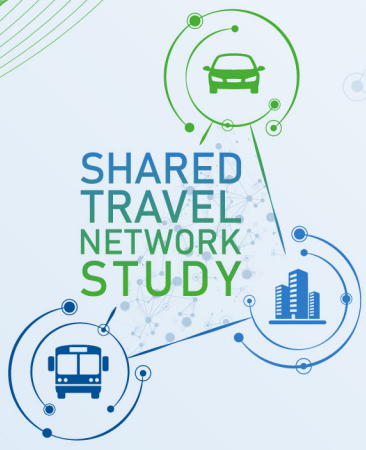
April 2022

SHARED TRAVEL NETWORK STUDY

APPENDICES



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APPENDICES

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A GLOSSARY

Automated Vehicle Location (AVL) system | A system capable of collecting and transmitting the location of a vehicle, most often through the use of global positioning system (GPS) satellites.

Freeway Bus on Shoulder (FBOS) | Operation of buses on highway shoulders, whether permanent or only during peak periods, allowing the transit vehicles to bypass roadway congestion and travel at near free-flow speeds. MassDOT currently allows part-time (peak period) use of the shoulder for all vehicles on sections of I-93 and formerly did so on I-95 to manage peak demand.

Bus Rapid Transit (BRT) | High-quality bus service characterized by bus-only lanes and enhanced station and fare infrastructure that are designed to streamline processes. There are two distinct types of BRT: a "direct service" model and a "trunk and feeder" model. The former focuses on providing rapid transit-level station amenities, signal priority, and dedicated lanes on a point-to-point basis to serve a market or improve service on an existing line. The latter improves a core segment of road or transitway to be shared by many overlapping services for part of their length.

Connected Device | An electronic device – in the case of this report, generally a cellular phone – that can communicate with other systems via the internet.

Central Transportation Planning Staff (CTPS) | The staff to the Boston Region Metropolitan Planning Organization.

Census Transportation Planning Package (CTPP) | A State DOT-funded, cooperative program that produces special tabulations of American Community Survey (ACS) data collected by the US Census that have enhanced value for transportation planning, analysis, and strategic direction.

Device-Miles Traveled (DMT) | Computed from StreetLight data, it is the product of trips and average trip mileage. As more than one device could be in a single-vehicle, it is more akin to person-miles traveled (PMT) than vehicle-miles traveled (VMT).

Demand-Responsive Transportation (DRT) | Any form of transport where day-to-day service provision is influenced by the demand of the users. The term covers wide range of vehicular transport solutions, from traditional "dial-a-ride" services to new transport services that allow journeys to be booked through a mobile application.

Driveshed | Similar to a walkshed, describes an area within a defined driving distance of a specified location. In the context of this report, is used to describe areas in which someone driving a longer distance might be diverted to park at an anchor location and switch to a shared travel mode.

Federal Highway Administration (FHWA) | A division of the United States Department of Transportation (U.S. DOT) that specializes in highway transportation.

Geospatial Information Services (GIS) | Data that is associated with a geographic location on a coordinate system, allowing it to be mapped. GIS tools map the data. GIS datasets can include shapes to be drawn on the map, including lines and polygons.

Global Positioning System (GPS) | A network of satellites that allows connected devices to precisely know and report their coordinates. While devices such as smartphones may use several methods to ascertain their location (e.g., triangulation from cellular towers), the concept of location services for mobile devices is colloquially referred to as “GPS”.

High-Frequency Transit | Frequency refers to how often transit vehicles arrive at transit stops. A bus that arrives every 10 minutes is considered high frequency; one that arrives every 30 minutes is not.

High Occupancy Toll (HOT) lane | A congestion management strategy in which vehicles not meeting established occupancy requirements for an HOV lane to "buy-into" the lane by paying a toll.

Highway Occupancy Vehicle (HOV) lane | A preferential lane designated for exclusive use by vehicles with two or more occupants for all or part of a day.

Home-Based Work (HBW) | This study primarily focuses on morning peak period travel, when travel is predominately home-based work (HBW)

Integrated Network | In a transportation context, the degree of integration reflects the ease of transition between modes or through transfers over the course of a trip.

In-Vehicle Travel Time (IVTT) | In this report, this metric identified by first identifying the origin and destination for each shared travel market, and routing that route by highway.

Location-Based Services (LBS) Data | In this context, location data collected from users’ connected devices. LBS data for this study are provided by StreetLight.

Managed Lanes | Defined by the FHWA as highway facilities or a set of lanes where operational strategies are proactively implemented and managed in response to changing conditions.

Motor Coach Bus | Motor Coach buses are designed to travel longer distances and as such offer some distinct features compared to typical transit buses. Motor Coach buses generally feature larger, padded seats, bathroom facilities, and both overhead and under bus storage.

Network Effect | A phenomenon by which the value or utility a good or service increases with the number of system users.

Park-and-Ride Lot | A parking lot that does not serve any adjacent use but rather exists as an assembly point for shared travel services, including buses and carpools. Park-and-Ride lots may be equipped with amenities for waiting users, such as rain shelters or trash receptacles.

Pulse Timetables | Timetables designed to connect riders of fixed public transport routes at convenient transfer points. A pulse network contrasts with demand-responsive services in emphasizing permanence, reliability, and simplicity through a single, stable network.

Public-Private Partnership | A cooperative relationship between one or more government and private sector partner.

Regional Transit Authorities (RTAs) | Massachusetts’ 15 RTAs serve urban, suburban, and some rural areas across the Commonwealth, from the Berkshires to the Islands. RTAs serve areas not served by the MBTA. The Greater Boston study area is served by the MBTA and seven regional RTAs: Brockton Area Transit Authority

(BAT); Cape Ann Transit Authority (CATA); Greater Attleboro Taunton Regional Transit Authority (GATRA); Lowell Regional Transit Authority (LRTA); Merrimack Valley Regional Transit Authority (MVRTA); MetroWest Regional Transit Authority (MWRTA); and Montachusett Regional Transit Authority (MART).

Service Area | The geography covered by a transit service. In Massachusetts, transit agencies each have a service area of municipalities to which they are statutorily required to provide service.

Shared Travel | Any mode of travel for which members of more than one household share a vehicle. This includes all forms of transit, demand-responsive transportation, and carpooling, but does not include a single household all in one car.

Single-Occupancy Vehicle (SOV) | Refers both to the vehicle (a car with only one person in it) and the mode of travel, which in industry is also called “drive alone”.

Surface Transportation | Transportation modes including road, train, or ship. Air travel is not considered surface transportation.

Transit Management Associations (TMA) | Partnerships among employers to provide shared travel services for commuters and customers.

Transit Priority Treatments | Interventions designed to allow transit vehicles to bypass traffic, thereby reducing travel time delay for these vehicles. Examples include transit signal priority (TSP) and bus-only lanes.

Transit-Oriented Development (TOD) | A pattern of urban development designed to concentrate residential, commercial, and other types of space around transit nodes. TOD is designed to promote dense urban centers and encourage transit use.

Transportation System Management and Operations (TSMO) | A set of strategies that maintain and improve the performance of the existing transportation system without adding roadway capacity. They may include work zone and event management, incident response, demand management for travel and freight, traffic signal coordination, ramp management, traveler information, and improved pedestrian and bicycle facilities.

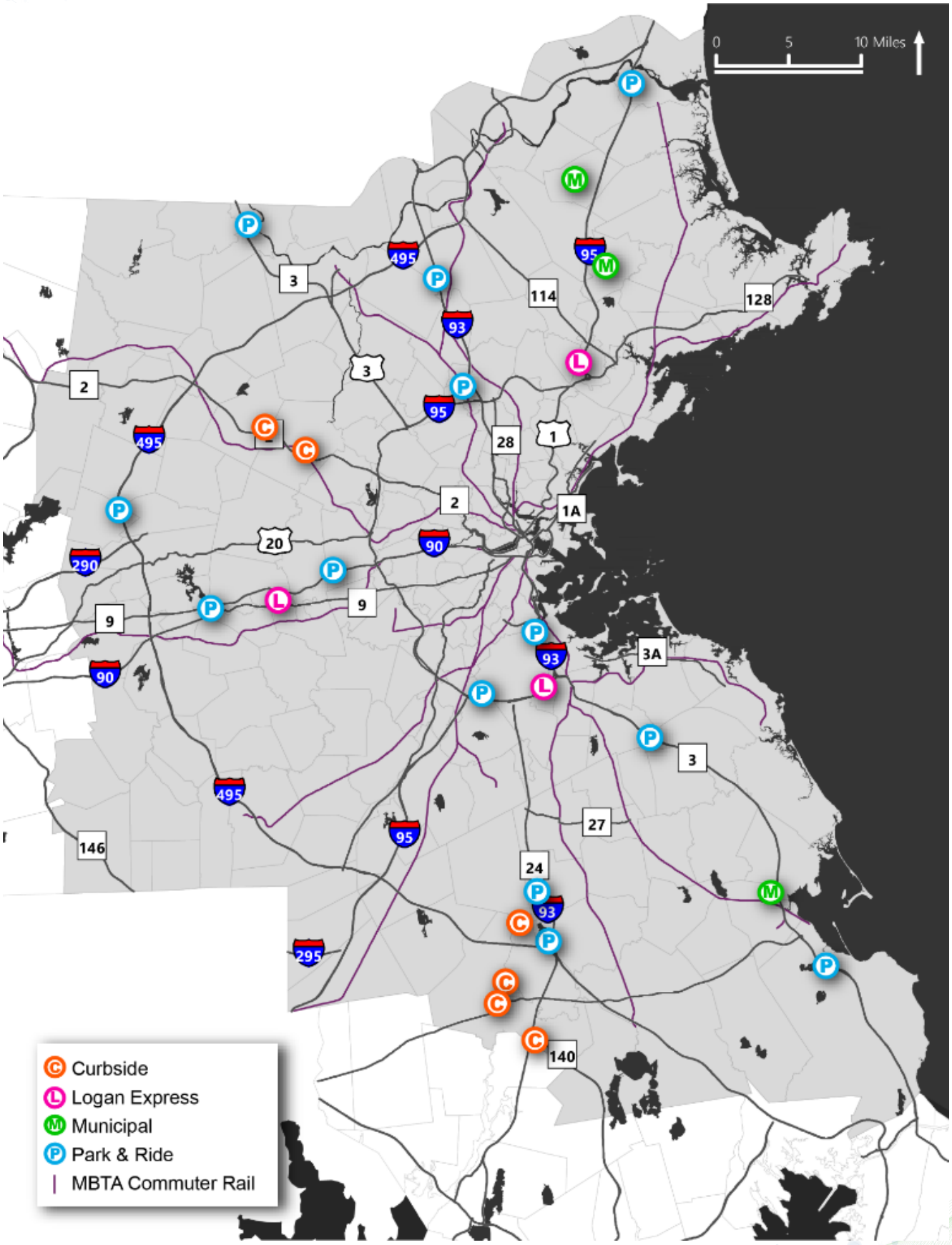
B ANALYSIS AND INVENTORY OF MASSDOT PARK-AND-RIDE LOTS IN GREATER BOSTON

Park-and-Ride Lots: An Overview

MassDOT owns and maintains more than a dozen Park-and-Ride lots in eastern Massachusetts. These lots, shown in Figure 1 below, vary in size from small (a couple of dozen parking spaces, such as the West Tewksbury Park-and-Ride) to very large (hundreds of parking spaces, such as the Andover Park-and-Ride). The intent of owning and maintaining these lots is to provide a service to residents and visitors to the Commonwealth to park a vehicle and connect with regional transit, meet up with others for a carpool, or in some instances to access recreational trails on foot or bicycle.

Most of the Park-and-Ride lots are paved and striped for parking, have directional signage from the regional roadway network, and have some illumination. But that is where commonalities end. Some lots are served by transit, but others are not. Some lots have shelters, but others do not. Some lots connect to local attractions via sidewalk, but many do not. One theme across lots is that they are fairly well utilized, but without much understanding of how they are used. The Shared Network Study explored amenities available and utilization at 13 MassDOT-owned Park-and-Ride facilities, to ask the questions of: how are these facilities being used today? What opportunities exist for future improvements to these facilities? If underutilized, what are some reasons why lots are not better used?

FIGURE 1 | PARK-AND-RIDE LOTS OWNED BY MASSDOT IN THE STUDY AREA



The Shared Network Study inventoried all the Park-and-Ride lots in eastern MA, from Newburyport to the north to Plymouth to the south. The inventory tabulated the following:

- Pavement condition
- Cost of parking
- Number of parking spaces (total, accessible)
- Hours of operation
- Lighting
- Amenities (shelter, benches, trash receptacles)
- Connections to transit
- Connections to local attractors
- Bike and pedestrian network

The Park-and-Ride lots are typically available 24/7, parking is free, and lots are easily accessible by car. In most cases, accessing the Park-and-Ride lots through walking or riding a bike is more challenging due to a lack of pedestrian and bicycle infrastructure and environments that are more oriented to automobile travel.

The thirteen Park-and-Ride lots vary with regard to their condition and amenities. One lot has 45 spaces and minimal amenities and another has over 600 spaces and seating, bike parking, and a small building. While there are lots are in good condition, others are in need of additional investment such as repaving and striping. At lots such as Tyngsborough, there may be insufficient capacity while at Newburyport there is less demand for the space available. Eight of the thirteen Park-and-Ride lots are served by some level of transit service and five are not. The transit service ranges from traditional bus service, to private commuter bus services, to on-demand bus services.

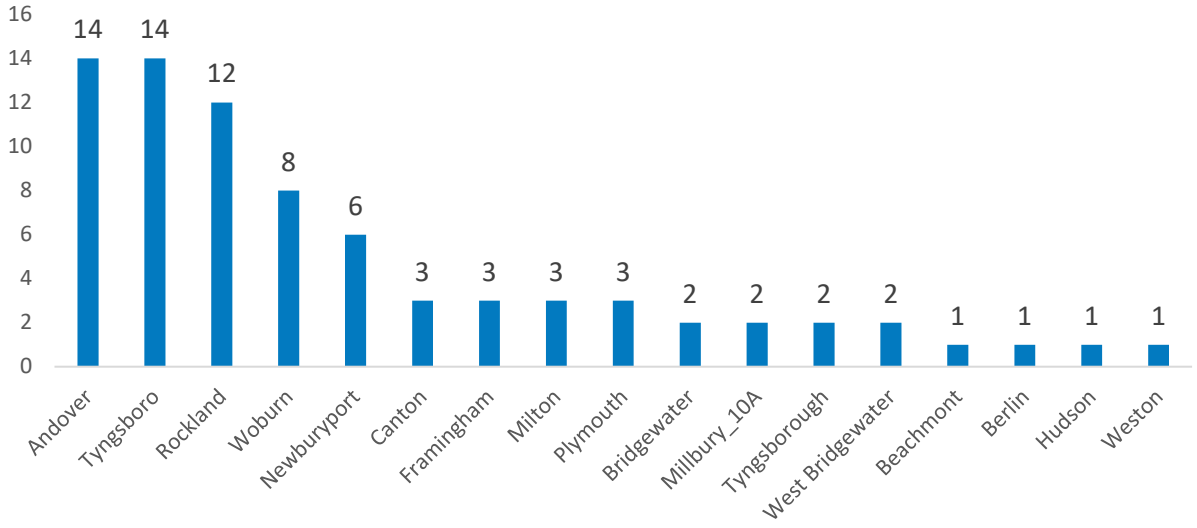
FIGURE 2 | PARK-AND-RIDE SURVEY FLYER

Park-and-Ride Usage Survey

The inventory effort was helpful to better understand the Park-and-Ride assets, but it left the team wondering about how the lots were being used. Site visits and review of aerial images show that some Park-and-Ride lots are well utilized though they are not served by transit. Lots are available to the public, and MassDOT sought to better understand how the lots were being used by issuing an online survey in November 2021. Lot users were made aware of the survey through fliers (example in Figure 2) placed on vehicle windshields and printed signs along the lot perimeter, both of which carried a QR code and URL to access the survey. MassDOT staff and members of the Shared Travel Network team visited the Park-and-Ride lots throughout November to distribute fliers and observe the lots. The following are some main findings.

People use the Park-and-Ride lots for multiple reasons and in multiple ways. A total of 78 people completed the survey. A majority (54%) of survey respondents used the Park-and-Ride lots for carpooling, though a substantial percentage (35%) reported using the lot to connect to transit. Many (53%) respondents use the lots every day. About half of survey respondents use the Park-and-Ride lot for the length of a workday. Other people use the Park-and-Rides on occasion or overnight (NOTE: overnight usage is not currently allowed at MassDOT-owned Park-and-Ride lots.) The distribution of responses by location is shown in Figure 3.

FIGURE 3 | DISTRIBUTION OF PARK-AND-RIDE SURVEY RESPONSES BY LOT



The most common destination for lot users is Boston (60% of survey respondents, with another 29% listing Logan Airport, which is also located in Boston). Other destinations listed were Cape Cod (3%), New Hampshire (3%), and western MA (5%). The majority of lot users connecting to transit were destined to Logan Airport.

In addition to learning how people are currently using MassDOT-owned Park-and-Ride lots the survey asked for opinions and ideas. Some major themes from survey respondents include:

1. **If bus service is provided, people will take it.** Especially if the bus goes to Logan or downtown Boston – there are people who see this as a more convenient alternative to driving or passenger rail options. This is true for Boston Express service to Logan and Downtown Boston from Tyngsboro; MBTA route 354 service from Woburn; or P&B service from Plymouth. The old adage, “if you offer it, people will use it” seems to apply. Bus service is also tied to maintenance of the lot – regarding the departure of C&J from the Newburyport Park-and-Ride, one respondent commented “Super bummed the bus no longer runs here. The lot is looking neglected. Seems to have lots of potential.”

2. **Many PNR users rely on the lots as part of their daily routine, even if it is not travel-related**. Out of 78 valid responses, 53% of survey respondents indicated that they use the lots every day. Of those that indicate daily PNR use, 10 out of 41 respondents are connecting to bus service, while 29 are meeting others to carpool. Of the survey respondents using the lots for daily use, 8 refer to Andover, 8 refer to Tyngsboro, 7 refer to Woburn, 5 refer to Rockland, and 4 refer to Newburyport (others include Framingham, Milton, West Bridgewater, Berlin, and Canton). However, not all daily users are ‘parking and riding’ – many respondents citing the Canton lot indicate they use the lot for Blue Hills hiking purposes and one respondent indicated that the Weston Park-and-Ride is also used for ‘overfill parking from 680 South Avenue condo townhomes.’

3. **Most respondents indicated they park during the workday, but others leave their vehicles overnight or long-term, despite the lots being unmonitored and unsecured**. Although MassDOT lots are technically closed to the public from dusk until dawn and the degree of lighting varies between them, many drivers who avail themselves of these facilities are comfortable parking and riding for extended periods of time.

Those distributing flyers observed that lots were used by people on lunch breaks, for meeting up with friends, by TNC drivers between rides, and at times there appeared to be people living out of their cars parked in some lots.

Highly Used Lots

Among the more highly-used lots in this analysis include Andover, Tyngsborough, West Bridgewater, and Woburn. These lots vary in size and are all served in some way by a transportation service provider. Andover, Tyngsborough, and West Bridgewater all have formal waiting areas and amenities: lighting, shelter, seating, and bike racks. Woburn stands out as a smaller lot and does not have these amenities, however, there is lighting and walk access to restaurants, retail, and job sites.

Least Used Lots

FIGURE 4 | BRIDGEWATER PARK-AND-RIDE

Newburyport, Weston, and Bridgewater (pictured in Figure 4) are less-used Park-and-Ride lots. None of these lots are served by a transportation service provider. Newburyport Park-and-Ride is a large lot with over 600 parking spaces and amenities such as lighting, a small building, seating, and bike parking. C&J formerly served the Newburyport Park-and-Ride, and its move to Portsmouth has directly resulted in the lot's underutilization. The lot connects directly to the William Lloyd Garrison Trail at its north end and several lot users park their vehicles in the Park-and-Ride lot and picnic at the tables and benches at the trailhead, and walk or bicycle along this trail, which extends north, in I-95 ROW, to Salisbury.

The Weston and Bridgewater Park-and-Ride lots are smaller lots with poor access to the regional roadway network, no obvious commuter purpose, and with limited amenities. Both of these lots have less visibility. The Bridgewater Park-and-Ride lot features signage warning drivers to not leave valuables in their car unattended.

Potential Park-and-Ride Lot Improvements

This section presents several potential recommendations for how to improve the utility of the MassDOT-owned Park-and-Ride lots. These recommendations stem specifically from the Park-and-Ride inventory and survey, and include restriping at several lots, improved lighting to improve a sense of safety/security, construction of consistent pedestrian infrastructure improvements around the lots, provision of bicycle parking at the lots, lot-specific improvements suggested by survey respondents, and some non-carpooling use cases for Park-and-Ride lots, including truck parking for lots adjacent to major freight routes.

Collectively, these improvements intend to be a cost-effective way to enhance the user experience in Park-and-Ride facilities. This section will also discuss the need to formalize management of lots where MassDOT has partners (e.g., DCR in Canton).

General Recommendations

From the Park-and-Ride inventory and user survey work the Shared Travel Network team observed that many MassDOT-owned Park-and-Ride lots are well used, as a means of accessing regional transit, as a means of meeting with others to carpool, and as a means of accessing nearby recreational facilities. In addition, Park-and-Ride lots serve as a resting point for travelers who might not have another easy option to stop and eat lunch, or rest between trips. All of these items are valid uses for a Park-and-Ride lot, and yet inconsistencies between lot maintenance and illumination lead to varied perceptions of safety and comfort among patrons. The following are recommendations to improve access to, comfort at, and increase the overall utility at Park-and-Ride lots:

- **Resurface and Repave Lots:** There are Park-and-Ride lots whose pavement is not in good condition. Explore resurfacing and repaving lots to improve their condition.
  - » Examples: Bridgewater, Canton, Framingham, Tyngsborough
- **Restripe Lots:** Several Park-and-Ride lots have unclear striping, leading to an inefficient use of the space. Striping lots can help to maximize the number of vehicles that can safely park in the lots.
  - » Lots which should be re-striped include: Berlin, Bridgewater, Canton, and Woburn
- **Partner with Transit Agencies to Provide Transit Connections at More Lots:** There are Park-and-Ride lots whose pavement is not in good condition. Explore resurfacing and repaving lots to improve their condition. Coordinating services with RTAs, Logan Airport, and private carriers could induce demand for them and presents an opportunity for traffic management and congestion mitigation.
  - » Examples: Berlin, Canton, Newburyport for new transit services
  - » Examples: Andover, Framingham, Plymouth, Rockland, Tyngsborough, West Bridgewater for additional transit services
- **Improve Lighting & Visibility:** To make people feel more comfortable using Park-and-Ride lots day or night, investing in improved visibility, including lighting, in and throughout the lots is warranted at some Park-and-Ride lots.
  - » Examples: Bridgewater, Rockland (back of the lot), Berlin, Plymouth, West Bridgewater, and Woburn.
  - » A survey respondent suggested the removal of the fencing at West Bridgewater. This is to due to visibility issues for drivers on Pleasant Street turning onto Route 106 and to make activity in the lot more visible, as vegetation growing on fencing can block visibility of the lot.
- **Improve Waiting Areas:** Invest in more comfortable spaces for people to wait at the Park-and-Rides. This can mean investing in new or upgraded shelters, seating, lighting, garbage receptacles, and information services. This may help people feel more comfortable at the Park-and-Ride and encourage their use.
  - » Examples: Milton, Rockland, Tyngsborough, and West Bridgewater.

- **Showcase Great Bike & Pedestrian Access:** Many Park-and-Ride lots do not have good pedestrian and bicycle access. But some do, and this connection could be showcased. These investments would make some Park-and-Ride lots accessible to more people, and would increase the utility of the lot to users, to include recreational as well as commuting purposes. The recommendation may require support from the municipalities the Park-and-Rides are located in.

  - Examples to showcase very good connections:

    - **Woburn |** Woburn is near a bus stop at the Montvale Avenue and Hill Street intersection. Invest in additional pedestrian infrastructure at the intersection to make walking to and from the bus stop easier and more comfortable for people. Additionally, a survey respondent suggested covered and locked bike storage at the Park-and-Ride would incentivize them to ride their bike to the Park-and-Ride.

      The lot is also approximately 200' from the Tri-Community Greenway trail. This trail connects the communities of Stoneham, Woburn, and Winchester. Good parking areas close to the trail can be hard to come by and the Park-and-Ride lot's location, and its proximity to the regional roadway network, could be better advertised to the lot is used for trail users.

    - **Canton |** The Park-and-Ride lot provides access to the Blue Hills Reservation. Though locals are aware of this connection and many users of the lot are trail users, the connection is not well marked for non-users or occasional users.

    - **Newburyport |** The William Lloyd Garrison Trail is accessed through the north end of the Newburyport Park-and-Ride lot. This 1.9 mile trail just opened in 2018 and part of a network of Coastal Trails in Amesbury, Newbury, Newburyport, and Salisbury, MA. With amenities such as picnic benches, benches, wayfinding, bike racks, and trash bins at the Newburyport Park-and-Ride connection point, this trail is a great spot for family and recreational use and exercise.

    - **West Bridgewater |** This lot is located in a relatively flat and walkable area with a variety of restaurants and businesses located within ¼ mile distance from the lot.

    - **Weston |** The Weston Park-and-Ride lot is directly adjacent to the Hultman Aquaduct Path. The trail map on the Mass-Trails website lists the Park-and-Ride lot as parking for path use. This conservation property is owned by the Massachusetts Water Resources Authority and is open to the public.

- **Encourage Development of a First-/Last-Mile Program:** Encourage the development of a first-/last-mile service that beings people to and from Park-and-Rides. At Park-and-Ride locations with particularly high demand, this service may help to alleviate the need for additional space.

  - Examples where investments could be made to link Park-and-Ride lots to nearby attractions:

    - **Framingham |** an easy and obvious pedestrian connection could be made between the Park-and-Ride, which is well served by MWRTA Route 7 and the adjacent Dunkins.

    - **Plymouth |** the pedestrian connection that exists between the Park-and-Ride and the service plaza McDonalds is a good one, and this lot could be made more accessible to bicyclists and pedestrians

through some first/last mile investments to the retail and commercial developments along Long Pond Road south of Route 3.

- **Highway Variable Message Signage:** Inform the public of Park-and-Ride lots using variable message signage on adjacent highways. The signage could communicate current capacity of the lots, services at the lots, and highlight travel times by single occupancy vehicle versus the transportation options available at the Park-and-Ride.
  - » Examples: the only Park-and-Ride lots which appear to come close to being at capacity are Tyngsborough and Andover.
- **In-Lot Variable Message Signage:** A survey respondent proposed an electric sign for Plymouth so people know when to expect the next bus. MassDOT could explore with their public and private partners the installations of VMS where appropriate or other tools for keeping people informed of when to expect their bus.
- **Address High Demand for Woburn Park-and-Ride:** A survey user expressed concern about the demand for space at the Woburn Park-and-Ride. Site observations are that this lot is regularly used for construction workers to meet and carpool to job sites. Explore use of the lot to determine if it is at or over capacity and if there is a need to redesign or expand the lot to accommodate demand. Additionally, investing in bike and pedestrian infrastructure and encouraging the development of first-/last-mile services to support alternative means of reaching the Park-and-Ride may help alleviate demand.
- **Improve Sense of Safety at the Lots:** Improving lighting and visibility at Park-and-Ride lots is one way to make people more comfortable at lots because they can better see their surroundings. Other ideas to improve a sense of safety include increasing activity at the site.
  - » Examples: Canton, Framingham, Plymouth, West Bridgewater, and Woburn all have nearby restaurant and/or retail.
- **Consider Repurposing a Site:** Some Park-and-Ride lots may just not be suited to publicly-owned parking facilities, and could be repurposed for storage or another use, or sold to private property owners.
  - » Examples: Bridgewater, Berlin.

Alternative Uses for Park-and-Ride Lots

- **Truck Parking:** Park-and-Ride lots are sited adjacent to highways, many of which are freight routes. There is an opportunity to use Park-and-Ride lots for truck parking, particularly overnight. If there are well-publicized locations for large trucks to park, this may reduce conflict in other areas.
- **MassDOT Storage:** It appears MassDOT currently uses Park-and-Ride facilities for storage of their vehicles and other materials. Formally designating lots or areas in lots for MassDOT use may be appropriate as this use may discourage Park-and-Ride users from using the area.
- **Provide Parking for Businesses and Residences:** There may be an opportunity at some Park-and-Ride lots to partner with businesses, apartments, or other institutions to provide parking to people. Already, the Weston Park-and-Ride is used by people at nearby residences. The idea could encourage more activity at

Park-and-Ride lots making them more comfortable places to be. Additionally, it could be an opportunity to help fund the maintenance of the lots.

Management of Park-and-Ride Lots

MassDOT's Park-and-Ride lots are managed by the Highway Division, Office of Real Estate and Asset Development (OREAD), and Highway Districts. These organizations have specific roles for the management of the lots. Additionally, some of the lots may be operated by a separate operator through a contract. MassDOT may benefit from exploring how to keep the Park-and-Ride lots more uniform in their condition.

Park-and-Ride Lot Inventory

Andover

Address: 145 Dascomb Road, Andover, MA

The Andover Dascomb Road Park-and-Ride is located directly off I-93 in Andover. There is easy access to and from the lot and it provides a relatively direct connection with several communities including Andover, Tewksbury, Lowell, and Lawrence. The Park-and-Ride used for carpooling and transit connections. It is served by Flightline Inc[1]. which provides a bus connection to Logan International Airport[2]. There is no pedestrian or bicycle infrastructure supporting access to the lot. A summary of the lot is provided in Figure 5.

FIGURE 5 | SUMMARY FOR THE ANDOVER PARK-AND-RIDE

Curbside/Transit Service	Yes
Cost of Parking	Free
Parking Spaces	154
Accessible Parking Spaces	5
Hours	24/7
Overall Lot Condition	Good

Lighting	Yes
Bus Shelter	Yes
Benches	Yes
Trash Receptacle	Yes
Bike Rack(s)	Yes, covered

[1] Mass.gov. https://www.mass.gov/locations/andover-dascomb-road-Park-and-Ride
[2] Mass.gov. https://www.mass.gov/locations/andover-dascomb-road-Park-and-Ride

Recommendations

- The lot might benefit from improved pedestrian access Raytheon Technologies office park located off Lowell Street (directly north of Dascomb Street), which provides 4,750 jobs in Andover.
- The lot might benefit from improved pedestrian and bicycle connections to nearby neighborhoods.
- Boston Express provides curbside service to New Hampshire via I-93 and could serve this Park-and-Ride lot.
- The Park-and-Ride is within the service district of the Merrimack Valley Regional Transportation Authority (MVRTA). The MVRTA Route 75 connects Andover with the Buckley Transportation Center in Lawrence, and the Route 73 connects Andover with the Haverhill Transit Center at Washington Square. Both routes come within ¾ mile of the Dascomb Road Park-and-Ride and could provide an additional connection to the communities of Lawrence and Haverhill. MVRTA currently provides service to Downtown Boston from Andover via Route 99 that does not serve the Park-and-Ride.

Berlin

Address: 2 Central Street, Berlin, MA

The Berlin Park-and-Ride is adjacent to I-495 just north of the interchange with I-290 at Exit 67. The lot is located on MA-62 with local connections to Berlin, Clinton, and Hudson and I-290 provides a direct connection with Worcester. MA-62 in this area is a narrow rural two-lane roadway without sidewalks nor bicycle lanes. Although the topography is relatively flat and the scenery is bucolic, only the strong and confident cyclist would be comfortable accessing the Park-and-Ride, and pedestrians would be forced to use the shoulder.

Pre-pandemic photos show 50% utilization despite the lack of transit service, indicating that the lot is popular for carpooling and vanpooling.[3] A summary of the lot is provided in Figure 6.

FIGURE 6 | SUMMARY FOR THE BERLIN PARK-AND-RIDE

Curbside/Transit Service	No
Cost of Parking	Free

Lighting	Yes
Bus Shelter	No

[3] Mass.gov https://www.mass.gov/locations/berlin-Park-and-Ride

Curbside/Transit Service	No
Parking Spaces	45
Accessible Parking Spaces	0
Hours	24/7
Overall Lot Condition	Fair

Lighting	Yes
Benches	No
Trash Receptacle	No
Bike Rack(s)	No

Recommendations

- The lot may benefit from a designated space (with amenities such as benches or a trash receptacle) for people to wait for their carpool or vanpool.
- The striping is faded and could benefit from repainting.
- There are two RTAs that provide service near to the Park-and-Ride.
  - » The Worcester RTA provides transit service to the north (West Boylston) and south (Southborough) of this Park-and-Ride, providing regular service into Worcester. Future service expansions with this RTA could provide service along I-290 and/or I-495.
  - » Closer to the study area the MetroWest RTA recently expanded its service area to include service to Hudson, and specifically to the Shops at Highland Commons, which is approximately a half-mile from the Park-and-Ride. This is a weekday service connecting Hudson with Marlborough, where connections can be made to Framingham, and connections to Boston via transfer to MBTA.

Bridgewater

Address: 2011 Pleasant Street, Bridgewater, MA

Bridgewater Park-and-Ride is split between two locations along either side of Pleasant Street in Bridgewater, MA. One location is a more traditional lot that also provides access to a public boat ramp for Lake Nippenicket. The other location is off-road angle parking along Old Pleasant Street. Collectively this Park-and-Ride is located near Exit 24 of MA-24 just north of its interchange with I-495. There is incomplete pedestrian infrastructure and no bicycle infrastructure. The lot is not served by transit but may be used for people carpooling or vanpooling.[4] A summary of the lot is provided in Figure 7.

[4] Mass.gov https://www.mass.gov/locations/bridgewater-Park-and-Ride

FIGURE 7 | SUMMARY FOR THE BRIDGEWATER PARK-AND-RIDE

TABLE 3 | INVENTORY FOR THE BRIDGEWATER PARK-AND-RIDE

Curbside/Transit Service	No
Cost of Parking	Free
Parking Spaces	60
Accessible Parking Spaces	Unknown
Hours	No Overnight
Overall Lot Condition	Poor

Lighting	No
Bus Shelter	Unknown
Benches	Unknown
Trash Receptacle	No
Bike Rack(s)	No

Recommendations

- Old Pleasant Street could be converted to a more traditional parking area. The spots appear relatively well used and appear to serve as a meeting point for carpooling, for regular users. Improved wayfinding to the parking area, and the parking area itself, would make it a friendlier destination for new users. The spaces are not currently striped and Old Pleasant Street has poor pavement condition.
- Pedestrian infrastructure could be improved to the lot from Pleasant Street, including resurfacing.
- Lighting for the lot would improve the perception of safety.
- The lot may benefit from a designated space (with amenities such as benches or a trash receptacle) for people to wait for their carpool or vanpool.

Canton

Address: 2990 Washington Street, Canton, MA (2991 MA-138, Canton, MA)

The Canton Park-and-Ride is about half a mile north of I-93 Exit 2. Owned by the Department of Conservation and Recreation, it is embedded in Blue Hills State Reservation but has poor pedestrian and bicycle access. MBTA Route 716 passes the lot without stopping. A summary of the lot is provided in Figure 8.

FIGURE 8 | SUMMARY FOR THE CANTON PARK-AND-RIDE

Curbside/Transit Service	No
Cost of Parking	Free
Parking Spaces	170
Accessible Parking Spaces	0
Hours	No Overnight
Overall Lot Condition	Good

Lighting	Yes
Bus Shelter	No
Benches	No
Trash Receptacle	No
Bike Rack(s)	No

Recommendations

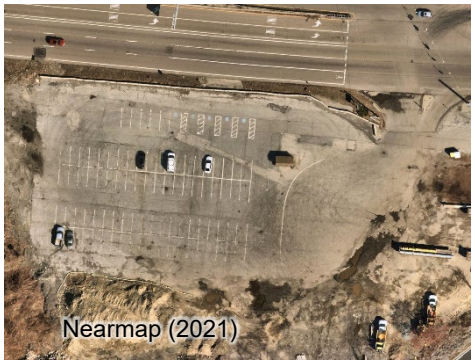
- The lot could benefit from striping (none exists). Cars appear to be parked in a haphazard manner. Organized striping could also increase the effective capacity of the lot, which is well-utilized (potentially for recreational use).
- The lot may benefit from a designated space (with amenities such as benches or a trash receptacle) for people to wait for their carpool or vanpool.
- A stop on MBTA Route 716 could allow the lot to be used to access Mattapan and points beyond.
- The sidewalk on Washington Street is often unpaved and might benefit from improvement.

Framingham

Address: 1672 Worcester Road, Framingham, MA

The Framingham Park-and-Ride is located in the vicinity of the MA-9/I-90 interchange. It is served by MWRTA Route 7 from Downtown Marlborough to Downtown Framingham. Major corporate offices located nearby include Bose, Genzyme Corporation, Staples, and Workhuman, and all of these provide large parking lots free-of-charge. There is no pedestrian or bicycle infrastructure to the Park-and-Ride. MassDOT uses some of the space to store vehicles and materials. A summary of the lot is provided in Figure 9.

FIGURE 9 | SUMMARY FOR THE FRAMINGHAM PARK-AND-RIDE



Curbside/Transit Service	Yes
Cost of Parking	Free
Parking Spaces	90
Accessible Parking Spaces	5
Hours	24/7
Overall Lot Condition	Fair

Lighting	Yes
Bus Shelter	Yes
Benches	Unknown
Trash Receptacle	Yes
Bike Rack(s)	No

Recommendations

- The lot could receive consideration as a stop for any future transit service on MA-9.
- Small pedestrian improvements (such as a safe connection to the Dunkin' adjacent to the Park-and-Ride, or a means to cross Route 9 with the traffic signal at California Avenue to provide a connection to Wendy's) could improve comfort for waiting users.

Milton

Address: Granite Avenue, Milton, MA

The Milton Park-and-Ride is located just southeast of I-93 Exit 11. It is easy to access by car from the highway and for communities along Granite Avenue such as West Quincy, East Milton, and Adams Village, and there is pedestrian connectivity to from the neighborhoods to the east and south. The lot is served by MBTA's Route 215 which operates between the Ashmont and Quincy Center. The lot is adjacent to a MassDOT Maintenance Facility and appears well used (between 50% and 75%). A summary of the lot is provided in Figure 10.

FIGURE 10 | SUMMARY FOR THE MILTON PARK-AND-RIDE

Curbside/Transit Service	Yes
Cost of Parking	Free
Parking Spaces	237
Accessible Parking Spaces	Unknown
Hours	24/7
Overall Lot Condition	Good

Lighting	Yes
Bus Shelter	No
Benches	No
Trash Receptacle	No
Bike Rack(s)	No

Recommendations

- Trees and foliage are lined along Granite Avenue which appear to block activity in the Park-and-Ride from view. This may impact perceptions of safety, particularly at night.
- The lot may benefit from an expanded space (with amenities such as benches or a trash receptacle) for people to wait for the MBTA bus or a carpool or vanpool.

Newburyport

Address: 150 Storey Avenue, Newburyport, MA

The Newburyport Park-and-Ride is located right off of I-95 at Exit 86, with pedestrian access. Until November 2020, C&J regional bus service served this location and amenities for that service are still present on the site.[5] MVRTA Route 24 operates on Storey Avenue and stops a block from the lot. A summary of the lot is provided in Figure 11.

[5] Coach Company https://coachco.com/schedules/ & C&J https://www.ridecj.com/locations/newburyport-ma/ & Mass.gov https://www.mass.gov/locations/newburyport-Park-and-Ride

FIGURE 11 | SUMMARY FOR THE NEWBURYPORT PARK-AND-RIDE

Curbside/Transit Service	No
Cost of Parking	Free
Parking Spaces	618
Accessible Parking Spaces	14
Hours	24/7
Overall Lot Condition	Good

Lighting	Yes
Bus Shelter	Yes
Benches	Yes
Trash Receptacle	Yes
Bike Rack(s)	Yes

Recommendations

- As of 2021 (i.e., since the departure of C&J), this lot is dramatically underutilized relative to the infrastructure provided. C&J moved their terminal to Seabrook, NH due to capacity constraints on the Newburyport site. The company cites difficulty winning approval for expansion from MassDOT and municipal government as the driving reason for the move – the new Seabrook terminal is owned by the company. There may be local support to study the site and seek another operator.[6]

- The lot could be served directly by MVRTA Route 54.

Plymouth

Address: 5 Long Pond Road, Plymouth, MA

The Plymouth Park-and-Ride is located just off MA-3 at Exit 13 and there is a multi-use path providing bicycle and pedestrian access. It is served by GATRA's Mayflower Link which operates between Plymouth and Manomet.[7] Plymouth & Brockton and Peter Pan both serve Boston (South Station and Logan Airport) and Hyannis with curbside service.[8,9,10] A summary of the lot is provided in Figure 12.

[6] Stewart Lytle, "C&J Bus Lines Growing Again – in Seabrook". *The Town* Common, April 27, 2021. https://towncommonmedia.com/2021/04/27/cj-bus-lines-growing-again-in-seabrook/
[7] MassDOT Park-and-Ride Inventory
[8] Mass.gov https://www.mass.gov/locations/plymouth-Park-and-Ride
[9] https://www.p-b.com/wp-content/uploads/2021/04/Hyannis-Boston-Logan-Schedule-2021-Phase-1.pdf
[10] https://peterpanbus.com/11201-2/

FIGURE 12 | SUMMARY FOR THE PLYMOUTH PARK-AND-RIDE

Curbside/Transit Service	Yes
Cost of Parking	Free
Parking Spaces	200
Accessible Parking Spaces	6
Hours	24/7
Overall Lot Condition	Poor

Lighting	Yes
Bus Shelter	Yes
Benches	Yes
Trash Receptacle	Yes
Bike Rack(s)	0

Recommendations

- This location could intercept Cape-bound travelers during the upcoming Cape Cod Bridges project.
- Transit priority treatments on MA-3 (including variable message signage indicating availability) could improve the lot's ability to intercept Boston-bound travelers.
- Improved lighting could improve perceived safety.

Rockland

Address: 1150 Hingham Street, Rockland, MA

The Rockland Park-and-Ride is located along Hingham Street, just off of MA-3 at Exit 14. Communities along Hingham Street and Pilgrims Highway, such as places within Rockland, Norwell, and Hingham, have easy access to the Park-and-Ride by car, but there is no pedestrian or bicycle infrastructure Plymouth & Brockton and Peter Pan both serve Boston (South Station and Logan Airport) and Hyannis with curbside service.[11][12][13] Pre-pandemic it appears well utilized, with between 50% and 75% utilization (not indicated in photo below). A summary of the lot is provided in Figure 13.

[11] Mass.gov https://www.mass.gov/locations/plymouth-Park-and-Ride
[12] https://www.p-b.com/wp-content/uploads/2021/04/Hyannis-Boston-Logan-Schedule-2021-Phase-1.pdf
[13] https://peterpanbus.com/11201-2/

FIGURE 13 | SUMMARY FOR THE ROCKLAND PARK-AND-RIDE

Curbside/Transit Service	Yes
Cost of Parking	Free
Parking Spaces	427
Accessible Parking Spaces	8
Hours	24/7
Overall Lot Condition	Fair

Lighting	No
Bus Shelter	Yes
Benches	Unknown
Trash Receptacle	No
Bike Rack(s)	No

Recommendations

- The lot may benefit from an improved space (with amenities such as benches or a trash receptacle) for people to wait for the bus or a carpool or vanpool.
- Transit priority treatments on MA-3 (including variable message signage indicating availability) could improve the lot's ability to intercept Boston-bound travelers.
- This location could intercept Cape-bound travelers during the upcoming Cape Cod Bridges project.
- Improved pedestrian and bicycle infrastructure could improve access for nearby neighborhoods.

Tyngsborough

Address: 99 Kendall Road, Tyngsborough, MA

The Tyngsborough Park-and-Ride is located along Kendall Road, just off US-3 at Exit 90 but there is no pedestrian or bicycle infrastructure. Boston Express Bus provides curbside service to Boston (South Station and Logan Airport) and Nashua, NH.[14] There is a trailer at the site where people can get information.[15] Before COVID-19, demand was exceeding supply in the lot. A summary of the lot is provided in Figure 14.

[14] Mass.gov https://www.mass.gov/locations/tyngsborough-Park-and-Ride & Boston Express https://www.bostonexpressbus.com/route/route-3-to-boston-logan-airport/
[15] MassDOT Park-and-Ride Inventory

FIGURE 14 | SUMMARY FOR THE TYNGSBOROUGH PARK-AND-RIDE

Curbside/Transit Service	Yes
Cost of Parking	Free
Parking Spaces	245
Accessible Parking Spaces	10
Hours	24/7
Overall Lot Condition	Fair

Lighting	Yes
Bus Shelter	Yes
Benches	Yes
Trash Receptacle	No
Bike Rack(s)	Yes

Recommendations

- The lot might benefit from physical improvements, such as reconfiguration of elements (e.g., moving the bus stop to the north property line), crack sealing, and restriping.
- Pre-pandemic, capacity constraints were such that cars were parked on the perimeter grass. Capacity could be increased through either expanding the lot or restriping it.
- The lot may benefit from an improved space (with a trash receptacle) for people to wait for the bus or a carpool or vanpool.

West Bridgewater

Address: 9 Pleasant Street, West Bridgewater, MA

The West Bridgewater Park-and-Ride is located just off of MA-24 at Exit 28. Though automobile access is convenient from Easton, West Bridgewater, and East Bridgewater, pedestrian infrastructure is incomplete and there is no bicycle infrastructure. Bloom Bus provides curbside service to Boston.[16] A summary of the lot is provided in Figure 15.

[16] Mass.gov https://www.mass.gov/locations/west-bridgewater-Park-and-Ride & Bloom Charter Service https://www.bloombus.com/commuter-services/

FIGURE 15 | SUMMARY FOR THE WEST BRIDGEWATER PARK-AND-RIDE

Curbside/Transit Service	Yes
Cost of Parking	Free
Parking Spaces	186
Accessible Parking Spaces	7
Hours	24/7
Overall Lot Condition	Fair

Lighting	Yes
Bus Shelter	Yes
Benches	Yes
Trash Receptacle	No
Bike Rack(s)	Yes

Recommendations

- Bloom is demand-responsive and at $14.50 for a one-way is more expensive than MBTA Commuter Rail from Bridgewater (A one-way fare to Downtown Boston is $10.50 from Bridgewater, while BAT local bus fares in the area are $1.50 per ride). It may be that service that is priced competitively and scheduled could take better advantage of the lot's excellent location.
- The lot may benefit from an improved space (with amenities such as benches or a trash receptacle) for people to wait for the bus or a carpool or vanpool.
- Improved pedestrian and bicycle infrastructure could improve access for nearby neighborhoods.

Weston

Address: 672 South Avenue, Weston, MA

The Weston Park-and-Ride is located directly off of I-90 at the State Police and Weston Maintenance Facility (direct but unsigned access to both directions of the highway). The lot is not advertised as a Park-and-Ride and is used to store MassDOT equipment. A summary of the lot is provided in Figure 16.

FIGURE 16 | SUMMARY FOR THE WESTON PARK-AND-RIDE

Curbside/Transit Service	No
Cost of Parking	Free
Parking Spaces	100
Accessible Parking Spaces	0
Hours	Unknown
Overall Lot Condition	Fair

Lighting	No
Bus Shelter	Unknown
Benches	Unknown
Trash Receptacle	No
Bike Rack(s)	No

Recommendations

- MassDOT may wish to discuss if or how this lot should be activated, as it has excellent access to and from a congested freeway corridor on a straight shot to Downtown Boston.

Woburn

Address: 1 Hill Stret, Woburn, MA

The Woburn Park-and-Ride is located just off of I-93 and situated off of Montvale Avenue. The location is convenient for access to and from the communities of Woburn, Winchester, Wilmington, Wakefield, Reading, and Burlington, among others, and the proximity to I-93 allows for easy access to the regional roadway network. It is served by the MBTA Route 354 which connects riders with a direct ride into Medford Center (City Hall) and downtown Boston (Haymarket, Government Center, and State Street). Unlike many other MassDOT-owned Park-and-Ride lots this lot provides easy walk access to fast-food restaurants (e.g., McDonalds, Wendy's), sit-down restaurants (Sam Walker's American Tavern, Bickford's Family Restaurants, Polcari's Restaurant), and hotels (Comfort Inn, Best Western Plus). There is access to the lot from the Tri-Community Greenway trail. Although pedestrian access is direct from the south side of Montvale Avenue, crossing Montvale Avenue at Hill Street is dangerous due to traffic volumes, the proximity to the free-flow I-93 freeway ramps, lighting, and sight distance.

A summary of the lot is provided in Figure 17.

FIGURE 17 | SUMMARY FOR THE WOBURN PARK-AND-RIDE

Curbside/Transit Service	Yes
Cost of Parking	Free
Parking Spaces	66
Accessible Parking Spaces	2
Hours	24/7
Overall Lot Condition	Poor

Lighting	Yes
Bus Shelter	No
Benches	No
Trash Receptacle	No
Bike Rack(s)	No

Recommendations

- Not all of the spaces in the lot are striped. The lot may benefit from striping. In the MassDOT Park-and-Ride Inventory, it is noted the lot will be reconstructed.
- Improved pedestrian and bicycle infrastructure could improve access to and from the lot. Based on imagery from 2019, there is plant overgrowth in the sidewalks.

C DETAILED METHODOLOGY FOR ORIGIN/DESTINATION ANALYSIS

Background

The objectives of the markets analysis were to:

- Identify key regional destinations. Recalling the two types of trips of interest in this project, destinations will be both in the urban core and outside of it.
- Use StreetLight location-based services (LBS) data to observe demand from origins to destinations.
- Use GIS analytics to cluster origins based on physical proximity and demand to destinations.

This chapter discusses the methodology used to accomplish these steps and the findings of the analysis.

Methodology

StreetLight Origin/Destination Data

LBS data are collected anonymously from connected devices. Specifically, some smartphone apps support the contribution of a device's GPS location to a central database several times per minute. This analysis uses the StreetLight LBS dataset purchased by MassDOT for the whole of the Commonwealth. StreetLight conducts several important data enhancement steps on the raw device pings before they can be used for analysis:[17]

- **Creating Trips |** Device pings are a sequence of timed dots known to originate from the same device, and each device pings continuously day and night, whether or not it is traveling. StreetLight identifies trips within the dataset – a device remaining in one general area for an extended period leaves that area and ultimately reaches another where it stays for another extended period.
- **Network Context |** A device pinging every 10 seconds might turn a corner and the segment connecting those points would cut the corner. To correct for this, StreetLight "contextualizes" pings with known geography (e.g., the road network and parcel boundaries), speed limits, one-way roads, etc. to create trips that are "locked" to the known world.
- **Normalization |** LBS data are inevitably a sample of total trips – 100% of trips do not and cannot send device pings. StreetLight scales the dataset up based on the population and number of evident reporting

[17] "Our Methodology and Data Sources". *StreetLight*, October 2018. https://www.StreetLightdata.com/wp-content/uploads/StreetLight-Data_Methodology-and-Data-Sources_181008.pdf

devices living in each US Census block. For this reason, StreetLight data can be thought of as a representative model of travel volumes, but not a ground truth measurement.

StreetLight data used in this analysis include weekdays Monday through Thursday. A query of the StreetLight dataset aggregates trips by user-defined origin and destination polygons and times of day, providing total tips and average zone-to-zone trip distance.

Analysis Zones

StreetLight data can be processed on ambiguous, user-defined polygons (as opposed to established building blocks such as US Census blocks, blockgroups, or tracts). The team drew 228 analysis zones using local knowledge and professional judgment. It also named those zones based on either the municipality or the destination cluster therein (e.g. “South Station” as the area of Downtown Boston in the South Station catchment).

- Zones for known destination clusters (identified from satellite imagery by commercial and institutional buildings and sometimes by their parking lots) should be comprehensive of the demand in that cluster. “No ping left behind.”
- Zones should be drawn around destination clusters crossing municipal boundaries. They would thus be accounted separately from the rest of those municipalities.
- Zones for Boston and immediate neighboring communities should follow the commonly-accepted neighborhood boundaries, regardless of municipal boundaries.
- Zones should be continuous.
- Unless one of the above applies, zones should be established using municipality boundaries. This reduces processing time because municipalities are larger destinations. Some destination clusters, such as Marlborough, Lowell, Brockton, and Franklin, are fully contained within municipal boundaries and don’t need to be split off.

Destinations

When generalized at a zone-to-zone level, the StreetLight dataset contains volume (the number of devices reporting the trip); the average distance and time to make the trip. This analysis utilized the first two of these (time was not considered as relevant) and also added the square mileage of the destination to normalize as a density. Four metrics were computed to assess the prominence of analysis zones as regional destinations:

- Volume of trips ending in the zone during the AM peak period. The first run of the analysis used data from March, April, September, and October 2019, Monday through Thursday.
- Density of volume, equal to volume divided by area in square miles.
- Device-Miles Traveled (DMT) ending in the zone. It is computed by multiplying volume by average trip length.
- Density of DMT. This is calculated by dividing the DMT by the square mileage of the destination.

For each of the four metrics, the methodology computed the number of standard deviations (positive or negative) between the zone's value and the mean of all zones. The sum of these four metrics was normalized on a 0-100 scale relative to the maximum value.

The four metrics were weighted equally. Short trips are prioritized in a volume-based ranking, while long trips are prioritized with DMT. Ranking directly by volume or DMT prioritizes destinations contained in municipalities (as the count would also include the rest of the municipality), while using density prioritizes smaller zones that just include the destination. The equal weighting is an attempt to account for both longer and shorter trips and larger and smaller destinations equally. The results of this analysis are provided in Table 1.

TABLE 1 | ZONE-LEVEL VOLUME AND DMT TO DESTINATIONS

Destination	AM Peak Volume	AM Peak DMT	Score
South Station	70,385	710,088	100
Back Bay/South End	51,994	419,962	42
Kendall/Central	73,511	526,390	42
North Station	44,254	445,254	42
LMA/Fenway/Mission Hill	59,997	411,590	36
South Boston Waterfront	29,422	285,164	27
Brockton	63,446	499,897	24
Lowell	68,889	466,779	21
Harvard Square/Cambridge Highlands	31,462	182,137	15
Logan Airport	27,428	284,816	15
N2 Innovation District/Needham Street	22,181	254,711	15
Plymouth	38,990	390,250	15
Route 3/Burlington	23,747	303,176	15
Waltham Business Park	24,223	318,262	15
Allston/Brighton - South	27,799	209,837	12
Beverly	36,822	297,931	12
East Somerville/Union/Inman	32,165	187,168	12
Lawrence	43,899	306,311	12
North Dorchester	29,226	225,394	12
Roxbury	38,637	202,838	12
South Weymouth/Route 3 South	33,509	338,051	12
Taunton	39,633	311,149	12
Andover	32,942	307,297	9
Chelsea-South	14,663	94,839	9
Golden Triangle	16,887	195,121	9
Lower Mystic	24,939	191,130	9
Marlborough	32,618	360,196	9

Destination	AM Peak Volume	AM Peak DMT	Score
Riverside/Lower Falls	19,808	237,093	9
South Boston	22,971	159,377	9
Woburn/Wilmington Office Parks	26,526	311,353	9
Alewife	14,072	109,012	6
Billerica	27,860	225,927	6
Braintree	24,479	179,464	6
Canton	21,276	208,357	6
Charlestown/Sullivan Square	20,727	158,930	6
Chelmsford	27,439	225,297	6
Davis/Porter/Tufts	22,838	130,287	6
Franklin	25,915	226,143	6
Gloucester	23,090	171,911	6
Haverhill	31,443	241,512	6
Jamaica Plain	22,716	144,659	6
Lynn - East	30,506	182,714	6
North Brookline	22,478	137,202	6
North Shore Malls	11,041	105,128	6
Quincy - East	28,825	200,160	6
Quincy - North	23,807	183,497	6
Route 1/Dedham	8,764	100,857	6
Salem	31,010	215,190	6
Wakefield	24,414	176,613	6
Waltham/South Side/Common/East	31,351	221,889	6
Wellesley	21,435	186,531	6
Woburn	27,212	214,772	6
Attleboro	21,062	155,315	3
Braintree Split/Granite Street	18,211	217,714	3
Chelsea-North	11,660	67,142	3
Concord	17,295	175,374	3
East Boston	19,379	113,594	3
East Watertown/Arsenal	18,258	141,878	3
Hanscom	14,819	183,822	3
Milford	20,731	172,497	3
Route 1 North Corridor	20,458	201,187	3
South Dorchester	27,639	153,528	3

Destination	AM Peak Volume	AM Peak DMT	Score
University Avenue	14,544	191,286	3
Westborough	15,829	190,455	3
Acton	16,209	143,663	0
Allston/Brighton - North	11,438	87,721	0
Arlington - East	11,155	67,919	0
Arlington - West	12,967	69,156	0
Ashland	10,162	71,205	0
Bedford	8,494	83,451	0
Belmont - East	12,952	68,692	0
Bridgewater	15,789	131,107	0
Chestnut Hill	15,071	113,718	0
Danvers	17,988	131,098	0
Dedham	17,301	146,305	0
Dracut	10,722	68,281	0
Easton	16,859	145,937	0
Everett - North	16,045	91,882	0
Framingham North	13,236	102,097	0
Framingham South	16,237	132,261	0
Framingham/Mass Pike	7,687	113,033	0
Hanover	11,514	103,181	0
Hingham	12,895	101,313	0
Holliston	8,850	69,239	0
Hopkinton	12,059	132,492	0
Hudson	11,169	82,852	0
Hyde Park	19,353	132,463	0
Ipswich	9,515	87,891	0
Kingston	11,756	100,266	0
Lexington	20,801	164,032	0
Lynn - West	15,547	84,492	0
Lynnfield	15,258	112,489	0
Malden - West	20,340	116,920	0
Mansfield	16,244	154,115	0
Marshfield	12,148	90,326	0
Mattapan	16,923	98,033	0
Melrose	13,096	79,984	0

Destination	AM Peak Volume	AM Peak DMT	Score
Methuen	20,522	151,182	0
Middleborough	12,970	114,391	0
Milton	19,635	150,183	0
Natick	19,207	149,119	0
Needham	20,303	161,876	0
Newburyport	12,698	107,688	0
Newton - Center	11,281	82,838	0
Newton - North	17,227	139,479	0
Newton - West	11,036	79,578	0
North Andover	17,399	144,252	0
North Attleborough	13,912	93,150	0
North Reading	11,401	99,816	0
Norton	8,674	72,376	0
Norwood	17,811	132,977	0
Peabody - East	15,892	101,288	0
Pembroke	9,820	85,655	0
Randolph	12,069	100,035	0
Raynham	13,200	119,010	0
Reading	18,901	127,373	0
Revere Beach/Beachmont	11,009	71,586	0
Roslindale	14,920	95,108	0
Route 1/East Walpole/Norwood	11,290	133,396	0
Route 128/ Route 2 Office Parks	5,280	68,144	0
Route 3/Bedford/Billerica	9,663	135,354	0
Saugus	18,610	127,974	0
Stoneham	17,222	116,235	0
Stoughton	13,781	104,546	0
Sudbury	11,565	100,998	0
Tewksbury	19,960	170,116	0
Tyngsborough	8,870	71,564	0
Walpole	13,866	111,088	0
Waltham/Brandeis	10,063	100,742	0
Watertown Square/West End	13,163	80,161	0
Wayland	8,888	73,024	0
West Bridgewater	8,434	76,412	0

Destination	AM Peak Volume	AM Peak DMT	Score
West Revere/East Revere	13,988	77,586	0
West Roxbury	17,216	129,328	0
Westford	15,390	148,313	0
Weston	9,990	95,038	0
Weymouth-North	16,889	118,487	0
Wilmington	16,832	159,417	0
Winchester	16,228	93,770	0
Abington	10,480	64,097	-3
Burlington	9,468	57,364	-3
Foxborough	8,338	75,617	-3
Littleton	6,762	74,637	-3
Malden - East	9,581	51,922	-3
Marblehead	12,980	63,244	-3
Medford - West	8,981	51,940	-3
Route 1/Gillette	5,503	76,916	-3
Route 28 (Stoughton/Avon)	8,404	101,573	-3
Winthrop	9,382	40,717	-3
Amesbury	7,295	55,437	-6
Avon	3,433	26,590	-6
Ayer	4,064	35,425	-6
Bellingham	8,135	63,441	-6
Belmont - West	4,317	39,655	-6
Berlin	1,355	12,513	-6
Blackstone	3,257	19,376	-6
Bolton	3,197	28,439	-6
Boxborough	3,071	41,870	-6
Boxford	4,043	33,688	-6
Carlisle	1,849	18,201	-6
Carver	4,965	44,406	-6
Centennial Drive	5,331	59,839	-6
Clinton	4,700	30,627	-6
Cohasset	4,869	39,152	-6
Devens	3,804	54,449	-6
Dover	3,945	33,599	-6
Dunstable	896	6,775	-6

Destination	AM Peak Volume	AM Peak DMT	Score
Duxbury	6,560	56,406	-6
East Bridgewater	7,877	56,711	-6
Essex	2,005	18,526	-6
Framingham/Route 9	6,568	63,689	-6
Georgetown	4,677	33,440	-6
Groton	4,419	39,528	-6
Groveland	2,072	17,776	-6
Halifax	2,645	23,559	-6
Hamilton	4,952	47,733	-6
Hanson	6,954	45,443	-6
Harbor Islands	13	69	-6
Harvard	2,219	18,897	-6
Holbrook	4,629	33,814	-6
Hopedale	2,752	16,791	-6
Hull	4,877	33,674	-6
Lakeville	4,945	48,990	-6
Lancaster	2,410	22,443	-6
Lincoln	4,627	46,291	-6
Manchester	3,995	31,069	-6
Maynard	5,643	44,820	-6
Medfield	5,346	43,419	-6
Medford - East	4,976	30,678	-6
Medford - South	7,785	52,672	-6
Medway	7,609	53,834	-6
Mendon	3,810	28,248	-6
Merrimac	1,739	16,044	-6
Middleton	4,745	47,008	-6
Millis	3,939	33,440	-6
Millville	535	5,238	-6
Nahant	1,205	8,611	-6
Natick/Natick Labs	5,251	51,542	-6
Newbury	4,402	40,559	-6
Newton - South	7,179	42,703	-6
Norfolk	5,532	48,846	-6
Northborough	6,519	54,087	-6

Destination	AM Peak Volume	AM Peak DMT	Score
Northbridge	7,423	47,735	-6
Norwell	5,166	47,372	-6
Peabody - West	3,718	27,921	-6
Pepperell	2,655	19,071	-6
Plainville	5,467	51,098	-6
Plympton	1,167	14,171	-6
Rockland	8,068	54,033	-6
Rockport	4,481	30,317	-6
Rowley	3,433	35,093	-6
Salisbury	4,260	34,703	-6
Scituate	7,829	59,862	-6
Sharon	7,060	56,512	-6
Sherborn	1,466	14,460	-6
Shirley	1,189	11,740	-6
South Brookline	8,138	61,744	-6
Southborough	6,474	65,257	-6
Stow	3,714	35,523	-6
Swampscott	6,746	35,222	-6
Topsfield	3,342	34,037	-6
Upton	5,077	41,526	-6
Uxbridge	5,287	37,247	-6
Wenham	2,076	17,265	-6
West Newbury	2,655	17,009	-6
Westwood	7,618	66,387	-6
Whitman	6,645	44,248	-6
Wrentham	6,131	59,635	-6

Zones were selected for inclusion in destinations by:

- Assigning all zones with a destination score (see Appendix A) greater than zero to a destination. Outside of MA-128, these zones were grouped if they were nearby and formed a logical destination in the average resident's mind (e.g., "Waltham" or "Burlington/Woburn").
- Zones with a destination score of zero or lower were added to destinations when necessary to make them contiguous.
- Zones with a destination score greater than zero inside of MA-128 were defined as destinations alone.

The destinations are listed and crosswalked in Table 2.

TABLE 2 | ZONES INCLUDED IN DESTINATIONS

Destinations	Zones Included in Destinations
Alewife	Alewife
Allston-Brighton - South	Allston/Brighton - South
Assembly/Wellington	Lower Mystic
Attleboro	Attleboro
East Watertown/Arsenal	East Watertown/Arsenal
Back Bay/South End	Back Bay/South End
Braintree/Weymouth	Braintree; Braintree Split/Granite Street; South Weymouth/Route 3 South
Brockton	Brockton
North Brookline	North Brookline
Burlington/Woburn	Route 3/Bedford/Billerica; Route 3/Burlington; Woburn; Woburn/Wilmington Office Parks
Charlestown/Sullivan Square	Charlestown/Sullivan Square
Chelsea North	Chelsea-North
Chelsea South	Chelsea-South
Davis/Porter/Tufts	Davis/Porter/Tufts
Dedham/Westwood/Canton	Canton; Route 1/Dedham; University Avenue
North Dorchester	North Dorchester
South Dorchester	South Dorchester
East Boston	East Boston
Framingham/Natick	Framingham North; Framingham South; Framingham/Mass Pike; Framingham/Route 9; Golden Triangle
Franklin	Franklin
Gloucester	Gloucester
Hanscom/Concord	Concord; Hanscom
Harvard Square/Cambridge Highlands	Harvard Square/Cambridge Highlands

Destinations	Zones Included in Destinations
Haverhill	Haverhill
Jamaica Plain	Jamaica Plain
Kendall/Central	Kendall/Central
Lawrence/Andover	Andover; Lawrence
LMA/Fenway/Mission Hill	LMA/Fenway/Mission Hill
Logan Airport	Logan Airport
Lowell/Billerica	Billerica; Lowell
Lynn - East	Lynn - East
Marlborough/Westborough	Marlborough; Westborough
Milford	Milford
Newton/Needham/Wellesley	N2 Innovation District/Needham Street; Needham; Riverside/Lower Falls; Wellesley
North Station	North Station
Plymouth	Plymouth
Roxbury	Roxbury
Salem/Beverly/Peabody	Beverly; Centennial Drive; North Shore Malls; Peabody – East; Route 1 North Corridor; Salem
Seaport	South Boston Waterfront
South Boston	South Boston
South Station	South Station
Taunton	Taunton
Quincy - East	Quincy - East
Quincy - North	Quincy - North
East Somerville/Union/Inman	East Somerville/Union/Inman
Wakefield	Wakefield
Waltham	Waltham Business Park; Waltham/Brandeis; Waltham/South Side/Common/East

Anchors and Drivesheds

DMT was totaled pairwise between analysis zones and "roll-up" destinations. This allowed for a visual assessment of where demand to each destination seemed to be centered, or "anchored." Where possible, these anchors were selected as MassDOT's existing Park-and-Ride lots. If no Park-and-Ride existed, the location was placed on or near a major interchange using engineering judgment.

Drivesheds were established for identified anchors and existing Park-and-Rides (20 total locations) using a GIS network analysis. A driveshed is the area in which someone driving a longer distance within the region might be diverted to park at an anchor location and take a shared travel service for the remainder of the trip.

- Drivesheds of 5 and 15 minutes were created from each anchor, assuming travel at the posted speed limit.
- Driveshed times were adjusted to account for traffic congestion and traffic signals:
  - The Boston congestion index was assumed to be 1.3, meaning that congested travel times are 30% longer than uncongested travel times.[18]
  - A 5-minute congested driveshed is the equivalent to a 3.85 minute uncongested driveshed because travel is slower in congestion.
  - A 15-minute driveshed is equivalent to 11.54 minutes.
- Driveshed results were further modified to account for how commuters would utilize a shared-travel service on a bus that makes multiple stops – parabolic, with a 5-minute (congested) driveshed downstream toward the destination and a 15-minute (adjusted) driveshed upstream away from the destination.[19] The direction that was downstream was identified with engineering judgement based on the same initial visual inspection of the data described above.
- Analysis zones were identified as falling within the driveshed if they were fully covered by the generated shape. In zones that partially overlapped, a visual assessment and engineering judgment were used to determine if it was "inside". From this point onward in the analysis, the "driveshed" was defined as the overlapping zones.

A crosswalk showing the analysis zones included in the drivesheds is provided in Table 3.

[18] Bureau of Transportation Statistics https://www.bts.gov/content/travel-time-index
[19] Robert Spillar, "Park-and-Ride Planning and Design Guidelines". Parsons Brinkerhoff Quade & Douglas, Inc., 1997. http://cdn.wspgroup.com/8kzmue/Park-and-Ride-planning-and-design-guidelines.pdf

TABLE 3 | ANALYSIS ZONES INCLUDED IN DRIVESHEDS

Origin Market Drivesheds	Zones Included in Drivesheds
Andover (AN)	Andover; Lawrence; Lowell; Methuen; North Andover; Tewksbury
Berlin (BE)	Berlin; Bolton; Boxborough; Clinton; Harvard; Hudson; Stow
Bridgewater (BG)	Bridgewater; Raynham; Taunton
Burlington (BL)	Bedford; Billerica; Burlington; Hanscom; Lexington; Reading; Route 3/Bedford/Billerica; Route 3/Burlington
Canton (CN)	Braintree; Braintree Split/Granite Street; Canton; Dedham; Hyde Park; Milton; Norwood; Randolph; Route 1/Dedham; Route 1/East Walpole/Norwood; Route 28 (Stoughton/Avon); Stoughton; University Avenue; Westwood
Chelmsford (CH)	Andover; Chelmsford; Dracut; Lowell; Tewksbury; Tyngsborough; Westford
Framingham (FR)	Ashland; Framingham North; Framingham South; Framingham/Mass Pike; Framingham/Route 9; Hopkinton; Marlborough; Southborough; Westborough
Foxborough (FX)	Attleboro; Easton; Foxborough; Mansfield; North Attleborough; Norton; Plainville
Lexington (LX)	Bedford; Burlington; Concord; Hanscom; Lexington; Lincoln; Route 128/Route 2 Office Parks; Route 3/Bedford/Billerica; Route 3/Burlington; Woburn; Woburn/Wilmington Office Parks
Milton (ML)	Braintree; Braintree Split/Granite Street; Hyde Park; Mattapan; N2 Innovation District/Needham Street; North Dorchester; Quincy-East; Quincy-North; Randolph; Roslindale; South Dorchester
Natick (NK)	Ashland; Framingham North; Framingham Soth; Framingham/Mass Pike; Framingham/Route 9; Golden Triangle; Natick/Natick Labs; Southborough

Origin Market Drivesheds	Zones Included in Drivesheds
Newburyport (NW)	Amesbury; Merrimac; Newburyport; Salisbury; West Newbury
Peabody (PB)	Beverly; Centennial Drive; Danvers; Middleton; North Shore Malls; Peabody-East; Peabody-West; Route 1 North Corridor; Salem; Wenham
Plymouth (PL)	Plymouth
Rockland (RK)	Rockland; Hanover; Hingham; Norwell; Rockland; South Weymouth/Route 3 South; Whitman
Tyngsborough (TY)	Dracut; Dunstable; Tyngsborough
West Bridgewater (WB)	Bridgewater; East Bridgewater; Easton; Raynham; Taunton; West Bridgewater
Westborough (WE)	Hopkinton; Hudson; Marlborough; Northborough; Southborough; Westborough
Weston (WS)	Framingham North; Golden Triangle; Natick; Natick/Natick Labs; Needham; Newton-North; Newton-West; Riverside/Lower Falls; Waltham Business Park; Waltham/Brandeis; Waltham/South Side/Common/East; Wayland; Wellesley; Weston
Woburn (WO)	Billerica; Burlington; East Somerville/Union/Inman; Lexington; Lower Mystic; Lynnfield; Malden-West; Medford-East; Medford-South; Medford-West; Melrose; North Reading; Reading; Route 3/Bedford/Billerica; Route 3/Burlington; Stoneham; Tewksbury; Wakefield; Wilmington; Winchester; Woburn; Woburn/Wilmington Office Parks

Markets were defined as pairs of drivesheds and “roll-up” destinations. The methodology assessed all 940 of the resulting pairs, computing the total DMT from the zones in the driveshed to the zones in the destination. DMT *and Volume* were used in when ranking destinations because a “major destination” conceptually is one with both short and long-distance travel. DMT alone was used to rank markets as markets with more mileage traveled and longer regional trips are better suited for shared travel service.

As with the destinations, the standard deviations from the mean were calculated for both DMT and DMT/square mile (total of driveshed and destination) and summed equally, the sums then normalized from 0-100. Markets were included in the normalization (and the final ranked list) only if the driveshed and destination were not adjacent (i.e., zones did not exist that were in both areas).

Impact of COVID-19

The analysis was conducted for five time two-month periods:

- March 1 – April 30 and September 1 – October 31, 2019 (StreetLight's definition of "2019").
- March 1 – April 30, 2020.
- May 1 – June 30, 2020.
- September 1 – October 31, 2020.
- February 15 – April 15 2021.

Table 4 shows the temporal trends in DMT density for all destinations across all 5 time periods. Based on these data, COVID-19 has had a far larger impact on some destinations (e.g., South Station, Kendall Square, the Seaport, and Waltham) than it has had on others (e.g., Back Bay/South End, the Longwood Medical Area, and Gateway City downtowns), with impacts to suburban destinations other than Waltham falling in the middle.

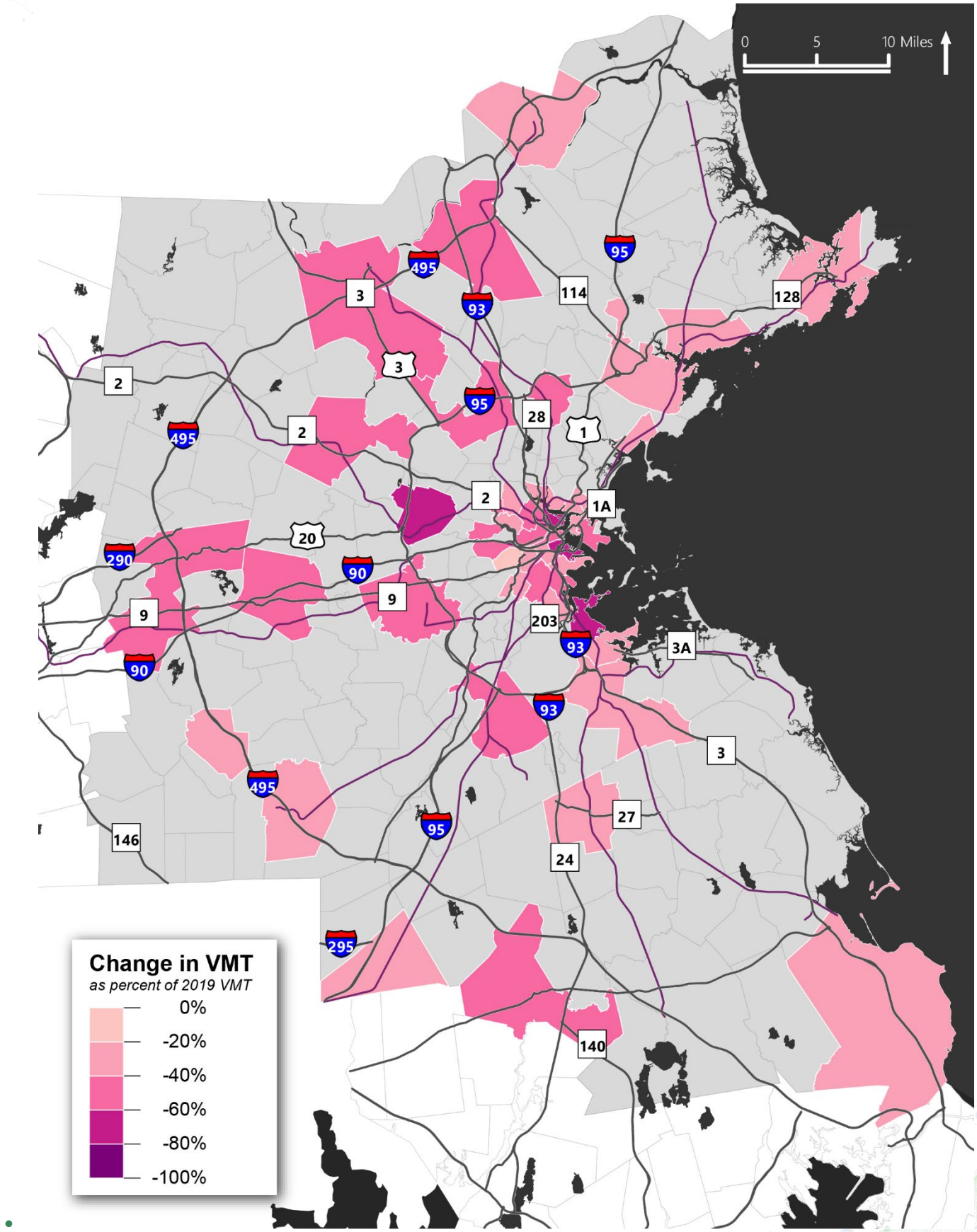
TABLE 4 | DEVICE-MILES TRAVELED PER SQUARE MILE IN AVERAGE AM PEAK HOUR IN ALL 2019-2021 ANALYSIS PERIODS, RANKED BY 2019 VALUE

Destination	2019	Q1 2020	Q2 2020	Q3 2020	Q1 2021	2021 as % of 2019
South Station	936,792	161,092	192,079	294,557	298,929	32%
North Station	385,836	109,987	140,813	202,404	185,259	48%
Back Bay/South End	326,260	116,112	170,626	229,749	233,258	71%
Seaport	271,247	53,218	70,489	102,288	86,858	32%
Kendall Square/Central Square	213,742	41,062	57,373	88,222	90,914	43%
Longwood Medical Area/Fenway	210,639	101,426	126,318	159,087	159,075	76%
Charlestown	122,041	29,033	37,735	47,601	43,957	36%
Logan Airport	106,668	17,475	22,519	33,998	47,772	45%
Southern Chelsea	106,339	38,083	47,663	50,366	65,500	62%
Alewife	103,657	31,494	38,497	53,378	51,011	49%
Northern Dorchester	100,518	25,410	32,252	45,532	46,752	47%
Harvard Square	95,917	34,608	55,803	63,294	61,324	64%
Southern Allston-Brighton	83,020	31,752	40,238	51,934	49,755	60%
Union Square/Inman Square	71,138	30,683	33,572	39,578	38,880	55%
South Boston	70,453	32,918	41,208	45,946	45,629	65%

Destination	2019	Q1 2020	Q2 2020	Q3 2020	Q1 2021	2021 as % of 2019
Watertown Arsenal	65,540	19,056	26,770	32,190	32,242	49%
Assembly Square/Wellington	61,498	28,332	34,038	38,523	38,926	63%
Northern Brookline	59,705	34,096	49,182	58,772	57,695	97%
Davis Square/Porter Square	58,884	21,151	31,082	44,467	47,003	80%
Roxbury	54,196	21,588	25,955	31,460	31,712	59%
Jamaica Plain	53,238	23,563	29,388	40,353	40,016	75%
Northern Chelsea	52,393	25,093	31,646	37,626	34,943	67%
Waltham	49,149	13,982	16,700	19,732	19,679	40%
East Boston	49,057	20,755	28,241	35,333	35,525	72%
Burlington/Woburn	48,309	17,536	20,620	24,072	23,399	48%
Eastern Lynn (Central Square)	46,107	22,389	24,951	31,785	33,706	73%
Southern Dorchester	42,327	17,574	19,857	22,022	27,538	65%
Northern Quincy	38,055	10,818	12,590	15,139	14,532	38%
Eastern Quincy	33,933	15,777	17,766	22,068	23,813	70%
Newton/Needham/Wellesley	32,692	9,462	11,915	15,286	15,718	48%
Salem/Beverly/Peabody	24,826	10,711	12,928	16,827	17,875	72%
Braintree/Weymouth	24,210	9,414	11,411	15,159	15,027	62%
Brockton	23,235	10,632	12,478	15,294	15,965	69%
Framingham/Natick	22,122	7,430	9,244	10,894	11,092	50%
Wakefield	22,093	6,740	8,350	10,339	11,421	52%
Dedham/Westwood/Canton	21,345	8,148	9,753	12,290	11,590	54%
Lawrence/Andover	15,503	4,855	5,652	7,413	7,661	49%
Lowell/Chelmsford/Billerica	14,603	5,803	6,853	8,008	7,990	55%
Milford	11,482	6,210	7,091	9,051	8,136	71%
Hanscom/Concord	11,415	3,622	4,493	6,460	6,225	55%
Marlborough/Westborough	11,381	3,650	4,535	5,764	5,473	48%
Franklin	8,103	3,244	3,800	4,567	4,979	61%
Haverhill	6,765	2,845	3,327	4,322	4,631	68%
Gloucester	6,438	3,062	4,281	4,515	4,441	69%
Taunton	6,342	2,637	2,956	3,606	3,416	54%
Attleborough	5,593	2,632	3,119	4,276	4,372	78%
Plymouth	3,795	1,994	2,330	3,071	2,993	79%

Figure 18 illustrates the percentage change in DMT density in these destinations between 2019 and February-April 2021.

FIGURE 18 | PERCENTAGE CHANGE IN DMT FOR DESTINATIONS, FEB/APR 2021 VS. 2019



D MENU OF SHARED TRAVEL SERVICE MODELS AND VEHICLES

TABLE 5 | MENU OF SHARED TRAVEL SERVICE MODELS AND VEHICLES

Service Model	Vehicle	Capacity	Potential Legal Issues in MA	Applicability to MA Context
Transit	35-foot bus	30	Minor barriers to entry - services must be non-discriminatory, able to take all potential users, and operate according to their filed tariffs and routes which allows transit operators to enter and exit the market almost freely. However, infrastructure owners have the powers to charge a bus operator for use of their facility.	This type of service and vehicle is applicable to MA, and already operate as some of the RTA routes and local bus services. Generally, Transit services work best in condensed areas where passengers are collected from fewer locations and have a common destination.
	40-foot bus	42	Minor barriers to entry - services must be non-discriminatory, able to take all potential users, and operate according to their filed tariffs and routes which allows transit operators to enter and exit the market almost freely. However, infrastructure owners have the powers to charge a bus operator for use of their facility.	This type of service and vehicle is applicable to MA, and already operate as some of the RTA routes and local bus services. Generally, Transit services work best in condensed areas where passengers are collected from fewer locations and have a common destination. The larger the bus the more road space is needed to maneuver around corners.
	Articulated bus	60	Minor barriers to entry - services must be non-discriminatory, able to take all potential users, and operate according to their filed tariffs and routes which allows transit operators to enter and exit the market almost freely. However, infrastructure owners have the powers to charge a bus operator for use of their facility.	Articulated buses already operate within Boston Bay area. The main benefits of these vehicles are the multiple sets of doors which allow faster boarding onto the vehicle and lessens dwell time. Generally, Transit services work best in condensed areas where passengers are collected from fewer locations and have a common destination.

Service Model	Vehicle	Capacity	Potential Legal Issues in MA	Applicability to MA Context
	Double-decked bus	80	Minor barriers to entry - services must be non-discriminatory, able to take all potential users, and operate according to their filed tariffs and routes which allows transit operators to enter and exit the market almost freely. However, infrastructure owners have the powers to charge a bus operator for use of their facility.	This vehicle allows a greater capacity than a single bus. The routing of a double decker will need to be considered due to the height restrictions on bridges, underpasses, street trees, and signs that may not allow sufficient clearance for the bus – therefore it is more common in rural to urban routes. Generally, Transit services work best in condensed areas where passengers are collected from fewer locations and have a common destination.
Curbside	Van	12	Minor barriers to entry - services must be non-discriminatory, able to take all potential users, and operate according to their filed tariffs and routes which allows transit operators to enter and exit the market almost freely. However, infrastructure owners have the powers to charge a bus operator for use of their facility.	Curbside services work best in rural areas where passengers are collected from many different locations along the route.
	Cutaway	3	Minor barriers to entry - services must be non-discriminatory, able to take all potential users, and operate according to their filed tariffs and routes which allows transit operators to enter and exit the market almost freely. However, infrastructure owners have the powers to charge a bus operator for use of their facility.	Curbside services work best in rural areas where passengers are collected from many different locations along the route. The low capacity of a cutaway will result in many vehicles needed to satisfy a large market as a curbside service. If the main goal of curbside services is to alleviate congestion, then this will not suffice, however could work in rural areas where the market is smaller, like a DRT service.
	Motor coach/ 40 ft Bus	40	Minor barriers to entry - services must be non-discriminatory, able to take all potential users, and operate according to their filed tariffs and routes which allows transit operators to enter and exit the market almost freely. However, infrastructure owners have the powers to charge a bus operator for use of their facility.	Curbside services work best in rural areas where passengers are collected from many different locations along the route. A motor coach is a transit service alternative for rural areas.

Service Model	Vehicle	Capacity	Potential Legal Issues in MA	Applicability to MA Context
DRT	Car	3	TNCs are exempt from regulation unless regulators define the ridesharing as being 'commercial' and not occasional.	DRT services work best in rural areas where passengers are collected from many different locations when the service is prebooked. The main purpose of a DRT service is to create better connectivity to main shared services to allow users in rural areas access to them.
	Van	12	TNCs are exempt from regulation unless regulators define the ridesharing as being 'commercial' and not occasional.	DRT services work best in rural areas where passengers are collected from many different locations when the service is prebooked. The main purpose of a DRT service is to create better connectivity to main shared services to allow users in rural areas access to them. A van provides all the benefits as a private vehicle whilst having a bigger capacity.
Car Share	Car	3	TNCs are exempt from regulation unless regulators define the ridesharing as being 'commercial' and not occasional.	Car share is applicable to localized areas where users are within a certain proximity to each other, can be collected on route or all meet at a single place. This works best for users who work within the same office/area and requires some form of coordination.
	Van	12	TNCs are exempt from regulation unless regulators define the ridesharing as being 'commercial' and not occasional.	Car share is applicable to localized areas where users are within a certain proximity to each other, can be collected on route or all meet at a single place. This works best for users who work within the same office/area and requires some form of coordination.

E DETAILED METHODOLOGY FOR COMPETITIVENESS ASSESSMENT

The highlighted findings of MassDOT's scoping studies on FBOS and Managed Lanes were applied in a competitiveness analysis that built on the markets analysis and services analysis discussed in the report and described in detail in prior appendices. Using highway performance data (travel time) from INRIX, the following steps were completed for 18 largest markets identified through the origin/destination analysis.

- A route for shared travel service was defined from origin to destination on the INRIX XD roadway network.
- The in-vehicle travel time (IVTT) for SOV was computed from the INRIX data along the route for every minute between 6:00 am and 8:00 pm. For 2019, the average, 80th percentile, and maximum travel times were calculated.
- A transit travel time was estimated for the same period of the day, assuming that the FBOS and managed lanes opportunities identified in the scoping studies were fulfilled on the route, and that arterial improvements (TSP, queue jump lanes, and managed lanes) were implemented per engineering judgment. If, for instance, FBOS were assumed to be implemented on a segment, the transit travel time would be 5% lower than the INRIX observation but with a floor speed of 45 mph. Note that the routings generally had several different assumed infrastructure improvements applying in series over the full length.
- Using the SOV and transit travel times as well as some other variables, the transit share was estimated at each minute of the day based on a logit probability curve of a user choosing the shared travel service over SOV, adapted from the Central Transportation Planning Staff (CTPS) regional model.[20] One of the products of the analysis was the average estimated transit share over the whole day.
- Ridership for the AM peak period was roughly estimated from the market volume derived from Streetlight and the estimated transit share. As this should not be taken as a true ridership estimate, it was obfuscated into the other product of the analysis, AM peak period ridership score, by normalizing on a 0-100 scale.

In-Vehicle Travel Time (IVTT)

IVTT was computed for a route laid on the network for each major market. The route began at the anchor (sometimes a Park-and-Ride lot, sometimes a new point identified during the Markets Analysis). The route ended at a destination which was typically a major commercial center within the destination market area. Once the origin and destination for each shared travel market was identified, a highway route was determined using Google Maps to identify the fastest highway route between the identified origin and destination. If two routes for an O-D pair had similar travel times, both routes were identified, even though one of the routes had tolls (ex. MassPike).

[20] https://www.ctps.org/data/pdf/about/mpo/recert_2014/CTPS_GLE_Modeling_Method_20130416.pdf

The highway performance data for IVTT was drawn from INRIX's XD Traffic Analytics portal managed by the University of Maryland's CATT Lab. The data are provided in terms of travel time and speeds for each minute and highway segment. Travel times in 1-minute intervals were obtained for all weekdays during 2019 between 6AM and 8PM, for the segments that made up the route from origin to destination.

The INRIX travel times were then processed to obtain the travel times for the whole route. The segment times were summed in sequence, as a vehicle would reach them, to obtain IVTT for SOV. To obtain the IVTT for shared travel, they were adjusted as described earlier in this appendix and as listed in Table 6.

TABLE 6 | IVTT ADJUSTMENTS FOR SHARED TRAVEL INFRASTRUCTURE

XD Segment Link Type	Highway Travel Time Adjustment	Min Speed Limitation to Travel Time Adjustment	Max Speed Limitation to Travel Time Adjustment
Freeway segments feasible for managed lane	-10%		60 mph
Freeway segment feasible for shoulder use	+5%	45 mph	55 mph
Arterial segment with TSP	-10%		35 mph
Arterial segment with TSP and Queue Jump Lanes	-15%		35 mph
Arterial segment with TSP and Dedicated Bus Lane	-20%		35 mph

User Cost

The user cost of SOV included the cost of gasoline (in most cases), tolls, and parking. It was assumed to be $0.25 per mile (estimated initially based on Internal Revenue Service reimbursement rate of $0.56 per mile but reduced subsequently to calibrate the model to the 6% transit share in the American Community Survey (ACS) for the Lowell/Burlington market as described below). Additionally, a cost of $1.50 was added if the identified highway route included I-90 to reflect toll charges, and a cost of $2.00 was added for destinations within the City of Boston to reflect destination parking charges. These added costs were determined based on a review of existing transit shares to Boston from several surrounding cities and towns such as Arlington, Medford, Natick, Newton, Woburn, Waltham and Watertown. The existing transit shares were obtained from the ACS data available on the Census Transportation Planning Products (CTPP) portal. For the shared travel service, this includes the fare and any additional parking cost. This was assumed to be $2.00 per trip. The cost of gasoline, tolls and parking assumed were meant more to reflect relative disincentives of SOV and shared travel within the context of the logit model rather than their actual costs.

Transit Share

To estimate transit share, a binary logit function was utilized for SOV and shared travel service. The function to compute the disutility of each mode was as shown below:

$$U = a(IVTT) + b(TermTime) + c(WalkTime) + d(WaitTime) + e(AccessTime) + f(Cost)$$

where,

- **U** is the disutility of the mode (SOV auto or shared travel service).

- **IVTT** is the In-vehicle Travel Time (minutes).
- **TermTime** is the Terminal time (minutes): the time it takes for a user to travel from their point of origin (typically home) to the starting point of the highway route. This was assumed to be 5 minutes for SOV. This value is nonzero for SOV and zero for shared travel, as both the origin and destination are located on the highway network.
- **WalkTime** (minutes) is the time to walk to/from the mode. This is mostly applicable to the shared travel service as the user has to walk from their vehicle to the bus stop at the starting point and walk from the ending point bus stop to their place of work. This was assumed to be a total of 10 minutes.
- **WaitTime** (min) is the time for a user to wait for the shared travel service. It was assumed that a user will have access to smartphone apps which they will use to arrive at the starting point bus stop no more than 5 minutes from the scheduled departure of the shared travel service. This is not applicable to SOV.
- **AccessTime** (minutes) is the time to access the park-ride lot or starting point of the shared travel service (i.e., the "anchor" as described in Appendix C). Access time was assumed to be 15 minutes. This is not applicable to SOV.
- **Cost** is the Cost of the trip in dollars.

The coefficients a, b, c, d, e, and f were taken from CTPS' HBW mode split model and are shown in Table 7[21] below.

TABLE 7 | LOGIT FUNCTION VARIABLES AND COEFFICIENTS

Coefficient	Logit Function Variable	Value
a	IVTT	-0.05466
b	TermTime	-0.292
c	WalkTime	-0.1007
d	WaitTime	-0.11292
e	AccessTime	-0.13665
f	Cost	-0.32

For each shared travel market and the associated highway route, disutility "U" was computed for SOV and for shared travel. The probability of shared travel use was computed using the following equation:

$$Shared\ Travel\ Probablity = \frac{e^{U_t}}{(e^{U_t} + e^{U_a})}$$

Where,

- U_t is the disutility of shared travel.

[21] https://www.ctps.org/data/pdf/about/mpo/recert_2014/CTPS_GLE_Modeling_Method_20130416.pdf, Table 10

- U_a is the disutility of SOV.

The values for TermTime, WalkTime, WaitTime and AccessTime were kept consistent across markets. IVTT and Cost varied across markets.

To verify if the above shared travel probability methodology would result in reasonable estimates, the methodology was initially applied to the shared travel market between Lowell and Burlington as this market has an existing RTA service between the two suburban areas. ACS data from 2012-2016 indicate that roughly 6% of daily commuters to work between these markets use transit.[22] The assumptions utilized for the various parameters as described above were adjusted as necessary until the shared travel probability estimate was 6%. The adjusted parameters in combined with the user cost values discussed above where used to estimate the shared travel probabilities for all identified shared travel markets.

Ridership Score

The next step was to rank the identified shared travel markets, services, and improvements. The markets analysis provided the daily vehicle trips in each shared travel market. Assuming a vehicle occupancy of 1.7[23], the vehicle trips were converted to person-trips.

Assuming that the total daily person-trips are distributed over the 6:00 am to 8:00 pm time period in direct relation to the 80th percentile highway travel time, the person-trips during each minute was estimated. The person-trips during each minute was multiplied by the shared travel probability to estimate the number of shared travel riders for each minute. The ridership for each minute were aggregated for the entire period between 6:00 am and 8:00 pm. This resulted in an estimate of total daily ridership for each shared travel market. Given that the StreetLight dataset is an estimate and may not perfectly represent travel demand, the estimated daily shared travel ridership was normalized by assigned a value of 100 to the highest ridership market and adjusting the rest of the markets.

[22] http://data5.ctpp.transportation.org/ctpp1216/Browse/browsetables.aspx. Table A302103 – Means of Transportation (Workers 16 years and over) was generated for RESIDENCE – Lowell City, and WORKPLACE – Burlington Town

[23]

F SUMMARY OF COMPETITIVNESS FINDINGS FOR LARGEST O/D MARKETS

The appendix consists of a single page for each market, including a description of the route; a list of the improvements assumed for hypothetical shared travel services; a chart of travel times and transit share over the course of an average day; and ultimately the average transit share and ridership score.

Table 8 provides an example of the assumptions for the Woburn to Lowell Market.

TABLE 8 | EXAMPLE COMPETITIVENESS ANALYSIS OUTPUT FOR WOBURN-TO-LOWELL MARKET

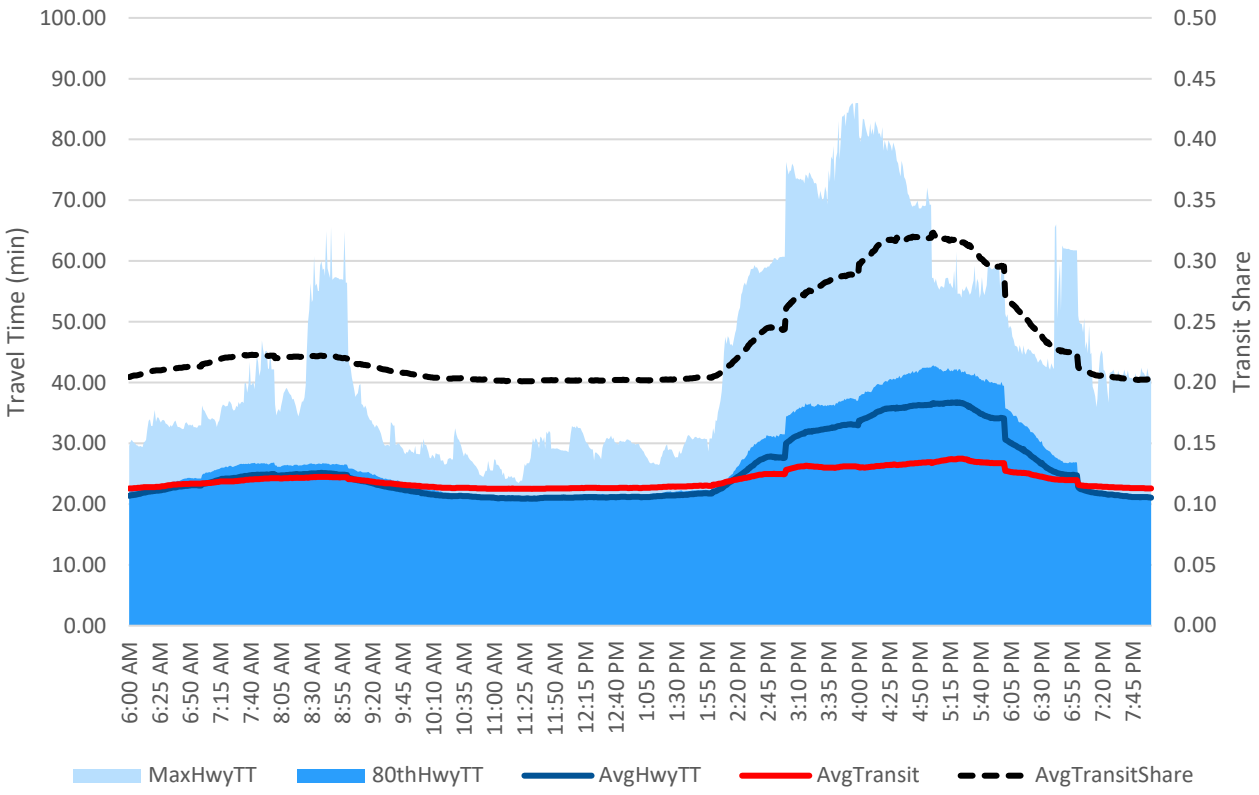
Route Characteristics	
Origin	30 Atlantic Avenue, Woburn
Destination	Lowell Connector at Gorham St
Route	Atlantic Ave -> I-93 SB -> I-95 SB -> Route 3 NB -> Lowell Connector -> Gorham St
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	Route 3 (I-95 to Lowell Connector)
Freeway Bus-on-Shoulder	I-93 (Atlantic Ave to I-95); I-95 (I-93 to Route 3)
Transit Signal Priority (TSP)	Atlantic Ave, Woburn; Lowell Connector, Lowell
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.23
Ridership Score	11,540

The characteristics include the precise origin and destination points assumed for the market (the origin was located at the anchor from Appendix C; the destination was judgment-defined for this step near the center of the cluster of zones making up the destination area), as well as the route between those points on the INRIX XD road network. The characteristics also include two contributors to the SOV cost term in the probability model: the presence of any tolls on segments of the route and any assumed parking fee (parking was assumed to be free for destinations other than North and South Station in Boston).

The locations of surface network infrastructure improvements are noted. **This analysis does not mean to imply that any or all of these improvements are recommended for implementation.** This is a sketch intended only to inform discussion later in the project: "Improvements to the network will make a significant difference from A to B, so we should study each possible improvement more closely to assess its marginal benefit."

Figure 19 provides an example of the travel time histogram for Woburn-to-Lowell.

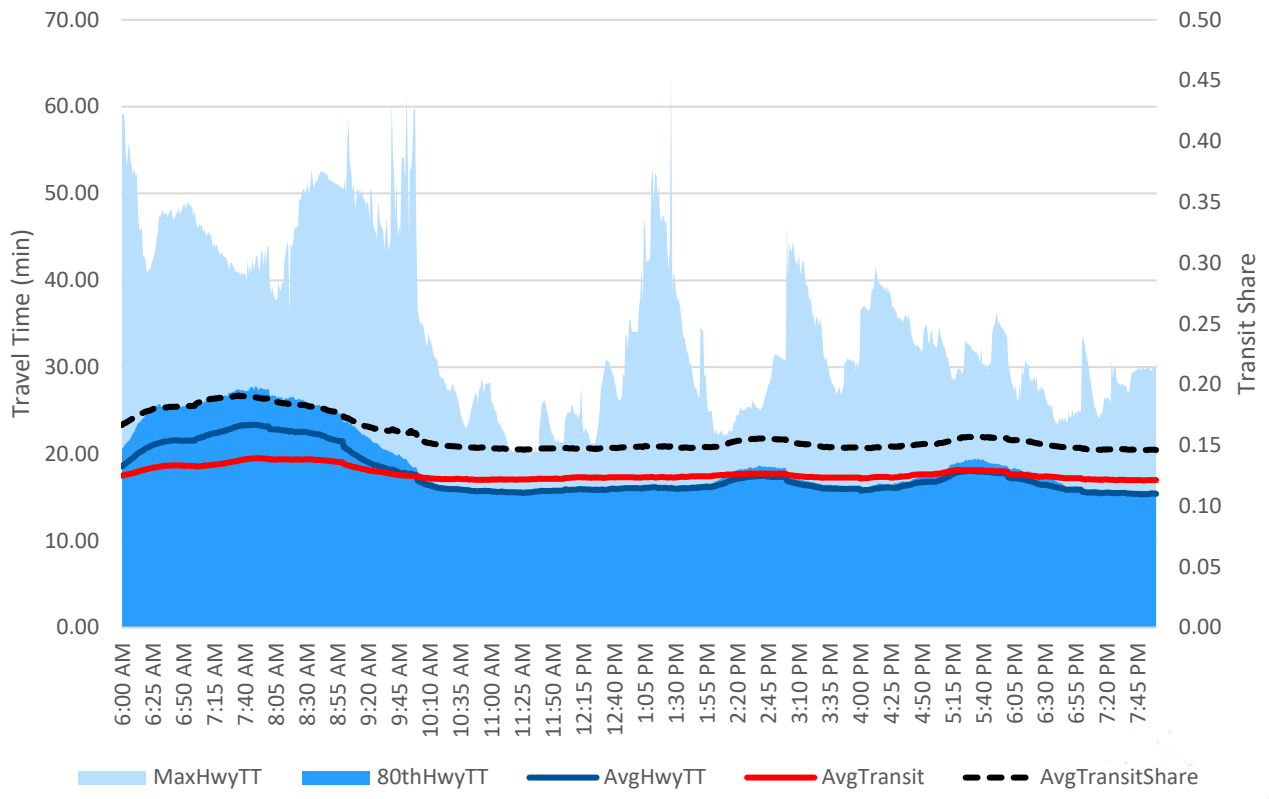
FIGURE 19 | EXAMPLE TRAVEL TIME HISTOGRAM FOR WOBURN-TO-LOWELL



When the blue shaded areas cross the red line, the implication from this analysis is that an improved shared travel service would be faster than driving alone. The black dashed line takes this a step further, using the CTPS-derived model to estimate the transit mode share on the right-hand secondary axis. Note that this very preliminary analysis suggests a maximum mode share of between 15% and 20% in the PM peak hour (up from 6% today), assuming these significant infrastructure improvements.

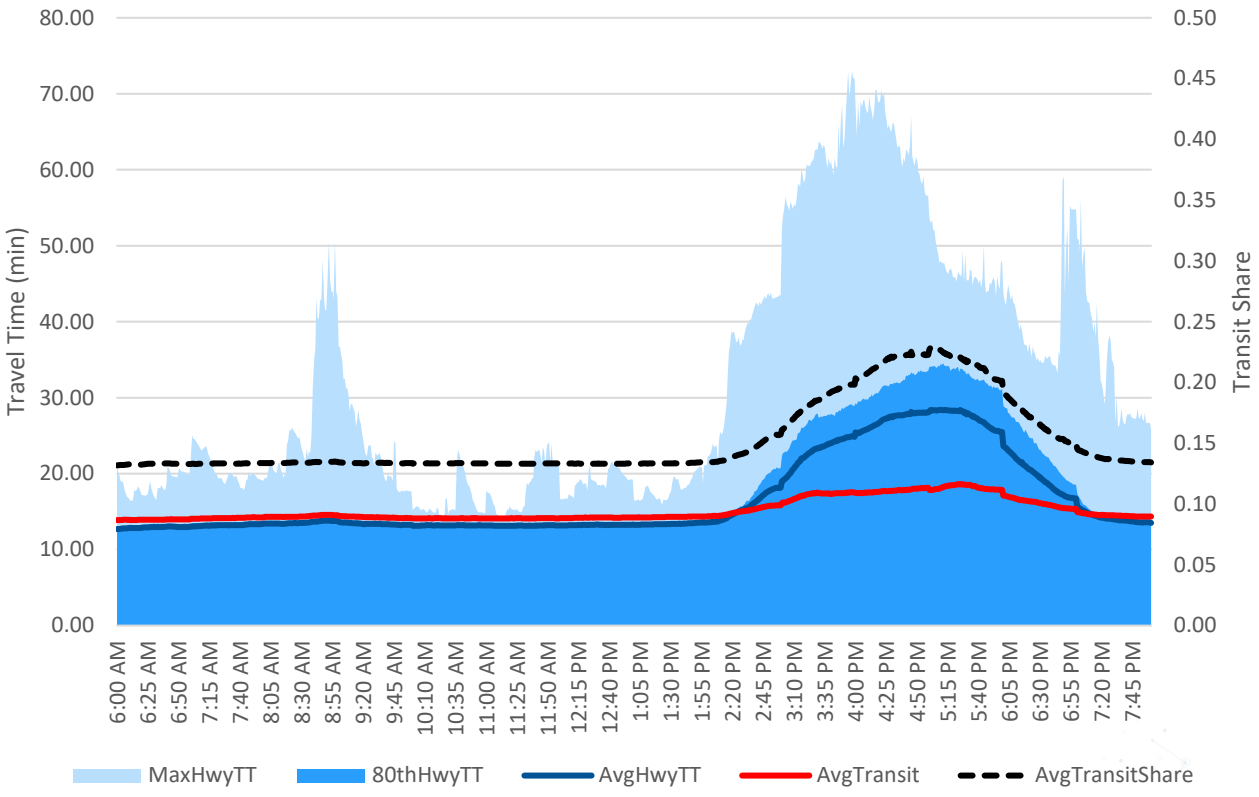
Andover – Burlington

Route Characteristics	
Origin	Andover Park-Ride (Dascomb Rd)
Destination	Burlington Mall
Route	Dascomb Rd -> I-93 SB -> I-95 SB -> Middlesex Turnpike
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	I-93 (Dascomb Rd to I-95); I-95 (I-93 to Route 3)
Transit Signal Priority (TSP)	Middlesex Turnpike, Burlington
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.16
Ridership Score	19



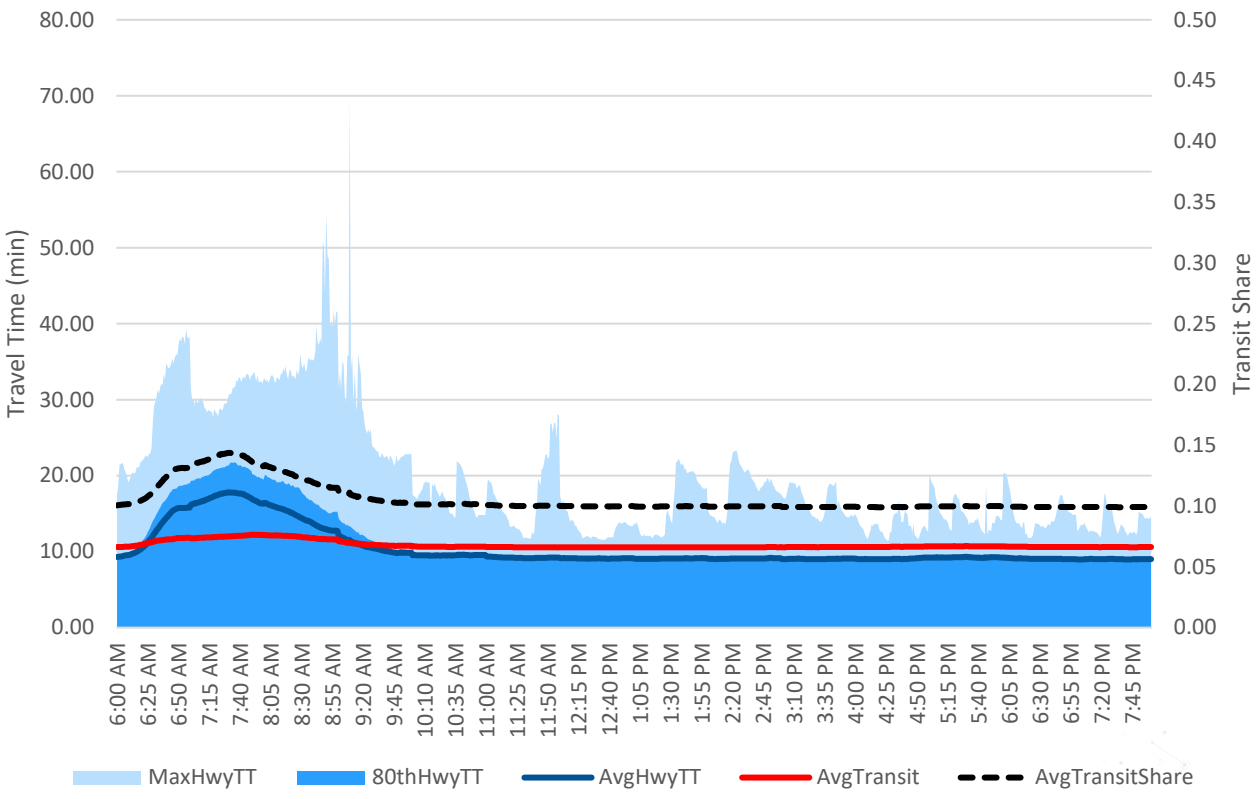
Burlington – Lowell

Route Characteristics	
Origin	Middlesex Turnpike at Mall Rd
Destination	Lowell Connector at Gorham St
Route	Middlesex Turnpike -> I-95 SB -> Route 3 NB -> Lowell Connector -> Gorham St
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	Route 3 (I-95 to Lowell Connector)
Freeway Bus-on-Shoulder	None
Transit Signal Priority (TSP)	Middlesex Turnpike, Burlington
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.15
Ridership Score	54



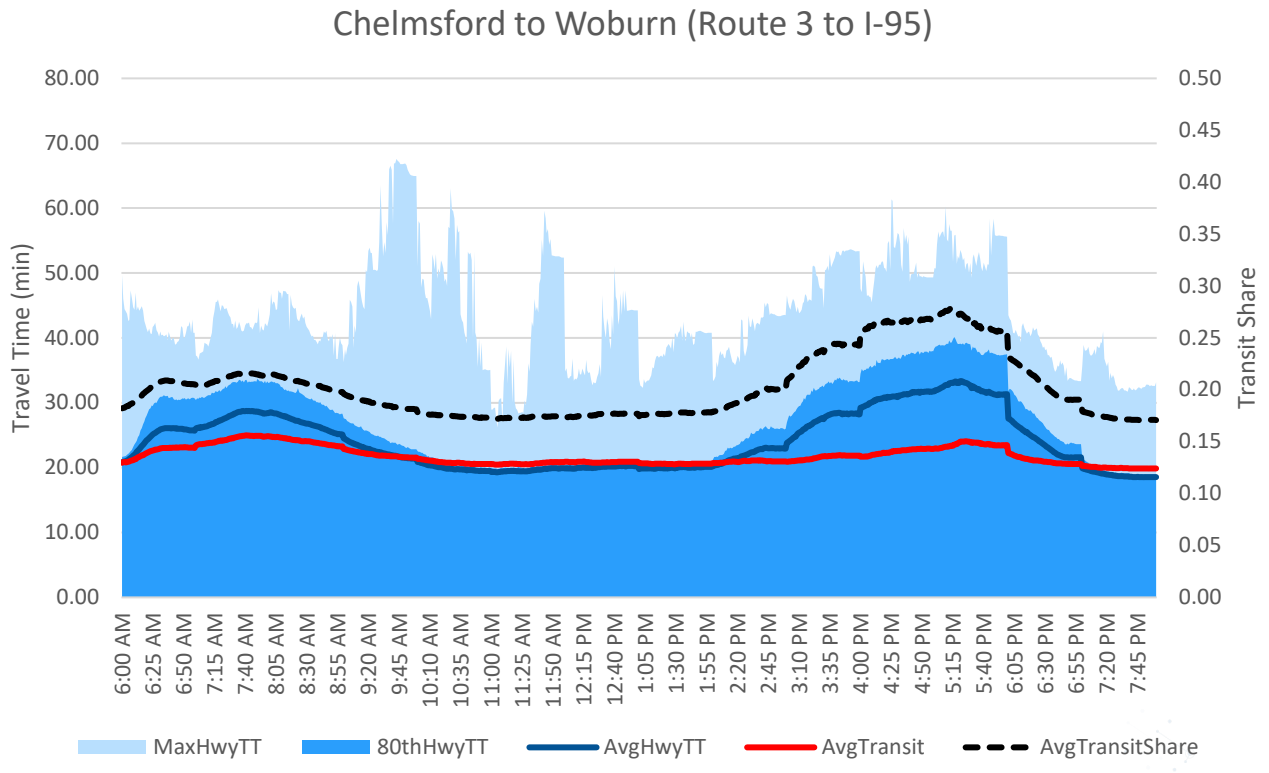
Canton – Needham

Route Characteristics	
Origin	Canton Park-Ride
Destination	Kendrick St at Third Ave, Needham
Route	Route 138 SB -> I-93 SB -> I-95 NB -> Kendrick St
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	I-93 (Route 138 to I-95); I-95 (I-93 to Kendrick St)
Transit Signal Priority (TSP)	Route 128, Canton; Kendrick St, Needham
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.11
Ridership Score	7



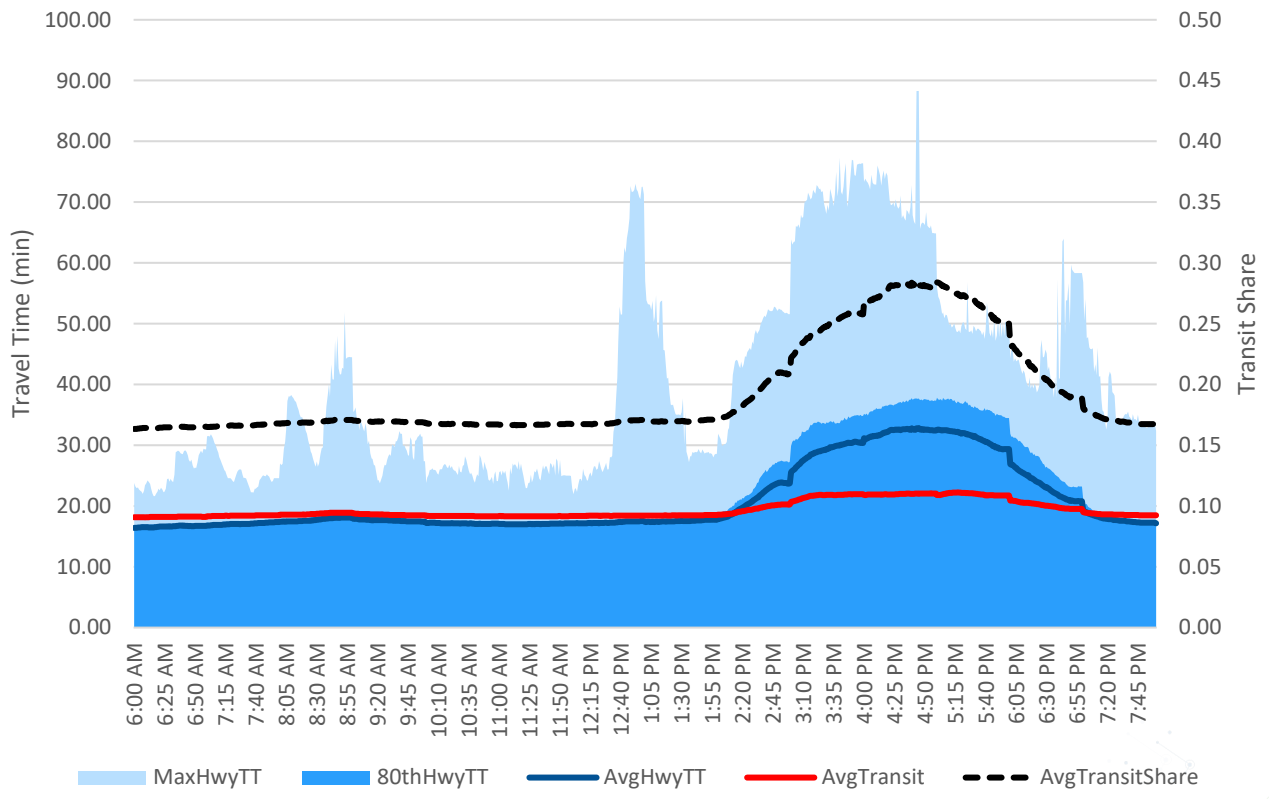
Chelmsford-Woburn

Route Characteristics	
Origin	Industrial Ave at Lowe's Way
Destination	Woburn Village (296 Mishawum Road)
Route	Industrial Ave -> Lowell Conn -> Rte 3 SB -> I-95 NB -> Washington St -> Mishawum Rd
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	Route 3 (Lowell Connector to I-95)
Freeway Bus-on-Shoulder	I-95 (Route 3 to Washington St Exit)
Transit Signal Priority (TSP)	Washington St, Woburn; Mishawum Rd, Woburn
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.20
Ridership Score	28



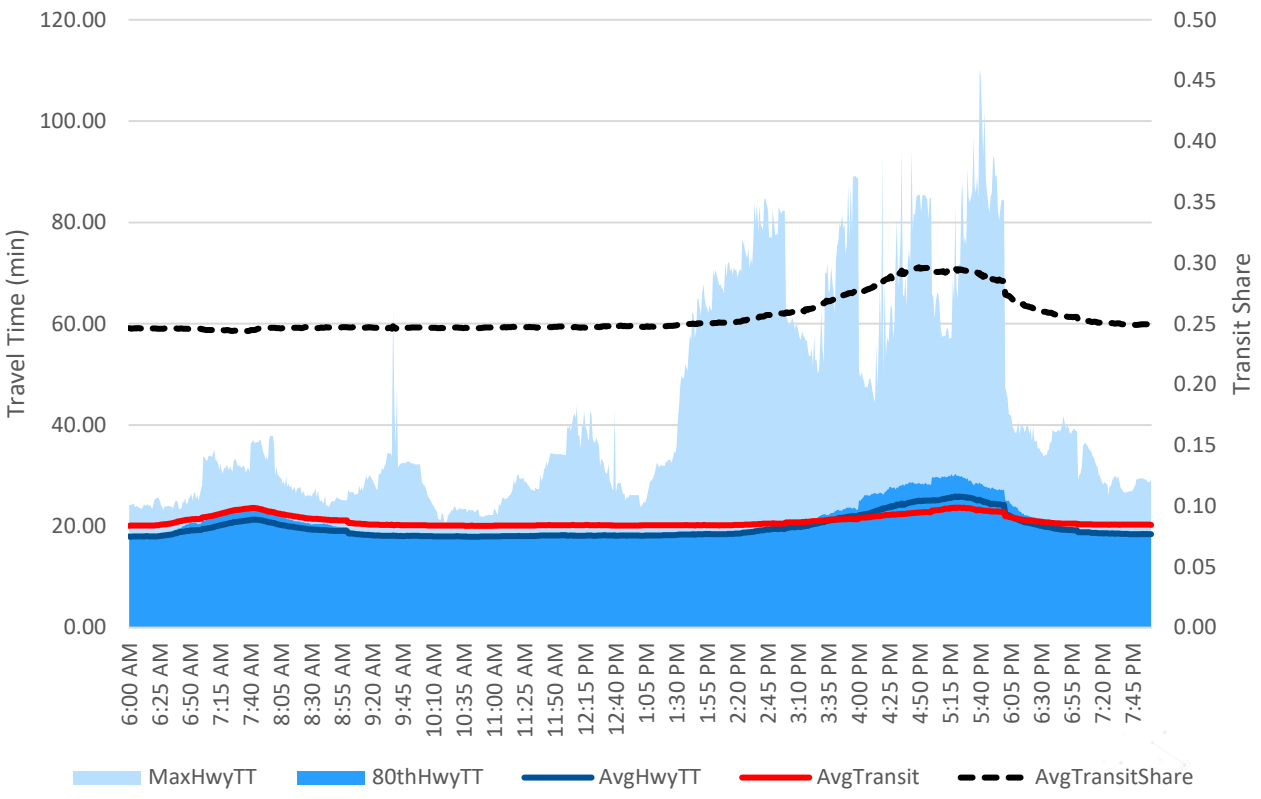
Lexington-Lowell

Route Characteristics	
Origin	Route 2A at Forbes Rd, Lexington
Destination	Lowell Connector at Gorham St
Route	Route 2A EB -> I-95 NB -> Route 3 NB -> Lowell Connector -> Gorham St
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	Route 3 (I-95 to Lowell Connector)
Freeway Bus-on-Shoulder	I-95 (Route 2A to Route 3)
Transit Signal Priority (TSP)	Lowell Connector, Lowell
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.19
Ridership Score	13



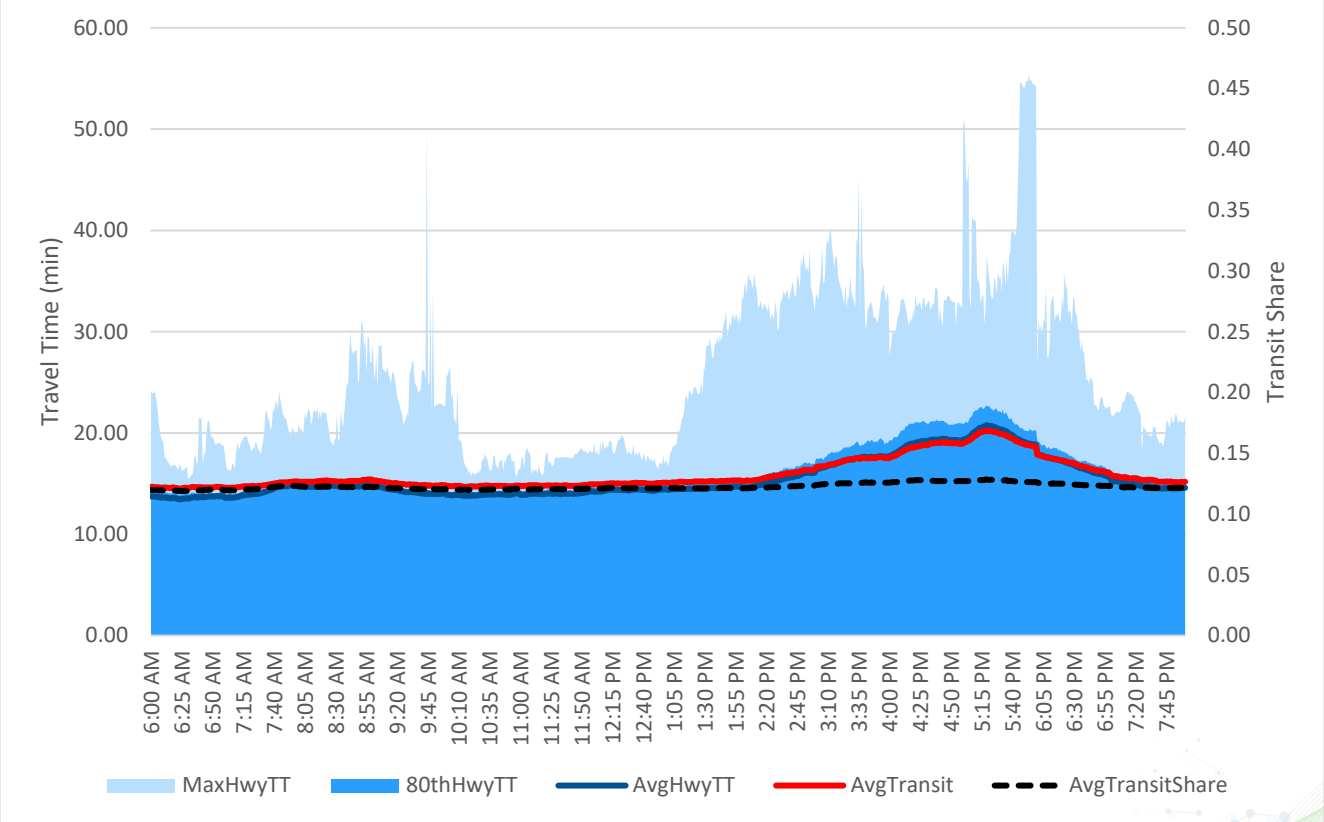
Natick – Marlborough via I-90

Route Characteristics	
Origin	Shopper's World, Natick
Destination	Simarano Dr at Cedar Hill Rd, Marlbourgh
Route	Route 30 -> I-90 WB -> I-495 NB -> Simarano Dr
Toll	Yes, on I-90
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	I-90 (Route 30 to I-495)
Transit Signal Priority (TSP)	Simarano Dr, Marlborough
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.26
Ridership Score	15



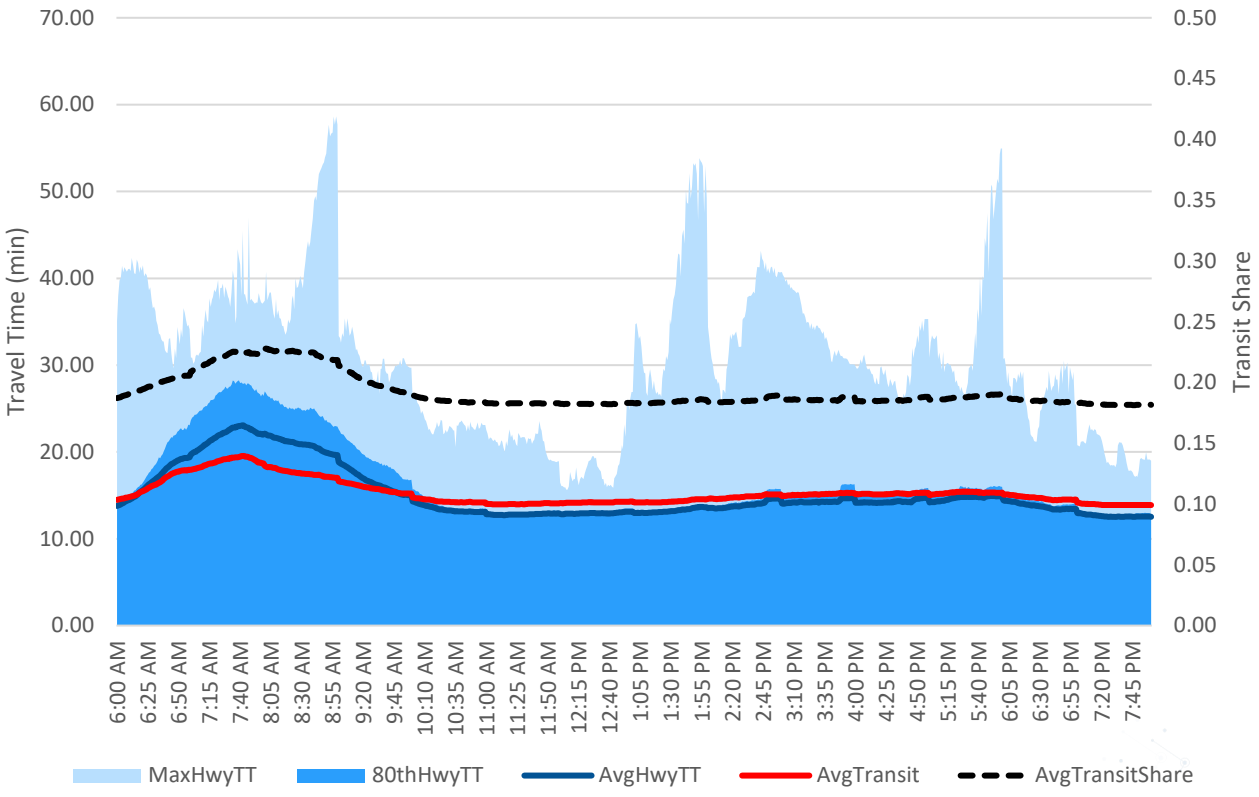
Natick – Marlborough via MA-9

Route Characteristics	
Origin	Shopper's World, Natick
Destination	Simarano Dr at Cedar Hill Rd, Marlbourgh
Route	Route 9 -> I-495 NB -> Simarano Dr
Toll	Yes, on I-90
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	None
Transit Signal Priority (TSP)	Route 9, Natick; Simarano Dr, Marlborough
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.12
Ridership Score	7



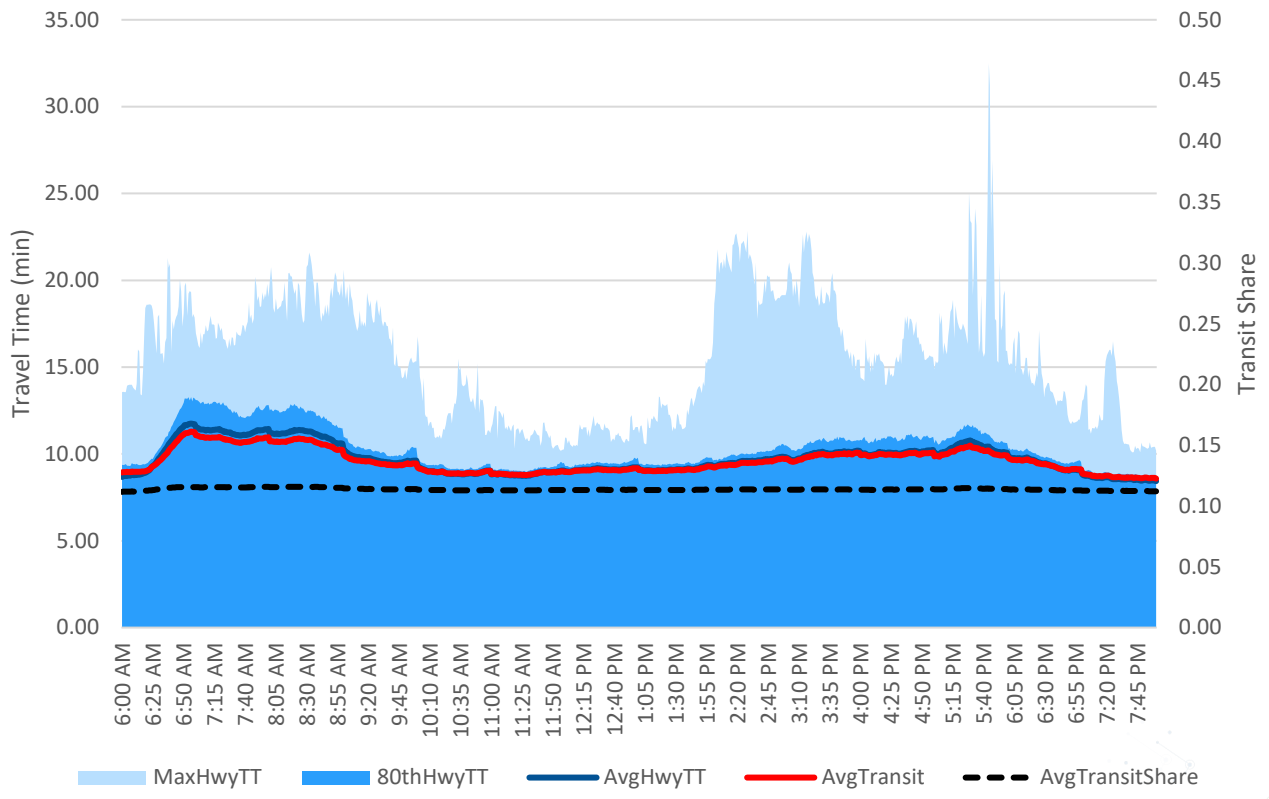
Natick – Needham via I-90

Route Characteristics	
Origin	Shopper's World, Natick
Destination	Kendrick St at Third Ave, Needham
Route	Route 30 -> I-90 EB -> I-95 SB -> Kendrick St
Toll	Yes, on I-90
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	I-90 (Route 30 to I-95); I-95 (I-90 to Kendrick St)
Transit Signal Priority (TSP)	Route 30, Natick; Kendrick St, Needham
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.19
Ridership Score	9



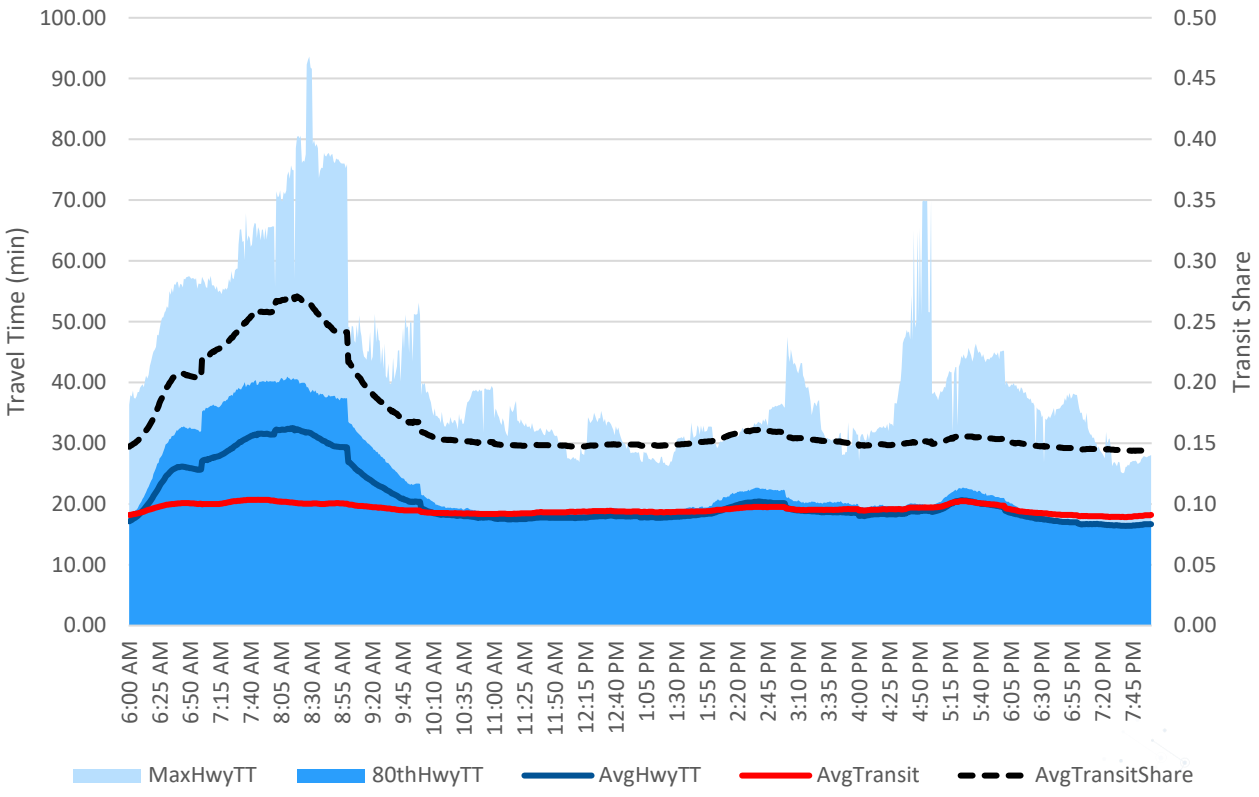
Natick – Needham via MA-9

Route Characteristics	
Origin	Shopper's World, Natick
Destination	Kendrick St at Third Ave, Needham
Route	Route 9 -> I-95 SB -> Kendrick St
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	I-95 (Route 9 to Kendrick St)
Transit Signal Priority (TSP)	Route 9, Natick & Wellesley
TSP + Queue Jump Lane	Route 9, Natick & Wellesley
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.11
Ridership Score	5



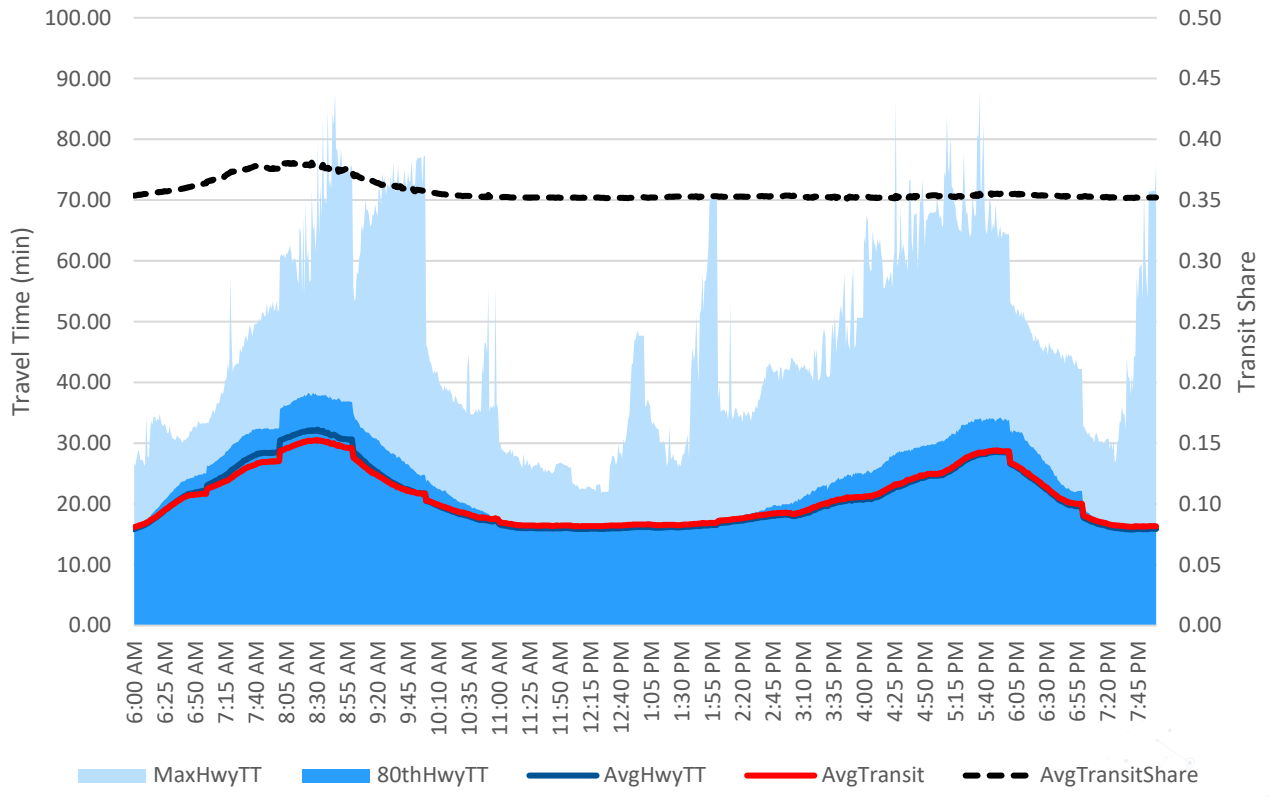
Peabody - Burlington

Route Characteristics	
Origin	Peabody Logan Express
Destination	Burlington Mall
Route	US Route 1 -> I-95 SB -> Middlesex Turnpike
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	I-95 (US Route 1 to Route 3)
Transit Signal Priority (TSP)	Middlesex Turnpike, Burlington
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.17
Ridership Score	8



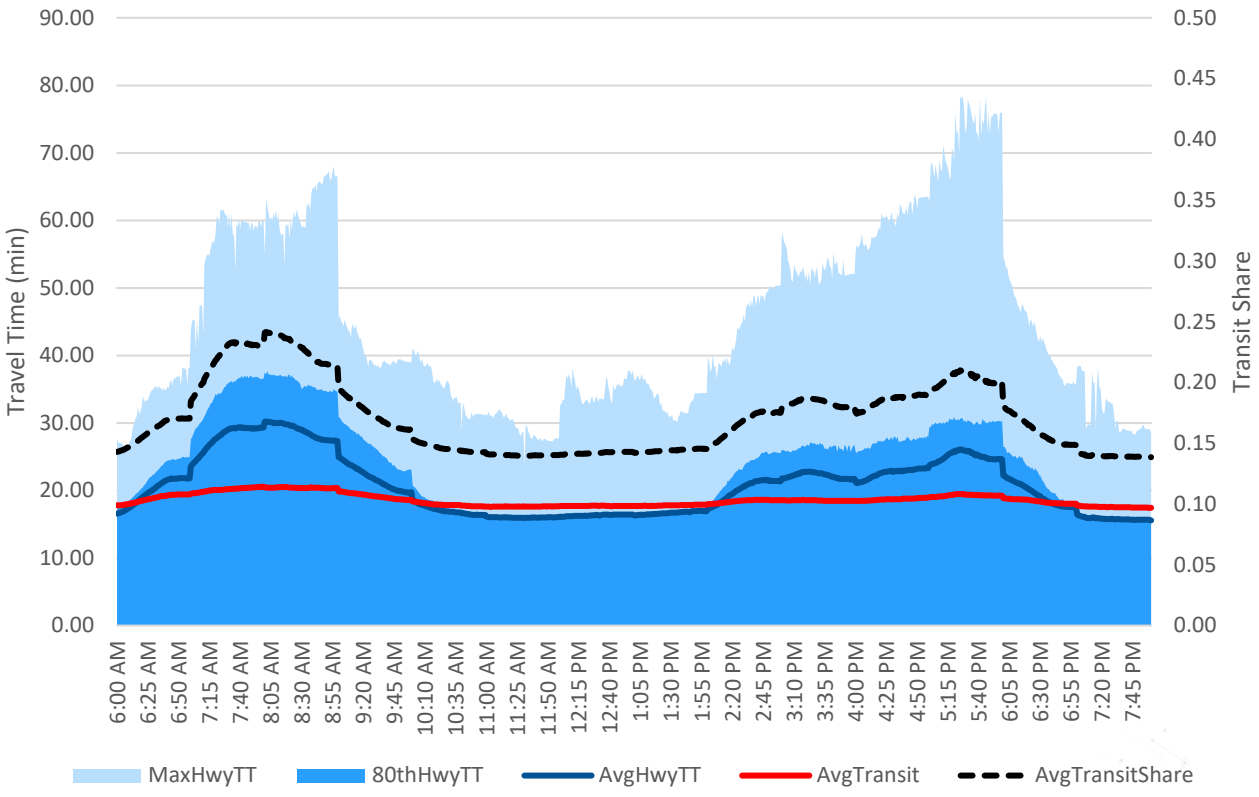
Weston – South Station

Route Characteristics	
Origin	Weston Park-Ride
Destination	South Station, Boston (Atlantic Ave at Summer St)
Route	I-90 EB -> Atlantic Ave
Toll	Yes, on I-90
Parking Cost	Yes
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	
Transit Signal Priority (TSP)	Atlantic Ave, Boston
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.36
Ridership Score	20



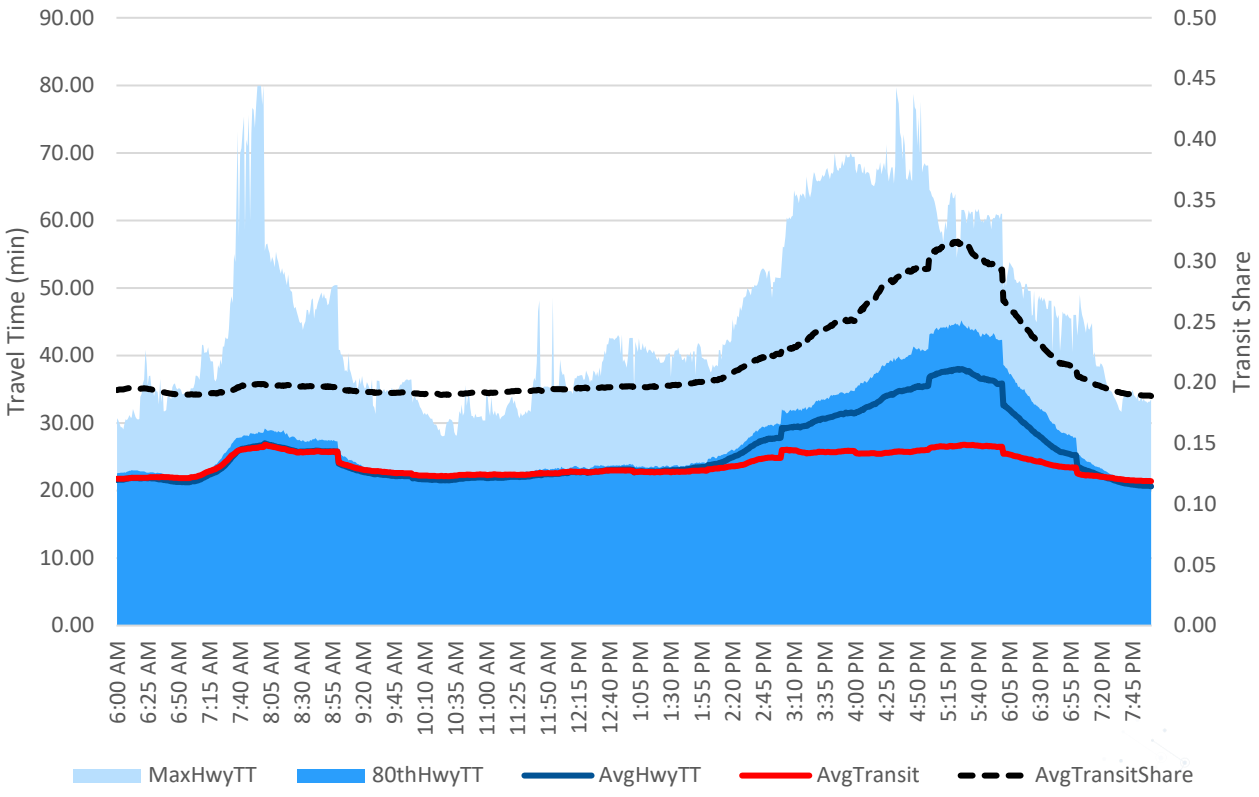
Woburn - Waltham

Route Characteristics	
Origin	30 Atlantic Avenue, Woburn
Destination	Winter St at West St, Waltham
Route	Atlantic Ave -> I-93 SB -> I-95 SB -> Winter St
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	I-93 (Atlantic Ave to I-95); I-95 (I-93 to Winter St)
Transit Signal Priority (TSP)	Atlantic Ave, Woburn; Winter St, Waltham
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.17
Ridership Score	18



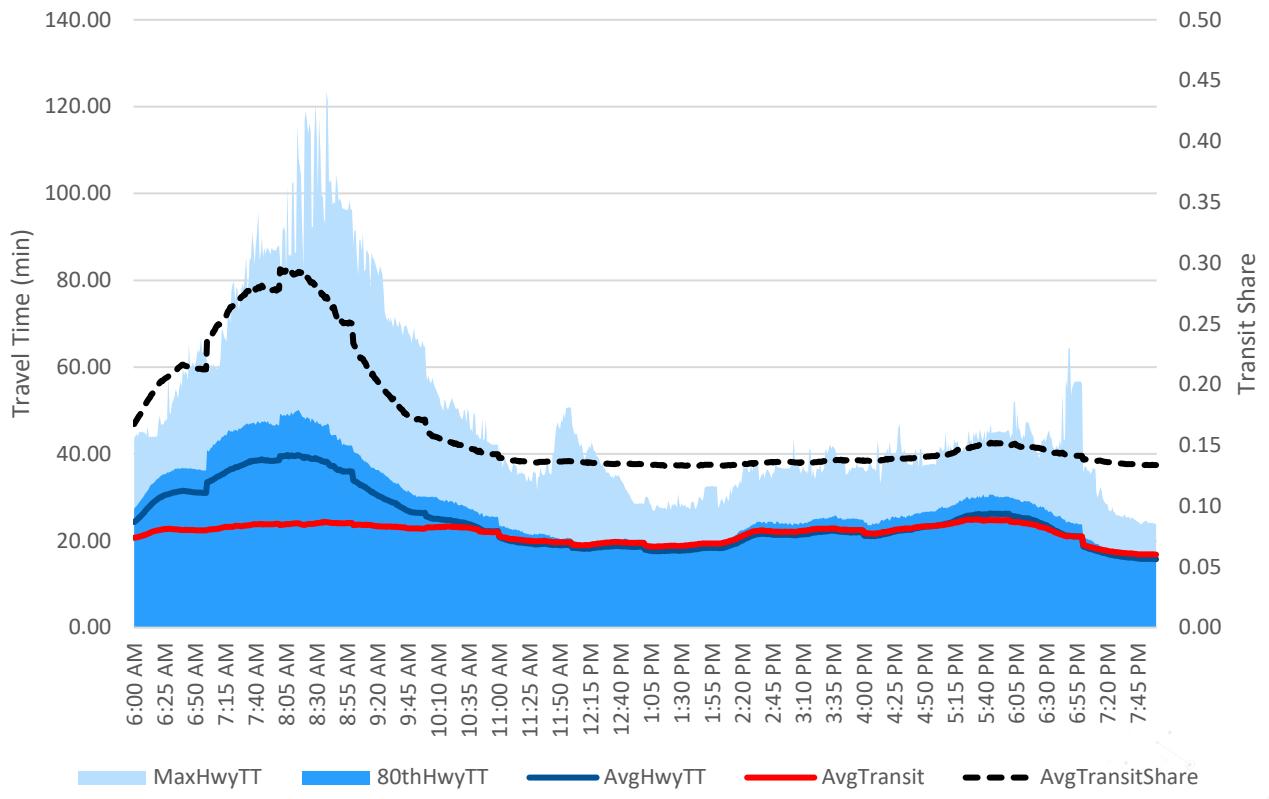
Woburn - Beverly

Route Characteristics	
Origin	30 Atlantic Avenue, Woburn
Destination	Cummings Center, Balch St, Beverly
Route	Atlantic Ave -> I-93 SB -> I-95 NB -> Route 128 NB -> Dodge St -> Cabot St
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	I-93 (Atlantic Ave to I-95); I-95 (I-93 to US Route 1)
Transit Signal Priority (TSP)	Atlantic Ave, Woburn; Dodge St/Cabot St, Beverly
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.22
Ridership Score	20



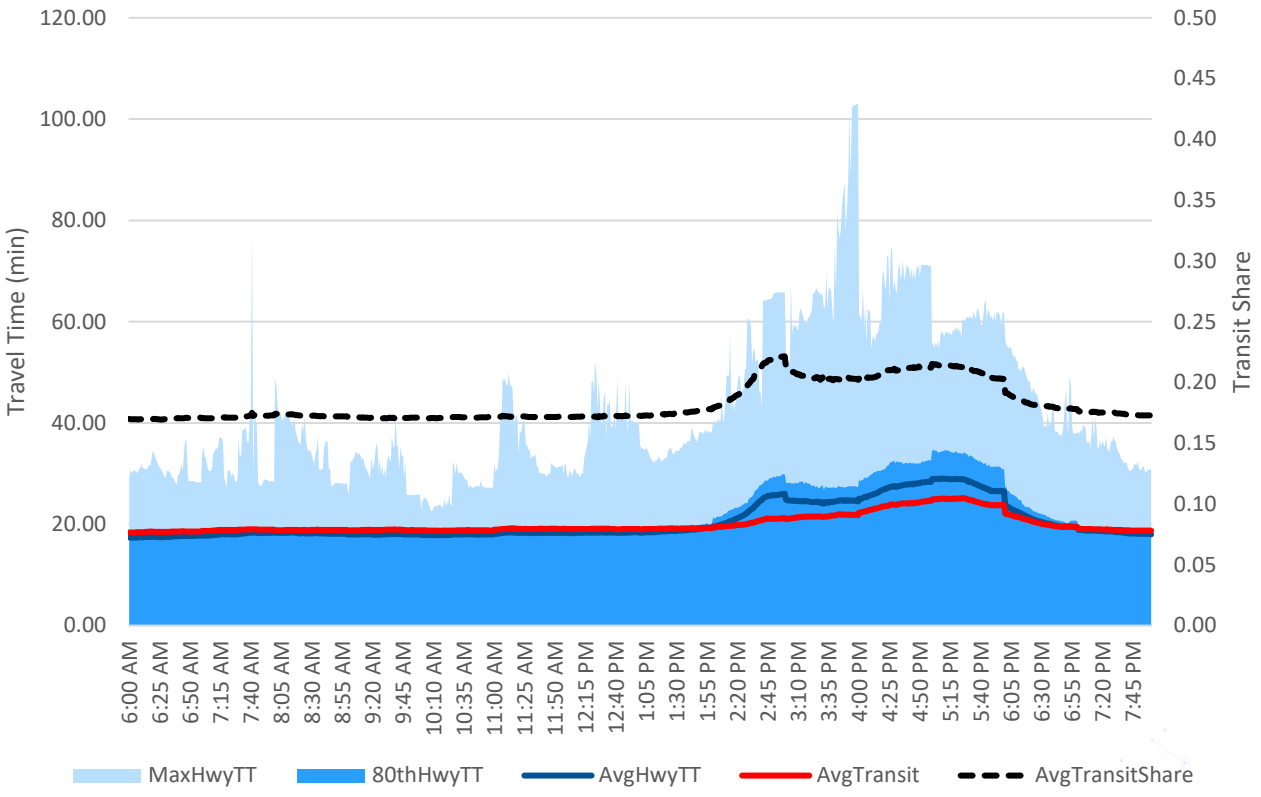
Woburn – Kendall Square

Route Characteristics	
Origin	30 Atlantic Avenue, Woburn
Destination	Kendall Square, Cambridge
Route	Atlantic Ave -> I-93 SB -> Storrow Dr -> Longfellow Bdg -> Broadway
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	I-93 (Atlantic Ave to Storrow Dr Exit)
Transit Signal Priority (TSP)	Atlantic Ave, Woburn; Broadway, Cambridge
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.27
Ridership Score	61



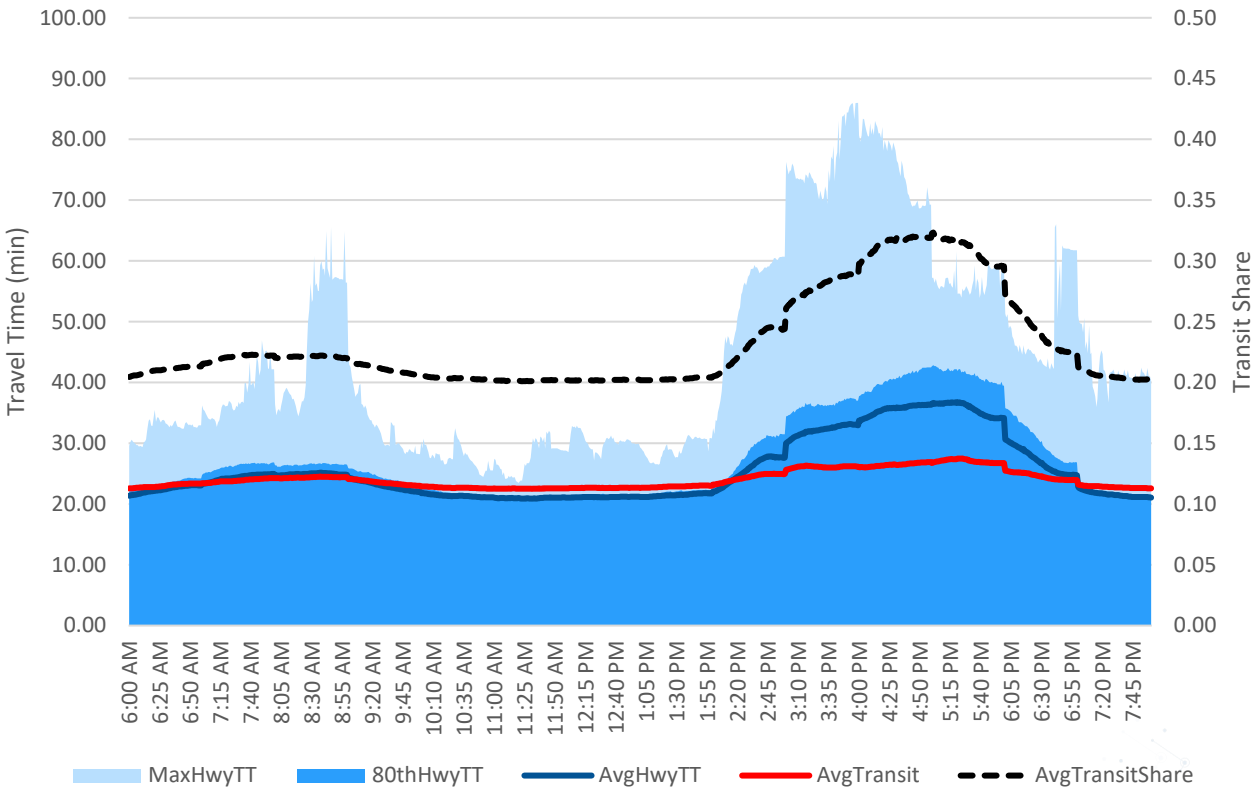
Woburn – Lawrence

Route Characteristics	
Origin	30 Atlantic Avenue, Woburn
Destination	Canal St at Union St, Lawrence
Route	Atlantic Ave -> I-93 NB -> I-495 NB -> Marston St -> Canal St
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	I-93 (Atlantic Ave to I-495)
Transit Signal Priority (TSP)	Atlantic Ave, Woburn; Marston St/Canal St, Lawrence
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.18
Ridership Score	15



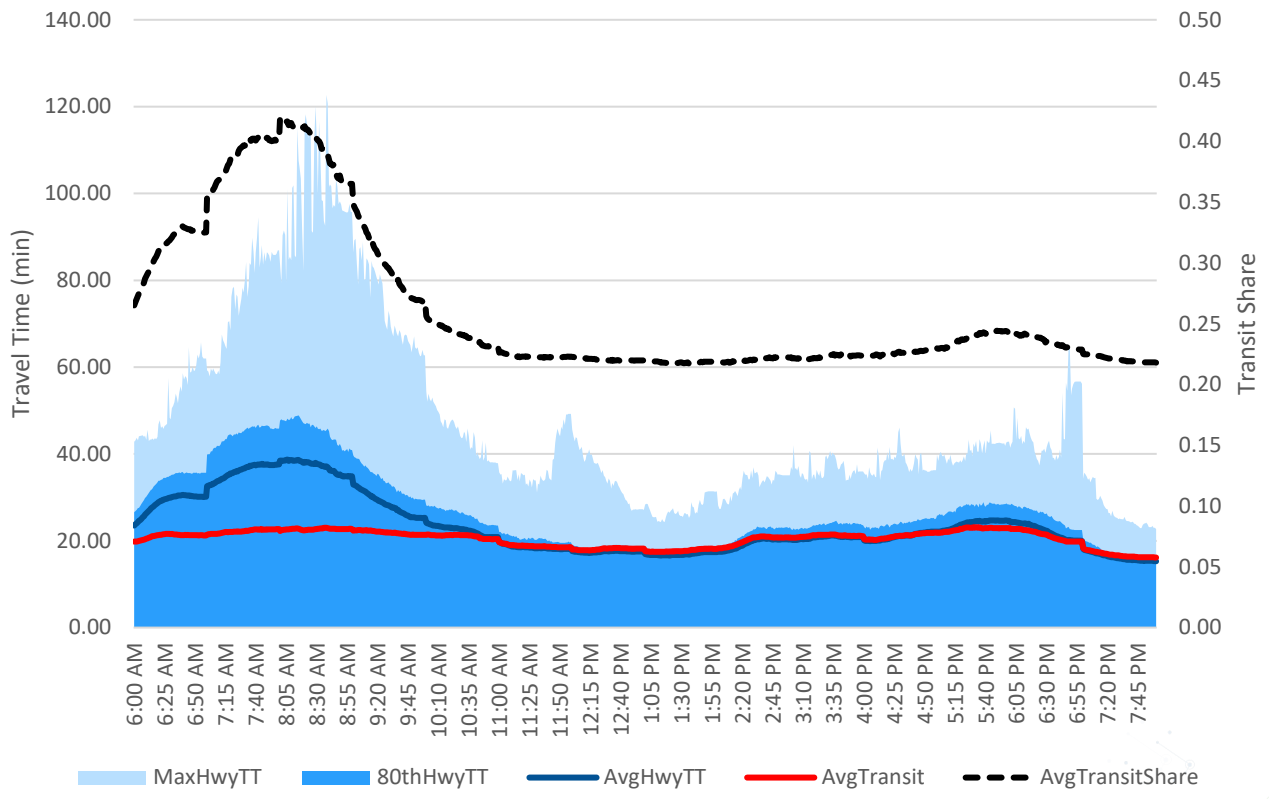
Woburn – Lowell

Route Characteristics	
Origin	30 Atlantic Avenue, Woburn
Destination	Lowell Connector at Gorham St
Route	Atlantic Ave -> I-93 SB -> I-95 SB -> Route 3 NB -> Lowell Connector -> Gorham St
Toll	None
Parking Cost	None
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	Route 3 (I-95 to Lowell Connector)
Freeway Bus-on-Shoulder	I-93 (Atlantic Ave to I-95); I-95 (I-93 to Route 3)
Transit Signal Priority (TSP)	Atlantic Ave, Woburn; Lowell Connector, Lowell
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.23
Ridership Score	100



Woburn – North Station

Route Characteristics	
Origin	30 Atlantic Avenue, Woburn
Destination	North Station, Boston (Causeway St at Staniford St)
Route	Atlantic Ave -> I-93 SB -> I-95 SB -> Route 3 NB -> Lowell Connector -> Gorham St
Toll	None
Parking Cost	Yes
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	None
Freeway Bus-on-Shoulder	I-93 (Atlantic Ave to Storrow Dr Exit)
Transit Signal Priority (TSP)	Atlantic Ave, Woburn; Nashua St & Staniford St, Boston
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.17
Ridership Score	39



Woburn – South Station

Route Characteristics	
Origin	30 Atlantic Avenue, Woburn
Destination	South Station, Boston
Route	Atlantic Ave -> I-93 SB -> Purchase St -> Summer St @ Atlantic Ave
Toll	None
Parking Cost	Yes
Assumed Surface Network Improvements for Shared Travel Service	
Freeway Managed Lane	I-93 (Route 16 to Zakim Bridge)
Freeway Bus-on-Shoulder	I-93 (Atlantic Ave to Route 16)
Transit Signal Priority (TSP)	Atlantic Ave, Woburn; Purchase St, Boston; Summer St, Boston
TSP + Queue Jump Lane	None
TSP + Dedicated Bus Lane	None
Top Line Findings for this Market	
Average Transit Share	0.29
Ridership Score	31