4 Intersections

Introduction 137
Intersection Design Principles 138
Multimodal Intersections 141
Intersections and Street Types 148
Placemaking at Intersections 151
Intersection Geometry 157
Crosswalk Design 171
Guidelines for Crosswalk Installation 175
Signalized Intersections 185
Transit Accommodations at Intersections 195
Bicycle Accommodations at Intersections 205
Transit Accommodations at Intersections

When designing intersections to accommodate transit vehicles, the major goals are to improve the reliability and efficiency of transit service. Intersections are where most transit stops occur and are a major source of delay for transit vehicles. Waiting at traffic signals accounts for at least 10% of overall bus trip time and up to 50% or more of bus delay.

A majority of the Massachusetts Bay Transit Authority’s (MBTA) transit stops are located at intersections on Boston streets. While many stops are demarcated only by signs, several hundred bus shelters have been installed through Boston’s Coordinated Street Furniture program. In addition, as part of the MBTA’s ongoing Key Bus Routes initiative, several streets such as Cambridge Street in Allston/Brighton, Dudley Street, and Blue Hill Avenue are being improved with new bus stops and shelters.

It is important to minimize conflicts between transit vehicles and vulnerable users such as pedestrians and bicyclists. With one of the highest mode shares for walking in the country and a growing presence of bicyclists on Boston’s Streets, the interactions of all modes at intersections should be taken into consideration. Ideally, space will be provided for each mode, however, where space is not available, designs must maximize safety, sight lines, and minimize conflicts wherever possible. Bus drivers should be professionally trained to learn techniques that minimize conflicts with pedestrians and bicyclists.

This section covers design strategies to improve transit operations and safety, and reduce delay for transit vehicles at intersections. While individual strategies can be implemented independently, in many cases a combination of strategies, including the appropriate location of the stop and signal prioritization, will be most effective. Implementation of these strategies should also be complemented by operational improvements being carried out by the MBTA, including smart fare payment systems and real-time tracking. Transit lanes are covered in Chapter 3: Roadways. Bus stop and shelter designs are covered in Chapter 2: Sidewalks.

All transit accommodations at intersections must be approved by BTD, PWD, and the MBTA. The MBTA Bus Stop Planning and Design Guidelines serve as the primary reference for the design, location and spacing of transit stops in Boston.
Overview

All bus stop locations must be ADA compliant, and should be safe, convenient, well-lit, and clearly visible. Proper spacing and siting of bus stops involves many considerations such as the bus route, population density, popular destinations, transfer locations, intersection operations and geometry, parking restrictions, and sightlines.

Bus stop locations should be determined on a site-by-site basis and must be approved by BTD and the MBTA.

Use

Where buses are required to pull out of traffic, bus stops should be located at the near- or far-side of intersections wherever possible and not at mid-block locations. Intersections are also convenient for passengers because they can intercept other transit connections, crosswalks, pedestrian routes, and building entrances easily. At signalized intersections, far-side placement is generally recommended.

The charts below are from the MBTA Bus Stop Planning and Design Guidelines.

MBTA Bus Stop Spacing Distances

<table>
<thead>
<tr>
<th>Density Types</th>
<th>Minimum Population / Square Mile</th>
<th>Distance between Stops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>-</td>
<td>750’</td>
</tr>
<tr>
<td>High Density (Urban)</td>
<td>5,000’ &gt;</td>
<td>750’</td>
</tr>
<tr>
<td>Medium Density</td>
<td>3,500’ to 5,000’</td>
<td>750’ to 1,000’</td>
</tr>
<tr>
<td>Low Density (Suburban)</td>
<td>&lt; 3,500’</td>
<td>&gt; 1,000’ to 1,320’</td>
</tr>
<tr>
<td>Bus Rapid Transit (BRT) Route</td>
<td>5,000’ &gt;</td>
<td>1,500’</td>
</tr>
</tbody>
</table>

MBTA Bus Stop Lengths

<table>
<thead>
<tr>
<th>Placements</th>
<th>40’ Bus</th>
<th>60’ Bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Far-Side</td>
<td>Preferred</td>
<td>Minimum</td>
</tr>
<tr>
<td></td>
<td>80’</td>
<td>60’</td>
</tr>
<tr>
<td>Near-Side</td>
<td>100’</td>
<td>80’</td>
</tr>
<tr>
<td>Far-Side, after Left Turn</td>
<td>130’</td>
<td>100’</td>
</tr>
<tr>
<td>Mid-block</td>
<td>130’</td>
<td>100’</td>
</tr>
</tbody>
</table>

Typically, mid-block bus stops require the greatest amount of curbside space unless curb extensions are provided. Where curb extensions at bus stops are provided, also known as bus bulbs, the length of the bus stop can be less than the prescribed minimums listed below because buses will not be required to pull out of traffic. The minimum bus stop length at bus bulbs should provide a clear and level landing zone at each door of the bus. For more information, see Bus Bulbs later in this section.

The frequency of stops should balance passenger convenience and minimizing bus travel times. Spacing is typically determined by population density. The minimum spacing between bus stops is ≥ 750’.
Mid-block bus stops typically require a minimum of 100’ of curb space. If bus bulbs are installed, the curb side space required may be reduced to the length of the bus doors. The additional curb space can used to provide parking spaces and sidewalk amenities like bus shelters, and also does not require the bus to pull out of traffic.

The minimum recommended spacing between bus stops is 750’.
Considerations

Selecting a location for a bus stop at an intersection depends on a variety of factors, such as the available curbside space, condition of sidewalks, width of sidewalks, traffic and pedestrian volumes, the number and width of travel lanes, turning movements, sight distances, and the presence of parking, bicycle facilities, and/or crosswalks.

Far-side Stop

Advantages

- Minimizes conflicts between buses and right turning vehicles traveling in the same direction
- Provides additional right turn capacity by making curb space available
- Minimizes sight distance problems on approaches to the intersection
- Encourages pedestrians to cross behind the bus
- Creates shorter deceleration distances for buses since the bus can use the intersection to decelerate
- Bus drivers can take advantage of the gaps in traffic flow that are created at signalized intersection behind the stop

Disadvantages

- May block the intersection during peak periods with queuing buses
- May obscure sight distances for vehicles exiting the side street and crossing the intersection/turning left
- May increase sight distance problems at the far-side of the crosswalk for crossing pedestrians
- May result in traffic queued into intersection when a bus is stopped in travel lane/queuing buses
- May increase number of rear-end accidents since drivers do not expect buses to stop again after stopping at a red light
- Can result in the bus stopping twice, firstly for a red light and then again at the far-side stop, which interferes with both bus operations and all other traffic

Recommended Circumstances

- When traffic is heavier on the near-side of an intersection
- At intersections with heavy right turns on the major approach, or heavy left and through movements from the side street
- When pedestrian access and existing landing area condition are better than the near-side
- At intersections where traffic condition and signal patterns may cause delays
- At intersections with transit signal priority treatments
- At signalized intersections
Near-side Stop

**Advantages**
- Minimizes interference when traffic is heavy on the far-side of the intersection
- Allows passengers to board bus closest to crosswalk
- Width of intersection is available for the bus to pull away from curb and reenter traffic
- Eliminates the potential for double stopping/parking

**Disadvantages**
- Increases sight distance problems for crossing pedestrians
- Increases conflicts with right-turning vehicles traveling in the same direction
- May result in stopped buses obscuring curbside traffic control devices and crossing pedestrians
- May block the through lane during peak periods with queuing buses

**Recommended Circumstances**
- When street crossings and other pedestrian movements are safer with the bus stop on the near-side
- When traffic is heavier on the far-side of the intersection
- When pedestrian access and existing landing area conditions are better than the far-side
- When a bus route continues straight through an intersection or set back a reasonable distance to enable right turns

Mid-block Stop

**Advantages**
- Passenger waiting areas experience less pedestrian congestion
- Minimizes sight distances problems for vehicles and pedestrians
- May result in less interference with traffic flow

**Disadvantages**
- Requires additional curb space for no-parking restriction unless bus bulb is provided
- Encourages passengers to cross street at mid-block (jaywalking)
- Increases walking distances for passengers crossing at intersection

**Recommended Circumstances**
- When traffic or street/sidewalk conditions at the intersection are not conducive to a near- or far-side stop
- When the passenger traffic generator is located in the middle of the block
- If the distance between intersections is too far apart
Overview

By prioritizing transit at intersections, service can become more reliable, efficient, and environmentally friendly due to less queuing and stopping and starting, thus making transit a more attractive mode of transportation. Transit prioritization strategies include signal coordination, signal priority, transit only lanes, and queue jump or bypass lanes.

The first strategy for improved traffic flow is coordinated signal timing; for more information, see Coordinated Signal Timing discussed previously in this chapter. In addition to signal coordination, transit signal priority enables transit vehicles to shorten or extend a traffic signal phase without disrupting the phase sequence or overall signal timing. Signal priority is being considered for the MBTA Key Bus Routes program.
Transit only lanes at intersections provide transit vehicles a dedicated space to bypass traffic. Queue jump or bypass lanes are specially designated transit lanes at intersections that share a similar idea to the leading pedestrian interval discussed previously in this chapter. Queue jump lanes can provide an early green signal or hold a green signal for transit vehicles while other vehicles traveling in the same direction are given a red light.

Transit only and queue jump lanes must be approved by BTD, PWD, and the MBTA. All signal coordination and prioritization must be approved by BTD and the MBTA.

Use

Signal coordination can reduce delay for transit as well as motor vehicles. In addition to coordination, signal priority for transit vehicles allows transit to stay on schedule during peak hours when there is congestion. Signal priority allows delay to be reduced by extending a green for an approaching bus or shortening a red phase for a bus that is waiting. The difference in the time can be made up in the next cycle of the signal, but all other signal operations can remain intact.

Signal coordination and signal priority can be used with or without the presence of dedicated transit only lanes or queue jump and bypass lanes at intersections. Queue jump lanes can be used at intersections without a bus stop as well as with one at either the near- or far-side so long as there is enough space on the roadway.

Considerations

- Providing a queue jump lane with a leading signal phase must take into consideration the overall signal cycle lengths and impacts to delay for other users.
- If space is not available for a queue jump lane or bypass lane, consider using a right-hand turn lane to double as a bus advantage lane by allowing buses to move up in the queue at a signal where right turn on red is permitted. If right-turn lanes are used, appropriate signage such as **RIGHT LANE MUST TURN RIGHT** must be accompanied by **EXCEPT BUSES** placards.
- Transit signal priority should be considered on all priority transit routes.
- Transit signal priority studies should be conducted to understand the impact to traffic on cross streets of the transit route.
- Signal coordination should not increase delay for all modes, and take into consideration the acceleration rates and speeds of bicyclists.
- Transit agencies must address and train employees on how to handle bus and bicycle interactions in transit and bus-only lanes.
- Transit priority may be considered for late buses only in order to keep on schedule.
Overview

Bus bulbs are curb extensions along the length of a bus stop that eliminate the need for buses to pull in and out of traffic. Similar to normal curb extensions found at intersections, bus bulbs have the same advantages of reducing crossing distances for pedestrians and providing additional space for street furniture, landscaping and pedestrian queuing.

Bus bulbs will be installed on a case-by-case basis determined by an engineering study, and all designs must be approved by BTD and PWD in consultation with the MBTA.

Use

Bus bulbs are only appropriate on streets where on-street parking is present. Bus bulbs provide extra passenger queuing space and are most appropriate at stops with higher passenger volumes. Bus bulbs are effective in enforcing parking restrictions within bus stops and do not require as much space as curbside stops because the bus does not need space to pull in and out of the stop, but may cause occasional traffic delay behind them.

Considerations

- Since the bus remains in the travel lane while stopped, bus bulbs can result in traffic delays or unsafe maneuvers by drivers and bicyclists to steer around buses. Designs must consider the Street Type, number of travel lanes, and headways of buses.
- Bus bulbs can interfere with right-turning vehicle movements at near-side intersections.
- Bus bulbs are most effective at reducing travel time if they are utilized throughout a corridor by eliminating the need for buses to pull in and out of traffic all together.
- The MBTA operates different length buses. Bus bulbs will require different lengths depending on the service provided on the bus route. Consultation should be done with the MBTA and BTD to determine the appropriate design.
Off-Bus Fare Collection

Overview

A significant cause of delay for transit vehicles is the queuing of customers paying fare on the vehicle. In addition to promoting “smart card” fares, pre-payment is the fastest method of fare collection, and allows passengers to enter the vehicle from all doors without waiting in line to pay. Compared to an additional minute for exact fare or dip/swipe systems, off-bus fare collection can save up to a minute over 10 passengers.\(^5\)

Use

- Off-bus fare collection should be used at transit stops where high ridership counts delay vehicles due to large amounts of passengers boarding.

Considerations

- Off-bus fare collection requires more space and infrastructure than standard bus-stops.
- Electronic fare equipment may require staffing. If left unattended at stops, weather and compliance may become problems.
- An alternative to off-bus fare collection methods could be to have a second electronic fare collector to allow patrons with Charlie Cards to bypass cash-fare customers.
- Fare-free zones could be considered in extremely high-volume destinations.