

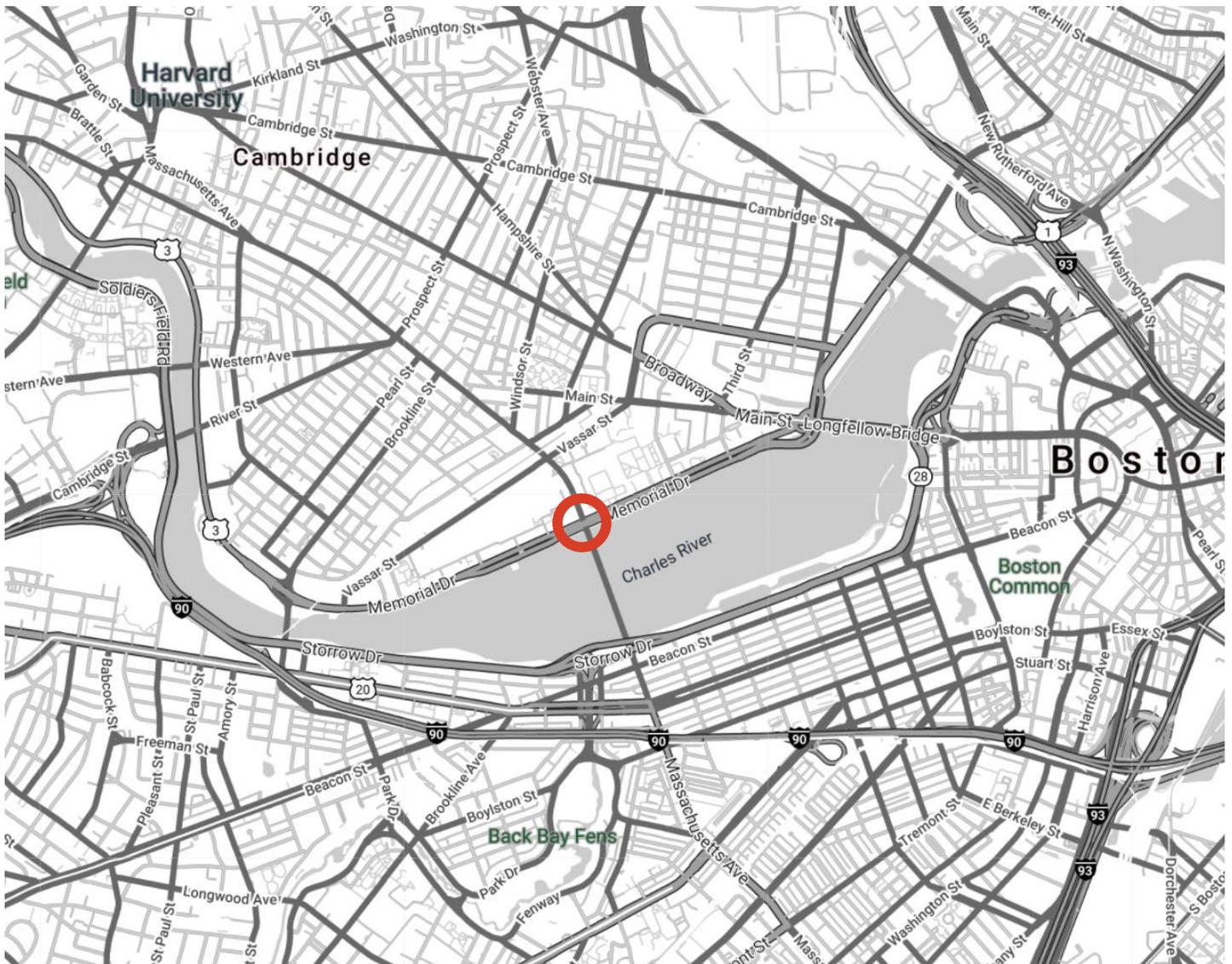


MASS AVE & MEMORIAL DRIVE

PROPOSED BIKE AND PEDESTRIAN IMPROVEMENTS

EDWARD ORDE

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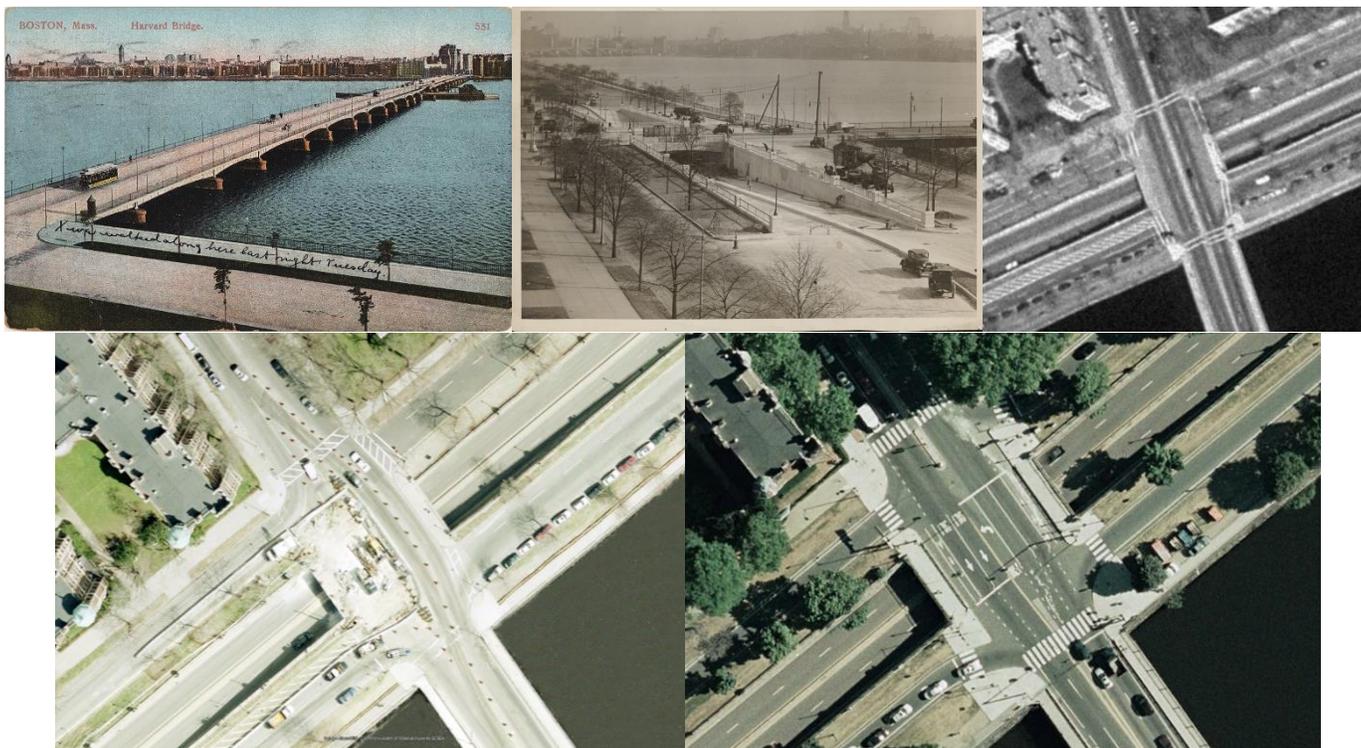
BIKES, BUSES AND PEDESTRIANS

Massachusetts Avenue and Memorial Drive are two major regional roadways carrying significant traffic volumes. Massachusetts Avenue also carries the Route 1 bus, along with several private shuttles serving Central Square and Longwood. Both Massachusetts Avenue and Memorial Drive are key bike and pedestrian routes, connecting recreational routes along the river and major commuting destinations in Boston and Cambridge.

BACKGROUND

History

Harvard Bridge was constructed in 1891 to connect Boston and Cambridge. The bridge originally contained two trolley tracks in addition to two vehicle lanes. The trolley tracks were removed in 1939. Although the bridge has been modified and reconstructed multiple times, the overall dimensions and lane layout have remained consistent since its inception. The overpass at Massachusetts Avenue and Memorial Drive was constructed in 1931 at a cost of \$225,000. At some point the intersection was restricted to only right turns and u-turn areas were built on Memorial Drive. The overpass was modified in the early 2000s to narrow the Memorial Drive approaches to one lane. This modification was completed by 2005 and the road layout has not been modified since.



Row 1 – Harvard Bridge with streetcars, 1910; Memorial Drive underpass construction, 1931; Road layout, 1995.
Row 2 – Intersection reconstruction, 2001; Road layout, 2005

Volumes

The intersection of Mass Ave and Memorial Drive serves a significant number of people across all modes. Traffic counts conducted in mid-November 2020 found that the intersection serves 1,919 vehicles per hour in the PM peak. From Summer 2020 City of Boston data, 2,125 bikes cross the Mass Ave bridge daily, representing 14.1% of total traffic on the bridge. City of Cambridge counts from 2019 show that 819 bikes cross Mass Ave during the AM and PM peak on the Paul Dudley White bike path. And MBTA data from 2019 shows the Route 1 bus carried over 8,000 passengers a day through the area, with the bridge representing the peak load point for the route. The current lane configuration and signal timing does not reflect the mix of users at the intersection, disproportionately favoring single occupancy vehicles over other modes.

Safety

The current signal timing and lane configuration does not make pedestrian and bike safety a priority. Despite high volumes, pedestrian signals are not on recall leading to confusion and non-compliance when the pedestrian phase is skipped. Most pedestrian movements are only served once during the 110 second cycle, leading pedestrians to cross the Memorial Drive slip lanes on red. There is also a significant right hook threat for bikes coming off the bridge into Cambridge, where over 23% of vehicles turn right onto Memorial Drive with a permitted conflict with the bike lane. The intersection also uses protected-permitted lefts for the northbound lefts, introducing another bike/pedestrian and vehicle conflict point.



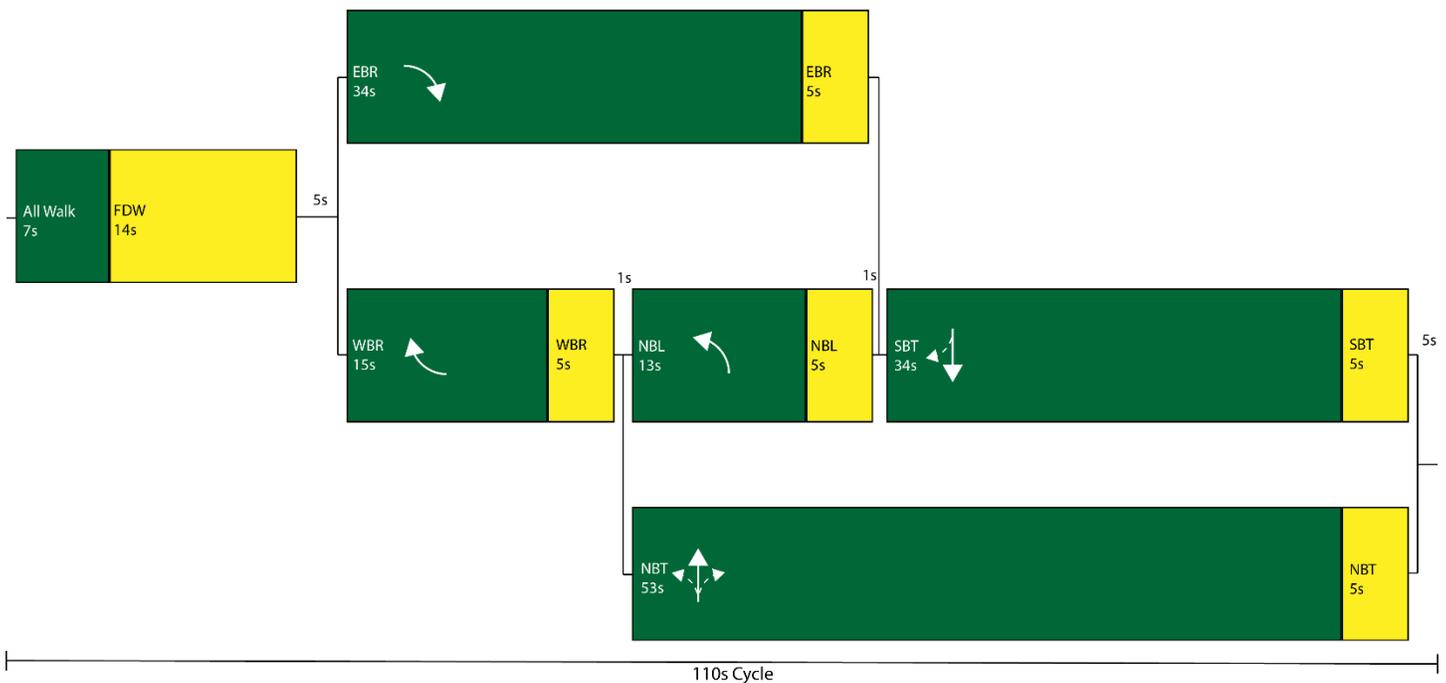
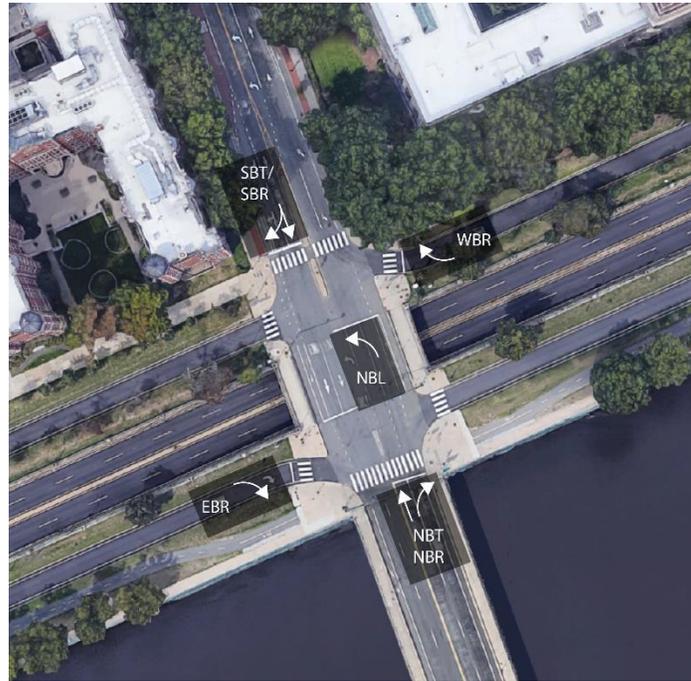
Figure 2 – The right turn/bike conflict and permitted left turns

Recent Mass Ave Changes

Massachusetts Avenue has recently undergone several changes to improve bike safety and bus delay on either side of the intersection, however neither project has modified the intersection itself. The South Mass Ave Safety project in Cambridge has added a southbound bus lane which ends just before the intersection and is adding protected bike lanes to Mass Ave north of the intersection. In response to community advocacy, MassDOT is currently trialing protected bike lanes on the Mass Ave bridge to the south of the intersection. That project begins over 100 feet south of the intersection to avoid impacting the current intersection operations. This leaves the intersection as a key gap in the protected bike infrastructure on Mass Ave, and the bus priority infrastructure in Cambridge.

EXISTING CONDITIONS

Timing



The intersection is currently timed to provide an all-pedestrian phase once per cycle if a request is received, if not the cycle is shortened by 26s and the pedestrian phase is skipped. This means the cycle length is either 110 seconds or 84 seconds. Northbound lefts are served with a leading protected phase followed by a permitted left. The north and south movements have extended clearance times due to the size of the intersection. There are two signal masts for north and south, which are offset by 4 seconds. To simplify analysis these have been treated as one, with extended red clearance times used in the model to account for this. The nearby Amherst Street and 77 Mass Ave pedestrian crossings run on an independent 90s cycle.

Volumes

Movement	Volume	
	AM	PM
NBL	85	74
NBT	588	478
NBR	219	341
EBR	215	300
WBR	112	119
SBT	373	552
SBR	8	56

AM traffic counts were conducted on Monday November 15th, 2021, at 8:30am. The PM peak counts were conducted on Tuesday November 9th, 2021, at 4:30pm.

Delays

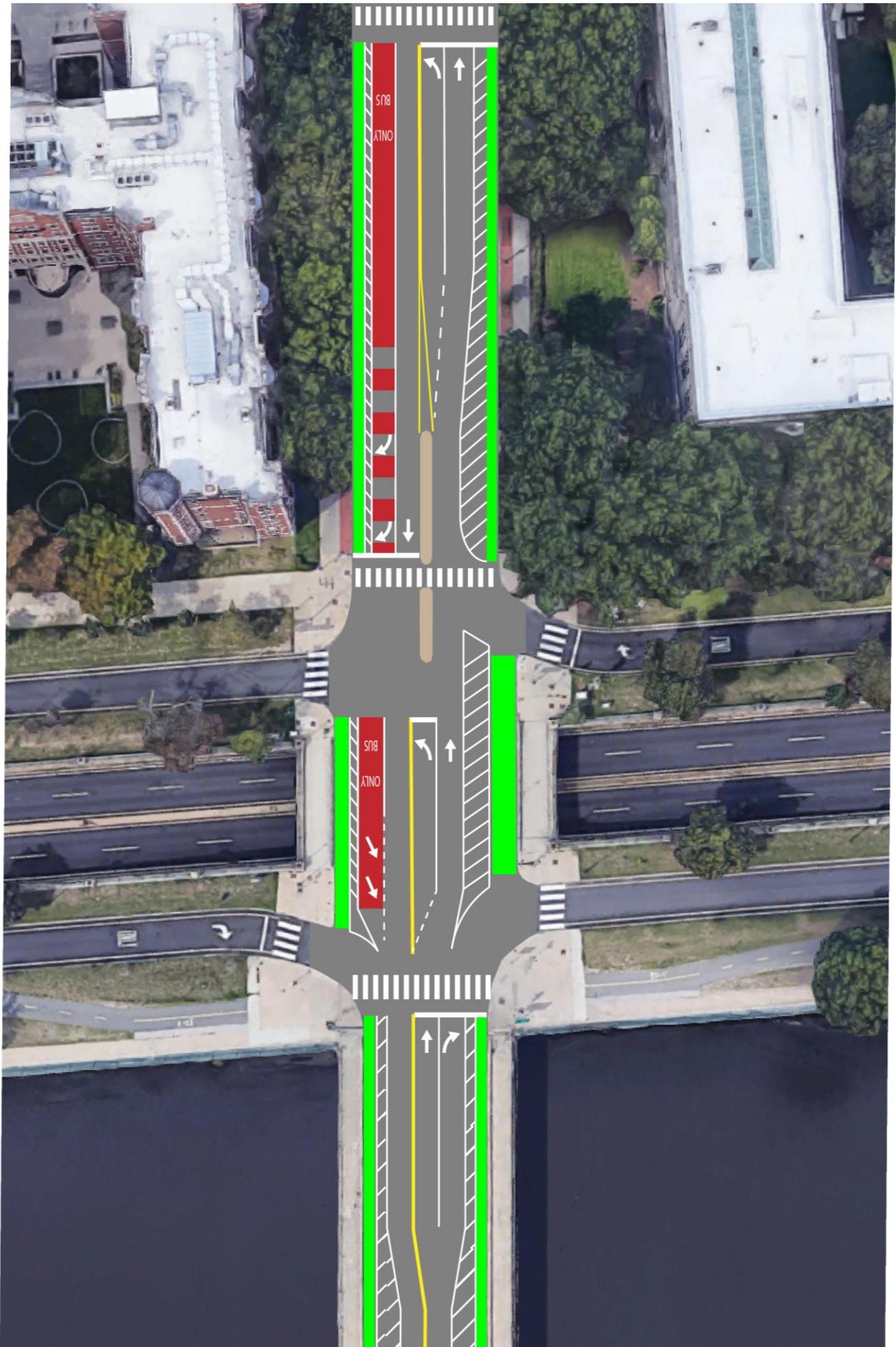
Delay was modelled in PTV Vissim 2020 using an existing conditions network with measured volumes. The network was modelled to include the Amherst Street intersection and the 77 Mass Ave pedestrian crossing. Using multiple runs with different random seeds the average vehicular delay was 41.9 seconds through the network. The lack of coordination between the intersections leads to backups and queues through the intersection. During some phases traffic is flowing freely, while during others the intersection is completely unsaturated due to blockages at the other intersections.

Pedestrians are primarily served once per cycle, except for pedestrians crossing the Memorial Drive offramps who are also served during the through phase. Pedestrians crossing Mass Ave have an average delay of 52 seconds, assuming a pedestrian phase is requested every cycle which was not true in observation. North/south pedestrians face a similar amount of delay as the crossings of the onramps to Memorial Drive are only served once per cycle, however due to short crossing length the pedestrian signal adherence here is low.

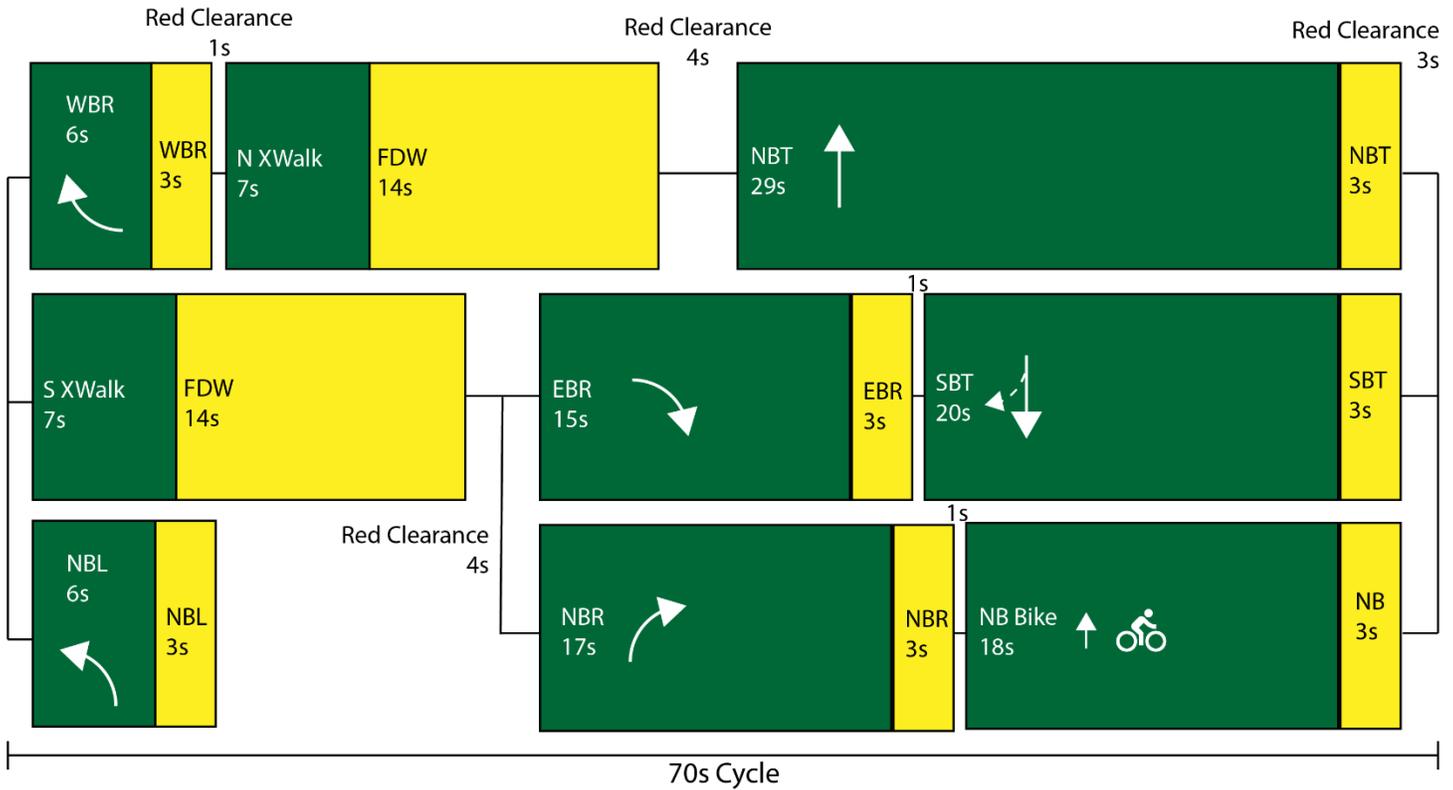
PROPOSED DESIGN

The proposed design eliminates the permitted bike/pedestrian and vehicle conflicts while reducing delays for all modes. The protected bike lanes on either side of the junction are extended through the intersection to allow for safe and comfortable biking. The southbound bus lane is extended into the intersection to allow for buses to jump the queue and reduce delay. A northbound right only lane allows for separate right turn phasing, removing the right hook threat for bikes. The proposed signal timing also includes coordination with the nearby Amherst St signal and the 77 Mass Ave pedestrian crossing to allow for a bidirectional green wave, reducing delay for all modes. The northbound left is switched to a lagging protected only phase, although could be returned to a permitted/protected if needed.

This proposal is designed as a quick build project, only require striping and timing changes to be implemented. No geometric curb changes are proposed and detector loops would not have to be installed as it maintains the existing pretimed set up.



Timing Plan



Movement	X	Li	frt	flt	fhv	Saturation Flow	Volume AM	AM V/Sx	AM Needed	Volume PM	PM V/Sx	PM Needed	Split	AM Slack	PM Slack	
1 NBL		0.85	3	0	1	0.98	1768.9	85	0.0565	6.96	74	0.0492	6.45	10	3	3.6
2 NBT		0.92	4	0	0	0.98	1862	588	0.3432	28.03	478	0.279	23.53	35	7	11.5
3 NBR		0.85	3	1	0	0.98	1610.63	219	0.16	14.2	341	0.2491	20.44	21	6.8	0.6
4 EBR		0.85	3	1	0	0.98	1610.63	215	0.157	13.99	300	0.2191	18.34	19	5	0.7
5 WBR		0.85	3	1	0	0.98	1610.63	112	0.0818	8.73	119	0.0869	9.08	10	1.3	0.9
6 SBT		0.92	4	0	0	0.99	1881	373	0.2146	19.02	552	0.3136	25.95	26	7	0
7 SBR		0.85	3	1	0	0.96	1610.63	8	0.0058	3.41	56	0.0409	5.86	26	22.6	20.1
NPed	NPED		25										25	25	0	0
SPed	SPED		25										25	25	0	0
Conflicting	AM V/s	PM V/s	Critical Lost	Cycle					61.75			69.29	70			
SPed-4-6	0.3717	0.5327	32	68.48												
5-NPed-2	0.4251	0.366	32	50.47				chosen c		70						

Delay

Delay was modelled in Vissim using the same volumes and the new design. Network delay across 10 runs with random seeding averaged to 22.6 seconds per vehicle. Since the intersections are coordinated there was no backups into other intersections. This delay is 19.3 seconds lower per vehicle than the existing conditions, a 46% reduction in delay.

Pedestrian service is significantly improved in the proposed layout. Due to the decreased cycle length, pedestrians crossing Mass Ave have an average delay of only 24 seconds, a reduction of 20 seconds. North/south pedestrians have significantly reduced delay as the removal of the permitted northbound right and northbound left mean the north/south pedestrian movements can run during the majority of the cycle.

Crossing	Existing Delay (s)	New Delay (s)
Mem Dr EB Toward	5.89	3.78
Mem Dr EB Away	15.82	4.46
Mem Dr WB Toward	1.31	0.26
Mem Dr WB Away	15.82	1.4
Mass Ave @ Mem	44.55	24.86
Mass Ave @ Amherst	34.67	24.86
Mass Ave @ 77 Mass	28.01	24.86

Vissim Models

Videos of models running viewable at: <https://youtu.be/-teTWbL-d7g>

