# MBTA State of Good Repair Report

Key Infrastructure and Capital Spending Issues

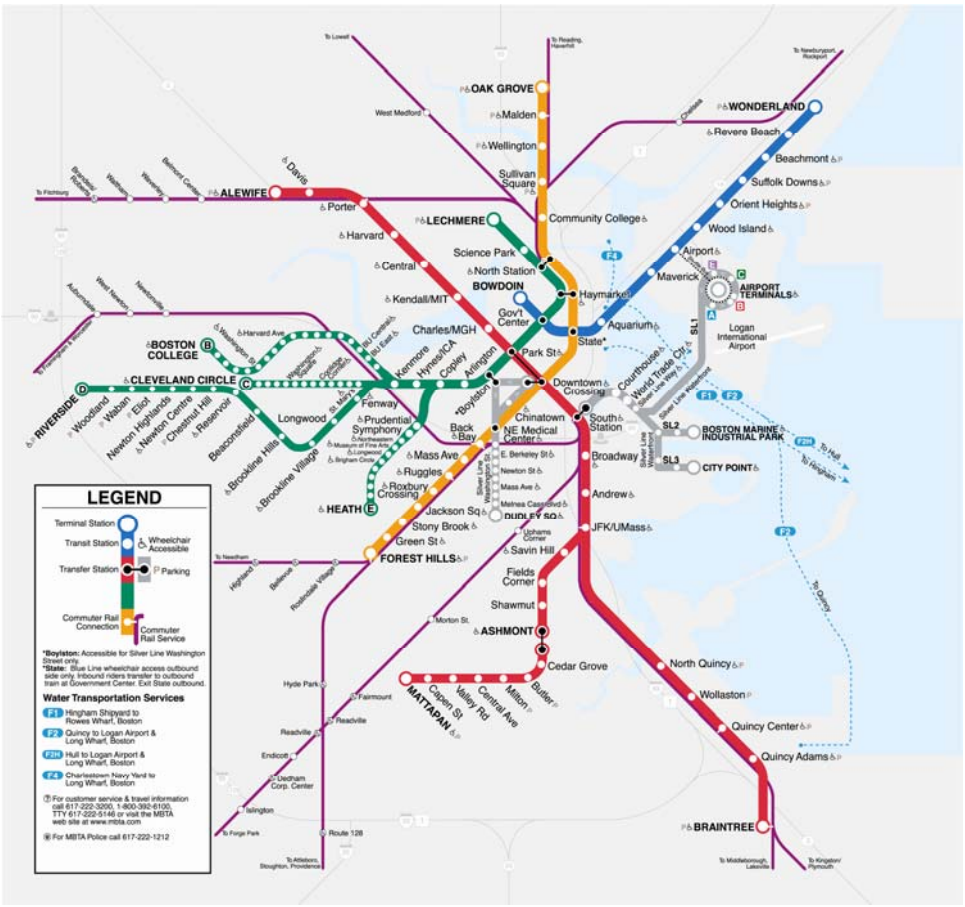
## 2006 Edition

Massachusetts Bay Transportation Authority

# DEFINING THE SYSTEM

The Massachusetts Bay Transportation Authority (MBTA) is the fifth-largest transit property in the United States, serving 1.1 million passengers per day in 175 communities over an area of over 3,200 square miles. The system contains a total of 181 routes and 252 stations (with an additional 9,000 bus stops). The system is also one of the most modally diverse in the nation, providing passenger service in bus, rapid transit, bus rapid transit, light rail streetcars, trackless trolleys, commuter rail, ferries, and paratransit vehicles. The MBTA's physical plant represents over 100 years of major investment in public transit. In the 108 years since America's first subway began operating between the Park and Boylston Street stations, the Massachusetts public transportation system has grown dramatically in response to ever-increasing demand for transit.

A conservative estimate of the present-day cost to replace its major assets is in the range of $12 billion (not including real estate).



Over 2,500 Vehicles

275 Stations

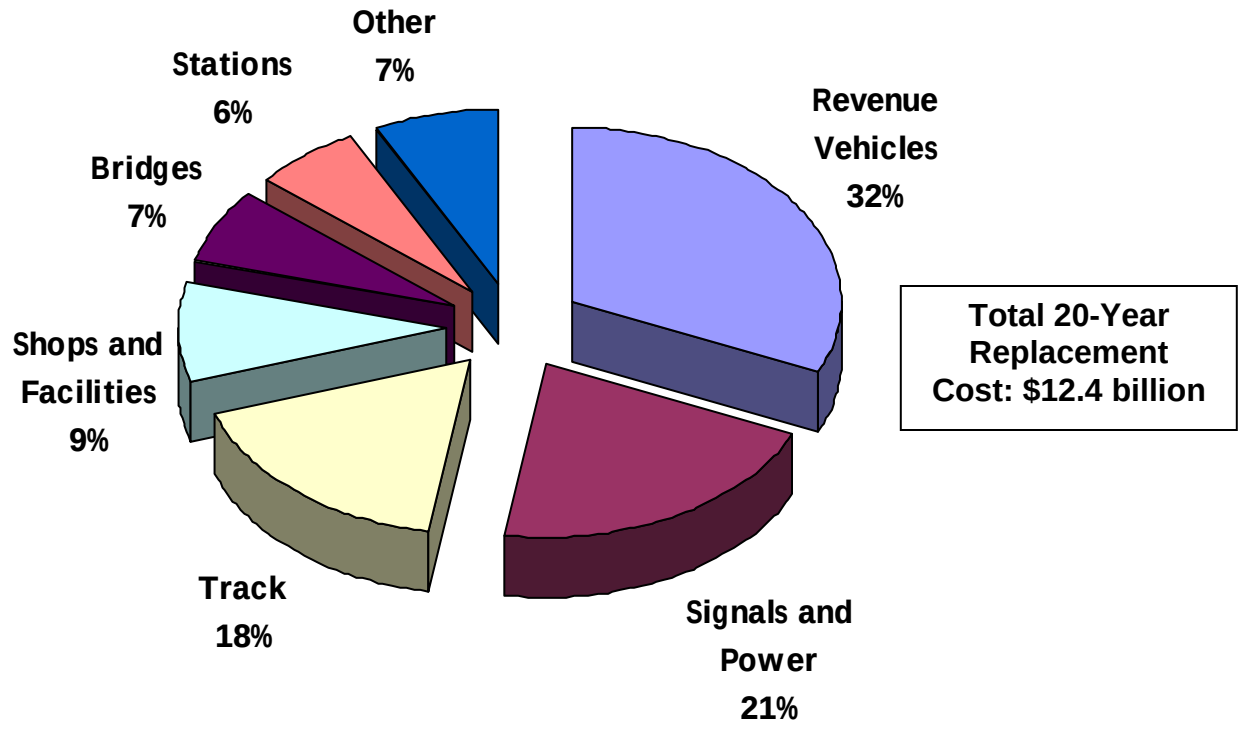
19 Maintenance Shops

885 Miles of Track

496 Bridges

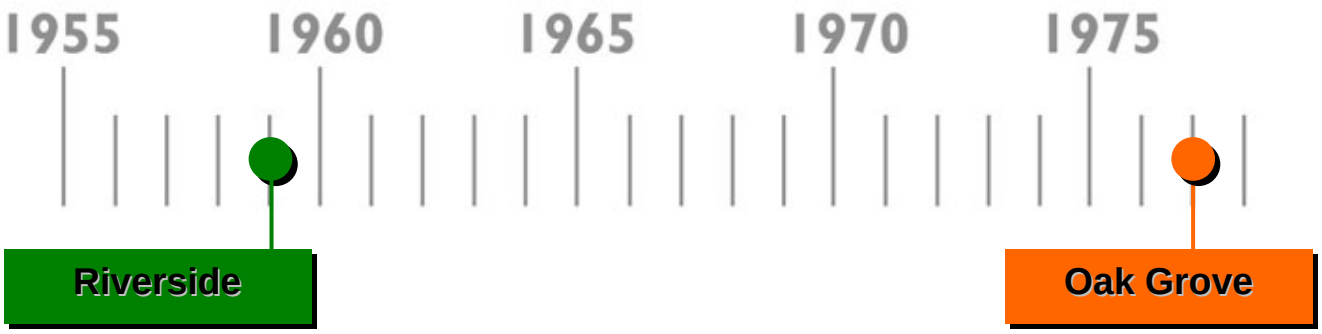
20 Miles of Tunnels

MBTA Asset 20-Year Replacement Cost - By Asset Type




The MBTA's infrastructure is extensive and has major capital needs.

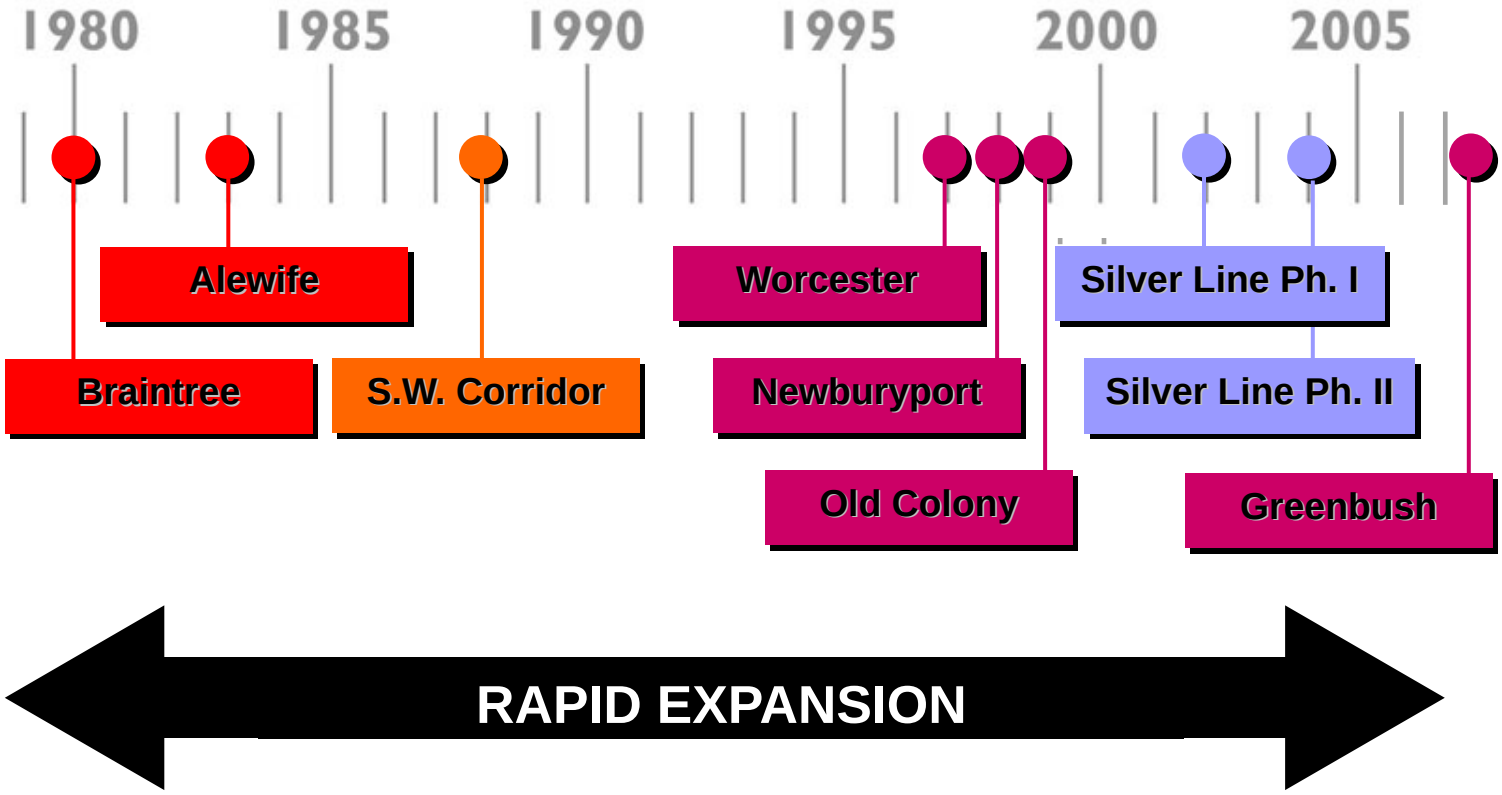
# SETTING THE STAGE




This timeline shows the dramatic increase in major system expansion projects over the past thirty years.

Massachusetts has been the setting for one of the greatest public transportation success stories of the past 30 years. Boston had one of the first public transit systems in the United States, and by 1960, it was showing signs of its age. The capital plant, including the oldest subway section in North America, was in need of additional investment. Renewal of the system began in the 1960's, but the 1973 Highway Act marked a sea change for the MBTA and the nation. The bill was the first legislation under which Federal Highway Funds could be exchanged for Federal transit assistance ("Interstate Transfer"), at state and local discretion. State and local officials, working through the metropolitan planning and programming process, elected to use billions of dollars in federal highway assistance for transit instead of previously planned Interstate Highway construction inside Route 128. As shown in the timeline above, the result of these efforts was a dramatic increase in capital investment for renewal and expansion of the MBTA system. During the 1970's, 80's and 90's, the vehicle fleet was completely replaced or renewed. During the same period, portions of the historic elevated Orange Line were completely relocated and extended northward to Oak Grove, and along the Southwest Corridor to Forest Hills.

Major extensions of the Red Line were completed north to Alewife Parkway and south



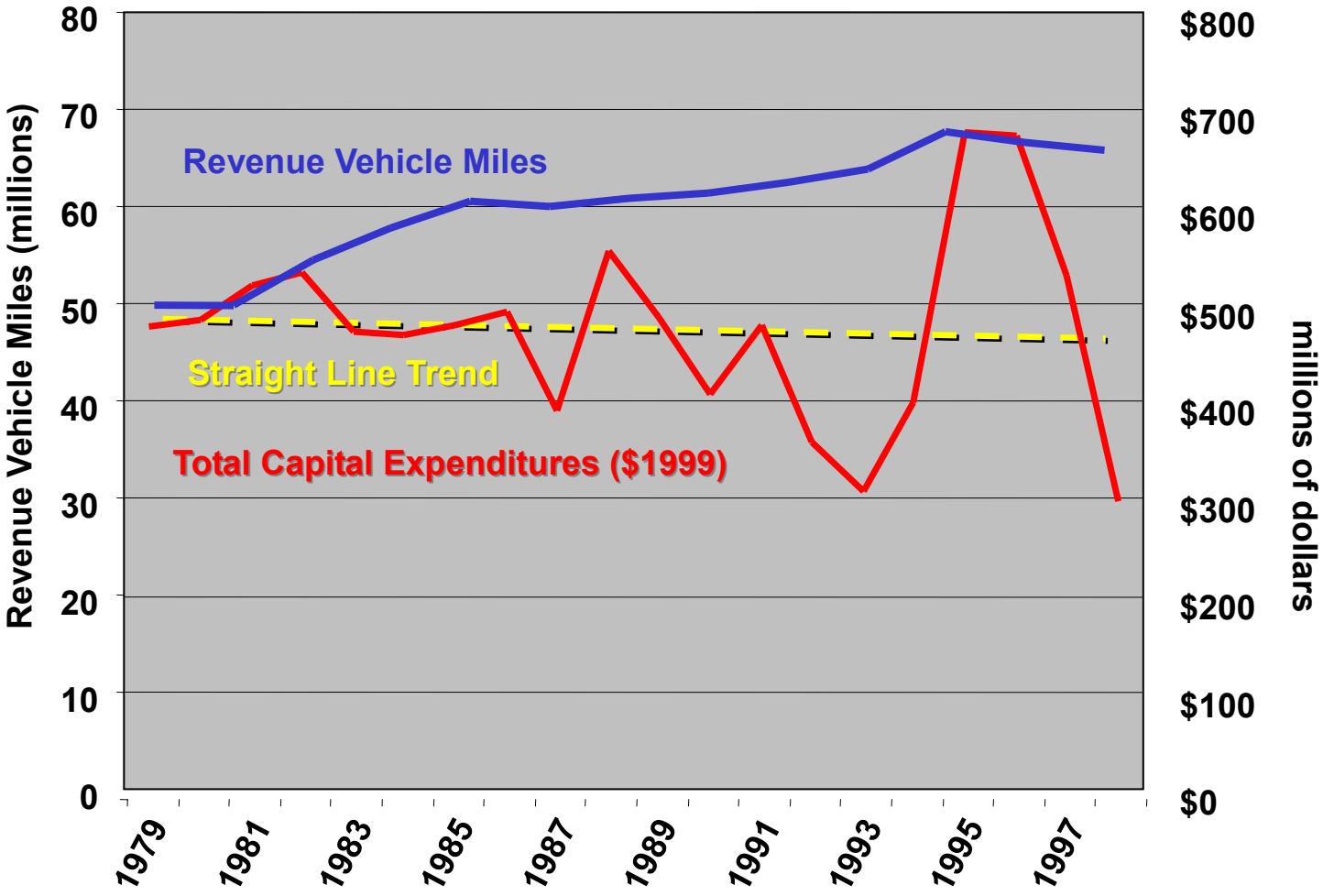

to Braintree. Following the MBTA's acquisition of the commuter rail network from the Penn Central and B&M railroads, existing commuter rail lines were extended (e.g., to Newburyport and Worcester), and two new commuter rail corridors opened on the right-of-way of the Old Colony line. For decades, the total number of vehicle miles traveled each year has increased as improved public transit services have reached into more and more areas of Massachusetts. Ridership on the MBTA has also increased over the same period as a result of these massive public investments.

Today, however, 30 years after the start of this transit resurrection, many of the new and renovated facilities, and much of the new rolling stock and equipment have reached the age at which renewal and/or replacement is once again in order. At the same time, the MBTA is currently facing strict financial limitations. Federal operating assistance has almost disappeared, and federal rail modernization funds are distributed by a formula less advantageous for the MBTA. Access to New Starts capital funds managed by the Federal Transit Administration is extremely competitive.

In short, the pace of expansion at the MBTA has increased dramatically over the past 30 years, and the bill for the renewal of these projects is "coming due."

# RECOGNIZING THE PROBLEM

Against this backdrop of significant expansion, capital spending on the MBTA's infrastructure has not kept pace with growing needs. The chart below shows total capital expenditures over the past twenty years, controlling for inflation. There is significant variation in year-by-year capital spending; however, the overall trend line is slightly downward.



The expansion projects and improved infrastructure described in the previous section have increased the stock of capital infrastructure that the MBTA must now maintain. Yet since the 1970s, as shown in the chart to the left, capital expenditures on the MBTA's existing infrastructure have declined over the same period. Indeed, while the system has greatly expanded and is carrying significantly more riders, less money in real terms is being spent to sustain it.

*Forward Funding*, the financial mechanism through which the MBTA currently operates, has transformed the Authority into a self-supporting transit system with a balanced operating budget and a sustainable capital program. This financial structure enables the MBTA to fund its operating and capital needs from a dedicated revenue source from the Commonwealth of Massachusetts (20% of the state sales tax), along with farebox and other own-source revenues, federal assistance and assessments from cities and towns in its service district.

However, while the MBTA can now rely on a dependable funding stream, this stream is limited and places strict restrictions on the Authority's capacity to take on new debt. In fact, almost one third of the MBTA's operating budget is now consumed by debt service to pay of existing and past capital projects. Therefore, absent a new funding source, the capital program can take on no significant additional expansion or enhancement projects without either increasing the MBTA's debt load to unsustainable levels or allowing its existing infrastructure to slide into a state of disrepair.

Therefore, faced with an aging physical plant of infrastructure and relatively fixed resources with which to maintain and replace it, the MBTA has actively refocused its available funds on reinvesting in the existing system.

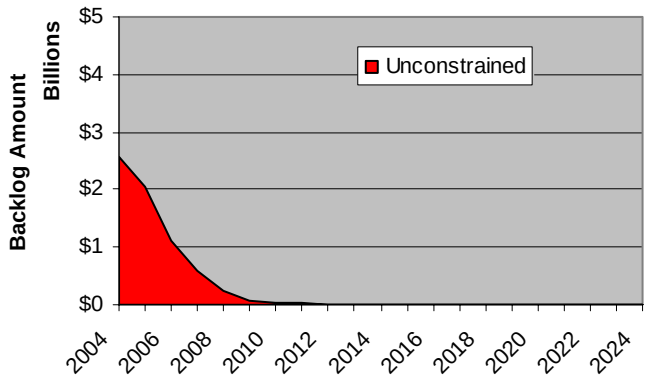
# MEETING THE CHALLENGE

**The SGR Study**
In 1999, the MBTA began work on a *State of Good Repair (SGR) Study.* This project was undertaken to determine the current state of the MBTA's capital assets, and the measures needed to bring the system to a state of good repair. The study covered major, MBTA-owned assets that currently exist or are substantially under construction.

**The SGR Database**
To measure the magnitude and priority of the system preservation needs of the system, the MBTA included as part of this study a *State of Good Repair Database* began evaluating and quantifying the state of repair and level of ongoing reinvestment needed for its entire physical plant. The study inventories all MBTA capital assets, assigns each a replacement value and a "useful life" after which the asset should be replaced, and calculates the level of ongoing capital expenditures needed to maintain a state of good repair based on this information. The SGR Database forecasts asset renewal and replacement needs over time, and allocates available budgets to infrastructure needs on the basis of established capital
program goals and objectives.

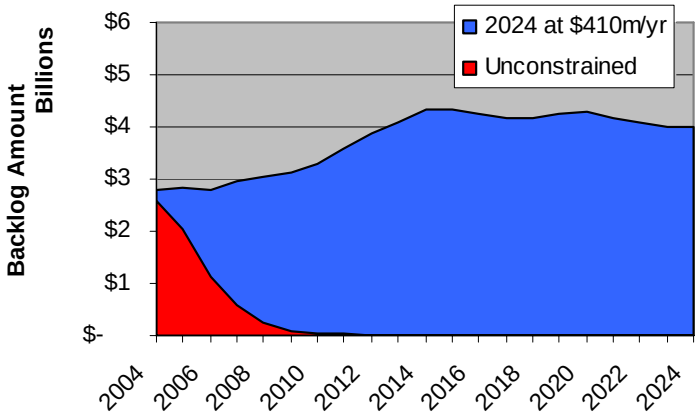
**The Results: A "Roadmap" to a State of Good Repair**
The SGR Database examines a series of questions about the MBTA system's condition, as well as to summarize various 20-year future funding strategies to bring the Authority closer to an ideal state of repair.

**What are the system's current needs?**
The "backlog" is defined as the total cost to renew or replace all assets that are currently beyond their useful life. *In 2006, the MBTA's backlog is estimated at $2.7 billion.* Even with unlimited funds, it would take nearly seven years to complete these backlogged projects, during which time an additional $2.1 billion in needs would be generated. In other words, undertaking enough projects to bring the Authority to an ideal state of good repair would require a massive investment of around $4.8 billion over seven years.



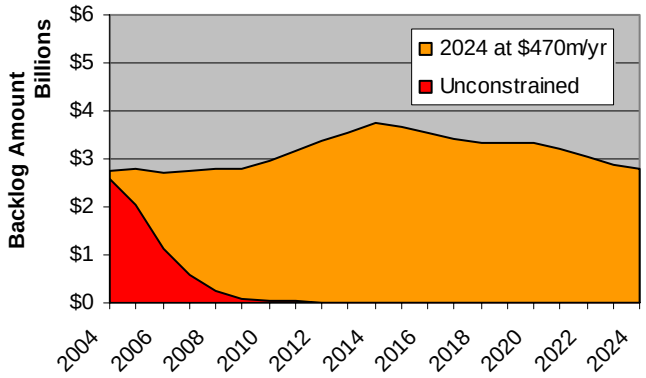
**What would happen to the system if current funding levels remain the same?**

The MBTA's FY06-10 Capital Investment Program allocates approximately $410m in capital funds per year to existing infrastructure. Were this spending level to remain steady until 2024, *the backlog would increase to nearly $4.0 billion by 2024*. This degradation would result in declining system speed and reliability, and in turn declining ridership and revenues as well.



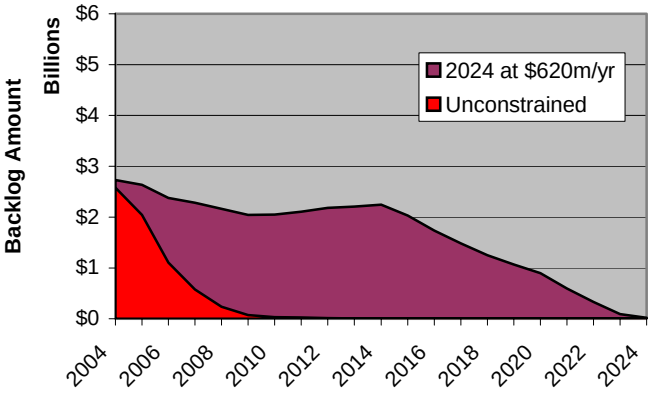

**What level of funding is needed to maintain the current state of repair?**

The MBTA could maintain its existing infrastructure in its current state of repair and hold the backlog steady at $2.7 billion over the next twenty years with a capital spending level of *$470 million per year*.




**What level of funding would be needed to eliminate the backlog in 20 years?**

To complete all backlogged projects and begin normal on-time programmatic replacement of all of its assets, the MBTA would need a capital spending level of *$620 million per year*.



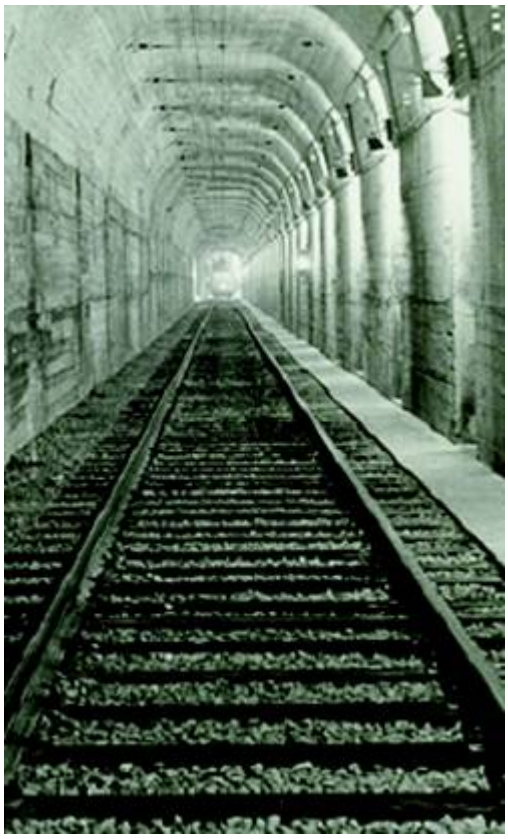
# MOVING FORWARD

The MBTA has recognized its challenges, taken corrective action, and is working within its means to advance the system closer to a state of good repair.

**Coping with the SGR Shortfall**

No 100-year old transit system can claim that all its assets meet the age standards identified in this study. Like many other systems around the nation and the world, the MBTA operates safely with some older equipment with careful and proactive maintenance. For example, the Federal Transit Administration (FTA) considers the useful life of a bus to be 12 years. With careful and proactive maintenance; MBTA buses are typically kept in service for 15 years and beyond with good results. On the Red Line, many rail cars will be kept in service for over 40 years, well beyond the FTA standard of 35 years.

However, there is no question that overage equipment has an adverse effect on MBTA operations. Old track has resulted in speed restrictions, malfunctioning switches generate delays, and deferred capital maintenance can reduce reliability. This in turn undercuts ridership and revenues, increases operating costs, and limits the Authority's ability to finance further debt. Finally, passengers are inconvenienced when equipment such as escalators and air conditioning do not function properly, and outdated facilities affect their perception of the system.

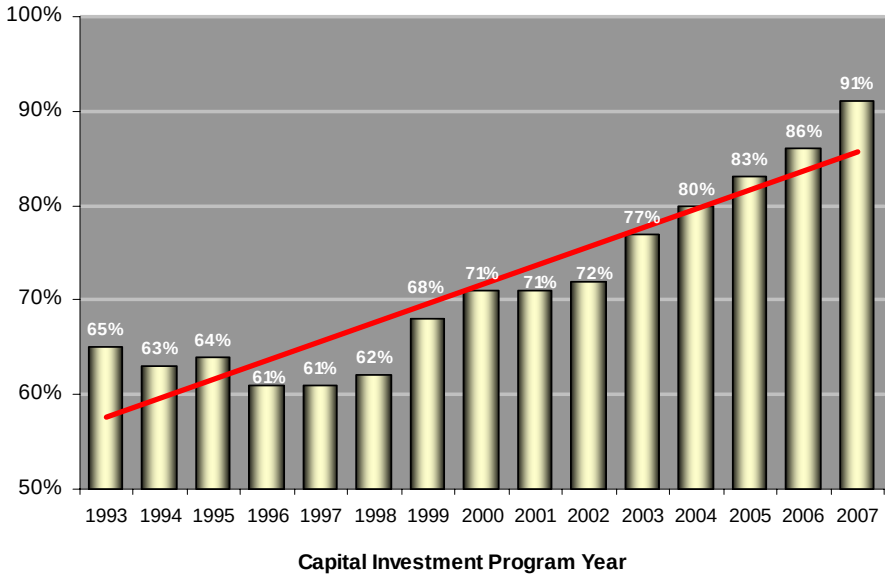


**Prudent, Cost-Effective Expansion**

System expansion has been an integral part of the MBTA's history, and an essential element in the system's present-day success. Potential service to new communities, and enhancements within the existing service area provide valuable, tangible improvements in regional mobility and environmental quality. However, given the clear need for renewal of the existing physical plant and equipment, infrastructure projects should receive the highest priority in the immediate future. System expansion can continue, but should be limited to the most prudent, cost-effective projects, and pursued at a rate that permits higher SGR spending. Moving forward, the MBTA must focus on reinvestment in its existing assets in order to maintain safe, reliable and cost-effective service.

## Progress So Far

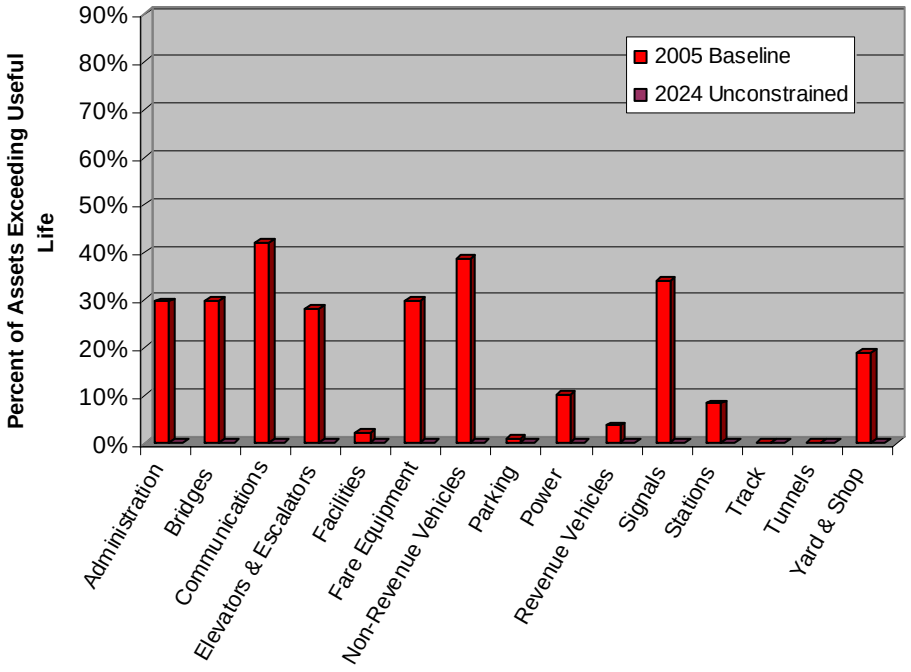
To date, the MBTA has taken a proactive approach to directing unallocated funds towards system reinvestment and preservation, and the results have been dramatic. From a percentage of funds programmed for SGR activity near 60% a decade ago, the current capital program allots a record-high 91% of available funds to the Authority's existing infrastructure. The MBTA's Capital Investment Program (CIP) presents an aggressive agenda and a broad vision to rebuild stations, replace vehicles, and maintain and modernize all necessary infrastructure over the next five years. Projects in the CIP are selected through an ongoing prioritization process that strives to balance capital needs across the entire range of MBTA transit services. In addition, any capital project proposed as a candidate for inclusion in the capital program must now undergo a rigorous set of tests proving that it directly replaces or renews existing assets, corrects existing deficiencies in a variety of categories such as safety and operations, or demonstrates a legal obligation to the Authority. Any enhancement or expansion project must be prudent and cost-effective.

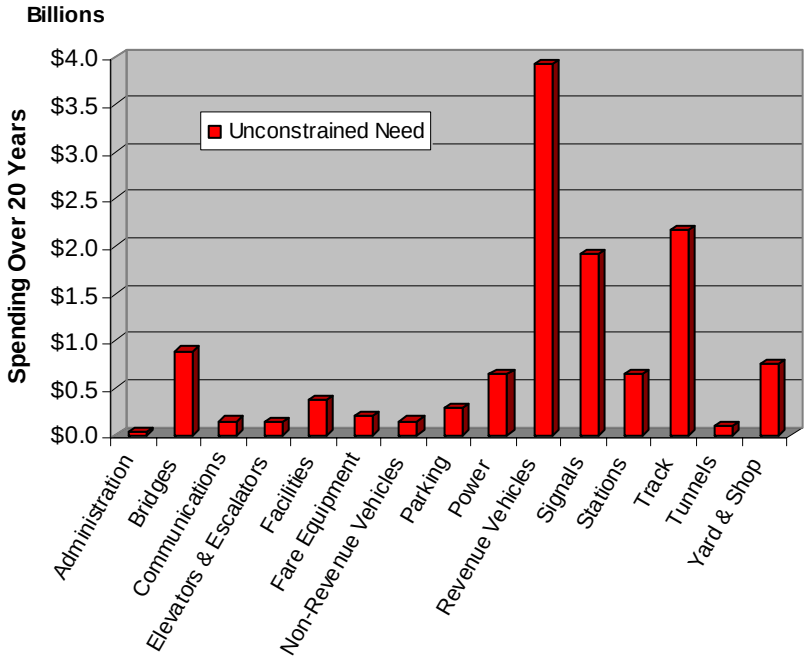


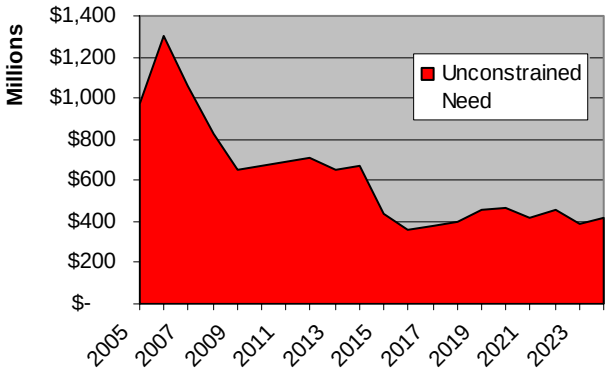

*Proportion of capital program allotted to existing infrastructure, with straight line trend.*

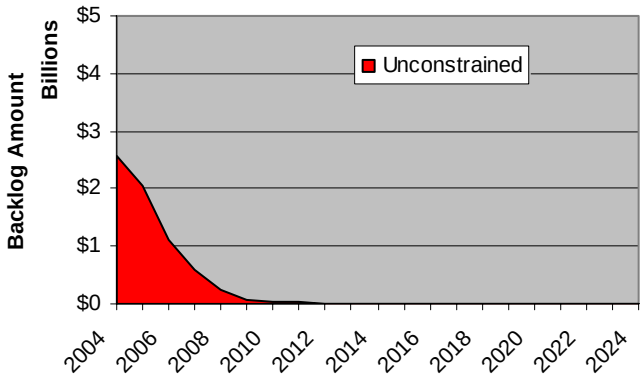
## SGR In the Future

However, the current capital program is insufficient to meet all ongoing state of good repair needs over the long term. In 2006, the SGR study estimated that an annual level of reinvestment of around $620 million was needed to both eliminate the current backlog of overdue projects and continue to meet future needs over a 20-year period. In the current CIP, the actual level of reinvestment meets or exceeds that figure in the first few fiscal years but falls below the minimum in the later fiscal years of the five-year plan. While the CIP does outline an effective strategy to meet the need for a state of good repair in the short term, the projected need for reinvestment will exceed the capacity of the MBTA's capital program in the long term.


Percent of Assets Exceeding Useful Life
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2005 Baseline
2024 Unconstrained
Administration
Bridges
Communications
Elevators & Escalators
Facilities
Fare Equipment
Non-Revenue Vehicles
Parking
Power
Revenue Vehicles
Signals
Stations
Track
Tunnels
Yard & Shop


Billions
Spending Over 20 Years
$4.0
$3.5
$3.0
$2.5
$2.0
$1.5
$1.0
$0.5
$0.0
Unconstrained Need
Administration
Bridges
Communications
Elevators & Escalators
Facilities
Fare Equipment
Non-Revenue Vehicles
Parking
Power
Revenue Vehicles
Signals
Stations
Track
Tunnels
Yard & Shop


Millions
$1,400
$1,200
$1,000
$800
$600
$400
$200
$-
Unconstrained Need
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023


Backlog Amount
Billions
$5
$4
$3
$2
$1
$0
Unconstrained
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024

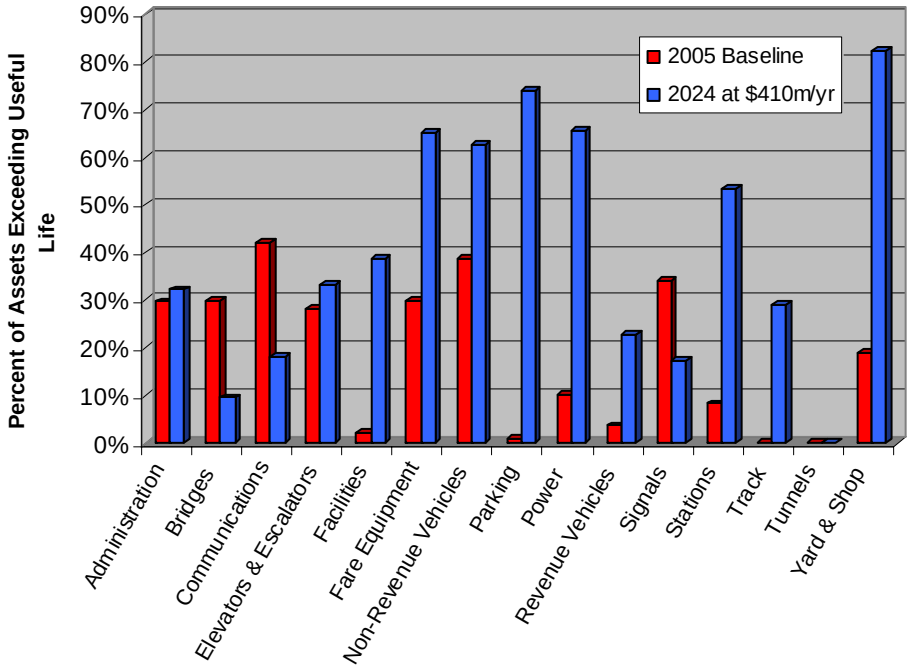
# APPENDIX: Scenario A

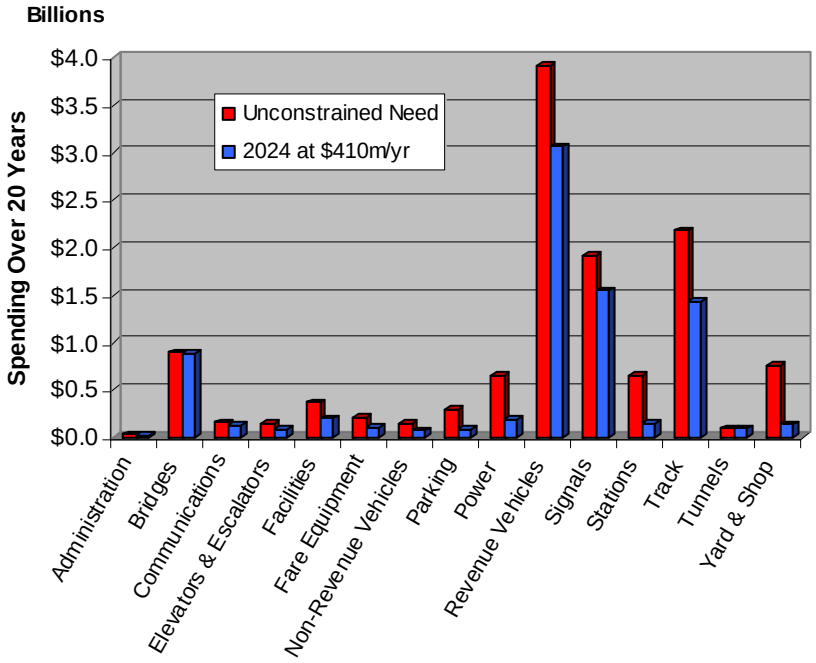
**Annual Budget: Unconstrained**

This scenario simulates the effect of unlimited funding as applied to SGR needs over 20 years. Although unrealistic, the scenario is a useful benchmark for evaluating how well other funding scenarios meet system needs. Most importantly, it determines 1) the funding and minimum time needed to overcome the backlog, and 2) the funding required to maintain the system in a steady state once SGR is achieved.

Backlog is defined as the total funding in constant dollars that was not, but should have been, allocated to replace or renew assets so that they will not be used beyond their useful lives. Backlog reflects the total cost to replace or renew all assets not currently within their age limits by 2005. As shown in the "Funding Backlog" chart, the initial backlog is approximately $2.7 billion. Even with unlimited funds, it would take seven years to actually complete the backlogged projects. During this time, $2.1 billion in other replacement/renewal needs would be generated. Therefore, approximately $4.8 billion and seven years would be needed to bring the system to SGR by 2011.

The minimum time needed to eliminate the backlog is 7 years. After the backlog is funded, the system reaches a steady state condition - all SGR needs are funded on-time. An average of $480m is spent annually during the remaining years of the period.
Note that funding needs continue to fluctuate from year to year even once the Authority reaches a steady state of ideal repair and meets all capital needs on time. The "Spending Over 20 Years" chart shows the allocation of needs among the different asset categories in the system. The overwhelming share of total needs is associated with the parts of the system that are critical for daily operations - revenue vehicles, signals, and track. The funding for these three areas accounts for 65% of the total spending during the 20-year period. Since the system reaches a steady-state condition in this scenario, all assets at the end of the 20-year planning period are operating within their useful lives.


Percent of Assets Exceeding Useful Life
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2005 Baseline
2024 at $410m/yr
Administration
Bridges
Communications
Elevators & Escalators
Facilities
Fare Equipment
Non-Revenue Vehicles
Parking
Power
Revenue Vehicles
Signals
Stations
Track
Tunnels
Yard & Shop


Billions
Spending Over 20 Years
$4.0
$3.5
$3.0
$2.5
$2.0
$1.5
$1.0
$0.5
$0.0
Unconstrained Need
2024 at $410m/yr
Administration
Bridges
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Non-Revenue Vehicles
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Tunnels
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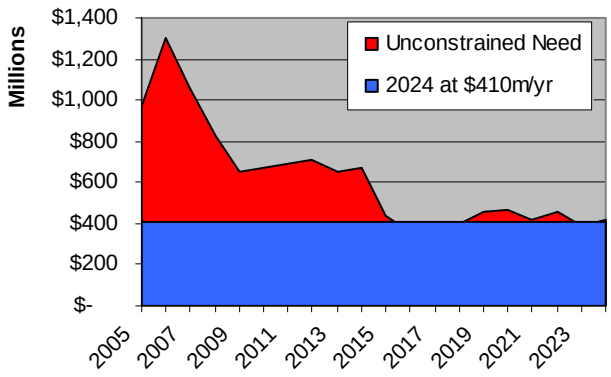
Millions
$1,400
$1,200
$1,000
$800
$600
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$200
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Unconstrained Need
2024 at $410m/yr
2005
2007
2009
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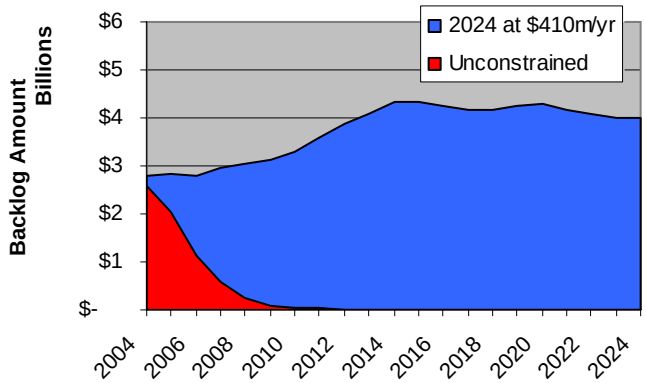
2017
2019
2021
2023


Backlog Amount
Billions
$6
$5
$4
$3
$2
$1
$-
2024 at $410m/yr
Unconstrained
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024

# APPENDIX: Scenario B

**Annual Budget: $410,000,000**

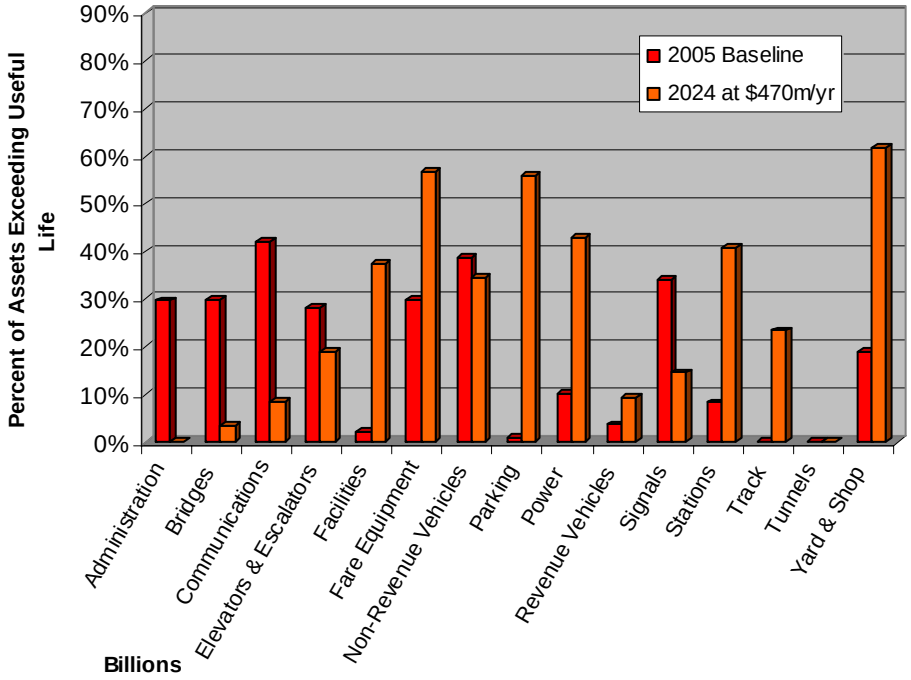
This scenario examines the question: *What would happen to the system if the current funding patterns are maintained?* This scenario assumes that the infrastructure reinvestment levels as laid out in the FY06-FY10 Capital Investment Program (CIP) remain constant for the next twenty years. Although spending authorized in the CIP varies greatly from year to year, the average amount is around $410m annually.

As shown in the spending chart at left, this current funding level falls significantly short of meeting the needs of the MBTA system as established under the unconstrained scenario. Indeed, under this scenario, the SGR model predicts that the MBTA would continue to struggle with a backlog of capital reinvestment projects over the twenty year period.

It is worthwhile to note that the amount of need "spikes" at roughly the midpoint of the scenario, around 2015. This effect occurs in all the scenarios, and is primarily driven by commuter rail assets. As mentioned in the introduction, the Authority made significant investments in the rolling stock, track, and signals on its commuter rail system in the 1970s and 1980s, many assets of which carry a 20- or 30-year useful life. Around 2015, this cohort of assets "comes due" simultaneously, creating a temporary increase in infrastructure needs.

The inadequate funding provided in this scenario adversely affects the funding backlog, which grows from $2.7b in 2005 to almost $4.0b in 2024. In addition, the mix of assets that is funded is significantly different from that funded under the unconstrained scenario. Overall, only about 61% of infrastructure needs are met. As the SGR model prioritizes actions in this constrained fiscal environment, it provides funds for the parts of the system that are critical to daily operations, such as vehicles, track, signals, and communications. Less-critical areas such as parking, maintenance shops, and fare equipment, as well as those assets whose functioning affects fewer passengers, receive a lower priority.
The current funding scenario dramatically affects the timing of funding actions. Only 7% of the needs are funded on-time, 62% are funded late, and about 32% of needs are not funded at all.

The $410 million annual funding also adversely affects the condition of assets which must remain in service beyond their useful life. In many asset categories, over 50% of assets would exceed their useful lives by 2024. The advanced age of the system's assets would decrease system reliability and increase operating costs.


Percent of Assets Exceeding Useful Life
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70%
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40%
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20%
10%
0%
2005 Baseline
2024 at $470m/yr
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Fare Equipment
Non-Revenue Vehicles
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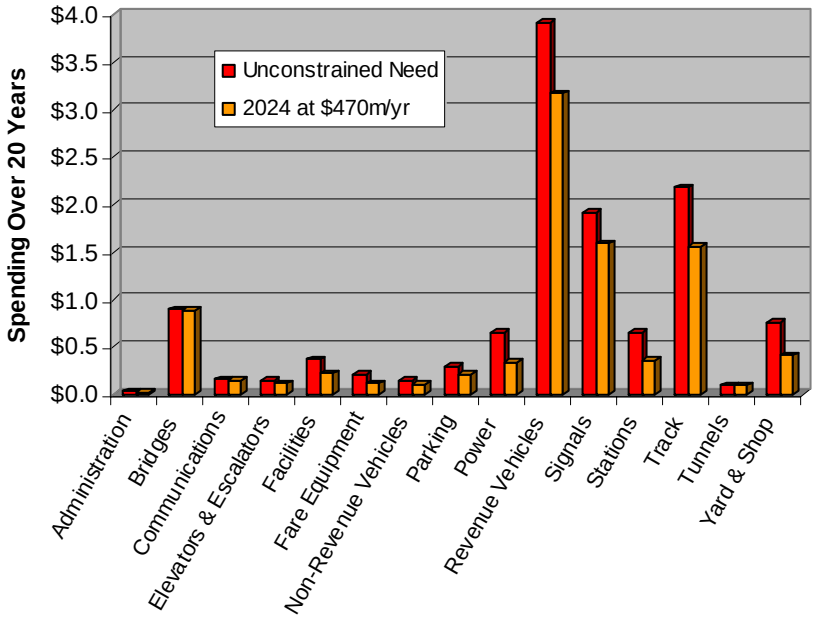
Revenue Vehicles
Signals
Stations
Track
Tunnels
Yard & Shop


Billions
Spending Over 20 Years
$4.0
$3.5
$3.0
$2.5
$2.0
$1.5
$1.0
$0.5
$0.0
Unconstrained Need
2024 at $470m/yr
Administration
Bridges
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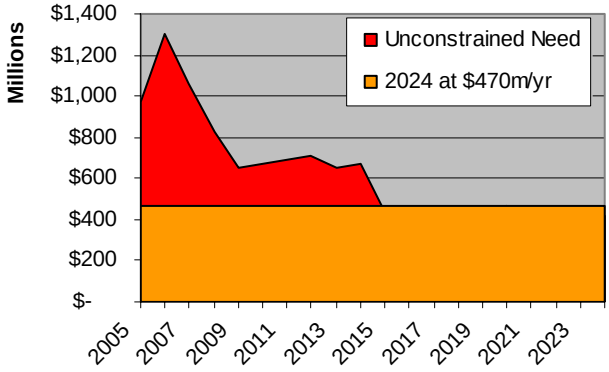
Elevators & Escalators
Facilities
Fare Equipment
Non-Revenue Vehicles
Parking
Power
Revenue Vehicles
Signals
Stations
Track
Tunnels
Yard & Shop


Millions
$1,400
$1,200
$1,000
$800
$600
$400
$200
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Unconstrained Need
2024 at $470m/yr
2005
2007
2009
2011
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2017
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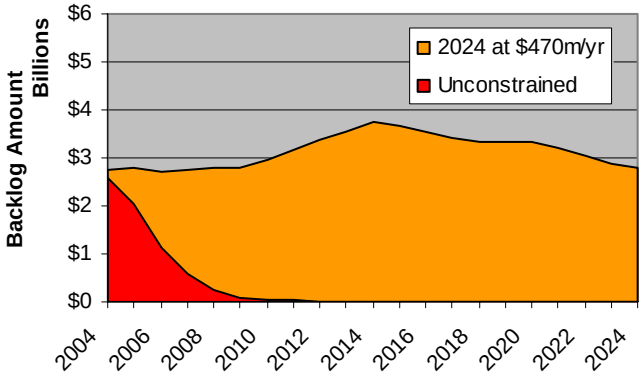
2021
2023


Backlog Amount
Billions
$6
$5
$4
$3
$2
$1
$0
2024 at $470m/yr
Unconstrained
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024

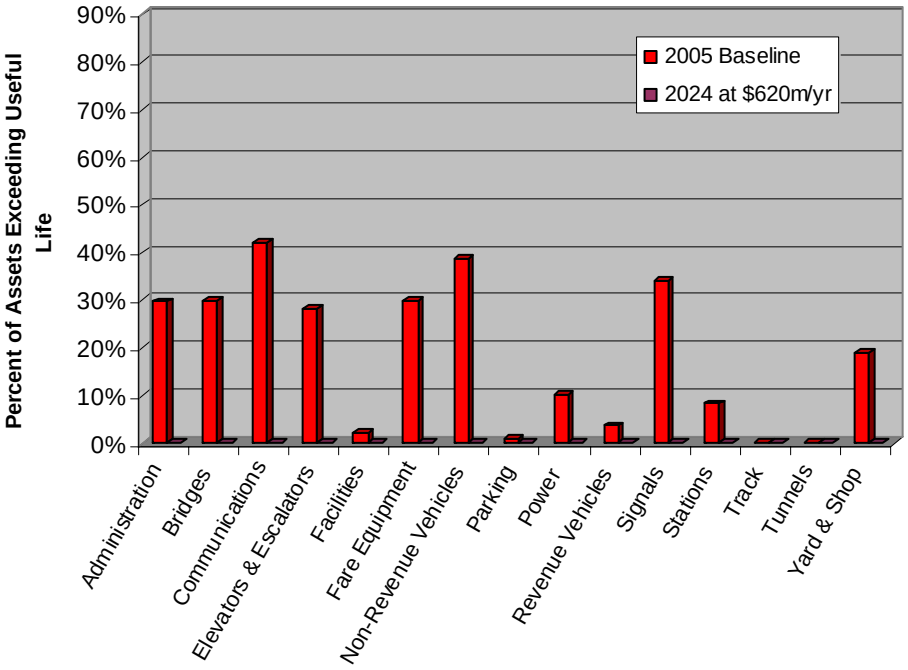
# APPENDIX: Scenario C

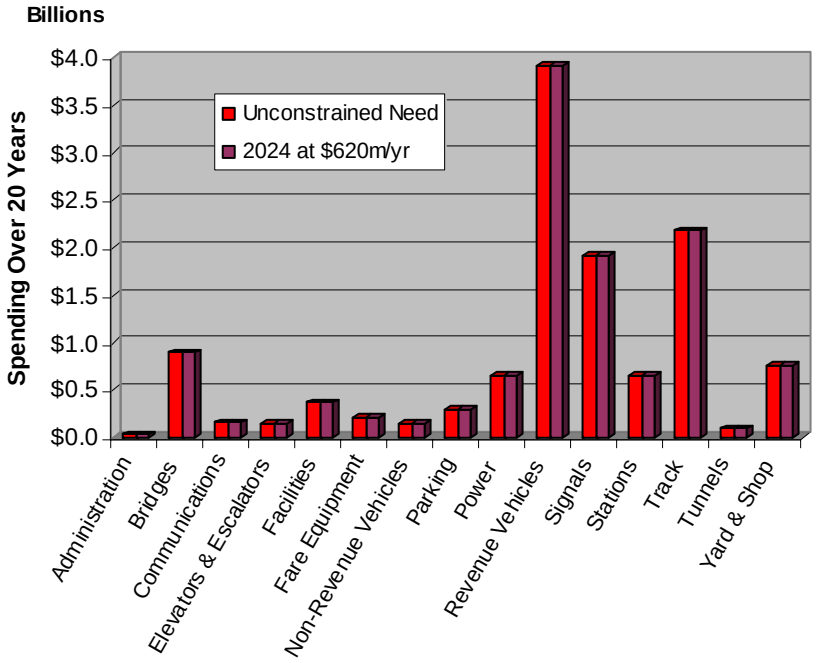
**Annual Budget: $470,000,000**

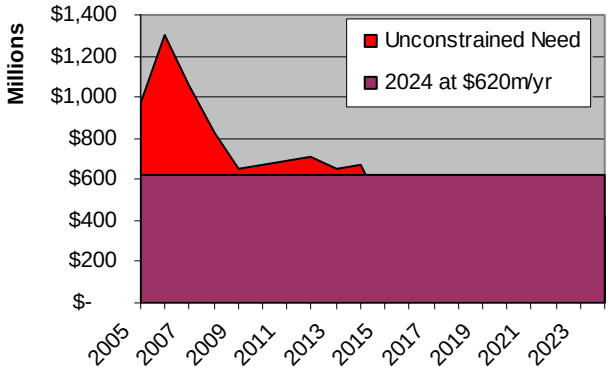
This scenario examines the question: *What annual funding level is needed to maintain the MBTA in its current level of repair?* In the scenario, capital funding is adequate to meet ongoing infrastructure needs, but is not sufficient to reduce the backlog of needs. This means that the funding backlog remains about $2.7 billion throughout the 20-year planning period, and by 2024 the MBTA would be in roughly the same condition in which it is now.

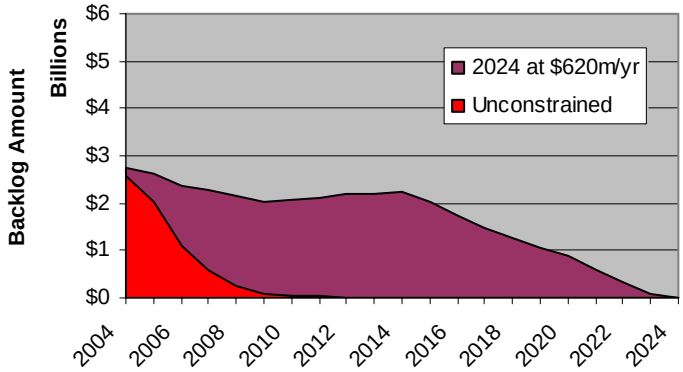
As shown in the spending chart, the $470 million annual funding level approximates the steady-state funding level determined in the unconstrained scenario. However, the MBTA would lose ground in the first 10 years, and gain ground in the second 10 years of this scenario as addressed the backlog of infrastructure needs. While the total backlog remains roughly the same magnitude by 2024, the mix of assets which make up the backlog shifts as funds are prioritized per the SGR model's criteria. In the fiscally constrained environment, the model prioritizes those assets which are critical to daily operations and which affect the highest number of passengers. To this end, around 85% of operationally-critical needs - communications, bridges, vehicles, track, and signals - are funded. On the other hand, less than 65% of the SGR needs associated with facilities, parking, and power are funded.

The $470 million in annual funding has a significant effect on the timing of funding actions. In general, while this scenario manages to fund around 80% of the MBTA's needs, the majority of replacements and renewals are funded late. This funding level also dramatically affects the percentages of non-critical assets that are must remain in operation beyond their useful lives. Over 60% of yards and shops, 40% of stations, 55% of parking facilities, and 55% of fare equipment will exceed their useful lives by 2024 in this scenario. However, consistent with the assigned priority weights, only a small proportion of key operational assets will exceed their useful lives. In short, the model predicts in this scenario that the MBTA would, at the expense of keeping less critical assets in operations beyond their useful life, stay approximately current in meeting the needs of its most critical infrastructure.


Percent of Assets Exceeding Useful Life
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2005 Baseline
2024 at $620m/yr
Administration
Bridges
Communications
Elevators & Escalators
Facilities
Fare Equipment
Non-Revenue Vehicles
Parking
Power
Revenue Vehicles
Signals
Stations
Track
Tunnels
Yard & Shop


Billions
Spending Over 20 Years
$4.0
$3.5
$3.0
$2.5
$2.0
$1.5
$1.0
$0.5
$0.0
Unconstrained Need
2024 at $620m/yr
Administration
Bridges
Communications
Elevators & Escalators
Facilities
Fare Equipment
Non-Revenue Vehicles
Parking
Power
Revenue Vehicles
Signals
Stations
Track
Tunnels
Yard & Shop


Millions
$1,400
$1,200
$1,000
$800
$600
$400
$200
$-
Unconstrained Need
2024 at $620m/yr
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023


Billions
Backlog Amount
$6
$5
$4
$3
$2
$1
$0
2024 at $620m/yr
Unconstrained
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024

# APPENDIX: Scenario D

**Annual Budget: $620,000,000**

This scenario examines the question: *What annual funding level is needed to eliminate the funding backlog by 2024?* This scenario shows how the Authority would gradually reduce the backlog over many years, so that by the end of the planning period the entire MBTA system would be on an ideal program of on-time replacements, and all assets would be functioning within their useful lives.

As shown in the spending chart, this $620 million annual funding level addresses a smaller amount of the backlog in the first seven years of the planning period than does the unconstrained funding scenario. However, except for the "spike" in funding needs near the midpoint of the timeframe, this scenario compensates by meeting more SGR needs (i.e., spending more capital money) in each of the remaining years of the analysis period to bring the backlog to zero by the end.

Timing is the major difference between this and the unconstrained scenario. Since both scenarios bring the system to an ideal state of good repair within 20 years, the mixes of assets funded and the amount of money spent in both scenarios are nearly identical.

However, no SGR actions are deferred in the unconstrained scenario, while over 61% of needs are delayed (but eventually funded) in this scenario. The model predicts that at this spending level, the MBTA would eventually reach a steady state condition, whereby all assets at the end of the 20-year planning period are operating within their useful lives.