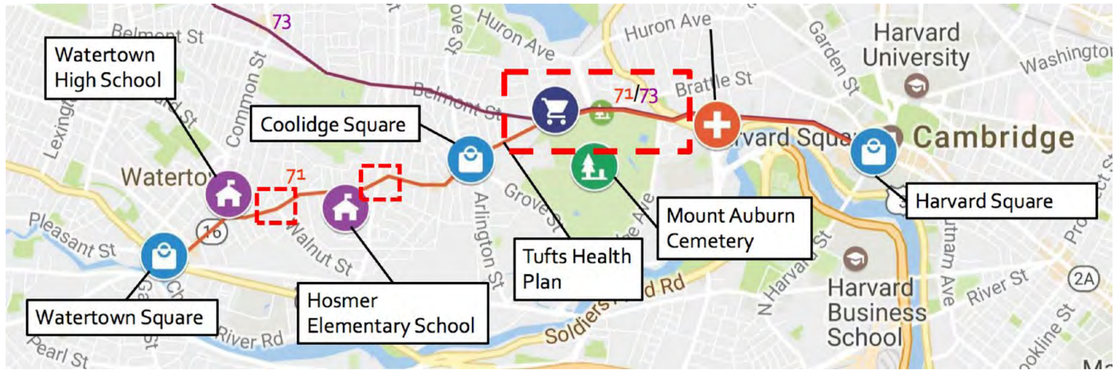
Project Context

CAMBRIDGE WATERTOWN BRT

Context

Pilot Area



MBTA Route73 (Harvard to Waverly Square)

MBTA Route 71 (Harvard to Watertown Square)

Pilot Project Areas

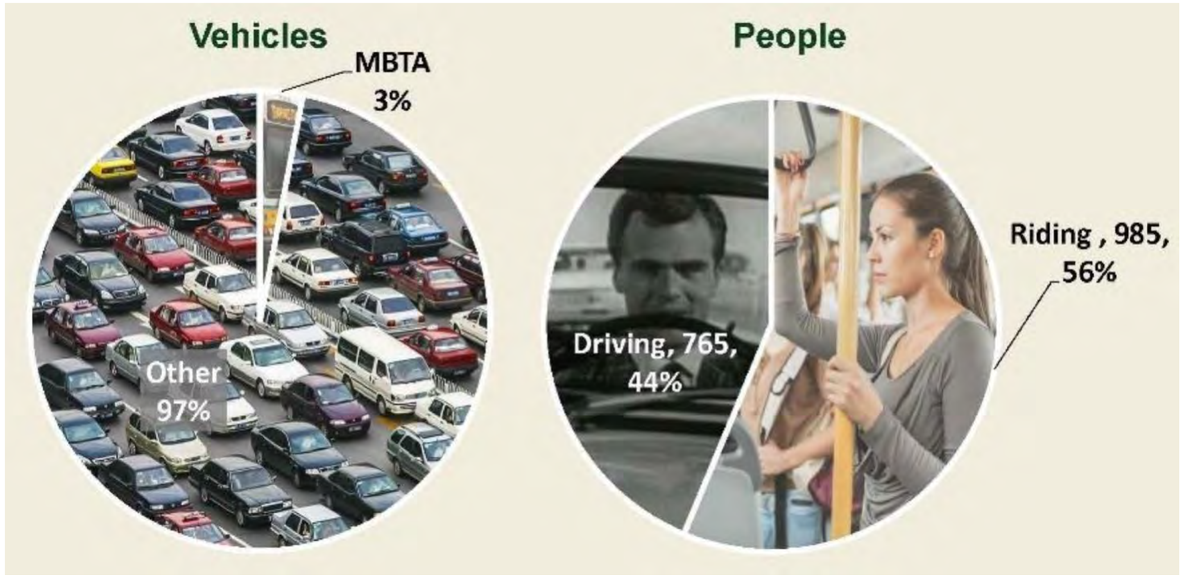
City Policies

2016 Cambridge and 2017 Watertown Complete Streets policies:
Complete Streets are designed and operated to enable safe access for all users – regardless of age, ability, or mode of transportation.

2016 Vision Zero policy:
Calls for the elimination of fatalities and serious injuries resulting from traffic crashes, and emphasizes that they can and should be prevented.

Why are buses (MBTA and private) so important?

Vehicle and MBTA bus counts compared to people counts on Mt. Auburn Street from Brattle to Coolidge in the morning rush hour



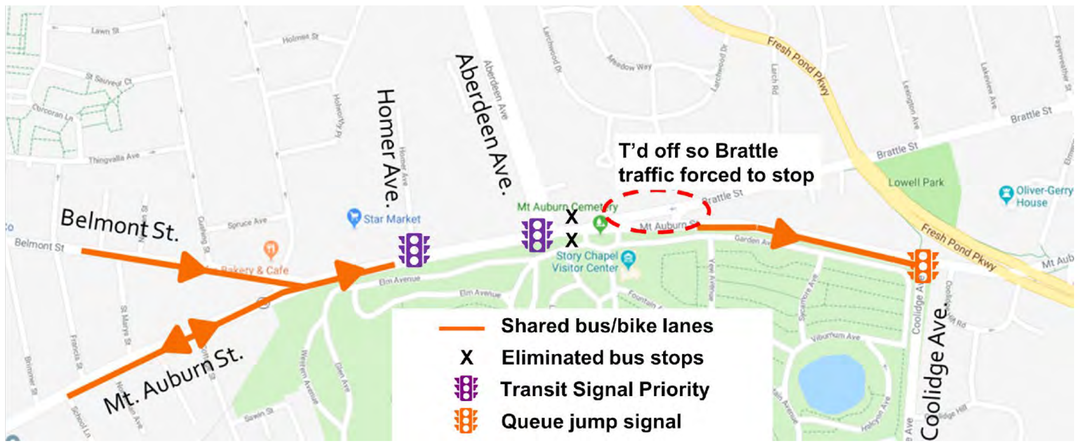
(Source: DCR Public Presentation, January 10, 2016, Slide 70)
http://www.mass.gov/eea/agencies/dcr/conservation/planning-and-resource-protection/projects/mount-auburn-street-corridor-study.html

- MBTA Routes 71 and 73 provide 12,000 weekday daily passenger trips compared to 19,000 daily vehicle trips – while MBTA buses are only 3% of the vehicles on the street; MBTA buses carry over half of the people on the street at certain points.
- For private shuttles, Mt. Auburn Hospital runs shuttles continuously to two off-site parking lots in Watertown from roughly 5:30am to 10:00am and 2:00pm to 8:45pm, and another 8 midday trips. Athenahealth has 30 shuttle trips per day on Mount Auburn St.
- This pilot addresses some of the worst MBTA bus delay and unreliability in Cambridge. A 2014 transit delay and reliability study showed that in the morning rush hours (7-9am) there were a total of almost 80 hours of passenger delay experienced in the segment approaching Coolidge Ave (eastbound).
- The more transit ridership we can encourage, the less drivers will be contributing to congestion on the street, especially in the rush hours.

Design – What did we do?

CAMBRIDGE WATERTOWN BRT

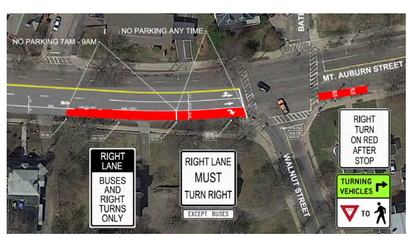
Pilot Features

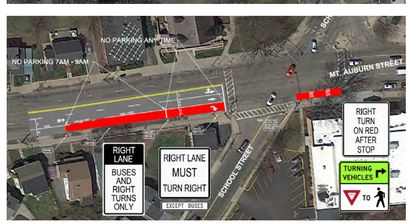


Features/Elements

- All day bus/bike-only lanes eastbound (toward Harvard)
- All day bus/bike-only for a short section westbound (toward Watertown Square)
- One queue jump signal at DCR's Coolidge Ave intersection
- Transit signal priority at two Cambridge intersections
- Bike lanes in Cambridge westbound (toward Watertown/Belmont)
- Two additional Watertown queue jump lanes (see below)

Watertown Queue Jump Lanes





- Inbound right turn/ queue jump lanes which allow buses to get to the front of an intersection
- Right turns on red allowed at all times
- Parking restricted in AM

What do we mean by a "Pilot"?

- **Partnership between Cambridge, Watertown, DCR, and MBTA**
- **Minimal or no construction, paint, signal changes, signs**
- **No specific timeframe, intended to test and evaluate to develop long-term plan**
- **Education and enforcement during transitional period**

Massachusetts Bay Transportation Authority

dcr Massachusetts

ITDP Institute for Transportation & Development Policy

Outreach / Implementation Timeline

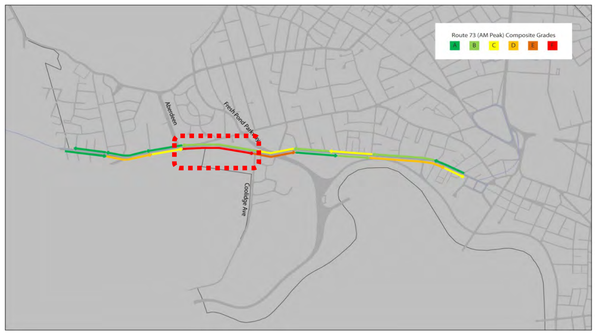
Jan/Mar, 2018:	Internal stakeholder City Advisory Committees
Feb 15, 2018:	Watertown Mt. Auburn corridor transit meeting
Mar 27, 2019:	Joint Strawberry Hill Neighborhood Meeting
Mar/April 2018:	Outreach to external stakeholders (businesses, institutions)
April/May, 2018:	Data collection for pre implementation evaluation
May 1, 2018:	Joint Watertown/Cambridge public meeting
May 14, 2018:	Watertown Mt. Auburn Project Open House
Summer 2018:	Finalize design and prepare for implementation, Mayor's Program youth street teams, partial implementation
October 2018:	Full implementation, evaluate and refine
Spring 2019:	Data collection for post implementation evaluation

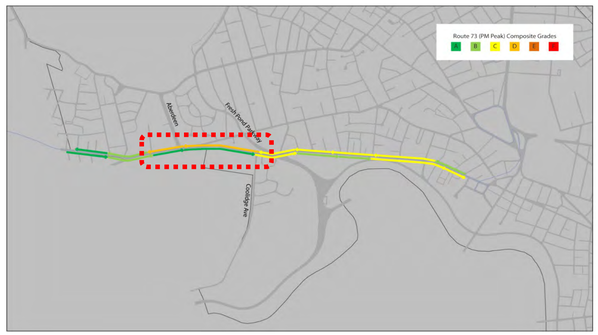
Pre-Pilot Existing Conditions

CAMBRIDGE WATERTOWN BRT

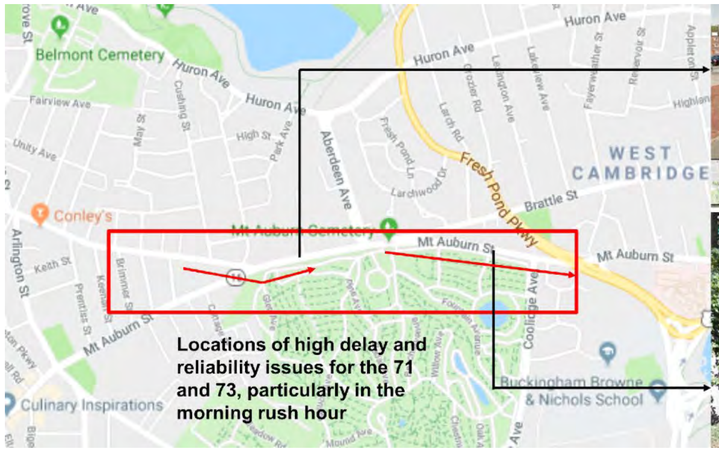
2014 Analysis of Transit Delay and Reliability

We used MBTA Automatic Passenger Count (APC) data to look at the delay and unreliability for buses in bus stop-to-bus stop segments. The change in standard deviation of delay from segment to segment was used to estimate reliability. Mt. Auburn Street between Aberdeen and Coolidge Ave was identified to have some of the worst delay and reliability for buses in all of Cambridge.





Overall Project Area Characteristics

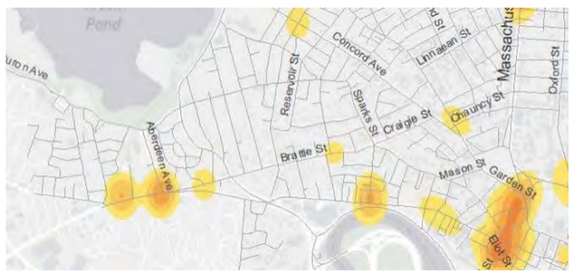


- Primarily two lanes of travel in each direction
- On-street parking exists on Mt. Auburn Street only west of Belmont Street and on Belmont Street. We did not remove parking in the pilot, except for roughly one parking spot on Brattle Street near the reconfigured intersection with Mount Auburn.

Other Transportation Conditions

No bike facilities

Challenging pedestrian crossings



See City of Cambridge Crash Analysis Summary, http://www.cambridgema.gov/cpd/Publications/2017/05/cityofcambridgecrashanalysissummary

Density map of crashes requiring EMS transport, reported by responding officer

Multiple lanes of traffic, not well marked

Post-Pilot Conditions

CAMBRIDGE WATERTOWN BRT

Interim Conditions (Summer to Fall of 2018)

- Lane markings, addition of bicycle lanes westbound, transit signal priority
- Two Watertown queue jumps to allow buses to move to the front of intersection
- Resulted in early safety improvements

Painted lane markings for bus/bike lanes without restricting to buses/bikes

Belmont St @ Brimmer St

Clarified traffic flow and increase markings for pedestrian crossings

Mt. Auburn St @ Brattle St

Added westbound bicycle lanes

Mt. Auburn St @ Homer bus stop

Reduced number of lanes pedestrians cross on Mt. Auburn at Brattle Street

Mt. Auburn St @ Brattle St

Added green street markings at conflict areas for cyclists

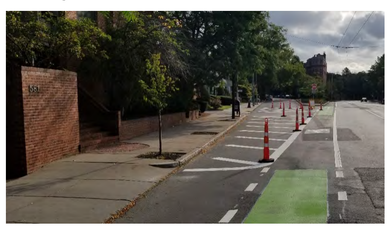
Mt. Auburn St @ Homer bus stop

Added yield markings to pedestrian crossing on Brattle Street

Brattle St @ Mount Auburn

“Teed” off intersection at Brattle St. with cones and markings to give priority to traffic on Mt. Auburn Street and to improve safety

Mt. Auburn St @ Brattle St



Mt. Auburn St @ Brattle St

Installed bus queue jumps at Walnut and School Streets to allow buses to bypass cars stopped at intersection

Mt. Auburn St @ School St

Final Pilot Conditions (fully in place in November of 2018)

- Added bus lane markings and signs, including red paint
- Implemented signal timing changes at Mt. Auburn at Fresh Pond Parkway (DCR)

Added bus/bike-only red lane and other markings and signs throughout the project area

Queue jump westbound on Mount Auburn St. at Belmont St

Bus lane eastbound on Mt. Auburn at Belmont St

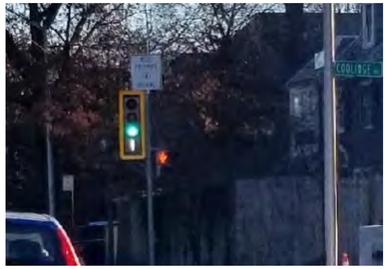
Cyclist eastbound on Mt. Auburn

Bus lane westbound on Belmont St. at St. Mary’s St.

MBTA bus and private shuttle travelling eastbound in bus lane

Bus lane eastbound on Mt. Auburn St. in Watertown

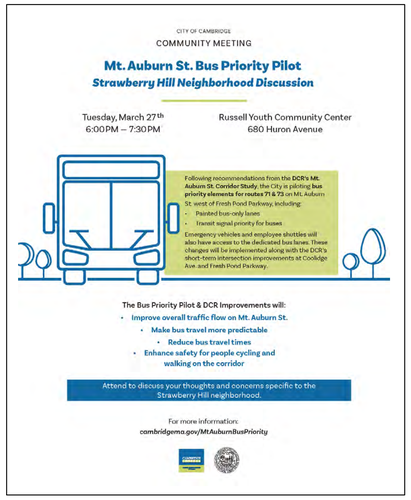
Added new signal equipment and updated signal timings



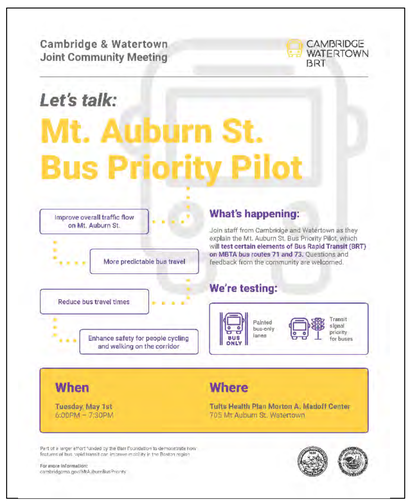
New, retimed signals at Coolidge Ave.

Outreach & Education

Flyering & Bus Shelter PSAs



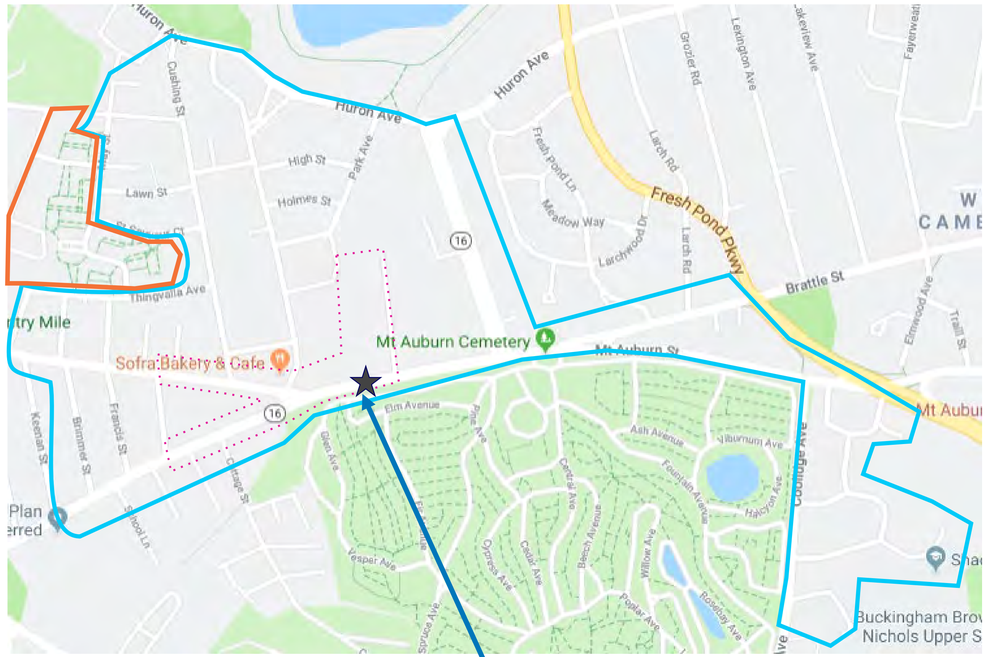
March 2018
Neighborhood Meeting

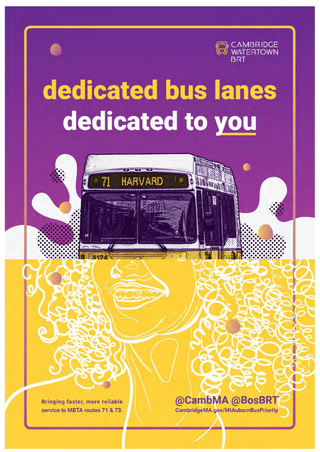


May 2018
Joint Community Meeting

June 2019
Open House

Door flyers Bulletin Board Business outreach



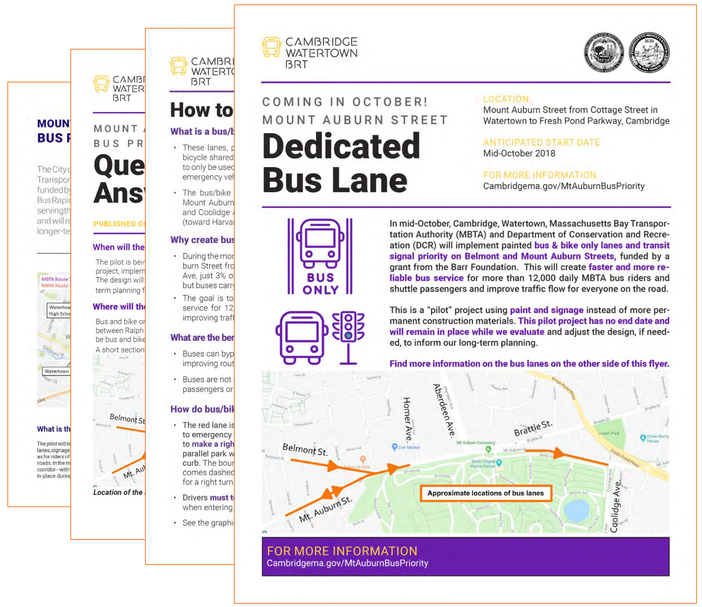


Outreach & Education

Youth-led Outreach: Flyering, Street Teams, Tabling

Through the Cambridge Mayor's Summer Youth Employment Program, Cambridge high school students spoke to people about the Mt. Auburn Bus Priority Project throughout July and August 2018.

Factsheets & Information



Online, at events, and left at doors

- FAQs (April and September)
- User guide: bus/bike lane (October)
- Q'n'A on street designs (October)

Videos

City of Cambridge:

- 1-minute "What you need to know"
- 3-minute "Learn about the bus priority lanes"
- 5-minute "Learn about the details"

Public Events

March 27, 2018: Strawberry Hill Meeting (Russell Youth Center)

May 1: Joint Watertown-Cambridge Meeting (Tufts Health Plan Building)
October 26: Launch event at 699 Mount Auburn St.

June 12, 2019: Open house for transportation analysis

Before & After Results - Route 71

CAMBRIDGE WATERTOWN BRT

The Mount Auburn Bus Priority pilot aimed to improve travel time and reliability for people on buses in the pilot area as well as the route as a whole. Results indicate that the pilot achieved this goal, with significant time savings and improvements in reliability (seen in the 90th percentile figures) on both the Route 71 and 73.

Travel times in the pilot area

Route 71 – Pilot Area 50th %ile (Average Day)

Route 71 experienced a 42% decrease in running time at 8 a.m. inbound, **saving 3.6 minutes, or almost cutting time in half!**

Outbound, Route 71 saved **1.3 minutes** at 5 p.m., for a 23% decrease in overall running time.

INBOUND: 8.5 min → 42% → 4.9 min

OUTBOUND: 5.8 min → 25% → 4.5 min

A daily rider saves: 5 min/day or over 21 hours/year!

We used the 50th percentile travel time because it represents the time it takes a bus to travel through the project area on a typical weekday.

Route 71 – Pilot Area 90th %ile (Typical Bad)

The 90th percentile suggests the system performance on a typical bad day or bus run.

Between 8 and 9 a.m., the intervention decreased the inbound 90th percentile by 48%, or **nearly 6 minutes**

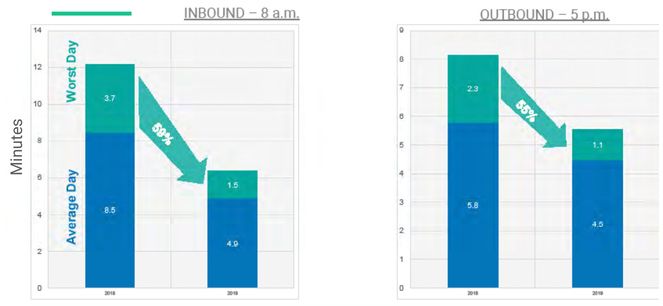
Between 5 and 6 p.m., the decrease in outbound travel was 32%, or 2.6 **minutes.**

INBOUND: 12.1 min → 48% → 6.4 min

OUTBOUND: 8.1 min → 32% → 5.5 min

We chose the 90th percentile travel time because it represents the time it takes a bus to travel project areae on a day with serious congestion. Here we call the 90th percentile travel time as -- "typical bad". The 90th percentile travel time is the kind of trip where congestion is bad, an event is happening, or other factors can create slow travel. The 90th percentile travel time is also important because the MBTA plans its schedules based on the 90th percentile travel time.

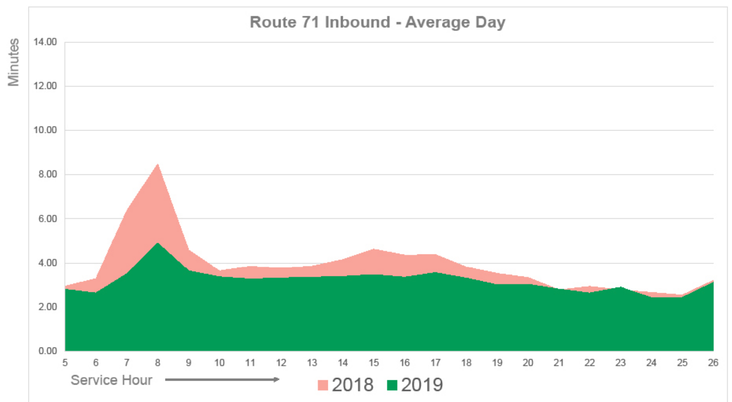
Route 71 – Variance

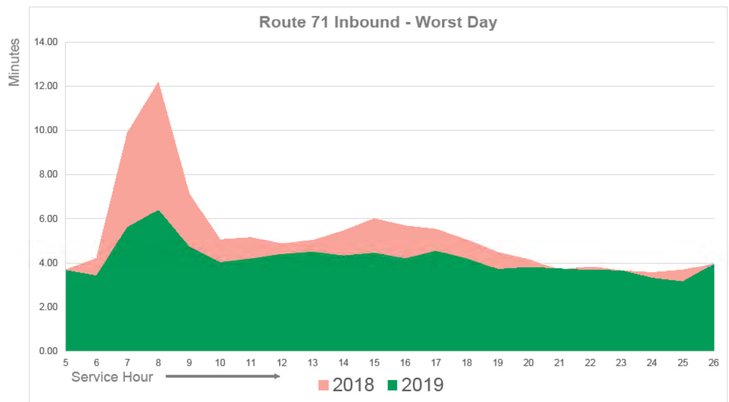


Travel time variance is the difference between the travel time on a typical day (50th percentile) and on the "typical bad day" (90th percentile) in the project area. We show travel time variance because it is how we measure the day-to-day reliability of buses. One way to describe variance is the "planning" time or additional time that people use as a "buffer" for in their trips to account for delays on the bus.

On the charts above, we show the travel times for typicial weekdays, typical bad weekdays, and the change in the variance before and after we changed the street. Not only did the bus travel faster on typical and typical bad weekdays, but, the pilot also decreased the variance in the project area meaning that after all the changes, people could depend on the bus to travel even closer to the regular schedule.

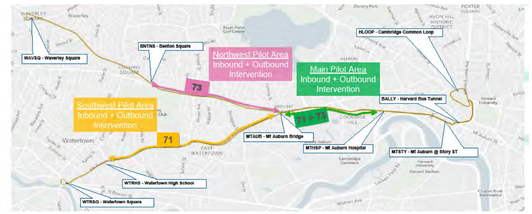
Travel times in the pilot areas throughout the entire day





Travel time for bus riders in the pilot area segment traveling towards Harvard improved not only during the rush hour, but throughout the day. The pink in the charts to the left represents the time savings at each hour for both a typical (50th percentile) and "typical bad" (90th percentile) travel day.

Notes on data



This data is from the "Main Pilot Area," the area marked in green on the map above. The MBTA collected data using 2 time frames:

- Pre-Pilot: March 19 - May 4, 2018, Monday through Friday
- Post-Pilot: March 18 - May 3, 2019, Monday through Friday

The source of this data is Automatic Vehicle Location (AVL) data that tracks vehicles by when they arrive and leave specific "timepoints" or bus stops on a route. Specifically, the "Main Pilot Area" is from the intersection of Mount Auburn and Belmont Streets to Mount Auburn Hospital stops, as shown above.

For more information, visit the MBTA blog: https://www.mbtabackontrack.com/blog/46-how-the-mbta-tracks-vehicles

Before & After Results - Route 73

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CAMBRIDGE WATERTOWN BRT

Travel times in the pilot area

Route 73 – Pilot Area 50th %ile (Average Day)

Route 73 experienced a 46% decrease in running time at 8 a.m. inbound, **saving over 4 minutes.**

INBOUND: 8.9 min → 46% → 4.8 min

Outbound, Route 73 saved **1.5 minutes** at 5 p.m., for a 26% decrease in overall running time.

OUTBOUND: 6.0 min → 26% → 4.5 min

A daily rider saves: 5.7 min/day or almost 25 hours/year!

We used the 50th percentile travel time because it represents the time it takes a bus to travel through the project area on a typical weekday.

Route 73 – Pilot Area 90th %ile (Typical Bad)

The 90th percentile suggests the system performance on a typical bad day or bus run.

Between 8 and 9 a.m. the intervention decreased the inbound 90th percentile by 45%, or **over 5 minutes.**

Between 5 and 6 p.m., the decrease in outbound travel was 29%, or **2.4 minutes.**

INBOUND: 12.1 min → 45% → 6.7 min

OUTBOUND: 8.3 min → 29% → 5.9 min

We chose the 90th percentile travel time because it represents the time it takes a bus to travel project areae on a day with serious congestion. Here we call the 90th percentile travel time as -- "typical bad". The 90th percentile travel time is the kind of trip where congestion is bad, an event is happening, or other factors can create slow travel. The 90th percentile travel time is also important because the MBTA plans its schedules based on the 90th percentile travel time.

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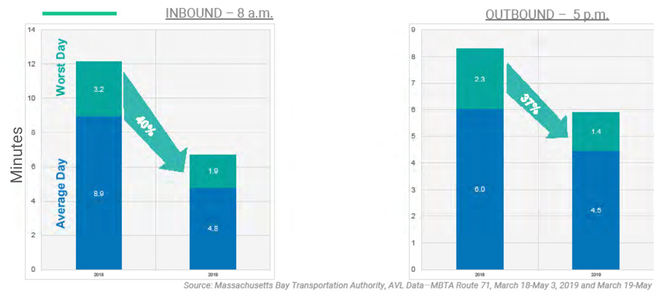

Source: Massachusetts Bay Transportation Authority, AVL Data--MBTA Route 71, March 18-May 3, 2019 and March 19-May

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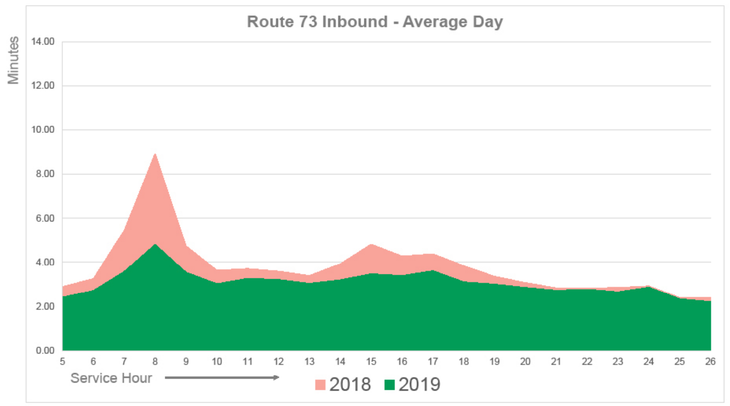
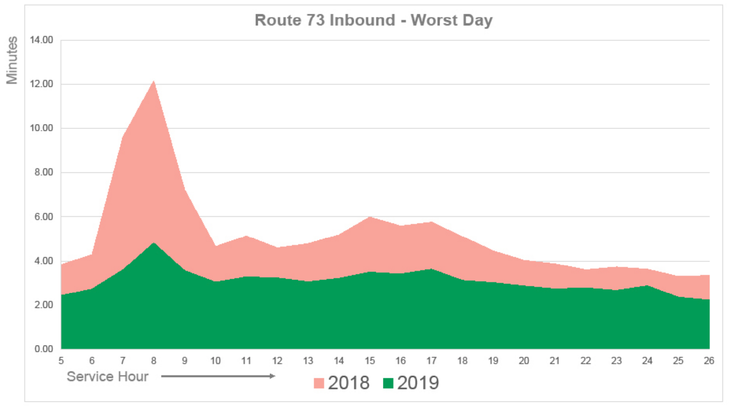
On the charts above, we show the travel times for typicial weekdays, typical bad weekdays, and the change in the variance before and after we changed the street. **Notably, the travel time through the pilot area segment on the worst day is now less than the travel time on an average day before the pilot.** Therefore, the pilot significantly increased the overall reliability of the bus and made the worst day travel time more similar to the average day.

Travel times in the pilot areas throughout the entire day





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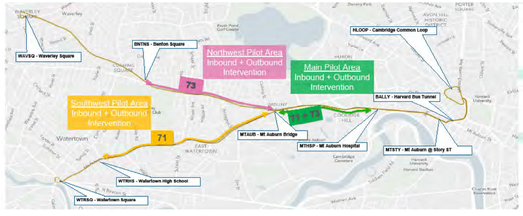

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Before & After Results – Vehicles

Traffic volume counts and a travel time survey were completed for the study corridor before and after implementation of the bus lanes to understand impacts to drivers.

Key Results

- **Vehicle volumes are about the same** throughout the day
- **No indication of traffic diversion** to parallel routes
- Vehicle travel times **did not indicate a significant impact** to drivers as a result of the pilot
- Off-peak traffic does not experience delay due to bus lanes

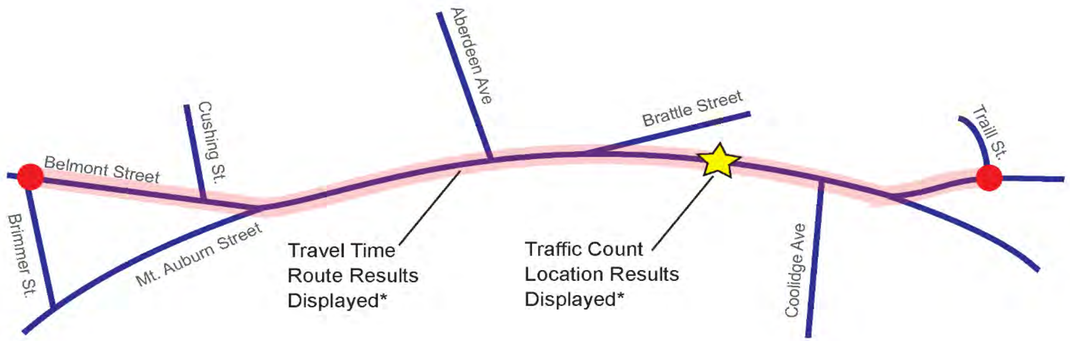
Vehicle Travel Times

- The **largest increase** was up to 2 minutes during evening rush hour towards Harvard. This increase affects about 1/3 of vehicles on the street at that time which is far less of the people travelling on the street at that time.
- Measured travel time was **more reliable** in the morning rush hour: The maximum observed travel time was 13 minutes before vs. 9 minutes after. The largest increase in morning rush hour was 30 seconds.
- The measured increase in travel time in the westbound direction in the evening rush hour doesn't correlate with the more extensive bus data. In this direction, buses and vehicles are all operating in mixed traffic.

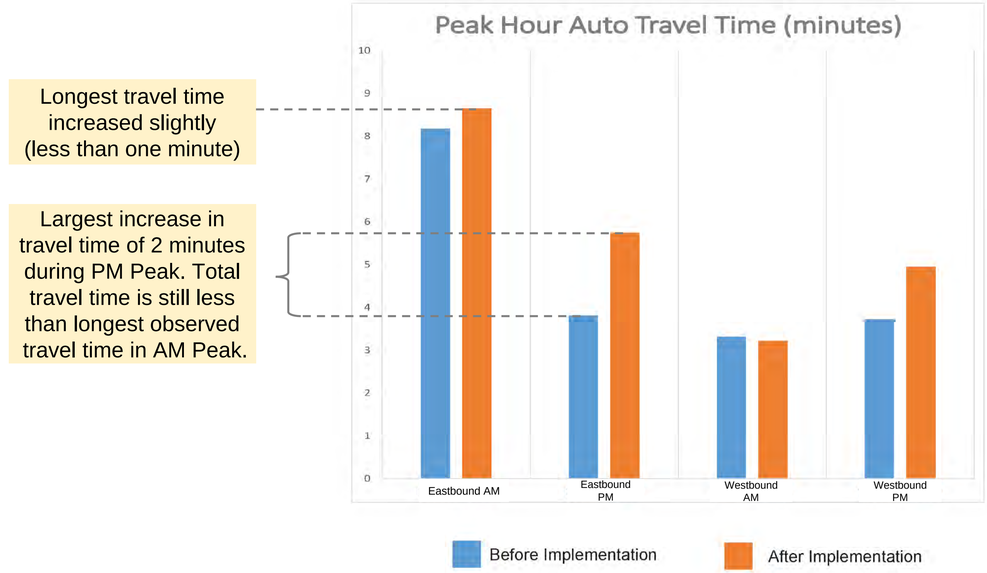
Data Collected

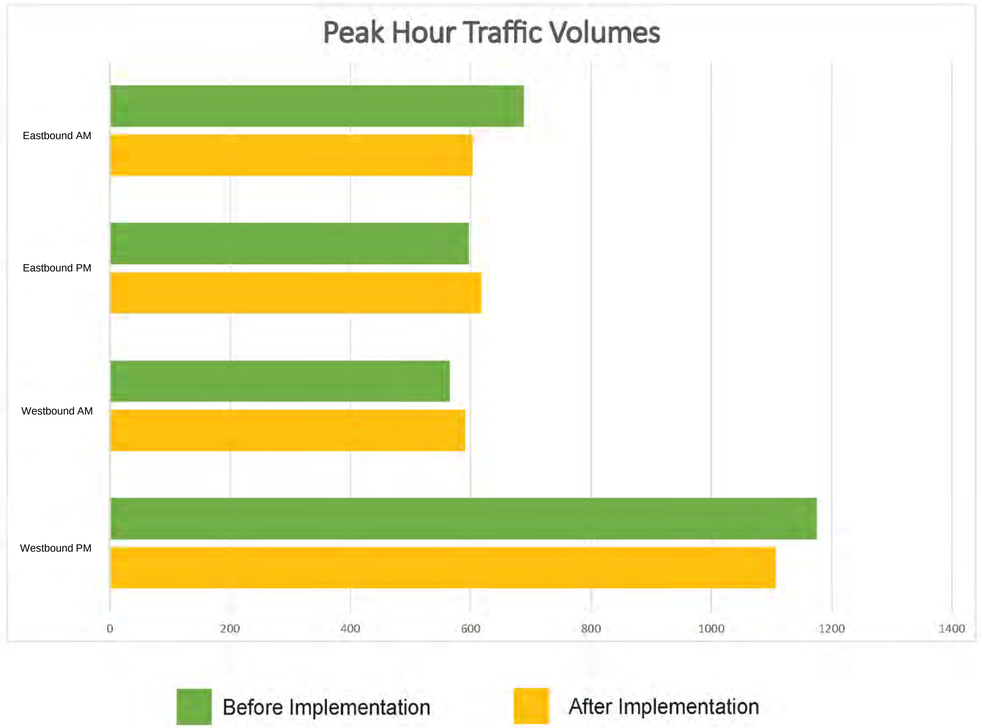
- Automated Traffic Recorders to understand daily traffic volumes;
- Turning Movement Counts at intersections on and parallel to the corridor to understand changes in peak hour traffic volumes
- Vehicle travel time observations where bus lanes were implemented
- Vehicle queues and turning delays for two unsignalized intersections during the AM and PM peak hours

Map of Travel Time Route and Count Location



*Additional study results available upon request





Street User Perception

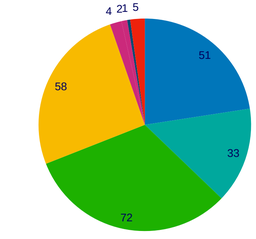
CAMBRIDGE WATERTOWN BRT

We surveyed people:

- who drive, walk, bike, or take transit in the project area
- to find out people's feelings about the function of Mount Auburn St. and levels of comfort and if people changed how often they come to Mount Auburn Street
- before implementation, between July and October 2018, and again after implementation, mid-November 2018 to February 2019

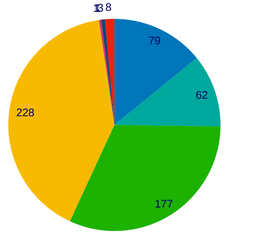
Before
218 Surveyed

How people got to Mount Auburn St.



After
586 Surveyed

How people got to Mount Auburn St.



Walked
Drove/rode
Other
Biked
Commercial Vehicle
Did not answer
Bus
Taxi/TNC

People rated Mount Auburn Street on a scale of 1 to 5 for:

Design and function

Average	Before	After	Change
Overall	2.7	3.5	+0.8
Walking	2.9	3.7	+0.8
Biking	2.3	4.1	+1.8
Taking bus	2.7	4.6	+1.9
Driving	2.8	2.5	-0.3

Comfort

Before	After	Change
3.3	3.5	+0.2
3.7	3.8	+0.1
2.4	3.6	+1.2
3.4	4.0	+0.6
3.3	2.9	-0.4

Change in use or visits to Mount Auburn St. after changes to the street

	Less	Same	More	Ride in the new lanes
Overall	9%	70%	21%	--
Walking	5%	80%	15%	--
Biking	0%	33%	42%	25%
Taking bus	0	60%	40%	--
Driving	20%	77%	3%	--

People told us their thoughts about Mount Auburn Street after implementation:

Walking

It has made walking on Mount Auburn Street near Belmont St much more pleasant.

It's better than it was; automobile traffic flows better, but at some places pedestrians still have a hard time.

Biking

It feels much safer to bike on Mount Auburn, now.

Awesome to have a safer, almost continuous bike lane on Mount Auburn St. This street used to be terrifying to ride, and there were few alternative routes. The only downside is where the bike lane has a gap.

Taking transit

In the afternoons, I am able to stay at work 15 minutes longer and still arrive home at the same time as I did before. I could not be happier.

The buses are more consistent, reliable, and faster. I used to take 70 but now I take the 71 and Red Line for my commute.

Driving

It took a little while, but the bus-bike separated lane is great and traffic seems to be back to normal.

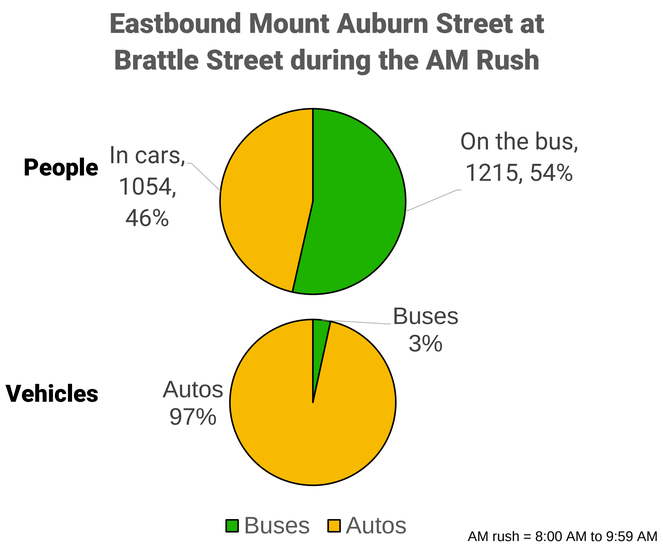
The new markings make it easier to navigate in a car. Much clearer which lanes are for which purpose.

Key Takeaways

CAMBRIDGE WATERTOWN BRT

Key Points

More than half of the people on Mount Auburn Street headed toward Harvard Square in the morning rush hour are on the bus



People are more comfortable, especially biking

When we asked people how comfortable they are on Mount Auburn Street, the improvement was for people biking increasing from an average 2.4 to an average 3.6 out of 5.

36,000 person-hours saved on the bus

On an annual basis, we calculated a significant time savings for people on buses in the project area.

Limited negative impacts to people driving

Even though the project team made a lot of changes to the street, all our traffic data show limited negative impacts for drivers:

- Average rush hour travel times increased by less than 1 minute
- People driving told us the street feels about as comfortable and functional and almost 80% didn't change how often they drive on Mount Auburn St.

Lessons Learned During Implementation

Phase 1, Summer 2018

Lane markings and two Watertown queue jumps

- Realized early safety improvements
- Maintained momentum and interest in the project

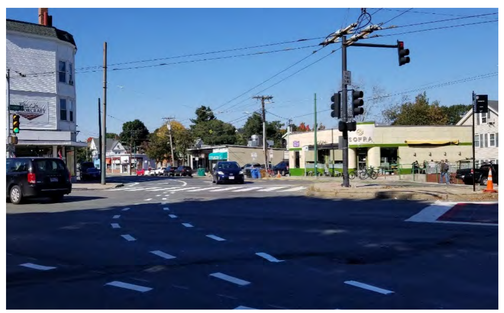
Phase 2, October 2018

Full implementation of bus priority (red lanes, TSP, queue jump signal) and signal changes at Fresh Pond Parkway

- Cold weather meant that work could not be done at night
- Took place over almost one month with ongoing signal timing adjustments

Lessons Learned Throughout the Project

- Significant resources needed for communication and monitoring
- Lane width matters – narrow lanes can be blocked
- Painting during daytime has operational impacts, and paint is less durable
- Trackless trolley wires limit changes we can make to the street
- Enforcement is challenging without safe places for police to observe traffic, i.e. no parking lanes



What's next?

CAMBRIDGE WATERTOWN BRT

Pilot Improvements

Unfunded Potential Capital Improvements to Pilot

- Make the configuration of the new Brattle-Mt. Auburn intersection more permanent, enhance plaza, improve bicycle and pedestrian facilities, and re-locate bus stop
- Improve pedestrian crossings and bicycle facilities

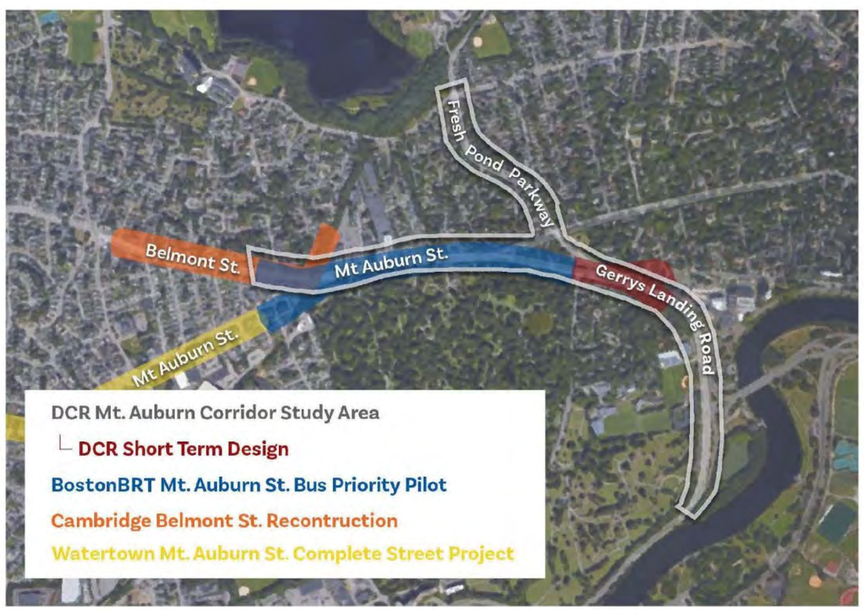
2016 - 2017
DCR Mt. Auburn Street Corridor Study

2018
DCR Short Term Design Implementation

2018
BostonBRT Mt. Auburn St. Bus Priority Pilot

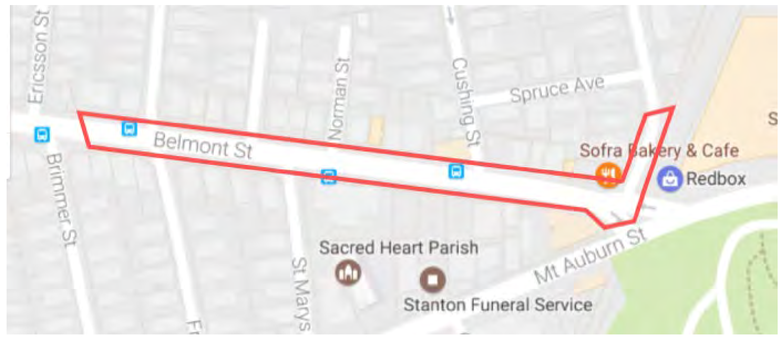
2018 - 2021
Cambridge Belmont St. Design and Construction

2022
Watertown Mt. Auburn St. Complete Street Project



City of Cambridge Belmont Street Construction

- New sidewalks and paving, improve accessibility, make improvements for all users
- All of Belmont St. and Holworthy St., up to #37-39



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Watertown's Mt. Auburn Street

Mount Auburn Street
A Complete Streets **Project**

- Create a safer street through traffic calming and street design, while also maintaining street capacity
- Promote alternative modes of transportation such as walking, biking and public transit to decrease congestion
- Schedule: Design underway, construction begins 2022

More information: https://mountauburnstreet.com/