Southwest Ohio Regional Transit Authority

BUS STOP DESIGN GUIDELINES

April 2019

METRO

Table of Contents

Table of Figures

List of Tables

ABBREVIATIONS & ACRONYMS

Abbreviation	Description
ADA	Americans with Disabilities Act
ADAAG	ADA Accessible Guidelines
BRT	Bus Rapid Transit
COTA	Central Ohio Transit Authority
PROWG	Public Right-of-Way Guidelines
SORTA	Southwest Ohio Regional Transit Authority
TOD	Transit Oriented Development
TVM	Ticket Vending Machine

1. PURPOSE

Southwest Ohio Regional Transit Authority (SORTA) has over 4,000 bus stops serving its local bus operations in the City of Cincinnati and Hamilton County, in addition to Butler County, Clermont County and Warren County. One of the main goals of a transit agency is to provide all transit passengers, with varying abilities, a safe, accessible, and comfortable facility that will provide for an adequate waiting area, accurate bus information, and shelter from elements. Hence, the purpose of this document is to create guidelines for bus stops that will ensure consistent implementation of bus stops and amenities. This bus stop design guidelines document applies to bus stop infrastructure, signage, customer facilities, and other amenities that could be installed in conjunction with SORTA bus stops. This document also stresses the importance of transit facilities through compliance with Americans with Disabilities Act (ADA) and Public Right-of-way Guidelines (PROWAG).

2. INTRODUCTION

The public's first impression of SORTA and its services is the bus stop. It is also the first point of contact between the passenger and the bus service. The spacing, location, design, and operation of bus stops significantly influences transit system performance. In addition, it is vital that a bus stop is an easily identifiable, safe, accessible, clean and comfortable place to wait for the bus. SORTA strives to make bus stops a positive contribution to communities' streetscapes and a place where patrons can obtain transit-related information and are encouraged to use public transit.

SORTA is responsible for the siting and installation of new bus stops in conjunction with the local jurisdiction in which the bus stops are located. SORTA staff provides initial recommendations regarding bus stop placement and what amenities will be installed. SORTA then works with the local jurisdiction to obtain permits for the installation of the bus stop and to finalize its location. If concrete pads are constructed at bus stops, SORTA is responsible for ensuring that the bus stop meets all federal and local guidelines and regulations, including those associated with the ADA requirements.

Although it is SORTA's role to provide public transit service throughout the Greater Cincinnati area and to install bus stops, it is usually the role of local municipalities and developers to provide infrastructure for pedestrians, motorists, and bicyclists to access that transit service. Hence, when new development or redevelopment occurs at or near an existing SORTA bus stop location, it is the developer's and the local jurisdiction's responsibility to ensure that the bus stop can be properly served by SORTA's transit vehicles and easily accessed by transit riders. Compliance with the ADA guidelines as well as roadway design standards is crucial to providing access to transit.

SORTA urges developers to take existing and proposed bus stops into consideration from the inception of the planning and design processes. Developers and local officials should coordinate with and get the guidance of SORTA staff in making design decisions on development and local infrastructure that affects transit stops.

2.1. GOALS

The purposes of the guidelines are to:

- Enhance consistency in bus stop placement and design throughout the SORTA service area.
- Urge local municipalities to design bus stops to be served by SORTA that meet the operational guidelines and requirements of its vehicles.
- Encourage the local community to utilize public transit through the provision of safe, comfortable, and convenient transit facilities.

The document is organized as follows:

3 Bus Stop Location: This section provides guidelines for improving customer experience on the street side of planned bus stops. It also presents guidelines for suitable bus stop placement relative to the intersection, and different types of street-side designs like on-street stops, curb-extensions, and bus bays.

4 Bus Stop Spacing: This Section discusses guidelines on appropriate spacing between bus stop locations and an analysis of the current spacing between stops for the SORTA lines.

5 Bus Stop Elements and Passenger Amenities: This section details guidelines for improving the overall accessibility to bus stops and coordination of bus stop elements such as bus stop signs, bus stop posts, information cases, passenger information, bus stop shelters, benches, bus stop lighting, ADA landing pads, trash cans, vendor boxes, and art at transit stops.

6 Process for Determining Addition or Removal of Amenities: This section provides a flow chart showing the steps and process SORTA follows for either adding or removing an amenity at a bus stop. The process concludes with the implementation of numerous interrelated decisions.

7 Roadway Design for Transit Vehicle Use: This section provides details of geometric design guidelines for bus stops and bus routes.

8 Transit Oriented Development (TOD): The land use development and transportation system patterns of a city or neighborhood are closely linked and strongly affect the efficiency and viability of public transportation. This section represents the importance of creating more vibrant and convenient communities in which people would live and work, where car ownership is not a necessity, and household transportation costs can be kept low.

9 Public Involvement Concerning Bus Stops and Inputs: This section discusses strengthening the link between transit planning and community planning. It focuses on stimulating increased participation in the decision- making process by community organizations, minority and low- income residents, and persons with disabilities.

3. BUS STOP LOCATION AND INFRASTRUCTURE

This section discusses the physical location of a bus stop from two aspects: relative to the intersection, and relative to the travel lanes. The first part of this section deals with the placement relative to the intersection as in a stop being located just before an intersection, just after the intersection or mid-block. The characteristics, advantages and disadvantages of each of these placements are discussed below.

In terms of bus stops' physical location relative to the travel lane, this section discusses how stops may be located at the curb next to the travel lane, or may be a curb stop along a parking lane, a curb bulb or as a bus bay. Each of these are discussed along with their characteristics.

3.1. Location of Bus Stops

The location of a bus stop generally refers to the placement of the stop relative to the nearest intersection. The three types of bus stop placement—as it relates to the intersection—are: Far-side (located immediately after an intersection); Near-side (located immediately before intersection); and Mid-block (located between intersections).

Far-side stops occur when the bus makes a stop after proceeding through the intersection. Studies have found that far-side bus stops are the preferable choice for service in general because they reduce conflicts between right-turning vehicles and stopped buses, eliminate sight-distance deficiencies on approaches to an intersection and encourage pedestrian crossing at the rear of the bus. Mid-block stops occur when the bus stops in between intersections, usually in a well-defined area. The main advantage of a mid-block stop is when the stop has a large volume of riders, requiring a larger waiting area than space allows at the intersection. Near-side stops occur when the bus stops before the intersection. Advantages are the passengers can board and alight closer to the crosswalk. On the other hand, there may be some safety concerns related to near-side stops. It is important to note that the final decision on bus stop location is dependent on ease of operation, transfer situations, space availability, traffic volumes, pedestrian facilities, safety considerations, and other conditions found at that site. It is also important to note that bus stops are typically located in pairs (one at each side of the street along two-way route segments) and should be positioned close together along the route to ensure simplicity in planning the return trip. Each type of bus stop location offers advantages and disadvantages to bus drivers, bicyclists, and pedestrians—which are explained in the following sections.

3.1.1. Far-Side Stops

For a standard 40-foot transit bus, the bus stop should be located at least 50 feet after the intersection to ensure that the rear of the bus does not extend into the intersection or straddles the pedestrian crosswalk. Figure 1 illustrates an example of a far-side bus stop. Far-side bus stop locations should be the default unless there are overwhelming safety, operating or other concerns.

3.1.2. Near-Side Stops

Bus stops located near-side of the intersection should be placed at least 5 feet from the crosswalk to impede the bus from straddling the crosswalk while it's stopped to serve the stop. Figure 2 illustrates an example of a near-side bus stop. Near-side bus stop should be utilized if:

- Far-side is not feasible due to safety or operating reasons
- The primary trip generator is downstream from the intersection.
- Existing pedestrian facilities are greater than on the far-side.
- Pedestrian movements are safer than on the far-side.
- Route requires a right turn at the intersection.
- Vehicular traffic is heavier on the far-side.

3.1.3. Mid-Block Stops

Generally mid-block bus stops are not preferred and should be avoided whenever possible. Figure 3 illustrates an example of a mid-block bus stop. A case that might necessitate a mid-block bus stop is where:

- The major trip generators are between intersections and cannot be served at the nearest intersection.

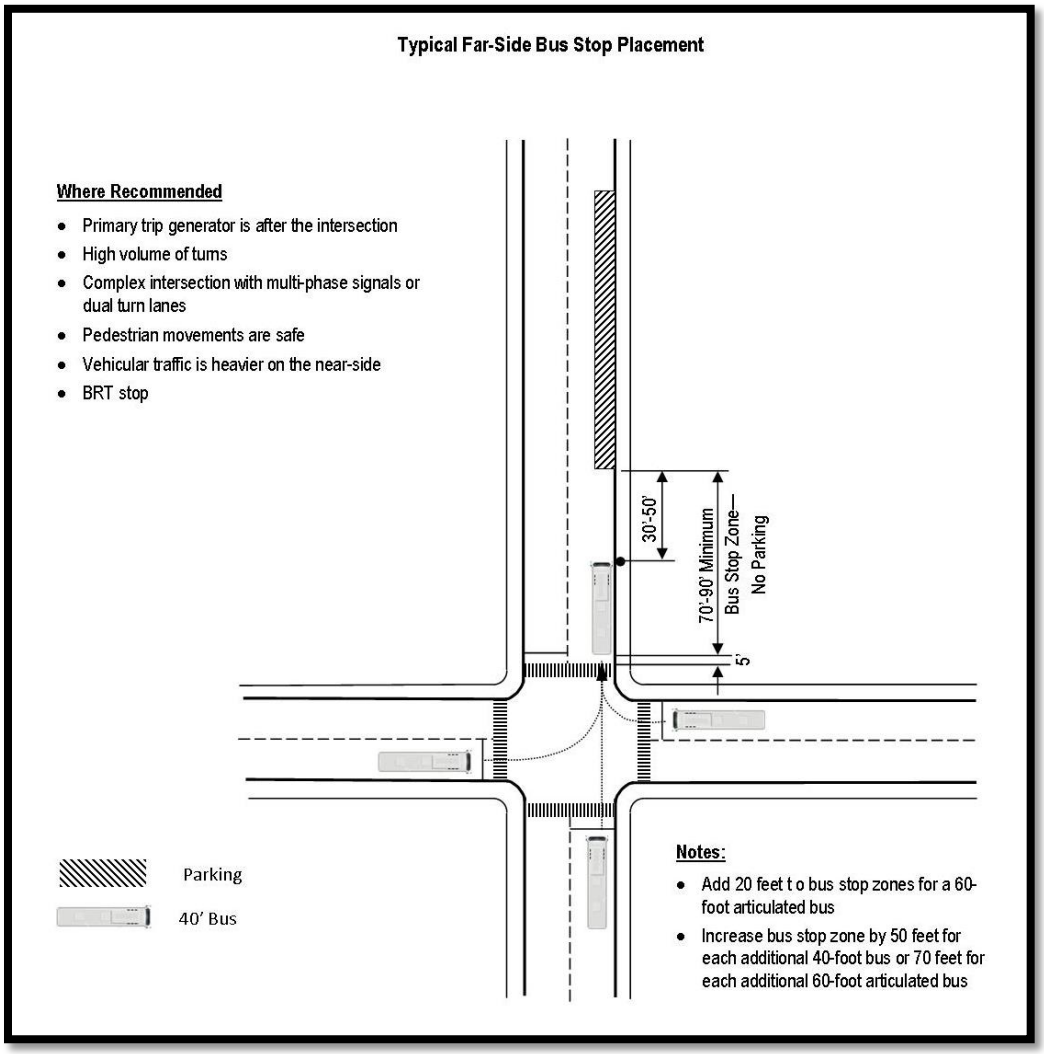

Figure 1: Example of Far-Side Bus Stop

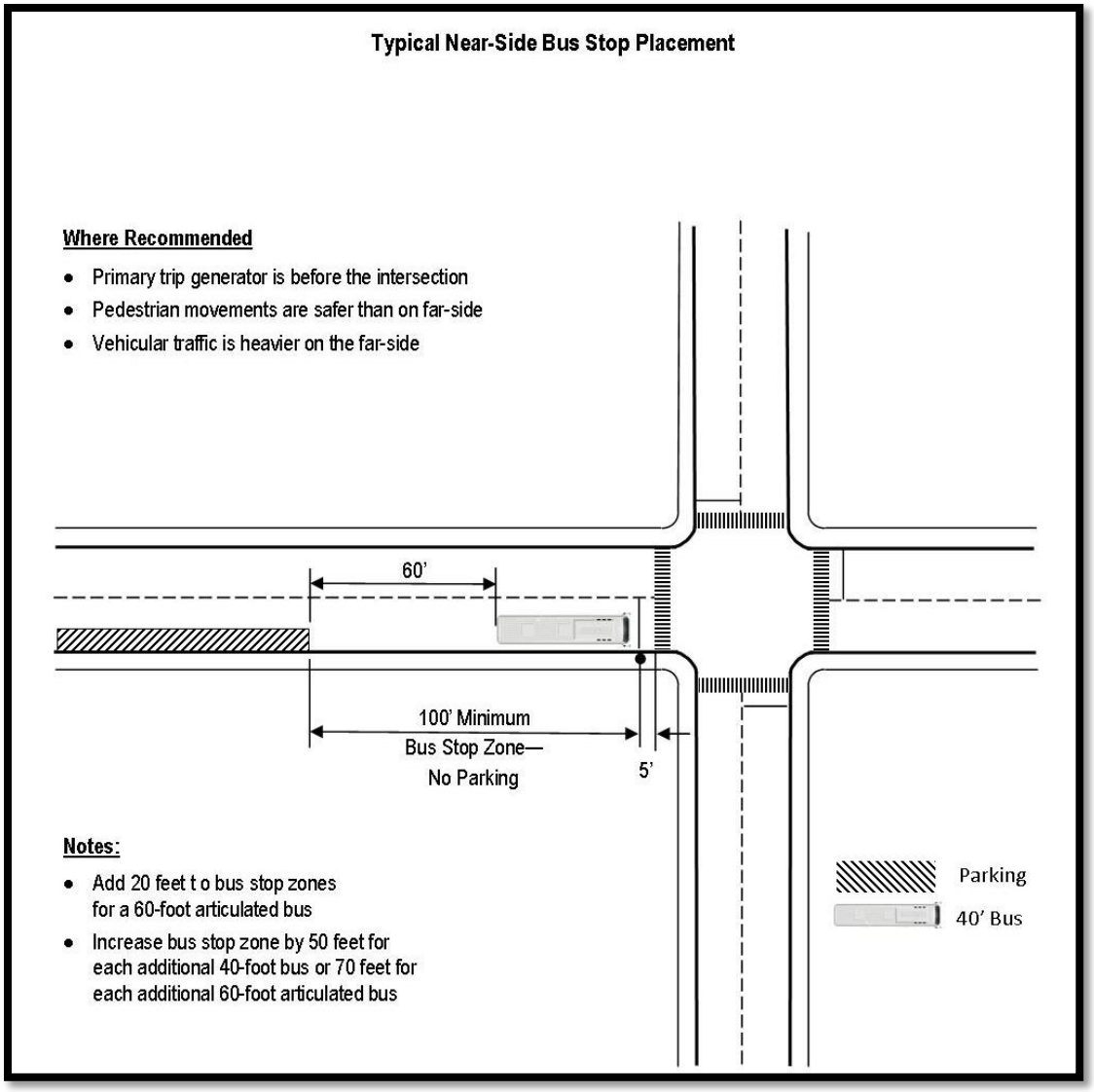

Figure 2: Example of Near-Side Bus Stop

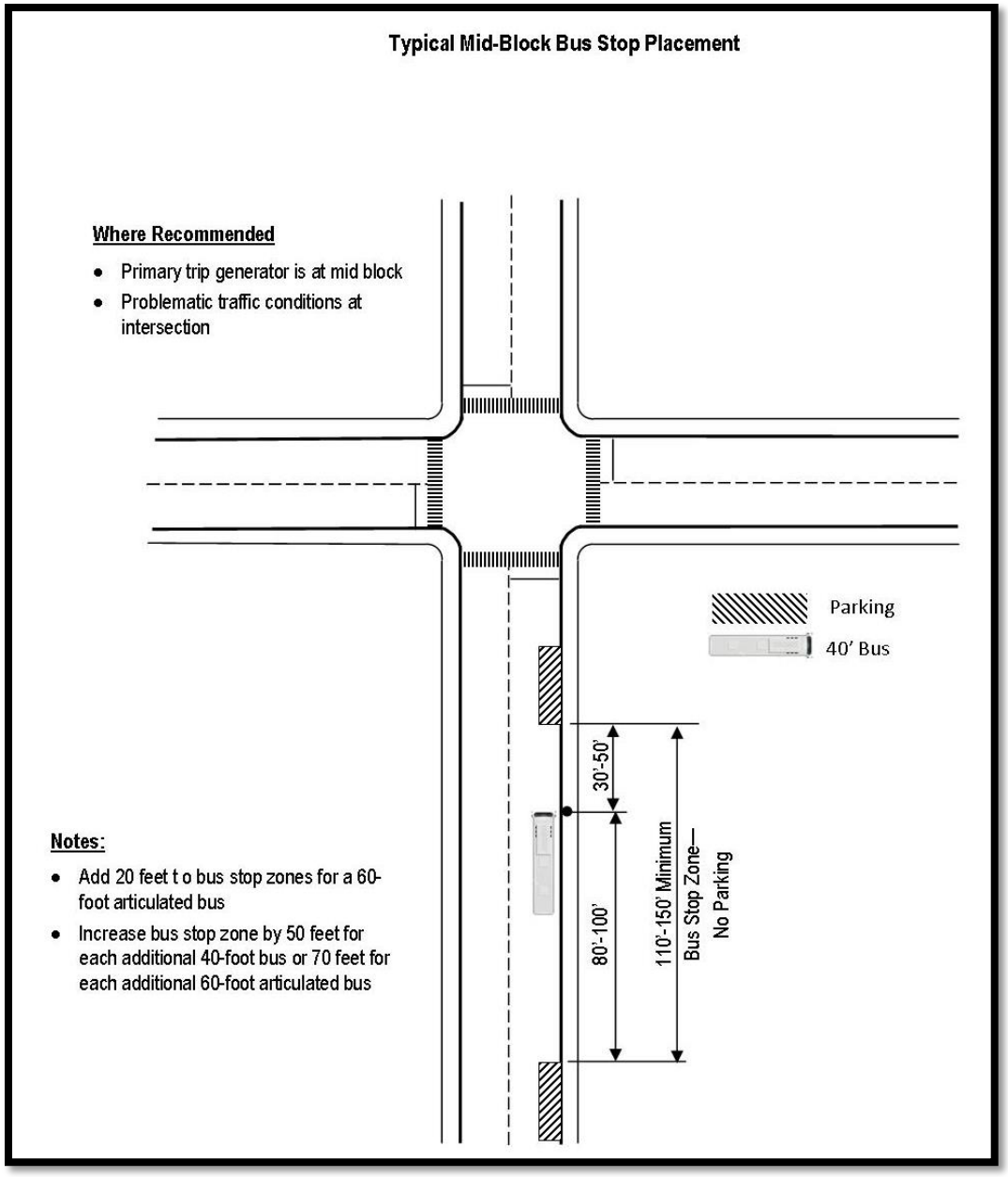

Figure 3: Example of Mid-Block Bus Stop

3.2. Bus Stop Installation Considerations

When considering a bus stop location relative to an intersection, the following factors should be taken into consideration:

- Adjacent land use and activities, including major trip generators and origins/destinations of special populations.
- Bus route alignment (for example, turning movements at an intersection).
- Intersecting transit routes and transfer possibilities.

- Pedestrian access – accessibility should be considered in the placement of all new bus stops; though the construction of sidewalks and other pedestrian infrastructure is often beyond the control of SORTA, bus stops should be placed in accessible areas to the extent possible given existing conditions.
- Existing right-of way - wherever possible, bus stops should be located where there is adequate right-of-way space for the construction of passenger amenities.
- Traffic conditions (volume and speed) and traffic control devices.

In addition, to allow for safe maneuvering for a left turn, Table 1 shows the minimum distance from bus stop to intersection for left turn movement. For example, on a 4-lane street with a 45 mph rated speed, a bus stop should be at least 600 feet from the intersection to allow enough distance for the driver to cross 3 lanes to make a left turn. Additional distance may be required in highly congested areas.

Table 1: Minimum Distance from Bus Stop to Intersection for Left Turn Movement (based on posted speed, traffic volume, & number of lanes to be crossed)

	Number of Lanes Crossed				
MPH	**1**	**2**	**3**	**4**	**5**
65	**750 ft.**	**775 ft.**	**825 ft.**	**875 ft.**	**925 ft.**
60	**675 ft.**	**725 ft.**	**775 ft.**	**825 ft.**	**875 ft.**
55	**625 ft.**	**650 ft.**	**700 ft.**	**750 ft.**	**800 ft.**
50	**575 ft.**	**600 ft.**	**650 ft.**	**675 ft.**	**725 ft.**
45	**525 ft.**	**550 ft.**	**575 ft.**	**600 ft.**	**625 ft.**
40	**450 ft.**	**475 ft.**	**525 ft.**	**550 ft.**	**575 ft.**
35	**400 ft.**	**425 ft.**	**450 ft.**	**475 ft.**	**500 ft.**
30	**350 ft.**	**375 ft.**	**400 ft.**	**425 ft.**	**450 ft.**
25	**275 ft.**	**300 ft.**	**325 ft.**	**350 ft.**	**375 ft.**
20	**225 ft.**	**225 ft.**	**250 ft.**	**275 ft.**	**300 ft.**

Source: TCRP-19: Guidelines for the Location and Designs of Bus Stops

3.2.1. Accessibility Factors

Whether the bus stop is located near-side, far-side, or mid-block, the bus stop location should have adequate sidewalk connections, and roadway crossing amenities (e.g. marked crosswalks, median islands, curb ramps or cuts, pedestrian signals, etc.).

3.2.2. Safety

For safety purposes, bus stops should not be placed in the following locations:

- On the side of a roadway with limited space for pedestrian movement (i.e. constrained by a ditch, guardrail, or retaining wall).
- Around a blind curve, where oncoming traffic will be unable to see a stopped bus.
- Immediately over a crest of a hill, where oncoming traffic will be unable to see a stopped bus.
- On limited-access roads.

- In proximity to driveways; however, where unavoidable, the following should be taken into consideration:
    - Attempt to keep at least one exit and entrance driveway open for vehicles to access site.
    - Locate stop so passengers do not wait, board, or alight in driveway.
    - It is preferable for the bus to **fully** rather than **partially** block a driveway.

3.2.3. Other placement considerations

- Bus stops should be placed where they are easy to see by the bus driver, as well as other drivers and bicyclists.
- Bus stops should preferably be placed close to existing pedestrian crossings, good pedestrian infrastructure and adequate lighting.
- In high-transfer locations, bus stops should be located so as to minimize the intersection crossings required of transferring passengers.
- In areas with on-street parking, parking restrictions will need to be put in place to ensure bus access to the curb.

The relative advantages and disadvantages for each type of bus stop placement are illustrated in Table 2.

Table 2: Bus Stop Locations

Location Related to Intersection	Advantages	Disadvantages	Where Recommended
Far-side (Located immediately after an intersection)	Does not conflict with vehicles turning right. Appropriate after the route has made a turn. The stopped bus does not obscure sight distance to the left for vehicles entering or crossing from the side street. At signalized intersections, buses can more easily re-enter traffic. The stopped bus does not obscure traffic control devices or pedestrian movements at the intersection.	The stopped bus obscures the sight distance to the right of drivers entering from the cross street to the right of the bus. If the bus stops in the travel lane, it may result in queued traffic behind it blocking the intersection.	When traffic is heavier on the near-side than on the far-side of the intersection. At intersections where heavy left or right turns occur. When pedestrian access and existing landing area conditions on the far-side are better than on the nearside. At intersections where traffic conditions and signal patterns may cause delays. At intersections with transit signal priority treatments.
Near-side (Located immediately before an intersection)	Less potential conflict with traffic turning onto the bus route street from a side street. The bus boarding door is close to the crosswalk. Bus has intersection to merge into traffic. Bus Driver can see oncoming buses with transfer passengers.	Potential conflicts with right turning traffic due to cars cutting in front of the bus. The stopped bus obscures vehicle driver's sight of pedestrians entering from the right (from in front of the bus). The stopped bus may block visibility of the stop signs or	When traffic is heavier on the far-side than on the approaching side of the intersection. When pedestrian access and existing landing area conditions on the near-side are better than on the far-side. When street crossings and other pedestrian movements are safer when the bus stops on the near-side than the far-side.

		traffic signals. **At signalized intersections, may result in schedule delays.**	**When the bus route does not go straight through the intersection.** **When adequate sight distance can be achieved at the intersection.** **At intersections with bus queue jump lane**
Mid-Block (Located 300 feet or more beyond or before an intersection)	**The stopped bus does not obstruct sight distances at an intersection.** **May be closer to major activity centers than the nearest intersection.** **Less conflicts between waiting and walking pedestrians.**	**Requires most curb clearance of the three options (unless a midblock sidewalk extension or bus bulb is built).** **Encourages mid-block jaywalking.** **May increase customer walking distances if the trip generator is close to an intersection. Length of mid-block stops can vary due to depth of a turn-out and a bus's ability to maneuver in/out of traffic lanes.**	**When traffic or street/sidewalk conditions at the intersection are not conducive to a near-side or far-side stop.** **When the passenger traffic generator is located in the middle of a long block.** **When the interval between adjacent stops exceeds stop spacing standards for the area.** **When a mid-block stop is compatible with a corridor or district plan.**

Source: COTA Bus Stop Guidelines

3.3. On- Street Bus Stop

On-street stops are locations where the bus stops in the travel lane, parking lane or shoulder. These types of bus stops are most commonly used because of their operating efficiency. They provide easy access for bus operators and have minimal delays to service. In addition, these types of stops can be established, relocated or eliminated with relative ease.

3.3.1. Usage Factors

While on-street bus stops are the most common and the easiest to establish, there are some site characteristics that should be considered when evaluating a location for an on-street stop. Here are some considerations:

- Posted speed limit not to exceed 40 mph.
- Proper street lighting.
- Proximity to controlled intersections.
- Availability of pedestrian facilities (i.e. sidewalk, crosswalks, pedestrian signals).
- Adequate curb clearance to accommodate buses pulling in and out of bus stop zone (applicable to stops in the parking lane or shoulder).
- Suitable right-of-way for passenger amenities and wheelchair access.

On-street bus stops (that do not require curb modifications) may be implemented in 2 different ways based on space availability, and operating considerations. The two types are:

1. In Travel Lane
2. In Parking Lane

3.3.2. Bus Stop Installation Types

Any of the above discussed stops may be implemented in a number of configurations. A bus stop may be "installed" as a curb lane stop, where the bus stops in the travel lane; further, a bus stop may be installed within a parking lane, or as bulb. The type of installation depends entirely on roadway and sidewalk design, posted speed limit, traffic signalization, traffic conditions, the number of buses servicing the stop at a time, length of the stop layover, curbside clearance, and position of the stop related to the intersection. The following sections explain each of these installation types.

3.3.3. Bus Stop in Travel Lane

On-street bus stops that are located in the travel lane require minimum design and are the simplest of the three kinds of on-street bus stops to create. In this case, a bus travelling on the right lane will simply stop in its travel lane. Stops within the travel way should be avoided at locations with high volumes of rider activity, at which the bus may be stopped for significant periods of time and could possibly disrupt the flow of traffic. Figure 4 represents a typical on-street bus stop in the travel lane.

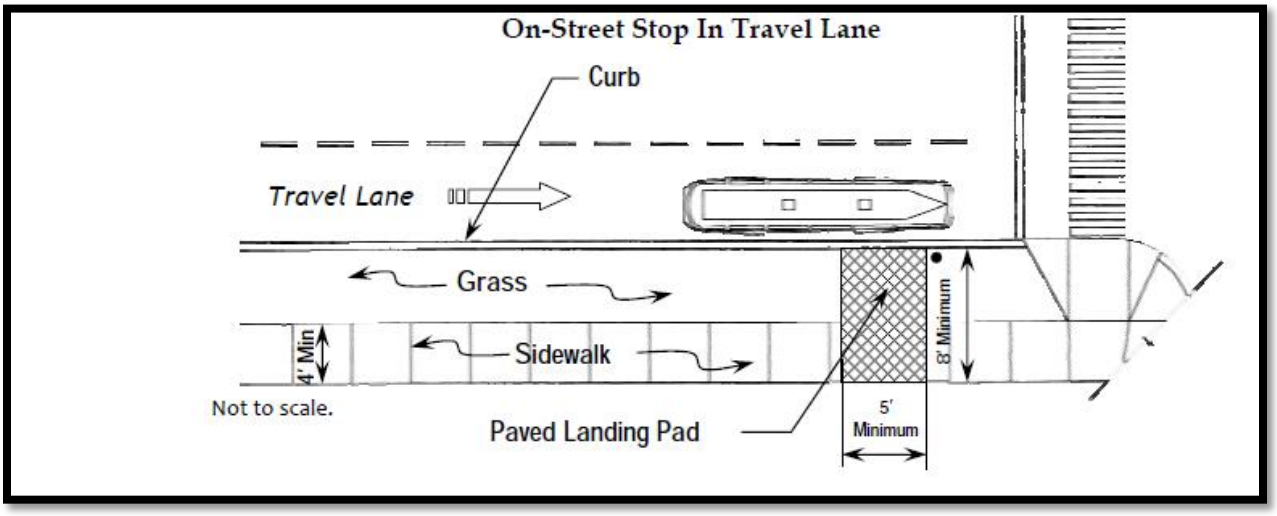

Figure 4: Example of Bus Stop in Travel Lane
Source: WMATA Bus Stop Guidelines.

3.3.4. Bus Stop in Parking Lane

In this scenario, a bus will use the parking lane to make a stop. The bus will be traveling in the lane next to the parking one, crosses over to the parking lane and stops at the bus stop. After departure, the bus will leave the parking lane and travel in the travel lane. The bus stopping and acceleration/deceleration areas need to be designated as "No Parking" with enforcement, to make sure parked cars do not block bus access to the curb and render the stop inaccessible to passengers who use wheelchairs. As a result of the parking capacity that this kind of bus stop removes, the jurisdiction may want to consider constructing a curb bulb for stops which otherwise could be made on street. Figure 5 represents a typical on-street bus stop in the parking lane. Table 3 shows space requirements for travel lane at the bus stop.

Table 3: No Parking Zone Requirements for In Line/Travel Lane Bus Stops

Bus Stop Relationship to Intersection	Minimum Clearance for Standard Bus
Near-Side Bus Stop	100 Feet (60 feet behind bus)
Far-Side Bus Stop	90 Feet (50 feet in front of bus)
Far-Side Bus Stop After Turn	90 Feet (50 feet in front of bus)
Mid-Block Bus Stop	150 Feet (50 feet in front of bus)

Source: *TCRP-19: Guidelines for the location and Designs of Bus Stops*

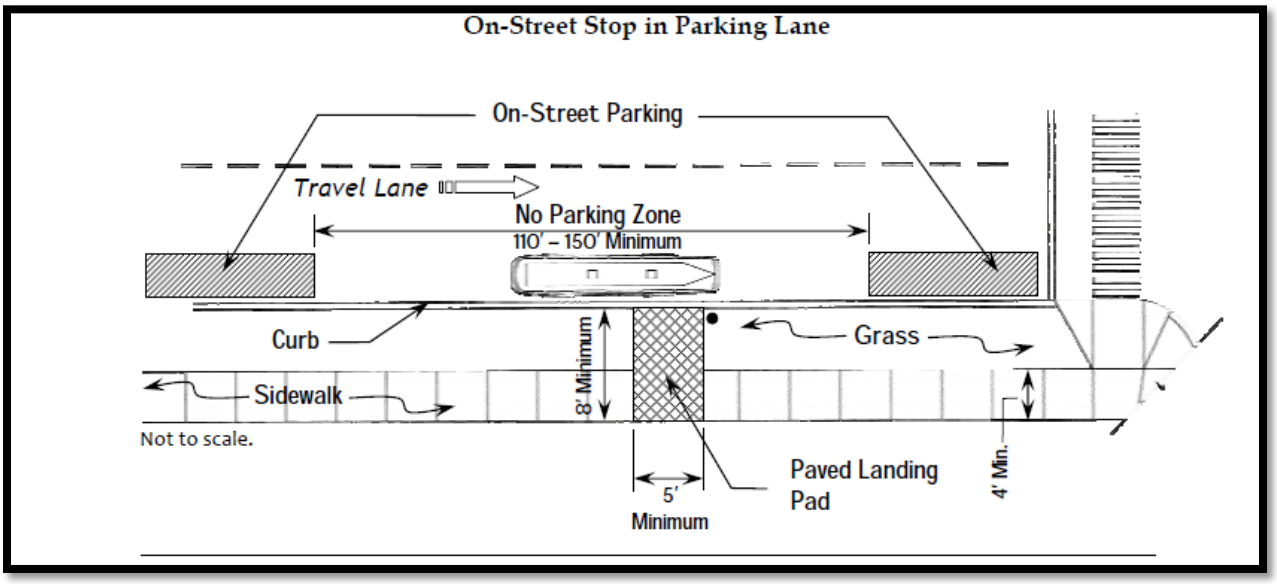

Figure 5: Example of Bus Stop in Parking Lane
Source: WMATA Bus Stop Guidelines.

3.3.5. Bus Stops and Driveways

For on- street bus stops, it is recommended that bus stops not be placed near driveways. However, if a placement near a driveway is unavoidable:

- Attempt to keep at least one exit and entrance open to vehicles accessing the property while the passengers are boarding and alighting the bus. When there are two driveways to a lot on the same street, the upstream driveway should be blocked forcing vehicles to turn behind the bus to enter the driveway.
- It is recommended to fully block a driveway to prevent vehicles from attempting to squeeze by the bus in a situation with reduced sight distance.
- Install bus stops at locations to allow good visibility for vehicles leaving property to minimize cars/bus conflicts. This is best achieved by placing bus stops where driveways are behind the stopped bus.
- Make sure that passengers have a safe area to wait where boarding occurs in or adjacent to driveway.

3.3.6. Accessibility Factors

Buses should have access to the curb adjacent to the bus stop particularly for stops that are in parking lane or on shoulder. This will allow safe access for all types of customers to board and alight the bus. Further, on-street bus stops should be located so that the front door of the stopped bus aligns with the ADA landing pad.

3.4. Curb Bulb

3.4.1. Introduction

Curb bulbs, also known as curb extension, bulb-out, bump out or nub, is an extension of side walk into an existing parking lane, creating additional space for pedestrian movement and waiting area. Installing curb extensions along transit routes can increase the efficiency of a route by reducing the amount of time a bus is stopped at a bus stop. Delays caused by buses re-entering the flow of traffic can be eliminated by allowing the bus to remain within the travel lane when stopped for customers to board and alight. Curb bulbs provide enough space for bus passengers to comfortably board and alight from the bus away from nearby general pedestrian traffic. Furthermore, curb bulbs shorten the pedestrian walking distance across a street, which reduces pedestrian exposure to on-street vehicles; therefore, enhancing sight angles for pedestrians and motorists. Finally, curb bulbs are intended to maximize pedestrian space while increasing pedestrian safety and transit operations.

Even though more expensive to construct, the installation of a curb bulb can overcome limitation to on-street parking and sidewalk space needed for transit amenities by providing additional space for boarding or waiting areas, shelters, benches, and trash cans. In addition, a curb bulb reduces the length of the bus stop zone and eliminates the need for deceleration and acceleration space, allowing for more on-street parking and prevents parking within the bus stop zone. Curb bulb should not be considered where traffic is high volume or on high speed roadways where speeds are greater than 45 miles per hour as vehicle stacking can become challenging. Figure 6 represents a curb bulb.

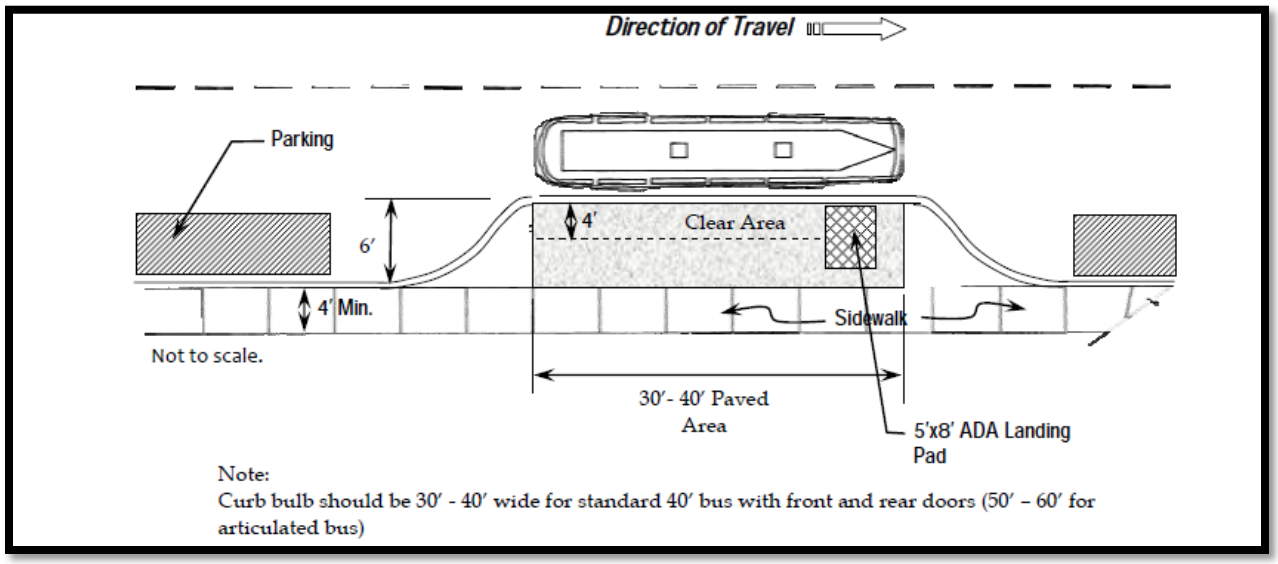

Figure 6: Example of Curb Bulb
Source: WMATA Bus Stops Guidelines.

Table 4: Represents Minimum Bus Bulb Dimensions

Criteria	Requirement
Design Speed	<45 MPH
Minimum Width	8 Feet
Bus Stopping Area*	30 Feet (Standard) 45 Feet (articulated)

3.4.2. Usage Factors

Curb bulbs should be located:

- On newly constructed streets.
- On streets with high pedestrian activity and high traffic volumes.
- On streets with a history of pedestrian safety concerns.
- On wide streets with lengthy pedestrian crossing distance and times.
- In areas where curbside parking is critical.
- In areas with limited curb clearance.
- In areas where buses experience delays in re-entering the traffic lane.
- In areas where traffic calming is desired.
- Where the existing sidewalk is too narrow to accommodate transit amenities or pedestrians through traffic is limited.

3.4.3. Design Factors

Curb bulbs should be 30 feet to 40 feet long for a standard 40 foot transit bus that has front and rear doors. And for a 60 foot articulated bus, the curb clearance should be 50 feet to accommodate rear door access.

3.4.4. Accessibility Factors

To inhibit obstruction to the front and rear doors of the bus, a 4-foot wide area adjacent to the curb needs to be clear of such items as trash containers, vendor boxes, electricity poles, planters, benches and shelters. The cemented area of the curb bulb should be connected to a 4 feet wide sidewalk.

3.5. Bus Bays

A bus bay stop is a type of stops that is separated from the normal travel lane and is designed to allow through traffic to flow freely without the obstruction of stopped buses. Bus bays are typically provided on high-volume or high-speed streets that allow buses to pick up and drop off customers outside of the travel lane. Heavily jammed arterial roads, where there are large numbers of people who board and alight, may benefit from the installation of a bus bay stop. This kind of stopping area should be designated as a “No Parking & No Stopping” area and be reinforced with a concrete pad. This kind of structure requires enough right-of-way so that sidewalk capacity would not be negatively affected. Although a bus bay’s preferable width is 12 feet, 10 feet may also be acceptable. The total length of a bus bay should allow room for an entrance taper, a deceleration lane, a stopping area, an acceleration lane, and an exit taper. Figure 7 and Figure 8 provide examples of bus bay layouts while Table 5 provides the minimum required dimensions for Bus Bays. Table 6 represents acceleration and deceleration dimensions for Bus Bays.

The two common types of bus bays are (both described later):

- Parallel bus bay.
- Sawtooth bus bays.

3.5.1. Usage Factors

Criteria to be considered for using bus bays should include:

- Traffic speeds that exceed 40 miles per hour.
- Traffic in the curb lane that exceeds 250 vehicles during the peak hour.
- Average peak-period dwell time exceeds 30 seconds per bus.
- Buses are expected to lay over at the end of a trip.
- Multiple buses service the stop at the same time.
- History of repeated traffic and pedestrian accidents at stop location.
- Potential for auto/bus conflicts warrants separation of transit at stop location.
- A right-of-way width that is adequate to construct the bay without adversely affecting sidewalk pedestrian movement.

Figure 7: Example of SORTA Bus Bay

3.5.2. Parallel Bus Bays

This kind of stop is commonly referred to as a bus bay, or turn-out. They are constructed as an inset into the curb, typically with tapered ends for acceleration and deceleration. There are two kinds of parallel bus bays: closed bus bays and open bus bays. Closed bus bays have tapered ends for acceleration and deceleration, whereas open bus bays have one tapered end either for acceleration or deceleration, but not both. Generally, closed bus bays are preferred because it provides the greatest level of protection for buses with the least amount of disruption to traffic. The bus zone, including the deceleration and acceleration areas, should be designated as “No Parking & No Stopping”. In addition, the surface area of the bus stop zone should be constructed of concrete.

Table 5: Represents Minimum Bus Bay Dimensions

Criteria	Requirement
Design Speed	>40 MPH
Minimum Width	12 Feet
Bus Stopping Area*	50 Feet (Standard) 70 Feet (articulated)

***Note: All Bus Bays located in urbanized areas (curb and gutter) shall be designed to accommodate as least 2 busses.**

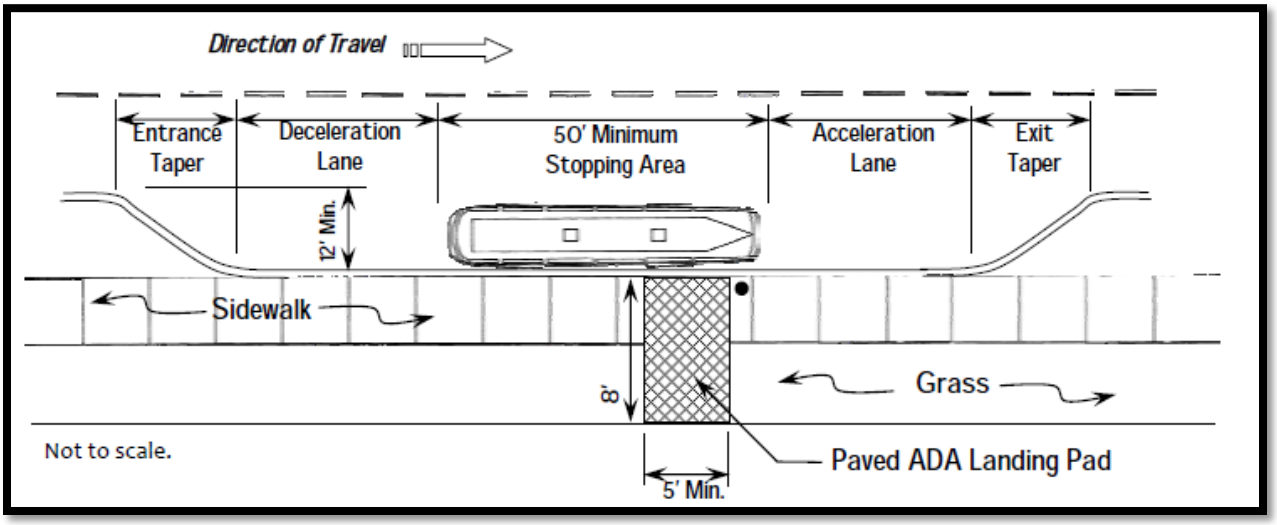

Figure 8: Example of Parallel Bus Bay

Table 6: Provides Acceleration and Deceleration Dimensions for Bus Bay

Acceleration and Deceleration Dimensions			
Through Speed (mph)	**Acceleration Lane Length (feet)**	**Deceleration Lane Length (feet)**	**Entrance and Exit Taper Length (feet)**
35	**250**	**184**	**170**
40	**400**	**265**	**190**
45	**700**	**360**	**210**
50	**975**	**470**	**230**
55	**1400**	**595**	**250**
60	**1900**	**735**	**270**

Source: TCRP-19: Guidelines for the location and Designs of Bus Stops

3.5.3. Sawtooth Bus Bays

In off-street bus stopping areas, such as bus transfer centers, and park & ride lots, sawtooth bus bays are preferred for their efficient use of constrained curb space. Sawtooth bays are usually wider than parallel bays; however, they require shorter curbside distance as buses typically are moving at a much slower speed in these facilities. Figure 9and Figure 10 represent examples of a sawtooth bus bays.

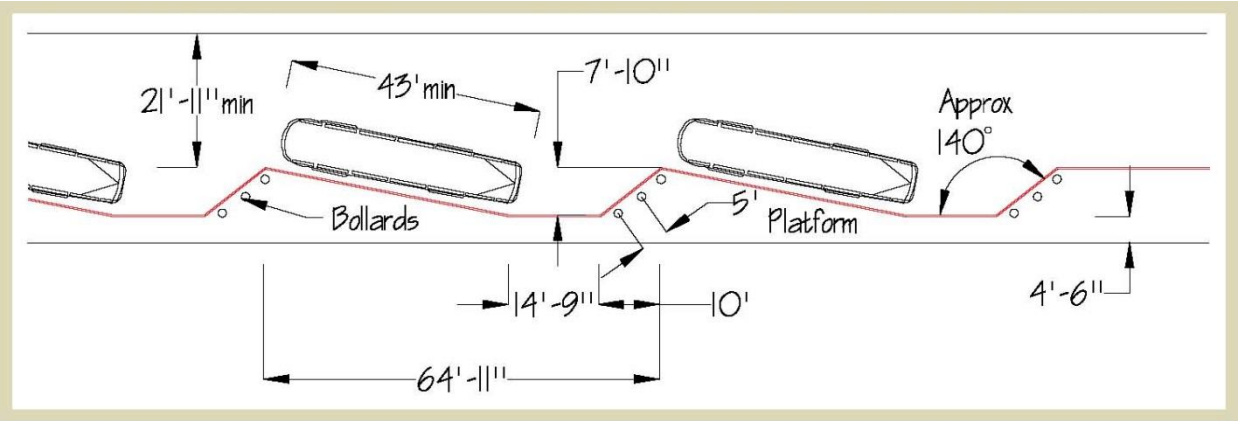

Figure 9: Example of Sawtooth Bus Bay
Source: *Accessing Transit – Designing Handbook for Florida Bus Passenger Facilities*

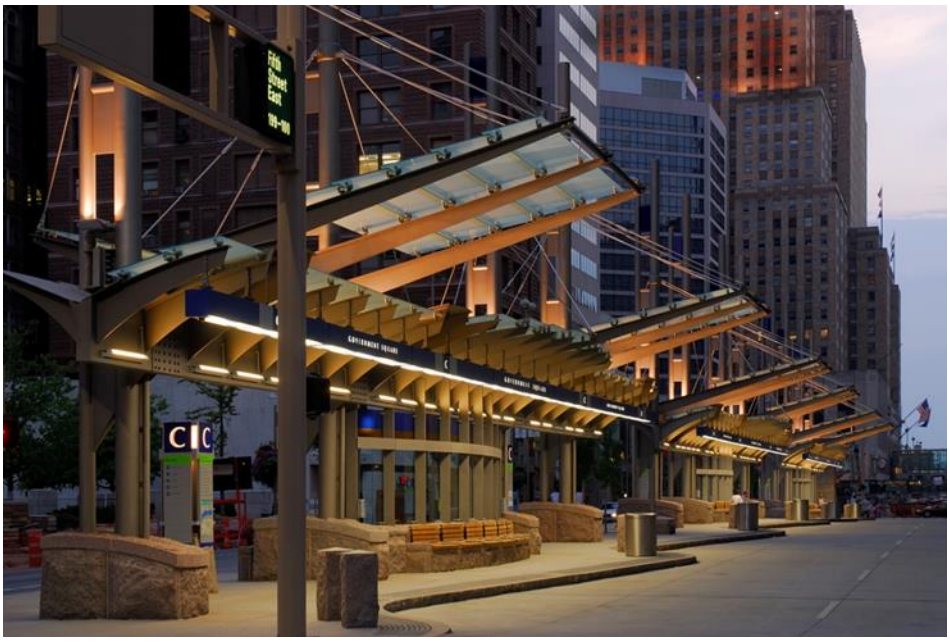

Figure 10: SORTA Sawtooth, Cincinnati, Ohio

4. BUS STOP SPACING

Stop spacing distances in Table 7 were developed for the bus stop optimization project. Thresholds for residential density patterns were aligned with the documented Central Ohio Transit Authority (COTA) stop spacing standards, with the addition of an employment density component based on the natural breakpoints in employment found within the SORTA service area.

Table 7: Recommended Stops Spacing

Operating Environment	Density	Optimal Stop Spacing min (feet)	Number Stops per mile
High Density	> 20 residents per acre > 10 jobs per acre	700 – 900	6 - 8
Moderate Density	10-20 residents per acre 5-10 jobs per acre	1,000 - 1,300	4 - 5
Low Density	< 10 residents per acre < 5 jobs per acre	1,300 - 1,800	3 - 4

Although these distances are to be used as the optimum minimum distances between stops, there may be times when stops need to be closer or farther apart depending on critical needs.

5. BUS STOP ELEMENTS AND PASSENGER AMENITIES

5.1. Introduction

SORTA has over 4,000 bus stops and just like many other transit agencies, SORTA's resources for providing and improving customer facilities are limited, requiring the need to concentrate on what and where improvements should be made. These improvements enhance safety, accessibility, and/or comfort and convenience at and around bus stops. SORTA follows a hierarchy of bus stop elements and passenger amenities. The hierarchy of bus stops includes stops that are basic, enhanced and transit center. However, it's important to note that there are no strict criteria that determine whether a particular bus stop will be basic, enhanced, or transit center. Instead, amenities at bus stops are decided on a case-by-case basis and affected by a variety of factors, including ridership, existing conditions, number of routes serving the stop, transfer opportunities, and special populations served by the stop. Table 8 provides a list of recommended elements and passenger amenities for each bus stop class. Table 9 provides minimum ridership figures that would justify the addition of bus stop elements and amenities.

SORTA's bus stop hierarchy types are:

- Basic
- Enhanced
- Transit Center
- Bus Rapid Transit (BRT)
- Park and Ride

Table 8: Bus Stop Hierarchy ("O" is optional amenity and "S" is standard for that bus stop type)

Amenity	Basic Stop	Enhanced Stop	Transit Center	Bus Rapid Transit (BRT)	Park and Ride
SORTA Sign	S	S	S	S	S
Regulatory Sign	S	S	S	S	S
ADA Landing Pad	O	S	S	S	S
Information Case	O	S*	S	S	O
System Map	O	S**	S	S	O
Seating	O	Trip Generator Based	S	S	S
Shelter	O	S**	S	S	S
Lighting	S	S***	S	S	S
Trash Receptacles	Site Specific	Site Specific	S	S	S
Bicycle Rack	O	S***	S	O	S
Real Time Display	O	S	S	S	O
Interactive Phone System on Site	O	O	S	O	O
TVM	O	O	S	O	O

*Major Stops **50 + boarding/day ***Site Specific

Table 9 describes the minimum daily boardings required at a particular stop to justify the provision of certain amenities. However it is important to make clear that these are guidelines and exceptions may be made. For example, at locations where there is a large number of elderly and/or individuals with special needs, the minimum boardings may be relaxed. On the other hand, locations where they meet the minimum boardings listed in Table 9 may not require certain amenities (i.e. a bench) if the frequency of service is extremely high.

Table 9: Required Daily Boarding Figures

Daily Boarding's					
Feature	**<25**	**25-49**	**50-99**	**100-250**	**>250**
Sign and Pole	✓	✓	✓	✓	✓
Accessible	✓	✓	✓	✓	✓
Bench		✓	✓	✓	✓
Passenger Shelter			✓	✓	✓
Timetable				✓	✓
Route Map/Info			✓	✓	✓
Trash Receptacles				✓	✓
Bus Pads	✓	✓	✓	✓	✓
Lighting			✓	✓	✓
Electronic Sign					✓

5.1.1. Basic Bus Stops

Basic bus stops are stops that are marked out by the placement of a SORTA route sign, without requiring additional improvement. These kinds of stops are placed in areas with existing sidewalks, or in areas without existing sidewalks but no other construction were being performed at the time of installation. Figure 11 represents a basic bus stop. The Basic bus stops are utilized where boardings/alightings activities are light and where, usually, no transfers occur.

Figure 11: Example of SORTA Basic Bus Stop

5.1.2. Enhanced Bus Stops

Enhanced Bus Stops are boarding/alighting stops that have an ADA landing pad connected to a sidewalk and a SORTA route sign. Further, if the stop has adequate daily ridership, additional amenities such as shelters and benches are recommended. Figure 12 illustrates an example of a SORTA enhanced bus stop.

Figure 12: Example of SORTA Enhanced Bus Stop (with bench and trash bin)

5.1.3. Transit Centers

Transit Centers are boarding/alighting areas designed to be served by multiple routes. They're located at major destinations with high numbers of transfers, where several bus routes converge. Transit Center stops have shelters, benches and other amenities. They serve as efficient "hubs" to allow passengers from various locations to assemble at a central point to take advantage of express trips or other route-to-route transfers. Figure 13 represents SORTA's Government Square Transit Center stop.

5.1.4. Special Service Stops (Metro Plus)

Special Service stops are designated as a limited stop/skip stop service. In terms of SORTA service, these are stops served by Metro Plus service. This type of stops serves a select number of bus stops along selected corridors in order to provide a higher level of service. They should have the same amenities as basic stops as well as a system map, real time travel information and additional passenger waiting shelter(s) for boardings of 300 or more per day.

Figure 13: Transit Center, Government Square, Cincinnati, Ohio

5.1.5. Park-and-Ride

Park-and-Ride lots are off-street intermodal facilities which allow users to change from automobile travel to public transit. Park-and-Ride facilities may consist of parking garages and/or paved areas used for transit riders to park their automobiles while commuting by bus. In addition, park-and-ride facilities serve as collector sites for bus service or as transit centers. A typical park-and-ride facility includes shared-use lots (passengers and non-passengers use it) or permanent, single use lots or garages. Since customers likely arrive by cars, the service area for a park-and-ride facility is much greater than a typical pedestrian bus stop and may:

- Serve local/BRT/express bus service
- Be located at end of a route
- Require shelter, benches and information signs
- Include charging stations for electric cars
- Include restroom facilities for drivers

5.2. Bus Stop Sign

5.2.1. Introduction

Bus stop signs are placed to notify the general public and bus drivers of the designated location of the bus stop. To prevent signs from being struck by the bus mirrors, signs should be placed at a sufficient distance from the curb as not to interfere with bus mirrors and affect the pedestrian path of travel. For best visibility, bus stop signs should

usually be placed 2 feet from the face of curb and no further than 4 feet away from the face of curb so that they are still clearly visible to riders and bus operators. The sign flag should be mounted on the pole perpendicular to the roadway and allow for 7 feet of clearance below the bottom of the sign. Location of signs must follow the provisions with city standards, policies and guidelines as outlined in Cincinnati Municipal Code Section 502-22. Further, stop signs publicize services and routes being served at such locations. Figure 14 represents SORTA bus stop signs.

Figure 14: SORTA Bus Stop Signs

5.2.2. Usage Factors

Each active SORTA bus stop location should be marked with a bus stop sign and text indicating which routes serve the stop.

5.2.3. Design Factors

Minimum information on the bus stop sign should include:

- Metro name
- Metro logo
- Customer Service phone number
- Website address
- 4-digit stop ID
- Route numbers/names.

The sign must be easily visible to the approaching bus operator and customers and be clear of the side mirrors of buses. Other design considerations include:

- Sign should neither obstruct nor be obstructed by other objects.
- Sign should be perpendicular to the street.

- Whenever possible, the bus stop sign should be located at the front of each bus zone.
- Whenever possible, bus stop signs should be placed independently of all other street signs to maintain transit stop identity. Figure 15 shows bus stop sign placement criteria guidelines.

5.2.4. Accessibility Factors

Bus stop signs should meet ADA Accessibility Guidelines (ADAAG) requirements for height, width, and visibility. The bottom edge of the sign should be positioned at a height of at least 84" above the ground. Signs mounted on bus stop shelters should also have a clearance of 84" to 98" from the base of the sign to the ground. ADAAG guidelines for information related to accessibility include:

- Locate outside pedestrian access route leading from the waiting area to the boarding and alighting area.
- Locate outside of minimum 3 feet clear circulation zone away from transit amenities and street furniture.
- Locate outside the 8 feet x 5 feet wheelchair landing pad.
- Locate outside the 4 feet minimum pedestrian access route.
- Non-glare finish characters and background.
- Characters contrasted with background with either light characters on a dark background or dark characters on a light background.
- Provide a minimum of 7 feet vertical clearance from the bottom of the sign to the ground or floor surface.
- Install at a maximum of 10 feet from the top of the sign to the ground or floor surface.

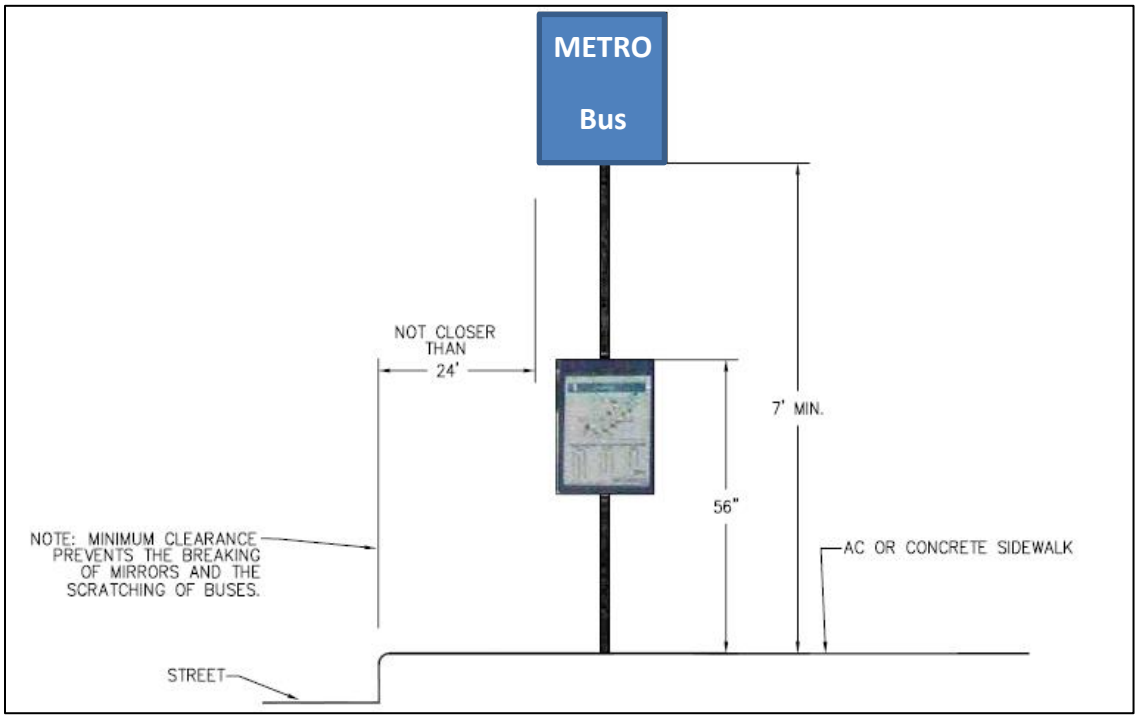

Figure 15: Bus Stop Sign Placement Criteria
Source: Darnell and Associates INC.

5.3. Bus Stop Sign Post

5.3.1. Introduction

Bus stop posts provide a way to firmly mount customer information and amenities such as the bus stop sign, and information case.

5.3.2. Usage Factors

Bus stop locations should have their own bus stop posts, and using other kinds of posts such as utility poles, traffic sign posts, and light poles should be completely avoided.

5.3.3. Design Factors

It is recommended that bus stop sign posts be installed far-side of the landing area and be rust resistant, painted white, and uniform in design.

5.3.4. Accessibility Factors

It is recommended that bus stop posts be more unique and distinguishable from other posts in the same location so they are easily recognizable by customers with visual impairments. Consistent placement of the sign pole provides the bus operator with a landmark at which to align the front end of the bus to make deployment of the ramp possible. Additionally, it provides customers with an indication of where they will be boarding.

5.4. Information Case

5.4.1. Introduction

Information cases are used to show routes serving bus stop, type of route (local or express), schedules, fares and other system information. The cases can be mounted on SORTA sign poles or be part of the overall design of a passenger shelter. Example of information cases are shown in Figure 16.

Figure 16: Examples of Local Information Cases

5.4.2. Usage Factors

Information cases should be placed at bus stop locations with a higher ridership and stops that serve as transfer points between routes.

5.4.3. Design Factors

Information cases are generally installed on the bus stop poles, but can be part of the overall design of the customer shelter. Cases that are installed on the bus stop poles can be either rectangular or cylindrical. While the bus schedules, timetables, and maps that are posted in the information case are not subject to ADAAG, the information case itself must meet applicable ADAAG requirements to ensure that they do not create a potential hazard for pedestrians. Some recommendations for route or passenger information displays are as follows:

- Provide updated information when changes are made to routes and schedules.
- Consider the quality and appearance of information displays. A visually poor route map conveys a negative impression of the system.
- Make information display permanent. Temporary methods for displaying information (such as tape mounting) create cluttered, unsophisticated appearance at the bus stop.
- Follow ADA clearance, mobility, and guidelines for access of information by individuals with impairments.

5.4.4. Accessibility Factors

There are a few types and styles of information cases such as stationary and rotational. Although the type of information case and placement may vary by jurisdiction, a paved access to all transit information displayed in the case must be provided. An advantage of an information case that's able to rotate or spin around the bus stop pole is that paved access only needs to be provided on one side of the case. It's important to note that cylindrical cases may distort the text and make it difficult to read/see for some. The recommended height for placing or viewing information case for passengers that are either seated or standing is between 48 inches to 67 inches on center from the ground. Figure 17 provides suggested viewing heights.

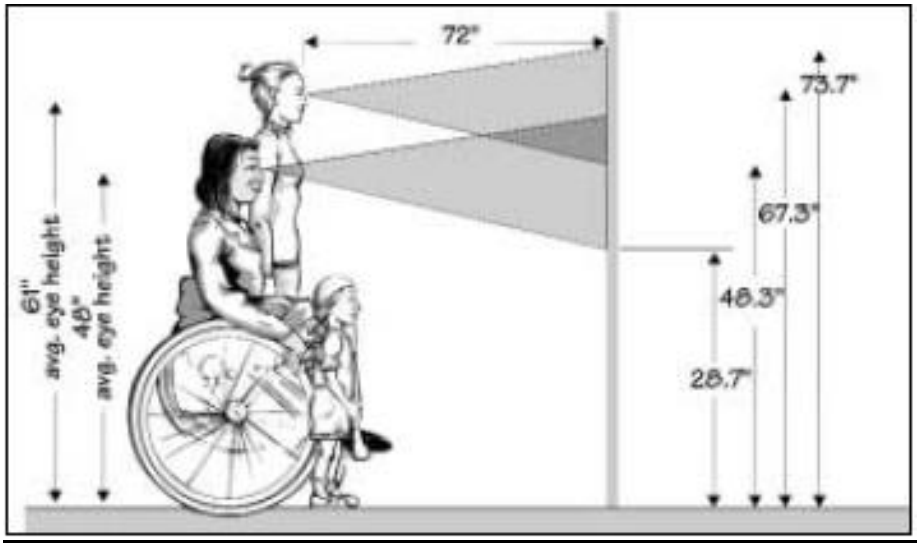

Figure 17: Suggested Viewing Heights
Source: *Design for Accessibility: A Cultural Administrator's Handbook.*

5.5. Lighting

5.5.1. Introduction

Lighting within the bus stop area enhances safety by improving both SORTA's operator and rider visibility. Lighting also provides a sense of security and contributes to defining the waiting area, in addition to illuminating route and schedule information for patrons. Further, good lighting can enhance one's sense of comfort, while bad lighting can encourage the misuse of a facility. Finally, the addition of lighting at a bus stop may enhance overall security in the surrounding area as part of a CrimePprevention Through Environmental Design (CPTED) approach.

5.5.2. Usage Factors

Proper lighting should be considered for stops based on their location, usage and service hours (early morning and late night service).

5.5.3. Design Factors

To avoid lighting cost, bus stops can be located near existing street lights. The bus stop signage should be illuminated and, if present, shelter fixtures can provide added light levels. Bus stop light fixtures or shelter illumination should be between 2.0 to 5.0 foot-candles. However, shelter lighting should be on the lower range as to not create a spotlight affect, where it's difficult for passengers waiting inside the shelter to see outside. Wherever possible, energy saving devices, such as efficient lamps, solar power, and daylight sensing equipment should be used.

5.6. ADA Landing Pad

5.6.1. Introduction

Level and paved waiting areas with adequate space provide greater access to transit service for wheelchair users, the elderly, and other encumbered riders such as parents with strollers. Another benefit to providing an adequate waiting area is that passengers waiting for the bus will be set back further from the curb and the flow of traffic. Figure18 provides an example of ADA landing pads.

Figure 18: Landing Pad with Sidewalk Set Back from Curb

5.6.2. Usage Factors

Creating a bus stop with just a pole and sign does not automatically initiate the need for an ADA landing pad unless other improvements such as shelters and other amenities are constructed. Nevertheless, in order to enhance access to transit services to all, it is recommended that ADA landing pads be constructed, to the extent possible, at all bus stop locations. Whenever municipalities or other jurisdictions undertake construction or renovation of an accessible pathway in close proximity to an existing or proposed bus stop, SORTA should require that the project include making those stops fully ADA- accessible, including an ADA landing pad and accessible route to the stop. SORTA will place new stops in accessible locations to the maximum extent practical but will not install a pad or shelter in locations without existing pedestrian facilities. Figure 19 represents an example of some design considerations for slopes around bus stops and for curb ramps.

5.6.3. Design Factors

Landing pads can be connected to the backside of the sidewalk or located between the curb and sidewalk. The location of the boarding/alighting area (wheelchair landing pad) must comply with the ADA Act of 1990. The design of a landing pad should take the following into consideration:

- The surface must be durable, slip resistant, and free of horizontal or vertical obstructions or tripping hazards.
- Clear of obstructions, at least 96 inches (8 feet) perpendicular from the curb/roadway and at least 60 inches (5 feet) parallel to the roadway. A landing area of this size or larger is necessary for deployment of the vehicle's ramp and for a customer using a wheelchair to maneuver on and off the lift.
- Constructed of hard, solid material.
- Connected to curb.
- Ensure proper water run off to avoid standing water.
- Avoid using catch basins as part of or all of the landing pad/passenger waiting area.
- Slope of the pad parallel to the roadway shall be the same as the roadway.
- Cross slope not to exceed 1:5 (2%).

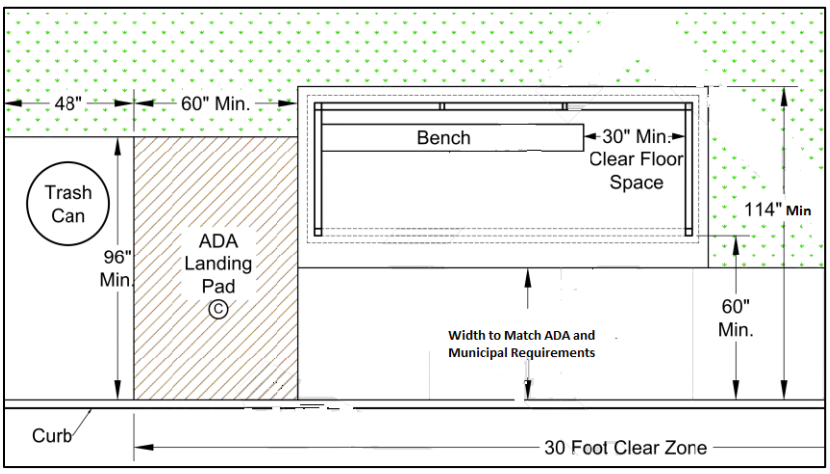

Figure 19: Example of Maximum Cross Slope on 4' wide and 2% Accessible Route

5.7. Benches

5.7.1. Introduction

Benches offer a place for transit riders to rest comfortably while waiting for the next available bus in the bus stop zone. Benches encourage social activities and provide places to rest along neighborhood corridors with transit service. In addition, benches enhance the appearance of the neighborhood around the bus stop. Benches may not be needed at every bus stop location, but do greatly improve the comfort of riders, especially the elderly, disabled, or those with limited mobility. Transit stops adjacent to large developments or near activities that generate a higher amount of transit passengers or have very long headway will require a bench. Figure 20 illustrates an example of a SORTA bus bench.

Figure 20: Example of SORTA Bus Bench

5.7.2. Usage Factors

Benches are recommended at transit stops adjacent to large developments or near activities that generate higher amount of ridership; stops that attract riders who may have difficulty walking or standing, especially stops with headways longer than 30 minutes, should be considered for benches.

5.7.3. Design Factors

Benches should be made of durable material, resistant to vandalism and wear from exposure to weather. The bench should be ADA- compliant in dimensions, with a recommended minimum length of 6 feet, or the equivalent of three seats. Further, benches shall be permanently secured to the sidewalk in accordance with a properly obtained sidewalk construction permit issued pursuant to Chapter 721 of the Cincinnati Municipal Code. The design of the bench should:

- Be coordinated with existing landscaping (e.g. shade trees) to provide protection from wind, sun, and rain.
- Be coordinated with existing street lighting to increase visibility and security.
- Not be located in undeveloped area near bench.
- Not be placed on ADA landing pad

- Not obstruct the sidewalk
- Be a minimum of 5 feet from the curb.
- Be oriented towards the street.
- Discourage sleeping on the bench.
- Include seats with 20 to 24 inches in depth and minimum of 42 inches in length; seat height should be 17 to 19 inches from the ground.
- Be at a slip-resistant surface that allows for proper drainage.

5.8. Shelters

5.8.1. Introduction

A bus shelter provides protection for passengers from sun, wind, and rain, while waiting for a bus to arrive. Shelters are installed at major boarding or transfer locations, shopping centers, and medical facilities. While SORTA strives to provide comfortable waiting areas for all customers, shelter installation must be prioritized due to limited resources. SORTA uses ridership figures as the primary criterion for determining which bus stops warrant shelters. Bus stop locations with 50 passenger boardings per day or more will be considered for shelters. Yet, there are additional factors that are taken into consideration that support placement of a shelter. Figure 21 provides some examples of SORTA bus shelters.

Existing site conditions such as the following may make shelter placement unfeasible:

- Adequate shelter of some type is not readily available
- Shelter location is not approved by the local jurisdiction
- Shelter location generates severe local community/business opposition.
- Inadequate Right-of-Way
- Lack of existing pedestrian amenities.

5.8.2. Usage Factors

Bus stops with ridership exceeding 50 boardings per day are priority candidates for new shelters. Bus stop locations that serve senior communities, colleges/universities, hospitals, major trip generators, other special trip generators, and major transfer points between routes may be suitable for passenger shelters.

Figure 21: Example of SORTA Bus Shelters

5.8.3. Design Factors

The shelter should be constructed of durable, architecturally sound materials to withstand heavy use and continual exposure to the elements. It can range from an overhead canopy structure, to one with a roof and be enclosed on at least two sides to provide a screen from prevailing winds. A clear view of the approaching bus and bus loading pad is necessary and can be accomplished using tempered, clear glass panels. Films or clear view materials can add design elements to the shelter exterior. Shelters should be oriented so they are placed facing the travel lane and nearside of the landing pad. However, some specific sites may call for a rear-facing shelter, for example, where ADA access can only be achieved with a rear-facing shelter due to narrow right-of-way. Shelters should be cleaned and maintained on a regular basis. Figures 22 and 23 provide bus shelter design diagrams.

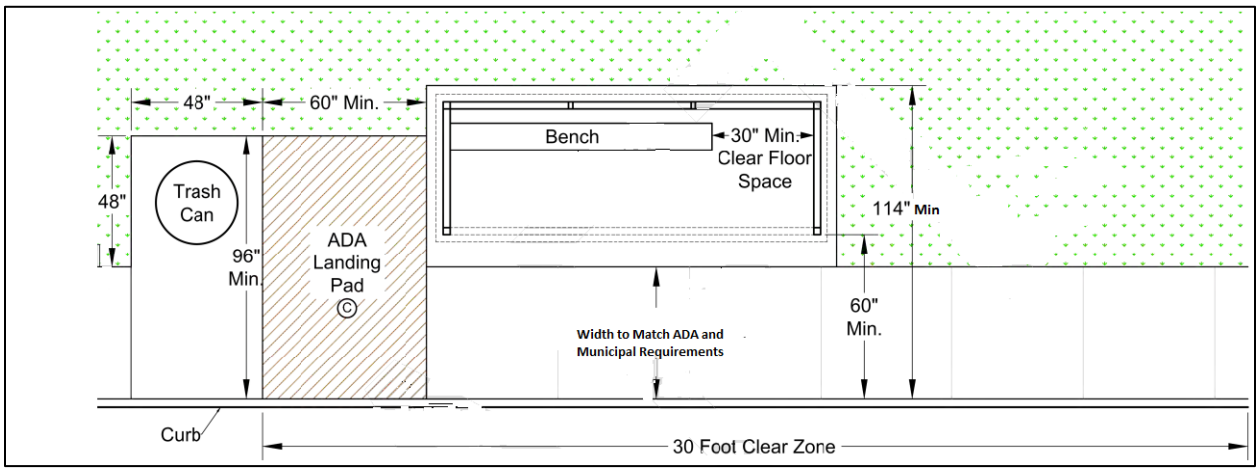

Figure 22: Bus Shelter with Adjacent Sidewalk and ADA Landing Pad Next to Shelter.
Source: COTA Bus Stop Guidelines

The design of passenger shelters should take into account the following:

- Anchor seating securely to concrete accessory pad or shelter.
- Provide seating inside the shelter.
- Provide additional waiting area near shelter, if required.
- Material should be durable and resistant to vandalism and weather conditions.
- Transparent sides for greater visibility; panels should be resistant to fading and clouding.
- Should accommodate at least one wheelchair.

5.8.4. Accessibility Factors

No matter how a shelter is placed, all shelters must meet both local jurisdictional accessibility requirements and ensure adequate access and maneuverability for those with mobility limitations. To ensure bus stop and shelter access for customers, the following should be taken into account:

- Provide a minimum clear floor area of 30 inches wide by 48 inches deep (including knee and toe clearance) entirely within the perimeter of the shelter to permit wheelchair access.

- Provide for a forward or parallel wheelchair approach with open side of shelter adjoining a pedestrian access route or another clear space.
- Provide for wheelchair maneuvering space:
    - Forward approach: a minimum of 36 inches wide where depth exceeds 24 inches.
    - Parallel approach: a minimum of 60 inches wide where depth exceeds 15 inches.
- Unobstructed access to customer information (i.e., area map, audio push button) on shelter.

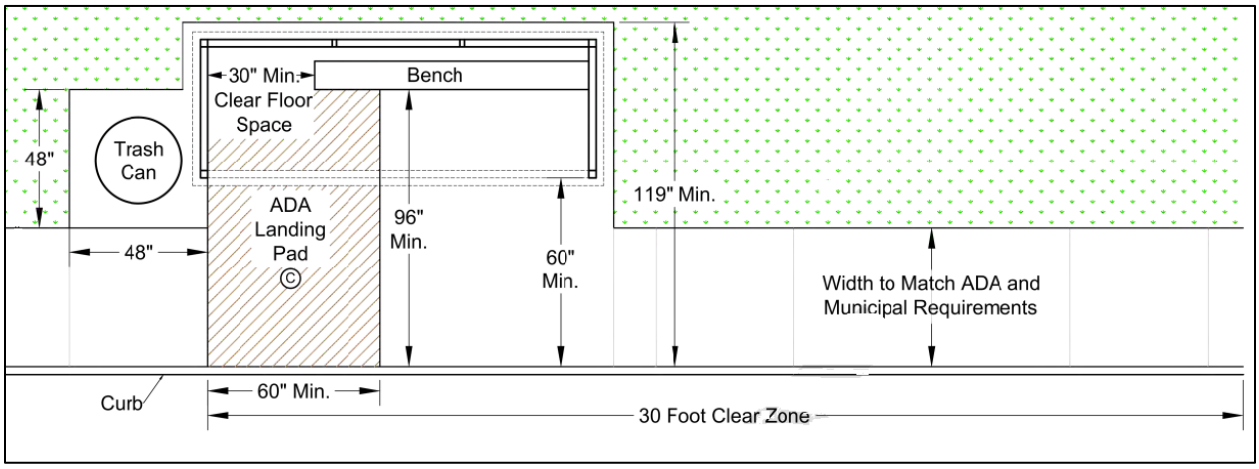

Figure 23: Bus Shelter with Adjacent Sidewalk and ADA Landing Pad in front of Shelter.
Source: COTA Bus Stop Guidelines

5.9. Trash Receptacles

5.9.1. Introduction

Trash receptacles provide a place for trash disposal and improve the appearance of a transit stop. Trash receptacles may not be needed at every transit stop, especially those with low ridership. It is important to properly maintain the receptacles and the trash collection. Figure 24 illustrates an example of SORTA trash Receptacle.

Figure 24: Example of SORTA Trash Receptacles

5.9.2. Usage Factors

SORTA requests from local municipalities to place trash receptacles at most bus stop locations with shelters, at high-ridership stops, and at locations where litter has become problematic SORTA places trash receptacles at its own transit centers. Figure 25 provides diagram with trash can.

5.9.3. Design Factors

The receptacles should reflect other publicly owned and maintained trash receptacles in the local jurisdiction and along the corridor. The receptacles should be anchored securely to the ground to reduce unauthorized movement.

5.9.4. Accessibility Factors

Trash receptacles should be installed where they do not create an obstruction or interfere with the accessibility of the bus stop or the adjacent sidewalk including:

- ADA landing pad area.
- Access to posted information.
- Access to shelter or information/maps displayed on shelter.
- Access to audio push buttons for real time bus information (where applicable).

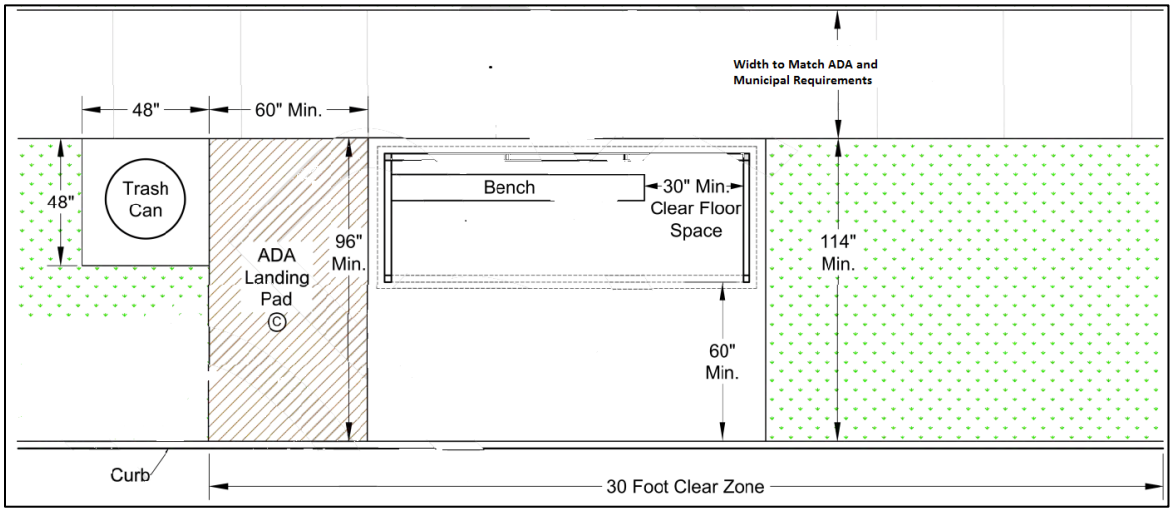

Figure 25: Bus Shelter with Setback Sidewalk and ADA Landing Pad next to Shelter.

5.10. Shelter Maps Display Boxes

5.10.1. Introduction

SORTA bus shelter maps display boxes are attractively designed to display helpful passenger information in a concise layout. Information posted may include:

- Maps
- Fare information
- System information
- Other general information

Figure 26 represents an example of SORTA shelter map display boxes.

Figure 26: Example of SORTA Shelter Map

5.10.2. Usage Factors

Display boxes are currently at some key SORTA transit locations.

5.10.3. Design Factors

The display boxes are typically bolted to the shelter. Ideally, display boxes should be designed to fit and blend with the overall design of and structure of the shelter.

5.10.4. Accessibility Factors

As with all passenger information at a bus stop, safe and easy access needs to be ensured. Access to the information should be cleared of all obstructions.

5.11. Bicycle Racks

Bicycle racks and parking facilities are increasingly used to accommodate commuters who use bicycles to access transit but prefer not to use on-board bike racks. Bicycle parking facilities discourage the practice of locking bicycles onto bus facilities or onto adjacent property. SORTA will incorporate bicycle racks into the design of SORTA owned facilities such as park-and-rides and transit centers when developing or renovating these locations. Municipalities and

other parties may install bicycle racks near bus stops, as long as they do not obstruct or interfere with the accessibility of the stop or adjacent sidewalk. Bicycle racks should never be placed on the wheelchair landing pad, within the shelter, or blocking access from the shelter to the boarding area or access to the sidewalk network. Bicycle racks should conform to municipal standards. Figure 27 illustrates an example of bicycle racks.

Figure 27: Example of Bicycle Racks

5.12. Vendor Boxes

Vendor boxes, also referred to as newspaper boxes, can be an added convenience to customers. Vendor boxes are generally found at locations where there is a high level of pedestrian activity. Similar to other street furniture, vendor boxes should be placed so that they do not obstruct the sidewalk or ADA landing pad or interfere with passenger access to the bus, shelter, or patron information. Vendor boxes are not permitted to be located on SORTA infrastructure. Vendor boxes in violation of these guidelines may be removed or relocated. The use of vendor box "corrals" or fixed modular vendor boxes is encouraged in order to ensure that vendor boxes are placed and remain in suitable locations. Figure 28 represents examples of vendor boxes.

Figure 28: Example of Vendor Boxes

5.13. Landscaping

Shade trees and landscaping, such as grass and shrubs, can enhance the environmental comfort and aesthetics of a transit center. Street trees can act as a safe buffer between automobile and pedestrian traffic. Furthermore, trees shade transit customers from the sun, and protect them from light rain. Trees should be pruned to allow 12 feet minimum vertical clearance from the surface of the travel way to allow buses to pass without obstructions.

Additional shrubs and landscaping will further shelter passengers from inclement weather. Typically, tree branches that extend into the roadway should be trimmed back at least 3 feet from the curb to avoid damage to vehicles or trees. In order for bus drivers to see passengers, and for passengers to feel safe at the bus stop, there should not be tall, dense, or overgrown landscaping in the immediate vicinity of the bus stop. Low growing shrubs, ground cover, shade trees and drought- tolerant plants are preferred. Finally, ground cover between the curb and the back of the waiting area should not exceed 2 feet in height. Figure 29 represents an example of street trees.

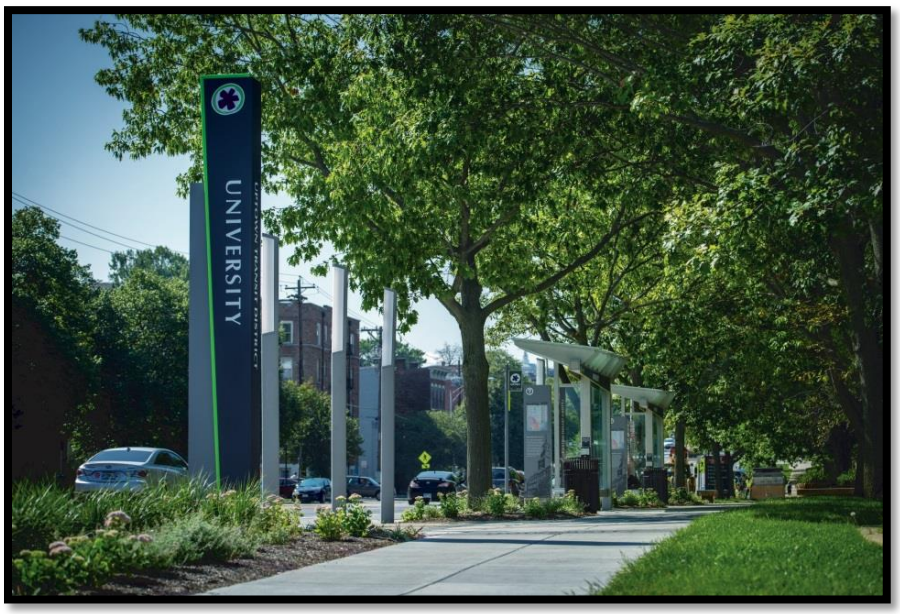

Figure 29: SORTA Bus Stop in Clifton, Ohio

6. PROCESS FOR DETERMINING ADDITION OR REMOVAL OF AMENITIES

The purpose of the flowchart (**Error! Reference source not found.**) is to provide a clear process that SORTA's staff an follow when making a decision on whether to add or remove an amenity. By following a standard process, SORTA will maintain consistency in deciding on placement of amenities while at the same time ensure equal evaluation and treatment of all requests for amenities. The process for adding or removing an amenity may be triggered by either a request from the public or as part of service changes.

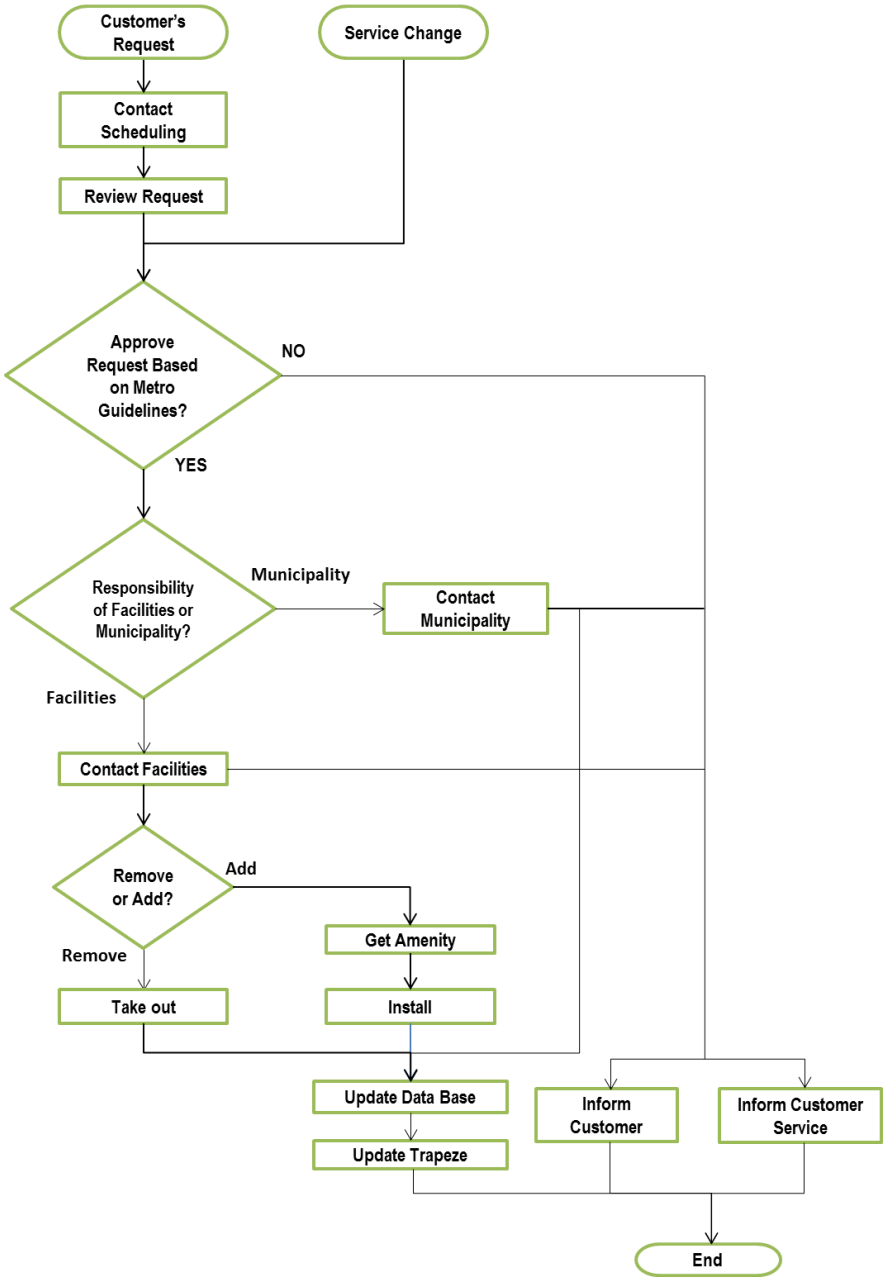

Figure 30: Process for Determining Addition or Removal of Amenities

7. ROADWAY DESIGN FOR TRANSIT VEHICLE USE

Roadway and intersections with bus traffic and bus stops should be designed to accommodate the size, weight, and turning requirements of buses. The safety and operation of a roadway improve when these elements are incorporated into the design. SORTA's bus fleet consists of buses of various sizes, and the roadway should be designed to accommodate the maximum measurements of SORTA's buses.

The maximum height of SORTA's current fleet is 11 feet; the maximum width (including the mirrors) is 9 feet 10 inches; and the maximum length is 42 feet. Additionally, SORTA owns five 60-foot articulated bus models. These buses will exhibit different facility requirements due to their increased length and altered door placement. It is recommended that developers always contact SORTA during the project planning process in order to receive more detailed vehicle fleet information as well as general plan reviews. Table 10 illustrates the dimensions of the current SORTA fleet.

Table 10: SORTA Fleet

Year	Mfg & Model	Length	Actual Measurements			Turning Radius		
		Manufacturer Advertised Length	Height	Width	Length	Radius Over Bumper	Radius Over Outside Tire	Radius Over Inside Tire
2002	Gillig Phantom	40 ft.	10'	9' 10"	41'	44' 11"	40' 4"	33' 7"
2004	Gillig Phantom	40 ft.						
2006	Gillig Low Floor	40 ft.	10'	9' 10"	41'	46' 2"	41' 9"	35' 2"
2008	Gillig Low Floor	40 ft.						
2008	New Flyer D40LF (SR1289)	40 ft.	10'	9' 10"	42'	44'	40' 4"	33' 7"
2008	New Flyer D40LF (SR1290)	40 ft.	11'	9' 10"	42'			
2009	New Flyer D40LF (SR1336)	40 ft.	10'	9' 10"	42'			
2009	New Flyer D40LF (SR1418)	40 ft.						
2009	New Flyer D60LF (SR1354)	60 ft.	11'	11'	62'	42' 6"	40'	33'
2010	New Flyer DE41LF (SR1437)	40 ft.	11'	9' 10"	42'	44'	40' 4"	33' 7"
2010	New Flyer DE30LFR (SR1438)	30 ft.	11'	9' 10"	32'	30' 4"	25' 9"	18' 11"
2011	New Flyer DE40LFR (SR1567)	40 ft.	11'	9' 10"	42'	44'	40' 4"	33' 7"
2012	Gillig Low Floor	40 ft.	10'	9' 10"	41'	46' 2"	41' 9"	35' 2"
2013	Gillig Low Floor BRT Plus	40 ft.	11'	9' 10"	41'			
2013	Gillig Low Floor	40 ft.	10'	9' 10"	41'			
2015	Gillig Low Floor	40 ft.						
2015	Gillig Low Floor	40 ft.						
2016	Gillig Low Floor	40 ft.	10'	11'	41'			
2018	Gillig Low Floor	40 ft.						

7.1. Bus Pads

Roadway pavements need to be of sufficient strength to accommodate repetitive bus axle loads of up to 25,000 pounds. Exact pavement designs will depend on site-specific soil conditions. Areas where buses start, stop, and turn are of particular concern because of the increased loads associated with these activities. Using reinforced concrete pavement pads in these areas reduces pavement failure problems that are common with asphalt. The pad should be a minimum of 11 feet wide (12 feet desirable) with a pavement section designed to accept anticipated loadings. The length of the pad should be based on the anticipated length of the bus that will use the bus stop and the number of buses that will be at the stop simultaneously. SORTA should be consulted to determine the number of buses expected to arrive or dwell at a bus stop jointly. Figure 31 includes an example of concrete bus pad.

Figure 31: Example of Concrete Bus Pad

7.2. Lane Width

A traffic lane used by buses should be wide enough for a maximum bus width of 10'-6" including mirrors and be designed to permit adequate maneuvering space and to avoid sideswipe accidents. When a bicycle lane and bus stop are both present, an operator must be able to see cyclists in both directions while approaching the stop. To accommodate transit vehicles on both public and private roadways, SORTA recommends lane widths of 12 feet or more to allow for proper bus maneuverability.

7.3. Roadway Grade

Selection of the roadway grade is related to topography and cut-and-fill material consideration. Typically, the maximum grade for 40-foot buses is between 6 and 8 percent. The recommended grade change between a street and a driveway is less than 6 percent. SORTA recommends that changes in roadway grade should be gradual so that buses can easily negotiate changes with adequate ground clearance for passenger safety and comfort.

7.4. Curb Height

An appropriate curb height for efficient passenger service operation is between 6 and 9 inches. If curbs are too high, the bus will be hindered from moving close to it and the operations of a ramp could be negatively affected. If curbs are too low or not present, elderly persons and passengers with mobility limitations may have difficulty boarding and alighting.

7.5. Turning Radii

The radius of street intersections should be designed to allow buses to turn at appropriate operating speeds without "jumping" the curb line or encroaching into adjacent traffic lanes. Although the curb radius and other roadway design features of municipal streets are regulated by the local municipality, the typical turning radius of SORTA's vehicles should be considered, as it will affect the ability of SORTA to operate safely on roadways with minimal intrusion into other lanes of traffic. Private developments that are intended to receive bus service should design facilities that will accommodate smooth and easy turning movements by SORTA's vehicles. Such developments should be designed to accommodate a minimum 50 feet outside corner radius and a minimum 30 feet inside corner radius. Figure 32 shows appropriate curb radii values for transit vehicles and varying lane configurations.

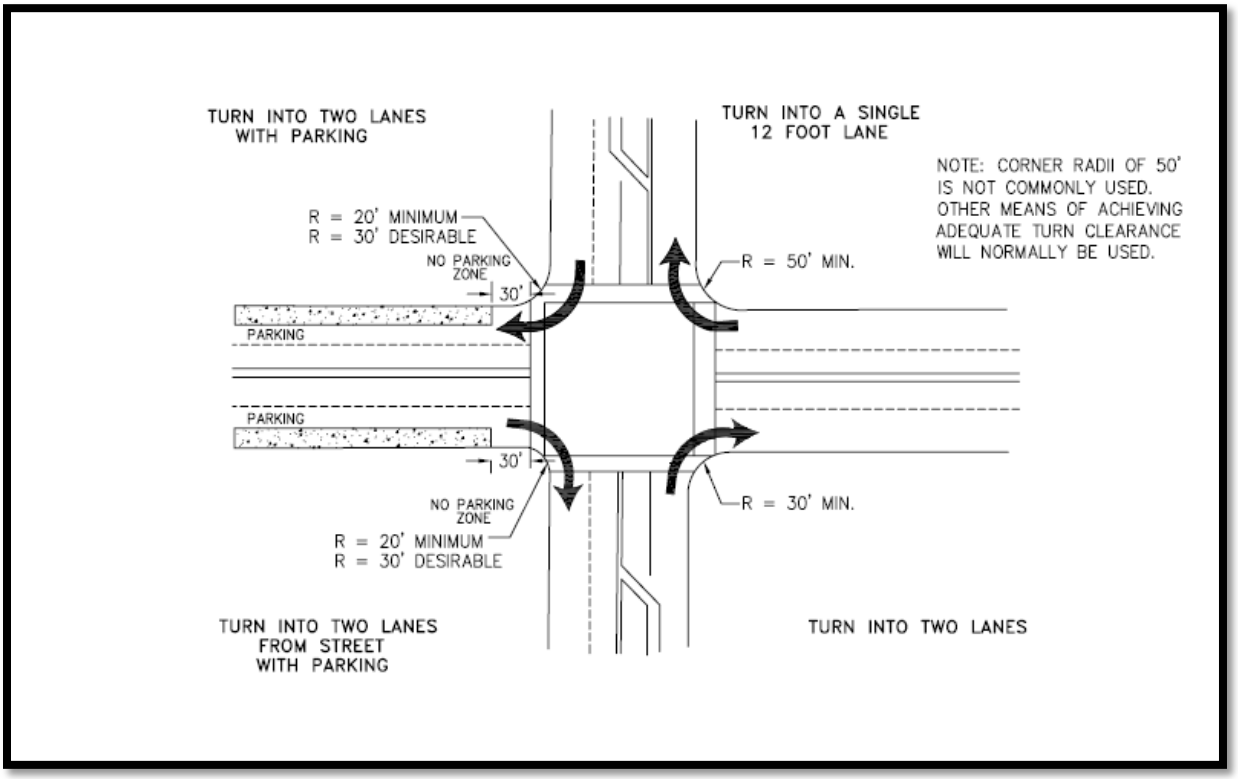

Figure 32: Represents Curb Design for Bus Turning.
Source: Darnell and Associates INC.

8. TRANSIT-ORIENTED DEVELOPMENT (TOD)

The land use development and transportation system patterns of a city or neighborhood are closely linked and strongly affect the efficiency and viability of public transportation. TOD is aimed to increase public transport ridership by reducing the use of private cars as well as encouraging transit agencies to provide transit service. According to Institute for Transportation and Development Policy, “Transit-oriented development is often defined as higher-density mixed-use development within walking distance or a half- mile of transit stations.” TOD also provides superior walking and bicycling facilities so that residents can easily travel between their homes, shopping, work, and transit stations. Overall, TOD is intended to create more vibrant and convenient communities for people to live and work, where car ownership is not a necessity and household transportation costs can be kept low. Further, TOD provides affordable housing opportunities that are supported by lowered household transportation cost.

9. PUBLIC INVOLVEMENT CONCERNING BUS STOPS AND INPUTS

Bus stops as public spaces are as much a part of a community as streets, pathway, parks and plazas. SORTA encourages communities and citizens to recognize their value and to build a sense of ownership. SORTA also strives to keep passengers well-informed of any changes that will affect service, including changes to bus stops. SORTA may remove bus stops for a number of reasons including better alignment with bus stop spacing guidelines, route realignments, safety issues, construction projects, or changes in land use. Whenever possible, it is SORTA's policy to post signs alerting customers and explaining the service change, including contact information for Customer Relations on all bus stops that are to be removed or have a major change in service prior to the change taking effect.

In circumstances where SORTA has the ability to control the movement or removal of a bus stop, SORTA may seek additional public input concerning bus stop changes and will post signs several weeks before the change and again when a final decision is made. SORTA also strives to notify the public about proposed and final bus stops at public hearings and through information posted on our website and social media. SORTA encourages and welcomes input from the public about bus stops. All comments, questions or concerns including requests for new stops, shelters or other amenities, concerns about bus stop placement, or feedback about proposed stop removals should be directed to SORTA Customer Relations.

10. REERENCES

Arlington County-Bus Stop Standards-
http://www.commuterpage.com/TDM/pdf/ArlingtonCoBusStopStandards.pdf
Arlington County (VA)- Bus Stop Design Standards (2002)

AC Transit Bus Stop Policy-
http://www.actransit.org/aboutac/bod/policies/pdfs/Policy508- Bus Stop Policy.pdf
Alameda- Contra Costa Transit District (CA) Board Policy 508- Bus Stop Policy (2005)

COTA Bus Stop Design Guide-
https://www.cota.com/bus-stop-design-guide/
Central Ohio Transit Authority (OH) – Bus Stop Design Guide (2012)

Grand Junction Transit Design Standards-
http://www.gjcity.org/CityDeptWebPages/PublicWorksAndUtilities/TransportationEngineering/TEFilesThatLINKintoDWStoreHere/TEDS/TRANSITREGS.pgf
Grand Junction/Mesa County Metropolitan Planning Organization (CO)- Transit Design Guidelines (2003)

OCTA Policy-
http://www.octa.net/temp/OCTA Bus Stop Safety and Design Guidelines.pdf
Orange County Transportation Authority (CA) - Bus Stop Safety and Design Guidelines (2004)

Palm Tran- Transit Design Manual-
http://www.co.palm-beach.fl.us/palmtran/library/TRANSIT DESIGN MANUAL.pdf
Palm Beach County, Florida Transit Design Manual (2004)

TRCRP Report 19- http://trb.org/news/blurb_detail.asp?id=2597
This Transit Cooperative Research Program report titles “Guidelines for the location and Design of Bus Stops” was prepared by the Texas Transportation Institute at Texas A&M University (1996)

Washington Metropolitan Area Transit Authority (WMATA)
https://nacto.org/docs/usdg/design_and_placement_of_transit_stops_kfh.pdf
Washington D.C. Area Design and Placement of Transit Stops (2009)