The Underpass Option at Austin Street: Impacts and Comparison Against the 7-Lane Surface Option

An analysis of the City's proposed "Underpass Option" for the intersection of Rutherford Ave and Austin Street.

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City officials have stressed that the underpass option is bound to be more pedestrian-friendly than a surface option because it removes so much traffic from the intersection. And it's natural to think that an underpass option must be better for cars. And some people worry that if there isn't an underpass, the neighborhood might be run over with traffic trying to avoid the congestion on Rutherford Ave.

However, an analysis of the underpass option reveals exactly the opposite:

- Three of its four pedestrian crossings are unsafe – that is, they involve conflicts with right turning traffic with traffic volumes nearly triple the limit allowed by MassDOT.
- While cars that can use the underpass will fly through unimpeded, the surface streets will face delays of 2 to 2.5 minutes, with queues on the Rutherford Ave surface roads growing to almost 500 ft in both directions.
- Far from protecting the neighborhood from cut-through traffic, the underpass option will actually create serious congestion that gives traffic heading to the Gilmore Bridge an incentive to cut through the neighborhood.

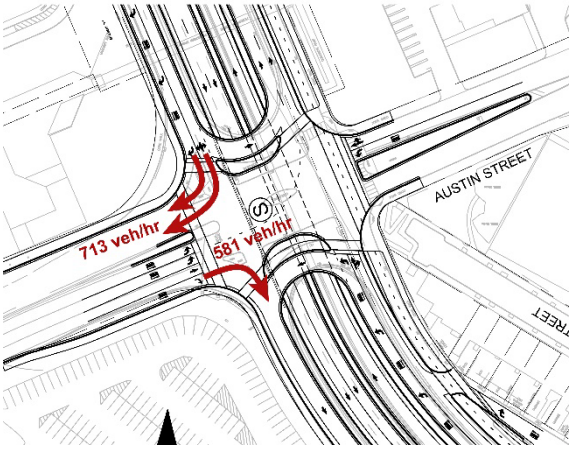
The layout for the City's underpass option can be found at the project website. The City provided us with their proposed signal timing plan and capacity / delay analysis made using Synchro.

For Pedestrians: Crossings with Unacceptable Right-Turn Conflicts

The layout of the underpass option (see figure below) looks pedestrian-friendly – there are crosswalks across all four legs of the intersection, there are no delta islands with slip lanes for right turning traffic, and the Austin Street crosswalks are drawn in a way that shows that pedestrians there will have simple, one-stage crossings.

But when one considers the interaction of traffic and crossing pedestrians, it turns out that three of the crossings are unsafe because they involve conflicts with unacceptably large volumes of right-turning traffic.

Consider first crossing Austin Street on the Gilmore Bridge side. The way the intersection is laid out, the only time its WALK interval could run is concurrently with the southbound traffic on Rutherford Ave. Concurrent pedestrian phases are normal and acceptable when the right-turning volume is small; MassDOT allows concurrent pedestrian phases when the right turning volume is up to 250 vehicles per hour. But the right-turning volume here is more than 700 vehicles per hour! And what's more, cars will be allowed to turn right from two lanes! Clearly, it would not be safe to have pedestrians cross in the face of this massive conflict.



Heavy right-turn flows that conflict with pedestrians in the Underpass Option

The southern crossing of the southbound surface road has the same kind of conflict. It will be concurrent with the eastbound traffic leaving the Gilmore Bridge, presenting a conflict with 310 vehicles per hour turning right in the a.m. peak, and 550 turning right in the p.m. peak, more than double the MassDOT limits for conflicting right turns.

One might ask, Couldn't there be an all-pedestrian phase? In principle, yes; but because the intersection in the underpass option is overcapacity already, adding an all-ped phase would result in such an enormous capacity shortfall that the intersection would be jammed in all four directions.

For the northern crossing of the southbound surface road, the conflict that makes the crossing unsafe is with right turns on red. Right turn on red can be a small, acceptable conflict when the right turn volume is low; but in this case, it's 710 vehicles per hour, turning from two lanes!

Again, one could ask, Couldn't they prohibit right turn on red? Yes, in principle – but, again, that would lead to unacceptable traffic performance because in the underpass option, the intersection design relies on right-turn-on-red to relieve congestion.

The table below compares average pedestrian delay in the underpass option versus the 7-lane surface option (a.m. peak period). Results are for a full crossing, not a single stage.

Average pedestrian delay for the underpass and 7-lane surface options (Rutherford Ave. at Austin Street, a.m. peak hour)

	underpass option	7-lane surface option
East leg, heading north	45 s	13 s
East leg, heading south	45 s	11 s
North leg, heading west	Not safe	28 s
North leg, heading east	Not safe	34 s
South leg, heading west	Not safe	38 s
South leg, heading east	Not safe	46 s
West leg, heading north	Not safe	38 s
West leg, heading south	Not safe	34 s

Other Ways the Underpass Option Fails to Serve Pedestrians

Consider other dimensions of pedestrian-friendliness – how does the underpass option measure up, compared to the 7-lane surface option?

1. Does the underpass option leave as much space for pedestrians walking in the linear park? Not at all. It leaves only 21 ft for a linear park, most which will be paved with a shared use path. Bikes and pedestrians will have to share a 12-ft path, instead of each having their own path, which is preferred. At the Austin Street intersection, pedestrians waiting at the light to cross Rutherford Ave will crowd the path, blocking people on foot or on bike who are trying to get by.

In contrast, the 7-lane surface option leaves 49 ft for a linear park – that's enough space for an 11 ft path for bikes, a 7 ft path for pedestrians, and 31 ft of green space separating them from the road and each other.

2. Does the underpass option mean a shorter signal cycle? Remarkably, while the underpass option has 40% less traffic to process through the intersection, it needs a longer cycle – 130 seconds, versus 120 seconds for the 7-lane surface option. So with an underpass, pedestrians (and motorists, too!) have to wait longer for the next cycle.

3. At least the underpass option doesn't have delta islands and slip lanes on the western corners. In drawings presented to the public, the underpass option indeed looks pedestrian-friendly because, unlike the surface option, it lacks delta islands with slip lanes for right-turning traffic in the two western corners of the intersection. But this is deceptive. The absence of those delta islands is exactly what forces the pedestrian phases to have unacceptable conflicts with heavy right turning traffic. As the underpass option is refined, expect those delta islands and slip lanes to be added – it's the only way to resolve the conflict between heavy right turns and pedestrians.

4. The 7-lane surface option has multistage crossings. Doesn't the underpass option avoid multistage crossings? No. The underpass layout presented to the public has 2-stage crossings across the north and south legs. And once they add the delta islands that are needed in the western corners, there will be 3-stage crossings. Across the east leg only, the underpass option offers a true single stage crossing, but

then so can the surface option – but in the surface option, pedestrian delay will be less because the signal cycle will be shorter and the WALK interval will be longer.

For Cars: Insufficient Traffic Capacity and Severe Congestion

For cars that can use the underpass, the underpass option offers an obvious advantage.

However, the majority of traffic will still have to pass through the intersection. Three traffic movements, affecting more than 1000 vehicles per hour, won't have enough capacity in the a.m. peak hour to keep up with demand (see table below), resulting in long delays and long queues. On Rutherford Ave's two surface roads, average delay will be more than 2.5 minutes and queues extend back nearly 500 ft (on average). Austin Street, leaving the neighborhood, will also be overcapacity, with 2 minute delays and queues longer than 200 ft. These long queues and delays will give drivers an incentive to find alternative routes, cutting through the neighborhood instead of using Rutherford Ave and Austin Street.

Traffic movements with capacity shortfalls in the underpass option (a.m. peak hour)

	a.m. peak hour volume	capacity shortfall	average delay	50th percentile queue length
Northbound surface road, left turn	370	18%	152 s	475 ft
Southbound surface road, thru & left	427	19%	152 s	472 ft
Westbound thru	209	5%	122 s	229 ft
Total	**1006**			

By comparison, in the 7-lane surface option, none of the traffic movements are overcapacity; each has at least 7% slack capacity.

The table below summarizes average vehicular delay for the two options in the morning peak. Averaging all vehicles together, the two options offer a similar level of service: 40 s of delay for one option, 48 s of delay for the other. In the surface option, average delay to thru traffic on Rutherford Ave. is not large – only about 40 s – and the most congested movement has an average delay of less than 90 s.

The underpass option, however, is a tale of two extremes, with zero delay for the two traffic movements that use the underpass and large delays for other traffic movements.

Vehicular delay for the two options

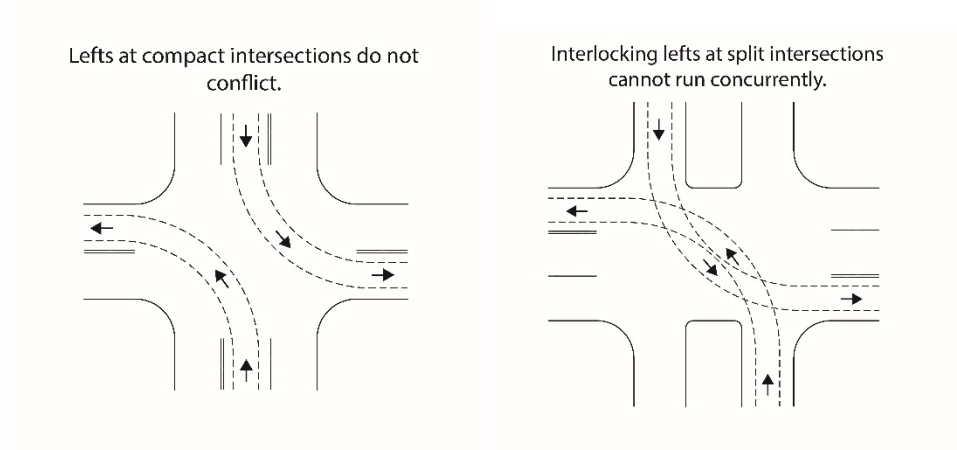
	underpass option	7-lane surface option
Thru traffic on Rutherford Ave		
- Southbound thru average delay (s)	0	43
- Northbound thru average delay (s)	0	24
All other movements		
- Average delay (s)	74	59
- Average delay for most congested movement (s)	152	87
Average delay, all traffic (s)	**40**	**48**

The Inherent Inefficiency of an Underpass Layout

The underpass option removes 40 percent of the traffic from the intersection, yet it performs poorly compared to a surface option. How can this be? It turns out that there are three aspects of an underpass that makes it an inherently inefficient solution.

First, ***the underpass consumes an inordinate amount of space, leaving insufficient space for the surface roads*.** One might think that, because the City's underpass option cuts the number of travel lanes from 6 (existing) to 3 (proposed, with 2 lanes southbound and 1 lane northbound), the space consumed by the underpass will shrink a lot. But no – the overall space consumed by the underpass shrinks by only 10 ft, because an underpass – with unavoidably high speed traffic – requires wide shoulders, as well as space for structural walls. As a result, the surface roads are limited to 2 lanes each, which isn't enough to serve the heavy traffic trying to turn onto the Gilmore Bridge.

Second, ***an underpass creates a split intersection.*** The northbound and southbound surface roads will be separated from one another by about 60 ft. As a result, left turns cannot run concurrently, because they interlock, as illustrated in the figure below. The traffic signal plan is therefore forced to follow an arrangement called "split phasing," in which each of the four legs has a turn in sequence. Split phasing is both less flexible and less efficient than the normal phase sequence in which opposite directions (e.g., northbound and southbound) run concurrently. One can observe this inefficiency at other intersections with underpasses, such as Mass Ave @ Commonwealth Ave and Mass Ave @ Huntington Ave in Boston, where traffic on the surface roads is often backed up.



Split intersections result in interlocking lefts, which prevent left turns from running concurrently

Third, ***the underpass removes only through traffic, leaving all the turning traffic, which intersections can't process efficiently.*** Traffic signals can process thru traffic efficiently by spreading it over multiple lanes, running opposite directions concurrently, and running it concurrently with pedestrians. Turning traffic, in contrast, can be processed only at low capacity, can't run concurrently with most pedestrian crossings, and (due to the interlocking mentioned earlier) cannot run concurrently with each other.

It's understandable to expect that removing 40% of an intersection's traffic would make it more efficient. However, because the only traffic removed is through traffic, and because the remaining traffic has to be served with a split intersection and without the space it needs for turning lanes, the underpass option actually results in longer delays and longer queues than the surface option.

A Comparison of Impacts

At first glance, the prospect of making a lot of traffic "disappear" by putting it in an underpass seems to offer the promise of better service for everybody. However, it turns out that only underpass users will be better off; everybody else will be worse off, including both pedestrians, motorists who can't use the underpass, and local residents. Below is a list of important impacts, comparing the underpass option against the 7-lane surface option.

1. ***Space for a linear park.*** The surface option leaves 49 ft for a linear park – enough for a walking path, a bicycle path, and 30 feet of green space separating them from traffic and from each other. The underpass option leaves only enough only for a path that pedestrians and bikes have to share, with only a narrow strip of green space separating them from the road.
2. ***Traffic delay.*** Averaged over all vehicles, including those in the underpass, there is only an 8 s difference in average delay between the two alternatives. Of course, the underpass option offers an obvious advantage for long-distance through traffic using Rutherford Ave.; however, this advantage isn't large, because in the surface option, delay to Rutherford's through traffic is only about 40 s. Meanwhile, for traffic that has can't use the underpass, the underpass option has serious capacity shortfalls that affect more than 1000 cars per hour and that result in delays greater than 2.5 minutes and queues almost 500 ft long on Rutherford Ave.'s two surface roads. The surface option has no capacity shortfalls, no long queues, and no long delays.

3. ***Protecting the neighborhood from cut-through traffic by limiting traffic congestion.*** The underpass option results in serious congestion for traffic turning onto the Gilmore Bridge, with backups of almost 500 ft predicted on both surface roads. That will give traffic an incentive to divert to neighborhood streets. In the surface option, there is no such congestion. The delay to through traffic on Rutherford Ave is only 40 s, creating little incentive for people to divert to neighborhood streets.
4. ***Access into and out of the neighborhood.*** With the underpass option, turns into the neighborhood and the traffic movement leaving the neighborhood on Austin Street are overcapacity, with long queues and long delays, while in the 7-lane surface option, all traffic movements into and out of the neighborhood have sufficient capacity. And the surface option creates additional intersections where neighborhood traffic can turn left onto Rutherford Ave (Lynde Street and Baldwin Street), easing the pressure on Austin Street and eliminating the need for U-turns at Austin Street.
5. ***Pedestrian safety and convenience.*** With the underpass option, three out of the four legs of the intersection have crossings with unacceptably high right-turn conflicts, making them unsafe. At the same time, the long signal cycle results in long pedestrian delays. With the surface option, all pedestrian crossings are safe from heavy turn conflicts and pedestrian delays are reasonable. And for people walking along Rutherford Ave., the surface option gives them a path separate from bicycles and far removed from the streets, while the underpass option puts them in a path shared with bicycles and far closer to the street.
6. ***Flood control.*** The underpass option has far more impervious space than the surface option, increasing runoff that can lead to neighborhood flooding. During storm surges and heavy thunderstorms, the underpass is vulnerable to flooding.
7. ***Noise and air pollution.*** With the surface option, the neighborhood is buffered from the street by a wide linear park, with ample space for trees that help capture particulates. With the underpass option, that buffer is only 21 ft wide, with limited green space for vegetation.
8. ***Flexibility to adapt to future needs.*** The future is going to bring vast changes to transportation that are hard to predict. With a surface option, it would easy and relatively inexpensive to add an additional lane if traffic grows more than expected, and would likewise be easy to shrink the road if traffic grows less than expected, or if technology (connected vehicles, automated vehicles) makes traffic flow so much more efficient that fewer lanes needed. With an underpass option, the road layout is locked in – there is no room for further road expansion, nor would not be possible to shrink the road without getting rid of the underpass.
9. ***Cost.*** The underpass option costs a lot more than a surface option. In any comparison of impacts, one should consider the benefits that could be obtained if MassDOT could save millions of dollars on this project and invest them elsewhere.

The table below summarizes this impact comparison.

Another interesting comparison to make is against the existing situation. The Commonwealth and City are planning to spend around $150 million for this project – what will they get for it? The underpass option essentially changes nothing, except for adding about 10 ft of green space to the neighborhood side of Rutherford Ave and converting the sidewalk into a shared use path. And it fails to provide increased capacity for traffic turning onto the Gilmore Bridge.

By contrast, the surface option creates new value – a linear park with benefits to walking, bicycling, recreation, flood control, and a buffer against noise and air pollution in the neighborhood. The flexible layout of a surface option allows for expanded capacity for traffic turning onto the Gilmore Bridge. The more compact intersection layout will serve pedestrians better, and the more efficient traffic flow will ease access to and from the neighborhood and better protect it from cut-through traffic.

Alternatives comparison indicating the more favorable alternative by impact

	underpass option	7-lane surface option
Parkland		√
Delay to long distance, north-south commuters	√	
Delay to all other traffic		√
Protect neighborhood from cut-through traffic by preventing congestion		√
Neighborhood access		√
Pedestrian safety and convenience		√
Flood control and resilience		√
Noise and air pollution		√
Flexibility		√
Cost		√

In transportation planning, rarely is a comparison of alternatives this lopsided. The underpass scores better on only one impact: less delay to some long-distance commuters, and the amount – 40 seconds – is almost trivial. The 7-lane surface option is superior on all the other impacts, costing less and providing flexibility for the future, while giving the neighborhood and the Boston region something of lasting value.