,891	0
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	4	25
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	+4,040 hours	0
Geographic Distribution	Change in regional accessibility	+5,280 hours	0
Network Leverage	Weighted average of MTA, Public and Private ROW	51%	34

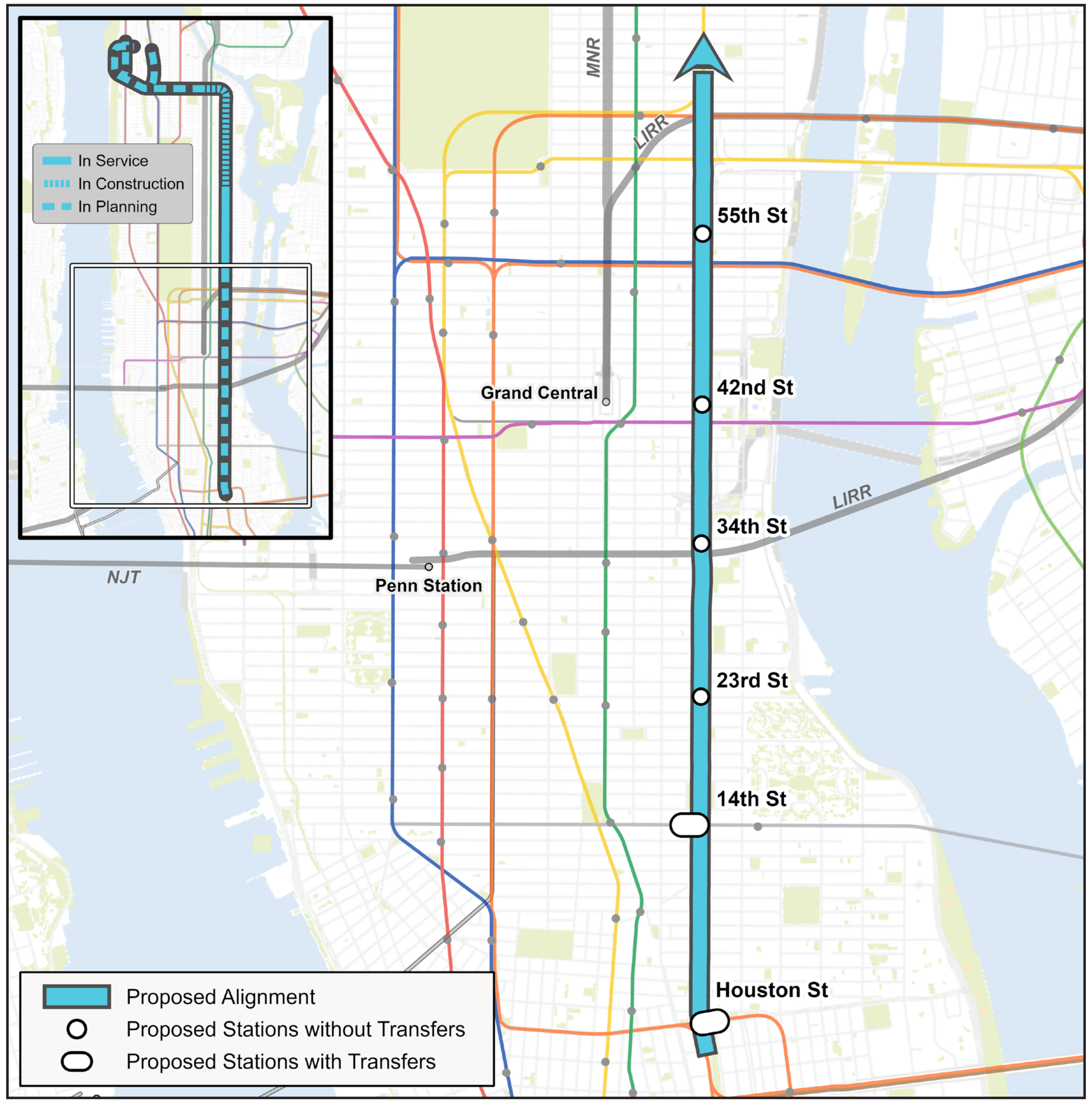
Findings

The LIRR alternative has a slightly lower cost but would serve dramatically fewer riders and would increase travel time to riders on the main LIRR branch, making it even less cost-effective than the NYCT alternative.

Second Avenue Subway South to Houston

Description: Extending the Second Avenue Subway south by three miles, from 72nd Street to Houston Street, including the construction of six new subway stations at 55th, 42nd, 34th, 23rd,14th St, and Houston Streets.

Project objectives: Provide service to underserved communities; enhance transit options and improve network connectivity by providing transfer opportunities; increase subway service frequency between 72nd St and 125th St with the addition of new T line service; reduce travel times for customers east of 2nd Avenue; reduce demand on the Lexington Avenue Line; and support opportunities for development and growth near stations.



Above, Second Ave Subway South to Houston

Evaluation results

Construction Cost (2027): $13.5 billion

Fleet Cost (2027): $611 million

Annual O&M Cost (2027): $106 million

Daily Ridership (2045): 230,400

New Daily Riders (2045): 2,900

Riders from Equity Areas (2045): 137,500

Travel Time Saved Per Trip (minutes): 2.0

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$4.47/ min	73
Equity	Percent of riders from Equity Areas	60%	48
Sustainability	Change in daily vehicle miles traveled	-3,747	5
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	16	100
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-2,595 hours	63
Geographic Distribution	Change in regional accessibility	-296 hours	0
Network Leverage	Weighted average of MTA, Public and Private ROW	50%	33

Findings

The high cost of this project is partially offset by the high ridership and moderate travel time savings.

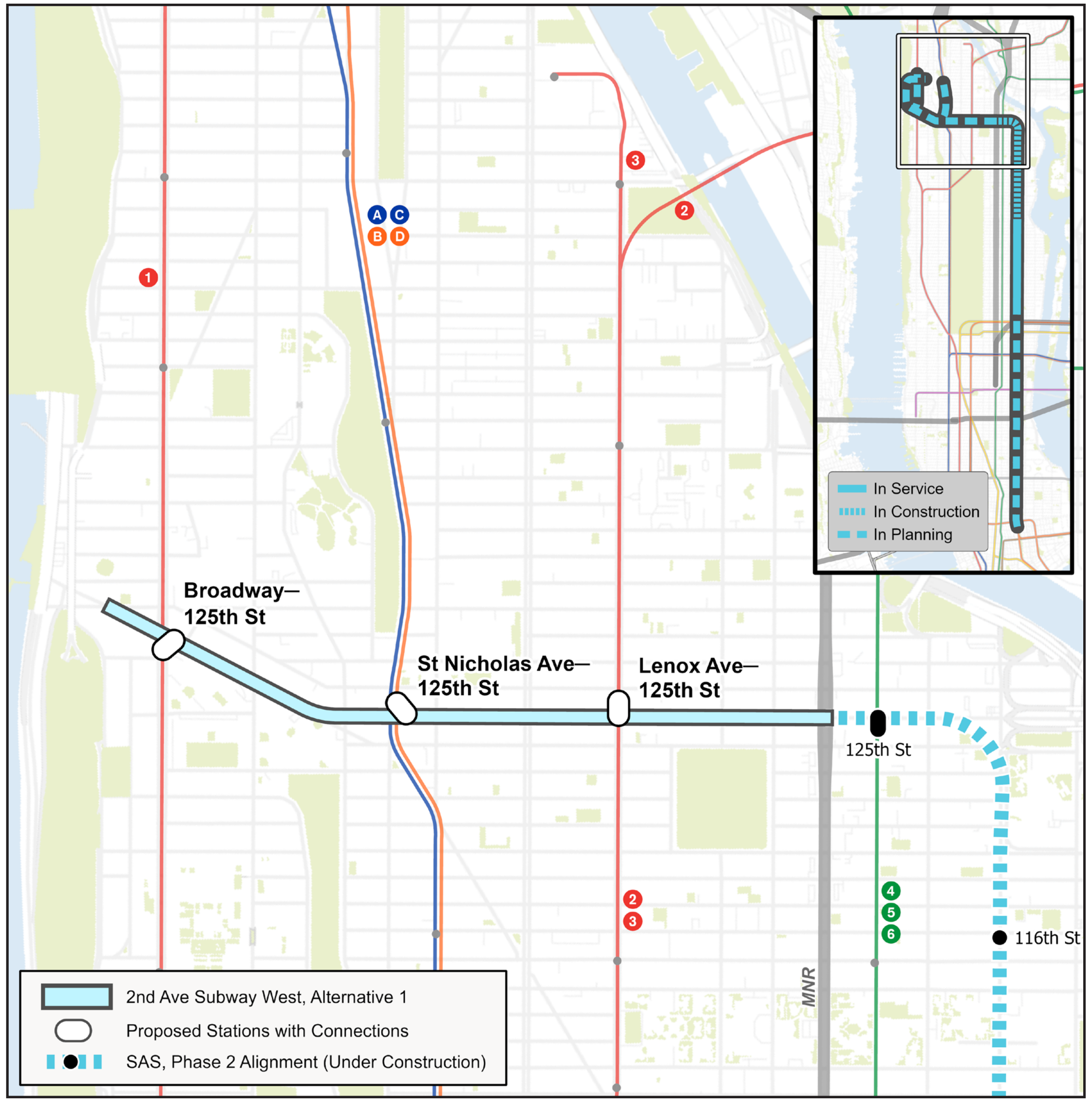
Extending the Second Avenue Subway south to Houston St scores above average in cost effectiveness because of very high ridership and moderate time savings, which offset the project's the high cost. A little more than half of the total riders are from equity areas, resulting in an average score in equity. It reduces auto use only slightly and does not score as well in sustainability compared to other projects. However, it provides new rail connections to many subway lines, and gets a very high resiliency score. While it does reduce crowding, it scores below average in capacity compared to other projects. It does not really improve regional accessibility and scores poorly in geographic distribution. It scores below average in network leverage because it would require tunneling under New York City-owned streets.

Second Avenue Subway West Extension

125th Street/Broadway

Description: Extension of the Second Avenue Subway west along 125th Street, terminating at Broadway-125th St, with three new subway stations.

Project objectives: Improve mobility and connections between West and East sides of Manhattan; provide customers with accessibility to East Side job centers via Second Avenue Subway; add opportunities for development and growth near stations; reduce congestion on bus routes along 125th Street.



Above, Second Ave Subway West to 125th St/Broadway

Evaluation results

Construction Cost (2027): $7.5 billion

Fleet Cost (2027): $611 million

Annual O&M Cost (2027): $65 million

Daily Ridership (2045): 239,700

New Daily Riders (2045): 7,500

Riders from Equity Areas (2045): 224,050

Travel Time Saved Per Trip (minutes): 3.6

Special Considerations:
Prerequisite to this project is the completion of Second Avenue Subway Phase 2.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$1.43/ min	97
Equity	Percent of riders from Equity Areas	93%	93
Sustainability	Change in daily vehicle miles traveled	-26,017	36
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	11	69
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-6,952 hours	100
Geographic Distribution	Change in regional accessibility	-4,106 hours	15
Network Leverage	Weighted average of MTA, Public and Private ROW	50%	33

Findings

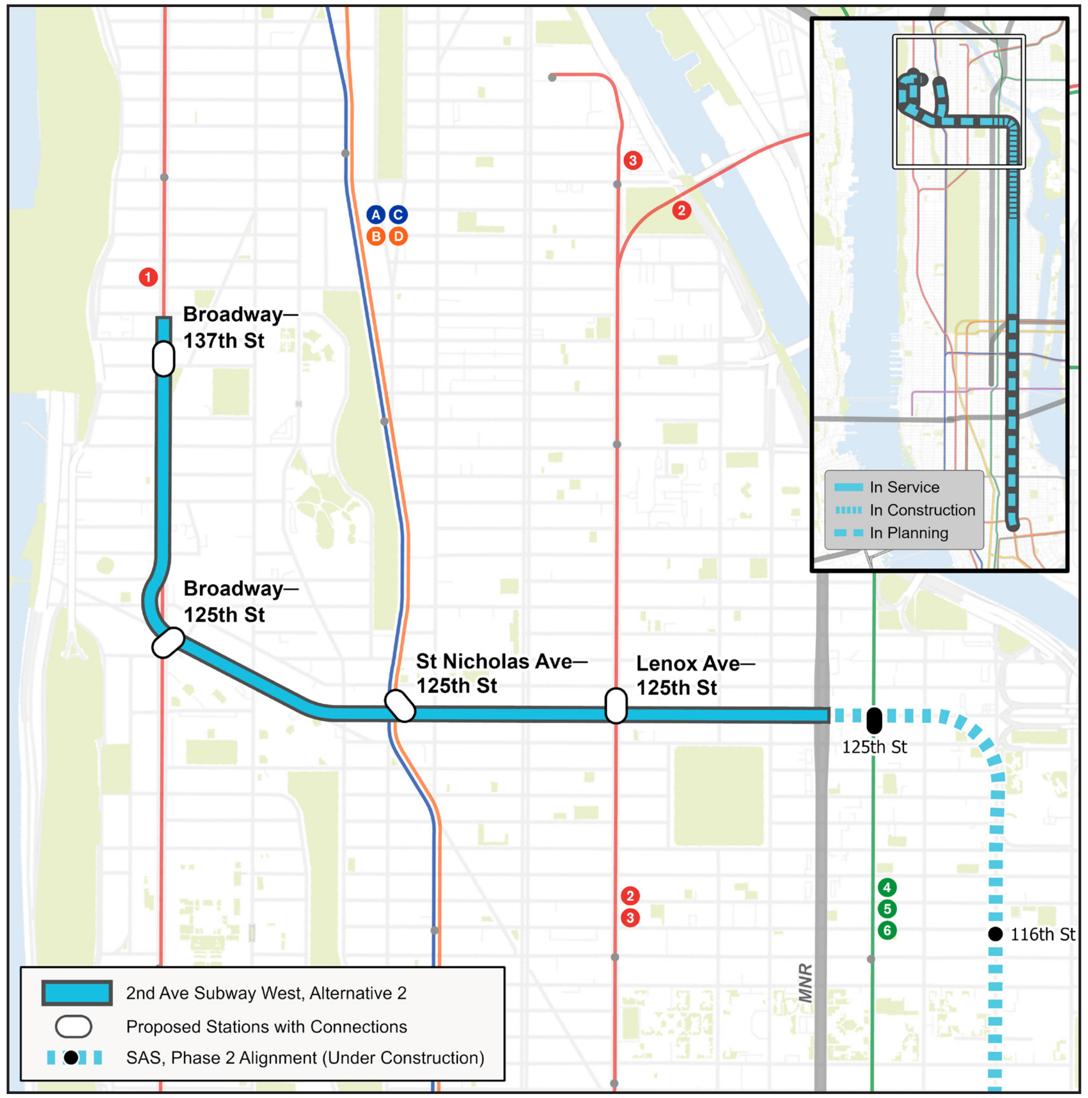
Despite the high cost, this project is cost effective with very high ridership and moderate travel time savings.

Extending the Second Avenue Subway west along 125th Street gets a high score in cost effectiveness because it provides a new east-west connection across Manhattan, saves travel time and serves a great deal of riders, most of which are in equity areas. It reduces car usage by a fair amount and connects with numerous other rail lines, resulting in average sustainability and high resiliency scores. It scores well on capacity since it reduces crowding, mainly on west side subway lines. Though it improves regional accessibility slightly, the score is low relative to other projects. It scores below average in network leverage because it would require tunneling under New York City-owned streets.

Second Avenue Subway West Extension

Alternative Considered: 137th Street/Broadway via Broadway

Description: Extension of the Second Avenue Subway west along 125th Street then turning north along Broadway, terminating at Broadway-137th St, with up to four new subway stations.



Above, Second Ave Subway West to 137th St/Broadway via Broadway

Evaluation results

Construction Cost (2027): $9.1 billion

Fleet Cost (2027): $717 million

Annual O&M Cost (2027): $80 million

Daily Ridership (2045): 256,800

New Daily Riders (2045): 8,800

Riders from Equity Areas (2045): 240,930

Travel Time Saved Per Trip (minutes): 3.8

Special Considerations:
Prerequisite to this project is the completion of Second Avenue Subway Phase 2.

Involves tunneling under existing ① line requiring stabilization.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$1.52/ min	96
Equity	Percent of riders from Equity Areas	94%	93
Sustainability	Change in daily vehicle miles traveled	-31,518	43
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	11	69
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-10,377 hours	100
Geographic Distribution	Change in regional accessibility	-8,981 hours	34
Network Leverage	Weighted average of MTA, Public and Private ROW	50%	33

Findings

This alternative is less cost effective than the 125th Steet/Broadway alternative selected for analysis, with a higher cost without a correspondingly higher ridership or time savings benefit. As a result, preliminary analysis indicates that the 125th Street/Broadway alternative is the most promising westward configuration for Second Avenue Subway.

Feasibility of Other Alternatives:

Second Avenue Subway West to 137 Street/Broadway via Riverside

- This alternative was also considered as an alternate underground configuration to reach 137 St and Broadway. Cost modeling showed it would be more expensive and so it was not included in the final analysis at this time.

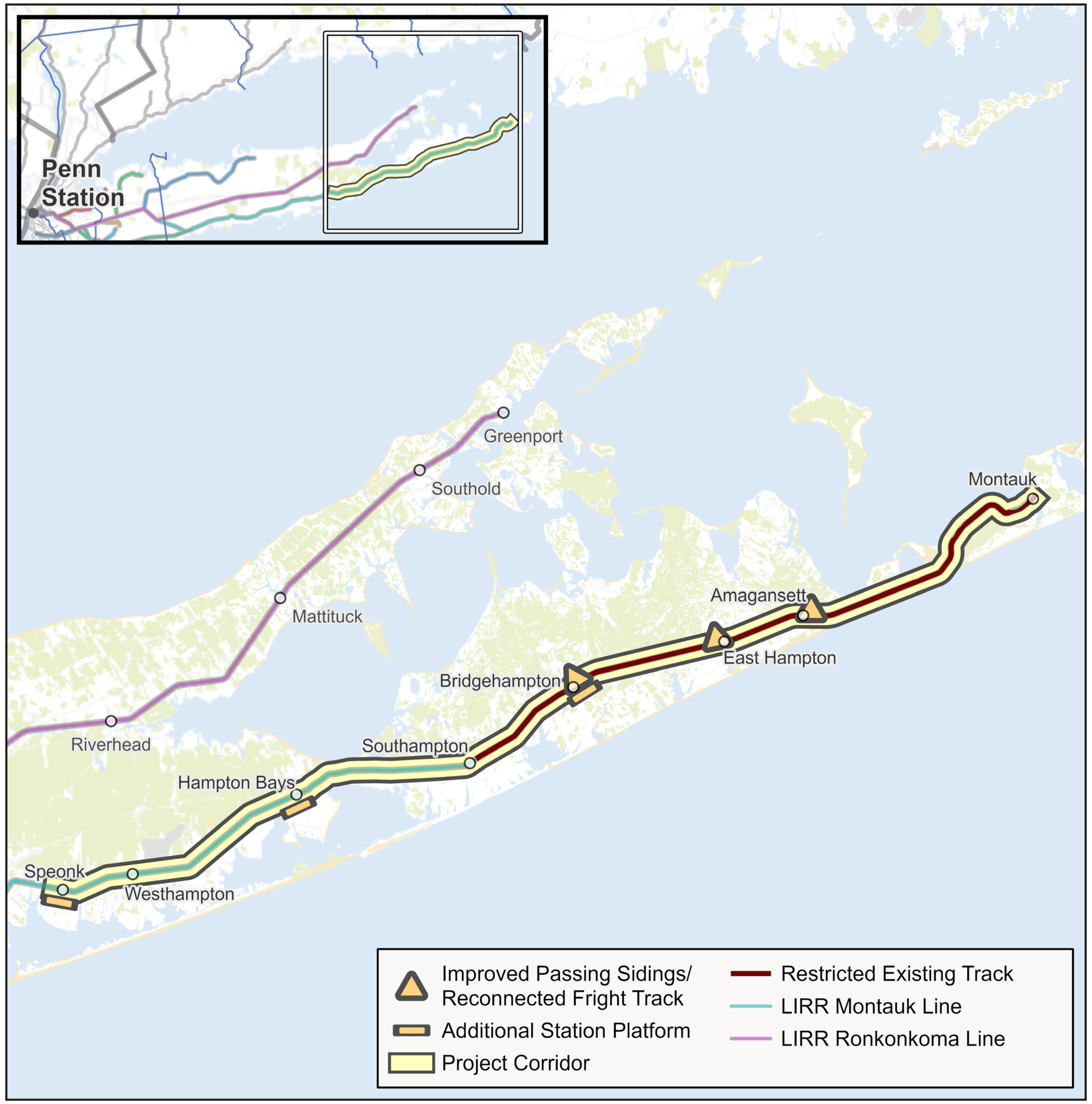
Second Avenue Subway West via St Nicholas Ave

- In further analyzing this alternative, significant operational problems were identified, especially related to capacity on the Ⓐ Ⓑ Ⓒ Ⓓ lines. As a result, this alternative was not selected for analysis at this time.

Speonk-Montauk Capacity Improvements

Description: Improvements of the Long Island Rail Road Montauk Branch between Speonk and Montauk, including signal upgrades and associated infrastructure work.

Project objectives: Improve operational flexibility and ability to add service westbound during the PM.



Above, Speonk-Montauk Capacity Improvements

Evaluation results

Construction Cost (2027): $260 million

Fleet Cost (2027): $78 million

Annual O&M Cost (2027): $6 million

Daily Ridership (2045): 1,500

New Daily Riders (2045): 100

Riders from Equity Areas (2045): 540

Travel Time Saved Per Trip (minutes): 2.9

Special Considerations:

Full investment package required to take full advantage of benefits, including provision of South Fork Commuter Connection service on summer Fridays in the PM peak.

Studies needed to assess fleet needs and right-of-way requirements.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$13.66 /min	3
Equity	Percent of riders from Equity Areas	35%	16
Sustainability	Change in daily vehicle miles traveled	-2,143	3
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	0	0
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	+1,063 hours	0
Geographic Distribution	Change in regional accessibility	-2,049 hours	7
Network Leverage	Weighted average of MTA, Public and Private ROW	100%	100

Findings

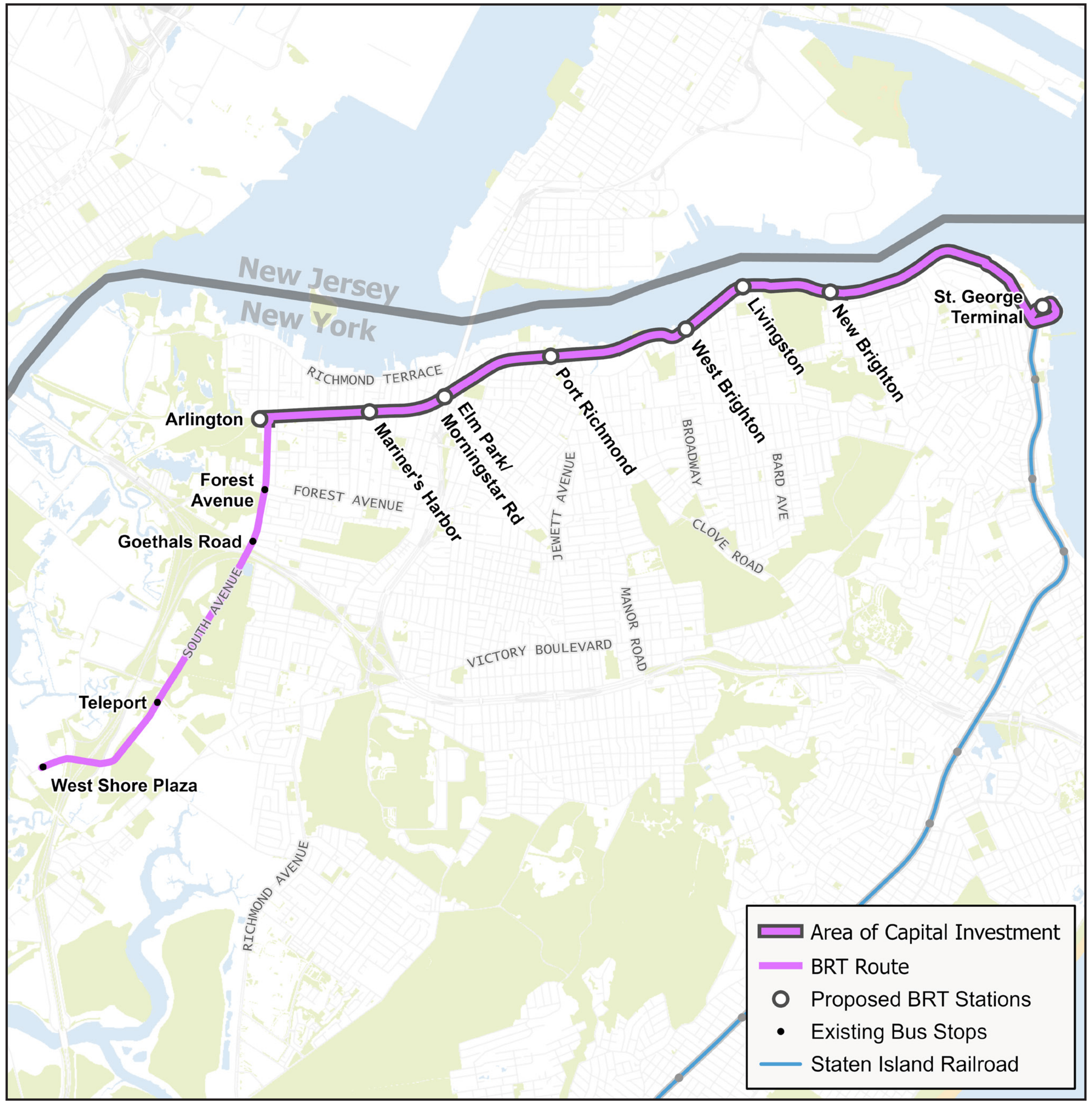
This project would not attract many riders and, despite its relatively low cost, it is not cost effective. It would not significantly address highway congestion concerns to/from the South Fork.

Improvements to the LIRR's Montauk Branch are not cost effective with very low ridership and moderate time savings. It would not serve many riders from equity areas. While it reduces vehicle usage slightly, it is below average compared to other projects and does not score well in sustainability. It does not provide any new rail connections and scores poorly in resiliency. It gets a low score for capacity as well, since it actually increases crowding and adds more riders to existing LIRR trains. It improves regional accessibility slightly but scores low in geographic distribution relative to other projects. Since it is entirely on MTA's right-of-way, it scores well in network leverage.

Staten Island North Shore Bus Rapid Transit

Description: Implementation of a new 8-mile Bus Rapid Transit (BRT) service along 4.8 miles of the former North Shore Railroad right-of-way and 3.2 miles on City streets; operating on an exclusive bus lane along Richmond Terrace (0.5 mi) and in mixed traffic along South Avenue (2.7 mi).

Project objectives: Improve connections between neighborhoods and existing North and West Shore activity centers, industries, employment centers, and the Staten Island Railway; enhance transit reliability.



Above, Staten Island North Shore Bus Rapid Transit

Evaluation results

Construction Cost (2027): $1.3 billion

Fleet Cost (2027): $34 million

Annual O&M Cost (2027): $26 million

Daily Ridership (2045): 32,000

New Daily Riders (2045): 1,300

Riders from Equity Areas (2045): 22,820

Travel Time Saved Per Trip (minutes): 5.6

Special Considerations:
Competing transportation demands along portions of former North Shore railroad right-of-way and along Richmond Terrace, including potential impact to significant number of on-street parking spaces and NYPD parking.

Parkland alienation and historic preservation concerns at Snug Harbor.

Preserving active maritime business uses at Atlantic Salt and Caddell Dry Dock with a land exchange.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$1.46/ min	96
Equity	Percent of riders from Equity Areas	71%	64
Sustainability	Change in daily vehicle miles traveled	-7,904	11
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	1	6
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	+42 hours	0
Geographic Distribution	Change in regional accessibility	-11,013 hours	42
Network Leverage	Weighted average of MTA, Public and Private ROW	50%	33

Findings

This project improves reliability and efficiency, resulting in the travel time savings for a significant number of riders and a high cost effectiveness score.

A new BRT route along Staten Island's North Shore receives a high cost effectiveness score due to reduced travel times for a significant number of riders. It scores above average in equity since many of those riders are from equity areas. Although it reduces vehicle usage, it is below average compared to other projects and receives a fair score in sustainability. It scores poorly in resiliency since it only provides one new rail connection. It scores poorly in capacity as well since it increases crowding by adding riders to subway lines in lower Manhattan. It improves regional accessibility and receives an average score in geographic distribution relative to other projects. For network leverage, it scores below average since its alignment is along New York City-owned right-of-way.

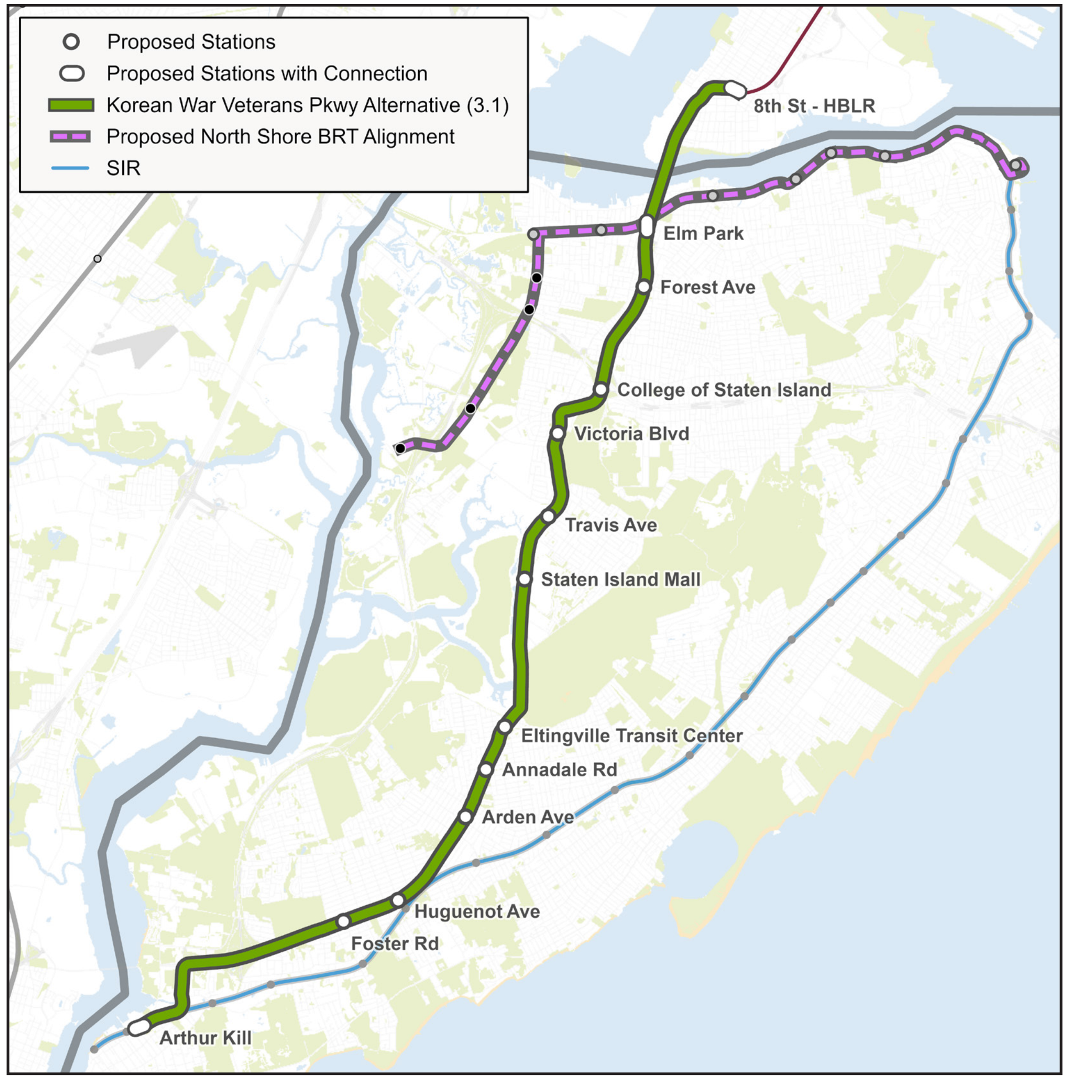
Staten Island West Shore Bus Rapid Transit

Korean War Veterans Pkwy

Description: Improvements to transit connectivity and access within, to, and from the West Shore of Staten Island.

The best performing alternative considered is Bus Rapid Transit along Korean War Veterans Pkwy and Richmond Avenue from Tottenville to Bayonne

Project Objectives: Provide more reliable transit service on Staten Island's West Shore. Improve connections between neighborhoods, activity, and employment centers, and add opportunities for development and growth near stations.



Above, Staten Island West Shore BRT via Koren War Veterans Pkwy

Evaluation results

Construction Cost (2027): $1.9 billion

Fleet Cost (2027): $11 million

Annual O&M Cost (2027): $29 million

Daily Ridership (2045): 16,900

New Daily Riders (2045): 2,800

Riders from Equity Areas (2045): 6,320

Travel Time Saved Per Trip (minutes): 9.9

Special Considerations:
The North Shore BRT project is part of the baseline for the West Shore Transit Improvements. Therefore, the West Shore Transit improvements could not occur until after North Shore BRT is operational.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$1.95/ min	93
Equity	Percent of riders from Equity Areas	37%	19
Sustainability	Change in daily vehicle miles traveled	-25,279	35
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	3	19
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-46 hours	0
Geographic Distribution	Change in regional accessibility	-25,566 hours	100
Network Leverage	Weighted average of MTA, Public and Private ROW	50%	33

Findings

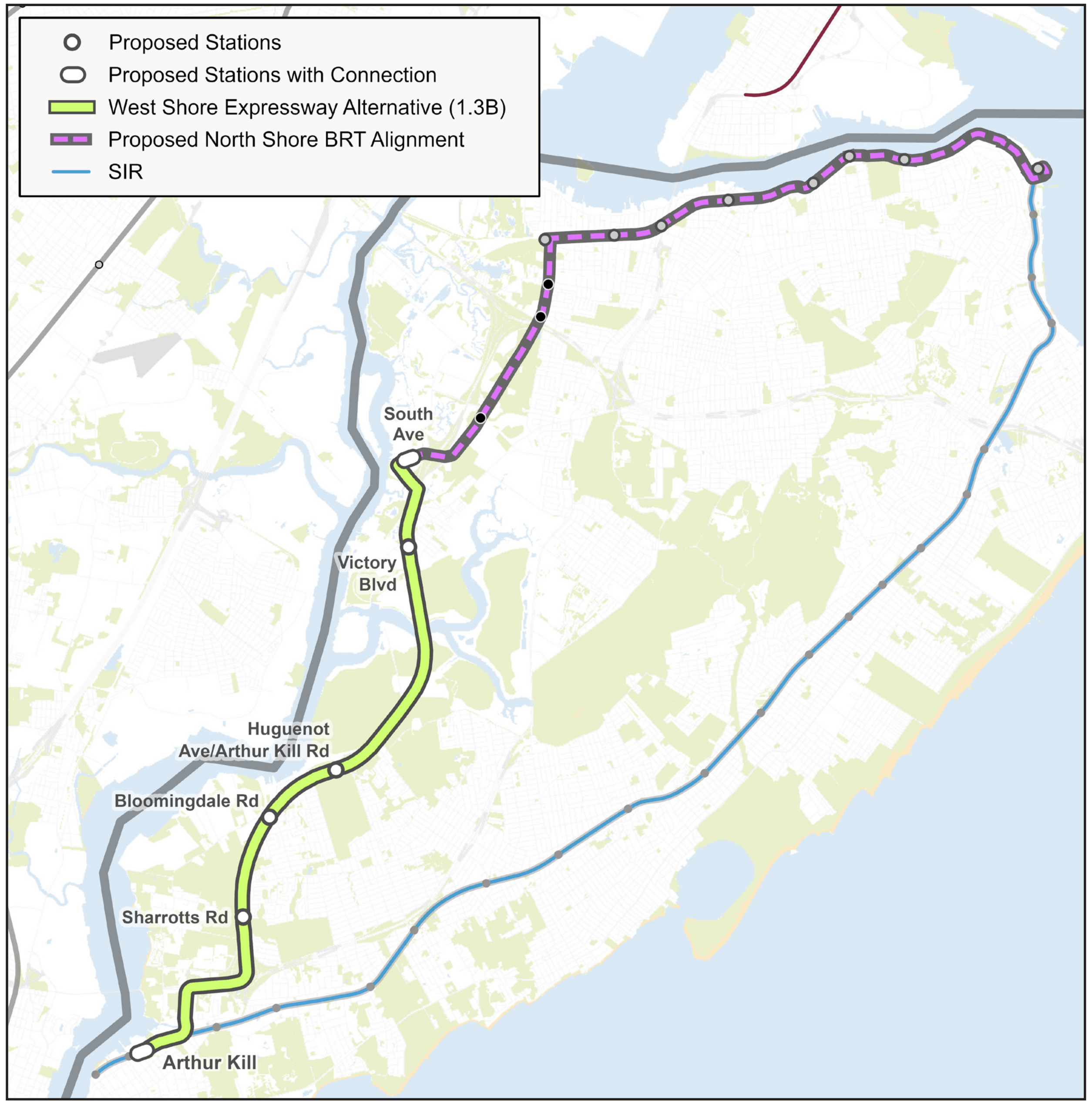
This project would provide better connections and reliability, resulting in significant travel time savings, but for a relatively small number of riders.

A new BRT route along Staten Island's Korean War Veterans parkway receives a high cost effectiveness score since it provides a significant reduction in travel time for project riders. It improves regional accessibility and receives a high score geographic distribution. It receives a low score in equity since about a third of riders are from equity areas. The reduction in vehicle usage is moderate and it receives an average score in sustainability. Resiliency is below average compared to other projects, but it would provide connections to three rail lines, one of which is NJ Transit LRT at Bayonne. It scores poorly in capacity since it does not meaningfully reduce crowding. For network leverage, it scores below average since its alignment is along City-owned right-of-way.

Staten Island West Shore Bus Rapid Transit

Alternative Considered: West Shore Expressway

Description: Bus Rapid Tranist along West Shore Expwy from Tottenville to North Shore.



Above, Staten Island West Shore BRT via West Shore Expressway

Evaluation results

Construction Cost (2027): $2.1 billion

Fleet Cost (2027): $16 million

Annual O&M Cost (2027): $24 million

Daily Ridership (2045): 8,200

New Daily Riders (2045): 800

Riders from Equity Areas (2045): 2,440

Travel Time Saved Per Trip (minutes): 12.8

Special Considerations:
The North Shore BRT project is part of the baseline for the West Shore Transit Improvements. Therefore, the West Shore Transit improvements could not occur until after North Shore BRT is operational.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$2.33/ min	90
Equity	Percent of riders from Equity Areas	30%	9
Sustainability	Change in daily vehicle miles traveled	-16,545	23
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	1	6
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-47 hours	0
Geographic Distribution	Change in regional accessibility	-10,613 hours	41
Network Leverage	Weighted average of MTA, Public and Private ROW	50%	33

Findings

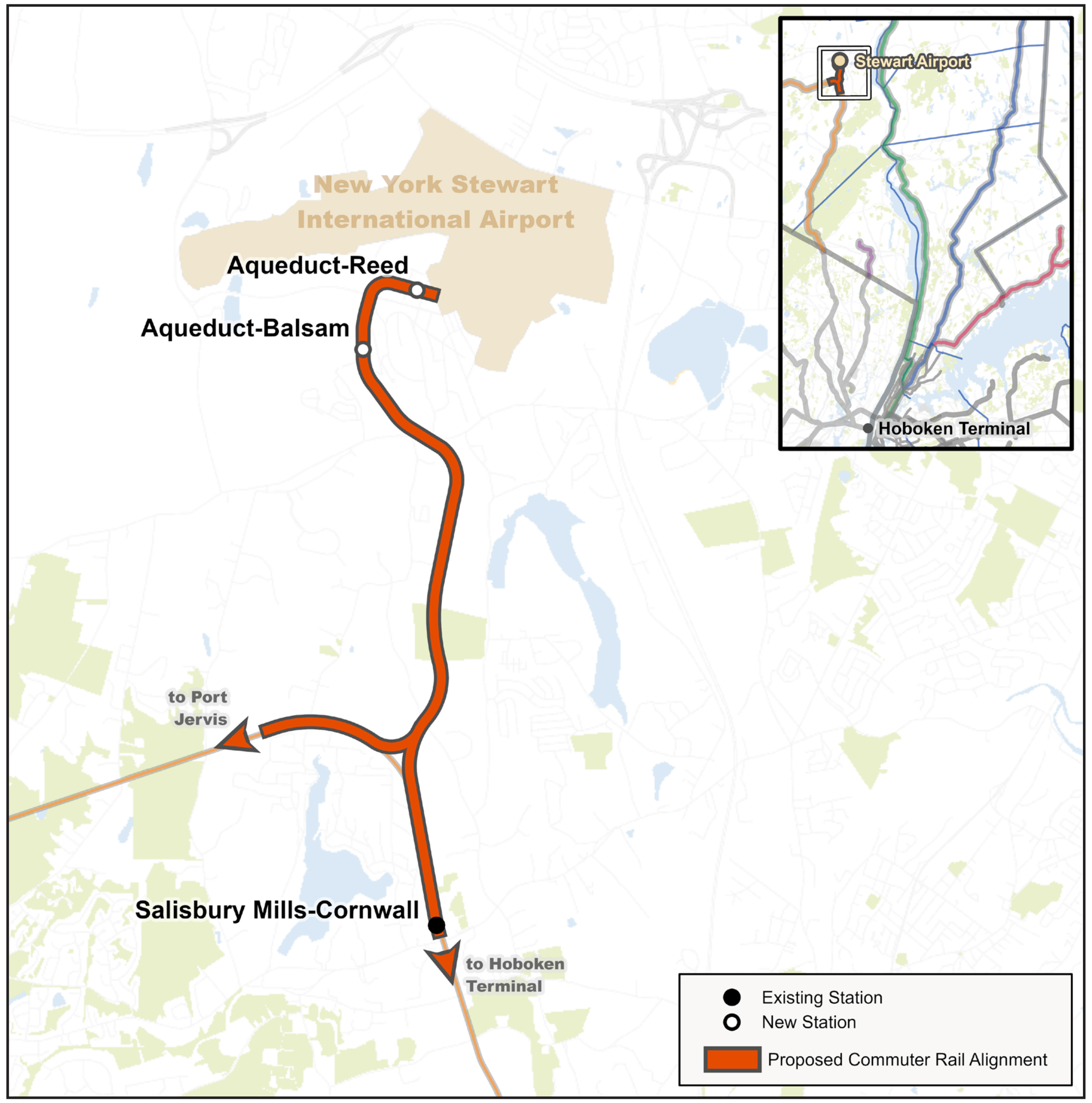
Routing the West Shore BRT via the West Shore Expressway is less cost effective than via the Korean War Veterans Parkway, as its ridership is lower while its cost is higher.

Stewart Airport Commuter Rail

Description: Implementation of new or improved transit service to Stewart International Airport (SWF). Several alternatives were analyzed, as listed below, although the Evaluation results on this page correspond to the Commuter Rail option.

- Bus from Beacon Station on the Metro-North Hudson Line
- Direct bus service from NYC
- Commuter rail extension from Salisbury Mill on the Port Jervis Line*
- Bus Rapid Transit from Salisbury Mills

Project objectives: Improve mobility and transit access between Orange County, Stewart International Airport and surrounding regions, Lower Hudson Valley, and New York City and reduce traffic and vehicle emissions to/from the airport.



Above, Stewart Commuter Rail Alternative

Evaluation results

Construction Cost (2027): $1.4 billion

Fleet Cost (2027): $461 million

Annual O&M Cost (2027): $43 million

Daily Ridership (2045): 4,300

New Daily Riders (2045): 1,900

Riders from Equity Areas (2045): 3,260

Travel Time Saved Per Trip (minutes): 7.9

Special Considerations:

Commuter rail extension from Salisbury Mills Station on the Port Jervis Line (PJL) to SWF would be the only alternative that MTA Metro-North would operate.

Direct Manhattan Service via Secaucus Loop, Gateway Program, Penn Station Expansion, other NJ improvements, and PJL improvements are a prerequisite.

Requires coordination with the PANYNJ, NYS DOT, and the Town of New Windsor.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$10.65/ min	**26**
Equity	Percent of riders from Equity Areas	75%	**68**
Sustainability	Change in daily vehicle miles traveled	-117,470	**100**
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	1	**6**
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	+3 hours	**0**
Geographic Distribution	Change in regional accessibility	+20,390 hours	**0**
Network Leverage	Weighted average of MTA, Public and Private ROW	30%	**7**

Findings

This project would attract relatively few riders at a high cost, and is dependent on additional long-term, high cost regional investments.

Construction of a commuter rail extension from the Port Jervis Line to Stewart Airport does not score well in most metrics. Cost effectiveness gets a low score mainly due to low ridership and the high cost. It does score above average in equity since many of its riders are from equity areas. Also, it reduces vehicle usage significantly, largely because it provides an alternative to driving to Stewart Airport therefore getting a high score in sustainability. It would only provide one new rail connection, resulting in a low resiliency score. It does not improve capacity or geographic distribution, both of which receive low scores. Network leverage gets a low score since MTA does not own the right-of-way along the proposed alignment.

Sunnyside Station (LIRR)

Description: Construction of a new Long Island Rail Road station in Sunnyside/Long Island City area.

Project objectives: Improve connectivity for Sunnyside and Long Island City neighborhoods to the existing network.

Above, Sunnyside Station (LIRR)

Evaluation results

Construction Cost (2027): $490 million

Fleet Cost (2027): N/A

Annual O&M Cost (2027): $2 million

Daily Ridership (2045): 7,900

New Daily Riders (2045): 900

Riders from Equity Areas (2045): 5,120

Travel Time Saved Per Trip (minutes): 1.6

Special Considerations:

Unique and complex station location at Harold Interlocking.

Coordination required with Amtrak, which owns the right-of-way.

Adds travel time for existing LIRR customers.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	No Time Saved*	0
Equity	Percent of riders from Equity Areas	65%	55
Sustainability	Change in daily vehicle miles traveled	-15,006	20
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	6	38
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	+1,216 hours	0
Geographic Distribution	Change in regional accessibility	-246,220 hours	100
Network Leverage	Weighted average of MTA, Public and Private ROW	38%	17

** No overall time savings due to increased travel for existing users.*

Findings

This project saves travel time for new riders but creates additional travel time for existing LIRR customers, resulting in no net time savings. Despite the relatively low cost, there are marginal benefits in an area already well served by transit.

A new LIRR station in Sunnyside/Long Island City is not cost effective even though it saves time for new riders, because it creates additional travel time for existing LIRR customers, resulting in no net time savings. It receives an average score for equity since more than half of the riders are from equity areas. It provides new connections to rail lines and scores average in resiliency, but the reduction in vehicle usage is lower than other projects and it receives a fair score in sustainability. The network leverage score is below average because MTA does not own the land required for this station.

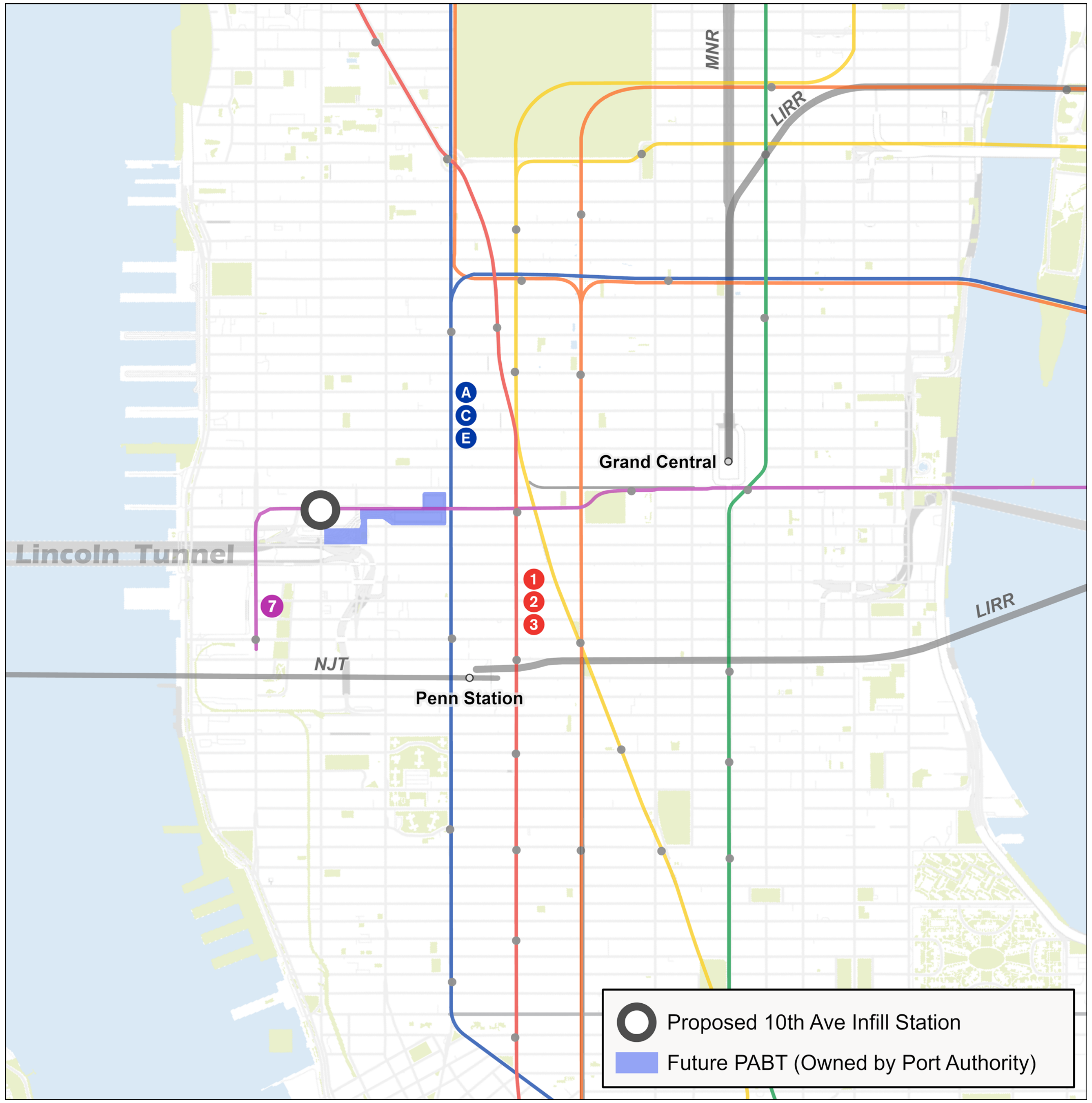
Feasibility of Other Alternatives:

In addition to creating a stop for LIRR service, creating a stop for Metro-North Penn Access Service at the proposed Sunnyside station was explored. Metro-North and Amtrak trains from the Hell Gate Line (connecting from points north) will follow the newly constructed Westbound Bypass through the busy Harold Interlocking to avoid interference with LIRR inbound services. Since the Westbound Bypass is climbing a grade from a tunnel at the location of the proposed Sunnyside Station, it is not physically possible to stop trains using the bypass at the Sunnyside platforms (which are already locationally constrained due to track geometry).

Tenth Av Station on the 7 Line

Description: Construction of a new subway station at 41 Street and 10 Avenue on the 7.

Project objectives: Shorten commute times to developing areas of Hudson Yards.



Above, 10th Ave Station on the Flushing 7 Line

Evaluation results

Construction Cost (2027): $1.9 billion

Fleet Cost (2027): $41 million

Annual O&M Cost (2027): $10million

Daily Ridership (2045): 55,000

New Daily Riders (2045): 600

Riders from Equity Areas (2045): 26,860

Travel Time Saved Per Trip (minutes): 0.9

Special Considerations:
Easement needed in CUNY building to lead to a 40th St station house; additional ventilation building has not been obtained.

Coordination with PANYNJ needed to ensure new bus terminal does not encorach on station envelope, minimizes elemnts that would prevent the station from being built via cut and cover, and to understand potential connections between new bus terminal and station.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$81.29/ min	0
Equity	Percent of riders from Equity Areas	49%	34
Sustainability	Change in daily vehicle miles traveled	-198	0
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	3	19
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-1,086 hours	26
Geographic Distribution	Change in regional accessibility	-1,023 hours	3
Network Leverage	Weighted average of MTA, Public and Private ROW	100%	100

Findings

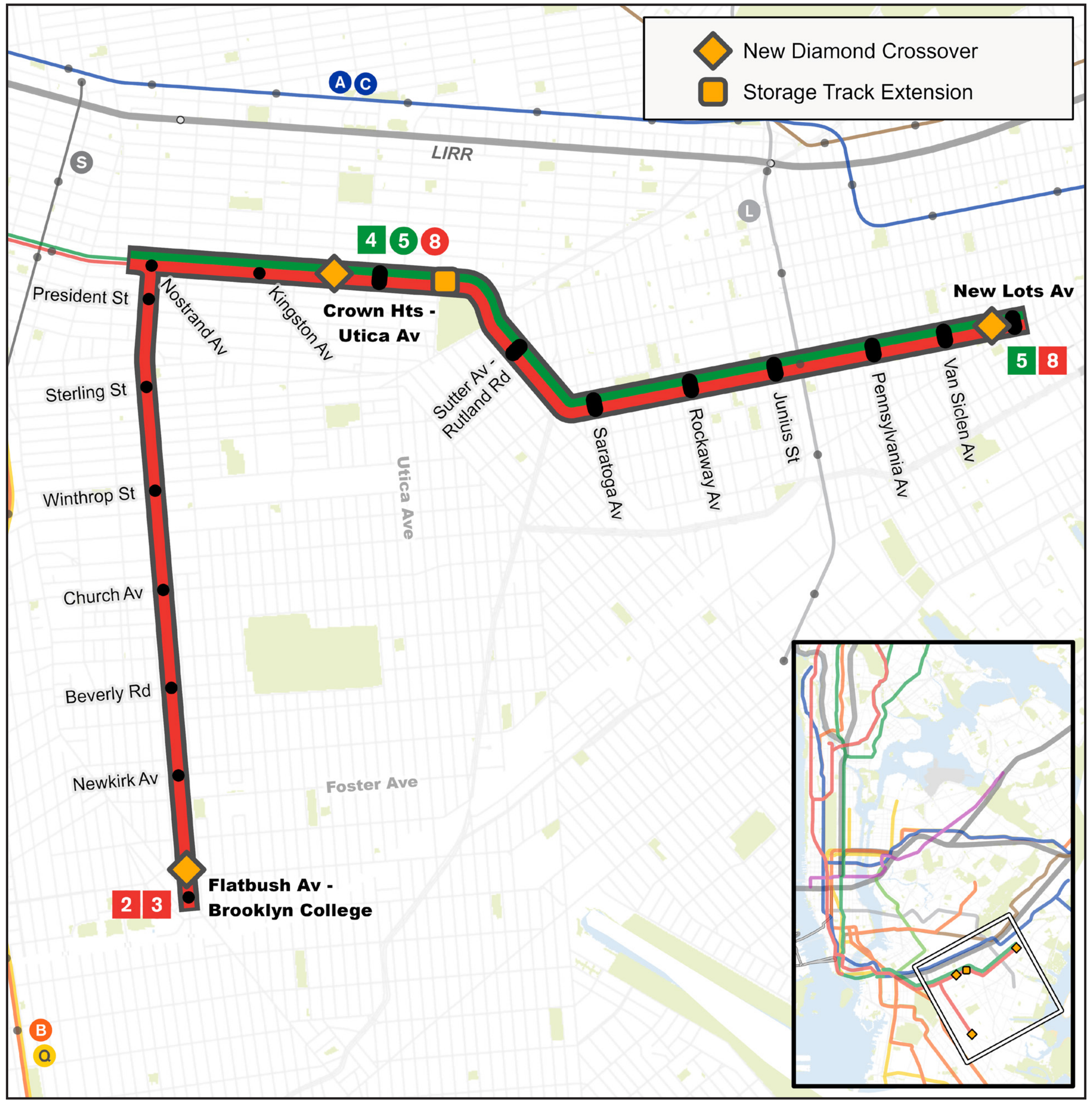
This project has a high cost in relation to the benefits that it provides. While it would shorten travel times slighlty for a small number of new riders, it would add travel time for existing riders to or from 34th St.

An infill station on the 7 line would shorten commute times for some customers traveling to and from emerging areas of Hell's Kitchen and Hudson Yards, but the project would have a significant construction cost and would not substantially decrease crowding or expand accessibility regionally, since it serves an area already served by other transit lines. The project would reduce the travel times for those using the station by 1 minute, but it would increase the travel times of those traveling through the station by 1 minute as well, resulting in small overall time savings in relation to the cost of the project. The project does not perform well in serving riders from equity areas in relation to other projects. It scores well in network leverage since it's within the MTA's right-of-way.

Utica Nostrand Junction Capacity Improvements

Description: Construction of subway improvements, including three new crossovers at the Brooklyn IRT (numbered lines) terminals and extended storage tracks south of Crown Heights-Utica Av to alleviate the Nostrand Junction chokepoint and improve service.

Project objectives: Boost service reliability and capacity by mitigating congestion issues at Nostrand Junction. Addresses major bottlenecks, enhance operations, and reliability. Increase service capacity for existing customers of the ②③④⑤ lines not just in Brooklyn, but also in Manhattan and the Bronx.



Above, Utica Nostrand Junction Capacity Improvements

Evaluation results

Construction Cost (2027): $410 million

Fleet Cost (2027): $224 million

Annual O&M Cost (2027): $24 million

Daily Ridership (2045): 319,900

New Daily Riders (2045): 8,700

Riders from Equity Areas (2045): 295,080

Travel Time Saved Per Trip (minutes): 1.7

Special Considerations:
Subway improvements are required to add capacity and remove Nostrand Junction bottlenecks; this is a separate project and is assumed as a baseline condition for for Utica Avenue transit improvements.

Branch to Flatbush Av-Brooklyn College loses direct service requires cross-platform transfer to Lexington Av line weekdays

Service Plan:

②③ lines to/from Flatbush Av-Brooklyn College

④⑤ lines to/from Crown Heights-Utica Av and New Lots Av

A new ⑧ line to/from New Lots Av with local stops at Nostrand Av and Kingston Av

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$0.28/ min	100
Equity	Percent of riders from Equity Areas	92%	91
Sustainability	Change in daily vehicle miles traveled	-55,752	77
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	2	13
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-13,078 hours	100
Geographic Distribution	Change in regional accessibility	-43,841 hours	100
Network Leverage	Weighted average of MTA, Public and Private ROW	100%	100

Findings

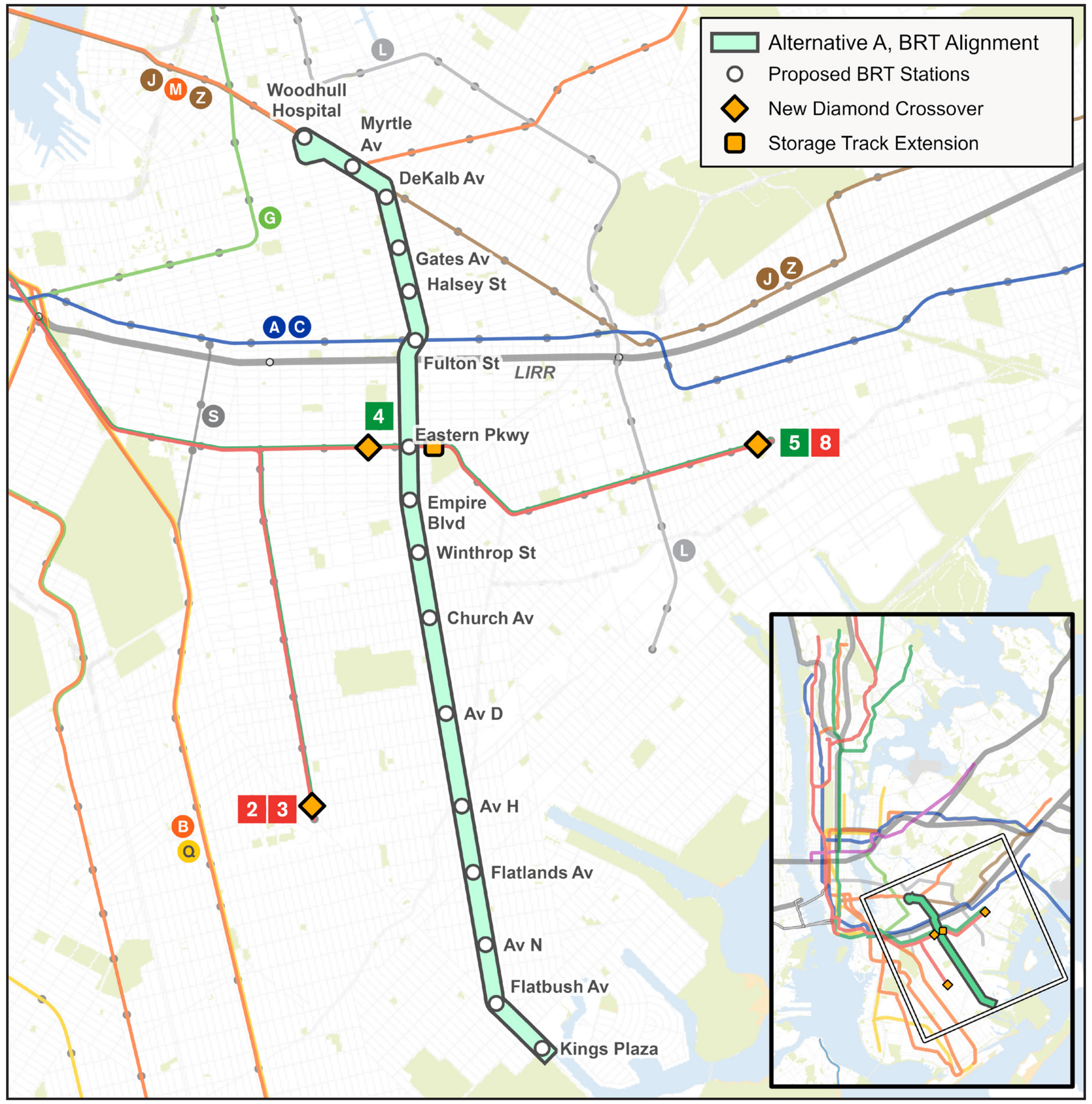
This project alleviates a major chokepoint at Nostrand Junction, resulting in significant benefits for customers along the entirety of some of the busiest subway lines, and increases service on ②③. It reduces travel times for thousands of riders, many of them from equity areas.

The Utica Nostrand Junction Capacity Improvements scores very well in most metrics, with a low cost for total time saved, high ridership, high number of riders from equity areas. The subway improvements scores very well in reducing passenger hours of crowding, improves regional accessibility and scores highly in equity. The project reduces crowding on the ③④⑤ lines.

Utica Alt A: BRT (Kings Plaza to Woodhull Hospital)

Description: Implementation of enhanced transit services along the Utica Avenue Corridor in southeast Brooklyn by considering several options, with subway improvements as part of the baseline. Alternative A consists of a Bus Rapid Transit (BRT) route between Kings Plaza and Woodhull Hospital. with center running BRT lanes and stations.

Project objectives: Improve travel options for intra- and inter-borough travelers in underserved communities to activity centers; provides opportunities for development and growth near stations; address major bottlenecks and enhances service for existing customers of the 2 3 4 5 lines as well as the B46 local and B46-SBS bus customers, one of the city's busiest bus corridors.



Above, Utica Alt A: BRT (Kings Plaza to Woodhull Hospital)

Evaluation results

Construction Cost (2027): $220 million

Fleet Cost (2027): N/A

Annual O&M Cost (2027): $6 million

Daily Ridership (2045): 71,900

New Daily Riders (2045): 3,900

Riders from Equity Areas (2045): 67,810

Travel Time Saved Per Trip (minutes): 3.9

Service Plan:

2 3 lines to/from Flatbush Av-Brooklyn College

4 line to/from New Lots Av and Crown Heights-Utica Av

5 to New Lots Av and Crown Heights-Utica Av

8 to New Lots Av

BRT (Alt A): BRT replaces B46 local/SBS between Woodhull Hospital and Kings Plaza

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$0.32/ min	100
Equity	Percent of riders from Equity Areas	94%	94
Sustainability	Change in daily vehicle miles traveled	-16,692	23
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	6	38
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	+3,674 hours	0
Geographic Distribution	Change in regional accessibility	-6,484 hours	24
Network Leverage	Weighted average of MTA, Public and Private ROW	59%	45

Findings

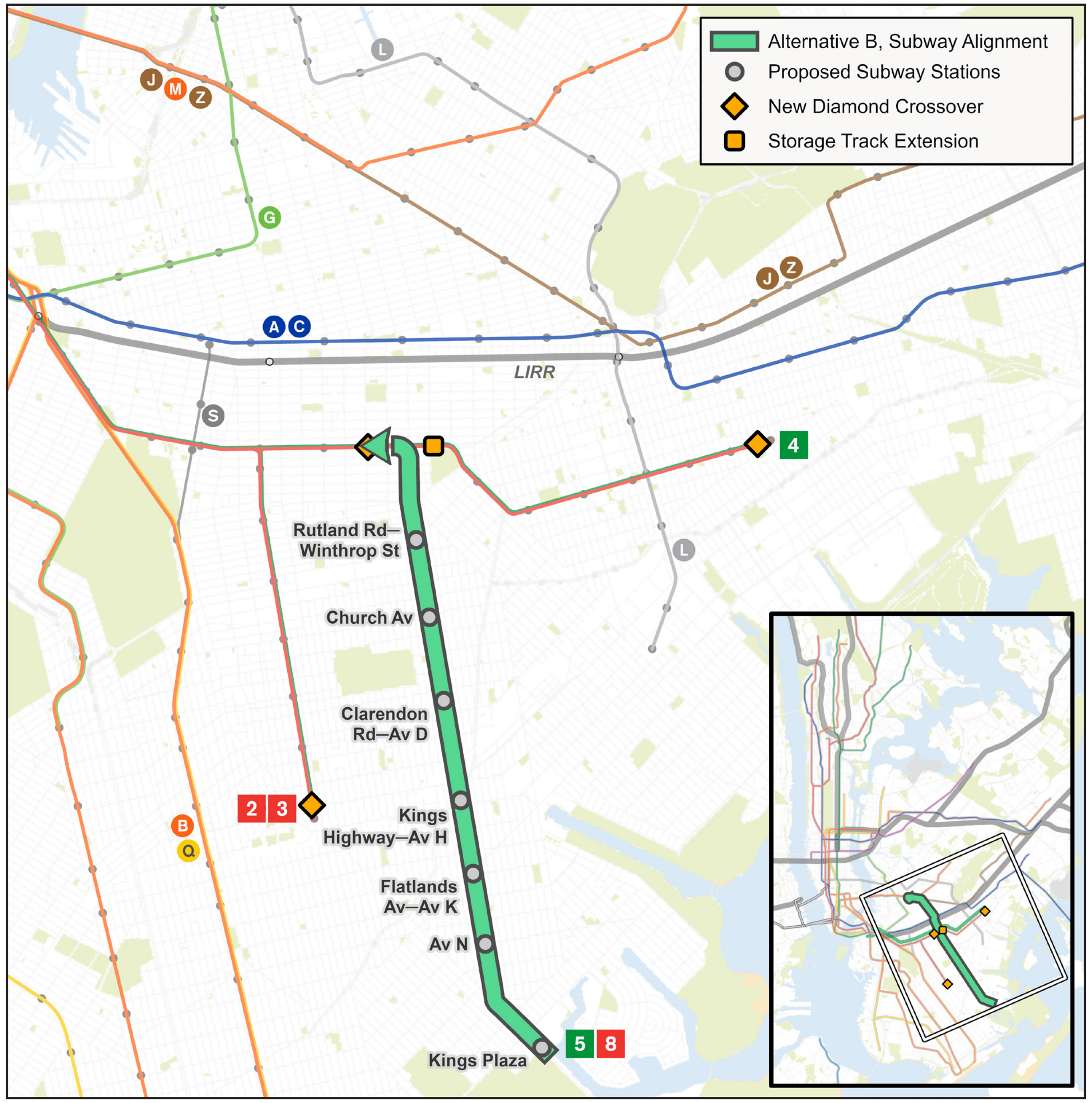
Utica Alt A BRT does very well in cost effectiveness and equity.

A BRT route between Kings Plaza-Woodhull Hospital receives a high cost effectiveness score due to its relatively low cost, high ridership and moderate time savings. It also scores highly in equity with most of its riders from equity areas. Since the BRT would extend north of Utica Avenue, it would provides rail connections to the A C J M, as well as the 4 5 at Utica Avenue, resulting in an average resiliency score. The reduction in vehicle usage is moderate in relation to other projects and it receives average scores in sustainability. This BRT option scores poorly in capacity since it would result in a net increase in crowding due to transfers to the subway, increasing it on others that are at or near capacity already. Regional accessibility is improved but is relatively low compared to other projects and scores below average. Since most of the BRT alignment is on New York City-owned streets and not on MTA property, it gets an average network leverage score.

Utica Alt B: Subway to Kings Plaza

Description: Implementation of enhanced transit services along the Utica Avenue Corridor in southeast Brooklyn by considering several options, with subway improvements as part of the baseline. Alternative B consists of a subway extension to Kings Plaza.

Project objectives: Improve travel options for intra- and inter-borough travelers in underserved communities to activity centers; provides opportunities for development and growth near stations; address major bottlenecks and enhances service for existing customers of the 2 3 4 5 lines as well as the B46 local and B46-SBS bus customers, one of the city's busiest bus corridors.



Above, Utica Ave Alt B: Subway to Kings Plaza

Evaluation results

Construction Cost (2027): $15.9 billion

Fleet Cost (2027): $246 million

Annual O&M Cost (2027): $124 million

Daily Ridership (2045): 55,600

New Daily Riders (2045): 2,900

Riders from Equity Areas (2045): 48,070

Travel Time Saved Per Trip (minutes): 9.0

Service Plan:

2 3 lines to/from Flatbush Av-Brooklyn College

4 line to/from New Lots Av

5 line to/from Kings Plaza

8 line to/from Kings Plaza with local stops at Nostrand Av and Kingston Av

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$4.80/ min	**71**
Equity	Percent of riders from Equity Areas	86%	**83**
Sustainability	Change in daily vehicle miles traveled	-30,917	**42**
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	2	**13**
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-3,364 hours	**81**
Geographic Distribution	Change in regional accessibility	-13,184 hours	**51**
Network Leverage	Weighted average of MTA, Public and Private ROW	59%	**45**

Findings

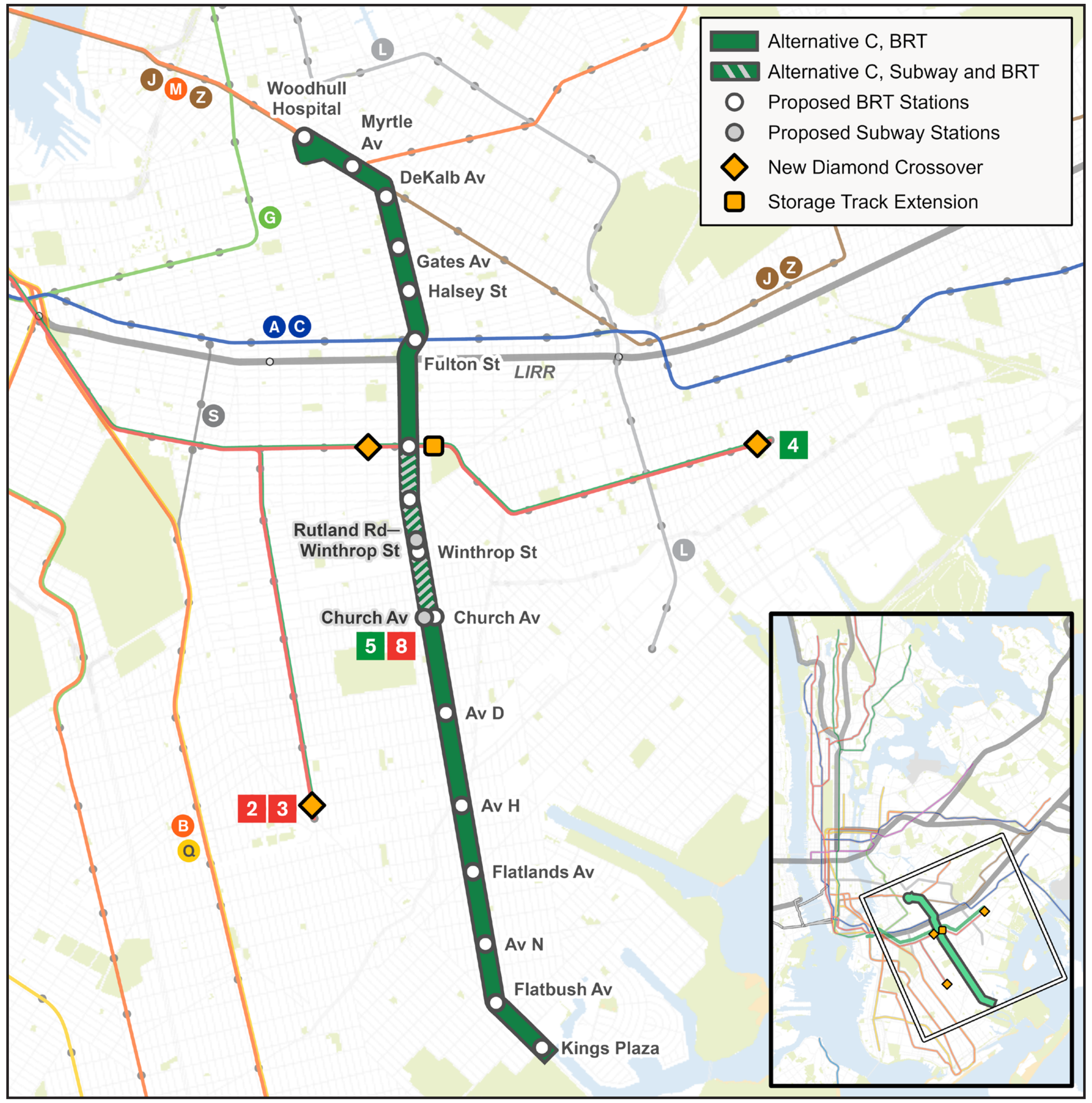
Utica Alt B is in the middle when it comes to cost effectiveness, mainly because of travel time savings and high ridership. However, cost is extremely high, especially in comparison to the Utica Alt A BRT, which also delivers significant benefits for a fraction of the cost.

A full subway extension to Kings Plaza along Utica Avenue (Alt B) receives an above average cost effectiveness score mainly due to the travel time savings it provides project riders, though it is very expensive. It scores well in equity with the majority of its riders from equity areas. With only two new rail connections, it receives a low score in resiliency, because, unlike the BRT, the subway extension would not provide new connections to the A C J M north Utica Avenue. It would reduce vehicle usage enough that it receives an average score in sustainability. This subway extension has the potential to reduce crowding systemwide and gets a average score for capacity. Similarly, it would improve regional accessibility somewhat, and gets an average score for geographic distribution. Since most of the subway alignment is on New York City-owned streets and not on MTA property, it gets an average network leverage score.

Utica Alt C: Subway to Church Avenue and BRT

Description: Implementation of enhanced transit services along the Utica Avenue Corridor in southeast Brooklyn by considering several options, with subway improvements as part of the baseline. Alternative C consists of a subway extension to Church Avenue and a Bus Rapid Tranist route between Kings Plaza and Woodhull Hospital.

Project objectives: Improve travel options for intra- and inter-borough travelers in underserved communities to activity centers; provides opportunities for development and growth near stations; address major bottlenecks and enhances service for existing customers of the ② ③ ④ ⑤ lines as well as the B46 local and B46-SBS bus customers, one of the city's busiest bus corridors.



Above, Utica Ave Alt C: Subway to Church Ave and BRT

Evaluation results

Construction Cost (2027): $6.8 billion

Fleet Cost (2027): $186 million

Annual O&M Cost (2027): $23 million

Daily Ridership (2045): 81,200

New Daily Riders (2045): 7,300

Riders from Equity Areas (2045): 75,680

Travel Time Saved Per Trip (minutes): 7.3

Service Plan:

② ③ lines to/from Flatbush Av-Brooklyn College

④ line to/from New Lots Av

⑤ line to/from Church Av

⑧ line to/from Church Av with local stops at Nostrand Av and Kingston Av

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$1.59/ min	96
Equity	Percent of riders from Equity Areas	93%	92
Sustainability	Change in daily vehicle miles traveled	-39,094	54
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	6	38
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-4,121 hours	100
Geographic Distribution	Change in regional accessibility	-12,715 hours	49
Network Leverage	Weighted average of MTA, Public and Private ROW	59%	45

Findings

Utica Alt C is in the middle when it comes to cost effectiveness, mainly because of travel time savings and high ridership. However, the cost is extremely high, especially in comparison to the Utica Alt A BRT, which also delivers significant benefits for a fraction of the cost.

A partial subway extension to Church Avenue along Utica Avenue (Alt C) receives an above average cost effectiveness score mainly due to the travel time savings for a significant number of riders in a dense portion of Brooklyn, though it is still quite expensive. It scores well in equity with the majority of its riders from equity areas. It provides six new rail connections and receives an average score in resiliency, and an above average score in sustainability due to a significant reduction in vehicle usage. This partial subway extension gets average scores in capacity and geographic distribution since it does result in some crowding reductions and improves regional accessibility. Since most of the alignment is on New York City-owned streets and not on MTA property, it gets an average network leverage score.

W to Red Hook

Description: Extension of the W line from Whitehall Street in Manhattan through the Montague Street Tunnel to Red Hook, Brooklyn with three additional new stations at Columbia St, Atlantic Basin, and Red Hook.

Project objectives: Increase service and transit options for communities in Red Hook; reduce travel times between Red Hook and Lower Manhattan; and provide opportunities for development and growth near stations.

Above, W to Red Hook

Evaluation results

Construction Cost (2027): $11.2 billion

Fleet Cost (2027): $295 million

Annual O&M Cost (2027): $68 million

Daily Ridership (2045): 7,600

New Daily Riders (2045): 100

Riders from Equity Areas (2045): 1,743

Travel Time Saved Per Trip (minutes): 2.4

Special Considerations:
Significant project risks include:

- Breaking through Montague Tube's cast-iron lining.
- Constructing a grade separated turnout under Furman Street.
- Avoiding potential conflicts with BQE triple cantilever reconstruction and the Red Hook Interceptor Sewer.

<20
20-39
40-59
60-79
>=80

Scorecard

Criteria	Metrics	Result	Score (0-100)
Cost, Ridership & Time Savings	Cost/Time saved (30 years)	$90.46 /min	0
Equity	Percent of riders from Equity Areas	23%	0
Sustainability	Change in daily vehicle miles traveled	-1,154	1
Resiliency	Rail connections within ½ mile (NYC) or 5 miles (suburbs)	0	0
Capacity	Change in passenger hours of crowding systemwide *(AM peak period)*	-8,012 hours	100
Geographic Distribution	Change in regional accessibility	-1,297 hours	4
Network Leverage	Weighted average of MTA, Public and Private ROW	65%	53

Findings

The project performs poorly due to its high cost in relation to its benefits. Despite reducing crowding, the project would attract relatively few riders, while providing no significant improvements in time savings, geographic distribution, or percentage of equity riders.

Extending the W line to Red Hook gets a low score in cost effectiveness due to its high cost and low ridership. It does not score well in equity with less than a quarter of its riders from equity areas. It reduces vehicle usage slightly, but in comparison to other projects, it gets a below average score in sustainability. Only one new rail connection is provided resulting in a low score in resiliency. This project scores very well in capacity since it reduces crowding on existing subway lines by providing an alternative to the 4 5 2 3 R N lines serving Brooklyn, and improves crowding on the 6 by providing additional service on the parallel W. Geographic distribution receives a low score, relative to other projects, since the regional accessibility improvement is small. The network leverage score is average because only about a third of the alignment is on MTA owned right-of-way.