Western Avenue Express Bus Facilities and Service Enhancement Project

Toolbox for Intersection Design

Elements to Enhance Express Bus Services

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August 2005
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How to use this toolbox

This document has been prepared for the CTA to facilitate the transfer of knowledge about the transit specific application of roadway and urban design elements. As CTA moves forward with the increased development of express and limited stop bus services, this Toolbox is intended to guide the design solutions in the affected travel corridors.

This toolbox contains a wide range of conceptual intersection improvements that may have the potential to improve dwell time and ridership on express / limited stop bus services. The purpose of this toolbox is to provide a description of the element and to provide some guidance on the applicability of each item.

The Toolbox document is divided into sections that address various aspects of the bus or pedestrian experience at bus stops. The following categories of elements are described:

- Bus Stop Placement
- Elements that Improve Intersection Geometrics
- Elements that Reduce Bus Dwell Time
- Elements that Improve Bus Travel Time
- Elements that Improve Pedestrian Safety
- Elements that Raise the Profile of Transit Service

A matrix summarizing the various elements and the conditions for their application is on the following page. This matrix should be helpful in identifying the particular elements that might be applicable under specific intersection characteristics. The reader can then refer to the appropriate sections within this Toolbox document for additional detail on that particular element. The element descriptions are intended to focus on the specific application of traffic engineering and urban design to transit operations. At times, the transit application will have different characteristics and impacts compared to, for instance, a roadway design application of a traffic engineering element.
### Summary Matrix

<table>
<thead>
<tr>
<th>TYPE OF INTERSECTION</th>
<th>NUMBER OF LINES</th>
<th>LANE WIDTH</th>
<th>SIDEWALK WIDTH</th>
<th>PEDESTRIAN VOLUME</th>
<th>BUS STOP BOARDINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Near side</td>
<td>Far side</td>
<td>Ped. oriented</td>
<td>Auto-oriented</td>
<td>With rail station</td>
</tr>
<tr>
<td>BUS STOP PLACEMENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near side</td>
<td>■</td>
<td>■</td>
<td>x</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Far side</td>
<td>x</td>
<td>x</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Mid-block</td>
<td>x</td>
<td>x</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
</tbody>
</table>

### Improvements in Intersection Geometrics

- **Pavement Materials and Bus Pads**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **On Street Parking**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Bicycle Traffic**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Driveway Curb Cuts**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Turning Radii**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

### Transit Signal Priority

- **Transit Signal Priority**
  - x Not applicable

### Reduce Dwell Time

- **Bus Bay Configuration**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Curb Extensions**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Curb Height and Profile**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Off-vehicle Fare Collection**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

### Improve Bus Travel Time

- **Curb Lane and Travel Lane Width**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Queue Jumping Lanes**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Exclusive Bus Lane**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

### Improve Pedestrian Safety

- **Leading Pedestrian Interval**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Pedestrian Countdown Signal**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Crosswalks**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

### Reduce Pedestrian / Vehicle Conflicts

- **Lighting**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Landscaping**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Sidewalk Configuration and Condition**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

### Amenities to Raise Profile of Transit Service

- **Signage Posts**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Signage Elements**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Paving**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Seating Elements**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Bicycle Racks**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Information Kiosks**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Vending Kiosks**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Emergency Call / Response Buttons**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Trash Receptacles**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Telephone Kiosks**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Newspaper Boxes**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Real-time Traveler Information**
  - ■ No change
  - x Increase
  - /boxsolid
  - /boxopen

- **Applicable for use**
- **Consider for use**
- **Not applicable for use**

---

**Total:**

- **Actual:**
- **Considered:**
- **Not considered:**
1. Bus Stop Placement
1.1 Bus stop placement: nearside, farside, or mid-block

Description

Nearside
Nearside stops refer to bus stops that are located immediately prior to an intersection.

Farside
Farside stops refer to bus stops that are located immediately after passing through an intersection.

Mid-block
A mid-block stop is one that is located away from an intersection, within the block.

Nearside is the most common type of bus stop in Chicago. Only recently, farside stops have become more common in Chicago. Farside stops were seen primarily on routes whose heritage dates back to the Chicago Motor Coach Company. However, the CTA has engaged in a policy of moving stops at signalized intersections to farside in conjunction with the City’s program of installing concrete pavement at bus stops and the JC Decaux shelter program, following the recommendation to move to farside stops contained in the Western Avenue Traffic Signal Priority Feasibility Study, Project Summary Report [1]. Mid-block stops are unusual in Chicago.

Implementation

Criteria for usage / appropriate location

In general, stops should be located at intersections to allow access to crosswalks and convenient connections to intersecting transit routes [1], mid-block stops should only be installed at very specialized locations. At intersections, stops should normally be located farside, except at locations where site-specific issues demand a nearside or mid-block stop (e.g. issues related to ridership sources/destinations). The following table presents site-specific characteristics of an intersection that suggest the use of one of the stop placement types [3].

<table>
<thead>
<tr>
<th>Nearside</th>
<th>Farside</th>
<th>Mid-block</th>
</tr>
</thead>
<tbody>
<tr>
<td>A major origin/destination is located in the nearside block.</td>
<td>Intersection is signalized: this avoids the conflict between stopped buses and right-turning cars.</td>
<td>A major ridership source/destination (i.e. school, rail station, hospital) is located mid-block, between intersections.</td>
</tr>
<tr>
<td>Bus route is turning right at the intersection.</td>
<td>The intersection is equipped with Transit Signal Priority; there is no good way to submit a priority request so that it is granted at the right moment while boarding passengers at a nearside stop.</td>
<td>Very long blocks with a major ridership source.</td>
</tr>
<tr>
<td>Non-signalized locations.</td>
<td>On-street parking spaces are required: usually, farside bus bays require the least space to accommodate a stop</td>
<td>On-street parking is not an issue: mid-block bus stops are very long to allow buses to get in and out of traffic lanes (175’ vs. 85’ for a standard nearside or farside stop) [2].</td>
</tr>
</tbody>
</table>

In addition to the previous characteristics, the following factors should be considered when selecting the type of bus stop:
Intersecting transit routes and passenger flow: the location of stops from intersecting transit routes or major passenger origins and destination create a main passenger flow; the stop should be located nearside, farside, or mid-block depending on which type would provide the safest and most convenient environment for passengers.

Passenger origins and destinations and potential patronage: if there is a particularly significant source of ridership around the stop, the stop should be conveniently located closer to that source.

Impact on intersection operations: the stop type selected should not impact negatively the general traffic operations of the intersection.

Intersection geometry: the intersection geometry may lend itself to a safer environment for passengers with certain type of bus stop. For example, if the nearside has an extended curb (bulb out) and the farside location has a driveway, a nearside stop may be considered the best placement.

Pedestrian access, including accessibility for people using wheelchairs: the presence of driveways or other elements that may be considered a disturbance for pedestrian access must be taken into account when determining the stop type.

Physical roadside constraints (trees, poles, driveways, etc.): the stop location should consider physical road constraints that may hinder one type of stop. For example, a nearside tree reduces sight distance for cars making it safer to place the stop in the farside.

Potential Drawbacks

<table>
<thead>
<tr>
<th>Nearest</th>
<th>Farside</th>
<th>Mid-block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing conflicts with right-turning vehicles.</td>
<td>Intersection being blocked, especially during peak periods, by queued buses or general traffic behind a bus stopped on a traffic lane.</td>
<td>Boarding or alighting customers crossing the street at a point away from a crosswalk (i.e. jaywalking).</td>
</tr>
<tr>
<td>Blocking through lane with queued buses during peak periods.</td>
<td>Obscuring sight distances for crossing vehicles.</td>
<td>Locating a midblock stop on a roadway with two or more high speed lanes per direction, where a safe crosswalk would be difficult to implement due to the speed of the vehicles.</td>
</tr>
<tr>
<td>Increasing sight distance problems for crossing pedestrians.</td>
<td>Increasing sight distance problems for crossing pedestrians.</td>
<td></td>
</tr>
<tr>
<td>Moving nearside stops that have been in place at non-signalized intersections for many years may not be justified, unless there are site-specific reasons for relocation.</td>
<td>Increasing number of rear-end accidents because car drivers do not expect buses to stop again after stopping at a red light.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High volume of bus routes stopping at farside stops may block intersection.</td>
<td></td>
</tr>
</tbody>
</table>

Applicability of element to intersection prototype

The following list discusses the applicability of the stop placement alternatives to prototypical intersection configurations.

Intersection with rail: the bus stop should be placed as close as possible to the rail line access points. For Western Avenue stops this means using mid-block stops at intersections with rail lines because the rail line stations have access points in the middle of blocks.

Auto-oriented land-use: nearside and farside stops are more applicable to auto-oriented intersections than mid-block stops because they allow more convenient access to crosswalks and crossing streets. Unless the major destination is in front of the stop, mid-block stops would introduce longer walks for passengers in an environment that is not pedestrian-friendly.
- **Pedestrian-oriented land use**: any of the three stop placement alternatives are applicable to pedestrian-oriented land use, choosing the final placement should be done according to the discussion in the Implementation section.

**Examples**

- **Nearside**: An example of an appropriate use of a nearside stop would Western/Leland, northbound, where the Brown Line ‘L’ station is located on the nearside of the intersection.

- **Farside**: Most stops at signalized intersections (which include virtually all X49 stops) in the Western Avenue Corridor are currently located farside.

- **Mid-block**: A good example of an appropriate placement of a mid-block stop is on Western Avenue south of Addison Street, southbound. This allows Western Ave. buses to serve the Lane Technical High School without the need for students to walk to Addison Street. This block is two standard blocks long, so not stopping here would create abnormally long stop spacing, at a point of heavy customer need. This location also allows space for multiple buses to stop simultaneously, very helpful for staging/boarding buses at the end of the school day.

**Impacts**

**Dwell time impacts**

**Nearside**
- Because it is not possible to accurately predict when a bus at a nearside stop will be ready to leave (after passengers complete boarding and alighting), the use of nearside stops at an intersection equipped with Traffic Signal Priority is not likely to impact positively (or negatively) the dwell time already experienced at the stop.

**Farside**
- Use of farside bus stops at signalized intersections may reduce dwell by avoiding those situations when the bus is forced to sit through an extra cycle because a few passengers arrived at the stop as the bus was ready to leave and the light turned green.
- Avoiding the situation explained above also reduces dwell time for buses that may be queued behind the vehicle at bus stop.
- Further dwell time reductions may be observed when farside stops are complemented with Transit Signal Priority (see 3.1 Transit Signal Priority)

**Mid-block**
- Buses may experience delays when pulling back into traffic.

**Ridership impacts**

**Nearside**
- If farside stops are moved to nearside (not recommended) ridership could be negatively affected by the longer travel times.

**Farside**
- The shorter dwell times/travel times achieved when moving from nearside to farside stops could translate into increased ridership.

**Mid-block**
- Ridership impacts are localized: it could increase ridership from major mid-block origin/destination.
Costs

The direct cost of building any of the three stop placement alternatives is comparatively the same. For nearside and farside stops, cost effects would only be significant if the difference in travel time results in a difference in the number of buses required to operate a given level of service. For all stop types, but especially for mid-block stops, metered parking spaces may be lost due to the construction of a bus stop.

References

2. Pace Development Guidelines, 1999 Edition, Figure V-1
2. Elements that improve intersection geometrics
2.1 Paving Materials for Bus Stops and Bus Pads

Description

Use of colored and/or textured materials for bus stops and bus pads can greatly enhance the visibility and better delineate the bus areas. Bus pads and stops can be constructed with paving materials other than the conventional black asphalt or grey concrete surfaces. Textured and colored driving surfaces would be constructed adjacent to the bus stop for the length of the stopping area or bus bay. Similarly, bus pads can use similar texturizing treatments or color schemes to compliment the bay. Treatments can incorporate “branding” schemes and motifs. Alternative materials and treatments include:

- Colored/tinted concrete.
- Texturized concrete with designs stamped or pressed onto the surface (can simulate brick pavers).
- Brick pavers.
- Asphalt with stamped or pressed surface textures.

For bus pad designs and other bus stop treatments, refer to Section 8 Stop Amenities.

Implementation

Criteria for usage / appropriate location

Colored and textured materials for bus pads and bays may be considered when the following conditions are observed:

- Bus stop is difficult to view from the roadway.
- High transit patronage volume.
- Locales with significant tourist activity.
- Roadways with high traffic volumes.
- High bus related accidents such as sideswipe and rear end accidents.
- Narrow outside travel lane widths, less than 12 ft.
- Roadways with one travel lane in each direction
- Designated bus bays and lanes are already present
- Roadways with on-street parallel parking.
- Heavy bus volumes which can accelerate the wear and tear of the roadway.
- Character enhancement of a corridor is desired.
- Appropriate parties have committed to maintenance requirements.

Situations to avoid in implementation

Conditions that may limit the use of alternative pavement treatments include:

- Pavement treatment that may obstruct roadway drainage.
- May not facilitate pavement maintenance, such as snow removal and street sweeping.

Applicability of element to intersection prototype

Use of alternative paving materials for bus bays and pad is applicable for all five prototype intersections. Regardless of the intersection type it assists both pedestrians and vehicles to determine the location and limits of the bus bay and stop area. However, use of alternative paving materials for bus bays is most applicable at intersections with auto oriented land where vehicle volumes may be higher and nearside stops where vehicles may encroach in the bus stop area to turn right onto the cross street. For both these prototype intersections clearly defining the bus bay area will improve bus operations of getting in and out of the bus bay.

Examples and Images

Colored brick pavers for bus pad and bus bays – Los Angeles
Impacts

**Ridership impacts**
- The use of colored and/or textured materials for bus bays and bus pads may enhance the visibility of the bus system, which may encourage more riders to use the buses, however, explicit impacts have not been studied and specific figures are difficult to determine.

**Dwell time impacts**
- The use of colored and/or textured materials for bus bays and bus pads helps to delineate better the area designated for buses, which may improve enforcement of parking in bus stop areas, and in turn reduce average dwell time by ensuring that the bus pad is always free of cars violating the bus area. This has been observed in Chicago (on California Avenue between 31st and 55th) where diamond markings in the bus stop area have created better self-enforcement of bus stop ‘No Parking’ zones. However, this impact has not yet been quantified and it depends greatly on the existing parking enforcement in the area.

Costs

Includes cost for alternative materials and treatment:
- Bus Bays (a bus bay unit is defined as 150 feet long and 12 feet wide)
  - Concrete surface - $6,700/unit
  - Brick Pavers – $9,600/unit
- Bus Pad (a bus pad unit is defined as 25 feet long and 8 feet wide)
  - Brick Pavers - $1,600/unit

Construction of a bus bay may require some roadway widening. Additional costs may be incurred for sidewalks, adjustments of drainage structure, utilities, light poles, signal relocations, and additional ROW.

Evaluation

When considering alternative paving materials or treatments, the following factors need to be evaluated:
- The selected material should provide clear delineation between general travel lanes and bus usage areas.
- The construction material should withstand the heavy load of the buses and the wear and tear of frequent stopping and starting maneuvers of the bus.
- Construction material and treatment should be able to sustain specific weather conditions, such as freeze and thaw conditions in the city of Chicago.
- Drainage is facilitated by the proposed paving material or treatment.
- The material and treatment should facilitate unobstructed maintenance of the roadway and the bus pads.
2.2 On-street parking

Description

On-street parking is parking allowed on the roadway, usually in the curbside (right-most) lane. The advantages usually associated with on-street parking are [1]:

- It serves business districts by providing nearby access to their commercial destinations.
- The buffer created between sidewalks and travel lanes improves pedestrian safety and provides a perceived reduction in the level of noise.
- It utilizes less land per space than off-street parking.
- It can reduce crossing distance for pedestrians if curb bulbs are installed.
- It may serve as a traffic calming device.

The disadvantages usually associated with on-street parking are [1]:

- The buffer created may introduce obstruction of sight lines for both pedestrians and vehicles.
- It uses space that could otherwise be used for wider sidewalks, bike lanes, or exclusive bus lanes.
- It may increase roadway congestion as drivers circle and search for open spaces or as drivers maneuver into and out of spaces.
- It encourages driving to a destination, which could generate additional traffic.

Parallel parking lane widths are typically a minimum of 8 feet and desirably 10 feet wide. To provide better clearance and the potential to use the parking lane during peak periods as a through-travel lane, a parking lane width of 10 to 12 feet is desirable. This will also better accommodate bus operations. The gutter flag width may be included as part of the parking lane width [6]. See element 4.1 Curb lane and travel lane width for additional information.

Implementation

Criteria for usage / appropriate location

- Viability of nearby businesses and commercial districts may be improved by provision of parking.
- The cross section of the road must be wide enough to accommodate the parking lane.
- The average roadway speed should be less than 35 mph.
- The roadway should be less than 3 lanes in each direction.
- Based on the MUTCD [5], on-street parking should be restricted a minimum of 20 feet from the crosswalks of an intersection, and a minimum of 30 feet from the crosswalk on approach to a signalized intersection. However, a clearance of at least 85 feet is required at intersections with bus stops in order to provide adequate space for bus movements.
- Pavement striping to delineate the parking area helps define the parking lane limits and reduces encroachment into the bus stop area.
- Use of curb extension between parking space and bus stop may prevent encroachment of standing cars in the bus stop, as well as providing space for additional amenities at the bus stop.

Situations to avoid in implementation

Utilize design strategies that discourage the following:

- Allowing parking too close to bus stop at the intersection, which does not help to keep bus stop area clear and sight lines unobstructed at the corners.
- Parking too close to the intersection, which may prevent a bus from pulling up close to the curb at the bus stop and may make right turning maneuvers difficult for buses.
- Unstriped or undelineated parking areas, which may encourage vehicles to use the parking lane as right turn lanes near the intersection.
Applicability of element to intersection prototype

In general, on-street parking is not desirable for any of the stop prototypes because it provides opportunities for vehicles to encroach within the bus stop transit space. However, if on-street parking cannot be eliminated, a minimum clearance of 85 feet must be provided and enforced.

Examples and Images

Parallel parking on Broadway Av, Albany, NY; On-street parking payment booth in downtown Boston

Impacts

Ridership impacts
- Insignificant ridership impacts due to parking itself.
- On-street parking allows the creation of curb extension stops and narrower crosswalks, which provide a more pedestrian friendly environment, which in turn could lead to higher ridership (see element 3.2 Curb extensions).

Dwell time impacts
- Insignificant dwell time impacts due to parking itself.
- On-street parking allows the creation of curb extension stops, which reduces the time a vehicle requires to access a bus stop (see element 3.2 Curb extensions).
- On-street parking may also create opportunities for cars to park in the bus stop (if weak enforcement) resulting in an additional delay for buses and passengers at bus stops.

Other impacts
- Removal of on-street parking and replacement with off-street parking facilities is a consideration for reducing parking conflicts with bus stop operations. However, coordination with the roadway agency of jurisdiction is recommended because of associated costs and responsibilities for constructing and maintaining off-street parking facilities.
- Similarly, removal of parking from the main travel route and relocating it to the minor cross streets would be subject to the same design requirements and coordination with the roadway agency of jurisdiction. However, in most cases within the City of Chicago, the minor cross street already allows on-street parking.

Costs

Direct (construction) costs [4]
- Suburban area: $1,700 per space
- Urban area: $3,000 per space
- CBD: $10,500 per space

Annual Operation & Maintenance costs [4]
- Suburban area: $100 per space
- Urban area: $150 per space
- CBD: $250 per space

Removal or addition of a paid on-street parking space may also have revenue impacts that should be considered in an evaluation of costs. Costs will depend on local conditions.

Evaluation

The function of parking lanes can be evaluated as part of a signalized intersection’s operations through the resulting level-of-service (LOS). The intersection LOS can be affected by the number of parking maneuvers per hour which disrupts traffic flow and capacity through the intersection.

Secondly, maintaining or removing on-street parking can be evaluated from a safety perspective. Accident history can be reviewed to determine if on-street parking is contributory to the accident experience along the roadway or at the intersection.
References

   www.nyu.edu/wagner/transportation/publications/report_docs/Parking%20Report%20Final.pdf


2.3 Bicycle traffic

Description
Integration of transit and bicycle traffic may provide greater levels of mobility. The combination of cycling and public transit often replaces trips that could otherwise only be made by automobile. It also allows cyclists to pass major barriers, such as tunnels or freeways where cycling is prohibited, or particularly difficult [1]. Western Avenue intersects with many on-street bicycle routes. CTA customers also frequently use on-street bicycle racks as well as racks mounted to the front of CTA buses. For bike parking facilities see element 7.4 Bike Racks for additional information.

Bicycle routes in Chicago are designated either with route signing and/or a striped bike lane. Typically, bike lanes and routes are designated as a portion of the road striped for use by cyclists, usually the curbside lane, shoulder, or adjacent to parking lanes [1].

Because bicycles and buses are relegated to the curbside lane, they compete for road space. Since the road is shared with cyclists, their presence on the road poses operational and safety concerns for buses. These concerns are amplified for buses because of the relative smaller size of a bicycle and their greater maneuverability than a bus.

Safety concerns include:
- Cyclists riding in the “blind spot” of the bus.
- Cyclists passing buses on the right side.
- Cyclists waiting along the curbside during red lights may impede boarding/alighting.

At locations where a bike route crosses a bus route, bike rack and storage facilities can be provided. In addition, another approach to integrate transit and bicycle traffic is to allow bicycles in transit vehicles, which allows using the bicycle at both ends of the transit trip.

Implementation

Criteria for usage / appropriate location
The following should be considered in determining the level of accommodations for bicyclists at bus stops:
- Presence of a major bike route, bicycle facility, or land use that promotes bicycle use, such as a park, forest preserve, or off-street bicycle paths.
- There is available space to provide bike racks and storage facilities at the bus stops.
- Bicycle loading areas can be provided at curb extensions by providing a buffer zone from the travel lane for the cyclist.
- For the City of Chicago refer to the Bike Lane Design Guide: Chicago's Bike Lane Design Manual [2].

Making all streets friendly to bicycle traffic can only enhance the area and improve the integration between transit and biking. Thus bicycle traffic and its integration with transit should be encouraged at all transit locations.

Situations to avoid in implementation
Bike racks and storage facilities should be avoided when:
- There is not available physical space within the bus stop area.
- There is no supportive bicycle route or lane along the bus route or cross street to provide access to cyclists.

Applicability of element to intersection prototype
Five types of intersection prototypes have been identified: 1) Nearside; 2) Farside; 3) Intersection with rail; 4) Auto-oriented land use; and 5) Pedestrian-oriented land use. The lane width affects the operations along roadway segments and at intersections. Recommendations regarding bicycle traffic apply to all prototypes.
Examples and Images

- Transit ridership may be increased due to its integration with bicycles facilities because its catchment area is expanded: while a transit stop normally draws pedestrians within a 10-minute walk, or 0.25 mile, cyclists can cover three to four times the distance in the same time, increasing the catchment area by about ten-fold [1]. For example, 30% of users of Vancouver’s bike lockers at a transit station had not previously used public transit to commute [3].

**Dwell time impacts**

- Insignificant dwell time impacts

**Other impacts**

- Introducing bicycle traffic in neighborhoods may generate a more livable community through greater mobility opportunities and a safer environment due to higher presence of people on streets

**Costs**

- Refer to element 8.8 Bike racks for bike parking costs.
- The cost of providing bus-mounted bike racks is roughly $300, including installation.

**Impacts**

**Ridership impacts**

**References**

2.4 Access Management (Driveway Consolidation)

Description

Bus stops are often located near intersections that unavoidably also have driveways and curb cuts to access properties such as gasoline stations, business parking lots, and private properties. The management of these driveways and curb cuts is part of the broader activity usually referred to as Access Management.

Access Management involves changing land use planning and roadway design practices to limit the number of driveways and intersections on arterials and highways, constructing medians to control turning movements, encouraging clustered development, creating more pedestrian-oriented street designs, and road space reallocation to encourage efficiency. Although Access Management is primarily intended to improve motor vehicle traffic flow, it can help convert automobile-oriented strip development into more accessible land use patterns that are better suited to walking, cycling and public transit [1].

Implementation

Criteria for usage / appropriate location

Locating bus stops and driveways near each other should be avoided to the extent possible but when the situation is unavoidable the following general guidelines should be used:

- Consolidate driveways: combine multiple driveways for one development and connect parking lots to avoid re-entering arterials to move between developments.
- Locate driveways as far away from the intersection as possible.
- Consider the use of right-in, right-out only driveways.
- Use standard driveway flares and radii to ease exiting and entering maneuvers (e.g. ASHTO standards).
- Depending on sidewalk width and traffic volumes into the development, consider raising the driveway to provide continuity to sidewalk instead of roadway.
- Minimize vehicle/bus conflicts and sight distances problems for cars accessing the private lot.
- Provide sufficient space between stop and driveway to avoid forcing passengers to wait on the driveway.
- Consider use of vertical barriers to separate driveway from passenger waiting area.

Situations to avoid in implementation

- Reducing sight distances for car drivers entering or leaving the private lot [2].
- Locating a bus stop adjacent to the only driveway to a development.

Applicability of element to intersection prototype

Access management should be considered for all intersection prototypes. Presence of multiple curb cuts is most likely in auto-oriented locations due to the nature of the land uses in these areas. Special consideration of driveway consolidation should be made in these areas by working closely with business owners, Aldermen and the City of Chicago to design auto access into business while balancing the needs and safety of transit passengers and pedestrians.
Impacts

Ridership impacts

- The existence of multiple driveways and curb cuts near a bus stop may degrade the surrounding pedestrian environment and may discourage some potential riders to use the bus system.

Dwell time impacts

- Driveway and curb cuts may generate an unnecessary delay for buses approaching a nearby stop, especially if the stop is in the near side of the driveway, where buses may need to wait for a vehicle to leave the property. Thus, it is recommended to locate bus stops on the far side of the driveway to avoid negative dwell time impacts.

Other Impacts

Managing the number of driveways and curb cuts on an arterial may also have other impacts including [1]

- Reduced automobile travel if it results in higher-density, more accessible, clustered, mixed-use, pedestrian-friendly, transit-oriented development.
- Encouraging automobile traffic by improving speed on arterials.
- Improving non-motorized travel conditions including for people with disabilities.
- Reduced number of accidents [3].

Costs

- Direct costs: re-building driveways, sidewalks, and potentially roadway
- Planning costs: costs associated with shifting planning and design practices (e.g. staff training, development of new guidelines and standards); negotiations with property owners.
References
   http://www.vtpi.org/
Description

Most CTA routes do not require many turning movements, however maintaining minimum turning radii is important to ensure safe operation of the buses on the street. Designing for buses and vehicles often encourages larger turning radii. Large turning radii at corners increases the crossing distance for pedestrians, and can encourage drivers to speed when turning. Thoughtful consideration of these issues will help lead to appropriate intersection design.

Not properly designing for the turn radii may cause a bus to run over the corner curb or conflict with oncoming traffic on the cross street. The bus operator would need to significantly reduce the bus speed to safely negotiate the turn. Usually, right turns are more challenging for buses than left turns. Right turns are made in much “tighter” space. The turn is constrained by the corner curb on the right side of the bus, and opposing vehicles on the cross street along the left side of the bus. For left turns, the bus can swing wide through the intersection during the maneuver and negotiate the turn more easily.

However, when designing the corner radius for the turning radii of the design vehicle, a balance must be provided between the needs of the bus, and the safety and sidewalk space for the pedestrians. Providing an excessively large corner radius design reduces the sidewalk space and lengthens the crosswalk distance for pedestrians.

Figures 1 and 2 show the turning template for a B-40 bus and a B-60 articulated bus, respectively. The turning path of the bus for a right turn has been shaded. The turning path of the bus is not a simple radius. The vehicle path follows a more parabolic line.

To help balance the bus’s need and still provide as much sidewalk width as possible, the corner radius can be designed using a 2 or 3-centered curve, or a combination of a radius with a taper [1]. This provides a corner curb line that follows the bus turning track better without unduly reducing the sidewalk space and increasing the width of the crosswalk.
Figure 1. Appropriate turning radii for 40-foot buses [2]
Implementation

Criteria for usage / appropriate location
- All street corners where bus turns are anticipated should comply with minimum radii required by buses, but special attention should be given to those intersections where buses currently make right turns.
- Keeping turning radii to the size required by buses would also improve the operation of other large vehicles such as fire engines, and large trucks.
- Consideration should be provided for items within the corner area, such as on-street parking, curb extensions, and bus bays, as these will affect the travel path of the bus.

Situations to avoid in implementation
- Designing turning radii for a vehicle type different than the buses that will actually use the route, for example design for 40-foot buses when articulated buses would operate on that intersection as well.
- If right-of-way is limited and installing a larger corner radius would impact buildings or significantly reduce sidewalk space and width to less than 7 feet or increase crossing distance or safety in a pedestrian area.
- Designing turning radii larger than necessary, particularly given the lack of turning movements required on typical CTA bus routes.

Applicability of element to intersection prototype
Providing properly designed corner radii to accommodate the bus design vehicle turning radii is desirable for any of the stop prototypes because it provides smoother bus turning movements while balancing the need for pedestrian safety. However, it is more applicable at the following prototype intersections:
- Nearside: the bus typically pulls up to the curb line requiring a tighter maneuver when making a right turn.
- Auto-oriented land-use: where vehicle volumes are higher, improved turning maneuvers for the bus will improve operations and safety.
- Pedestrian-oriented land-use: where pedestrian volumes may be higher, a properly designed corner radius will facilitate safe pedestrian crossings.

Impacts

Ridership impacts
- In general, appropriate turning radii for buses make the operations safer, and a safer environment should encourage greater ridership.

Dwell time impacts
- The impacts on dwell time generated by appropriate turning radii for buses are negligible.

Other impacts
- Bus routes with a significant number of right turns built into the route may observe positive travel time impacts (i.e. a decrease of travel time) when the corners at intersections are re-built with appropriate turning
radii. However, very few bus routes may have a significant number of right turns, especially in the CTA grid network.

- Complying with appropriate turning radii dimensions for buses may
  - Reduce the number of accidents caused by buses that are not able to negotiate right turns within its designated lane;
  - Generate a safer environment for passengers;
  - Reduce accidents with the public in general (i.e. pedestrians, properties) because sight lines are improved;
  - Reduce maintenance costs for transit agency; and
  - Reduce driver’s stress.

**Costs**

- The construction costs of building the corners of street intersections with appropriate turning radii for buses are comparable with those of corners that have smaller turning radii. However, the cost of the land may be higher because more space is required to follow the wider radii design guidelines.

**References**

3. Elements that reduce bus dwell time
3.1 Improved bus bay configuration and design

Description

A bus bay (or turnout) is a specially constructed area separated from the travel lanes and off the normal section of a roadway that provides for the pick up and discharge of passengers. This design allows through traffic to flow freely without the obstruction of stopped buses. On the other hand, it often imposes a penalty on buses because it may be difficult for them to rejoin the through lanes due to heavy traffic resulting in an additional delay for buses. Bus bays are provided primarily on high-volume or high-speed roadways, such as suburban arterial roads because it may be dangerous to stop on the through lanes due to the higher speed of cars, or on heavily congested downtown and shopping areas where large numbers of passengers may board and alight and an unbearable delay may be caused to general traffic if the bus stopped on a through lane [1].

The total length of the bus bay should allow room for an entrance taper, a deceleration lane, a stopping area, an acceleration lane, and an exit taper. However, the common practice is to accept deceleration and acceleration in the through lanes and only build the tapers and the stopping area. Providing separate deceleration and acceleration lanes is desirable on suburban arterial roads and should be incorporated in the design wherever feasible. An acceleration lane in a bay design allows a bus to obtain a speed that is within an acceptable range of the through traffic speed and more comfortably merge with the through traffic. The presence of a deceleration lane enables buses to decelerate without inhibiting through traffic. Typical bus bay dimensions (minimum and recommended) are shown in the figure and table below. Where bike lanes are provided, a bus bay should include a marked through lane to guide bicyclists along the outside of the bus bay [1].

Notes:
1) Stopping area length consists of 50 feet for each standard 40-foot bus and 70 feet for each 60-foot articulated bus expected to be at the stop simultaneously.
2) Bus bay width is desirable 12 feet. For traffic speeds under 30 mph, a 10-foot minimum bay width is acceptable. These dimensions do not include gutter width.
3) Suggested taper lengths are listed in table below. Desirable taper length is equal to the major road through speed multiplied by the width of the turnout bay. A taper of 5:1 is a desirable minimum for an entrance taper to an arterial street bus bay while the merging or re-entry taper should not be sharper than 3:1.
4) Minimum design for a busy bay does not include acceleration or deceleration lanes. Recommended acceleration and deceleration lengths are listed in the table below.

Bus bay schematic [1]
Recommended bus bay dimensions [1]

An improvement to bus bay design may be a partially open bus bay (or a partial sidewalk extension). This alternative allows buses to use the intersection approach in entering the bay and provides a partial sidewalk extension to reduce pedestrian street-crossing distance. It also prevents right-turning vehicles from using the bus bay for acceleration movements. The figure below illustrates the design for a partial open bus bay [1].

<table>
<thead>
<tr>
<th>Through Speed (mph)</th>
<th>Entering Speed(^a) (mph)</th>
<th>Length of Acceleration Lane (Feet)</th>
<th>Length of Deceleration Lane(^b) (Feet)</th>
<th>Length of Taper (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>25</td>
<td>250</td>
<td>184</td>
<td>170</td>
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<tr>
<td>60</td>
<td>50</td>
<td>1900</td>
<td>735</td>
<td>270</td>
</tr>
</tbody>
</table>

\(^a\) Bus speed at end of taper, desirable for buses to be within 10 mph of travel lane vehicle speed at the end of the taper.

\(^b\) Based on 2.5 mph/sec deceleration rate.

**Implementation**

**Criteria for usage / appropriate location**

Bus bays should be considered at a location when the following factors are present [1]:

- Traffic in the curb lane is between 250 and 1,000 vehicles per hour. With less than 250 vehicles per hour, curbside or curb extension stops are recommended to reduce delays caused by entering and leaving the bay. With more than 1,000 vehicles per hour evidence shows that drivers will not use the bus bay because the heavy volumes make it extremely difficult to maneuver a bus out of a midblock or near-side bay, and that the bus must wait an unacceptable period of time to re-enter the travel lane.

- Traffic speed is greater than 40 mph.

- Bus volumes are 10 or more per peak hour on the roadway.

- Average peak-period dwell time exceeds 30 seconds per bus at the stop.

- Buses are expected to layover at the end of a trip.

- Potential for auto/bus conflicts warrants separation of transit and passenger vehicles.

- History of repeated traffic and/or pedestrian accidents at stop location.

- Right-of-way width is adequate to construct the bay without adversely affecting sidewalk pedestrian movement.
- Sight distances (i.e., hills, curves) prevent traffic from stopping safely behind a stopped bus.
- Appropriate bus signal priority treatment exists at an intersection.
- Bus parking in the curb lane is prohibited.
- Improvements are planned for a major roadway. This provides the opportunity to include the bus bay as part of the reconstruction, resulting in a better-designed and less-costly bus bay.
- Far-side stops (may vary with site conditions): place bus bays at signal-controlled intersections so that the signal can create gaps in traffic that allows buses to re-enter traffic lane (/1).

**Situations to avoid in implementation**

- Nearside bays should be avoided because of conflicts with right-turning vehicles, delays to transit service as buses attempt to re-enter the travel lane, and obstruction of traffic control devices and pedestrian activity (/1).
- Midblock bus bay locations are not desirable unless associated with key pedestrian access to major transit-oriented activity centers (/1). However, if the bus bay significantly reduces sidewalk area, it may not be appropriate for use.
- Bus bays are not typically used in the Chicago transit environment.

**Applicability of element to intersection prototype**

- **Nearside**: nearside bus bays should be avoided because of conflicts with right-turning vehicles, delays to transit service as buses attempt to re-enter the travel lane, and obstruction of traffic control devices and pedestrian activity. Nearside stops are preferred to be curbside or curb extensions, otherwise re-entering the traffic lanes from a bus bay may cause unacceptable delays in higher traffic urban roads.
- **Farside**: (may vary with site conditions) the implementation of bus bays should be avoided in farside locations as well because they may generate delays for the buses when re-entering the traffic lanes. If implementation is necessary, place bus bays at signal-controlled intersections so that the signal can create gaps in traffic that allows buses to re-enter traffic lane (/1).
- **Intersection with rail**: a bus bay may be acceptable at stops that intersect with rail stations because high ridership and longer dwell times would be expected, thus the bus bay may help avoiding bus/car conflicts and provide a refuge for buses from general traffic, allowing the bus to wait for a train to arrive or to get back on schedule.
- **Auto-oriented land-use**: at this intersection prototype, high auto flow and higher car speeds are expected. Thus, while installing bus bays would provide the advantages of avoiding bus/car conflicts on higher speed roads and protecting passengers, it would also be more difficult for the buses to pull out of the bay given the higher speed of the general traffic.
- **Pedestrian-oriented land use**: bus bays are not particularly applicable to pedestrian-oriented environments because the roads are expected to have a lower traffic speed, and the sidewalk space is better used as sidewalk than as a bus bay. In addition, the bus does not experience further delay by pulling in and out of the bay. If boardings and alightings are very high, a bus bay may be considered to avoid extended stays of buses on the traffic lanes.
Examples and Images

Mid-block bus bay [1]

Far side open bus bay [1]

Impacts

*Dwell time impacts*

Dwell time reductions may be expected with the addition of bus bays, assuming the acceleration and deceleration lanes are built with the recommended dimensions and the bus bays are enforced as no parking zones. However, if buses experience difficulty in returning to the travel lane after stopping in a bus bay, the overall travel time of the bus may increase.

The potential time reduction impact depends on the current condition on the corridor. At stops where there is a recurrent problem with parking enforcement and opportunities for the buses to re-enter the through traffic lane,
the impact will be higher. Conversely, at stops where currently buses have no problems getting back onto the traffic lane or with parked cars, the impact will be lower.

**Ridership impacts**

If a dwell time reduction is generated through the improvement of the bus bays configuration, a total travel time reduction is observed, which may result in an expected increase in ridership. Ridership may increase by 0.35% by every percent point (1%) reduced in travel time [2].

**Costs**

The costs of improving a bus bay are highly correlated with the existing characteristics of the stop and the design of the improved bus bay, including:

- Current dimensions of bus bay
- Paving material
- Utilities elements (i.e. light poles, hydrants) that need to be moved
- Private driveways that need to be reconfigured

**Evaluation**

Consider improving the bus bay configuration if:

- Dwell time at the stop is higher than 10 seconds per passenger (boarding and alighting).
- Delay re-entering the through traffic lane is unacceptable (i.e. for example, the added delay caused to buses at the stops is equal or more than the time spent boarding and alighting passengers).

**References**


3.2 Curb extension

**Description**

Curb extension is a section of sidewalk that extends from the curb of a parking lane (or right turn lane) to the edge of a through lane. The bus stop is placed on the sidewalk extension, allowing buses to stop on the through lane instead of weaving into a parking-lane curbside stop, also known as bus bay [1]. Curb extensions are also known as bus bulbs, bulb outs, nubs, and bus bulges.

**Implementation**

**Criteria for usage / appropriate location**

Curb extensions may be considered when the following conditions are observed:

- High transit patronage volume
- High pedestrian volumes and narrow sidewalks that cannot accommodate passenger amenities (such as shelters, benches)
- Buses have difficulties re-incorporating to through lanes from bus bay stops
- Lower operating speeds in the corridor (less than 40 mph)

Appropriate locations for curb extensions application are

- Streets with two travel lanes per direction (vehicles can pass stopped buses)
- Streets with 24-hour curbside parking
- Areas in which transit and pedestrians are high priority
- Locations with wider cross-section to facilitate crossing the street for pedestrians
- Locations that require additional parking (i.e. bus bays use more space to allow for maneuvering)

**Situations to avoid in implementation**

Conditions that may limit the use of curb extensions include

- Two-lane streets (one through lane in each direction)
- Streets with high operating speed (40 or more mph)
- Streets with very high traffic volume
- Streets without 24-hour curbside parking
- Sites with frequent wheelchair lift operations
- Sites with complex drainage patterns
Applicability of element to intersection prototype

- **Nearside:** curb extensions in nearside stops provide priority to buses over right-turning vehicles, however, if the volume of vehicles turning right is significantly high, the queue of right-turning vehicles that may form behind the bus may affect general traffic negatively.

- **Farside:** in this case the conflict described above between right-turning vehicles and buses is avoided but sight distance for vehicles crossing or entering the street may be hindered.

- **Intersection with rail:** a curb extension may be applicable here if the sidewalk space is reduced and a wider sidewalk is required to hold transfer customers.

- **Auto-oriented land-use:** at this intersection prototype, high auto flow and higher car speeds are expected. Thus, while installing curb extensions will avoid unnecessary delays for stopping buses due to re-entering the traffic lanes, the high speed of the road may create dangerous situations for both buses and vehicles if a bus stops on a travel lane.

- **Pedestrian-oriented land-use:** curb extensions are applicable to intersection with high pedestrian volumes because they help avoiding conflicts between bus passengers waiting at the stop and pedestrians walking along the sidewalk.

Impacts

**Ridership impacts**

Ridership impacts may stem from reduced travel time and improvements to pedestrian environments.

- The industry standard for ridership gains due to 1% of travel time reduction is 0.35% [2]

- Ridership impact from improvement to pedestrian environment is very difficult to quantify. No studies were found where this impact was documented.

**Dwell time impacts**

The replacement of curbside stops with curb extensions may impact dwell time by reducing the time required by buses when entering and leaving the stop area, which in turn reduces average travel time. Curbside stops are also often occupied by illegally parked cars, causing delays to buses that need to use the stop. Curb extensions can alleviate this problem.

Travel time of general traffic may also be reduced when replacing curbside (or bus bays) with curb extensions because with the former configuration, buses often stop blocking one travel lane and re-enter traffic using both lanes. In Mission St, San Francisco:

- The average speed of the general traffic increased with the installation of curb extension by 17% (2 mph) northbound and 46% (7 mph) southbound. The average speed of buses in the same street increased by 7% (0.5 mph).
- While slight dwell time reductions were observed in nearside stops, farside stops did not reveal noticeable dwell time changes when going from bus bays to curb extensions.

Costs

Reported costs for curb extensions built in the 1990s are [1]

- San Francisco: $500,000 for designing and building 9 bus bulbs ($55,500 per bulb)
- Portland: $15,000 to $30,000 per bulb
- Vancouver: CAN$24,000 per bulb
- Seattle: $17,500 per bulb (most of the expenses associated with drainage and accommodating wheelchair lift)

Examples and Images

- Curb extensions have been used in North America in Charlotte (NC), Grand Rapids and Lansing (MI), Orlando and West Palm Beach (FL), Portland (OR), San Francisco (CA), Seattle (WA), and Vancouver (Canada).
- Well developed, mixed-use urban settings, with high pedestrian and transit volumes are usually considered for curb extensions implementation.
Sidewalk clearance created by curb extension in Seattle, Washington. [1]

Neardside curb extension in Portland, Oregon. [1]

Curb extension in Vancouver, Canada. [1]

References


3.3 Curb height and profile

Description

One of the desirable elements of an express service or BRT system design is “precision boarding.” Precision boarding is achieved by the close alignment of the bus with the boarding area (both horizontally and vertically), to allow rapid and convenient boarding and alighting. This is a normal feature of rail systems. It has also been adopted on overseas BRT systems. In Europe, attention has been focused on cases where this is done through application of guided bus technology. In South America, this is accomplished with manual driving (supplemented with retractable gap fillers in Curitiba).

Actual practice in North America, particularly within the Chicago area is much different. Precision boarding as described above cannot be achieved primarily because of two standard roadway features, 1) use of 6-inch high barrier curb and gutter adjacent to travel and parking lanes, and 2) sidewalk elevations which follow the top of curb elevations. A horizontal gap is created because bus operators are trained to come no closer than a few inches to the barrier curb face to avoid damaging tire sidewalls by rubbing up against them. A vertical gap is created because the first step of a CTA bus is 14 to 15 inches above the pavement (for either standard or low floor buses) while the standard Chicago curb height, which is nominally 6 inches, varies from 3 to 9 inches. The sidewalk is, normally kept level longitudinally while the edge of pavement is warped to provide positive drainage along the gutter flags. Keeping the sidewalk level while warping the edges of pavement causes the variation in curb heights. Typically, city sidewalk elevations are set by ordinance and cannot be changed randomly. Standard City of Chicago curb and gutter is Type B-V.12. B-V.12 curb and gutter provides for a vertical barrier curb face of variable height (ranging between 3 to 9 inches), with a 12 inch gutter flag.

To improve precision boarding movements, there are two separate design concepts which could be adopted to provide a narrower gap or near level boarding with a minimal gap:

- Use of mountable curbs at bus stops would allow bus operators to drive tight against the curb without fear of tire damage.
- Raising the level of sidewalks in sections utilized as bus stops, in combination with the use of low floor buses could virtually eliminate the need for customers to climb steps. A nominal “platform” height of 12 inches is recommended as the most universal to best accommodate bus boarding/alighting. ADA regulations allow a maximum of 8.3 percent ramp slopes when the horizontal length of the ramp is 30 feet or less. Therefore, assuming a 6-inch curb height, it would require 6 feet to “ramp up” to the 12-inch platform height. It would be desirable to install a tactile platform edge (probably using pre-cast concrete segments), although this is not required by ADA because these are bus facilities, specifically exempted from most ADA regulations [3].

Implementation

Criteria for usage / appropriate location

- Mountable curb and gutters could be utilized at bus stops located at off-road terminals, along bus bays, or at locations where there is no need to provide a physical barrier between the sidewalk and the live travel or parking lane.
- Installation of raised platforms at bus stops needs to be carefully coordinated with other uses in the vicinity of the stop.
- Raised platforms can be used in locations where their installation would not conflict with other users.
- Raised platforms could only be located adjacent to a curb cut/driveway if a railing was installed to prevent people from stepping off the resulting drop-off.
- Raised platforms and sloped curbs are not covered in current CDOT design guidelines. Coordination with these guidelines will be required.
- Bus bulbs would be especially good locations for raised platforms as long as the raised platform does not introduce corner sight distance obstructions.

**Situations to avoid in implementation**

- Mountable curbs should not be used adjacent to travel lanes and parking lanes. The City of Chicago requires a barrier (B-type) curb to prevent vehicles from running onto or parking on the sidewalks.
- Raised platforms should not be used where it is likely that the front platform of a turning bus is likely to sweep over the sidewalk (sometimes an issue, particularly in terminals and at intersection corners).
- Raised platforms should be avoided at stops where buses may not be able to reliably get both the front and rear doors to the curb/platform where passengers would need to make a high step both down and up to get from the curb to the bus, or vice versa.
- Raised platforms should not be installed where the raised sidewalk level would create conflict with adjacent buildings or create drainage issues.

**Applicability of element to intersection prototype**

Intersection prototype is not a significant issue in relation to this element.

**Examples and Images**

Design for factory pre-cast sloped curb. A similar design could be poured in place, consistent with City of Chicago practice. Raised square rumble strip provides tactile feedback to bus operator that bus is proper distance from curb. In Chicago climate, with snowplowing, an indentation or rumble strip would be more appropriate [2]

Small transit station with sloped curbs, Germany [1]

CTA Pulaski/Peterson terminal, with sloped curbs [TranSystems photo]
Impacts

Dwell time impacts
- The near level boarding condition will reduce dwell time, as it does on rail.
- Further research is required to document the amount of savings.

Ridership impacts
- Faster service resulting from reduced dwell time would result in increased ridership. The amount of increase would depend on time savings.
- The overall improvement of the experience would also increase ridership, although this is even more difficult to quantify.

Other impacts
Installation of raised platforms, in conjunction with sloped curbs, can improve the customer experience with near-level boarding. Perhaps, even more important, is the visibility it provides in the community of a higher quality of service, particularly if applied with other elements of the toolbox.

Costs
- A typical cost for removal of curbs and gutters is $5/linear foot and installation of new curb and gutter is $15 to $20/foot. Mountable curbs cost roughly the same as a standard barrier curb. The cost of making short indentions to create a rumble strip in the gutter flag should be nominal.
- Typical cost for removal of sidewalk is $1/square foot and construction of new sidewalk costs $5/foot. Any increase in cost due to the higher installation as a platform would be minor.

Based on these unit costs, construction of a typical 40 foot long raised platform, with mountable curb, should cost less than $5000. Additional cost may be incurred if implementing either of these options requires drainage
adjustments. Lastly, within the City of Chicago, the sidewalks may be vaulted underneath. In order to construct a platform sidewalk, these vaults will need to be removed. Removal of vaulted sidewalks involve providing a structural wall, typically at the face of the adjacent building, before the vault can be filled in and the sidewalk platform built over it.

References


2. Marshalls PLC. http://www.marshalls.co.uk/kerb. 2004

3.4 Off-vehicle fare collection

Description

Off-vehicle fare collection refers to a combined set of strategies to shift the collection of some, or all, fare revenue from the vehicles to pre-payment of fares at Ticket Vending Machines (TVMs) at the station (or elsewhere) or through other channels (i.e. supermarkets, currency exchanges, banks, internet, etc.). CTA’s Chicago Card™/Chicago Card Plus™ and plans for installation of fare media vending kiosks at locations other than rail stations (see 7.6 Vending kiosks) are moves in this direction. There are two main strategies to achieve the actual fare media collection/validation:

- **Barrier fare collection or enclosed stations**: Passengers go through a control barrier (e.g. a set of turnstiles) that validates the fare and allows them to enter the “paid area” of the station. Everyone inside the “paid area” is assumed to have paid the fare and is able to board any vehicle that stops at the station. No cash fares are collected on vehicles.

- **Barrier-free fare collection** (also known as Proof of Payment-POP): Devices for media validation are provided at stops or at the entry to vehicles but passengers never need to go through a barrier that controls the payment. Cash fares may be collected by the bus operator, with POP issued to the customer. Enforcement of fare payment is through random checks performed on board. Key to this process is the deployment of inspection staff with the authority to remove of passengers found without POP and issue citations requiring payment of a fine, to be collected using procedures akin to parking meter violations. A supporting legal framework and quasi-judicial process need to be established.

Barrier collection is heavily used in urban rail system and often requires more robust infrastructure. Barrier-free is more used in western European countries than in the US, where it is often employed on light rail and commuter rail systems. Thus far, MAX BRT in Las Vegas and articulated buses on the Transitway in Ottawa are the only bus systems in North America that have implemented POP fare collection. Many U.S. BRT systems are planning its implementation. In Chicago, 22% of customers boarding buses pay cash fares. The remaining 78% already have some form of Proof of Payment in their possession that can be checked (a transfer, pass, Chicago cards, etc.) [1]. Of the 22%, a substantial number are already issued transfers; others would need to be issued some form of POP.

Implementation

**Criteria for usage / appropriate location**

In general, off-vehicle fare collection should be considered if 1) passenger volumes at stops are high, 2) dwell times are high, and/or 3) dwell time variation is high creating a negative impact on reliability. The following table provides corridor characteristics that suggest the use of either barrier-free or barrier fare collection.

<table>
<thead>
<tr>
<th>Barrier fare collection (enclosed stations)</th>
<th>Barrier-free fare collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ridership volumes are very high –very crowded vehicles will interfere with effective fare inspections</td>
<td>- The space for the stations limits the construction of enclosed stations with “paid areas”, usually because of physical constraints</td>
</tr>
<tr>
<td>- There are serious concerns about the fare evasion expected in the barrier-free “honor system”.</td>
<td>- The system is likely to operate with low-floor buses – implies curb-height stations, which are less effective at self-enforcing the “paid area” because it is easy to enter the paid area.</td>
</tr>
<tr>
<td>- Stops and buses can be equipped for high-level boarding.</td>
<td></td>
</tr>
</tbody>
</table>
Application of barrier-free fare collection can be limited to specific routes or even, as in Ottawa, to certain bus types on certain routes. Thus, for example, application could be readily limited to route X49, before 6 p.m. this would be facilitated if the X49 were fully “branded”, with specially painted buses.

**Applicability of element to intersection prototype**

The **Intersection with rail** and **Pedestrian oriented** prototypes may suggest a high concentration of ridership in that station, which makes off-vehicle fare collection more applicable to these prototypes. The characteristics of the other intersection prototypes (i.e. nearside, farside, and auto-oriented) are not significant in relation to the fare collection system.

**Examples and Images**

![TVM in RTD system in Denver](image1)

![Smart card validator located at bus doorway](image2)

![Inspector with handheld device for smart card and magnetic ticket inspection](image3)

**Impacts**

**Dwell time impacts**

Switching from a driver-interaction on-board to an off-vehicle fare collection system would most certainly reduce the average dwell time, principally as a result of allowing passengers to board at all doors. The total impact depends heavily on the current average dwell time observed in the corridor. Dwell time in the X49 route has been observed at approximately 3 sec/passenger [3]. Several studies [4], [5] have shown that dwell times for systems with off-vehicle fare collection range between 0.4sec/pass and 2.5 sec/pass. The lower service times are observed in systems with at-grade boarding (high platforms and high buses), and multiple and wide doors used for boarding.

**Ridership impacts**

Dwell time impacts, which in turn reduce travel time, may generate a 0.35% ridership increase for every 1% reduction in travel time [6].

**Other impacts**

Implementation of POP fare collection systems implies changes to vehicle design; more and wider doors, equipped for power operation, preferably with pushbuttons for passenger operation, installation of multiple card
validators, (with a switch for the bus operator to turn them off as an inspector boards). All of these features combine to influence the boarding and alighting rates, which in turn affect the service productivity and level of service. Faster boarding rates produce a faster and more reliable service [3]. The variability of boarding rates (which is higher with on-board fare collection) has little effect on route travel time, but does contribute to greater unreliability [4].

A study [4] simulated a tram route that has similar characteristics to a heavy urban bus route in an exclusive lane (i.e. 5-minute headway, 18 km long, 32 signalized intersections, 75-passengers vehicles, and cruise speed of 50 km/h). Route productivity was measured in terms of route travel time and level of service in terms of different user related characteristics of the route. The impacts on these characteristics when moving from an 8 sec/pass-boarding rate (driver operation providing change) to a 1 sec/pass one (proof-of payment) were found to be:
- a 20% reduction in route travel time,
- a 22% reduction in average passenger waiting time,
- and a 80% reduction on the probability of having buses bunched on the route

Although these figures need to be carefully analyzed to apply them in a different context, they do show the general sensitivity and impact on route performance of different fare collection systems. A case study conducted in 2002 for the X49 corridor concluded that dwell time reductions due to off-vehicle fare collection may generate a total travel time reduction of 2.5% to 6% for the X49 route [3].

To effectively utilize off-board fare collection, passengers must be able to freely board through all doors. This requires that powered rear doors be installed, preferably with exterior switches allowing passengers to open the doors. In the longer term, the greatest effectiveness would result from the ordering of new buses with doors wide enough for the entry of two streams of passengers (allowing simultaneous passenger entry and exit).

Frequently, full utilization of barrier-free fare collection is limited to busy periods, when it is most cost-effective. In many European systems, and in Ottawa, all passengers are asked to board through the front door and allow the bus operator to inspect fare media during evening and some, or all, weekend time periods. Thus, it is not necessary to deploy fare inspectors during these time periods.

**Costs**

There are too many variables to allow calculation of detailed costs of a barrier-free/POP fare collection system. The total annual operating cost of the X49 route is about $3,200,000 on a marginal cost basis [7]. If travel time,
and thus operating costs, were to be reduced by 2.5-6%, as described above, this would equal about $80,000-
192,000 per year. This is enough to justify a substantial initial capital expenditure for TVMs and equipment
onboard buses, as well as the employment of fare inspectors.

Evaluation

The issues that must be evaluated to determine the desirability and make decisions about the implementation of
off-vehicle fare collection can be grouped in three categories:

■ Policy and enforcement issues
  - Legal authorization for enforcement
  - Fare evasion (i.e. measuring evasion rate, treatment of fare evaders, fare evasion fine structure, fare
evasion follow-up program)
  - Inspection, mostly for barrier-free systems (i.e. inspection strategy, inspection rate and number of
  personnel, type of inspection personnel)

■ Operational issues
  - Fare structure
  - Fare media distribution
  - Use of electronic fare media
  - Station monitoring and security
  - Marketing/Education

■ Capital and Equipment issues
  - Types of barrier-free fare collection equipment or barrier equipment
  - Ticket Vending Machines for barrier-free systems (i.e. placement, quantities, fare media options, ticket
purchase options, user interface)
  - Stations for barrier systems (i.e. placement, dimensions, barrier location, number of barrier fare
collection equipments, height, interface with buses, design to control fare evaders)
  - Ticket validation
  - Fare collection at stops without TVMs or without enclosed stations

References

1. CTA System Ridership, Fare Media Summary - May 2004, Planning & Development, Data Services &
Development

2. Transportation Cooperative Research Program. “Report 80 A Toolkit for Self Service, Barrier Free Fare


service”. Transportation Research Record 1036: 79-87.


7. Route X49 operating costs calculated from schedule data provided by Eric Harris in attachments to emails July
21 and 23, which allowed estimate of number of pay hours (279.9) and miles (3097) per weekday,
factored by marginal operating cost data provided by Mary Kay Christopher in phone conversation July
26, 2004 ($38.9/pay hour, $0.625/bus mile).
4. Elements that improve bus travel time
4.1 Curb lane and travel lane width

Description

The travel lane width directly affects the flow characteristics of the roadway, and safety and maneuverability of vehicles. The standard lane width is typically 12 feet. Narrow travel lanes tend to cause drivers to drive at slower speeds and drive away from the pavement edge or parking lane. Narrow lanes may also cause drivers to take larger sweeping turns to stay within the lanes. Therefore, for larger vehicles like buses the lane width is a critical consideration. In the absence of a bus pull out lane or bus bay, the curb lane also serves as a bus stop. It is recommended that when possible the curb lane be 1 to 2 feet wider than the standard travel lanes to accommodate buses.

Travel lanes narrower than 12 feet may have the following adverse effects on traffic and the roadway:
- Reduces capacity of roadway
- Reduces travel speeds
- Restricts vehicle maneuverability and left and right turning ability
- Increases potential for sideswipe accidents
- Limits roadway’s ability to accommodate bicyclists (or other shared use functions)

Narrower lanes have a more drastic effect on buses. Reduced capacity and travel speed directly affect the schedule of the buses. Due to narrow lanes buses also experience difficulty merging into the through travel lanes from the bus stops. The restricted maneuverability and turning ability could lead to conflicts with other vehicles, pedestrians and bicyclists.

Implementation

Criteria for usage / appropriate location

According to IDOT Bureau of Design and Environmental (BDE) [1], the recommended width for all travel lanes, including curb lanes, is 12 feet. The recommended curb and gutter type is B-6.24. The width of the curb lane depends on other facilities that it accommodates. The cross-sections shown below (IDOT, BDE) indicate typical lane widths that accommodate vehicular traffic, bicycle routes, and on-street parking.

The two cross-sections above show a wider outside lane to accommodate bicyclists. The recommended curb and gutter type would be B-6.24.
Sometimes in the City of Chicago, the outside parking lane is converted to a through travel lane during peak traffic hours. The figure below shows a typical cross-section for a roadway with designated bus and bicycle lanes.

**TWO-LANE SECTION WITH COMBINED BICYCLE AND PARKING USE AREAS**  
(Unmarked Bicycle Use Area)

**TWO-LANE SECTION WITH MARKED PARKING**  
(Marked Bicycle Lanes)

**MINIMUM CROSS SECTIONS FOR CURBED STREETS WITH PARKING**

The figure below shows a typical cross-section for roads under the City of Chicago jurisdiction. The 11-foot curb lane width includes the 1-foot gutter flag of type B-V.12 curb and gutter. With an on-street bicycle route, the recommended lane width for the curb lane is 13 feet which includes the gutter flag of the B-V.12 curb and gutter.

**BICYCLE LAINES ADJACENT TO BUS LANES**  
Figure 17-2F

**MINIMUM CROSS-SECTION FOR CURBED STREETS**  
CITY OF CHICAGO
Wider curb lanes should be considered under the following situations:

- Roadways with heavy bus and truck traffic
- Roadways without bus pullout lanes
- Roadways with on-street parking
- Roadways with on-street bike routes
- Roadway segments and intersections with high accident rates

**Situations to avoid in implementation**

The following should be considered with regards to roadway width:

- Where left or right turn lanes are needed to provide additional capacity and improve intersection operations. In such cases where widening the roadway is not possible, the available roadway width may be redistributed to provide turn lanes thereby creating narrower through lanes.
- Wider roadways may require additional right-of-way (ROW).
- Wider roadways degrade the pedestrian environment.
- ROW acquisition may involve acquisition of a building or a business.
- Additional difficulties may be experienced due to the presence of major utilities and other structures.

**Applicability of element to intersection prototype**

Five types of intersection prototypes have been identified: 1) Nearside; 2) Farside; 3) Intersection with rail; 4) Auto-oriented land use; and 5) Pedestrian-oriented land use. The lane width affects the operations along roadway segments and at intersections. Curb lane and travel lane width recommendations apply to all prototypes.

**Impacts**

*Dwell time impacts*

Dwell time reductions may be observed when improving travel lanes width to 12 feet or more. As mentioned above, narrow lanes restrict the maneuverability and turning ability of the buses pulling in and out of bus stops. Wider lanes may reduce the time required by vehicles to negotiate traffic.

In addition to travel time reduction caused by shorter dwell times, travel time may also be reduced through wider lanes because the general speed of the buses and general traffic is improved with wider lanes.

*Ridership impacts*

The travel time reduction caused by wider lanes explained above (through dwell time reduction or operating speed increase) may result in an increase in ridership. Ridership may increase by 0.35% by every percent point (1%) reduced in travel time. However, wider lanes increase the crossing distance for pedestrians and increase the speed of vehicular traffic, thereby degrading the pedestrian environment, which may negatively impact ridership.
Costs

The cost of pavement widening could vary from $50 to $60 per sq. yd. depending upon the pavement type. Additional costs to consider when widening a roadway would include: pavement striping, drainage structure adjustments, utility relocations, light pole/signal relocations or installations, and ROW acquisition. The cost to install and/or modernize a traffic signal installation varies from $100,000 to $130,000 per intersection.

References

4.2 Transit Signal Priority

Description

Transit Signal Priority (TSP) refers to the application of technology to extend green phases and/or shorten red traffic signal phases encountered by buses. TSP has been identified as one of the most effective strategies for improving the quality of bus service. While there has been concern that the installation of TSP would result in unacceptable delays for general traffic, experience in a wide variety of settings has shown that this is not an issue. The CTA is anticipating a grant from the RTA to implement a pilot TSP project on Western Avenue starting in 2006. The scope of this project is broken into two phases: Phase I would equip the 25 buses required to operate the X49 route and 20 intersections, Phase II would equip another 40 intersections (virtually all of the CDOT-controlled intersection in the corridor [1].

Implementation

Criteria for usage / appropriate location

- Past studies have suggested that corridors with bus headways of about ten minutes, or better, are typically required to justify the financial commitment. At the other end of the spectrum, TSP become infeasible in an area such as downtown Chicago with a heavy concentration of buses, particularly, with major bus flows that cross each other.
- Crosstown streets, with good levels of service, such as Western Avenue, are ideally-suited for TSP.

Situations to avoid in implementation

- TSP is not as effective at nearside stops; see below.

Applicability of element to intersection prototype

- **Nearside**: TSP does not work effectively at a nearside stop because there is no good way to submit a priority request so that it is granted at the right moment while boarding passengers. If it is necessary to retain a nearside stop, the onboard CAD/AVL system can be programmed to transmit a priority request when the doors close or a certain number of seconds after the bus opens its doors at a stop. It would be possible to vary this setting by day type and time of day. However, this would be a large setup and maintenance issue for a system with many such stops and the effectiveness of the result would be limited because it would be based on average dwell time. If the bus is ready to leave sooner than the defined time the request would be transmitted when the doors close, but processing could take a long time. If the bus is delayed in leaving the stop it may not be ready when the priority is granted and, if the delay is significant, the cycle could time out, with the bus missing the cycle and cross traffic unnecessarily delayed.
- **Farside**: TSP works best with farside stops.
- **Intersection with rail station**: Little significance to the decision of implementing TSP.
- **Auto-oriented land use**: The fact that the intersection is in an auto-oriented area suggests that the share of general traffic in the area may be significantly high. TSP may not be as effective in highly congested corridors or intersections.
- **Pedestrian-oriented land use**: The fact that the intersection is in a pedestrian-oriented area may suggest that priority should be given to transit, thus TSP may be applicable in this intersection prototype.
Examples and Images

Application of TSP is widespread in Europe, where the applications have become fairly standardized. In the past few years it has been deployed in a number of North American cities, including Los Angeles, Seattle, Portland, and Charlotte and is in the planning stages in many more. Most of these have been initial, pilot installations and a wide range of technological approaches have been utilized. Based on these experiences, a more limited range of choices has emerged as the most successful and cost-effective. In the Chicago region, the section of Cermak Road between 54th Station and North Riverside Plaza, served by both Pace and CTA buses, has been equipped with an “Absolute Priority” system; i.e. buses continuously request priority regardless of their schedule adherence. “Conditional Priority” can be achieved by connecting the request transmitter to Computer-Aided Dispatch/Automatic Vehicle Location (CAD/AVL) equipment onboard the bus, transmission of requests can be limited to the specific locations that TSP-equipped intersections are installed, and requests can be suppressed when the bus is ahead of schedule. Thus, travel time savings and improved reliability can both be achieved simultaneously.

Impacts

Dwell time impacts

- A microsimulation of the X49 route found that substantial amounts of non-productive time now spent standing in traffic, with the doors closed, would be eliminated by TSP: 10 minutes in the AM peak and 4.5 minutes in the PM in the northbound direction, 13 minutes in the AM and over 6 minutes in the PM for the round trip.

Ridership impacts

- A 15% overall reduction in running time could be expected to result from installation of TSP. This figure is consistent with results found in applications in other cities. A large reduction such as this could be expected to lead to an increase in ridership on the order of 5%.

Costs

- Capital cost of implementation of TSP has several components:
  - Traffic signal controllers must be capable of a flexible response to TSP requests received at the full range of points in their cycle. The City of Chicago has been purchasing Peek LMD40 controllers, which were found in the Western Avenue TSP Feasibility Study to be very effective, thus no additional costs will be incurred.
  - Purchase and installation of signal interconnects – Modern “closed loop” signal systems have links between intersections and connection to a central monitoring/control point to supports the implementation of timing that is adaptive to real-time traffic flow while maintaining signal progression. This becomes particularly important if signal timing is modified to respond to real-time TSP requests. Again, the City is currently completing the last phase of installation of signal interconnect in the corridor, so no additional costs will be incurred.
  - Interface to onboard CAD/AVL system – While the CTA grant application indicates that this may not be accomplished in Phase I, this capability makes more specific, conditional TSP requests possible. The main system suppliers have already developed this interface, so inclusion of this requirement would add negligible cost to the procurement of a system. CTA buses are already equipped with the Advanced Voice Annunciation System (AVAS) system, which calculates location, and schedule adherence
  - Purchase and installation of onboard TSP request transmitting equipment – There are several different technologies available.
- Purchase and installation of wayside equipment for receiving requests and passing them to signal controllers.
- Calibration of TSP system – Initial installation, configuration and monitoring of system software is a very critical element of the installation of TSP. Considerable effort is required to set up software for a particular corridor and the planned method of operation.

- The Phase I grant to the CTA is expected to be $515,000, with Phase II for a similar amount.
- The previous Western Avenue TSP Study [2] recommended adoption of infrared transmission of priority requests (a technology that has been supplied almost exclusively by 3M using their proprietary Opticom™ system). Since that time, NTCIP standard 1211 has been approved to be balloted for formal adoption. This will permit installation of TSP using open architecture, rather than proprietary interfaces, between the above elements. This will avoid a situation under which if one buys a specific brand of equipment for one side of the interface, that one will be effectively committed to that brand for all units of both sides throughout the city. This, most notably, applies to the choice of the onboard and wayside equipment.

- The estimated savings in running time identified in the simulation are approximately equivalent to the reduction of one headway in each rush hour (somewhat more in the AM and somewhat less in the PM). Without doing a full run cut, it seems reasonable to assume that this would enable one bus to be removed from the route, while retaining the same headway. This could save on the order of $160,000 per year [4], with much higher savings if a bus were saved during off-peak periods, as well. Conversely, the estimated 5% increase in ridership that would result from the faster service could require adding service; a 5% service increase also equals one bus. Actual ridership counts would need to be compared to loading standards to determine if the existing 10 minute headway would need to be improved. The increased reliability/consistency of service that would be expected to result from the application of TSP and CAD/AVL would likely allow the existing scheduled headway to comfortably carry the anticipated increase in the number of riders. The largest element of increased ongoing operating costs for TSP in the Corridor would consist of staff time for ongoing maintenance of onboard and wayside hardware and software. It might be most effective to contract some of this effort. These costs have not been estimated to date.

Evaluation

- It is recommended that installation of TSP be included in all scenarios considered in the study.

References


4. Per conversation with Mary Kay Christopher, CTA General Manager, Service Planning, July 9, 2004
4.3 Queue jumper lanes

Description

A queue jumper lane is an extra lane provided for the exclusive use of buses when leading to an intersection. Usually, this piece of infrastructure is coupled with bus-only green light seconds before the green light for the general traffic, allowing the buses to jump several car lengths at intersections. Often, the queue jumper lanes are shared with right-turn lanes. The actual location of the bus stop at an intersection featuring a queue is still an open debate. A far side bus bay is often recommended [1], however the buses end up being caught in the same traffic they just jumped before the intersection. A far side curbside or curb extension stop provides more priority to buses but may disrupt general traffic and intersection operation if the dwell time at stop is high. A near side stop at the queue jumper eliminates the counterintuitive operation of stopping right after jumping several cars, but it may conflict with right-turn vehicles (in case of a shared right-turn and queue jumper lane).

Implementation

Criteria for usage / appropriate location

Consider queue jumpers if [1]:

- The bus route has an average headway of 15 minutes or less
- Traffic volumes exceed 250 vehicles per hour in the curb lane during the peak hour
- The intersection operates at a level of service “D” or worse (see the Highway Capacity Manual for techniques on evaluating the operations at an intersection)
- There is a commitment to enforce the queue jumper from appropriate agencies

Situations to avoid in implementation

- A shared right-turn and queue jumper lane when right-turn volumes exceed 400 vehicles during the peak hour.
Applicability of element to intersection prototype

A queue jumper lane is most desirable at signalized intersections without a bus stop because buses can take full advantage of the priority given in relation to private automobiles without stopping nearby. Whether a **nearside** or a **farside** stop is more desirable with a queue jumper has been an on-going debate because both options have pros and cons. With a nearside stop the buses may miss the priority in a cycle because passengers are boarding at the stop, and in cases where the queue jumper lane is shared with a right-turn lane, this may cause additional delays to right-turning vehicles. With a farside stop, the priority given to a bus to move ahead of the vehicles in queue is almost lost when the bus needs to stop in the farside of the intersection to pick up passengers. This is aggravated when a bus bay instead of curbside stop is designed. But with a curbside stop, if the bus has a long stop, a delay and disturbance may be caused to vehicular traffic behind it.

The other intersection prototypes have little significance in relation to queue jumpers.

Examples and Images

Examples of queue jumper (shared with right-turn lane) with far side bus bay stop [1]

Queue jumper with near side stop in Troy, NY
Impacts

Dwell time impacts
Insignificant impacts on dwell time

Other impacts
- Travel time: The implementation of queue jumpers is expected to reduce total travel time by reducing the time spent at traffic signals. The specific impact depends on the existing level of congestion at the intersections. If no data is available a rough estimate of a 30-second reduction per queue jumper per bus using it is often used.
- Travel time variability and reliability: the use of queue jumpers on a bus route also reduces the travel time variability, which in turn has a positive impact in the overall reliability of the service.

Ridership impacts
Travel time impacts may generate a 0.35% ridership increase for every 1% reduction in travel time /2/.

Costs
There are three main costs associated with the implementation of a queue jumper lane:
- Infrastructure: costs associated with building the extra lane, the specific amount highly depends on land acquisition costs and utilities relocation. These costs may be avoided if an existing right-turn lane is used.
- Traffic control: costs associated with the traffic signal devices required to control the bus only phase in the traffic signal cycle.
- Enforcement costs: these costs vary highly depending on the enforcement strategy, which may be a physical barrier, physical distinction of pavement, police oversight, or more advanced technological methods such as cameras that capture violators. Any of these enforcement alternatives have costs associated with them and they should be considered when evaluating the possibility of implementing it.

References
4.4 Exclusive lane at a choke point

Description
This element refers to the provision of a lane for the exclusive use of buses in a segment of the road to expedite their movement through a choke point or area with congestion. This differs from a queue jumper lane in that it is not necessarily located at an intersection and it would often be a longer segment than most queue jumpers. Examples of choke points may be a narrow bridge, a congested intersection, a segment where multiple collector streets join the main road, etc.

The exclusive lane, although short, should comply with all specifications described in the Highway Capacity Manual and consider the recommendations provided in this section in element 4.1 Curb lane and travel lane width.

Implementation

Criteria for usage / appropriate location
Consider queue jumpers if:
- The bus route has an average headway of 15 minutes or less.
- Traffic volumes are high and the road segment or intersection operates at a level of service “D” or worse (see the Highway Capacity Manual for techniques on evaluating the operations at an intersection).
- There is a commitment to enforce the exclusive lane from appropriate agencies.

Situations to avoid in implementation
- Implementing an exclusive lane for buses and worsening the travel conditions for general traffic if general traffic throughput (people per unit of time) is higher than transit throughput.
- Where enforcement is unlikely.

Applicability of element to intersection prototype
An exclusive bus lane at a choke point is applicable at all intersection prototypes. Its applicability depends mainly on the congestion experienced in the segment rather than the intersection prototype.

Examples and Images

Example of choke point created before the bridge, buses need to merge with bike lane and then the regular travel lanes
Impacts

*Dwell time impacts*

Insignificant impacts on dwell time.

*Other impacts*

- Travel time: The implementation of exclusive bus lanes specifically at choke points would reduce total travel time in an effective manner, allowing the buses to move quickly through those points where is very likely to encounter congestion otherwise. The specific impact depends on the existing level of congestion at the segment or intersection.
- Travel time variability and reliability: avoiding choke points in a bus route also reduces the travel time variability, which in turn has a positive impact in the overall reliability of the service.

*Ridership impacts*

Travel time impacts may generate a 0.35% ridership increase for every 1% reduction in travel time [1].
Costs

There are two main costs associated with the implementation of an exclusive lane segment:

- **Infrastructure**: costs associated with building the extra lane, the specific amount highly depends on land acquisition costs and utilities relocation. These costs may be avoided if using an existing lane, in which case the impact caused to current users of that lane must be accounted for.

- **Enforcement costs**: these costs vary highly depending on the enforcement strategy, which may be a physical barrier, physical distinction of pavement, police oversight, or more advanced technological methods such as cameras that capture violators. Any of these enforcement alternatives have costs associated with them and they should be considered when evaluating the possibility of implementing it.

References

5. Elements that improve pedestrian safety
5.1 Leading Pedestrian Interval

Description
A Leading Pedestrian Interval (LPI) is a three-second head start provided to allow pedestrians to start crossing an intersection prior to the release of turning vehicles. With this time advantage, pedestrians assume the right-of-way and turning vehicles usually stop for pedestrians, reducing the conflicts between the two flows.

Implementation

Criteria for usage / appropriate location
- LPI should be used at every intersection where right turn and crossing pedestrian phases occur at the same time and conflicts arise.
- Those intersections with higher pedestrian volume (i.e. near a bus stop) and right-turn movements should be given priority.

Applicability of element to intersection prototype
Conflicts between right-turning cars and pedestrians are likely to occur at all intersections where vehicles may turn right, which include most intersections except for midblock intersections.

Examples and Images
LPI has been installed in several cities in the US, including:
- New York, NY: downtown Brooklyn at Atlantic Avenue and Clinton Street
- Saint Petersburg, FL: three intersections

Impacts

Dwell time impacts
No dwell time impacts were found in the literature. However, slightly longer wait times may be expected for buses to negotiate right turn traffic at nearside stops when a LPI is in place.

Ridership impacts
Pedestrian safety improvements may encourage some potential users to become more frequent users of transit, especially elderly, people with mobility impairments, and children.

Other Impacts
The main impact resulting from the implementation of a LPI is a reduced number of conflicts between pedestrians and turning vehicles. In St. Petersburg, Florida, a study found that the possibility of a conflict for pedestrians leaving the curb during the beginning of the walk period was reduced by about 95 percent, from 2.8 to 0.2 per 100 pedestrians. In addition, the likelihood of a pedestrian yielding to a turning vehicle decreased by about 60 percent, enhancing pedestrian safety.
Costs

- The direct cost to install a LPI is insignificant when a traffic signal already exists in the intersection. Most signalized intersections have the ability to being reprogrammed to allow for a 3-second head start for pedestrians.
- The indirect cost is associated with the added congestion that may be generated by delaying the turning green phases.

Evaluation

When evaluating the suitability of LPI for an intersection the following characteristics may be considered:

- Pedestrian traffic in the intersection: if high a LPI may be desirable
- Turning vehicle traffic: if high a LPI may be desirable
- Previous conflicts between pedestrians and turning vehicles: if accidents have occurred a LPI may be desirable
5.2 Pedestrian Countdown Signal

Description

Pedestrian countdown signals are used in conjunction with conventional pedestrian signals to provide additional information to the pedestrian regarding the number of seconds remaining to safely cross the road. The purpose of countdown pedestrian signal is to enhance the safety of the pedestrian crossing a street during the walk phase of the signal cycle. A study conducted by the Federal Highway Administration’s (FHWA) Human Centered Systems team for evaluation of pedestrian signals concluded that the countdown signal is highly effective. A significant portion of the public does not fully understand the standard MUTCD pedestrian crossing signal display. The additional information provided by countdown signals helps pedestrian make better crossing decisions, thereby reducing accidents. The pedestrian countdown signal is recognized by the MUTCD.

As seen in Figure 1, the countdown indicator is placed adjacent to the standard pedestrian “Walk” sign (graphic man) within the same signal head. After the countdown is completed the “Don’t Walk” sign (graphic hand) is displayed till the next pedestrian actuation. The countdown can be displayed in two modes; total countdown and clearance countdown. In the total countdown mode, the countdown is displayed during the entire “Walk” and “Flashing Don’t Walk” interval. In the clearance countdown mode, the countdown is displayed only during the “Flashing Don’t Walk” interval (See Figure 2). According to MUTCD (Section 4E.07) [3], countdown displays shall not be used during the “Walk” interval nor during the yellow change interval of a concurrent vehicular phase.

Implementation

Criteria for usage / appropriate location

A pedestrian signal is only provided at signalized intersections with striped crosswalks. Signalized intersections without crosswalks should be striped prior to installing pedestrian signals. The countdown signal provides additional information to the pedestrian so that they can better decide whether to enter the crosswalk. The feature is an enhancement to the standard signal and can be installed at all crossing locations. It is highly recommended at intersections with heavy pedestrian traffic, like Central Business Districts, and where many pedestrian related accidents have occurred.

Situations to avoid in implementation

The pedestrian countdown signal enhances safety at an intersection and should be considered whenever affordable. The following factors should be considered before the countdown signal heads are installed:

- The signal head should be compatible with the existing controller if being installed on an existing signal system.
- The signal head should be capable of restarting at the correct part of the signal cycle after a power outage or after a signal cycle had been interrupted by a pre-emption [2].

Applicability of element to intersection prototype

Pedestrian countdown signals assist pedestrians in making a more informed decision while crossing a road and enhance safety at all intersections. The pedestrian countdown signals option applies to all prototypes. In general, intersections at stops with higher ridership should be prioritized to implement this element.
Examples and Images

Figure 1. Countdown Pedestrian Signal Heads – Typical applications [1], [4]

Figure 2. Countdown Pedestrian Signal Clearance Countdown Mode

Impacts

*Dwell time impacts*

No significant dwell time impacts.

*Ridership impacts*

The use of pedestrian countdown signals may improve safety for some groups of passengers, especially elderly and people with disabilities. This improvement in accessibility may encourage more passengers to use transit, however, explicit impacts have not been studied and numerical figures are difficult to determine.

Costs

The cost for a countdown signal head could vary from $1,100 to $1,300. However, the cost to install and/or modernize a traffic signal installation varies from $100,000 to $130,000 per intersection.

Evaluation

- The performance of signal installations at intersections can be evaluated by the use of Highway Capacity Software. The evaluation is based on the intersection's Level-of-Service (LOS). Analysis of the location considers vehicle and pedestrian volumes, roadway condition, lane configuration, presence of on-street parking, traffic volume make-up, and phasing sequence and timing. A LOS C or better is desirable; however, a LOS D is acceptable for highly urbanized congested conditions [5].
Secondly, the effectiveness of pedestrian signals can be evaluated from a safety perspective. Accident history can be reviewed to determine if the intersection is experiencing high pedestrian related accidents. In such situations, countdown signals can be considered.

References

2. Traffic Engineering Manual, Section 3.9, Florida State
4. www.walkinginfo.org
5. www.fhwa.dot.gov
5.3 Crosswalks

Description

A crosswalk is a designated area for crossing a road at signalized and unsignalized intersections. A well defined crosswalk provides a safe zone for pedestrians to cross and warns vehicle drivers of their presence. It is a very critical safety element for all intersections. The MUTCD figure 3B-16 shows the standard crosswalk markings recommended in the MUTCD. The most commonly used is the two horizontal bars for pedestrian crossings. The straight vertical bars are provided for crossings near a school. The inclined bars, Zebra, are used for Bicycle and Equestrian crossings.

![MUTCD Figure 3B-16. Examples of Crosswalk Marking](image)

It has been identified through several studies that the location of the crosswalk and its visibility play an important role in the safety of the intersections. The following measures that will enhance the visibility of crosswalks have been reviewed.

5.3.1. Overhead crosswalk signs

The overhead crosswalk sign is placed over the road on a mast arm or on wires. These signs are similar to other overhead signs that can be seen from a farther distance. The picture below shows a typical application. They can be illuminated at night for better visibility.

![Overhead Crosswalk Sign, Gulfview Blvd at 5th Street, Clearwater, Florida](image)

![Overhead Crosswalk Sign, Illuminated Gulfview Blvd at 5th Street, Clearwater, Florida](image)
5.3.2. In-Pavement Crosswalk Lighting
In-pavement lights are used to alert drivers of the presence of a pedestrian crossing or preparing to cross the road. The lights are embedded in the pavement on both sides of the crosswalk facing the oncoming traffic. The lights start flashing when a pedestrian actuates the signal using a push-button. The lights turn off after the pedestrian phase is over. The pedestrian phase of the intersection could be extended if the presence of pedestrians is detected by a pedestrian detection system in which case the lights will keep flashing for an additional time [5]. They are primarily used for mid-block crossings. In-pavement lighting is accepted by the MUTCD.

5.3.3. Pedestrian Refuge Islands
A refuge island is an area within a roadway median where pedestrians can wait till they obtain the right-of-way to cross the road. Refuge islands provide a safe area for pedestrians to stop in the middle of the road. The refuge islands could be provided at signalized and unsignalized intersections and at mid-block crossings. At signalized intersections with wide streets, pedestrians may not get adequate time to cross the street in one cycle. Pedestrians can wait on a refuge island until they get the walk signal to complete crossing the street. At unsignalized intersections and at mid-block crossings, pedestrians have to only look at the traffic in one direction to cross from the near side curb to the refuge island in the median and then to the far side curb.

5.3.4. Advance Stop-Bar
As per MUTCD recommendations, a stop bar is placed 4 feet behind the crosswalk. It has been observed that motorists do not comply and stop beyond the stop bar or within the crosswalk leading to vehicle-pedestrian
conflicts. Based on the study conducted by Retting, R A. and Houten, R V. [2], it was observed that vehicle-pedestrian conflicts were reduced when the stop bar was placed 6 to 10 feet behind the crosswalk [2]. The farther stop bar provided greater separation between the vehicles and the pedestrians, reducing potential conflicts and accidents. In addition to placing the stop bar beyond 4 feet of the crosswalk, crosswalks wider than the standard 6 feet could be provided. Wider crosswalks provide additional capacity and more separation from the vehicles.

5.3.5. Alternative Paving Material
Use of colored and/or textured materials can greatly enhance the visibility and better delineate the crosswalks. Crosswalks can be constructed with paving materials other than the conventional black asphalt or grey concrete surfaces. Alternative materials and treatments include colored/tinted concrete, texturized concrete with designs stamped or pressed onto the surface (can simulate brick pavers), brick paver blocks or stones, and asphalt with stamped or pressed surface textures.

![Textured Crosswalk, Mid-block crossing](image)

5.3.6. High-visibility crosswalk marking
High–visibility marking includes the Zebra and the Ladder Bar marking pattern. These alternative markings are used instead of the conventional horizontal bars. Drivers are more likely to yield to high-visibility marking causing fewer vehicle-pedestrian conflicts. Pedestrian are more likely to cross at the high-visibility marking because of the clearer crossing area delineation. In general, high-visibility markings are likely to have a positive effect on drivers and pedestrians [3]. An alternative, low maintenance marking called the Piano marking is also shown below.

![Ladder Crosswalk Marking](image)

![Piano Crosswalk Marking](image)
Implementation

Criteria for usage / appropriate location

The measures discussed above are improvements to existing standards for crosswalk placement and construction to enhance safety. Specific criteria are not available for all measures. The individual measures are discussed below:

5.3.1. Overhead Crosswalk Signs: Specific criteria for installing overhead crosswalk signs are not available. However, MUTCD guidelines for overhead signs could be applied. The following locations could be considered when installing overhead signs:

- Intersections with high pedestrian volumes
- Intersections with high pedestrian related accidents
- Mid-block crossing
- Central Business Districts, school zones, and tourist destinations

5.3.2. In-Pavement Crosswalk Lighting: The lighting system should be compatible with the signal controller and comply with MUTCD guidelines. The following locations could be considered when installing crosswalk lighting:

- Mid-block crosswalks where pedestrian crossings are not normally expected
- At locations where the crosswalk is not visible due to limited sight distance
- Intersections with high pedestrian volumes
- Intersections with high pedestrian related accidents
- Locations that experience pedestrian activity during evening hours such as theatre district, colleges, and tourist destinations

5.3.3. Pedestrian Refuge Islands: Refuge islands can be provided at signalized and unsignalized intersections and at mid-block crossing. Under all situations, the refuge island should provide adequate surface area and safe space for pedestrians to wait. The refuge area should meet all ADA requirements for horizontal clear space, ramp slopes, and vertical profiles. The following locations can be considered for refuge islands:

- Intersection with high pedestrian volumes
- Large signalized intersections where the road cannot be crossed in one cycle
- Unsignalized intersections with heavy traffic volumes
- Intersections used by the elderly, pedestrians with disabilities, and children

5.3.4. Advance Stop-Bar: Advance stop bars are intended to encourage motorists to yield farther back from the crosswalk. When a motorist stops too close to the crosswalk when yielding to pedestrians, their vehicle can obscure the view of drivers traveling in adjacent lanes that the pedestrian needs to cross next. On the other hand, when motorists stop farther back from the crosswalk, drivers in adjacent lanes and pedestrians have improved sight distance. According to MUTCD Section 3B.16, stop and yield lines should be placed a minimum of 4 feet in advance of the nearest crosswalk line at controlled intersections. However, recent findings suggest stop bars should be placed much further back, up to 30 feet, from the crosswalk for maximum effectiveness. Advance stop-bars have been cited as the single most effective means of prevention against multiple-threat pedestrian crashes. In addition, studies have indicated that the use of a “STOP HERE FOR PEDESTRIANS” sign placed 50 feet before each side of a crosswalk can increase the distance that motorists stop behind the crosswalks, and that these effects persisted over time. Advance stop bars can be considered in the following situations:

- Intersection with high pedestrian volumes
- Intersections with high pedestrian related accidents
- Intersections used by the elderly, pedestrians with disabilities, and children
5.3.5. Alternative Paving Material for Crosswalk: Alternative paving materials and treatment can be proposed to increase the conspicuity of the crosswalk. The alternative paving material should provide good traction for various weather conditions and be durable to withstand vehicular weights, Chicago weather conditions, and maintenance activities, such as snow plowing. The following locations can be considered for alternative materials and treatment:

- Intersection with high pedestrian volumes
- Intersections with high pedestrian related accidents
- At locations where the crosswalk is not visible due to limited sight distance
- Intersections used by elderly, pedestrians with disabilities, and children

5.3.6. High-Visibility Crosswalk Marking: Crosswalk marking material should meet the requirements of the governing roadway agency of jurisdiction for the pavement type. The following locations can be considered for refuge islands:

- Intersection with high pedestrian volumes
- Intersections with high pedestrian related accidents
- At locations where the crosswalk is not visible due to limited sight distance
- Intersections used by the elderly, pedestrians with disabilities, and children

**Situations to avoid in implementation**

5.3.1. Overhead Crosswalk Signs

- When the crosswalk sign is likely to obstruct the view of other overhead signs
- At intersections that has several other signs that need drivers attention

5.3.2. In-Pavement Crosswalk Lighting

- May obstruct roadway drainage
- May not facilitate pavement maintenance, such as snow removal and street sweeping
- May become ineffective at intersections with very high pedestrian volumes due to constant activation (i.e., drivers can become immune to effects of continual lighting)

5.3.3. Pedestrian Refuge Islands

- When the roadway width and conditions prohibits the installation of the island, or the island introduces a hazard to the motoring public and intersection operations (such as left turn lanes)
- May not facilitate pavement maintenance, such as snow removal and street sweeping

5.3.4. Advance Stop Bars

- If the unmarked area of the intersection becomes greater than 176 feet

5.3.5. Alternative Paving Material

- May not facilitate pavement maintenance, such as snow removal and street sweeping
- Pavement treatment that may obstruct roadway drainage

5.3.6. High-Visibility Crosswalk Marking

- If the marking leads to skidding of vehicles or slipping of pedestrians
Applicability of element to intersection prototype

Five types of intersection prototypes have been identified: 1) Nearside; 2) Farside; 3) Intersection with rail; 4) Auto-oriented land use; and 5) Pedestrian-oriented land use. A well-defined crosswalk provides a safe zone for pedestrians to cross and warns vehicle drivers of their presence. The measures discussed in this section would reduce vehicle-pedestrian conflicts and enhance safety at all intersections. These alternatives apply to all prototypes.

Impacts

Dwell time impacts
No significant dwell time impacts.

Ridership impacts
The improvement of crosswalks would enhance the pedestrian environment around the stop. This improvement in accessibility may encourage more passengers to use the buses; however, explicit impacts have not been studied and numerical figures are difficult to determine.

Costs

1. Overhead Crosswalk Signs: The complete setup including the concrete foundation, pole and mast arm and the sign could vary from $5,000 to $6,000.

2. In-Pavement Crosswalk Lighting: For a five lane cross-section, the installation would cost approximately $20,000. Additional pavement rehabilitation may be necessary.

3. Pedestrian Refuge Islands: The cost of a refuge island would depend on several factors including the materials used, landscape treatments, safety features, and necessary roadway widening. The cost of the island could vary from $10/sq.ft to $15/sq.ft. The cost of pavement widening could vary from $50 to $60 per sq. yd depending upon the pavement type.

4. Advance Stop Bars: The cost, including the removal of existing stop bar and new thermoplastic pavement striping material would be $6/ft.

5. Alternative Paving Material: The cost for alternative paving material could vary from $8 per sq. ft to $10 per sq. ft

6. High-Visibility Crosswalk Marking: The cost would depend on the marking pattern, zebra, ladder, piano. The cost of 6” thermoplastic pavement marking tape varies from $1.00 to $1.25 per foot.

Evaluation

Accident history can be reviewed to determine if the intersection is experiencing high pedestrian related accidents. In such situations, alternative crosswalk treatments could be considered for implementation.
References


2. Retting, Richard A., Houten, Ron Van, Safety Benefits of Advance Stop Lines at Signalized Intersections: Results of a Field Evaluation

3. Van Derlofske, John F., Boyce, Peter R., Gilson, Claudia H., Evaluation of In-Pavement, Flashing Warning Lights on Pedestrian Crosswalk Safety


5. [www.walkinginfo.org](http://www.walkinginfo.org)


6. Streetscape elements that reduce conflict between pedestrian and vehicles
6.1 Lighting

Description

As part of the basic set of components, enhanced lighting should be considered at all X49 bus stops to promote a safe and secure environment and to clearly mark express service stops as special.

Depending on the circumstances, lighting may fall into one of two categories. The first, and more basic, category should provide functional lighting of appropriate levels to supplement or replace existing street lights while being consistent with other proposed express stop components. The second category should provide unique and/or custom lighting to improve recognition of express bus stop locations. By providing a unique, decorative lighting component, riders will more likely identify bus stop locations among a consistent corridor appearance, especially if other bus stop components are not present. When combined with other bus stop components, lighting styles and colors should be kept consistent with all the other express service family of elements. The opportunity also exists to integrate signage or kiosks with lighting poles/components. Any lighting elements chosen for express stop locations must factor in lighting output and coordination with integral lighting fixtures of existing City of Chicago (JC Decaux) shelters.

In general, lighting should maintain the proper distances, clearances, and separations specified by the City of Chicago’s Streetscape Guidelines /1/ in addition to meeting CDOT or other agency illumination/photometric requirements /2/. Three types of lights are prescribed by the City’s Streetscape Guidelines: cobra or gateway 2000 poles (Type 1), single-acorn fixture (Type 2), and historic twin-arm pole (Type 3). Cobra lights are to be used at all intersection locations throughout the city. Gateway 2000 and Type 2 or 3 should be used along streets between intersections. Type 4 lighting provides an alternative “custom” lighting approach for use at only express stop locations in which a unique custom lighting element is integral to the shelter component design or theme.

Type 1 lighting should:

- Maintain a minimum of 7'-0” clearance from bus shelters.
- Provide proper illumination levels and photometrics per the City’s Department of Transportation, Bureau of Electricity, Streetscape Guidelines, and other agencies.
- Maintain a minimum 12’ sight triangle from right-of-way at driveway and alley locations.
- Minimize glare and light intrusion on second-story office and/or livable space.

Type 2 and 3 lighting should:

- Maintain a minimum of 7'-0” clearance from bus shelters.
- Provide proper illumination levels and photometrics per the City’s Department of Transportation, Bureau of Electricity, Streetscape Guidelines, and other agencies.
- Incorporate a Type IV lens with lower wattage bulb (100 watts recommended.)
- Do not exceed a design height of 16’.
- Maintain a minimum 12’ sight triangle from right-of-way at driveway and alley locations.
- Minimize glare and light intrusion on second-story office and/or livable space.

Type 4 lighting should:

- Be installed only where a consistent streetscape lighting theme is not present.
- Only be used as a designed integral component of the express bus stop shelter theme.
- Provide proper illumination levels and photometrics per the City’s Department of Transportation, Bureau of Electricity, Streetscape Guidelines, and other agencies.
- Incorporate a Type IV lens with lower wattage bulb (100 watts recommended.)
- Not exceed a design height of 16’.
- Maintain a minimum 12’ sight triangle from right-of-way at driveway and alley locations.
- Minimize glare and light intrusion on second-story office and/or livable space.
- Maintain safe and accessible clearances as defined in the City of Chicago Streetscape Guidelines.

As with all other bus stop components, lighting must meet City of Chicago and CTA design standards. Light fixtures should be durable and easily maintainable. If unique integrally designed (Type 4) and/or custom lighting is used, the design should permit ease of removal and relocation when express stops are reassigned.

**Implementation**

**Criteria for usage / appropriate location**

At all key intersections where express bus stops are located, Type 1 lighting will be required, if not already implemented, to provide light levels to illuminate the full intersection and meet CDOT requirements. Along sections of Western Avenue corridor where an existing City sponsored streetscape program is in place or planned and where budgetary constraints allow, a Type 2 or 3 lighting element should be used away from intersections at appropriate spacing. At locations along the Western Avenue corridor where no existing streetscape theme has been planned or implemented, a Type 4 custom shelter-integrated lighting element should be considered. Colors for all lighting along the entire corridor should be consistent.

**Situations to Avoid**

It is not recommended to locate Type 2 lighting in areas where:

- Sidewalks are less than 9’ wide due to its wide base.
- Do not locate on exceptionally wide right-of-ways, as the fixture is not bright enough to cover both street and sidewalk.

**Applicability of element to intersection prototype**

As part of any City of Chicago streetscape improvement, especially along major commercial corridors, new lighting should be implemented at key intersections, all express stops and appropriate mid-block areas as defined by the Chicago Streetscape Guidelines.

**Impacts**

Any new lighting type will, at a minimum, improve safety by providing a well-lit environment and enhance the streetscape through consistent lighting components. New lighting in the form of unique integral custom fixtures will improve identification and definition of express bus stop areas. It is anticipated to have an indirect impact on ridership because of increased visibility and awareness of station locations and safety components.

**Costs**

Depending on location of existing street lighting and electrical routes, typical installed costs for the alternative Type 1-4 fixtures would be as noted below. In areas where no existing street lighting, electrical feeds or additional underground routing are required, the associated costs may be expected to increase by 50%.
- Type 1 (Cobra or Gateway 2000 Pole): To Be Determined
- Type 2 (Single-Acorn Fixture): $4,500.00 each.
- Type 3 (Historic Twin-Arm Pole): $5,500.00 each.
- Type 4 (Concept Only): To Be Determined
- Type 4 (Optional Integral Custom Component): To Be Determined

Examples and Images

Type 1. Cobra Light

Type 2. Gateway 2000 Pole

Type 3. Single Acorn Fixture

Type 4. Historic Twin-Arm Pole
References
2. Bureau of Electricity, Streetlight Standards
6.2 Landscaping

Description

As part of the basic set of components, landscaping in some form should be considered as a defining element for at all X49 bus stops. Landscaping is comprised of elements such as trees and shrubs, as well as accents such as perennial and annual color. Landscaping provides year-round seasonal interest, defines space within the overall streetscape, and protects pedestrians from harsh winter and summer weather conditions. In general, landscaping should maintain the proper distances and clearances specified by the City of Chicago’s Landscape Ordinance [1] and Streetscape Guidelines [2]. Where there are space limitations, landscaping should, at a minimum, include parkway trees installed in a drained tree pit with a cast-iron tree grate that is flush with the sidewalk. Where space permits, low raised and/or precast moveable planters are recommended in addition to required parkway trees. These landscaping components should be used to define and separate X49 bus stops and designated waiting areas from the surrounding sidewalk and streetscape. Where no landscaping exists, or where landscaping is in poor condition, new landscaping should be installed per the City of Chicago Landscape Ordinance. Special consideration must be given so that landscaping elements (notably, tree grates, planters) do not interfere with the need for passenger circulation in bus stop areas.

As with all other bus stop components, landscaping must meet City of Chicago and CTA design standards. Landscaping should:

- Consist of native, salt-tolerant, and disease resistant tree-species as outlined in the City’s Landscape Ordinance (see Appendix C of Chicago Landscape Ordinance).
- Be maintained by the City of Chicago as agreed between the CTA and the City of Chicago.
- Not incorporate shrubs that exceed 2’-6” in clear height above the asphalt pavement.
- Maintain a minimum 12’-0” sight triangle from right-of-way at driveway and alley locations.
- Maintain a minimum branch height of 6’-0” from top of root ball.
- Provide adequate soil volumes, soil mix, and subsurface drainage to ensure future growth.

Where raised or moveable planters are an alternate solution based upon space limitations, landscaping should:

- Maintain a minimum 3’-0” clearance around all sides.
- Incorporate cast-in-place curbs 6”-8” in height (or higher curbs, as discussed in 4.3).
- Maintain a minimum inside (back-of-curb to back-of-curb) dimension of 4’-0” x 8’-6”.
- Consider decorative, low (1’-6” or less in height) metal railing around the top of the curb.
- Consider permanent or as-needed irrigation components such as drip-irrigation, pop-up heads, or quick coupler connections.

Implementation

Criteria for usage / appropriate location

Should be used:

- At locations where a clear landscape maintenance agreement has been made.
- At all permanent X49 bus stops where space permits.
- Where space for landscaping that will meet the minimum requirements set forth in Chicago’s Streetscape Guidelines/Landscape Ordinance and passenger circulation is available.
**Situations to Avoid**

Do not locate in areas where:

- There are restrictions due to budgetary or lead-time constraints.
- No maintenance plan has been developed.
- Restrictions or constraints limit adjacent circulation requirements for ADA accessibility and pedestrian flow.
- Restrictions or constraints that would locate a parkway tree closer than 40'-0” from a bus shelter at a nearside intersection.
- Restrictions or constraints that would locate a parkway tree closer than 75'-0” from a bus shelter at a farside intersection.
- Restrictions or constraints that would locate a parkway tree closer than 12'-0” from an existing or future street light.
- Vaulted sidewalks exist, unless hanging baskets and/or moveable planters.

Refer to Page 15 of the Chicago Landscape Ordinance for additional information regarding minimum landscaping distances from structures.

**Applicability of element to intersection prototype**

Landscaping is appropriate at all stop prototype locations based on available or future space limitations.

**Impacts**

New landscaping will, at a minimum, provide relief from climatic conditions (i.e. sunlight vs. shade, wind screening) at waiting/boarding areas and provide visual interest along the street. New landscaping in the form of raised or moveable planters will improve identification and definition of X49 bus stop areas. The impact on ridership is likely to be indirect, as new riders are attracted by the enhanced environment.

**Costs**

Typical installed cost for landscape elements are as follows:

- Parkway Tree: $650.00 each.
- Ornamental Trees: $450.00 each.
- Low Shrub Plantings: $40.00 - $60.00 each.
- Perennial Plantings: $10.00 - $20.00 each.
- Cast-Iron Tree Grates: $1,500.00 each.
- Precast Moveable Planters: $1,000.00 each.
- Raised Planter Curb (6”-8”): $18.00 - $25.00 per linear foot. (depending on material)
- Hanging Baskets: $200.00 each.
- Irrigation: N/A (site-specific).

A key issue with landscaping is maintenance. CTA has responsibility for maintenance of landscaping at its off-street turnarounds/terminals but, to date, has no program for maintenance at on-street facilities. CTA will install landscape elements at on-street locations only in the event that a maintenance agreement with the City of Chicago has been reached. Some community/merchant groups have maintenance programs through Special Service Areas or similar funding mechanisms, but CTA has yet to successfully explore this mechanism for long-term landscape maintenance.
Examples and Images

Parkway trees in cast-iron tree grates and raised planters

Planters on Michigan Avenue (requires wide sidewalk)

References

6.3 Sidewalk configuration and condition

Description

As part of the basic set of components, modification of sidewalks to ensure minimum proper and safe configurations must be considered at all X49 bus stops. In general, sidewalks should provide a minimum clearance of 3'-0” around all shelters and other bus stop components. Where space limitations exist, at least one side of a component must have the proper 3'-0” clearance. Where space is available, sidewalks should maintain a minimum of 6'-0” clearance past bus stops and designated waiting areas for passenger circulation. Adequate snow storage areas should be provided to allow for the above minimum clearances and widths to be maintained during seasonal snow periods. Consideration should be given to installation of a raised section of sidewalks to provide level boarding for passengers as outlined in 4.3 Curb Height and Profile.

As with all other bus stop components, sidewalk configurations must meet ADA, City of Chicago, and CTA design standards.

Under most circumstances sidewalks should be monolithic, broom-finished concrete with expansion joints corresponding to pavement and sidewalk joints. Where surrounding sidewalks and/or key intersections incorporate a streetscape theme with materials other than concrete, sidewalks should be designed to extend those materials, patterns, and layouts as suggested by the City of Chicago Streetscape Guidelines [1]. Enhancements to the City’s normal sidewalk construction standards to assist in the differentiation of express stops should be considered: tactile warning patterns and changes in pavement texture, treatment, or color for sidewalk boarding/waiting areas adjacent to the back of curb.

Implementation

Criteria for usage / appropriate location

Enhancements to normal City sidewalks should be considered for all permanent X49 bus stops.

Applicability of element to intersection prototype

Enhanced sidewalk configurations are appropriate at all stop prototype locations.

Impacts

Adequate circulation space is required to minimize dwell time. New sidewalk configurations will improve accessibility and pedestrian circulation at and around bus stops by providing appropriate travel and boarding/waiting areas. This will have an indirect impact on ridership.

Costs

Typical cost for finished concrete sidewalks is $5.00 - $8.00 per square foot. Special paving for sidewalk areas increases cost to $10.00 - $20.00 per square foot.
Examples and Images

Typical preferred sidewalk clearance

Existing shelter with minimum sidewalk clearance

References
7. Stop amenities that raise the profile of transit service
7.0 General Overview of Amenity Components

Description

In general, bus stop amenities sustain rider comfort and safety, improve short and long term recognition of the overall transit system and improve ease of navigation along system routes. Amenities may also facilitate fare transactions or complement City of Chicago or other community information exchanges where appropriate.

Generally, planning for the inclusion of amenities starts with the organization of required and desirable components as established by CTA policy or as determined by demand at any particular node along the transit system. In general, components complement traffic engineering, current City streetscape objectives, and each other as a kit of parts. However space is not available at every node to install an idealized set of components. Consequently, selection criteria have been established to assist in the decision making process: i.e. what to include or exclude at any particular node.

Amenities are grouped into the following categories:

1. Required Functional Components, to be provided at all bus stop locations:
   7.1 Signage Post – to be located as specified by CTA near-side and far-side stop requirements.
   7.2 Signage Elements – for overall system recognition, information and line identity.
   7.3 Paving – for accessibility, safety and to coordinate with the adjacent streetscape image.

2. Desirable Functional Components, to be provided where space is sufficient:
   7.4 Seating Elements – for rider comfort, disabled riders, to support system identity
   Bus Shelters – for rider comfort, system identity and ‘next bus’ signs (see 7.10)

3. Primary Amenities, as determined by an analysis of demand, and limited by available space:
   7.5 Bicycle Racks – to complement CTA “Bike/Ride” initiatives
   7.6 Kiosks – to complement Transit System, Communications, or Neighborhood awareness.
      7.6.1 Vending Kiosks – to improve access for fare transactions
      Interactive Traveler Info – as determined by Transit Operations (see 7.10)
      7.6.2 Emergency Call/Response Buttons – per site context, and CTA policies.

4. Complementary Streetscape Amenities by the City of Chicago, to be considered in the design:
   7.7 Trash Receptacles
   7.8 Telephone Kiosk
   7.9 Newspaper Boxes

5. Other items:
   7.10 Real Time Traveler Information
Therefore, selection and placement of components should occur according to the corresponding sequence:

**BUS STOP AMENITY SELECTION CHART:**

1. **SIGNAGE POST**
2. **SIGNAGE ELEMENTS**
3. **PAVING**
4. **SEATING**
5. **SHELTER 2 or 3**
6. **BICYCLE RACKS**
7. **KIOSKS**
   - INFORMATION
   - REAL TIME TRAVEL INFORMATION
   - VENDING
   - EMERGENCY CALL / RESPONSE BUTTON
8. **TRASH RECEPTACLE**
9. **TELEPHONE KIOSK**
10. **NEWSPAPER BOXES**
7.1 Signage Posts

Description

Signage posts hold bus stop signage for the X49 and other bus lines. As a part of the basic set of components, the post should be used at all X49 bus stops. If the design of the basic components is kept consistent from one stop to the next, riders will more likely recognize the location of stops among varied combinations of settings and within sets of streetscape elements that compete for attention. This is especially true when both near-side and far-side stops are used in the system. Because the JC Decaux shelters will dominate the majority of bus stops, basic stop components should be designed so they are easily associated with their color and detailing, even when shelter cannot be placed at a stop. When a shelter is not present, posts, in combination with other basic components, will reinforce the overall continuity of the system.

Design

As with any component, a minimum three-foot clearance should be provided on all sides of the post. The location of a post will define the overall position of the bus in relation to the stop. To be visible by bus drivers and riders, posts must be located adjacent to the right front bumper of a lead bus at full stop. To clear bus mirrors, the minimum clearance from the curb must be 24 inches. As with other basic bus stop components, a design has been chosen to meet the requirements of the City and the CTA [1]; [2]: The posts should be durable and easily maintainable. The posts should permit ease of removal and relocation when express stops are reassigned. The posts should provide the maximum number of opportunities for installation of other bus stop signage. The posts should be compatible with the design of the JC Decaux shelters. When a shelter is not present, posts will reinforce the overall continuity of the system from stop to stop. As an armature for identification and information components the post will allow for stop recognition from many distances and provide a high degree of adjustability and control of the density and clarity of information for each viewing distance.
Tall, twelve-foot high, post functions as an armature for line identity, informational signage, and other bus stop signs. When used for primary signage, posts should provide power for illumination. Post finishes should coordinate with JC Decaux Shelter finishes (black powder-coat finishes with white-metal trim) while maintaining durability and maintainability (stainless steel as base material).

**Implementation**

**Criteria for usage / appropriate location**

Should be used at all permanent X49 or express bus stops.

**Situations to Avoid**

Do not locate in areas where

- There are restrictions due to budgetary or lead time constraints. Only under such circumstances, use existing signposts or other armatures. Temporary use of existing signposts will facilitate scheduling during the conversion of old stops to new standards. It will allow the CTA to sustain the global integrity of information and line identity for riders and avoid conflicts with construction schedules.

**Applicability of element to intersection prototype**

Signage posts are applicable to all intersection prototypes.

**Impacts**

Posts are a part of the basic set of bus stop components. The locations of posts define the position of the buses in relation to stops. When present, the post will be its logical visual extension.

**Costs**

Custom Post: $4,000.00

**References**

7.2 Signage Elements

Description

Signage elements are the primary means of identifying X49 bus stops. As a part of the basic set of components, the signage elements should be used at all X49 bus stops. If the design of the basic components is kept consistent from one stop to the next, riders will more likely recognize the location of stops among varied combinations of settings and within sets of streetscape elements that compete for attention. This is especially true when both near-side and far-side stops are used in the system. Two levels of identification have been developed – primary and secondary – each addressing the need for identification from long and short distances.

A design has been developed to meet the requirements of the CTA [1], [2]: The signage and other identifiers should be simple, bold, and distinctive so that they are clearly visible from long and short distances, and so that they are not confused with competing signage and other surrounding graphic elements. The signage should be easily applied to groupings of conventional signs and provide ease of removal and relocation when express stops are reassigned. The signage materials should be durable and easily maintainable. The signage should be compatible with conventional signage. The signage should not interfere with any other signage or traffic signaling in intersections.

Design

Design is consistent with CTA requirements.
Primary signs should be highly visible, illuminated X49 line identifiers (12-inch diameter) attached by conventional means to custom posts or existing signposts. They should be used at all stops served by an X49 bus. When tall signage posts are used, the primary identifiers should be red, illuminated signs attached to the highest point of the post. As an added element, illumination could be modified to provide differentiated color change (flashing blue for conventional – red for express) to alert riders when a bus is approaching. This primary identifier would allow riders to distinguish express stops from other stops, from significant distances (300 feet maximum), and at night. When tall custom posts cannot be installed, the identifier may be side mounted, without illumination, on existing posts.

Secondary signs are highly visible, smaller X49 line identifiers (6-inch diameter) attached by conventional means to custom posts or existing signposts. They are to be used at all stops served by an X49 bus. Secondary identifiers allow riders to distinguish express stops from other stops, from conventional distances (25 feet average). Where multiple parallel lines are served by one stop, the identifiers reinforce the presence of express service.

Text or other information must comply with height and visibility requirements as described in the Chicago Transit Authority Engineering Graphics & Design Graphics Manual [2].

Implementation

Criteria for usage / appropriate location
Should be used at all permanent X49 stops.

Situations to Avoid
Do not locate in areas where there are restrictions due to budgetary or lead time constraints.

Applicability of element to intersection prototype
Signage elements are applicable to all intersections prototypes.

Examples and Images

London, UK

London, UK
Impacts

Signage elements are a part of the basic set of bus stop components. Primary identifiers will allow a riders and drivers to easily distinguish express stops from other stops from a significant distance, and at night. Secondary identifiers will allow a riders and drivers to easily distinguish express stops from other stops from a reasonable distance. The consistent visual language and repetition will clearly reinforce line identity and locations of service. Flexibility of installation will permit ease of adjustment during stop reassignment.

Costs

Custom Signage: $2,000.00

References

7.3 Paving

Description

As a part of the basic set of components, paving must be considered at all X49 bus stops. Sidewalk surface components include modifications to the color, texture, hardness, and durability of the horizontal ground surface. Materials can include paving, ground cover, vegetation, and the incorporation of branding and identity markers. In general, paving should extend a distance of 3'-0” around shelters and other bus stop components. Where there are space limitations, at least one side of a component must have an accessible clearance. Shelters may not accommodate the total number of riders. Where demand dictates additional area for waiting riders, a paved area should be provided, being equivalent in area to one shelter bay. Where no paving currently exists or where existing paving is in poor condition, consistent demarcation of larger zones for waiting and boarding will help reduce possible conflicts between riders and adjacent vehicular and pedestrian traffic. Where no pavement exists, or where existing pavement is in poor condition, new pavement should be installed per the City of Chicago Streetscape Guidelines [1].

As with other basic bus stop components, the paving should meet the requirements of the City and the CTA: The paving should be durable and easily maintainable. The paving should be compatible with surrounding paving materials, layouts, and patterns.

Under most circumstances paving should be monolithic broom-brushed concrete with joints corresponding to surrounding pavement and sidewalk joints. Bus stop paving may have additional joints at the half points of surrounding paving. Where surrounding paving is of materials other than concrete, bus stop paving should be designed to extend materials, patterns and layout as suggested by the City of Chicago Streetscape Guidelines.

Implementation

Criteria for usage / appropriate location

Should be used at all permanent X49 stops.

Situations to Avoid

Do not locate in areas where there are restrictions due to budgetary or lead time constraints. Only under such circumstances, place bus stop components over existing paving.

Applicability of element to intersection prototype

Paving is applicable to all intersection prototypes.
Examples and Images

Paving Extension, Mountain View, CA

Paving Extension (Art Shelter), Tempe, AZ

Paving Extension, Kinzie & Clark, Chicago, IL

Impacts

New paving will improve accessibility and provide visual and tactile identification of waiting and boarding locations. Paving will improve consistency and continuity of surfaces between waiting and boarding areas at street frontage, especially in areas where the surrounding context is less developed, or where frontage and waiting areas are not adjacent.

Costs

Paving: $10.00 - $40.00 per square foot

References

7.4 Seating Elements

Description

As a part of the basic set of components, seating elements should be used at all X49 bus stops. Because the JC Decaux shelters will dominate the majority of bus stops, basic stop components should be designed so they are easily associated with their color and detailing, even when shelters cannot be placed at a stop. If the design of the basic components is kept consistent from one stop to the next, riders will more likely recognize the location of stops among varied combinations of settings and within sets of streetscape elements that compete for attention. When a shelter is not present, benches, in combination with other basic components, will reinforce the overall continuity of the system. Typically, shelters include benches. Demand will dictate if additional benches are required when a shelter is in place. Benches should be located only when there is sufficient space to accommodate them. A minimum clearance of 3’-0” is required in front of and in the approach to benches. Whenever possible, benches should be attached to signage posts, and if allowed, to shelters.

As with other basic bus stop components, a design has been chosen to meet the requirements of the City and the CTA [1], [2]: The benches should be durable and easily maintainable. The bench design should permit ease of removal and relocation when express stops are reassigned. The benches should be compatible with the design of the JC Decaux shelters.

Design

Benches incorporate seat and back. Bench finishes should coordinate with JC Decaux Shelter finishes (black powder-coat finishes with white-metal trim and wood seats) while maintaining durability and maintainability.
Implementation

**Criteria for usage / appropriate location**

Should be used where there is:

- Opportunity, along with adequate space, to combine with basic and other supplemental bus stop components.
- Demand for benches as suggested by adjacent land use.
- High volume of rider traffic.

Locate in areas where there is:

- Adjacent, critical masses of retail, recreational, or similar activity.
- Intense inter-modal and intra-modal transportation activity.
- Evidence of demand as established by the City.

**Situations to Avoid**

Do not locate in areas where there are:

- Restrictions and constraints due to adjacent circulation requirements for accessibility and flow of passersby, and available area.

**Applicability of element to intersection prototype**

Seating is applicable to all intersection prototypes, provided that there is sufficient space.

**Examples and Images**

![Victor Stanley RB-28 bench](image1)

![Victor Stanley CR-10 bench](image2)

**Impacts**

Benches are a part of the basic set of bus stop components. The locations of benches help to define bus stops. When shelters are installed, additional benches will represent a logical visual extension. When a shelter is not present, benches will reinforce the overall continuity of the system from stop to stop.
Costs

Custom Bench: $10,000.00

References

7.5 Bicycle Racks

Description

Streetscape amenities, such as bicycle racks, may be incorporated into the design of X49 bus stops, but conceptually they should be included only by the demands of the general area, intersection or street segment in which the bus stop is located. Bicycle racks are supplemental to the basic set of bus stop components, and can, if their need is established, be incorporated in the layout of the stop. Although the function of a bicycle rack may not directly serve the bus line, spatial adjacency suggests that general guidelines for coordination and inclusion be addressed. As with any component, a minimum three-foot clearance should be provided on at least two sides of the racks. For ease of use, bicycle racks should be located a minimum of thirty inches from any other bus stop component. In general, placement of bicycle racks should be as dictated or suggested in the City of Chicago Streetscape Guidelines [1].

Design

The bicycle Racks design is consistent with the City of Chicago Streetscape Guidelines. The Bicycle Rack Program, managed by the City of Chicago Department of Transportation’s Bureau of Traffic, provides for the installation of bicycle racks, based on a review of overall streetscape plans. The standard rack is a square tube, with a black powder-coated finish, U-shaped rack directly bolted to pavement.

Implementation

Criteria for usage / appropriate location

Should be used where there is:

- Opportunity, along with adequate space, to combine with basic and other supplemental bus stop components.
- Demand for racks as suggested by adjacent land use.
- High volume of bicycle traffic.
Locate in areas where there is:

- Adjacent, critical masses of retail, recreational, or similar activity.
- Intense inter-modal and intra-modal transportation activity.
- Evidence of demand as established by the City.
- Adjacent to parallel or perpendicular bike lanes.

**Situations to Avoid**

Do not locate in areas where there are:

- Restrictions and constraints due to adjacent circulation requirements for accessibility and flow of passersby, and available area.

**Applicability of element to intersection prototype**

Bicycle racks are applicable to all prototypes. The location may be determined by CTA where not already supplied and installed by the City of Chicago, or where a supplemental rack is deemed necessary to support the CTA Park/Ride initiatives; coordination with City of Chicago Streetscape Guidelines is recommended.

**Impacts**

Bicycle racks may contribute greatly to the quality of waiting areas. Bicycle racks reinforce the intermodal nature of the system.

**Costs**

Bicycle racks: $400.

**References**

7.6 Kiosks and Neighborhood Identifiers

Description

Information kiosks may be incorporated into the design of X49 bus stops, but conceptually they are organized by the demands of the general area, intersection or street segment in which the bus stop is located. Information kiosks are supplemental to the basic set of bus stop components, and should, if their need is established, be incorporated in the layout of the stop. The function of the information kiosk may directly serve the X49 bus line, in addition to serving the CTA system as a whole. It may also serve the community at the transit node. As with any component, a minimum three-foot clearance should be provided on all sides of the kiosk. For Transit and City of Chicago information, a design has been chosen to meet the requirements of the City and the CTA [1], [2]: The kiosks should be durable and easily maintainable. The kiosks should provide the maximum number of opportunities for display of information within the smallest footprint. The kiosks should be compatible with the design of the JC Decaux shelters. To reinforce system identity, the kiosks may incorporate system identification through the use of a standard, lit CTA sign. The lit CTA sign should not be used in locations that suffer from an overabundance of signage and other competing graphics.

Design

Design is consistent with City and CTA standards. Kiosks should accommodate basic services: CTA System Hub Information; Line Identity Information; Community Information; Real-Time Transit Information; Emergency Call Buttons and Hot Phones. Kiosks may also be used to display advertising and artwork. Kiosk finishes should coordinate with JC Decaux Shelter finishes (black powder-coat finishes with white-metal trim) while maintaining durability and maintainability of embodied in of standard CTA finishes (stainless steel as base material).
Implementation

**Criteria for usage / appropriate location**

Should be used where there is:

- Opportunity, along with adequate space, to combine with basic and other supplemental bus stop components.
- Demand for supplemental system-wide or community information as suggested by adjacent land use.
- High volume of rider traffic and transfers.

Locate in areas where there is:

- Adjacent, critical masses of retail, recreational, or similar activity.
- Intense inter-modal and intra-modal transportation activity.
- Evidence of demand as established by the CTA.

**Situations to Avoid**

Do not locate in areas where there are:

- Restrictions and constraints due to adjacent circulation requirements for accessibility and flow of passersby, and available area.
- Limitations for regular maintenance and service of signage, which might result in obsolete or degraded information.

**Applicability of element to intersection prototype**

Applicable to all types provided that there is sufficient space and demand. Kiosks are particularly applicable to inter-modal transit locations.

**Impacts**

Information kiosks may contribute greatly to the quality and comfort of waiting areas. Placing information kiosks in strategic locations helps improve the ability of a rider to independently gather information and to plan trips successfully. Similarly, kiosks improve rider awareness of transportation nodes relative to adjacent land use, and create a sense of continuity between the system and the communities it serves.
Costs

Kiosk: $16,000

Examples and Images

Kiosk at CTA Hub: Clark and Lake

Information Kiosk: London UK
References

7.6.1 Transit card vending kiosks

Description

Installation of fare vending kiosks at BRT bus stops has been proposed as a way of both speeding up boarding, as part of off-vehicle fare collection strategies (see 3.4 Off-vehicle fare collection) and as a way of expanding distribution channels for CTA fare media in Chicago neighborhoods. Installation of the CTA’s standard Ticket Vending Machines (TVMs) is not appropriate since they are not designed to be installed in an outdoor environment and, because they are designed to perform many functions, they are quite expensive and require frequent service visits to collect revenue and replenish ticket stock. Installation of simpler machines, with fewer capabilities, would be more appropriate to this role. Specifically, a machine that would allow customers to obtain the CTA’s quantity discount (for purchases in excess of $10) when re-charging CTA Chicago Card™/Chicago Card Plus™ smart cards for customers with credit/debit cards and, perhaps bills, would be expected to be very popular. Currently, smart cards can only be re-charged over the internet or at rail station TVMs, alternatives that are not conveniently available to large numbers of Chicago residents. Such machines could perform a dual purpose, also serving as interactive real-time information devices (see 8.10 Real time travel information).

Implementation

Criteria for usage / appropriate location

Because even machines with the capability for performing these limited functions would be expensive, they should be placed in areas that are anticipated to generate a large number of transactions. Since their cost is expected to be about 40% of the cost of a standard CTA TVM machine, for which the CTA considers 800-1000 daily transactions at low volume rapid transit stations to be a minimum [1], but servicing costs would not be reduced proportionately, 400 transactions might be a reasonable threshold for justifying installation of one of these machines. Perhaps, a somewhat lower minimum number of transactions could be justified if the machines also serve as information kiosks. It is important to note that even though a machine might be located at a particular stop, it could be made visible to riders boarding other CTA services in the neighborhood; buses going in the opposite direction and buses on cross lines. It would be desirable to locate them in conjunction with the installation of video monitoring, for the protection of users, as well as the protection of the machines themselves. Machines would need electric power supply and communications to the CTA’s central fare collection computer system.

As part of this program, sites for sale of Chicago Card™/Chicago Card Plus™ should be established in the neighborhoods. This is now limited to the internet and the CTA’s Merchandise Mart offices. When the Illinois Tollway started sales through Jewel stores, and started accepting cash for setup of I-Pass accounts, sales went up dramatically. 68% of sales are now through this channel [2].

Situations to avoid in implementation

Low volume stops, and those in isolated locations, should be avoided.

Applicability of element to intersection prototype

Stop location is not a significant issue.
Examples and Images

The Cubic “Express Vendor” shown above is capable of adding value to smart cards or magnetic tickets. It can also be utilized as an information kiosk. These machines are only 13.5 inches deep, 21 inches wide and 42 inches high and, thus, could be easily integrated into a street furniture module [5].

Impacts

Ridership impacts

Installation of a network of such machines (in conjunction with initial sales through the current store/currency exchange channel for transit cards) has the potential to greatly increase CTA smart card sales. Thus, the discounts and convenience now enjoyed by many people would be made available to what is, perhaps, the majority of Chicago residents who do not have regular access to the internet and/or credit cards or have difficulty accessing the stores or currency exchanges that sell passes. Further research would be required to identify the amount of ridership increase that would be expected to result. These results would apply to riders who ride all routes in the area where a machine is installed, not only the route(s) that off-vehicle fare collection is applied to.

Dwell time impacts

Shifting the 22% of bus riders who now pay with cash to pre-paid media [3], in combination with the implementation of off-vehicle fare collection, would greatly reduce dwell time (see 4.4 for a discussion of the time savings that might be expected).

Costs

There are too many variables to allow calculation of detailed costs at this time. Costs fall into capital costs and operating costs. Installation of vending machines at a large number of stops would be the major capital expense. APC data should be reviewed to identify the busiest stops. Development/integration (Non-Recurring Engineering – NRE) costs for a machine for integration into the CTA fare collection system are estimated at $500,000. Order of magnitude estimate for an initial production run of 25 machines for the X49 corridor is $625,000 ($25,000 each) [4]. Not every stop needs to be equipped with a fare vending machine, and a backup machine need not be provided, because these are only re-charging devices; customers can still board, paying their
fare through the farebox in the normal manner if no machine is available. Communications could utilize either a connection to the City’s fiber optic cable that has been installed along the Western Avenue corridor or commercial DSL service. Installation costs would include some trenching to reach a power source and, perhaps, communications. A WiFi connection, protected in a Virtual Private Network (VPN), could be utilized if trenching costs were extreme. Operating costs would consist principally of collection of currency (assuming a bill acceptor is included), occasional servicing and the monthly DSL line charges, if required.

Offsetting revenue would come from the additional fare revenue generated from customers attracted by the convenience of the sale of discounted media, as well as revenue from new riders attracted by the faster service made possible by off-vehicle fare collection. Again, this faster service also has the potential to substantially reduce operating costs through the improved operator and bus productivity.

Evaluation

It is recommended that busy stops on the X49 route be equipped with machines capable of re-charging CTA smart cards. They should be capable of accepting credit and debit cards, as well as bills. This should be done in conjunction with the installation of video monitoring. It would be most effective to establish a network of on-street fare vending machines as part of a program to establish off-vehicle fare collection on the route. The feasibility of utilizing the same devices as information kiosks should be researched further.

References

1. Per Peter Fahrenwald, Manager, Facility and ADA Planning, in meeting, June 9, 2004.
3. CTA System Ridership, Fare Media Summary - May 2004, Planning & Development, Data Services & Development.
5. Cubic website
7.6.2 Emergency Call / Response Buttons

Description
Emergency Call / Response Buttons serve the passengers to alert the CTA and the police of an emergency situation. The element can be a telephone handset that connects only to the police or the CTA control center or it can be just a button that does not allow voice communication but only provides a signal at the operations or police end alerting of an emergency.

This element may be incorporated into the design of X49 bus stops, but conceptually they are organized by the demands of the general area, intersection or street segment in which the bus stop is located. Emergency Call / Response Buttons are supplemental to the basic set of bus stop components, and should, if their need is established, be incorporated in the layout of the stop. The function of the Emergency Call / Response Buttons may directly serve the X49 bus line, in addition to serving the CTA system as a whole. It may also serve the community at the transit node. The element could be a stand-alone piece of urban furniture or it could be attached to the information kiosk. As with any component, a minimum three-foot clearance should be provided on all sides of the kiosk or the element if stand alone. The specific design should meet the requirements of the City and the CTA [1], [2]: the element should be durable and easily maintainable. The kiosks or element should be compatible with the design of the JC Decaux shelters.

Implementation
Criteria for usage / appropriate location
Should be used in areas where there is:
- An identified higher crime and violence risk.
- A common perception of the stop as unsafe.
- Opportunity, along with adequate space, to combine with basic and other supplemental bus stop components.
- High volume of pedestrian traffic.
- Evidence of demand as established by the City and by local community.

Situations to Avoid
Do not locate in areas where there are:
- Restrictions and constraints due to adjacent circulation requirements for accessibility and flow of passersby, and available area.
- Limitations for regular maintenance and service of receptacles.

Applicability of element to intersection prototype
The Emergency Call / Response Buttons are applicable to all intersection prototypes.
Examples and Images

Example of an Emergency Call / Response Button. Source: TranSystems.

Impacts

The impact of implementing an Emergency Call / Response Button is mainly an improved perception of safety from passengers, more particularly vulnerable groups including elderly and children.

Costs

Emergency Call / Response Button: $1,000 – $4,000 including installation

References

7.7 Trash Receptacle

Description

Streetscape amenities, such as trash receptacles, may be incorporated into the design of X49 bus stops, but conceptually they should be included only by the demands of the intersection or street segment in which the bus stop is located. Trash receptacles are supplemental to the basic set of bus stop components, and can, if their need is established, be incorporated in the layout of the stop. Although the function of a trash receptacle may not directly serve the bus line, spatial adjacency suggests that general guidelines for coordination and inclusion be addressed. As with any component, a minimum three-foot clearance should be provided on at least two sides of the receptacle. For ease of maintenance and servicing, trash receptacles should be located a minimum of twelve inches from any other bus stop component. In general, placement of trash receptacles should be as dictated or suggested in the City of Chicago Streetscape Guidelines [1].

Design

The City has chosen the Victor-Stanley Steelsites (S-42) container, or approved equal, in the color black as the standard waste receptacle for use in the public way. According to the Streetscape Guidelines, the local community generally verifies actual locations during the design phase of the project.

Implementation

Criteria for usage / appropriate location

Should be used where there is:
- Opportunity, along with adequate space, to combine with basic and other supplemental bus stop components.
- Demand for receptacle as suggested by adjacent land use.
- High volume of pedestrian traffic.

Locate in areas where there is:
- Adjacent, critical masses of retail, recreational, or similar activity.
- Intense inter-modal and intra-modal transportation activity.
- Evidence of demand as established by the City and by local community.
Situations to Avoid
Do not locate in areas where there are:
- Restrictions and constraints due to adjacent circulation requirements for accessibility and flow of passersby, and available area.
- Limitations for regular maintenance and service of receptacles.

Applicability of element to intersection prototype
Location not determined by CTA, located and provided by the City of Chicago. Their location must be coordinated with Chicago Avenue Streetscape Guidelines.

Examples and Images
Alternate trash receptacle located on Upper Wacker Drive and Dearborn.

Impacts
Trash receptacles are applicable to all prototypes. The location is not typically determined by CTA but must be coordinated with the layout of the stop in accordance with City of Chicago Streetscape Guidelines.

Costs
Trash Receptacle: $1,000.00.

References
7.8 Telephone Kiosk

Description

Streetscape amenities, such as telephone kiosks, may be incorporated into the design of X49 bus stops, but conceptually they should be included only by the demands of the intersection or street segment in which the bus stop is located. Telephone kiosks are supplemental to the basic set of bus stop components, and can, if their need is established, be incorporated in the layout of the stop. Although the function of a telephone kiosk may not directly serve the bus line, spatial adjacency suggests that general guidelines for coordination and inclusion be addressed. As with any component, a minimum three-foot clearance should be provided on all sides of the kiosk. For ease of maintenance and servicing, kiosks should be located a minimum of twelve inches from any other bus stop component. As with the information kiosk, a design has been chosen to meet the requirements of the City and the CTA [1], [2]: The kiosks should be durable and easily maintainable. The kiosks should provide the maximum number of opportunities for display of information within the smallest footprint. The kiosks should be compatible with the design of the JC Decaux shelters.

Design

The design is consistent with city and CTA standards. In addition to accommodating regular or TTY telephones, the kiosks may also accommodate community information, advertising, or artwork. Kiosk finishes should coordinate with JC Decaux Shelter finishes (black powder-coat finishes with white-metal trim) while maintaining durability and maintainability of embodied in of standard CTA finishes (stainless steel as base material).
Implementation

Criteria for usage / appropriate location

Should be used where there is:

- Opportunity, along with adequate space, to combine with basic and other supplemental bus stop components.
- High volume of rider traffic and transfers.

Locate in areas where there is:

- Adjacent, critical masses of retail, recreational, or similar activity.
- Intense inter-modal and intra-modal transportation activity.
- Evidence of demand as established by the City and CTA.

Situations to Avoid

Do not locate in areas where there are restrictions and constraints due to adjacent circulation requirements for accessibility and flow of passersby, and available area.

Applicability of element to intersection prototype

Telephone Kiosks are applicable to all prototypes. The location may be determined by CTA if supplemental to the ones already provided and installed by others; however coordination with the layout of the stop and City of Chicago Streetscape Guidelines is recommended.

Impacts

Telephone kiosks may contribute greatly to the quality and comfort of waiting areas. Community information placed on kiosks may improve rider awareness of transportation nodes relative to adjacent land use, and create a sense of continuity between the system and the communities it serve.

Costs

Kiosk: $14,000
Examples and Images

Telephone kiosks near the State of Illinois Building on Randolph

References

7.9 Newspaper Boxes

Description

Streetscape amenities, such as newspaper boxes, may be incorporated into the design of X49 bus stops, but conceptually they should be included only by the demands of the intersection or street segment in which the bus stop is located. Newspaper boxes are supplemental to the basic set of bus stop components, and can, if their need is established, be incorporated in the layout of the stop. Although the function of a newspaper box may not directly serve the bus line, spatial adjacency suggests that general guidelines for coordination and inclusion be addressed. As with any component, a minimum three-foot clearance should be provided on all sides of the newspaper box. For ease of maintenance and servicing when boxes are ganged in a row, boxes should be located a minimum of twelve inches from each other. As with the information kiosk, a design has been chosen to meet the requirements of the City and the CTA [1], [2]: The boxes should be durable and easily maintainable. The boxes should provide the maximum number of opportunities for display of information within the smallest footprint. The boxes should be compatible with the design of the JC Decaux shelters.

Design

The newspaper boxes are consistent with City and CTA standards. In addition to accommodating newspapers, the boxes may also accommodate community information, advertising, or artwork. Box finishes should coordinate with JC Decaux Shelter finishes (black powder-coat finishes with white-metal trim) while maintaining durability and maintainability of embodied in of standard CTA finishes (stainless steel as base material).
Implementation

Criteria for usage / appropriate location
Should be used where there is:
- Opportunity, along with adequate space, to combine with basic and other supplemental bus stop components.
- High volume of rider traffic and transfers.

Locate in areas where there is:
- Adjacent, critical masses of retail, recreational, or similar activity.
- Intense inter-modal and intra-modal transportation activity.
- Evidence of demand as established by the City and CTA

Situations to Avoid
Do not locate in areas where there are:
- Restrictions and constraints due to adjacent circulation requirements for accessibility and flow of passersby, and available area.

Applicability of element to intersection prototype
Newspaper boxes are applicable to all prototypes. Boxes may have already been supplied and installed by the others; in this situation coordination with the layout of the stop in accordance with City of Chicago Streetscape Guidelines is recommended.

Examples and Images

Newspaper boxes in front of the State of Illinois Building on Randolph
Impacts

Newspaper boxes may contribute greatly to the quality and comfort of waiting areas. Community information placed on boxes may improve rider awareness of transportation nodes relative to adjacent land use, and create a sense of continuity between the system and the communities it serve.

Costs

Kiosk: $14,000

References

7.10 Real time traveler information

Description

Technology is rapidly emerging that will allow the CTA to provide real-time information to its customers. Four forms of real-time traveler information are addressed here:

- “Next Bus” signs at stops
- Interactive real-time walk-up information devices located at stops or other locations
- “Hot phones” installed at stops that provide direct access to the RTA Travel Information Center.

“Next Bus” information (expected arrival time, typically expressed in terms of a countdown of the number of minutes until the predicted arrival of the next bus on each route that stops at a given stop). The foundation of the information that these systems is built on is the scheduled arrival time and current schedule adherence information. Under its Regional Bus Arrival System project (called BusInfo) the RTA is creating a system to collect location data taken from real-time management systems operated by the service boards (CTA and Pace) and creating a real-time database of predicted arrival times at stops [1]. The integration of a display of next bus information into the JC Decaux passenger shelters was anticipated and is permitted under the City’s contract. A specific design will have to be approved by the City and JC Decaux. Power is available, but it has been assumed that wireless communications will be utilized [2]. The RTA also plans to distribute the real-time BusInfo data calculated on an ad hoc basis in response to requests from wireless devices such as PDAs and browser-equipped cell phones [1].

An Interactive real-time walk-up information device is a device that allows the user to search for the information that they need. This is similar to accessing information on the web. In fact, the RTA Kiosk program demonstration accesses its existing itinerary planning and the CTA, Pace and Metra websites, as well as accessing information on specific attractions. It substitutes a touch screen monitor for a mouse. It allows printing of itineraries and timetables. Installation of 9 devices in the next phase of the demonstration is scheduled for 2004. With the deployment of these initial devices (and the de-bugging that will be undertaken during this pilot phase), the central databases and systems will be in place to support a network in the region [1]. Installation at bus stops in the Western Avenue corridor would require both power and a TCP/IP (internet) communications link. Most such devices are in climate-controlled environments. While they can be configured such that they can function in outdoor settings, there are problems, particularly in terms of screen readability in sunlit situations. Such units are more expensive than standard units. It would be possible for the same device to function as both an information device and as a device for adding value to fare media (see 7.6 Vending kiosks).

Another type of information device that can be installed at a bus stop is a telephone that provides direct access to the RTA Travel Information Center. While telephones are easier for customers to use, there may be a wait to talk to a representative. In addition, the RTA is charged for each call.

Implementation

Criteria for usage / appropriate location

Devices such as “Next Bus” signs and walk-up information devices are relatively expensive. Thus, installation should be limited to locations where they are likely to be heavily used. APC data should be reviewed to identify the busiest stops. Some agencies (notably, the Metro Rapid BRT system in Los Angeles) have adopted real-time information at all stops as a defining element of BRT.
**Situations to avoid in implementation**

Given the cost of these devices it would be desirable that they not be installed at low volume locations or in isolated locations where there would be a high risk of vandalism.

**Applicability of element to intersection prototype**

Stop location is not a significant issue.

**Examples and Images**

Real time information sign at stop - integrated into shelter. *Source: TranSystems*

Real time information sign at stop – free standing. *Source: TranSystems*
Impacts

Ridership impacts
If customers have information about transit routes and service they are more likely to utilize transit. The elimination of the uncertainty as to when the next bus will arrive is especially important as research has shown that passengers value waiting time at about 3 times the value of in-vehicle time. The availability of accurate wait time information can greatly reduce this difference.

Dwell time impacts
The only dwell time impact that is anticipated would be the reduction in time that bus operators spend answering questions.

Costs
There is a wide variation in cost for both types of devices, depending on specifics. For both, the amount of weather-proofing and other packaging issue is critical. In the case of the signs, the choice of display technology, which needs to be optimized for the environment (most notably, whether or not they will be sunlight), one color vs. multi-color, size and one or two-sided, makes a large difference. Costs for a sign design, designed to be integrated into the BusInfo system should range from $3,000 to $8,000, when purchased in a reasonable quantity (at least, 25 units). Standalone information kiosks, designed for an outdoor environment could range in cost from $5,000 to $15,000. Clearly, there it would be best to install dual purpose devices that could also serve as devices for re-charging smart cards are fare cards (see 8.10). In addition, to the relatively modest cost of installing and maintaining hot phones, the RTA is charged 83¢ for each call answered by a representative (the call center is operated by a contractor) [3].

Evaluation
Real-time information at stops has been found extremely effective in making transit service more attractive to potential customers. The efforts of the RTA to establish the infrastructure to support these systems has greatly reduced the complexity and cost of installing these systems. The CTA may want to consider installing real-time information at all BRT stops, as Los Angeles has done. Installation of walk-up devices would be much more cost-effective if done as dual purpose devices, combined with fare vending machines. Hot phones are not recommended because of the usage charges.

References