



# Minute Man National Historical Park: *Feasibility Study for Town-Led Shuttle Service*



North Bridge Source: NPS/P.Lupsiewicz. North Bridge Lot Source: NPS/K. Kavanagh. Minute Man Visitor Center Source: NPS



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## Report notes

The U.S. Department of Transportation John A. Volpe National Transportation Systems Center (Volpe Center) in Cambridge, Massachusetts prepared this report. Andrew Breck, of the Energy Analysis and Sustainability Division, led the project team, which included Drew Quinton, Heather Richardson, Melissa Frankil, and Rahi Patel of the Transportation Planning Division, and Gretchen Reese of the Energy Analysis and Sustainability Division. This effort is part of the 2018 Interagency Agreement between the National Park Service (NPS) and the Volpe Center (NPS agreement P18PG00356).



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## Definitions

The following terms appear in this report:

AA DT	Average <u>Annual</u> Daily Traffic (different from ADT, below).
AASHTO	American Association of State Highway Transportation Officials
ADT	Average Daily Traffic (distinct from AADT; not an annual average)
API	Application Program Interface
ATM	Automated Teller Machine
AVL	Automatic Vehicle Locator
CAD	Computer Assisted Dispatch
CCR TA	Cape Cod Regional Transit Authority
CLRP	Comprehensive Long Range Plan
COVID-19	Novel Coronavirus of 2019
DOT	Department of Transportation
E-W	East-West
FHWA	Federal Highway Administration
FLAP	Federal Lands Access Program
FTA	Federal Transit Administration
GPS	Global Positioning System
GTFS	General Transit Feed Specification
Headway	Average time between vehicles traveling the same direction on a route
LOS	Level of Service
MassDOT	Massachusetts Department of Transportation
MBTA	Massachusetts Bay Transportation Authority
MIMA	Minute Man National Historical Park
MPO	Metropolitan Planning Organization
NPS	National Park Service
N-S	North-South
PUSO	NPS Public Use Statistics Office
Relative Ridership	Ridership as a percent of overall relevant visitation
RFI	Request for Information
RFTA	Roaring Fork Transportation Authority
WMATA	Washington Metropolitan Area Transit Authority
WOTR	Wolf Trap National Park
USFS	United States Forest Service
YARTS	Yosemite Area Regional Transportation System



## Executive Summary

This report summarizes a study that assessed the feasibility of a proposed town-led shuttle service that would connect cultural and recreational points of interest and community resources in the towns of Lexington, Lincoln, and Concord, and in the Minute Man National Historic Park (MIMA). It is not a detailed plan and will not result in a decision or project without further planning and organization among stakeholders. As stakeholders move forward toward implementation, other analyses will be necessary, such as service planning. Notably, the novel coronavirus of 2019 (COVID-19) pandemic occurred during the study, impacting conditions during the analysis, and also potentially resulting in longer-term changes that may impact the assumptions of this study. It was not within the scope of this study to predict conditions and changes post-pandemic, but the study does identify key areas to reassess post-pandemic, such as ridership assumptions and traffic conditions.

The specific objectives of the study were to:

- Understand current conditions in the study area and goals for a shuttle service;
- Provide transit scenarios that illustrate options and tradeoffs; and,
- Identify possible business models.

The study and this associated report resulted from a collaborative planning effort with substantial engagement and partnership between the three towns, the National Park Service (NPS), and Volpe, the National Transportation Systems Center, of the U.S. Department of Transportation. The primary findings are immediately below, and the full report analysis follows.

### *Current Conditions*

#### Study Area

- Population, development, and associated traffic congestion have all increased in the three towns in recent years.
- The Minute Man National Historical Park (MIMA) is a seven-mile long linear park situated between the three towns that attracts more than one million visitors a year.
- Visitation to the study area may increase substantially around 2025, the 250<sup>th</sup> anniversary of “the shot heard round the world.”

#### Goals for the Shuttle Service

- According to stakeholders, the primary goal is to improve resident and visitor access to recreational and cultural points of interest within the three towns and Minute Man National Historical Park.
  - Primary objectives are to improve visitor experience, spur economic development, and alleviate traffic and parking congestion.
- Figure 2 depicts points of interest that stakeholders identified as desired shuttle stops.

#### Multimodal Access

- Only a few of the proposed sites are within a short walking distance of an existing transit stop. Additionally, the schedules of existing transit services are not optimal for recreational or tourism travel, which tends to be outside of rush hours and on weekends.

- *Rail*: Lincoln and Concord have Massachusetts Bay Transportation Authority (MBTA) commuter rail stations.
- *Bus*: Lexington has Lexpress and MBTA bus routes. The 62/76 MBTA bus route also serves a small portion of northeastern Lincoln, adjacent to MIMA. This bus does not operate on Sundays, a major day of the week for visitation at MIMA.
- *Bicycling*: Many of the bicycle routes connecting the sites are only realistically accessible by experienced cyclists comfortable with high-stress routes.
- *Walking*: There are walking connections between many sites. There are also opportunities to improve walking connections through safer crossings, etc.
- *Other*: Lexington has historically offered a seasonal guided tour on a trolley, called the Liberty Ride. This has mainly functioned as a recreational attraction rather than a transit system, as riders can only disembark at the North Bridge.

### Visitation

- Visitation varies, with the most popular sites drawing over one hundred thousand visitors per year and less frequented sites drawing a few thousand per year.
- Visitation to MIMA exceeds the other sites, reliably drawing about one million visitors per year across all MIMA sites.
- Almost all sites have peak visitation from April to October, with significantly less visitation in the remaining months. Some sites close during the winter months.
- Most sites report higher visitation on weekends than on weekdays. While some sites are open consistently seven days a week, others are open for longer hours on the weekends and/or may close on certain weekdays.
- Table 1 provides further detail on visitation to the sites in the study area.

### Parking and Access

- The majority of visitors to all sites arrive by private motor vehicle.
- Many sites report parking constraints at certain times, such as the North Bridge Visitor Center, while a few sites, such as the deCordova Museum, indicated that they often have excess parking.
- Sites vary in their capacity to accommodate a large transit vehicle.
- Table 2 and Table 3 describe parking details.

### Traffic

- Route 2A, which borders most of the Battle Road Unit, has a heavy traffic flow especially during morning and evening commute hours, which negatively affects the visitor experience at MIMA.
- The surrounding three towns of Concord, Lincoln, and Lexington have seen recent development and growth leading to heavier traffic volumes.

### Previous Studies

- MIMA attempted a few shuttle pilots in the late 1970s and early 1980s.
- MassDOT awarded CrossTown Connect a \$160,000 Workforce Transportation Grant in February of 2020 to fund the Concord Shuttle. This project is on hold due to the global novel coronavirus of 2019 (COVID-19) pandemic.
- Lexington was a part of the Tri-Town Transit Study aimed at improving MBTA, Lexpress, and other municipal transit services; the study did not focus on visitor access to cultural/historic/recreational destinations.



## Transit Scenarios

### Common to All Scenarios

- Based on stakeholder input and visitation patterns, the shuttle would ideally operate between 9:30 AM and 4:30 PM from April – October as a “hop-on, hop-off” service with an interpretive component.
- One proposed route runs east west between Concord and Lexington. The other route runs north south from the Minute Man Visitor Center to points of interest in Lincoln.
- The three scenarios use different approaches for balancing a tradeoff: coverage versus frequency. Stopping at more locations increases coverage by reducing walking distances; however, this also increases travel times and resulting headways.
- Table 6 provides details of the costs associated with each scenario such as interpretation costs and vehicle costs.
- The estimated headways are rough approximations, based solely on drive time and dwell time, absent any significant traffic.
- Some points of interest are so close together that they are “clustered” into one stop in order to provide an efficient shuttle service.
- This study estimates ridership for the shuttle scenarios based on a review of ridership data from peer shuttle services (other NPS transit services that provide “mobility to or within the park,” as well as the Liberty Ride). Ridership is likely to be between 0.5 to 2.5 percent of visitation to the sites along the route.

### Scenario 1: All Stops

- This scenario stops at the greatest number of locations, minimizing the amount of walking a user would have to do to access the nearby points of interest.
- The only point of interest this scenario does not explicitly stop at is the Hancock-Clarke House, which is 0.4 mile from the nearest shuttle stop. All other points of interest are 0.1 mile or less from a shuttle stop.

### Scenario 2: Fewer Stops

- This scenario stops at fewer locations. This means users need to walk more to access the nearby points of interest from the designated stops. Fewer stops also means greater frequency of the shuttle, potentially reducing the needed number of vehicles thus reducing costs and/or improving service.
- All points of interest are within 0.5 mile of a stop.
- *At the stakeholder meeting on December 14, 2020, the three towns and MIMA determined their preferred scenario is Scenario 2 with two vehicles dedicated to the E-W route and two vehicles dedicated to the N-S route.*

### Scenario 3: Flexibility

- This scenario is an attempt to maintain high frequency and high coverage at the same time by providing 8 stops by default and an additional 11 upon request.
- This scenario requires an automated vehicle locator (AVL) system that communicates with a user-friendly app, which users could use to request stops.

## *Business Model Options*

NPS has a few different operational models for shuttle service to and within parks. MIMA does not have the staff or financial capacity to operate its own service or manage contracts or agreements, so the only feasible options for this proposed service would be a commercial use authorization or special use permit to one or all towns, depending on how they coordinate (see Table 24). The towns would contract with an experienced operator using their agreed upon contracting mechanism and manage the service.

## *Next Steps*

Stakeholders will continue meeting to refine the assumptions of this study and attain more certainty on details regarding funding and operation of the service. This would involve decisions and additional work on items such as:

- Fare (whether to charge and how much);
- High and low cost items in the report's cost estimate tables (which to pursue);
- Funding sources (how the service would be funded); and
- Post-pandemic outlook (how conditions will rebound after the COVID-19 pandemic, and how changing circumstances may impact the viability of a service).

Stakeholders from the towns and MIMA will collaboratively determine subsequent next steps and timeline, keeping in mind key questions in the Business Models section. The towns may choose to run a pilot with existing resources, or may develop a request for information (RFI) to gauge whether any private or public transit service operators are interested in operating the service in whole or part.



## Introduction

### *Project Purpose*

This report assesses the feasibility of implementing a transit service connecting the Minute Man National Historical Park (MIMA) and other sites of interest in the towns of Lexington, Concord, and Lincoln in Massachusetts. This report provides details about the feasibility of implementing a service based on visitation, projected demand, anticipated requirements, estimated costs, and other factors. The goal is to provide the towns and NPS with information to inform future decisions about a possible joint transit service. The novel coronavirus of 2019 (COVID-19) pandemic was ongoing during this study and it will likely delay implementation of a service. Most of the information in this analysis would still be applicable a year or two hence. However, travel times and costs would likely change and would be key information to revisit and update.

### *Methodology and Report Organization*

The project team conducted this analysis using the following steps. First, the team received input from stakeholders in the towns of Concord, Lexington, Lincoln, and the Minute Man National Historical Park. Then the team collected visitation and parking data with the assistance of stakeholders, and gathered and reviewed other sources of information, such as prior studies.

This study contains the following sections:

- **Current Conditions** describes the regional context, site visitation patterns, parking and site layout, traffic, multimodal access, and previous studies.
- **Transit Scenarios** describes some possible transit scenarios and supporting context.
- **Business Model Options** describes relevant NPS operational models for shuttle service to and within parks.
- **Next Steps** discusses possible follow-on activities, based on stakeholder discussions to date.

## Current Conditions

### *Overview of the Study Area*

Concord, Lexington, and Lincoln, Massachusetts are each rich in cultural and natural history, with many recreational destinations for residents and visitors, such as historical homes and landscapes, museums, and greenspaces. While they share much in common, they also differ; Lexington is the closest to Boston, about 10 miles, as the crow flies, from downtown, and the most densely populated, at almost 2,000 residents per square mile. Concord, in contrast, has 710 residents per square mile, and Lincoln is the most rural, at 444 residents per square mile.<sup>1</sup> The populations of Concord, Lexington and Lincoln have been increasing. From 2010 to 2019, Concord's population went from 17,660 to 18,918 (7 percent increase), while Lexington's population grew from 31,406 to 33,132 (6 percent increase) in the same period. Lincoln's population increased from 6,371 in 2010 to 7,052 in 2017, which is a growth of about 10 percent.<sup>2</sup> Overall, the region has developed from a

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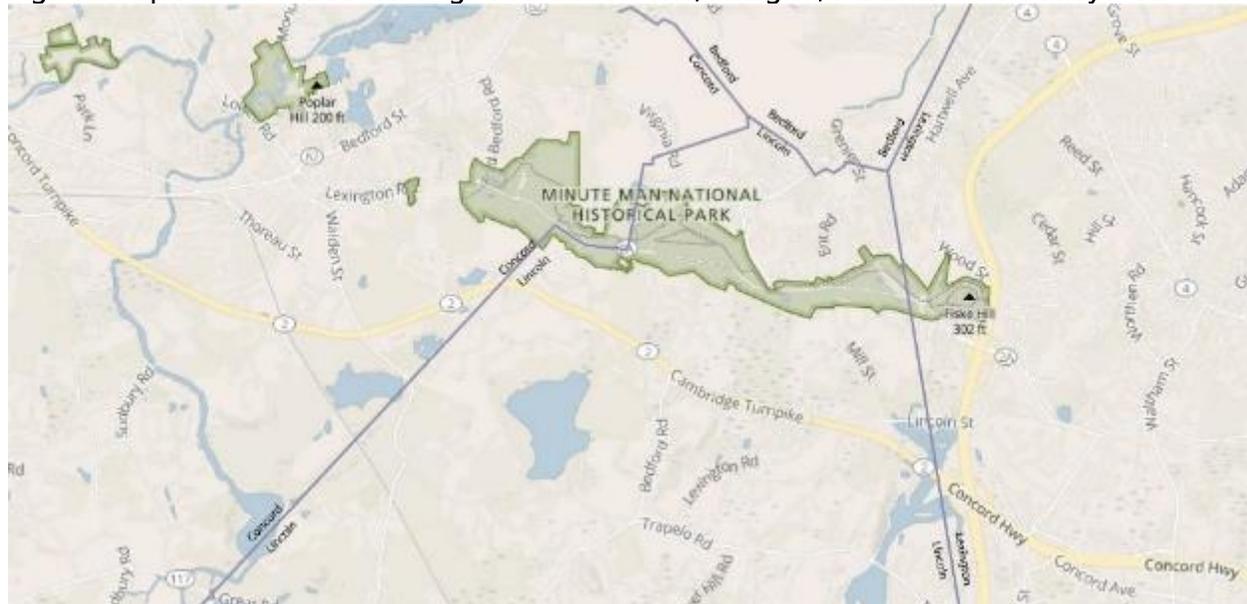
<sup>1</sup> Based on 2010 census.

<sup>2</sup> (United States Census Bureau 2019)

semi-rural area to mature suburbs, but in many places retains a rural character, as one component of its heritage. At the same time, the area experiences continual growth pressures, as evidenced by population growth. While all three communities are primarily residential, there is also a burgeoning commercial and industrial presence, especially in Lexington.

Figure 1 shows MIMA, a seven-mile-long, linear park spanning all three towns that attracts more than one million visitors each year. Public law (P.L.) 86-321 established the park in 1959. After completion of the 1991 General Management Plan, P.L. 102-488 (1992) broadened the park's strategic mission and expanded the park boundary, especially along the Battle Road. P.L. 111- 11 (2009) expanded the park boundary to incorporate Barrett's Farm, the home of the 1775 commander of the Middlesex Militia, Colonel James Barrett. Comprising 1,038 acres, the park preserves historical sites, structures, properties, and landscapes associated with the opening battles of the American Revolution, which occurred April 19, 1775. It also preserves resources related to America's literary tradition, such as The Wayside, home to three families of American authors.

Figure 1: Map of MIMA and Surrounding Portions of Concord, Lexington, and Lincoln in the Study Area



Source: NPS Park Tiles

Tourism and recreation are important components of economic development and quality of life for the three towns. Concord's comprehensive long-range plan (CLRP) from 2018, "Envision Concord: Bridge to 2030," notes that many of the businesses in Concord's three vibrant commercial centers rely on tourism and visitor spending to remain viable.<sup>3</sup> Lincoln's CLRP, published in 2009, places a special emphasis on agro-tourism.<sup>4</sup> Lexington is in the midst of its next CLRP update, as of 2020; recent presentations describe the visitor-based economy as an important and growing sector. A significant component of Lexington's visitation is from destinations outside of Massachusetts. For example, the Lexington Visitor

<sup>3</sup> (Concord Comprehensive Long Range Plan Committee 2018).

<sup>4</sup> (Community Opportunities Group, Inc. 2009).



Center has an annual average of 120,000 visitors, and 110,000 of these come from outside the state.<sup>5</sup>

For each town, traffic and parking demand are increasing, and, while private automobiles are the predominant mode of transportation in all three towns, more transportation options would improve mobility. Concord's CLRP anticipates future trends of increased congestion and increased demand for parking within the village centers. Its transportation goals center on enhancing multimodal access while reducing parking demand and motor vehicle traffic volumes. Lincoln's CLRP is consistent with Concord's plan. Lexington's CLRP update is still in progress; the 2003 update also focused on these themes.

### *Goals for Shuttle Service and Requested Stops*

The primary goal for a potential shuttle service would be to improve resident and visitor access to recreational and cultural points of interest within the three towns and Minute Man National Historical Park. Primary objectives are to improve visitor experience, spur economic development, and alleviate traffic and parking congestion. In particular, a shuttle service could help mitigate congestion associated with an expected sharp increase in visitation leading up to and extending past the year 2025, due to the 250<sup>th</sup> anniversary of the "shot heard round the world," which initiated the first battle in the American Revolutionary War. At the same time, Lexington stakeholders are interested in providing routes and hours of operation that are accessible to the general public; this could mean exploring the viability of extending hours of operation. A shuttle service that purely focuses on cultural, historical, and recreational visitors would likely operate between 9:30 AM and 4:30 PM from April – October. Serving other sites, such as the Minute Man Regional Vocational Technical School, or the Aloft and Element Hotels, would necessitate year-round service and/or a longer day to support commuting and access. Stakeholders from the towns identified a preference for a "hop-on, hop-off" model, and the town of Lexington indicated a preference for an interpretive guided component, at least during core touring hours. Stakeholders from the three towns and MIMA identified the points of interest that a shuttle service would ideally serve. Figure 2 is a map depicting these locations, which also appear below in general west to east order by town:

- Concord Stops
  - Massachusetts Bay Transportation Authority (MBTA) commuter rail station in Concord center
  - North Bridge Visitor Center\*\* (a.k.a. Buttrick Estate)\*\*
  - North Bridge/Old Manse/Robbins House\*\*
  - Concord Visitor Center
  - Concord Museum/Emerson House
  - The Wayside/Orchard House\*\*
  - Meriam's Corner\*\*
  
- Lincoln Stops
  - MBTA commuter rail station in South Lincoln
  - Drumlin Farm
  - Codman Community Farm
  - Codman Estate
  - Gropius House

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<sup>5</sup> (Tintocalis 2020).

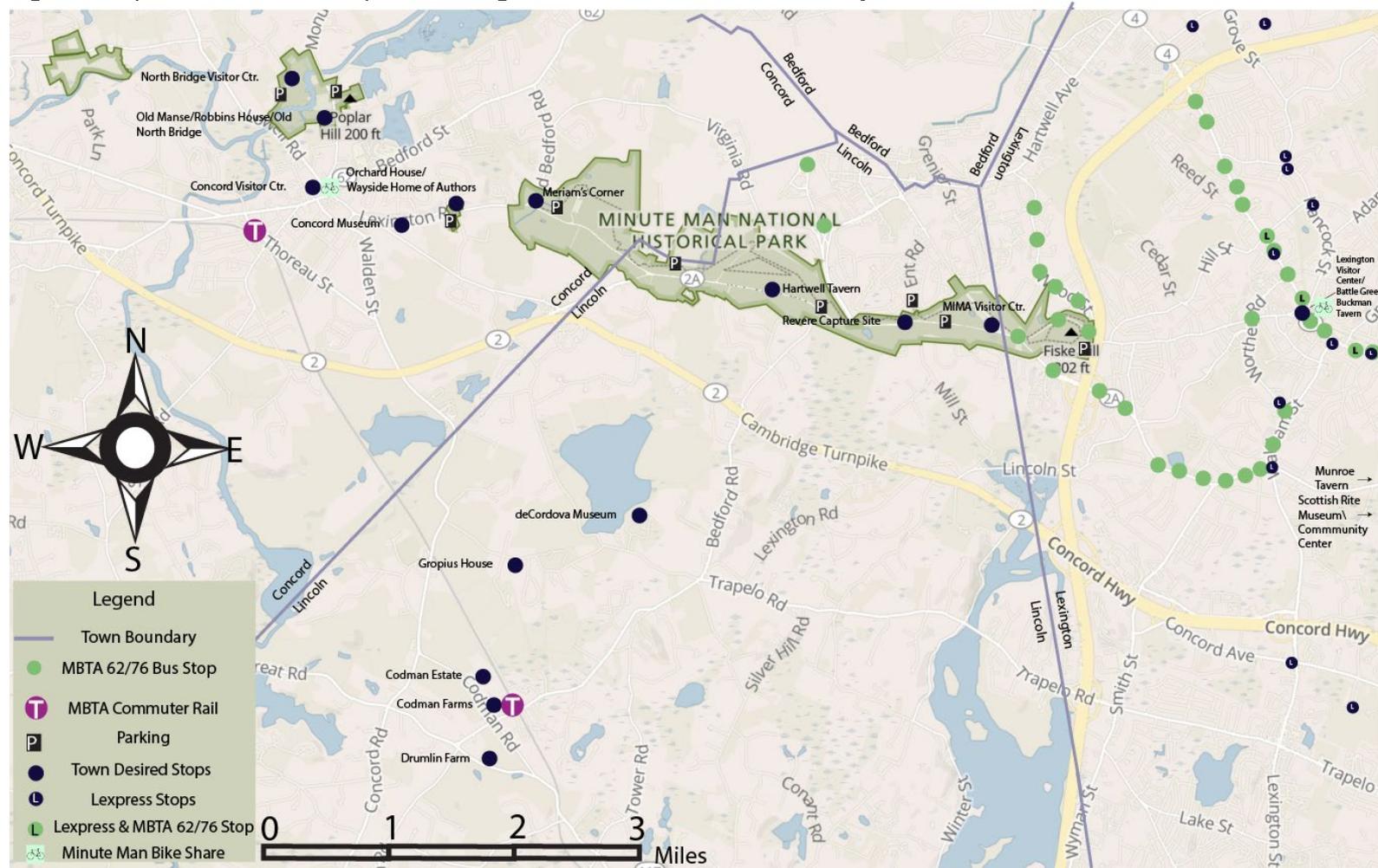
- deCordova Museum
- Hartwell Tavern\*\*
- Paul Revere Capture Site\*\*
- Minute Man Regional Vocational Technical School\*
- Minute Man Visitor Center\*\*
  
- Lexington Stops
  - Aloft and Element Hotels\*
  - Lexington Visitor Center/Battle Green/Buckman Tavern/Hancock-Clarke House
  - MBTA/Lexpress bus connections
  - Munroe Tavern
  - Scottish Rite Museum/ Community Center

\*\*Indicates sites within MIMA park boundaries

\*Possible additional sites to serve, if feasible.



Figure 2: Map of Desired Shuttle Stops and Existing Transit Connections in MIMA Vicinity



Sources: NPS Park Tiles; MBTA; Lexpress: <https://www.lexingtonma.gov/economic-development/pages/minuteman-bike-share>; <https://concordma.gov/2420/Bike-Share-Locations>



## *Multimodal Access*

Although most visitors access the proposed sites via privately owned motor vehicle, alternative modes of transit exist near some sites. This section describes existing multimodal options in the vicinity, further illuminating the context for a possible future shuttle service.

### Summary

All three towns in the study area have modes of transportation that provide alternatives to private motor vehicles, to varying degrees. Lincoln and Concord have MBTA commuter rail stations. The 62/76 MBTA bus route also serves a small portion of northeastern Lincoln, adjacent to MIMA. Lexington has Lexpress and MBTA bus routes and connects to adjacent municipalities via the Minuteman Bikeway. The paved portion of the Minuteman Bikeway ends in Bedford but continues unpaved to Concord Center. There is local concern about paving this segment due to the wetlands it runs through, including the Great Meadows National Wildlife Refuge.

However, only a few of the proposed sites are within a short walking distance of an existing transit stop. Additionally, the schedules of existing transit services are not optimal for recreational or tourism travel, which tends to be outside of rush hours and on weekends. Lexington has also historically offered a seasonal guided tour on a trolley, called the Liberty Ride. The Liberty Ride tours many of the points of interest in the study area, beginning and ending with the Lexington Visitor Center, but riders can only get on and off the trolley at the North Bridge. The Liberty Ride is a recreational attraction, rather than a transit system.

While all sites are connected to a paved road network, and therefore technically accessible by bicycle, many of the routes connecting the sites are only realistically accessible by experienced cyclists comfortable with high-stress routes.

### Bus Connections

Figure 2 in the prior section shows existing MBTA and Lexpress bus stops and MBTA commuter rail stations in relation to the potential stops for a new shuttle service.

Lexington is the only town in the study area that serviced by MBTA buses (with the exception of two stops on the 76 route within the boundaries of Hanscom Air Force Base in Lincoln). Two routes service the study area, the 62 and the 76, and for some segments and schedules, these routes overlap and act as one route. Lexpress is a public bus service operated by the town of Lexington. Of these two services, only the MBTA bus routes connect to the MBTA light rail system, at Alewife Station on the Red Line.

Research shows that most people are willing to walk 0.25 to 0.5 miles to access transit.<sup>6</sup> Identified points of interest located within that distance of an existing bus stop include:

- Lexington Visitor Center/ Battle Green/ Buckman Tavern/ Hancock-Clarke House;
- Munroe Tavern;

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<sup>6</sup> (Federal Highway Administration 2013)



- Scottish Rite Museum and Community Center;
- Minute Man Visitor Center (connection is not easy or intuitive);
- Minute Man Regional Vocational Technical School (connection is not easy or intuitive); and
- Aloft and Element Hotels.

In fact, the above sites are located within 0.1 miles of a bus route. All other identified sites are further than one mile from the nearest existing bus stop.

Lexpress does not operate on weekends, which is the time of highest visitation for almost all sites, and the MBTA 62/76 route does not operate on Sundays. Sites are not accessible by bus at all on Sundays.

### Rail Connections

The towns of both Concord and Lincoln have MBTA commuter rail stations. As mentioned, most people will walk 0.25 to 0.5 miles to access transit; however, this distance increases “considerably” when people are walking to heavy rail stations (e.g. the commuter rail).<sup>7</sup>

Two sites are located within a 0.5-mile walk of an existing commuter rail stop: one in Concord and one in Lincoln: Concord Visitor Center and Codman Community Farm, respectively.

The 0.5-mile walk from the Concord commuter rail station to the Concord Visitor Center provides a paved sidewalk for the entire distance as well as marked crosswalks at every intersection.

In Lincoln, two identified points of interest are just beyond the 0.5-mile threshold. The Codman Estate and Codman Farm are each a 0.6-mile walk from the Lincoln commuter rail station. Drumlin Farm is 0.8 miles from the Lincoln commuter rail station. Pedestrians walking from the Lincoln commuter rail station to any of the points of interest in Lincoln need to walk along Lincoln Road, Codman Road, and/or South Great Road. The route to Drumlin Farm has a paved walking path and a newly constructed pedestrian island with a flashing amber light to assist in crossing South Great Road. Pedestrian facilities do not extend all the way from the Lincoln commuter rail station to Codman Farm or Codman Estate.

All other proposed sites are farther than one mile from the nearest commuter rail station. Commuter rail schedules are optimized for weekday commuting, making off-peak and weekend visitor travel difficult.

### Bicycle Connections

Each of the three towns is popular among recreational cyclists and has a mix of bicycle routes in place.

- “Least-stress” options that provide separation from motor vehicle traffic, such as multi-use paths;
- “Low-stress” options, such as bicycle lanes; and
- “Moderate-stress” options, such as roadways with speed limits lower than 25 miles per hour, but no dedicated infrastructure or accommodations for bicyclists.

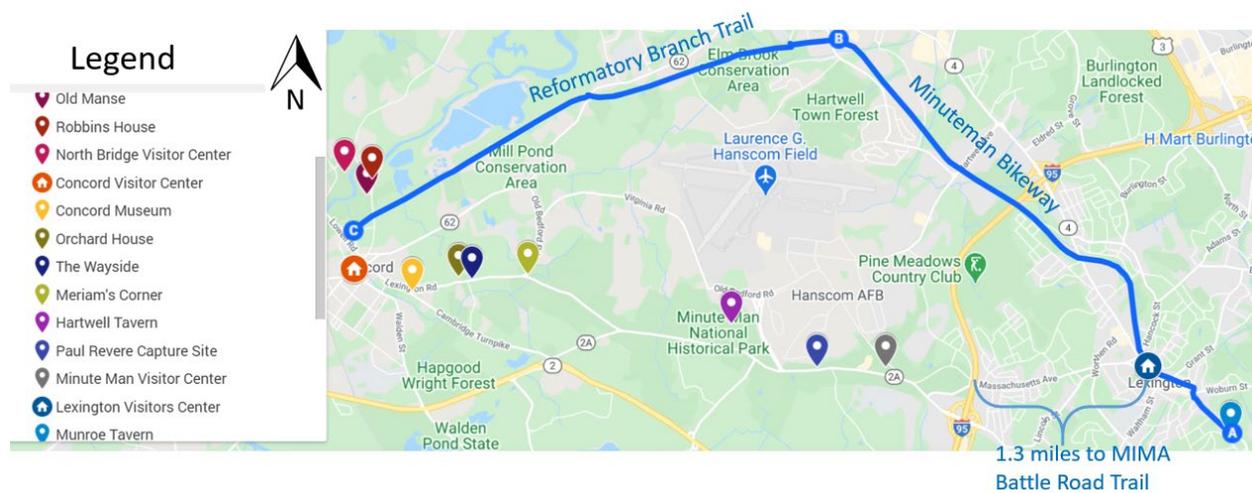
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<sup>7</sup> (Federal Highway Administration 2013)

Accessing most of the identified sites would require a departure from “low-stress” options for at least a portion of the trip. Most travel routes in the three towns do not have dedicated facilities for bicyclists. Experienced cyclists may be confident, but others may not feel comfortable negotiating these segments.

The Minuteman Bikeway is a 10-mile long multi-use path that connects downtown Bedford to the Alewife MBTA station in Cambridge.<sup>8</sup> The Bikeway runs northwest from Somerville through downtown Lexington and on to Bedford. Cyclists can access MIMA by exiting the Bikeway at Hancock Street in downtown Lexington, near the Lexington Visitor Center, and riding west along Massachusetts Avenue for 1.3 miles. Also, a short distance from the Bedford terminus of the Minuteman Bikeway is the Reformatory Branch Trail, which continues west for another 8.8 miles, terminating in Concord center just after passing only 0.3 miles to the south of the North Bridge, The Old Manse, and Robbins House. Additionally, many people ride bicycles on the 4.6-mile Battle Road Trail through MIMA. The trail is at times congested, and it can sometimes lead to conflicts between different uses (pedestrian versus bicycle) due to different travel speeds. Bicyclists must dismount at all bridges. Figure 3 shows bicycle connections on the map.

Figure 3: Bicycle Connections in MIMA and Surrounding Areas



Source: Google Maps

## Visitation

In order to understand how visitors would use a circulator bus, and therefore the best way to implement such a service, it is helpful to understand how and when visitors access the proposed stops in the study area. The following sections describe visitation at the proposed stops, based on staff responses.

## Summary

Visitation varies a great deal from site to site in the study area, with the most popular points of interest drawing over one hundred thousand visitors per year, and less frequented

<sup>8</sup> <http://minutemanbikeway.org/home/about/>



sites drawing a few thousand per year. Visitation to MIMA exceeds the other sites, reliably drawing about one million visitors per year.

Almost all sites have peak visitation from April to October, with significantly less visitation in the remaining months. The sites that are open year-round and could quantify seasonal variation showed, on average, about 80 percent of visitation from April to October, and the remaining 20 percent of visitation from November to March. Sites report higher visitation on weekends than on weekdays. While some sites are open consistently seven days a week, others are open for longer hours on the weekends and/or may close on certain weekdays. Some sites close during the winter months.

The exceptions to the above generalizations are the Minute Man Regional Vocational Technical School and Aloft and Element Hotels, which likely do not have the same seasonal pattern for visitation. As described above, these latter three sites are possible stops that the town of Lexington suggested considering, if feasible, as they could extend the utility of a shuttle service. Information is not yet available for these latter sites. Table 1 summarizes key information across sites.

Table 1: Summary of Visitation and Parking for Sites in and around MIMA

Sites	Annual Visitation Est.	Average Daily Visitation Est. (Apr – Oct)	Typical Visit Duration (Hours)	Parking Spaces (Red= Constrained, Blue= Excess Capacity)
Minute Man Visitor Center	151,000 <sup>9</sup>	421	1.5 <sup>10</sup>	31 plus 12 bus
Paul Revere Capture Site	116,000	367	1.5	26
Hartwell Tavern	164,000	591	1.5	37 plus 2 bus
Concord Visitor Center	12,000	50	Unknown	138 plus 2 bus (constrained at times Sep – May, weekdays; ample Jun – early Sep)
North Bridge/ Robbins House	>282,000 <sup>11</sup>	>1,027	1 – 1.5	61 plus 4 bus and some emergency overflow (115 in Sargent’s Field) (constrained Apr, Oct, and weekends from May–Sep)
The Old Manse	> 47,000	~150	1.0	15 plus 10 overflow
North Bridge Visitor Center	136,000	433	1.5	47 plus 5 bus
Meriam’s Corner	181,000	575	1.5	22
Wayside	48,000	143	1.5	22 plus small bus
Orchard House	> 150,000	560 <sup>12</sup>	Unknown	13
Concord Museum/ Emerson House	> 45,000	~150	Unknown	56 (constrained on weekends)
Codman Estate	> 5,000	27	Unknown	12
Codman Community Farm	~20,000	~100	Unknown	15 plus overflow
Drumlin Farm	>87,000	Weekend day: 742, Weekday: 186	2	72 (Sep – May), but only 27 (Jun – Aug); 80+ overflow spaces, conditional on weather (constrained spring, summer)
Gropius House	9,000	50	Unknown	15
deCordova Museum	80,000	300 <sup>13</sup>	2	260 (only ever reaches 75% capacity, even at its busiest)
Lexington Visitor Center/ Battle Green/ Buckman Tavern/ Hancock-Clarke House	136,000	588	Unknown	Limited dedicated street parking
Munroe Tavern	2,000	10	Unknown	Limited street parking
Scottish Rite Museum/ Community Center	Unknown	Unknown	Unknown	Excess capacity
Minute Man Regional Vocational Technical School	Unknown	Unknown	Unknown	Unknown
Aloft and Element Hotels	Unknown	Unknown	Unknown	Unknown; likely ample

<sup>9</sup> MIMA site-specific estimates use the following methodology: multiply vehicle count data by the 3.4 “person per vehicle” estimate from NPS Public Use Statistics Office (PUSO). Then multiply by 1.25, since the analysis in the parking section of this report suggests that the PUSO formulas assume 20 percent of visits are NOT via personal motor vehicle.

<sup>10</sup> MIMA durations are assumed to be 1.5 hours, based on information from the NPS PUSO.

<sup>11</sup> 282,000 based on North Bridge lot and Sargent’s Field counts (this is inclusive of Robbins House visitation of 7,000, since the site does not have its own lot). The Old Manse appears as a separate entry, as it does have its own parking lot. Sargent’s Field vehicles do not get counted in foliage season, so the “>” symbol indicates that the actual visitation is greater than the number here.

<sup>12</sup> Includes an estimate of 560 for Orchard House, with the assumption that 80 percent of visitation is April to October.

<sup>13</sup> Based on assumption that 80 percent of visitation is from April to October.



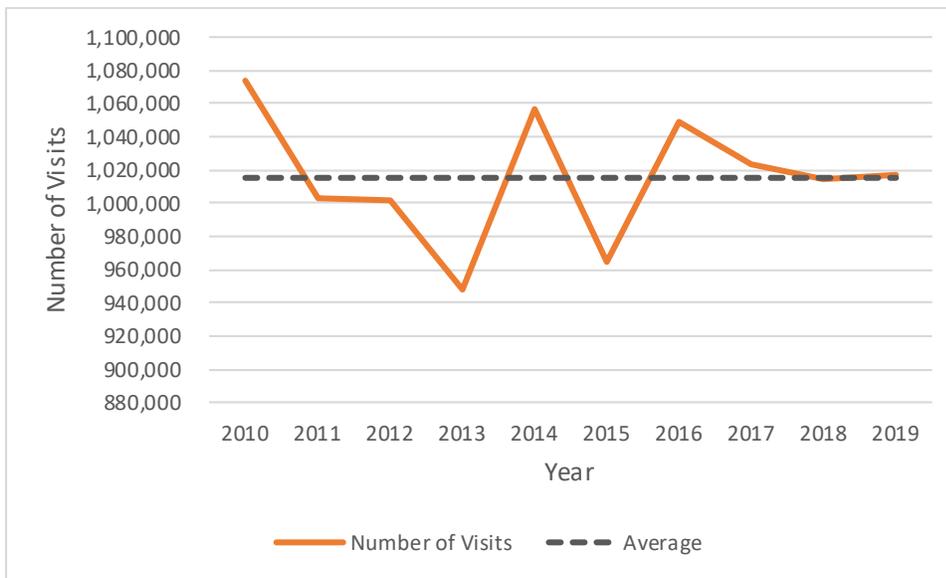
Sources: (National Park Service 2020) and stakeholder communications

## Details

### *Minute Man National Historical Park*

Figure 4 shows that visitation to MIMA has fluctuated between about 1.07 million and 0.94 million visitors per year over the past 10 years.<sup>14</sup> Although it has fluctuated over that period, it does not seem to be consistently increasing or decreasing, but hovers around the annual average of 1.01 million. Historically, MIMA has seen large jumps in visitation in years of major anniversaries. Across the nation, relevant parks had large increases in visitation in the 1970s, coinciding with the 200<sup>th</sup> anniversary of various events associated with the American Revolution. MIMA had about 550,000 visitors per year in 1970, which jumped to over 800,000 visitors per year in 1974 and again to 1,200,000 visitors in 1996<sup>15</sup>. The park anticipates a sharp increase in visitation with the upcoming 250<sup>th</sup> anniversary of the “shot heard round the world” in Lexington, which initiated the first battle in the American Revolutionary War, in 2025.

Figure 4: Annual Visitation to MIMA, 2010-2019



Source: (National Park Service 2020)

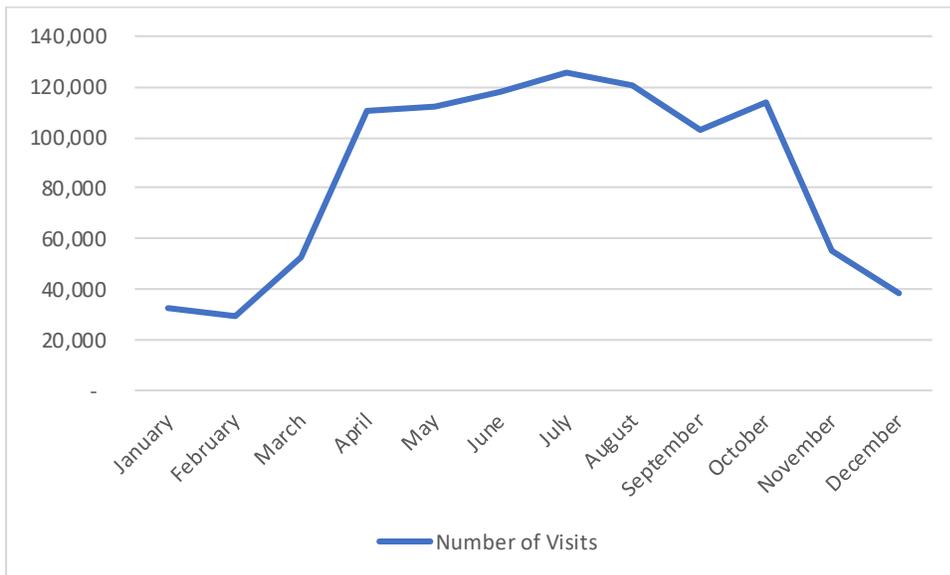
Figure 5 shows a seasonal trend, based on averaging the number of visitors by month over the last 10 years.<sup>16</sup> For seven months of the year, April through October, MIMA reliably welcomes over 100,000 visitors per month. The dramatic increase in visitation from March to April can be attributed to Patriots’ Day, the actual anniversary of the battles of Lexington and Concord on the third Monday in April. For the other five months, November through March, the park reliably sees fewer than 65,000 visitors per month.

<sup>14</sup> (National Park Service 2020)

<sup>15</sup> (National Park Service 2020)

<sup>16</sup> (National Park Service 2020)

Figure 5: MIMA Visitation by Month, 2010-2019



Source: (National Park Service 2020)

The NPS Public Use Statistics Office (PUSO) estimates visitation based primarily on parking lot vehicle count data, using a formula with associated assumptions. There is no direct measurement of visitors that access the park via means other than private motor vehicle. Park staff note that visitation data may underestimate visitation. One example of an underestimate is with respect to Sargent's Field, which provides overflow parking for more than 100 vehicles near the North Bridge, The Old Manse, and Robbins House. In foliage season in the fall, this overflow is open almost every day, but without capturing any vehicle count data.

#### *Sites Adjacent to Minute Man National Historical Park*

##### The Old Manse

The Old Manse is located within the NPS administrative boundary adjacent to the North Bridge but is owned and operated by a large non-profit organization called The Trustees of Reservations. It is a historical house in which Ralph Waldo Emerson and Nathaniel Hawthorne each lived for a time, and from which the Emerson family witnessed the battle on April 19, 1775. The bulk of visitation to The Old Manse comes from school groups and small education programs from April through November. The tourist traffic tends to peak during September and October, especially on weekends. Guests tend to stay for approximately one hour (the length of a house tour), though some opt to stay longer. See parking section below for parking issues.

##### Robbins House

The Robbins House is similar to The Old Manse in that it is located near the North Bridge on Concord town-owned land that is managed by NPS through an agreement. The Robbins House is owned and operated by a non-profit organization called Robbins House, Inc. Visitation to the Robbins House increases month-by-month beginning in April, peaking in mid-summer, and decreasing through November. The Robbins House welcomes over 7,000



visitors per year and visitation is steadily increasing. The Robbins House uses the North Bridge parking lot.

The Robbins House sees the most visitation on Fridays, Saturdays, and Sundays and their operating hours reflect that, as the building is open on those days only as the season winds down in September and October. From Memorial Day through Labor Day; however, The Robbins House is open six days a week (closed Tuesdays).

In addition, the Robbins House offers programming and events that attract 50 to 250 visitors at once. Most events coincide with the anniversary of a historical event, and some events are coordinated with events at North Bridge, programmed by Minute Man National Historical Park. One example is an Independence Day celebration when the Robbins House hosts a reading of Fredrick Douglass' "What to the Slave is the Fourth of July" followed by a reading of the Declaration of Independence at North Bridge.

#### Orchard House

Louisa May Alcott's Orchard House, the location in which Louisa May Alcott set her novel *Little Women* and where she wrote it, is located near the NPS site, the Wayside: Home of Authors. Annually, the Orchard House welcomes about 50,000 visitors for guided tours (the only way to view the interior of the house) and over 100,000 visitors who enjoy the exterior of the property. As with other sites, the Orchard House sees most visitors between April and October. For the 2020 season, they were expecting a 350 percent increase in visitation due to a recently released major motion picture, *Little Women*.<sup>17</sup> This projection is based on a similar surge (an increase of 400 percent) in 1994 at the release of another movie adaptation of the book, *Little Women*.

The Orchard House experiences the highest visitation on weekends, and the lowest visitation on Wednesdays. The busiest time of day is usually between 1 and 4 PM, and mornings from 10 AM through noon are almost as busy.

#### *Sites in Concord*

#### Concord Visitor Center

The Concord Visitor Center in Concord center welcomes 12,000 guests per year. It is open 7 days a week April – November, in a normal year. Visitors go there to pick up brochures and maps, and to speak to volunteer staff about nearby activities.

#### Emerson House

The Ralph Waldo Emerson House, the former home of the transcendentalist philosopher and writer, is an eight-minute walk from Concord center and directly across the street from the Concord Museum, another popular historical attraction. Emerson House welcomes about 3,000 visitors through its doors and an additional 2,000 visitors explore the grounds surrounding the house, which are open 7 days a week year-round. The house is open from 10 AM-4:30 PM Friday through Saturday, and Sunday afternoons from 1-4:30pm; visitors tend to stay for at least an hour.

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<sup>17</sup> 2020 visitation has been adversely affected due to the COVID-19 pandemic

Emerson House staff does not know how visitors arrive to their site, but suspect that the large majority arrive by car. About 15-20 percent of visitors arrive for scheduled group visits by bus or van.

### Concord Museum

The Concord Museum records 40,000 annual visitors although the actual visitation is higher as outdoor events and rentals are not included in that estimate. Further, the Museum is in the final phase of the New Museum Experience, involving newly renovated and redesigned permanent galleries, with a target completion date of June 2021. The Concord Museum expects this to bring in even more visitation. The Concord Museum sees higher visitation on weekends and, on a larger scale, from Patriots Day through October. The Museum also sees a spike in visitation November 25 through January 3 when they host their annual Family Trees event.

### *Sites in Lincoln*

The Town of Lincoln has a small commercial center located in South Lincoln along with the MBTA commuter rail stop. All of the selected sites described below are within an approximate 1.5-mile radius from the commercial center and MBTA commuter rail station. None of the below sites are more than a 10-minute car ride from any of the other Lincoln sites.

### Drumlin Farm

Drumlin Farm, a working farm and wildlife sanctuary, has welcomed over 87,000 visitors annually on average over the most recent 5 years. The highest days of visitation are weekends, which can have as much as five times the number of visitors per day as weekdays. Staff at Drumlin Farm estimate that the average length of stay is most likely under 2 hours. Since visiting the farm is primarily an outdoor experience, Drumlin Farm experiences seasonal visitation as with the other sites. The farm kicks off visitation season with a large spike in visitation in April when there are baby lambs and goats to see. Visitation drops off a little after April but remains quite high through October. Some visitors do enjoy Drumlin Farm from November through March, but many fewer than during summertime.

### deCordova Museum and Sculpture Park

The deCordova Museum and Sculpture Park welcomes about 80,000 visitors annually with visitation weighted toward the summertime and fewer visitors in the winter. The museum hits its visitation peak sometime between May and July, depending on the year, due to weather and exhibition schedules. As with other sites, visitation is highest on the weekends and there is a slight peak in ticket sales in the early afternoon. The Museum estimates that most guests stay for about 2 hours, but some have been known to stay for the entire day.

### Gropius House

Gropius House, a National Historic Landmark designed by Walter Gropius, the founder of the Bauhaus design school, welcomes about 9,000 visitors per year. The site offers guided tours Wednesday through Sunday from May to October. Tours are limited to weekends the rest of the year. The visitation pattern at Gropius House is slightly different than other sites. They welcome the most visitors in spring and fall, due to large tour groups and



students. Individuals and smaller groups tend to visit during the summer months. On a typical day Gropius House receives about 50 visitors.

#### Codman Estate

Codman Estate, the country seat that has housed five generations of the Codman family, is one of the only sites in Lincoln that is a short walk from the Lincoln MBTA commuter rail station. Overall, the site has about 5,000 visitors each year in the period from April – October, although general visitation is limited on weekends, as it is primarily used for weddings. The way most visitors experience Codman Estate is by exploring the grounds, usually by passing through the trails that provide access to the surrounding conservation land. Otherwise, the only way to visit the interior is on a guided tour, available between the hours of 10 AM to 2 PM on the second and fourth Saturdays from June through October. Only about 350 visitors participate in these guided tours each year.

#### Codman Community Farm

Codman Community Farm is a working farm where visitors can view heritage breed livestock, go on a guided tour, and shop in the farm store. It is even closer to the Lincoln commuter rail station than Codman Estate. A pedestrian who took the train to Lincoln would walk past Codman Community Farm to arrive at Codman Estate. Codman Community Farm does not charge for entry and does not keep records of visitation, but due to the number of transactions in the farm store, a safe estimate of visitation is in the low-to-mid thousands per month during peak season. The farm is open seven days a week, and they report that their busiest days are Saturdays and slowest days are Mondays. Similar to other sites, visitation is seasonal, with highest visitation in May through November.

#### *Sites in Lexington*

##### Lexington Visitor Center/ Battle Green/ Buckman Tavern/ Hancock-Clarke House

Lexington Visitor Center welcomes 120,000 visitors annually. It is located in Lexington center and less than a 10-minute walk from two notable historical sites: the Hancock-Clarke House, where John Adams and Sam Adams slept the night preceding the Battles of Lexington and Concord; and Buckman Tavern, where militiamen gathered to await the arrival of the British army that same day. These two sites combined attract 16,000 visitors annually.

##### Munroe Tavern

Munroe Tavern was built in 1735 and was used by the British army as a stopover on their retreat from the Battles of Lexington and Concord. It has 2,000 visitors annually and is a 17-minute walk (0.9 miles) east from the Lexington Visitor Center.

### *Parking and Access*

#### Summary

Most visitors to all sites arrive via private motor vehicle (primarily by car and some by bus). Most sites are self-sufficient when it comes to balancing their parking supply and demand and some employ strategies, such as opening overflow parking when demand exceeds supply. Many sites experience parking constraints at certain times. One site, the

deCordova Museum, indicated that they always have excess parking capacity, as the lot only fills to a maximum of 75 percent capacity, even on the busiest days.

Sites vary in their capacity to accommodate a large vehicle, such as a bus. Some can accept large vehicles in their current condition without any changes. These sites include some of the MIMA lots, the deCordova Museum, the Concord Museum, Codman Estate, and Drumlin Farm. Some sites may be able to accommodate a bus with minor changes to pavement markings and/or parking policy, such as the Ralph Waldo Emerson House. If a site and the town in which it is located agree, some on-street parking spaces could be converted to a shuttle stop.



**Table 2: Summary of Parking Capacity and Large Vehicle Accessibility for Sites in and around MIMA**

Town	Sites	Parking Spaces (Red= Constrained, Blue= Excess Capacity)	Large Vehicle Accessibility
Concord	Concord MBTA	86	Medium
Concord	North Bridge/ Old Manse/ Robbins House*	76 plus 4 bus and some emergency overflow (115 in Sargent's Field) (constrained Apr, Oct, and weekends from May-Sep)	High
Concord	North Bridge Visitor Center*	47 plus 5 bus (constrained Apr, Oct, and weekends from May-Sep)	High
Concord	Concord Visitor Center	138 plus 2 bus (constrained at times Sep-May, weekdays; ample Jun – early Sep)	High
Concord	Concord Museum/ Emerson House	56 (constrained on weekends)	Medium
Concord	Meriam's Corner*	22	Medium
Concord	Wayside*/ Orchard House	35 plus 2 bus	Medium
Lincoln	Lincoln MBTA	161 (but only 100 spaces that are generally available to the public, which are typically full with commuters except on weekends) <sup>18</sup>	Medium
Lincoln	Drumlin Farm	72 (Sep – May), but only 27 (Jun – Aug); 80+ overflow spaces, conditional on weather (constrained spring, summer)	High
Lincoln	Codman Farm	15 plus overflow	Low
Lincoln	Codman Estate	12	High
Lincoln	Gropius House	15	Low
Lincoln	deCordova	260 (only ever reaches 75% capacity, even at its busiest)	High
Lincoln	Hartwell Tavern*	37 plus 2 bus	High
Lincoln	Minute Man Visitor Center*	31 plus 12 bus	High
Lincoln	Paul Revere Capture Site*	26	Low
Lexington	Lexington Visitor Center/Buckman Tavern/Hancock-Clarke House	Three blocks of on-street parking, constrained at times Sep-May, weekdays; ample Jun – early Sep. Space for buses to park along the green.	High
Lexington	Munroe Tavern	Limited street parking	Low
Lexington	Scottish Rite Museum/ Community Center	Unknown	Unknown
Lexington	Minute Man Regional Vocational Technical School	Unknown	High
Lexington	Aloft and Element Hotels	267	Unknown

Sources: (National Park Service 2020) and stakeholder communications

\* Denotes MIMA site

<sup>18</sup> The MBTA does not own any parking spots for the station. The town of Lincoln owns two lots. The resident lot is reserved for town residents with a sticker. This lot is full Monday through Friday. The town's second lot of approximately 100 spots is a paid commuter lot. This lot is full Monday through Friday but minimally used during the weekends.

## Details

### *Minute Man National Historical Park and Adjacent Sites*

Minute Man National Historical Park has traffic counters in eight of its eleven parking lots. Park personnel go to each parking lot counter at the conclusion of each month and record the data that the counter collected. This provides the park with monthly vehicle counts, so it is difficult to assess parking demand on a daily or weekly basis more precisely than a simple average.<sup>19</sup>

**Table 3: Parking Detail for MIMA Lots**

Location	Spaces	Buses	Handicap	Road Location	Average Vehicles Per Day (April - October)	Number of Lot Turnovers Per Day
North Bridge Visitor Center	44	5	3	Liberty Street	102	2.0
North Bridge, Monument Street	58	4	3	Monument Street	235	3.6
Wayside	22	2	1	Lexington Road	34	1.4
Meriam's Corner	21	0	1	Lexington Road	135	6.1
Samuel Brooks	14	0	1	Route 2A	Unknown	Unknown
Hartwell	35	2	2	Route 2A	139	3.6
Paul Revere Capture site	25	0	1	Route 2A	86	3.3
Minute Man Visitor Center	28	12	3	Route 2A	99	2.3
Lower Fiske Hills	22	0	1	Old Massachusetts Avenue	63	2.7
Fiske Hill (Wood Street)	10	0	1	Wood Street		0.0
Sargent's Field	Unknown	Unknown	Unknown	Route 2A	6	Unknown
Total	279	25	17	--	--	--

Source: (National Park Service 2020)

Note that the North Bridge lot directly serves North Bridge, Robbins House, and The Old Manse, and indirectly serves North Bridge Visitor Center.

Parking usage trends very closely with overall visitation. The NPS PUSO estimates a person-per-vehicle rate of 3.4 for MIMA. Using this multiplier to estimate the number of visitors who arrive by car, we can compare it to the total number of visitors, which the PUSO formula also estimates based on parking lot counts. This comparison for the past ten years shows that the PUSO formula assumes that about 80 percent of visitors arrive to

<sup>19</sup> (Volpe National Transportation Systems Center 2019)



MIMA by private motor vehicle, meaning roughly 20 percent of visitors walk, bike, or arrive by some other mode. Further, the estimated percentage of visitors arriving by automobile varies little from year to year, with a maximum of 82 percent and a minimum of 80 percent over the ten-year period. This suggests that the PUSO formula and assumptions have not changed in the past ten years.

#### North Bridge and North Bridge Visitor Center

While the North Bridge parking lot on Monument Street is the largest parking lot owned by Minute Man National Historical Park, it also serves at least three locations. Visitors arriving by car or bus to the Robbins House, The Old Manse, and the North Bridge itself may use this lot, as it is close to these locations. The Old Manse does also have its own parking lot. Visitors may also choose to park here if they plan to visit the North Bridge or the North Bridge Visitor Center, although the North Bridge Visitor Center also has its own parking lot.

#### The Robbins House

Robbins House staff characterized the parking lot as crowded on weekends but containing ample capacity on weekdays. They also reported that most visitors arrive by car, but all modes of transportation are represented (including bus, bike, and pedestrians). Staff also noted that visitors often disembark from their buses and visit the North Bridge before coming to the Robbins House.

#### The Old Manse

The Old Manse's parking lot is across the street from the MIMA North Bridge parking lot and accommodates 15 cars with an additional 10 spaces for emergency overflow. At times, when both lots are full, MIMA has opened Sargent's Field for emergency overflow parking. For special events when parking demand exceeds supply, or when buses arrive, the site has had to apply for temporary access to the MIMA North Bridge lot and has even rented shuttle buses and contracted annexed parking at the CareOne facility a few miles away. Visitors tend to arrive via car, especially in the summer, which has the highest visitation. Approximately 5 to 10 percent of visitors arrive via alternative transportation.

#### Louisa May Alcott's Orchard House and the Wayside: Home of Authors

Louisa May Alcott's Orchard House is adjacent to the NPS site, the Wayside: Home of Authors, and across the street from the Wayside parking lot. The Orchard House has 13 on-street parking spaces directly in front of the site. When those are full, visitors park in the Wayside lot, about a 500-foot walk away. Staff at the Orchard House note that many visitors who park in the Wayside lot visit the Orchard House instead of The Wayside. According to Concord staff, the Wayside lot reliably has available parking spaces during the week; we do not have any information on weekend parking congestion.

Staff at the Orchard House also indicated that the pre-existing shuttle stop at the western edge of the on-street parking area, which is currently used by the Liberty Ride, would be a good location for a stop.

## *Sites in Concord*

### Concord Visitor Center

The Concord Visitor Center has 138 parking spaces in the adjacent municipal lots, of which two are designated for electric vehicles and six or seven are designated for accessible parking. The eastern edge of the lot has two parking spaces for buses or larger vehicles. These parking lots reliably have spaces available throughout the summer (June – August and early September) and on most weekends until mid-late November. September through May, however, parking can be difficult. If there are available parking spots dispersed throughout Concord center, they are difficult to find for someone unfamiliar with the geography. A shuttle bus would easily be able to stop behind the Visitor Center for passengers. People generally arrive to the Concord Visitor Center by car and by tour bus.

### Concord Museum

The Concord Museum has 50 parking spots in its lot and additional parking on side streets. Visitors mostly arrive by car and tour bus. During good weather, tourists walk from the center of town or from other attractions. The Museum also has a new bus and shuttle parking space with a turn-around loop currently used for school groups and other group visitation.

### Emerson House

Emerson House, owned by the Ralph Waldo Emerson Memorial Association, has no dedicated parking, but there are six on-street parking spaces across the street from the site without road markings. Directly in front of the site, there is a wide, gravel shoulder with unmarked space for parking. On-street parking spaces also serve the Concord Museum. No signage indicates that the Concord Museum lot is exclusively for Museum visitors, so it is reasonable to assume that some visitors arriving to the Emerson House by car may park in the nearby Concord Museum lot.

## *Sites in Lincoln*

### Drumlin Farm

Drumlin Farm, located off South Great Road in Lincoln, has an off-street paved parking lot that can accommodate about 80 cars, but has the option of opening an overflow lot on a nearby grassy field, which can accommodate more than 80 additional cars. Most visitors arrive by car. Drumlin Farm staff estimate that on weekends, about 2.75 people arrive per vehicle. On weekdays, it is closer to two people per vehicle. Drumlin Farm staff occupy at least six spaces year-round, and as many as 45 spaces are occupied with camp staff for the duration of the day from June through August. The overflow field's usability is conditional on weather, as it is unusable during rainy periods due to mud. This is often an issue in the spring, constraining parking. Drumlin Farm sometimes welcomes large groups at a single time, but this does not generally lead to a parking demand issue, as most large groups arrive in school buses. Buses drop visitors near the entrance and park remotely elsewhere.

### deCordova Museum

The deCordova Museum, located off Sandy Pond Road in Lincoln, has a dedicated off-street parking lot with a capacity of 260 vehicles which can fill up to a maximum of about 75



percent capacity on a busy summer weekend day. Almost all visitors arrive by car with an “extremely low” percentage of visitors arriving by foot or bike, per museum staff. The parking lot is expansive and provides many opportunities for a long vehicle, such as a bus, to turn around. The lot also features a bus drop-off location at the entrance of the museum store and café.

#### Gropius House

Gropius House, on Baker Ridge Road in Lincoln, has an off-street parking lot that accommodates 15 cars and does not provide enough room for a full-size coach bus to turn around; however, a shorter, mid-sized bus could.

#### Codman Estate

Codman Estate is located on Codman Road in Lincoln. The off-street parking lot is close to the road and has capacity of 12 cars. The site itself is located at the end of a long driveway, which includes a loop that a longer vehicle would be able to navigate to drop off visitors at the front entrance.

#### Codman Community Farm

Codman Community Farm, also on Codman Road, has an off-street parking lot that can accommodate 15 cars.<sup>20</sup> For larger events, Codman Community Farm has the flexibility to open an overflow area. Farm staff estimate that 90 percent of visitors arrive by car and the remainder arrive by biking or walking (which may also include taking the commuter rail into Lincoln from elsewhere). Due to the generally short length of stay by each visitor, turnover in the parking lot is high. When the parking lot capacity is at capacity, visitors park on the side of the road on a narrow grass buffer adjacent to a rock wall running the perimeter of the property. The parking lot cannot accommodate a long vehicle. However, staff suggested the following possible shuttle stop locations: at the corner near the police station, in front of the farm on Codman Road, or at the shopping plaza near the commuter rail station, 0.3 miles from the farm.

#### *Sites in Lexington*

All of the non-MIMA sites in Lexington are close to Lexington center, where development is denser than that of other areas analyzed in this document. Most sites do not have dedicated off-street parking, with the exception of the Scottish Rite Museum and Community Center, the Minute Man Regional Vocational Technical School, and the Aloft and Element Hotels.

Munroe Tavern is located on Massachusetts Avenue, which serves as the Lexington central business district’s “main street.” There is no on street parking on this section of Massachusetts Avenue for 0.25 miles. The Hancock-Clarke house similarly lacks on street or informal parking. Buckman Tavern is on a three-way intersection; all of the streets that converge offer on-street parking for at least a block in all directions from the Tavern. Some of the on-street parking is metered, while some is free with a two-hour limit. There are some MBTA bus stops where a shuttle could be co-located; however, there is no place for a bus to dwell or turn around.

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<sup>20</sup> Spaces are unmarked, so if guests park efficiently, it is possible to fit more than 15 cars in the lot.

## *Traffic*

This section describes existing traffic conditions that may affect visitation and a potential shuttle service.

### Summary

As the towns' CLRPs all note, traffic is an issue in this area and improved alternative transportation has the potential to alleviate this issue, at least partially. Route 2A, which borders most of the Battle Road Unit, has already been studied for its heavy traffic flow, which negatively affects the visitor experience at MIMA. Further, the surrounding three towns of Concord, Lincoln, and Lexington have seen recent development and growth leading to heavier traffic volumes.

### Details

#### *Traffic in the Region*

Traffic is a common concern throughout the study area for both morning and evening commuting hours. Concord's 2030 CLRP underlines the importance of reducing traffic during commuting hours; it is the number one transportation issue according to a survey of residents from 2017.<sup>21</sup> A 2019 survey found that the majority of respondents in Lexington who take transit to commute do so to avoid traffic.<sup>22</sup> Roadway congestion is not new to Lexington. Lexington's 2003 comprehensive plan cited traffic as an issue in terms of safety, queuing, congestion, delays, and level of service (LOS).<sup>23</sup> The 2009 Lincoln CLRP recognizes traffic as a growing issue for Lincoln as it inhibits mobility and creates congestion for commuters, an unsafe environment for pedestrians, and difficulty for drivers exiting driveways.

Traffic impedes park staff moving between the four NPS units and impacts visitors' ability to enter and exit parking areas.<sup>24</sup> In the most recent visitor study conducted for MIMA in 2007, 17 percent of respondents indicated that high traffic volumes detracted from their experience in response to a question directly asking about this.<sup>25</sup>

Figure 6 below is a screenshot from the [MS2 database](#) developed by the Massachusetts Department of Transportation (MassDOT) with an inventory of Average Annual Daily Traffic (AADT) of major roadways. AADT is a measure of traffic volume and does not directly describe congestion on its own. For example, this map shows that traffic volumes are higher on Route 2 as compared to Route 2A, but it is also true that Route 2 has higher capacity, due to a greater number of lanes and differences in speed and access. While Route 2A may see less volume, it can still be more congested.

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<sup>21</sup> (Concord Comprehensive Long Range Plan Committee 2018)

<sup>22</sup> (Tintocalis 2020)

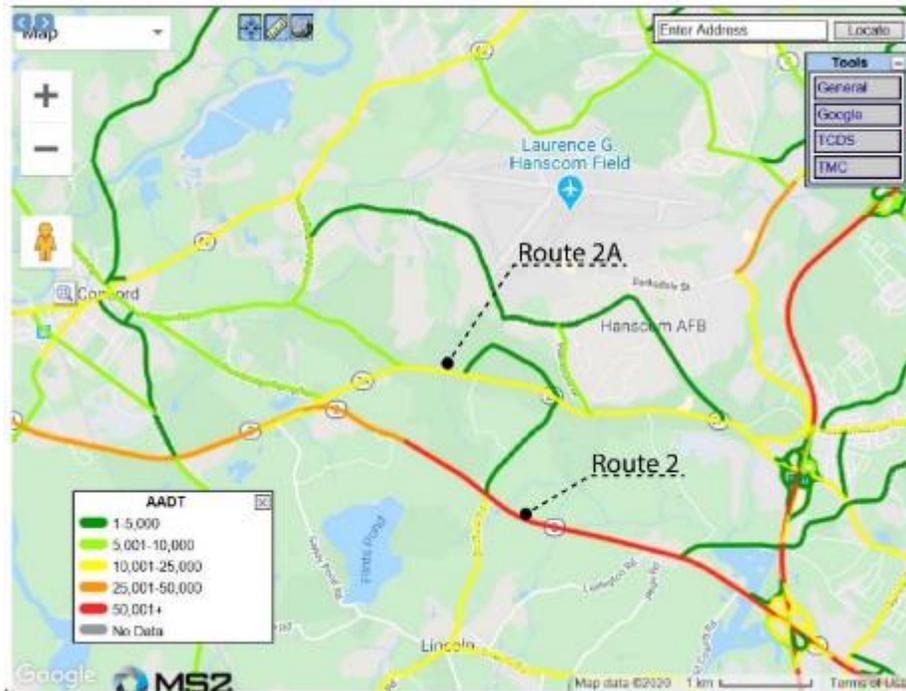
<sup>23</sup> (Lexington Planning Board 2003)

<sup>24</sup> (Richardson, Breck and Wood 2019).

<sup>25</sup> (Idaho 2007)



Figure 6: Screenshot of MS2 database showing AADT of roadways in and around MIMA



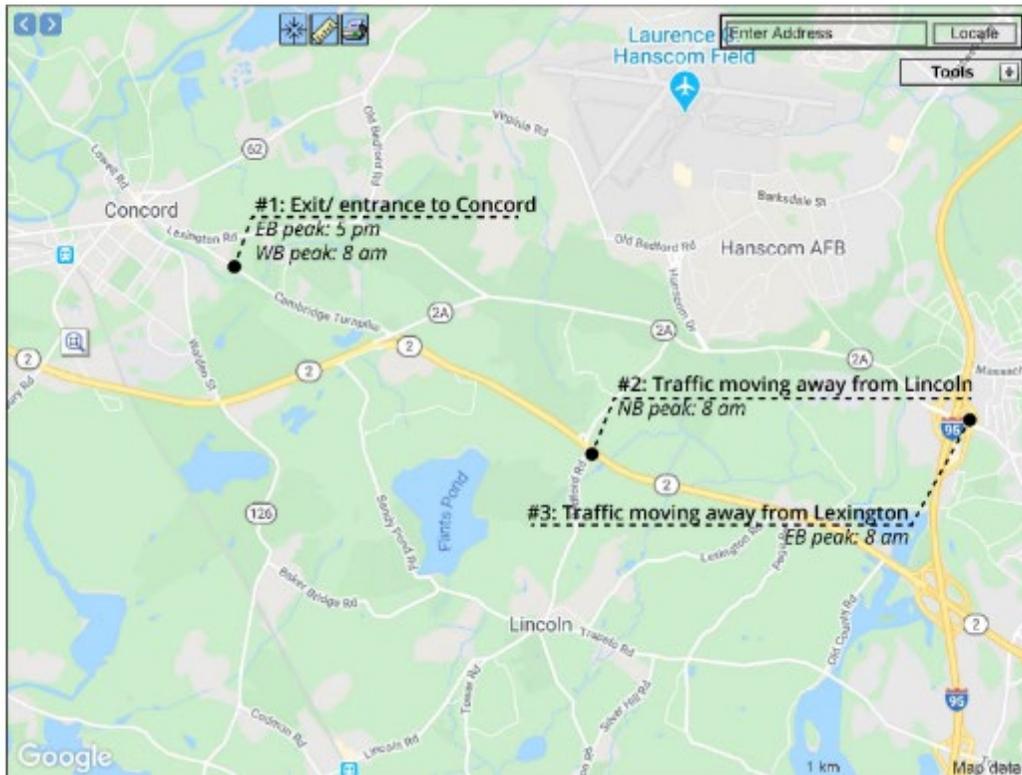
Source: (MassDOT n.d.)

The MassDOT MS2 most recent entries from 2019 included three count locations where the traffic could potentially affect the proposed shuttle. These counts are numbered in Figure 7 below at their count locations.<sup>26</sup>

- Count number one is along Concord Turnpike, which connects Lexington Road to the Route 2/ 2A juncture. It has an AADT of 6,199 total: 2,594 in the eastbound direction and 3,605 in the westbound direction. This location's westbound (towards Concord) peaks in the morning around 8 AM with about 150 vehicles. This location's traffic count peaks in eastbound (towards MIMA and Boston) direction around 5 PM with about 115 vehicles.
- Count number two at the off-ramp from Route 2 onto Bedford Road in the northbound direction (away from Lincoln). It has an AADT of 3,810 which peaks around 8 AM with about 150 vehicles.
- Count number three at the off-ramp from I-95 onto Route 2A in the westbound direction (away from Lexington). It has an AADT of 5,807, which peaks around 8 AM with about 190 vehicles.

<sup>26</sup> (MassDOT n.d.)

Figure 7: Recent Traffic Counts from MS2 Relevant to MIMA Shuttle Analysis



Source: (MassDOT n.d.)

### *Route 2A and Adjacent Areas near MIMA*

Route 2A is heavily travelled and runs parallel to the Battlefield Road unit within park boundaries. It is a minor arterial meaning it makes vital connections to the highway system but also provides more local access. The corridor runs east west and is the primary means to access MIMA. Aside from providing vehicular access to the park, Route 2A provides access to Hanscom Air Force Base, Hanscom Regional Airport, the Minute Man Regional Vocational Technical School, local residences, and local businesses, and is a cut-through for trips originating west of MIMA to points east within the Metro Boston area and vice versa. The Volpe Center studied the corridor in 2002 in order to understand the traffic, determine the maximum traffic before it becomes a detriment to the park, and to propose options to achieve and maintain the desired traffic level.<sup>27</sup> More recently, MassDOT contracted with Toole Design to study the Route 2A corridor and recommend traffic calming measures to improve multimodal safety; the project is ongoing as of 2020.

Figure 8 shows detailed historical traffic count data from the 2002 study. Although this graph only extends as recently as 2000 and does not show any data for the last two decades, more recent data from MassDOT suggest that traffic volumes have not substantially increased since 2000. 2007 AADT was 22,174,<sup>28</sup> which corresponds closely to

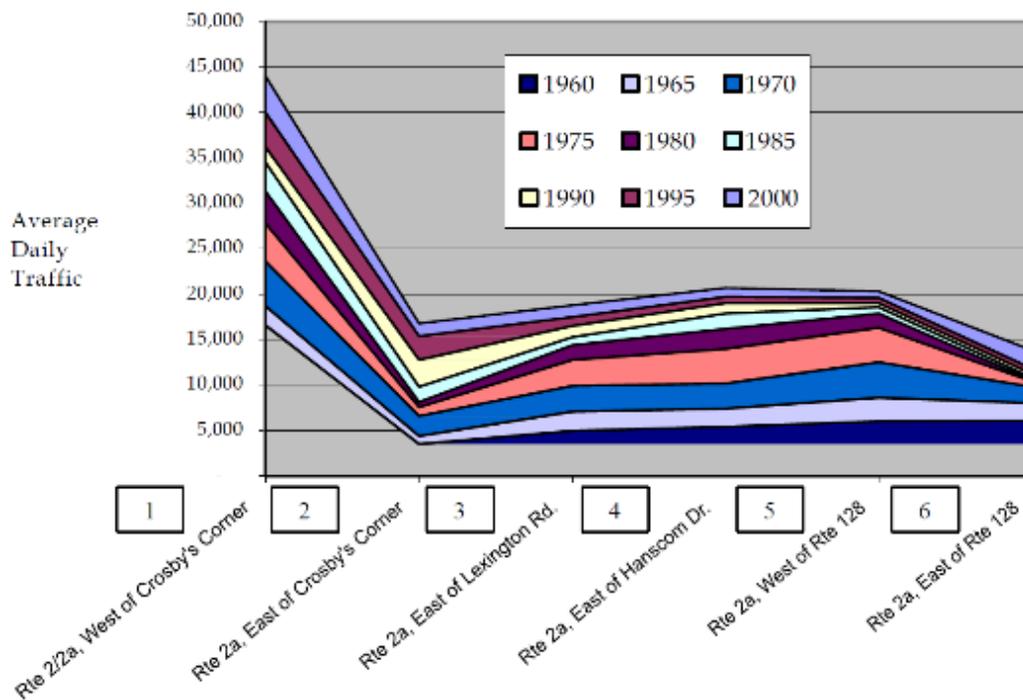
<sup>27</sup> (Volpe National Transportation Systems Center 2002)

<sup>28</sup> (MassDOT n.d.)



the 2000 average daily traffic volume for that location in Figure 8 (appearing as location number five in the horizontal axis label). Although Figure 8 uses the terminology “average daily traffic” (ADT) rather than AADT, their definition implies that the measurements approximated AADT.<sup>29</sup> AADT is an estimated average over an entire year, while ADT is only an average over a given count period. Count numbers three through five in Figure 8 are most representative of the traffic around the park as they are all within park boundaries. Growth slows from 1980 on, as indicated by narrower bands, suggesting that traffic was approaching Route 2A’s saturation point. The most recent traffic data collected over five days in April of 2019 on Route 2A west of Bedford Road, resulted in an ADT of 14,200. While this is significantly lower than the other prior values, it is important again to note that ADT only represents the sample period, while AADT estimates the annual average of daily traffic. The 2019 counts found peak traffic eastbound at around 7 AM with about 1,000 vehicles and a peak westbound at around 4 PM with about 1,000.<sup>30</sup>

Figure 8: Historical Average Daily Traffic Volumes on Route 2A



Source: (Volpe National Transportation Systems Center 2002)

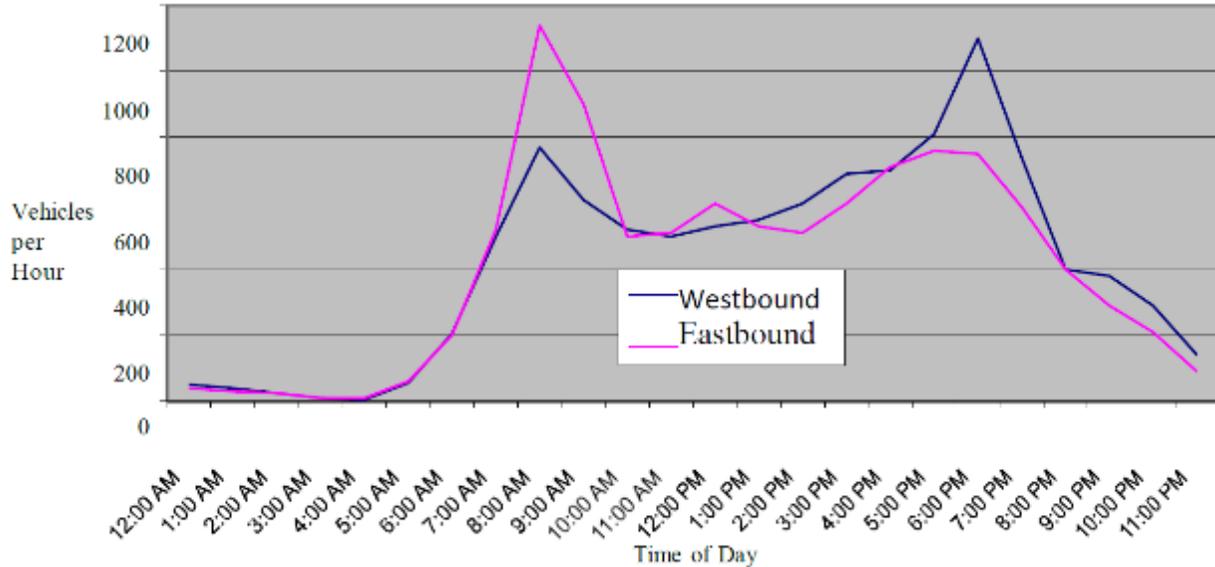
Figure 9 shows hourly vehicle counts in each direction of travel from 2002, corresponding to location 5 in **Error! Reference source not found.** (Route 2A west of Route 128). This shows 8 AM and 6:30 PM peaks of about 1,200 vehicles in the peak direction of travel, and about 800 vehicles in the non-peak direction. Research indicates that roads with an estimated 1,000 cars per hour have a break in traffic sufficient for pedestrian crossing

<sup>29</sup> (Volpe National Transportation Systems Center 2002)

<sup>30</sup> Personal communication with Toole Design, 7/24/2020

every 6 minutes on average. This would mean that pedestrians crossing Route 2A would be subject to an even longer wait to cross at peak congestion.<sup>31</sup>

Figure 9: Hourly Traffic Volumes on Route 2A East of Hanscom Drive



Source: (Volpe National Transportation Systems Center 2002)

Route 2A is classified as an urban/suburban minor arterial. The American Association of State Highway Transportation Officials (AASHTO) standard for this class of road is Level of Service (LOS)<sup>32</sup> C for all its intersections. Table 4 shows the documented grade three Route 2A intersections according to a Traffic Impact Study conducted by the United States Air Force Hanscom Base in 2000.

Table 4: Locations along Route 2A and Their LOS Rating

Location	Morning LOS	Evening LOS
Route 2A at Hanscom Dr.	F	F
Route 2A at Bedford Rd.	D	F
Route 2A at Lexington Rd.	F	B

Source: (Volpe National Transportation Systems Center 2002)

The 2002 Route 2A study concluded that the optimal daily traffic volume along Route 2A is 8,000 to 12,000 vehicles to minimize negative impacts to the MIMA visitor experience and improve visitor safety. A reduction in current traffic levels between 40 to 60 percent would be needed to bring all of the Route 2A intersections up to LOS C during the peak periods in the morning and in the evening. The same amount of reduction would have to occur for the pedestrian crossing time of Route 2A to reduce to a minute or two.

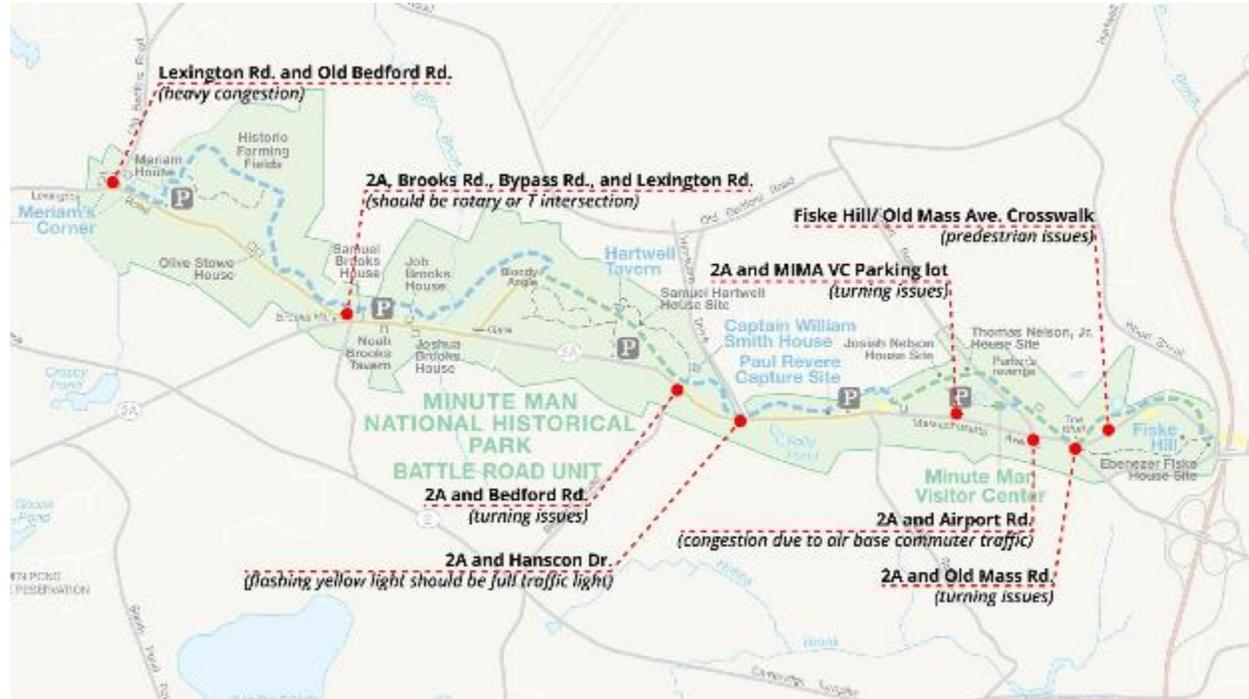
<sup>31</sup> (Volpe National Transportation Systems Center 2002)

<sup>32</sup> LOS is used to determine how efficiently an intersection is operating by examining factors such as speed travel time, interruption, freedom to maneuver, driver comfort, convenience, safety, and operating costs and is evaluated on a scale from A (best) to F (worst)



Figure 10 illustrates roadway congestion issues within MIMA park boundaries, including many intersections along Route 2A. MassDOT owns the right of way and NPS owns the surrounding lands.

Figure 10: Identified Roadway Congestion Hotspots within MIMA Boundaries



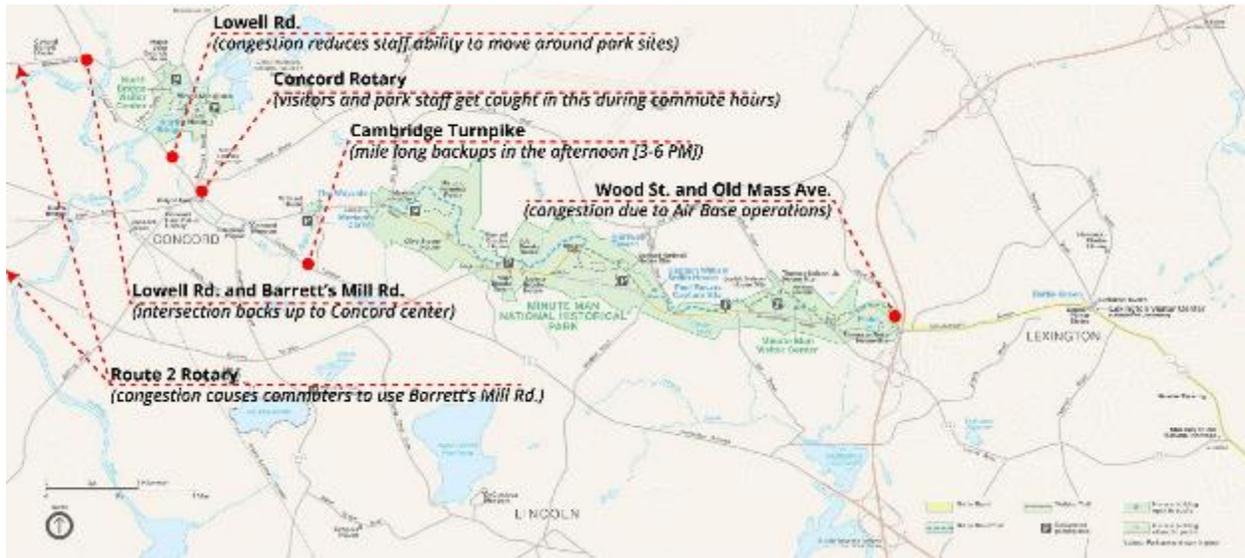
Source: (Richardson, Breck and Wood 2019)

Figure 11 illustrates additional roadway congestion issues near but outside of MIMA park boundaries.<sup>33</sup> Many of these congestion points are located on roadways in and around Concord. This is in line with the findings of Concord's CLRP, which cites anecdotal evidence about the increase in traffic on local roads. This is perhaps due to apps such as Waze, which often directs commuters off Route 2 during peak commuting hours and into the town of Concord.<sup>34</sup>

<sup>33</sup> (Richardson, Breck and Wood 2019)

<sup>34</sup> (Concord Comprehensive Long Range Plan Committee 2018)

Figure 11: Identified Roadway Congestion Hotspots outside MIMA Boundaries



Source: (Richardson, Breck and Wood 2019)

## *Summary of Previous Studies*

### NPS Shuttle Studies

As early as the 1971 Interpretive Prospectus, the NPS had a vision for a mass transit program within MIMA.<sup>35</sup> The original idea was for two routes departing from the anticipated Minute Man Visitor Center (not yet constructed) where it stands today. One route would go to Lexington and the Battle Green and the other to Concord and the North Bridge. The initial idea was for the service to be “hop-on, hop-off” with interpretive programming for which visitors would pay a modest fee. The 1971 Interpretive Prospectus identified 14 stops for the transit system and provided ideas for interpretation. NPS planners justified the system by arguing that the personal car “is incompatible with the historical and environmental character that the Service seeks to achieve here.”<sup>36</sup> This was around the time that NPS planners were also hoping that the state would relocate Route 2A which would alleviate some traffic strain around the park; this relocation never happened.

In 1974, there was discussion between NPS and Concord’s Board of Selectmen to create a new parking lot at North Bridge to accommodate the heavy visitation there. The project did not proceed due to objections that a new parking lot would be detrimental to the historical site and would only encourage more traffic and parking congestion. An attractive alternative for many was to have a shuttle bus service to reduce the number of vehicles at North Bridge while accommodating more visitors.

NPS initiated a pilot shuttle program in July and August of 1975 (the new Minute Man Visitor Center had not completed construction at the time), funded by the U.S. Department of the Interior. The route picked visitors up at the former Fairway Restaurant on Route 2A

<sup>35</sup> (Zenzen 2010)

<sup>36</sup> (National Park Service 1971)



in Concord and took them to North Bridge and back. The pilot concluded that visitors preferred to stay with their car and tour the park themselves. With low ridership, NPS deemed the pilot shuttle a financial failure.<sup>37</sup>

MIMA later contracted a private planning firm, Vollmer Associates, in 1976, to conduct a transportation study for a mass transit system through MIMA. The firm could not determine an accurate estimation of visitors who would use the shuttle. Thus, they recommended that the park run a trial operation of four chartered buses on a fixed schedule originating at the Minute Man Visitor Center, taking a tour of the Battle Road and North Bridge. The firm emphasized that the success of the system would depend on aggressive marketing and outreach to visitors, as well as providing a well-guided tour, a service unavailable to visitors making the tour in their own private vehicles. The park experimented with various shuttles in the intervening years with little success.<sup>38</sup> The park found a more effective method of reducing parking pressure on the North Bridge by relocating living-history presentations to the new Minute Man Visitor Center.<sup>39</sup>

### Concord Shuttle Studies

Concord's long-range plan mentions a previous shuttle bus service. According to town staff, the Recreation Department operated the service, using a refurbished school bus. Concord discontinued the service due to low ridership, rising maintenance expenses, and difficulty finding qualified drivers. This left private shuttles to fill the void. However, these transportation services are funded by specific grants or have other limitations, which restrict service providers to only using their vans/buses for their constituents. For example, the Council on Aging can provide shuttle service to transport Concord seniors, age 65 and older, around town for medical appointments, trips to the bank, haircuts, events at the Council on Aging, and more. It cannot serve other age groups.<sup>40</sup>

Most recently, Concord received a grant for a Workforce Transportation shuttle service in coordination with CrossTown Connect, a Transportation Management Association (TMA),<sup>41</sup> which has already developed four successful shuttles in Massachusetts. The shuttle's purpose is to alleviate traffic and parking congestion and improve mobility. There are two commuter rail stops in downtown Concord with no other transit connections aside from the aforementioned private shuttle services. Concord sought a flexible means to move residents, visitors, and workers around town for work and other essential activities while reducing emissions. The proposal recommended a fixed route shuttle between the commuter rail stations and major employment centers.<sup>42</sup>

CrossTown Connect recommended that the proposed shuttle should have an automatic vehicle locator (AVL) so that riders could know the real-time location of the shuttle, and a marketing and awareness campaign should include flyers, mailings, news segments, social media, and a website to promote the service. The proposed route contains stop locations

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<sup>37</sup> (Zenzen 2010)

<sup>38</sup> The firm recommended the park collect data such as visitation, mode of access, boardings, time spent at the park, and arrival/ departure patterns; this data was either not collected during the trials or lost

<sup>39</sup> (Zenzen 2010)

<sup>40</sup> (Concord Comprehensive Long Range Plan Committee 2018).

<sup>41</sup> A TMA is a partnership between businesses, municipalities, residential communities, property developers, and stakeholders. Participants join together to reduce traffic congestion, air pollution, and improve transportation mobility options in a region

<sup>42</sup> (CrossTown Connect 2019)

that collectively employ more than 4,000 workers and would run from 7 AM to 7 PM. With conservative estimates, first year ridership is estimated to be about 30 one-way riders per day, but that number is expected to grow over time with more visibility. CrossTown Connect will monitor the program for cost effectiveness by tracking boarding and alighting to calculate cost per mile, cost per rise, trips per miles, and trips per hour of the system.

MassDOT awarded CrossTown Connect a \$160,000 Workforce Transportation Grant in February of 2020 to fund the Concord Shuttle. Concord will provide a \$38,000 matching contribution. This project is expected to commence in fall 2020, although it may be delayed due to current concerns about the novel coronavirus (COVID-19) pandemic.<sup>43</sup> Figure 12 shows the service routes.

Previously, Concord, in partnership with MIMA, had submitted another related proposal in 2018 as an application for the Federal Lands Access Program. That application highlighted a dual purpose for a proposed shuttle that would transport employees into town at rush hour and at other times sustainably move visitors to MIMA and Great Meadows National Wildlife Refuge, which lays north of Concord.

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<sup>43</sup> (Town of Concord Select Board 2020)



Figure 12: Map of Concord's Workforce Transportation Shuttle; Stop #1 and #10 are Commuter Rail Stations and Others Are Employment Centers, Hospitals, and Hotels



Source: (CrossTown Connect 2019)

### Lincoln Shuttle Studies

The Town of Lincoln's 2009 Comprehensive plan recognizes increasing traffic and raises the idea of a shuttle service to mitigate traffic congestion. The town has not yet pursued a shuttle service.<sup>44</sup>

### Lexington Shuttle Studies

The towns of Lexington, Burlington, and Bedford were part of the Tri-Town Transit Study conducted by Foursquare ITP, a multimodal transportation-planning firm. This study aimed to improve MBTA, Lexpress, and other municipal transit services in the area based on a

<sup>44</sup> (Community Opportunities Group, Inc. 2009)

systematic approach. The approach consisted of studying the area to determine transit potential, transit need, and a service index for the three towns to inform transit recommendations.

The findings of the Tri-Town Transit Study are only tangentially relevant to the present study, for two reasons:

- The study area only overlaps in one portion of Lexington.
- The Tri-Town Transit Study did not focus on visitor access to cultural/historic/recreational destinations.

The Tri-Town Transit Study did not recommend a new service, given the area's saturation of bus services including Lexington's Lexpress. Figure 13, Figure 14, and Figure 15 illustrate the study's assessment of Lexington's transit potential, transit need, and service index by census tract. Transit potential is a consideration of the population in relation to employment densities. Traditional transit need is determined by compiling concentrations of populations most likely to need transportation: older adults, youth and young adults, people with disabilities, low-income households, and zero-vehicle households. The service index is similarly determined by compiling concentrations of basic services that may also serve as employment centers: retail/ restaurant services, educational services, government services, healthcare services, and recreational services.<sup>45</sup>

The report recommended (1) the creation of a streamlined fixed route service connecting the three towns, (2) taking on a micro-transit project through the vendor, Via, and (3) continuing to fund a demand-response service<sup>46</sup> as a "safety net" for populations who would not be well-served by the first two service categories.<sup>47</sup> After the report, Lexington discovered that the second recommendation was cost-prohibitive.

The three towns then went to 128 Business Council, a private research organization,<sup>48</sup> with Foursquare ITP's final draft plan for review. 128 Business Council then returned to the three towns with questions, concerns, and corrections at an in-person meeting in May of 2019.<sup>49</sup> The draft report was updated based on the three Towns' and the 128 Business Council's input and submitted back to Foursquare ITP in June of 2019. 128 Business council suggested short, medium, and long-term solutions:

- Re-evaluate current schedules and routing within the parameters of existing contracts
- Systematize daily ridership counting procedures to record every ride without the need for separate study
- Undertake data collection across both residential and employee populations to gather real-trip origin-destination pairings tied to current mode usage and trip time of day

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<sup>45</sup> (Foursquare ITP 2019)

<sup>46</sup> "Demand response" is any non-fixed route system of transporting individuals that requires advanced scheduling by the customer, including services provided by public entities, nonprofits, and private providers- often called paratransit

<sup>47</sup> (Foursquare ITP 2019)

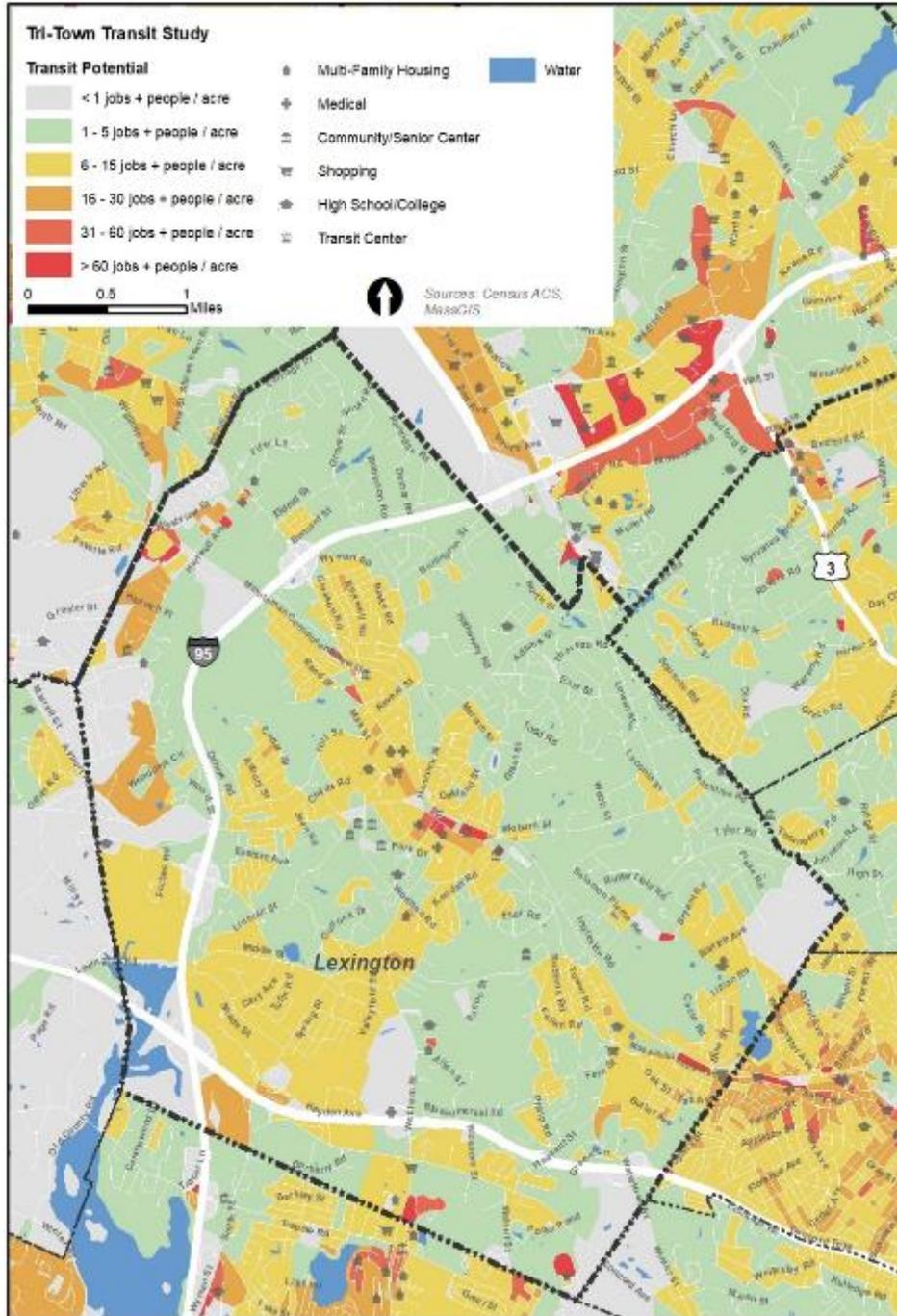
<sup>48</sup> 128 Business council's mission is to offer innovative transportation solutions; they conduct research but also provide private commuter shuttles in the area

<sup>49</sup> (128 Business Council 2019)



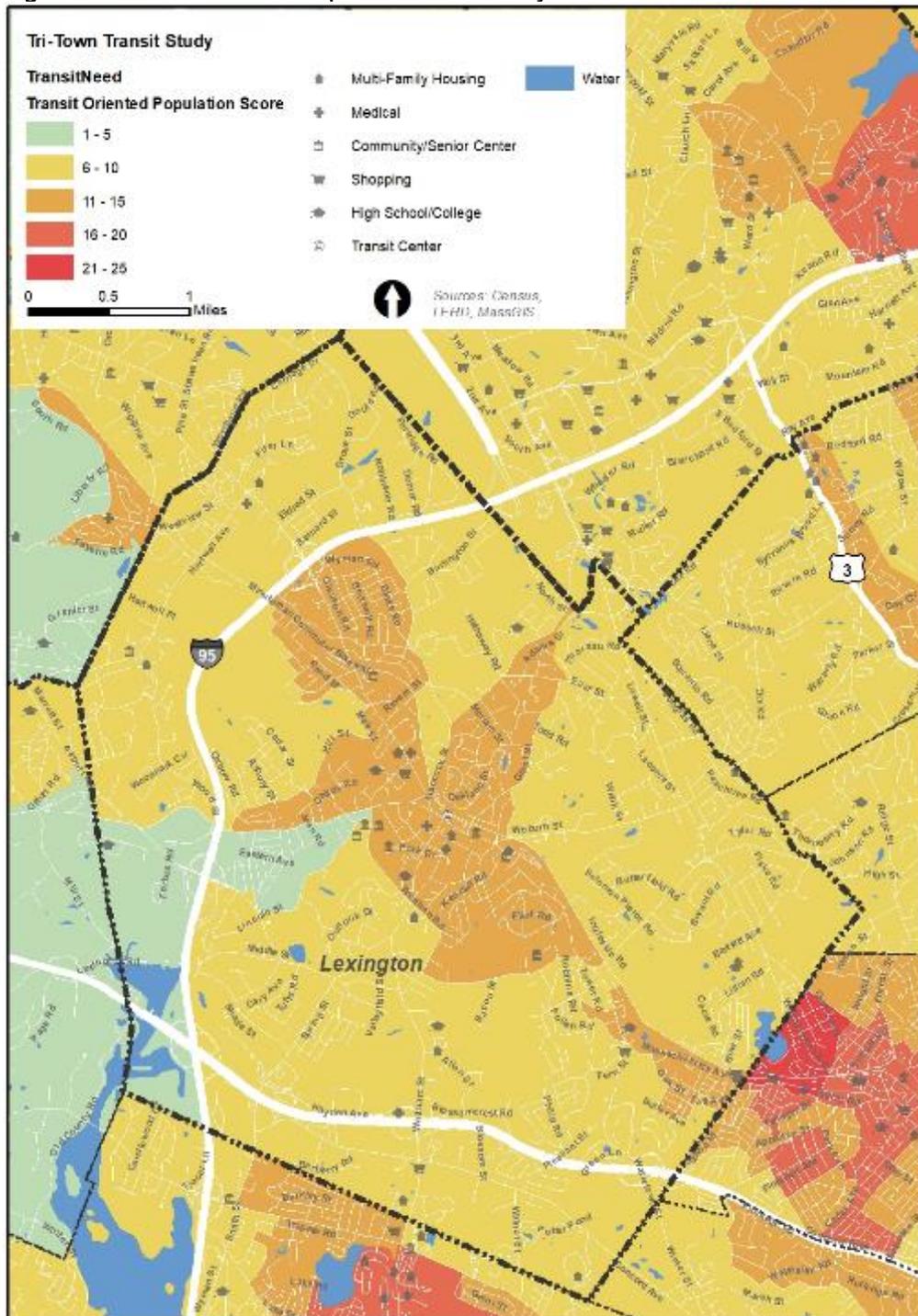
- Start talking to municipal leaders and the public about integrating school transportation budgets, contracts, and infrastructure with other public transportation needs
- Overhaul town permitting processes to start building incentivized private-sector partners for local public transportation financing and route-building

Figure 13: Transit Potential of Lexington Based on Densities of Jobs and People



Source: (Foursquare ITP 2019)

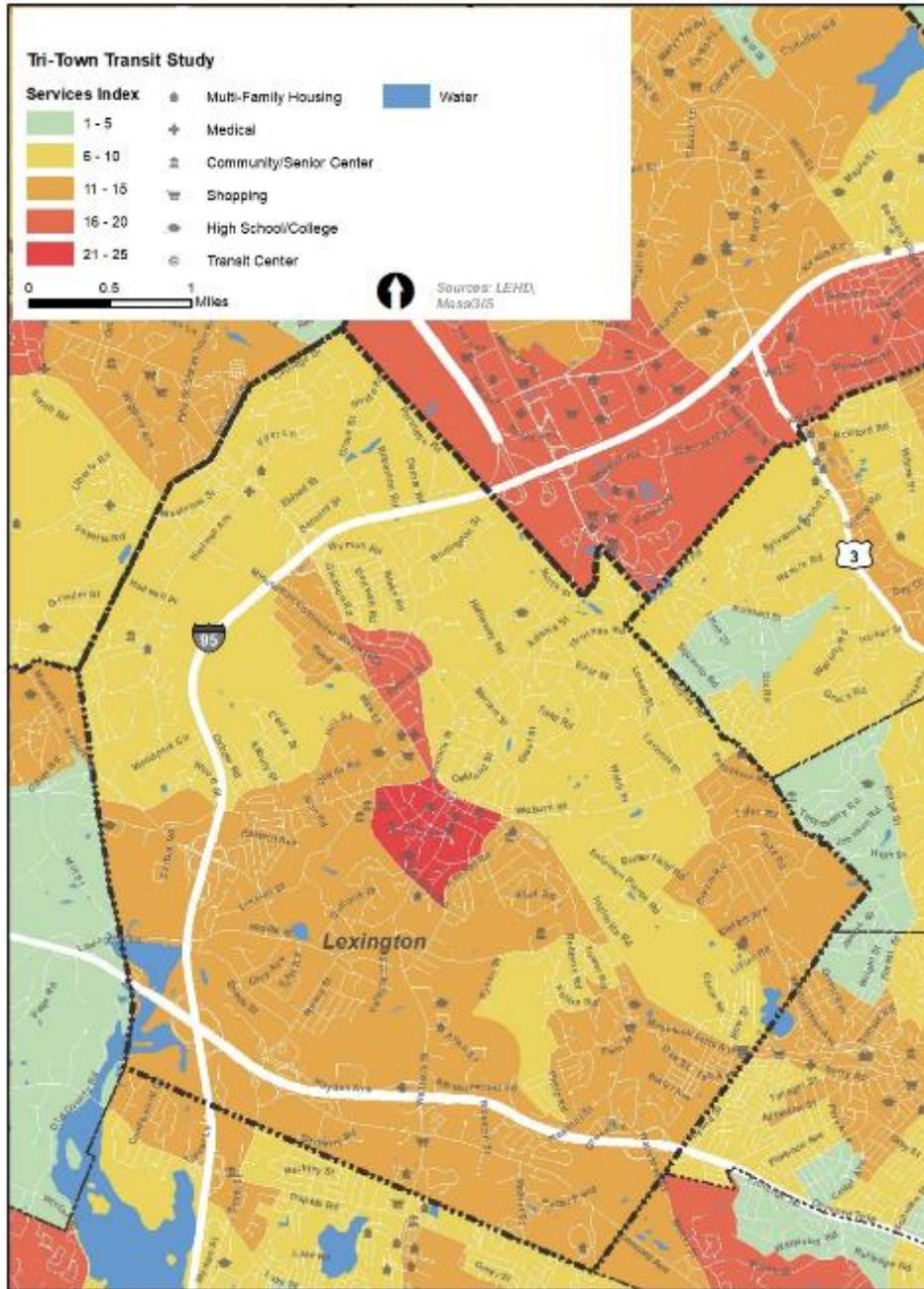
Figure 14: Concentrations of Populations More Likely to Need Transit



Source: (Foursquare ITP 2019)



Figure 15: Map of a Composite Service Index of High-Need Destinations Including Recreational Services



Source: (Foursquare ITP 2019)

## Transit Scenarios

This section describes some possible transit scenarios and supporting context.

### *Summary*

This section begins with a high-level comparison of the scenarios and then summarizes aspects that are common to all. The subsequent section describes each scenario in detail.

### Scenarios at a Glance

Table 5 shows shared and unique characteristics across the scenarios.



**Table 5: Scenarios Summary for Town-Led Shuttle Service in and around MIMA**

Characteristic	Scenario One (All Stops)	Scenario Two (Fewer Stops)	Scenario Three (Flexibility)
Routing	Two fixed routes, with one common stop (Minute Man Visitor Center): (1) East-West, Lexington-Concord; and (2) North-South, Lincoln.		Two fixed routes with limited stops that “flex” for additional set stops on request.
Interpretation	All scenarios assume interpretation, either live or recorded.		
Fare	All scenarios include “free” and “fare” sub-scenarios. Possibility for shuttle ticket purchase to be valid for discount on site fees.		
Seasonal Operation	April – October		
Hours/Days of Operation	9:30 AM – 4:30 PM, seven days per week		
Number of Stop Locations	18	14	8 fixed plus 10 on-request
Sites <b>without</b> a Stop within 0.1 mile (Parentheses Show Distance to Nearest Walkable Stop)	Hancock-Clarke House (0.4 miles)	Concord MBTA (0.5 miles) North Bridge Visitor Center (0.4 miles) Hancock-Clarke House (0.4 miles) Munroe Tavern (0.9 miles) Scottish Rite Museum (1.5 miles) Gropius House (N/A) Codman Farm (0.3 miles)	Hancock-Clarke House (0.4 miles), although only 8 sites have fixed stops, and the remainder are “on-request” only.
Roundtrip Travel Time (Minutes) <i>Range due to flex stops.</i>	East-West: 109 North-South: 59	East-West: 78 North-South: 52	East-West: 57 ( <i>109 with flex</i> ) North-South: 35 ( <i>59 with flex</i> )
Headway (Minutes) <sup>50</sup> <i>Range due to fleet size – more vehicles enable shorter headways.</i>	East-West: 36-54.5 North-South: 32	East-West: 39 North-South: 26-52	East-West: 28.5-109 North-South: 35-59
Vehicles in Operation	4-5	3-4	2-3

Source: Volpe Center analysis

<sup>50</sup> Headway is the average time interval between vehicles traveling in the same direction on a route.

Table 6 shows total cost estimates for each scenario over the course of an operating season from April to October. In these scenarios there are different options that affect cost, labeled as high or low. In the transportation row, the high-cost option is the trolley and the low-cost option is the mini-bus. For Scenarios One and Two, the high-cost option for automatic vehicle locator (AVL) is to include a basic AVL system, and the low-cost option is to omit the AVL. *Scenario Three* requires a more sophisticated AVL system in order to be viable, so the high-cost option is higher, and there is no low-cost option. It requires the Stop Hopper technology described below, or equivalent. The coordinator row has a full-time seasonal employee as the high-cost option, and a part-time seasonal coordinator as the low-cost option. Interpretation assumes a live guide as the high-cost option and a recording and/or brochures as the low-cost option. The cost of providing a recorded narration is not known at this time, but the estimate assumes that it would primarily entail a one-time upfront cost, and very little recurring costs. The remaining rows assume a high (direct) cost option of contracting for these activities, and a low-cost option of performing them in-house, although this would still incur an indirect cost by diverting staff from other activities. More information is in the individual scenario sections.



Table 6: Cost Summary for Town-Led Transit Scenarios in and around MIMA

Category	High/ Low Options	1A: 4 vehicles	1B: 5 vehicles	2A: 3 vehicles	2B: 4 vehicles	3A: 2 vehicles	3B: 3 vehicles
Headway (in Minutes)		E-W route: 54.5  N-S route: 32	E-W route: 36  N-S route: 32	E-W route: 41  N-S route: 52	E-W route: 41  N-S route: 26	E-W route: 57-109  N-S route: 31-59	E- W route: 28.5-54.5  N-S route: 31-59
Transportation (vehicles, driver wages, insurance, maintenance, fuel, dispatch, back-up vehicle)	<i>High:</i> Trolley	\$691,900	\$864,800	\$518,900	\$691,800	\$345,900	\$518,900
Transportation	<i>Low:</i> Mini-bus	\$596,400	\$746,500	\$447,300	\$596,400	\$298,200	\$447,300
AVL (including provision of information to public)	<i>High:</i> AVL *Scenario 3 requires particular technology	\$5,900	\$7,000	\$4,700	\$5,900	\$12,600*	\$18,900*
AVL	<i>Low:</i> No AVL	\$0	\$0	\$0	\$0	N/A	N/A
Coordinator	<i>High:</i> Full time. 6 Days/Week 7 Hours/Day	\$31,500	\$31,500	\$31,500	\$31,500	\$31,500	\$31,500
Coordinator	<i>Low:</i> Part time. 3 Days/Week 7 Hours/Day	\$15,800	\$15,800	\$15,800	\$15,800	\$15,800	\$15,800
Interpretation	<i>High:</i> Live narration	\$89,500	\$111,800	\$67,100	\$89,500	\$44,700	\$67,100

Category	High/ Low Options	1A: 4 vehicles	1B: 5 vehicles	2A: 3 vehicles	2B: 4 vehicles	3A: 2 vehicles	3B: 3 vehicles
Interpretation	<i>Low:</i> Recorded narration	TBD	TBD	TBD	TBD	TBD	TBD
Advertising	<i>High:</i> Incur direct costs	\$19,200	\$19,200	\$19,200	\$19,200	\$19,200	\$19,200
Advertising	<i>Low:</i> Towns perform in-house	\$0	\$0	\$0	\$0	\$0	\$0
Supplies, Printing, and Other Services	<i>High:</i> Incur direct costs	\$13,500	\$13,500	\$13,500	\$13,500	\$13,500	\$13,500
Supplies, Printing, and Other Services	<i>Low:</i> Towns perform in-house	\$0	\$0	\$0	\$0	\$0	\$0
Seasonal Total Gross Cost (High)		\$851,500	\$1,047,800	\$654,900	\$851,500	\$467,400	\$669,100
Seasonal Total Gross Cost (Low)		\$612,200	\$762,300	\$463,100	\$612,200	\$326,600	\$482,000
Seasonal Revenue (High) Assuming a Fare of \$18		\$118,900- \$598,100	Same as 1A	\$118,900- \$598,100	Same as 2A	\$118,900- \$598,100	Same as 3A
Seasonal Revenue (Low) Assuming a Fare of \$7		\$46,200- \$232,600	Same as 1A	\$46,200- \$232,600	Same as 2A	\$46,200- \$232,600	Same as 3A

Source: Volpe Center analysis

### Common to All Scenarios

The sections that follow summarize cross-cutting issues for all scenarios. Also see the Peer Systems section on page 82 for background information that helped inform the scenarios.



### Coverage versus Frequency

The three scenarios use different approaches for balancing a tradeoff: coverage versus frequency. Stopping at more locations increases coverage by reducing walking distances; however, this also increases travel times and resulting headways (assuming a fixed number of vehicles in operation). Adding vehicles reduces headways, but at higher cost. Table 7 below illustrates the findings of research from the Transportation Research Board. It indicates how users respond to various levels of service (LOS) based on the headway.

Table 7: Transit Levels of Service

Level of Service	Headway (minutes)	Frequency (Vehicles per Hour)	Comments
A	<10	>6	Passengers don't need schedules
B	10-14	5-6	Frequent service, passengers consult schedules
C	15-20	3-4	Maximum desirable time to wait if bus/train missed
D	21-30	2	Service unattractive to choice riders
E	31-60	1	Service unavailable during hour
F	>60	<1	Service unattractive to all riders

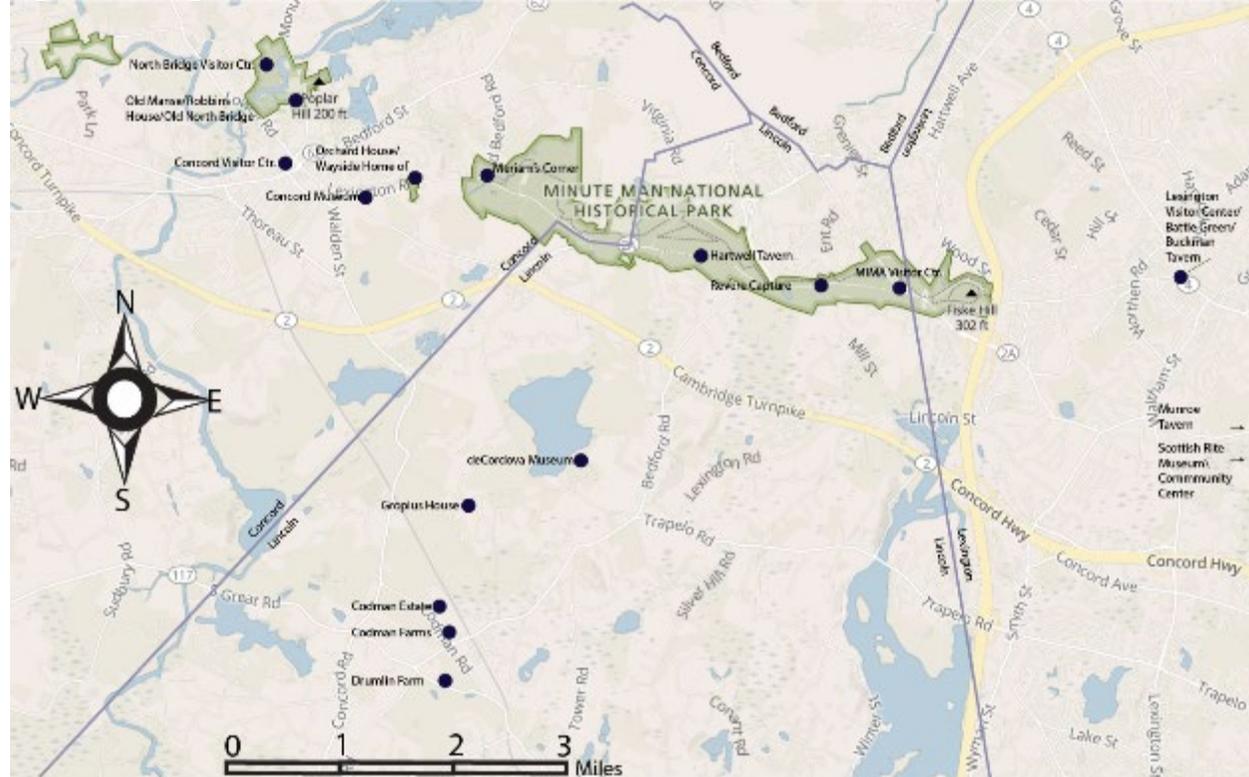
Source: (Transportation Research Board and National Academies of Sciences, Engineering, and Medicine 2013)

Given that an LOS of F is “unattractive to all users,” the scenarios presented include the minimum number of vehicles such that passengers would never need to wait longer than one hour. The source explains that research has shown that these levels of service apply regardless of the type of service.

### Routing and Headways

The 22 identified points of interest lie in a configuration illustrated in Figure 16. A logical way to connect these points is by breaking them up into two separate routes: an east-west route with termini at or near Concord center to the west and at or near Lexington center to the east; and a north-south route with a northern terminus at the MIMA Visitor Center and southern terminus near south Lincoln. All of the scenarios use this common route framework.

Figure 16: Configuration of Identified Points of Interest for Town-Led Shuttle Service in and around MIMA



Source: Google Maps and Stakeholder Input

The Volpe Center relied largely on Google Maps in calculating driving and walking times between two points. These data helped inform researchers on which points to include or exclude in different scenarios. Specifically, the Volpe Center used the Google Maps Directions Application Program Interface (Google Maps API). “The [Google Maps] API returns the most efficient routes when calculating directions. Travel time is the primary factor optimized, but the API may also take into account other factors such as distance, and number of turns when deciding which route is the most efficient.”<sup>51</sup>

Since this is a feasibility study, the estimated headways are rough approximations, based solely on drive time and dwell time, absent any significant traffic. The actual headways of the vehicles would likely be longer than the estimates presented in this study, for several reasons.

- **Traffic:** The above method reflects current driving times, but underestimates future driving times, assuming that traffic congestion will increase with recovery from the COVID-19 pandemic. Other datasets provide historical traffic volumes at various points, but these data are not detailed enough to predict travel times.
- **Break/cleaning times:** The headways do not budget times for drivers to take breaks or clean vehicles. A posted schedule would also need to consider these factors, in addition to traffic.

<sup>51</sup> <https://developers.google.com/maps/documentation/directions/overview>



### *Interpretive Aspects*

The town of Lexington has expressed a desire for guided interpretation as part of a shuttle. For this reason, all scenarios assume some form of interpretation. The “high” cost option assumes live interpretation from a tour guide, and the “low” cost option assumes recorded interpretation, or simply pamphlets with a map of the shuttle routes, schedule, and descriptions of points of interest. Further analysis could explore a scenario variant that provides live interpretation during peak visitation times, and recorded interpretation at other times. As one example, the Zion National Park shuttle has recorded interpretation that plays on its shuttle in one direction. In the reverse direction, the recording does not play, allowing park staff to augment the narration and answer questions.<sup>52</sup> Interpretation would likely increase ridership, as the shuttle would then be an attraction and not just a form of transportation.

### *Ridership Estimation*

This analysis estimates ridership for the shuttle scenarios based on a review of ridership data from peer shuttle bus services. Peer shuttle services include those in the 2018 NPS National Transit Inventory that provide voluntary “mobility to or within the park,”<sup>53</sup> as well as the Liberty Ride.

The method involved dividing ridership by overall relevant visitation (for the sites served during the shuttle’s operational months) for each peer service, in order to calculate “ridership as a percentage of visitation,” or “relative ridership,” a metric that is comparable across systems, regardless of size.

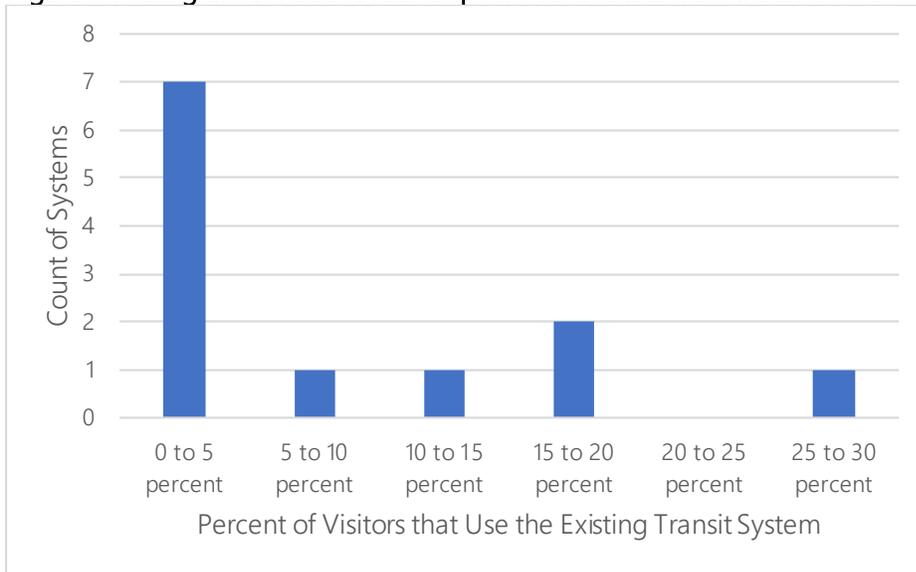
The 12 shuttle systems from the 2018 NPS National Transit Inventory had an average relative ridership of eight percent. However, the median is only 2.5 percent, which indicates that most services have much lower relative ridership. Figure 17 below shows a histogram of this metric for these peer shuttles.

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<sup>52</sup> (National Park Service 2018)

<sup>53</sup> (Washington Support Office 2018)

Figure 17: Histogram of Relative Ridership for Peer Shuttles from the 2018 NPS Transit Inventory



Source: (Washington Support Office 2018)

See Table 8 to compare these services based on operating seasons, fare, relative ridership, and qualitative notes. No two parks and no two transit systems are identical, which makes estimating ridership difficult. Some peer services serve areas with extreme parking congestion and are free of charge, resulting in high relative ridership; examples include the Grand Canyon’s South Rim shuttle (ridership represents 30 percent of visitation) and the Yosemite Valley shuttle (14 percent).

In contrast, the Yosemite Area Regional Transportation System (YARTS) shuttle has a lower relative ridership of just one percent; this could be because it serves a different function, displacing automobile trips entirely by bringing visitors to the park from the nearby town. It could also be due to the fare or the geographic context. Similarly, the Fairfax Connectors Wolf Trap Express, which connects Washington Metropolitan Area Transit Authority (WMATA) trains to Wolf Trap National Park for the Performing Arts (WOTR), may have a relatively low ridership (one percent) due to its function, or because it requires a five dollar fare. The Muir Woods Shuttle also connects a park to surrounding municipalities. However, unlike the above examples, the park restricts on-site parking, and requires parking reservations, resulting in a much higher relative ridership of 19 percent.

Relative ridership for the Liberty Ride in the most recent year was 2.8 percent. This calculation is based on visitation for all sites where the Liberty Ride stops, even though the Liberty Ride only allows passengers to alight and re-board at the North Bridge. At other sites, passengers remain on the vehicle while it pauses and the tour guide provides live interpretation. These sites include Lexington Visitor Center, Battle Green, Hancock-Clark House, Fiske Hill, Orchard House, North Bridge, and Munroe Tavern. The calculation did not use visitation for other locations where the Liberty Ride drives by but does not stop: MIMA and Concord Center.

Based on the data from the peer services, this analysis uses conservative bounds for expected relative ridership on a proposed shuttle, ranging from 0.5 percent to 2.5 percent.



The MIMA shuttle would most closely resemble the Roosevelt Ride, the Fairfax Connectors Wolf Trap Express, and Liberty Ride in terms of the context (similar traffic patterns, area coverage, connections to transit, historical significance, etc.). Specifics of the shuttles from the 2018 NPS Transit Inventory, a few interpretive tours, and the Liberty Ride are in Table 8 below.

Table 8: Peer Shuttle Services for Town-Led Shuttle Service in and around MIMA (2018)

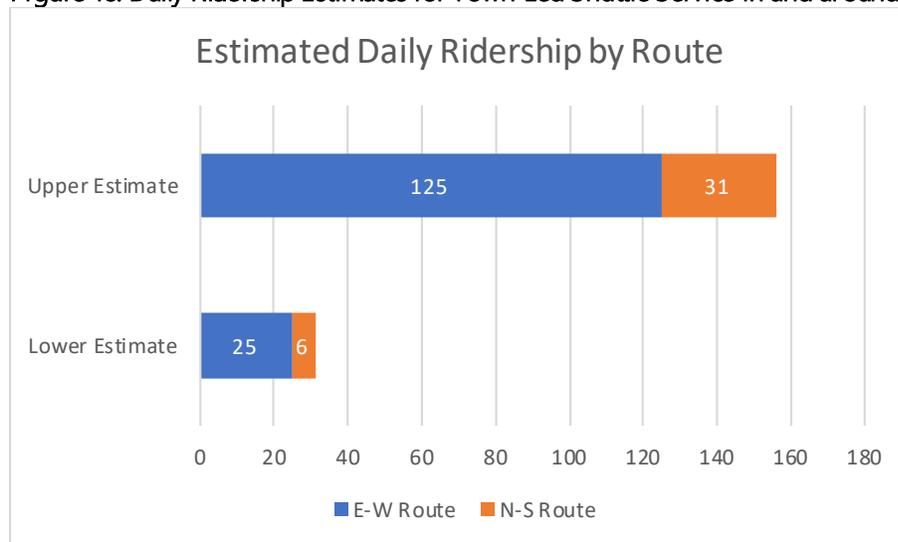
System Name	Description	Relative Ridership (% of Visitation)	Service Start	Service End	Fare
Acadia Island Explorer	Hop-on hop-off service connecting trails	11.88	May 24	Oct 9	Free
Bryce Canyon Shuttles	Aims to reduce parking congestion in the park	18.59	Apr 24	Oct 29	Free
Fairfax Connectors Wolf Trap Express	Connects WMATA subway to WOTR for shows in the summer	1.06	May 25	Sep 17	\$5
Glacier Hiker Shuttle	Alt. to driving, no parking or traffic issues noted	0.09	Jun 5	Sep 18	Free
Glacier Sprinter and Optima Shuttles	Alt. to driving, no parking or traffic issues noted	2.44	Jul 1	Sep 24	Free
Grand Canyon North Rim Shuttle	Alternative to driving to one specific trail	0.02	May 15	Oct 15	Free
Grand Canyon South Rim Shuttle	Alternative to driving to trails, points of interest, and hotels where there is parking congestion	30.12	Jan 1	Dec 31	Free
Roosevelt Ride	Shuttle connecting subway to 3 NPS sites	2.07	May 1	Oct 31	Free
Muir Woods Shuttle	Takes visitors from 3 outlying towns to Muir Woods	18.53	Jan 1	Dec 31	\$3 Round Trip, plus \$8.50 per vehicle for shuttle parking
Sequoia Gateway Shuttle	Serves the park and multiple stops outside the park	1.26	May 25	Sep 4	\$20
YARTS	Local transit to Yosemite from neighboring towns, about 2+ hour runs	1.13	Jan 1	Dec 31	\$5-22
Yosemite Valley Shuttle	Smaller scale shuttle stopping at destinations in the Valley	13.65	Jan 1	Dec 31	Free

System Name	Description	Relative Ridership (% of Visitation)	Service Start	Service End	Fare
Liberty Ride <sup>54</sup>	Guided interpretive tour through the same area the MIMA shuttle would cover	2.82	Apr 1	Oct 27	\$12-28

Source: (Washington Support Office 2018)

To estimate relative ridership for the proposed shuttle service, this analysis used seasonal visitation (April through October) for the requested stops found in the Goals for Shuttle Service and Requested Stops section and multiplied by 0.5 percent for the lower ridership estimation and 2.5 percent for the upper ridership estimation.<sup>55</sup> Dividing by operating days and hours produced daily and hourly estimates, respectively, with the coarse assumption that visitation is relatively constant. Figure 18 and Figure 19 show the results. These estimates are based on the suggestion that the shuttle only runs April through October from 9:30 AM to 4:30 PM.

Figure 18: Daily Ridership Estimates for Town-Led Shuttle Service in and around MIMA



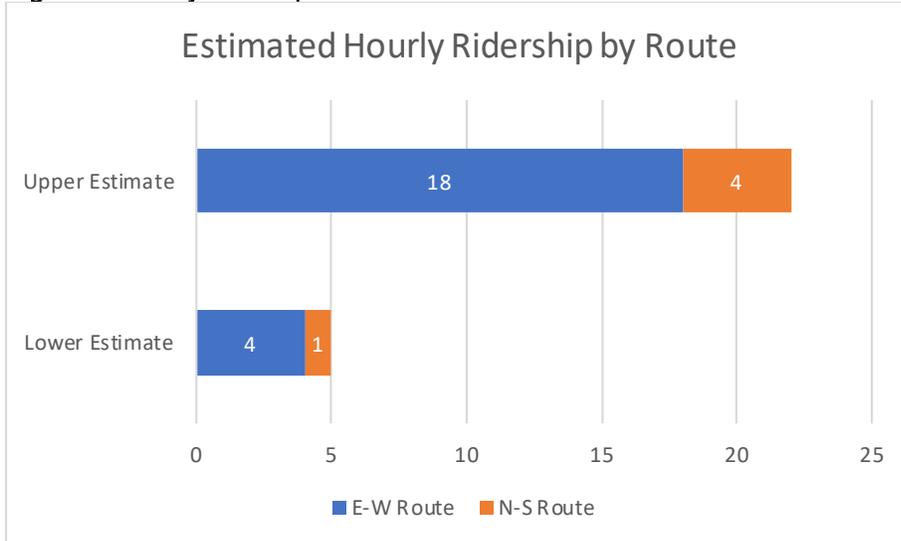
Source: Volpe Center analysis, (Washington Support Office 2018)

<sup>54</sup> The data used for the Liberty Ride are from 2017 (the most recent full year of data) whereas the data for the rest of the peer services are from 2018.

<sup>55</sup> While the peer shuttles had relative ridership values ranging from 0.02 percent to 30.12 percent, the research team determined that a more narrow range of 0.5 percent to 2.5 percent seemed most likely for this proposed shuttle service, considering its characteristics in relation to those of the peer shuttles.



Figure 19: Hourly Ridership Estimates for Town-Led Shuttle Service in and around MIMA



Source: Volpe Center analysis, (Washington Support Office 2018)

The ridership estimates presented in this document are initial coarse hypotheses, from which stakeholders can begin to make decisions. This analysis uses the same range of ridership estimates for all scenarios, and all fare levels; while it is true that changing the scenario attributes and the fare level will affect ridership, we do not have sufficient data to capture these changes quantitatively. The overall relative ridership range of 0.5 to 2.5 percent is designed to capture the range of these influences, without conveying a false sense of precision that would be implied by showing quantitative ridership differences between specific scenario/fare combinations. Town stakeholders could consider administering a survey to existing and potential visitors to better understand how many visitors would be willing to ride a shuttle between these points of interest.

### *Seasonality*

MIMA sites and many of the other proposed shuttle stops have a seasonal trend in visitation. This analysis assumes a seasonal operation from April to October, 9:30 AM to 4:30 PM, and does not attempt to assess the feasibility of year-round service. Sites with sufficient data show approximately 80 percent of visitation from April to October, with the remainder of the year only accounting for 20 percent. Three quarters of the peer shuttles also have seasonal visitation and only operate seasonally, typically from May or July through September or October. Stakeholders could consider offering a shuttle in some form throughout the year, if there is an interest in broadening the shuttle’s purpose; that could be a separate, additional analysis.

### *Fare versus Free*

A fare could provide revenue to pay for operating costs, but it would also reduce ridership. Typically transit demand is very elastic (i.e., sensitive) to fare changes, but there is no single elasticity that best fits all cases. For this analysis, data are insufficient to predict the ridership impacts of fare levels at a granular level.

Urban area size and initial fare level are the major variables effecting fare elasticity; large urban areas and large fare increases both lead to greater elasticity of transit demand.<sup>56</sup> The former can be explained by understanding that a larger urban area likely has more alternatives to transit than rural areas. In rural areas the only options may be car or transit whereas urban areas may be accessed by walking, biking, scootering, or ride hail services. MIMA is a developed suburban area, not fully urban.

From 1973 to 2004, Kennesaw Mountain National Battlefield Park operated a free shuttle service that brought visitors to the top of Kennesaw Mountain. In June of 2004, the service introduced a two-dollar fare and ridership immediately dropped 25 to 30 percent, eventually settling at approximately half of its former level without any corresponding change in visitation.<sup>57</sup> As of 2019, the structure changed again, such that the shuttle is again available at no additional charge beyond the price of a day pass or annual pass. The impact of this most recent change on ridership is not yet known, as data are not yet available.

The majority of the peer systems introduced in the ridership section provide a shuttle service for park visitors at no additional cost beyond the park entrance fee, and most often provide access within a park, connecting hikers and bikers to different trails. For example, Acadia's free shuttle runs a loop through the park, mostly connecting recreational points of interest, as well as some lodging. The few peer systems that do charge a separate fare all provide alternative access to their park from surrounding areas to fill in gaps local transit does not service. For example, the Fairfax Connectors Wolf Trap Express provides a shuttle from the WMATA station to WOTR and the Muir Woods Shuttle takes visitors from three surrounding towns into the Muir Woods National Monument. In this analysis, a hypothetical shuttle would fall somewhere in between these two types and a guided tour. It would provide access to multiple destinations within and beyond MIMA from three neighboring towns, and could provide connections to local transit, while also providing guided interpretation. Transit services tend to charge a relatively low fare. Lexpress charges \$2, the Fairfax Connectors Wolf Trap Express charges \$5, and MBTA's local buses charge \$1.70 for one-way trips. Interpretive tours tend to be more expensive. The Liberty Ride fare of \$28 for adults generates enough revenue to break even in a typical year.

Table 9 shows rough estimates of fares that would potentially be enough to cover operating expenses under the most optimistic assumptions, i.e., that the service selects all lowest cost options from

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<sup>56</sup> (Schimek 2015)

<sup>57</sup> (Volpe National Transportation Systems Center 2010)



Table 6 and that ridership is at the high end of the expected range. The fare required ranges from around \$5 to \$13. Given that these use the most optimistic assumptions, they may still result in a net cost to run the service. With this in mind, external funding sources would be necessary if many “high-cost” options are pursued for the MIMA shuttle. With the peer shuttles and these estimates in mind, this analysis assumes as a placeholder that the proposed shuttle charges somewhere between \$6 and \$15. As it is a hop-on hop-off service, riders would be able to keep their ticket to show the bus operator every time they hop on. The \$6 fare option may apply if only brochures and/or recorded narration are provided on board, while a \$15 or greater fare may be more appropriate if there is a live tour guide on board.

The proposed shuttle stops that charge an entry fee could potentially offer a discount to visitors that show proof of shuttle ticket purchase. This may offset the impacts of a fare on ridership, and make the service more attractive. Each point of interest could determine their own discount or incentive. One may offer a discount on their entry fee, another may offer a discount at their gift shop, and another may offer a service for free with the purchase of a shuttle pass such as a tour of the site’s grounds. Many of these points of interest charge different entry fees while some are free, which makes standardization of discounts difficult.

Table 9: “Break Even” Fares under Optimistic Assumptions (Low-End Costs and High-End Ridership) for Town-Led Shuttle Service in and around MIMA

	Scenario 1a	Scenario 1b	Scenario 2a	Scenario 2b	Scenario 3a	Scenario 3b
Fare	\$17.95	\$22.44	\$13.46	\$17.89	\$8.98	\$13.46

Source: Volpe Center analysis

### Payment Systems

If the service does collect a fare, payment systems will be necessary. One method would be to collect cash fares on-board. This might cause issues for visitors wanting to ride the shuttle with no cash or no nearby automated teller machine (ATM). Another option would be to set up each proposed stop with the capacity to take payment for the shuttle fare at their registers - cash or card. This may require some set up costs. Another option would be to have an app to collect fares via card, although if this were the only means to pay, it would exclude those without access to a banking system, credit card, or smartphone, and those uncomfortable entering their information into an app. The app option would also have start up fees to establish the app, as well as smaller on-going costs to keep the platform running. Potentially the same app could show riders the location of the shuttles via AVL technology. Similarly, the shuttle could collect fares online using a system such as Unipay,<sup>58</sup> which does not have any added costs.

Lexpress allows its riders to pay with cash onboard, tickets or passes. Passes can be paid online using the aforementioned Unipay system for no added fee for Lexpress. Rather, the ticket purchaser absorbs the small added fee. Lexpress tickets have sold at local stores for decades under a cash only system (\$20 for 14 tickets). Liberty Ride sells tickets online using Fareharbor or in person. Fareharbor similarly charges purchasers a small fee for credit card transactions. Liberty Ride also sells tickets through Viator and Trip Advisor

<sup>58</sup> Lexpress offers UniPay as one way to purchase a fare for their buses.

where a portion of the fee (same price charged through Fareharbor) goes to Viator and Trip Advisor and a portion goes to Liberty Ride. Liberty Ride also sells tickets through the Go Boston Program;<sup>59</sup> every time someone uses a Go Boston Card for Liberty Ride, Go Boston pays Liberty Ride about half the price of the ticket.

If the shuttle purpose were to broaden beyond solely tourism, an eventual partnership with the MBTA could theoretically allow riders to use a CharlieCard<sup>60</sup> to pay onboard the shuttle. Since visitors would need to acquire a CharlieCard, adding a step to the payment process, this option should not be implemented alone but rather could be considered to supplement another one of the above options. This option would require startup costs to cover the needed technology to accept a CharlieCard onboard. This option could be convenient for any riders connecting from the MBTA commuter rail lines, or from the 62/76 bus.

### *Vehicle Options*

Two possible vehicle types could serve all scenarios. Either one would have sufficient capacity for the estimated ridership, and likely be small enough to navigate the stop locations. Maintaining a desirable level of service (minimizing headway) is the primary limiting factor motivating the addition of more than one operating vehicle to the scenarios, rather than a need to add passenger capacity. Figure 20 shows the high-cost shuttle option, a 28 passenger historical trolley, similar to the one that the Liberty Ride has used in recent years. An historical trolley would not have a bicycle rack, so this may exclude some recreational uses of the shuttle. Figure 21 shows the low-cost option, a 23-24 passenger light-duty “cutaway” style shuttle bus, similar to what Lexpress operates on its routes. This would be at least \$35-45 cheaper per vehicle service hour.<sup>61</sup>

The hourly rates per vehicle service hour in the financial estimates include the costs of vehicle, driver, maintenance, insurance, fuel, backup vehicle, and dispatch. There is a possibility that the MIMA shuttle could share a backup vehicle with another local service, such as Lexpress or the Concord Workforce Shuttle, pending discussions with those entities. This could reduce costs, but might also reduce ridership if it removes the possibility of having a branded shuttle with vinyl wrapping displaying the name/logo on the vehicle exterior. Peer services have attributed ridership increases to successful branding. See the Peer Systems section for more information.

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<sup>59</sup> [The Go Boston Program](#) gives Boston Visitors access to 25+ attractions such as the Liberty Ride, Boston Duck Tour, and Franklin Park Zoo at a discount

<sup>60</sup> The CharlieCard is the payment method for MBTA, and several regional public transport systems in the U.S. state of Massachusetts. It is a MIFARE-based contactless smart card on which the passenger loads fares.

<sup>61</sup> (Joseph's Transportation 2020)



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Figure 20: 28 - Passenger Historical Trolley



Source: Joseph's Transportation (<https://www.josephslimousine.com/>)

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Figure 21: 24 - Passenger Shuttle Bus



Source: Goshen Coach, Goshen G-Force, and Richland Source

### *Shuttle Communication Technology*

All scenarios assume some form of AVL technology and corresponding communication to convey the information to passengers. Providing passengers with real-time information on the location of shuttle vehicles can enhance their experience and may attract more ridership. A more sophisticated system that additionally provides real-time information on expected wait times can provide an even better experience; however, this would be more expensive. Providing information via existing platforms such as Google Maps and the Transit app may be beneficial, as it would also provide information on other nearby transit services. The Shuttle Communication Technology Options section on page 88 describes options in more detail.

### *Details*

This section provides supporting information for the summary section above. It describes each scenario, followed by a summary of lessons learned from peer systems and an explanation of shuttle communication technology options.



## Scenario One: All Stops

*Scenario One: All Stops* illustrates a scenario in which a shuttle service errs on the side of stopping at a higher number of locations, minimizing the amount of walking a user would have to do to access the nearby points of interest. This scenario illustrates how a service would operate when the points of interest are grouped into many clusters, with each cluster including points of interest that are almost adjacent. The distance one would need to walk from the shuttle stop to a point of interest is at most 0.1 miles, with the exception of the Hancock-Clarke House, which requires a 0.4-mile walk.

### *Routing*

*Scenario One* includes 18 stops to accommodate all 22 points of interest identified by stakeholders. There are 12 stops on the east-west route and 7 on the north-south route (the Minute Man Visitor Center is common to both). Table 10 describes the stops that this scenario includes, grouped by cluster, and indicates how well each site can accommodate a large vehicle, how far a pedestrian would need to walk from the stop to other points in the cluster, as well as any noted walkability issues and accommodations on the walking route. The stops are generally arranged from east to west and do not indicate the order in which a shuttle would service them.

Table 10: *Scenario One* Stops by Cluster for East-West Route

Cluster	Point of Interest	Large Vehicle Accommodation	Shuttle Stop Location	Distance Walking from Stop	Walkability
Concord 1	Concord MBTA Commuter Rail	Medium	Yes	0.0 mi	N/A
MIMA 1	North Bridge Visitor Center	High	Yes	0.0 mi	Crosswalks: Yes; use trail not roadway
MIMA 2	North Bridge/Old Manse/Robbins House	High	Yes	0.0 mi	N/A
Concord Center	Concord Visitor Center	High	Yes	0.0 mi	N/A
Concord 2	Concord Museum	Medium	Yes	0.0 mi	N/A
Concord 2	Emerson House	Low	No	0.1 mi	Crosswalks: No Sidewalks: Yes; one side only
Concord 3	Orchard House/Wayside Home of Authors	Medium	Yes	0.0 mi	N/A
Concord 4	Meriam's Corner	Medium	Yes	0.0 mi	N/A
MIMA 3	Hartwell Tavern	High	Yes	0.0 mi	N/A
MIMA 4	Minute Man Visitor Center	High	Yes	0.0 mi	N/A
Lexington Center	Lexington Visitor Center/Buckman Tavern	High	Yes	0.0 mi	Formalized stop may require road markings
Lexington Center	Hancock Clarke House	Low	No	0.4 mi	Sidewalks: Yes Crosswalks: Yes
Lexington 1	Munroe Tavern	Low	Yes	0.0 mi	N/A
Lexington 2	Scottish Rite Masonic Museum & Library	High	Yes	0.0 mi	N/A

Source: Volpe Center analysis

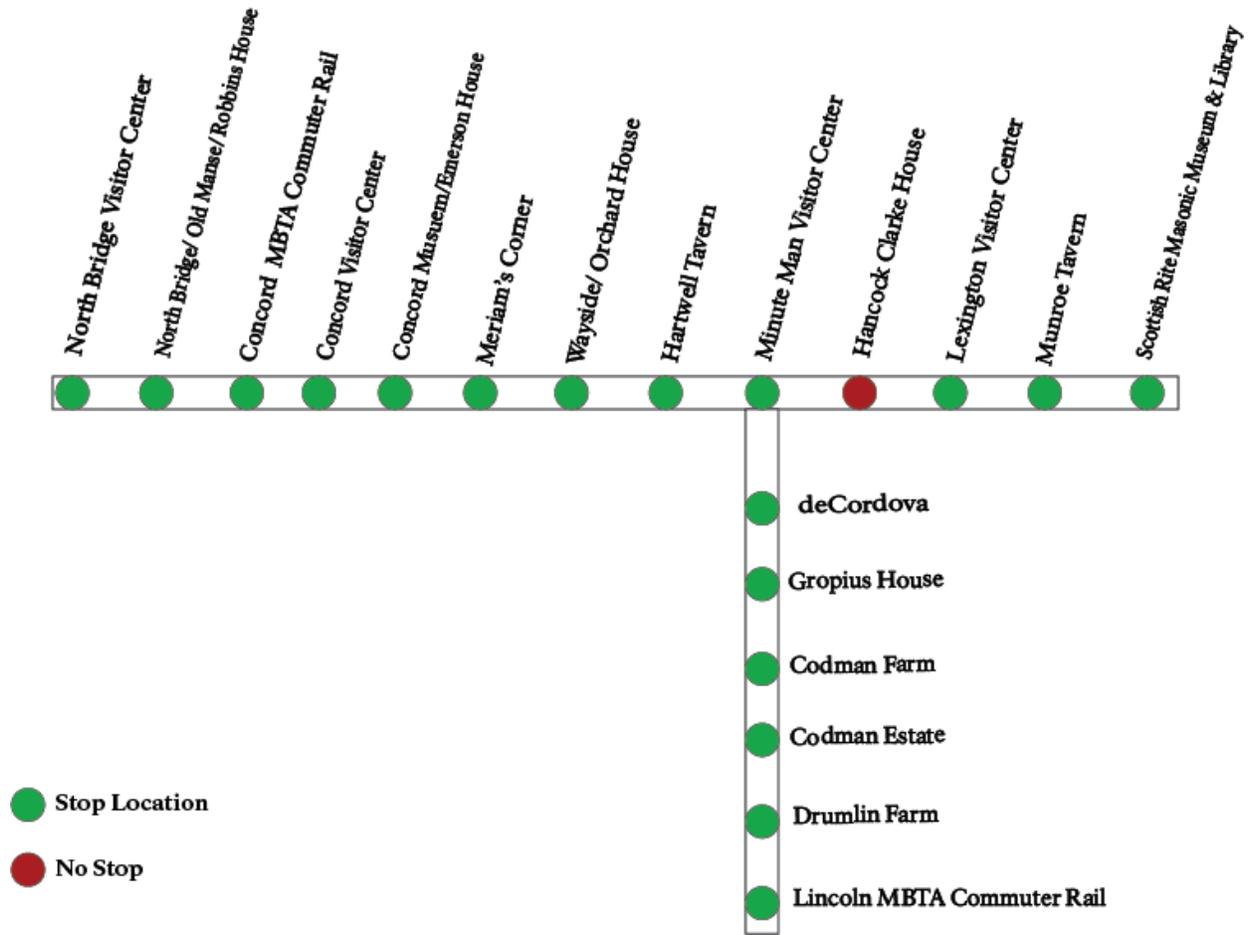


Table 11: *Scenario One* Stops by Cluster for North-South Route

Cluster	Point of Interest	Large Vehicle Accommodation	Shuttle Stop Location	Distance Walking from Stop	Walkability
MIMA 3	Minute Man Visitor Center	High	Yes	0.0 mi	N/A
Lincoln 1	deCordova	High	Yes	0.0 mi	N/A
Lincoln 2	Gropius House	Low	Yes	0.0 mi	N/A
Lincoln 3	Codman Farm	Low	Yes	0.0 mi	N/A
Lincoln 4	Codman Estate	High	Yes	0.0 mi	N/A
Lincoln 5	Lincoln MBTA Commuter Rail	Medium	Yes	0.0 mi	N/A
Lincoln 6	Drumlin Farm	High	Yes	0.0 mi	N/A

Source: Volpe Center analysis

Figure 22: Linear Map of *Scenario One* Stops for Town-Led Shuttle Service in and around MIMA



Source: Volpe Center analysis

*Operations*

Stop Order

The origin point is somewhat arbitrary in that the first stop during operating hours can be anywhere on the circuit that is closest to the shuttle’s origin. This report will assume that the Minute Man Visitor Center is the beginning and end for both routes as it is the only stop common to both.

The shuttle will depart from the Minute Man Visitor Center and head eastbound on Route 2A stopping at all stops until the easternmost terminus, the Scottish Rite Masonic Museum & Library. From here, the shuttle would turn around and stop at all of the same stops in the opposite direction, returning to the Minute Man Visitor Center before continuing westbound. Stopping at all points on the east-west route, the shuttle would arrive at the westernmost terminus, the North Bridge Visitor Center, before returning to all stops in an eastbound direction and completing the circuit at Minute Man Visitor Center. The shuttle



would continue on this path, picking up and dropping off passengers at each stop, for the duration of the operating hours.

Similar to the east-west route, the north-south route would follow the same model. Beginning at the Minute Man Visitor Center, the northern-most point on the route, the shuttle would stop at all stops southbound before reaching the southernmost terminus, Drumlin Farm. From here, the shuttle would stop at all stops again, in reverse order, before returning to the Minute Man Visitor Center to complete the circuit.

### Headways

On the east-west route, as there are 12 unique stops, the shuttle will make 22 stops per circuit, stopping at each one in both directions (save the termini, at which a shuttle would only need to stop once per circuit). The Volpe Center is assuming a one-minute dwell time at each stop to allow passengers to alight and board. *Scenario One* prioritizes coverage and minimizes the distance a user would need to walk, resulting in a high number of stops. Including dwell time and the travel time between each stop (excluding any traffic congestion that the shuttle may experience), it would take one vehicle approximately 109 minutes to complete one full circuit. Two vehicles would reduce the headway to 54.5 minutes, which is the maximum headway users will accept. Three vehicles would reduce the headway to a much more accommodating 36 minutes. However, the reduced headway comes with a proportional increase in cost. Running three vehicles would cost three times what one vehicle would.

The north-south route includes 6 unique stops, at which the shuttle would stop 10 times for a complete circuit, once at each in both directions. Using a one-minute dwell time at each stop, it would take a shuttle a total of 59 minutes to complete one circuit. This does not include any delays due to traffic congestion. Again, as this is the upper limit of acceptable headway times, running one vehicle may work, but after accounting for traffic delays, it may not. Running a second vehicle would reduce this headway on this route to about 32 minutes.

As stated in the *Common to All Scenarios* section, headways longer than one hour are “unattractive to all users”. As such, *Scenario One* would work best with a minimum of four vehicles total, two running on each route. See Table 12 for a breakdown of Scenarios 1A and 1B, with an illustration of the cost difference of running more vehicles.

### *Ridership Estimates*

Refer to the *Common to All Scenarios* section and Figure 18 and Figure 19 for ridership estimates. *Scenario One* is the most holistic as it makes stops within 0.1 mile of every proposed stop identified by stakeholders. This makes for a long roundtrip travel time. This could be unattractive for some visitors, but on the other hand, this comprehensive route could have a similarly comprehensive interpretive tour, which may be very attractive for some visitors.

### *Financial Estimates*

In Table 12 below, Scenario 1A has the fewest viable number of vehicles in operation: two vehicles on the east west and two on the north-south route, for a total of four. Scenario 1B adds a third vehicle on the E-W route to reduce the headway to 36 minutes, for a total of 5 vehicles. The high and low-cost rows show the difference in cost choices available in each

category. In this table, the “total seasonal gross cost (high)” row assumes the high-cost option for every category. The “total seasonal gross cost (low)” row assumes the opposite. In reality, a mix of the high/low options could be chosen, but for simplicity, the calculations assume all high or all low.



Table 12: *Scenario One* Financial Estimates Summary Table for Town-Led Shuttle Service in and around MIMA

Category	High/Low Cost Options	1A: 4 vehicles E-W Headway: 54.5 min. N-S Headway: 32 min	1B: 5 vehicles E-W Headway: 36 min. N-S Headway: 32 min
Transportation (vehicles, driver wages, insurance, maintenance, fuel, dispatch, back-up vehicle)	High: Trolley	\$691,900	\$864,800
Transportation	Low: Mini-bus	\$596,400	\$745,500
AVL (including provision of information to public)	High: AVL	\$5,900	\$7,000
AVL	Low: No AVL	\$0	\$0
Coordinator	High: Full time. 6 Days/Week 7 Hours/Day	\$31,500	\$31,500
Coordinator	Low: Part time. 3 Days/Week 7 Hours/ Day	\$15,800	\$15,800
Interpretation	High: Live narration	\$89,500	\$111,800
Interpretation	Low: Recorded narration	TBD	TBD
Advertising	High: Incur direct costs	\$19,200	\$19,200
Advertising	Low: Towns perform in-house	\$0	\$0
Supplies, Printing, and Other Services	High: Incur direct costs	\$13,500	\$13,500
Supplies, Printing, and Other Services	Low: Towns perform in-house	\$0	\$0
Seasonal Total Gross Cost (High)		\$851,500	\$1,047,800
Seasonal Total Gross Cost (Low)		\$612,200	\$762,300
Revenue (High) Assuming a Fare of \$18 and Daily Ridership of 31-156		\$118,900-\$598,100	\$118,900-\$598,100
Revenue (Low) Assuming a Fare of \$7 and Daily Ridership of 31-156		\$46,200-\$232,600	\$46,200-\$232,600

Source: Volpe Center analysis

### Summary

*Scenario One* is best suited for a historical visitor. The route is comprehensive, enabling a similarly comprehensive interpretive tour. This scenario may also be well suited for visitors with mobility issues, seniors, and families as the shuttle stops are so close to each

point of interest. The high round-trip travel times may be deterrent for some, and require more vehicles (and therefore higher costs) to provide an acceptable level of service (headway) as compared to *Scenario Two* and *Scenario Three*. A summary of the benefits and issues with *Scenario One* are in Table 13 below.

**Table 13: *Scenario One* Summary Points for Town-Led Shuttle Service in and Around MIMA**

Pros	Cons
<ul style="list-style-type: none"> <li>• Provides a holistic interpretive tour</li> <li>• Could retain many riders looking for a comprehensive historical experience</li> <li>• Provides great coverage with almost all points of interest within a 0.1-mile walk</li> </ul>	<ul style="list-style-type: none"> <li>• High round trip travel times may deter some</li> <li>• Requires more vehicles and higher costs to provide an acceptable level of service</li> </ul>

Source: Volpe Center analysis

### Scenario Two: Fewer Stops

*Scenario Two: Fewer Stops* takes the opposite approach as *Scenario One*. This scenario illustrates a case in which a shuttle service errs on the side of stopping at fewer locations. Infrequent stops result in users needing to walk more to access the nearby points of interest from the designated stops. However, what *Scenario Two* loses in coverage, it makes up for in frequency and/or cost. One shuttle can complete the route more quickly, achieving the same headway with fewer vehicles. *Scenario Two* illustrates how a service would operate when the points of interest are grouped into clusters such that all of the points of interest are within a 0.5-mile walk from the shuttle’s stop location.

### *Routing*

*Scenario Two* includes 14 stops to accommodate all 22 points of interest identified by stakeholders. There are ten stops on the east-west route and five on the north-south route (the Minute Man Visitor Center is common to both). The longest distance that a user would have to walk to arrive at a point of interest from the nearest shuttle stop is 0.6 miles (Scottish Rite Museum to Munroe Tavern). The average distance is 0.14 miles, which would take just less than 3 minutes to walk. Table 14 describes the stops that *Scenario Two* includes, grouped by cluster, and indicates how well each site can accommodate a large vehicle, how far a pedestrian would need to walk from the stop to other points in the cluster, as well as walkability issues and accommodations on the walking route. The stops are generally arranged from east to west and do not indicate the order in which a shuttle would service them.



Table 14: *Scenario Two* Stops by Cluster for East-West Route

Cluster	Point of Interest	Large Vehicle Accommodation	Shuttle Stop Location	Distance Walking from Stop	Walkability
Concord Center	Concord Visitor Center	High	Yes	0.0 mi	N/A
Concord 1	Concord MBTA Commuter Rail	Medium	Yes	0.0 mi	N/A
MIMA 1	North Bridge/Old Manse/Robbins House	High	Yes	0.0 mi	N/A
MIMA 2	North Bridge Visitor Center	High	No	0.4 mi	N/A
Concord 2	Concord Museum	Medium	Yes	0.0 mi	N/A
Concord 2	Emerson House	Low	No	0.1 mi	Crosswalks: No Sidewalks: Yes; one side only
Concord 3	Orchard House/Wayside Home of Authors	Medium	Yes	0.0 mi	N/A
Concord 4	Meriam's Corner	Medium	Yes	0.0 mi	N/A
MIMA 3	Hartwell Tavern	High	Yes	0.0 mi	N/A
MIMA 4	Minute Man Visitor Center	High	Yes	0.0 mi	N/A
Lexington Center	Lexington Visitor Center/Buckman Tavern	High	Yes	0.0 mi	Formal stop may require road markings
Lexington Center	Hancock Clarke House	Low	No	0.4 mi	Sidewalks: Yes Crosswalks: Yes

Source: Volpe Center analysis

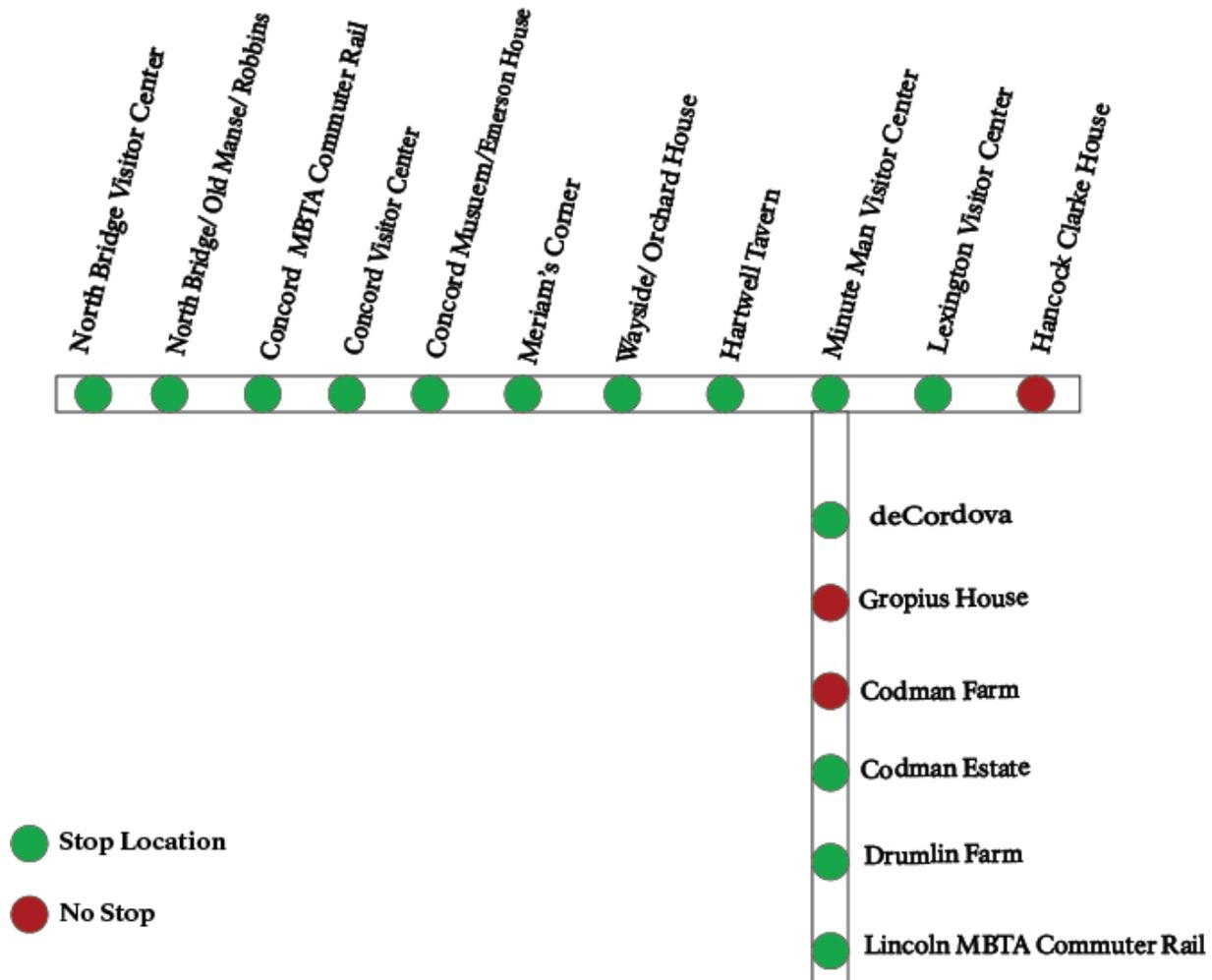
Table 15: *Scenario Two* Stops by Cluster for North-South Route

Cluster	Point of Interest	Large Vehicle Accommodation	Shuttle Stop Location	Distance Walking from Stop	Walkability
MIMA 4	Minute Man Visitor Center	High	Yes	0.0 mi	N/A
Lincoln 1	deCordova	High	Yes	0.0 mi	N/A
Lincoln 2	(Gropius House)	(Low)	(No)	(N/A)	Shuttle does not service Gropius House in <i>Scenario Two</i>
Lincoln Off-Center	Codman Estate	High	Yes	0.0 mi	N/A
Lincoln Off-Center	Codman Farm	Low	No	0.3 mi	Sidewalks: Partial Crosswalks: No
South Lincoln	Lincoln MBTA Commuter Rail	Medium	Yes	0.0 mi	N/A
Lincoln 3	Drumlin Farm	High	Yes	0.0 mi	N/A

Source: Volpe Center analysis



Figure 23: Linear Map of *Scenario Two* Stops for Town-Led Shuttle Service in and around MIMA



Source: Volpe Center analysis

### *Operations*

#### Stop Order

In *Scenario Two*, a shuttle would stop at the above stops in the order they appear in Table 14. The shuttle would operate in the same manner as explained in the Routing section of *Scenario One: All Stops*- i.e., stopping at all listed locations in both directions on both routes.

One of the key differences between *Scenario Two* and *Scenario One* is that *Scenario Two* abbreviates the east-west route at the eastern terminus. On the east side, this route ends at the Lexington Visitors Center, and does not provide access to Munroe Tavern or the Scottish Rite Masonic Museum & Library, which are a 0.9 mile and a 2.3 mile walk from the Lexington Visitors Center respectively. On the west side, rather than ending at the North

Bridge Parking Lot, letting users walk 0.4 miles to the North Bridge Visitor Center, this route includes the North Bridge Visitor Center as the westernmost stop.

The two key differences for the north-south route as compared to *Scenario One* are the absence of Gropius House as a stop, and the clustering of Codman Estate and Codman Community Farm, stopping at Codman Estate. Due to the location of Gropius House, eliminating it as a stop allows the shuttle to run a more direct route down Bedford and Lincoln Roads rather than diverting to Sandy Pond and Baker Ridge Roads, which necessitates looping around Concord and Codman Roads to get back on course.

#### Headways

On the east-west route, as there are 10 unique stops, the shuttle would make a total of 18 stops per circuit, stopping at each one in both directions (except for the termini). Including dwell time and the travel time between each stop, it would take one vehicle approximately 78 minutes to complete one full circuit.

The north-south route includes five unique stops, which means a vehicle would make eight stops per circuit. One circuit of the route would take a total of 52 minutes.

Removing the Gropius House as a stop and clustering Codman Farm and Codman Estate achieves a higher frequency. This re-routing and elimination of two stops saves seven minutes per circuit. One full circuit on the north-south route in *Scenario Two* takes approximately 52 minutes rather than 59. A seven-minute difference per circuit, over the course of an eight-hour day allows the shuttle to complete nine full circuits per day instead of eight.

As stated in the Common to All Scenarios section, headways longer than one hour are “unattractive to all users”. As the east-west route far exceeds one-hour headway, it is necessary that this route run at least two vehicles. As the north-south route is close to a one-hour headway, one shuttle meets this threshold with no traffic congestion, but two shuttles would improve the level of service. See the Financial Estimates section below for details on *Scenario Two*, including two variants, Scenarios 2A and 2B.

#### *Ridership Estimates*

Refer to *Common to All Scenarios* section and Figure 18 and Figure 19 for ridership estimates. *Scenario Two* attempts to provide a higher level of service (shorter headways) at less cost, by omitting some stops that add a significant amount of travel time and are within walking distance of another stop. Ridership could be higher than for *Scenario One*, if riders value the time savings. Conversely, ridership could be lower if riders are discouraged by the decrease in coverage for some sites.

#### *Financial Estimates*

In Table 16 below, Scenario 2A has the fewest viable number of vehicles in operation: two vehicles on the east west and one on the north-south route, for a total of three. Scenario 2B adds a second vehicle on the north-south route to reduce the headway to 26 minutes, for a total of four vehicles. The high and low-cost rows show the difference in costs of choices available in each category. In this table, the “total seasonal gross cost (high)” assumes the high-cost option for every category. The “total seasonal gross cost (low)” assumes the opposite. In reality, a mix of the high/low options could be chosen, but for simplicity, the calculations assume all high or all low.



**Table 16**  
**Scenario Two** Financial Estimates Summary Table for Town-Led Shuttle Service in and around MIMA

Category	High/Low Cost Options	2A: 3 vehicles E-W Headway: 39 min. N-S Headway: 52 min.	2B: 4 vehicles E-W Headway: 39 min. N-S Headway: 26 min
Transportation (vehicles, driver wages, insurance, maintenance, fuel, dispatch, back-up vehicle)	High: Trolley	\$518,900	\$691,800
Transportation	Low: Mini-bus	\$447,300	\$596,400
AVL (including provision of information to public)	High: AVL	\$4,700	\$5,900
AVL	Low: No AVL	\$0	\$0
Coordinator	High: Full time. 6 Days/Week 7 Hours/Day	\$31,500	\$31,500
Coordinator	Low: Part time. 3 Days/Week 7 Hours/ Day	\$15,800	\$15,800
Interpretation	High: Live narration	\$67,100	\$89,500
Interpretation	Low: Recorded narration	TBD	TBD
Advertising	High: Incur direct costs	\$19,200	\$19,200
Advertising	Low: Towns perform in-house	\$0	\$0
Supplies, Printing, and Other Services	High: Incur direct costs	\$13,500	\$13,500
Supplies, Printing, and Other Services	Low: Towns perform in-house	\$0	\$0
Seasonal Total Gross Cost (High)		\$654,900	\$851,500
Seasonal Total Gross Cost (Low)		\$463,100	\$612,200
Revenue (High) Assuming a Fare of \$18 and Daily Ridership of 31-156		\$118,900-\$598,100	\$118,900-\$598,100
Revenue (Low) Assuming a Fare of \$7 and Daily Ridership of 31-156		\$46,200-\$232,600	\$46,200-\$232,600

Source: Volpe Center analysis

## Summary

*Scenario Two* is better suited for visitors wishing to get between points of interest efficiently. In order to create an efficient route, this shuttle omits some stops within walking distance of another nearby stop. For the best result, *Scenario Two* would ideally coincide with new wayfinding and pedestrian safety improvements to strengthen the walking connections between nearby sites. Having fewer stops and a shorter roundtrip travel time also means that the interpretive tour might be less comprehensive. *Scenario Two* also optimizes the route to only stop at stops which can most comfortably accommodate a larger vehicle, reducing the reducing the vehicle operator's stress. *Scenario Two* does not stop at the Concord commuter rail stops. This loss of connection reduces the pool of potential riders to exclude people who want to connect from the commuter rail and are not willing or able to walk 0.5 miles to the next closest shuttle stop at the Concord Visitor Center. Table 17 below summarize the benefits and drawbacks of *Scenario Two*.

Table 17: *Scenario Two* Summary Points for Town-Led Shuttle Service in and around MIMA

Pros	Cons
<ul style="list-style-type: none"><li>• Is more cost and time efficient than <i>Scenario One</i></li><li>• Only makes stops where a large vehicle can most comfortably be accommodated</li></ul>	<ul style="list-style-type: none"><li>• Interpretive tour may be less comprehensive</li><li>• Riders may need to walk further and not all walking connections are intuitive</li><li>• Lack of direct connection to the Concord commuter rail station</li></ul>

Source: Volpe Center analysis

## Scenario Three: Flexibility

*Scenario Three: Flexibility* is an attempt to maintain high frequency and high coverage at the same time. By default and absent any rider request, the service would bring riders to seven default stops. There would be 11 additional on-request stops that riders could request upon boarding or from the stop via an app. The total number of available stops is 18, which is the same as in *Scenario One*. The difference is that *Scenario One* stops at all 18 by default, while *Scenario Three* stops at 8 by default, while 10 are on-request only.

*Scenario Three* combines elements from other transit services:

- Flexing off a fixed route to accommodate rider requests, such as with the Cape Cod Regional Transit Authority's (CCRTA's) FLEX service; and
- App-based technology to enable riders to request service via a mobile device, such as with Rabbittransit's Stop Hopper.

The Peer Systems section below describes both of the above examples.

*Scenario Three*, as presented, would require similar partnerships, technology, and costs as described in the Rabbittransit section on Stop Hopper.<sup>62</sup> It would require a sophisticated AVL and computer assisted dispatch (CAD) technology in conjunction with a user application for real-time updates. These could allow riders to request a trip and be

<sup>62</sup> (Rabbittransit 2020)



accommodated within at most one headway's duration. Refer to the Shuttle Communication Technology section for more details on AVL. This scenario would benefit from a multi-lingual user application given the draw to this area from around the world.

### *Routing*

The routing for *Scenario Three* includes five fixed plus six on-request stops on the east-west route and three fixed plus four on-request stops on the north-south route. See Table 18 below for details. This table is adapted from *Scenario One's* Routing table (Table 10) with some clusters now "on request" instead of default stops. The scenario identifies default stops based on several criteria: visitation, large vehicle accommodation, and distance from the fastest route. The sites at these stops have higher visitation than other sites, and can most easily accommodate a large vehicle. They also involve little deviation from the two main corridors- Bedford Road/ Lincoln Road for the north-south route and Route 2A/Lexington Road/ Massachusetts Avenue for the east-west route. The four fixed route stops on the east-west route and two fixed route stops on the north-south route are all on or near the major corridor and span almost the entire study area.

In general, such a large reduction in default stops saves time, improving travel convenience. For example, the deCordova Museum is a mile off the north-south route and adds 10 minutes to the route. These 10 minutes are extraneous if no one gets on or off at this stop. However, there is a possibility that deviation in travel times due to on-request stops could cause issues for those hoping to make their whole trip on transit by connecting to one of the MBTA commuter rail stations. These trains come infrequently and an unpredictable shuttle schedule could make it difficult for such a rider to catch their return train home at the MBTA station.

Table 18: *Scenario Three* Stops by Cluster for East-West Route

Cluster	Point of Interest	Large Vehicle Accommodation	Shuttle Stop Location	Distance Walking from Stop	Walkability
Concord 1	Concord MBTA Commuter Rail	Medium	On Request	0.0 mi	N/A
MIMA 1	North Bridge Visitor Center	High	Yes	0.0 mi	Crosswalks: Yes; use trail not roadway
MIMA 2	North Bridge/Old Manse/Robbins House	High	On Request	0.0 mi	N/A
Concord Center	Concord Visitor Center	High	Yes	0.0 mi	N/A
Concord 2	Concord Museum	Medium	On Request	0.0 mi	N/A
Concord 2	Emerson House	Low	No	0.1 mi	Crosswalks: No Sidewalks: Yes; one side only
Concord 3	Orchard House/Wayside Home of Authors	Medium	Yes	0.0 mi	N/A
Concord 4	Meriam's Corner	Medium	Yes	0.0 mi	N/A
MIMA 3	Hartwell Tavern	High	On Request	0.0 mi	N/A
MIMA 4	Minute Man Visitor Center	High	Yes	0.0 mi	N/A
Lexington Center	Lexington Visitor Center/Buckman Tavern	High	Yes	0.0 mi	Formalized stop may require road markings
Lexington Center	Hancock Clarke House	Low	No	0.4 mi	Sidewalks: Yes Crosswalks: Yes
Lexington 1	Munroe Tavern	Low	On Request	0.0 mi	N/A
Lexington 2	Scottish Rite Masonic Museum & Library	High	On Request	0.0 mi	N/A

Source: Volpe Center analysis



Table 19: *Scenario Three* Stops by Cluster for North-South Route

Cluster	Point of Interest	Large Vehicle Accommodation	Shuttle Stop Location	Distance Walking from Stop	Walkability
MIMA 3	Minute Man Visitor Center	High	Yes	0.0 mi	N/A
Lincoln 1	deCordova	High	On Request	0.0 mi	N/A
Lincoln 2	Gropius House	Low	On Request	0.0 mi	N/A
Lincoln 3	Codman Farm	Low	On Request	0.0 mi	N/A
Lincoln 3	Codman Estate	High	On Request	0.0 mi	Sidewalks: Partial Crosswalks: No
Lincoln 4	Lincoln MBTA Commuter Rail	Medium	Yes	0.0 mi	Sidewalks: Partial Crosswalks: No
Lincoln 5	Drumlin Farm	High	Yes	0.0 mi	N/A

Source: Volpe Center analysis

Figure 24: Linear Map of *Scenario Three* Stops for Town-Led Shuttle Service in and around MIMA



Source: Volpe Center analysis

*Operations*

Stop Order

*Scenario Three*, a shuttle will stop at the above stops on the east-west route in the following order. The shuttle will depart from the Minute Man Visitor Center and head eastbound on Route 2A stopping at the Lexington Visitor center. If passengers do not request any other stops east of Lexington center, the shuttle would turn around, returning to the Minute Man Visitor Center before continuing westbound. However, if riders do request a stop at the two points of interest east of Lexington center, the Munroe Tavern or the Scottish Rite Masonic Museum & Library, the shuttle would continue east.

Continuing west from MIMA’s Visitor Center, the shuttle would make stops at Meriam’s Corner, then the Concord Visitor Center, and then the North Bridge Visitor Center before heading back to the Minute Man Visitor Center- stopping at Meriam’s Corner and the Concord Visitor Center again on the way back- if no other stops are requested. Riders could request stops at the Concord commuter rail station, the North Bridge/Robbins House/Old



Manse, the Concord Museum/Emerson House, the Wayside/Orchard House, Hartwell Tavern, Munroe Tavern, and the Scottish Rite Masonic Museum & Library.

As for the north-south route, the shuttle would depart from the Minute Man Visitor Center southbound on Bedford Road, which turns into Lincoln Road, stopping at the Lincoln MBTA stop then Drumlin Farm. If riders do not request any other stops, the shuttle turns around to head back to the Minute Man Visitor Center. Riders could request stops at the deCordova Museum, Codman Estate, and Codman Farm on the southbound or northbound route.

Refer to Table 18 for the full list of all points of interest within a short walk from these default and on-request stops.

### Headways

Given the variability in route, there will be variation in roundtrip travel time. If riders request every possible stop, *Scenario Three's* roundtrip travel time would be equivalent to that of *Scenario One*. Roundtrip travel time would be 109 minutes on the east-west route and 59 minutes on the north-south route. If no one requests any on-request stops, roundtrip travel time would be 57 minutes on the east-west route and 35 minutes on the north-south route. As these travel times are different depending on the number of stops requested, it would be crucial to provide real-time information to riders.

For continual improvement, shuttle service operators could document which stops are most frequently requested. The most popular could be added to the default stops so that shuttle riders have a more consistent shuttle schedule to plan their trip. In this way, *Scenario Three* could start with one or two vehicles as a pilot to see how visitors prefer to use the system. If demand rises so much so that headways are exceeding one hour, the service could add vehicles. This could reduce initial costs until sufficient evidence exists to extend the system to include more fixed route stops.

### *Ridership Estimates*

Refer to *Common to All Scenarios* section and Figure 18 and Figure 19 for ridership estimates. *Scenario Three's* ridership is especially uncertain. Marketing will be even more important for this scenario since riders will have to know that they have to download an app and know how to use it. Further, by opting to have a streamlined route that is highly flexible, riders could have vastly varying experiences. On the positive side, they may appreciate it as an efficient way to get to their next destination. On the negative side, they may find it confusing or suspect it may be unreliable. *Scenario Three* may not be attractive for riders desiring a comprehensive and consistent tour, more similar to the Liberty Ride.

### *Financial Estimates*

In Table 20 below, Scenario 3A has one vehicle on the east west and one on the north-south route, for a total of two vehicles. Scenario 3B adds a second vehicle on the east-west route to reduce the headway to 54.5-28.5 minutes, for a total of three vehicles. The headways in *Scenario Three* vary depending on the number of stops actually requested. The high and low rows show the difference in costs of choices available in each category. *Scenario Three* requires a sophisticated AVL in order to be viable, so there is no low-cost option in that category. In this table, the "total seasonal gross cost (high)" assumes the high-cost option for every category. The "total seasonal gross cost (low)" assumes the opposite.

Table 20: *Scenario Three* Financial Estimates Summary Table for Town-Led Shuttle Service in and around MIMA

Category	High/Low Cost Options	3A: 2 vehicles E-W Headway: 109-57 min. N-S Headway: 59-31 min	3B: 3 vehicles E-W Headway: 54.5-28.5 min. N-S Headway: 59-31 min
Transportation (vehicles, driver wages, insurance, maintenance, fuel, dispatch, back-up vehicle)	High: Trolley	\$345,900	\$518,900
Transportation	Low: Mini-Bus	\$298,200	\$447,300
AVL (including provision of information to public)	High: Stop Hopper AVL	\$12,600	\$18,900
AVL	Low: No Option	N/A	N/A
Coordinator	High: Full time. 6 Days/Week 7 Hours/Day	\$31,500	\$31,500
Coordinator	Low: Part time. 3 Days/Week 7 Hours/ Day	\$15,800	\$15,800
Interpretation	High: Live narration	\$44,700	\$67,100
Interpretation	Low: Recorded narration	TBD	TBD
Advertising	High: Incur direct costs	\$19,200	\$19,200
Advertising	Low: Towns perform in-house	\$0	\$0
Supplies, Printing, and Other Services	High: Incur direct costs	\$13,500	\$13,500
Supplies, Printing, and Other Services	Low: Towns perform in-house	\$0	\$0
Seasonal Total Gross Cost (High)		\$467,400	\$669,100
Seasonal Total Gross Cost (Low)		\$326,600	\$482,000
Revenue (High) Assuming a Fare of \$18 and Daily Ridership of 31-156		\$118,900-\$598,100	\$118,900-\$598,100
Revenue (Low) Assuming a Fare of \$7 and Daily Ridership of 31-156		\$46,200-\$232,600	\$46,200-\$232,600

Source: Volpe Center analysis



## Summary

*Scenario Three* may hold potential as a pilot implementation with a few stops and limited route that could grow over time, as operators gain knowledge of the target market and demand, and as awareness grows. It is important to note that to date this analysis has not found any example that exactly matches the type of flexible fixed route service described in *Scenario Three*. However, there are related examples in practice that demonstrate the use of the enabling technologies, as described in the Peer Systems section. There are many like FLEX and many like Stop Hopper but none that combine the technology for a point-to-point service with a flexible fixed route model that only serves pre-determined “on-request” stops.

*Scenario Three* as a pilot could serve as a real-world survey of visitors to understand their movements between points of interest and willingness to use a shuttle. This scenario’s worth is in its ability to cater to both ends of the spectrum, with respect to frequency and coverage. It can bring riders to and from any of the points of interest and is also time and cost efficient as it has limited fixed stops and skips other stops unless requested.

However, the variable route may mean that *Scenario Three* loses the ability to provide a consistent interpretive tour. Brochures could still be available on the vehicle, but a recorded audio tour option would be difficult to implement effectively. Here, a live tour guide might be the better option as they could adjust to the route in real time seamlessly, but this does not address the lack of consistency. Further, an application-based system may bring up some concerns for certain user groups. Some visitors may not want to or be able to download an app on a smart phone. Even if that hurdle is overcome, some users may have trouble understanding how to request a stop off route.

Though *Scenario Three* aims to reduce costs by shortening routes and, thus, requiring fewer vehicles, there is also an added cost of a more complex AVL system and a partnership with an entity that can provide CAD through an app. Rabbittransit appears below in the Peer Systems section and is very relevant to *Scenario Three* as it provides a point to point service- Stop Hopper- using the TransLoc platform, which supplies the CAD technology and app at a cost of \$500 to \$600 per vehicle per month, on top of traditional AVL costs. This additional cost is necessary to realize *Scenario Three* as presented in this report. If such a partnership is deemed too costly, this scenario could be adjusted to either (1) use the concept of CCRTA’s FLEX bus wherein riders can call the dispatchers a day in advance to request an off route stop at a certain time, and/or (2) use a system wherein riders can “flag down” the bus wherever it is safe to stop; this would mean that on-request stops would need to be visible from the default fixed route. CCRTA’s FLEX also appears below in the Peer Systems section for reference.

Table 21 below summarized the major advantages and disadvantages of *Scenario Three*.

Table 21: *Scenario Three* Summary Points for Town-Led Shuttle Service in and around MIMA

Pros	Cons
<ul style="list-style-type: none"> <li>• Most cost effective by making only “necessary” stops</li> <li>• Creates time savings which improves rider experience</li> <li>• Improves coverage for people less willing/able to walk, without fully sacrificing headway level of service</li> <li>• Could serve as a pilot for understanding the demand before deciding routes</li> </ul>	<ul style="list-style-type: none"> <li>• Causes complications for any interpretive audio tour</li> <li>• Potentially, some visitors may be averse to using an app on a smart phone</li> <li>• Necessitates more sophisticated AVL and associated technology (added cost and complication)</li> <li>• Could potentially create anxiety for vehicle operator</li> <li>• Makes the posted schedule less reliable; riders wishing to connect from the MBTA commuter rail lines may have difficulty timing their connection to the shuttle</li> </ul>

Source: Volpe Center analysis

### Peer Systems

When estimating numbers for the MIMA shuttle such as cost and ridership and when predicting best practices for vehicle options, agreement types, and general operations, it is helpful to consider past and present peer shuttle systems with similar existing conditions and goals. Rabbitransit of the Gettysburg National Military Park area; the trolley at Adams National Historical Park; the trams of San Juan National Historic Site; the NB Line of the New Bedford Whaling National Historical Park; PresidiGo of the Golden Gate Recreation Area; the Roosevelt Ride serving the Home of Franklin D. Roosevelt, Eleanor Roosevelt, and Vanderbilt Mansion National Historic sites; and the Williamsburg Shuttles of Colonial Williamsburg all shed light on potential challenges and transferrable lessons.

#### *Conclusions from Peer Systems*

Below is a summary of suggestions categorized into actions that stakeholders should definitely pursue and actions that they should consider after weighing costs and demands of riders.



Table 22: Summary of Takeaways from Peer Services

Definitely Should:	Consider:
<ul style="list-style-type: none"> <li>• Provide <i>full</i> service only during peak visitation months</li> <li>• Add shuttle directions to MIMA and stakeholder webpages</li> <li>• Have some interpretive aspects on board shuttle vehicles</li> <li>• Have an agreement between partners and stakeholders with explicit roles and measures for enforcement</li> <li>• Fund the shuttle with strategic partnerships</li> <li>• Require some form of ticket for shuttle use (whether free or for a fare)</li> </ul>	<ul style="list-style-type: none"> <li>• Providing additional service to accommodate commuting and other uses</li> <li>• Charging a fare to offset costs</li> <li>• Branding the vehicles</li> <li>• Sharing costs and resources with other local transit entities</li> <li>• Surveying visitors to understand demand and desired shuttle aspects</li> <li>• Providing a flexible service either via FLEX's low-cost methods or Rabbittransit's more user-friendly methods</li> </ul>

Source: Volpe Center analysis

### Rabbittransit

Rabbittransit of Gettysburg is a private transit authority that operates in Gettysburg, PA and a few other south-central Pennsylvania counties. In Gettysburg, Rabbittransit has five fixed routes. Three of these service Gettysburg National Military Park. Park ticketholders can ride those lines for free. This is made possible by a partnership with the local Gettysburg Foundation. The foundation is a partner to NPS for the preservation of Gettysburg National Military Park and education on its lasting significance. Providing free fare for park visitors lowers the barrier for visitation to the park, a key tenant of the Foundation's mission. Stakeholders could consider making such a partnership with a similar organization to reduce fares for park visitors.

Historically, a conservative estimation for the proportion of visitors who access the park via Rabbittransit would be just two percent of all visitors. To improve service for visitors, Rabbittransit plans to incorporate "Stop Hopper" to Gettysburg routes. This was motivated by surveys of Gettysburg Hotel guests, which found that visitors want more flexible transit service. Stop Hopper is Rabbittransit's point-to-point micro transit service, which they already offer successfully in neighboring counties in select geo-fenced areas of about 15 square miles. They advertise Stop Hopper as a convenient way to connect to fixed route lines.

This sort of on-demand service requires a partnership with a company that can provide CAD and a user app, such as TransLoc or Via. Costs for such a service from one of these entities would be around \$500 to \$600 per vehicle per month and would include access to the operating system and an app for riders to request rides. There would also be a lump sum start up or preparation fee. On top of that, this on-demand service requires some additional AVL costs; each vehicle must have a device with a cellular plan and global positioning system (GPS) which would cost at least \$25 per month per vehicle.<sup>63</sup>

Rabbittransit also provides some insight into the tradeoffs of vehicle sharing with other local transit entities. Rabbittransit operated as "Freedom Transit" in Gettysburg since 2009

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<sup>63</sup> (Rabbittransit 2020)

as a branding campaign. They used trollies to provide a historical ambiance. In 2020, Rabbittransit determined that the benefits of the historical branding no longer outweighed their drawbacks. The regional transit agency ran into issues when shifting vehicles around for maintenance and special events and determined that having identical vehicles across its regional fleet would be best.

### FLEX

Somewhere in between a fixed route service and a “Stop Hopper” service is FLEX, the local transit route provided by the CCRTA that runs through Cape Cod National Seashore. The service gets its name because the bus can “flex” up to 0.75 miles from its fixed route upon rider request. CCRTA asks that riders make flex reservations two days in advance. There are a couple of designated flex points at grocery stores and schools, which have the bus stop branding. This way of deviating from a fixed route is less cost and technology intensive than the Stop Hopper system but is also less convenient.

### Adams National Historical Park Trolley

The Adams National Historical Park Trolley is very similar to the proposed service in this analysis in that it serves a historical town in Massachusetts with connections to MBTA service. The trolley system brings visitors to historical sites with an interpretive tour in chronological sequence, following the lives of the two Adams presidents and their families. The trolley was inspired by reports that navigation between the sites was often confusing for people unfamiliar with the city of Quincy. A very similar observation has been documented for MIMA visitors at least since 1985.<sup>64</sup> MIMA visitors tend to start their visit to MIMA on the eastern end by way of Lexington then make their way west on the Battle Road. This westward progression can be confusing as the park interpretation is presented in an eastward progression, commemorating the direction of the battle. As the Adams National Historical Park Trolley guides visitors through chronological interpretation, park personnel view the trolley as an essential service.

In 2006, Adams National Historical Park piloted an extended shuttle route that ran from the ferry terminals and local hotels to the historical sites. Due to low ridership they discontinued that pilot and the park now only runs the interpretive shuttle today. Stakeholders in and around MIMA could consider piloting a more extensive route with better transit connections, but may temper expectations, recognizing that the resources needed to extend such a route might not pay off in terms of increased ridership. The Adams National Historical Park Trolley itself -the vehicle- is considered a strong marketing technique; it appears in Figure 25. The trollies are well branded and go along with the historical milieu to attract riders interested in a historic, interpretive tour. Branding the bus either in this trolley style or with a vinyl wrapping can help to alleviate any visitor confusion if multiple transit vehicles are circulating in the same area. The Adams National Historical Park Trolley is free for park ticketholders and is exclusive to park ticketholders.

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<sup>64</sup> (Harvard University 1985)



Figure 25: Adams National Historical Park Trolley



Source: Adams National Historical Park [website](#)

#### Trams of San Juan National Historic Site

The 2012-2017 tram service at San Juan National Historic Site in Old San Juan, Puerto Rico had a few lessons learned. For one, the free service was not exclusive to ticketholders. Many people were observed “joy riding” the tram throughout Old San Juan, sometimes meaning that park visitors had to wait for the next tram to come due to the tram being at capacity. Joy riding is a term used here to describe how people would ride the shuttle continuously seemingly with no intentions to visit the NPS site or any other stop on the tram’s route.

Another key lesson learned in this transit system was that having a concrete agreement is essential to the transit system’s success. This shuttle had a memorandum of understanding between the Park, a private transit organization that provided drivers, and the city of San Juan. Due to the less than explicit nature of the memorandum of understanding, both the transit organization and the city failed to uphold their ends of the agreement. The operator had unreliable drivers and the city never found a place to store the trams, which led to their speedy deterioration. A more robust contract or cooperative agreement could have included measures to ensure each party held up their end as well as timeframes and metrics to determine whether the shuttle pilot should be made permanent. Stakeholders should develop a formal commitment or agreement that clarifies roles and responsibilities for each party with metrics and timelines for continual reassessment.

#### NB Line

The NB Line, the pilot shuttle service at the New Bedford Whaling National Historical Park, had some of the same issues that the San Juan National Historic Site encountered. The NB Line did not continue past the pilot period. They too observed joy riding and had issues with their contract agreement. When contract management is less involved or is run through a third party, as was the case for the NB Line, it can be harder to maintain service standards. Active management of a contract can help to ensure better service. For example, the Adams National Historical Park commented that their regular interaction and follow up with the transit contractor has led to better results in system performance.

The New Bedford Whaling National Historical Park also had some issues with marketing. Potential NB Line riders started at a disadvantage as the route, schedule, and related information were difficult to find online and not readily available in the Visitor Center. The NB Line did not wrap their vehicles in branded vinyl until the last year of the pilot. Ridership did jump that year from 17 to 31 riders per day on average, which was largely attributed to the vinyl branding. This shuttle pilot concluded that online and hard copy communications are essential for success, and it is important to have bus drivers knowledgeable about the area and stops on the route as visitors are often unfamiliar with the area. Brochures available on the vehicles with maps and explanations would also be helpful. Signage and a system map and schedule at each stop would help to orient riders, easing confusion and improving the visitor experience.

### PresidiGo

PresidiGo is unique in that it serves visitors to the Golden Gate Recreation Area but also commuters and employees in the service area. It runs two free routes throughout the park and one that goes to downtown San Francisco. The former two routes are open to everyone. During commuting hours, the latter route is exclusive to commuters and employees in the service area who apply for a PresidiGo pass. Stakeholders in the MIMA area may want to consider additional analysis on whether a service could additionally serve commuters or other users. Possibly, the shuttle could run a commuting route for peak commute hours to provide service along the congested Route 2A corridor then transition to a more visitor-oriented route in the midday. Commuters could pay a fare to help sustain the shuttle. This would require additional analysis to assess feasibility.

PresidiGo's service also highlights the importance of communication with partners and riders. The Presidio Trust provides robust online transit information, including real-time bus location information. Riders can sign up for shuttle updates by email and can use the website to submit complaints and suggestions for improving service. PresidiGo regularly receives comments from their customers through the website and does their best to act on those comments. Their responsiveness demonstrates to customers that they are being heard. PresidiGo has noted that communication with partners is also critical to make and confirm decisions regarding the shuttle.

### Roosevelt Ride

The Roosevelt Ride shuttle operated in a similar environment as MIMA; a historical area along a regional rail route with a nearby stop linking it to a major metropolitan city. For the Roosevelt Ride, that would be New York City and for MIMA it is Boston. The goal for the Roosevelt Ride shuttle was to attract more New York City residents to the Home of Franklin D. Roosevelt, Eleanor Roosevelt, and Vanderbilt Mansion National Historic Sites. The shuttle also provided sole access to one historical location not accessible by private motor vehicle. NPS began a marketing campaign in 2001 at the start of the service, advertising the historical sites and the Roosevelt Ride connecting them to the Metro North rail station.

The Roosevelt Ride received visitors at the Metro North rail station in the morning, did a few loops through the parks during the day, and then dropped visitors back at the train station, coordinating with the Metro North schedule. Although the service successfully attracted riders to the parks, it was too costly for the park to support. Since 2018, New Dutchess County Transit has assumed operations of a transit route providing access to the historic sites. Now, the C and J routes take riders from the Metro North Station to the Wallace Visitor Center of the Home of Franklin D. Roosevelt. Similarly, stakeholders in this



study area could consider partnering with existing transit operators for assistance in operating the service and would need to ensure a stable financial basis.

### Colonial Williamsburg Shuttles

In 2005, Colonial National Historical Park, including land in Yorktown and Jamestown and the Colonial Parkway through Williamsburg, initiated a free shuttle service between the three historical towns, called the Historic Triangle Shuttle.<sup>65</sup> Figure 26 shows a map of the area. The Colonial Parkway takes 40 minutes to traverse, end-to-end, similar in scale to this MIMA study area. NPS funding for the service ran out in 2011 and Colonial Williamsburg assumed the \$300,000 year cost before ending service in 2014 due to lack of funds.<sup>66</sup> This shows that stakeholders should pursue long-term funding for the shuttle service- either grants, partnerships, or a fare- or risk financial instability.

Figure 26: Colonial National Historical Park with Historic Triangle Shuttle along the Green “Colonial Parkway”



Source: Colonial National Historical Park [Facebook](#)

Currently, the same vehicles, which have always been owned by Williamsburg Area Transit Authority and paid for by Colonial Williamsburg, only operate in a more limited 20-minute downtown loop of Williamsburg for ticket-holding visitors. The purpose of this shuttle is to ease parking congestion at the historical sites in downtown Williamsburg. The shuttle stops at hotels and restaurants to collect visitors from their origins who may have otherwise driven to historical sites. Potentially, stakeholders in the MIMA study area could consider adding similar stops to the fixed route. However, every stop lengthens the headway of the

<sup>65</sup> (Volpe National Transportation Systems Center 2010)

<sup>66</sup> [News Report](#) from WYDaily

shuttle and decreases the visitor experience, unless the service counters this by adding more vehicles at higher cost.

Table 23: Peer Systems Business Models

Service	Business Model	Notes
Rabbittransit	Service contract	Private transit operator
FLEX	Service contract	Private transit operator
Adams Trolley	Service contract	The trolley service is paid for using park operating funds.
SAJU tram	Memorandum of Understanding	The downfall of this tram system is attributed, in part, to the non-binding nature of the Memorandum of Understanding.
NB Line	Cooperative agreement	Park and city of New Bedford applied for grant money to secure buses, and the regional transit authority operated them
PresidiGo		Buses owned by Presidio Trust (11); private contractor operates buses and manages drivers.
Roosevelt Ride	NPS owned and operated	Since the sunset of the Roosevelt Ride, the local transit agency has filled the gap and now provides access to the parks from the regional rail stop.
Historic Triangle Shuttle, Colonial Williamsburg Shuttle		Vehicles owned by local transit agency and paid for/ operated by Colonial Williamsburg
Liberty Ride	Concession contract	Breaks even most years

### Shuttle Communication Technology Options

This section contains supporting detail on how AVL and associated communication systems work and possible applications. It supports the corresponding portion of the Common to All Scenarios section, above, which describes an overall recommendation pertinent to this analysis.

#### *Basic Components of AVL*

- GPS** - AVL relies on several different technologies in order to provide vehicle location information. The first element is GPS. This is a network of low-earth orbit satellites that circle the earth at high speed. Originally developed by the US military to support precision-guided missiles, GPS has been made available for public use, although some of the precision has been mathematically clouded to prevent effective use by adversarial weapon systems, and would be disabled in the event of an attack.



Today GPS is used by millions of devices and systems to provide relatively accurate location information.

- **Communications** - GPS only identifies the location of a vehicle. Associated communication technologies are necessary to communicate the location.
  - **Digital Radio** - Historically, transit bus systems that offer dispatchers (and sometimes customers) bus-tracking services have used a digital channel in their radio communications systems to transmit GPS data into their network. Most of these used Motorola radio equipment that provided both analog voice services and digital data. However, the equipment used on each bus was often expensive because it also provided other telemetry data such as passenger counts and vehicle performance and maintenance information. More recently, companies such as Avail Technologies have stopped supporting digital radio as a communications mechanism.
  - **Wireless Broadband** - In recent years, coverage for cellular-based devices has expanded greatly, which has caused many bus tracking providers to move away from supporting radio-based solutions. However, wireless broadband still suffers from dead zones in some places, and there is a recurring monthly cost that is approximately \$40 per bus for most applications. Lexpress uses cellular-based GenX devices to communicate vehicle locations.
  - **Transponders** - Another approach is to place transponders (similar to toll tags) in buses, and interrogators at bus stops. This approach obviates the need for any digital communications system inside the bus and works well in remote areas where radio or cellular coverage may not exist. However, in those cases, terrestrial internet service at the bus stop is required, and in all cases, interrogators require alternating current power.

### *Commonly Used Systems*

AVL systems are often components of CAD systems purchased by bus operators. Others are part of a technology suite developed by fare collection contractors. Both may offer a passenger app for iPhone or Android that provides AVL information to riders. Below are the AVL systems used by transit operators in the study area.

- MBTA – TransitMaster, a component of the technology solutions purchased from Trapeze.
- MIT Lincoln Labs Shuttle – NextBus, one of the more commonly used AVL solutions, a product of Cubic Transportation Systems.
- Lexpress – RIDE Systems, a web-based tracking-only solution

### *Summary*

For small operators that do not need automated passenger counters or vehicle telemetry, the on-board vehicle equipment could be as simple as an application running on a smartphone. AVL is comprised of GPS, wireless communications, and a processor, all of which are present in a mobile phone. However, most large transit operators have invested heavily in their AVL functions to include predictive arrival times and dynamic displays at bus stops.

*Scenario Three* has the greatest need for sophisticated and more expensive AVL and associated CAD. The requirements for *Scenario One* and *Scenario Two* are more basic and a simple and less expensive solution could fulfill them. Also, it may be possible for stakeholders to collaborate with some of the bus operators above and share their AVL platform. However, there are still costs involved. Each bus would need a tracking device, and there would be monthly communications costs. Also, there is a fee associated with providing data to passengers via an application. However, this cost could potentially be shared via collaboration, and there may be creative solutions that involve embedding a map on a web page to provide AVL information if interactive maps are not required.

For context, Lexpress pays \$95 per month in communication fees for each active bus, and \$45 per month for the backup bus. Lexpress also pays \$750 per year for assistance with the general transit feed specification (GTFS) and semi-annual updates, to enable sharing data via google maps and the Lexpress website. This level of AVL would be more than sufficient for *Scenario One* or *Scenario Two* in this analysis. In contrast, Rabbittransit, which has the type of AVL/CAD/and user app that *Scenario Three* would require, reports that the technology combination they use would cost \$500 to \$600 per vehicle per month, on top of the basic AVL costs (\$25-\$40 per vehicle per month for a device with cellular communications and GPS).

There are a variety of approaches to offer shuttle AVL data to visitors. There are solutions scalable to even the smallest of operations and simplest requirements.

## Business Model Options

The National Park Service has a few different operational models for shuttle service to and within parks. These include concession contracts, service contracts, cooperative agreements, park owned and operated, special use permits (SUP), and commercial use authorizations (CUA). MIMA does not have the staff or financial capacity to operate its own service or manage contracts or agreements, so the only feasible options for this proposed service would be a CUA or SUP to one or all towns, depending on how they coordinate (see Table 24). The towns would contract with an experienced operator using their agreed upon contracting mechanism and manage the service.



Table 24: Comparison between CUA and SUP

Feature	Commercial Use Authorization (CUA)	Special Use Permit (SUP)
Operator Type	For profit entity	Non-profit organization (e.g. Local/regional government transportation authority, public transportation)
Purpose of Service	Simple shuttle to provide visitor experience such as a tour. Focus is on business opportunity.	Provides a transportation service but not one required by NPS. Focus is on providing transportation and not generating profit.
Timeframe	2 years maximum (new agreement would then be needed to continue service)	5 years maximum (new agreement would then be needed to continue service)
Revenue	Generates profit for the operator. Focus is business operation	Does not generate profit; revenue can only cover operating costs
Fees Charge by NPS	Yes, required by law; funds go to park for CUA program support	Fees for permit may be charged or waived at park discretion
Fares Charged to Passengers	Yes, usually	Able to charge a modest fare for cost recovery but may not generate profit
Level of NPS Control	No input on level of service. NPS does require service and does not dictate schedule. Not required to provide service.	Limited; can only establish a maximum level of service, not a minimum. Not required to provide service.
NPS Infrastructure or Assets	Cannot modify NPS infrastructure or assets, or install fixtures/infrastructure.	Able to modify NPS infrastructure or assets.

Source: TRIPTAC and Michael Slobodian in the NPS Region 1 Contracting Office

### *Town Coordination*

Whereas the Park is limited in its ability to manage a shuttle service, the towns may be able to pool resources and coordinate to establish a service. A coordinated service requires strong commitment by each town since the three operate independently with separate budgets and management. The opportunity for increased visitation and economic development must be bolstered by benefits to the local town populations, including providing transit service for underserved populations and the general public. A service focused solely on tourists would be hard for the town managers to justify in the operating budget contributions.

At the stakeholder meeting on December 14, 2020, the three towns and MIMA determined their preferred scenario is Scenario 2 with two vehicles dedicated to the E-W route and two vehicles dedicated to the N-S route. The towns need to discuss and come to agreement on a number of decisions, including:

- Whether the shuttle will be operated by a private entity or through contract with an existing transit authority;
- How to structure management and oversight of the service provider (e.g., hire an external manager, or have one town oversee);

- Where to direct visitors to park to access the hop-on, hop-off service (see Parking and Access section on page 23 for information on parking capacity and constraints);
- How much each town will contribute to fund operations;
- Whether and how much to ask sites benefiting from the service to contribute;
- Whether to charge a fare for the service and how much to charge; and
- How to promote the service widely to facilitate access by tourists and local residents.

The participating stakeholders can advocate for the shuttle system with the towns' managers by providing examples of funding and operation models for successful shuttle systems that operate in a similar context. The following passages describe example services operated in Philadelphia, Colorado Springs, and Aspen.

### PHLASH

The Philadelphia PHLASH operates on city streets in Philadelphia, Pennsylvania and stops at a series of historic sites along its route in a “hop-on, hop-off” model.<sup>67</sup> The Southeastern Pennsylvania Transportation Authority initially operated it before transferring operations to the City. The Independence Visitor Center Corporation (IVCC), a 501c3 non-profit, now manages the service. It works in cooperation with the National Park Service, Visit Philadelphia®, Philadelphia Convention and Visitors Bureau, the City of Philadelphia, and the Commonwealth of Pennsylvania. The PHLASH runs six branded transit buses in two loops on city streets, connecting various historic and cultural institutions, primarily facilitating tourist access to the sites. It operates on weekends in the spring (March, April) and autumn (September through November), and daily from May through August.

IVCC receives funds to operate PHLASH service from several sources. These include ticket sales; the Southeastern Pennsylvania Transportation Authority (\$250,000 annually); and the Pennsylvania Department of Transportation (\$918,000 annually), which requires a 15% match on those funds. The matching funds total about \$130,000. IVCC raises these funds through ticket sales and contributions from organizations with stops served by PHLASH (\$7,000-12,000 annually). The city of Philadelphia helps fill in funding gaps when one occurs (although the city's contribution is never more than 20 percent).<sup>68</sup> The sites served by PHLASH include:

- The Barnes Foundation,
- Eastern State Penitentiary,
- Please Touch Museum,
- The Franklin Institute,
- Philadelphia Museum of Art,
- Philadelphia Zoo,
- National Constitution Center,
- National Museum of American Jewish History,
- Reading Terminal Market, and
- Spruce Street Harbor/Penn's Landing.

The IVCC continually works to maintain support for the service, establishing that the “PHLASH serves as both an advertisement and an ambassador for the attractions it

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<sup>67</sup> (Neff Associates 2021)

<sup>68</sup> (Nagle 2020)



services.”<sup>69</sup> The IVCC conducts visitor surveys and uses independent consultants to estimate annual visitation brought to each of the sites by PHLASH service. Ridership analysis from fare mix data indicates that most passengers use the bus to access local attractions, although some Philadelphians likely use the service as a means of local transportation.

### Garden of the Gods

Garden of the Gods Park is a designated National Natural Landmark that the city of Colorado Springs owns and manages with support from the Garden of the Gods Foundation. Since 2013, as visitation has risen, Colorado Springs has witnessed high congestion, particularly on summer weekends. This congestion has led to vehicle queuing outside the entrance gate to the main parking lot, for a distance of about one mile. Concerned about safety and visitor experience, Colorado Springs sought to address congestion with a shuttle system during the peak season.<sup>70</sup>

In 2019, Colorado Springs and the Garden of the Gods Foundation contracted with a private operator to run a pilot service with two 14-passenger shuttle vans plus an additional 14-passenger jeep for back up. Parking for shuttle passengers was at the 15 parking areas within the park, which have a total of 335 parking spaces, and 3 other parking lots at the periphery of the park. Colorado Springs plans to expand one of the peripheral lots to encourage shuttle use and mitigate traffic within the park. The pilot service was free to the public and ran from 9:00am to 4:30pm between Memorial Day and Labor Day. The cost to operate the pilot service was \$600 per vehicle per day, including staff and maintenance. To operate two vehicles for a 90-day pilot, this came to about \$108,000. The Garden of the Gods Foundation and Colorado Springs split this cost.

### Maroon Bells

The Maroon Bells shuttle system provides exclusive access from Aspen Highlands to the popular Maroon Bells Scenic Area and the Maroon Bells-Snowmass Wilderness in the Aspen-Sopris Ranger District of the White River National Forest in Colorado. Development of the service involved the effort of a multi-agency working group that includes the U.S. Forest Service (USFS), the Roaring Fork Transportation Authority (RFTA), Pitkin County, the City of Aspen, the Chamber of Commerce, and the Aspen Ski Company. RFTA operates the service itself, paying the majority of operating expenses with revenue from ticket sales. The service starts at a parking garage in Aspen Highlands that the Aspen Ski Company operates and terminates eight miles southwest in the Maroon Bells Scenic Area. Though the other partners do not make direct financial contributions to the system (the city and county do contribute to covering RFTA’s general operating expenses), they have an equal voice regarding how the system operates and they all support marketing and communication about the shuttle service.

The shuttle continued operation during the 2020 pandemic with the institution of a reservation system, developed and managed by H2O Ventures. Ticket prices increased in 2020 from \$8 to \$16 because the buses are only able to carry half of the passengers due to social distancing requirements and to cover the cost of the reservation system. The fare revenue is distributed amongst RFTA (~\$10 per ticket), H2O for the reservation system (~\$5), and the USFS for administration (~\$1). When ticket sales do not meet RFTA’s

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<sup>69</sup> (Independence Visitor Center Corporation 2016)

<sup>70</sup> (Volpe National Transportation Systems Center 2019)

operating expenses, the RFTA Board has helped make up the shortfall with general operating funds. These subsidies are meant to only cover up to ten percent of the total operating budget.

### Hanging Lake

Hanging Lake, a National Natural Landmark, is one of the most popular destinations in the White River National Forest. The site, 13 miles east of Glenwood Springs, Colorado, is a popular hiking location for local visitors and tourists throughout the spring, summer, and fall months. However, the site's popularity has also created problems, including parking lot congestion, trail overcrowding, public safety concerns, and resource degradation. After substantial analysis and stakeholder outreach, the USFS and Colorado Department of Transportation recommended piloting a parking reservation and shuttle system.

The city of Glenwood Springs published a request for proposals for a reservation and shuttle system. The responses were reviewed by a working group that included the city, USFS, Colorado Department of Transportation (which owns the rest area/parking lot where people access the trail), and the Glenwood Springs Chamber of Commerce. The city oversees the contract and handles day-to-day management with the selected bidder, H2O Ventures, which is a private company. H2O also provides staffing to check reservations, maintain the restrooms, and provide support on the trail. Unlike Maroon Bells, RFTA does not operate the shuttle and is not engaged in the working group.

Fare revenue is the primary source of funding for the system. The fare in 2019 was \$10 per person. Shuttle service halted in 2020 due to the pandemic and visitors were then required to purchase a reservation to park at the site. The fee remained \$10 per person. Operating the shuttle in 2020 at half capacity would have required increasing the fare to recover costs of additional buses and drivers.

### Next Steps

After reaching agreement in December 2020 that Scenario 2 is the preferred option, the stakeholders will collaboratively determine next steps and timeline for moving forward. Stakeholders will continue meeting to refine the assumptions of this study and attain more certainty on details regarding funding and operation of the service. This would involve decisions and additional work on items such as:

- Fare (whether to charge and how much);
- High and low cost items in the report's cost estimate tables (which to pursue);
- Funding sources (how the service would be funded); and
- Post-pandemic outlook (how conditions will rebound after the COVID-19 pandemic, and how changing circumstances may impact the viability of a service).

Stakeholders also expressed an intent to present the feasibility study results to the public in the three towns and collect feedback. Stakeholders will also need to consider the key questions that appear in the Town Coordination section on page 91, regarding business model, collaboration, and communication.

With respect to implementation, one possibility is that the towns may choose to run a pilot using existing resources, if there are one or more vehicles available, such as repurposed school buses. A pilot could help gather data to refine service details and inform a full



implementation. Another possibility is that the towns may choose to develop a request for information (RFI) to gauge whether any private or public transit service operators are interested in providing the service, or some component of it, depending on the business model. Such an RFI could ask respondents what type of vehicle they would operate, the number of vehicles they have or would need to purchase, and the fee structure (daily flat rate, per service mile or hour). The RFI responses could help the towns and MIMA further define service details and potential operating costs. The RFI responses may also help the towns to determine whether the service qualifies for grants from the state, federal agencies, or other organizations.

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## Appendix A: Funding Sources

### *Federal Sources*

The following fund sources are grants from the Federal Transit Administration (FTA) and Federal Highway Administration (FHWA), which must funnel through a metropolitan planning organization (MPO), state department of transportation (DOT), or public transit agency. The direct recipient can then allocate the funds to projects, such as the town-led MIMA shuttle. For this reason, stakeholders would need to coordinate with the Boston region metropolitan planning organization (Central Transportation Planning Staff), MassDOT, or a transit agency in order to pursue the following funding sources.

- [Congestion Mitigation and Air Quality \(CMAQ\)](#)<sup>71</sup> (FHWA): Funds transportation projects or programs that are likely to contribute to the attainment or maintenance of a national ambient air quality standard.
  - Potential amount: Dependent on which entity (MPO, state DOT, transit agency) funds the project, their available funds, and the value of the project.
- [Surface Transportation Block Grant Program](#)<sup>72</sup> (FHWA): Funds a broad range of surface transportation capital needs, including roads; transit, sea, and airport access; and vanpool, bicycle, and pedestrian facilities.
  - Potential amount: Dependent on which entity (MPO, state DOT, transit agency) funds the project, their available funds, and the value of the project.
- [Low or No Emission Vehicle Program](#)<sup>73</sup> (Section 5339(c)) (FTA): Funds the purchase or lease of zero-emission and low-emission transit buses as well as acquisition, construction, and leasing of required supporting facilities.
  - Precedent: MassDOT and the Martha's Vineyard Transit Authority will receive funds to purchase new electric buses and charging infrastructure (\$1,100,000 awarded).

#### Other federal sources

- [Federal Lands Access Program](#)<sup>74</sup> (FLAP): Aims to improve transportation facilities that provide access to, are adjacent to, or are located within Federal lands.
  - Potential amount: An estimated \$1 million is available for programming in Massachusetts.
  - Precedent: In fiscal year 2018, Massachusetts completed 8 FLAP projects, mostly sidewalk, multi-use trail, and parking improvements, this involved the programming of \$2.9 million in FLAP funds with about 20 percent local match.
- [Battlefield Preservation Planning Grants](#)<sup>75</sup> (NPS): Grants for projects that relate to planning, interpreting, and protecting historic battlefields and sites associated with

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<sup>71</sup> <https://www.fhwa.dot.gov/fastact/factsheets/cmaqfs.cfm>

<sup>72</sup> <https://www.fhwa.dot.gov/fastact/factsheets/stbgfs.cfm>

<sup>73</sup> <https://www.transit.dot.gov/funding/grants/lowno>

<sup>74</sup> <https://highways.dot.gov/federal-lands/programs-access>

<sup>75</sup> <https://www.nps.gov/subjects/battlefields/battlefield-planning-grants.htm>



armed conflict on American soil. Potentially, this grant money could support the interpretive aspects of the shuttle.

- Potential amount: Typical awards range from \$30,000-\$150,000

### *State Sources*

- [Helping Hand Mini Grant](#)<sup>76</sup> (MARTap): State grants to support transit services in rural and small urban areas. Could support acquisition of accessory equipment such as GPS, tires, wheelchairs, etc. or marketing/ promotional materials such as web page design and setup.
  - Potential amount: Small grants of up to \$1,000
- [Community Transit Grant Program](#)<sup>77</sup>: A Massachusetts state-wide grant opportunity aimed at improving community transit specifically for seniors and individuals with disabilities. Though the discussed MIMA shuttle service does not specifically target these user groups, it could serve them.
  - Potential amount: In fiscal year 2020, entities were awarded between 1 and 14 vehicles for capital awards or between \$12,000 and \$190,000 for management and operating awards.

### *Boston Region MPO Sources*

- [Community Connections Funding Program](#)<sup>78</sup>: Funds first- and last-mile connections to transit, community transportation, and other small, non-traditional transportation projects. New transit operations projects are eligible for this funding source. The next funding cycle should open October 2021. This is a newer program (piloted in 2019) so no projects have come to fruition from these funds yet.
  - Potential amount: The whole program is funded at a level of \$2 million per year in the fiscal years 2021-25 Transportation Improvement Program.

### *Other Funding Sources*

- [Smith Family Foundation's Small Capital Grants initiative](#)<sup>79</sup>: These grants have an open application process with the purpose of funding one-time capital expenses, including purchase of vehicles.
  - Potential amount: \$10,000 to \$50,000 grants for one-time capital expenses
- [Transportation Network Company disbursements](#)<sup>80</sup>: Municipalities receive annual funding based on the number of transportation network company rides originating there on an annual basis.
  - Potential amount: In 2018, Lincoln received \$1,770.90, Lexington received \$16,504.40, and Concord received \$4,789.20.

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<sup>76</sup> <https://www.mass.gov/how-to/apply-for-a-helping-hand-mini-grant><https://www.mass.gov/how-to/apply-for-a-helping-hand-mini-grant>

<sup>77</sup> <https://www.mass.gov/community-transit-grant-program>

<sup>78</sup> <https://www.ctps.org/community-connections>

<sup>79</sup> <https://rssff.org/our-giving-areas/community-giving/>

<sup>80</sup> <http://www.mapc.org/wp-content/uploads/2019/07/TNC-Funds-Fact-Sheet-2019.pdf>

## Appendix B: Cost Estimate Assumptions and Details

**Table 25**  
**Assumptions and Details for Financial Estimates**

Category	High/Low Cost Options	Details
Transportation (vehicles, driver wages, insurance, maintenance, fuel, dispatch, back-up vehicle)	High: Trolley	Assumes a rate of \$116 per hour, based on the Liberty Ride.
Transportation	Low: Mini-bus	Assumes a rate of \$100 per hour, based on information from a few companies.
AVL (including provision of information to public)	High: AVL	Assumes basic AVL, using Lexpress cost information. This involves \$95 per month in communication fees for each active bus, and \$45 per month for a backup. It also includes \$750 per year for assistance with the general transit feed specification (GTFS) and semi-annual updates, to enable sharing data via google maps and website.
AVL	Low	Assumes no AVL
Coordinator	High: Full time	Assumes one staff person 6 days per week 7 hours per day at a rate of \$25 per hour.
Coordinator	Low: Part time	Assumes one staff person 6 days per week 7 hours per day at a rate of \$25 per hour.
Interpretation	High: Live narration	Assumes an average of \$15 per hour for each tour guide, 7 hours per day
Interpretation	Low: Recorded narration	TBD; would require further research
Advertising	High: Incur direct costs	Assumes a flat amount based on the cost for the Liberty Ride in FY2018: \$19,200
Advertising	Low	Assumes that towns perform in-house, so incur indirect rather than direct costs.
Supplies, Printing, and Other Services	High: Incur direct costs	Assumes a flat amount based on the cost for the Liberty Ride in FY2018: \$13,500
Supplies, Printing, and Other Services	Low: Towns perform in-house	Assumes that towns perform in-house, so incur indirect rather than direct costs.
Seasonal Total Gross Cost (High)		Assumes all "high" cost options in all of the above categories.
Seasonal Total Gross Cost (Low)		Assumes all "low" cost options in all of the above categories.
Revenue (High)		Assumes a Fare of \$18 and Daily Ridership of 31-156
Revenue (Low)		Assumes a Fare of \$7 and Daily Ridership of 31-156

Source: Volpe Center research

**REPORT DOCUMENTATION PAGE**

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As the nation’s principal conservation agency, the Department of the Interior has the responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our parks and historic places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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