9 SUMMARY OF FINDINGS AND RECOMMENDATIONS

No single measure is adequate by itself to address congestion and improve mobility in the region. As described in Chapter 2 of the 2004–2025 Regional Transportation Plan, many multimodal strategies are being implemented in the region. In addition to recommendations of continuing the application of the effective strategies already being applied in our region, the CMS recommendations include some different strategies that should also contribute to improving mobility.

The CMS project staff believes that the recommendations presented in this chapter are consistent with the project-selection policies of the MPO, as stated in the 2004–2025 Regional Transportation Plan. These policies pertain to land use, safety and security, mobility, air quality, intermodal connections, accessibility, environmental justice, preservation and modernization, economic opportunities, and community preservation. In summary, the best approach to improving mobility is one that contains a mix of measures, each applied to the geographic area and travel market where it has the maximum impact.

9.1 ARTERIAL ROADWAYS

9.1.1 Summary of Findings

Since the previous monitoring, average peak-period speeds on arterial roadways have dropped and delay has increased. The percent of roads with average speeds at 18 mph or less increased by 3 percent regionwide between the 1996–1999 and 2001–2003 monitoring periods, and 4 percent fewer roads now have average travel speeds greater than 30 mph. Furthermore, average peak-period speeds are now below the posted speed limit on about 40 percent of the monitored network. Plus, *average vehicle peak-period delay* in the region increased on a delay-per-mile basis by 13 seconds (76 percent) in the morning peak period and by 14 seconds (67 percent) in the evening peak period. (These results are discussed in Section 3.3.1.)

In terms of delay at intersections, over 15 percent of the monitored signalized intersections have at least two approaches at an unacceptable level of service in the evening peak period, compared to 10 percent in the morning peak period.

The following are location-specific highlights from the arterial analysis, as described in Chapter 3:

- The results of the signalized intersections delay analysis indicate that the majority of the congested intersections are located in Boston and the inner suburbs. However, intersections in the outer suburbs bear their share of congestion as well, especially those located in parts of the region which have higher employment densities, like the MetroWest and North Suburban Planning Council communities. Tables 3.11 and 3.12 list the intersections on the CMS network that have approaches with 80 seconds of delay or more during, respectively, the morning and evening peak periods.
- Crashes and crash rates, which are usually a function of volumes, congestion, conflicting movements, and roadway geometry, generally follow the same location pattern as congestion: most of the top 60 crash locations are in Boston and the inner suburbs. However, again, many intersections located on congested, high-traffic-volume roadways in the outer suburbs experience a high number of crashes as well. Table 3.13 lists the top 60 crash locations on arterial roadways in the region.
- The examination of CMS roadway corridors included a tabulation in which traffic volumes, intersection delay, and safety were considered together. When roadway corridors were ranked on

the basis of delay, analysis showed that, generally, delay and safety concerns increase with the number of daily users. Other findings from this analysis, which can be found in Table 3.14, include the following:

- Of the high-traffic-volume corridors, the four most highly delayed are Route 99, Route 16 east of Route 128, Route 60, and Route 28 South. These are all urban corridors serving, largely, high-population and -employment neighborhoods.
- In the high-to-medium-traffic-volume category, the four most highly delayed roadways are Massachusetts Avenue, Route 4/225, Route 38, and Route 126.
- In the medium-volume category, the four most highly delayed roadways are Route 107, Route 1A (north of Route 16), Route 129, and Route 129A.
- Finally, in the low-volume category, the four most delayed roadways are Route 2A east, Route 119, Route 123, and Route 115.

Field observations were made during CMS roadway data collection. Many of these observations noted factors that affect traffic flow. Among the observations were the following:

- Lack of signal coordination, lack of adaptive traffic control, and poor signal timing were noted to contribute to unnecessary delays at intersections. In some cases, vehicles waited in a queue for more than one traffic signal cycle.
- Intersections were sometimes blocked by queues of crossing traffic that failed to clear the intersection. (This behavior is also an issue of traffic law enforcement.)
- Many signalized intersections lack adequate signs and pavement markings to indicate traffic lane assignments. This was often a source of frustration for drivers, as they would wait in the wrong queue for the desired movement and have to maneuver belatedly into the correct one.
- Signs for street names and route designations are often difficult to see or nonexistent.
- In commercial districts, CMS field observers found evidence of parking violations affecting the flow of traffic during the peak periods. Double-parked vehicles, for instance, decrease roadway capacity. Specific roadways where this was observed to be an issue include (but are not limited to) the following: Huntington Avenue in Boston, Boylston Street in Copley Square, Harvard Avenue in Allston, Harvard Street in Brookline, Beacon Street in Boston and Brookline, and Massachusetts Avenue in Boston and Cambridge.

9.1.2 Recommendations

Various types of operational improvements can increase mobility, enhance traffic flow, and improve safety on arterial roadways. These include improved signal timing, coordination of signals, intersection redesign, effective pavement striping and signing, and enforcement of on-street parking regulations. Increased mobility on arterials will benefit buses as well as other vehicles: MBTA buses along congested arterials in the region generally have schedule adherence problems. The recommendations described in the following sections are based on the CMS findings. Some of the recommendations are for specific operational improvements, while others are for the study of specific congested corridors and intersections.

Arterial level of service largely depends on the processing capacity of the signalized intersections along the roadway.[1] Traffic signals allow for the orderly processing of traffic. If they are timed

[1] According to the Texas Transportation Institute (TTI), "making improvements to traffic signals can be one of the most cost-effective tools to increase mobility on arterials" (Schrank and Lomax, *Annual Urban Mobility*

correctly and coordinated with nearby signals (as appropriate), they increase capacity and reduce the frequency of crashes. Coordination allows platoons of vehicles to proceed through a set of consecutive intersections under lower-delay conditions. State-of-the-art equipment facilitates periodic modification of timing and coordination plans, which may be required, since traffic patterns frequently change.

9.1.2.1 An Intersection Improvements Program to Address Congested and High-Crash Intersections

An intersection improvement program should be created to mitigate problems at congested and high-accident locations. This study would be similar to the very well-received and recently completed Congested Signalized Intersections Study, which was a recommendation from a previous cycle of the CMS program. Often crashes are evidence of congestion, stop-and-go traffic, and geometric or operational deficiencies at the intersection. Subject intersections would be identified on a subregional basis from the top accident locations findings, which are shown in Table 3.13, and from the monitored signalized intersections with failing level of service, shown in Tables 3.11 and 3.12. Once identified, these intersections would be targeted for safety and delay improvements. Safety evaluations would be done from the perspective of the motorist, pedestrian, and bicyclist. Improvements could include equipment upgrades to allow for more flexible traffic signal design and vehicle actuation, timing and phasing updates, safe pedestrian crossings, green phase extension for buses, or preemption provisions for emergency vehicles.

9.1.2.2 Traffic Signal Coordination

In roadway reconnaissance during CMS data collection, it was observed that a number of segments of arterial roadways could benefit from traffic signal coordination. Coordination allows for the smooth flow of traffic through consecutive traffic signals that are spaced closely enough (usually one-fourth mile or less) for the platoon of vehicles to be maintained. Traffic signal coordination is a relatively inexpensive way to extract capacity from the roadway system without lane additions.

For the CMS, a preliminary analysis was performed that identified arterial roadway segments where the number of traffic signals and the distance and spacing between signals make those corridors candidates for signal coordination. The results are listed in Table 3.14. As this was only a preliminary analysis, a regionwide study should be conducted to identify all candidate roadway segments.

The study would examine all municipalities, including those where some signals are already coordinated, as there may be additional signals that should be coordinated there. In evaluating the potential of a group of signals for coordination, the study would consider arterial roadway congestion, traffic signal density, type of coordination to consider (traffic-actuated or progressive), and other parameters.

In addition to introducing traffic signal coordination to previously isolated signals, it is important to review existing traffic coordination plans. Since traffic patterns frequently change, modification of

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Report: Volume 2, 2003, p. 9). TTI researched the benefits of traffic signal improvements and coordination (both actuated and progressive) in very large urban areas like the Boston metropolitan region and found that they reduced hours of delay on principal arterial streets (Schrank and Lomax, p. 11). The Institute of Transportation Engineers publication, *A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility* (Michael Meyer, ed., 1997), which compiles results from various studies that analyzed the benefits of different strategies, states (p. 75) that traffic signalization improvements are “one of the most cost-effective tools” and notes that “the cost effectiveness of improved signal timing is significant primarily due to the reduced delay at intersections.” The document cites studies that found that improved timing or coordination of signals reduced delay as much as 15 to 20 percent.

timing, phasing, and coordination plans may be required to maintain smooth handling of traffic at all times.

9.1.2.3 Studies of the Most Congested Arterial Roadway Corridors

Another recommendation is to comprehensively study the most congested of the arterial roadway corridors in the region. Each of these studies should be a multimodal study that addresses vehicle, pedestrian, bicycle, safety, access management, and truck flow issues. These corridors should be studied systematically as part of a "Corridors Program" in which an MPO subcommittee, along with CTPS personnel, would choose priority corridors for study (and subsequent funding of the implementation of recommendations), basing priority on land use, corridor function, transit availability, and congestion-related criteria.

Provided in Table C.1 (in Appendix C) is a summary of recommendations (and their implementation status) from corridor and subarea studies already conducted by CTPS for the Boston Region MPO or its member agencies. (The table lists studies that date back to 1990.) These study recommendations are listed for reference and for MPO members to consider those recommendations that still need to be implemented. Furthermore, many of the present CMS's recommendations for arterial roadways listed earlier in this section reflect issues and conclusions drawn from these studies.

Based on the CMS findings, the following corridors are recommended for study:

Route 28 from Massachusetts Avenue in Boston to Randolph Avenue–Pleasant Street in Milton

CMS monitoring identified low peak-period travel speeds and high peak-period delays in this corridor. The corridor study would make recommendations on access management, parking management, signal coordination, pedestrian and bicycle movement, land use, and bus route service improvement.

Route 107 in Lynn and Revere

This is a congested urban corridor that needs to be evaluated for pedestrian and bicycle mobility, traffic signal improvements, signal coordination, access management, and land use.

Route 99 in Everett, Malden, and Saugus

According to CMS monitoring results, this is one of the most congested roadways in the region during both peak hours. Average daily traffic ranges between 25,000 and 30,000 vehicles, and land use is generally mixed and dense.

The recommendations of this study would not likely include improvements to the road in Everett, since Route 99 there already has programmed improvements. However, Route 99 in Everett would still be included in the study to find out whether the implemented improvements are working synergistically and to determine the impact of improvements further north along the corridor.

Route 3A in Quincy

This roadway is congested and needs to be examined for access management improvements and for roadway and pedestrian mobility concerns.

Route 129 & Route 129A in Lynn and Lynnfield

These are congested corridors with associated safety and delay concerns. The study should include an assessment of pedestrian and bicycle mobility, access management, and transit and roadway improvements.

Route 2A in Acton

The study of this corridor is also recommended in *MAGIC Subregional Area Study: Phase I Report*, which identified this road as having congestion problems and access management issues.[2] The report notes that traffic flow is disrupted by vehicles making left turns into driveways serving the commercial strips. Improved access management should address safety and congestion.

Route 60 from Waltham to Revere

This is a congested route with high per-mile delays. Based on input from local authorities, the study should examine pedestrian and bicycle mobility, access and on-street-parking management, signal coordination, other roadway improvements, and bus transit service. Other study tasks could be undertaken, as desired by a task force of local community representatives.

Route 38 from Lowell town line to Route 28, Somerville

This is the third-most congested route in the category of CMS roadways that have average daily traffic between 30,000 and 45,000 vehicles (see Table 3.14). This study should focus on traffic signal control, access management, and pedestrian access.

Washington Street from Massachusetts Avenue, Boston, to Route 1A, Dedham

This is a roadway with mixed land use on either side of it. It is the fourth-most congested route in the category of the routes with average daily traffic of 15,000 to 30,000 vehicles (see Table 3.14). This study should focus on pedestrian and bicycle access, parking management, access management, and bus service improvements.

Route 2A from Route 2, Lincoln, to Route 3/3A, Arlington

This route proceeds through largely residential neighborhoods in Lincoln, Lexington, and Arlington. Traffic signal control and pedestrian and bicycle movement should be the emphases of this study.

9.1.2.4 Intersection Design: Improvement of Signs and Markings

During reconnaissance and monitoring it was observed that approaches at many intersections in the region could benefit from improved placement of signs and pavement markings. For example, in many cases, signs and markings informing motorists of how to use lanes through an intersection are lacking or confusing, causing last-minute lane shifts which contribute to delays and, sometimes, accidents. Municipal and state traffic-operation officials should investigate installing appropriate pavement markers and signs to facilitate traffic flow at intersections and reduce delays. In addition, officials should enforce traffic rules, to prevent the blocking of intersections, through the use of “Do Not Block Intersection” signs, pavement markings, and citations.

9.1.2.5 Enforcement of On-Street Parking Regulations

Illegal parking, especially during the peak periods, has a serious impact on traffic flow, including the operation of buses. Double-parking and parking in bus stop bays cause incidents and delays affecting cars and MBTA vehicles, as has been documented in detail in past studies.[3] This can be especially problematic in Boston and its inner suburbs, where a given road can be shared by buses, the Green Line, commercial vehicles that are loading and unloading freight, and on-street parking vehicles.

[2] Mary P. McShane, et al., *MAGIC Subregional Area Study: Phase I Report: Current Conditions and Proposed Additional Studies*, produced by CTPS for the Boston MPO, February 2002, p. 58.

[3] For example, the *MBTA Bus Route 66 Arterial Improvement Study* (L. Dantas et al., CTPS, 2001) report.

This phenomenon and its serious impacts on congestion and air quality have been observed repeatedly during CMS data collection and field observations for CMS studies. Some of the roadways in the inner suburbs where this has been observed to take place include Huntington Avenue in Boston, Boylston Street at Copley Square, Harvard Avenue in Allston, Harvard Street in Brookline, Beacon Street in Boston and Brookline, and Massachusetts Avenue in Boston and Cambridge.

The City of Boston and inner suburban communities should seriously address illegal parking activity through additional police enforcement, on-street parking regulations for loading and unloading freight, and identification of off-street parking locations.

Through one study or a series, CTPS staff could assist municipalities by assessing on-street parking concerns. Such an initiative would quantify the harmful effects of mismanaged on-street parking, inventory deficiencies in existing parking signs and markings, and identify alternative off-street parking locations and commercial loading areas. In addition to guiding enforcement, a parking study can aid in understanding the nature of illegal parking and of parking turnover.

9.2 LIMITED-ACCESS HIGHWAYS

9.2.1 Summary of Findings

During the latest monitoring, 8 percent more of the region's expressway network had average peak-period speeds of less than 50 mph in the morning than during the previous monitoring, according to CMS findings, as summarized in Table 3.16. In the evening peak period, however, the CMS results indicate that speeds have not changed significantly between the two monitoring periods, possibly because evening deterioration is harder to detect and measure, as the network is more congested throughout the evening peak period than throughout the morning peak period.

Delay and crash data related to interchanges were analyzed as part of the CMS in order to identify bottlenecks on the limited-access highways. It was found that interchange bottlenecks, crashes, and crash severity are closely correlated. Some of the most congested and crash-plagued interchanges include (in no particular order) Route 1–Route 129/Walnut Street in Saugus, Route 1–Route 60 (Copeland Circle) in Revere, Route 1A–Route 60 (Mahoney Circle) in Revere, Route 2 at the Concord Rotary in Concord, Route 2 at Route 16/Alewife Brook Parkway in Cambridge, Route 3 South at Route 18 in Weymouth, I-93 North at Route 38/Mystic Avenue in Somerville, Storrow Drive at the Charles Street and Leverett Circle ramps in Boston, I-93 at I-95/Route 128 in Woburn, I-90 (MassPike) at I-95/Route 128 in Weston, and I-495 at I-90 in Hopkinton. These results can be reviewed in Table 3.18.

As presented in Section 3.3.2.6 of Chapter 3, congestion (as measured by comparing average daily traffic per lane to an empirical capacity threshold of 20,000 vehicles per lane per day) progressively grew between 1970 and 2000. By this definition of congestion, the most affected highways include I-95/Route 128, I-93 North, I-93/Southeast Expressway, Route 3 South, and Route 2.

9.2.2 General Recommendations

9.2.2.1 Intelligent Transportation Systems (ITS)

Develop a Regional ITS Plan

This plan would essentially be an update of the 1994 *Early Deployment Plan for the Region,* and it would build on the *Operational Concept and Implementation Plan* outlined in the recently completed *Regional ITS Architecture Plan for Metropolitan Boston*. To do this, the plan should include an inventory of the elements that have already been implemented and outline a deployment time frame for specific ITS elements on the transportation system. (As part of the latest Transportation Planning Certification Review, the FHWA and FTA recommended that the MPO compile a synthesis of all the regional agency ITS plans; this would then be the basis upon which ITS projects are programmed in the Transportation Improvement Program.)

Continue to Implement an Incident Management Program on Limited-Access Highways

An incident management program has been in effect on many Massachusetts highways since the early 1990s. It is very effective in addressing nonrecurring congestion. This program should continue to be implemented in accordance with the *Operational Concept and Implementation Plan* outlined in the recently completed *Regional ITS Architecture Plan for Metropolitan Boston* and with regular monitoring to ensure its success.

9.2.2.2 Interchange Improvements

As Tables 3.13 and 3.17 indicate, most of the top crash locations in the region are interchanges. Interchanges are key elements of our transportation system that carry high traffic volumes, contain many elements, involve a variety of maneuvers, and present conflict opportunities at numerous points. In addition, uncongested interchanges that do not back up into expressway and arterial mainlines help to keep traffic on the expressway system instead of causing "spillover" to secondary roadways.

A Priority Interchange Evaluation Program is recommended. Such a program would (1) identify problems at interchanges that are creating congestion and reducing safety, (2) recommend changes to the interchange operation and design, and (3) assign priority for funding of design and construction. The program could be structured as a series of studies and the subsequent programming and implementation of improvements. Each study would evaluate the interchange design parameters and point out the elements of each interchange that need to be corrected. Priority for design and implementation would be assigned to interchanges most in need of improvements, likely based on the number of crashes, traffic volume, and queue lengths.

(Section 9.2.3 lists some interchange improvements that are underway and some interchanges that should potentially be improved, based on a cursory look at traffic volume, speeds, and safety parameters.)

9.2.2.3 Correction of Travel-Lane Continuity Inconsistencies

A few highways have segments where lane continuity is interrupted, resulting in traffic bottlenecks forming upstream from those locations. In some of these cases the shoulder lane has been assigned for temporary use for travel during the peak periods. Demand cannot be accommodated efficiently where lane discontinuities exist; solutions need to be found within the guidelines of federal and MPO policies. Examples of lane discontinuities are found in segments of Route 128 (some already under improvement), on Route 3 South, and within the Braintree Split (junction of I-93 and Route 3) area. Recommendations for these and other expressway segments are included in the following section of this report.

Correcting travel-lane discontinuities can promote safety by eliminating bottlenecks and freeing up shoulders presently employed as travel lanes for their legitimate use by disabled vehicles.

9.2.3 Corridor- and Interchange-Specific Findings and Recommendations

Limited-access highway corridor- and interchange-specific findings and recommendations are listed below. These are based on CMS monitoring and analysis (described in Chapter 3), as well as research on existing conceptual planning studies, feasibility studies, and environmental impact reports.

9.2.3.1 Route 1 North, between I-95, Peabody, and I-93, Charlestown

Summary of Findings

- Average speeds remained relatively unchanged during both peak periods.[4] A notable exception is the speed and delay improvements along segments of the Tobin Bridge and segments leading toward or away from I-93, mostly caused by the Central Artery/Tunnel project construction.
- The location with the most prevalent congestion and safety concerns along Route 1 is its interchange with Route 60 at Copeland Circle. Based on the 1997–1999 crash figures, this is the site with the highest ranking in crashes and crash severity along Route 1 North.

[4] In Section 9.2.3, all of the speed-trend analyses are based on comparisons between the 1994–1995 and 1999–2000 data collection periods.

- The segment of Route 1 between Copeland Circle in Revere and Route 99 in Saugus is four lanes wide, in contrast to its adjacent segments to the north and south, which are six lanes wide. This discontinuity contributes to bottlenecks and slowdowns.
- The location with the second-highest ranking in crashes and crash severity is Route 1 at Route 129/Walnut Street.
- Delays in the four-lane Lynnfield Square tunnel and truck rollovers on the Route 128 northbound off-ramp have been cited in the 1999 CTPS *Lynnfield Square Traffic Operations Study*[5] as the main concerns at the respective locations. Delays relate to the lane drop north of Lynnfield Square, which begins just south of the Lynnfield Square Tunnel, and to backups from the Route 1 "jug handle" signal north of the tunnel.

Recommendations

- Consider implementing the recommendation of the *Lower North Shore Transportation Study* to correct the lane discontinuity problem between Route 60 (Copeland Circle) and Route 99.[6] The next step would be to perform an environmental analysis and roadway design. (Copeland Circle is being studied as part of MassHighway's analysis of the Route 1 segment between Route 60 and Route 99; MassHighway is investigating design alternatives for Route 1 alignment and the Copeland Circle interchange.)
- As part of the above recommendation, implement safety improvements at the Salem Street–Lynn Street interchange in Revere. (A feasibility study of these improvements has been completed.[7])
- Complete the Route 1–Route 16 interchange by constructing two ramps: an on-ramp from Route 16 westbound to Route 1 northbound and an off-ramp from Route 1 southbound to Route 16 eastbound.[8]
- Implement safety improvements to the off-ramp from Route 128 eastbound to Route 1 southbound.[9]
- Implement traffic signal and geometric improvements to Lynnfield Square.[10]
- Study, design, and implement operational improvements for the Main Street and Essex Street interchanges in Saugus, which rank in the top five locations along Route 1 for number of crashes and crash severity.
- Follow up on the findings related to the studies of the I-95/Route 128, Route 1, and Route 129 interchange area, which included an evaluation of delay and connectivity concerns at points on Route 1 in Danvers, Peabody, and Lynnfield.[11]

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[5] Susan Lincoln, *Lynnfield Square Traffic Operations Study*, produced by CTPS for the Massachusetts Highway Department, 1999.

[6] Chen-Yuan Wang and Jim Gallagher, *The Lower North Shore Transportation Improvement Study*, produced by CTPS for the Massachusetts Highway Department, October 2000.

[7] Ibid.

[8] Ibid.

[9] Susan Lincoln, *Lynnfield Square Traffic Operations Study*.

[10] Ibid.

[11] In 1996, CTPS provided traffic forecasts for Routes 1/114 and Routes 1/128/I-95 for these efforts, detailed in *Route 114 Corridor Study: Conceptual Improvement Plan* [Vanasse Hangen Brustlin, Inc.; 1996], *Improvements to I-95/Route 128, U.S. 1 and Route 129 Interchange Area: Final Concept Development Report* [Vanasse Hangen Brustlin, Inc.; 1996], and *Danvers Route 114/1/95 Roadway and Interchange Project* [Frederic R. Harris, Inc., 1997], all produced for Massachusetts Highway Department, the Town of Danvers, and the City of Peabody.

9.2.3.2 Route 60–Route 1A, between Route 1, Revere, and Callahan/Sumner Tunnels, Boston

Summary of Findings

- With a few exceptions, average speeds during both peak periods have remained largely unchanged in both directions.
- Long peak-direction delays persist in the vicinity of Boardman Street, Mahoney Circle (Route 1A at Route 60 and Route 16), Revere Street, and Route 60 between Route 1 and Brown Circle (Route 107).
- Mahoney Circle is ranked the second-highest crash location (after Copeland Circle) along Route 1A–Route 60, based on the number and severity of crashes.
- Northbound and southbound average speeds have increased on the segments leading to and away from the airport tollbooths. Likely factors contributing to this change in speeds are recent toll increases, the implementation of automatic toll collection for Fast Lane users, and diversions of traffic to the Williams Tunnel, which contributed to the 60 percent decrease in traffic volumes in the Sumner and Callahan Tunnels.

Recommendations

- Study the feasibility of improvements along Route 1A from just north of Logan Airport to Mahoney Circle, including the feasibility of grade-separating Route 1A and Route 60 at Mahoney Circle.
- Following the recommendation of the *Lower North Shore Transportation Study*,[12] complete the Route 1–Route 16 interchange by constructing an on-ramp from Route 16 westbound to Route 1 northbound and an off-ramp from Route 1 southbound to Route 16 eastbound.
- Following the recommendation of the *Lower North Shore Transportation Study*, reconstruct the Chelsea Street bridge with a direct connection from Route 1A.
- Follow up MassHighway's study of conceptual grade-separation design alternatives by proceeding with the production of environmental documents for the Boardman Street intersection.
- Following the recommendation of the *Lower North Shore Transportation Study*, study the feasibility of connecting Route 1A, Route 16, and Route 145 into a single grade-separated interchange at Route 1A.

9.2.3.3 Route 2, between Route 27, Acton, and Route 16/Alewife Brook Parkway, Cambridge

Summary of Findings

- East of I-95/Route 128, average speeds have generally remained the same, except for the approaches to I-95/Route 128 and between the Lake Street on-ramps and the Alewife Brook Parkway traffic signal, where speeds have decreased.
- The most congested segment of Route 2 east of I-95/Route 128 is the four-lane segment between Lake Street and the Alewife Brook Parkway traffic signal.
- The highest crash location for this roadway is the interchange of Route 2 with I-95/Route 128.

[12] Wang and Gallagher, *The Lower North Shore Transportation Improvement Study*.

- There is usually a long queue on Route 2 westbound waiting to enter the ramp that leads to I-95/ Route 128 southbound.
- West of I-95/Route 128, average speeds have generally decreased, with particular speed reductions and delays in the vicinity of Crosby's Corner and the Concord Rotary.

Recommendations

- Continue to investigate improvements along the segment of Route 2 between the Concord Rotary and the Piper/Taylor Road intersection in Acton.
- Following completion of the CTPS study *Route 2 Improvements from Route 111 in Acton to Baker Avenue in Concord: A Feasibility Study*, MassHighway should proceed with the production of the environmental documents and design for the grade separation at the Concord Rotary.
- Following the findings and recommendations of the MassHighway Environmental Impact Report for Crosby's Corner, complete final design and construct a grade-separated interchange on Route 2 at Cambridge Turnpike–Concord Turnpike (Crosby's Corner).

9.2.3.4 Storrow Drive and Fresh Pond Parkway, between Route 2 at Route 16, Cambridge, and Route 28/Leverett Circle, Boston

Summary of Findings

- Average speeds have remained unchanged during both peak periods, with some exceptions.
- Average speeds decreased on segments of Fresh Pond Parkway in Cambridge.
- In Boston, between the Copley off-ramp and Leverett Circle, eastbound evening speeds increased.
- Long delays continue to be present on Fresh Pond Parkway and also along much of Soldiers Field Road and Storrow Drive, particularly in the eastbound lanes approaching the Leverett Circle traffic signals. Delays at Leverett Circle are likely to decrease after completion of the Central Artery/Tunnel project.
- The highest crash rate among all of the Storrow Drive interchanges is at the Charles Circle ramps.

Recommendations

- Study design improvements relevant to access management, traffic circulation, and connections between Route 2, Alewife Station, and Route 16 (Alewife Brook Parkway).
- Study design improvements at the I-90/MassPike–Soldiers Field Road–Western Avenue–River Street interchange.
- Study design improvements at the Storrow Drive–Fenway–Charlesgate interchange.
- Study the feasibility of geometric improvements along the roadway segment between the intersection of Fresh Pond Parkway and Memorial Drive, and the location where Soldiers Field Road merges with eastbound Storrow Drive.

9.2.3.5 Route 3 North, between the New Hampshire State Line and I-95/Route 128, Burlington

Summary of Findings

- In general, speeds along Route 3 North decreased prior to the beginning of the reconstruction of this highway from four to six lanes.
- Morning southbound average speeds were slowest in the I-495 area.
- Average evening peak period northbound speeds decreased between the interchanges at Route 62 and I-495.
- Route 3 North was recently widened from four to six lanes between I-95/Route 128 and the New Hampshire state line. The final section of Route 3 southbound opened to three lanes on October 25, 2004; this milestone completes the implementation of three lanes in each direction corridor-wide. Soon-to-be-conducted travel-time runs will indicate whether delays have decreased.

Recommendations

- Monitor volumes, delays, and travel times on the newly reconstructed highway to determine the “after” effect of the reconstruction.

9.2.3.6 Route 3 South, between Route 14, Duxbury, and I-93, Braintree

Summary of Findings

- Between the mid- and late 1990s, speeds decreased during the morning peak period in the northbound direction between Route 14/Route 139 in Duxbury and the MBTA station ramps; they remained largely unchanged in the southbound direction in the morning and in both directions in the evening peak period.
- In the morning a major bottleneck occurs between Route 228 and the MBTA station ramps, with northbound average speeds below 40 mph.
- In the evening peak hour, the major slowdown occurs between the MBTA station ramps and Route 53.
- The top two crash locations are the interchanges at Route 18 and at Union Street.

Recommendations

- Continue the environmental impact study of Route 3 South.
- Complete the Braintree Split Study.

9.2.3.7 I-93/Southeast Expressway, between Route 3, Braintree, and Storrow Drive, Boston

Summary of Findings[13]

- In the late 1990s, traffic delays worsened and travel speeds decreased along I-93/Southeast Expressway, partly due to the construction of the Central Artery/Tunnel project; drivers usually experienced the highest delays between the Columbia Road interchange and Storrow Drive.
- Since the opening of the northbound Central Artery Tunnel and all the connections between I-90, I-93, and the Ted Williams Tunnel, most of the segments of the northern portion of I-93/ Southeast Expressway, between Columbia Road and Storrow Drive, have improved dramatically. Continued CMS monitoring should confirm the traffic impacts of the project.
- From the Braintree Split (the junction of I-93 and Route 3) to Columbia Road, conditions remained largely the same between the mid- and late 1990s. Some general-purpose-lane improvements upstream of the high-occupancy-vehicle (HOV) lane openings, in the northbound direction in the morning peak period and in the southbound direction in the evening peak period, reflect the change on July 1, 1999, of the HOV lane occupancy restriction (from three or more occupants per vehicle, to two or more occupants).
- North of the Braintree Split, high volumes from on-ramps at Granite Avenue and at Route 3A/ Neponset Circle to I-93/Southeast Expressway northbound largely cause slow morning peak-direction speeds.
- In the southbound (peak) direction in the evening peak period, delays are largely caused by traffic backups into the Braintree Split from I-93 southbound delays at Route 37 and Route 24.

Recommendations

- Continue monitoring I-93/Southeast Expressway to identify post–Central Artery/Tunnel project conditions and compare these with conditions from the two previous monitoring periods, the mid- and late 1990s.
- Study the feasibility of operational improvements (including acceleration lanes and ramp metering) at on-ramp locations along the Southeast Expressway, where high volumes cause speed reductions and delays for mainline traffic.
- Complete the Braintree Split Study.
- Study the potential of constructing an HOV facility connecting the current northern terminus of the I-93/Southeast Expressway HOV lane and the proposed Central Artery/Tunnel project's HOV lane between Southampton Street and Kneeland Street. There is about a 1.5-mile gap between the existing HOV lane and the proposed HOV lane.

[13] These findings are based on speed and delay data collected prior to the opening/start of the following facilities/service changes: I-90 Extension, Ted Williams Tunnel (opening for restricted use), and Tobin Bridge toll increase, July 2002; I-90 connector to Ted Williams Tunnel, I-93 northbound to I-90 eastbound connector, and I-90/Ted Williams Tunnel (opening to all traffic) in January 2003; I-93 Central Artery northbound, March 2003; I-90 westbound to I-93 southbound connector and I-93 Central Artery southbound, December 2003; and Tobin Bridge toll increase, April 2004.

9.2.3.8 I-93 North, between the New Hampshire State Line and I-95/Route 128, Reading

Summary of Findings

The effect on traffic speeds of the use of the breakdown lane for vehicle travel, which is currently allowed between Route 213 in Methuen and Route 125 in Andover,[14] is exemplified by the following findings:

- Morning and evening peak-period southbound speeds have increased on the segments between Exit 46 and the on-ramp to I-495.
- Evening peak-period northbound speeds have increased between the point where use of the breakdown lane begins and the interchange at I-495.
- Morning southbound speeds have decreased on the segment between Route 125 in Andover where the lane drop ends and the interchange with I-95/Route 128. (Before use of the breakdown lane was allowed, three lanes fed into the greater capacity of four lanes.)

Recommendations

- The Merrimack Valley Planning Commission (working on behalf of the Merrimack Valley Metropolitan Planning Organization) completed its transportation study of the Route I-93 corridor in Andover and Methuen.[15,16] The study considered four highway design alternatives to improve congestion along this roadway, and concludes:

> Widening the roadway to eight 12-foot lanes with a 10-foot outside shoulder and full 12-foot median shoulder appears to be the most beneficial mainline alternative. Widening the roadway to four general purpose travel lanes is likely to provide for higher levels of service than the HOV treatments and entails no additional cost or environmental effect.

The study also states, "The potential widening of I-93 should be balanced with transit improvements to provide a comprehensive multimodal transportation system." The study references light rail, commuter rail, and bus improvements, and TDM measures as well.

The implementation of that study's recommendation would eliminate the use of the breakdown lane for mainline travel, thereby improving safety. However, the implementation should not proceed until further analysis has ensured that the impacts to I-93 in the Boston Region MPO area are fully understood. Furthermore, the study's main alternative should only be implemented if the design/construction does not preclude the corridor's having HOV lanes added in the future.

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[14] Since 1999, MassHighway has allowed travel on the outside breakdown lane of I-93 in the peak direction, roughly between Route 125 in Wilmington and Route 113 in Methuen. This short-term operational strategy has helped improve congestion along this segment of I-93, which currently contains three lanes per direction.

[15] *Interstate 93 Corridor Traffic Study: Andover and Methuen, Massachusetts*, prepared for the Merrimack Valley Planning Commission, with support from the Massachusetts Highway Department and the Merrimack Valley Regional Transit Authority, by Vanasse Hangen Brustlin, Inc., October, 2003.

[16] This roadway lies outside the Boston Region MPO area. However, changes to this facility will likely impact travel in the 101-community region of the Boston Region MPO.

9.2.3.9 I-93 North, between I-95/Route 128, Woburn/Reading, and Route 28, Somerville

Summary of Findings

- Average morning-peak-period southbound speeds have increased on the segments between Route 28 and the end of the HOV lane. In 1999, the I-93–Storrow Drive Connector opened to traffic. In the same year, the HOV lane occupancy restriction was reduced (from 3 or more occupants per vehicle to 2 or more) and the hours of operation were extended.
- Average northbound speeds have decreased between Storrow Drive and Route 28 during both peak periods.
- Delays due to the I-93–I-95/Route 128 interchange affect speeds on the I-93 approach to the interchange during both peak hours.
- Northbound evening delays are a frequent occurrence between the interchange at Route 60 and the interchange at Route 28/Route 38, especially in the vicinity of the latter interchange in the peak directions.
- Along this segment of I-93, the top crash locations are the interchanges at I-95/Route 128, at Route 38 (Mystic Avenue), and at Route 28/Route 38.

Recommendations

- Continue the MassHighway study of the I-93–I-95/Route 128 interchange in Woburn.
- Follow up with *Assembly Square Transportation Plan*[17] study recommendations on improvement to the interchange at Route 28/Route 38.

9.2.3.10 I-93 South, between Route 3, Braintree, and I-95, Canton[18]

Summary of Findings

- In the morning peak period, speeds have decreased in the three-lane southbound section between Route 24 and I-95/Route 128. These changes can be attributed to a number of factors, including the traffic volume increase on I-95/Route 128 north of University Avenue, where an average weekday traffic increase of 5.8 percent was reported between 1997 and 2000.
- During the evening peak period, the segment between the Braintree Split and Route 24 is severely delayed. Reasons for these delays include the Route 3 merge at I-93 south, the Route 3 traffic weave to the Route 37 exit, and the two-lane, left-side diverging exit lanes from I-93 southbound to Route 24 southbound.

Recommendations

- Consider designing and implementing Braintree Split Study improvements pertaining to I-93 operations in the vicinity of Route 37 and Route 24.
- Proceed with environmental analysis and construction of I-93–I-95/Route 128 interchange improvements in Canton and Westwood.

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[17] Rizzo Associates, *Assembly Square Transportation Plan: Final Report,* submitted to the City of Somerville, Office of Housing and Community Development, Somerville, Mass., May 13, 2003.

[18] This roadway section is popularly referred to as Route 128.

9.2.3.11 I-95/Route 128 (Southern/Western Section), between I-95, Canton, and I-93, Woburn/Reading

Summary of Findings

- Between the Route 24 and Route 9 interchanges, observed travel speeds on I-95/Route 128 are slow (LOS F) in the northbound direction during the morning peak period and in the southbound direction during the evening peak period.
- The widening of I-95/Route 128 between the Route 24 and Route 9 interchanges from six lanes to eight lanes is programmed for implementation. This lane addition will address the current lane discontinuity along the southwest portion of I-95/Route 128.
- On the northbound approach to the Route 20 interchange, I-95/Route 128 observed traffic speeds are slowest (at LOS F) in the morning peak period; southbound traffic speeds are lower in the evening peak period, nearing LOS F.
- Between Route 20 in Waltham and I-93 in Woburn, morning peak period congestion primarily occurs in the southbound direction, especially in the vicinity of Route 2, whereas the evening peak period congestion occurs in the northbound direction particularly in Burlington and Woburn.
- The interchange of I-95/Route 128 with I-93 in Woburn is the highest crash location in the Boston region. (MassHighway is presently studying design improvements to this interchange.)
- Based on MassHighway's index of crash severity, the second- and third-most hazardous locations along this highway are, respectively, the interchanges at Washington Street–Mishawum Street in Woburn (presently under study by MassHighway and CTPS) and Totten Pond Road–Winter Street in Waltham.

Recommendations

- MassHighway is ready to begin the design phase for improvements to the segment of I-95/Route 128 that includes the Highland Avenue–Needham Street interchange and the Route 9 interchange. Also proposed for this project is the creation of an interchange at Kendrick Street. (The impacts of the potential interchange at Kendrick Street have been studied by CTPS.[19])
- Implement improvements at the Totten Pond Road–Winter Street interchange. (These improvements are currently in the design phase at MassHighway.)
- Continue the MassHighway study of the I-93–I-95/Route 128 interchange (Exit 37). Coupled with this study is the analysis of the Mishawum Road–Washington Street–Commerce Way interchange (Exit 36), which is nearby in Woburn.

9.2.3.12 I-95/Route 128 (Northern Section), between I-93, Woburn/Reading, and the I-95–Route 128 Split, Peabody

Summary of Findings

- Average northbound speeds have not changed during either of the peak periods, while southbound speeds have increased somewhat between Walnut Street in Lynnfield and Route 28 in North Reading during the morning peak period.

[19] Seth Asante, *Potential I-95 (Route 128)–Kendrick Street Interchange, Needham, Massachusetts: An Evaluation of Traffic Impacts*, produced by the Central Transportation Planning Staff for the Boston Metropolitan Planning Organization, December 2003.

- This segment of I-95/Route 128 remains congested due to difficult traffic weaves and merges at and near the cloverleaf interchange at I-93 in Woburn. During the morning peak period, long queues are prevalent in the southbound direction, upstream from this location. In the evening, the delays occur in the northbound direction leading to the lane drop at Route 28 (from four to three lanes).

Recommendations

- Study the feasibility of alternatives for processing more trips along this roadway.

9.2.3.13 Route 128, between I-95, Peabody, and Blackburn Circle, Gloucester

Summary of Findings

- Average speeds have decreased between the Route 1A interchange in Beverly and Forest Street in Peabody in the evening peak period.
- Speeds are slow in the northbound direction in the evening peak period between Centennial Drive and the Route 1A interchange.

Recommendations

- Complete the operational and safety improvements on Route 128 from Peabody to Beverly. (Improvements are currently under design by MassHighway.)
- Continue the study of operational and safety improvements for the Route 128 segments between Beverly and Gloucester.
- Investigate the feasibility of capacity improvements on Route 128 from Peabody to Beverly.

9.2.3.14 Route 24, between I-495, Bridgewater, and I-93, Randolph

Summary of Findings

- During the morning peak period, average speeds have decreased on the northbound segments between the Route 27 interchange (Exit 18) in Brockton and the I-93 interchange (Exit 21), where delays occur at the merge of the Route 24 northbound ramp and I-93 northbound. The traffic volume simply cannot be accommodated effectively here, resulting in queues on Route 24.
- During the evening peak period, average speeds have increased on nearly all segments in both directions, with the exception of the southbound approach to I-495.
- Traffic queues exist at the point where the two on-ramps from I-93 (southbound and northbound) merge into Route 24 southbound.

Recommendations

- Study the I-93–Route 24 interchange, specifically the merge/diverge points of the direct ramp connections, for improvement recommendations.

9.2.3.15 I-95 South, between I-495, Foxborough, and I-93/Route 128, Canton

Summary of Findings

- In the northbound direction, morning-peak-period queues have increased between Coney Street in Walpole and Route 128, with average speeds well below the speed limit.

Recommendations

- Pursue the environmental impact study and design of I-95/Route 128–I-93 interchange improvements in Canton.

9.2.3.16 I-90 (Massachusetts Turnpike/Massachusetts Turnpike Extension) between Interchange 13, Framingham, and the Central Artery, Boston

Summary of Findings

- Generally, delays on I-90 are correlated with slowdowns at interchanges that have high ramp volumes or at toll collection plazas.
- Delays occur between Interchange 13 and I-95/Route 128: during the morning peak period they occur in the eastbound direction, and in the evening peak period they occur in both directions. The highway at the on-ramp merge areas at Exit 13 and at segments leading to toll plazas at I-95/ Route 128 are often congested.
- Major delays between I-95/Route 128 and the Newton Corner exit were exacerbated by the elimination of the toll for the section of highway between the West Newton exit and the Newton Corner exit.[20]
- Average speeds, which had decreased on the segment between the Prudential/Copley exit and the South Station off-ramp (because of impacts of the Central Artery reconstruction), have significantly recovered since the opening, in January 2003, of the I-90 connector (which runs from the interchange at I-93 through the Ted Williams Tunnel and on to where I-90 ends at Route 1A).

Recommendations

- Study the feasibility of designing and constructing a reversible HOV lane along the median between Exit 13 and the I-95/Route 128 toll plaza. The study should consider other measures as well, including peak-period pricing and increased promotion of participation in the Fast Lane program.

9.2.3.17 I-495, between Route 109, Milford, and Route 2, Acton

Summary of Findings

- Traffic at the southbound I-495 approach to the Route 20 interchange in Marlborough is delayed in the morning peak period. Based on the latest (spring 2000) travel time data for I-495 traffic, there were morning southbound peak-hour delays upstream from the Route 20 interchange. After the 2004–2005 freeway monitoring cycle is completed, it will be evident whether the new I-495 interchange just south of the I-495–Route 20 interchange has improved the situation.

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[20] *The Effects of the July 1, 2002 Boston Extension (I-90) Toll Increase on Newton Neighborhoods*, prepared by URS Corporation for the Massachusetts Turnpike Authority, January 2003.

- Also, the southbound delays at the I-495–Route 20 interchange have probably been mitigated by the new interchange at Crane Meadow Road.
- The two most hazardous locations (based on number of crashes and crash severity index) are the interchanges at I-290 and at I-90.

Recommendations

- Complete the programmed safety improvements at the I-90–I-495 interchange, which include the construction of a second lane for the eastbound I-90 off-ramp to I-495 southbound.
- At the interchange with I-290, design and construct the safety improvements recommended in MassHighway's *Route 85 Connector Transportation Study*.[21]

9.2.3.18 I-495, between Route 2, Littleton, and Route 125, Haverhill

Summary of Findings

- In the morning peak period, there are slowdowns in the southbound direction approaching I-93.
- In the evening peak period, low speeds persist in the northbound direction between Route 3 and Route 38, and in the vicinity of Routes 110 and 213 in Methuen.

Recommendations

- Conduct an environmental impact study to determine what improvements to the interchange between I-495 and I-93 will be most cost-effective and environmentally sensitive. Conceptual alternatives for this interchange have been developed by the Merrimack Valley Planning Commission (working on behalf of the Merrimack Valley Metropolitan Planning Organization).[22,23] The recently-completed transportation study of the I-93 corridor in Andover and Methuen identified traffic weave difficulties between ramps at the I-495–I-93 interchange. The study considered three highway design alternatives to improve weaving problems at this location, including direct ramp connections and collector distributor roads.
- Consider the findings from the Massachusetts Highway Department's forthcoming I-495 Corridor Transportation Study.

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[21] *Route 85 Connector Transportation Study,* prepared by the Massachusetts Highway Department's Bureau of Transportation Planning and Development, November 2001.

[22] *Interstate 93 Corridor Traffic Study: Andover and Methuen, Massachusetts*, prepared for the Merrimack Valley Planning Commission, with support from the Massachusetts Highway Department and the Merrimack Valley Regional Transit Authority, by Vanasse Hangen Brustlin, Inc., October, 2003.

[23] This roadway lies outside the Boston Region MPO area. However, changes to this facility will likely impact travel in the 101-community region of the Boston Region MPO.

9.3 PUBLIC TRANSIT

9.3.1 Summary of Findings

Chapter 4 provides a cursory review of the monitoring data and assessment results for the commuter rail, transit, and bus systems of the MBTA.[24] Reported in the chapter are two measures of performance—schedule adherence and passenger crowding—which offer a glimpse into the performance of the major MBTA systems. With regard to buses, these two measures are also useful for the CMS roadway analysis, as they may be indications of roadway congestion.

9.3.1.1 Schedule Adherence (On-Time Performance)

The schedule adherence findings, in summary, are as follows:[25]

- The Green Line's B branch met the schedule adherence performance standard. All other light rail and rapid transit rail lines fail to meet the standard. Whereas the rapid transit lines are within 5 percentage points of meeting the standard, the Green Line's C, D, and E branches are off by 10 to 15 percentage points.
- The Lowell commuter rail line, which heads into North Station, met the on-time-performance standard. The other commuter rail lines into North Station came within 3 percentage points of meeting the standard.
- The Needham and Fairmount commuter rail lines, which head into South Station, met the on-time-performance standard. The other commuter rail lines into South Station came within 6 percentage points of meeting the standard.
- Of the morning peak-period bus trips, 36 percent arrived more than five minutes late.
- Of the evening peak-period bus trips, 39 percent arrived more than five minutes late.

9.3.1.2 Passenger Crowding

The performance results, in summary, for passenger crowding are as follows:[26]

- All transit and commuter rail lines except for the Providence and Plymouth/Kingston lines met the passenger-crowding performance standard.
- The passenger-crowding standard was nearly reached by the Blue Line, the Braintree branch of the Red Line, and branches C and D of the Green Line.
- Five percent of the morning and four percent of the evening peak-period bus trips violated the passenger-crowding standard.

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[24] This type of evaluation is not meant, by any means, to replace the already existing comprehensive data collection and evaluation processes of the MBTA. These processes include the Program for Mass Transportation, the Capital Investment Program, a biennial Service Plan, and other service planning evaluations.

[25] The results are from the following data collection efforts: rapid transit service was comprehensively checked in 1995 and 1997; bus ridechecks were performed between the fall of 1997 and the winter of 2002; commuter rail service data for 2003–2004 were provided by the Massachusetts Bay Commuter Railroad Company (MBCR), which is the operator of MBTA commuter rail service. The MBTA, as part of the implementation of its system preservation goals, has taken steps to improve schedule adherence on these systems.

[26] The results are from the following data collection efforts: rapid transit service was comprehensively checked in 1995 and 1997; bus ridechecks were performed between the fall of 1997 and the winter of 2002; commuter rail data come from "Results of Commuter Rail Peak Load Counts," a memorandum from the Central Transportation Planning Staff to the Massachusetts Bay Transportation Authority, August 4, 2000.

9.3.2 Recommendations

As there already exist well-defined and detailed MBTA processes that analyze and recommend improvements to the region's public transportation system and services, this report does not make transit recommendations, except for a few for the bus system. For the reader's information, Section 9.3.2.1 provides an inventory of regionally significant projects for MBTA system expansion or service improvement that have been undertaken or are planned. Section 9.3.2.2 details recommendations for new strategies for improving bus service, particularly service operating on congested roadways.

9.3.2.1 Regionally Significant MBTA System Expansion and Service Improvement Projects

The MBTA has plans to implement a number of system expansion and service improvement projects in the next 20 years, as the region responds to the goal of enhancing mobility in the face of population growth, economic growth, and changes in commuting and travel patterns. In order to guide the implementation of their projects, the MBTA developed a strategy for prioritizing investments. The strategy consists of the following elements, according to the 2003 *Program for Mass Transportation* (PMT):

- Address the backlog of system preservation needs
- Reinvent the MBTA bus system
- Improve the environmental performance of facilities and operations
- Relieve system capacity constraints
- Strive for a balanced capital program that is responsive to urban-core mobility needs and suburban demand for transit choice

Presented below are the regionally significant transit improvement projects that are planned or have been recently undertaken, according to the long-range Regional Transportation Plan or the PMT. Some are legal commitments.[27]

Completed

- Newburyport commuter rail expansion*
- Old Colony commuter rail restoration: Middleborough and Kingston lines*
- Park-and-ride lot expansion (20,000 new parking spaces)*
- Purchase of 400 new buses*
- South Boston Piers Transitway (Silver Line Phase II)*[28]
- Washington Street Replacement Service (Silver Line Phase I)*
- Worcester commuter rail expansion and new stations*

Under construction

- Blue Line station modernization: six-car platforms*
- Old Colony commuter rail restoration: Greenbush Line*

[27] The Commonwealth has certain legal project obligations to satisfy related to the State Implementation Plan, the Central Artery/Tunnel Project mitigation program, and the terms outlined in an Administrative Consent Order. It is on this basis that certain projects listed in this section are noted as being a "legal commitment."

[28] Silver Line service began operating in South Boston in December 2004; the remaining service to Logan Airport is scheduled to open by June 2005.

In planning stages[29]

- Arborway Green Line restoration*
- Blue Line–Red Line connector*
- Fairmount Line improvements
- Green Line extension to Medford Hillside*
- North Shore transit improvements, Revere to Salem
- Purchase of additional buses and improvement of maintenance facilities
- Purchase of new Orange Line vehicles and upgrading of signals*
- Russia Wharf Ferry Terminal*
- Silver Line Phase III
- Urban Ring (Phases 1 and 2)

* Legal commitment

Collectively, these system expansion and service improvement projects are intended to offer congestion relief, improve mobility, reduce vehicle emissions, and make transit a more attractive transportation mode. Most of these projects will be constructed along corridors that are congested or are within congested subregions, and they have the potential to improve conditions in those areas. For example: North Shore transit improvements, which may include a Blue Line extension, could help reduce roadway delays for North Shore residents who drive to their destination; the purchase of additional MBTA buses could improve service frequency and bus crowding conditions; and the Urban Ring project would eliminate many trips through downtown Boston that are made for the sole purpose of transferring to another transit line.

9.3.2.2 Bus Mobility Strategies

In addition to the regionally significant projects listed above, the CMS analysis has led to the recommendation of the following bus-transit-related improvements:

Traffic Signal Priority Strategy

The MBTA should consider, in cooperation with local communities, a pilot project to implement and demonstrate the benefits of traffic signal priority treatment. This would be done using hardware and software technologies that would enable MBTA buses (or Green Line B, C, and E cars) to invoke the green signal phase or extend the duration of the green phase so that they could pass through an intersection more quickly. In addition to evaluating various priority-treatment strategies, the study should assess their potential effect on bus "bunching" and side-street traffic queues.

A major benefit of such a system would be that the number of people passing through the intersection would be maximized. Another benefit of signal priority for transit would be improvement in schedule adherence, since bus headways could be actively managed through automatic vehicle location (AVL) technology. Consequently, the problem of bus bunching could be drastically reduced or even eliminated.

Enforcement of On-Street Parking Regulations

The City of Boston and inner-suburban communities should seriously consider addressing the issue of how to reduce illegal on-street parking through police enforcement, on-street parking

[29] According to information in the 2004–2005 Regional Transportation Plan and the 2003 PMT, these projects are planned for implementation.

regulations for loading and unloading freight, and identification of off-street parking locations. Past studies have shown that illegal on-street parking (such as double-parking and parking at a bus stop) has a serious impact on roadway mobility, including the efficient movement of buses.[30] (Also, please see Section 9.1.2.5.)

Alternative Bus Technologies and Vehicles

To reduce overcrowding on bus routes, the MBTA should continue to investigate alternative strategies for carrying additional demand, including both the operation of articulated buses on crowded routes and the use of AVL equipment to better manage operation of the bus fleet. Both strategies help to address bus "bunching."

The MBTA is already deploying articulated buses. The Silver Line uses them, and since August 2003 Route 39 has been using them. Other routes are under consideration.

The MBTA is also working toward installation of AVL technology on buses as part of its intelligent transportation system (ITS) program, which is being incorporated into the development of a new bus-operations center. When completed, the new facility will use global positioning system (GPS) devices to better schedule and direct the bus fleet.

Technological improvements have already been implemented on MBTA vehicles: automatic stop-announcement equipment has been installed on the MBTA's crosstown bus routes and will eventually be installed on all vehicles; and Silver Line vehicles are equipped with GPS-based AVL technology.[31] (Also, please see Section 9.2.2.1.)

[30] For example, the *MBTA Bus Route 66 Arterial Improvement Study* (L. Dantas et al., CTPS, 2001) report.

[31] *Program for Mass Transportation (PMT),* prepared for the Massachusetts Bay Transportation Authority by the Central Transportation Planning Staff, May 2003, p. 2-11.

9.4 PARK-AND-RIDE LOTS

9.4.1 Summary of Findings

Of the 107 MBTA commuter park-and-ride lots surveyed in 2002, 76 (71 percent) filled to 85 percent or more of capacity, and 49 (46 percent) reached capacity well before the last morning peak-period inbound train. The 1998 CMS park-and-ride inventory found that 80 percent of MBTA park-and-ride lots fill to over 85 percent of capacity. Several large-scale parking lot expansions and openings took place between the two inventory periods, increasing the supply of spaces at several stations. (Please refer to Section 5.2.2.)

Use of four of the five MassHighway park-and-ride lots in the region is not high. Only the lot in Milton was observed to fill to capacity.

9.4.2 Recommendations for Park-and-Ride Lots at Transit Stations

The transit station park-and-ride lots listed in Table 9.1 are recommended for expansion. These are the lots already identified by the MBTA in its Program for Mass Transportation (PMT) as lots where added capacity is desirable and apparently feasible. The recommended priority level for each lot is given in the far-right column of the table; the lots are in order from highest to lowest priority. The priority levels are based on the MBTA's prioritization for lot expansion as reported in the PMT and complemented by the lot utilization measure from the CMS inventory, both of which are also given in the table. These two sources are described below.

1. *PMT Ratings:* The 2003 PMT assigns a priority rating of high, medium, or low to each park-and-ride lot.[32] The criteria used in determining these ratings were projected future demand, potential utilization, convenient access for the commuter, MBTA ownership or access to land and air rights, cost per unit of parking spaces, environmental concerns, ease of implementation, community support, and funding options.
2. *CMS Utilization Measure:* The CMS field inventory identified the lots that fill to capacity and when they fill up; for the other lots, it determined how much of their capacity is used. (The detailed findings are explained and listed in Chapter 5.) The time of day a lot reaches capacity may be an indication of the level of demand for additional commuter parking capacity. In other words, a lot's filling up before the departure of the last morning peak-period train might indicate considerable unmet demand for commuter parking; a lot's filling up sometime after the departure of the last morning peak-period train might indicate lower unmet demand.

   In Table 9.1's column conveying lot utilization information, the lots are assigned to one of three categories: lots that fill up before the last morning-peak-period train departs, lots that fill up later in the day, and lots that do not fill up but which reach at least 85 percent of capacity.

The recommended priority levels, given in Table 9.1's last column, follow the PMT ratings but further prioritize the lots within each rating category by applying the CMS utilization measure. For example, the lots with a "high" PMT rating are highest in priority, but among them, the Natick, North Quincy, and Salem station lots should be expanded first because they fill up before the last morning

[32] Please refer to Table 5B-2 and pages 5B-32 through 36 of the 2003 PMT for further details. These ratings are taken from assessments originally made by the MBTA Planning Department and reported in *Commuter Parking Expansion Program: Project Evaluation Analysis* (March 2002).

Table 9.1. Transit Station Park-and-Ride Lots: Recommended Lots for Expansion

Station	Line	# of Non-Disability Parking Spaces	Lot Utilization: Does Lot Fill Up Before Last Morning Peak Period Train?*	Time of Last Morning Peak-Period Train	PMT Project Priority Rating	Recommended Priority Level Based on PMT Rating and Lot Utilization
Natick	Worcester	72 (town)	Yes	9:02	HIGH	1
North Quincy	Red Line	1,187	Yes	8:59	HIGH	1
Salem [1]	Newburypt./Rockpt.	556	Yes	8:27	HIGH	1
Franklin	Franklin	241	No, but fills up	7:52	HIGH	2
Beverly Depot	Rockport/ Newburyport	252 (total) 85 (town)	No, but fills up ≥85%	8:23	HIGH	3
Forge Park	Franklin	668	No, but fills up ≥85%	7:45	HIGH	3
Quincy Adams	Red Line	2,479	No, but fills up ≥85%	8:59	HIGH	3
Woodland	Green 'D' Line	442	No, but fills up ≥85%	8:59	HIGH	3
Littleton	Fitchburg	99	Yes	7:50	MEDIUM	4
Milton	Mattapan Line	35	Yes	8:59	MEDIUM	4
S. Weymouth	Plymouth/Kingston	522	Yes	9:02	MEDIUM	4
Gloucester	Rockport	185	No, but fills up	7:33	MEDIUM	5
Norfolk	Franklin	538	No, but fills up	7:59	MEDIUM	5
Walpole	Franklin	531	No, but fills up	8:05	MEDIUM	5
Hingham	Boat	1,829	No, but fills up ≥85%	9:15	MEDIUM	6
Rockport	Rockport	105	No, but fills up ≥85%	7:25	MEDIUM	6
Hyde Park	Providence	135	Yes	9:04	LOW	7
West Medford	Lowell	35 (public) 65 (total)	Yes	8:59	LOW	7
Lincoln	Fitchburg	237	No, but fills up ≥85%	8:56	LOW	8
Winchester	Lowell	193	No, but fills up ≥85%	8:53	LOW	8
Stations that are located outside the MPO region and were not included in the CMS survey:						
Bridgewater, Fitchburg, Kingston, Lawrence, South Attleborough, Whitman					HIGH	Not prioritized
Abington, Attleboro, Devens-Shirley, Mansfield, North Leominster					MEDIUM	Not prioritized
Ayer					LOW	Not prioritized

* Based on the CMS inventory taken in 2002, except for Natick (1997) and Salem (2000).

1. In mid-2003, the MBTA initiated a design study phase for a new parking garage at the existing Salem Commuter Rail Station.

peak-period train. The Franklin lot, which is also rated "high" in the PMT but which fills up later in the day, is next in priority, followed by Beverly Depot, Forge Park, Quincy Adams, and Woodland, with "high" PMT ratings and utilization reaching at least 85 percent of capacity.

9.4.3 Recommendations for MassHighway Park-and-Ride Lots

According to the recent status and recommendations report on MassHighway park-and-ride lots,[33] all five lots located in the Boston MPO region would benefit from having a standard MassHighway park-and-ride sign posted at the lot entrance. The informational sign should indicate available services and restrictions. In addition, trailblazing signs should be erected in the vicinity of each lot, in order to lead motorists to the lot. The study also made the following lot-specific recommendations:

- Canton: The lot needs to be cleaned regularly. Longer hours (after 8:00 PM) may also encourage usage. Permanent MBTA bus stops should be located near the lot entrance and across Route 138 from the lot, and bus stop signs posted at both locations. This will allow access to Mattapan Square and Red Line stations. A bus stop location on the other side of Route 138 will require a small clearing, and a bus shelter is recommended.
- Framingham: A pay phone is recommended. The lot's hours of operations need to be extended in the evening.
- Pembroke: Vegetation needs to be cut back and the area cleaned on a regular basis. Overhead lighting is also recommended. In addition, attracting a private bus carrier to serve this lot could increase its use, since it is accessible to Route 3; a bus shelter at the Riverside/Old Church intersection will be necessary if a private carrier is found.
- Rockland: Safety was once a problem, and it will be necessary for the State Police to maintain their patrols. A fence around the site might also help with safety.

(Note: The study's recommendations for the Milton lot are no longer applicable.)

The *MassHighway Park-and-Ride Lots: Status and Recommendations* report also includes the following general recommendations:

- Increase the attractiveness and use of MassHighway park-and-ride lots and promote ridesharing by considering new lot locations, lot expansion, additional transit services, and improvement of lot maintenance and amenities.

[33] Alicia P. Wilson et al., *MassHighway Park-and-Ride Lots: Status and Recommendations*, produced by the Central Transportation Planning Staff for the Boston MPO and the Massachusetts Highway Department, June 2003.

9.5 HIGH-OCCUPANCY-VEHICLE (HOV) LANES

9.5.1 Summary of Findings

- The reversible HOV lane on I-93/Southeast Expressway carries daily an average of 8,700 vehicles and an estimated 33,660 persons. These numbers remained stable between 2001 and 2003.[34] (No figures are available for the I-93 North HOV lane.)
- Based on vehicle occupancy counts from an October 30, 2003, survey by CTPS, 21,142 vehicles traveled northbound on the four general-purpose lanes of I-93/Southeast Expressway between 6:00 AM and 10:00 AM, corresponding to an estimated 23,406 occupants—a ratio of 1.11 occupants per vehicle. That same morning, 4,193 vehicles traveled on the HOV lane, a volume that carried approximately 12,451 occupants—a ratio of 2.97 occupants per vehicle.
- The change of the occupancy rule for the I-93/Southeast Expressway HOV lane from 3+ to 2+ occupants in June of 1999 resulted in a 150 percent increase in total daily HOV traffic, based on MassHighway counts.
- Using spring and fall travel-time observations, each vehicle in the I-93 HOV lane into Boston from the north saved an average of 6.5 minutes over the use of the general-purpose lanes in 2003.[35]
- The I-93/Southeast Expressway HOV lane into Boston saved drivers an average of nearly 6 minutes over the use of the general-purpose lanes in the morning (based on spring and fall 2003 monitoring). In the evening, heading southbound, the HOV lane provided an average travel-time savings of 4.75 minutes over the general-purpose lanes.

9.5.2 Recommendations

9.5.2.1 HOV Lane System Plan

As expansion of the region's expressway system capacity is becoming infeasible and undesirable, building HOV lanes in order to increase the system's person-carrying capacity may be the strategy of the future. This is one strategy that promotes more operational (transportation system management or TSM) and travel demand management (TDM) types of improvements in the region. To this end, it is recommended that the Boston Region MPO develop a plan for the region's future HOV system.

An initial phase of plan development could be conceptual, where broad, rule-of-thumb criteria could be used to develop some initial alternatives. These alternatives would include a plan for extending the HOV lane network further from the existing HOV lanes on I-93 North and I-93/Southeast Expressway. In later phases, the plan may be refined and expanded using modeling tools and cost/ benefit parameters to identify suitable HOV system designs and set priorities.

9.5.2.2 HOV Lane Connections

Examine the feasibility of constructing an HOV-lane connection between the I-93/Southeast Expressway HOV lane's northern terminus and the proposed HOV lane between Southampton Street and Kneeland Street (planned for construction as part of the Central Artery/Tunnel project).

[34] HOV lane traffic counts provided by MassHighway. Vehicle occupancy counts conducted by CTPS.

[35] Travel time observations collected by CTPS for MassHighway.

9.6 TRAVEL DEMAND MANAGEMENT (TDM) AND RIDESHARING PROGRAMS

9.6.1 Summary of Findings

9.6.1.1 Ridematching

Mass*RIDES* has increased the size of the statewide ridematching database to approximately 3,000 commuters, during the first nine months of operation in 2004.[36] This is an increase over CARAVAN's statewide ridematching database, which averaged about 1,300 to 1,500 commuters each year.

CARAVAN reported that in 2002, 82 percent of commuters who requested ridematching assistance received information on at least one alternative to driving alone. Furthermore, 33 percent of commuters seeking ridematching assistance from CARAVAN either switched from driving alone or began a new commute using a shared-ride mode. The mode shift percentage fluctuated a few percentage points from year to year, but regularly exceeded the national average of about 25 percent. Commuters who switched from driving alone or who began a new commute chose the following travel options: bus (37 percent), commuter rail (26 percent), carpool (19 percent), subway (9 percent), and vanpool (9 percent).

9.6.1.2 Ridesharing: Vanpools

Currently, 40 vans originate in or are destined to urban and suburban locations in the Boston region, with an average daily round-trip mileage of 113 miles. Significant markets include commuters traveling from Cape Cod, southern New Hampshire, Worcester, and areas west of Worcester.

9.6.1.3 Ridesharing: Park-and-Ride Lots

Use of the five MassHighway park-and-ride lots in the region is not high. Only the lot in Milton was observed to fill to capacity. (Please refer to Chapter 5 and Section 9.4.3.)

9.6.1.4 Suburban Transit: Shuttle Services

Shuttle ridership on four different suburban transit shuttles is reported in CTPS's *Suburban Transit Opportunities Study*.[37] The results are as follows:

- The two Alewife Shuttles of the Route 128 Business Council TMA carried an average of 326 passengers a day during the first six months of 2003.
- Burlington "B" Line ridership averaged 250 to 275 boardings per day, between 1995 and 2000.
- The Town of Framingham's LIFT service's Route 7, which is promoted by the Metrowest/ 495 TMA, averaged 201 passengers per day in fiscal year 2003.
- The two lines of the Natick Neighborhood Bus handled an average of 118 boardings a day, based on October 2002 numbers. The routes were reorganized in late 2003.

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[36] Since January 2004, URS Corporation has been under contract with MassHighway to manage its statewide commuter travel options program, called Mass*RIDES*. The program was previously called CARAVAN.

[37] Steven D. Santa Maria, *Suburban Transit Opportunities Study,* CTPS, 2004.

9.6.2 Recommendations

9.6.2.1 Support Commuter Ridesharing and Related TDM Services

Statewide Commuter Services Program

Continue MassHighway's statewide commuter services program (currently operated by Mass*RIDES*) and seek ways to promote and influence TDM choices at the level of individual employers.

Park-and-Ride Lots

Increase the attractiveness and use of MassHighway park-and-ride lots and promote ridesharing, by implementing the recommendations made in the *MassHighway Park-and-Ride Lots: Status and Recommendations* report. These include considering new lot locations, expanding lots, adding transit services, and improving lot maintenance and amenities.

TDM Options as Enforceable Mitigation of Development

Coordinate the efforts of MassHighway, the Executive Office of Transportation, the MBTA, the Massachusetts Environmental Policy Act Office, and Mass*RIDES* to ensure that TDM options become an integral part of enforceable mitigation of development.

Identify Status of Flex-time Employment, Telecommuting Employment, and Other TDM Programs in the Region

The purpose of this recommendation is to compile information on existing TDM-related efforts in order to document the "state-of-practice" in the region. The results of this study could be used as a guide for future funding of TDM programs that work. Also, this task should be defined to complement other efforts in the region.

9.6.2.2 Study Suburban Transit Opportunities for Subregions

A study on this subject was successfully completed recently by CTPS for the North Suburban Planning Council, and a follow-up study is currently underway. It is recommended that similar studies be performed for the other subregions of the MPO region.

9.7 BICYCLE AND PEDESTRIAN FACILITIES

9.7.1 Summary of Findings

9.7.1.1 Pedestrian and Bicycle Access to MBTA Stations

- Most stations appear to have sufficient crosswalks in the immediate vicinity. However, there are some stations without marked street crossings, including Capen Street, Valley Road, Butler Street, and Cedar Grove on the Mattapan High Speed Line, and Shawmut on the Red Line.
- Walking is the mode used for approximately half of all trips to MBTA rapid transit stations: 56 percent of trips to the Red Line, 43 percent of trips to the Blue Line, and 47 percent of trips to the Orange Line.[38]
- Approximately 54 percent of the population within the MPO region is within walking distance of transit service.[39]
- Thirty-six of the commuter rail system's stations do not have bicycle racks. Reconnaissance survey results indicated that there are bicycles chained to other fixtures at or near the following stations: Gloucester, Beverly, Swampscott, Melrose Heights, Canton Junction, Dedham Corporate Center, Endicott, and Natick. This may indicate potential (additional) bicycle demand at these stations. However, a more detailed field reconnaissance and a passenger survey would have to be conducted to determine potential demand.
- Seventeen rapid transit stations do not have bicycle racks.
- Most light rail stations do not have space for bicycle parking facilities.
- Stations with the most bicycle-parking capacity include Alewife, Davis, Malden Center, Quincy Adams, and Kendall. The bicycle racks at most of these stations are well utilized.
- Stations with 75 percent or more bicycle rack utilization include Davis, Porter, Harvard, Central, Kendall, Wollaston, Oak Grove, Malden Center, Sullivan Square, and Maverick.

9.7.1.2 The Suitability of CMS Roadways for Bicycling

The majority of roads that were evaluated for bicycling suitability (the CMS arterial roadway network) are predicted to be poor for bicycling. Overall, only about 250 of the 1,800 CMS arterial roadway network miles (directional) are rated "medium" or "best" for bicycling suitability.[40] In other words, about 14 percent of the CMS arterial roadway network has a favorable suitability rating. However, this evaluation is for only about 8 percent of the entire roadway network in the MPO region, since the CMS network primarily consists of arterial roadways of functional class 4 and higher. Even though these major arterials are the most heavily used roads in our region, local and collector roadways—which typically have lower volumes, slower travel speeds, and few, if any, truck traffic—were not evaluated for bicycle suitability. The majority of these roads likely would receive a favorable bicycle suitability rating.

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[38] Central Transportation Planning Staff, *MBTA Systemwide Passenger Survey: Rapid Transit/Light Rail 1994*, produced for the Massachusetts Bay Transportation Authority, July 1996.

[39] Walking distance to transit (used to identify the potential transit market area) is defined as the distance of ¾ mile or less from a rail station and ½ mile or less from a bus stop. Population is based on 2000 census.

[40] CMS data collection and analysis, Table 7.5.

Bicycle suitability was determined based on the following roadway characteristics: travel speeds (collected for the CMS), traffic volumes, median width, terrain, and truck route designation (as an indication of the presence of heavy vehicles).

9.7.1.3 The Off-Street Bicycle (and Shared-Path) Network

The major facilities in the existing network of off-street bicycle (shared- or multi-use) paths in the MPO region are the Minuteman Commuter Bikeway, the Dr. Paul Dudley White Bike Path, and the Southwest Corridor Trail. Other significant off-street, paved trails in the region include the Charles River Greenway, Mystic River Bicycle Path, Marblehead Rail Trail, Battle Road Trail, Neponset River Trail, Muddy River Path, Jamaica Pond Path, Linear Park, Somerville Community Path, and East Boston Greenway.

Nearly 19 miles of new bike paths have been constructed in the Boston region since 1992, beginning with the opening of the 11-mile Minuteman Commuter Bikeway. The off-street bicycle network was not evaluated as part of the CMS effort.

9.7.2 Recommendations

9.7.2.1 Bicycle Parking at Transit Stations

The MBTA recognizes that providing bicycle parking facilities—and keeping them in state of good repair—attracts riders to access the transit stations by bicycle, and thus may contribute to increased ridership. This sentiment is noted in the PMT, which includes a project that would provide new or improved bicycle parking facilities at commuter rail and rapid transit stations.[41]

9.7.2.2 Bicycle Transportation Plan

Funding and construction/implementation of projects related to a particular strategy should be developed in the context of a comprehensive transportation plan. Regional plans serve the purpose of guiding future studies and prioritizing projects for implementation through the TIP process. A bicycle transportation plan would emphasize the connectivity between bicycle trails and on-street bicycle facilities for the purpose of providing seamless bicycle transportation across the region. Such a plan would guide future funding of new and improved bike paths and routes.

Efforts to create a bicycle transportation plan are underway, and the continuation of these is recommended. As part of "Alternative Mode Planning and Coordination" activities listed in the FY 2005 UPWP, MAPC is updating the *MAPC Regional Bicycle & Pedestrian Plan* (1997).[42] The UPWP notes that effort will be directed toward proposing creative solutions for connectivity, identifying regional priorities, and creating a long-range plan for improving metropolitan Boston's bicycle and pedestrian facilities.

Presently, MAPC's bicycle planning efforts are largely focused on identifying roadways that may be suitable for on-road bicycle facilities and specifying possible treatments so these roads may provide better bicycle accommodation. The proposed bicycle plan update will include a review of existing conditions and proposed modifications to the regional bicycle and pedestrian systems.

[41] *Program for Mass Transportation,* prepared by the Central Transportation Planning Staff for the Massachusetts Bay Transportation Authority, May 2003, p. 5B-39.

[42] FY 2005 *Unified Planning Work Program (UPWP)* for the Boston Region MPO, p. 8-3.

9.7.2.3 Bicycle and Pedestrian Planning: Studies and Programs

Also recommended are three programs (and their supporting studies) related to bicycle and pedestrian transportation planning in the Boston metropolitan region. Essentially, the programs would consist of implementation of a strategy through a continuous study of problems, recommendation of solutions, and implementation of the solutions through the use of TIP funding. In this fashion, the programs would be a targeted approach to conducting both the expansion and the maintenance and repair of the system. The recommended programs are:

Pedestrian and Bicyclist Access to Transit Stations

Convenient and safe access to transit is a very important determinant of transit use. This proposed study (and/or program) would follow up and expand upon the existing pilot study *Improving Pedestrian and Bicyclist Access to Selected Transit Stations*.[43] Such a study should identify the transit and commuter rail stations that need improved pedestrian and bicyclist access and identify appropriate improvements. It should assess access/egress roadway elements for the accommodation of pedestrians and bicycles, including sidewalk design and condition, wheelchair ramps, crosswalks, lighting, signs, and pedestrian phases in traffic signals.

Bicycle Parking at Activity Centers

A bicycle parking program could be a stand-alone program or be combined with other efforts. Tasks could include bike counts, inventory of racks, identification of issues that stand in the way of additional bicycle use to the activity center, and identification of funding. Activity centers can include town, civic, transportation, and shopping centers. The details of the program, including its goals, would be established during the work scope development.

Pedestrian Corridor Improvement

This program could systematically identify and correct discontinuities that pedestrians encounter in their travel to and from an activity center. Discontinuities occur in the form of insufficient sidewalks and unsafe crossing locations. Connections to study could be between, to, or through parks, neighborhoods, transit facilities, employment centers, and shopping centers.

[43] Lourenço Dantas, *Improving Pedestrian and Bicyclist Access to Selected Transit Stations* (draft), a report produced by CTPS for the Executive Office of Transportation's Office of Transportation Planning (formerly Massachusetts Highway Department's BTP&D) and the Massachusetts Bay Transportation Authority, 2004. The study focused on recommendations to improve access for pedestrians and bicyclists to six transit stations, and could be used as a model for future studies.

9.8 RECOMMENDATIONS FOR OTHER CONGESTION-REDUCING STRATEGIES AND PROGRAMS

This section presents additional CMS recommendations that consist of congestion-reduction and mobility-enhancing strategies for entities in this region to undertake in concert with other efforts they are already making. These strategies are related to travel demand management (TDM) and land use management. Some TDM recommendations have already been made in Section 9.6.2. Like TDM, land use management is a key factor in relieving the growth in congestion and improving mobility.

9.8.1.1 Travel Demand Management (Also see Section 9.6.2)

Study the Implementation of Distance-Based Fees for Vehicle Registration and Insurance

This research study would examine the feasibility of charging vehicle registration and insurance fees based on distance driven. Presently, fees are based largely on place of residence. For this type of study, coordination with the insurance industry, the Registry of Motor Vehicles, and possibly the American Automobile Association would be required.

Examine Conditions under Which Parking Charges and Removal of Parking Subsidy Are Feasible to Reduce Single-Occupant-Vehicle (SOV) Impacts

Free or subsidized parking, which promotes the use of SOVs, is widely available in the less densely developed parts of the region. However, there are exceptions, such as parking charges in the garages of shopping centers that are seeking to recover building costs. A study could determine under what conditions this strategy can be applied at other developments. The study could also identify what incentives and other types of regulatory control would be required to implement such a program.

9.8.1.2 Land Use Management

Promote Zoning that Encourages Mixed-Use Development and Higher Development Densities

Rezoning is an effective mechanism for achieving higher densities and supporting mixed-use and transit-oriented development.[44]

Promote Development Plan Reviews by Cities and Towns

Presently, many municipalities in the region lack the regulatory processes for exercising control over impact mitigation during development reviews. Cities and towns should be encouraged to adopt such planning regulations, so that they will be empowered to ensure that developers implement specified mitigation measures. This capability is key to a community's developing in a considered and responsible manner.

Encourage Cities and Towns to Develop Greenfield and Brownfield Sites (Infill and Redevelopment)

These sites tend to be in the proximity of developed areas and near roadway or transit infrastructure. The premise is that, when redeveloped with good urban design, minor to moderate

[44] The land use component of the current TIP project-selection criteria considers the average residential and employment density within a project’s corridor. Also examined are the zoning, development, and parking regulations in the project area.

roadway modifications, and additions to the existing infrastructure, growth at these sites will promote walking and transit use.[45]

Inventory "Smart Growth" Best Practices and Their Application in Eastern Massachusetts

This empirical research study could consist of a literature search on best practices applied by local, regional, and state authorities to implement comprehensive land use and transportation policies. This white paper would examine the legal and regulatory support needed to effect such polices and would assess their applicability in the MPO region and elsewhere in Massachusetts. Research results would be shared with cities and towns as they update their zoning ordinances or plan new development.

[45] The land use component of the current TIP project-selection criteria considers the amount of developable land within a project's corridor.