Logan Airport Parking Freeze Amendment Ground Access and Trip Reduction Strategy Studies

A Report to the Massachusetts Department of Environmental Protection

Prepared by Massport, 2019

bostonlogan massport

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LIST OF ABBREVIATIONS

ACRP	Airport Cooperative Research Program
API	Application Programming Interface
APM	Automated People Mover
AV	Automated Vehicle
BOS	Boston Logan International Airport
CMR	Code of Massachusetts Regulations
CTF	Centralized Transportation Facility
CV	Connected Vehicle
DCA	Ronald Reagan Washington National Airport
EDR	Environmental Data Reports
EPA	Environmental Protection Agency
eVTOL	Electric Vertical Takeoff and Landing
EWR	Newark Liberty International Airport
HKG	Hong Kong International Airport
HOV	High-Occupancy Vehicle
IAD	Dulles International Airport
JFK	John F. Kennedy International Airport
LAWA	Los Angeles World Airports
LAX	Los Angeles International Airport
LGA	LaGuardia Airport
LGW	Gatwick Airport
LHR	Heathrow Airport
LOS	Level-of-Service
MaaS	Mobility-as-a-Service
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
Massport	Massachusetts Port Authority
MBTA	Massachusetts Bay Transportation Authority

MCMS	Mode Choice Model and Simulator
MIA	Miami International Airport
ML	Mixed Logit
MNL	Multinomial Logit
MOD	Mobility-on-Demand
NAAQS	National Ambient Air Quality Standards
NL	Nested Logit
O-D	Origin-Destination
PANYNJ	Port Authority of New York and New Jersey
PHL	Philadelphia International Airport
Ride App	Ride-Hailing Services (e.g., Uber and Lyft)
RTD	Regional Transportation District
SAN	San Diego International Airport
SEA	Seattle-Tacoma International Airport
SFO	San Francisco International Airport
SOV	Single-Occupancy Vehicle
SP	Stated Preference
TCRP	Transit Cooperative Research Program
TSA	Transportation Security Administration
VMT	Vehicle Miles Traveled

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Executive Summary

Project Background and Purpose

The following sections provide an overview of Boston Logan International Airport (hereafter the Airport or Logan Airport), a domestic and international airport located in East Boston and Winthrop, Massachusetts, and briefly describe the history of the Logan Airport Parking Freeze (Parking Freeze), including the 2017 Parking Freeze Amendment.

Overview of Logan Airport

The Massachusetts Port Authority (hereafter Massport or the Authority) owns and operates Logan Airport. It is New England's busiest airport, serving more than 40.9 million air passengers in 2018. Massport continuously strives to refine and improve its ground access plan and trip reduction strategy. Specifically, Massport's ground transportation strategy utilizes transit, being served by the Massachusetts Bay Transportation Authority's (MBTA's) Airport Station on the Blue Line. The Airport is well served by several ground access modes. In addition to public transit, modes serving the Airport include high-occupancy vehicle (HOV) modes like Massport's Logan Express network, which would be the seventh largest regional transit authority by ridership, free outbound MBTA Silver Line service, scheduled buses and vans, water transportation (ferry), courtesy shuttle buses, and charter buses. The Airport is also served by private automobiles, unscheduled private black car limousines and vans, taxis, rental cars, and ride apps. Massport owns and operates structured and surface commercial parking facilities at the Airport.

Massport prioritizes a reduction in private vehicles that access the Airport via environmentally undesirable drop-off/pickup modes. These trips generate up to four vehicle trips per passenger instead of just two vehicle trips for passengers who drive and park. Reducing vehicle miles traveled and their associated emissions requires utilizing the appropriate amount of available on-Airport parking.

2017 Parking Freeze Amendment and Studies

In 1975, the US Environmental Protection Agency (EPA), in cooperation with public agencies in Massachusetts, developed a transportation control plan for the

state, to be implemented under the federal Clean Air Act of 1963,[1] which included: 1) incentive programs to reduce single-passenger, commuter vehicle use; and 2) the Parking Freeze. These measures were intended to reduce automobile emissions and to enable Massachusetts to achieve compliance with the EPA's National Ambient Air Quality Standards (NAAQS) for carbon monoxide at localized sites and for ozone. EPA has designated all of Massachusetts as attainment/unclassifiable for the 2015 ozone NAAQS.

Logan Airport is the only airport in the nation subject to a parking freeze, which limits the number of commercial (i.e., for departing air passengers) and employee parking spaces available for use at the Airport. The Parking Freeze was substantially amended in June 2017 when the Massachusetts Department of Environmental Protection submitted amendments to the Parking Freeze as a formal revision to the Massachusetts State Implementation Plan. The revised Parking Freeze increases the total number of commercial spaces in the Parking Freeze area by 5,000 spaces to a total of 26,088 spaces (the 2017 Parking Freeze Amendment).

Consistent with prior amendments, the 2017 Parking Freeze Amendment specified that Massport was to conduct three ground access studies within the following 24 months to aid in the continual development of its Logan Airport Ground Access and Trip Reduction Strategy.

1. **Study #1: Logan Airport Ground Access HOV Services**. A study of the costs, feasibility, and effectiveness of potential measures to improve HOV access to the Airport. This study shall consider, among other things, possible improvements to Logan Express bus service and the benefits of increasing MBTA Silver Line buses with service to the Airport.

2. **Study #2: Logan Airport Ground Access HOV Pricing**. A study of the costs and pricing for different modes of transportation to and from the Airport to identify a pricing structure and evaluate allocation of revenues generated to promote HOV modes of transportation by air travelers and visitors at the Airport. This study shall include an evaluation of short- and long-term parking rates and their influence on different modes of ground access transportation to and from the Airport.

[1] 42 U.S.C. § 7401.

3. **Study #3: Logan Airport Ground Access and Reducing Non-HOV Operations**. A study of the feasibility and effectiveness of potential operational measures to reduce non-HOV drop-off/pickup modes of transportation to the Airport, including an evaluation of emerging ride app and other ride-hailing/ridesharing modes.

Summary of Methods and Approach

Massport developed a comprehensive framework to conduct the three ground access studies required as part of the 2017 Parking Freeze Amendment. The framework was developed using the following broad steps:

- Identify and develop potential policies that Massport could implement to address the HOV goals of the Logan Airport Parking Freeze Amendment Ground Access and Trip Reduction Strategy and its three studies.
- Review case studies and best practices to determine lessons learned for the Airport.
- Develop an analytical framework to evaluate each policy using a consistent set of metrics.
- Collect data and build tools to support the policy analysis.
- Summarize the results of the policy analysis within the analytical framework.

Policy Development

The study team worked closely with a diverse group of Massport staff to develop a set of policy variables that could influence traveler preferences for HOV ground access modes to the Airport. The study team identified a set of policy variables appropriate for each of the three ground access studies and analyzed combinations of relevant policy variables for each study.

Case Studies and Relevant Practices

The study team evaluated each policy variable in the context of relevant practices from other domestic and international airports. The case studies helped identify the policy variables that may have the greatest effect on HOV ridership based on successful implementation elsewhere.

Analytical Framework

The study team developed an analytical framework to evaluate the effects of each policy variable across several criteria, including the following:

- Ground access mode choice.
- Revenues and costs.
- Operations.
- Customer service.
- Air quality.
- Community and stakeholders.

Policy Tools

The study team reviewed existing data, conducted primary research, and developed tools to help Massport understand the effects of the policy scenarios on ground access mode choice and travel demand. The primary policy tool, the Mode Choice Model and Simulator (MCMS), used stated and revealed preference data,[2] derived from the fall 2018 Logan Air Passenger Ground Access Survey (hereafter the 2018 Passenger Survey), to build a mode choice model. The MCMS predicts the changes in share for each transportation mode that would occur with a given set of policy variables and simulates the likely changes in mode share.

While policy variables can be individually simulated using the MCMS, most variables change in combination with other variables. For example, to encourage more Logan Express ridership, a combination of policies like increasing Logan Express frequency, adding amenities, and adjusting pricing could be complementary. In short, many cases exist where a policy is not one change but a "package" of changes to obtain the desired policy outcome.

[2] Data detailing what people might do (hypothetical) and did do (observational), respectively.

Summary of Findings

This report describes policies and their effects, often by combining policy variables, to obtain optimal outcomes to enhance Massport's strategic goals. It describes the methods by which these combinations are derived to establish a framework for any future policy development and decisions by Massport on what ground access strategies to next implement.

The first policy development protocol tests each variable on its own to understand the sensitivities and effects each variable has on ground access mode choice. It then considers developing policy initiatives that are realistic and include logical variable combinations. Since Logan Airport already achieves one of the highest ground access HOV shares in the country, it becomes increasingly difficult to increase HOV share (law of diminishing returns). Thus, even policy variables with small effects, but that are relatively easy to implement (e.g., allowing a prioritized security line for those accessing the Airport via HOV modes), are worth considering.

The following report provides a detailed background and introduction to the Parking Freeze and includes the results of the Massachusetts Department of Environmental Protection-mandated studies (Study #1, Study #2, and Study #3). Each chapter details the actions taken and the results for each scenario. Each chapter can be read independently of the others, which results in some information being repeated across chapters; this is intentional.

Summary of Recent Implementation of the Logan Trip Reduction Strategy

This report describes the methods and approach employed by the study team to conduct each of the three studies. It also describes the data, tools, and analysis used for each study and the results and outcomes from each study. The studies' outcomes have already informed decision-making within Massport and have led to the development and recent implementation of the following ground access services and policies:

- **Additional Logan Express service**, which included relocating and revising Back Bay service to provide riders with priority access at the Airport[3] security screening for Back Bay users (2019), increasing service frequency from Back Bay and Braintree (2019), planning for new service from North Station (to be implemented in 2020), and planning for a possible new Logan Express suburban site thereafter.
- **Revised ride app ground access policies and fees**, which included consolidating ride app operations at dedicated areas on the ground floor of the Central/West Garage, implementing a new Airport ride app drop-off fee of $3.25 (in addition to the current $3.25 pickup fee), and providing a discounted fee of $1.50 for shared-ride (such as UberPool and Lyft Line) customers.

[3] This service is free to passengers leaving Logan Airport and $3 for those coming to Logan Airport. Prior to this policy change, the service was priced at $7.50 each way, with a discounted $5 fare for riders presenting a valid MBTA pass.

Introduction

This chapter provides an overview of the 2017 Parking Freeze Amendment, including the three required studies. It also includes a discussion of Massport's ongoing trip reduction strategies and improvements to high-occupancy vehicle (HOV) access modes, several of which have already been fully implemented.

2017 Parking Freeze Amendment

Considerable study and analysis in recent years has shown growth in passenger volume. Coupled with the fixed supply of parking spaces, this growth is beginning to have counter effects by increasing the number of drop-off/pickup trips for air passengers accessing the Airport, which is the exact effect the original regulation was intended to offset. In effect, this doubles the number of trips—taking up to four trips to get to the Airport as opposed to two trips for parkers. If an air passenger is dropped off when departing on an air trip, and is picked up upon return, then that single air passenger generates a total of four ground access trips: two for the drop-off trip (one inbound to the Airport and one outbound) and two for the pickup trip (one inbound to the Airport and one outbound). The air passenger may be dropped off and picked up in a private vehicle, or may use taxi, ride apps, or black car limousine services. These access modes may not carry a passenger during all segments of travel to and from the Airport.

Despite the Massachusetts Port Authority's (hereafter Massport or the Authority) industry-leading efforts to dampen ground access vehicle trips and vehicle miles traveled (VMT) through a capped parking supply and implementing the HOV/shared-ride mode initiatives, vehicle trips continue to increase with growth in air travel. As air passenger numbers are predicted to increase, the lack of available parking at the Airport has increased drop-off/pickup vehicle trips and, in turn, VMT and related air emissions.

As a result, in June 2016, Massport requested that Massachusetts Department of Environmental Protection (MassDEP) amend 310 CMR 7.30[4] to increase the Parking Freeze limit by 5,000 spaces. The analysis by Massport indicated that, with increasing air passenger growth at the Airport, the current commercial parking cap has the unintended effect of negatively affecting air quality. The analysis also indicates that the constrained parking supply causes 75 percent of passengers who would otherwise choose to park at the Airport to instead use a

[4] CMR refers to "Code of Massachusetts Regulations."

drop-off/pickup mode.[5] This increases Airport-related VMT and associated air emissions. The analysis showed that adding 5,000 commercial spaces to the Parking Freeze limit would result in a substantive decrease in Airport-related VMT and could provide a significant air quality benefit.

The growth in drop-off/pickup ground access vehicle travel has been augmented by the advent of ride apps and the rapid adoption of these ride-hailing services by consumers. Ride app ground access shares at the Airport have grown from 14 percent in 2016 to more than 29 percent in 2019, drawing share from all other ground access modes, including HOV/shared-ride services, driving and parking, traditional taxi services, private vehicle drop-off/pickup, and rental cars. Ride app ground access, in the absence of being able to rematch a passenger pickup directly after a passenger drop-off, also results in four trips compared to two.

Following an extensive stakeholder and public engagement process in response to Massport's 2016 request to consider an amendment to the Parking Freeze, MassDEP approved the requested parking increase of 5,000 commercial spaces and issued the amended regulation on June 30, 2017.[6] On December 5, 2017, the EPA proposed a rule approving the revision of the State Implementation Plan incorporating the amended Parking Freeze.[7] The EPA approved the proposed rule on March 6, 2018, and the rule went into effect on April 5, 2018.[8] The new total Parking Freeze limit is 26,066 parking spaces, of which 23,640 are commercial spaces.[9]

[5] Steer Davies Gleave, "2013 Logan International Airport Air Passenger Ground-Access Survey." Massport, May 2014, https://www.massport.com/media/1553/2013-logan-air-passenger-ground-access-survey.pdf. (accessed September 13, 2019).
[6] Massachusetts Department of Environmental Protection, "Final 310 CMR 7.30 amendments," *Mass.gov*. June 30, 2017, https://www.mass.gov/files/documents/2017/06/zi/lpf-freg.pdf. (accessed September 13, 2019).
[7] Air Plan Approval; Massachusetts; Logan Airport Parking Freeze, 82 Fed. Reg. 57415, 57418 (December 5, 2017) (revising 310 C.M.R. § 7.30 and 310 C.M.R. § 7.31).
[8] Air Plan Approval; Massachusetts; Logan Airport Parking Freeze, 83 Fed. Reg. 9438, 9440 (March 6, 2018) (revising 310 C.M.R. § 7.30).
[9] Massachusetts Department of Environmental Protection, "Background Document on Proposed Amendments to 310 CMR 7.30: Massport/Logan Airport Parking Freeze, Regulations.gov. March 24, 2017, https://www.regulations.gov/document?D=EPA-R01-OAR-2017-0590-0004. (accessed September 13, 2019).

2017 Parking Freeze Amendment Studies

The 2017 Parking Freeze Amendment required that Massport conduct three ground access studies within 24 months. These studies sought to identify programs and actions that could complement Massport's comprehensive ground access goals related to air quality, terminal curb operations, customer service, and fiscal responsibility. The three ground access studies, which comprise the Logan Airport Parking Freeze Amendment Ground Access and Trip Reduction Strategy project, include the following:

1. **Parking Freeze Amendment Study #1**: A study of the costs, feasibility, and effectiveness of potential measures to improve HOV access to the Airport. This study shall consider, among other things, possible improvements to Logan Express bus service and the benefits of increasing Massachusetts Bay Transportation Authority (MBTA) Silver Line buses with service to the Airport.

2. **Parking Freeze Amendment Study #2**: A study of the costs and pricing for different modes of transportation to and from the Airport to identify a pricing structure and evaluate allocation of revenues generated to promote HOV modes of transportation by air travelers and visitors at the Airport. This study shall include an evaluation of short- and long-term parking rates and their influence on different modes of ground access transportation to and from the Airport.

3. **Parking Freeze Amendment Study #3**: A study of the feasibility and effectiveness of potential operational measures to reduce non-HOV drop-off/pickup modes of transportation to the Airport, including an evaluation of emerging ride app and other ride-hailing/ridesharing modes.

The results of the above studies are the subject of this report and are documented in detail in the subsequent chapters. In addition to satisfying regulatory requirements, this analysis further supports Massport's continuous development and implementation of its trip reduction strategy.

Current Supporting Ground Access Initiatives

Massport's ongoing trip reduction strategies have been most recently supplemented by additional initiatives as described below.

Improvements to High-Occupancy Vehicle Access

Massport is undertaking several improvements to HOV access modes, several of which have already been fully implemented:

- Doubling the number of MBTA Silver Line vehicles purchased by Massport for the Silver Line service to the Airport, making it more convenient to use the transit line for Airport access. Massport has partnered with the MBTA to promote its Silver Line access to the Airport. Massport's financial support of the MBTA Silver Line has included Airport route subsidization (including paying for free boarding at the Airport), the prior purchase of eight MBTA Silver Line buses, and a commitment to purchase eight more MBTA Silver Line buses in the future.
- Continuing to provide free, clean-fuel shuttle bus service for passengers between the MBTA Blue Line Airport Station and all terminals.

Improvements to Logan Express

In an effort to double Logan Express to 4 million passengers annually, Massport is improving and expanding Logan Express options. Related measures include the following:

- Relocating Back Bay Logan Express service to the MBTA's Back Bay Station, eliminating the fare from the Airport to Back Bay, and reducing the fare from Back Bay to the Airport from $7.50 to $3.00. This effort was implemented in May 2019.
- Increasing the total number of Logan Express "seats" by 10 percent. This goal was accomplished in the summer of 2019.
- Reducing headways by 10 percent and adding amenities at existing Logan Express locations.
- Adding a new urban Logan Express service at North Station with free service from the Airport. Massport expects to start service in 2020.
- Increasing parking capacity at the Framingham and Braintree Logan Express locations by a combined total of 3,000 spaces.
- Identifying new suburban Logan Express locations with parking.
- Offering online e-ticketing for Logan Express passengers.

Improvements to Ride App Access and Pricing

As ground access mode shares for ride apps continue to increase, Massport has developed a plan to revise the operations and pricing for these modes. To date, this has entailed the following:

- Consolidating ride app operations at dedicated areas on the ground floor of the Central Garage to promote vehicle "rematch" of the driver making a drop-off and an arriving air passenger to reduce "deadheading."
- Implementing a new drop-off fee of $3.25 (in addition to the current $3.25 pickup fee) and providing a discounted fee of $1.50 to incentivize shared-ride (such as UberPool and Lyft Line) use by customers.

Parking Rates and Reservation System

Massport uses daily parking rates to incentivize travelers to use HOV/shared-ride modes to access the Airport.[10] In 2019, the parking rates at the Central Garage complex and the Economy Garage were $38/day and $29/day, respectively. In addition, Massport has also eliminated the weekly parking discount previously available for Economy Garage parkers. Despite these rate increases, the Airport parking garages are often at or near capacity during the peak travel periods. Massport also plans to introduce a parking reservation system to allow air passengers to reserve and pay for parking spots in advance of their travel.

Roadway and Circulation Infrastructure

In addition to the above policy- and program-based initiatives, Massport has several capital projects underway to improve circulation and reduce congestion on terminal roadways, including the following three examples:

- **Terminal B to C Roadway Improvements**. This project will revamp the terminal area roadways to eliminate backups and allow passengers to move between the terminals more quickly. New construction will replace aging roadway infrastructure along both the Arrivals and Departures levels. This project will create more curb space at Terminal C and reduce on-Airport congestion by improving traffic flow and increasing traffic safety.

[10] Despite daily parking rate increases, the Central Garage complex and Economy Garage are often at or near capacity during the peak travel periods.

- **Parking Garage Construction**. Following the 2017 Parking Freeze Amendment, Massport is advancing plans to construct 5,000 new commercial parking spaces in structured parking facilities at two on-Airport sites selected with community input. Approximately 2,000 spaces will be sited in a new garage on existing surface parking lots in front of Terminal E, and approximately 3,000 spaces are to be accommodated at the Economy Garage facility through an expansion of the existing garage. These additional parking spaces are currently under review by the Massachusetts Environmental Policy Act Office. The additional parking spaces are expected to reduce the number of passengers using drop-off/pickup ground access modes, thereby reducing Airport-related VMT and associated air emissions.
- **Feasibility Study for a Centralized Transportation Facility**. Massport is in the early stages of assessing the feasibility of building a centralized transportation facility. This project could assist in reducing on-Airport circulation traffic and congestion and could free up constrained curb space at the terminals.

Study #1. Logan Airport Ground Access High-Occupancy Vehicle Services

Study Introduction

This section details the methodology and findings of **Study #1. Logan Airport Ground Access High-Occupancy Vehicle Services (hereafter Study #1)**, which explores the costs, feasibility, and effectiveness of potential measures to improve high-occupancy vehicle (HOV) access to Boston Logan International Airport (hereafter the Airport or Logan Airport). The study considers, among other things, possible improvements to Logan Express bus service and the benefits of adding more Massachusetts Bay Transportation Authority (MBTA) Silver Line buses with service to the Airport.

To inform this study, the Massachusetts Port Authority (hereafter Massport or the Authority) conducted the fall 2018 Logan Air Passenger Ground Access Survey (hereafter the 2018 Passenger Survey). The overall survey comprised two parts: 1) an origin-destination (O-D) survey describing the current trip to the Airport (Logan Airport was always the destination for this study); and 2) a stated preference (SP)[11] survey. The O-D section included details of the Airport access trip like origin address and type of origin place (e.g., work, home), trip purpose, mode of transportation, parking costs, time of day, party size, length and location of stay, frequency of travel from the Airport, and demographic information.

The SP section of the survey used this detailed O-D data to customize a set of hypothetical choice experiments. An efficient experimental design determined the choices experiment participants saw. Specifically, this experimental framework comprised 61 designs (targeting different types of respondents), with 10 unique blocks of 6 experiments each, for a total of 3,660 experiments. Each respondent was randomly assigned to one of the 10 blocks and shown all 6 experiments. Each of these 6 experiments, in turn, presented between 4 and 15 alternatives. The number and types of modes that were shown in the SP experiments were determined by the following logic:

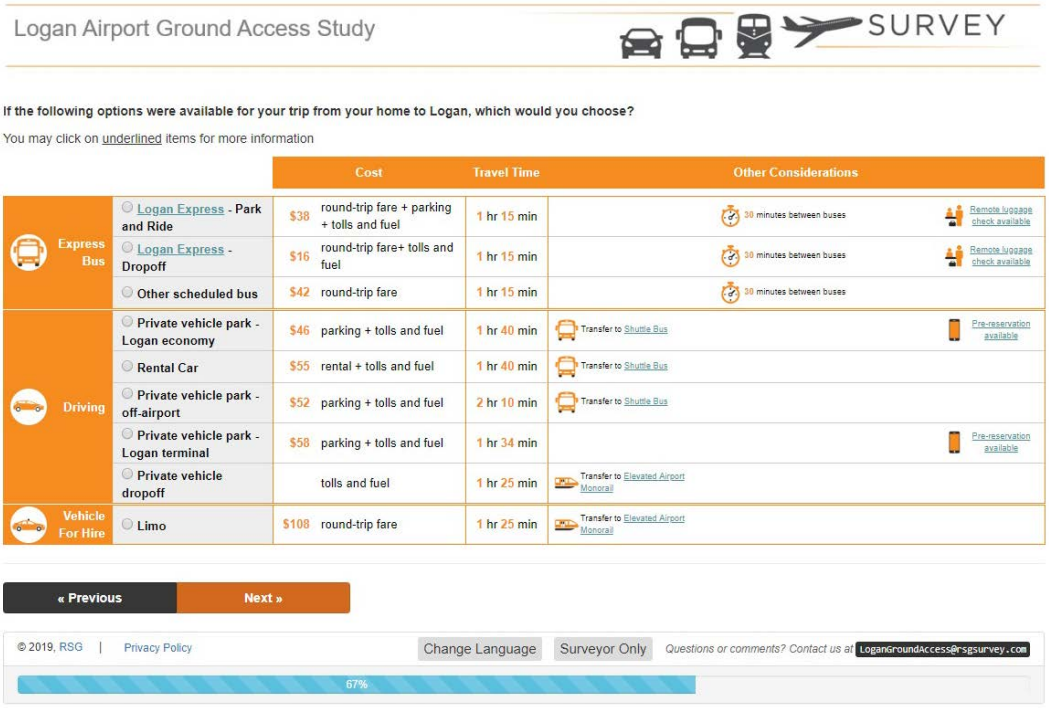
- Respondents originating from within the MBTA subway service area were shown MBTA Blue Line, MBTA Silver Line, MBTA ferry, and water taxi.
- Respondents who also originated within 0.5 miles of Kendall Square or North Station were shown an additional hypothetical express bus service.

[11] Data detailing what people might do (hypothetical).

- Respondents originating outside of the MBTA subway service area were shown rental car, Logan Express, and other scheduled bus service.
- Respondents originating from the South Shore also saw MBTA ferry.
- All respondents saw taxi and ride apps except those originating beyond I-495.
- All respondents saw limousine.
- All respondents who mentioned a car was available for this trip saw private vehicle drop-off and parking options, including Logan Express drop-off if originating outside of the MBTA subway service area.
- Superseding all logic above, each respondent saw the mode they indicated using for their Airport trip.

Figure 1 illustrates the screen viewed by survey respondents for the SP section.

FIGURE 1: SCREENSHOT OF SP SURVEY EXPERIMENT



Source: RSG

For each choice alternative, several associated trip characteristics were displayed. These included travel time, cost and, if applicable, headway and whether a transfer to a shuttle bus was required. Across all the scenarios, the respondent was presented with different levels of each attribute (each attribute varied independently of the others) and asked to “trade off” among the choice alternatives.

The survey was conducted as a self-administered tablet-based intercept interview between October 15, 2018 and October 31, 2018 at terminal gates, with the aim of collecting a representative sample of originating passengers. Four survey teams (pairs of two) were provided four flight assignments staggered over their eight-hour shift to accommodate breaks and travel both to and within the terminal. To prevent any lost time due to flight delays or cancellations, each flight assignment included multiple similar backup flights that could be sampled if an issue occurred with the original assignment. Over 5,000 surveys were completed in the development of the survey database.

The study team used these data to develop a Mode Choice Model and Simulator (MCMS) to simulate dozens of policy scenarios and explore the effects of potential changes to Massport-related ground access services.

Best practice for airport mode choice models includes development of a separate model for each trip purpose. Segmentation by type of airport users is important because airport access differs greatly by trip purpose (e.g., residents are far more likely than nonresidents to drive and park a personal vehicle at the Airport). In this regard, models are segmented into the following classifications:

- Resident business.
- Resident nonbusiness (leisure).
- Nonresident business.
- Nonresident nonbusiness (leisure).

Mode Choice Model and Simulator Format

Traditional airport mode choice models employ a multinomial logit (MNL) or, preferably, nested logit (NL) format. The logit format is employed because the probabilistic structure, where choices are expressed as the probability of choosing each option, accommodates realistic nuance whereby changes in behavior occur at the margins. People tend not to be binary decision-makers. Ideally, choice models are not binary either. The NL format, specifically, is employed because it accounts for asymmetric preference across modes. People are likely to substitute among modes with similar characteristics (e.g., air passengers are more likely to switch from a taxi to a ride app than to a ferry). The NL model can be used to determine, statistically speaking, which modes compete most directly.

However, as the study team iterated on MNL and NL model formats, it became clear that NL models were not nesting[12] effectively. Respondents showed significant taste heterogeneity, meaning much of the respondent choice was not dictated by broad, aggregate trends but, rather, by individual preferences and tastes. To account for this nuance, the study team's final models applied a mixed logit (ML) format. In the ML format, respondents have a unique MNL utility function to account for their unique preferences. This model format allows for the simplicity of MNL construction while accounting for asymmetric competition between modes in the way an NL model would.

Variables

The following variables were included in the final models:

1. Travel Time ($/hour)
2. Cost (in $)
3. Headway (Ferry) (in minutes)
4. Headway (Urban Transit) (in minutes)
5. Headway (Suburban Bus) (in minutes)
6. Transfers (MBTA) (number)
7. Remote Baggage Check (Binary—yes/no)
8. Pre-Reserved Parking (Binary—yes/no)
9. Automated People Mover Egress (Binary—yes/no)
10. Shuttle Bus Egress (Binary—yes/no)
11. Alternative Specific Constants for each mode:
    a. MBTA Ferry
    b. Water Taxi
    c. MBTA Blue Line

[12] Nesting refers to how the parameters of one model relate to another. For instance, a "nested" model is one that uses a subset of parameters of another model. This model is then "nested."

d. MBTA Silver Line

e. Ride App—Standard

f. Ride App—Shared

g. Taxi

h. Limousine

i. Private Vehicle Drop-Off

j. Parking—Central Parking

k. Parking—Economy

l. Parking—Off-Airport

m. Rental Car

n. Logan Express—Park-and-Ride

o. Logan Express—Drop-Off

p. Other Scheduled Bus

Model Estimation

The study team conducted model estimation in a statistical package of the open-source analysis tool "R."[13] This package is specifically designed to conduct choice model estimation.

Review of Model Fit and Iteration

After initial estimation, the study team reviewed the model output and considered the reasonableness of the results. This phase functioned as an iterative process through which any concerns regarding the statistical model could be explored and corrected. This, as previously mentioned, included altering the model format, adjusting explanatory variables, and reviewing and adjusting initial assumptions developed in the revealed preference dataset.[14]

[13] *The R Project for Statistical Computing*, www.r-project.org (accessed September 13, 2019).
[14] Data detailing what people did do (observational).

Model Calibration

Once the iterative specification, estimation, and review process was complete, the study team calibrated the resultant model to mode shares from the 2018 Passenger Survey. The study team also integrated Logan Express ridership data from 2018 into the calibration to ensure the MCMS accurately captured the relative ridership across Logan Express locations. These calibration steps allowed the model to represent the base case (2018 existing conditions) situation with proper shares for each mode. Once calibrated, the model was then used to forecast future ground access scenarios. Finally, for ultimate analysis of changes in HOV mode share, the study team calibrated the model output to CY 2018 annual ridership levels for Airport ground transportation, by mode. This analysis is the basis for all results in this study. The facilitation of a 5,000-respondent intercept survey and development of the MCMS was exhaustive.

This section summarizes the most important results from Study #1. Massport is already using the MCMS in decision-making, implementing several high-performing policies simulated as part of this study, and is planning to implement additional policies soon.

Policy Development

The study team worked closely with a diverse group of Massport staff to develop a set of policy variables that could influence traveler mode choice preferences for HOV ground access modes to and from the Airport. A set of policy variables were identified for inclusion in this study, including travel time, cost, frequency for transit modes, and the introduction of new offerings like remote baggage check and pre-reserved parking.

Policy Tool

The study team developed the MCMS to describe the effects of potential policies on ground access mode choice. The MCMS is a Microsoft Excel-based tool that includes interfaces for policy input and mode share effect output. The MCMS predicts the changes in share for each transportation mode for a given policy (or combination of policies). The 2018 Passenger Survey facilitated development of the MCMS, which estimates air passenger behavior models from the survey data. The framework of this survey is described in the section below, Analytical Framework and Assumptions. Appendix B details the survey deployment and content.

Calculating mode share helps Massport understand the effects of the policies in terms of anticipated ridership, required operational adjustments, and the effect on trip generation associated with Airport access. To illustrate, consider Massport's recent decision to increase weekday Logan Express frequencies to and from Braintree from every 30 minutes to every 20 minutes:

- In this example, the MCMS calculates the new share of Logan Express riders to estimate the additional air passenger **ridership** demand that would use the Braintree Logan Express.
- From an **operations** and financial standpoint, the policy implementation becomes clearer. There must be enough buses and staff to operate the 20-minute headways of the additional Braintree service. There must also be enough parking or other means to get customers to the Braintree terminal to serve any new demand for this service. Further, there must be enough curb space at the Airport to drop off and pick up added Braintree passengers.
- Finally, the tools help Massport better assess the effects of ground access on the Airport's overall **trip generation**. Reduction in overall trips is integral to Massport's trip reduction strategy.

Demand and Supply Assumptions

The MCMS assumes that demand is unconstrained,[15] meaning that there are no restrictions on the amount of demand a given mode alternative might generate. When demand exceeds supply, the demand often goes elsewhere. For example, if Logan Express parking lots are full, then some travelers who might have used this mode to travel to the Airport may instead opt to drive and park at the Airport. The demand model assumes that anyone who wants to use Logan Express facilities can do so. Therefore, the predicted mode share is, to an extent, dependent on the provision of adequate facilities and services to meet demand.

Policies and Policy Packages

In the MCMS, several variables can be changed to reflect potential policies. While all these variables can be individually simulated, most variables make sense to change in combination with other variables. For example, to encourage more Logan Express demand, a combination of policies like increasing Logan Express frequency, adding amenities, or adjusting pricing can be

[15] Using unconstrained models is common for policy decision-making.

complementary. In short, many cases exist where a policy is not one change but a "package" of changes to obtain the desired policy outcome.

Analytical Framework and Assumptions

The analytical work undertaken for Study #1 used a robust dataset from a survey of air passengers and their mode choice preferences. The study evaluated potential policies that address the questions asked by the Massachusetts Department of Environmental Protection as part of the Parking Freeze Amendment. The study team comprehensively evaluated each policy according to the following criteria:

- **Mode Choice**. How does the policy increase (or decrease) HOV ground access mode share to the Airport? The study team developed the MCMS to conduct this analysis.
- **Revenues and Costs**. How much revenue would a policy generate for Massport and at what cost? This criterion analyzes financial effects overall and per net new HOV rider to understand the cost/benefit of different policies.
- **Operations**. For a given policy, what are the types of operational changes that are necessary for Massport implementation? For example, are new facilities, permits, staff training, or technology necessary, and what are the benefits and challenges?
- **Customer Service**. What are the effects on customers/air passengers? How can alternatives to commercial and private vehicle pickup and drop-off modes be made more attractive to passengers? How can the benefits of these alternative modes be marketed even when there are also drawbacks? For example, an HOV trip option may require additional travel time, but customers may experience a more relaxing trip where they do not have to drive in traffic and navigate; alternatively, Massport may implement various additional services for HOV customers to enhance the experience.
- **Air Quality**. It is assumed that policies that increase HOV mode had a positive effect on air quality.
- **Community Stakeholder**. These effects focus on how a policy might change the patterns of Airport ground transportation behavior (e.g., volume, routing, new facilities). This criterion assesses effects from the perspective of surrounding communities.

Policy Analysis

Table 1 summarizes the range of policy scenarios explored in this study, organized by transportation mode type. These groupings exist to ensure the policy analysis reflects similarities and differences in mode attributes among the offerings. This analysis focuses on modes and service characteristics that are within the purview of Massport's control or influence. The mode-type groupings are as follows:

- Urban/Suburban Logan Express Bus.
- Public Transit/Multistop Bus.
- Water Transportation.

TABLE 1: HOV SERVICES POLICY SCENARIOS

MODE GROUP	POLICY SCENARIO
Urban/Suburban Logan Express Bus	Logan Express: Increase Frequency
	Logan Express: Provide Remote Bag Check
	Logan Express: Provide New Remote Park-and-Ride Terminal
	Logan Express: Provide New Suburban Park-and-Ride Route(s)
	Logan Express: Rebrand and Expand Urban Shuttle
Public Transportation/ Multistop Bus	MBTA Silver Line: Increase Frequency
	MBTA Silver Line: Provide Remote Check-in/Bag Check
	MBTA Silver Line: Provide South Station Semiexpress Service
Water Transportation	MBTA Water Ferry: Increase Frequency
	Logan Harbor Water Shuttle Bus: Provide Security Line Privileges

Source: RSG

Policies Outside or Partially Outside Massport Control

Several policies directly or indirectly affect Massport but are outside of the Authority's control. For example, Massport does not own, regulate, or manage the Boston Harbor tunnels, and therefore cannot control tunnel capacity and operations. Similarly, Massport also has no control over real estate development on non-Massport-owned properties, which increases local and regional traffic volumes and congestion. For the purposes of this study, Massport remains agnostic about such policies and, rather, focuses on areas where the Authority can directly exert influence. Massport's goal is to design sensible ground access strategies to reduce Airport traffic effects. It focuses on the assets under Authority control and strives to both understand and work constructively within the surrounding context out of Massport's control.

Urban/Suburban Logan Express Bus

Introduction to Urban/Suburban Airport Express Bus

Urban/suburban express bus service to the Airport is provided by Massport through its Logan Express network. The following sections document the current conditions of this service and include relevant practices (case studies).

Current Conditions

Service Summary and Attributes

Logan Express is a policy, programmatic, and operational system that is an important component of Massport's air passenger HOV program, which is the cornerstone of Massport's HOV strategy.

Massport's Logan Express service provides air passengers with frequent, scheduled express bus service to and from the Airport from suburban park-and-ride lots in Braintree, Framingham, Woburn, and Peabody. Each of these locations includes a full-service bus terminal and secure parking. Additionally, since 2014, Massport has provided express urban shuttle bus service from Boston's Back Bay neighborhood. Until recently this street-side service originated from Hynes Convention Center and Copley Square in downtown Boston. In May 2019, the Back Bay stop at Copley Square was relocated to the MBTA/Amtrak Back Bay intermodal transit station. No dedicated customer parking is provided for the Back Bay service (current or previous location).

Suburban Logan Express buses run every 20 to 60 minutes, depending on location, time of day, and day of week, while the Back Bay service runs every 20 minutes. One-way adult fare is $12 ($11 if purchased as part of a round-trip ticket) from the suburban locations, with discounts for seniors and free rides for children and active duty military. As of May 2019, Back Bay fares are $3 to the Airport and free from the Airport to the Back Bay and Hynes Convention Center stops.

Ridership

Logan Express ridership in 2017 approached 2 million. Logan Express ridership has steadily increased since 2010, when total ridership was approximately 1.1 million. Logan Express ridership has continued to grow following the introduction of Back Bay service in 2014. In recent years, growth was concentrated at suburban locations.

New Policies

As of May 2019, Massport had implemented several significant improvements to Logan Express service:

- Realigning the lightly used Copley Square stop to the MBTA Back Bay Station, which includes transfers to the MBTA Orange Line subway, the MBTA Commuter Rail, and Amtrak.
- Reducing all fares from Back Bay to the Airport from $7.50 to $3.00 and offering free service from the Airport to the Back Bay locations.
- Offering Back Bay riders priority access at Airport security screening.
- Increasing Braintree Logan Express frequency during peak hours from every 30 minutes to every 20 minutes.
- Launching a marketing and awareness program for the new Back Bay service.
- Increasing Braintree Logan Express frequency during peak hours from every 30 minutes to every 20 minutes.

Back Bay service ridership has more than doubled, year over year, since implementing these new policies. Braintree Logan Express air passenger ridership has grown, as expected.

Relevant Practices

The following case studies highlight relevant practices at other airports. Table 2 summarizes these findings.

Case Study: FlyAway (Los Angeles)

Name: FlyAway
Airport: Los Angeles International Airport (LAX)
Founded: 1975

FIGURE 2: FLYAWAY BUS STATIONS

Source: Los Angeles World Airports

The most notable precursor to the Logan Express system was the Van Nuys FlyAway bus (Figure 2), which is operated by the Los Angeles World Airports (LAWA); LAWA owns and operates Los Angeles International Airport and Van Nuys Airport. Offering a one-hour trip, the FlyAway is near Van Nuys Airport and 21 miles from Los Angeles International Airport. It operates services to Los Angeles International Airport every half hour, with 15-minute frequencies during the AM peak period and 1-hour frequencies after 1:30 a.m. The Van Nuys FlyAway terminal is one of the larger dedicated off-site airport parking facilities in the world. By the calculations of LAWA, the FlyAway system has lowered vehicle

miles traveled (VMT) by 23 million miles and saved one million gallons of gas—and operates at a profit.[16]

Since the successful operation of Van Nuys, LAWA has sought to develop additional, albeit smaller, services under its FlyAway brand. In addition, the FlyAway brand markets Amtrak's Union Station as another destination. Previous estimates suggest the FlyAway system claims 3 percent of the traveler market share.[17] The most recent survey released by LAWA shows 4 percent of the traveler market share for all scheduled bus combined for air travelers. Importantly, the since-abandoned FlyAway lines may provide benchmarking lessons for Massport; these lines include West Los Angeles, Irvine, La Brea, and Santa Monica.

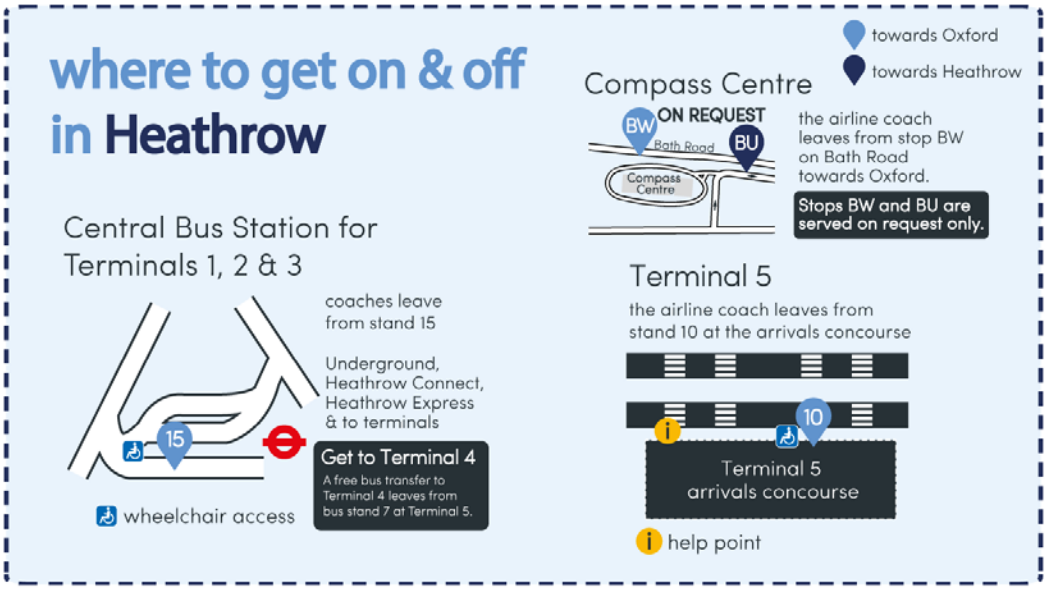
Case Study: The Airline (Oxford, England)

Name: The Airline (Oxford, England)
Airport: Heathrow Airport (LHR) and Gatwick Airport (LGW)
Founded: N/A

While Logan Airport is unique in its systematic coverage of the region by Logan Express, examples of individual bus services for a small number of markets can be found in Europe. Dedicated airport buses link the city of Oxford, England, to both Heathrow Airport and Gatwick Airport. Marketed as "the airline," buses operated by the Oxford Bus Company (Figure 3) provide continuous daily service to the airports. The system offers only one parking facility: Thornhill Park and Ride. Another example of dedicated suburban airport bus service is in Cambridge, England. Many nonexclusive intercity bus routes serve the airports with conventional bus services.

[16] Nelson\Nygaard Consulting Associates, "Maximizing Mobility in Los Angeles – First & Last Mile Strategies: Volume II Appendices," *Southern California Association of Governments.* December 2009, http://www.scag.ca.gov/Documents/LA-Maximizing-Mobility-Final-Vol2-Appendix1.pdf. (accessed September 13, 2019).
[17] MarketSense Consulting LLC, "ACRP Report 35: Planning for Offsite Airport Terminals." Transportation Research Board, 2010, http://www.trb.org/Publications/Blurbs/164094.aspx. (accessed September 13, 2019).

FIGURE 3: OXFORD BUS COMPANY STOPS AT HEATHROW AIRPORT



Source: Oxford Bus Company

Other Relevant Practices

Massport's successful Logan Express bus system is unique. However, the concept of using specially designed coaches to bring ground passengers to airports is not new; rather, what is new is using them in a coordinated environmental strategy. That said, no airport has done what Logan Airport has done to serve its catchment area, which is to create a large-scale public sector scheduled express bus service.

Aside from the Logan Express bus service, the highest recorded mode share for bus use in American airports comes from New Orleans, where a high-quality service carries air passengers from Louis Armstrong Airport to the downtown.[18] This service includes several loops to carry tourists to multiple hotels and popular destinations. At 15 percent share of all air passenger ground access trips, New Orleans' bus mode share ranked the highest in the series of airport ground access studies.[19] The New Orleans example shows that robust service from an airport to major tourist destinations makes sense. But it makes sense for a particular market—the nonresident, nonbusiness market.

However, at many American airports (such as Logan Airport), the number of resident travelers exceeds the number of visiting travelers. These airports require

[18] Leigh Fisher Associates, "TCRP Report 62: Improving Public Transportation Access to Large Airports." Transportation Research Board, 2000, http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_62-a.pdf. (accessed September 13, 2019).
[19] *Ibid.*

a strategy to capture riders from the *resident* market. The resident nonbusiness segment is important for another reason: This is the market segment most prone to resorting to pickup and drop-off as an alternative to high parking fees. The drop-off/pickup mode creates (approximately) twice the VMT than if travelers parked at the Airport. Logan Express exists because Massport saw the need to create a viable, marketable HOV alternative to pickup and drop-off in this market segment.

Historically, specialized airport bus services in the United States were to and from the central business district and not the adjacent suburban or nearby metropolitan airport catchment areas. High-quality bus coaches were the dominant public mode to airports in the United States and abroad—rail did not arrive until the 1960s or later.[20] In New York City, public access occurred through downtown check-in terminals such as the East Side Air Terminal; similar facilities were found in Washington, DC, and San Francisco. Internationally, specially designed coaches (to handle baggage) were in operation from two London check-in centers until the opening day of the Piccadilly line, when they both closed. Check-in service was provided to serve dedicated airport buses in Paris, Zurich, and Munich until new rail services began to compete with traditional services and replace them.

TABLE 2: URBAN/SUBURBAN AIRPORT EXPRESS BUS CASE STUDY SUMMARY

CASE STUDY	KEY FINDINGS
FlyAway (Los Angeles)	• Successful urban/suburban express bus; high-frequency bus • Large dedicated off-site airport parking facility
The Airline (Oxford, England)	• Successful urban/suburban express bus; high-frequency bus • Only one parking facility in the system

Source: RSG

Relevance to Logan Airport

In general, most European airports do not depend on suburban and near-intercity buses to the extent that Logan Airport does. Logan Airport is a leader in this field; as such, the international experience described here does not provide any useful insights beyond confirming the successful strategy of what Logan Airport has already done or is doing. Additionally, Los Angeles International Airport tried to copy its own park-and-ride strategy at several other locations. The authority, LAWA, had to be creative to adapt its service strategy to include buses to serve

[20] Two exceptions were Gatwick and Brussels, both around 1958.

dense near-downtown locations where no parking would be provided. LAWA's experience in creating new urban bus services is instructive in the development of new services for Logan Airport.

Urban/Suburban Logan Express Bus Policy Scenarios

Overview of Urban/Suburban Express Bus Policies

Massport's policy scenarios tested service improvements at existing Logan Express locations and implementation of Logan Express service at new locations. Specifically, the tested scenarios explored the following policy variables:

1. **Frequency**: Increase frequency of how often Logan Express buses depart.

2. **Baggage check**: Provide remote baggage check at Logan Express stations.

3. **Security prioritization**: Introduce prioritized/separate security line access at the Airport when arriving via Logan Express.

4. **Urban Logan Express expansion/rebrand**: Add new, high-frequency Logan Express locations within the urban core.

5. **Suburban Logan Express expansion**: Add Logan Express locations within the Metro Boston area.

The study team simulated over 30 unique policies from within these categories. Appendix A presents details of these individual policy scenarios. The following section explores three policy scenarios that involved likely combinations of Logan Express policies. Combination 1 includes policies that Massport has recently implemented, is currently planning, or is likely to pursue in the near future. Combination 2 and Combination 3 include these policies and add policies that might require additional time, cost, and support to feasibly implement.

- **Logan Express Policy Combination 1**:

    a. Frequency: Decrease headways at Braintree from 30 minutes to 20 minutes.

    b. Urban Logan Express expansion/rebrand: Realign Back Bay service to stop at the MBTA Back Bay Station (Orange Line,

commuter rail, Amtrak); add new Logan Express service from North Station; reduce fares to $3 to Airport and free from Airport.

c. Security prioritization: Provide priority security line access at the Airport to Logan Express passengers from Back Bay and North Station.

- **Logan Express Policy Combination 2**:

  a. Frequency: Decrease headways at Braintree and Framingham from 30 minutes to 20 minutes.

  b. Urban Logan Express expansion/rebrand: Shift Back Bay service from Copley Square to Back Bay Station (MBTA); add new Logan Express service from North Station; reduce fares to $3 to Airport and free from Airport.

  c. Suburban Logan Express expansion: Add new MetroWest service and Near North Shore service; remove Peabody service as corresponding move to new Near North Shore service.

  d. Security prioritization: Provide priority security line access at the Airport to all Logan Express passengers.

- **Logan Express Policy Combination 3**:

  a. Frequency: Decrease headways at Braintree and Framingham from 30 minutes to 20 minutes.

  b. Urban Logan Express expansion/rebrand: Shift Back Bay service from Copley Square to the Back Bay Station (MBTA); add new Logan Express service from North Station; reduce fares to $3 to Airport and make fares free outbound from the Airport.

  c. Suburban Logan Express expansion: Add new MetroWest service and Near North Shore service; remove Peabody service and replace it with a new Near North Shore service.

  d. Security prioritization: Provide priority security line access at the Airport to all Logan Express passengers.

  e. Baggage check: Provide remote baggage check services to all Logan Express passengers at each Logan Express location.

Urban/Suburban Express Bus Policy Effects

Table 3 summarizes the MCMS results of Logan Express policy scenarios.

TABLE 3: LOGAN EXPRESS POLICY SCENARIO EFFECTS SUMMARY

EFFECTS	COMBO 1	COMBO 2	COMBO 3
HOV Mode Share (% of total cumulatively)	+0.7%	+1.4%	+1.6%
Net Cost*/New HOV Rider	$$	$$	$$$

*Net Cost/New HOV Rider Key: **$** <$10/year; **$$** $10-25/year; **$$$** $25-50/year; **$$$$** $50+/year*
**Includes estimated new operating costs and amortized capital expenditures for direct provision of the service. Does not account for potential additional capital expenses associated with new or expanded facilities. Includes estimated revenues based on the MCMS, as well as revenue lost or gained from other modes (e.g., parking and rental) due to mode share shifts.*
Source: RSG

Mode Choice

In Logan Express Policy Combination 1, HOV mode share is forecast to increase by 0.7 percentage points. This shift is due to an expected increase in overall Logan Express mode share. The increase includes 6 percent growth at Braintree (reduced headways), doubled shares for the Back Bay service, and significant new Logan Express system ridership at the planned new North Station location. Correspondingly, mode share drops across other modes. Single-occupancy vehicle (SOV) mode shares decrease: ride app use would decrease by 2.6 percent, and non-Logan Express HOV options would decrease by 4.7 percent.

In Logan Express Policy Combination 2, HOV mode share is forecast to increase by 1.4 percentage points. This shift is due to an expected increase in overall Logan Express mode share, nearly doubling Logan Express use. The increase includes over 20 percent growth at Braintree (reduced headways, security prioritization) and approximately doubled share at the realigned Back Bay Station (with security prioritization providing a key boost). This scenario also includes significant additional share at the new North Station, MetroWest, and Near North Shore locations. Correspondingly, mode share drops across other modes. SOV mode shares decrease: Ride app use would decrease to nearly 4 percent, and non-Logan Express HOV share would decrease to approximately 5 percent.

In Logan Express Policy Combination 3, HOV mode share is forecast to increase by 1.6 percentage points. This shift is due to an expected increase in overall

Logan Express mode share, nearly doubling Logan Express use. The increase includes over 30 percent growth at Braintree (reduced headways, security prioritization, and remote baggage check) and a more than doubled share at the realigned Back Bay Station (with security prioritization and baggage check providing key boosts). This scenario also includes significant additional share at the new North Station, new MetroWest, and Near North Shore locations. Correspondingly, mode share would drop across other modes. SOV mode shares would drop, ride app use would decrease to over 4 percent, and non-Logan Express HOV share would decrease to 5.7 percent.

Cost to Authority[21]

Logan Express Policy Combination 1 is estimated to produce gross cost of approximately $4 million per year upon implementation. The primary costs include investment in labor and vehicles to reduce headways at Braintree, investment for the Back Bay relocation, investment for the new North Station location, and costs to discount Back Bay fares. With direct revenue and revenue offsets from other modes under $1 million per year, net cost to Authority is approximately $4 million.

Logan Express Policy Combination 2 is estimated to produce an overall cost of approximately $11 million per year upon implementation. Costs that make this option more expensive than Logan Express Policy Combination 1 include investment for the development of MetroWest service and Near North Shore service. With direct revenue near $8 million per year and revenue offsets from other modes of only $5 million per year, net cost to Authority is approximately $8 million.

Logan Express Policy Combination 3 is estimated to produce an overall cost of approximately $25 million per year upon implementation. Costs that make this option significantly more expensive than Logan Express Policy Combination 2 entail investment to provide remote baggage check services at each Logan Express location. With direct revenue near $10 million per year and revenue

[21] These cost figures generally include only operating expenses including, for the purposes of this study, contract fees associated with equipment typically procured as part of third-party service agreements (e.g., as buses and remote baggage check equipment). These figures do not include major capital expenditures for facilities and improvements such as the development of new Logan Express sites, or the potential need to expand parking and other facilities at existing sites. Therefore, evaluation of Combination 2 and Combination 3 must also consider the potential for these policies to trigger (or contribute to the triggering) of additional large-scale capital expenditures.

offsets from other modes of only $5 million per year, net cost to Authority increases to approximately $20 million.

Operations

Accommodating reduced headways at Braintree and Framingham would require additional labor and vehicles to serve the busier schedule and more curb space to accommodate the vehicles at the Airport terminals. These service increases may also require additional traffic management to manage circulation and overflow at the remote sites.

Baggage check services would likewise require additional labor, infrastructure, logistics, and security. Standard coaches may not be able to accommodate the prechecked baggage, and ancillary vans or trailers may be required. This infrastructure (at the remote site, in transit, and at induction points to Airport baggage systems) would need to support secure baggage protocols, potentially proving costly or logistically challenging.

Service increases and improvements would necessitate other changes. Security prioritization would likely require some more up-front logistics and coordination with airlines and security, but current experience suggests minimal day-to-day disruption. Another byproduct of increased and improved service at current Logan Express locations would be the potential need for increased parking capacity. Headway reductions along with provision of new baggage check and security prioritization services may necessitate additional parking spaces to meet demand. Massport has already released requests for proposals for design of expanded and new structured parking at Framingham and Braintree, respectively, based on current and projected demand.

Operations for new services at current and new locations would also require increases in staffing, customer amenities and services, and more.

Customer Service

Key customer service considerations include explaining service changes to customers and supporting those customers as they use the new offerings. New service locations and new procedures around baggage check and security prioritization would require significant customer support. Massport staff will face the challenges related to aspects of customer experiences that may include elements outside of Airport property and control (e.g., congestion on roadways near remote sites). Furthermore, for existing and new locations, marketing the new or additional capacity (e.g., increased frequency) and benefits from the

enhanced services needs to be communicated to potential new and existing customers. Massport has already launched a multimedia marketing campaign to accompany the service improvements announced in May 2019; this is a precursor to more significant marketing that would be required to support myriad new policies under consideration.

Air Quality

Any measure that Massport can take to reduce pickup and drop-off trips or increase HOV mode share will have a measurable positive benefit to air quality. This benefit will be quantified in upcoming Massport Environmental Data Reports (EDR) as outlined in the Parking Freeze Amendment regulations.

Community Stakeholder

Community stakeholder effects largely pertain to two broad groups: East Boston and communities near remote Logan Express sites.

East Boston: Effects at the Airport and East Boston involve congestion reduction on Airport property, in the neighborhoods, and along the major gateway roads. The policies and scenarios proposed would positively benefit the community through the reduction of congested hours along the major roads, which should relieve pressure on neighborhood roads.

Remote Sites: In the case of Logan Express Policy Combination 1, new service from North Station would affect the resident, tourist, and business communities within walking distance of the station in a positive way by providing more access to the Airport. New service at North Station also positively affects people in other urban core areas who may be taking different transit services that are in the area of North Station. Each service decision, and thus financial commitment, comes with an opportunity cost that should be explainable and transparent to community stakeholders.

Public Transit/Multistop Bus

Introduction to Public Transit/Multistop Bus

Public transit/multistop bus service to the Airport is provided by the MBTA via the Blue Line (subway train) and Silver Line (bus rapid transit). The following sections document the current conditions of these services and include relevant practices (case studies).

Current Conditions

Service Summary and Attributes

The MBTA Blue Line and MBTA Silver Line are the primary multistop transit options to the Airport. The MBTA Blue Line provides service to a remote transit station at the Airport's western edge, connecting to the terminals via free Massport shuttle bus. The MBTA Silver Line provides service directly to the terminal curbs. MBTA Blue Line riders pay standard MBTA subway fares to/from the Airport while the MBTA Silver Line is free from the Airport, accommodating all-door boarding.

While both services see similar mode share and ridership to the Airport, this report focuses primarily on the MBTA Silver Line because Massport has played and will continue to play a direct role in the financing and operations of that service (e.g., purchase of buses, subsidization of operations, and provision of roadway and curb infrastructure).

The MBTA Silver Line connection from the four air terminals at the Airport to the South Boston Seaport and to South Station combines a custom airport service and a general-purpose local bus route. Often, general-purpose public transit bus services have not done well in airport access applications, as is documented in the accompanying case studies.

In short, the MBTA Silver Line to the Airport is something of a hybrid service. The line primarily operates to get workers in and out of jobs at the South Boston Seaport (connecting in South Station) and then continues to the Airport. In general, sharing bus services with other submarkets makes the headways shorter but the travel times longer. The MBTA Silver Line takes roughly 25 minutes from Terminal A to South Station, with delays of 20 minutes reported at the time of this writing.[22]

[22] The 20-minute delay reference is from the MBTA website, which offers real time departures (e.g., on May 24, 2019 and May 26, 2019).

FIGURE 4: MBTA SILVER LINE POWERED BY TWO TROLLEY POLES DURING IN-TUNNEL OPERATION

Source: Massachusetts Department of Transportation Blog

Mode Share and Ridership

In 2018, MBTA Silver Line mode share was estimated at 2.4 percent of departing air passengers, while MBTA Blue Line was 1.8 percent. While MBTA Silver Line ridership for the Airport is no longer reported due to elimination of Airport fareboxes during the service redesign in 2013, internal Massport counts indicate 2018 ridership to the Airport of approximately 2 million, including air passengers and employees. Massport estimates 2018 MBTA Blue Line air passenger ridership at approximately 900,000.

New Policies

No major service changes to MBTA Blue Line or MBTA Silver Line were underway at the time of this writing. Massport has committed to purchasing 8 new Silver Line buses for the MBTA to double the size of the Silver Line fleet serving the Airport to 16.

Relevant Practices

The following case studies highlight relevant practices at other airports. Table 4 summarizes these findings.

Case Study: SkyRide Bus Service (Denver)

Name: SkyRide Bus Service (Denver)
Airport: Denver International Airport (DEN)
Founded: 1995

When Denver International Airport was relocated from Stapleton to its present location in 1995, the Regional Transportation District (RTD) developed an ambitious program to provide bus services to employees whose jobs were moved to the new location that was farther from the downtown. Early on, RTD was operating five lines in their “SkyRide” service to Denver International Airport. Figure 5 shows the baggage drop area at the airport transit station, which was provided to reduce the passenger burden of bringing luggage on the public transit option.

FIGURE 5: BAGGAGE DROP AREA AT TRANSIT STATION AT DENVER INTERNATIONAL AIRPORT

Source: Regional Transportation District

The service is highly unusual in that it serves airport workers with early and late working hours. Operators report that some workers chose the bus in the morning and found carpool services for the return trip.[23]

Case Study: Airport Bus Service to Hong Kong International Airport (Hong Kong)

Name: Airport Bus Service to Hong Kong International Airport (Hong Kong)
Airport: Hong Kong International Airport (HKG)
Founded: 1998

Hong Kong International Airport created airport-specific bus services when it moved to its present island location in 1998.[24] These buses carry approximately twice the number of air passengers as the high-quality Airport Express rail service between Hong Kong International Airport and downtown. Figure 6 shows the in-town check-in at Hong Kong Station.

FIGURE 6: IN-TOWN CHECK-IN AT HONG KONG STATION

Source: WeViewTaiwan/YouTube/CityLab

[23] Leigh Fisher Associates, "TCRP Report 62: Improving Public Transportation Access to Large Airports." Transportation Research Board, 2000, http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_62-a.pdf. (accessed September 13, 2019).
[24] Mark Landler, "A 6-Hour Move, and Landing in Hong Kong Loses a Thrill," *The New York Times*. July 6, 1998, https://www.nytimes.com/1998/07/06/world/a-6-hour-move-and-landing-in-hong-kong-loses-a-thrill.html. (accessed September 17, 2019).

TABLE 4: PUBLIC TRANSIT/MULTISTOP BUS CASE STUDY SUMMARY

CASE STUDY	KEY FINDINGS
SkyRide Bus Service (Denver)	• Successful high-frequency bus service • Bus service that accommodates airport workers and air passengers
Airport Bus Service (Hong Kong)	• Successful urban express bus service • Preferred by residents due to routes to local residential neighborhoods

Source: RSG

Relevance to Logan Airport

The Denver example underscores the concept that public transportation services benefit from accounting for the unique needs of airport workers and their (sometimes) unusual shifts and working hours. Doing so creates an opportunity for service that could also support and encourage greater use by air passengers. The Hong Kong example draws attention to an important airport passenger market that is neither in the downtown nor in the more distant suburbs. The Hong Kong buses provide direct service to close-in residential neighborhoods, which tend to be far more densely settled than neighborhoods in the United States. However, this setup may be applicable to some neighborhoods in Boston.

Public Transit/Multistop Bus Policy Scenarios

Overview of Public Transit/Multistop Bus Policies

MBTA Silver Line policy scenarios tested service improvements on that line. Specifically, the tested scenarios explored the following policy variables:

1. **Frequency**: Decrease headways of MBTA Silver Line bus departures.
2. **Semiexpress Service**: Provide semiexpress service that does not make local stops between South Station and the Airport.
3. **Remote baggage check**: Provide remote baggage check services to MBTA Silver Line riders at South Station.

The study team simulated a range of unique policies from within these categories. Appendix A presents details of these individual policy scenarios. The following section explores three policy scenarios that involved likely combinations of MBTA Silver Line policies.

- **MBTA Silver Line Policy Combination 1**:

    a. Frequency: Decrease headways on MBTA Silver Line by 10 percent.

    b. Express Service: Run express service between South Station and the Airport (five-minute time savings).

- **MBTA Silver Line Policy Combination 2**:

    a. Frequency: Decrease headways on MBTA Silver Line by 20 percent.

    b. Express Service: Run express service between South Station and the Airport (10-minute time savings).

- **MBTA Silver Line Policy Combination 3**:

    a. Frequency: Decrease headways on MBTA Silver Line by 20 percent.

    b. Semiexpress Service: Run express service between South Station and the Airport (10-minute time savings).

    c. Baggage check: Provide remote baggage check services to MBTA Silver Line riders at South Station.

Massport does not control MBTA Silver Line headways. For the purpose of this study, the study team tests this possibility based on Massport's purchase of additional MBTA Silver Line buses.

Public Transit/Multistop Bus Policy Effects

Table 5 summarizes the anticipated public transit/multistop bus policy scenario effects.

TABLE 5: PUBLIC TRANSIT/MULTISTOP BUS POLICY SCENARIO EFFECTS SUMMARY

EFFECTS	COMBO 1	COMBO 2	COMBO 3
HOV Mode Share (% of total cumulatively)	+0.3%	+0.7%	+0.8%
Net Cost*/New HOV Rider	N/A	N/A	N/A

Net Cost/New HOV Rider Key: ***$*** *<$10/year;* ***$$*** *$10-25/year;* ***$$$*** *$25-50/year;* ***$$$$*** *$50+/year*
**Includes estimated new operating costs and amortized capital expenditures for direct provision of the service. Does not account for potential additional capital expenses associated with new or expanded facilities. Includes estimated revenues based on the MCMS, as well as revenue lost or gained from other modes (e.g., parking and rental) due to mode share shifts.*
Source: RSG

Mode Choice

In MBTA Silver Line Policy Combination 1, HOV mode share is forecast to increase by 0.3 percentage points. This shift is due to an expected increase in overall MBTA Silver Line mode share. SOV mode shares decrease: Ride app use would decrease by less than 1 percent, and MBTA Blue Line share would also decrease by less than 1 percent.

In MBTA Silver Line Policy Combination 2, HOV mode share is forecast to increase by 0.7 percentage points. This shift is due to an expected increase in overall MBTA Silver Line mode share. SOV mode shares decrease: Ride app use would decrease to over 1 percent, and MBTA Blue Line share would also decrease to nearly 1 percent.

In MBTA Silver Line Policy Combination 3, HOV mode share is forecast to increase by 0.8 percentage points. This shift is due to an expected increase in overall MBTA Silver Line mode share. SOV mode shares decrease: Ride app use would decrease to over 1 percent, and MBTA Blue Line share would also decrease to over 1 percent.

Cost to Authority[25]

It is premature to develop a net cost/new HOV rider estimate due to several factors. While Massport has committed to purchasing eight additional Silver Line buses for the MBTA, this investment is not directly tied to any specific change in service. Moreover, the MBTA will determine the operating procedures required to deploy a given level-of-service to and from the Airport. To calculate Massport's ultimate subsidy to the MBTA would require knowledge of MBTA's operations for these hypothetical scenarios. Nonetheless, Massport's purchase of the eight new MBTA Silver Line buses, and its ongoing subsidy of the service, represents a substantial financial commitment by the Authority to support public transit services to and from the Airport.

Operations

Accommodating increased frequency on the MBTA Silver Line shuttle bus would require additional labor and vehicles to serve the busier schedule and more curb space to accommodate the shuttle buses at the Airport terminals. These service increases may also require additional traffic management to efficiently facilitate circulation of the shuttle buses at the Airport, in transit, and at South Station. Semiexpress bus service would involve many of the same operational effects and significant infrastructure investment to support the unobstructed flow of buses to the Airport.

Baggage check services would likewise require additional labor, infrastructure, logistics, and Transportation Security Administration safety measures. MBTA Silver Line buses are likely unable to accommodate the prechecked baggage; ancillary vans, trailers, or some other system may be required. This infrastructure (at South Station, in transit, and at induction points to the Airport baggage systems) would need to support secure baggage protocols, potentially proving costly or logistically challenging.

Customer Service

Key customer service considerations include conveying service changes to customers and supporting those customers as they use the new offerings. New procedures around baggage check would require significant customer support. Massport staff will face challenges related to elements of customer experiences

[25] These cost figures generally account for only operating expenses including, for the purposes of this study, contract fees associated with equipment typically procured as part of third-party service agreements. These figures do not include major capital expenditures for facilities and improvements.

outside of Airport property and control (e.g., at South Station). Furthermore, marketing the additional capacity (e.g., increased frequency) and benefits from the enhanced services needs to be communicated to potential new and existing customers.

Air Quality

Any measure that Massport can take to reduce pickup and drop-off trips or increase HOV mode share will have a measurable positive benefit to air quality. This benefit will be quantified in upcoming Massport EDR as outlined in the Parking Freeze Amendment regulation.

Community Stakeholder

Community stakeholder effects largely pertain to two broad groups: South Boston and South Station.

South Boston: Possible effects at the Airport and South Boston involve congestion reduction on Airport property, in the neighborhoods, and along the major gateway roads. The policies and scenarios proposed would positively affect the community through the reduction of congested hours along the major roads, which should relieve pressure on neighborhood roads. Semiexpress MBTA Silver Line service should also improve MBTA Silver Line conditions for non-Airport riders as the Airport ridership would be more confined to those trips. Conversely, infrastructure improvements to accommodate increased trips and semiexpress service may require significant construction or other disruptions during initial rollout.

South Station: Significant community stakeholder effects relate to implementation of increased service from South Station. Additional service from South Station would positively affect the resident, tourist, and business communities within walking distance of the station. Construction related to supporting additional capacity and baggage check services may create temporary mobility challenges in and around South Station.

Water Transportation

Introduction to Water Transportation

Ferry service to the Airport is provided by the MBTA and private water taxi operators. While Massport does not provide ferry service to the Airport, it constructed the water shuttle dock and waiting shelters and provides free shuttle

bus service from the water shuttle dock on Harborside Drive to the terminals. The following sections document the current conditions of these services and include relevant practices (case studies).

Current Conditions

Service Summary and Attributes

Water transportation to the Airport includes both on-demand private water taxi service and scheduled MBTA ferry service. Water taxis operate from Long Wharf and other Boston Harbor locations, while MBTA ferries operate from Long Wharf and Hingham and Hull. MBTA ferry service to the Airport runs seven times per day on weekdays and four to six times per day on weekends. The one-way fare from Hingham or Hull to the Airport is $9.25, while the fare from Long Wharf is $3.75. Water taxis and MBTA ferries arrive at the Airport water shuttle dock where Massport shuttle buses then transfer passengers at no charge to the terminals.

Mode Share and Ridership

In 2018, mode share for each water taxi and MBTA ferry service is estimated in the range of 0.1 percent, with 2018 water taxi ridership approaching 80,000 annually.

New Policies

No major service changes to water transportation options were underway at the time of this writing.

Relevant Practices

The following case studies highlight relevant practices at other airports. Table 6 summarizes these findings.

Case Study: Gravina Island Ferry (Ketchikan, Alaska)

Name: Gravina Island Ferry
Airport: Ketchikan International Airport (KTN)
Founded: 1973

Ketchikan International Airport is on an island and requires ferry service from three ferries (Figure 7). Ferry schedules vary by time of year, with an increase in ferry frequency during spring and summer (every 15 minutes) and a decrease in

frequency during fall and winter (every 30 minutes). Other than in Ketchikan, Alaska, where the airport has no road connections at all, ferry transportation plays no significant role in US airports outside of Boston. By contrast, plans for a major new ferry terminal at LaGuardia[26] have been announced by the New York governor's advisors, but its implementation is uncertain.

FIGURE 7: KETCHIKAN GATEWAY BOROUGH AIRPORT FERRY

Source: Ketchikan Gateway Borough

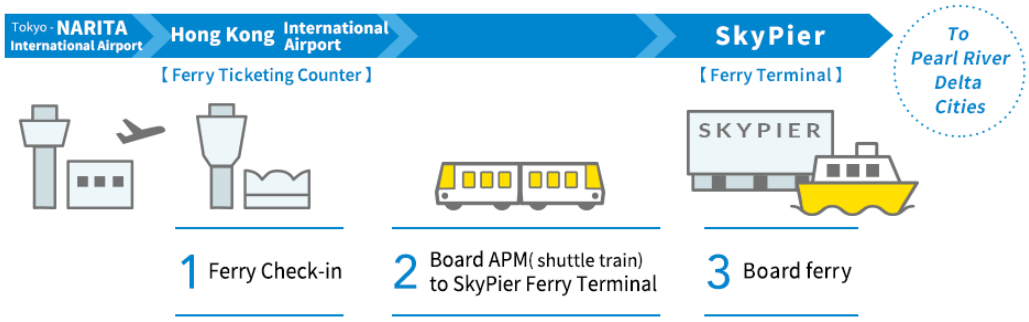
[26] Nathan Tempey, "$4 Billion Plan To Completely Rebuild LaGuardia Includes A Ferry Terminal," *Gothamist*. July 27, 2015, https://gothamist.com/news/4-billion-plan-to-completely-rebuild-laguardia-includes-a-ferry-terminal. (accessed September 17, 2019).

Case Study: Hong Kong Pearl River Delta Ferry System (Hong Kong)

Name: Hong Kong Pearl River Delta Ferry System
Airport: Hong Kong International Airport (HKG)
Founded: 2009

One of the most effective examples of airport access by water transportation is the elaborate ferry network, and cross-boundary ferry pier (SkyPier) (Figure 8), established at Hong Kong International Airport to connect with both the Island of Macao and cities of the Pearl River Delta. Hong Kong comprises several islands geographically separated from the mainland, and the ferries carry passengers as efficiently as possible to cities along the Pearl River Delta. The result is a unique system where the ferry is considered a transfer mode, comparable to a connecting airline elsewhere. The arriving airline passengers show their baggage claim at a central Ferry Transfer desk where the location of the baggage is confirmed. Passengers are then taken from the gate by a within-security automated people mover (APM); they then proceed into the single and highly centralized arrival terminal but do not proceed through baggage pickup or customs clearance. An APM connects the ground terminal to docks where passengers find connecting ferries. Customs clearance and final baggage claim take place after the completion of the ferry trip to either the Island of Macao or the mainland cities along the Delta.

FIGURE 8: SKYPIER FERRY TRANSFER SERVICE



Source: Vanilla Air

TABLE 6: WATER TRANSPORTATION CASE STUDY SUMMARY

CASE STUDY	KEY FINDINGS
Gravina Island Ferry (Ketchikan, Alaska)	• Only other US example of ferry service to airport aside from Logan Airport • Ferry is only way to access island/airport
Hong Kong Pearl River Delta (Hong Kong)	• Centralized/compact arrival terminal allows passengers to access connecting ferry without proceeding through customs/security • Coordinated baggage system; luggage follows passengers through system

Source: RSG

Relevance to Logan Airport

While the Gravina Island Ferry in Ketchikan, Alaska, is not as applicable to Logan Airport, the Hong Kong system of using ferries for relatively long-distance connecting "flights" could be of interest to Massport. Hong Kong's system shows the versatility of the basic layout at Hong Kong International Airport, in which all arriving passengers are processed in a compact terminal supporting several onward movements. Hong Kong International Airport's highly centralized arrival terminal and baggage system is one of the most ambitious intermodal terminal facilities of any airport in the world, in contrast to Logan Airport's five separate baggage pickup locations. On the other hand, the concept of ferries as connecting modes to be handled within security is not relevant to the role of ferries as "ground" transportation modes at Logan Airport.

Water Transportation Policy Scenarios

Overview of Water Transportation Policies

Water transportation policy scenarios tested service improvements for MBTA ferries and water taxis. Specifically, the tested scenarios explored the following policy variables:

1. **Frequency**: Change how often ferries depart; schedule water taxis to function more like ferries.

2. **Security prioritization**: Introduce prioritized/separate security line access at the Airport when arriving via water transportation.

The study team simulated a range of unique policies from within these categories. Appendix A presents details of these individual policy scenario outcomes. The following section explores one policy scenario that involved plausible combinations of water transportation policies.

- **Water Transportation Policy Combination 1**:

    a. Frequency: Increase all MBTA ferry frequencies by 50 percent.

    b. Security prioritization: Provide priority security line access at the Airport to Logan Express passengers arriving by MBTA ferry.

Massport does not control MBTA ferry schedules. For the purposes of this report, Massport modeled increased frequencies of the existing MBTA ferry service as a representative example of the effects of increasing downtown scheduled water transportation service.

Water Transportation Policy Effects

Table 7 summarizes the water transportation policy scenario effects.

TABLE 7: WATER TRANSPORTATION POLICY SCENARIO EFFECTS SUMMARY

EFFECTS	COMBO 1
HOV Mode Share (% of total cumulatively)	+0.0%
Net Cost*/New HOV Rider	N/A

*Net Cost/New HOV Rider Key: **$** <$10/year; **$$** $10-25/year; **$$$** $25-50/year; **$$$$** $50+/year*
**Includes estimated new operating costs and amortized capital expenditures for direct provision of the service. Does not account for potential additional capital expenses associated with new or expanded facilities. Includes estimated revenues based on the MCMS, as well as revenue lost or gained from other modes (e.g., parking and rental) due to mode share shifts.*
Source: RSG

Mode Choice

In Water Transportation Policy Combination 1, overall HOV mode share is forecast to increase by less than 0.1 percentage points. This shift is due to an expected increase in overall MBTA ferry mode share, from 0.1 percent to 0.2 percent of all Airport access trips. All other mode shares would see marginal decreases due to the nominal ferry share/changes.

Cost to Authority

Estimating cost to the Authority for this policy combination would require additional financial analysis and is not currently calculable. This study uses more frequent MBTA service to illustrate the concept and market for water transportation services from downtown Boston to and from the Airport; additional scheduled service could take different forms of ownership or operation. Massport will conduct additional analysis prior to any recommendation to move forward on the policy combination or components therein.

Operations

Accommodating reduced headways for MBTA ferries would require additional labor and, potentially, boats to serve the busier schedule. These service increases may also require additional traffic management to manage circulation and overflow in Hingham and Hull. Security prioritization requires minimal additional support and enforcement at MBTA ferry docks (or on board) and at Airport terminal security areas. One byproduct of increased and improved service at current MBTA ferry locations would be the potential need for increased parking capacity at Hingham and Hull.

Customer Service

Improvements to customer service would be limited given the small number of people this service would transport.

Air Quality

Any measure that Massport can take to reduce pickup and drop-off trips or increase HOV mode share will have a measurable positive benefit to air quality. This benefit will be quantified in upcoming Massport EDR as outlined in the Parking Freeze Amendment.

Community Stakeholder

Community stakeholder effects are too small to calculate.

High-Occupancy Vehicle Services Summary Policy Scenarios

Overview of High-Occupancy Vehicle Services Summary Policies

The study team compiled the combinations from the previous sections to develop three HOV service macrocombinations. Combination 1 includes policies that Massport has recently implemented, is currently planning, or is likely to pursue soon. Combination 2 and Combination 3 include these policies and add policies that might require additional time, cost, and support to feasibly implement. Table 8 summarizes which previously outlined combinations were included in the modeling for the HOV services macrocombinations.

TABLE 8: POLICY AREA COMBINATION COMPONENTS IN HOV SERVICE MACROCOMBINATIONS

POLICY AREA	COMBO 1	COMBO 2	COMBO 3
Urban/Suburban Express Bus	Combo 1	Combo 2	Combo 3
Public Transit/Multistop Bus	Combo 1	Combo 2	Combo 3
Water Transportation	Combo 1	Combo 1	Combo 1

Source: RSG

High-Occupancy Vehicle Services Summary Policy Effects

Table 9 summarizes the HOV services policy scenario effects.

TABLE 9: HOV SERVICES POLICY SCENARIO EFFECTS SUMMARY

EFFECTS	COMBO 1	COMBO 2	COMBO 3
HOV Mode Share (% of total cumulatively)	+1.0%	+2.1%	+2.5%

Source: RSG

Mode Choice

In HOV Services Policy Combination 1, HOV mode share is forecast to increase by 1 percentage point. This shift is due to an expected increase in overall Logan Express mode share. SOV mode shares decrease: Ride app use would decrease by less than 1 percent, and MBTA Blue Line share would also decrease by less than 1 percent.

In HOV Services Policy Combination 2, HOV mode share is forecast to increase by 2.1 percentage points. This shift is due to an expected increase in overall Logan Express mode share. SOV mode shares decrease: Ride app use would decrease by over 1 percent, and MBTA Blue Line share would also decrease by nearly 1 percent.

In HOV Services Policy Combination 3, HOV mode share is forecast to increase by 2.5 percentage points. This shift is due to an expected increase in overall Logan Express mode share. SOV mode shares decrease: Ride app use would decrease by over 1 percent, and MBTA Blue Line share would also decrease by over 1 percent.

Cost to Authority

Estimating cost to the Authority for these policy combinations would require additional financial analysis and is not currently calculable for water transportation. Massport will conduct additional analysis prior to any recommendation to move forward on the policy combinations or components therein.

Operations

Increased Frequencies: Accommodating increased frequencies on various services would require additional labor and vehicles to serve the busier schedules and more curb space to accommodate the vehicles at Airport terminals (Logan Express, MBTA Silver Line). These service increases may also require additional traffic management to manage circulation and overflow at the remote sites (Logan Express).

Remote Baggage Check: Remote baggage check services would likewise require additional labor, infrastructure, logistics, and security. Standard coaches and MBTA Silver Line vehicles may not be able to accommodate the prechecked baggage, and ancillary vans or trailers may be required. This infrastructure (at the remote site, in transit, and at induction points to Airport baggage systems) would need to support secure baggage protocols, potentially proving costly or logistically challenging.

Other: Service increases and improvements would necessitate other changes. **Security prioritization** would likely require some additional support and enforcement at Logan Express stations, South Station, and at Airport terminal security areas. Another byproduct of increased and improved service at current Logan Express locations and, to a lesser extent, MBTA ferry locations would be the potential need to **accommodate increased parking demand**. Headway reductions along with provision of new baggage check and security prioritization services may necessitate additional parking spaces to meet demand. Operations for new services at new locations would also require **more staffing**, vehicles, siting, construction, marketing, and other.

Air Quality

Any measure that Massport can take to reduce pickup and drop-off trips or increase HOV mode share will have a measurable positive benefit to air quality. This benefit will be quantified in upcoming Massport EDR as outlined in the Parking Freeze Amendment.

Customer Service

Key customer service considerations include conveying service changes to customers and supporting those customers as they use the new offerings. New service locations and new procedures around baggage check and security prioritization would require significant customer support. Massport staff will face the challenges related to elements of customer experiences outside of Airport property and control (e.g., congestion at remote sites, collocated services at South Station). Furthermore, for existing and new locations, marketing the new or additional capacity (e.g., increased frequency) and benefits from the enhanced services should be communicated to potential new and existing customers. As noted, Massport has launched a multimedia marketing campaign to accompany the service improvements announced in May 2019; this is a precursor to more significant marketing that would be required to support myriad new policies under consideration.

Community Stakeholder

Community stakeholder effects largely pertain to three broad groups: Airport/East Boston/South Boston.

Airport/East Boston/South Boston: Effects include congestion reduction on Airport property, in the neighborhoods, and along the major gateway roads. The policies and scenarios proposed should benefit the community through the reduction of congested hours along the major roads, which should relieve pressure on neighborhood roads. Express MBTA Silver Line service would also improve MBTA Silver Line conditions for non-Airport riders as the Airport ridership would be more confined to those express trips. Conversely, infrastructure improvements to accommodate increased trips and express service may require significant construction or other disruptions during initial rollout.

Study #1: Services Conclusions

1. **Unmet demand exists for Logan Express**. Providing more frequent service and service from more locations would lead to increases in Logan Express ridership. Low-cost complementary incentives like priority access in Airport security screening have the strong potential to improve ridership with low investment. High-cost innovations like remote baggage check would not seem to have as much of an effect.

   Because of the increases the MCMS indicates, Massport has already started to implement these policy combinations. The improvements to Back Bay Logan Express and increased Braintree Logan Express frequencies have been implemented, additional buses needed for the North Station service have been ordered, and potential new suburban sites have been identified.

2. **Improvements to the MBTA Silver Line would have some effect**. Often, general-purpose public transit bus services have not had the same effect as express bus services, and the MCMS indicates that this is also the case with MBTA Silver Line service to the Airport. However, there are some positive effects from these policy combinations.

3. **Water transportation would need to be reimagined on a systemwide basis for Airport passengers to switch to this mode on a large scale**. Unlike with Logan Express, incrementally improving the current water transportation services does not produce much effect. Doubling the frequency of existing service offers minimal returns. However, it is possible that introducing security prioritization would have some effect at minimal cost.

Study #2. Logan Airport Ground Access High-Occupancy Vehicle Pricing

Study Introduction

This section details the methodology and findings of **Study #2. Logan Airport Ground Access High-Occupancy Vehicle Pricing (hereafter Study #2)**, which explores the costs and pricing for different modes of transportation to and from the Boston Logan International Airport (hereafter the Airport or Logan Airport) to identify a pricing structure and evaluate allocation of revenues generated to reduce pickup and drop-off mode use to the Airport. This study includes an evaluation of short- and long-term parking rates and their influence on different modes of ground access transportation to and from the Airport.

To inform Study #2, the Massachusetts Port Authority (hereafter Massport or the Authority) conducted the fall 2018 Logan Air Passenger Ground Access Survey (hereafter the 2018 Passenger Survey). The overall survey comprised two parts: 1) an origin-destination (O-D) survey describing the current trip to the Airport (Logan Airport was always the destination for this study); and 2) a stated preference (SP)[27] survey. The O-D section included details of the Airport access trip like origin address and type of origin place (e.g., work, home), trip purpose, mode of transportation, parking costs, time of day, party size, length and location of stay, frequency of travel from the Airport, and demographic information.

The SP section of the survey used this detailed O-D data to customize a set of hypothetical choice experiments. An efficient experimental design determined the choice experiments participant saw. Specifically, this experimental framework comprised 61 designs (targeting different types of respondents), with 10 unique blocks of 6 experiments each, for a total of 3,660 experiments. Each respondent was randomly assigned to one of the 10 blocks and shown all 6 experiments. Each of these 6 experiments, in turn, presented between 4 and 15 alternatives. The number and types of modes that were shown in the SP experiments were determined by the following logic:

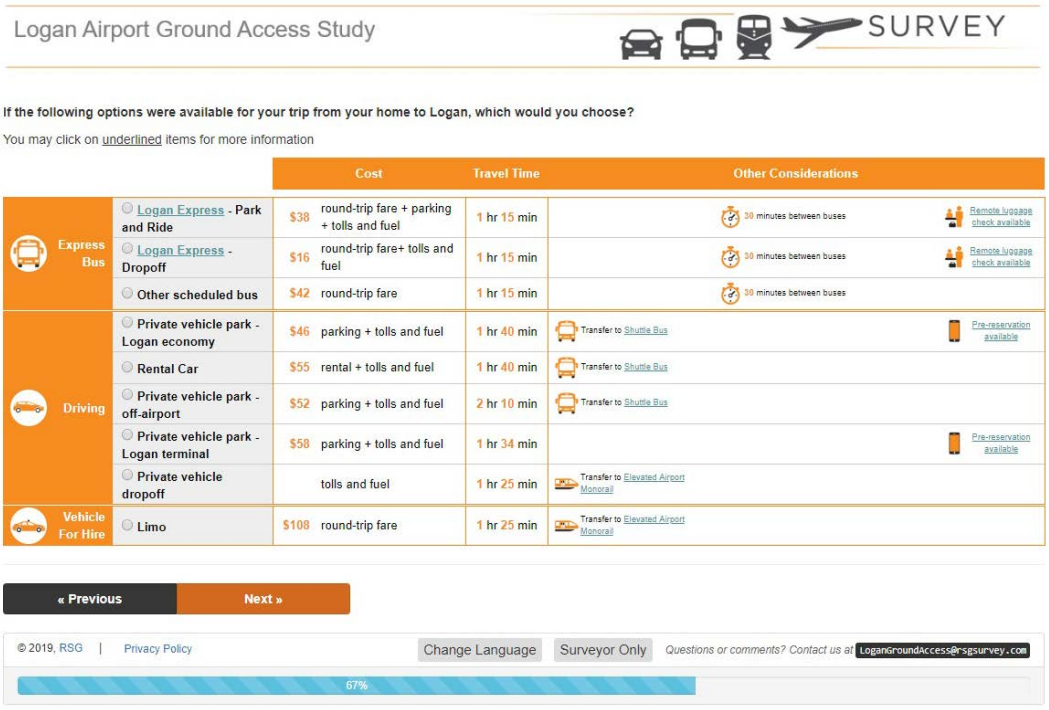
- Respondents originating from within the Massachusetts Bay Transportation Authority (MBTA) subway service area were shown MBTA Blue Line, MBTA Silver Line, MBTA ferry, and water taxi.

[27] Data detailing what people might do (hypothetical).

- Respondents who also originated within 0.5 miles of Kendall Square or North Station were shown an additional hypothetical express bus service.
- Respondents originating outside of the MBTA subway service area were shown rental car, Logan Express, and other scheduled bus service.
- Respondents originating from the South Shore also saw MBTA ferry.
- All respondents saw taxi and ride app except those originating beyond I-495.
- All respondents saw limousine.
- All respondents who mentioned a car was available for this trip saw private vehicle drop-off and parking options, including Logan Express drop-off if originating outside of the MBTA subway service area.
- Superseding all logic above, each respondent saw the mode they indicated using for their Airport trip.

Figure 9 illustrates the screen viewed by survey respondents for the SP section.

FIGURE 9: SCREENSHOT OF SP SURVEY EXPERIMENT



Source: RSG

For each choice alternative, several associated trip characteristics were displayed. These included travel time, cost and, if applicable, headway and whether a transfer to a shuttle bus was required. Across all the scenarios, the respondent was presented with different levels of each attribute (each attribute

varied independently of the others) and asked to “trade off” among the choice alternatives.

The survey was conducted as a self-administered tablet-based intercept interview between October 15, 2018 and October 31, 2018 at terminal gates, with the aim of collecting a representative sample of originating passengers. Four survey teams (pairs of two) were provided four flight assignments staggered over their eight-hour shift to accommodate breaks and travel both to and within the terminal. To prevent any lost time due to flight delays or cancellations, each flight assignment included multiple similar backup flights that could be sampled if an issue occurred with the original assignment. Over 5,000 surveys were completed in the development of the survey database.

The study team used these data to develop a Mode Choice Model and Simulator (MCMS) to simulate dozens of policy scenarios and explore the effects of potential changes to Massport-related ground access services.

Best practice for airport mode choice models includes development of a separate model for each trip purpose. Segmentation by type of airport users is important because airport access differs greatly by trip purpose (e.g., residents are far more likely than nonresidents to drive and park a personal vehicle at the Airport). In this regard, models are segmented into the following classifications:

- Resident business.
- Resident nonbusiness (leisure).
- Nonresident business.
- Nonresident nonbusiness (leisure).

Mode Choice Model and Simulator Format

Traditional airport mode choice models employ a multinomial logit (MNL) or, preferably, nested logit (NL) format. The logit format is employed because the probabilistic structure, where choices are expressed as the probability of choosing each option, accommodates realistic nuance whereby changes in behavior occur at the margins. People tend not to be binary decision-makers. Ideally, choice models are not binary either. The NL format, specifically, is employed because it accounts for asymmetric preference across modes. People are likely to substitute among modes with similar characteristics (e.g., air passengers are more likely to switch from a taxi to a ride app than to a ferry). The NL model can be used to determine, statistically speaking, which modes compete most directly.

However, as the study team iterated on MNL and NL model formats, it became clear that NL models were not nesting[28] effectively. Respondents showed significant taste heterogeneity, meaning much of the respondent choice was not dictated by broad, aggregate trends but, rather, by individual preferences and tastes. To account for this nuance, the study team's final models applied a mixed logit (ML) format. In the ML format, respondents have a unique MNL utility function to account for their unique preferences. This model format allows for the simplicity of MNL construction while accounting for asymmetric competition between modes in the way an NL model would.

Variables

The following variables were included in the final models:

1. Travel Time ($/hour)
2. Cost (in $)
3. Headway (Ferry) (in minutes)
4. Headway (Urban Transit) (in minutes)
5. Headway (Suburban Bus) (in minutes)
6. Transfers (MBTA) (number)
7. Remote Baggage Check (Binary—yes/no)
8. Pre-Reserved Parking (Binary—yes/no)
9. Automated People Mover Egress (Binary—yes/no)
10. Shuttle Bus Egress (Binary—yes/no)
11. Alternative Specific Constants for each mode:
    a. MBTA Ferry
    b. Water Taxi
    c. MBTA Blue Line

[28] Nesting refers to how the parameters of one model relate to another. For instance, a "nested" model is one that uses a subset of parameters of another model. This model is then "nested."

d. MBTA Silver Line

e. Ride App—Standard

f. Ride App—Shared

g. Taxi

h. Limousine

i. Private Vehicle Drop-Off

j. Parking—Central Parking

k. Parking—Economy

l. Parking—Off-Airport

m. Rental Car

n. Logan Express—Park-and-Ride

o. Logan Express—Drop-Off

p. Other Scheduled Bus

Model Estimation

The study team conducted model estimation in a statistical package of the open-source analysis tool "R."[29] This package is specifically designed to conduct choice model estimation.

Review of Model Fit and Iteration

After initial estimation, the study team reviewed the model output and considered the reasonableness of the results. This phase functioned as an iterative process through which any concerns regarding the statistical model could be explored and corrected. This, as previously mentioned, included altering the model format, adjusting explanatory variables, and reviewing and adjusting initial assumptions developed in the revealed preference dataset.[30]

[29] *The R Project for Statistical Computing*, www.r-project.org (accessed September 13, 2019).
[30] Data detailing what people did do (observational).

Model Calibration

Once the iterative specification, estimation, and review process was complete, the study team calibrated the resultant model to mode shares from the 2018 Passenger Survey. The study team also integrated Logan Express ridership data from 2018 into the calibration to ensure the MCMS accurately captured the relative ridership across Logan Express locations. These calibration steps allowed the model to represent the base case (2018 existing conditions) situation with proper shares for each mode. Once calibrated, the model was then used to forecast future ground access scenarios. Finally, for the ultimate analysis of changes in high-occupancy vehicle (HOV) mode share, the study team calibrated the model output to CY 2018 annual ridership levels for Airport ground transportation, by mode. This analysis is the basis for all results in this study. The facilitation of a 5,000-respondent intercept survey and development of the MCMS was exhaustive.

This section summarizes the most important results from Study #2. Pricing strategy is evaluated on its effect on mode choice as it relates to the hierarchy of airport modes. The modal hierarchy places parking as more desirable than private vehicle drop-off, ride apps, and taxis, but less preferable to all HOV options. Parking pricing strategies are explored to reduce vehicle drop-off rates.

Policy Development

This study emphasizes the pricing variable for on-Airport parking. Rather than develop numerous pricing scenarios for modeling, the study focuses on the effects of pricing rate policies approved by the Massport Board. In this way, the study establishes the basic quantitative relationship between pricing, parking demand, and diversion to or from other modes. Once these quantitative relationships are established, the study proceeds through several possible conceptual approaches to using parking pricing policy to affect outcomes, emphasizing strategic and often qualitative considerations. This includes consideration of a variable pricing concept.

Detailed policy analysis in this study prioritizes on-Airport parking pricing because pricing policies for other modes are covered in the other two Logan Parking Freeze Amendment studies. In those cases, pricing is modeled as part of larger policy scenarios to promote ridership on HOV services (e.g., Logan Express in Study #1) or to influence passenger behavior toward more efficient use of non-HOV modes (e.g., ride app centralization, drop-off fees, and discounted shared-ride product pricing in Study #3). These analyses, combined

with the detailed analysis of on-Airport parking pricing in this study, provide a representative overview of the potential applications of Massport pricing policies to influence ground access behavior.

Policy Tool

The study team developed the MCMS to describe the effects of potential policies on ground access mode choice. The MCMS predicts the changes in share for each transportation mode for a given policy (or combination of policies). The 2018 Passenger Survey facilitated development of the MCMS, which provided the critical data to develop the air passenger behavior models. The framework of this survey is described in the section below, Analytical Framework and Assumptions. Appendix B details the survey deployment and content, and Appendix C provides additional detail on the MCMS.

Calculating mode share helps Massport understand the effects of the policies in terms of parking demand, required operational adjustments, and the effect on trip generation associated with Airport access. To illustrate, consider Massport's scheduled parking rate policy, which includes a $3 increase to the daily rate for both the Logan Terminal Area and Economy Parking facilities on July 1, 2019, and another $3 increase to the respective daily rates for July 1, 2021:

- In this example, as the modeling in this chapter illustrates, the MCMS calculates a decrease in parking **demand**, which will lead to fewer parking facilities transactions or durations.
- From an **operations** and **financial** standpoint, congestion within the parking facilities should be reduced along with the costs required to implement irregular parking operation procedures when garages are full (e.g., diverting cars to other/overflow lots and implementing vehicle valet, which often requires parking vehicles in nonlined spaces for a period of time). As this chapter will show, the parking rate increases will generate enough new revenue to offset loss in demand.
- Finally, the tools help Massport better assess the effects of ground access on the Airport's overall **trip generation**. In particular, the tool can estimate the diversion to or from other pickup/drop-off modes, both private and commercial; this allows Massport to assess the overall effect of a policy on the regional highway network.

Demand and Supply Assumptions

The MCMS assumes that demand is unconstrained, meaning that there are no restrictions on the amount of demand a given mode alternative might generate.

When demand exceeds supply, the demand often goes elsewhere. For example, if on-Airport parking lots are full, then some travelers who might have used this mode to travel to the Airport may instead opt to take a private or commercial pickup/drop-off mode. Pickup/drop-off modes generate more ground access trips per air trip than parking.

The demand model assumes that anyone who wants to use on-Airport parking facilities will be serviced in their likely parking product of choice. Although in practice Massport accommodates all customers who want to park at the Airport, the specific facility that a customer would otherwise choose may not be available. For example, a travel party may decide to drive to the Airport with the intention of parking in the terminal garages based on the attributes of that parking product, but may be diverted to Economy Parking or an overflow lot, or offered to valet the vehicle with an Airport parking staffer.

Although the MCMS is unconstrained and, hence, does not account for irregular parking operations like diversions and valet, Massport did and continues to thoroughly evaluate the operational effect of policies and improvements outlined for their ability to accommodate the anticipated customer increase.

This study emphasizes long-term parking demand. The traffic effects of short-term parking are more closely associated with pickup/drop-off modes. Massport's objective to use pricing as a tool to reduce short-term parking has been covered consistently in other public filings. This study focuses on the more nuanced perspective required for developing a long-term parking strategy, which for Massport typically involves multiple days of parking space occupancy.

Policies and Policy Packages

In the MCMS, several variables can be changed to reflect potential policies. While all these variables can be individually simulated, most variables make sense to change in combination with other variables. For the purposes of Study #2, however, the entire focus is on the pricing variable for Airport parking modes, with an emphasis on long-term parking. Consideration of pricing as part of policy packages for Logan Express is covered in Study #1, and consideration of pricing as part of policy packages for ride apps is covered in Study #3.

Analytical Framework and Assumptions

The analytical work undertaken for Study #2 used a robust dataset from a survey of air passengers and their mode choice preferences. This study evaluated potential policies that address the questions asked by the Massachusetts

Department of Environmental Protection as part of the Parking Freeze Amendment. The study team holistically evaluated each policy according to the following criteria:

- **Mode Choice**. How does the policy increase (or decrease) private vehicle and commercial pickup/drop-off mode share to the Airport? The study team developed the MCMS to conduct this analysis.
- **Revenues and Costs**. How much revenue would a policy generate for Massport and at what cost? This criterion analyzes financial effects overall and per net new HOV rider to understand the cost/benefit of different policies.
- **Operations**. For a given policy, what are the types of operational changes that are necessary for Massport implementation? For example, are new facilities, permits, staff training, or technology necessary, and what are the benefits and challenges?
- **Customer Service**. What are the effects on customers/air passengers? How can alternatives to commercial and private vehicle pickup and drop-off modes be made more attractive to passengers? How can the benefits of these alternative modes be marketed even when there are also drawbacks? For example, an HOV trip option may require additional travel time, but customers may experience a more relaxing trip where they do not have to drive in traffic and navigate; alternatively, Massport may implement various additional services for HOV customers to enhance the experience.
- **Air Quality**. It is assumed that policies that increase HOV mode had a positive effect on air quality.
- **Community Stakeholder**. These effects focus on how a policy might change the patterns of Airport ground transportation behavior (e.g., volume, routing, new facilities). This criterion assesses effects from the perspective of surrounding communities.

Policy Analysis

Table 10 summarizes the range of policy scenarios explored in this study.

TABLE 10: HOV PRICING POLICY SCENARIOS

POLICY SCENARIOS
Parking: General Short- and Long-Term Rates
Parking: Variable and Discount Pricing

Source: RSG

Policies Outside or Partially Outside Massport Control

Several policies directly or indirectly affect Massport but are outside of the Authority's control. For example, Massport does not own, regulate, or manage the Boston Harbor tunnels, and therefore cannot control tunnel capacity and operations. Similarly, Massport also has no control over real estate development on non-Massport-owned properties, which increases local and regional traffic volumes and congestion. For the purposes of this study, Massport remains agnostic about such policies and, rather, focuses on areas where the Authority can directly exert influence. Massport's goal is to design sensible ground access strategies to reduce Airport traffic effects. It focuses on the assets under Authority control and strives to both understand and work constructively within the surrounding context out of Massport's control.

Logan Airport Parking

Introduction to Logan Airport Parking Pricing Policies

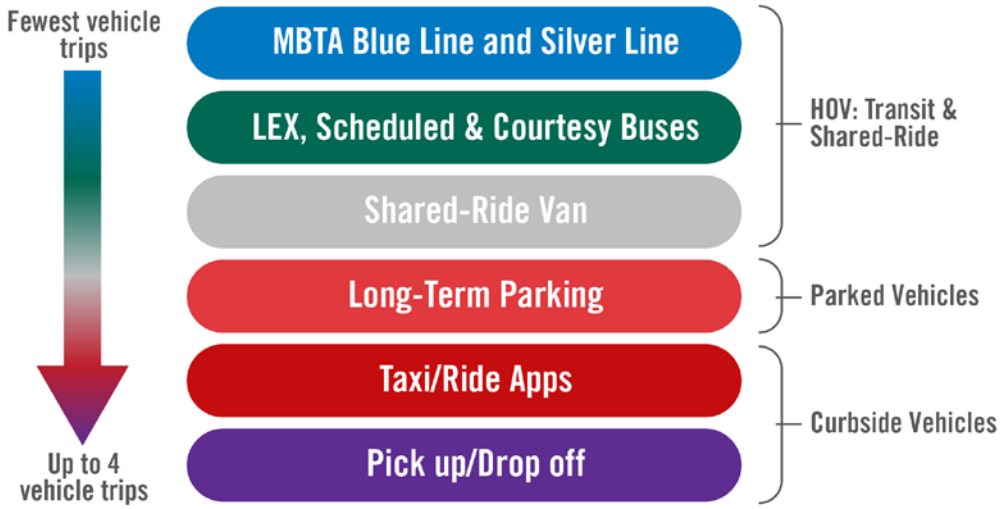
Massport owns and operates commercial parking facilities at the Airport, including the Central/West Garage, Terminal B Garage, Terminal E lots, and Economy Garage. The following sections document the current conditions of these services and provide additional context.

Logan Airport Parking Strategy

Massport's parking strategy should be contextualized within the Authority's long-term goal to minimize air quality effects of ground transportation associated with Airport air travel demand. The Logan Parking Freeze Amendment studies focus on the objective of reducing the number of air passenger vehicle trips to and from the Airport. A critical element of Massport's parking strategy to meet its air quality goal is to promote Airport ground access in modes that do not pick up or drop off at terminal curbs, which generates the most ground access trips per air trip.

Massport's parking strategy incorporates within an overarching Logan Ground Access trip reduction framework. This framework is described by a hierarchy among ground access transportation modes with respect to trip generation, which then relates to air quality effects. Figure 10 illustrates this hierarchy of ground access modes.

FIGURE 10: LOGAN AIRPORT HIERARCHY OF GROUND ACCESS MODE EFFECTS



Source: Massport

HOV transit and shared-ride modes generate the fewest roadway vehicle trips. Hierarchies also exist within the HOV category as, for instance, public transit includes *very* high-occupancy vehicles, some of which generate no roadway trips (e.g., rail transit).

Vehicles parked long term at the Airport, including on-Airport private vehicle parking and rental cars (which are parked in the Logan Consolidated Rental Car Center), comprise the next most preferable tier. Each air trip generates just one trip to the Airport and one trip from the Airport, as the vehicle is stored in on-Airport facilities upon air trip departure.

Curbside vehicles, which comprise both commercial and private pickup and drop-off modes, generate the most trips. Private vehicle pickup and drop-off generates four vehicle roadway trips, as the vehicle enters and exits the Airport both for the departing and arriving air trip. Commercial pickup/drop-off modes like limousine car service, ride apps, and taxis can also generate up to four trips for each air trip depending on whether the service provider arrives or leaves the Airport without riders. Each of these “deadhead” trips[31] increases the number of ground access trips generated to and from the Airport for each air trip.

Policies to minimize deadhead trips among limousine car service, ride apps, and taxis can help reduce total trips from four to as few as two. Study #3 covers some of these policies. For the purposes of evaluating parking pricing strategies in

[31] A deadhead trip refers to a trip without a passenger.

Study #2, however, all curbside pickup/drop-off modes are classified together as the least desirable outcome.

In addition, Massport continues to study and implement policies to address other key ground access objectives contributing to the overall goal of minimizing air quality effects. These include, but are not necessarily limited to, the following: subsidizing HOV modes; installing free electric vehicle charging stations to promote lower-and zero-emission vehicle use; implementing employee HOV strategies; and pursuing investments and other policies aimed at reducing on-Airport vehicle miles traveled (VMT), vehicle idling, and associated congestion on Airport roadways and curbs.

The Airport parking strategy addresses Massport's goal of minimizing air quality effects. Trip reduction is a critical long-term objective; however, the Airport parking strategy also encompasses other important variables related to air quality and minimizing environmental and community effects more generally. Taken together, elements of the strategy include, but are not necessarily limited to, the following:

1. For air passengers choosing automobile modes, reducing the number of vehicle trips to and from the Airport by providing and promoting parking as an alternative to more environmentally harmful private and commercial vehicle pickup/drop-off activity.

2. Placing a premium price on short-term parking, which ultimately produces similar numbers of trips to and from the Airport as pickup/drop-off modes and reduces capacity for long-term parking.

3. Constructing on-Airport parking capacity to meet forecasted long-term demand, thus reducing the additional VMT and other environmental effects associated with vehicle circulation, diversions to different facilities, and other irregular parking operations.

4. Using pricing as an operational and facility management strategy to help balance demand with supply at any given time, and to anticipate periods of supply constraint during facility construction, renovation, or routine maintenance activities.

5. Deriving the financial resources to subsidize HOV modes (e.g., Logan Express parking, MBTA Silver Line boardings, on-Airport shuttles connecting to public transit), and to fund parking facility construction to decrease private and commercial vehicle pickup/drop-off modes.

This list also excludes other Massport goals like providing superior overall customer experience, which relates to the Airport's broader mission to serve the robust economy and diverse people of the Commonwealth of Massachusetts.

While individual parking policies will reflect the important priorities at any given time, the broader objective is to align parking policy with the broader long-term goal of minimizing air quality effects and, more generally, minimizing the environmental footprint of the Airport and being a good neighbor to surrounding communities. This study provides a detailed analysis of the effects of parking pricing policy on these goals and objectives.

Current Conditions

Service Summary and Attributes

Massport manages on-Airport parking supply in accordance with the provisions of the Logan Airport Parking Freeze, which is detailed in the Introduction. The Airport manages the Central/West Garage (accessible to terminals, A, B, C, and E), the Terminal B Garage, Terminal E parking lots, and the Economy Garage. Economy Parking is accessible to the terminals via the free Massport shuttle system. Table 11 summarizes the current number of lined spaces in Logan Terminal Area and Economy Parking facilities.

TABLE 11: LOGAN TERMINAL AREA AND ECONOMY PARKING SPACES

FACILITY	CURRENT TERMINAL AREA & ECONOMY PARKING SPACES
Terminal Area Parking: Central/West Garage	10,939
Terminal Area Parking: Terminal B Garage	2,212
Terminal Area Parking: Terminal E Surface Lots	533
Economy Parking Garage	2,864
Total[32]	**16,548**

Source: Massport

The number of parking spaces in Terminal Parking facilities had declined by approximately 1,800 since the beginning of 2018. This decline includes the loss of spaces to repurpose part of the Central/West Garage for the centralized ride app pickup/drop-off area (described in Study #3). It also includes the temporary

[32] These figures exclude overflow capacity (both lined and unlined), which can be used during irregular operations when demand exceeds supply in the Logan Terminal and Economy parking facilities.

loss of other Terminal Parking spaces due to other construction activities. Additionally, nearly all on-Airport overflow parking spaces have been removed from service either permanently—to make way for other facilities—or temporarily during construction.

The construction of a new 2,000-space terminal parking garage at the current Terminal E parking lots area will permanently replace a substantial share of the existing surface spaces at this location. Many of these surface lot spaces will be taken out of operation during construction but prior to the opening of the new parking facility. Parking garage construction is anticipated to begin in the spring of 2020, with completion in the spring of 2022.[33]

Until the new garage at Terminal E is complete, the Airport will operate with significantly fewer terminal area lined parking spaces. This presents at least a temporary challenge on numerous fronts with implications during those periods where demand will exceed a more limited supply. These include, but are not necessarily limited to, the following:

- Increased operational risk requiring irregular parking operations like parking diversions and valet activities, and the associated significant financial and labor costs.
- Potential decline in the customer experience when the preferred parking product is unavailable, requiring diversion to other parking products/ locations or valet.
- Community and economic effects of these externalities.
- Loss of revenues due to parking diversion.
- Increases in overall air quality effects due to operational inefficiencies (e.g., vehicle circulation, irregular parking operations), which increase VMT, idling, and other general roadway congestion effects.

Building the Terminal E Garage is consistent with Massport's parking strategy to reduce vehicle trips to and from the Airport by providing enough parking supply to meet potential demand. The 2019 Logan Airport Air Passenger Ground Access Survey estimates that air passengers parking at the Airport would otherwise choose pickup/drop-off modes over 80% of the time, or more than four times the

[33] More information on Logan's parking development program can be viewed at: https://www.massport.com/logan-forward/initiatives/parking-program/.

number that would choose HOV modes.[34] In short, parking reduces the number of vehicle trips into and out of the Airport.

However, until such time that enough parking supply is delivered, Massport will need to leverage parking pricing as a tool to help manage demand to match current capacity. While the data suggest would-be parkers are more likely to take pickup/drop-off modes as their primary alternative, this demand cannot be efficiently serviced in existing facilities. Although Massport strives to meet all parking demand through diversions, valet, and other irregular operations, these activities carry significant air quality and other environmental effects (e.g., additional circulation/VMT) that negate the benefits of trip reduction.

Analysis from the MCMS suggests that pricing is an effective tool to meaningfully influence Airport parking behavior by reducing demand. Therefore, approved parking rate increases support the imperative to manage scarce current parking supply while helping to generate the financial resources (by generating net revenues from parking and avoiding additional costs of irregular parking operations) to support the construction of new on-Airport parking facilities. However, the MCMS also estimates increasing price elasticity[35] of demand, suggesting a diminishing ability to finance new garage construction with the proceeds of parking rate increases. Therefore, pricing is an effective but limited tool for the near-term objective to manage scarce garage capacity and to help finance the longer-term objective to build more on-Airport parking capacity.

[34] Limousine car service is considered a commercial drop-off/pickup mode; however, this mode has also traditionally been included in the Massport definition of HOV. Therefore, policies that reduce Airport parking tend to inflate the HOV benefits, as many would-be parkers choose limousine car service.
[35] Elasticity in this context refers to how much a change in price would affect demand.

Mode Share and Parking Volumes

In 2018, on-Airport long-term parking mode share was estimated at 8.8 percent of departing air passengers, with 7.3 percent at Terminal Parking and 1.5 percent at Economy Parking. This share is down from 2016, when on-Airport parking mode share was greater than 11 percent.[36]

Parking rate increases have contributed to declining on-Airport parking mode shares. Between the time of the 2016 Logan Air Passenger Ground Access Survey (April/May 2016) and 2018, Massport implemented two parking rate increases. Taken together, these policies accomplished the following:

- Increased Terminal Parking daily rates from $29 per day to $35 per day.
- Increased Economy Parking daily rates from $20 per day to $26 per day.
- Restructured short-term parking to eliminate 30-minute increment hourly rates, thereby increasing hourly rates overall.

Although parking demand has declined notably in *relative* terms since the 2016 survey, actual *absolute* parking demand has declined by only 6 percent from 2.7 million in 2016 to 2.5 million in 2018. This is because air passenger demand has *grown* by 13 percent over that same period. Therefore, while parking exits per emplaning air passenger declined, the overall number of emplaning air passengers has grown significantly. Table 12 illustrates recent trends in parking exits by Airport parking product.

TABLE 12: CHANGES IN LOGAN AIRPORT PARKING DEMAND BY PRODUCT, 2016–2018 (CALENDAR YEAR)

LOGAN AIRPORT PARKING PRODUCT	2016	2018	CHANGE
Terminal Area Parking: Long-term	1,151,158	1,157,159	0.5%
Economy Parking Lot	215,436	184,421	-14.4%
Short-term Parking	1,285,969	1,141,137	-11.3%
Total	**2,652,563**	**2,482,717**	**-6.4%**

Source: Massport

[36] The 2016 Logan Air Passenger Ground Access Survey, the most recent data preceding the 2018 Passenger Survey, did not distinguish between long-term and short-term parking. Detailed analysis of the 2016 Survey suggests that most short-term parkers classified their ground access mode as private vehicle drop-off, but some also likely self-classified as on Airport park. Therefore, for comparison with the 2018 Survey, the 2016 Survey estimated mode share is likely somewhat overstated.

Declining overall parking demand largely reflects Massport's successful strategy to use pricing to encourage long-term parking over short-term parking, the latter of which is associated with private vehicle pickup/drop-off activities. Approximately 85 percent of the decline in parking exits between 2016 and 2018 were classified as short-term parking. Within the long-term parking category, Terminal Parking demand is up while Economy Parking demand is down.

Despite declining relative propensity to park for at least some Airport parking products, Massport struggles to accommodate Airport parking demand during peak seasons. Massport implemented parking diversion or valet operations on 24 days during the peak months of February and April in 2019. These supply constraints occurred just prior to the removal from service of ~1,000 parking spaces to accommodate the new ride app pickup/drop-off area under development and other construction. Therefore, Massport anticipates significant challenges in the next several years to meet parking demand until new garage space capacity is delivered, especially in Terminal Parking.

Recently Implemented Parking Rates

Current and near-term future Airport parking rates follow a schedule approved by the Massport Board. As of July 2019, daily parking rates increased by $3 at both Terminal Area and Economy Parking locations, to $38 and $29, respectively. The first hour at any on-Airport facility increased from $7 to $8. Another scheduled $3 increase in daily rates will occur in July 2021, which will result in daily Terminal Area and Economy Parking rates of $41 and $32, respectively, and an increase in the first-hour rate at any on-Airport facility to $9.

Table 13 and Table 14 summarize the on-Airport parking fee structure, by parking product.

TABLE 13: LOGAN AIRPORT PARKING RATE SCHEDULE: TERMINAL AREA

TERMINAL AREA PARKING RATES	JULY 2017	JULY 2019	JULY 2021
First hour	$7	$8	$9
1 hour–2 hours	$19	$21	$23
2 hour–3 hours	$24	$26	$28
3 hours–4 hours	$28	$30	$32
4 hours–7 hours	$32	$34	$36
7 hours–24 hours	$35	$38	$41
1 day and 0–6 hours	$53	$57	$62
1 day and 6–24 hours	$70	$76	$82
Each additional day	$35	$38	$41
Each additional day, 0–6 hours	$18	$19	$21

Source: Massport

TABLE 14: LOGAN AIRPORT PARKING RATE SCHEDULE: ECONOMY

TERMINAL AREA PARKING RATES	JULY 2017	JULY 2019	JULY 2021
First hour	$7	$8	$9
1 hour–2 hours	$18	$20	$22
2 hours–3 hours	$20	$22	$24
3 hours–4 hours	$23	$25	$27
4 hours–24 hours	$26	$29	$32
1 day and 0–6 hours	$39	$44	$48
1 day and 6–24 hours	$52	$58	$64
Each Additional Day	$26	$29	$32
Each Additional Day, 0–6 hours	$13	$15	$16

Source: Massport

Relevant Practices

The following sections include an overview of relevant practices at airports across the United States.

Overview of Relevant Practices

It is difficult to compare parking policies across airports. Different airports offer different types of parking products and services tailored to local and regional markets. Context matters, as the size of the airport, the market it serves, and its physical location within that market (e.g., downtown urban, peripheral urban, suburban/rural) are relevant to parking demand, land constraints to build parking facilities, and the cost of construction. Moreover, airports located in denser population centers will tend to have more ground access options.

Logan Airport's portfolio of parking products includes the following:

- Terminal Parking, with hourly and daily rates.
- Discounted Economy Parking facility, with hourly and daily rates.
- The PASSport Gold frequent parking program, a fee-based membership program offering premium guaranteed on-demand Terminal Parking.
- The Exit Express frequent parking program, offering expedited payment.

- Heavily discounted parking at four satellite locations as part of the Logan Express park-and-ride service.

Massport is constantly benchmarking Logan Airport against its peers to analyze best practices and implement promising policies that fit its unique context. Some of the policies currently pending implementation and analyzed in the Logan Parking Freeze Amendment studies include the following:

- Expanding Logan Express to new park-and-ride facilities (Study #1).
- Parking pre-reservation (Study #3).

Given the diversity of airport typologies and parking products, price benchmarking is not straightforward. One approach, if imperfect, is to compare the highest standard daily terminal parking rates among closest peer airports, excluding other services (e.g., valet, pre-reservation). In general, for the purposes of analyzing ground access, peer airports for Logan Airport include Large Hub airports[37] located within dense urban areas with limited physical footprints and opportunities for expansion. For the purposes of this report, the study team focused on coastal airport markets, which may have additional constraints on expansion due to surrounding water.

Table 15 summarizes this analysis across a representative sample of peer airports in the United States.

TABLE 15: DAILY REGULAR PARKING RATES, LOGAN AIRPORT AND PEER AIRPORTS

AIRPORT	STANDARD TERMINAL AREA DAILY PARKING RATES
Boston Logan International Airport (BOS)	$38
Los Angeles International Airport (LAX)	$40
Miami International Airport (MIA)	$17
New York—John F. Kennedy International Airport (JFK)	$35–$39
New York—LaGuardia Airport (LGA)	$39
New York—Newark Liberty International Airport (EWR)	$34–$39
Philadelphia International Airport (PHL)	$24
San Diego International Airport (SAN)	$32

[37] As defined by the Federal Aviation Administration.

AIRPORT	STANDARD TERMINAL AREA DAILY PARKING RATES
San Francisco International Airport (SFO)	$36
Seattle-Tacoma International Airport (SEA)	$39
Washington—Ronald Reagan Washington National Airport (DCA)	$25
Washington—Dulles International Airport (IAD)	$25

Source: Massport and respective airport authority parking websites

Two-thirds of the airports listed have standard terminal parking rates in the $32–$40 range, encompassing Logan Airport's pricing policy. Local factors, however, tend to have a stronger influence on airport parking rates. Logan Terminal Parking daily rates fall within the range of pricing for similar products in adjacent downtown Boston. Many downtown garages charge over $40 per day for standard weekday parking (Table 16).

TABLE 16: DOWNTOWN BOSTON MAXIMUM STANDARD DAILY PARKING RATES

AIRPORT	STANDARD TERMINAL AREA DAILY PARKING RATES
Boston Common Garage	$32
Post Office Square Garage	$36
Theatre District Garage	$36
Logan Airport Terminal Parking	$38
Government Center Garage	$39
25 Summer Street Garage	$40
Lafayette Garage	$40
101 Arch Street Garage	$41
One Devonshire Garage	$42
Pi Alley Garage	$44

Source: Massport and parking garage websites, as accessed via https://www.downtownboston.org/getting-around-in-downtown-boston/parking-and-driving/

Logan Airport Parking Policy Scenarios

Overview of Logan Airport Parking Pricing Policies

Airport parking policy scenarios tested include pricing changes at on-Airport parking facilities. Specifically, the tested scenarios explored the following policy variables:

1. **Daily rate**: Changes in the daily rate for parking.

2. **Variable parking pricing**: Vary parking rates (general concept) during different periods of time to maximize efficiency of facility use.

The study team simulated two parking pricing levels based on Massport Board-approved scheduled rates. Combination 1 includes recently implemented pricing changes. Combination 2 includes the effect of the combined rate increases for July 2019 and July 2021.

- **Logan Airport Parking Policy Combination 1**:

    a. Daily rate: Increase daily parking rate at Terminal Parking and Economy Parking[38] by $3.

- **Logan Airport Parking Policy Combination 2**:

    a. Daily rate: Increase daily parking rate at Terminal Parking and Economy Parking[39] by $6.

Although the July 2019 rate increase has already occurred (Combination 1), the MCMS was built using 2018 base-year data. The underlying air passenger survey was also completed in 2018. Therefore, it is appropriate to model the July 2019 parking policy as a rate increase using the MCMS.

The study team modeled price increases for both Combination 1 and Combination 2 in nominal dollars. This process excludes consideration of inflation or other time-value-of-money adjustments that may decrease the actual consumer effects of these parking rate changes, especially for Combination 2, which will not occur until 2021. The study team applies nominal dollars for simplification purposes and under the assumption that changes in real value over

[38] Off-Airport parking rates are assumed to increase at the same rate as Massport rates.
[39] *Ibid*.

a short period of time will be modest and a factor of relative degree within the context of the overall analysis.

This analysis evaluates how on-Airport parking pricing policies affect on-Airport parking facility demand. However, assumptions are still required for parking facilities advertising Airport parking but located off the Airport property. This is because some would-be on-Airport parkers may choose off-site parking lots if the latter offers enough discounts. This analysis assumes that off-Airport parking operators will continue to offer discounts relative to Airport rates, but that they will benchmark their pricing to Airport parking rates. This analysis also assumes that off-Airport parking operators increase their daily rates by the same nominal dollars as Logan Airport, maintaining the existing price differentials. Actual competitive responses will likely vary in general and among the various off-Airport parking operators.

Further, and as previously detailed in this study, this analysis is limited to the effects of parking pricing policies on long-term parking. This includes parking in the Terminal Area and Economy garages for four or more hours. Massport estimates four hours as a minimum threshold for determining whether a parker is likely an air passenger on an air trip as opposed to a short-term parker picking up or dropping off another air passenger.[40] For simplification, the MCMS assumes that behavior of air passengers with same-day inbound and outbound flights to the Airport (and, hence 4–24 hours of parking time) make ground access decisions based on daily parking rates. Daily rates are identical to seven-plus hour rates in Terminal Parking, and only slightly discounted for four or more hours. Economy Parking daily rates and four-or-more-hour rates are identical.

Additionally, this analysis does not consider the effects of frequent-parker programs such as PASSport Gold or Exit Express on ground access mode choices or other quantitative and qualitative evaluation criteria detailed later in this study. A blended revenue per-parking-exit figure is used for the Cost to Authority evaluation.

Variable rate pricing is discussed as a general concept as part of the policy evaluation sections and as an extension of Logan Airport Parking Policy Combination 1 and Logan Airport Parking Policy Combination 2. This general concept seeks to reconcile some challenging elements of the Logan Airport Parking Strategy via the following:

[40] The Logan Airport property has separate parking facilities designated for Airport employees, hotel patrons, contractors, and other visitors.

1. Increasing the trip reduction potential of parking facilities at off-peak times by encouraging diversions from harmful private and commercial vehicle pickup/drop-off activity when long-term parking capacity exists.

2. Increasing revenues from parking to help subsidize HOV services and fund parking facility construction by increasing the utilization of Airport parking during off-peak times.

3. Retaining higher relative prices during peak demand seasons or when construction activities reduce supply, thus reducing the additional VMT and other environmental effects associated with vehicle circulation, diversions to different facilities, and other irregular parking operations.

Massport continues to explore potential applications of variable pricing at the Airport. No specific or preferred policy structure has been identified, but due diligence continues. Nonetheless, the analysis of pricing in this study illustrates the general direction and effects of increasing parking mode shares, which would apply to changes in standard daily rates and variable rates.

Logan Airport Parking Policy Effects

Table 17 summarizes the Airport parking policy scenario effects.

TABLE 17: LOGAN AIRPORT PARKING POLICY SCENARIO EFFECTS SUMMARY

EFFECTS	COMBO 1	COMBO 2
HOV Mode Share (% of total cumulatively)	+0.2%	+0.5%
Net Cost*/New HOV Rider	N/A	N/A

*Net Cost/New HOV Rider Key: **$** <$10/year; **$$** $10-25/year; **$$$** $25-50/year; **$$$$** $50+/year*
**Includes estimated new operating costs and amortized capital expenditures for direct provision of the service. Does not account for potential additional capital expenses associated with new or expanded facilities. Includes estimated revenues based on the MCMS, as well as revenue lost or gained from other modes (e.g., parking and rental) due to mode share shifts.*
Source: RSG

Mode Choice

In Logan Airport Parking Policy Combination 1, HOV mode share is anticipated to increase by 0.2 percentage points, although a significant share of these HOV volumes are associated with limousine car service. Correspondingly, mode share increases across all nonparking modes.

In Logan Airport Parking Policy Combination 2, HOV mode share is anticipated to increase by 0.5 percentage points, although approximately 0.2 percentage points are associated with limousine car service. Correspondingly, mode share increases across all nonparking modes.

While on-Airport rate increases will divert some parkers to more environmentally desirable HOV modes, more would shift to commercial and private vehicle pickup/drop-off modes. Therefore, parking rate increases may increase trip generation to and from the Airport, at least in the short term. However, since the MCMS evaluates unconstrained demand, it does not account for parkers who might still be diverted due to limited supply.

A variable rate policy that encourages off-peak parking would likely decrease HOV mode share, but it would likely produce additional trip reduction because a larger quantity of commercial and private pickup/drop-off modes will be diverted.

Other policy evaluation sections that follow will detail the potential air quality benefits, at least in the short term, of using pricing policy to reduce on-Airport parking demand until enough parking supply is available.

Cost to Authority

Logan Airport Parking Policy Combination 1 is estimated to produce net revenues to the Authority. Parking demand is responsive to pricing, as evidenced by declining relative (and, in the case of the Economy Garage, absolute) long-term parking mode shares after recent rate increases, as discussed in the Mode Share and Parking Volumes analysis section, and as illustrated in actual parking exits trends in Table 12. Nonetheless, demand is still strong enough that a $3 increase in daily rates for Terminal Area and Economy Parking leads to an overall net revenue gain.

Logan Airport Parking Policy Combination 2 is estimated to produce additional net revenues to the Authority above and beyond those generated under Combination 1. However, there is a diminishing return in this case, as price elasticity of demand increases at higher price points.

Massport will also realize savings from reduced irregular parking operations when parking demand exceeds parking capacity. Procedures such as parking diversion and valet activities require substantial additional labor expenditures.

A variable parking rate concept, if designed correctly, increases total parking revenues by increasing the utilization of parking facilities during off-peak periods.

Operations

Increased daily parking rates will specifically improve the efficiency of Airport parking operations and generally improve ground access operations. This is especially the case in the short term until additional parking can be brought into operation to meet estimated demand. A new, 2,000-space Terminal E parking garage is planned for delivery in the spring of 2022. Until then, increased pricing will help manage demand for scarce parking space at the Airport via the following:

- Reducing circulation within and while accessing Airport parking facilities, which generates general on-Airport ground access VMT and congestion.
- Reducing the need for irregular parking operations (e.g., diversions, valet) that require substantial additional staffing.

A variable parking rate concept, if designed correctly, can increase parking utilization without adversely affecting Airport parking operations and, more generally, Airport ground access operations.

Customer Service

Massport strives to support a superior customer experience throughout an air passenger's entire journey from origin to destination. In addition to reducing VMT, constructing new parking facilities will help meet the demonstrated demand for more parking capacity, and the revenues generated by parking fees help fund parking facility construction and subsidize numerous HOV ground access alternatives.

Nevertheless, increased parking fees and the short-term reduction in parking supply due to various construction projects will inconvenience many air passengers accessing the Airport. For this reason, Massport continues to aggressively study and, in many cases, has already implemented new HOV services (detailed in Study #1) while also developing new customer amenities like parking pre-reservation (detailed in Study #3). Massport's Logan Forward[41] marketing campaign seeks to build channels for communicating ground access and other important information during a time of significant disruption due to construction activities. This information helps air passengers to better prepare for their journeys.

[41] *Logan Forward*, https://www.massport.com/logan-forward/ (accessed September 17, 2019).

A variable parking pricing concept, if designed correctly, could enhance the customer experience by helping to match as much available parking capacity as possible for air passengers preferring to drive and park at the Airport through the duration of their air trip.

Air Quality

Any measure that Massport can take to reduce pickup and drop-off trips or increase HOV mode share will have a measurable positive benefit to air quality. This benefit will be quantified in upcoming Massport Environmental Data Reports as outlined in the Parking Freeze Amendment regulation.

Community Stakeholder

Community stakeholder effects largely pertain to two broad groups: East Boston and the wider region.

East Boston: In the short term, the policies and scenarios described in this study would benefit the community by reducing various air quality effects by managing ground access efficiently during a time when parking demand exceeds supply. In the long term, delivery of additional parking supply to meet demand will reduce vehicle trips to and from the Airport, delivering congestion and air quality benefits. In the meantime, neighborhood roads could see an uptick in traffic if customers interested in parking pursue off-Airport parking in the East Boston and Chelsea areas.

Construction of the parking garage in front of Terminal E will occur in the interior of the Airport property, limiting direct effects to the surrounding community. Nonetheless, additional construction activities will temporarily generate additional construction vehicle traffic to and from the Airport.

A variable parking pricing concept, if designed correctly, should encourage more on-Airport long-term parking and divert more environmentally harmful commercial and private vehicle pickup/drop-off modes.

Region: The wider region will experience less of the direct effects of construction activities. However, the current lack of parking capacity decreases the opportunity to divert environmentally harmful pickup/drop-off modes to and from the Airport. In the long-term, the trip reduction benefits of parking, coupled with the continued subsidy of HOV services from parking revenues, should help reduce overall regional traffic congestion.

Study #2: Pricing Conclusions

1. **Parking rate increases can help combat Airport parking scarcity and related impacts**. Parking rate increases can help reduce physical and operational constraints due to current parking scarcity. Parking rate increases can also help reduce externalities related to air quality and other environmental effects resulting from congestion of parking facilities and associated irregular parking operations.
2. **Parking rate increases can help financially support the Airport's current initiatives**. Massport's recent and planned parking rate increases will generate net new revenues, helping to fund construction of new parking capacity and subsidizing HOV mode alternatives for accessing the Airport.
3. **Variable parking pricing can help during off-peak periods**. Massport will continue to explore the potential application of variable parking pricing as a tool to help increase utilization of parking facilities during off-peak periods.

Study #3. Logan Airport Ground Access and Reducing Non-High-Occupancy Vehicle Operations

Study Introduction

This section details the methodology and findings of **Study #3. Logan Airport Ground Access and Reducing Non-High-Occupancy Vehicle Operations (hereafter Study #3)**, which explores the feasibility and effectiveness of potential operational measures to reduce non-high-occupancy vehicle (HOV) drop-off/pickup modes of transportation to Boston Logan International Airport (hereafter the Airport or Logan Airport), including an evaluation of emerging ride app and other ride-hailing/ridesharing modes.

To inform this study, the Massachusetts Port Authority (hereafter Massport or the Authority) conducted the fall 2018 Logan Air Passenger Ground Access Survey (hereafter the 2018 Passenger Survey). The overall survey comprised two parts: 1) an origin-destination (O-D) survey describing the current trip to the Airport (Logan Airport was always the destination for this study); and 2) a stated preference (SP)[42] survey. The O-D section included details of the Airport access trip like origin address and type of origin place (e.g., work, home), trip purpose, mode of transportation, parking costs, time of day, party size, length and location of stay, frequency of travel from the Airport, and demographic information.

The SP section of the survey used this detailed O-D data to customize a set of hypothetical choice experiments. An efficient experimental design determined the choices experiment participants saw. Specifically, this experimental framework comprised 61 designs (targeting different types of respondents), with 10 unique blocks of 6 experiments each, for a total of 3,660 experiments. Each respondent was randomly assigned to one of the 10 blocks and shown all 6 experiments. Each of these 6 experiments, in turn, presented between 4 and 15 alternatives. The number and types of modes that were shown in the SP experiments were determined by the following logic:

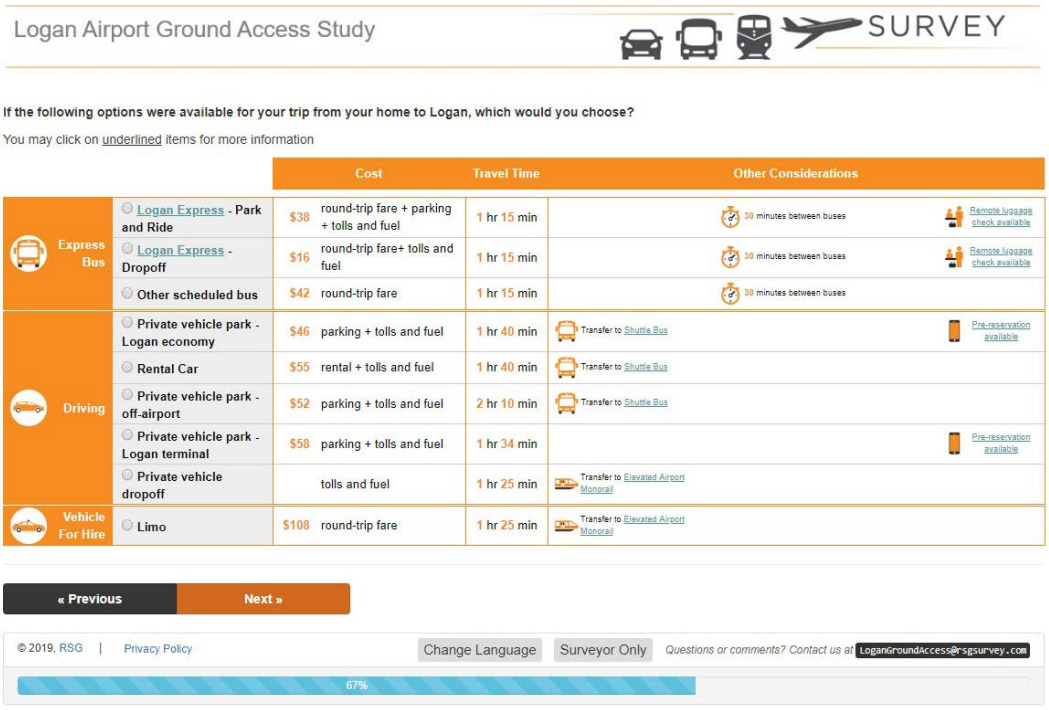
- Respondents originating from within the Massachusetts Bay Transportation Authority (MBTA) subway service area were shown MBTA Blue Line, MBTA Silver Line, MBTA ferry, and water taxi.

[42] Data detailing what people might do (hypothetical).

- Respondents who also originated within 0.5 miles of Kendall Square or North Station were shown an additional hypothetical express bus service.
- Respondents originating outside of the MBTA subway service area were shown rental car, Logan Express, and other scheduled bus service.
- Respondents originating from the South Shore also saw MBTA ferry.
- All respondents saw taxi and ride app except those originating beyond I-495.
- All respondents saw limousine.
- All respondents who mentioned a car was available for this trip saw private vehicle drop-off and parking options, including Logan Express drop-off if originating outside of the MBTA subway service area.
- Superseding all logic above, each respondent saw the mode they indicated using for their Airport trip.

Figure 11 illustrates the screen viewed by survey respondents for the SP section.

FIGURE 11: SCREENSHOT OF SP SURVEY EXPERIMENT



Source: RSG

For each choice alternative, several associated trip characteristics were displayed. These included travel time, cost and, if applicable, headway and whether a transfer to a shuttle bus was required. Across all the scenarios, the respondent was presented with different levels of each attribute (each attribute

varied independently of the others) and asked to “trade off” among the choice alternatives.

The survey was conducted as a self-administered tablet-based intercept interview between October 15, 2018 and October 31, 2018 at terminal gates, with the aim of collecting a representative sample of originating passengers. Four survey teams (pairs of two) were provided four flight assignments staggered over their eight-hour shift to accommodate breaks and travel both to and within the terminal. To prevent any lost time due to flight delays or cancellations, each flight assignment included multiple similar backup flights that could be sampled if an issue occurred with the original assignment. Over 5,000 surveys were completed in the development of the survey database.

The study team used these data to develop a Mode Choice Model and Simulator (MCMS) to simulate dozens of policy scenarios and explore the effects of potential changes to Massport-related ground access services.

Best practice for airport mode choice models includes development of a separate model for each trip purpose. Segmentation by type of airport users is important because airport access differs greatly by trip purpose (e.g., residents are far more likely than nonresidents to drive and park a personal vehicle at the Airport). In this regard, models are segmented into the following classifications:

- Resident business.
- Resident nonbusiness (leisure).
- Nonresident business.
- Nonresident nonbusiness (leisure).

Mode Choice Model and Simulator Format

Traditional airport mode choice models employ a multinomial logit (MNL) or, preferably, nested logit (NL) format. The logit format is employed because the probabilistic structure, where choices are expressed as the probability of choosing each option, accommodates realistic nuance whereby changes in behavior occur at the margins. People tend not to be binary decision-makers. Ideally, choice models are not binary either. The NL format, specifically, is employed because it accounts for asymmetric preference across modes. People are likely to substitute among modes with similar characteristics (e.g., air passengers are more likely to switch from a taxi to a ride app than to a ferry). The NL model can be used to determine, statistically speaking, which modes compete most directly.

However, as the study team iterated on MNL and NL model formats, it became clear that NL models were not nesting[43] effectively. Respondents showed significant taste heterogeneity, meaning much of the respondent choice was not dictated by broad, aggregate trends but, rather, by individual preferences and tastes. To account for this nuance, the study team's final models applied a mixed logit (ML) format. In the ML format, respondents have a unique MNL utility function to account for their unique preferences. This model format allows for the simplicity of MNL construction while accounting for asymmetric competition between modes in the way an NL model would.

Variables

The following variables were included in the final models:

1. Travel Time ($/hour)
2. Cost (in $)
3. Headway (Ferry) (in minutes)
4. Headway (Urban Transit) (in minutes)
5. Headway (Suburban Bus) (in minutes)
6. Transfers (MBTA) (number)
7. Remote Baggage Check (Binary—yes/no)
8. Pre-Reserved Parking (Binary—yes/no)
9. Automated People Mover Egress (Binary—yes/no)
10. Shuttle Bus Egress (Binary—yes/no)
11. Alternative Specific Constants for each mode:
    a. MBTA Ferry
    b. Water Taxi
    c. MBTA Blue Line

[43] Nesting refers to how the parameters of one model relate to another. For instance, a "nested" model is one that uses a subset of parameters of another model. This model is then "nested."

d. MBTA Silver Line

e. Ride App—Standard

f. Ride App—Shared

g. Taxi

h. Limousine

i. Private Vehicle Drop-Off

j. Parking—Central Parking

k. Parking—Economy

l. Parking—Off-Airport

m. Rental Car

n. Logan Express—Park-and-Ride

o. Logan Express—Drop-Off

p. Other Scheduled Bus

Model Estimation

The study team conducted model estimation in a statistical package of the open-source analysis tool "R."[44] This package is specifically designed to conduct choice model estimation.

Review of Model Fit and Iteration

After initial estimation, the study team reviewed the model output and considered the reasonableness of the results. This phase functioned as an iterative process through which any concerns regarding the statistical model could be explored and corrected. This, as previously mentioned, included altering the model format, adjusting explanatory variables, and reviewing and adjusting initial assumptions developed in the revealed preference dataset.[45]

[44] *The R Project for Statistical Computing*, www.r-project.org (accessed September 13, 2019).
[45] Data detailing what people did do (observational).

Model Calibration

Once the iterative specification, estimation, and review process was complete, the study team calibrated the resultant model to mode shares from the 2018 Passenger Survey. The study team also integrated Logan Express ridership data from 2018 into the calibration to ensure the MCMS accurately captured the relative ridership across Logan Express locations. These calibration steps allowed the model to represent the base case (2018 existing conditions) situation with proper shares for each mode. Once calibrated, the model was then used to forecast future ground access scenarios. Finally, for the ultimate analysis of changes in HOV mode share, the study team calibrated the model output to CY 2018 annual ridership levels for Airport ground transportation, by mode. This analysis is the basis for all results in this study. The facilitation of a 5,000-respondent intercept survey and development of the MCMS was exhaustive.

This section summarizes the most important results from Study #3. The study team evaluated operational strategies with the aim to reduce private and commercial vehicle drop-off and increase use of HOV modes.

Policy Development

The study team worked closely with a diverse group of Massport staff to develop a set of policy variables that could influence traveler mode choice preferences for HOV ground access modes to and from the Airport. A set of policy variables were identified for inclusion in this study, including travel time, cost, frequency for transit modes, and the introduction of new offerings like remote baggage check and pre-reserved parking.

Policy Tool

The study team developed the MCMS to describe the effects of potential policies on ground access mode choice. The MCMS is a Microsoft Excel-based tool that includes interfaces for policy input and mode share effect output. The MCMS predicts the changes in share for each transportation mode for a given policy (or combination of policies). The 2018 Passenger Survey facilitated development of the MCMS, which estimates air passenger behavior models from the survey data. The framework of this survey is described in the section below, Analytical Framework and Assumptions. Appendix B details the survey deployment and content.

Calculating mode share helps Massport understand the effects of the policies in terms of anticipated ridership, required operational adjustments, and the effect on

trip generation associated with Airport access. To illustrate, consider Massport's recent decision to shift ride app drop-off and pickup to a centralized location.

- In this example, the MCMS calculates the new share of ride app users as well as the new share for HOV modes to estimate the additional **ridership** demand for other HOV modes in lieu of ride apps.
- From an **operations** and financial standpoint, implementing the policy would require staff and infrastructure to support the centralized drop-off and pickup.
- Finally, the tools help Massport better assess the effects of ground access on the Airport's overall **trip generation**, which is integral to Massport's trip reduction strategy.

Demand and Supply Assumptions

The MCMS assumes that demand is unconstrained,[46] meaning that there are no restrictions on the amount of demand a given mode alternative might generate. When demand exceeds supply, the demand often goes elsewhere. For example, if Logan Express parking lots are full, then some travelers who might have used this mode to travel to the Airport may instead opt to drive and park at the Airport. The demand model assumes that anyone who wants to use Logan Express facilities can do so. Therefore, the predicted mode share is, to an extent, dependent on the provision of adequate facilities and services to meet demand.

Policies and Policy Packages

In the MCMS, several variables can be changed to reflect potential policies. While all these variables can be individually simulated, most variables make sense to change in combination with other variables. For example, to encourage more Logan Express demand, a combination of policies like increasing Logan Express frequency, adding amenities, or adjusting pricing can be complementary. In short, many cases exist where a policy is not one change but a "package" of changes to obtain the desired policy outcome.

Analytical Framework and Assumptions

The analytical work undertaken for Study #3 used a robust dataset from a survey of air passengers and their mode choice preferences. This study evaluated potential policies that address the questions asked by the Massachusetts Department of Environmental Protection as part of the Parking Freeze

[46] Using unconstrained models is common for policy decision-making.

Amendment. The study team holistically evaluated each policy according to the following criteria:

- **Mode Choice**. How does the policy increase (or decrease) HOV ground access mode share to the Airport? The study team developed the MCMS to conduct this analysis.
- **Revenues and Costs**. How much revenue would a policy generate for Massport and at what cost? This criterion analyzes financial effects overall and per net new HOV rider to understand the cost/benefit of different policies.
- **Operations**. For a given policy, what are the types of operational changes that are necessary for Massport implementation? For example, are new facilities, permits, staff training, or technology necessary, and what are the benefits and challenges?
- **Customer Service**. What are the effects on customers/air passengers? How can alternatives to commercial and private vehicle pickup and drop-off modes be made more attractive to passengers? How can the benefits of these alternative modes be marketed even when there are also drawbacks? For example, an HOV trip option may require additional travel time, but customers may experience a more relaxing trip where they do not have to drive in traffic and navigate; alternatively, Massport may implement various additional services for HOV customers to enhance the experience.
- **Air Quality**. It is assumed that policies that increase HOV mode had a positive effect on air quality.
- **Community Stakeholder**. These effects focus on how a policy might change the patterns of Airport ground transportation behavior (e.g., volume, routing, new facilities). This criterion assesses effects from the perspective of surrounding communities.

Policy Analysis

Table 18 summarizes the range of policy scenarios explored in this study.

TABLE 18: NON-PICKUP/DROP-OFF OPERATIONAL POLICY SCENARIOS

POLICY SCENARIOS
Remote Baggage Check
Parking Pre-Reservation System
Other Operational Changes 1. Changes in drop-off locations (ride apps directed to Central Parking) 2. Ride app shared-ride discount 3. Mobility-as-a-Service (MaaS) and e-ticketing 4. Use of direct ramp access to the Ted Williams Tunnel

Source: RSG

Policies Outside or Partially Outside Massport Control

Several policies directly or indirectly affect Massport but are outside of the Authority's control. For example, Massport does not own, regulate, or manage the Boston Harbor tunnels, and therefore cannot control tunnel capacity and operations. Similarly, Massport also has no control over real estate development on non-Massport-owned properties, which increases local and regional traffic volumes and congestion. For the purposes of this study, Massport remains agnostic about such policies and, rather, focuses on areas where the Authority can directly exert influence. Massport's goal is to design sensible ground access strategies to reduce Airport traffic effects. It focuses on the assets under Authority control and strives to both understand and work constructively within the surrounding context out of Massport's control.

Remote Baggage Check

Introduction to Remote Baggage Check

Remote baggage check does not currently exist at Logan Airport. The following sections include relevant practices (case studies) from other airports that have remote baggage check in place.

Current Conditions

Remote baggage check is a service that allows air passengers to check luggage at an off-site facility prior to arrival at the standard terminal check-in facility. Remote baggage check does not currently exist at Logan Airport. However, Massport plans to offer, as a convenience to air passengers, remote baggage

check in the new ride app drop-off/pickup area currently under construction. This section explores the potential introduction of remote baggage check at off-Airport locations.

Relevant Practices

The following case studies highlight relevant practices at other airports. Table 19 summarizes these findings.

Case Study: Newark Rail Station (Newark)

Name: Newark Rail Station Baggage Check-In
Airport: Newark Liberty International Airport (EWR)
Founded: 2001

Nearly two decades ago, Continental Airlines worked with the Port Authority of New York and New Jersey (PANYNJ) (the owners of the station) to build a baggage check-in terminal located conveniently within the Newark Rail Station (Figure 12). Chutes carried bags down to a truck that transported the bags to the airport terminal while the passengers used the AirTrain monorail.

FIGURE 12: NEWARK RAIL STATION BAGGAGE CHECK-IN

Source: RSG

The baggage check-in terminal opened in November 2001 and was actively promoted by Continental Airlines, which provided adequate staffing for the station. The airline requested that bags be checked two hours before flight departure time, but staff were reportedly willing to accept the bags considerably later than that.[47]

Service ended in 2003 after less than two years in operation. Use of the new service did not meet initial expectations. This was primarily because most air passengers who could have used the service did not choose to release their bag before the airport terminal. For most air passengers, controlling their bag until the last possible moment seemed to be associated with a lower chance of the bag being lost in the system.

Case Study: Union Station FlyAway (Los Angeles)

Name: Union Station FlyAway
Airport: Los Angeles International Airport (LAX)
Founded: 2006

Los Angeles International Airport offers a convenient "FlyAway" bus service to Union Station at all hours of the day. This option serves several connecting modes. Multiple metropolitan and intercity bus and rail services converge at Union Station. The FlyAway bus operates on a busway located in a far corner of the station complex.

Los Angeles World Airports, which owns and operates Los Angeles International Airport and Van Nuys Airport, contracted with Baggage Airline Guest Services (also known as "Bags") to develop the remote baggage check service (Figure 13) that was part of their remote check-in product.[48] The charge was $5 per bag, which was in addition to a $3 fare for the FlyAway bus. This remote check-in was allowed three hours before a scheduled flight departure time. The service was offered in cooperation with all major domestic American carriers, but not for international departures. Remote check-in baggage was tagged and accepted on the sidewalk, offering no shelter from weather conditions. The service was abandoned after low customer demand.[49]

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[47] Leigh Fisher Associates, "TCRP Report 83: Strategies for Improving Public Transportation Access to Large Airports." Transportation Research Board, 2002, http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_83a.pdf. (accessed September 13, 2019).
[48] Bags, "Remote Airline Check-In." 2017, https://www.bagsinc.com/remote. (accessed September 13, 2019).
[49] Jane Engle, "Check bags on the way to LAX," *Los Angeles Times*. September 10, 2006, https://www.latimes.com/archives/la-xpm-2006-sep-10-tr-log10-story.html. (accessed September 13, 2019).

FIGURE 13: UNION STATION FLYAWAY KIOSK

Source: RSG

Case Study: Heathrow Express Downtown Baggage Check-In (London)

Name: Heathrow Express
Airport: Heathrow Airport (LHR)
Founded: 1999

Heathrow Airport Holdings (the airport operator) developed the Heathrow Express rail service as part of a major commitment to improving public mode share to Heathrow Airport. Marketing managers at the time felt that the ability to check bags at the downtown terminal would be an essential element of the marketing strategy, and massive capital costs were expended to make the system work.

Paddington Station was expanded to provide for the check-in station and support facilities (Figure 14). The facility opened in November 1999 with all major airlines represented. Once checked, all baggage was scanned before being placed into containers. At the first on-Airport stop, the containers were transferred to trucks above the platform. The containers then traveled to processing facilities within the baggage distribution system of the airport. For the trip from the airport to downtown, all baggage was carried by the passenger aboard the rail vehicle.

FIGURE 14: PADDINGTON BAGGAGE CHECK-IN FOR HEATHROW EXPRESS

Source: RSG

After September 11, 2001, United States air carriers pulled out of the system due to new security restrictions, and the entire system was abandoned shortly thereafter. By 2003, British Airways had discontinued service, with the facility closing in 2004. Surveys undertaken by the airport operator at the time showed that approximately one air traveler in five chose to separate themselves from their bags early; most kept their bags until the latest possible chance to check them in. Further analysis, for *ACRP*[50] *Report 4: Ground Access to Major Airports by Public Transportation*, found that airport rail mode share did not fall with the collapse of the system—even for the nonresident market, for whom it was well designed to serve.[51]

[50] ACRP: Airport Cooperative Research Program.
[51] Matthew Coogan, "ACRP Report 4: Ground Access to Major Airports by Public Transportation." Transportation Research Board, 2008, http://www.trb.org/Publications/Blurbs/157099.aspx. (accessed September 13, 2019).

Case Study: Vienna International Airport Terminal (Vienna)

Name: City Airport Terminal
Airport: Vienna International Airport (VIE)
Founded: 2002

Vienna International Airport is the majority stakeholder in the City Airport Train, which provides nonstop express services dedicated to air passengers between the airport and its City Airport Terminal in downtown Vienna. There, the airport runs a small check-in counter with 10 stations, which is operated only by the airline members of the Star Alliance, in which Austrian Airlines is a member as a subsidiary of Lufthansa (Figure 15).

The facility is designed to encourage self-service check-in via technology that reads both tickets and passports; this was highly unusual at the time of its implementation. In addition, at least one desk is operated by Austrian Airlines personnel. Because the airport owns a portion of the rail company, the equipment has been designed to accommodate the checked baggage.

FIGURE 15: VIENNA INTERNATIONAL AIRPORT TERMINAL CHECK-IN

Source: RSG

The Vienna service is an example of a moderate investment designed to serve a small portion of passengers who choose to relinquish their bags to the airlines outside of the airport. The rail vehicles have extensive luggage racks on board, as all baggage is carried aboard the train for the trip from the airport to downtown.

TABLE 19: REMOTE BAGGAGE CHECK CASE STUDY SUMMARY

CASE STUDY	KEY FINDINGS
Domestic	• Domestic remote baggage check services have encountered weak demand, even when offered for free, due to passengers being unwilling to part with their baggage in advance of arrival at the airport • Remote baggage check programs operated for Newark Liberty International Airport and Los Angeles International Airport were discontinued after lower-than-expected demand
International	• Consumer demand for remote baggage check abroad has been similarly weak, with some exceptions • While Heathrow Airport's Heathrow Express downtown baggage check-in was discontinued, the City Airport Train serving Vienna International Airport is one notable exception

Source: RSG

Relevance to Logan Airport

Overwhelmingly, consumer reaction to off-site baggage services has been weaker than hoped for by the project proponents around the world. In general, customer response has not been strong enough to justify the continuation of service on the part of the airlines who had to shoulder the costs. This is true for the longer-distance segments, like Paddington Station to Heathrow Airport, and shorter segments, like Newark Rail Station to Newark Liberty International terminals.

Legacy airlines now compete with budget and low-cost competitors. This means every service is carefully evaluated for its practicality and cost effectiveness. As such, airlines are unlikely to offer amenities, like remote baggage check-in, that they do not have to provide. That said, Austrian Airlines supports a locally popular City Airport Terminal, and Swiss Federal Railways provides a high-priced service to a small group of willing consumers. Both may be examples of niche markets and unusual motivations, but their success is evident.

Remote Baggage Check Policy Scenarios

Overview of Remote Baggage Check Policies

Remote baggage check policy scenarios tested adding this service at several major public transit hubs serving the Airport. The potential effects of remote baggage check as an amenity for Logan Express are covered separately in Study #1. Consideration of potential effects of remote baggage check for on-Airport facilities is covered as part of the new ride app pickup and drop-off lot analyzed later in this study. Specifically, the tested scenarios explored the following policy variable:

1. **Baggage Check**: Add remote baggage check at South Station (MBTA Silver Line) and the MBTA Blue Line Airport Station.

The study team simulated several unique policies from within these categories. Appendix A presents details of these individual policy scenarios. The following section explores the policy scenario that involved a plausible combination of policies.

- **Remote Baggage Check Policy Combination 1**:
    a. Baggage Check: Add remote baggage check services at South Station (MBTA Silver Line) and the MBTA Blue Line Airport Station.

Remote Baggage Check Policy Effects

Table 20 summarizes the remote baggage check policy scenario effects.

TABLE 20: REMOTE BAGGAGE CHECK POLICY SCENARIO EFFECTS SUMMARY

EFFECTS	COMBO 1
HOV Mode Share (% of total cumulatively)	+0.3%
Net Cost*/New HOV Rider	$$$

*Net Cost/New HOV Rider Key: **$** <$10/year; **$$** $10-25/year; **$$$** $25-50/year; **$$$$** $50+/year*
**Includes estimated new operating costs and amortized capital expenditures for direct provision of the service. Does not account for potential additional capital expenses associated with new or expanded facilities. Includes estimated revenues based on the MCMS, as well as revenue lost or gained from other modes (e.g., parking and rental) due to mode share shifts.*
Source: RSG

Mode Choice

In Remote Baggage Check Policy Combination 1, HOV mode share is forecast to increase by 0.3 percentage points. This shift is due to an expected increase in MBTA Blue Line and MBTA Silver Line mode share. Correspondingly, mode share drops across all other modes.

Cost to Authority[52]

Remote Baggage Check Policy Combination 1 would be an expensive program that yields relatively limited improvements in HOV mode share and trip reduction.

Operations

Baggage check services would require additional labor, infrastructure, logistics, and security. Systems and vehicles would be required to transport baggage from the remote sites to the Airport. This infrastructure (at the remote site, in transit, and at induction points to Airport baggage systems) would need to support secure baggage protocols, potentially proving costly or logistically challenging.

While implementing baggage check services at the MBTA Blue Line Airport Station would be a logistical challenge, similar services at the MBTA Silver Line at South Station would likely carry additional complexity. South Station has numerous users and scarce capacity for existing operations, as evidenced by South Station expansion plans. Vehicles carrying bags to the Airport would need access to South Station and a means of processing and moving bags from the lowest level (MBTA Silver Line) to the surface. Moreover, bags would need to be transported to the Airport over right-of-way not owned by Massport.

Customer Service

In general, a remote baggage check service should offer an overall customer benefit. However, according to the case studies, only a small segment of the market is willing to pay for this service. If a service were heavily subsidized, there may still be a challenge of generating demand if customers are ultimately uncomfortable checking bags prior to arrival at terminal check-in areas.

Key customer service considerations will include explaining operations changes to customers and supporting those customers as they use the new offerings.

[52] These cost figures generally include only operating expenses including, for the purposes of this study, contract fees associated with equipment typically procured as part of third-party service agreements. These figures do not include major capital expenditures for facilities and improvements.

Massport staff will face challenges influencing customer experiences on those segments of the ground access journey outside of Airport property and control (e.g., at South Station). In particular, the customer service benefits must be justified to the airlines, as recent case studies all suggest a remote bag check service is unlikely to be financially self-supporting.

Air Quality

Any measure that Massport can take to reduce pickup and drop-off trips or increase HOV mode share will have a measurable positive benefit to air quality. This benefit will be quantified in upcoming Massport Environmental Data Reports (EDR) as outlined in the Parking Freeze Amendment regulation.

Community Stakeholder

Community stakeholder effects largely pertain to two broad groups: East Boston and communities near remote access sites (e.g., South Station).

East Boston: Effects at the Airport and East Boston involve congestion reduction on Airport property, in the neighborhoods, and along the major gateway roads that will benefit from increases in public transit use relative to other modes. This would be somewhat offset by additional activities related to vehicles transporting bags to Airport induction points. Nevertheless, the proposed scenario should at least benefit the community through the reduction of congested hours along major roadways to and from the Airport, which should relieve pressure on surrounding neighborhood roads.

Remote Sites: Any proposed change in facility needs at South Station will require coordination with, at a minimum, the Massachusetts Department of Transportation (MassDOT), the MBTA, the City of Boston, and Amtrak. South Station is a critical asset in the regional multimodal transportation system, and it is in a busy downtown Boston area. Moreover, Massport does not own South Station, nor does it own any of the surrounding transportation assets. Bags operations would add an additional layer of complexity to operating the capacity-constrained South Station. Moreover, any required facility improvements may create temporary challenges in and around these sites.

Parking Pre-Reservation

Introduction to Parking Pre-Reservation

General parking pre-reservation does not currently exist at the Airport. Massport is, however, planning to introduce an on-Airport parking pre-reservation service in 2020. The following sections include relevant practices (case studies) from other airports that have parking pre-reservation in place.

Current Conditions

Parking pre-reservation is a service that allows users to pay for and reserve a parking space in advance of their arrival at a parking facility. General parking pre-reservation does not currently exist at the Airport, but Massport is in the process of developing this new product and capability, with a planned launch in 2020.

Massport currently offers a frequent parking program, PASSport Gold, that includes parking in dedicated, reserved areas for members. Members pay an initial registration fee, an annual membership fee, and a higher daily parking fee in return for guaranteed parking in several convenient locations in the Airport terminal area parking garages. Members receive a card to swipe in and out of the parking revenue control system. However, the PASSport Gold program does not include pre-reservation or any kind of advanced booking.

Massport also currently offers an expedited payment program, Exit Express, for on-Airport parking. Exit Express requires registration and an initial fee. However, the program does not guarantee parking in any location, nor does it charge an annual fee or a premium daily rate. Members receive a card to swipe in and out of the parking revenue control system, which bills the member's credit card on file. The program simply offers an expedited payment method.

This section explores the potential introduction of a general nonsubscription parking pre-reservation program at the Airport. This program would be *in addition to*, and would not replace, PASSport Gold or Exit Express.

Relevant Practices

The following case studies highlight relevant practices at other airports. Table 21 summarizes these findings.

Case Study: Domestic Private Sector (Multiple)

The private sector understands the strength of the airport parking market, usually involving park-and-fly lots *near* airports rather than *at* airports. The difficulty in imposing environmental controls on such facilities has led many airports to prefer on-Airport facilities. Some websites offer travelers the ability to make reservations at 39 off-site lots near 23 major American airports.[53] In addition, other websites offer hotel-with-parking combination packages, which would be an attractive option for some travelers.[54]

Case Study: Domestic Public Sector (Multiple)

PANYNJ offers multiple reservation options for travelers. Recently, PANYNJ began offering a "premium reserve option," which offers reservations at higher-priced short-term parking garages for a premium charge of $2 per day. It also includes a discount for pre-reserving spaces in one of two economy lots at Newark Liberty International Airport.[55] Reservations are advised for many New York City-area airport parking areas, except for John F. Kennedy International Airport's Long-Term Parking Lot, which touts "ample parking."[56]

The Chicago Department of Aviation initiated new reservation services at both O'Hare International Airport and Chicago Midway International Airport for a surcharge of $10 per day.

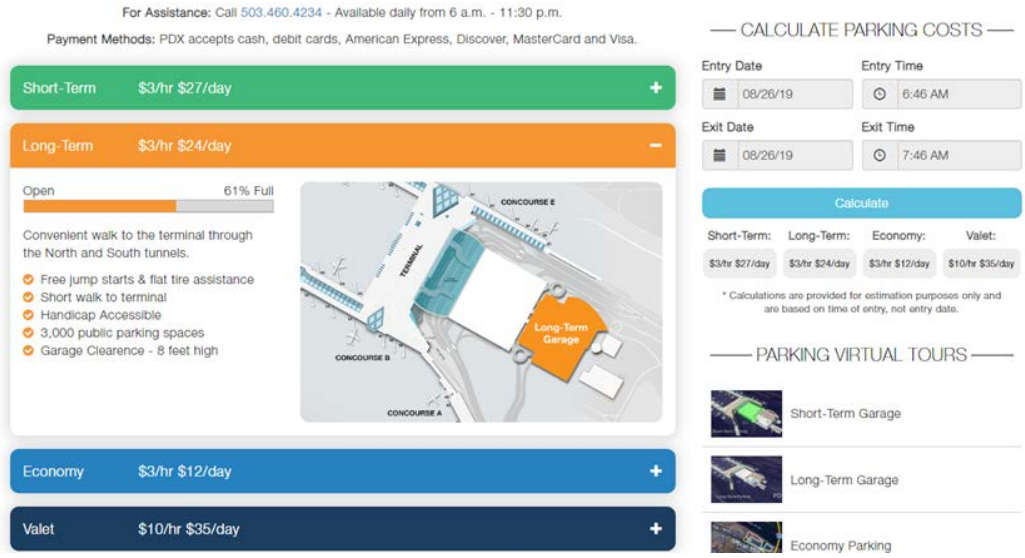
A review[57] of key major American airports suggests that the concept of pre-reservations for on-Airport parking is less popular on the West Coast, where lack of parking supply is not as readily apparent in policies or public communications.

Seattle-Tacoma International Airport does not offer a reservation option, but it has one level of parking charges called "Passport Parking" available for $365 per

[53] *Airport Parking*, https://www.theparkingspot.com/ (accessed September 13, 2019).
[54] *Save Big on Airport Parking*, https://www.airportparkingreservations.com (accessed September 13, 2019).
[55] *Parking Newark*, https://parking.newarkairport.com/book/EWR/Parking (accessed September 13, 2019).
[56] Port Authority of New York and New Jersey, "Prebook Parking: Book Your Parking Space Online." 2019, https://www.panynj.gov/airports/online-reserved-parking.html. (accessed September 13, 2019).
[57] The source of all publicly available information about parking at airports comes from their individual websites.

month, which is similar to Massport's Parking PASSport Gold program. With approximately 12,000 parking spaces in one area, Seattle-Tacoma International Airport has abundant parking. Similarly, the website for Portland International Airport in Oregon does not offer pre-reservations for parking at the airport. However, the airport handles parking capacity by showing (in real time) the availability of parking for all four categories of parking price (Figure 16). In the example below, the Long-Term Garage was 61 percent full. (Clear and legible calculations of parking costs by garage category are also shown to the user.).

FIGURE 16: REAL-TIME PARKING AVAILABILITY INFO AT PORTLAND INTERNATIONAL AIRPORT



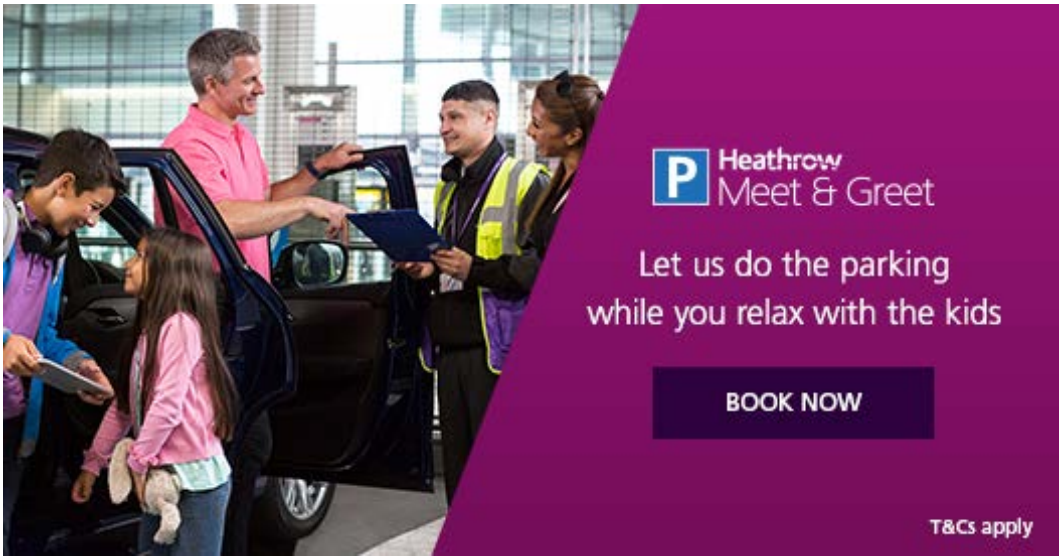
Source: Port of Portland

San Francisco International Airport does not offer pre-reservation services, but it does offer one-day valet parking service at $45 per day. Similarly, Los Angeles International Airport does not offer any reservation options, but it does have a parking availability feature that is like that offered by Portland International Airport.

Case Study: International Pre-Reserved Parking

Reservation for airport parking is popular among major European airports, usually with some discount offered for early booking. Heathrow Airport emphasizes advance booking on its website, with “book now” messages prominently displayed. Advance booking is also available at London Stansted Airport and Manchester Airport for “Meet & Greet,” which is a more affordable version of valet parking; it occurs in a dedicated parking area apart from the terminal curb. An appointment is made to pick up the car in the return trip, and the car is brought to the designated zone several hours before the scheduled arrival of the return flight. Those making reservations for parking are offered a service akin to “precheck” security lines for the equivalent of $16.

FIGURE 17: HEATHROW ADVANCED BOOKING MARKETING



Source: Heathrow Airport

Frankfurt Airport also offers prebooking of higher-quality parking spaces. In addition, Amsterdam Airport Schiphol notes that prebooking is not required for most lots (other than a special holiday lot), but it cautions that drivers pay the equivalent of $*15 per day* more if they forget to reserve. Zurich Airport also charges less per day with advance parking reservations, with daily fees the equivalent of $86 without reservations, and the equivalent of $73 with reservations for a garage next to the terminal.

TABLE 21: PARKING PRE-RESERVATION CASE STUDY SUMMARY

CASE STUDY	KEY FINDINGS
Domestic	• Airport parking reservation is more popular on the East Coast than the West Coast due to space constraints • Reservations programs like those at Newark Liberty International Airport, or real-time parking supply tools like the one offered by Portland International Airport, may encourage more air passengers to avoid the additional deadhead trips with the drop-off/pickup mode choice
International	• Airport parking reservation programs are popular among European airports, and many offer discounts • Both London Stansted Airport and Manchester Airport offer "Meet & Greet" parking, which is similar to but more affordable than valet and occurs apart from the terminal

Source: RSG

Relevance to Logan Airport

A comprehensive trip reduction strategy should encompass all market decisions made by the traveler. Often, the decision is between driving to the airport (and parking there) and being driven to the airport by a person who must make a "deadhead" trip back to the point of origin. To discourage four-segment round trips, parking should be available and reliable. As noted, the perception that parking might not be available leads to the selection of the drop-off/pickup mode for the round trip. Thus, for the traveler not included in a higher-priced frequent-parker program that guarantees space availability, the ability to know that a space is available could contribute to selection of the environmentally superior choice.

Currently, airport parking pre-reservation programs are more popular at the denser, urban East Coast airports than in the more auto-oriented West Coast airports. As noted, Massport has plans to introduce a parking reservation system to allow air passengers to reserve and pay for parking spots in advance of their travel. Programs to encourage early booking of parking spaces are also common in major European airports, usually with discounts for the early/reserve option.

Because Logan Airport's program of comprehensive off-site regional parking is unique, no directly relevant precedent exists for providing reservations at the Logan Express lots/garages. Logically, knowing a parking space is available—perhaps reserved at the time of trip planning—could be effective in a long-term

plan to increase the importance of those regional facilities. (The only other off-site airport parking garage, in Van Nuys, California, does not offer an advanced reservation option.)

Finally, provision of user-friendly frequent-parker programs could be intertwined with agency promotion of other services, such as Logan Express and the planned urban bus shuttles (e.g., Back Bay Station). Such a frequent-parker program could be used in targeted marketing programs; the existence of a mailing list of dedicated users of Logan Airport's garages could be valuable in this regard.

Parking Pre-Reservation Policy Scenarios

Overview of Parking Pre-Reservation Policies

Logan Express policy scenarios tested service improvements at existing Logan Express locations and implementation of service at new locations. Specifically, the tested scenarios explored the following policy variables:

1. **Parking Pre-Reservation**: Add parking pre-reservation services at Massport Terminal Area and Economy Parking facilities and Logan Express parking facilities.

The study team simulated several unique policies from within this category. Appendix A presents details of these individual policy scenarios. The following section explores two policy scenarios that involved plausible combinations of remote baggage check policies. Combination 1 includes policies that only affect on-Airport parking, while Combination 2 expands the implementation to Logan Express sites.

- **Parking Pre-Reservation Policy Combination 1**:
    a. Parking Pre-Reservation: Add pre-reservation to terminal area Economy Parking facilities.
- **Parking Pre-Reservation Policy Combination 2**:
    a. Parking Pre-Reservation: Add pre-reservation to Terminal Area and Economy Parking facilities and suburban Logan Express parking facilities.

Parking Pre-Reservation Policy Effects

Table 22 summarizes the parking pre-reservation policy scenario effects.

TABLE 22: PARKING PRE-RESERVATION POLICY SCENARIO EFFECTS SUMMARY

EFFECTS	COMBO 1	COMBO 2
HOV Mode Share (% of total cumulatively)	-0.1%	-0.1%
Net Cost*/New HOV Rider	N/A	N/A

Net Cost/New HOV Rider Key: ***$*** *<$10/year;* ***$$*** *$10-25/year;* ***$$$*** *$25-50/year;* ***$$$$*** *$50+/year*
**Includes estimated new operating costs and amortized capital expenditures for direct provision of the service. Does not account for potential additional capital expenses associated with new or expanded facilities. Includes estimated revenues based on the MCMS, as well as revenue lost or gained from other modes (e.g., parking and rental) due to mode share shifts.*
Source: RSG

Mode Choice

In Parking Pre-Reservation Policy Combination 1, HOV mode share is forecast to decrease by 0.1 percentage points. This shift is due to an expected increase in overall on-Airport parking mode share. Correspondingly, mode share drops across other modes.

In Parking Pre-Reservation Policy Combination 2, HOV mode share is forecast to decrease by less than 0.1 percentage points. This slightly smaller shift is due to estimated mode share growth at Logan Express (HOV) in addition to on-Airport parking (non-HOV). Correspondingly, mode share drops across other modes.

Cost to Authority

It is a challenge to calculate net cost/new HOV rider for the parking reservation system in the same manner as for policies outlined in Study #1. This is due, in part, to the fact that the objective is largely to reduce drop-off/pickup modes by increasing parking utilization. In the case of Combination 1, the policy slightly *reduces* HOV.

Massport is in the process of implementing parking pre-reservation. Several interdependencies exist between the new system and legacy revenue control and other Massport IT systems, which will ultimately contribute to the overall program costs. The goal, however, is to help recoup some of the ongoing system

maintenance and operation costs with incremental revenues from new parking demand.

Operations

Parking pre-reservation will require additional revenue control, payment processing, and reporting infrastructure and software, as well as IT and vendor support. The parking pre-reservation programs will also need to be integrated with existing parking revenue control and related parking systems. Much of the additional effort, however, is up front. Once the system is implemented, operational benefits should accrue, including the establishment of a new tool to help forecast and manage parking demand.

These investments are currently being made and implementation is underway for Logan on-Airport parking products, with anticipated delivery in 2020.

Customer Service

Key customer service considerations would include explaining operations changes to customers and supporting those customers as they use the new offerings. Furthermore, marketing the new operations and benefits from the enhancements needs to be communicated to Airport users.

Air Quality

Any measure that Massport can take to reduce pickup and drop-off trips or increase HOV mode share will have a measurable positive benefit to air quality. This benefit will be quantified in upcoming Massport EDR as outlined in the Parking Freeze Amendment.

Community Stakeholder

Community stakeholder effects largely pertain to two broad groups: East Boston and the wider region.

East Boston: Effects at the Airport and East Boston involve congestion reduction on Airport property, in the neighborhoods, and along the major gateway roads by increasing parking (thus diverting from commercial and private drop-off/pickup modes) and, in the case of potential future expansion to Logan Express, diverting air passengers to HOV modes. The proposed parking pre-reservation scenario should benefit the community through the reduction of congested hours along the major roads and particularly Airport roadways, which should relieve pressure on surrounding neighborhood roads.

Region: For the wider region, introduction of parking pre-reservation will reduce roadway congestion.

Other Operations Policies

Overview of Other Operations Policies

Other operations policy scenarios tested operations improvements for HOV options. Specifically, the tested scenarios explored the following policy variables:

1. **Change in pickup and drop-off location**: Change drop-off location for modes at the Airport.

2. **Differential fees**. Charge lower Airport access fees to commercial modes to encourage shared-ride products.

3. **MaaS**: Use advances in mobile software and other streamlining tools and processes to make trip planning and purchase more seamless for users.

4. **Transit priority**: Change lane priority for HOV modes en route to the Airport.

The study team simulated several unique policies from within these categories. Appendix A presents details of these individual policy scenarios. The following section explores three policy scenarios that involved potential combinations of policies. Combination 1 includes policies that Massport has recently implemented. Combination 2 and Combination 3 include more ambitious policies.

- **Other Operations Policy Combination 1**:

    a. Drop-off and pickup location: Direct ride apps to dedicated ride app drop-off/pickup area in the Central West Garage.

    b. Add a $3.25 drop-off fee, consistent with the current $3.25 pickup fee.

    c. Shared-ride app discount: $1.50 trip fee discount for shared rides compared to standard ride app rides.

    d. Include a remote bag-drop option at the ride app drop-off/pickup area

- **Other Operations Policy Combination 2**:

    a. MaaS: Improve coordination of trip planning and purchase for transit modes: MBTA ferry, MBTA Blue Line, MBTA Silver Line, and Logan Express. Improvements proxied by a two-minute travel time reduction.

- **Other Operations Policy Combination 3**:

    a. Transit priority: Use of direct ramp access for HOV modes into the Ted Williams Tunnel, proxied by five-minute travel time reduction for Logan Express and MBTA Silver Line.

Massport is planning to implement Policy Combination 1 by the end of 2019. In addition, Massport is planning to implement an e-ticketing program for Logan Express in early 2020. The Logan Express e-ticketing program offers an important new tool that could help support future MaaS applications.

Other Operations Policy Effects

Table 23 summarizes other operations policy scenario effects.

TABLE 23: OTHER OPERATIONS POLICY SCENARIO EFFECTS SUMMARY

EFFECTS	COMBO 1	COMBO 2	COMBO 3
HOV Mode Share (% of total cumulatively)	+1.2%	+0.2%	+0.4%
Net Cost*/New HOV Rider	N/A	N/A	N/A

*Net Cost/New HOV Rider Key: **$** <$10/year; **$$** $10-25/year; **$$$** $25-50/year; **$$$$** $50+/year*
**Includes estimated new operating costs and amortized capital expenditures for direct provision of the service. Does not account for potential additional capital expenses associated with new or expanded facilities. Includes estimated revenues based on the MCMS, as well as revenue lost or gained from other modes (e.g., parking and rental) due to mode share shifts.*
Source: RSG

Mode Choice

In Other Operations Policy Combination 1, HOV mode share is forecast to increase by 1.2 percentage points. This shift is due to an expected decrease in overall ride app mode share. One important reason this equates to such a large HOV increase is that limousine mode share increases by 15 percent and is categorized as HOV for the purposes of this analysis. Mode share also increases across all other modes, including all HOV modes.

In Other Operations Policy Combination 2, HOV mode share is forecast to increase by 0.2 percentage points. This shift is due to an expected increase in MBTA Silver Line, MBTA Blue Line, MBTA ferry, and Logan Express mode share. Correspondingly, mode share drops across other modes.

In Other Operations Policy Combination 3, HOV mode share is forecast to increase by 0.4 percentage points. This shift is due to an expected increase in MBTA Silver Line and Logan Express mode shares. Correspondingly, mode shares drop across other modes.

Cost to Authority

Estimating cost to the Authority for these policy combinations would require additional financial analysis and is not currently calculable.

Understanding the costs and revenues associated with ride app centralization (Other Operations Policy Combination 1) is complex and difficult to distill into a single metric as it has been consistently applied elsewhere in the Parking Freeze studies. Some of the economic costs to the Authority relate to lost revenue opportunities for parking spaces that are being taken out of service for the facility. More fundamentally, a critical objective for this policy is reducing ride app deadheading, rendering a net cost/new HOV ridership metric less helpful and comparable.

New revenues generated by ride app drop-off fees are intended to help offset construction and long-term operating expenses (e.g., for staffing, remote bag drop, services for persons with disabilities), with any potential net new revenues supporting HOV initiatives.

Other Operations Policy Combination 2 and Other Operations Policy Combination 3 largely involve costs borne by other parties, whether they be app developers (MaaS) or MassDOT/MBTA (bus/roadway operations). Nonetheless, Massport has committed to related investments, including Logan Express e-

ticketing and purchasing eight new Silver Line buses for the MBTA, which can help support implementation of these policy packages.

Operations

Employing a new centralized drop-off/pickup location for ride apps requires significant alterations to parking facilities and operations. The challenges to reduced parking supply are discussed in Study #2. Moreover, significant additional staff will be required to support these operational changes and provide important customer services like wheelchair services.[58] Massport is making these investments.

In the case of the new ride app drop-off/pickup area, there will be additional operations benefits to reducing so-called “deadhead” trips, or ride app trips to or from the Airport with no passengers. The new centralized facility is being designed to facilitate the near-immediate matching of ride app vehicles dropping off air passengers with arriving air passengers ordering ride app trips from the Airport.

Customer Service

Key customer service considerations would include explaining operations changes to customers and supporting those customers as they use the new offerings. Furthermore, marketing the new operations and benefits from the enhancements needs to be communicated to potential new and existing MBTA Silver Line and Logan Express customers.

In the case of disruptions to customer journeys associated with ride app drop-off/pickup in the Central/West Garage, Massport has committed to several important customer service improvements. These include, but are not necessarily limited to, remote bag check services and various services to support customers with disabilities.

Air Quality

Any measure that Massport can take to reduce pickup and drop-off trips or increase HOV mode share will have a measurable positive benefit to air quality. This benefit will be quantified in upcoming Massport EDR as outlined in the Parking Freeze Amendment.

[58] Customers with disabilities traveling in ride apps will be permitted to board or disembark from the ride app vehicle at Logan Airport terminal curbs, but support services will still be offered in the centralized ride app drop-off/pickup area.

In addition to increasing HOV, a critical rationale for developing the centralized ride app drop-off/pickup area is the reduction in deadhead trips to and from the Airport. In this manner, the centralized ride app drop-off/pickup area reduces trips to and from Logan even for those air passengers that continue to use the ride app modes.

Community Stakeholder

Community stakeholder effects largely pertain to two broad groups: East Boston and communities near remote access sites (e.g., Logan Express sites, South Station).

East Boston: Effects at the Airport and East Boston involve congestion reduction on Airport property, in the neighborhoods, and along the major gateway roads. The proposed scenarios should benefit the community through the reduction of congested hours along the major roads and particularly airport roadways, which should relieve pressure on surrounding neighborhood roads.

A centralized ride app drop-off/pickup area will help reduce deadheading, driving congestion relief.

Remote Sites: Significant community stakeholder effects relate to the likely need for increased service from suburban Logan Express locations, South Station, and along the MBTA Blue Line. Additional service from South Station or Logan Express sites would affect the resident, tourist, and business communities within walking distance of those locations. Construction related to supporting additional capacity may create temporary challenges in and around these sites.

High-Occupancy Vehicle Operations Summary Policy Scenarios

Overview of High-Occupancy Vehicle Operations Summary Policies

The study team compiled the combinations from the previous sections to develop two HOV service macrocombinations. Combination 1 includes policies that Massport has recently implemented, is currently planning, or would be generally plausible to pursue. Combination 2 includes more ambitious policies that might require additional time, cost, and support to feasibly implement. Table 24 summarizes which previously outlined combinations were included in the modeling for the HOV services macrocombinations.

TABLE 24: POLICY AREA COMBINATION COMPONENTS IN HOV OPERATIONS MACROCOMBINATIONS

POLICY AREA	COMBO 1	COMBO 2
Remote Baggage Check	Combo 1	Combo 1
Parking Pre-Reservation	Combo 1	Combo 2
Other Operations	Combo 1 and 2	Combo 2 and 3

Source: RSG

High-Occupancy Vehicle Operations Summary Policy Effects

Table 25 summarizes HOV operations policy scenario effects.

TABLE 25: HOV OPERATIONS POLICY SCENARIO EFFECTS SUMMARY

EFFECTS	COMBO 1	COMBO 2
HOV Mode Share (% of total cumulatively)	+1.8%	+0.9%

Source: RSG

Mode Choice

In HOV Operations Policy Combination 1, HOV mode share is forecast to increase by 1.8 percentage points. This shift includes a decrease in ride app share and an increase in limousine share. One important reason this equates to such a large HOV increase is that limousine is categorized as HOV for the purposes of this analysis. Nevertheless, other HOV modes collectively experience a significant increase in mode shares.

In HOV Operations Policy Combination 2, HOV mode share is forecast to increase by 0.9 percentage points. This shift includes an increase in MBTA Silver Line share and a decrease in ride app, taxi, and limousine share.

Cost to Authority

Remote bag check at MBTA Silver Line and MBTA Blue Line stations represents a relatively expensive policy proposal for the estimated HOV gain.

Specific net cost/new HOV rider metrics were not developed for other policy packages in Study #3. It is a challenge to develop a single uniform cost metric for Study #3 that is directly comparable to policies whose primary objectives are specifically to increase HOV services (Study #1 and remote bag check at MBTA stations in Study #3). This is because, in these instances, a critical air-quality-related variable against which costs should be measured (e.g., reduced commercial and private vehicle drop-off/pickup due to parking pre-reservation and reduced deadheading due to ride app centralizations) are different or more complex. Other policies generally involve policies and programs enabled by Massport investments, but which would ultimately be operated by other parties (e.g., MaaS, MBTA bus services).

In general, Massport's plan is to fund the additional costs of new operations policies with new revenues (e.g., ride app drop-off fees, increased parking demand due to pre-reservation options), with any additional revenues helping to subsidize HOV initiatives.

Operations

Baggage check services would require additional labor, infrastructure, logistics, and security. Systems and vehicles would be required to transport baggage from the remote sites to the Airport. This infrastructure (at the remote site, in transit, and at induction points to Airport baggage systems) would need to support secure baggage protocols, potentially proving costly or logistically challenging. This investment and these operations are being implemented for on-Airport remote bag check at the new ride app drop-off/pickup area that will be delivered by late 2019.

Parking pre-reservation would require additional labor and infrastructure. Web application and software would be required to house the system, while hardware and staff would be needed on site to support and enforce the system. Again, Massport is making this investment for on-Airport parking, with a pre-reservation system expected to be fully implemented in 2020.

The new ride app drop-off/pickup area offers both operational challenges and opportunities. Additional staffing requirements and challenges associated with displaced parking will add general ground access operations challenges.

However, overall benefits to ground access operations will accrue from reducing "deadhead" trips, or ride app trips to or from the Airport with no passengers.

Employing new drop-off locations for ride apps and MaaS services would require significant new infrastructure and investment. Massport is planning to deliver at least a Logan Express e-ticketing program in 2020

Customer Service

Key customer service considerations would include explaining operations changes to customers and supporting those customers as they use the new offerings. Massport staff will face challenges influencing customer experiences on those segments of the ground access journey (e.g., at South Station, in the Ted Williams Tunnel). Furthermore, marketing the new operations and benefits from the enhancements needs to be communicated to Airport users.

In the case of disruptions to customer journeys associated with ride app drop-off/pickup in the Central/West Garage, Massport has committed to several important customer service improvements. These include, but are not necessarily limited to, remote bag check services and various services to support customers with disabilities.

Air Quality

Any measure that Massport can take to reduce pickup and drop-off trips or increase HOV mode share will have a measurable positive benefit to air quality. This benefit will be quantified in upcoming Massport EDR as outlined in the Parking Freeze Amendment.

The centralized ride app drop-off/pickup area reduces trips to and from the Airport even for those air passengers that continue to use the ride app modes. Reducing these "deadhead" trips reduces air quality impacts. Addressing potential additional congestion related to displace parking supply is addressed in Study #2.

Community Stakeholder

Community stakeholder effects largely pertain to two broad groups: East Boston and communities near remote access sites (e.g., Logan Express sites, South Station).

East Boston: Effects at the Airport and East Boston involve congestion reduction on Airport property, in the neighborhoods, and along the major gateway roads. The proposed scenarios should benefit the community through the reduction of congested hours along the major roads and particularly Airport roadways, which should relieve pressure on surrounding neighborhood roads. In the case of the centralized ride app drop-off/pickup area, reduced deadheading will help drive this congestion relief.

Remote Sites: Significant community stakeholder effects relate to the potential need for increased service from suburban Logan Express locations, South Station, and along the MBTA Blue Line. Additional service from South Station or Logan Express sites would affect the resident, tourist, and business communities within walking distance of those locations. Construction related to supporting additional capacity may create temporary challenges in and around these sites.

Study #3: Operations Conclusions

1. **A centralized service for pickup and drop-off modes can be a powerful tool for influencing mode share and reducing vehicle trips**. The introduction of a centralized ride app location gives Massport a lever to speed up or slow down any given mode. By sending ride apps to a central location, Massport can improve operations and make HOV modes more attractive. Moreover, operational improvements to reduce ride app "deadheading" will improve roadway congestion. Massport will be moving ride apps to a central location in late 2019.

2. **Reduction in travel time for HOV modes will increase HOV mode share**. Travel time savings has a demonstrable effect on incentivizing transit use. Any improvements, like the direct ramp access to the Ted Williams Tunnel that is currently being evaluated, will help in increasing HOV ridership.

Implementation of Study Results

Analysis from the Mode Choice Model and Simulator (MCMS) and the three studies allows the Massachusetts Port Authority (hereafter Massport or the Authority) to confidently pursue new policies that are predicted to effect high-occupancy vehicle mode share increases at Boston Logan International Airport (hereafter the Airport or Logan Airport). Massport has already utilized results from the MCMS and the three studies and, at the time of publication, progress had already been made on several recommendations across the studies. The following sections summarize Massport's progress on implementation of recommendations for each study.

Study #1

- Relocating Back Bay Logan Express service to the Massachusetts Bay Transportation Authority's (MBTA's) Back Bay Station, eliminating the fare from the Airport to Back Bay, and reducing the fare from Back Bay to the Airport from $7.50 to $3.00.
- Increasing peak-hour frequency on Logan Express' Braintree service from 30-minute to 20-minute headways.
- Advancing a new urban Logan Express service at North Station with free service from the Airport.
- Identifying new suburban Logan Express locations with parking.
- Implementing a new ride app drop-off fee of $3.25 (in addition to the current $3.25 pickup fee) and providing a discounted fee of $1.50 for shared-ride (such as UberPool and Lyft Line) customers.

Study #2

- Implemented parking pricing that discourages short-term parking that is associated with pickup and drop-off uses.

Study #3

- Piloted use of the South Boston Waterfront – Emergency Access Ramp, reducing travel time on the MBTA Silver Line (SL1) service to help encourage use.
- Consolidating ride app operations at dedicated areas on the ground floor of the Central Garage, making it easier for drivers to pick up arriving air passengers after dropping off departing air passengers without having to circulate around the Airport.

APPENDIX A. Policy Scenario Details

This appendix provides Boston Logan International Airport (hereafter the Airport or Logan Airport) policy scenario details for Study #1, Study #2, and Study #3. These details support the study findings described in the main report.

Study #1. Logan Airport Ground Access High-Occupancy Vehicle Services

The following sections outline the policy scenario details for Study #1.

Urban/Suburban Airport Express Bus

Frequency

Table 26 summarizes the incremental policy scenarios associated with changes in frequency of service at each Logan Express location. These policy scenarios explore effects of reducing headways from 30 minutes to 20 minutes at the suburban locations (except for Peabody, which explores an increase in service frequency from one hour to 30 minutes and 20 minutes). Braintree and Framingham see the largest effects from increases in service frequency because these locations have the most current and potential demand for Logan Express service.

TABLE 26: LOGAN EXPRESS FREQUENCY POLICY SCENARIOS SUMMARY

DESCRIPTION	HIGH-OCCUPANCY VEHICLE (HOV) MODE SHARE (% OF TRIPS)
Braintree Increase frequency to 20 min.	+0.04%
Framingham Increase frequency to 20 min.	+0.05%
Woburn Increase frequency to 20 min.	+0.02%
Peabody Increase frequency to 30 min.	+0.02%
Peabody Increase frequency to 20 min.	+0.04%

Source: RSG

Baggage Check

Table 27 summarizes the incremental policy scenarios associated with adding remote baggage check services at each Logan Express location. Braintree and Framingham see the largest effects from adding remote baggage check because these locations have the most current and potential demand for Logan Express service.

TABLE 27: LOGAN EXPRESS BAGGAGE CHECK POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
Back Bay Add remote baggage check to realigned Back Bay	+0.02%
Braintree Add remote baggage check	+0.04%
Framingham Add remote baggage check	+0.06%
Woburn Add remote baggage check	+0.02%
Peabody Add remote baggage check	+0.01%
North Station Add remote baggage check	+0.01%

Source: RSG

Security Prioritization

Table 28 summarizes the incremental policy scenarios associated with adding Airport security line prioritization services for passengers from each Logan Express location. Back Bay sees the largest effects from adding security prioritization (explored as a 10-minute reduction in egress travel time) because the travel time reduction for shorter, urban trips comprises a more significant percentage of overall travel time than for more distant potential suburban Logan Express riders.

TABLE 28: LOGAN EXPRESS SECURITY PRIORITIZATION POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
Back Bay Add security line priority to realigned Back Bay	+0.16%
Braintree Add security line priority	+0.09%
Framingham Add security line priority	+0.11%
Woburn Add security line priority	+0.04%
Peabody Add security line priority	+0.01%
North Station Add security line priority	+0.06%

Source: RSG

Urban Logan Express Expansion/Rebrand

Table 29 summarizes the incremental policy scenarios associated with adding new or adjusted, high-frequency Logan Express locations within the urban core. The realigned Back Bay Station produces the largest effects while North Station proves the most impactful new location.

TABLE 29: LOGAN EXPRESS URBAN EXPANSION/REBRAND POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
Back Bay Realign Back Bay to Massachusetts Bay Transportation Authority (MBTA) Back Bay Station	+0.21%
North Station Add North Station location	+0.17%
Kendall Add Kendall location	+0.12%
Allston Add Allston location	+0.15%
Newton Corner Add Newton Corner location	+0.13%

Source: RSG

Suburban Logan Express Expansion

Table 30 summarizes the incremental policy scenarios associated with adding new Logan Express locations in the suburban, Metro Boston area. Framingham (a second location) and Newton prove the most impactful options for expansion. While Framingham's potential exceeds that of Newton, the latter is incorporated within the primary policy scenarios due to expected ease of land acquisition at potential Newton sites (I-90 and Route 128 interchange) compared to those in Framingham.

TABLE 30: LOGAN EXPRESS SUBURBAN EXPANSION POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
Framingham Add additional Framingham location	+0.31%
Hopkinton Add Hopkinton location	+0.20%
Newton Add Newton location	+0.26%
Waltham Add Waltham location	+0.17%
Saugus Add Saugus location	+0.12%
Saugus without Peabody Add Saugus location and remove Peabody location	+0.10%

Source: RSG

Public Transit/Multistop Bus

Frequency

Table 31 summarizes the incremental policy scenarios associated with increasing service frequency on the MBTA Silver Line. Changes in frequency do not produce large effects.

TABLE 31: MBTA SILVER LINE FREQUENCY POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
MBTA Silver Line Increase frequency by 10%	+0.03%
MBTA Silver Line Increase frequency by 20%	+0.06%

Source: RSG

Express Service

Table 32 summarizes the incremental policy scenarios associated with initiating express service on the MBTA Silver Line between South Station and the Airport. This express service is explored through travel time reductions. Travel time reductions produce much larger effects than frequency increases.

TABLE 32: MBTA SILVER LINE EXPRESS SERVICE POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
MBTA Silver Line Decrease travel time by 5 min.	+0.27%
MBTA Silver Line Decrease travel time by 10 min.	+0.58%

Source: RSG

Baggage Check

Table 33 summarizes the incremental policy scenario associated with adding remote baggage check services at South Station. The policy shows greater effect than frequency changes for MBTA Silver Line but less effect than travel time savings due to express service.

TABLE 33: MBTA SILVER LINE BAGGAGE CHECK POLICY SCENARIO SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
MBTA Silver Line Add remote baggage check at South Station	+0.16%

Source: RSG

Water Transportation

Frequency

Table 34 summarizes the incremental policy scenario associated with increases in service frequency for MBTA ferry. With low demand for the service, frequency changes have little effect.

TABLE 34: MBTA FERRY FREQUENCY POLICY SCENARIO SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
MBTA Ferry Increase frequency by 50%	+0.03%

Source: RSG

Security Prioritization

Table 35 summarizes the incremental policy scenario associated with adding security prioritization for those who arrive at the Airport by MBTA ferry. Again, this policy has little effect due to low demand for ferry service.

TABLE 35: MBTA FERRY SECURITY PRIORITIZATION POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
MBTA Ferry Add security line priority	+0.01%

Source: RSG

Scheduled Taxi Service

Table 36 summarizes the incremental policy scenario associated with developing scheduled water taxi service at 10-minute intervals. This was tested in the Mode Choice Model and Simulator by examining MBTA ferry service with 10-minute headways. Even at greatly reduced headways—or described as frequent, scheduled water taxi service—the effect remains limited.

TABLE 36: SCHEDULED WATER TAXI SERVICE POLICY SCENARIO SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
Water Taxi Create scheduled service at 10-min. headways	+0.03%

Source: RSG

Study #3. Logan Airport Ground Access and Reducing Non-High-Occupancy Vehicle Operations

The following sections outline the policy scenario details for Study #3.

Baggage Check

Table 37 summarizes the incremental policy scenarios associated with adding remote baggage check services for the MBTA Blue Line and MBTA Silver Line. Both policies show similar, moderate effects.

TABLE 37: LOGAN AIRPORT BAGGAGE CHECK POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
MBTA Blue Line Add remote baggage check at Airport Station	+0.15%
MBTA Silver Line Add remote baggage check at South Station	+0.16%

Source: RSG

Parking Reservation

Table 38 summarizes the incremental policy scenarios associated with offering parking reservation services at Airport parking and Logan Express parking. Parking reservation at on-Airport locations produces minor, negative effects by incentivizing a single-occupancy vehicle (SOV) option. Parking reservation at Logan Express produces minor, positive effects by incentivizing an HOV option.

TABLE 38: LOGAN AIRPORT PARKING RESERVATION POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
Terminal Offer parking reservation at Terminal	-0.07%
Economy Offer parking reservation at Economy	-0.02%
Logan Express Offer parking reservation at all suburban Logan Express locations	+0.03%

Source: RSG

Shuttle Frequency

Table 39 summarizes the incremental policy scenario associated with increasing the service frequency for on-Airport shuttles. This policy is examined by providing small travel time reductions to the following modes that use the on-Airport shuttle: MBTA ferry, MBTA Blue Line, rental vehicles, and Economy Parking. The mixed effect for these HOV and SOV modes results in a moderate positive effect.

TABLE 39: LOGAN ON-AIRPORT SHUTTLE FREQUENCY POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
On-Airport Shuttle Increase frequency, 5 min. travel time savings	+0.12%

Source: RSG

Tunnel Transit Priority

Table 40 summarizes the incremental policy scenarios associated with developing transit priority in the Ted Williams Tunnel. This policy is proxied by travel time reductions for MBTA Silver Line and Logan Express services that use the Ted Williams Tunnel. Even modest travel time reductions result in significant positive effects. These effects increase as travel time reductions grow.

TABLE 40: TED WILLIAMS TUNNEL TRANSIT PRIORITY POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
Ted Williams Tunnel Priority Decrease travel time by 5 min. for MBTA Silver Line and Logan Express	+0.43%
Ted Williams Tunnel Priority Decrease travel time by 10 min. for MBTA Silver Line and Logan Express	+0.93%

Source: RSG

Mobility-as-a-Service/E-Ticketing

Table 41 summarizes the incremental policy scenarios associated with developing Mobility-as-a-Service (MaaS)/e-ticketing services for transit mode: MBTA ferry, MBTA Blue Line, MBTA Silver Line, and Logan Express. Proxied by travel time reductions, this policy shows moderate to significant effects.

TABLE 41: MAAS/E-TICKETING POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
MaaS/E-Ticketing Add Maas/E-Ticketing for MBTA and Logan Express services (2-min. travel time savings proxy)	+0.23%
MaaS/E-Ticketing Add Maas/E-Ticketing for MBTA and Logan Express services (5-min. travel time savings proxy)	+0.60%

Source: RSG

Ride App Drop-off/Pickup

Table 42 summarizes the incremental policy scenario associated with moving ride apps to Central Parking and discounting shared ride app rides by $1.75. This policy shows significant effects on HOV use.

TABLE 42: RIDE APP DROP-OFF/PICKUP POLICY SCENARIOS SUMMARY

DESCRIPTION	HOV MODE SHARE (% OF TRIPS)
Ride App Pickup/Drop-off Move ride apps to Central Parking, charge a $3.25 drop-off fee, and discount shared rides by $1.75	+1.20%

Source: RSG

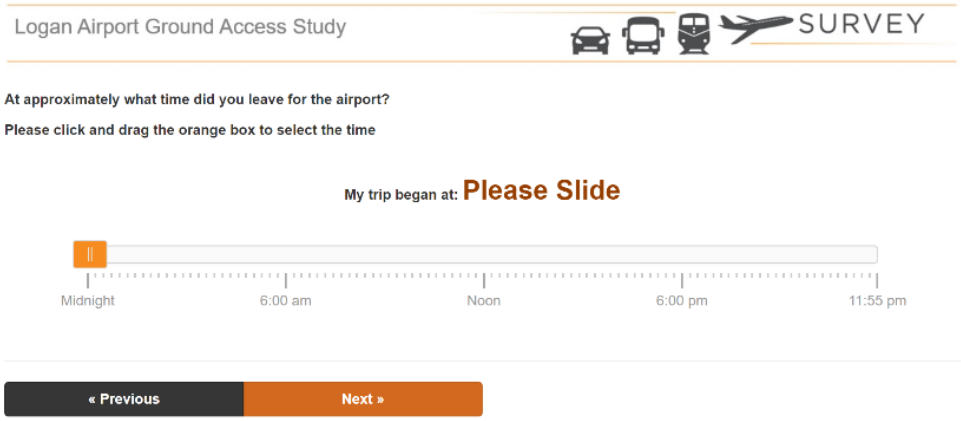
APPENDIX B. Survey Methodology and Administration

RSG conducted the fall 2018 Logan Air Passenger Ground Access Survey (hereafter the 2018 Passenger Survey) to provide the Massachusetts Port Authority (hereafter Massport or the Authority) with the data required to estimate models and develop the Mode Choice Model and Simulator (MCMS).[59] The survey and ensuing model support the policy analyses required for the three Boston Logan International Airport (hereafter the Airport or Logan Airport) Parking Freeze studies and include both traditional elements of Massport's ground access surveys and a new stated preference (SP)[60] section that is integral to development of the MCMS.

Survey Design

The overall survey comprised two parts: 1) an origin-destination (O-D) survey describing the current trip to the Airport (Logan Airport was always the destination for this study); and 2) an SP survey. The O-D section included details of the Airport access trip, including origin address and type of origin place (e.g., work, home), trip purpose, mode of transportation, parking costs, time of day, party size, length and location of stay, frequency of travel from the Airport, and demographic information. Figure 18 is an example of a programmed question about the respondent's departure time to the Airport.

FIGURE 18: EXAMPLE QUESTION FOR DEPARTURE TIME TO LOGAN AIRPORT



Source: RSG

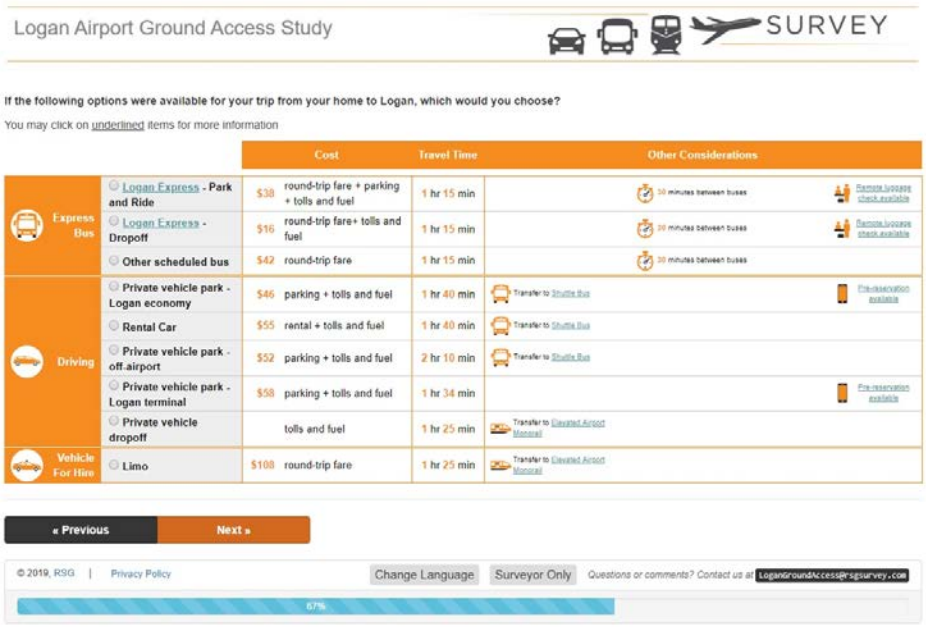
[59] RSG is the consultant hired by Massport to complete the 2018 Passenger Survey and develop the MCMS.
[60] Data detailing what people might do (hypothetical).

The SP section of the survey used the detailed O-D data to customize a set of hypothetical choice experiments. An efficient experimental design determined the choices experiment participants saw. Specifically, this experimental framework comprised 61 designs (targeting different types of respondents), with 10 unique blocks of 6 experiments each, for a total of 3,660 experiments. Each respondent was randomly assigned to one of the 10 blocks and shown all 6 experiments. Each of these 6 experiments, in turn, presented between 4 and 15 alternatives. The number and types of modes that were shown in the SP experiments were determined using the following logic:

- Respondents originating from within the Massachusetts Bay Transportation Authority (MBTA) subway service area were shown MBTA Blue Line, MBTA Silver Line, MBTA ferry, and water taxi.
- Respondents who also originated within 0.5 miles of Kendall Square or North Station were shown an additional hypothetical express bus service.
- Respondents originating outside of the MBTA subway service area were shown rental car, Logan Express, and other scheduled bus service.
- Respondents originating from the South Shore also saw MBTA ferry.
- All respondents saw taxi and ride app except those originating beyond I-495.
- All respondents saw limousine.
- All respondents who mentioned a car was available for this trip saw private vehicle drop-off and parking options, including Logan Express drop-off if originating outside of the MBTA subway service area.
- Superseding all logic above, each respondent saw the mode they indicated using for their Airport trip.

For each choice alternative, several associated trip characteristics were displayed. These included travel time, cost and, if applicable, headway and whether a transfer to a shuttle bus was required. Across all the scenarios, the respondent was presented with different levels of each attribute (each attribute varied independently of the others) and asked to “trade off” among the choice alternatives (see Figure 19 for an example of one SP exercise)

FIGURE 19: SCREENSHOT EXAMPLE OF STATED PREFERENCE EXERCISE



Source: RSG

In case respondents wanted more information about an attribute in the SP experiment, highlighting an attribute revealed more information, which often included a picture with an additional description (see Figure 20).

FIGURE 20: EXAMPLE OF POP-UP EXPLANATION

Source: RSG

Flight Selection Process

RSG employed a random process to select flights to be intercepted. This process selected flights with characteristics that were representative of expected passenger flows from the Airport during the survey period. Specifically, RSG analyzed the Airport's flight departure data from October 1, 2018 to November 15, 2018.[61] RSG sampled proportional to air passenger volumes by the following sampling segments:

- **Flight type**: Domestic commuter, domestic noncommuter, and international.
- **Day of week**: "Weekday" (Mon.–Thu.) and "weekend" (Fri.–Sun.).
- **Time of day**: 5:00 a.m.–8:59 a.m., 9:00 a.m.–1:59 p.m., 2:00 p.m.–6:59 p.m., 7:00 p.m.–10:59 p.m.
- **Airline**: JetBlue, legacy (American, Delta, United), Southwest, and other.

For flight type, a commuter flight was defined as one for which the marketing airline was different than the operating airline (e.g., a United Airlines flight operating as a Republic Airlines flight).

For day of week, Friday was included within the weekend categorization because a significant portion of business travel for the week finishes on Thursday, with Friday flights serving leisure travelers.

For airline, legacy carriers (American, Delta, and United) were grouped together due to their similar operating and pricing strategies. JetBlue and Southwest, the other two major airlines at the Airport, remained separate while all other airlines were grouped as "other." Terminal was not chosen as an additional criterion because airlines at the Airport provide near-perfect proxy for the distribution of air passengers across terminals. However, this sampling plan was devised to ensure every terminal was surveyed over at least two separate days during the fielding effort.

For each survey date, a combination of survey criteria was chosen (e.g., PM flights by "other" airlines in Terminal E, or AM flights by JetBlue in Terminal C) and flights meeting these criteria were randomly selected. After conducting random selection, RSG manually inspected each shift to ensure enough spacing between flights throughout the eight-hour period. Any selection that did not allow enough time between flights was swapped for another randomly selected flight

[61] Flight-pull data provided by Massport with data from Airline Data Inc.

until the daily schedules were spaced sufficiently. RSG continued to iterate the final flight list to ensure the distribution closely matched that of the segment targets. Where variances were observed in this process, flights in overrepresented segments were swapped with other similarly timed/located flights in underrepresented segments. This process continued until all distributions were within a few percentage points of the targets established by total flight seats. In total, RSG selected 232 flights. Table 43 to Table 46 show the sample segment characteristics compared with the seat distributions. Table 47 confirms that the flight selection would also accurately sample air passengers by airplane size.

TABLE 43: SAMPLED FLIGHT AND SEAT DISTRIBUTIONS, BY FLIGHT TYPE

FLIGHT TYPE	SAMPLE	TOTAL
	% of sampled flights	*% of total flight seats*
Domestic Noncommuter	77%	77%
Domestic Commuter	7%	6%
International	17%	17%
Total	**100%**	**100%**

Source: RSG, Massport, and Airline Data, Inc.

TABLE 44: SAMPLED FLIGHT AND SEAT DISTRIBUTIONS, BY DAY OF WEEK

DAY OF WEEK	SAMPLE	TOTAL
	% of sampled flights	*% of total flight seats*
Weekday (Mon.–Thu.)	62%	62%
Weekend (Fri.–Sun.)	38%	38%
Total	**100%**	**100%**

Source: RSG, Massport, and Airline Data, Inc.

TABLE 45: SAMPLED FLIGHT AND SEAT DISTRIBUTIONS, BY TIME OF DAY

TIME OF DAY	SAMPLE	TOTAL
	% of sampled flights	*% of total flight seats*
5:00 a.m.–8:59 a.m.	24%	26%
9:00 a.m.–1:59 p.m.	29%	24%
2:00 p.m.–6:59 p.m.	25%	30%
7:00 p.m.–10:59 p.m.	22%	19%
Total	**100%**	**100%**

Source: RSG, Massport, and Airline Data, Inc.

TABLE 46: SAMPLED FLIGHT AND SEAT DISTRIBUTIONS, BY AIRLINE

AIRLINE	SAMPLE	TOTAL
	% of sampled flights	*% of total flight seats*
Legacy (American, Delta, United)	41%	45%
JetBlue	31%	27%
Southwest	7%	7%
Other	21%	21%
Total	**100%**	**100%**

Source: RSG, Massport, and Airline Data, Inc.

TABLE 47: SAMPLE AND ACTUAL DISTRIBUTIONS, BY AIRPLANE SIZE

AIRPLANE SIZE	SAMPLE	TOTAL
	% of sampled flights	*% of total flight seats*
Small (<100 seats)	13%	12%
Medium (100–199 seats)	75%	77%
Large (200 or more seats)	13%	11%
Total	**100%**	**100%**

Source: RSG, Massport, and Airline Data, Inc.

Survey Administration

RSG conducted the survey as a self-administered tablet-based intercept interview between October 15, 2018 and October 31, 2018 at terminal gates, with the aim of collecting a representative sample of originating passengers. Four survey teams (pairs of two) were given four flight assignments staggered over their eight-hour shift to accommodate breaks and travel both to and within the terminal. To prevent any lost time due to flight delays or cancellations, each flight assignment included multiple similar backup flights that could be sampled if an issue occurred with the original assignment.

The team of interviewers approached passengers waiting to board selected flights at departure gates within the secure area of the terminals in the Airport. Each potential respondent was screened to ensure that they were on the sampled flight, that nobody in their travel party had taken the survey, that they were beginning their air travel at the Airport (i.e., were not connecting passengers), and that they were willing to participate. If a passenger was not eligible or not willing to participate in the study, then interviewers thanked them and approached the next person. Eligible participants willing to participate were handed a tablet, which allowed them to complete the survey on their own. Each surveyor had three or four tablets that he or she distributed to departing passengers.

Each interviewer team remained at designated gate areas until the departing flight prepared to board, at which time interviewers collected the tablets from respondents. If a participant was not finished with the survey, but was willing to complete it at a later point, then the interviewer selected a “Continue Later” button on the bottom of the survey page, which allowed them to record the respondent’s email address. Similarly, for late-arriving passengers (i.e., those arriving less than 10 minutes prior to boarding), interviewers were instructed to only obtain an email address after the screener question confirmed a passenger’s eligibility. RSG then distributed email invitations to these respondents. Emailed invitations contained a unique survey link for the respondent to continue the survey where they had left off.

Data Cleaning

To ensure that completed surveys were both accurate and only from respondents who qualified for the study, some survey responses were adjusted or removed from the dataset for the following reasons:

- Adjusted
  - Where resident status was incongruent with home ZIP Code (e.g., Logan Airport was not reported as home airport, but home ZIP Code was in Boston), status was changed to match the home location.
  - Where respondents listed an access mode as “other,” records were visually inspected and recoded to match the appropriate mode categorization (e.g., an “Uber” write-in would be recategorized within ride app).
  - Where respondent mode order did not make sense, the order was adjusted or, in cases with no plausible adjustment, the record was removed (e.g. “MBTA Blue Line to walking” can be plausibly reordered to “walk to MBTA Blue Line”).
- Removed
  - If respondent mode order did not make sense and could not be plausibly rectified.
  - If survey completion duration was under five minutes, or under four minutes if no SP was required.
  - If origin location was too far from Boston to be a plausible airport access trip (beyond Northeast in United States or adjacent Canadian locations).

Response Rates

After data cleaning,[62] the final dataset included 5,057 usable surveys from nontransferring passengers at the Airport. Table 48 shows the breakdown of response rates by survey completion language.

TABLE 48: COMPLETES, BY COMPLETION LANGUAGE

COMPLETION LANGUAGE	COMPLETES
English	5,002
Spanish	22
Chinese	16
French	9
Portuguese	8
Total	**5,057**

Source: RSG

[62] Data cleaning is a process whereby a dataset is "cleaned" to remove erroneous or inaccurate records. Data cleaning is a normal part of the data collection process and helps ensure the final dataset is accurate and useful to planners.

APPENDIX C. Mode Choice Model and Simulator Methodology

This appendix summarizes methods and assumptions used to develop the Mode Choice Model and Simulator (MCMS) for the Massachusetts Port Authority to complete the Boston Logan International Airport (hereafter the Airport or Logan Airport) Parking Freeze Amendment Ground Access and Trip Reduction Strategy project. The MCMS is a Microsoft Excel-based tool that includes interfaces for policy input and mode share effect output. The MCMS was employed to support the Massachusetts Department of Environmental Protection (MassDEP) studies to estimate the mode share effects of policies under consideration.

Overview

The study team created the MCMS through a multistep process of data preparation, modeling, and development. This appendix details that process and highlights key components of the methodology and major assumptions that went into the final product.

Data

The MCMS uses two primary data input types: data from the fall 2018 Logan Airport Ground Access Air Passenger Survey (hereafter the 2018 Passenger Survey) and complementary inferential data, which is explained below.

Survey Data

The base data required for the MCMS came from the 2018 Passenger Survey, which is detailed in Appendix B. Key MCMS input data from the survey included respondent origin location, access mode, party size, trip purpose, trip duration, and answers to the stated preference (SP)[63] choice experiments.

Stated Preference Data

Remote baggage check, pre-reserved parking, and introduction of an automated people mover (APM) were explored through SP experiments. These dummy variables are expressed in binary format, as either the presence or omission of the innovation. In the case of the APM, omission of the APM is expressed as

[63] Data detailing what people might do (hypothetical).

curb access for modes that currently go to the terminal curb or as shuttle bus access for those modes that are currently served by the Massport shuttle.

Inferential Data

The following sections outline the process involved in using inferential data.

Mode Availability

Before modeling, the study team defined an individual's choice set. While the ground access survey indicates which mode a respondent used to get to the Airport, it does not directly inquire about the full range of modes that an individual could feasibly have used. Therefore, the study team developed general logic rules that would govern an individual's available options for the trip. These assumptions were also used to construct the SP experiments for the survey. The main assumptions for available options are outlined here:

- Respondents originating from within the Massachusetts Bay Transportation Authority (MBTA) subway service area had MBTA Blue Line, MBTA Silver Line, MBTA ferry, and water taxi service available.
- Respondents originating from outside the MBTA subway service area had rental car, Logan Express, and other scheduled bus service available.
- Respondents originating from the South Shore area also had MBTA ferry service available.
- All respondents within I-495 had taxi service and ride app available.
- All respondents had limousine service available.
- All respondents who mentioned a car was available for this trip had private vehicle drop-off and on-Airport parking options available, including Logan Express drop-off if originating outside of the MBTA subway service area.
- Superseding all logic above, respondents had the mode they indicated using for their airport trip available.

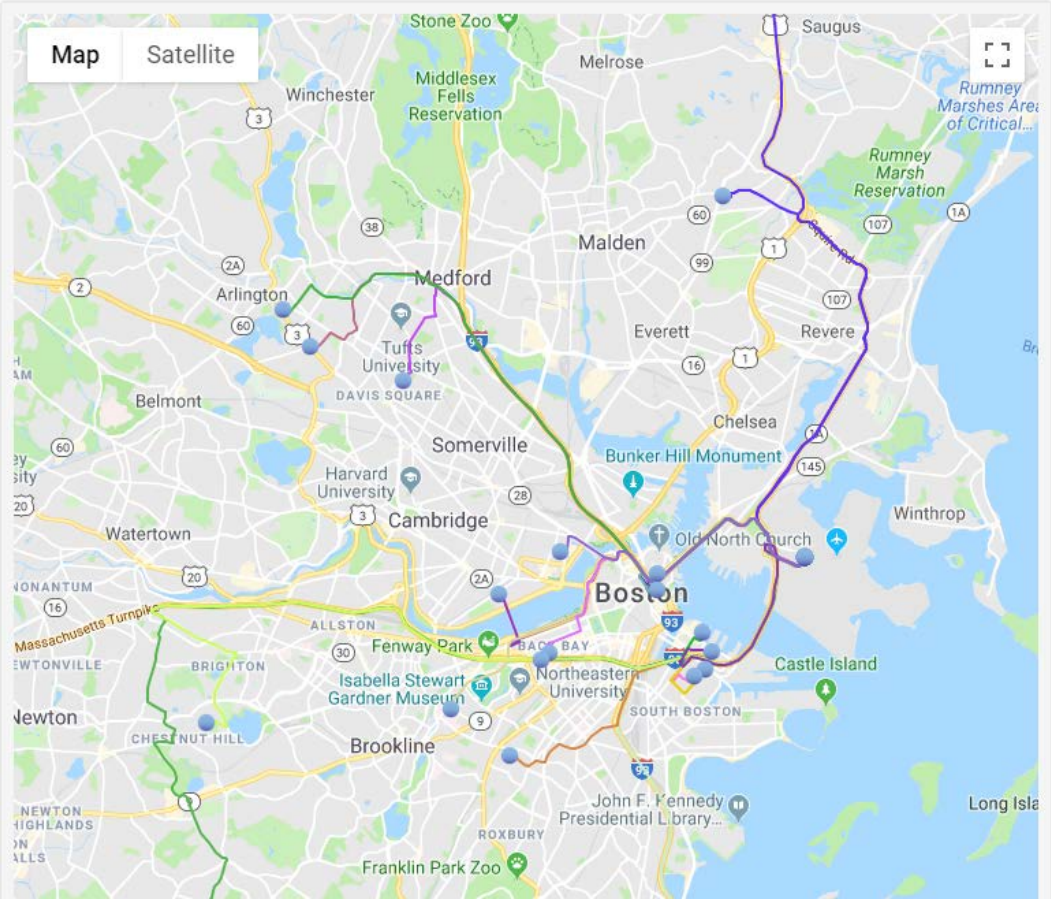
Skim-Building

Traditional airport mode choice models rely on zone-to-zone skim data[64] to infer vehicle travel time for individuals. This approach is coarse and fails to capture the nuance of one's specific origin location and corresponding trip. For Logan Airport, where granular origin survey data exist, the study team developed individual

[64] Refers to a matrix with estimated travel data between two locations.

zone-to-zone skim data by running every respondent's origin location through the Google Directions application programming interface (API).[65] In this tool, seen in Figure 21, the study team captured the optimized route for the given trip at the indicated time of day. The tool developed travel times for both auto trips and transit trips. The Google Directions API became the primary data source for travel time and MBTA transfers.

FIGURE 21: SCREENSHOT OF EXAMPLE GOOGLE DIRECTIONS API TOOL IN PROCESS



Source: Google Maps API Query

Other Archived Data

Cost and frequency data (for those modes where it applies) were captured through querying archived internet data. For example, using The Wayback Machine internet archive,[66] the study team could examine MBTA schedules at

[65] The Directions API is a service that calculates directions between locations. You can search for directions for several modes of transportation, including transit, driving, walking, or cycling.
[66] *Internet Archive: Wayback Machine*, www.web.archive.org (accessed September 17, 2019).

the time of the survey to ensure accuracy of the current conditions for respondents' trips.

Modeling

The modeling process can be summarized as an iterative process, which means it built on previous modeling steps. These steps included model specification, model estimation, and review of goodness of fit. Once this process was complete, the study team calibrated and used the model for simulation.

Model Specification

The following sections outline the process involved in model specification.

Segmentation

Best practice for airport mode choice models includes development of a separate model for each trip purpose. Segmentation by type of airport user is important because airport access differs greatly by trip purpose (e.g., residents are far more likely than nonresidents to drive and park a personal vehicle at the Airport). In this regard, models are segmented into the following classifications:

- Resident business.
- Resident nonbusiness (leisure).
- Nonresident business.
- Nonresident nonbusiness (leisure).

Model Format

Traditional airport mode choice models employ a multinomial logit (MNL) or, preferably, nested logit (NL) format. The logit format is employed because the probabilistic structure, where choices are expressed as the probability of choosing each option, accommodates realistic nuance whereby changes in behavior occur at the margins.

People tend to not be binary decision-makers. Ideally, choice models are not binary either. The NL format, specifically, is employed because it accounts for asymmetric preference (i.e., preferences that change) across modes. People are likely to substitute among modes with similar characteristics (e.g., air passengers are more likely to switch from a taxi to a ride app than to a ferry). As a result, the NL model can be used to determine, statistically speaking, which modes compete most directly.

However, as the study team iterated on MNL and NL model formats, it became clear that NL models were not nesting[67] effectively. Respondents showed significant taste heterogeneity, meaning much of the respondent choice was driven by individual preferences and tastes. To account for this nuance, the study team's final models applied a mixed logit (ML) format. In the ML format, respondents have a unique MNL utility function to account for their unique preferences. This model format allows for the simplicity of MNL construction while accounting for asymmetric competition between modes in the way an NL model would.

Variables

The following variables were included in the final models:

1. Travel Time ($/hour)
2. Cost (in $)
3. Headway (Ferry) (in minutes)
4. Headway (Urban Transit) (in minutes)
5. Headway (Suburban Bus) (in minutes)
6. Transfers (MBTA) (number)
7. Remote Baggage Check (Binary—yes/no)
8. Pre-Reserved Parking (Binary—yes/no)
9. Automated People Mover Egress (Binary—yes/no)
10. Shuttle Bus Egress (Binary—yes/no)
11. Alternative Specific Constants for each mode:
    a. MBTA Ferry
    b. Water Taxi
    c. MBTA Blue Line

[67] Nesting refers to how the parameters of one model relate to another. For instance, a "nested" model is one that uses a subset of parameters of another model. This model is then "nested."

d. MBTA Silver Line

e. Ride App—Standard

f. Ride App—Shared

g. Taxi

h. Limousine

i. Private Vehicle Drop-Off

j. Parking—Central Parking

k. Parking—Economy

l. Parking—Off-Airport

m. Rental Car

n. Logan Express—Park-and-Ride

o. Logan Express—Drop-Off

p. Other Scheduled Bus

Model Estimation

The study team conducted model estimation in a statistical package of the open-source analysis tool "R."[68] This package is specifically designed to conduct choice model estimation.

Review of Model Fit and Iteration

After initial estimation, the study team reviewed the model output and considered the reasonableness of the results. This phase functioned as an iterative process through which any concerns regarding the statistical model could be explored and corrected. This, as previously mentioned, included altering the model format, adjusting explanatory variables, and reviewing and adjusting initial assumptions developed in the revealed preference dataset.[69]

[68] *The R Project for Statistical Computing*, www.r-project.org (accessed September 13, 2019).
[69] Data detailing what people did do (observational).

Model Calibration

Once the iterative specification, estimation, and review processes were complete, the study team calibrated the resultant model to mode shares from the 2018 Passenger Survey. The study team also integrated Logan Express ridership data from 2018 into the calibration to ensure the MCMS accurately captured the relative ridership across Logan Express locations. These calibration steps allowed the model to represent the base case (2018 existing conditions) situation with proper shares for each mode. Once calibrated, the model was then used to forecast future ground access scenarios. Finally, for the ultimate analysis of changes in high-occupancy vehicle (HOV) mode share, the study team calibrated the model output to CY 2018 annual ridership levels for Airport ground transportation, by mode.

Asserted Shares

Three modes were asserted[70] instead of being included in the modeling process: hotel shuttles, charter buses, and the subsection of rental cars that were not obtained explicitly for the one-way airport trip. These three modes were not included in the mode choice models because individuals using these modes are not deemed to be trading off between modes: Those airport users who have access to a free hotel shuttle are likely to use that option; those on a charter bus are likely part of a group and made no individual decision regarding their airport trip; and those in rental cars that were not obtained explicitly for the airport trip likely had compelling reasons to select a rental car (e.g., a lengthy trip requiring a car throughout). While these modes were omitted from the models themselves, their share remains a real and significant component of overall Airport access. These shares were included directly into the calibration at the levels calculated from the 2018 Passenger Survey.

Headway

The study team found that headway did not model well. In lieu of modeled coefficients, the coefficients were asserted at 0.75 multiplied by the individual time posterior for each respondent, in line with a commonly used estimate for headway time burden.

[70] Asserting a mode in the modeling process meant that mode share was not arrived at through model estimation; instead, the mode was included as a set percentage based on data gathered from the 2018 Passenger Survey.

Simulation

The study team then used the final models to develop the MCMS. The tool allows the user to explore changes in estimated Airport access mode share based on implementation of hypothetical policy changes.

Structure

As noted, the MCMS is a Microsoft Excel-based tool that includes interfaces for policy input and mode share effect output. The tool is underpinned by the final models—with an exception related to Logan Express.

Logan Express Locations

To test the introduction of potential new Logan Express sites, the MCMS included appropriate adjustments to the final model structure. Current and potential Logan Express locations were nested into a probabilistic submodel that then determined the most likely Logan Express location choice for any given individual based on travel time, cost, and frequency of service associated with each location. The study team used two assumptions to underlie this submodel. First, air passengers were only assigned to an urban Logan Express location (e.g., Back Bay) if they were within a 15-minute walk of the location. No one could be assigned to two or more urban Logan Express locations. Second, the study team assumed that nonurban originating individuals would not shift across zones of the region (loosely defined as North Shore, Metro West, and South Shore). For example, if bus fare decreased significantly at Braintree, then the study team assumed that Woburn-based air passengers would not travel through Boston and past the Airport to go to Braintree.

Input

Corresponding to the variables included in the final models, several parameters were adjusted to explore policy changes. Key inputs included changes in travel time (percent or absolute), cost (fares and parking rates by percent or absolute), headways, and binary options for new innovations. These inputs are all mode-specific and mode-appropriate.

Output

MCMS output is expressed as the resulting updated modeled mode shares for each mode and the percentage change from the base case for each mode. These outputs are expressed by market segment and overall. The study team filtered output by geographic zone, time of day, day of week, and Airport

gateway. Furthermore, the MCMS provided the modeled estimated overall HOV share and the percentage change and percentage point change in HOV share from the base case depending on each scenario.

High-Occupancy Vehicle Mode Share

For the purposes of the MassDEP studies, HOV mode share encompasses the following:

Any trip that is ***not*** made by…

- Private vehicles (dropped off or parked).
- Rental vehicles.
- Taxi.
- Ride app.

APPENDIX D. Emerging Technology and Scenario Planning

Introduction

This appendix summarizes emerging transportation and mobility technology, focusing on advances that could affect ground access at the Boston Logan International Airport (hereafter the Airport or Logan Airport). With the help of short- and medium-term scenarios exercises, it also describes the likely effect of these future developments on ground access from a qualitative perspective, followed by a discussion of general principles for addressing the risks and opportunities in planning, design, and implementation of new technology at the Airport.

Specifically, this appendix has three objectives:

1. Describe new technologies that may have a material effect on ground access to the Airport.

2. Estimate the potential magnitude of these effects and when they may occur.

3. Identify the potential risks and opportunities presented by these technologies.

This discussion assists the Massachusetts Port Authority (hereafter Massport or the Authority) in developing strategies to make optimal use of its new and existing parking facilities, to maintain and advance the Airport's high-occupancy vehicle (HOV) mode share for ground access trips, and to support ground access planning efforts generally. The analyses described in this appendix contributed to the development or the refinement of policies evaluated in the three studies.

Landscape of Emerging Technologies

The emerging technologies that could affect ground access mode choice to the Airport can be classified into three groups:

- ***Intrinsic*** emerging technologies can transform the existing transportation landscape. These technologies could either expand or reduce the set of options available from the doorstep and could shape travel preferences for at least the first stage of all future ground access journeys. Massport has no control over these forces that may have fundamental effects on ground access mode choice.
- Within the context of the intrinsic technologies, ***targeted*** emerging technologies relate specifically to ground access. These technologies can increase or reduce the attractiveness of each mode—or combination of modes—that travelers may use to access the terminal. They may be strategically applied by Massport to promote shifts in ground access mode choice.
- ***Tertiary*** emerging technologies do not relate directly to mode choice but may have effects that produce modest shifts in ground access mode choice, either by changing the attributes of some modes (like cost or travel time) or by making new modal variants possible.

Recognizing the order of importance of these effects, the set of emerging technologies that influence ground access mode choice are shown in Table 49.

TABLE 49: EMERGING TECHNOLOGIES

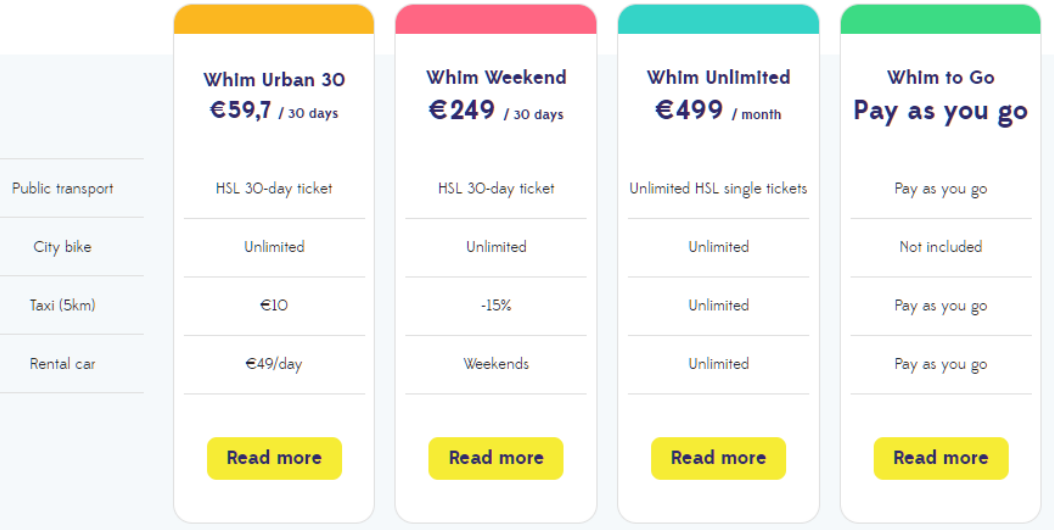
INFLUENCE ON MODE CHOICE	EMERGING TECHNOLOGY	GROUND ACCESS JOURNEY STAGE			
		PRETRIP	IN TRANSIT	TERMINAL APPROACH	TERMINAL LANDSIDE
Intrinsic	Mobility-as-a-Service (MaaS)	✓			
	Automated Vehicle (AV) Technologies	✓	✓	✓	
	Connected Vehicle (CV) Technologies	✓	✓	✓	
Targeted	Automated Electric Vertical Takeoff and Landing (eVTOL) Aircraft		✓	✓	
	Remote Baggage Drop-off and Check-In		✓	✓	
	Ground Transportation Management Systems			✓	
	Parking and Carshare Systems			✓	
Tertiary	Security Technologies				✓

Source: RSG

Mobility-as-a-Service

MaaS encompasses digital platforms that provide a gateway for users to view, reserve, and pay for a menu of real-time mobility options—both public and private—such as transit, rail, ride app, carshare, bikeshare, micromobility, and any combination thereof. MaaS provides users with a seamless combination of end-to-end real-time trip planning, booking, e-ticketing, and payment within a common ecosystem via a single mobile app. This enables users to easily determine their most attractive mobility option based on their individual preference for time savings, trip amenities, convenience, and cost. Figure 22 displays the current subscription offerings from one such MaaS ecosystem, Whim, which is a provider operating in Helsinki, Finland.

FIGURE 22: SUBSCRIPTION OFFERINGS FROM WHIM



Source: Whimapp.com

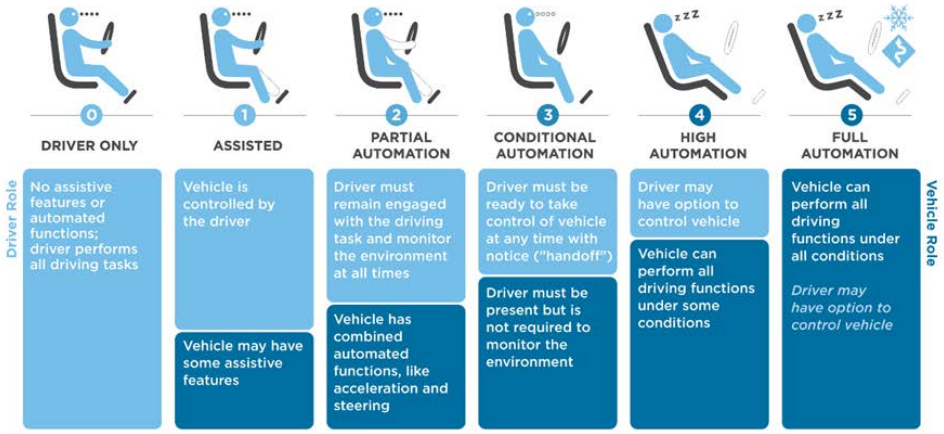
Integrated MaaS applications are at an early stage of development. Experimentation is ongoing, and the number of pilot programs is expected to rise. Most critical, however, is convincing all stakeholders—both private and public—to cooperate. As MaaS applications continue to develop, it is important that airports make investments in improving digital information sharing to present ground transportation options to passengers and, in turn, promote different modes of access.[71]

[71] Mark Streeting et al., "The Future of Ground Access: How Airports Can Respond to Disruption." L.E.K. Consulting, November 19, 2018, https://www.lek.com/insights/sr/future-airport-ground-access-disruption. (accessed September 13, 2019).

Automated Vehicle Technologies

AV technology, sometimes referred to as self-driving vehicle technology, enables a vehicle to guide itself with little to no physical control or monitoring by a human operator. Many theoretical benefits attach to widespread implementation of AV technology. These include improved safety, more free time for occupants, increased mobility and access, reduced emissions (associated with smoother acceleration and traffic signal coordination), and greater opportunities for higher utilization of vehicles that could be shared. As shown in Figure 23, SAE International has defined six levels of driving automation from Level 0 to 5.[72] These levels have been adopted by the National Highway Traffic Safety Administration.[73]

FIGURE 23: SAE INTERNATIONAL LEVELS OF AUTOMATION



Source: RSG

For the systemwide benefits of consumer application of AVs to be fully realized, vehicles would have to achieve SAE Level 5, which requires sustained automated driving system performance without any expectation that the user will respond to a request to intervene, unconditional of the operating environment. While full system automation may provide benefits, this scenario is highly unlikely for several decades. The US Department of Transportation anticipates having mixed-flow conditions for the foreseeable future, and systems have to be

[72] SAE International, "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles J3016_201806." June 15, 2018, https://www.sae.org/standards/content/j3016_201806/. (accessed September 13, 2019).
[73] National Highway Traffic Safety Administration, "U.S. DOT releases new Automated Driving Systems guidance." US Department of Transportation, September 17, 2017, https://www.nhtsa.gov/press-releases/us-dot-releases-new-automated-driving-systems-guidance. (accessed September 13, 2019).

designed to provide mobility for highly automated and traditional human drivers.[74] Nevertheless, a watchful eye should be kept on progress made locally as this could affect ground access at the Airport.

Connected Vehicle Technologies

CV technology allows vehicles to communicate wirelessly with surrounding vehicles (referred to as vehicle-to-vehicle, or V2V), infrastructure (vehicle-to-infrastructure, or V2I), the cloud/network (vehicle-to-network, or V2N), and pedestrians (vehicle-to-pedestrian, or V2P). These technologies are collectively referred to as vehicle-to-everything, or V2X. Together, these components constitute a CV environment, which is a core attribute facilitating the development of CVs/AVs, intelligent transportation systems, and smart city initiatives.

Although the safety improvements offered by the adoption of CV technologies may only have marginal effects on mode choice, this motivating factor to install these systems facilitates a CV environment. A CV environment could subsequently affect mode choice and ground access by accelerating CV/AV implementation, thereby offering airport agencies the systems needed to manage on-campus congestion, operations, and safety.

Automated Electric Vertical Takeoff and Landing Aircraft

After Uber released its vision for a future of on-demand urban air transportation in 2016, there has been a resurgence of interest in developing “flying cars,” specifically in the form of eVTOL aircraft.[75] Uber’s “Elevate” team envisions providing a network of small, automated eVTOLs that offer on-demand urban air mobility service via app, transporting customers between designated areas around the city at prices equivalent to their existing UberX service. In 2019, Uber Copter began offering helicopter service to JFK International Airport for $200 to $225 per person. While not an eVTOL aircraft, the service represents the

[74] US Department of Transportation, “Preparing for the Future of Transportation: Automated Vehicles 3.0.” September 12, 2017, https://www.transportation.gov/sites/dot.gov/files/docs/policy-initiatives/automated-vehicles/320711/preparing-future-transportation-automated-vehicle-30.pdf. (accessed September 13, 2019).
[75] Uber Elevate, “Fast-Forwarding to a Future of On-Demand Urban Air Transportation.” Uber, October 27, 2016, https://www.uber.com/elevate.pdf. (accessed September 13, 2019).

entrance of a ride app into the growing on-demand urban air transportation market.[76]

That said, automated eVTOL aircraft are still in the exploratory stages of development, and it is unlikely that the technology, regulatory, and infrastructure hurdles can be overcome in time to meet Uber's aggressive schedule. Although the battery technology required for eVTOL is a long way away,[77] many believe that regulation and economics will be an even larger hurdle. In terms of distance, Boston's downtown business district is only two miles away from the Airport, and taking access and flight times into account, journey by air may not offer a significant time advantage for many trips. Competitive commercial airports are not far away, including T.F. Green Airport (60 miles by highway) and Manchester-Boston Regional Airport (54 miles by highway).

Remote Baggage Drop-Off and Check-In

Remote baggage drop-off and check-in is an emerging technology that can save airport travelers a significant amount of time on their trip to the terminal. In most implementations, it allows passengers to print their luggage tags and boarding passes using a multiairline kiosk. In some cases, it can also eliminate the nuisance of carrying bags long distances within a terminal or waiting in line. These services can also be strategically located to serve specific ground access modes. Current implementations have located these services in areas like rental car facilities, shuttle lots, transit stations, and curbside at the terminal. Locating them in conjunction with a specific ground access mode may act to make that mode a more attractive option for users. For airports with terminal space constraints, remote drop-off and check-in services offer the potential to shift more of their baggage processing off site, reducing pressure on their constrained infrastructure.

At this stage, the technology is driven mainly by airports that are seeking new and creative ways to improve the customer experience as they face capacity concerns on site, and these services remain relatively small. Bags, a provider of remote bag-drop services, is currently working with Delta Air Lines at eight domestic airports and United Airlines at five domestic airports. However, not all attempts at remote baggage drop-off have been successful. For instance, remote

[76] Darrell Etherington, "Uber Copter offers on-demand JFK helicopter service for top-tier users," *TechCrunch*. June 6, 2019, https://techcrunch.com/2019/06/06/uber-copter-offers-on-demand-jfk-helicopter-service-for-top-tier-users/. (accessed September 13, 2019).
[77] Eric Adams, "The age of electric aviation is just 30 years away," *Wired.* May 31, 2017, https://www.wired.com/2017/05/electric-airplanes-2/. (accessed September 13, 2019).

baggage drop-off and check-in were offered at one point at Phoenix Sky Harbor International Airport and Heathrow Express, but these services were discontinued due to lack of demand and economic viability.[78]

Ground Transportation Management Systems

As new technologies continue to promote the growth of mobility-on-demand (MOD) services, effectively managing their access to the curbside would likely become increasingly critical to prevent congestion on Airport access roads. To mitigate current concerns and prepare for the future, many airports are installing ground transportation management systems that allow them to track app-based MOD service providers as they travel throughout the airport premises. Systems have been installed at airports that use a Web API (application programming interface) to monitor and collect information on ride app trips to and from the airport. Collected information includes the ride app ID, driver ID, trip ID, location, timestamp, type of event (e.g., airport entry, pickup, drop-off, airport exit), and the number of passengers (as reported by the driver). Airports can use these systems to their benefit by adopting policies and integrating systems that charge ride-hailing companies for their time spent on the airport's premises or by charging fees based on the number of passengers in the vehicle.

Parking and Carshare Systems

New parking technologies aim to make off-street parking facilities more user-friendly for customers and profitable for owners. The core attribute of these modern "smart-parking" systems is wireless in-ground sensors powered by long-life batteries. These systems use infrared and magnetic technology to detect vehicles. Owners of the parking facility can utilize data from parking sensors to set prices based on real-time demand, streamline payment and enforcement, and reduce parking management costs. Historical data from these parking systems can also be used to develop booking platforms that offer discounts based on the time of arrival, as at Adelaide airport in Australia.

Another emerging technology in the parking industry is combining parking services with carshare services, especially near airport facilities. By combining both services, these companies (such as TravelCar) can offer low-cost mobility options for both users parking at the airport and users seeking to rent a vehicle. These services typically work by allowing a traveler to list their vehicle on the company's website/mobile app ahead of their flight. The app then matches it with

[78] Amy Lipkin, "When Being Separated From Your Luggage Is a Good Thing," *The New York Times*. September 18, 2019, https://www.nytimes.com/2018/09/17/business/luggage-travel-airports.html. (accessed September 13, 2019).

a separate user seeking to rent a vehicle during the period they are away. In return, the user gets free parking at the facility and a commission based on how many miles their vehicle was rented for.

Security Technologies

Security checkpoints are typically the most unpredictable aspect of a customer's trip to the gate and a source of stress or anxiety for many travelers. As a result, customers typically desire that the remaining stages of their trip be highly reliable and predictable. Emerging technologies are expediting the security process by enabling systems that can screen multiple airport passengers at once. The Transportation Security Administration (TSA) is testing a new technology known as "passive terahertz" screening that can conduct a full-body screening of passengers as they walk through a checkpoint without slowing down.[79] Passive terahertz technology has already been implemented by security agencies to scan passengers in transit stations.

Another technology set to speed up the security process is biometrics technology. In September 2018, TSA released a plan to guide its biometric efforts to modernize aviation passenger identity verification in the coming years.[80] The TSA has started testing and using facial recognition and fingerprint technology to verify passengers' identity in a handful of US airports.[81] Faster and smoother security processing may have small second-order effects on access mode choice by reducing the access time "budget" travelers need to allow themselves, particularly due to the uncertainty associated with the overall check-in process. That may make air travelers willing to accept some additional uncertainty or transfer time in an airport ground access trip.

[79] Hugo Martin, "TSA gives green light to test new technology that can screen passengers from 25 feet away," *Los Angeles Times*. November 2, 2018, https://www.latimes.com/business/la-fi-travel-briefcase-tsa-screening-technology-20181101-story.html. (accessed September 13, 2019).
[80] Transportation Security Administration, "TSA Biometrics Roadmap for Aviation Security & the Passenger Experience." September 2018, https://www.tsa.gov/sites/default/files/tsa_biometrics_roadmap.pdf. (accessed September 13, 2019).
[81] Dami Lee, "TSA lays out plans to use facial recognition for domestic flights," The Verge. October 15, 2018, https://www.theverge.com/2018/10/15/17979688/tsa-precheck-facial-recognition-airport-cbp-biometric-exit. (accessed September 13, 2019).

Scenario Analysis

Approach and Objectives

This section presents a scenario analysis describing the potential effects from the technologies profiled in Study #1 on the Airport's ground access. It describes the approach and objectives in undertaking the analysis, defines a discrete set of scenarios for analysis, and provides a qualitative assessment of the potential effects of each scenario on ground access volumes, mode shares, and Massport's finances.

This scenario analysis is intended as a high-level, critical-thinking exercise to provide a preliminary indication as to whether certain technologies, if realized, present the potential to have a material effect on ground access at the Airport (or, conversely, whether certain technologies might not matter under any foreseeable circumstances). It is neither a modeling exercise nor a forecast, but rather a preliminary qualitative assessment intended to identify concerns warranting further, more detailed analyses.

Each scenario is based on key assumptions about the nature and extent of future technological deployment. For the assumed future state comprising each scenario, the analysis provides an assessment of the following:

- How it might occur.
- What it might look like.
- Likely consequences for ground access.

This understanding of the potential roadmap to each future technology state, and the likely implications for the Airport's ground access characteristics, informs a qualitative assessment of the possible effects on ground access mode shares.

Scenario Definitions

This analysis defines five scenarios, each reflecting different key assumptions about the future state of the ground access environment at the Airport. High-level scenario descriptions are provided in Table 50.

TABLE 50: SCENARIO DESCRIPTIONS

NO.	SCENARIO	DESCRIPTION
1	Rapid Technology Adoption	Most optimistic forecasts of ride app growth, AV penetration, and decline in personal auto ownership are realized
2	Advanced Shared-Ride Services	Significant application of both ground-based and airborne AV technology targeted at improving access to the Airport
3	Improved Internal Logistics/Circulation	Advent of Automated People Mover (APM) along with on-demand/high-frequency automated shuttles for internal circulation
4	Increased Single-Occupancy Vehicle (SOV)	Limited technology improvements coupled with higher-than-expected growth in share of SOV drive-and-park access
5	Business as Usual	Limited technological advancement in the near- to medium-term timeframe

Source: RSG

Each of the scenarios reflects assumptions about the nature and extent of the further development and application of some technology or combination of the technologies described in the Landscape of Emerging Technologies section of this appendix. Specifically, assumptions about key relevant characteristics, including the following, helped to define scenarios:

- Specific technology or technologies involved.
- Stage/maturity of technology development.
- Access modes affected.
- Nature and extent of application in Boston and at the Airport.
- Assumptions about underlying secular trends.

These characteristics inform further assumptions about the following parameters and metrics:

- Level-of-service (LOS) characteristics (e.g., travel times, costs, service frequency).
- Quality-of-service characteristics (e.g., reliability, comfort).
- Ground access mode shares (where applicable).

Scenario Analysis

Table 51 summarizes the results of the scenario analysis. The results indicate that considerable shifts in HOV ground access mode shares are unlikely to result from the advent and deployment of the emerging technologies described in the Landscape of Emerging Technologies section of this appendix.

TABLE 51: SCENARIO ANALYSIS SUMMARY

NO.	SCENARIO	DESCRIPTION	KEY RESULTS
1	Rapid Technology Adoption	• Optimistic ride app growth • Rapid AV penetration	• Further ride app growth only modestly erodes HOV share (reduced by 2.1% in 2030) • AVs not likely to significantly increase ride app share (additional 1.1% in 2025; 2.3% in 2030) • No material effect from private AVs (less than 1% reduction in drive-and-park, HOV shares)
2	Advanced Shared-Ride Services	• AV access shuttles • Airborne AV shuttles	• Under best-case assumptions ground AV shuttles could carry less than 9% of access trips; eVTOL aircraft could carry less than 7% • More realistic assumptions imply <4% and <2% of trips, respectively • Low capacity of vehicles limits potential effects
3	Improved Internal Logistics/ Circulation	• AV circulator shuttles • Airport APM	• Unlikely to have material effect on ground access mode shares • Modest effect on overall ground access journey; no effect on HOV modes dropping off at curbs • Elimination of transfer (“one-seat ride”) likely necessary for material effect
4	Increased SOV	• Higher SOV drive-and-park access share	• Increasing drive-and-park share to 2007 level (+4 points) would reduce HOV share about 1.5 points from 2016 level • Large increases in SOV share would be required to offset the positive trend in HOV share gains
5	Business as Usual	• Limited technology advancement	• Air passenger growth and demographic trends continue to drive parking demand upward

Source: RSG

These results indicate that the emerging technologies considered within the timeframe of this analysis would affect only a modest portion of the current ground access volume serving the Airport, produce only marginal effects in overall ground access LOS characteristics, or both.

Even optimistic assumptions about the penetration of AV technologies suggest that they would comprise only a modest percentage of the private vehicle or ride app fleets even as far out as 2030. This result suggests that the introduction of AVs into ride app fleets would produce a modest overall average price reduction for ride app services.

The automated shared vehicle operations contemplated here (microtransit shuttles and eVTOL aircraft) are of limited capacity. In practice, they would not be able to carry a significant portion of ground access trips even under optimistic assumptions about their operating performance. Furthermore, the potential improvements to internal circulation from on-campus AV microtransit shuttles would not affect the several prominent HOV modes that provide direct service to terminal curbs from outside the Airport.

Finally, although the *share* of ground access passengers driving and parking at the Airport has been declining, further air travel growth and demographic trends (e.g., more trip ends beyond the service area of HOV modes) would continue to increase the overall demand for parking. However, because drive-and-park (and SOV ground access trips generally) represents only a portion of all ground access trips, only a significant increase in the share of air passengers driving and parking would reverse the positive gains in HOV share made over the last decade.

Strategic Considerations

This section discusses the strategic implications of the technology-related scenario analysis. It describes how the emergence of new technologies might affect Massport's future planning needs, identifies potential financial risks and opportunities for Massport from the potential disruptive effect of these technologies, and gives Massport actionable recommendations.

Future Planning Needs

At a high level, all the emerging technologies described have at least one thing in common: there is significant *uncertainty* as to when and to what extent they would ultimately affect ground access at the Airport. This is the nature of

disruptive technologies—they are only recognized as disruptive once they have had a significant effect, and that effect comes quickly and without warning.[82]

This inherent uncertainty, although not unique to disruptive technologies, has important implications for Massport's planning process. It suggests an approach to planning that is at once *dynamic*—able to adapt to rapidly changing conditions—and *flexible*—able to accommodate significant unanticipated shifts in the demands on the Airport's limited infrastructure. Just as terminals have evolved to incorporate multiuse gates, the Airport would need to plan for more "adaptive reuse" of its landside terminal infrastructure.

More specifically, the Scenario Analysis section of this appendix suggests three key areas in which it would be especially important to accommodate this increased uncertainty with a dynamic and flexible approach:

- Future ride app growth.
- Advent of AVs.
- APM planning.

Ride App Growth

Ride apps have demonstrated the effect of disruptive technology, going from zero in 2013 to more than a 14 percent mode share in 2016, and to about one-fourth of all ground access trips at the Airport at present. Massport has already had to make significant investments to reconfigure its limited infrastructure to accommodate this rapid growth and change. Further ride app growth would require more such changes.

Ride app operators represent a potentially important partner in realizing Massport's ambitious goals for further HOV share growth going forward. Specifically, Massport can plan for the closer integration of ride apps in the achievement of its HOV share goals and can develop innovative methods to further grow the number of shared rides using ride app modes. At the same time, Massport would need to plan for managing the number of ride app vehicles accessing the Airport, including the processing of arriving and departing ride app ground access passengers, and the management of limited pickup or curb space at the terminals.

[82] As one well-known example, Apple's iPhone grew to represent one-third of all smartphones sold in the world just five years after its launch. Prior to that, the company did not make phones.

At its April 2019 Board meeting, Massport began setting new policies to deal with the strategic challenges caused by ride apps and their rapid growth, which is affecting Airport operations, congestion, and revenues. Massport approved the following new ride app policies that will be implemented in the fall of 2019:

- Ride app solo passenger pickup and drop-off fees of $3.25 (previously pickup was $3.25 and drop-off was not charged).
- Any shared-ride ride app trips get a $1.50 charge on both pickup and drop-off (previously pickup was $3.25 and drop-off was not charged).
- All ride app pickups will be directed to Central Parking only. Drop-offs will only be allowed at terminal curbs between 4:00 a.m. and 10:00 a.m., otherwise drop-offs must also go to Central Parking.
- Baggage-checking services will be available at the Central Garage.

Automated Vehicles

The scenario analysis suggests that AVs are unlikely to have a major effect on ground access mode shares in the near term. At the same time, however, AVs will be part of Boston's transportation future and used in one form or another for ground access at the Airport. Massport will need to plan for them, incorporating their applications, operating characteristics, eventual demand patterns, and the like.

Moreover, AVs may ultimately be deployed in a wide range of applications, from private vehicles to ride apps to higher capacity shuttles—or even aircraft. As such, they have the potential to affect ground access mode shares, demand for curb space, and the utilization of parking facilities, among other factors. While there remains significant uncertainty about exactly when and to what extent these vehicles would ultimately be used at the Airport, adaptation and management would be easier if Massport begins planning for them now.

Automated People Mover Planning

Massport is undertaking a feasibility study to better understand the potential implications of implementing a landside APM. Although the scenario analysis suggests that the APM would not be a universal panacea for significantly increasing transit mode share for ground access, an APM may nevertheless have important implications for ground access. Many details remain to be worked out, but it appears at least from the initial concept for the system that the project may include the construction of a new centralized transportation facility (CTF) at its southern terminus. The CTF might serve as a central transfer point for several

ground access modes, with the APM replacing the shuttle buses in transporting passengers to their respective terminals.

For certain passengers, an “internal” APM (i.e., one connecting only Airport-related points) may represent a marked improvement over the existing shuttle buses, most notably those currently traveling from the Massachusetts Bay Transportation Authority Blue Line station to Terminal E. At the same time, ground access modes that currently drop passengers off directly at the terminals, if rerouted to drop off at the CTF, could see significant deterioration of their ground access LOS (they would incur both additional travel time and an additional transfer). As such, decisions about the planning of the APM might have more far-reaching implications for ground access to the extent that a relocation of certain modes to the CTF is contemplated.

It is unclear whether relocation of ride app drop-off (or pickup) to the CTF is being contemplated. In any case, the planning for the APM should assess both the ground access mode share implications of any such relocation and incorporate the need to flexibly adapt the APM/CTF infrastructure to potential technology-induced changes in the Airport’s ground access going forward.

Potential Risks and Opportunities

The emerging technologies scenario analysis suggests that the technologies assessed here are not likely to be major disruptors to the Airport’s ground access composition in the near term. However, these technologies could affect the level and quality of ground access service to the Airport. They may yet have some effect on ground access mode shares and—by implication—the achievement of Massport’s important environmental goals. As such, these technologies represent both strategic risks and valuable opportunities. Specifically, these risks and opportunities include the following:

- **Continued ride app growth**. Further growth in ride app trips could exacerbate Airport roadway congestion, contribute to the region’s road congestion generally, siphon parking revenues, place further burden on the Airport’s limited infrastructure, or erode the Airport’s HOV share.
- **Reduced parking revenue/utilization**. Further ride app growth, the advent of AVs, carsharing, and new mobility options could dampen parking demand, and significant shifts could threaten this important source of revenue, representing a financial risk to Massport. New parking pricing strategies could mitigate this risk and help maximize revenue and optimize parking capacity utilization.

- **Impairment of environmental goals**. Growth in SOV trips, or the diversion of trips from HOVs by modes enabled by new technologies, could slow or reverse the progress made in the last decade, making it difficult for Massport to achieve its commitments to higher HOV mode share.

At the same time, inherent in these potential challenges are ways forward in which Massport might proactively engage this rapidly evolving technological environment for the benefit of its stakeholders and in furtherance of its public policy goals. Specifically, the following strategic opportunities may emerge from this new technology landscape:

- **Leverage ride app for HOV growth**. A larger base of ride app use would serve as a potentially effective lever in bolstering HOV share through rides shared by travel parties of more than one person.
- **Proactively shape the environment for AVs**. Through strategic, targeted, and early-stage testing of AVs at the Airport, and through the flexible adaptive reuse of its limited infrastructure, Massport could proactively shape the environment for their more widespread deployment in the future, allowing Massport to more directly steer their adoption toward HOV-enhancing applications.
- **Advance Massport's role in environmental stewardship**. The emerging technologies discussed here generally use all-electric (or, in some cases, hybrid-electric) vehicles. Further development and strategic deployment of these vehicles could help advance Massport's important role in environmental stewardship for the Boston metropolitan area and the state.