MBTA Resilience Roadmap

Spring 2026

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Figure 1: A snowplow clears a boarding platform during a winter weather event.

Executive Summary

The Resilience Roadmap is the result of dozens of conversations with staff across the organization whose jobs are impacted by climate change. It builds on past analysis and planning, staff expertise, and best practices to outline nine priorities:

1. **Improve the resiliency of the power system**
2. **Address flooding in tunnels and right-of-way**
3. **Reduce employee and passenger exposure to extreme heat**
4. **Address flooding at support facilities**
5. **Address flooding at stations**
6. **Increase signal and communication systems' resilience to extreme temperatures**
7. **Increase track's resilience to extreme heat**
8. **Leverage internal capacity to strengthen climate planning**
9. **Collaborate externally to advance regional resilience**

Each priority contains goals and strategies, including departments responsible for implementation and the timelines within which they should be addressed. Key recommendations are listed in Figure 3.

This work will not be accomplished overnight, and it will require a multi-pronged approach. The Resilience Roadmap will guide the MBTA's decisions as we invest in our assets, prepare the system for future climate disruptions, and collaborate regionally in a dynamic environment. The roadmap will be updated every five years to account for that changing environment, take stock of progress, and chart the path forward for future work.

Figure 2: A bus operating during a heavy precipitation event.

Key Recommendations:

Regional Partnerships and Studies:

- Power System and Climate Vulnerability
- Scenario planning to align long-term capital strategy and climate resiliency strategy
- Evaluate opportunities for district-scale solutions

Capital Investments:

- Airport Portal Flood Door
- Orient Heights Flood Mitigation
- Cabot Yard Flood Mitigation

Operational Changes:

- Implement advanced preventative maintenance program for drainage infrastructure
- Incorporate extreme heat into Severe Weather Operations Plan
- Test 2 – 3 insurer approved deployable flood barriers to establish preferences

Figure 3: Key recommendations of the Resilience Roadmap

Acronyms and Contributors

The following acronyms are used throughout the document:

BH-FRM: Boston Harbor Flood Risk Model

CCVA: Climate change vulnerability assessment

MC-FRM: Massachusetts Coastal Flood Risk Model

ROW: Right of way

SGR: State of Good Repair

SLR/SS: Sea level rise / storm surge

SOP: Standard operating procedure

The creation of this roadmap would not have been possible without the contributions of individuals and teams across the MBTA. Special thanks to:

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The MBTA's Approach to Climate Resilience

A resilient MBTA is key to a resilient Commonwealth.

Residents and visitors alike depend on the safe, continuous operation of the MBTA to travel to the places where they work, live, and play. Decisions we make today can help ensure the MBTA will continue to fulfill this mission in the future and provide a low-carbon transportation option that advances the climate goals of the Commonwealth.

Providing high-quality service requires 1) a well-staffed workforce with the skills necessary to operate the system; 2) sufficient funding to deliver robust service and maintain state of good repair (SGR); and 3) investment and preparation for external threats, such as climate change.

Climate resilience at the MBTA encompasses activities to plan for, mitigate and adapt to risks from adverse climate impacts to minimize disruption and rapidly restore service where disrupted. It includes a multi-pronged approach that addresses impacts to riders, workforce, and infrastructure (see Figure 4). Safety of both riders and workers is essential to resilience at the MBTA; resilience in turn enhances safety and functionality of service.

The work is interconnected and efforts to address one aspect of resilience can reinforce the strength of another; for example, a more resilient workforce can lead to more resilient infrastructure, which can lead to more resilient service for riders.

The MBTA's dedication to building climate resilience is reflected in its strategic goals, including one to **"Increase the environmental sustainability and resilience of our transit system."**

Past work further demonstrates this commitment, including developing:

- Climate change vulnerability assessments;
- Standards to incorporate climate risk into capital projects;
- Operational changes to respond to climate risk;
- Flood protection infrastructure; and
- New staff positions to advance this work.

In 2024, the MBTA released its Climate Assessment to take stock of the MBTA's climate mandate and achievements to date, articulate a vision for future resilience and sustainability work, and identify key next steps to implement climate goals. **Action 1.1 of the Assessment was to develop a systemwide resilience plan that leveraged prior work to define a path forward across assets.**

The following roadmap answers that call and identifies **nine focus areas** where the T must actively work to build a more resilient transit system for the region. Ensuring reliable service and functionality over time will require a balance of short- and long-range capital and operational interventions, including investing for a State of Good Repair while anticipating future needs.

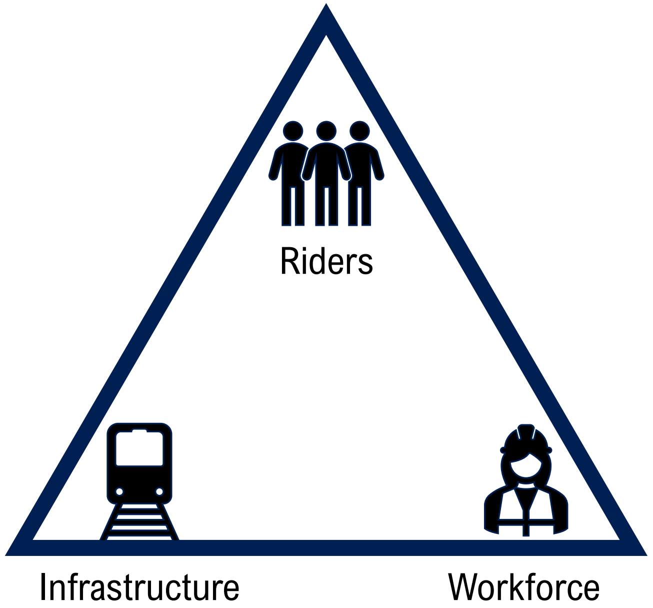

Figure 4: Three components of climate resilience at the MBTA.

The MBTA's climate resilience approach includes strategies that address climate impacts to our riders, workforce, and infrastructure.

However, climate resilience does not fit neatly into buckets – progress requires interdisciplinary work, breaking down silos, and tackling many problems at once. There are many strategies listed within these broader topic areas that the organization must pursue over the next five years, but it is critical that the MBTA remains nimble and responsive to a changing landscape.

While this approach might mean that the specific strategies we pursue shift, the MBTA's climate resilience work will continue to:

- **Evaluate** climate vulnerabilities to understand potential risk and options to address them.
- **Embed** climate risk into decisions to leverage cross-departmental work and deliver impactful projects and programs.
- **Engage** local, regional, and state partners to share data, develop innovative solutions, and be a part of the solution for the communities we serve.

This work will change and evolve, and an adaptive approach will be a stronger one. This is especially true given the interconnectedness of the MBTA's resiliency actions and the actions of the communities the T serves.

Climate resiliency is a big, complex challenge, and some solutions will require a big, coordinated approach. It is critical that the MBTA moves forward swiftly with identified strategies across the agency; **it is equally important that the organization considers broader questions of regional resilience that stretch further into the future than this roadmap can address – to 2050, 2070, and beyond.**

The Resilience Roadmap has four goals, shown below in Figure 5.

Goals of the Resilience Roadmap

1. Synthesize climate hazards and their impacts across asset classes.
2. Identify and prioritize strategies to address climate risks.
3. Integrate with existing asset-based and capital planning efforts.
4. Provide clear messaging on climate priorities to internal and external partners.

Figure 5: The four goals of the Resilience Roadmap

Climate Hazards: Sea-Level Rise & Extreme Precipitation

MBTA staff have completed numerous climate change vulnerability assessments (CCVAs) to categorize the near- and long-term climate vulnerabilities from the following hazards:

Sea-Level Rise and Storm Surge. Coastal flooding from sea-level rise and storm surge is the most consequential climate hazard facing the MBTA. Inundation events can damage or disrupt power, communications, and signaling equipment. In addition to the acute impacts of flooding, latent damage from exposure to corrosive salt water can impact track infrastructure, including the third rail.

The MBTA has already experienced impacts from storm surge: in 2018, Boston experienced the largest tide swell since 1978 with a 12-foot tide and 3-foot storm surge, inundating Aquarium Station and closing the stop.[1]

Extreme Precipitation. Extreme precipitation can create inland flooding events that disrupt service, damage equipment, and shorten the lifespans of critical assets. When drainage and pump room systems are overwhelmed by rainfall, water can pool near the track – impacting service and critical equipment located along the right of way. Repairs can be time intensive and expensive. Even in the event that an asset does not need to be replaced, repeated exposure to water can degrade the asset and reduce its expected useful life and move assets out of SGR earlier than anticipated.

Below-grade stations are at increased risk of damage from flooding, but stations at or above grade may be vulnerable in the future.

In September of 2023, Leominster experienced 9.5 inches of rain over 24-hours, washing out key commuter rail infrastructure, including a culvert. Storms like this could be more routine in the future – by 2030 and 2070 respectively, regular rain events are anticipated to yield 8.6 and 9.8 inches of precipitation over 48-hours, a 22-40% increase over baseline precipitation events.[2] A culvert washout prevention program is detailed on p. 23.

Figure 6: Flooding in Leominster, Photo by Joshua Qualls, MA Governor's Press Office

Climate Hazards: Extreme Temperatures & Wind

Extreme Temperatures. Extreme heat is a growing threat in Massachusetts. According to the 2022 Massachusetts Climate Change Assessment, "by 2030, the average summertime temperature will feel like summers in New York; by 2050, like Maryland; by 2070, like North Carolina; and by 2090, summer in Massachusetts could feel like summer in Georgia today."[3] In the Boston metro area, there may be four times as many days above 90 degrees by 2030 (40 days) and nine times by 2070 (90 days).[3]

Temperatures over 90 degrees can cause significant damage to the transit system itself. Rail tracks warp and buckle, overhead catenary sags, signals and track sensors malfunction, and electrical systems overheat – all leading to impacts to service. Heat can also cause broader disruptions to the electricity grid and create power outages, which has significant implications for the MBTA as the Commonwealth's largest consumer of electricity.

The number of days over 90 degrees will grow by…

4X by 2030

9X by 2070

Prolonged and more extreme heat exposure has impacts on MBTA employees and riders, too. The risks of heat exhaustion, heat stress, and heat stroke can escalate quickly and impact riders and workers alike, especially those with pre-existing conditions such as cardiovascular diseases, respiratory diseases, and diabetes.

Snow, ice, and extreme cold are also climate hazards. While annual snowfall is anticipated to decrease, individual snow events will be more intense and could impact above-ground stations and assets. Snowstorms and ice can limit station and track access, weigh down catenary lines, cause equipment to malfunction, and lead to track separation. There may also be cascading impacts through the power system if the electrical grid is damaged due to downed power lines.

During the winter of 2015, Boston experienced what is locally known as "Snowmageddon," a set of snowstorms that ravaged the area for weeks. Across the season, the area received 110.6 inches of snow, 95 of which dropped between January 24th and February 22nd in a series of 4 consecutive storms.[4] The MBTA system experienced mechanical failures that led to long service delays for the commuter rail and subway lines.

Wind. Wind impacts above-ground stations and assets, knocking over signals, stressing bridges and structures, and causing trees and debris to foul the right-of-way and damage power lines. Additionally, wind speeds above 50 mph can cause slowed travel or obstructions to the rail lines. The intensity and frequency of future windstorms are hard to estimate; however, they are likely to coincide with more intense projected storms.

Figure 7: Snowstorm near Boylston Station

Past Climate Change Resilience Work

The MBTA has been working to understand the threats that climate change and severe weather pose by using the best available climate hazard data from the Massachusetts Energy and Environmental Affairs' Office of Climate Science. This includes the Massachusetts Coastal Flood Risk Model (MC-FRM), which provides state of the art, analysis-ready probabilistic coastal flood projections. Prior to the MC-FRM, the Boston Harbor Flood Risk Model (BH-FRM) was utilized.

CCVAs leverage data sources such as the MC-FRM, site visits, and the experiences of frontline staff to provide high-level, indicator-based, screening assessments of climate vulnerability for stations, maintenance facilities, and sections of guideway.

Components of Vulnerability

Exposure, or the degree to which the asset is experiencing, or is projected to experience, weather and climate stressors

Sensitivity, or the impact on the asset when exposed to weather and climate stressors

Adaptive capacity, or the ability to adjust to, or cope with, weather and climate stressors

Figure 8: The three components of vulnerability scores

The scope of these studies range from entire rapid transit lines to critical sites. Additional, forthcoming high priority analyses are identified on p. 43. For more detail on any of the assets mentioned in this document, please reference the Capital Needs Assessment and Inventory (CNAI). CCVAs have been completed for the following:

All Rapid Transit Lines (2018 – 2022)

In-depth, comparable assessments that scored the stations, maintenance yards, and guideway sections for their overall vulnerability, including:

Blue Line (2018, 2022): Sea level rise and storm surge are major concerns throughout the Blue Line. Orient Heights Yard, the sole maintenance facility, is vulnerable to coastal and precipitation-based flooding. This is the most vulnerable rapid transit line, and flooding poses risks to its stations, guideway, and maintenance facility.

Red Line and Mattapan Line (2021): Maintenance facilities on the Red Line are highly vulnerable to flooding, including Cabot Yard and Tenean Yard. Additionally, several stations are vulnerable to precipitation-based and sea level rise-based flooding by 2030 and 2070.

Orange Line (2021): Heavy precipitation and sea level rise and storm surge are the predominant threats to Orange Line stations and guideway, especially at North Station and Sullivan Square Station. Drainage issues along the Southwest Corridor pose particular challenges during heavy precipitation events.

Green Line (2022): Wind and extreme temperatures are the dominant threats on the Green Line where stations and guideway are more often outdoors rather than underground. Drainage issues pose potential issues at all three maintenance facilities, and flooding poses a risk to Green Line assets closer to the downtown core.

Silver Line Tunnel Flood Vulnerability & Protection (2024)

Detailed study of flooding vulnerabilities of the Silver Line Tunnel between the Portal Opening on D street and Courthouse Station, including the World Trade Center Station. The study identified vulnerable assets and preferred mitigation strategies at key locations.

Pump Room Inventory & Drainage (2019, 2021, and 2023)

Pump rooms help mitigate the impacts of water intrusion from routine events and extreme storms. Three detailed studies of pump room systems catalogued the MBTA's 51 pump rooms, assessed their condition, and identified the potential for remote monitoring. Recommendations from these studies informed the development of the Systemwide Tunnel Flood Mitigation Program, which includes a ranked priority list of pump room projects to pursue.

Power, Signals, & Communications Systems (2021)

A preliminary analysis of power, signals, and communications systems on the Red, Blue, Orange, Green, and Silver lines, including 1,200 power assets, 1,780 signal assets, and 575 communications assets.

- **Power Assets.** Numerous assets exposed to flooding - by 2070 all switching stations will be exposed, and traction power and unit substation exposure increases 2.5 times by 2070. Wind and ice already pose a threat to overhead catenary, and the risk of power system failure from extreme heat increases over time.
- **Signals Assets.** Signal assets can malfunction and fail during extreme heat, and saltwater flooding can corrode equipment and lead to failure.
- **Communications Assets.** Communications assets are vulnerable to extreme heat and flooding. Without cooling capacity in communications rooms, electrical equipment can overheat and fail. Additionally, communications rooms in flooding prone areas (Aquarium, Maverick, Sullivan Square, JFK-UMass) can be damaged by water infiltration.

Bus Facilities (2020)

A preliminary analysis using coastal flood models (BH-FRM) and FEMA flood maps to evaluate 11 bus facilities and understand expected frequency of coastal flooding and impact to bus network performance in the event of disruption. The Lynn Garage is at a high risk of frequent and severe flooding by 2030, and further analysis is currently underway. Quincy Garage, which was proposed during the time of the study and is now under construction, incorporated flood resilient design elements to mitigate future flood risk.

Commuter Rail Facilities and Parking Lots (2022)

A preliminary analysis using MC-FRM data to evaluate 33 commuter rail maintenance facilities and 77 parking facilities to understand expected frequency and intensity of coastal flooding events. Three parking facilities (Salem Garage, North Quincy, and Newburyport) have high vulnerability by 2030. The Commuter Rail Maintenance Facility (formerly known as Boston Engine Terminal), Widett Service and Inspection, as well as additional support facilities, such as Cobble Hill and South Station, were ranked as most vulnerable and recommended for additional study.

Cabot Yard Phase 1 (2022); Cabot Yard Phase 2 (ongoing)

Site specific vulnerability assessment of Cabot Yard's assets. Additional in-depth analysis that will make recommendations for near-term and long-term adaptation measures is underway.

Orient Heights Yard (2018, 2024, 2025)

Site specific vulnerability assessment of Orient Heights Yard's assets, with an additional drainage analysis completed in 2024. A current analysis of potential flood mitigation strategies to address medium- to long-term flood risk is underway.

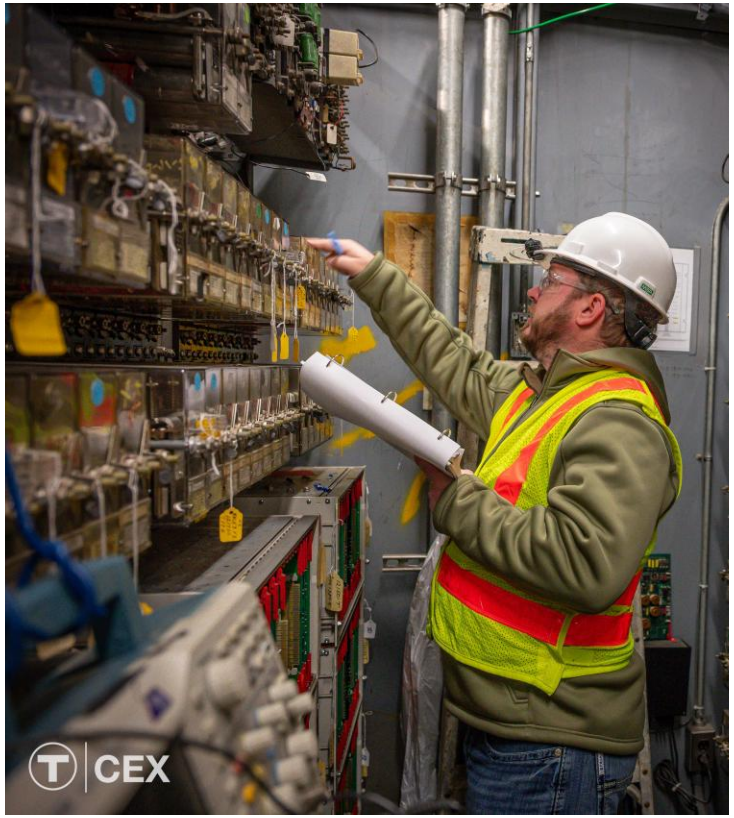

Figure 9: A signals bungalow is inspected.

Well-functioning signal bungalows help ensure safe, on-time service. Some of these bungalows are vulnerable to extreme heat and flooding without mitigation measures.

Climate Vulnerabilities Addressed in Roadmap, at a glance

Mode	Key Vulnerabilities *(Roadmap Section #)*	Key Locations
Rapid Transit	• Power outages from flooding, wind, extreme temperatures *(1)* • Flooding in tunnels and along right-of-way *(2)* • Flooding at support facilities *(4)* • Flooding at stations *(5)* • Signal and communications outages due to extreme temperatures or flooding *(6)* • Rail kinking due to extreme temperatures *(7)*	• Airport Portal • Orient Heights Yard • Cabot Yard • North Station • South Station
Commuter Rail	• Power outages from flooding, wind, extreme temperatures *(1)* • Rail and culvert washouts *(2)* • Flooding at support facilities *(4)* • Signal and communications outages due to extreme temperatures or flooding *(6)* • Rail kinking due to extreme temperatures *(7)*	• Commuter Rail Maintenance Facility • Widett • Cobble Hill
Bus	• Electric buses are vulnerable to power outages without battery storage *(1)* • Flooding at support facilities *(4)* • Flooding on roadways *(9)*	• Lynn Bus Garage
Paratransit	• Flooding at support facilities *(4)* • Flooding on roadways *(9)*	• Lynn Storage Facility
Ferry	• Flooding at ferry terminals *(5)*	• Long Wharf

Figure 10: The key climate vulnerabilities by transit mode, including locations where vulnerabilities are especially pronounced

Snapshot of Rapid Transit Vulnerabilities (current & projected)

Current Impacts

Park Street Station

Summer temperatures currently impact riders and employees within underground stations and the broader tunnel system.

Southwest Corridor

Drainage issues currently cause delays and closures during **heavy rainfall** events.

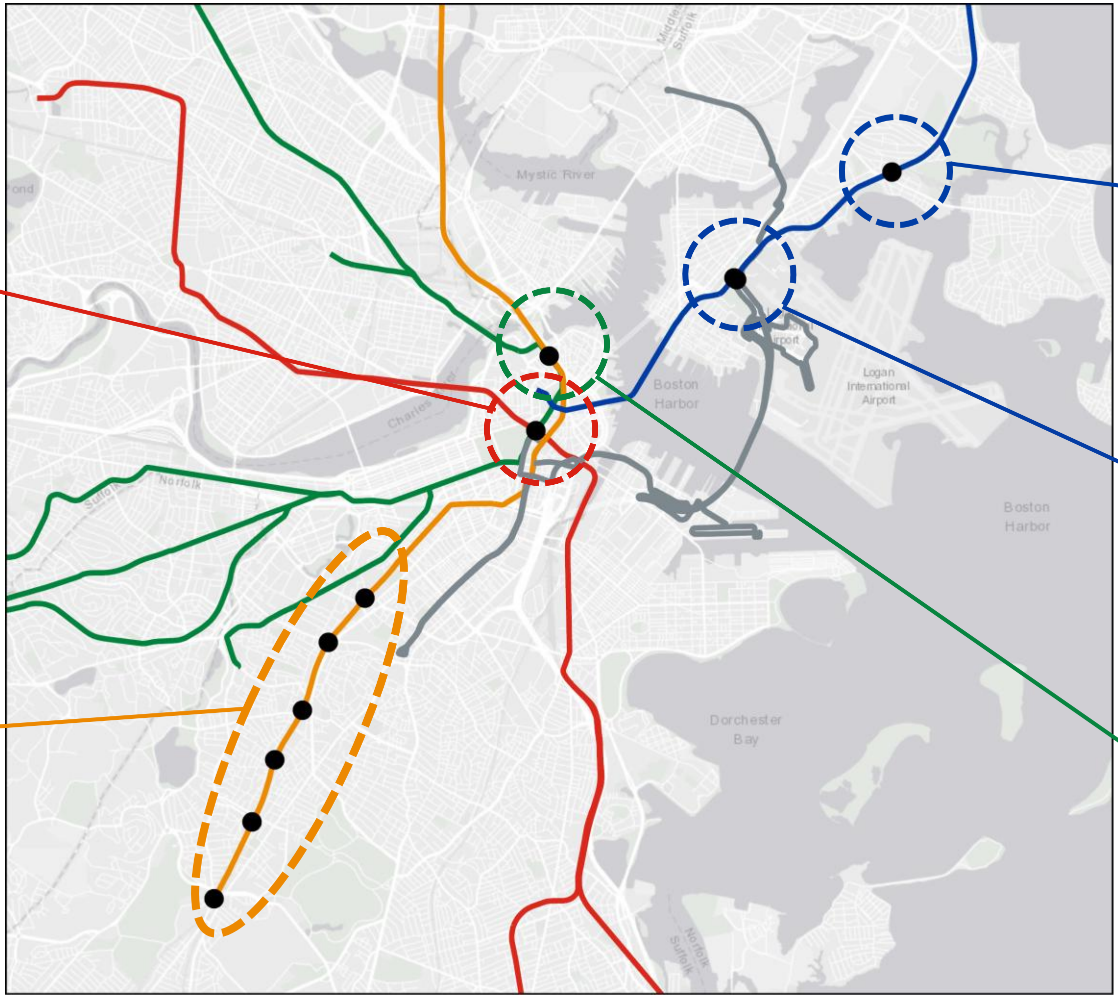

Figure 11: A map showcasing vulnerabilities along the rapid transit system

Future Impacts

Orient Heights Yard

Future sea level rise and heavy rainfall can cause flooding and **drainage issues** across the site, threatening operations along the Blue Line.

Airport Portal

Future sea level rise can lead to water inundation at Airport Portal that could **impact the central tunnel system** and ripple across the entire rapid transit network.

North Station

Future projections make North Station vulnerable to flooding from **sea level rise and storm surge**, affecting both the rapid transit and commuter rail systems.

Snapshot of Systemwide Vulnerabilities (projected)

RIDE Facility

Sea level rise and storm surge threaten access to and from the site in 2050 and beyond, impacting the 100 – 120 vehicles stored at this location.

Commuter Rail Maintenance Facility

Extreme heat and stormwater flooding are projected to impact operations at the Commuter Rail Maintenance Facility.

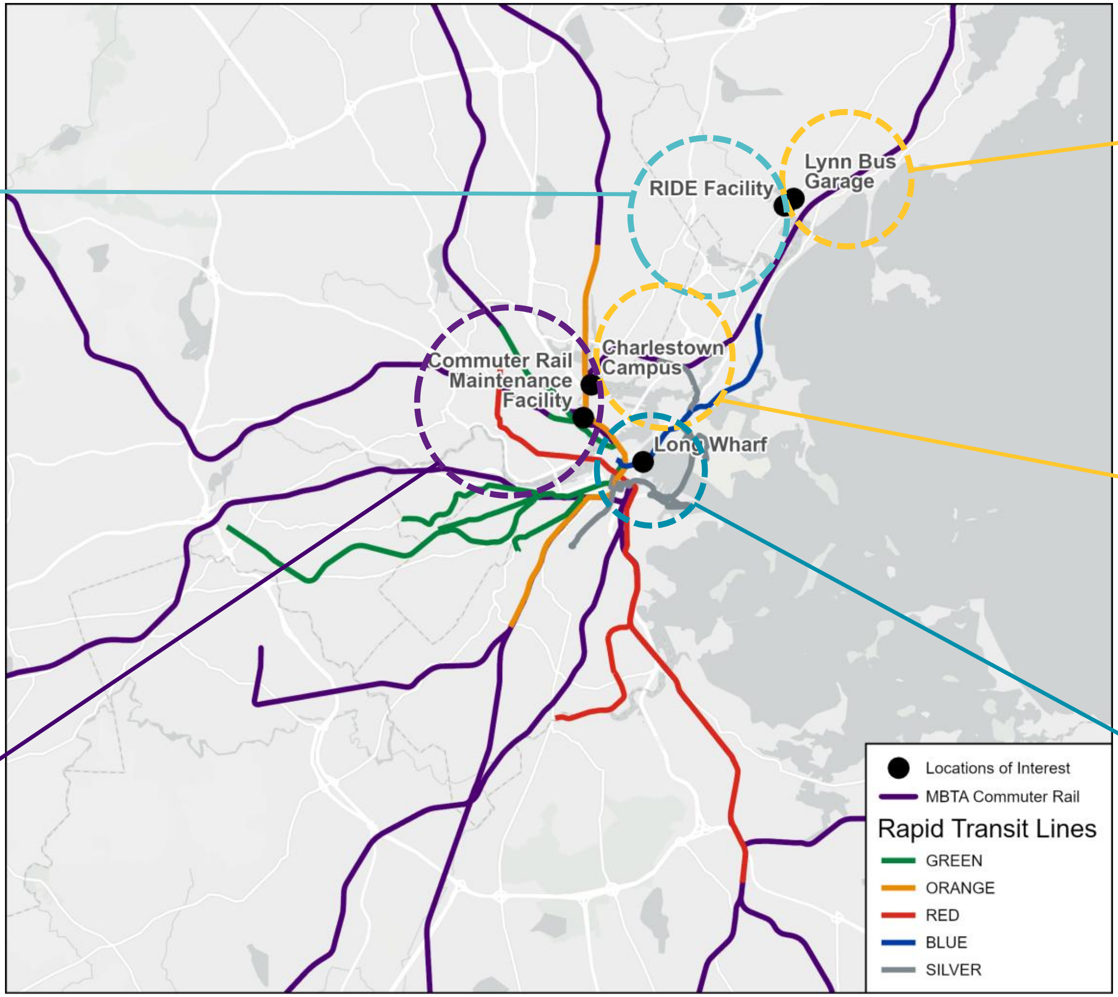

Figure 12: A map showcasing systemwide vulnerabilities

Lynn Bus Garage

Sea level rise and storm surge threaten access to and from the site, potentially impacting routes serviced by Lynn Bus Garage

Charlestown Campus

A seawall currently protects Charlestown Campus – a critical facility for bus operations – from sea level rise and storm surge.

Long Wharf Ferry Terminal

Sea level rise is projected to obstruct access to the Long Wharf Ferry Terminal.

Leveraging this roadmap

The Resilience Roadmap is the result of dozens of conversations with staff across the organization whose jobs are impacted by climate change. It builds on past analysis and planning, staff expertise, and best practices to outline nine priorities:

1. **Increase the resiliency of the power system**
2. **Address flooding in tunnels and right-of-way**
3. **Reduce employee and passenger exposure to extreme heat**
4. **Address flooding at support facilities**
5. **Address flooding at stations**
6. **Increase signal and communication systems' resilience to extreme temperatures**
7. **Increase track's resilience to extreme heat**
8. **Leverage internal capacity to strengthen climate planning**
9. **Collaborate externally to advance regional resilience**

Each priority contains goals and strategies with relevant departments, relative cost, and the timelines within which they should be addressed. Individual strategies are prioritized based on potential impact, existing synergies with other priorities, and available capacity and resources. Ongoing work is identified separately in each section, and new strategies are designated as either near-term (within the next five years) or long-term (over five years) depending on their estimated completion timeframe. A simple categorization of relative cost is assigned to each strategy and is defined as such:

- $: Minimal capital investment, primarily staff time
- $$: Moderate capital investment
- $$$: Major capital investment

The numbered priorities reflect each category's importance to human health and safety, service continuity, and fiscal responsibility. While the priorities are presented in numbered order, components of each must move in tandem.

In many cases, actions taken to address one priority will have implications for another. Decisions to minimize flooding on the ROW will impact our approach at support facilities and stations. Capital investments made today will dictate long-term resiliency needs and the menu of options available to address them.

As such, developing a vision for the MBTA that accounts for potential climate disruptions through 2050 and 2070 is one of the most pressing overall recommendations of this roadmap.

Everyone must work together to build a more resilient transit system, from engineers and mechanics to planners and data analysts. There will need to be frequent engagement with regional partners and honest discussions about the potential for cascading impacts. In some cases, collaborating with external partners can reduce the transit system's exposure. Many of these strategies that address "how" the work is done are found in sections 8 and 9.

This work cannot be done successfully in a vacuum.

The roadmap's strategies offer a starting point for advancing climate resilience work at the MBTA, and many of the strategies' details will be further defined as they are implemented. Priorities may change as opportunities and challenges emerge, but the MBTA's climate resilience framework will allow for adaptive leadership amidst uncertainty.

MBTA Resilience Framework

Evaluate climate vulnerabilities to understand potential risk and options to address it.

Embed climate risk into decisions to leverage cross-departmental work and deliver impactful projects and programs.

Engage local, regional, and state partners to share data, develop innovative solutions, and be a part of the solution for the communities we serve.

Figure 13: Components of the MBTA's approach to resilience

Prioritizing amongst asset classes

Hierarchy of impacted assets

The nine categories of work identified in the roadmap are presented in relative order of priority. Six of these priorities are focused on MBTA infrastructure, and their order was determined by considering the overall climate vulnerability of the asset class as well as the operational disruption if an impact were to occur. The climate vulnerability axis considers asset class exposure, sensitivity, and adaptive capacity (for more, see p. 9).

Plotting these two factors against each other created a hierarchy amongst asset classes, with power, tunnels, and support facilities having some of the highest potential climate vulnerability as well as a large potential for operational disruption. Strategies regarding these three asset classes are at the top of the priority list.

While stations may face serious climate impacts, there is a greater ability to recover from an operational perspective if a station were to be impacted and closed for a period of time.

Signals and communications equipment, as well as track, are broadly speaking less vulnerable to climate change. While the operational disruption is notable, it is not as severe as disruptions to the other asset classes – leading these strategies to appear towards the end of the priority list.

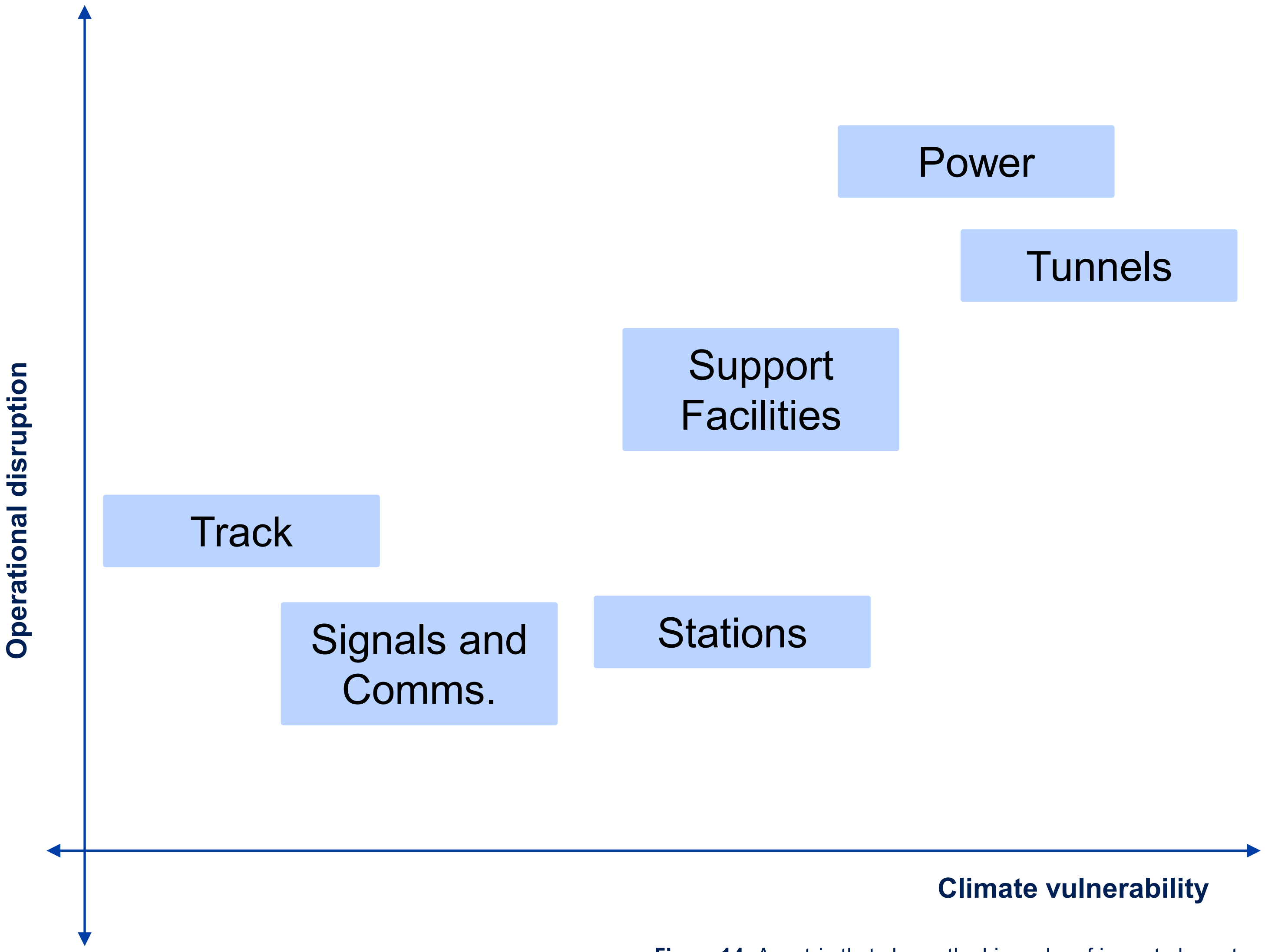

Figure 14: A matrix that shows the hierarchy of impacted assets

Resilience Strategies


115-13.8KV
XFMR A
TAP CHANGER POSITION
NEUT.
52NA
BKR 52L-1
BKR 52L-2
BKR 52L-3
BKR 52L-4
13.8KV BUS A
TO NEUT.
BKR 52NC
13.8KV BUS C
SYNC 1
115KV OCBS
LINE 02
METERS
LINE C1
METERS
XFMR B
METERS
CEX

1. Increase resiliency of the power system

The power system is an extensive and critical network that moves vehicles, supports key network systems, provides passenger stations and support facilities with energy, and has the ability to generate power. As the 2021 Power, Signals, and Communications CCVA states, **"The MBTA is only as reliable as the power source."** This is especially true as electricity powers more of the MBTA's modes in alignment with organizational and state climate goals, which call for more decarbonized service. To that end, securing funding for resiliency investments in the power system is one of the **highest priorities** identified by this roadmap.

The power system needs large capital investment, now and in the future. Power assets represent 20.8% of the SGR backlog but only received 2-3% of capital investment prior to FY26-30. Progress has been made, and there is ongoing work to improve SGR of power assets – including those that are highly sensitive to water infiltration or high temperatures. These SGR projects, including work to study the South Boston Power Complex, make electrical distribution repairs, renovate and replace unit substations, and expand and improve upon the network of back-up generators all offer resiliency co-benefits. More detailed descriptions of each of these programs are found in Figure 17.

A power system that is in a state of good repair is foundational to the T's climate resilience, and the highlighted ongoing work represents important investments that must continue. However, more explicit resiliency investments, proactive siting decisions, and operational changes are also needed to address flooding and extreme heat concerns across power assets.

To build a resilient power system of the future, the MBTA will need to pursue three goals within the next five years:

1) Continue to invest in state of good repair for the existing power system.

2) Improve understanding of the power system's existing vulnerabilities and capabilities.

2) Develop operational procedures to limit damage to power assets during extreme storms.

The strategies on the following page outline opportunities to advance these goals in both the short- and long-term.

Figure 15: South Boston Power Complex

Ongoing Work

South Boston Power Complex Study

- Planning and concept development to evaluate SGR investment needs and define renewal approaches and cost estimates. Additionally, this planning effort will evaluate feasibility of alternative scenarios at the site, including upgraded generations systems, battery storage, and flood protection.

Systemwide Power Systems Reliability Program

- Prioritizes electrical distribution repairs for facilities and transit. Though not explicitly a resilience investment, this program can improve power system performance during severe weather events.

Systemwide Electrical Unit Substation (USS) Upgrade & Replacement

- Provides major renovations to aging power unit substations and involves electrical repairs at each location. Procurement of materials and construction services to complete USS upgrades has begun. Where feasible, replacement substations should be located above ground.

Systemwide Generators Program

- Addresses the addition, repair, or replacement of generators and life safety emergency and standby power systems.

Figure 16: Ongoing work to increase resilience of power system

ID	Action	Description	Hazards Addressed	Locations of Interest	Departments	Cost	Timeline
1	Carry out Power System Climate Change Vulnerability Assessment	Building on past CCVA methodology and preliminary analyses of the power system, complete an in-house analysis of flooding risk and MBTA power assets to understand potential cascading impacts. Identify potential risk reduction strategies that can be taken and scope potential CIP requests, such as the Systemwide Power Systems Reliability Program, Systemwide Electrical Unit Substation Upgrade & Replacement Program, and Systemwide Generators Program.	All	Systemwide	Power Systems Maintenance, Asset Management, Environmental	$	Near-Term
2	Pilot temporary flood protection at vulnerable power assets	Working with the MBTA insurer, develop SOPs to pilot deployable flood protection at vulnerable power locations and incorporate into the Severe Weather Operations Plan.	Sea Level Rise / Storm Surge	Airport, Wonderland	Risk, Power Systems Maintenance, and Transit Facilities Maintenance	$$	Near-Term
3	Implement standard operating procedure (SOP) to de-energize facilities in advance of a storm	Utility providers that de-energized facilities in flood prone areas prior to the arrival of Hurricane Sandy were able to repair and restore operations faster. De-energizing MBTA facilities is currently done in an ad-hoc manner prior to the arrival of a storm, but there is an opportunity to standardize this response and incorporate it into the Severe Weather Operations Plan and Continuity of Operations Plan.	Sea Level Rise / Storm Surge, Extreme Precipitation	Systemwide	Power Systems Maintenance, Security and Emergency Management	$	Long-Term

Figure 17: Strategies to increase the resilience of the power system to all climate hazards


MATTAPAN-ASHMONT
3087
STOP

2. Address flooding in tunnels and right-of-way

Flooding in the MBTA tunnels and along the ROW is one of the largest overall vulnerabilities to the MBTA system, and it can lead to impacts on the rapid transit and commuter rail systems.

Rapid Transit

The primary concern is flooding within the central tunnel system from sea level rise and storm surge. With a large storm, **water may enter through the tunnel portals, station entrances, vent shafts, and elevator shafts** and spread throughout the tunnel system**.** Inundation at tunnel portals and station entrances has the potential to introduce sizeable amounts of water into the entire system; water infiltration at vent shafts and elevator shafts can also cause damage, but it is a less severe threat. Saltwater can damage sensitive signal, communications, and power equipment located within the tunnels – causing the assets to cease to function until flooding recedes and repairs can be made. Even when an asset is not completely lost, frequent exposure to flooding can lead to corrosion and shorten the asset's expected useful life – leading to a more frequent replacement or repair schedule. Impacts to infrastructure can lead to serious economic impacts. Research conducted in 2023 suggested that prior to the Aquarium Station floodproofing project, estimated annual losses to the rapid transit system from flooding could reach $63 million by 2030. The Aquarium resiliency project significantly reduced potential annual losses to $39 million by 2030.[5]

In addition to the floodproofing project at Aquarium Station, the MBTA has taken action to address flooding elsewhere on the system, including the installation of floodgates and large steel doors at the Fenway Tunnel Portal in 2020 to mitigate flooding from the Muddy River. While these are important projects, estimated annual losses on the rapid transit system are projected to increase by 6% each year without further action.[6]

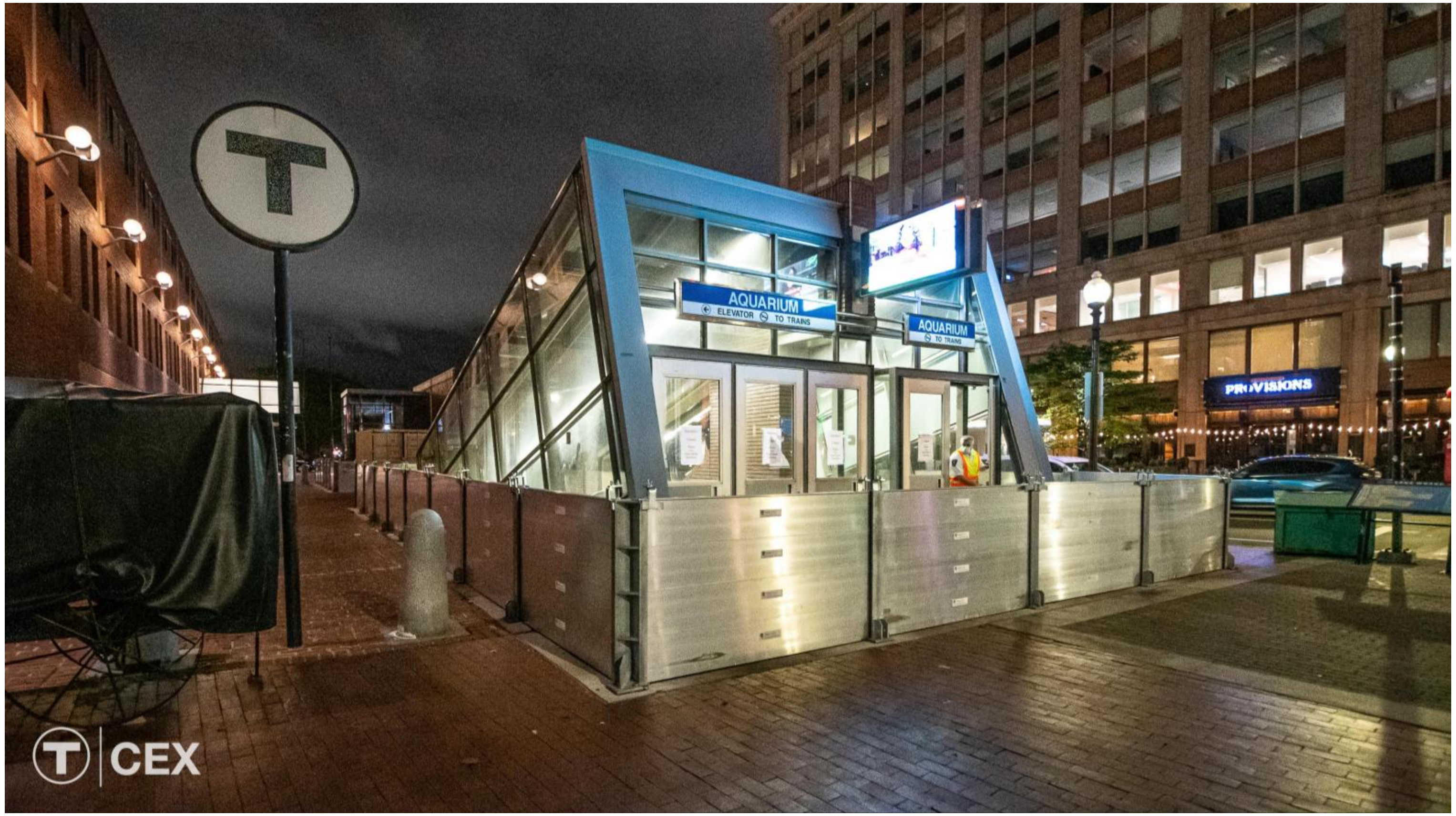

Figure 18: Flood planks are deployed at Aquarium Station to address flooding impacts

2. Address flooding in tunnels and right-of-way

STRATEGIES

Commuter Rail

Outside of downtown Boston's central tunnel system, the Commuter Rail is vulnerable to track and equipment washouts after flooding on the ROW. This can occur from both sea level rise/storm surge, as well as extreme precipitation – as was the case in 2023 near Leominster when a culvert washed out and destroyed track infrastructure (pictured on page 7).

Ongoing and Newly Identified Work

Work is underway to address flooding concerns on both the rapid transit and commuter rail systems, including the Systemwide Tunnel Flood Mitigation Program and the Commuter Rail Culvert Washout Program (see Figure 20 for more details).

Both ongoing programs and newly identified initiatives seek to advance the following goals:

1) **Harden tunnel and rail infrastructure to mitigate severe flooding.**

2) **Increase capacity to respond to drainage issues and conduct preventative maintenance.**

Strategies proposed here complement existing capital projects and planning efforts, and together they seek to address major flooding entry points as well as distributed ones, such as vent shafts. Work will occur in tandem with regional efforts to scope potential district-scale solutions (see priority #9 for more information).

Ongoing Work

Commuter Rail Washout Prevention Program

- Established in 2024, this program focuses on identifying high priority locations for needed upgrades and repairs to prevent severe flooding on the commuter rail. Program monitors impacts across the commuter rail system, with a focus on historical flooding locations.

Systemwide Tunnel Flood Mitigation Program

Established in 2020, this program addresses water infiltration points throughout the MBTA tunnel system, including tunnel portals, headhouses, and vent shafts. Priorities of the program thus far are:

- **Harden tunnel portals to prevent severe flooding.** Design for Airport Portal flood door is underway, as is scoping of flood protection options for the Silver Line (SL1, SL2, and SL3).
- **Harden stations that pose flooding risk to central tunnel system.** Aquarium Station Flood Planks reduced 2030 estimated annual flood risk by $24M. Courthouse and World Trade Center Stations are priorities for upcoming work.
- **Bring pump rooms into a State of Good Repair and add remote monitoring capabilities where feasible.** Blue Line Under Harbor pump room repairs are in progress with a completion date in early 2026. Contracting for design of the next four high-priority pump rooms is also underway.
- **Analyze vent shafts for flooding implications.** In addition to the large water entry points of tunnel portals and headhouses, water can also enter via vent and elevator shafts. Analysis is underway to understand which vent shafts pose the greatest flooding risks.

Figure 19: Ongoing work to address flooding in tunnels and right-of-way

Valuable analytical work is underway to better understand design options to mitigate flooding at high priority locations. As conceptual designs become available, funding and delivering these projects is a critical next step for building resiliency to coastal flooding and extreme precipitation events.

ID	Action	Description	Hazards Addressed	Locations of Interest	Departments	Cost	Timeline
4	Analyze flood vulnerability of the Community College Portal	Community College Portal has been identified as a potential flooding vulnerability. Conduct analysis to understand this vulnerability and options to address it, as well as related regional resiliency work that is planned near the project area.	Sea Level Rise and Storm Surge	Community College Portal	Environmental, Technical Engineering and Design	$	Near-Term
5	Implement advanced preventative maintenance (APM) program for drainage infrastructure	The ROW can experience flooding when drainage systems are clogged with debris. An advanced preventative maintenance program that removes vegetation, inspects drainage systems in known flooding areas, and addresses clogs prior to a storm can help mitigate impacts. For commuter rail, include APM in contracts.	Extreme Precipitation; Sea Level Rise and Storm Surge; Wind	Southwest Corridor, Braintree Branch	Maintenance of Way, Railroad Operations	$$	Near-Term
6	Pilot passive mitigation strategies for vent shafts	Working in tandem with the vent shaft state of good repair program, identify 2 – 5 vent shafts for passive flood mitigation pilot program. Ideal candidates do not create accessibility concerns and exist on MBTA property. Where feasible, incorporate urban design elements (benches, bike racks) into mitigation strategies.	Extreme Precipitation; Sea Level Rise and Storm Surge	Systemwide	Infrastructure Planning, Environmental, Capital Delivery	$$	Near-Term

Figure 20: Strategies to address flooding in tunnels and along right-of-way

Figure 21: Vent shaft covers such as the one pictured to the right from the Metropolitan Transportation Authority (MTA) in New York City, can both passively protect vent shafts from flooding while also providing public benefits, such as seating and placemaking. The bench pictured is one option to consider while piloting passive mitigation strategies for vent shafts.


CEX

3. Reduce employee and passenger exposure to extreme heat

Massachusetts is not historically known for extreme heat and humidity. However, climate change is increasingly making heat a part of the state's present and future reality.

Heat can cause serious impacts to customer and employee health and experience. The risk of heat exhaustion, heat stress, and heat stroke can impact riders and workers alike, especially those with pre-existing conditions such as cardiovascular diseases, respiratory diseases, and diabetes.

Across the Commonwealth, a diverse group of institutions are coming together to address extreme heat. Businesses are implementing new policies to protect workers during extreme heat, academic institutions are refining data sources for higher resolution understanding of heat impacts, and government and nonprofit organizations are developing community-based tools to raise awareness and build resilience to extreme heat.

The MBTA has also been actively engaging in internal and external conversations to better understand the impact of heat on employees and customers, as well as identify and develop solutions to mitigate those impacts.

Heat impacts to infrastructure are addressed in later sections of the roadmap.

Ultimately one of the most effective heat strategies the MBTA can pursue for passengers is **providing fast, reliable, and efficient service that minimizes waiting times in hot environments.**

Additionally, pursuing the following three goals will help the MBTA be better prepared for extreme heat's impact on riders and employees:

1) **Increase organizational understanding of and resources for extreme heat.**
2) **Increase resources for riders to stay healthy during extreme heat.**
3) **Improve employee facilities to mitigate impacts of extreme heat.**

Several strategies that advance these goals are ongoing and described in Figures 22 and 24.

Ongoing Work (continued on next page)

Bus shelter network expansion

- Install 100 new bus shelters across the network that prioritize improvements in urban heat islands within next 18 – 24 months.

Figure 22: Ongoing work to address extreme heat impacts

Figure 23: A bus shelter provides shade to passengers

3. Reduce employee and passenger exposure to extreme heat

Ongoing Work (cont.)

Employee heat safety promotion

- Train employees on recognizing the signs and symptoms of heat illness and best practices to avoid and respond to heat illness. Procure and distribute heat safety personal protection equipment, water, and electrolytes.

Proactive communication during heat emergencies

- Alert riders when extreme heat is forecasted, with information on what to expect during extreme heat as well as resources for traveling in the heat.

Ventilation and cooling at maintenance facilities

- Where feasible, ventilation and cooling equipment is addressed as maintenance facilities are overhauled and renovated.

Heat data collection and collaboration

- There is an ongoing internal pilot project to take temperature, humidity, heat index, and wet bulb globe temperature measurements at stations. Additionally, MBTA staff are collaborating with external partners to improve the availability and quality of heat data.

HVAC assessment, upgrade, and response program

- Inspection and maintenance program that will update and extend the useful life of priority HVAC systems. Increase staffing levels for prompt response and increase capital funding for proactive HVAC renewals.

Figure 24: Ongoing work to address extreme heat impacts

Figure 25: MBTA employees work outdoors during a summer day

STRATEGIES

In addition to ongoing work that is already underway, this roadmap outlines four additional strategies to pursue, as described in Figure 26.

#	Action	Description	Hazards Addressed	Locations of Interest	Departments	Cost	Timeline
7	Incorporate extreme heat into the Severe Weather Operations Plan	The Severe Weather Operations Plan (SWOP) currently identifies the MBTA's response to hurricanes, flooding, severe thunderstorms, and high winds prior to storms. Improved data could allow for heat to be incorporated into the SWOP.	Extreme Heat	N/A	Climate Policy and Planning, Security and Emergency Management	$	Near-Term
8	Investigate heat capture opportunities within tunnel system	Scope preliminary research studies to understand if heat can be captured for energy generation and removal.	Extreme Heat	Park St.	Environmental, Climate Policy and Planning, Infrastructure Planning	$	Near-Term
9	Leverage Building Management System (BMS) for temperature data	Leverage BMS capabilities to expand temperature data collection and monitoring efforts.	Extreme Heat	Systemwide	Transit Facilities Maintenance	$$	Near-Term
10	Expand canopy coverage and shading at stations	Identify stations on rapid transit and commuter rail with high heat exposure and limited existing shade for temporary or permanent shade installations, as well as tree canopy expansion, where feasible.	Extreme Heat; Extreme Precipitation	TBD	Systemwide Accessibility, Transit Facilities Maintenance, Railroad Operations	$$	Long-Term

Figure 26: Strategies to reduce employee and passenger exposure to extreme heat


LEVEL UP GAME NIGHT WITH THE MASS STATE LOTTERY
KENO
T

4. Address flooding at support facilities

STRATEGIES

Support facilities are the bus and rail yards, maintenance garages, fuel depots, fleet storage, specialized trade shops, and administration buildings that are foundational to successful day-to-day operations. They house many pieces of critical equipment, and flooding events can render important and expensive equipment inoperable. While flooding damage to a station can impact service and riders within a particular section of service, impacts to support facilities ripple across entire lines or modes.

The MBTA has completed resiliency projects that protect key maintenance facilities, including the reconstruction of the Charlestown Sea Wall near the Charlestown Bus Garage (2022). This project was funded by the FTA Emergency Relief Program after Hurricane Sandy and includes landscaping and a multi-use path managed by the Massachusetts Department of Conservation and Recreation. In addition to Charlestown, CCVAs identified flooding concerns by 2030 at the following locations shown on the map in Figure 27: Lynn Bus Garage, Orient Heights Car House and Yard, Cabot Campus, Tenean Yard, Riverside Carhouse, and The RIDE's Lynn storage facility.

Riverside Carhouse is primarily exposed to flooding from drainage issues during extreme precipitation events, whereas Lynn Bus Garage and The RIDE's Lynn storage facility are primarily exposed to flooding caused by sea level rise.

Orient Heights Car House and Yard, Cabot Yard, and Tenean Yard face dual flooding threats from both extreme precipitation and sea level rise/storm surge.

In many cases, support facilities are located in or near communities that are also exploring regional flood protection. Where feasible, the MBTA wishes to coordinate with these efforts to expand project impact.

If no resiliency strategies are pursued at these locations, entire rapid transit lines or regions of bus service could be regularly disrupted for extended periods of time, requiring a significant mobilization of alternative transit options to ensure riders are able to continue traveling throughout the region. The following goals are key to addressing flooding at support facilities:

1) **Improve understanding of vulnerabilities and potential mitigation strategies at key maintenance facilities.**

2) **Explore potential relocation of vulnerable support facilities.**

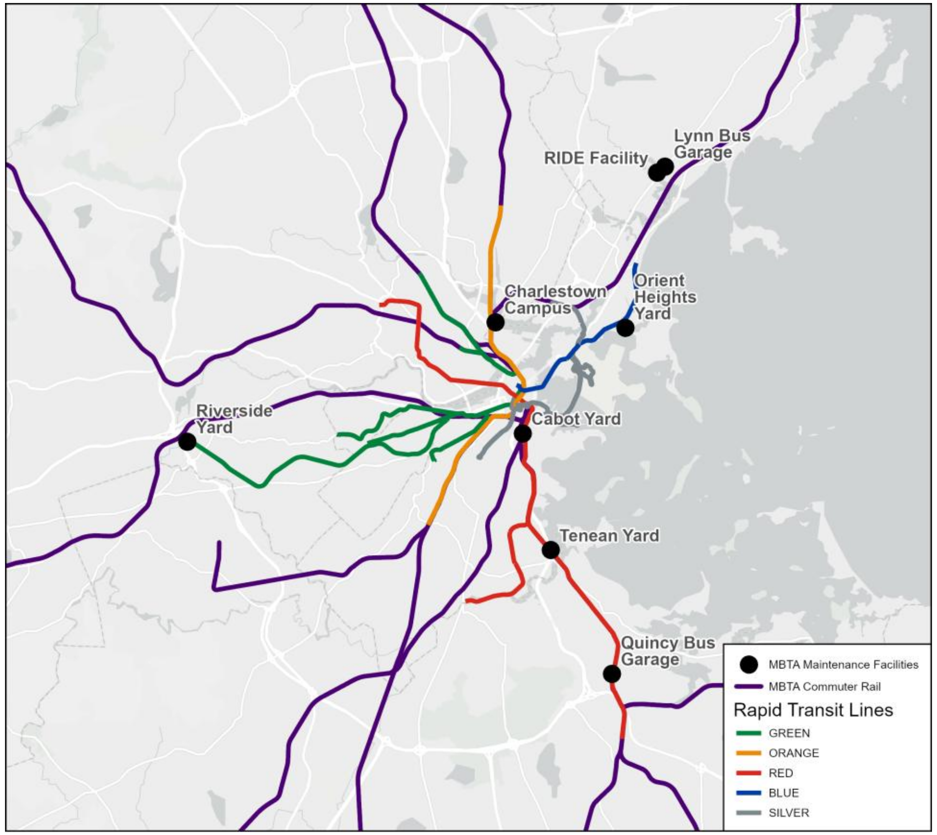

Figure 27: Map of vulnerable support facilities by 2030

The new Quincy Bus Garage incorporates several climate resiliency features. It was designed to be resilient to extreme precipitation and sea level rise. Resilience features include:

- Site elevation of up to 3 feet in some locations
- Critical equipment and infrastructure was elevated
- Waterproofing of structure
- Proposed watershed plan includes underground infiltration basins and rain gardens, among other investments

Each of these features helps to achieve a bus facility that is resilient now and into the future.

STRATEGIES

Ongoing Work

Follow-on vulnerability studies at key support facilities

- Builds on initial climate change vulnerability assessments to analyze asset level vulnerabilities across key sites, as well as identify potential mitigation strategies, at Orient Heights, Cabot Yard, and Lynn Bus Garage.

Ongoing incremental investments

- Make ongoing investments in resilience of new maintenance facilities, e.g., Widett Layover Facility, Arborway Bus Garage.

Figure 28: Ongoing work to reduce flooding at support facilities

Figure 29: The new Quincy Bus Garage incorporated several resiliency design features, including the building waterproofing shown in the above photo.

STRATEGIES

#	Action	Description	Hazards Addressed	Locations of Interest	Departments	Cost	Timeline
11	Create flood response plans or SOPs at high flood-risk locations.	Once vulnerabilities are better understood, create flood response plans or SOPs for vulnerable support facilities and incorporate into Severe Weather Operations Plan.	Sea Level Rise / Storm Surge; Extreme Precipitation	Lynn Bus Garage, 200 Newport, 45 High Street	Security and Emergency Management, Operations Control Center, Transit Facilities Maintenance, Risk	$	Near-Term
12	Prioritize and fund projects to harden vulnerable support facilities	As detailed CCVAs of additional support facilities are completed, develop a prioritized program of projects to implement within the next 5 – 10 years to harden infrastructure against flooding impacts.	Sea Level Rise / Storm Surge; Extreme Precipitation	Orient Heights, Cabot Yard	Environmental, Infrastructure Planning	$$$	Near-Term
13	Acquire property with lower flood risk	Where appropriate, acquire property for potential relocation of maintenance and support facilities. In addition to relocating existing facilities, this could include expansion, such as land ownership to serve The RIDE, which currently leases space (some with flood risk).	Sea Level Rise / Storm Surge	Lynn Bus Garage, The RIDE Lynn facility	Real Estate, Environmental, Climate Policy and Planning, Strategic Transit Planning, Infrastructure Planning	$$$	Long-Term

Figure 30: Strategies to address flooding at support facilities


F
2-3A
This Door Is Controlled & Monitored By:
MBTA SECURITY
Use Employee I.D. To Gain Access.
Before Opening Door You Must Call The O.C.C. At:
X-5774
CEX

5. Address flooding at stations

Stations are the front door to MBTA service and often the first and last thing that a rider sees. Station assets include busways, platforms, mezzanines, and back-of-office space for employees. Currently the MBTA owns 260 stations across transit (125), commuter rail (126), bus (8), and ferry (1) service.

In addition to their role in rider satisfaction, stations also contain critical equipment that helps to ensure rider safety and transit operations.

Climate hazards pose many threats to stations: extreme weather could make stations inaccessible or render critical equipment inoperable. Flooding from sea level rise/storm surge and extreme precipitation pose the greatest threat to stations and already impact operations today.

In 2018, Winter Storm Grayson brought 75mph winds and over a foot of snow to Boston, as well as high tides and massive waves that flooded Aquarium Station along with many homes and businesses. Since that event, the MBTA installed flood planks at Aquarium Station to prevent future flooding damage (see priority #2). In less extreme examples, water infiltration from routine weather events corrodes stairs, escalators, and elevators, impacting the MBTA's ability to fulfill its accessibility duties.

CCVAs found that 32 stations have high vulnerability to flooding by 2030. Given the large need across the system and limited financial resources available,12 priority locations were determined by a weighted score that balanced climate vulnerability, operations criticality, ridership, and equity. In addition to weighting these factors, findings in Figure 32 were validated with feedback from field staff.

The primary goals are to:

1) **Use deployable and permanent flood protection infrastructure to harden key rapid transit stations.**

2) **Reduce stormwater runoff near stations.**

Category	Weight
CCVA Score	40%
Operations Criticality	30%
Ridership	15%
Equity	15%

Figure 31: Prioritization methodology included the above weighted factors. Overall vulnerability scores are a critical piece of information, but they are not the only factor in determining a path forward for addressing vulnerability.

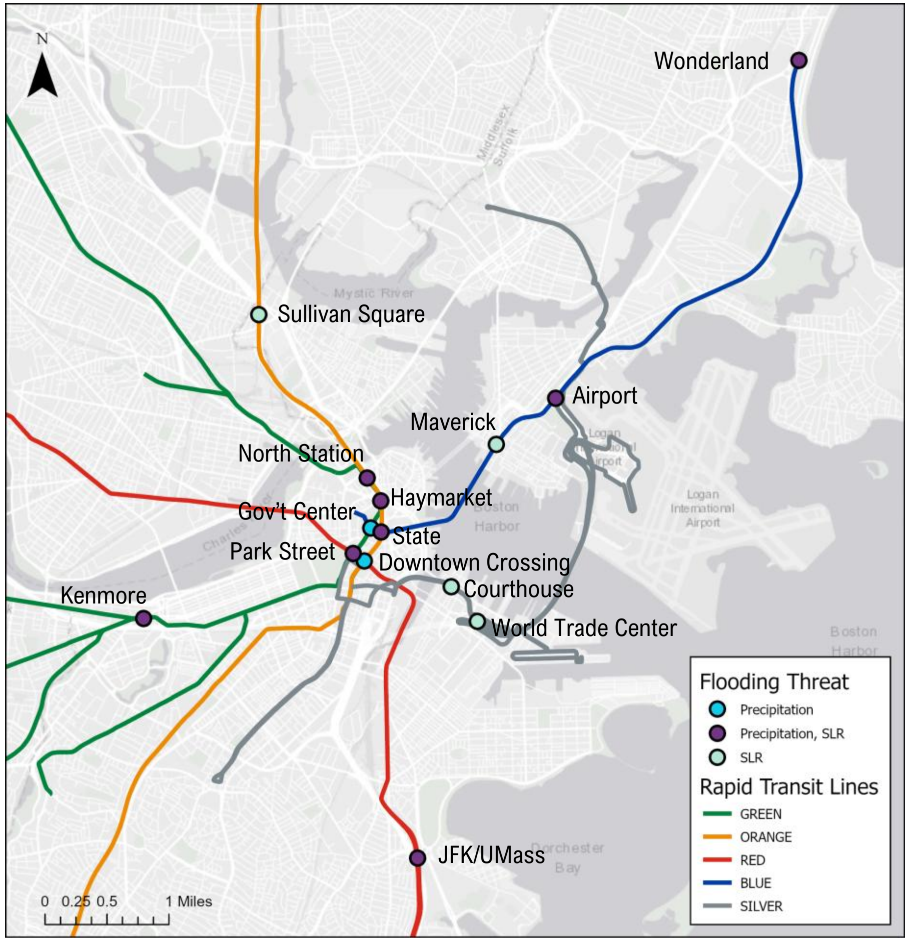

Figure 32: Map of prioritized stations by flooding threat (precipitation, sea level rise, and both)

STRATEGIES

#	Action	Description	Hazards Addressed	Locations of Interest	Departments	Cost	Timeline
14	Test 2 – 3 property insurer approved flood deployable barriers to establish organizational preferences	The MBTA currently owns and operates Tiger Dams and Stop Log Flood Barriers to mitigate flood risk at stations. However, new products are regularly developed and released. To prepare for future procurements, work with MBTA insurer to evaluate 2 – 3 possible deployable barriers and establish preferences. Scale use as needed while evaluating permanent flood protections (see 5.1b).	Sea Level Rise / Storm Surge	N/A	Transit Facilities Maintenance, Risk, Environmental, Climate Policy and Planning, Capital Delivery	$	Near-Term
15	Pursue permanent flood protection for high-priority stations in concert with Systemwide Tunnel Flood Mitigation Program (Section 2)	Passive solutions, such as elevated street stairs, curb raises, and other permanent infrastructure, should also be considered for station hardening. Building on existing analyses from CCVAs, conduct preliminary analysis of site-specific flood protection strategies for high-priority stations. Collaborate with Systemwide Accessibility to find opportunities to protect elevators and otherwise ensure accessibility.	Sea Level Rise / Storm Surge; Extreme Precipitation	Map on p. 33	Capital Delivery, Systemwide Accessibility, Environmental, Climate Policy and Planning	$$$	Near-Term
16	Incorporate flood resilience into upcoming station overhauls	As vulnerable stations are overhauled, permanent or deployable flood protection should be incorporated into station design.	Sea Level Rise / Storm Surge; Extreme Precipitation	JFK/UMass, Park Street, and Sullivan Square	Technical Engineering and Design, Capital Delivery, Environmental	$$$	Long-Term
17	Install green infrastructure at high-priority surface level stations locations	Install green infrastructure near surface level stations with chronic flooding issues where feasible.	Sea Level Rise / Storm Surge; Extreme Precipitation	Systemwide	Environmental, Transit Facilities Maintenance, Railroad Operations	$$	Long-Term

Figure 33: Strategies to address flooding at stations


SHP PRO
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CEX

6. Increase signal and communication systems' resilience to extreme temperatures

In addition to the serious human health and safety concerns that heat poses, temperatures at 90 degrees or above can cause significant damage to transit system assets. Rail tracks warp and buckle, overhead catenary sags, signals and track sensors malfunction, and electrical systems overheat – all leading to impacts to service. Heat can cause equipment failures within the signals and communications systems and lead to delays on both the rapid transit and commuter rail systems. Signals and communications equipment are also vulnerable to winter weather – pieces of equipment can freeze or ice over in some extreme conditions and cease to function.

Service can technically continue without current signal and communications systems, but it is poor, slow service.

While extreme temperatures are the primary concerns at this juncture, signals and communications assets are also vulnerable to flooding when sited in areas that are exposed to sea level rise or have poor drainage infrastructure. SGR investments can help insulate assets by ensuring the locations where they are located are protected from the elements and do not have leaks or openings where water can damage sensitive equipment. Across the system, state of good repair investments in signals and communications bolster the MBTA's climate resiliency.

Investing in the resiliency of the signals and communications systems means investing in two goals:

1) Invest in a state of good repair to improve reliability and reduce sensitivity to climate hazards.

2) Expand cooling capacity for critical equipment.

Existing programs that install HVAC with critical equipment, replace and upgrade switch heaters, and rehabilitate communications rooms each advance these goals and are described in more detail in Figure 36.

Continued funding of each existing program is key for building resilience to climate change within these assets.

Figure 34: MBTA employees address signal equipment

Ongoing Work

HVAC installations in signal bungalows and central instrument houses

- Install HVAC systems to provide cooling support and avoid heat related disturbances across the rapid transit and commuter rail systems.

Manual switch heater replacement systemwide

- Replace manual signal switch heaters with modernized equipment to improve reliability during extreme temperatures as well as reduce energy consumption across the rapid transit and commuter rail systems.

Communications room upgrades program

- Upgrade communications rooms, including installation of HVAC, floodproofing, and drainage improvements where necessary. Develop ongoing maintenance program for communications rooms.

White roof pilot project

- Use reflective white paint on signal bungalows to evaluate cooling potential and maintenance needs.

Figure 35: Ongoing work to increase resilience of signals and communications equipment

#	Action	Description	Hazards Addressed	Locations of Interest	Departments	Cost	Timeline
18	Implement phasing strategy for HVAC installation program	Ongoing work to install HVAC systems to provide cooling support and avoid heat related disturbances across the rapid transit and commuter rail systems requires additional funding to reach all signal bungalows and central instrument houses.	Extreme heat	Systemwide	Signals and Communications; Transit Facilities Maintenance	$$	Near-Term
19	Implement phasing strategy for communications room upgrades	Current program is only partially funded. Provide full funding to implement a phased approach that reaches all high priority communications rooms.	Extreme heat, Extreme Precipitation, Sea Level Rise / Storm Surge	Systemwide	Signals and Communications; Information Technology Department, Transit Facilities Maintenance	$$	Near-Term
20	Implement phasing strategy for systemwide manual signal switch heater replacement	Current program is only partially funded. Provide full funding to reach 70 additional switch machines over outlined phases.	Extreme cold	Systemwide	Signals and Communications	$$	Near-Term

Figure 36: Strategies to build resilience of signal and communications systems


CEX

7. Increase track's resilience to extreme temperatures

The MBTA's rapid transit system has 136 miles of revenue track and 40 miles of non-revenue track, and commuter rail has 706 track miles. When air temperatures reach 90℉ or above, rail temperatures can extend far beyond ambient air temperature to 120 – 140℉ depending on sun exposure. At these temperatures, tracks can kink or buckle – causing serious safety concerns and impacts to service.

In the winter, the track is also vulnerable to extreme temperatures: tracks can separate due to frost heaves and ice expansion, freeze-thaw cycles can damage concrete ballast, and the track bed can be destabilized from snow and ice. The MBTA faced several impacts to service caused by extreme cold during the winter of 2015 and the agency soon mobilized to develop the Snow and Ice Operations Plan. While the MBTA has made progress on winter extremes in the intervening years, it has not made as much progress on extreme heat.

Outside of weather-related impacts, maintaining a state of good repair for track assets has been an organizational priority in recent years. In 2024, the MBTA completed the Track Improvement Plan, removing more than 220 speed restrictions and replacing more than 250,000 feet of rail across the system – more than a third of the system's revenue track. The work continues today as the Track SGR Program, providing tangible benefits during mild and extreme temperatures.

As temperatures continue to swing between extremely hot and extremely cold in the course of a year, the MBTA will need to **increase capacity to proactively plan for, monitor, and respond to extreme temperatures** via the strategies outlined here.

Ongoing Work

Snow and Ice Plan (updated annually)

- Outlines a comprehensive strategy to prepare for, respond to, and recover from winter weather.

Remote temperature sensors pilot program

- Deploy sensors to proactively identify areas of rail at risk for heat kinking.

Systemwide CWR Replacement

- Replace existing Continuous Welded Rail helps to reduce the risk of heat kinks on the rapid transit system.

Track SGR Program

- Makes SGR improvements across the track network.

Figure 37: Ongoing work to increase track resilience

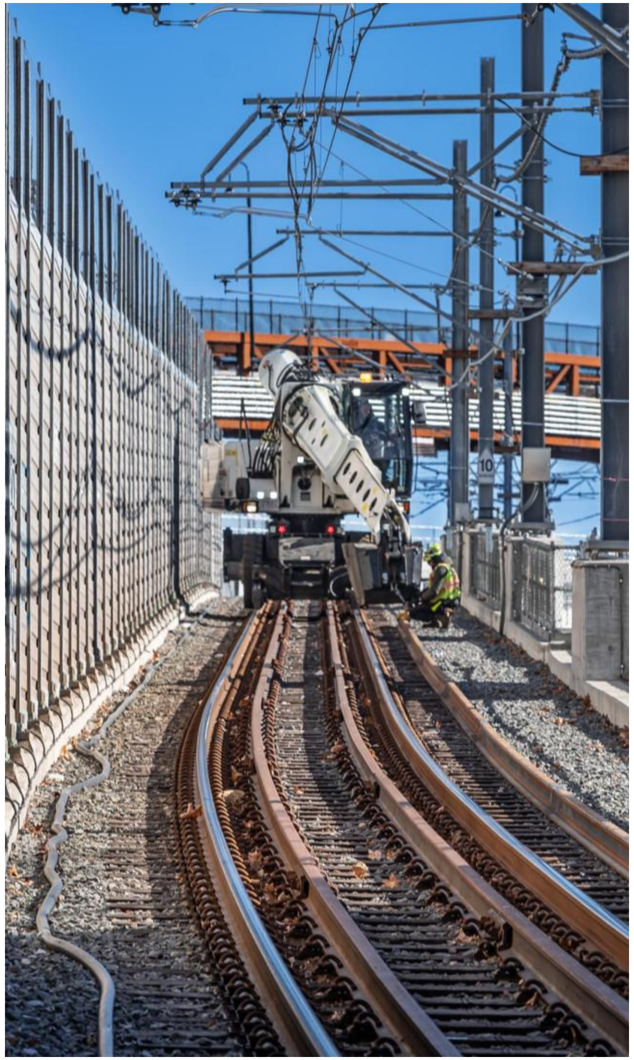

Figure 38: MBTA employees execute track repair work

STRATEGIES

#	Action	Description	Hazards Addressed	Locations of Interest	Departments	Cost	Timeline
21	Invest in in-house Maintenance of Way personnel, capacity, and equipment	These critical operational investments will bolster the MBTA's ability to proactively address track concerns (e.g., track and catenary inspections) as well as respond efficiently when weather related impacts occur.	All	N/A	Maintenance of Way, Human Resources	$$	Near-Term
22	Initiate a rail destressing program	Initiate a rail destressing program to prepare track for extreme temperatures. Rail destressing is currently underway for all newly installed track, though this could be expanded to existing track in the future.	Extreme temperatures	Systemwide	Maintenance of Way, Railroad Operations	$$	Long-Term
23	Initiate a track weatherization program	As feasible and appropriate, weatherize track to better sustain extreme temperatures, such as by installing expansion joints in guideways with stone ballasts, reducing tie spacing, and re-tamping ballast to increase ballast density to reduce the likelihood of track kinking and buckling.	Extreme temperatures	Systemwide	Maintenance of Way, Railroad Operations	$$	Long-Term

Figure 39: Strategies to increase track resilience


537
CEX

8. Leverage internal capacity to strengthen climate planning

Successful climate planning and project implementation requires many teams working together. In addition to close coordination in key project areas, there are also opportunities to integrate climate vulnerability data and mitigation strategies into existing planning processes. As internal capacity is bolstered, there will be deeper relationships, more widespread organizational awareness of climate issues, and valuable research that is co-produced with and disseminated to relevant partners.

Leveraging internal capacity centers on three goals:

1) **Expand available climate data and better integrate it into existing processes.**

2) **Strengthen interdisciplinary planning partnerships to develop long-term solutions.**

3) **Align capital planning and long-term resiliency investments to deliver future service goals.**

First and foremost, we must ensure that existing available data is easily accessible across teams. Several projects are underway to leverage existing data, and there are also new high-priority vulnerability assessments that are ongoing to expand the MBTA's available climate data (see Figure 41).

There are also many teams currently working on long-range planning, each with their own focus – whether that be asset investment plans, transit-oriented development, and financial risk mitigation. Coordinating across these existing teams and developing tools and touchpoints for them to collaborate more seamlessly is also a focus of this section.

Finally, the resiliency investments identified in this roadmap, as well as new investments that have yet to be identified, will require long-term capital strategy. Aligning resiliency investments with the MBTA's service goals in Full T Ahead and the forthcoming Program for Mass Transportation (PMT) is paramount.


Choose Transit

Full T Ahead

A set of priorities to build a system that makes public transit the preferred choice of travel that the public is proud of and wants to use.

Figure 40: The cover of Full T Ahead

Ongoing Work

High-priority vulnerability assessments

- Builds on systemwide CCVAs to carry out detailed assessments for high-priority locations, including critical facilities such as Cobble Hill, Commuter Rail Maintenance Facility, and the Charlestown campus.

Design Standards and Guidelines process

- A team of subject matter experts are informing the Environmental, Sustainability, and Resilience chapter of the Design Standards and Guidelines and integrating resilience into other chapters as appropriate.

Interactive climate dashboard

- Synthesizes existing climate vulnerability data into an accessible, updatable dashboard of tabular and spatial data.

Track and analyze weather-related delays

- Tracks weather-related delay data on Commuter Rail system to provide insight into relationships between climate hazards and delays. Additional data collection and analysis needed to understand underlying causes of delays.

Figure 41: Ongoing work to leverage internal capacity

STRATEGIES

#	Action	Description	Hazards Addressed	Locations of Interest	Departments	Cost	Timeline
24	Explore options to track weather delay data on rapid transit and bus systems	Building off lessons learned from weather delay data of commuter rail, explore options to track weather delay data on rapid transit and bus systems.	All	Systemwide	Climate Policy and Planning, Operations Control Center, Office of Performance Management and Innovation	$	Near-Term
25	Strengthen connections between Climate, Environmental, Security and Emergency Management, and Risk teams	Further collaboration amongst these teams may include: • Annual severe weather tabletop exercises • Severe weather drills, such as flood door exercises. • Flood emergency response plans at insurer identified sites	All	Systemwide	Climate Policy and Planning, Environmental, Security and Emergency Management, Risk	$	Near-Term
26	Create a cross-department working group of Transit Oriented Development, Real Estate, Environmental teams	This cross-department group may: • Identify high-priority collaboration areas and potential climate strategies to pursue in key locations • Create a framework for evaluating the climate risk of TOD and real estate projects • Review long-term leases at South Station, North Station, and Back Bay, and identify ways to address resiliency concerns • Create a climate resiliency checklist for 3rd party agreements and land acquisitions • Incorporate climate risk into shared mapping resources	All	Systemwide	Climate Policy and Planning, Transit Oriented Development, Real Estate, Environmental	$	Near-Term
27	Host scenario planning conversations to discuss long-term resiliency strategy	Working across teams, host scenario planning conversations to discuss future threats and develop long-term strategy to reduce risk through capital strategy. Integrate findings into Asset Management records and planning efforts, such as Capital Needs Assessment and Inventory and long-term capital strategy.	All	Systemwide	Capital Planning, Infrastructure Planning, Climate Policy and Planning, Environmental, Risk	$	Near-Term

Figure 42: Strategies to leverage internal capacity and strengthen climate planning


T Mobile

9. Collaborate externally to advance regional resilience

As the impacts of climate change will be borne regionally, proactive collaboration with regional partners will advance stronger solutions. This may mean collaborating with academic and research institutions to improve data quality and collection methods, working closely with local governments and nonprofits to identify and design district-scale flood protection, or engaging in statewide processes to improve collective disaster response. The MBTA currently engages in many state and regional processes to this extent, including but not limited to ResilientMass, ResilientCoasts, Belle Isle Marsh Working Group, and the Boston Green Ribbon Commission. These regional planning and project groups provide opportunities to share data and collaborate on potential solutions.

In some cases, projects led by other entities could reduce risk at MBTA properties, as shown on the next page. Strategically engaging in regional projects to achieve district-scale flood protection will help steward limited resources. Rather than several institutions protecting their own islands of infrastructure, partners can potentially come together to share the cost of a larger coastal resiliency project that protects multiple properties simultaneously. Creative partnerships, especially in a constrained funding environment, are paramount.

Complementing this bigger picture planning are more discrete projects, such as stormwater improvements. This is especially important for our bus network, where MBTA vehicles travel on municipality- and state-owned streets – meaning collaboration with regional partners is the primary tool available for enhancing climate resilience. Aside from threats to bus maintenance facilities, the main vulnerability of the bus network is flooding on roadways that the MBTA does not own or maintain – thus partnerships are essential to help address stormwater flooding on roadways, as seen in Figure 46 on page 47.

Building and investing in strong partnerships and relationships is foundational to achieving this work. As appropriate, the MBTA will need to engage with ongoing work led by partners, convene new efforts where appropriate, and inform regional resiliency planning efforts by providing a clear vision of future service levels and corresponding resiliency investments.

The goal guiding the strategies identified in this section is:

1) Engage in, convene, and inform regional resiliency planning efforts

Ongoing Work

Centralized resource of ongoing regional projects

- Track regional projects to strategically identify areas where the MBTA can take an active, collaborative role to bring mutually beneficial projects into existence.

Participate in statewide and regional collaboratives

- Regularly engage in regional and statewide planning efforts, working groups, and project-specific efforts. Examples include ResilientMass and Resilient Coasts.

Figure 43: Ongoing work to collaborate externally

There are many opportunities to collaborate with local partners on projects that protect local communities and MBTA owned assets. In some cases, these projects could provide protections to MBTA assets that are located far away from the projects themselves. For example, the Amelia Earhart Dam could protect Alewife Station and Garage. In addition to the specific projects called out below, the MBTA is also actively engaging in the City of Boston's Army Corps study for flood protection along the coast (covering the area shown in light green on the map to the right).

Amelia Earhart Dam

The potential elevation of the Amelia Earhart Dam could protect the communities of Cambridge, Everett, and Somerville, as well as key MBTA locations such as Alewife Station and Garage.

Bennington Street

The elevation of Bennington Street will provide neighborhood flooding relief in Boston and Revere, as well as help mitigate impacts at Suffolk Downs Station.

Raymond L. Flynn Marine Park

Flood mitigation measures could reduce flood pathways into the Seaport, protecting Silver Line infrastructure.

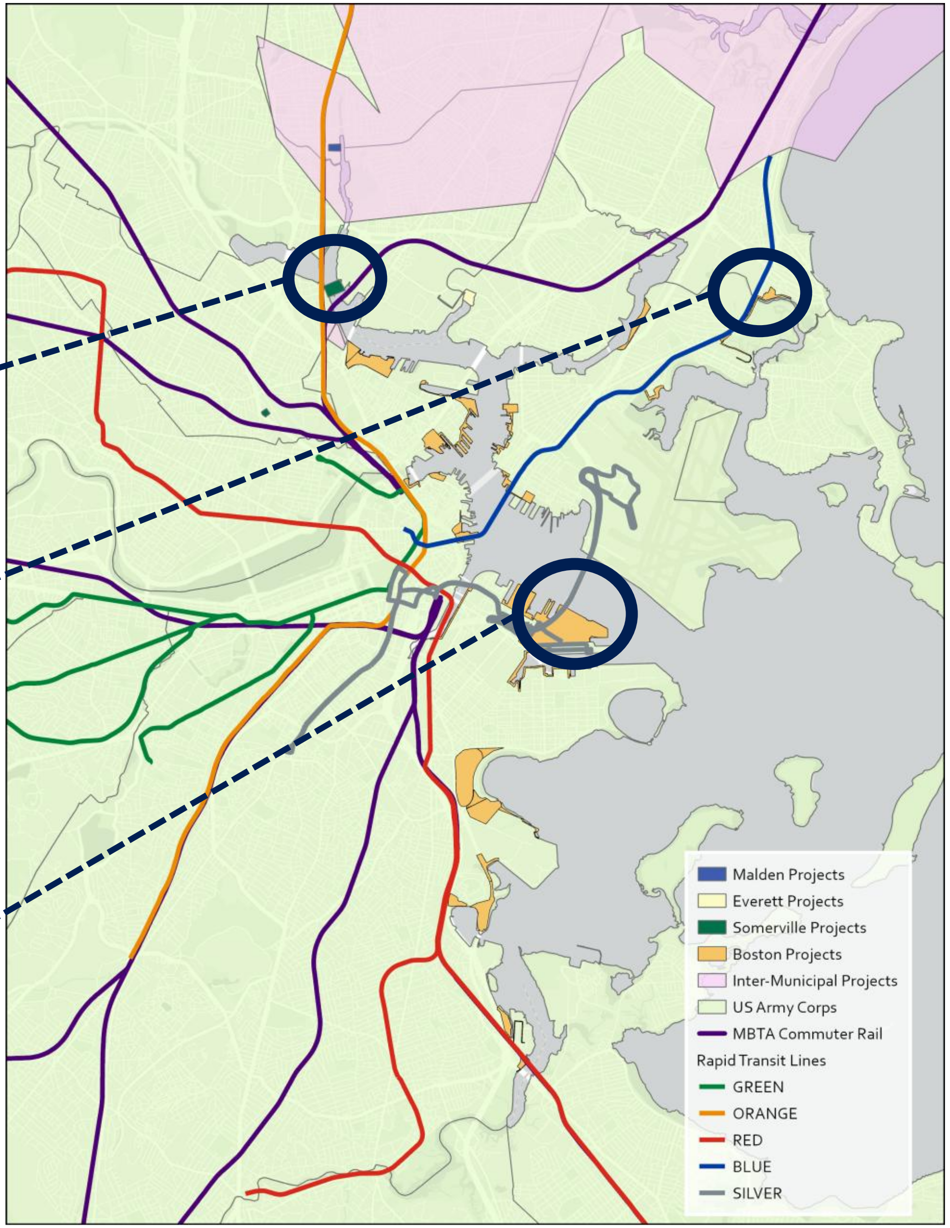

Figure 44: Planned regional projects that could mitigate risks to MBTA infrastructure.

#	Action	Description	Hazards Addressed	Locations of Interest	Departments	Cost	Timeline
28	Evaluate opportunities for district-scale solutions	Establish a decision-making framework for evaluating and engaging in district-scale projects that weigh factors such as potential flooding damage over time, the order of magnitude cost of independent vs. district-scale solutions, capacity of local jurisdiction, and external resources.	All	Systemwide	Climate Policy and Planning, Environmental, Strategic Transit Planning, Transit Oriented Development	$	Near-Term
29	Collaborate on stormwater infrastructure planning with regional partners	Conduct internal analysis on stormwater flooding vulnerability, ridership, and criticality to identify high priority areas of the MBTA network for collaborating with local stormwater agencies. Where appropriate, develop joint emergency protocols or alternative routes.	Extreme Precipitation, Sea Level Rise / Storm Surge	Systemwide	Climate Policy and Planning, Environmental, Transit Oriented Development, Strategic Transit Planning	$	Near-Term
30	Partner on research projects to advance regional planning efforts	Work with regional partners and academic institutions to develop research projects that advance shared goals.	All	Systemwide	Strategic Transit Planning, Climate Policy and Planning, Environmental	$	Near-Term

Figure 45: Strategies for external collaboration

Figure 46: Stormwater flooding on roadways while MBTA bus operates. Flooding on roadways is one of the key vulnerabilities facing bus and paratransit operations, and extreme flooding can halt service while operators wait for local officials to arrive on the scene. In some cases, alternative routes are used to circumnavigate flooding issues, but this can cause disruptions to passengers if their usual stop is bypassed. At times, flooding on roadways can be so severe that it prevents buses from returning to their assigned garage.

Implementation

The plan identified nine focus areas and 30 strategies to pursue to build resilience, 23 of which are recommended for near-term action within the next five years and seven of which we can initiate action on but may take longer to implement. These strategies may be accomplished through many levers – regional partnerships and studies, capital investments, and operational changes – with marquee examples of each highlighted in Figure 47. Collaboration, both internally and externally, will be key to successful implementation.

Many ongoing projects and programs were also identified in each focus area to highlight the existing progress the MBTA is making today. Ensuring these responsibilities remain part of the everyday work done to keep the MBTA running is key, and continuing to fund existing programmatic work is critical.

The MBTA operates in a **fiscally constrained environment with many competing priorities**, which is why this plan seeks to find alignment with existing investment plans, as well as highlight opportunities to address both climate and day-to-day concerns in operational changes. As much as possible, this roadmap seeks to solve for many needs at once to keep the MBTA and the region it serves running.

Successfully implementing this plan will require an all-of-organization approach that leverages existing capacity and projects to move strategies forward. In some cases, it will require additional investment staff capacity.

The MBTA currently tracks capital investments that have a climate resilience component, but additional metrics will need to be developed to measure progress as the roadmap moves towards implementation. Examples of potential metrics include the number and length of weather delays and response time in emergency events – in addition to tracking progress on specific strategies.

Integrating this plan into the internal planning efforts will also be key, such as the Capital Needs Assessment and Inventory, Strategic Plan, Full T Ahead, Severe Weather Operations Plan, and Rail Modernization Plan.

There is also a flurry of climate resilience-related planning efforts going on within the Commonwealth that intersect with MBTA-led work. Key regional and state-led efforts include the ResilientMass plan, ResilientCoasts Initiative, and MassDOT's Resilience Improvement Plan.

This work will not be accomplished overnight, and it will require a multi-pronged approach. The Resilience Roadmap will guide the MBTA's decisions as we invest in our assets, prepare the system for future climate disruptions, and collaborate regionally in a dynamic environment. **This plan will be updated every five years to account for that changing environment, take stock of progress, and chart the path forward for future work.**

Key Recommendations:

Regional Partnerships and Planning Studies:

- Power System and Climate Vulnerability
- Scenario planning to align long-term capital strategy and climate resiliency strategy
- Evaluate opportunities for district-scale solutions

Capital Investments:

- Airport Portal Flood Door
- Orient Heights Flood Mitigation
- Cabot Yard Flood Mitigation

Operational Changes:

- Advanced preventative maintenance program for drainage infrastructure
- Incorporate extreme heat into Severe Weather Operations Plan
- Test 2 – 3 insurer approved deployable flood barriers to establish preferences

Figure 47: Key recommendations of the Resilience Roadmap

Footnotes

[1] Global Resilience Institute. “Severe Winter Weather Slams the East Coast, Causing Storm Surge in Massachusetts.” Global Resilience Institute, n.d. https://globalresilience.northeastern.edu/winter-bomb-cyclone-slams-the-east-coast-and-causes-storm-surges-in-massachusetts/.

[2] Massachusetts Bay Transportation Authority. 2018. *Climate Change Vulnerability Assessment for the Blue Line*. https://cdn.mbta.com/sites/default/files/2022-02/2022-02-15-blue-line-climate-change-vulnerability-assessment.pdf.

[3] City of Boston. 2016. *Climate Ready Boston*. https://www.boston.gov/departments/climate-resilience#climate-ready-boston-.

[4] DeCosta-Klipa, Nik. "The Wildest Stats and Numbers from Boston's 'Snowmageddon' Winter of 2015." Wbur. January 27, 2025. https://www.wbur.org/news/2025/01/27/boston-snow-winter-2015-by-the-numbers-newsletter.

[5] Martello, Michael. (2023). Climate Change Adaptation Planning and Decision Making for Transit Infrastructure. 10.13140/RG.2.2.26449.40809.

[6] Ibid.

To learn more about the MBTA's climate initiatives,
please visit MBTA.com/sustainability