Hub and Spoke

CORE TRANSIT CONGESTION AND THE FUTURE OF TRANSIT AND DEVELOPMENT IN GREATER BOSTON

Urban Land Institute
Boston
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ULI Foundation

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EXECUTIVE SUMMARY

Far less publicized than the recent bad news about the financial crisis at the Massachusetts Bay Transportation Authority (MBTA) has been some very good news: ridership is up. These additional riders, however, are filling the MBTA's rush hour trains and straining the aging system's capacity. This success brings with it even greater financial challenges: how will the MBTA serve its growing ridership?

Transit-oriented development, which concentrates homes and businesses near T stations and encourages transit use, has helped fuel this ridership growth. The T's "hub and spoke" travel pattern concentrates ridership — and congestion — in the core of the system, so the success of TOD anywhere along the commuter rail and rapid transit lines depends on the capacity of the MBTA to accommodate additional riders in the core. The Boston District Council of the Urban Land Institute prepared this report in order to better understand core transit capacity and congestion in the MBTA system in anticipation of development trends and ridership growth.

How fast is the MBTA's ridership growing?

Over the past two decades, MBTA ridership has risen at an average annual rate of 1.2%. Growth accelerated in the past five years, with trips increasing at an average annual rate of 2.9% between 2006 and 2011. 2012 is off to a strong start: April 2012 marked the fifteenth consecutive month in which year-over-year ridership increased — and the third straight month that average weekday ridership exceeded 1.3 million.

How will real estate development trends affect future MBTA ridership?

Three real estate development trends have contributed to the recent rise in MBTA ridership and are likely to continue generating riders: transit-oriented development, more intensive use of existing built space in urban core neighborhoods, and promotion of transit use by regulators, building owners and employers in transit-served locations. Interest in TOD is being driven both by growing demand for homes and workplaces near transit and by state, regional and local smart growth policies. A just-released report by the Metropolitan Area Planning Council identifies the potential for 75,000 new residential units and commercial space for 130,000 new jobs near MBTA rapid transit and commuter rail stations by 2035.

How much additional ridership should the MBTA plan to accommodate over the next decade?

Based on three ridership scenarios developed for this report, the MBTA is likely to serve a minimum of 420 million unlinked trips annually, and potentially as many as 500 million, within a decade. This rate of ridership growth translates to an increase in average weekday ridership from 1.3 million trips currently, to 1.4 - 1.7 million weekday trips by 2021. The MBTA should therefore plan to serve an additional 100,000 to 367,000 more daily riders within ten years.

Which MBTA rapid transit lines are congested?

The MBTA system has limited capacity to accommodate growing ridership. This report proposes a three-tiered approach to identifying problematic congestion levels, and assesses existing and forecast congestion under this system. Unacceptable levels of congestion and potential capacity constraints were found on portions of the Green, Orange and Red Lines and the waterfront portion of the Silver Line bus rapid transit line — on every part of the rapid transit system except for the Blue Line.

MBTA CONGESTION

The waterfront portion of the Silver Line bus rapid transit system is rated as **congested**.

The Orange Line from North Station to Downtown Crossing, the C and D branches of the Green Line and portions of the Red Line are rated as **highly congested**.

The Green Line central subway (from Copley to Government Center) and portions of the Red Line are rated as **over capacity**. South Station is also operating above its design capacity for commuter rail and Amtrak trains.

Where are the congestion "hot spots" in the Boston/Cambridge core?

The MBTA's congestion problems raise concerns that future transit-oriented development could be impeded by lack of capacity. Taking into consideration current and projected transit and land use patterns, this report identifies fourteen rapid transit station areas in the Boston/Cambridge core, as well as the Silver Line stations in the Seaport, as areas of concern. These stations cluster into roughly five congestion "hot spots": Downtown Boston, Back Bay, Longwood Medical Area, the Seaport and Kendall Square. Because of the "hub and spoke" nature of the MBTA transit system, transit congestion in these core locations can affect future transit-oriented development along the outer "spokes" of the system as well.

How should the Massachusetts Department of Transportation and MBTA address core transit congestion?

Core transit congestion is a problem born of both success and failure: success in attracting a growing ridership and catalyzing transit-oriented development, and failure to invest enough in the regional transit system to provide the capacity needed to meet the growing demand for transit.

Congestion relief has long been a priority for highway spending — it is past time to recognize that addressing congestion is equally important for the transit system. Ensuring sufficient capacity to meet ridership demand without unacceptable levels of congestion will require both better planning and more investment. MassDOT and the MBTA should create a core congestion assessment and management system and use this information to put a price tag on the investments needed for congestion relief and increasing core capacity. The Commonwealth of Massachusetts then needs to find the resources and make the investments necessary to ensure that the MBTA can continue to serve a growing ridership, anchor transit-oriented development in cities and towns throughout greater Boston and support a prosperous regional economy.

INTRODUCTION: HUB AND SPOKE

Far less publicized than the recent bad news about the financial crisis at the Massachusetts Bay Transportation Authority (MBTA) has been some very good news: ridership on the T is up, substantially and consistently. As of April 2012 ridership has increased for fifteen consecutive months, rising to 1.37 million riders on an average weekday. While MBTA ridership has been growing steadily for some time, the pace of growth has accelerated over the past five years as gasoline and downtown parking prices increased, fares remained stable and state employment growth resumed coming out of the recent recession.

These additional riders are increasingly filling the MBTA's s rush hour trains and straining the aging system's capacity to meet both current and future demand. The transit system's success in attracting new riders brings with it even greater financial challenges: how will the MBTA serve its growing ridership?

The Boston District Council of the Urban Land Institute, supported by a grant from the Urban Land Institute's 75th Anniversary Urban Innovation Fund, and its local funding partners, sponsored this report in order to better understand the MBTA's lesser known, but no less real, crisis: core transit congestion. The MBTA's nearly 300 commuter rail, rapid transit, trolley and bus rapid transit stations anchor varied neighborhoods filled with existing and potential residential, commercial, retail and institutional development. Transit-oriented development — vital to greater Boston's economic prosperity and environmental sustainability — depends on the ability of the MBTA to serve the riders generated by both existing development and by projects in the region's planning and development pipeline.

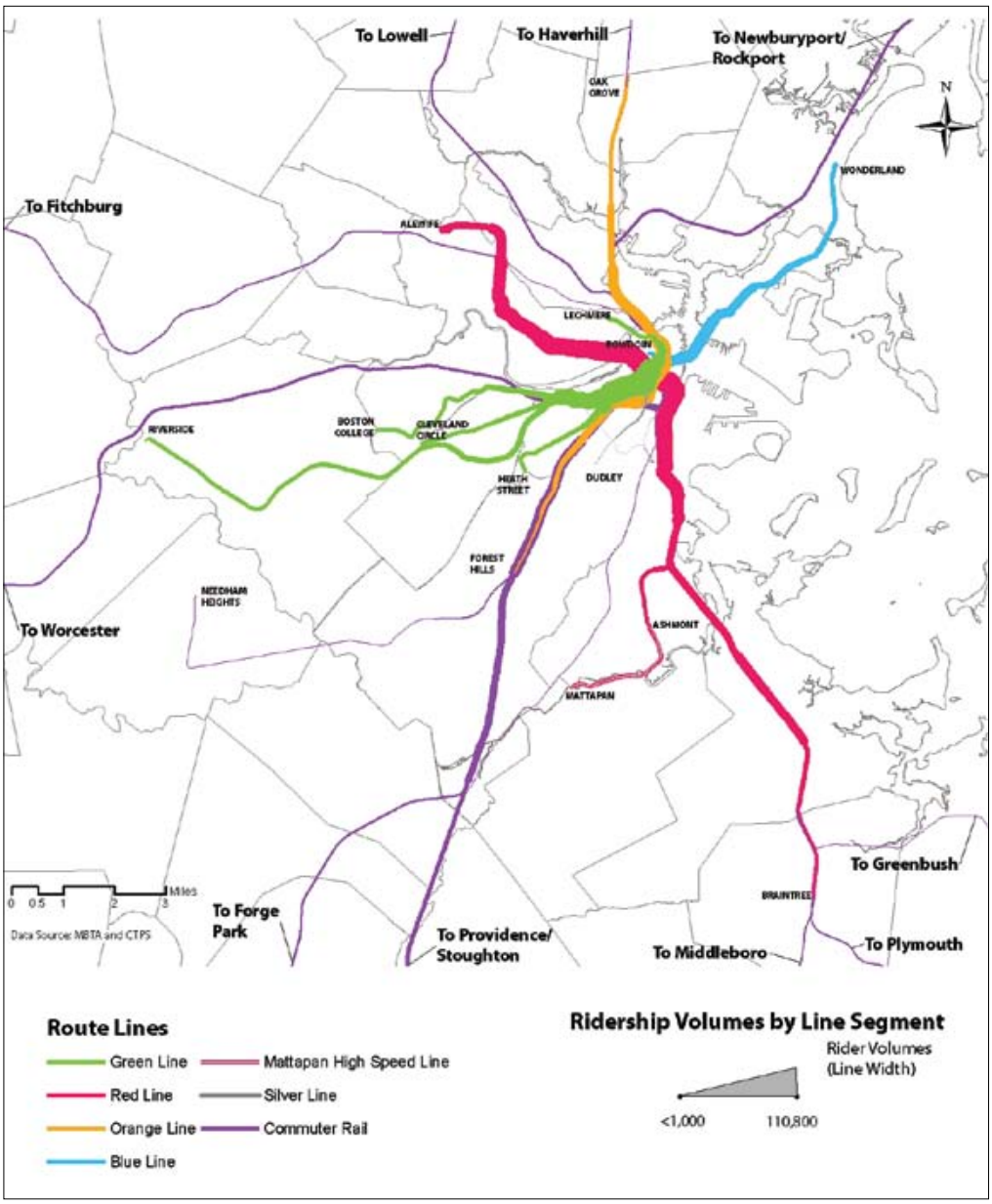
While the potential for transit-oriented development exists throughout the MBTA system, riders tend to travel from most of those stations toward the core or "hub" of the MBTA's "hub and spoke" transit system. Four rapid transit lines serving eleven communities, and fourteen commuter rail lines serving 79 cities and towns funnel riders into Boston and Cambridge. While Boston's urban core may or may not be the hub of the universe — as Oliver Wendell Holmes so famously asserted in the 19th century — it is unquestionably the hub of the regional transit system. As illustrated in the map below (prepared for a 2010 report by the Boston Metropolitan Planning Organization's Congestion Management Process) ridership volume is substantially greater in the core. The twenty busiest subway stations in Boston and Cambridge — roughly one in ten of the stations in the combined subway and commuter rail system — handle approximately half of all daily boardings. (MBTA Blue Book 2010).

The T's "hub and spoke" travel pattern concentrates ridership — and congestion — in the core of the system. This report therefore examines whether the aging and increasingly crowded hub of the MBTA system can accommodate projected future ridership, posing and answering the following questions:

- How fast is the MBTA's ridership growing?
- How will transit-oriented development and other real estate development trends affect future MBTA ridership?
- How much additional ridership should the MBTA plan to accommodate over the next decade?
- Which rapid transit lines are capacity-constrained?
- Where are the congestion "hot spots" in the Boston/Cambridge core where growing ridership demand and capacity constraints may combine to affect key locations for future transit-oriented development?
- How should the Massachusetts Department of Transportation and the MBTA address the problems of constrained capacity and core transit congestion in order to ensure that the regional transit system can support robust economic development over the next decade?

While Boston's urban core may or may not be the hub of the universe — as Oliver Wendell Holmes so famously asserted in the 19th century — it is unquestionably the hub of the regional transit system.

MBTA RIDERSHIP VOLUME



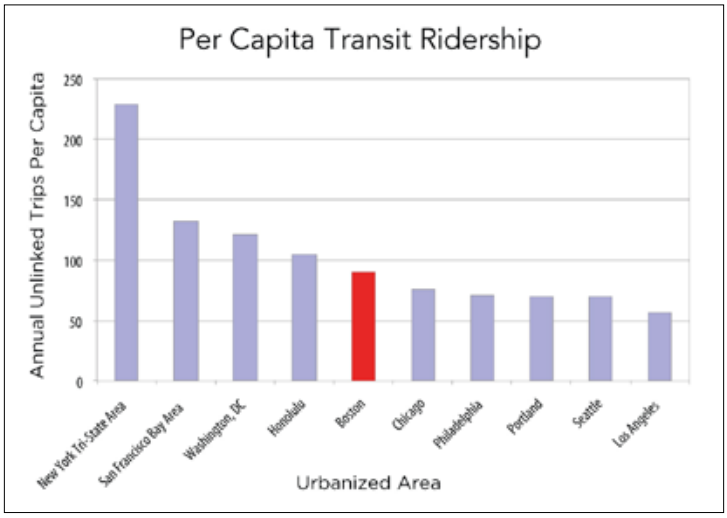
RISING RIDERSHIP

The Massachusetts Bay Transportation Authority, known locally as the T, serves 175 communities with a population of almost 4.7 million people spread over 3,200 square miles. The MBTA's integrated transit system includes 14 commuter rail lines, 4 subway lines and over 180 bus routes as well as bus rapid transit, trackless trollies, ferries and a paratransit system. (MBTA Blue Book 2010).

Boston is one of the top five metropolitan areas in the United States for transit ridership. In 2010, the last year for which the American Public Transportation Association compiled comparative data from the Federal Transit Administration's National Transit Database, the MBTA was the fifth largest transit system in the United States, when measured by the total number of unlinked passenger trips served annually[1] (APTA Fact Book 2011). And when per capita transit use is the metric, as shown in Figure 1, Boston also ranks fifth nationally.

FIGURE 1

U.S. METROPOLITAN AREAS RANKED BY PER CAPITA TRANSIT RIDERSHIP

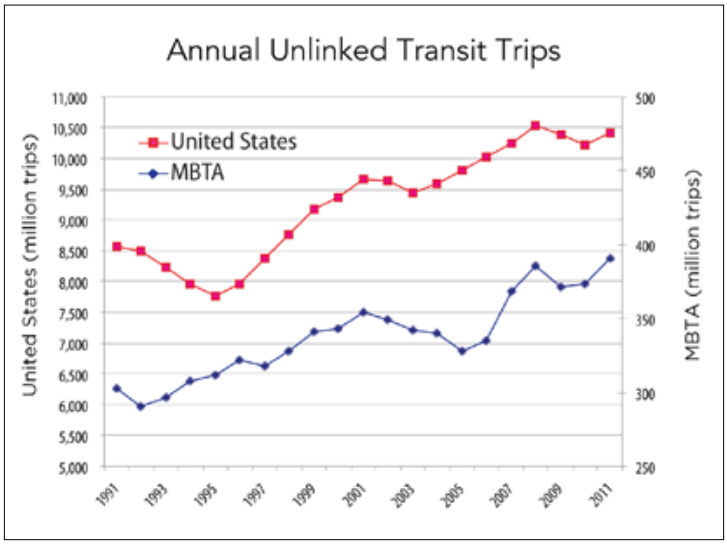


Like transit systems across the country, the MBTA has continued to grow its ridership even in the face of the persistent predictions that transit was a dying transportation mode. Six years ago, when the Urban Land Institute's Boston District Council and Northeastern University's Dukakis Center for Urban and Regional Policy last teamed up to examine transit and transit-oriented development in metropolitan Boston, that *On the Right Track* report acknowledged that "transit ridership has declined in recent years." But the report noted a number of trends "that point toward a future of growing demand for higher quality transit." That prediction, and others like it, has proven correct — ridership has grown steadily and the rate of increase has accelerated.

Transit ridership has actually been growing modestly but steadily for the past two decades, both nationally and on the MBTA. 2011 marked the sixth consecutive year that Americans took more than 10 billion trips on public transportation. The 2011 total of 10.4 billion trips was the second highest annual ridership recorded since 1957, according to the American Public Transportation Association.

FIGURE 2

TRANSIT RIDERSHIP TRENDS FOR THE U.S. AND MBTA



As shown in Figure 2, the MBTA's ridership over the past two decades roughly parallels the national increase in ridership, rising at an average annual rate of 1.2% between 1991 and 2011. Ridership growth on the MBTA has accelerated during the past five years, with trips increasing at an average annual rate of 2.9% between 2006 and 2011. And 2012 is off to a strong start: April 2012 marked the fifteenth consecutive month in which year-over-year ridership on the MBTA increased and the third straight month that average weekday ridership exceeded 1.3 million. Between January 2007 and April 2012 — with fares remaining unchanged and the retail price of gasoline in Massachusetts rising from $2.26/gallon to $3.86/gallon — MBTA ridership rose at more than twice its longer-term historical average of increasing just over one percent per year.

1 "Unlinked trips" are the number of times passengers board public transportation vehicles. Passengers are counted each time they board vehicles, no matter how many vehicles they use to travel from their origin to their destination.

DEVELOPMENT TRENDS AND RIDERSHIP GROWTH

One driver of ridership growth on the MBTA (and other transit systems around the country) is the growing trend toward locating residential, commercial, retail and institutional development near transit stations and encouraging those who live in, work in or visit such "transit-oriented developments" to use transit. Both market forces and public policy have catalyzed TOD throughout metropolitan Boston for at least the past decade. Driven by growing demand for homes and workplaces near transit, and encouraged by state, regional and local smart growth policies, transit-oriented development in the greater Boston region over the coming decade and beyond is likely to continue generating additional transit trips.

In the six years since ULI Boston and the Dukakis Center last analyzed the state of transit-oriented development in the region, many large-scale TOD projects have moved from concept to reality:

- Assembly Row, a $1.5 billion mixed-use TOD project incorporating a new Orange Line station in Somerville that will eventually include 2,100 apartments and 1.5 million square feet of retail
- Fan Pier, a 21-acre development in Boston's Seaport district, served by the Silver Line, that will encompass 3 million square feet of commercial and residential space
- Fenway Center, where a new Yawkey Station commuter rail station is under construction as the first piece of a $500 million, 1.3 million square foot development that will include 500 new residences, office space and neighborhood-oriented retail
- The Hamilton Canal District, which will transform 15 acres of vacant and underutilized land near the multimodal Gallagher Terminal in Lowell into a new mixed-use neighborhood including up to 1,000 residential units
- Jackson Square, an 11 acre, $250 million mixed-use project adjacent to the MBTA Orange Line in Roxbury that will include more than 400 housing units, a youth and family center, small and mid-scale retail space and new open spaces and plazas
- North Point, a $1.5 billion redevelopment of 44 acres in East Cambridge that will eventually contain up to 2 million square feet of office and lab space, 2,800 residences and more than ten acres of green space adjacent to a new Green Line Lechmere Station
- SouthField, a $2.5 billion, 1,400-acre master planned residential community adjacent to the South Weymouth commuter rail station that will eventually include more than 2,800 residences and 2 million square feet of commercial and retail space

An analysis of the Metropolitan Area Planning Council's "Development Database"[2] confirms that additional TOD projects now in the planning or entitlement process will likely generate substantial additional transit ridership over the coming decade. The Development Database includes more than 250 TOD projects near subway and commuter rail stations, which collectively would create 36,000 housing units and space for 92,000 permanent jobs. The accompanying maps illustrate the amount and location of this extensive pipeline of both residential and mixed-use/commercial transit-oriented development. And this pipeline represents only some of the potential for transit-oriented development in the region. A just-released report by the Metropolitan Area Planning Council (MAPC) highlights the potential for 75,000 new residential units and commercial space for 130,000 new jobs to be built near MBTA rapid transit and commuter rail stations by 2035.

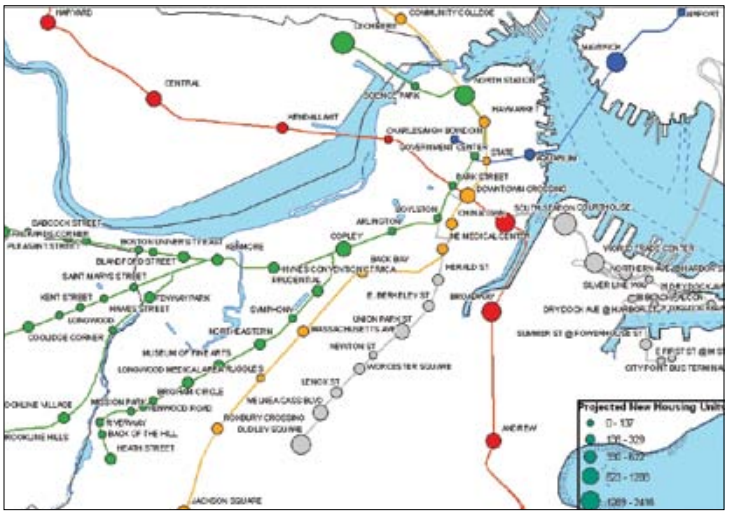
2 The Development Database contains information on nearly 1,700 development projects recently completed, in construction, or planned among the 101 cities and towns of Metropolitan Boston, compiled by the Metropolitan Area Planning Council and available online at http://www.mapc.org/data-services/available-data/devtdatabase; the March 2011 version was analyzed for this report.

Transit-oriented development is not the only real estate development trend contributing to the recent rise in MBTA ridership and likely to continue generating new transit riders for the system. The three key real estate market trends driving greater transit ridership are:

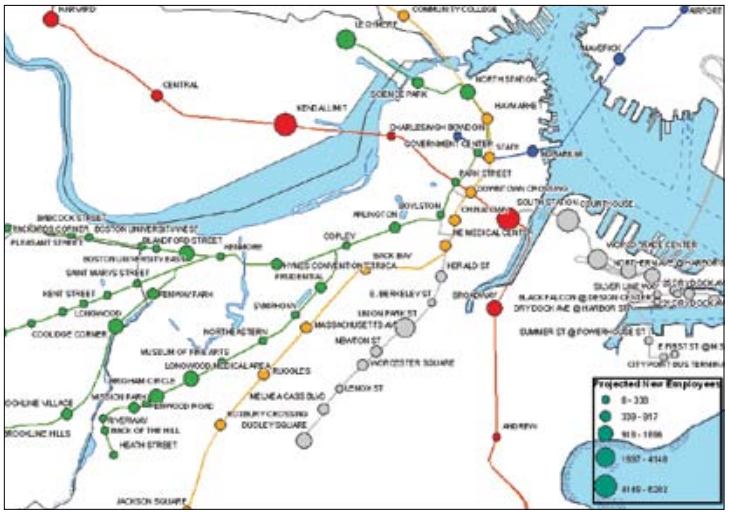
- New construction of residential, commercial, mixed-use and institutional transit-oriented development
- More intensive use of existing commercial space in urban core neighborhoods and
- Promotion of transit to users of both new and existing development in transit-served locations.

Existing commercial space in Boston's urban core — not just new transit-oriented development — appears to be generating more transit riders as employers squeeze more employees into existing buildings, including those near MBTA transit stations. Building users report — and building owners confirm — that the "employment density" in commercial buildings is increasing. One recent study conducted by Jones Lang LaSalle indicates that the historical rule of thumb, in which employers allow for 200 square feet per employee, may shrink to as little as 50 square feet for some tenants by 2015. This greater employee intensity puts a greater number of potential transit riders into transit-accessible locations — a trend that may not show up in conventional travel demand modeling, which calculates employment based on a fixed ratio of employees per square foot established at the time a new development opens. If the number of employees or other users of a building increases over time, those additional users may not be reflected in modeling. For example, the modeling done to evaluate the Red Line/Blue Line Connector project, which would extend the Blue Line from Bowdoin Station to the existing Red Line station at Charles/MGH, appears to underestimate the number of potential transit riders in the station area. A March 2010 draft Environmental Impact Report forecast Red Line boardings at Charles/MGH in 2030 (assuming the Connector is not built) at 10,050 — slightly less than the 10,615 actual boardings at the station in 2009. One explanation for this result is that the regional travel model fails to capture the growing number of employees working at Massachusetts General Hospital and other institutions near the Charles/MGH Red Line stop.

RESIDENTIAL DEVELOPMENT PIPELINE
WITHIN ONE-HALF MILE OF MBTA STATIONS



COMMERCIAL DEVELOPMENT PIPELINE
WITHIN ONE-HALF MILE OF MBTA STATIONS



A third trend contributing to growing transit ridership is a concerted effort to change local and regional travel behavior by encouraging workers and others to use transit more and drive less. Measures taken by regulators, building owners and employers to encourage transit use by residents and employees increase transit ridership from both existing and new development. Currently four transportation management associations in Boston and one in Cambridge work with developers, building owners and tenants/employers to encourage transit use and broaden commuting options for building tenants. In Boston, the Boston Redevelopment Authority and Boston Transportation Department use regulatory mechanisms such as Transportation Access Plan Agreements to promote greater transit use and the Boston Air Pollution Control Commission administers parking "freezes" to limit new parking in downtown, South Boston and Logan Airport. In

Cambridge, a Parking and Transportation Demand Management Ordinance first adopted in 1998 has contributed to greater use of transit by those who work and live in that city, with public transit's "mode share" growing from 21% in 1990 to 27% in 2010.

MAPC highlights the potential for 75,000 new residential units and commercial space for 130,000 new jobs to be built near MBTA rapid transit and commuter rail stations by 2035.

The combined effect of all three trends — new transit-oriented development, more intensive use of existing commercial space located near transit and "mode shift" from driving to transit — can be seen in Boston's Longwood Medical Area, as illustrated in Table 1.[3] The increased intensity of land use — here calculated in terms of both students and employees — is driven both by the addition of institutional and commercial space (measured as gross square footage) as well as by increasing intensity of use of existing space. At the same time, efforts by the transportation management association and area institutions have increased the transit mode share for Longwood Medical Area from 39% of trips in 2000 to 44% of trips in 2010. Total transit ridership associated with the Longwood Medical Area increases as more students and workers use existing buildings, as more buildings are developed and as a higher share of trips made into and out of Longwood Medical Area are made by transit rather than in motor vehicles.

As regional residential, commercial and institutional real estate markets rebound from the recent recession, more intensive use of existing built space and greater concentration of high density development near MBTA commuter rail and subway stations is expected to continue. In combination with local and state regulatory policies designed to promote transit use and shift trips from motor vehicles to transit, this increasingly transit-oriented approach to real estate development in metropolitan Boston can and should fuel ridership growth throughout the MBTA. MAPC's recent analysis of TOD potential, for example, calculated that the new transit-oriented development alone could generate more than 60,000 commute trips per weekday by 2035. The question for real estate developers, users, planners and policymakers alike is whether the MBTA will have the capacity to serve its expanding ridership.

TABLE 1

LAND USE CHANGES IN LONGWOOD MEDICAL AREA

Year	Employees	Students	Acres	Employees/ Acre	Students + Employees/Acre	Gross Square Feet Developed Space	GSF/Acre
1993	26,000	10,000	175	149	206	13,100,000	74,857
2001	37,000	15,000	210	176	248	13,691,115	65,196
2005	40,000	18,200	213	188	273	15,347,400	72,054
2008	43,600	19,200	213	205	295	18,123,992	85,089
2010	45,200	21,000	213	212	311	17,500,000	82,160

3 All of the data presented in Table 1, as well as the Longwood Medical Area transit mode share data, were provided by MASCO.

FUTURE RIDERSHIP GROWTH

With MBTA ridership rising modestly and steadily over the past twenty years — and the annual rate of increase more than doubling from 1.2% over the past 20 years to 2.9% over the past five years — the MBTA must plan for higher ridership in the future. Even with fares set to increase, which may at least temporarily slow ridership growth, analysis of the MBTA's historical and more recent ridership data, as well as recent modeling performed by the Commonwealth's Central Transportation Planning Staff, support the conclusion that the MBTA needs to plan to be able to serve significantly more riders in the near future.

How many more transit trips should the MBTA plan to accommodate? For this report the Dukakis Center developed three scenarios for forecasting MBTA ridership growth from 2011 through 2021: a baseline forecast, a moderate growth scenario and a high growth scenario. The results, as illustrated in Figure 3 and explained in "Ridership Growth Scenarios" on the next page, are both exciting and sobering.

The MBTA's 2011 ridership was 390 million unlinked trips or approximately 1.28 million unlinked trips on an average weekday, with average weekday ridership increasing to over 1.3 million average weekday riders in the early months of 2012. Figure 4 shows the forecast level of ridership in 2021:

- The baseline growth rate of 1.2% annually predicts that the MBTA would serve at least 420 million unlinked trips in 2021, equivalent to approximately 1.4 million average weekday riders.
- The moderate growth rate of 1.5% annually predicts that the MBTA would serve 450 million unlinked trips in 2021, equivalent to approximately 1.5 million average weekday riders.
- The growth rate of 2.9% annually predicts that the MBTA would serve 500 million unlinked trips in 2021, equivalent to approximately 1.67 million average weekday riders.

FIGURE 3

FORECAST MBTA RIDERSHIP GROWTH IN 2021

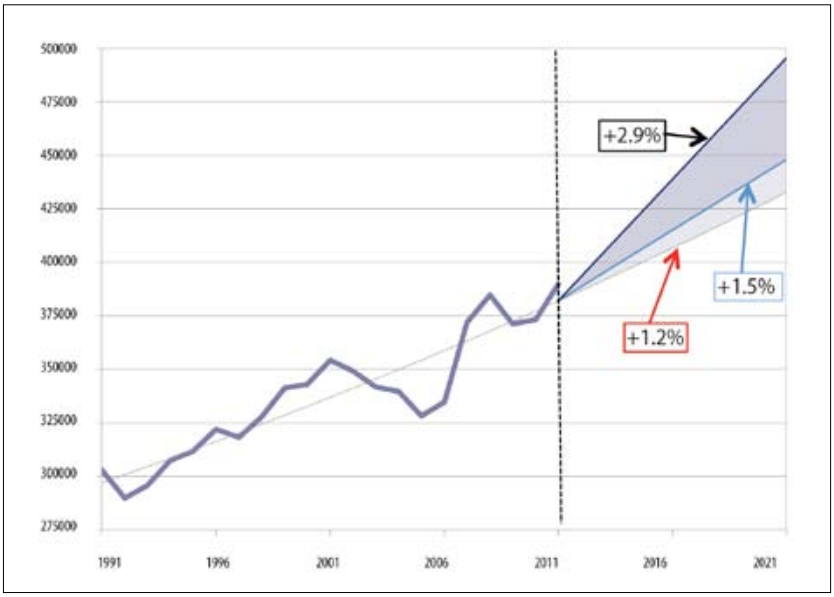
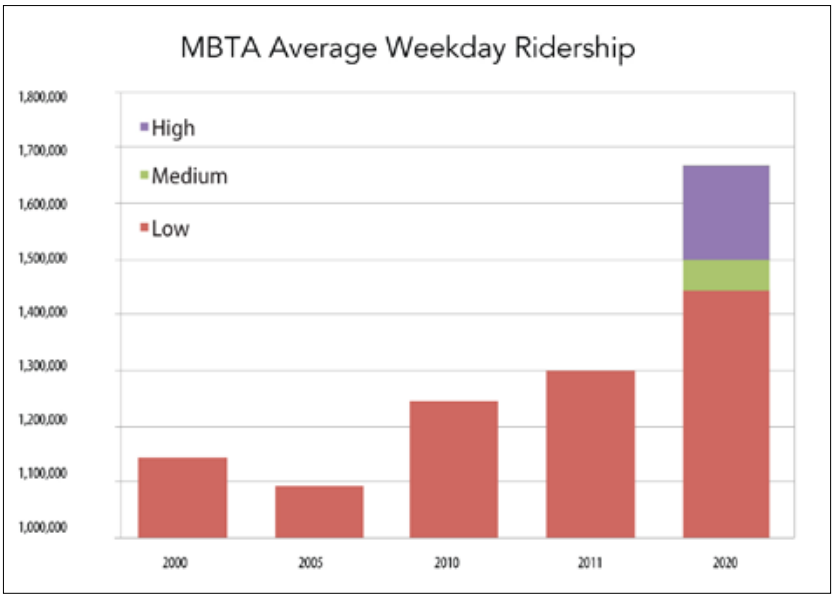


FIGURE 4

FORECAST GROWTH IN AVERAGE WEEKDAY RIDERSHIP



Does the MBTA really need to plan to serve an *additional* 100,000-367,000 riders on an average weekday in 2021? Yes. To validate these forecasts, a number of other analyses conducted both at the national and Boston regional level were reviewed. This additional research reinforces the reasonableness of the projection that MBTA ridership can be expected to grow at a rate of between 1.2 and 2.9% annually over the next decade.

RIDERSHIP GROWTH SCENARIOS

Baseline Growth: The lowest growth "baseline" scenario assumes that the next ten years will be like the last twenty years (and that the MBTA's system capacity is not constrained). This projection was developed by establishing a "trendline" for ridership growth over the past twenty years. The Dukakis Center analyzed historical MBTA ridership data and used both linear and power analyses to develop a trend line which best fit the pattern of ridership growth between 1991 and 2011. Both the linear analysis and power analysis pegged the annual rate of ridership growth at 1.2 percent, although the slightly different shapes of the resulting trend lines produces a "baseline" estimate of 2021 ridership of either 420 million or 433 million annual unlinked trips.

Moderate Growth: The moderate growth scenario falls between the baseline and high growth scenarios. Like the baseline scenario, this forecast assumes that the MBTA's system capacity is not constrained. Average annual increases in ridership are moderately higher than the 20-year average of 1.2%, with a combination of economic factors (moderate employment and income growth), demographic factors (increasing numbers of seniors and immigrants) and relatively small (ineleastic) responses to expected fare increases having a mixed but still overall positive impact on the number of unlinked trips.

Higher Growth: The higher growth scenario assumes that the next ten years are like the last five years, with a higher growth rate than the longer 20-year historical trend driven by rising gasoline prices, relatively flat transit fares and growth in employment. The growth rate of 2.9% annually — identical to that seen by the MBTA between 2006 and 2011 — predicts that the MBTA would serve 500 million unlinked trips in 2021, equivalent to approximately 1.67 million average weekday riders.

Does the MBTA really need to plan to serve an *additional* 100,000-367,000 riders on an average weekday in 2021? Yes.

The U.S. Department of Transportation's Federal Transit Administration (FTA) recently investigated the appropriate rate of ridership growth to use for purposes of estimating needed investment in transit systems nationwide in order to support future passenger loads. The FTA's analysis, included in a recent report to Congress, concluded that metropolitan areas were underestimating transit ridership growth and therefore the amount of capital investment needed over the next twenty years. The FTA found that ridership projections by Metropolitan Planning Organizations "have typically fallen well short of actual growth in recent years." According to the FTA, the MPOs were projecting ridership to grow by 1.4% annually for ten years, but actual ridership trends supported an assumed ten year trend of 2.8% annual growth. (USDOT, FTA and FHWA 2010) The FTA therefore based its estimates for needed transit investment on a ridership growth range with a lower bound of 1.4% and an upper bound of 2.8% annual growth — quite similar to the proposed range of 1.2 — 2.9% generated by the Dukakis Center scenario analysis.

The American Association of State Highway and Transportation Officials (AASHTO) conducted a similar analysis and concluded that future transit investments should be projected based on an even higher range of future ridership growth. AASHTO's lower bound for ridership growth was 2.4% annually, equal to the nationwide increase in transit trips between 1995 and 2007; the upper bound was annual ridership growth of 3.5% annually, a rate that would result in a doubling of ridership in twenty years.

While the MBTA does not forecast ridership, the state's Central Transportation Planning Staff (CTPS) periodically runs a sophisticated regional travel demand model in order to assess future travel behavior

and evaluate future transportation plans and investments. As part of its preparation of the legislatively-required Program for Mass Transportation — a long-term plan for future MBTA investments — the MBTA had CTPS model system-wide boardings (another term for unlinked trips) in 2030, from a 2008 base year. The scenario which assumed that the MBTA would only invest in deferred maintenance projects to achieve a "State of Good Repair", rather than investing in enhancement or expansion projects, nevertheless projected unlinked trips rising from 1.22 million average weekday trips in 2008 to 1.74 million average weekday trips in 2030, an increase of 43% over 22 years. (MBTA 2009)

Perhaps the most important reason that the Commonwealth and region should plan for continued growth in transit ridership is that more transit users will help achieve local, regional and statewide transportation, sustainability and economic objectives. A myriad of local, regional and state policies call for greater use of transit in metropolitan Boston and throughout Massachusetts. The City of Boston's Climate Action Plan establishes a goal of reducing greenhouse gas emissions 25% by 2020 and includes increasing transit ridership as one strategy for achieving that goal. The Metropolitan Area Planning Council's MetroFuture plan for 101 cities and towns throughout the greater Boston region establishes an aggressive target of 2.2 million transit trips on an average weekday by 2030. The MBTA's December 2009 Program for Mass Transportation establishes a less ambitious but still substantial target of increasing "ridership system wide by 1% per year, or at least 250,000 new unlinked trips/day, between now and 2030." On July 2, 2010 the Massachusetts Department of Transportation launched GreenDOT, a comprehensive sustainability initiative designed to position MassDOT as a national leader in greening the state transportation system. GreenDOT's three primary goals are to reduce greenhouse gas emissions, promote the healthy transportation options of walking, bicycling and public transportation and support smart growth development. Achieving any or all of these goals will require higher transit ridership and so, as part of its implementation of GreenDOT, MassDOT has committed to adopt "transit first" as statewide policy and set a specific target for shifting trips to transit, biking, walking and carpooling during 2012.

Perhaps the most important reason that the Commonwealth and region should plan for continued growth in transit ridership is that more transit users will help achieve local, regional and statewide transportation, sustainability and economic objectives.

In short, ridership on the MBTA has been rising, will likely continue to increase and should increase to support achievement of local, regional and statewide transportation, economic and environmental policy objectives. The MBTA, MassDOT and local and regional planners should plan for MBTA ridership growth from its 2011 level of 1.28 million average weekday trips to a range of 1.4 to 1.7 million weekday trips by 2021.

THE CHALLENGE OF RIDERSHIP GROWTH

The MBTA's ridership can and should grow — but can the T's aging and financially stressed transit system support all of that additional ridership? One immediate consequence of adopting a planning assumption that transit ridership growth will continue and perhaps accelerate is the urgent need to assess whether the MBTA system — and especially the core or hub of the hub-and-spoke system — has the capacity to accommodate hundreds of thousands of additional trips every weekday.

From a policy perspective, growth in transit ridership should be encouraged. But from a practical and financial perspective, ridership growth presents a potential challenge if the existing transit system cannot accommodate the additional passengers.

When the Federal Transit Administration adopted a similar planning range for transit ridership growth at the national level, the agency concluded that such ridership growth could not occur unless transit agencies invested billions more to make capital improvements to their systems in order to accommodate the additional passengers. "Assuming the actual rate of ridership growth is closer to the trend rate of growth for the last decade" of 2.8% annually, rather than the 1.4% assumed in MPO plans, the FTA concluded that "an average of $7.3 billion in annual transit capital expansion investment would be required over the next 20 years to support an additional 6.2 billion annual boardings." (USDOT, FTA and FHWA 2010). Especially given the seriousness of the MBTA's financial condition, policymakers and planners need to understand whether the existing system can accommodate projected ridership growth or whether creating the capacity for those riders will require additional investment.

From a policy perspective, growth in transit ridership should be encouraged. But from a practical and financial perspective, ridership growth presents a potential challenge if the existing transit system cannot accommodate the additional passengers. Capacity constraints — and congestion — may occur if the available supply of transit cannot accommodate the growing demand.

While transportation planners have long raised concerns about capacity and congestion on roads and highways, only recently has the issue been raised with regard to transit systems. But, as with highways, there is a limit to the number of passengers that a transit system is designed to carry. A briefing paper done for the National Surface Transportation Policy and Revenue Study Commission in 2007 noted the transit industry lacks even a definition for a transit bottleneck, making it difficult to determine how widespread the problem is or how much investment would be needed to address such capacity constraints. The briefing paper defined a "transit bottleneck" or "core capacity constraint" as "a limitation on transit system capacity that prevents service expansion, absent a significant capital investment, to meet growing demand." Quite simply, "ridership has exceeded the system's design capacity." (Cambridge Systematics 2007).

The briefing paper explains that "the issue of transit bottlenecks is emerging as a growing concern among large urban transit agencies as recent investments in transit and a renewed emphasis on urban development are contributing to an increasing number of transit riders." The authors explain why transit systems with growing ridership, like the MBTA, need to be concerned about such bottlenecks:

- Transit systems lacking the capital to address transit capacity constraints will experience decreased operating efficiency, increased operating costs, reduced service reliability and potential safety problems due to system overcrowding.
- Bottlenecks affects drivers, not just transit passengers: capacity constraints can shift travel from transit to cars, increasing regional highway congestion.
- In the longer term, capacity constraints can contribute to the dispersal of homes and jobs away from existing transit lines, to more distant locations not as readily served by transit.

The American Association of State Highway and Transportation Officials (AASHTO), the American Public Transportation Association (APTA) and the Federal Transit Administration (FTA) have all acknowledged that core capacity constraints on large urban transit systems are real and will be costly to address. A 2008 survey of its members by APTA during the 2008 ridership surge that accompanied the run-up in gasoline prices found that more than half of the responding agencies "are allowing crowding beyond local service standards" and nearly 40 percent "report they are now turning away passengers." AASHTO's 2009 *Bottom Line* report calculated the total national investment needed to ensure that large urban transit systems can accommodate projected ridership growth, noting that "without significant capital investment to expand the core capacity of these systems, it is likely that some public transportation systems will be unable to address growing demands — potentially resulting in shifts of people from overburdened public transportation systems to the use of the urban areas' already congested highway networks." AASHTO estimated that $44.5 billion would need to be invested over the next twenty years to expand and modernize the assets of urban transit systems in order to accommodate a projected ridership growth of 2.4%, the average annual growth rate for ridership across urban transit systems between 1995 and 2007, and well within the range of possible forecasts for the MBTA presented earlier in this report. This investment is three times the $17.5 billion national "State of Good Repair" gap more commonly cited as the amount needed to simply maintain and replace existing assets suffering from decades of deferred maintenance.

Is the MBTA one of those urban transit agencies with growing ridership that will need to invest more in order to address core capacity constraints and transit bottlenecks? To answer that question, the level of ridership growth discussed earlier needs to be evaluated in light of existing and projected capacity on the MBTA's rapid transit and commuter rail systems.

ASSESSING CAPACITY AND CONGESTION

What is the MBTA's capacity to accommodate all of the passengers projected to be using the system in 2020 and beyond? A transit system's capacity is not fixed but depends on the size and condition of its assets. Three of the most important factors, as explained in the accompanying box, are the number of passengers that can fit into each transit vehicle, the number of cars assembled into train sets and the frequency or "headway" at which the transit operator can run trains, particularly at peak travel times.

How does the MBTA know when capacity is strained and congestion has become a problem? The MBTA has historically evaluated congestion against the benchmark of the "vehicle load standards" established by the T's Board of Directors as part of its Service Delivery Policy. Optimally, ridership volumes should not exceed these policy standards, which are designed to "establish the average maximum number of passengers allowed per vehicle to provide a safe and comfortable ride." These standards were last reviewed and revised by the MBTA board in June 2010. (MBTA 2010).

THE ABC'S OF MBTA CAPACITY

The hourly capacity of the MBTA, or any other transit system, depends on three factors:

A The number of passengers that can fit in each car;

B The number of cars in each train; and

C How many trains the MBTA can run, particularly during peak hours.

Passengers Per Car: There are three levels of capacity for a given transit vehicle: seated capacity, "service policy" capacity and "crush" capacity. Each type of vehicle in the MBTA fleet has a certain number of seats for passengers; the car's total capacity is usually calculated as a multiple of the number of seated passengers. The Service Delivery Policy establishes vehicle load standards for each type of subway car, commuter rail vehicle and bus. These standards "establish the average maximum number of passengers allowed per vehicle to provide a safe and comfortable ride." (MBTA 2010). This number is often referred to as the "service policy" capacity. More riders can, however, be jammed into the cars so a second, higher capacity measure is used — the "crush capacity" is calculated by calculating the number of seated passengers plus 1.5 square feet per standing passenger (2 square feet on buses).

Cars Per Train: The number of cars that combine to form a single train varies on the different rapid transit lines, depending in part on system conditions such as the length of platforms and the amount of power available to serve longer train sets. Another factor is vehicle availability, which is "whether there are enough vehicles available to run all the service that is scheduled each day." (MBTA Scorecard, available online at http://www.mbta.com/about_the_mbta/scorecard/). Due in part to its continuing financial woes and deferred maintenance, at times the MBTA lacks enough vehicles, particularly on the Orange and Red Lines. Lacking sufficient funds to buy new fleets, the MBTA will spend nearly $130 million to extend the useful life of some of its Orange, Red and Green line vehicles to buy time until new fleets can be procured, hopefully by the end of this decade or the early 2020s.

Trains Per Hour: The number of trains that can be run per hour depends on the "headways" or the amount of time between trains. For example, in the underground portion of the Green Line — usually called the Central Subway — there are cars running every 5-7 minutes on the Boston College (B), Cleveland Circle (C), Riverside (D) and Heath Street (E) branches, so the "headways" can be as frequent as every 90 seconds or so, for a total of 42 trains per hour during peak periods. The MBTA can increase headways only if the power and signal systems can ensure that trains can safely run more frequently (and if there are enough vehicles). The condition of signal systems needed to maintain headways is a concern on both the Red Line and Green Line.

Several systems are in place to monitor available capacity and congestion levels. The Central Transportation Planning Staff (CTPS) oversees the Congestion Management Program, which tracks congestion on roadways and transit. CTPS also uses a regional travel demand model to forecast future conditions on the regional transportation system, including the MBTA transit system; modeling results are used to inform many planning processes including the preparation of a long-range transportation plan for the region. And the MBTA issues periodic online "Scorecards" which do not directly track congestion but which provide up-to-date information on factors that affect both capacity (such as vehicle availability) and congestion (such as ridership).

All too frequently, however, capacity constraints and congestion problems are identified after problems have become significant, when ridership volumes are found (or forecast) to exceed the vehicle load standards established in the Service Delivery Policy. In order to ensure that the Service Policy standards work — and that MBTA passengers can count on a safe and comfortable ride — congestion needs to be "flagged" as a problem before load standards are exceeded, when there is time to plan ahead and implement measures to relieve congestion and increase capacity. This report therefore adopts a three-tiered approach to defining congestion on the MBTA, similar to those in use at other transit agencies such as the Washington Metro, designed both to identify problematic congestion levels even before the Service Policy is violated and to ensure that specific (and increasingly urgent) steps are taken when congested conditions are either identified or are forecast to occur in the future during the regional transportation planning process.

PROPOSED MBTA CONGESTION ASSESSMENT AND MANAGEMENT SYSTEM

A service is **congested** if peak hour ridership volumes are (or are forecast to be) consistently at 80%-100% of the Service Policy standard. In order to avoid future capacity constraints and violations of the Service Policy, steps should be taken to relieve congestion.

A service is **highly congested** if peak hour ridership volumes consistently exceed (or are forecast to exceed) the Service Policy standard but are below "crush capacity". A congestion relief plan should be put in place to bring vehicle loads below the Service Policy standard.

A service is **over capacity** if peak hour ridership volumes consistently exceed (or are forecast to exceed) crush capacity. A congestion relief and capacity expansion plan should be put in place immediately and should include both shorter-term measures to reduce vehicle loads and longer-term measures to expand capacity to meet projected ridership demand without experiencing violations of Service Policy standards.

Using this system and available public data, researchers and students at the Kitty & Michael Dukakis Center for Urban & Regional Policy at Northeastern University evaluated current and likely future congestion on the MBTA's rapid transit system.

This report... adopts a three-tiered approach to defining congestion on the MBTA... designed both to identify problematic congestion levels even before the Service Policy is violated and to ensure that specific (and increasingly urgent) steps are taken when congested conditions are either identified or are forecast to occur in the future during the regional transportation planning process.

CONGESTION ON THE MBTA

Transit congestion is a serious problem on the MBTA, particularly in the core portions of the rapid transit system. This conclusion comes as no surprise to those who closely follow transportation planning at the Boston Metropolitan Planning Organization, MassDOT and MBTA. A July 2010 overview of the Boston MPO's congestion management process documented violations of the Service Policy vehicle load standards on the B, C and D Branches of the Green Line and the Braintree branch and trunk of the Red Line. The regional "needs assessment" prepared by the MPO flagged a number of serious examples of overcrowding on the Green Line and Orange Line, while also highlighting challenges for meeting increased ridership demand in the future. As the MBTA acknowledged in its 2010 Program for Mass Transportation, "meeting anticipated 2030 demand for transit poses a significant challenge for the MBTA." (MBTA 2010). But while the Central Transportation Planning Staff and MBTA have quietly but persistently been raising concerns about congestion and capacity for the past few years, these warnings have largely gone unnoticed and unheeded.

Additional congestion and capacity concerns surfaced during a broader review of other relevant documents including, for example, environmental review documents for both planned transit projects and large-scale transit-oriented developments. Our review of publicly available documents raises serious concerns about congestion and potential capacity constraints on portions of the Green, Orange and Red Lines and the waterfront portion of the Silver Line bus rapid transit line — in other words, on every part of the rapid transit system except for the Blue Line. Indeed, the Blue Line serves as an important example of the length of time and depth of resources needed to successfully identify, plan for and address transit congestion.

THE BLUE LINE MODERNIZATION PROJECT

The Blue Line modernization project marshaled federal and state planning and capital resources to increase capacity by upgrading that line from four- to six-car trains and thereby increasing capacity by approximately fifty percent. As part of this effort, the MBTA purchased a new fleet of 94 cars, lengthened platforms at several stations and modernized others, upgraded power and signal systems and retrofitted maintenance facilities. The Federal Transit Administration provided slightly over half of the nearly $600 million in project costs, with the MBTA issuing bonds to pay for the rest.

GREEN LINE

The "central subway" portion of the Green Line — from Copley to Government Center — is already operating at capacity. (CTPS 2011). In addition, the Congestion Management Program has documented congestion exceeding the MBTA's service policy standard on both the C and D lines. The MBTA has worked to increase Green Line capacity, first by eliminating single car trains in 2007 and then by expanding to three car trains on some train sets during rush hour beginning in 2011. Unfortunately, the power feeding into the Green Line is unreliable and insufficient to accommodate capacity expansion to all three-car trains (even if the T had sufficient rolling stock for such an

expansion), so in effect there is a limit on the number of these longer trains that can be run during peak times. The CTPS needs assessment flatly concluded that "the 1920-era signals in the Green Line's central tunnel need to be replaced" — these are apparently the oldest transit signals of their kind in regular use anywhere in the United States. (CTPS 2011). Vehicle availability is also a problem: the MBTA has recently decided to spend $100 millioon to rehabilitate some older Green Line cars to extend their useful life because procurement of needed new cars will have to wait until finances allow and the more pressing problem of the Orange and Red Line fleet is addressed. Yet the Green Line can expect continued growth in ridership, generated in part by real estate development in Back Bay and Longwood Medical Area as well as the extension of the Green Line to Somerville and Medford.

ORANGE LINE

The CTPS needs assessment found that "the Orange Line is currently overcrowded during peak hours between Downtown Crossing and North Station." One major limitation on the T's ability to increase capacity on the Orange Line to address this congestion is the age and condition of the Orange Line vehicle fleet. All 120 Orange Line cars built in 1979-1981 (with an intended lifespan of 25 years) need to be replaced. The MBTA Capital Investment Program (CIP) for fiscal years 2012 through 2017 calls for the procurement of 152 new Orange Line cars (as well as some Red Line cars, as noted below) but fails to provide enough resources to undertake the required procurement. Even while hoping to invest $350 million in the procurement for Red and Orange Line cars through fiscal year 2017, the CIP estimates that an additional $389 million will be needed. The MBTA frequently lacks the number of cars it needs to run the Orange Line — the MBTA's March 2012 "Scorecard" report indicates that the Orange Line requires 103 vehicles to be available but in recent months only 96 vehicles were available. If even fewer cars are available in the future, as rolling stock reaches a point where it can no longer be used safely, the MBTA will be unable to maintain current headways, inadequate capacity on this overcrowded line will actually decline, and congestion will increase further.

RED LINE

The Red Line was the most difficult of the rapid transit lines to assess based on public data. Although not mentioned as problematic in the CTPS needs assessment, the 2004 and 2008 Congestion Management Program reports identified the Braintree branch of the Red Line as close to reaching the vehicle load standard and a 2010 online update found that both the Braintree branch and the "trunk" portion of the Red Line had sometimes failed the vehicle load standards. Acknowledging crowded conditions, the T introduced "Big Red" high capacity cars with most of the seats removed in order to increase capacity. And the City of Cambridge, as part of its Kendall Square/Central Square planning study, has predicted capacity constraints as over 8 million square feet of new residential, commercial and research and development space is built out through 2030. While pinpointing the exact extent and location of capacity constraints is difficult, the combination of existing high ridership and high density development in parts of Boston and Cambridge served by the Red Line is likely to produce growing congestion. Further, like the Orange Line, the Red Line's potential capacity expansion is limited by its

aging rolling stock. Replacements are needed for 74 cars, about one-third of the fleet, built in 1969-70. Vehicle availability, as tracked by the MBTA scorecard, is already problematic. The Red Line has been able to run with the 168 vehicles needed, but barely — there are generally 171 or 172 Red Line cars available at any given time. Recent breakdowns on the Red Line may well become a common occurrence if the hoped-for procurement is delayed due to lack of funds and the number of available vehicles falls below the minimum number needed to maintain current capacity.

SILVER LINE

The portion of the Silver Line bus rapid transit system from South Station through the Seaport neighborhood of Boston provides an excellent example of the need for a congestion assessment and management system that "flags" future capacity concerns even when existing capacity is adequate. As explained below, development is booming in this area and millions of additional square feet are in the development pipeline. Silver Line ridership rose substantially in 2011, with an unexpected increase on weekends due to the growing popularity of the area as a dining destination. Future capacity increases on the Silver Line will require increasing headways from two-and-a-half minutes to sixty seconds and purchasing additional buses. While recent capacity assessments done for the Seaport Square development project and the City of Boston's 100 Acres District Master Plan ultimately concluded that an expanded Silver Line could accommodate growing future demand, concerns remain. Earlier capacity calculations, for example, assumed a third phase of the Silver Line (from South Station to Boylston) would be constructed and that project has since been cancelled. Of perhaps greater concern is the fact that planning has been based on the assumption that Silver Line buses would not be considered over capacity unless passenger loads exceeded 170% of seated capacity — but the Service Policy standard is 140% of seated capacity. There is ample evidence to support concerns about future congestion, in violation of Service Policy standards, on the Silver Line as the buildout of the Seaport proceeds.

SOUTH STATION AND RAIL CAPACITY

While this study focused on congestion and capacity on the MBTA rapid transit system, no report on transit capacity in the Boston core would be complete without highlighting the problem of capacity constraints at South Station and their effect on the MBTA's commuter rail system and Amtrak's intercity trains. Completed in 1899, South Station is New England's busiest rail station and the MBTA's second busiest station, used by 48,000 commuter rail passengers, 23,000 Red Line passengers and 3,600 Amtrak passengers daily. As noted in the MBTA's Program for Mass Transportation, South Station currently operates above its design capacity. During morning and afternoon peaks, trains arrive or depart every 60-90 seconds on the station's thirteen platforms. Expansion of South Station would enable the planned expansion of the MBTA's commuter rail services; the two-thirds of the MBTA commuter rail lines that terminate at South Station cannot provide any additional trains until the South Station bottleneck is addressed. The inability to accommodate additional trains during peak periods also significantly constrains Amtrak rail service in the busy Northeast Corridor. Addressing the South Station capacity constraint will be complicated and expensive, requiring relocation of the US Postal Service's mail facility at South Station. MassDOT applied for and received a $32.5 million grant from the Federal Railroad Administration for planning and environmental review of a South Station expansion project that would add 7-11 new platforms. But an expanded South Station will be expensive and require many years of planning, design, financing and construction.

CONGESTION HOT SPOTS

Congested transit lines are obviously a problem for the riders who rely on the MBTA system, but inadequate capacity is also a problem for the greater Boston region and its economy. New residential, commercial and institutional development requires transportation access and relies on transportation infrastructure to succeed. And transit-oriented development, which is designed to be accessed by transit rather than primarily by driving, is particularly dependent on the MBTA transit system for access; its success may be undermined if the regional transit system lacks the capacity to serve the ridership generated by transit-oriented development.

To better understand where growing ridership demand and capacity constraints might affect key locations for transit-oriented development in the Boston/Cambridge core, researchers and students at the Dukakis Center sought to identify those areas where limited transit capacity would intersect with growing ridership generated by transit-oriented development. The goal of this effort was to identify areas of concern — transit-served neighborhoods in the Boston/Cambridge core where existing and planned transit-oriented development could be impeded by congestion on the transit system. This assessment provides a basis for future planning efforts to focus on addressing capacity constraints and alleviating congestion in the identified "hot spots" to ensure the continued success of transit-oriented residential, commercial and institutional development in those areas.

An assessment methodology was developed for identifying TOD and congestion "hot spots" which began with the portions of the transit lines identified above as being congested and then examined the rapid transit stations along those lines to evaluate the likelihood that boardings at specific stations or groups of stations would increase substantially in the future. This methodology, described in more detail in the accompanying box, relied on factors which have been found to be associated with increased future transit ridership:

- The stations in any given transit system with the highest daily boardings tend to remain stable over time, so those stations with the highest current boardings were considered likely to have high boardings in the future.
- Station areas (within a half-mile radius of a subway station) where existing land use patterns are associated with higher numbers of transit trips, including both overall development "intensity" (the density of residents and workers in the station area) and employment mix (an employment, rather than residential, oriented mix of uses in the station area).
- Station areas where planned or proposed transit-oriented development projects have the potential to generate substantial additional transit boardings.

ASSESSING FUTURE RISK OF CONGESTION AT MBTA CORE STATIONS

A five-step methodology was used which identified stations of concern for future congestion, which examined whether rapid transit stations exceeded a specific threshold with respect to:

1. **Identified Capacity Constraints:** Any station or section of transit line identified as being congested based on current conditions (as assessed by the Congestion Management Program or in the CTPS needs assessment) or based on future conditions as identified in a modeling study exceeded this threshold.

2. **High Current Boardings:** The twenty rapid transit stations with the highest average weekday boardings based on the 2010 MBTA Blue Book exceeded the threshold for high boardings.

3. **Current Land Use/Intensity:** The Metropolitan Area Planning Council developed a database on current land use in station areas (the area within a half-mile radius of an MBTA rapid transit station) and calculated a normalized measurement of development intensity, which combined both population and employment in the station area per developed acre of land; this threshold was exceeded if such land use intensity was greater than 150 persons per developed acre.

4. **Current Land Use/Employment Rich:** Using the same MAPC data set, employment mix (the proportion of employment to total development) was assessed in each station area; station areas with an employment mix of greater than or equal to 0.7 (meaning 70% or more of total development is employment) exceeded this threshold.

5. **Future Transit-Oriented Development:** Using data from MAPC's development database, measures of future development, and potential transit ridership generated by such development, were evaluated to identify the likelihood that future TOD would generate substantial numbers of additional riders. This threshold was exceeded if two of the following three criteria were met: an estimated increase of more than 25% in worker commuters by 2035, an estimated increase of more than 25% in residential commuters by 2035, and an estimated increase of more than 20% in development intensity by 2035. (Because the half-mile "buffers" do not accurately describe the characteristics of the Longwood Medical Area, an alternative metric was used for development intensity at those two Green Line stations based on the data presented previously in Table 1.)

As shown in Table 2, any rapid transit station that met at least three of the five threshold criteria is categorized as an "area of concern" with the potential to become a congestion bottleneck in the MBTA system as ridership grows and development takes place in the near future. Fourteen rapid transit station areas in the Boston/Cambridge core, as well as the Silver Line stations in the Seaport, were identified as areas of concerns. Given the geographic clustering of many of these stations, they were grouped into five areas of concern: Downtown Boston (the stations along the Green Line from Boylston to Government Center, the stations along the Orange line from North Station to Downtown Crossing and South Station), Back Bay (Copley and Arlington stations on the Green Line and Back Bay Station), Longwood Medical Area (Longwood on the D line and Longwood Medical Area on the E line), the Seaport (the Silver Line stations in the Seaport) and Kendall Square. These five transit congestion hot spots are the areas in the Boston/Cambridge core of the MBTA rapid transit system where the combination of current transit use, current land use, current and future transit system congestion and future ridership generated by transit-oriented development may combine to create problematic transit congestion.

TABLE 2

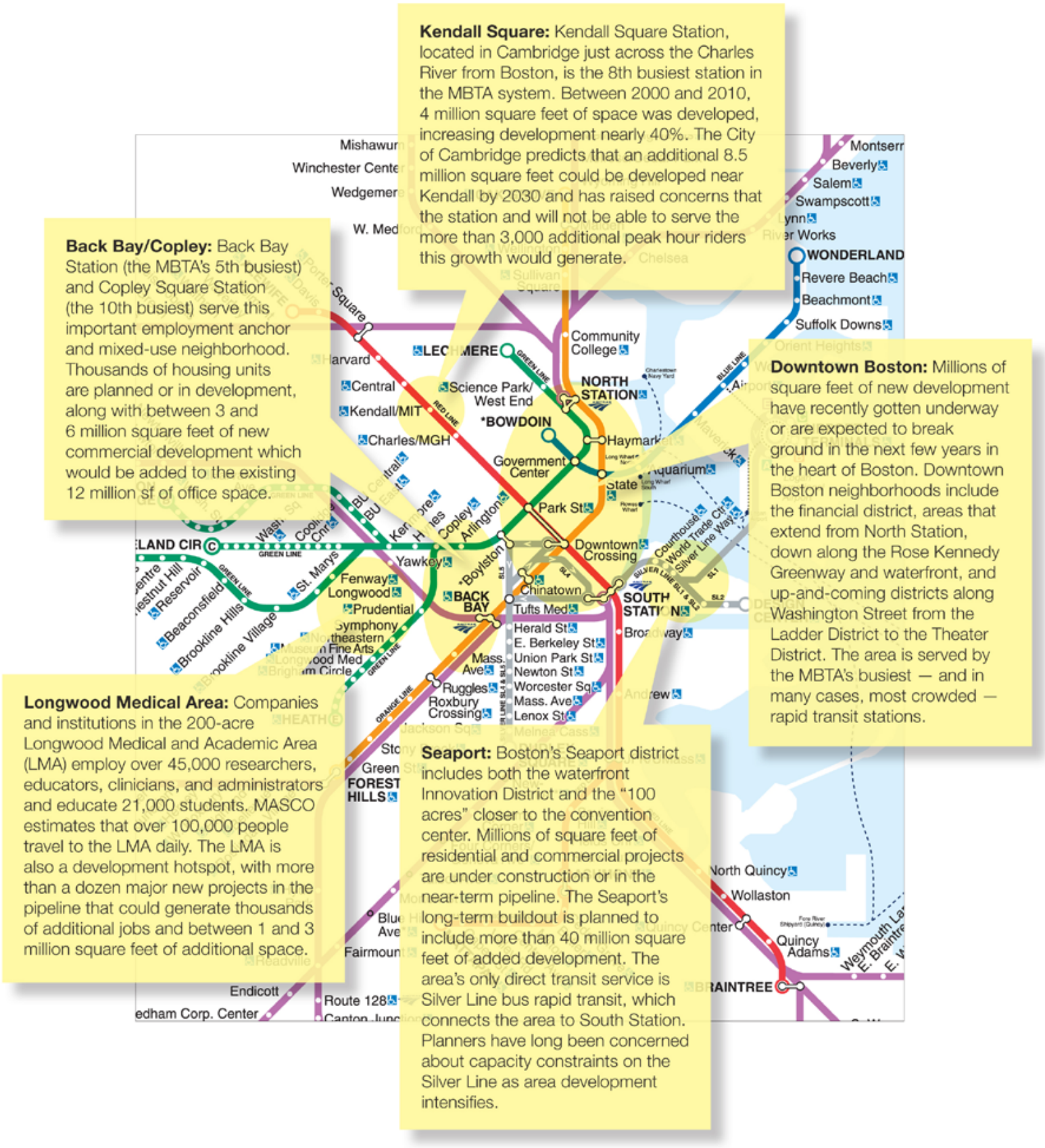
ASSESSMENT MATRIX TO IDENTIFY STATION AREAS OF CONCERN FOR FUTURE CONGESTION

	Line	Identified Capacity Constraints	High Current Boardings	Current Land Use/Intensity	Current Land Use/ Employment Rich	Future Transit-Oriented Development
Arlington	Green	!		!	!	
Back Bay	Orange		!	!	!	
Boylston	Green	!		!	!	
Copley	Green	!	!	!	!	
Downtown Crossing	Orange	!	!	!	!	
Government Center	Green	!	!	!	!	
Haymarket	Orange	!	!	!	!	
Kendall/MIT	Red	!	!	!	!	
Longwood Medical Area*	Green	!			!	!
Longwood*	Green	!			!	!
North Station	Orange	!	!	!	!	!
Park Street	Green, Red	!	!	!	!	
South Station	Red, Commuter Rail	!	!	!	!	!
State	Orange	!	!	!	!	
Waterfront stations	Silver	!			!	!

* Different measure of intensity used for Longwood Medical Area stations

Relieving core transit congestion and addressing capacity constraints in these five hot spots is critical to future economic and real estate development in metropolitan Boston, for two reasons. First, these congestion hot spots represent some of the most important residential and commercial real estate markets in metropolitan Boston, areas where substantial future growth in housing, employment and mixed-uses is expected but which may not be able to realize their potential for future transit-oriented development due to core transit congestion and constrained capacity. Second, because of the "hub and spoke" nature of the MBTA transit system — with the majority of trips from commuter rail and rapid transit stations in the outer portions of the system headed into the Boston/Cambridge core — transit congestion in the core can affect future transit-oriented development throughout the system. Large-scale projects at commuter rail stations generate demand for additional service that cannot be met until the South Station capacity constraint is addressed. Transit-oriented development at rapid transit stations from Malden to Cambridge to Newton to Quincy — and that planned for the Green Line extension in Somerville and Medford — will generate additional riders who travel into the congested core stations, so system wide transit-oriented development ultimately depends on sufficient capacity in the core. If the entire metropolitan Boston region is to realize the potential benefits of transit-oriented development, the Massachusetts Department of Transportation and MBTA need to address capacity constraints and transit congestion in Downtown Boston, Back Bay, Longwood Medical Area, the Seaport and Kendall Square.

TRANSIT CONGESTION HOT SPOTS



CONCLUSIONS: TRANSIT CONGESTION RELIEF

The MBTA is facing two challenges: in addition to its well-known financial problems, the regional transit system is challenged by growing core transit congestion caused by the inability of the MBTA's aging system to meet growing ridership demand. Core transit congestion is a problem born of both success and failure: success in attracting a growing ridership and catalyzing transit-oriented development and failure to invest enough in the regional transit system to provide the capacity needed to meet the growing demand for transit. While the T's capacity constraints have been far less understood than the financial crisis that precipitated the recent fare increase and service cut proposals, this quiet crisis of congestion is becoming more visible and urgent as a growing ridership fills the system's trains and trollies.

The Massachusetts Department of Transportation and the MBTA urgently need to address the problem of constrained capacity and core transit congestion in order to ensure that the regional transit system can support robust economic development throughout metropolitan Boston over the next decade. Planning efforts should identify how the MBTA can serve a minimum of 420 million unlinked trips annually, and potentially as many as 500 million, within a decade. This rate of ridership growth translates to an additional 100,000 to 367,000 weekday riders, on top of the 1.3 million riders that currently use the MBTA on a typical weekday.

MassDOT and the MBTA will face both planning and financial challenges as they focus on addressing core transit congestion and increasing capacity to serve growing ridership demand. Ensuring sufficient capacity to meet ridership demand without unacceptable levels of congestion will require both better planning and more investment.

With respect to planning, transportation and transit planners need to assess congestion and identify capacity constraints years in advance. As part of ongoing performance management efforts, MassDOT and the MBTA should therefore create a core congestion assessment and management system designed to forecast ridership demand and capacity needs and ensure that Service Policy standards for vehicle congestion are not violated. These forecasts should, of course, account for planned and proposed transit-oriented development and more intensive use of existing built space. When these assessments identify transit lines or stations likely to be congested or highly congested, Congestion Relief Plans should be developed and implemented. And when these assessments identify hot spots where services are forecast to be over capacity — with vehicles at crush capacity during peak hours and riders left behind on platforms — the MBTA should both implement shorter-term congestion relief measures and create and implement Capacity Expansion Plans.

Ensuring sufficient capacity to meet ridership demand without unacceptable levels of congestion will require both better planning and more investment.

Implementing these plans to relieve core transit congestion and increase capacity to serve growing demand will require both increasing and prioritizing investment in the MBTA system. Billions of dollars will need to be invested in new rolling stock and upgraded power and signal systems in order to address the capacity problems identified in this report on the Green, Orange and Red Lines and, as development occurs in the Seaport, on the waterfront portion of the Silver Line bus rapid transit system. The south side of the commuter rail system — serving two-thirds of all commuter rail passengers — will remain capacity-constrained until funding is found for the South Station expansion project.

These capacity investments should not be seen as expansion of the MBTA system. Indeed, recent debates over whether to invest in maintaining the transit system (by achieving a State of Good Repair) or expanding the system fail to address the MBTA's most fundamental need over the next decade: having

the capacity to serve its growing ridership, including trips generated by transit-oriented development throughout the region. The multi-billion dollar "State of Good Repair" backlog actually includes two equally important types of investment needs: spending on system maintenance (in order to ensure that the system at its current capacity achieves a State of Good Repair) and spending on investments necessary to maintain and increase capacity and relieve congestion. Congestion relief has long been a priority for highway spending — it is past time to recognize that addressing congestion is equally important for the transit system.

In order to move beyond the polarizing maintenance vs. expansion debates, MassDOT and the MBTA should reorganize the MBTA Capital Investment Program to address the system's three fundamental challenges: system maintenance, relieving congestion, and increasing core capacity and expansion. Priority should be given to investments that relieve congestion and improve capacity in the core of the MBTA system, including improving and expanding the vehicle fleet, shortening headways and enabling riders to travel between the spokes of the system without first traveling into its congested core.

MassDOT and the MBTA need to put a price tag on the investments needed for congestion relief and increasing core capacity. The Commonwealth of Massachusetts then needs to find the resources and make the investments necessary to ensure that the MBTA can continue to serve a growing ridership, anchor transit-oriented development in cities and towns throughout greater Boston and support a prosperous regional economy.

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